Change Monitoring Inventory – British Columbia

Ground Sampling Procedures

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

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Major Amendments for 2018

1. Clarity added regarding measuring and recording tree length on trees with unusual form. (sec. 4.2)
2. Explanatory text added regarding how to deal with DRS when found on the main stem. (sec. 4.5 and 5.3)
3. Clarity added regarding the assessment of suppression in tree cores for site index suitability. (sec. 4.8)
4. Clarity added regarding best practice for grading a log with ¼ butt rott. (sec. 6.2)

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1. Introduction

The procedures developed for the Ministry of Forests, Lands and Natural Resource Operations Vegetation Resources Inventory (VRI) form the basis for the Change Monitoring Inventory (CMI). As the sample design is different, it has been necessary to modify some of the VRI procedures to suit the CMI design.

Background

Developing the ability to report on the current status of the forest resource in British Columbia and to monitor changes in the forest has become a serious need in the last few years. The CMI was initiated to enable these new data needs to be met.

The permanent plot design of the CMI allows for the repeated measuring of forest attributes at defined locations. While permanent plots have been used for more than 80 years to track changes in the growth of trees across the province, the NFI-BC has expanded the practice to include the monitoring and measurement of photo-based information. The program has also increased the set of ecologically based data collected on the ground.

The program is designed to provide status and trend data—at the provincial and, ultimately, national levels—on 25 attributes of sustainability. Up to now, reporting on the current state of the forest resource in British Columbia has relied on an annual summary of the information contained in all the province’s map sheets. The permanent, re-measurable design of the CMI puts in place a statistically based system of monitoring and reporting, which can be completed in conjunction with the national program.

The data requirements for the CMI closely paralleled the attributes collected in the British Columbia Vegetation Resources Inventory (VRI) ground sampling program. The foundations for the procedures in this document are derived from the VRI program.

Principles of the Ground Sampling Process

1. Sample plots will be selected randomly from a Provincial grid.
2. Moving plots to more typical locations is never acceptable. Sample plots must be placed where they fall. Special procedures will be used when this constitutes a temporary or permanent safety hazard.
3. All data attaches to the Integrated Plot Centre.
4. The ground sampling must be done correctly and carefully. Errors in the ground samples are translated directly into errors in the inventory. Accuracy is the watchword.
5. Quality of answer includes the concepts of no bias and small sampling error. It is achieved by ensuring the following:
   - No bias

     The sampling processes are statistically valid.

     Rounding and vague definitions are avoided.
   - Small sampling error

     The sample selection method may be combined with traditional stratification to ensure variance stabilizes more quickly than a random sample and that ensures controlled sample sizes in all land types.

6. Measurements are made to a known level of precision. Estimates made at the sample plot are acceptable where measurements cannot be taken.
7. All measurements are to be completed and recorded in the field.

How to Use This Document

This document deals with the ground sampling component of the CMI. It describes procedures for the location and establishment of sample plots, and the collection of data related to:

- trees
- site, soils, plants and succession
- woody debris
- range resources

The major activities associated with the ground sampling process are illustrated in Figure 1.1. Sample tally sheets for recording field information are also included in this document. A handheld data entry program is also available for recording field information. The procedures for entering data in the handheld are not discussed in detail in this document.

A brief background is provided in Section 1 to explain the rationale behind the procedures. The remainder of the document describes the procedures or methods required for ground sampling.

- Section 2 and 3 describe the procedures required to locate and establish sample plots.
- Section 4 explains the measurement and recording of tree information at the Integrated Plot Centre.
- Sections 5 and 6 describe the call grading and net factoring criteria, guidelines, and rules.
- Section 7 describes the procedures required to gather site, soils, plants and succession information.
- Section 8 contains the procedures for measuring coarse woody debris, and
- Section 9 describes the procedures for measuring range resources.

Each of these sections contains a brief introduction, objectives, general procedures, and detailed procedures. Definitions, examples, and tips are also provided.

A glossary of terms and a detailed index are included in this document to ensure the usability of the document as a reference tool.

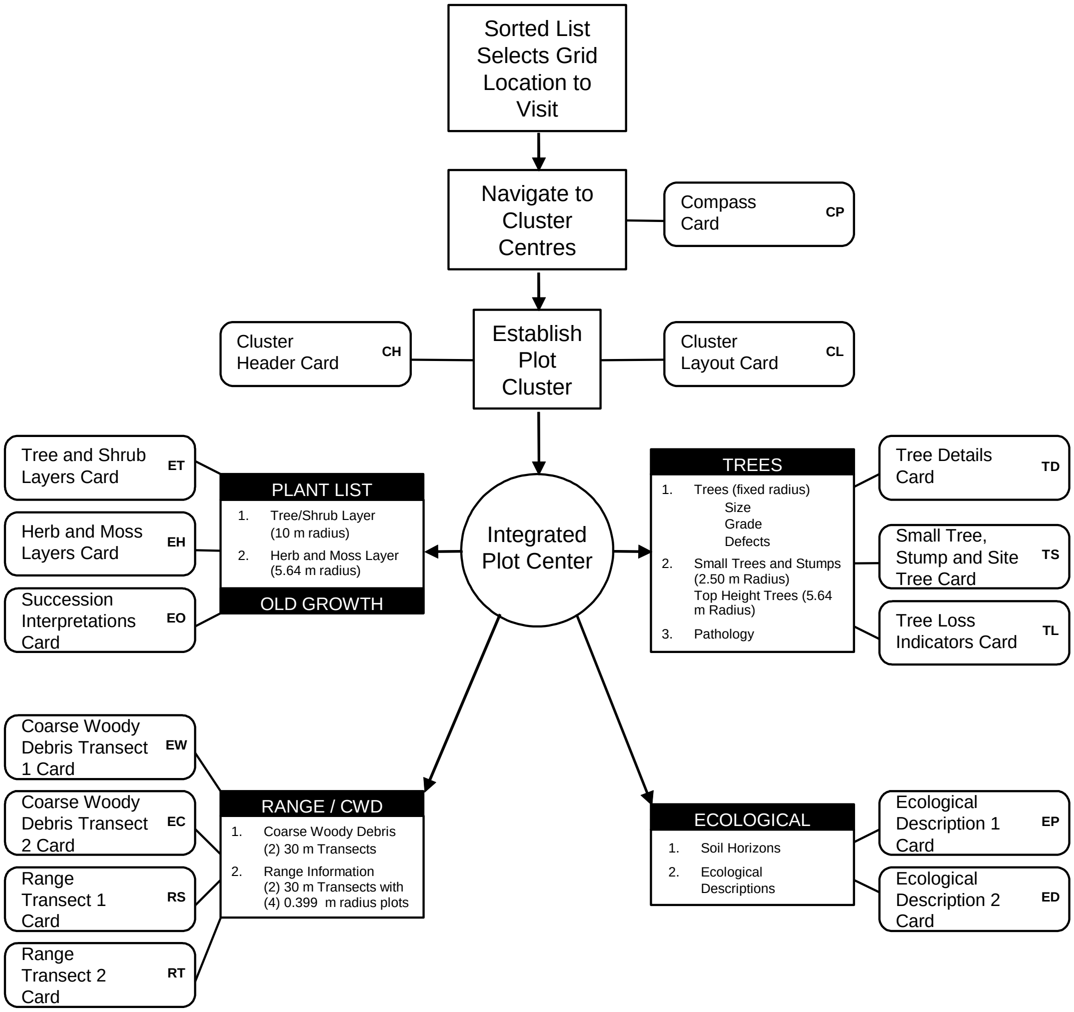


Figure 1.1 - Major activities in the ground sampling process.

2. Field Orientation and Navigation

Introduction

This section outlines the steps needed to traverse from a geographically located feature (the access point) to the Integrated Plot Centre (IPC). The field crew is responsible for selecting suitable access points, navigating to the tie point/reference point and IPC, and recording the navigation information. The route must be suitably marked to locate the plot centre and to aid relocation in the near future (5-10 years).

The current preferred method of establishing the Integrated Plot Centre (IPC) is to establish the reference point at 15.00 m from the IPC using a hand-held GPS unit (effectively making the reference point the tie point), and then measuring out the 15.00 m with a tape to establish the IPC. As this method will not always be practicable, the traditional method of tight-chaining from a tie point location is contained in Appendix J. Throughout this chapter, which has been updated to reflect the new GPS-based sample establishment, “reference point” and “tie point” are synonymous and can be used interchangeably.

Objectives

1. To locate the IPC at the given UTM co-ordinates for the sample.
2. To mark and document the IPC location and navigation points to allow for short and long-term sample relocation.
3. To facilitate no special treatment of the plots, the plot marking and tree marking will be hidden as much as practical.

General Procedures

Office Preparation

1. Prepare and become familiar with area characteristics and access prior to field visitation.
    - Identify the location of the IPC on the orthophoto.
    - Identify the location of the IPC on the map.
    - Determine the relative accuracy of the map:orthophoto relationship.
2. Determine if GPS-based establishment of the reference point will be possible. It may not be possible in steep terrain or dense timber that leads to GPS signal interference.
3. Locate a potential tie point and alternatives on the map and orthophoto, in case GPS-based establishment is not possible.

Field Location

1. Locate and confirm an access point in the field and mark it.
2. Roughly navigate to the reference point using any desired means, including GPS.
3. Ensure you are in the correct ground position as indicated on the orthophoto and by the UTM coordinates.
4. Use a hand-held GPS unit to provide a final location for the reference point.

5. Place a steel or iron bolt in the end of a plot centre pin (to facilitate re-location with a metal detector). The head of the bolt should be large enough that it will sit on the top of the cylindrical pin and not fall through it. Drive the Reference Pin fully into the ground.
6. Paint and tag the Reference Tree and measure the bearing and distance to the Reference Pin. Place tag at ground level.
7. Measure 15.00 m to the IPC.
8. Place a steel or iron bolt in the end of a plot centre pin and drive it fully into the ground. This is the IPC.

A simple illustration of the components of field orientation and navigation is contained in Figure 2.1.

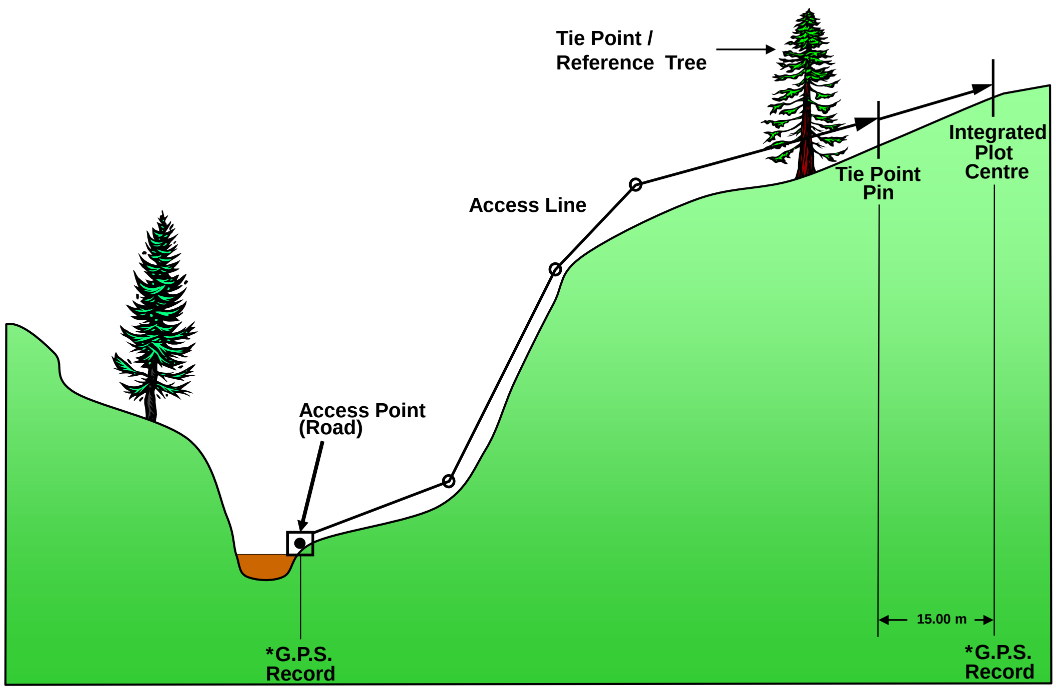


Figure 2.1 - Components of Field Orientation and Navigation

Field Cards for this Section

Header Card (CH) (Appendix A, Figures A.1 and A.2)
polygon ID, project ID, sample plot, date, crew, general notes and access details.

Compass Card (CP) (Appendix A, Figures A.3 and A.4)
Access Point, Reference Pin Location, Reference Tree, GPS, location, field survey notes.

Cluster Layout (CL) (Appendix A, Figures A.5 and A.6)
Integrated plot details, sample cluster details.

Detailed Procedures

Standard procedures of location, marking, and recording must be followed so that sample plots are easy to relocate for quality control and re-measurement purposes. The following procedures are designed to be used with a hand-held GPS unit as the primary means of navigation and plot location. Traditional survey methods of plot location (such as compass, clinometer, and distance-measuring equipment) are contained in Appendix J for reference in cases where GPS navigation is not used.

Now that the selective availability of GPS has been turned off, the use of GPS to locate sample plot locations is another tool that can be used. It is mandatory that GPS only be used up to the location of the reference point. It is important to remember there is still error in GPS readings, especially in dense timber and on steep slopes. The crew will still need to confirm that the sample is in the correct location.

GPS data will be recorded at the access point, reference point (as the tie point), and the Integrated Plot Centre. Basic GPS requirements for CMI are outlined in section 2.6. Detailed standards and procedures for GPS data collection can be found in the document: "*GPS Data Collection Procedures for Georeferencing Vegetation Resources Inventory and National Forest Inventory Field Sample Plots (January 2004)*." This document is available on the MFLNRO Vegetation Resources Inventory website.

2.1 Locating and Marking the Access Point

An access point is selected and marked to ensure it can be found again with reasonable effort using the field crew's documentation. This is typically at a roadside location or helicopter landing spot. The access point is the first physical point of contact that a revisiting field crew has with a sample, and therefore, an access point should be established for every sample.

Office Preparation

1. **Determine if the access point will be stand-alone or double with the reference tree:**
    - In most instances the reference point will not be directly accessible, unless the IPC is very near the location where the truck is parked or the helicopter puts down:
        - If the reference point will not be in very close proximity to the roadside/helispot or will not be visible from this location, a stand-alone access point is required.
        - In rare instances where the reference point is close enough to the roadside/helispot and will be easily visible from this location, a single tree (or other suitable feature) can be selected and marked to serve as both the access point and the reference tree.
2. **Locate the access point:**
    - The field crew is responsible for the selection of a suitable access point. An access point should have the following characteristics:
        - must be locatable on the ground
        - preferably should be locatable on the orthophoto
        - preferably should be locatable on the appropriate forest cover map
        - should permit efficient access to the sample
        - should be very near to where the field crew leaves the truck or helicopter

- If reasonable to do so, an access point should be a tree located at some distinct roadside ground feature that can be easily referenced in the access notes. Where this would unnecessarily increase the distance to the reference point, a tree at the closest roadside location to the IPC that allows efficient access to the sample will suffice. Some possible features are:
  - road junction
  - bridge on a stream crossing
  - timber boundary features
  - singular tree or small clump of trees
  - swamp, pond, or lake edges
  - significant bend in the road
  - helicopter put down location

Field Location

1. **Establish the access point in the field:**
   - Confirm the access point location or select an alternative.
   - Select an Access Point Tree or stump of suitable size (20+ cm) so that the stem will be present for a number of years (not immediately beside a road where it may be removed during road maintenance).
   - Where no suitable trees or stumps are available, use another feature, such as a rock cut, boulder, and so on. A small rock cairn can aid relocation.
2. **Mark the access point tree for relocation of the sample in the short term (up to 5 – 10 years):**
   - Make the access point visible to a field crew conducting surveys, but not overly visible to the general public. For example:
     - if available the tree should be greater than 20 cm in diameter
     - choose conifers over deciduous, cedars over other conifers
     - limb the complete stem to shoulder height
     - remove understory vegetation around the tree, if practical
     - paint the tree on 4 sides
     - ribbon the tree bole
     - record the project name and sample number on the flagging

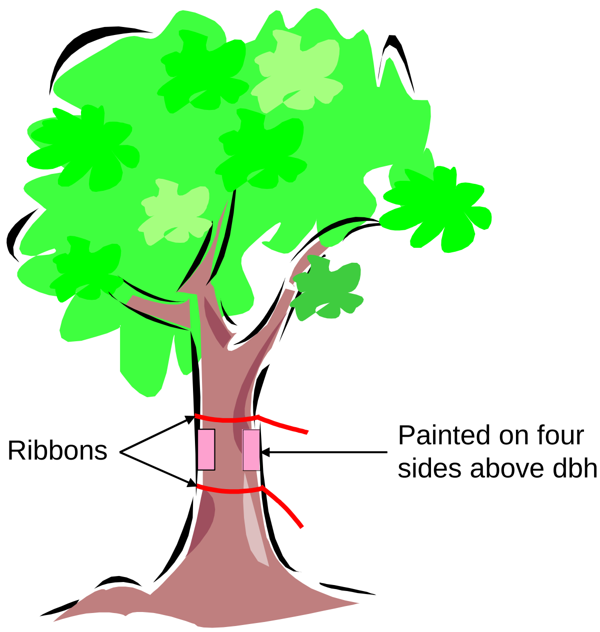


Figure 2.2 - Marking the Access Point Tree

Note: Tree marking and ribboning must be coordinated with the appropriate land manager or owner.

3. Describe the access point in the access notes:

- The back of the Header field card provides space for the crew to record access notes to aid in relocation of the sample. The notes should include a narration of the route traveled from a known location (e.g., the junction of a highway and a secondary road) to the access point, in enough detail to aid relocation by a different crew for re-measurement in approximately 5 to 10 years.
- Provide a thorough physical description of the access point at the end of the access notes.
- Note the approximate bearing(s) and distance(s) (or whatever other navigation notes are appropriate) from the access point to the reference point following the description of the access point.

Note: An increasing number of samples are being visited by various field crews, which may or may not have GPS capability or GPS data was not available at the site. Extra effort should be made in providing detailed access notes for future visitation.

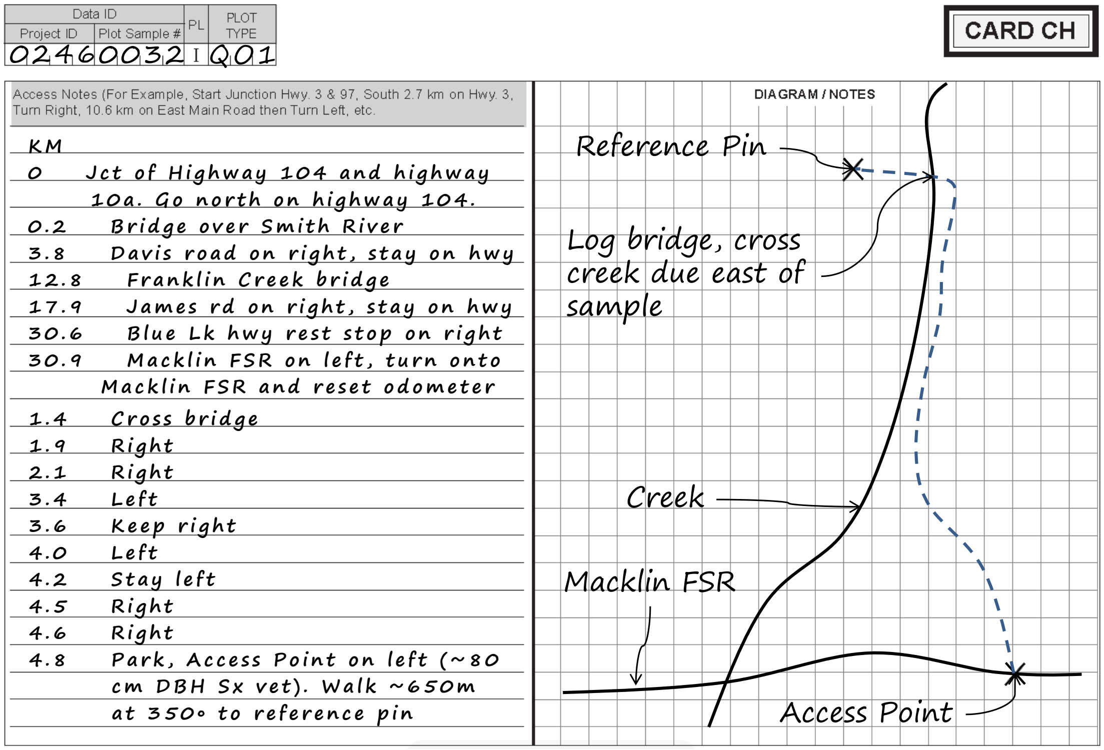


Figure 2.3 - Example of Completed Access Notes

4. **Collect and record GPS data at the access point location:**
   - Record a brief description of the location in the 'Descrip.' field on the CP card.
   - Collect a GPS file and record the file number in the field for 'GPS Access Point' on the CP field card. Access point coordinates may be collected using any reliable GPS unit, and do not need to be post-processed.

   When GPS data cannot be collected at the access point, move to an area where data can be collected (such as an opening). Measure the distance and bearing from the point where data was collected back to the access point. Record these measurements in the Comments section on the Compass Card. If GPS data cannot be collected for the access point at any site, enter "NoData" for the GPS file ID.

2.2 Navigating to the Reference Point

From the Access Point navigate to the Reference Point location.

Procedures

1. Locate the Reference Point using a rough bearing and distance and/or a hand-held GPS unit.
2. Walk around unsafe or difficult situations.
3. Flag the access line well enough to be easily followed. Flagging is to aid in short-term relocation of the IPC (within one field season).

4. Evaluate the location. When you find that the orthophoto and ground location agree, proceed with establishing the Reference Point and Reference Tree. When you arrive at the Reference Point and find that the orthophoto and ground location do not agree, evaluate the problems and find the correct sample location. The objective is to find the **correct ground location** as per the given UTM co-ordinates of the sample point. You will not be "moving" the plot location if there is a conflict, you will be "finding" it. The map, GPS, and other tools are aids in finding the correct location.

2.3 Establishing the Reference Point and Reference Tree

The purpose of establishing a Reference Point is to eliminate potential small-scale bias for the Integrated Plot Centre location. The Reference Point will also help in relocating the IPC. In standard forest conditions, the reference tree will be marked as follows. If the sample occurs on sensitive areas, the project manager will designate that hidden plot procedures are employed (Appendix K).

Procedures

1. Determine the intended Reference Point coordinates by subtracting 15 m off of the IPC intended northing coordinate; this point will be 15 m south of the IPC. If it appears that another cardinal direction out from the IPC would provide a more practical or safer location, adjust from the IPC intended coordinates as required, for example:
    - Adding to the northing or easting puts the reference point north or east of the IPC, respectfully.
    - Subtracting from the northing or easting puts the reference point south or west of the IPC, respectively.
2. Navigate via any preferred method (including GPS) from the Access Point to the pre-determined reference point coordinates as calculated above.
3. Stop at the approximate coordinates for the reference point and use a hand-held GPS unit to record an averaged waypoint (collect between 100 and 150 averaged points).
4. Compare the averaged waypoint coordinates to the intended reference point coordinates, and adjust the required X (easting) and Y (northing) distances with a tape to get to the intended tie point/reference point coordinates. The following table provides an example of this exercise.

	Easting	Northing
Intended IPC coordinates:	689283	5616623
Intended RP coordinates (-15 m from Northing):	689283	5616608
Averaged waypoint coordinates (from GPS unit):	689287	5616606
Required adjustment to get from waypoint to RP:	Go 4 m West…	and 2 m North

5. Establish the Reference Pin at this point. Place a steel or iron bolt in the end of a plot centre pin (to facilitate re-location with a metal detector). The head of the bolt should be large enough that it will sit on the top of the cylindrical pin and not fall through it. Drive the pin firmly into the ground until top of pin is level with the ground surface. If the pin can not be embedded to this depth, remove the excess length (with a pipe cutter or hacksaw). If appropriate, establish a small rock cairn at the pin location.

6. Choose a suitable Reference Tree (greater than 20 cm in diameter, if possible). The Reference Tree should be reasonably close, in relatively good health, with a high probability of survival, and with particular distinguishing features when possible (such as a forked tree, aspen in spruce stand, veteran in immature stand). The Reference Tree should not be a tree in the sample plots.
7. Record the species, diameter, azimuth and distance from the Reference Tree to the Reference Pin on the Compass Card (discussed in Section 3.5). This data is replicated for the Tie Point Reference Details on the same card (establishing the reference point by GPS essentially results in the reference point being the tie point).
8. Mark the tree with flagging tape and paint on four sides above DBH. Securely nail an aluminum identification tag (Figure 2.4) with aluminum nails at the base of the tree below potential felling height (0.3 m) and facing the Reference Pin. If site conditions make this impossible, the tag location is at the discretion of the crew. Record the tag number on the Header Card (CH) and Compass Card (CP).
9. Record 15 m at the appropriate azimuth (e.g., 0 degrees if the reference point is south of the IPC) for the straight line bearing and distance to IPC on the Compass Card (CP).
10. When the reference point (i.e., tie point) is established using the GPS methods described above, the field crew is not required to collect a GPS file at this point. Instead, derive the reference point coordinates by removing 15 m from the corrected IPC UTM northing (or other required adjustment if the reference point is not south of the IPC). These derived coordinates are then entered for the tie point on the Compass Card (CP). The GPS file ID should be entered as “Derived”.

Figure 2.2 - Example of Tag for the Reference Tree

2.4 Establishing the Integrated Plot Centre

From the Reference Point, measure to the Integrated Plot Centre.

Procedures

1. Accurately measure the 15.00 m along the correct bearing to the IPC to eliminate any possible small-scale bias in placing the centre (Figure 2.5).

   This point becomes the Integrated Plot Centre regardless of the site or conditions. The plot centre may be in an open forest, a rocky area, a road, a creek, or inside a standing tree.

Note: If you feel that the site is unsafe or poses an undue hazard, the sample may be dropped (see Section 2.5). The project supervisor will review other means of completing these hazardous samples.

2. Place a steel or iron bolt in the end of a plot centre pin (to facilitate re-location with a metal detector). The head of the bolt should be large enough that it will sit on the top of the cylindrical pin and not fall through it. Drive the pin fully into the ground at the IPC. If site conditions make it impossible or inappropriate to imbed the aluminum pin at the IPC, place it as close as possible to the plot centre, and record the offset distance and bearing from the pin to the plot centre on the Cluster Layout (CL) card (Figure A.5).
3. Collect GPS data at the IPC. When GPS data cannot be collected at the plot centre, move to an area where data can be collected (such as an opening). Measure the distance and bearing from the point where data was collected back to the IPC. Record these measurements in the appropriate section on the Cluster Layout card. The final coordinate entered into the software must include any adjustments for offsets. If GPS data cannot be collected for the IPC at any site, the intended coordinates must be recorded using "Intended" as the GPS file ID and the intended coordinates entered in the "corrected UTM field" on the CL card.

Note: It is critical that IPC coordinates are as accurate as possible in order to ensure samples can be used in a variety of analyses where knowing the precise location of the IPC is crucial. This is also important as the IPC is the only location requiring post-processed coordinates.

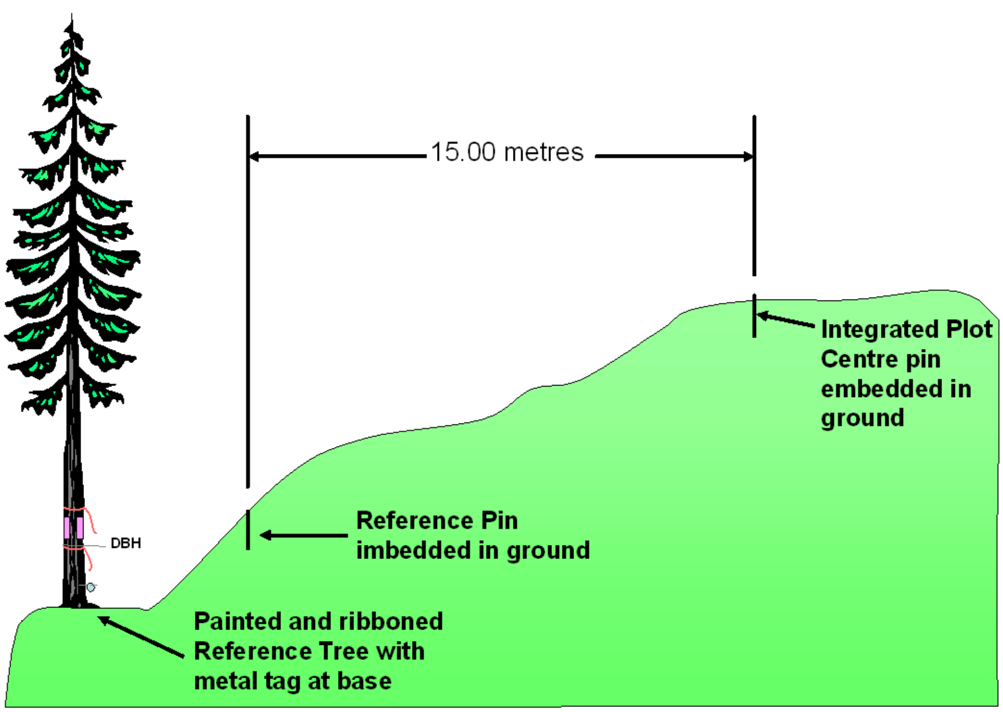


Figure 2.3 - Layout of Reference Pin and Integrated Plot Centre

2.5 When the sample is inaccessible

In some instances, the complete sample or some part will not be accessible because of factors such as dangerous slopes, denied access, or physical safety concerns. It may be readily apparent from the access point or earlier that the area is inaccessible, or only as the sample location is approached. In some cases, small unmapped local features such as beaver ponds and water bodies may be encountered. The field crew is not expected to sample beyond what is considered reasonable and safe. For example, if the water level is above the "boot tops," then estimate the attributes if possible or drop the plot if reasonable estimates cannot be made.

The safety of the field crew is the first priority.

Complete as much information as possible on the field cards, maps, and orthophotos to the point where field work was terminated. It is appropriate to estimate the portion of a sample not physically accessible [for example if the last few metres of a line transect is inaccessible but it can be seen that no pieces or a few pieces have to be estimated it is preferable to record the estimate(s) rather than recording the line portion as not sampled]. In another example, if ½ of the large tree plot is accessible and ½ is not accessible but can be estimated it is preferable to estimate the inaccessible portion.

When a sample is dropped, complete the CH card and return it to the project manager. Specify why the sample cannot be established, for example:

- access to plot is too dangerous
- plot would be located in an unsafe area
- plot would be located in a river or lake
- permission denied to access private land

Provide detailed comments as required.

2.6 GPS Requirements

The Access point and IPC are to have GPS data collected and post processed. The Tie Point (Reference Point, in this case) only requires Post-processed GPS data if it is established in the traditional methods described in Appendix J. Otherwise, derived coordinates from the post-processed IPC GPS coordinates are acceptable, with the GPS file ID noted as “Derived.”

The GPS hardware and software must be capable of achieving a target accuracy of 10 meters horizontal and 15 meters vertical, for 95% of the points collected in a feature using standard single-frequency pseudo-range differential correction techniques.

Offsets are to be recorded on the field cards and the coordinate that will be keypunched in the data entry program will have the offset already included. Final GPS coordinates must be entered into the ground sample data entry program before submission.

GPS reference stations must conform with the requirements shown in: “*GPS Data Collection Procedures for Georeferencing Vegetation Resources Inventory and National Forest Inventory Field Sample Plots (January 2004)*.” This document is available on the MFLNRO Vegetation Resources Inventory website.

3. Plot Establishment

Introduction

This section outlines the layout of plots and measurement procedures at the Integrated Plot Centre. For more detailed procedures refer to the appropriate sections.

Objectives

To establish sample plots for the Change Monitoring Inventory.

Definitions

The CMI sample design consists of a series of sample data and sampling designs relating to a single plot centre. The location of the sample is pre-determined, using statistically appropriate procedures.

The **Integrated Plot Centre** is the location around which the detailed sample information will be collected. All attributes are attached to the plot centre point (See Figure 3.1).

General Procedures

1. Confirm that the Integrated Plot Centre is in the correct location.
2. Assess safety considerations.
4. Determine and carry out the sequence of activities.
   - Assess the site vegetation and determine the most efficient sequence of measurements to ensure that specific values are not degraded by other activities. For example, on a site that has forage value, plants of interest may be trampled if tree heights are measured first.
5. Record the Integrated Plot characteristics (for example, project and sample ID, type of plot, plot radii).

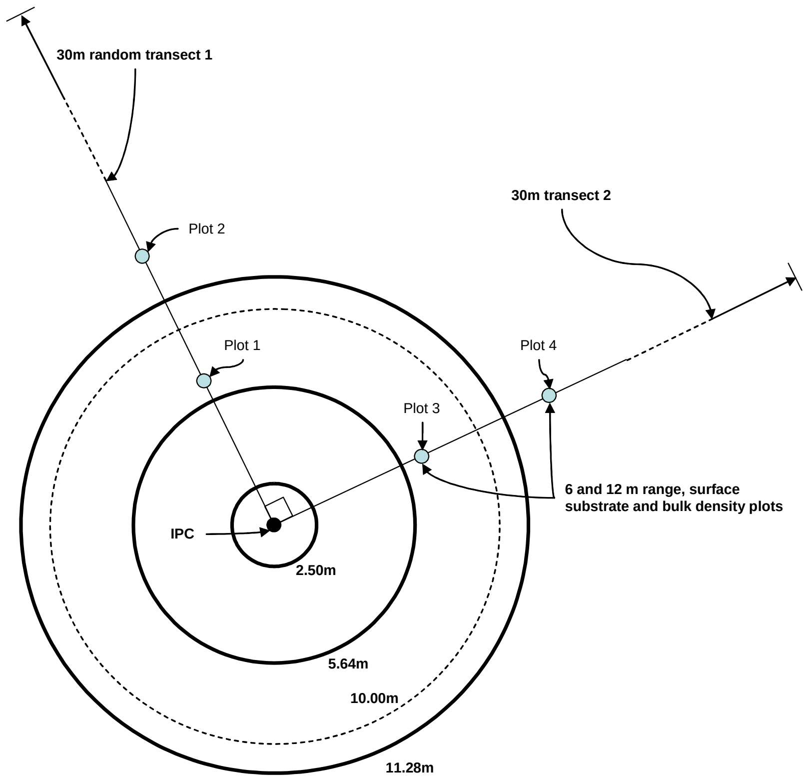


Figure 3.1 - Layout of sampling plots and transects and summary of data collected.

All attributes collected on the sample are attached to the location of the plot centre point

Sampling methodology	Data collected
2.50 m fixed-radius	small tree and stump data
5.64 m fixed-radius	tree details ≥ 4cm dbh, top height tree, vegetation species and cover percent (herbs, grasses, bryoids)
0.04 hectare quadrants	sample tree details
Within 10 m fixed-radius	estimated tree and shrub cover percentage, ecological data, soil pit
11.28 m fixed radius	tree details ≥ 9cm dbh
Approximately 25 m radius	succession interpretations, slope gradient, aspect, old growth, etc.
30 m line transects	coarse and small woody debris, surface substrate
0.399 m radius along each line transect at 6 m and 12 m	Range, fine woody debris, location for bulk density sampling

Field Cards for this Section

Header Card (CH) (Appendix A, Figures A.1 and A.2)
Polygon ID, project ID, sample plot, date, crew, notes

Compass Card (CP) (Appendix A, Figures A.3 and A.4)
Tie-Point Tree, Reference Pin Location, Reference Tree, GPS, file numbers, field survey notes

Cluster Layout (CL) (Appendix A, Figures A.5 and A.6)
Integrated plot details sample cluster details

Detailed Procedures

Depending on the sequence of measurements, perform the functions described below.

3.1 Establishing the Plots at the Integrated Plot Centre

Tree Detail Plot

1. Establish a 5.64m fixed-radius plot (Figure 3.2), for trees 4.0 cm DBH and larger.
2. Establish an 11.28m fixed-radius plot (Figure 3.2) for trees 9.0 cm DBH and larger.
3. Number the trees sequentially clockwise in sectors from the north.
4. Make detailed measurements on the selected “in” trees for diameter, length, grade, wildlife tree attributes, damage agents, loss indicators, and other details.

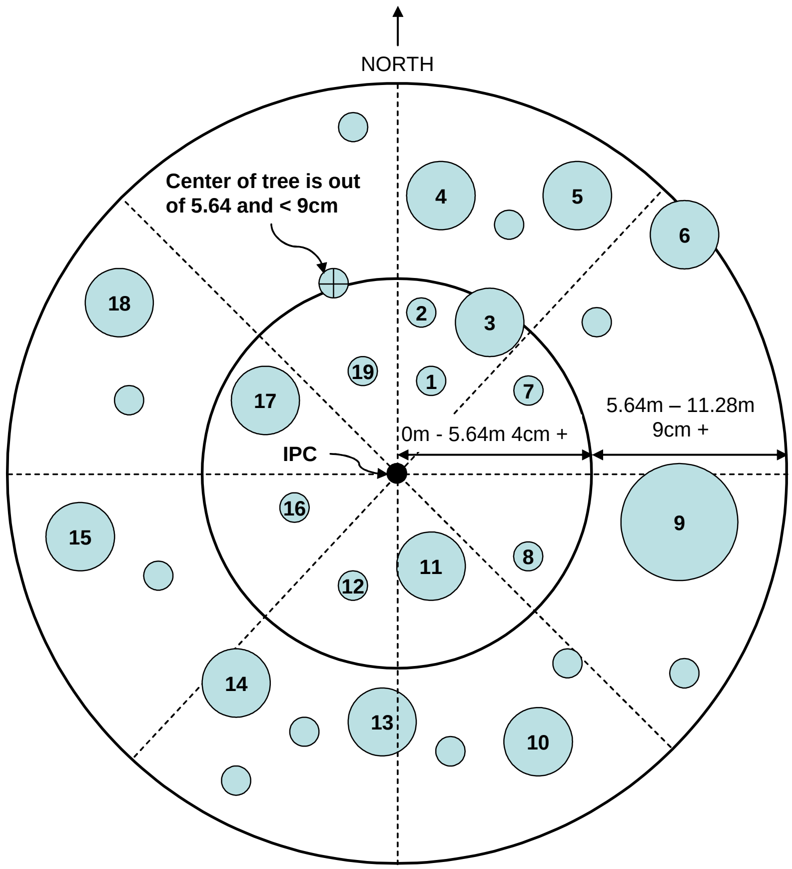


Figure 3.2 - 5.64m and 11.28m fixed-radius plot layout.

Small Tree Plot (2.50 m, 3.99m, or 5.64m fixed-radius)

1. Establish a 2.50 m, 3.99 m or 5.64 m fixed-radius plot (as determined by the project specifications), centered on the Integrated Plot Centre.
2. Count live trees less than 4.0 cm DBH and more than 10 cm in length. Record in three predetermined classes.

Stump Plot (2.50 m fixed-radius)

1. Establish a 2.50 m fixed-radius plot, centered on the Integrated Plot Centre (Figure 3.5).
2. Collect stump data (larger than 4.0 cm top diameter inside bark) on this plot. The stump plot is never split for too many stumps.

Top Height Tree Plot (5.64 m fixed-radius plot)

1. Establish a 5.64 m fixed-radius plot, at the Integrated Plot Centre (Figure 3.3).
2. Measure a top-height tree, if a suitable tree is available within this plot.
3. Determine the species composition (by basal area) for the sample.

4. Measure a sample tree of the species leading in basal area, if a suitable tree is available within each quadrant.
5. Measure a sample tree of the next species in order of basal area, if a suitable tree is available within each quadrant.

The first tree selected at the IPC is the top height tree; for example this tree may be a cedar tree. After completing the sample, the leading species by basal area for the sample is determined to be cedar. The cedar tree may also be the "leading species tree" and the data will be copied into the leading species information data fields. Alternatively, if the sample leading species by basal area is hemlock, then the cedar tree may be the second species tree and the data will be copied as required.

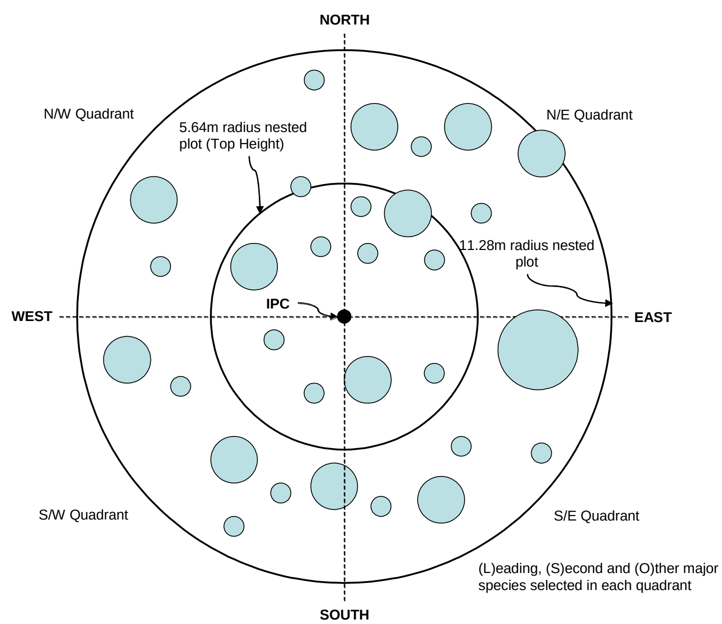


Figure 3.3 - Top-height tree 5.64 m fixed-radius plot.

Ecological Data Plots

1. Establish a full fixed-radius plot (10 m radius) – centred on the Integrated Plot Centre – to measure trees and shrubs (Figure 3.4).
2. Establish a full fixed-radius plot (5.64 m radius) to measure herbs, grasses, and bryoids.
3. Within a 25 m radius of the Integrated Plot Centre determine succession and old-growth characteristics of the Integrated Plot Centre within the 11.28 m plot.
4. Establish a soil pit describing the Integrated Plot Centre within the 10 m radius plot.

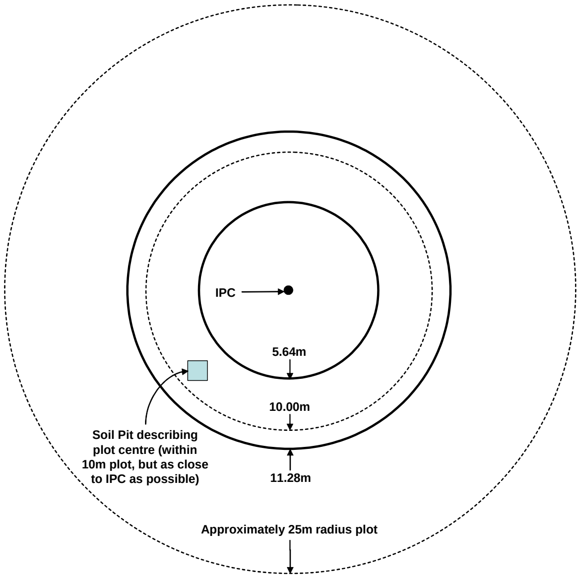


Figure 3.4 - Ecological data collection plot layout.

Coarse Woody Debris Line Transects

(The CWD line length was changed for the 2012 field season to 24m. This applies to all establishments after this point. Some remeasurement projects may want to use the previous 30m length for consistency or measure both lines) See Appendix for previous procedures.

1. Establish a 24 m horizontal line transect from the Integrated Plot Centre along a previously selected random bearing (Figure 3.8).
2. Measure all coarse woody debris greater than 7.5 cm diameter at the point of intersection.
3. Include detailed measurements at the transect crossing point on diameter, tilt angle, and decay class. Also record species and piece description.
4. Establish a second 24 m transect from the Integrated Plot Centre at plus 90° from the first line and take measurements again.

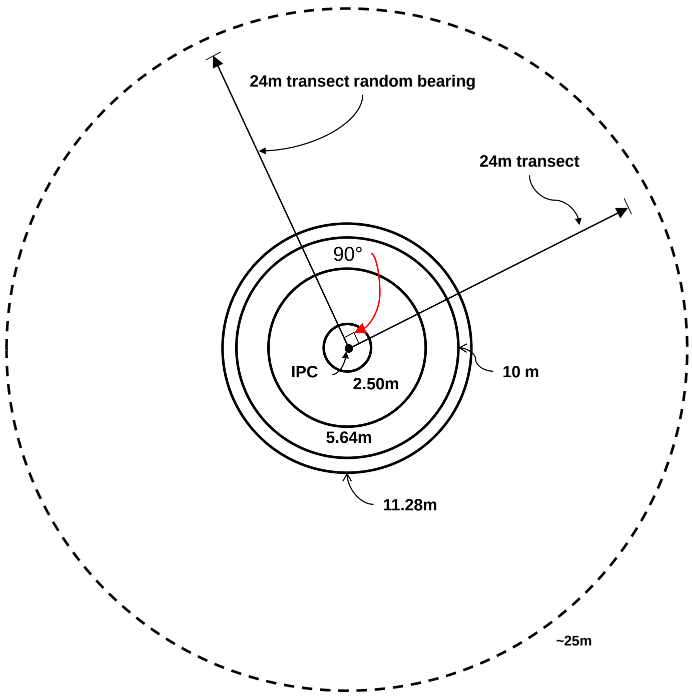


Figure 3.5 - Woody debris line transect layout

3.2 Taking Ground Photographs

A series of ground photos will be taken at each Integrated Plot using a quality digital camera with flash. . Individual file size should be approximately 1024 x 768 pixels

Objectives

The photos will be available as digital data for:

- initial assessment by potential users who may want to sub-sample on these locations for other values; and
- "capturing" some information that is not directly measured.

Procedure

Take a minimum of eight photos at each Integrated Plot location. The required photos are as follows:

1. a close-up of the Integrated Plot Centre pin
2. a photo along the first random-bearing transect line
3. a photo along the second random bearing transect line
4. a photo along the reverse of the first random-bearing transect line
5. a photo along the reverse of the second random-bearing transect line
6. a photo representative of the sample vegetation and structure at the IPC
7. a photo of the forest canopy directly overhead at the IPC
8. a photo of the soil profile that has been described in the soil pit.

