Field Verification of Priority Old Forest Deferral Areas: Technical Guidance

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Ministry of Forests

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STEP 4 – COLLECTING AND COMPILING FIELD DATA

USE CRUISE DATA TO EVALUATE STRATIFIED STANDS: AUGMENT WITH ADDITIONAL DATA

Cruise data are needed only when cut blocks have already been identified, during reconnaissance stages, as unlikely to meet priority deferral criteria. Where reconnaissance surveys indicate priority deferral criteria will be met, deferral areas can be identified without additional data collection.

Cruise Plot Procedures for Deferral Areas (currently mapped areas or replacement areas)

For blocks that have already been cruised, review cruise data for the cut block and separate cruise plots that overlap with each of the Forest Types stratified as per Step 3. This may require stratification or re-stratification of the cruise to the Forest Type scale. Generate required summaries and evaluate age, height, and diameter criteria separately for each stratified Forest Type. Compilations for appraisal purposes are different entities from compilations for the old forest priority deferral process.

Determine whether the full measure plots provide sufficient coverage to evaluate the potential deferral area (e.g., stratified Forest Types from Step 3). All appraisal full measure plots within a Forest Type identified for field verification must be used to evaluate the criteria. Additional full measure plots are required when there is insufficient coverage for a Forest Type. For the purposes of assessing old forest priority deferral criteria, the following methods apply:

- Minimum coverage for the priority deferral process is defined as follows:
  a. Forest Types 20.0 ha or larger should contain 20 full measure plots or a density equivalent to a 100 m x 100 m grid.
  b. Forest Types less than 20 ha should have a density of measure plots equivalent to a 100 m x 100 m grid.

Existing count plots may be converted to full measure plots to meet the coverage requirements. If count plots are converted, all count plots within a Forest Type must be converted.

Where additional full measure plots must be located to meet minimum coverage requirements:

- Use the procedures in the Cruising Manual Section 2.4.
- Only information required for the priority deferral process must be collected in additional full measure plots or converted count plots (e.g., species, height, diameter, and age (where selecting trees to age core is described in the section below).
- Plots that are added for the priority deferral process do not affect appraisal data.
- The general standards and intent of the Cruising Manual must be followed when locating additional plots.

New cut block development follows similar processes. However, detailed Forest Typing is required at the Cruise Plan stage (see Step 3).

For modifications of existing cut blocks and development of new cut blocks, **final cut block submission to follow existing cruising and appraisal procedures**, as described in the Cruising Manual and relevant appraisal manuals.

Determining Stand Age from Tree Cores

Accurate tree ages are important for assessing stands relative to priority deferral criteria. Determining tree and stand ages in old and ancient forests can be difficult, and detailed guidance is provided in Appendix 4.

If the stand is clearly ancient or old, and this will lead to a deferral decision, ages do not need to be taken. This can be determined in the reconnaissance stage of block assessment (or re-assessment for cut blocks that were developed and/or approved prior to decisions to proceed with priority deferrals) (see Step 1) where a stand can be identified as meeting deferral criteria without further field data collection. If tree core ages are not collected to quantify ages in the field, the stand will be considered "old", based on the minimum ages in Table A6.1. If the stand structure indicates the likelihood that a stand may be ancient, collecting tree core data is strongly recommended to avoid accidental harvest.

Tree core ages of the oldest trees in the stand (i.e., Forest Type) are collected to provide a field-based estimate of the time since the last stand-replacing disturbance.[20] This differs from the cruising objective of determining the tree class in each measure plot to assign the correct loss factor table and maturity class to each tree (e.g., mature, old-immature, immature). There is rarely a need in cruise data collection to core or record ages for trees greater than 120 years old in the interior or 140 years old on the coast. Therefore, tree core ages using standard cruising approaches are not appropriate for describing the stand age of older mature, old, or ancient forests.

To determine the stand age of an old forest, age cores must be taken from the oldest living trees, which are most often those with the largest diameter. Field staff may choose to also age trees of additional species with smaller diameters to better understand stand dynamics (e.g., yellow-cedar or western hemlock may be smaller, but old(er) than faster-growing tree species in the stand).

To capture the stand age for comparison to the priority deferral criteria in Appendix 6, collect age cores from:

- at minimum, the five (5) largest diameter, living trees in the main canopy (excluding veteran trees), selected from all cruise plots within each Forest Type.[21]

The final age of the stand (cut block or Forest Type) is the average age of the five largest/oldest trees age cored in the main canopy (excluding veteran trees), where tree ages include growth to breast height (see Appendix 4).

