DRAFT

VEGETATION INVENTORY

Sampling Procedures

As presented to the
Vegetation Inventory Working Group
by the Sampling Team

March 31, 1995
Preamble

The Resources Inventory Committee consists of representatives from various ministries and agencies of the Canadian and the British Columbia governments. First Nations peoples are represented in the Committee. RIC objectives are to develop a common set of standards and procedures for the provincial resources inventories, as recommended by the Forest Resources Commission in its 1991 report The Future of Our Forests.

Primary funding of the Resources Inventory Committee work, including the preparation of this document by the Vegetation Inventory Working Group, is provided by the Canada-British Columbia Partnership Agreement on Forest Resources Development: FRDA II is a five year (1991-1996) $200 million dollar program cost-shared equally by the Federal and Provincial governments. Additional support has been provided by some of the organizations listed beside the names of the specialists which their organizations allowed to participate in the VIWG process.

The contents of this report are presented for discussion purposes only. A formal technical review of this document has not been completed. Funding from the partnership agreement does not imply acceptance or approval of any statements or information contained herein by either government. This document is not official policy of the Canadian Forest Service, nor of any British Columbia Government Ministry or agency.

For additional copies, any/or further information about the Resources Inventory Committee and its various Task Forces, please contact:

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The Vegetation Inventory Working Group (VIWG) within the Terrestrial Ecosystems Task Force has produced recommendations and procedures for inventories of vegetation within the Province. The major reports prepared by the VIWG [dated March 31, 1995] are as follows:

- Final Recommendations Vegetation Inventory Working Group
- The British Columbia Land Cover Classification
  Background and Definitions - A Working Document
- Vegetation Inventory - Draft Photo Interpretation Procedures
- Vegetation Inventory - Draft Sampling Procedures

The documents and their associated procedures have undergone pilot testing in a variety of areas within the Province. They will be used extensively in operational and training projects in 1995 during which modifications will surely follow. Suggestions and critiques are welcomed.

Additional copies of any of the above reports are available at:

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AFFECTATION INVENTARY
WORKING GROUP REPORTS
MARCH 1898

The Vegetation Inventory Working Group (VIVG) within the Terrestrial Ecosystems Project focuses on developing recommendations and protocols for vegetation occurrence determination and description.

The following are recommendations for the VIVG working group:

- Terrestrial Ecosystems Vegetation Inventory Working Group
- Terrestrial Communities and Eco-Community Development and Definition - A Working Document
- Vegetation Inventory - Draft Field Investigation Procedures
- Vegetation Inventory - Draft Sampling Procedures

The recommendations and their associated procedures have been included herein to assist in a variety of areas within the project. They will be used communally in accordance with their purpose in 1999 and subsequent years.

Additional copies of some of the above reports are available at:

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SAMPLING TEAM MEMBERS
[as of January 1995]

A sampling team was established to provide expertise on sample establishment and measurement procedures. The team members were drawn from Industry, Educational Institutions, Ministry of Environment and the Ministry of Forests. This group has met regularly over the past few months developing the measurement procedures.

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Chapter 1
General Process
Vegetation Inventory

Chapter 1
General Processes
Sampling Procedures for the Vegetation Inventory 1994 Test Projects

General Process

The inventory provides estimates for vegetation characteristics. These characteristics, such as soil type, biomass, site index, etc. are called the "parameters" of interest. By a correct and careful combination of initial estimates, ground samples, correct use of the data and final adjustments we expect to get:

- Appropriate overall totals.
- Reasonable estimates for individual polygons.

The design of the inventory is in two phases:

- Estimates of all polygons from mid-scale aerial photography.
- Ground samples in some of the polygons for adjustment of the estimates.

The initial estimates, made on all polygons, cannot cause a bias in the inventory, but they are essential in the efficiency of the inventory. If these estimates are consistently proportional to the actual values then the ground samples will quickly adjust these estimates to an unbiased final total. In addition, the polygon-specific estimates will also be close to the correct value. In this phase "consistency" is the watchword. The consistency which this refers to is between the estimated and the actual polygon values for a particular parameter. If all the estimates are off by +40% there is no problem. If the estimates vary from -20 to +20 then that would be a problem.

The ground work can cause bias in the inventory, and therefore must be done correctly and carefully. In this phase of the work "accuracy" is the watchword. Any errors in the ground samples are translated directly into errors in the inventory.
Sample Selection Principles

There is considerable flexibility in how initial polygon estimates are done. In essence, the estimation phase of the inventory simply cannot lead to a bias in the final answer. The ground phase, however, can easily lead to a bias, and the first bias encountered is when a proper sample is not selected. Without a proper sampling method we cannot have an unbiased inventory.

One of the first principles of sampling design is that the probability of selecting a sample for measurement must be known. This means a formal method of selecting the positions for sampling which has been carefully reviewed by technical specialists in sampling theory. The final choice, from many possible schemes, is based on considerations of efficiency and simplicity. This also means that moving plots is never acceptable. Many studies have shown that people trying to do the right thing by moving plots to a more representative area have made the answers worse, not better. In addition, the technical credibility of the inventory is destroyed by this process.

Polygon Sampling

In this inventory, we have an estimate for many of the parameters of the polygon, as estimated by Phase I photo interpretation. Since these estimates are to be corrected by the subsequent field work, the appropriate sampling method is to sample the polygon. In doing so, the number of plots will be chosen depending upon travel time, time on site, site complexity, etc. Technically, a set of plots used to produce one number in this way is called a "cluster", even though they will be spread out through the area. The cluster of plots used should be spread out as much as possible to produce one average summary to be compared to the polygon estimate.

Polygons will be chosen on the basis of area. This ensures that each hectare has an equal chance of being chosen. For example a 200 ha. polygon has four times the chance of being chosen as a 50 ha. polygon. This procedure is fairly general, and allows the data to be used in a number of ways. More complicated sampling schemes are slightly more efficient, but restrict the use of the data and they complicate the use of the plots in future remeasurements.

The number of clusters within the polygon will be selected by the project manager. This is based upon physical and economic considerations.
Sampling Principles in the Inventory

Purpose of ground measurement

There are two main purposes for the data from plots measured inside a polygon:

- The first purpose is to estimate the proper total for the population. This is fairly straightforward, and is common to most inventories. For modern planning and inventory uses simply having the correct totals, even by strata, is no longer sufficient.
- A second purpose is to distribute this total into adjusted descriptions for each polygon.

Having the data available by polygon has many data handling advantages, but the main reason is that it gives us the chance to get polygon-specific answers which are better than simply using the average for a large vegetation type. The choice of method depends upon whether the estimation phase of the inventory has already made an estimate of that population parameter.

Use of the field data

1) The "ratio" or "correction" approach.

Field data is used to determine the relationship of the "true" value compared to some previously "estimated" value. Using site index as an example, the true site index would be determined by a series of measurements, then compared to the estimated value. This relationship would, on the inventory level, be used to correct all the estimated site indexes. In most cases, a regression would be used to calculate the relationship.

2) The simple estimate approach.

For soil depth as an example, if it has not been estimated in advance, the ground visit is to get an estimate which is used directly. This approach is a less efficient system than the ratio approach but it is necessary in many instances where initial estimates are not available.

At some future time, based on research or further sampling, we may decide to raise the estimate on some polygons, and lower it on others with the restriction that the total be constant. This process ensures that the overall answer is still proper, and any changes we make are attempting to improve the polygon-specific answers.
Sampling Design

Placement of Plots

For both approaches, the objective is to gather average attribute values for the polygon. For this reason the sample points are spread out as much as is reasonable inside the polygon to sample across the variability.

In each instance, plots would not be moved to "more typical" areas. There are many purposes to which the inventory data will be applied, and there is simply no way to choose a "more representative" placement even when you are on the ground. It is therefore a very fundamental principle that plots be placed wherever they fall. Special procedures will be used when this constitutes a temporary or permanent safety hazard, but the principle of original placement is important and will be maintained. The intent is to not endanger field crews.

Selection of polygons to sample

The field crew will be provided with the preselected co-ordinates within the vegetation polygons selected to sample, and therefore this discussion is for general information only. There are many ways to select the polygons to sample. From a statistical point of view it would be desirable to "spread" the samples across the high to low values in the population. An example might be to choose the polygons from a list which is first sorted by site index in order to insure that a sample is taken across the entire site index range. Another example might be to sort the polygons by land use to ensure that each item is represented in the sample by nearly the same proportion it represents in the population. A random or systematic sample might miss a small land type altogether.

The choice of how to select the polygons is one of efficiency, therefore it will probably be made on an individual inventory basis as an operational decision. For any of these systems, the sample will represent a selection which can be defended on the basis of statistical correctness.

Adjustment of estimated answers

The field work alone would allow us to calculate appropriate totals and distributions for items of interest. On the other hand, we wish to have the best answers on a polygon-to-polygon basis for users of the inventory. Since many polygon characteristics can be reasonably well estimated from aerial photography or other data sources, at least in a relative sense, these initial estimates can be used. The old inventory methods made partial use of this philosophy when they lumped areas thought to be alike into strata.
and gave them all the same answer. In this case, we choose not to "lump and average", but to use a continuous form of adjustment.

When the inventory is complete, we will be able to get a relationship between the many estimated and actual values. At this point, the intent is to go to each of the estimated polygon answers and adjust them by just enough to obtain an overall answer which is indicated by the field work. As an example, if the estimates were always 2% low, each of them could be individually raised by 2%, so that the sum of the polygons adds up to an unbiased answer for the entire inventory and the estimates are changed by the minimum amount to accomplish this.

In the future, we may decide to readjust the polygon values. In this case, the principle will be to retain the correct sum (e.g. for total volume), but allow individual polygon estimates to change in some way that research has shown will lead to better answers on a polygon-to-polygon basis.
Vegetation Inventory

Chapter 2
Plot Establishment
Vegetation Inventory

Chapter 2
Plot Establishment
Plot Establishment

Plot Location Procedures

Tie Point Location

Basic Premise
These procedures are designed for the current technology using survey field methods such as compasses, clinometers and distance measuring equipment. When the operational usage of "real time" Global Positioning Systems (GPS) is available these procedures will be revised.

Procedures
- selection of tie point is the responsibility of the field crew
- the objective is to ensure that the sample is correctly located and therefore in the correct polygon
- the selection of the tie point should permit efficient access to the sample
- the tie point must be locateable on:
  - the ground, and
  - the tie point should be locateable on the appropriate mid-scale aerial photo;
  - the appropriate forest cover map
- Field location
  i) the potential field locations are numerous; some suggested locations are:
     - road junctions [use the intersection of the road centre line]
     - in some cases pre-located GPS. tie-points will be established
     - bridges on stream crossings [on small creeks use the centre line of the bridge at the middle of the creek; on larger streams denote which edge of the stream was used]
     - definite projecting timber boundaries
     - creek junctions
     - well defined swamps, ponds, or lake edges
ii) cut blocks or roads - where the features are definitely locateable [use caution when using cutblock edges since in some cases additional harvesting may have occurred etc.] If any doubt exists as to the cutblock location measure from a topographic feature.

- Photo tie point establishment
  - locate the appropriate, reliable tie point visible on the field photo
  - pin prick the field photo
  - record the tie point location on the back of the photo with the following information:

  ![T.P. Project l.D., Sample No.](image)

  [75 m. @ 270 degrees on road
  hence 198 m. at 135 degrees]

  **Figure 2.1**

  _Aerial Photo Marking_

- Forest cover map establishment [in the absence of aerial photo's]
  - locate the tie point on the forest cover map
  - record the same information as above for the tie point on the map

- Field tie point establishment
  i) after selection of a re-locateable tie point the following procedure is recommended for tie point marking:

  **Note:** the tie point tree marking is primarily for relocation of the samples within the short term [up to 5 years]
  - an objective is to make the tie point visible to a field crew conducting surveys but not overly visible to the general population

  ii) select a tree of suitable size and stature such that the stem will be present for a number of years [i.e., not on the edge of a roadside where it may be subject to removal during road maintenance].

  iii) in instances where no trees are readily available a stump or other features such as a rock cut, boulder, etc. may be used.

  iv) potential ways of marking this tie tree:
  - limb the complete stem to shoulder height
  - remove understory vegetation around the tree if practical
  - spray paint the visible surfaces at eye level height
  - ribbon the tree bole
- scribe an aluminum tag and securely nail it to the base of the tree [this tag should be secured with aluminum nails at a point below potential powersaw felling height (0.3m)]
- if practical the tag should face the tie point location

v) record the diameter and species on the field card

![Provincial Vegetation Inventory](image)

**Figure 2-2**

**Tie Point Tree Tag**

- painted on four sides at d.b.h.
- metal tag below 0.3m

![Tie Point Tree Marking](image)

**Figure 2-3**

**Tie Point Tree Marking**
Note: the marking of tie points, ribboning etc. must be coordinated with the appropriate land manager, or owner.

**Compass Cards**

**Basic Premise**

the compass card provides an additional means of re-locating samples in the near and long term [20 years +] therefore efforts must be made to record all relevant data which may aid the process of relocation. It is anticipated that long term re-location will be made using a GPS system; but a plot which is not in the correct location may never be found by GPS, but may be found from the field notes! The primary use of the compass card notes will be in locating plots which have no GPS data records (see figure 2-4-Compass Card).

**Procedures**

1. a compass card(s) will be completed for each sample cluster
2. detailed compass cards shall record the following as a minimum:
   - project I.D., sample number
   - GPS records
   - survey date [year, month and date]
   - forest cover map number
   - air photo number upon which the tie point and sample are located
   - tie point tree measurements; reference tree measurements
     - species
     - DBH
     - special features of the tree, if any [i.e. major fork]
     - distance and azimuth to actual tie point location
   - other tie point feature used in absence of tie tree
   - description of actual tie point, i.e.:
     - junction Loss Creek Main and Branch 300
     - northeast corner of Cutblock 11 on Branch 302
     - northwesterly edge of snowslide track
   - distance(s) [horizontal] and azimuth(s) to the sample plot centre
   - map features along tie line such as:
     - vegetation or timber type changes
     - creek locations [names if known]
     - rock bluffs, etc.
VEGETATION INVENTORY COMPASS CARD (CP)

<table>
<thead>
<tr>
<th>Project Q: Plot No.</th>
<th>G.P.B. Main Plot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tie Point</td>
<td>Tie Point</td>
</tr>
<tr>
<td>Map Number</td>
<td>Tie Point</td>
</tr>
<tr>
<td>Polygon No.</td>
<td>Tree details</td>
</tr>
<tr>
<td>Flight Line</td>
<td>Diameter cm</td>
</tr>
<tr>
<td>Photo #</td>
<td>Species</td>
</tr>
<tr>
<td></td>
<td>Azimuth</td>
</tr>
<tr>
<td></td>
<td>Distance M</td>
</tr>
<tr>
<td></td>
<td>Azimuth</td>
</tr>
<tr>
<td></td>
<td>Distance M</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Azimuth

<table>
<thead>
<tr>
<th>Azimuth (°. arc)</th>
<th>Scale 1 cm.</th>
<th>m</th>
<th>Declination Used (degrees)</th>
</tr>
</thead>
</table>

### COMMENTS

- 
- 
- 

### ACCESS POINT LOCATION

<table>
<thead>
<tr>
<th>Descip.</th>
<th>G.P.B. Main Plot</th>
</tr>
</thead>
<tbody>
<tr>
<td>File No.</td>
<td></td>
</tr>
<tr>
<td>Uncontrolled UTM - Tie Point (NAD 83)</td>
<td>Easting</td>
</tr>
<tr>
<td>Nothing</td>
<td></td>
</tr>
<tr>
<td>Easting</td>
<td></td>
</tr>
</tbody>
</table>

March 31, 1995

**Sampling Procedures**

**Plot Establishment**

**DRAFT**
Reference Pin Location

Basic Premise
- the objective is to establish sample plots at the pre-determined location
- the objective is to sample the polygon as delineated by the photo interpreter
- field crews are responsible for achieving this goal using the appropriate equipment. This will normally be hand compasses, string boxes and/or nylon survey chains and clinometers. If real-time corrected GPS is available this may be used for locating the tie point and the reference pin.

Procedures
1. all distances measured will be corrected to the horizontal
2. the field crew may select the appropriate methods to locate the sample
   - the tie line may be established with the use of a string box as long as accuracy can be maintained within the required standards
   - the tie line should be measured using a nylon survey chain where obstacles or terrain make travel difficult
3. distances will be measured to the nearest metre
4. offsets should be used to traverse around unsafe or difficult situations
5. the tie line is to be lightly ribboned so the ribbon is just visible from one point to the next. The ribboning is to aid in short term plot relocation

Possible Problems in Navigation
In some instances a crew may arrive at the reference pin location and indications are evident that the photo location and ground location do not agree. The crew should evaluate the potential problems and confirm the sample location.

Questions to ask:
- is the feature (such as a creek) definite in its location
- how reliable is the base map?
- is the timber type only a small pocket or is it part of a large polygon (remembering that the minimum polygon size for forested area is generally >5 hectares).
- is the plot only a transition area between types?

Possible sources of error:
- an incorrect tie point location was selected
- an incorrect bearing was calculated or used
- the wrong compass declination was used
- a local magnetic attraction exists
- the base map was in error

[evaluate each of the above to determine probable cause

Possible solutions:
- return to the tie point and re-run the location line
- select another tie point and traverse from this point to the sample
- if an error was made in the calculations it may be possible to draw the location in relation to know features and calculate the distance and bearing to the correct location.

---

**Plot Location Establishment**

**Reference Tree and Pin**

**Basic Premise**

The purpose of establishing a reference tree and reference pin is to eliminate potential bias integrated plot location. It is also anticipated that these plots will be re-measured in the future, therefore the reference trees and pins will aid in relocating the plots.

**Procedures**

Measure from the tie point using the appropriate field methods.

This is achieved by maintaining (measuring with a suitable device) the bearing from the tie point towards the integrated plot location to a distance that is 15 metres short of the estimated full distance.

The reference pin and tree are to be established at that point. For instance, if the integrated plot location is 200 metres west of the tie point, the reference pin is established 185 metres west of the tie point.

At that point, an aluminum pin with an indicator of reference point and the plot number clearly stamped or engraved, is to be firmly driven into the ground. The code "R135" would be a suitable stamp for the pin placed at the reference point for plot 135.
A suitable reference tree (reasonably close in proximity, in relatively good health with a high probability of survival and not likely to be a tree in the adjacent plot) should be chosen.

Trees with particular distinguishing features should be chosen if possible (for instance, a forked tree, an aspen in a spruce stand, veterans in immature stands, etc.) and features such as species and diameter will be recorded on the field card.

The tree is to be appropriately ribboned with flagging tape (colour and type to be determined on a project basis) and the tree should be blazed on four sides above DBH. (the blazings should be visible for re-location in the future but not severe enough to damage or kill the tree). Paint the blazes to enhance visibility.

A metal tag is nailed to the base of the tree within 30 cm of the ground and facing the aluminum pin; (if the site conditions make this impossible then the metal tag location is at the discretion of the crew).

Information to be scribed on the metal tag is as follows:

```
Minimum Reference Tree

- the bearing and distance to be recorded on the tag (and field card) are taken from the face of the tree to the reference pin.
```

**Figure 2.5**

**Integrated Plot Location**

- PROJECT ID: 12
- SAMPLE NUMBER: 37
- TO: REFERENCE PIN
- TO: TIE POINT
- AZIMUTH: 16°
- DISTANCE: 7.2 m
- TO: PLOT CENTRE
- AZIMUTH: 273°
- DISTANCE: 15.0 m
- DATE: 1994 June 25
- CRW: J.K./L.S.

Ministry of Forests
The remaining 15.00 metres to the integrated plot must then be measured accurately to eliminate any possible local bias in locating the integrated plot centre.

This is done by measuring 15.00 horizontal metres with a steel or cloth tape (Careful attention must also be given to ensuring that the bearing is correctly maintained).

This point becomes the integrated (main) plot centre regardless of the site or conditions (the only exception is where crew safety would be compromised). The plot may be an open forest area, a rocky area, a road, even the centre of a standing tree.

An aluminum pin with the appropriate tag or engraving (e.g. "M12-37") is to be firmly driven into the ground at the plot centre. If the site conditions make it impossible or inappropriate to imbed the aluminum pin, it should be placed as close as possible to the plot centre in an area where it can be imbedded and the distance and bearing from the pin to the plot centre should be recorded accurately on the field card (see Fig. 2-7, Cluster Layout).
Figure 2-7

Vegetation Inventory Cluster Layout Field Card (CL)
Plot Configuration and Selection for Polygon Sampling

The design for polygon sampling will consist of two plot types:

[a] Main sample points (integrated plot measurements)
[b] Auxiliary sample points

The location of the main and auxiliary sample points will be determined prior to field location by the sampling plan design. These locations are selected in a statistically appropriate procedure by the field manager.

Integrated Sample Point

The main sample point is the location around which the detailed sample information will be collected for all disciplines. This will include the following major items:

- Coarse woody debris
- Ecological site data
- Range data
- Soils information
- Tree attributes
- Vegetation list and occurrence coverage
- Wildlife tree data

Auxiliary Sampling Points

The auxiliary sampling points will be used to enhance the information collected on the main sampling points. At this time only tree specific data is collected at these auxiliary points.

Sample Measurements

The inventory, as designed, is a two phase process. Phase I is photo estimation where estimates are made for vegetation attributes (volume, nutrient regime, height, site index etc.). Phase II is ground sampling which measures the same attributes for later adjustment of all estimates. A number of measurement procedures will be used including line transect, fixed area micro plots, small diameter fixed area plots and variable plot sampling. It is important that all vegetation characteristics be measured, whenever possible rather than estimated.

The field crew will assess the site vegetation and determine the most efficient sequence of measurements, ensuring that specific values are not degraded by other activities, (for example, if range values exist on the site then it may not be appropriate to measure tree heights first during which the forage plants could be trampled and result in poor measurement results).
Integrated Plot Centre Establishment

The following is a series of schematic diagrams outlining the specific measurement processes at the integrated sample point.

**Plot Location**

![Diagram showing the location of the integrated plot centre]

- Metal reference pin embedded in ground
- Reference tree blazed and tagged, bearing and distance to reference pin measured.
- Measurement of 15.00 m. to integrated plot centre
- Metal plot centre pin embedded at this point

*Figure 2-8
Integrated Plot Location*
Variable Plot Tree Data

- variable radius plot is established for trees 2.0 cm. DBH
- a basal area factor is used which selects 4-8 live trees on average for the cluster
- the trees are numbered sequentially from north in a clockwise direction
- detailed measurements on these trees are made for diameters, lengths, grades, wildlife tree measurements, damage indicators, and other details

**Figure 2-9**
**Variable Radius Plot**
**Tree Measurements**
Coarse Woody Debris

- From the plot centre a 24 metre horizontal line transect at a previously selected random bearing is established.
- All coarse woody debris >7.5 cm. is tallied.
- Detailed measurements on these pieces include species, diameter, tilt angle and a coarse woody debris code.
- A second transect of 24 metres is established at plus 50° to the first line and measurements taken.
- The first transect is the first field photo direction.

Figure 2-10
Line Transect
(rough Wooro Debris - C.W.D.)
Range forage plots are only established in areas with anticipated range usage. See the attached map in the Range Section.

Four 0.396 m radius plots are established on the C.W.D. transects at 6 m and 12 m from the plot centre.

A measurement of shrub intersect lengths is made on the two transect lines.

**Figure 2-11**

*Range Forage Production Plots*
Fixed Radius Plot - Small Tree Plot and Stump Data

- a 2.5 m radius plot is established
- measure trees from 10 cm in height to trees less than 2.0 cm in DBH
- stump data is also collected on this plot

Figure 2-12
Small Tree Fixed Radius Plot
- a 5.64 metre radius fixed plot is established
- a top height tree and an second species top tree is measured if available
a 10 metre fixed radius plot is established
floristic vegetation data are collected within this plot
- plant listings & coverage for trees and shrubs
- site description
- site series evaluation
- soils information
- plant listing and coverage for herbs, grasses and mosses are collected on the previously established 2.54 m. plot.
a soil pit is dug and measurements recorded

**Figure 2-14**
**Ecological Data Collection**
Auxiliary Plot Establishment

The following is a series of schematic diagrams outlining the general processes associated with establishing auxiliary sample points.

**Integrated and Auxiliary Plot Location**

- auxiliary plots are established at points 50 metres in cardinal directions from the integrated Plot Centre (the distance may vary by project)
- a metal pin is embedded at each location

*Figure 2-13
Location of auxiliary plots*
Auxiliary Variable Plot Tree Data

- Variable radius plot is established for live trees 2.0 cm and greater at D & H
- Species and diameters are recorded for these trees
- The first occurrence of a tree species not previously measured is enhanced

Figure 2-16
AUXILIARY PLOT MEASUREMENT
Fixed Radius Plot - Top Height

- a 5.04 metre radius fixed plot is established
- a top height tree

IS MEASURED.

Figure 2-17
Auxiliary Plot - Measurement of Site Tree
Vegetation Inventory

Chapter 3
Range Sampling
Vegetation Inventory

Chapter 3
Range Stabilization
Range Sampling

Background

Sampling for range management purposes is done as part of the integrated sample plot. In order to manage livestock, range managers require estimates of the amount of forage production and utilization for grasses and forbs in kg/ha. and a measure of shrub abundance.

A forb is:

- "any broad-leaved herbaceous plant other than those in the Gramineae (or Poaceae), Cyperaceae and Juncaceae families" (taken from A Glossary of Terms Used in Range Management; Society for Range Management (S.R.M.), 1989).

Grasses are:


Production is defined as the sum of live standing herbaceous biomass produced within a defined period of time (as defined by Singh, J.S., W.K. Lavenroth and R.K. Steinhast, 1976. The Botanical Review. 41(2):181-231). Production can be converted to Animal Unit Months (AUMs). An AUM 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" (S.R.M. 1989).

These estimates of production may be correlated to groups of vegetation (forest) cover attributes which are correlated to form General Range Types (GRTs) or a specific site series (currently under development for grasslands by Range Section). General Range Types are distinct, broad mapping units easily recognizable on aerial photographs that are used for initial pre-stratification of survey areas and for summary purposes. They are generated by a complex of variables such as forest cover type, age class, site class, height class, etc. A new set of GRTs will be developed when the British Columbia Land Cover Classification Scheme is implemented. Production estimates may be grouped and then graphed across the growing season (April to September) for a General Range Type.
Vegetation Inventory Range Sampling

The Vegetation Inventory range samples will consist of:

- micro plots to measure forage production, and
- shrub transects

The vegetation inventory range samples will be established on the integrated plot which could be established at any time during the growing season. Therefore range managers may choose to only use these estimates as an indication of total production for that location, considering that a General Range Type, such as open range or upland graminoid, may cover several site series. The Range Section has decided for purposes of the Vegetation Inventory that production estimates are only required in the interior of the province (refer to the attached map at the end of this section, Figure 3-4).

Production estimates will be modified or may not be used if forage utilization is greater than 15%. However, an estimate of forage utilization is required on all micro plots. Forage utilization information may be used by range managers to determine use zones and may also contribute towards (along with other range samples) range use plans.

Range managers also require information on the species composition of livestock forage and identification of site series. The field sampling method for identifying site series (if applicable) and collecting species composition data is described in the ecological vegetation sampling section. For range management purposes shrub species composition and foliar cover estimates will be collected using a line intersect.

Forage Production of Grasses and Forbs

Forage production measurements should be made immediately after the integrated plot centre is established, in order to avoid excessive trampling of forbs and grasses.

Four micro plots will be established at 6m and 12m points along the woody debris line transect as shown in Figure 3-1.
Forage Utilization

Within each of the four micro plots make an estimation of the herbaceous forage utilization as described in Table 1. The utilization estimate should be made and recorded before each of the micro plots are clipped. It is appropriate to include the immediate area (1 - 2 metres) surrounding the micro plots as part of the estimation procedure.

<table>
<thead>
<tr>
<th>Code</th>
<th>Class</th>
<th>Range</th>
<th>Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Nil</td>
<td>0%</td>
<td>The plants show no evidence of use by livestock or wildlife.</td>
</tr>
<tr>
<td>1</td>
<td>Slight</td>
<td>1 to 15%</td>
<td>The plants show very little evidence of use by livestock or wildlife 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.</td>
</tr>
<tr>
<td>2</td>
<td>Light</td>
<td>16 to 35%</td>
<td>The plants may be topped, skinned, or grazed in patches. Low-value plants are ungrazed and 60 to 80% of current leafage of key plants remain intact.</td>
</tr>
<tr>
<td>3</td>
<td>Moderate</td>
<td>36 to 65%</td>
<td>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.</td>
</tr>
</tbody>
</table>
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.

Table 1: Herbaceous Forage Utilization Classes and Codes [taken from Procedures for Environmental Monitoring in Range and Wildlife Habitat Management. MOF, MOELP 1990]

A utilization gauge (developed by the U.S.F.S. Rocky Mountain Forest and Range Experimental Station) may also be helpful in determining the percent utilization for a particular species and will be available during the field projects.

**Forage Measurements**

Clip and weigh the green wt. of forbs and grasses at all four (0.399m) plots. Record the measured green weight of forbs (MF) and measured green weight of grasses (MG) for the plot on the sample plot sheet. The four plots are combined and weighted; with the forbs and grasses kept separate. The bags of forbs and grasses will be returned to the field office where they will be oven dried (55° C. for 24 hours) and weighed.

**Shrub Species Composition and Foliar Cover Estimates**

Livestock and wildlife species utilize shrub biomass at various times of the year. These shrub locations may be critical to their health and survival. Therefore, resource stewards need to know the species and abundance of shrubs. Shrub estimates are required in order to derive the abundance of a particular shrub species.

The canopy cover of shrubs can be quickly and reliably estimated using line intercept methods (as described by "Methods for Vegetation Sampling and Analysis on Revegetated Mined Lands", by C. Chambers and R.W. Brown, 1983, Inter Mountain Forest and Range Environmental Station, General Technical Report INT-151). The lines established for the woody debris and forage production estimate will also be used for shrub abundance estimates. The objective is to vertically project the canopy of the shrub onto a horizontal plane and measure the intercept of the line and shrub canopy.
Procedure
A measuring tape is stretched out along the randomly selected woody debris transects (24 m.). The length of the line intercepted by the canopies of each shrub species is determined by measuring the horizontal distance along this line occupied by each individual shrub. The shrub species are recorded by the following layers:

"B1" Layer - shrubs greater than 2.0 meters in height
"B2" Layer - shrubs 2.0 meters and less in height

Note: In the 'B2" layer shrubs include deciduous and coniferous trees

The system works best if the intercepts are measured along one edge of the tape, to provide a narrow line width. Initially a plumb bob is used (at the beginning of the sampling season) to establish the beginning and end point of each shrub canopy along the line. After sampling crews have gained experience in identifying the intercept point on the tape, it can then easily be visually estimated, and the use of the plumb bob may be discontinued. Breaks in shrub canopies of less than 5 cm should be ignored. An example of the line intercept measurement is shown in Figure 3-2. Individual shrubs of the same species and layer which overlap are measured as one horizontal occurrence. If the canopies of different species or layers of shrubs overlap, the plants are to be recorded separately.

![Image of shrub measurement method]

**Figure 3-2**
The Line Intersect Method for Shrubs

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**Sampling Procedures**
March 31, 1995
Range Sampling  3  5
The extent of each species along the transect is divided by the total length of transect to provide an estimate of shrub cover. The percent cover of a species is determined by dividing the sum of individual transect lengths intercepted by the total transect length sampled, then multiplying by 100.

The line intersect plot design for the integrated plot design is shown in Figure 3-1. If the line transect intercepts the polygon border then the "bounce back" methodology is used [for example; the polygon border is at 18.5 meters from plot center. measure the occurrence of shrubs as encountered from plot center to 18.5 meters. Then record again the shrubs occurring on the portion from 18.5 meters to 13.0m.]

For example:

- transect full length = 24.0m.
- polygon border intercepted at = 18.5m.
- length of line to "bounce back" = 5.5m.
- therefore remeasure line from 18.5m. to 13.0m. (a distance of 5.5m.)

The sampling crew should start at the integrated plot centre and establish the first line intercept at a random bearing for a distance of 24 metres, as described in the woody debris section of this manual. It is recommended that the woody debris data be collected on the way out to the end of the
line and then the shrub intercepts shown be recorded on the way back to plot centre.

The second line (24 metres) is then established at 90° to the first line and the procedure for collecting shrub and woody debris data is repeated.
Ecological Sampling

Purpose

- Collect floristic data to provide a record of existing vegetation at forest inventory sample plot locations.
- Collect soils and site data to provide a record of conditions at forest inventory sample plot locations.
- Classify forest inventory sample plots within the Biogeoclimatic Ecosystem Classification system.
- Establish a network of relocatable sample plot locations which can be revisited. This will permit monitoring of floristic change through time for a variety of needs such as tracking trends in succession or impacts of management activities.
- Provide a database which will be useful for a variety of management and research applications, such as enhancing the provincial ecological classification system.
- Maintain a high standard in database quality and procedures.

General Procedures and Concepts

The intent is to gather information on vegetation and other ecosystem components which occur in the ecological plot. The ecological plot is 314 m² (10 m radius) in size and is centered on the inventory sample plot. A nested 100 m² (5.64 m radius) plot is established within the ecological plot to sample vegetation in the herb and moss layers. The inventory sampling methods do not allow movement of the ecological plot to more "typical" or homogeneous portions of the polygon as this would introduce sampling bias. However, this may result in a portion of plots falling in ecologically diverse areas (plots may contain more than one ecosystem). This leads to difficulties with secondary applications of the data such as ecological classification. To address this concern, a plot uniformity attribute has been included on the data form. The procedures for ecological description further address this issue by requiring estimates of the relative proportions of component site series\(^1\) comprising a plot. If the

\(^1\) site series is a basic classification unit in the biogeoclimatic classification
main centre point does not fall in the dominant site series within the 10 m plot radius, then additional soils and site data are collected for the dominant site series.

**Vegetation**

The intent is to produce comprehensive vegetation lists including species codes (based on Latin names) and percentage cover values. Vegetation samplers must have as much practical experience in plant identification as possible. Species unknown to the samplers need to be collected, labelled, and stored for identification by specialists.

There are a number of exceptions resulting in the same code for different species. Also, if the genus is known but not the species, all the characters (up to 7) in the genus are recorded. For example, if an unknown lichen of the Cladonia genus is collected, it is coded as CLADONI. Likewise, a grass of the Poa genus would be coded as POA. If the grass was known to be Poa alpina, it would be coded as POA_ALP. Although not encouraged, an 8 character code, may be used for special purposes to distinguish a variety or subspecies. For example, PINUCONI versus PINUCON2, to differentiate Pinus contorta var. contorta (shore pine) from Pinus contorta var. latifolia (lodgepole pine). Master lists of Latin, common and 7-letter code names for plant species are available, and should be consulted regularly to ensure no conflicting codes are used.

Some of the vegetation sampling must be planned for optimum floristic development in different biogeoclimatic subzones in the province. Advice may be obtained from regional ecologists with the Ministry of Forests on the best months, and in some cases, best weeks of the year to sample vegetation in different areas. In some circumstances it may be necessary to collect floristic data independently to take advantage of peak floristic conditions.

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.

