Spray Lake Sawmills

# Detailed Forest Management Plan 2001 – 2026

# Chapter 7 - Growth and Yield

December 15, 2006

# Chapter 7- Growth and Yield Report

Estimating forest growth and yield is fundamental to sustainable forest management and in particular to modeling and projecting sustainable forest harvest levels over time. Following is the report "The Growth and Yield Component of Spray Lake Sawmills Detailed Forest Management Plan" prepared by Golder Associates. The report addresses the volume sampling methodology and yield curve development for the Spray Lake Sawmills FMA.

Spray Lake Sawmills oversaw the project and provided general direction and feedback. Sustainable Resource Development has reviewed versions of the report and the technical development of the yield curves and provided valuable feedback. Digital data sets are included on the CD.

# Erratum

The following typographical errors were noted in the original report prepared by Golder Associates. The correct parameter values were used in all analysis.

**Table 8**
**Parameter Estimates of Deciduous 15/11 Volumes for Yield Strata**

| Strata Number | Strata | Decid_a | Decid_b | Decid_c | Decid_x | N |
|---|---|---|---|---|---|---|
| 1 | B9B-C–PL | 0.004046 | 1.93084 | | | 372 |
| 2 | B9B-C–SW | 0.02926 | 1.86694 | 0.014636 | 1 | 210 |
| 3 | B10B-C–PL | 0.004046 | 1.93084 | | | 372 |
| 4 | B10B-C–SW | 0.02926 | 1.86694 | 0.014636 | 0 | 210 |
| 5 | FMA-MX-n/a | 0.015030 | 2.22332 | | | 59 |
| 6 | FMA-D–n/a | 0.025263 | 2.27382 | | | 113 |

Figure 4. Strata 2 – Estimated coefficients – deciduous values should be as per table 8.

Figure 6. Strata 4 – Estimated coefficients – coniferous and deciduous values should be as per table 7 and corrected table 8 respectively.

**FINAL REPORT ON**

# THE GROWTH AND YIELD COMPONENT OF SPRAY LAKE SAWMILLS DETAILED FOREST MANAGEMENT PLAN

Submitted to:

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Forest Management Branch
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Attention: Mr. Dave Coish

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August 2004
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## 1.0 INTRODUCTION

As part of the Detailed Forest Management Plan development process, this document addresses the volume sampling methodology and yield curve development for the Spray Lake Sawmills Ltd. (SLS) Forest Management Agreement (FMA) area.

The FMA area consists of forest management units (FMUs) B10B and B9B. Also under SLS management (quota), but outside of the FMA area is the B9 FMU (Figure 1). B10B (previously B7) is the unit south of Highway #1. B9B and B9 (B9B/B9) are FMUs both north of Highway #1 and contain portions of the old B6 and B8 areas. These FMUs were renamed after a revised boundary agreement was made in 2001 between Sustainable Resource Development - Land and Forest Division, SLS and Sunpine Forest Products Ltd. (Sunpine).

SPRAY LAKE SAWMILLS (1980) LTD.

## Spray Lake Sawmills FMA - Quota and Surrounding Area

### *LEGEND*

FMA -Quota Area

C5 Area

**Ancillary Data**

Major Hydrography

Settlement

Major Road

Township Range Grid

### *MAP INFORMATION*

***Source:***

Settlement and transportation features provided by GAIA Consultants Inc. Spray Lake Sawmills FMA - Quota Area provided by the Alberta Government Sustainable Resource Division.

***Projection:***
Transverse Mercator (UTM Zone 11)

***Datum:***
NAD83

***Coordinate System:***
Alberta Township System Grid

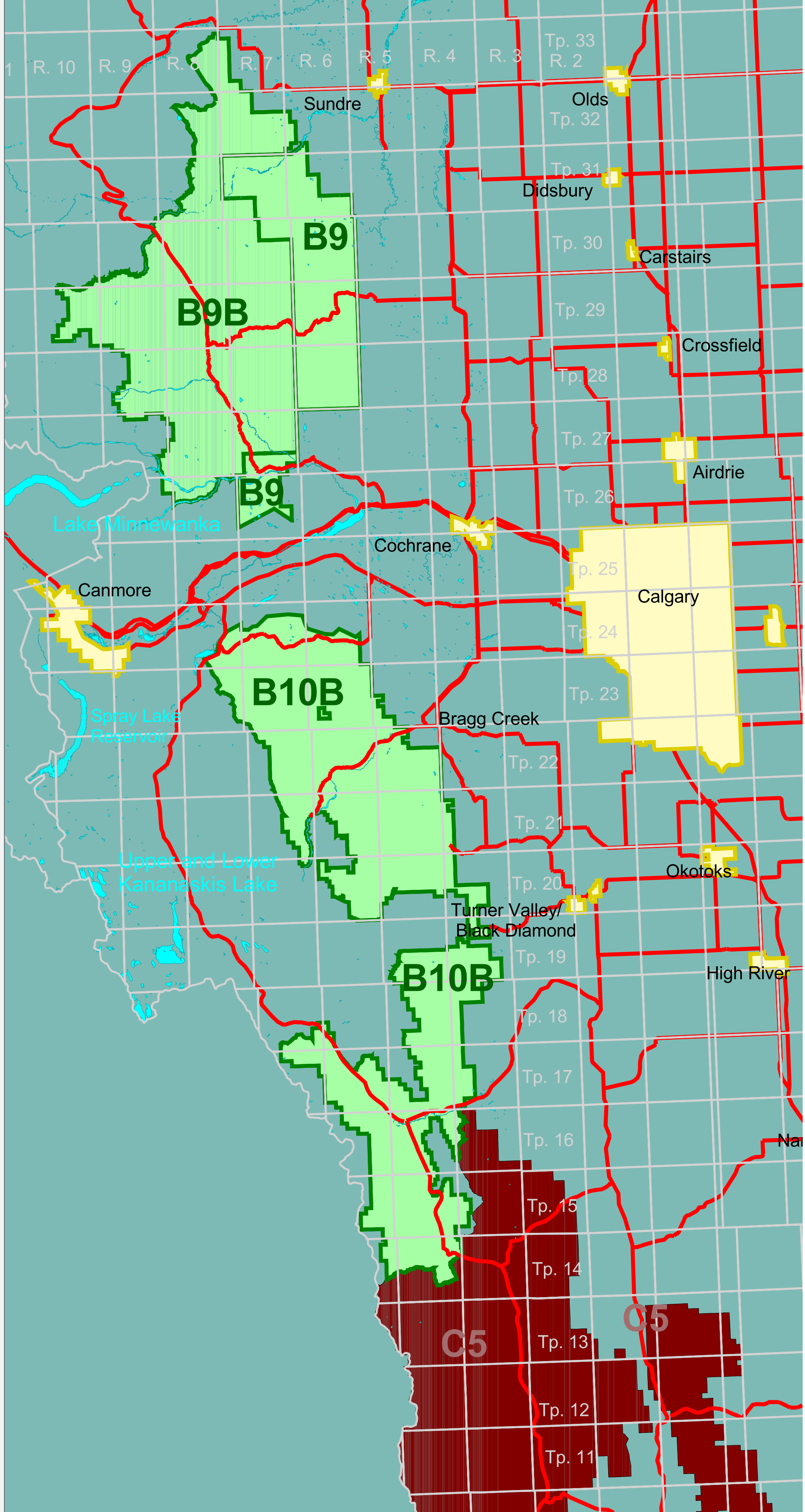
N

GAIA CONSULTANTS INC.

Created 02/09/6 for Golder Associates Ltd. by GAIA Consultants Inc.
GIS and Cartography by B. Trawick.

*Although there is no reason to believe there are any errors associated with the data used to generate this product or in the product itself, GAIA Consultants Inc.'s liability is limited to the purchase price of the service provided.*



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# 2.0 VOLUME SAMPLING

Two separate volume sampling programs, one by the Alberta Sustainable Resource Development - Land and Forest Division (the Crown) and the other a joint effort between SLS, Sunpine, and the Crown, provided plot and tree data to build the growth and yield relationships for SLS's timber supply planning. This section is organized to summarize both independent sampling designs (Sections 2.1 and 2.2) and to summarize the plot data collected (Section 2.3).

## 2.1 Forest Management Unit B10B

Five hundred and ten (510) plots were sampled in FMU B10B in 1997 and another 28 plots were completed in 1999; both programs were designed and implemented by the Crown.

Appendix I contains the sampling design document provided to SLS by the Crown titled, *Volume Sampling for the B7 Forest Management Unit*. All the information described in Sections 2.1.1 to 2.1.4 has been summarized from that document.

### 2.1.1 Sampling Design

The sampling design was intended to gather volume sampling data for the Alberta Vegetation Inventory (AVI) to be used in the development of regional and local stand volume and yield tables.

### 2.1.2 Plot and Stand Selection

Stands were selected randomly using proportional allocation based on appropriate crown density, species, and height classes. Stands were selected without replacement, and within each selected stand a cluster of three plots was established.

### 2.1.3 Measurement Procedures and Standards

At each plot center, a circular 100 $m^2$ plot was established whereby all trees ≥7.1 centimeter (cm) diameter at breast height (dbh) were measured. For each tree in the plot, the following data relevant to the yield curves presented later in this report were collected:

- species;
- dbh outside bark; and,
- stump diameter.

Measurement protocols ensured a representative range of heights and ages were measured for all tree species across all the distinct canopy layers.

#### 2.1.4 Quality Control

There was no statement for the desired precision of the sampling program.

The Crown first completed an office inspection of all tally cards to identify missing information, improperly coded information, and measurements that were obviously suspect. Secondly, a thorough field inspection consisting of checking all data tallied and ensuring they were within defined tolerance levels was completed for 10% to 20% of the plots.

### 2.2 FOREST MANAGEMENT UNITS B9B AND B9

Between 1998 and 2000, there was a joint effort between SLS and Sunpine to disentangle their shared timber resource boundary. That process resulted in the Crown participating with these two parties in the collection of volume sampling data in non-FMA areas of B6 and B8. As a result, a total of 474 plots were sampled within the current B9B/B9 FMU and are available to SLS for generating yield curves.

The sampling design is provided in Appendix II *Volume Sampling Manual for B9B/B9 Forest Management Units (Sunpine)*. Sections 2.2.1 to 2.2.4 represent summaries of that document.

