Chapter 2

Remeasuring Permanent Samples in Natural Stands – April 1996

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Introduction

Samples in natural stands are remeasured every ten years. This interval should be maintained whenever possible. A list of samples with their establishment and remeasurement dates and map locations is regularly circulated to the regions so that remeasurement can be planned in advance.

The standards of measurement for permanent samples are listed in Appendix 1.

If not already done, ecologically classify, according to Research Branch specifications, all samples due for remeasurement.

Since permanent samples are cost intensive, protecting them is of the utmost importance. To ensure their protection, the protection buffers illustrated in Appendix 19 are recommended.

Preparing for Field Work

Before field work starts, prepare and collect:

Copies of the original field sheets. If the previous measurements were recorded in imperial units, convert measurements to the metric equivalents for diameter and height.

Maps to show you how to get to the sample – example, 1:250 000 contour maps – and photocopies of parts of forest cover maps, which have an approximate scale of 1:20 000 and show the plot’s location in detail.

Photos showing original tie points, either those used when the sample was established, or, preferably, the latest photos on which tie points and sample locations were replotted.

Equipment. See Appendix 4 for the equipment needed.

Field Training

All personnel involved in remeasurement work must attend a brief field procedures course.
Relocating the Plot

Checking Location and Access

The notes on the location of the plot and access to the plot usually begin with a description of an easily identifiable point.

1. Follow the access notes to the tie point.
2. Correct the notes where necessary.

The reference or tie point generally is a prominent topographic feature distinguishable on the photos and on the ground. **Examples:** a road junction, road bend, creek junction or bridge.

The blazed and painted tie tree should be located nearby, as described in the access notes. Aluminum sample markers are usually nailed to the tie tree, and strands of plastic flagging tape should still be noticeable on or near the tree.

The aluminum marker contains pertinent sample information such as:
- region number
- compartment number
- sample type (G)
- sample number and plot number (usually 1, but 3-plot samples exist)
- bearing and distance to the plot centre
- date sample was established.

For more information on sample markers, see Appendix 5.
New Tie Point Needed

If a new tie point is needed:
1. Select a new tie point recognizable on the photos and the ground.
2. From the map, measure and record the new bearing and distance to the plot centre.
3. Paint both sides of the tie tree in the direction of the tie line.
4. Nail an aluminum sample marker above the paint.
5. Inscribe the pertinent information on the middle and bottom sections of the 2 markers. 
   Note: “Date” on the marker always refers to the date the sample was originally established. See Appendix 5.
6. Flag the tie tree with two strands of flagging tape, one above and one below the markers.
7. To aid future measurement crews, prepare a sketch showing the tie point, the sample location, and other significant topographic features. Attach the sketch to the access notes.

If you establish a new tie point, you must run a new tie line.

Checking the Tie Line

The tie line is run from the tie point with a hand compass, a clinometer and a measuring tape. When you rerun the original tie line, it is sufficient to paint the blazes, and to renew the tape markings.

If you establish a new tie point, you must run a new tie line.

Checking the Centre Tree

Each established plot has a centre tree marked with aluminum markers and strands of flagging tape. The markers and tape are usually secured about two metres above ground to avoid interfering with d.b.h. measurements. If the centre tree is missing, either because of natural causes or because somebody cut it down:
1. Select another centre tree near the plot centre.
2. Mark it with the two aluminum markers and flagging tape.
Checking the Plot Centre Tree Markers

Missing or Illegible Plot Markers

Discovering missing or illegible plot centre tree markers is not unusual. Here’s how to proceed:

1. Replace the old markers. Centre tree markers are the same as those used for tie point trees. See Appendix 5.

2. Complete the top and bottom sections of the markers. Include the following information:
   - sample type (G)
   - sample number
   - plot number
   - region number
   - compartment number
   - date plot was established.

When the Plot Centre Is Also a Tie Point

Very often the plot centre also serves as a tie point for the next plot on the tie line. When it is, the middle section of the marker should also be filled out.

Checking the Plot Centre Stake

The plot centre is marked by a tubular aluminum stake, either driven into the ground or supported by a cairn on rocky ground. You can usually identify the stake by the flagging tape on it.

Replace the plot centre stake if the stake is:
- missing
- pulled out but lying on the ground
- bent but still in the original location.

Replacing a bent stake is not difficult because it’s still stuck in the ground. For a stake found lying on the ground, you may locate its original position by simply looking around for signs of the plot centre location.
In Case the Stake is Missing

Unless the centre stake location was stem mapped, relocating a missing plot centre stake is a difficult, time-consuming, but necessary task.

