Forest Inventory and Monitoring Program: Growth and Yield Standards and Procedures

Chapter 4: Remeasurement of Permanent Sample Plots in Silviculturally Treated Stands

Prepared by
Ministry of Sustainable Resource Management
Terrestrial Information Branch
for the
Resources Information Standards Committee

March 31, 2003

Version 1.0

Published by the
Resources Information Standards Committee

National Library of Canada Cataloguing in Publication Data

Main entry under title:

Forest Inventory and Monitoring Program : Growth and Yield standards and procedures.

"March 31, 2003"

Contents: 1. Establishing permanent sample plots in natural stands -- 2. Remeasurement of permanent sample plots in natural stands -- 3. Remeasuring experimental plots in natural stands -- 4. Remeasurement of permanent sample plots in silviculturally treated stands -- Appendices.

Also available on the Internet.

ISBN 0-7726-4874-3

1. British Columbia. Forest Inventory and Monitoring Program. 2. Trees - Sampling - British Columbia – Methodology – Handbooks, manuals, etc. 3. Trees - Monitoring - British Columbia – Methodology – Handbooks, manuals, etc. 4. Trees – British Columbia – Growth.

5. Forest productivity – British Columbia. 6. Site index (Forestry) - British Columbia. I. British Columbia. Resources Information Standards Committee. II. British Columbia. Terrestrial Information Branch. III. British Columbia. Ministry of Forests. Growth and Yield Program.

SD387.S86F76 2003 6 34.9 C2002-960246-7

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Preface

The standards and procedures described in this chapter of *the Forest Inventory Manual (Volume 3 – Growth and Yield/ Decay and Volume)* are based upon the *Minimum Standards for the Establishment and Remeasurement of Permanent Sample Plots in British Columbia*.

The latter publication was developed for the Forest Productivity Council (FPC) to recommend minimum standards for measurement of permanent sample plots for the purpose of measuring growth and estimating future yield. It was last revised in March 1999. See the following web-site for further information: http://srmwww.gov.bc.ca/forestproductivity/ .

With the inactivity of the FPC, the Ministry of Sustainable Resource Management (previously Ministry of Forests) continues to upgrade the *Forest Inventory Manual* in response to client needs. The chapter following reflects that updated methodology and supersedes the FPC Minimum Standards document. The Ministry of Sustainable Resource Management recommends that this methodology be followed for all establishments and remeasurements of permanent sample plots.

Acknowledgments

The Government of British Columbia provides funding of the Resources Information Standards Committee work, including the preparation of this document. The Resources Information Standards Committee supports the effective, timely and integrated use of land and resource information for planning and decision making by developing and delivering focussed, cost-effective, common provincial standards and procedures for information collection, management and analysis. Representatives to the Committee and its Task Forces are drawn from the ministries and agencies of the Canadian and the British Columbia governments, including academic, industry and First Nations involvement.

The Resources Information Standards Committee evolved from the Resources Inventory Committee which received funding from the Canada-British Columbia Partnership Agreement of Forest Resource Development (FRDA II), the Corporate Resource Inventory Initiative (CRII) and by Forest Renewal BC (FRBC), and addressed concerns of the 1991 Forest Resources Commission.

For further information about the Resources Information Standards Committee, please access the RISC website at: http://srmwww.gov.bc.ca/risc/.

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Introduction

Samples in silviculturally treated 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 18 are recommended.

Preparing for Field Work

Before field work starts, prepare and collect:

Copies of the original field sheets

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 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 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 (T);
- sample number and plot number (usually 1, but 3-plot samples exist);
- bearing and distance to the plot centre;
- date the 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 renew the paint and the tape markings.

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 dbh 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 (T);
   - sample number;
   - plot number;
   - region number;
   - compartment number;
   - date the plot was established.

When the Plot Centre is also a Tie Point

Sometimes 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. If the plot centre stake location has never been stem mapped, select three trees around the plot centre, and record the bearing, slope, and distance from the plot centre stake to the centre of each tree. Place a nail at the centre of each tree for consistency in measuring distance to the centre stake.

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.
3. Find trees close to the plot perimeter and measure the plot radius from those trees until you determine the approximate plot centre. Using the 'approximate plot centre' and the plot radius as a starting point, check that all tagged trees are in the plot. If not, adjust the plot centre until they are.
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. Place a nail at the centre of each tree for consistency in measuring distance to the centre stake.
6. In sample remarks, record that the centre stake was missing.

Remeasuring the Plot

Accurate work is required when you compare new measurements with previous ones. Always position the dbh tape just above the nail and perpendicular to the bole of the tree. 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**: "dbh checked."