#### 2.2.1 Sampling Design

The program was designed to provide data suitable for the development of stand and stock tables as well as yield relationships. The sampling design followed a multi-stage stratified-random sampling design.

#### 2.2.2 Plot and Stand Selection

Possible townships for sampling were determined using a random selection algorithm. For each township selected, a list of five randomly selected quarter section centers was generated.

Within each of these randomly selected quarter sections, attempts were made to locate three to four stands requiring sampling, all within a distance of 1.5 km of each other. Each selected stand was then sampled with a cluster of three plots.

Plot stratification was generally based on Natural Subregion, species composition, density, and height class. Within each stratum, plots were distributed across the range of potentially merchantable height classes. The number of plots allocated per stratum was generally proportional to the area of the stratum. In strata having relatively large areas, it was necessary to impose maximums on the number of plots to ensure that other strata would be represented.

### 2.2.3 Measurement Procedures and Standards

A circular 160 $m^2$ plot was established and all trees $\geq$7.0 cm dbh were measured. For each tree in the plot the following data were collected:

- species; and,
- dbh outside bark.

Age, height, and stump diameter were measured for selected trees within each plot. Measurement protocols ensured that a representative range of ages, heights, and stump diameters were measured for all species across all the distinct canopy layers.

### 2.2.4 Quality Control

This sampling methodology was intended to estimate the merchantable volume of the current forest with a precision of +/-10% at the 90% confidence level. There is no report as to whether this was achieved.

SLS first completed an office inspection to ensure all tally cards were completed and recorded properly. Secondly, a thorough field inspection to ensure that all the plot data tallied was within defined tolerance levels was completed for 4% to 8% of the plots.

## 2.3 Summary of Data Collected

The following section presents tabular and spatial summaries of all the plots collected under the two sampling designs detailed in Sections 1.1 and 1.2. Table 1 summarizes the number of plots sampled in B10B by leading species and crown class. The 28 plots completed in 1999 did not have spatial co-ordinates and were matched to the AVI using the Township, Range, Meridian, and stand number.

**Table 1**
**Plots by Leading Species and Crown Class for B10B[1]**

| Leading Species | A | B | C | D | Blank | Grand Total |
|---|---|---|---|---|---|---|
| Deciduous | 6 | 10 | 50 | 12 | | **78** |
| Mixedwood | 8 | 6 | 6 | 3 | | **23** |
| Pine | 16 | 18 | 126 | 47 | | **207** |
| White Spruce/Fir | 36 | 41 | 105 | 9 | | **191** |
| Non Forested | | | | | 39 | **39** |
| **Grand Total** | **66** | **75** | **287** | **71** | **39** | **538** |

Table 2 summarizes the number of plots sampled in B9B/B9 by leading species and crown class.

**Table 2**
**Plots by Leading Species and Crown Class for B9B/B9**

| Leading Species | A | B | C | D | Blank | Grand Total |
|---|---|---|---|---|---|---|
| Deciduous | 2 | 12 | 21 | 3 | | **38** |
| Mixedwood | 2 | 14 | 16 | 7 | | **39** |
| Pine | 5 | 29 | 120 | 75 | | **229** |
| Black Spruce/Larch | 5 | | | 7 | | **12** |
| White Spruce/Fir | 11 | 28 | 42 | 1 | | **82** |
| Non Forested | | | | | 74 | **74** |
| **Grand Total** | **25** | **83** | **199** | **93** | **74** | **474** |

Table 3 summarizes the number of plots used in the analysis by leading species and crown class.

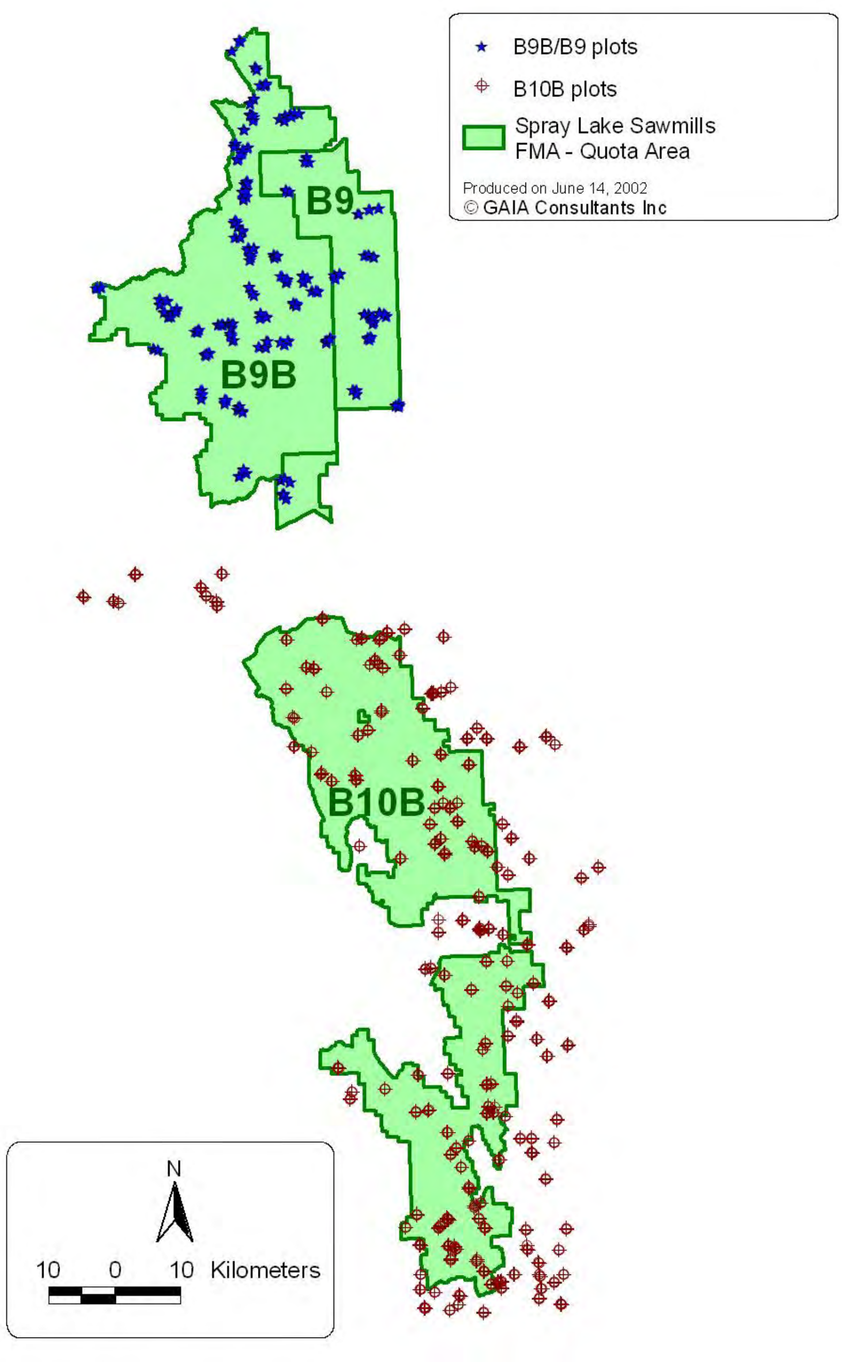
**Table 3**
**Plots by Leading Species and Crown Class for the Forest Management Agreement Area and B9 used to Generate Yield Curves**

| Leading Species | A | B | C | D | Blank | Grand Total |
|---|---|---|---|---|---|---|
| Deciduous | 8 | 22 | 71 | 15 | | **116** |
| Mixedwood | 10 | 20 | 22 | 10 | | **62** |
| Pine | 21 | 47 | 246 | 122 | | **436** |
| White Spruce/Fir/ Black Spruce/Larch | 52 | 69 | 147 | 17 | | **285** |
| Non Forested | | | | | 113 | **113** |
| **Grand Total** | **91** | **158** | **486** | **164** | **113** | **1012** |

[1] 260 plots are outside of the forest management agreement area. However, in discussions with the Crown, it was decided that these plots would be included in this analysis. See Appendix III for more details.

Figure 2 presents the locations of all 510 plots in B10B and all 474 plots in B9B/B9. The additional 28 plots sampled in B10B in 1999 are not included in Figure 2 because spatial co-ordinates were not available for these plots.

Figure 2 Plot Locations within the Spray Lake Sawmills Forest Management Area



# 3.0 PLOT COMPILATION

This section describes the procedures used to compile the tree and plot information to provide meters cubed per hectare ($m^3/ha$) estimates for both the coniferous and deciduous components.

## 3.1 TREE VOLUME COMPILATION

There were a total of 7,520 trees (538 plots) sampled in B10B and a further 8,495 trees (474 plots) sampled in B9B/B9[2]. A total of 2,289 trees (this includes the 28 no tally plots where sp = "NO") were deleted from the analysis since they were either too small (dbh <7.0 for B9B/B9 or dbh <7.1 for B10B), or dead (sp = "DC" or "DD"), which left 13,726 trees for the analysis. A volume needed to be calculated for each tree in order to compile volumes at the plot level ($m^3/ha$).

### 3.1.1 Stump Diameter as a function of Breast Height Diameter

Two equations[3] were used sequentially to determine a stump diameter for all trees in both B9B/B9 and B10B where an actual stump diameter had not been measured in the field. The following equations use species and Natural Subregion (NSR) based parameter estimates:

$$dibs = (a_0 * dbh^{a1}) * (a_2^{dbh}) * X^{(b1 * Z*Z + b2 * \ln(Z + 0.001) + b3 *SQRT(Z) + b4 * e(Z) + b5 * (dbh/ht))}, \text{ where:}$$

- X = (1 – SQRT[0.3/ht]) / (1 – SQRT[0.225]);
- Z = (0.3/ht);
- dibs = stump diameter inside bark;
- dbh = diameter at breast height;
- ht = tree height;
- e = base of the natural logarithm (approximately 2.71828); and,
- a0, a1, a2, b1, b2, b3, b4, b5 = parameter estimates.

$$stump = k7 + k8 *dibs, \text{ where:}$$

- stump = stump diameter outside bark; and,
- k7, k8 = parameter estimates.

[2] See data file "Raw_Tree_Data.dbf". For data dictionary information see Appendix IV.