**Site and Soils**

The intent is to provide data on key soil and site features to facilitate identification of the plot within the biogeoclimatic ecosystem classification. Statistics for certain attributes may also be generated from the data. The site and soil attributes selected for the ecological description represent a basic core set of properties that both meet the needs of the inventory and can be efficiently collected by field crews with a reasonable level of precision.
Field crews should have experience and proven abilities in biogeoclimatic ecosystem classification (BEC), with emphasis on soils. Soil samples will be collected from plots so field estimates of soil texture can be monitored for on-going crew calibration.
# Vegetation Inventory - Tree and Shrub Layers

**Plot Radius = 10.00**

### Initial Cover % Estimate by layer:

<table>
<thead>
<tr>
<th>Species (Enter codes)</th>
<th>% Cover A layer &gt;1% m</th>
<th>% Cover B1 layer 2-10 m</th>
<th>Average height (m)</th>
<th>% Cover B2 layer &lt;1 m</th>
<th>Average height (m)</th>
<th>% Cover D (soil)</th>
<th>% Cover D (wood)</th>
<th>% Cover D (rock)</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>32</td>
<td>36</td>
<td>37</td>
<td>38</td>
<td>39</td>
<td>40</td>
<td>41</td>
<td>42</td>
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<tr>
<td>6</td>
<td>1</td>
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<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

**SEEDLINGS**

- Recording species coverage less than 1/10%.
- For a coverage of 5/100 record as 5H.
- For a coverage of 5/1000 record as 5T.

Note: 1/100% = 16 cm x 16 cm (approximately)
1/1000% = 6 cm x 6 cm (approximately)

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**Species Comments/Notes**

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**March 31, 1995**
**VEGETATION INVENTORY - HERB AND MOSS LAYERS**

**PLOT RADIUS = 5.64 m**

---

**Table:**

<table>
<thead>
<tr>
<th>Species Code</th>
<th>Species</th>
<th>Layer</th>
<th>Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Species 1</td>
<td>Herb</td>
<td>Value 1</td>
</tr>
<tr>
<td>2</td>
<td>Species 2</td>
<td>Moss</td>
<td>Value 2</td>
</tr>
<tr>
<td>3</td>
<td>Species 3</td>
<td>Layer</td>
<td>Value 3</td>
</tr>
</tbody>
</table>

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**Figure 4-4**

*Vegetation Inventory - Herb and Moss Layers - Field Card [EH]*

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**Sampling Procedures**

March 31, 1995

Ecological Sampling • 4 - 7

DRAFT
The following diagrams illustrate some situations which may be encountered (Note, only one vegetation description is done for the entire plot, in all cases):

1. In example 1, the dominant site is A; one site and soil description is done at the main plot centre.
2. In example 2, the plot centre site is subdominant, the main site and soil description is done at plot centre in the B site; a second site and soil description is done for the dominant site A.
3. Example 3 is the same situation as 2, except the subdominant plot centre site is discontinuous.
4. In example 4, the plot centre site is dominant; one site and soil description is done at plot centre.

**Plot Information**

1. **Slope (%)**: record the slope gradient to the nearest percent. Assess the slope by averaging over a 100 m distance (for example 50 m above and below the plot center). If a major topographic slope break occurs, measure only to the break point.

2. **Azimuth (°)**: record the orientation of the slope by means of compass bearings. Level (<2% slope) ground has no aspect - code as 999

3. **Elevation (m)**: Record the elevation in meters.

4. **Surface shape**: describe the general shape of the slope the plot is situated on (convex, straight, or concave)
5. **Site position meso**: describes the relative position of the plot within a local catchment area that affects surface and subsurface water flow to the plot. Upper slopes shed water and tend to be drier, lower slopes receive additional water and tend to be wetter, while middle slopes are in balance. Slope position relates to the segment of slope between prominent topographic irregularities (for example major slope breaks).

![Diagram of Meso and Macro Slope](image)

**Figure 4-7**  
*The Slope Segment and Classes of Slope Position*

- **crest** - the generally convex upper portion of a hill.
- **upper slope** - the generally convex upper portion of the slope immediately below the crest.
- **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.
- **lower slope** - the area towards the base of a slope. It is generally concave.
- **toe** - the area demarcated from the lower slope by an abrupt decrease in slope gradient.
- **depression** - any area that is concave in all directions
- **flat** - any level area not directly adjacent to a slope (e.g. toe). The surface profile is generally horizontal.
6. **Microtopography**: describes the variability in the surface configuration of the site being described. Record one of the following classes:

- **smooth** - few or no mounds; mounds if present less than 0.3 m high and greater than 0.7 m apart
- **moderately mounded** - mounds 0.3-1 m high and 3-7 m apart
- **strongly mounded** - mounds 0.3-1 m high and less than 3 m apart
- **extremely mounded** - mounds greater than 1 m high

7. **Rocky substrates**: estimate the percentage of the ground surface of the plot covered by the following substrates within the 10 m plot radius:

- **cobbles and stones** - exposed rock fragments greater than 7.5 cm diameter. They may be covered by mosses, lichens for example, with a forest floor less than 2 cm thick.
- **bedrock** - exposed bedrock that may be covered by mosses, lichens for example, with a forest floor less than 2 cm thick

### Terrain

8. **Surficial material**: refers to the soil parent materials which are classified according to their mode of formation (Howes and Kenk 1988). Record the appropriate code from below. If two types of surficial materials are observed in the soil pit, record both as follows: **C_/M_** (colluvial over morainal).

- **colluvial** (C__) - materials that have reached their present position as a direct result of gravity-induced movement (for example most steep slopes, talus, landslide deposits, etc.). Generally on steep terrain; common below rock bluffs; coarse fragments are angular and of the same lithology as the local bedrock; coarse fragment content generally > 35%; materials are loosely packed and porous. Deposits from landslides and other slope failures are a type of colluvial parent material.

- **fluvial** (F__) - materials transported and deposited by streams or rivers (for example floodplains, fluvial terraces, fans, deltas). Deposits generally consist of gravels, sands, and/or silts depending on stream velocity during deposition. Gravels are typically rounded, fluvial sediments are commonly well sorted and may display stratification (layers); topography is generally flat, sometimes with a steep erosional scarp; generally along valley bottoms in proximity to a river or stream.
- **glaciofluvial (FG)** - materials deposited by glacial meltwater streams either directly in front of, within, or along the margins of glacial ice (for example eskers, kame terraces, outwash, etc.). Typically coarse textured non-sorted to well-sorted gravels and sands; may contain layers of finer textured materials; topography is generally flat, sometimes with a steep erosional scarp; may be along valley bottoms, part way up valley sides, or as an extensive plain outside valley systems; gravel pits are often present.

- **lacustrine (L__)** - sediments that have settled out in lakes (old lake bottoms) or have accumulated along their margins (old lake beaches). These generally consist of stratified silts and clays, often with "varves" evident (bands); lacustrine materials deposited in association with melting glaciers may contain ice-rafted stones and lenses of morainal or glaciofluvial material; topography is generally fiat, sometimes with a steep erosional scarp, usually along valley bottoms; slumps and landslides are often present.

- **eolian (E__)** - materials transported and deposited by wind action (for example loess, dunes, etc.). These are generally well-sorted silt or fine sand that is loose and fluffy; usually occurs as a capping over other parent material.

- **marine (W__)** - sediments deposited in salt water by offshore settling from suspension (former "mud flats") or through wave action along margins (former beach). Marine materials from offshore settling are fine textured (silts and clays) and often quite dense; old beach deposits are well-sorted sands and/or gravels with rounded coarse fragments; shells may be present; marine soils often contain concretions, topography is generally flat or very gently sloping, restricted to lower elevations in proximity to the ocean, although they may occur as high as 200 m above present sea level around the Georgia Strait area. Glaciomarine sediments are materials of glacial origin laid down from suspension in a marine environment. They are similar to marine sediments except they may contain stones and lenses of morainal or glaciofluvial materials.

- **organic (O__)** - sediments composed predominantly of organic materials. This includes wetland deposits (peat, muck, etc. in bogs, fens, and swamps) and upland deposits of forest floor overlying bedrock (L FH > 10 cm thick; noted as O/R).

- **bedrock (R__)** - exposed bedrock with or without a thin (< 10 cm) layer of organic materials.
- **volcanic (V__)** - unconsolidated volcanic sediments (for example ash, cinders, etc.). These usually occur as cappings over other parent materials (e.g. V_/M__).

- **anthropogenic (A__)** - man-made materials or man-modified geological materials (for example landfills, spoils, roadfills, etc.)

- **moraine (M__)** - (till) material deposited directly by glacial ice. Morainal materials are highly variable, generally consisting of compacted to non-compacted sediments that are non-sorted and contain a mixture of coarse fragments and fines. It often looks like "cement" with subrounded coarse fragments in a matrix of finer particles (sand, silt, clay); stones are often of different rock types and may have striations ("grinding" marks from the ice). Morainal deposits are the most widespread and variable parent material in B.C.

9. **Evidence of slope failure:** note any evidence of recent or past slope failures greater than 100 m² in surface area. This includes landslides, slumps, debris flows, debris torrents, and bedrock failures (Chatwin et al. 1994). Record if present in the plot, and if intercepted along the bearing between main plot and any of the four auxiliary plots. Not visited (NV) applies if evidence was not found, however, the lines between plot centre and the auxiliary plots were not all traversed. Features indicative of slope instability include:

- obvious recent failures (tracks of exposed soil oriented downslope)

- headwall or sidewall scarps that are rectangular or horseshoe shaped

- older failure tracks may be indicated by a significant vegetation difference (species and age) from the surrounding area

- deposits of slide materials at the base of the failure which are fan-shaped and often hummocky

- generally on steeper slopes, and often in association with wet sites (seepage zones, draws, etc.)

10. **Gullies:** note the presence of gullies. Gullies are long, linear depressions incised into the landscape where the channel is confined in a narrow ravine with banks usually higher than 3 m. Their long profile may range from gentle to steep, and uniform to irregular (benched). Their cross-section profile may be V-shaped to U-shaped with moderate to steep sidewalls. Record if present in the plot, and if intercepted along the line transect between main plot and any of the four auxiliary plots. Not visited (NV) applies if evidence was not
found, since, the lines between the main plot centre and the auxiliary plots were not all traversed.

11. **Flood hazard**: estimate the relative frequency of flooding of rivers, creeks and streams using the following biophysical features (adapted from Luttmersding et al. 1990 p.45):

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

12. **Open water**: estimate the percentage of the area in the 10 m plot occupied by either flowing or standing water.
Summary Information

13. **Plot uniformity**: a 5-point scale, from 1 = uniform to 5 = variable according to the following definitions:

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&gt; 95% of plot in one homogeneous ecosystem</td>
</tr>
<tr>
<td>2</td>
<td>81-95% of plot in one homogeneous ecosystem, the remainder in other ecosystems¹</td>
</tr>
<tr>
<td>3</td>
<td>51-80% of plot in one homogeneous ecosystem, the remainder in other ecosystems¹</td>
</tr>
<tr>
<td>4</td>
<td>20-50% of plot in one homogeneous ecosystem, the remainder in other ecosystems¹</td>
</tr>
<tr>
<td>5</td>
<td>mosaic with ≤ 20% of plot in any homogeneous ecosystem.</td>
</tr>
</tbody>
</table>

14. **Biogeoclimatic units**: record biogeoclimatic unit as determined on the ground. This includes zone, subzone, and variant (if applicable). Although not a formal category, biogeoclimatic phase is sometimes recognized.


15. **Site series number and coverage**: use the two digit site series or occasionally the three character site phase code from the appropriate MOF Regional field guide to site identification and interpretation

(for example, *Banner et al.* 1993. A field guide to site identification and interpretation for the Prince Rupert Forest Region. Land Management Handbook No. 26, B.C. Min. For., Victoria, B.C. 503pp.)

If the plot occurs on an ecosystem not recognized in the ecological classification, record the soil moisture regime (SMR) and soil nutrient regime (SNR) instead of site series number (for example 6/D for

¹ Other ecosystems includes different succesional stages or different sites (for example different site series, avalanche tracks, streams, gullies, rock outcrops, roads, etc.).
SMR/SNR). If soil moisture and nutrient regime cannot be estimated (for example, roads, gravel pits, boulder fields), record 99. Estimate percent coverage of the site within the 10 m radius plot for a maximum of 100% in the event of only one site series. Sites or land cover types covering less than 5% (16 m²) of the 10 m radius plot, are considered too small to recognize.

16. **Land cover classification**: record land cover class to the appropriate level from the B.C. Land Cover Classification Scheme (described in a field key and a separate document). You can record up to three separate land cover designations, corresponding on a one-to-one basis with up to three site series designations (in a highly variable 10 m radius plot). If "99" is recorded for site series, then the land cover classification will stand alone as a description of that portion of the 10 m radius plot.

**Soil Features**

A soil pit is located in the main plot at the centre point adjacent to and representative of conditions at plot centre, regardless of whether or not the plot centre is in the dominant site within the 10 m plot radius. A second soil pit will be established if necessary to characterize conditions in the dominant site. The soil pit is dug to a minimum depth of 60 cm unless impenetrable material is encountered. If a soil pit cannot be excavated on the plot, indicate on the form by drawing a line through the profile description section and record why in comments.

17. **Depth to (cm)**: record the observed depth from the "0 depth" (mineral soil surface for mineral soils, ground surface for organic soils) to the following features if present within the soil profile:

- **water table** - measure to the surface of visible water in the soil profile at the time of sampling
- **gleying** - measure to the surface of any gleyed layers, indicative of periodic anaerobic conditions in the soils associated with poor drainage. Gleying is recognized by dull bluish to grey soil matrix colours, usually with reddish coloured mottles.
- **root restricting pan** - measure to layers which impede root penetration (for example pans, cemented horizons, compact parent materials).
- **bedrock** - measure to consolidated bedrock. Weathered bedrock that can be removed with a shovel should be considered soil.

- **frozen layer** - measure to the top of a frozen layer at the time of sampling.
• carbonates - measure to the top of a layer containing carbonate accumulations.

18. **Humus form**: refers to the forest floor and organic-enriched surface mineral horizons. Humus forms are classified into one of the following types:

- **Mor** - LFH horizons prominent, F horizon is matted, with abundant fungal mycelia, mushroom smell common, usually abrupt transition to mineral soil.

- **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.

- **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.

- **Mullmoder** - intergrade between Moder and Mull, features well developed F and H (F+H > 2 cm thick) but Ah present which is thicker than the F+H horizons.

- **Mull** - Ah horizon prominent, F + H horizons < 2 cm thick, F horizon very friable, Ah granular, earthworms often present.

19. **Soil colour**: describe the general colour of the rooting zone mineral soil using the following categories:

- **dark** - chocolate brown or black coloured (Munsell colour value < 4 when moist)

- **medium** - intermediate colour (most commonly encountered)

- **light** - very pale coloured soil (Munsell colour value > 6 when moist)

Note, field crews will be provided with a small colour chart for comparison of dark, medium and light soil colour.

20. **Relative soil moisture regime**: soil moisture regime refers to the average annual amount of soil water available to plants. It is inferred from the physiographic and soil features described.

There are nine soil moisture regime classes described in Lutterminger et al. (1990 p. 35):

0 = very xeric
1 = xeric
2 = subxeric
3 = submesic
4 = mesic
5 = subhygic
6 = hygic
7 = subhydric
8 = hydric

21. **Nutrient regime**: refers to the amount of essential soil nutrients, particularly nitrogen, that are available to plants. It is inferred from physiographic and soil features (for a key to soil nutrient regime see pp. 276-279 in Green and Klinka (1994)).

There are six soil nutrient regime classes described in Lutterminger et al. (1990 p. 38):

A = very poor
B = poor
C = medium
D = rich
E = very rich
F = saline

**Soil Description**

22. **Horizon**: record the main types of organic and mineral horizons beginning with the uppermost horizon, followed by subsequent horizons proceeding down through the profile. These include L, F & H, Ah, Ae, B, and C. Subordinate horizons of B and C (e.g. Bf, Bf1, Bf2, Bfsg, Bt, Bm, etc.) may be recorded if the crew person can confidently identify them. Differentiate subdivisions of the B or C horizons (e.g. B1, B2) if properties differ substantially in colour, texture and coarse fragments and structure.

- **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 if they are difficult to distinguish*

---

1 The 8 (hydric) class is rarely used, but may be encountered in certain wetland ecosystems.

2 The F (saline) class is rarely used, but may be encountered.
- **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").

- **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.

- **R** - bedrock

23. **Depth (cm):** record the average upper and lower boundaries of each horizon in the profile. For forest floor horizons (L, F, H) depth is the top of the mineral soil and horizon boundary depths are measured in ascending order from 0 depth to the ground surface (e.g. L: 6-5, F: 5-2, H: 2-0). For mineral horizons, the top of the uppermost horizon is considered 0 depth, and upper and lower boundary depths are measured in descending order (for example A: 0-3, B: 3-25, C: 25-60+). Always record the maximum depth of the soil pit as the lowest boundary of the last horizon (e.g. 60+). For "Organic" soils, 0 depth is the top of the organic material. Organic soils are soils with > 60 cm of organic material (if surface horizons are Of), or > 40 cm of organic material (if surface horizons are Om and Oh), or > 10 cm thick if overlaying rock. (as described on pp. 82-86 in Agriculture Canada Expert Committee on Soil Survey 1987. The Canadian System of Soil Classification. 2nd ed. Agric. Can. Publ. 1646. 146pp.)
24. **Texture**: estimate texture of the mineral soil (less than 2 mm diameter) using field estimation methods as described in MOF regional ecology field guides (for example pp. 381-384, Lloyd *et al.* 1990. A guide to site identification and interpretation for the Kamloops Forest Region, Land Management Handbook, No. 23, B.C. Min. For., Victoria, B.C. 398 pp.). Collect a sample from the main B horizon for subsequent verification if necessary (enclose a waterproof label noting plot number and horizon).

25. **Coarse fragments**: estimate the proportion of the total volume of soil material by mineral soil horizon occupied by materials > 2 mm in diameter. Record the total coarse fragment volume, and the breakdown for gravels (2 mm - 7.5 cm) and cobbles + stones (> 7.5 cm).

**Succession Interpretations**

Look beyond the 10 m radius plot into similar surroundings (for instance up to a 25 m radius within the polygon) for succession interpretations.

26. **Factors influencing vegetation establishment** (adapted from pp. 58-59 in Luttermerding *et al.* 1990): record the major observable factors relevant to the development of the current vegetation and soil characteristics. The time frame is within approximately the past 500 years. Use from one up to a maximum of four of the following categories. Only record factors for which direct evidence can be observed. Enter UN or a slash if no evidence of a factor can be observed. Use 2-stage code (e.g. A2), or 1-character code (e.g. A) if the specific factor is unknown.

A. **Atmosphere related effects:**
   1. atmospheric pollution
   2. climatic extremes (for example extremes of temperature, hail, snow, ice, etc.)
   3. windthrow
B. Harvesting and soil disturbances
   1. abandoned or current construction sites (road bed, railway, camp, etc.)
   2. clearcut logging
   3. cultivation (excluding harvesting of native crops)
   4. excavation
   5. land clearing (includes grubbing and other forms of disturbance such as pipeline construction)
   6. mechanical site preparation
   7. selective logging (including shelterwood, seed tree, etc.)
   8. soil compaction (including effects of human, animal, and machinery traffic)
   9. harvest of native plants

C. Dumping, disposal, and spills
   1. chemical disposal or spill
   2. effluent disposal
   3. mine spoils
   4. oil spill or disposal

D. Fires
   1. severe surface fires
   2. light surface fires
   3. burning of logging slash
   4. overstory crown fire

E. Plant and animal related effects
   1. beaver tree cutting
   2. disease (specify if known)
   3. domestic grazing/browsing
   4. excrement accumulation (other than normally associated with grazing and browsing)
   5. insect kill (specify if known)
   6. wildlife grazing/browsing

F. Terrain related effects
   1. snow avalanching
   2. eolian (active deflation or deposition)
   3. recent deglaciation
   4. rock quarrying (including open pit mines)
   5. slope failures (active or recent slumps, landslides, etc.)
   6. volcanic activity
   7. fluvial deposition

G. Vegetation and site improvement related effects
   1. fertilization
   2. irrigation
3. planted to trees or shrubs
4. seeded or planted to grass or herbs
5. seeded to trees or shrubs
6. herbicide use
7. brushing, spacing or thinning trees

H. Water related effects
1. inundation (including temporary inundation from beaver activity)
2. water table control (diking, damming)
3. water table depression (associated with extensive water extraction from wells)

I. Miscellaneous
1. other (specify)

U. Unknown

27. Tree species succession: in forested ecosystems look for signs of the earlier predominant tree species. Record previous and current predominant tree species. If, for example, you are in a red alder stand with western hemlock and western red cedar stumps, record "previous species" as HwCw and "current species" as Dr. Alternatively, if the stand is, and appears to have always been BlSe, simply record as BlSe in both previous and current species boxes. The first of the maximum of two species should have the greater basal area. Record UN if stumps present but species unknown.

28. Tree harvesting: has the forest experienced some form of harvest?
C = Clearcut
P = Partial
N = None

29. Snags: do a count of standing dead trees ≥ 25cm dbh and ≥ 10m tall (unless shorter due to advanced stage of decay [for example snag classes 7-9]) within the larger 25 m radius. Stumps resulting from tree harvest, even if relatively tall, do not qualify as snags.

None = 0
Some = 1-5
Common = >5

30. Snags/CWD in all stages of decay and sizes: this observation is meant to distinguish those sites where snag and coarse woody debris recruitment is an ongoing process.

No = there are either no snags that meet the above size criteria, or all snags are within a narrow range of 1-2 decay classes. CWD is either absent or similarly limited to a narrow range of 1-2 decay classes.
Some = snags may fit the minimum size criteria but they are limited to a range of 3 consecutive decay class stages; CWD is similarly limited to 3 consecutive decay class stages.

Yes = snags fit the minimum size criteria and are represented in most decay stages; CWD is represented in most decay classes.

31. Canopy gaps due to tree mortality: Gaps are openings not yet occupied by A3-layer (>10 m tall) or equivalent trees. Look for openings in the canopy due to natural tree mortality. Mortality refers in this context to physical expression of natural causes of death; for instance trees have blown over, have snapped off, or have died standing. If it appears the cause of death was related to harvesting activities or other human intervention, do not count these as gaps. There will be instances where human intervention will be hard to rule out, for example, death due to fire or other damage that was possibly related to human activities. Gaps also do not include openings due to 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, roads, and so on. Also excluded are successionaly young sites recently disturbed or cut where trees have not yet grown into the A3-layer.

No = no apparently natural gaps due to canopy-layer tree mortality

Some = smaller gaps amounting to < 10% of crown closure in the larger 25 m radius and

Common = one or more larger gaps occupying ≥ 10% of the potential canopy area.

32. Vertical structure: this applies to the distribution of shrub and tree layer strata.

Simple = tends to be even-height, with limited coverage in up to two other strata (B2, B1, A3, A2, or A1).

Moderate = tends to be uneven height with >10% of total coverage in each of three of the strata B2, B1, A3, A2, or A1.

Complex = stand is uneven-height with > 10% of total coverage in each of four or five of the strata B2, B1, A3, A2, and A1.
33. **Successional stability**: has the forest reached a stage at which species composition is relatively stable?

- **Unstable** = if present, regenerating understory tree species are not the same species as those in the canopy. Successional trends suggest major change in canopy species is likely within less than the potential lifetime of the current dominant species.

- **Intermediate** = if present, the understory tree species are not all the same as those in the canopy. Change in canopy species composition is inevitable, but will likely take place over a time frame intermediate to the other two scenarios.

- **Stable** = the regenerating understory species are in most instances the same species as those throughout the canopy. Alternatively, the canopy species are long-lived, and could potentially retain dominance for 100 or more years in a biogeoclimatic unit (BGCU) group A or more years in BGCU group B (see age criteria for mature and old forest stages in attribute 36, Table 3).

34. **Trees are old for their species and site conditions**: as the procedures stand, practical limitations will result in few tree ages being collected, consequently this attribute will at times be difficult to determine. Uneven-aged stands will tend to be the easiest to evaluate. In some instances there will be a mosaic of trees of differing ages from relatively young to old, making it difficult to assign an approximate age for the trees dominating the site. Concentrate on the trees that dominate the canopy.
Young = characteristic of even-height forests in the young forest or earlier seral stages.

Intermediate = species may have attained near maximum height, however, there is little mortality in the main to upper canopy as the species are only in a mature forest stage.

Old = trees in the upper canopy have been established for a relatively long time. Some of the upper canopy trees appear to have reached their physiological maximum age. Others may already have died.

35. Tree size for species and site: as with the above attribute, the easiest stands to evaluate will be the uneven-aged ones. The larger trees will tend to be found on the more productive and less disturbed (older) sites.

36. Seral classification: 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>
<thead>
<tr>
<th>Structural Stage</th>
<th>Definition</th>
<th>Age Criteriaa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a. (NV) Non-vegetated</td>
<td>less than 5% vegetation</td>
<td>&lt;20 yrs. for normal forest succession. Up to 100+ years under certain soil and/or climatic conditions.</td>
</tr>
<tr>
<td>1b. (SP) Sparse</td>
<td>Initial stages of primary and secondary succession. Little or no residual vegetation except for bryophytes and lichens. Less than 10% cover of vascular plants.</td>
<td>&lt;20 yrs. for normal forest succession. Up to 100+ years under certain soil and/or climatic conditions.</td>
</tr>
<tr>
<td>2. (H) Herb</td>
<td>Early, or potentially prolonged, successional stage dominated by herb-layer (herb, graminoid, fern) vegetation; some invading or residual shrubs and trees may be present. Tree cover &lt;10%, herb-layer cover &gt;25%, or ≥33% of total cover.</td>
<td>&lt;20 yrs. for normal forest succession. Up to 100+ years under certain soil and/or climatic conditions.</td>
</tr>
<tr>
<td>3a. (LS) Low Shrub</td>
<td>Early, or potentially prolonged, successional stage dominated by shrubby vegetation &lt;2 m tall. Seedlings and advance regeneration may be abundant. Tree cover &lt;10%, shrub cover &gt;25% or ≥50% of total cover.</td>
<td>&lt;20 yrs. for normal forest succession. Up to 100+ years under certain soil and/or climatic conditions.</td>
</tr>
<tr>
<td>3b. (TS) Tall Shrub</td>
<td>Early, or potentially prolonged, successional stage dominated by shrubby vegetation &gt;2 m and &lt;10 m tall. Seedlings and advance regeneration may be abundant. Tree cover &lt;10%, shrub cover &gt;25% or ≥50% of total cover.</td>
<td>&lt;40 yrs. for normal forest succession. Up to 100+ years under certain soil and/or climatic conditions.</td>
</tr>
<tr>
<td>4. (PS) Pole/Sapling</td>
<td>Trees &gt;10 m tall and are typically dense; younger stands are vigorous and usually &gt;10-15 yrs. old; older pole-sapling stages, composed of dense, stagnated stands (up to 100 yrs. old) are also included in this stage. The pole-sapling stage persists until self-thinning and canopy differentiation becomes evident (often by 30 years in vigorous stands).</td>
<td>20-40 yrs. for normal forest succession. Up to 100+ years for dense (&gt;2,000 stems/ ha.) stagnant stands.</td>
</tr>
<tr>
<td>5. (YF) Young Forest</td>
<td>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 site.</td>
<td>40-80 yrs.</td>
</tr>
<tr>
<td>Structural Stage</td>
<td>Definition</td>
<td>Age Criteria(^1)</td>
</tr>
<tr>
<td>------------------</td>
<td>------------</td>
<td>--------------------</td>
</tr>
</tbody>
</table>
| 6. (MF) Mature Forest | Trees that were 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. BGCU group A consists of NDT\(^2\) type stands, while BGCU group B consists of all other NUTs. | 80-140 yrs. for Biogeoclimatic unit group A\(^3\)  
80-240 yrs. for Biogeoclimatic unit group B\(^4\) |
| 7 (OF) Old Forest | Stands with complex vertical structure. Tree species in the upper canopy are also often present in the understory. Non-regenerating trees from a major disturbance such as fire may still dominate the canopy. Snags and coarse woody debris are represented in all stages of decomposition. | >140 yrs. for Biogeoclimatic unit group A\(^3\)  
>240 yrs. for Biogeoclimatic unit group B\(^4\) |

37. **Percentage of live old trees remaining:** refers to the proportionate coverage of live old growth trees remaining. There should be evidence of snags, fallen trees or stumps to support your estimate of

---

1 Age criteria reflect typical rates of succession on forested sites. When determining structural stage, stand structure should be emphasized rather than stand age; deciduous stands will generally be younger than coniferous stands belonging to the same structural stage. Stages 2 and 3 may represent successively restricted ecosystems such as avalanche tracks or wetlands which may be much older than suggested here. Stages 3a and 3b may include very old krummholz <2 m tall and very old, low productivity stands such as bog woodlands <10 m tall respectively.

2 Natural disturbance Type 3 = frequent stand initiating events (usually wildfire); other NDTs include NDT1 = rare stand initiating events, NDT2 = infrequent stand initiating events, NDT4 = frequent stand maintaining events, and NDT5 = alpine tundra and parkland (high elevation biogeoclimatic units).

3 BGCU group B includes the following:  
BWBSdvk, BWBSmv1, BWBSwvk, ESSFdc, ESSFdk, ESSFdv, ESSFmv2, ESSFmv4, ESSFwvn, ESSFxc, IChdk, IChdw, ICHmnlk1, ICHmnlk2, ICHmnw1, ICHmnw3; MS, SBFs; SBSdh, SBSdk, SBSdw, SBSmc, SBSmh, SBSmk, SBSmm, SBSmv.

4 BGCU group A includes the following:  
BWBSvk; CDF, CWH; ESSFmc, ESSFmk, ESSFmn, ESSFmv1, ESSFmv3, ESSFwcn, ESSFwv, ESSFvc, ESSFvc, ESSFvc, ESSFvc, ICHm, ICHmc, ICHmnlk3, ICHmnw2, ICHwc, ICHwk, ICHvc, ICHvk, ICHxw, IDF, MH, PP; SBSwk, SBSvk, SWB.
main plot centre had about 10 individual old growth trees, and if only
3 are still alive or standing, the value would be 30%. If the value for
the percentage of live old trees remaining is less than 40%, the site is
likely too disturbed for the old growth forest designation.

38. Old growth forest: this decision should be based on evaluation of all
the above attributes in the succession interpretations. If "no - some"
is selected, this suggests the sample stand has some old growth forest
attributes, but it is not old growth.

Vegetation Description

39. Species: Comprehensive species lists are important for this project.
The data will be used for a variety of purposes, including an
accounting of species diversity. See the discussion on species codes
in the introductory section under "Vegetation". Unknown plants
should be collected and recorded for later identification using
established botanical procedures.

Coverage for tree- and shrub-layer species is visually estimated within
the 10 m slope-corrected plot radius, while a nested subplot of 5.64 m
radius is used for herb- and moss-layer species.

<table>
<thead>
<tr>
<th>Plot radius</th>
<th>10 m</th>
<th>5.64 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal surface area</td>
<td>314 m²</td>
<td>100 m²</td>
</tr>
<tr>
<td>25% coverage</td>
<td>78.5 m² or ¼ of the plot pie</td>
<td>25 m² or ¼ of the plot pie</td>
</tr>
<tr>
<td>1% coverage</td>
<td>3.14 m² or a 1.8 m sided square</td>
<td>1 m²</td>
</tr>
<tr>
<td>0.1% coverage</td>
<td>0.31 m² or a 55 cm sided square</td>
<td>0.1 m² or a 32 cm sided square</td>
</tr>
<tr>
<td>0.01% (1H* - hundredth of a percent)</td>
<td>314 cm² or a 18 cm sided square</td>
<td>100 cm² or a 10 cm sided square</td>
</tr>
<tr>
<td>0.001% (1T* - thousandth of a percent)</td>
<td>31.4 cm² or ~ 6 cm sided square</td>
<td>10 cm² or 3 cm sided square</td>
</tr>
</tbody>
</table>

*The hundredth and thousandth of a percent values, or multiples thereof (3H, 5H, 2T,
9T, ...) are meant to allow better cover estimates for species that have coverage less
than 0.1%. Enter the coverage as shown with the "H" or "T" factor. Note that 9H or
9T is as high as you should go with either factor since 10H ~ 0.1% and 10T ~ 1H.

Total coverage (%) is an estimate of the coverage of all species in
each of the A, B1, B2, C and D layers, and is used by the field person
to calibrate and adjust cover estimates for subsequent individual
species within strata. If there is overlapping coverage of species
within strata than total % may be considerably less than the sum of individual species coverage.

Total trees (A) includes dominant (A1) main canopy, or codominant (A2), and overtopped (A3) trees taller than 10 m. Cover values are estimated for individual tree species for the entire A-layer. Overlapping crown is not additive for the same species, consequently a given tree species cannot have coverage greater than 100%.

Tall shrubs (B1) 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. Low shrubs (B2) consists, with minor exception, of shrubs and established tree regeneration less than 2 m tall and at least 2 years old.

Herbs (C) refers to herb-layer plants such as ferns, graminoids, herbs, saprophytes, and some woody species. Table 4.1 in Luttmerding et al. (1990 p. 110) lists species of doubtful lifeform, still considered to be in the herb layer.

Mosses, lichens, liverworts and seedlings (D) includes tree seedlings less than 2 years old. Three main substrates are recognized here, Dh (on forest floor and mineral soil), Dw (on decaying wood) and Dr (on rock). In the moss-layer (Dh, Dw, and Dr) emphasize species growing on the main substrate, which in most cases will be Dh (forest floor or mineral soil); describe only the predominant species on atypical substrates for example Dw (decaying wood) and Dr (rock). However, if Dw or Dr is the main substrate, then the list should be more complete for this substrate.

40. Shrub height (m): a mean height estimate weighted by % cover for individual shrub-layer (B1 and B2) species should be provided. For example, if Douglas maple (ACERGLA) is generally 1.5 m tall and covers 30%, with the exception of one 8 m tall individual which covers 10%, the cover weighted height would be:

Example of Weighted average height calculation

\[
\text{Average height} = \frac{(1.5 \text{ m } \times 30\%) + (8 \text{ m } \times 10\%)}{30\% + 10\%} = \frac{0.45 \text{ m} + 0.8 \text{ m}}{0.45 \text{ m} + 0.8 \text{ m}} = 1.25 \text{ m} \cdot \frac{40\%}{40\%} = 3.1 \text{ m}
\]

There is not enough time to always calculate this in the field, rather you should come up with a quick visual estimate of average species height weighted by coverage. This includes all woody shrubs as well as trees in the shrub layers. The height and the % cover estimates will be used to calculate shrub volume by species.
41. **Comments**: focus on items of ecological interest otherwise missed on data forms.
Vegetation Inventory

Chapter 5
Coarse Woody Debris
Vegetation Inventory

Chapter 5

C. Anne Wnagba Daphne
Coarse Woody Debris

Basic premise
Coarse woody debris (CWD) refers to the larger dead and mostly down woody material which is in various stages of decomposition. Coarse woody debris is a major contributor to structural diversity in forests and provides habitat for plants, mammals, amphibians, insects and microorganisms. It influences hillslope and stream geomorphology, affects the microtopography and microclimate of the forest floor, is an important nutrient pool and possibly a nitrogen fixation site in some ecosystems.

Procedures
Sampling
Coarse woody debris includes:

- downed horizontal or suspended (not self-supporting) dead tree boles with or without roots attached. Coarse woody debris includes fallen trees which still have green foliage if they no longer have roots attached (no living cambium),
- only those pieces greater than 7.5 cm at the point where the sampling line crosses the piece.
- overturned stumps less than 1.3 m in length which have roots attached and anything longer with no roots attached,
- fallen broken tree tops which may be horizontal or leaning, or
- large fallen branches in some stage of deterioration.

Pieces may be suspended on nearby live or dead trees, other pieces of coarse woody debris, stumps or other terrain features.

Coarse woody debris does not include

- live or dead trees (still rooted) which are self supporting,
- dead branches still connected to standing trees,
- exposed live tree roots or
- upright stumps still rooted.
Two 24 m (horizontal distance) lines are used to sample coarse woody debris. These will run from the plot centre, the first following a pre-assigned random azimuth and the second at plus 90° to the azimuth. The slope of each line is taken and the slope distance required to produce a horizontal line of 24 m length is calculated and used. If for any reason all of the line cannot be sampled, the distance which was actually sampled out of the total distance is noted (record in comments section why the portion was not measured).