If the centre stake location was not stem mapped:
1. Tally the original trees on the plot before relocating the centre stake. Some tags may be down or missing, so replace them before relocating the centre stake.
2. Determine the approximate centre by observing the layout of the sectors. See Appendix 20.
3. Find trees close to the plot perimeter and measure the plot radius from those trees until you determine the approximate plot centre. This procedure is particularly important where the plot boundary goes through a clump of trees.
4. If not already done, build a cairn around the newly relocated plot centre stake.
5. Measure the bearing, slope percent, and slope distance from the plot centre to 3 trees nearby.
6. In sample remarks, record that the centre stake was missing.

Remeasuring the Plot and Establishing the Sub-plot

Accurate work is required when you compare new measurements with previous ones. Check measurements that appear to be out of the expected range, that is, measurements showing a very large increase compared with those showing little or no increase.

Correct any errors and note them in the remarks. Example: “Tree no. 60 is a Hw not a Fd.”

Converting Breast Height in Industrial Permanent Samples

Convert all industrial permanent sample plots (PSPs) not yet converted from imperial (1.37 m) to metric (1.3 m) breast height. The conversion is done only once to give a base-year measurement.

For all commercial and non-commercial trees 4 cm d.b.h. and greater in the plot and commercial trees 2 cm d.b.h. and greater in the sub-plot, measure the diameters at 1.3 m and at 1.37 m above the germination point. Measure all of the originally tagged trees, including those that died since the last measurement or were cut down as well as ingrowth plot and sub-plot trees.

To convert, use only one of the two methods described below. The first is the preferred one.

**Note:** Only one method should be used within a forest region.
Method 1

For trees tagged originally:
1. Make sure the tree number tags are nailed to each tree 1.37 m above the germination point.
2. If necessary, replace the nail and tag. The new tag must have the same number as the old one. Make sure the nail is far enough to allow for future growth.
3. Drive a second nail 0.07 m below the nail at 1.37 m.
4. Measure both diameters above the nails.

Method 2

For trees tagged originally:
1. Measure the diameter at 1.37 m above the germination point.
2. Mark the metric breast height 0.07 m below the nail at 1.37 m.
3. Move the nail and tag and place them at 1.3 m. If necessary, replace the nail and tag with a new tag with the same number.
4. Measure the diameter at 1.3 m.

For trees not previously tagged—example, ingrowth and sub-plot trees:
1. Mark the breast heights at 1.37 m and 1.3 m above the germination point.
2. Nail the tag at 1.3 m.
3. Measure the diameters at 1.37 m and at 1.3 m.

Note: If you convert breast height to 1.3 m during this measurement, ignore the sections in this manual dealing with measurement procedures after the one base-year measurement in which diameters at 1.3 m and 1.37 m were taken.

Establishing a Sub-plot

If a sub-plot is not already established, you must establish one to have some representation from trees below the tagging limit, that is, trees less than 4 cm d.b.h.

When you establish a sub-plot, the perimeter must not extend beyond the plot boundary. The objective in each sub-sample is to obtain a minimum of 20 commercial trees that are less than 4 cm d.b.h. but are at least 0.3 m high. The sub-sample size depends on stand density. See Appendix 6 for a list of sub-plot radii.

1. Choose the sub-sample size and mark the sub-plot circumference with string.
2. Within the sub-plot, tag all living commercial trees with a d.b.h. of 2 cm and greater, but under 4 cm at 1.3 m above germination. To tag, use methods 1 or 2 described in “Converting Breast Height” in this chapter.
For the trees in the sub-plot with a d.b.h. of less than 2 cm:

1. Count the trees in a dot tally.

2. Derive their metric d.b.h. classes—either d.b.h. class 0 or 1—are at 1.3 m. See "Table 1 Metric d.b,h. Classes and Limits" in this chapter.

**Tagging Trees**

Determine the breast height of trees with missing tags, as well as of ingrowth trees. In 1991, breast height determination changed from using the point of germination to using the base of the tree on the uphill side. Therefore:

- for samples established before 1991, continue using the point of germination
- for samples established from 1991, use the base of the tree on the uphill side

We completed one base-year measurement of diameters at 1.3 m and 1.37 m above the germination point for all Ministry of Forests samples. All future remeasurements of diameter will be at 1.3 m.

At the completion of the last remeasurement (1980 to 1989 inclusive), all living commercial trees 7.5 cm and greater in diameter measured at 1.3 m breast height, were tagged with either aluminum or round blue plastic tags in one of the following methods. The first method is the most common.

**Method 1**

The tree number tags were nailed to the trees at 1.37 m above germination. A second nail was driven into each tree at 1.3 m.

If method 1 was used:

1. Pull out the nail and tag at 1.37 m.
2. Nail the tree tag at 1.3 m, near the nail previously driven in at 1.3 m.
3. Pull out the original nail at 1.3 m.

**Method 2**

The tree number tags were nailed to the trees at 1.3 m above germination.

