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August 4, 2009

BY EMAIL

To: Regional Executive Directors

From: Murray Stech
Director
Revenue Branch

Re: Amendment No. 1 - *Cruising Manual*

I hereby approve the *2009 Cruising Manual* and attach a copy for your use.

These changes were undertaken to improve sampling efficiencies.

Please refer to Appendix I for the description of the principle changes.

This manual is effective August 1, 2009. Further amendments or revisions to this manual require my approval.



Murray Stech
Director
Revenue Branch

Attachment: *2009 Cruising Manual – Amendment #1 & Procedural Interpretations for the CGNF Standards and Procedures for the Coast Forest Region*

The changes to Chapter 2 are not highlighted, as much of the change involves only rearranging and reformatting the information. The actual changes in content are described in Appendix I.



Appendix I

The primary changes undertaken in Chapter 2 are as follows:

The increased use of count plots in scale and cruise based cutting authorities that include use in partial retention harvest systems.

Increased compatibility of the cruise design standards between the coast and interior.

The use of variable radius plots in the measurement of timber on road rights of way and linear tenures and increased flexibility with respect to grid design.

The addition of a new cruise grid placement procedure and sample diagram.

Reorganization and word edits to improve the presentation and understanding of the cruise design standards.

Figure 3.2 – The “sample” final cruise map is updated to coincide with the new cruise grid placement procedure.

Section 3.6.2 – The 30 day notice for cruise plan submission has been removed.

Figure 4.1 – Housekeeping.

Section 9.1.3.1 – The section is updated to ensure continuity between the interior and coastal cruise plan map standards.

Section 9.1.4.1.1 – The 30 day notice for cruise plans is removed.

Appendix A.4.2 – The section is clarified to indicate when pathological indicators will be recorded on dead potential trees.

FS693 – House-keeping and a statement is added to submit the cruise plan form and map in digital format.

FS694 – Housekeeping.

CGNF Standards & Procedures, Interpretations – Questions and answers have been added to describe solutions to some field situations that were encountered in 2008/09.

FOR FURTHER INFORMATION OR IF YOU HAVE A CHANGE OF ADDRESS, PLEASE CONTACT: Don Rorison Cruising Projects Specialist Revenue Branch Ministry of Forests 1st Floor, 1520 Blanshard Street Victoria, BC V8W 3K1 Phone: 250 – 356-7674 Email: Don.Rorison@gov.bc.ca FAX: 250 - 387-5670	MANUAL TITLE	
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Please make the following changes to your copy of the above Ministry manual.

ACTION (Remove/Insert)	(VOL.) CHAPTER-SECTION-SUBJECT		
	TABLE OF CONTENTS	PAGE(S)	COMMENTS
Remove	Table of Contents	1 - 6 9 - 10	After Highlights Tab
Insert		1 - 6 9 - 10	
Remove	Chapter 2	1 - 30	After Chapter 2 Tab
Insert		1 - 28	
Remove	Chapter 3	7 - 8 37 - 38	After Chapter 3 Tab
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Remove	Chapter 4	3 - 4	After Chapter 4 Tab
Insert		3 - 4	
Remove	Chapter 7	15 - 16 23 - 24	After Chapter 7 Tab
Insert		15 - 16 23 - 24	
Remove	Chapter 9	1 - 4	After Chapter 9 Tab
Insert		1 - 4	
Remove	Forms	1 - 4	After Forms Tab
Insert		1 - 4	
Remove	Appendix	19 - 20	After Appendix Tab
Insert		19 - 20	
Remove	Index	1 - 2	After Index Tab
Insert		1 - 2	
INSERT	Letter from Minister and Transmittal Sheet		After Amendments Tab

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Cruise Design

2

2.1 Cruise Objective

The objective of the timber cruise is to obtain an unbiased estimate of the volume and quality of timber on a cutting authority area to a specified confidence interval or sampling intensity. The area cruised may be one or multiple cutblocks that will be appraised in one cutting authority and subject to one appraisal.

The information from the cruise is applied as follows:

1. For scale-based sales, the cruise provides the basis for determining the stumpage rate while the amount invoiced is based on the scale.
2. For cruise-based cutting authorities, both the estimate of the stumpage rate and invoicing are based on the cruise.
3. In special cases, such as salvage sales, small sales and right-of-way sales, cruising standards may be varied by the Regional Executive Director in accordance with Chapters 4 and 6 of the *Coast Appraisal Manual* and *Interior Appraisal Manual*.

2.2 Cruise Plans

It is *mandatory* for licensees and Timber Sale Managers to submit plans to the District Manager prior to the commencement of a timber cruise. Plans are required for new or amended cruises. The District Manager does not approve cruise plans.

The plan is submitted to MFR staff to allow for the development of field quality assurance schedules and to provide a basis for comparison against the final appraisal map.

Cruise plans must contain the items specified in:

- Section 3.1.7,
- Forms section - FS 693 and 694, and
- Figure 2.1.

The cruise plan is a professional document that forms the basis for the statistical sample. It identifies 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 MFR that the data supplied to the appraisal was collected in an unbiased manner, however, like any plan, unforeseen circumstances may necessitate a change to the plan.

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

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 will have assessed the impact of the alterations against the principles of sampling identified in these standards. The submitting forest professional will submit a record of all relevant information that was used to develop the original cruise plan and final appraisal map. This model is consistent with the direction of professional reliance.

The District Manager will review each 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.