If the sample line runs out of the polygon and enters a different type, stop at the polygon boundary and follow the original sample line back into the polygon by retracing your steps. If the slope has not changed appreciably, it will probably not be necessary to recalculate the slope correction factor to determine the length of line needed to complete the 24 m sample. Resume tallying and measuring coarse woody debris along the line in the reverse direction. The pieces will have been sampled once before but they are treated as new pieces.

- Measure CWD pieces from plot centre to polygon boundary at 16 m
- Remeasure CWD pieces from 16 m back 8 m to complete 24 m transect

*Figure 5.1*

*Procedure when Transect Intercepts Polygon Boundary*

If the line falls in an area which has much windthrow or is felled and bucked or logging debris and coarse woody debris is plentiful, sample only the first and third quarters of the line (from 0 to 6 m and from 12 to 18 m) if the random azimuth assigned to that plot is odd. If the random azimuth is even then the second and fourth quarters of the line (from 6 to 12 m and from 18 to 24 m) will be sampled.
If the line falls on very heavy accumulations such as a windrow or debris pile, sample only the second quarter of the line (from 6 to 12 m) for even random azimuths and the third quarter (12 to 18 m) for odd random azimuths. In this case it will be necessary to measure the depth and length of debris intercepted and record the measurements. An estimate should be made of the numbers of pieces and their diameters in heavy accumulations which cannot be safely measured.

The intent of allowing for partial sampling is to avoid burdening field crews with excessive and time-consuming work. The reasoning is the same as when the variable plots are split to reduce both potential errors and sampling time.

Coarse woody debris in the form of felled and bucked logs or cold decks will be sampled even though this material will probably not remain on the site permanently. When non-linear pieces are encountered, the cross-sectional area under the sampling line will be estimated. This applies to "lily pads" (slices from logs) and chunks of odd configurations.

**Rules for Sampling**

There are a few rules regarding what is and isn't sampled:

**Rule 1**

- Coarse woody debris must meet a number of criteria related to diameter, length and condition. The Vegetation Inventory measures coarse woody debris greater than 7.5 cm in diameter at the line intersect point. Material smaller than this is ignored, except in relation to rule number 6.

**Rule 2**

- The sample line must cross the central axis (pith) of the piece.

![Diagram of sampling line and piece](image)

**Figure 5-2**

**Line Intersect Must Cross Central Axis of Piece**
Rule 3
- If the sample line exactly intersects the central axis, tally every other such piece. Track this on a plot-by-plot basis (not through the entire day, week or sampling period).

![Diagram of sampling lines and central axis of piece](image)

**Figure 5-3**
**Procedure - Line Intercept of Central Axis**

Rule 4
- When the sample line appears to coincide nearly exactly with the central axis of the piece it will be necessary to choose the most appropriate location on the piece at which to take the diameter measurement. A decision must be made as to whether the line crosses the central axis (yes or no), if yes the piece is measured.

![Diagram of sample line and central axis of piece](image)

**Figure 5-4**
**Procedure - Line Intercept Parallel to Central Axis**

Rule 5
- If the sample line intersects a curved or angular piece more than once, measure each intersection.

![Diagram of sample line intersecting curved piece](image)

**Figure 5-5**
**Procedure - Measure all Intercept of Pieces**
Rule 6
- If a log has split open but is still partially held together, record the diameter as if the piece were whole. If something has shattered into a number of distinct pieces, record them as individuals if each one is greater than 7.5 cm in diameter at the point of sampling.

Rule 7
- Do not tally undisturbed stumps. Tally uprooted stumps and exposed dead roots if they meet the other criteria.

Rule 8
- Tally only pieces whose central axis lies above the organic soil layer (top of the LFH) at the point of intersection.

Measurements
For each piece of coarse woody debris that is tallied, record:
- the tree species,
- diameter (to the closest 0.1 cm),
- the tilt angle of the piece in degrees, and
- the decay class.
- if piece is greater than 3 metres in length
- if piece is a product likely to be removed

- tree species are recorded using the same codes as for standing trees. If the species cannot be determined put "U" for unknown.
- the diameter of the piece is taken perpendicular to the bole at the point where the sampling line is considered to intersect the central axis of the piece. A diameter tape is wrapped around the bole when possible to measure the diameter, otherwise the reverse side of the tape is used to estimate the diameter. Calipers may also be used and are often easier when coarse woody debris is in several layers.
- the tilt angle refers to the tilt of the individual log away from the horizontal, regardless of the slope of the ground. A clinometer is
placed on the surface of the piece at the point of the intercept measurement and the angle from the horizontal (in degrees) is recorded.

- A five class system is used to describe the decay class of coarse woody debris. At the point of intersection of the sampling line with the coarse woody debris, look up and down the piece to determine its class. Choose a class based on the majority of the piece. In other words, if parts of the piece are class 3 and parts are 4, or parts are class 4 and parts are 5, choose a class based on the majority. Do not mix classes (i.e. 3/4 or 4/5). Refer to figure 5-8 for descriptions of classes.

- If the piece is more than 3 m in length this is noted on the form.

- If the material is a product likely be removed from the site at some future time a notation is made to that effect on the field card with an "x".

**Measurement of odd shaped pieces or accumulations**

- When "lily pads" or odd-shaped pieces are encountered the equivalent of their cross-sectional area is recorded along with species and decay class. Notations are made if the individual piece is likely to be removed or is longer than 3 m.

- Measurement of accumulation

![Diagram of measurement of accumulation]

- Record species as appropriate
  - If primarily one species record species code for that species
  - If several species can be identified the cross sectional area of each can be recorded
  - If a complex mixture of species, too difficult to distinguish, record as "U" for unknown

- Record the average line intercept length and average depth of the accumulation by species
- record the average CWD class for the species
- record the average angle in degrees for the species
- if the material is on average greater than 3m. in length record with an "x"
- if the materials are on average products likely to be removed record with an "x"
<table>
<thead>
<tr>
<th>PORION ON GROUND</th>
<th>Log decomposition Class 1</th>
<th>Log decomposition Class 2</th>
<th>Log decomposition Class 3</th>
<th>Log decomposition Class 4</th>
<th>Log decomposition Class 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>PORTION ON GROUND</td>
<td>Elevated on support points</td>
<td>Elevated but sagging slightly</td>
<td>Sagging near ground, or broken</td>
<td>All of log on ground, sinking</td>
<td>All of log on ground, partly sunken</td>
</tr>
<tr>
<td>TWIGS &lt; 3 cm (if originally present)</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
</tr>
<tr>
<td>BARK</td>
<td>Intact</td>
<td>Intact or partly missing</td>
<td>Trace</td>
<td>Absent</td>
<td>Absent</td>
</tr>
<tr>
<td>SHAPE</td>
<td>Round</td>
<td>Round</td>
<td>Round</td>
<td>Round to oval</td>
<td>Oval</td>
</tr>
<tr>
<td>TEXTURE</td>
<td>Intact, hard</td>
<td>Intact, hard to partly decaying</td>
<td>Hard, large pieces. Partly decaying</td>
<td>Small, blocky pieces</td>
<td>Many small pieces, soft portions</td>
</tr>
<tr>
<td>INVADING ROOTS</td>
<td>None</td>
<td>None</td>
<td>In sapwood</td>
<td>In heartwood</td>
<td>In heartwood</td>
</tr>
</tbody>
</table>

*Figure 5.8*

**Coarse Woody Debris Class Description**
VEGETATION INVENTORY - COARSE WOODY DEBRIS

**COARSE WOODY DEBRIS TRANSECT 1 (Azimuth °)***

<table>
<thead>
<tr>
<th>Num.</th>
<th>Species</th>
<th>Diameter (cm)</th>
<th>C Angle (deg)</th>
<th>L</th>
<th>Angle (deg)</th>
<th>Length (m)</th>
<th>P/R</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>22</td>
<td>33</td>
<td>7</td>
<td>1</td>
<td>5</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>19</td>
<td>35</td>
<td>10</td>
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**COARSE WOODY DEBRIS TRANSECT 2 (Azimuth ° 90°)***

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COMMENTS:

**Figure 5-9**

*Vegetation Inventory - Coarse Woody Debris - Field Card [EW]*

March 31, 1995
Vegetation Inventory

Chapter 6
Tree Measurements
Vegetation Inventory

Chapter E

Tree Measurement
Tree Measurements

Vegetation Inventory Field Data
Tree Specific Data - Field Cards

The field cards for usage in collecting the tree specific data follow. The specific field cards are:

- Figure 6-1  Vegetation Inventory Header Card [TH]
- Figure 6-2  Vegetation Inventory - Tree Details [TD]
- Figure 6-3  Vegetation Inventory - Tree Loss Indicators [TL]
- Figure 6-4  Vegetation Inventory - Small Tree, Stump and Site Tree Data [TS]
- Figure 6-5  Vegetation Inventory - Tree Auxiliary Plot [TA]

Procedures for the collection and recording of tree measurements are as follows:

- Chapter VI
  - tree measurement field cards
  - instructions for completing field cards
  - basic tree measurement on main plot

- Chapter VII
  - Net Factoring

- Chapter VIII
  - Call Grading

- Chapter IX
  - Wildlife Tree Classification

- Chapter X
  - Forest Health

- Chapter XI
  - Small Fixed Plot Measurements

- Chapter XII
  - Site Tree Measurements

- Chapter XIII
  - Auxilliary Plot Measurements
TREE MEASUREMENTS

Vegetation Inventory Field Data
The Specific Data - Field Guide
Vegetation Inventory

Chapter 3
Range Sampling
Range Sampling

Background

Sampling for range management purposes is done as part of the integrated sample plot. In order to manage livestock, range managers require estimates of the amount of forage production and utilization for grasses and forbs in kg/ha. and a measure of shrub abundance.

A forb is:

- "any broad-leafed herbaceous plant other than those in the Gramineae (or Poaceae), Cyperaceae and Juncaceae families" (taken from A Glossary of Terms Used in Range Management; Society for Range Management (S.R.M.), 1989.

Grasses are:


Production is defined as the sum of live standing herbaceous biomass produced within a defined period of time (as defined by Singh, J.S., W.K. Lavenroth and R.K. Steinheist, 1976. The Botanical Review. 41(2):181-231). Production can be converted to Animal Unit Months (AUMs). An AUM 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" (S.R.M. 1989)

These estimates of production may be correlated to groups of vegetation (forest) cover attributes which are correlated to form General Range Types (GRTs) or a specific site series (currently under development for grasslands by Range Section). General Range Types are distinct, broad mapping units easily recognizable on aerial photographs that are used for initial pre-stratification of survey areas and for summary purposes. They are generated by a complex of variables such as forest cover type, age class, site class, height class, etc. A new set of GRTs will be developed when the British Columbia Land Cover Classification Scheme is implemented. Production estimates may be grouped and then graphed across the growing season (April to September) for a General Range Type.
Vegetation Inventory Range Sampling

The Vegetation Inventory range samples will consist of:

- micro plots to measure forage production, and
- shrub transects

The vegetation inventory range samples will be established on the integrated plot which could be established at any time during the growing season. Therefore range managers may choose to only use these estimates as an indication of total production for that location, considering that a General Range Type, such as open range or upland graminoid, may cover several site series. The Range Section has decided for purposes of the Vegetation Inventory that production estimates are only required in the interior of the province (refer to the attached map at the end of this section, Figure 3-4).

Production estimates will be modified or may not be used if forage utilization is greater than 15%. However, an estimate of forage utilization is required on all micro plots. Forage utilization information may be used by range managers to determine use zones and may also contribute towards (along with other range samples) range use plans.

Range managers also require information on the species composition of livestock forage and identification of site series. The field sampling method for identifying site series (if applicable) and collecting species composition data is described in the ecological vegetation sampling section. For range management purposes shrub species composition and foliar cover estimates will be collected using a line intersect.

Forage Production of Grasses and Forbs

Forage production measurements should be made immediately after the integrated plot centre is established, in order to avoid excessive trampling of forbs and grasses.

Four micro plots will be established at 6m and 12m points along the woody debris line transect as shown in Figure 3-1.
**Forage Utilization**

Within each of the four micro plots make an estimation of the herbaceous forage utilization as described in Table 1. The utilization estimate should be made and recorded before each of the micro plots are clipped. It is appropriate to include the immediate area (1 - 2 metres) surrounding the micro plots as part of the estimation procedure.

<table>
<thead>
<tr>
<th>Code</th>
<th>Class</th>
<th>Range</th>
<th>Utilization</th>
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<tbody>
<tr>
<td>0</td>
<td>Nil</td>
<td>(0%)</td>
<td>The plants show no evidence of use by livestock or wildlife.</td>
</tr>
<tr>
<td>1</td>
<td>Slight</td>
<td>(1 to 15%)</td>
<td>The plants show very little evidence of use by livestock or wildlife and have the appearance of slight grazing. Key forage plants may be topped or slightly used. Current seed stalks and young plants of key species show little disturbance.</td>
</tr>
<tr>
<td>2</td>
<td>Light</td>
<td>(16 to 35%)</td>
<td>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.</td>
</tr>
<tr>
<td>3</td>
<td>Moderate</td>
<td>(36 to 65%)</td>
<td>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.</td>
</tr>
</tbody>
</table>
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.

---

Table 1: Herbaceous Forage Utilization Classes and Codes [taken from Procedures for Environmental Monitoring in Range and Wildlife Habitat Management. MOF., MOELP 1990]

A utilization gauge (developed by the U.S.F.S. Rocky Mountain Forest and Range Experimental Station) may also be helpful in determining the percent utilization for a particular species and will be available during the field projects.

**Forage Measurements**

Clip and weigh the green wt. of forbs and grasses at all four (0.399m) plots. Record the measured green weight of forbs (MF) and measured green weight of grasses (MG) for the plot on the sample plot sheet. The four plots are combined and weighted; with the forbs and grasses kept separate. The bags of forbs and grasses will be returned to the field office where they will be oven dried (55°C. for 24 hours) and weighed.

---

**Shrub Species Composition and Foliar Cover Estimates**

Livestock and wildlife species utilize shrub biomass at various times of the year. These shrub locations may be critical to their health and survival. Therefore, resource stewards need to know the species and abundance of shrubs. Shrub estimates are required in order to derive the abundance of a particular shrub species.

The canopy cover of shrubs can be quickly and reliably estimated using line intercept methods (as described by "Methods for Vegetation Sampling and Analysis on Revegetated Mined Lands", by C. Chambers and R.W. Brown, 1983, Inter Mountain Forest and Range Environmental Station, General Technical Report INT-151). The lines established for the woody debris and forage production estimate will also be used for shrub abundance estimates. The objective is to vertically project the canopy of the shrub onto a horizontal line and measure the intercept of the line and shrub canopy.
Procedure

A measuring tape is stretched out along the randomly selected woody debris transects (24 m.). The length of the line intercepted by the canopies of each shrub species is determined by measuring the horizontal distance along this line occupied by each individual shrub. The shrub species are recorded by the following layers:

"B1" Layer - shrubs greater than 2.0 meters in height
"B2" Layer - shrubs 2.0 meters and less in height

Note: In the 'B2" layer shrubs include deciduous and coniferous trees

The system works best if the intercepts are measured along one edge of the tape, to provide a narrow line width. Initially a plumb bob is used (at the beginning of the sampling season) to establish the beginning and end point of each shrub canopy along the line. After sampling crews have gained experience in identifying the intercept point on the tape, it can then easily be visually estimated, and the use of the plumb bob may be discontinued. Breaks in shrub canopies of less than 5 cm should be ignored. An example of the line intercept measurement is shown in Figure 3-2. Individual shrubs of the same species and layer which overlap are measured as one horizontal occurrence. If the canopies of different species or layers of shrubs overlap, the plants are to be recorded separately.

![Figure 3-2](image_url)

*Figure 3-2*

**The Line Intersect Method For Shrubs**
The extent of each species along the transect is divided by the total length of transect to provide an estimate of shrub cover. The percent cover of a species is determined by dividing the sum of individual transect lengths intercepted by the total transect length sampled, then multiplying by 100.

The line intersect plot design for the integrated plot design is shown in Figure 3-1. If the line transect intersects the polygon border then the "bounce back" methodology is used (for example, the polygon border is at 18.5 meters from plot center. measure the occurrence of shrubs as encountered from plot center to 18.5 meters. Then record again the shrubs occurring on the portion from 18.5 meters to 13.0m.

For example:
- transect full length = 24.0m.
- polygon border intercepted at = 18.5m.
- length of line to "bounce back" = 5.5m.
- therefore re-measure line from 18.5m. to 13.0m. (a distance of 5.5m.)

The sampling crew should start at the integrated plot centre and establish the first line intercept at a random bearing for a distance of 24 metres, as described in the woody debris section of this manual. It is recommended that the woody debris data be collected on the way out to the end of the
line and then the shrub intercepts shown be recorded on the way back to plot centre.

The second line (24 metres) is then established at 90° to the first line and the procedure for collecting shrub and woody debris data is repeated.
## Vegetation Inventory Range Sampling (RS)

### Shrub Transect #1

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### Forage Production

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**Comments:**

- Comment 1
- Comment 2
- Comment 3
- Comment 4

March 31, 1995
### SHRUB TRANSECT #2

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#### Utilization

- **0 Nil**: The plants show no evidence of livestock or wildfire.
- **1 Light**: The plants show evidence of use by livestock or wildfire and have the appearance of very slight grazing. Key forage plants may be trampled or slightly used. Current seed stalks and young plants of key species show little disturbance.
- **2 Moderate**: Key forage plants are trampled or slightly used. Current seed stalks and young plants of key species show moderate disturbance. Vitality of key species may be reduced and productivity may be reduced.
- **3 Heavy**: Key forage plants are trampled or used. Current seed stalks and young plants of key species show severe disturbance. Vitality of key species may be reduced and productivity may be severely reduced.
- **4 Extreme**: Key forage plants are trampled or used extensively. Current seed stalks and young plants of key species show severe disturbance. Vitality of key species may be reduced and productivity may be severely reduced.

**March 31, 1985**
Vegetation Inventory

Chapter 4
Ecological Sampling
Vegetation Inventory

Chapter 4
Ecological Sampling
Ecological Sampling

Purpose

- Collect floristic data to provide a record of existing vegetation at forest inventory sample plot locations.
- Collect soils and site data to provide a record of conditions at forest inventory sample plot locations.
- Classify forest inventory sample plots within the Biogeoclimatic Ecosystem Classification system.
- Establish a network of relocatable sample plot locations which can be revisited. This will permit monitoring of floristic change through time for a variety of needs such as tracking trends in succession or impacts of management activities.
- Provide a database which will be useful for a variety of management and research applications, such as enhancing the provincial ecological classification system.
- Maintain a high standard in database quality and procedures.

General Procedures and Concepts

The intent is to gather information on vegetation and other ecosystem components which occur in the ecological plot. The ecological plot is 314 m² (10 m radius) in size and is centered on the inventory sample plot. A nested 100 m² (5.64 m radius) plot is established within the ecological plot to sample vegetation in the herb and moss layers. The inventory sampling methods do not allow movement of the ecological plot to more "typical" or homogeneous portions of the polygon as this would introduce sampling bias. However, this may result in a portion of plots falling in ecologically diverse areas (plots may contain more than one ecosystem). This leads to difficulties with secondary applications of the data such as ecological classification. To address this concern, a plot uniformity attribute has been included on the data form. The procedures for ecological description further address this issue by requiring estimates of the relative proportions of component site series\(^1\) comprising a plot. If the

\(^{1}\) site series is a basic classification unit in the biogeoclimatic classification
main centre point does not fall in the dominant site series within the 10 m plot radius, then additional soils and site data are collected for the dominant site series.

**Vegetation**

The intent is to produce comprehensive vegetation lists including species codes (based on Latin names) and percentage cover values. Vegetation samplers must have as much practical experience in plant identification as possible. Species unknown to the samplers need to be collected, labelled, and stored for identification by specialists.

There are a number of exceptions resulting in the same code for different species. Also, if the genus is known but not the species, all the characters (up to 7) in the genus are recorded. For example, if an unknown lichen of the Cladonia genus is collected, it is coded as CLADONI. Likewise, a grass of the Poa genus would be coded as POA. If the grass was known to be Poa alpina, it would be coded as POA ALP. 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). Master lists of Latin, common and 7-letter code names for plant species are available, and should be consulted regularly to ensure no conflicting codes are used.

Some of the vegetation sampling must be planned for optimum floristic development in different biogeoclimatic subzones in the province. Advice may be obtained from regional ecologists with the Ministry of Forests on the best months, and in some cases, best weeks of the year to sample vegetation in different areas. In some circumstances it may be necessary to collect floristic data independently to take advantage of peak floristic conditions.

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.

**Site and Soils**

The intent is to provide data on key soil and site features to facilitate identification of the plot within the biogeoclimatic ecosystem classification. Statistics for certain attributes may also be generated from the data. The site and soil attributes selected for the ecological description represent a basic core set of properties that both meet the needs of the inventory and can be efficiently collected by field crews with a reasonable level of precision.
Field crews should have experience and proven abilities in biogeoclimatic ecosystem classification (BEC), with emphasis on soils. Soil samples will be collected from plots so field estimates of soil texture can be monitored for on-going crew calibration.
**VEGETATION INVENTORY ECOLOGICAL DESCRIPTION 1**

### A: SUMMARY INFORMATION

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### B: SITE FEATURES

#### BASIC DESCRIPTION

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#### Microtopography

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### C: SOIL FEATURES AND SOIL DESCRIPTION FOR PIN LOCATION

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### D: VEGETATION INVENTORY (EP)

**Enter one / per row (N = Not Value)**

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**March 31, 1995**
### Site and Soil Description for Dominant Stratum (when not at plot centre)

#### Site Features

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March 31, 1995
**VEGETATION INVENTORY - TREE AND SHRUB LAYERS**

**PLOT RADIUS = 10.00**

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**RECORDING SPECIES COVERAGE LESS THAN 1/10 %**

For a coverage of 5/100 record as [ ] 5H
For a coverage of 5/1000 record as [ ] 5T

*Note: 1/100% = 18 cm x 18 cm (approximately)*

**SPECS COMMENTS / NOTES**

---

**MARCH 31, 1995**
# Vegetation Inventory - Herb and Moss Layers

**Plot Radius** = 5.54 m

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<th>Initial Cover</th>
<th>Percent Coverage</th>
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<th>Moss Layer</th>
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<td>(wood)</td>
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</table>

**Recording species coverage less than 1/10%:**

**For a coverage of 5/100 record as:**

**For a coverage of 5/1000 record as:**

**Note:**
- 1/100% = 10 cm x 10 cm (approximately)
- 1/1000% = 3 cm x 3 cm (approximately)

**Species Comments:**

---

*Should Read 21 to 40*
VEGETATION INVENTORY - SUCCESSION INTERPRETATIONS
Interpret on 25m radius area.

<table>
<thead>
<tr>
<th>26. Factors Influencing Vegetation Establishment</th>
<th>27. Tree Species Succession Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-1</td>
<td>F-2</td>
</tr>
<tr>
<td>50</td>
<td>51</td>
</tr>
</tbody>
</table>

**Succession Interpretations**

<table>
<thead>
<tr>
<th>Event</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearcut</td>
<td>C</td>
</tr>
<tr>
<td>Partial</td>
<td>P</td>
</tr>
<tr>
<td>None</td>
<td>N</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Event</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (≥ 25 cm DBH)</td>
<td>28</td>
</tr>
<tr>
<td>None</td>
<td>N</td>
</tr>
<tr>
<td>Some (1-5)</td>
<td>S</td>
</tr>
<tr>
<td>Common (≥ 5)</td>
<td>C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Event</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>N</td>
</tr>
<tr>
<td>Some</td>
<td>S</td>
</tr>
<tr>
<td>Yes</td>
<td>Y</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Event</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canopy Gaps due to tree mortality</td>
<td>31</td>
</tr>
<tr>
<td>None</td>
<td>N</td>
</tr>
<tr>
<td>Some (&lt;10%)</td>
<td>S</td>
</tr>
<tr>
<td>Common (≥ 10%)</td>
<td>C</td>
</tr>
</tbody>
</table>

**Vertical Structure**

<table>
<thead>
<tr>
<th>Event</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple</td>
<td>S</td>
</tr>
<tr>
<td>Moderate</td>
<td>M</td>
</tr>
<tr>
<td>Complex</td>
<td>C</td>
</tr>
</tbody>
</table>

**Successional Stability**

<table>
<thead>
<tr>
<th>Event</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unstable</td>
<td>U</td>
</tr>
<tr>
<td>Intermediate</td>
<td>I</td>
</tr>
<tr>
<td>Stable</td>
<td>S</td>
</tr>
</tbody>
</table>

**Tree age for species & tree events**

<table>
<thead>
<tr>
<th>Event</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young</td>
<td>Y</td>
</tr>
<tr>
<td>Intermediate</td>
<td>I</td>
</tr>
<tr>
<td>Old</td>
<td>O</td>
</tr>
</tbody>
</table>

**Tree size for species & site**

<table>
<thead>
<tr>
<th>Event</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>S</td>
</tr>
<tr>
<td>Intermediate</td>
<td>I</td>
</tr>
<tr>
<td>Large</td>
<td>L</td>
</tr>
</tbody>
</table>

**Soil Classification**

<table>
<thead>
<tr>
<th>Event</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>N</td>
</tr>
<tr>
<td>Yes</td>
<td>Y</td>
</tr>
</tbody>
</table>

**Comments for Ecological Plots**

(Inset attribute number)
Detailed procedures

Plot Layout

Ecological data is collected on a horizontal 10 m radius main plot (314 m²) and a horizontal 5.64 m radius nested subplot (100 m²). Vegetation in the tree and shrub layers, as well as site, soil, and site classification information is collected from the main plot, while the subplot is used for vegetation in the herb and moss layers. Measure and flag the 10 m and 5.64 m radii at 90° intervals around the circumferences of the plots to demarcate plot boundaries.

Assess the ecological variability within the main plot and determine whether more than one site series occurs. 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 in this site series.

- If the plot centre falls within the dominant site (the dominant site can occur as discontinuous patches or as one contiguous area in the plot) only one site and soil description for this dominant type is done.

- If the plot centre is not in the dominant site, a soil description is done for the dominant site as well (do attributes 10-12 and 17-25 on the ecological data forms again - Form ED).

- The percentage cover of site series occurring in the plot is recorded on the form, with the plot centre site (or land cover if site classification does not apply) always in the position first (attributes 15 and 16 on Form EP).
The following diagrams illustrate some situations which may be encountered (Note, only one vegetation description is done for the entire plot, in all cases.):

1. In example 1, the dominant site is A; one site and soil description is done at the main plot centre.

2. In example 2, the plot centre site is subdominant, the main site and soil description is done at plot centre in the B site; a second site and soil description is done for the dominant site A.

3. Example 3 is the same situation as 2, except the subdominant plot centre site is discontinuous.

4. In example 4, the plot centre site is dominant; one site and soil description is done at plot centre.

**Plot Information**

1. **Slope (%)**: record the slope gradient to the nearest percent. Assess the slope by averaging over a 100 m distance (for example 50 m above and below the plot center). If a major topographic slope break occurs, measure only to the break point.

2. **Azimuth (°)**: record the orientation of the slope by means of compass bearings. Level (≤ 2% slope) ground has no aspect - code as 999.

3. **Elevation (m)**: Record the elevation in meters.

4. **Surface shape**: describe the general shape of the slope the plot is situated on (convex, straight, or concave)
5. **Site position** meso: describes the relative position of the plot within a local catchment area that affects surface and subsurface water flow to the plot. Upper slopes shed water and tend to be drier, lower slopes receive additional water and tend to be wetter, while middle slopes are in balance. Slope position relates to the segment of slope between prominent topographic irregularities (for example major slope breaks).

![Diagram showing Meso and Macro Slope segments and their components: crest, upper slope, middle slope, lower slope, toe, depression, flat, mountain top, and valley bottom.]

**Figure 4.7**

**The Slope Segment and Classes of Slope Position**

- **crest** - the generally convex upper portion of a hill.
- **upper slope** - the generally convex upper portion of the slope immediately below the crest.
- **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.
- **lower slope** - the area towards the base of a slope. It is generally concave.
- **toe** - the area demarcated from the lower slope by an abrupt decrease in slope gradient.
- **depression** - any area that is concave in all directions.
- **flat** - any level area not directly adjacent to a slope (e.g. toe). The surface profile is generally horizontal.
6. **Microtopography:** describes the variability in the surface configuration of the site being described. Record one of the following classes:

- **smooth** - few or no mounds, mounds if present less than .3 m high and greater than 7 m apart
- **moderately mounded** - mounds .3-1 m high and 3-7 m apart
- **strongly mounded** - mounds .3-1 m high and less than 3 m apart
- **extremely mounded** - mounds greater than 1 m high

7. **Rocky substrates:** estimate the percentage of the ground surface of the plot covered by the following substrates within the 10 m plot radius:

- **cobbles and stones** - exposed rock fragments greater than 7.5 cm diameter. They may be covered by mosses, lichens for example, with a forest floor less than 2 cm thick.
- **bedrock** - exposed bedrock that may be covered by mosses, lichens for example, with a forest floor less than 2 cm thick

**Terrain**

8. **Surficial material:** refers to the soil parent materials which are classified according to their mode of formation (Howes and Kenk 1988). Record the appropriate code from below. If two types of surficial materials are observed in the soil pit, record both as follows: C_/M_ (colluvial over morainal)

- **colluvial (C___)** - materials that have reached their present position as a direct result of gravity-induced movement (for example most steep slopes, talus, landslide deposits, etc.). Generally on steep terrain, common below rock bluffs, coarse fragments are angular and of the same lithology as the local bedrock; coarse fragment content generally > 35%, materials are loosely packed and porous. Deposits from landslides and other slope failures are a type of colluvial parent material.

- **fluvial (F___)** - materials transported and deposited by streams or rivers (for example floodplains, fluvial terraces, fans, deltas). Deposits generally consist of gravels, sands, and/or silts depending on stream velocity during deposition. Gravels are typically rounded; fluvial sediments are commonly well sorted and may display stratification (layers); topography is generally flat, sometimes with a steep erosional scarp; generally along valley bottoms in proximity to a river or stream.
- **Glaciofluvial (FG)** - materials deposited by glacial meltwater streams either directly in front of, within, or along the margins of glacial ice (for example eskers, kame terraces, outwash, etc.). Typically coarse textured non-sorted to well-sorted gravels and sands; may contain layers of finer textured materials; topography is generally flat, sometimes with a steep erosional scarp; may be along valley bottoms, part way up valley sides, or as an extensive plain outside valley systems; gravel pits are often present.

- **Lacustrine (L___)** - sediments that have settled out in lakes (old lake bottoms) or have accumulated along their margins (old lake beaches). These generally consist of stratified silts and clays, often with "varves" evident (bands); lacustrine materials deposited in association with melting glaciers may contain ice-rafted stones and lenses of morainal or glaciofluvial material; topography is generally flat, sometimes with a steep erosional scarp, usually along valley bottoms; slumps and landslides are often present.

- **Eolian (E___)** - materials transported and deposited by wind action (for example loess, dunes, etc.). These are generally well-sorted silt or fine sand that is loose and fluffy; usually occurs as a capping over other parent material.

- **Marine (W___)** - sediments deposited in salt water by offshore settling from suspension (former "mud flats") or through wave action along margins (former beach). Marine materials from offshore settling are fine textured (silts and clays) and often quite dense; old beach deposits are well-sorted sands and/or gravels with rounded coarse fragments; shells may be present; marine soils often contain concretions; topography is generally flat or very gently sloping; restricted to lower elevations in proximity to the ocean, although they may occur as high as 200 m above present sea level around the Georgia Strait area. Glaciomarine sediments are materials of glacial origin laid down from suspension in a marine environment. They are similar to marine sediments except they may contain stones and lenses of morainal or glaciofluvial materials.

- **Organic (O___)** - sediments composed predominantly of organic materials. This includes wetland deposits (peat, muck, etc. in bogs, fens, and swamps) and upland deposits of forest floor overlying bedrock (LFH > 10 cm thick; noted as O/R).

- **Bedrock (R___)** - exposed bedrock with or without a thin (< 10 cm) layer of organic materials.
- **volcanic (V__)** - unconsolidated volcanic sediments (for example ash, cinders, etc.). These usually occur as cappings over other parent materials (e.g. V_/M__).

- **anthropogenic (A__)** - man-made materials or man-modified geological materials (for example landfills, spoils, roadfills, etc.)

- **moraine (M__)** - (till) material deposited directly by glacial ice. Morainal materials are highly variable, generally consisting of compacted to non-compacted sediments that are non-sorted and contain a mixture of coarse fragments and fines. It often looks like "cement" with subrounded coarse fragments in a matrix of finer particles (sand, silt, clay); stones are often of different rock types and may have striations ("grinding" marks from the ice). Morainal deposits are the most widespread and variable parent material in B.C.

9. **Evidence of slope failure**: note any evidence of recent or past slope failures greater than 100 m² in surface area. This includes landslides, slumps, debris flows, debris torrents, and bedrock failures (Chatwin et al. 1994). Record if present in the plot, and if intercepted along the bearing between main plot and any of the four auxiliary plots. Not visited (NV) applies if evidence was not found, however, the lines between plot centre and the auxiliary plots were not all traversed. Features indicative of slope instability include:

- obvious recent failures (tracks of exposed soil oriented downslope)

- headwall or sidewall scarps that are rectangular or horseshoe shaped

- older failure tracks may be indicated by a significant vegetation difference (species and age) from the surrounding area

- deposits of slide materials at the base of the failure which are fan-shaped and often hummocky

- generally on steeper slopes, and often in association with wet sites (seepage zones, draws, etc.)

10. **Gullies**: note the presence of gullies. Gullies are long, linear depressions incised into the landscape where the channel is confined in a narrow ravine with banks usually higher than 3 m. Their long profile may range from gentle to steep, and uniform to irregular (benched). Their cross-section profile may be V-shaped to U-shaped with moderate to steep sidewalls. Record if present in the plot, and if intercepted along the line transect between main plot and any of the four auxiliary plots. Not visited (NV) applies if evidence was not
found, since, the lines between the main plot centre and the auxiliary plots were not all traversed.

11. **Flood hazard**: estimate the relative frequency of flooding of rivers, creeks and streams using the following biophysical features (adapted from Luttmceding *et al.* 1990 p.45):

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

12. **Open water**: estimate the percentage of the area in the 10 m plot occupied by either flowing or standing water.
Summary Information

13. **Plot uniformity** - a 5-point scale, from 1 = uniform to 5 = variable according to the following definitions:

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&gt; 95% of plot in one homogeneous ecosystem</td>
</tr>
<tr>
<td>2</td>
<td>81-95% of plot in one homogeneous ecosystem; the remainder in other ecosystems(^1)</td>
</tr>
<tr>
<td>3</td>
<td>51-80% of plot in one homogeneous ecosystem; the remainder in other ecosystems(^1)</td>
</tr>
<tr>
<td>4</td>
<td>20-50% of plot in one homogeneous ecosystem; the remainder in other ecosystems(^1)</td>
</tr>
<tr>
<td>5</td>
<td>mosaic with ≤ 20% of plot in any homogeneous ecosystem</td>
</tr>
</tbody>
</table>

14. **Biogeoclimatic units**: record biogeoclimatic unit as determined on the ground. This includes zone, subzone, and variant (if applicable). Although not a formal category, biogeoclimatic phase is sometimes recognized.


15. **Site series number and coverage**: use the two digit site series or occasionally the three character site phase code from the appropriate MOF Regional field guide to site identification and interpretation

(for example, Banner et al. 1993. A field guide to site identification and interpretation for the Prince Rupert Forest Region. Land Management Handbook No. 26, B.C. Min. For., Victoria, B.C. 503pp.)