Do not cut trees or vegetation to provide an unobstructed view.

Take the photo before taking measurements if the site may be damaged during sampling.

1. Photograph the IPC Pin at a steep angle (about 60°) above the pin showing the pin and the ground for approximately one metre or more around the pin so the vegetation can be seen (Figure 3.7). Include something to record the plot number, particularly on this photo.
2. Photograph the random-bearing transects from a position behind the plot centre pin (Figure 3.8).
   - Include the IPC Pin in the foreground, if possible.
   - Include something for relative scale determination.
   - Try to include the various crown levels with a “portrait” (vertical) format, if required.
3. For a representative photo, photograph a portion of the plot which the crew considers representative of the sample vegetation and structure (Figure 3.9). Include the IPC and an item for scale in the photo.
4. Photograph any other unusual features that you think would be of interest to users of this data. You may wish to illustrate issues about the sampling process, such as when rules do not seem clear or appropriate. Make notes about these photos so the points can be addressed later.
5. Try to include people in each photo for scale. Use a scale in any close-up photos.
6. Include the plot number in the photo.
7. Record the photos taken (roll and photo number) and any comments on the (CH) Header Card.
8. When samples are submitted, each file must be in JPEG format and named in the following manner Project_ID-Sample_ID-Plot_Type-photo_subject. For example 0241-0001-Q01-Representative.jpg

Figure 3.6 - Ground photo showing Integrated Plot Centre pin.

Figure 3.7 - Ground photo along the first transect line.

Figure 3.8 - Ground photo showing representative view.

3.3 Completing the Header Card (CH)

A Header Card (CH), must be completed for all samples. In addition, data must be recorded to identify each individual field card in case cards are separated. Some of the information is completed prior to sample establishment and some information during or as soon as possible after sample completion. In all cases the Header Card must be completed even if the sample was inaccessible and not completed.

Procedure

1. Record the following information on the Header (CH) card and all other field cards:

DATA ID	The Data ID (Project ID and Plot Sample #) must be recorded on all field cards (front and back), notes, sample collections, tree age cores, and so on.
PAGE — OF —	If the field cards provide inadequate space to record data, additional cards may be used as required.

2. The following information will be completed at another time:

FIELD CHECK BY	The full name of the person conducting a field check of the plot, and date of check. (This is not an Audit check.)
OFFICE CHECK BY	The full name of the person conducting the office check of the plot, and date of check.

3. Record the following information on the CH field card:

DATA ID	This section provides primary identification of the sample. The values are assigned prior to field sampling and provided to the field crew. Values may also be entered by the project supervisor prior to field sampling.
• **PROJECT ID**	The province has been divided into a number of inventory units. Record the code provided.
• **PLOT SAMPLE #**	Each sample is assigned a number. Record the number provided.
• **POLYGON IDENTIFIER**	A unique value is assigned to all NFI sample locations within the province. Enter the number provided. In most cases this number is not available at this time but will be entered at some future date.

PLOT TYPE	The plot type coding for monitoring samples consists of three characters as follows: Character 1 - type of sampling F = National **F**orest Inventory sample M = **M**anagement unit monitoring sample Y = **Y**oung stand monitoring sample L = **L**ight sample (basic attributes only) See Table 3.1 for field cards for each project type. Character 2 - intent of sample O = **O**riginal R = **Re-**measurement A = **A**udit M = **M**atching Character 3 - measurement number 1 = first measurement 2 = second measurement, and so on **Note:** Typical examples of coding are as follows: **-** FO1 = initial full National Forest Inventory sample -MR1 – First Re-measurement of a Management Unit Monitoring sample
MEASUREMENT DATE	The date the sample measurements were initiated. Use this format:1999AUG12.
CREW INITIALS	Record crew members in order of responsibility for the work done, Person #1 is the crew leader. A record of crew initials (usually 3 initials as assigned) will be maintained by the MSRM, and if overlaps occur a numeric value may be added (for example, JSF1 and JSF2).
FIELD RESPONSIBILITY	Record the full first and last name of the person with primary responsibility for collection of each type of data (tree data and ecological data).
PLOT CLUSTER RECORD	This section provides a record of the information collected for a sample. Check Yes or No for the information completed for each plot.
• **INTEGRATED**	Check No if the sample was inaccessible or unsafe. In the Notes section, provide reasons the sample was dropped or suggestions for accessing or completing the sample.
• **RANGE, ECOLOGICAL, CWD**	Check the plots completed.
• **PHOTOS**	Record number of photos taken.

• **TYPICAL: TREES, ECOLOGY**	Check (Yes or No) to indicate if the tree data or ecological data are typical of the plot being sampled. For example, the Integrated Plot may be located in a wetland microsite within an upland forest and not typical of the plot being sampled, in the opinion of the crew. Note that in all cases the sample will not be moved.

STAND DISTURBANCE	• If there is a natural or human induced event that has caused the volume to be reduced by more than 25% from that on the VRI phase I maps in any given plot, then a disturbance code must be recorded. The volume reduction is an estimate from the field crew only. The disturbance field is recorded as an attribute for the entire cluster. • This should not be confused with reductions in volume due to natural stand variability. For example a sample that falls in an unmapped pocket of shrubs, or an unmapped pocket of smaller trees would not be recorded under the disturbance code (unless caused by an agent listed in the disturbance codes). • Details of the disturbance should be recorded in the comments section, and should include an estimate of the volume lost, and any other details that may assist in the analysis of volume discrepancies. • Crews are not expected to calculate lost volume. The information provided will be reviewed during the sample analysis and inventory adjustment phase to determine reasons behind large discrepancies between the phase I estimates and phase II measurements of volume. • If there is more than one cause in a plot, choose the most significant cause. If there are two successive causes then record the most recent one (for example, an area burnt and then salvage logged would be recorded as logging) Stand Disturbance codes include NB - Fire NW - Windthrow DD - Heartrots DF - Foliage diseases DR - Root diseases D - Unknown disease IB - Bark Beetles ID - Insect defoliators A - Animal L - Logging, thinning, clearing, brushing and weeding (add details in comments) X - Other known (add details) U - Other unknown O - No significant damage Record the appropriate code for the disturbance in columns (S9 and S10) on the CH card with applicable comments recorded in the adjacent comments section.
NOTES	Enter any comments relevant to the sample measurements (such as photo notes, procedure problems).

PHOTO RECORD	Record the ground photos taken. If additional photos were collected, provide a short description with roll number and photo number. If no photos were taken, mark a "---" through both boxes and the reason photos were not taken.

Other Provincial Monitoring Ground Sample Programs

As indicated in Table 3.1, a complete set of field cards is required for the CMI program. The opportunity to collect either more or less than this set of data is possible in the management unit monitoring program. Any modifications to the data collection protocols indicated here would need to be identified through the Project Implementation Plan (VPIP).

Table 3.1 – Field cards for Ground Sample Types

Sample															
Type	**Code**	CH 1	CP 2	CL 3	RS 4	EW 6	EC 7	TD 8	TL 9	TS 10	EP 12	ED 13	ET 14	EH 15	EO 16
NFI	F	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CMI	M	X	X	X	O	O	O	X	X	X	O	O	O	O	O
YSM	Y	X	X	X				P	X	X					
LIGHT	L	X	P	P				P		P					

X = Mandatory,

O = Optional (note some optional cards must be completed in conjunction with other cards),

P = Partial (some portions of cards must be completed):

Type Y - Call Grading/ Net Factoring is not collected in YSM plots

Type L – The following information is not collected in "Light" plots:

- Tie point map, polygon and flight line number,
- Tie Point Tree information (Species, diameter, azimuth, distance, CMI tag number),
- Straight line bearing and distance to IPC,
- Height to Live Crown,
- Call Grading/Net Factoring,
- Wildlife codes,
- Damage Agents/Severity,
- Loss indicators,
- Small tree plots,
- Stump plots.

3.4 Completing the Compass Card (CP)

The Compass Card (CP) provides an additional means of relocating samples in the short and long term (20 years or more).

Procedures

Complete a Compass Card(s) for each sample. Record as much information as possible. In addition to the Data ID, at a minimum record the following:

MAP NO. / POLYGON NO.	Forest cover map and temporary polygon numbers.
FLIGHT LINE / PHOTO NO.	Air photo numbers on which the tie point and sample are located. If Orthophotos were used exclusively, use "Orthophoto 1".
TIE POINT / REFERENCE POINT DETAILS	Record the Tie Point and Reference Point details, and offset Reference Pin where applicable. Record the Species, Diameter (DBH in cm), the azimuths and distances from the Tie Point Tree to Tie Point Location and Reference Point Tree to Reference Point Location. In some cases a tie point or reference tree will not be available. In these cases the crew could use a rock feature as a reference [record "ROC" in the species record] or any other identifiable feature such as telephone pole, hydro tower [record "OTH" in the species record and specify the feature in the comments section].
COMMENTS	Record any special features of the tree (e.g., major fork). Record other features of the Tie Point. If there is no Tie Point Tree, describe the Tie Point (e.g., junction of Loss Creek Main and Branch 300; northeast corner of Cutblock 11 on Branch 302; northwesterly edge of snow slide track).
GPS FILE ID	Record offset GPS reading, if applicable
STRAIGHT LINE BEARING AND DISTANCE TO IPC	Record the horizontal distance and azimuth from the Tie Point to the Integrated Plot Centre.
NAVIGATION NOTES	Map the features along the tie line. Record vegetation or timber type changes, creek locations (names, if known), rock bluffs, etc.
ACCESS POINT LOCATION	Record description, GPS file ID.

3.5 Completing the Cluster Layout (CL) Card)

A Cluster Layout card (CL) will be completed for all samples. The card provides a location to record detail on the features around the Integrated Plot Centre and the features associated with the sample.

Procedure

Record the following information on the CL field card:

GPS INTEGRATED PLOT CENTRE	Record the file number in the GPS Integrated Plot Centre field. Record offset GPS reading, if applicable. If a GPS reading was not available at the site record in the comments section why no data was collected. Record offset Integrated Plot Pin details, if applicable. **Recording the "intended" or target UTM co-ordinates:** **Field cards** – on the field card record the "intended" UTM co-ordinates in the comments section on the back of the CL card. **Handheld –** the handheld program will collect the "intended" UTM co-ordinates. **Final corrected GPS data must be entered before sample data is submitted to Resource Information Branch.**
SLOPE PROFILE	Sketch the cross section including Integrated Plot Centre which best describes the local topography.
INTEGRATED PLOT DETAILS	Map distinctive features within the plot such as water bodies, rock outcrops, site series boundaries, B.C. Land Cover classification boundaries.
SAMPLE CLUSTER DETAILS	Map distinctive features within the sample area which may aid in plot relocation, such as creek locations, road locations, polygon boundaries. Map the Reference Pin location and tie point location if it is close to the Integrated Plot Centre.
COMMENTS	Record any comments which may aid in relocation of the plot, or other items of interest.

4. Inventory Cruising

Introduction

This section deals with the identification and collection of detailed tree information from which volume can be calculated, quality can be assessed, and site potential can be determined. Trees are sampled using a combination of fixed-radius plots.

Objectives

- To collect attributes for the calculation of tree and stand volumes.
- To collect site index information.
- To assess and collect tree attributes for:
  - future growth and yield assessment,
  - wildlife,
  - decay research
  - forest health information.

General Procedures

Tree measurements are discussed in this section as they appear on the field cards, but the field crew is free to measure attributes in the most efficient sequence. Net factoring and call grading are discussed in a separate section. The steps are discussed in the following order:

1. Establish plot layout and identify (tag) trees to measure.
2. Identify and record tree attributes.
3. Assess and record wildlife use.
4. Record damage agent and severity codes.
5. Identify and record tree loss indicators.
6. Establish fixed-radius plot for small tree and stump data.
7. Classify and tally small trees by species.
8. Measure and record stump data.
9. Establish a fixed-radius plot for top height and quadrants for sample tree measurements.
10. Determine leading species composition (by basal area) for the sample.
11. Select and record top height tree, leading, second species and other major species tree data.
12. Identify and record additional measurements on other major species, if required.

Field Cards for this Section

Tree Details (TD) (Appendix A, Figures A.10 and A.11)
Tree number, species, status, DBH, remaining bark, length, net factor, grades, stem map

Tree Loss Indicators (TL) (Appendix A, Figure A.12)
Damage agent, severity, loss indicators, location and frequency, and wildlife codes

Small Tree, Stump, and Sample Tree Data (TS) (Appendix A, Figure A.13)
Small tree, stump, height and age information.

Detailed Procedures

4.1 Establishing Plot Layout

Sampling Method

The sampling design specifies the use of a series of fixed-radius plots for the sample.

Measuring Borderline Trees “In” and “Out”

It is important to accurately determine if the trees are ‘in” or “out” of the appropriate fixed radius plot. The horizontal distance from the centre of the tree at "point of germination" to the IPC will be used to check this borderline distance.

Marking the Plot Circumference

1. Measure and mark the 5.64 metre and 11.28 metre plot radius around the IPC.
2. Carefully check the horizontal distance for trees close to the edge of the plot circumference. These trees are called borderline trees. Include borderline trees in the plot when at least half their base at the "point of germination" is inside the plot.

Boundary Plots – Walkthough Method (YSM Samples only)

Determine if there is a boundary within 22.56m of plot centre. A boundary, for this purpose, is defined as being a polygon which is outside the 15-50 year old YSM population definition. If a boundary is identified, then the Walkthrough Method (Appendix I) must be followed. The project manager will have identified potential samples for boundary plots during the project planning stage. However, there may be instances where a boundary has been created that the project manager did not know about. A new cutblock, not on the imagery or in RESULTS yet, is a good example.

Dividing the Plot into Sectors

Divide the plot into 8 pie-shaped, 0.005 ha (45 degrees) tagging sectors. These tagging sectors are later combined into pairs in order to have 0.01 ha quadrants [site sectors] for the selection of sample trees.

Sector 1 is always the first sector clockwise from due north. The additional sectors are numbered clockwise from sector 1.

Tagging Trees

Tag all living (standing and fallen) and dead (standing only) trees that have a DBH of 4.0 cm and greater within the 5.64 metre radius sub-plot, and trees with a DBH of 9.0 cm and greater between the 5.64 metre and 11.28 metre area. Do not duplicate tag numbers in a plot.

Tagging by Sectors

1. Start with sector 1. In this sector, affix the tags so that they face the **plot centre**.
2. Tag the trees near the plot centre first; then continue tagging outward by moving side-to-side across the pie-shaped sector. (see Figure 3.2)
3. As you reach the circumference of sector 1, make the last sideways pass in the direction of sector 2 so that the last tree tagged in sector 1 is as near as possible to the first tree tagged in sector 2.
4. In sector 2, affix the tags so that they face the **circumference** of the plot, away from plot centre.
5. Tag the trees near the circumference first, then continue tagging inward by moving side-to-side across the pie-shaped sector.
6. Make sure the last tree you tag in this sector is the one closest to the plot centre.
7. Repeat the procedures used in sectors 1 and 2 for the remaining sectors. Remember that tags in odd-numbered sectors face the plot centre while those in even-numbered sectors face the circumference (away from plot centre).

Attaching Tags to Trees

1. Determine the point at the base of the tree that is equal to the high side location. High side is defined as the highest point of mineral soil or a humus layer around the base of the tree, no lower than the point of germination. Nail the tag at 1.3m (NFI samples have the tags placed at high side):
   - use 6 cm aluminum nails;
   - drive the nail slightly upward so the tag hangs away from the tree;
   - drive the nail into the trunk just enough to hold the tag securely and yet allow for radial growth.

Tagging Forked Trees

Special rules are required for tagging forked trees:

1. Tag the stem as a single tree if:
   - the fork occurs above 1.3 m, and
   - the stem has a dbh of at least 4 cm within the 5.64 metre sub-plot or has a dbh of at least 9.0 cm if the stem is between the 5.64 metre and 11.28 metre area.
2. Tag each stem separately if:
   - the fork occurs below 1.3 m, and
   - two or more of the fork's stems have a dbh of 4 cm or greater within the 5.64 metre sub-plot or have a dbh of at least 9.0 cm if the stems are between the 5.64 metre and 11.28 metre area. Use consecutive numbers when you tag these stems (tag the stem farthest to the left first and finish with the stem farthest to the right).
   - On NFI plots, locate the tag at high side ground level directly below the fork so it is evident which tag belongs to each stem.

3. Tag the stem as a single tree if:
    - the fork occurs below 1.3 m, and
    - only one of the fork's stems has a dbh of 4 cm or greater within the 5.64 metre sub-plot or has a dbh of at least 9.0 cm if the stem is between the 5.64 metre and 11.28 metre area.

4.2 Identifying and Recording Tree Attributes

Record the following measurements in the appropriate fields on the Tree Details (TD) field card. The fields to be recorded are listed and described below.

For the purposes of this inventory, a **tree** is defined as:

- a species identified as a tree for the purposes of this inventory. The tree species recognized in the inventory is the current version of the BC Tree Code List which is available on the Ministry of Forests and Range, Research Branch website.longer than 1.3 m, having roots attached to the bole or an identifiable root collar; and
- greater than or equal to 4.0 cm at DBH.

TREE NUMBER

All trees will be marked with numbered tags to identify them in the field and on the field cards. The plots will be re-measured in the future and are subject to audit cruising, and tagging the trees in a consistent sequence will enhance the chances of a successful remeasurement program.

Recording Tree Sector Numbers

All trees will have the sector number recorded to assist relocation at the time of re-measurement. The sector number will be recorded in the spare column (S1) on the right side of the TD field card.

TREE SPECIES

Assign a species code to all trees, measuring all trees regardless of commercial value at the time of the survey. The tree species recognized in the inventory is the current version of the BC Tree Code List which is available on the Ministry of Forests, Lands and Natural Resource Operations, Research Branch website.

Note: It has been decided *not to measure* the willow “tree species” on the large tree or small tree plots. The ecological component will still collect data on these species.

Procedure

1. Record the tree number and a species code (up to 3-characters) for the tree being measured.
2. Code all species as accurately as possible using the BC Tree Code List. If the species cannot be identified with confidence, record the genus, if known. If the genus is not known, record the appropriate code for unknown species (such as Xc for an unknown conifer).

TREE STATUS

Assigning tree status allows for reporting trees in categories and reflects some potential for future growth.

<u>Procedure</u>

1. Record for each tree whether it is live or dead, standing or fallen.
2. Use the codes described in Table 4.1.

Table 4.1 – Tree Status Codes.

Code		Description
Live/Dead	**L**	**Live** trees have enough foliage to keep them alive (live cambium is present), and are rooted into the ground. Lack of foliage for some species, of course, is no indication of death during some seasons.
	D	**Dead** trees are obviously dead, or roots are separated from the ground.
Standing/ Fallen	**S**	**Standing** trees are self supporting (that is, the tree would remain standing if all supporting materials were removed).
	F	**Fallen** trees are not self-supporting.

DIAMETER BREAST HEIGHT (DBH)

Measure and record the diameter of all live (standing and fallen) and dead (standing), trees equal to or greater than 4.0 cm DBH.

<u>Procedure</u>

1. Determine high side ground level at the base of the tree, this is the height where the tag is placed for NFI samples.
2. High side is defined as the highest point of mineral soil or a humus layer around the base of the tree, no lower than the point of germination. Breast height is 1.3 m above high side measured parallel to the tree bole.
3. Measure the DBH in cm and tenths at 1.3 metres from the ground on the high side, at the tag location (Figure 4.1).
4. Use a stake marked at 1.3 m to accurately locate Breast Height on straight stems. On curved stems measure along the curve parallel to the centre of the tree. To ensure consistency with future measurements, crews should place the base of their DBH stake on the tree tag nail (for NFI plots where tags were placed at the level of high side ground) when determining the location to measure DBH.
5. Paint a dot on the tree, or mark a dot, where DBH was measured on non NFI plots, preferably facing the plot centre. Marking may vary depending on land owner preferences.

6. Record the DBH with a tight diameter tape, outside the bark, making no allowance for missing bark.
7. If there is abnormal swelling or obstructions at DBH measure above and below the location and average the values as appropriate. This would be recorded as an estimated value.
8. Record whether the DBH was measured (M) or estimated (E).

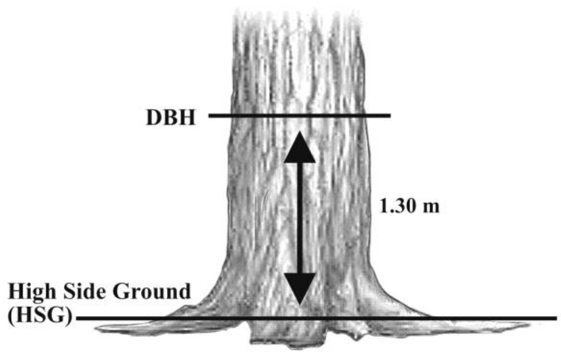


Figure 4.1.1

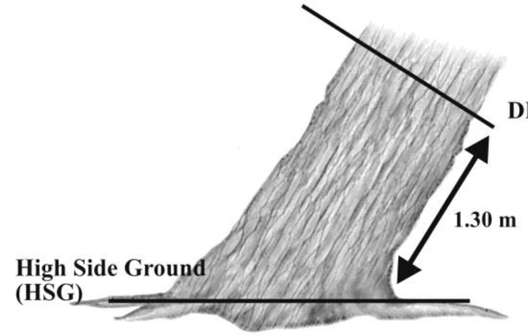


Figure 4.1.2

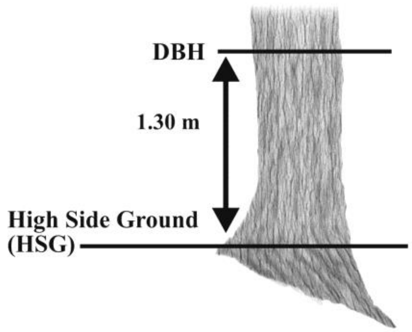


Figure 4.1.3

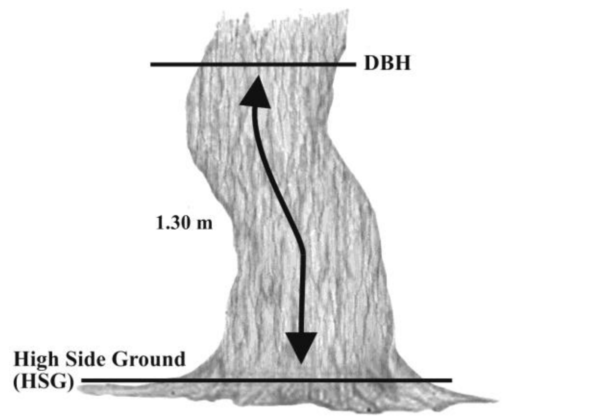


Figure 4.1.4

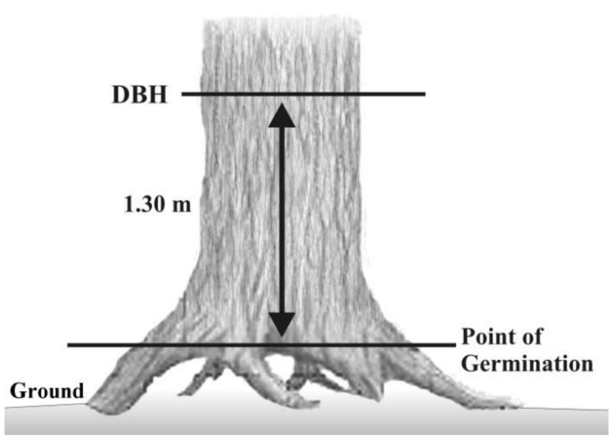


Figure 4.1.5

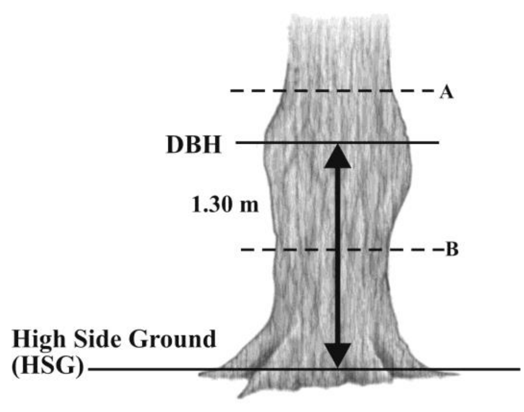


Figure 4.1.6

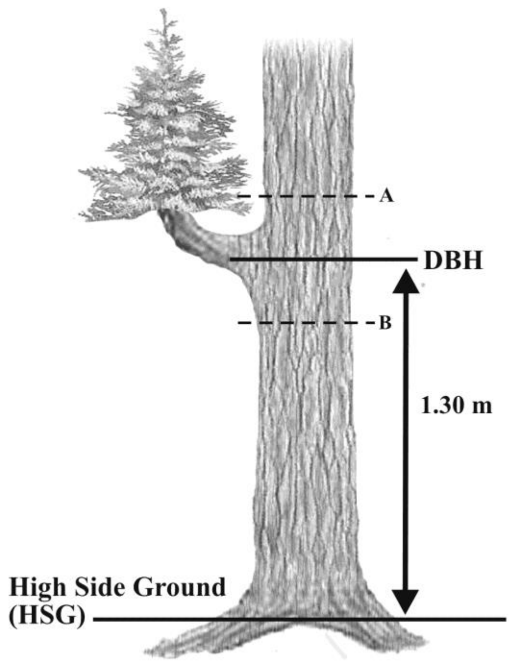


Figure 4.1.7

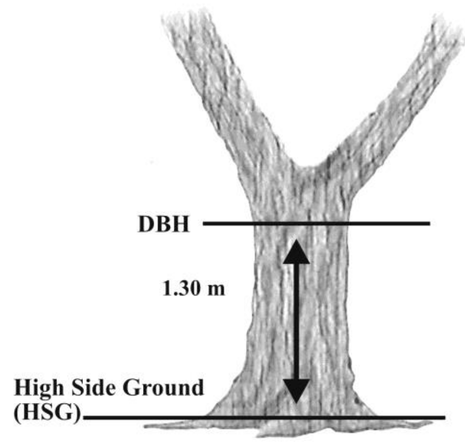


Figure 4.1.8

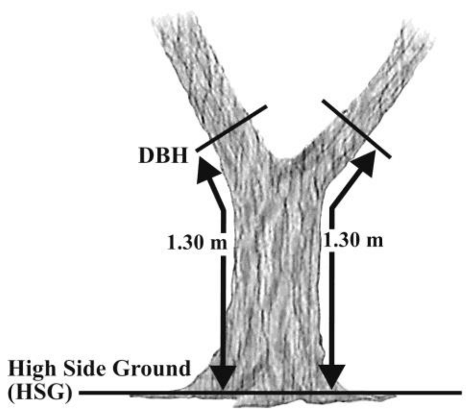


Figure 4.1.9

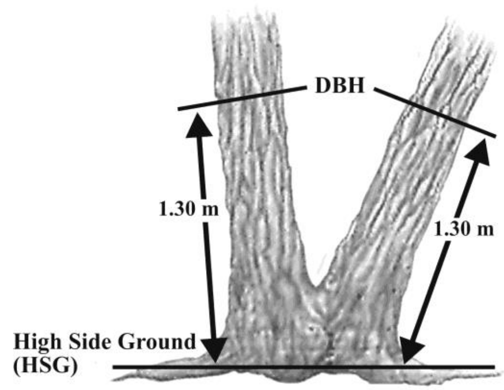


Figure 4.1.10

Figure 4.1 - DBH in Relation to High Side Ground and Point of Germination (diagrams courtesy of Canadian Forest Service)

REMAINING BARK PERCENTAGE

The percentage of bark remaining is required to determine the actual wood volume of the tree. The impact on wood volume will be minor when small amounts of bark are missing, but could become significant when large areas of bark are missing, particularly on thick-barked species.

Procedure

1. For each DBH measurement, record the percentage of bark remaining at DBH to the nearest percent, for example:

bark: 100%	record as	- -
bark: 90%	record as	90
bark: 13%	record as	13
no bark present:	record as	00

Note: It does not matter if the diameter tape touches the exposed wood or not.

2. Calculate the bark remaining.

A simple way to obtain the percentage of bark remaining is to observe the length along the diameter tape where the bark is missing, and subtract to find the amount remaining. Calculate the percentage of bark remaining using the following formula:

$$\text{Remaining Bark \%} = \left(\frac{\text{Length of tape with bark}}{\text{Total length of tape}}\right) {*100\ \%}$$

See Figure 4.2 for an example.

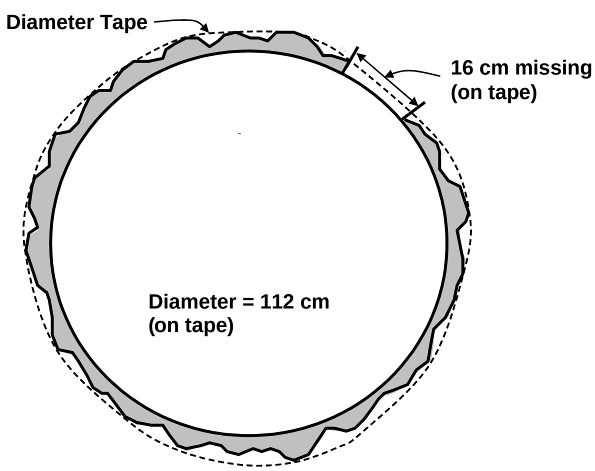


Figure 4.2 - Measurement of remaining bark.

EXAMPLE
On a 112.0 cm tree, bark is absent from 79 cm on the tape to 95 cm, a distance of 16 cm (95 – 79 = 16). The percent bark remaining is then calculated using the formula. $\text{Remaining Bark \%} = \left(\frac{\text{Length of tape with bark}}{\text{Total length of tape}}\right) *100\ \%$
$\text{Remaining Bark \%} = \left(\frac{\text{Length of tape with bark}}{\text{Total length of tape}}\right) *100\ \%$ $= \left(\frac{(112 - 16)}{112}\right) *100\ \%$ $= \left(\frac{96}{112}\right) *100\ \%$ = 85.7% (Record 86%)

TREE LENGTH

Measure the length of each tree within the integrated plot, including broken and fallen trees.

Measure all trees except where the measurement is physically obstructed, it is unsafe to make the measurement, or when an accurate measurement is impossible. In such cases estimate the tree length.

For trees with broken tops, see discussion of Broken Tops below. For odd-shaped trees see Figure 4.3.

Procedure

1. Estimate the tree length before measuring as a check on your calculations.
2. Measure the length of the tree from the ground level on the high side along the stem to the top of the stem. Record length to the nearest 0.1 m.
   - For species that typically have an apical droop (e.g., cedar and hemlock), the measurement of the length should be made while standing perpendicular to the droop and measured to the apex of the droop. No additional estimated length should be added to account for the remainder of the tree length that extends beyond the apex of the droop. This should be recorded as a measured length, not an estimated one.
   - For broken stems, measure the length that allows the most appropriate application of taper functions for calculating the volume of the tree.
   - For fallen, broken trees, record the length of the stem to the break. Measure the portion of the tree from the root collar to the top of the last connected portion (the pieces must be physically attached so that if one part is moved the next part will move).
3. Record whether the length was measured (M) or estimated (E).

- 'Estimated' should be recoded in several different circumstances:
  - The tree length (or a significant portion of it) is truly a visual estimate (e.g., the top third of an intermediate tree is fully buried in the thick crown of a dominant tree).
  - The entire tree has a severe lean and sweep/bend such that a straight-line measurement is unlikely to be reliable.
  - Using Pythagoras' theorem on a severely leaning tree.
  - For a non-apical drooping species, adding an estimated length to a measured portion of the overall tree length to account for a bent top.
- 'Measured' should be recorded in most other circumstances.

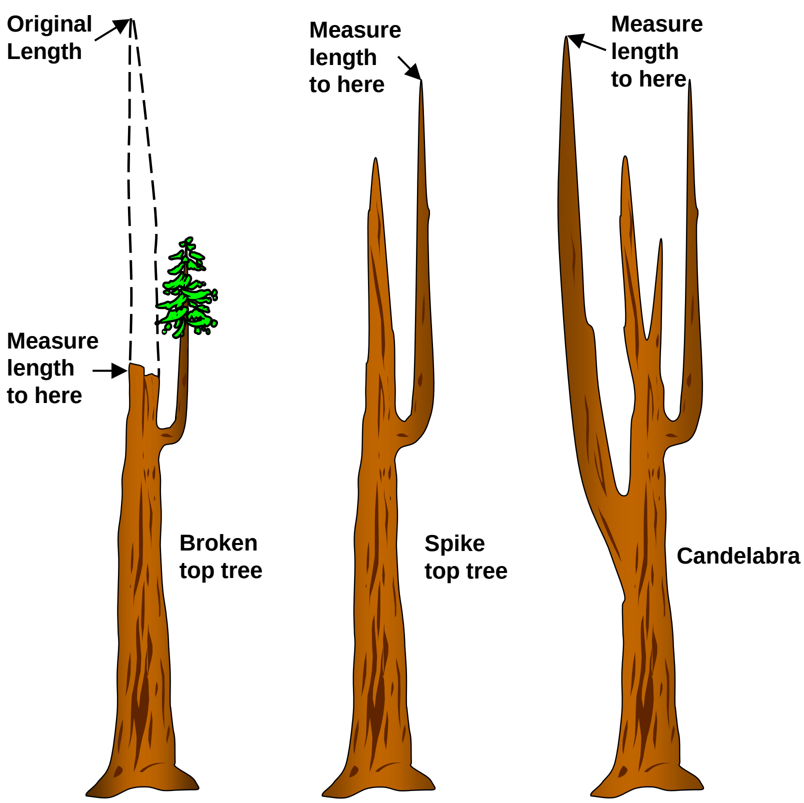


Figure 4.3 - Measurement of odd-shaped trees.

CROWN CLASS

Crown class is a ranking by crown position of a tree in relation to other trees in the immediate area surrounding the tree being measured. The crown class will be useful in future growth models.

<u>Procedure</u>

1. Assign a crown class code to all **standing live** trees using the descriptions in Table 4.2.

2. Dead trees and fallen live trees will **not** have a crown class assigned; mark a dash in the Crown Class box.
3. On trees with a broken or dead top assess the remaining live portion of the crown as to its present interception of light in the immediate area around the measured tree. For example, a tree was formerly in a dominant crown position but the top of the crown has died back and only the lower limbs are alive. This crown would most likely be ranked in the intermediate or suppressed position based on the current light interception of the remaining crown.

Table 4.2 - Crown class codes.

Code	Description
D	**Dominant** Trees with crowns that extend above the general level of the crown canopy (may include trees, shrubs or other obstructions) immediately around the measured trees. They are somewhat taller than the codominant trees, and have well-developed crowns, which may be somewhat crowded on the sides, receiving full light from above and partly from the side.
C	**Codominant** Trees with crowns forming the general level of the crown canopy (may include trees, shrubs or other obstructions) immediately around the measured trees. The crown is generally smaller than those of the dominant trees and is usually more crowded on the sides, receiving full light from above and little from the sides.
I	**Intermediate** Trees with crowns below, but extending into, the general level of the crown canopy (may include trees, shrubs or other obstructions) immediately around the measured trees. The crowns are usually small and quite crowded on the sides, receiving little direct light from above but none from the sides.
S	**Suppressed** Trees with crowns entirely below the general level of the crown canopy (may include trees, shrubs or other obstructions) around the measured trees, receiving no direct light either from above or from the sides.

Note: Portions of the plot may fall within *unmapped* areas of within-polygon variation (i.e., areas where the trees, ecology, microsite, etc. are significantly different from the average conditions of the majority of the plot and polygon). Although crown class in these situations can be highly subjective, with enough physical separation, trees that are significantly shorter than the polygon/plot average can still be deemed to be codominant. This issue has implications for which trees are available for sample tree selection (refer to section 4.8). Ideally, various plot conditions regarding crown class should be reviewed in the field with a Ministry representative to help reduce the subjectivity of this attribute in complex stand conditions.

HEIGHT TO LIVE CROWN

Measure the height to the live crown for future research on all live standing trees (live fallen trees do not require a height to live crown). *Height to live crown* is the distance along the bole from the high side ground level to the crown base. The crown base is normally the location on the stem where live branches occupy about three-quarters of the stem circumference. The primary objective is to estimate the "effective" extent of live crown for growth projections.

Procedure

1. Determine the crown base. If the definition of crown base is obviously not effective for the tree, then use your judgment as to the effective crown length. An example may be a tree that has no branches on one side.
2. Record the height to live crown for all live trees to the nearest metre.
3. Record two dashes (– –) for trees that are dead or have no effective crown (those having only a few green branches).

CLASSIFICATION OF RESIDUAL TREES

Classify all trees assessed on the large tree plot as to whether it is a residual from a former stand. In making this assessment, refer to the general area around the plot. Trees are classed as residual if they are present in even aged stands, are living remnants of a former stand, and occur as the occasional (< 25 per ha) large stem of an older age class than the stand as a whole. Typically these trees have larger diameters, a higher incidence or indications of decay, thicker bark, larger branching and "ragged" or flat tops. These trees must be clearly residual. Uneven-aged stands do not generally have residual trees.

Procedure

1. Determine if the tree is a residual as per the given definition.
2. In the spare column [S2 - column 56] record an "R" if the tree is a residual. If the tree is "not" a residual record a dash [-]. On the handheld data entry program enter a "R" immediately after the tree number in the "tree data" screen. The software assumes that a tree is not a residual "-" by default.

Note: The one exception to the definition of a residual tree can be encountered in YSM samples where the walkthrough method is employed (i.e., when the plot extends across a mapped inventory line into a neighbouring polygon, where there is a reasonably discernable line between the two stands in terms of physical appearance and age [e.g., when sampling a young cutblock where the plot extends into the neighbouring mature timber]). In this case, there is no requirement for residuals to occur only as occasional stems, but rather all the stems of the significantly older neighbouring stand can be classified as residual. This ensures that sample trees are chosen from the target population. This exception does not apply to multi-age stands, stands with advanced regen that are similar in stature (i.e., diameter and height) to the target population, or very gradual polygon transitions.

Note: Advance regen can be a grey area between residual and non-residual status. Some guiding principles regarding advance regen are as follows. If advanced regen are 1) relatively abundant in the stand and distributed throughout, and/or 2) of a similar diameter and height to the rest of the trees in the stand, then they should not be considered to be residuals. They are simply a component of a mixed-age stand and will likely be managed as part of the same cohort as the younger trees. As non-residuals, they will be available for sample tree selection, and if one is selected it will not be suitable for site index due to suppression in the core.

BROKEN TOPS

Measure all broken trees to the location of the break. For the compilation program to apply appropriate form factors to the tree stem, the diameter at the break point **OR** the original (projected) length of the tree must be recorded. If the broken top is available on the ground then a direct measure of diameter or actual "projected" height may be possible to measure.

Procedure

1. Measure the length of the tree stem to the break. For shattered stems, estimate the length after folding in shattered wood to make a whole diameter.
2. Record one of the following options, depending on which can be most reliably estimated:
   - diameter (cm) of the stem at the break
   - original unbroken height (m) of the tree

4.3 Assessing Tree Attributes for Wildlife

Trees can provide present or future habitat for the maintenance or enhancement of wildlife, including nest cavities and platforms, nurseries, dens, roosts, hunting perches, foraging sites, and display stations. Birds, mammals, amphibians, and various invertebrates use trees, and some species are highly dependent upon the specialized habitat provided by certain types of trees.

While knowledge of the size and abundance of live and dead trees permits an interpretation of the habitat suitability of a particular stand, specific wildlife-related data for each tree sampled is much more useful. A record of actual wildlife use of individual trees provides information on the preference of wildlife species for trees with certain characteristics.

All trees in the integrated plot will be assessed for the following attributes: visual appearance, crown condition, bark retention, wood condition, lichen loading, and wildlife use. These and other tree attributes, such as DBH, length, and percent sound, can be correlated to estimate wildlife habitat potential.

Procedure

1. Assess each tree in the 11.28m tree plot for wildlife attributes.
2. Record the appropriate codes on the Tree Details (TD) Card in the Wildlife Codes section.

VISUAL APPEARANCE

Classify the visual appearance and record the appropriate code (1 to 9) using the shape of the tree stem as the dominant characteristic (Figure 4.4).

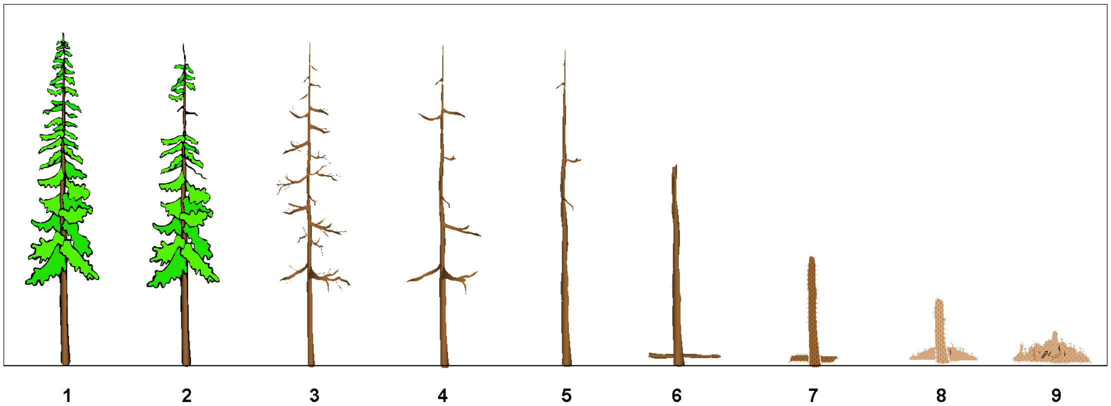


Figure 4.4 - Visual appearance codes.

Crown Condition

Examine the crown in relation to a normal live crown (lower crown loss due to self pruning is not included). Record the appropriate code (1 to 7) from Table 4.3.

Table 4.3 - Crown condition codes.

Code	Description
1	All foliage, twigs, and branches present.
2	Some or all foliage lost, possibly some twigs lost, all branches usually present, possible broken top.
3	No foliage, up to 50% of twigs lost, most branches present, possible broken top.
4	No foliage or twigs, up to 50% of branches lost, top usually broken.
5	Most branches gone, some sound branch stubs remain, top broken.
6	No branches, some sound and rotting branch stubs, top broken.
7	No branches, minimum of rotting branch stubs, top broken.

Bark Retention

Classify the proportion of bark remaining, and code (1 to 7) from Table 4.4.

Table 4.4 - Bark retention codes.

Code	Description
1	All bark present.
2	Bark lost on damaged areas only (<5% lost).
3	Most bark present, bare patches, some bark may be loose (5%–25% lost).
4	Bare sections, firm and loose bark remains (26%–50% lost).
5	Most bark gone, firm and loose bark remains (51%–75% lost).
6	Trace of bark remains (76%–99% lost).
7	No bark (100% lost).

WOOD CONDITION

Classify the wood texture (soundness) of the tree, and code (1 to 8) from Table 4.5.

Table 4.5 - Wood condition codes.

Code	Description
1	**No decay**.
2	**Probable limited internal decay** and/or deformities.
3	**Limited decay**, wood essentially hard.
4	**Wood mostly hard** but decay spreading, soft wood present.
5	**Balance of hard and soft** wood, spongy sections.
6	**More soft** and spongy wood **than hard** wood.
7	**No more hard wood**, all soft or spongy, powdery sections.
8	**Hollow shell**, outer wood mostly hard or firm.

LICHEN LOADING

Assess all standing trees for lichen loading **on the branches** within 4.5 m of the ground or root collar.

Assign a rating from 0 to 5 based on comparison with the appropriate set of photos contained in *Estimating the Abundance of Arboreal Forage Lichens* (Armleder et al. 1992). A value of 0 indicates no lichens. If a tree has lichens, but none are below the 4.5 m mark, a rating of zero will be given.

WILDLIFE USE

Activity

Record wildlife use as a two-part alpha code. When indicators or wildlife use of sampled trees is observed, record the following codes in the first field: Feeding (F_); Open nesting (O_); Cavity nesting (C_); Marking (M_); Denning (D_); Perching (P_).

User

If you can determine whether usage is by a mammal (_M), bird (_B), reptile (_R), or amphibian (_A), record it as a second code letter.

For example, a feeding bird (FB), nesting amphibian (OA or CA), denning mammal (DM).

If only the activity can be determined but not the responsible group, record only the first alpha code.

FEEDING (F __)

Feeding trees are very important to many wildlife tree users. Many woodpeckers feed on bark beetles; other birds glean insects from tree trunks, branches, and foliage; and hawks and eagles use trees as hunting and feeding perches.

Record if feeding behaviour or indicators are observed. Indicators might include the following:

1. Pileated Woodpeckers excavate large rectangular feeding holes
2. Red-breasted and Yellow-bellied Sapsuckers drill horizontal patterns of sapwells
3. Three-toed and Black-backed Woodpeckers scale off bark to feed on insects
4. Porcupines gnaw on large sections of bark (diagonal tooth marks are often apparent)
5. Rabbits, hares, and squirrels feed on the base of young trees (squarish “windows” or girdling at the base)
6. Squirrel cone caches or basal accumulations of cone bracts from squirrel feeding

NESTING (CAVITY NESTING C __ OR OPEN NESTING O__)

1. Record if evidence of cavity nesting (C __).

   Cavity nests might be difficult to detect, but their locations are predictable to some extent. Many woodpeckers (including Three-toed, Black-backed, Hairy and Pileated Woodpeckers, and flickers) prefer live hardwoods as nesting trees and often excavate their cavity underneath branches. Nuthatches and chickadees build their nests in broken-off standing dead trees, or in broken branch holes, often directly below the breakage point where stem rots have entered the tree and softened the heartwood. Trees with cavity nests are important to retain because they may be used over many years by a variety of species. During the breeding season, the begging calls of nestlings are easy to detect.

