

The Forestry Corp.
Field Season 2003/2004

Volume Sampling Field Manual

Prepared for Manning Diversified
 Forest Products Ltd.

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1.0 Introduction

1.1 Background

Manning Diversified Forest Products Ltd. (Manning Diversified) has coniferous rights within Forest Management Units (FMU) P6 and P9, located in northwestern Alberta (Figure 1). The Company requires a volume sampling program designed to enhance sample plot data previously collected within these areas.

The Volume Sampling Plan (The Forestry Corp. 2003) provides information on past volume sampling and the rationale behind the design of the current program. This Field Manual provides detailed protocols to be used for the collection of data during the 2003/2004 field season.

Accurate and reliable information is a crucial component in all growth and yield sampling and as such, following the protocols outlined in this manual is extremely important. The use of this manual will ensure high quality data collection and continuity of standards during the data collection process.

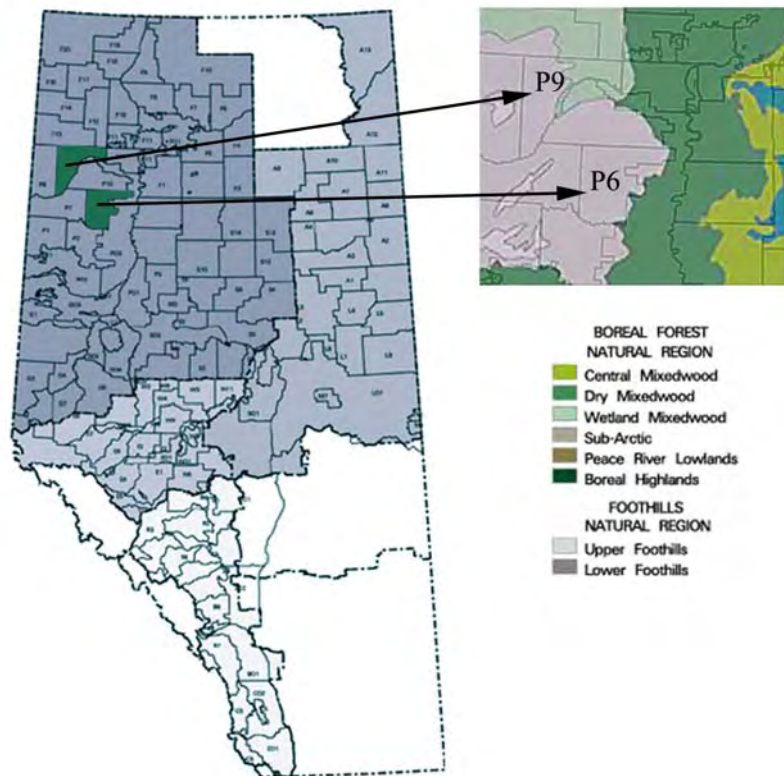


Figure 1. FMUs P6 and P9 and associated natural subregions.

1.2 Plot Design

The volume sampling plot will be comprised of two nested, fixed radius plots (Figure 2). A 7.98 m radius (0.02 ha) tree plot will be used to sample all live stems with a DBH of 9.1 cm and greater. A 3.99 m radius (0.005 ha) sapling plot will be nested within the larger plot, and will be used to sample live stems that are greater than 1.3 m in height with a DBH below 9.1 cm.

Species, DBH, crown class, and condition code will be measured for each live tree or sapling. In order to create a link between ground sampled data and inventory labels, each sampled stem will be assigned to a canopy layer, as defined by the AVI 2.1 inventory label¹. Heights will not be subsampled for trees (DBH \geq 9.1 cm), since good height equations already exist (e.g., Huang 1994). Because of the interest in understory layers, combined with the potential variability in height growth expected in non-dominant canopy positions (competitive effect interacting with species-specific response), saplings will be subsampled for total height within the 3.99 m radius plot.

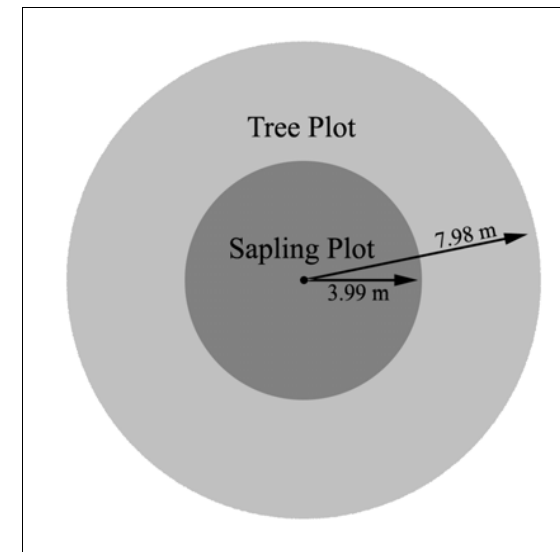


Figure 2. Volume sampling plot layout.

A 7.98 m radius age tree plot will be used to gather age data on Top Height and Site Index stems. The 7.98 m radius plot will coincide (overlap) with the location of the tree volume sampling plot, but in this case, no DBH classes will be used to assess suitability for sampling². This means that a selected stem may be outside of the sapling plot, but have a DBH below 9.1 cm.

Each identified canopy layer (based on AVI 2.1 inventory labels) will be sampled for ages. Species to be sampled will be selected based on AVI inventory labels rather than field observations, with certain exceptions which are outlined in this manual.

¹ In cases where the AVI call did not include layers identified by the field call, the field call will be used for sampling the additional layers.

² However, stems must exceed 1.3 m in height since breast height age must be sampled.

1.3 Summary of Tally Cards

The tally cards used for this sampling program are summarized below. Samples of all cards are provided in Appendix 2.

Stand Data Card

- ✓ one card per stand
- ✓ provides six pre-selected potential plot locations for sampling, the AVI 2.1 inventory call for the stand, and specifies the age tree sampling requirements (species and number of trees by layer) for each plot within the stand, based on the AVI information
- ✓ also used to record moved and offset plots

Seismic Data Card

- ✓ one card per moved or offset plot; to be used only when seismic lines intersect with the tree plot area
- ✓ used to record information on the plot prior to moving/offsetting, including location, estimated percent of the plot disturbed by seismic lines, and information on individual seismic line locations and widths

Plot Data Card

- ✓ one card per sampled plot
- ✓ used to record plot level information such as location, access information, field based assessment of inventory attributes, and required vs. actual age sampling

Volume and Age Sampling Card

- ✓ one or more cards per sampled plot
- ✓ used to record volume sampling information, such as DBH, crown class, condition code, AVI layer and sapling height
- ✓ used to record age sampling information, such as top height and site index potential, breast height age, stump height age and height

2.0 Sampling Protocols

2.1 Plot Pre-Location

Stands will be selected using sampling matrices and selection protocols described in the Volume Sampling Plan (The Forestry Corp 2003). **Three** volume and age sampling plots are to be established in each selected stand.

Six potential plot locations will be pre-selected in the office using random sampling techniques, and the locations will be provided to field crews on maps and/or aerial photography.

The following fields on the **Stand Data Card** are to be completed during the plot pre-selection process:

Field	Descriptions
FMU	Record the Forest Management Unit (<i>i.e.</i> , P6 or P9).
Township	Record the township number (<i>e.g.</i> , 102).
Range	Record the range number (<i>e.g.</i> , 08).
Meridian	Record the map sheet number (<i>e.g.</i> , W6).
Polygon No.	Record the polygon number from the inventory map (<i>e.g.</i> , 240) - right justify the entry.
UTM Co-Ords.	For each pre-selected plot location, record the UTM easting and northing.
AVI Call	For each layer in the inventory label, record the AVI 2.1 inventory call (moisture, crown closure class, origin age, height, species and species percentages).
Age Sample Reqs.	For each layer in the AVI call, record the species and number of trees to sample, based on the rules provided in Section 2.6.1.

