BRITISH COLUMBIA

Ministry of Forests

Revenue Branch

MEMORANDUM

File: 308-07-CRUI

March 19, 1999

To: Holders of the *Cruising Manual*

From: Maarten Prinsze
Cruising Policy Forester
Revenue Branch

Re: *Cruising Manual*

The *Cruising Manual* is amended and will be available on the Internet on April 1, 1999. The address is http://www.for.gov.bc.ca/revenue/manuals/cruising/index.htm. A copy can be downloaded from this file.

A printed copy of the manual or amendments is also available from Crown Publications, 521 Fort Street, Victoria, British Columbia, V8W 1E7 (telephone 250-386-4636, facsimile 250-386-0221).

Comments or questions about the manual should be referred to Maarten Prinsze, Cruising Policy Forester, Revenue Branch at 250-387-8357 or Don Rorison, Cruising Projects Specialist, Revenue Branch at 250-356-7674.

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BRITISH COLUMBIA Ministry of Forests

MANUAL REVISION TRANSMITTAL

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Cruising Manual

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MANUAL CO-ORDINATOR
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Director, Revenue Branch

Please make the following changes to your copy of the above Ministry manual. Please insert the following specified pages and **file this notice** immediately after the Amendments Tab.

ACTION (Remove/Insert)	(VOL.) CHAPTER-SECTION-SUBJECT	PAGE(S)	COMMENTS
	TABLE OF CONTENTS		
INSERT	Title Page		
INSERT	Annual Highlights	All	
INSERT	Table of Contents	All	
INSERT	Chapter 1	All	
INSERT	Chapter 2	All	
INSERT	Chapter 3	All	
INSERT	Chapter 4	All	
INSERT	Chapter 5	All	
INSERT	Chapter 6	All	
INSERT	Chapter 7	All	
INSERT	Chapter 8	All	
INSERT	Chapter 9	All	After Chapter 8 and before Tables
INSERT	Tables	All	
INSERT	Appendices	All	
INSERT	Forms	All	After Appendices and before Glossary
INSERT	Glossary	All	
INSERT	Index	All	
INSERT	Transmittal Sheet		After Amendments tab

REVENUE BRANCH

Cruising Manual

BRITISH COLUMBIA

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Annual Highlights

1999 Change Descriptions

The *Cruising Manual* is available on the Internet – site:

http://www.for.gov.bc.ca/revenue/manuals/cruising/index.htm

Section	Highlight
Section 2.1.1 – Scale Based Stumpage Assessment	Section revised to clarify clearcut and partial cut sampling objectives. All measure and count plot data originating from the harvest area must be used in the compilation. Minimum 1 measure plot per hectare up to sampling error and count plots may be used at a maximum 1:1 ratio. Count plots containing species not in measure plots in the same timber type must be converted into measure plots. Count plots may be used in partial cut cruises provided that sampling error is achieved with the full measure plots. Maximum grid spacing increased to 250 m for cruises greater than 250 ha.
Section 2.1.1.3 – Comparative Cruises	The following situations are candidates for comparative cruising: • cutting authorities 5 000 m^3 or less, • a negative indicated rate of minus $10.00 or lower (low value timber), and • timber is unsafe to cruise such as heavy blowdown or where the timber is in imminent danger or being lost or destroyed if not removed immediately. The inventory polygons for the comparative and parent cutting authorities must be the same. The parent data will be used (minimum of 6 measure plots per type) for the cruise parameters of the comparative cruise for each timber type.

Section	Highlight
Section 2.2.2.3 – Cruising Patch Cuts	The following sampling procedure is recommended for cruising patch cut, patch cut with reserves and group selection silviculture systems: • overlay a 100 m grid on the cruise plan map after the patch cuts are accurately located within the block and mapped, • increase or reduce the grid interval in multiples of 5 m until a minimum of one plot per hectare is obtained in the harvest area, • individual patch cut falling corners may be used as tie points for the cruise plots with the bearing and distance to each plot documented in the cruise plan, • sampling must be confined to the harvest area, therefore use border plots if timber outside the boundary influences a full plot.
Section 2.2.2.4 – Moving Plots	Moving plots will only be permitted in multiples of 25 m if documented in the cruise plan for: 1. Patch cut silviculture systems to meet sampling intensity. 2. Very irregular shape blocks to ensure that whole sample area is eligible for sampling.
Section 2.7.3.1 – Forest Typing	Two methods of stratification are recognized: 1. Pre-stratification with photo interpretation or forest cover polygons supported by type line verification documented in the field notes. 2. Stratification in the field by species, age and height class and volume with supporting documentation in the field notes. Post field stratification to improve sampling error is not permitted. If non-timber types are stratified out of the cruise area, they must be excluded from sampling.

Section	Highlight
Section 3.1.5 – Slopes	Record the most severe slope reading in the plot from plot centre to a point 15 m horizontal distance within the harvest area. Plot slope must be recorded in count plots.
Section 3.4.1.7 – Border Plots	Plot centres that fall outside the harvest area or on felled rights of way will be dropped. Border plots will be used when the plot centre falls on or adjacent to timber type lines or harvesting boundaries.
Section 3.5.3.1 – Leaning Trees	Measure the tree length of trees that are leaning more than 10 degrees. Use the Pythagorean right triangle formula to calculate the length. The degree of lean will not be a check cruising concern, but the tree length will be considered the true tree height.
Section 3.5.6.2 – Tree Class 3	Phrasing clarified to state that trees with green or red needles are considered live and trees with grey or no needles are dead. Spruce and pine added to the species that decay resistant. A reference added to a new Table 19 to assist in the determination of 50 percent sound wood content.
Section 3.5.7 – Quality Remarks	Required for coastal cutting authorities only.
Section 3.6.2.1 e. – Check cruising	Damage – all codes will be collected and compiled. Any damage type that effects risk group (all) or appraisal parameters (fire/blowdown) will be subject to the following check standards: • no more than 5 percent of all trees can have a missing or extra damage code, • missing or extra damage codes that result in a risk group change or appraisal parameter variation will contribute to the number of incorrectly called pathological indicators and risk groups, and • age in 10's, 13 and 14 must be verified in connection with the tree classes since those stems will be reported in the compilation with the second growth percent.

Section	Highlight
Section 3.6.3 – Allowable Non-Sampling (Measurement) Errors	Individual checked plot volumes (7 percent), total volume for checked plots (5 percent) and LRFs (1 percent) should be compiled on the most recent cruise compilation software for the adjudication of marginal pass/fail check cruises.
Section 4.6.1 – Summary of Required/Optional Reports	005b – Cruise stats – required hard copy. 006/007 – Stand/Stock and Extended – electronic or hard copy upon request. 008 – Volume and LRF – required hard copy. 006/007/009 Damage – required hard copy upon request. 011 – Plot Summary – required hard copy.
Tally Card – Card Type 2 – Position 21 and 22 – Age in 10's – Coast	Trees that are 141 years plus in a plot with age in 10's of 13 or 14 must be recorded as tree class 5 or 7 trees, as they must not contribute to the second growth percent.
Tally Card – Card Type 2 – Position 48 – Live Limb (Coast)	The 5 m log position where quality changes from: • no knots to knots or knot indicators, • from small knots to large knots, or • well spaced to excessive knots.
Tally Card – Card Type 2 – Positions 50 and 51 – Stub (Coast)	Clarify the alignment of the 4 quarters in the first 5 m must align with the 4 quarters in the second 5 m.
Tally Card – Card Type 2 – Position 60 – Root Rot	Root rot codes: 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 resinosus.

Section	Highlight
Tally Card – Card Type 2 – Positions 61 to 63 – Damage	All damage types will be compiled in a single cruise. Where multiple damage is compiled for a single tree, the most severe damage type for net volume will be compiled. If two damage types have equal effect on risk group for a single tree, then the precedence is Blowdown/Fire/Insect. All damage percents will be reported in the 015, Harvesting Method Reports.
Map Area Statement – Card Type A – Positions 2 to 7	Add new tenure type – Community Forest Agreements. Allow for tenure type – Timber Licence.
Map Area Statement – Card Type A – Positions 66 to 80	Add positions for "Cruised By" (Agency or Cruiser).
Section A.5.2.8 – Dead or Broken Top	Clarification of the fork/broken top rule – record forks that: • originate at a diameter larger than the minimum merchantable diameter, • do not contain a merchantable log (3 m long and a top diameter greater than minimum utilization), • do not show any evidence of broken wood at the junction of the fork. The 1998 manual provided an interpretation that would have resulted in a dead or broken top call.
Section A.9.1.3 – Insect Codes	Statement added for clarification. Any evidence of a bark beetle attack in a green tree will result in a green attack code.
Section A.9.2.1 – Fire Damage – Light	Statement added – trees with bark scorching that occurred 5 or more years previously to cruising do not qualify for fire damage coding.
Section A.9.2.3 – Fire Damage – Heavy	Add – multiple deep checks in trees less than 30 cm also qualify for heavy damage.

Section	Highlight
Section A.9.2.3 (continued)	Definitions: Merchantable Section – is the section of the stem between 30 cm stump height and the merchantable top diameter. Charring – destruction of wood by fire. There must be identifiable damage to a surface area greater than 100 cm^2. Shallow Charring – charring > 100 cm^2 and less than a third the radius of the tree. Extensive Shallow Charring – charring in the bottom third of the tree that has 3 or more areas at least 100 cm^2 of exposed and charred wood fibre. Deep Charring – charring is deeper than a third of the radius of the tree. Multiple Deep Checks – where more than 1 check is deeper than a third of the radius of the tree.
Section A.9.3.2 – Sampling Falldown	1. For uprooted trees, assign the tree class and record the pathological indicators as normal. Do not record Dead or Broken top if: • recent breaks < 5 years, and • breaks in the first third of the tree. 2. Do not record a dead or broken top in the middle third for standing trees that have broken in the middle third less than 5 years previous to cruising.
Chapter 9 – Regional Guidelines	New chapter.
Forms	New chapter. The following forms are now available: • Provincial Cruise Plan, • Provincial Cruise Plan and Map Check List,

Section	Highlight
Forms (continued)	• Office Check of Field Cruise Data, • Provincial Field Check Cruise Summary, • Provincial Compilation Check of Field Cruise Data, • Provincial Compilation Check.

Forest Service (FS) forms are available at the following site:
http://www.for.gov.bc.ca/isb/planning/forms/

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Introduction 1

This manual outlines the cruising procedures to be used for stumpage appraisal purposes for timber on the Crown lands of British Columbia. It supersedes previous manuals and instructions.

The sale of Crown timber is a business proposition and both the buyer and the Ministry of Forests (seller) must know the quantity and the quality of timber being sold. The cruise provides the essential data for determining stumpage rates, for establishing conditions of sale and for planning of the logging operations by the licensee.

In order to ensure that all purchasers of Crown timber are being treated equally and equitably, the manual sets out the minimum cruising standards that must be met. These include specifications for the statistical design of the cruise, the accuracy of field measurements and standard compilation procedures.

Implementation of the procedures and standards is a regional responsibility and the manual provides for sufficient flexibility that special circumstances can be accommodated. The appropriate Regional office should be consulted periodically for any revisions to the manual, for copies of Regional Guidelines, or the issuance of specifications for cruising salvage sales, minor product sales, etc. Refer to Chapter 4 of the *Coast and Interior Appraisal Manuals* for further guidance.

The reliability of any cruise is based on statistical concepts and the cruise provides an estimate of the volume on the area cruised. The reliability of this estimate is a function of the intensity of sampling, the uniformity of the timber on the area cruised and the degree of fit of the volume equation and loss factors to the particular stand. It is for these reasons that two cruises of the same stand, carried out to the same standard may yield different volumes. For administrative purposes it is assumed that the calculated volume is the true volume.

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Cruise Design 2

2.1 Cruise Objective

The objective of the cruise is to obtain an estimate, to a specified degree of accuracy and with a specified level of confidence, of the volume of timber on the area cruised. The area cruised may be one or several cutting blocks that will be covered under one cutting permit and subject to one appraisal. In order to achieve the required accuracy, each cruise must be planned and approved by a forest officer prior to the field work being undertaken (see Section 3.6.4). Unless special circumstances indicate otherwise, a systematic design for plot layouts must be used.

The cruise plan and the accuracy requirements are affected by the timber appraisal.

1. For scale-based sales, the cruise provides the basis for determining the stumpage rate while the amount billed is based on the scale.

   For cruise-based sales, both the estimate of the stumpage rate and billing are based on the cruise.

2. In special cases, such as salvage sales and right-of-way sales, cruising standards may be set by the Regional Manager in accordance with Chapter 4 of *Coast and Interior Appraisal Manuals*.

2.1.1 Scale-Based Stumpage Assessment - Timber Sales or Cutting Permits

General Conditions:

- all species listed under Section 6.3.2 of this manual shall be cruised,
- the minimum tree sizes shall be as specified in the Ministry of Forests *Timber Utilization Policy – Coast and Interior*,
- all references to "plots", "cruise plots", and "measure plots" must be interpreted as Full Measure Plots unless specified otherwise,
- Sampling Error objective is based on full measure and count plots (unless specified otherwise),

- all plots must originate from the harvest area. Plots in areas 100 percent reserved from cutting must not be used in the compilation. If an area is reserved after cruising, the sampling error requirements may be waived if it is evident that the sampling error objective would have been achieved prior to the placement of the reserve, and

- all measure and count plot data originating from the harvest area must be used in the cruise compilation.

Sampling Error Objective:

1. The scale-based cutting authorities sampling objective is 15 percent at 2 standard errors based on the total stand (before reduction). Where the 15 percent sampling error is achieved, the minimum number of trees per plot and the number of plots listed below are *recommended*, but it is not a check cruising concern.

2. The minimum number of measure plots is 1 per hectare unless sampling error is achieved.

3. Count plots that contain tree species that have not been measured in a full measure plot in the same timber type must be converted to measure plots.

4. The maximum grid spacing for cutting authorities up to 250 ha is 200 m and for cutting authorities greater than or equal to 250 ha is 250 m.

Sections 2.1.1.1 to 2.1.1.3 are subject to the requirements listed under Section 2.1.1 unless otherwise stated.

2.1.1.1 Clearcutting Sampling Requirements

1. Clear cutting is defined as: the area clearcut is 90 percent or more of the total net cruise area.

2. The required average minimum number of trees is 4 per plot excluding dead and live useless trees.

3. For cruises that meet the sampling objective, a maximum measure plot/count plot ratio of 1:1 is permitted.

4. Silviculture systems that qualify for clearcutting specifications are:

   a. clearcut,

b. seed tree,

c. coppice (deciduous only),

d. Riparian Management Zones (RMZ) which will be partially cut and represent less than 10 percent of the cruise area, and

e. group selection where the patch cuts average > or = 1 ha.

2.1.1.2 Partial Cutting Sampling Requirements

1. Partial cutting is defined as: the area clearcut is less than 90 percent of the total net cruise area.

2. Count plots may be used provided that the sampling error is achieved based on the full measure plots only.

3. The required average minimum number of trees is 6 per plot excluding dead and live useless trees.

4. All plots must originate from the harvest area. Areas where no cutting is prescribed such as RMZ's with 100 percent retentions are to be excluded from the cruise.

5. Silviculture systems that qualify for partial cutting specifications are:

   a. shelterwood,

   b. selection,

   c. patch cut, where the patches average < 1 ha,

   d. patch cut with reserves,

   e. intermediate cuttings, and

   f. any silviculture system that prescribes "faller selection" *must* meet the partial cutting sampling standards regardless of the partial cut percent.

2.1.1.3 Comparative Cruises

Comparative cruising is intended for cutting authorities where:

- the cutting authority volume is 5 000 m^3 or less, subject to the requirements of Section 6.2 of the *Coast Appraisal Manual* and *Interior Appraisal Manual*, or

- the timber is unsafe to cruise such as heavy blowdown or where the timber is in imminent danger of being lost or destroyed if not removed immediately, or
- the indicated stumpage rate will be negative $10.00 per cubic metre or lower.

Requirements:

1. A cruise plan and map must be submitted to the District Manager showing the blocks and parent cutting authority used for comparison including documentation to verify that the indicated stumpage rate will be minus $10.00 m^3 or lower. The parent cutting authority is defined as the cutting authority that the cruise information is borrowed from.

2. The cruise plan must include the following:
   - a stratified map based on the best available inventory maps (i.e., forest cover polygons) that verify that the same timber types exist in the parent and comparative cutting authorities. The same timber types may result in borrowed cruise information originating from more than one cutting authority,
   - there must be at least 6 measure plots for each timber type from the parent cutting authority, and
   - the parent cutting authority must originate from the same local drainage.

3. The District Manager may require that site specific data is provided to verify the comparability of the cutting authority with the parent cutting authority.

4. The cutting authority cannot be a competitive sale.

5. Prior to the District Manager giving approval to use comparative cruise data, they must consider the following:
   - appraisal thresholds (e.g., 0.2 m^3 per tree limit),
   - allowable annual cut thresholds (e.g., partition wood), and
   - silviculture prescription.

6. As directed by the District Manager, the licensee may be required to verify the accuracy of the comparative cruise with a submission of a cruise and scale comparison.

2.1.2 Cruise-Based Stumpage Assessment - Timber Sales or Cutting Permits

For cruise-based sales, sufficient samples must be established to meet the following sampling error objectives:

1. Plus or minus 8 percent sampling error at 2 Standard Errors (S.E.) for all stands except in 2. below. Count plots may be used provided that a plus or minus 12 percent sampling error at 2 S.E. is achieved with measured plots alone.

2. Proposed cut areas where the stands are comparatively very valuable or patchy must be reviewed by the Regional Revenue Manager, or his designate, to determine whether the above rules should be accepted or the number of sampling points increased.

3. Refer to the *Provincial Cruise Based Policy* at the following Internet site:

   Ministry of Forests Home Page

   http://www.for.gov.bc.ca/tasb/manuals/policy/resmngmt/rm8-16.htm

2.1.3 Standards for Recruising

A recruise is necessary if any of the following criteria are met or exceeded.

1. If the cruise is of mature timber (>120 years) and 10 years has elapsed since the fieldwork was performed.

2. If the cruise is of immature timber (<121 years) and 5 years has elapsed since the fieldwork was performed.

3. Catastrophic (severe damage) losses have occurred at any time after the field work was performed.

4. Any major amendments are proposed to the original cruise area. Refer to the current *Coast Appraisal Manual* or *Interior Appraisal Manual*, Section 2.3, 2.

5. If cruising Policy changes the way that data is collected and can result in changes to stumpage.

2.2 Types of Cruise

2.2.1 100-Percent Cruise

The Regional Manager may direct that for certain forest stands and valuable species, a 100-percent cruise is required.

2.2.2 Sampling Patterns-General

The prime objective of the cruise of a cutting permit is to obtain an estimate of the volume of timber that will be permitted for harvesting and the sampling design will be based on that criterion. The number of samples required therefore will be determined by the criteria outlined in Section 2.1.

A cruise plan prepared by the licensee must be submitted to and have been approved by the District Office prior to the commencement of field work.

Samples within cutting blocks from previous operational cruises of the area may be used in the sampling plan if they meet the standards set in this manual.

> Referring to the following types of sampling methods, systematic sampling in conjunction with a grid to locate the plots must be used for appraisal type cruises unless permission is granted by the Regional Manager to use one of the other sampling patterns.

2.2.2.1 Systematic Sampling

In systematic sampling, plots are at fixed intervals with a minimum of two full measure plots per timber type. One full measure plot in a timber type is acceptable if falling boundary amendments isolate some plots after cruising. The sampling intensities (hectare per plot ratios) must be consistent and the base sampling grid spacing must be the same for all timber types.

In addition:

1. The cruise grid should be aligned in cardinal directions (i.e., North/South or East/West) unless otherwise approved in a cruise plan, and the grid should be referenced to the point of commencement (P. of C.) using 1/2 of the grid interval.

2. The maximum plot spacing is 200 m. This will ensure adequate coverage of the area for timber typing and tree and terrain information.

3. Where plots must be added to an existing cruise area, they must be positioned in a systematic random way so they cover the entire cruise area. The following method is recommended for adding plots to an existing cruise:

    a. determine the number of additional plots required using the coefficient of variation from the original cruise. Adding 10 percent is recommended for a safety margin,

    b. determine the new grid for the cutting authority area to obtain the additional number of plots required,

c. lay the new grid over the original grid with the new plot that is nearest the original P. of C. plot over top of the original P. of C. plot. Use the same cruise grid orientation,

d. disregard the overlapping plot and locate the new plots on the cruise map, and

e. determine the bearings and distances to the new plots from the nearest original plots. This will reduce the amount of traversing required to establish the new plots.

> The new grid must be submitted with a cruise plan to the Ministry of Forests district office for approval at least 30 days prior to the commencement of field work.

2.2.2.2 Cruising Rights of Way

The following procedure is recommended for cruising road rights of way:

1. Widening existing rights of way - establish border plots at systematic intervals along alternating sides of the right of way using the right of way boundary as the split line. Refer to Section 3.4.1.7 regarding the correct use of border plots.

2. New rights of way - establish rectangular or square fixed area plots at systematic intervals. The plots must cover the entire width of the rights-of-way.

   Variable plots are acceptable provided that a prism basal area factor is used that should not sample trees outside of the rights-of-way and meets the minimum tree count requirements listed in Section 2.1.1.

2.2.2.3 Cruising Patch Cuts

The following sampling procedure is recommended for cruising patch cut, patch cut with reserves and group selection silviculture systems:

- overlay a 100 m grid on the cruise plan map after the patch cuts are accurately located within the block and mapped,

- increase or reduce the grid interval in multiples of 5 m until a minimum of one plot per hectare is obtained in the harvest areas,

- individual patch cut falling corners may be used as tie points for the cruise plots with the bearing and distance to each plot documented in the cruise plan, and

- sampling must be confined to the harvest area, therefore use border plots if timber outside the boundary influences a full plot.

2.2.2.4 Moving Plots

Plots can be moved in the following situations if documented in the cruise plan:

1. Patch cut or group selection cruises to ensure that the sampling intensity can be achieved.

2. Very irregular shaped blocks to ensure that a single strip is not established down the centre of the cruise area. The entire sample area must be eligible for sampling.

Plots may only be moved in multiples of 25 m until the plot centre is inside the cutting area. Border plots must be used if the plot is influenced by the cutting boundary or a timber type line.

2.2.2.5 Probability Proportional to Prediction

"Three P" sampling (Probability Proportional to Prediction) is a sampling technique which randomly selects the sample trees but one basic requirement is that each tree in the entire sale area must be estimated. This method is often used to increase efficiency in comparison to a 100 percent cruise. Three-P sampling is currently being reviewed for potential applications in appraisal cruising.

2.3 Sampling Errors

In timber cruising a complete record of all trees of merchantable size on the sale is seldom practical, so sampling becomes necessary. The object of sampling is to estimate the volume on only a portion of the area, and convert this to a total area basis.

In sampling there are two major sources of error:

Sampling error or errors in quantities of measurements. Sampling error is the difference between results that would have been obtained by a 100 percent cruise and the result that is obtained by a sample cruise. That is they are errors caused by samples not being absolutely representative of the natural variable conditions over the entire area.

1. The sampling error can be calculated and has been set at (Sections 2.1.1 and 2.1.2):

   - plus or minus 15 percent (19 times out of 20) for scale-based sales, and
   - plus or minus 8 percent (19 times out of 20) for cruise-based sales.

2. Measurement error or errors in qualities of measurements.

   The calculated sampling error can be seriously misleading if the basic data is unreliable.

   If reliable volume estimates are to be obtained measurement errors must be controlled. Constant care and checking is required on all direct measurements (see Section 3.6 Check Cruising).

   The population sampled is the cutting unit and, therefore, all samples on which the stand statistics are based must be systematically located within the proposed cutting boundary so that the forest area is adequately sampled.

2.4 Variable-Plot (Prism) Sampling

2.4.1 Plot Sample Size

In the fixed-area plot method of sampling, accurate boundary location is time-consuming and small diameter classes are sampled more intensively than large diameter classes. This occurs because the probability of tree selection is proportional to tree frequency.

"Prism" sampling (also known as "point" sampling, "plotless" sampling or "variable-plot" sampling) overcomes these two disadvantages, since the probability of tree selection is proportional to basal area and the large diameter trees therefore, are sampled with the same intensity as the small diameter trees.

The controlling factors for selecting the prism 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 high sample variance. 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.

Half plots may be used where identified in the cruise plan if the full sweep results in tree counts greater than 10 trees in the plot (excluding dead useless). This procedure must be used consistently throughout the cruise area. When a combination of count and measure plots are used to double sample, the same prism size should be used for the count and measured plots in the forest type.

2.4.2 Prism Sampling

The choice of plot size will influence the amount of sampling required to achieve the sampling error because sampling intensity depends on 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 included and the equation for determining the number of plots required becomes:

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

2.5 Fixed Area Plot Sampling

2.5.1 Fixed Sample Size

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:

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

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

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:

$$n=\frac{t^2 xCV^2 xN}{NxE^2+t^2 xCV^2} where$$

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.

2.6 Statistical Concepts

2.6.1 Probability Factor "t"

The value of "t" used in the above equations depends on the degrees of freedom (number of plots required minus 1 or n-1), and the desired probability. The desired probability has been specified as 2 S.E. or t.05.

Referring to the table of t.05 (Table 3) the probability factors are very close to 2, except for a small number of plots. The first approximation is done using a probability factor of 2. The probability factor for the resulting "n" is then used to calculate a new "n". This process is repeated until "n" (to the nearest whole number) no longer changes.

Calculate the number of 0.1 ha plots required for a sampling error of + 15 percent at 2 S.E. for a 40 ha timber sale with a coefficient of variation (CV) of 40 percent.

$$n=\frac{t^2 xCV^2 xN}{NxE^2+t^2 xC^2}=\frac{(2)^2 x(40)^2 x(40x10)}{(40x10)x(15)^2+(2)^2 x(40)^2}$$

$$n=\frac{6400x400}{90000+6400}=\frac{2560000}{96400}$$

$$=27 plots$$

Referring to the table of t.05 for 27-1 or 26 degrees of freedom, the probability factor is 2.056. Therefore, the new "n" is:

$$n=\frac{(2.056)^2 x(40)^2 x(40x10)}{(40x10)x(15)^2+(2.056)^2 x(40)^2}=28 plots$$

Again referring to the table of t.05 for 28-1 or 27 degrees of freedom, the probability factor is 2.052 and the new "n" is 28 plots. Therefore, 28 plots would be the number used.

2.6.2 Coefficient of Variation (CV)

Coefficient of variation may be difficult to estimate and is unique for each type, and also varies with the standard of utilization, gross or net volume, plot size (CV decreases as plot size increases) and shape, and the pattern of sampling. The coefficient of variation may be estimated as follows:

1. From plots previously measured in the same locality.

2. From plots measured in connection with the pre-examination, silvicultural examination, etc.

3. A general knowledge of the timber types on the sales.

By definition the coefficient of variation is the standard deviation expressed as a percentage of the mean volume. The volume of an individual plot minus the mean volume of a group of plots is termed a residual. The sum of the residuals squared, divided by the number of plots minus one, is the variance and the square root of the variance is the standard deviation. The standard deviation is a measure of the dispersion of the plots about the sample mean.

The standard deviation may be calculated by squaring the residuals with the use of a desk calculator and in practice the following method is preferred:

	Plot #	Plot Volume	Plot Vol Squared	
	1	119	14161	Standard deviation (SD)
	2	130	16900	$=\sqrt{\frac{\left(\Sigma(x^2)-\frac{(\Sigma x)^2}{n}\right)}{(n-1)}}$
	3	79	6241	
	4	215	46225	
	5	46	2116	
	6	223	49729	
	7	164	26896	
	8	317	100489	$=\sqrt{\frac{362145-\frac{2123^2}{16}}{16-1}}$
	9	160	25600	
	10	42	1764	Coefficient of Variation (CV)
	11	77	5929	
	12	105	11025	$=\frac{SD}{mean}x100$
	13	54	2916	
	14	151	22801	
	15	108	11664	$=\frac{73}{133}$ x 100 = 55 percent
	16	133	17689	
	Sum	2123	362145	
	Mean	133		

In prism cruising the volume per hectare is obtained directly, rather than volume per plot. The use of volume per hectare rather than volume per plot in the above calculations is valid.

When advantage cannot be taken of a sample-based estimate, then CV can be roughly estimated using general knowledge of the timber types. The steps involved are:

1. Estimate the range of volumes per hectare likely to be encountered. Convert this to volume per plot for the plot size to be used in the cruise.

2. Divide the range by 4 to obtain an estimate of the standard deviation (4 is suggested since the number of samples required is unknown and it is an average value for 16 or more samples).

3. Estimate the mean sample volume.

4. Divide the standard deviation by the mean sample volume to obtain an estimate of the coefficient of variation; convert this to percent.

For Example: It is estimated that the volume will range from 3 to 15 m^3 per plot. Therefore, the range is 15 - 3 = 12 m^3. The average sample volume is estimated to be 6 m^3.

Thus:

$$c = \frac{12/4}{6} x\ 100 = \frac{3}{6} x\ 100 = 50\ percent$$

This short-cut method provides a rough approximation of CV, and may only be used when a sample-based estimate of CV cannot be obtained. For an approximation of CV based on prism cruising the range and average volume per hectare can be used in the calculations.

Sample-based estimates of CV (provided 16 or more samples are used) are worth recording as "experience", and may be used for design purposes on nearby sales of comparable timber type.

2.6.3 Stratification

Coefficient of variation (and number of plots required) is directly related to the range of individual plot volumes. The smaller this range is in a population, the more efficient the sampling. The object is to increase sampling efficiency by stratifying larger populations (i.e., a timber sale or cutting permit) into smaller populations (timber types) in such a manner that each one of the timber types has a lesser variation than the larger population.

Consider the following:

1. Are there two or more distinctive types that can be identified and can readily be mapped.

2. The types can be readily mapped as a result of ground examination.

2.6.3.1 Forest Typing

Productive and non-productive areas must be segregated. Non-commercial and non-productive areas larger than 1 ha in size must be typed out. Currently the non-commercial areas larger than 4 ha must be segregated from the smaller areas for purposes of silviculture cost estimates in interior appraisals. Forest types should be kept fairly broad, with the minimum size normally being 1 ha for distinct homogeneous timber types. There is a common tendency to overtype, and nullifying any increases in sampling error achievement.

Use the following methodology for pre and post stratification:

1. Forest types must be distinguished before the cruise commences based on:

   a. aerial photograph interpretation, or

   b. the most recent forest cover maps,

2. Field inspection or sampling.

   The type lines must be documented in the traverse notes for methods 1 and 2.

3. If the transition from one timber type to another is very gradual and not detected in the field, then the type line must be drawn equidistant from dissimilar plots.

4. If non-forest types are stratified out of the harvest area, then they must not be sampled.

5. The modification of type lines to achieve sampling error or from the inspection of plot volumes is not permitted as this can cause bias.

2.6.3.2 Calculation of Number of Samples

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	ha	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	2 732	0.36	40	14.4
	40		7 604	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 *percent* at 2 S.E., the required number of samples is:

$$n = \frac{t^2 xCV^2 xN}{NxE^2 + t^2 xCV^2} = \frac{(2)^2 x(38)^2 x400}{400x(15)^2 + (2)^2 x(38)^2}$$

$$= \frac{4x1444x400}{400x225+1444} = \frac{5776x400}{90000+5776} = \frac{2310400}{95776}$$

$$= 24$$

The probability factor for n-1 or 23 is then used to calculate a new "n", which equals 26. These 26 samples are then distributed among the three types as follows:

$$n_1 = \frac{PCV_1}{PCV} x\, n \text{ etc.} = F\text{–}Pl; n = \frac{12.9}{37.8} x\, 26 = 9$$

$$Pl; n = \frac{10.5}{37.8} x\, 26 = 7 \qquad Pl\text{–}F; = \frac{14.4}{37.8} x\, 26 = 10$$

Exact estimates of type size, volume and coefficient of variation are not necessary in advance of cruising to predict sampling requirements. Reasonable approximation are sufficient 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 volume of the cut blocks, 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.

2.7 Double-Sampling

As the name implies double-sampling consists of sampling certain characteristics within a sample instead of measuring those characteristics throughout the sample. Double-sampling improves the volume estimate by species.

2.7.1 Type of Plots

Double-sampling requires the use of two types of prism plots, the measured plot and the count plot. The measure and count plots together represent the main sample. Fixed-radius plots may not be used in this form of double-sampling.

2.7.1.1 Measured Plots

The measured plots are conventional samples in which all variables for each tree are measured, identified, recorded and represent the subsample in the double sampling cruise.

2.7.1.2 Count Plots

Count plots are samples in which only trees by species are tallied. All live and dead potential trees which are to be included in the compilation are noted. Do not include any tree below the lower dbh to be compiled for that species or tree class 4 (dead useless) or tree class 6 (live useless) trees. Half plots and border plots are not permitted in count plots. These plots must be converted to measure half and border plots.

It is not possible to compile a double sampled cruise with a species recorded in a count-plot by a species which has not been sampled in a measured plot. A cruiser who finds in a count-plot, a tree species which has not been sampled in a measured-plot in the same timber type, and which may not be sampled in the remaining measured-plots, must change the count-plot to a measured-plot to ensure that a measured tree of that species is tallied.

If, at the compilation stage, an unmeasured species is found to have been recorded in a count plot, refer the matter to the Regional Manager or designate to resolve the problem.

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Field Procedures 3

3.1 General Provisions

3.1.1 Signatures

Stumpage rates are estimated on the data collected by timber cruisers. Therefore cruise tally sheets (FS 205 and industry versions) must be signed (or initialled) and dated by the cruiser who in so doing, accepts responsibility for the information contained on the card. This assists the check cruiser to sample a representative proportion of each cruiser's work.

3.1.2 Tie-Points

The cruise must originate from valid tie points such as unique photo and map locations like creek junctions, road locations, falling corners and GPS positions. All of the cruise strips must be linked together and to the boundary line. If the boundary traverse is completed after the cruise, it must be tied to the cruise in at least 2 places.

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.

3.1.3 Strip-Lines

The strip-line 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. The line should be marked with plastic marking tape so it is easily visible.

3.1.4 Plot-Centres

When the required distance has been measured along the strip line, a stake, tree or equally effective marker must be established at the plot centre where the compass person marks the chainage.

A reference point (RP) must be established on the nearest live tree to plot centre (PC). The bearing and horizontal distance from the RP to the PC must be written on the reference tree and tally card. The RP will be used to determine PC for check cruising purposes. Refer to Regional guidelines for any additional requirements and use of reference trees.

3.1.5 Slopes

3.1.5.1 Slope Percent

Record the most severe slope measurement from the plot centre to a point 15 m horizontal distance within the harvest area. Plot slope must be recorded in measure and count plots.

3.1.5.2 Distance Slope Correction

All distances (strip and base lines, plot radii and closed traverses) must be corrected for slope to obtain horizontal distance and measured to the standards listed in Section 3.6.2.1 or refer to Table 1.

The formula used to correct for slope is:

$$COS\left[TAN^{-1}\left(\frac{slope\%}{100}\right)\right] = slope\ correction\ factor \leq 1.000$$

The resulting number is multiplied by a measured slope distance to obtain the equivalent horizontal distance. For example:

- slope of 59 percent and measured slope distance of 8.62 m to tie-point,
- $COS\left[TAN^{-1}\left(\frac{59}{100}\right)\right] = 0.8613$, and
- 8.62 m x 0.8613 = 7.42 m horizontal distance to the tie-point.

To obtain a slope distance, the specified horizontal distance is multiplied by the inverse of the slope correction factor. For example:

- slope of 74 percent and specified horizontal distance of 50 m,
- $COS\left[TAN^{-1}\left(\frac{74}{100}\right)\right] = 0.8038 \qquad 0.8038^{-1} = 1.2441$, and
- 50 m x 1.2441 = 62.205 m slope distance will give 50 m horizontal distance. Refer to Table 1 for Correction Table.

3.1.6 Traversing

All cutting permits require a closed or GPS traverse of each cut-block. Stations, tie-points, reference points and boundaries must be well established on the ground for permanent future reference and must not be destroyed during or after harvesting operations. Refer to any established district policy on boundary marking where the cruise area is located (e.g., Forest Practices Code Boundary Marking Guidebook). Traverse notes shall include tree species and diameters recorded for all stations, tie-points and other boundary references. Refer to Section 3.6.2.1 for the tolerances.

References:	*Standard Procedures for Line and Polygon Mapping Using Global Positioning Technology* Ministry of Forests Home Page http://www.for.gov.bc.ca/resinv/standard/fri_man.htm
	Forest Practices Code of BC Act *Boundary Marking Guidebook* Ministry of Forests Home Page http://www.for.gov.bc.ca/tasb/legregs/fpc/fpcguide/bound/boundtoc.htm

3.1.7 Mapping

The minimum mapping standards for the final and cruise plan maps are as per Sections 3.1.7.1 and 3.1.7.2 (also see Figures 3.1 and 3.7).

3.1.7.1 Mapping Standards

1. The cruise map will be legible and of good quality.
2. The map will provide neat and clear lines, lettering and numbers.
3. The cruise map shall include the following:
   a. tenure,
   b. forest region and district,
   c. scale used,
   d. timber supply area,
   e. north arrow and declination,
   f. cut block(s) must be identified as mature or immature,
   g. timber type lines and description,
   h. plots must be numbered (measure and count identified).

i. existing and proposed roads,

j. adjacent logging and burn history,

k. inventory region and compartment number,

l. UTM grid (Small Business Tenures),

m. Forest Inventory Zone, and

n. PSYU.

3.1.7.2 Maps (see attached Exhibit A Cruise Map)

Cruise maps must accompany the compilation report, and must be produced as follows:

1. Scale of 1:5000, 1:10000 or as approved by the District Manager.
2. Plots used in the compilation are to be clearly indicated and numbered on the map.
3. Locations of baselines must be indicated if used,
4. Contour lines are recommended and must be indicated in such a fashion that they are clearly legible and indicative of local topographic features.
5. Physiographic features must be shown.
6. Legal survey features must be shown.
7. Forest and non-forest type boundaries must be clearly indicated.
8. Status clearance boundaries and cutting boundaries must be shown.
9. Any other features of significance with respect to the sale of Crown timber (i.e., windfall areas, fire areas, insect or disease infestations, fish-bearing streams), and contour logging considerations must also be shown.
10. Digital GPS Survey and mapping data must be provided upon request by the Ministry of Forests if GPS technology is used.

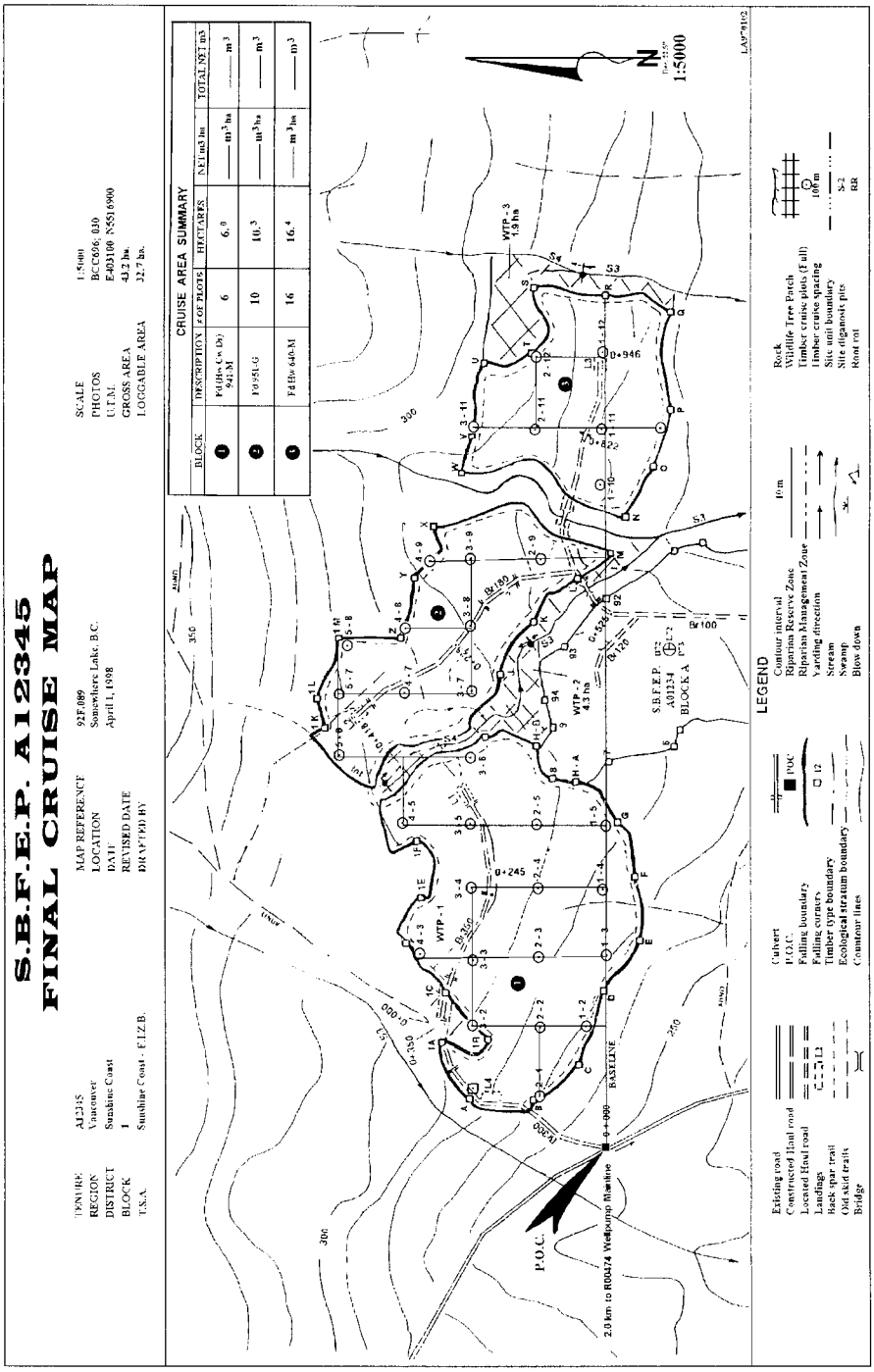


Figure 3.1 Final Cruise Map.

3.2 One Hundred Percent Cruises

The boundary of the 100 percent cruised sale must be well marked and each tree numbered or marked. In order to not miss trees a systematic procedure of tree measurement should be adopted:

1. Dividing the area into strips (maximum width 20 m) will help to ensure no trees are missed.

    - the denser the stocking the narrower the strips, and
    - the steeper the slope the narrower the strips.

3.3 Fixed-Area Plot Cruises

3.3.1 Circular Plots

Having established the plot centre, the plot circumference is then determined and marked with string or plastic flagging tape. More radii measurement will be required when there are many trees on or near the plot boundary. At the end of each radius measurement the tree on the plot circumference or nearest to the circumference within the plot must be marked with plastic flagging tape or paint.

When plots are established, slope allowances must be applied to each radius distance. That is, plots must not be established by assuming an average slope and making one slope correction for all radii. The plot radius slope allowance is added along the same slope in which the plot radius is being measured. Plot radii slope corrections are given in Table 2. The formula for calculating these corrections is in Section 3.1.5.2.

3.3.2 Rectangular Plots

A tree on the strip line at the start and end of each plot must be blazed on four sides. A metal tag and/or plastic flagging tape, showing strip number, compass bearing, distance on line and plot number must be attached.

The strip line must constitute the centre line of the plot, and slope allowances must be made in measuring this line. Slope allowances for various short distances are given in Table 1. The plot centre line must be marked with plastic flagging tape every 5 m from the beginning to the end of the plot.

Plot width will be checked along the centre line and the boundary marked with plastic flagging tape. Plot width must be corrected for slope.

3.3.3 Borderline Trees (Fixed-Area Plots)

The horizontal plot radius or plot width must be checked for each borderline tree. A tree will be included "in" the plot if at least half of the diameter of the tree measured at DBH is inside the plot. In practical terms, the tree's plot radius is measured from the centre (middle) of the tree at DBH to the plot centre.

3.4 Variable (Prism) Plot Cruises

Having established the plot centre, the prism is used to determine which trees are "in" the plot. Then species, DBH, pathological remarks and quality are measured or determined for each tree.

3.4.1 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. The prism will be "swept" around plot centre and all live and dead trees equal or larger than the minimum specified size for the "in plot" trees recorded.

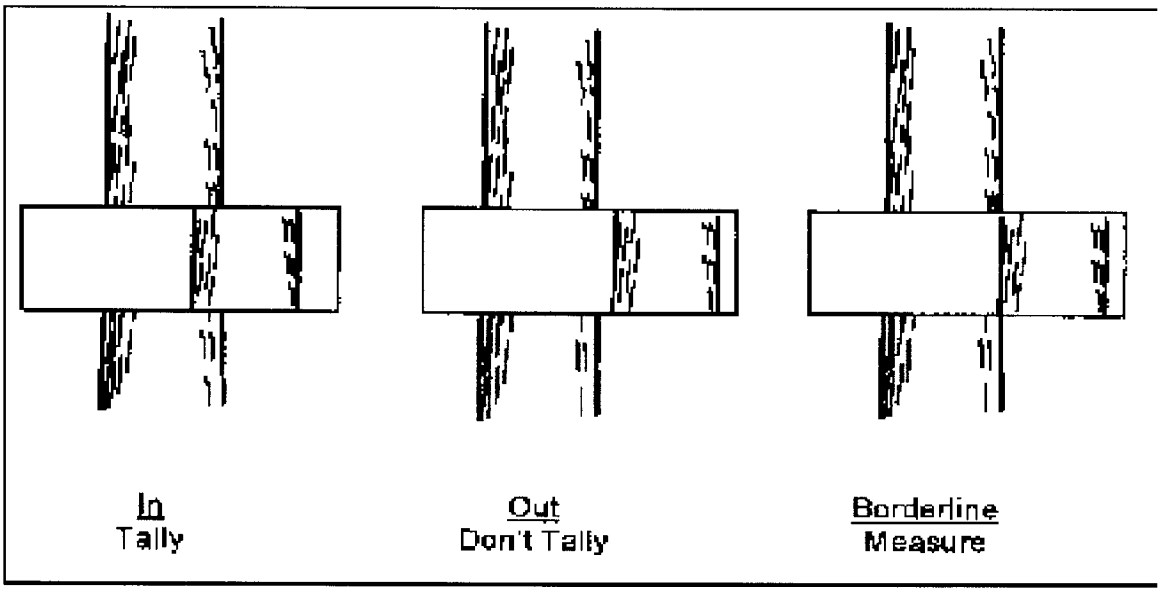


Figure 3.2 "In", "Out" and "Borderline" trees.

When two prisms are being used on the same plot, each prism will be "swept" through 360° about the plot centre. It is vital that only the appropriate trees be recorded for each sweep. Assume two prisms having basal area factors of 2 and 4 are being used. In this case on the 2 basal area sweep only those trees whose diameters are 17.5 cm and over and less than 27.5 cm DBH, will be recorded. Trees whose diameters are 27.5 cm or greater will not be recorded even if they appear to be "in". Conversely on the 4 basal area sweep, trees whose diameters are less than 27.5 cm will not be recorded even if the appear to be "in". Therefore, on the tally sheet it is vital to record the basal area factors used and the tree diameters to which they apply.

3.4.1.1 BAF Selection

The choice of the proper BAF is based upon two principal considerations:

1. The visibility of the trees that should be "in".

2. The number of trees counted at each point.

The minimum average tree counts for clear-cut and partial cut is as stated in Section 2.1.1. The same prism should be used for all plots within a timber type, however each situation should be assessed, as more than one (1) prism size does not necessarily result in bias.

> The prism size must not be changed at plot centre to include or exclude certain trees or to achieve a specific tree count as that constitutes bias. The intentional use of more than one prism size in a timber type will not be permitted.

3.4.1.2 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 Section 3.1.5.2 for the slope distance correction factor formula). In borderline situations, trees are to be measured as described in the following section.

3.4.1.3 Borderline Trees (Prism Plots)

The status of borderline trees in measure and count-plots must be checked by measuring the horizontal distance from the plot centre to the centre of the tree trunk at DBH. In prism cruising every tree has its own plot radius depending on its diameter and the angle of the prism being used (see Table 4-1). The plot radius factor times DBH gives the appropriate plot radius for any tree. The trees plot radius, distance from the sample plot centre and the prism size determine whether the tree is "in" or "out" of the plot. A tree is "in" the plot if at least half of the diameter of the tree measured at DBH is inside the plot. In practical terms, the tree's plot radius is measured from the middle of the tree at DBH to the plot centre. Volume equations are based on DBH, therefore, the prism must be sighted on the tree at breast height in sampling.

The plot radius factor (PRF) is determined as follows:

$$PRF = 0.5/\sqrt{BAF}$$

Where BAF is the prism basal area factor in m^2/ha.

The following table gives plot radius factors for a selection of prism basal area factors.

Basal Area Factor	Plot Radius Factor	Basal Area Factor	Plot Radius Factor
1	0.5000	12.25	0.1429
2	0.3536	13	0.1387
3	0.2887	14	0.1336
4	0.2500	15	0.1291
5	0.2236	16	0.1250
6	0.2041	18	0.1179
6.25	0.2000	20	0.1118
7	0.1890	20.25	0.1111
8	0.1768	24	0.1021
9	0.1667	25	0.1000
10	0.1581	30.25	0.0909
11	0.1508	32	0.0884
12	0.1443	64	0.0625

For example, a tree having a DBH of 28 cm, sighted with a 4 BAF prism, will have a plot radius of 7 m. Therefore, if the horizontal distance from the plot centre to the tree centre is 7 m or less the tree is "in" and will be tallied. If the distance is greater than 7 m the tree is "out" and is not tallied. All "borderline" trees must be measured and the measurements recorded for checking purposes.

3.4.1.4 Leaning or "Down" Trees

Regardless of the direction of a tree's lean or position on the ground, the horizontal distance must be measured from the centre of the tree at DBH to the plot centre in order to decide whether a tree is "in" or "out". The position of the point of germination has no bearing on this decision.

3.4.1.5 Hidden Trees

Trees may be obscured by undergrowth or other trees. In these cases the prism may be moved off the sample centre, maintaining the same distance to the tree in question. However, it may still be difficult to sight the tree at breast height. If the tree qualifies as an "in" tree by sighting above breast height, it would also be an "in" tree if sighted at breast height, unless the tree leans toward the observer.

If a tree cannot be sighted by the above procedures it must be treated as a borderline tree, the trees plot radius calculated and the distance from the plot centre to the tree measured.

3.4.1.6 Half Plots

The use of half plots will be subject to demonstrated performance and approval by the Regional Manager or designate. Licensees and consultants must note their intention to use half plots on the cruise plan. Tree count errors will be doubled for purposes of check cruising.

> Half plots and border plots must not be used in count plots.
>
> Half plots must be used consistently throughout the cruise area or not at all.

The following method is recommended if half plots will be used:

1. The half plot method must be used in all plots where eleven (11) or more trees (excluding live and dead useless) are "in" the plot with the prism.

2. Number the trees consecutively starting with the first tree that has at least half of its stem to the right of true north. If two trees are exactly in line, count the tree closest to the plot centre first.

3. Measure and record odd number trees in the odd numbered plots and even number trees in even number plots.

4. Do not number the dead useless snags less than 3 m and the dead useless down trees.

3.4.1.7 "Boundary" or "Border" Plots (Plots Falling On Type or Block Boundaries)

Plot centres which fall on or adjacent to timber type lines or harvesting boundaries inside the sample area are split through the plot centre parallel to the type line. The trees inside the sample area are recorded and the plot noted as a B for border/half plot.

Plot centres which fall *outside* the sample area will be dropped.

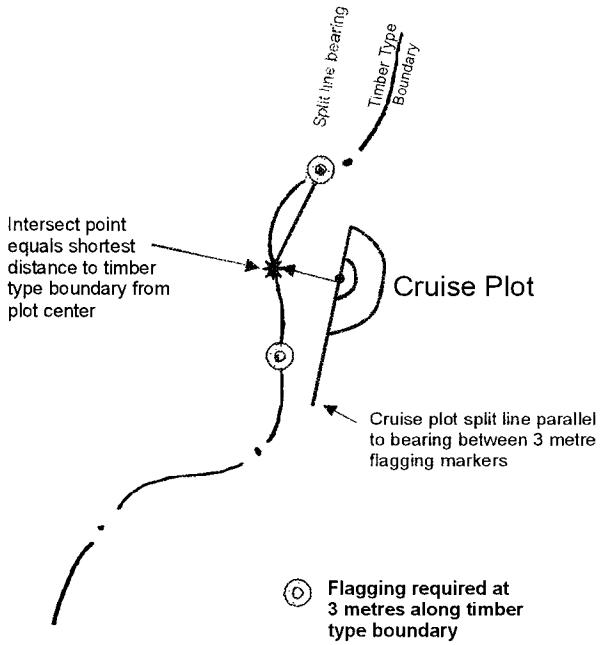


Figure 3.3 Border plot procedure.