If the plot occurs on an ecosystem not recognized in the ecological classification, record the soil moisture regime (SMR) and soil nutrient regime (SNR) instead of site series number (for example 6/D for

\(^{1}\) Other ecosystems includes different successional stages or different sites (for example different site series, avalanche tracks, streams, gullies, rock outcrops, roads, etc.).
SMR/SNR). If soil moisture and nutrient regime cannot be estimated (for example, roads, gravel pits, boulder fields), record 99. Estimate percent coverage of the site within the 10 m radius plot for a maximum of 100% in the event of only one site series. Sites or land cover types covering less than 5% (16 m²) of the 10 m radius plot, are considered too small to recognize.

16. **Land cover classification**: record land cover class to the appropriate level from the B.C. Land Cover Classification Scheme (described in a field key and a separate document). You can record up to three separate land cover designations, corresponding on a one-to-one basis with up to three site series designations (in a highly variable 10 m radius plot). If "99" is recorded for site series, then the land cover classification will stand alone as a description of that portion of the 10 m radius plot.

**Soil Features**

A soil pit is located in the main plot at the centre point adjacent to and representative of conditions at plot centre, regardless of whether or not the plot centre is in the dominant site within the 10 m plot radius. A second soil pit will be established if necessary to characterize conditions in the dominant site. The soil pit is dug to a minimum depth of 60 cm unless impenetrable material is encountered. If a soil pit cannot be excavated on the plot, indicate on the form by drawing a line through the profile description section and record why in comments.

17. **Depth to (cm)**: record the observed depth from the "0 depth" (mineral soil surface for mineral soils, ground surface for organic soils) to the following features if present within the soil profile:

- **water table** - measure to the surface of visible water in the soil profile at the time of sampling
- **gleying** - measure to the surface of any gleyed layers, indicative of periodic anaerobic conditions in the soils associated with poor drainage. Gleying is recognized by dull bluish to grey soil matrix colours, usually with reddish coloured mottles.
- **root restricting pan** - measure to layers which impede root penetration (for example pans, cemented horizons, compact parent materials).
- **bedrock** - measure to consolidated bedrock. Weathered bedrock that can be removed with a shovel should be considered soil.
- **frozen layer** - measure to the top of a frozen layer at the time of sampling.
• carbonates - measure to the top of a layer containing carbonate accumulations.

18. Humus form: refers to the forest floor and organic-enriched surface mineral horizons. Humus forms are classified into one of the following types:

• Mor - LFH horizons prominent, F horizon is matted, with abundant fungal mycelia, mushroom smell common, usually abrupt transition to mineral soil

• 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.

• 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

• Mullmoder - intergrade between Moder and Mull, features well developed F and H (F+H > 2 cm thick) but Ah present which is thicker than the F+H horizons.

• Mull - Ah horizon prominent, F + H horizons < 2 cm thick, F horizon very friable, Ah granular, earthworms often present.

19. Soil colour: describe the general colour of the rooting zone mineral soil using the following categories:

• dark - chocolate brown or black coloured (Munsell colour value < 4 when moist)

• medium - intermediate colour (most commonly encountered)

• light - very pale coloured soil (Munsell colour value > 6 when moist)

Note, field crews will be provided with a small colour chart for comparison of dark, medium and light soil colour.

20. Relative soil moisture regime: soil moisture regime refers to the average annual amount of soil water available to plants. It is inferred from the physiographic and soil features described.

There are nine soil moisture regime classes described in Luttmerding et al. (1990 p. 35):

0 = very xeric  
1 = xeric  
2 = subxeric  
3 = submesic  
4 = mesic  
5 = subhygic  
6 = hygic  
7 = subhydric  
8 = hydric

21. **Nutrient regime**: refers to the amount of essential soil nutrients, particularly nitrogen, that are available to plants. It is inferred from physiographic and soil features (for a key to soil nutrient regime see pp. 276-279 in Green and Klinka (1994)).

There are six soil nutrient regime classes described in Luttmerding et al. (1990 p. 38):

A = very poor  
B = poor  
C = medium  
D = rich  
E = very rich  
F = saline

**Soil Description**

22. **Horizon**: record the main types of organic and mineral horizons beginning with the uppermost horizon, followed by subsequent horizons proceeding down through the profile. These include L, F & H, Ah, Ae, B, and C. Subordinate horizons of B and C (e.g. Bf, Bfl, Bf2, Bfg, Bt, Bm, etc.) may be recorded if the crew person can confidently identify them. Differentiate subdivisions of the B or C horizons (e.g. B1, B2) if properties differ substantially in colour, texture and coarse fragments and structure.

- **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 if they are difficult to distinguish*

---

1. The 8 (hydric) class is rarely used, but may be encountered in certain wetland ecosystems.
2. The F (saline) class is rarely used, but may be encountered.
- **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").

- **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.

- **R** - bedrock

23. **Depth (cm)**: record the average upper and lower boundaries of each horizon in the profile. For forest floor horizons (L, F, H) depth is the top of the mineral soil and horizon boundary depths are measured in ascending order from 0 depth to the ground surface (e.g. L: 6-5, F: 5-2, H: 2-0). For mineral horizons, the top of the uppermost horizon is considered 0 depth, and upper and lower boundary depths are measured in descending order (for example A: 0-3, B: 3-25, C: 25-60+). Always record the maximum depth of the soil pit as the lowest boundary of the last horizon (e.g. 60+). For "Organic" soils, 0 depth is the top of the organic material. Organic soils are soils with > 60 cm of organic material (if surface horizons are Of), or > 40 cm of organic material (if surface horizons are Om and Oh), or > 10 cm thick if overlaying rock (as described on pp. 82-86 in Agriculture Canada Expert Committee on Soil Survey. 1987. The Canadian System of Soil Classification. 2nd ed. Agric. Can. Publ. 1646. 146pp.)
24. **Texture:** estimate texture of the mineral soil (less than 2 mm diameter) using field estimation methods as described in MOF regional ecology field guides (for example pp. 381-384, Lloyd et al. 1990. A guide to site identification and interpretation for the Kamloops Forest Region. Land Management Handbook, No. 23, B.C. Min. For., Victoria, B.C. 398 pp.) Collect a sample from the main B horizon for subsequent verification if necessary (enclose a waterproof label noting plot number and horizon).

25. **Coarse fragments:** estimate the proportion of the total volume of soil material by mineral soil horizon occupied by materials > 2 mm in diameter. Record the total coarse fragment volume, and the breakdown for gravels (2 mm - 7.5 cm) and cobbles + stones (> 7.5 cm).

**Succession Interpretations**

Look beyond the 10 m radius plot into similar surroundings (for instance up to a 25 m radius within the polygon) for succession interpretations.

26. **Factors influencing vegetation establishment** (adapted from pp. 58-59 in Luttimering et al. 1990): record the major observable factors relevant to the development of the current vegetation and soil characteristics. The time frame is within approximately the past 500 years. Use from one up to a maximum of four of the following categories. Only record factors for which direct evidence can be observed. Enter UN or a slash if no evidence of a factor can be observed. Use 2-stage code (e.g. A2), or 1-character code (e.g. A) if the specific factor is unknown.

A. **Atmosphere related effects:**
   1. atmospheric pollution
   2. climatic extremes (for example extremes of temperature, hail, snow, ice, etc.)
   3. windthrow
B. Harvesting and soil disturbances
   1. abandoned or current construction sites (road bed, railway, camp, etc.)
   2. clearcut logging
   3. cultivation (excluding harvesting of native crops)
   4. excavation
   5. land clearing (includes grubbing and other forms of disturbance such as pipeline construction)
   6. mechanical site preparation
   7. selective logging (including shelterwood, seed tree, etc.)
   8. soil compaction (including effects of human, animal, and machinery traffic)
   9. harvest of native plants

C. Dumping, disposal, and spills
   1. chemical disposal or spill
   2. effluent disposal
   3. mine spoils
   4. oil spill or disposal

D. Fires
   1. severe surface fires
   2. light surface fires
   3. burning of logging slash
   4. overstory crown fire

E. Plant and animal related effects
   1. beaver tree cutting
   2. disease (specify if known)
   3. domestic grazing/browsing
   4. excrement accumulation (other than normally associated with grazing and browsing)
   5. insect kill (specify if known)
   6. wildlife grazing/browsing

F. Terrain related effects
   1. snow avalanching
   2. eolian (active deflation or deposition)
   3. recent deglaciation
   4. rock quarrying (including open pit mines)
   5. slope failures (active or recent slumps, landslides, etc.)
   6. volcanic activity
   7. fluvial deposition

G. Vegetation and site improvement related effects
   1. fertilization
   2. irrigation
3. planted to trees or shrubs
4. seeded or planted to grass or herbs
5. seeded to trees or shrubs
6. herbicide use
7. brushing, spacing or thinning trees

H. Water related effects
1. inundation (including temporary inundation from beaver activity)
2. water table control (diking, damming)
3. water table depression (associated with extensive water extraction from wells)

I. Miscellaneous
1. other (specify)

U. Unknown

27. Tree species succession: in forested ecosystems look for signs of the earlier predominant tree species. Record previous and current predominant tree species. If, for example, you are in a red alder stand with western hemlock and western red cedar stumps, record “previous species” as Hwcw and “current species” as Dr. Alternatively, if the stand is, and appears to have always been Blse, simply record as Blse in both previous and current species boxes. The first of the maximum of two species should have the greater basal area. Record UN if stumps present but species unknown.

28. Tree harvesting: has the forest experienced some form of harvest?
   C = Clearcut
   P = Partial
   N = None

29. Snags: do a count of standing dead trees ≥ 25 cm dbh and ≥ 10 m tall (unless shorter due to advanced stage of decay [for example snag classes 7-9]) within the larger 25 m radius. Stumps resulting from tree harvest, even if relatively tall, do not qualify as snags.

   None = 0
   Some = 1-5
   Common = >5

30. Snags/CWD in all stages of decay and sizes: this observation is meant to distinguish those sites where snag and coarse woody debris recruitment is an ongoing process.

   No = there are either no snags that meet the above size criteria, or all snags are within a narrow range of 1-2 decay classes. CWD is either absent or similar limited to a narrow range of 1-2 decay classes.
Some = snags may fit the minimum size criteria but they are limited to a range of 3 consecutive decay class stages; CWD is similarly limited to 3 consecutive decay class stages.

Yes = snags fit the minimum size criteria and are represented in most decay stages; CWD is represented in most decay classes.

31. Canopy gaps due to tree mortality: Gaps are openings not yet occupied by A3-layer (>10 m tall) or equivalent trees. Look for openings in the canopy due to natural tree mortality. Mortality refers to this context to physical expression of natural causes of death; for instance trees have blown over, have snapped off, or have died standing. If it appears the cause of death was related to harvesting activities or other human intervention, do not count these as gaps. There will be instances where human intervention will be hard to rule out, for example, death due to fire or other damage that was possibly related to human activities. Gaps also do not include openings due to 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, roads, and so on. Also excluded are successionaly young sites recently disturbed or cut where trees have not yet grown into the A3-layer.

No = no apparently natural gaps due to canopy-layer tree mortality

Some = smaller gaps amounting to < 10% of crown closure in the larger 25 m radius and

Common = one or more larger gaps occupying ≥ 10 % of the potential canopy area.

32. Vertical structure: this applies to the distribution of shrub and tree layer strata.

Simple = tends to be even-height, with limited coverage in up to two other strata (B2, B1, A3, A2, or A1).

Moderate = tends to be uneven height with >10% of total coverage in each of three of the strata B2, B1, A3, A2, or A1.

Complex = stand is uneven-height with > 10% of total coverage in each of four or five of the strata B2, B1, A3, A2, and A1.
33. **Successional stability**: has the forest reached a stage at which species composition is relatively stable?

- **Unstable** = if present, regenerating understory tree species are not the same species as those in the canopy. Successional trends suggest major change in canopy species is likely within less than the potential lifetime of the current dominant species.

- **Intermediate** = if present, the understory tree species are not all the same as those in the canopy. Change in canopy species composition is inevitable, but will likely take place over a time frame intermediate to the other two scenarios.

- **Stable** = the regenerating understory species are in most instances the same species as those throughout the canopy. Alternatively, the canopy species are long-lived, and could potentially retain dominance for 100 or more years in a biogeoclimatic unit (BGCU) group A or more years in BGCU group B (see age criteria for mature and old forest stages in attribute 36, Table 3).

34. **Trees are old for their species and site conditions**: as the procedures stand, practical limitations will result in few tree ages being collected, consequently this attribute will at times be difficult to determine. Uneven-aged stands will tend to be the easiest to evaluate. In some instances there will be a mosaic of trees of differing ages from relatively young to old, making it difficult to assign an approximate age for the trees dominating the site. Concentrate on the trees that dominate the canopy.
Young = characteristic of even-height forests in the young forest or earlier seral stages.

Intermediate = species may have attained near maximum height, however, there is little mortality in the main to upper canopy as the species are only in a mature forest stage.

Old = trees in the upper canopy have been established for a relatively long time. Some of the upper canopy trees appear to have reached their physiological maximum age. Others may already have died.

35. Tree size for species and site: as with the above attribute, the easiest stands to evaluate will be the uneven-aged ones. The larger trees will tend to be found on the more productive and less disturbed (older) sites.

36. Seral classification: 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>
<thead>
<tr>
<th>Structural Stage</th>
<th>Definition</th>
<th>Age Criteriaa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a. (NV) Non-vegetated</td>
<td>less than 5% vegetation</td>
<td>&lt;20 yrs. for normal forest succession. Up to 100+ years under certain soil and/or climatic conditions.</td>
</tr>
<tr>
<td>1b. (SP) Sparse</td>
<td>Initial stages of primary and secondary succession. Little or no residual vegetation except for bryophytes and lichens. Less than 10% cover of vascular plants.</td>
<td>&lt;20 yrs. for normal forest succession. Up to 100+ years under certain soil and/or climatic conditions.</td>
</tr>
<tr>
<td>2. (H) Herb</td>
<td>Early, or potentially prolonged, successional stage dominated by herb-layer (herb, graminoid, fern) vegetation; some invading or residual shrubs and trees may be present. Tree cover &lt;10%, herb-layer cover &gt;25%, or ≥50% of total cover.</td>
<td>&lt;20 yrs. for normal forest succession. Up to 100+ years under certain soil and/or climatic conditions.</td>
</tr>
<tr>
<td>3a. (LS) Low Shrub</td>
<td>Early, or potentially prolonged, successional stage dominated by shrubby vegetation &lt;2 m tall. Seedlings and advance regeneration may be abundant. Tree cover &lt;10%, shrub cover &gt;25% or ≥50% of total cover.</td>
<td>&lt;20 yrs. for normal forest succession. Up to 100+ years under certain soil and/or climatic conditions.</td>
</tr>
<tr>
<td>3b. (TS) Tall Shrub</td>
<td>Early, or potentially prolonged, successional stage dominated by shrubby vegetation &gt;2 m and &lt;10 m tall. Seedlings and advance regeneration may be abundant. Tree cover &lt;10%, shrub cover &gt;25% or ≥50% of total cover.</td>
<td>&lt;40 yrs. for normal forest succession. Up to 100+ years under certain soil and/or climatic conditions.</td>
</tr>
<tr>
<td>4. (PS) Pole/Sapling</td>
<td>Trees &gt;10 m tall and are typically dense; younger stands are vigorous and usually &gt;10-15 yrs. old; older pole-sapling stages, composed of dense, stagnated stands (up to 100 yrs. old) are also included in this stage. The pole-sapling stage persists until self-thinning and canopy differentiation becomes evident (often by 30 years in vigorous stands).</td>
<td>20-40 yrs. for normal forest succession. Up to 100+ years for dense (&gt;2,000 stems/ha.) stagnant stands.</td>
</tr>
<tr>
<td>5. (YF) Young Forest</td>
<td>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 site.</td>
<td>40-80 yrs.</td>
</tr>
</tbody>
</table>
### Structural Stage

<table>
<thead>
<tr>
<th>Structural Stage</th>
<th>Definition</th>
<th>Age Criteria(^1)</th>
</tr>
</thead>
</table>
| **6. (MF) Mature Forest** | Trees that were 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. BGCU group A consists of NDTs\(^2\) type stands, while BGCU group B consists of all other NDTs. | 80-140 yrs. for Biogeoclimatic unit group A\(^3\)  
80-240 yrs. for Biogeoclimatic unit group B\(^4\) |
| **7 (OF) Old Forest** | Stands with complex vertical structure. Tree species in the upper canopy are also often present in the understory. Non-regenerating trees from a major disturbance such as fire may still dominate the canopy. Snags and coarse woody debris are represented in all stages of decomposition. | >140 yrs. for Biogeoclimatic unit group A\(^3\)  
>240 yrs. for Biogeoclimatic unit group B\(^4\) |

---

37. **Percentage of live old trees remaining:** refers to the proportionate coverage of live old growth trees remaining. There should be evidence of snags, fallen trees or stumps to support your estimate of

---

\(^1\) Age criteria reflect typical rates of succession on forested sites. When determining structural stage, stand structure should be emphasized rather than stand age; deciduous stands will generally be younger than coniferous stands belonging to the same structural stage. Stages 2 and 3 may represent successively restricted ecosystems such as avalanche tracks or wetlands which may be much older than suggested here. Stages 3a and 3b may include very old krummholz <2 m tall and very old, low productivity stands such as bog woodlands <10 m tall respectively.

\(^2\) Natural disturbance Type 3 = frequent stand initiating events (usually wildfire); other NDTs includes NDT1 = rare stand initiating events, NDT2 = infrequent stand initiating events, NDT4 = frequent stand maintaining events, and NDT5 = alpine tundra and parkland (high elevation biogeoclimatic units).

\(^3\) BGCU group B includes the following:  
BWBs dk, BWBs mw, BWBs wk, ESSF dc, ESSF dk, ESSF dv, ESSF mv2, ESSF mv4, ESSF w, ESSF vc, ICH mk1, ICH mk2, ICH mw1, ICH mw3, MS; SBPS; SBS dh, SBS dk, SBS dw, SBS mc, SBS mh, SBS mk, SBS mm, SBS mw.

\(^4\) BGCU group A includes the following:  
BWBs v, CDF; CWH; ESSF nc, ESSF mk, ESSF mm, ESSF mw, ESSF mv, ESSF mv3, ESSF wc, ESSF wk, ESSF wv, ESSF vc, ESSF v; ICH mm, ICH mc, ICH mk3, ICH mw2, ICH wc, ICH wk, ICH vc, ICH wk, ICH xv; IDF; MH; PP, SBS wk, SBS v, SWB.
38. **Old growth forest**: this decision should be based on evaluation of all the above attributes in the succession interpretations. If "no - some" is selected, this suggests the sample stand has some old growth forest attributes, but it is not old growth.

**Vegetation Description**

39. **Species**: Comprehensive species lists are important for this project. The data will be used for a variety of purposes, including an accounting of species diversity. See the discussion on species codes in the introductory section under "Vegetation". Unknown plants should be collected and recorded for later identification using established botanical procedures.

Coverage for tree- and shrub-layer species is visually estimated within the 10 m slope-corrected plot radius, while a nested subplot of 5.64 m radius is used for herb- and moss-layer species.

**Table 4-4. Conversion From Percent to Horizontal Surface Area in the 10 m Radius Main Plot and 5.64 m Radius Nested Plot**

<table>
<thead>
<tr>
<th>Plot radius</th>
<th>10 m</th>
<th>5.64 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal surface area</td>
<td>314 m²</td>
<td>100 m²</td>
</tr>
<tr>
<td>25% coverage</td>
<td>78.5 m² or ¼ of the plot pie</td>
<td>25 m² or ¼ of the plot pie</td>
</tr>
<tr>
<td>1% coverage</td>
<td>3.14 m² or a 1.8 m sided square</td>
<td>1 m²</td>
</tr>
<tr>
<td>0.1% coverage</td>
<td>0.31 m² or a 55 cm sided square</td>
<td>0.1 m² or a 32 cm sided square</td>
</tr>
<tr>
<td>0.01% (1H* - hundredth of a percent)</td>
<td>314 cm² or a 18 cm sided square</td>
<td>100 cm² or a 10 cm sided square</td>
</tr>
<tr>
<td>0.001% (1T* - thousandth of a percent)</td>
<td>31.4 cm² or ~ 6 cm sided square</td>
<td>10 cm² or 3 cm sided square</td>
</tr>
</tbody>
</table>

*The hundredth and thousandth of a percent values, or multiples thereof (3H, 5H, 2T, 9T, . . .) are meant to allow better cover estimates for species that have coverage less than 0.1%. Enter the coverage as shown with the "H" or "T" factor. Note that 9H or 9T is as high as you should go with either factor since 10H = 0.1% and 10T = 1H.*

Total coverage (%) is an estimate of the coverage of all species in each of the A, B1, B2, C and D layers, and is used by the field person to calibrate and adjust cover estimates for subsequent individual species within strata. If there is overlapping coverage of species
within strata then total % may be considerably less than the sum of individual species coverage.

Total trees (A) includes dominant (A1) main canopy, or codominant (A2), and outgrown (A3) trees taller than 10 m. Cover values are estimated for individual tree species for the entire A-layer. Overlapping crown is not additive for the same species, consequently a given tree species cannot have coverage greater than 100%.

Tall shrubs (B1) 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. Low shrubs (B2) consists, with minor exception, of shrubs and established tree regeneration less than 2 m tall and at least 2 years old.

Herbs (C) refers to herb-layer plants such as ferns, graminoids, herbs, saprophytes, and some woody species. Table 4.1 in Luttmerning et al. (1990 p. 110) lists species of doubtful lifeform, still considered to be in the herb layer.

Mosses, lichens, liverworts and seedlings (D) includes tree seedlings less than 2 years old. Three main substrates are recognized here. Dh (on forest floor and mineral soil), Dw (on decaying wood) and Dr (on rock). In the moss-layer (Dh, Dw, and Dr) emphasize species growing on the main substrate, which in most cases will be Dh (forest floor or mineral soil); describe only the predominant species on atypical substrates for example Dw (decaying wood) and Dr (rock). However, if Dw or Dr is the main substrate, then the list should be more complete for this substrate.

40. Shrub height (m): a mean height estimate weighted by % cover for individual shrub-layer (B1 and B2) species should be provided. For example, if Douglas maple (ACERGLA) is generally 1.5 m tall and covers 30%, with the exception of one 8 m tall individual which covers 10%, the cover weighted height would be:

\[
\text{Average height} = \frac{(1.5 \text{ m} \times 30\%) + (8 \text{ m} \times 10\%)}{30\% + 10\%} = \frac{0.45 \text{ m} + 0.8 \text{ m}}{40\%} = \frac{1.25 \text{ m}}{40\%} = 3.1 \text{ m}
\]

There is not enough time to always calculate this in the field, rather you should come up with a quick visual estimate of average species height weighted by coverage. This includes all woody shrubs as well as trees in the shrub layers. The height and the % cover estimates will be used to calculate shrub volume by species.
41. **Comments**: focus on items of ecological interest otherwise missed on data forms.
Vegetation Inventory

Chapter 6
Course: Woodland Depsis
Coarse Woody Debris

Basic premise

Coarse woody debris (CWD) refers to the larger dead and mostly down woody material which is in various stages of decomposition. Coarse woody debris is a major contributor to structural diversity in forests and provides habitat for plants, mammals, amphibians, insects and microorganisms. It influences hillslope and stream geomorphology, affects the microtopography and microclimate of the forest floor, is an important nutrient pool and possibly a nitrogen fixation site in some ecosystems.

Procedures

Sampling

Coarse woody debris includes:

- downed horizontal or suspended (not self-supporting) dead tree boles with or without roots attached. Coarse woody debris includes fallen trees which still have green foliage if they no longer have roots attached (no living cambium),
- only those pieces greater than 7.5 cm at the point where the sampling line crosses the piece.
- overturned stumps less than 1.3 m in length which have roots attached and anything longer with no roots attached,
- fallen broken tree tops which may be horizontal or leaning, or
- large fallen branches in some stage of deterioration.

Pieces may be suspended on nearby live or dead trees, other pieces of coarse woody debris, stumps or other terrain features.

Coarse woody debris does not include

- live or dead trees (still rooted) which are self supporting,
- dead branches still connected to standing trees,
- exposed live tree roots or
- upright stumps still rooted.
Two 24 m (horizontal distance) lines are used to sample coarse woody debris. These will run from the plot centre, the first following a pre-assigned random azimuth and the second at plus 90° to the azimuth. The slope of each line is taken and the slope distance required to produce a horizontal line of 24 m length is calculated and used. If for any reason all of the line cannot be sampled, the distance which was actually sampled out of the total distance is noted (record in comments section why the portion was not measured).

If the sample line runs out of the polygon and enters a different type, stop at the polygon boundary and follow the original sample line back into the polygon by retracing your steps. If the slope has not changed appreciably, it will probably not be necessary to recalculate the slope correction factor to determine the length of line needed to complete the 24 m sample. Resume tallying and measuring coarse woody debris along the line in the reverse direction. The pieces will have been sampled once before but they are treated as new pieces.

- Measure CWD pieces from plot centre to polygon boundary at 16 m
- Remeasure CWD pieces from 16 m back 8 m to complete 24 m transect

**Figure 5.1**

*PROCEDURE WHEN TRANSPECT INTERCEPTS POLYGON BOUNDARY*

If the line falls in an area which has much windthrow or is felled and bucked or logging debris and coarse woody debris is plentiful, sample only the first and third quarters of the line (from 0 to 6 m and from 12 to 18 m) if the random azimuth assigned to that plot is odd. If the random azimuth is even then the second and fourth quarters of the line (from 6 to 12 m and from 18 to 24 m) will be sampled.
If the line falls on very heavy accumulations such as a windrow or debris pile, sample only the second quarter of the line (from 6 to 12 m) for even random azimuths and the third quarter (12 to 18 m) for odd random azimuths. In this case it will be necessary to measure the depth and length of debris intercepted and record the measurements. An estimate should be made of the numbers of pieces and their diameters in heavy accumulations which cannot be safely measured.

The intent of allowing for partial sampling is to avoid burdening field crews with excessive and time-consuming work. The reasoning is the same as when the variable plots are split to reduce both potential errors and sampling time.

Coarse woody debris in the form of felled and bucked logs or cold decks will be sampled even though this material will probably not remain on the site permanently. When non-linear pieces are encountered, the cross-sectional area under the sampling line will be estimated. This applies to "lily pads" (slices from logs) and chunks of odd configurations.

**Rules for Sampling**

There are a few rules regarding what is and isn't sampled:

**Rule 1**
- Coarse woody debris must meet a number of criteria related to diameter, length and condition. The Vegetation Inventory measures coarse woody debris greater than 7.5 cm in diameter at the line intersect point. Material smaller than this is ignored, except in relation to rule number 6.

**Rule 2**
- The sample line must cross the central axis (pith) of the piece.

![Figure 5-2](image-url)

**Figure 5-2**
*Line intersect must cross central axis of piece*
Rule 3
- If the sample line exactly intersects the central axis, tally every other such piece. Track this on a plot-by-plot basis (not through the entire day, week or sampling period).

![Diagram of Line Intercept of Central Axis](image1)

**Figure 5-3**
PROCEDURE - LINE INTERCEPT OF CENTRAL AXIS

Rule 4
- When the sample line appears to coincide nearly exactly with the central axis of the piece it will be necessary to choose the most appropriate location on the piece at which to take the diameter measurement. A decision must be made as to whether the line crosses the central axis (yes or no), if yes the piece is measured.

![Diagram of Line Intercept Parallel to Central Axis](image2)

**Figure 5-4**
PROCEDURE - LINE INTERCEPT PARALLEL TO CENTRAL AXIS

Rule 5
- If the sample line intersects a curved or angular piece more than once, measure each intersection.

![Diagram of Measure All Intercepts of Pieces](image3)

**Figure 5-5**
PROCEDURE - MEASURE ALL INTERCEPT OF PIECES
Rule 6
- If a log has split open but is still partially held together, record the
diameter as if the piece were whole. If something has shattered into a
number of distinct pieces, record them as individuals if each one is
greater than 7.5 cm in diameter at the point of sampling.

Rule 7
- Do not tally undisturbed stumps. Tally uprooted stumps and exposed
dead roots if they meet the other criteria.

Rule 8
- Tally only pieces whose central axis lies above the organic soil layer
(top of the LFH) at the point of intersection.

![Diagram](image.png)

**Figure 5-6**

**PROCEDURE - MEASUREMENT OF BURIED PIECES**

**Measurements**

For each piece of coarse woody debris that is tallied, record:
- the tree species,
- diameter (to the closest 0.1 cm),
- the tilt angle of the piece in degrees, and
- the decay class.
- if piece is greater than 3 metres in length
- if piece is a product likely to be removed

- tree species are recorded using the same codes as for standing trees. If
the species cannot be determined put "U" for unknown.
- the diameter of the piece is taken perpendicular to the bole at the point
where the sampling line is considered to intersect the central axis of the
piece. A diameter tape is wrapped around the bole when possible to
measure the diameter, otherwise the reverse side of the tape is used to
estimate the diameter. Calipers may also be used and are often easier
when coarse woody debris is in several layers.
- the tilt angle refers to the tilt of the individual log away from the
horizontal, regardless of the slope of the ground. A clinometer is
placed on the surface of the piece at the point of the intercept measurement and the angle from the horizontal (in degrees) is recorded.

- a five class system is used to describe the decay class of coarse woody debris. At the point of intersection of the sampling line with the coarse woody debris, look up and down the piece to determine its class. Choose a class based on the majority of the piece. In other words, if parts of the piece are class 3 and parts are 4, or parts are class 4 and parts are 5, choose a class based on the majority. Do not mix classes (i.e. 3/4 or 4/5). Refer to figure 5-8 for descriptions of classes.

- if the piece is more than 3 m in length this is noted on the form.

- if the material is a product likely be removed from the site at some future time a notation is made to that effect on the field card with an "x".

**Measurement of odd shaped pieces or accumulations**

- when "lily pads" or odd-shaped pieces are encountered the equivalent of their cross-sectional area is recorded along with species and decay class. Notations are made if the individual piece is likely to be removed or is longer than 3 m.

- measurement of accumulation

```
Average Length of
Line Intercept in m.
```

```
Average Depth m.
```

**Figure 5-7**

**Measurement of Accumulation**

- record species as appropriate
  - if primarily one species record species code for that species
  - if several species can be identified the cross sectional area of each can be recorded
  - if a complex mixture of species, too difficult to distinguish, record as "U" for unknown

- record the average line intercept length and average depth of the accumulation by species
• record the average CWD class for the species
• record the average angle in degrees for the species
• if the material is on average greater than 3m. in length record with an "x"
• if the materials are on average products likely to be removed record with an "x"
<table>
<thead>
<tr>
<th></th>
<th>Class 1</th>
<th>Class 2</th>
<th>Class 3</th>
<th>Class 4</th>
<th>Class 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Portion on Ground</strong></td>
<td>Elevated on support points</td>
<td>Elevated but sagging slightly</td>
<td>Sagging near ground, or broken</td>
<td>All of log on ground, sinking</td>
<td>All of log on ground, partly sunken</td>
</tr>
<tr>
<td><strong>Twigs &lt; 3 cm (if originally present)</strong></td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
</tr>
<tr>
<td><strong>Bark</strong></td>
<td>Intact</td>
<td>Intact or partly missing</td>
<td>Trace</td>
<td>Absent</td>
<td>Absent</td>
</tr>
<tr>
<td><strong>Shape</strong></td>
<td>Round</td>
<td>Round</td>
<td>Round</td>
<td>Round to oval</td>
<td>Oval</td>
</tr>
<tr>
<td><strong>Texture</strong></td>
<td>Intact, hard</td>
<td>Intact, hard to partly decaying</td>
<td>Hard, large pieces, Partly decaying</td>
<td>Small, blocky pieces</td>
<td>Many small pieces, soft portions</td>
</tr>
<tr>
<td><strong>Invading Roots</strong></td>
<td>None</td>
<td>None</td>
<td>In sapwood</td>
<td>In heartwood</td>
<td>In heartwood</td>
</tr>
</tbody>
</table>

**Figure 5.8**
*Coarse Woody Debris Class Description*
### VEGETATION INVENTORY - COARSE WOODY DEBRIS

#### COARSE WOODY DEBRIS TRANSECT 1 (Azimuth°)

<table>
<thead>
<tr>
<th>Number</th>
<th>Species</th>
<th>Diameter (cm)</th>
<th>C Angle (deg)</th>
<th>Pl</th>
<th>Fr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>50</td>
<td>60</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>45</td>
<td>70</td>
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<td>1</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>40</td>
<td>80</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>35</td>
<td>90</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

**Line Length Observed:**

- 26 m
- 27 m
- 28 m
- 29 m
- 30 m

**M of:**

- 1 m
- 2 m
- 3 m
- 4 m
- 5 m

### ACCUMULATIONS - LINE 1

<table>
<thead>
<tr>
<th>Species</th>
<th>Length (m)</th>
<th>Depth (m)</th>
<th>C Angle (deg)</th>
<th>Fr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>4</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>5</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>6</td>
<td>8</td>
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*P/R = Product to Remove March 31, 1995*

**COMMENTS:**

- [Blank]

#### COARSE WOODY DEBRIS TRANSECT 2 (Azimuth° 90°)

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</tr>
</tbody>
</table>

**Line Length Observed:**

- 26 m
- 27 m
- 28 m
- 29 m
- 30 m

**M of:**

- 1 m
- 2 m
- 3 m
- 4 m
- 5 m

### ACCUMULATIONS - LINE 2

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<tr>
<th>Species</th>
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**COMMENTS:**

- [Blank]

---

**Figure 5-9**

*Vegetation Inventory - Coarse Woody Debris - Field Card [EW]*

---

**5 - 8 • Coarse Woody Debris**

March 31, 1995

Vegetation Inventory
Vegetation Inventory

Chapter 6
Tree Measurements
Tree Measurements

Vegetation Inventory Field Data
Tree Specific Data - Field Cards

The field cards for usage in collecting the tree specific data follow. The specific field cards are:

- Figure 6-1 Vegetation Inventory Header Card [TH]
- Figure 6-2 Vegetation Inventory - Tree Details [TD]
- Figure 6-3 Vegetation Inventory - Tree Loss Indicators [TL]
- Figure 6-4 Vegetation Inventory - Small Tree, Stump and Site Tree Data [TS]
- Figure 6-5 Vegetation Inventory - Tree Auxilliary Plot [TA]

Procedures for the collection and recording of tree measurements are as follows:

- Chapter VI
  - tree measurement field cards
  - instructions for completing field cards
  - basic tree measurement on main plot
- Chapter VII
  - Net Factoring
- Chapter VIII
  - Call Grading
- Chapter IX
  - Wildlife Tree Classification
- Chapter X
  - Forest Health
- Chapter XI
  - Small Fixed Plot Measurements
- Chapter XII
  - Site Tree Measurements
- Chapter XIII
  - Auxilliary Plot Measurements
Tree Measurements

Vegetation Inventory Field Data

Tree Specific Data - Field Cards

The field cards are designed to contain the data described below. The
sections listed below are:

- Vegetation Inventory - Tree Data (TD)
- Vegetation Inventory - Tree Gonion Data (TG)
- Vegetation Inventory - Tree Gonion Data, site Tree Gonion Data (TG)
- Vegetation Inventory - Tree Gonion Data, site Tree Gonion Data (TG)
- Vegetation Inventory - Small Tree Gonion Data (TTG)

Instructions for field work may be found in the measurement
sections below.