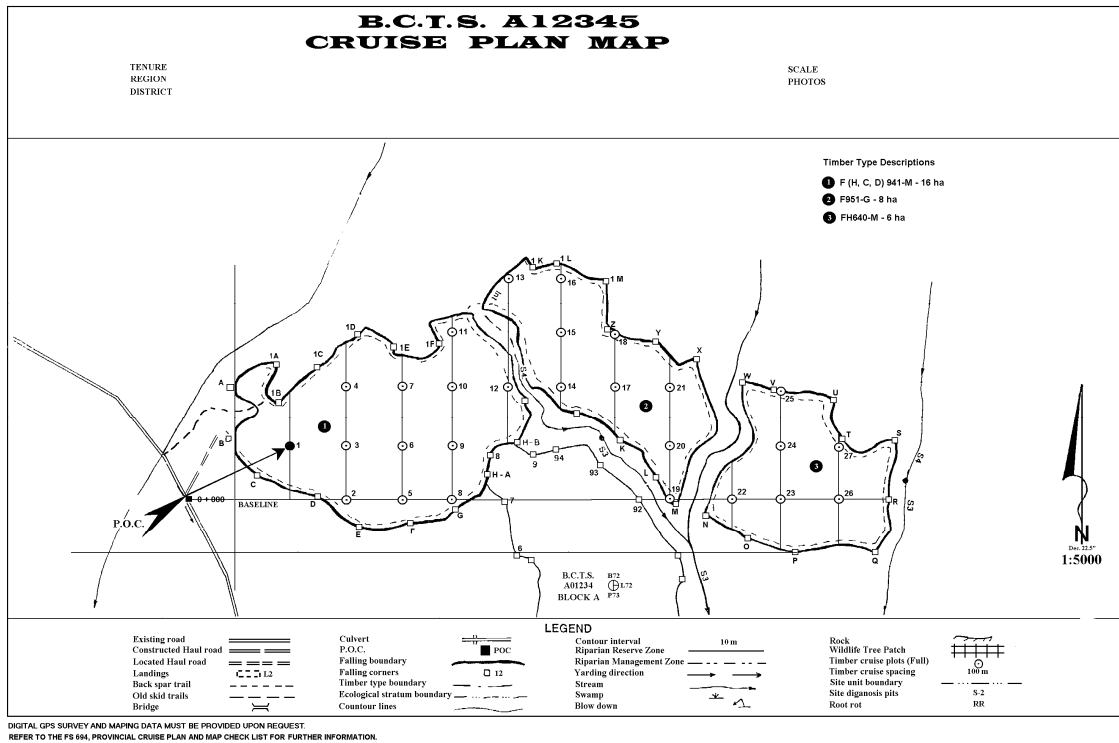


Figure 2.1 Sample Cruise Plan Map.

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 establish 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.

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. For cutting authorities less than 20 ha in size:

- a. A 100 metre by 100 metre, systematic grid of full measure plots has been established and an average of at least 4.0 trees per plot has been met.
- b. A 70 metre by 70 metre, systematic grid of full measure plots has been established and an average of at least 2.0 trees per plot has been met.
- c. A 50 metre by 50 metre, systematic grid of full measure plots has been established and an average of at least 1.0 trees per plot has been met.

2.4.2 General Cruise Based Cutting Authorities

The following standards apply to all cruise based cutting authorities.

1. 8% at 2 S.E. on all plots, and
2. If count plots are used, then a 2 S.E. of 12% on full measure plots must be achieved.

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

For further guidance, refer to the Provincial Cruise Based Policy at the following Internet site:

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

2.5 Sampling Patterns – General Conditions

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

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

Plots cannot be moved.

2.5.1 Sampling Patterns

In systematic sampling, plots are established at fixed intervals with a minimum of two full measure plots per timber type. The sampling grid spacing must be the same within each timber type.

The preferred method of establishing plot locations is to use a computer (GIS) generated grid covering a large geographic area such as a watershed or a landscape unit. If a grid system is not available, then 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. You can start at any identifiable tie-point and tie-in to the nearest plot.
- ii. If count plots are used in the cruise design then the plot closest to the point of commencement must be a measure plot.

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

2.6 Other Timber Cruising Conditions

This section describes the timber cruising procedures that are required for situations where timber must be re-cruised, cruise plots must be added to an existing cruise to meet sampling error, 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 Adding Plots to a Cruise to Meet Sampling Error

Where plots must be added to an existing cruise to meet the sampling error requirement, they must be located in a systematic random fashion. It is recommended to target the timber type(s) that has the highest variability. Determine the number of additional plots required using the coefficient of variation calculation from the statistical summary report. As a safety margin, it is recommended to increase the number of plots by 10%.

The following procedures should be used to establish the additional plots:

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. Old Cruise Design
 - a. Additional plots must be systematically located on the existing cruise strips.

2.6.4 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 2.9 of this manual when comparative cruising is permitted by the *Interior Appraisal Manual*.

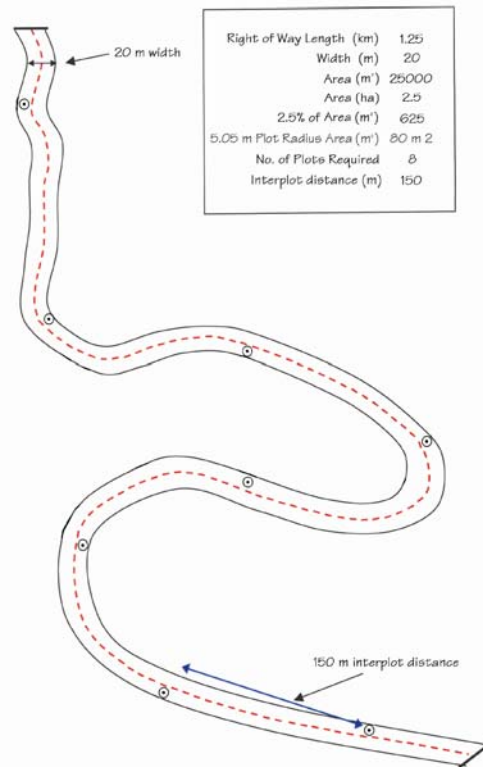


Figure 2.2 Sample Right-of-Way Cruise.

2.6.5 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>

2.6.5.1 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.

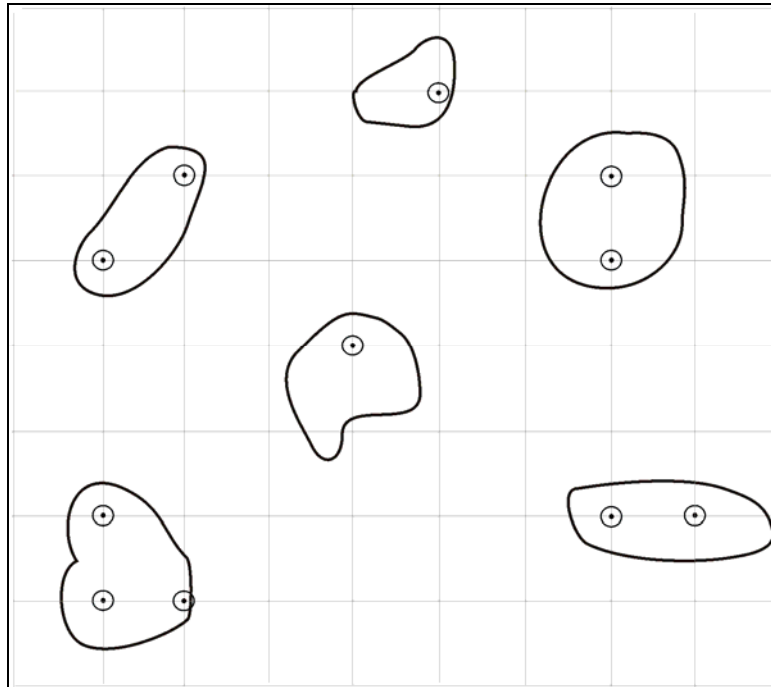


Figure 2.3 Patches Greater Than or Equal One Hectare.

