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Ministry of Forests,
Lands and Natural Resources

Timber Pricing Branch

MEMORANDUM

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April 14, 2011

BY EMAIL

To: Regional Executive Directors

From: Murray Stech, Director, Timber Pricing Branch

Re: 2010 Cruising Manual: Amendment No. 2

The purpose of this memo is to inform you that Amendment No. 2 of the *Cruising Manual* becomes effective on April 15, 2011.

The cruise design changes allow for one measure plot for timber type polygons less than 1.0 hectare, the sampling intensity standards are based on the planned number of plots and section 2.5 is re-written to clarify the cruise design standards.



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

<http://www.for.gov.bc.ca/hva/manuals/cruising.htm>

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

Comments or questions about this manual should be referred to Keith Tudor, Cruising Policy Forester, Timber Pricing Branch at (250) 387-8357 or Don Rorison, Cruising Projects Specialist, Timber Pricing Branch at (250) 356-7674.

Murray Stech
Director
Timber Pricing Branch

Attachment

pc: Els Armstrong, Regional Cruising Officer, Cariboo Forest Region
Ron Alton, Cruising and Waste Specialist, Omineca/Skeena Forest Region
Bruce Markstrom, Cruising and Waste Coordinator, South Coast Forest Region

Cruising Manual Amendment No. 2

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

<http://www.for.gov.bc.ca/hva/manuals/cruising.htm>

The *Call Grade Net Factor Standards and Procedures* are available in Appendix 10:

<http://www.for.gov.bc.ca/hva/manuals/CGNF.htm>

Section	Description
1.1 – Terms of Reference	The section is updated to define the recent name changes for the resource ministries.
2.3 – General Conditions, Scale & Cruise-Based	Statements are added that in the cruise plan, timber type polygons that are 1.0 hectare or larger must contain at least 2 measure plots. Timber type polygons that are less than 1.0 hectare must contain at least 1 measure plot.
2.5. Sampling Patterns: General Conditions	The section is rewritten to increase clarity.
2.5.1 –Standards for the location of plots using a grid	The section is rewritten to increase clarity.
2.5.2 - Standards to identify full measure or count plots using a grid	New procedures are included to identify full measure and count plots in timber type polygons to meet the sample design standards.
2.5.3 – Standards for the location of additional plots to meet section 2.3 requirements.	This section is moved from section 2.6.3. New procedures are included for adding plots to timber type polygons if the minimum sampling standards could not be achieved in the cruise plan or in the field.
2.5.4 – Standards for sampling timber type polygons created by non-forest types.	This section is added to state that timber type polygons separated by non-forest types can be considered as one contiguous timber type.
2.5.5 – Standards for the location of additional plots to meet sampling error.	This section is edited and moved from section 2.6.3.
2.6 – Other Timber Cruising Conditions	A statement is removed because section 2.6.3 has been moved to section 2.5.3.
2.6.3 – Adding Plots to a Cruise to Meet Sampling Error	This section is deleted and moved to section 2.5.4.

2.6.4, 2.6.5, 2.6.5.1, 2.6.5.2, 2.6.5.3	Re-number sections 2.6.3, 2.6.4, 2.6.4.1, 2.6.4.2 and 2.6.4.3 to accommodate the changes in sections 2.5 to 2.6.3.
2.9 – Forest Typing	A statement is revised to allow one measure plot in a timber type polygon that is less than 1.0 hectare and non-forest types are defined.
2.9 – Cruising Interpretations	The Cruising Interpretations link is removed from the <i>Cruising Manual</i> .
2.9.1 – Minimum Plots/Timber Type	The section is deleted. The amended procedures are now in section 2.5.2.
9.1.5.2 – Sampling Patterns	The procedure is deleted to align the local cruise grid procedure with section 2.5.1 of the <i>Cruising Manual</i> .