Chapter IV - Net Production
Chapter V - Cal Pixley
Chapter IX - Whole Tree Crown
Chapter X - Whole Tree Crown

Appendix A - Net Production

Factors of Importance

Chapter XIII - Small Plot Measurements

Appendix B - Field Measurements

Chapter XIV - Additional Field Measurements

Appendix C - Data Analysis
### VEGETATION INVENTORY FIELD DATA

**TREE SPECIFIC DATA**

<table>
<thead>
<tr>
<th>REGION</th>
<th>COMPART</th>
<th>SUBCOMPART</th>
<th>SAMPLE NUMBER</th>
<th>POLYGON IDENTIFIER</th>
<th>CREW 1</th>
<th>CREW 2</th>
<th>CREW 3</th>
<th>CREW 4</th>
<th>FLIGHT NUMBER</th>
<th>PHOTO NUMBER</th>
<th>MEASUREMENT DATE</th>
<th>VERSION NUMBER</th>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>YR. MO. DAY.</td>
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<td>71</td>
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</tr>
<tr>
<td>74</td>
<td></td>
</tr>
</tbody>
</table>

CRUISED BY (please)  
CHECKED BY (please)  
SIGNATURE: I CERTIFY THAT THIS IS A TRUE STATEMENT OF SAMPLING DONE BY ME AT THE PLACE SHOWN  
SIGNATURE  
DATE  
DATE
Vegetation Inventory Field Data Cards - Tree Measurements

Note: the field cards are currently under revision; the following reflects the current field cards which may change slightly before the 1995 field season.

Vegetation Inventory Header Card [TH]

Region - the number assigned to an administrative and planning level boundary dividing the Province into 88 units.

Compartment - an alpha value assigned to a subdivision of an inventory Region usually defining a portion or more of a watershed.

Sub-compartment - an alpha value assigned to a subdivision of an inventory compartment.

Project I.D. - a two digit numeric code to identify the Vegetation Inventory sampling project area. The present area is the Forest District boundary with the assigned two digit number. Completed on all pages of all forms.

Sample Number - the inventory sample number unique to the project area. Completed on all pages of all forms.

Cluster - alpha code for the location of the plot in the sample. This will be "M" for main on all cards.
Polygon Identifier - this is a unique identifier for the polygon to be sampled. At present we are using mapsheet number (left oriented) and polygon number (right oriented) with the blank characters zero filled.

Person 1 to 4 - Initials of the individuals collecting the data for the sample.

Measurement Date
- Year - two digit numeric code of the year the sample was completed (95 for 1995)
- Month - 3 character alpha code for month the sample was completed (JUN=June)
- Day - two digit numeric code of the day the sample was completed.

Responsibility - record the name of the person (printed) responsible for the collection of the tree data sections and the ecological data sections.

Plot Cluster Record - mark with an "X" whether the plots as shown were completed (yes or no).

Notes - record pertinent field comments (for example west plot not completed as the site was unsafe to measure).

Vegetation Inventory - Tree Details [TD]

Card Type "B"

Basal Area Factor - The basal area factor for the prism or relaskop used for the variable radius plot of trees 2.0 cm or greater at DBH.

OR Plot radius - The radius in metres if a fixed plot is used to select trees 2.0 cm or greater at DBH (this is presently 5.64 m in all cases).

Full - An identifier that the plot sweep is a "full" 360 degrees starting from the north (mark with an "x").

Half - An identifier that the plot sweep is only half or 180 degrees of a circle (mark with an "x").
Quarter - An identifier that the plot sweep is only a quarter or 90 degrees of a circle (mark with an "x").

Boundary OR Split - Describe why the plot is coded as HALF or QUARTER. A boundary plot is halved or quartered because it falls on a vegetation type boundary identified for the polygon. Split describes the plot being halved or quartered to reduce the number of trees tallied if a full sweep would have more than 10 live trees in the sweep (mark with an "x").

Plot Radius Factor - Is the plot radius factor used to calculate whether border line trees are in or out of the variable radius plot.

Project I.D. - Identification of plot as per header card.

Card Type "C"

Tree number - The number painted on the tree to identify it in the field.

Species - A three digit code of the genus and species of the tree being measured. If the species is not known then genus is recorded. If genus is not known then "U" is recorded for unknown.

Live/Dead - A descriptive coding of the tree being measured. Valid codes are:
L - Live
D - Dead

Standing/Fallen - A descriptive coding of the tree being measured. Valid codes are:
S - Standing
F - Fallen

Diameter Breast Height - The diameter of the main stem of the tree measured outside bark at 1.3 metres above the high side of the tree.

Measurement or Estimate - Coded M or E to describe whether the diameter is measured or estimated.
Remaining Bark % - The percentage of the bark present at the DBH line

Tree Length - The length of the tree or portion of tree [in the case of a broken top the length is to the height of the break].

Measurement or Estimate - Coded M or E to describe whether the length is measured or estimated.

Crown Class - Crown class of the tree. This is coded as:
D - dominant  C - co-dominant,
I - intermediate  S - suppressed.

Height to Live Crown - Height to crown as defined (effective crown)

Log Grades, lengths and % sound

Log Grade - The letter grade based on modified Coastal Metric scaling log grades.

Length - The variable length of the bole which will maintain the letter grade.

% sound - The percentage of sound wood for the log measured to the nearest percentage.

Sweep - Measured in degrees from the base of the tree to a point 5 metres along the main stem.

Lean - Measured in degrees from the base of the tree to the top of the main stem.

Wildlife Codes

Visual Appearance - Classification of visual appearance of the tree coded from 1-9.

Crown Condition - Classification of crown condition from full crown to no branches or stubs present. This is coded from 1-7.

Bark Retention - Classification of the proportion of bark on tree coded from 1-7.

Wood Condition - Classification of the wood condition (soundness) of the tree coded from 1-8.

Lichen - A descriptive coding of the availability of forage lichens on stem and branches in the lower 4.5 metres.

Wildlife Codes - The following alpha codes are entered if appropriate:
F - Feeding
N - Nesting
M - Marking
D - Denning
P - Perching
[ - ] - Nil

**Broken Top Diameter** - Diameter of the top of the main stem if broken.

**Projected Height** - The estimated length the tree would have been if the top had not broken.

(Note: Trees which have a broken top must have either a broken top diameter or a projected height. The option is left to the sampler whether to enter a broken top diameter or a projected height depending on which estimate can be made with greater confidence.

**Stem Mapping** - In many instances a sample may be located in a sensitive area such as private land, parks or wilderness area where tree marking is not desirable. Stem mapping may also be required on some plots for further research.

**Azimuth to Tree (degrees)** - record the azimuth to the tree from the plot centre.

**Distance in Metres** - record the distance to the nearest metre.

---

**Vegetation Inventory - Tree Loss Indicators [TL]**

**Project I.D.** - identification of plot as per header card.

**Card Type "D"**

**Tree Number** - number of tree as assigned during plot establishment.

**Damage Agent Code (1 and 2)** - enter the appropriate damage agent code(s) as observed.

**Severity** - enter the appropriate severity alpha code (left justified) or numeric value (right justified).

**Loss Indicator Code**
(1 to 4) - list the most significant loss indicators as per the appropriate code.
+ - (Plus/Minus) - enter as "+" if location of loss indicator is above ground level (high side), "-" if below ground level (high side).
From - To - record the lower extent and upper extent of the loss indicator to the 1/10th metre above or below high side as appropriate.
Frequency - This is a record of the number of occurrences resulting from a single event [such as: a number of scars along a tree from another tree falling against it] for each loss indicator.

**Vegetation Inventory - Small Tree, Stump and Site Tree Data [TS]**

**Card Type "E"**
This information denotes the Project I.D., Sample Number, size and configuration for the small tree tally and the stump tally.

- **Project I.D.** - project I.D. number.
- **Sample Number** - sample number.
- **Cluster** - cluster identification (M).
- **Plot radius** - fixed plot radius in metres.
- **Full/Half/Quarter** - designates whether plot is full, half or quarter sweep (see tree details).
- **Boundary/Split** - designates the reason a plot is a half or quarter plot area (see tree details).

**CARD TYPE "F"**

**Small Tree Count by Length Classes**
- **Species** - species of tree is recorded
- **Length Classes** - length classes of small trees are dot tallied by species into the following:
  - 0.1 metres to 0.3 metres in height
  - 0.3 metres to 1.3 metres on height
- 1.3 metres in height to 1.9 centimeters in diameter at DBH

Total(s) - The dot tallied stems are added to the total recorded.

**CARD TYPE "G":**

Stump Tally [these are stumps less than 1.3 metres in height only, stumps greater than 1.3 metres are measured in the variable radius plot]

- **Species** - Species of stump.
- **Diameter Inside Bark** - Average diameter of stump measured inside bark.
- **Length (M)** - Length of stump in metres.
- **Wildlife Codes** - Classification is assigned for:
  - Bark retention
  - Wood soundness
- **Wildlife Use** - Enter appropriate code if wildlife use is observed.
- **Root Rot Species** - Enter the species of root rot if present.

**CARD TYPE "H":**

This section records the detailed information on the Top Height Tree [T], and the second top Height tree [S], measured on a 5.64 metre radius plot. A random tree age [R] is also measured for the Integrated plot.

- **Tree #** - Tree number as recorded in variable plot or as designated if not present in the variable radius plot (or fixed radius plot - 5.64m).
- **Species** - Tree species.
- **Crown Class** - Record as appropriate (D, C, I, S).
- **Tree Length (m)** - Measured length of the tree.
- **Bored height** - Height at which the tree was bored.
- **Boring (OB) Diameter** - Diameter outside bark at location of age boring.
- **Bark Thickness (mm)** - Thickness of bark at location of boring(s).
- **Bored Height (m)** - Height above high side at which boring was made.
Measurement Code - Recorded when it is not possible to physically measure an age; the code indicates the reason an age was not measured.

Acceptable codes are:

- ROT - core of tree is rotten
- WHO - total age reached from whorl count
- CRC - increment borer cannot reach center
- OUT - age from similar tree outside of plot
- PHY - Physiological age recorded in bored age record

Bored Physiological Age - Record the physiological age in years as measured or calculated.

Growth (mm) - Record the growth in millimeters for the last 5, 10 and 20 years.

Prorate - When the full boring is not possible record the actual measurements in this section.

Length (cm) - Length of increment core upon which the ring count was made.

Ring Count - Actual count of tree whorls on the previous core length.

Direct Age Measurement - on some young stands with regular branch whorls it is possible to count the years above the boring height to attain the total tree age directly.

Direct Age Correction - Number of years tree growth above the boring height.

Total Age - Total tree age when direct age corrections made.

Vegetation Inventory - Tree Auxiliary Plot [TA]

- This field card is used for the auxiliary sample plots in the cluster. The card is a combination of data fields as required.

Refer to the details of the previous cards for instructions on completing specific section.
Tree Measurements for the Variable Plot or 5.64 m Fixed Plot

Tree Specific Measurements

The tree specific measurements described below are listed in relationship to their occurrence on the tree specific field cards. The measurements on net factoring, call grading and wildlife tree measurements has been dealt with in separate sections in the interests of clarity. The sampling crew is free to measure the attributes in the most efficient manner while maintaining the integrity of all measurements.

Selection of Variable or Fixed Radius plot layout

The sampling design accommodates the use of either variable radius plots or fixed radius plots for the sample clusters. Once selected the sampler will maintain the plot type throughout the cluster. It has been decided to limit the usage of each type to the situation where it is most appropriate.

The selection of the appropriate plot type will be made by the Project Manager prior to the field sampling using the guidelines below.

Variable Radius Plots

The variable radius plot will be used in most stands in the inventory.

Fixed Radius Plots

Fixed radius plots may be used in the following situations:

- stands with regeneration only
- non forested stands
- stands expected to have less than 15 square metres of basal area

It was decided to limit the plot size to one measurement of 5.64 metres in radius. The selection of one plot size eliminates potential bias which could
be introduced by a crew changing plot sizes in the field trying to obtain the optimum tree count.

**Tree Measurements for the Integrated (Main) Plot**

**Selection of trees to measure in the integrated and auxiliary plots**

**Basic Premise**

These variable and fixed plot types are responsible for:

- all standing and fallen trees [see tree classes for details] as follows:
  - **standing trees** are self supporting, (for example; the tree would remain standing if all touching stems were removed)
    - the tree can be either live or dead
    - the **length of the tree is greater than 1.3 metres** [the tree has an identifiable DBH]
    - the tree is 2.0 centimeters or greater at the DBH
  - **all fallen trees** have roots attached; these may be suspended against other trees or otherwise non self supporting or laying on the ground
    - the length of the tree is **greater than 1.3 metres**
    - the tree is 2.0 centimeters or greater at the DBH
  - **measurement of broken stems (snags)**
    - a stem is a dead portion of a standing or fallen tree with the roots attached
    - the measurement of all above ground woody material is made within the series of plots around the integrated plot centre. The decision upon which plot measures short (often broken) stems is as follows:
      1. if the stem has a complete DBH at 1.3 m. this is measured in the variable radius plot or 5.64 m. radius plot
      2. if the stem is ≥ 1.3 m. when missing wood is folded back to create a whole stem, measure this tree in the variable radius plot or in the 5.64 m. radius plot. See the following diagram.
- record as a dead tree
- measure diameter at the highest point having a complete
diameter and record this figure

(3) if the stem, when folded back for missing wood, is less than
1.3 m. in length then this will be recorded in the 2.5 m. plot
for stumps, then do not record in variable of fixed radius tree
plot

Selection of Basal Area Factor

Basic premise
The objective is to have an accurate tally of trees at all points. A secondary
objective is to have an efficient number of trees for analysis of the
measurements.

Procedures
Within the polygon an average of between 4 and 8 live trees per point is
appropriate. If the sample point contains less than 4 live trees on average
for a cluster or more than 8 live trees on average per cluster this is
acceptable but over the entire cluster an average of 4 to 8 live trees is
desirable. In stands with high numbers of dead stems the average of live
stems may be considerably less. If the sampling crew is consistently below
or above the desired range of stems the project manager will review the
process with the crew.

This sample size will ensure adequate volume and basal area measurements
and will minimize non-sampling error due to excessive or difficult
measurements.
Prism/Relaskop B.A.F. [Basal Area Factor] Selection

The inventory standard will be the use of one prism size (B.A.F.) throughout the sample cluster. The selection of this B.A.F. will be determined prior to arrival at the first plot in the cluster. As a minimum the selection will be made at the reference pin location on route to the integrated plot. The selection of B.A.F. could be made in the following ways:

- as the crew approaches the sampling site within the Polygon the sampler can quickly do tree counts using selected prism sizes
- in areas with restricted visibility the selection may be to increase the prism size to reduce the potential of missing trees
- each polygon will have an estimated basal area; the basal area divided by the desired tree count may provide the approximate prism size to select

In order to reduce the plot radius to a reasonable distance and avoid missing trees the minimum prism size has been set at a metric 5 B.A.F.

All measurements will be recorded using metric B.A.F.

The selection of prism sizes is limited to discourage switching of prisms to obtain the desired tree count by the sampler since this can create a potential bias. The standard sizes are as follows:

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<th>Relaskop Value (m²/ha)</th>
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</tr>
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Table 6-1 - Standard BAF Sizes to be Used

Once the selection of a prism size for the cluster has been made the decision will be final. Procedures are in place to modify the work load to be done if the prism selection results in an excessive number of measurements which potentially could result in non-sampling errors. The preference is to use the same prism size throughout the polygon.
Variable Plot Sampling

Variable plot sampling was developed in Europe by Dr. Walter Bitterlich in 1948. The procedure was introduced into the United States by Lewis Grosenbaugh in 1952. Variable plot sampling is also known as the Bitterlich method, pointless cruising or point sampling.

The term chosen here, variable plot, refers to the characteristic that each tree chosen to tally ("in tree") has its own plot radius. The plot radius for each tree is dependent on the tree DBH (outside bark) and the angle gauge used to select the tallied tree. Each tree has its own plot. The plot radius, for each tree, varies with the tree DBH; thus VARIABLE PLOT.

Process

At plot center a fixed angle gauge (prism or relaskop) is used to determine which trees are to be tallied and which are to be ignored. (Fig 6-7). It is apparent from (Fig 6-7) that small trees close to the plot center may be selected and larger trees may be further away and still be selected. It is also apparent that each tree has a maximum distance that it may be away and still be selected. This maximum distance (Fig 6-8) is that tree's plot radius. The tree is said to be "BORDERLINE" at that point.

**Figure 6-7**
**VARIABLE PLOT**
**TREES TO TALLY**

**Figure 6-8**
**VARIABLE PLOT**
**BORDERLINE TREES**
How It Works

For the purpose of calculations imagine that each tree is "BORDERLINE" and is at its maximum distance from the plot center (Fig. 6-8).

The ratio of the maximum distance in metres (radius) to the DBH in centimeters is the Plot Radius Factor (PRF) (Fig. 6-9). Plot Radius Factor is simply the maximum distance divided by the DBH. Therefore the maximum distance a tree may be away and still be tallied is the PRF of the angle gauge times the DBH of the tree (R=PRF X DBH). For metric cruising the units of the plot radius factor are metres of distance per centimeter of diameter. For imperial cruising the units are feet of distance per inch of diameter.

In the example shown two trees will be tallied. The third tree will be ignored. Each tree has its own radius (PRF X DBH) and therefore its own plot. (Fig. 6-10)

In our example the prism or relaskop used to select 2 trees to tally has a:

- Plot Radius Factor of .2 m distance/cm of diameter
- Basal Area Factor of 6.25 m²/ha

The plot (sample) has 6.25 (BAF) X 2(trees) or 12.5 m²/ha of basal area.

It is apparent that both the BAF and PRF will change if we work in different units (metric vs. imperial). The PRF can be expressed as a ratio of 100. This is called the DIOPTER instead of the PRF. Since we normally work in metric which is conveniently base 100, and there are 100
cm in a metre. The conversion is very easy, DIOPTER is 1/PRF for metric calibration.

Our example prism or relaskop DIOPTER is .5 (1/2 PRF). For each 100 units of distance our angle gauge will have a displacement of 5 units. This number will remain constant regardless of the units.

**Trees per Hectare**

In the example the small tree (25 cm) has a maximum distance or radius of 5 metres. A plot with a radius of 5 metres is 78.5 square metres. Since a hectare is 10,000 square metres the 25 cm tree represents 10,000/78.5 or 127 trees per hectare. We can fit 127 plots of 78.5 square metres into a hectare.

The larger 40 cm tree has a maximum distance or radius of 8 metres. A plot with a radius of 8 metres is 201 square metres. We can fit (10,000/201) or 50 of these into a hectare. The 40 cm tree represents 50 trees per hectare.

The smaller 25 cm tree represents 127 trees per hectare.

The large 40 cm tree represents 50 trees per hectare.

**Basal Area Per Hectare**

The basal area per hectare represented by each tree is simply the trees per hectare X the basal area of THE TREE.

Example: basal area of a 25 cm tree is : -.049m²

For the 25 cm tree:

\[ .045m² \times 127 \text{ trees/ha} = 6.25 \text{ m²/ha} \]

For the 40 cm tree:

\[ .1257 \text{ m²} \times 50 \text{ trees/ha} = 6.25 \text{ m²/ha} \]

The smaller tree has less individual basal area but more trees per hectare. The larger tree has more individual basal area but fewer trees per hectare.

Each tree REGARDLESS OF IT'S DBH represents the SAME BASAL AREA PER HECTARE when it is selected with the same angle gauge.

This basal area per hectare is called the BASAL AREA FACTOR (BAF) for the angle gauge being used.

**Split Plots and Border Plots**

**Basic Premise**

In some instances it will not be possible to establish a full 360° plot in which case split or border plots will be established. The use of these
differing plot types is to be strictly controlled by the processes as outlined with each. The values as collected for a half plot will be doubled for the final measurement while the results from a quarter plot will be multiplied by a factor of four.

**Procedure**

**Split Plots**
The sampler has selected a prism size or fixed radius plot size which may result in excessive trees to be measured at one or more plots within the cluster. It is not desirable to measure all these trees as the following may occur:

- trees may be missed or additional trees added to the plot due to the number of measurements required
- valuable crew time is expended at one location which may be better utilized on other measurements or at other locations

**Process:**

- estimate the number of trees "in" with the prism or fixed area for a full sweep around the plot; no measurements are made at this time.
- if this estimate indicates more than 10 trees will be "in" then the plot will be split as per the following conventions:
  - Even numbered plot = measure East half
  - Odd numbered plot = measure West half
  - the plot will be split along the north / south cardinal bearings through the plot center
  - Record the plot as split on the field card
- Once the decision has been made to split the plot; the split will be maintained even if further measurements indicate that 10 or less trees would have been in the original plot.

**Border Plots**
The sampler has established the plot center and a sweep of area indicates that the polygon boundary is sufficiently close that the sample would or could be encroaching on the adjacent polygon. The sampling as described is polygon based and all tree measurements will be taken within the polygon of interest only.

**Process:**

- estimate the location of the polygon boundary
- roughly determine the general bearing of the polygon boundary
- establish a line parallel to this general bearing through the plot center
Border Quarter Plots

- In some instances, the boundary of the polygon will not allow the establishment of a half plot in which case it will be necessary to establish a quarter plot.

Process:

- Determine the location of the polygon boundary.
- Roughly determine the general bearings of the polygon boundary.
- Establish a right angle quadrant within the area available for sampling.
- Record the plot as quarter on the field card.
Measurement of Borderline Trees

The objective of the inventory is to correctly determine which trees are within the plot as sampled. The methodology will vary as to the plot type. The center of a tree at DBH will be used to determine the borderline distance.

Procedure

Fixed Radius Plots

- all measurements will be done corrected for horizontal distance
- on fixed radius plots the central point of the tree stem at DBH will be used to determine if the tree is "in" or "out" of the sample; this central point is generally equated with the tree pith

Variable Radius Plots

In/Out Trees

A Prism or relaskop is used to select trees for measurement only when the tree can be clearly seen to be "in" or "out". If the observed DBH is not obviously in or out, the tree will be measured for DBH and the horizontal distance compared with its plot radius.
Procedure to measure "in" or "out" Trees

If the cruiser is not able to clearly decide if a tree is "in" or "out" it must be measured.

Measure the horizontal distance from the plot centre to the centre of the tree.

Compare the horizontal distance to the calculated plot radius for the tree (DBH x PRF). If the horizontal distance is within the tree plot radius the tree is in. If the horizontal distance is greater than the tree plot radius the tree is out and not tallied.

If the measured horizontal distance is within 5 centimetres of the tree plot radius RE-DO the horizontal distance by measuring from the plot centre to the face of the tree and add 1/2 of the tree's diameter at DBH. If the horizontal distance is greater than the tree plot radius the tree is out and not tallied.

Tree Numbering

Basic Premise

These plots may be re-measured in the future and are subject to check cruising. Therefore techniques which are consistently applied will enhance the chances of a successful remeasurement program. The desire is to mark the trees similar to an operational cruise plot so they will not be treated in a "special" manner.

Procedure

All standing and fallen trees will be numbered

- trees are to be marked with good quality paint to aid in quality control checking and for relocation in the near future by others who may wish to use the sample
- tree numbering will be initiated due north from the plot center on all plots and progress in a clockwise direction
- trees which are initially missed in the numbering will be indicated on the field card [ for example tree 9 is between tree 3 and 4 ]
- number trees facing plot center if possible
- trees that are too small to be clearly painted will have a tag attached to a branch with wire near DBH
- painting an "X" on trees that are measured "out"
- on some locations it will not be desirable to mark trees. In these cases stem mapping will be required or alternate marking methods may be employed.
- **stem mapping**
  - measure from the plot centre pin to the tree and record:
    - azimuth
    - distance in metres
**Tree Species**

**Basic Premise**
All trees will be assigned a species as per the acceptable codes. All tree species as listed on the approved species list will be measured.

All trees are assigned a code regardless of commercial value at the time of survey, the current non-commercial species can be separated from the data base as desired.

**Procedures**
- tally all trees using the genus and species symbols as shown in the following table
- if possible the species should be identified
- if the species cannot be identified the genus will be recorded

---

**Tree Species Identification**

**Tree Species Codes**
Extracted 93/11/08

**LIST IS UNDER REVISION**

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<thead>
<tr>
<th>SPECIES CODE</th>
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Tree Measurements
March 31, 1995
DRAFT

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<td>YC</td>
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</table>
**Tree Classes**

**Basic Premise**

The assignment of tree classes allows the reporting of trees in categories and reflects the potential for future growth.

**Procedure**

All trees within the integrated plot will be recorded according to the following categories:

- **Standing or Fallen**
  - **S - Standing**
    - those trees or portions of trees with the root attached and self supporting (for example, the tree would remain standing if all touching stems were removed).
  - **F - Fallen**
    - those trees or portions of trees with the root attached and non self-supporting, greater than 1.3m in length.

- **Live or Dead**
  - **L - Live**
    - live trees with green needles or leaves during the active growing season or live cambium.
  - **D - Dead**
    - trees with an identifiable DBH with no green needles or leaves or with stem severed from roots (cut) or crown (broken).

**Tree Diameters**

**Basic Premise**

All standing/fallen, live/dead trees will be measured for diameter.

**Procedure**

- measure the DBH in centimeters and tenths of centimeters at breast height on the tree at 1.3 metres from the high side.
- the minimum DBH to be measured on the plots is 2.0 centimeters
- a marked stake is recommended to locate DBH accurately
- a line to indicate where DBH was measured will be painted on the tree preferably facing plot center
- record the DBH with a tight diameter tape, make no allowance for missing bark
Bark Percent Measurement

Basic Premise

All measurements of diameter will have a record made of the percentage of bark missing at the DBH. The percentage of bark present is required to determine the actual wood volume of the tree. The impact on wood volume will be minor with small amounts of bark missing but could become significant with large areas of bark missing especially on thick barked species.

Procedure

Record the amount of bark present to the nearest percent, for example:

- 100% bark record as = --
- 90% bark record as = 90
- 82% bark record as = 82
- 13% bark record as = 13
- no bark present record as = 00

* when recording the bark present it does not matter if the diameter tape touches the wood or not
* see the following diagram for measurement details:

MEASUREMENT OF MISSING BARK

![Diagram showing measurement of missing bark]

- another simple procedure to calculate the percent of bark present is to observe the portion along the diameter tape where the bark is
not present, for example on a 112.0 centimeter tree the bark is absent from 79 cm. to 95 cm. [95 less 79 = 16 cm]. Therefore the percent bark present on example A =

- step 1 112 - 16 = 96
- step 2 96 divided by 112 * 100% = 85.7%
- step 3 record as 86% bark present

Example A

\[
\text{Remaining bark} \% = \frac{\text{diameter of tree with bark}}{\text{total tree diameter}} \times 100\% = \frac{[112 - 16]}{112} \times 100\% = \frac{96}{112} \times 100\% = 85.7\% = 86\%
\]
### Example B

\[
\text{Remaining bark \%} = \frac{\text{diameter of tree with bark missing}}{\text{total tree diameter}} \times 100\%
\]

<table>
<thead>
<tr>
<th>Remaining bark %</th>
<th>[160 - 85]</th>
<th>100%</th>
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</thead>
<tbody>
<tr>
<td>[\frac{75}{160}]</td>
<td>46.9%</td>
<td>47%</td>
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</table>

### Total Length Measurement

#### Basic Premise

All trees within the Integrated plot must have a total length measured. Trees that are broken will have the length of the stem to the position at which the stem is broken recorded. On fallen trees, the portion of the tree to measure will be from the root collar to the top of the last connected portion (for example, the pieces must be physically attached such that when one portion is moved, the next portion would be affected).

#### Procedure

- Measure the length of the tree from the ground level at high side along the stem to the top of the stem and record the length to the nearest one tenth of a metre.
- All trees require an accurate measurement or estimate of length and will be checked for length during quality control checks by measurement.
- Before measuring tree lengths, the recommended procedure is to estimate the length prior to measurement as a check on measurement calculations.
- When measuring broken stems, the objective is to measure the length which allows the most appropriate application of taper functions to calculate the volume of the tree; see the example below:
All trees will be recorded as measured [M] or estimated [E]. All trees will be measured except where the measurement is physically obstructed or it is unsafe to make the measurement or accurate length estimation is possible.

A methodology is available for trees with broken tops; see the section on "Broken Tops" that follows.

**Crown Class**

**Basic Premise**

The crown classes of all trees will be recorded as these can be used in future growth models.

**Procedure**

All standing live trees will be assigned a crown class designation as follows:

**D** = dominant

Trees with crown extending above the general level of the layer. They are somewhat taller than the codominant tree, and have well developed crowns, which may be somewhat crowded on the sides.
C = **codominant**

Trees with crowns forming the general level of the crown canopy. The crown is generally smaller than those of the dominant trees and is usually more crowded on the sides.

I = **intermediate**

Trees with crowns below, but extending into, the general level of the crown canopy. The crowns are usually small and quite crowded on the sides.

S = **Suppressed**

Trees with crowns entirely below the general level of the crown canopy.

**Height to Live Crown**

**Basic Premise**

The height to live crown will be measured for future research measurements relating to tree growth and stand characteristics. The primary objective is to estimate the effective portion of live crown for growth.

**Procedure**

- all live trees will have the height to crown recorded in metres
- the height is normally the location on the stem where live branches occupy about \( \frac{3}{4} \) of the stem circumference
- trees which have no "effective" crown (for example - a few green branches only) will be recorded as dashes (---)

**Broken Tops**

**Basic Premise**

All trees will be measured to the location of the broken top. In order to apply appropriate form factors to the stem the diameter at this point or the total original height of the potential tree must be known.

**Procedure**

- measure the length of the stem to the break
- the field crew then has two options available:
  - estimate the diameter of the stem at the break
- estimate the original height of the tree prior to the break
- the field crew should select the option with which they have the greatest confidence in the estimate
- enter either the broken top diameter or the projected height or both on the field card
Vegetation Inventory

Chapter 7
Net Factoring
Net Factoring

Net Factoring Using Variable Length Logs

Basic Premise

That a qualified individual can estimate, using measurements and conventions, the net volume of sound wood (gross volume less decay) to assigned log lengths. These net volumes are based on the following:

1. Direct measurements
   - This includes visual estimates and physical measurements

2. Standard estimates associated with pathological symptoms
   - A set of conventions has been developed and will be applied to the symptom or combination of symptoms

The net factoring process is based on only making allowances for decay on consistently measurable or observable features. Some trees will contain decay but will not have any visible symptoms. These "hidden" decay losses will be determined by research.

"Call grading" and "net factoring" are processes to assess quality and volume estimates for timber. Call grading is to some degree based on net factoring, but may be considered a separate procedure.

Net Factoring

Principles

- Standard conventions will be used to determine the extent of the rot and the calculation of the "net factor" (% sound wood).
- "Pencil Bucking" (the imaginary sectioning of a portion of the tree) is used to identify the location of the defect in the log and to localize where the net factor (% sound wood) is applied.
- Net factoring is for sound wood loss only (decay or missing wood). No additional deductions are made for anticipated breakage or manufacturing loss.
- "Diameter" of the log will be the DBH when dealing with the bottom log, or will be estimated at the base of the log when dealing with upper
sections of the tree. This may be slightly different than with some of the scaling conventions.

Procedures

Volume deductions, by log, will only be made where:

- A pathological indicator is present, such as conk.
- Decay or missing wood is visible, such as open scar, sap rot.

Unobserved decay will be deducted as a "hidden" factor, derived from volume and decay data.

Loss Indicators and Deduction Rules

Heart Rot Conk

Deduction area:
- 2 metres above conk
- 4 metres below conk

Net factor: 50%

Grade: Y

Where multiple conks exist and "lengths" between conks are less than the 4 metre minimum, decay is assumed to extend 2 m above the top conk and 4 metres below the lowest conk. The decayed length is given a net factor of 50% and a grade of Y.

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.

Blind Conk

In the

(1) interior and transition zones - typically with bright orange showing when knots are cut open

or

(2) coastal area - typically showing: excessive swelling of the bole or a collapsed bole

The deduction rule is

Deduction area: entire tree
Net factor: 50% of the entire tree
Grade: Y, entire tree
Scar

Indicator is present and rot is evident

The net factor can be calculated using one of the following two methods:

**Method A.  Depth of Rot Can Be Measured,**
(for example, Butt Scars)

- Assume scar is "rectangular" in nature.
  Decay volume = length * width * depth
- Assume log is cylindrical in nature, diameter at midpoint.
  Log volume = \( \pi \times \text{radius}^2 \times \text{length} \)

Net Factor is \[ \left( \frac{\text{volume of log} - \text{decay volume}}{\text{volume of log}} \right) \times 100\% \]

**For Example:**
10 metre log length, 100 cm diameter
scar 10 metres in length, 20 cm wide, 10 cm deep

1. **Volume of Decay**
   \[
   = L \times W \times D \\
   = 10 \text{ m} \times 0.2 \text{ m} \times 0.1 \text{ m} \\
   = 0.2 \text{ m}^3
   \]

2. **Volume of Log**
   \[
   = \pi \times (0.5 \text{ m})^2 \times 10 \text{ m} \\
   = 3.14 \times 0.25 \text{ m}^2 \times 10 \text{ m} \\
   = 7 \text{ m}^3
   \]

3. **Net Factor**
   \[
   = \left( \frac{7.0 - 0.2}{7.0} \right) \times 100\% \\
   = \left( \frac{6.8}{7.0} \right) = 97\%
   \]

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

**Method B.  Depth of Rot Cannot Be Measured**

1) Estimate width and length of scar on log
2) Calculate circumference of log at the scar by \((\pi \times D)\)
3) Calculate "Length" Deduction
\[
\frac{1}{2} \times \left( \frac{\text{width of scar}}{\text{circumference of log}} \right) \times \text{scar length} \times 100\%
\]

4) Volume of Log = \( \pi R^2 L \)

5) Net Factor is \( \left( \frac{\text{length of log} - \text{decay "length"}}{\text{length of log}} \right) \times 100\% \)

For example,

10 metre log length
100 cm diameter
scar 6 metres in length, 20 cm wide

Decay "Length" = \( \frac{1}{2} \times \left( \frac{20\text{ cm}}{3.14 \times 100\text{ cm}} \right) \times 6\text{ m} = 0.19\text{ m} \)

Net Factor = \( \left( \frac{10\text{ m} - 0.19\text{ m}}{10\text{ m}} \right) \times 100\% = 98\% \)

**Frost Crack**

Frost cracks, in general, are a serious defect due both to their affect on the volume of a log and/or the grade assigned to that log.

Frost cracks will be "pencil bucked" at the top and bottom of the longest indicator to determine the length affected.

Frost crack will deduct 10% for each frost crack, if they extend the length of the log, up to a maximum deduction of 40% loss (60% sound).
For partial lengths:

\[
\text{Deduction} = \left( \frac{\text{# of frost cracks} \times \text{crack length}}{\text{log length}} \right) \times 10\%
\]

**Note:** Direction of the frost crack(s) - for instance, across the grain of the log, may result in a lower grade. This would be due to the percent of lumber volume lost, rather than the percent of merchantable volume lost.

**Fork and Crook**

Unless visible decay is evident, no deductions will apply. However, in most cases, the position of the fork/crook will signify a change of grade. If the fork/crook is major in both size and impact on grade, it may be "pencil bucked" out in 1 metre lengths with a grade of "Y" assigned to that section and a net factor of 100%.

**Mistletoe**

If no decay is visible: Not a grade consideration
Net Factor = 100%

If decay is visible:
1 meter deduction
Y grade
Net Factor = 50%

**Rotten Branches**

Larger rotten branches/knots (Greater than or equal to 10 cm inside bark) are a significant indicator of cylindrical rot.

<table>
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<tr>
<th>Deduction area</th>
<th>1 metre above the Rotten Branch (knot)</th>
<th>1 metre below the Rotten Branch (knot)</th>
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<tbody>
<tr>
<td>Net Factor</td>
<td>50%</td>
<td>Y</td>
</tr>
</tbody>
</table>

**Note:** For multiple over-lapping rotten branches/knots (less than 2 m apart) the deduction extends one metre above and below the series.