[3] Dr. Shongming Huang. "Ecologically-based Individual Tree Volume Estimation for Major Alberta Tree Species. Report # 1. Individual Tree Volume Estimation Procedures for Alberta: Methods of Formulation and Statistical Foundations". Alberta Environmental Protection. Edmonton. 1994.

### 3.1.2 Tree Height as a function of Breast Height Diameter

All tree heights for the B10B data were estimated in the field. For the B9B/B9 data, where a field-measured tree height was not provided, the following Chapmann-Richards style equation[4] was used:

$$ht = 1.3 + k_1 * (1 - EXP^{(-k2 * dbh)})^{k3}\text{, where:}$$

- ht = tree height(m);
- dbh = diameter at breast height (cm);
- EXP = natural exponent; and,
- k1, k2, k3 = parameter estimates.

### 3.1.3 Individual Tree Volume

The Crown's NSR based taper model[5] was used both in B9/B9B and B10B for the calculation of tree volumes from a 15 cm stump diameter to an 11 cm top diameter (15/11) with a minimum log length of 3.6 m[6]. The model form was:

$$d = a_0 D^{a1} a_2^{D} X^{(b1*Z*Z + b2*\ln(Z+0.001)+b3*SQRT(Z)+b4*EXP(Z)+b5(D/H))}\text{, where:}$$

- d = diameter inside bark at h (cm);
- D = diameter at breast height outside bark (cm);
- X = (1 – SQRT[h/H]) / (1 – SQRT[p]);
- Z = h / H;
- h = height above the ground (m), $0 \leq h \leq H$;
- H = total tree height (m);
- p = location of inflection point, assumed to be at 22.5% of total height above ground;
- EXP = natural exponent; and,
- $a_1$, $a_2$, $a_3$, $b_0$, $b_1$, $b_2$, $b_3$, $b_4$, $b_5$ = species and NSR based parameter estimates.

[4] Dr. Shongming Huang. "Ecologically-based Individual Tree Volume Estimation for Major Alberta Tree Species. Report # 1. Individual Tree Volume Estimation Procedures for Alberta: Methods of Formulation and Statistical Foundations". Alberta Environmental Protection. Edmonton. 1994.

[5] Dr. Shongming Huang. "Ecologically-based Individual Tree Volume Estimation for Major Alberta Tree Species. Report # 1. Individual Tree Volume Estimation Procedures for Alberta: Methods of Formulation and Statistical Foundations". Alberta Environmental Protection. Edmonton. 1994.

[6] See data file "Compiled Tree Volumes (15-11) new.dbf". For data dictionary information see Appendix IV.

## 3.2 PLOT VOLUME COMPILATION

Plot volumes were calculated by summing the volumes, independently, for coniferous and deciduous trees for each plot at 15/11 utilization levels and converting to a per hectare basis[7]. No tally plots were given conifer and deciduous volumes of 0 $m^3$/ha. The assignment of species code as either coniferous or deciduous is shown in Table 4.

**Table 4**
**Species Assignment**

| Species Code | Common Name | Species Class |
|---|---|---|
| AW | Trembling Aspen | Deciduous |
| FA | Alpine Fir | Conifer |
| FB | Balsam Fir | Conifer |
| FD | Douglas Fir | Conifer |
| LA | Alpine Larch | Conifer |
| LT | Tamarack Larch | Conifer |
| PA | Whitebark Pine | Conifer |
| PB | Balsam Poplar | Deciduous |
| PF | Limber Pine | Conifer |
| PL | Lodgepole Pine | Conifer |
| SB | Black Spruce | Conifer |
| SE | Engelmann Spruce | Conifer |
| SW | White Spruce | Conifer |

The plot information was then matched to the AVI[8]. The file used to match the plot data to the AVI was created by linking the global positioning system (GPS) data for each plot to the AVI where GPS data were available. In cases where no GPS file was available (1999 sampling program in B10B) the township, range, meridian, and stand number in the plot information was used to match the plot information to the AVI. Three plots unfortunately could not be matched to the AVI, and are assumed to be non-forested. Using a unique identifier, the plot data were then linked to the AVI[9]

[7] See data file "Compiled Plot Volumes (15-11).dbf". For data dictionary information see Appendix IV.

[8] See data file "AVI_match_file.dbf". For data dictionary information see Appendix IV.

[9] See data file "Compiled Plot Volumes (15-11) with AVI (overstorey).dbf. For data dictionary information see Appendix IV.

# 4.0 YIELD CURVE DEVELOPMENT

This section describes the methodology for determining a stratification scheme and the subsequent modelling procedures used to develop the yield curves.

## 4.1 PLOT SELECTION

The selection of sample plots to use in the construction of yield curves must be consistent with the rules used in netting down the landbase. Therefore, only plots found in strata represented in the SLS net landbase were used. Plots not located in these strata were removed hierarchically from the analysis in the following order:

1. unproductive stands (TPR = “U”);
2. non-forested stands (SP1 = “ ”);
3. black spruce or larch leading stands (SP1 = “Sb”, “Lt”, or “La”);
4. stands with larch as the second species (SP2 = “Lt” or SP2 = “La”); and,
5. unproductive pine leading stands:
   - pine leading stands (SP1 = “Pa”, “P”, or “Pl”), with a height ≤ 6 m tall and origin ≤1945; or,
   - pine leading stands (SP1 = “Pa”, “P”, or “Pl”), with a height ≤ 12 m tall and origin ≤1925.

Plots that fell in cutblocks (MOD1 = “CC”) were removed from the analysis only if the polygon was also non-forested (*i.e.*, plot exclusion #2). The hierarchical plot exclusion process is outlined in Table 5.

**Table 5**
**Plot Exclusion Hierarchy**

| Reason for Deletion | Number of Plots |
|---|---|
| **Total Plots Available** | **1012** |
| TPR = “U” | 101 |
| Non Forested | 89 |
| SB/LT Leading | 10 |
| Larch Second Species | 2 |
| Unproductive Pine | 56 |
| **Remaining Plots Available** | **754** |

### 4.2 MODEL SELECTION

Selection of an appropriate model form is critical for generation of accurate and biologically reasonable yield curves. Seven model forms were examined:

1. Volume = a*(1-exp[-b*age]);
2. Volume = a*age**b;
3. Volume = a*(1-exp[-b*age]**c);
4. Volume = a*age**b*exp(-c*age);
5. Volume[10] = a*age**b*exp(-a*age);
6. Volume = a/(1+b*exp[-c*age]); and,
7. Volume = age/(a+b*age+c*sqrt[age]).

The conifer volume of fully stocked (“C” or “D” density) pure conifer stands (>=80% conifer) with pine as leading species was used to test the different model forms. This strata was used to test the model forms because it contains the largest number of plots, and has a good distribution of plots across the various age classes. Each model form was assessed based on its biological relevance (*i.e.*, curve shape), the residual plots, and the fit statistics (*i.e.*, $R^2$).

Model 5 was chosen for the generation of yield curves for the following reasons:

- maintains low volumes in the younger age classes;
- declining yield in older age classes;
- timing of inflection point is reasonable; and,
- relatively good fit.

### 4.3 STRATIFICATION

After the plots were compiled, mutually-exclusive and exhaustive strata were defined to capture all forest types. The strata used to develop yield relationships were based on FMU, broad cover group, and leading species of the overstorey11. Other variables including natural sub-region, crown closure and site class were also examined for their use in stratifying the landbase. Due to limitations in the data, natural sub-region, crown

[10] This is also the model form used by Sunpine Forest Products Ltd (2001) in generating the yield curves for the FMA immediately north of the SLS FMA and the Crown (1999) in generating yield relationships for the B10B portion of the SLS FMA.

[11] See data file “Compiled Plot Volumes (15-11) with AVI (overstorey).dbf”. For data dictionary information see Appendix IV.

closure and site class were not used in the stratification. The resulting strata with plot and area summaries are provided in Table 6.

**Table 6**
**Spray Lake Sawmills Yield Strata[12]**

| FMU | Broad Cover Group | Leading Species | Strata | Strata Number | Number of Plots | % of Total Plots | Area (ha) in Net Landbase | % of Total Area |
|---|---|---|---|---|---|---|---|---|
| B9B | Conifer | Pine | B9B-C–PL | 1 | 194 | 26% | 76,778 | 34% |
| B9B | Conifer | Spruce/Fir | B9B-C–SW | 2 | 73 | 10% | 17,743 | 8% |
| B10B | Conifer | Pine | B10B-C–PL | 3 | 178 | 23% | 63,537 | 29% |
| B10B | Conifer | Spruce/Fir | B10B-C–SW | 4 | 137 | 18% | 21,757 | 10% |
| FMA | Mixedwood | n/a | FMA-MX-n/a | 5 | 59 | 8% | 15,913 | 7% |
| FMA | Deciduous | n/a | FMA-D–n/a | 6 | 113 | 15% | 17,937 | 8% |
| FMA | Composite | n/a | FMA-comp[13] | 99 | 0 | 0% | 8,909 | 4% |
| **TOTALS** | | | | | **754** | **100%** | **222,574** | **100%** |

Note: FMU = forest management unit; FMA = forest management agreement.

## 4.4 YIELD CURVE CONSTRUCTION

### 4.4.1 Conifer Volumes

The conifer volume from the pure deciduous and mixedwood strata were modelled using the following model form:

convol=a*age**b*exp(-a*age), where:

- age = age of stand at time of measurement (year cruised – origin);
- exp = natural exponent; and,
- a, b = parameter estimates.

The pure coniferous strata (both the pine and spruce leading) used a variant of the same model form. The data supports stratifying the pure conifer strata by FMU and leading species, however, the best fit line using the selected model form did not always generate biologically reasonable yield curves (*i.e.*, exponential growth). In order to control this, the B9B/B9 pine was grouped with the B10B pine and the conifer volume was modelled

[12] See Appendix III for more details regarding the plots located outside of the forest management agreement area.

[13] More detailed information on methodology and results for the composite curve construction is provided in Section 5.0.

together using an indicator variable to differentiate between the two FMUs. The same methodology was also used for the spruce strata. The model form for the conifer volume in the conifer strata is as follows:

convol=(a+c*x)*age**b*exp(-a*age), where:

- x=0 if FMU = B10B and x=1 if FMU = B9B;
- age = age of stand at time of measurement (year cruised – origin);
- exp = natural exponent; and,
- a, b, c = parameter estimates.