<p>FOR FURTHER INFORMATION OR IF YOU HAVE A CHANGE OF ADDRESS, PLEASE CONTACT:</p> <p>Don Rorison Cruising Projects Specialist Timber Pricing Branch Ministry of Forests, Lands and Natural Resource Operations 1st Floor, 1520 Blanshard Street Victoria, BC V8W 3K1 Phone: 250 – 356-7674 Email: Don.Rorison@gov.bc.ca FAX: 250 - 387-5670</p>	MANUAL TITLE	
	Coast Appraisal Manual	
	AMENDMENT	ISSUE DATE
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MANUAL CO-ORDINATOR		
Judy Laton Publication/Administrative Co-ordinator		
AUTHORIZATION (Name, Title)		
Murray Stech Director, Timber Pricing Branch		

Please make the following changes to your copy of the above Ministry manual.

ACTION	(VOL.) CHAPTER-SECTION-SUBJECT	PAGE(S)	COMMENTS
(Remove/Insert)	TABLE OF CONTENTS		
Remove	Table of Contents	i - xii	After Table of Contents Tab
Insert		i - xii	
Remove	Chapter 1	1 - 2	After Chapter 1 Tab
Insert		1 - 2	
Remove	Chapter 2	5 – 6 9 – 24	After Chapter 2 Tab
Insert		5 – 6 9 – 24	
Remove	Chapter 9	1 – 4 7 – 8	After Chapter 9 Tab
Insert		1 – 4 7 – 8	
Remove	Index	i - ii	After Index Tab
Insert		i - ii	
INSERT	Letter from Director, Highlights and Transmittal Sheet		After Amendments Tab

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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.

If a timber cruiser determines that it is unsafe to measure any cruise attribute(s) and the safety concern cannot be reasonably mitigated, they can estimate the attribute(s). Information not measured by the cruiser due to a safety concern will be estimated by the Ministry of Forests and Range.

The sale of Crown timber is a business proposition and both the buyer and the Ministry of Forests and Range (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 Appraisal Manual* and *Interior Appraisal Manual* 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.

1.1 Terms of Reference

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

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

In all Cruising and Cruise Compilation Manuals, the term ‘Ministry of Forests and Range’ means the ‘Ministry of Forests, Lands and Natural Resource Operations’.

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

2.3 General Conditions - Scale and Cruise Based Cutting Authority Cruises

- All species listed under Section 6.3.2 of this manual shall be cruised,
- The merchantability specifications are identified in Chapter 6,
- Unless otherwise specified, the sampling error objectives are based on full measure and count plots,
- All plots must originate from the harvest area. Plots in areas 100 percent reserved from cutting must not be used in the compilation.
- If the minimum tree count can not be achieved with a BAF 2 prism, then the minimum tree count requirement may be waived. See section 2.4.1.
- The minimum tree count requirements include tree classes 1, 2, 3, 5, 7, 8, 9 and not tree classes 4 and 6. See section 2.4.1.
- There are no minimum tree count requirements if the minimum sampling error standard has been achieved.
- Fixed area plots require an average of at least 8 trees per plot.
- The minimum requirement for the establishment of a full measure plot is as follows:
 - i. cutting authorities < 250 ha: a 200 meter grid or 4.0 hectares per plot.
 - ii. cutting authorities > 250 ha: a 250 meter grid or 6.25 hectares per plot.
- Count plots may be established on the full measure plot grid.
- For each timber type, measure tree data is required for every species recorded in the count plots.
- Cruises are the responsibility of the district that contains fifty percent or more of the cruise area.
- Timber type **polygons** must be **contiguous and** unique to a **cutblock**.
- **In the cruise plan, timber type polygons that are 1.0 hectare or larger must contain at least 2 full measure plots and timber type polygons that are less than 1.0 hectare must contain at least 1 full measure plot.**

2.4 Sampling Error Objectives

2.4.1 Scale Based Cutting Authorities

- These standards apply to both clearcut and partial retention harvest systems.
- Unless otherwise stated, the scale-based cutting authority sampling error objective is 15.0 percent at 2 standard errors based on the total stand net merchantable volume prior to any partial harvest reductions.
- Rights of Way - see section 2.6.4 for the cruising procedures - cruises must:
 - i. Meet the 15% sampling error requirement using fixed or variable radius plots, or
 - ii. Sample at least 2.5% of the R/W area using fixed area plots.
- Helicopter Single Stem – the options are:
 - i. 100% cruise of the cut trees,
 - ii. Achieve at least a 15% sampling error on the cut trees at 2 SE using variable radius plots, or
 - iii. Sample using 2 variable radius measure plots/ha and at least 2.0 cut trees/plot.