**Dead Tops (broken top is handled separately)**

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

**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.
Net Factor = \left[ \frac{\text{volume of sound cone}}{\text{volume of cone}} \right] \times 100\% 

\text{Derivation of formula}

Net Factor = \left[ \frac{(1/3) \pi (R_{\text{sound}})^2 L}{(1/3) \pi (R_{\text{total}})^2 L} \right] \times 100\%

= \left[ \frac{(R_{\text{sound}})^2}{(R_{\text{total}})^2} \right] \times 100\%

= \left[ \frac{R_{\text{sound}}}{R_{\text{total}}} \right]^2 \times 100\%

For Example,

Midpoint diameter 20 cm (10 cm radius)
2 cm depth of sap rot (giving 8 cm radius of sound wood)

Net Factor = \left[ \frac{8 \text{ cm}}{10 \text{ cm}} \right]^2 \times 100\% = 64\%

Broken Tops

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.
Net Factor = \[
\frac{\text{volume of sound cone}}{\text{volume of cone}}\] \times 100\%

**Derivation of formula**

\[
\text{Net Factor} = \left[ \frac{\frac{1}{3} \pi (R_{\text{sound}})^2 \text{ L}}{\frac{1}{3} \pi (R_{\text{total}})^2 \text{ L}} \right] \times 100\%
\]

\[
= \left[ \frac{(R_{\text{sound}})^2}{(R_{\text{total}})^2} \right] \times 100\%
\]

\[
= \left[ \frac{(R_{\text{sound}})}{(R_{\text{total}})} \right]^2 \times 100\%
\]

**For Example,**

Midpoint diameter 20 cm (10 cm radius)
2 cm depth of sap rot (giving 8 cm radius of sound wood)

\[
\text{Net Factor} = \left[ \frac{8 \text{ cm}}{10 \text{ cm}} \right]^2 \times 100\% = 64\%
\]

**Broken Tops**

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 metre below the break.

\[
\text{Net Factor} = \left[ \frac{\text{last log length} - 1.0}{\text{last long length}} \right] \times 100\%
\]

**For Example,**

Last Log Length is 10 metres up to a broken top

\[
\text{Net Factor} = \left[ \frac{10 \text{ m} - 1 \text{ m}}{10 \text{ m}} \right] \times 100\% = 90\%
\]
Deduction rules for Decayed or Missing Wood

**Butt Rot / Cat Face**

"Cat face" is a scar or missing section of wood allowing the observation of internal defect.

**Note that in many cases**, cat faces will be "pencil bucked" at the visible top of the rot, and that will be the log length.

There are 2 rules for dealing with this form of internal decay. The associated heart rot may be cylindrical or conical in nature, and that decision must be made by the cruiser on site.

**Method 1) : Cylindrical Defect Rule**

\[
\text{Net Factor is } \quad = \left[ \frac{\text{volume of log} - \text{volume of decay}}{\text{volume of log}} \right] \cdot 100\%
\]

**Derivation of formula** \((L=\text{log length}, \, ld=\text{length of decay})\)

\[
\text{Net Factor} = \left[ \frac{\pi \left( R_{(\log)} \right)^2 L - \pi \left( R_{(\text{decay})} \right)^2 ld}{\pi \left( R_{(\log)} \right)^2 L} \right] \cdot 100\%
\]

\[
= \left[ \frac{\left( R_{(\log)} \right)^2 L - \left( R_{(\text{decay})} \right)^2 ld}{\left( R_{(\log)} \right)^2 L} \right] \cdot 100\%
\]

\[
= \left[ 1 - \frac{\left( R_{(\text{decay})} \right)^2 \frac{ld}{L}}{\left( R_{(\log)} \right)^2} \right] \cdot 100\%
\]
For Example,
Log length 10 meters
Cat face for 6.0 metres

Sound wood = 20 cm (solid outer ring of wood)
Diameter = 200 cm (radius = 1.0 metre)

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

= \left[ 1 - (0.384) \right] \times 100\% = 62\%

Method 2): Conical Defect Rule (decay length = log length)

Net Factor is \[
= \left( \frac{\text{volume of log} - \text{volume of decay}}{\text{volume of log}} \right) \times 100\%
\]
Derivation of formula \( L = \log \text{length}, \ ld = \text{length of decay} \)

**Net Factor:**

\[
= \left[ \frac{\pi \left( R_{\text{log}} \right)^2 L - \pi \left( \frac{1}{3} \right) \left( R_{\text{decay}} \right)^2 ld}{\pi \left( R_{\text{log}} \right)^2 L} \right] \cdot 100\%
\]

\[
= \left[ \frac{\left( R_{\text{log}} \right)^2 - \left( \frac{1}{3} \right) \left( R_{\text{decay}} \right)^2 \left( \frac{ld}{L} \right)}{\left( R_{\text{log}} \right)^2} \right] \cdot 100\%
\]

\[
= \left[ 1 - \left( \frac{\left( \frac{1}{3} \right) \left( R_{\text{decay}} \right)^2 \left( \frac{ld}{L} \right)}{\left( R_{\text{log}} \right)^2} \right) \right] \cdot 100\%
\]
For Example, (defect length not equal to log length)

Cat face for 5.0 metres of 8.0 metre log
Sound wood 20 cm (solid outside radius, therefore 80 cm defective core)
Diameter = 200 cm (radius = 1.0 metre)

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

\[ = \left[ 1 - \left( \frac{1}{3} \right) \left( 0.64 \right) \left( 0.63 \right) \right] \times 100\% \]

\[ = \left[ 1 - 0.13 \right] \times 100\% = 87\% \]
Example: Using Shortcut method

(diameter of decay = defect length \textbf{equal} to log length)

[Uses butt rot factor table (see Appendix I)].

1) \[
\text{Ratio} = \left(\frac{\text{diameter of decay}}{\text{DBH}}\right) = \left[\frac{160 \text{ cm}}{200 \text{ cm}}\right] = \frac{3}{4}
\]

2) Use Table entry for 6 metre log with $\frac{3}{4}$ ratio of butt rot.

Giving Table Net Factor of 81%.

Sap Rot

Depth of sap rot is determined at DBH and is presumed to be constant for that tree. For a "fallen tree", if the sap rot only occurs above DBH, then measure at the midpoint of each log and apply the net factor \textit{only} to those logs affected.

\textbf{Note:} Two sapwood width measurements should be taken, and \textbf{averaged} particularly for fallen trees.

Net Factor is \[
\left[\frac{\text{area of soundwood}}{\text{area of tree}}\right] \times 100\%
\]

Derivation of formula:

Net Factor \[
= \left[\frac{\pi \left(R_{\text{sound}}\right)^2}{\pi \left(R_{\text{tree}}\right)^2}\right] \times 100\%
\]

\[
= \left[\frac{\left(R_{\text{sound}}\right)^2}{\left(R_{\text{tree}}\right)^2}\right] \times 100\% = \left[\frac{R_{\text{sound}}}{R_{\text{tree}}}\right]^2 \times 100\%
\]
For example,

DBH = 40 cm, (20 cm radius)
Sap rot depth (radius) = 4 cm

\[ \frac{(16)^2}{(20)^2} \times 100\% = \left( \frac{16}{20} \right)^2 \times 100\% \]

\[ = 64\% \]

**Missing Wood**

External: Calculate as you would for a scar. (example, mechanical damage)

Internal: Use appropriate decay formula. (example, Hollow section)

**Root Rot**

All root rots are assumed conical in nature. Unless otherwise observed, the inventory convention is that the cone of rot extends 3 metres 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 meter section) is a constant, with the net factor always equal to 81% for that section.

**Derivation of formula:** (decay length = dl)

Net Factor is:

\[ = \left( \frac{\text{volume of log}}{\text{volume of log}} - \frac{\text{volume of decay}}{\text{volume of log}} \right) \times 100\% \]

\[ = \left( \frac{\pi \left( R_{(\log)}^3 \right)^2 \cdot L - \pi \left( \frac{1}{3} \cdot R_{(decay)}^3 \right)^2 \cdot 1L}{\pi \left( R_{(log)}^3 \right)^2 \cdot L} \right) \times 100\% \]

\[ = \left[ \left( R_{(log)}^2 - \frac{1}{3} \cdot R_{(decay)}^2 \right) \left( \frac{1L}{L} \right) \right] \times 100\% \]

**Simplified Version**

Since the relative size of the defect is constant, the decayed percentage for the first 3 meters is a constant of 19%. Therefore the simplest form of the equation is:

Net Factor = 100% - 19% * \left( \frac{1L}{L} \right)
Example:

Log Length 3 Metres \{\text{therefore } (ld/L) \text{ drops out}\}
Rot Ratio (fixed) 75\%
Log Diameter 120 cm (radius = 60 cm)
Rot Diameter 75\% \times 120\ cm = 90\ cm (radius 45\ cm)

Net Factor \[ \frac{(0.06)^2 - (1/3) \times (0.45)^2}{(0.06)^2} \times 100\% = \frac{.36\ m^2 - 0.07\ m^2}{.36\ m^2} \times 100\% = 81\% \]

Example:

Log Length 8 Metres, Rot extend 3 meters
Rot Ratio (fixed) 75\%
Log Diameter 120 cm (radius = 60 cm)
Rot Diameter 75\% \times 120\ cm = 90\ cm (radius 45\ cm)

Net Factor \[ \frac{(0.6)^2 - \left[ (1/3) \times (0.45)^2 \times (2/3) \right]}{(0.6)^2} \times 100\% \]
\[ \left[ \frac{.36\ m^2 - \left(1/3 \times 0.2\ m^2 \times 0.375\right)}{0.36\ m^2} \right] \times 100\% = \frac{.025\ m^2}{0.36\ m^2} \times 100\% = 93\% \]
Simplified Version

Since the relative size of the defect is constant, the decayed percentage for the first 3 meters is always 19%. Therefore a simplest form of the equation is:

\[
\text{Net Factor} = 100\% - \left[ 19\% \times \frac{3}{8} \right] \\
= 100\% - [19\% \times .35] \\
= \left[ 100\% - [7\%] \right] = 93\%
\]

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 previous net factoring procedures.

There are several concepts, however, that should be noted:

1. Net factors less than 50% will only occur with:
   - severe cylindrical butt rot
   - severe sap rot
   - severe missing wood

2. 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%.

3. Sections equal to 4 metres or longer can be separately described as logs. Sections equal to 3 metres or shorter are not described separately.
Example (of isolated section between defects)

Conk at 12 m and 22 metres

This creates a 4 m section between the defect areas, which is permissible. We have the options of describing it as a separate log, but in this case it happens to be the same grade, so we will combine all 3 sections into 1 log. The defect is not presumed to run through this isolated section. The section would be assumed to be defect free even if it were shorter than 4 meters and was forced to have the same "Y" grade as the sections above and below it.

- Log Length (from 8 m - 24 m) = 16 m
- Conk Deduction 50% (of 12 m) = 6 m
- Grade (all 3 sections) = Y
- Net Factor = \[ \frac{16 \text{ m} - 6 \text{ m}}{16 \text{ m}} \times 100\% = 63\% \]

Note: The same procedure should be used whenever grade is assigned, particularly for butt rot and/or cat face.
### Net Factor Table By Log Length

<table>
<thead>
<tr>
<th>Butt Rot Ratio is Roughly</th>
<th>Log Length (conical deduction)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>14 m</td>
</tr>
<tr>
<td>1/4 diam</td>
<td>-</td>
</tr>
<tr>
<td>2/4 diam</td>
<td>98</td>
</tr>
<tr>
<td>3/4 diam</td>
<td>92</td>
</tr>
<tr>
<td>4/4 diam</td>
<td>80</td>
</tr>
<tr>
<td>m 5</td>
<td>m 3</td>
</tr>
<tr>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td>-</td>
<td>90</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Vegetation Inventory

Chapter 8
Call Grading
Vegetation Inventory

Chapter 8
Cell Grazing
Call Grading

Call Grading Using Variable Length Logs

Basic Premise
A qualified individual can assign MOF statutory log grades (modified coastal log grades) to standing and fallen timber using conventions and measurements. Trees that do not meet the minimum log sizes for coastal log grades are assigned a small tree grade developed for use in the Vegetation Inventory.

Call grading is a process for developing local quality estimates for timber. Call grading is to some degree based on the net factoring process but can be considered as separate procedures.

Call grading is the procedure used to assign one of the MOF statutory grades, or quality estimates, (fig. 1) to the log under consideration. "Variable length call grading" recognizes only a minimum length (fig. 1) and allows the cruiser to "pencil buck" at grade changes rather than at predetermined set log lengths.

Table 8-1 – Minimum Log Lengths In Metres By Grades And Species (Highest At Left)

<table>
<thead>
<tr>
<th>Lumber</th>
<th>Peclet</th>
<th>Sawlog</th>
<th>Shingle</th>
</tr>
</thead>
<tbody>
<tr>
<td>D,F,G D</td>
<td>B,C</td>
<td>H</td>
<td>I</td>
</tr>
<tr>
<td>DOUG-FIR</td>
<td>5</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>CEDAR</td>
<td>5</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>HEMLOCK</td>
<td>5</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>BALSAM (Abies)</td>
<td>5</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>SPRUCE</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>PINE/Larch/Yew</td>
<td>5</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>CYPRESS</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>DEDICIOUS</td>
<td>-</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>
The cruiser must recognize the hierarchical process of grading, as implied in Figure 1, and extend the grade up the tree or along the piece as long as the grade rules allow. When knot characteristics or the diameter of the piece can no longer support that higher grade, the cruiser changes the grade for the next portion of the tree.

To call grade the cruiser must be able to:

- apply statutory minimum log lengths (Table 8-1);
- recognize statutory grades and apply the grading hierarchy (Table 8-1);
- change the grade when minimum diameter, knot size, knot frequency, or quality limitations are reached;
- understand and utilize the net factoring and recoverability requirements of the statutory grades.

Call grading and net factoring 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. The piece is assessed as it exists.

- The MOF coastal statutory log grades will be used throughout the provincial inventory (with minor changes due to the differences between scaling and cruising applications).
- Variable log lengths will be used with whole metre increments based on the minimum length for that grade (Table 8-1)

**CALL GRADING**

**Principles**

1. MOF coastal statutory grades, with some modifications, are assigned to logs based on size, quality, and soundwood recoverability.

2. Grades are assigned using the hierarchy of provincial grades (Table 8-1). Start at the first grade in the hierarchy, if the log cannot be that grade, then move to the next in the list until the grade can be met.

3. Logs cannot be "one grade or another; they can only be one grade. It is not a choice of market preference, current harvesting practices, accessibility, etc. - they are the highest grade that they qualify for within the hierarchy.

4. It is particularly important that the cruiser grade the log into at least the correct major category. The major categories are:
<table>
<thead>
<tr>
<th>Category</th>
<th>Grades</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lumber</td>
<td>D, F, G</td>
</tr>
<tr>
<td>Peeler</td>
<td>B, C</td>
</tr>
<tr>
<td>Sawlog</td>
<td>H, I, J</td>
</tr>
<tr>
<td>Shingle</td>
<td>K, L, M</td>
</tr>
<tr>
<td>Utility</td>
<td>U, X</td>
</tr>
<tr>
<td>Chipper</td>
<td>Y</td>
</tr>
<tr>
<td>Missing portion</td>
<td>N</td>
</tr>
</tbody>
</table>

The intent is for trained cruisers to consistently be in the correct category, and hopefully within one grade of the correct choice.

5. Grades are assigned to ALL trees (live or dead, standing or fallen) selected within the "main plot" used for measuring the larger trees (it could be either a variable plot or a fixed plot).

**Procedure**

1) **STANDING TREE, live or dead**

No Major Defect

1) Based on grading rules and characteristics of the minimum log lengths for that species, determine the highest grade the bottom log would satisfy.

2) Add to that log in one metre increments until the top diameter of the log 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.

3) Record the grade and the length. For example, an "H grade 16 meter log" is "H 16".

4) Follow the same procedure for the next log up the tree. If a grade continues to the top of the tree, the convention is to record the grade and then "99" for the length, for example (X, 99). It is recommended that the cruiser not attempt to grade the top log based on top diameter (utilization diameter), or on the fact that it may be a short log due to utilization top diameter - simply carry the last grade to the top of the tree with the "99" convention.

   This simplifies the grading in immature stands where the first log is a "J" and the remaining portion is too small for the grading rules - simply call the whole tree "J" grade (J, 99)
5) Assign a net factor to each log graded. If the log has no major defects, and the cruiser detects no measurable soundwood loss, the net factor is 100% which is recorded as two dashes (- -).

**Major Defects Exist**

1) If the tree has certain defects (for example: excessive butt rot, fork, conk, rotten branches) the cruiser may want to isolate those portions of the tree (because they will affect the grade) then use appropriate net factors specifically in those areas.

   **A. Butt Rot**

   If the rot lowers the grade of the butt log, then a normal procedure would be to take a short (3 m) X or Y grade from the butt, assign the appropriate net factor just to that log and then carry on above the rot with a different grade log.

   **B. Conk**

   Scaling conventions assume that conk extends 2 m above the conk and 4 m below it. This is normally a 6 metre Y grade log with a net factor of 50%. The cruiser may, if they 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 metre increments.

   For example, an "H" grade tree with a conk at 12 metres could be graded "H" grade for 8 metres, "Y" for 6 metres (net factor 50%), then "H" grade again starting 2 metres above the conk.

   **C. Fork**

   Fork may be pencil bucked out in 1 m increments and graded as "Y" grade with the appropriate net factor.

   **D. Broken Top**

   The tree is graded and net factored to the broken top. The missing portion is graded as "N" and net factored as "00" (0%).

2) **FALLEN TREES (live or dead)**

   All fallen trees will be graded in the same way as standing trees.

3) **BROKEN TREES (snags)**

   If the stem is over 1.3 m tall, grade and net factor it like any other tree with a broken top. The stem will have to be graded on its length and recoverability (usually it will be an X or Y grade).
CONVENTIONS

Grading

- Trees with conk or blind conk will have the affected portion graded as "Y" grade unless the defect can be measured to determine another grade.

- The last grade on the tree will normally be carried to the top of the tree ("99") regardless of utilization limits (this applies to grades J,U,X,Y,N).

- Cedar will not be graded as shingle if it can make a sawlog grade.

- Missing tops will be graded as grade "N" (for nothing).

- Twist is measured over a 30 cm length at the midpoint of the log. The displacement is then expressed as a % of the log top diameter.

Small Tree Grades

A quality assignment will be given to entire trees in the main plot when they are not large enough in diameter and length to qualify for the statutory grading rules. These quality assignments are:

"P" - "Potential" Sawlog
  - Straight and good form.
  - Well spaced / distributed knots or branches.

"Q" - "Questionable" Sawlog
  - Slight sinuosity, minor crooks etc.
  - Small knots

"R" - "Reject" Sawlog
  - Major sinuosity or deformity.
  - Large knots.
  - Uneven distribution of knots or branches.

In all cases the "99" convention will be used to specify a single grade for the entire lengths of these small trees.

Specific Grading Information

Heart Rot

- Conk, blind conk and rotten branches have specific lengths and grades applied.
Conk       Y     2 m above, 4 m below, 50% sound
Blind Conk Y     Entire tree, 50% sound for entire tree
Rotten Branch Y     1 m above, 1 m below, 50% sound

- 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.

**Butt Rot**
- Is generally included with the log for its maximum grade length.
- Table 1 is the conical butt rot factor table. Note that the net factor may determine the grade, based on the % lumber recovery or other grade requirements.

**Frost Cracks**
- "Pencil buck" at the top of the frost crack 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% for the frost cracks (net factor of 60%).
- Note that the angle, position, or net factor will determine the appropriate grade based on % lumber recovery and/or % merchantable.

**Broken (missing) Tops**
- "Pencil buck" at the break.
- Assign:
  
  | Grade | N (nothing) |
  | Length | 99 (to original top) |
  | Net Factor | 00 (0 soundwood) |

**Sun checks and/or Insect Damage**
- There is no soundwood deduction applied to sun checks or insect damage.
- Grade considerations, particularly % lumber, are applied.

Sound % Lumber Calculation (for Grade Consideration)

\[
\% \text{ Recovered} = \frac{\pi \left( \frac{R_{(awable \ lumber)}}{2} \right)^2}{\pi \left( \frac{R_{(wsc)}}{2} \right)^2} \times 100\%
\]
For example,

Diameter = 50 cm
Sun checks = 5 cm deep (radius)
Whole tree is sun checked

\[
\text{Grade (recovery) Consideration} = \left( \frac{R_{\text{sawable lumber}}}{R_{\text{tree}}} \right)^2 \times 100\%
\]

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

All 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).

**Twist**

- There is no sound wood 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%.

Restrictions on twist: Displacement & Percent:

Lumber Grades D, F, G 4% of top diameter, and a limit of 6 cm maximum displacement
Peeler Grades  | B, C | (displacement is always measured over the 30 cm distance).
Sawlog        | H    | 7% of top diameter, and a limit of 8 cm maximum displacement
Sawlog        | I    | As above
Smallwood     | J    | 10% of top diameter, and a limit of 9 cm maximum displacement
Utility       | U, X | 10% of top diameter
              |      | (no upper limit for displacement)
              |      | 13% of top diameter, and a limit of 13 cm maximum displacement

**Note:**

- "Waterline to waterline" (180 degree twist over 2 metres) is automatically Y grade.
- If twist only appears on a portion of a tree - it must be "pencil bucked" out with the appropriate grade, length and net factor applied.

### Examples:

<table>
<thead>
<tr>
<th>Log</th>
<th>Est. top DIB</th>
<th>Severe twist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log 1</td>
<td>60 cm</td>
<td>8 cm (along 30 cm section)</td>
</tr>
<tr>
<td>Log 2</td>
<td>25 cm</td>
<td>Minor twist 2 cm displacement</td>
</tr>
</tbody>
</table>

### Log 1

\[
\text{% twist} = \left( \frac{8 \text{ cm twist}}{60 \text{ cm top}} \right) \times 100\% = 13\%
\]

Log is Graded as U, since the maximum displacements allowed are 8 cm and 13% of top diameter.
Log 2

\[
\text{% twist} = \left( \frac{2 \text{ cm twist}}{25 \text{ cm top}} \right) \times 100\% = 8\%
\]

This Log is graded as J, since the maximum displacement allowed is 10% (with no maximum of actual displacement).

Cedar Shingle Criteria

Convention: If a log, due to heart rot or butt rot has less than 75% sound wood, but meets slab thickness requirement for that grade, the log becomes shingle grade.

If logs are unsuitable for lumber manufacture due to:

1. shape (heavy fluting),
2. heart rot (less than minimum % sound for lumber recovery),
3. splits,

changes to

Former D grade \rightarrow K grade
Former F grade \rightarrow L grade
Former H/I grade \rightarrow M grade

Convention:

Grade as Shingle if:

"Fluted shape" with bark seams leads to lumber % less than 75%,

OR Heart Rot/ Butt Rot leads to "U" shaped slabs,

OR Splits lead to very "Triangular shaped" slabs.
# Summary Log Grades by Species

## Fir/Pine/Larch

<table>
<thead>
<tr>
<th>Grade</th>
<th>Min. Length</th>
<th>Min. Top DIB</th>
<th>Min. Top DIB Knots</th>
<th>Knots max</th>
<th>Min Scale</th>
<th>Defects</th>
<th>Rings / 2cm</th>
<th>Twist</th>
</tr>
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<tbody>
<tr>
<td>D Lumber</td>
<td>5M</td>
<td>76</td>
<td>76+</td>
<td>90% surface clear</td>
<td>75% L 50%CL</td>
<td>no conk no ring shake</td>
<td>6</td>
<td>4% (6cm)</td>
</tr>
<tr>
<td>F Lumber</td>
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<td>60</td>
<td>60-74</td>
<td>75% surface clear</td>
<td>75% L 50%CL</td>
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<td>4% (6cm)</td>
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<tr>
<td>B* Peeler</td>
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<td>60-74</td>
<td>2.6m butt clear</td>
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<td>7% (8cm)</td>
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<td>76+</td>
<td>2.6m butt knot ind. allowed</td>
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<td>C* Peeler</td>
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<td>80% V</td>
<td>as above</td>
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<td>7% (8cm)</td>
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<tr>
<td>H sawlog</td>
<td>5M</td>
<td>38</td>
<td>38-48</td>
<td>4cm or 5cm top half of log</td>
<td>75% L 65% M</td>
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<td>7% (8cm)</td>
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<tr>
<td></td>
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<td>4 cm or 5cm top 2/3 of log or 8cm top half of log</td>
<td>50% L 65% M</td>
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<td>4M</td>
<td>38</td>
<td>38-48</td>
<td>8cm</td>
<td>75% L 50% M</td>
<td>or former H 50% L 65% M</td>
<td>10% (9cm)</td>
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<td></td>
<td>50-74</td>
<td>9cm</td>
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<td>10cm</td>
<td>50% M</td>
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L = Lumber  
CL = Clear  
M = Merch  
V = Veneer
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<th>Grade</th>
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<th>Min. Top DIB (cm)</th>
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<th>% Surface Clear</th>
<th>Min Scale</th>
<th>Defects</th>
<th>Rings / 2cm</th>
<th>Twist</th>
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<tr>
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<td>5M</td>
<td>60</td>
<td>60-74</td>
<td>75% surface clear</td>
<td>75% L</td>
<td>no powderworm</td>
<td>4% (6cm)</td>
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<td>50% L</td>
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<td>50-58</td>
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<td>75% L</td>
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<td>4% (6cm)</td>
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</tr>
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<td>25% CL</td>
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<td>5M</td>
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<td>4cm or 5cm top half of log</td>
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<tr>
<td>I</td>
<td>5M</td>
<td>38</td>
<td>38-48</td>
<td>8cm</td>
<td>75% L</td>
<td>or former H</td>
<td>10% (9cm)</td>
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<td>50% SS</td>
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<td>75% CL</td>
<td>75% L</td>
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<td>75% L</td>
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<td>50% CL</td>
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<td>slabs &gt;16cm thick</td>
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### Hemlock/Balsam

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<th>Min Scale</th>
<th>Defects</th>
<th>Rings / 2cm</th>
<th>Twist</th>
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<tbody>
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<td>5M</td>
<td>66</td>
<td>66-74</td>
<td>90% surface clear</td>
<td>75% L</td>
<td>no conk, blind conk or rotten branches</td>
<td>6</td>
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<td>76+</td>
<td>80% surface clear</td>
<td>50% CL</td>
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<td>F lumber</td>
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<td>50-64</td>
<td>75% surface clear</td>
<td>75% L</td>
<td>no conk blind conk rotten branches</td>
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<td>66+</td>
<td>50% surface clear</td>
<td>25% CL</td>
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<tr>
<td>H sawlog</td>
<td>5M</td>
<td>38</td>
<td>38-48</td>
<td>4cm or 5cm top half of log</td>
<td>75%</td>
<td>or former D,F 50% L 25% CL</td>
<td>5</td>
<td>7% (8cm)</td>
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<td>4cm or 5cm top 2/3 of log or 8cm top half of log</td>
<td>65%</td>
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<tr>
<td>I sawlog</td>
<td>4M</td>
<td>38</td>
<td>38-48</td>
<td>8cm</td>
<td>75% L</td>
<td>or former H 50% L 65% M</td>
<td>10%</td>
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<td>Defects</td>
<td>Rings / 2cm</td>
<td>Twist</td>
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<td>76+</td>
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<td>75% L 50CL</td>
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<td>75% L 25%CL</td>
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<td>4% (6cm)</td>
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<tr>
<td><strong>H sawlog</strong></td>
<td>4M</td>
<td>38</td>
<td>38-48</td>
<td>4cm or 5cm top half of log</td>
<td>75% L 65% M</td>
<td>no conk</td>
<td>5</td>
<td>7% (8cm)</td>
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<td><strong>I sawlog</strong></td>
<td>4M</td>
<td>38</td>
<td>38-48</td>
<td>8cm</td>
<td>75% L 50% M</td>
<td>or former H 50% L 65% M</td>
<td>10% (9cm)</td>
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**Sampling Procedures March 31, 1995**

**DRAFT**
## Cypress

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<tr>
<th>Grade</th>
<th>Min. Length</th>
<th>Min. Top DIB</th>
<th>Min Top DIB Knots</th>
<th>Knots max DIB</th>
<th>Min Scale</th>
<th>Defects</th>
<th>Rings / 2cm</th>
<th>Twist</th>
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<tr>
<td>H</td>
<td>4M</td>
<td>38</td>
<td>38-48</td>
<td>4cm</td>
<td>50%</td>
<td>7%</td>
<td>(8cm)</td>
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</tr>
<tr>
<td></td>
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<td>or 5cm top half of log</td>
<td></td>
<td>65%</td>
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<td>50+</td>
<td>4cm</td>
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<td></td>
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<td>or 5cm top 2/3 of log</td>
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<td>or 8cm top half of log</td>
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<td>I</td>
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<td>38</td>
<td>38-48</td>
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<td>50% L</td>
<td>10%</td>
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<td>50-74</td>
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<td>50% M</td>
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<td>76+</td>
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## Common Grades to All Species

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<th>Min Scale</th>
<th>Defects</th>
<th>Rings / 2cm</th>
<th>Twist</th>
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<td>J sawlog</td>
<td>5M*</td>
<td>15-36</td>
<td>10-26</td>
<td>4cm</td>
<td>75% L</td>
<td>10%</td>
<td>(9cm)</td>
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<tr>
<td>U utility</td>
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<td>13%</td>
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<tr>
<td>Y chipper</td>
<td>10+</td>
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<td>X &gt; Y &gt; Z</td>
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*Note Spruce & Cypress 4M*
### Deciduous

<table>
<thead>
<tr>
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<th>Min. Length</th>
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<th>Min Top DIB Knots</th>
<th>Knots max DIB</th>
<th>Min Scale</th>
<th>Defects</th>
<th>Rings / 2cm</th>
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<td>Y chipper</td>
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<td>&lt; 50% scale at both ends of log or less than 3 meters in length</td>
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</tbody>
</table>

* Cottonwood only
Inventory Call Grading Criteria

FIR

D GRADE
Minimum top diameter inside bark 76 cm.
Minimum log length 5 m.
Minimum percentage lumber 75%
Minimum percentage clear lumber 50%
Minimum rings per 2 cm of radius 6 rings
Maximum twist over 30 cm of length 4% of top diameter
Max. deviation 6 cm.

Grade Requirements

Knots
A. ≥ 90% surface clear, with well spaced knots or knot indicators permitted on the upper 10% of two sides of the log length only.
B. ≥ 90% surface clear, with well spaced knots or knot indicators permitted on the upper 20% of one side of the log length only.

Rot
A. No conk or pocket rot permitted.
B. No insect or worm holes penetrating the sap wood permitted.
C. Rot permitted provided 75% lumber attained.

Misc.
A. No ring shake permitted.
B. No pitch pockets permitted.

F GRADE
Minimum top diameter inside bark 60 cm.
Minimum log length 5 m.
Minimum percentage lumber 75%
Minimum percentage clear lumber 25%
Minimum rings per 2 cm of radius 6 rings
Maximum twist over 30 cm of length 4% of top diameter
Max. deviation 6 cm.
Grade Requirements

Knots
A. ≥75% surface clear, with well spaced knots or knot indicators permitted on the upper 25% of two sides of the log length only.
B. ≥75% surface clear, with well spaced knots or knot indicators permitted on the upper 50% of one side of the log length only.

Rot
A. No conk or pocket rot permitted.
B. No insect or worm holes penetrating the sap wood permitted.
C. Rot permitted provided 75% lumber is attained.

Misc.
A. No ring shake permitted.
B. No pitch pockets permitted.

B GRADE
Minimum top diameter inside bark 60 cm.
Minimum log length 5 m.
Minimum percentage veneer 80%
Minimum rings per 2 cm of radius 6 rings
Maximum twist over 30 cm of length 7% of top diameter
Max. deviation 8 cm.

Grade Requirements

Knots
A. No knots or bunch knots over 4 cm are permitted.
B. Logs 60-74 cm top diameter must have the lower 2.6 m free of knots or knot indicators.
C. Logs ≥76 cm top diameter must have the lower 2.6 m free of knots. Knot indicators are permitted.

Rot
A. No conk or pocket rot permitted.
B. No butt rot permitted.
C. Sap rot permitted to 4% of top diameter or 5 cm in depth.

Misc.
A. No ring shake permitted.
B. No splits or internal checks permitted.
C. No pitch pockets permitted.
D. Sun checks permitted to a depth of 4% of top diameter or to a maximum of 5 cm in depth.
E. Sweep is not permitted.
F. Crook is not permitted.
G. Burrs are permitted to 1 burl per 2.6 m of log length.

C GRADE

Minimum top diameter 38 cm.
Minimum log length 5 m.
Minimum percentage veneer 80%
Minimum rings per 2 cm of radius 6 rings
Maximum twist over 30 cm of length 7% of top diameter
Max. deviation 8 cm.

Grade Requirements

Knots
A. No knots or bunch knots over 4 cm are permitted.

Rot
A. No conk or pocket rot permitted.
B. No butt rot permitted.
C. Sap rot:
   - None permitted in logs < 50 cm top diameter.
   - ≥ 50 cm top diameter permitted to 4% of the top diameter to a maximum of 5 cm.

Misc.
A. No ring shake permitted.
B. No splits or internal checks permitted.
C. No pitch pockets permitted.

D. Sun checks:
   - None permitted in logs < 50 cm top diameter.
   - ≥ 50 cm top diameter permitted to 4% of the top diameter to a maximum of 5 cm.

E. Sweep is not permitted.

F. Crook is not permitted.

G. Burls are permitted (1 burl per 2.6 m of log length).

H GRADE

Minimum top diameter 38 cm.
Minimum log length 5 m.
Minimum lumber percentage:
   - Logs ≥ 38 cm Top Diameter 75%
   - Logs ≥ 50 cm Top Diameter 50%
Minimum merchantable percentage 65%
Minimum rings per 2 cm of radius 5 rings
Maximum twist over 30 cm of length 7% of top diameter Max. deviation 8 cm.

Grade Requirements

Knots

A. 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.

B. ≥ 50 cm top diameter:
   - 4 cm knots over the entire log OR
   - 5 cm knots over the upper 66 2/3 % 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.
Rot
A. Permitted provided percentage lumber is maintained.
B. No insect or worm holes penetrating the sap wood permit.

I GRADE
Minimum top diameter 38 cm.
Minimum log length 4 m.
Minimum lumber percentage:
- Logs ≥ 38 cm Top Diameter 75%
- Logs ≥ 50 cm Top Diameter 50%
- Logs 38-48 cm Top Diameter 50%
  (former H log quality)
Minimum merchantable percentage 50%
OR
former H log quality 38-48 cm/top diameter 65%
Maximum twist over 30 cm of length 10% of top diameter
Max. deviation 9 cm.

Grade Requirements
Knots
A. 38 - 48 cm top diameter 8 cm.
B. 50 - 74 cm top diameter 9 cm.
C. ≥ 76 cm top diameter 10 cm.
Rot
A. Permitted provided percentage lumber is attained.

J GRADE
Minimum top diameter 16 cm.*
Minimum log length 5 m.
Maximum top diameter 36 cm.
Minimum lumber percentage 75%
Minimum merchantable percentage 50%
Maximum twist over 30 cm of length 10% of top diameter.
Grade Requirements

Knots
A. 15 - 26 cm top diameter  4 cm.
B. 28 - 36 cm top diameter  6 cm.

Rot
Permitted provided 75% lumber is attained.

U GRADE
Minimum top diameter  10 cm.*
Minimum log length  5 m.
Minimum lumber percentage:
- 10 - 14 cm Top Diameter  75%
- 16 - 36 cm Top Diameter  66 2/3 %
- ≥ 38 cm Top Diameter  50%
Minimum merchantable percentage  35%
Maximum twist over 30 cm of length  13%
Max. deviation 13 cm.

Grade Requirements
Knots
A. 10 - 14 cm Top Diameter  4 cm
B. 16 - 26 cm Top Diameter  6 cm
C. 28 - 36 cm Top Diameter  8 cm
D. 38 - 48 cm Top Diameter  10 cm
E. 50 - 74 cm Top Diameter  12 cm
F. ≥ 76 cm Top Diameter  14 cm
Rot
- Permitted provided percentage lumber is attained.