   Test a tree with a cavity nest by carefully and safely striking it to determine if the nest is occupied. Cavity nesters have perfectly round or oval nest holes

   - Pileated Woodpecker and the Common Flicker have oval holes due to their large size
   - Downy Woodpeckers, Chickadees and Nuthatches have small round holes
   - Brown Creepers have hammock nests under the loose bark
   - Some ducks, owls, and squirrels nest in abandoned woodpecker holes

2. Record if evidence of open nesting (O__).

   Raptors and herons build large platform-style stick nests. Open nests of eagles, hawks, owls, and herons are usually situated in the upper part or crown of live and dead trees. Many of these nests are used by the same or different pairs over many years; therefore, nest trees for open nesters have a very high habitat value.

MARKING (M __)

Record evidence of marking, such as claw marks by grizzly or black bears, and antler rubbing by deer or elk. These trees are used mostly for communication of territorial boundaries and during courtship.

DENNING (D __)

Record evidence of denning by bears, squirrels, bats, or other mammals. Other mammals that use wildlife trees for denning include marten, fisher, weasels, skunks, and raccoons. Bears often hibernate in the hollow trunks of large standing trees, especially western red cedars. Entrances to tree dens can be basal or arboreal. Sometimes loggers discover dens while working; care should be taken not to destroy or injure the bears.

PERCHING (P __)

Perching and roosting trees are also essential habitat elements for wildlife tree users.

Characteristic perch trees of aerial foraging and hawking birds have prominent dead branches that provide a good view of the surrounding area. Perching use may be observed, particularly on tall trees with good vantage, especially near riparian edges. Plucking spots where raptors feed are especially important. They can be identified by "whitewash" and the remains of prey in the vicinity.

Roost trees are often in sheltered locations and have natural or excavated cavities. Roosts provide shelter from predators and inclement weather, some provide the environmental conditions appropriate for raising young. Roosting sites in trees include cavities, hollows, beneath bark, and in foliage.

NOTHING OBSERVED (– –)

Record if no wildlife use is evident or observed.

M-UMOU unspecified mouse

4.4 Assessing Damage Agents and Severity

Note: The assessment of damage agents and loss indicators share some common elements but they are separate and distinct processes. Tree loss indicators are discussed in Section 4.5.

The CMI will sample for damage agents and severity on individual trees to provide an assessment of forest health. The sample will identify the agent or agents that cause the damage and quantify severity of the damage. The data is recorded on the Tree Loss Indicator (TL) field card. Damage agent types include abiotic, disease, insects, treatment injuries, and animal damage.

The damage agent and severity information can be used to determine:

- causes of tree mortality related to damage agents;
- stand growth reductions related to damage agents;
- species succession as related to damage agents;
- incidence and extent of the damage agent conditions;
- relationships between vegetation (forest) cover and damage agent conditions, used to derive a BEC forest cover hazard and risk rating;
- forest level yield projection and planning procedures (such as stratification of data by damage type, damage intensity, or damage risk class); and
- the relationship between damage agent and estimation of sound wood volume as determined through the net factoring and hidden defect processes.

Procedure

1. Assess damage agent(s) or conditions, and damage severity (ies) on all tagged trees, within the integrated plot.
    - Use the *Field Guide To Pests of Managed Forests in British Columbia* (Fink et al. 1989) to help identify damage agents and conditions. See Appendix D for damage agent codes, and Appendix E for damage severity and mortality condition codes and standards.

2. Record the damage agents for each tree on the Tree Loss Indicators (TL) Field Card.
   - Use a 1-, 2-, or 3-letter code, depending on your confidence in the identification. The damage agent codes are hierarchical and enable coding from very general (type or category) to specific (species). The first letter indicates the type of damage agent: abiotic (N), disease (D), insect (I), mites (M), treatment (T), and animal damage (A). The second and third letters indicate the specific agent, if it can be determined.
   - For example, Armillaria root disease is coded DRA (D = disease, R = root rot, A = Armillaria). If unable to identify the specific disease, only that it is a root disease, record DR. If you cannot determine that it is a root disease, but you are certain it is a disease (not an insect or other damage agent), record D for disease.
3. When the tree has more than two damage agents, list at least the most important two damage agents on the TL card. If you wish to list more than two damage agents repeat the tree number on successive rows.
4. Record the damage severity using the codes listed in Appendix D: Damage Severity and Mortality Condition Codes and Standards.
5. Record "O" (alpha character O) if no damage agent is observed.
6. Record "U" if the damage agent is not known. In many instances damage may be evident but the damage agent is not known.

Detailed Rust & Canker Measurements (YSM Samples Only)

In addition to the standard procedures for damage agents and severity, the following additional forest health data must be collected for YSM samples.

When comandra blister rust (DSC), stalactiform blister rust (DSS), western gall rust (DSG), elytroderma needle cast (DFE) (expressed as a stem canker), and atropellis canker (DSA) are encountered, they must be recorded for up to five instances per tree (combined). Incidences will be prioritized and recorded in order of height starting at the bottom of the tree.

The severity codes will be a combination of infection height to the nearest metre and percent encirclement to the nearest decile as follows:

Infection Height (1st digit)		% Encirclement (2nd digit)	
Severity Code	Ht. Range (m)	Severity Code	(% Encirclement)
0	0.0 – 0.5	0	1 - 5
1	0.6 – 1.5	1	6 - 15
2	1.6 – 2.5	2	16 - 25
3	2.6 – 3.5	3	26 - 35
4	3.6 – 4.5	4	36 - 45
5	4.6 – 5.5	5*	46 - 55
6	5.6 – 6.5	6	56 - 65
7	6.6 – 7.5	7	66 - 75
8	7.6 – 8.5	8	76 - 85

9	8.6 +	9	86 - 100

*There is a significant break-point for modelling the rusts/cankers at the 50% mark – particular attention should be paid when an infection is close to this % encirclement to ensure the correct decile is recorded.

Note that all damage agents present on a tree (rusts, cankers or otherwise) need to be ranked in priority together in order to determine what is recorded for each tree (up to the maximum of 5 damage agents per tree). Priority ranking is determined by the potential for mortality and soundwood loss (preserving the bottom-up ranking for rusts/galls). For example, a tree with bark bettle, root rot, 3 rusts/galls, and terminal weevil should have the damage agents ranked as follows: 1- IBM/RA, 2- DRA/CS, 3-DSG/12, 4-DSA/31, 5-DSG/62. Red attack bark beetle will be the most damaging (death), followed by root rot (severe soundwood loss and probable eventual blowdown), then the rusts/galls (possible girdling/topkill). The terminal weevil is ranked last because its only impact is on the form of the tree, and it is not recorded as it would be the sixth damage agent. Notice that the rusts/galls are recorded from the bottom of the tree up as opposed to their % encirclement.

4.5 Assessing Tree Loss Indicators

Specific loss indicators signify the potential presence of decayed wood. The loss indicators to be measured are: conks, blind conks, frost cracks, scars, forks, crooks, large rotten branches, dead tops, root rot, soundings, direct observation, and broken tops. The specific indicator, its extent, and frequency are recorded on the TL field card.

The inventory design for measurement and description of loss indicators attempts to adopt the traditional definitions and procedures of British Columbia and the Pacific Northwest wherever possible. The objective is to maintain a system that is compatible with current and past inventories, but will also meet future needs.

Procedure

1. Record loss indicators for all live trees (standing and fallen) within the Integrated Plot. It may be beneficial to collect the loss indicators on dead standing trees to assist with net factoring.
2. Enter the appropriate code for the loss indicator (see Table 4.6 for codes and description).
3. Enter a "+" if the location of the loss indicator is above high side ground level or "–" if below high side ground level.
4. Measure the position of each loss indicator on the stem of each numbered tree from ground level on the high side of the tree, to the nearest 0.1 m. Record the lower and upper extents as "From" – "To".
5. If an indicator is a point feature, such as a singular conk, record the location once under the "From" column with a frequency of "1".
6. If the indicator occurs more than once and is best described as a series, record the frequency as the number of times the loss indicator occurred in a particular interval. The maximum number of occurrences to record is 9. If there are more than 9 occurrences, still enter 9.

7. If it is necessary to record more than three loss indicator occurrences, list the tree number as often as required on the TL card.
8. Record multiple occurrences of loss indicators which do not have common causes as separate occurrences. The intent is to localize the loss indicator (for example a tree with basal scars from logging and a scar in the upper crown from a rubbing tree stem would be entered as separate occurrences).

Note: Loss indicators are only recorded for the main stem on trees forked above DBH.

Table 4.6 - Loss indicator codes.

Code	Description
DD __	Unknown stem decay (conk) DDE is a known stem decay (*Echinodontium tinctorium*)
DR __	Unknown root decay DRA is a known root decay (*Armillaria ostoyae*)
BNK	Blind Conk
NGC	Frost Crack
SCA	Scar
FRK	Fork
CRO	Crook
LRB	Large Rotten Branch
DTP	Dead Top
BTP	Broken Top
SNG	Sounding
OTH	Other (cause is known, but no appropriate code)
DIR	Direct observation (decay or missing wood seen without cause observed)

LOSS INDICATOR – STEM DECAY (DD _) AND ROOT DISEASE (DR _)

Only specific root, butt, and heart-rot conks are considered to be loss indicators. Slash conks that occur on dead branches and wounds of living or dead trees are not considered as loss indicators. (Refer to Appendix D: Damage Agent Codes for stem decay and root disease conk codes.)

Stem Decays (Conks) Observed on Bole (DD _)

Conks refer to the fruiting bodies (sporophores) of stem decay fungi and are definite and reliable indicators of decay. Typically conks are thick, hard, woody-like perennial structures. Fruiting bodies can occur anywhere on the main stem and/or branches, but they appear most frequently around knots and on the underside of dead branch stubs and live branches.

Record the following:

1. The code for the species of conk
    - The loss indicator codes for conks are hierarchical. They are taken from the Forest Damage Agent and Condition Codes. The code identifies stem decay damage agents as DD_. The species of conk is then identified by the third letter. The codes for specific stem decays are shown in Appendix D.
2. Length to any single or isolated conk.
    - The frequency is 1.
3. If multiple conks occur in one section of the stem, record:
    - species of conk (should only be one species in each multiple occurrence)
    - length to the lowest in the series; length to the highest
    - frequency as to the number of conks in the series
    - if conk series are widely separated record as two series

<u>Stem Decays (Root Rot) Observed on Roots or Ground (DR__)</u>

Root Rot refers to fruiting bodies which are located on the roots and are associated with stem decay.

Typically fruiting bodies are short-lived, soft, and fragile. Often you may be able to see an indication of root rot decay directly on the roots.

Schweinitzii butt rot (*Phaeolus schweinitzii*, DRS) is considered a root rot species, but the fruiting body may occasionally be observed on the main stem some distance above the ground (see Section 5.3 #2 for how to address this specific occurrence).

Record the following:

1. The code for the species of root rot
    - The loss indicator codes for root rots are hierarchical. They are taken from the Forest Damage Agent and Condition Codes. The code identifies stem decay damage agents as DR_. The species of conk is then identified by the third letter. The codes for specific root rots are shown in Appendix D.
2. Length for any single or isolated root rot indicator is recorded as "0.0" (ground level).
    - The frequency is 1.
3. If multiple root rot indicators are observed, record:
    - species of root rot (should only be one species in each multiple occurrence)
    - length from "0.0" to "0.0"
    - frequency of indicators in the series

LOSS INDICATOR – BLIND CONK (BNK)

Blind conks are pronounced swellings or depressions around knots, usually caused by *P. pini* (DDP) on conifers, and *P. tremulae* (DDT) on aspen. Blind conks are definite indicators that decay is extensive in the tree stem.

Evidence of **conks** should be found in the surrounding stand before recording blind conk as an indicator.

Blind conks are identified as follows:

- stem swellings and stem depressions thought to be where the tree attempts to heal over decay emerging through a knot or branch stub.

- bright yellow to buff-coloured material found by chopping into basal branch stubs. This form is most often found in the interior of the province and crews will be directed by the project supervisor regarding procedures for chopping into trees.

Note: Verifying the existence of blind conk is the only situation where we allow crews to chop into live trees on the plot.

Record the following:

1. The loss indicator code BNK
2. For a single occurrence record:
   - the length to blind conk
   - the frequency as "1"
3. For multiple blind conks in one area of the stem, record:
   - length to the lowest; length to the highest
   - the frequency as the number in the series, including the lowest and highest

Loss Indicator – Frost Crack (NGC)

Frost cracks result from deep radial splitting of the trunk, caused by uneven expansion of moisture in the tree after a sudden and pronounced drop in temperature. The cracks usually originate at the base of the trunk and may extend many metres up the tree, following the longitudinal grain of the tree. The wound will often spiral up the tree following the movement of moisture.

Frost cracks are often reopened and extended by wind stresses or refreezing. Repeated healing of the cambium produces pronounced callous tissue, giving a ribbed appearance to the wound.

Record the following:

1. The loss indicator code NGC
2. For a single frost crack, record:
   - lowest extent (may be a negative value if it extends below ground on high-side)
   - the highest extent.
   - the frequency as "1"
3. For multiple frost cracks on one section of the stem, record:
   - lowest extent of the lowest frost crack in the series and highest extent of the highest frost crack in the series
   - frequency as to the number of frost cracks in the series

Loss Indicator – Scar (SCA)

A scar is an injury caused by external forces that damage the cambium or heartwood of the tree exposing the tree to wood decay fungi. A scar can occur anywhere on the main stem or root collar of the tree. Scars on branches or candelabras are not recorded.

A scar may be "open" meaning the wood is exposed, or "closed" meaning that the bark has grown over the injury.

Record the following:

1. The loss indicator code SCA

2. For an individual scar record:
   - lower extent of the scar (may be a negative number if it extends below ground on high side)
   - upper extent of the scar
   - the frequency as "1"
3. For multiple scars along one section of the stem, record:
   - lowest extent of the lowest scar in the series; highest extent of the highest scar
   - frequency of scars in the series

LOSS INDICATOR – FORK (FRK)

A fork is caused by damage to the leader of a tree that results in more than one branch (leaders) competing for apical dominance. The damage to the leader—from external forces, physiological factors, animals or insects (weevil) — exposes the stem to potential wood or decay fungi.

The following conditions are **not considered forks**:

- natural branching in deciduous trees
- small sharply angled branches or spikes, unless associated with a noticeable offset or diameter change at the location
- flattening of the tree tops caused by wind or physiological conditions where no terminal leaders are evident
- candelabra branches

If the secondary leader is visible, record the following:

1. Loss indicator code FRK (no minimum size limit)
2. Location of fork (the divergence of the stems); frequency as "1"
3. Distinct forks (record as separate occurrences)
4. Multiple forks within a reasonable range and a probable common cause (record upper and lower occurrence and number observed)

LOSS INDICATOR – CROOK (CRO)

A crook is caused by damage (mechanical, physiological, animal or insect attack) to the leader of a tree. Crooks potentially expose the wood to decay fungi.

To be recorded as a crook, it must meet the following conditions:

- The diameter of the main stem changes noticeably from the normal taper, and indicates that an injury has occurred.
- The stem must be offset severely enough to indicate that damage has occurred to the main stem.

Record the following:

1. Loss indicator code CRO
2. For a single occurrence, record
   - height of each individual crook
   - frequency as "1"
3. For multiple crooks in a section of the stem, record:

- length to the lowest crook; length to the highest
- frequency as the number of crooks

Loss Indicator – Large Rotten Branch (LRB)

Large rotten branches are defined as those with a diameter inside the bark greater than 10 cm at the base. They have obvious signs of heart rot, and typically appear as short, rotten branches on overmature trees. They should not be confused with branches that have died through normal causes.

Record the following:

1. The loss indicator code LRB
2. For a singular occurrence, record:
   - the height to the central point of the branch
   - frequency as "1"
3. For multiple occurrences record:
   - the length to the central point of the lowest branch in the series
   - the length to the central point of the highest branch
   - the frequency as the number in the series (including the highest and lowest)

Loss Indicator – Dead Top (DTP)

A dead top can be caused by any number of external injuries, physiological stresses, insects, or diseases. The top should be obviously dead with no green needles or leaves present.

Record the following:

1. The loss indicator code DTP
2. Length to the base of the dead top (top of live crown), length to the top of the tree; frequency as "1"

Loss Indicator- Broken Top (BTP)

A broken top is the product of an external force or condition resulting in the top of the tree breaking away from the main bole.

Broken tops can be caused by a variety of causes: wind breakage, snow damage, mechanical damage from other falling trees, and so on.

Record the following:

1. The loss indicator code BTP
2. The length to the break (estimate by folding back any jagged parts of the stem to form a complete stem); frequency as "1"

Loss Indicator – Sounding (SNG)

Every tree on every plot is sounded. Sounding the tree involves striking the bole near the base of the tree with a blunt instrument. A hollow sound indicates a large amount of potential rot. If the tree sounds hollow it must be bored to confirm the presence or absence of decay.

Record the following:

1. The loss indicator code “SNG” whenever the tree “sounds” hollow. If subsequent boring indicates no decay or decay is present, the “SNG” loss indicator code is left on the field card. Record in the comments section that no decay was found.
2. Frequency and length are not recorded

LOSS INDICATOR – OTHER (OTH)

Sometimes rot or missing wood can be observed directly, and the cause is **known**. However, there is no appropriate loss indicator code.

Examples of “Other” may be hollow trees, butt rot, or sap rot on a live tree. In all these examples the cause is **known**.

Record the following:

1. Loss indicator code OTH
   - In the Comments, state the reason for the loss
2. Location and frequency, if appropriate

Note: If this type of loss occurs frequently an appropriate code will be assigned in the future.

LOSS INDICATOR – DIRECT OBSERVATION (DIR)

Sometimes rot or missing wood can be observed directly, but the cause is **not** known.

An example of “Direct Observation” may be hollow trees where the cause is **unknown**.

Record the following:

1. Loss indicator code DIR
   - Make a comment in the Comments section if you think it is appropriate to do so.
2. Location and frequency, if appropriate

Note: If this type of loss occurs frequently an appropriate code will be assigned in the future.

4.6 Stem Mapping

All trees in the Integrated Plot will be stem mapped. This is to aid in the remeasurement of samples and the relocation of the IPC pin. **The stem map data is recorded on the TL field card.**

Procedure

1. Measure and record the azimuth (nearest degree) from the Plot Centre Pin to the centerline of the tree at its point of germination.
2. Measure and record the distance (nearest 0.01 m) from the Plot Centre Pin to the center of the tree (point of germination).

Note: In some locations there may be no tagged trees within the plot. However, some stem map information must be recorded to aid in the relocation of the Plot Centre Pin. If trees are present that are less than the minimum diameter for tagging, three of the largest stems can be tagged and measurements would be taken from these stems. If only stumps are available then tag the appropriate stumps and take measurements from these stumps or a combination of small trees and stumps as required. In some instances, with no trees or stumps available, rocks or other features may be used to facilitate relocating the IPC. Record any abnormal situations in the comments section.

4.7 Measuring Small Trees and Stumps

Small Trees

A fixed-radius small-tree plot will be established at all Integrated Plot locations. The purpose of this plot is to determine relative numbers of small diameter live trees that are not sampled in the main tree plot. Measurements are recorded on the TS field card.

Procedure

1. At the Integrated Plot Centre establish a fixed-radius plot that is either 2.50m, 3.99m or 5.64m in radius, as determined in the project plan. The edge of this plot may be marked temporarily to ensure accurate measurements.
2. Count the live trees, less than 4.0 cm DBH and taller than 10 cm. Record the total number by species and by length class. Small trees must have their point of germination within the fixed plot radii to be measured as "in" trees.

Note: The dot tally columns on the field card are provided for your convenience in recording. Sum the data by classes and record the totals on the field card.

Example of small tree tally			
Species	**Length**		
	10 to 29 cm	**30 cm to 1.3 m**	**> 1.3 m but < 4.0 cm @ DBH**
Cw	4	2	1
Hw	9	6	—
Fdc	—	1	3

Plots with Clumps of Trees or Sucker Growth from Stumps

In some instances, particularly with deciduous species, clumps of stems originating from a common root system or stump that is vegetatively alive are encountered. Some or all of these stems could potentially grow into trees at some time in the future. The sampling intent is to identify the stems which express apical dominance to the best *judgment* of the field crew.

Procedure

1. Count the number of stems that appear to express apical dominance. The intent is not to examine each stem in detail but to arrive at a reasonable assessment of numbers within each class.

Stumps

The CMI is attempting to sample the biomass of above-ground vegetation both living and dead. This includes measuring the biomass in self-supporting stumps in the 2.5 m fixed-radius plot on the integrated plot. Stumps are defined as being less than or equal to 1.3m in length and 4.0 cm top diameter inside bark or greater. The centre of the stump must lie within the plot (Figure 4.5). Only stumps which are vegetatively dead are recorded.

Treat stumps with roots detached from the ground as "coarse woody debris."

Procedure

1. Select stumps to tally in the 2.50 m plot. Stump must be 4.0 cm top diameter inside bark with the germination point of the stump inside the plot boundary.
2. In a clockwise direction from the north, record the following information for all stumps 4.0 cm or greater:
   - Species — to the level that can be determined by the field crew.
   - Frequency of stumps — usually "1", but if numerous stumps are in the plot (such as after spacing) record them by groups with the same characteristics.
   - Average diameter inside the bark.
   - Length to nearest 0.1 m (must be less than 1.3 m).
   - Estimate the percent sound wood for the stump.
   - Wildlife codes

     bark retention code

     wood texture
   - Wildlife use

     enter appropriate code(s) if wildlife use observed
   - Root rot species

     if root rot is present, record the damage agent code (if no root rot is found, then record three dashes).

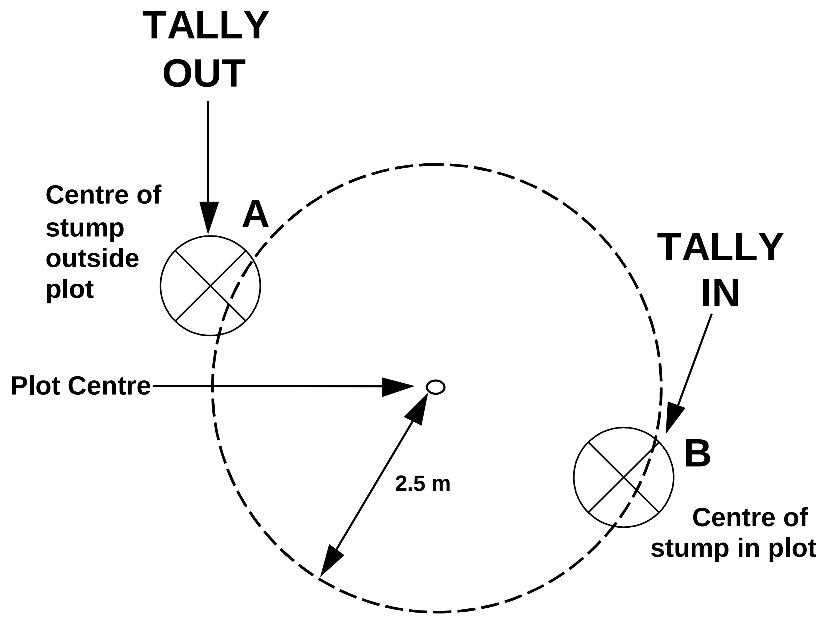


Figure 4.5 - Measurement of "in" and "out" stumps.

3. To measure the length of broken stumps, visually fold down the broken sections to compensate for the missing parts. Level out the wood on the cross section as you view it from the side to determine stem length (Figure 4.6). A similar process is used for broken tree length measurements.

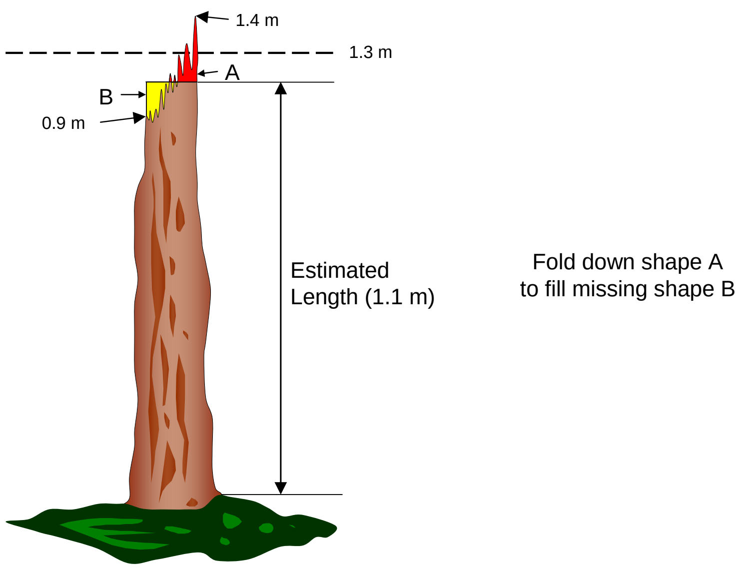


Figure 4.6 - Measuring height of broken stumps.

4.8 Recording Sample Tree Data

Sample tree data is recorded on the Small Tree, Stump, and Sample Tree Data (TS) card.

Objective

Sample trees are measured to determine age and height for the major species by basal area in the sample and can also be used to estimate site index.

General Procedures

The following types of sample trees are measured for age and height (length):

Standard selection types:

- **T**op height (Type = **T**) in the 0.01 ha plot measured within a 5.64 m radius of the plot center; of the trees that are live and dom/codom, (regardless of species or residual status); the largest DBH tree
- **L**eading species (Type = **L**) in each 0.01 ha quadrant of the 11.28 m plot; of the trees that are of the leading species by basal area, live, dom/codom, and non-residual; the largest DBH tree
- **S**econd species (Type = **S**) in each 0.01 ha quadrant of the 11.28 m plot; of the trees that are of the second species having more than 20% of the basal area in the plot, live, dom/codom, and non-residual; the largest DBH tree
- **O**ther major species (Type = O) in each 0.01 ha quadrant of the 11.28 m plot; of the trees that are of all species (other than the leading or second leading species) having more than 20% of the basal area in the plot, live, dom/codom, and non-residual; the largest DBH tree
- Residual Tree (Type = V) in the 11.28 m plot; of the live residual trees; one "representative" tree (if present)

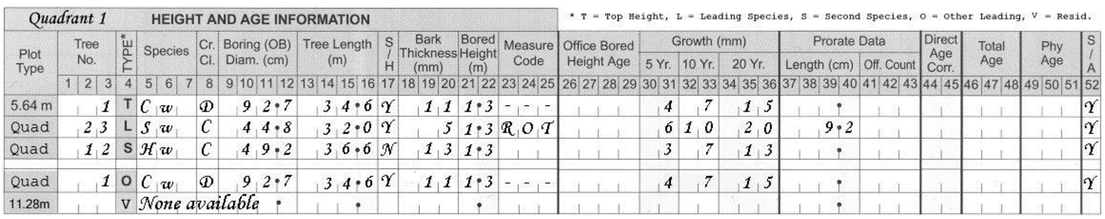
Table 4.7 - Guide for selection of sample trees

	Population Selection Criteria							Tree Selection Criterion
Type	*Plot*	*Species*	*B.A.*	*L/D*	*C.C.*	*Age Suit.*	*Ht Suit.*	*Only 1 Consideration:*
T	5.64 m Plot			Live	D/C			Largest DBH
L	11.28 m Quad	Leading		Live	D/C	Non-Resid.		Largest DBH
S	11.28 m Quad	Second	>20%	Live	D/C	Non-Resid.		Largest DBH
O	11.28 m Quad	Other	>20%	Live	D/C	Non-Resid.		Largest DBH
V	11.28 m Plot			Live		Residual		Representative
X								Representative

The leading species, second species and other major species are determined from the basal area of the **live** trees (excluding residuals) equal to or greater than 4.0 cm DBH tallied at the Integrated Plot within the 5.64 and the 11.28 metre plots. The number of stems less than 9cm is weighted as these stems are only collected in the 5.64m plot. The tree species with the greatest basal area is the leading species; similarly the species with the second largest basal area is the second leading species. On fixed radius plots collected on electronic field data recorders the basal area calculations are performed within the program. When paper field cards are used an excel spreadsheet and a paper worksheet have been produced to calculate the basal area of all species in the field (see Appendix J - Calculating Basal areas in the Field).

Note: Selected trees may be less than 4.0 cm

Note: The field cards have not been updated to the format shown below. Field crews will need to modify the cards as necessary (e.g. write in correct plot type, etc). Separate field cards should be used for each quadrant..



Quadrant 1 — HEIGHT AND AGE INFORMATION

* T = Top Height, L = Leading Species, S = Second Species, O = Other Leading, V = Resid.

Plot Type	Tree No. (1-3)	TYPE* (4)	Species (5-7)	Cr. Cl. (8)	Boring (OB) Diam. (cm) (9-12)	Tree Length (m) (13-16)	S/H (17)	Bark Thickness (mm) (18-20)	Bored Height (m) (21-22)	Measure Code (23-25)	Office Bored Height Age (26-29)	Growth (mm) 5 Yr. (30-31)	Growth (mm) 10 Yr. (32-33)	Growth (mm) 20 Yr. (34-36)	Prorate Data Length (cm) (37-40)	Prorate Data Off. Count (41-43)	Direct Age Corr. (44-45)	Total Age (46-48)	Phy Age (49-51)	S/A (52)
5.64 m	1	T	Cw	D	92.7	34.6	Y	11	1.3	- - -		4	7	15	.					Y
Quad	23	L	Sw	C	44.8	32.0	Y	5	1.3	ROT		6	10	20	9.2					Y
Quad	12	S	Hw	C	49.2	36.6	N	13	1.3			3	7	13	.					Y
Quad	1	O	Cw	D	92.7	34.6	Y	11	1.3	- - -		4	7	15	.					Y
11.28m		V	None available		.	.			.						.					

Figure 4.7 - Recording of Height and Age Information on the TS card

Non-standard selection type X:

- **X** extra (Type = X) an alternate tree outside 0.01 ha plot

Additional X trees may also be selected in a non-standard manner at the discretion of the field crew. This flexibility is provided for instances where the field crew feels that adequate information cannot be provided following the standard procedure alone. For example, the sample is located in a patch of recently killed trees or a tree is unsafe to measure. For this to be of any practical use, comments must be supplied to explain why the tree was selected.

Suitability of Height and Age

All sample trees must be assessed for suitability in two ways:

1) Height and age suitability (comparing the sample tree to other similar trees in the plot in terms of height and age) (note that residuals are always not suitable for age).
2) Site index suitability (determining if the sample tree will provide a reliable site index based on the SIBEC standard)

First assessment: height and age suitability

The intent of this assessment is to provide an indication of whether the sample tree *generally* reflects the height and age of the average plot tree in its cohort (i.e., other trees in the plot of the same species, crown class, diameter class, and age cohort).

Examples of reasons for a tree not being suitable for height:

- significant broken top
- significant dead top
- fork or crook that significantly affects height growth
- abnormally high amount of scarring or other damage that may have affected height growth [for example - significant mistletoe infection]

Note: *Significant* refers to a reduction in the length of the tree compared to what it would be if undamaged. This is a subjective assessment without any defined percent height loss requirement. If the sample tree appears shorter than the majority of the other plot trees from the same cohort (species, crown class, diameter class, general age), then it should be called not height suitable.

The only reason for a tree not being suitable for age:

- residual (see the following definition)
  - Trees are classed as residual if they are present in even aged stands, are living remnants of a former stand, and occur as the occasional (< 25 per ha) large stem of an older age class than the stand as a whole. Typically these trees have larger diameters, a higher incidence or indications of decay, thicker bark, larger branching and "ragged" or flat tops. These trees must be clearly residual. Uneven-aged stands do not generally have residual trees.

Note: The T tree and the X tree are the only sample tree types that can have age suitability recorded as either Y or N. The V tree must be N by definition. The L, S and O sample tree types must be Y by definition.

Second assessment: site index suitability

The intent of this assessment is to indicate if the sample tree will provide a reliable site index, using the SIBEC standard as the assessment tool. The requirements for the SIBEC "tree selection" standard must be met for the sample tree to be called "suitable for site index" (the SIBEC "plot selection" standard is not considered).

To meet the SIBEC tree selection standard (in addition to the requirements meet to be the sample tree [live, dom/codom, largest DBH, etc.]), the sample tree must be:

- free of suppression;
- not wolf, open-grown, or residual;
- straight-stemmed, free of disease, rot, insect damage, and other significant damage including forks, scars, and breakage (minor damage is allowed but should not occur over more than 5% of total tree height);
  - temporary exemption: Lodgepole pine and ponderosa pine trees that are in the green- or red-phase of Mountain Pine Beetle (MPB) attack are suitable site trees. However, these trees must be in recently attacked stands (green- or red-phase) and still meet all the other requirements of a site tree; and
- vigourous with a full crown.

Suppression will be exhibited in the increment core as a number of tight growth rings (at least 2-3) immediately around pith followed by better diameter growth "release" rings.

Assessing for a maximum total height loss of 5% can be subjective, but can be somewhat objectively assessed by comparing the sample tree to other trees in its cohort, and by looking for shorter than expected internodes above visible damage (when compared to "undamaged" internodal distances further above and below the damage). This becomes harder to accurately assess in older sample trees, as past damage and/or visible height loss can become "overgrown" and hidden.

Note: The subset of sample trees that are assessed as "suitable for site index" can accurately be referred to as "site trees" (in addition to being a "sample tree").

Measurement of Sample Trees

1. Measure and record tree height for each selected tree.
   - Measure and record the length of the tree along the stem from high side ground. If the tree is broken off, measure and record the length to the break
   - determine suitability for height and enter code in S/H column [Yes or No]. If the height is "not suitable" record in the comments the factor(s) which make the height "not suitable" and if possible estimate a projected height.
2. Measure age and radial increment for each selected tree.
   - determine suitability for age for the Top Height (T) tree and enter "Y" or "N" in the S/A column. Leading (L), Second Species (S) and Other Leading (O) trees in the sample must have a "Y" entered for suitable for age. The Extra tree (X) must follow the convention of the sample tree type it is representing, and the Residual tree (V) must have a suitable for age of "N".

Measuring Height, Age, and Growth Information

Age is used to determine the site index and projected rate of growth.

In each Integrated Plot a top height tree, up to four leading species trees, up to four second species trees, up to four each of other major species, and one residual if present will be bored to determine age.

Procedure for Measuring Age on Bored Trees

1. Bore the tree at Breast Height facing plot centre, if possible. If Breast Height cannot be bored conveniently, record the height of boring; corrections will be made later.
2. Determine the age by a ring count from an increment borer core, if possible, and enter the data in the **field age count** section on the tally card. The count will be the number of full rings. It is up to the field crew to determine when diameter growth has essentially stopped for the season.
3. The pith should be included in sample tree cores as often as possible to ensure accuracy, particularly in stands less than 80 years old. If you can get within a few years of the pith (relative to the tree age) and can confidently estimate the remainder, there is no need to re-bore the tree. Record the actual age counted on the increment borer core at the level where the tree was bored. Adjustments for years to reach that point will be done in the office compilation.
4. On large trees, or trees that have rotten centers, record the code for rot, age of the sound portion, and the length of sound core. The computer will calculate an age using these measurements. Be careful to measure only inside bark length along the core.

Note: Age relationships can also be derived from actual stump counts if working near felled road rights-of-way or logged areas.

5. Collect all tree cores in labeled “straws”.
   - It is the crew’s responsibility to accurately record field age data. The initial determination will be made in the field. All CMI samples must have ages microscope counted and the age entered in the office bored height age field.
   - Record at least the following on labels attached to the straws: Project #, Sample Number, Plot (for example, IPC), tree type (T, L, S, O, X, or V) and tree number (for example, Project CMI4, Sample 27, IPC, TH, Tree #3).

Procedure for Direct Measurement of Small Tree Ages

1. Count the whorls for the entire tree and add one to calculate the age of the tree.
   - Record bored height as 0.0 m
   - Enter the code WHO
   - Record the age in the Total Age field
2. Rather than damaging a small tree on the plot, select a tree of similar apparent age from outside the plot. This would frequently happen with trees of less than 2m in length. The replacement tree should be outside the 11.28m fixed-radius plot, if possible. Determine the Breast Height age by cutting or boring.
   - Enter the code OUT
   - Record the length and diameter for the originally selected top height tree, but record the age from the tree selected from outside the plot.
   - If the replacement tree does not reach breast height, it is recommended that the whorl count method be used on the original sample tree inside the plot.

Procedure for Direct Measurement of Age Correction on Large Trees

1. Where a tree can be safely bored at 1.3m and an accurate age correction determined from whorl counts, use the following method.
   - Record bored height as 1.3 m
   - Enter the code WHO
   - Enter the number of rings from the increment core on the field bored height age (and later office bored height age) column.
   - Count the whorls below 1.3m and add one year. Enter this number in the direct age correction field.
   - Record the combined age in the Total Age field

Procedure for Measuring Radial Increments

1. Make radial increment measurements on all trees counted for age.
2. Bore on the side facing the plot centre, at Breast Height if possible. Use the same core that was used for age determination if possible.
3. When it is not practical to take the increment in this direction, take it at two points at right angles on the bole of the tree (at the same height as the age boring) and average them.
4. Record the radial increment (in mm) for 5, 10, and 20 years.

Procedure for Measuring Physiological Age

The collection of physiological age information is “optional” for monitoring projects. Individual projects may collect the information if a need is determined.

1. If a sample tree for age measurement was suppressed in its early years, record the unsuppressed (physiological) age as calculated for that tree. The intent is to give an age that would be typical for the tree size if the tree had not undergone unusual suppression (or, more rarely, unusual growth).
2. Determine the physiological age as follows:
   - Enter the PHY code to indicate that a physiological age is used. The computer will calculate the age for you if you have not entered the age yourself.
   - For small trees, where you can interpolate accurately across the suppressed section, simply count “equivalent” rings.
   - For larger trees, particularly where centre sections are missing, leave the boring height age blank, and:

     Count the number of years along the section closest to the bark. As with small trees, account for any clearly atypical growth sections by interpolation.

     Enter the length of the core over which you have counted the partial age. The computer will use this data to calculate the “missing rings.”

     If you have a good estimate of the tree age it would also be useful to have that in the notes section.

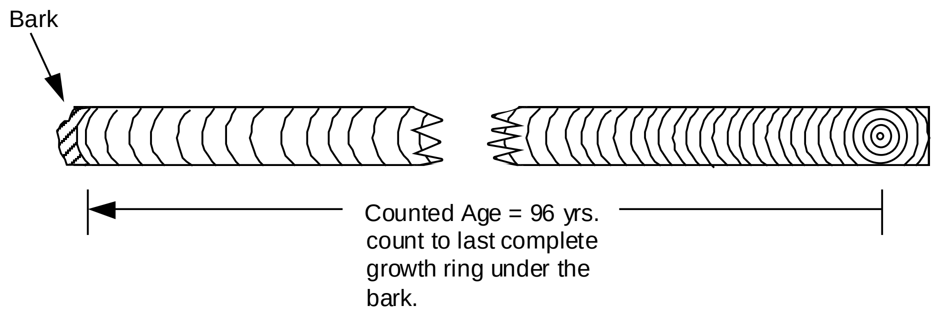
Recording Height, Age, and Growth Information

See Section 4.2, "Identifying and Recording Tree Attributes," for a complete description of codes. The following details are recorded on the TS field card:

TREE NO.	Tree number as recorded in tree measurement plot.
TYPE	T = top height tree, L = leading species, S = second species, O = other major species tree, V = residual tree, X = additional tree.
SPECIES	Tree species code.
CROWN CLASS (C. CL.)	Record crown class code (D, C, I, S).
BORING (OB) DIAMETER (cm)	Diameter outside bark at location of increment boring.
TREE LENGTH (m)	Measured length of the tree to 0.1 m.
SUITABLE HEIGHT	Record a "Y" for "yes" if the tree height has not been significantly affected and is suitable for calculating a reliable site index estimate. Record a "N" for "no" of the tree height has been significantly affected.
BORED HEIGHT (m)	Height (above high side ground level) where boring was made.
MEASURE CODE	If the crew did not physically measure to the pith, this code indicates the reason. Acceptable codes are:
	ROT = Core of tree rotten or missing.
	WHO = Total age determined from whorl count rather than boring.
	CRC = Increment borer cannot reach centre (tree too large).
	OUT = Age and radial increments determined from similar tree outside of plot, all other measurements for the tree within the plot.
	PHY = Physiological age is recorded or calculated on that tree. Usually due to atypical growth ring patterns.
FIELD AGE COUNT	Repeat the Tree No. For each type, and record the actual age (number of rings) at boring height in the lower-left corner of the card.
OFFICE BORED HEIGHT AGE	Increment cores are recounted in the office under magnification. Enter the recounted age in this data field.
GROWTH (mm)	Growth for last 5, 10, and 20 years.
PRORATE DATA	When a full boring is not possible record the actual measurements.
• **LENGTH (CM)**	Length of increment core, from outer edge inward, upon which the ring count was made.
• **RING COUNT**	Actual or representative count of tree rings along that core length.
DIRECT AGE CORRECTION	Number of full years of tree growth below the boring height, if it can be determined directly on that tree.
PHYSIOLOGICAL AGE	Physiological age at the bored height determined by the crew. Record PHY in "Measure Code" field. It is not always necessary to enter this information. Optional for monitoring projects.
SUITABLE AGE	If a top height tree is residual then record a "N" for not suitable, otherwise record a "Y". All other sample trees must have a "Y" entered for suitable for height, with the exception of the X tree which must follow the convention of the sample tree type it is representing, and the "V" tree which must have a suitable for age of "N".

Examples of Recording Age Information

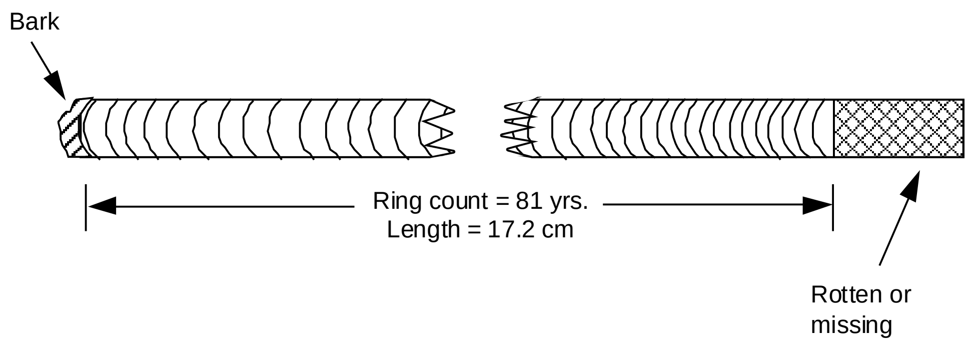
1. Normal tree where the increment borer can reach the tree pith (enter --- in the Measure Code field)



Plot Type	Tree No.	TYPE*	Species	Cr. Cl.	Boring (OB) Diam. (cm)	Tree Length (m)	S / H	Bark Thickness (mm)	Bored Height (m)	Measure Code	Office Bored Height Age	Growth (mm) 5 Yr.	Growth (mm) 10 Yr.	Growth (mm) 20 Yr.	Prorate Data Length (cm)	Prorate Data Off. Count	Direct Age Corr.	Total Age	Phy Age	S / A
Quadrant 1 — HEIGHT AND AGE INFORMATION											* T = Top Height, L = Leading Species, S = Second Species, O = Other Leading, V = Resid.									
	1 2 3	4	5 6 7	8	9 10 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 47 48	49 50 51	52
5.64 m	1	T	Cw	D	92.7	34.6	Y	11	1.3	- - -	96	4	7	12						Y
Quad		L																		
Quad		S																		
Quad		O																		
Quad		V																		

Figure 4.8 - Recording age for full boring.

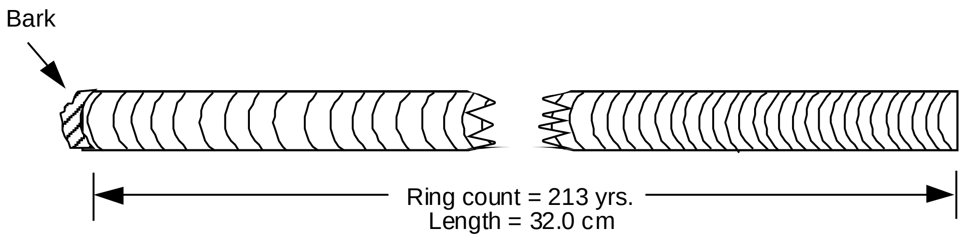
2. Tree with rotten or missing core (ROT)



Plot Type	Tree No.	TYPE*	Species	Cr. Cl.	Boring (OB) Diam. (cm)	Tree Length (m)	S / H	Bark Thickness (mm)	Bored Height (m)	Measure Code	Office Bored Height Age	Growth (mm) 5 Yr.	Growth (mm) 10 Yr.	Growth (mm) 20 Yr.	Prorate Data Length (cm)	Prorate Data Off. Count	Direct Age Corr.	Total Age	Phy Age	S / A
Quadrant 1 — HEIGHT AND AGE INFORMATION											* T = Top Height, L = Leading Species, S = Second Species, O = Other Leading, V = Resid.									
	1 2 3	4	5 6 7	8	9 10 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 47 48	49 50 51	52
5.64 m	1	T	Cw	D	92.7	34.6	Y	11	1.3	ROT		4	7	12	17.2	81				Y
Quad		L																		
Quad		S																		
Quad		O																		
Quad		V																		

Figure 4.9 Recording age for tree with missing core (ROT).

3. Trees where increment borer cannot reach centre of the tree (CRC)



Quadrant 1 — HEIGHT AND AGE INFORMATION

* T = Top Height, L = Leading Species, S = Second Species, O = Other Leading, V = Resid.