2.2 Plot Location

Plot locations are to be determined from a tie point which is a relatively permanent land feature (*e.g.*, road intersection, well site corner). If the plot is located fairly far from the tie point, intermediate tie points are to be used which may not be as permanent or as distinct as the primary tie point (*e.g.*, intersection of intermittent stream). The purpose of these subsequent tie points is to assist in relocating the plot for quality control purposes.

The primary tie point and all intermediate tie points are to be marked with flagging and, if possible, spray paint. All location information is to be reported from the primary tie point. Distances are to be measured with a hip chain. Directions are to be recorded to the nearest azimuth, using the appropriate declination for the area (**21° 30' for P6 and 22° 20' for P9**).

Once the pre-selected plot location is reached, ensure that the plot center corresponds to the UTM coordinates provided using GPS equipment. Appendix 3 provides GPS performance standards for equipment use. Plots are not to be placed in anthropogenic (human-made) openings (*e.g.*, seismic lines, well sites, harvested blocks). Each potential plot location will be field assessed for suitability and appropriate actions will be taken, as follows:

1. If the plot falls on a **mappable** disturbance, such as seismic line greater than or equal to 5 m in width, well site or another large disturbance, proceed to the next plot location. Prior to proceeding to the next location, some measurements of the total plot area disturbed by seismic lines must be made (see next section). Potential plot locations will be visited **in order** from plot 1 to plot 6 until a total of three plots have been sampled.
2. If the plot is intersected by an **unmappable** seismic line (less than 5 m in width), the plot location will be offset. **Do not replace with the next pre-selected plot location.** Prior to proceeding to the next location, some measurements of the total plot area disturbed by seismic lines must be made (see next section).
3. Plots **must not** be moved if they fall within natural clearings or within an intermittent or ephemeral creek, since these features are not excluded from the forested landbase. Plots that are suitable, but have no trees that qualify for measurements (*e.g.*, small trees or natural clearings), will still be sampled (*i.e.*, header information will be documented, and the plot will be considered one of the three sample plots, but no other data will be recorded). **Do not replace with the next pre-selected plot location and do not offset.**

When checking for suitability, assess the plot from plot center to the plot boundary. Correct for slope by holding the tape horizontally rather than parallel to the ground surface, or using a correction for slope (Appendix 4).

The following fields on the **Stand Data Card** are to be completed as described:

Field	Descriptions
Offset	Mark with an 'X' if the plot was offset. Offsetting will only occur when the plot is intersected by an unmappable disturbance (seismic line < 5 m wide).
Moved	Mark with an 'X' if the plot was moved (proceed to the next pre-selected plot location). The plot will be moved if it is intersected by a mappable disturbance (seismic line ≥ 5 m wide and other mappable anthropogenic disturbances).
Loc'n Notes	Record the reason for moving/offsetting.

2.3 Seismic Data Collection

If any part of the plot is intersected by a seismic line it must be offset or moved³. Some basic data collection must be completed first. Seismic data collection is only required for the first three eligible plots, and only if there is anthropogenic disturbance within the plot.

The following fields on the **Seismic Data Card** are to be completed as described:

Field	Descriptions
FMU	Record the Forest Management Unit (<i>i.e.</i> , P6 or P9).
Township	Record the township number (<i>e.g.</i> , 102).
Range	Record the range number (<i>e.g.</i> , 08).
Meridian	Record the map sheet number (<i>e.g.</i> , W6).

³ Mappable disturbance takes precedence over unmappable disturbance. If any plots have both types of disturbance, the plot will be moved rather than offset.

Polygon No.	Record the polygon number from the inventory map (<i>e.g.</i> , 240).
Plot No.	Record a number between 1 and 6 (corresponding with the pre-selected plot numbers listed on the Stand Data Card) representing the number of the plot being sampled. In the case of offset plots, the offset plot will retain the same plot number as the original plot (<i>e.g.</i> , plot number on the Seismic Data Card, Plot Data Card and Volume and Age Sampling Card will be the same).
Date	Record the date of survey in YYYY/MM/DD format (<i>e.g.</i> , 2003/12/17).
Crew	Record the initials of the survey crew.
Plot Sketch Map	Draw a sketch of the plot, showing the location and approximate size of each seismic line.
UTM Co-Ords.	The UTM easting and northing should correspond to the pre-selected plot location on the stand data card.
Estd. % Disturbed	Estimate the total percent of the plot area that has been disturbed by seismic lines and other large anthropogenic disturbances (<i>e.g.</i> , roads, well sites, etc.). Appendix 5 provides examples of percent area coverage.
Seismic Line Info	Take the distance from the plot center to the nearest edge of the seismic line, ensuring that the line is perpendicular to the seismic line (D1). Take the distance from the plot center to the farthest edge of the seismic line (whether or not it is outside of the plot) (D2). Examples are provided in Appendix 6. If all seismic line widths are less than 5 m in width, the plot should be offset prior to sampling volumes and ages. If one or more seismic lines are ≥ 5 m wide, then the plot should be moved rather than offset (see Section 2.2).
X Center	If the seismic line crosses through the plot center, mark with an 'X'.

Mark the plot center with flagging and, if possible, spray paint. Once the seismic line measurements are made on the original plot location, the plot for volume and age tree sampling can be offset or moved. To offset the plot center, move 10 m away from the seismic line in a direction perpendicular to the general orientation of the seismic line. Reassess the new plot area, and repeat until the plot is located entirely within an undisturbed area. If there is more than one seismic line, proceed in a direction away from the majority of seismic activity.

2.4 Plot Establishment

Once the plot location for volume and age sampling has been confirmed (after moving or offsetting as required), **the plot centre is to be clearly marked with spray paint and flagging.**

The following fields on the **Plot Data Card** are to be completed as described:

Field	Descriptions
FMU	Record the Forest Management Unit (<i>i.e.</i> , P6 or P9).
Township	Record the township number (<i>e.g.</i> , 102).
Range	Record the range number (<i>e.g.</i> , 08).
Meridian	Record the map sheet number (<i>e.g.</i> , W6).

Polygon No.	Record the polygon number from the inventory map (<i>e.g.</i> , 240).
Plot No.	Record a number between 1 and 6 (corresponding with the pre-selected plot numbers listed on the Stand Data Card) representing the number of the plot being sampled. Offset plots will have the same plot number as the original plot.
Date	Record the date of survey in YYYY/MM/DD format (<i>e.g.</i> , 2003/12/17).
Crew	Record the initials of the survey crew.
Tree Plot Area	Tree plot area (200 m ²).
Sapling Plot Area	Sapling plot area (50 m ²).
UTM Co-Ords.	Record the UTM easting and northing. The co-ordinates should correspond to the pre-selected plot location on the stand data card unless the plot has been offset.
Access Info.	Describe the tie point(s) and access information for plot location.
Field Call	Record the field call (moisture, crown closure class, height, species and species percentages) for each observed canopy layer to AVI 2.2 standards (Appendix 7). The field call is assessed with respect to the plot and that portion of the stand immediately surrounding the plot.
Age Sample Reqs.	Required age tree sampling by layer (species and number of stems to sample) should be the same as in the Stand Data Card .

2.5 Volume Sampling

2.5.1 Tree Data Collection

Information is to be collected on all **live** trees within the tree (7.98 m radius) plot that have a DBH of 9.1 cm or greater. Trees are to be tallied from the north azimuth (360°), proceeding clockwise.

All tallied trees are to be marked using a lumber crayon or spray paint with a horizontal line at breast height facing towards the plot centre and tree number marked above the breast height line.