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

1. **For cutting authorities of 20 ha or larger in size:**
 - a. A 100 metre by 100 metre systematic grid has been established and a maximum of one count plot to one full measure plot has not been exceeded and an average of at least 4.0 trees per plot has been met.
 - b. A 70 metre by 70 metre systematic grid has been established and a maximum of one count plot to one full measure plot has not been exceeded and an average of at least 2.0 trees per plot has been met.
 - c. A 50 metre by 50 metre systematic grid has been established and a maximum of one count plot to one full measure plot has not been exceeded and an average of at least 1.0 trees per plot has been met.

2.5 Sampling Patterns – General Conditions

Plots established within cutblocks from previous operational cruises may be used in new sampling plans if they meet the standards in this manual.

The minimum standards for appraisal cruising require the use of systematic sampling techniques using fixed area grids to locate the plots. The exception is a 100% cruise where all trees within the cutblock are measured.

Plots can be established using a predetermined management unit specific GIS grid or by a local cutblock level grid system. The cruise plan must identify the grid interval for each timber type polygon. Licensees using a GIS grid must notify the District office of its use.


All possible sample points that can be established in the harvest area must be cruised.

Plots cannot be moved within a timber type polygon.

The grid may be square or staggered, however the option selected must be used consistently for the cutting authority. Refer to Figure 2.1 for an example of a square grid.

2.5.1 Standards for the Location of Plots Using a Grid

The following section describes the types of grids that must be used in a cruise plan:

- a. GIS Grid: The grid locations are predetermined by the local management unit GIS grid.
- b. Local Grid: A local grid must be established using the following procedure:
 - i. Project a line due south from the block's most western point and another line due west from the block's most southern point. Starting at the intersection of these two lines, lay the local plot grid on the map oriented in cardinal directions (N-S & E-W) to determine the plot locations. 
 - ii. If count plots are used in the cruise design then the plot closest to the point of commencement must be a measure plot.



2.5.2 Standards to Identify Full Measure or Count Plots Using a Grid

If the grid identified a number of full measure and count plots in a timber type polygon, but failed to identify the minimum number of full measure plot locations in the timber type polygon; change the required number of count plots to full measure plots.

2.5.3 Standards for the Location of Additional Plots to Meet Section 2.3 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 plot per timber type polygon standard specified in Section 2.3.

2.5.3.1 Office Cruise Plan Procedure

Reduce the grid interval on the cruise plan using the largest grid that will meet the minimum plot establishment standards.

2.5.3.2 Field Procedure

In the event that in the field, plots fall outside the timber type polygon, then use the procedure in the following table to establish the 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 will be applied from the planned plot locations that fell outside the timber type polygon in the field.

2.5.4 Standards for Sampling Timber Type Polygons that were Created by Non-forest Types

The following section describes a procedure that can be used where a timber type polygon is separated by a non-forest type.

All portions of a timber type polygon separated by a non-forest type as defined in section 2.9 can be considered as one contiguous timber type polygon.

2.5.5 Standards for the Location of Additional Plots to Meet Sampling Error



The following procedures will be used where additional plots must be added to an existing cruise to meet the sampling error standard:


1. New Grid Design
 - a. Determine a new grid design that will meet the new sample size requirements,

- b. Over-lay the new grid by positioning the new plot grid over top of the original plot grid that is nearest to the P. of C. Use the same cruise grid orientation,
- c. Disregard the overlapping plot and locate the new plots on the cruise map, and
- d. It is recommended to determine the bearings and distances to the new plots from the nearest original plots.