Plot Type	Tree No. (1–3)	TYPE* (4)	Species (5–7)	Cr. Cl. (8)	Boring (OB) Diam. (cm) (9–12)	Tree Length (m) (13–16)	S/H (17)	Bark Thickness (mm) (18–20)	Bored Height (m) (21–22)	Measure Code (23–25)	Office Bored Height Age (26–29)	Growth (mm) 5 Yr. (30–31)	Growth (mm) 10 Yr. (32–33)	Growth (mm) 20 Yr. (34–36)	Prorate Data Length (cm) (37–40)	Prorate Data Off. Count (41–43)	Direct Age Corr. (44–45)	Total Age (46–48)	Phy Age (49–51)	S/A (52)
5.64 m	1	T	Cw	D	123.0	42.6	Y	11	1.3	CRC		4	7	12	32.0	213				Y
Quad		L																		
Quad		S																		
Quad		O																		
Quad		V																		

Figure 4.10 - Recording for partial boring (CRC)

4. Out-of-plot tree taken for sample age (OUT)

   If the selected sample trees are too small to be bored without damaging the tree, or the length of the plot trees is less than 2 m, a representative tree of the same species from outside the 11.28 m radius plot can be cut down and counted, or bored. The preference in young stands (less than 2 m in height) would be to count the age as close as practical to the ground.

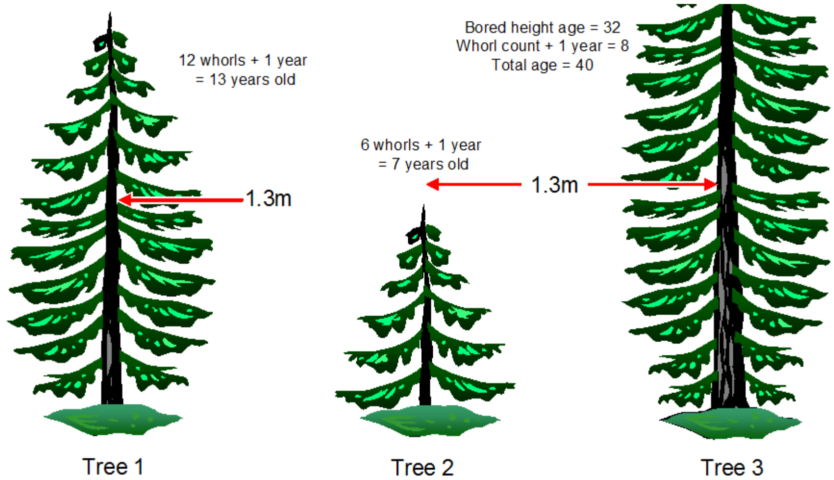
Quadrant 1 — HEIGHT AND AGE INFORMATION

* T = Top Height, L = Leading Species, S = Second Species, O = Other Leading, V = Resid.

Plot Type	Tree No. (1–3)	TYPE* (4)	Species (5–7)	Cr. Cl. (8)	Boring (OB) Diam. (cm) (9–12)	Tree Length (m) (13–16)	S/H (17)	Bark Thickness (mm) (18–20)	Bored Height (m) (21–22)	Measure Code (23–25)	Office Bored Height Age (26–29)	Growth (mm) 5 Yr. (30–31)	Growth (mm) 10 Yr. (32–33)	Growth (mm) 20 Yr. (34–36)	Prorate Data Length (cm) (37–40)	Prorate Data Off. Count (41–43)	Direct Age Corr. (44–45)	Total Age (46–48)	Phy Age (49–51)	S/A (52)
5.64 m	1	T	Hw	D	4.6	5.1	Y	2	1.3	OUT	17	7	14	- - -						Y
Quad	48	L	Cw	C	- - . - -	1.0	Y	- -	0.0	OUT		- -	- -	- - -				9		Y
Quad		S																		
Quad		O																		
Quad		V																		

Figure 4.11 - Recording age for out-of-plot-tree.

5. Tree age determined directly from count of branch whorls (WHO)



Quadrant 1 — HEIGHT AND AGE INFORMATION

* T = Top Height, L = Leading Species, S = Second Species, O = Other Leading, V = Resid.

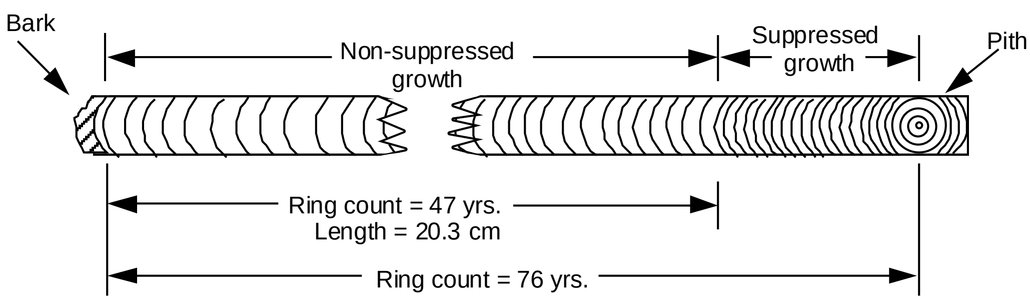
Plot Type	Tree No.	TYPE*	Species	Cr. Cl.	Boring (OB) Diam. (cm)	Tree Length (m)	S/H	Bark Thickness (mm)	Bored Height (m)	Measure Code	Office Bored Height Age	Growth (mm) 5 Yr.	Growth (mm) 10 Yr.	Growth (mm) 20 Yr.	Prorate Data Length (cm)	Prorate Data Off. Count	Direct Age Corr.	Total Age	Phy Age	S/A
	1 2 3	4	5 6 7	8	9 10 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 47 48	49 50 51	52
5.64 m	1	T	Sw	C	4.6	2.6	Y	1	0.0	WHO								13		Y
Quad	2	L	Hw	C	—	1.1	Y	—	0.0	WHO								7		Y
Quad	3	S	Cw	D	18.5	22.4	Y	8	1.3	WHO	32	14	25	59			8	40		Y
Quad		O																		
Quad		V																		

Figure 4.12 - Recording age using whorl count.

6. Physiological Age Measurement (code as PHY)

Calculation of physiological age:

1. non-suppressed growth rate (47 years ÷ 20.0 cm = 2.35 years/cm)
2. physiological age (2.35 years/cm X 25.0 cm = 59 years)



Quadrant 1 — HEIGHT AND AGE INFORMATION

* T = Top Height, L = Leading Species, S = Second Species, O = Other Leading, V = Resid.

Plot Type	Tree No.	TYPE*	Species	Cr. Cl.	Boring (OB) Diam. (cm)	Tree Length (m)	S/H	Bark Thickness (mm)	Bored Height (m)	Measure Code	Office Bored Height Age	Growth (mm) 5 Yr.	Growth (mm) 10 Yr.	Growth (mm) 20 Yr.	Prorate Data Length (cm)	Prorate Data Off. Count	Direct Age Corr.	Total Age	Phy Age	S/A
	1 2 3	4	5 6 7	8	9 10 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 47 48	49 50 51	52
5.64 m	1	T	Hw	C	49.6	17.3	Y	7	1.3	PHY	76	3	5	9	20.3	47			59	Y
Quad		L																		
Quad		S																		
Quad		O																		
Quad		V																		

Figure 4.13 - Recording physiological age.

Sampling and Enhancement of CMI Ground Samples for NVAF

The purpose of sampling and enhancement of the CMI ground samples is to tally a large set of trees for Net Volume Adjustment Factor (NVAF) sample tree selection purposes and to collect (enhancement) a set of tree attributes to allow for the estimation of net tree volume.

Sampling and enhancement for NVAF involves:

1. Enhancement of tallied trees in the auxiliary plots of VRI phase 2 sample clusters, or
2. Establishment of auxiliary plots from CMI samples and the enhancement of their tallied trees.

NVAF and the CMI Sample

For the CMI samples have been randomly selected for NVAF sampling, there are four departures from the regular CMI sampling procedures:

1. The establishment of two variable radius auxiliary plots from the CMI sample, where one plot is located exactly 100 m north and the other is preselected randomly to be 50 m either north, west or east of the first auxiliary plot.
2. The selection of a basal area factor using the standard VRI phase 2 procedure.
3. The tallying and enhancement of all standing trees with a DBH >= 12.5 cm. The standard suite of VRI tree attributes will be recorded for all tallied trees.
4. The collection of extra attributes describing tree conditions and general sample conditions to aid the stem analysis phase. These extra attributes are described below.

List of Extra Tree and Sample Attributes to Record

The non standard VRI attribute to collect is comments about individual trees on their extreme unsuitability as NVAF sample trees which would include the following:

- Major wildlife use, which includes eagle nests, bear dens and the like.
- Unsafe tree conditions that would imperil the faller.
- Site conditions that would prevent the tree once felled from being sampled, which include trees above bluffs and waterways.

Additional site and stand conditions, collected by the sampler, will facilitate the work of the destructive sampling crew. Useful information, in the form of comments, include descriptions of the general site conditions for the walk in and in and around the sample plots:

- Falling difficulty
- Sample access
- Terrain
- Brush
- Windfall and slash

Literature Cited

Armleder, Harold M., Susan K. Stevenson, and Stephen D. Walker. 1992. Estimating the Abundance of Arboreal Forage Lichens. Land Management Handbook Field Guide Insert 7. B.C. Ministry of Forests.

Fink, K. E., P. Humphreys, and G. Hawkins. 1989. Field Guide To Pests of Managed Forests in British Columbia. B.C. Ministry of Forests, Victoria, B.C. FRDA Publication 16, ISSN 0843-4719.

Ministry of Forests, B.C. Environment. 1996. Field Manual for Describing Terrestrial Ecosystems. Draft for 1996 field season.

5. Net Factoring

Introduction

This section outlines the steps needed to assess the net volume of trees on the Integrated Sample Plot.

Call grading and *net factoring* are processes used to assess timber quality and net tree volume. They are applied to the tree as the cruiser sees it. No attempt is made to predict grade based on falling breakage or any manufacturing process, or to predict volume loss without direct evidence. The two processes are related but will be presented separately for presentation ease.

The CMI will employ the same Net Factoring procedures as developed for the Vegetation Resources Inventory.

Objectives

To provide a rule-based estimate of net tree volume.

Definitions

Net Factoring involves estimating the net volume of sound wood (gross volume less decay) of variable log lengths. These net volumes are based on: (1) direct measurements (includes visual estimates and physical measurements); or (2) standard, rule-based deductions associated with loss indicators.

The net factoring process is based on *only* making allowances for decay on consistently measurable or detectable features. Some trees will contain decay but will not have any visible symptoms.

Pencil bucking is the imaginary sectioning of trees into potential logs.

General Procedures

- Standard rule-based deductions will be used to determine the extent of the defect and the calculation of the net factor (% sound wood).
- Pencil bucking is used to identify grade changes in a tree and to localize where the net factor is applied. Pencil bucking is the imaginary sectioning of trees into potential logs.
- Net factoring is for sound wood loss only (decay or missing wood). No additional deductions are made for anticipated breakage, manufacturing loss, or splits and fractures.
- When calculating log volumes the diameter of the log will be the DBH, when dealing with the bottom log, or will be estimated at the midpoint of the log when dealing with upper sections of the tree. This may be slightly different than with some of the scaling conventions.

Field Cards for this Section

Tree Details (TD) (Appendix A, Figures A.10 and A.11)
log grades, lengths, % sound

Tree Loss Indicators (TL) (Appendix A, Figure A.12)
damage agent, severity, loss indicator, location, frequency

Detailed Procedures

5.1 Net Factoring Procedures

All trees in the Integrated Plot will have net factors calculated for each log.

1. Complete the tree loss indicators information prior to the net factor process.
2. In conjunction with the grading rules, determine the applicable log lengths for each tree.
3. Using measurements and rule-based deductions, calculate the net factor for each log section.
4. Where loss indicators are located on the tree below high side ground or extend below high side ground, consider the application as if the indicator was in the first log length. For example, a frost crack that extends from minus 0.5 m to plus 1.5 m is calculated as a 2 m frost crack with losses applied to the first log. Similarly a root rot conk present on the ground is applied to the first log length.
5. Measure all net factor calculations from high side ground.
6. Since net factoring is a priority when major defects exist it is desirable that the defect be isolated as a log. If this process creates an unrealistic description of the tree, incorporate the defect into a longer log.
7. Assign a net factor to each log. If the log has no major defects, and you detect no measurable sound wood loss, the net factor is 100%, recorded as two dashes (- -).

Net factors will only be recorded where:

- a conk, frost crack, or blind conk is present
- decayed or missing wood is visible (note – broken tops, dead tops, forks and other loss indicators can not have net factor deductions applied unless rot is visible).
- sounding of the stem indicates decay, and subsequent boring provides a relative decay ratio
- root rot is observed

5.2 Calculating Volume

In assessing the percent deduction of a log, you will need to calculate volumes. Logs are considered cylindrical, and depending on the type of defect, the decayed portion is considered to be rectangular (such as scars), cylindrical (such as conks), or conical (such as butt rot). The following conventions and formulas shown in Table 5.1 will be used in the calculations.

Diameter: length of a straight line passing through the centre of a circle.

Radius: line extending from the centre of a circle to the circumference (½ diameter).

L = length; W = width; D = depth; R = radius; π = 3.14 (to 2 decimal places).

Table 5.1 - Formula for calculating volume.

Shape	**Formula**
Rectangular solid	Volume = L * W * D
Cylinder	Volume = $\pi R^2 * L$
Cone	Volume = $(1/3) \pi R^2 * L$
Units must be consistent (all cm or all m).	

5.3 Applying Deduction Rules

.

Table 5.2 - Summary of procedures for determining net factor for loss indicators.

Defect	Form	Method	Deduction area	% Sound of Deduction Area	Grade
1. Heart Rot Conk (DD_)	Cylindrical	Rule	4 m above conk 6 m below conk	50%	Y
2. Root rot (DR_)	Conical	Rule	3 m	81%	assigned*
3. Blind Conk (BNK)	Cylindrical	Rule	4 m above conk 6 m below conk	50%	Y
4. Frost crack (NGC)	Other	Rule	extent of frost crack	calculated	assigned*
5. Scar (SCA)	Rectangular	Calculate	extent of scar	calculated	assigned*
6. Cat face (SCA)	Conical	Calculate	extent of scar	calculated	assigned*
7. Fork (FRK)	Other	Rule	if decay present: 1 m below	50%	Y
8. Crook (CRO)	Other	Rule	if decay present: 1 m below	50%	Y
9. Rotten branch (LRB)	Cylindrical	Rule	1 m above 1 m below	50%	Y
10. Dead top (DTP)	Other	Calculate	live crown to top of tree	calculated	assigned*
11. Broken top (BTP)	Other	Rule	broken off portion remaining stem 1.0 m of decay below break, only if rot is visible at the break	00 00	N assigned*
12. Sounding (SNG)	Other	Calculate	various	calculated	assigned*
13. Direct Observation (DIR)	Other	Rules	various	calculated	assigned*
14. Other (OTH)	Other	Rules	various	calculated	assigned*
* Assigned by cruiser in the field					

1. Heart Rot Conk (DD _)

Inventory conventions assume that conk rot extends 4 m above the conk and 6 m below it. This is normally a 10 m Y grade log with a net factor of 50%.

For example, an H grade tree with a conk at 12 m could be graded “H” grade for 6 m, “Y” for 10 m (net factor 50%), then “H” grade again starting 4 m above the conk.

The rule for heart rot conk is as follows:

Table 5.3 - Deduction rule for Heart Rot Conk.

Form	Cylindrical
Method	Rule
Deduction area	4 m above conk; 6 m below
% Sound of deduction area (net factor)	50%
Grade	Y

For multiple conks, where the lengths between conks are less than the 10 m minimum, decay is assumed to extend 4 m above the top conk and 6 m below the lowest conk. The length is given a net factor of 50% and a grade of Y.

If you can measure more severe decay, pencil buck the affected portion and grade it a Y with a greater net factor. This is done in at least 1 m increments.

Note: Other major defects, such as frost cracks associated with conk, can be assumed to be cylindrical in nature as well, with the same net factor and grade.

2. Root Rot (DR_)

All root rots are assumed to be conical in nature. Unless otherwise observed, the inventory convention is that the cone of rot extends 3 m from the ground and that the ratio of the diameter of the rot to the diameter of the butt is 75% (¾).

The deduction (for the 3 m section) is a constant, with the net factor always equal to 81% for that section.

The rule for root rot is as follows:

Table 5.4 - Deduction rule for Root Rot.

Form	Conical
Method	Rule
Deduction area	0 — 3 m
% Sound of deduction area (net factor)	81%
Grade	Assigned

Note that if a Schweinitzii butt rot (*Phaeolus schweinitzii*, DRS) fruiting body is observed above the ground on the main stem, then the rule is modified slightly: the first log should extend from the ground to 3 m above the highest DRS fruiting body, the standard net factor of 81% still applies, but additionally, the grade is an automatic X, due to a grade consideration of 2 m loss for every 3 m of log (33%).

Formula

$$\text{Net Factor \%} = \left(\frac{\text{volume of log} - \text{volume of decay}}{\text{volume of log}}\right) * 100\ \%$$

Shortcut Formula

Since the relative size of the defect is constant, the decayed percentage for the first 3 m is a constant of 19%. The simple form of the equation is:

$$\text{Net Factor \%} = 100\% - \left(19\% * \left[\frac{\text{length of decay}}{\text{log length}}\right]\right)$$

EXAMPLE
Log length: 8 m; Rot extends: 3 m Since the relative size of the defect is constant, the decayed percentage for the first 3 m is always 19%. Net Factor = $100\% - \left(19\% * \left[\frac{3}{8}\right]\right)$ = 100%-(19% * 0.35) = 100% - 7% = 93%

Figure 5.1 - Example of net factor calculation for Root Rot.

Note: An alternate net factor calculation to the one describe above is to apply a standard 0.6 m length deduction [based on: (3.0 m rot section – 0.6 m length deduction) / 3.0 m log = 80%].

3. Blind Conk (BNK)

Interior and transition zones: typically bright orange rot is visible when knots are cut open.

Coastal zone: typically excessive swelling of the bole or a collapsed bole.

The rule for blind conk is as follows:

Table 5.5 - Deduction rule for Blind Conk

Form	Cylindrical
Method	**Rule same as conk**
Deduction area	4 m above conk; 6 m below
% Sound of deduction area (net factor)	50%
Grade	Y

4. Frost Crack (NGC)

The rule for frost crack is as follows:

Table 5.6 - Deduction rule for Frost Crack.

Form	Other
Method	Rule
Deduction area	Pencil buck at top and bottom of the series of frost cracks.
% Sound of deduction area (net factor)	Sum of frost crack length(s)/log length * 10%. Maximum deduction 40% (Net factor would be 60% sound).
Grade	Assigned

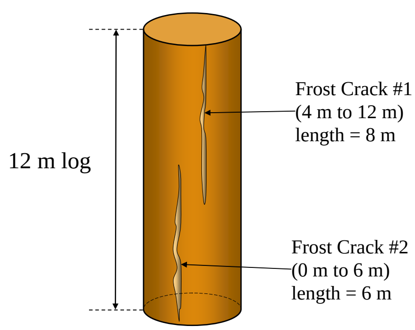
Note: Frost crack(s) that run across the grain of the log, may result in a lower grade. This would be due to the percent of merchantable lumber volume loss, rather than the percent of sound wood loss.

EXAMPLE

log length: 12 m;

Two frost cracks are located as follows: 6 m long (from 0 m to 6 m)
8 m long (from 4 m to 12 m)

$$\text{Deduction} = \left(\frac{\Sigma \text{ crack lengths}}{\text{log length}}\right) * 10\%$$



Calculation of Net Loss Factor

$$\text{Net Loss} = \left(\frac{\Sigma \text{ crack lengths}}{\text{log length}}\right) * 10\%$$

$$= \left(\frac{8+6}{12}\right) * 10\%$$

= 12% volume loss

Figure 5.2 - Example of net factor calculation for Frost Cracks.

5. SCAR (SCA)

The rule for scar is as follows:

Table 5.7– Deduction rule for Scar.

Form	Rectangular
Method	Calculate
Deduction area	Extent of scar
% Sound of deduction area (net factor)	Calculated
Grade	Assigned

Indicator is **present** and rot or missing wood is **evident**.

Calculate the net factor using one of the following two methods, depending on whether or not the depth of rot can be measured.

Method 1: When depth of rot can be measured (for example, butt scars)

Assume the scar is rectangular:

$$\text{Volume of Decay} = \text{length} * \text{width} * \text{depth}$$

Assume the log is cylindrical (diameter DBH for butt logs, midpoint for other logs):

$$\text{Log volume} = \pi * \text{radius}^2 * \text{length}$$

Formula

$$\text{Net Factor \%} = \left(\frac{\text{volume of log} - \text{volume of decay}}{\text{volume of log}}\right) * 100\ \%$$

Note: To have a net factor less than 90% is rare for a scar.

EXAMPLE	
log length: 10 m; diameter: 100 cm	
scar: length 10 m, width 20 cm, depth 10 cm	
1. Volume of Decay	= L * W * D (volume of rectangle)
	= 10 m * 0.2 m * 0.1 m
	= 0.2 m^3
2. Volume of Log	= $\pi R^2 L$ (volume of cylinder)
	= $\pi * (0.5\ m)^2 * 10\ m$
	= $3.14 * 0.25\ m^2 * 10\ m$
	= 7.8 m^3
3. Net Factor	= $\left(\frac{7.8 - 0.2}{7.8}\right) * 100\%$
	= $\left(\frac{7.6}{7.8}\right) * 100\%$
	= 97%

Figure 5.3 - Example of net factor calculation for Scar with known depth.

Method 2: When depth of rot cannot be measured

1. Estimate width and measure length of scar on log
2. Calculate circumference of log at the scar (π * D)
3. Calculate "decay length" deduction = $\frac{1}{2}\left(\frac{\text{width of scar}}{\text{circumference of log}}\right) * \text{scar length}$
4. Net Factor = $\left(\frac{\text{length of log} - \text{decay length}}{\text{length of log}}\right) * 100\%$

EXAMPLE

log length: 10 m; diameter: 60 cm; scar 6 m in length, 20 cm wide

Decay Length $= \frac{1}{2}\left(\frac{\text{width of scar}}{\text{circumference of log}}\right) * \text{scar length}$

$= \frac{1}{2}\left(\frac{20\text{cm}}{3.14 * 60\text{cm}}\right) * 6\text{m}$

$= 0.32\text{ m}$

Net Factor $= \left(\frac{\text{length of log} - \text{decay length}}{\text{length of log}}\right) * 100\%$

$= \left(\frac{10\text{m} - 0.32\text{m}}{10\text{m}}\right) * 100\%$

$= 97\%$

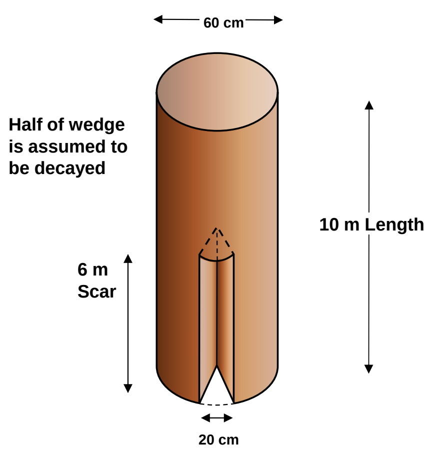


Figure 5.4 - Example of net factor calculation for Scar with unknown depth.

6. CAT FACE (SCA)

The rule for cat face is as follows:

Table 5.8– Deduction rule for Cat Face.

Form	Cylindrical/Conical
Method	Calculate
Deduction area	Extent of Scar
% Sound of deduction area (net factor)	Calculated
Grade	Assigned

Cat face is a scar (SCA) or missing section of wood that allows measurement of decayed or missing wood.

There are two methods of dealing with this form of internal decay, depending on whether the associated heart rot is cylindrical or conical in nature, and that decision must be made by the cruiser on-site.

<u>Method 1: Formula for Cylindrical Defect</u>

$$\text{Net Factor \%} = \left(\frac{\text{volume of log} - \text{volume of decay}}{\text{volume of log}}\right) * 100\ \%$$

Shortcut Cylindrical Formula

$$\text{Net Factor \%} = \left[1 - \left(\frac{(\text{radius of decay})^2 * \left(\frac{\text{length of decay}}{\text{log length}}\right)}{(\text{radius of log})^2}\right)\right] * 100\%$$

EXAMPLE Cylindrical Defect

Log length: 10 m; Cylindrical cat face for 6.0 m

Sound wood = 20 cm (solid outer ring of wood)

Diameter = 200 cm (radius = 100 cm [1.0 m])

$$\text{Net Factor} = \left[1 - \left(\frac{(0.80\text{m})^2 * \left(\frac{6\text{m}}{10\text{m}} \right)}{(1.0\text{m})^2} \right) \right] * 100\%$$

$$= [1 - (0.384)] * 100\%$$

$$= 62\%$$

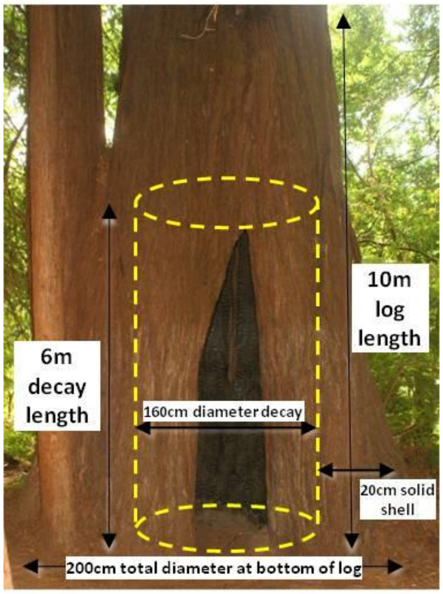


Figure 5.5 - Example of net factor calculation for Cat Face (cylindrical defect).

<u>Method 2: Formula for Conical Defect</u>

$$\text{Net Factor \%} = \left(\frac{\text{volume of log} - \text{volume of decay}}{\text{volume of log}}\right) * 100\ \%$$

Shortcut Conical Formula

$$\text{Net Factor \%} = \left[1 - \left(\frac{\left(\frac{1}{3}\right) * (\text{radius of decay})^2 * \left(\frac{\text{length of decay}}{\text{log length}}\right)}{(\text{radius of log})^2}\right)\right] * 100\%$$

EXAMPLE (Conical)
defect length not equal to log length

Conical cat face for **5.0** m of **8.0** m log

Sound wood 20 cm (solid outside radius, therefore 80 cm defective core)

Diameter = 200 cm (radius = 1.0 m)

$$\text{Net Factor} = \left[1 - \left(\frac{\left(\frac{1}{3}\right) * (0.8\text{m})^2 * \left(\frac{5\text{m}}{8\text{m}}\right)}{(1\text{m})^2}\right)\right] * 100\%$$

$$= \left[1 - \left(\frac{0.33 * 0.64 * 0.63}{1}\right)\right] * 100\%$$

$$= [1 - (0.13)] * 100\%$$

$$= 87\%$$

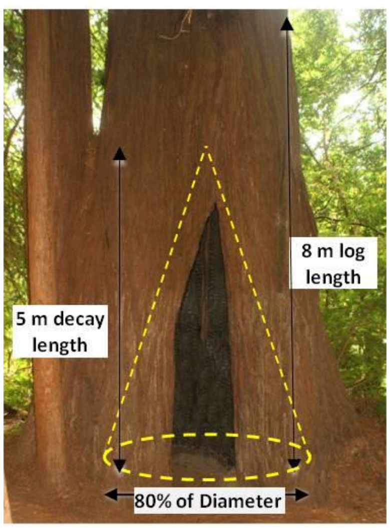


Figure 5.6 - Example of net factor calculation for Cat Face (conical depth).

Method 3: Uses table 5.9, butt rot guide for length deductions

1. Find the ratio $\left(\frac{\text{diameter of decay}}{\text{DBH}}\right)$
2. Use Butt Rot table for ratio of butt rot.

Note: to develop consistency in the net factoring process individuals should not interpret between the butt rot ratios. Determine the nearest ratio and apply the selected value.

3. Express length deduction as percentage of log length.

Another option of conical defect associated with butt rot is to use the butt rot guide for length deductions.

Butt rot is generally included with the log for its maximum grade length. However, if the rot lowers the grade of the butt log, take a short log (minimum 3 m) and assign a grade and net factor to that short log.

The Butt Rot Guide (Table 5.9) gives the conical butt rot ratios by log length. Note that the net factor may determine the grade, based on the percent lumber recovery or other grade requirements. Deductions and grade considerations are based on rot/DBH ratio. Calculate the ratio to the nearest ¼ diameter, determine the deduction from the table below, and reduce the log volume by the deduction.

Table 5.9 - Butt Rot guide for length deductions.

Ratio	Length	Deduction	Grade Consideration*
¼ diameter	1.8–2.4 m	0.2 m	0.6 m
½ diameter	3.6–4.2 m	0.4 m	1.8 m
¾ diameter	5.4–6.0 m	1.2 m	3.6 m
4/4 diameter	7.2 m	2.4 m	4.2 m
*Grade consideration describes how much of a piece will not produce lumber.			

EXAMPLE

The butt rot length is not visible, therefore we need a process to determine deduction length.

Rot diameter = 55 cm; DBH = 102 cm; log length = 10 m

$$\text{Ratio} = \frac{\text{diameter of decay}}{\text{DBH}} = \frac{55}{102} = \text{approximately } \frac{1}{2}$$

Using the table, butt rot extends from 3.6 m to 4.2 m, and the deduction is 0.4 m length.

$$\text{Net Factor} = \left(\frac{10 - 0.4}{10}\right) * 100\ \%$$

$$= 96\%$$

Figure 5.7 - Example of net factor calculation for Cat Face (using butt rot table).

7. FORK (FRK)

In most cases, the position of the fork will signify a change of grade. If the fork is major, both in size and impact on grade, it may be pencil bucked out in 1 m lengths with a grade of Y assigned to that section and a net factor of 100%.

If decay is visible the rules for fork are as follows:

Table 5.10 - Deduction rule for Fork.

Form	Other
Method	Rule
Deduction area	1 m below
% Sound of deduction area (net factor)	50%
Grade	Y

8. CROOK (CRO)

In most cases, the position of the crook will signify a change of grade. If the position of the crook will result in a change of grade, both in size and impact on grade, it may be pencil bucked out in 1 m lengths with a grade of Y assigned to that section and a net factor of 100%.

If decay is visible the rules for crook are as follows:

Table 5.11 - Deduction rule for Crook.

Form	Other
Method	Rule
Deduction area	1 m below
% Sound of deduction area (net factor)	50%
Grade	Y

9. ROTTEN BRANCH (LRB)

Larger rotten branches/knots (≥ 10 cm inside bark) are a significant indicator of cylindrical rot.

The rule for rotten branches is as follows:

Table 5.12 - Deduction rule for Rotten Branch.

Form	Cylindrical
Method	Rule
Deduction area	1 m above the rotten branch; 1 m below
% Sound of deduction area (net factor)	50%
Grade	Y

Note: For multiple, overlapping rotten branches/knots (less than 2 m apart), deduction extends 1 m above and below the series.

10. Dead Tops (DTP)

(Broken tops are handled separately.)

Dead tops are usually associated with sap rot, but rot must be visible before a net factor can be applied.

The rule for dead tops is as follows:

Table 5.13 - Deduction rule for Dead Tops.

Form	Other
Method	Calculate
Deduction area	From top of live crown to tree length
% Sound of deduction area (net factor)	Calculated
Grade	Assigned

Note: Dry checked wood may affect grade, but will not affect the sound wood content (net factor).

Sap rot depth is to be estimated at the midpoint of the dead top.

Formula

$$\text{Net Factor \%} = \left(\frac{\text{volume of sound cone}}{\text{volume of cone}}\right) * 100\ \%$$

Shortcut Formula

$$\text{Net Factor \%} = \left(\frac{\text{radius of sound wood}}{\text{radius of log}}\right)^2 * 100\ \%$$

EXAMPLE

Midpoint diameter 20 cm (10 cm radius)

2 cm depth of sap rot (giving 8 cm radius of sound wood)

$$\text{Net Factor \%} = \left(\frac{8\text{cm}}{10\text{cm}}\right)^2 * 100\ \% = 64\%$$

Figure 5.8 - Example of net factor calculation for Dead Tops.

11. BROKEN (MISSING) TOPS (BTP)

The tree is graded and net factored normally to the broken top (pencil buck at the break). The missing portion is graded as "N" and net factored as "00" (no sound wood).

Table 5.14 - Deduction rule for Broken Tops.

Form	Other
Method	Rule
Deduction area	from break to original top
% Sound of deduction area (net factor)	00 = no sound wood
Grade	N (nothing)

Broken tops, particularly on hemlock and balsam, are usually associated with rot, but rot must be observed on the stem (or broken top if it is on the ground nearby) before a net factor can be applied.

Rot associated with logs below the broken top is assumed to run 1 m below the break.

Table 5.15 - Deduction rule for Rot Associated with Broken Tops.

Form	Other
Method	Rule
Deduction area	1 m below the break
% Sound of deduction area (net factor)	00
Grade	Y

<u>Formula</u>

$$\text{Net Factor \%} = \left(\frac{\text{last log length} - 1.0\text{m}}{\text{last log length}}\right) * 100\ \%$$

EXAMPLE

Last log length is 10 m up to a broken top

$$\text{Net Factor \%} = \left(\frac{10\text{m} - 1.0\text{m}}{10\text{m}}\right) * 100\ \% = 90\%$$

Figure 5.9 - Example of net factor calculation for Broken Tops.

12. Sounding for Decayed or Missing Wood (SNG)

"Sound" all measured trees in the Integrated Plot. Only if the tree gives a hollow sound, bore the tree with an increment borer on the side facing the plot centre and record the loss indicator "SNG." Even if the boring does not reveal any decay, the "SNG" code is still left as recorded.

Decay discovered by boring will not be used for net factoring except in the case of sounded trees. For instance, discovering decay by boring a top height tree, which did not sound hollow, would not result in a deduction.

Measure the sound wood.

Determine the ratio of decay to tree DBH. If there are no other indicators, assume that the rot is conical in nature and apply the deduction in Table 5.9 Butt Rot Guide for Length Deductions.

13. Direct Observation (DIR)

Sometimes rot or missing wood can be observed directly without, but the cause is **not** known.

The rule for direct observation is as follows:

Table 5.16 - Deduction rule for Direct Observation.

Form	Other
Method	Rules
Deduction area	Various
% Sound of deduction area (net factor)	Calculated
Grade	Assigned

14. Other (OTH)

Sometimes rot or missing wood can be observed directly, and the cause is **known**. However, there is no appropriate loss indicator code.

The rule for Other is as follows:

Table 5.17 - Deduction rule for Other.

Form	Other
Method	Rules
Deduction area	Various
% Sound of deduction area (net factor)	Calculated
Grade	Assigned

15. Multiple Defects

In general, the assignment of net factors to trees with multiple defects is left to the professional judgment of the cruiser, based on the net factoring procedures discussed here.

However, several concepts should be noted:

- Net factors less than 50% will only occur with severe:
  - cylindrical butt rot
  - sap rot
  - missing wood
- Severe frost cracks/scars associated with conk on the lower bole can be assumed to be connected and treated as cylindrical rot, with a net factor of 50%.
- Sound sections 3 m or longer between defects can be treated as separate logs. Sound sections less than 3 m are incorporated with the log section above or below.

EXAMPLE
of isolated section between defects

Conk at 12 m and 24 m. This creates a 2 m section between the defect areas, so we can combine all three sections into one log.

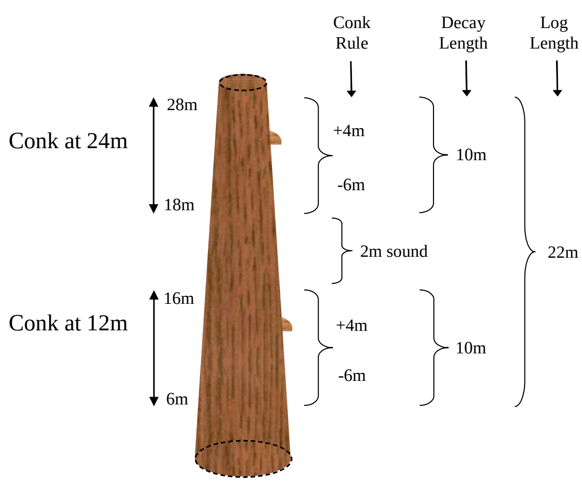
Deduction length	=	$2 \times (6 + 4) = 20$ m
Log Length (from 6 m — 28 m)	=	22 m
Conk Deduction 50% (of 20 m)	=	10 m
Grade (all 3 sections)	=	Y

Net Factor $= \left(\frac{\text{length of log} - \text{length of deduction}}{\text{length of log}} \right) * 100\ \%$

Net Factor $= \left(\frac{22\text{m} - 10\text{m}}{22\text{m}} \right) * 100\ \%$

$= 54.5\%$ Record as 55%

Note: The same procedure should be used whenever grade is assigned, particularly for butt rot and/or cat face.



Note: If the upper conk were at 25 m, it would create a 3 m log between the two defects. This log would be treated as a separate sound log with its own grade. This would create three separate logs, each with its own grade and net factor (a more detailed description of the tree).

Figure 5.10 - Example of isolated sections between defects.

6. Call Grading

Introduction

This section outlines the steps needed to assess the quality of measured trees. The call grading criteria and procedures as developed for the Vegetation Resources Inventory will be employed in the Change Monitoring Inventory.

Objectives

To provide a rule-based estimate of tree quality.

Definitions

Call grading is the procedure used to assign one of CMI grades (modified coastal log grades) to standing and fallen timber. Grading is a hierarchical process. The grade extends up the tree as long as the grade rules allow. When a knot or other defect is encountered or the diameter can no longer support that grade, the grade changes for the next portion of the tree.

Some trees are too small to meet the minimum log sizes for CMI grades. These small trees are assigned a small-tree grade developed for use in the CMI.

Variable length call grading recognizes only a minimum length (see Section 6.1) and allows the cruiser to pencil buck (the imaginary sectioning of a portion of the tree) at grade changes rather than at predetermined log lengths.

General Procedures

- **The cruiser will be able to grade the log into at least the correct major category. The major categories are lumber, peeler, sawlog, shingle, and utility chipper.**
- Grades are assigned to logs based on size, quality, and soundwood recoverability.
- Grades are assigned using the hierarchy. Start at the highest grade in the hierarchy. If the log cannot meet that grade, move to the next in the list until the grade can be met.
- A log is the highest grade it qualifies for within the hierarchy. It is not a choice of market preference, current harvesting practices, accessibility, or other factors.
- Grades are assigned to ALL trees (live or dead, standing or fallen) within the integrated plot.
- Small trees are assigned a small tree grade developed for use in the CMI.
- Grade consideration is applied by the cruiser to determine the percentage of soundwood available for manufacturing. It includes deductions for rot, missing wood and surface characteristics as well as wood unavailable due to defect shape or characteristics. Grade consideration must be taken into account for butt rot, checks, insect/bird holes and twist. The grade consideration due to butt rot is shown in Table 6.2 below. For example, a sawlog (H-grade) fir log that is 8 m long and has a 45 cm top and severe butt rot (3/4 ratio):
    - Net factor = (8.0 m - 1.2m)/8.0 m = 85% (this alone would result in an H-grade, but then grade consideration must be calculated)
    - Grade consideration = 3.6 m = (8.0 m - 3.6 m)/8.0 m = 55%

- o Therefore it is an X-grade since it does not meet the minimum lumber percentage criteria for an H-, I-, J-, or U-grades

Field Cards for this Section

Tree Details (TD) (Appendix A, Figures A.10 and A.11)
Log grades, lengths, % sound

Tree Loss Indicators (TL) (Appendix A, Figure A.12)
Damage agent, severity, loss indicator, location, frequency

Detailed Procedures

6.1 Call Grading Procedures

For Standing or Fallen Trees

1. Measure all log lengths from the high-side ground level.
2. Determine the highest grade the bottom log would satisfy, based on grading rules and characteristics of the minimum log lengths for that species.

Table 6.1 - Minimum log lengths (in m) by grade and species (highest grade at left).

Category	Lumber	Peeler	Sawlog	Shingle	Utility Chipper
GRADES	**[D,F,G]**	**[B,C]**	**[H I J]**	**[K L M]**	**[U X Y]**
Douglas-fir	5	5	5 **4** 5	-	5 **3** 1
Cedar	5	-	5 **4** 5	**4**	5 **3** 1
Hemlock	5	-	5 **4** 5	-	5 **3** 1
Balsam (*Abies*)	5	-	5 **4** 5	-	5 **3** 1
Spruce	**4**	-	**4 4 4**	-	5 **3** 1
Pine/Larch	5	-	5 **4** 5	-	5 **3** 1
Cypress/Yew	**4**	-	**4 4 4**	-	5 **3** 1
Deciduous	-	5*	- 5 -	-	5 — 1

Act is the only deciduous species that can have a peeler grade.

3. Add to that log in 1-metre increments until the top diameter of the log (measured as diameter inside bark [DIB]) or the log quality results in a grade change.

   Maintain that log grade as long as possible if the next grade would be a lower one in the hierarchy.

   Change the grade as soon as possible if the next log grade would be a higher one in the hierarchy.
4. Record the grade and the length. For example, an H grade 16 m log is "H 16".
5. Follow the same procedure for the next log up the tree.

6. The last grade on the tree will normally be carried to the top of the tree and "99" recorded (except when top of tree is broken off), regardless of utilization limits (applies to grades J, U, X, Y). Do not attempt to grade the top log based on top diameter or on the fact that it may be a short log due to utilization top diameter.
7. For grading in immature stands where the first log is a J and the quality of the remaining stem is similar, call the whole tree J (J99). Similarly for grades U, X, and Y.
8. If the tree has certain defects (such as excessive butt rot, fork, conk, rotten branches) you may want to isolate for grading those portions of the tree.

For Broken or Cut Stems

If the stem is over 1.3 m tall, grade and net factor it like any other tree up to the broken top. The missing or unconnected portion is always graded as "N-99-00".

For Small Trees

Trees that do not meet the minimum log size of 5 m to a 10 cm top diameter (U grade) are assigned a small tree grade developed for use in the CMI. Assign a single grade to the entire tree, using the following codes:

P – Pretty good
- Straight and good form.
- Well spaced/distributed knots or branches.

Q – Questionable
- Slight sinuosity, minor crooks or deformities
- Small knots

R – Reject
- Major sinuosity or deformity.
- Large knots/uneven distribution of knots or branches

Note:

- For broken top trees, record the small tree grade to the break, and record "N-99-00" for the broken-off portion.
- Dead trees are assessed on their condition at the time of the survey. For example a dead tree with straight and good form with no checking could still be graded as a "P" grade. Trees with very minor checking could be "Q" grade if they meet the other grade criteria. Trees with moderate to severe checking should be graded as "R" grade.
- Trees that fall into the small tree category with conk or blind conk should be assigned an "R" grade, and net factors are as shown for heart rot below.

6.2 Grading Conventions and Guidelines

Conventions

- Trees with conk or blind conk will have the affected portion graded as "Y" grade.
- The last grade on the tree will normally be carried to the top of the tree and is coded as "99" regardless of utilization limits (this applies to J, U, X, Y and small tree grades).
- If the top of the tree is broken off (missing), the missing portion is graded as "N" (Nothing), length is assigned as "99", and net factored as "00" (0% sound wood).

Guidelines

1. Heart Rot

- Conk, blind conk, and rotten branches have specific lengths and grades applied.

Conk	Y	4 m above, 6 m below, 50% sound
Blind Conk	Y	4 m above, 6 m below, 50% sound (like conk)
Rotten Branch	Y	1 m above, 1 m below, 50% sound

- Scars

  Severe cylindrical cat face should be pencil bucked at the top of the cat face, with that length and net factor used to determine the grade.

2. Butt Rot

- Refer to the Butt Rot Guide for Length Deductions table. Note that the net factor may determine the grade, based on the % lumber recovery or other grade requirements. The table also provides a guide for "grade considerations," which is how much of the piece will not produce lumber.
- Best practice is to isolate butt rot in a short log if it is 2/4 or more; but if there is only ¼ butt rot, best practice is to extend the bottom log to allow for a higher grade (as opposed to pencil bucking a very short valueless X-grade log.

Table 6.2 – Butt rot guide for length deductions.

Ratio	Length	Deduction	Grade Consideration*
¼ diameter	1.8–2.4 m	0.2 m	0.6 m
½ diameter	3.6–4.2 m	0.4 m	1.8 m
¾ diameter	5.4–6.0 m	1.2 m	3.6 m
4/4 diameter	7.2 m	2.4 m	4.2 m
*Grade consideration describes how much of a piece will not produce lumber.			

3. Frost Cracks

- Pencil buck at the top of the frost crack(s) for log length.
- Assign a percentage loss (based on 10% per frost crack, if they run the length of the log) with a maximum total deduction of 40% (net factor of 60%).

Note: The angle, position, or net factor will determine the appropriate grade based on % lumber recovery and/or % merchantable.

4. Occasional Larger Knots (OLK)

All sawlog grades (H, I, J, U and X grades) can have occasional larger knots (OLK's). Occasional larger knots are allowed to the extent of one per 3 meters of log length [two per 3 meters for X grade logs over 50 centimeters top diameter] and must be located where knot sizes for portions of the logs are specified.

For example, if a grade requirement allows 4 cm knots over the entire log, then occasional larger knots can be anywhere on the log. Where the requirement allows larger knots on a portion of the log then the occasional larger knots must be within this portion only.

5. Sun Checks and/or Insect Damage

- A check is a separation of the wood, at right angles to the annular rings that runs through the heart of the log. There is no soundwood deduction for sun checks or insect damage.
- Grade considerations, particularly % lumber, are applied.
- No soundwood deduction for sun checks or insect damage.

Formula for Grade Consideration Calculation of Sound % Lumber

$$\% \text{ Recovered} = \left(\frac{\pi r^2}{\pi R^2}\right) * 100\ \%$$

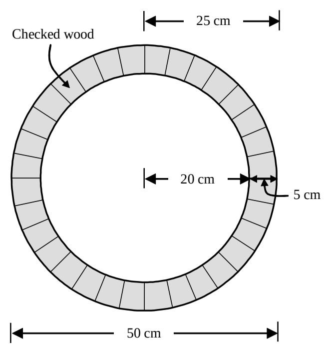
where r = radius of sawable lumber portion, and
R = radius of tree

EXAMPLE

Diameter = 50 cm; Radius of tree (R) = 25 cm; Sun check = 5 cm

Radius of sawable lumber portion (r) = 20 cm

Whole tree is sun checked



$$\% \text{ Recovered} = \left(\frac{\pi r^2}{\pi R^2}\right) * 100\ \%$$

$$= \left(\frac{r^2}{R^2}\right) * 100\ \%$$

$$= \left(\frac{20^2}{25^2}\right) * 100\ \% \quad \text{OR} \quad \left(\frac{40^2}{50^2}\right) * 100\ \%$$

(These give the same mathematical result.)

