BRITISH COLUMBIA

Ministry of Forests Timber Pricing Branch

MEMORANDUM

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August 1, 2024

BY EMAIL

To: Regional Executive Directors

From: Allan W. Bennett
Director
Timber Pricing Branch

Re: Amendment No. 2 to the *Cruising Manual*

I hereby approve Amendment No. 2 to the *Cruising Manual*.

The manual can be found here: *Timber Cruising Manual*

The purpose of this amendment is to update the *Cruising Manual*, which provides:

- Removal of MPB cruise based requirements.
- Removal of forest cover map aging procedures for lodgepole pine.
- Addition of Check Cruise Submission Form requirements.
- Removal of contiguous timber typing requirements and clarification of timber typing and minimum sampling intensity procedures.
- Addition of quality assurance guidelines for sample point integrity test (SPIT) plots.
- Updated check cruise dispute mechanism.
- Updates and improved clarity of various roles, standards, and procedures.

Amendment No. 2 comes into effect on August 1, 2024.

Allan W. Bennett, RPF
Director
Timber Pricing Branch

pc: Melissa Sanderson, Assistant Deputy Minister, Timber, Range and Economics Division
Patrick Asante, Manager, Timber Pricing
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TIMBER PRICING BRANCH

Cruising Manual

Effective: July 1, 2020

Includes Amendments	Effective Date
Amendment No. 2	August 1, 2024
Amendment No. 1	July 1, 2021

Highlights

Section	Description
Throughout manual	Removed reference to mountain pine beetle cruise based cutting authorities.
1.1 and throughout manual	Updated references to Area Director.
Throughout manual	References to ABCFP were updated to FPBC.
Throughout manual	Removed references to staggered cruise grids.
2.2	Removal of contiguous timber typing requirements. Updated requirements for deletion of polygons when timber types span multiple polygons.
2.3	Added clarity on process to achieve minimum number of plots in the field when measure plots are dropped.
2.3.5 (3)	Add clarity on written rationale requirement.
2.4.2.2	Added clarity that only measure plots are required to be moved in order to meet sampling intensity requirements.
2.5.2	Updated approval authority from Regional Executive Director to Area Director. Clarified unsafe to cruise processes.
2.8	Removed ‘contiguous’ from timber typing requirements.
Table 3-1	Removal of stubbed tree mapping requirements.
3.3	Updated audit targets are to be based on the submission.
3.3.1	New section: Check Cruise Submission Form
3.5	Added Sample Point Integrity Test plot procedures and standards.
3.7	Update check cruise dispute mechanism.
3.8	Added Check Cruise Submission Form to submission requirements and clarity on submission requirements for cruise tally sheets.
4.3.1.15	Removal of stubbed tree sampling procedures, clarity on walkthrough process, clarity on boundary ribboning procedures. Updated process for meeting minimum tree count requirements.

4.3.2.6	Removal of process to use forest cover maps to determine lodgepole pine tree ages. All insect attacked trees with less than 5% red needles classified as dead. Clarify process for determining ages of dead trees.
5.2.4	Updated list of dry belt and wet belt BEC zones and subzones.
7.6.1.1	Updated description for percentage of coloured needles required for each beetle damage code.
7.6.3	Added verbiage regarding blowdown codes for beaver felled trees.
7.16	Updated hyperlink to determine declination.
7.17.2.2	Clarity on saprophytic fungi survey procedures.
7.17.2.4	Added clarity on scars caused by sloughing bark.
Appendix 7.7	Changed wording in saprot table calculations to use DIB at the same location where saprot is being measured.

1.1. Definitions

In this manual:

"**100% Cruise**" means a cruise in which every tree is measured.

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

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

"**Area Director**" means the Area Director of Pricing and Tenures for the North or South Areas, the Area Director of Pricing, Tenures and Administration for the Coast Area, and/or their delegates;

"BAF (Basal Area Factor)" means the basal area (m^2) per hectare that each "in" tree represents when using a prism or relaskop. Prisms are sometimes classified as "diopter" size or inscribed with the BAF number. The size denotes the basal area factor (i.e., an 8 BAF prism which tallies 7 trees in a plot would give a basal area (in timber) of 56 m^2/hectare);

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

"**BCTS**" means BC Timber Sales;

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

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

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

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

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

"**CGNF**" or "**Call Grade Net Factor**" means the survey methodology used by timber cruisers to estimate decay, waste and grade for individual logs in a tree.

"Check Cruiser" means a person authorized by the Ministry to assess the veracity of timber cruising data.

"CEP" means Circular Error Probability, a measure of precision, defined as the radius of a circle,

centered around the mean, which is expected to include 50% of the results.

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

"**Coast**" or **"Coast Area"** means the area subject to the *Coast Appraisal Manual*;

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

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

"Correct" is used in this manual in the context of an audit (or check cruise). In this context, correct means the value determined by a check cruiser. This definition recognizes that cruisers and check cruisers are fallible. This underscores the importance respectful communication, extending the benefit of the doubt where there is valid doubt, and dispute mechanisms as a last resort.

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

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

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

"**Cutblock**" for Interior cruises is as defined as a '*logical unit*' in the *Interior Appraisal Manual*. A coast definition may be provided in a future Coast Appraisal Manual amendment.

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

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

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

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

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

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

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

2.2. Cruise Plans

Cruise plans are professional documents and must be:

1. prepared by a qualified registered or associate member (RPF, RFT, ATE) of Forest Professionals British Columbia, or

2. supervised by a registered member (RPF, RFT) of Forest Professionals British Columbia.

It is mandatory for licensees and Timber Sale Managers to submit plans to the District Manager prior to the commencement of a timber cruise. In areas where district staff do not check cruise BCTS, the Timber Sale Manager must maintain the cruise plans on file.

Cruise plans must be submitted to Ministry staff to allow for the development of field quality assurance schedules and to provide a basis for comparison against the final cruise submission.

Cruise plans must contain the items specified in:

- Section 3.2.1, and
- Forms section - Figure 7.6 FS 693 - Provincial Cruise Plan (Page 1 of 2).

For an example of a cruise plan map, please see the following link:

Sample_Cruise_Plan_Map.pdf

All forest and non-forest type areas must be identified on the cruise plan prior to field sampling. A non- forest type, as identified on the cruise plan map, is not sampled for appraisal (i.e., rock bluff, swamp, constructed linear tenure, creek, riparian reserve area, slide track and gravel pit). (See Section 2.8)

Timber type polygons must be unique to each cutblock. If forest types are not identified on the cruise plan each cutblock must be compiled as a single forest type.

Timber types that are 1.0 hectare or larger must contain at least 2 full measure plots and timber types that are less than 1.0 hectare must contain at least 1 full measure plot. See Section 2.4.2 for additional information on locating the minimum number of plots.

Each cutblock will be administered as being in the district that contains fifty percent or more of the net merchantable cruise area.

The cruise plan is a professional document and forms the basis for the statistical sample. It must identify the population to be sampled and the design that will be used to meet the minimum cruise standards. The cruise plan is the key document that provides assurances to the Ministry that the data supplied to the appraisal was collected in an unbiased manner.

Changes to a cruise plan must be rare and minor in nature and must only be undertaken to affect unforeseen issues that affect good forest management or other minor operational issues.

An entire timber type may be added or removed without requiring a rationale. However, any

modifications that involve altering portions (e.g. adding or deleting of areas) of a cutblock polygon must be supported by a rationale.

This practice allows some flexibility in cutting authority composition, while maintaining the sampling integrity of pre-established timber types.

The submitting forest professional recognizes that changes to a plan, such as a change in area or the removal of a plot(s) is biased and must have assessed the impact of the alterations against the principles of sampling identified in this manual. The submitting forest professional must submit a record of all relevant information that was used to develop the original cruise plan and final cruise map, including a written rationale where changes have been made. This model is consistent with the direction of professional reliance.