X GRADE
Minimum top diameter  10 cm.*
Minimum log length  3 m.
<table>
<thead>
<tr>
<th>FIR</th>
<th>Minimum lumber percentage</th>
<th>33 1/3%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum merchantable percentage</td>
<td>35%</td>
</tr>
<tr>
<td></td>
<td>Maximum twist over 30 cm of length</td>
<td>13%</td>
</tr>
<tr>
<td></td>
<td>Max. deviation 13 cm.</td>
<td></td>
</tr>
</tbody>
</table>

**Knots**

<table>
<thead>
<tr>
<th>A</th>
<th>10 - 14 cm Top Diameter</th>
<th>4 cm</th>
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</thead>
<tbody>
<tr>
<td>B</td>
<td>16 - 26 cm Top Diameter</td>
<td>6 cm</td>
</tr>
<tr>
<td>C</td>
<td>28 - 36 cm Top Diameter</td>
<td>8 cm</td>
</tr>
<tr>
<td>D</td>
<td>38 - 48 cm Top Diameter</td>
<td>10 cm</td>
</tr>
<tr>
<td>E</td>
<td>50 - 74 cm Top Diameter</td>
<td>12 cm</td>
</tr>
<tr>
<td>F</td>
<td>≥ 76 cm Top Diameter</td>
<td>14 cm</td>
</tr>
</tbody>
</table>

**Rot**

- Permitted provided 33 1/3% lumber is attained.

**Y Grade**

- Lower than X grade.
Cedar

**D GRADE**

**Logs**
- Minimum top diameter: 60 cm.
- Minimum length: 5 m.
- Minimum percentage lumber: 75% OR
- $\geq 120$ cm Top Diameter: $66 \frac{2}{3} \%$
- Minimum percentage clear lumber: 50%
- Maximum twist over 30 cm of length: 4% Max. deviation 6 cm.

**Slabs**
- Minimum top diameter: 50 cm.
- Minimum thickness: 38 cm.
- Minimum length: 5 m.
- Minimum percentage lumber: 75%
- Minimum percentage clear lumber: 50%
- Maximum twist over 30 cm of length: 4% Max. deviation 6 cm.

**Grade Requirements**

**Knots**

A. $60 - 74$ cm top diameter, $\geq 75\%$ 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.

B. $\geq 76$ cm top diameter, $\geq 66 \frac{2}{3}\%$ surface clear, with well spaced knots or knot indicators permitted on the upper $33 \frac{1}{3}\%$ of one side OR on the upper $66 \frac{2}{3}\%$ of one side of the log length only.

**Note:** Surface clear applies to small knots or knot indicators only, which by their nature are an indication of shallowness and as such does not preclude the grading of a log with one or two large knots lower down the log on large diameter logs.
Rot
A. No powder worm permitted.
B. Rot permitted provided percentage lumber is met.

F GRADE

Logs
Minimum top diameter 50 cm.
Minimum length 5 m.
Minimum percentage lumber 75%
Minimum percentage clear 25%
Maximum twist over 30 cm of length 4%
Max. deviation 6 cm.

Slabs
Minimum top diameter 50 cm.
Minimum length 5 m.
Minimum thickness 38 cm
Minimum percentage lumber 75%
Minimum percentage clear 25%
Maximum twist over 30 cm of length 4%
Max. deviation 6 cm.

Grade Requirements

Knots
A. 50-58 cm top diameter, must be surface clear of knots or knot indicators.

B. 60-74 cm top diameter, 66 2/3% surface clear with well spaced knots or knot indicators permitted on the upper 33 1/3% of two sides or on the upper 66 2/3% of one side of the log length only.

C. ≥ 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
A. No powder worm permitted.
B. Permitted provided 75% lumber is attained.

H GRADE
Minimum top diameter 38 cm.
Minimum length 5 m.
Minimum percentage lumber 75%
Minimum percentage clear 65%
Maximum twist over 30 cm of length 7% Max. deviation 8 cm.

Grade Requirements
Knots
A. 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.
B. ≥ 50 cm top diameter:
   - 4 cm knots over the entire log OR
   - 5 cm knots over the upper $\frac{2}{3}$% 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.

Rot
A. No powder worm permitted.
B. Rot permitted provided 75% lumber is attained.

I GRADE
Minimum top diameter 38 cm.
Minimum log length 5 m.
- Logs ≥ 4 m in length
- Top Diameter ≥ 38 cm. 75% lumber,
Cedar

Logs ≥ 10 m in length
- Top Diameter ≥ 50 cm.

Logs ≥ 10 m in length
- Top Diameter ≥ 38 cm.
- Otherwise H Grade.

Maximum twist over 30 cm of length
10%
Max. deviation 9 cm

Grade Requirements

Knots
A. 38 - 48 cm top diameter
8 cm.
B. 50 - 74 cm top diameter
9 cm.
C. ≥ 76 cm top diameter
10 cm.

Rot
Permitted provided percentage lumber is attained.

J Grade

Minimum top diameter
16 cm.*

Minimum log length
5 m.

Maximum top diameter
36 cm

Minimum lumber percentage
75%

Minimum merchantable percentage
50%

Maximum twist over 30 cm of length
10% of top diameter.

Grade Requirements

Knots
A. 15 - 26 cm top diameter
4 cm.
B. 28 - 36 cm top diameter
6 cm.

Rot
Permitted provided 75% lumber is attained.
K GRADE

Logs
Minimum top diameter 50 cm.
Minimum log length 4 m.
Minimum percentage shingle or shakes 75%
Minimum percentage clear shingle or shakes 25%
Maximum twist over 30 cm of length 4%
Max. deviation 6 cm.

Slabs
Minimum top diameter 50 cm.
Minimum thickness 38 cm.
Minimum log length 4 m.
Minimum percentage shingle or shakes 75%
Minimum percentage clear shingle or shakes 25%
Maximum twist over 30 cm of length 4%
Max. deviation 6 cm.

Grade Requirements

Knots
A. 50-58 cm top diameter, must be surface clear of knots or knot indicators.
B. 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.
C. ≥ 76 cm top diameter, ≥ 66 \(\frac{2}{3}\) % surface clear with knots or knot indicators permitted on the upper 33 \(\frac{2}{3}\) % of two sides or the upper 66 \(\frac{2}{3}\) % of one side of the log length only.

Rot
A. No powder worm permitted
B. Rot permitted provided 75% lumber is attained.

Note:
"D" quality logs with < 75% lumber (≥ 120 cm top diam < 66 2/3 % lumber) become K shingle.

**L GRADE**

**Logs**
- Minimum top diameter: 38 cm.
- Minimum log length: 4 m.
- Minimum percentage shingle or shakes: 50%
- Minimum percentage clear shingle or shakes: 50%
- Maximum twist over 30 cm of length: 7%
  - Max. deviation 8 cm.

**Slabs**
- Minimum top diameter: 38 cm.
- Minimum thickness: 26 cm.
- Minimum log length: 4 m.
- Minimum percentage clear shingle or shakes: 50%
- Maximum twist over 30 cm of length: 7%
  - Max. deviation 8 cm.

**Grade Requirements**

**Knots**
- A. ≥ 50% surface clear, with knots permitted on the upper 50% of two sides or all of one side of the log length only.

**Rot**
- A. No powder worm permitted.
- B. Rot permitted provided 50% lumber is attained.

**Note:**
"F" quality logs < 75% lumber become L shingle.

**M GRADE**

**Logs**
- Minimum top diameter: 38 cm.
- Minimum log length: 4 m.
- Minimum percentage shingles: 50%
- Minimum percentage clear shingles: 25%
Cedar

Maximum twist over 30 cm of length 7%
Max. deviation 8 cm.

Slabs
Minimum top diameter 38 cm.
Minimum thickness 16 cm
Minimum log length 4 m.
Minimum percentage shingles 50%
Minimum percentage clear shingles 25%
Maximum twist over 30 cm of length 7%
Max. deviation 8 cm.

Grade Requirements

Knots
A. \( \geq 25\% \) surface clear.

Rot
A. No powder worm permitted.
B. Rot permitted provided 50% lumber is attained.

U Grade
Minimum top diameter 10 cm.*
Minimum log length 5 m.
Minimum lumber percentage - 10 - 14 cm Top Diameter 75%
- 16 - 36 cm Top Diameter 66 \( \frac{2}{3} \)%
- \( \geq 38 \) cm Top Diameter 50%
Minimum merchantable percentage 35%
Maximum twist over 30 cm of length 13%
Max. deviation 13 cm.

Knots
A. 10 - 14 cm Top Diameter 4 cm
B. 16 - 26 cm Top Diameter 6 cm
C. 28 - 36 cm Top Diameter 8 cm
D. 38 - 48 cm Top Diameter 10 cm
E. 50 - 74 cm Top Diameter 12 cm
**Cedar**

F. ≥ 76 cm Top Diameter 14 cm

Rot
- Permitted provided percentage lumber is attained.

**X Grade**

Minimum top diameter 10 cm.*
Minimum log length 3 m.
Minimum lumber percentage 33 \(\frac{1}{3}\) %
Minimum merchantable percentage 35%
Maximum twist over 30 cm of length 13%
Max. deviation 13 cm

**Knots**

A. 10 - 14 cm Top Diameter 4 cm
B. 16 - 26 cm Top Diameter 6 cm
C. 28 - 36 cm Top Diameter 8 cm
D. 38 - 48 cm Top Diameter 10 cm
E. 50 - 74 cm Top Diameter 12 cm
F. ≥ 76 cm Top Diameter 14 cm

Rot
Permitted provided 33 \(\frac{1}{3}\) % lumber is attained.

* Log length code "99" will allow computer estimation of 15 cm, etc.
i.e.: J, U, X and Y grade can be a "0" top diameter.

**Y Grade**

- Lower than X grade.
**Hemlock and Balsam**

### D Grade

- Minimum top diameter: 66 cm.
- Minimum log length: 5 m.
- Minimum percentage lumber: 75%
- Minimum percentage clear: 50%
- Minimum No. of rings per cm of radius: 6
- Maximum twist over 30 cm of length: 4%
- Max. deviation: 6 cm.

**Grade Requirements**

**Knots**

A. 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.

B. ≥ 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**

A. No conk of blind conk permitted.

B. Rot permitted provided 75% lumber is attained.

### F Grade

- Minimum top diameter: 50 cm.
- Minimum log length: 5 m.
- Minimum percentage lumber: 75%
- Minimum percentage clear lumber: 25%
- Minimum No. of rings per 2 cm of radius: 6
- Maximum twist over 30 cm of length: 4%
- Max. deviation: 6 cm.

**Grade Requirements**

**Knots**

A. 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.
Hemlock and Balsam

B. ≥ 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
A. No conk of blind conk permitted.
B. Rot permitted provided 75% lumber is attained.

H GRADE
Minimum top diameter 38 cm.
Minimum log length 5 m.
Logs ≥ 38 cm top diameter 75% Lumber
Logs ≥ 50 cm top diameter Former "D" or "F" grade
50% merchantable
50% lumber
50% clear
Minimum No. of Rings per 1 cm of radius 5
Maximum twist over 30 cm of length 7%
Max. deviation 9 cm.

Grade Requirements
Knots
A. 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

B. ≥ 50 cm top diameter:
   - 4 cm knots over the entire log OR
     - 5 cm knots over the upper 66 2/3% 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.

Rot
Permitted provided 75% lumber is attained.
### I Grade

Minimum top diameter 38 cm.
Minimum log length 4 m.
Logs ≥ 38 cm top diameter OR 75% Lumber
- OR 50% merchantable
Logs ≥ 38 cm top diameter Former "H" grade
- ≥ 50% lumber
- ≥ 50% merchantable
Maximum twist over 30 cm of length 10%
Max. deviation 9 cm.

#### Grade Requirements

**Knots**

A. 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.

B. ≥ 50 cm top diameter:
   - 4 cm knots over the entire log OR
   - 5 cm knots over the upper 66 2/3% 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.

**Rot**
Permitted provided percentage lumber is attained.

### J Grade

Minimum top diameter 16 cm.*
Minimum log length 5 m.
Maximum top diameter 36 cm
Minimum lumber percentage 75%
Minimum merchantable percentage 50%
Maximum twist over 30 cm of length 10% of top diameter.
Hemlock and Balsam

Grade Requirements

Knots
A. 15 - 26 cm top diameter 4 cm.
B. 28 - 36 cm top diameter 6 cm.

Rot
Permitted provided 75% lumber is attained.

U GRADE

Minimum top diameter 10 cm.*
Minimum log length 5 m.
Minimum lumber percentage:
- 10 - 14 cm Top Diameter 75%
- 16 - 36 cm Top Diameter 66 2/3%
- ≥/ 38 cm Top Diameter 50%
Minimum merchantable percentage 35%
Maximum twist over 30 cm of length 13%
Max. deviation 13 cm.

Grade Requirements

Knots
A 10 - 14 cm Top Diameter 4 cm
B 16 - 26 cm Top Diameter 6 cm
C 28 - 36 cm Top Diameter 8 cm
D 38 - 48 cm Top Diameter 10 cm
E 50 - 74 cm Top Diameter 12 cm
F ≥ 76 cm Top Diameter 14 cm

Rot
Permitted provided percentage lumber is attained.
Hemlock and Balsam

**X GRADE**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum top diameter</td>
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<tr>
<td>Minimum log length</td>
<td>3 m.</td>
</tr>
<tr>
<td>Minimum lumber percentage</td>
<td>33 1/3%</td>
</tr>
<tr>
<td>Minimum merchantable percentage</td>
<td>35%</td>
</tr>
<tr>
<td>Maximum twist over 30 cm of length</td>
<td>13%</td>
</tr>
<tr>
<td></td>
<td>Max. deviation 13 cm.</td>
</tr>
</tbody>
</table>

**Grade Requirements**

**Knots**

<table>
<thead>
<tr>
<th>Knot</th>
<th>Diameter</th>
<th>Maximum Permitted</th>
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<tbody>
<tr>
<td>A</td>
<td>10 - 14 cm</td>
<td>4 cm</td>
</tr>
<tr>
<td>B</td>
<td>16 - 26 cm</td>
<td>6 cm</td>
</tr>
<tr>
<td>C</td>
<td>28 - 36 cm</td>
<td>8 cm</td>
</tr>
<tr>
<td>D</td>
<td>38 - 48 cm</td>
<td>10 cm</td>
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<tr>
<td>E</td>
<td>50 - 74 cm</td>
<td>12 cm</td>
</tr>
<tr>
<td>F</td>
<td>≥ 76 cm</td>
<td>14 cm</td>
</tr>
</tbody>
</table>

Rot

Permitted provided 33 1/3% lumber is attained.

**Y GRADE**

Lower than X grade
**Cypress**

**D GRADE**
- Minimum top diameter: 60 cm.
- Minimum length: 4 m.
- Minimum percentage lumber: 75%
- Minimum percentage clear: 50%
- Maximum twist over 30 cm of length: 4%
  - Max. deviation: 6 cm.

**Grade Requirements**

**Knots**
- A. 50-74 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.
- B. ≥ 76 cm top diameter, ≥ 66 2/3 % surface clear with knots or knot indicators permitted on the upper 33 1/3 % of two sides or the upper 66 2/3 % of one side of the log length only.

**Rot**
- Permitted provided 75% lumber is attained.

**F GRADE**
- Minimum top diameter: 50 cm.
- Logs ≥ 50 cm top diameter:
  - Minimum Log Length: 4 m
  - Minimum Lumber %: 75%
  - Minimum Clear %: 25%
- Former "D" Grade
- Logs ≥ 60 m top diameter:
  - Minimum Log Length: 6 m
  - Minimum % Lumber: 50%
  - Minimum % Clear: 50%
  - Maximum twist over 30 cm of length: 4%
  - Max. deviation: 6 cm.
Cypress

Grade Requirements

Knots
A. 50-58 cm top diameter, \geq 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.
B. \geq 60 cm top diameter, \geq 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
Minimum top diameter \hspace{1cm} 38 cm.
Minimum length \hspace{1cm} 4 m.
Minimum percentage lumber \hspace{1cm} 50\%
Minimum percentage clear \hspace{1cm} 65\%
Maximum twist over 30 cm of length \hspace{1cm} 7\% Max. deviation 8 cm.

Grade Requirements

Knots
A. 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 \leq 2 cm in diameter permitted over the lower 50\% of the log.
B. \geq 50 cm top diameter:
   - 4 cm knots over the entire log OR
   - 5 cm knots over the upper 66 2/3\% of the log OR
   - 8 cm knots over the upper 50\% of the log with knots \leq 2 cm in diameter permitted over the lower portion of the log.

Rot
- Permitted provided 50\% lumber is attained.

I GRADE
Minimum top diameter \hspace{1cm} 38 cm.
Minimum log length \hspace{1cm} 4 m.
Minimum percentage lumber \hspace{1cm} 50\%
Minimum percentage clear \hspace{1cm} 50\%
Maximum twist over 30 cm of length \hspace{1cm} 10\%
Cypress

Max. deviation 9 cm.

Grade Requirements

Knots
A. 38 - 48 cm top diameter 8 cm.
B. 50 - 74 cm top diameter 9 cm.
C. ≥ 76 cm top diameter 10 cm.

Rot
- Permitted provided 50% lumber is attained.

J Grade

Minimum top diameter 16 cm.*
Maximum top diameter 36 cm.
Minimum log length 4 m
Minimum percentage lumber 75%
Minimum percentage merchantable 50%
Maximum twist over 30 cm of length 10%

Grade Requirements

Knots
A. 15 - 26 cm top diameter 4 cm.
B. 28 - 36 cm top diameter 6 cm.

Rot
- Permitted provided 75% lumber is attained.

U Grade

Minimum top diameter 10 cm.*
Minimum log length 5 m.
Minimum lumber percentage:
- 10 - 14 cm Top Diameter 75%
- 16 - 36 cm Top Diameter 66 2/3 %
- ≥ 38 cm Top Diameter 50%
Minimum merchantable percentage 35%
Maximum twist over 30 cm of length 13%
Max. deviation 13 cm.

Grade Requirements

Knots
A. 10 - 14 cm Top Diameter 4 cm
B. 16 - 26 cm Top Diameter 6 cm
**Cypress**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Top Diameter Range</th>
<th>Top Diameter</th>
<th>Log Length</th>
<th>Lumber Percentage</th>
<th>Merchantable Percentage</th>
<th>Twist Over 30 cm of Length</th>
<th>Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>28 - 36 cm</td>
<td>8 cm</td>
<td>3 m</td>
<td>33 ⅓%</td>
<td>35%</td>
<td>13%</td>
<td>13 cm</td>
</tr>
<tr>
<td>D</td>
<td>38 - 48 cm</td>
<td>10 cm</td>
<td>3 m</td>
<td>33 ⅓%</td>
<td>35%</td>
<td>13%</td>
<td>13 cm</td>
</tr>
<tr>
<td>E</td>
<td>50 - 74 cm</td>
<td>12 cm</td>
<td>3 m</td>
<td>33 ⅓%</td>
<td>35%</td>
<td>13%</td>
<td>13 cm</td>
</tr>
<tr>
<td>F</td>
<td>≥ 76 cm</td>
<td>14 cm</td>
<td>3 m</td>
<td>33 ⅓%</td>
<td>35%</td>
<td>13%</td>
<td>13 cm</td>
</tr>
</tbody>
</table>

**X Grade Requirements**

- Minimum top diameter: 10 cm
- Minimum log length: 3 m
- Minimum lumber percentage: 33 ⅓%
- Minimum merchantable percentage: 35%
- Maximum twist over 30 cm of length: 13%
- Max. deviation: 13 cm

**Y Grade**

- Lower than X grade.
- Permitted provided percentage lumber is attained.
Deciduous

C GRADE

- Minimum top diameter 25 cm.
- Minimum log length 5 m.
- Minimum percentage Veneer 80%
- Maximum twist over 30 cm of length 7%
  Max. deviation 8 cm.

Grade Requirements

Knots
- A. No knots over 4 cm in diameter are permitted.
- B. Knots < 4 cm in diameter must be well spaced.

Rot
- A. No conk allowed.
- B. No butt rot allowed.

Misc.
- A. No sweep permitted.
- B. No crook permitted.

I GRADE

- Minimum top diameter 25 cm.
- Minimum log length 5 m.
- Minimum percentage lumber 50%
- Minimum percentage merchantable 50%
- Maximum twist over 30 cm of length 10%
  Max. deviation 9 cm.

Grade Requirements

Knots
- A 25 - 36 cm top diameter 4 cm
- B 36 - 48 cm top diameter 6 cm
- C 50 - 74 cm top diameter 8 cm
- D 76 - 98 cm top diameter 10 cm

Rot
- Permitted provided 50% lumber is attained.

J GRADE

- Minimum top diameter 16 cm.*
- Maximum top diameter 36 cm.
- Minimum log length 4 m
## Deciduous

Minimum percentage lumber: 75%
Minimum percentage merchantable: 50%
Maximum twist over 30 cm of length: 10%

### Grade Requirements

#### Knots

| A | 15 - 26 cm top diameter | 4 cm |
| B | 28 - 36 cm top diameter | 6 cm |

#### Rot
- Permitted provided 75% lumber is attained.

### U Grade

Minimum top diameter: 10 cm.*
Minimum log length: 5 m.
Logs 10 - 14 cm top diameter: 75% Lumber

15 - 36 cm top diameter: 66 2/3 Lumber

≥ 38 cm top diameter: 50% Lumber

Minimum merchantable percentage: 35%
Maximum twist over 30 cm of length: 13

Max. deviation 13 cm.

### Grade Requirements

#### Knots

| A | 10 - 14 cm Top Diameter | 4 cm |
| B | 16 - 26 cm Top Diameter | 6 cm |
| C | 28 - 36 cm Top Diameter | 8 cm |
| D | 38 - 48 cm Top Diameter | 10 cm |
| E | 50 - 74 cm Top Diameter | 12 cm |
| F | ≥ 76 cm Top Diameter | 14 cm |

#### Rot
- Permitted provided percentage lumber is attained.

### Grade Y

- Lower than X grade.
Spruce

F GRADE

Minimum top diameter: 76 cm.
Minimum log length: 4 m.
Minimum percentage lumber: 75%
Minimum percentage clear lumber: 50%
Minimum No. of rings per 1 cm of radius: 6
Maximum twist over 30 cm of length: 4%
Max. deviation 6 cm.

Grade Requirements

Knots
A. 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
A. No conk, blink conk or pocket rot permitted.
B. Insect or worm holes must not penetrate the cambium.
C. Permitted provided 75% lumber is attained.

G GRADE

Minimum top diameter: 60 cm.
Minimum log length: 4 m.
Minimum percentage lumber: 75%
Minimum percentage clear lumber: 25%
Minimum No. of rings per 1 cm of radius: 6
Maximum twist over 30 cm of length: 4%
Max. deviation 6 cm.

Grade Requirements

Knots
A. 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.

B. ≥ 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.

C. ≥ 76 cm top diameter, with whorls of large knots spaced so that 75% of the log can be cut into clear 2.6 meter lengths.
Spruce

D. ≥ 100 cm top diameter with whorls of large knots spaced so that 50% of the log can be cut into clear 2.6 meter lengths.

Rot
A. No conk, blind conk or pocket rot permitted.
B. Insect or worm holes must not penetrate the cambium.
C. Rot permitted 75% lumber is attained.

H GRADE
Minimum top diameter 38 cm.
Minimum log length 4 m.
Logs ≥ 38 cm top diam ≥ 75% Lumber
≥ 65% merchantable
Logs ≥ 60 cm top diam Former "For G" grade
≥ 50% lumber
≥ 25% clear

Minimum No. of rings per 1 cm of diam 5
Maximum twist over 30 cm of length 7%
Max. deviation 8 cm.

Grade Requirements

Knots
A. 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.
B. ≥ 50 cm top diameter:
   - 4 cm knots over the entire log OR
   - 5 cm knots over the upper 66 2/3% 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.

Rot
A. Insect or worm holes must not penetrate the cambium.
B. Permitted provided percentage lumber is attained.

L GRADE
Minimum top diameter 38 cm.
Minimum log length 4 m.
Spruce

Logs ≥ 38 cm top diam  
≥ 75% Lumber  
≥ 65% merchantable

Logs ≥ 38 cm top diam  
Former "H" grade  
≥ 50% lumber

Logs ≥ 50 cm top diam-  
≥ 25% merchantable  
≥ 50% lumber

Maximum twist over 30 cm of length-  
≥ 50% merchantable  
Max. deviation 9 cm.

Grade Requirements

Knots

A. 38 - 48 cm top diameter  
8 cm.

B. 50 - 74 cm top diameter  
9 cm.

C. 76 - 98 cm top diameter  
10 cm

D. ≥ 100 cm top diameter  
13 cm

Rot

Permitted provided percentage lumber is attained.

J GRADE

Minimum top diameter  
16 cm.*

Maximum top diameter  
36 cm.

Minimum log length  
4 m

Minimum percentage lumber  
75%

Minimum percentage merchantable  
50%

Maximum twist over 30 cm of length  
10%

Grade Requirements

Knots

A. 15 - 26 cm top diameter  
4 cm.

B. 28 - 36 cm top diameter  
6 cm.

Rot

Permitted provided 75% lumber is attained.

U GRADE

Minimum top diameter  
10 cm.*

Minimum log length  
5 m.

Minimum lumber percentage:  
75%

- 10 - 14 cm Top Diameter
### Spruce

- 16 - 36 cm Top Diameter  
  - 66 2/3 %

- ≥ 38 cm Top Diameter  
  - 50% 

Minimum merchantable percentage  
- 35%

Maximum twist over 30 cm of length  
- Max. deviation 13 cm.

#### Grade Requirements

**Knots**

<table>
<thead>
<tr>
<th>Knots</th>
<th>10 - 14 cm Top Diameter</th>
<th>14 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4 cm</td>
<td></td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
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<td>10 cm</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>12 cm</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>14 cm</td>
<td></td>
</tr>
</tbody>
</table>

**Rot**

- Permitted provided percentage lumber is attained.

#### X Grade

Minimum top diameter  
- 10 cm.*

Minimum log length  
- 3 m.

Minimum lumber percentage  
- 33 2/3 %

Minimum merchantable percentage  
- 35% 

Maximum twist over 30 cm of length  
- Max. deviation 13 cm.

#### Grade Requirements

**Knots**

<table>
<thead>
<tr>
<th>Knots</th>
<th>10 - 14 cm Top Diameter</th>
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<tbody>
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<tr>
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<tr>
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<td>12 cm</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>14 cm</td>
<td></td>
</tr>
</tbody>
</table>

**Rot**

- Permitted provided 33 2/3 % lumber is attained.

#### Y Grade

- Lower than X grade
Vegetation Inventory

Chapter 9
Wildlife Tree Classification
Vegetation Inventory

Chapter 3

Wildlife Tree Classification
Wildlife Tree Classification

Basic premise

All trees are wildlife trees; these can be living or dead in various conditions or stages of decay. They provide present and/or future habitat for the conservation or enhancement of wildlife species, being used for nest cavities and platforms, nurseries, dens, roosts, hunting perches, foraging sites and display stations. Birds, mammals, amphibians and various invertebrates use wildlife trees and some species are highly dependent upon the specialized habitat provided by certain types of wildlife trees.

While knowledge of the numbers and sizes of live and dead trees permits interpretations regarding wildlife habitat suitability for a particular stand, the provision of more specific wildlife-related data for each tree sampled is much more useful. By also describing wildlife usage of individual trees it becomes possible to determine the selection preference of wildlife species for wildlife trees with certain characteristics.

Procedures

Sampling

All trees as selected for sampling in the variable radius plot (or 5.64 m fixed radius plot) are classified. The classification is used to describe their condition from which interpretations of actual or potential wildlife use can be made. Live trees may be healthy or have some crown defect, broken top, bole scar or decay. Dead trees in various stages of deterioration are classified according to a number of attributes which relate to the suitability of the tree for wildlife usage.
Classification

Each tree sampled is classified according to the following criteria and the appropriate code entered on the field form.

Visual Appearance

![Visual Appearance Codes for Wildlife Trees](image)

Crown condition

Tree crowns are assessed by examining the crown in relation to a normal live crown (lower crown loss due to self-pruning is not included).

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

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
1 - no decay
2 - probable limited internal decay and/or deformities
3 - wood essentially hard, limited decay
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
Lichen loading is assessed on the lowest 4.5 m of each tree (not the lowest 4.5 m of the crown, wherever that may be). A rating from 0 to 5 is assigned based on comparison with a set of photos.* A value of 0 is given when there are no lichens, whether it is a live tree with branches and foliage or a dead tree. At the present time there is no rating system to classify lichen abundance on the tree boles alone - just for the lower branches. If a tree has lichens but none are below the 4.5 m mark a rating of zero will be given.

Wildlife Tree Use

In cases where wildlife usage of sampled trees is observed, the following categories are recorded on the field form:

Feeding (Code F ___)
This involves birds and mammals:
- Pileated Woodpeckers excavate large rectangular holes
- Red-breasted and Yellow-bellied Sapsuckers drill horizontal patterns of sapwells


iii + 22 p.
- Three-toed and Black-backed Woodpeckers scale off bark to feed on insects
- Porcupines gnaw on large sections of bark (diagonal tooth marks are often apparent)
- Rabbits, Hares and Squirrels feed on the base of young trees (squarish "windows" or girdling at the base)
- Unidentified woodpecker, other bird or mammal feeding
- Squirrel cone caches

**Nesting (Code N __ )**

- Cavity nesters have perfectly round or oval holes:
  - Pileated Woodpeckers 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 bark
  - Some ducks, Owls and Squirrels (both Flying and others) nest in abandoned woodpecker holes.
  - The large platform-style stick nests of raptors and herons are usually easily visible and should be noted.

A tree with a cavity nest will have to be judiciously and safely struck to determine if the nest is indeed occupied. If a wildlife species responds and is seen or otherwise identified, the species presence on the plot should be noted in the comments section as per the "species codes," below.

**Marking (Code M __ )**

This includes claw marking by Grizzly or Black bears and antler rubbing by deer or elk.

**Denning (Code D __ )**

Evidence of denning by bears, squirrels, bats or other mammals (e.g. marten, fisher, raccoon)

**Perching (Code P __ )**

Perching use may be noted. These are often 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 found in the vicinity.
Species Codes

Where a positive identification can be made of the species using wildlife trees in the plot, the species codes assigned follow the six-digit codings found in "Describing Ecosystems in the Field." The first letter identifies the species as a mammal (M), bird (B), reptile (R) or amphibian (A) and the remaining four are formed from the first two letters of the genus and species names or common name in the case of birds. For example:

- M-LEAM  Mammal, Snowshoe Hare (*Lepus americanus*)
- B-BLGR  Bird, Blue Grouse
- R-THEL  Reptile, Western Garter Snake (*Thamnophis elegans*)
- A-BUBO  Amphibian, Western Toad (*Bufo borealis*)

Unidentified mammals are M-UNID, birds are B-UNID, reptiles R-UNID and unidentified amphibians are A-UNID. A partial identification such as a hawk, species unknown, would be B-HA.

These wildlife species codes are recorded in the comments section on the Ecological Description card. If a wildlife species is actually observed on the plot this should be noted in the comments section using the codes as described above. The purpose of the standardized coding is to allow researchers to scan the computerized notes to find specific sightings rather than reading through thousands of entries.
Forest Health

Damage Agent and Conditions

Basic Premise:
The Vegetation Inventory will sample for damage agents, symptoms and severity on individual trees to provide an assessment of forest health and sound wood volumes. The sample will identify the agent or agents that cause the damage, record the location of certain specific loss indicators and quantify the condition or severity of the damage.

Types of damage agents are: Abiotic, Disease, Insects, Treatments, Vegetation and Wildlife.

Loss Indicators signify the potential presence of decayed wood. The specific loss indicators (previously known as pathological indicators) measured are: Conks, Blind conks, Frost cracks, Scars, Crooks, Forks, Broken tops, Dead tops and Large rotten branches.

The damage agent, severity and loss indicator information will be used to determine:

- damage agent related causes of tree and stand growth reduction, mortality, and species succession;
- assessments of incidence and extent of the damage agents conditions;
- derivation of relationships between vegetation (forest) cover and damage agent conditions, for example, resulting in a BEC-forest cover hazard and risk rating;
- forest level yield projection and planning procedures (e.g., stratification of data by damage type, damage intensity or damage risk class);
- estimation of sound (undecayed) wood volume as determined through the net factoring and hidden defect processes.

The measurement and description of loss indicators will be conducted using the current descriptions for pathological indicators of decay where applicable. The objective is to maintain a system which is compatible with the current and past inventories but also meets the needs of the future.
Procedures for identification of damage agents and severity rating:

- Damage agent(s) or conditions, and damage severity (ies) are assessed on individual trees. These conditions are assessed on the main plot. Stumps in the 2.5 metre fixed radius plot are also assigned a damage code for root diseases.

- The cruiser will identify damage agents and conditions using the *Field Guide To Pests of Managed Forests in British Columbia*, FRDA Joint Report Number 16, as a reference. The damage codes used to record incidence (listed separately) are hierarchical in nature and enable coding from very general damage agent type or category to the specific damage agent (species). For example, Armillaria root disease is coded "DRA": the first letter "D" denotes disease, the second "R" denotes Root rot, and the third letter "A" denotes Armillaria. If unable to identify that the tree has Armillaria root disease, but able to identify that it is a root disease then record "DR". If you cannot determine that it is a root disease but you are certain it is a disease (and not an insect or other damage agent) then record "D" for disease.

- Record and code the damage agent or condition under the Damage agent column using the Damage Agent and Condition Codes (following). Note: the codes include a set of damage symptoms for use when the causal agent is unknown but the damage symptoms are evident.

- Record and code the damage severity under the Severity column using the Damage Severity and Mortality Condition Standards (pp. 54-55).

Procedures for identification and measurement of Loss Indicators:

Certain damage agents have a greater impact on the volume of trees. More detailed measurements of the location, extent and frequency of these agents are recorded. If the tree has a number of the loss indicators the cruiser will rank the five most severe. The loss indicators that require these additional measurements are as follows.

1. **Loss Indicator Conk (D___):**

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

**Procedure:**

- Record the following:
  - species of conk
  - height from high side to the conk to nearest 0.1 metres
  - if multiple conks in one area of the stem record:
    - species of conk (should only be one species in each multiple occurrence)
    - height from high side to the lowest conk to nearest 0.1 metres
    - height from high side to the highest conk to nearest 0.1 metres
    - number of conks in the series, including the lowest and highest conk.

The loss indicator codes for the conks are hierarchical codes taken from the Forest Damage Agent and Condition Codes. The code identifies stem decay damage agents as DD. The species of the conk is then identified by a third character following the code DD. The codes for specific decays are:

- **DDE** *Echinodontium tinctorum* (rust-red stringy rot, or Indian paint fungus)
- **DDF** *Fomitopsis pinicola* (brown crumbly rot)
- **DDP** *Phellinus pini* (pini or red ring rot)
- **DDT** *Phellinus tremulae* (aspen trunk rot)
- **DDS** *Laetiporus sulphureus* (sulfur fungus)
- **DDA** *Ganoderma applanatum* (artists conk)
- **DDL** *Ganoderma tsugae* (lacquer conk)
- **DDB** *Fomes fomentarius* (birch trunk rot)
- **DDI** *Phellinus ignarius* (hardwood trunk rot)
- **DDQ** *Fomitopsis officinalis* (quinine conk)
- **DDC** *Portia sericeomollis* (cedar brown pocket rot)
- **DRS** *Phaedus Schweinitzii* (Schweinitzii buttrot)

*Note, if the species of conk is not known it is coded as CNK, not DD.*

2. **Loss Indicator - Blind Conk (BNK):**

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

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

Blind conks are identified as follows:

- **stem swellings and stem depressions** thought to be a result of the tree attempting to heal over decay emerging through a knot or branch stub;

- another indicator of the blind conk is found by chopping into basal branch stubs of trees; the decay will appear as a bright yellow to buff coloured material. This form is most often found in the interior of the province.