Sectors in the Plot

Plots were generally divided into eight tagging sectors with number one starting clockwise from the direction of the original tie line or, in later years, from the north. In order to aid in the choosing of top height and site trees, the plot must also be divided into 0.01 ha site sectors using the same procedure previously used; that is, starting clockwise from the direction of the original tie line or from the north. See Appendix 24.

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.

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.

Measuring DBH

For all **numbered living trees**, measure above the nail, to the nearest millimetre, the diameter at 1.3 m.

To more accurately measure the diameter of trees that are or will soon be joined together at dbh, 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 above the nail.
2. If you can't find the dead tree, assign it the same diameter as in the previous measurement. If the tree was cut down, record it as Tree Class 6 and assign the same diameter as in the previous measurement.

For all **previously dead unnumbered trees that are ≥10.0 cm dbh and ≥1.3 m in height**:

1. If standing, collect the '*Dead tree Attributes'*.
2. If down, or you cannot find, record it as (**F**)allen.

For all **previously dead unnumbered trees that are ≥10.0 cm dbh and ≥1.3 m in height**:

1. Tag the tree with a unique number.
2. Collect the *'Dead tree Attributes'*.

Classifying Trees

Classify each tagged tree according to its pathological indicators.

To classify a tree properly, view it from all sides. The person measuring dbh 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.

Record each pathological indicator as occurring on the lower, middle or upper third of the total height of the tree. Do this by entering the following Pathological (Decay) Indicator Position Codes:

Code	Position on Tree (tree is divided into thirds)
1	Lower third
2	Middle third
3	Upper third
4	Lower and middle third
5	Middle and upper third
6	Lower and upper third
7	All thirds

Tree Classes

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

1. Tree Class 1: Residual;
2. Tree Class 2: Suspect;
3. Tree Class 3: Dead potential;
4. Tree Class 4: Dead useless;
5. Tree Class 5: Veteran;
6. 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 any decay indicators.

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.

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 dbh and greater than or equal to 3 m in height or length.

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 damage agents and severity 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.

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 damage agents and severity codes.

Tree Class 5: Veteran

For simple 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 6% for the sample.

In complex 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.

Pathological Indicators

The eight indicators of decay (pathological indicators) are:

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

Scar must be weathered and may be open or closed.

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

Dead or Broken Top broken or dead leader.

Conk the fruiting body of decay fungi.

Mistletoe is a parasitic flowering plant.

Blind Conk pronounced swelling of depression around knots.

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

See Appendix 11 for definitions and illustrations of these pathological indicators.

The following abnormalities are not pathological indicators.

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

Assessing Damage Agents and Severity

We collect insect, disease and injury data to quantify their effect on tree growth.

For each tree affected:

1. Identify, if possible, the damage agent (see Appendix 14 for damage agents and codes).
2. Assess the damage severity.
3. Record the primary damage agent code to a level that you are confident.
   - The damage agent codes are hierarchical and enable coding from very general (type or category) to specific (species). The first letter indicates the type of the damage while the second and third indicate the specific agent.
   - If you are unable to identify the damage agent 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_30.

For the sample affected:

1. Identify the primary damage agent in the sample;
2. Make a general percent assessment of the agent for the sample;
3. Record this assessment in the header. If known, also record the year in which the damage took place.

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:

1. Crown Class 1: Dominant;
2. Crown Class 2: Codominant;
3. Crown Class 3: Intermediate;
4. Crown Class 4: Suppressed;
5. Crown Class 5: Veteran;
6. Crown Class 6: Understory.

For more details on crown classes, see Appendix 12.

Assign a crown class code of 1 through 4 and 6 to each tagged tree classed as Tree Class 1, 2. For tree class 5, assign crown class 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.

Estimate, to the nearest 10 percent, the live-crown length of all living tagged trees.

- 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.

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 that limit.

When all previously numbered trees have been remeasured, tag all commercial and non-commercial living trees that are $\geq$ 4.0 cm. 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 dbh 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 dbh: 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. Do not use previously used numbers within the plot.
4. Record:
    - the tree number;
    - the species;
    - the tagging sector number;
    - the site sector number;
    - the dbh;
    - the tree class;
    - any pathological indicators;
    - the crown class;

- the live-crown length;
- damage agent codes, if applicable;
- the tree number of the closest, previously numbered living tree.

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

Remeasuring the Sub-plot

To have some representation from trees below the tagging limit, a sub-sample 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. These trees were tagged with a nail if 2.0 cm dbh and greater; if less, the tag was wired onto either a branch or the main stem. These tags and wire should be removed, if possible, to prevent girdling of the stems.