When a proposed cut block (or Forest Type) is in a BEC unit where **Older Mature Forests** are included in priority deferrals (see Table A6.1), additional age cores must be taken from the **veteran tree layer** where the main canopy age is > 80 years old and there are > 20 stems per hectare of veteran trees:

- the two (2) largest diameter live veteran trees; this is in addition to the largest diameter trees cored in the main canopy (for a total of seven (7) tree cores).

[20] In many ecosystems, the oldest tree in the main canopy (excluding vets) will reflect time since disturbance. Mean age is used here for consistency with inventory ages.

[21] For cut blocks that have already been cruised, determination of the target trees to age core should be made in the office using existing tree diameter data from individual cruise plots for each Forest Type.

Ages for veteran trees will be used to confirm veteran status in the Priority Deferral Decision Flowchart in Step 2 of this document for assessing deferrals where Older Mature Forests are identified in deferrals (see part 6(a) of the Flowchart).

Expect to determine ages of veteran trees frequently in NDT 4 ecosystems (IDF, PP, driest ICH) and other BEC subzones/variants where Older Mature Forests are identified for priority deferral. See Table A6.1 for a full list of ecosystems where Older Mature Forests are identified for deferrals.

Trees designated as "veterans" in the field must be living remnants that survived a previous stand-replacing disturbance. Veteran trees are generally much larger in diameter (and often height) than other trees in the stand.

Veteran trees do not need to be measured and counted for field verification in BEC subzones/variants where Older Mature Forests are not identified for deferrals. However, veteran trees often provide important stand level biodiversity and wildlife values when retained, and confirmation of veteran tree status can also ensure that the largest, oldest non-veteran trees are selected for assessment of stand age.

Note that an age core is not required at each cruise plot; the requirement for the largest/oldest trees applies at the Forest Type scale (or cut block scale for homogeneous blocks). Therefore, some cruise plots will not have any age core samples collected to assess the age of the stand, while the occasional cruise plot may have more than one tree aged.

Tree ages must be based on ring counts from age cores as well as an estimate of years for the tree to grow to breast height. **Apply the methods described in Appendix 4 to determine field ages to assess against deferral criteria.**

Calculating Stand Height and Quadratic Mean Diameter from Cruise Data

The calculation of stand diameter and stand height need to be done at the Forest Type scale, not at the cut block or Cutting Permit level. Compile a separate Type Summary Report (see Figure 4) for each of the Forest Types in the cut block, where stratification processes are outlined in Step 3. Compiled cruise data can be rounded to one decimal place (e.g., 55.4) for comparison with the values in Table A6.1.

Extract **stand height** values from cruise data using the "Avg Weight Total Ht" for each Forest Type being assessed. The compiled stand height from cruise data is the Lorey height and is calculated as the basal-area-weighted mean height of all merchantable trees within a cruise plot (e.g., Lorey's height = Sum (Ht * BA) / Total BA).

The **Quadratic Mean Diameter (QMD)** is recorded as the "Avg DBH (Live and DP)" in cruise compilation and is based on the merchantable diameters of trees in the cruise plots. QMD is a measure of the average tree diameter in a stand where greater weight is assigned to larger trees. QMD can be calculated using basal area (BA) or individual tree diameters. Both methods provide the same answer.

QMD is used for assessing field measures for each potential deferral area (e.g., Forest Type). There are two formulas for calculating QMD:

QMD Formula 1:

$$\sqrt{\frac{BA}{k * n}}$$

Where BA = stand basal area (in metres), n = number of trees, and k is a constant = 0.0000785.

QMD Formula 2:

$$\sqrt{\frac{\sum D_i^2}{n}}$$

Where D = diameter of the i^{th} tree and n = number of trees.

Cruise compilation programs automatically calculate the QMD and report it as average dbh.