**Procedure:**

Record the following:

- The loss indicator code for blind conk (BNK)

For a single occurrence:

- height of blind conk to the nearest 0.1 metres measured from the high side.
  - the frequency is recorded as 1.

- If multiple blind conks in one area of the stem record:
  - height from high side to the lowest blind conk
  - height from high side to the highest blind conk
  - number of blind conks in the series, including the lowest and highest blind conk.

3. **Loss Indicator - Frost Crack (AFC):**

Frost cracks result from deep radial splitting of the trunk caused by uneven expansion of moisture in the tree after sudden and pronounced drops 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. In many instance the wound tends to spiral up the tree following the movement of moisture which occurs in a similar manner.

These cracks are often repeatedly opened by wind stresses or by low temperatures which freezes the moisture in the cracks and expands and splits the tree further.

Repeated healing of the cambium produces pronounced callous tissue giving a ribbed appearance to the wound.
Procedure:

Record the following:

- The loss indicator code for Frost Crack (AFC)
- if individual frost crack record:
  - lowest extent measured from the high side (note: this may be a negative value)
  - upper extent measured from the high side.
  - the frequency is recorded as 1.
- if multiple frost cracks on one area of the stem record:
  - lowest extent of the lowest frost crack measured from the high side.
  - upper extent of the highest frost crack measured from the high side.
  - number of occurrences

4. Loss Indicator - Scar (SCA):

A scar is an injury caused by external forces which 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.

Procedure:

Record the following:

- The loss indicator code for scar (SCA)
- if an individual scar record:
  - bottom extent of the scar (note - this may be a negative number as the scar may extend lower than the ground level as measured for high side)
  - upper extent of the scar (note - there is no diameter limit as to describing the scar extent)
  - the frequency is recorded as 1.
- if multiple scars occur on one portion of the stem, record:
  - bottom extent of lowest scar measured from the high side
  - upper extent of highest scar measured from the high side
  - number of occurrences
5. Loss Indicator - Fork (FRK):
A fork is a result of damage to the leader of a tree which results in more than one branch (leaders) competing for apical dominance. The damage to the leader of the tree whether from external forces, physiological factors, or insect (defoliator, weevil) damage, exposes the stem to potential wood or decay fungi.

Some conditions are very similar to forks but are not considered as such:
- natural branching in deciduous tree species
- small sharply angled branches or spikes are not considered forks unless associated with a noticeable offset or diameter change at the location
- flattening of the tops of trees caused by wind or physiological conditions where no terminal leaders are evident
- candelabra branches in some coniferous species

Procedure:
Record the following:
- if the secondary leader is visible record the loss indicator code for fork (FRK), (no minimum size limit)
- record the location of forks to the 0.1 metres (the location of a fork is the divergence of the stems
- Note: the sources of forks have a bearing on the number of separate occurrences.
  a) distinct forks (record as separate occurrences)
  b) multiple forks within a reasonable range and a probable common cause (record the upper and lower occurrence and the number observed)

6. Loss Indicator - Crook (CRO):
A crook is caused by damage (mechanical, physiological or insect attack) to the leader of a tree. Crooks potentially expose the wood to decay fungi.

Crooks must meet the following conditions:
- the diameter of the main stem changes noticeably from it's normal taper to indicate that a injury has occurred.
- an offset of the stem which is severe enough to indicate that damage has occurred to the main stem.

Procedure:
Record the following:
• The loss indicator code for Crook (CRO)
• record the height of all Crooks measured from high side to the nearest 0.1 meters
  - the frequency is recorded as 1.
• if multiple crooks occur on a portion of the stem, record:
  - The height of the lowest crook measured from the high side.
  - The height of the uppermost crook measured from the high side.
  - The number of crooks from the lowest to uppermost.

7. Loss Indicator- Large Rotten Branches (LRB):
Large rotten branches are branches with a diameter inside bark greater than 10 cm. at the base. These branches have obvious signs of internal heart rot. The typical appearance is short, rotten branches which generally occur on overmature trees. These branches should not be confused with dead branches that have died through normal causes.

Procedure:
Record the following:
• The loss indicator code for Large Rotten Branches (LRB)
• if a singular occurrence record:
  - the height to the central point of the branch to the nearest 0.1 meters measured from the high side
• if multiple occurrences record:
  - the height to the central point of the branch of the lowest occurrence
  - the height to the central point of the branch of the upper occurrence
  - number of occurrences from the lowest to the highest

8. 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.

Procedure:
Record the following:
• The loss indicator code for Dead Top (DTP)
• record the location of the uppermost living branch (the remainder of the stem has no green needles or leaves within the growing season) to the nearest 0.1 meters measured from the high side

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9. 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, and mechanical damage from other falling trees, etc.

Record the following:

- The loss indicator code for Broken Top (BTP)
  
  - the measurement of the height to the break of the main stem to the nearest 0.1 meters measured from the high side
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<tr>
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<td>AK</td>
<td>fumekill</td>
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<td>AL</td>
<td>lighting</td>
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<td>road salt</td>
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<tr>
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<td>larch needle blight <em>Hypodermella laricis</em></td>
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<td>DFL</td>
<td>pine needle cast <em>Lophodermella concolor</em></td>
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<td>DFM</td>
<td>larch needle cast <em>Meria laricis</em></td>
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<td>fir-fireweed rust <em>Pucciniastrum epilobi</em></td>
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<td>Douglas-fir needle cast <em>Rhabdocline pseudotsugae</em></td>
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<td>cedar leaf blight <em>Didymascella thuina</em></td>
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<td>red band needle blight <em>Scirrhia pini</em></td>
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<td>siroccus tip blight <em>Siroccus stroblimus</em></td>
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<td><strong>LEADER OR BRANCH DIEBACK</strong></td>
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<tr>
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<td>dermea canker <em>Dermea pseudotsugae</em></td>
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<td>homopsis canker <em>Phomopsis lokoyae</em></td>
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<td>Sydowia (sclerophoma) tip dieback <em>Sclerophoma pithyophila</em></td>
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<td>aspen-poplar twig blight <em>Venturia spp.</em></td>
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<td>hemlock dwarf mistletoe <em>Arceuthobium tsugense</em></td>
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<td>lodgepole pine dwarf mistletoe <em>Arceuthodium laricis</em></td>
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<td>lodgepole pine dwarf mistletoe <em>Arceuthobium americanum</em></td>
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<tr>
<td>DR</td>
<td><strong>ROOT DISEASE</strong></td>
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<tr>
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<td>armillaria root disease <em>Armillaria ostoyae</em></td>
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<tr>
<td>DRB</td>
<td>black stain root disease <em>Leptographium wageneri</em></td>
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<tr>
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<td>laminated root rot, cedar strain <em>Phellinus weirii</em></td>
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<td>DRL</td>
<td>laminated root rot <em>Phellinus weirii</em></td>
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<td>annosus root disease <em>Heterobasidiom amosum</em></td>
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<td>DRR</td>
<td>rhizina root disease <em>Rhizina undulata</em></td>
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<td>schweinitzii butt rot <em>Phaeolus schweinitzii</em></td>
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<td>tomentosus root rot <em>Inonotus tomentosus</em></td>
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<tr>
<td>Field Codes</td>
<td>Description</td>
</tr>
<tr>
<td>-------------</td>
<td>-------------</td>
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<tr>
<td>DS</td>
<td>STEM DISEASE (BARK CANKERS &amp; RUSTS)</td>
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<td>atropellis canker <em>Atripellis piniphila</em></td>
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<tr>
<td>DSB</td>
<td>white pine blister rust <em>Cronartium ribicola</em></td>
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<tr>
<td>DSC</td>
<td>comandra blister rust <em>Cronartium comandrae</em></td>
</tr>
<tr>
<td>DSG</td>
<td>western gall rust <em>Endocronartium harknessii</em></td>
</tr>
</tbody>
</table>
| DSN         | aspen cankers (general):  
|             | *Hypoxylon mammatum*  
|             | *Cryptosphaeria populina*  
|             | *Nectria galligena*  
|             | *Ceratozystis fimbriata*  
|             | *Encoelia pruinosa*  
|             | *Cytospora chrysosperma* |
| DSS         | stalactiform blister rust *Cronartium coleosporioides* |
| DSX         | exploding canker of Douglas-fir and interior spruces |

### INSECTS

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<td>giant conifer aphid <em>Cnara spp.</em></td>
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<tr>
<td>IAG</td>
<td>Cooley spruce gall adelgid <em>Adelges cooleyi</em></td>
</tr>
<tr>
<td>IAS</td>
<td>green spruce aphid <em>Elatobium abietinum</em></td>
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<table>
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<td>western balsam bark beetle <em>Dryocetes confusus</em></td>
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<td>Douglas-fir beetle <em>Dendroctonus pseudotsugae</em></td>
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<td>IBI</td>
<td>engraver beetle <em>Ips spp.</em></td>
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<td>IBM</td>
<td>mountain pine beetle <em>Dendroctonus ponderosae</em></td>
</tr>
<tr>
<td>IBP</td>
<td>twig beetle and others <em>Pityogenes, Pityophthorus spp.</em></td>
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<td>spruce beetle <em>Dendroctonus rufipennis</em></td>
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<td>red turpentine beetle <em>Dendroctonus vales</em></td>
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<td>western pine beetle <em>Dendroctonus brevicomis</em></td>
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<td>larch casebearer <em>Coleophora laricella</em></td>
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<tr>
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<td>looper (deciduous) <em>Erannis vancouverensis</em></td>
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<td>eastern spruce budworm <em>Choristoneura fumiferana</em></td>
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<td>Field Codes</td>
<td>Description</td>
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<td><strong>DECOLLATORS (CONTINUED)</strong></td>
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## Table 10-2 - Damage Severity and Mortality Condition Standards

### Damage Severity and Mortality Condition Standards For Individual Trees in Vegetation Inventory Samples

(Also Used on Growth and Yield Permanent Sample Plots)

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<td></td>
<td>SO</td>
<td>Standing - Old dead</td>
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<td>WR</td>
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<td>WS</td>
<td>Windthrow - Soil Failure</td>
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<th>Damage/condition or agent</th>
<th>Severity code</th>
<th>Code description and classification¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defoliators, needle rusts and biigths (for general use) (Total crown rating scale; past and present attack)</td>
<td>Enter percent</td>
<td>Enter actual % (100% = _ _ )</td>
</tr>
<tr>
<td></td>
<td>defoliated</td>
<td>discoloured</td>
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<tr>
<td></td>
<td>or infected</td>
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<th>Damage/condition or agent</th>
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<th>Code description and classification¹</th>
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<tr>
<td>Terminal weevils</td>
<td>Enter no. of years of attacks (1-9)</td>
<td>1 to 9 attacks , and</td>
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<tr>
<td></td>
<td>N</td>
<td>Minor crook</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>Major crook</td>
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<tr>
<td></td>
<td>F</td>
<td>Forking</td>
</tr>
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<td>Staghead</td>
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<table>
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<th>Damage/condition or agent</th>
<th>Severity code</th>
<th>Code description and classification¹</th>
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<tr>
<td>Stem rusts</td>
<td>BC</td>
<td>Branch canker(s)</td>
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<td></td>
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<td>Stem Canker(s)</td>
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<td>TK</td>
<td>Top-kill</td>
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<th>Damage/condition or agent</th>
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<th>Code description and classification</th>
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<tbody>
<tr>
<td>Root rots</td>
<td>W5</td>
<td>Within 5 m of <em>A. xidoyae</em> infection source</td>
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<tr>
<td></td>
<td>LC</td>
<td>Light crown symptoms</td>
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<td>SC</td>
<td>Severe crown symptoms</td>
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<tr>
<td></td>
<td>RL</td>
<td>Basal resinosis (light) ≤ 50% circumference</td>
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<tr>
<td></td>
<td>RS</td>
<td>Basal resinosis (severe) &gt; 50% circumference</td>
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<tr>
<td></td>
<td>BR</td>
<td>Butt rot</td>
</tr>
<tr>
<td></td>
<td>CS</td>
<td>Confirmatory symptoms, stain, decay, mycelia, rhizomorphs, or sporophores</td>
</tr>
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| Dwarf mistletoes (Hawksworth's 6-class rating system) for all species and species | Enter one |
| Stem Swelling Defect classes for coastal western hemlock | N ≥ 1 minor stem swelling per tree |
|                                                            | M ≥ 1 major stem swelling per tree |

| Mammals, birds, and root collar weevil (girdlers) | Enter per cent girdled | Enter Actual % 100% = (- -) |

<table>
<thead>
<tr>
<th>Defoliators Western Spruce Budworm (current foliage only)</th>
<th>Enter per cent defoliated</th>
<th>Enter actual % 1-20% current year's foliage Bud and/or shoot destruction</th>
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</thead>
<tbody>
<tr>
<td>Defoliators Douglas-fir Tussock moth</td>
<td>Enter per cent defoliated</td>
<td>Enter actual % 100% = (- -)</td>
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**Table 10-3. FOREST DAMAGE AGENT RANK & PRIORITY FOR DAMAGE APPRAISAL & TREATMENT RESPONSE**

**Biogeoclimatic Zone**

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<td>DRA</td>
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**NB.**
1. Damage agent rankings are a 1st Approximation that are reviewed and revised periodically.
2. Stem decays (DD's) although a significant damage agent are assessed by the Inventory Branch, and are only shown here to provide a context for the rankings.
3. *Italicized* and *emboldened* damage agents indicate the top-ranking selections for the Pest Damage Appraisal Matrix (Table 1). The lowest rank is *underlined* indicating the cut-off for selection. Some damage agents have been skipped-over for several reasons: (a) they are well represented by other biogeoclimatic units, (b) the damage is on deciduous hosts, (c) more epidemiology of the damage agent is required before ranking can be done, or (d) the damage agents were not presently considered a significant impact by the subcommittee, but need further review for the 2nd Approximation of the Matrix.

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March 31, 1995
Vegetation Inventory

**DRAFT**
### Table 10-4: Forest Damage Agent Rank & Priority for Damage Appraisal & Treatment Response

**Based on Estimated Growth and Yield Impacts**

<table>
<thead>
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**NB:**
1. Damage agent rankings are a '1st Approximation' that are reviewed and revised periodically.
2. Stem decays (DD's) although significant damage agents are assessed by the Inventory Branch, and are only shown here to provide context for the rankings.
3. *Italicized* and emboldened damage agents indicate the top-ranking selections for the Past Damage Appraisal Matrix (Table 1). The lowest rank is *underlined* indicating the cut-off for selection. Some damage agents have been skipped over for several reasons: (a) they are well represented by other biogeoclimatic units, (b) the damage is on deciduous hosts, (c) more epidemiology of the damage agent is required before ranking can be done, or (d) the damage agents were not presently considered a significant impact by the subcommittee, but need further review for the 2nd Approximation of the Matrix.

---

**Sampling Procedures**

March 31, 1995

Forest Health

DRAFT
### Table 10-3: Forest Damage Agent Rank & Priority for Damage Appraisal & Treatment Response

**Based on Estimated Growth and Yield Impacts**

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<td>13</td>
</tr>
</tbody>
</table>

**NB:**
1. Damage agent rankings are a 1st Approximation that are reviewed and revised periodically.
2. Stem decays (DD's) although a significant damage agent are assessed by the Inventory Branch, and are only shown here to provide a context for the rankings.
3. *Italicized* and *emboldened* damage agents indicate the top-ranking selections for the Pest Damage Appraisal Matrix (Table 1). The lowest rank is underlined indicating the cut-off for selection. Some damage agents have been skipped-over for several reasons: (a) they are well represented by other biogeoclimatic units, (b) on deciduous hosts, (c) the damage agents were not presently considered a significant impact by the subcommittee, but need further review for the 2nd Approximation of the Matrix.
### Table 10-6: Forest Damage Agent Rank & Priority for Damage Appraisal & Treatment Response

**Based on Estimated Growth and Yield Impacts**

<table>
<thead>
<tr>
<th>Biogeoclimatic Zone</th>
<th>Late Mortality Damage Agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rank</td>
<td>BWBS</td>
</tr>
<tr>
<td>1</td>
<td>IBS</td>
</tr>
<tr>
<td>2</td>
<td>IBB</td>
</tr>
<tr>
<td>3</td>
<td>AW</td>
</tr>
<tr>
<td>4</td>
<td>SP</td>
</tr>
<tr>
<td>5</td>
<td>WP</td>
</tr>
<tr>
<td>6</td>
<td>IDL</td>
</tr>
<tr>
<td>7</td>
<td>DRB</td>
</tr>
</tbody>
</table>

**NB.**

1. Damage agent rankings are a 1st Approximation that are reviewed and revised periodically.
2. Stem decays (DD's) although a significant damage agent are assessed by the Inventory Branch, and are only shown here to provide a context for the rankings.
3. *Italicized* and *bolded* damage agents indicate the top-ranking selections for the Pest Damage Appraisal Matrix (Table 1). The lowest rank is *underlined* indicating the cut-off for selection. Some damage agents have been skipped-over for several reasons: (a) they are well represented by other biogeoclimatic units, (b) the damage is on deciduous hosts, (c) more epidemiology of the damage agent is required before ranking can be done, or (d) the damage agents were not presently considered a significant impact by the subcommittee, but need further review for the 2nd Approximation of the Matrix.
Vegetation Inventory

Chapter 11
Small Fixed Plot Measurement
2.5 m Plot
Vegetation Inventory

Chapter 1
Small Fixed Plot Measurement
2.5 m Plot
Fixed Plot Measurements for the Integrated Plot

Fixed Radius Plot - Small Trees

Basic Premise
A small diameter fixed radius plot will be established at all integrated plot locations. The purpose of this plot is to establish relative numbers of small live trees which are not effectively sampled by the variable radius plot or are less than 1.3 metres in height and therefore are not sampled by the variable radius plot. The plot size is kept small to maintain quality sample measurements.

Procedure
At the integrated plot centre establish a 2.5 metre fixed radius plot commencing from north and sweeping clockwise. The edge of this plot may be marked temporarily by the field crew to ensure accurate measurements.

a) Trees Less Than 2.0 cm
A tally of the number of trees by species in classes will be made as per the following table.

Example

<table>
<thead>
<tr>
<th>Species</th>
<th>0.1 m to 0.3 m Height</th>
<th>0.31 m to 1.3 m Height</th>
<th>1.3 m to 1.9 cm (Height)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cw</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Hw</td>
<td>9</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>Fdc</td>
<td>-</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Dr</td>
<td>3</td>
<td>11</td>
<td>1</td>
</tr>
</tbody>
</table>
The following trees are not tallied:

a) trees less than 10 cm (0.10 metres) in height
b) trees greater than 2.0 cm or greater at DBH
c) dead trees

Plots with Excessive Trees

In some instances the plot will contain numerous small stems, it is not necessary to tally all these stems. It is important to maintain accuracy therefore the plot may be split into halves or if necessary in quarters to decrease the effort in multiple measurements but meanwhile maintaining accuracy.

Procedure

The cruiser will estimate the number of stems to be tallied within the small tree plot. If the preliminary estimate indicates more than 50 trees are involved then the plot will be split as per the following:

a) **Even** plot number - measure East half
b) **odd** plot number - measure west half
   - record the plot as split "S"

If the number of trees in the split plot is still greater than 50 then this plot may be split again into a quarter plot as per the following:

a) **Even** plot number - NorthEast quadrant
b) **odd** plot number - southwest quadrant

Fixed Radius Plot - Stumps Measurement

Basic Premise

The vegetation inventory is attempting to sample the biomass of above ground vegetation both living and dead. The biomass in stumps less than 1.3 metres in height are not sampled by the variable radius plot; they are also not sampled in the coarse woody debris transects.

These stumps will be measured in the fixed radius plot.

Procedures

Sweeping in a clockwise direction from the north, record the following information for all stumps 2.0 cm or greater inside bark:

- species
- diameter inside bark
- length in metres (must be less than 1.3m)
- number of stumps (note - this will usually be a 1 but if numerous stumps are in the plot, such as spacing slash stumps record the number by average diameters)
- wildlife codes
  - assign a bark retention code
  - assign a wood condition code
- root rot species
  - if root rot is present record the damage agent species (if no root rot is found record a dash through the field on the card).

Stumps in upright position in the ground are measured (up to 45° tilted from the vertical).

\[
\text{Figure 11-1} \\
\text{Measurement Of "In" & "Out" Stumps}
\]

- in the example stump "A" is out and stump "B" is in.
measuring the height of broken stumps:
  - use the scaling convention to assess the height
  - fold in the broken section to determine height (see following example)

Direction - fold the volume at "A" to replace the missing volume at "B"

Figure 11-2
Measuring Heights Of Broken Stems

- the recorded height in this example is 1.1 metres
Vegetation Inventory

Chapter 12

Site Tree Measurements
Site Tree Measurement

Site Measurement

Top Height

Objective Selection of Top Height trees (Procedures from VIWG)
The intent is to have an objective way of choosing the tree to be measured. This method should lead to the same field results no matter who makes the selection. One of the advantages of such a system is that when regressions are done by researchers and later applied to site index calculations the trees chosen match the assumptions and data methods of the regression equations.

It is inevitable that these field procedures will overlook some special case, and the field crew will always have the option of including an extra measurement which they consider more appropriate, with a statement of why they consider it more appropriate. At the same time, they are expected to follow the standard procedure (if there is no safety hazard). In the long run, this will allow an actual comparison of the results in each case.

Purpose of Selecting Top Height Trees
For the most part, top height trees are chosen in order to calculate site index. Because of this, it would be best if they were chosen the same way as the data used in the site index equations. In fact, it is likely that the inventory will come before the site index equations are finalized, and the site index methods will probably follow the inventory procedures.

In order to allow future recomplilations with new equations the age and height of the top height trees will be kept. Individual site indexes will be computed for each tree, then averaged. This allows some indication of the statistical precision of the site index value.

Definition of Top Height
Top height is defined differently and somewhat loosely in various parts of the world. We have chosen to follow the British method. It is fairly widely accepted. The official definition as "the average height of the 100 largest
diameter trees per hectare" has many problems, and they have recognized this. Basically, there is no way to sample for this definition in the field.

Rather than change the definition itself, which would complicate the paperwork already done, they have bypassed the problem and simply standardized their field procedures on a 1/100 hectare plot, choosing the largest diameter tree. In BC we have chosen to adopt the same field procedure, but making the definition match the procedure. The Top Height is therefore defined as:

The average height of the largest diameter "suitable" tree on a non-empty 1/100 hectare plot.

If a tree does not exist on the plot, then no top height tree is chosen and the average is computed on the plots which do have trees.

The method allows us to sample for top height (and site index) on a fairly precise basis where trees large enough to give good results occur. Actually, it only works with the species which happens to be there, so we need procedures which give some indication of site index for other species. Research can do this, and to lesser extent it can be done by collecting multiple species data during the inventory.

The definition of "suitable" has been intentionally left somewhat vague, but generally it refers to a tree where the height-age relationship is expressed reasonably. While it might even allow dead trees, we choose to limit the measurement to live trees if they are present. Suitable trees are:

- Dominant or Codominant trees;
- Live;
- Without damage which significantly effects height growth;
- Of any species.

The idea of the "dominant species on the polygon" has been rejected for many reasons, but the most important reason is that the field measurement represents many polygons, and without looking at all of them we simply cannot know what the dominant species really is.

Field Technique
Establish a 1/100 hectare plot (5.64 metre radius), and choose the largest diameter tree. If this tree is not suitable for any of the reasons listed, check the next largest diameter until you find a suitable tree (if one exists). If none exist, that is quite acceptable. The reason for rejecting a potential tree can be recorded in the notes section.

If you strongly disagree with the tree selected, you can always measure an additional second tree, and record your reason on the plot card. In all cases, the tree chosen by the field procedure will be measured and recorded.
Measure the tree height and age at DBH by boring the tree. If the species permits it, by conspicuous whorls for instance, record the actual age as well. This will aid in developing DBH to Actual Age corrections.

When significant repress of growth has occurred at an early age, an attempt will also be made to estimate the "physiological age" of that tree by comparing the rate of later growth. This physiological age is considered a better indicator of site index.

**Second Species Top Height Tree**

In order to establish a data set which compares the site index of several trees which occur on the same area, a second species of top height tree will be taken on most inventories.

After the first top height tree has been chosen, ignore all trees of the same species as the top height tree already chosen and repeat the process for the remaining trees.

**Random Tree**

A random tree will be selected at each main (integrated) plot centre from the large tree plot. Height, age and growth characteristics will be measured on this tree. The selection will be determined by a random number provided to the field crew. The sample will provide data from throughout the stand profile.

**Crown Class**

Crown class is a ranking by height of a tree in relation to other trees in the stand.

D. Dominant
   - trees having crowns receiving full light from above and full to partial light from the side.

C. Codominant
   - trees having crowns receiving full light from above and comparatively little direct light from the sides.

I. Intermediate
   - trees having crowns below, but still extending into, the general level of the crown canopy and receiving little direct light from above but none from the sides.

S. Suppressed
   - trees having crowns below the general level of the crown canopy and receiving no direct light either from above or from the sides.
Age

Ages are an important measurement in cruising as it helps in determining the following:

- Site index;
- Rate of growth;

Age Sample Tree Selection

A top height, a second species top height as well as a random tree will be bored in each main plot to determine age. These trees should be alive and usually are dominant or codominant.

Age Measurement

All ages are bored from the standard 1.3 m above the high side. The age is determined by a ring count from an increment borer core.

The pith should be included in at least half the sample tree cores on each plot. In cases where the pith is not contained in the core and is missed by an estimated three years, the tree should be rebored.

In all cases, the height of the sample tree must be measured.

On large trees or trees that have rotten centers count the age of the sound portion and measure the length of sound core and calculate an average number of years per centimeter. Apply this average growth per centimeter to the remaining uncounted portion. Be careful to consider inside bark diameter only. Record in the notes section the dimensions measured.

Example

Tree #5 190 years in 26 cm

Bored age 320

Note: Age relationships can also be derived from actual stump counts if working near felled road right of ways or logging.

- In all cases actual age should be recorded
- record the actual age only, any adjustments for years to reach BH will be done in the office compilation.

Radial Increment

All trees counted for age will have radial increment measurements.

Boring will be taken facing plot centre at 1.3 m above the high side.

When it is not practical to take the increment in this direction, it will be taken at two points on opposite sides of the tree and averaged.
Record the radial increment in mm for five, ten and twenty years.

Physiological Age

If a sample tree for age measurement was suppressed in its early years, the unsuppressed (physiological) age is to be recorded for that tree. The unsuppressed age can be determined as follows:

- Calculate the rings per cm of the unsuppressed growth.
- Apply the rings per cm of the unsuppressed to the suppressed portion and calculate the age.
Physiological Age

Recent life history information is not for intervention and treatment planning. This point needs to be emphasized more strongly.

Intervention (physiological) age is to be considered for intervention. The next question is whether the age can be determined or follow:

- Clinical age
- Nongenetic age
- Natural age
- Genetic age

Any one of the above could be the appropriate intervention age.
Vegetation Inventory

Chapter 13
Measurements for the Auxiliary Plots
V egetation Inventory

Chapter 12

Measurements for the Auxillary Phase
Measurements for the Auxilliary Plots

Basic Premise
The auxilliary sampling points will be used to enhance the information collected on the main sampling points. The procedures applicable on the main sampling plot will be used in completing the auxilliary plot.

Procedures
a) Range Sampling
   - no data collection at this time
b) Ecological Sampling
   - no data collection at this time
c) Tree Measurements
The following data will be collected on a variable radius plot (or 5.64 m fixed plot):
   - tree numbers
   - tree species
   - tree diameter
   - percentage of bark remaining
   - estimated or measured diameter code

The following data will be collected on a fixed radius (5.64 metre) plot.
- top height tree
  - number, species, height, age & radial increment are recorded for this tree
Measurements for the Auxiliary Plate

Basic Procedure

The auxilliary auxiliary plate will be used to add or remove the instrument.

Collect the main study field data. The instrument equipment on the

more equipment life will be used to complete the auxiliary plate.

Investigations

(a) Water sampling

- no gate collection at this time

(b) Sedimentary Sampling

- no gate collection at this time

(c) Turbidity Measurements

- Turbidity

- Total Suspended

- Total Dissolved

- Water Temperature

- Particulate or Non-Turbulent

- Sludge or Residual Cations

- Estimate of Residual Cation levels

The following data will be collected on each sample (e.g. water) prior

- Samples stored

- Sample location, sample, age, and weight in cubic feet to be recorded

- Date received
Vegetation Inventory

Chapter 14
Ground Photo Collection
Vegetation Inventory

Chapter 14
Ground Photo Collection
Ground Photo Collection

Basic Premise
A series of ground photos using 35 mm or equivalent cameras will be taken at each main sample point. These will be available as a digital data base for review by individuals for:

- plot relocation
- initial plot assessment by potential users who may desire to sub-sample on these locations.

Procedure
At the current time a minimum of three sample photos are taken at each main(integrated) plot location. There are no photos being taken at the auxiliary plots. The three photos are as follows:

- sample plot centre pin (main plot)
- photo on random bearing transect line for Range and CWD measurements
- representative shot at the crews discretion

- do not cut trees or vegetation to provide an unobstructed view
- in some instances it will be best to take the photo prior to sample measurements if the site may be damaged during sampling
- photograph the plot centre pin at a step angle (about 60°) above the pin showing the pin and the ground for approximately one metre or more around the pin
- include a marker with a recorded plot number
• photograph the random bearing transect from a position behind plot centre
• include the plot centre pin in the foreground
• include the measuring tape or other items for relative scale determination
• try to include the various crown levels by means of portrait format if required
- photograph a portion of the plot which the individual considers representative of the sample
- if possible the sample plot centre and an item for scale should be included in the photo

Photos of other items of concern can be taken as appropriate.

It is suggested that the following equipment be used:

- 35 mm cameras with 28 mm or 35 mm lens preferred (if a zoom lens work in the 28 to 35 mm range)
- would prefer 100 ASA slide films (200 ASA is acceptable)
- Fuji film types are recommended for forest stand conditions
Vegetation Inventory

Chapter 15
Check Cruising In the Vegetation Inventory
Vegetation Inventory

Chapter 16

Vegetation Utilization in the Vegetation Inventory
Check Cruising in the Vegetation Inventory

Check cruising has 3 major purposes:

1) **Error rate** - A reasonable question in an inventory is "how reliably were individual components measured or estimated". This kind of information might be critical to researchers using the data, and is always of interest to the inventory organization. In addition, the normal error rate of experienced individuals can be used to set the requirements or "standards" for individual field measurements.

2) **Training** - For improving the accuracy of field work it would be useful to know what items need more attention.

3) **Work Approval & Payment** - The payment for contract work should contain specific requirements for accuracy. If these are not met, some form of penalty would likely be imposed.

These are different objectives, requiring different kinds of attitudes and qualifications by the check cruisers.

1) **Error rate** - The output of this error data would be a histogram showing the frequency of errors of particular magnitudes (or an error matrix, in the case of categorical errors like species). In addition, we would be interested in the error of the average of these measurements.

There are two issues here:

a) **What is the difference between reasonably qualified crews doing this work on a regular basis?**

In other words "what are the disagreements due to individual differences of the people doing the work (regardless of what is "right")". This is a classic question of "repeatability". It could be answered by insuring that several crews measure the sample plot information. One way to do this is to have the crews on the inventory measure a single plot, as time permits, during the inventory. A plot located in an area where they drive past anyway, with the trees already marked, would minimize time spent. If it was explained that "better work" would just tighten
the future standards, and "worse work" would make it easy for
their competition to qualify then I believe that most crews would
perform the work in their normal way. In addition, I would not
record the names of the crews on these data sheets, as another
incentive to do no more typical work. The remaining objection
would always be that the crew routine was non-typical, compared
to an actual plot, and that time pressures and fatigue would not be
properly simulated.

If there is a serious concern that this method will not give typical
results, then perhaps the most reasonable way to get this
individual item information is to compare it to check cruise
measurements. This assumes that the check cruiser is not more or
less accurate than the average crew member in making
measurements, even though it is assumed that he is better at
following the procedural rules. This is "free data", in the sense
that check cruising must be done anyway, simply requiring that
the data be compared and analyzed.

b) What is the difference in crew work vs. "correct"
measurements?

This requires that the measurements be much more carefully
performed, and that some effort is expended to find the cause of
any error. For example, it is one thing to say that "diameters were
accurate within ± .3 cm" when the check is made at the same
point on the tree vs. the situation where DBH was judged
differently by the check cruiser and diameter was measured at a
different point.

This kind of comparison to "true" values is probably not necessary
for individual measurements, and if it ever becomes necessary it
should be done as a special project performed on an inventory in
progress. It is obviously not possible to carry out this work
several years later after trees have grown. This requires a higher
level of competency in check cruisers, and should probably be left
to researchers with specific interests.

The Vegetation Inventory should concentrate on question (a), and
obtain this data from check cruisers.

2) Training - the objective here is to identify errors in the field, either in
measurement technique or interpretation of the rules.

This feedback is to individuals, and must be quickly delivered. There
should be an obvious distinction between the situation where basic
quality control and the psychology of field work require an overall
attitude of careful and complete work (and future research might use
the data) and the situation where immediately useful information is
compromised. An example is diameter in Variable Plot sampling. It is mainly used to calculate tree volume, and an error may have no influence on stand volume, which is of immediate concern. It would not be critical, therefore, if an individual tree diameter were badly measured. On the other hand, this data may be used for future research in some situation where diameters are much more important, and we do not want to foster an attitude of sloppy work.

It is desirable to give the field crew an appreciation for both situations, but perhaps it is also important to make the distinctions between errors in intermediate measurements and errors in the final products which are known to be of importance. We want the field crew to focus their time and concentration of items known to be of importance.

As a field aid, we should attempt to put any of this information possible on portable computers, so that the differences in the results of measurements can be seen on the spot. If this was available to contractors then perhaps they might use this to determine the result of measurement differences and help to determine where the most time and effort should be spent in the field. This could immediately be done for tree volume and value, and probably for site index information as well. In addition, such programs might be valuable to the initial training process.

**I believe that this information should be quickly delivered to the crews doing the work, based on the check cruisers measurements of the plots.**

Since this is a training issue, it should involve visiting the plot with the measurement crew whenever possible. This offers an opportunity to discover and correct inappropriate, inefficient or poorly explained procedures in the Vegetation Inventory process. In addition, it provides an opportunity to repeat the explanations of underlying concepts to the field crews.

When reporting a group of measurements, such as the Variable Plot data or soil data, the complete set should be done, so that the full set of measurements is available for comparison and to establish the error rate. The tendency of past checks, to simply look at a few examples for unacceptable errors, should not be continued.

**Work Approval & Payment** - the objective here is a formal process which allows or withholds payment and insures that contracts are enforced.

In this case, we should take guidance from the scaling community. Scalers long ago realized that concentrating on individual measurements was not fruitful for "pass/fail" situations, and based the
rejection of a scale on the total result of many measurements. Too much attention to individual measurements causes a proliferation of rules and often a loss of perspective.

In the tree measurement criteria, there are several variables of primary importance or which summarize a variety of measurements. In terms of future stand projections, site index is an obvious item. Gross Volume will reflect the selection and basic measurements for sample trees. Net value will combine defect reductions, species errors and grade differences. There are summary items like this in the ecological data sets which can be evaluated.

In addition, there will be a number of individual items of probably interest to the research community. In these cases, the performance of well trained crews should be used to specify an unacceptable error rate for field work. In the case of poorly located plots (due to navigation errors) the check cruiser should be allowed the discretion to use the measurements on the properly placed plot as the comparison values.

In the case of "acceptance/rejection" criteria, we should base the decision on site index, gross volume, net value and the basic ecological data sets from a number of plots combined. In addition, maximum error rates should be set for a minimal number of specific measurements.

Individual errors might compensate and allow acceptance in this scheme. They should be considered as training issues and reported to the contractor as such.

The output from these programs will provide the information necessary to report error rates of measurements, set standards, and improve training of field crews.