2.6.5.2 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.

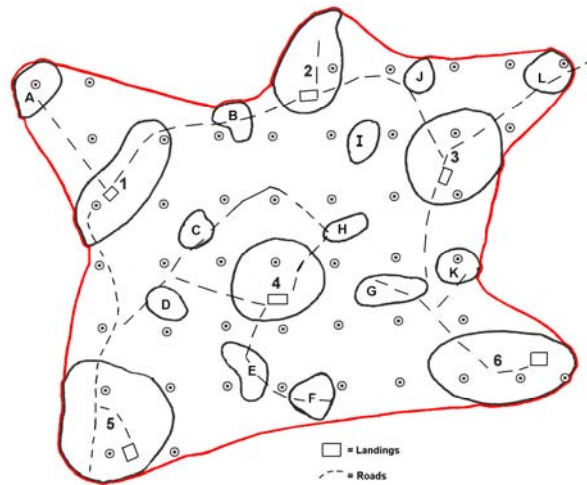


Figure 2.4 Patches Less than One Hectare.

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

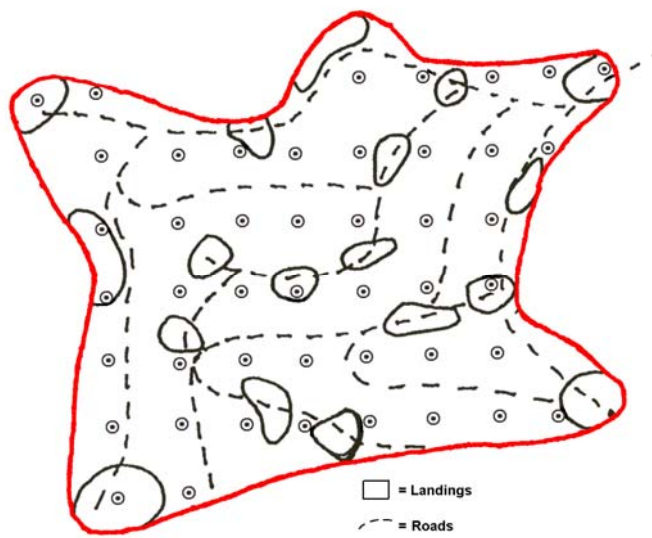


Figure 2.5 All Patches Less than One Hectare.

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:

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

Exact estimates of type size, volume and coefficient of variation are not necessary in advance of cruising to predict sampling requirements. Reasonable approximation are sufficient to establish correct relative intensities of sampling for each type.

The sampling error objective (e.g., *plus or minus 15 percent*, 19 times out of 20) for scale based cruises is for the total volume of the 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.

Figure 2.2 illustrates how count plots must be recorded if they are used for cutting authorities that have different appraisal and merchantability specifications:

[illegible]

Figure 2.6 Sample Cruise Tally Sheet (FS 205) – Card Type 9.

2.9 Forest Typing

Forest types must be kept fairly broad. There is a common tendency to overtype which nullifies any increases in sampling error achievement.

Forest type islands must not be smaller than 1.0 ha unless the block is less than 1.0 hectare and then the type area can match the block area. Brush patches smaller than 1 ha are normally left in the forest type and sampled. Non-productive types, and other small areas reserved from harvesting, should be typed the same as the partial cut source documents. All types that contain merchantable timber must be sampled unless the timber is reserved from harvesting in the partial cut source documents.

If typing changes after the cruising field work, cruisers may need to revisit the cruise plots in the field to ensure they are not influenced by these changes. Good traverse notes may reduce the need for cruisers to re-visit cruise plots.

Use the following methodology for stratification:

1. During cruise design:
 - a. aerial photograph interpretation, or
 - b. the most recent forest cover maps,
2. During field sampling:
 - a. The type lines must be documented in the traverse notes.
 - b. If the transition from one timber type to another is very gradual, then the type line must be drawn equidistant from dissimilar timber types.
 - c. If non-forest types are stratified out of the harvest area, then they must not be sampled.

2.9.1 Minimum Plots/Timber Type

The Average Line Method of Compilation requires a minimum of two measure plots per timber type.

When a grid results in one plot in a timber type, then the second plot will be located according to the following procedure:

1. Locate the second plot one half of the inter-plot spacing along the strip line in the current direction of travel from the single plot in the type. If the plot is still not in the timber type, then

2. Locate the second plot one quarter of the inter-plot spacing along the strip line in the current direction of travel from the single plot in the type. If the plot is still not in the timber type, then
3. Continue steps 1 or 2 at ninety degrees clockwise from the strip line until the second plot can be established.

2.10 Comparative Cruises

While the *Interior Appraisal Manual* determines the situations **when** comparative cruise data **may be** used for appraisal purposes, the overriding principle of “***if there is time to perform a full cruise, then the timber will be cruised***” **shall be followed**

1. Definitions:

New Cutting Authority (NCA): the area affected as a “catastrophic event” (i.e., Mountain Pine Beetle infestations, severe blowdown, etc.) that is to be appraised.

Parent Cutting Authority: a cutting authority that has been previously cruised which supplies the cruise data that will be “borrowed” and recompiled for the appraisal of the “New Cutting Authority”.

Insufficient Time to Harvest: when a delay in harvesting will severely impact quality and quantity of timber to be harvested.

2. Factors for Determining the Level of Data Required:

The following matrix is to be used as a guide to determine the amount of work and the level of data required to justify use of a specific comparative cruise.

Factors	Condition	Points	Condition	Points	Condition	Points
New Cutting Authority size m ³	>100 000	15	20 000 – 100 000	10	< 20 000	5
Catastrophic Event Type	None	10	Beetle	5	Unsafe to Cruise	2
Percent beetle in stand	< 25%	3	25% - 75%	2	> 75%	1
Cruise Types Similarity	Dissimilar	3	Similar	2	Very Similar	1
Species & size variability	Variable	3	Average	2	Uniform	1
Sufficient time to harvest	Some	15	Little	5	No time	1

0 to 13 points	A minimum of 2 plots per timber type in the New Cutting Authority.
14 to 23 points	A minimum of 6 plots per timber type in the New Cutting Authority.
> 23 points	Full Cruise of the New Cutting Authority.