3.5 Tree Measurements - Prism and Fixed-Area Plots

3.5.1 Marking Trees

A paint line or tag must be displayed on the tree at the point of DBH measurement, with the numbers facing the plot centre, to facilitate checking. Borderline "in" trees should be numbered; "out" trees should have an "X". In count plots, only the first tree must be numbered, with an arrow painted on that tree indicating whether the tree tally goes clockwise or counter clockwise. Live useless and dead useless stems are not tallied in count plots.

3.5.2 Species

All living and dead, standing and down trees which are listed in Section 6.3.2 (except dead and down useless) and which meet or exceed the utilization limit must be recorded when present in a plot. Section 6.3.2 gives a complete list of the commercial tree species and the proper use of genus and species codes.

3.5.3 Heights

The "One Hundred Percent method" must be used on all scale and cruise based tenures cruised after March 31, 1997. The Sample Height method is restricted to use in stump cruises or where severe damage due to windshear or freezing has occurred. Severely damaged stands must be identified on the cruise plan and submitted to the Regional Manager or their designate for sampling alternatives.

3.5.3.1 Leaning Trees

The following method should be used for measuring the tree length of trees leaning more than ten degrees (B) from the vertical (see Figure 3.4). The angle A must be 90 degrees.

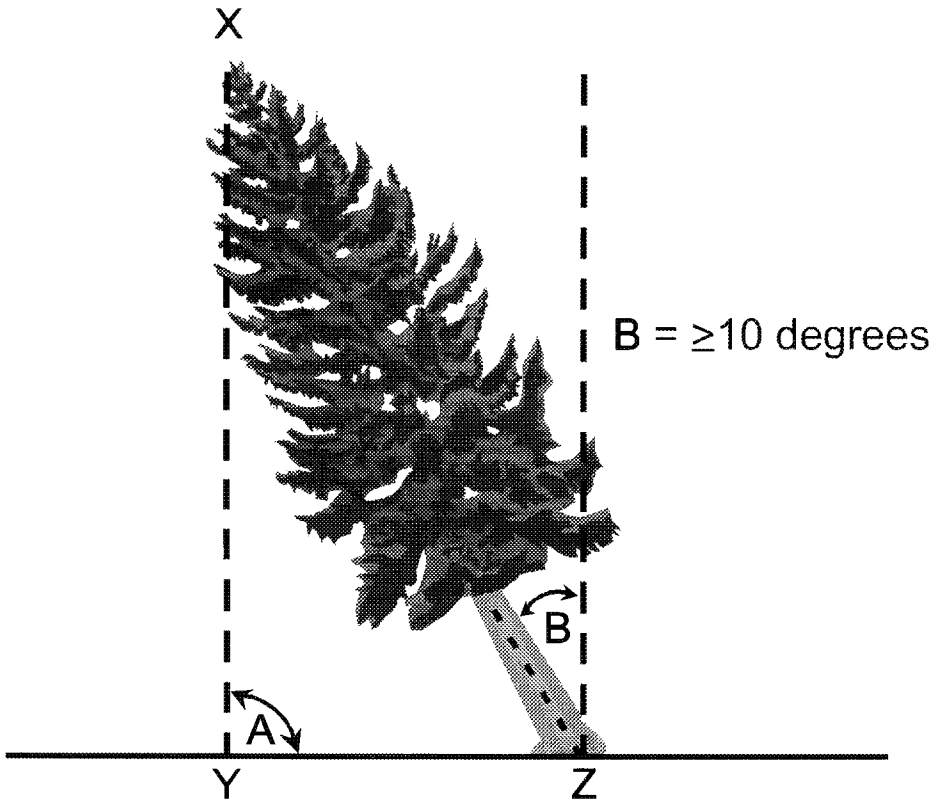


Figure 3.4 Measuring height of leaning trees.

1. Calculate the vertical distance from the ground (Y) to the top of the tree (X) using a clinometer or electronic measuring device from a point perpendicular to the lean of the tree (i.e., A = 90 degrees).

2. Measure the horizontal distance from the centre of the tree (Z) to a point directly under the top of the leaning tree (Y).

3. Calculate the tree length by using the Pythagorean formula for right triangles:

$$\text{Tree Length (m)} = \sqrt{\left(\text{length } XY_{(m)}\right)^2 + \left(\text{length } YZ_{(m)}\right)^2}$$

The degree of lean will not be a check cruising item, however, tree length will be considered the true tree height.

3.5.3.2 "One Hundred Percent" Height Measurements

This is the mandatory method of tree height determination.

With the 'One Hundred Percent' height measurement method all trees tallied in C.T. 2 have their heights either *measured or estimated* and entered in columns 27 - 29 (Total Height - metres) between the tree number and species on the Cruise Tally Sheet. The use of a clinometer or electronic measuring device is recommended for tree height measurements and estimates. These measured and estimated heights are used to calculate the volume of the trees within the plot, as opposed to constructing a height curve from height samples.

Estimated heights are obtained for the remaining trees by comparing their height to one or more measured heights.

In plots where there is a high variation of tree heights, more measured height samples may have to be taken to maintain the desired degree of accuracy for the trees.

3.5.3.3 "Sample-Height" Heights (Height/Diameter Curves)

The "sample-height" method only collects heights for some of the tallied trees. This method predicts average height from a height/diameter curve and is restricted to use in stump cruises and severely damaged stands.

Height Sample Size

In general, at least 20 sample trees from each species in each site class on the cutting permit or timber sale must be measured for height. These sample heights must be evenly distributed throughout each type or site-class (i.e., at least one sample height per plot). If it appears that a certain species exhibits the same height/DBH relationship in two or more forest types in the same cutting unit, it is permissible to develop a common height - DBH curve; the tree heights for a given species must be similar throughout the diameter range common to the species. In this case only a total of 20 sample trees need be taken within the two or more forest types. The "same height/diameter relationship" means an average height variation that does not exceed 3 percent over the full range of diameters between two sets of data.

Height Sample Selection (Height/Diameter Curve)

All trees must be marked and numbered at the point of DBH (to facilitate checking) so that the number can be seen when standing at the plot centre (see Section 6.3.3 positions 25-26 for details).

If the sample tree has also been measured for height and/or age, it must be recorded with the same number, species and DBH. These heights will be used to calculate a height/diameter curve. If the height sample tree is taken outside the plot it will only be recorded in the "Sample Tree Detail" and given numbers 99, 98, 97, etc. to prevent confusion with sample trees inside the plot boundaries.

Abnormal trees such as leaning trees, trees with heavy sweeps, broken tops or forks must not be used as height sample trees. Trees with minor forks or crooks may be used if these trees comprise a considerable portion of the stand.

Dead potential trees should not normally be selected as height sample trees. Under the assumption that these stems died as a result of low vigour and/or pathological depletion, their growth rate would be less than average, hence incorporation of their heights into a general species population height curve could unduly bias that species' height curve. However, if a significant proportion of the population of a certain species is classed as dead potential, a representative number of dead potential stems should be sampled for height (refer to Section 8.3 for additional information).

Height Sample Distribution (Height/Diameter Curves)

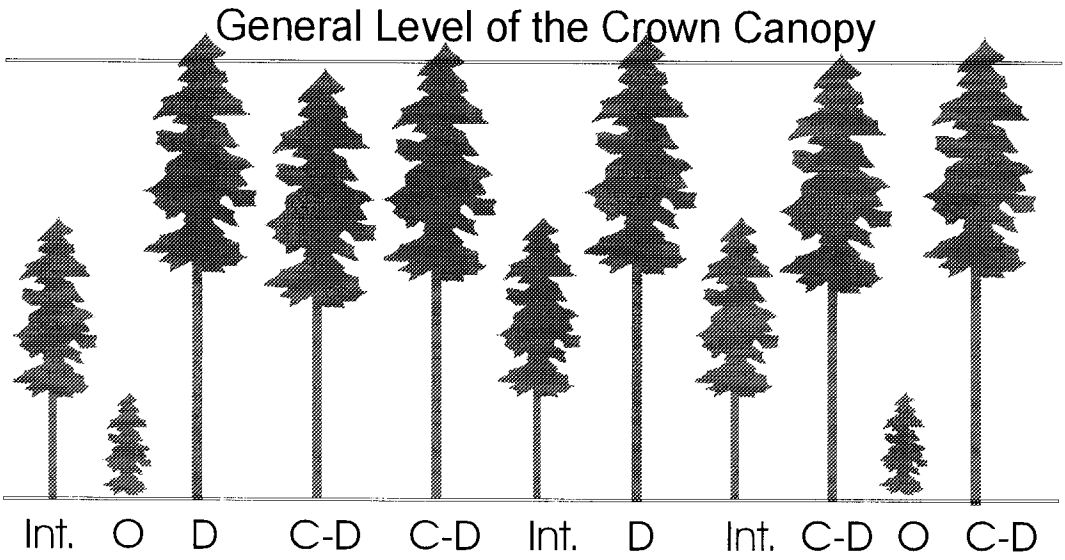
Measurements of height and DBH are required so that height DBH relationships can be developed and, therefore, height sample trees must cover the range of heights and diameters in the stand. Each height curve must represent only one species and have at least 2 sample trees for each 10 cm DBH class. The reference point for diameter and height is the high side of the tree as shown in Figure 3.6 of this chapter.

Height samples must be distributed as follows in the normal mature types for each species:

Measure	1/4 in the dominant crown class
Measure	1/2 in the co-dominant crown class
Measure	1/4 in the intermediate and overtopped crown classes

Crown Classes

There are four crown classes (Figure 3.5) as follows:



1. = Dominant (D) — Trees with crowns extending above the general level of the crown canopy. They are somewhat larger than the average and have well developed crowns which may be somewhat crowded on the sides.

2. = Codominant (C-D) Trees — Trees with crowns forming the general level of the crown canopy. The crown is generally smaller than that of the dominant trees and usually more crowded on the sides.

3. = Intermediate (Int) — Trees with crowns below, but still extending into, the general level of the canopy. The crowns are usually small and quite crowded on the sides.

4. = Overtopped (O) — Trees with crowns entirely below the level of the canopy.

Figure 3.5 Crown classes.

Height Sample Measurements

Tree heights will be measured from the ground on the high side of the tree. The total height of lodgepole pine and broad leaf species is measured to the highest point of the crown, not at the point where the main bole commences natural forking. In general, the lower the reading, the more precise the measurement so try to keep the reading below 100 percent. The most important aspect of taking a tree height is seeing clearly to the top and breast height or bottom of the tree.

Consideration must be given to:

1. Slopes: trees standing adjacent to each other for comparison may not be on the same horizontal plane (i.e., uphill or downhill).

2. Regeneration and underbrush.

3. Tree length of leaning trees must be measured if they lean more than 10 (ten) degrees from vertical.

Paint an "S" on the sample tree facing the direction that the sample tree height was measured from, and must be measured at a 90 degree angle from the direction of the lean.

3.5.4 Diameters

The diameter of all trees of minimum diameter and larger will be measured with a diameter tape at a point 1.3 m above the of the tree (see Figure 3.6). High side is defined as the highest point of mineral soil around the base of the tree. Any *loose* debris should be removed. Diameter will be measured and recorded to the nearest 0.1 cm.

Special situations are handled as follows:

Forked trees: Where a tree forks below 1.3 m, measure as two trees. Where a tree forks at or above 1.3 m, measure as one tree and record the diameter at 1.3 m or lower if this diameter is smaller. Where two trees are growing together, "caliper" the diameter of each tree. To "caliper" a tree, hold the distance side of a diameter tape up against the tree and determine the distance across from one side of the tree to the other.

Debris at the base: Where there is an accumulation of forest litter or stones at the base of the tree, this should be moved aside to the level where the litter becomes partially decomposed on the highest side of the tree. If the obstacles are too large to move, the root collar will be the high side.

Abnormalities at 1.3 m: (abnormal butt swell due to branch whorls or mistletoe) measure above and below 1.3 the abnormality and estimate the DBH based on the normal taper of the tree.

Trees without bark or with a catface: No allowance for missing bark will be made.

Pronounced sweep: The root collar will be the high side.

Portion of a tree removed (i.e., firewood cut from tree and DBH portion is missing): estimate the diameter of the tree or measure the DBH of an adjacent tree of the same species and 5 cm diameter class at high side and of the same species.

Cruising in the snow will only be permitted when DBH can be located at 1.3 m and the diameter accurately measured.

Flared roots: Trees growing on windfall, chunks or rocks, will have long sloping roots. In order to calculate an accurate volume, these trees should have high side located so that DBH is the same as for a normal tree. The root collar is often a good position for high side in this situation. High side can not be lower than the point of germination.

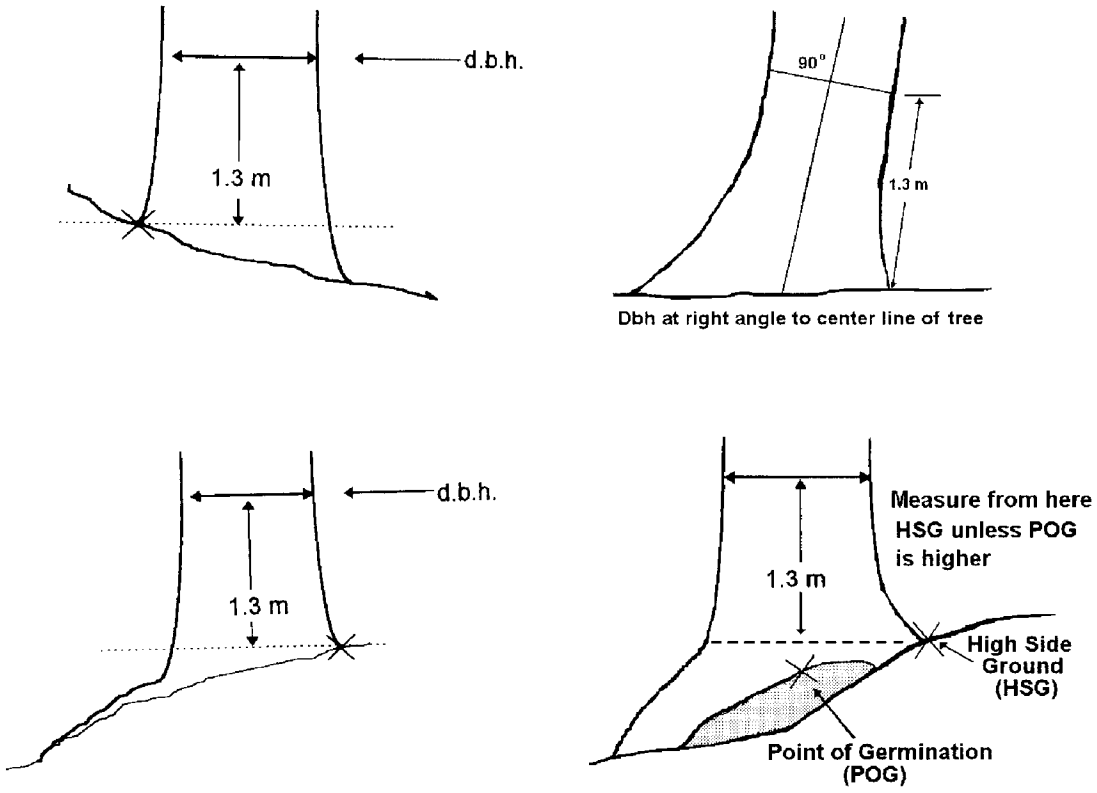


Figure 3.6 DBH in relation to high side.

3.5.5 Pathology

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 and scars on the root collars. There are qualifications to many of the suspect characters such as age of scars, position of fork or crook, size of rotten branches, etc (please refer to Appendix 4, for a detailed description of pathology).

3.5.6 Tree Classes

All living and dead trees must be given the appropriate tree class code numbered from 1 to 9. It is essential that every tree be viewed from all sides before classification as Residual or Suspect.

> Refer to Appendix 4 for diagrams and further information about residual and suspect trees.

3.5.6.1 Tree Class 1 (Residual)

These are living trees with none of the eight external pathological indicators.

3.5.6.2 Tree Class 2 (Suspect)

These are living trees containing one or more of the following eight external pathological indicators of decay:

Conks, Blind Conks, scars, fork and/or pronounced crook, frost crack, mistletoe (trunk infection), rotten branches, dead or broken top.

All pathological indicators must be recorded for each tree where they occur in order for the computer to properly assign the appropriate loss factor. Tree classification will be made on the basis of the above signs of decay only. See "Metric Diameter Class Decay, Waste and Breakage Factors" for the specifications of Risk Groups and Table 18 for risk group assignments by pathological indicators.

3.5.6.3 Tree Class 3 (Dead Potential)

Dead standing or down timber which is estimated to contain at least 50 percent of its original gross volume in sound-wood content. All dead potential standing and down trees must be tallied.

Trees with green and/or red needles are considered live trees and will be classified based on pathological indicators. Standing or windfall trees with grey or no needles will be considered dead trees.

Down stems in this class will be determined as "in" or "out" by measuring from DBH on the tree where it lies to the plot centre (see Section 3.4.1.4, Leaning or "Down" Trees). For net merchantable volume compilation, dead potential stems will have the highest Risk Group factor for that particular species.

The 50 percent or more firmwood rule is the key consideration. Consider the resistance to decay of the species and the local climate (refer to Table 19 for the Sound Wood Factors for saprot and formulas to assist in the determination of 50 percent soundwood content).

Decay should be determined at various intervals on the tree. Tables are available to estimate cross-sectional area of decay. For example, the outer one-third of a tree represents one half the volume. Also, the bottom third of a tree contains approximately one half of its volume. Other tables are available which show the percentage of volume of the tree in each 10 m log. By estimating percent firmwood in each 10 m log, the firmwood percent of the tree can be determined.

1. Dead Standing

   Decay percent is difficult to assess on standing trees, "Sounding" with an axe can be helpful. Before sounding, look for overhead hazards that may be dislodged.

2. Dead Down

   Good judgement must be exercised in applying tree classes to down material. Since some species are more resistant to decay than others, decisions will therefore be influenced by the tree species involved as well as by local climatic conditions. C, Cy, F, S, P and L are the most decay resistant species and are less likely to exhibit extensively sloughing bark and conks. Other species exhibiting these characteristics are more likely to be "Dead Useless". However, it should be remembered that in drier areas, dead and down Pl and Py may be entirely bark-free yet still be relatively sound.

   Pathology is called on TC 3 trees on the Coast for the log grade algorithm. However, pathology is not required for these trees in the Interior.

3.5.6.4 Tree Class 4 (Dead Useless)

Dead standing trees that have less than 50 percent of their original gross volume in firmwood content or otherwise fails to meet the criteria of a dead potential tree as described in Section 3.5.6.3 will be classified as "dead useless" trees. Only dead useless standing trees will be tallied (dead useless down trees are *not* tallied). Dead useless trees are considered standing if they are leaning into another tree. Dead useless standing trees will not be compiled for volume, but along with Live Useless trees, provide a record of snag density in the stand for appraisal purposes. Only trees equal or greater than 3 m high and equal or greater than the minimum utilization diameter must be tallied. Estimate their actual observed height; not an estimate of the stems original height.

3.5.6.5 Tree Class 5 (Veteran)

A veteran is defined as a mature living tree (121 years or older for all species except deciduous greater than 40 years or Cottonwood and Aspen in FIZ K & L greater than 80 years) in a main stand which has been classified as immature (less than 121 years) (e.g., a former remnant of a mature Douglas fir stand in an immature stand of lodgepole pine).

A reasonable number of veteran ages should be sampled along with the age drilling of the main stand component.

3.5.6.6 Tree Class 6 (Live Useless)

Live Useless trees are trees that have only one or two live limbs. They are combined with TC 4 for the compilation of percent snags. This tree class must not be confused with a Tree Class 2 tree, which has a high proportion of rot due to conk.

Cedar and Cypress	The tree must be almost completely rotten or hollow with just a thin shell of sound wood remaining. The low proportion of sound wood must be obvious (i.e., rotten or hollow knots, and large open scar).
Hemlock, Balsam, Fir, Pine & Spruce	The tree must be broken off in the lower or middle thirds (i.e., at least the top third must be missing) with only a few live branches and almost completely rotten or hollow.

3.5.6.7 Tree Class 7 (Veteran Dead Potential)

This class is a combination of Veteran and Dead Potential so that the correct loss factor tables are applied in the compilation. The guidelines for TC 3 and TC 5 apply.

3.5.6.8 Tree Class 8 (Immature)

An immature is defined as an immature tree (less than 121 years, etc.) within a mature stand. This classification enables the correct loss factor tables to be applied in the compilation.

3.5.6.9 Tree Class 9 (Immature Dead Potential)

This class is a combination of Immature and Dead Potential so that the correct loss factors are applied in the compilation. The guidelines for TC 3 and TC 8 apply.

3.5.7 Quality

Stem quality information forms the basis for a computerized grading system. Quality remarks are also used for the experimental interior Douglas Fir quality and the interior log grade algorithms (refer to Appendix 8). They are recorded when observed 30 cm or more above the high side of the tree. This data collection is currently optional in the interior.

The quality class information will be collected on all commercial living and dead potential trees (refer to Chapter 6, Position 45-51, required on the coast for immature cutting authorities).

3.5.8 Damage Codes

Standard cruising methods as outlined in Chapter 6 and Appendix 7 of the *Cruising Manual* are to be followed.

Damage codes are to be used when damage is identifiable.

Code the trees as they appear at the time of the cruise with no attempt to guess what the future condition of the trees will be.

3.5.9 Ages

Measurements of age should concentrate on co-dominant trees as the purpose is to obtain average stand age. Two to three trees should be bored for age 1.3 m above high side on each plot when the type is near a loss factor age-change (younger immature/older immature, older immature/mature or mature/over mature) or individual species have a different age.

For 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 average age in 10's on the Cruise Tally Sheet is required for all measure and count plots. This age is used in each plot to assign the correct loss factor table, determine maturity and for stratification. It is important that height as well as age be taken on each age sample tree because the height is used to estimate the years to boring height to obtain total age.

In older immature stands with scattered veterans, however, age counts of the older portion of the stand are important in order to distinguish the veterans from the younger trees. Refer to Table 9 for the correct application of the age in 10's and tree class combinations that must be recorded.

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 at least half the sample tree cores on each plot. 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 rebored.

"Age bored at 1.3 m must be accompanied by a sample tree height. The Site Index is then determined by using the bored height age (1.3 m trees above high side) and the height of the sample tree. The Total Age of the Age Sample Tree is determined by adding the boring height age to the years to boring height (as determined by the Site Index)."

3.6 Check Cruising

If requested by the Ministry of Forests for checking purposes the licensee or consultant shall submit the originals of the cruise tally sheets, cruise map and traverse notes. If magnetic data is requested it must contain the Map Area Statement completed as per Chapter 7 and be followed with the tally sheet data listed in numerical order, and shall be submitted in ASCII format on 3 1/2" floppy disks (Regional exceptions may exist).

> Obvious bias in any phase of the data collection or recording such as diameter measurements, height calculations, plot tree counts, pathological indicators, quality remarks and plot appraisal information will lead to rejection of the cruise.

3.6.1 Objectives of Check Cruising

The purpose of check cruising is to verify that field observations and measurements were taken and noted correctly. Checking includes traverse notes, compass notes and tally sheets.

Certain guiding principles will be the basis for all aspects of cruising:

1. All measurements shall be accurately and carefully taken. Personal bias must be eliminated and each classification determined fairly and honestly.

2. Magnitude of sampling errors should be calculable.

3. All measurements must be made with instruments of proven accuracy.

The field check should be performed while the production cruisers are on site provided that an acceptable cruise plan was submitted to the appropriate district office at least 30 days in advance of the commencement of field work. Whenever possible, the cruising agency must be given the opportunity to attend the check cruise.

The risk management principles for check cruising include emphasizing check cruising on parameters that have significant impact in the appraisal. The following parameters should be checked:

1. A minimum of 5 measure (or 4 measure and 2 count) plots and 20 trees, including their tree heights and diameters.

2. Distribute check plots to check each cruiser's work.

3. Random selection of plots from the entire cruise area.

4. A segment of the cutting boundary and timber type lines. Boundary and typeline checks will qualify as a check cruise.

5. At least one plot interval distance check per cruiser.

6. Emphasis in the plot measurements must include tree count, trees species, tree heights risk groups, diameters at breast height (DBH), and plot slope.

The following should be used in establishing check cruising priorities:

1. Cruiser's past performance,

2. Cruiser's experience,

3. High value timber (as determined by species selling prices in the *Coast or Interior Appraisal Manuals*),

4. Licensee's Allowable Annual Cut in the district.

Upon request, a copy of the Ministry of Forests check cruise comparison shall be submitted to the licensee or consultant in a format acceptable to the Regional Manager or their designate.

Check cruising is required for all cruise based sales.

3.6.2 Allowable Non-Sampling Errors

Any one of the items listed in Section 3.6.2 can lead to either the remeasurement of the entire cruise or the specific parameters that were exceeded.

These standards are defined as the maximum allowable measurement error or variation in any measured quantity before such a measurement is considered to be incorrect. Individual standard parameters are to determine whether bias has occurred or not. When an item has a *two part standard*, both parameters must be exceeded before the item is classed as incorrect.

The individual items to be checked and the acceptable limits of error are:

3.6.2.1 Tree Data

1. Number of Stems:

    a. Fixed area plots:

        i. not more than plus or minus 1 stem in 50 trees from the true number on each individual plot for 90 percent of the plots checked.

        ii. Plus or minus 5 percent from true number for all plots checked.

b. Prism Plots - not more than plus or minus 1 stem in 50 trees checked from the true number for all plots checked (measure and count-plots).

This tolerance (1 stem in 50 trees) is to be applied as follows.

Trees Checked	Allowable Error
1 to 50	plus or minus 1 tree
51 to 100	plus or minus 2 trees
101 to 150	plus or minus 3 trees

- The stem count will include all merchantable trees except live useless or dead useless trees in this check parameter,
- all borderline trees must be checked by actual measurement from the plot centre and measurement of the diameter to determine whether the tree is "in" or "out",
- all borderline trees are to be measured as per Section 3.3.3 and 3.4.1.3 of the *Cruising Manual*,
- if the borderline tree has not been measured and found to be "in" on the check-cruise it will be counted as a "missed" tree,
- if the borderline tree has not been measured and found to be "out" on the check-cruise it will be counted in the incorrect stem count, and
- if the borderline tree has been measured and recorded in the original cruise it will be accepted, providing all measurements are within the allowable limits.

Dead useless and live useless tree count is a check cruising item for interior appraisal cruises for snag percent.

Trees incorrectly identified as dead potential, dead useless or live useless contribute to an incorrect stem count.

2. Species identification - not more than 2 percent of the trees in a cruise can be incorrectly identified.

3. Heights:

   - any significant bias to tree height measurements will result in rejection,
   - use a clinometer and measuring tape or an electronic measuring device to check all tree heights. The accuracy of electronic measuring devices must be demonstrated prior to the commencement of check cruising if they will be used for the true height, and
   - a minimum of 20 tree heights must be checked. If the total cruise does not have 20, then check a minimum of 50 percent of the heights.

     All Tree Heights - Average absolute variation must not exceed 5 percent.

Original		Check		Difference
40.0		42.0		-2.0
42.0		41.0		1.0
43.0		44.0		-1.0
46.0		44.0		2.0
Sum	=	171.0		6.0

$$\text{Absolute Variation} = \frac{6.0}{171.0} = 3.51 \text{percent}$$

4. Pathological Indicators

   a. Plots - plus or minus 1 external indicator on an individual plot. The incorrectly called indicator must move the tree from one Risk Group to another as described in "Metric Diameter Class Decay, Waste and Breakage Factors", and

   b. Block or Cutting Permit - no more than 5 percent of all trees checked can have a risk group change.

5. Damage Codes – if they effect the risk group or an appraisal variable.

   a. No more than 5 percent of all trees checked can have a missing or extra damage code, and

b. missing or extra damage codes that result in a risk group change will contribute to Section 3.6.2.1, 4.

6. Ages: Refer to Section 3.5.9.1.

   - 95 percent of all trees must be placed in the correct maturity class for loss factor deductions,

   - Coast – age in 10's of 13 and 14 - all tree classes must be verified since tree classes 1, 2, 3, 8 and 9 contribute to the percent second growth reporting (see Chapter 6, Positions 21 and 22).

     Incorrect age in 10's and tree classes will result in rejection of the cruise.

7. Breast Height: when this limit is exceeded, the true position is used for a. and b. below. The height of the diameter-line marked at breast-height must not exceed plus or minus 5 percent (plus or minus 6.5 cm) from the true breast-height of 1.3 m above high side.

Diameter at Breast Height (DBH)			
•	as measured with a steel or equally accurate DBH tape.	a.	Plus or minus 90 percent of individual stems checked must be within 2 percent of true DBH.
•	DU trees can be estimated to the nearest 5 cm class.	b.	Average absolute variation of all DBH's checked must be within plus or minus 2 percent.

8. Strip lines or tie lines to prism or fixed-area plots.

   Plus or minus 3 percent of horizontal distance.

   Bearing-strip to strip or plot to plot and plot centre reference:

   Plus or minus 2^0.

Plot centre reference	Plus or minus 1 percent of horizontal distance
Radius - fixed area plots	Plus or minus 1 percent of horizontal distance
Radius - prism plots	Plus or minus 1 percent of horizontal distance
Length and width: fixed rectangular plots	Plus or minus 1 percent of horizontal distance

Boundary Traverse	**Cruise-Based**	**Scale-Based**
Closure error	Plus or minus 0.7 percent	Plus or minus 1 percent
Area error	Plus or minus 1 percent	Plus or minus 1.5 percent
Inter-station distance	Plus or minus 1 percent	Plus or minus 2 percent

3.6.2.2 Quality - as they affect grade (Coast Immature Cutting Authorities)

1. Pathological indicators: Plus or minus 90 percent of these individual indicators which occur in the middle or lower 1/3 of the stem must be coded in the correct third on an individual plot.

2. Quality indicators:

   a. Individual Check Plots - Indicators: spiral grain:

   ≥ 90 percent of all quality indicators checked must be within plus or minus 1 code change.

   Log number of: 1st live limb and 1st stub (when they occur in first 10 m):

   Average variation of all part 2. quality indicators checked in an individual plot must be within plus or minus 1 code change.

Spiral grain greater than 4 doesn't require checking.

Knots and knot indicators: applies only to first and second 5 m logs, and trees less than 60 cm should not be included in statistics generated in 2. In the case of knots, to apply the above standard, there must be ≥ 2 quarters difference.

b. all check plots: ≥ 90 percent of the above quality indicators, on all stems in all plots must be coded correctly within the limits of Section 3.6.2.2, 2., b.

These standards are designed to reflect the areas where a change in grade would occur with incorrect coding.

3.6.2.3 Slopes

Slope:

1. Plots – ≥ 90 percent of the individual plots checked must be within plus or minus 5 slope percentage points of the slope measured by the check cruiser.

2. Block or Cutting Permit - The average variation of all slopes checked must be within plus or minus 5 slope percent.

3.6.3 Allowable Non-Sampling Errors - Original Versus Check Plots

Compile original and check plots as separate cruises on the most recent cruise compilation software.

3.6.3.1 Net Volume Standard

The following standards may be used to adjudicate marginal pass/fail check cruises.

	Allowable Error
1. Individual checked plot volumes	• ≥ 90 percent of the individual plot volumes must be within 7 percent of their true plot volume.
2. Total volume for all checked plots	• Average variation must be within 5 percent of true plot volume as determined by the check- cruiser. Minimum of 5 plots.
3. LRF's (Interior only)	• LRF must be plus or minus 1 percent of true LRF for all plots checked.

Any one of the foregoing items which are outside the permissible measurement standard are grounds for redoing the work.

3.6.4 Cruise Plans

It is *mandatory* for licensees (both Industry and Forest Service) to submit plans to the Ministry of Forests district office 30 days prior to commencement of a cruise.

This includes submission of cruise plans for all cut block(s), including amendments to existing cutting permits. The 30 days will commence on the date the plan is received (stamped) at the district office (see the attached *sample* Cruise Plan format in Section 3.6.5).

Cruise plans must be submitted to the appropriate district manager on either the prescribed Ministry of Forests format or on a format designed by the licensee or consultant, but containing all the information requested by the Ministry of Forests.

Response to cruise plans will be either in writing, e-mail or by phone within 10 working days.

3.6.5 Standards for Some Basic Cruise Functions

- Sample location must be sufficiently accurate to enable relocation of the samples at a future date. Fixed-area plots are subject to the standards in Section 3.3,
- adequate records must be kept of all data so that they may be traced to their specific sources for evaluation in their primary or later applications,
- the sampling design should meet the standards of Chapter 2,
- inadequate identification of plot centres, sample trees and strip lines in the field may also lead to rejection of the cruise, and
- forest typing must meet the criteria listed in Section 2.7.3.1 to ensure consistency of forest typing within cut blocks and among multiple cut blocks.

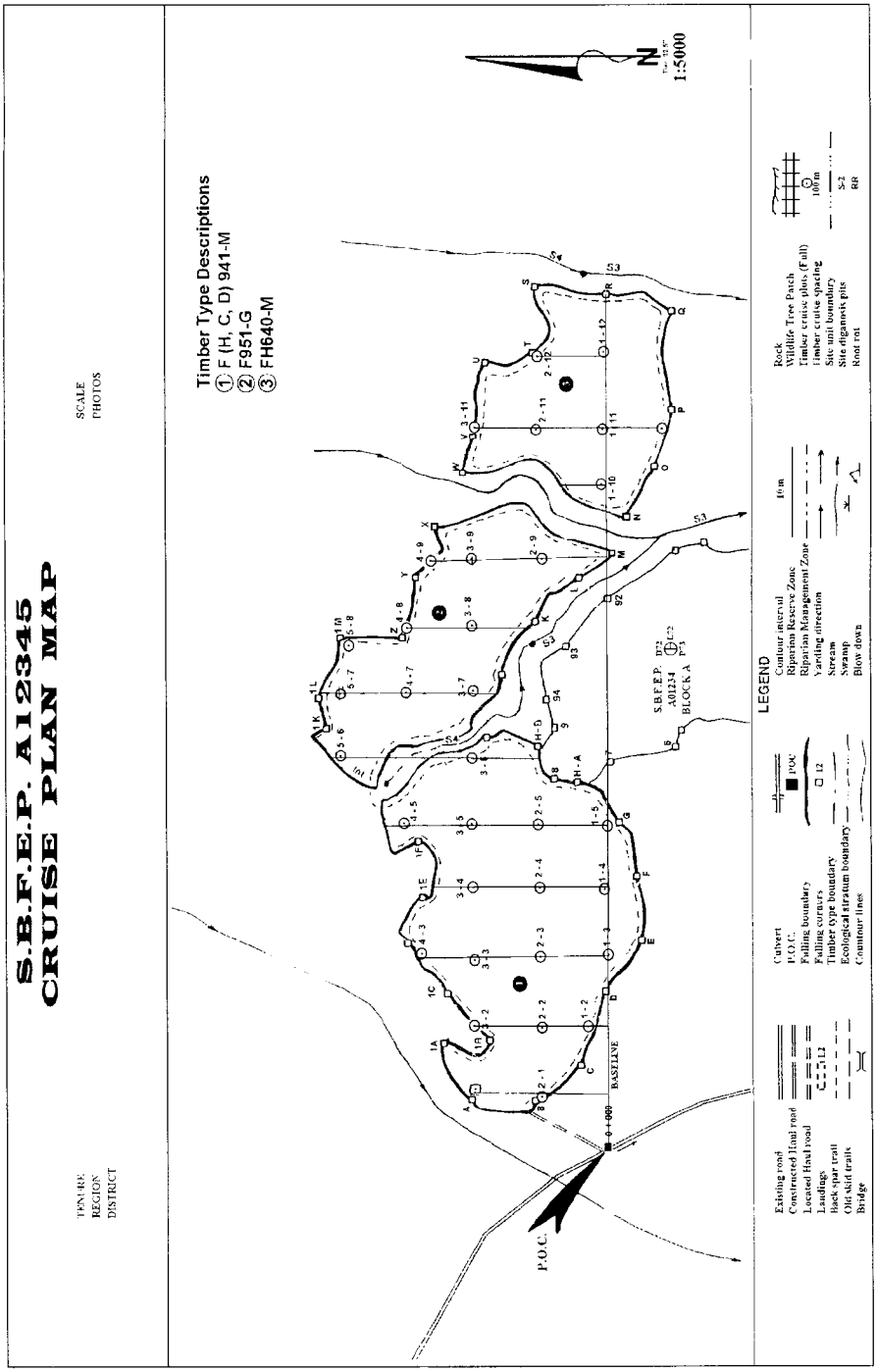


Figure 3.7 Cruise Plan Map.

Cruise Compilation Procedures 4

Because of numerous field observations, complex compilation requirements and a multitude of final reports for appraisal and operational purposes, the system has been oriented towards electronic computers with the facility to quickly and easily summarize the cruise data for each cutting permit or timber sale. Uniformity in the treatment of this data is one of the primary objectives of the system.

4.1 Input

The map area statement (FS 121) and tally sheet (FS 205) are the ministry format used for collection of cruise data. Cruisers may use their own versions of these forms. However, the ministry format and data sequence must be observed when submitting magnetic data for check compilation purposes.

4.1.1 Cruise Tally Sheet (FS 205)

The Ministry of Forests Cruise Tally Sheet (FS 205) has been designed so that the information from one sample plot can be directly key punched (Chapter 6).

4.1.1.1 Plot Record (Card Type 9)

Each plot record (Card Type 9) is identified by plot location within a timber sale or cutting permit, the forest type where it occurs, the average age and height of the co-dominant and dominant trees which is used to designate loss factors, volume table and calculation of site index. Also recorded here are plot type plot size or basal area factor, harvesting method and slope percent (Section 6.3.1).

4.1.1.2 Individual Tree Records (Card Type 2)

Individual Tree Records (Card Type 2) show species code, DBH, tree class, pathological and quality remarks (Section 6.3.2).

4.1.1.3 Sample Tree Details (Card Type 3)

Sample Tree Details (Card Type 3) include species code, DBH, crown class and measured height and ages (Section 6.3.3).

4.1.2 Map Area Statement (FS 121)

This form provides area information, cutting specification and height/DBH method for the cutting permit or timber sale (Chapter 7).

4.1.2.1 Cruise Identity (Card Type A)

This card establishes the location and describes the nature of the cutting permit or timber sale (Section 7.1).

4.1.2.2 Compilation Standard (Card Type B)

This card defines the standard of compilation and the output required for the sale (Section 7.2).

4.1.2.3 Type Description (Card Type C)

This card contains the type description and silviculture treatment units along with the type number which corresponds to that on the record for every stratum in the cutting permit or timber sale (Section 7.3).

4.1.2.4 Block Description (Card Type D)

The sampling plan is made on the basis of the timber sale or cutting permit which may consist of several sub-units, namely blocks or settings. This card allows the printout, if desired, by species of the net volume for each type in the sub-unit block (Section 7.4).

4.1.2.5 Height/DBH Description (Card Type E)

This card allows the amalgamation of sample trees for the same species in 2 or more types. Minor species should not be amalgamated. The 100 percent height method must be used. If a species for a given type has sufficient sample trees (see Section 3.5.7.1) or if a local height/DBH curve is provided, this card need not be used but if a species does not have sufficient heights then this card must be used to designate how the heights for each sample tree (Card type 2) will be calculated (Section 7.5).

4.1.2.6 Harvesting Method Description (Card Type F)

The sampling plan is made on the basis of the timber sale or cutting permit which may consist of several harvesting methods.

4.1.2.7 Silviculture Treatment Unit Description (Card Type G)

The treatment units are user coded so that reports are titled by the user definition.

4.2 Compilation Programmes

4.2.1 Height-DBH Relationships for Stump Cruises and Severe Damage Timber Cruises

Height-DBH relationships (curves or equations) by species must be used to determine the height for local conditions. Careful height measurement to the nearest 0.1 m and diameter measurements to the nearest 0.1 cm must be made on at least 20 sample trees of each major species in each type included in the cruise. Each major species must have its own curve. If minor species are present (refer to Section 8.2.2).

4.2.1.1 Height-DBH Regression Programme

This programme uses the height sample trees only to calculate regression constants, standard errors of the estimate for height and volume and the bias for both height and volume for the following equations.

1. Parabola $H=a+bD+cD^2$
2. Conditioned Parabola $H=1.3+bD+cD^2$
3. Hyperbola $H=\frac{a+b}{D+cD}$
4. Conditioned Hyperbola $H=\frac{1.3-bD}{(D+1)}+cD$
5. Weibull $H=a*\left[1.0-e^{(-b*D^c)}\right]$
6. Conditioned Weibull $H=1.3+a*\left[1.0-e^{(-b*D^c)}\right]$

Where a, b and c are regression constants:

- E is natural logarithm,
- H is Total height, and
- D is DBH.

The programme selects for the particular set of height sample trees under consideration, the equation which provides the lowest standard error of the estimate for volume. At this point the user has the option to override the computer selection and insert one of the other equations if the equation selected does not on inspection meet the requirements of fit over the range of DBH's.

If the curve with the lowest standard error generates a negative height at 10 cm DBH, the next best curve shall be selected.

Limitations:

1. There must be twenty height sample trees before the constants can be calculated for an equation.

2. The programme will only automatically calculate the height sample trees for a particular type. It will not group height sample trees into one equation for like species on the same site from another forest type unless Card Type E is coded with those instructions (see Section 7.5).

4.2.2 Volume and Taper Equations

The 1988 Kozak taper equations Version 4.1 are used to predict log diameters within each tree. These equations are a subroutine in the cruise compilation program.

The information necessary in this subroutine:

1. Species Code

1	=	F
2	=	C
3	=	H
4	=	B
5	=	S
6	=	Y
7	=	Pw
8	=	Pl
9	=	Py

10	=	L
11	=	Ac
12	=	D
13	=	Mb
14	=	E
15	=	At
16	=	Pa

2. Forest Inventory Zone.

Zone	Code
A, B, C	1
D, E, F, G, H, I, J	2
K, L	3

3. DBH - diameter at breast height (high side) outside bark (nearest 0.1 cm).

4. HT - Total height (nearest 0.1 m).

5. SH - Stump height for utilization (nearest 0.1 m).

6. TD - Top diameter for utilization (nearest 0.1 cm).

7. GOL - Log length for log breakdown. In the interior of BC the lumber recovery factors are based on 5 m logs.

Information provided by this subroutine:

1. Number of GOL metre long logs plus one short from the top of the tree.

2. Volume for each log (1, 2, etc.).

3. Top diameter inside bark for each log.

4. Length of top log.

5. Butt diameter inside bark of first log.

6. Total volume between stump height and top diameter.

7. Total volume between ground level and top of the tree.

8. Bark thickness at breast height.

A more complete description of the derivation of this taper equation can be found in the Canadian Journal of Forest Research by A. Kozak, entitled "A Variable-Exponent Taper Equation", Volume 18, 1988.

4.2.3 Net Volume Factors

The "Cruise Compilation Loss Factor Table Manual" specifies the loss factor tables to be used in the "Metric Diameter Class Decay, Waste and Breakage Factors", 1976, Ministry of Forests.

The proper application of the factors is outlined in the preamble preceding the tables. Suffice to note:

1. The factors are generally by species, age and Forest Inventory Zone.

2. Ministry of Forests local factors are published within this book and when available they *must* be used in preference to the Forest Inventory Zone factor for that species.

3. The age classes to which the loss factors (Forest Inventory Zone or local) apply are shown at the top of each table.

4. The factors usually consist of three Risk Groups, each group containing a percent loss for decay, waste and breakage. Some species may have only 1 or 2 Risk Group factors.

5. The table number of the loss factor used in compilation shall be entered on the output sheet, preferably the Plot Summary.

Dead potential trees (standing or down) will be compiled for volume using the Group III loss factors or the Group II factors for species where no Group III factors are available.

Dead and live useless trees (standing only) will not be compiled for volume but must be recorded as they provide a record of the number of snags per hectare.

In applying the loss factors it must be emphasized that they must be applied individually and in the correct order to the gross merchantable volume of the log or tree.

4.3 Volume Compilation - Fixed Area Plot Cruising

Total cutting authority volume will be based on compiling the volume of each plot, as this information is necessary in order to calculate the sampling error of the cruise. If the cutting authority has been stratified, a total volume for each type will be compiled separately.

Type volume is the average volume (i.e., sum of plot volumes divided by number of plots measured) multiplied by the possible number of plots that could be included in the type of cutting authority. If volume per hectare is required, this is the average plot volume divided by plot size. Cutting authority or type volume is then volume per hectare times cutting authority or type area.

4.4 Log Grade Volume Compilation

The cruise programme calculates:

1. For the interior appraisal zones, lumber and chip recoveries.

2. For the coast appraisal zone, volumes by log grades.

The logic for these calculations may be found in the Ministry of Forests, Revenue Branch, *Cruise Compilation Design Manual*.

4.5 Volume Compilation - Variable-Plot Cruising

In Variable-Plot (prism) cruising, since the radius of the plot varies directly with the diameter of the individual trees being measured, every tree has its own plot size. The area of the plot is directly proportional to the basal area of the tree diameter it represents. Therefore, the relationship of the basal area of one tree to its plot area is the same as the relationship projected to a hectare basis. Basal area per hectare, for a given prism, is the same for every tree regardless of diameter 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 x 30 = 6 m. Therefore, a 30 cm tree is counted if it falls within 6 m of the sample point.

The area of 6 m radius plot is 113.098 m^2 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 x 0.07069 or 6.25 m^2.

Similarly a 90 cm tree has a plot radius of 0.2 x 90 = 18 m and an area of 1017.878 m^2 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 x 0.63617 or 6.25 m^2.

In the foregoing example it is shown that each tree regardless of diameter, contributed 6.25 m^2 of basal area per hectare. The Basal Area Factor of the prism used was 6.25. Therefore, total basal area per hectare can be calculated directly by multiplying stem count per point x basal area factor, and this 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, and enough tree heights to be able to assign a height to all trees which have been measured for DBH. There are several possible methods of calculating volume per hectare, depending on the method of sampling used and the kind and amount of information required (e.g., total volume per hectare, volume per hectare by species, number of trees per hectare either total, by species or by diameter classes).

4.5.1 Compilation Methods - Using a Single Prism and Full Sweep (360°)

1. A common method of prism cruising is to use the prism simply as a range finder (i.e., to use the prism to determine which trees are to be tallied on the sample). All "in" trees are then recorded by species and DBH and enough sample trees measured for height to permit the derivation of height-diameter relationships (i.e., height -DBH curves or equations). The number of trees per hectare that each counted tree represents is then calculated by first multiplying the plot radius factor times the tree diameter to give the area or plot size each tree with that particular diameter represents and second, by dividing the area of one hectare by the tree's "plot" area.

   Here is the formula for trees per hectare (TPH):

$$tph = \frac{10{,}000 x baf}{\pi\left(\frac{dbh}{2}\right)^2}$$

   The volume of a tree of given DBH and height is determined from a standard volume equation (Newton's) and multiplied by the number of trees per hectare which each counted tree represents (e.g., a prism having a basal area factor of 4, plot radius factor of 0.25) counts one mature fir tree in the Interior (residual) which has a 30 cm DBH and is 21 m tall. Each 30 cm DBH, tree represents 56.59 trees per hectare. The whole stem volume of this tree is 0.525 m^3.

   Therefore, the whole stem volume per hectare represented by this one counted tree is $56.59\,{}^{t}/_{ha} \times 0.525\,{}^{m^3}/_{t} = 29.73 m^3/ha$. It is then necessary to reduce this volume to gross and then net merchantable volume by calculating first the gross volume between stump-height and minimum utilization diameter, dib, for the toplog to determine the gross merchantable volume and then applying the loss factors for decay, waste 2 and breakage (or, in some cases, decay and breakage only) to arrive at the net merchantable volume.

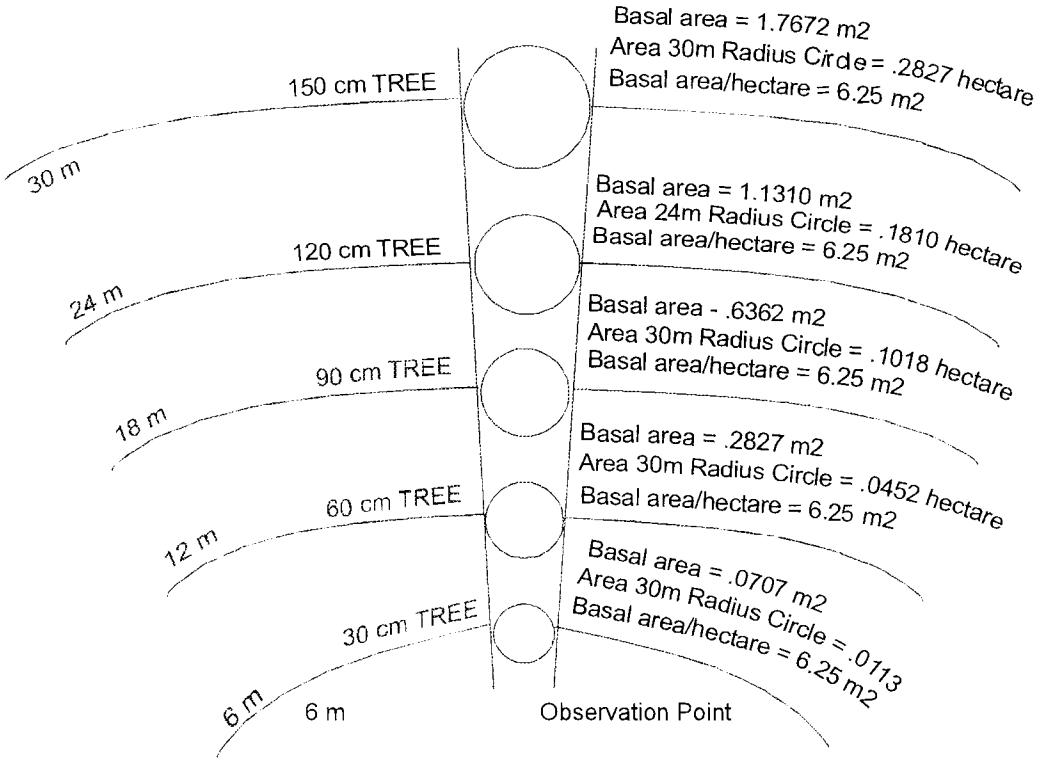


Figure 4.1 Illustration of Basal Area/Hectare.

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.

4.5.2 Compilation Methods - Using 2 Different Prisms And Full Sweep (360°)

It is important to remember that when two different prisms are used, the trees included by each prism will be handled separately. If compiling is done by determining the number of trees per hectare represented by each counted tree, then care must be taken to use the plot radius factor corresponding to the prism used for each DBH range.

4.5.3 Compilation Methods - Using One Prism With Full And Half-Sweeps

If full sweeps are used, the stem count at each sampling point is converted to basal area per hectare. When half-sweeps are used the stem count at each sampling point is doubled by the computer and then converted to basal area per hectare. Therefore in calculating volume per hectare for trees included by a half-sweep the following procedure is required:

Calculate the plot radius for each tree by multiplying tree DBH by the prism plot radius factor (prf). The area of the plot calculated from this plot radius is divided into the area of one hectare. This resulting value is the number of trees per hectare that a given tree represents for a full sweep plot (360^{o}). However, when a half-sweep (180^{o}) is used, the number of trees represented by each counted tree are on a half hectare basis and so the resulting number of trees represented by each counted tree must be doubled by the compilation program to bring the answer up to a per hectare basis.

It is important to note that in calculating volume for the trees counted on the half-sweep, the compilation program multiplies the prism BAF used by two, since the prism basal area factor is for one hectare. For example, consider a 30 cm DBH tree counted using a prism with a basal area factor of 4. The plot radius for this tree is 7.5 m and the plot area is 0.01767 ha. However, if the tree is included in a half-sweep the plot area is only 0.00883 ha or the same plot area as for a 30 cm DBH tree included in a full sweep using a prism with a basal area factor of 8.

> The computer compilation programme makes the appropriate adjustment.

4.5.4 Compilation Methods - Using Count-Plots

Where count plots are recorded in addition to measured plots, volumes calculated from measured tree data by species are modified by multiplying each species volume by the total species stem count of the measured and count-plots and the number of measured plots and dividing by the species stem count of the measured plots and by the total number of measured and count plots. Where sample plots have been stratified by timber type, the calculations are made for each type using only the data of measured and count-plots which are located within the type area.

A double sampling ratio (DSR) is calculated to prorate species volumes by timber type when count plots are included in a prism cruise.

Assume a timber type includes two full measure and two count plots using a BAF 10 prism in the following example:

Full meaure plot	#1 - 4 Fir	Total = 9 Fir
Full measure plot	#2 - 5 Fir	
Count plot	#1 - 6 Fir	Total = 8 Fir
Count plot	#2 - 2 Fir	
Total	17 Fir	

$$DSR_{(fir)} = \frac{Number\ measure\ plots}{Total\ number\ plots} x \frac{Total\#\ trees\ /\ species\ x\ Average\ Basal\ Area}{\#\ measure\ trees\ /\ species\ x\ Average\ Basal\ Area}$$

$$= \frac{2}{4} x \frac{17x10}{9x10}$$

$$DSR_{(fir)} = 0.9444$$

4.6 Computer Compilation Output

The cruise compilation shall accurately represent the area and volume to be appraised and shall be compiled on the most recent version of the cruise compilation program approved by the Revenue 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 Manager or their designate.