For guidance on how to prepare a professional rationale, please refer to the document "Professional Quality Rationales" published by the FPBC and available at:

Professional Quality Rationales

The District Manager will review each proposed change on a case-by-case basis and determine if the change meets the intent of providing good forest management or addressing unforeseen minor operational issues.

A spreadsheet that can be used to assist in cruise design can be accessed at the following website:

Cruising Calculations

2.3. Sampling Error Objectives

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

Where minimum sampling intensities are specified, higher intensity sampling intensities and tree count are encouraged. When sampling error requirements were not achieved and additional plots are added later, a combination of superimposed grids with equivalent sampling intensity will be accepted. Count plots in addition to minimum full measure plot requirements are acceptable. Any additional plots must be submitted to the District Manager in a revised cruise plan prior to commencement of fieldwork.

The following standards apply to both clearcut and partial cutting systems:

- For cutting authorities ≥ 250 ha (net merchantable area), the largest grid to be used in each type between full measure plots is a 250 metre square (6.25 ha per full measure plot).
- For cutting authorities < 250 ha (net merchantable area), the largest grid to be used in each type between full measure plots is a 200 metre square (4.0 ha per full measure plot).
- For coastal and interior cruises, a ratio of three (3.0) count plots to one (1.0) full measure plot cannot be exceeded on the cruise plan even if sampling error is achieved.
- For cruises where cruise grades will be used in the appraisal, the minimum tree count must be met even if the sampling error requirement has been achieved.
- For coastal cruises where cruise grades will not be used in the appraisal and for all interior cruises, there is no required minimum number of trees per plot when the sampling error requirement is achieved.
- The minimum tree count requirements include tree classes 1, 2, 3, 5, 7, 8, and 9 (not tree classes 4 or 6).

Do not change count plots to measure plots in the field where measure plots are dropped due to landing outside the boundary in the field. The correct measure to count ratio must be identified on the cruise plan and the minimum number of measure plots per type must be achieved (see Section 2.4.2). If the required minimum number of measure plots is not achieved in the field, as plots are dropped due to landing outside the boundary, moving the measure plot(s) as per section 2.4.2.2 is required.

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

Situation			Applicable section that details cruising standards
Road Right of Way			2.3.6
Coastal Cutting Authority	Great Bear Rainforest North (excl. that part of TFL 25 within the Coast Mtn. and North Isl. Central Coast Forest Districts, and Forest Licences A91438 and A94535)	Cruise Based Cutting Authority	2.3.5
		Cruise Based Road Permit	2.3.6 (1), 2.3.6(2)
		Road Right of Way appraised with adjacent cutblocks	2.3.6(3)
	Non-Great Bear Rainforest North	Cruise Based Cutting Authority	2.3.4
		Scale Based Cutting Authority	2.3.1
		Road Right of Way appraised with adjacent cutblocks	2.3.6(3)
Interior Cutting Authority	Cruise Based		2.3.2
	Scale Based		2.3.1

2.3.1. Scale Based Cutting Authorities

1. Unless otherwise stated, the scale-based cutting authority sampling error objective is ≤15.0% at 2 SE based on the total stand net merchantable volume prior to any percent reductions.
2. Single Stem – the options are:
    a. 100% cruise of the cut trees,
    b. Achieve ≤15.0% sampling error on the cut trees at 2 SE using variable radius plots, or
    c. Sample using at least 2 variable radius measure plots/ha and at least 2.0 cut trees/plot.

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

1. A systematic square grid of equal intervals and spacing of 100 metre by 100 metre, or less, has been established in each timber type.
2. For cutting authorities:
    a. of 20.0 ha net merchantable area or larger in size, a maximum ratio of 1.0 count plot to 1.0 full measure plot has not been exceeded, or
    b. of less than 20.0 ha net merchantable area in size, only full measure plots are used. (Count plots are acceptable in addition to the required intensity of full measure plots. E.g. A 70 metre by 70 metre grid with alternating full measure and count plots is acceptable.) And
3. An average of at least 4.0 trees per plot per cutblock has been met. If the minimum tree count cannot be achieved with a BAF 2 prism, then the minimum tree count requirement will be waived.

2.3.2. Cruise Based Cutting Authorities – Interior

The following minimum sampling error objectives apply to all cruise based cutting authorities within the Interior as described in the Interior Appraisal Manual:

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

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

2.3.3. Cruise Based Cutting Authorities – Coast

The following minimum sampling error objectives apply to all cruise based cutting authorities within the Coast area (except road right of way timber to be transported under road timbermark) as described in the Coast Appraisal Manual:

Cutting authorities must:

i. An average of at least 4.0 trees per plot per cutblock has been achieved, and

ii. Full measure variable plots have been established along the road centre line using a grid spacing that will achieve a minimum of 2.0 full measure plots per hectare. Timber types less than 1.0 hectare must contain 2 full measure plots. The first plot is to be located at half the calculated grid spacing along the first tributary road that accesses the cutlbock.

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

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

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

merchantable area.

Plots cannot be moved within a timber type polygon, except as required in Section 2.4.2 to achieve the minimum number of plots in a timber type polygon.

The grid must be square and of equal interval (rectangular grids are not permitted), the grid spacing selected must be consistent within a timber type.

A "Checkerboard" or equivalent consistent pattern of alternating full measure and count plots will be considered to meet the 1:1 ratio requirements described in Sections 2.3.1, 2.3.3, 2.3.4 and 2.3.5. This is acceptable despite irregular cutblock shapes that may hinder the mathematical achievement of the intended ratio.

