
Change Monitoring Inventory – British Columbia

Quality Assurance Procedures & Standards for Ground Sampling

Prepared by
Ministry of Forests, Lands and Natural Resource Operations
Forest Analysis and Inventory Branch

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For further information about the Resources Information Standards Committee, please access the RISC website at:

<https://www.for.gov.bc.ca/hts/risc/>

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Major Amendments for 2017

1. Combined CMI QA procedures (2002 version) and CMI QA standards (2016 version) into one document. This document (specifically the procedures) has been updated to match the procedures and language of the VRI QA manual where applicable, to capture the changes that have been made to general VRI/CMI QA procedures since 2002.
2. If the randomly selected quadrant for the QA of tagged trees has <20 trees, the QA will continue sequentially until 20 trees are audited (as opposed to selecting another full quadrant for QA). (QA Procedures, Field Audit, Audit for Timber Attributes table)
3. Six (6) subjectively selected trees will be audited for stem mapping, and they will span a range of distances from the IPC. (QA Procedures, Field Audit, Audit for Timber Attributes table)
4. QA standards for damage agents and loss indicators updated to match the standards applied under the VRI for those same attributes. (QA Standards, Pass/Fail Point Standards, Tree Attributes table)
5. Appendices added back into document (Appendix 3 updated to capture QA standards changes from previous years).
6. Minor updates to text and tables throughout document for grammatical correctness and formatting.

Table of Contents

| | |
|--|-----|
| Acknowledgments | iii |
| Major Amendments for 2017 | v |
| Table of Contents | vii |
| Ground Sampling Quality Assurance Procedures | 1 |
| Introduction | 1 |
| Objectives | 3 |
| Feedback..... | 3 |
| Contract Administration..... | 3 |
| Audit Principles | 3 |
| Plot Selection..... | 3 |
| Sample Batches | 3 |
| Pass/Fail Standards..... | 4 |
| Batch Submission Requirements..... | 4 |
| General Procedures..... | 4 |
| Detailed Procedures..... | 4 |
| Selecting Sample Plots to be Audited | 4 |
| Office Checking | 4 |
| Field Audit..... | 5 |
| Audit for Timber Attributes..... | 5 |
| Audit for Ecological Attributes | 5 |
| Preparing the Quality Assurance Report | 6 |
| Ground Sampling Quality Assurance Standards | 9 |
| Introduction | 9 |
| Critical Pass/Fail Standards..... | 10 |
| Plot Cluster Location..... | 10 |
| Tree Attributes..... | 10 |
| Ecological Attributes..... | 10 |
| Pass/Fail Point Standards | 11 |
| Plot Cluster Location..... | 11 |
| Tree Attributes..... | 11 |
| Sample Tree Attributes..... | 11 |
| Small Tree Attributes | 12 |

CMI Ground Sampling Quality Assurance Procedures & Standards

| | |
|---|----|
| Supporting Information Attributes..... | 13 |
| Navigation and Layout..... | 13 |
| Tree Attributes | 13 |
| Stump Attributes | 14 |
| Ecological Attributes | 14 |
| Coarse Woody Debris Attributes | 14 |
| Ecological Site Description..... | 14 |
| Soil Description | 15 |
| Vegetation Layers | 16 |
| Succession Interpretation | 17 |
| Appendix 1: Auditor’s List..... | 19 |
| Appendix 2: Audit Plot Selection List | 21 |
| Appendix 3: Audit Report Template..... | 23 |

Ground Sampling Quality Assurance Procedures

Introduction

The Change Monitoring Inventory (CMI) ground sample plots are being established across the Province on a grid to monitor the changes and trends over time of the timber and non-timber resources of British Columbia. These samples are to be re-measured periodically on a 5 to 10 year cycle. A quality assurance audit is performed concurrently with the ground sampling.

Two monitoring/checking processes are used to ensure that quality field measurements are being collected in the ground sampling phase:

Quality Assurance is an external process, whereby the work is evaluated based on approved standards by an independent auditor and rated as having passed or failed. The auditor must be certified in VRI Ground Sampling Timber or Ecology depending on the data that is to be audited. The auditor must also be an experienced individual capable of conducting quality measurements and assessments to ensure the ground sampling procedures have been conducted within standards. There should be an arm's length relationship between the Quality Assurance auditor and the project and crew being evaluated.

Quality Control is an internal process, whereby the project manager ensures that the fieldwork is being done to the required standards in accordance with the procedures. This is the opportunity for the project manager to provide additional training to field crews.

The procedures described here are the quality assurance procedures developed by the Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) to be implemented on all CMI ground sampling projects. It is expected that field sampling crews will have their own quality control procedures.

The objectives of the audit are to:

- provide feedback to improve sample quality, and
- provide information for contract administration.

The auditor identifies substandard sampling work and provides feedback to improve the crews' performance. Another important aspect of the auditor's work is to provide positive feedback to sampling crews on a task well done.

An important issue for contract managers is whether the completed work is acceptable. Several levels of standards have been established for the data collection.

- Pass/fail standards have been established for critical attributes.
- Optional pass/fail standards have also been established for the compiled gross and net volumes.
- Pass/fail point standards have also been established for specific attributes.
- Standards have also been established for supporting information that contributes to the location, establishment, and measurement of samples.

If the audit shows a batch does not meet these standards, the batch fails and the samples must be revisited.

CMI Ground Sampling Quality Assurance Procedures & Standards

The standards for ground sampling are included in this document and provide the standards of accuracy for CMI attributes measured from ground samples. A standard is a maximum allowable error for a given attribute. The standards are based on levels of precision achievable by auditors and were developed in consultation with a group of auditors in the various fields.