### 4.4.2 Deciduous Volumes

Deciduous volumes were generated using the same indicator variable method for the spruce strata. The model form for the deciduous volume in these strata is as follows:

decvol=(a+c*x)*age**b*exp(-a*age), where:

- x=0 if FMU = B10B and x=1 if FMU = B9B;
- age = age of stand at time of measurement (year cruised – origin);
- exp = natural exponent; and,
- a, b, c = parameter estimates.

For the pine strata, the indicator variable was removed and the deciduous volumes were calculated for both pine strata, combining all pure conifer, pine-leading plots without differentiation between FMUs. This was done to prevent the generation of unreasonable deciduous volumes (>800 $m^3$/ha at 300 years), which were generated when using the indicator variable method.

The deciduous volume from the pure conifer, pine-leading strata, as well as the deciduous and mixedwood strata were modelled using the following model form:

decvol=a*age**b*exp(-a*age), where:

- age = age of stand at time of measurement (year cruised – origin);
- exp = natural exponent; and,
- a, b = parameter estimates.

### 4.5 YIELD CURVES

Table 7 provides the parameter estimates for the conifer volume (15/11), while the deciduous parameter estimates are found in Table 8. The yield curves with 20 year age class mean volumes[14], and yield tables with mean annual increment[15] (MAI) are found in Figures 3 to 8. In Appendix V the yield curves are graphed with the plot volumes along with the residual plots.

**Table 7**
**Parameter Estimates of Conifer 15/11 Volumes for Yield Strata**

| Strata Number | Strata | Conif_a | Conif_b | Conif_c | Conif_x | N |
|---|---|---|---|---|---|---|
| 1 | B9B-C–PL | 0.013437 | 2.33965 | 0.000466 | 1 | 372 |
| 2 | B9B-C–SW | 0.01675 | 2.36505 | 0.000281 | 1 | 210 |
| 3 | B10B-C–PL | 0.013437 | 2.33965 | 0.000466 | 0 | 372 |
| 4 | B10B-C–SW | 0.01675 | 2.36505 | 0.000281 | 0 | 210 |
| 5 | FMA-MX-n/a | 0.014986 | 2.27467 | | | 59 |
| 6 | FMA-D–n/a | 0.021488 | 2.21928 | | | 113 |

**Table 8**
**Parameter Estimates of Deciduous 15/11 Volumes for Yield Strata**

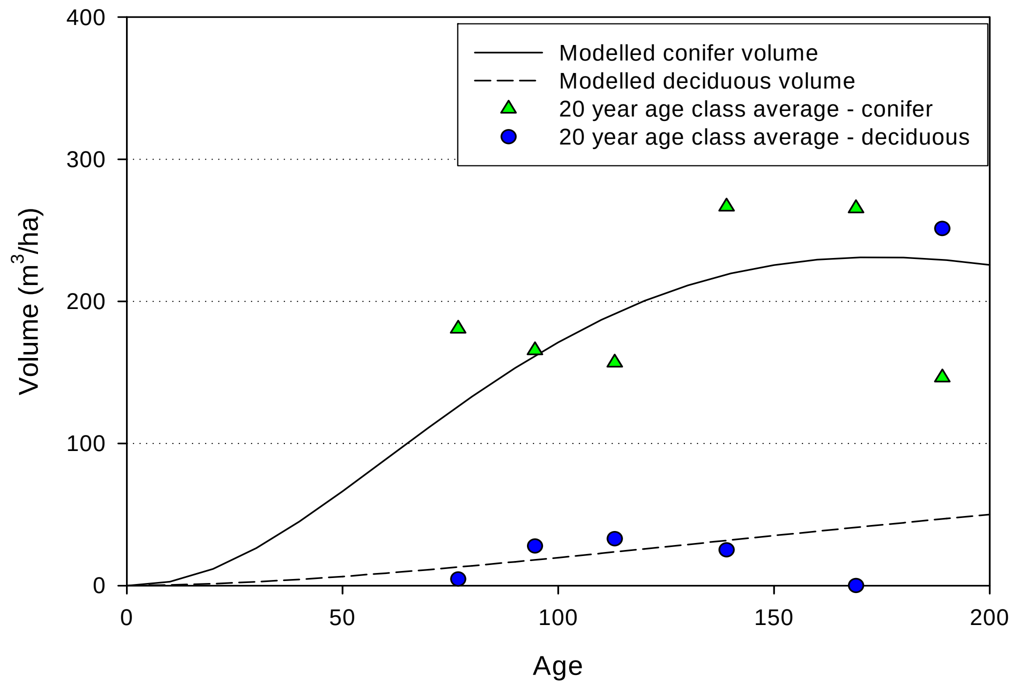
| Strata Number | Strata | Decid_a | Decid_b | Decid_c | Decid_x | N |
|---|---|---|---|---|---|---|
| 1 | B9B-C–PL | 0.004046 | 1.93084 | | | 372 |
| 2 | B9B-C–SW | 0.02926 | 1.86694 | 0.014636 | 1 | 210 |
| 3 | B10B-C–PL | 0.004046 | 1.93084 | | | 372 |
| 4 | B10B-C–SW | 0.029359 | 1.86473 | 0.015437 | 0 | 210 |
| 5 | FMA-MX-n/a | 0.015030 | 2.22332 | | | 59 |
| 6 | FMA-D–n/a | 0.025263 | 2.27382 | | | 113 |

---

[14] The 20 year age classes are from 0 – 20, 21 – 40, 41 – 60 *etc*. The location of the average volumes along the X-axis is the average age for the plots within each age class.

[15] Mean annual increment was calculated by dividing the predicted volume by the age. Also, the number of plots per age class given in the yield table uses the age class as a mid-point (*i.e*., for strata 1, 10 plots in the 70 year age class means that there are 10 plots in strata 1 between 65 and 74 years old).

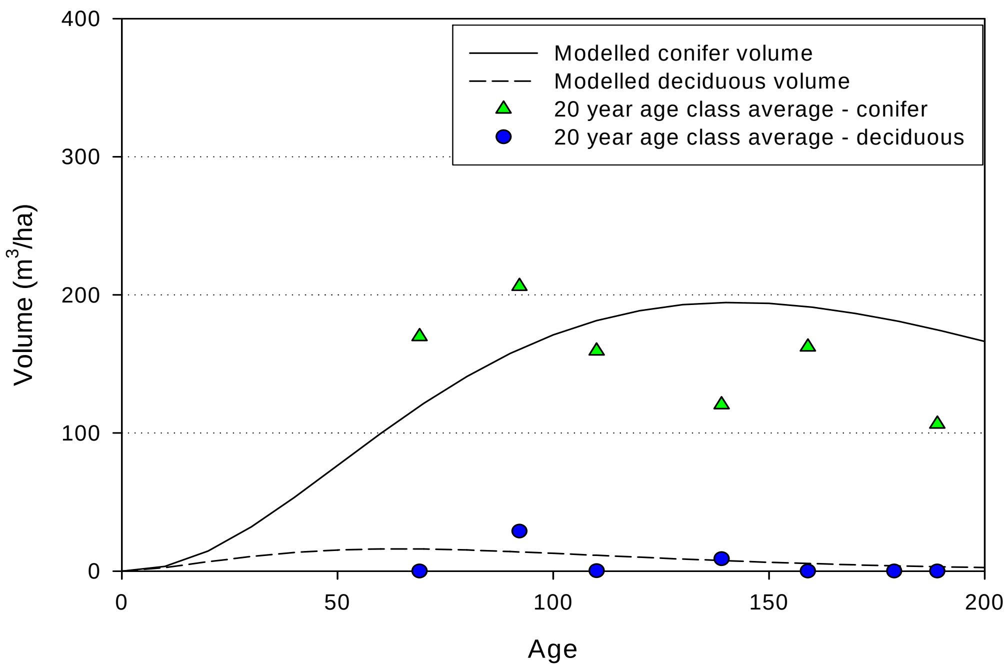
Figure 3 Strata 1: B9B/B9 Pine 76,778 ha 194 plots




| Estimated Coefficients | Conif_a | Conif_b | Conif_c | Conif_x | Decid_a | Decid_b | Decid_c | Decid_x |
|---|---|---|---|---|---|---|---|---|
| | 0.013437 | 2.33965 | 0.000466 | 1.0 | 0.004046 | 1.93084 | | |

| **Age Class** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** | **140** | **150** | **160** | **170** | **180** | **190** | **200** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conifer Volume | 3 | 12 | 27 | 45 | 67 | 90 | 113 | 135 | 155 | 173 | 189 | 203 | 214 | 222 | 229 | 232 | 234 | 234 | 232 | 229 |
| Conifer MAI | 0.27 | 0.59 | 0.88 | 1.14 | 1.34 | 1.50 | 1.61 | 1.68 | 1.72 | **1.73** | 1.72 | 1.69 | 1.65 | 1.59 | 1.52 | 1.45 | 1.38 | 1.30 | 1.22 | 1.14 |
| Deciduous Volume | 0 | 1 | 3 | 4 | 6 | 9 | 11 | 14 | 17 | 20 | 23 | 26 | 29 | 32 | 35 | 38 | 41 | 44 | 47 | 50 |
| Deciduous MAI | 0.03 | 0.06 | 0.08 | 0.11 | 0.13 | 0.14 | 0.16 | 0.17 | 0.19 | 0.20 | 0.21 | 0.21 | 0.22 | 0.23 | 0.23 | 0.24 | 0.24 | 0.25 | 0.25 | **0.25** |
| # Plots | | | | | | | 10 | 36 | 29 | 37 | 36 | 25 | | 15 | | | 3 | | 3 | |