3. Requirements to ensure that the New and Parent Areas are Comparable:

Levels of data/work required:

The factors in Section 2 above determine the level of the data required. The levels of work required based on individual situations are:

- a. Ten plots in the “NCA” with a minimum of two plots per type (0 - 13 points).
- b. Twenty plots in the “NCA” with a minimum of six plots per type (14 - 23 points).
- c. A full cruise (as per Section 2.1.2 of the *Cruising Manual* - > 23 points).

Other requirements:

- a. Both Parent and NCA cruise must be in the same biogeoclimatic subzone, FIZ, PSYU, Wet or Dry Belt.
- b. If the comparative cruise is for a beetle damaged stand the timber species impacted must exceed 70% of the total stand net volume (volume based on sample plots taken on NCA area).
- c. The parent cruise must not be older than five years for immature timber and ten years for mature timber.
- d. The Provincial Comparative Cruise Checklist (FS 698) of the *Cruising Manual* is to be used in comparing the new and parent cruise’s data.
- e. Parent Cutting Authority and the NCA piece size [Merch Vol/Tree (m^3)] must be similar. **BOTH DATA SETS MUST BE $> 0.20 \text{ m}^3$ OR $< 0.20 \text{ m}^3$.**

THERE SHALL BE NO VARIATION FROM THIS REQUIREMENT.
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4. Pre-planning:

- a. The licensee must request in writing the use of a comparative cruise and must meet with MOFR District staff to determine the level of field work to be completed prior to the approval of the request for the use of comparative cruising.
- b. Written request must include the following:
 - i. The application to use comparative cruising in lieu of a full cruise must meet the requirements of the *Interior Appraisal Manual* and all other requirements as outlined in Section 2 above.
 - ii. The licensee shall submit a cruise plan as per the *Cruising Manual* for plots to be established within the “NCA”.
 - iii. A list of all cutting authorities and the specific timber types that may be used in the comparison must be provided to the MOFR.

5. Field Procedures:

- a. All plots in the “NCA” must be established using an unbiased systematic grid and must be representative of the timber type areas.
- b. All cruise plots will be full measure variable radius plots. Plot prism size must be consistent throughout the type and must be chosen so that there is a minimum average of five merchantable coniferous trees (live and/or dead potential) per plot.
- c. All measurements in the “NCA” plots including slope and damage codes must be done as per the cruising requirements as set out in this manual.

The damage codes recorded in the “NCA” plots will be brought forward to the parent cruise data and the same percentages will replace the parent damage coding.

The recorded slope of the “NCA” plots shall be averaged and brought forward to all the parent plot slopes.

- d. There must be a minimum of two tree ages measured for the leading species of every plot and 1 age taken for all other species.
- e. Field checking of comparative cruise areas will be expedited so that forest operations will not be delayed unnecessarily.

6. Data Submission:

The licensee shall submit the following information to the District Manager:

- a. A complete cruise plan form (FS 693) for the “NCA” - prior to commencing field work, and the original cruise plan for the parent cruise.
- b. Two maps; a location map showing the “NCA” area in comparison to the Parent cutting authority(s) location; and cruise plan map for the “NCA”.
- c. All field cruise cards and strip traversing notes for the Parent and “NCA”.
- d. Digital cruise data files for the Parent cutting authority (as per Section 4.6.1 of the *Cruising Manual*), and digital files for the sample plots for the NCA.
- e. Full cruise compilations for the Parent and “NCA” – including data listings (i.e., Parent Full Volume, “NCA” Full Volume, “NCA” Factored Compilation, etc.).
- f. Schedule B for residue and waste issues for the “NCA”.
- g. A completed copy of the Provincial Comparative Cruise Checklist (FS 698).

7. Compiling Procedures:

All compilations used for comparison cruising purposes must be compiled using the most recent version of an approved cruise compilation program.

- a. It is acceptable to select timber types from different parent cruises. If there is more than one type in the new cruise, the selected parent cruise(s) must be recompiled using the comparative parent type averages and the new cruise type areas.

A full volume compilation of the original cruise data must be submitted for each parent timber type selected

- b. Once the “appropriate” parent cruise type has been selected and approved for the comparative cruise, the original parent cruise data must be compiled to the new cruise areas.

The timber type may be the whole CP if one type (this must be jointly agreed to between the licensee and the district). **The parent data type shall have a minimum of 10 plots to be eligible to be used as a parent data set.**

For example, the original parent cruise is 143.5 ha, and the NCA is 75.2 ha. The area (ha's) in the new compilation submitted for appraisal purposes must be equal to the NCA area (75.2 ha).

- c. The District will review the submitted information to ensure that the parent and new cruises meet the standards for comparative cruises as described in the *Cruising Manual* and in the Provincial Comparative Cruise Checklist.

8. Accountability:

The Licensee shall record and submit to the Ministry of Forests and Range the rationale for choosing the data used in selecting a “Parent Cruise”. This document will be reviewed by District staff and will be attached to the cutting authority file.

9. Data Review and Acceptability:

- a. The comparison MAY be made by using either cutting permit or type summaries of similar sales, NOT block summaries.
- b. The following parameters shall be compared to those from the established statistical cruise in the same area which is intended to be used for the comparison:

Criteria	Acceptability Parameter	Critical Value (High – Medium)
Major Species Composition	$\pm 5 \%$	HIGH
Minor Species Composition	$\pm 10 \%$	MEDIUM
Net Merch. Vol/ha	$\pm 10 \%$	HIGH
Average DBH	$\pm 10 \%$	MEDIUM
Average Height	$\pm 10 \%$	MEDIUM
PIECE SIZE Merch. Vol/tree (m ³)	$\pm 10 \%$	HIGH
Stems/ha	$\pm 10 \%$	MEDIUM
Average LRF	± 5 points	HIGH

- c. The NCA data shall be compared to the “parent” data to determine whether it falls within acceptability parameters listed above.

Comparative data may be accepted if all High Valued criteria parameters are met. The Medium Valued criteria “may” be varied by an additional 10 % after consultation with District staff.

- d. The Forest Officer responsible for cruising in a district shall make a decision as to whether to use similar data on its own, or establish more plots to supplement the cruise; based on the outcome of the comparative cruise.

10. Reporting:

Licensees shall report to the district the harvested and R & W volumes for the cutting authority once harvesting is completed. This provides feedback to the district and licensee on the reliability of the parent to NCA data selection and assists in refining the comparative cruise methodology.