= 64% lumber recovery

The appropriate grade is X (J grade would require 75% lumber; U grade would require 66% lumber).

Figure 6.1 - Example of grade calculation for sun checked logs.

6. TWIST

- There is no soundwood deduction for twist.
- Grade considerations, however, are applied.
- The amount of twist is measured along 30 cm at the mid-point of the log. The percentage of twist is calculated by dividing this amount by the diameter at the top of the log. With the exception of J grade, there are maximums of both of these values, as shown below. Twist must be less than both of these restrictions. For example, a D grade must deviate by no more than 6 cm over the 30 cm distance, and the deviation divided by the top diameter must be no more than 4%.
- The displacement of twist over 30 cm is also observed.
- Twist comprises two factors: percentage of top diameter; and maximum displacement over 30 cm. Table 6.3 shows the maximum values for specific grades. If the parameters are not met, the next lower grade applies.

Table 6.3 – Maximum twist displacement by grade.

Grades		% of top diameter	Maximum displacement (over 30 cm)
Lumber	D, F, G	4%	6 cm
Peeler	B, C	7%	8 cm
Sawlog	H	7%	8 cm
Sawlog	I	10%	9 cm
Sawlog	J	10%	No limit
Utility	U, X	13%	13 cm
Note: "Waterline to waterline" (180 degree twist) over 2 m is automatically Y grade.			

- If twist only appears on a portion of a tree – it should be pencil bucked out with the appropriate grade, length, and net factor applied.

EXAMPLE 1

Calculations

Estimated top DIB: 60 cm for log section
Severe twist 8 cm (along 30 cm section)

% twist = (8 cm twist)/(60 cm top) * 100% = 13%

This log is graded as U, since this is the first grade met in the hierarchy (other defects may lower the grade further).

EXAMPLE 2

Calculations

Estimated top DIB 25 cm for log section
Minor twist, 2 cm displacement

% twist = (2 cm twist)/(25 cm top) * 100% = 8%

This log is graded as J, since this is the first grade met in the hierarchy.

Figure 6.2 - Examples of grade calculation for twist.

7. CEDAR SHINGLE CRITERIA

Cedar will not be graded as a shingle if it can make a sawlog grade. If a log, due to heart rot or butt rot, has less than 75% soundwood, but meets slab thickness requirement for that grade, the log becomes shingle grade.

If logs are unsuitable for lumber manufacture due to, shape (heavy fluting), heart rot (less than 75 % lumber), or splits (creating triangular or "U" shaped slabs), but otherwise meet the grade criteria, then:

initial grade	**changes to**
D grade	K grade
F grade	L grade
H/I grade	M grade

8. SURFACE CLEAR

Logs which are free of knots and knot indicators are valued for use in specialty forest products, such as window and door stock. A typical log grade criteria will be written as "90% surface clear". In application this indicates 10% of the log may have knots or knot indicators on any surface [from the top of the log] with the remaining 90% of the log being clear of knots or knot indicators. Similarly, a log grade that requires 80% surface clear may have 20% of the log with knots or knot indicators on any surface [from the top of the log] with the remaining 80% of the log being clear of knots or knot indicators.

6.3 Inventory Call Grading Criteria

Fir/Pine/Larch Grades and Grade Requirements

Table 6.4 – Fir/Pine/Larch Grades and Grade Requirements.

D GRADE	**Fir/Pine/Larch**
Min. top diameter inside bark	76 cm
Min. log length	5 m
Min. percentage lumber	75%
Min. percentage clear lumber	50%
Max. twist over 30 cm of length	4% of top diameter, Max. deviation 6 cm
Grade Requirements	
Knots	• ≥ 90% surface clear, with well-spaced knots or knot indicators permitted on the upper 10% of two sides of the log or upper 20% of one side of the log only.
Rot	• No conk permitted. • Rot permitted, provided 75% lumber attained.

F GRADE	**Fir/Pine/Larch**
Min. top diameter inside bark	60 cm
Min. log length	5 m
Min. percentage lumber	75%
Min. percentage clear lumber	25%
Max. twist over 30 cm of length	4% of top diameter, Max. deviation 6 cm
Grade Requirements	
Knots	• Logs 60-74 cm must have ≥ 75% surface clear, with well-spaced knots or knot indicators permitted on the upper 25% of two sides of the log or upper 50% of one side of the log only. • Logs 76 cm or greater must have ≥ 50% surface clear, with well-spaced knots or knot indicators permitted on the upper 25% of two sides of the log or upper 75% of one side of the log only.
Rot	• No conk permitted. • Rot permitted, provided 75% lumber attained.

B GRADE (Fir only)	**Fir/Pine/Larch**
Min. top diameter inside bark	60 cm
Min. log length	5 m
Min. percentage veneer	80%
Maximum twist over 30 cm of length	7% of top diameter, Max. deviation 8 cm
Grade Requirements	
Knots	• No knots or bunch knots over 4 cm are permitted. • Logs 60-74 cm top diameter must have the lower 2.6 m free of knots or knot indicators. • Logs ≥ 76 cm top diameter must have the lower 2.6 m free of knots. Knot indicators are permitted.
Rot	• No conk rot permitted. • No butt rot permitted. • No butt rot in adjacent log permitted • Sap rot permitted to 4% of top diameter or 5 cm in depth.
Misc.	• No splits permitted. • Sun checks or insect holes permitted to a depth of 4% of top diameter or to a maximum of 5 cm in depth. • Sweep is not permitted. • Crook is not permitted. • Burls are permitted to 1 burl per 2.6 m of log length.

C GRADE (Fir only)	**Fir/Pine/Larch**
Min. top diameter	38 cm
Min. log length	5 m
Min. percentage veneer	80%
Max. twist over 30 cm of length	7% of top diameter, Max. deviation 8 cm

Grade Requirements	
Knots	• No knots or bunch knots over 4 cm are permitted.
Rot	• No conk permitted. • No butt rot permitted. • No butt rot in adjacent log permitted • Sap rot: – For logs < 50 cm top diameter, none is permitted. – For logs ≥ 50 cm top diameter, permitted up to 4% of the top diameter, and a maximum of 5 cm actual depth.
Misc.	• No splits permitted. • Sun checks or insect holes: – For logs < 50 cm top diameter, none is permitted. – For logs ≥ 50 cm top diameter, permitted up to 4% of the top diameter, and a maximum of 5 cm actual depth. • Sweep is not permitted. • Crook is not permitted. • Burls are permitted (1 burl per 2.6 m of log length).

H GRADE	**Fir/Pine/Larch**
Min. top diameter	38 cm
Min. log length	5 m
Min. lumber percentage: — Logs ≥ 38 cm top diameter — Logs ≥ 50 cm top diameter	 75% 50%
Min. merchantable percentage	65%
Max. twist over 30 cm of length	7% of top diameter, Max. deviation 8 cm

Grade Requirements	
Knots	• 38 — 48 cm top diameter: – 4 cm knots over the entire log **OR** – 5 cm knots over the upper 50% of the log, with knots ≤ 2 cm in diameter permitted over the lower 50% of the log. • ≥ 50 cm top diameter: – 4 cm knots over the entire log **OR** – 5 cm knots over the upper 66⅔% of the log* **OR** – 8 cm knots over the upper 50% of the log* (* with knots ≤ 2 cm in diameter permitted over the lower portion of the log). • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres.
Rot	• Permitted provided percentage lumber is maintained.
Misc.	• No insect holes penetrating the sapwood permitted.

I GRADE	**Fir/Pine/Larch**
Min. top diameter	38 cm
Min. log length	4 m
Min. lumber percentage: – Logs ≥ 38 cm top diameter – Logs ≥ 50 cm top diameter – Logs 38-48 cm top diameter (former H log quality)	 75% 50% 50%
Min. merchantable percentage	50%
OR former H log quality 38-48 cm top diameter	65%
Max. twist over 30 cm of length	10% of top diameter, Max. deviation 9 cm

Grade Requirements	
Knots	• 38 — 48 cm top diameter 8 cm • 50 — 74 cm top diameter 9 cm • ≥ 76 cm top diameter 10 cm • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres.
Rot	• Permitted, provided 75% percentage lumber is attained.

J GRADE (same for all Coniferous species)	**Fir/Pine/Larch**
Min. top diameter	16 cm *
Max. top diameter	36 cm
Min. log length	5 m
Min. lumber percentage	75%
Min. merchantable percentage	50%
Max. twist over 30 cm of length	10% of top diameter
***** Refer to grading procedure, item 6, Section 6.1 for variance to this diameter limit.	
Grade Requirements	
Knots	• 16 — 26 cm top diameter 4 cm • 28 — 36 cm top diameter 6 cm • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres.
Rot	Permitted provided 75% lumber is attained.

U GRADE (same for all Coniferous species)	**Fir/Pine/Larch**
Min. top diameter	10 cm *
Min. log length	5 m
Min. lumber percentage: – 10–14 cm top diameter – 16–36 cm top diameter – ≥ 38 cm top diameter	 75% $66\frac{2}{3}$% 50%
Min. merchantable percentage	35%
Max. twist over 30 cm of length	13%, Max. deviation 13 cm
***** Refer to grading procedure, item 6, Section 6.1 for variance to this diameter limit.	
Grade Requirements	
Knots	• 10–14 cm top diameter 4 cm • 16–26 cm top diameter 6 cm • 28–36 cm top diameter 8 cm • 38–48 cm top diameter 10 cm • 50–74 cm top diameter 12 cm • ≥ 76 cm top diameter 14 cm • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres
Rot	Permitted provided percentage lumber is attained.

X GRADE (same for all Coniferous species)	**Fir/Pine/Larch**
Min. top diameter	10 cm *
Min. log length	3 m
Min. lumber percentage	$33^1/_3$%
Min. merchantable percentage	35%
Max. twist over 30 cm of length	13% Max. deviation 13 cm
* Refer to grading procedure, item 6, Section 6.1 for variance to this diameter limit.	
Grade Requirements	
Knots	**Same as "U" Grade** • 10–14 cm top diameter 4 cm • 16–26 cm top diameter 6 cm • 28–36 cm top diameter 8 cm • 38–48 cm top diameter 10 cm • 50–74 cm top diameter 12 cm • ≥ 76 cm top diameter 14 cm • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres for logs < 50cm. • Logs ≥ 50 cm may have oversize knots up to a maximum of 2 per 3 m of log length
Rot	Permitted provided $33^1/_3$% lumber is attained.

Y GRADE (same for all Coniferous species)	**Fir/Pine/Larch**
Lower than X grade.	

Cedar Grades and Grade Requirements

Table 6.5 – Cedar Grades and Grade Requirements.

D GRADE		**Cedar**
Logs	Min. top diameter	60 cm
	Min. length	5 m
	Min. percentage lumber	
	• 60–118 cm top diameter	75%
	• ≥ 120 cm top diameter	66⅔%
	Min. percentage clear lumber	50%
	Max. twist over 30 cm of length	4%, Max. deviation 6 cm
Slabs	Min. top diameter	50 cm
	Min. thickness	38 cm
	Min. length	5 m
	Min. percentage lumber	75%
	Min. percentage clear lumber	50%
	Max. twist over 30 cm of length	4%, Max. deviation 6 cm
Grade Requirements		
Knots	• 60 – 74 cm top diameter, ≥ 75% surface clear*, with well spaced knots or knot indicators permitted on the upper 25% of two sides or on the upper 50% of one side of the log length only. • ≥ 76 cm top diameter, ≥ 66⅔% surface clear, with well spaced knots or knot indicators permitted on the upper 33⅓% of one side or on the upper 66⅔% of one side of the log length only.	
Rot	• Rot permitted provided percentage lumber is met.	
Misc.	• “D” quality logs with < 75% lumber OR if > 120 cm with less than 66⅔% lumber become “K” shingle	

F GRADE		Cedar
Logs	Min. top diameter	50 cm
	Min. length	5 m
	Min. percentage lumber	75%
	Min. percentage clear	25%
	Max. twist over 30 cm of length	4%, Max. deviation 6 cm
Slabs	Min. top diameter	50 cm
	Min. length	5 m
	Min. thickness	38 cm
	Min. percentage lumber	75%
	Min. percentage clear	25%
	Max. twist over 30 cm of length	4%, Max. deviation 6 cm
Grade Requirements		
Knots	• 50–58 cm top diameter, must be surface clear of knots or knot indicators. • 60–74 cm top diameter, 66⅔% surface clear with well spaced knots or knot indicators permitted on the upper 33⅓% of two sides or on the upper 66⅔% of one side of the log length only. • ≥ 76 cm top diameter, ≥ 50% surface clear with well spaced knots or knot indicators permitted on the upper 50% of two sides or on the upper 75% of one side of the log length only.	
Rot	• Permitted provided 75% lumber is attained.	
Misc.	• “F” quality logs with < 75% lumber become “L” shingle	

H GRADE	Cedar
Min. top diameter	38 cm
Min. length	5 m
Min. percentage lumber	75%
Min. percentage clear	65%
Max. twist over 30 cm of length	7%, Max. deviation 8 cm
Grade Requirements	
Knots	• 38–48 cm top diameter: – 4 cm knots over the entire log **OR** – 5 cm knots over the upper 50% of the log (with knots ≤ 2 cm in diameter permitted over the lower 50% of the log). • ≥ 50 cm top diameter: – 4 cm knots over the entire log **OR** – 5 cm knots over the upper 66⅔% of the log* **OR** – 8 cm knots over the upper 50% of the log* (*knots ≤ 2 cm in diameter permitted over the lower portion of the log). • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres.
Rot	• Rot permitted, provided 75% lumber is attained.
Misc.	• “H” quality logs with < 75% lumber become “M” shingle provided clear requirements can be met.

I GRADE	**Cedar**
Min. top diameter	38 cm
Min. log length 4 m – top diameter ≥ 38 cm **OR**	75% L 50% M
– Logs ≥ 10 m in length – top diameter ≥ 50 cm **OR**	50% L 50% M
– Logs ≥ 10 m in length – top diameter ≥ 38 cm	50% L 65% M
– Otherwise H Grade	
Max. twist over 30 cm of length	10%, Max. deviation 9 cm
Grade Requirements	
Knots	• 38–48 cm top diameter 8 cm • 50–74 cm top diameter 9 cm • ≥ 76 cm top diameter 10 cm • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres.
Rot	Permitted provided percentage lumber is attained.
Misc.	• "I" quality logs with < 75% lumber become "M" shingle provided clear requirements can be met.

J GRADE (same for all Coniferous species)	**Cedar**
Min. top diameter	16 cm*
Max. top diameter	36 cm
Min. log length	5 m
Min. lumber percentage	75%
Min. merchantable percentage	50%
Max. twist over 30 cm of length	10% of top diameter
*Refer to grading procedure, item 6, Section 6.1 for variance to this diameter limit.	
Grade Requirements	
Knots	• 16–26 cm top diameter 4 cm • 28–36 cm top diameter 6 cm • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres.
Rot	Permitted provided 75% lumber is attained.

K GRADE		**Cedar**
Logs	Min. top diameter	50 cm
	Min. log length	4 m
	Min. percentage shingle or shakes	50%
	Min. percentage clear shingle or shakes	75%
	Max. twist over 30 cm of length	4%, Max. deviation 6 cm
Slabs	Min. top diameter	50 cm
	Min. thickness	38 cm
	Min. log length	4 m
	Min. percentage shingle or shakes	50%
	Min. percentage clear shingle or shakes	75%
	Max. twist over 30 cm of length	4%, Max. deviation 6 cm
Grade Requirements		
Knots	• 50–58 cm top diameter, must be surface clear of knots or knot indicators. • 60–74 cm top diameter, ≥ 75% surface clear with knots or knot indicators permitted on the upper 25% of two sides or the upper 50% of one side of the log length only. • ≥ 76 cm top diameter, ≥ $66\frac{2}{3}$% surface clear with knots or knot indicators permitted on the upper $33\frac{1}{3}$% of two sides or the upper $66\frac{2}{3}$% of one side of the log length only.	
Rot	• Rot permitted provided 50% shingles or shake is attained.	
Note: D quality logs with < 75% lumber (≥ 120 cm top diameter with < $66\frac{2}{3}$ % lumber) become K shingle.		

L GRADE		**Cedar**
Logs	Min. top diameter	38 cm
	Min. log length	4 m
	Min. percentage shingle or shakes	50%
	Min. percentage clear shingle or shakes	50%
	Max. twist over 30 cm of length	7%, Max. deviation 8 cm
Slabs	Min. top diameter	38 cm
	Min. thickness	26 cm
	Min. log length	4 m
	Min. percentage shingle or shakes	50%
	Min. percentage clear shingle or shakes	50%
	Max. twist over 30 cm of length	7%, Max. deviation 8 cm
Grade Requirements		
Knots	• ≥ 50% surface clear, with knots permitted on the upper 50% of two sides or all of one side of the log length only.	
Rot	• Rot permitted provided 50% shingle or shakes is attained.	
Note: F quality logs with < 75% lumber become L shingle.		

M GRADE		**Cedar**
Logs	Min. top diameter	38 cm
	Min. log length	4 m
	Min. percentage shingles	50%
	Min. percentage clear shingles	25%
	Max. twist over 30 cm of length	7%, Max. deviation 8 cm
Slabs	Min. top diameter	26 cm
	Min. thickness	16 cm
	Min. log length	4 m
	Min. percentage shingles	50%
	Min. percentage clear shingles	25%
	Max. twist over 30 cm of length	7%, Max. deviation 8 cm
Grade Requirements		
Knots	• ≥ 25% surface clear.	
Rot	• Rot permitted provided 50% shingle or shakes is attained.	

U GRADE (same for all Coniferous species)		**Cedar**
Min. top diameter	10 cm*	
Min. log length	5 m	
Min. lumber percentage: – 10–14 cm top diameter – 16–36 cm top diameter – ≥ 38 cm top diameter	 75% 66⅔% 50%	
Min. merchantable percentage	35%	
Max. twist over 30 cm of length	13%, Max. deviation 13 cm	
*Refer to grading procedure, item 6, Section 6.1 for variance to this diameter limit.		
Grade Requirements		
Knots	• 10–14 cm top diameter 4 cm • 16–26 cm top diameter 6 cm	
	• 28–36 cm top diameter 8 cm • 38–48 cm top diameter 10 cm • 50–74 cm top diameter 12 cm • ≥ 76 cm top diameter 14 cm • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres	
Rot	Permitted provided percentage lumber is attained.	

X GRADE (same for all Coniferous species)	**Cedar**
Min. top diameter	10 cm*
Min. log length	3 m
Min. lumber percentage	33 1/3%
Min. merchantable percentage	35%
Max. twist over 30 cm of length	13%, Max. deviation 13 cm
*Refer to grading procedure, item 6, Section 6.1 for variance to this diameter limit.	
Grade Requirements	
Knots	• 10–14 cm top diameter 4 cm • 16–26 cm top diameter 6 cm • 28–36 cm top diameter 8 cm • 38–48 cm top diameter 10 cm • 50–74 cm top diameter 12 cm • 76 cm top diameter 14 cm • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres for logs < 50cm. • Logs ≥ 50 cm may have oversize knots up to a maximum of 2 per 3 m of log length
Rot	Permitted provided 33 1/3% lumber is attained.

Y GRADE (same for all Coniferous species)	**Cedar**
Lower than X grade.	

Hemlock/Balsam Grades and Grade Requirements

Table 6.6 – Hemlock/Balsam Grades and Grade Requirements.

D GRADE	**Hemlock/Balsam**
Min. top diameter	66 cm
Min. log length	5 m
Min. percentage lumber	75%
Min. percentage clear	50%
Max. twist over 30 cm of length	4%, Max. deviation 6 cm
Grade Requirements	
Knots	• 66–74 cm top diameter, must be 90% surface clear with well spaced knots or knot indicators permitted on the upper 10% of two sides or on the upper 20% of one side of the log length only. • ≥ 76 cm top diameter, must be 80% surface clear with well spaced knots or knot indicators permitted on the upper 20% of two sides or on the upper 40% of one side of the log length only.
Rot	• No conk permitted. • Rot permitted, provided 75% lumber is attained. Rot in balsam must be confined to centre 10% of log.

F GRADE	**Hemlock/Balsam**
Min. top diameter	50 cm
Min. log length	5 m
Min. percentage lumber	75%
Min. percentage clear lumber	25%
Max. twist over 30 cm of length	4%, Max. deviation 6 cm
Grade Requirements	
Knots	• 50–64 cm top diameter, must be 75% surface clear with knots or knot indicators permitted on the upper 25% of two sides or on the upper 50% of one side of the log length only. • Logs ≥ 66 cm top diameter, must be 50% surface clear with knots or knot indicators permitted on the upper 50% of two sides or on the upper 75% of one side of the log length only.
Rot	• No conk or blind conk permitted. • Rot permitted, provided 75% lumber is attained.

H GRADE	**Hemlock/Balsam**
Min. top diameter	38 cm
Min. log length	5 m
Logs ≥ 38 cm top diameter	75% lumber 65% merchantable
Logs ≥ 50 cm top diameter Former “D” or “F” grade	50% lumber 25% clear
Max. twist over 30 cm of length	7%, Max. deviation 8 cm
Grade Requirements	
Knots	• 38–48 cm top diameter: – 4 cm knots over the entire log **OR** – 5 cm knots over the upper 50% of the log (with knots ≤ 2 cm in diameter permitted over the lower 50% of the log). • ≥ 50 cm top diameter: – 4 cm knots over the entire log OR – 5 cm knots over the upper $66\frac{2}{3}$% of the log* OR – 8 cm knots over the upper 50% of the log* (* knots ≤ 2 cm in diameter permitted over the lower portion of the log). • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres.
Rot	• Permitted, provided 75% lumber is attained.

I GRADE	**Hemlock/Balsam**
Min. top diameter	38 cm
Min. log length	4 m
Logs ≥ 38 cm top diameter	75% lumber 50% merchantable
Logs ≥ 38 cm top diameter (former H grade)	≥ 50% lumber ≥ 65% merchantable
Max. twist over 30 cm of length	10%, Max. deviation 9 cm
Grade Requirements	
Knots	• 38–48 cm top diameter 8 cm • 50- 74 cm top diameter 9 cm • ≥ 76 cm top diameter 10 cm • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres.
Rot	• Permitted, provided percentage lumber is attained.

J GRADE (same for all Coniferous species)	**Hemlock/Balsam**
Min. top diameter	16 cm*
Max. top diameter	36 cm
Min. log length	5 m
Min. lumber percentage	75%
Min. merchantable percentage	50%
Max. twist over 30 cm of length	10% of top diameter
*Refer to grading procedure, item 6, Section 6.1 for variance to this diameter limit.	
Grade Requirements	
Knots	• 16–26 cm top diameter 4 cm • 28–36 cm top diameter 6 cm • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres.
Rot	• Permitted, provided 75% lumber is attained.

U GRADE (same for all Coniferous species)	**Hemlock/Balsam**
Min. top diameter	10 cm*
Min. log length	5 m
Min. lumber percentage: – 10–14 cm top diameter – 16–36 cm top diameter – ≥ 38 cm top diameter	 75% $66\frac{2}{3}$% 50%
Min. merchantable percentage	35%
Max. twist over 30 cm of length	13%, Max. deviation 13 cm
*Refer to grading procedure, item 6, Section 6.1 for variance to this diameter limit.	
Grade Requirements	
Knots	• 10–14 cm top diameter 4 cm • 16–26 cm top diameter 6 cm • 28–36 cm top diameter 8 cm • 38–48 cm top diameter 10 cm • 50–74 cm top diameter 12 cm • ≥ 76 cm top diameter 14 cm • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres
Rot	• Permitted, provided percentage lumber is attained.

X GRADE (same for all Coniferous species)	**Hemlock/Balsam**
Min. top diameter	10 cm*
Min. log length	3 m
Min. lumber percentage	$33\frac{1}{3}$%
Min. merchantable percentage	35%
Max. twist over 30 cm of length	13%, Max. deviation 13 cm
*Refer to grading procedure, item 6, Section 6.1 for variance to this diameter limit.	
Grade Requirements	
• Knots	• 10–14 cm top diameter 4 cm • 16–26 cm top diameter 6 cm • 28–36 cm top diameter 8 cm • 38–48 cm top diameter 10 cm • 50–74 cm top diameter 12 cm • ≥ 76 cm top diameter 14 cm • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres for logs < 50cm. • Logs ≥ 50 cm may have oversize knots up to a maximum of 2 per 3 m of log length
Rot	• Permitted, provided $33\frac{1}{3}$% lumber is attained.

Y GRADE* (same for all Coniferous species)	**Hemlock/Balsam**
Lower than X grade.	

Spruce Grades and Grade Requirements

Table 6.7 – Spruce Grades and Grade Requirements.

F GRADE	**Spruce**
Min. top diameter	76 cm
Min. log length	4 m
Min. percentage lumber	75%
Min. percentage clear lumber	50%
Max. twist over 30 cm of length	4%, Max. deviation 6 cm
Grade Requirements	
Knots	• Must be 90% surface clear with well spaced knots or knot indicators permitted on the upper 10% of two sides or on the upper 20% of one side of that log length only.
Rot	• No conk permitted. • Insect holes must not penetrate beyond the sapwood. • Permitted provided 75% lumber is attained.

G GRADE	**Spruce**
Min. top diameter	60 cm
Min. log length	4 m
Min. percentage lumber	75%
Min. percentage clear lumber	25%
Max. twist over 30 cm of length	4%, Max. deviation 6 cm
Grade Requirements	
Knots	• 60–74 cm top diameter, must be 75% surface clear with well spaced knots or knot indicators permitted on the upper 25% of two sides or on the upper 50% of one side of the log length only. • ≥ 76 cm top diameter: – must be 50% surface clear with well spaced knots or knot indicators permitted on the upper 50% of two sides or on the upper 75% of one side of the log length only **OR** – with whorls of large knots spaced so that 75% of the log can be cut into clear 2.6 m lengths. • ≥ 100 cm top diameter with whorls of large knots spaced so that 50% of the log can be cut into clear 2.6 m lengths.
Rot	• No conk rot permitted. • Insect holes must not penetrate beyond the sapwood. • Rot permitted if 75% lumber is attained.

H GRADE	**Spruce**
Min. top diameter	38 cm
Min. log length	4 m
Logs ≥ 38 cm top diameter	≥ 75% Lumber ≥ 65% merchantable
Logs ≥ 60 cm top diameter (former "F or G" grade)	≥ 50% lumber ≥ 25% clear
Max. twist over 30 cm of length	7%, Max. deviation 8 cm
Grade Requirements	
Knots	• 38–48 cm top diameter: – 4 cm knots over the entire log **OR** – 5 cm knots over the upper 50% of the log (with knots ≤ 2 cm in diameter permitted over the lower 50% of the log). • ≥ 50 cm top diameter: – 4 cm knots over the entire log **OR** – 5 cm knots over the upper $66\frac{2}{3}$% of the log* **OR** – 8 cm knots over the upper 50% of the log* (*knots ≤ 2 cm in diameter permitted over the lower portion of the log). • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres.
Rot	• Insect holes must not penetrate beyond the sapwood. • Permitted, provided percentage lumber is attained.

I GRADE	**Spruce**
Min. top diameter	38 cm
Min. log length	4 m
Logs ≥ 38 cm top diameter	≥ 75% Lumber ≥ 50% merchantable
Logs ≥ 38 cm top diameter (former "H" grade)	≥ 50% lumber ≥ 65% merchantable
Logs ≥ 50 cm top diameter	≥ 50% lumber ≥ 50% merchantable
Max. twist over 30 cm of length	10%, Max. deviation 9 cm
Grade Requirements	
Knots	• 38–48 cm top diameter 8 cm • 50–74 cm top diameter 9 cm • 76–98 cm top diameter 10 cm • ≥ 100 cm top diameter 13 cm • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres.
Rot	• Permitted, provided percentage lumber is attained.

J GRADE (same for all Coniferous species)	**Spruce**
Min. top diameter	16 cm*
Max. top diameter	36 cm
Min. log length	4 m
Min. percentage lumber	75%
Min. percentage merchantable	50%
Max. twist over 30 cm of length	10%
*Refer to grading procedure, item 6, Section 6.1 for variance to this diameter limit.	
Grade Requirements	
Knots	• 16–26 cm top diameter 4 cm • 28–36 cm top diameter 6 cm • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres.
Rot	• Permitted, provided 75% lumber is attained.

U GRADE (same for all Coniferous species)	**Spruce**
Min. top diameter	10 cm*
Min. log length	5 m
Min. lumber percentage: – 10–14 cm top diameter – 16–36 cm top diameter – ≥ 38 cm top diameter	 75% 66⅔% 50%
Min. merchantable percentage	35%
Max. twist over 30 cm of length	13%, Max. deviation 13 cm
*Refer to grading procedure, item 6, Section 6.1 for variance to this diameter limit.	
Grade Requirements	
Knots	• 10–14 cm top diameter 4 cm • 16–26 cm top diameter 6 cm • 28–36 cm top diameter 8 cm • 38–48 cm top diameter 10 cm • 50–74 cm top diameter 12 cm • ≥ 76 cm top diameter 14 cm • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres
Rot	• Permitted, provided percentage lumber is attained.

X GRADE (same for all Coniferous species)	**Spruce**
Min. top diameter	10 cm*
Min. log length	3 m
Min. lumber percentage	33⅓%
Min. merchantable percentage	35%
Max. twist over 30 cm of length	13%, Max. deviation 13 cm
*Refer to grading procedure, item 6, Section 6.1 for variance to this diameter limit.	
Grade Requirements	
Knots	• 10–14 cm top diameter 4 cm • 16–26 cm top diameter 6 cm • 28–36 cm top diameter 8 cm • 38–48 cm top diameter 10 cm • 50–74 cm top diameter 12 cm • 76–98 cm top diameter 14 cm • ≥ 100 cm top diameter 16 cm • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres for logs < 50cm. • Logs ≥ 50 cm may have oversize knots up to a maximum of 2 per 3 m of log length
Rot	• Permitted, provided 33⅓ % lumber is attained.

Y GRADE (same for all Coniferous species)	**Spruce**
Lower than X grade.	

Cypress/Yew Grades and Grade Requirements

Table 6.8 – Cypress/Yew Grades and Grade Requirements.

D GRADE	**Cypress/Yew**
Min. top diameter	60 cm
Min. log length	4 m
Min. percentage lumber	75%
Min. percentage clear lumber	50%
Max. twist over 30 cm of length	4%, Max. deviation 6 cm
Grade Requirements	
Knots	• 60–74 cm top diameter, ≥ 75% surface clear with knots or knot indicators permitted on the upper 25% of two sides or the upper 50% of one side of the log length only. • ≥ 76 cm top diameter, ≥ $66\frac{2}{3}$% surface clear with knots or knot indicators permitted on the upper $33\frac{1}{3}$% of two sides or the upper $66\frac{2}{3}$% of one side of the log length only.
Rot	• Permitted, provided 75% lumber is attained.

F GRADE	**Cypress/Yew**
Min. top diameter	50 cm
Logs ≥ 50 cm top diameter – Min. Log Length – Min. percentage lumber – Min. percentage clear lumber	 4 m 75% 25%
Logs ≥ 60 m top diameter (former “D” grade) – Min. Log Length – Min. percentage lumber – Min. percentage clear lumber	 6 m 50% 50%
Max. twist over 30 cm of length	4%, Max. deviation 6 cm
Grade Requirements	
Knots	• 50–58 cm top diameter, ≥ 75% surface clear with knots or knot indicators permitted on the upper 25% of two sides or the upper 50% of one side of the log length only. • ≥ 60 cm top diameter, ≥ 50% surface clear with knots or knot indicators permitted on the upper 50% of two sides or the upper 75% of one side of the log length only.
Rot	• Permitted, provided percentage lumber is attained.

H GRADE		**Cypress/Yew**
Min. top diameter		38 cm
Min. length		4 m
Min. percentage lumber		50%
Min. percentage merchantable		65%
Max. twist over 30 cm of length		7%, Max. deviation 8 cm
Grade Requirements		
Knots	• 38–48 cm top diameter: – 4 cm knots over the entire log **OR** – 5 cm knots over the upper 50% of the log, with knots ≤ 2 cm in diameter permitted over the lower 50% of the log. • ≥ 50 cm top diameter: – 4 cm knots over the entire log **OR** – 5 cm knots over the upper $66\frac{2}{3}$% of the log* **OR** – 8 cm knots over the upper 50% of the log* (*knots ≤ 2 cm in diameter permitted over the lower portion of the log). • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres.	
Rot	• Permitted, provided 50% lumber is attained.	

I GRADE		**Cypress/Yew**
Min. top diameter		38 cm
Min. log length		4 m
Min. percentage lumber		50%
Min. percentage merchantable		50%
Max. twist over 30 cm of length		10%, Max. deviation 9 cm
Grade Requirements		
Knots	• 38–48 cm top diameter 8 cm • 50–74 cm top diameter 9 cm • ≥ 76 cm top diameter 10 cm • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres.	
Rot	• Permitted provided 50% lumber is attained.	

J GRADE (same for all Coniferous species)	**Cypress/Yew**
Min. top diameter	16 cm*
Max. top diameter	36 cm
Min. log length	4 m
Min. percentage lumber	75%
Min. percentage merchantable	50%
Max. twist over 30 cm of length	10%
*Refer to grading procedure, item 6, Section 6.1 for variance to this diameter limit.	
Grade Requirements	
Knots	• 16–26 cm top diameter 4 cm • 28–36 cm top diameter 6 cm • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres.
Rot	• Permitted, provided 75% lumber is attained.

U GRADE (same for all Coniferous species)	**Cypress/Yew**
Min. top diameter	10 cm*
Min. log length	5 m
Min. lumber percentage: – 10–14 cm top diameter – 16–36 cm top diameter – ≥ 38 cm top diameter	 75% 66⅔% 50%
Min. merchantable percentage	35%
Max. twist over 30 cm of length	13%, Max. deviation 13 cm
*Refer to grading procedure, item 6, Section 6.1 for variance to this diameter limit.	
Grade Requirements	
Knots	• 10–14 cm top diameter 4 cm • 16–26 cm top diameter 6 cm • 28–36 cm top diameter 8 cm • 38–48 cm top diameter 10 cm • 50–74 cm top diameter 12 cm • ≥ 76 cm top diameter 14 cm • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres
Rot	• Permitted, provided percentage lumber is attained.

X GRADE (same for all Coniferous species)		**Cypress/Yew**
Min. top diameter		10 cm*
Min. log length		3 m
Min. lumber percentage		$33\frac{1}{3}$%
Min. merchantable percentage		35%
Max. twist over 30 cm of length		13%, Max. deviation 13 cm
*Refer to grading procedure, item 6, Section 6.1 for variance to this diameter limit.		
Grade Requirements		
Knots	• 10–14 cm top diameter 4 cm • 16–26 cm top diameter 6 cm • 28–36 cm top diameter 8 cm • 38–48 cm top diameter 10 cm • 50–74 cm top diameter 12 cm • ≥ 76 cm top diameter 14 cm • Logs ≥ 50 cm may have oversize knots up to a maximum of 2 per 3 m of log length. • Occasional larger knots (OLKs) are permitted, to 1 per 3 metres for logs < 50cm. • Logs ≥ 50 cm may have oversize knots up to a maximum of 2 per 3 m of log length	
Rot	• Permitted, provided percentage lumber is attained.	

Y GRADE (same for all Coniferous species)	**Cypress/Yew**
Lower than X grade.	

Deciduous Grades and Grade Requirements

Table 6.9 – Deciduous Grades and Grade Requirements.

C GRADE (ACT - Cottonwood only)		**Deciduous**
Min. top diameter		25 cm
Min. log length		5 m
Min. percentage veneer		80%
Max. twist over 30 cm of length		7%, Max. deviation 8 cm
Grade Requirements		
Knots	• No knots over 4 cm in diameter are permitted. • Knots < 4 cm in diameter must be well spaced.	
Rot	• No conk allowed. • No butt rot allowed. • No butt rot in adjacent log permitted	
Misc.	• No sweep permitted. • No crook permitted.	

I GRADE		**Deciduous**
Min. top diameter		25 cm
Min. log length		5 m
Min. percentage lumber		50%
Min. percentage merchantable		50%
Max. twist over 30 cm of length		10%, Max. deviation 9 cm
Grade Requirements		
Knots	• 25–36 cm top diameter 4 cm • 38–48 cm top diameter 8 cm • ≥ 50 cm top diameter 9 cm	
Rot	• Permitted provided 50% lumber is attained.	

U GRADE		**Deciduous**
Min. top diameter		10 cm*
Min. log length		5 m
Logs 10–14 cm top diameter 16–24 cm top diameter ≥ 25 cm top diameter		75% Lumber 66% Lumber 50% Lumber
Min. merchantable percentage		35%
Max. twist over 30 cm of length		13%, Max. deviation 13 cm
* Refer to grading procedure, item 6, Section 6.1 for variance to this diameter limit.		
Grade Requirements		
Knots	• 10–14 cm top diameter • 16–24 cm top diameter • 25–36 cm top diameter • 38–48 cm top diameter • ≥ 50 cm top diameter	4 cm 6 cm 8 cm 10 cm 12 cm
Rot	• Permitted, provided percentage lumber is attained.	

Y GRADE	**Deciduous**
Lower than X grade.	

6.4 Summary of Log Grades by Species

Table 6.10 – Fir/Pine/Larch log grade summary.

Grade	Min. Length (m)	Min. Top DIB (cm)	Min. Top DIB Knots	Knots max DIB	Min. Scale	Defects	Twist
D Lumber	5 m	76	76+	90% surface clear	75% L 50% CL	no conk, blind conk or rotten branches	4% (6 cm)
F Lumber	5 m	60	60-74	75% surface clear	75% L 25% CL	no conk, blind conk or rotten branches	4% (6 cm)
			76+	50% surface clear			
B* Peeler	5 m	60	60-74	2.6 m butt block is clear	80% V	no conk, blind conk or butt rot	7% (8 cm)
			76+	2.6 m butt block knot indicators allowed		no butt rot in adjacent log	
C* Peeler	5 m	38	38+	4 cm Maximum	80% V	no conk, blind conk or butt rot no butt rot in adjacent log	7% (8 cm)
H** Sawlog	5 m	38	38-48	4 cm **or** — 5 cm top half (rem. 2 cm max.)	75% L 65% M		7% (8 cm)
			50+	4 cm **or** — 5 cm top 2/3 (rem. 2 cm max.) **or** — 8 cm top half (rem. 2 cm max.)	50% L 65% M		
I** Sawlog	4 m	38	38-48	8 cm	75% L 50% M	or former H 50% L 65% M	10% (9 cm)
			50-74	9 cm	50% L 50% M		
			76+	10 cm			

**** Fir only   ** Occasional larger knots (OLKs) 1 per 3 m***

L = Lumber   CL = Clear   M = Merchantable   V = Veneer

Table 6.11 – Cedar log grade summary.

Grade	Min. Length (m)	Min. Top DIB (cm)	Min. Top DIB Knots	Knots max DIB	Min. Scale	Defects	Twist
D	5 m	60	60-74	75% surface clear	75% L		4%
			76-118	66% surface clear	50% CL		(6 cm)
			120+	66% surface clear	66% L 50% CL		
F	5 m	50	50-58	100% surface clear	75% L		4%
			60-74	66% surface clear	25% CL		(6 cm)
			76+	50% surface clear			
H ***	5 m	38	38-48	4 cm **or** — 5 cm top half (rem. 2 cm max.)	75% L 65% M		7% (8 cm)
			50+	4 cm **or** — 5 cm top 2/3 (rem. 2 cm max.) **or** — 8 cm top half (rem. 2 cm max.)			
I ***	4 m	38	38-48	8 cm	75% L 50% M	or former H 50% L 65% M	10% (9 cm)
			50-74	9 cm	50% L/50% M		
			76+	10 cm	50% L/65% M		
K	4 m	50	50-58	100% surface clear	50% SS*****	slabs >38cm thick	4%
former			60-74	75% surface clear	75% CL		(6 cm)
D			76+	66% surface clear			
L former F	4 m	38	38+	50% surface clear	50% SS 50% CL	slabs > 26 cm thick	7% (8 cm)
M	4 m	38	38+	25% surface clear	50% S****** 25% CL	slabs >16 cm thick	7% (8 cm)

*****SS = shingles or shakes ******S = shingles only *** OLK = 1 per 3 m

Table 6.12 – Hemlock/Balsam log grade summary.

Grade	Min. Length (m)	Min. Top DIB (cm)	Min. Top DIB Knots	Knots max DIB	Min. Scale	Defects	Twist
D lumber	5 m	66	66-74	90% surface clear	75% L 50% CL	no conk, blind conk or rotten branches	4% (6 cm)
			76+	80% surface clear			
F lumber	5 m	50	50-64	75% surface clear	75% L 25% CL	no conk, blind conk, or rotten branches	4% (6 cm)
			66+	50% surface clear			
H sawlog *	5 m	38	38-48	4 cm **or** — 5 cm top half (rem. 2 cm max.)	75% L 65% M		7% (8 cm)
			50+	4 cm **or** — 5 cm top 2/3 (rem. 2 cm max.) **or** — 8 cm top half (rem. 2 cm max.)		or former D,F 50% M 25% CL	
I sawlog*	4 m	38	38-48	8 cm	75% L 50% M	or former H 50% L 65% M	10% (9 cm)
			50-74	9 cm			
			76+	10 cm			
** OLK = 1 per 3 m*							

Table 6.13 – Spruce log grade summary.

Grade	Min. Length (m)	Min. Top DIB Grade (cm)	Min. Top DIB Knots	Knots max DIB	Min. Scale	Defects	Twist
F lumber	4 m	76	76+	90% surface clear	75% L 50% CL	no conk	4% (6 cm)
G lumber	4 m	60	60-74	75% surface clear	75% L 25%CL	no conk	4% (6 cm)
			76-98	50% surface clear or 2.6 m clear sections over 75% of the log			
			100+	50% surface clear or 2.6 m clear sections over 50% of the log			
H sawlog *	4 m	38	38-48	4 cm **or** — 5 cm top half (rem. 2 cm max.)	75% L 65% M		7% (8 cm)
			50+	4 cm **or** — 5 cm top 2/3 (rem. 2 cm max.) **or** — 8 cm top half (rem. 2 cm max.)			
			60+			or former F, G 50% L 25% CL	
I sawlog *	4 m	38	38-48	8 cm	75% L 50% M	**or** former H 50% L 65% M	10% (9 cm)
			50-74	9 cm	50% L 50% M		
			76-98	10 cm			
			100+	13 cm			

** OLK = 1 per 3 m*

Table 6.14 – Cypress/Yew log grade summary.

Grade	Min. Length (m)	Min. Top DIB (cm)	Min. Top DIB Knots	Knots max DIB	Min. Scale	Defects	Twist
D	4 m	60	60-74	75% surface clear	75% L		4%
lumber			76+	66% surface clear	50% CL		(6 cm)
F	4 m	50	50-58	75% surface clear	75% L 25% CL		4%
lumber			60+	50% surface clear		or former D (6m) 50% L 50% CL	(6 cm)
H sawlog	4 m	38	38-48	4 cm or 5 cm top half (rem. 2 cm max.)	50% L 65% M		7% (8 cm)
*			50+	4 cm or 5 cm top 2/3 (rem. 2 cm max.) or 8 cm top half (rem. 2 cm max.)			
I	4 m	38	38-48	8 cm	50% L		10%
sawlog			50-74	9 cm	50% M		(9 cm)
*			76+	10 cm			
** OLK = 1 per 3 m*							

Table 6.15 – Coniferous Common Grades log grade summary.

<table>
<tr><th>Grade</th><th>Min. Length (m)</th><th>Min. Top DIB Grade (cm)</th><th>Min. Top DIB Knots</th><th>Knots max DIB</th><th>Min. Scale</th><th>Defects</th><th>Twist</th></tr>
<tr><td>J† sawlog</td><td>5 m*</td><td>16-36**</td><td>16-26
28-36</td><td>4 cm
6 cm</td><td>75% L
50% M</td><td></td><td>10%</td></tr>
<tr><td rowspan="6">U utility ****</td><td rowspan="6">5 m</td><td rowspan="6">10</td><td>10-14</td><td>4 cm</td><td>75% L
35% M</td><td rowspan="6"></td><td rowspan="6">13% (13 cm)</td></tr>
<tr><td>16-26</td><td>6 cm</td><td rowspan="2">66% L
35% M</td></tr>
<tr><td>28-36</td><td>8 cm</td></tr>
<tr><td>38-48</td><td>10 cm</td><td rowspan="3">50% L
35% M</td></tr>
<tr><td>50-74</td><td>12 cm</td></tr>
<tr><td>76+</td><td>14 cm</td></tr>
<tr><td rowspan="6">X utility ****</td><td rowspan="6">3 m</td><td rowspan="6">10</td><td>10-14</td><td>4 cm</td><td rowspan="6">33% L
35% M</td><td rowspan="4"></td><td rowspan="6">13% (13 cm)</td></tr>
<tr><td>16-26</td><td>6 cm</td></tr>
<tr><td>28-36</td><td>8 cm</td></tr>
<tr><td>38-48</td><td>10 cm</td></tr>
<tr><td>50-74</td><td>12 cm</td><td rowspan="2">2 oversized per 3 m</td></tr>
<tr><td>76+</td><td>14 cm</td></tr>
<tr><td>Y chipper</td><td>1 m</td><td>***</td><td colspan="5">Logs lower in grade than “X”</td></tr>
<tr><td>N Missing</td><td></td><td>***</td><td colspan="5">On Broken Top tree missing portion graded as N-99-00</td></tr>
<tr><td colspan="8">*Note Spruce & Cypress 4 m ** Maximum top diameter 36 cm *** No minimum diameter ****OLK 1 per 3m</td></tr>
</table>

Table 6.16 – Deciduous Species log grade summary.