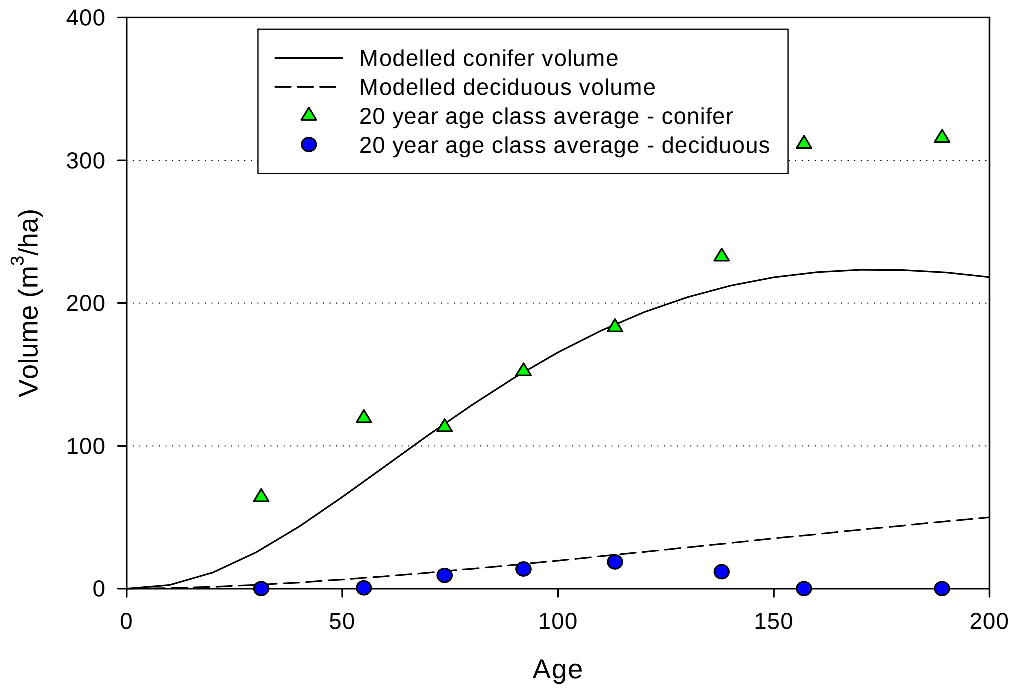
Figure 4 Strata 2: B9B/B9 Spruce 17,743 ha 73 plots




| Estimated Coefficients | Conif_a | Conif_b | Conif_c | Conif_x | Decid_a | Decid_b | Decid_c | Decid_x |
|---|---|---|---|---|---|---|---|---|
| | 0.01675 | 2.36505 | 0.000281 | 1.0 | 0.029359 | 1.86473 | 0.015437 | 1.0 |

| **Age Class** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** | **140** | **150** | **160** | **170** | **180** | **190** | **200** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conifer Volume | 3 | 15 | 32 | 54 | 77 | 100 | 122 | 141 | 158 | 171 | 182 | 189 | 193 | 194 | 193 | 191 | 186 | 180 | 173 | 165 |
| Conifer MAI | 0.33 | 0.73 | 1.07 | 1.34 | 1.54 | 1.67 | 1.74 | **1.77** | 1.75 | 1.71 | 1.65 | 1.57 | 1.48 | 1.39 | 1.29 | 1.19 | 1.09 | 1.00 | 0.91 | 0.83 |
| Deciduous Volume | 2 | 7 | 10 | 13 | 15 | 16 | 16 | 15 | 14 | 13 | 11 | 10 | 9 | 7 | 6 | 5 | 4 | 4 | 3 | 2 |
| Deciduous MAI | 0.24 | 0.33 | **0.35** | 0.33 | 0.30 | 0.26 | 0.23 | 0.19 | 0.16 | 0.13 | 0.10 | 0.08 | 0.07 | 0.05 | 0.04 | 0.03 | 0.03 | 0.02 | 0.02 | 0.01 |
| # Plots | | | | | | | 5 | | 13 | 6 | 17 | 2 | | 11 | | 6 | | 5 | 2 | |

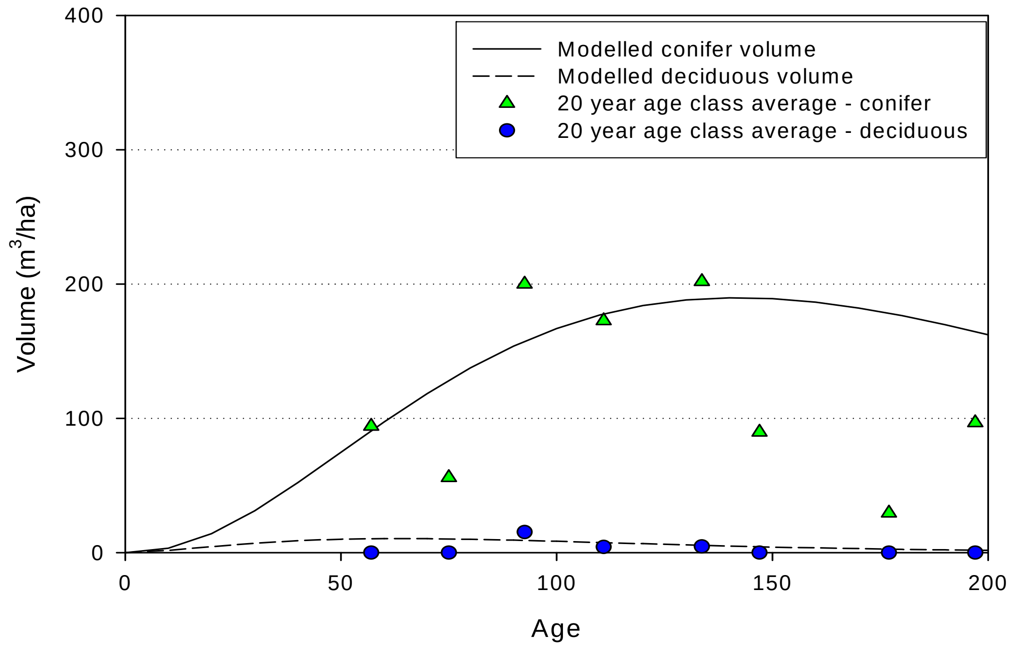
Figure 5 Strata 3: B10B Pine 63,537 ha 178 plots




| Estimated Coefficients | Conif_a | Conif_b | Conif_c | Conif_x | Decid_a | Decid_b | Decid_c | Decid_x |
|---|---|---|---|---|---|---|---|---|
| | 0.013437 | 2.33965 | 0.000466 | 0.0 | 0.004046 | 1.93084 | | |

| **Age Class** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** | **140** | **150** | **160** | **170** | **180** | **190** | **200** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conifer Volume | 3 | 11 | 26 | 44 | 65 | 87 | 109 | 130 | 150 | 168 | 183 | 196 | 207 | 215 | 221 | 225 | 226 | 226 | 224 | 221 |
| Conifer MAI | 0.26 | 0.57 | 0.86 | 1.10 | 1.30 | 1.45 | 1.55 | 1.63 | 1.66 | **1.68** | 1.66 | 1.63 | 1.59 | 1.54 | 1.47 | 1.40 | 1.33 | 1.26 | 1.18 | 1.11 |
| Deciduous Volume | 0 | 1 | 3 | 4 | 6 | 9 | 11 | 14 | 17 | 20 | 23 | 26 | 29 | 32 | 35 | 38 | 41 | 44 | 47 | 50 |
| Deciduous MAI | 0.03 | 0.06 | 0.08 | 0.11 | 0.13 | 0.14 | 0.16 | 0.17 | 0.19 | 0.20 | 0.21 | 0.21 | 0.22 | 0.23 | 0.23 | 0.24 | 0.24 | 0.25 | 0.25 | **0.25** |
| # Plots | | | 7 | 3 | 3 | 12 | 20 | 41 | 16 | 16 | 14 | 23 | | 13 | | 3 | | | 3 | |

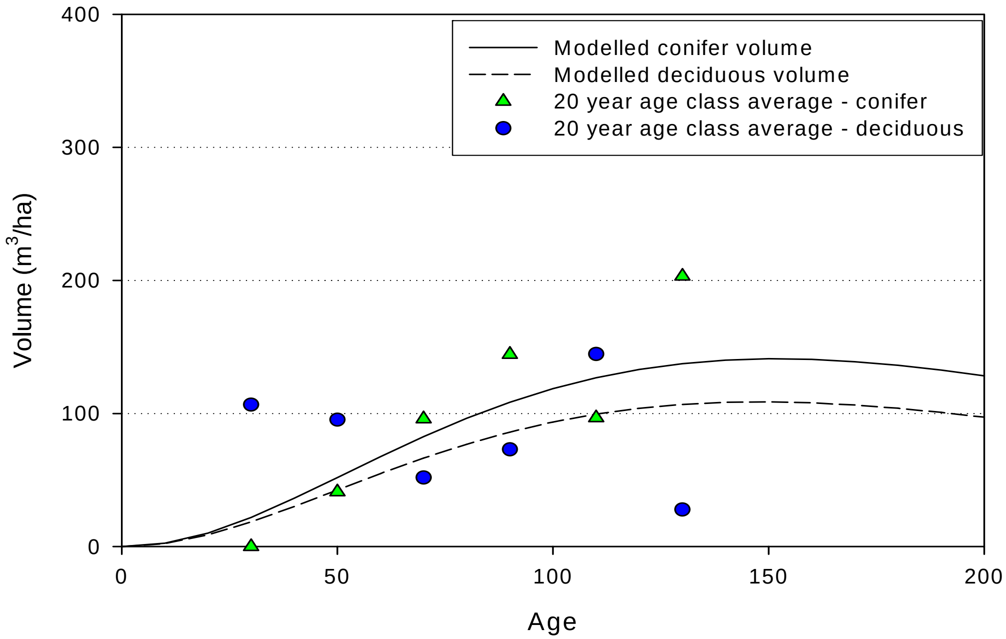
Figure 6 Strata 4: B10B Spruce 21,757 ha 137 plots




| Estimated Coefficients | Conif_a | Conif_b | Conif_c | Conif_x | Decid_a | Decid_b | Decid_c | Decid_x |
|---|---|---|---|---|---|---|---|---|
| | 0.016662 | 2.36222 | 0.000410 | 0.0 | 0.029359 | 1.86473 | 0.015437 | 0.0 |

| **Age Class** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** | **140** | **150** | **160** | **170** | **180** | **190** | **200** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conifer Volume | 3 | 14 | 32 | 53 | 76 | 98 | 120 | 139 | 155 | 169 | 179 | 186 | 190 | 191 | 190 | 187 | 183 | 177 | 170 | 163 |
| Conifer MAI | 0.33 | 0.72 | 1.05 | 1.32 | 1.51 | 1.64 | 1.71 | **1.74** | 1.73 | 1.69 | 1.62 | 1.55 | 1.46 | 1.37 | 1.27 | 1.17 | 1.08 | 0.98 | 0.90 | 0.81 |
| Deciduous Volume | 2 | 4 | 7 | 9 | 10 | 11 | 11 | 10 | 9 | 8 | 8 | 7 | 6 | 5 | 4 | 4 | 3 | 2 | 2 | 2 |
| Deciduous MAI | 0.16 | 0.22 | **0.23** | 0.22 | 0.20 | 0.18 | 0.15 | 0.13 | 0.10 | 0.08 | 0.07 | 0.06 | 0.04 | 0.04 | 0.03 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 |
| # Plots | | | | | | 6 | 2 | 8 | 19 | 24 | 12 | 9 | 13 | 26 | 4 | | | 1 | | 4 |