The horizontal distance to any borderline tree is to be measured to determine if the tree lies within the sample plot. Measure the distance from the plot centre to the centre of the tree at stump height (0.3 m), with slope corrections as required (Appendix 4).

Heights will be sampled in pine-leading conifer stands only (*e.g.*, where the AVI call deciduous component ≤ 20% and species 1 = Pl or Pj). Randomly select two pine trees from within the tree plot. Measure total height to the nearest 0.1 m. Spray paint is to be used to mark the stem to show the direction in which height was taken.

The following fields on the **Volume and Age Sampling Card** are to be completed as described:

Field	Descriptions
Record Type	Record "T".
Number	Identification number starting at 001 (<i>e.g.</i> , 001, 002, 003... etc.). If there are no live trees (DBH ≥ 9.1 cm), record '999'; no other measurements need to be recorded (<i>e.g.</i> , species, DBH etc.).

Species	Record the species using a 2 digit species code as provided in Appendix 8.
DBH	Measure and record the diameter at breast height (1.3 m) to the nearest 0.1 cm. Diameter measurement methods are presented in Appendix 9.
Crown Class	Assess and record the crown class on all trees. Crown class is assessed with respect to the plot and that portion of the stand immediately surrounding the plot. Trees with a broken top or severe lean will not be assigned a crown class. Appendix 10 defines crown classes.
Condition Codes	Assess and record the condition of each tree. Record a maximum of 3 conditions, in order of priority. Appendix 11 lists the conditions to be considered in order of priority and their 2 digit code.
AVI Layer	Assign each stem to an AVI layer based on the AVI 2.1 inventory labels (not based on the field call) ⁴ . Use layer heights from the AVI call to help distinguish layers (<i>e.g.</i> , there is a 4 m height difference between layer 1 and layer 2, as opposed to a 15 m height difference between layer 1 and layer 2 - this will indicate to the field crew where they should be looking).
Height	For pine-leading conifer stands only: measure and record the height on selected trees to the nearest 0.1 m. Detailed instructions for determining height are provided in Appendix 12.

2.5.2 Sapling Data Collection

Information is to be collected on all **live** saplings within the sapling (3.99 m radius) plot that exceed 1.3 m in height and have a DBH below 9.1 cm. Saplings are to be tallied from the north azimuth (360°), proceeding clockwise.

All tallied saplings are to be marked using a lumber crayon or spray paint with a horizontal line at breast height facing towards the plot centre and sapling number (where possible) marked **below** the breast height line (to distinguish saplings from trees).

The horizontal distance to any borderline sapling is to be measured to determine if the sapling lies within the sample plot. Measure the distance from the plot centre to the centre of the sapling at stump height (0.3 m), with slope corrections as required (Appendix 4).

Select the **first** sapling of each species encountered during sampling for measuring height (*e.g.*, one sapling per species). Only those species that are represented within the sapling plot are to be sampled. Mark the stem to show the direction in which height was taken.

The following fields on the **Volume and Age Sampling Card** are to be completed as described:

Field	Descriptions
Record Type	Record "S".
Number	Identification number continuing from tree numbering (<i>e.g.</i> , 057, 058, 059... etc.). If there are no live saplings, record '999'; no other measurements need to be recorded (<i>e.g.</i> , species, DBH etc.).
Species	Record the species using a 2 digit species code as provided in Appendix 8.

⁴ In cases where the AVI call did not include layers identified by the field call, the field call will be used **for the additional layers only**.

DBH	Measure and record the diameter at breast height (1.3 m) to the nearest 0.1 cm. Diameter measurement methods are presented in Appendix 9.
Crown Class	Assess and record the crown class on all saplings. Saplings with a broken top or severe lean will not be assigned a crown class. Appendix 10 defines crown classes.
Condition Codes	Assess and record the condition of each sapling. Record a maximum of 3 conditions, in order of priority. Appendix 11 lists the conditions to be considered in order of priority and their 2 digit code.
AVI Layer	Assign each stem to an AVI layer based on the AVI 2.1 inventory labels (not based on the field call) ⁵ . Use layer heights from the AVI call to help distinguish layers (<i>e.g.</i> , there is a 4 m height difference between layer 1 and layer 2, as opposed to a 15 m height difference between layer 1 and layer 2 - this will indicate to the field crew where they should be looking).
Height	Measure and record the height on selected saplings (1 per species) to the nearest 0.1 m. Detailed instructions for determining height are provided in Appendix 12.

2.6 Age Sampling

Ages of each leading species will be sampled from each AVI 2.1 layer. Sampling will occur within the 7.98 m radius plot, with selection based on AVI 2.1 layers (rather than DBH classes)⁶. To be eligible for sampling, a given stem must exceed 1.3 m in height, since breast height age must be taken.

The following selection rules are to be used for selecting the species and number of stems to be sampled for each canopy layer. Generally, this process will be completed during the pre-selection phase, and the information will be provided to the crew on the **Stand Data Form**. However, in the case of missed layers or incompatible AVI calls, the crew will need to use these rules to determine sampling requirements. For information on when to vary from the provided age sampling requirements, see Section 2.6.2.

2.6.1 Selecting Samples by AVI Layer

The **AVI 2.1 inventory label** is to be used to determine whether the layer is a conifer, deciduous or mixedwood layer, with some exceptions (see section 2.6.2). Leading species are then selected within each cover type as follows:

Conifer Types. For pure conifer layers (deciduous component $\leq 20\%$), **2 ages** are to be sampled for each of the **two leading coniferous species** found in the AVI label.

For example:

$Pl_7Sw_1Bw_1Aw_1 = 2$ lodgepole pine ages and 2 white spruce ages $Pl_9Aw_1 = 2$ lodgepole pine ages $Pl_6Sw_2Sb_2 = 2$ lodgepole pine ages and 2 white spruce ages
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⁵ In cases where the AVI call did not include layers identified by the field call, the field call will be used for the **additional layers only**.

⁶ See Appendix 13 for a comparison of volume and age sampling.

Deciduous Types. For deciduous layers (deciduous component $\geq 80\%$), **2 ages** are to be sampled for the **leading deciduous and coniferous species** found in the AVI label. If present, incidental white spruce (not in AVI label) is also to be aged.

For example:

$Aw_{10} = 2$ aspen ages and 1 incidental white spruce age $Aw_8Pb_1Sw_1 = 2$ aspen ages and 2 white spruce ages $Aw_8Pl_2 = 2$ aspen ages, 2 lodgepole pine ages and 1 incidental white spruce age $Aw_8Pb_2 = 2$ aspen ages and 1 incidental white spruce age
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Mixedwood Types. For mixedwood layers ($21\% \leq$ deciduous component $\leq 79\%$), **2 ages** are to be sampled for the **leading deciduous and coniferous species** found in the AVI label.

For example:

$Sw_6Aw_4 = 2$ white spruce ages and 2 aspen ages $Aw_4Pb_3Sw_3 = 2$ aspen ages and 2 white spruce ages $Sw_7Pb_3 = 2$ white spruce ages and 2 balsam poplar ages

2.6.2 Exceptions to the Selection Rules

Incompatible AVI Call. If there is a disagreement between leading species on the AVI label and the field call that would prevent sampling tree ages, sample the species present and note on the **Plot Data Card** by marking the '**Incompatible AVI**' field with an 'X'.

If there is a difference between the species percentages that would affect the definition of the leading species, follow the AVI label and **do not** change the leading species selection.

For example:

Sb_{10} is actually $Sw_{10} = 2$ white spruce ages and note Aw_7Sw_3 is actually $Pb_7Sw_3 = 2$ balsam poplar ages and 2 white spruce ages and note $Aw_4Pb_3Sw_3$ is actually $Pb_6Aw_2Sw_2 = 2$ aspen ages and 2 white spruce ages (unchanged)

If the required species is not found within the plot, replace with another species of the same type (*e.g.*, replace conifer species by another conifer species and deciduous species by another deciduous species). If no replacement is available, **do not** replace with a species of another type (*i.e.*, do not replace a conifer species with a deciduous species or vice versa). There must be **no** eligible stems of that species in order to justify substitution.