2. **Existing** Cruise Design

Additional plots must be systematically located on the existing cruise strips.

2.6 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 and where road rights of way must be cruised.

2.6.1 Standards for Re-cruising and Appraisal Amendments

These standards are applicable if the cutting authority is to be appraised or re-appraised for changed circumstances as outlined in the *Coast* or *Interior Appraisal Manuals*.

Re-cruising is required:

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 *Coast Appraisal Manual* or *Interior Appraisal Manual*.
5. As determined by the Regional Executive Director.

2.6.2 Unsafe to Cruise

Two methods may be utilized in determining stand volume for a cutting authority where it is unsafe for cruisers to sample the stand due to a high down tree component or where heavy fire damage has occurred.

1. The preferred methodology is to establish cruise plots in the same timber type (where it is safe to cruise) adjacent to the unsafe area.

The sampling intensity must be sufficient to reliably estimate the attributes of the unsafe area.

As appropriate, the damage codes (see Appendix #6) should be determined by a VRI certified photo interpreter or by other procedures subject to mutual agreement by the licensee and the District Manager.

2. Where the adjacent stand has insufficient area to reliably estimate the cruise attributes in the damaged stand, then the procedures outlined in section 2.10 (Comparative Cruising) may be utilized.

2.6.3 Cruising Road Rights-of-Way and Linear Tenures

The following procedures should be used to cruise rights-of-way:

1. Use existing standards and procedures.
2. Locate plot centres in a systematic linear fashion.
3. Where timber on road rights-of-way within a cutblock is removed under a road permit (R.P.) after the block is cruised, the cruise plots that are within the area of the R.P. shall be included in the cruise compilation for the cutting permit and the area of R.P. will be removed from the cruise compilation. Record R/W areas that are not part of the cutting authority in card Type H of the Map Area Statement.
4. Refer to Section 2.10 of this manual when comparative cruising is permitted by the *Interior Appraisal Manual*.

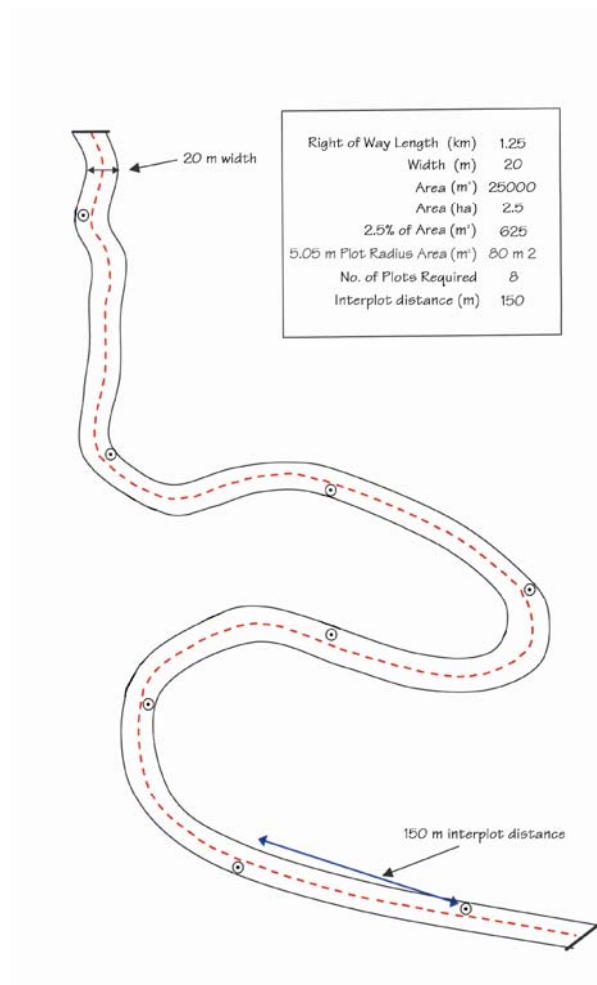


Figure 2.2 Sample Right-of-Way Cruise.