Note: Some silviculturally treated samples were established shortly after spacing or thinning took place. In order to meet the minimum requirement of stems less than the tagging limit, a large sub-plot size may have been used. If this same sub-plot is used now, ten years later, it could mean an excessive number of sub-plot trees.

Therefore, a one time change during **measurement one** in sub-plot size is allowed. Choose a sub-sample size from Appendix 8 that will yield 20 commercial stems in the sample that are less than the tagging limit but at least 0.3 m in height.

Notice of this change and the new sub-plot radius must be entered in the sample remarks section. Also, any previously tagged sub-plot tree that is now outside the new sub-plot must be "dropped" in screen #106 of the GyHand.

Gathering & Recording Information About Sub-plot Trees

Trees of commercial species 2 cm dbh and greater:

For each tree 2 cm dbh and greater in the sub-plot, record the following:

- the measurement number;
- the tree number;
- the species;
- the tagging sector number;
- the site sector number;
- the dbh;
- the tree class;
- any pathological indicators;
- the crown class;
- the live-crown length;
- damage agent codes, if applicable;
- suitability for height measurement, (Y)es, (N)o, (C)ould be, (F)lagged, (V)ery difficult to measure; (E)asy to measure;
- the number of the closest previously tagged plot living tree.

Trees of commercial species less than 2 cm dbh:

Count trees less than 2 cm dbh in a dot tally and record them:

- as dbh class 0 or 1. See Table 1 below
- by species. See Appendix 3.

Table 1. Metric dbh Classes and Limits

dbh Class	Limits
0	0.3 m to 1.3 m high
1	0.1 cm to 1.9 cm dbh

Forked Trees Less than 2 cm dbh:

Gives special attention to the method of counting forked trees less than 2 cm dbh. **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 dbh See Appendix 10.

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:

1. Single layer, simple stands (even age and height)
    - with veterans;
    - without veterans.
2. Single layer, complex stands (uneven age and height)
    - with veterans;
    - without veterans.
3. Multi layer stands
    - layer 1 is the top layer;
    - layer 2 is the bottom layer.

For single layer stands, layer 1 is assumed for trees in the main stand and tree class 5 identifies the veteran layer.

For multi layer stands, record 1 for the top layer trees and 2 for the bottom layer. The sample primary layer, according to regional priorities, must be identified.

For further details on stand structure, see Appendix 13.

Height Sample Trees

Local height-diameter curves are constructed from sample data before compiling samples.

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 basal area. In the field, use the calculated basal area for stand composition.

Top Height

Select the top height tree from the site sector one. Top height (1998) is the height of the largest diameter tree, regardless of species, in a 0.01 ha plot, providing the tree is suitable. A suitable tree must be healthy, not have a broken or damaged top, not have its height growth affected by a competitor nor be a residual left from previous logging. There is no substitution for an unsuitable tree.

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

First Two Major Species

For each of the first two major species (20 percent or more by composition), select trees for the sample as follows:

1. Select the required number of site trees on the basis of the largest diameter living tree per 0.01 ha plot or sector, to a maximum of ten. In the case of a sample larger than 0.1 ha, randomly select ten site sectors and take the site trees from them - do not substitute. In future remeasurements, the same sector numbers will be used to choose site trees. For a 3 plot sample of 0.045 ha with each plot = 0.015 ha, work out the number of degrees that a 0.01 ha site sector comprises (240 degrees). The site tree is selected on this portion of the plot. The remainder of the plot is not sampled for site trees. For a 3 plot sample of 0.075 ha with each plot = 0.025 ha, each site sector equals 144 degrees, thus 2 site trees selected on each plot and the remaining 72 degrees are left unsampled for site trees.

   Suitable site trees have the following characteristics:
   - free of major defects;
   - crown class of 1 or 2. The exception is in the case of the second layer in a two-layer stand where crown class 3 and 4 are acceptable;
   - cannot be substituted.

   Example: On a 0.1 hectare sample, the ten largest dbh trees from each of the two leading major species are selected for site tree measurements. Similarly, four trees would be selected in a 0.04 hectare sample.

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

For Third and Fourth Majors, Minor and Scattered Species

For the third and fourth major species (20 per cent or greater by composition), each minor species (10 to 19 percent by composition) and for scattered species (less than 10 percent by

composition), select 15 trees, if present and suitable. Distribute them across the dbh range, down to 2 cm dbh. Place 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.