For cruises compiled by electronic data processing methods, the following basic data will be submitted with the volume compilation for either/or both Coast and Interior timber sales or cutting permits.

4.6.1 Summary of Required/Optional Reports

001a	Edit report (data listing) of cruise data or 3.5 diskette	Required - electronic
001b	Scattergram of Card Type 2's and Card Type 3's	Required if ht/dia curves used - electronic
003a	Scattergram of Sample Trees - Regression Coefficients	Required if ht/dia curves used - electronic
003b	Original scattergram and regression coefficients if suggested curve is overridden. Provide a written explanation and computer report of actual keyed values	Required if ht/dia curves used - electronic
004a	Edit checks if calculating heights from height curves	Required if ht/dia curves used - electronic
004b	Double Sampling Ratios	Required - electronic
005a	Percent Reduction input values	Required - electronic
005b	Cruise Statistics	Required – hard copy
006	Extended Forest Type Stand and Stock Tables	Clearcut - optional – electronic Partial cut - required – electronic or hard copy upon request
006	Partial Cut Damage Reports	Required – hard copy upon request
007	Stand and Stock Tables	Clearcut – optional – electronic Partial - required – electronic or hard copy upon request
007	Partial Cut Damage Reports	Required – hard copy upon request
008	Volume and Lumber Recovery Information (Interior compilations)	Required – hard copy
009	Volume Summary	Required - hard copy & electronic
009	Partial Cut Damage Reports	Required – hard copy upon request
011	Plot Summary	Required – hard copy & electronic
012	Plot Summary by Maturity (Coast compilations only)	Required - electronic
015a	Harvesting Method and Appraisal Summary	Required - hard copy & electronic
015b	Second and Old Growth Summary (Coast compilations only)	Required - hard copy & electronic

Figure 4.2 Required/optional reports.

If percent reduction is being applied, two sets of reports will be required. The original reports before percent reduction applied and the reports after percent reduction has been applied. Also required are the keyed input values for the percent reduction.

* Electronic = 3.5 diskette

Cruise Analysis 5

5.1 General

For each cruise the sampling error and the coefficient of variation must be calculated. The sampling error will be calculated to the utilization standard specified for the cutting authority.

5.2 Calculation of Sampling Error - Variable Plots

When volume is compiled by calculating the number of trees per hectare represented by each counted tree.

5.2.1 Stratified Sampling

In this case a volume per hectare is determined for each plot.

Using a 30 ha timber sale stratified into 21 ha of fir-lodgepole pine (type 1) and 9 ha of lodgepole pine (type 2). There are 22 plots in type 1 and 9 plots in type 2. For type 1 the average volume per hectare is 202 m^3, the coefficient of variation is 30 percent, and the sampling error is:

$$\frac{CV}{\sqrt{n}} = \frac{30.0}{\sqrt{22}} = \text{plus or min us } 6.39 \text{ percent at 1 S.E.}$$

For type 2 the average volume per hectare is 214 m^3, the coefficient of variation is 35 percent, and the sampling error is 11.67 percent at 1 S.E.

The sampling error for the total sale volume is calculated as follows:

Type	Area Hectares	Volume/ Hectares	Total Volume	P.V. (a)	$(P.V.^2)$	S.E. % (b)	$(S.E.)^2$	$(P.V.)^2 \times (S.E.)^2$
1	21	202	4,242	0.6877	0.4729	6.39	40.83	19.31
2	9	214	1,926	0.3123	0.0975	11.67	136.19	13.28
	30		6,168	1.0000				32.59

1. P.V. = proportional volume.

2. S.E. = sampling error.

Sampling error $=\sqrt{32.59}$ = plus or minus 5.71 percent at 1 S.E.

Degrees of freedom equals (22-1) + (9-1) = 29 and from Table 7 the value of "t" for 29 degrees of freedom is 2.045. Therefore, the sampling error for a probability of 19 times out of 20 is 2.045 x 5.71 = plus or minus 11.68 percent.

5.2.2 Unstratified Sampling

If the timber sale or cutting permit has been sampled as a single type, then the sampling error (percent) at 1 S.E. is simply the coefficient of variation divided by the square root of the number of plots. The procedure for obtaining the error at a probability of 19 times out of 20 is as shown above.

5.3 Calculation of Sampling Error - Fixed Area Plots

5.3.1 Stratified Sampling

If the tract has been stratified into a number of types, then generally each type will have a different area and will have been sampled with a different number of samples. The sampling error is then calculated as the square root of the sum of the variance for each type. Type variance is calculated as:

$$\text{Variance} = \frac{\frac{N_1 - n_1}{N_1} \times N_1^2 \times S_1^2}{n^1} \text{ where :}$$

N = total possible number of plots of the size used to sample the type that could be established in type 1.

n = actual number of plots established in type 1.

S = standard deviation for type 1. Standard deviation times 100 divided by mean plot volume equals coefficient of variation in percent (see Section 2.6 for calculation of standard deviation).

Assume we have a 30 ha timber sale stratified into 21 ha of fir-lodgepole pine (type 1) and 9 ha of lodgepole pine (type 2). The sampling plan consisted of twenty-two 0.04 ha plots in type 1 and nine 0.04 ha plots in type 2. The standard deviation of plot volume for type 1 is 4 m^3 and for type 2 is 6 m^3. The average plot volume for type 1 is 16.3 m^3 and for type 2 is 17.3 m^3.

0.04 ha plots 22 plots type 1, standard dev. type 1 = 4 m^3
9 plots type 2, standard dev. type 2 = 6 m^3

Plus 17.5 cm DBH close utilization less decay only; the sampling error is calculated as follows:

Variance type 1

$$= \frac{\frac{N_1 - n_1}{N_1} \times N_1^2 \times S_1^2}{n^1}$$

$$= \frac{\frac{\left(\frac{21}{.04}\right) - 22}{\left(\frac{21}{.04}\right)} \times \left(\frac{21}{.04}\right)^2 \times (4)^2}{22} = 192{,}054.54$$

Variance type 2

$$= \frac{\frac{N_2 - n_2}{N_2} \times N_2^2 \times S_2^2}{n^2}$$

$$= \frac{\frac{\left(\frac{9}{.04}\right) - 9}{\left(\frac{9}{.04}\right)} \times \left(\frac{9}{.04}\right)^2 \times (6)^2}{9} = 194{,}400.00$$

Error (volume) $= \sqrt{192{,}054.54 + 194{,}400.00} = 621.65$

Error (percent) $= \frac{\text{Error Volume}}{\text{Total sale volume}} \times 100$

Total sale volume = the summation of average plot volume times the total possible number of plots for each type.

Total sale volume $= 16.3 \times 525 + 17.3 \times 225 = 12\,450\ m^3$

Sampling error (%) $= \frac{621.65}{12\,450}\ m^3 \times 100 =$ plus or min us 5.0 percent at 1 S.E.

Since the sampling error must be expressed for a probability of 19 times out of 20, it is necessary to determine the number of degrees of freedom and the corresponding value for "t". Degrees of freedom equals the sum of number of plots minus one for each type (i.e., (22-1) + (9-1) = 29). From Table 3 the value of "t" for 29 degrees of freedom is 2.045.

Therefore, the sampling error (percent) for a probability of 19 times out of 20 is:

2.045 x 5.0 = plus or minus 10.22 percent

5.3.2 Unstratified Sampling

If the timber sale or cutting permit has been sampled as a single type, then the sampling error (volume) at 1 S.E. is simply the square root of the variance of the type. The procedure for obtaining the error (percent) at a probability of 19 times out of 20 is as shown above.

5.4 Interpretation of Sampling Error

The introduction of statistical methods cannot change the element of chance or improve on the results of individual cruises. It does however provide a measure of confidence in results, known as sampling error. For the odds quoted (19 times out of 20), for the type of timber measured, for the size of sale and for the kind and intensity of sampling employed. The sampling error is a limiting difference that will only be exceeded 1 time in 20 because of chance effects of sampling which are beyond the control of the cruiser.

It should be noted that the estimate for sampling error from a cruise does not tell how much the timber sale volume estimate of that cruise would vary from a 100 percent cruise volume. The actual result of a cruise is not claimed as any more reliable an estimate of the volume than any other number between the limits quoted, but for administrative purposes is assumed to be the correct volume.

Ministry of Forests Cruise Tally Sheet (FS 205) 6

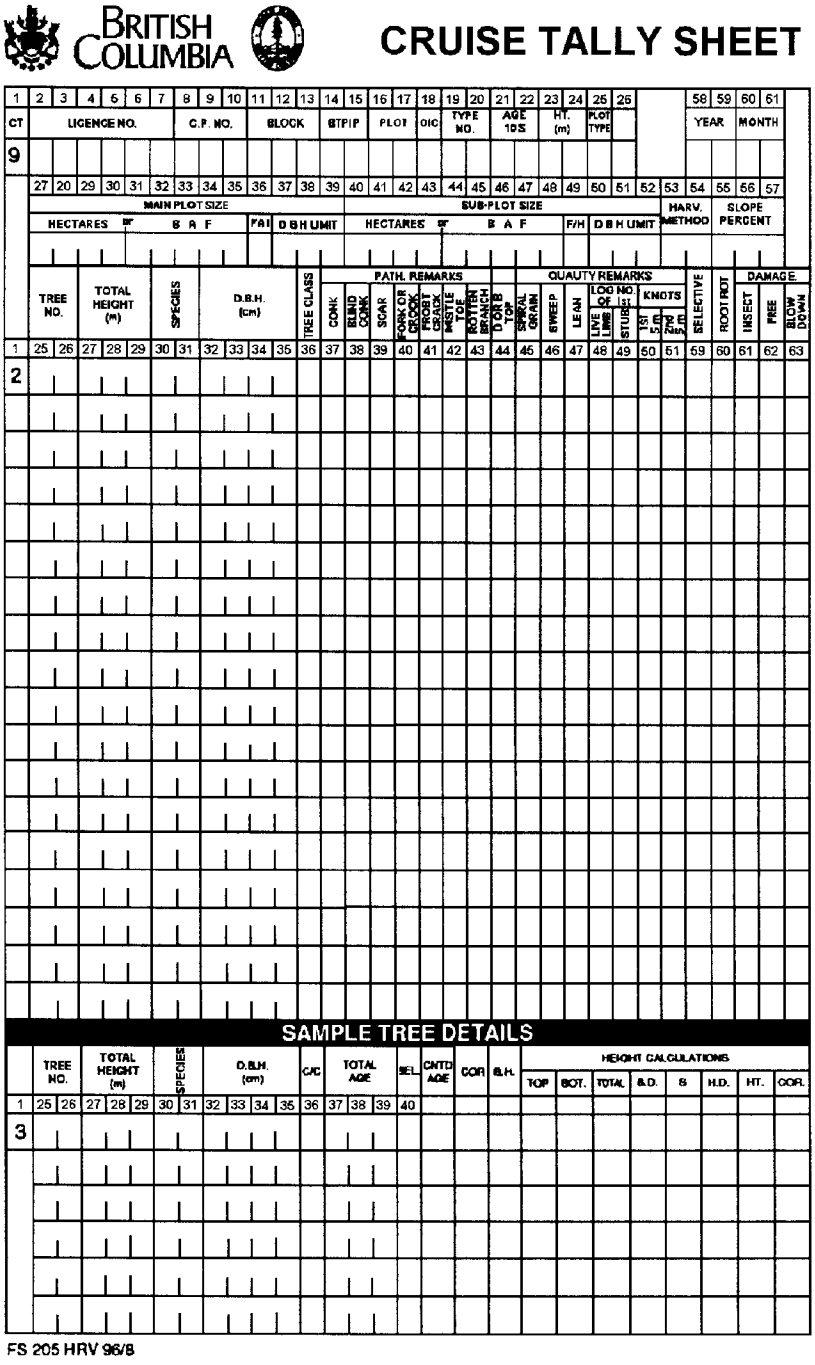
6.1 Form Design - General

Measurements taken on samples established in timber sales, cutting permits, etc. will be recorded on the FS 205 Cruise Tally Sheet. The front side of the form identifies the plot, records the plot sizes and individual tree measurements while the reverse side provides the sample tree height information.

6.2 Entry of Data in Divided Spaces or Numbered Columns

Alphabetic fields are left justified as in the species code whereas numeric fields are right justified. It is not absolutely necessary that zeros be entered in spaces not required but their use helps avoid errors in placing the digit in its correct column and it is extremely important that this error is not made. For example, if columns for an item are 8, 9 and 10 and the magnitude of the item ranges from 0 to 999, then column 10 will be used for the units digit, column 9 for the tens digit and column 8 for the hundreds digits. For example:

	8	9	10
4 entered as	0	0	4
54 entered as	0	5	4
954 entered as	9	5	4



FS 205 HRV 96/8

Figure 6.1 Front Side of Cruise Tally Sheet (FS 205 HVA 96/8).

6.3 Front Side of Cruise Tally Sheet (FS 205 HVA 96/8)

6.3.1 Card Type 9

Position 1 Identity Information

This card is to be completed for every new plot. The data on this card gives the location of the plot, forest type in which it occurs, average age and height, and the plot type.

If more than one sheet is required to code all the tree measurements on a given plot, the strip and plot number should be repeated on the second sheet.

Position 2-7 Licence Number

Enter:

1. For X type licences:

Position:	2	X
	3	Region
	4 and 5	Year
	6 and 7	District No. (Region = 00)

2. A56789 for licence A56789.

3. TFL001 for TFL 1
   TFL038 for TFL 38.

4. YV0001 for licence to cut.

5. TL0421 for Timber Licence TL 421.

6. If Unauthorized Timber Harvesting use the ERA case file number in positions 2 to 10.

Position 8 to 10 Cutting Permit

Enter:

- can be either left or right oriented. Each tally sheet must be entered in the same format,

- 001 for Cutting Permit #1 (right oriented) (zero entries may be left blank),
- 38 for Cutting Permit #38 (left oriented), and
- A for Cutting Permit A.

-"X" type = sequential numbering -- CP 001 for the first District or Region compilation for that fiscal year and CP 002 for the next cruise in the same District or Region in the same fiscal year, etc.
-"Y" licence numbers -- cannot have a cutting permit. These positions must be left blank.
-"A" licence numbers -- might or might not have a cutting permit number, BUT if there is not a cutting permit number, the positions cannot be left blank. There must be at least one zero in one of these three positions.

Position 11 to 13 Block (within the Cutting Permit)

Enter:

- can be either left or right oriented. Each tally sheet must be entered in the same format,
- 001 for Block #1 (right oriented) (zero entries may be left blank),
- 38 for Block #38 (left oriented), and
- A for Block A (left oriented).

Position 14 to 15 Strip Number or Letter (Number or Letter of Strip on which Plot is Located)

Enter 01 for strip #1.

Strips should be numbered or lettered consecutively without duplication for a Block.

Position 16 to 17 Plot Number or Letter

Will accept alpha/numeric designations, either left or right oriented.

Enter 01 for plot #1.

Plots are to be numbered consecutively without duplication on a strip.

Position 18 O/C This Field Must Be Entered

Enter:

O if original measurements.

C if check cruise measurements.

Position 19 to 20 Type Number

Enter the number given to the type in which this plot is located (corresponds to positions 14, 15 on Card type C).

Position 21 to 22 Age in 10's This Field Must Be Entered

Enter the average total age in tens of co-dominants of the first major species in the plot. Following are the age limits with the age class code:

Age Limits (years)	Class	Age Limits (years)	Class
21-30	03	91-100	10
31-40	04	101-110	11
41-50	05	111-120	12
51-60	06	121-130	13
61-70	07	131-140	14
71-80	08	141-250	15 to 25
81-90	09	251 plus	26

It is important that these age class limits be observed as they govern the proper selection of loss factors.

Coast

The second growth reporting in the 015B – All Harvesting Method Summary will include tree classes 1, 2, 3, 8 and 9 when the age in 10's for the plot is 13 or 14.

Three scenarios for *trees* (not plot age) 121 to 140 years old are provided for further clarification:

1. *Trees* that are 121 to 140 years old in an immature plot (age in 10's less than or equal to 12) will continue to be tree class 5 trees. Tree class 5 trees *will not* be included in the second growth percent.

2. Trees that are 121 to 140 years of age in a plot of an age in 10's greater than or equal to 15 will not be included in the second growth percent. They will continue to be tree class 1, 2, and 3 trees.

3. Trees that are 141 years plus in a plot of an age in 10's 13 or 14 must be recorded as tree class 5 or 7 trees.

Loss factor assignments and log grade algorithm predictions will not be effected by this change to the percent second growth reporting in the 015B report.

Position 23 to 24 Height in metres

Enter the height to the nearest 1 m for the dominant and co-dominant trees of the major species in the plot. This classification applies to the plot area only and is based on sample tree heights taken on the plot.

Position 25 Plot type

- Blank or "M" for measured plot,
- "C" for count plot, and
- "S" for stump cruise.

Position 26 This column is not in use.

Positions 27 to 39 Main Plot Size (this field must be entered)

These positions describe the plot size of the main stand element being sampled and the minimum DBH.

Position 27 to 30 Hectares (Fixed Plot)

Enter plot size in hectares for circular or rectangular shaped fixed plots: Leave blank if prism plots are used.

The following plot sizes are recommended:

Size (hectares)	Circular Plots Radius (metres)	Square Plots One Side (metres)
0.005	3.99	7.07
0.010	5.64	10.00
0.02	7.98	14.14
0.03	9.77	17.32
0.04	11.28	20.00
0.05	12.62	22.36
0.06	13.82	24.49
0.08	15.96	28.28
0.10	17.84	31.62
0.20	25.23	44.72

Positions 31 to 35 Basal Area Factor (BAF Variable Plots) m^2/ha

Enter the BAF for the main stand element being sampled. It must be entered to three decimal places.

Imperial/Diopter Conversions

BAF (m^2/ha) = BAF (sq. ft./acre) x 0.229568
where 1 square foot per acre = 0.229568 m^2/ha

BAF (m^2/ha) = $10,000/(1+ (200/diopters)^2)$
Where 1 diopter represents a right-angled deflection of one unit per one hundred units in distance or 0.5728888° (decimal degrees).

Position 36 Prism Sweep

Enter:

- F (full 360° plot) - All trees,
- H (half 360° plot) - Every second tree, and
- B (border 180° plot) - All trees in measured 1/2 of plot.

Position 37 to 39 DBH Limit

The minimum DBH to which the trees on the main plot are measured. Examples:

Interior	Coast
1. PL with other species code 12.5 cm	1. Immature - code 12.0 cm
2. PL absent from cruise area – code 17.5 cm	2. Mature - code 17.5 cm

The MAS determines the compilation level of the cruise. Measured trees below this minimum can be tallied but, based on diameter, will be ignored in the compilation. For count-plots the minimum DBH tallied must be the same as the DBH entered on the Map Area Statement (MAS) Section 7.2, Positions 19 to 21.

Positions 40 to 52 Sub-Plot Sizes

In stands with an excessive number of stems in the lower diameter classes, a sub-plot may be established for these lower diameter classes. To prevent unnecessary error, the same sub-plot size should be maintained throughout the timber type. The sub-plot size should never equal or be larger than the main plot size.

Position 40 to 43 Hectares (Fixed Plot)

Smaller plot areas may be required and the following are acceptable in addition to any listed under the main plot (Positions 27 to 30).

Hectare	Radius (m)
0.005	3.99
0.008	5.05
0.010	5.64
0.020	7.98

Position 44 to 48 Basal Area Factor (BAF) Variable Plots

See description as per Main Plot entries in Positions 31 to 35.

Position 49 Prism Sweep

See description under Main Plot entries in position 36.

Positions 50 to 52

The minimum DBH to which trees on the subplot are measured.

Position 53 to 54 Harvesting Method

The harvesting method which will be used:

HC	=	helicopter clearcut
HS	=	helicopter selective
CC	=	cable clearcut
CS	=	cable selective
SL	=	sky line
HO	=	horse
SC	=	ground skidding-clearcut
SS	=	ground skidding-partial cutting
SP	=	specified operation

Position 55 to 57 Slope Percent

Record the most severe slope measurement in any direction to a point 15 m horizontal distance from plot centre. If slope is missing, it will be compiled as a zero. Plot slope in a border plot must be measured from within the 15 m arc in the plot. Plot slope must be recorded in count plots.

Position 58 to 61 Date

Record the year and month that the fieldwork was performed. This information will be entered in the compilation.

6.3.2 Card Type 2

Position 1 Tree Details

This card contains the individual tree details or quality and size measurements.

Positions 2 to 24 Common to Card Type 9

Position 25 to 26 Tree Number

Number consecutively preferably from 1 for each plot (no duplicate numbers on any plot). Plot trees selected as sample trees maintain the same number in Sample Tree Details.

Positions 27 to 29 Total Height

When a height is measured or estimated and entered here, it will be used in the calculation of that individual tree's volume. The height must be recorded to the nearest 0.1 m.

Positions 30 to 31 Species

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

Genera 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 should only be used when positive identification can be made in the field and the appraisal requires it, however, they must be combined by genus for the harvest method summary.

Commercial Tree Species Names and Symbols

Common Name of Genus/Species	Scientific Name of Genus/Species	Genus Symbol*	Species Symbol*
Alder	Alnus	**D**	
Red Alder	A. rubra		Dr
Balsam	Abies	**B**	
Alpine fir	A. lasiocarpa		Bl
Amabilis fir	A. amabilis		Ba
Grand fir	A. grandis		Bg
Birch	Betula	**E**	
Common paper birch	B. papyrifera		Ep
Alaska paper birch	B. neoalaskana		En
Cedar	Thuja	**C**	
Western red cedar	T. plicata		Cw
Cypress	Chamaecyparis	**Y**	
Yellow cedar	C. nootkataensis		Cy
Douglas-fir	Pseudotsuga	**F**	
Douglas-fir	P. menziesii		Fd
Hemlock	Tsuga	**H**	
Mountain hemlock	T. mertensiana		Hm
Western hemlock	T. heterophylla		Hw
Larch	Larix	**L**	
Alpine larch	L. lyallii		Ll
Tamarack	L. laricina		LT
Western larch	L. occidentalis		LO
Maple	Acer	M	
Broadleaved maple	A. macrophyllum		**Mb**

Common Name of Genus/Species	Scientific Name of Genus/Species	Genus Symbol*	Species Symbol*
Pine	Pinus	P	
Lodgepole pine	P. contorta		**Pl**
Western white pine	P. monticola		**Pw**
Whitebark pine	P. albicaulis		**Pa**
Yellow pine	P. ponderosa		**Py**
Poplar	Populus	A	
Aspen	P. tremuloides		**At**
Balsam poplar	P. balsamifera		**Ac**
	sub. sp. balsamifera		
Black cottonwood	P. balsamifera		**Ac**
	sub. sp. trichocarpa		
Spruce	Picea	**S**	
Black spruce	P. mariana		Sb
Englemann spruce	P. engelmannii		Se
Sitka spruce	P. sitchensis		Ss
White spruce	P. glauca		Sw
Yew	Taxus	**T**	Optional
Western Yew	T. brevifolia		

* 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 used.

Positions 32 to 35 DBH

Enter the diameter in centimetres and decimal centimetres at breast height (1.3 m above the high side) of each tree equal to or above the contract specification. Whole numbers are recorded as decimals (e.g., 12.0 not 12).

Where diameters are measured to the nearest cm, they will be recorded as 24.0, 17.0 etc.

Position 36 Tree Class (see Section 3.5.6 for Detailed Descriptions)

The tree class must be consistent with the age in 10's reported by plot.

Positions 37 to 44 Pathological Remarks

Refer to the box entitled "Path Code". This indicates the numerical coding to be used in this section. The tree is schematically divided into thirds, with the left-hand block representing the bottom third, and middle block the middle third, and the right-hand block the top third. The shading indicates in which third or thirds the defects occur. The applicable numerical code is shown to the left of the blocks. Thus, if the defects occur in the lower third only, "1" is entered under the class of defect; if they occur in both the middle and upper thirds, "5" is entered; etc.

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

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 suspect characters listed must be noted where they occur.

Refer to the Cruise Compilation Loss Factor Table for pathological occurrence by species and forest inventory zones.

Examples:

1. A suspect tree has conks on the middle and upper thirds of the trunk and an open basal scar on the lower third. Under "Conk" enter "5" and under "Scar" enter "1".

2. A suspect tree has a fork on the middle third, blind conks on the upper third and a broken top. Under "Fork" enter "2", under "Blind Conk" enter "3" and under "D. or B. Top" enter "3".

3. A suspect tree has a fork on the middle third, with a frost crack extending from the ground to the fork; one of the leaders of the fork is broken and the leader is not of merchantable size. Under "Fork or Crook" enter "2", under "Frost Crack" enter "4".

Positions 45 to 51 Quality Remarks - Optional in Interior

The quality information will be collected on all age classes and will apply to all commercial living trees plus dead potential standing or down trees found on the plot and on the largest leader on a forked stem. This is in addition to the eight pathological indicators of decay which can also be considered as affecting the quality of products obtained from a given tree.

Quality remarks must include information on all items indicated under this heading. Codes are indicated in the "Quality Code" box on the back of the plot sheet.

Position 45 Spiral Grain

Also known as "twist". The direction of the grain can best be seen in exposed wood such as the open scars in living trees or dead trees with sloughing bark. Spiralling bark fissures and frost cracks provide the next best evidence of the characteristic.

Spiral grain or twist shall be estimated at the halfway point between stump height and 10.3 m and expressed as a percentage.

- Determine the most severe spiral grain on the 1 m section at 5.3 m above the high-side. The offset from the vertical line in centimetres is the percent spiral grain per metre. Use the spiral at DBH as a guide for estimation.

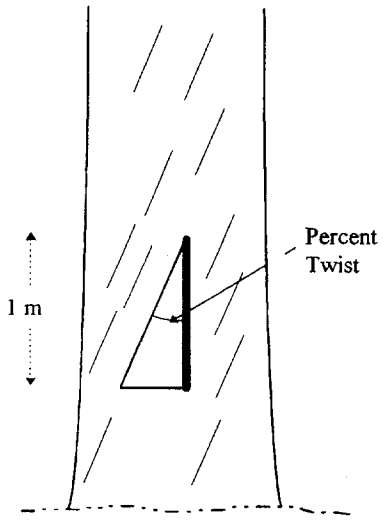


Figure 6.2 Determination of percent twist.

Recording Code	% Displacement	Recording Code	% Displacement
0	0 - 5%	5	46 - 55%
1	6 - 15%	6	56 - 65%
2	16 - 25%	7	66 - 75%
3	26 - 35%	8	76 - 85%
4	36 - 45%	9	86 +

Experimental interior log grade algorithm

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

The sap rot and weather check codes are as follows:

1. Record by tree third as per pathological indicators.

2. Record codes 1 to 7 for tree thirds that will not be suitable to produce 50 percent lumber.

Refer to Appendix 8 for a more detailed description of the algorithm.

> This algorithm is currently coded in the Ministry of Forests cruise compilation program for testing purposes.

Position 46 Sweep - Currently not required on the Coast

Sweep must be distinguished from crook, which is recorded under Path Remarks but not Quality Remarks. Sweep is the gradual bowing of one-half of the merchantable bole of the tree; crook is an abrupt bend in the tree caused by a broken main-stem leader, with resulting exposure of the heartwood to decay organisms. The angle of sweep is determined by means of the Christen's hypsometer. This is the angle subtended at the point of germination between the vertical and straight line to a point midway along the length of the sweep. It may affect either the top half of the tree ("top sweep") or the bottom half ("bottom sweep" or "hockey stick"). Coding is as follows:

Code	Angle	Remarks
0	0° - 4.9°	No sweep
1	5° - 9.9°	Minor sweep
2	10°+	Major sweep

Position 47 Lean - Currently not required on the Coast.

Lean is the deviation of a straight stem from the vertical. The angle of lean is determined by the angle gauge on the Christen's Hypsometer. This is the angle subtended at the point of germination between the vertical and the direction of the bole. Coding is as follows:

Code	Angle	Remarks
0	0° - 4.9°	No lean
1	5° - 9.9°	Minor lean
2	10°+	Major lean

> A tree can be coded as having either lean or sweep; not both.

Log Number

"Logs" are individual 5 m lengths and are numbered starting at the top of a 30 cm "stump".

Position 48 Live Limb (Grade Change)

Definition: The 5 m log where quality changes from: *no knots* to *knots or knot indicators* or from *small knots* to *large knots* or from *well spaced knots* to *excessive knots*.

The purpose of recording live limb is to identify the first grade change as you move up the tree.

This will assist the log grade algorithm to better determine the cruise grade distribution produced by the cruise compilation program.

If the branching is consistent in frequency and size from the base of the utilization top of the tree, record live limb as a one (1).

The grades on trees smaller than 60 cm DBH are not affected by the live limb code. On deciduous trees, live limb is recorded as the 5 m log where the natural forking starts.

Position 49 Log No. of 1st Stub

Enter the log number on which the first stub or first branch occurs, irrespective of diameter or length. This may occur on the same log as the Base of Crown or at some point below.

Any stub, live or dead branch, is considered when identifying the log number of the first stub (see the following Section for discussion of epicormic branching).

Positions 50 and 51 Knots, 1st 5 m and 2nd 5 m

The location of clear surface area in the first two 5 m logs indicates the potential grade of a log. The location of the four quarters on the second 5 m log must be the same as the location of the four on the first 5 m log.

A clear quarter must be free of any open knot, knot indicator, branch stub, dead or living side branch, bunch knots or forks. Epicormic branches, suckers and candelabras are not classed as knots. 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 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.

Positions 52 to 56

These columns are not in use.

Position 59 Partial Cutting

L = leave tree

Blank or C = cut tree

Position 60 Miscellaneous - optional data collection.

Root Rot

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 Grading – Saprot/Checks – see Algorithm (Appendix 8)

Use location codes 1 to 7:

- coding is same as pathological indicator tree positions,
- see also position 45, spiral grain for code definitions, and
- knot code 6 (see Section 6.3.2, Position 50 and 51) second 5 m log moves tree into chipper.

Positions 61 to 63 Damage Codes (see Section A.7.1)

Damage codes are to be used at all times, and shall be recorded as they appear 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.

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

Position 61 Insect and Disease Codes (see Appendix 7)

Position 62 Fire Damage Codes (see Section A.7.2)

Position 63 Uprooted Stands (see Section A.7.3)

6.3.3 Card Type 3

Position 1 Sample Tree Details

At least two to three sample trees should be measured in a prism plot (see Section 3.5.3). Only reliably measured trees should be entered as no estimations will be entertained in this section of the plot record. The readings after column 40 will not be keypunched but they should be entered for checking purposes. Sample tree details may be entered on count-plots.

Position 2 to 24

Common to Card type 1 and 2.

Position 25 to 26 Tree Number

Use the same tree number which was recorded under "Tree Details". Sample trees measured outside the plot should be numbered 99, 98, 97 etc. to prevent confusion with trees numbered on the plot.

Position 27 to 29 Total Height

Enter the calculated height plus correction if any as arrived at from the readings in the green shaded columns in the right hand columns.

Position 30 to 31 Species

As per "Tree Details" (see Section 6.3.2).

Position 32 to 35 DBH

As per "Tree Details" (see Section 6.3.2).

Position 36 C/C Crown Class

Enter the crown class for the tree by number code as shown in the box on the reverse side of the field sheet.

1 = Dominant (D)

Trees with crowns extending above the general level of the crown canopy. They are somewhat larger than the average and have well developed crowns which may be somewhat crowded on the sides.

2 = Codominant (C-D)

Trees with crowns forming the general level of the crown canopy. The crown is generally smaller than that of the dominant trees and usually more crowded on the sides.

3 = Intermediate (Int.)

Trees with crowns below, but still extending into the general level of the canopy. The crowns are usually small and quite crowded on the sides.

4 = Overtopped (O)

Trees with crowns entirely below the level of the canopy.

Positions 37 to 39 Total Age (see Section 3.5.9.1)

The age of at least three codominant sample trees for each major species must be established for each forest type if the age of the forest type is as follows: coniferous - 90 to 150 years; deciduous - 20 to 60 years; aspen/cottonwood (FIZ K & L) - 50 to 170 years. In order to do this, measure the total height for each tree that will be sampled for age (total height is from "high-side" to the tree's top or highest point). If the age of the forest type is not within the above limits, the age of at least one codominant sample tree for each major species must be established for each forest type.

Each age is calculated as follows:

1. Boring Height - always 1.3 m above high-side (breast height).

2. Breast Height Age - enter the age of the tree measured at the boring height according to the ring count (pith counts for one year).

3. Correction - use the Site Index Curves and Tables for BC – Coastal Species (February, 1991) or Interior Species (June, 1994) (see Appendix 1). Go to the bottom of the appropriate Site Index Table and note the "Years to bh" (Years to boring height) correction value.

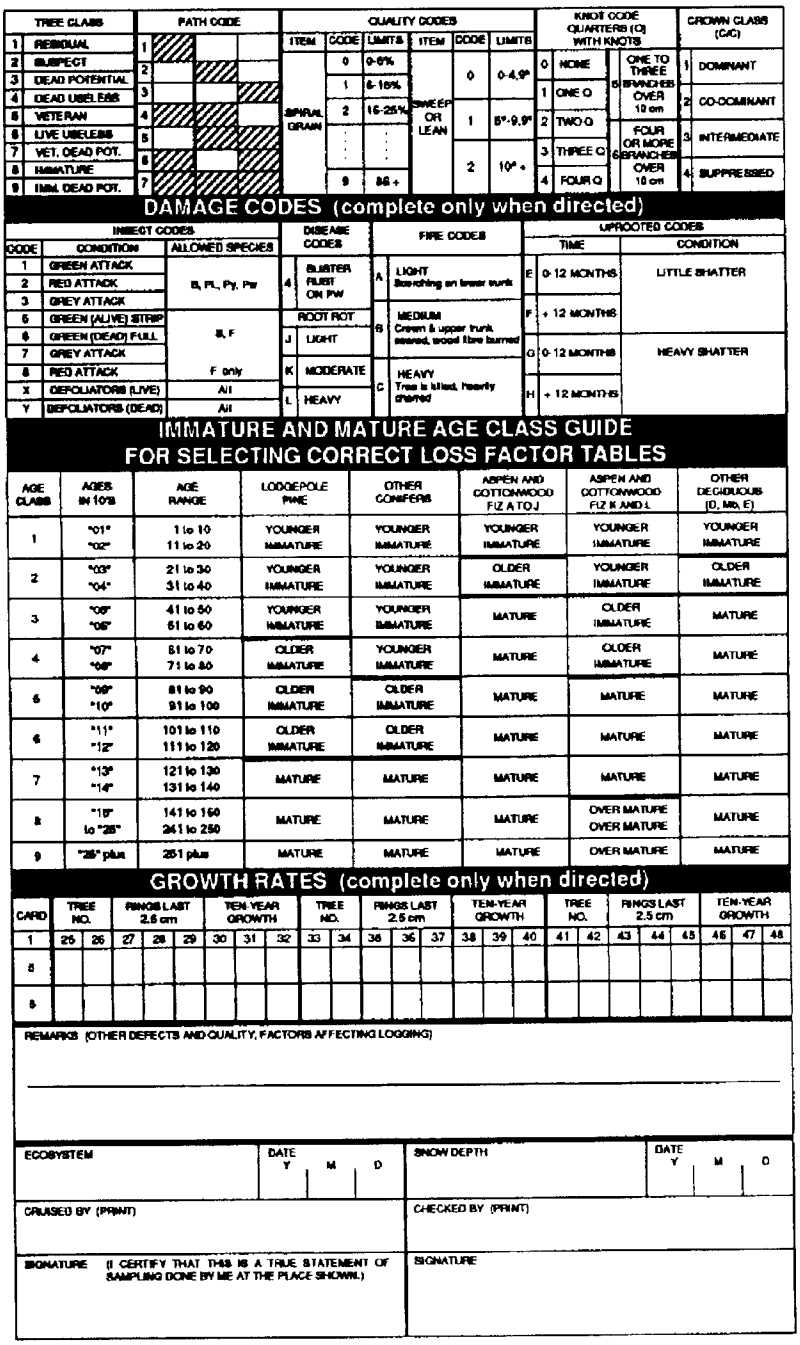
4. Total Age - the sum of the Breast Height Age and the Correction.

Position 40 Partial Cutting

L = leave tree

Blank or C = cut tree

This coding must match card type 2.



TREE CLASS		PATH CODE	QUALITY CODES						KNOT CODE QUARTERS (Q) WITH KNOTS		CROWN CLASS (C/C)	
1	RESIDUAL	1	ITEM	CODE	LIMITS	ITEM	CODE	LIMITS	0	NONE	1	DOMINANT
2	SUSPECT	2	SPIRAL GRAIN	0	0-5%	SWEEP OR LEAN	0	0-4.9°	1	ONE Q	2	CO-DOMINANT
3	DEAD POTENTIAL	3		1	6-15%		1	5°-9.9°	2	TWO Q	3	INTERMEDIATE
4	DEAD USELESS	4		2	16-25%		2	10° +	3	THREE Q	4	SUPPRESSED
5	VETERAN	5		:	:				4	FOUR Q		
6	LIVE USELESS	6		9	26 +							
7	VET. DEAD POT.	7										
8	IMMATURE											
9	IMM. DEAD POT.											

ONE TO THREE BRANCHES OVER 10 cm

FOUR OR MORE BRANCHES OVER 10 cm

DAMAGE CODES (complete only when directed)

INSECT CODES		
CODE	CONDITION	ALLOWED SPECIES
1	GREEN ATTACK	B, PL, Py, Pw
2	RED ATTACK	
3	GREY ATTACK	
5	GREEN (ALIVE) STRIP	B, F
6	GREEN (DEAD) FULL	
7	GREY ATTACK	F only
8	RED ATTACK	
x	DEFOLIATORS (LIVE)	All
Y	DEFOLIATORS (DEAD)	All

DISEASE CODES	
4	BLISTER RUST ON PW
ROOT ROT	
J	LIGHT
K	MODERATE
L	HEAVY

FIRE CODES	
A	LIGHT Scorching on lesser trunk
B	MEDIUM Crown & upper trunk seared, wood fibre burned
C	HEAVY Tree is killed, heavily charred

UPROOTED CODES		
	TIME	CONDITION
E	0-12 MONTHS	LITTLE SHATTER
F	+ 12 MONTHS	
G	0-12 MONTHS	HEAVY SHATTER
H	+ 12 MONTHS	

IMMATURE AND MATURE AGE CLASS GUIDE FOR SELECTING CORRECT LOSS FACTOR TABLES

AGE CLASS	AGES IN 10's	AGE RANGE	LODGEPOLE PINE	OTHER CONIFERS	ASPEN AND COTTONWOOD FIZ A TO J	ASPEN AND COTTONWOOD FIZ K AND L	OTHER DECIDUOUS (D, Mb, E)
1	"01" "02"	1 to 10 11 to 20	YOUNGER IMMATURE	YOUNGER IMMATURE	YOUNGER IMMATURE	YOUNGER IMMATURE	YOUNGER IMMATURE
2	"03" "04"	21 to 30 31 to 40	YOUNGER IMMATURE	YOUNGER IMMATURE	OLDER IMMATURE	YOUNGER IMMATURE	OLDER IMMATURE
3	"05" "06"	41 to 50 51 to 60	YOUNGER IMMATURE	YOUNGER IMMATURE	MATURE	OLDER IMMATURE	MATURE
4	"07" "08"	61 to 70 71 to 80	OLDER IMMATURE	YOUNGER IMMATURE	MATURE	OLDER IMMATURE	MATURE
5	"09" "10"	81 to 90 91 to 100	OLDER IMMATURE	OLDER IMMATURE	MATURE	MATURE	MATURE
6	"11" "12"	101 to 110 111 to 120	OLDER IMMATURE	OLDER IMMATURE	MATURE	MATURE	MATURE
7	"13" "14"	121 to 130 131 to 140	MATURE	MATURE	MATURE	MATURE	MATURE
8	"15" to "25"	141 to 150 241 to 250	MATURE	MATURE	MATURE	OVER MATURE OVER MATURE	MATURE
9	"25" plus	251 plus	MATURE	MATURE	MATURE	OVER MATURE	MATURE

GROWTH RATES (complete only when directed)

CARD	TREE NO.		RINGS LAST 2.5 cm			TEN-YEAR GROWTH			TREE NO.		RINGS LAST 2.5 cm			TEN-YEAR GROWTH			TREE NO.		RINGS LAST 2.5 cm			TEN-YEAR GROWTH		
1	25	26	27	28	29	30	31	32	33	34	36	36	37	38	39	40	41	42	43	44	45	46	47	48
8																								
9																								

REMARKS (OTHER DEFECTS AND QUALITY, FACTORS AFFECTING LOGGING)

ECOSYSTEM	DATE Y M D	SNOW DEPTH	DATE Y M D
CRUISED BY (PRINT)		CHECKED BY (PRINT)	
SIGNATURE (I CERTIFY THAT THIS IS A TRUE STATEMENT OF SAMPLING DONE BY ME AT THE PLACE SHOWN.)		SIGNATURE	

Figure 6.3 Reverse Side of Cruise Tally Sheet (FS 205 HRV 96/8).

6.4 Reverse Side of Cruise Tally Sheet (FS 205 HVA 96/8)

6.4.1 Card Type 5

Position 1 Growth Rates

Growth Rates for increment Tables (complete only when directed).

Positions 2 to 24

Common to card types 1, 2, 3 and 4.

Positions 25 to 26

Use the same tree number as recorded under Card Type 2 and 3.

Positions 27 to 29 Rings Last 2.5 cm

Count from cambium towards the pith.

Position 30 to 32 Ten Year Growth (last 10 years)

Measure from the cambium towards the pith to the nearest 0.1 cm.

Position 33 to 40

Repeat 25 to 32.

Positions 41 to 48

Repeat 25 to 32.

6.4.2 Miscellaneous

Snow Depth

Note average depth of snow in centimetres at time of cruise for a given cruise plot along with the date on which the cruise plot was completed.

Signature

All Cruise Tally Sheets (FS 205 and industry versions) must be signed and dated by the cruiser in charge and in so doing, accepts responsibility for the information contained on the card.

Ministry of Forests Map Area Statement (FS 121) 7

The Map Area Statement consists of seven cards A, B, C, D, E, F, and G which are to be completed for every new Cutting Permit in a TSHL or TFL; if none then for the Licence Number of the Timber Sale, Timber Berth or Licence, etc. being cruised and on which the sampling plan was based.

7.1 Card Type A

Positions 2 to 80

Cruise Identity Card - this card establishes the location of the cruise from the broadest area (Forest Region) to the most exact (UTM Grid Co-ordinates) and describes the nature of the sale.

Position 2 to 7 Licence Number

Enter:

1. For X type licences:

Position	2	X
	3	Region
	4 and 5	Year
	6 and 7	District No. (Region = 00)

2. CF0001 for Community Forest Agreement.

3. A56789 for licence A56789.

4. TFL001 for TFL 1
   TFL038 for TFL 38.

5. YV0001 for licence to cut.

6. TL0421 for Timber Licence TL 421.

7. If Unauthorized Timber Harvesting use the ERA case file number in positions 2 to 10.

Position 8 to 10 Cutting Permit

Enter 001 for CP1 or 01A for CP1A. Use sequential numbering for X type licences.

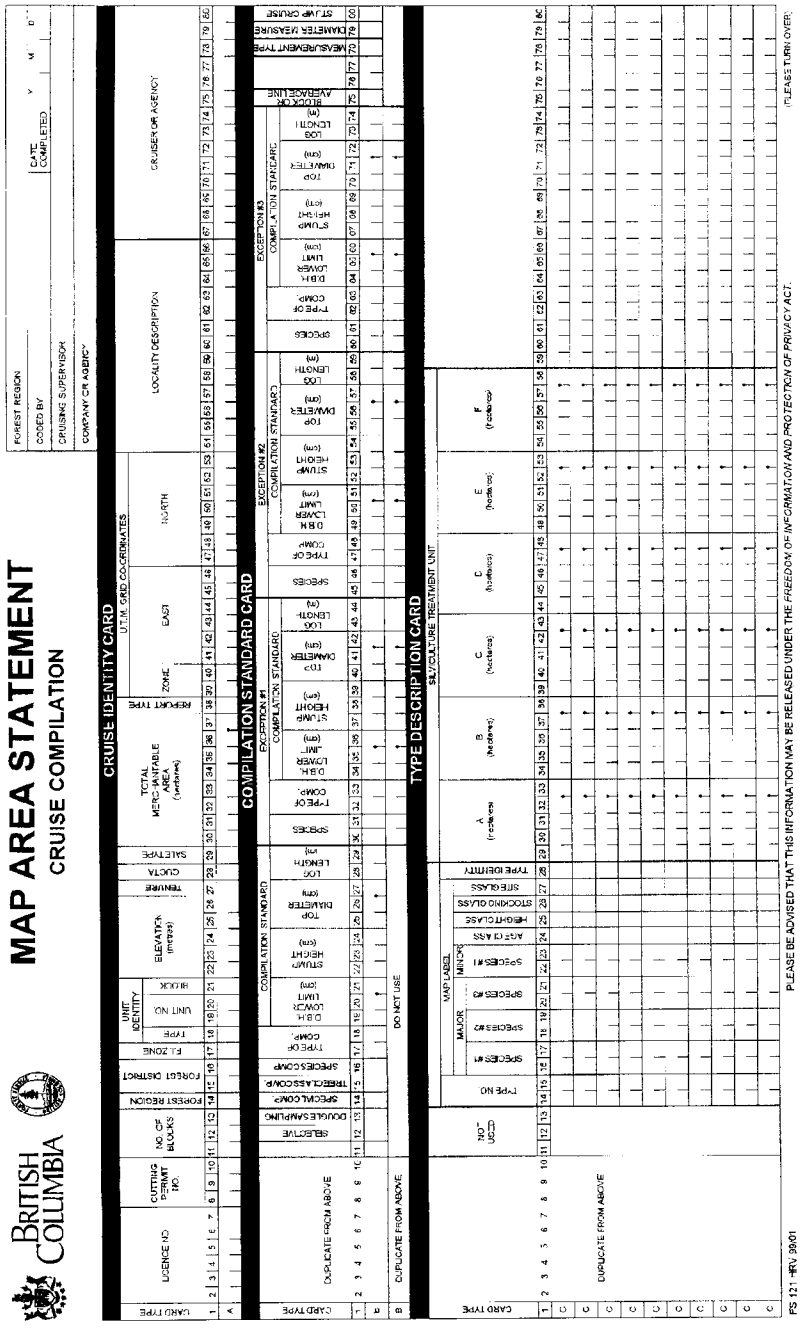


Figure 7.1 Front Side of Map Area Statement Form (FS 121 HRV 99/01).

Position 11 to 13 Number of Blocks

Enter 001 for one Block
010 for ten Blocks

Position 14 to 16 Forest Regions and Districts

Enter:

Code	Region
1	Vancouver
2	Prince Rupert
3	Kamloops
4	Prince George
5	Nelson
6	Cariboo

Every district has a number unique to the forest region. If the sale is located within two or more districts, code it by the district with supervisory responsibility.

Refer to Appendix 9 for detailed district coding.

Position 17 Forest Inventory Zones

The province is divided into 12 Forest Inventory Zones:

- A, B, C are all Coast zones, and
- D to L are all Interior zones.

The correct zone is vital for the application of volume equations and loss factors.

If more than 1 FIZ exists in a cruise, use the FIZ with the greatest area.

Unit Identity (Positions 18 to 21)

Position 18 Type (of Unit)

Enter 0 if the sale area is located within an established or proposed PSYU which is not part of a larger PHA (Pulp Harvesting Area).

1	if it is located within PHA 1
2	if it is located within PHA 2
3	if it is located within PHA 3
5	if it is located within PHA 5
7	if it is located within PHA 7

Enter:

B	if located in Blue Mountain Forest Reserve
C	if sold under Beach Clearing Licence
E	if located in E & N Land Belt
G	if located in Gulf Islands
K	if located in Kitimat Valley but not in Skeena PSYU or TFL41
L	if sold as Pulp Timber Sale in Nootka PSYU
M	if located in a Municipality
P	if located in a Park
S	if located in a Special Sale Area
T	if located in a TFL
W	if located in a Watershed Reserve.

Leave this position blank if none of the foregoing codes apply.

Position 19 to 20 Number (of the Units)

See Table 17.

Position 21 Block Number (of the Unit)

Enter Zero if unit has no block numbers (see Table 17).

Position 22 to 26 Elevation

Record the elevation of the centre of the sale to the nearest 50 m. Do not leave blank or zero. Must have at least a 1 entered.

Position 27 Tenure

Tenure Description	Code
Coast	
Forest Licences	A
Timber Licences	B
C.G. 1914 to date – stumpage & royalty	S
C.G. 1914 to date – stumpage including royalty	U
Road Permits	V
Timber Sales & Licences to Cut	X
T.F.L. Cutting Permits	Y
Woodlot Licences	1
Community Forest Agreements	4
Interior	
Forest Licences	W
C.G. 1914 to date – stumpage & royalty	T
C.G. 1914 to date – stumpage including royalty	2
Road Permits	3
Community Forest Agreements	4
Timber Sales & Licences to Cut	5
T.F.L. Cutting Permits	6
Woodlot Licences	7
All	
Timber Sale Licence Major	8
Unauthorized Timber Harvest	9

Position 28 Quota Type

Leave this column blank if the licensee quota is in a proposed or managed TSA, TFL or SSA.

Enter:

D	for Regional Manager Quota
H	for Handlogging Timber Sale
N	for Non-quota timber sold in a managed PSYU, TFL or SSA.
R	for Prince Rupert 20 percent contractor Northline timber
S	for Dead and Down Salvage Sale
T	for Third Band Sale
Q	for Quota Holder

Position 29 Sale Type

Leave blank if none of the following apply.

Enter:

A	for Deciduous
B	for Salvage – Blowdown
C	for Salvage - Cleanup or Residuals
D	for Salvage - Dead or Down
E	for Salvage – Decadent
F	for Salvage - Flood Killed
G	for Salvage - Winter Killed
H	for Salvage - Pondage Clearing
I	for Salvage - Insect Killed
J	for Salvage - Disease Killed

K	for Salvage - Fire Killed
M	for Minor Products only
N	for Cash or Direct Sale
R	for Right of Way Clearing

Positions 30 to 37 Total Merchantable Area (Hectares)

Enter the number of merchantable hectares for each Cutting Block within a Cutting Permit or for the Cutting Permit within a Forest Licence or for each Timber Sale, Timber Licence, Licence to Cut, etc. right oriented (e.g., 157.5 ha enter as 00001575).

Position 38 Ministry of Forests - Appraisal Information

A	=	compilation to be used for appraisal purposes - reports titled "For Appraisal Purposes."
blank or other	=	*Not* for appraisal purposes - reports titled "Not for Appraisal Purposes".

Position 39 to 53 U.T.M. Grid Co-ordinates

In the Universal Transverse Mercator (UTM) projection the spheroid is divided into 60 zones, each 6° of longitude in width numbered eastward from the 180° meridian through Greenwich. Four zones numbered 8, 9, 10 and 11 cover British Columbia.

The approximate centre of the cut block should be referenced with this system (Standard System of Mapping for British Columbia, Geographic Data BC, Ministry of Environment, Lands and Parks).

Positions 54 to 66 Locality Description

Enter a brief description where the sale is located (e.g., 15 km N.E. of Pr. George, FADEAR CR. LT 2315).

Positions 67 to 80 Cruised By

Enter first initial and last name or cruising agency name.

7.2 Card Type B

Position 1

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

Positions 2 to 10 Common to Card Type A.

Position 11 Damage Reporting

Blank	All damage reporting

Position 12 Partial cutting indicator

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

Position 13 Double Sampling Indicator

Enter:

0	0 = all plots to be used
1	count-plots not to be used

Position 14 Special Compilation

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

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.

Enter:

(blank)	if Coast compilation
0	if Interior compilation is required by the three quality classes. *This option has been disabled.*
1	if interior fir is present and sale is in the Wet Belt.
2	if interior fir is present and sale is in the Dry Belt.

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 cruise data.

Position 15 Tree Class Combinations

This column states which tree classes will be included in the final volume.

Blank or 0	useless volumes excluded - if only residual, suspect and dead potential tree volumes are required,
1	useless volumes included - if residual, suspect, dead potential plus live and dead useless volumes are required. Do Not use for appraisal purposes. Reports will be titled "Not for Appraisal Purposes".

Position 16 Species Compilation

This column indicates whether all the species on the sale are to be compiled in the same manner or whether an exception is required. For example:

1. Cedar poles or veneer for only Douglas Fir (not programmed as yet).

2. The stump height, top dib, DBH limit or log length could be altered for one species on the sale (e.g., in the Interior, lodgepole pine is compiled to 12.5 cm plus, while all other species are compiled to a 17.5 cm DBH in mature stands).