2.6.4 Cruising Partial Cut Silviculture Systems

The following sampling procedure must be used for cruising patch cuts:

1. Overlay a 100 m grid on the cruise plan map after the patch cuts are accurately located within the block and mapped.
2. 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.
3. 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.
4. Sampling must be confined to the harvest area.

Refer to the following web link in the *Cruise Compilation Manual* for more partial cut scenarios:

<http://www.for.gov.bc.ca/hva/manuals/percentreductionsenarios.htm>

2.6.4.1 Partial Cut Patches Greater Than or Equal to One Hectare

Overlay an appropriate grid interval over the patches that will sample the patches to design requirements.

Example - a 90 metre grid that achieves a sampling intensity of at least 1.0 plots per hectare. All patch cuts are at least 1.0 hectare.

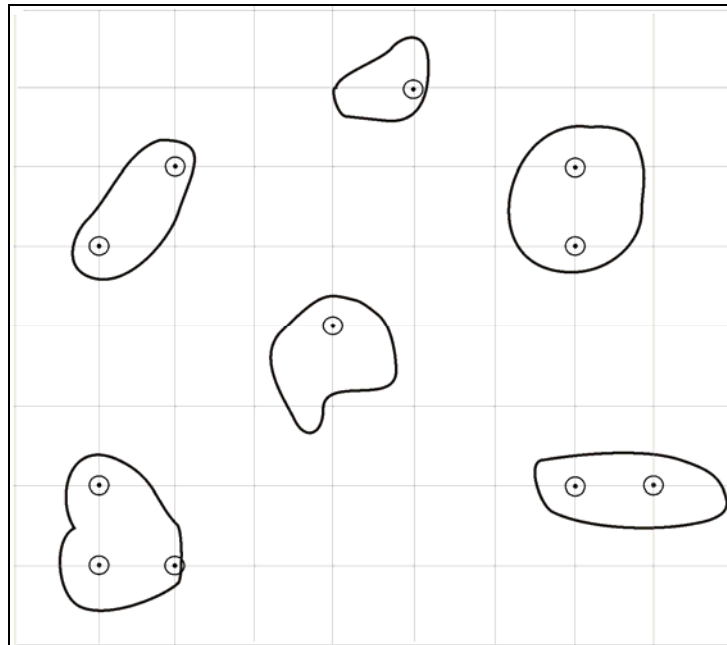


Figure 2.3 Patches Greater Than or Equal One Hectare.

2.6.4.2 Partial Cut Patches Less Than One Hectare Using Faller Selection

Overlay an appropriate grid interval over the gross block area that will sample the patches and the surrounding area to achieve the design requirements.

Example:

Gross Block = 30.0 hectares

STU A = Clearcut = 6 patch cuts = 9.0 ha

STU B = Partial cut = 12 patch cuts (A to L) = 5.0 ha

STU C - Clearcut (roads) = 1000 metres x 10 metres = 1.0 ha outside the patch cuts.

Percent Reduction

STU B = Partial cut harvest method = $30.0 - (9.0 + 1.0) = 20.0$ ha.

Therefore $1 - \left(\frac{5.0 \text{ ha}}{20.0 \text{ ha}} \right) = 75\%$ reduction.