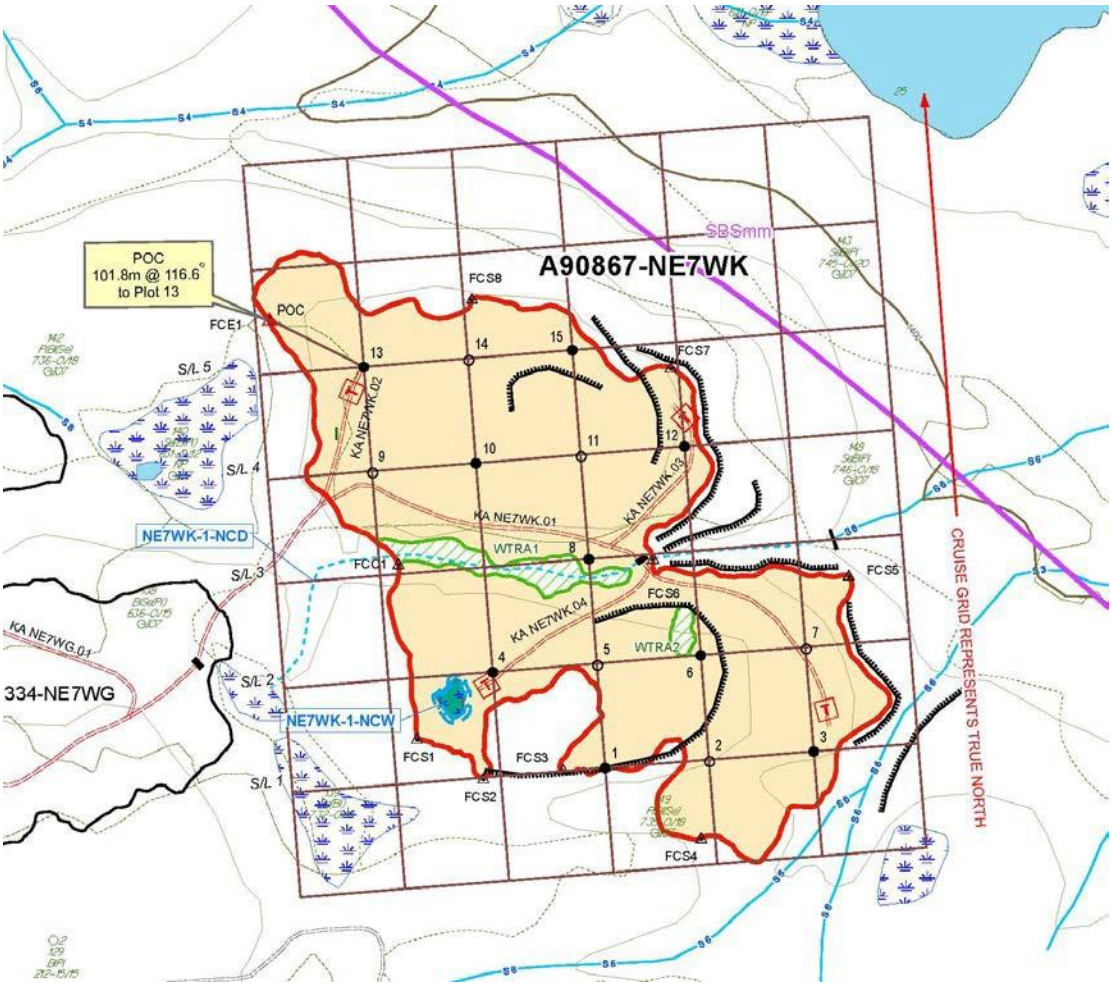

Figure 2-1 Example of Local Grid Design

*** Please note** – This example in Figure 2-1 of a local grid is oriented to true north instead of map north. For a detailed explanation of the difference in these terms, please see True North, Magnetic North and Grid North in the Appendices. Some Districts may prefer for cruise maps to be submitted with grids oriented to grid north – please refer to District or Area contacts for further information.

2.4.2. Standards for the Location of Additional Plots to Meet Section 2.2 Requirements

The following sections describe the situations and procedures to establish additional plots where the grid design does not meet the minimum one or two full measure plot per timber type polygon standard specified in Section 2.2.

2.4.2.1. Office Cruise Plan Procedure

When creating the cruise plan map, reduce the grid interval (using the same grid system) within the desired timber type by increments of 10 metres until the largest grid spacing meets the minimum plot establishment standards is achieved. The grid must be reduced from the point where the grid originates (See Section 2.4.1), but only for the type in which additional plots are needed, not for the entire cutblock or cruise.

2.4.2.2. Field Procedure

In the event that in the field, measure plots fall outside the timber type polygon, then use the procedure in the following table to establish the measure plot(s) inside the timber type polygon:

Sequence	Location	Sequence	Location	Sequence	Location	Sequence	Location
1	1/2 Grid North	2	1/2 Grid East	3	1/2 Grid South	4	1/2 Grid West
5	1/4 Grid North	6	1/4 Grid East	7	1/4 Grid South	8	1/4 Grid West
9	1/8 Grid North	10	1/8 Grid East	11	1/8 Grid South	12	1/8 Grid West
13	1/16 Grid North	14	1/16 Grid East	15	1/16 Grid South	16	1/16 Grid West

The procedure must be applied from the planned measure plot locations that fell outside the timber type polygon in the field. This procedure is used to obtain the required number of measure plots in the timber type polygon. If the plot cannot be established inside the timber type polygon using this procedure, attempt to establish the plot using this procedure with NE, NW, SE or SW bearings.

2.4.3. Standards for the Location of Additional Plots to Meet Sampling Error

Where plots must be added to an existing cruise plan to meet the sampling error requirement, they must be added in a systematic random manner. It is recommended to target the timber type (s) with the greatest variability. Determine the number of plots required using the coefficient of variation statistic for the timber types from the compilation (See Coefficient of Variation in the Appendices).

Where the added plots result in an overall sampling intensity equivalent to a 100m by 100m grid, or a 70m by 70m grid, it will be considered equivalent to that grid spacing. Smaller grids may be used in a sample design at the discretion of the person preparing the cruise plan.

2.5. Other Timber Cruising Conditions

This section describes the timber cruising procedures that are required for situations where timber must be re-cruised, where it is unsafe to cruise, where patch cuts are used and where there is a combination of different land classifications or tenures.

2.5.1. Standards for Re-cruising

Re-cruising is required:

1. If the cruise is of mature timber and 10 years has elapsed since the fieldwork was performed.
2. If the cruise is of immature timber and 5 years has elapsed since the fieldwork was performed.
3. If requested by a statutory decision maker as required in the *Coast* or *Interior Appraisal Manuals*.
4. As required by a check cruise (Chapter 3 Quality Assurance).
5. As determined by the Area Director.

In order to determine the maturity of timber for the purposes of this section, the following procedure will be used:

> Review the Net Immature % of the Block Summary report from the post-reduction compilation. If the Net Immature is >50.0 %, the timber is immature. If the Net Immature is ≤50.0 %, the timber is mature.

2.5.2. Unsafe to Cruise

Where individual plot or tree data are unsafe to cruise the cruiser can estimate the attributes, provided the estimates are signed off by a registered or associate member of the FPBC.

If an individual plot cannot be completed safely, it will be dropped and the reason documented.

If multiple cruise plots cannot be completed safely, all plots that can be cruised must be completed and the methodology of determining the cruise volume and value of the uncruised plots will be determined by the Area Director.

Where it is unsafe for cruisers to sample an entire cutblock, or timber type, the methodology of determining cruise volume and value is subject to approval by the Area Director.

As appropriate, the damage codes and slope will be determined by a procedure approved by the Area Director.

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

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

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

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

2.6. Types of Cruises

2.6.1. One Hundred Percent Cruise

A 100% cruise requires that all trees to be harvested are measured and recorded as per Section 4.3 and Section 5.2.12 of this manual. Each tree in a 100% cruise cutting authority must be physically numbered and marked as a cut tree.

2.6.2. Fixed Area Plot Sampling (See Section 4.3.1.13)

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

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

For additional information on fixed area plots and calculating sample size, please see Appendix 1 on Additional Sampling Information.

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

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

For additional information on variable plot sampling, calculating sample size, and calculating coefficient of variation (CV) please see Appendix 1 on Additional Sampling Information.

2.7. Double Sampling (See Section 4.3.1.10)

Double sampling consists of sampling certain characteristics within a sample instead of measuring those characteristics throughout the sample. Double sampling can improve the volume estimate by species.

Double sampling requires the use of two types of variable cruise plots, the measure plot and the count plot. Fixed radius plots are not used in this form of double sampling.

2.7.1. Measure Plots

The measure plots are conventional samples in which all variables for each tree are measured.

2.7.2. Count Plots

Count plots are samples where only the tree species and plot slope are tallied. All live and dead potential trees are tallied. Do not include any trees below the DBH limit or tree class 4 (dead useless) and tree class 6 (live useless) trees. DBH or DBH classes must be recorded where timber merchantability specifications may indicate a different DBH limit level from the field tally level.

Within each timber type, measure tree data is required in the measure plots for each species recorded in the count plots. Occasionally, a species is tallied in a count plot that has not been tallied in a full measure plot. This creates a situation where no measure data is available to compile the tree. This tree is called an 'orphan tree'.

The procedure for dealing with orphan trees in count plots during or because of fieldwork is to record the measure information for the first occurrence (first tree from facing north (0°) and turning clockwise within the count plot) of the orphan species within the first count plot where the orphan species is encountered. If the orphan species is not measured in a measure plot in the same timber type, the data from the orphan species tree will be moved to the nearest measure plot in the same timber type with the same BAF and will be deleted from the count plot. This procedure will be completed after the fieldwork is complete or at the compilation stage. Orphan trees moved from a count plot to a full measure plot should be recorded using tree numbers 99, 98, 97, etc. Consideration will be given to waiving the sampling error if the minimum sampling error requirement is exceeded due to the shift in the tree count.