Enter:

0	if all species are to be compiled in the same manner.
1	if all species are to be compiled the same with an exception.

Positions 17 to 18 Type of Compilation (majority of species)

The code for the appropriate end product or combination of products is entered. Present appraisals require option *3 for the interior and option *32 (because of log grading) for the coast.

*3.	Lumber including all logs
*32.	Coast Integrated Company - with Peeler segregation

Compilation Standard

Specify the utilization level required. This will be for the majority of the species.

Positions 19 to 21 DBH Lower Limit

Specify to the nearest 0.1 cm the minimum DBH to be compiled. If less than 7.5 cm, reports titled "Not for Appraisal Purposes".

Coast:	Mature (121 yrs +) = 17.5 cm Immature (< 121 yrs) = 12.0 cm

Positions 22 to 24 Stump Height

Specify Stump Height required to the nearest cm (e.g., Close utilization = 30 cm).

Positions 25 to 27 Top Diameter

Specify top dib for the tree to the nearest 0.1 cm

Coast	Mature (121 yrs +) = 15 cm Immature (<121 yrs) = 10 cm
Interior	10 cm

Red cedar (Interior only):

- if age is < 141 years, compile to a 10 cm top, and
- if age is = > 141 years, compile to 15 cm top.

Positions 28 to 29 Log Lengths (to the nearest metre)

Log Lengths for product analysis. At present we only have lrf's for 5 m logs. Coast grading requires 10 m log length. If not equal to 5 m for Interior or 10 m for Coast, reports are titled "Not for Appraisal Purposes".

Log Lengths for other purposes can be 1 to 99 m.

(Zero) 0 = total tree length between stump height and top dib.

Positions 30 to 44

Exception Number 1.

Compilation for a species may require a different type of compilation; Lower DBH Limit (e.g., PL = 12.5 cm DBH). Stump height, top dib, and log length.

Positions 45 to 59

Exception Number 2 (e.g., Cedar 160 years = 15 cm top) Stump height, top dib, and log length.

Positions 60 to 74

Exception Number 3.

> Positions 30 to 74 on second line allows three more exceptions for one compilation.

Position 75 Block or Average Line Method (Type Average) of Compilation

A	average line (type average) method.
B	block method.

The average line (type average) method of compilation uses all plots from the timber type that is common to all blocks of cruise.

The block method uses only the plots in the timber type within the block or the plots in the timber type within the harvest method. Only one method must be used for an appraisal cruise.

The average line method is the default method.

The block method must be used for the following types of compilations:

1. Percent reduction by block.
2. Cutting permit compilations where immature and mature block combinations occur.
3. Other compilations approved by the Regional Manager in the cruise plan.

Position 78 Stump Diameter Measurement Type

Code "C" for centimeters.

Code "R" for rads.

Stump height must be in centimeters.

Position 79 Diameter Measurements

Code "I" for inside bark.

Position 80

Code "S" for stump cruise.

7.3 Card Type C

Position 1 Type Description

This card contains the type number (corresponds to positions 19 and 20 on Card Type 9), the map or stratum label for the type and the area of the type in hectares for every type island within the Cutting Block, Cutting Permit, Timber Sale, Berth or Lease.

Positions 2 to 10

Common to Card Type A and B.

Positions 11 to 13

These columns are not in use.

Positions 14 to 15 Type Number

This is the number given to similar type islands within the sale. Each Map Label which differs in some respect requires a new Type Number with the numbers starting at 1 for the unit under consideration. Several type islands with the same map label will have the same type number. The type numbers must be zero filled (e.g., 01, 02, etc.).

Map Label (Positions 16 to 27)

Major Species

A species is major if it comprises 20 percent or more of the total Gross volume.

Positions 16 to 17 Species #1

Leading species in terms of gross volume for the type.

Positions 18 to 19 Species #2

Second leading species in terms of gross volume.

Positions 20 to 21 Species #3

Third leading species in terms of gross volume.

Positions 22 to 23 Minor Species

A minor species comprises less than 20 percent of the gross volume for the type. A new type number should be assigned very infrequently when the only difference in the stratum is the first minor species.

Position 24 Age Class

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

Position 25 Height Class (metres)

Code	Height Class Limits (metres)
1	0-10.4
2	10.5-19.4
3	19.5-28.4
4	28.5-37.4
5	37.5-46.4
6	46.5-55.4
7	55.5-64.4
8	64.5 +

Position 26 Stocking Class

Code	Description
0	Immature Stands Mature Stands
1	Mature Residual-Disturbed 26 to 75 percent by area or volume
2	Stocking Class 1 to 76 or more trees per hectare 27.5 cm + DBH.
3	Stocking Class 2 – Fewer than 76 trees per hectare 27.5 cm + DBH.

Position 27 Site Class

Site is determined for all productive forest types by the application of sample tree age and height measurements to the site index tables in Appendix 1.

	Code
G	good site
M	medium site
P	poor site
L	low site

The site is established on the first species in order of predominance regardless of the percentage composition of the stand or the number of species in the label.

Position 28 Type Identity

The recognized classes of cover on forest land are Immature, Mature, Mature Residual, Not Satisfactorily Restocked (NSR), Non-commercial (NC), Non-Productive Forest and Disturbed-Stocking Doubtful (DSD).

However, program will only accept code 1, 2 or 3.

A map note may distinguish the various types of Non-Forest Lands but only one code (6) is assigned to this classification.

Code	Identity	Description
1	Immature (Imm.)	Coniferous trees younger than 121 years with the exception of deciduous which must be younger than 41 years to be classed as immature.
2	Mature (Mat.)	Coniferous trees older than 120 years with the exception of deciduous species where the age break is more than 40 years.
3	Mature Residual (Mat. R.)	Types disturbed 26 to 75 percent; supporting remnants of the original forest stand where the most significant element of the surviving stand is classed as mature.
4	NSR	Denuded areas that do not meet minimum stocking requirements of approximately 750 healthy, well-distributed seedlings or juvenile stems per hectare.

In cases where there is reasonable doubt as to whether the area is NSR the category DSD should be used. Ground examination to verify NSR areas is desirable.

Code	Identity	Description
5	Non-Commercial (NC)	This cover class is used very sparingly being confined almost exclusively to deciduous brush growing on productive sites. On occasion it may be used to describe stands usually disturbed, of very low quality that cannot be, as a practical matter, classified as commercial, NSR or DSD.
6	Non-Productive Forest	Forest land of very low productivity presenting no commercial possibilities in the foreseeable future.
7	Disturbed, Stocking Doubtful (DSD)	Denuded areas where there is reasonable doubt as to whether the area is NSR.

Positions 29 to 58

Record the merchantable timbered hectares for each timber type (stratum) and silviculture treatment unit in the cutting block, cutting permit, Timber Sale or Timber Licence to the nearest 0.1 ha.

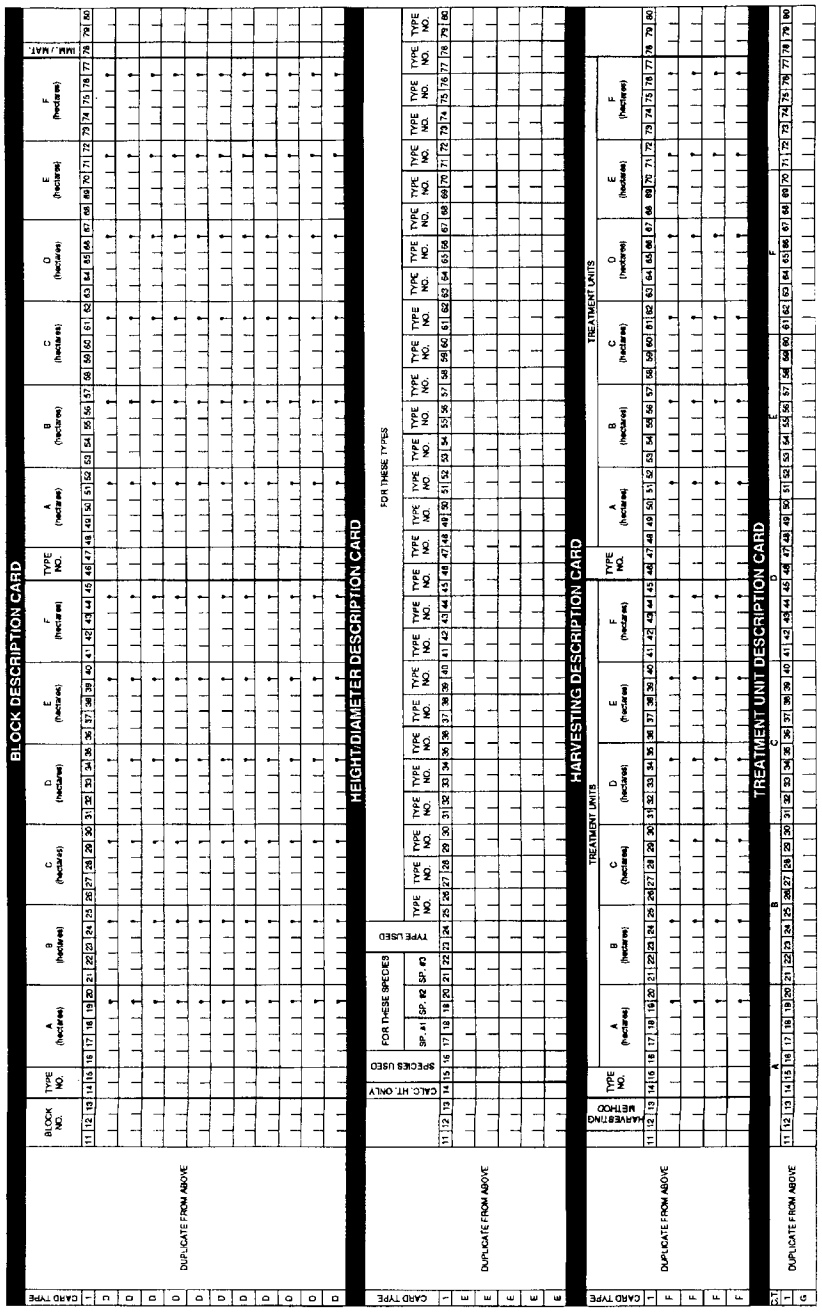


Figure 7.2 Reverse Side of Map Area Statement Form (FS 121 HVR 96/11).

7.4 Card Type D

Position 1

Block Description

The sampling plan and the appraisal is made on the basis of the Timber Sale or Cutting Permit which may consist of several separate sub-units, namely blocks or settings. If for operational purposes an estimate by species is required of the net volume for each type in these sub-units (blocks) the Card Type D must have an entry for each type separately within each block. The number of blocks entered must equal the numerical entry in positions 11 to 13 of Card Type A.

Positions 2 to 10

Common to all Card Types.

Positions 11 to 13 Block No.

Enter the Block Number within the Cutting Permit or Timber Sale. Each block identified must have a unique number or letter.

Position 14 to 15 Type No.

Enter the Type Number of a type island which is contained or partially contained by this Block. The numbers must correspond to Type Numbers defined by a previous card C. The type No. must be zero filled (e.g., 01, 02, etc.).

Position 16 to 45 Silviculture Treatment Units

Enter the number of merchantable hectares of the block which is part of this type and silviculture treatment unit. The sum of all of the areas for one type should equal the area specified for that type on the Card Type C.

Position 46 to 47 Type No.

See description for Position 14 to 15.

Position 48 to 77 Silviculture Treatment Units

See description for Position 16 to 45.

Position 78 Coast - Block Growth Indicator

I	Immature
M	Mature

If either of these codes is not used, reports will be marked "Not for Appraisal Purposes".

7.5 Card Type E

Position 1

Height/DBH Description - Stump Cruises & Severely Damaged Stands

This card is not needed if there is a sufficient number of sample trees (20 or more) to calculate a height/DBH equation for a species within a stratum or forest type. However, this card must be used for any of the following situations which occur usually through the minor position of the species in the type or the type itself in the Cutting Permit. This usually means the collection of enough sample heights to establish a curve becomes impractical.

1. The sample trees for one major species occurring in two or more types (keep in mind the rules in Section 3.5.3.2) can be combined into one equation which will be applied against all trees of that species for the designated types.

2. The sample heights for two or more different species exhibiting similar growth characteristics can be combined into one equation so that all trees of the species indicated will have their heights calculated by this one equation.

3. One species may be so minor that no sample heights were taken and this card can designate which height equation should be used to calculate heights for this species. It is recommended that all minor species sample trees be measured or estimated where gathering enough height samples is not practical.

Examples:

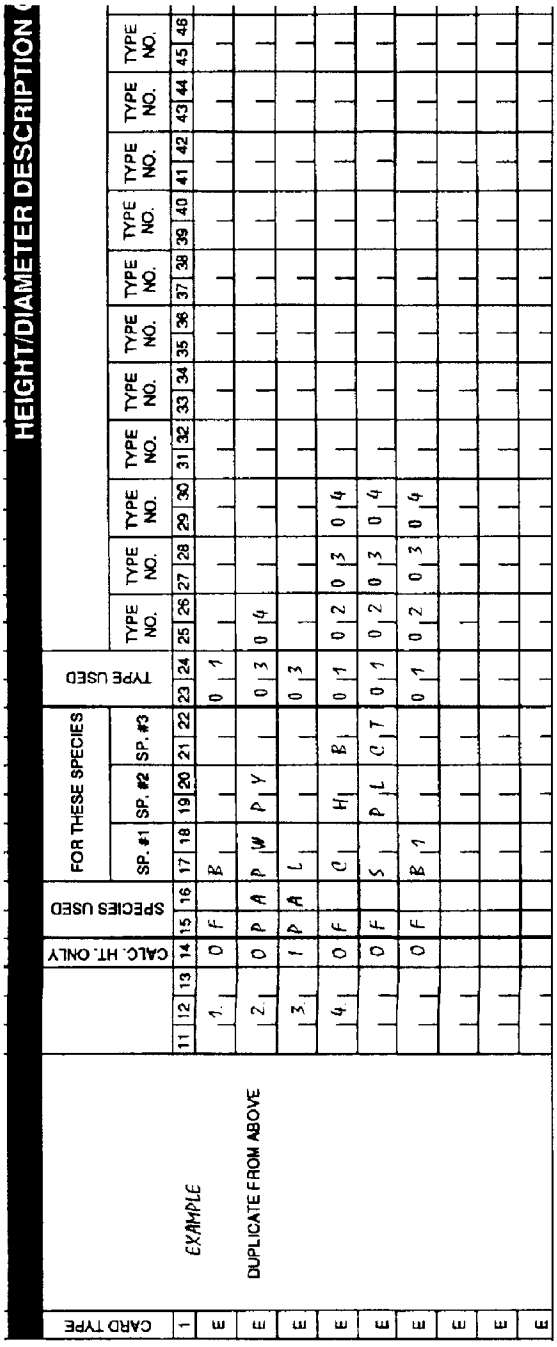


Figure 7.3 Height/Diameter Description Card.

Example 1.	One height/diameter equation will be produced from all the F and B sample trees (Card Type 3) submitted in Type 1. This equation will be labelled as an equation for F in Type 1. All F and B trees (Card Type 2) in Type 1 with no heights will have their heights calculated by this one equation.
Example 2.	One height/diameter equation will be produced from all the Pa, Pw and Py sample trees (Card Type 3) submitted in Type 3 and 4. This equation will be labelled as an equation for Pa in Type 3 and will have characteristics implied by the Site Code and Type Identity specified for Type 3. All Pa, Pw and Py trees (Card Type 2) in Type 3 and 4 with no heights will have their heights calculated by this one equation.
Example 3.	The height/diameter equation for PA in Type 3 is to be used to calculate the tree heights of all L and Pa trees in Type 3 with no heights.

If examples 2 and 3 were submitted in the same compilation, a height/diameter equation used would be produced from the grouped set of data defined by example 2. Example 3 would use this equation as described above. In addition, example 3 cannot request that the equation for species Pw or Py of Types 3 or 4 be used or that the equation for species Pa, Pw or Py of Type 4 be used because this equation is labelled for species Pa of Type 3.

Example 4.	When wanting to make one curve for all the species and there are too many species for one line, it can be continued on the next line(s). The first species and first type on each line must be repeated (otherwise they will each be treated as separate curves). The program will combine all these lines (in the example) and make one curve. The column 14 can be either 0 or 1.

Position 2 to 10

Common to all Card Types.

Position 11 to 13

Not used.

Position 14 Calculated Height Only

Code	
0 or blank	The sample trees from all the species (columns 15 to 22) and all the types (columns 23...) will be grouped together to calculate one height/diameter equation. The height from this curve will be used for all the plot trees of these same species and types.
1	Sample trees from only the species used (columns 15 to 16), and only the type used (columns 23 to 24) will be used to make an equation. The heights from this equation will then be applied to all the species (columns 15 to 22) and all the types (columns 23...).

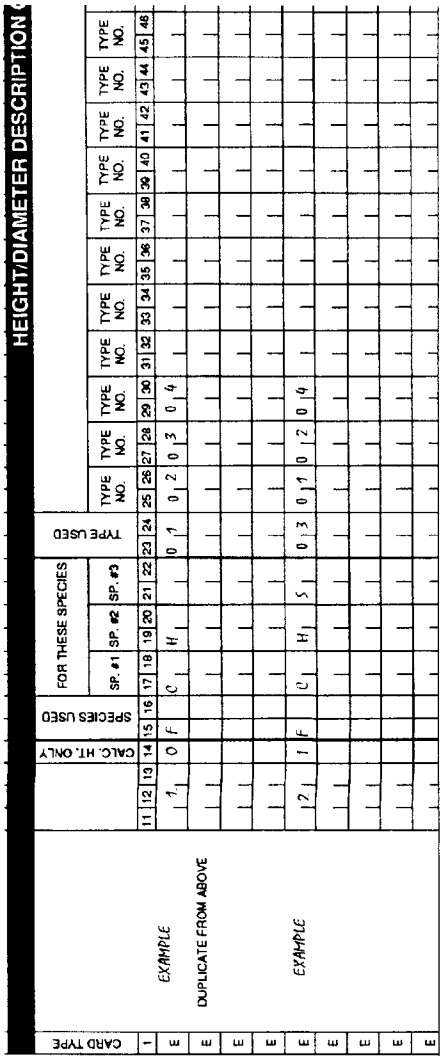


Figure 7.4 Height/Diameter Description Card.

Card column *14* makes the difference in how the equation will be formulated.

Example 1.	if (column 14) is 0 it means; the sample trees from *all* the species listed (F, C, H) and *all* the types listed (1, 2, 3, 4) will be grouped together to make a curve. The heights for all F, C, H in types 1, 2, 3, 4 on card type 2 will be applied from this curve.
Example 2.	if column 14 is *1* it means: the sample trees from the first species- F - (columns 15 and 16) in the first type -3- (columns 23 and 24) *only* will be used to make a curve. The heights from this curve will *then* be applied to *all* the species in *all* the types as listed on that line.

Position 15 to 16 Species Used

If only one species is involved, enter that species. If more than one species is involved, enter the major species. All trees of the species in positions 17 to 22 and type No. in positions 23 to 80 will use this same equation.

Position 17, 18, 19 to 20, 21 to 22 For These Species

Enter the species, if any, which are to be grouped with the species entered in the Species Used position.

Position 23 to 24 Type Used

If only one type is involved, enter that type. If more than one type is involved, enter the type that has the Site Code and Type Identity (Card Type C fields) values which best describe the whole group being combined.

Positions 25 to 26, 27 to 28, ..., 78 to 80 for These Types

Enter the types, if any, whose species are to be involved in the grouping.

Type numbers must be zero filled (e.g., 01, 02, etc.).

7.6 Card Type F

Position 1

Harvesting Method Description

The sampling plan and the appraisal is made on the basis of the Cutting Authority which may consist of several separate sub-units, namely Harvesting Methods.

Position 2 to 10

Common to all Card Types.

Position 11

This column is not in use.

Position 12 to 13 Harvesting Method

Enter the Harvesting Method Code within the Cutting Authority.

HC	=	helicopter clearcut
HS	=	helicopter selective
CC	=	cable clearcut
CS	=	cable selective
SL	=	skyline
HO	=	horse
SC	=	ground skidding clearcut
SS	=	ground skidding partial cutting
SP	=	specified operation

Position 14 to 15 Type No.

Enter the Type Number of a type island which is contained or partially contained by this Method. The numbers must correspond to Type Numbers defined by a previous Card Type C. The type No. must be zero filled (e.g., 01, 02, etc.).

Position 16 to 45

Enter the number of merchantable hectares of the Harvest Method which is part of this type and silviculture treatment unit. The sum of all of the areas for one type should equal the area specified for that type on the Card Type C.

Position 46 to 47

See description for Position 14 to 15.

7.7 Card Type G

Silviculture Treatment Unit Description

Enter up to six user coded descriptions so that individual treatment unit summaries will be identified by the coded description.

Stump Cruising 8

8.1 Introduction

The following methods are prioritised 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,
- utilization standards will be based on whether the unauthorised timber harvesting (UTH) occurred in Coastal or Interior administrative areas. Refer to the most recent *Utilization Standards Policy*,
- 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 respective forest region.

8.2 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 3.6.2.1 of the *Cruising Manual* (CM) under cruise based allowable errors, and
- if the unauthorised harvest will result in an administrative penalty under Section 117 of the *Forest Practices Code*, then a closed traverse of the area will be required since the penalty levied is in dollars per hectare.

8.3 Measurement Methods

The following methods are listed in order of preference. If stumps are lower than 30 cm height at high side, record the actual height as the additional volume removed will be included with the UTH volume in the compilation.

8.3.1 Method 1: Areas Less than 10 ha

Conduct a 100 percent cruise of the trees if the trees are still full length. If the trees have been bucked into log lengths, scale them as per scaling procedures outlined in the *Scaling Manual*.

If the UTH area is within a homogeneous pine or pine and spruce timber type of a density of 1 000 stems per hectare or more and greater than 3 ha, method 2 may be used.

8.3.2 Method 2: Areas Greater than or Equal to 10 ha

The sampling intensity must be sufficient that a sampling error of plus or minus 8 percent is achieved at the 95 percent confidence interval.

If the sampling error cannot be achieved, establish 400 m^2 (.04 ha) plots at an intensity to cover at least 10 percent of the area. A grid spacing of 60 m should be sufficient to ensure a plot coverage of 10 percent of the area.

Establish 400 m^2 (11.28 m radius) fixed area plots on a systematic grid. Record all of the necessary information for each tree represented by an "in the plot stump"(i.e., pith of stump is within 11.28 m of plot centre).

The sampling intensity must be sufficient that a sampling error of plus or minus 8 percent is achieved at the 95 percent confidence interval.

If the sampling error cannot be achieved, establish 400 m^2 (.04 ha) plots at an intensity to cover at least 10 percent of the area. A grid spacing of 60 m will be sufficient to ensure a plot coverage of 10 percent of the area.

8.4 Tree Heights

Tree heights must be selected from a similar timber type and nearest adjacent area wherever possible. Adjacent height curve equations from existing data may be acceptable if the data is validated in the field.

8.4.1 Stump Cruise Tally Sheet (FS 205S)

Record the Enforcement Action Administrative Review and Appeals (ERA) system case file number (i.e., DPA960001) in the licence and cutting permit header box. The first three characters identify the administrative organization unit, the next two characters identify the fiscal year, and the last four characters identify the number of the incident in the Administrative Organizational Unit (AOU) for the reporting year. The AOU codes are defined in the FTAS users manual. The ERA file number must be recorded in the locality description boxes in Card Type A of the Map Area Statement.

Complete the FS 205S stump cruise tally sheet and sign and date each one.

Code column 26 of each stump cruise tally sheet with a unique letter (A to Z) and/or number (0 to 9). This code will simplify the field data reconciliation of the cruise compilation. Also see Section 7.2 of the *Cruising Manual* for the correct coding of the map area statement stump cruise codes.

If the stump cruise is 100 percent measure, enter a plot area in positions 27 to 30. Calculate the plot area as follows:

$$\frac{\text{Total stump cruise area}}{\text{Number of tally cards}} = \text{plot size in hectares}$$

> The sum of the plot areas must equal the total stump cruise area.

The stump cruise tally sheet, Card Type 3 tree heights must be assigned unique tree numbers from the Card Type 2's on the same tally sheet. The tree heights may be entered on a separate tally sheet if necessary, however the plot must be used in the determination of the plot size calculation and assigned a unique plot number.

8.4.2 Major Species (≥ 20 percent of the UTH area gross volume)

A minimum of 20 tree heights per major species per timber type evenly distributed throughout the full range of diameters at breast height (dbh) represented on the UTH area.

8.4.3 Minor Species (< 20 percent of the UTH Area Gross Volume)

The following options are listed in the order of preference.

8.4.3.1 Option 1

Select a minimum of 10 tree heights per minor species per timber type and evenly distributed throughout the full range of stump diameters measured on the UTH area. This data will be used to produce a height diameter curve.

8.4.3.2 Option 2

Combine the minor species with another species within the same timber type and with a similar height/diameter relationship.

8.4.3.3 Option 3

In situations where only a few trees of a high value species are present, consider the following method.

Measure two or more standing trees of the same species and 5 cm diameter class outside bark at the equivalent stump height as the stump measurement. Calculate the average for the measured tree heights for assignment for the minor species stump.

8.5 Timber Available For Measuring

This method can be used if the timber is safe to measure and the cruiser or scaler can confirm which tree originated from which stump.

The following points apply to all options under Section 8.5.

8.5.1 Tally Card – FS 205S

Use the FS 205S stump cruise tally sheet unless the timber is being scaled. If the timber is scaled, use the FS 161 residue and waste tally sheet.

Record the Enforcement Action Administrative Review and Appeals (ERA) system case file number (i.e., DPA960001) in the licence and cutting permit header box. The first three characters identify the administrative organization unit (AOU), the next two characters identify the fiscal year, and the last four characters identify the number of the incident in that AOU for the reporting year. The AOU codes are defined in the "FTAS Users Manual". The ERA file number must be recorded in the locality description boxes in Card Type A of the Map Area Statement.

Code column 26 of each stump cruise tally sheet with a unique letter (A to Z) or number (0 to 9). This code will simplify the field data reconciliation of the cruise compilation. Also see Section 7.2 of the *Cruising Manual* (CM) for the correct map area statement stump cruise codes.

8.5.2 Field Measurements

If performing a cruise of the felled trees, complete the FS 205 cruise tally sheet as you would for a regular fixed area cruise and record all of the necessary information including pathological indicators and quality remarks. The cruiser must sign and date each tally card.

Record the total length of each tree in the height field and include the height of the stump in the total tree length.

Record the dbh of the felled trees and take the stump height into account when determining dbh. Use the FS 205S stump tally sheet if the decision is made to measure the stump heights and diameters. Record the total tree lengths in the margin of the tally sheet beside each stump tally.

All stumps and corresponding trees must be numbered. Each stump and its corresponding tree must be numbered with the same unique number.

8.6 Timber Not Available For Measuring

The following options apply if the timber has been removed from the UTH area, it is unsafe to measure the timber, or the scaler is unable to determine which tree originated from which stump. If this situation has occurred, use this measurement method for the whole stump cruise.

8.6.1 Tally Card FS 205S

The following points apply to all of the options under Section 8.5.

Record the Enforcement Action Administrative Review and Appeals (ERA) system case file number (i.e., DPA960001) in the licence and cutting permit header box. The first three characters identify the administrative organization unit, the next two characters identify the fiscal year, and the last four characters identify the number of the incident in the Administrative Organizational Unit (AOU) for the reporting year. The AOU codes are defined in the FTAS users manual. The ERA file number must be recorded in the locality description boxes in Card Type A of the Map Area Statement.

Complete the FS 205S stump cruise tally sheet and sign and date each one.

Code column 26 of each stump cruise tally sheet with a unique letter (A to Z) and/or number (0 to 9). This code will simplify the field data reconciliation of the cruise compilation. Also see Section 7.2 of the *Cruising Manual* for the correct coding of the map area statement stump cruise codes.

8.6.2 Stump Measurements

Measure and record stump height to the nearest centimeter above the ground on the high side of the stump. Measure and record stump diameters inside bark (d.i.b.) as the average of the maximum and minimum measurements (see Figure 8.1).

The measurement type must be consistent for the entire stump cruise. Check one of the measurement type boxes "rads" or "centimetres" on the card type 9 of the stump cruise tally sheet (FS 205S).

8.6.3 Roads and Land Clearing

If there are skid trails, roads or cleared areas present on the UTH area and the stumps have been removed from these areas or are so badly damaged that they cannot be measured, determine the area covered by the skid trails, roads or cleared areas. Do not sample the area of the skid trails or roads. Move any samples when the plot center is on the road or cleared area 12 m (approximately 1 plot radius) North. If this fails try East, then South, then West. If this fails, increase distance to 24 m.

If the plot area is influenced by the road or cleared area, use the following border plot method:

Plot centres which fall within the stratum to be stump cruised but partially cover the skid road, road or cleared area will be made into border plots.

Divide the plot through the plot centre and parallel to the type line and measure the half which is entirely within the stratum to be sampled.

Refer to Section 3.4.1.7 for a diagram of the border plot procedure.

8.6.4 Measurement Options

The following options are listed in order of preference. Use Option 1 if it is feasible. If Option 1 is not feasible (adjacent information is not representative or unavailable or the area is too large), then proceed to the next option.

8.6.4.1 Option 1

Conduct a 100 percent stump cruise to determine the gross and net volume if the UTH area is < 10 ha.

Classify all of the stumps according to their maturity in relation to the stand, their defect and whether they are live or dead. See also Section 3.5.6 of the *Cruising Manual* or the back of the FS 205 cruise tally sheet for the definition of the allowable tree classes. The correct tree class is necessary to ensure that the correct loss factor tables are used in the compilation.

Record scar and/or frost crack on the FS 205S if the stump has heart rot showing and the diameter of the rot is greater than 50 percent of the diameter of the stump (see Figure 8.2). This will ensure that the stump is moved into risk group 2. Coding scar will move all species into risk group 2 except Hemlock in FIZ A and FIZ C, which will require coding both scar and frost crack. Spruce in FIZ A, B and C will require coding both scar and frost crack to move them into risk group 2.

Record dead stumps that have sap rot that extends more than 1/6 the stumps diameter as tree class 4 (dead useless) as this indicates less than 50 percent sound wood content (see Figure 8.2).

Record conk if present on the outside perimeter of the stump or phaeolus schweinitzii is growing on the ground near the base of the stump or on the exposed root. Recording conk will move the stump into the highest risk group.

8.6.4.2 Option 2

Establish 400 m^2 fixed area (11.28 m radius) plots on a systematic grid to determine the gross volume if the UTH area is ≥ 10 ha.

Classify all of the stumps according to their maturity in relation to the stand, their defect and whether they are live or dead. See also Section 3.5.6 of the *Cruising Manual* or the back of the FS 205 cruise tally sheet for the definition of the allowable tree classes. The correct tree class is necessary to ensure that the correct loss factor tables are used in the compilation.

Record scar and/or frost crack on the FS 205S if the stump has heart rot showing and the diameter of the rot is greater than 50 percent of the diameter of the stump (see Figure 8.2). This will ensure that the stump is moved into risk group 2. Coding scar will move all species into risk group 2 except Hemlock in FIZ A and FIZ C, which will require coding both scar and frost crack. Spruce in FIZ A, B and C will require coding both scar and frost crack to move them into risk group 2.

Record dead stumps that have sap rot that extends more than 1/6 the stumps diameter as tree class 4 (dead useless) as this indicates less than 50 percent sound wood content (see Figure 8.2).

Record conk if present on the outside perimeter of the stump or phaeolus schweinitzii is growing on the ground near the base of the stump or on the exposed root. Recording conk will move the stump into the highest risk group.

8.6.4.3 Option 3

Use adjacent cruise information for the gross and net volume per hectare if the timber in the UTH area is the same as the timber type in the adjacent cruise information.

8.7 All Stumps Removed From the UTH Area (i.e., Land Cleared, Road has Been Built)

8.7.1 Option 1

Perform a variable plot cruise or fixed area cruise in the adjacent timber as per the *Cruising Manual* to determine the net volume per hectare.

Measure the length of the timber edge along the UTH area and equally space the plots along that edge.

8.7.2 Option 2

Use adjacent cruise information for the net volume per hectare if the timber types were the same on the forest cover map.

8.7.3 Option 3

Use aerial photographs (approximate scale 1:3000 is recommended) taken before (pre) and after (post) the UTH occurred. Ensure that pre and post aerial photos are enlarged to the same scales for photo interpretation. Use the following procedure to determine a volume estimate for the UTH:

1. A qualified photo interpreter should be utilized to identify the tree count by species removed from the UTH cleared area based on the pre-harvest and post-harvest aerial photographs. The UTH boundary must be transposed to the aerial photographs using legal map references and iron pin (legal references) found on site.

2. Field staff must attend the site and measure tree heights and diameters at breast height (dbh) for all species identified on the pre-harvest aerial photos as cut from the UTH area. Selected measured trees of various heights must be stem mapped with bearing and distance recorded to points on the ground that are visible on the post-logging aerial photograph. This will assist the photo interpreter in determining the tree heights of the cut trees on the pre-harvest aerial photographs.

3. The tree height and dbh data collected for the removed trees must be plotted onto a height diameter curve by species (x-axis dbh, y-axis height). The height/diameter relationship can now be used to interpolate tree diameters for the tree heights provided by the photo interpreter for the removed trees.

4. Using the tree heights provided by the photo interpreter and the diameters interpolated from the height diameter curve, compute a net volume using Option 8 in the mainframe cruise compilation program (TSO) for the UTH area.

8.8 Portions Of Trees Removed (i.e., Shake Blocks or Special Forest Products Removed From a Segment Of Tree(s))

Use the residue and waste tally sheet FS 161 to record the missing and remaining portions of the tree using scaling procedures as per the *Scaling Manual*. Code the missing portion(s) as "A" for remaining and "U" for missing under the "Kind" column. These codes will permit segregation of the removed and remaining volumes in the Block Type Summary Report of the residue and waste systems reports.

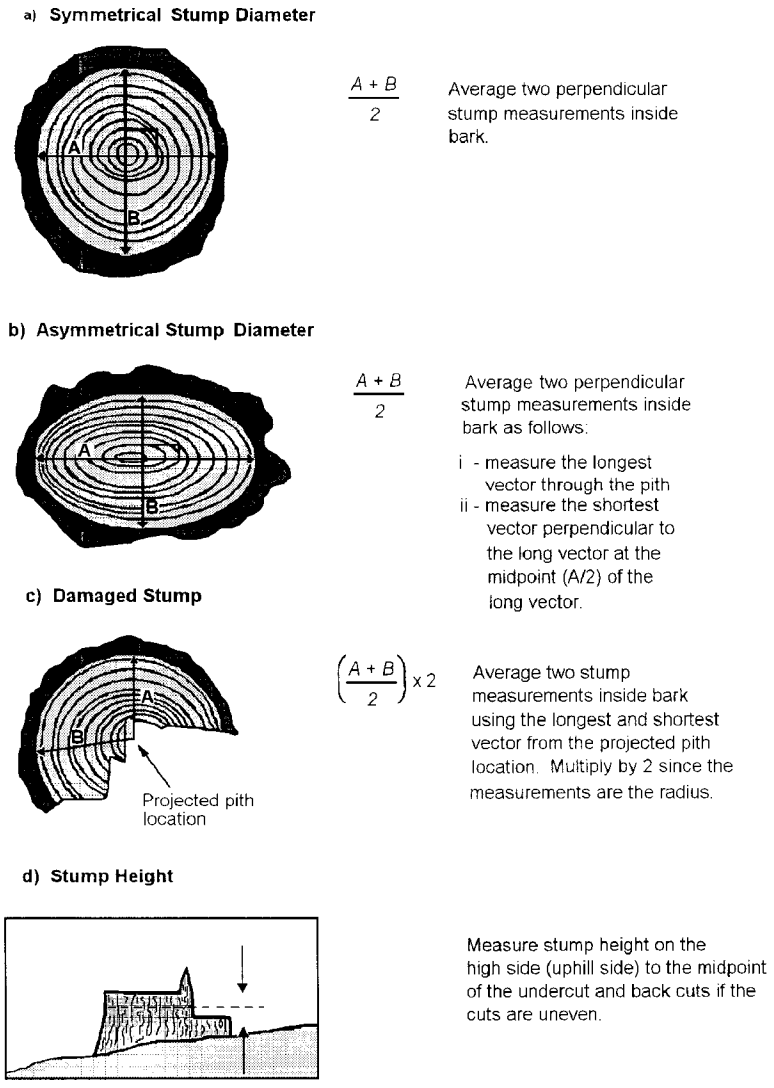
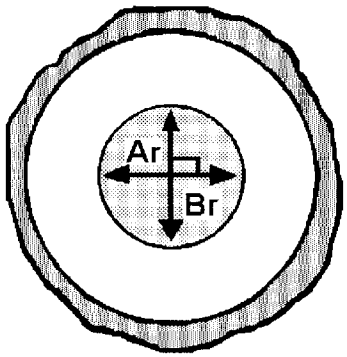


Figure 8.1 Examples of recommended stump measurements.

a) Stumps with heartrot > 50% of stump diameter

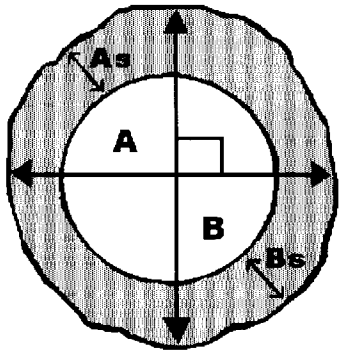


i determine stump diameter inside bark using long and short vectors - $\frac{A + B}{2}$

ii determine the rot diameter using long and short vectors - $\frac{Arot + Brot}{2}$

iii if the rot diameter is greater than 1/2 the stump diameter, record scar or scar & frost cract (refer to Section 8.541) to ensure that the stump is compiled as Risk Group 2.

b) Dead stumps

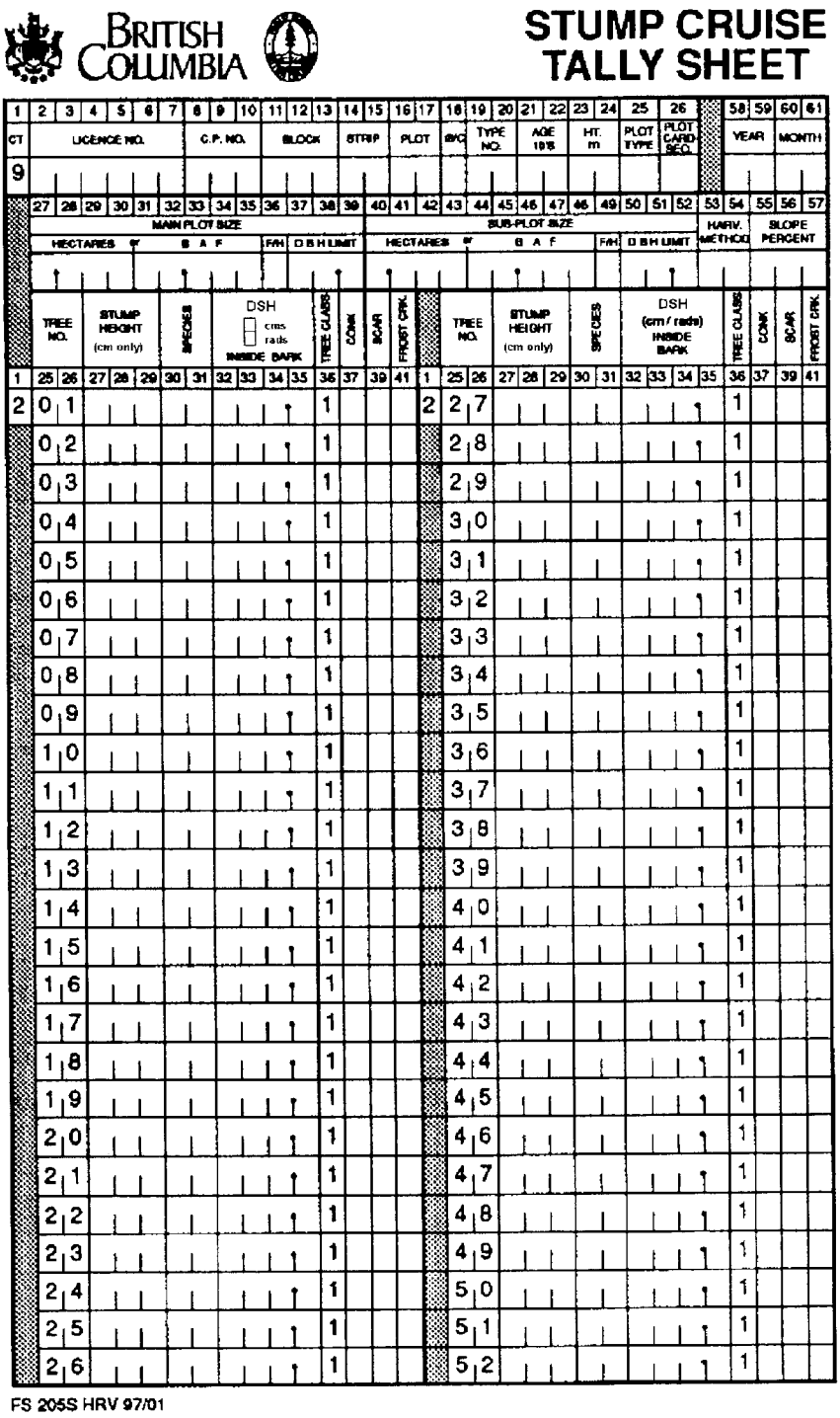


i determine stump diameter inside bark using long and short vectors - $\frac{A + B}{2}$

ii determine average thickness of the sap rot - $\frac{As + Bs}{2}$

iii if the average sap rot thickness is 1/6 or more of the average stump diameter, record the stump as a tree class 4 (dead useless). If not, record the stump as tree class 3 (will be compiled as highest risk group).

Figure 8.2 Examples of risk group determinations for stumps.



BRITISH COLUMBIA

STUMP CRUISE TALLY SHEET

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		58	59	60	61
CT	LICENCE NO.						C.P. NO.			BLOCK			STRIP		PLOT		BYC	TYPE NO.		AGE 19/5		HT. m		PLOT TYPE	PLOT CARD SEQ.		YEAR		MONTH	
9																														

27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57
MAIN PLOT SIZE													SUB-PLOT SIZE													HARV. METHOD	SLOPE PERCENT			
HECTARES					BAF				FIH	DBH LIMIT			HECTARES					BAF				FIH	DBH LIMIT							

TREE NO.	STUMP HEIGHT (cm only)	SPECIES	DSH cms / rads INSIDE BARK	TREE CLASS	CONK	SCAR	FROST CRK.	TREE NO.	STUMP HEIGHT (cm only)	SPECIES	DSH (cm / rads) INSIDE BARK	TREE CLASS	CONK	SCAR	FROST CRK.
1	25 26	27 28 29	30 31	32 33 34 35	36	37	39	41	1	25 26	27 28 29	30 31	32 33 34 35	36	37	39	41
2	0 1				1				2	2 7				1			
	0 2				1					2 8				1			
	0 3				1					2 9				1			
	0 4				1					3 0				1			
	0 5				1					3 1				1			
	0 6				1					3 2				1			
	0 7				1					3 3				1			
	0 8				1					3 4				1			
	0 9				1					3 5				1			
	1 0				1					3 6				1			
	1 1				1					3 7				1			
	1 2				1					3 8				1			
	1 3				1					3 9				1			
	1 4				1					4 0				1			
	1 5				1					4 1				1			
	1 6				1					4 2				1			
	1 7				1					4 3				1			
	1 8				1					4 4				1			
	1 9				1					4 5				1			
	2 0				1					4 6				1			
	2 1				1					4 7				1			
	2 2				1					4 8				1			
	2 3				1					4 9				1			
	2 4				1					5 0				1			
	2 5				1					5 1				1			
	2 6				1					5 2				1			

FS 205S HRV 97/01

Figure 8.3 FS 205S Ministry of Forests Stump Cruise Tally Sheet (side 1 of 2).

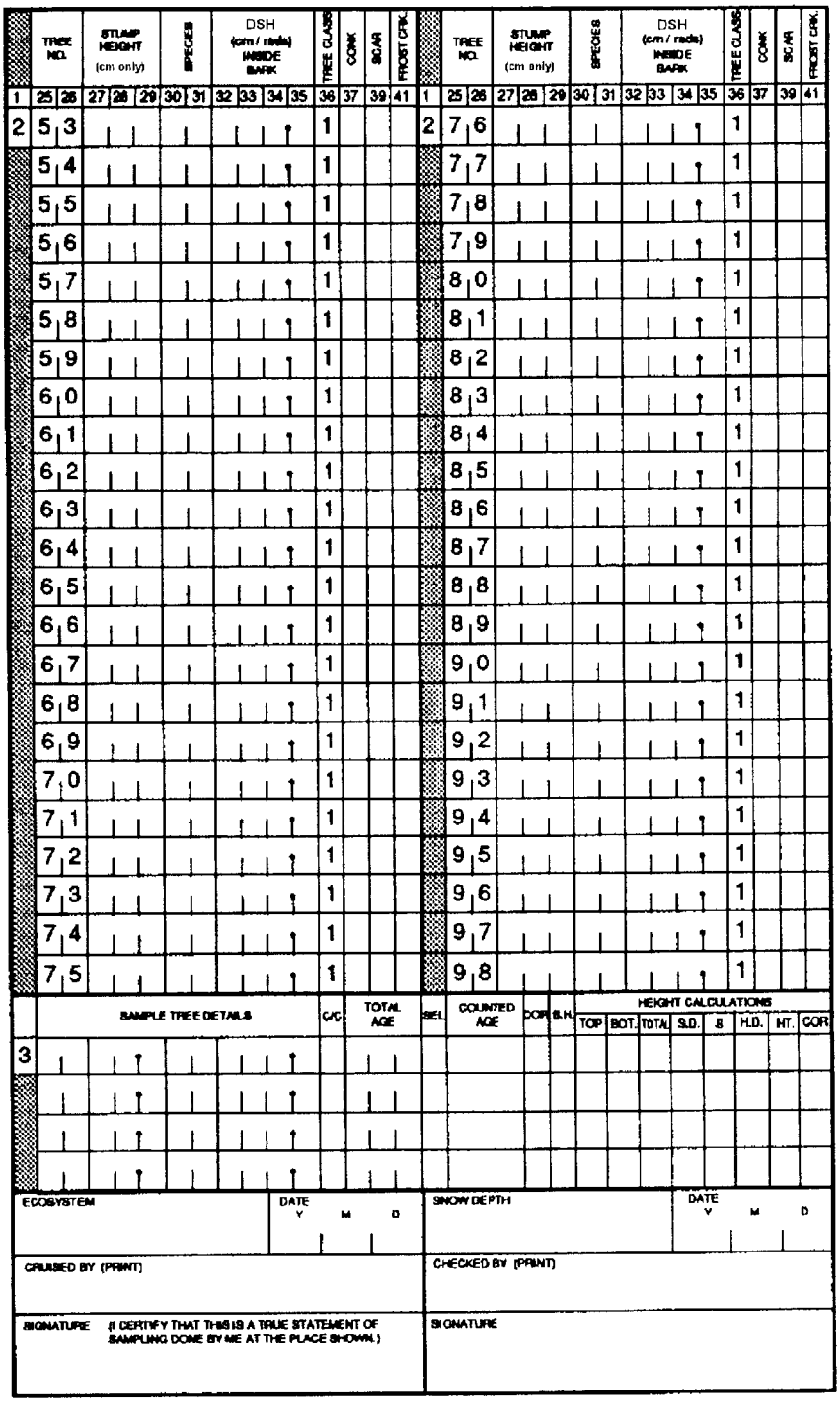


Figure 8.4 FS 205S Ministry of Forests Stump Cruise Tally Sheet (side 2 of 2).

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Regional Guidelines 9

Chapter 9 will be updated as the Regional Guidelines become available.

9.1 Vancouver Forest Region Operational Cruising Requirements

9.1.1 Information Sources Regarding Policy and Procedures

Current cruising policies and procedures are outlined in the following publications and circulars:

1. "*Forest Service Cruising Procedures and Cruise Compilation Manual*", Ministry of Forests *Cruising Manual*.

2. "Coast" Timber Utilization Requirements:
   Ministry of Forests Policy Manual – Chapter 8 – Volume 1
   Ministry of Forests Timber Administration Manual.

3. This circular.

4. Information letters as a result of the Vancouver Region Cruising Seminars.

9.1.2 Responsibility for Operational Cruising

The Ministry of Forests is responsible to ensure that all scale and cruise based non-replaceable timber sale licences under the Small Business Forest Enterprise Program and replaceable timber sale licences up to 10 000 m^3 are cruised.

Major licensees, as defined under the *Forest Act*, will be responsible for cruising on all their tenures that are subject to the payment of stumpage.

It is the prerogative of the Ministry of Forests to pre-empt the licensees' responsibility for cruising on any tenure or portion thereof. The district manager may also authorize a licensee of any replaceable timber sale licence up to 10 000 m^3 to carry out their own operational cruise per Section 9.1.1.1 above.

9.1.3 Tenures Requiring an Operational Cruise

All tenures subject to a stumpage appraisal pursuant to Section 84 and 85 of the *Forest Act* must normally be cruised. The regional manager may grant exemption to this requirement in specific cases. Cruising may also be required on other tenures under special circumstances at the discretion of the Regional Manager.

9.1.4 Submission of Cruise Plans

Licensees should submit cruise plans to the Ministry of Forests district office 30 days prior to commencement of a cruise. This includes submission of cruise plans for all amendments to existing cutting permits and for all blocks that have more than four plots added to the old cruise information. The 30 days will commence on the date the plan is received (stamped) at the district office.

The following information is mandatory on a cruise plan:

- tenure,
- block number(s),
- block designation (mature or immature),
- area (ha) by block,
- plot grid,
- number of measure plots,
- ratio of count to measure plots,
- dates of cruising,
- cruise plan map,
- proposed silviculture system (if known), and
- who the cruiser(s) will be (if known).

All other information is optional, unless specified by the district in a small business contract, but will assist the district in carrying out a check cruise.

Cruise plans must be submitted to the appropriate district manager containing all mandatory information listed above. The provincial cruise plan form is located in the *Cruising Manual* in the chapter called Forms. The licensee or consultant may use their own form if it contains all mandatory information.

The scale of the cruise plan map can be from 1:5 000 to 1:20 000. Once a cutting authority has been selected for check cruising, the licensee must bring along or supply the district with a map and compass notes which allow the ministry check cruiser to check actual plot locations, timber types, POC(s) and tie-point(s).

Response to cruise plans will be either in writing or by phone within 10 working days. No response confirms acceptance of the plan.

9.1.5 Acceptability of Cruise Data

9.1.5.1 Check Cruising

With the submission of cruise plans in accordance with the 30-day rule, the Ministry of Forests will have the capability to initiate and carry out a check cruise while the cruisers are on site. This does not preclude a check cruise after the cruise is completed.

Where 30 days lead time has not been given, it is the prerogative of the Ministry of Forests to conduct a check cruise, regardless of any delay in the processing of a cutting permit application until the final issuance of the cutting permit.

Where the cruise plan has been submitted 30 days prior to commencement of cruising, and no check is carried out while the cruisers are on site, the basic field data will not normally be contested at a later date, subject to "Use of Older Cruise Data" below.

9.1.5.2 Use of Older Cruise Data

1. In mature stands where increment is very slow and decay would offset the growth since the cruise was carried out, the cruise data will be considered acceptable if the cruising was done within the last 10 years.

2. In immature stands where increment is normal, the old data should be considered for updating after five (5) years or at the discretion of the District Manager.

3. New cruise data must be collected if there is a major change in the stand condition as a result of fire, insect, disease or wind throw (refer to Section 9.1.1.11 – Cruising Damaged Stands and Exceptional Circumstances).

Notwithstanding the above, policy changes may necessitate updated cruise data to be collected.

Where there is doubt as to the applicability of the cruise data, it is the prerogative of the District Manager to request evidence that the cruise data still accurately depicts the stand parameters.

When a re-cruise is necessary, it will be mandatory that a cruise plan be submitted to the District Manager as per Section 9.1.1.4 – Submission of Cruising Plans.

9.1.6 Technical Criteria

All distances in this circular are horizontal distances (corrected for slope).

9.1.6.1 Sampling Error Requirements

Where the sampling error requirement is achieved there is no required minimum number of trees per plot.

When the count plots are used in conjunction with full measure plots, all information must be used for determining if the sampling error requirement has been met, provided that a ratio of three (3) count plots to one (1) full measure plot is not exceeded.

The standards for judging whether the sampling error requirement was met will be the standards in place at the time the cutting authority was cruised.

Scale Based - Clear-cut and Selection Logging

> Sampling Error Requirement = 15 percent sampling error at two (2) standard errors (95 percent confidence level).