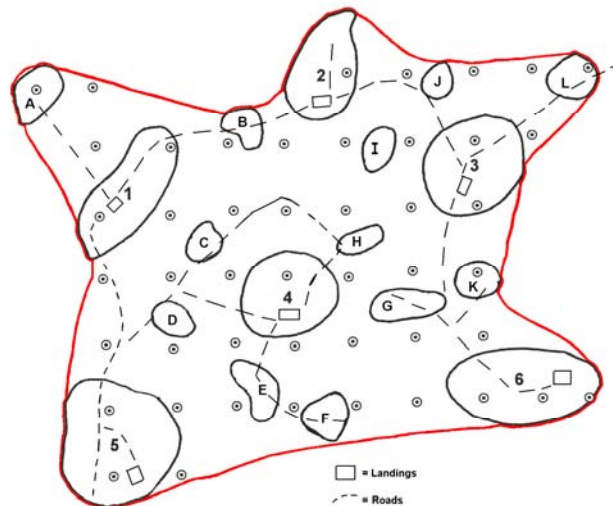


Figure 2.4 Patches Less than One Hectare.

2.6.4.3 All Patches Less Than One Hectare and Single Tree Selection Between the Patches

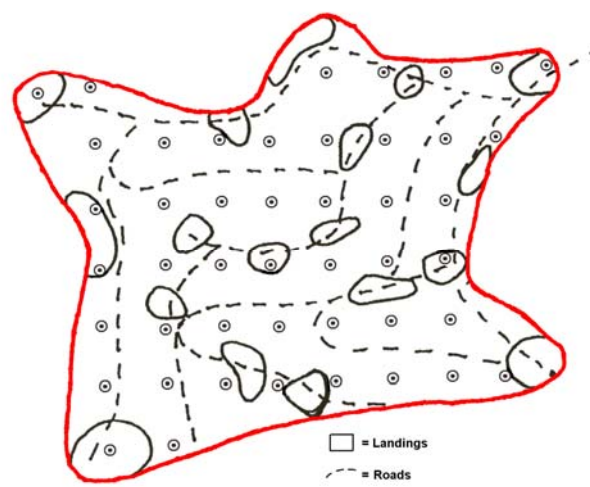


Figure 2.5 All Patches Less than One Hectare.

Overlay an appropriate grid interval over the gross block area that will sample the whole harvest area to meet the design requirements.

Example:

Gross Block = 30.0 hectares, one timber type, one block, species composition is Lodgepole pine, Douglas fir.

STU A = Partial cut = 18 patches = 6.0 ha

STU B = Partial cut = 30.0 ha – (6.0 + 2.0) = 22.0 ha

STU C = Clear cut (roads) = 2 000 metres * 10 metres = 2.0 ha outside of the patch cuts

Percent Reduction

STU A = Partial cut harvest method = 6.0 ha since all patches are less than 1.0 ha. Prescription is to leave all Douglas fir trees greater than the 35 cm class. Therefore, code the percent reduction worksheet:

Row #1 – Fir, Type 1, STU A, enter 100% in all of the diameter classes 40 cm and greater.

STU B – Partial cut harvest method = 22.0 ha. Prescription is to cut all PL beetle code 1, 2 and 3 trees outside of the patches and leave all fir trees. Therefore, code the percent reduction worksheet:

Row #2 – PL, Type 1, STU B, code I (insect) in the damage column (cut all beetle coded trees).

Row #3 – Fir, Type I, STU B, code 100% in all diameter classes.

STU C = clear cut = 100% cut.

2.7 Types of Cruises

2.7.1 One Hundred Percent Cruise

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

2.7.2 Fixed Area Plot Sampling

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.

2.7.2.1 Fixed Area 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:

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

t = probability factor

CV = coefficient of variation

E = error objective in percent

N = total possible number of plots in the sale

n = actual number of plots in the sale

$N-n/N$ = the finite population multiplier

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

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

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

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

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

	Type Area		Area X	Proportional	Weighted CV	
Type	Hectares	Av. Volume/ha	Av. Vol.	(Area x Vol)	CV	(P x CV)
F P1	12	272	3 264	0.43	30	12.9
P1	12	134	1 608	0.21	50	10.5
P1 F	16	171	2 732	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:

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

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:

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

Exact estimates of type size, volume and coefficient of variation are not necessary in advance of cruising to predict sampling requirements. Reasonable approximations are sufficient 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 cutblocks, and the basis for estimating the number of samples required to meet this objective is the forest types within the area to be cut and their relative volumes.