Grade	Min. Length (m)	Min. Top DIB Grade (cm)	Min. Top DIB Knots	Knots max DIB	Min. Scale	Defects	Twist
C* peeler	5 m	25	25+	4 cm	80% V	no conk or butt rot no butt rot in adjacent log	7% (8 cm)
I sawlog	5 m	25	25-36	4 cm	50% L 50% M		10% (9 cm)
			38-48	8 cm			
			50+	9 cm			
U utility	5 m	10+	10-14	4 cm	75% L 35% M		13% (13 cm)
			16-24	6 cm	66% L 35% M		
			25-36	8 cm	50% L 35% M		
			38-48	10 cm			
			50+	12 cm			
Y chipper	1 m		Logs lower in grade than "U"				
N Missing		***	On Broken Top tree missing portion graded as N-99-00				

*** Cottonwood only** ***** No minimum diameter**

7. Plants, Soils, and Old Growth

Introduction

The data collected in this section of the inventory will be used in a variety of ways:

- To provide data for management and research applications, such as enhancement of the provincial ecological classification system, particularly in previously undescribed ecosystems and managed successionally younger ecosystems.
- To generate vegetation lists, including species codes and percentage cover values, and to assist in wildlife management and resource planning.
- To build a database that will permit different users to track floristic changes over time, in different regions, and in a variety of biogeoclimatic zones or subzones.
- To assist in the calculation of total ecosystem carbon.

Objectives

- To establish a network of sample plots that can be located and re-sampled in the future.
- To collect accurate information about plant species composition CMI sample plots.
- To identify, estimate, and measure selected soil and site features to provide a record of conditions at CMI sample plot locations.
- To determine the successional characteristics of the stand.
- To classify CMI sample plots using the biogeoclimatic ecosystem classification system, the British Columbia Land Cover Classification Scheme, and to identify the site series.
- To describe forested as well as non-forested ecosystems.

General Procedures

The following is a recommended sequence of steps in collecting the ecological measurements (steps 3 and 4 may be interchanged):

1. Establish the 10 m fixed-radius plot and the 5.64 m sub-plot.
2. Describe vegetation in the 5.64 m and 10 m fixed-radius plots before the soil pit is dug and the site is trampled too much.
3. Record the site and soil description.
4. Sample the coarse woody debris transects (Cards EW and EC) discussed in Section 8. CWD sampling can provide insights into successional processes and recent stand history on sampled sites.
5. Interpret the successional characteristics of the stand. Refer to other data collected to make successional interpretations.

Field Cards for this Section

Ecological Description 1 (EP) (Appendix A, Figures A.14 & A. 15)
Site classification, site features, soil features, soil description for pin location and summary information

Ecological Description 2 (ED) (Appendix A, Figures A.16 & A.17)
As above, for when plot centre not in dominant site

Tree and Shrub Layers (ET) (Appendix A, Figures A.18 and A.19)
Species, and cover by species and for seedlings

Herb and Moss Layers (EH) (Appendix A, Figures A.20 and A.21)
Species, and cover by species and substratum

Succession Interpretations (EO) (Appendix A, Figures A.22 and A.23)
Factors influencing vegetation establishment, tree species succession, stand structure features, structural stages, old growth assessment

Detailed Procedures

7.1 Establishing Plots

The main ecological plot is 10 m radius (314 m^2), centered on the Integrated Plot Centre. It is used to collect vegetation data from the tree and shrub layers, and for site description, soil, and site classification.

The nested subplot is 5.64 m radius (100 m^2), also centered on the Integrated Plot Centre. It is used to sample vegetation in the herb and moss layers, and tree seedlings.

In order to evaluate slope gradient, aspect, meso slope position, succession interpretations, and a number of other attributes it is necessary to look beyond the 10 m main ecological plot to an approximate radius of 25 m around the Integrated Plot Centre, depending on the attribute, site variability, and topographic breaks.

The inventory sampling method does not allow movement of the ecological plot to more "typical" or homogeneous portions of the area as this would introduce sampling bias. Some plots may therefore contain more than one site series. This may lead to difficulties with secondary applications of the data such as ecological classification.

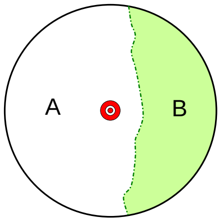
To address this concern, field crews will assess the ecological variability (uniformity) of the plot and estimate the relative proportions of component site series and/or land cover classes comprising a plot. If the Integrated Plot Centre does not fall in the dominant site series (within the 10 m plot), then additional soil and site data are needed for the dominant site series.

Procedure

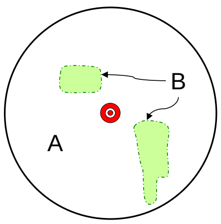
Measure the 10 m and 5.64 m plots and flag at appropriate intervals around the circumferences of the plots to demarcate plot boundaries. For detailed procedures, see Section 3: Plot Establishment.

7.2 Assessing Ecological Variability

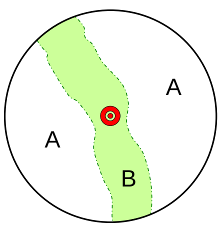
1. Assess the ecological variability within the integrated plot. If more than one site series occurs, identify the dominant site series (occupying the greatest proportion of the plot) and determine whether the plot centre falls within this site series. The dominant site can occur as discontinuous patches or as one contiguous area in the plot.
2. If the plot centre falls within the dominant site series, record only one site series and soil description (Field Card EP).
3. If the plot centre is not in the dominant site series, record the site features of the plot centre on Field Card EP, and a second set of soil and site features for the dominant site on Field Card ED.
4. Record the percentage cover of site series and land cover class, or land cover alone if site series does not apply.
5. Figure 7.1 illustrates some situations that may be encountered. Note that only one plant list is done for the entire plot, in all cases.



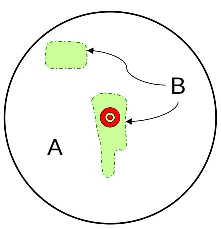
- <u>Example 1:</u> plot centre is in dominant site series (A)
- complete one site and soil description at plot centre
- complete EP card for A only.



- <u>Example 2:</u> plot centre is in dominant site series (A); subdominant (B) is discontinuous
- complete one site and soil description at plot centre
- complete the EP card for A only.



- <u>Example 3:</u> plot centre is subdominant site series (B)
- complete one site and soil description at plot centre
- complete **another** site/soil description within dominant site (A)
- complete ED card for A and EP card for B.



- <u>Example 4:</u> plot centre is in subdominant (B), but site series is discontinuous
- complete one site and soil description at plot centre
- complete **another** site/soil description at dominant site (A)
- complete ED card for A and EP card for B.

Figure 7.1 - Assessing uniformity and attributes in areas with ecological variability within the 10 m fixed-radius plot.

7.3 Identifying and Recording Site and Soil Features

The following classifications are based on all the observations taken in this section. Record your observations on the field cards in the numbered areas indicated for each observation.

A. Site Classification

1. Uniformity

Record the uniformity of the plot using the five-class scale shown in Table 7.1.

Table 7.1 – Plot uniformity codes.

Code	Description
1 — (uniform)	> 98% of plot in one homogeneous* ecosystem or site series
2	> 90%–98% of plot in one homogeneous* ecosystem or site series; the remainder in other ecosystems**
3	> 70%–90% of plot in one homogeneous* ecosystem or site series; the remainder in other ecosystems**
4	> 50%–70% of plot in one homogeneous* ecosystem or site series; the remainder in other ecosystems**
5 — (variable)	50% or less of plot is the largest homogeneous* ecosystem or site series

* *Homogeneous* means the same site series and structural stage.

** *Other ecosystems* include different successional and structural stages (for example, major structural differences beyond that of understorey vegetation associated with smaller canopy gaps due to mortality of 1-3 trees) as well as different sites (different site series, or inclusions of avalanche tracks, streams, gullies, rock outcrops, roads).

2. Biogeoclimatic Unit

Record the biogeoclimatic unit as determined on the ground. This includes zone, subzone, variant, and phases (if applicable).

Note: Biogeoclimatic phases have not been defined for all variants. An example of a phase is the ICH mc1a (ICH Zone, Moist Cold Subzone, Nass Variant, Amabilis Fir Phase) as described in Chapter 5 page 116 of the *Field Guide to Site Identification for the Prince Rupert Forest Region*.

For a concise introduction to biogeoclimatic and site unit terminology see *Ecosystems of British Columbia* (Meidinger and Pojar 1991).

A digital copy of valid codes for "Biogeoclimatic Unit" and "Site Series and Coverage" is available (boxes 2 and 3 on the EP12 card). This complete list of BEC Zones, Subzones, Variants, Phases and matching Site Series is available from the MoF Research Branch website. It is called **BECdb.mdb**. Currently it is only available as a relational database file (MS Access 97). To obtain a copy, go to the following website:

http://www.for.gov.bc.ca/HRE/becweb/resources/codes-standards/index.html

These are the official provincial codes from Research Branch. MoF Research Branch is the data custodian of the BEC and Site Series information.

3. Site Series and Coverage

As clarified by Klinka et al. (1989), *Indicator Plants of Coastal British Columbia*, site series identification is aided by indicator plants, even when their cover and vigour are low and their presence is sporadic. Although, the CMI ecological methodology does suggest you do not need to record genera or species with less than 1% coverage, this does not imply that such plants should be ignored when doing site series identification.

1. Identify the site series at the plot centre and up to 2 other sites within the 10 m radius plot.
2. Enter the three-character site series/phase code from the appropriate MFLNRO regional field guide to site identification and interpretation.
3. If the plot occurs on an ecosystem not recognized in the ecological classification, record the soil moisture regime (SMR) and soil nutrient regime (SNR). If these values cannot be estimated (for example, roads, gravel pits, boulder fields), record “site series #” as 99_ and in the SMR and SNR columns record a dash (–).
4. Estimate the coverage of each site series as a percentage of the 10 m plot, to a maximum of 100% if there is only one site series.

Note: Second and third site series or land cover classes covering less than 5% (16 m^2) are considered too small to recognize.

4. Soil Moisture Regime

Relative Soil Moisture Regime (**SMR**) refers to the average annual amount of soil water available to plants, relative to a given biogeoclimatic subzone variant. This attribute is particularly valuable when the site series is not defined.

1. Record SMR for the plot centre and up to two other sites.
2. The SMR classes, given in Table 7.2, are inferred from the physiographic and soil features described. (A more complete description and keys are in the relevant regional field guide and in *Describing Ecosystems In The Field*, Luttmerding et al. 1990.)

Table 7.2– Relative Soil Moisture Regime codes.

Code	Description
0	very xeric **(very dry)**
1	xeric
2	subxeric
3	submesic
4	mesic
5	subhygric
6	hygric
7	subhydric **(very wet)**
8	hydric (certain wetland ecosystems and persistent standing water)

5. Soil Nutrient Regime

Soil Nutrient Regime (**SNR**) refers to the amount of essential soil nutrients, particularly nitrogen, available to plants. This attribute is particularly useful when the site series cannot be determined in other ways.

1. Record SNR for the plot centre and up to two other sites.
2. The SNR classes, given in Table 7.3, are inferred from the physiographic and soil features described. (A more complete description and keys are in the relevant regional field guide and in *Describing Ecosystems In The Field,* Luttmerding et al. 1990.)

Table 7.3 – Soil Nutrient Regime codes.

Code	**Description**
A	very poor
B	poor
C	medium
D	rich
E	very rich
F	ultra rich or saline (rarely used, but may be encountered)

6. Land Cover Classification

Please refer to Appendix G for a description of the land cover levels and simplified flow charts.

1. Record the land cover class to the appropriate level.
2. Record up to three separate land cover designations if necessary, corresponding on a one-to-one basis with up to three site series designations (in a highly variable 10 m radius plot).
3. If “99_” is recorded for site series, then the land cover classification still provides a description for that area of the plot.
4. Map the land cover classes encountered on to the CL field card in the section for "Integrated Plot Details (top view)".

Note: Second and third site series or land cover classes covering less than 5% (16 m^2) are considered too small to recognize.

See Table 7.4 for a condensed version of the B.C. Land Cover codes. A more detailed description can be found in Appendix G. For full definitions and tables, please refer to the current Vegetation Resources Inventory B.C. Land Cover Classification Scheme Manual.

Table 7.4 – B.C. Land Cover Classification codes in condensed form.

	Codes	Description
		Level I
	Codes	Description
	V	**Vegetated** Total cover of tree-, shrub-, herb-, and moss-layers (other than crustose lichens) = 5% of the site within the 10m radius plot.
	N	**Non-vegetated** Total cover of tree-, shrub-, herb-, and moss-layers (other than crustose lichens) < 5% of the site within the 10m radius plot.
		Level II
	Codes	Description
V	**T**	**Treed** = 10% of the area is covered in tree species of any size.
	N	**Non-Treed** < 10% of the area is covered in tree species of any size.
NV	**L**	**Land** More than half of the area is not covered by water as defined below.
	W	**Water** More than half of the area is covered by a naturally occurring static water body = 2m in depth in some portion, or flowing water between continuous definable banks. These flows may be intermittent or perennial; but does not include ephemeral flows where a channel with no definable banks is present. Islands within streams that have definable banks are not part of the stream; gravel bars are part of the stream.
		Level III
	Codes	Description
NV or V	**W**	**Wetland** Includes SMR = 7 and wetter. Land having the water table near, at, or above the soil surface, or which is saturated for a long enough period to promote wetland or aquatic processes as indicated by poorly drained soils, specialized vegetation, and various kinds of biological activity which are adapted to the wet environment.
	U	**Upland** Includes everything between wetland and alpine; SMR ranges from 0 to 6.
	A	**Alpine** Treeless by definition (for practical purposes =1 % tree cover can be included) with vegetation dominated by shrubs, herbs, graminoids, bryoids and lichens. Much of the alpine is covered by primarily rock, ice and snow.
		Level IV
	Codes	Description
V	**TB**	**Treed Broadleaf** Total cover of broadleaf trees is = 75 % of the total tree cover, and tree cover is = 10%.
	TC	**Treed Coniferous** Total cover of coniferous trees is = 75 % of the total tree cover, and tree cover is = 10%.
	TM	**Treed Mixed** Neither coniferous nor broadleaf trees cover = 75 % of the total tree cover, and tree cover is = 10%.
	ST	**Shrub Tall** Shrub site with height > 2 m and = 10 m.
	SL	**Shrub Low** Shrub site with height = 2 m.
	HE	**Herb** Herb site with no distinction between forbs and graminoids.
	HF	**Herb – Forbs** Herb site with forbs (non-graminoid) > 50% of the herb cover.
	HG	**Herb – Graminoids** Herb site with graminoids (grasses, sedges & rushes) > 50% of herb cover.
	BY	**Bryoid** Bryoid site with no distinction between mosses, liverworts, hornworts and lichens.
	BM	**Bryoid – Moss** (bryophytes) Bryoid site with mosses, liverworts and hornworts forming > 50% of the bryoid cover.
	BL	**Bryoid – Lichens** Bryoid site with lichens (not crustose) forming > 50% of the bryoid cover.
NV	**SI**	**Snow / Ice** Permanent snow or ice.
	RO	**Rock / Rubble** Bedrock or fragmented rock moved to present position by gravity or ice.
	EL	**Exposed Land** All other forms of exposed land.
		Level V
	Codes	Description

	Codes	Description		Codes	Description
V	**DE**	**Dense** Tree, shrub or herb cover 61–100%	**NV**	**LL**	**Landing**
	OP	**Open** Tree, shrub or herb cover 26–60%, or bryoids =50%		**BU**	**Burned Area**
	SP	**Sparse** Treed cover 10–25%, and shrub and herb cover <26%		**RZ**	**Road Surface**
	CL	**Closed** Bryoid site, with bryoid cover > 50%		**MU**	**Mudflat Sediment**
NV	**GL**	**Glacier**		**CB**	**Cutbank**
	PN	**Snow Cover**		**MN**	**Moraine**
	BR	**Bedrock**		**GP**	**Gravel Pit**
	TA	**Talus**		**TZ**	**Tailings**
	BI	**Blockfield**		**RN**	**Railway**
	MZ	**Rubbly Mine Spoils**		**UR**	**Urban**
	LB	**Lava Bed**		**OT**	**Other**
	RS	**River Sediments**		**LA**	**Lake**
	ES	**Exposed Soil**		**RE**	**Reservoir**
	LS	**Pond or Lake Sediments**		**RI**	**River / Stream**
	RM	**Reservoir Margin**		**OC**	**Ocean**
	BE	**Beach**			

Comments

Record on the field cards any items of ecological interest that have been otherwise missed. Preface your remarks with card and attribute identification.

B. Site Features

Site features such as slope, aspect, surface shape, meso slope, microtopography, rocky substrates, flood hazard, and open water should be assessed only for the particular site being described. For example, in the event of a site A and a site B (see Figure 7.1; examples 3 and 4 requiring EP and ED cards), do not average any of the above attributes (7, 8, 10, 11, 12, 13, 16, and 17) across the two site series. Record separate values on the EP and ED field cards.

7. SLOPE (%)

Record the slope gradient to the nearest percent. On uniform conditions, assess slope by averaging over a 100 m distance (50 m above and below the plot centre). On the EP card give more weight to the slope conditions at the IPC, particularly when the IPC falls within a topographically different site series, compared with the remainder of the 10 metre radius plot. If there is a major topographic break in the slope, measure only to the break point. If required, record separate values on the EP and ED cards.

8. ASPECT (°)

Record the orientation of the downward slope (in degrees) using a compass bearing. On the EP card give more weight to the slope orientation at the IPC, particularly when the IPC falls within a topographically different site series, compared with the remainder of the 10 metre radius plot. Level ground (less than 2% slope) has no aspect; code as 999. If the aspect is "due north" the value is recorded as "000" degrees. If required, record separate values on the EP and ED cards.

9. ELEVATION (M)

Record the elevation of the plot centre in metres.

10. SURFACE SHAPE

Describe the general shape of the slope the site is situated on (convex, straight, concave). If required, record separate values on the EP and ED cards.

11. MESO SLOPE

Meso slope describes the relative position of the site within a local catchment area, which affects surface and subsurface water flow to the plot. Slope position relates to the segment of slope between prominent topographic irregularities (for example, major slope breaks). If required, record separate values on the EP and ED cards.

1. Describe the meso slope of the site. Refer to Figure 7.2 for descriptive terms.
2. Record using the codes described in Table 7.5.

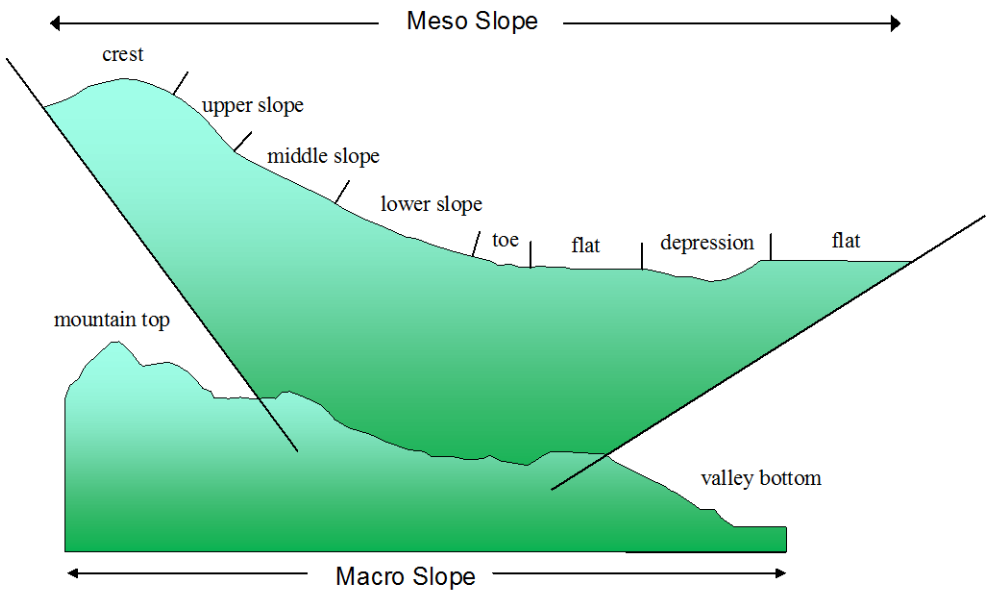


Figure 7.2 - Side view showing meso slope descriptive terms

Table 7.5 – Meso slope codes.

Code	Description
C	**crest** the generally convex upper portion of a hill.
U	**upper slope** the generally convex upper portion of the slope immediately below the crest.
M	**middle slope** the area of the slope between the upper slope and the lower slope where the slope is generally neither distinctly convex or concave.
L	**lower slope** the area towards the base of a slope, generally concave.
T	**toe** the area demarcated from the lower slope by an abrupt decrease in slope gradient.
D	**depression** any area that is concave in all directions.
F	**flat** any level area not directly adjacent to a slope (for example, toe). The surface profile is generally horizontal.

12. MICROTOPOGRAPHY

1. Microtopography describes the variability (or mounding) of the surface of the site being described. If required, record separate values on the EP and ED cards.
2. Record one of the classes of microtopography shown in Table 7.6.

Table 7.6 – Microtopography codes.

Code	Description
SM	**smooth** few or no mounds; if present, less than 0.3 m high and more than 7 m apart
MO	**moderately mounded** mounds 0.3 to 1 m high and 3 to 7 m apart
ST	**strongly mounded** mounds 0.3 to 1 m high and less than 3 m apart
EX	**extremely mounded** mounds more than 1 m high

13. ROCKY SUBSTRATES

1. Estimate the percentage of the within-site ground surface covered by rocky substrates within the 10 m radius plot. If required, record separate values on the EP and ED cards.
2. Record percentage for codes listed in Table 7.7.

Table 7.7 – Rocky substrate codes.

Codes	Description
CS	**cobbles/stones** exposed rock fragments larger than 7.5 cm***** diameter; may be covered by mosses or lichens, for example, with a forest floor less than 1 cm thick.
BR	**bedrock** exposed bedrock that may be covered by mosses or lichens, for example, with a forest floor less than 1 cm thick.
*Coarse fragment size or diameter is measured along the b axis, where a = length, b = width, and c = height (a > b > c).	

14. SLOPE FAILURE

1. Note any evidence of recent or past slope failure greater than 100 m^2 surface area in the plot or intercepted by a portion of the 11.28 m plot. Evidence of failure includes landslides, slumps, debris flows, debris torrents, and bedrock failures. For further information about slope failure refer to Chatwin (Chatwin et al. 1994).
2. Record if present in the plot (Y or N).
3. Features that would indicate slope instability are shown in Table 7.8.

Table 7.8 – Indicators of slope instability.

• obvious recent failures (tracks of exposed soil oriented downslope)
• headwall or sidewall scarps that are rectangular or horseshoe shaped
• deposits of slide materials at the base of the failure which are fan-shaped and often hummocky
• a significant difference in vegetation (species and age) from the surrounding area, which may indicate older failure tracks
• generally on steeper slopes, and often in association with wet sites (seepage zones, draws, and so on)

15. Gullies

Gullies are long, linear depressions incised into the landscape by active erosion processes, mainly running water in places accompanied by mass movement and/or snow avalanching. Where the stream channel is confined in a narrow ravine with banks usually higher than 3 m. The longitudinal profile may range from gentle to steep, and uniform to irregular (benched). The cross-section profile may be V-shaped to U-shaped with moderate to steep sidewalls (50% or greater slope). Dry draws (gully shaped features without a stream) with long established vegetation and soils, and stream channels with none of the above active or potentially active sidewall erosion features are not included.

1. Note the presence of gullies in the main plot or intercepted by a portion of the 11.28 m plot.
2. Record if present in the plot (Y or N).

16. Flood Hazard

Estimate the relative frequency of flooding of rivers, creeks, and streams using the biophysical features shown in Table 7.9. If required, record separate values on the EP and ED cards.

Table 7.9 – Indicators of flood hazard.

Flood hazard	Flood frequency	Overbank deposits	Vegetation	Topography	Litter cover
Frequent F	subject to annual flooding	recent organic or inorganic deposits may be present	none, or species of primary colonization	low lying areas adjacent to the potential flood waters	none or very thin layer of fresh litter
Occasional O	occasionally flooded	recent organic or inorganic deposits may be present	mature vegetation, typically deciduous species; conifers restricted to elevated sites	areas of moderate elevation relative to the potential flood waters	thin forest floor ranging from fresh to partially decomposed material
Rare R	subject to flooding at high stage	no evidence of recent organic or inorganic overbank deposits	mature vegetation, includes coniferous species	areas of high elevation relative to the potential flood waters	thicker forest floor with developed profile
Not Applicable N	not subject to flooding			well above or away from potential flood waters	

(adapted from *Describing Ecosystems in the Field* Luttmerding et al. 1990).

17. Open Water

1. Estimate the within-site area covered by either flowing (**F**) or standing water (**S**). If required, record separate values on the EP and ED cards.
2. Record as a percentage.

C. Soil Features

1. Dig a soil pit to represent the centre point of the Integrated Plot and representative of conditions at the plot centre, regardless of which point is the most representative of the dominant site of the 10 m radius plot.
2. Dig a second soil pit if necessary to represent the most dominant site. Complete a second soil pit only where the dominant site (versus the IPC site) is clearly one of contrasting site quality due to obviously different site and soil conditions.
3. The soil pit should be a minimum of 60 cm deep unless impenetrable material is encountered. If a soil pit cannot be excavated on the plot, draw a line through the soil features section on the field card and note the reason in the comments.
4. Upon completion of the sample, refill the soil pit.

18. Surficial Material

Surficial material refers to the soil parent materials. They are classified according to their mode of formation. The following description is based on the *Terrain Classification System for British Columbia* (Version 2), Howes and Kenk 1997.

1. Record the surficial materials seen in the soil pit using the appropriate code shown in Table 7.10.
2. If two types of material are observed, record both (for example, C_/M_ [colluvial over morainal]).

Table 7.10 – Surficial material codes.

Code	Description
A __	**Anthropogenic** • landfill, mine spoils, roadfill
C __	**Colluvium** • deposits a direct result of gravity (talus, landslide deposits) • on steep terrain; below rock bluffs • coarse fragments, angular, same rock type as bedrock • coarse fragment >35%, loosely packed, porous. • landslide and slope failure deposits
E __	**Eolian** • wind action (loess, dunes) • well-sorted silt or fine sand, loose and fluffy • a capping over other material
F __	**Fluvial** • transported & deposited by streams or rivers (floodplain, fluvial terrace, fan, delta) • deposits gravels, sands, and/or silts, depending on stream velocity • rounded gravels • well sorted, stratified • topography flat, or steep erosional scarp • along valley bottoms near a river or stream
FG	**Glaciofluvial** • deposited by glacial meltwater streams in front of, within, or along margins of glacial ice (eskers, kame terraces, outwash) • coarse-textured, non-sorted to well-sorted, gravels and sands, with layers of finer textured materials • topography flat, sometimes steep erosional scarp • along valley bottoms, up valley sides, or extensive plain outside valley systems • gravel pits are often present
L __	**Lacustrine** • old lake bottoms or old lake beaches • stratified silts and clays, often with varves • glaciolacustrine sediments may contain ice-rafted stones and lenses of morainal or glaciofluvial material • topography flat, sometimes with a steep erosional scarp, along valley bottoms • slumps and landslides are often present

Code	Description
M __	**Morainal "Till"** • (till) deposited directly by glacial ice • highly variable, compacted to non-compacted sediments, unsorted mixture of coarse and fines • looks like "cement" • stones of different rock types may have striations (grinding marks from the ice). The most widespread and variable parent material in B.C.
O __	**Organic** • wetland (peat, muck in bogs, fens, swamps) and forest floor overlying bedrock (LFH >10 cm thick; noted as O/R)
R __	**Bedrock** • exposed bedrock , organic layer (<10 cm)
V __	**Volcanic** • unconsolidated ash, cinders • cappings over other parent materials (for example, V / M)
W __	**Marine** • salt water deposits old mud flats old beaches • fine textured (silts and clays) often dense • old beaches are well-sorted sands and/or gravels with rounded coarse fragments • shells, marine concretions • flat or very gently sloping • lower elevations near the ocean (as high as 200 m above present sea level in the Georgia Strait area) • glaciomarine sediments similar to marine except may contain stones and lenses of morainal or glaciofluvial materials

19. DEPTH TO: (IN CM)

Record the observed depth from the “0 depth” (mineral soil surface for mineral soils, ground surface for organic soils) to each of the features shown in Table 7.11, if present within the soil profile.

Table 7.11 – Soil features codes.

Code	Description
W	**water table or seepage** Measure to the free water surface in the soil, or to the line along which water emerges. Free water may collect as the result of a high groundwater table or it may be due to a temporary accumulation of water above a relatively impermeable layer. Depth to water table and depth to seepage are closely related concepts which are combined here to avoid unnecessary difficulties in the field.
M	**mottles (not applicable in organic soils)** Measure to the surface of orange to red (oxidized) spots or blotches within a predominantly dull yellow, grey, blue, or olive-coloured (reduced) mineral soil horizon. Mottles are characteristic of soils with periodic intense reduction (absence of free oxygen from the atmosphere). The mottled zone often overlies a permanently reduced, or strongly gleyed horizon of dull bluish to grey colour (often indicated by **presence of a water table or seepage**). Mineral soils with more intensely reduced conditions have relatively greater volumes of bluish-grey colours. Soils become reduced when they are anaerobic, or deficient in oxygen – which happens when microorganisms and plant roots use oxygen faster than it can be replaced from the atmosphere, or when oxygen entry is blocked, as in compact basal till. The colours associated with mottles and gleying are due to the effects of oxidation and reduction on iron, aluminum, manganese, and other metals.
R	**root-restricting pan** Measure to layers that impede root penetration (pans, cemented horizons, compact parent materials).
B	**bedrock** Measure to consolidated bedrock. Weathered bedrock that can be removed with a shovel should be considered soil.
F	**frozen layer** Measure to the top of a frozen layer.
C	**carbonates** Measure to the top of a layer containing carbonate accumulations.
N	**not observable (glacier, paved surface, lake)**

20. HUMUS FORM

Humus refers to the forest floor and organic-enriched surface mineral horizons.

Describe the humus form as one of the types shown in Table 7.12.

Table 7.12 – Humus form codes.

Code	Description
MO	**Mor** LFH horizons prominent, F horizon is matted, with abundant fungal mycelia, mushroom smell common, usually abrupt transition to mineral soil.
MM	**Mormoder** intergrade between Mor and Moder, F horizon not strongly matted and often variable with clumps of matted material and pockets of friable material, fungal mycelia and insect droppings may both occur, but neither clearly predominates over the other.
MD	**Moder** LFH horizons prominent, F horizon loose and friable, fungal mycelia less common, insects and droppings common, rich "potting-soil" smell, may have thin Ah horizons
MR	**Mullmoder** intergrade between Moder and Mull, features well developed F and H (F+H horizons >2 cm thick) but Ah present which is thicker than the F+H horizons.
MU	**Mull** Ah horizon prominent, F + H horizons <2 cm thick, F horizon very friable, Ah granular, earthworms often present.
NA	**Not applicable** use this option when none of the above humus forms apply. For example, in situations where there is very little or no surface organic matter, such as on bare bedrock, on fresh mineral deposits (floodplain sands, active talus slopes), and on road surfaces. The L, F, H horizons are freely drained, upland organic horizons which are found on most mineral soils, and occasionally on some organic soils. You may need to use this category when describing wetland ecosystems.

21. SOIL COLOUR

1. Describe the general colour of the rooting-zone mineral soil.
2. Record one of the categories shown in Table 7.13.

Table 7.13 – Soil colour codes.

Code	Description
D	**dark** chocolate brown or black (Munsell colour value <4 when moist)
M	**medium** intermediate colour (most commonly encountered)
L	**light** very pale soil (Munsell colour value >6 when moist)
N	**not applicable** (bedrock, no soil)

D. Soil Description

22. HORIZON

1. Record the main types of organic and mineral horizons.
2. Enter the appropriate code left justified, using Table 7.14, beginning with the uppermost horizon, followed by subsequent horizons proceeding down through the profile.
3. Horizons include L _ _, F _ _ & H _ _, Ah _, Ae _, B _ _, and C _ _.
4. Differentiate subdivisions of the B or C horizons (for example, B1 _, B2 _) if they differ substantially in colour, texture, coarse fragments, or structure.
5. Subordinate horizons of B and C (for example, Bf _, Bf1, Bf2, Bfg, Bt _, and Bm _) may be recorded if they can be confidently identified. The soil classification system follows the *Canadian System of Soil Classification* (1998) with additional combinations specific to British Columbia. The additional combinations are documented in the "Field Manual for Describing Terrestrial Ecosystems". A list of allowable codes can be found on the Resource Information Branch website for reference.

Table 7.14 – Examples of important soil horizons.

Horizon	Description
L __ __	an upland organic horizon consisting of relatively fresh, undecomposed plant residues.
F __ __	an upland organic horizon consisting of partly decomposed plant residues in which fragmented plant residues are generally recognizable as to origin.
H __ __	an upland organic horizon comprised of well-decomposed plant residues in which plant structures are generally not recognizable. **Note**: F _ _ and H _ _ can be combined and recorded as an FH _ horizon if they are difficult to distinguish
Ah __	surface mineral horizons enriched with organic matter (darker coloured than underlying horizon)
Ae __	surface mineral horizons leached (eluviated) of organic matter, Fe, Al, and other elements (lighter [usually light greyish] coloured than underlying horizon).
B __ __	mineral horizons affected by pedogenic processes and characterized by enrichment in organic matter, Fe and Al, clay, or by the development of soil structure, or by a change in colour indicating gleying or oxidation.
C __ __	mineral horizons relatively unaffected by pedogenic processes except gleying, and accumulation of carbonates and salts. It represents the unweathered parent material.
Of __	a wetland organic horizon consisting of poorly decomposed plant residues that are readily identifiable as to origin (“peat”).
Om __	a wetland organic horizon consisting of partly decomposed plant residues which are at a stage of decomposition intermediate between Of and Oh horizons (“peat”).
Oh __	a wetland organic horizon consisting of well decomposed plant residues (“black muck”).
R __ __	bedrock

23. DEPTH (CM)

1. Record the average distance from 'zero' depth for each horizon in the profile (Figure 7.3).
   - For forest floor horizons (L, F, H) zero depth is the boundary between organic and mineral horizons. Depths are measured from the ground surface to 0 depth (for example, in the diagram, L: 6, F: 4, H: 2).
   - For mineral horizons, zero depth is the top of the uppermost mineral horizon, and lower boundary depths are measured in descending order (for example, in the diagram A: 3, B: 10, C: 60).
   - For organic soils, zero depth is the top of the organic material. Organic soils are soils with greater than 60 cm of organic material (if surface horizons are Of _), or greater than 40 cm of organic material (if surface horizons are Om _ and Oh _), or greater than 10 cm thick if they overlie rock, as described on pp. 97-99 in the *Canadian System of Soil Classification* (1998).
2. Record the total depth of the soil pit (DOP).

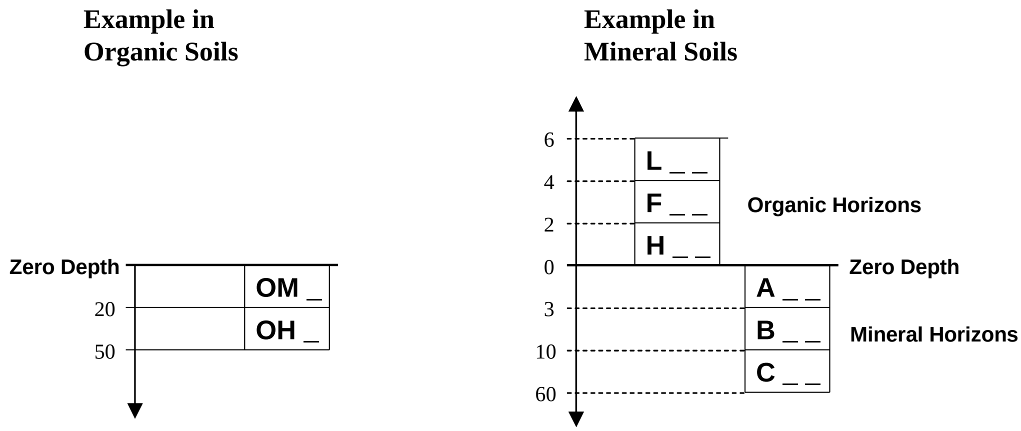


Figure 7.3 - Example of recording horizon depth in organic soils and mineral soils.

24. TEXTURE

1. Estimate the texture of the mineral soil (grains 2 mm or less in diameter) using field estimation methods as described in *MOF Regional Ecology Field Guides to Site Identification and Interpretation*.
2. Estimate texture of each mineral soil horizon, not just the main horizon.
3. Enter the appropriate codes.

25. COARSE FRAGMENTS

1. For each mineral soil horizon, estimate the proportion of the total volume of soil material occupied by mineral particles larger than 2 mm in diameter.
2. Record the total coarse fragment percentage. Coarse fragment size or diameter is measured along the b axis, where a = length, b = width, and c = height (a > b > c).
3. Break this total down into two categories:
   - gravel (greater than 2 mm and less than 7.5 cm)
   - cobbles and stones (greater than or equal to 7.5 cm)

E. Surface Substrate and Soil bulk Density Measurements

Introduction

In support of National Forest Inventory (NFI) requirements for the measurement of total ecosystem carbon stocks (TECS), a need was identified for the collection of data related to:

- Surface substrates (decaying wood, bedrock, cobbles and stones, mineral soil, organic matter and water)
- Forest floor organics
- Soil bulk density and carbon content

The data from these measurements will be applied in reports on climate change, criteria and indicators of sustainable forest management, biodiversity and forest health.

Surface Substrate Sampling

Objectives

To determine percent surface substrate for NFI sample plots. This will be determined by measuring 10 sample points taken at every metre along each of the woody debris transects (total of 20 sample points) to the edge of the large tree plot boundary.

Definitions

Percent surface substrate, for the purposes of this inventory, is defined as the proportion of the ground surface covered by each class of substrate with the corresponding depth. Surface substrate descriptions are listed in Table 7.15.

The total for all six classes must sum to 100%.

General Procedures

1. Set out two, randomly oriented, 30-metre woody debris transects (the same transects as used for woody debris).
2. Measure and record information for surface substrate type and depth (where applicable) to the edge of the large tree plot boundary.

Detailed Procedures

Surface substrate is measured every metre for 10 meters, along the two, 30-metre line transects extending from the Integrated Plot Center. Detailed field forms are shown in Appendix M.

1. Establish the woody debris line transects as per woody debris protocol.
2. For every metre along the woody debris transect, check the box applicable to the surface substrate type.
3. For organic substrate and buried wood, measure and record the depth in centimetres.
4. Total the number of surface substrate occurrences in each category.
5. Note: in plots where the organic layer throughout the transect is greater than 40 cm thick, depth measurements need only be recorded every second metre of transect. If only a portion of the line falls in deep organics (for example, a swamp) where the actual measurements would be difficult, an estimate should be made of the interim locations. The maximum depth that would be measured in thick organic layers would be to 40 cm. (record the depth as >40).

6. Anomalous conditions: if the sample point along the transect lands in an anomalous site, such as a cone pile, squirrel cache, debris pile, or large ant hill, the surface substrate would be classified as organic and a depth to mineral soil would still be measured. A note should be made in the comments section for this location. If the sample point lands on a sound log, the sample point should be moved to just beside the log.

Table 7.15 - Surface substrate classes and definitions.

Surface Substrate	Definition
Organic matter	Surficial accumulations of organic materials include the following: ▪ organic layers ≥ 1 cm thick overlying mineral soil, cobbles, stones or bedrock; ▪ layers of decaying wood < 10 cm thick; ▪ large animal droppings; and ▪ areas covered by dead mats of graminoids or other vegetation (mats include L and F horizon materials),
Buried wood	The proportion of the ground surface covered by buried wood: ▪ class 5 woody debris with > 50% **below** the surrounding surface; ▪ does not include freshly fallen material that has yet to decompose; ▪ may be covered by mosses, lichens, liverworts, or other living plants; ▪ if an organic layer has developed over the wood, buried wood must be > 10 cm thick otherwise it is classed as “organic matter”.
Decaying wood	Fallen trees, large branches on the ground surface, and partially buried stumps with an exposed edge: ▪ does not include freshly fallen material that has not yet begun to decompose (e.g. decay class 1 and 2 logs). Note that if there is a recently fallen class 1 or class 2 log blocking measurement, move the sample point to just beside the log (see anomalous conditions); ▪ may be covered with mosses, lichens, liverworts, or other living plants; ▪ if an organic layer has developed over the wood, decaying wood must have > 50% of its thickness **above** the surrounding surface, otherwise it is classed as “buried wood”.
Bedrock	Bedrock includes exposed consolidated mineral material: ▪ may have a partial covering of mosses, lichens, liverworts, or other epilithic plants; ▪ does not qualify as bedrock if covered by unconsolidated mineral or organic material ≥ 1 cm in thickness.
Rock or cobbles and stones	Rock (cobbles and stones) includes exposed unconsolidated rock fragments > 7.5 cm in diameter: ▪ may be covered by mosses, lichens, liverworts; or an organic residue layer < 1 cm in thickness ▪ does not include gravels < 7.5 cm in diameter.
Mineral Soil	Unconsolidated mineral material of variable texture not covered by organic materials: ▪ may have a partial cover of mosses, lichens, and liverworts; ▪ often associated with cultivation, tree tip-ups, active erosion or deposition, severe fires, trails, or late snow retention areas; ▪ includes small cobbles and gravel < 7.5 cm in diameter; ▪ areas of living grass or forb cover where mineral soil is visible between stems are classed as mineral soil, as are exposed Ah or Ap horizons.
Water	Streams or areas of open water in bogs or fens. Note: this **does not include** “casual” or non-permanent water. The sample point should be recorded to reflect the conditions at the time of sampling, e.g. a gravel or sandbar below the high water mark for a stream would be recorded as mineral soil.

Forest Floor Sampling

Objectives

To collect four samples of the forest floor/litter layer which will be analyzed for total carbon and mineral content.

General Procedures

1. Establish the forage sampling micro-plots along the woody debris transects.
2. Excavate and sample the forest floor organic layer(s) from each of the four plots **or** at an equivalent, representative area nearby that is in or near the micro-plot.

Detailed Procedures

1. Establish the woody debris transects as per woody debris protocol.
2. Establish the four forage micro-plots at pre-assigned distances along the woody debris transects.
3. Select a suitable (level if possible and free of large organic debris) representative site within each of the four micro-plots. In very few instances, the sample may need to be located outside of the micro-plot if the location is physically obstructed.
4. At the selected site in an area approximately 30cm by 30cm remove all live vegetation (including bryophytes and lichens) and woody debris from the sampling area.
5. Using the 20 cm x 20 cm (inside dimensions), square aluminium template, cut out the forest floor layer (combined litter and humus) to the top of the mineral soil from each of the four micro-plots (see Appendix M for a complete list of field equipment). Use the hand saw or knife to accomplish this and be careful not to compress the soil sample underneath as this will affect its bulk density.
6. With a hand trowel, use inward scooping motions to remove the forest floor organic matter (L, F and H layers) taking care to remove all organic material above the mineral soil. Discard any rocks or pebbles collected with the forest floor material. It is beneficial to have a tarp or piece of thick plastic on which the sample materials can be placed as the sample is collected. This may avoid loss of parts of the sample.
7. Bag and label each forest floor sample separately in a 10-mm weight, plastic bag. Place a label in each bag identifying the sample number and micro-plot number and whether there is more than 1 bag for a sample (identify as 1 of 1, or 2 of 3, etc.).
8. Measure the average depth of the excavated surface organic matter or residue to the nearest 0.5 cm. In order to capture the average depth, make sure the depth is measured in several places in the excavated hole. Record the average depth of the forest floor layer on the tally card.
9. Note: the forest floor sample may be offset 0.5 m to 1.0 m from the transect to avoid trampling and disturbance of the plot for other measurements, e.g. shrub and herb clipping and measurements, as long as the site chosen is representative of the site. The forest floor sample will also be offset if anomalous site conditions are encountered, e.g. a large ant hill, fallen sound wood. If the forest floor site is offset, clip and remove the fine wood and plants as per the normal micro-plot procedure.

Forest floor organics > 20 cm in depth

10. Collect the top 20 cm of surface organics on all four clip plots.
11. Collect and measure the total surface organics, in 20 cm thick intervals, to mineral soil / rock surface on **one** of the clip plots. This sample is necessary in order to get at least one bulk density measurement and sample for all depths of the surface organics.
12. Sampling of these sites should be conducted in the driest portion of the field season. The volume measurement of the organics will be obtained using the dimensions of the cut-out forest floor sample. No further excavations beyond the mineral / organic interface are necessary in instances where the organic layer extends beyond 60 cm in depth.
13. Note: there will be a large bulk of sample to bring back to the lab on these types of sites, e.g. the West Coast of Vancouver Island and North-Eastern parts of B.C.

Soil Bulk Density and Carbon Sampling

Objective

To collect seven, 1.0 to 1.5-Litre samples of mineral soil at approximate depths of 0 to 15 cm, 15 to 35 cm and 35 to 55 cm for each plot.

To measure the volume of each of the mineral soil samples extracted for the determination of soil bulk density. The samples will also be analyzed in the laboratory for carbon content, various mineral components, cat-ion exchange capacity, pH and other soil properties.

Definition

General Procedures

Establish the forage sampling micro-plots along the woody debris transects.

Excavate the bulk density soil samples from the soil pit and three additional sites at three of the four micro-plots **or** at an equivalent, representative area nearby that is in or near the micro-plot. The following samples are to be taken:

- At the soil pit take 3 samples
  - 1 sample from 0 to 15 cm
  - 1 sample from 15 to 35 cm
  - 1 sample from 35 to 55 cm
- At one of the micro-plots take 2 samples
  - 1 sample from 0 to 15 cm
  - 1 sample from 15 to 35 cm
- At two of the other micro-plots take 1 sample
  - 1 sample from 0 to 15 cm

Detailed procedures

1. Upon cutting out the square forest floor layer at the soil pit, clear an area of the remaining organic material that is larger than the template (e.g. 50 x 50 cm) to begin excavation of the soil pit and samples.
2. Level an area about 20 x 20 cm and excavate a round hole inside the square for extracting the first soil sample. The hole should be approximately 12 to 15 cm in diameter (for a 15 cm deep sample) to allow for the extraction of at least 1.0 to 1.5 Litres of mineral soil.