The sampling error requirement will be waived where:

1. For cutting authorities of 10 ha or larger in size, a 100 m by 100 m, or equivalent, systematic grid (1 plot per hectare) has been established and a ratio of one count plot to one full measure plot has not been exceeded.

2. For cutting authorities less than 10 ha in size, a 100 m by 100 m, or equivalent, systematic grid (1 plot per hectare) of full measure plots has been established.

An average of four (4) trees per plot is the minimum requirement for clear-cuts. An average of six (6) trees per plot is the minimum requirement for selection logging.

Cruise Based Sales

Cruise based sales will only be approved when the Regional Manager, or delegated district manager is satisfied that:

1. The loss factors, taper equations, and grade/quality standards proposed for use are appropriate, and that

2. utilization will be improved compared to scale based sales, or

3. administration will be simplified.

Sampling Error Requirement = 8 percent sampling error at two (2) standard errors (95 percent confidence level).

Count plots may be used in determining if the above requirement has been met. Proposed cruise based sales where the timber is very valuable or patchy, will be reviewed by the Regional Revenue Manager or designate, to determine if the above requirement should be accepted or changed.

For more information on cruise-based sales and their requirements, refer to the Ministry of Forests policy and procedures on Cruise Based Sales dated January 1, 1995.

9.1.6.2 Sampling Patterns

Plot grids are to be square or rectangular, and oriented in a cardinal direction.

The direction of travel between plots is at the discretion of the cruiser, but must be clear to the ministry check cruiser.

Collection of slope information necessitates the implementation of fully systematic cruise designs in order to assure representative sampling over the entire cutting area.

A minimum of two (2) full measure plots per cutting authority is required.

A minimum of one full measure plot per timber type is required although two or more is recommended. Timber type areas should be proportionally represented by plots.

In situations where the timber type is small and no plots exist within the type, it must be combined with an adjacent similar type as outlined in the *Provincial Cruising Manual*.

9.1.6.3 Plot Data

All information requested on the Ministry of Forests cruise tally sheet (FS 205), including quality remarks (live limb, stub, knots and spiral grain), must be collected except for growth rates, which only have to be collected when directed to by the District Manager.

Where age collection is necessary, sufficient ages must be taken to record the appropriate tree class for proper loss factor determination.

Quality Remarks

Quality remarks (live limb, stub, knots and spiral grain) should be called on all cruises, but will not be grounds for rejecting a cruise on licences that use historical grade information for the appraisal.

Quality remarks which exceed the allowable non-sampling errors in Section 3.622 b. of the *Cruising Manual* will be grounds for rejecting a cruise of SBFEP sales, woodlots and immature blocks, since the cruise grades from the compilation are used in the appraisal for all species that don't have at least 2 000 m^3 scaled to that timber mark.

Live Limb (Grade Change)

Live limb (grade change) is defined as the 5 m log where quality changes from:

- no knots to knots or knot indicators,
- from small knots to large knots, or
- from well spaced knots to excessive knots.

The purpose of recording live limb is to identify the first grade change as you move up the tree.

This will assist the log grade algorithm to better determine the cruise grade distribution produced by the cruise compilation program.

If the branching is consistent in frequency and size from the base of the tree to the utilization top diameter of the tree, record live limb as a one (1).

The grades on trees smaller than 60 cm dbh are not affected by the live limb code. On deciduous trees, live limb is recorded as the 5 m log where the natural forking starts.

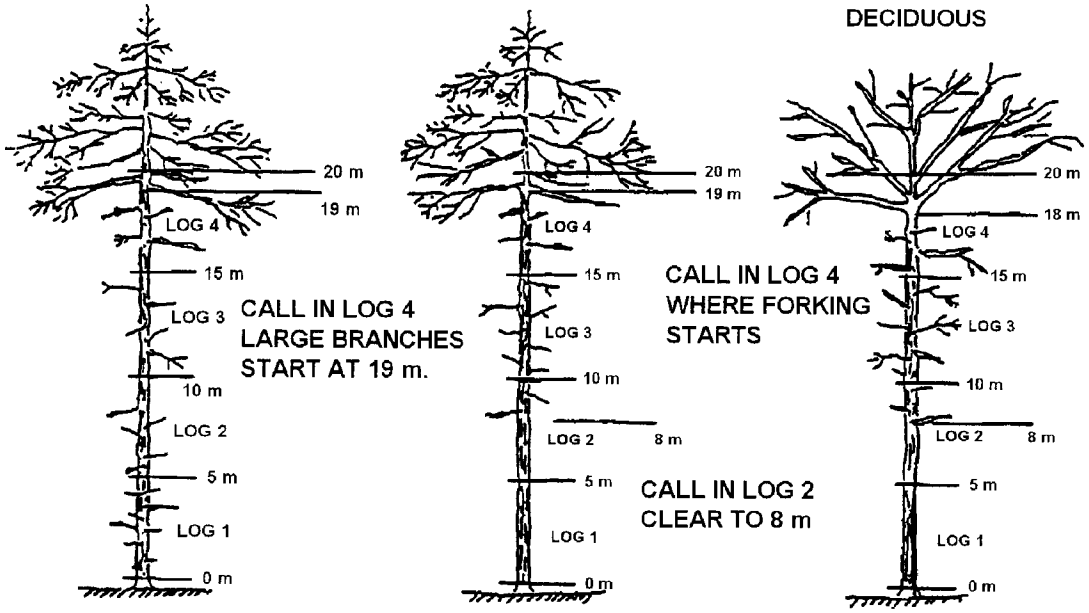


Figure 9.1 Example of live limb.

Pathological Indicators

Pathological Indicators above the utilization top diameter (15 cm on mature trees and 10 cm on immature trees) are not to be recorded.

If the pathological indicator is close to the utilization top diameter, use your judgement and call is above or below. Benefit of the doubt goes to the cruiser.

Fork or Crook Versus Dead or Broken Top

If there is a merchantable log (3 m long to the utilization top diameter) above the crook, you call the injury a fork or crook.

If a merchantable log does not exist above the crook, call it a dead or broken top. Definite forking is always called a fork or crook and not a dead or broken top.

9.1.6.4 Prism Size (Basal Area Factor)

Any prism size (BAF) may be used provided that a prism is available for use during a check cruise.

The same prism size (BAF) is recommended to be used throughout a timber type, but the use of more than one prism size (BAF) is allowed.

However, prism size (BAF) cannot be changed at plot centre to include or exclude certain trees, or to achieve a pre-determined number of trees in a plot as that constitutes bias.

9.1.6.5 Heights

The 100 Percent Height Method must be used on all scale and cruise based tenures.

Use of the Sample Height (height curve) Method is only allowed for stump cruises and stands which are severely damaged due to wind shear or shatter due to freezing (i.e., most of the trees have their tops broken off) and must be identified in the cruise plan and approved by the district.

9.1.6.6 Field Marking

Tie Points

The cruise must be tied to at least one (1) and preferably two (2) tie points. They must be good photo ties (GPS) positions, or unique map locations. Tie points must be linked to the cruise grid with an accurate traverse.

Cruise Lines (Striplines)

Cruise lines should be tied to the cut block boundary, where available.

Cruise lines should be established with a compass, clinometer and tape, or an electronic measuring device.

Plot Centres

Plot centre for full measure and count plots must be marked by a stake or wire flag.

The strip and plot number must be marked on the plot centre and/or the reference tree.

A reference tree with a blazed side or metal tag facing the plot centre must identify the bearing and distance to plot centre. The information on the reference tree should also be noted on the cruise card in case the metal tag is missing or the information written on the blaze is unreadable.

Tree Identification

All trees determined to be within a full measure plot will be numbered, where safely possible, with paint or a tag with the number facing plot centre.

The dbh will be marked at 1.3 m above the ground on the high side with a paint stripe facing plot centre.

For count plots, number the first tree and paint an arrow on that tree showing the direction of travel. Number enough trees so that plot can be checked.

Borderline tree measurements must be recorded on the cruise card or on the tree. Trees measured out should be marked with OUT or an X on the stem facing plot centre.

9.1.6.7 Diameter at Breast Height Measurement (DBH)

1. Coniferous Species

   a. Mature (Old Growth)

      A stand of timber that has an average age greater than 120 years.

      Minimum DBH is 17.5 cm at 1.3 m above the ground on the high side.

   b. Immature (Second Growth)

      A stand of timber that has an average age less than 121 years.

      Minimum DBH is 12.0 cm at 1.3 m above the ground on the high side.

2. Deciduous Species

   a. Mature

      A stand of timber that has an average age greater than 40 years.

      Minimum DBH is 17.5 cm at 1.3 m above the ground on the high side.

   b. Immature

      A stand of timber that has an average age less than 41 years.

      Minimum DBH is 12.0 cm at 1.3 m above the ground on the high side.

> It is the prerogative of the District Manager to set minimum DBH specifications on a site specific basis for deciduous species.

9.1.6.8 Cut Block Label – Mature and Immature

Prior to cruising and at the five (5) year plan update, distinct proposed cut blocks of timber which fall into the Mature and Immature label must be segregated and numbered separately by individual cut block.

Once the label has been established for the cut block, the minimum DBH measurement as per Section 9.1.6.7 must be used.

Each cut block cruised must be numbered and labelled as Mature or Immature on the cruise plan map, and the map attached to the cutting permit application.

The determining factor for labelling of the cut block as mature or immature will be the gross volume. If the gross volume of the mature portion is 51 percent or more of the total gross volume of the cut block, the block will be labelled Mature. If the gross volume of the immature portion equals 50 percent or more of the total gross volume of the cut block, then the cut block will be labelled Immature.

9.1.6.9 Plot Establishment

Half Plots

The use of half plots is optional but must be consistent. If the decision is made to use half-plots, they must be used on all plots with 10 or more "IN" trees (dead useless excluded) based on an initial sweep.

If the decision is made not to use half-plots, they cannot be used on any plots no matter how many trees are in the plot.

When establishing a half plot, all trees, including standing dead useless, are included for numbering the trees. Start with the first tree which has at least half of its stem to the right of due north and consecutively number all IN trees moving clockwise around the plot. If two trees are exactly in line when looking out from plot centre record the tree closer to plot centre first.

Odd Number Plots	Measure and record only the odd number trees.
Even Number Plots	Measure and record only the even number trees.

The use of half plots is not recommended for use in stands with a significant amount of deciduous trees because of the large difference in value between deciduous and coniferous trees.

Border Plots

The plot must be established if the plot centre falls inside the area to be sampled and a half-circle (180 degree) plot can be established without sampling outside the area/type the plot is inside.

The plot will be split in half to avoid sampling outside the area unless the timber outside the area to be sampled is the same as the timber inside the area to be sampled.

Make note on the cruise card that it is half plot because it is too close to a border or type line.

Where a plot falls on a pre-typed photo type line, those pre-typed lines will be the basis for establishing a border plot. Use 100 m arcs to the type line in both directions and determine the bearing between the end of the two arcs. That bearing will be used from plot centre to split the plot in half.

Moving Plots

Cruise plots must not be moved unless the plot centre is outside the area to be sampled.

The method of moving cruise plots must be identified and approved at the cruise plan stage or the default method of moving plots 25 m in the direction of travel into the area to be sampled must be used.

If boundaries have not been finalized, the field plots should only be moved if they fall in a non-productive area that is being typed out.

9.1.7 Timber Typing

Timber typing is to be based on species, volume and age, and may be used on field or photo typing. A cruise may be rejected due to obviously wrong or biased timber typing.

Modification of timber type lines is permitted, provided that original field data or photo timber typing data is retained and is available for auditing.

Where special management zones exist timber typing may be based on those special management zones.

9.1.8 Cruising of Cutting Authority Amendments

Refer to the current *Coast Appraisal Manual.*

If accumulated amendments (either addition or deletion of area containing merchantable timber) made to the cutting authority at any time from the effective date of the initial appraisal or reappraisal, exceed 25 ha or 25 percent of the merchantable area, whichever is less, the cutting authority must be reopened in accordance with the current *Coast Appraisal Manual.*

In this case, the entire cruise must be recompiled and the stumpage rate recalculated.

To facilitate the administration of (current *Coast Appraisal Manual*) the following criteria will be used to determine if an amendment to a cutting authority requires cruising:

1. If the amendment will cause the cutting authority to be re-appraised, then all amendments (which have not been cruised) will have to be cruised using the same grid from the cutting authority and the entire cruise re-compiled.

2. All other amendments do not have to be cruised.

Amendments must be submitted to the forest district with the following information:

- size (ha) of amendment,
- map,
- volume by species, and
- appraisal information (i.e., roads, bridges and any other required information).

9.1.9 Cruise Reports

9.1.9.1 Cruise Compilations

Cruises must be compiled using the current (latest) version of a compilation program, which has been approved by the Ministry of Forests.

For more information on the specifications for the reports and how cruise data must be compiled, refer to the Ministry of Forests, *Cruise Compilation User Manual* and the *Cruise Compilation Design Manual.*

Please note the following:

1. Summaries must be given for the entire application area.

2. Where more than one cut block exists, individual cut block summaries must be supplied unless otherwise directed by the District Manager.

3. Each cut block must be labelled as mature or immature for compilation purposes and to establish the utilization level for residue and waste purposes.

4. All blocks with both immature and mature types must be compiled using the Block Method, because using the Average Line Method will result in either the immature or mature types being compiled to a different level than the utilization level for that block.

Schedule "A" (Timber Licence) and "B" (Crown) Land Splits

Schedule "A" and "B" lands in a Tree Farm Licence (TFL) can be cruised, compiled and appraised together, but a separate summary page is required for both.

Schedule "A" and "B" lands not in a TFL can be cruised together, but must have separate compilations because they must be appraised separately.

The stumpage rate for timber licence cutting authorities will be set at a percentage of the appraised rate. The appropriate percentages are listed in Table 5-1 (Timber Licence Stumpage Rate Adjustment Schedule) of the *Coast Appraisal Manual*.

Cut Block Rights-of-Way

Right-of-way(s) within the cut blocks must be cruised and compiled unless the right-of-way volume has been removed.

The area and net volume of right-of-way(s) must be included for appraisal purposes unless the right-of-way(s) volume has been removed under a different timber mark.

For Small Business Forest Enterprise Program timber sales, right-of-way(s) area and net volume will only be included in the compilation and for appraisal purposes when the right(s)-of-way will be harvested by the licensee.

Cruise Compilation Reports

The following is a summary of all reports which are currently produced, whether each report is mandatory, mandatory under certain circumstances or optional, and whether a hard copy and/or electronic copy (3.5 diskette) of the report is required.

No. 001 Edit Report	a.	Edit Report (Data Listing) of cruise data. Mandatory – electronic.
	b.	Scattergram of Card Type 2's and Card Type 3's. Mandatory if height curves are used – electronic.
No. 3 – Calculate Height/Diameter Equations Report	a.	Regression coefficients of different height curves. Mandatory, if height curves are used – electronic.
	b.	Original scattergram and regression coefficients. Mandatory, if height curves are used and suggested curve is overridden – electronic. A written explanation and computer report of actual keyed values are required.
No. 004 Create Heights Report	a.	Edit Check Listing Mandatory, only if height curves are used – electronic.
	b.	Double Sampling Ratios Mandatory, only if Double Sampling is used – electronic.
No. 5 Cruise Statistics Report		Mandatory – electronic.
No. 6 Extended Stand and Stock Table Report		Optional – electronic (may be required by the district in selective logging SBFEP timber sales).
No. 7 Stand and Stock Tables Report		Optional – electronic.
No. 009 Summary Page Report		Mandatory – hard copy and electronic.

No. 011 Plot Summary Report		Mandatory – electronic.
No. 012 Plot Summary by Maturity Report		Mandatory, if Coast Compilation – electronic.
No. 015 Harvesting Method Summary Report	a.	Harvesting Method and Appraisal Summaries (slope, damage, and % immature). Mandatory – hard copy and electronic.
	b.	Second and Old Growth Summaries. Mandatory, if Coast Compilation – hard copy and electronic.

If a percent reduction is being applied, the following is required:

1. The original harvest method summary report (015 a. and b.) before the percent reduction was applied.

2. All mandatory reports after the percent reduction was applied.

3. The input values for the percent reduction.

9.1.9.2 Form and Content of Cruise Reports

Upon request from the district, the licensee must supply the cruise cards along with the electronic data disk mentioned in Section 9.1.9.1.

1. Information as indicated in Section 9.1.9.2 must be included.

2. Historic information as indicated below must be given:

   a. name of company or individual(s) performing the cruise,

   b. date(s) of cruise,

   c. name of company that computed the cruise data.

3. Cruise map(s) must accompany the report and comply with Ministry of Forests (MoF) cartographic standards, as documented in the MoF "Visual Identifier Standards Guide". The map should be produced at a scale of 1:5 000 and include the following:

   a. tenure,

   b. forest region and district,

   c. scale,

   d. timber supply area,

   e. north arrow,

   f. cut blocks must be identified by their block number and whether they are Mature or Immature,

   g. tie-points,

   h. timber type lines and timber type descriptions,

   i. area by type, block and cutting authority,

   j. plot location, plot numbers and types,

   k. cutting boundaries, and

   l. any other features of significance with respect to the sale of Crown timber such as areas of blowdown, fire damage, insect or disease infestations, fish-bearing streams and special management zones.

9.1.10 Re-compilations

All re-compilations must be done using the current (latest) version of a compilation program that has been approved by the Ministry of Forests.

9.1.11 Cruising Damaged Stands and Exceptional Circumstances

Cruising standards and techniques must be indicated on the cruise plan and may be amended by the District Manager.

9.1.12 Sampling in Unsafe Conditions

Unsafe working conditions can arise in cruising of salvage logging areas, and in certain other situations.

For unsafe working conditions, it is recommended that the cruise plots in the unsafe area be dropped and cruise information from the fringes of the unsafe area, or similar timber in the cutting authority, or similar timber in the vicinity of the cutting authority be used for appraisal purposes.

Tables

Table 1 Correction Table for Chaining Short Horizontal Distances

% Slope	Chainage Plus Slope Allowance									
				Horizontal Distance in Metres						
	5	10	15	20	25	30	35	40	45	50
10	5.02	10.05	15.07	20.10	25.12	30.15	35.17	40.20	45.22	50.25
12	5.04	10.07	15.11	20.14	25.18	30.22	35.25	40.29	45.32	50.36
14	5.05	10.10	15.15	20.20	25.24	30.29	35.34	40.39	45.44	50.49
16	5.06	10.13	15.19	20.25	25.32	30.38	35.45	40.51	45.57	50.64
18	5.08	10.16	15.24	20.32	25.40	30.48	35.56	40.64	45.72	50.80
20	5.10	10.20	15.30	20.40	25.50	30.59	35.69	40.79	45.89	50.99
22	5.12	10.24	15.36	20.48	25.60	30.72	35.84	40.96	46.08	51.20
24	5.14	10.28	15.43	20.57	25.71	30.85	35.99	41.14	46.28	51.42
26	5.17	10.33	15.50	20.66	25.83	31.00	36.16	41.33	46.50	51.66
28	5.19	10.38	15.58	20.77	25.96	31.15	36.35	41.54	46.73	51.92
30	5.22	10.44	15.66	20.88	26.10	31.32	36.54	41.76	46.98	52.20
32	5.25	10.50	15.75	21.00	26.25	31.50	36.75	42.00	47.25	52.50
34	5.28	10.56	15.84	21.12	26.41	31.69	36.97	42.25	47.53	52.81
36	5.31	10.63	15.94	21.26	26.57	31.88	37.20	42.51	47.83	53.14
38	5.35	10.70	16.05	21.40	26.74	32.09	37.44	42.79	48.14	53.49
40	5.39	10.77	16.16	21.54	26.93	32.31	37.70	43.08	48.47	53.85
42	5.42	10.85	16.27	21.69	27.12	32.54	37.96	43.38	48.81	54.23
44	5.46	10.93	16.39	21.85	27.31	32.78	38.24	43.70	49.16	54.63
46	5.50	11.01	16.51	22.01	27.52	33.02	38.53	44.03	49.53	55.04
48	5.55	11.09	16.64	22.18	27.73	33.28	38.82	44.37	49.92	55.46
50	5.59	11.18	16.77	22.36	27.95	33.54	39.13	44.72	50.31	55.90
52	5.64	11.27	16.91	22.54	28.18	33.81	39.45	45.08	50.72	56.36
54	5.68	11.36	17.05	22.73	28.41	34.09	39.78	45.46	51.14	56.82
56	5.73	11.46	17.19	22.92	28.65	34.38	40.11	45.84	51.58	57.31
58	5.78	11.56	17.34	23.12	28.90	34.68	40.46	46.24	52.02	57.80
60	5.83	11.66	17.49	23.32	29.15	34.99	40.82	46.65	52.48	58.31
62	5.88	11.77	17.65	23.53	29.42	35.30	41.18	47.06	52.95	58.83
64	5.94	11.87	17.81	23.75	29.68	35.62	41.55	47.49	53.43	59.36
66	5.99	11.98	17.97	23.96	29.95	35.94	41.94	47.93	53.92	59.91
68	6.05	12.09	18.14	24.19	30.23	36.28	42.33	48.37	54.42	60.46
70	6.10	12.21	18.31	24.41	30.52	36.62	42.72	48.83	54.93	61.03
72	6.16	12.32	18.48	24.64	30.81	36.97	43.13	49.29	55.45	61.61
74	6.22	12.44	18.66	24.88	31.10	37.32	43.54	49.76	55.98	62.20
76	6.28	12.56	18.84	25.12	31.40	37.68	43.96	50.24	56.52	62.80
78	6.34	12.68	19.02	25.36	31.71	38.05	44.39	50.73	57.07	63.41
80	6.40	12.81	19.21	25.61	32.02	38.42	44.82	51.22	57.63	64.03
82	6.47	12.93	19.40	25.86	32.33	38.80	45.26	51.73	58.19	64.66
84	6.53	13.06	19.59	26.12	32.65	39.18	45.71	52.24	58.77	65.30
86	6.59	13.19	19.78	26.38	32.97	39.57	46.16	52.76	59.35	65.95
88	6.66	13.32	19.98	26.64	33.30	39.96	46.62	53.28	59.94	66.60
90	6.73	13.45	20.18	26.91	33.63	40.36	47.09	53.81	60.54	67.27
92	6.79	13.59	20.38	27.18	33.97	40.76	47.56	54.35	61.15	67.94
94	6.86	13.72	20.59	27.45	34.31	41.17	48.04	54.90	61.76	68.62
96	6.93	13.86	20.79	27.72	34.66	41.59	48.52	55.45	62.38	69.31
98	7.00	14.00	21.00	28.00	35.00	42.00	49.00	56.01	63.01	70.01
100	7.07	14.14	21.21	28.28	35.36	42.43	49.50	56.57	63.64	70.71
102	7.14	14.28	21.43	28.57	35.71	42.85	49.99	57.14	64.28	71.42
104	7.21	14.43	21.64	28.86	36.07	43.28	50.50	57.71	64.92	72.14
106	7.29	14.57	21.86	29.15	36.43	43.72	51.00	58.29	65.58	72.86
108	7.36	14.72	22.08	29.44	36.80	44.16	51.52	58.87	66.23	73.59
110	7.43	14.87	22.30	29.73	37.17	44.60	52.03	59.46	66.90	74.33

Table 2 Plot Radii Slope Allowance

Table 2 – Plot Radius – Page T-3									
% Slope	Plot Radii Plus Slope Allowance								
	0.005 ha	0.008 ha	.010 ha	0.02 ha	0.04 ha	0.06 ha	0.08 ha	0.1 ha	0.2 ha
	3.99	5.05	5.64	7.98	11.28	13.82	15.96	17.84	25.23
10	4.01	5.08	5.67	8.02	11.34	13.89	16.04	17.93	25.36
12	4.02	5.09	5.68	8.04	11.36	13.92	16.07	17.97	25.41
14	4.03	5.10	5.70	8.06	11.39	13.95	16.12	18.01	25.48
16	4.04	5.11	5.71	8.08	11.42	14.00	16.16	18.07	25.55
18	4.05	5.13	5.73	8.11	11.46	14.04	16.22	18.13	25.64
20	4.07	5.15	5.75	8.14	11.50	14.09	16.28	18.19	25.73
22	4.09	5.17	5.77	8.17	11.55	14.15	16.34	18.27	25.83
24	4.10	5.19	5.80	8.21	11.60	14.21	16.41	18.35	25.95
26	4.12	5.22	5.83	8.25	11.66	14.28	16.49	18.43	26.07
28	4.14	5.24	5.86	8.29	11.71	14.35	16.57	18.53	26.20
30	4.17	5.27	5.89	8.33	11.78	14.43	16.66	18.63	26.34
32	4.19	5.30	5.92	8.38	11.84	14.51	16.76	18.73	26.49
34	4.21	5.33	5.96	8.43	11.91	14.60	16.86	18.84	26.65
36	4.24	5.37	5.99	8.48	11.99	14.69	16.96	18.96	26.82
38	4.27	5.40	6.03	8.54	12.07	14.78	17.07	19.08	26.99
40	4.30	5.44	6.07	8.59	12.15	14.88	17.19	19.21	27.17
42	4.33	5.48	6.12	8.66	12.23	14.99	17.31	19.35	27.36
44	4.36	5.52	6.16	8.72	12.32	15.10	17.44	19.49	27.56
46	4.39	5.56	6.21	8.78	12.42	15.21	17.57	19.64	27.77
48	4.43	5.60	6.26	8.85	12.51	15.33	17.70	19.79	27.99
50	4.46	5.65	6.31	8.92	12.61	15.45	17.84	19.95	28.21
52	4.50	5.69	6.36	8.99	12.71	15.58	17.99	20.11	28.44
54	4.53	5.74	6.41	9.07	12.82	15.71	18.14	20.27	28.67
56	4.57	5.79	6.46	9.15	12.93	15.84	18.29	20.45	28.92
58	4.61	5.84	6.52	9.23	13.04	15.98	18.45	20.62	29.17
60	4.65	5.89	6.58	9.31	13.15	16.12	18.61	20.80	29.42
62	4.69	5.94	6.64	9.39	13.27	16.26	18.78	20.99	29.69
64	4.74	6.00	6.70	9.47	13.39	16.41	18.95	21.18	29.95
66	4.78	6.05	6.76	9.56	13.52	16.56	19.12	21.38	30.23
68	4.83	6.11	6.82	9.65	13.64	16.71	19.30	21.57	30.51
70	4.87	6.16	6.88	9.74	13.77	16.87	19.48	21.78	30.80
72	4.92	6.22	6.95	9.83	13.90	17.03	19.67	21.98	31.09
74	4.96	6.28	7.02	9.93	14.03	17.19	19.85	22.19	31.39
76	5.01	6.34	7.08	10.02	14.17	17.36	20.05	22.41	31.69
78	5.06	6.40	7.15	10.12	14.31	17.53	20.24	22.63	32.00
80	5.11	6.47	7.22	10.22	14.45	17.70	20.44	22.85	32.31
82	5.16	6.53	7.29	10.32	14.59	17.87	20.64	23.07	32.63
84	5.21	6.60	7.37	10.42	14.73	18.05	20.84	23.30	32.95
86	5.26	6.66	7.44	10.53	14.88	18.23	21.05	23.53	33.28
88	5.31	6.73	7.51	10.63	15.03	18.41	21.26	23.76	33.61
90	5.37	6.79	7.59	10.74	15.18	18.59	21.47	24.00	33.94
92	5.42	6.86	7.66	10.84	15.33	18.78	21.69	24.24	34.28
94	5.48	6.93	7.74	10.95	15.48	18.97	21.90	24.48	34.63
96	5.53	7.00	7.82	11.06	15.64	19.16	22.12	24.73	34.97
98	5.59	7.07	7.90	11.17	15.79	19.35	22.35	24.98	35.33
100	5.64	7.14	7.98	11.29	15.95	19.54	22.57	25.23	35.68
102	5.70	7.21	8.06	11.40	16.11	19.74	22.80	25.48	36.04
104	5.76	7.29	8.14	11.51	16.27	19.94	23.03	25.74	36.40
106	5.81	7.36	8.22	11.63	16.44	20.14	23.26	26.00	36.77
108	5.87	7.43	8.30	11.75	16.60	20.34	23.49	26.26	37.14
110	5.93	7.51	8.38	11.86	16.77	20.54	23.73	26.52	37.51
112	5.99	7.58	8.47	11.98	16.94	20.75	23.96	26.79	37.88
114	6.05	7.66	8.55	12.10	17.11	20.96	24.20	27.05	38.26

continued...

Table 2 – Plot Radius – Page T-3									
% Slope	**Plot Radii Plus Slope Allowance**								
	0.005 ha	0.008 ha	.010 ha	0.02 ha	0.04 ha	0.06 ha	0.08 ha	0.1 ha	0.2 ha
116	6.11	7.73	8.64	12.22	17.28	21.17	24.44	27.32	38.64
118	6.17	7.81	8.72	12.34	17.45	21.38	24.69	27.59	39.02
120	6.23	7.89	8.81	12.47	17.62	21.59	24.93	27.87	39.41
122	6.29	7.97	8.90	12.59	17.79	21.80	25.18	28.14	39.80
124	6.36	8.04	8.98	12.71	17.97	22.02	25.42	28.42	40.19
126	6.42	8.12	9.07	12.84	18.15	22.23	25.67	28.70	40.59
128	6.48	8.20	9.16	12.96	18.32	22.45	25.92	28.98	40.98
130	6.54	8.28	9.25	13.09	18.50	22.67	26.18	29.26	41.38
132	6.61	8.36	9.34	13.22	18.68	22.89	26.43	29.54	41.78
134	6.67	8.44	9.43	13.34	18.86	23.11	26.69	29.83	42.18
136	6.74	8.52	9.52	13.47	19.04	23.33	26.94	30.12	42.59
138	6.80	8.61	9.61	13.60	19.22	23.55	27.20	30.40	43.00
140	6.86	8.69	9.70	13.73	19.41	23.78	27.46	30.69	43.41

Radii for plot sizes smaller than those given in the table can be measured by holding the tape horizontally.

Table 3 Distribution of "t"

Degrees of Freedom	0.05
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
40	2.021
60	2.000
120	1.980
∞	1.960

Stump and Breast Height Diameter Tables for the British Columbia Merchantable Tree Species (Tables 4 to 9)[1]

The following tables (Tables 4 to 9) are designed to be used in the estimation of diameters breast height outside bark (DBH) from stump diameter inside bark (DSIB) measured at a fixed height above ground level (SH). Each table was derived from a regression equation that was fitted on butt diameter measurements of the same trees that were used in the Ministry of Forests metric volume equations.

The regression equations are of the following form:

$$DBH = DSIB + b_0\ DSIB\ (2.3 - SH) + b_1\ DSIB\ \ln\left[(SH + 1.0) / 2.3\right]$$

where DBH and DSIB are in centimetres. SH is measured in metres and can range from 0.15 to 1.05 m. For a given stump cruise, all DSIB measurements should be at a given stump height to facilitate computer compilation.

The constant b_0 and b_1 for the various species and zones are listed in Table 4. A map of the British Columbia forest inventory zones is shown in Appendix 4.

[1] A. Kozak, Faculty of Forestry, University of British Columbia and S. A. Omule, Research Branch, Ministry of Forests, February 1989.

Table 4 Constants for Species and Zones

Species	Age*	Zone[b]	No. of Observations	B_0	B_1	SEE[c]
Douglas-fir	MAT.	ABC	2027	0.192451	0.656977	5.24
Douglas-fir	IMM.	ABC	1180	0.155107	0.564107	1.77
Douglas-fir	ALL	D-L	9978	0.189385	0.712098	3.62
Redcedar	MAT.	ABC	1988	0.032043	0.585026	5.70
Redcedar	IMM.	ABC	1297	0.055116	0.706639	2.98
Redcedar	ALL	D-L	4669	0.059052	0.655006	4.16
Hemlock	MAT.	ABC	4058	0.064571	0.534355	4.68
Hemlock	IMM.	ABC	2167	0.077996	0.438284	1.73
Hemlock	ALL	D-L	5466	0.100771	0.504787	2.94
Spruce	MAT.	ABC	1197	0.021123	0.530663	8.23
Spruce	IMM.	ABC	980	0.046301	0.580005	4.23
Spruce	ALL	D-J	13755	0.065728	0.575037	3.11
Spruce	ALL	KL	11494	0.062808	0.442810	1.46
Balsam	ALL	ABC	2548	0.057484	0.573054	4.84
Balsam	ALL	D-J	11760	0.073625	0.477491	2.02
Balsam	ALL	KL	2307	0.073358	0.431277	1.24
Yellow-Cedar	ALL	A-L	905	0.037211	0.460492	2.03
White Pine	ALL	ABC	275	0.057377	0.561538	3.32
White Pine	ALL	D-L	774	0.056953	0.449184	1.76
Lodgepole pine	ALL	A-J	8318	0.056984	0.374589	1.23
Lodgepole pine	ALL	KL	5259	0.051075	0.337046	0.91
Yellow pine	ALL	A-L	2023	0.154163	0.638001	3.18
Larch	ALL	A-J	2520	0.190001	0.682016	4.06
Larch	ALL	KL	811	0.078977	0.532930	0.91
Cottonwood	ALL	A-J	996	0.117130	0.565108	3.91
Cottonwood	ALL	KL	2137	0.136074	0.498340	1.80
Alder	ALL	A-L	1556	0.055705	0.374983	1.34
Maple	ALL	A-L	416	0.064992	0.421552	0.72
Birch	ALL	A-J	923	0.070797	0.455765	1.60
Birch	ALL	KL	750	0.070901	0.407800	0.84
Aspen	ALL	A-J	2204	0.103886	0.492890	1.55
Aspen	ALL	KL	4100	0.097907	0.469721	1.50
Whitebark pine	ALL	A-L	148	0.036171	0.482541	1.66

*Age: IMM. = immature, up to 120 years old, MAT. = mature, more than 120 years old, ALL = all ages.

[b]Zone: A = North and central coast region, B = Southern coast region, C = South Coast transition belt, D = South western interior dry belt, E = West Kootenay region, F = East Kootenay region, G = central Columbia region, interior wet belt, H = Nechako, Fraser plateau region, I = Central interior, J = North west plateau region, Stikine, Skeena, K = North Central Region, Cassiar, Omineca, L = North eastern plains region.

[c]SEE: = Standard error of estimated DBH, for all diameter classes (cm).

Table 5 Butt Taper - Mature - FIZ A, B and C - Coast

dbh (ob)	F*		C*		H*		B		S*		Y	
(cm) @ 1.3 m	dib	dob	dib	dob	dib	dob	dib	dob	dib	dob	dib	dob
06	6	7	8	9	7	8	8	8	8	8	7	8
08	8	9	11	11	10	10	10	10	11	11	10	10
10	10	12	14	14	12	13	13	13	14	14	12	13
12	12	14	17	17	15	15	15	16	16	17	15	15
14	14	17	19	20	17	18	18	18	19	19	17	18
16	16	19	22	22	19	20	20	21	22	22	20	20
18	18	21	25	25	22	23	23	23	24	25	22	23
20	20	24	27	28	24	25	25	26	27	27	25	25
22	22	26	30	31	27	28	28	29	30	30	27	28
24	24	28	33	34	29	30	31	31	33	33	30	31
26	26	31	36	37	32	33	33	34	35	36	32	33
28	28	33	38	39	34	35	36	36	38	38	35	36
30	30	35	41	42	36	38	38	39	41	41	37	38
32	32	38	44	45	39	40	41	41	43	44	39	41
34	34	40	47	48	41	43	43	44	46	47	42	43
36	36	43	49	51	44	45	46	47	49	49	44	46
38	38	45	52	54	46	48	48	49	51	52	47	48
40	40	47	55	56	49	50	51	52	54	55	49	51
42	42	50	58	59	51	53	53	54	57	58	52	53
44	44	52	60	62	53	55	56	57	60	60	54	56
46	46	54	63	65	56	58	58	60	62	63	57	59
48	48	57	66	68	58	60	61	62	65	66	59	61
50	50	59	69	70	61	63	64	65	68	69	62	64
55	55	65	75	77	67	69	70	71	74	75	68	70
60	59	71	82	84	73	76	76	78	81	82	74	76
65	64	77	89	92	79	82	83	84	88	89	80	83
70	69	83	96	99	85	88	89	91	95	94	86	89
75	74	89	103	106	91	94	95	97	101	103	92	95
80	79	94	110	113	101	102	104	108	108	110	99	102
85	84	100	116	120	103	107	108	110	115	116	105	108
90	89	106	123	127	109	113	114	117	122	123	111	114
95	94	112	130	134	115	120	121	123	129	130	117	121
100	99	118	137	141	121	126	127	130	135	137	123	127
105	104	124	144	148	127	132	133	136	142	144	129	133
110	109	130	151	155	134	138	140	142	149	151	136	140
115	114	136	158	162	140	145	146	149	156	158	142	146
120	119	142	164	169	146	151	152	155	162	164	148	153

* Mature - Forest Inventory Zones - A, B, C, - Coast (table shows diameter at stump height of 0.3 m).

continued...

dbh (ob)	Pw		Pl		Ac		Alder		Maple		Birch	
(cm) @ 1.3 m	dib	dob	dib	dob	dib	dob	dib	dob	dib	dob	dib	dob
06	8	8	7	7	7	7	7	7	7	7	7	7
08	10	10	9	10	9	10	9	9	9	10	9	10
10	13	13	11	12	11	12	11	12	11	12	11	12
12	15	16	13	14	13	14	13	14	14	14	14	15
14	18	18	16	17	15	17	16	17	16	17	16	17
16	20	21	18	19	18	19	18	19	18	19	18	19
18	23	23	20	21	20	21	20	21	20	22	20	22
20	25	26	22	24	22	24	22	24	23	24	23	24
22	28	28	24	26	24	26	25	26	25	26	25	27
24	30	31	27	28	26	28	27	28	27	29	27	29
26	33	34	29	31	29	31	29	31	29	31	30	31
28	35	36	31	33	31	33	31	33	32	34	32	34
30	38	39	33	36	33	36	33	35	34	36	34	36
32	40	41	36	38	35	38	36	38	36	38	36	39
34	43	44	38	40	37	40	38	40	38	41	39	41
36	45	46	40	43	40	43	40	42	41	43	41	43
38	48	49	42	45	42	45	42	45	43	45	43	46
40	50	52	44	47	44	47	45	47	45	48	45	48
42	53	54	47	50	46	50	47	49	47	50	48	51
44	55	57	49	52	48	52	49	52	50	53	50	53
46	58	59	51	54	51	55	51	54	52	55	52	55
48	60	62	53	57	53	57	54	56	54	57	55	58
50	63	65	56	59	55	59	56	59	56	60	57	60
55	69	71	61	65	60	65	61	65	62	66	62	66
60	76	77	67	71	66	71	67	71	68	72	68	72
65	82	84	72	77	71	77	72	76	73	78	74	78
70	88	90	78	83	77	83	78	82	79	84	79	84
75	94	97	83	89	82	89	84	88	84	90	85	90
80	101	103	89	95	88	95	89	94	90	96	91	96
85	107	110	94	100	93	101	95	100	96	102	96	102
90	113	116	100	106	99	107	100	106	101	108	102	108
95	102	123	106	112	104	113	106	112	107	114	108	115
100	126	129	111	118	110	118	111	118	112	120	113	121
105	132	135	117	124	115	124	117	123	118	126	119	126
110	139	142	122	130	121	130	123	129	124	131	125	133
115	145	148	128	136	126	136	128	135	129	137	131	139
120	151	155	133	142	132	142	134	141	135	143	136	145

* Mature - Forest Inventory Zones - A, B, C, - Coast (table shows diameter at stump height of 0.3 m).

Table 6 Butt Taper - All Ages - FIZ D to J - Interior

dbh (ob)	F		C		H		B		S		Pw	
(cm) @ 1.3 m	dib	dob	dib	dob	dib	dob	dib	dob	dib	dob	dib	dob
06	6	7	8	8	7	7	7	7	8	8	7	7
08	8	10	11	11	9	9	9	10	10	11	9	10
10	10	12	14	14	11	12	11	12	13	13	12	12
12	12	15	16	17	13	14	14	15	15	16	14	15
14	14	17	19	19	15	17	16	17	17	18	16	17
16	17	20	22	22	18	19	18	19	20	21	19	20
18	19	22	24	25	20	21	21	22	22	24	21	22
20	21	25	27	28	22	23	23	24	25	26	23	25
22	23	27	30	31	24	26	25	27	27	29	26	27
24	25	30	32	33	26	28	27	29	30	32	28	30
26	27	32	35	36	29	31	30	31	32	34	30	32
28	29	35	38	39	31	33	32	34	35	37	33	35
30	31	37	40	42	33	35	34	36	37	39	35	37
32	33	40	43	44	35	38	37	39	40	42	37	39
34	35	42	46	47	37	40	39	41	42	45	40	42
36	37	45	48	50	39	42	41	44	45	47	42	44
38	39	47	51	53	42	45	43	46	47	50	44	47
40	41	49	54	55	44	47	46	48	50	53	47	49
42	43	52	56	58	46	50	48	51	52	55	49	52
44	45	54	59	61	48	52	50	53	55	58	51	54
46	47	57	62	64	50	54	53	56	57	60	54	57
48	49	59	65	67	53	56	55	58	60	63	56	59
50	51	62	67	69	55	59	57	60	62	66	58	62
55	57	68	74	76	60	65	63	66	69	72	64	68
60	62	74	81	83	66	71	69	73	75	79	70	74
65	67	80	87	90	71	77	74	79	81	85	76	80
70	72	87	94	97	77	82	80	85	87	92	82	86
75	77	93	101	104	82	88	86	91	93	98	88	92
80	82	99	108	111	88	94	92	97	100	105	93	99
85	87	105	114	118	93	100	97	103	106	112	99	105
90	93	111	121	125	99	106	103	109	112	118	105	111
95	98	117	128	132	104	112	109	115	118	125	110	117
100	103	124	134	139	110	118	114	121	125	131	117	123
105	108	130	141	145	115	124	120	127	131	138	122	129
110	113	136	148	152	121	130	126	133	137	144	128	136
115	118	142	155	159	126	135	132	139	143	151	134	142
120	123	148	161	166	131	141	137	145	149	157	140	148

All Ages - Forest Inventory Zones - D to J - Interior (table shows diameter at stump height of 0.3 m).

continued...

dbh (ob)	Pl		Py		Larch		Ac		Birch		Aspen	
(cm) @ 1.3 m	dib	dob	dib	dob	dib	dob	dib	dob	dib	dob	dib	dob
06	7	7	6	7	6	8	7	7	7	7	7	7
08	9	10	9	10	8	11	9	10	9	10	9	10
10	11	12	11	12	10	14	11	12	11	12	11	12
12	13	14	13	15	12	16	13	14	14	15	13	14
14	16	17	15	17	14	19	15	17	16	17	15	17
16	18	19	17	20	16	22	18	19	18	19	17	19
18	20	21	19	22	18	24	20	21	20	22	19	21
20	22	24	21	25	20	27	22	24	23	24	22	24
22	24	26	23	27	22	30	24	26	25	27	24	26
24	27	28	25	30	24	33	26	28	27	29	26	29
26	29	31	28	32	26	35	29	31	30	31	28	31
28	31	33	30	35	28	38	31	33	32	34	30	33
30	33	36	32	37	30	41	33	35	34	36	32	36
32	36	38	34	40	32	43	35	38	36	39	35	38
34	38	40	36	42	34	46	37	40	39	41	37	40
36	40	43	38	45	36	49	40	43	41	43	39	43
38	42	45	40	47	38	52	42	45	43	46	41	45
40	44	47	42	50	40	54	44	47	45	48	43	48
42	47	50	45	52	42	57	46	50	48	51	45	50
44	49	52	47	55	44	60	48	52	50	53	48	52
46	51	54	49	57	46	62	51	54	52	55	50	55
48	53	57	51	59	48	65	53	57	55	58	52	57
50	56	59	53	62	50	68	55	59	57	60	54	60
55	62	65	58	68	56	75	60	65	62	66	59	66
60	67	71	64	74	61	81	66	71	68	72	65	72
65	72	77	69	81	66	88	71	77	74	78	70	77
70	78	83	74	87	71	95	77	83	79	84	76	83
75	83	89	80	93	76	102	82	89	85	90	81	89
80	89	95	85	99	81	109	88	95	91	96	86	95
85	94	100	90	105	86	115	93	101	96	102	92	101
90	100	106	95	111	91	122	99	107	102	108	97	107
95	106	112	101	118	96	129	104	113	108	115	103	113
100	111	118	106	124	101	136	110	118	113	121	108	120
105	117	124	111	130	106	143	115	124	119	127	113	125
110	122	130	117	136	111	149	121	130	125	133	119	131
115	128	136	122	142	116	156	126	136	131	139	124	137
120	133	142	127	149	121	163	132	142	136	145	130	143

All Ages - Forest Inventory Zones - D to J - Interior (table shows diameter at stump height of 0.3 m).

Table 7 Butt Taper - All Ages - FIZ K and L - Interior

(Table shows diameter at stump height of 0.3 m)

dbh (ob)	H		B		S		Pl	
(cm) @ 1.3 m	dib	dob	dib	dob	dib	dob	dib	dob
06	7	7	7	7	7	7	7	7
08	9	9	9	9	9	10	9	9
10	11	12	11	12	12	12	11	12
12	13	14	13	14	14	15	13	14
14	15	17	16	17	16	17	15	16
16	18	19	18	19	18	19	18	18
18	20	21	20	21	21	22	20	21
20	22	23	22	24	23	24	22	23
22	24	26	24	26	25	27	24	25
24	26	28	27	28	28	29	26	28
26	29	31	29	31	30	31	29	30
28	31	33	31	33	32	34	31	32
30	33	35	33	35	34	36	33	34
32	35	38	36	38	37	39	35	37
34	37	40	38	40	39	41	37	39
36	39	42	40	42	41	43	40	41
38	42	45	42	45	44	46	42	44
40	44	47	44	47	46	48	44	46
42	46	50	47	50	42	51	46	48
44	48	52	49	52	50	53	48	50
46	50	54	51	54	53	56	51	53
48	53	56	53	57	55	58	53	55
50	55	59	56	59	57	60	55	57
55	60	65	61	65	63	66	61	63
60	66	71	67	71	69	72	66	69
65	71	77	72	77	75	78	71	75
70	77	82	78	82	80	84	77	80
75	82	88	83	88	86	91	82	86
80	88	94	89	94	92	97	88	92
85	93	100	94	100	97	103	93	98
90	99	106	100	106	103	109	99	103
95	104	112	106	112	109	115	104	109
100	110	118	111	118	115	121	110	115
105	115	124	117	124	120	127	115	121
110	121	130	122	130	126	133	121	126
115	126	135	128	135	132	139	126	132
120	131	141	133	141	138	145	132	138

continued...

dbh (ob)	Larch		Ac		Birch		Aspen	
(cm) @ 1.3 m	dib	dob	dib	dob	dib	dob	dib	dob
06	7	8	6	7	7	7	7	7
08	9	10	8	9	9	9	9	10
10	12	13	10	11	11	12	11	12
12	14	15	12	14	13	14	13	14
14	16	18	14	16	15	16	15	17
16	19	20	16	18	18	19	17	19
18	21	23	18	20	20	21	19	22
20	23	25	20	23	22	23	22	24
22	26	28	22	25	24	26	24	26
24	28	30	24	27	26	28	26	29
26	31	33	26	29	29	30	28	31
28	33	35	28	32	31	33	30	34
30	35	38	30	34	33	35	32	36
32	38	40	32	36	35	38	35	38
34	40	43	34	39	37	40	37	41
36	43	45	36	41	40	42	39	43
38	45	48	39	43	42	45	41	45
40	47	50	41	45	44	47	43	48
42	49	53	43	48	46	49	45	50
44	52	55	45	50	48	52	47	53
46	54	58	47	52	51	54	50	55
48	56	60	49	54	53	56	52	57
50	59	63	51	57	55	59	54	60
55	64	69	56	62	61	64	59	66
60	70	75	61	68	66	70	65	72
65	76	81	66	74	72	76	70	78
70	82	88	71	79	77	82	75	84
75	88	94	76	85	83	88	81	90
80	94	100	81	91	88	94	86	96
85	100	106	86	96	94	100	92	102
90	105	113	91	102	99	105	97	108
95	111	119	96	108	105	111	102	114
100	117	125	101	113	110	117	108	120
105	123	132	106	119	116	123	113	126
110	129	138	111	125	121	129	119	132
115	135	144	116	130	127	135	124	138
120	140	150	121	136	132	141	129	144

Table 8 Butt Taper - Immature - FIZ A, B and C - Coast

(Table shows diameter at stump height of 0.3 m)

dbh (ob)	F		C		H		S	
(cm) @ 1.3 m	dib	dob	dib	dob	dib	dob	dib	dob
06	6	7	9	9	7	7	8	8
08	8	10	11	12	9	10	11	11
10	10	12	14	15	11	12	13	13
12	12	14	17	18	13	14	16	16
14	14	17	20	20	16	17	18	19
16	16	19	23	23	18	19	21	21
18	18	21	26	26	20	21	24	24
20	20	24	28	29	22	24	26	27
22	22	26	31	32	24	26	29	29
24	24	29	34	35	27	28	32	32
26	26	31	37	38	29	31	34	34
28	28	33	40	41	31	33	37	37
30	30	36	42	44	33	36	39	40
32	32	38	45	47	35	38	42	42
34	34	40	48	50	38	40	45	45
36	36	43	51	53	40	43	47	48
38	38	45	54	55	42	45	50	50
40	41	48	57	58	44	47	53	53
42	43	50	59	61	46	50	55	56
44	45	52	62	64	49	52	58	58
46	47	55	65	67	51	54	60	61
48	49	57	68	70	53	57	63	64
50	51	59	71	73	55	59	66	66
55	56	65	78	80	61	65	72	73
60	61	71	85	87	66	71	79	79
65	66	77	92	95	72	77	85	86
70	71	83	99	102	77	83	92	93
75	76	89	106	109	83	89	99	99
80	81	95	112	117	88	95	105	106
85	86	101	120	124	94	101	112	113
90	91	107	127	131	99	106	118	119
95	96	113	134	138	105	112	125	126
100	101	119	142	146	110	118	131	132
105	106	125	149	153	116	124	138	139
110	111	131	156	160	121	130	144	146
115	116	137	163	168	127	136	151	152
120	121	142	170	175	133	142	158	159

Table 9 to 16

Tables 9 to 16 do not exist at this time.

Table 17 Cruise Compilation Loss Factor Table

It is the Policy of Revenue Branch to utilize, for Appraisal, the loss factor tables listed in this manual. This list is the reference for Cruise Compilation and the auditing of Cruise Compilations.

1 Tree Farm Licences

The TFL loss factors are the same as those approved by the Chief Forester in the Management Plans (MP). This manual will be updated as new Management Plan's result in loss factors changes. All "local" factors noted below apply only to mature volumes(i.e., 121 years or greater).

All loss factors referenced in the following lists refer to the Resources Inventory Branch publication entitled: *Metric Diameter Class Decay, Waste And Breakage Factors 1976.*

Vancouver Region

TFL 6	Kingcome locals for Cedar and Hemlock. All others FIZ "B"
TFL 10	All FIZ "B"
TFL 19	Nootka local for mature Hemlock. All others FIZ "B"
TFL 24	All FIZ "A"
TFL 25	Area #1 (Dean PSYU) - Kingcome locals for Cedar and Hemlock. All others FIZ "A" Area #2 (Quadra PSYU) - Kingcome locals for Cedar and Hemlock. All others FIZ "B" Area #3 (South Island) - All FIZ "B".
TFL 26	Vancouver locals for Hemlock and Balsam. All others FIZ "C".
TFL 37	Kingcome locals for mature cedar and hemlock for decay and waste.. All other species use FIZ "B" decay and waste. Company breakage factors for all species and maturity classes.
TFL 38	Soo locals for Hemlock and Balsam. All others FIZ "B"
TFL 39 Blocks 1, 2, 4, 5	Company decay and waste factors for mature. All other maturity classes are FIZ "B". Mature is 121 years +.

Blocks 3, 6 and 7	Company decay and waste factors and FIZ "A" breakage factors for mature. All other maturity classes are FIZ "A" (Queen Charlotte Islands).
TFL 43 Northern Blocks	Kingcome locals for Cedar and Hemlock. All others FIZ "A"
Fraser Block	Dewdney (Chilliwack) locals for Hemlock and Balsam. All others FIZ "C"

TFL 44	Company decay and waste factors and FIZ "B" breakage factors for mature. All other maturity classes are FIZ "B". Mature is 121 +.
TFL 45	Area #1 (old TFL 17) - Kingcome locals for Cedar and Hemlock. All others FIZ "A". Area #2 (old TFL 36) - All FIZ "B".
TFL 46	Nootka local for Hemlock. All others FIZ "B".
TFL 47	Area #1 (majority) - Kingcome locals for Cedar and Hemlock. All others FIZ "B". Area #2 (4 small islands) - Kingcome locals for Cedar and Hemlock. All others FIZ "A". Area #3 (Queen Charlottes) - All FIZ "A".
TFL 54	Nootka locals for hemlock. All others FIZ "B".