2.7.3 Variable-Plot (Prism) Sampling

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 Dbh) 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 relascope).

2.7.3.1 Variable Plot Sample Size

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

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

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

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

t = probability factor

CV = coefficient of variation

E = error objective in percent

n = number of plots

2.7.3.2 Coefficient of Variation (CV)

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

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

The coefficient of variation may be estimated from:

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

The CV is calculated as shown in the following example.

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

2.8 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.

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.

2.8.1 Measured Plots

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

2.8.2 Count Plots

Count plots are samples where only the tree species are tallied. All live and dead potential trees are tallied. 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.

The procedure for dealing with potential orphan trees (a species not recorded in a measure plot) in count plots during the fieldwork is to record the measure information for all of the orphan species trees in the first count plot where the orphan species is encountered. Then, move the tree(s) into the nearest measure plot in the same timber type. This will ensure that the same basal area factor has been used in the count and measure plots and that the orphan trees are maintained in the same timber type. If the orphan species is subsequently measured in a measure plot, then return the count plot orphan tree(s) to their respective count plot and remove the measure data from the tree(s).

Record the tree number as 99 (98, 97, etc. if required). Mark the tree numbers on the trees in the field and strike a line through the tree details on the count plot. Record the tree attributes in the nearest measure plot. 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.

2.9 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 Version 2.6’ at the following web link:

<http://www.for.gov.bc.ca/hts/vri/standards/index.html#photo>

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 type polygons must be contiguous and unique to each cutblock.
2. **Non-Forest Types:**  Describe area of non-merchantable timber. (i.e., rock,  swamp, **constructed linear tenure, creek, slide track and gravel pit**). These areas do not contain merchantable timber and are not sampled for appraisal. 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.

All forest and non-forest type areas must be identified on the cruise plan prior to field sampling and cannot change. Changes to forest reserves and STUs are permitted as specified in section 2.2. If forest or non-forest types are not identified on the cruise plan then each block must be compiled as a single forest type. Increased consistency in appraisal submissions will be achieved by restricting changes to forest and non-forest types.



Coast Forest Region - Regional Guidelines

9

9.1 Coast Area Operational Cruising Requirements

In all Cruising and Cruise Compilation Manuals, the term 'Coast Forest Region' means the 'West Coast Region and South Coast Region'. The terms 'Coast Forest Region Operational Cruising Requirements' and 'Coast Forest Region – Regional Guidelines' means the 'Coast Area 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. Ministry of Forests, **Lands and Natural Resource Operations**, *Cruising Manual*.
2. Coast Forest Region Operational Cruising Requirements (Chapter 9.1 of the *Cruising Manual*) and *Coast Call Grade Net Factor Standards and Procedures*:

<http://www.for.gov.bc.ca/hva/manuals/cgnf.htm>
3. Information letters from the Coast Forest Region as a result of the Coastal Cruising Seminars.
4. Ministry of Forests and Range Policy Manual.
5. *Forest Act*.

9.1.2 Tenures Requiring an Operational Cruise

All tenures subject to a stumpage appraisal must normally be cruised. The regional executive director may grant exemption to this requirement in specific cases.

9.1.3 Submission of Cruise Plans

9.1.3.1 Individual Cruise Plans

Licensees must submit cruise plans to the Ministry of Forests, **Lands and Natural Resource Operations** district office 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.

Cruise plans must be submitted to the appropriate district containing all mandatory information listed below.

District staff are not required to approve or disapprove cruise plans.

Submission of cruise plans is required to allow the district to know how much cruising is being done, when and where, so they can conduct the necessary check cruising and to provide a basis for comparison against the final cruise and appraisal maps.

The following information is mandatory on a cruise plan:

- tenure, including block numbers,
- area (ha) by block,
- inventory timber types (i.e, HB 941-M)
- plot grid (i.e., 100 m by 100 m),
- number of measure and count plots or ratio of measure plots to count plots,
- dates of cruising,
- cruise plan map which meets the cruise plan requirements in Section 3.1.7.1,
- access (vehicle, helicopter, boat, plane, etc.)
- block maturity (if known), and
- who the cruiser(s) will be (if known).