It is intended that quality assurance audits will be carried out as soon as possible after the samples are completed.

In order for the MFLNRO to ensure the data meets current standards, copies of all 3rd party quality assurance reports must be sent to the Ministry Representative as soon as the report is completed.

The flowchart in Figure 1 provides an overview of the ground sampling and audit process for the CMI.

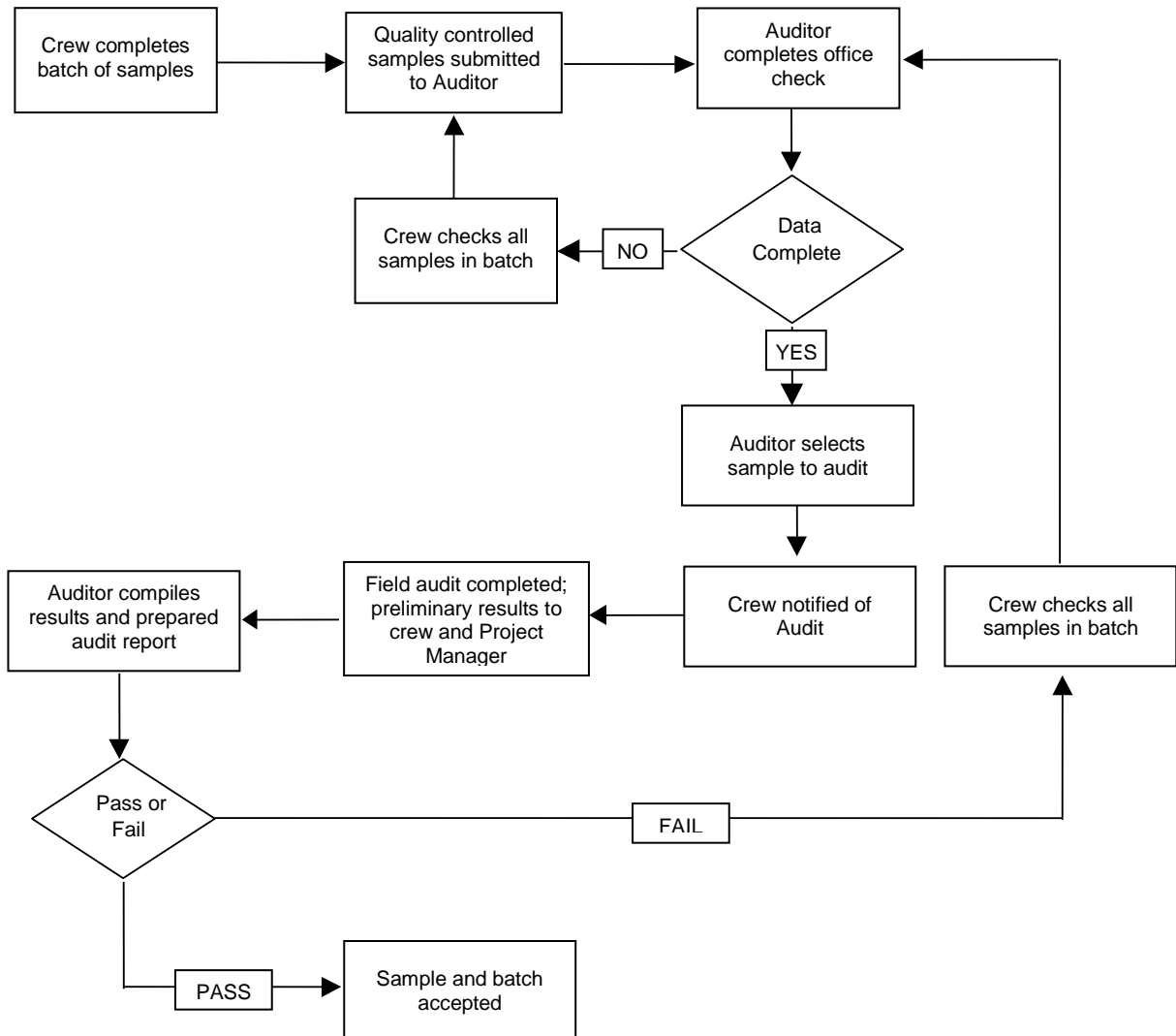


Figure 1. Flowchart of the ground sampling and audit process.

Objectives

The audit process has two main objectives:

- to provide feedback to improve sample quality, and
- to provide information for contract administration.

Feedback

Feedback from the audits is important for the continual improvement in sample establishment. The auditor will note any problems found in the audits so that the field crews will be aware of areas where they may require improvement. Positive feedback is also valuable in improving sample measurements. To successfully accomplish this objective the crews should be audited early in the project and subsequent batches should be audited as soon as possible after they are submitted. The field crews will benefit from accompanying the auditor in the field and are encouraged to attend especially on the initial audits.

Contract Administration

The audit provides the contract administrator with information about the quality of the work being completed. Standards have been established for the location and measurement of samples. Contract administrators will use the pass/fail criteria as the basis for payment.

Audit Principles

Plot Selection

An audit system requires a statistically valid sample of ground samples. For the sample to be valid, four criteria must be met:

1. Batches of samples must be established. The criteria for defining a batch will be discussed at the pre-work conference.
2. Audit samples must be chosen randomly within each batch except in specific "abnormal" circumstances as described in the detailed procedures.
3. The selection probability (i.e., number of audit samples divided by total number of samples) must be known and recorded.
4. The list of samples included in a batch must be recorded.