For example:

Sw_6Aw_4 : no white spruce is present in plot but lodgepole pine is present = 2 aspen ages and 2 lodgepole pine ages Sw_6Aw_4 : only one white spruce is present but there is abundant lodgepole pine = 2 aspen ages and 1 white spruce age Sw_6Aw_4 : white spruce is present but unsuitable for sampling (see next section); lodgepole pine is present and suitable = 2 aspen ages and 2 lodgepole pine ages
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Missed Layer. If the AVI call information missed a layer that was called during field sampling, the field call will be used for assigning species and number of stems to be sampled (refer to the selection rules in Section 2.6.2) for the **additional layer only**. Note on the **Plot Data Card** by marking the '**Missed Call**' field with an 'X'.

2.6.3 Age Data Collection

For each selected leading species **by layer**, identify potential Top Height and Site Index stems within the 7.98 m (0.02 ha) radius tree plot. Top Height stems are defined as the 100 largest DBH stems of a given species per hectare that are relatively straight, undamaged, healthy and not “wolf”, “super dominant” or veterans. Top Height stems are suitable for Site Index prediction if they lack evidence of periods of suppression or repression⁷.

What is it?

- It is a **potential Top Height stem** if:
 - ✓ It is straight, undamaged and healthy AND
 - ✓ It is not a “wolf”, “superdominant” or veteran stem
- It is a **potential Site Index stem** if:
 - ✓ It is a potential Top Height stem AND
 - ✓ There is no evidence of suppression or repression (generally, dominant or open grown crown classes)

The two largest DBH stems in each layer (and for each selected species) that qualify for Site Index will be sampled, if two are available. If less than two Site Index stems are available, the largest DBH stems that qualify for Top Height (but not Site Index) will be selected until the total number of stems sampled (by selected species) is equal to two, if two are available. If no stems are suitable for Top Height, no sample is to be taken.

For example:

Leading Species 1: seven stems qualify for Top Height, four of which also qualify for Site Index; select the two largest DBH Site Index stems **regardless of whether the other Top Height stems have a larger DBH.**

Leading Species 2: six stems qualify for Top Height, one of which qualifies for Site Index; select the one Site Index stem and the largest DBH Top Height stem.

Leading Species 3: ten stems qualify for Top Height but none of these qualify for Site Index (*e.g.*, stand is repressed lodgepole pine, or layer 2 is suppressed by layer 1); select the two largest DBH Top Height stems.

For all selected Site Index stems, breast height age and total height are to be recorded. If the selected stem qualifies for Top Height only (unsuitable for Site Index because of signs of suppression or repression), ages are also to be taken at stump height, since there is reduced confidence in the applicability of years to breast height models.

Ages are to be sampled using either increment cores or cookies (for stems that are too small to be cored). All increment cores are to be properly labeled and saved for future reference by placing them in straws and sealing the ends. Cookies are to be properly

⁷ Suppressed stems are those whose height growth has been slowed by competition from other stems or vegetation. Repressed stems are those whose height growth has been slowed by competition resulting from excessive stand density. Both can occur in Top Height stems.

Periods of suppression can often be identified by examining increment cores for sections with dense rings. Layers 2 and 3 will often be suppressed by the presence of layer 1. Repressed stands can often only be identified by examining stand conditions, since stems may show consistently dense growth rings, which may be indicative of either repression or poor site quality.

labeled and saved for future reference by placing them in zippered bags. **Labels should include header information (township, range, meridian, polygon number and plot number), record type (T, S or A), number and whether the sample is from breast height or stump height.** Coniferous ages will be determined in the field wherever possible. Deciduous and remaining coniferous ages will be determined in an office environment.

The following fields on the **Plot Data Card** are to be completed as described:

Field	Descriptions
Actual Sampling	Species should be the same as the required species listed in the Stand Data Card , except where there is an incompatible AVI call or missed layer (see Section 2.6.2). Number of stems sampled for each species may vary, depending on availability within the plot.
Incompatible AVI	Mark with an ‘X’ if an incompatible AVI call led to a change in the species sampled.
Missed Call	Mark with an ‘X’ if a missing AVI layer was sampled (based upon the field call).
Not Avail.	Mark with an ‘X’ if no stems were available within the plot for a given AVI layer. This includes cases where the layer was below the minimum height required for sampling.

The following fields on the **Volume and Age Sampling Card** are to be completed as described:

Field	Descriptions
Top Height	Mark potential Top Height stems with an ‘X’ in the ‘Top Height’ field.
Site Index	Mark potential Site Index stems with an ‘X’ in the ‘Site Index’ field.
Breast Ht. Age	Count and record coniferous breast height ages where possible. Label and place all increment cores into straws and place all cookies into zippered bags for counting in an office environment.
Stump Ht. Age	For Top Height stems only (deemed unsuitable for Site Index). Count and record coniferous stump height ages where possible. Retain cookies/cores.
Height	Measure and record the height on every aged stem in the sample plot to the nearest 0.1 m. Detailed instructions for determining height are provided in Appendix 12. Spray paint is to be used to mark the stem to show the direction in which height was taken.

If the selected stem has a DBH below 9.1 cm and is located outside of the sapling plot, it will not have been recorded on the tally card. In this case, record the following additional data on the **Volume and Age Sampling Card**:

Field	Descriptions
Record Type	Record “A”.
Number	Identification number starting continuing from sapling numbering (<i>e.g.</i> , 133, 134, 135... etc.).

Species	Record the species using a 2 digit species code as provided in Appendix 8.
DBH	Measure and record the diameter at breast height (1.3 m) to the nearest 0.1 cm. Diameter measurement methods are presented in Appendix 9.
Crown Class	Assess and record the crown class on all age stems. Age stems with a broken top or severe lean will not be assigned a crown class. Appendix 10 defines crown classes.
Condition Codes	Assess and record the condition of each age stem. Record a maximum of 3 conditions, in order of priority. Appendix 11 lists the conditions to be considered in order of priority and their 2 digit code.
AVI Layer	Assign the stem to an AVI layer based on the AVI 2.1 inventory labels (not based on the field call) ⁸ .

⁸ In cases where the AVI call did not include layers identified by the field call, the field call will be used for the additional layers only.

3.0 Quality Control

Approximately 10% of the sample plots established will be field checked to ensure that all establishment and measurement standards are being met. Standard quality control checks for the volume sampling plots will involve checking approximately 50% of the measurements within the plot (except for total number of stems and species which will have a 100% check). At the discretion of the check cruiser, more than 50% of the measurements may be checked.

A total plot error of ≥ 2.0 points is considered unacceptable and the volume and age sampling plot may have to be remeasured, at the discretion of the check cruiser. If a plot is to be remeasured, all plots within a stand will be remeasured. In some cases, portions of plots may have to be remeasured. This would occur where one or two variables are consistently measured incorrectly. If this occurs, only those variables measured incorrectly would be remeasured.

All costs associated with remeasurement will be the responsibility of the field crew. Any remeasured plots will be returned to the pool for quality control selection.