If method 2 was used:

- Do nothing. The tag and nail are already at 1.3 m.
Missing Tags

For all previously measured living trees with missing tags:

1. Determine breast height at 1.3 m above germination, or 1.3 m above the base of the tree on the uphill side for samples established after 1990.
2. Nail a tag which has the same tag number as the missing one.

Finding Missing Tags

During the establishment, tagging began near the centre in sector 1 and continued in a zigzagging pattern toward the circumference with the tags facing the plot centre. Once all taggable trees in sector 1 were tagged, the procedure was repeated in sector 2, only this time tagging began at the circumference with the tags facing away from the plot centre. The procedures for tagging sectors 1 and 2 were repeated alternately for all remaining sectors of the plot.

For subsequent measurements, repeat this same procedure. Under sample remarks, record the percentage of tags missing at the time of remeasurement.

Measuring D.B.H

For all numbered living trees, measure above the nail, to the nearest millimetre, the diameter at 1.3 m and at 1.37 m if the plot is being converted to metric diameter at breast height.

If the tag is missing, renumber the tree as described in Tagging Trees in this chapter.

To more accurately measure the diameter of trees that are or will soon be joined together at d.b.h., use the “1/2 wrap” method. To do this, measure or estimate, as accurately as you can, the diameter of each affected tree. Then, from the nail with the tag, measure half of the diameter around the bole of the tree and place a second nail. Note in the remarks that these are “1/2 wrap” measurements. In the future, the distance between the two nails will be measured and multiplied by two to arrive at the diameter of the tree.

After remeasuring the diameter:

- Pull out the nail holding the number enough to allow for tree growth until the next remeasurement.

For all previously numbered living trees now dead:

1. Measure the diameter at 1.3 m above the nail – and at 1.37 m if the permanent plot is being converted to metric diameter at breast height.
2. If you can’t find the dead tree, assign it the same diameter as the previous measurement. If the tree was cut down, record it as Tree Class 6 and assign it the same diameter as for the previous measurement.
Classifying Trees

Classify each tagged tree according to its pathological indicators. To classify a tree properly, view it from all sides. The person measuring d.b.h. should move far enough away from the tree to be able to classify the lower third of the stem. The recorder should move around the tree to classify the upper two thirds.

In the pathological remarks section, record each decay indicator occurring on the lower, middle or upper third of the total height of the tree. Do this by entering the correct numerical position code as follows:

<table>
<thead>
<tr>
<th>Code</th>
<th>Position on Tree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(tree is divided into thirds)</td>
</tr>
<tr>
<td>1</td>
<td>Lower third</td>
</tr>
<tr>
<td>2</td>
<td>Middle third</td>
</tr>
<tr>
<td>3</td>
<td>Upper third</td>
</tr>
<tr>
<td>4</td>
<td>Lower and middle third</td>
</tr>
<tr>
<td>5</td>
<td>Middle and upper third</td>
</tr>
<tr>
<td>6</td>
<td>Lower and upper third</td>
</tr>
<tr>
<td>7</td>
<td>All thirds</td>
</tr>
</tbody>
</table>

Tree Classes

Each tagged tree is classed in one of the following categories:

- **Tree Class 1**: Residual
- **Tree Class 2**: Suspect
- **Tree Class 3**: Dead potential
- **Tree Class 4**: Dead useless
- **Tree Class 5**: Veteran
- **Tree Class 6**: Dead, cut down.

**Tree Class 1: Residual**

Record Tree Class 1 if:

- the tree is alive, not a veteran and free of the decay indicators, or
- the tree is tagged and has a d.b.h. of less than 2 cm. We do not assess decay indicators for trees in this category.
Tree Class 2: Suspect

Record Tree Class 2 if:

- the tree is alive
- the tree is not a veteran, and
- the tree has one or more decay indicators.

Note: For tagged trees less than 2 cm d.b.h., do not record pathological indicators. Note them only in the remarks. Record tagged trees less than 2 cm d.b.h. as Tree Class 1.

Tree Class 3: Dead Potential

Record Tree Class 3 if:

- the tree is dead, either standing or down
- the tree contains at least an estimated 50% of sound wood by volume, and
- the tree is greater than or equal to 10 cm d.b.h. and greater than or equal to 3 m in height or length.

In the remarks, record “SSS” if the tree is standing and “DDD” if the tree is down.

If you can determine the tree died as a result of an insect or a disease, record the primary insect or disease responsible for the death. See Appendix 14 for pest and injury codes.

Tree Class 4: Dead Useless

Record Tree Class 4 if:

- the tree is dead, either standing or down
- the tree is not potentially useful. See Tree Class 3.

In the remarks, record “SSS” if the tree is standing and “DDD” if the tree is down.

If you can determine the tree died as a result of an insect or a disease, record the primary insect or disease responsible for the death. See Appendix 14 for pest and injury codes.