Prince Rupert Region

TFL 1	Skeena (Terrace) - locals for Balsam. All others FIZ "A" or "J".
TFL 41	Skeena (Terrace) - locals for Hemlock and Balsam. All others FIZ "A".
Old TFL 51	(Now Cranberry TSA).
Skeena (Kitwanga)	locals for Hemlock and Balsam. All others FIZ "J".

Kamloops 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, Cedar and Hemlock. All others FIZ "D". Area #2 (old TFL 16) - Kamloops local for Fir. All others FIZ "D".

Prince George Region

TFL 30	Monkman locals for Cedar, Hemlock, Balsam, and Spruce. All others FIZ "I"
TFL 42	Stuart locals for Balsam and Spruce. All others FIZ "I"
TFL 48	All FIZ "L"
TFL 53	Naver locals for Hemlock, Balsam and Spruce. All others FIZ "H, I"

Nelson Region

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".

Cariboo Region

TFL 5	All FIZ "H".
TFL 52	Cottonwood locals for Cedar, Hemlock, Balsam and Spruce. All others FIZ "I".

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. The use of FIZ C and the Vancouver locals for the crown portion of the E & N lands in the South Island Forest District.

4. The Greater Vancouver Water District uses the Vancouver PSYU locals for hemlock and balsam.

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.

All references are to mature factors unless otherwise indicated.

4 Tabular Listing Of Table Numbers

The following listing is provided for easy reference and compilation edit checks.

	Mature						OI.	MAT.	
PSYU/ SSA / TSA /TFL	**#**	**F**	**C**	**H**	**B**	**S**	**PL**	**PL**	**FIZ**
Public Sustained Yield Units									
Adams	01		95	87					G
Alsek	02								K
Arrowhead	03		93	89					G
Ashnola	04	98							D
Babine	05				93	99			I
Barriere	06		95	87					G
Barton Hill	07	98							D
Bell Irving	08			91					J
Big Bar	09	99							D
Big Valley	10				92	98			I
Blueberry	11								L
Botanie	12	98							D
Boundary	13								A K
Bowron	14		96	90	92	98			I
Burns Lake	15								H I
Canoe	16		92	86					G
Carp	17				91	97			I
Chilko	18						98		B H
Cottonwood	19		98	90	92	98			I

	Mature						Ol.	MAT.	
PSYU/ SSA / TSA /TFL	**#**	**F**	**C**	**H**	**B**	**S**	**PL**	**PL**	**FIZ**
Public Sustained Yield Units									
Cranbrook	20								F
Creston	21								E
Crooked River	22				91	97			I
Dean	23								A
Dease - Proposed	25								K
Dewdney: Chilliwack Portion Yale Portion Harrison Portion	26 - 1 - 2 - 3			 99 95 99	 99 98 99				 C D C C
Eagle	27		94	85					G
Edgewood	28								E G
Fernie	29								F
Finlay	30					96			I K
Fontas - Proposed	31								L
Fort Nelson - Proposed	32								L
Granby	33								E
Hecate	34								A
Kamloops	35	98							D
Ketchika - Proposed	36								K
Kettle	37					95		97	E
Kinbasket	38		92	86					G

	Mature						Ol.	MAT.	
PSYU/ SSA / TSA /TFL	**#**	**F**	**C**	**H**	**B**	**S**	**PL**	**PL**	**FIZ**
Public Sustained Yield Units - cont'd									
Kingcome	39		99	98					A B
Klappan - Proposed	40								K
Kluskus	41								H
Kotcho - Proposed	42								L
Lac La Hache	43	99	98						D G H
Lardeau	44		91	84					G
Liard - Proposed	45								L
Longworth	46		96	90	92	98			G
Moberly	47								L
Monkman	48		96	90	92	98			I
Morice	49		13	12	93	99			H J
Nakusp	50		91	84					G
Narcosli - P.H.A. #5	51								H
Naver	52			90	92	98			H I
Nechako - P.H.A #1	53								H I
Nehalliston - P.H.A. #2	54								G
Nicola	55	98							D
Niskonlith - P.H.A. #2	56								G
Nootka	57			96					B
North Thompson	58		97	88					G
Okanagan	59	98	94	85					D E

	Mature						OI.	MAT.	
PSYU/ SSA / TSA /TFL	**#**	**F**	**C**	**H**	**B**	**S**	**PL**	**PL**	**FIZ**
Public Sustained Yield Units - cont'd									
Ootsa	60								H
Parsnip	61				91	97			I
Peace - P.H.A. #7	62								L
Purden	63		96	90	92	98			I
Quadra	64								B
Queen Charlotte	65								A
Quesnel Lake	66		98	90	92	98			D G H
Raft	67		97	88					G
Rivers Inlet	68								A
Robson	69		96	90	92	98			G
Salmo	70								E G
Salmon Arm	71		94	85					G
Shuswap	72		95	87					G
Sikanni - Proposed	73								L
Similkameen	74	98							D
Skeena	75								
Terrace Portion	-1			94	96				A J
Kitwanga Portion	-2			94	96				J
Hazelton Portion	-3			92	94				J
Slocan	76		91	84					G
Smithers	77		13	12	93	99			I J

	Mature						OI.	MAT.	
PSYU/ SSA / TSA /TFL	**#**	**F**	**C**	**H**	**B**	**S**	**PL**	**PL**	**FIZ**
Public Sustained Yield Units - cont'd									
Soo	78			97	97				C
Spallumcheen	79		94	85					G
Stikine	80			91					K
Stuart Lake	81				91	97			I
Stum	82	99					98		H
Takla	83				91	97			I
Taku – Proposed	84								K
Upper Kootenay	85								F
Vancouver	86			99	99				C
Wapiti	87								L
Westlake	88				92	98			H
Williams Lake	89	99							D H
Willow River	90			90	92	98			I
Windermere	91								F
Yalakom	92	99							D
Special Sale Area									
Fort St James	S02				91	97			I
Prince George – Quesnel	S04	99			92	98			H I
Tree Farm Licence									
TFL 1 - Terrace	01				96				A J
TFL 3	03		91	84					G

	Mature						OI.	MAT.	
PSYU/ SSA / TSA /TFL	**#**	**F**	**C**	**H**	**B**	**S**	**PL**	**PL**	**FIZ**
Public Sustained Yield Units - cont'd									
TFL 5	05								H
TFL 6	06		99	98					B
TFL 8	08					95		97	E
TFL 10	10								B
TFL 13	13								F
TFL 14	14		91	84					G
TFL 15	15								D
TFL 18	18		97	88					G
TFL 19	19			96					B
TFL 23	23		91	84					G
TFL 24	24								A
TFL 25	25								
Dean PSYU	-1		99	98					A
Quadra PSYU	-2		99	98					B
South Island	-3								B
TFL 26	26			99	99				C
TFL 30	30		96	90	92	98			I
TFL 33	33		94	85					G
TFL 35	35								D G
TFL 37	37		99	98	Kingcome Locals				B

	Mature						OI.	MAT.	
PSYU/ SSA / TSA /TFL	**#**	**F**	**C**	**H**	**B**	**S**	**PL**	**PL**	**FIZ**
Tree Farm Licence - cont'd									
TFL 37	37 Company breakage factors for all maturity classes								B
TFL 38	38			97	97				B
TFL 39 Blks 1,2,4,5	39 Company DW & FIZ "B" breakage factors for mature.								B
Blks 3,6 & 7	39 Company DW & FIZ "A" breakage factors for mature.								A
TFL 41	41			94	96				A
TFL 42	42				91	97			I
TFL 43	43								
Northern Blocks	-1		99	98					A
Fraser Block	-2			99	99				C
TFL44	44 Company DW & FIZ "B" breakage factors for mature.								B
TFL 45	45								
old TFL 17	-1		99	98					A
old TFL 36	-2								B
TFL 46	46			96					B
TFL 47	47								
majority	-1		99	98					B
4 small islands	-2		99	98					A
Queen Charlottes	-3								A
TFL 48	48								L

	Mature						OI.	MAT.	
PSYU/ SSA / TSA /TFL	**#**	**F**	**C**	**H**	**B**	**S**	**PL**	**PL**	**FIZ**
Tree Farm Licence - cont'd									
TFL 49	49								
old TFL 9 & 32	-1	98	94	85					D
old TFL 16	-2	98							D
TFL 51 – Kitwanga	51	93	95						J
TFL 52	52		98	90	92	98			I
TFL 53	53			90	92	98			H, I
TFL 54	54			96					B
TFL 55	55		93	89					G
TFL 56	56		93	89					G
Watersheds									
G. Van. W. D.	01			99	99				C

Parks	#	FIZ	Parks	#	FIZ
Apex Mountain	01	D	Manning	22	D
Birkenhead Lake	02	C	Monashee	23	G
Bowron Lake	03	G	Mount Assiniboine	24	F
Boya Lake	04	K	Mount Edziza	25	J
Cape Scott	05	A	Mount Revelstoke	26	G
Cathedral	06	D	Mount Robson	27	G
Champion Lakes	07	E	Mount Seymour	28	C
Crooked River	08	I	Muncho Lake	29	L
Cultus Lake	09	C	Naikoon	30	A
Darke Lake	10	D	Pacific Rim	31	B
Elk Falls	11	B	Sasquatch	32	C
Eneas Lakes	12	D	Silver Star	33	D
Garibaldi	13	C	Skagit River	34	C D
Glacier	14	G	Stagleap	35	E
Golden Ears	15	C	Stone Mountain	37	L
Hamber	16	G	Strathcona	38	B
Kikomun Creek	17	F	Tweedsmuir	39	H
Kokanee Glacier	18	G	Wells Gray	40	G
Kootenay	19	G	White Pelican	41	H
Liard River Hot Springs	20	L	Yoho	42	G
Little Qualicum Falls	21	B	Other – not specified	99	

Tree Class Modification Of Loss Factor Tables

Tree Classes for Determination of Decay, Waste and Breakage Factors

Coniferous All Forest Inventory Zones				**Lodgepole Pine All Forest Inventory Zones**			
Age in	**Tree Classes**			**Age in**	**Tree Classes**		
10's	1, 2, 3, 4, 6	5, 7	8, 9	10's	1, 2, 3, 4, 6	5, 7	8, 9
2	YI	M	YI	2	YI	M	YI
3	YI	M	YI	3	YI	M	YI
4	YI	M	YI	4	YI	M	YI
5	YI	M	YI	5	YI	M	YI
6	YI	M	YI	6	YI	M	YI
7	YI	M	YI	7	OI	M	OI
8	YI	M	YI	8	OI	M	OI
9	OI	M	OI	9	OI	M	OI
10	OI	M	OI	10	OI	M	OI
11	OI	M	OI	11	OI	M	OI
12	OI	M	OI	12	OI	M	OI
13	M	M	OI	13	M	M	OI
14	M	M	OI	14	M	M	OI
15	M	M	OI	15	M	M	OI
16	M	M	OI	16	M	M	OI
..	.	.	..	..	.	.	..
25	M	M	OI	25	M	M	OI

Deciduous F.I.Z. A - L Except Aspen and Cottonwood F.I.Z. K & L				**Aspen & Cottonwood F.I.Z. K & L**			
Age in	**Tree Classes**			**Age in**	**Tree Classes**		
10's	1, 2, 3, 4, 6	5, 7	8, 9	10's	1, 2, 3, 4, 6	5, 7	8, 9
2	YI	M	YI	2	YI	M	YI
3	OI	M	OI	3	YI	M	YI
4	OI	M	OI	4	YI	M	YI
5	M	M	OI	5	OI	M	OI
6	M	M	OI	6	OI	M	OI
7	M	M	OI	7	OI	M	OI
8	M	M	OI	8	OI	M	OI
9	M	M	OI	9	M	OM	OI
10	M	M	OI	10	M	OM	OI
11	M	M	OI	11	M	OM	OI
12	M	M	OI	12	M	OM	OI
13	M	M	OI	13	M	OM	OI
14	M	M	OI	14	M	OM	OI
15	M	M	OI	15	M	OM	OI
16	M	M	OI	16	M	OM	OI
..	.	.	..	..	.	.	..
26	M	M	OI	26	OM	OM	OI

YI = Young Immature OI = Older Immature M = Mature OM = Over Mature

FOREST INVENTORY ZONE SERIES NUMBERS

S P E C I E S

F.I.Z.	Douglas Fir			Western Red Cedar			Hemlock			Balsam			Spruce			Yellow Cedar			White Pine			Lodgepole Pine		
	YI	OI	M	YI	OI	M	YI	OI	M	YI	OI	M	YI	OI	M	YI	OI	M	YI	OI	M	YI	OI	M
A	01	02	10	01	02	10	01	02	10	01	02	10	01	02	10	01	02	10	01	02	10	01	02	10
B	01	02	10	01	02	11	01	02	14	01	02	11	01	02	10	01	02	10	01	02	10	01	02	10
C	01	02	11	01	02	12	01	02	11	01	02	11	01	02	10	01	02	10	01	02	10	01	02	10
D	03	04	12	03	04	14	03	04	13	05	06	14	03	04	12	01	02	10	03	04	11	01	04	13
E	03	04	13	03	04	14	03	04	13	05	06	14	03	04	12	01	02	10	03	04	11	01	04	13
F	03	04	13	03	04	14	03	04	13	05	06	14	03	04	12	-	-	-	03	04	11	01	04	13
G	03	04	13	03	04	14	03	04	13	05	06	14	03	04	12	01	02	10	03	04	11	01	03	12
H	03	04	12	03	04	14	03	04	13	05	06	13	03	04	11	-	-	-	03	04	11	01	03	12
I	03	04	14	03	04	14	03	04	13	05	06	13	03	04	11	-	-	-	-	-	-	01	03	12
J	-	-	-	03	04	13	03	04	12	03	04	12	03	04	13	01	02	10	-	-	-	01	03	11
K	-	-	-	-	-	-	03	04	12	05	06	13	03	04	11	-	-	-	-	-	-	01	03	12
L	-	-	-	-	-	-	-	-	-	05	06	13	03	04	11	-	-	-	-	-	-	01	03	12

F.I.Z.	Yellow Pine			White Bark Pine			Larch			Cottonwood				Alder			Broadleaf Maple			Birch			Aspen		
	YI	OI	M	YI	OI	M	YI	OI	M	YI	OI	M	ON	YI	OI	M	YI	OI	M	YI	OI	M	YI	OI	m	on
A	-	-	-	01	02	10	-	-	-	01	02	10	-	01	02	10	01	02	10	01	02	10	01	02	10	-
B	-	-	-	01	02	10	-	-	-	01	02	10	-	01	02	10	01	02	10	01	02	10	01	02	10	-
C	01	02	10	01	02	10	-	-	-	01	02	10	-	01	02	10	01	02	10	01	02	10	01	02	10	-
D	01	02	10	03	04	11	01	02	10	01	02	11	-	-	-	-	-	-	-	01	02	11	01	02	10	-
E	01	02	10	03	04	11	01	02	10	01	02	11	-	-	-	-	-	-	-	01	02	11	01	02	10	-
F	01	02	10	03	04	11	01	02	10	01	02	11	-	-	-	-	-	-	-	01	02	11	01	02	10	-
G	01	02	10	03	04	11	01	02	10	01	02	11	-	-	-	-	-	-	-	01	02	11	01	02	10	-
H	-	-	-	03	04	11	01	02	10	01	02	11	-	-	-	-	-	-	-	01	02	11	01	02	10	-
I	-	-	-	03	04	11	01	02	10	01	02	11	-	-	-	-	-	-	-	01	02	11	01	02	10	-
J	-	-	-	03	04	11	-	-	-	01	02	11	-	01	02	10	-	-	-	01	02	11	01	02	10	-
K	-	-	-	-	-	-	01	02	10	03	04	12	13	01	02	10	-	-	-	01	02	11	04	03	11	12
L	-	-	-	-	-	-	01	02	10	03	04	12	13	-	-	-	-	-	-	01	02	11	04	03	11	12

Note - Species prefix codes are: Fir - 1 / Cedar - 2 / Hemlock - 3 / Balsam - 4 / Spruce - 5 / Yellow Cedar - 6 / White Pine - 7 / Lodgepole Pine - 8 / Yellow Pine - 9 / Larch - 10 / Cottonwood - 11 / Alder - 12 / Maple - 13 / Birch - 14 / Aspen - 15 / Whitebark Pine - 16

Example - FIZ A, Mature Fir = Table 110

See Table 17 for Local Loss Factor Table Numbers for a specific PSYU/SSA/TSA/TFL.

Figure T.1 Forest Inventory Zone Series Numbers.

Table 18 Risk Group Ratings by Pathological Indicators

Species	Location	Age Group	Age Range	Risk Group 1	Risk Group 2	Risk Group 3
Cw	All FIZ	Immature	1-80	Any indicator		
		Old Immature	81-120	No indicators	Any indicator	
	FIZ D to I	Mature	121+	No indicators or large rotten branch	Any other indicators	
	FIZ A, B, C, J	Mature	121+	No indicators or either frost crack or fork/crook	Any other indicator(s)	
	Exceptions	Mature	121+	Height ≥ 40.5 m.	Height < 40.5 m.	Bowron, Longworth, Monkman, Purden, Robson PSYU's and TFL30
CY	All FIZ	Immature	1-80	Any indicator		
	All FIZ	Old Immature	81-120	No indicators	Any indicator	
	All FIZ	Mature	121+	No indicators	Any indicator	

Species	Location	Age Group	Age Range	Risk Group 1	Risk Group 2	Rick Group 3
Fd	All FIZ	Immature	1-80	Any indicator		
	FIZ A, B, C	Old Immature	81-120	Any indicator		
	FIZ D to I	Old Immature	81-120	No indicators	Any indicator	
	FIZ A, B, C	Mature	121+	1 of dead/broken top or large rotten branch or frost crack	Any other indicator other than conk or blind conk	Conk or blind conk
	FIZ D, H	Mature	121+	1 of mistletoe or large rotten branch or frost crack	Two or more of mistletoe, large rotten branch or frost crack or 1 of any other indicator.	
	FIZ E, F, G	Mature	121+	1 of large rotten branch or mistletoe.	Two or more of large rotten branch\or mistletoe or 1 of any other indicator	
	FIZ I	Mature	121+	1 of dead/broken top, mistletoe,large rotten branch, or frost crack	Two or more of dead/broken top, or frost crack or 1 of any other indicator other than conk or blind conk	Conk or blind conk

Species	Location	Age Group	Age Range	Risk Group 1	Risk Group 2	Risk Group 3
B	All FIZ	Immature	1-80	Any indicator		
		Old Immature	81-120	No indicators	Any indicator	
		Mature	121+	No indicator or forks/crooks	3 or less indicators	Conk or blind conk or 4 or more other indicators
H	All FIZ	Immature	1-80	ANY INDICATOR		
	All FIZ	Old Immature	81-120	No indicators	Any indicator	
	FIZ A	Mature	121 +	D or B Top, large rotten branch,mistletoe, frost crack, fork/crook or scar	2 or 3 indicators	4 or more categories or conk or blind conk
	FIZ B, C	Mature	121 +	D or B Top and/or mistletoe	frost crack or fork/crook or scar or indicators in 2 or 3 categories	4 or more categories or rotten branch, conk, or blind conk
	Kingcome Local & TFLs 6, 25, 37, 43, 45, and 47	Mature	121 +	No indicators or one or both of D or B top or mistletoe	frost crack, fork/crook, scar or rotten branch or 2 or more categories	4 or more categories or conk or blind conk
	FIZ D to K	Mature	121 +	No indicators	No more than 3 of any indicator other than conk/blind conk	Conk/blind conk or 4 Or more of any other indicators

Species	Location	Age Group	Age Range	Risk Group 1	Risk Group 2	Risk Group 3
PL	All FIZ	Immature	1 - 60	Any indicator		
	All FIZ	Old Immature	61 - 120	No indicators	Any indicator	
	FIZ A, B, C	Mature	121 +	No indicators	Any indicator	
	FIZ D to L	Mature	121 +	No indicators	Any other than conk/blind conk	Conk/blind conk
Pw and Pa	All FIZ	Immature	1 - 80	Any indicator		
		Old Immature	81 - 120	No indicators	Any indicator	
		Mature	121 +	No indicators	Any indicator	
Py	All FIZ	Immature	1 - 80	Any indicator		
		Old Immature	81 - 120	No indicators	Any indicator	
		Mature	121 +	Fork/crook	Any indicator otherthan fork/crook	

Species	Location	Age Group	Age Range	Risk Group 1	Risk Group 2	Risk Group 3
S	All FIZ	Immature	1 - 80	Any indicator		
	FIZ A, B, C	Old Immature	81 - 120	Any indicator		
	FIZ D to L	Old Immature	81 - 120	No indicators	Any indicator	
	FIZ A, B, C	Mature	121 +	D or B Top, rotten branch, mistletoe, frost crack, fork/crook, scar	More than 1 indicator or Conk or Blind conk	
	FIZ D to L	Mature	121 +	No indicators	Any other than conk/blind conk	Conk/blind conk
L	All FIZ	Immature	1 - 80	Any indicator		
		Old Immature	81 - 120	No indicators	Any indicator	
		Mature	121 +	No indicators	Any other than conk or blind conk	Conk or blind conk

Species	Location	Age Group	Age Range	Risk Group 1	Risk Group 2	Risk Group 3
Ac	FIZ A to J	Immature	1-20	Any indicator		
	FIZ K, L	Immature	21-40	Any indicator		
	FIZ A to J	Old Immature	21 - 40	Any indicator		
	FIZ K, L	Old Immature	41 - 80	Fork/crook	Any other than fork/crook	
	FIZ A to J	Mature	41 +	Any indicator		
	FIZ K, L	Mature	81 - 140	Fork/crook	Any other than fork/crook	
	FIZ K, L	Over Mature	141 +	Any indicator		

Species	Location	Age Group	Age Range	Risk Group 1	Risk Group 2	Risk Group 3
At	FIZ A to J	Immature	1-20	Any indicator		
	FIZ K, L	Immature	1-40	Any indicator		
	FIZ A to J	Old Immature	21 - 40	Any indicator		
	FIZ K, L	Old Immature	41 - 80	Any indicator		
	FIZ A to J	Mature	41 +	No indicators	Any	
	FIZ K, L	Mature	81 - 140	Fork/crook	Any other than fork/crook or conk or blind conk	Conk or Blind Conk
	FIZ K, L	Over Mature	141 +	Any indicator		
E	All FIZ	Immature	1 - 80	Any indicator		
		Old Immature	81 - 120	Any indicator		
		Mature	121 +	No indicators	Any	

Species	Location	Age Group	Age Range	Risk Group 1	Risk Group 2	Risk Group 3
D	All FIZ	Immature	1 - 20	Any indicator		
		Old Immature	21 - 40	Any indicator		
		Mature	41 +	Any indicator		
Mb	All FIZ	Immature	1 - 20	Any indicator		
		Old Immature	21 - 40	Any indicator		
		Mature	41 +	No indicators	Any indicator	

Table 19 Sound Wood Factors for Saprot

	Saprot Depth - cm														
*Diameter	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
20	**0.81**	**0.64**	0.49	0.36	0.25	0.16	0.09	0.04	0.01						
25	**0.85**	**0.71**	**0.58**	0.46	0.36	0.27	0.19	0.13	0.08	0.04	0.01				
30	**0.87**	**0.75**	**0.64**	**0.54**	0.44	0.36	0.28	0.22	0.16	0.11	0.07	0.04	0.02		
35	**0.89**	**0.78**	**0.69**	**0.60**	**0.51**	0.43	0.36	0.29	0.24	0.18	0.14	0.10	0.07	0.04	0.02
40	**0.90**	**0.81**	**0.72**	**0.64**	**0.56**	0.49	0.42	0.36	0.30	0.25	0.20	0.16	0.12	0.09	0.06
45	**0.91**	**0.83**	**0.75**	**0.68**	**0.60**	**0.54**	0.47	0.42	0.36	0.31	0.26	0.22	0.18	0.14	0.11
50	**0.92**	**0.85**	**0.77**	**0.71**	**0.64**	**0.58**	**0.52**	0.46	0.41	0.36	0.31	0.27	0.23	0.19	0.16
55	**0.93**	**0.86**	**0.79**	**0.73**	**0.67**	**0.61**	**0.56**	**0.50**	0.45	0.40	0.36	0.32	0.28	0.24	0.21
60	**0.93**	**0.87**	**0.81**	**0.75**	**0.69**	**0.64**	**0.59**	**0.54**	0.49	0.44	0.40	0.36	0.32	0.28	0.25
65	**0.94**	**0.88**	**0.82**	**0.77**	**0.72**	**0.66**	**0.62**	**0.57**	**0.52**	0.48	0.44	0.40	0.36	0.32	0.29
70	**0.94**	**0.89**	**0.84**	**0.78**	**0.73**	**0.69**	**0.64**	**0.60**	**0.55**	**0.51**	0.47	0.43	0.40	0.36	0.33
75	**0.95**	**0.90**	**0.85**	**0.80**	**0.75**	**0.71**	**0.66**	**0.62**	**0.58**	**0.54**	**0.50**	0.46	0.43	0.39	0.36
80	**0.95**	**0.90**	**0.86**	**0.81**	**0.77**	**0.72**	**0.68**	**0.64**	**0.60**	**0.56**	**0.53**	**0.49**	0.46	0.42	0.39
85	**0.95**	**0.91**	**0.86**	**0.82**	**0.78**	**0.74**	**0.70**	**0.66**	**0.62**	**0.58**	**0.55**	**0.52**	0.48	0.45	0.42
90	**0.96**	**0.91**	**0.87**	**0.83**	**0.79**	**0.75**	**0.71**	**0.68**	**0.64**	**0.60**	**0.57**	**0.54**	**0.51**	0.47	0.44
95	**0.96**	**0.92**	**0.88**	**0.84**	**0.80**	**0.76**	**0.73**	**0.69**	**0.66**	**0.62**	**0.59**	**0.56**	**0.53**	**0.50**	0.47
100	**0.96**	**0.92**	**0.88**	**0.85**	**0.81**	**0.77**	**0.74**	**0.71**	**0.67**	**0.64**	**0.61**	**0.58**	**0.55**	**0.52**	**0.49**
105	**0.96**	**0.93**	**0.89**	**0.85**	**0.82**	**0.78**	**0.75**	**0.72**	**0.69**	**0.66**	**0.62**	**0.60**	**0.57**	**0.54**	**0.51**
110	**0.96**	**0.93**	**0.89**	**0.86**	**0.83**	**0.79**	**0.76**	**0.73**	**0.70**	**0.67**	**0.64**	**0.61**	**0.58**	**0.56**	**0.53**

* Use estimated diameter inside bark at the top of first third of tree.

Tree Volumes by Third

1st Third	50%	= 1/2
2nd Third	33%	= 1/3
3rd Third	17%	= 1/6

Useful Formulas

Volume of Tree = 1/3 $\pi R^2 L$, where R = tree dbh and L = tree length
Volume of Cylindrical Rot = $\pi R^2 L$, where R = the radius of the rot and L = rot length
Volume of Conical Rot = 1/3 $\pi R^2 L$, where R = the radius of the rot and L = rot length

$$\% \text{ Sound} = 100 - \frac{Volume\ of\ Rot}{Volume\ of\ Tree\ or\ Log}$$

Figure T.2 Sound wood factors for saprot.

Appendices

A.1 Site Index and Age Correction Tables

Site curves and boring height/age correction tables developed by the Ministry of Forests can now be found in the publications:

Site Index Curves and Tables for British Columbia:

- Coastal Species. Land Management Handbook. Field Guide Insert 3, February 1991, and FRDA Report #037, August, 1988.

- Interior Species. Land Management Handbook Field Guide Insert 6, June 1994.

These publications may be purchased from:

Crown Publications Inc.
521 Fort Street
Victoria, BC V8W 1E7
Web: http://www.crownpub.bc.ca/

A brief explanation of their use in operational cruising follows in Section A.1.1.

A.1.1 Use of Site Curves and Tables for British Columbia

1. The arbitrary range of site index given is 5 - 40 m in the tables and 5 - 30 m for most curves. The tables and curves are given in a common format for consistency among species and do not necessarily represent the range of site index or age used in the development of the curves. All species use top height to represent dominant height and 50 years (breast-height age) as the site index reference age. Estimates of height and site index that are beyond the range of the data used in the analyses (given in the notes section for each species) should be interpreted with caution.

2. Bore the tree at breast-height (1.3 m) above the high-side.

3. Count the growth rings between the cambium and the pith (count the pith as one ring). Enter under "Counted Age" on Card Type 3 (FS 205).

4. From top height and boring height age, determine the site index. Then go to the bottom of the Site Index Table to obtain the "Years to bh" (boring height) age correction.

5. Add this age correction to "Counted Age" to get the total age.

Table A.1 Age Class Limits

Age and Height Limits for Age in Tens					
Age	**Limits**	**Age**	**Limits**	**Age**	**Limits**
10	1-10	100	91-100	190	181-190
20	11-20	110	101-110	200	191-200
30	21-30	120	111-120	210	201-210
40	31-40	130	121-130	220	211-220
50	41-50	140	131-140	230	221-230
60	51-60	150	141-150	240	231-240
70	61-70	160	151-160	250	241-250
80	71-80	170	161-170	260	251-260
90	81-90	180	171-180	270	261-270

Height Class Limits for Height in Threes					
Height	**Limits**	**Height**	**Limits**	**Height**	**Limits**
3	0.0-4.4	24	22.5-25.4	45	43.5-46.4
6	4.5-7.4	27	25.5-28.4	48	46.5-49.4
9	7.5-10.4	30	28.5-31.4	51	49.5-52.4
12	10.5-13.4	33	31.5-34.4	54	52.5-55.4
15	13.5-16.4	36	34.5-37.4	57	55.5-58.4
18	16.5-19.4	39	37.5-40.4	60	58.5-61.4
21	19.5-22.4	42	40.5-43.4	63	61.5-64.4

A.2 Magnetic Declination and Annual Change for February 9, 1999

Latitude and Longitude for selected points for Magnetic Declination determination and Annual Change					
Region	Location	Latitude	Longitude	Declination	Annual
		in degrees, minutes		February 9, 1999	Change
Vancouver	Chilliwack	49,10	121,57	19 36 E	6.2 W
Vancouver	Haney	49,13	122,36	19 46 E	6.2 W
Vancouver	Abbotsford	49,03	122,17	19 38 E	6.2 W
Vancouver	Vancouver	49,15	123,07	19 54 E	6.3 W
Vancouver	Squamish	49,45	123,07	20 07 E	6.5 W
Vancouver	Powell River	49,51	124,32	20 27 E	6.5 W
Vancouver	Campbell River	50,01	125,20	20 41 E	6.6 W
Vancouver	Port McNeill	50,35	127,06	21 13 E	6.9 W
Vancouver	Gold River	49,41	126,07	20 39 E	6.5 W
Vancouver	Nanaimo	49,10	123,56	20 02 E	6.2 W
Vancouver	Tofino	49,07	125,53	20 22 E	6.3 W
Vancouver	Duncan	48,47	123,42	19 49 E	6.1 W
Vancouver	Port Alberni	49,14	124,58	20 16 E	6.3 W
Vancouver	Sayward	50,23	125,58	20 57 E	6.8 W
Vancouver	Holberg	50,39	128,01	21 21 E	6.9 W
Vancouver	Port Renfrew	48,33	124,25	19 52 E	6.0 W
Vancouver	Massett	54,01	132,06	23 18 E	8.4 W
Vancouver	Queen Charlotte City	53,15	128,31	22 43 E	8.1 W
Vancouver	Klemtu	52,35	128,31	22 22 E	7.8 W
Vancouver	Hagensborg	52,23	126,33	22 01 E	7.7 W
Vancouver	Security Bay	51,22	127,28	21 38 E	7.2 W
Vancouver	Alison Sound	51,15	127,00	21 31 E	7.2 W
Vancouver	Pemberton	50,19	122,48	20 19 E	6.7 W
Vancouver	Boston Bar	49,52	121,26	19 49 E	6.5 W
Vancouver	Stuart Island	50,22	125,08	20 48 E	6.8 W
Vancouver	Sewell Inlet	52,53	131,59	22 41 E	7.9 W
Vancouver	Franklin River	49,00	124,45	20 07 E	6.2 W
Vancouver	Rivers Inlet	51,41	127,15	21 46 E	7.4 W
Prince Rupert	Burns Lake	54,21	126,31	23 06 E	8.7 W
Prince Rupert	Houston	54,27	126,37	23 11 E	8.8 W
Prince Rupert	Smithers	54,47	127,11	23 27 E	9.0 W
Prince Rupert	Hazelton	55,13	127,35	23 47 E	9.2 W
Prince Rupert	Terrace	54,31	128,36	23 27 E	8.7 W
Prince Rupert	Prince Rupert	54,18	130,20	23 26 E	8.6 W
Prince Rupert	Stewart	55,57	130,00	24 25 E	9.4 W
Prince Rupert	Lower Post	55,55	128,32	24 19 E	9.5 W
Prince Rupert	Dease Lake	58,27	130,02	26 06 E	10.9 W
Prince Rupert	Atlin	59,35	133,41	26 29 E	11.1 W
Kamloops	Chase	50,49	119,41	19 53 E	7.0 W
Kamloops	Lillooet	50,40	121,56	20 19 E	6.9 W
Kamloops	Merritt	50,07	120,47	19 48 E	6.6 W
Kamloops	Princeton	49,28	120,30	19 25 E	6.3 W
Kamloops	Penticton	49,30	119,35	19 13 E	6.3 W
Kamloops	Vernon	50,16	119,16	19 31 E	6.7 W
Kamloops	Salmon Arm	50,42	119,16	19 44 E	6.9 W
Kamloops	Kamloops	50,40	120,19	19 58 E	6.9 W
Kamloops	Clearwater	51,39	120,02	20 24 E	7.4 W

Latitude and Longitude for selected points for Magnetic Declination determination and Annual Change					
Region	Location	Latitude	Longitude	Declination	Annual
		in degrees, minutes		February 9, 1999	Change
Prince George	Valemount	52,50	119,15	20 50 E	8.0 W
Prince George	McBride	53,18	120,10	21 19 E	8.3 W
Prince George	Hixon	53,52	122,35	22 10 E	8.6 W
Prince George	Prince George	53,55	122,45	22 13 E	8.6 W
Prince George	Bear Lake (Hart Hwy)	54,30	122,40	22 33 E	9.0 W
Prince George	Vanderhoof	54,01	124,01	22 31 E	8.6 W
Prince George	Kenny Dam	53,36	124,58	22 26 E	8.4 W
Prince George	Ft. St. James	54,26	124,15	22 49 E	8.9 W
Prince George	Takla Landing	55,29	125,58	23 45 E	9.4 W
Prince George	Manson Creek	55,40	124,29	23 39 E	9.6 W
Prince George	Aiken Lake	56,26	125,45	24 24 E	10.0 W
Prince George	Bear Lake (Driftwood)	56,12	126,51	24 22 E	9.8 W
Prince George	Mackenzie	55,18	123,10	23 10 E	9.4 W
Prince George	Fort Ware	57,26	125,38	25 09 E	10.7 W
Prince George	Ingenika Point	56,47	124,52	24 32 E	10.3 W
Prince George	Ingenika Mine	56,42	125,11	24 31 E	10.2 W
Prince George	Dawson Creek	55,46	120,14	22 45 E	9.8 W
Prince George	Chetwynd	55,42	121,38	23 05 E	9.7 W
Prince George	Tumbler Ridge	55,07	120,55	22 32 E	9.4 W
Prince George	Fort St. John	56,15	120,51	23 14 E	10.1 W
Prince George	Beaton River (settl.)	57,23	121,25	24 12 E	10.9 W
Prince George	Pink Mountain	57,02	122,31	24 14 E	10.6 W
Prince George	Fort Nelson	58,48	122,43	25 44 E	12.0 W
Prince George	Muncho Lake	58,59	125,47	26 25 E	11.8 W
Prince George	Nelson Forks	59,30	124,01	26 37 E	12.4 W
Nelson	Beaverdell	49,26	119,05	19 04 E	6.3 W
Nelson	Castlegar	49,19	117,39	18 37 E	6.2 W
Nelson	Cranbrook	49,30	115,46	18 04 E	6.3 W
Nelson	Creston	49,06	116,31	18 10 E	6.1 W
Nelson	Flathead	49,22	114,37	17 34 E	6.2 W
Nelson	Golden	51,18	116,58	19 20 E	7.2 W
Nelson	Grand Forks	49,02	118,27	18 43 E	6.1 W
Nelson	Invermere	50,31	116,02	18 37 E	6.8 W
Nelson	Kalso	49,55	116,54	18 39 E	6.5 W
Nelson	Mica Creek	52,05	118,34	20 15 E	7.6 W
Nelson	Nakusp	50,14	117,48	19 05 E	6.7 W
Nelson	Nelson	49,29	117,17	18 35 E	6.3 W
Nelson	Revelstoke	50,59	118,12	19 35 E	7.1 W
Nelson	Sparwood	49,43	114,53	17 49 E	6.4 W
Cariboo	Quesnel townsite	52,57	122,30	21 38 E	8.1 W
Cariboo	Farwell Canyon	51,49	122,34	21 02 E	7.5 W
Cariboo	mid - Horsefly Lake	52,24	121,02	21 02 E	7.8 W
Cariboo	100 Mile House Townsite	51,39	121,17	20 41 E	7.4 W
Cariboo	Chilanko Forks Settlement	52,07	124,04	21 28 E	7.6 W

Internet Site:

http://www.geolab.nrcan.gc.ca/geomag/e_cgrf.html

A.3 Forest Inventory Zones

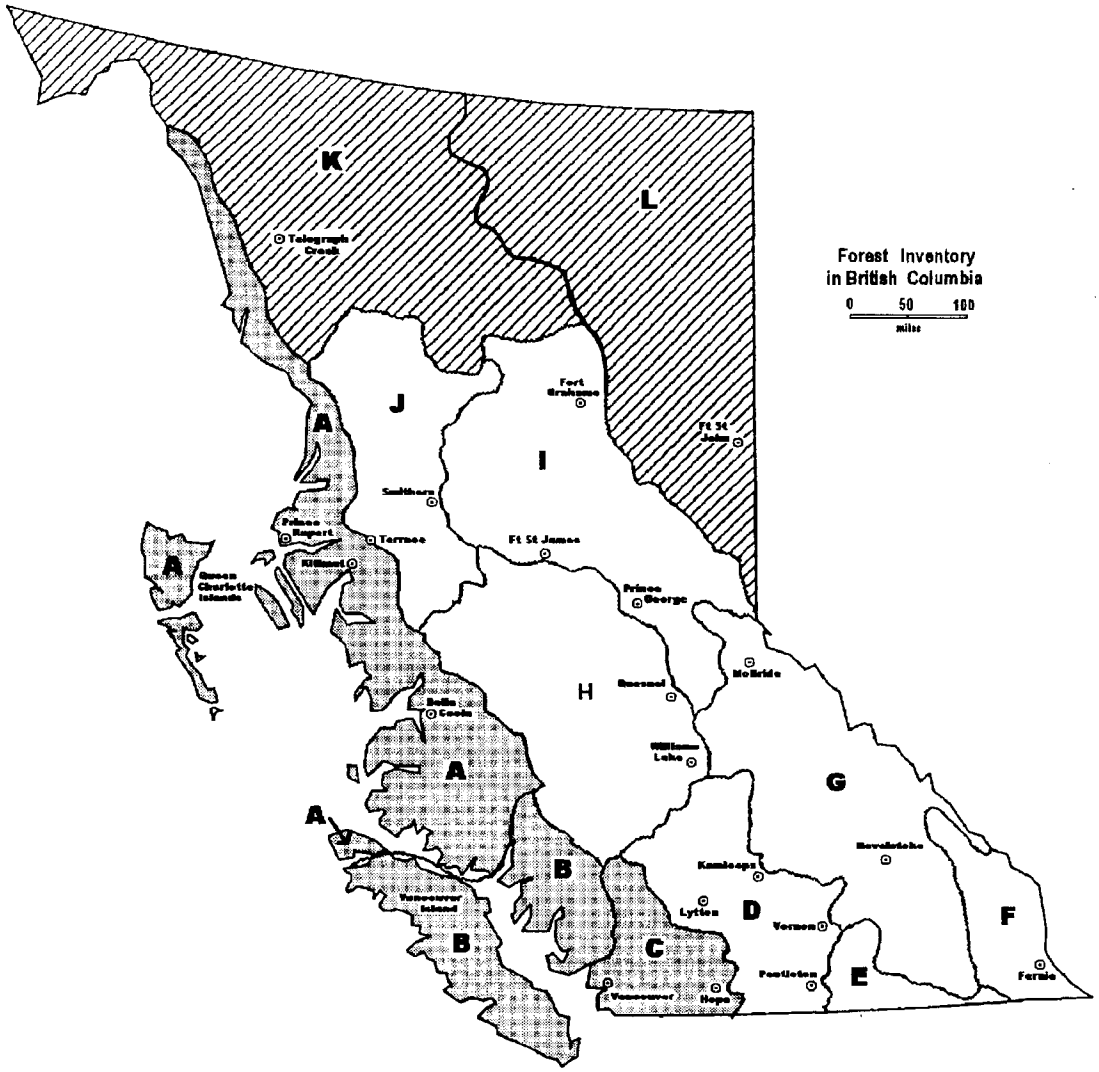


Figure A.1 Forest inventory zones.

Refer to large scale maps from Resources Inventory Branch to confirm Forest Inventory Zone Zonal and Local geographic locations.

A.4 Pathological Classification of Trees

Within mature stands, or stands approaching maturity, (i.e., older immature stands) individual trees contain varying amounts of decay. Thus, in stands of this type the estimation of cull is subject to considerable error. Therefore, it would be advantageous to know which trees are likely to contain decay, particularly those which are likely to contain excessive amounts of decay. Recent pathological studies have shown that two broad classes of living trees are clearly recognizable in stands of this character. As the classification of trees is made on the basis of the presence or absence of external signs of decay, it is anticipated that each class of tree so defined will represent a different potential loss factor within the stand.

A.4.1 Class of Trees

All living trees measured on each sample plot will be classed as:

- residual, or
- suspect.

A.4.1.1 Suspect Trees

Suspect trees are living trees which bear one or more of the following external indications of decay, on or immediately adjacent to the trunk of the tree within the limits specified.

1. Conks.
2. Blind conks (swollen knots).
3. Scars.
4. Fork or pronounced crook.
5. Frost crack.
6. Trunk infections or mistletoe.
7. Rotten branches.
8. Dead or broken top.

> "Suspect" classifications will be made on the basis of the above signs of decay only; no other abnormalities are to be used.
>
> See Tables 12 - 15 for Pathological Occurrence by Species and Forest Inventory Zones.

A.4.1.2 Residual Trees

Residual trees are living trees which bear none of the external indications of decay listed above.

It must be pointed out that these signs and defects are expressive of decay in the stand, rather than in individual trees. The amount of decay indicated by signs will be subject to considerable variation within species and individual trees. For example, frost cracks may be highly significant as indicators of decay on a particular species in the stand as a whole, but not as significant on individual trees.

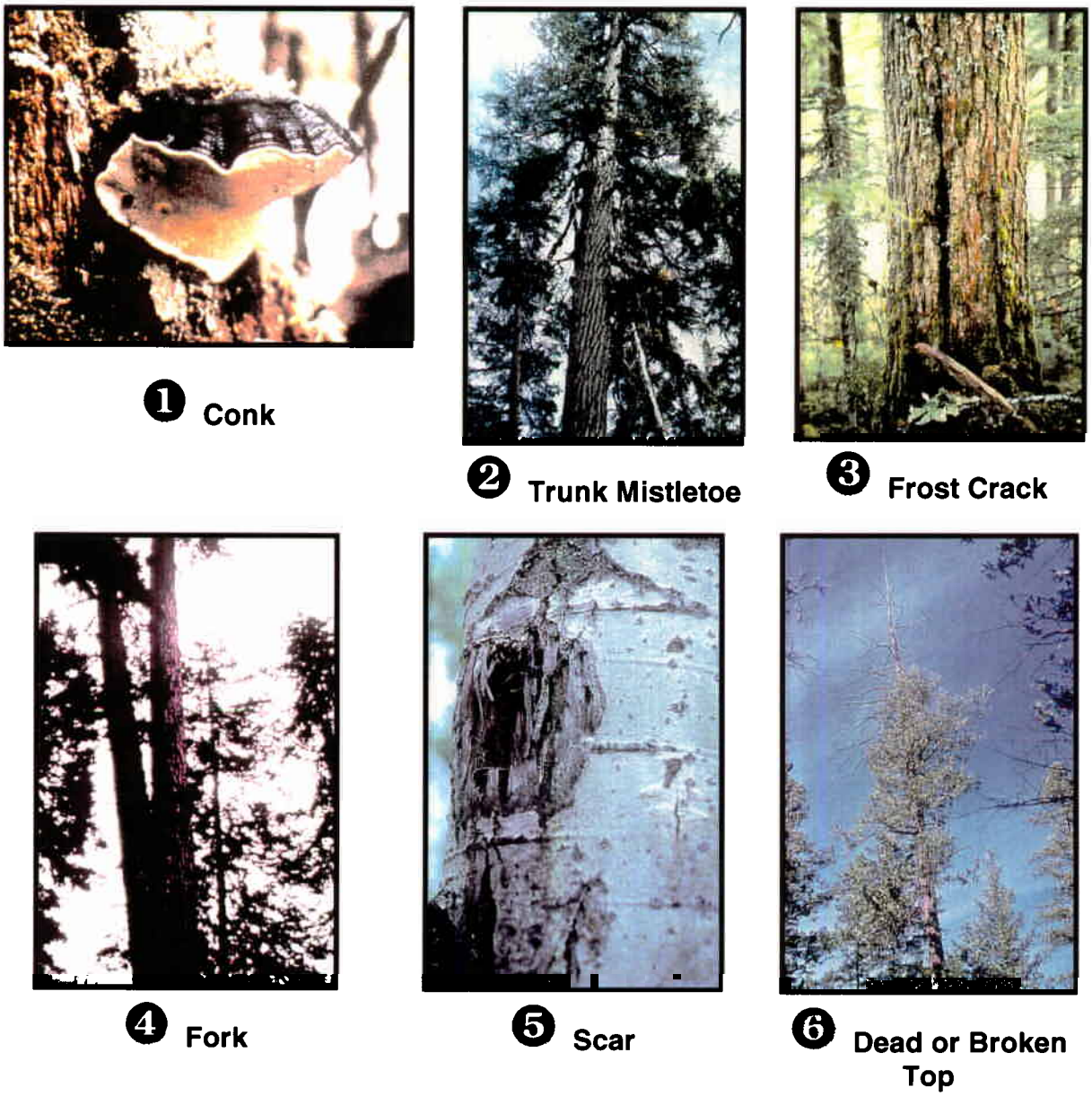


Figure A.2 Residual trees.

A.4.2 Signs and Defects Indicative of Decay in Standing Trees

The following is a brief description and explanation of the external indications of decay listed in Section A.4.1.1. These indicators are to be called on all live and dead potential (except dead potential in the Interior) trees from the base of the tree to the **utilization top** including secondary leaders which contain a merchantable log (3 m long to a 15 cm top - except 10 cm top for the interior and for coastal immature). Do not record pathological indicators above utilization top diameter. Not shown are large rotten branches and blind conks.

A.4.2.1 Conks

Conks are the fruiting bodies (sporophores) of decay fungi and are definite and reliable indicators of decay. Conks occur anywhere on the main stem, branches and exposed roots of the tree but appear most frequently around knots and on the underside of both dead branch stubs and live branches. For current cruising purposes, only specific root, butt and heart rot conks are suspect indicators. Slash conks are not suspect indicators (see Figure A.3 for a list of host species for selected decay fungi).

It is important to be able to differentiate between the fruiting of slash fungi that occur on dead branches and wounds of living trees and those that occur on the roots, live branches and trunks of living trees. It is necessary to be able to recognize the conks of the major heart rotting fungi found on living conifers and hardwoods. On conifers, the main conks to recognize are, *Echinodontium tinctorium, Phellinus (Fomes) pini, Phaeolus (Polyporous) schweinitzii and Fomitopsis (Fomes) pinicolii.* On hardwoods, the main conks are Phellinus igniarius and Phellinus tremulae. See the following host list for major and some minor heartwood decay species.

The major heart rot conks are hard, thick, woody-like perennial structures and form singly at branch stubs or in small clusters on the underside of living branches. An exception is the mushroom-shaped to bracket-like sporophore of *P. schweinitzii* that is annual but may persist for more than two years. Before calling conks on living branches in the upper crown, there must be fruiting bodies of the heart rot fungus evident in the stand. Slash conks that occur on dead wood of living trees can be both annual (small, thin, leathery) and perennials, are often more numerous and occur anywhere on the tree. The slash conks that occur on old exposed wounds are not allowed as suspect indicators. An exception is the conk of *F. pinicola*, which is common on dead trees but may also occur on large, old wounds as studies have found its occurrence indicates significant decay. However, *F. pinicola* that occurs on dead branches is not a suspect indicator.

Conks vary in size and shape and therefore are hard to spot, particularly when they are just developing or occur on the upper trunk. Conks of *E. tinctorium* and *Phellinus pini*, frequently appear as a small hoof-like or shelf-like structure on the underside of dead branch stubs on the middle and/or lower trunk of an infected tree. Moss-covered branch stubs and burls often resemble conks, particularly when viewed from directly below; it is important therefore to view the tree from the side before making a decision.

Conks of Phaeolus schweinitzii

P. schweinitzii is the cause of brown cubical root and butt rot of most conifers but Douglas-fir and spruce are the most susceptible. The fruiting bodies may occur:

- on the base of a tree,
- on the ground up to 2 m from the tree where no exposed roots are evident, or
- on the exposed roots.

If a conk is mid-way between:

1. Two living susceptible trees only one tree is considered to be infected.
2. A highly susceptible species (e.g., Douglas-fir) and a less susceptible species (e.g., red cedar), the most susceptible species is considered to be infected.
3. A living tree and a stump showing brown cubical rot, and it is not on a root of the live tree, it is assumed to be associated with the stump.

A.4.2.2 Blind Conks

Blind conks are pronounced swellings or depressions around knots caused mainly by *P. pini* on conifers and *P. tremulae* on aspen and if identified correctly, are definite indicators of decay (see Figure A.3). The swelling or depression results from the tree attempting to heal over an abortive conk; a newly developing conk; or a point from which an old conk has dropped. Non-typical forms may appear as small branch holes or branch stubs at the base of trees. This form is often found in over-mature Douglas-fir and balsam species in the coast-interior transition zone (e.g., Boston Bar). Therefore over-mature trees with basal branch stubs should be examined for blind conk.

All blind conks must be verified by cutting with an axe. This will reveal a bright yellow or buff-colour of the conk. Inaccessible blind conks must not be called indicators unless they are similar to ones that have been previously identified in the stand or on adjacent cutting permits.

Large holes left by fallen large rotten branches may not be blind conk suspect indicators

Root and butt rots

Armillaria spp.

- *Abies amabilis*
- *A. grandis*
- *A. lasiocarpa*
- *Chamaecyparis lawsoniana*
- *Larix decidua*
- *L. leptolepis*
- *L. occidentalis*
- *Picea abies*
- *P. engelmannii*
- *P. glauca*
- *P. sitchensis*
- *Pinus contorta*
- *P. monticola*
- *P. muricata*
- *P. nigra*
- *P. pinaster*
- *P. ponderosa*
- *P. radiata*
- *P. resinosa*
- *P. sylvestris*
- *Pseudotsuga menziesii*
- *Taxus brevifolia*
- *Thuja plicata*
- *Tsuga heterophylla*
- *Alnus rubra*
- *Betula papyrifera*
- *Populus X canadensis*
- *P. nigra*
- *P. tremuloides*
- *P. trichocarpa*
- *Quercus garryana*
- *Salix* sp.

Heterobasidion annaosum

- *Abies amabilis*
- *A. grandis*
- *Picea glauca*
- *P. sitchensis*
- *Pseudotsuga menziesii*
- *Thuja plicata*
- *Tsuga heterophylla*
- *Acer macrophyllum*
- *Alnus rubra*

Phellinus weirii

- *Abies amabilis*
- *A. grandis*
- *A. lasiocarpa*
- *Chamaecyparis nootkatensis*
- *Larix occidentalis*
- *Picea sitchensis*
- *Pinus contorta*
- *P. monticola*
- *P. ponderosa*
- *Pseudotsuga menziesii*
- *Thuja plicata*
- *Tsuga heterophylla*

Phaeolus schweinitzii

- *Larix* spp.
- *Picea* spp.
- *Pinus* spp.
- *Pseudotsuga menziesii*
- *Thuja plicata*
- *Tsuga heterophylla*

Inonotus tomentosus

- *Abies amabilis*
- *Picea engelmannii*
- *P. glauca*
- *P. sitchensis*
- *Pinus contorta*
- *P. monticola*
- *Tsuga heterophylla*

Rhizina undulata

- *Larix occidentalis*
- *Picea engelmannii*
- *P. glauca*
- *P. sitchensis*
- *Pinus contorta*
- *Pseudotsuga menziesii*
- *Tsuga heterophylla*

Heart rots

Echinodontium tinctorium

- *Abies* spp.
- *Thuja plicata*
- *Tsuga heterophylla*
- *T. mertensiana*

Phellinus igniarius

- *Acer* spp.
- *Alnus* spp.
- *Arbutus menziesii*
- *Betula* spp.
- *Cornus nuttallii*
- *Malus* spp.
- *Populus* spp.
- *Salix lasiandra*

Phellinus pini

- *Abies* spp.
- *Larix occidentalis*
- *Picea* spp.
- *Pinus* spp.
- *Pseudotsuga menziesii*
- *Thuja plicata*
- *Tsuga heterophylla*
- *T. mertensiana*

Stereum sanguinolentum

- *Abies amabilis*
- *A. grandis*
- *A. lasiocarpa*
- *Larix occidentalis*
- *Picea glauca*
- *P. sitchensis*
- *Pinus contorta*
- *P. monticola*
- *P. ponderosa*
- *Pseudotsuga menziesii*
- *Thuja plicata*
- *Tsuga heterophylla*
- *T. mertensiana*

Figure A.3 Host list.