3.1.6.1 Combined GPS and Conventional Traverse Procedure

To calculate the closing error for traverses where you have a combination of conventional traversing (using a compass, clinometer and metric tape or electronic measuring device) and Global Positioning Systems (GPS) traversing:

1. Calculate the bearing and distance between the first GPS point (end of conventional traverse) and the last GPS point (beginning of conventional traverse).

On the Internet go to:

<http://aardvark.gov.bc.ca/apps/mascotw/>, and:

- a. select Survey Utilities,
 - b. select Computations on the Ellipsoid,
 - c. select Compute Geodetic Observations using the Inverse Problem,
 - d. input the latitude [Degrees (45-65), Minutes (00-59), Seconds (0.00000-59.99999)] of the first GPS point under OCCUPIED,
 - e. input the longitude [Degrees (109-145), Minutes (00-59), Seconds (0.00000-59.99999)] of the first GPS point under OCCUPIED,
 - f. input the latitude [Degrees (45-65), Minutes (00-59), Seconds (0.00000-59.99999)] of the last GPS point under SIGHTED,
 - g. input the longitude [Degrees (109-145), Minutes (00-59), Seconds (0.00000-59.99999)] of the last GPS point under SIGHTED, and
 - h. click on “Do Calculation” or hit the “Enter” key and the program will calculate the Azimuth bearing and the distance between the two GPS points.
2. Option to calculate the conventional azimuth bearings from UTM Northing and Easting GPS readings:
 - a. select Survey Utilities,
 - b. select Mapping Plane Computation,
 - c. select Compute Grid Observations using the Inverse Problem,
 - d. input the Northing of the first GPS point under OCCUPIED,
 - e. input the Easting of the first GPS point under OCCUPIED,
 - f. input the Northing of the last GPS point under SIGHTED,

- g. input the Easting of the last GPS point under SIGHTED, and
- h. click on “Do Calculation” or hit the Enter key, and the program will calculate the azimuth bearing and the distance between the two GPS points.

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

3. Use the calculated bearing and distance between the first and last GPS points to close the conventional portion of the traverse and determine the closing error.
4. The closing error determined in Step 2. is used to determine if the traverse meets the closure error requirement in Section 3.6.3.

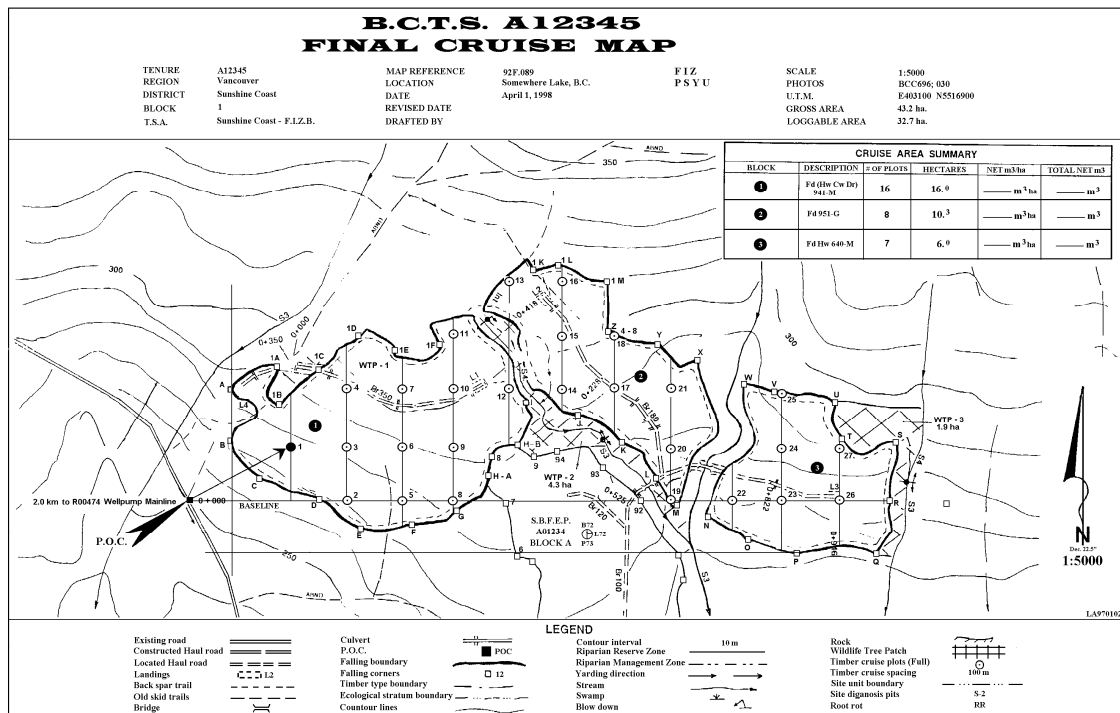


Figure 3.2 Final Cruise Map.

3.6 Check Cruising

If requested by the Ministry of Forests and Range for checking purposes the licensee or consultant shall submit the originals of all the cruise tally sheets, cruise map and traverse notes. All required fields on the cruise tally card must be completed if a cruise compilation check is performed. If magnetic data is requested it must contain the Map Area Statement completed as per Chapter 7, the percent reduction data and followed with the tally sheet listed in numerical order, and shall be submitted electronically in ASCII format.

3.6.1 Data Replacement and Responsibility for Data

All cruise tally cards must be signed and dated by the original cruiser and as appropriate the check cruiser.

Any changes made to plot card data after the original cruise must be initialled and dated by the person making the change.

Any data that was changed must be reflected in the appraisal compilation.

If a re-cruise has been performed, then the cruiser will mark the date that they re-cruised the plot on the reference tree.

A field or compilation check does not preclude a check cruise at a later date by Ministry of Forests and Range staff.

3.6.2 Objectives of Check Cruising

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

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

1. All measurements shall be accurately and carefully taken. Personal bias must be eliminated and each classification determined fairly and honestly.
2. Magnitude of sampling errors should be calculable.
3. All measurements must be made with instruments of proven accuracy, and they must be calibrated regularly.

The field check should be performed while the production cruisers are on site provided that an acceptable cruise plan was submitted to the appropriate district office **prior to** the commencement of field work. The licensee and cruising agency must be given the opportunity to attend the check **cruise** .