*** FOR APPRAISAL PURPOSES *** P E R C E N T R E D U C T I O N A P P L I E D

Type Summary

Average Line Method
CONIFEX MACKENZIE
Licence Number: A15385 CP: G02
Project: 180250

Grades: MOF Computerized
Computerized Decay
Computerized Waste
Computerized Breakage

PSYU: Finlay
Region: 6 - Omineca
District: 04 - Mackenzie

Net Area: Type 1 (M):Sx(B1) 835, Plots in Type: 16, TUs: [A : 13.8]

		Total	Conifer	Decid	B	S	PL
Utilization Limits							
Min DBH	cm (M)				17.5	17.5	12.5
Stump Ht	cm (M)				30.0	30.0	30.0
Top Dia	cm (M)				10.0	10.0	10.0
Log Len	m				5.0	5.0	5.0
Volume and Size Data							
Gross Merchantable	m3	6384	6384		1544	3793	1048
Net Merchantable	m3	4940	4940		1023	3287	630
Net Merch - All	m3/ha	358	358		74	238	46
Distribution	%	100	100		21	67	13
Decay	%	13	13		24	9	13
Waste	%	4	4		8	3	4
Waste(billing)	%	5	5		12	3	6
Breakage	%	6	6		2	2	23
Total Cull (DWB)	%	23	23		34	13	40
Basal Area / Ha	m2/ha	45.7	45.7		11.9	26.0	7.9
Net VBAR	m3/m2	7.825	7.825		6.242	9.161	5.801
[illegible]	[illegible]	[illegible]	609.7		173.2	283.4	153.1
Avg DBH (Live & DP)	cm	30.9	30.9		29.5	34.2	25.6
[illegible]							
Avg Snag DBH	cm						
Gross Merch Vol/Tree	m3	0.76	0.76		0.65	0.97	0.50
[illegible]	[illegible]	[illegible]	0.59		0.43	0.84	0.30
Avg Weight Total Ht	m	28.3	28.3		26.0	30.2	25.0
[illegible]	[illegible]	[illegible]	23.4		20.7	25.1	20.3
Net Merch Vol/Log	m3	0.19	0.19		0.15	0.23	0.13
Gross Merch Vol/Log	m3	0.23	0.23		0.21	0.26	0.16
Avg # of Logs/Tree		3.34	3.34		3.01	3.67	3.10
Net Immature	%	23.2	23.2		12.7	31.0	
LRF and Log Summary							
Net Merch - Stud	%	28.0	28.0		32.6	22.9	47.3
Net Merch - Small Log	%	61.4	61.4		70.8	54.0	84.2
Net Merch - Large Log	%	38.6	38.6		29.2	46.0	15.8
Avg LRF All	bdft/m3	183.5	183.5		152.3	204.6	124.3
Statistical Summary							
Coeff. of Variation	%	45.9	45.9		89.7	65.5	140.9
Two Standard Error	%	24.5	24.5		47.8	34.9	75.0
Number and Type of Plots		MP = 16					
Number of Potential Trees		80					
Plots/Ha		1.2					
Cruised Trees/Plot		5.0					

Figure 4. Example of a Type Summary Report showing diameter (QMD) and height fields for use in priority deferral field verification.

APPENDIX 4. BEST PRACTICES FOR CORING AND AGING TREES TO DETERMINE STAND AGE

This appendix provides guidance for detailed methods on collecting tree ages from old forests, including information on:

- Which trees to core
- How to record tree age measurements
- How to estimate ages from incomplete cores due to internal decal
- How to estimate age to breast height in older stands
- How to determine final tree and stand ages.

A spreadsheet has been developed to accompany the instructions provided here and to calculate tree ages using the formulas and methods described here:

TreeAgeCalculationForDeferralAssessment_Appendix4.xlsx

Suggested equipment

- Increment borer that is long enough to reach the centre of trees that are "large" for the ecosystem you are working in.
- Plastic straws with a diameter wide enough to fit samples from your increment corer.
- Masking tape to seal the ends and write tree ID labels on.
- Sharpie or ballpoint pen to write on tape on straws.
- Map tube or PVC equivalent for carrying straws; note that a thick, plastic bag is often more efficient, particularly in wet climates.

SELECTING TREES TO AGE CORE

The goal of coring trees to assess deferral criteria is to estimate the time since the last stand-initiating disturbance, i.e., the largest/oldest trees.

For each potential deferral Forest Type (e.g., BEC subzone/variant and stand structural condition):

- Collect age cores from a minimum of the five (5) largest diameter living trees in the cruise plots for each Forest Type assessed.

The veteran tree layer must be sampled separately in ecosystems where older mature forests are included in deferrals and where there are > 20 sph in the veteran layer (see Table A6.1).

- The veteran tree layer includes trees that survived the last stand-replacing disturbance (veteran tree layers are defined in Appendix 1).
- Collect age cores from a minimum of two (2) veteran trees in addition to the trees cored from the main canopy (described above).
    - Core the largest diameter trees in the veteran layer.
    - Where a veteran tree layer with > 20 sph occurs, a minimum of seven (7) trees will be cored (five from the main canopy and two from the veteran layer).