Tree Class 5: Veteran

For single-layered stands, record Tree Class 5 if:

- a tree is at least 40 years older than the mean age of the main stand.
- the veteran component has an estimated crown closure of less than six percent.
In complex-layered stands, a tree is considered a veteran only when it:

- is a remnant of a much older stand
- is at least 100 years older than the oldest sample trees of the main stand
- has a much larger diameter than trees in the main stand. This criterion is necessary because of the subjectivity in determining what constitutes the main stand owing to the wide range of ages possible in it.

Veterans are not recognized in stands 121 years or older, except in lodgepole pine stands, which may have a veteran component of douglas fir or larch.

Record pathological indicators for veteran trees the same way as for other trees.

_TREE CLASS 6: DEAD, CUT DOWN_

Record Tree Class 6 if the tree is dead as a result of being cut down. In addition, record “cut down” in the remarks.

_PATHOLOGICAL INDICATORS_

The eight indicators of decay (pathological indicators) are:

**Conk** the fruiting body of decay fungi.

**Blind Conk** pronounced swelling of depression around knots.

**Scar** must be weathered and may be open or closed.

**Fork** or **Crook** the result of damage to the main leader.

**Frost Crack** may resemble a scar but always follows the grain.

**Mistletoe** is a parasitic flowering plant.

**Rotten branch** obviously decayed large branches with a DIB of over 10 cm.

**Dead or Broken Top** broken or dead leader.

See Appendix 1.1 for definitions and illustrations of these pathological indicators.

The following abnormalities are not pathological indicators – nevertheless, record their occurrence in the remarks.

- butt rot
- flute
- candelabra branch
- branch fan
- black knot
- burl and gall
- sapsucker hole
- insect boring
- sweep
- exposed root
- spiral grain
- dry side
Assessing Pest Damage

We collect insect, disease and injury data to quantify the effects of pests on tree growth.

For each tree affected:
1. Identify, if possible, the pest species.
2. Assess the severity of the pest attack.
   - If you are suitably trained, assess the severity of the pest attack using the rating system in the “Quantification of Damage” section of the “Pest and Injury Codes Table” in Appendix 14. Assess only the severity of attacks by pests listed within the table. For pests not listed, consult the appropriate specialist for a rating system.
   - If you are not suitably trained, assess the severity of the pest attack using the following subjective assessment codes:
     \[ L = \text{Low} \]
     \[ M = \text{Moderate} \]
     \[ S = \text{Severe} \]
     \[ P = \text{Past attack} \]
3. Record the primary pest or injury code as listed in Appendix 14.
   - If you are unable to identify the insect or disease species, a short, incomplete label is still useful. Example: You may identify a defoliating insect and assess the percent defoliation for the tree as 30 percent. Record this as ID_3.

For the sample:
1. Make a general assessment of the primary insect, disease or injury for the total sample.
2. Record the assessment for the total sample in the sample header section. If known, also record the year of the attack.

Assigning a Crown Class Code

Crown class refers to the position of the crown of a tree relative to all other trees within the general plot area, not the whole stand.

There are six crown classes:
- Crown Class 1: Dominant
- Crown Class 2: Codominant
- Crown Class 3: Intermediate
- Crown Class 4: Suppressed
- Crown Class 5: Veteran
- Crown Class 6: Understory.

For more details on crown classes, see Appendix 12.
Assign a crown class code of 1 through 6 to each tagged tree classed as Tree Class 1, 2 or 5 (see "Classifying Trees" in this chapter).

**Note:** Crown Class 6 should be used sparingly; do not confuse it with Crown Class 4. Use Crown Class 6 only in stands 60 years or older where the understory trees, usually shade tolerant, are clearly much younger than the main stand.

**Estimating Live-crown Length**

Live-crown length is the distance between the treetop, if the top is alive, or from the top of the live portion, if the treetop is dead, and the base of the lowest contiguous live crown. The estimate is expressed as a percentage of the total height of the tree.

1. Estimate, to the nearest 10 percent, the live-crown length of tagged tree.
   - When determining the base of the lowest contiguous live crown, do not consider forks or epicormic branches.
   - The tops of defoliated trees may appear dead at the time of the assessment. Make sure it is or you may underestimate the live-crown length.

2. Assign to each live tagged tree a live-crown length, estimated to the nearest 10%.

**Tagging Ingrowth Trees**

The term ingrowth trees refers to commercial and non-commercial trees that were below the tagging limit during the last measurement but that now exceed the limit.

When all previously numbered trees have been remeasured, tag all commercial and non-commercial living trees now 4 cm and greater at d.b.h. by consecutive number for the plot.