The minimum depth of the initial excavation should be 15 cm but could be adjusted to allow for sampling an entire layer.

3. During the excavation, extreme care must be taken not to compact the sides of the hole as this will affect the bulk density of the sample. A good way to avoid soil compaction during excavation is to always keep the handle of the trowel pointed in towards the centre of the hole, with the blade of the trowel pointing outwards.

Mineral soil sampling on sloped terrain

4. Note: as much as is possible, the soil bulk density sample should be taken on as level a surface as possible. In terrain located on a slope, the excavated hole should be located in the flattest location possible. This may mean clearing away a few centimetres of the Ae or Ah on one side to ensure a flat surface for sampling.
5. For the first excavation, measure the average depth of the hole after the few centimetres of Ae or Ah on one side have been cleared away.
6. Use glass beads or water for the volume measurement.
7. Note in the comments section that the depth measurement was taken on a slope and the percent of the slope.

Mineral soil sampling in sites abundant with coarse fragments

8. Note: if rocks (> 7.5 cm diameter, cobbles and stones) are encountered that take up more than ½ of the volume of the excavated hole, abandon the site and proceed with a new excavation in a different location. On sites where there are a lot of coarse fragments, this means that the initial excavation may take 2 or 3 tries before it is successful. An alternative to this method would be to excavate a larger diameter hole that captures the boundary of the coarse fragment(s).
9. Optional: to avoid having to carry the larger rocks removed from the hole, any adhering soil could be cleaned off the rocks and placed into the sample bag. The rock would then be weighed to the nearest gram. The volume of the rocks could then be estimated assuming rock to have a density of 2.65 g/cm3.

Mineral soil sample excavation and extraction

10. Extract the loose soil from the hole using the long-handled soup spoon and place in the 10-mm, heavy-duty bag.
11. Clean off the face of the hole using the hand-clippers or knife. All roots extending into the hole must be clipped and included in the sample.
12. Using your fingers or knife, smooth the surface of the hole and make sure there are no voids, e.g. where coarse fragments may have been extruding. If there are voids, the dimensions of the hole must be extended to accommodate a reasonably smooth surface.
13. Using the 5-mm weight plastic bag, line the hole and fill the bag with the glass beads (or water). Make certain the surface of the beads is flush with the top of the excavated hole.
14. Pour the beads (or water) into the 1.0-L graduated cylinder, measure the volume to the nearest 10.0 mL and record the information on the tally card. The volume of beads exceeding 1.0 L can be measured using the 100 mL cylinder for greater accuracy.

15. Mark the sample number, volume and depth on the tally card, label inside the sample bag and on the outside of the sample bag. If large rocks were removed from the sample, make note of their volume on the bag and the tally card also.

Mineral soil excavations for second and third samples

16. Pick a feature in the excavated hole that marks the depth of the excavation. A golf tee or aluminium nail may also be used to mark the depth. It is important to excavate samples at depths that are continuous with one another.
17. Clear an area (to the same depth) that is larger than the already excavated area (e.g. 50 x 50 cm) to allow for sampling at the next depth. This larger area can serve as the soil pit on one site that needs to be dug for pedogenic layer description and coarse fragment content estimation.
18. Perform the second excavation using the same method as the first excavation. The second excavation should be between 15 cm to 35 cm in depth and should be approximately 1.0 L to 1.5 L of mineral soil. Record the sample number (sample 278), depth (15 cm to 35 cm) and volume (1.6 Litres) of the second excavation on the tally card, place a label inside the sample bag, and on the outside of the sample bag.
19. Perform the third excavation also using the same method. The third excavation should be between 35 cm to 55 cm in depth and should equal 1.0 to 1.5 L of mineral soil. Record the sample number, depth and volume of the third excavation on the tally card, place a label inside the sample bag, and on the outside of the sample bag.
20. Note: the second and third excavations will require extra care and effort to obtain. The top layer of the initial excavation surface should be cleared to a broad and level surface (an area larger than the size of the 40 cm square) before successive deeper holes are excavated.

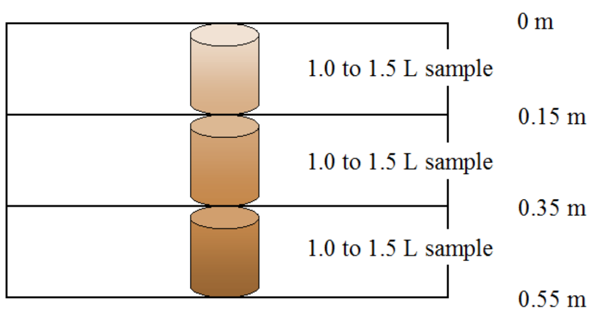


Figure 7.4 - Mineral bulk density excavation sample depths.

Importance of obtaining continuous mineral samples

21. The highest amount of carbon is located in the first and second excavations of mineral soil. For analysis purposes, it is important to obtain samples that are continuous with one another.
22. Due to site-specific reasons, excavating at the specified depth increments may not always be possible. If excavating at the specified depths is not possible still attempt to take three continuous samples at successive depths.

23. Make note of why taking the samples at the targeted depths was not possible on the tally card in the comments section. Ensure the depth that the sample was taken at is noted on the tally card, the label inside the sample bag and on the outside of the sample bag.

Distinguishing organic/mineral interfaces

24. Distinguishing the organic/mineral interface can be more difficult on sites with humus forms that are well-mixed, e.g. a Moder humus over an Ah layer.
25. Technically, a soil horizon is classed as mineral soil when it contains an organic carbon content ≤ 17% by weight. For field purposes, the determination is usually made by hand-feeling for the presence of mineral materials in order to judge the organic/mineral interface.
26. Where the determination is unclear, make a best judgment call in the field and then note it on the tally card in the comments section. Appropriate measures will be taken in the lab processing of the samples.

Unobtainable samples

27. If a sample was not obtained due to site-specific reasons, e.g. 'hit bedrock or site filled with large coarse fragments', label an empty bag and send this back with the samples that were successfully obtained.
28. Make sure to note why the sample was not obtained on the tally card in the comments section and the label inside the empty sample bag.
29. Sending an empty sample bag, with the reason the sample was not obtained in the field, ensures the lab staff are better able to keep track of the samples, e.g. the lab staff do not think that one of the samples was lost or is missing.

Quality Assurance of Bulk Density Samples

The bulk density procedures will involve destructive sampling. Extreme care must be taken in the sampling of mineral soils for bulk density measurements, as quality assurance for these procedures will not be possible.

It is suggested that the field crew member performing the bulk density sampling procedures perform a dozen practice excavations before the actual data collection to ensure that consistency of methods is achieved.

Bulk Density Sampling in Organic Sites/Soils

Bulk density sampling in organic soils will not be conducted this field season.

7.4 Describing Vegetation

Species Coding System

There are a number of taxonomically difficult plants which need only be identified to the level of genus. In the interests of saving time, you are not required to identify these plants to the species level. However, if you know the species and/or time permits, you are encouraged to record these genera to the species level.

In general, species codes consist of the first 4 letters of the genus and the first 3 letters of the species. The most current plant species codes and descriptive information is available at the following website:

http://www.for.gov.bc.ca/HRE/becweb/resources/codes-standards/standards-

species.htmlHowever, there are a number of instances which would result in the same code for two different species. For example *Vaccinium myrtilloides* and *Vaccinium myrtillus*. The species that comes first alphabetically is assigned the standard code, and the last letter of the code for the second species defaults to the fourth letter in that species' name. Thus *V. myrtilloides* = VACCMYR _ and *V. myrtillus* = VACCMYT _. This is a potentially serious error, which may be impossible to detect or correct. You must refer to master lists provided for the biogeoclimatic units in your project area, to ensure the code you use is correct.

If the genus is known but not the species, record all the characters (up to 7) in the genus. For example, if an unknown lichen of the *Cladonia* genus is collected, it is coded as CLADONI _. A grass of the *Poa* genus would be coded as POA _ _ _ _ _. If the grass is known to be *Poa alpina*, it would be coded as POA_ALP _.

If you are uncertain of genus but know the plant family, record the first 6 letters of the family name, and collect a specimen for determination. As an example, several species from the sunflower family could be recorded as ASTERA1 and ASTERA2, rather than as HERB1 and HERB2.

Assuming the species is unknown, use the following coding priority for vascular plants:

- genus > family > non-Latin code such as "FERN."

Since family names are not as widely documented for lichens, liverworts, and mosses, the coding priority for these non-vascular unknown species is:

- genus > non-Latin code such as "MOSS" (see Table 7.16).

As a general rule, the non-Latin unknown code uses 4 letters (MOSS), the family code uses 6 (ASTERA), and the genus code uses 7 (VACCINI) or fewer if there are not 7 available (POA, CAREX, SALIX).

Although not encouraged, an 8-character code may be used for special purposes to distinguish a variety or subspecies. For example, PINUCON1 versus PINUCON2, to differentiate *Pinus contorta* var. *contorta* (shore pine) from *Pinus contorta* var. *latifolia* (lodgepole pine).

Table 7.16 – Suggested coding conventions for collected unknown species.

Code*	**Description**
"genus"	code first 7 letters of genus
"family"	code first 6 letters of family
TREE	coniferous or deciduous tree
SHRU	coniferous or deciduous shrub
SEED	coniferous or deciduous seedling
HERB	herb (catch-all for herb-layer species)
LYCOPO *or* CLUB	clubmosses belong to one family "Lycopodiaceae" clubmoss
SELAGIN	lesser-clubmosses belong to one genus "*Selaginella*"
EQUISET *or* HORS	horsetails belong to one genus "*Equisetum*" horsetail
FERN	fern

Code*	Description
GRAM	graminoid (grass, rush or sedge)
POACEA *or* GRAS	grasses belong to one family "Poaceae" grass
JUNCAC	rushes belong to one family "Juncaceae"
or RUSH	rush
CYPERA *or* SEDG	sedges belong to one family "Cyperaceae" sedge
SAPR	saprophyte or parasite
LICH	lichen
LIVR	liverwort
MOSS	moss

*CODE – add numbers to the codes for multiple samples.
For example, CLADONI3, CAREX2, CYPERA3, VIOLAC2, HERB3, LIVR2, MOSS4.

Collecting Unknown Species and Voucher Specimens

1. Collect a sample for any species you cannot identify in the field for which you should record a percentage.

   Depending on the project, Voucher Specimens may be required. *Voucher Specimens* are samples collected, preserved, and stored to later verify identifications made in the field.

   - For trees, low shrubs, and tall shrubs, collect representative samples of flowers, fruits/cones, bark, a branch with leaves (needles) showing branching patterns. Record the height of plants when they are not collected as an intact specimen; this would obviously apply to trees and most shrubs.
   - For herb-layer species collect the entire plant or as much of the plant as feasible, including roots and, in particular, any flowering structures.
   - For mosses and lichens, collect a "palm-of-the-hand" size sample. Try to include moss capsules, lichen apothecia.

2. The following points will ensure good-quality specimens:

   - Use appropriate containers: paper bag, envelopes, plastic bags (allow air in occasionally).
   - Press or process as soon as possible.
   - Keep different genera separated.
   - Keep mosses/lichen samples separated and un-pressed to maintain their three-dimensional form.
   - Cross-reference to item number on field card.
   - Collect specimens from outside the plot area, if possible.

3. Complete a waterproof plant label: for each plant sample being forwarded for identification (Fig. 7.5). Concentrate on microsite conditions directly associated with the plant, rather than duplicating general habitat or site information for the larger sample plot.

Typical plant microsite habitat information:

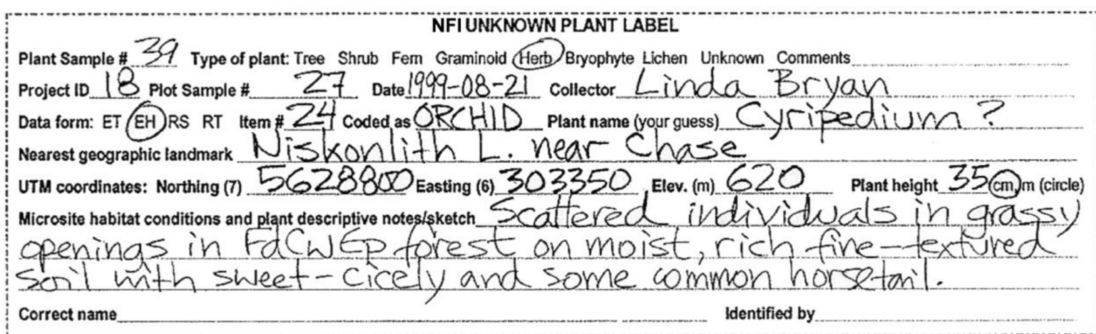
- soil or substrate conditions (humus, decaying wood, fibric organic soil, coarse- or fine-textured mineral soil, disturbed or recently mixed soil, SMR and SNR conditions, salinity)
- drainage (seepage track, stream or pond margin, depressional hollow or shedding mound)
- exposure and other physical factors (growing in open exposed or in relatively protected/shaded conditions, in an avalanche or a slide track, exposure to periodic or frequent flooding from standing or moving water).

Record only the most applicable microsite conditions, such as in these examples: "associated with an exposed seepage draw in saturated nutrient-poor organic soil; growing in steep well-drained mor humus beneath a large canopy gap; on disturbed sandy mineral soil associated with overturned tree roots; in a rocky south-aspect grassy patch with coarse well-drained dark soil."

In the descriptive notes, include diagnostic characteristics which may not be obvious from a casual look at the dried and/or pressed specimen. Here are some examples of useful additional descriptive information:

- distribution and abundance (solitary individuals in a scattered pattern; common and growing in small clumps; several large clumps within the plot; continuous coverage)
- leaves (leaves feel slightly sticky; fresh leaves have a cucumber scent when crushed; blades have an undulating margin)
- associated species (with skunk cabbage and lady fern; within clumps of *Cladonia spp*., in patches with *Veratrum*, *Fauria* and *Sphagnum*)

Keep documentation on the labels as concise and applicable as possible. Do not allow labels to become separated from their relevant plant samples.



NFI UNKNOWN PLANT LABEL

Plant Sample # 39 Type of plant: Tree Shrub Fern Graminoid (Herb) Bryophyte Lichen Unknown Comments

Project ID 18 Plot Sample # 27 Date 1999-08-21 Collector Linda Bryan

Data form: ET (EH) RS RT Item # 24 Coded as ORCHID Plant name (your guess) Cyripedium ?

Nearest geographic landmark Niskonlith L. near Chase

UTM coordinates: Northing (7) 5628800 Easting (6) 303350 Elev. (m) 620 Plant height 35 (cm) m (circle)

Microsite habitat conditions and plant descriptive notes/sketch Scattered individuals in grassy openings in FdCwEp forest on moist, rich fine-textured soil with sweet-cicely and some common horsetail.

Correct name Identified by

Figure 7.5 - NFI Unknown plant label.

Plant Identification

As a guideline, you should not need to spend more than 10 minutes per plot checking your plant identification references. If you cannot quickly identify the plant, collect it.

Identify Vascular Plants to the Species Level

Identification of vascular plants (tree-, shrub-, and herb-layer) should be carried to the species level.

Identify Non-vascular Plants to Genus Level

Identification of bryophytes and lichens need only go to the genus level. Alternatively, if the species is known or if there is enough time to sample, you are encouraged to carry on to the species level. If you are uncertain about the genus, you should sample anyway.

Recommended Procedure for Identification of Collected Plants

Time permitting, identify collected plants in the evening if this can be done efficiently.

If identification of unknown samples is not possible within a designated time, the identifications should default to genus or possibly a higher taxonomic level, such as family. Specimen quality or developmental stage may also limit identification to a higher taxonomic level. In any case, the final database entry must be the correct code for the particular taxonomic level.

Unknown Species Coding

Please use the unknown species coding conventions listed in Table 7.16, as this will help simplify interpretation of the unknown coding on the forms. You are encouraged to continue recording your descriptive notes for unknown species in the comments section on the ET and EH forms, as this will help you remember the species when you determine its cover value, and later when you key the plant or store it for identification.

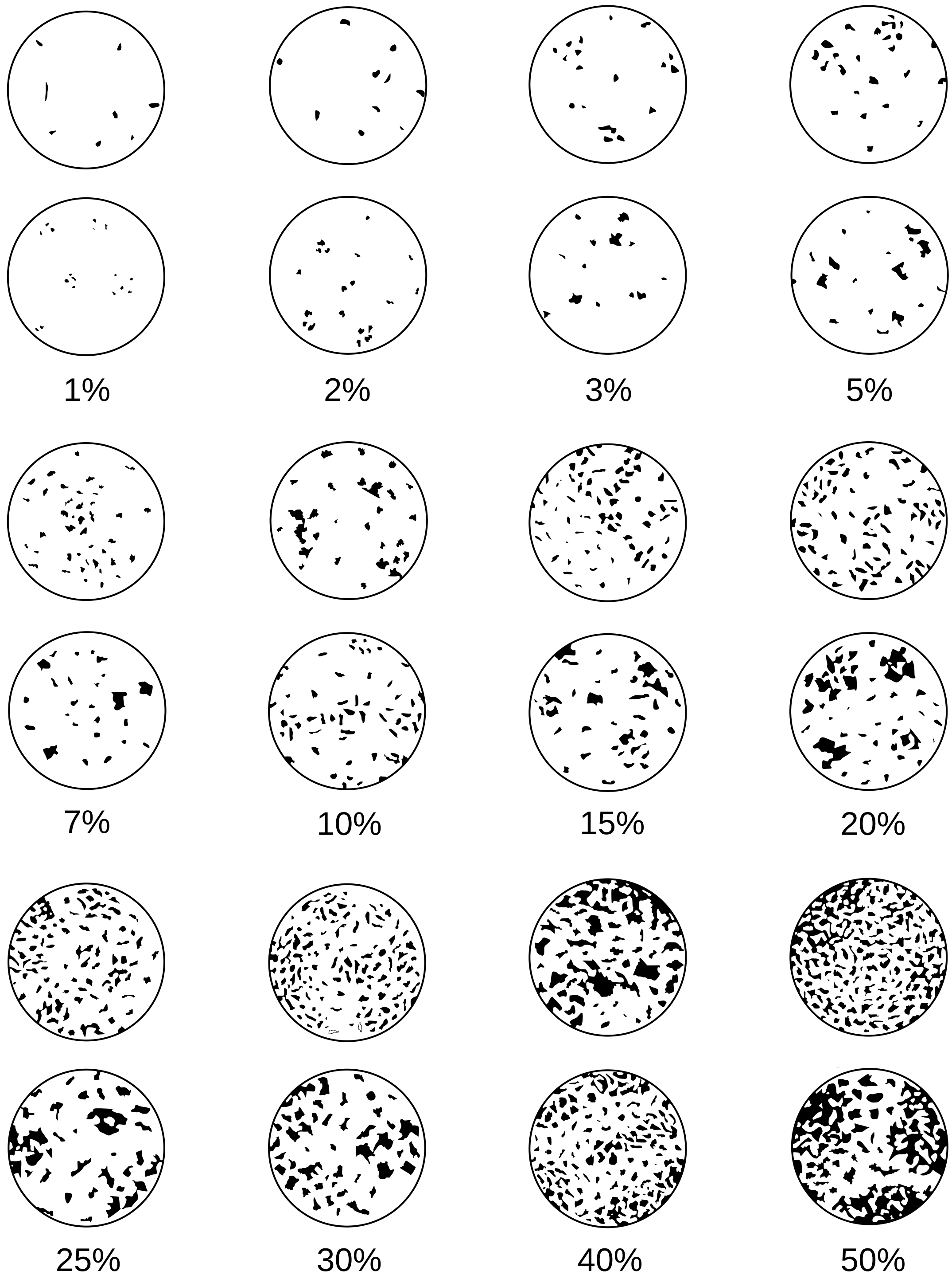
These codes are normally temporary if the plant has been collected for identification, and they should be replaced on the forms and in the database with the correct Latin codes upon receiving results.

26. SPECIES CODES

1. Record all shrub and tree species growing in the 10 m radius plot, and all herbs and bryoids growing on the dominant substrate within the nested 5.64 m radius plot, using codes based on the scientific names. A list of scientific names with codes will be provided by a local ecologist for an inventory project. Collect samples of any unknown species, bag and label them for later identification by specialists. Record the item number from the field card on the tagged plant sample as a cross-reference.
2. Maintain a systematic method of recording the species in the plot. The results are much easier to read and compile. One common method is to record species by strata, starting with the uppermost stratum, and within strata by abundance.
3. In some circumstances it may be necessary to collect the plant list at another time of the year to take advantage of peak floristic conditions.
4. Certain ecosystems are more difficult to sample (for example, alpine, subalpine meadows, wetlands, riparian edge communities, grasslands, rock outcrops, and disturbed sites with introduced weedy and non-native species). It may be necessary to have these plots sampled by specialists.

Estimating Percent Coverage by Layer

Percent canopy cover is the percent of the ground area covered by a vertical projection of the crown of the plant onto the ground surface. When estimating percent cover, care must be taken not to bias estimates because of crown density. Except for distinct holes in the crown, the area within the perimeter of the crown is assumed to be fully covered. It is required that percent cover be recorded for each species in each plot. To aid in assessing percent cover, a set of comparison charts are provided in Figure 7.6. Table 7.18 also provides examples of the area coverage and the percent cover for the plot. Figure 7.7 illustrates some relative amounts of percent canopy coverage and shows the “drip line” of the plant.



Developed by Richard D. Terry and George V. Chillinger. Journal of Sedimentary Petrology 25(3): 229 – 234, September 1955

Figure 7.6 - Comparison charts for visual estimation of foliage cover.

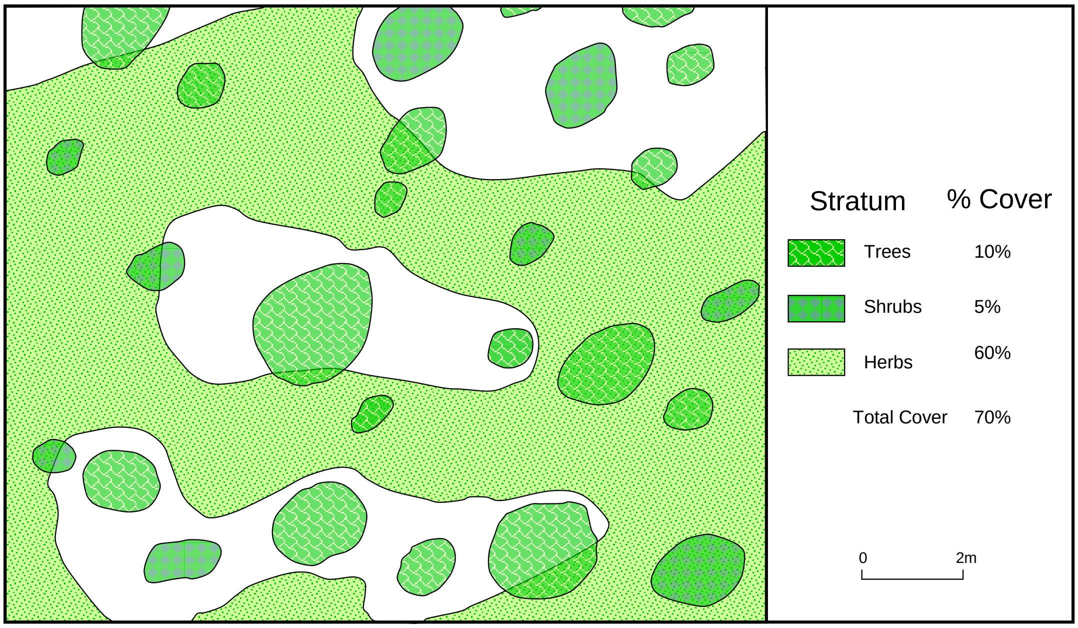


Figure 7.7 - An example of percent coverages in a plot, viewed from above.

Percent cover is estimated as the percentage of the ground surface covered when the 'crowns' of the plants are projected vertically. The values are estimates that will vary somewhat between individuals, however, the relative cover values are required to provide information on species abundance.

With regards to species of very low coverage, you are not expected to produce an exhaustive list. It is easy to overlook a few species given the seasonal variation in flowering and vegetative production. Species of very low coverage, less than 0.1 percent can easily be missed by anyone. Save time and energy by focusing on the main substrate, which in most forested ecosystems is the forest floor, as discussed in item 4 below.

1. Initially, record an estimate of overall coverage (in percent) in each layer (all species), excluding any overlapping. Use this figure to help calibrate cover estimates for individual species.
2. Estimate the coverage for each species in the tree and shrub layers within the 10 m radius plot.

   Estimate the coverage within the nested subplot (5.64 m radius)

   - for seedlings (ET card)
   - for herbs and mosses (EH card)

   For calibration, Table 7.18 (conversion factors) shows the equivalent area for percent cover when applied to the 10 m radius main plot and 5.64 m radius nested plots.
3. If the total of individual species percentages in a layer is less than the overall total, adjust cover estimates for individual species or totals.

If the cover of a species overlaps within a strata, then the total percentage may be considerably less than the sum of individual layer coverages, but never more. **Do not sum the individual cover values to compute the overall coverage.**

Vegetation layers are listed in Table 7.17 and in Figure 7.8.

4. The D layer consists of mosses, lichens, liverworts, and seedlings. Three main substrates are recognized in Layer D:

   - Dh (on forest floor and mineral soil)
   - Dw (on decaying wood)
   - Dr (on rock)

In Layer D emphasize species growing on the main substrate, which in most cases will be Dh (forest floor or mineral soil). Describe the species on atypical substrates (for example, Dw – decaying wood, and Dr – rock) only when these substrates individually represent 40% or more of the 5.64 m vertically projected plot surface. If present, forest floor (Dh) species should always be described, because they are often important indicators of soil conditions.

Table 7.17 – Vegetation layer codes.

Layer	Description
A	**Tree layer:** includes all woody plants greater than 10 metres tall. Estimate cover values for individual tree or shrub species for the entire A layer. Overlapping crown is not additive for the same species, consequently a given tree or shrub species cannot have coverage greater than 100%.
B1	**Tall shrubs:** includes all shrubs and advanced tree regeneration between 2-10 m tall. In some low productivity and young ecosystems the canopy of mature trees may be less than 10 m tall and should be recorded in the B1 layer.
B2	**Low shrubs**: consist, with minor exceptions, of shrubs and established tree regeneration less than 2 m tall and at least 2 years old.
C	**Herbs:** refers to herb-layer plants such as ferns, graminoids, forbs, saprophytes, and some woody Species. Appendix H provides a list of low woody species and species of doubtful lifeform assigned to the herb (C) layer.
D	**Mosses, lichens, liverworts and seedlings:** includes tree seedlings less than 2 years old.

Table 7.18 – Conversion factors from percent coverage to horizontal area.

Percent coverage	10 m radius plot	5.64 m radius plot
Horizontal surface area	314 m^2	100 m^2
25% coverage	¼ of the plot pie or 78.5 m^2	¼ of the plot pie or 25 m^2
1% coverage	1.8 m × 1.8 m or 3.14 m^2	1 m^2
Note: You are not required to record genera or species with less than 1% coverage.		
0.1% coverage	~ 55 cm × 55 cm or 0.31 m^2	~ 32 cm × 32 cm or 0.1 m^2
0.01% (1H* – hundredth of a percent)	~ 18 cm × 18 cm or 314 cm^2	~ 10 cm × 10 cm or 100 cm^2
0.001% (1T* – thousandth of a percent)	~ 6 cm × 6 cm or 31.4 cm^2	~ 3 cm × 3 cm or 10 cm^2
*1H and 1T, or multiples (3H, 5H, 2T, 9T . . .), allow for better estimates for species with very small coverage. Note that 9H or 9T is the maximum since 10H = 0.1% and 10T = 1H. "~" means approximately		

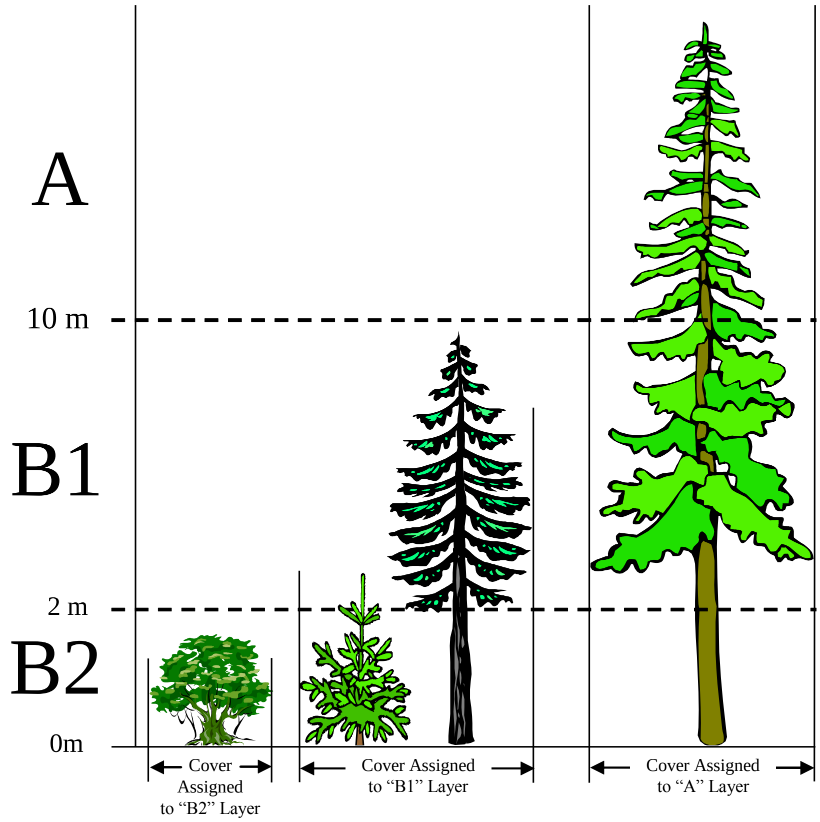


Figure 7.8 - Taller Vegetation Layers.

Estimating Average Shrub Height

27. Average Shrub Height B1 (m) and B2 (m)

The height and the percent cover estimates will be used to calculate shrub volume by species.

1. Record the mean height, weighted by percent cover, for each species in shrub layers. Include all woody shrubs as well as trees in the shrub layers.

EXAMPLE
The following calculation provides the weighted average for a stand of Douglas maple 3 m tall covering 30%, with one 8 m tall shrub covering 10%.

Cover-weighted average height $= \Sigma\ (\text{height} \times \text{cover}) / \Sigma\ \text{cover}$

$$= \frac{(3m * 0.3) + (8m * 0.1)}{(0.3 + 0.1)}$$

$$= \frac{(0.9m + 0.8m)}{0.4}$$

$$= \frac{1.7m}{0.4}$$

= 4.2m (round down to nearest 0.1m)

2. There is not enough time to calculate the weighted average in the field, and you are not expected to do it. Develop a quick visual estimate of average species height, weighted by coverage.

7.5 Interpreting Succession

Successional interpretations are based on an area within approximately 25 m of the Integrated Plot Centre, and within the 11.28 m plot. As the sample may cover more than one land cover type the succession interpretation which best describes the IPC location is to be recorded.

1. Record data on the EO Field Card using appropriate codes.
2. Identify factors influencing vegetation, including previous and current tree species, and structural class of the area surrounding the Integrated Plot Centre.
3. Assess the factors used to determine old growth characteristics of the stand, and estimate the percent of old trees remaining.
4. Decide whether the stand is old growth or not.
5. If not old growth, decide whether the stand has some old-growth characteristics.

28. FACTORS INFLUENCING VEGETATION ESTABLISHMENT

Record the major observable factors that are relevant to development of the current vegetation and soil characteristics. The time frame is (approximately) the past 500 years. Use from one to a maximum of four of the categories shown in Table 7.19. Only record factors for which direct evidence can be observed.

Use a 2-character description (such as Aw), or a 1-character description (such as A __) if the specific factor is unknown.

Leave the field blank if no evidence can be observed.

Table 7.19 is adapted from the *Field Manual for Describing Terrestrial Ecosystems* draft, 1996. Table 7.20 provides a more detailed description of certain factors – marked *.

Table 7.19 – Site disturbance codes.

Code		Description
A	**Atmosphere-related effects**	
	e	climatic extremes (extreme cold and/or heat; glaze ice, hail, heavy snow)
	p	atmospheric pollution (toxic gases, acid rain)
	w	windthrow*
B	**Biotic effects (specify animal or plant in comments)**	
	b	beaver tree-cutting*
	d	domestic grazing/browsing
	e	excrement accumulation (other than that normally associated with grazing/ browsing)
	i	insects (infestation, kill)*
	p	disease (excluding insects)*
	v	aggressive vegetation
	w	wildlife grazing/browsing (specify animals)
D	**Disposals**	
	c	chemical spill or disposal
	e	effluent disposal
	g	domestic garbage disposal
	m	mine spoils
	o	oil spill or disposal
	r	radioactive waste disposal or exposure
F	**Fires**	
	c	overstorey crown fire*
	g	light surface (ground) fire
	i	repeated severe surface fires (intense)
	l	burning of logging slash (broadcast burn, piled and burned, burned windrows)
	r	repeated light surface fires
	s	severe surface fire*
L	**Forest harvesting**	
	a	patch cut system
	c	clearcut system (if slash burned, see also Fires)
	d	seed tree system (uniform, grouped)
	e	selection system (group selection, strip, single tree)
	l	land clearing (includes abandoned agriculture)
	o	coppice
	s	shelterwood system (uniform, group, strip, irregular, natural, nurse tree)

M	**Plant or site modification effects**	
	c	herbicide (chemical) use
	f	fertilization
	g	seeded or planted to grasses
	h	seeded or planted to herbs
	i	irrigation
	s	planted or seeded to shrubs
	t	planted or seeded to trees
P	**Gathering or removal of plant products**	
	f	firewood gathering
	m	mushrooms
	o	moss
	s	salal
	x	other (specify in comments)
S	**Soil disturbance**	
	a	cultivation (agricultural)
	c	compaction
	e	excavation
	f	sidecast/fill
	g	gouging (> 5 cm into mineral soil)
	m	mining effects (placer tailings, rock quarrying, open pit mines, tailings)
	p	mechanical site preparation (brush blading, scarification, trenching, mounding)
	r	road bed, abandoned
	s	scalping (forest floor removed)
	t	railway, abandoned
T	**Terrain-related effects**	
	a	avalanche
	d	recent deglaciation
	e	eolian (active soil removal or deposition by the wind)
	s	terrain failures (active/recent slumps, slides, solifluction – soil creeping)
	v	volcanic activity
W	**Water-related effects**	
	d	water table control (diking, damming)
	e	water table depression (associated with extensive water extraction from wells)
	i	inundation (including temporary inundation resulting from beaver activity)
	s	temporary seepage (usually man-induced; excludes intermittent seepage resulting from climatic conditions)
X	**Miscellaneous (for further disturbance types, enter "X" and describe in comments)**	
*Indicates additional information in Table 7.20		

For certain factors shown in Table 7.19, further details are provided in Table 7.20.

Table 7.20 – Indications of site disturbances.

Signs of windthrow

- trees may be uprooted or snapped along the bole
- may lie parallel to each other if in patches
- stands arising after extensive windthrow will have mounded terrain

Signs of clearcut logging

- scattered, large stumps of similar species, size condition
- evidence of saw cut or felling machine cut on stumps
- CWD may be of a few large logs from previous stand and smaller material from mortality in new stand
- new growth will contain trees of fairly uniform DBH/height

Signs of selective logging

- scattered larger stumps, possibly of the same species
- skid trails will be visible
- larger trees of the logged species should still be present
- do not confuse with small clearcut

Signs of surface fire

- larger CWD will be charred or partially burned
- standing trees will have charred lower boles, and crowns raised (crown scorch)
- lower crown foliage discoloured (recent fire)
- dead or dying smaller trees in the understorey (recent fire)
- fire scars on larger trees (basal wound with a burned catface) if surface fires common in area

Signs of overstorey crown fire

- most trees dead; most of their foliage gone and some small twigs
- bark charred (recent); bark shed, leaving silvery snag (older)
- soil organic layer consumed to various degrees
- tree roots exposed near boles
- charred debris present

Signs of beaver tree-cutting

- stumps show chipping and conical tops
- bark may be removed from larger branches
- primarily hardwood trees and willowy shrubs

Signs of disease

- symptoms specific to each agent (cankers, rusts, mistletoes, blights, root diseases)
- swellings on branches or boles
- dead leaves, needles, bark, tops
- resin flows, galls, brooms
- distress cone crops and fruiting bodies on various parts

Signs of Insects

- symptoms specific to each type (defoliators, sucking insects, woody tissue feeders)
- foliage discolouration to foliage loss
- curled twigs, branch galls, crown distortion

• stunted or deformed leaders
Signs of snow avalanching
• tracks (if fairly frequent); shrub and herb species instead of trees (in tracks)
• broken branches, snapped boles, piles of debris
• windthrow or pushed over trees
• forests affected may be on slope beside or between tracks or in valley floor below runout zone
Signs of slope failures
• sharp boundaries with remaining forest (severe)
• upper portion consists mostly of exposed mineral soil
• lower portion composed of soil, rock and forest debris
• debris forms mounded or lobed pattern
• trees dead, displaced or leaning
• older failures show decreasing mineral soil and increased organic matter
• slow regeneration of trees

29. Tree Species Succession

1. In forested ecosystems look for signs of the earlier predominant tree species. The primary species has the greatest basal area.
2. Record previous and current predominant tree species with the appropriate code. For example, in a red alder stand with western hemlock and western red cedar stumps, record "previous species" as Hw _ Cw _, and "current species" as Dr _. Alternatively, if the stand is, and appears to have always been Bl _ Se _, simply record as Bl _ Se _ in both previous and current species boxes.
3. If stumps are present but they are unidentifiable, record the appropriate code for: Unknown (X _ _), Unknown hardwood (Xh _), Other hardwood species (Zh _).

Stand Structure Features

Evidence for the decision as to whether or not the stand has some old growth characteristics will be based on the following set of observations.

30. Tree Harvesting

Record if the forest has experienced some form of harvest:

Clearcut	C	Partial	P	None	N

31. Snags > 25 cm DBH

Count the standing dead trees within the 25 m radius that meet the minimum size criteria: >25 cm DBH and >10 m tall or shorter due to advanced stage of decay (for example, wildlife tree classes 7 to 9).

None 0	N	Some 1–5	S	Common > 5	C

32. Snags/CWD in All Sizes and Stages of Decay

Assess the range of size and decay stage of the snags and CWD and record using codes in Table 7.21. This observation is meant to identify those sites where snag and coarse woody debris recruitment is an ongoing process.

Table 7.21– Snags/CWD codes.

Code	Description
N	**No** No snags that meet the minimum size criteria, or all snags are within a narrow range (1 or 2) of decay classes; CWD absent or limited to a narrow range of decay classes.
S	**Some** Snags meet the minimum size criteria but are limited to 3 consecutive decay classes; CWD limited to 3 consecutive decay classes.
Y	**Yes** Snags meet the minimum size criteria and represent most decay stages; CWD in most decay classes.

33. Canopy Gaps Due to Tree Mortality

Gaps are openings, caused by natural tree mortality, which are not yet occupied by A3 layer (>10 m tall) or equivalent trees. Mortality refers to natural causes of death; for instance trees have blown over, snapped off, or died standing.

1. Record gaps in the canopy that are due to natural tree mortality using codes in Table 7.22.
2. Do not count gaps if the cause of death appears to be related to harvesting or other human activities. It may be hard to decide, for example, where death is due to fire or other damage that could be related to human activities.
3. Do not include openings due to climatically drier or otherwise harsh regimes where trees are widely spaced. This also does not include natural stocking irregularities which may be caused by edaphic factors such as shallow soils, bluffs or rock outcrops, seepage or stream channels, wet depressional sites, colluvium, slide or avalanche tracks, snow accumulation patches, landings, trails, and roads.
4. Do not include successionally young sites where trees have not yet grown into the A3 layer.

Table 7.22 – Canopy gap codes.

Code	Description
N	**None** No apparently natural gaps.
S	**Some** Smaller gaps amounting to <10% of crown closure in 25 m area.
C	**Common** One or more larger gaps occupying 10% or more of the potential canopy area.

34. Vertical Structure

Describe the distribution of shrub and tree layer strata using Figure 7.9 and Table 7.23.

Table 7.23 – Vertical structure codes.

Code	Description
S	**Simple** Tends to be even-height, with limited coverage in up to two other strata (B2, B1, A3, A2, or A1).
M	**Moderate** Tends to be uneven height with >10% of total coverage in each of three strata (B2, B1, A3, A2, or A1).
C	**Complex** Stand is uneven-height with >10% of total coverage in each of four or five strata (B2, B1, A3, A2, and A1).

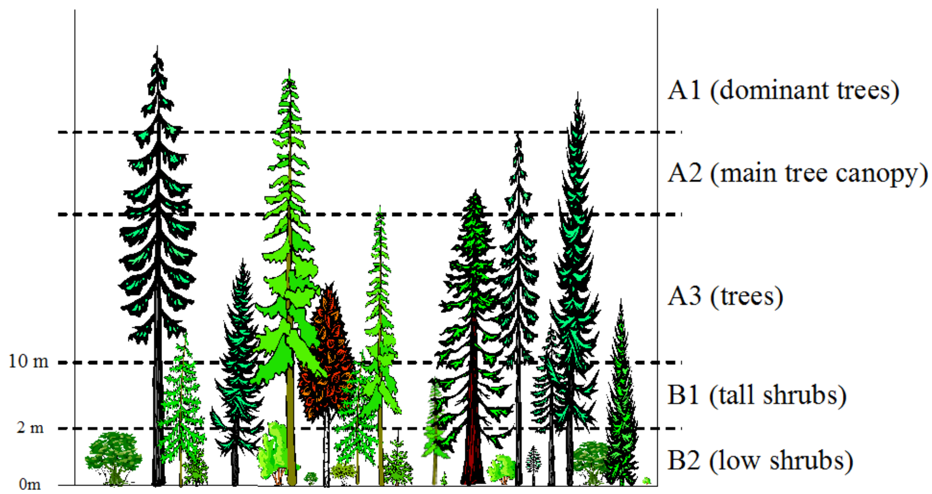


Figure 7.9 - Stratification of forest stands, shrubs, and trees.

35. Successional Stability

Assess whether the dominant species composition is relatively stable and record the appropriate code from Table 7.24. We need to know if there is likely to be change in species composition of the dominant vegetation. It is important to consider the potential of a given species in a particular site.

For example, in a MH_ _wh_ subzone plot there may be frequent Hw __ and Cw __ in the understorey, but observations on the way to the plot suggest that in spite of their shade tolerance, few, if any, Hw __ and Cw __ survive into the main canopy, which is occupied by Hm __, Yc __ and some Ba __.

Table 7.24 – Successional stability codes.

Code	Description
U	**Unstable** Change in dominant species composition is imminent. Clues are recently disturbed sites, early structural stages, or presence of shade-intolerant (pioneer) species for the given site. With no apparent sign of a short cyclic major disturbance regime (floods, slides, windthrow, fire, disease) the vegetation will likely progress unimpeded to more advanced structural stages, with changes in dominant species composition along the way. Unstable means that the relative rate of change is rapid (on the order of less than 40 years).
I	**Intermediate** Change in species composition has and will continue to take place in the dominant vegetation. The longevity of the species involved is such that the relative rate of change in composition is gradual, but directional (on the order of 40 — 80 years).
S	**Stable** Persistence in dominant species composition is apparent from factors such as advanced structural stage, occupation by shade-tolerant species, or when the rate of change in the dominant species composition is relatively very slow (stable for more than 80 years). Even relatively young dominant vegetation may qualify as stable if there is little sign of change in species composition. For example, an avalanche track dominated by slide alder would be considered stable if disturbance appears to be frequent enough to maintain the alder. Likewise a young shade-tolerant Hw __ stand that is unlikely to undergo much change in dominant species composition as its canopy gains height and structural complexity, would also be considered stable.

36. Tree Age for Species and Site Series

Assess whether the trees appear old for their species and the site conditions, and record one of the codes shown in Table 7.25.

Because few tree ages are being collected, this will be difficult to determine. Even-aged stands will tend to be the easiest to evaluate. In a stand with differing tree ages, assigning an approximate age for the trees dominating the site will be difficult. Concentrate on the trees that dominate the canopy.

Table 7.25 – Stand age codes.

Code	Description
Y	**Young** Characteristic of even-height forests in the young forest or earlier structural stages.
I	**Intermediate** Species may have attained near-maximum height, but there is little mortality in the main to upper canopy as the species are only in a mature forest stage.
O	**Old** Trees in the upper canopy have been established for a relatively long time. Some upper canopy trees appear to have reached their physiological maximum age. Others may already have died.

37. Tree Size for Species and Site

Evaluate the size of the trees on the plot, relative to the potential size expected for the site quality, amount of disturbance, and growing time. Relatively larger trees will obviously tend to be found in the less disturbed, older stands. Even-aged stands will be easier to evaluate.

Small	S	Intermediate	I	Large	L

38. Structural Stages

Evaluate the stand and record one of the codes shown in Table 7.26. Note that, depending on the climatic conditions and the site properties, the length of time required to reach mature and/or old forest stages varies considerably.

Table 7.26 – Structural stage codes.

Code	Structural Stage	Definition	Time since major disturbance[1]
NV	**Non-vegetated**	Less than 5% vegetation cover	<20 years for normal forest succession. Up to 100+ years for rocky or bouldery substrates and other severe sites.
SP	**Non-vegetated or Sparse**	Initial stages of primary and secondary succession. Little or no residual vegetation except up to 100% cover of bryophytes and lichens. Less than10% cover of vascular plants. This stage may be prolonged (50 — 100+ years) where there is little or no soil development (bedrock, boulder fields).	
H	**Herb**	Early successional stage or restricted development due to environmental conditions or disturbance (snow fields, avalanche tracks, wetlands, flooding, grasslands, intensive grazing, intense fire damage) dominated by herb-layer (forb, graminoid, fern) vegetation; some invading or residual shrubs and trees may	<20 years for normal forest succession. Up to 100+ years under conditions of soil, climate, or disturbance which limit succession.