3.6.2.1 Risk Management

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

1. Check the greater of:
 - a. Ten percent of the cruise plots in the cruise.
 - b. Five measure or four measure and two count plots.
 - c. Twenty trees, including their heights and diameters.
2. Randomly select plots to check each cruiser's work.
3. Compare the cruise plan map with the cruise strip traverse notes and the final cruise map to verify that the timber type lines and cutting boundaries are correct. Verify that the cruise plots used in the compilation are not within wildlife tree patches (WTP) and non-forest areas, and that these areas are mapped according to the traverse notes. It is important to determine the reason for the addition or deletion of all cruised plots. If the placement of wildlife tree patches (WTPs) causes a cruise plot to be deleted, and it appears that the location of the WTP is not environmentally sound, an explanation by the licensee is required. It is recommended that a written explanation be obtained defending the location of the WTP.
4. At least one plot interval distance check per cruiser.
5. Emphasis in the plot measurements must include tree count, trees species, tree heights risk groups, diameters at breast height (DBH), and plot slope.
6. Boundary and type-line checks will contribute the equivalent of three cruise plots to the check cruise for each one-half day spent checking boundary and type lines.

The following should be used in establishing check cruising priorities:

1. Cruiser's past performance,
2. Cruiser's experience,
3. High value timber (as determined by species selling prices in the Coast Appraisal Manual or Interior Appraisal Manual),
4. Licensee's Allowable Annual Cut in the district.

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

In order to obtain volume per hectare it is necessary to measure DBH on all or some of the samples, and enough tree heights to be able to assign a height to all trees which have been measured for DBH. There are several possible methods of calculating volume per hectare, depending on the method of sampling used and the kind and amount of information required (e.g., total volume per hectare, volume per hectare by species, number of trees per hectare either total, by species or by diameter classes).

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

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

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

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

The volume of a tree of given DBH and height is determined from a standard volume equation (Newton's) and multiplied by the number of trees per hectare which each counted tree represents (e.g., a prism having a basal area factor of 4, plot radius factor of 0.25) counts one mature fir tree in the Interior (residual) which has a 30 cm DBH and is 21 m tall. Each 30 cm DBH, tree represents 56.59 trees per hectare. The whole stem volume of this tree is 0.525 m³.

Therefore, the whole stem volume per hectare represented by this one counted tree is

$$56.59 \frac{t}{ha} \times 0.525 \frac{m^3}{t} = 29.73 \frac{m^3}{ha}$$

. It is then necessary to reduce this volume to gross and then net merchantable volume by calculating first the gross volume between stump-height and the merchantable diameter, dib, for the top log to determine the gross merchantable volume and then applying the loss factors for decay, waste 2 and breakage (or, in some cases, decay and breakage only) to arrive at the net merchantable volume.

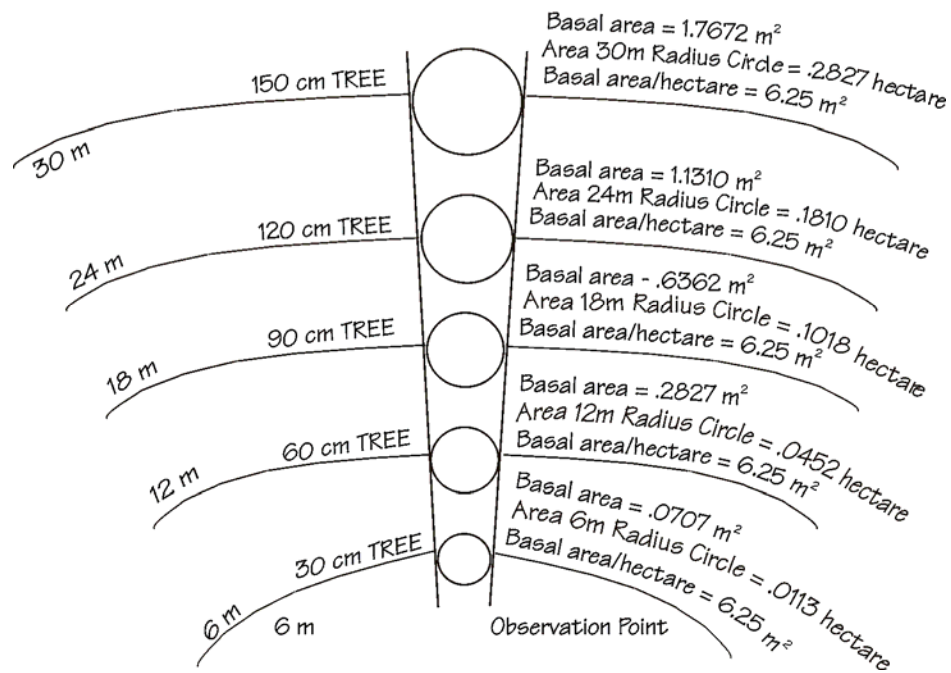


Figure 4.1 Illustration of Basal Area/Hectare.

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

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

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

One exception is the portion of the Kalum Forest District west of the Cascade Mountains administrative line in coastal FIZ A utilizes Interior appraisals. This area is permitted to use 5 m logs for interior appraisal purposes.

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

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

Positions 30 to 44

Exception Number 1.

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

Positions 45 to 59

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

Positions 60 to 74

Exception Number 3.

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

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

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

The average line (type average) method of compilation uses all plots from the timber type that are common to all blocks in a cruise. The average line method must be used for all appraisal cruises.

The block method uses only the plots in the timber type within the block or the plots in the timber type within the harvest method. This method is no longer **approved** for appraisal **cruising**.

If a reduction by block is required by the prescribing forest professional, then the timber types that are common to more than one block will need to be assigned unique timber type numbers so that the timber types are unique to the blocks.

On the coast, if there are immature and mature block combinations that require different timber merchantability specifications by block, then the timber types that are common to more than one block will need to be assigned unique timber type numbers.

7.4 Card Type D

Position 1 Block Description

▶▶ The Card Type D must have an entry for each type ▶▶ within each block. The number of blocks entered must equal the numerical entry in positions 11 to 13 of Card Type A.

Positions 2 to 10

Common to all Card Types.

Positions 11 to 13 Block No.

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

Position 14 to 15 Type No.

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

Position 16 Coast Block Maturity Indicator

I	Immature
M	Mature

If the percent immature in the block summary or appraisal summary of the post reduction compilation is 50 percent or more, then the block must be compiled to immature merchantability requirements by coding this indicator as I. If the percent immature is reported as less than 50 percent, then the block must be compiled to mature merchantability requirements by coding this indicator as M.

Position 17 to 21, 22 to 26, etc.

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

The number of Silviculture Treatment Units (STUs) has been expanded from 12 to 99 STUs effective June 1, 2005.