All other information is optional, unless specified by contract, but will assist the district or BC Timber Sales (BCTS) 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 this manual, in the chapter called Forms, however, any form that includes the necessary information is acceptable.

Cruise plans must be emailed to the district office.

The scale of the cruise plan map cannot exceed 1:5 000.

9.1.4 Acceptability of Cruise Data

9.1.4.1 Check Cruising

9.1.4.1.1 Benefit of the Doubt

Cruising and its related measurements can involve subjectivity.

Decisions based on opinion or a range of acceptable values, where no clear decision can be made based on fact, will be accepted based on the adage “the benefit of the doubt goes to the operator”. Due diligence must be recognized by the check cruiser. Due diligence is the standard of care that a reasonably prudent person would take in those particular circumstances. The intent of “Benefit of the Doubt” is not to condone poor quality work errors.

Once a cutting authority area has been selected for check cruising, the licensee must bring along or supply the district with a map and field notes which allow the ministry check cruiser to check actual plot locations, timber types, POC(s) and tie-point(s).

The plots to be checked must be randomly selected without reviewing the cards to determine which plots will be checked, or the results on the checked plots cannot be applied to the rest of the plots for that cruise.

If the check cruiser decides to only check a specific part of a cruise (i.e., timber type, type of plot, cruiser) the results of that check cruise can only be applied to that part of the cruise that was specifically checked (i.e., timber type, type of plot, cruiser).

With the submission of cruise plans well in advance of the commencement of cruising, the Ministry of Forests, **Lands and Natural Resource Operations** 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 at any time after the cruise is completed.

- b. A 70 meter by 70 meter, systematic grid has been established, a ratio of one count plot to one full measure plot has not been exceeded and the minimum tree count requirement of an average of 2.0 trees per plot has been met.
 - c. A 50 meter by 50 meter, systematic grid has been established, a ratio of one count plot to one full measure plot has not been exceeded and the minimum tree count requirement of an average of 1.0 trees per plot has been met.
2. For cutting authorities less than 20 ha in size:
- a. A 100 meter by 100 meter, systematic grid of full measure plots has been established and the minimum tree count requirement of an average of 4.0 trees per plot has been met.
 - b. A 70 meter by 70 meter, systematic grid of full measure plots has been established and the minimum tree count requirement of an average of 2.0 trees per plot has been met.
 - c. A 50 meter by 50 meter, systematic grid of full measure plots has been established and the minimum tree count requirement of an average of 1.0 trees per plot has been met.
 - Excludes live useless and dead useless trees.

If more than one cruise plot grid is used in a cutting authority then the minimum tree count requirement must be achieved individually for each of the grids before the sampling error is waived.

The number of trees per plot is calculated to the nearest tenth and not rounded up to the nearest whole number (i.e., 3.6 does not round up to 4).

Cruise Based Sales

Cruise based sales will only be approved when the Regional Executive Director, 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 Executive Director 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 Section 8.16 of the *Ministry of Forests and Range Policy Manual*, which is located on the Internet at:

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

9.1.5.2 Sampling Patterns

The cruise grid must be square or rectangular and oriented in cardinal directions (N-S, & E-W) (unless otherwise approved by the district in a cruise plan). Do not use a staggered grid.



The direction of travel between plots is at the discretion of the cruiser, but must be clear to the ministry check cruiser.

9.1.5.3 Plot Data

All information on the Ministry of Forests and Range cruise tally sheet (FS 205) relevant to the appraisal and compilation of the data must be collected.

It is recommended that quality remarks (live limb, stub, knots, and spiral grain) be collected on all cruises in case they end up being required for appraisal purposes.

Where age collection is necessary, sufficient ages must be taken to record the appropriate tree class for proper loss factor determination.

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