PLOT LOCATION	Allowable Error	Points
Move/Offset	- the correct choice to move or offset must be made based on location rules	2
Moved/Offset Plots	- sketch map must be completed and labelled - seismic line widths must be within 0.5 m	0.5 0.25 per line
Plot Center	- center must be same as pre-selected UTM unless offset - access information must be complete and accurate - must be correctly flagged and identified - plot header information must be complete and accurate	1
Tree Plot	- size must be corrected for slope where necessary	1
Sapling Plot	- must be correctly located within the tree plot - size must be corrected for slope where necessary	1
VOLUME SAMPLING	Allowable Error	Points
No. of Live Stems	- no error allowed	0.5 per stem
Species	- no error allowed	0.5 per stem
Breast Height Markings	- must be marked on each stem, facing towards plot centre - must be within ± 3 cm from 1.3 m	0.25 per stem
DBH	- must be within ± 0.2 cm or 2% of the diameter, whichever is greater	0.25 per stem
Crown Class	- a maximum of 10% of stems can be misclassified by one crown class; no stems can be misclassified by more than one class (e.g., identifying stem as an I when it is a D)	0.25 per stem > 10% or per stem > 1 class
Condition Codes	- a maximum of 10% of the affected stems may be misclassified	0.25 per stem > 10%
AVI Layer	- a maximum of 5% of stems can be misclassified by one AVI layer; no stems can be misclassified by more than one AVI layer (e.g., layer 1 when it is in layer 3)	0.25 per stem > 10% or per stem > 1 layer
Measured Heights	- must be within 5% of the height - measured stems must be correctly marked with paint	0.25 per stem
AGE SAMPLING	Allowable Error	Points
Ages	- must be within 2 years or 10% of correct age, whichever is greater, for all stems	0.5 per stem
Measured Heights	- must be within 5% of the height - measured stems must be correctly marked with paint	0.25 per stem
Species Selection	- correct species must be sampled based on AVI call and sampling rules	0.5 per species

4.0 Literature Cited

Alberta Sustainable Resource Development. 2002. Permanent Sample Plot (PSP) Field Procedures Manual. Edmonton, AB. 130 p.

Nesby, R. 1997. Alberta Vegetation Inventory Version 2.2. Alberta Environmental Protection. Edmonton, AB. 58 p. plus appendices.

Olympic Resource Management. 2001. Volume Sampling Field Manual. Vancouver, BC. 43 p. plus appendices.

The Forestry Corp. 2003. Manning Diversified Forest Products Ltd. Volume Sampling Plan. Edmonton, AB. 13 p.

Appendix 1. List of Equipment

Expendable

- Spray Paint
- Flagging Tape
- Lumber Crayons
- Tally Cards
- Writing Implements
- Hip Chain Thread
- Straws and Masking Tape
- Zippered Bags

Reusable

- Volume and Age Sampling Field Manual
- Aluminum Clipboard
- GPS Unit
- Hip Chain
- Pocket Calculator
- Compass
- Measuring Tape
- 30 m Tape
- Clinometer
- Diameter Tape
- Increment Borers
- Lighter (For Melting Ends of Straws)
- Hand Lens
- Axe
- Saw (For Cutting Cookies)
- First Aid Kit

Optional

- Laser Height Measuring Device

Appendix 2. Sample Tally Cards

STAND DATA CARD

STAND INFORMATION

FMU	TWP.	RGE.	MERID.	POLYGON NO.

PLOT LOCATION INFORMATION

PLOT	PRE-SELECTED UTM CO-ORDINATES				OFFSET	MOVED	LOCATION NOTES
	UTM EASTING	UTM NORTHING					
1							
2							
3							
4							
5							
6							

* Shaded sections to be completed in the field.

AVI CALL FOR THE STAND

	MOIST	CC	ORIGIN	HT (m)	SP1	SP1%	SP2	SP2%	SP3	SP3%	SP4	SP4%	SP5	SP5%
1														
2														
3														

AGE TREE SAMPLING REQUIREMENTS (ALL PLOTS)

LAYER	SPP. 1 #	SPP. 2 #	SPP. 3 #
1			
2			
3			

NOTES

SEISMIC DATA CARD

PLOT HEADER INFORMATION

FMU	TWP.	RGE.	MERID.	POLYGON NO.	PLOT	DATE (yyyy/mm/dd)	CREW 1	CREW 2

PLOT SKETCH MAP (ONLY FOR PLOTS WITH SEISMIC, PRIOR TO OFFSETTING/MOVING)

** Label each sketched seismic line with seismic line number used in data collection.

SEISMIC LINE INFORMATION

SEISMIC LINE #	D1 (m)	D2 (m)	X-CENTER
0 1			
0			
0			
0			
0			

PLOT INFORMATION

EST'D % DISTURB. BY	UTM EASTING	UTM NORTHING
SEISMIC OTHER LG. ANTHRO		

* Recorded UTM co-ordinates should correspond to pre-selected plot location on stand data card.

NOTES

PLOT DATA CARD																
PLOT HEADER INFORMATION																
FMU	TWP.	RGE.	MERID.	POLYGON NO.	PLOT	DATE (yyyy/mm/dd)		CREW 1	CREW 2							
							/		/							
TREE PLOT AREA (m²)	SAP. PLOT AREA (m²)	UTM EASTING			UTM NORTHING			* Recorded UTM co-ordinates should correspond to pre-selected plot location on stand data card unless plot was offset.								
2 0 0	0 5 0															
ACCESS INFORMATION INCL. TIE POINT(S)						ACCESS MAP										
<hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>						<hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>										
FIELD CALL																
1	MOIST	CC	HT (m)	SP1	SP1%	SP2	SP2%	SP3	SP3%	SP4	SP4%	SP5	SP5%			
2	MOIST	CC	HT (m)	SP1	SP1%	SP2	SP2%	SP3	SP3%	SP4	SP4%	SP5	SP5%			
3	MOIST	CC	HT (m)	SP1	SP1%	SP2	SP2%	SP3	SP3%	SP4	SP4%	SP5	SP5%			
AGE TREE SAMPLING																
LAYER	REQUIRED SAMPLING						ACTUAL SAMPLING						NOTES			
	SPP. 1	#	SPP. 2	#	SPP. 3	#	SPP. 1	#	SPP. 2	#	SPP. 3	#		INCOMPAT	MISSED CALL	NOT AVAIL.
1																
2																
3																
FIELD NOTES																
<hr/> <hr/> <hr/>																

VOLUME AND AGE SAMPLING CARD										Side 1							
PLOT HEADER INFORMATION																	
FMU	TWP.	RGE.	MERID.	POLYGON NO.	PLOT	DATE (yyyy/mm/dd)		CREW 1	CREW 2								
							/		/								
REC TYPE	NUMBER	SPP.	VOLUME SAMPLING DATA					AGE SAMPLING DATA									
			DBH (cm)	CROWN CLASS	COND CODE 1	COND CODE 2	COND CODE 3	AVI LAYER	HEIGHT (m)	TOP HEIGHT	SITE INDEX	BREAST HT. AGE (years)	STUMP HT. AGE (years)	HEIGHT (m)			

VOLUME AND AGE SAMPLING CARD

Side 2

REC TYPE	NUMBER	SPP.	VOLUME SAMPLING DATA						AGE SAMPLING DATA					
			DBH (cm)	CROWN CLASS	COND CODE 1	COND CODE 2	COND CODE 3	AVI LAYER	HEIGHT (m)	TOP HEIGHT	SITE INDEX	BREAST HT. AGE (years)	STUMP HT. AGE (years)	HEIGHT (m)