**Dealing with Forked Trees**

Special rules govern the tagging of forked trees:

- If the fork occurs **above 1.3 m**: Tag the stem as a single tree, provided it has a d.b.h. of at least 4 cm.
- If the fork occurs **below 1.3 m**, and two or more stems of the fork are 4 cm or greater in d.b.h.: Tag each stem separately using consecutive numbers. Record, in the remarks, that these stems are forked together.
- If the fork occurs **below 1.3 m, and only one of the stems is 4 cm or greater**: Tag it as a single tree.
Tagging Procedure for Ingrowth Trees

1. If a large number of ingrowth trees are present, use consecutive, pre-numbered blue plastic tags. If few trees are present, use aluminum tags and inscribe the consecutive tree numbers for the plot.

2. Nail the tag to the tree 1.3 m above the germination point—or above the base of the tree on the uphill side, for samples established after 1990.

3. Record:
   - the measurement number
   - the tree number
   - the species
   - the sector
   - the measured diameter at 1.3 m, to the nearest millimetre
   - the tree class
   - any pathological indicators
   - the crown class
   - the live-crown length
   - pest or injury codes, if applicable
   - the tree number of the closest, previously numbered living tree.

For plots in dense stands, string the plot circumference beforehand.

Sub-plot and Tree Count

To have some representation from trees below the plot tagging limit, a sub-plot was established for each sample. The objective was to obtain a total of 20 living commercial trees that were less than the plot tagging limit but at least 0.3 m in height. For a list of sub-plot radii, see Appendix 6.

Within the sub-plot, all living commercial trees **2 cm d.b.h. and greater but less than the plot tagging limit** were tagged using method 1 or method 2, previously mentioned in "Tagging Trees" in this chapter.

Trees of commercial species **less than 2 cm d.b.h. but 0.3 m in height** had their tags wired onto either a branch or the main stem. However, except in very young stands where the major component was in stems less than 2 cm d.b.h., the practice of tagging trees less than 2 cm d.b.h. was discontinued in 1988.
Retagging Sub-plot Trees

For trees 2 cm d.b.h. and greater previously tagged within the sub-plot, use the same method of re-tagging used to retag trees within the main plot—that is, use either method 1 or method 2. See “Tagging Trees” in this chapter.

Attach the tag to the tree with a nail at breast height (1.3 m) if the tree:
- was less than 2 cm d.b.h. during the last measurement
- now has a d.b.h. of 2 cm or greater, and
- is a commercial species

Include the tree in the dot count if the tree:
- was less than 2 cm d.b.h. during the last measurement
- is still less than 2 cm d.b.h., and
- is a commercial species

Special rules govern the tagging of forked trees at least 2 cm d.b.h. but less than 4 cm d.b.h. within the sub-plots:
- If the fork occurs above 1.3 m, tag the stem as a single tree.
- If the fork occurs below 1.3 m, tag each fork as a tree, provided each is 2 cm d.b.h. and greater.

Gathering & Recording Information About Sub-plot Trees

Trees 2 cm d.b.h. and greater:

For each tree 2 cm d.b.h. and greater in the sub-plot, record the following:
- the measurement number
- the tree number
- the species
- the sector number
- the d.b.h. at 1.3 m
- the tree class
- any pathological indicators
- the crown class
- the live-crown length
- pest or injury codes, if applicable
- the number of the closest previously tagged plot living tree.
Trees Less than 2 cm d.b.h.:

Count trees less than 2 cm d.b.h. in a dot tally and record them:
- as d.b.h. class 0 or 1. See Table 1 below
- by species. See Appendix 3.

Forked Trees Less than 2 cm d.b.h.:

Give special attention to the method of counting forked trees less than 2 cm d.b.h.
Example: To avoid counting numerous leaders of trees that have been severely browsed, count only the tallest leader. See Appendix 10 for a further explanation.

Unusual Trees:

Now and then, you will find unusual live trees within the sub-plot. Special rules apply when measuring the height of abnormal trees less than 2.0 cm d.b.h. See Appendix 10.

Table 1 Metric d.b.h. Classes and Limits

<table>
<thead>
<tr>
<th>d.b.h. class</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.3 m to 1.3 m high</td>
</tr>
<tr>
<td>1</td>
<td>0.1 cm to 1.9 cm d.b.h.</td>
</tr>
</tbody>
</table>

Determining the Stand Structure

Stand structure is the physical arrangement or pattern of organization of the stand. Stand structure is described and classified according to recognizable differences in age and in height.

The recognized stand structures are:

Single layer stand
1. Simple structure – even age, even height
   - with veterans
   - without veterans
2. Complex structure – uneven age, uneven height
   - with veterans
   - without veterans
Multi-layer stand

A multi-layered stand has two distinct layers:
1. Layer 1, the top layer
2. Layer 2, the bottom layer.

For further details on stand structure, see Appendix 13.

Recording Stand Structure

For each tagged tree, identify the layer to which it belongs.
- For single-layered stands, leave the layer field blank (including veterans). The number 1 is assumed for trees in the main stand. Tree Class 5 identifies the veteran layer.
- For multi-layered stands, record the layer code for each tagged tree. Use codes 1 and 2 for layer 1 and layer 2, respectively.