Code	Structural Stage	Definition	Time since major disturbance[1]
		be present. Tree cover <10%, shrub cover <20% or <33% of total cover, herb-layer cover ≥20%, or ≥33% of total cover.	
LS	**Low Shrub**	Early successional stage or restricted development due to environmental limitations and conditions, dominated by shrubby vegetation <2 m tall. Seedlings and advance regeneration may be abundant. Tree cover <10%, shrub cover ≥20% or ≥33% of total cover.	
TS	**Tall Shrub**	Early successional stage or restricted development due to environmental limitations and conditions dominated by shrubby vegetation > 2 m and < 10 m tall. Seedlings and advance regeneration may be abundant. Tree cover <10%, shrub cover ≥ 20% or ≥ 50% of total cover.	<40 years for normal forest succession. Up to 100+ years under conditions of soil, climate, or disturbance which limit succession.
PS	**Pole/ Sapling**	Trees >10 m tall, have overtopped shrub and herb layers and stands are typically densely stocked; younger stands are vigorous and usually > 10–15 years old. Older pole-sapling stages composed of stagnated stands (up to 100 yrs. old) are also included. This stage persists until self-thinning and vertical structure becomes evident in the canopy (often by the age of 30 yrs. in vigorous deciduous stands). Deciduous stands are generally younger than coniferous stands belonging to the same structural stage.	< 40 years for normal forest succession. Up to 100+ years for dense (> 2,000 stems/ha.) stagnant stands.
YF	**Young Forest**	Self-thinning has become evident and the forest canopy has begun differentiation into distinct layers (dominant, main canopy, and overtopped); vigorous growth and a more open stand than in the pole-sapling stage; begins as early as age 30 and extends to 50 — 80 years depending on tree species and ecological conditions.	40 — 80 years
MF	**Mature Forest**	Trees established after the last disturbance have matured and a second cycle of shade tolerant trees may have become established; understories become well developed as the canopy opens up.	80 — 140 yrs. for Biogeoclimatic group A[2] 80 — 240 yrs. for Biogeoclimatic group B[3]
OF	**Old Forest**	Old, structurally complex stands comprised mainly of shade tolerant and regenerating tree species, although older seral and long-lived trees from a disturbance such as fire may still dominate the upper canopy; snags and coarse woody debris in all stages of decomposition are typical and understories are patchy. In some ecosystems, such as high elevation, or otherwise stressed, the understorey may have a number of tree species which are uncommon in the canopy,	>140 yrs. for Biogeoclimatic group A[2] >240 yrs. for Biogeoclimatic group B[3]

Code	Structural Stage	Definition	Time since major disturbance[1]
		due to the inherent limitations of these tree species under the given conditions.	
[1]Structural characteristics have priority over time guidelines)			
[2]BGCU Group A includes the following: BWBSdk, BWBSmw, BWBSwk, BWBSvk, ESSFdc, ESSFdk, ESSFdv, ESSFxc, ICHdk, ICHdw, ICHmk1, ICHmk2, ICHmw1, ICHmw3, MS, SBPS, SBSdh, SBSdk, SBSdw, SBSmc, SBSmh, SBSmk, SBSmm, SBSmw, SBSwk1 (on plateau), and SBSwk3.			[3]BGCU Group B: All other biogeoclimatic units.

39. Percentage of Live Old Trees Remaining

Assess the proportion of live old-growth trees by examining the numbers of dead and living old forest or old-growth trees (see table 7.26 Old Forest structural stage ages for your biogeoclimatic unit: for example, in the MS zone trees > 140 years are old growth trees, or their remains, in the form of snags, fallen trees, or stumps to support your estimate. This is not an estimate of the number of live old trees versus an imaginary potential number of old-growth trees. For example, if the 25 m radius area has evidence of 10 old trees and only 3 are still alive and standing, the value would be 30%.

Examples:

$$\frac{\text{2 old trees}}{\text{(2 old trees + 0 old tree snags + 0 fallen old trees + 0 stumps)}} \times 100\% = 100\%$$

$$\frac{\text{0 old trees}}{\text{(0 old trees + 2 old tree snags + 1 fallen old trees + 3 stumps)}} \times 100\% = 0\%$$

$$\frac{\text{3 live old trees}}{\text{(3 live old trees + 2 dead old trees + 5 stumps of old trees)}} \times 100\% = 30\%$$

If the percentage of live old trees remaining is less than 40%, the site is probably too disturbed for the old growth forest designation.

40. Old-Growth Forest

Base your choice on your opinion using all the succession attributes discussed above. “No (some)” suggests the stand has *some* old growth forest attributes, but it is not old growth.

Record one of the following:

No	No (some)	Yes

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8. Coarse Woody Debris

Introduction

Coarse woody debris (CWD) is a major contributor to structural diversity in forests and provides habitat for plants, mammals, amphibians, insects, and micro-organisms. It influences hillslope and stream geomorphology, affects the microtopography and microclimate of the forest floor, is an important nutrient and moisture pool, and in some ecosystems, may be a nitrogen fixation site.

This section outlines the procedures for establishing the sampling transects, for deciding which CWD to measure, and for recording the measurements.

Objectives

1. To accurately determine the gross volume of coarse woody debris by decay class.
2. To identify merchantable material and potential removals.

Definitions

Coarse woody debris (CWD), for the purpose of this inventory, is dead woody material located above the soil, in various stages of decomposition. CWD must be larger than 7.5 cm in diameter (or equivalent cross section) at the crossing point, and not self-supporting. Trees and stumps (intact in ground) are considered self supporting.

CWD can also be in the form of felled and bucked logs or log decks.

General Procedures

1. Set out the 24 m sampling transects.
2. Assess the transect conditions.
3. Measure and record information for the CWD pieces.

Field Cards for this Section

Coarse Woody Debris (EW) (Appendix A, Figure A.9)
Field card for the random transect 1, species, diameter, % class 1, other decay class, tilt angle, accumulations.

Coarse Woody Debris (EC) (Appendix A, Figure A.10)
Field card for transect 2 — species, diameter, % class 1, other decay class, tilt angle, accumulations.

Detailed Procedures

8.1 Establishing the Sampling Transects

Coarse woody debris is sampled along two horizontal 24 m line transects extending from the Integrated Plot Centre.

1. Establish the first line at a pre-assigned random azimuth from the plot centre.
    - Measure out along the random azimuth with a tape to 24.0 m, correcting the distance to horizontal.
    - Mark the end of the transect, for example, with a small stick stuck in the ground, flagged with ribbon (temporary marking for quality control), or a small paint mark on the ground.
    - Mark along the line with logging paint the intersection of the line transect with potential coarse woody debris.
    - Number a few of the large CWD with log marking paint to aid re-measurement and quality control.
2. Establish the second line at plus 90° from the first transect commencing at the Integrated Plot Centre.
3. Record the azimuth of each line on the Coarse Woody Debris (EW) and (EC) Field Cards.

8.2 Assessing the Transect Conditions

Normally, the full length of the transect will be sampled. However, because the transects are based on a random bearing, unsafe or difficult conditions may be encountered and you may be unable to sample the full length.

If the full length of the line cannot be sampled, record the distance you actually sampled, and explain in the Comments section why the remainder was not measured.

Possible situations are:

1. **Normal conditions** — Sample both 24 m transects using the procedures outlined in Section 8.3.
2. **Anomalous conditions —** If the sample line intercepts an anomaly within the polygon such as a stream, pond, avalanche chute, on a rock outcrop (Figure 8.1) continue to sample the line as long as it is safe to do so. If the debris is floating, the pieces are measured in their location at the time of sampling (make a note of this in the comments).

Note: Irregularities, such as swamps, rock outcrops, roads, and trails, are to be sampled **if they are part of the polygon**.

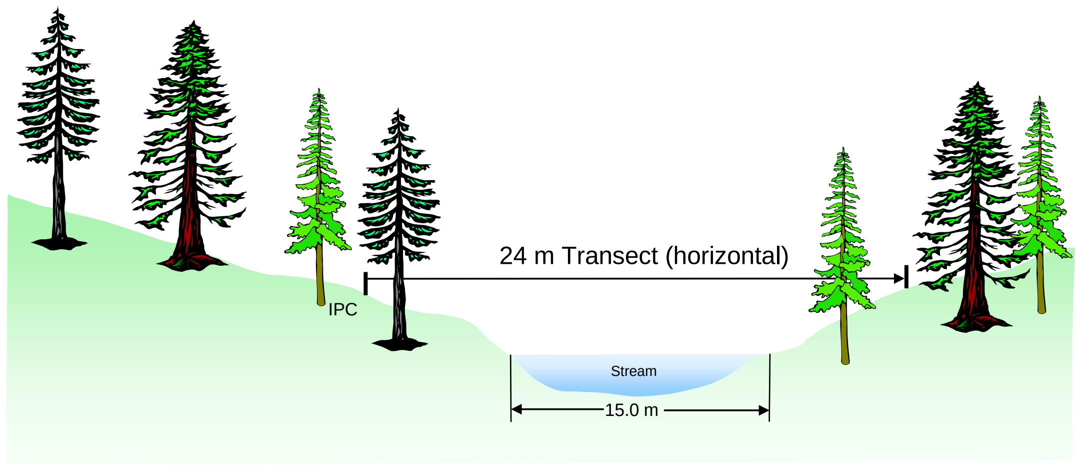


Figure 8.1 - CWD Transect Encounters an Anomaly Within the Polygon

3. **Unsafe conditions —** If the sample line intercepts unsafe conditions, record the length of the line actually sampled in the field.(for example if you encounter a cliff at metre 19 record "horizontal length observed 19 out of 24" Note in the Comments section why a portion was not sampled.

4. One or both transects encounter the polygon boundary

   If the sample line would cross the polygon boundary and enter a different polygon:

   - Stop at the polygon boundary and follow the original line back into the polygon (called the 'bounce-back' method).
   - Continue recording the CWD along the line in the reverse direction to complete the required 24 m sampling transect.
   - Although each CWD is measured a second time, record it again with a new number (Figure 8.2).
   - If the polygon boundary is reached before the halfway point (before 12 m), the bounce-back will pass through and past the Integrated Plot Centre.

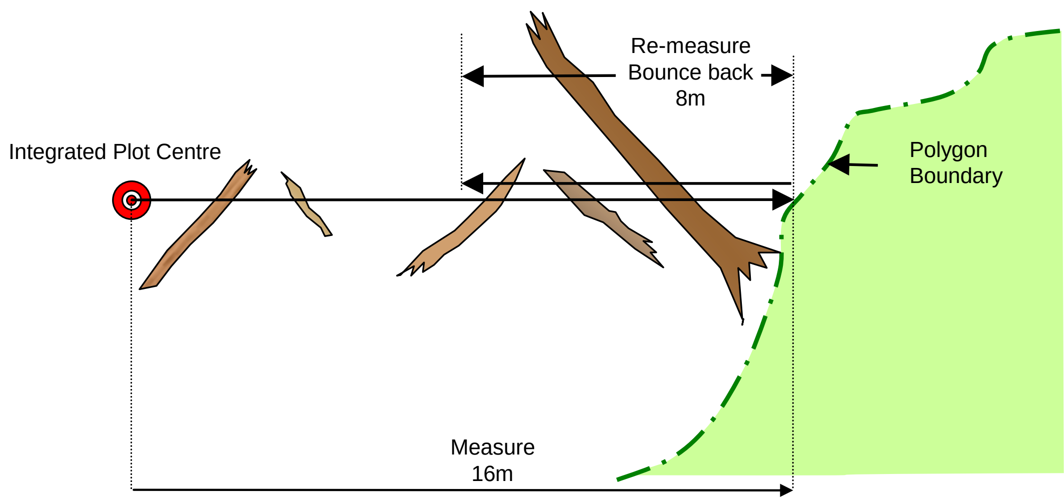


Figure 8.2 - The Bounce-Back Method When the Transect Intersects the Polygon Boundary

5. Transect encounters a heavy accumulation of CWD

If a heavy or very heavy accumulation of CWD is encountered (for example, windthrow, felled and bucked timber, logging debris), the transect may be partially sampled. Each transect is individually assessed and a decision to split the transect is made before establishing each transect. Partial sampling reduces potential errors and sampling time.

- On **heavy** accumulations sample as follows:
  - even azimuth: sample the 2nd quarter (from 6 to 12 m) and the 4th quarter (from 18 to 24 m)
  - odd azimuth: sample the 1st quarter (from 0 to 6 m) and the 3rd quarter (from 12 to 18 m)
  - record the length observed as “12 m of 12 m”
  - note in the Comments section the type of accumulation encountered, such as windthrow, felled and bucked timber, cold decks, or logging debris.
- If the line falls on **very heavy** accumulations, sample the partial line as follows:
  - even azimuth: sample the 2nd quarter (from 6 to 12 m)
  - odd azimuth: sample the 3rd quarter (from 12 to 18 m)
  - record the length observed as “6 m of 6 m”
  - note in the Comments section the type of accumulation encountered, such as windthrow, felled and bucked timber, cold decks, or logging debris.

8.3 Sampling CWD Along the Transects

Which CWD to measure

Measure the following along the transects:

- All pieces of CWD greater than 7.5 cm in diameter (or an equivalent area at the crossing of 44.2 square centimetres measured perpendicular to their length for odd shaped pieces) where the centreline is crossed by the vertically projected transect.
- Fallen or suspended (not self-supporting) dead tree boles, with or without roots attached, that intercepts the vertically projected sample line whether the transect passes above or below the CWD (Figure 8.3). CWD may be suspended on nearby live or dead trees, other coarse woody debris, stumps, or other terrain features. Visually estimate un-measureable suspended CWD at the intercept point.

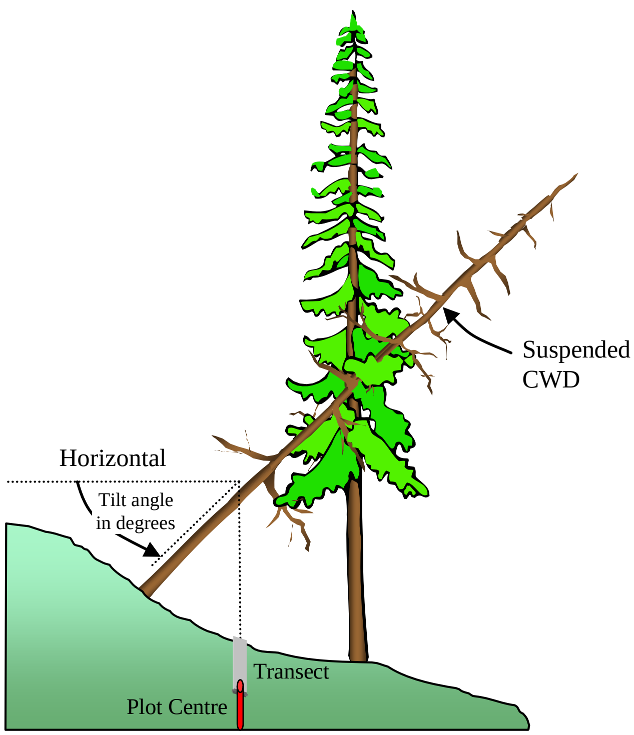


Figure 8.3 - Measuring Suspended CWD

- Fallen trees with green foliage if they are no longer rooted to the ground.
- Large fallen branches and fallen broken tree tops, horizontal or leaning.
- Pieces that are physically attached (lengthwise) are considered to be one piece.
- Recently cut logs.
- Uprooted (not self-supporting) stumps greater than 7.5 cm in diameter and less than 1.3 metres in length, and any exposed dead roots greater than 7.5 cm.
- CWD that lies above the soil (Figure 8.4). CWD is considered no longer above the soil when it is entirely buried beneath a layer of surface organic matter (forest floor) or mineral soil.

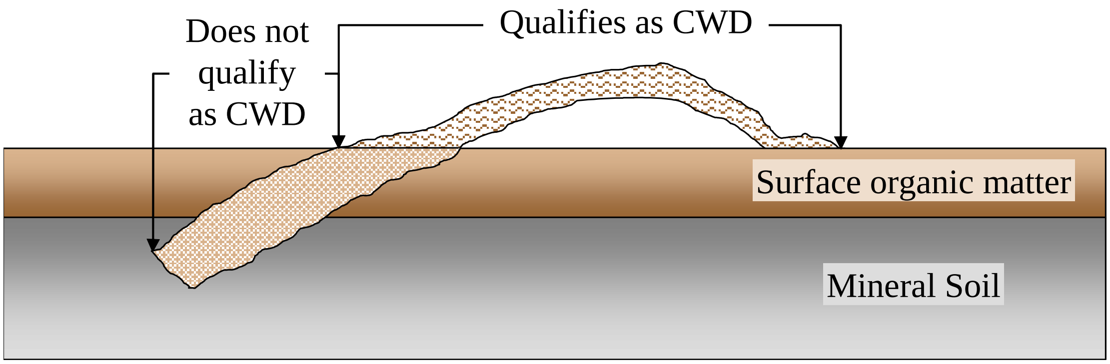


Figure 8.4 - Side View of Partially Buried Coarse Woody Debris

Do not measure the following:

- live or dead trees (still rooted) which are self-supporting
- dead branches still connected to standing trees
- exposed roots of self supporting trees
- self-supporting stumps or their exposed roots
- a piece is no longer considered CWD when the wood is decomposed to the point where it could be described as forest floor humus.

Determining "in" or "out" CWD

To be measured the CWD piece must be greater than 7.5 cm in diameter (or equivalent) at the point where the line transect crosses the centreline. The *centreline* is the midline of any section of wood (Figure 8.5 and 8.6.), and may not correspond to the pith.

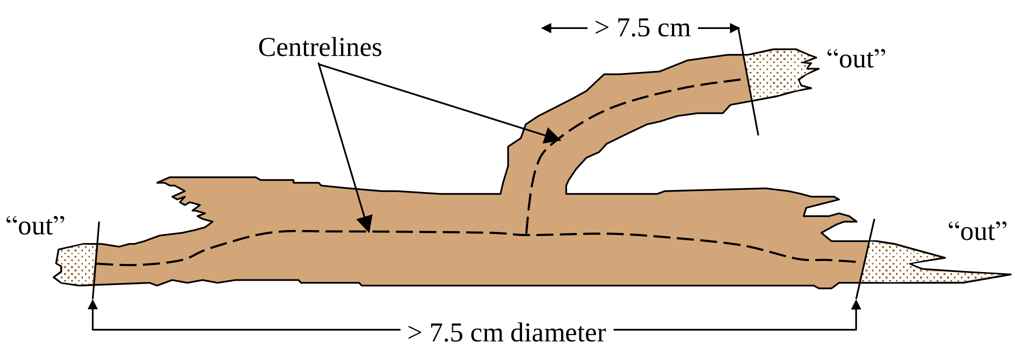
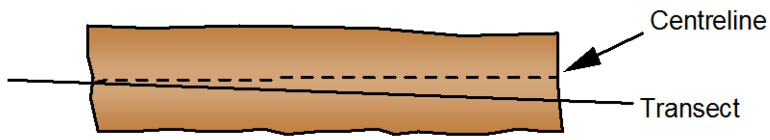


Figure 8.5 - Centreline of a CWD Piece (Top View)

If the sample line appears to follow the centreline of the CWD, decide whether it is "measured" (transect line crosses centreline of CWD) or "not measured" (transect line does not cross centreline). If the sample line is close to the centreline at the end of the CWD, decide whether it is "measured" (transect line crosses centreline of CWD) or "not measured" (transect line does not cross centreline).



If the sample line is close to the centreline at the end of the CWD, decide whether it is "measured" (transect line crosses centreline of CWD) or "not measured" (transect line does not cross centreline).

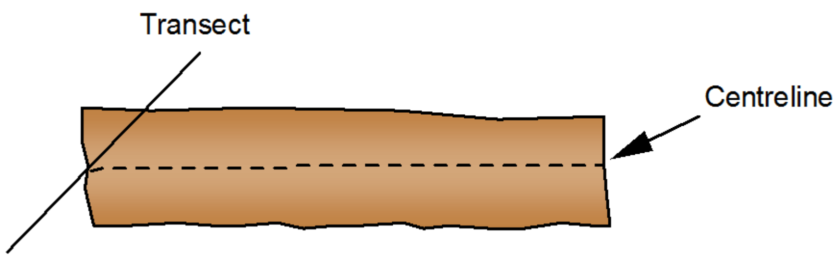


Figure 8.6 - Measuring CWD Near the Centreline of the Piece (viewed from above)

Measuring CWD in the Standard Transect Section

For each CWD record the following:

SPECIES	Record tree species at the level it is reliably known. See Code Table below.
DIAMETER	Record the diameter (to nearest 0.1 cm) perpendicular to the point where the transect crosses the centreline of the CWD. For non-circular pieces, record in the "Accumulation and/or Odd-shaped Pieces" by a different method.
LENGTH (*OPTIONAL*)	Note the length of the piece of CWD.
% DECAY CLASS 1 (*OPTIONAL*)	Record the percentage of "Class 1" wood at the transect crossing.
CLASS OTHER (*OPTIONAL*)	Record the decay class of the **remaining** percentage at the transect crossing.
TILT ANGLE	Measure the tilt angle of the piece, in degrees.
MERCHANTABLE	Note if the piece is merchantable (X grade or better).
P/R	Note if the CWD is a product likely to be removed (P/R).
DECAY CLASS FOR PIECE	Record the decay class of the CWD piece.

SPECIES

1. Record the tree species using the approved tree species code from the BC Tree Code List.
2. If the species or genus cannot be determined, record the best available information as follows:

Zc _	other conifer not on the list (record species name in Comments section)
Xc _	unknown conifer
Zh _	other hardwood not on the list (record species name in Comments section)
Xh _	unknown hardwood
X _ _	unknown (you cannot determine if it was conifer or deciduous)

DIAMETER

1. Record (to nearest 0.1 cm) the diameter (or equivalent) of the CWD perpendicular to the bole at the point where the transect crosses the CWD (Figure 8.7).

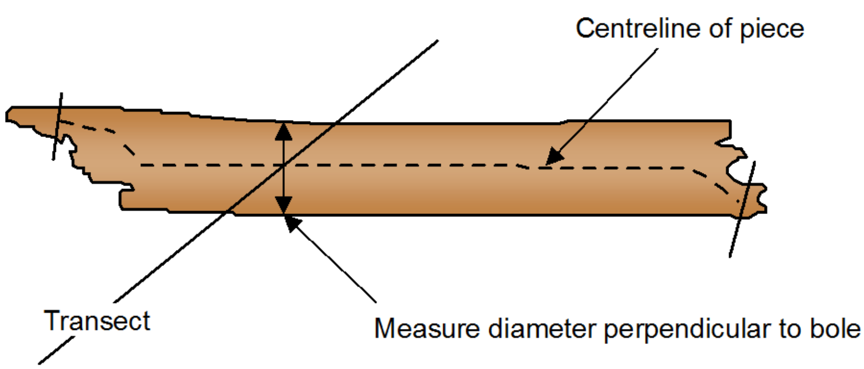


Figure 8.7 - Measuring Diameter of Circular CWD Cross Sections

2. If the sample line intersects a curved or angular CWD more than once, measure each intersection as a separate observation, as shown in Figure 8.8.

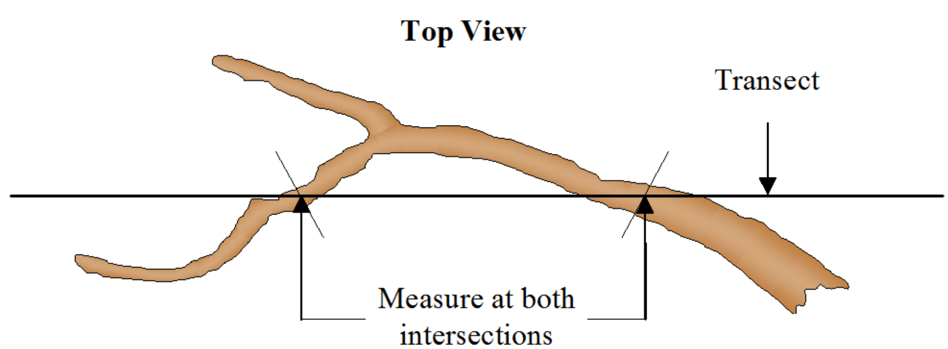


Figure 8.8 - The Sample Line Intersects the CWD More Than Once

3. If the cross section is oval rather than circular estimate an "equivalent diameter" that will more accurately suggest the cross-section area. If the cross section is hard to express as a circle (or equivalent to a circle), refer to the procedures for measuring odd-shaped CWD.
4. Estimate an "equivalent" diameter for the remaining portion of CWD where part of the wood has decayed and become part of the soil layer.
5. If a log has split open but is still partially held together, record the equivalent diameter as if the piece were whole. If a stem has shattered into a number of distinct unconnected pieces, record each piece that is larger than 7.5 cm in diameter at the point of sampling.
6. If the CWD is hollow, estimate the diameter equivalent to the remaining wood.

LENGTH

For the Provincial VRI, the measurement of piece length is not required. A field has been left on the field card in case specific projects require length measurements for other purposes.

% Decay Class 1 (at the Transect Crossing)

(This is optional as of field season 2012)

All CWD cross sections will be assessed a percentage decay class 1. The decay classes are shown in Table 8.1.

- Determine the percentage decay class 1 by probing the CWD close to the point of intersection with an axe (do not destroy the CWD at the line intercept)
- Record the percentage of decay class 1
- If decay class 1 equals 100%, record as "__ __"
- If decay class 1 equals 0%, record as "00"

Note: Percentage decay class 1 is an estimate across the cross section, not for the CWD as a whole. Decay class 1 is equivalent to wood commonly referred to as "sound" which is suitable for lumber or chips (regardless of the length or diameter).

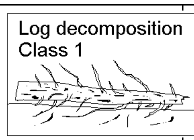
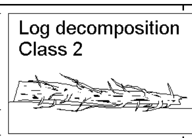
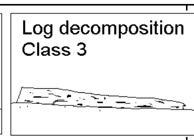
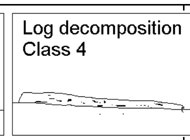
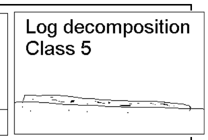
CLASS OTHER (AT THE TRANSECT CROSSING)

(This is optional as of field season 2012)

Record the decay class of the **remaining** percentage of the CWD piece cross section using the classification scheme shown in Table 8.1.

- The emphasis is on the wood texture. Other criteria, such as portion on the ground, twigs, bark, shape, and invading roots, are guidelines to the wood texture.

Table 8.1 — Coarse woody debris decay classes

					
	CLASS 1	**CLASS 2**	**CLASS 3**	**CLASS 4**	**CLASS 5**
WOOD TEXTURE	**intact, hard**	**intact, hard to partly decaying**	**hard, large pieces, partly decaying**	**small, blocky pieces**	**many small pieces, soft portions**
Other associated characteristics					
PORTION ON GROUND	elevated on support points	elevated but sagging slightly	sagging near ground, or broken	all of log on ground, sinking	all of log on ground, partly sunken
TWIGS < 3 cm (if originally present)	twigs present	no twigs	no twigs	no twigs	no twigs
BARK	bark intact	intact or partly missing	trace bark	no bark	no bark
SHAPE	round	round	round	round to oval	oval
INVADING ROOTS	none	none	in sapwood	in heartwood	in heartwood

TILT ANGLE

The tilt angle is the angle, measured in degrees, between the central axis of the CWD and the horizontal plane at the crossing point (Figure 8.9).

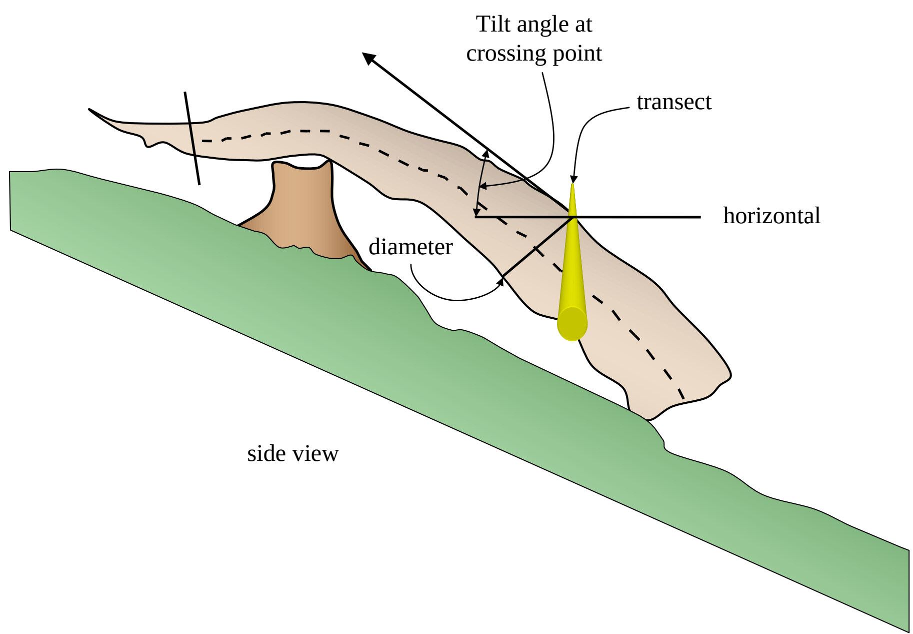


Figure 8.9 - Measuring the Tilt Angle of CWD Pieces

Measure the angle the CWD makes from the horizontal, regardless of the slope of the ground. Normally you can place a clinometer on the top surface of the CWD at the point of the intercept and record the angle in degrees.

MERCHANTABILITY

If the CWD is an X grade or better, record it appropriately. An X grade or better may potentially be harvested.

PRODUCT TO REMOVE P/R

This procedure is designed to accommodate wood that might be removed from the site. If the piece is expected to be removed as product (for example, blowdown which is scheduled for harvest, shakeblocks or felled and bucked material), record.an "X" in the P/R Column. This does not include a merchantable piece that is expected to be left on site.

DECAY CLASS FOR PIECE

Record the class for the entire CWD piece using the classification scheme shown in Table 8.1.

- Decay Class is based on the wood texture. Assess the conditions along the entire piece length to determine Class on the basis of volume. Other criteria, such as the portion on the ground, twigs, bark, shape, and invading roots, are guidelines to the wood texture.

Measuring Odd-Shaped CWD

Record any odd-shaped CWD encountered in the appropriate section of the field card.

Note: It is important that any CWD that is not round or oval in cross section be recorded in this category. A different volume compilation formula is used because the measurement is made along the transect line, **not** at right angles to the centreline of the CWD.

1. Record the species of the CWD.
2. Measure the full horizontal length and average vertical depth of the CWD along the transect (this gives a rectangular area equivalent to the cross section along the transect).
   - the length is the **full** distance along the line intersect (shown as "L" in Figure 8.10).
   - the depth of the cross section is the **average** depth along the line intersect (shown as "D" in Figure 8.10).

   Note: It is incorrect to measure the length and width, average the values, and record it as a circular cross section.

   Example: An odd-shaped CWD is 25 cm x 40 cm.

   Consider the cross section as a rectangle and record the 25 and 40 in the accumulations section.

   Record the other information in the same way as in the "standard transect" section for round pieces.

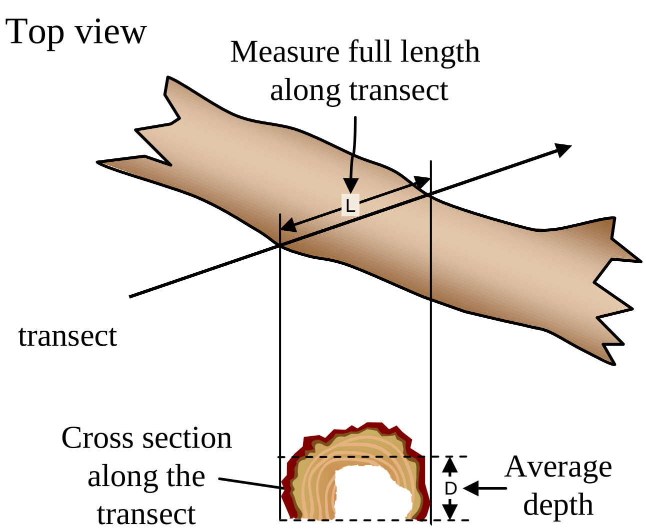


Figure 8.10 - Measuring the Horizontal Length and Vertical Depth of Odd-Shaped CWD

Measuring Accumulations

In heavy accumulations that cannot be safely or accurately measured, record an estimate of the depth and length of the accumulation.

1. Record the **full** horizontal length of the line intercept through the accumulation, and the **average** vertical depth of the accumulation. Visually compress the pile to measure the actual cross sectional area of wood, not the space between the pieces, as shown in Figure 8.11.
2. Identify and record species, as possible.

If the mixture of species is complex or too difficult to identify, record the following:

Zc _	other conifer not on the list (record species name in Comments section)
Xc _	unknown conifer
Zh _	other hardwood not on the list (record species name in Comments section)
Xh _	unknown hardwood
X _ _	unknown (you cannot determine if it was conifer or deciduous)

3. If species can be determined, estimate the proportion of each, and record length and depth for each species separately.

Note: This horizontal and vertical cross section is the part which is *along the transect line*, not the average of the entire pile, and CWD described in this way is treated as rectangular in cross section.

4. For each species, record the other information in the same way as in the standard transect section.

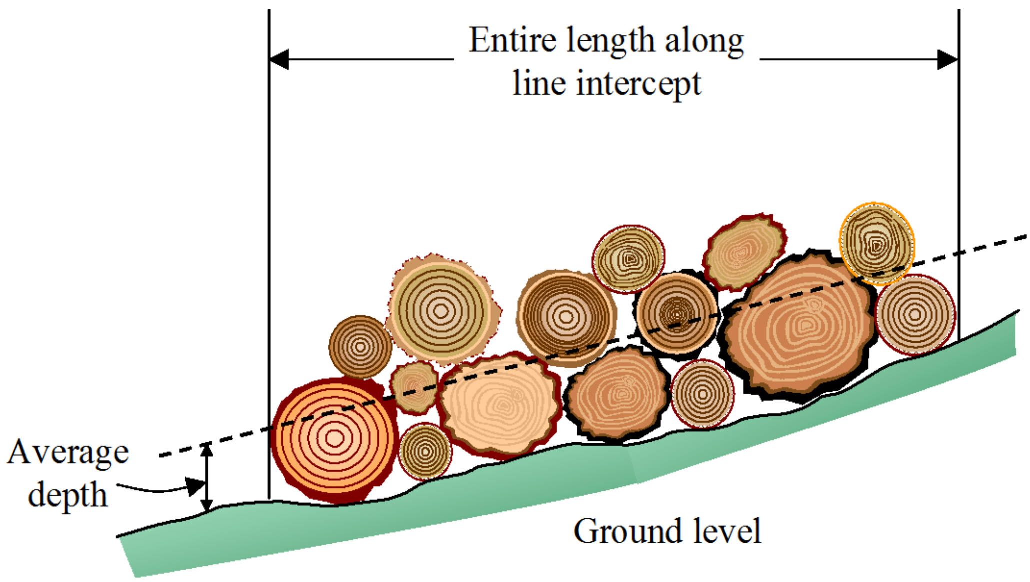


Figure 8.11 - Measuring an Accumulation of Coarse Woody Debris

9. Range Resources

Introduction

Livestock and wildlife species use shrub and herbaceous biomass at various times of the year, and depend on the availability of these plants for their health and survival.

To manage livestock, range managers also need estimates of forage production and utilization of graminoids and forbs. This information may be used to allocate forage to livestock and wildlife in selected areas, to create short- and long-term plans, to make decisions on range improvements, to determine seral stages of plant communities, and to measure changes in plant community composition over time. Species composition and identification of site series is described in Section 7.

Forage production estimates may be correlated with other vegetation (such as forest or terrestrial) cover attributes and then projected across the growing season for site series or other vegetation classes.

Forage utilization information is used to adjust production estimates to reflect total forage abundance prior to grazing by wildlife or livestock. These estimates may also be used to determine use zones and may also contribute towards range-use planning (along with other range samples). Forage measurements in the CMI procedures can be made at any time during the growing season, therefore range managers may choose to use these estimates only as an indication of total production or utilization for that location.

Range managers require information on the species composition of livestock forage and identification of site series. The method for generating a comprehensive vegetation list for identifying site series is described in Section 7: Plants, Soils and Old Growth.

Objectives

1. To provide estimates of forage production of graminoids and forbs by clipping plots.
2. To provide estimates of forage utilization of graminoids and forbs using forage utilization classes.

Definitions

Where indicated, definitions are from *A Glossary of Terms Used in Range Management*, Society for Range Management (S.R.M.) 1989.

Foliar Cover is defined as the percentage of ground covered by the vertical projection of the aerial portion of plants. Small openings in the canopy and intraspecific overlap are excluded. Foliar cover is always less than canopy cover; either may exceed 100% (S.R.M.).

Forage Production is the weight of forage that is produced within a designated period of time on a given area. The weight may be expressed as either green, air-dry, or oven-dry. The term may also be modified as to time of production such as annual, current year’s, or seasonal forage production (S.R.M.). Production can also be expressed as animal unit months (AUMs), which is the amount of dry forage required by one animal unit for one month based on a forage allowance of 26 pounds (11.7 kg) per day.

Forbs are any broad-leafed herbaceous plants except Gramineae (or Poaceae), Cyperaceae and Juncaceae families (S.R.M.) and, for forage measurement purposes, include ferns and fern allies, club mosses, and horsetails.

Graminoids are grass or grass-like plants (sedges and rushes) such as *Poa*, *Carex*, and *Juncus* species (S.R.M.).

Phenology is the study of periodic biological phenomena which are recurrent, such as flowering or seeding, especially as related to climate (S.R.M.).

A shrub is defined as a plant that has persistent woody stems and a relatively low growth habit and that generally produces several basal shoots instead of a bole. It differs from a tree by its low stature (generally less than 10 m) and non-treelike form (*Glossary of Range Terms*, Ministry of Forests 1994). Appendix K Low woody species and intermediate life forms lists doubtful lifeform species that are, for the purpose of this inventory, to be considered forbs and not shrubs. Therefore they are to be included in the clipped plot and not in the line intercept.

Stolon is a horizontal stem which grows along the surface of the soil and roots at the nodes (S.R.M.). A stoloniferous plant is a plant that has stolons.

Utilization is the proportion of current year's forage production that is consumed or destroyed by grazing animals. May refer either to a single species or to the vegetation as a whole (S.R.M.).

Utilization refers to the percentage of plant weight removed, not the percentage of plant height removed.

General Procedures

Forage production measurements are discussed in this section. The recommended sequence of procedures is shown below:

1. On the transect line established for the measurement of woody debris, establish the forage sampling micro-plots.
2. Estimate and record forage use.
3. Clip the forbs and graminoids to measure forage abundance.

Field Cards for this Section

Range Sampling (RS) (Appendix A, Figure A.7)
forage production section only (it should be noted that the existing field cards indicate the collection of information that is additional to the data collection requirements for this program.)

Detailed Procedures

9.1 Establishing Forage Sampling Micro-Plots

Forage production measurements are usually made immediately after the Integrated Plot Centre (IPC) is established to avoid trampling of the forbs and graminoids.

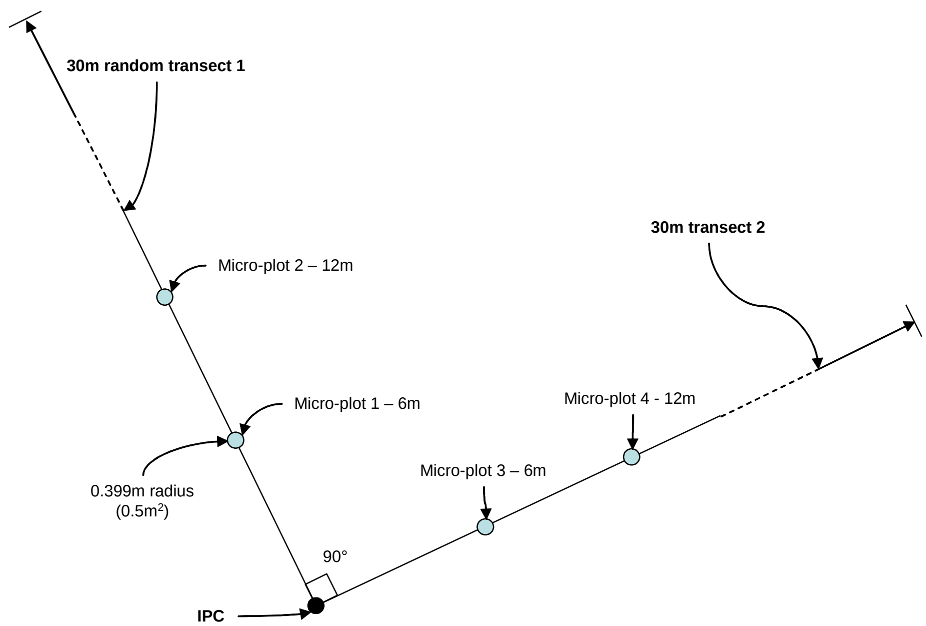


Figure 9.1 - Range resources sampling transects and micro-plots.

Procedure

1. Using the coarse woody debris transects, establish four micro-plots at points 6 m and 12 m (horizontally corrected distance) from the IPC. Each micro-plot has a radius of 0.399 m and an area of 0.5 m^2.
2. The design of the transects and micro-plots is shown in Figure 9.1.

9.2 Estimating Forage Utilization

Procedure

1. Examine the herbaceous plant use within each of the four micro-plots and the area immediately adjacent (1 — 2 m around) and estimate forage use. Refer to Table 9.1 for a description of utilization classes and codes. You may find the utilization gauge developed by the USFS Rocky Mountain Forest and Range Station useful for some British Columbia species.
2. Record the utilization code on the field card before clipping herbaceous plants as described in Section 9.3.

Table 9.1 - Herbaceous forage utilization classes and codes

Code	Class	Range (% utilized)	Utilization
0	Nil	(0%)	The plants show no evidence of use.
1	Slight	(1 to 15%)	The plants show very little evidence of use and have the appearance of very slight grazing. Key forage plants may be topped or slightly used. Current seed stalks and young plants of key species show little disturbance.
2	Light	(16 to 35%)	The plants may be topped, skimmed, or grazed in patches. Low-value plants are ungrazed and 60 to 80% of current leafage of key plants remain intact.
3	Moderate	(36 to 65%)	The plants appear rather uniformly grazed. Fifteen to 25% of the number of current leafage of key species remain intact. No more than 10% of the number of low-value forage plants are used. (Moderate use does not imply proper use). Applied to a use zone, the area is entirely covered as uniformly as natural features or livestock facilities will allow.
4	Heavy	(66 to 80%)	Key species are almost entirely used, with <10% of the current leafage remaining. More than 30% of the number of low-value plants have been utilized. Applied to a use zone, the area has the appearance of complete search. Some trampling damage may be evident.
5	Extreme	(>80%)	Key species that are carrying the grazing load and are closely cropped. There is no evidence of reproduction or current seed stalks of key species. Applied to a use zone, the area has a mown appearance, and there are indications of repeated coverage. Trampling and trailing is evident.
From *Procedures for Environmental Monitoring in Range and Wildlife Habitat Management*, Habitat Monitoring Committee 1990			

9.3 Clipping the Plot

Procedure

1. All plots will be fully clipped. Record an “X” in the “full” box on the field card.
2. Collect and label the current year’s growth of herbaceous material. Clip all the live material (at a height of 2 cm) of the forbs and graminoids in each of the four micro-plots. The material will be oven-dried in a drying oven at 55° C for 24 hours, and weighed in the field office. This measurement is used as an indicator of forage production.
3. Clip all forb and graminoid species as listed in the B.C. Ministry of Forests Vegetation Coding List.
   - Clip a forb or graminoid if the germination point is within the plot.
   - A plant is considered “in” or “out” of the plot depending on the germination point where the plant enters the soil.
   - A stolon from a stoloniferous plant (such as wild strawberry) rooted within the plot is considered part of the plot. (Clip the stolon at the plot boundary if the stolon is rooted outside the plot perimeter.)

- A non-rooted stolon connected to a stolon rooted within the plot is considered part of the plot.
- If a plot splits a large clump of grass (where the germination point is not easily determined) then clip the portion within the plot.
- If the base of the forage is in standing water, clip the material below water line at the 2 cm height if practical. If not practical, clip the material at the water line and record an estimate of the portion clipped in the comments.
- Clip doubtful forb species listed in Appendix K — Low woody species and intermediate life forms.
- Do not spend excessive time separating live current year's growth from dead vegetation. If a small amount of dead forbs or graminoids are present, simply remove a corresponding amount of live material. This will save time and still give a reasonable estimate of forage production.

4. Record (Y/N) on the RS Field Card (Appendix A, Figure A.7) if the forbs or graminoids have been collected.
5. Place the clipped samples in collection bags. Keep the forbs and graminoids in separate bags. Group all the forbs for a sample (4 micro-plots) in one bag and all graminoids for a sample in a separate bag.
6. Complete the sample labels (Figure 9.2) and return the bags to the field office where they will be oven dried (55°C for 24 hours) and weighed, and the information recorded on the RS field card. It is appropriate to air dry the sample before oven-drying. To air-dry, leave the forage in paper bags open in a warm dry room for several days as necessary to remove excess moisture. Rotate the forage in the bags to ensure even drying and to prevent decomposition.

Appendix K provides a list of low woody species and species of doubtful lifeform assigned to the herb (C) layer. These plants are collected as forbs in the forage production plots. A complete species list is available for downloading in Access97 database format or as an Excel file from the following locations via the RISC or Ministry of Forests websites at: http://www.for.gov.bc.ca/research/becweb/standards-species.htm

The species of doubtful lifeform are listed as "lifeform 12" on these files.

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