It is recommended that a minimum of 10% of all samples should be audited and that auditing be more frequent at the beginning of the project.

Sample Batches

The exact batch size and composition of the batch will vary for each project and will be discussed at the pre-work conference.

To ensure that all types of data collected has been audited, auditors must also ensure that all sample types are audited in proportion to the numbers of samples by type in the project. For example if 25% of the samples in a project are YSM samples (type Y) then approximately 25% of the audits on the project must be on type "Y" samples. Auditors should attempt to group sample types together in separate batches where possible.

To ensure early detection of potential errors the initial batch(s) should be small (3-5 samples) and should be separated by crew leader. Future batch sizes and the composition of each (for

example, crew leader or company, low volume or high volume samples, immature versus mature) will be based on the outcome of the initial audits.

Pass/Fail Standards

Pass/fail standards have been established to ensure that the work meets minimum standards. These pass/fail standards are outlined in the *Ground Sampling Quality Assurance Standards* in this document.

Batch Submission Requirements

It is expected that all submitted batches will be complete as set out in the pre-work conference. This includes requirements for air photos, maps, field cards and any other project specific information. The field cards for all samples in the batch must be complete before the auditor will field audit any sample in the batch. All samples in the batch will be returned if the batch is not complete when submitted.

General Procedures

1. Select the samples to audit.
2. Perform office checking.
3. Perform field audit.
4. Prepare audit summary.

Detailed Procedures

The following is a suggested process to follow:

Selecting Sample Plots to be Audited

1. Determine the batch to be audited.
2. Randomly select the sample(s) to audit from the batch and document the selection. If “abnormal” weather, safety or access restrictions do not allow the sample to be audited, another audit sample may be randomly selected to satisfy contract administration requirements. Any time an audit sample is replaced the reasons must be documented.
3. A list of all the samples in each batch, the samples audited, dates audits were completed, and results of audits must be maintained. An example of an auditor’s list is found in Appendix 1.
4. It is also mandatory that documentation around the random selection of audit samples be maintained as well. An example of such documentation is found in Appendix 2.

Office Checking

Complete an office evaluation of all samples in the batch. If any of the samples are incomplete or errors are noted, all samples will be returned and the audit will take place when the completed batch is returned. All corrections or additions to the field cards, after the field crew has left the field, must be done in **red** ink on the original cards.

Notify the field crew and project manager that an audit will take place. It is recommended that the original field crew accompany the auditor, especially in the early phase of the project.

Field Audit

The Change Monitoring ground samples can take from one to three days for the original three-person field crew to complete. The intent is to complete the ground sample audit in one day with a two- or three-person audit crew. Therefore it is usually necessary to split the sample and only re-measure a portion of the sample. The selection of which attributes and the number of attributes to be measured should be made prior to visiting the field site. The suggested methodology for splitting the plot is listed below.

1. Perform a field audit of the selected samples.
 - Audit fully the locating and marking of the sample location.
 - Audit the applicable attributes in the following manner:

Audit for Timber Attributes

| | |
|-------------------------------|--|
| Large trees | Randomly select one quadrant to re-measure. If less than 20 trees are encountered in this quadrant then continue re-measuring trees sequentially until 20 have been re-measured. The full suite of measurements is taken on the selected trees plus the determination of missing or extra trees within the selected quadrant(s). |
| Small tree plot | If time does not permit a full re-measurement of the small trees by classes conduct a total count ignoring the class breaks for the small trees. |
| Stumps | Re-measure all stump attributes. |
| Sample tree selection | Confirm the selection of all sample trees in all quadrants. |
| Stem mapping | Re-measure the stem mapped trees and sample IPC marking. In the case where all tagged trees are stem mapped, re-measure only six (6) trees from the randomly selected quadrant. Choose the six trees subjectively, ensuring they span a range of distances from the IPC. |
| Reference pin to IPC distance | Re-measure the distance and bearing from the Reference pin to the IPC pin. |

Audit for Ecological Attributes

| | |
|---------------------|---|
| Coarse woody debris | Randomly select one transect. For round pieces collect species, diameter and decay class for the piece. For accumulations and/or odd shaped pieces, collect species, horizontal length and vertical depth on transect, and decay class for the piece. |
|---------------------|---|

CMI Ground Sampling Quality Assurance Procedures & Standards

| | |
|---------------------------------|---|
| Range data | Use the same transect as randomly selected for the CWD. Measure all values for the one transect. |
| Ecological Description [EP] | Collect the following attributes [1] Uniformity, [2] Biogeoclimatic unit, [3] Site series and coverage, [4] SMR, [5] SNR, [6] Land cover classification, [7] Slope, [8] Aspect, [9] Elevation, [10] Surface shape, and [11] Meso slope. Collect 7 to 11 on card ED if required. |
| Tree and shrub layers [ET] | Collect the data as usual, excluding average height values, for all species with $\geq 1\%$ coverage. Do overall cover estimate for the A, B1 and B2 layers. |
| Herb and moss layers [EH] | Collect data as usual for those species with $\geq 1\%$ coverage. Do the overall % cover estimate for the C, and applicable D layers. |
| Succession interpretations [EO] | Collect all attributes as usual excluding attribute 29 (tree succession species). |

2. After collecting the initial audit data, crosscheck the original plot data in the field to validate similar data and assess measurement differences.
 - No changes are to be made to the original field data cards at this time. If minor errors or data omissions have been identified that must be corrected, to enable the data to be processed, the entries will be entered in **red** ink on the original field cards. The project manager decides who will enter the data.
 - Document the major discrepancies or favourable measurements in the comments section on one of the audit field cards before leaving the sample.
3. The preliminary audit results should be presented to the field crew and project manager as soon as practical following the audit.