Height Sample Trees

Local height-diameter curves are constructed from sample data before samples are compiled. To construct reliable curves, a substantial number of heights is needed for each species. The number depends on the stand composition which, ultimately, is based on gross volume. In the filed, use the calculated basal area for stand composition.

For single-layered stands, or for each layer in a multi-layered stand, select height sample trees as follows:
For Major Species

For each major species (20% or greater by composition), select trees as follows:

1. Select the required number of top height trees to a maximum of 10.

   **Note:** top height trees are measurement specific. They can change from measurement to measurement.

   **Top height** is the average height of the 100 largest diameter suitable trees per hectare of the same species. Suitable trees have the following characteristics:
   - largest diameter trees
   - living
   - free of major defects
   - crown class of 1 or 2

   **Example:** On a 0.1 hectare plot, the ten largest d.b.h. trees are selected for top height measurements.

2. Select an additional 15 trees distributed evenly across the remaining d.b.h. range, down to 2 cm d.b.h.

For Minor and Scattered Species

For each minor species (10 to 19% by composition) and scattered species (less than 10% by composition), select 15 height sample trees, if present and suitable. Distribute them across the d.b.h. range down to 2 cm d.b.h. Place the emphasis on larger diameter classes.

For Veterans

For the veteran layer:

1. Select one sample tree from each species present.
2. Estimate the height of all others.
3. Record the estimated height of all the veterans in the small tree or Vet height section.
4. Write “estimated” in the remarks.

Remeasuring Height

Ensure that height sample trees previously taken are remeasured for height (unless no longer suitable) even if the resultant distribution over the d.b.h. classes is not optimum. However, ensure that the full range of diameters down to 2 cm d.b.h. is covered.
Selecting Sample Trees

When possible, select residual trees (Tree Class 1). See “Classifying Trees” in this chapter. Otherwise, select trees that do not have major suspect characteristics, such as a major fork, which affects the true height, or a major scar at breast height which affects the true diameter.

Do not select trees with:

- diameters that were estimated
- sweeps or leans greater than 5 degrees.

In some areas, it may be impossible to meet sample height requirements if only suitable trees as described above are taken. In this situation, take the best of the “poor” trees to meet the requirements. However, do not select a tree if its height is less than 95% of what it would be without its defect – lean, fork, broken top, etc. Make a note of the number of meters you have underestimated top height due to the less than suitable trees in your sample.

Measuring Suppressed Trees with Flattened Tops

To ensure accurate measurements of suppressed trees:

1. Sight on the highest point of the top.
2. For hemlock trees, sight on the highest point of the droop.
3. For cedar trees, make sure you take the top reading on the tiny leader and not on a lateral branch, which may be higher.

Measurement Consistency

To make sure the height measurement is taken consistently from the same location, paint a blue dot at d.b.h. to indicate the direction from which you made the height measurement.

Age Sample Trees

Note: If all the present top height trees had their ages taken at 1.3 m during the last measurement, add the number of years since the last measurement to the individual previous age. If a top height tree does not have an age at 1.3 m, it must be taken now.

In single-layer, simple structure stands, pure and mixed, the age of the stand is determined by averaging the ages of the top height trees of the leading major species in the sample. However, ages of the top height trees of the second major species must also be taken.
In **mixed stands**, take one additional age for any other major species to determine if their age is in the same age class. If the third major species belongs to a different age class, and its volume is within 10 percent of the second, then also take the same number of ages for it. Do not include the age of the second or third major species in the average age calculation, but note the presence and the age of it in the stand description.

The sample mean age is derived from the top height trees of the leading species only, even if some of their cores are rotten. By estimating the rotten portion, you can derive a total age for the tree. See “Counting Rings on Rotted Cores” in this chapter.

Bore trees that appear to be veterans to confirm they are in fact veterans. Bore the smallest diameter veteran per species only; the others can be assumed to be veterans too. Do not use the ages of the veterans to calculate the main stand age. However, use the ages for the veteran layer.

In **single-layer, complex structure stands**, determine the average age of the stand from the ages of the top height trees of the leading major species. However, to show the variation of the stand’s age, take two additional ages of the leading major species from the younger portion of the stand. For additional major species, treat them as in mixed stands.

In **multi-layered stands**, select sample trees, as outlined above, for each layer. The top height method for determining site index is more suitable for even-aged stands. However, to simplify matters, select sample trees for both layers using the top height requirements as above.