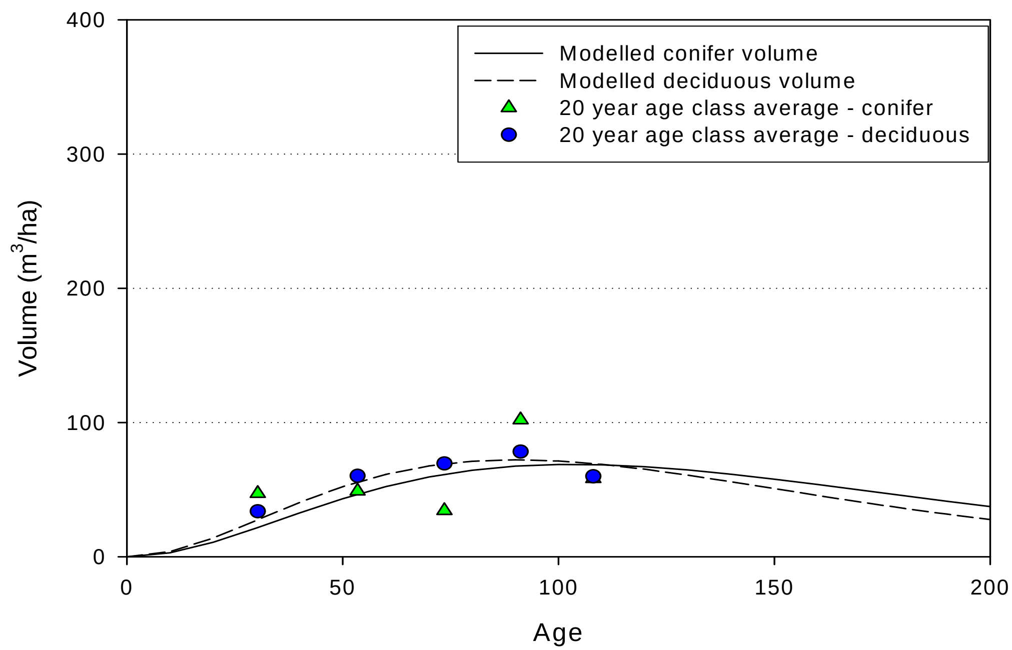
| Figure 7 Strata 5: FMA Area Mixedwood | 15,913 ha 59 plots |
|---|---|




| Estimated Coefficients | Conif_a | Conif_b | Conif_c | Conif_x | Decid_a | Decid_b | Decid_c | Decid_x |
|---|---|---|---|---|---|---|---|---|
| | 0.014986 | 2.27467 | | | 0.015030 | 2.22332 | | |

| **Age Class** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** | **140** | **150** | **160** | **170** | **180** | **190** | **200** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conifer Volume | 2 | 10 | 22 | 36 | 52 | 68 | 83 | 96 | 108 | 119 | 127 | 133 | 137 | 140 | 141 | 141 | 139 | 136 | 133 | 128 |
| Conifer MAI | 0.24 | 0.51 | 0.73 | 0.91 | 1.04 | 1.13 | 1.18 | 1.20 | **1.20** | 1.19 | 1.15 | 1.11 | 1.06 | 1.00 | 0.94 | 0.88 | 0.82 | 0.76 | 0.70 | 0.64 |
| Deciduous Volume | 2 | 9 | 18 | 30 | 42 | 55 | 66 | 77 | 86 | 94 | 99 | 104 | 107 | 108 | 109 | 108 | 106 | 104 | 101 | 97 |
| Deciduous MAI | 0.22 | 0.43 | 0.61 | 0.75 | 0.85 | 0.91 | 0.95 | **0.96** | 0.96 | 0.94 | 0.90 | 0.87 | 0.82 | 0.77 | 0.72 | 0.67 | 0.62 | 0.58 | 0.53 | 0.49 |
| # Plots | | | 1 | | | 2 | | 4 | 15 | 11 | 9 | 12 | | 5 | | | | | | |

Figure 8 Strata 6: FMA Area Deciduous 17,937 ha 113 plots




| Estimated Coefficients | Conif_a | Conif_b | Conif_c | Conif_x | Decid_a | Decid_b | Decid_c | Decid_x |
|---|---|---|---|---|---|---|---|---|
| | 0.021488 | 2.21928 | | | 0.025263 | 2.27382 | | |

| **Age Class** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** | **140** | **150** | **160** | **170** | **180** | **190** | **200** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conifer Volume | 3 | 11 | 21 | 33 | 43 | 52 | 59 | 64 | 68 | 69 | 69 | 67 | 65 | 61 | 58 | 54 | 50 | 45 | 41 | 37 |
| Conifer MAI | 0.29 | 0.54 | 0.71 | 0.82 | 0.87 | **0.87** | 0.85 | 0.81 | 0.75 | 0.69 | 0.62 | 0.56 | 0.50 | 0.44 | 0.39 | 0.34 | 0.29 | 0.25 | 0.22 | 0.19 |
| Deciduous Volume | 4 | 14 | 27 | 40 | 52 | 61 | 68 | 71 | 72 | 71 | 69 | 65 | 61 | 56 | 51 | 46 | 41 | 36 | 32 | 28 |
| Deciduous MAI | 0.37 | 0.69 | 0.90 | 1.01 | **1.04** | 1.02 | 0.97 | 0.89 | 0.80 | 0.71 | 0.63 | 0.54 | 0.47 | 0.40 | 0.34 | 0.28 | 0.24 | 0.20 | 0.17 | 0.14 |
| # Plots | | | 9 | 3 | 11 | 15 | 13 | 18 | 20 | 9 | 14 | 1 | | | | | | | | |

## 5.0 COMPOSITE YIELD CURVES

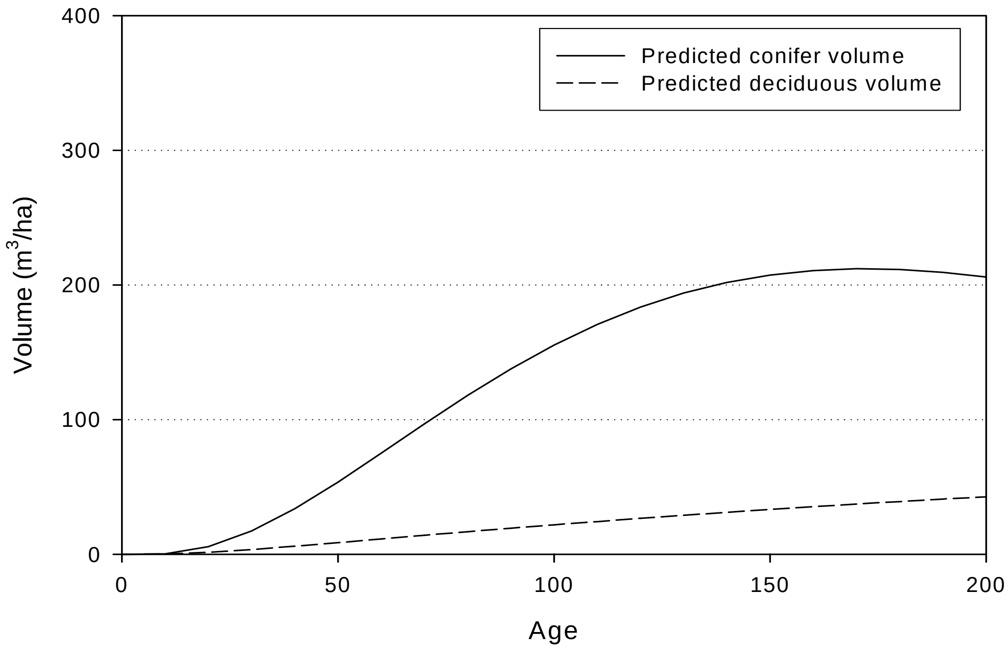
An area-weighted composite curve was developed for assigning a yield trajectory to regenerating cutblocks in the AVI (*i.e.*, MOD1 = “CC”) that are also classified as non-forested (SP1 = “ ”). This method was approved by the Crown in a letter to SLS dated April 3, 2002, and re-approved in an email dated March 15, 2004.

The method used is as follows:

1. removed the area of non-forested cutblocks from the total net area;
2. calculated the relative areas of each yield stratum within the net conifer landbase;
3. determined the predicted deciduous and conifer volume for each ten year age class of the five different yield strata on the conifer landbase using a six year regeneration lag;
4. multiplied the relative factor (calculated in #2) of each yield strata by the predicted volume (for deciduous and conifer species) of each ten year age class for each regenerating yield stratum; and,
5. summed the relative volumes of each age class across all five yield strata to produce a total area-weighted composite curve for both the coniferous and deciduous components.

The composite curve (in graphic and tabular forms) is provided in Figure 9.