COLLECTING TREE CORE SAMPLES

- Trees should be cored at breast height (BH), which is defined as 1.3 m above the high side ground (HSG). HSG is the highest point of mineral soil or a humus layer around the base of the tree and no lower than the point of germination (as per the Cruising Manual)
- Drill trees perpendicular to the direction of the pith.
- The process for determining how to core trees with complex growth forms is outlined in Section 4.3.2.5 of the Cruising Manual and in the VRI Ground Sampling Procedures (2018).
- Record the height of the tree core extraction and the diameter at the extraction height if the tree is cored at a height that differs from BH when it is not possible to core trees at BH because of obstructions or complex growth forms.

DETERMINING TREE AGE FROM TREE CORES TO ESTIMATE STAND AGE[30]

1. Core the tree and assess core quality
    a. Take an age core from the tree at the location determined above (i.e., ideally at BH, but moved a minimum amount if necessary). Attempt to include pith for every core.
    b. If the age core is solid but pith was missed by a wide margin, age core the tree again, attempting to get closer to pith. Continue to re-drill the tree until pith is obtained in a solid age core, or the rings indicate you are within ≤ 5 years from pith.[31]
        i. If pith was obtained, record PTH ('pith') for the **measurement code**.[32]
        ii. If pith was not obtained, record NOP ('no pith') for the measurement code.
    c. When the tree is too large in diameter to allow your increment borer to reach the center, take the longest age core you can, and record CRC ('cannot reach center') for the measure code.
        i. For old growth forests, a longer than normal increment borer will be required, and field practitioners are expected to be provided with an increment borer that will reach the centre of trees that are "typical" for the largest/oldest trees in the ecosystem they are working in.
    d. When the age core is rotten towards the center of the tree, take the best or longest solid core you can, and record ROT ('rotten age core') for the measurement code.

2. Count the age core in the field

- In all measure codes described above, record the number of growth rings physically present on the age core in the **field count**.
- For NOP (No Pith) age cores, additionally record your **estimated years to pith**. Estimates of years missing to pith require sufficient visible curvature on the age core to estimate the number of rings to pith. This can be done using overlays of concentric rings that rely on the ring pattern in the age core. The ring count plus the missed years to pith equal BH age.

[30] The procedures here are summarised from the VRI Ground Sampling Procedures (2018) and may differ slightly from those in the Cruising Manual. This is because of different objectives for collecting tree ages between Cruising and Forest Inventory.

[31] Overlays of concentric rings can be used to estimate the distance to pith (when relatively close) using the pattern of rings.

[32] Measure code can be recorded in the spreadsheet (TreeAgeCalculationForDeferralAssessment_Appendix4.xlsx) and used in summary data for professional rationales (see Appendix 7).

- For CRC (Cannot Reach Centre) and ROT (Rotten) age cores, additionally measure the length of the present/solid/countable portion of the age core (in centimetres, to the nearest decimal, excluding any attached bark/cambium) and record that in **core length**. A calculation will be done to estimate the missing portion of the age core based on the rings/cm, recorded diameter, and database-estimated bark thickness.
- Where tree rings are too close together to accurately count in the field, or where ages are very close to applicable thresholds for a deferral category, collect age cores in plastic straws for counting in the office.

3. Count the age core in the office

- Where office-based counting is required, each collected age core should be counted under a microscope for a more accurate age count. This age is recorded as the **office count**.
- The office age count should only count physically present rings. It should not include the value of the missed years to pith from NOP age cores, nor the calculated missing rings from CRC or ROT age cores.
- There are many ways to aid in an accurate office count, but one primary method is to shave the top of the age core with a razor blade to expose very clear growth rings. Slightly moistening age cores can also help to enhance contrast between early and late wood.