Where orphan trees are created as a result of boundary changes or an error discovered after the fieldwork, the options for dealing with an orphan species in a count plot are (in order of preference):

- Return to the field and convert the count plot orphan tree to a measure tree and move it to a measure plot, or
- Change the orphan species to a species of similar tree form and value (if available) in that same timber type and move it to the nearest measure plot as stated above, or
- If a similar species is not available in the type, use the average data from the same species in the nearest plot of an adjacent type and move it to the nearest measure plot as stated above, or

- Delete all the count plots in that timber type from the compilation.

Figure 2.3 Sample Cruise Tally Sheet (FS 205) – Card Type 9. illustrates how count plots should be recorded if they are used for cutting authorities that have different appraisal and timber merchantability specifications:

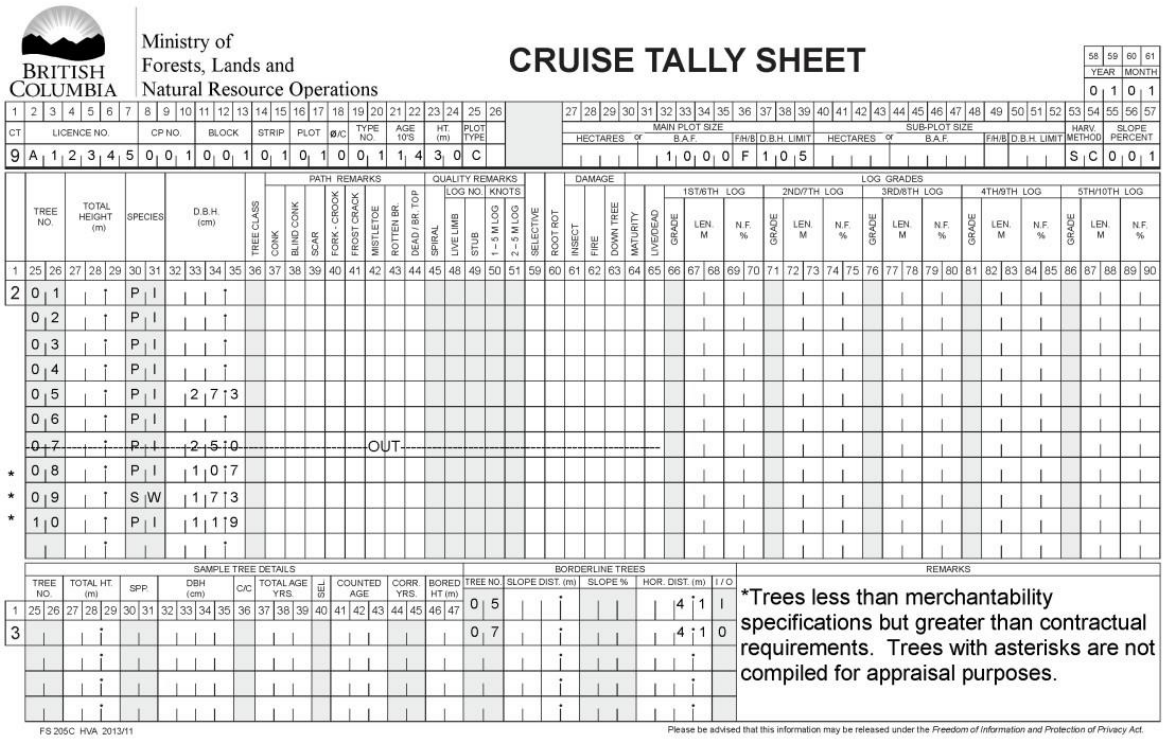

Figure 2-3 Sample Cruise Tally Sheet (FS 205) – Card Type 9

2.8. Forest Typing

Forest types are areas of land identified on a cruise plan map with similar timber characteristics. They are generally identified from aerial photos and may increase sampling efficiency and provide a more accurate estimate of timber volume and value.

For more information on the general principles and procedures that may be used to describe forest types, see the document titled 'VRI Photo Interpretation Procedures' at the following web link:

https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-inventory/forest-cover-inventories/photo-interpretation

Appraisal cruising recognizes four categories of stratification:

1. **Forest Types (Timber Types):** Generally describe areas of similar inventory forest cover composition (e.g., first and second leading species by volume, age, height and site class). These areas contain merchantable timber and are sampled for appraisal. Timber types must be unique to each cutblock.

2. **Non-Forest Types:** These areas are not sampled for appraisal (i.e., rock bluff, swamp, constructed linear tenure, creek, riparian reserve area, slide track and gravel pit). A non-productive area can be less than one hectare in size, but typing out of non-productive areas must be consistent (e.g., if a 0.5 ha non-productive area is typed out then all non-productive areas 0.5 ha and larger must be typed out).

3. **Forest Reserves:** Describe areas reserved from harvest due to forest management purposes (e.g., Goshawk nest, visual quality reserve, wildlife tree patch). These areas may contain merchantable timber but are not sampled for appraisal.

4. **Silviculture Treatment Units:** Describe areas that will receive different forms of silvicultural or harvest treatments. (e.g., stumping for root rot and partial cutting areas). These areas contain merchantable timber and are sampled. Treatment units may consist of an entire timber type, a portion of a timber type or a portion of multiple timber types.

2.9. Comparative Cruises – Interior Only

The Interior Appraisal Manual specifies the situations when comparative cruise data may be used for appraisal purposes.

The use of comparative cruise data is an exception and must be approved by:

- the Regional Executive Director or BCTS Executive Director when the estimated volume is greater than 5,000 m^3, or
- the District Manager if the estimated volume is 5,000 m^3 or less.

Sample design and methods used in a comparative cruise are subject to approval by the appropriate government representative specified in this section.

3.1. Introduction

Ministry audits timber cruises to ensure all appropriate standards are followed, support revenue objectives, ensure the correct calculation of stumpage rates, and to ensure the consistent application of cruise data in the market pricing system (MPS).

As such, the Ministry is responsible for setting the minimum standards for timber cruising, while licensees are responsible, under contract, to meet these minimum standards. Information from the cruise that meets these standards may be used for appraisal.

The Ministry may consider exceptions to these minimum standards in extenuating circumstances on a case-by-case basis.

For quality assurance purposes, cruising field work will be assessed according to the Cruising Manual in effect at the time the field work was completed.

Objectives

The objectives of the quality assurance review are to ensure:

1. The integrity of the sample design. This is achieved by assessing the cruise plan as specified in section 3.2.

2. The measurements of the tree or site attributes meet the minimum standards. This is achieved by comparing a sample of cruiser's measurements against the check cruiser's measurements as specified in sections 3.3, 3.4, 3.5, and 3.6.

3. The reports generated from the approved cruise compilation program and final cruise submission are consistent with the cruise plan and reflect the data collected in the field. This is achieved by assessing the cruise compilation and final cruise submission as specified in section 3.8.

If any of the preceding components of the cruise are not acceptable, the licensee must undertake corrective actions to ensure the cruise meets the minimum Ministry standards.

In addition, if the cruise is not consistent with the procedures included in this manual the Ministry may require that corrective action be undertaken before the cruise data is used for appraisal purposes.

3.2. Cruise Plan Standards

The cruise plan is a key document that supports the integrity of the sample design.

A cruise plan must include the requirements identified in sections 2.2 and 3.2.1, as well as the cruise plan form (FS 693). If all the required information is included on the cruise plan map, a cruise plan form (FS693) is not required.