Preparing the Quality Assurance Report

1. Complete a report for each audit sample. The recommended sample summary report is included in Appendix 3. Summary reports can vary by project and any variance in format must be discussed at the pre-work conference.
2. If necessary, compile the audit sample to determine whether the data meets the established pass/fail criteria. If the pass/fail criteria are not met, the sample fails. In this case the “batch” of work will fail and the crew will be instructed to revisit, at their own cost, all samples in the batch to correct the items identified as contributing to the rejection. The batch of samples will then be subjected to an additional audit.
3. Provide feedback to the field crews and project manager about any items that may need work.
4. The project manager will be advised in "writing" of the samples that comprised the batch, which sample was selected for audit, and the results of the audit. The audit summary will be attached for reference.

CMI Ground Sampling Quality Assurance Procedures & Standards

5. Copies of all audit reports are to be sent to the Ministry Representative as they are completed.

Ground Sampling Quality Assurance Standards

Introduction

This document contains the data collection standards for the Ground Sampling phase of the Change Monitoring Inventory (CMI). The standards were established in consultation with quality assurance auditors, and after a review of audit field data, and are considered achievable by sampling crews.

The standards are based on the assumption that **all batches will be complete when submitted**. This means that all field cards must be completely filled out, photos and maps must meet the requirements as set out in the pre-work conference, and any other required information must be present as well. If the submitted batches are not complete they will not be accepted and will be returned to the field crew for completion. A batch is an identified number of samples to be completed by the field crew as determined at the pre-work conference.

There are three levels of timber attribute standards specified in this document:

- critical pass/fail standards;
- pass/fail point standards;
- Supporting information standards set for specific attributes and/or details. These attributes are not considered pass/fail criteria; however the established standards are expected to be met.

Critical pass/fail standards have been established for a number of attributes. If the standards are not met for any of these attributes the sample fails and the batch is rejected.

Pass/fail point standards have been established for many of the attributes that are important but individually do not have as large an impact on the overall result. Points are assigned when the measurement is outside the accepted standard. The sample is rejected when 10 or more points have been accumulated.

Standards have been assigned to all other attributes which are considered as supporting information. It is still expected that the standards for these attributes are to be met. If it is found the attributes are repeatedly measured or conducted below standard the field crew may be required to revisit the batch to ensure project standards are attained.

It is expected that the standards will change over time. Feedback about these standards is appreciated and should be directed to:

Manager, Vegetation Resources Inventory
Ministry of Forests, Lands and Natural Resource Operations
Forest Analysis and Inventory Branch
PO Box 9512 Stn Prov Govt
Victoria, BC V8W 9C2

Critical Pass/Fail Standards

Critical pass/fail standards have been established for a number of attributes. If the standards are not met for any of these attributes the sample fails and the batch is rejected.

Plot Cluster Location

| Attribute | Crew standard |
|-----------------------|---|
| Relative IPC location | ± 30 metres when appropriate field ties available |

Tree Attributes

| Attribute | Crew Standard |
|-----------------------|--|
| Tree Count | 1 error allowed per 40 trees. No errors on samples with less than 20 trees. (missed and added trees do not cancel each other) |
| Tree Genus | 1 error maximum |
| Tree Species | 1 error maximum |
| Live/Dead | 1 error maximum Live/Dead errors also count as tree count errors. |
| DBH | Absolute variation ≤ 2% (sum of individual absolute differences/sum of audit DBHs) |
| Tree Length | Absolute variation ≤ 3% (sum of individual absolute differences/sum of audit heights) |
| Sample Tree Selection | No error allowed in determining the leading species and second species 1 error maximum in the selection of sample trees (includes all leading species, second species, and top height trees). |
| Net Factor | 90% of the live tree net factors must be within ±10%** 90% of the dead tree net factors must be within ±20%** (the same log length must be used to determine the net factor) |

**Example: net factor between 40% - 60% is acceptable for auditor's result of 50%

Ecological Attributes

| Attribute | Crew Standard |
|---|---|
| Range transect total shrub coverage (m) | ± 15% |
| CWD – Gross volume (m ³ /hectare) | ± 15% |
| Tree/shrub species identification ¹ | > 90% of occurrences correctly identified |
| Herb/bryoid species identification ¹ | > 80% of occurrences correctly identified |

¹Species identification: the species is correctly listed as “counted” and “species correctly recorded” (either as a “known” or else collected and called an “unknown”) by the crew.

Pass/Fail Point Standards

Pass/fail point standards have been established for many of the attributes that are important but individually do not have as large an impact on the overall result. Points are assigned when the measurement is outside the accepted standard. The sample is rejected when the total points obtained is greater than 10% of the total points possible. If it is found that a given attribute is repeatedly measured or conducted below standard, even in a single field plot, the field crew may be required to revisit the batch to ensure project standards are attained.