**Taking the Age of a Tree**

1. Bore the selected trees at 1.3 m above the base of the tree on the uphill side.
2. Remove the core. Make sure two cores per species include the pith.
3. If the core includes the pith, record Y in the pith field.
4. Rebore the tree if you missed the pith by more than an estimated:
   - 2 years on a tree younger than 100 years, or
   - 2 percent on a tree older than 100 years.
5. While in the field, count the rings on the core and record the count.
6. Measure and record the radial increment for the last 10 and 20 years.
7. If required, put the cores in plastic straws with the following information:
   - the region number, R#
   - the compartment number, Co#
   - the sample number, G#
   - tree number
   - species
   - counted age
Counting Rings on Rotted Cores

If the sample tree has rotten portions:
1. Count the rings on the sound portion of the core.
2. Estimate the number of years in the rotten portion.
3. Add the number of years in the sound portion to the estimated number of years in the rotten portion.
4. Record the total breast-height age.
5. Record R for rot in the remarks.

Estimating The Sample Crown Closure and Slope Position

Estimating Crown Closure

Crown closure is the percentage of ground area covered by the vertically projected crowns of trees.

For each plot, estimate and record the crown closure by layer to the nearest ten percent.

For the veteran component of the plot, record crown closure to the nearest percent. If the crown closure of the veteran component is six percent or more, it must be classified as a separate layer.

Determining Slope Position

Slope position is the relative position of the plot within a water catchment area. Determine the slope position and record the appropriate code:

<table>
<thead>
<tr>
<th>Code</th>
<th>Category</th>
<th>Slope Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Crest:</td>
<td>crest</td>
</tr>
<tr>
<td>U</td>
<td>Upper</td>
<td>upper slope</td>
</tr>
<tr>
<td>M</td>
<td>Mid</td>
<td>middle slope</td>
</tr>
<tr>
<td>L</td>
<td>Lower</td>
<td>lower slope</td>
</tr>
<tr>
<td>T</td>
<td>Toe</td>
<td>toe</td>
</tr>
<tr>
<td>F</td>
<td>Flat (level)</td>
<td>flat</td>
</tr>
<tr>
<td>D</td>
<td>Depression</td>
<td>depression</td>
</tr>
<tr>
<td></td>
<td></td>
<td>mountain top</td>
</tr>
<tr>
<td></td>
<td></td>
<td>valley bottom</td>
</tr>
</tbody>
</table>
Stem Mapping

If the sample was previously stem mapped, you only have to stem map the tagged ingrowth trees in both the plot and the sub-plot.

Ten percent of the samples established in natural stands are stem mapped. The Resources Inventory Branch decides which sample and stratum (type group, site, age class) to stem map. The stem maps are used in distance-dependent growth modeling studies.

To create a stem map, you begin from the plot centre stake and measure the bearing and distance to each tagged tree. See Appendix 4 for a list of equipment needed for stem mapping.

To stem map the plot, follow this procedure:
1. If no large tree nearby interferes with sight lines, set up the compass directly over the aluminum plot centre stake, then:
   - level the instrument
   - record that the compass was not offset.
2. If a large tree interferes with sight lines, set up the compass in an opening close to the plot centre, then:
   - level the instrument
   - measure and record the bearing and distance from the compass to the plot centre
   - record that the compass was offset.
3. Adjust the compass for magnetic declination and raise the sighting vanes. In western Canada, magnetic declination is east of true north. Obtain the correct magnetic declination from an isogonic chart. See Appendix 7.
4. Systematically sight along to each tagged tree on the plot.
5. Here are some sighting tips:
   - To avoid sighting the wrong tree, wrap the d.b.h. stick with flagging tape to make it more visible, and place the stick in front of the tree.
   - To avoid false compass readings, keep sources of magnetic interference away from the compass, including steel tapes, axes, knives, steel datum holder, eye glasses with steel frames, and most metal objects.
   - To simplify recording, use a compass with Azimuth bearings, when possible.
6. Measure the slope distance between the compass and the centre of the tree.
7. Measure the slope with the Suunto clinometer using the percent scale.
8. Read the compass bearing on the scale at the north end of the compass needle.
9. Record the measurements for each tagged tree in the plot.
Quality Control

Sampling crews should emphasize accuracy over production. For the standards of measurement see Appendix 1.

Checking Sampling Crews

To ensure crews continue to work efficiently, and to ensure they follow and understand recommended procedures, carry out regular inspections.

1. Inspect at least 10 percent of all samples remeasured. If the sample has been poorly done, the original crew may be required to redo it.

2. Make spot checks as work progresses to be sure tie points and tie lines are run on the designated bearings.

3. To observe sampling crew performance, occasionally visit each crew on the sample.

After inspecting the sample, correct all errors greater than the allowable standard.