Appendix 3. GPS Equipment Performance Standards

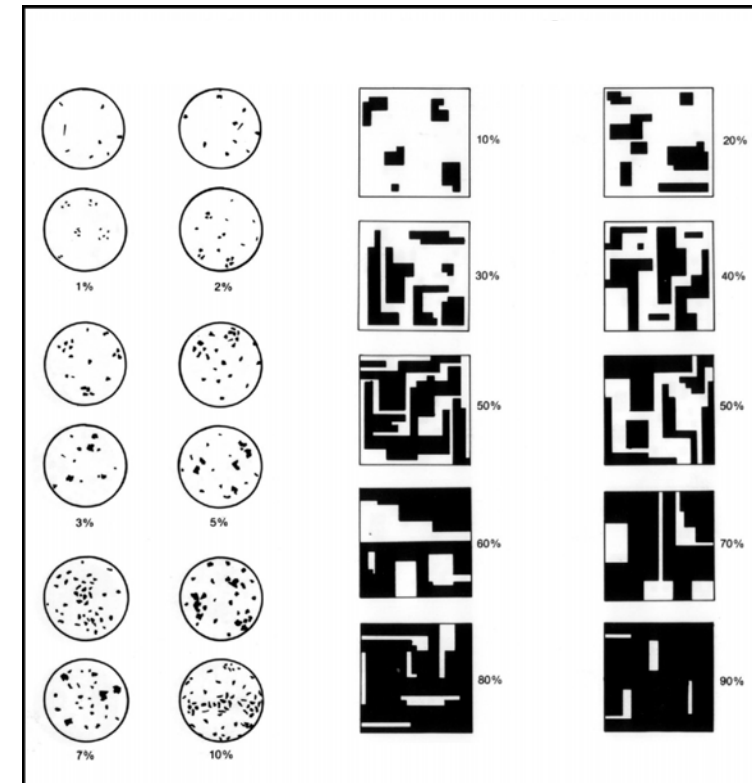
- PDOP – maximum PDOP=8
- # points per plot to confirm location: minimum 30
- NAD1983
- UTM coordinate system with post differential correction

Appendix 4. Slope Correction

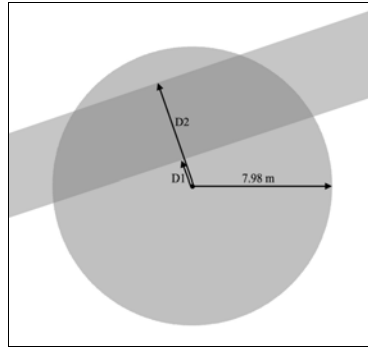
Percent Slope	Slope Correction	Slope Distance		Percent Slope	Slope Correction	Slope Distance	
		HD=7.98 m	HD=3.99 m			HD=7.98 m	HD=3.99 m
10	0.995	8.02	4.01	55	0.876	9.11	4.55
11	0.994	8.03	4.01	56	0.873	9.15	4.57
12	0.993	8.04	4.02	57	0.869	9.19	4.59
13	0.992	8.05	4.02	58	0.865	9.23	4.61
14	0.990	8.06	4.03	59	0.861	9.27	4.63
15	0.989	8.07	4.03	60	0.857	9.31	4.65
16	0.987	8.08	4.04	61	0.854	9.35	4.67
17	0.986	8.09	4.05	62	0.850	9.39	4.69
18	0.984	8.11	4.05	63	0.846	9.43	4.72
19	0.982	8.12	4.06	64	0.842	9.47	4.74
20	0.981	8.14	4.07	65	0.838	9.52	4.76
21	0.979	8.15	4.08	66	0.835	9.56	4.78
22	0.977	8.17	4.09	67	0.831	9.61	4.80
23	0.975	8.19	4.09	68	0.827	9.65	4.83
24	0.972	8.21	4.10	69	0.823	9.70	4.85
25	0.970	8.23	4.11	70	0.819	9.74	4.87
26	0.968	8.25	4.12	71	0.815	9.79	4.89
27	0.965	8.27	4.13	72	0.812	9.83	4.92
28	0.963	8.29	4.14	73	0.808	9.88	4.94
29	0.960	8.31	4.15	74	0.804	9.93	4.96
30	0.958	8.33	4.17	75	0.800	9.98	4.99
31	0.955	8.35	4.18	76	0.796	10.02	5.01
32	0.952	8.38	4.19	77	0.792	10.07	5.04
33	0.950	8.40	4.20	78	0.789	10.12	5.06
34	0.947	8.43	4.21	79	0.785	10.17	5.08
35	0.944	8.45	4.23	80	0.781	10.22	5.11
36	0.941	8.48	4.24	81	0.777	10.27	5.13
37	0.938	8.51	4.25	82	0.773	10.32	5.16
38	0.935	8.54	4.27	83	0.769	10.37	5.19
39	0.932	8.57	4.28	84	0.766	10.42	5.21
40	0.928	8.59	4.30	85	0.762	10.47	5.24
41	0.925	8.62	4.31	86	0.758	10.53	5.26
42	0.922	8.66	4.33	87	0.754	10.58	5.29
43	0.919	8.69	4.34	88	0.751	10.63	5.31
44	0.915	8.72	4.36	89	0.747	10.68	5.34
45	0.912	8.75	4.38	90	0.743	10.74	5.37
46	0.908	8.78	4.39	91	0.740	10.79	5.39
47	0.905	8.82	4.41	92	0.736	10.84	5.42
48	0.902	8.85	4.43	93	0.732	10.90	5.45
49	0.898	8.89	4.44	94	0.729	10.95	5.48
50	0.894	8.92	4.46	95	0.725	11.01	5.50
51	0.891	8.96	4.48	96	0.721	11.06	5.53
52	0.887	8.99	4.50	97	0.718	11.12	5.56
53	0.884	9.03	4.52	98	0.714	11.17	5.59
54	0.880	9.07	4.53	99	0.711	11.23	5.61

Appendix 5. Assessing Percent Area Disturbed

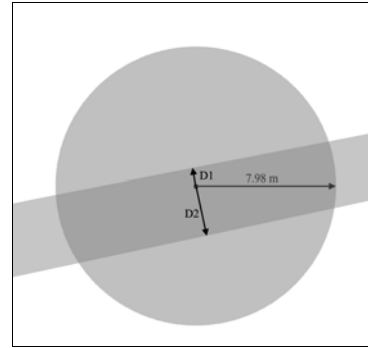
Use the images below to aid in estimating the percent of the total plot area which is disturbed by unmappable (< 5 m in width) seismic lines.



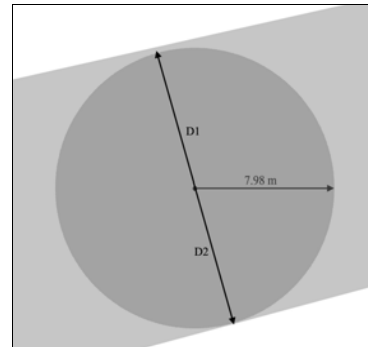
Appendix 6. Measurements of Area Disturbed by Seismic Lines



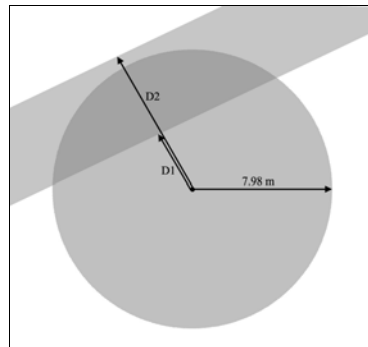
Case 1. Seismic line extends through plot.



Case 2. Seismic line crosses plot center.



Case 3. Seismic line crosses entire plot.



Case 4. Part of seismic line crosses plot.

Appendix 7. AVI 2.2 Short Data Dictionary

This document is designed to provide a list and brief explanation for the common AVI codes used. For definitions and more detailed explanations please refer to the AVI Version 2.2 Standards Manual (Nesby 1997).

Ecological Moisture Regime. Ecological moisture regime is recorded as a numeric code selected from the following:

Moisture Regime	Code
Very Xeric	0
Xeric	1
Subxeric	2
Submesic	3
Mesic	4
Subhygric	5
Hygric	6
Subhydric	7
Hydric	8

Crown Closure Class. Crown closure of forested and non-forested land refers to the percentage of ground area covered by a vertical projection of crown areas onto the ground. Crown closure class is recorded using the following codes:

Crown Closure Class (%)	Code
01 – 05	V
06 – 10	0
11 – 20	1
21 – 30	2
31 – 40	3
41 – 50	4
51 – 60	5
61 – 70	6
71 – 80	7
81 – 90	8
91 – 100	9

Origin. Origin age will be calculated based upon sampled age stems after field sampling.