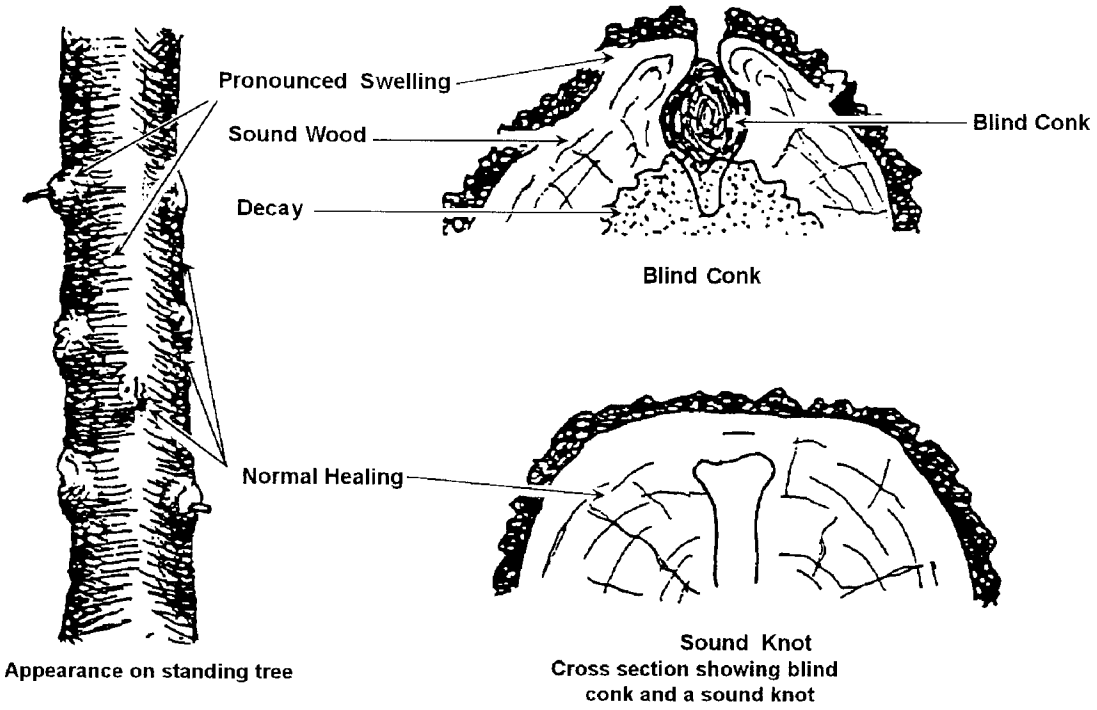


Figure A.4 Blind conk and sound knot.

A.4.2.3 Scars

A scar is an injury caused by external forces which has damaged the cambial layers of the tree and exposes either the sap wood or heartwood (or both) to potential attack by wood rotting fungi. These wood rotting fungi are ever present in forest stands and are carried widely by air currents.

Forms of scars - both open and closed scars will be called.

Open scars:

- open scars appear as areas of exposed wood of varying sizes and shapes (see Figure A.6), and
- scars are slow to heal over and the wood tissues of the tree may remain exposed for a considerable time allowing entrance of wood rotting fungi.

Closed scars:

- closed scars appear as slight to pronounced indentations of the bark in the case of early scarring which has healed over, or as pronounced scar tissue or callous growth in the case of later scarring. The latter type of scars frequently show considerable resin flow (see Figure A.5).

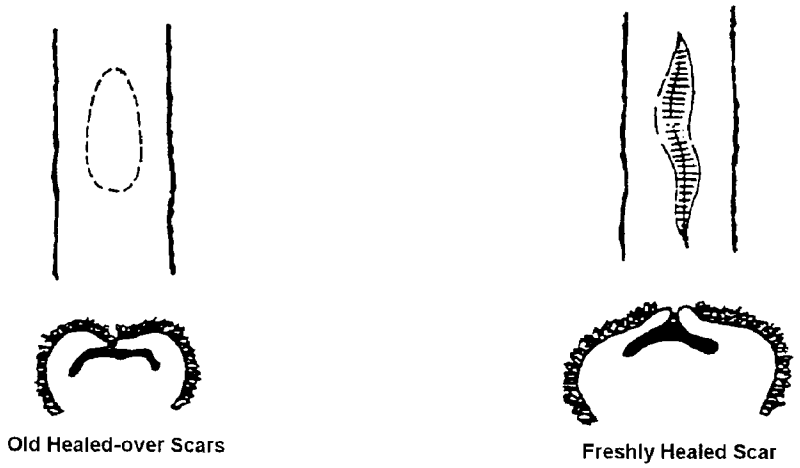


Figure A.5 Closed scars.

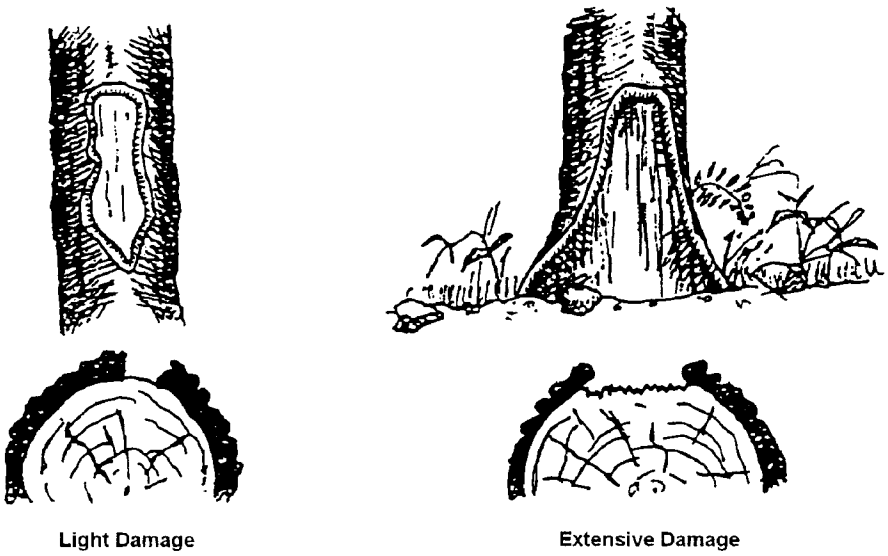


Figure A.6 Open scars.

The volume and decay studies of the past thirty years identified only scars visible to the naked eye without the use of binoculars or other lens. The scars were assessed without chopping into the indicator. To be compatible with these initial assessments, the same methodology must therefore be followed today. This also is the most practical method of observation at present.

A scar may or may not have visible decay associated with it.

The decay studies have scars with both decay and no decay in the data base.

Causes of scars:

Scars may be caused by many external forces, such as:

1. Fire:

    - old fire scars that have healed over appear typically as slight ridging of the bark and may have very old callous tissue on the bark, whereas more recent fire scars or ones resulting from severe damage appear as open catfaces or hollowing of the stem,

    - fire scars are usually confined to the base of the tree, and

    - fire scars may be important indicators of decay. Trees growing in forest stands (i.e., south or west facing slopes with pioneer species such as Fir or Lodgepole Pine) having a history of fire should be examined carefully for evidence of charred wood in root crotches or on exposed roots.

2. Lightning:

    - lightning can cause extensive damage to the top and stem of the tree. It typically appears as narrow to wide strips of torn wood, often extending down the entire length of the tree and often in the form of a spiral around the stem.

3. Damage by a falling tree:

    - trees are frequently scarred by other trees falling against them. Scars of this type are common in selectively logged stands or decadent stands where windfall trees are more common.

4. Machinery damage:

    - machinery can cause extensive damage, especially where selective logging has occurred, and

    - these scars are usually confined to the lower trunk, but they may also occur on the upper trunk when damage is caused by rigging lines.

5. Blazes:

   - blazes are entry points for decay fungi if they penetrate into the cambium layer.

6. Breakage of branches, secondary leaders or suckers from the bole of the tree:

   - high winds or heavy snows may cause the above to break from the main stem creating exposed wood.

7. Falling rocks (see Figure A.8):

   - rock slides or individual rock movement can cause extensive damage to trees in their path,

   - scars caused by rocks are usually confined to the basal portion of the trunk on the uphill side, and

   - falling rocks may in some instances scar trees a considerable height above the ground, either due to snow levels at the time of injury or bouncing rocks on steeper slopes.

8. Animal/bird damage:

   - wood must be exposed,

   - bear, moose, deer etc. can cause damage by removing areas of bark and cambium from the trunks of many trees,

   - rodents and beavers also cause damage to trees by gnawing on areas of the trunk,

   - woodpecker holes of considerable size provide entrance for wood rotting fungi, however, sap sucker holes are *not* scars, and

   - care must be taken to exclude superficial damage caused by these agents.

9. Cankers caused by fungi (see Figure A.7):

   - only cankers with exposed weathered wood are called, and

   - cankers caused by fungi result in the death of localized areas of bark and cambium on the trunks of trees. Eventually the dead bark is sloughed off exposing the underlying wood. There is usually evidence of repeated callous growth, and for this reason cankers are frequently mistaken for mechanical scars. Cankers are usually flattened and elongated, and may be indefinite in contour. The exposed wood is often stained and impregnated with resin. Fruiting bodies of the fungus may also be in evidence.

The calling of scars as pathological indicators:

- a scar which extends from the first or second third of the tree into the upper 1/3 of the tree on which the top is dead will be classified as a scar "4" by convention, and
- scars occurring completely below the point of germination either on the lower trunk or root collar adjacent to the trunk will be classified as a scar.

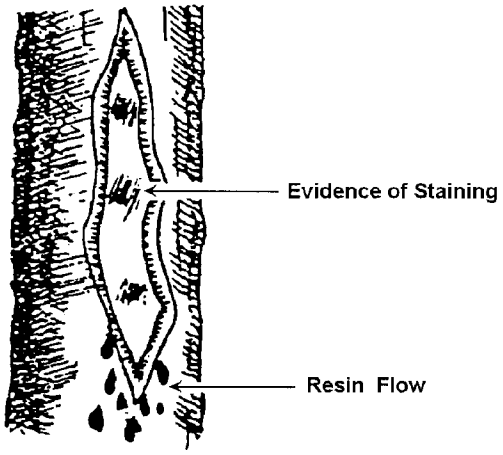


Figure A.7 Cankers caused by fungi.

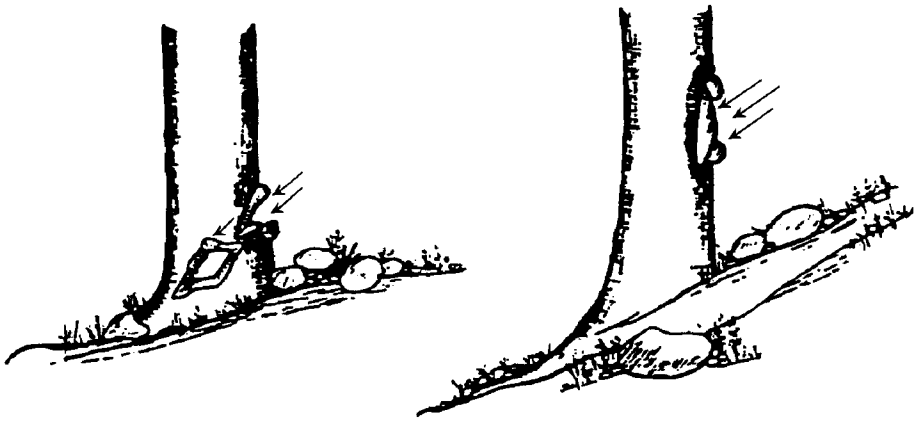


Figure A.8 Scars caused by rock slides and falling rocks.

Age of scar:

- a scar shall be not recent in origin. This is interpreted as the injury having not occurred within approximately the past five years,
- the scar or catface should show greyed or weathered wood. Weathered wood shall be described as:
  - dried and some "sun checking" evident,
  - usually associated with change of wood colour to a greyish tone,
  - callous growth should also be evident where the tree is attempting to grow over the scar, and
  - decay does not have to be evident.

Location of scar:

- a scar should be called if the damage occurs on any portion of the trunk of the main stem or on the secondary leader (only if the secondary leader contains a merch log),
- a scar which extends from the first or second third of the tree into the upper 1/3 of the tree on which the top is dead will be classified as a scar "4" by convention. The objective is not to double call the pathological indicators in the upper 1/3 of the tree,
- scars occurring completely below the point of germination, either on the trunk or an exposed root adjacent to the trunk, will be classified as a scar, and
- do not record scars above utilization top diameter.

Abnormalities similar to scars but not classified as scars:

Black knots:

- black knots frequently develop around unhealed knots and wounds. A superficial saprophytic fungus, which feeds on the exuded sap, causes the blackness. Black knots are quite sound and when cut into with an axe do not signify decay.

Burls and galls:

- burls and galls develop from abnormal cell growth in trees and are not associated with scarring, however scars occurring on burls and galls will be called.

Dry side:

- dry side results from the death of the cambium through bruising by other trees or by other physiological causes. Dry side may appear as a narrow to wide strip or as a localized area on the side of a tree. The bark remains over the affected area and provides protection against wood rotting fungi. Dry side is not a scar unless the bark has sloughed (is missing).

Sap sucker holes:

- sap sucker holes are superficial in extent and have no established significance for causing decay.

Insect borings:

- borings by bark beetles or other insects are generally recent in origin and they are not pathological indicators.

A.4.2.4 Fork or Pronounced Crook

A fork or crook is the result of damage to the main leader of the tree where one or more lateral limbs take over as the main stem. Fork or crook is called if severe enough to indicate that the original injury exposed the wood and provided an entrance point for decay fungi. Fork or crook are to be called between the root collar and the minimum top diameter specified in the cutting authority document.

Forks are called for any of the following conditions:

1. The main stem is markedly forked to indicate that 2 or more leaders have resulted from serious damage to the original leader (see Figure A.9, Example A and B).

2. The diameter of the main stem changes excessively from its normal taper to indicate that a serious injury has occurred. For cruising purposes, the diameter change must be at least 10 percent (see Figure A.9, Example C, D, and E).

Crooks are called if:

1. A stub is visible at the offset, with a 10 percent diameter change of the bole at the base of the stub (see Figure A.9, Example G).

2. The offset is severe enough to indicate that damage occurred to the main stem. For cruising purposes, the offset must be at least 50 percent of the diameter of the tree at the crook (see Figure A.9, Example E). Offsets less than 50 percent must be sharply crooked over a short length of the bole.

Some forks and crooks are not called (see Figure A.22). Forks and Crooks may be a growth characteristic of the tree species (for example deciduous species) or may have developed from malformation of the terminal leader due to insect or mistletoe attack. In addition, a fork may be confused with a branch. Forks or crooks which are not called are as follows:

1. Crooks with a minor offset (for cruising purposes, an offset less than 50 percent of the diameter of the tree at the crook).

2. Small sharply angled branches or spikes (for cruising purposes, less than a 10 percent change in the diameter of the main stem).

3. Natural forking in deciduous tree species.

4. If the damage is less than 5 years old and/or occurs above the minimum top diameter specified in the Provincial Utilization Standards Policy (Coast or Interior).

5. Flattening of the top of the tree caused by wind or natural outgrowth.

6. Candelabra branches in coniferous species.

Pathological indicators are called on secondary leaders which contain a merchantable log. They shall not be called on secondary leaders smaller than this or on candelabras.

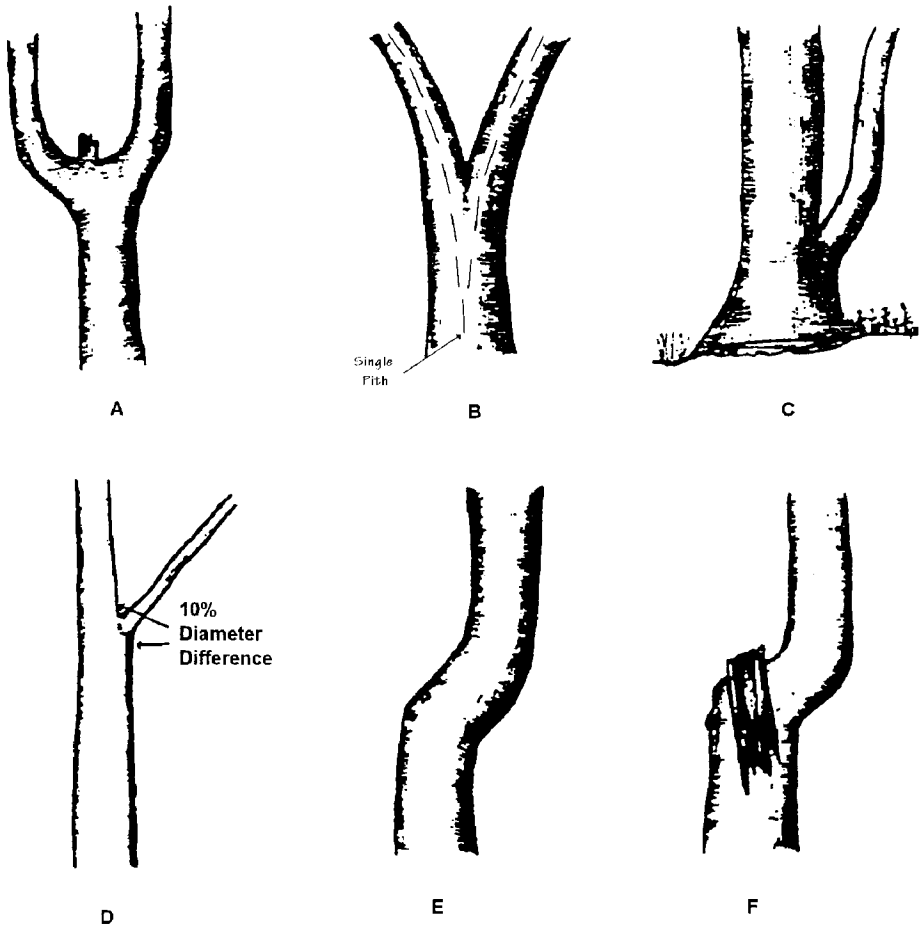


Figure A.9 Types of forks and crooks which are recorded.

Examples A, B and E illustrate forks which occur in the merchantable portion of the trunk. Examples C and D illustrate forks which occur on the basal portion of trees. Examples E and F illustrate pronounced crook.

A.4.2.5 Frost Cracks

- frost cracks result from deep radial splitting of the trunk caused by uneven expansion of the wood after sudden and pronounced drops in temperature,
- the cracks usually originate at the base of the trunk and extend up the tree following the longitudinal grain of the tree (see Figure A.10),

- frost cracks are often repeatedly opened by wind stresses or by low temperatures which freeze the moisture within the cracks and expands and splits the tree further,
- repeated healing of the wood produces considerable callous tissue giving the wood a pronounced ribbed appearance.

Frost cracks are often associated with severe basal decay.

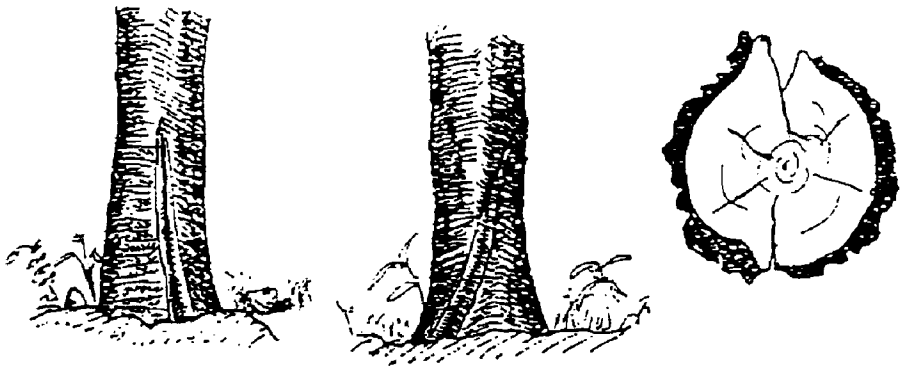


Figure A.10 Appearance of frost crack on standing trees.

A.4.2.6 Mistletoe Trunk Infections

Trunk infections of mistletoe are indicated either by abnormal swelling or malformations of the trunk at the point of infection, or by clusters of dead and broken branches on the trunk or on hypertrophied branches immediately adjacent to the trunk (see Figure A.11).

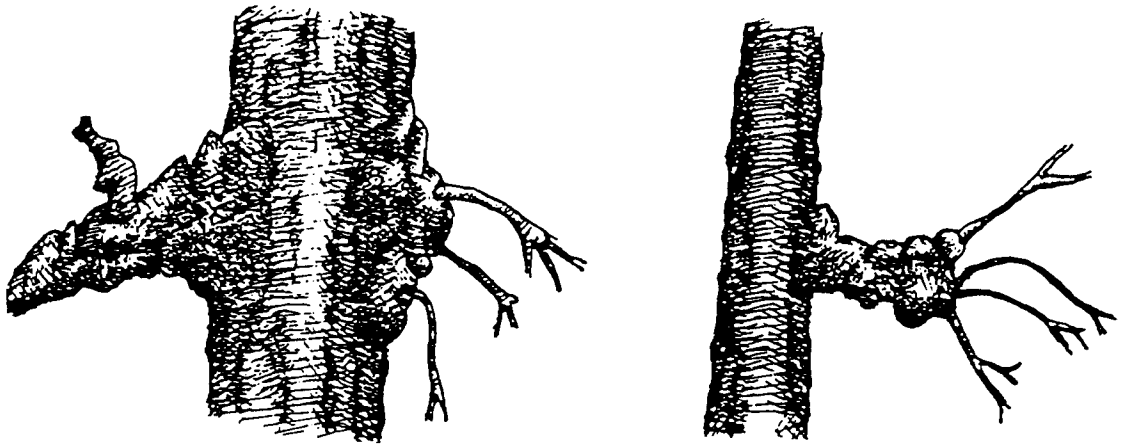
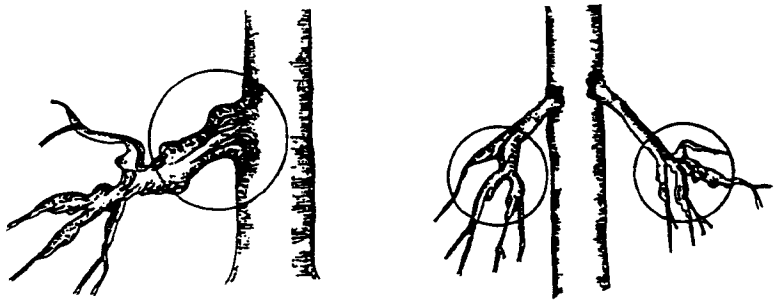


Figure A.11 Trunk infections of mistletoe.

Wood-rotting fungi gain entrance to the trunk through the dead hypertrophied branches or branch stubs where the swelling is on, or adjacent to the trunk.

Do not include mistletoe on living limbs or limbs that are swollen only at some distance from the trunk. Include only those branch infections in which the swelling has clearly extended to trunk (Figure A.12).



Suspect branch infection extending to the trunk of the tree.

Branch infection which is not suspect.

Figure A.12 Branch infections of mistletoe.

A.4.2.7 Large Rotten Branches

Large rotten branches are dead branches that are large (over 10 cm DIB) and are clearly decayed. These branches are usually broken off within a couple of metres of the trunk. Decayed heartwood close to or at the branch base should be obvious. The branches may be found at any position on the tree, but are generally confined to a position below the base of the live crown. This indicator is typically found on overmature trees (see Figure A.13).

Large rotten branches should not be confused with the normal decay of dead branches. It should be associated with large branches that have broken off, exposing a large heartwood surface to decay producing fungi, thereby potentially infecting the adjacent trunk.

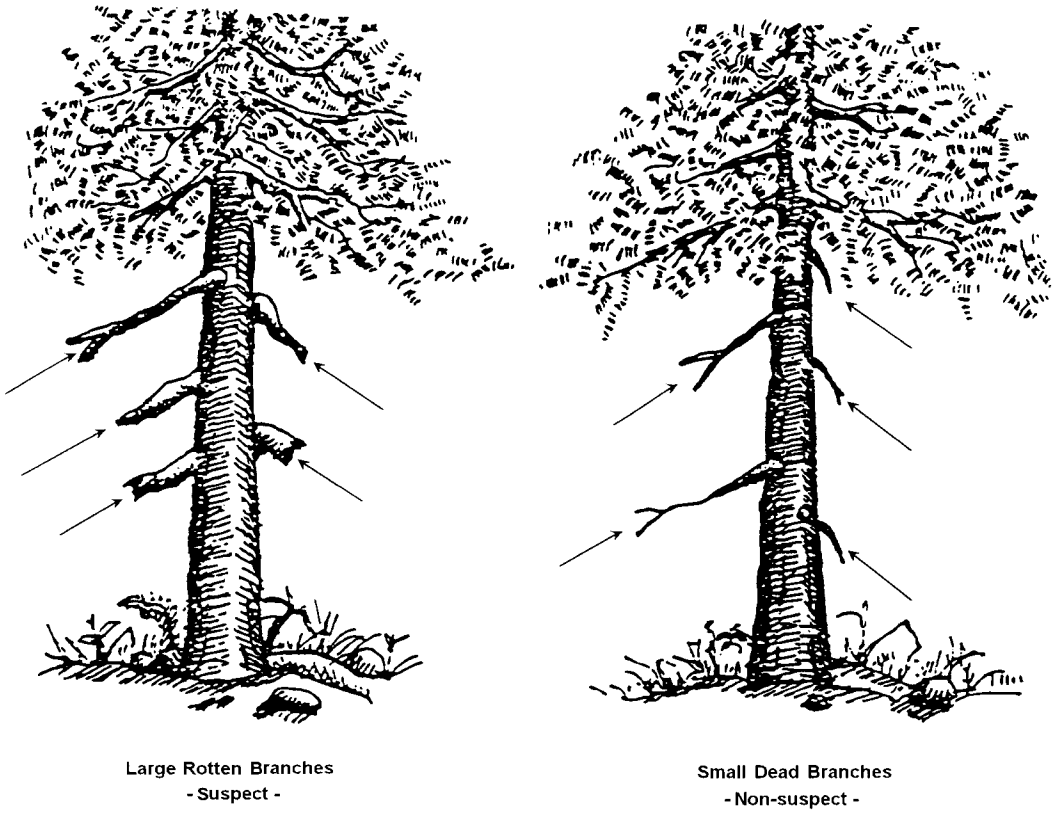


Figure A.13 Rotten branches.

A.4.2.8 Dead or Broken Top

Definition:

- where the tree top or complete stem has died due to various physiological causes.

Causes of dead tops

Dead tops may be caused by several factors such as:

- insect attack,
- drought conditions,
- sun scald, and
- physiological death.

The calling of dead tops:

- a dead top must be obviously weathered, indicating that death occurred at least five (5) years ago and below utilization top before it will be called as a pathological indicator, and
- if a fork is present at a broken top position, record the fork if a merchantable log (3 m and 10 or 15 cm top) can be recovered from the fork. If the fork is not of merchantable size, record the d or b top. Do not call both indicators. If a candelabra, record d or b top.

Broken tops:

- broken tops can be caused by various causes:
  - wind breakage,
  - snow damage,
  - damage from falling trees, etc.
- broken tops must be obviously weathered (see scar criteria) before being called as a pathological indicator, and
- standing trees that have windsheared and are broken in the bottom third will have a windthrow damage code assigned. Do not record a dead or broken top in 1.

Flat topped trees:

- when trees attain their potential height for a specific site, the tendency for the top of the crown to flatten out is prevalent especially in certain species such as Douglas fir. This flattening of the crown is not indicative of damage to the tree and will not be called as a pathological indicator.

A.4.3 Abnormalities which are not Recorded

The following abnormalities are not indicative of decay and are, therefore, not recorded.

A.4.3.1 External Evidence of Butt Rot not Associated with Suspect Abnormalities

Butt rot may be evident in exposed roots or within root crotches. However, unless one or more of the suspect abnormalities appears on the tree, such trees will not be classed as Suspect, it is defect of this nature which contributes to the decay loss factor associated with the Residual tree class.

A.4.3.2 Flutes

Pronounced flutes on the trunk are a common growth characteristic of many species. They have no decay significance except in the case of interior cedar where the fold may hide an open scar leading to a hollow or decayed tree centre (Figure A.14).

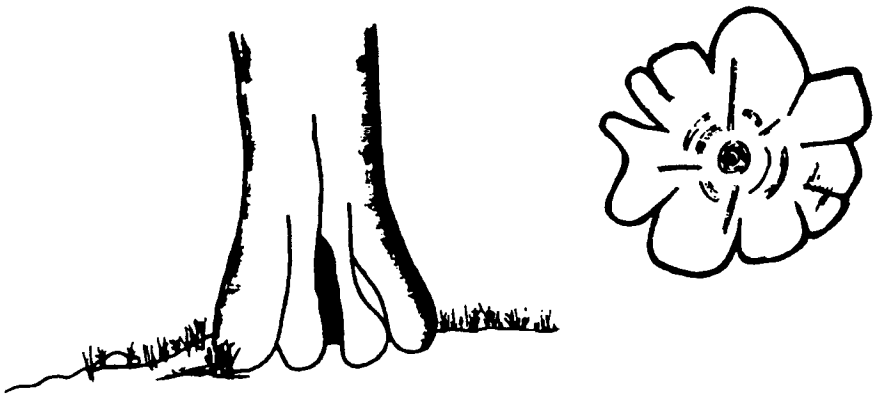


Figure A.14 Flutes.

A.4.3.3 Candelabra Branches

"Candelabra" branches develop as a result of abnormal branch growth and as such are confused with Suspect forking. Branching of this type has no decay significance. It is important to note that candelabra branches do not originate as a fork in the trunk of a tree (Figure A.15). Do not call defect on candelabras.

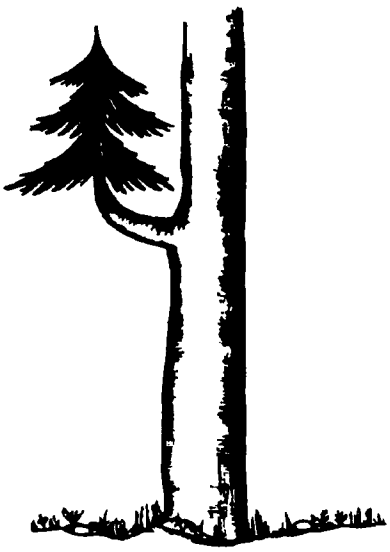


Figure A.15 Candelabra branches.

A.4.3.4 Branch Fans

Branch fans which appear most commonly as 'fans' of branches originating from burl-like swellings on the trunks (Figure A.16) are not Suspect.



Figure A.16 Branch fans.

A.4.3.5 Black Knots

Black knots frequently develop around unhealed knots and wounds. The blackened appearance develops from a superficial saprophytic fungus which feeds on the exuded sap. Black knots are quite sound when cut into with an axe and have no decay significance (Figure A.17).



Figure A.17 Black knots.

A.4.3.6 Burls and Galls

Burls and galls develop from abnormal cell growth in trees and although formidable in appearance, have no decay significance (Figure A.18).

Scars will be tallied on burls.

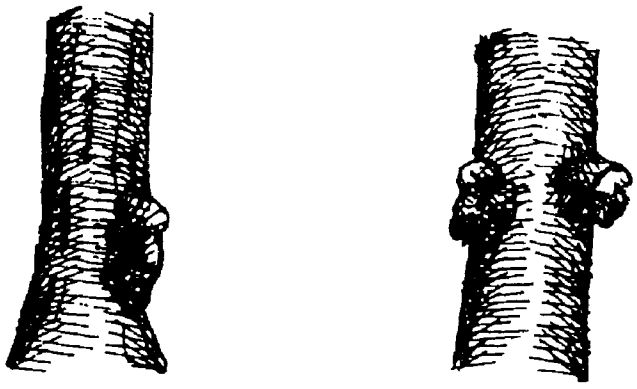


Figure A.18 Burls and galls.

A.4.3.7 Sweep

Sweep which is a slight curvature or distortion of the trunk has no decay significance (Figure A.19).

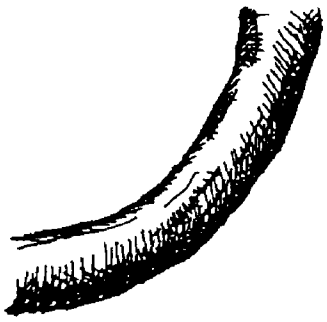


Figure A.19 Sweep.

A.4.3.8 Exposed Roots

Exposed roots and buttress roots have no established decay significance unless scarring is present above mean ground level (Figure A.20).



Figure A.20 Exposed roots.

A.4.3.9 Other

Spiral Grain

Spiral grain is a growth characteristic of trees and has no decay significance.

Dry Side

Dry side results from the death of the cambium resulting from bruising by other trees or from other physiological causes. Dry side appears as a narrow to wide strip down the side of the tree or as small localized areas. The bark often remains intact over the dead areas. Although dry side may be responsible for the complete rejection, or degrade of a pole tree, it has no established decay significance. Dry side is not a scar unless the bark has sloughed (is missing).

Sap Sucker Holes

Sap sucker holes are superficial in extent and have no established decay significance. They are in marked contrast to Suspect scarring caused by woodpeckers (Figure A.21).

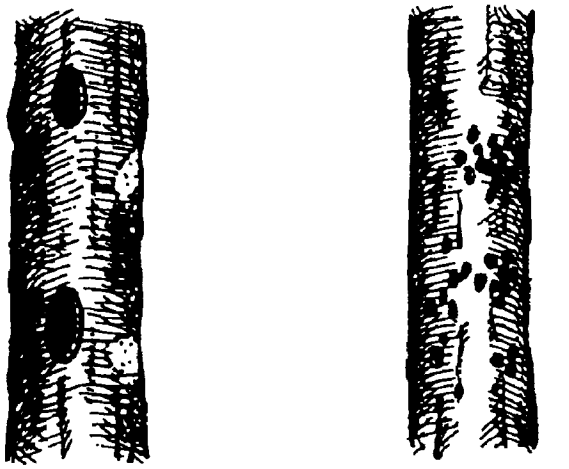


Figure A.21 Bird damage.

Insect Borings

Borings by bark beetles or other insects have no established decay significance and will not be classed as Suspect.

Non-Suspect Forking

Figure A.22 shows two types of non-Suspect forking most commonly occurring in deciduous trees. Deciduous trees with "U" shaped forks containing a dead branch are definitely suspect. Non-Suspect forking is more "V" shaped.

Trees growing in clumps, such as birch, should not be classed as suspect on this characteristic alone.

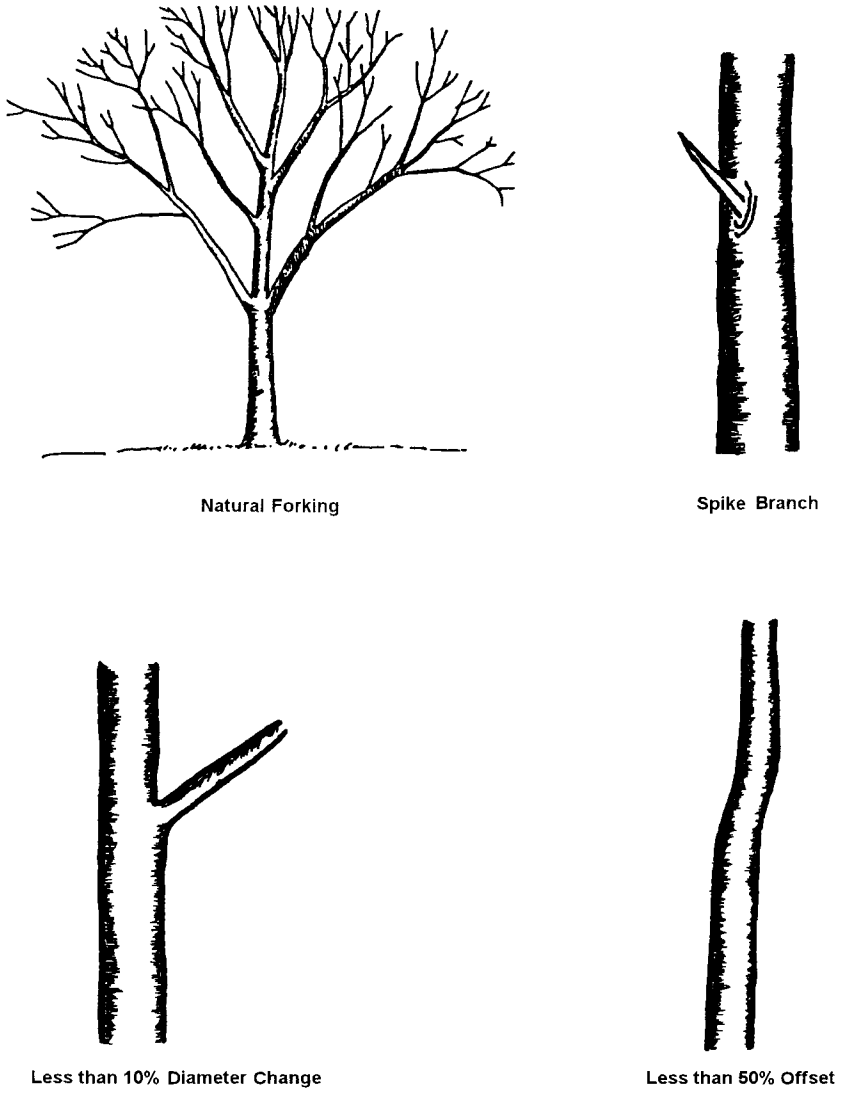


Figure A.22 Illustrates forks and crooks which are not suspect.

A.4.4 Some Common Decays of Forest Tree Species in British Columbia

Brief descriptions of some of the major decays of commercial tree species in British Columbia have been included as an aid to their identification in the field. Pathological studies have shown that although most tree species are subject to attack by a large number of wood-rotting fungi only a few are of major significance. Descriptions of eleven of these have been included.

The following colour photographs were contributed by the Canadian Forest Service.

A.4.4.1 The Indian Paint Fungus



❶ **Echinodontium tinctorium showing the dark, furrowed upper surface and grey, spiny lower surface.**

Cross section showing the brown stringy nature of decay caused by E. tinctorium. ❷





❸ **E. tinctorium on living hemlock associated with dead branches.**

Longitudinal section of brown stringy rot caused by E. tinctorium. ❹

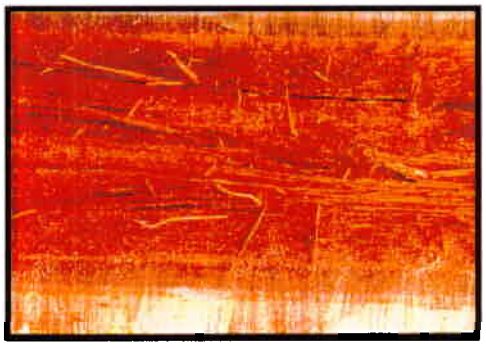


Figure A.1 Indian paint fungus.

Scientific name (fungus):	Echinodontium tinctorium (Ell. & Ever).
Common name (decay):	Brown stringy trunk rot.
Hosts:	Reported on a large number of coniferous hosts. Of major importance in British Columbia only on western hemlock, alpine fir and amabilis fir. Reported from the coast only at higher elevations and in the north.
Sporophores:	Perennial, hard, woody, sessile, ungulate: upper surface black, furrowed; context brick-red; lower surface grey.
Decay:	The incipient stage may appear as a light yellow to brown or water-soaked stain. Later, the wood darkens to a reddish-brown to brownish-yellow colour. Small rust-coloured spots and occasionally red streaks bay develop. Finally, the wood is reduced to a brown, fibrous, string mass.
Entrance:	Infections occur in living branches after 35 to 45 years, but normally do not become established in the trunk for another 100 years. Conditions affecting entry into the trunk are unknown.

A.4.4.2 The Pine Root Fungus



❶ **Upper and lower surfaces respectively of bracket-like sporophores of Fomes annosus, the pine root fungus.**

Resupinate sporophore of F. annosus on the under surface of an exposed root. ❷





❸ **Cross section of advanced decay caused by F. annosus showing the white spongy nature of the rot.**

Longitudinal section of decay caused by F. annosus showing the numerous elongated pits. Black flecks, commonly associated with advance decay rot are not evident here. ❹



Figure A.24 Pine root fungus.

Scientific name (fungus):	Heterobasidion annosum (Fr.:Fr.) Bref.
Common name (decay):	Annosus root and butt rot
Hosts:	Occurs on most hardwoods and conifers. Common in western hemlock. Range is generally west of the coast mountains and in the ICH biogeoclimatic zone.
Sporophores:	Perennial, woody to leathery, sessile, ungulate or bracket-like to resupinate; upper surface dark-coloured to black, zones, margin acute; context white to cream coloured, poroid, pores small and regular.
Decay:	The incipient stage may appear as a reddish-brown stain. In the advanced stage the wood is reduced to a white stringy or spongy mass containing numerous black flecks running parallel to the grain. In the final stage the wood may be completely destroyed.
Entrance:	Roots and scars.
Activity:	Heartwood and occasionally sapwood decomposition of lignin and to a lesser or slower extent cellulose. Generally confined to the roots and butt sections.
Remarks:	Sporophores generally produced on dead material or on the undersurface of roots exposed to the atmosphere. Capable of causing extensive root rot in young stands. Also occurs as a common decay of mature timber.

A.4.4.3 The Picture Conk



❶ **Typical sporophores of Fomes applantus.**

Section of white mottled rot caused by F. applantus showing the white mycelial accumulations and zone lines. ❷

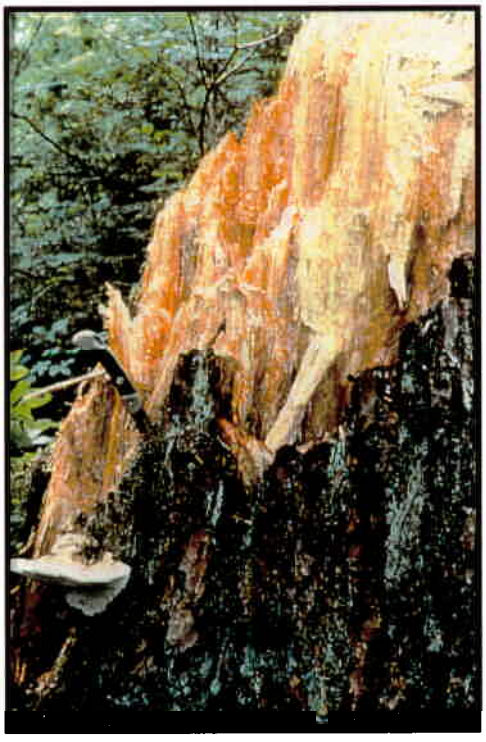


Figure A.25 Picture conk.

Scientific name (fungus):	Ganoderma Applanatum (Pers.) Pat. Fomes applanatus Pers.
Common name (decay):	White mottled rot, Applanatus rot.
Hosts:	Known to occur on conifers, but more frequent on hardwoods in all regions of BC.
Sporophores:	Perennial, leathery to woody, sessile, applanate; upper surface light brown to grey, often shiny; context dark brown; lower surface white, turning dark brown when bruised; poroid, pores regular.
Decay:	The incipient stage may appear as a light stain or infected wood may have a bleached appearance and be difficult of detection. In the advanced stage the decay is characterized by a mottled appearance. The wood is white or light coloured, soft and spongy, and often contains zone lines and accumulations of mycelium.
Entrance:	Scars.
Activity:	Heartwood and sapwood decomposition of lignin and to a lesser and slower extent cellulose. May occur in the butt or trunk.
Remarks:	Sporophores develop infrequently on living trees. The lower surface of fresh sporophores may be permanently marked on contact (the picture conk). Brownish spores may be carried to the upper surface giving a dusty brown appearance to the sporophore.

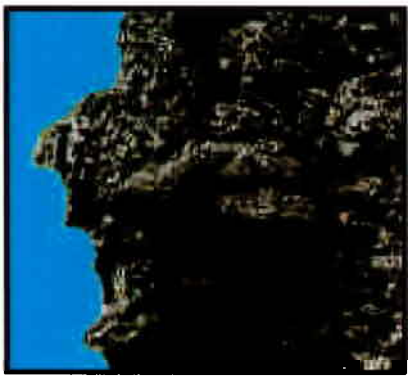
A.4.4.4 The Conk Fungus



❶ **Typical sporophores of Fomes pini, the conk fungus.**

Cross section of advanced decay caused by F. pini showing the honeycomb nature of the rot. ❷





❸ **Fruiting body on living Douglas fir.**

Fruiting body on dead branch. ❹



Figure A.26 Conk fungus.

Scientific name (fungus):	Phellinus pini (There:fr) Ames. Fomes pini (Thore) Lloyd, formerly referred to as Trametes pine (Thore) Fr.
Common name (decay):	Conk rot, white-pitted rot, red ring rot, pecky rot, honeycomb rot, etc.
Hosts:	Occurs essentially on all conifers in British Columbia, very common in hemlock, spruce and Douglas fir. Also known to occur on hardwoods.
Sporophores:	Perennial, wood to punky, sessile, ungulate, occasionally effused-reflexed if on branches; upper surface dark brown, furrowed; context cinnamon brown; lower surface light brown, poroid, pores regular to daedaloid.
Decay:	The incipient stage may appear as a reddish stain. Later small white, spindle-shaped pits develop parallel to the grain.
Entrance:	Unknown - probably branches and wounds.
Activity:	A lignin destroying heartrot, mostly occurring in the trunk.
Remarks:	One of the most important decay fungi in British Columbia. Of greater importance on good sites. Conks develop on living trees and provide a valuable index to hidden defect. Also recognized through the occurrence of blind conks (punk knots) which constitute early or abortive stages in the development of sporophores.

A.4.4.5 The Red Belt Fungus

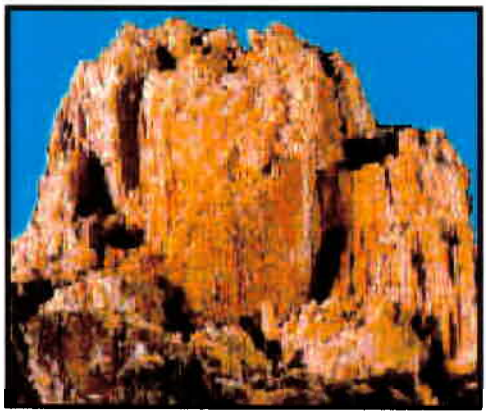


❶ **The red belt fungus, Fomes pinicola, showing the bracket-like nature of the sporophore.**

Typical sporophores of F. pinicola on recently killed western hemlock.

❷





❸ **Section of decay caused by F. pinicola showing the typical brown cubical formations and white mycelial felts.**

Figure A.27 Red belt fungus.

Scientific name (fungus):	Fomitopsis pinicola (SW.:Fr) P. Karst. Fomes pinicola (sw.) Cke.
Common name (decay):	Brown crumbly rot.
Hosts:	Common on most conifers and hardwoods.
Sporophores:	Perennial, woody to leathery, sessile, variable, ungulate, bracket-like, occasionally effused-reflexed; upper surface dark brown to black, outer margin often reddish or otherwise lighter in colour; context cream to light brown; lower surface white, often tinged with yellow; poroid, pores small and regular.
Decay:	The incipient stage may appear as a light brown discolouration. Later the wood breaks into small brown cubes which are soft and crumbly. White felts of mycelium may be formed in the shrinkage cracks.
Entrance:	Scars, dead tops, insect injuries, etc.
Activity:	A cellulose-destroying trunk rot, occurring in the heartwood or sapwood.
Remarks:	Very common in dead trees, slash, and other forest litter, thus occasionally known as the scavenger fungus. May be associated with decay in living trees, frequently gaining entrance through scars. Also an important rot contributing to the deterioration of killed stands, especially by fire and insects. Sporophores develop infrequently on living trees.

A.4.4.6 The Velvet-Top Fungus



❶ **Sporophore of P. schweinitzii attached to an underground root and growing through the duff.**

Cross section of decay caused by P. schweinitzii showing the typical dark brown cubical formations. ❷





❸ **Longitudinal section of decay caused by P. schweinitzii showing the dark brown cubical formations.**

Figure A.28 Velvet-top fungus.

Scientific name (fungus):	Phaelous schweinitzii (Fr.:Fr.) Pat. Polyporus schweinitzii Fr.
Common name (decay):	Brown cubical butt rot.
Hosts:	On conifers, common in Douglas fir, spruce and pine. Occasionally found on hardwoods found in all regions in BC.
Sporophores:	Annual, spongy to leathery, stipitate; upper surface reddish-brown; velvety with concentric rings and a light yellow margin; context yellow-green to light brown; lower surface yellow-green turning brown when bruised; pores regular to daedaloid.
Decay:	The incipient stage may be difficult to detect, often appearing as a light yellow stain. At a late stage the wood becomes brittle and breaks into large cubes, reddish-brown in colour. An odour of anise is often associated with advanced decay.
Entrance:	Roots.
Activity:	A cellulose-destroying heartrot, generally confined to the roots and basal log.
Remarks:	Very general distribution throughout North America. Occurs in trees of all ages. Young trees may be killed outright, older trees become subject to windfall. Sporophores develop on roots and freshly felled trees and provide a valuable index of infection.

A.4.4.7 The Sulphur Fungus



❶ **Typical sporophore of P. sulphureus, showing the fan-shaped nature.**

Sporophores of P. sulphureus fruiting at the base of an infected tree.



❷



❸ **Cross section of decay caused by P. sulphureus showing the typical brown cubical formation and thick white mycelial felt in the shrinkage cracks.**

Longitudinal section of brown cubical trunk rot caused by P. sulphureus showing the white mycelial felts.



❹

Figure A.29 Sulphur fungus.

Scientific name (fungus):	Laetiporus sulphureus (Bull.:Fr) Murrill. Polyporus sulphureus (bull.)
Common name (decay):	Brown cubical trunk rot.
Hosts:	Common on most hardwoods and conifers, including oak, true fir, Douglas fir and spruce in all regions in BC.
Sporophores:	Annual, spongy to leathery, sessile or stalked (stem eccentric), applanate to bracket-like; upper surface orange-yellow; context white; lower surface sulphur-yellow; poroid, pit regular. Old sporophores white and brittle.
Decay:	The incipient stage may appear as a light brown stain. Later the wood breaks into small brown cubes. The decay may have a 'rippled' appearance in longitudinal section and white mycelial felts may develop in the shrinkage cracks.
Entrance:	Scars, dead branch stubs.
Activity:	A cellulose decomposing heartrot and occasionally saprot. May occur in the butt or trunk, generally the latter.
Remarks:	Sporophores develop infrequently on living trees but are easily recongnized by their shape, size and colour. They decompose quickly following insect attack and weathering and seldom remain on the host past one season.

A.4.4.8 The Spongy Butt Rot Complex



❶ **Resupinate sporophore of the spongy butt rot on the surface of an old stump.**

Cross section of spongy butt rot. ❷





❸ **Cross section of spongy butt rot showing the laminate and stringy nature of decay.**

Figure A.30 Spongy butt rot complex.

Scientific name (fungus):	The three fungi most commonly involved in the complex are Corticium galactinum (Fries) Bur, Odontia bicolor (Alb. and Schw. ex. Fr.) Bres., and Poria subacida (Beck) Sacc.
Common name (decay):	Spongy butt rot, feather rot, white stringy butt rot.
Hosts:	Occurs in conifers and hardwoods. Common in true fir, spruce and hemlock found in all regions of BC.
Sporophores:	Superficially similar in the three species: annual to perennial, resupinate, white, yellow or buff. The surface of C. galactinum smooth and waxy, O. bicolor cracked with age and covered with short fragile evenly-distributed teeth and P. subacida small pores.
Decay:	The incipient stage may appear as a light stain. Later, small white pits develop and coalesce to form masses of white spongy fibres containing small black flecks. The annual rings may separate to form a laminate decay. Finally, the wood is reduced to a spongy mass.
Entrance:	Roots.
Activity:	A lignin and to a slower or lesser extent cellulose decomposing heartrot and saprot generally confined to the roots and butt.
Remarks:	Poria subacida which formerly was considered the sole causal fungus is in some hosts now believed to be the least important of the fungi commonly associated with the disease. White spongy butt rot is widely distributed throughout North America; common in mature age classes. Sporophores of the three fungi associated with this rot are generally on the undersurface of old logs.