Plot Cluster Location

| Attribute | Standard | Point Value |
|--|----------|-------------|
| Distance - reference pin to IPC (15.0 m) | ± 0.2m | 1 |
| Azimuth - reference pin to IPC | ± 2° | 1 |

Tree Attributes

These attributes must be checked on a minimum of five, randomly selected, IPC or enhanced trees in the cluster. Point values are applied to each tree and are cumulative.

| Attribute | Standard | Point Value |
|---|---|-------------|
| Stand/fall | Correctly identified | 1 |
| Diameter (if a tree is also a sample tree, the sample tree standards will be applied instead) | ± 3% or 0.3cm, whichever is greater | 1 |
| Tree length (if a tree is also a sample tree, the sample tree standards will be applied instead) | ± 5% or 0.2m, whichever is greater | 2 |
| Crown class | in correct class | ½ |
| First log grade | within 1 grade | ½ |
| First log length | ± 30% of length | ½ |
| First log net factor | ± 5% when net factor > 80% ± 20% when net factor < 80% | ½ |
| Second log grade | within 1 grade | ½ |
| Second log length | ± 30% of length | ½ |
| Second log net factor | ± 5% when net factor > 80% ± 20% when net factor < 80% | ½ |
| Broken top diameter | ± 20% of diameter | 1 |
| Projected height | ± 10% of length | 1 |
| Damage agents | ± 1 damage agent | ½ |
| Loss indicators | ± 1 indicators identified | 1 |

Sample Tree Attributes

These attributes must be measured on all sample trees (*top height, leading species, second species, other leading, and Veteran*).

| Attribute | Standard | Point Value |
|-----------------------|---------------------------------------|-------------|
| Sample tree selection | No Error | 1 |
| Tree length | ± 3% or 0.2m, whichever is greater | 2 |
| Diameter | ± 3% or 0.3cm, whichever is greater | 1 |
| Office counted age | ± 3% or 3 years, whichever is greater | 1 |
| Pro-rate Core length | ± 1.0 cm | ½ |

CMI Ground Sampling Quality Assurance Procedures & Standards

Small Tree Attributes

| Attribute | Standard | Point Value |
|--------------------|--------------------------|--------------------|
| Small tree species | 90% correctly identified | 1/2 |
| Total trees | ± 10% | 1/2 |

Supporting Information Attributes

Standards have been assigned to all other attributes which are considered as supporting information. It is still expected that the standards for these attributes are to be met. If it is found the attributes are repeatedly measured or conducted below standard the field crew may be required to revisit the batch to ensure project standards are attained.

Navigation and Layout

| Attribute | Standard |
|---|------------------|
| Azimuth – tie point tree to tie point | ± 2° |
| Azimuth – reference tree to reference pin | ± 2° |
| Azimuth – tie point to Reference Pin | ± 4° |
| Azimuth – IPC to auxiliary plots | ± 4° |
| Distance from tie point to tie point tree | ± 4% of distance |
| Distance from reference tree to reference pin | ± 4% of distance |
| Distance from tie point to Reference Pin | ± 5% of distance |
| Distance from reference pin to IPC (15.0 m) | ± 0.2m |
| Offset GPS distance to point | ± 4% of distance |
| Random and second transect azimuth | ± 4° |
| Transect length | ± 0.5 m |
| Location of forage plots | ± 0.2 m |
| Herb and bryoid plot (5.64 m) | ± 0.2 m |
| Tree and shrub plot (10.0 m) | ± 0.4 m |
| Azimuth for stem mapping | ± 2° |
| Distance for stem mapping | ± 2% of distance |

Tree Attributes

| Attribute | Standard |
|----------------------------|--|
| Field Bored Age | ± 10% |
| Bark remaining % | ± 10% |
| Height to live crown | ± 2 m |
| Third + log grade | * 90/100 in correct “category” |
| Third log length | ± 30% of length |
| Third log net factor | ± 5% when net factor > 80% ± 20% when net factor < 80% |
| Visual appearance | 90% in correct or adjacent class |
| Crown condition | 90% in correct or adjacent class |
| Bark retention | 90% in correct or adjacent class |
| Wood condition | 90% in correct or adjacent class |
| Lichen loading | 90% in correct or adjacent class |
| Wildlife use | 90% in correct class |
| Position of loss indicator | ± 1.0 m for indicator in lower 10 m ± 2.0 m for indicator in upper stem |
| Frequency | 90% correctly identified |
| Bark thickness | ± 2 mm or 20% (whichever is greater) |
| 5 year growth | ± 2 mm |
| 10 year growth | ± 4 mm |
| 20 year growth | ± 6 mm |

Stump Attributes

| Attribute | Standard |
|-----------------------------|----------------------------------|
| Stump species | 90% correctly identified |
| Stump diameter inside bark | ± 5 cm |
| Stump length | ± 0.2 m |
| Stump percentage sound wood | ± 20% |
| Stump bark retention code | 90% in correct or adjacent class |
| Stump wood condition code | 90% in correct or adjacent class |

Ecological Attributes

| Attribute | Standard |
|---|--|
| Shrub species | 85% [Maximum ± 2 added or missed] |
| Layer designation - B1 vs. B2 | 95% within correct layer |
| Shrub genus | 90% within correct genus [Maximum 1 missed or added] |
| Phenology | 95% within correct class |
| Transect – percent shrub coverage per species | ± 10% of actual when coverage is < 10.0 m. ± 15% of actual when coverage is ≥ 10.0 m. |
| Graminoid and forb separation | 90% of weight within correct designation |
| Forage utilization | 95% in correct or adjacent class |
| Forage (dry wt.) abundance | ± 2 grams if 0–50g ± 4% if ≥ 50g |

Coarse Woody Debris Attributes

| Attribute | Standard |
|---------------------------|---|
| CWD pieces | ± 2 pieces per transect |
| Species | 90% correct species identified for decay class 1, 2 or 3 pieces 75% correct species identified for decay class 4 or 5 pieces |
| Diameter | ± 4 cm for stems < 40 cm ± 10% for stems ≥ 40 cm |
| Length (optional in VRI) | ± 0.4 m for pieces < 10 m ± 5% for pieces > 10 m |
| Tilt angle | ± 5° |
| Merchantability | 80% correctly identified as “X” grade or better [Maximum 1 error] |
| Product to remove | 98% in correct class [Maximum 1 error] |
| Decay class for the piece | 90% in correct or adjacent class |