The cruise fieldwork and compilation may not be accepted by the Ministry for use in the appraisal if the above conditions are not met.

3.2.1. Cruise Plan Map Standards

1. The cruise plan map must be legible and of good quality 1:5 000 or 1:10 000 scale.
2. The cruise plan map must provide clear and legible lines, lettering and numbers.
3. The cruise plan and/or cruise plan map shall include the items indicated in Table 3-1.

A sample cruise plan map can be seen at the following link:

Sample Cruise Plan Map.pdf

Table 3-1 Requirements for Cruise Plan and Final Cruise Submissions

	Requirements	Cruise Plan Submission	Final Cruise Submission
a	Tenure and Cutting authority	Yes (if known)	Yes
b	Forest Region and District	Yes	Yes
c	Scale	Yes	Yes
d	Timber Supply Area	Not required	Yes
e	North Arrow, Declination, Map base	Yes	Yes
f	Cruise or Scale Base Indicator	Yes (Coast only)	Yes (Interior and Coast)
g	Maturity of forest inventory polygons/cutblocks identified	Yes	Yes
h	Timber type lines and identifier (including a forest cover map of the cruise and adjacent areas for cruises containing Lodgepole Pine)	Yes (Forest Cover map not required for Coast)	Yes
i	Plots identified as measure or count plots and numbered	Yes	Yes
j	Cutblock numbers (including any old numbers if changed)	Yes	Yes
k	Cutblock and type net areas	Yes	Yes

	Requirements	Cruise Plan Submission	Final Cruise Submission
l	Harvest methods and areas	Only required for heli logging areas	Yes
m	Existing and proposed roads	Yes	Yes
n	Forest Inventory Zone	Not Required	Yes
o	PSYU	Not Required	Yes
p	Biogeoclimatic zone(s) and sub zone(s)	Not Required	Interior only
q	Plots used in the compilation are clearly indicated	Not required	Yes
r	Locations of baselines (when used), boundary tie lines, points of commencement and actual strip line location with direction of travel (direction of travel and strip line location not required for GPS located plots)	Not Required	Yes
s	Actual location of plots in field (after fieldwork is completed)	Not Applicable	Yes
t	Physiographic features	Only if they affect sampling	Only if they affect sampling
u	Legal survey features	Only if they affect sampling	Yes
v	Forest and non-forest type boundaries	Yes	Yes
w	Cutting boundaries	Yes	Yes
x	Location of Marked to Leave Percent Reduction Trees	Yes (if known)	Yes
y	Name of person or company who produced map and date map was produced	Yes	Yes
z	Name of person(s) who completed the cruise field work	Yes - proposed	Yes
Aa	Signature of submitting professional	Yes	Yes
Ab	Registration type (ATE, RFT, RPF) and registration number	Yes	Yes
Ac	Indicate if the submission is original or a revision	Yes	Yes

3.3. Principles

The following summary outlines the general principles that guide the check cruising process:

The check cruiser has the necessary experience and knowledge to perform the audit.

The check cruiser will strive to select plots to audit using a random process or by a process agreed to by the cruiser and the check cruiser. The check cruiser must define the sample population prior to auditing and the results will apply to that pre-defined sample population.

In order to accept or reject a cruise on the basis of tree data attributes or plot slopes, the check cruisers will audit at least 10.0% of the plots or 5 plots within the sample population (e.g. submission, cutting authority, cutblock, cruiser), whichever is greater. If a cruise is being rejected for measure plot data, the minimum number of plots must be based on measure plots. Otherwise, the minimum number of check plots can include both count and measure plots. If there are fewer than 5 plots in the population, all plots must be audited. If fewer plots have been audited and there is mutual agreement between the cruiser or licensee representative and the check cruiser, the cruise may be rejected or accepted.

The check cruiser should provide an opportunity for the cruiser or company representative to attend the audit by providing advance notice.

The cruiser must take responsibility for the cruise data in accordance with Section 3.8(5) of this manual.

A copy of the check cruise report will be provided to the cruiser in a format that is acceptable to the respective Area Director.

Benefit of the doubt will be extended to the cruiser. If a call is considered borderline or difficult to discern, a brief rationale should be noted by the cruiser on the cruise card and where appropriate, in the field. The cruiser's decision will be accepted where the decision is reasonable in the particular circumstances.

Plot centres, plot centre reference trees, sample trees and strip lines (where used) must be marked in the field and in a fashion so as to provide a reasonable level of identification to support the audit function.

3.3.1. Check Cruise Submission Form

The Check Cruise Submission Form allows the Ministry to assess the need for a field check cruise. When submitting the form licensees must use the most recent version of the Check Cruise Submission Form. The form must be completed and submitted to the District Manager prior to a field audit of a timber cruise. A copy of the fillable form can be downloaded on the Ministry's timber cruising website:

Timber Cruising - Province of British Columbia (gov.bc.ca)

Although not required prior to an ECAS submission of the cruise data, licensees may choose to

submit any combination of cutblocks on the form to the District Manager, subject to the criteria below.

The District Manager may require the submission of the form and associated cruise data prior to submission of the cruise data into ECAS. In these cases licensees must, at a minimum, submit the form and associated cruise data for the requested cutblocks via email within five (5) business days.

When the cruise data is submitted into ECAS, licensees must attach a completed Check Cruise Submission Form to the submission. The cutblocks included on the form must be all cutblocks in the cutting authority.

The minimum criteria for cutblocks to be included in a Check Cruise Submission Form prior to submission to ECAS:

1. All cutblocks must be in the same District,

2. All cutblocks must be for the same licensee, and

3. The form must be endorsed by a forest professional or associate member with the FPBC (RFT, RPF, ATE or AFP-LL) who takes responsibility for all data on the document.

The minimum criteria for cutblocks to be included in a Check Cruise Submission Form when part of an appraisal data submission in ECAS:

1. All cutblocks in the cutting authority must be included on the form, and

2. The form must be endorsed by a forest professional or associate member with the FPBC (RFT, RPF, ATE or AFP-LL) who takes responsibility for all data on the form.

Table 3-7 Sample of Required Format for PRP Table

CB	TYPE	PLOT	HD (m)	BRG (°)	PDOP	HDOP	#SAT	# HIT	MDH (m)	Local Date, Time	PRP Easting UTM	PRP Northing UTM	PT Easting UTM	PT Northing UTM
7	2	1	16.6	110	3.4	1.9	6	50	0.3	13:52:23 8/16/2019	683417.473	5657508.768	683433.292	5657503.723
7	2	2	9.7	329	3.9	2.3	8	50	0.1	14:12:50 8/16/2019	682934.854	5657577.685	682929.529	5657585.834
7	2	3	8.9	157	2.3	2.9	8	50	0.5	15:30:51 8.16.2019	683125.834	5657600.981	683129.624	5657592.922
7	2	4	11.6	063	2.0	1.7	9	50	0.4	16:01:20 8/16/2019	683219.529	5657590.781	683229.672	5657596.466
7	2	5	11.7	349	2.0	2.2	9	50	0.2	16:30:59 8/16/2019	683332.437	5657588.624	683329.720	5657600.010

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

1. The average absolute variation of all cruise plot locations checked must be within 3.0 m of the check cruise plot locations.
2. Individual variations between check cruise plot locations and the original cruise plot locations must be within 5.0m. A tolerance of one plot location outside of 5.0m will be allowed for every ten (or less) plots checked.
3. The distance and bearing between the cruiser's PRP and cruise plot must meet the same standards as those for conventional methods:
    a. Horizontal distance: plus or minus 2.0 percent
    b. Bearing: plus or minus 2.0 degrees

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

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

3. Sample Point Integrity Test (SPIT) Plots

The District Manager or Area Director may audit a cruise for basal area bias using sample point integrity test (SPIT) plots.