Stand Height. Stand height is the average height in metres of the dominant and codominant trees of the leading species in a stand.

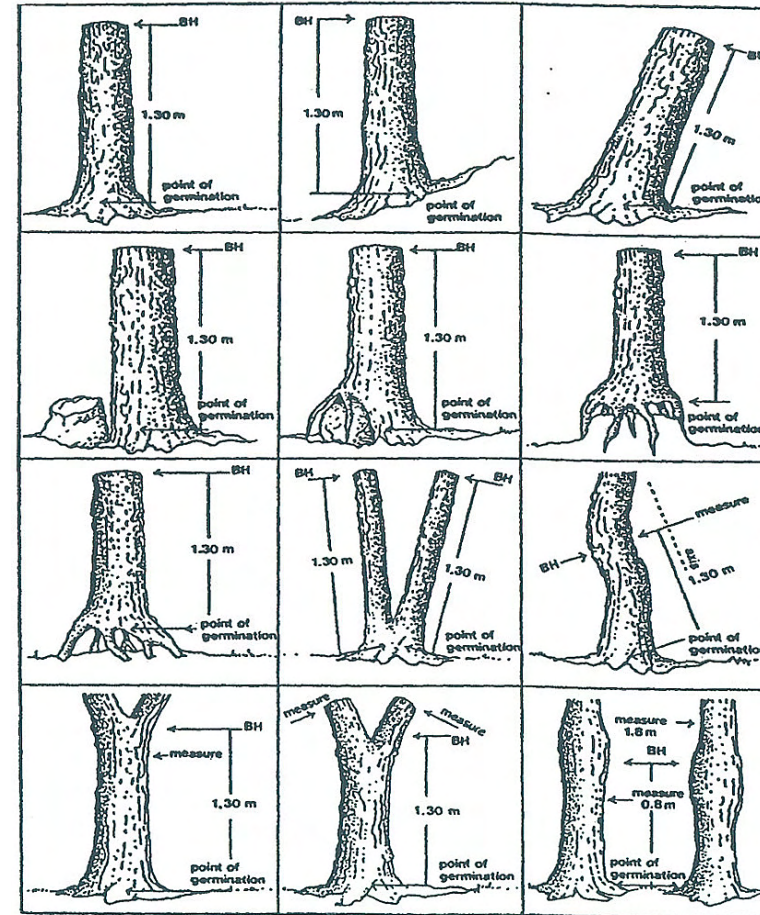
Species Composition. Species composition is expressed in percent crown closure that an individual species contributes to the overall species composition.

Appendix 8. Species List and Codes

Species Name	Common Name	Species Code
<i>Abies lasiocarpa</i>	Alpine fir	FA
<i>Abies balsamea</i>	Balsam fir	FB
<i>Betula papyrifera</i>	Paper birch	BW
<i>Pseudotsuga menziesii</i>	Douglas-fir	FD
<i>Larix lyallii</i>	Alpine larch	LA
<i>Larix laricina</i>	Tamarack	LT
<i>Larix occidentalis</i>	Western larch	LW
<i>Pinus flexilis</i>	Limber pine	PF
<i>Pinus banksiana</i>	Jack pine	PJ
<i>Pinus contorta</i>	Lodgepole pine	PL
<i>Pinus albicaulis</i>	White pine	PW
<i>Populus tremuloides</i>	Trembling aspen	AW
<i>Populus balsamifera</i>	Balsam poplar	PB
<i>Picea glauca</i>	White spruce	SW
<i>Picea engelmannii</i>	Engelmann spruce	SE
<i>Picea mariana</i>	Black spruce	SB

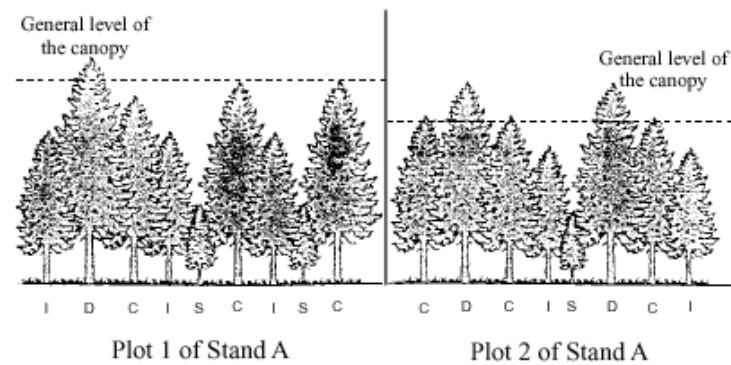
Appendix 9. Diameter Measurement Techniques

This diagram was taken from Alberta Sustainable Resource Development (2002). Measure diameter at 1.30 m above the root collar, paying attention to the following anomalies:



Appendix 10. Definition of Crown Classes

Crown Class	Code	Definition
Dominant	D	Crown extends above the general level of the canopy.
Codominant	C	Crown forms the general level of the canopy.
Intermediate	I	Crown is below the general level of the canopy but extends into the bottom of the canopy layer.
Suppressed	S	Crown is entirely below the general level of the canopy.
Open Grown	O	Crown is in a very open stand.
No Crown Class	X	For damaged trees with no crown class assignment



Diagrams were taken from Alberta Sustainable Resource Development (2002).

Appendix 11. Definition of Condition Codes

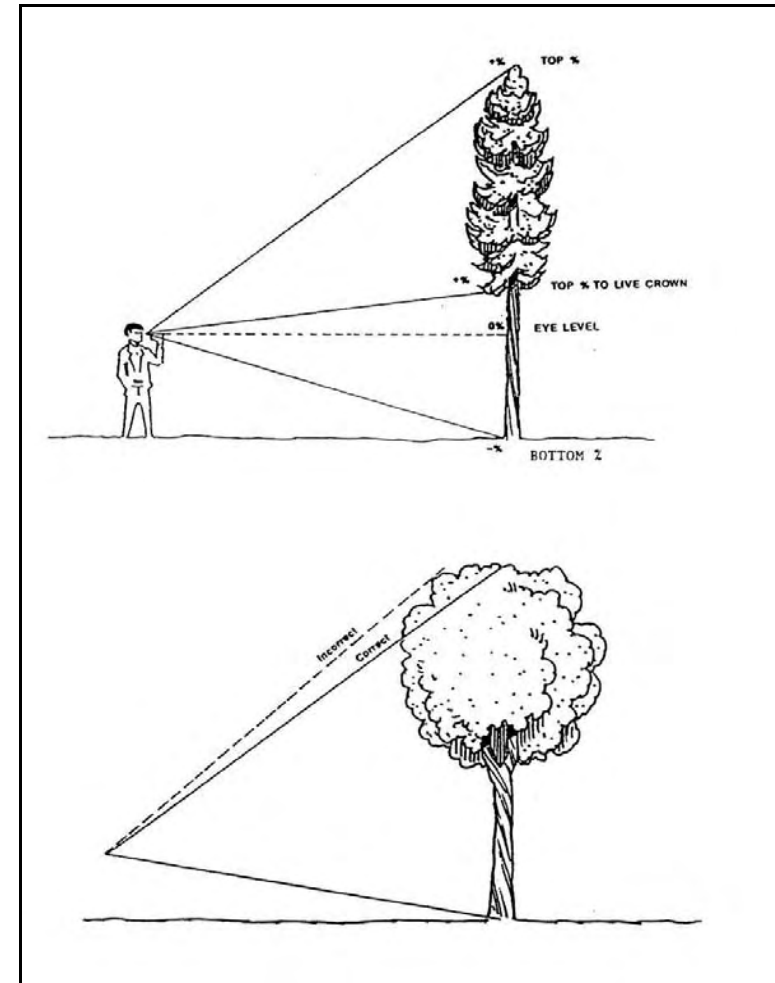
Condition Code	Description
00	Healthy
01	Insects
02	Disease
03	Rabbit Browsing
04	Shepherd's Crook
05	Other Browsing
06	Fire
07	Mechanical
08	Windthrow
09	Climate
10	Flooding
11	Poor Planting
12	Suppression
13	Frost Heaving
14	Erosion
15	Missing
16	Dead Top/Dieback
17	Poor Seedbed
18	Herbicide
19	Western Gall Rust (only pine)
20	Armillaria Root Rot
21	Mouldy Planting Stock
22	Multiple Leaders
23	Poor Form
24	Broken Top (new or old)
25	Dead and Standing (no CC)
26	Snow Press
27	Dead Top Dieback with NEW Leader
28	Sucker(s) from OLD Stump
29	Cut Down
30	Terminal Weevil
31	Spruce Gall Aphid
32	Tent Caterpillar
33	Root Collar Weevil
34	J-Root
35	Leaning
36	Same Stump
37	Unknown
38	Pitch Moth
39	DBH Taken on New Leader
40	Nutrient Deficiency
41	Mouse Feeding
42	Ungulate Feeding/Rubbing
43	Domestic Livestock Feeding/Rubbing