Figure 9 Strata 99: FMA Area Composite 8,909 ha 756 plots




| **Age Class** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** | **140** | **150** | **160** | **170** | **180** | **190** | **200** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conifer Volume | 0 | 6 | 17 | 34 | 54 | 76 | 98 | 119 | 139 | 157 | 172 | 185 | 196 | 204 | 209 | 213 | 214 | 213 | 211 | 208 |
| Conifer MAI | 0.03 | 0.28 | 0.58 | 0.85 | 1.08 | 1.26 | 1.40 | 1.49 | 1.54 | **1.57** | 1.57 | 1.54 | 1.51 | 1.45 | 1.40 | 1.33 | 1.26 | 1.19 | 1.11 | 1.04 |
| Deciduous Volume | 0 | 1 | 4 | 6 | 9 | 12 | 14 | 17 | 20 | 22 | 25 | 27 | 29 | 32 | 34 | 36 | 38 | 40 | 41 | 43 |
| Deciduous MAI | 0.02 | 0.07 | 0.12 | 0.15 | 0.18 | 0.19 | 0.20 | 0.21 | 0.22 | 0.22 | 0.23 | 0.23 | **0.23** | 0.23 | 0.23 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 |

## 6.0 ASSESSMENT OF CULL DEDUCTIONS

This section presents the cull losses determined from the scale records of recent SLS harvest operations and describes how SLS accounts for waste and breakage. Table 9 presents the scaled measurements of cull for sample loads from the last five years of SLS's quota operations in their current FMA area. The percentage cull is presented and summarized on a license basis. It is then totalled as an area weighted volume on an annual basis. The total found at the bottom of the Table 9 is the value for all five years combined. The license-specific sample cull losses range from 1.87% to 4.63%. The average annual estimate ranges from 2.12% to 3.80%. The five-year average is 3.07%.

The cull loss of gross volume is an estimate determined at the time of harvest. It is therefore appropriate to represent this loss outside of the base yield relationships and add it as a reduction to any derived annual allowable cut (AAC) estimates. SLS proposes to use 3.07% as a net reduction to the final AAC determination in the subsequent timber supply analysis.

SLS is required to bring all merchantable material from merchantable trees to the sawmill including any breakage. As a result, no deductions due to waste or breakage are expected.

## Table 9
## Cull Measurements from Scaled Loads

| Licence Identification | Gross Sample Scale Volume ($m^3$) | Scaled Cull Volume ($m^3$) | % Cull in the Scale Sample | Annual Gross Sample Scale Volume ($m^3$) | Annual Scaled Cull Volume ($m^3$) | Annual % Cull in the Scale Sample |
|---|---|---|---|---|---|---|
| **2001/02** | | | | **8692.761** | **316.449** | **3.64%** |
| B8L11 | 2535.131 | 105.360 | 4.16% | | | |
| B7L7 | 1543.911 | 54.667 | 3.54% | | | |
| B6L22 | 1286.937 | 45.521 | 3.54% | | | |
| B8L7 | 1503.069 | 46.364 | 3.08% | | | |
| B2L18 | 604.589 | 15.071 | 2.49% | | | |
| B7L8 | 1219.124 | 49.466 | 4.06% | | | |
| **2000/01** | | | | **8655.387** | **328.921** | **3.80%** |
| B8L11 | 2140.957 | 78.59 | 3.67% | | | |
| B7L7 | 1362.657 | 57.417 | 4.21% | | | |
| B6L22 | 1376.475 | 50.136 | 3.64% | | | |
| B8L7 | 2167.07 | 100.292 | 4.63% | | | |
| B6L20 | 1608.228 | 42.486 | 2.64% | | | |
| **1999/00** | | | | **10924.84** | **316.981** | **2.90%** |
| B8L11 | 6224.998 | 173.171 | 2.78% | | | |
| B7L7 | 1882.976 | 60.048 | 3.19% | | | |
| B6L20 | 1941.367 | 54.025 | 2.78% | | | |
| B8P20 | 431.668 | 15.627 | 3.62% | | | |
| B6P50 | 443.826 | 14.11 | 3.18% | | | |
| **1998/99** | | | | **8200.107** | **219.731** | **2.68%** |
| B8P20 | 2565.9632 | 83.429 | 3.25% | | | |
| B6L20 | 1878.008 | 45.535 | 2.42% | | | |
| B7L7 | 1447.332 | 28.345 | 1.96% | | | |
| B8L11 | 1075.304 | 23.139 | 2.15% | | | |
| B6P50 | 1233.5 | 39.283 | 3.18% | | | |
| **1997/98** | | | | **6694.088** | **142.2109** | **2.12%** |
| B8L11 | 1912.249 | 51.925 | 2.72% | | | |
| B8L8 | 1073.083 | 20.824 | 1.94% | | | |
| B6L20 | 3708.756 | 69.4619 | 1.87% | | | |
| **Average** | **1798.632** | **55.179** | **3.07%** | | | |
| **Total** | **43167.178** | **1324.293** | | | | |

## 7.0 CLOSURE

This growth and yield report was completed by Golder Associates Ltd. (Golder) on behalf of SLS. We trust that the information provided meets the requirements of the growth and yield component requirement for the SLS Detailed Forest Management Plan. Golder wishes to thank SLS for the opportunity to complete this work. Should there be any further requirements or clarification please do not hesitate to contact the undersigned.

**GOLDER ASSOCIATES LTD.**


| | |
|---|---|
| Report Prepared by: | Report Reviewed by: |
| David Pelster, B.Sc.F. RPF.<br>Analysis Forester<br>Project Co-ordinator | John Virgl, Ph.D.<br>Senior Biometrician<br>Project Manager |

DP/JV/msd

# APPENDIX I

# VOLUME SAMPLING FOR THE B7 FOREST MANAGEMENT UNIT (CROWN)

# Volume Sampling for the B7 Forest Management Unit

## Schedule A
## Request for Bids

### PURPOSE

The Forest Resource Information Centre, Forest Management Division, Alberta Environmental Protection, has a need to develop stand volume and yield tables that are applicable at both the natural region and the forest management unit level. A substantial amount of data related to the structure of forest stands will be required to reach this goal. This data must be collected in a statistically defensible manner and must provide information that is representative of the forest stands found in these areas.

### OBJECTIVES

The objective of this contract will be to gather volume sampling data for the Alberta Vegetation Inventory on the B07 Forest Management Unit to be used in the development of regional and local stand volume and yield tables.

### PROCEDURES AND CRITERIA

#### Stand and Plot Selection

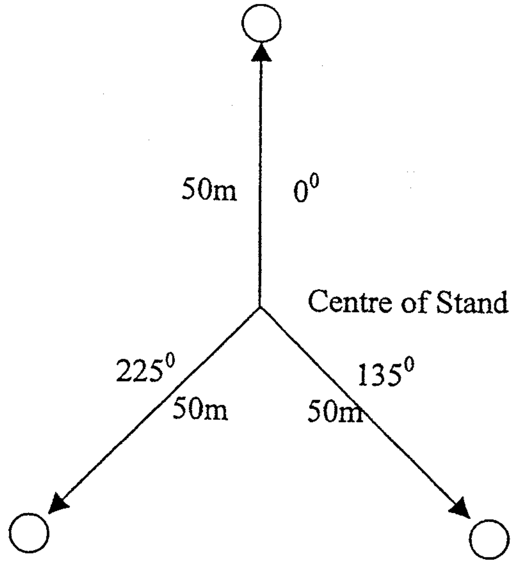
510 temporary sample plots will be established and measured within the B07 Forest Management Unit. Plot establishment will occur as follows. Stands will be selected randomly using proportional allocation based on appropriate crown density, species and height classes. The general classes to be used will be:

Crown density classes:
- A – A and B density stands, and
- C – C and D density stands.

Leading species Sw, Sb, Pl, Aw, Pb or F_:
- Engelman spruce and Douglas fir will be treated as Sw,
- Larch will be treated as Sb, and
- F_ includes Fa and Fb.

Height classes:
1. 0 - 12.0 m.,
2. 12.1 – 18.0 m,
3. 18.1 – 22.0 m, and
4. > 22.0 m.

Stands will be selected without replacement. Within each selected stand, a cluster of three plots will be established as follows:




If a plot lands on an anthropogenic disturbance (road, seismic line, well site, etc.) or a naturally non-vegetated area (lake, pond, river, stream, etc.) continue in the same direction for an additional 20 m and establish the plot centre at this point. If the plot can still not avoid these obstacles, go 10 m in a cardinal direction away from the obstacle. Note that plots must be placed within the appropriate stand, at least 5 m from the stand boundary.

The Contractor can include the selection of stands as part of their bid (with the extra cost of selection included as a separate line item in the bid) or he/she can have the Forest Resource Information Centre do the selection. If the Contractor does the selection, a list of the selected stands must be provided to the Forest Resource Information Centre for approval before field work begins. If the Forest Resource Information Centre does the selection, a list of stands to be sampled and their locations will be provided to the contractor. The option chosen should be clearly noted in the bid proposal.

Plot establishment and measurement will be the responsibility of the Contractor and will be done in accordance with the following guidelines.

**Plot establishment**

Access to the plot must be described on the tally sheet and the route taken to the plot clearly marked with biodegradable flagging. The centre of the stand and the centre point of each plot will be marked with an aluminum stake to facilitate check cruising ( pigtail pins are acceptable ). Differentially corrected GPS will be used to record the location of each plot centre.

**Plot Size(s) and Shape**

At each sample point, two circular plots will be established using the same plot centre point. The first plot will be 100 $m^2$ ($r = 5.64$ m) and the second plot will be 25 $m^2$ ($r = 2.82$ m).

**Tree Measurements**

On the large (100 $m^2$ ) circular plot all trees (live and dead) $\geq$ 7.1 cm dbh will be measured. For these trees record:

- species,
- dbhob (cm) at 1.3 m above average ground level,
- crown class (D, C, I, S),
- height from the ground to live crown (m),
- breast height (1.3 m) age (see below),
- stump diameter (0.3 m above average ground level),
- 10- year radial increment widths for the last 20 years of growth (see below), and
- up to three condition codes (list of codes provided).

Measure the height of $1/5^{th}$ of the trees on the plot, ensuring that a representative range of the heights encountered on the plot is measured. For ease in check cruising, trees should be selected and numbered (on the tally sheet) beginning at true north and moving in a clockwise direction, from the centre of the plot outward.

If the trees tallied in the plot are all the same species and the plot is a single storey stand, select one dominant and two co-dominant trees for age measurement. These trees should be representative of the average trees in the stand and not remnant (trees that survived the break up of the previous stand) or wolf trees. All trees selected for age measurement should have a height measurement. Extract an increment core at breast height for each of the selected trees (core should be within ± 2 years of the pith) and place the core in a straw marked with the appropriate township, range, meridian, stand, plot and tree number. These cores should be taken back to a well lit environment for age and increment measurement. Age determination should proceed from the cambium to the pith and the location of each $1/10^{th}$ ring should be clearly marked on the increment core. Freeze the core after measurement for subsequent checking.