Remeasuring Heights Consistently

To ensure future height measurements are taken consistently from the same direction, paint a blue dot, if not already done, at dbh to indicate the direction from which the height measurement was taken.

Ensure that height sample trees previously taken are remeasured for height and from the same direction as indicated by the blue painted dot (unless no longer suitable) even if the resultant distribution over the dbh classes is not optimum. If possible, strive for the full range of diameters down to 2 cm dbh.

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.

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.

Age Sample Trees

Note: If the present top height and site trees had their ages taken at 1.3 m during the last measurement, no further ages are required. If the top height tree or any site tree of the first and second leading major species do not have an age at 1.3 m, it must be taken now.

In **single layer, simple stands,** pure and mixed, the age of the stand is determined by averaging the ages of the trees of the leading major species in the sample. However, ages of the site trees of the second major species must also be taken.

The sample mean age is derived from the site trees of the leading species only, even if some of their cores are rotten. The rotten portion must be estimated to 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. Use these ages for the veteran layer.

In **single layer, complex stands**, the average age of the stand is determined from the ages of the site 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. Treat the second major species the same as the leading.

In **multi-layer stands**, select sample trees, as outlined above, for each layer.

Taking the Age of a Tree

1. Bore the selected trees at 1.3 m.
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 5, 10 and 20 years.
7. Measure and record the evidence of suppression, if any. See Appendix 23.
8. Place the cores in plastic straws with the following information:
   - the region number, R#
   - the compartment number, Co#
   - the sample number, T#
   - 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 with a (**R**)otted for pith.

Estimating Other Plot Attributes

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 10 percent.

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

Determining Elevation

Determine and record the elevation of each plot if not already done.

Determining Aspect and Slope

Determine the aspect and slope for each plot if not already done.

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:

Code	Category	Slope Position
C	Crest	
U	Upper	
M	Mid	
L	Lower	
T	Toe	
F	Flat (level)	
D	Depression	

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 Terrestrial Information 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. Sight on to the first tree on the plot. Some tips for sighting are listed below:
   - to avoid sighting the wrong tree, wrap the dbh stick with flagging tape to make it more visible, then place the stick in front and center of the tree;
   - to avoid false compass readings as you sight the tree, keep sources of magnetic interference away from the compass, including steel tapes, axes, knives, steel datum holders, eye glasses with steel frames, and most metal objects;
   - to simplify recording and possible minimize errors, use a staff compass with Azimuth bearings when possible.
5. Measure the slope distance between the compass and the centre of the tree.
6. Measure the slope with the Suunto clinometer using the percent scale.
7. Read the compass bearing on the scale at the north end of the compass needle.
8. Record the measurements for each tagged tree in the plot.

Quality Control, Damaged Samples and Returning Samples to Victoria

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

Checking Sampling Crews

To ensure crews 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 properly marked.
3. To observe sampling crew performance, occasionally visit each crew on the sample.

Checking the Samples in the Office

All samples must be inspected in the office before sending them to the Vegetation Resources Inventory Section of the Terrestrial Information Branch. Ensure that:

1. The sample identification is correct and valid.
2. The sample header is as complete as possible
3. The number and distribution of tree heights - both top height and others - were met.
4. The required number of ages and piths were met.
5. 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, FS 822-1. See Appendix 15.
5. Randomly select five 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. Select two age cores and check the age count as well as the suppression readings.
8. Transcribe the age measurements to the sample tree section of the plot inspection report.
9. Transcribe the crown closure, aspect, slope and slope position 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 and verify their accuracy and completeness.
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 plot centre markers were inscribed correctly and the plot centre stake was properly protected with a cairn.
5. 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.
6. Check that the chosen diameter class was properly dot tallyed.
7. 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;
   - **Stem mapping** - If the sample was stem mapped, check the selected ingrowth trees for bearing, distance and percent slope.
8. Assess the crown closure for the plot.

9. Compare your measurements with the previous ones giving the crew the benefit of the doubt.
10. Check that the results conform to the standards of measurements. See Appendix 1.
11. If the difference between two measurements is greater than the allowable error, place an asterisk in the margin.
12. If the error is greater than two times the allowable error, circle the asterisk.
13. Complete the inspection items section of the inspection report.
14. Rate the quality of the work on the plot using the weighted system in Appendix 2.
15. 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, if necessary, on how to improve their work.
3. Correct 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 20.

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. Send a list of all the samples, any original field sheets, the electronic download from the GyHost as well as a hard copy of reports 1,2,3,5,6 and 7 to the Vegetation Resources Inventory Section of the Terrestrial Information Branch.
2. Keep a copy of all the above in the forest region for security and reference.