Condition Code	Description
44	Nest
45	Other Mammalian/Avian Evidence
51	Conks/Blind Conks
52	Open Scars
53	Burls and Galls
54	Fork
55	Pronounced Crook
56	Broken Top (<=10 cm DIB at break, DBH>=9.1 cm) (no CC)
57	Limby
58	Leaning (DBH>=9.1 cm)(if severe no CC)
59	Broken Stem (>=10 cm DIB at break)(no CC)
60	Generic Woodpecker Feeding
61	Dead and Down (no CC)
62	Stem Insects
63	Stem Disease
64	Foliar Insects
65	Foliar Disease
66	Stem Form Defect (>=7.0 cm DIB at point where begins)
67	Closed Scars
68	Atropellis Canker
69	Comandra Blister Rust
70	Elytroderma Needle Cast
71	Hypoxylon Canker
72	Spruce Cone Rust
73	Stalactiform Blister Rust
74	Tomentosus Root Rot
75	Spruce Spanworm
76	Cone Maggot
77	Coneworm
78	Eastern Spruce Budworm
79	Mountain Pine Beetle
80	Spruce Beetle
81	Spruce Needle Budworm
82	Yellow Headed Spruce Sawfly
83	Large Aspen Tortrix
84	Excavation by Woodpeckers
85	Yellow-Bellied Sapsucker Feeding
86	Small Mammal Feeding on Tree Bole
87	Small Cavity
88	Large Cavity
89	Hollow Tree or Hollow Bole Section
90	Beaver Feeding/Harvesting
91-96	Mistletoe Rating System
98	Data Changed by Office

Condition codes were taken from Olympic Resources Management (2001). No CC indicates that trees with this damage type are not to be assessed for crown class.

Appendix 12. Height Measurement Techniques

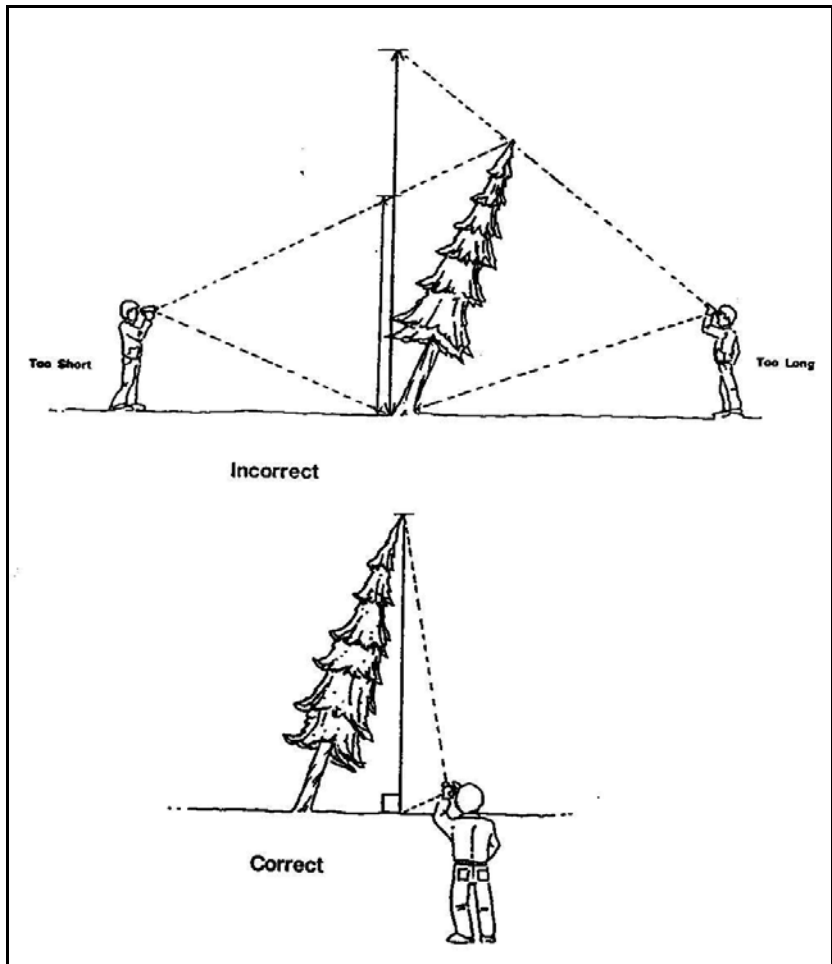
Diagrams were taken from Alberta Sustainable Resource Development (2002). Using a clinometer, total tree height is measured in the following manner: measure the distance from the crew person to the tree in m. Using a clinometer, measure the percent angle to the top of the tree (Top %) and to the base of the tree (point of germination, Bottom %).



For leaning trees, all measurements should be taken from the side, so that measurements are not biased (see below). The total tree height is then calculated using:

$$\text{Total Tree Height (m)} = \text{Horizontal Dist (m)} * \frac{\text{Top\%} - \text{Bottom\%}}{100}$$

Alternatively, time-saving electronic height measurement equipment (such as a laser rangefinder) may be used.



Appendix 13. Volume vs. Age Sampling

An example of the differences between selection of volume sampling trees and age trees is provided below. Shown is a multilayer stand. Diameter at breast height for the overstory aspen layer (layer 1) ranges from 10.5 to 12.7 cm. The understory spruce layer (layer 2) ranges from 7.3 to 9.4 cm DBH. The mixed deciduous understory (layer 3) ranges from 1.7 to 3.4 cm DBH.

For the purposes of volume sampling, all of the overstory aspen would be defined as trees (DBH ≥ 9.1 cm). The larger understory spruce with a DBH greater than or equal to 9.1 cm would also be defined as trees. Sampling of trees will occur within the 7.98 m radius tree plot. The remaining smaller spruce and all mixed deciduous understory trees (all with DBH <9.1 cm) would be defined as saplings. Sampling of saplings will occur within the 3.99 m radius plot.

For the purposes of age sampling, all aspen would be defined as layer 1 trees (based on AVI 2.1 labels), all spruce would be defined as layer 2 trees (based on AVI 2.1 labels), and all mixed deciduous would be defined as layer 3 trees (possibly based upon a field call). A 7.98 m radius plot, overlapping the location of the tree plot, will be used for sampling. This means that a selected stem for age sampling may be outside of the sapling plot, but have a DBH less than 9.1 cm.