The process for establishing SPIT plots is to establish four satellite plot centers 10.0m from the original plot center, one in each cardinal direction (North, East, South, West). The SPIT plots will be cruised using the same BAF as the original plot. All merchantable live and dead potential trees within the plots and associated species information will be tallied.

Although more data can be collected at the discretion of the check cruiser, the minimum amount of data collected at SPIT plots will be the same as the information collected in count plots as per section 2.7.2.

If a SPIT plot lands outside the harvest area the plot must be dropped.

The walkthrough method must be used as per section 4.3.1.15 of this manual.

The recommended minimum number of original cruise plots to have SPIT plots established is fifty (50). If there are fewer than fifty (50) original cruise plots in the audit area then all plots in the submission should have SPIT plots established.

The survey results must meet both the following minimum quality assurance standards for SPIT plots:

- The average basal area (m^2/ha) of the checked plots from the original cruise is ≤10.0% of the average SPIT plot basal area (m^2/ha), or
- The average basal area (m^2/ha) of each species in the checked plots from the original cruise is within ≤20.0% of the average SPIT plot species basal area (m^2/ha).

If quality assurance standards are not met the audit area must be recruised with a new grid and cruise plots. Failure to meet this standard may lead to further inquiries into the integrity of plot locations and resulting appraisal data for both the licensee and cruising agency.

4. Harvest Boundary Traverse

The standards used for the measurements to establish the harvest boundaries are in Table 3-8. This standard applies to original appraisals and reappraisals.

Table 3-8 Harvest Boundary Standards

Boundary Traverse	Cruise-Based	Scale-Based
Closure Error	+ or – 0.7%	+ or – 1.0%
Area Error	+ or – 1.0%	+ or – 1.5%
Inter-station Distance	+ or – 1.0%	+ or – 2.0%

For conventional traverses, both closure error and area error must be exceeded before the traverse is deemed to be incorrect. The closure error standards do not apply to GPS traverses. To calculate closure error for traverses that are a combination of GPS and conventional traverses, refer to the Combined GPS and Conventional Traverse Procedure found in the

3.7. Check Cruise Dispute Mechanism

If the licensee wishes to dispute the result of a rejected check cruise the following process will be followed:

Step	Action
1	The licensee and/or their agent must notify the District Manager in writing and provide a rationale supporting the acceptance of the cruise information.
2	The Ministry check cruiser and licensee and/or their agent attend the site and attempt to resolve the concerns.
3	If the concerns from step 2 are not resolved, the licensee may submit a written complaint to the District Manager within 30 days of the site visit in step 2 requesting further review. The District Manager will forward the written request to the Area Director.
4	The Area Director will review the concerns and respond to the licensee and/or their agent preferably within 30 days of receipt of the written complaint. The Area Director may coordinate a second check cruise.
5	The Area Director will make a decision based on all information, which will be binding and final.

3.8. Cruise Data Submission Standards

The following conditions must be met. If they are not met, the cruise data may not be used for an appraisal:

1. Starting September 1, 2024, a Check Cruise Submission Form(s) must be attached to the appraisal submission. A Check Cruise Submission Form may also be submitted pre-ECAS as part of a check cruise request.
2. The field data must be consistent with the data used in the appraisal compilation.
3. The field data must be compiled in a manner that is consistent with the cruise plan or final cruise map and changes to the cruise plan in accordance with Section 2.2.
4. When requested by the Ministry, the licensee must submit the original plot cards (in the format requested by the District Manager), traverse notes (if traversed with chain and compass), and raw and corrected GPS files (if traversed with GPS).
5. If GPS is used to establish cruise plots, the following items must be submitted upon request to the Ministry:
    a. PRP Table in pdf format as specified in Section 3.5.
    b. Digital shape file depicting the established GPS cruise plot locations and plot numbers.
6. The cruiser must take responsibility for the cruise data submitted by either:
    a. submitting the original cruise cards and any subsequent changes (including name, date and signature), or
    b. submitting a cover letter (including name, date and signature) with the cruise data indicating which plots they cruised or made subsequent changes to.

    If the cruiser is a registered or associate member of the Forest Professionals British Columbia (FPBC), they must provide their professional designation.

    If the cruiser is not a registered or associate member of the FPBC, an additional cover letter must be submitted with the cruise data signed by a registered member or associate member indicating they supervised the work and are accepting responsibility for the information collected and submitted by the cruiser on that cutting authority. This cover letter is in addition to any letter submitted by a cruiser who is not a registered or associate member of the FPBC.
7. The cruise data must be compiled on an approved version of the compilation software. (See Section 5.10.2)
8. Final cruise maps must accompany the compilation report and the final submission must include the requirements identified in Table 3-1.

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

Sampling Procedures

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

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

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

If a tree bole is shattered and extends through DBH and either the standing or down portion of the tree fall outside of the plot, use the portion of the tree with greater than 50% of the basal area at breast height to determine if the tree is "in" or "out" and assign applicable damage codes (See Section 7.6.3)

All trees with boundary ribbons or paint attached must be excluded from cruise plots.

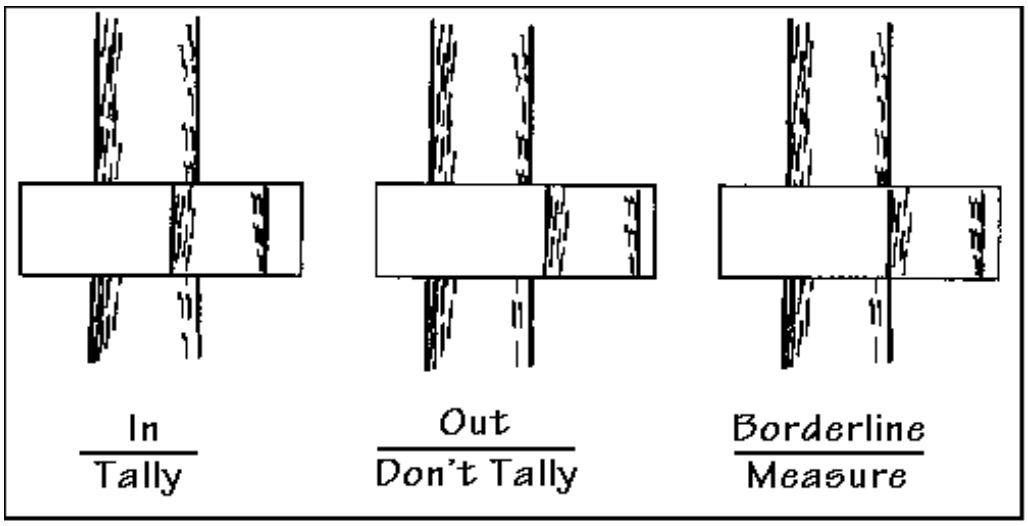

Figure 4-4 "In", "Out" and "Borderline" Trees

BAF Selection

Changing BAFs within a timber type polygon may introduce a bias in the reporting of summary stand statistics. The BAF may be changed once within each timber type polygon. Once the change is made, the BAF cannot be changed again regardless of stand composition. More than one BAF change in a timber type polygon may result in the rejection of the cruise. The determination of the BAF must not be made at plot centre. When a BAF change is made, the location of the BAF change must be noted on the cruise field notes or cruise cards.

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

If the minimum tree count requirement for a cutblock is not met after a cruise is completed, all plots within one timber type must be recruised with a smaller BAF in order to meet minimum requirements. The BAF must be the same for all plots within the timber type that is recruised.

Prism Slope Correction

Since each tree on the area may have its own unique slope angle from the centre, each tree must be considered individually in making slope corrections (see Horizontal Distance Correction in Appendix 14). In borderline situations, trees are to be measured as described in the following section.