7.5 Card Type E

Position 1

Height/DBH Description - Stump Cruises & Severely Damaged Stands

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

1. The sample trees for one major species occurring in two or more types (keep in mind the rules in Section 3.5.3.4) can be combined into one equation, which will be applied against all trees of that species for the designated types.
2. The sample heights for two or more different species exhibiting similar growth characteristics can be combined into one equation so that all trees of the species indicated will have their heights calculated by this one equation.
3. One species may be so minor that no sample heights were taken and this card can designate which height equation should be used to calculate heights for this species. It is recommended that all minor species sample trees be measured or estimated where gathering enough height samples is not practical.

Examples:

HEIGHT/DIAMETER DESCRIPTION																																													
CARD TYPE														CALC. HT. ONLY	SPECIES USED	FOR THESE SPECIES							TYPE USED																						
																SP. #1			SP. #2			SP. #3																							
	11	12	13	14	15	16	17	18	19	20	21	22	23			24	25	26	27	28	29	30		31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46						
1	EXAMPLE																																												
E				1		0	F	B						0	1																														
E		DUPLICATE FROM ABOVE																																											
E				2		0	P	A	P	W	P	Y			0	3	0	4																											
E				3		1	P	A	L						0	3																													
E				4		0	F	C		H		B			0	1	0	2	0	3	0	4																							
E						0	F	S		P	L	C	T		0	1	0	2	0	3	0	4																							
E						0	F	B	1						0	1	0	2	0	3	0	4																							
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Figure 7.3 Height/Diameter Description Card.

Coast Forest Region - Regional Guidelines

9

9.1 Coast Forest Region Operational Cruising Requirements

9.1.1 Information Sources Regarding Policy and Procedures

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

1. Ministry of Forests and Range, *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 and Range 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 may be faxed 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 and Range 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.



Forms

The following forms with FS numbers are provided in a fillable format that can be downloaded from the Internet. The FS 693 Provincial Cruise Plan and FS 698 Provincial Comparative Cruise Checklist are the only forms that are available to the public. The FS 694 Provincial Cruise Plan and Map Check List, FS 695 Provincial Office Check of Field Cruise Data, FS 696 Provincial Field Check Cruise Summary, and FS 697 Provincial Compilation Check Form are available for in service only.

The sites are located under:

Internet <http://www.for.gov.bc.ca/pscripts/ISB/FORMS/forms.asp>

Intranet <http://wwwinternal.for.gov.bc.ca/iscripts/ISB/FORMS/forms.asp>
(In Service)

FS 693 Provincial Cruise Plan



		PROVINCIAL CRUISE PLAN		TENURE: C.P.:		CRUISE BASE OR SCALE BASE	
		Base Map #					
A. ATTENTION:							
District Manager:				Cruise Area (ha):			
Licensee:		Contact:					
Geographic Location:							
TSA:	PSYU:	FIZ:	Inv. Reg. No:	Comp't. No:			
Coast:	Immature:	Mature:	Both:				
B. CRUISING AGENCY:				COMPILING AGENCY:			
Agency Name:		Name:		Address:			
Cruiser Names (if known):		Address:					
Address:							
C. TENTATIVE CRUISE DATES:							
From:		To:					
Proposed Years of Logging:		Access:					
D. HARVESTING SYSTEM:							
Harvesting System:							
Systematic Grid:							
1. Segregate silv. System (patch clearcut, seed tree, note avg. opening size).							
E. NUMBER OF PLOTS:							
Measure Plots:	Count Plots:	Estimated C.V.:	S.E. Waived (Y/N):				
Grid Spacing (in m)	by	200 x 200 m if cruise < 250 ha		250 x 250 m if cruise ≥ 250 ha			
PLOT TYPE:	Prism/Relascope:	Fixed Area:	Plot Size (ha):				
F. MINIMUM DIAMETER LIMITS:		COAST		INTERIOR			
		Mature	Immature	Species (cm to)		Exemption (cm)	
Field Tally							
Compilation - Appraisal (cm)							
Compilation - Cutting Permit (cm)							
G. MARKING	Ribbon Colour	Paint Colour	Axe Blaze	Other (tags)			
Boundaries							
Baseline							
Strips							
Plot Centre							
Tie Points							
Non Forest Types							
Riparian Areas							
Wildlife Tree Patches							
Other							
H. OTHER:							
Comments:							
Note The original traverse notes must be provided to Ministry of Forests and Range Personnel upon request.							
Signed:		Authorized Licensee Representative		RPF/RFT/ATC or ATE Number		Date:	
Are block(s) in an approved Forest Stewardship or Forest Development Plan?							
Please submit the cruise plan form and map to the MOFR in digital format.							

FS 693 HVA 2009/07

Please be advised that this information may be released under the Freedom of Information and Protection of Privacy Act

Figure F.1 FS 693 - Provincial Cruise Plan (Page 1 of 2).



SECTIONS J, K, L (TO BE FILLED OUT WHEN REQUIRED)

I. STRATIFIED SYSTEMATIC SAMPLING: (Calculate sampling requirements for each timber type)											
Type No.	Type Description	BEC Subzone / Variant	Plot/Prism size	Type Area (ha)	Average m ² /ha	Estimated Vol/Type m ³	Type Vol. % of Total Vol.	Estimated Type CV	Weighted Type CV	Total Plots/CP	Grid Spacing
1										Refer to Sections 2.4, 2.5 Provincial Cruising Manual	
2											
3											
4											
5											
6											
7											
Tot. Ha's					Tot. Vol.			Tot. Weighted CV			

EXPLANATION OF FORMULA

$C = A \times B$
 $D = \frac{C}{\text{Sum } C1...7} \times 100$
 $E = \text{cruising manual, section 2.62}$

Variable Plot $F = D \times E$
Fixed Plot $F = A \times E$
 $G = \text{cruising manual section 2.4, 2.5}$
 $H = \sqrt{\frac{\text{Total hectares} \times 10,000}{G(\text{number of plots})}}$

J. SOURCE OF CV ESTIMATES	
Type 1:	
Type 2:	
Type 3:	
Type 4:	
Type 5:	
Type 6:	
Type 7:	

K. INSTRUCTIONS FOR SECTIONS	
A	Enter district and tenure information.
B	Enter the name and address of the cruising and compiling agencies.
C	Enter the tentative start and completion dates of the field work.
D	Enter yes beside applicable headings.
E	Enter the number of plots and the grid spacing.
F	Enter the diameter limits measured and compiled to, and prism BAF.
G	Enter the colour(s) of paint and flagging used, and the type of blazing and plot tags.
H	Enter remarks if required. Signature and date are mandatory.
I	OPTIONAL. Enter data ONLY if stratified systematic sampling is used. Type description – include: species/ age class/ height class/ site quality.
J	OPTIONAL. Enter source of CV estimates.
ATTACH: CRUISE PLAN MAP. Drawn to 1:5,000 or 1:10,000 scale, topography, (streams and roads), air photo numbers, strips and baselines, plot locations, boundaries, area in the merch and total by cut block, label the cut block (mature or immature). <u>MUST BE SUBMITTED WITH THIS FORM.</u>	
AERIAL PHOTOGRAPH: Submit a copy with timber typing.	