A.4.4.9 The Bleeding Conk



❶ **Typical sporophore of the bleeding conk, Stereum sanguinolentum, showing the thin, crust-like nature of the fruiting body.**

Typical sporophore of the bleeding conk, Stereum sanguinolentum, showing the thin, crust-like nature of the fruiting body. ❷



Figure A.31 Bleeding conk.

Scientific name (fungus):	Stereum sanguinolentum A. & S. ex. Fr.
Common name (decay):	Red heart rot.
Hosts:	Occurs on conifers. Very common in true fir, pine and white spruce. Found throughout the range of hosts in British Columbia.
Sporophores:	Annual, leathery, resupinate to effused-reflexed, forming thin crust-like layers; lower surface grey to light brown, turning blood red when bruised, surface roughened.
Decay:	The incipient stage is firm and appears as a reddish brown stain, in the advanced stage, the wood becomes light brown to reddish-brown, dry and friable. Mycelial sheets, white to buff in colour, may develop.
Entrance:	Broken tops and scars of living trees.
Activity:	A lignin and generally to a slower or less extent cellulose destroying heartrot, generally found in the trunk.
Remarks:	A very important decay-producing fungus, also occurs commonly as a slash destroyer. Sporphores develop occasionally on living trees, but are of limited value as indicators of defect owing to their infrequent occurrence, small size and colour.

A.4.4.10 The False Tinder Fungus

Hoof-shaped sporophores Fomes igniarius; deeply zoned grey-black upper surface. ❶





❷ **Hoof-shaped sporophores Fomes igniarius; deeply zoned grey-black upper surface.**

Yellow-white stringy advanced decay with included black zone in aspen. ❸



Figure A.32 False tinder fungus.

Scientific name (fungus):	Phellinus igniarius (L.:Fr) Quél. Fomes igniarius (L.) Gill.
Common name (decay):	white trunk rot or white heart rot.
Hosts:	Occurs mainly on hardwoods. Common in aspen and birch.
Sporophores:	Perennial conks are usually hoof-shaped, but sometimes shelflike and may obtain a width of 20 cm or more. The upper surface is greyish-black to black, dull or shiny, smooth when younger becoming rough and cracked with age. Undersurface is brown with mouths of tubes small and circular in outline. Context or interior of conk is rusty-brown, often interspersed with silver-grey flecks.
Decay:	Incipient stage has yellowish-white spots, streaks, or larger areas in the heartwood, the whole usually surrounded by a yellowish-green to brownish-black zone. In the advanced stage the wood is light in weight, soft, whitish, and rather uniform in texture with fine black lines running throughout. In aspen, the incipient wood is faintly coloured from light pink to straw-brown, in the intermediate stage of decay, the wood is straw to chocolate-brown, but is still hard and firm; and in the advanced stage all soft, punky wood irrespective of colour is included.
Entrance:	Unknown - probably branches and wounds.
Activity:	Sporophores from on standing trees and on slash; the presence of a single sporophore generally indicates a considerable volume of decay.

A.4.4.11 Poria Obliqua



❶ Internal view of the Poria oblique - decay complex.



❷ Section view of sterile conk on birch. Note black zone lines and canker-like appearance of the stem.



❸ Longitudinal section showing advanced decay.

Figure A.33 Poria obliqua.

Scientific name (fungus):	Poria obliqua (pers.) Bres.
Hosts:	Occurs on hardwoods. This sample was found on wester paper birch (Betula papyrifera).
Decay:	A heart rot in living birches similar to that caused by Fomes igniarius. Fine black zone lines are a feature of the advanced stage (Example 3).
Appearance:	Black, warty, rough, clinkerlike sterile conks are produced on living trees, appearing to issue from knots and wounds. The conks in this illustration appears in the centre of a conspicuous canker. The context or interior of the conk is rusty-brown.

A.5 Woods Safety and Emergency Procedure

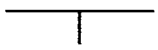
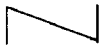
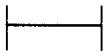
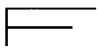
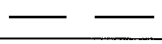
A.5.1 Ground to Air Signals

Visual patterns to be used in emergencies, in Forest Protection work and Forest Inventory Branch food drops.

Wherever possible, a smoke fire should be used to attract aircraft. Use toilet paper, poles, rolled tents, etc., to make signals.

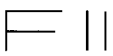
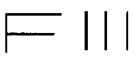
A.5.2 Emergency Signals - downed aircraft, ground emergency, etc.

In most cases personnel should remain at the scene of any wreck, unserviceable aircraft or ground accident in back areas. If the trip has been properly planned and E.T.A.'s left at party headquarters, every effort will be made to start a search if personnel become overdue.

Serious inury, require doctor	
Drop here, all O.K.	
Negative	
Yes	
Require Helicopter	
Require food	
Require radio and/or batteries	
Which way do we go?	
Am proceeding in this direction	
All O.K.	
Not understood	
Require fuel	

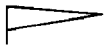
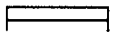
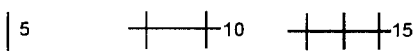
A.5.3 Forest Inventory Branch Food Drop Signals

In pre-dropping operations these signals are to be left at drop site. When check flight is made later pilot is able to determine if ground crew found previous drops O.K. The signals are solely for food drops. If any emergency has developed, signals in (Section A.5.2) above are to be used.

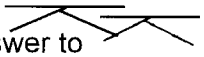
Everything O.K. No drops required	
Drop again 1 parcel	
Drop again 2 parcels	
Drop again 3 parcels	

A.5.4 Fire Fighting and Water Dropping Signals

It is possible District personnel may be involved in forest protection duties where aircraft are being used for water bombing or other protection duties. The Forest Protection Branch has specified certain air-ground signals to be used as follows:

Require saw	
Require pump	
Require hose	
Require hand tools	
Require men	
Water dropping target -	Centre of target between two balloons or like indicators. Distance between balloons indicates length of target.

Air to Ground Signals

Proceed to Target Circle three times	Answer to  , fire, or target here.
Low pass over drop area Revving motors	Take cover - air drop coming
Pass over drop area Wobbling wings	Finished dropping or signals recognized

A.5.5 Basic First Aid

Sprains	Simple: wrap with elastoplast or bandage, cold compress, and elevate and rest. Serious: Treat as a break.	
Diarrhea	Black tea and burnt toast.	
Food Poisoning	Induce vomiting - salt water and finger, continue until clear, and drink lots of milk and water.	
Bleeding – Control by:	1.	Pad and pressure on wound (more pads on top as required).
	2.	Elevation of wound.
	3.	Pressure on major artery above wound may be necessary in extreme cases.
Broken Bones	1. 2.	Immobilize before moving Use lots of padding. Splints can be made from boards, saplings, air mattresses, tallybag, etc.
Burns	1. 2.	Soak in cold water to relieve pain Cover with sterile gauze

Artificial Respiration	Mouth-to-Mouth Method – *start immediately!*	
	1. 2. 3. 4. 5. 6.	Clear throat, tongue not swallowed. Tilt head back. Pinch nostrils. Cover patient's mouth with yours and blow. Remove your mouth so they can exhale while you inhale. Repeat 4 and 5.
In all cases treat for shock -	1. 2. 3. 4. 5.	Warmth - especially if cold and wet Air - loosen clothing at neck and waist Rest - lie on back, raise legs Shelter Stimulants - tea, coffee, milk (no alcohol) - avoid if internal injuries present.

A.5.6 If You Must Leave Your Partner in the Bush

A.5.6.1 Make Sure They are Comfortable and Treat All Injuries Before you Leave

A.5.6.2 Leave Them With

- shelter - in case of rain,
- water,
- food,
- fire, wood, kindling, and matches,
- knife and axe,
- flare kit,
- extra clothing - both over and under,
- tallybag, and
- watch.

A.5.6.3 Tell Them Your Plans

- direction and route you are taking,
- estimated time of return,
- what you will do when you reach your fly camp or truck, and
- reassure them before you leave.

A.5.6.4 Mark Their Location Well With Flagging, etc. (you may have to return in the dark)

A.5.6.5 Flag or Blaze Your Way out Using Your Compass. Take Aerial Photo Having Marked Their Location Before Leaving

A.5.6.6 If Lost

1. Remain calm.
2. Take stock of what you have with you.
3. Sit down, relax - then try to figure out where you are.
4. Use your compass.
5. Proceed to high point to obtain idea of lay of land and to be more readily spotted.
6. If you have not discovered your position by 7:00 p.m., admit you are lost.
7. Prepare to spend the night out:
    a. check instructions in flare kit,
    b. prepare smoke signal fire - lay out ground to air signals if necessary,
    c. make a shelter, build a fire, and
    d. keep busy but prevent exhaustion and exposure.

Exposure - body energy is dissipated much more rapidly under tension or stress, particularly when a person is cold and wet, this results in exhaustion and eventual collapse. Do not attempt further travel under these conditions. Build a fire in a sheltered spot and get warm.

    e. conserve food.

A.5.6.7 Flare Kit Instructions

To attract attention:

- pick an opening and/or hilltop if possible,
- aim in front of approaching aircraft,
- fire flare vertically, and
- watch where flare lands in case of fire.

If lost:

- space out your flares - at least 1/2 hour apart.

Save at least two (2) for the next morning.

Remember: Dusk and dawn are the best times for spotting flares. Search crews will stop about 10 p.m. and wait until moring to restart.

Stay put when you have been spotted: Unless directed otherwise by search party. Keep ground to air signals in your hard hat.

A.6 Abbreviations and Symbols

Basal area factor	BAF
Close utilization	CU
Coefficient of variation	CV
Decay and breakage	DB
Decay, waste 2 and breakage	DW2B
Diameter at breast height	dbh
Diameter at stump height	dsh
Diameter inside bark	dib
Diameter outside bark	dob
Plot radius factor	PRF
Standard deviation	S.D.
Standard error	S.E.

A.7 Damaged Stands

Trees are assigned damage codes so as to apply 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 damaged code categories so as to enable cost and value adjustments in appraisal.

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

Depending on the patchiness of the beetle attack, or fire and wind damage, consideration should be given when drawing up the sampling plan as to whether these patches should be treated as "types" and be a part of the stratification.

A.7.1 Pest Damage

The following section applies for all cruises. Standard cruising methods as outlined in the *Cruising Manual* are to be followed with all beetle attack trees on the sale area coded in accordance with the Bark Beetle Code.

A.7.1.1 Bark Beetle Codes[1]

When Bark Beetle codes are recorded, the compilation program modifies the risk group. The compilation reports state the volume affected by this damage.

Trees are coded as they appear at the time of the cruise with no attempt to guess what the future condition of the trees will be.

A.7.1.2 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).[2]

Douglas fir beetle attacks Douglas fir and sometimes western larch.[3]

Spruce beetle attacks mainly white and Englemann spruce in the Interior.[4]

Western pine beetle attacks ponderosa pine.

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

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[1] L. Safranyik, D.M. Shrimpton, H.S. Whitney, Management of Lodgepole Pine to Reduce Losses from Mountain Pine Beetle, 1974, Forestry Technical Report 1, Environment Canada.

[2] R.O. Wood, Foliage Changes of Three Pine Species, Pacific For. Res. Centre, Internal Report BC-17.

[3] L.H. McMullen, 1977, Douglas Fir Beetle, Pacific For. Res. Centre, Pest Leaflet A.

[4] C.B. Cottrel, 1978, Spruce Beetle, Pacific For. Res. Centre, Pest Leaflet B.

A.7.1.3 Attack codes for balsam, 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 mountain pine beetle (PL, PY, PW), the western pine beetle (PY) and western balsam bark beetle (B).

In large, active infestations of these beetles, trees which have strip attacks and unsuccessful full attacks due to tree resistance will generally be low in numbers. Therefore, additional codes are not necessary to identify them for the purpose of normal timber sale or inventory cruising.

Any evidence of bark beetle attack in a green tree must be tallied as a green attack bark beetle code.

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. For lodgepole pine, green attacked trees are common from late July to late May in most areas. White pine and yellow pine infested by mountain pine beetle often start discolouring by fall or mid-spring.

Red Attack Code 2

This code represents trees that, on average, had been attacked during the previous two seasons. The crowns first fade to straw colour, then to red and finally to rust colour before the needles fall off the tree. By the time the foliage is rust coloured, the beetles have usually left these trees to infest green trees. The boles of many trees in this category may be heavily worked by woodpeckers, making them susceptible to checking.

Grey Attack Code 3

This code will represent trees which are dead and have grey needles. The bole of the older kills will have much checking and loose bark. However, pitch tubes on the bark of the lower bole and/or bark beetle galleries under the bark will be readily discernible.

The western pine beetle has a different gallery pattern than the mountain pine beetle, but infested trees go through the same sequence of foliage changes after attacks by either beetle. Therefore, the same attack code is applicable.

The western balsam bark beetle usually completes its life cycle in two years. Therefore, both green and red attacked trees will contain brood. Also quite often there is no evidence of pitch tubes on the trunk of infected trees. Therefore, the boles of balsam fir need to be examined at close range for signs of boring dust in the crevices of the bark and/or small round holes in the bark that signify entry or emergence by this beetle. Thus, in the green infected stage, attacked trees are quite difficult to find.

A.7.1.4 Blister Rust Code 4

Normally used in stands where white pine is a major species (more than 20 percent of the volume) which is seriously infected with blister rust. This code can be used in a normal old growth H-C type containing a few scattered PW veterans.

A.7.1.5 Attack Codes for Spruce, Douglas Fir

Code	Description
5	Green (Alive) Strip Attack – S and F
6	Green (Dead) Full Attack – S and F
7	Grey Attack – S and F
8	Red Attack – Fir only

The first three codes are applicable to the spruce and fir beetle. Spruce foliage turns yellowish for a brief period in the winter season following an attack before the needles drop off the tree. Therefore, the species was not included in the red attack. Infested trees with faded crowns should be included in the green (dead) full attack.

Green (Alive) Strip Attack Code 5

The trees in this code will be infested in a strip on the lower bole where broods either failed or succeeded in completing their development. In either case, the attacks did not kill the trees. These trees will live on, at least until subsequent attacks (which can happen quite often) completely girdle the bole. In the case of Douglas fir, strip attacked (green alive) in well established infestations are usually much less common than Green (dead) fully attacked trees. The loss factors are unaffected by this code.

Green (Dead) Fully Attacked Code 6

The trees in this code still have green foliage but the attack by the bark beetles has completely girdled the tree. Some of these trees will have a considerable amount of their bark removed by woodpeckers lowering the value because of checks and splits.

In the case of Douglas fir, the beetle usually has a one year life cycle. The attack is usually in May and June. The crowns of infested trees stay green from a few months to a year after attack. Do not code as Tree Class 3. The compilation program will downgrade these trees to Risk Group 2.

Gray Attack Code 7

This code represents trees which are dead and have gray needles. Little or no foliage is left, the boles of the older kills may have much checking and loose bark. The compilation program downgrades these trees to the highest risk group.

Red Attack Code 8

This code is reserved for Douglas fir where the red foliage remains on the tree for an average of two years. For bole and crown symptoms of infestation, consult the publication on Douglas fir Beetle[3] under the headings Damage and Detection. The compilation program downgrades these trees to Risk Group 2. If they have conk or blind conk or are tree class 3, 7, or 9 they will be compiled as Risk Group 3.

A.7.1.6 Defoliators

This damage category includes hemlock looper, budworms, moths and other defoliators. If the classification is doubtful, assess the cambium on the north side at DBH.

- Code X - trees with living cambium. Tree classes 1, 2, 5, 6, 8, and
- Code Y - trees with dry cambium. All tree classes are allowed.

A.7.2 Fire Damage

The following section applies to situations where trees are damaged by fire.

Standard cruising methods as outlined in the *Cruising Manual* are to be followed in conjunction with the following classifications and their attack codes.

A.7.2.1 Light Damage - Code A

Damage consisting of scorched bark and foliage but no charring in the merchantable portion of the stem.

Classification: No change to the tree classification for light fire damage trees.

Trees with bark scorching that occurred greater than or equal to 5 years previously do not qualify for fire damage coding.

A.7.2.2 Moderate Damage - Code B

Damage consisting of some shallow charring of wood fibre in the merchantable portion of the stem.

Classification: Assign the tree class and record the pathological indicators as normal. The compilation program will down grade risk group 1 trees to risk group 2.

A.7.2.3 Heavy Damage - Code C

Damage consisting of extensive shallow charring or deep charring in the merchantable portion of the stem. Multiple deep checks in trees less than 30 cm DBH also qualify for heavy damage.

Classification: Assign the tree class and record the pathological indicator as normal. The compilation program will down grade these trees to the highest risk group.

Trees are coded as they appear at the time of the cruise only and not at the anticipated time of harvesting.

Definitions:

Merchantable section	is the section of the stem between 30 cm stump and the 10 cm top diameter.
Charring	is the actual destruction of wood by fire. There must be identifiable damage to a surface area greater than100 cm^2.
Shallow charring	is charring which is greater than 100 cm^2 in surface area and less than one-third of the radius of the tree.
Extensive shallow charring	is charring in the bottom third of the tree that has 3 or more areas (each at least 100 cm^2) of exposed and charred wood fibre.
Deep charring	is where charring is deeper than one-third of the radius of the tree.
Multiple deep checks	is where more than 1 check is deeper than one-third of the radius of the tree.

1. Surface checking may occur as the result of fire damage but this does not affect tree classification.

2. Trees are coded as they appear at the time of the cruise and not at the anticipated time of harvesting.

A.7.3 Uprooted Stands (Windthrow, Flood Damaged)

A.7.3.1 Pre-Assessment of Fall-down

Falldown should be assessed and reported in the cruise plan. The report is to include the approximate proportion of the stand affected and the species, diameter range, orientation and pattern of the downed trees.

A.7.3.2 Sampling Fall-down

The following applies to situations where trees have been blown down or uprooted. Standard cruise methods as outlined in the *Cruising Manual* are to be followed in conjunction with the following criteria.

- fixed or variable plots can be used for both standing and falldown,
- trees will be coded as of the time of cruising,
- for uprooted trees, assign the tree class and record the pathological indicators as normal, except recent breaks < 5 years and breaks in the first third do not record dead or broken top,
- standing trees that are broken in the bottom third will have a windthrow damage code assigned. Do not record a dead or broken top in 1,
- standing trees that are broken in the middle third will only have wind throw damage codes E or F assigned. Do not record a dead or broken top in 2 unless the damage is $\geq$ 5 years since occurrence,
- do not record uprooted tree class 4 and 6 trees,
- the allowable tree classes for all codes are 1, 2, 3, 5, 7, 8, and 9,
- all trees with red or green needles are classified as living trees, and
- the following Damage Codes will be entered in column 63 of the Tally Sheet (FS 205).

Length of Time		Condition of Uprooted Trees
Code	**Time Since Damage**	**Description**
E	0 - 12 months	The tree may have one clean break in the merchantable portion of the stem. The compilation program will assign the risk group by tree class and pathological indicators.
F	+ 12 months	The tree may have one clean break in the merchantable portion of the stem. The compilation program will assign the risk group by tree class and pathological indicators.
G	0 – 12 months	The tree must have two or more clean breaks or one or more shattered breaks within the merchantable portion of the stem. The compilation program will down grade these trees to the highest risk group.
H	+ 12 months	The tree must have two or more clean breaks or one or more shattered breaks within the merchantable portion of the stem. The compilation program will down grade these trees to the highest risk group.

Definitions:

Clean break is a break in the merchantable portion of the stem which can be bucked out in a length equivalent to the diameter of the stem at the break.

Shattered break is a break more severe than a clean break.

Examples of Windshear/Snow Press:

- if < 5 years since the damage and the tree is broken or shattered in the top third *do not* code blowdown or dead/broken top,
- if ≥ 5 years since the damage and the tree is broken or shattered in the top third below utilization diameter, code dead or broken top *only*. If broken above utilization diameter do not tally blowdown or dead or broken top,
- if < 5 years since the damage and the tree is broken or shattered in the middle third, code E or F only and do not record dead or broken top,
- if ≥ 5 years since the damage and the tree is broken or shattered in the middle third, code F only and tally dead or broken top in 2nd third, and

- all breaks in the first third of the tree code E/F/G or H and do not tally a dead or broken top.

Examples of Windfall (Downtrees):

- all uprooted trees, assign the appropriate blowdown code,
- if tree is partially uprooted and supported by another standing tree assign the appropriate blowdown code, and
- if tree is partially uprooted and self-supporting do not assign a blowdown code.

A.7.4 Extremely Damaged Stands (Windthrow, Flood Damaged, Fire, Insects or Disease)

Where damage conditions are such that a stand cruise procedure becomes too costly in terms of recoverable values from the salvageable material, the Regional Manager has the following options of estimating the volume and quality of both the damaged and undamaged wood left on the area:

1. Applying an estimated damage factor (derived either by aerial or ground reconnaissance) to an earlier cruise of the area when the stand was undamaged.
2. Applying an estimated damage factor to volumes derived from the inventory map and average lines for the area.

Appendix 8 Interior Log Grade Algorithm

The Interior Log Grade Algorithm is for the ministry compilation program. Industry compilers may also include it.

A.8.1 Assumption

Pathological and quality indicators on the tree can predict grade.

A.8.2 Procedures

1. The compilation program utilizes the table below for allocation of path in thirds to the logs.

2. Conk, blind conk, frost crack, rotten branch, D & B top and spiral grain, are collected as per the manual.

3. Saprot/checks are recorded (by thirds) in the rootrot column. Record these defects as listed in the *Scaling Manual*. The overall rule is that at least 50 percent of the log must be suitable for lumber. Sound cores must be at least 10 cm top diametre. Heart checks on logs 15 cm or less can have only one check 4 cm deep or more.

4. Four or more branches over 10 cm in bottom third of tree = knot code 6 in position 50 of the cruise tally card.

The body of the table contains the log number that is affected (e.g., a code of 3 (top third) in a 6 log tree affects 5 and 6).

Path Code	Number of Logs in the Tree							
by Third	1	2	3	4	5	6	7	8
1	1	1	1	1	1	1, 2	1, 2	1, 2, 3
2	1	1	2	2, 3	2, 3, 4	3, 4	3, 4, 5	4, 5
3	1	2	3	4	5	5, 6	6, 7	6, 7, 8
4	1	1	1, 2	1, 2	1, 2, 3, 4	1, 2, 3, 4	1, 2, 3, 4	1 to 5
5	1	2	2, 3	3, 4	2, 3, 4, 5	3, 4, 5, 6	3, 4, 5, 6	4 to 8
6	1	1, 2	1, 3	1, 4	1, 5	1, 2, 5, 6	1, 2, 6, 7	1, 2, 6, 7
7	1	1, 2	1, 2, 3	1, 2, 3, 4	1 to 5	1 to 6	1 to 7	1 to 8

The compilation program applies the following flow chart:

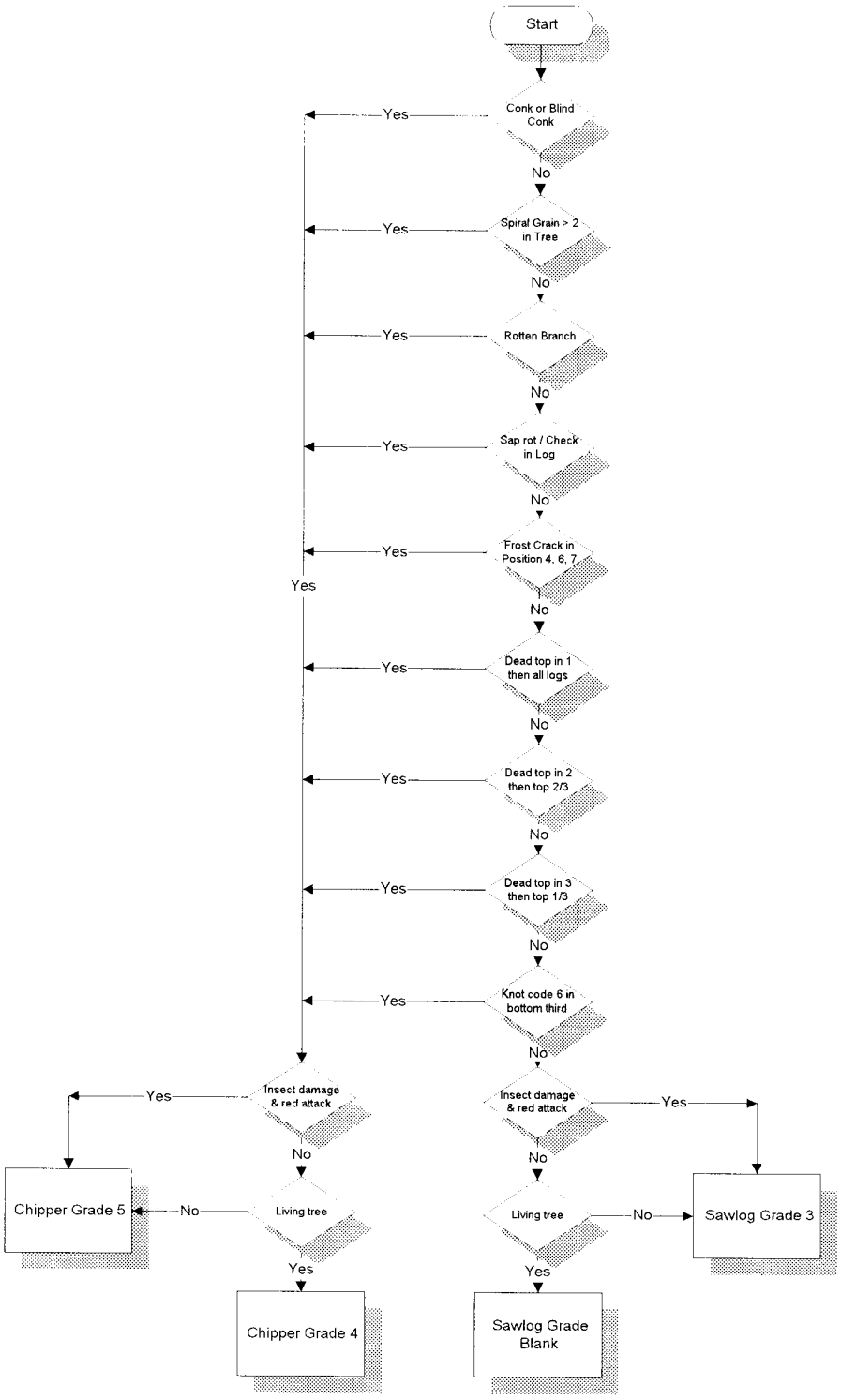


Figure A.34 This table converts the third of a tree into log number.

Appendix 9 Region and District Codes

Region	Number	District	Number
Vancouver	1	Chilliwack	01
		Squamish	03
		Sunshine Coast	05
		Duncan (South Island)	06
		Port Alberni (South Island)	07
		Campbell River	08
		Port McNeill	09
		Mid-Coast	0A
		Queen Charlotte	0B
Prince Rupert	2	Lakes	01
		Morice	02
		Bulkley (Bulkley/Cassiar)	03
		Kispiox	04
		Kalum	05
		North Coast	08
		Cassiar (Bulkley/Cassiar)	09
Kamloops	3	Clearwater	01
		Kamloops	02
		Salmon Arm	03
		Vernon	04
		Penticton	05
		Merritt	06
		Lillooet	07
Prince George	4	Prince George	01
		Robson Valley	03
		Vanderhoof	04
		Fort St. James	05
		MacKenzie	06
		Dawson	07
		Fort St. John	08
		Fort Nelson	09
Nelson	5	Cranbrook	01
		Invermere	02
		Golden (Columbia)	03
		Revelstoke (Columbia)	04
		Arrow	05
		Boundary	06
		Kootenay	07

Region	Number	District	Number
Cariboo	6	Quesnel Williams Lake Horsefly 100 Mile House Chilcotin	01 02 03 04 05

Forms

1999 Provincial Cruise Plan

BRITISH COLUMBIA

1999
PROVINCIAL CRUISE PLAN

TENURE: _____ CRUISE BASE OR SCALE BASE
C.P.: _____ _____

A ATTENTION: District Manager: _____

LICENSEE: _____ CONTACT: _____

GEOGRAPHIC LOCATION: _____

TSA: _____ PSYU: _____ FIZ: _____ INV. REG. NO.: _____ COMP'T NO.: _____

COAST: IMMATURE: _____ MATURE: _____ BOTH: _____

B CRUISING AGENCY: _____ COMPILING AGENCY: _____

ADDRESS: _____ ADDRESS: _____

C TENTATIVE CRUISE DATES: _____ To: _____

PROPOSED YEARS OF LOGGING: _____ ACCESS: _____

D HARVESTING SYSTEM: _____ SELECTIVE HARVESTING: _____
* Seglegate silv system (ie patch clearcut, seed tree, note cave opening size)

SYSTEMATIC GRID: _____ STRATIFIED SYSTEMATIC:[1] _____

[1]NOTE: If Stratified Systematic Cruising is selected Parts J and K on the Reverse Side MUST be filled out.

DAMAGE CRUISE: (indicate the type of damage (i.e. Insects, Fire, Windthrow) _____

E PLOT NO. MEASURE PLOTS: _____ COUNT PLOTS: _____ ESTIMATED C.V. _____

GRID SPACING _____ m BY _____ m NOTE: SHALL NOT EXCEED 200 x 200 M

PLOT TYPE PRISM/RELASCOP _____ FIXED AREA _____ PLOT SIZE _____ ha

HALF PLOTS yes / no

F MINIMUM DIAMETER LIMITS:

	DIAMETER LIMITS			
	COAST		INTERIOR	
	MATURE	IMMATURE	SPECIES	EXEMPTION
FIELD TALLY			cm to	cm
COMPILATION--APPRAISAL cm			cm to	cm
COMPILATION--UTILIZATION cm			cm to	cm

G MARKING

	RIBBON COLOUR	PAINT COLOUR	AXE BLAZE	OTHER (TAGS)
BOUNDARIES				
BASELINE				
STRIPS				
PLOT CENTRE				
THE POINTS				
RIPARIAN AREAS				

H TREE HEIGHTS: TOTAL HEIGHT METHOD IS MANDATORY

HEIGHT ESTIMATION METHOD (i.e. Ocular, Vertex, etc.) _____

HEIGHT MEASURING INSTRUMENT (Cino', Vertex Hypsometer, Other...) _____

I OTHER(S): _____

SIGNED: _____ By authorized Licensee Representative

_____ Timber Cruiser Accreditation # TC

DATE: _____

APPROVED: _____ REJECTED: _____ NAME: _____ DATE: _____

(District to forward copy to Region)

SECTIONS J, K, L (TO BE FILLED OUT WHEN REQUIRED)

J STRATIFIED SYSTEMATIC SAMPLING: Calulate Sampling Requirements for Each Timber Type.

				A	B	C	D	E	F	G	H
Type No.	Type Description	BEC Subzone /Variant	Plot/Prism Size	Type Area (ha)	Average m3/ha	Estimated Vol./Type (m3)	Type Vol. % of Total Vol.	Estimated Type CV	Weighted Type CV	Total Plots/C.P.	Planned Plots/Type
1										Refer to	
2										Sections	
3										2.4,2.5	
4										Provincial	
5										Cruising	
6										Manual	
7											
			Tot. Ha's		Tot. Vol.		Tot. Weighted CV				-G

EXPLANATION OF FORMULA

C = A x B	$D = \frac{C}{C1..7} \times 100$	E = Cruising Manual, Section 2.72
F - D x E	G = Cruising Manual, Section 2.6, 2.71	$H = \frac{C}{F1..7}$

K SOURCE OF CV ESTIMATES

Type 1: _____
Type 2: _____
Type 3: _____
Type 4: _____
Type 5: _____
Type 6: _____
Type 7: _____

INSTRUCTIONS:

A Enter District and Tenure information.

B Enter the Name and Address of the Cruising and Compiling Agencies.

C Enter the 'Tentative' start and completion dates of the field work.

D Check the applicable box.

E Enter the number of plots and the grid spacing.

F Enter the diameter limits measured and compiled to, and prism BAF.

G Enter the colour(s) of paint and flagging used, and the type of blazing and plot tags.

H Enter the appropriate height estimation method, and height measuring instrument used.

I Enter remarks if required. Signature and date are mandatory.

J OPTIONAL. Enter data ONLY if Stratified Systematic Sampling is used.
Type Description - include: Species / Age Class / Height Class / Site Quality

K OPTIONAL. Enter source of CV estimates.

ATTACH: CRUISE PLAN MAP: Drawn to 1:5 000 or 1:10 000 scale, topography, (streams and roads), Air Photo Numbers, strips and baselines, plot locations, boundaries, area in the (merch and total) by cut block, label the cut block (mature or immature). MUST BE SUBMITTED WITH THIS FORM.

AERIAL PHOTOGRAPH: Submit a copy with timber typing.

1999 Provincial Cruise Plan and Map Check List

1999
PROVINCIAL
CRUISE PLAN AND MAP CHECK LIST

TENURE: _____
C.P.: _____

		YES	NO	N/A
A.	**TENURE and CRUISING AGENCY INFORMATION (Cruise Design -- Parts A to C)**			
1.	Licensee's name shown?			
2.	Tenure and Cutting Permit numbers shown?			
3.	TSA, PSYU, FIZ, Region and Compartment Numbers indicated.			
4.	Cruising and Compiling Agencies indicated.			
B.	**HARVESTING and SAMPLING SYSTEM INFORMATION (Cruise Design -- Parts D to G, J and K)**			
11.	Harvesting and sampling system acceptable? (Part D)			
12.	Number of plots and plot type acceptable? (Part E)			
13.	Diameter Limits acceptable? (Part F)			
14.	Boundary marking acceptable? (Part G)			
C.	**TREE HEIGHTS AND HEIGHT METHOD (Cruise Design -- Parts H)**			
15.	Tree height measuring instrument and estimation method indicated?			
D.	**CRUISE PLAN MAP and PLOT ESTABLISHMENT INFORMATION (Cruise Plan Map)**			
16.	Tenure Information adequate? (I.e. Licence, CP, FIZ zone, UTM Grid No's, Reg. and Compt. No's...etc..)			
17.	Acceptable map scale? (1:5 000; 1:10 000; 1: 15 000, 1:20 000)			
18.	Map area statement clearly shown? (Timber type descriptions and areas indicated?)			
19.	Timber types colour coded on the cruise plan map?			
20.	Minimum of 2 plots per type?			
21.	Sufficient number of plots per type (as per type C.V.)?			
22.	Consistent plot and/or strip spacing within each type? (Maximum grid - 200 m if cruise < 250 ha/250 m if cruise ≥ 250 ha)			
23.	Plots well distributed within each type?			
24.	Prism and/or fixed area plot size consistent in each type?			
25.	Cut block boundaries and forest types clearly delineated on map?			
26.	Baseline established and tied to a well defined geographical feature or a legal survey mark if possible.			
27.	P.O.C. established?			
28.	Strips tied to cutblock boundaries?			
29.	Plots and strips clearly marked?			

Note: There may be some exceptions to the above criteria. If in doubt check Chapters 2 and 3 of the Provincial Cruising Manual, or contact the Regional Cruising Coordinator.

Remarks: _____

Accepted:	**Rejected:**	**Date:**
Action:		
Signature:		
Approval/rejection letter sent by:		**Date:**

1999 Provincial Office Check of Field Cruise Data

1999
PROVINCIAL
OFFICE CHECK OF FIELD CRUISE DATA

TENURE: _____
C.P.: _____

A. CRUISE PLAN and FINAL CRUISE MAP	YES	NO	N/A
1. Is Cruise Plan approved?			
2. Was the Cruise Plan followed?			
3. Is the **FINAL** Cruise Map acceptable			

B. PLOT CARDS	YES	NO	N/A
4. Are all of the plot cards submitted?			
5. Is each plot card properly filled out?			
6. Is each plot card **SIGNED** and **DATED**? (Prov. Cruising Manual,Sect. 3.11)			
7. Is the prism (or fixed area plot) size consistent within each timber type?			
8. Do the plot locations by type, strip and cutblock concur with the final cruise map?			
9. If count plots are used, indicate the count/measure ratio	COUNT	MEASURE	

C. MERCHANTABLE STEM COUNT:

PRISM CRUISES (Prov. Cruising Manual,Sect. 2.11)
1. Clearcut logging. Minimum average of **4** merchantable trees per plot if SE 15% not achieved.
2. Partial cut logging. Minimum average of **6** merchantable trees per plot if SE 15% not achieved.

FIXED AREA CRUISES
1. Clearcut logging. **"Recommended"** average tree count is **not less than 10**.
2. Partial cut logging. **"Recommended"** average tree count is **not less than 15**.

	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6	Type 7	TOTAL
10. Total Number of Plots								
11. Average Number of stems per plot.								
12. No. Plots with < than the recommended average stem no.								
13. Average No. of Stems per point per type acceptable? **(Y/N)**								

D. HEIGHTS	YES	NO	N/A
14. Are the height calculations done correctly?			
15. Are sufficient samples taken for each major (≥20%) species?			
16. Have 100% of the heights been taken for all minor species (<20%)?			

E. AGES	YES	NO	N/A
17. Are adequate age samples collected?			
18. Are age/height corrections done properly?			
19. **Are the maturity classes correct?**			

Remarks: _____

Accepted:	**Rejected:**	**Date:**
Action:		
Signature:		
Approval/rejection letter sent by:		**Date:**

1999 Provincial Field Check Cruise Summary

1999
PROVINCIAL
FIELD CHECK CRUISE SUMMARY

TENURE: _____
C.P.: _____

IS CHECK CRUISE REQUIRED? _____ (Note: **If no**, inform licensee.)

Cruised by: _____ **Cruise Date:** _____ **# plots:** _____

Checked by: _____ **Check Date:** _____ **# plots:** _____

A. PLOT ESTABLISHMENT & DISTANCE MEASUREMENT:	ACCEPTABLE (Y/N)	MANUAL REFERENCE
1. Distance AND Bearings between plots		(Sec. 3.6.2.1, 8)
2. Plot establishment		(Sec. 3.6.2.1, 8)
3. Sample trees marked		(Sec. 3.5.3.3, 3.6.5)
4. Age samples representative of stand		(Sec. 3.5.9, 3.6.2.1, 6)
5. Boundaries checked: (*Indicate Yes, No or NOT Checked*)		(Sec. 3.6.2.1, 8)
B. SPECIES IDENTIFICATION		**(Sec. 3.6.2.1, 2)**
6. % of Stems incorrectly identified:		
C. NUMBER OF STEMS:		**(Sec. 3.6.2.1, 1)**
7. FIXED AREA PLOTS		
i. % of Plots where stem count difference is > **1 STEM IN 50**		(Sec. 3.6.2.1, 1)
ii. % Average variation of all stems counted		(Sec. 3.6.2.1, 1)
8. PRISM PLOTS		
i. Variation of all stems counted		(Sec. 3.6.2.1)
D. BREAST HEIGHT:		**(Sec. 3.6.2.1, 7)**
9. Total Number of Stems Checked:		
10. Number of Stems > **5% HIGH or < 5% LOW**		
11. Average Error of All Samples:		
E. DIAMETERS:		**(Sec. 3.6.2.1, 7)**
12. Number of Diameters Checked		
13. % of Diameters in Error by > **± 2%:**		(Sec. 3.6.2.1, 7, a)
14. Average Absolute Error of All Samples:		(Sec. 3.6.2.1, 7, b)
F. PATHOLOGICAL INDICATORS/DAMAGE CODES:		**(Sec. 3.6.2.1, 4)**
15. Number of Plots with > **1 Risk Group Change**		(Sec. 3.6.2.1, 4, a)
16. % Risk Group changes --- all trees.		(Sec. 3.6.2.1, 4, b)
17. % trees checked with incorrect fire/blowdown code		
G. HEIGHT SAMPLES:		**(Sec. 3.6.2.1, 3)**
17. Height samples representative of stand		(Sec. 3.6.2.1, 3)
18. **100% HEIGHT METHOD**		(Sec. 3.6.2.1, 3)
i. # of heights checked		(Sec. 3.6.2.1, 3)
ii. % Average absolute variation of all heights checked (*Measured & Estimated*)		(Sec. 3.6.2.1, 3)
H. AGES:		**(Sec. 3.6.2.1, 6)**
19. 95% of ALL trees in correct maturity class for loss factor deductions		
I. QUALITY (Coast Immature Only)		
20. i. % trees with path incorrectly coded in 1st and 2nd third		(Sec. 3.6.2, 1)
ii. % of quality indicators ± 1 code change		(Sec. 3.6.2.2, 2, a)
iii. Spiral grain – code > 4 does not require checking		(Sec. 3.6.2.2, 2, a)
iv. Knots and knot indicators - # of 5 m log quarters > 2 quarters difference		(Sec. 3.6.2.2, 2, a)
J. IS THERE ANY BIAS OBSERVED IN THIS CRUISE?		**(Sec. 3.6)**

Accepted:	Rejected:	Date:
Action:		
Signature:		
Approval/rejection letter sent by:		Date:

NOTE: ANY UNACCEPTABLE FINDINGS MAY BE GROUNDS FOR REJECTION.

1999 Provincial Compilation Check Form

1999
PROVINCIAL
COMPILATION CHECK FORM

TENURE: _____
C.P.: _____

A. CRUISE/TENURE INFORMATION			
1. Cruise Type [Scale Base, Cruise Base]			
2. Cruise System [Prism or Fixed Area Plots or Mixed (both)]			
3. Partial Cut or Clearcut (Section 2.11 of the Cruising Manual)			
4. a) Forest Inventory Region Number			
b) Forest Inventory Compartment Number			
c) Forest Inventory Zone (FIZ)			
B. MAP AREA STATEMENT	**YES**	**NO**	
5. Net Merchantable Area			ha
6. a) Does the map merchantable area agrees with compilation?			
b) Does the number and area of the Cutblocks on the map agrees with the compilation?			
c) Does the number and area of the Timber Types on map agrees with compilation?			
C. FIR LRF'S	**YES**	**NO**	**N/A**
7. a) Type of Compilation..... WET or DRY Belt Fir (See Chapter 7, position 14 of Cruising Manual)			
b) Proper Fir LRF's used?			
c) Does the compilation type agree with the PHSP?			
D. PLOT SUMMARIES AND LOSS FACTORS	**YES**	**NO**	
9. Is there more than one plot size per type?			
10. Have the correct Forest Inventory Loss Factors been used for each species?			
E. SPECIAL COMPILATIONS *(Complete as required)*	**YES**	**NO**	
11. DAMAGE CODING All Damage compiled (See 015B - All Harvesting Method Summary Report)			
12. FALLER'S SELECTION			
a) First compilation submitted (NO REDUCTIONS).?			
b) Has licensee's proposed treatment been approved?			
c) Second compilation submitted with reduction data as approved.			
F. SAMPLE ERROR ACHIEVEMENT	**YES**	**NO**	**N/A**
13. HAS THE PROPER S.E.% BEEN ACHIEVED?(See Sections 2.11 - 2.12 of the Cruising Manual)			
G. APPRAISAL DATA SHEET --- CRUISE DATA	**YES**	**NO**	
14. Is the cruise data entered on the Appraisal Data Sheet the same as the compilation? (IF NOT, EXPLAIN !)			

REMARKS :

Accepted:	Rejected:	Date:
Action:		
Signature:		
Approval/rejection letter sent by:		Date:

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Glossary

Accuracy	The nearness of a measurement to the actual value of the variable being measured.
AAC (Allowable Annual Cut)	The rate of harvest determined by the Chief Forester for Timber Supply Areas (TSA's) and Tree Farm Licences (TFL's), and by the District Manager for Woodlot Licences (WL's), and the rate of harvest specified for a licence or in a management plan.
Absolute Variation	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).
BAF (Basal Area Factor)	Basal Area Factor or "BAF". Prisms come in a wide variety of sizes. They are classified by "diopter" size. The size denotes the basal area per hectare that each "in" tree represents (i.e., an 8 prism which tallies 7 trees in a plot would give a basal area (in timber) of 56 m^2/hectare).
Bias	Measurement bias occurs when the mean of the measured values differs from the mean of the actual values. Sampling bias occurs when certain sampling units are more likely to be included than others (lack of randomness). Statistical bias occurs when the expected value of the statistic differs from the population parameter.
Boring-Height	The boring-height is the distance from the ground (high-side) up the tree to where an age is taken with an increment-borer. It is always taken at dbh (1.3 m) above high-side.
Breakage	Breakage is defined as any piece broken at both ends and shorter than 3 m which results from normal falling or yarding/forwarding operations.

Breast-Height	The location on a tree where its diameter (dbh) is taken. It is located exactly 1.3 m above "high-side."
Catastrophic Losses	Damage to timber from fire, windfall, insects or disease that inflicts losses well above the norm reflected in the forest inventory for the locality or region.
Cardinal	North, South, East and West.
Closure Error	In a closed traverse, the closure error is the distance between the start and end of the traverse, divided by the length of the traverse, and is usually expressed in percent. It can also be calculated by taking the square root of the sum of the squared sum of latitudes plus the squared sum of departures. A closure error of 1 percent will result in an area error of approximately 2 percent.
Coast	The Coast is defined as that geographic area included within the Vancouver Forest Region, as established by the Forest Act and Regulations, and that part of the Prince Rupert Forest Region west of the Cascade Mountains Administrative Line from Tweedsmuir Park to the State of Alaska. There is one exception to the above delineation, where timber in that portion of the Kalum Forest District, lying west of the Cascade Mountains Administrative Line is appraised using the Interior Appraisal Manual.
Coefficient of Variation (CV)	A relative measure of variation, equal to the sample standard deviation expressed as a percentage of the sample mean.
Confidence	An expression of accuracy of sample estimates, usually assessed by confidence intervals, a specified proportion of which, such as 95 percent confidence intervals, contain the true population parameters.
Count-Plot	A prism plot where only the number of "in" trees by species is noted. No individual tree measurements are taken. Enhanced count-plots have some measurements taken as required (i.e., diameters or heights).
Crown-Class	Trees are classified into four crown classes. They are dominant, co-dominant, intermediate and overtopped (see Section 3.5.3.2).
Cut Block	A discrete area covered by a form of licence and logged according to an approved harvesting plan.

Cutting Authority	The authority to harvest Crown timber, as provided by the Forest Act. (Cutting Authority means a Timber Sale Licence, a Licence to Cut, a Road Permit, or a cutting permit issued under a Tree Farm Licence, Forest Licence, Timber Licence or a Woodlot Licence.)
Cutting Specifications	The timber cutting specifications contained in the Minimum Utilization Standards of the cutting authority.
DBH (Diameter Breast Height)	The outside-bark diameter of a tree taken at breast-height (1.3 m above the high side of the ground).
DIB (Diameter Inside Bark)	The inside-bark diameter of a tree. It can be anywhere along the stem of the tree from the base to the top.
Diopter	One way 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: $baf = 10{,}000 / \left[1 + \left(\frac{200}{diopters}\right)^2\right]$.
Double-Sampling	This sampling method incorporates a second sampling procedure where only some of the characteristics of the main sampling method are noted. An example is measure and count-plots established on a cut-block. The major reason for using this method is the savings in time and therefore money because the count-plots take much less time to put in.
Endemic Losses	Damage to timber from normal populations of insects or disease that inflicts average losses over the long term for the locality or region. The forest inventory provides net merchantable volumes which reflect "endemic" (average or normal) losses.
Enhanced Count Plot	A count plot where some individual tree species measurements or specific tree attributes are measured to improve the estimate for the species or specific attributes.
Fixed-Area Plot Sampling	A sampling method where a fixed amount of area is sampled in each plot within a stratum. All trees above minimum utilization are tallied regardless of their distance from plot center. All plots within a stratum must be the same size and shape.

GPS (Global Positioning System)	A method of accurately determining or relocating a ground position using the signal from several satellites simultaneously. A small portable computer evaluates the time for each signal to reach it and then computes a three dimensional location.
High-Side	The position where the ground meets the tree on the (uphill side – side of the stump adjacent to highest ground), ignoring any root flare, obstacles, vegetation, and loose matter that has accumulated at the base of the tree.
Interior	The Interior is defined as the entire province of British Columbia, with the exception of the Vancouver Forest Region, as established by the *Forest Act* and *Regulations*, and that part of the Prince Rupert Forest Region west of the Cascade Mountains Administrative Line from Tweedsmuir Park to the State of Alaska. There is one exception to the above delineation, where timber in that portion of the Kalum Forest District, lying west of the Cascade Mountains Administrative Line is appraised using the *Interior Appraisal Manual*.
Licensee	The holder of the cutting authority.
Log Grade	Those log grades that are defined in the *Scaling Regul*ation.
Major Species	Comprises 20 percent or more of total gross volume in a timber type, cut-block or cutting permit.
Minor Species	Comprises less than 20 percent of the total gross volume in a timber type, cut-block or cutting permit.
Mean (Mode & Median)	The "mean" of a set of measurements is the sum of all measurement values divided by the number of measurements. The "mode" of a set of measurements is the value which occurs most often or with the greatest frequency. The "median" of a set of measurements arranged in an increasing order of magnitude is the middle value (or arithmetic mean of the two middle values).

Mean Absolute Variation	The arithmetic mean of a set of absolute variations.
Variation:	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).
Mean Absolute Variation:	The arithmetic mean of a set of absolute variations.
Minimum Utilization Standards	The standards of timber cutting and log utilization specified in the cutting authority.
100% Cruise	A cruise in which every tree is measured. There are no samples or estimates.
Partial Cutting	A variety of silviculture systems in which a stand may be cut to ensure regeneration. In a Partial Cutting system, only some of the trees are felled during the harvesting phase. The selection method may specify "removal" or "leave" trees. Some examples of selection criteria are diameter, species, volume, age, height, disease or other damage.
Percent Reduction	In reference to partial cutting, this refers to a specified percent reduction of the total cruise volume which is targeted to be left or to be cut and removed.
PRF (Plot Radius Factor)	In prism cruising, each tree has its own plot radius. This is a function of tree diameter (dbh) and prism baf size. The plot radius factor (prf) times the dbh gives the appropriate plot radius for any tree. The prf formula is: $prf = 0.5 / \sqrt{baf}$
Plot Sampling	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	The closeness, to each other, of repeated measures of the same quantity, expressed as Sampling Error or Standard Error of the sample estimate.

Recompilation	A second or subsequent cruise compilation with some plots added or deleted, or both.
Residual	Living trees with none of the eight pathological indicators.
Risk-Group	As the name implies, this is simply a grouping by expected "risk" or probability of average decay, waste and breakage, for volume deduction by individual tree. These take the form of from one to three "risk-groups" which are individually specified for each tree species by age and location (Forest Inventory Zone) in the Province. Each risk-group (by species and location) keys to a loss factor table with volume deductions for decay, waste, and breakage. The pathological indicators place each tree into a tree-class. Various tree-classes are grouped together into one of three risk groups which in turn determine the severity of the deductions for volume.
Sampling Error (S.E.)	The expressing of the accuracy of the sampling of the cruise. It is calculated as a percent of an estimated mean to a desired probability.
Site-Class	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.
SD (Standard Deviation)	The Standard Deviation is 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. On the average, about two-thirds of the unit values of a normal population will be within one standard deviation of the mean. About 95 percent will be within two standard deviations and about 99 percent within 2.6 standard deviations.

Stratum	A specified portion of a subpopulation area for which separate volumes and sampling statistics are calculated. A subpopulation may be made up of one or many strata.
Stratification	The process of delineating strata boundaries within a subpopulation, where each stratum has unique characteristics such as species composition, height, stand volume or age.
Strip-Line	A ribboned line running through the forest and tied to a base-line and/or boundary at one or both ends. Cruise plots are located at regular intervals along each strip.
Stumpage	Stumpage is the price that is paid to the provincial government for the right to harvest timber from Crown land. The amount of stumpage that is charged for the timber depends upon the appraised value of the stand and, in some cases, a price bid above this value.
Suspect	A living tree with one or more pathological indicators.
Tie-Point	An important point from which a boundary, base-line or cruise strip is "tied" into (e.g., legal lot corner (I.P.); creek and road junction (mapped)).
Timber Supply Area	Large contiguous areas of Crown land on which an annual allowable cut is calculated.
Top-Height	The mean height of the 100 trees per hectare of largest diameter.
Tree-Class	A series of classes (nine) primarily used for age/maturity and live/dead classification. This classification puts each tree into the appropriate risk-group for volume deduction.
True	Refers to height, diameter, number, sum, plot volume, LRF, or other variable. The "true" value is determined by the Forest Service.

Variance	The mean of squared deviations of observations about a sample mean. (These deviations or differences from the mean are called residuals).
Waste	In the timber cruising compilation programme, decay, waste and breakage are deducted from the gross tree volume. The waste component is the firmwood volume associated with 5 m logs in a tree which contain less than 50 percent of their gross scale in firmwood volume. These logs are assumed to be left on the cut-block and so their remaining firmwood volume is then classified as waste.

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