Borderline Trees (Variable Plot Cruises)

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

1. Determine the horizontal distance from the plot centre to the face of the tree trunk at breast height. The plot centre is the point at which the plot marker (stake, pin, etc.) enters the ground and not the top of the marker.

2. Add one half of DBH to the horizontal distance to determine the horizontal distance from the tree centre to the plot centre.

3. Multiply the plot radius factor times DBH. This represents the plot radius for the tree. In variable cruising every tree has its own plot radius depending on its diameter and the angle of the prism being used (see Variable Plot Sampling in Appendices).

4. If the horizontal distance from the tree to the plot centre is less than or equal to the plot radius, the tree is considered “in”. If the horizontal distance from the tree to the plot

use a full sweep plot. Similarly, full sweep plots are appropriate where plots are located on a road centerline external to a cutblock and the boundary of the right of way is not ribboned in the field.

All "in" or "out" tree distance measurements are recorded on a horizontal basis and are measured at 1.3 metres breast height.

Boundary ribbons must not be hung on any tree that is within the harvest area. Hang ribbons on trees and vegetation that will be retained after harvest is complete. Trees with boundary ribbons on the stem must not be included in the plot, regardless of whether stubbing is planned.

Regular Boundary – see Figure 4.6 Walkthrough Method - Regular Boundary.

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

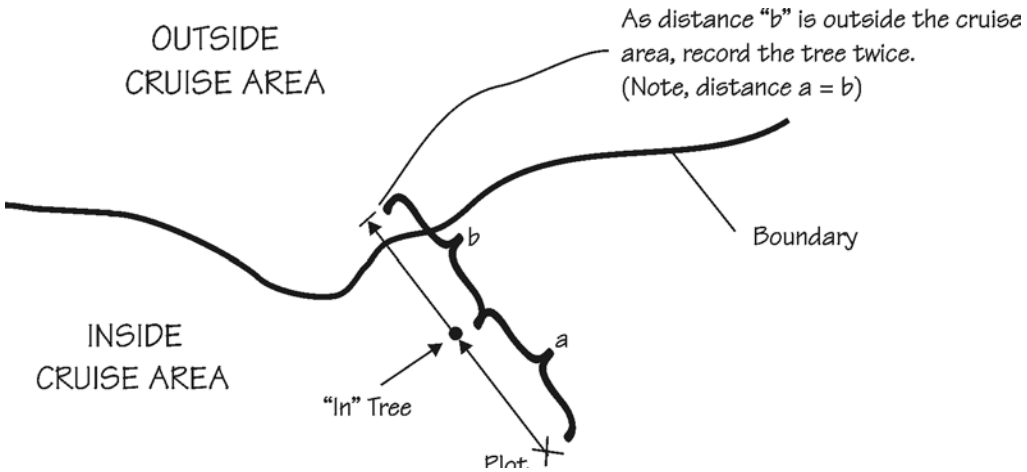

Figure 4-6 Walkthrough Method - Regular Boundary

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

Irregular Boundary – see Figure 4.7 Walkthrough Method - Irregular Boundary.

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

Tree Class 2

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 swelling), rotten branches, dead or broken top.

All pathological indicators must be recorded for each tree in the tree third where they occur 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 Risk Group Ratings by Pathological Indicators (Appendix 20: Table 7.20.1) for risk group assignments by pathological indicators.

Tree Class 3 (Dead Potential; Older Immature Dead Potential in Interior)

Tree Class 3 are dead standing or down timber which is estimated to contain at least 50 percent of its original gross volume in soundwood (firmwood) 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; except for insect attacked trees where a tree with less than 5.0% red needles will be considered dead.

For net merchantable volume compilation, dead potential stems will have the highest Risk Group deduction for the species, except Lodgepole Pine which will use Risk Group 2 Loss Factors.

Refer to Sound Wood Factors for Saprot (Appendix 7: Table 7.7.1) and the Ten Metre Log Table (Appendix 7: Table 7.7.2) to assist in the determination of 50.0 percent soundwood content.

Decay should be determined at various intervals on the tree, preferably at the mid-point of each third of down trees.

1. Dead Standing

   Decay percent is difficult to assess on standing trees. "Sounding" can be helpful, but must only be done in safe conditions.

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 be influenced by the tree

Class 5 apply.

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

Tree Class 8 (Younger Immature)

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

a. Coniferous trees, other than Lodgepole pine, equal to or less than 80 years of age,

b. Lodgepole pine trees equal to or less than 60 years of age, or

c. Deciduous trees equal to or less than 20 years of age.

Two exceptions exist:

a. Aspen and Cottonwood in FIZ K and L where tree classes 8 will be used for trees less than 81 years of age, or

b. Coastal cruises where the age in 10's is 13 or 14, tree class 8 will be used for trees equal to or less than 120 years of age.

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

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

Ages

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

The age correction to breast height is found in the Site Index Tables for British Columbia – All Species in Appendix 21.

Tree class 3, 7 and 9 trees – To assign age a dead tree, use the age of a similar species/size, and consider visual characteristics of the tree.

Age of living trees is determined by a ring count from an increment borer core, taken at diameter

5.2. Compilation Standard (Card Type B)

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

5.2.1. Position 11 Damage Reporting (required)

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

5.2.2. Position 12 Selective/ Leave Tree Indicator (required)

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

5.2.3. Position 13 Double Sampling Indicator (required)

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

5.2.4. Position 14 Special Compilation (required for interior cruises)

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

WET AND DRY BELT DOUGLAS FIR ZONES		
	Biogeoclimatic Zone	**Biogeoclimatic Subzone and Variant**
Wet Belt Code = 1	ESSF (Engelmann Spruce - Subalpine Fir)	dc, dcw, dh dk, dkw, dv, dvw, mc, mcw, mh, mk, mkw, mm, mmw, un, vc, vcw, ~~vv~~, wc, wcw, wh, wk, wm, wmw, wv, wvw
	ICH (Interior Cedar Hemlock)	dk, dm, dw, mc, mk, mm, mw, vc, vk, wc, wk
	SBPS (Sub-Boreal Pine - Spruce)	dc, mc, mk
	SBS (Sub-Boreal Spruce)	undifferentiated, dh, dk, dw, mc, mh, mk, mm, mw, vk, wk

	SWB (Spruce Willow Birch)	mk, mks, un, uns, vk, vks
Dry Belt Code = 2	BG (Bunchgrass)	xh, xw
	ESSF (Engelmann Spruce - Subalpine Fir)	xc, xcw, xv, xvw
	ICH (Interior Cedar Hemlock)	xm, xw
	IDF (Interior Douglas Fir)	dc, dh, dm, dw, mw, ww, xc, xh, xk, xw, xx
	MS (Montane Spruce)	dc, dk, dm, dv, dw, xk, xv
	PP (Ponderosa Pine)	xh,
	SBPS (Sub-Boreal Pine - Spruce)	xc

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

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

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

5.2.6. Positions 17 to 18 Type of Compilation (required)

Enter 3 for Interior Cruises and 32 for Coastal cruises. This represents the appropriate end product or combination of products.

5.2.7. Positions 19 to 27 Timber Merchantability Specifications (required for Interior compilations)

This section indicates the minimum timber merchantability specifications that will be assigned by the cruise compilation programs when the compilation program is used for appraisal purposes.

Coast		DBH	Stump	Top
	Mature	17.5	30	15.0
	Immature	12.0	30	10.0
Interior	All	17.5	30	10.0
	Lodgepole Pine	12.5	30	10.0

7.6. Appendix 6: Damaged Stands

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

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

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

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

7.6.1. Pest Damage

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

7.6.1.1. Bark Beetle Descriptions

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

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

Douglas fir beetle attacks Douglas fir and sometimes Western larch.