Figure F.2 FS 693 - Provincial Cruise Plan (Page 2 of 2).

FS 694 Provincial Cruise Plan and Map Check List





**PROVINCIAL
CRUISE PLAN AND MAP CHECK LIST**

TENURE: — —

C.P.: — —

CRUISE AREA (ha): — —

BASE MAP #: — —

A. TENURE and CRUISING AGENCY INFORMATION	YES	NO	N/A
1. Licensee's name shown?			
2. Tenure and Cutting Permit numbers shown?			
3. TSA, PSYU, FIZ, Region and Compartment Numbers indicated.			
4. Cruising and Compiling Agencies indicated.			
5. Timber Cruisers indicated?			
B. HARVESTING and SAMPLING SYSTEM INFORMATION			
6. Harvesting and sampling system acceptable? (Part D)			
7. Number of plots and plot type acceptable? (Part E)			
8. Diameter Limits acceptable? (Part F)			
9. Boundary marking acceptable? (Part G)			
C. CRUISE PLAN MAP and PLOT ESTABLISHMENT INFORMATION			
10. Tenure information adequate? (i.e. Licence, CP, FIZ zone, UTM Grid No's, Reg. and Compt. No's...etc.)			
11. Acceptable map scale? (1:5 000; 1:10 000)			
12. Map area statement clearly shown? (Timber type descriptions and areas indicated?)			
13. Timber types on the cruise plan map and forest cover map of the cruise and surrounding area provided?			
14. Minimum of 2 plots per type?			
15. Sufficient number of plots per type or number of plots per hectare and SE waived?			
16. Consistent plot and/or strip spacing within each type? (Maximum grid - 200m if cruise < 250 ha or 250m if cruise ≥ 250 ha).			
17. Plots well distributed within each type?			
18. Prism and/or fixed area plot size consistent in each type?			
19. Cut block boundaries and forest types clearly delineated on map?			
20. Baseline established and tied to a well defined geographical feature or a legal survey mark if possible.			
21. P.O.C. established?			
22. Strips tied to cutblock boundaries?			
23. Plots and strips clearly marked?			

Note: There may be some exceptions to the above criteria. If in doubt check Chapters 2 and 3 of the *Cruising Manual*, or contact the Regional Cruising Coordinator.

Remarks: _____

Accepted:	Rejected:	Date:
Action:		
Signature:		
Approval/rejection letter sent by:		Date:

FS 694 HVA 2009/07

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Figure F.3 FS 694 - Provincial Cruise Plan and Map Check List.

A.4.2 Signs and Defects Indicative of Decay in Standing Trees

The following is a brief description and explanation of the external indications of decay listed in Section A.4.1.1.

Coast - Pathological indicators must be recorded on all live and dead potential trees.

Interior - Pathological indicators must be recorded on:

- i. all live trees, and
- ii. dead potential white pine, hemlock and balsam trees, and
- iii. dead potential Lodgepole pine trees with conk and blind conk.

Do not record pathological indicators above 10 cm diameter.

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 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 except do not record sap rot fungi as conk.

A.4.2.1 Conks

Conks are the fruiting bodies (sporophores) of decay fungi and are definite and reliable indicators of decay. Conks occur anywhere on the main stem, branches and exposed roots of the tree but appear most frequently around knots and on the underside of both dead branch stubs and live branches. For current cruising purposes, only specific root, butt and heart rot conks are suspect indicators. Slash conks are not suspect indicators (see Figure A.6 for a list of host species for selected decay fungi).

It is important to be able to differentiate between the fruiting of slash fungi that occur on dead branches and wounds of living trees and those that occur on the roots, live branches and trunks of living trees. It is necessary to be able to recognize the conks of the major heart rotting fungi found on living conifers and hardwoods. On conifers, the main conks to recognize are, *Echinodontium tinctorium*, *Phellinus (Fomes) pini*, *Phaeolus (Polyporous) schweinitzii* and *Fomitopsis (Fomes) pinicolii*. On hardwoods, the main conks are *Phellinus igniarius* and *Phellinus tremulae*. See the following host list for major and some minor heartwood decay species.

The major heart rot conks are hard, thick, woody-like perennial structures and form singly at branch stubs or in small clusters on the underside of living branches. An exception is the mushroom-shaped to bracket-like sporophore of *P. schweinitzii* that is annual but may persist for more than two years. Before calling conks on living branches in the upper crown, there must be fruiting bodies of the heart rot fungus evident in the stand. Slash conks that occur on dead wood of living trees can be both annual (small, thin, leathery) and perennials, are often more numerous and occur anywhere on the tree. The slash conks that occur on old exposed wounds are not allowed as suspect indicators. An exception is the conk of *F. pinicola*, which is common on dead trees but may also occur on large, old wounds as studies have found its occurrence indicates significant decay. However, *F. pinicola* that occurs on dead branches is not a suspect indicator.

Conks vary in size and shape and therefore are hard to spot, particularly when they are just developing or occur on the upper trunk. Conks of *E. tinctorium* and *Phellinus pini*, frequently appear as a small hoof-like or shelf-like structure on the underside of dead branch stubs on the middle and/or lower trunk of an infected tree. Moss-covered branch stubs and burls often resemble conks, particularly when viewed from directly below; it is important therefore to view the tree from the side before making a decision.

Conks of *Phaeolus schweinitzii*

P. schweinitzii is the cause of brown cubical root and butt rot of most conifers but Douglas-fir and spruce are the most susceptible. The fruiting bodies may occur:

- on the base of a tree,
- on the ground up to 2 m from the tree where no exposed roots are evident, or
- on the exposed roots.

If a conk is mid-way between:

1. Two living susceptible trees only one tree is considered to be infected.
2. A highly susceptible species (e.g., Douglas-fir) and a less susceptible species (e.g., red cedar), the most susceptible species is considered to be infected.
3. A living tree and a stump showing brown cubical rot, and it is not on a root of the live tree, it is assumed to be associated with the stump.

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