Ecological Site Description

| Attribute | Standard |
|--------------------------------|---|
| Uniformity code | ± 1 class |
| Zone | No error unless on a transition boundary |
| Subzone | No error unless on a transition boundary |
| Variant | No error unless on a transition boundary |
| Slope | ± 5% |
| Aspect | ± 20° |
| Elevation | ± 50 metres |
| Surface shape | 100% within correct or adjacent class |
| Meso-slope position | 100% within correct or adjacent class |
| Microtopography | 100% within correct or adjacent class |
| % coverage of cobbles & stones | ± 5% if < 20% coverage; ± 10% if ≥ 20% coverage |

CMI Ground Sampling Quality Assurance Procedures & Standards

| Attribute | Standard |
|--|--|
| % coverage of bedrock | ± 5% if < 20% coverage; ± 10% if ≥ 20% coverage |
| Flood hazard | 100% in correct or adjacent category |
| % coverage of flowing water | ± 5% if < 20% coverage; ± 10% if ≥ 20% coverage |
| % coverage of standing water | ± 5% if < 20% coverage; ± 10% if ≥ 20% coverage |
| Slope failure in plot | No error |
| Slope failure between plots | No error |
| Gullies within plot | No error |
| Gullies between plots | No error |
| Soil moisture regime | ± one category |
| Soil nutrient regime | ± one category |
| Site series number | no error unless on boundary transition (use SMR/SNR) |
| Land cover - level 1 (vegetated versus non vegetated) | no error unless on boundary of class |
| Land cover - level 2 (treed versus non-treed) | no error unless on boundary of class |
| Land cover - level 3 (wetland / upland / alpine) | no error unless on boundary of class |
| Land cover - level 4 (cover type) | ± one category |
| Land cover - level 5 (density description) | ± one category |

Soil Description

| Attribute | Standard |
|------------------------------------|---|
| Soil horizons | main rhizosphere identified correctly, for other layers ± one layer |
| Distance from zero for each layer | ± 10 cm |
| Texture for each identified layer | 100 % in correct or adjacent class |
| Total % coarse fragments | ± 10% for fragments < 35 % ± 20 % for fragments ≥ 35 % |
| % gravel | ± 10% for fragments < 35 % ± 20 % for fragments ≥ 35 % |
| % cobbles and stones | ± 10% for fragments < 35 % ± 20 % for fragments ≥ 35 % |
| Depth to water table | ± 10 cm |
| Depth to gleying | ± 5 cm |
| Depth to root restricting pan | ± 5 cm |
| Depth to bedrock | ± 10 cm |
| Depth to frozen layers | ± 10 cm |
| Depth to carbonates | ± 10 cm |
| Humus form | no error within main category (mull, moder, mor) |
| Surficial material (primary layer) | no error |
| Soil colour | ± one category |
| L/F/H description and depth | layers correctly identified and within 2 cm. Cumulative depth |

CMI Ground Sampling Quality Assurance Procedures & Standards

Vegetation Layers

| Attribute | Standard |
|---|--|
| Tree Species identified | 90% correctly identified |
| Overall cover estimate "A" layer | ± 10 % for cover > 25 % ± 5 % for cover 11 to 25 % ± 3 % for cover 6 to 10 % ± 0.5 % for cover 0.5 % to 5 % |
| Overall cover estimate "B1" layer | ± 10 % for cover > 25 % ± 5 % for cover 11 to 25 % ± 3 % for cover 6 to 10 % ± 0.5 % for cover 0.5 % to 5 % |
| Shrub species identified | 90% correctly identified |
| Overall cover estimate "B2" layer | ± 10 % for cover > 25 % ± 5 % for cover 11 to 25 % ± 3 % for cover 6 to 10 % ± 0.5 % for cover 0.5 % to 5 % |
| Species coverage Layer "A" | ± 10 % for cover > 25 % ± 5 % for cover 11 to 25 % ± 3 % for cover 6 to 10 % ± 0.5 % for cover 0.5 % to 5 % |
| Attribute | Crew Standard |
| Species coverage – layer "B1" | ± 10 % for cover > 25 % ± 5 % for cover 11 to 25 % ± 3 % for cover 6 to 10 % ± 0.5 % for cover 0.5 % to 5 % ± 10% if "A" layer > 10% ± 5% |
| Species coverage – layer "B2" | ± 10 % for cover > 25 % ± 5 % for cover 11 to 25 % ± 3 % for cover 6 to 10 % ± 0.5 % for cover 0.5 % to 5 % |
| Average height of B 1 layer | ± 1 metre |
| Average height of B 2 layer | ± 0.4 metres |
| Percent coverage by species of seedlings (Dh, Dw, and Dr) | ± 10 % for cover > 25 % ± 5 % for cover 11 to 25 % ± 3 % for cover 6 to 10 % ± 0.5 % for cover 0.5 % to 5 % |
| Herb species identified | 90% correctly identified |
| Bryoid species identified | 80% correctly identified |
| Overall coverage of layer C | ± 10 % for coverage > 30 % ± 5 % for coverage 16 to 30 % ± 2 % for coverage 6 to 15 % ± 1 % for coverage 1 to 5 % |
| Overall coverage of layer D | ± 10 % for coverage > 30 % ± 5 % for coverage 16 to 30 % ± 2 % for coverage 6 to 15 % ± 1 % for coverage 1 to 5 % |
| Species ID ¹ -layer "C,Dh,Dw,Dr" | 80/100 correct species |
| Species coverage – layer "C" | ± 10 % for coverage > 30 % ± 5 % for coverage 16 to 30 % ± 2 % for coverage 6 to 15 % ± 1 % for coverage 1 to 5 % |