DETERMINE THE TOTAL TREE AGE

- The **office age** is the
    - estimated total tree core age; and
    - an estimate of years to grow to breast height.
- Determine office age by adding the BH age (see below) to ring counts or estimates that vary by the age core measurement code:
    - **PTH age cores** (pith included): use the full ring count from the age cores
    - **NOP age cores** (age cores estimated to be within ~5 years of pith): use full age core ring count plus number of estimated rings
    - **CRC or ROT age cores** (incomplete age cores): estimate the missing rings using the linear extrapolation method:
        - *Office age = ring count + missing ring estimate*
        - *Where:*
            - Missing ring estimate = avg rings ÷ cm × missing age core length
            - Avg rings/cm = ring count ÷ intact age core length
            - Length of missing age core = [(DBH x double bark thickness ratio) ÷ 2] – intact age core length
                - Double bark thickness ratios are derived from database values and are provided in Table A4.1.
        - This process is easily calculated in the spreadsheet that accompanies this appendix: **TreeAgeCalculationForDeferralAssessment_Appendix4.xlsx**

Table A4.1 Double bark thickness ratios[33]

Group	Double-bark thickness ratio
Thick-bark species – Fd, Lw, Py, Hw	0.890
Thin-bark species – Cw, Pl, Pw, B, S	0.968

GROWTH TO BREAST HEIGHT

The estimated age to breast height accounts for the time required for the tree to grow from establishment to breast height. Use the following estimates:

- For faster growing species including Fd, Lw, Pl, Pw, Py = add 10 years;
- For more shade tolerant and slower growing species including Hw, Cw, Se, Sx, Ss, Bl, Ba, Bg add 15 years to the age core count to determine total tree age.

The approach to estimating breast height age provided here differs from the methods outlined in the Cruise Manual (site index curves) or the VRI data compilation procedures (Site Tools) because those methods rely on Site Index calculations which are not considered reliable for forests > 120 years old.

Note that larger trees are also expected to have more complex growth histories, and thus higher rates of error.

FINAL TREE AGE

The final tree age is the **sum of the office age** and the **growth to breast height**, and it is based on either the field age (field count + estimated years to pith) for PTH and NOP age cores or the office age (office count + estimated missing years to pith) for CRC or ROT age cores.

STAND AGE FOR COMPARISONS TO PRIORITY OLD FOREST DEFERRAL CRITERIA

The final age of the stand (cut block or Forest Type) is the average age of the five largest/oldest trees age cored in the main canopy (excluding veteran trees), where tree ages include growth to breast height. The stand age should be compared to ages listed in the deferral criteria for each Forest Type being evaluated (see Table A6.1 in Appendix 6).

Ages for veteran trees are used to confirm veteran status in the Priority Deferral Decision Flowchart in Step 2 of this document and apply in ecosystems where Older Mature Forests are identified in deferrals (see part 6(a)).

TIPS FOR SUCCESSFUL TREE CORES IN OLD FORESTS:

Longer increment borers are generally required for assessing ages in old forests. These are increasingly fragile, and the following tips and suggestions are offered to reduce damage and frustration.

If the increment borer handle is difficult to turn when nearly fully inserted in a large tree, try switching to a shorter increment borer handle to complete the age core and reach the inner most rings (assuming you have the same brand of increment borer). This is especially helpful for trees with butt flare since a shorter handle covers a smaller radius.

[33] Based on average bark thickness ratios (DIB/DOB) from Kozak's taper model (2002).

To avoid compressing age cores within the shaft while an age core is being taken, try removing the age core in sections – drill approximately 20 cm into the tree, place the sample in a straw, then continue to take the remainder of the age core, removing sections every ~5 cm. Compressed age cores are “mashed together” and are not possible to count. They also jam an increment borer.

When extracting age cores from a long increment borer, try wrapping a shoelace around the end of the extractor/spoon and using it to pull straight back. This will reduce the risk of bending the end of the extractor.

Clean the inside of the shaft with a small amount of very fine steel wool sprayed with WD40 or Teflon spray lube that is wrapped around the end of the extractor (on the “teeth”). This will reduce the chance of jamming the increment borer. Cleaning is especially important for trees with lots of sap but should be done daily. An aluminum cleaning kit for a .22 caliber rifle also works well.

Wooden golf tees are also very helpful for removing small pieces of age core that may get stuck at the end of the shaft. Never insert a metal item into the bit; the sharp portion of an increment borer bit is very thin and short and is easily damaged.

When the pith is missed, try again. When removing the age core sample, always do a full rotation and make sure to take note of which way the inner rings are curved when “cracking” the increment borer. This will show the direction and approximate distance from your first attempt to the pith. Unwind the increment borer, place the extractor in the first hole, align the increment borer with the extractor only until it is securely in the tree, then remove the extractor and place it in a safe spot. Do not leave the extractor in the tree longer than required to get a “good bite” because any error in alignment with the subsequent attempt has the potential to have the bit hit the extractor. This will destroy the increment borer.