Checking the Samples in the Office

All samples must be checked in the office before sending them to the Growth and Yield Section of the Resources Inventory Branch. Follow this procedure:

1. Ensure the sample identification is correct and valid.

2. Ensure the sample header is as complete as possible.

3. Check that the minimum tree requirements were met for both plot and sub-plot.

4. Ensure that the number and distribution of tree heights - both top height and others - were met.

5. Ensure the requirement of ages were met.

6. Check that the access notes are complete and include the tie point sketch.

Inspecting the Sample

Once the samples have been checked in the office, randomly select one of the samples and conduct the following:

- a pre-field inspection
- a field inspection
- a post-field inspection.
Pre-field Inspection

1. Randomly select one plot from the ones checked in the office.
2. Enter the following information in the section at the top of the plot inspection report:
   - sample identification – region, compartment, sample, sample type, plot
   - the plot and sub-plot sizes
   - the plot and sub-plot radii
   - the inspection date
   - the original tally crew
   - the measurement date.
3. Randomly select 7 trees from the tree detail section.
4. Transcribe the measurements of the 7 trees to the top section of the plot inspection report. See Appendix 15.
5. Randomly select 5 trees for height from the sample tree section.
6. Transcribe the height measurements of the 5 trees to the sample tree section of the plot inspection report.
7. Randomly select 2 trees for age from the sample tree section.
8. Transcribe the age measurements to the sample tree section of the plot inspection report.
9. Transcribe the crown closure, aspect and slope of the plot to the appropriate section of the plot inspection report.
10. From the tree count summary section, randomly select one diameter class for a species. Later, you will use this diameter class in the field to check that the dot tally is correct for that class.

Field Inspection

1. Use the access notes to get to the sample.
2. If a new tie tree was selected on remeasurement, check that it was marked as specified in “Checking Location and Access” in this chapter.
3. If a new tie line was run, verify that the bearing and distance were run within the allowable standards.
4. Check that the aluminum plot centre markers were inscribed correctly and the plot centre stake was properly protected with a cairn.
5. Check that the bearings and distances from the plot centre to the three stem-mapped trees are correct.
6. Check the plot and sub-plot radius at a minimum of three different locations. Look for trees that should have been included or excluded from the plot or sub-plot. Flag with a circled asterisk any tree missed or mistakenly tallied.
7. Check that all sub-plot trees less than 4 cm d.b.h. but at least 0.3 m in height were either tagged or counted in the dot tally.
8. Carefully measure all the trees you selected in the pre-field inspection:
   - **Tree identification** - Check that the genus or species of each tree inspected is correct. If not, place a circled asterisk beside the tree.
   - **Tree tag height** - Check the tag height of the selected ingrowth trees to verify that breast heights, if applicable, were located at 1.3 m above the germination point for plots established before 1991, or at 1.3 m above the base of the tree on the uphill side for plots established after 1990. At the same time, make sure the nails were securely driven into the trees and the nail with the tag was driven in at a slight angle so that the tag hangs away from the tree.
   - **Diameter and pathological remarks** (decay indicators) - Measure the 7 selected trees and classify them.
   - **Sample tree heights** - Measure the 5 selected trees for height.
   - **Sample tree ages** - Count the age of the 2 trees selected for age.
   - **Stem mapping** - If the sample was stem mapped, check the 7 selected trees for bearing, distance and percent slope.

9. Assess the crown closure for the plot.

10. Compare your measurements with the previous ones giving the crew the benefit of the doubt.

11. Check that the results conform to the standards of measurements. See Appendix 1.

12. If the difference between two measurements is greater than the allowable error, place an asterisk in the margin.

13. If the error is greater than two times the allowable error, place a circled asterisk in the margin.

14. Complete the inspection items section of the inspection report.

15. Rate the quality of the work on the plot using the weighted system in Appendix 2.

16. Record your rating of the plot and any other comments in the remarks section of the plot inspection report.

**Post-field Inspection**

1. Discuss the results of your inspection with the original field crew.

2. Make recommendations to the original field crew, when necessary, on how to improve their work.

3. Amend the original data changing all the data that was flagged with an asterisk or a circled asterisk in your inspection report.
Damage to the Sample

Damage to samples can result from natural or artificial causes.

1. If the sample was damaged by natural causes such as slides, snow, fungi, insects, disease and fire, it should be remeasured if at least 25% of the plot trees are still living.

2. If the sample was damaged (disturbed) by artificial means, refer to “Guidelines For Deciding if Damaged Permanent Plots Should be Remeasured” in Appendix 24.

If a sample is to be destroyed:

1. Remeasure it one last time if at least three years have elapsed since the last measurement.

2. Classify it ecologically.

3. Make sure the plot centre can be relocated after logging so that the long-term productivity effects can be determined.

Returning the Samples to Victoria

Once the samples are checked in the office and corrected:

1. Make duplicate sets of the samples.

2. Write a covering letter listing the samples.

3. Make a duplicate of the covering letter and keep the duplicate.

4. Send one set of the samples and the original covering letter to the Growth and Yield Section at the Resources Inventory Branch

5. File the second set at the forest region for security and reference.