CMI Ground Sampling Quality Assurance Procedures & Standards

| Attribute | Standard |
|-------------------------------|--|
| Species coverage – layer “Dh” | ± 10 % for coverage > 30 % ± 5 % for coverage 16 to 30 % ± 2 % for coverage 6 to 15 % ± 1 % for coverage 1 to 5 % |
| Species coverage – layer “Dw” | ± 10 % for coverage > 30 % ± 5 % for coverage 16 to 30 % ± 2 % for coverage 6 to 15 % ± 1 % for coverage 1 to 5 % |
| Species coverage – layer “Dr” | ± 10 % for coverage > 30 % ± 5 % for coverage 16 to 30 % ± 2 % for coverage 6 to 15 % ± 1 % for coverage 1 to 5 % |

Species identification is for species listed as “known” by crew.

Succession Interpretation

| Attribute | Standard |
|--|---|
| Factors influencing vegetation establishment | ± one factor missed or added |
| Previous species | must have at least one species of two correctly identified |
| Current species | must have at least one species of two correctly identified |
| Tree harvesting | In correct or adjacent category |
| Presence of snags | In correct or adjacent category |
| Snags and CWD presence | In correct or adjacent category |
| Canopy gaps | In correct or adjacent category |
| Vertical structure | In correct or adjacent category |
| Successional stability | In correct or adjacent category |
| Tree size | In correct or adjacent category |
| Tree age | In correct or adjacent category |
| Structural stages | In correct or adjacent category |
| % old trees alive | ± 10% |
| Old growth | “No” correctly identified “No (some) or Yes in correct or adjacent class |

Appendix 1: Auditor's List

Vegetation Resources Inventory

Project Jones Creek

Sampling Crew Leader Bob Johnson Ecological Attributes

| Random Order | Plot Cluster No. | Date Sample Completed | Audit Batch | Date Audited | Pass / Fail | Comments |
|--------------|------------------|-----------------------|-------------|--------------|-------------|----------|
| 1 | 27 | May 12 | 1 | | | |
| 2 | 23 | May 13 | 1 | May 21 | Pass | |
| 3 | 7 | May 15 | 1 | | | |
| 4 | 13 | May 16 | 2 | | | |
| 5 | 17 | May 17 | 2 | May 26 | Fail | |
| 6 | 11 | May 18 | 2 | | | |
| 7 | 3 | May 19 | 2 | | | |
| 8 | 15 | May 20 | 2 | | | |
| 9 | 19 | May 23 | 3 | | | |
| 10 | 8 | May 24 | 3 | | | |
| 11 | 20 | May 25 | 3 | | | |
| 12 | 4 | May 26 | 3 | June 1 | Pass | |
| 13 | 13 | May 28 | 2 | | | Re-audit |
| 14 | 17 | May 28 | 2 | | | Re-audit |
| 15 | 11 | May 29 | 2 | June 1 | Pass | Re-audit |
| 16 | 3 | May 29 | 2 | | | Re-audit |
| 17 | 15 | May 30 | 2 | | | Re-audit |
| 18 | 47 | June 1 | 4 | | | |
| 19 | 54 | June 2 | 4 | | | |
| 20 | 12 | June 3 | 4 | | | |
| 21 | 46 | June 4 | 4 | | | |
| 22 | 5 | June 7 | 4 | | | |
| 23 | 1 | June 8 | 4 | | | |
| 24 | 16 | June 9 | 4 | | | |
| 25 | 25 | June 10 | 4 | June 12 | Pass | |
| 26 | | | | | | |
| 27 | | | | | | |
| 28 | | | | | | |
| 29 | | | | | | |
| 30 | | | | | | |
| 31 | | | | | | |
| 32 | | | | | | |
| 33 | | | | | | |
| 34 | | | | | | |
| 35 | | | | | | |

Appendix 2: Audit Plot Selection List

Project: Jones Creek

| Random Order | Sample Number | |
|--------------|---------------|---|
| 1 | 27 | Crew Leader <u>Bob Johnson</u> |
| 2 | 23 | |
| 3 | 7 | Batch # <u>1</u> |
| 4 | | |
| 5 | | Random # selected <u>2</u> |
| 6 | | |
| 7 | | Date <u>May 17, 2001</u> |
| 8 | | |
| 9 | | Auditor <u>J. Smith</u> |
| 10 | | |
| 11 | | |
| 12 | | Ecology <input type="checkbox"/> |
| 13 | | Trees <input checked="" type="checkbox"/> |
| 14 | | |
| 15 | | |

| Random Order | Sample Number | |
|--------------|---------------|---|
| 1 | 13 | Crew Leader <u>Bob Johnson</u> |
| 2 | 17 | |
| 3 | 3 | Batch # <u>2</u> |
| 4 | 15 | |
| 5 | | Random # selected <u>2</u> |
| 6 | | |
| 7 | | Date <u>May 23, 2001</u> |
| 8 | | |
| 9 | | Auditor <u>J. Smith</u> |
| 10 | | |
| 11 | | |
| 12 | | Ecology <input checked="" type="checkbox"/> |
| 13 | | Trees <input checked="" type="checkbox"/> |
| 14 | | |
| 15 | | |