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

Western pine beetle attacks Ponderosa pine.

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

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

https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/forest-health/forest-health-docs/field_guide_to_forest_damage_in_bc_web.pdf

Beetle Attack Code Definition

Green Attack Codes 1, 5, 6	Trees attacked have green needles, but other colours may also be present. Green attack must contain greater than or equal to 5% green coloured needles.
Red Attack Codes 2, 8	Trees attacked have red, fading and possibly some grey needles. Red includes straw to rust colour. Red attack must contain less than 5% green needles and greater than or equal to 5% red needles.
Grey Attack Codes 3, 7	Trees attacked have grey or no needles. Grey attack must have less than 5% red needles, except *Abies lasiocarpa*, which can have grey or red needles.

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

Code	Description
1	Green Attack
2	Red Attack
3	Grey Attack

These attack codes are applicable to the following insects:

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

Green Attack Code 1

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

compilation program will downgrade these trees to Risk Group 2.

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. The compilation program will downgrade these trees to Risk Group 2.

Grey Attack Code 3

This code will represent trees that are dead and have grey needles except *Abies lasiocarpa*, which can have grey or red 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.

Grey attack trees that have been dead for many years often no longer show evidence of beetle attack. In beetle attacked stands, it is acceptable for check cruisers to extend the "benefit of the doubt" on Grey Attack Code 3 classifications if these trees show signs of significant bark loss and other signs of long-time mortality but no remaining bark beetle signs (beetles, pitch-tubes, frass, exit holes, blue stain, etc.). Cruisers are still expected to look for beetle sign and to rationalize their damage codes if they suspect these sign to be removed, obscured, or faded. The compilation program will downgrade these trees to Risk Group 2 unless tree class and/or pathological indicators downgrade the tree further.

7.6.1.3. Blister Rust Code 4 (Risk Group 2, White Pine)

This attack code is applicable to the fungus species White Pine Blister Rust (*Cronartium Ribicola*). It applies only on western white pine and whitebark pine trees. Rusts on any other tree species cannot have this code.

The trees in this code must have a stem infection.

All bark beetle attack codes take precedence over Blister Rust, Code 4.

program will assign the risk group by tree class and pathological indicators.

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

A tree felled by a beaver will be considered equivalent to a chainsaw cut and does not cause a blowdown code.

7.6.3.2. Damage Code G

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

A tree with a break below stump height will be considered uprooted. If the break extends into the merchantable portion of the stem then the entire length of shatter will be assessed to determine if it is a clean break or a shattered break.

The length of shatter is measured from stump height (i.e., only the length of the shatter in the merchantable portion of the stem is considered). The compilation program will down grade these trees to the highest risk group.

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

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

7.7. Appendix 7: Dead Potential 50% Threshold Calculations

7.7.1. Sound Wood Factors for Saprot (Table 7.7.1)

$$\% \text{ Sound Fibre} = \left(\frac{DIB - 2 \times Saprot\ Depth}{DIB}\right) \text{ ^ } 2$$

A spreadsheet to calculate sound wood using the above equation can be found at the following website:

Cruising Calculations

**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 diameter of stem where saprot depth is measured

**Saprot depth is the average rot depth penetrating the stem radius

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

$$\% \text{ Sound} = 100 - \frac{Volume\ of\ Rot}{Volume\ of\ Tree\ or\ Log}$$

7.7.2. Ten Meter Log Tables (Table 7.7.2)

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

ii. dead potential white pine, balsam (Abies sp.) and hemlock trees, and

iii. dead potential lodgepole pine trees with conk and blind conk.

Do not record pathological indicators occurring above the top diameter timber merchantability specification[2].

7.17.2.1. Secondary Leaders

Record all pathological indicators on secondary leaders if the leader is alive and of merchantable size. Conks of an identifiable heart rot fungi may be called on non-merchantable live secondary leaders. Do not record any pathological indicators on non-merchantable dead secondary leaders.

Record pathological indicators on dead, merchantable secondary leaders for cedar and cypress only.

Record all pathological indicators on dead potential trees for the coastal log grade algorithm, however do not record saprophytic fungi as conk.

7.17.2.2. Conks

Conks are the fruiting bodies (sporophores) of decay fungi, and are definite and reliable indicators of decay. Conks can 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. Fruiting bodies from a variety of saprophytic fungi can also occur on slash, however saprophytic conks are not suspect indicators. It is important to be able to differentiate between the fruiting bodies of saprophytic fungi that occur on live and dead branches, wounds and roots of living trees and those of suspect indicators found on living conifers and hardwoods. For cruising purposes, only specific root, butt and heart rot conks are suspect indicators (see Figure 7.19 Residual and Suspect Indicators and Their Host Species for a list of Residual and Suspect indicators, as well as their host species native to British Columbia).

On conifers, the suspect indicators which must be recognized are *Echinodontium tinctorium*, *Phellinus (Fomes) pini*, *Phaeolus (Polyporous) schweinitzii* and *Fomitopsis pinicola*. On hardwoods, the suspect indicators to recognize are *Phellinus igniarius* and *Phellinus tremulae*.

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 to this is the mushroom-shaped to bracket-like sporophore of *P. schweinitzii* which is annual, but may persist for more than two years. Conks vary in size and shape and therefore are hard to spot, particularly when they are just developing, or when they occur on the upper trunk.

Before recording suspect conks on living branches in the upper crown, there must be conks of the suspect indicator heart rot fungi evident in the stand.

[2] *The merchantable portion of the tree is from 30cm stump height to a 10cm or 15cm top diameter inside bark as per the appropriate timber merchantability standards. Pathological factors outside of these limits were not included in the loss factor data.*

Conks of *E. tinctorium* and *P. pini* frequently appear as small hoof-like or shelf-like structures on the underside of dead branch stubs 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.

A variety of saprophytic conk species that occur on dead wood of living trees can be both annual (small, thin, leathery) and perennial, and are often more numerous, and occur anywhere on the tree. Saprophytic conks are not acceptable as suspect indicators, with the exception of *F. pinicola*, which is considered a suspect indicator only when occurring on live trees, as studies have found that its presence indicates significant decay. When *F. pinicola* occurs on dead trees, or dead branches on live trees, it is not considered a suspect indicator.

Conks of Phaeolus schweinitzii

P. schweinitzii is the cause of brown cubical rot and butt rot of most conifers, however 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 *P. schweinitzii* conk is located mid-way between:

1. Two living susceptible trees, only one tree is considered to be infected. If one tree is a highly susceptible species (e.g. Douglas-fir) and the other is a less susceptible tree (e.g. western red cedar), the most susceptible species is considered to be infected.
2. 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.

Conks of Phaeolus schweinitzii Vs. conks of Inonotus tomentosus

It may be easy to confuse conks of *P. schweinitzii* (shown in Figure 7.19 Residual and Suspect Indicators and Their Host Species and Figure 7.41 Suspect Indicators) with those of *I. tomentosus* (Figure 7.42: Residual Indicators), as the fruiting bodies can be somewhat similar in appearance. Particular care should be taken in identification of these pathogens.

Young conks of *P. schweinitzii* may often look the same as young conks of *I. tomentosus*, however conks of *I. tomentosus* are usually smaller (usually < 10 cm in diameter than those of *P. schweinitzii*, which can be up to 25 cm in diameter. In addition, conks of *P. schweinitzii* are often darker than those of *I. tomentosus*.

P. schweinitzii usually appears shelf-like when growing on a stem, stalked and stipate when growing on the ground. Its upper surface has concentric rings, and is red-brown and velvety in appearance. The lower surface of the fruiting body can appear a tan yellow-green in colour, and can turn a brown colour when bruised. In contrast, the fruiting bodies of *I.*