Appendix 3: Audit Report Template

Project # _____ **CMI Sample Audit Report**
Sample # _____

Establishment Crew: _____ **Date:** _____
Audit Crew: _____ **Date:** _____

Batch #: _____
Samples in Batch: _____

Overall Audit Summary:

Timber Attributes

Plot Cluster Location:

Critical Pass- Fail standards:

| Attribute | Standard | Pass(P)/Fail(F) |
|---------------------------|---|-----------------|
| Relative cluster location | ± 30 metres when appropriate field ties available | |

Points standards:

| Attribute | Standard | Possible Points | Points Obtained |
|--|----------|-----------------|-----------------|
| Distance - reference pin to IPC (15.0 m) | ± 0.2m | 1 | |
| Azimuth - reference pin to IPC | ± 2° | 1 | |
| Total Plot Cluster | | | |

Plot Cluster Attribute comments (including supporting attributes):

CMI Ground Sampling Quality Assurance Procedures & Standards

Tree Attributes:

Critical Pass-Fail Standards:

| Attribute | Standard | Pass(P)/Fail(F) |
|-----------------------|--|------------------------|
| Tree Count | 1 error allowed per 40 trees No errors on samples with less than 20 trees (missed and added trees do not cancel each other) | |
| Tree Genus | 1 error maximum | |
| Tree Species | 1 error maximum | |
| Live/Dead | 1 error maximum (live/dead errors also count as tree count errors) | |
| DBH | Average absolute variation $\leq 2\%$ (sum of individual absolute differences/sum of audit DBHs) | |
| Tree Length | Average absolute variation $\leq 3\%$ (sum of individual absolute differences/sum of audit heights) | |
| Sample Tree Selection | No error allowed in determining the leading species and second species 1 error maximum allowed in the selection of sample trees (includes all leading species, second species, and top height trees) | |
| Net Factor | 90% of the live tree net factors must be within $\pm 10\%$ 90% of the dead tree net factors must be within $\pm 20\%$ (the same log length must be used to determine the net factor) | |

Points standards:

| Attribute | Standard | Per Tree Point Value | Number of Trees | Possible Points (Point Value times number of trees audited) | Points Obtained |
|--|---|-----------------------------|------------------------|--|------------------------|
| Stand/fall | Correctly identified | 1 | | | |
| Diameter | $\pm 3\%$ or 0.3cm | 1 | | | |
| Tree length | $\pm 5\%$ or 0.2m | 2 | | | |
| Crown class | In correct class | $\frac{1}{2}$ | | | |
| First log grade | Within 1 grade | $\frac{1}{2}$ | | | |
| First log length | $\pm 30\%$ of length | $\frac{1}{2}$ | | | |
| First log net factor | $\pm 5\%$ (NF>80%), else $\pm 20\%$ | $\frac{1}{2}$ | | | |
| Second log grade | Within 1 grade | $\frac{1}{2}$ | | | |
| Second log length | $\pm 30\%$ of length | $\frac{1}{2}$ | | | |
| Second log net factor | $\pm 5\%$ (NF>80%), else $\pm 20\%$ | $\frac{1}{2}$ | | | |
| Broken top diameter/ projected height | $\pm 20\%$ of diameter or $\pm 10\%$ of length | 1 | | | |
| Damage agents | ± 1 damage agent | $\frac{1}{2}$ | | | |
| Loss indicators | ± 1 indicator | 1 | | | |
| Total Points | | | | | |

CMI Ground Sampling Quality Assurance Procedures & Standards

Tree attribute comments (including supporting attributes and optional pass fail criteria):

Sample Tree Attributes:

| Attribute | Standard | Point Value | Number of Trees | Possible Points (Point Value times number of trees audited) | Points Obtained |
|-----------------------|-----------------|-------------|-----------------|---|-----------------|
| Sample Tree selection | No error | 1 | | | |
| Tree Length | ± 3% or 0.2m | 2 | | | |
| Diameter | ± 3% or 0.3cm | 1 | | | |
| Office Counted Age | ± 3% or 3 years | 1 | | | |
| Pro-rate Core length | ± 1.0 cm | ½ | | | |
| Total | | | | | |

Sample Tree attribute comments (including supporting attributes):

Small Tree Attributes:

| Attribute | Standard | Point Value | Points Obtained |
|--------------------|--------------------------|-------------|-----------------|
| Small tree species | 90% correctly identified | ½ | |
| Total trees | ± 10% | ½ | |
| Total | | | |

Small Tree attribute comments (including supporting attributes):

Total Timber Attribute Points Summary:

| Section | Points possible | Points obtained | | |
|--|-----------------|-----------------|-------------------|------------------|
| Plot Cluster Location | | | | |
| Tree Attributes | | | | |
| Sample Tree Attributes | | | | |
| Small Tree Attributes | | | Percentage | Pass/Fail |
| Total (Must be less than 10% to pass) | | | % | |

Overall Timber attribute comments:

Ecological Attributes

Critical Pass/Fail Standards:

| Attribute | Crew Standard | Pass(P)/Fail(F) |
|--|---|-----------------|
| Range transect total shrub coverage (m) | ± 15% | |
| CWD – Gross volume (m ³ /hectare) | ± 15% | |
| Tree/shrub species identification | > 90% of occurrences correctly identified | |
| Herb/bryoid species identification | > 80% of occurrences correctly identified | |

Ecological Attribute comments (including supporting attributes):

Attach a table showing DBH and Length calculations, as well as other supporting information as required.

Add additional pages as necessary for further comment.