If the plot is composed of two species and the plot is a single storey stand, select two trees of each species for age measurement. If the plot is a single story stand and is composed of more than two species select two trees from each of the three leading species for age measurement. In either of these two cases, the selected trees should be dominant or co-dominant trees and be representative of the average trees in the stand for that particular species.

If the stand is a two story stand, with a distinct understorey, measure up to four (4) overstorey trees, depending on whether the overstorey is a single or multiple species overstorey, as described above, and select two representative trees from the understorey. For the understorey trees selected, cut a disk from these trees at ground level. Label these disks for future age measurement. Measure and save these disks in the same manner as the increment cores above.

Do not perform age measurements on more than six (6) trees in any single plot. For complex stands that have multiple species and/or multiple size classes, select up to six trees to age that represent the predominant species and/or size classes found in the stand.

On the small (25 $m^2$ ) plot measure all trees < 7.1 cm dbhob. For these trees record:

- species
- dbhob
- total height
- age ( for two trees if this is an understorey stand).

For efficiency purposes, dbhob can be measured with small calipers on the small plot.

If appropriate record up to 3 condition codes for each tree. A list of codes and their descriptions will be provided by the Forest Resource Information Centre, Land and Forest Service.

**Plot Description**

Descriptive attributes for each plot include:

- AVI field type (overstorey and understorey)
- elevation
- percent slope
- aspect
- stand structure
- surface expression
- slope position
- fire behavior data
- take one wide angle photograph, preferably facing north, that depicts the general forest cover found on the plot. The photograph should provide a view of the forest floor vegetation as well as the forest overstorey vegetation. The photograph should include a label that clearly identifies the stand and plot number represented.

Tally sheets for plot measurement will be provided by the Forest Resource Information Centre.

## QUALITY CONTROL

The Contractor is expected to maintain close contact with the designated representative from the Forest Resource Information Centre and to apprise this individual of progress being made and of any problems being encountered.

The Contractor is responsible for ensuring that all of the plot information has been collected correctly and that the tally sheets have been completely and legibly filled in. Items to be noted include:

- all of the required header information has been filled in,

- GPS location of the plot has been recorded,
- AVI field call is recorded and correct,
- tree species identified, coded and entered correctly,
- dbh, total height, height to live crown, and stump diameter measured and entered correctly,
- increment cores extracted correctly and containers for these cores properly labeled,
- condition codes have been identified correctly and the proper code entered,
- descriptive information has been completed on the back of the first tally sheet for the large plot,
- after the increment cores have been carefully measured this information has been recorded on the tally sheets.

Tally sheets will be evaluated by the Forest Resource Information Centre to ensure that all of the information required has been entered and that the information appears to be correct. Check cruising will be carried out to ensure that measurement standards for the sample plots are being met. A copy of the standards used to evaluate the cruise data is attached.

## DELIVERABLES AND TIMELINES

The successful completion of this project will result in the delivery of all completed tally sheets and/or diskettes ( see below) by Feb. 1, 1997 to the Forest Resource Information Centre.

The Contractor has the option of entering the tally sheet data into a computer data base format approved by the Forest Resource Information Centre. The additional cost for computer processing the tally sheets should be included as a separate line item in the bid. If this option is used, the Contractor will provide edited copies of the data in the form of 3- ½ inch floppy diskettes or a CD Rom diskette, along with the original tally sheets to the Forest Resource Information Centre.

# CHECK CRUISING PROCEDURES

Check cruising is done to ensure that the standards of measurement for temporary plot sampling are being met. These standards are designed to minimize non-sampling errors that occur in all plot sampling. The standards given here represent the maximum error allowed before a plot must be completely remeasured. Check cruising should be viewed as a method of assessing the performance of field crews, with the intent of identifying the human errors that occur due to a lack of care or knowledge in field procedures.

**Office Inspection**

Cruise tally sheets should be checked in the office to ensure that all of the appropriate information has been recorded and that the recorded information appears to be correct ( header information, species and other codes, tree measurements). This checking involves identifying missing information on the tally sheet, identifying data that has been improperly coded and identifying measurements that are obviously suspect. Plots with a number of errors of the types indicated should be considered as priority candidates for check cruising.

For check cruising to be of maximum benefit, it should be done near the beginning of any sampling program. More plots should be check cruised ( 20% is a reasonable recommendation) when a new crew begins cruising to ensure that correct procedures are being used to gather and record data. Check cruising of approximately 10% of the plots for experienced crews should be sufficient to maintain acceptable standards.

Plots selected for check cruising should encompass the range of conditions being encountered in the cruise, including access, topography, cover types and stand structure.

Specific forms or procedures are not available for check cruising. The following steps are recommended:

1. Randomly select the plots to be checked.
2. Use a new tally sheet to record data and indicate on the tally sheet that this is a check plot.
3. Complete the header, the AVI field call and the descriptor information for the plot.
4. Select a representative sample of trees, ~ 20-25% of the trees on the plot. For each tree checked:
   - record tree number, species and crown position,
   - measure dbh, total height, height to live crown, stump diameter, and record condition codes.
5. Compare the check tally sheet information to the original tally sheet.

**Allowable Errors**

1. Plot location:
   - the stand centre and plot centres must be correctly established and marked,
   - the stand must be the actual stand selected for sampling.

2. Plot Measurement
   - species composition of the tally trees should agree with the composition of the checked trees ( no obvious incorrect identification of tree species),
   - the number of trees tallied should agree with the original cruise,
   - dbh and stump diameter measurements of the checked trees should agree with the measurement of these variables on the tally sheet,
   - total heights and height to live crown of the checked trees should agree with the total heights recorded on the tally sheet,
   - crown classes of the checked trees should agree with crown classes on the tally sheet,
   - condition codes found on the checked trees should correspond to the condition codes listed on the tally sheets..

3. Descriptor Variables
   - AVI field call should agree with the tally sheet field call,
   - elevation, slope %, aspect, stand structure, surface expression, slope position, and fire behavior calls should agree with the tally sheet and be coded correctly.

Since the check cruise does not measure all of the trees on the plot, it may be difficult to identify specific trees. Care must be exercised to ensure a one to one correspondence between the checked trees and the original trees. If consistently wrong measurements are found or if a number of obvious gross errors in measurements have been made the Contractor will be required to remeasure the plot, without additional compensation being paid. As a general rule, the following errors are allowed:

- all tree species should be correctly identified. Some allowance will be made for Sw vs. Sb, Pl vs. Pj and for fir.
- ± 0.2 cm for dbh and stump diameter,
- ± 5% for total height and height to live crown,
- ± 3% for breast height age and 10 year radial increment width, and
- ± 1 class for crown position for C and D only.

The check cruise should evaluate whether the original data appears to be exceeding these errors limits on a consistent basis.

Alberta
ENVIRONMENTAL PROTECTION
LAND AND FOREST SERVICE

# AVI CRUISE TALLY SHEET

CSTM 28 (Rev. 15/97)

FMU ______ TWP ______ RGE ______ M ______ Sec ______ LS ______ Stand ______ Plot ______ Area($m^2$) ______ BAF ______

| | Deg. | Min. | Sec. |
|---|---|---|---|
| Latitude: | ____ | ____ | ____ |
| Longitude: | ____ | ____ | ____ |

Date: __________

Crew: __________________

AVI Field Type:

Overstory ____________________

Understory ____________________

Start or tie point: ________________________________________________

| Page No. | Tree No. | Species Code | D.B.H. (cm) | Total Height (m) | Hgt. to Live Cr (m) | Crown Class | Breast Height Age(yrs) | Stump Diameter (cm) | Incr. Width cm/10 years 0-10 | 11-20 | Condition Codes 1 | 2 | 3 | Crown Density |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | | | | | | | | | | | | |
| | 2 | | | | | | | | | | | | | |
| | 3 | | | | | | | | | | | | | |
| | 4 | | | | | | | | | | | | | |
| | 5 | | | | | | | | | | | | | |
| | 6 | | | | | | | | | | | | | |
| | 7 | | | | | | | | | | | | | |
| | 8 | | | | | | | | | | | | | |
| | 9 | | | | | | | | | | | | | |
| | 10 | | | | | | | | | | | | | |
| | 11 | | | | | | | | | | | | | |
| | 12 | | | | | | | | | | | | | |
| | 13 | | | | | | | | | | | | | |
| | 14 | | | | | | | | | | | | | |
| | 15 | | | | | | | | | | | | | |
| | 16 | | | | | | | | | | | | | |
| | 17 | | | | | | | | | | | | | |
| | 18 | | | | | | | | | | | | | |
| | 19 | | | | | | | | | | | | | |
| | 20 | | | | | | | | | | | | | |
| | 21 | | | | | | | | | | | | | |
| | 22 | | | | | | | | | | | | | |
| | 23 | | | | | | | | | | | | | |
| | 24 | | | | | | | | | | | | | |
| | 25 | | | | | | | | | | | | | |

## 4.6 Condition Codes

Condition codes are recorded in the following priority (i.e. a tree may have 5 conditions yet there is only room to record 3, so the codes are recorded in order of priority). Record the remaining codes in the comments section on the tally sheet.

NOTE: Plots established in Mountain pine beetle areas have special codes.

00 - Healthy
01 - Insects
02 - Disease
03 - Rabbit Browsing
04 - Sheperds Crook
05 - Browsing (Other)
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 on Pine)
20 - Armillaria Root Rot
21 - Moldy Planting Stock
22 - Multiple Leader
23 - Poor Form
24 - Broken Top (New or Old)
25 - Dead
26 - Snow Press
27 - Dead Top Dieback with NEW Leader
28 - Sucker(s) from OLD Stump
29 - Cutdown
30 - Terminal Weevil
31 - SW Gall Aphid
32 - Tent Caterpillar
33 - Root Collar Weevil
34 - J-Root
39 - DBH taken on new leader
40 - nutrient deficiency
51 - Conks/Blind Conks
52 - Open Scars
53 - Burls and Galls (DBH>9.1cm)
54 - Fork (DIB>7.0cm-2.5m past fork)
55 - Pronounced Crook (DIB 7.0cm-2.5m past crook)
56 - Broken Top (<=10cm DIB at Break) (NO CC)
57 - Limby (DBH>9.1cm)
58 - Leaning (DBH>9.1cm + if severe NO CC)
59 - Broken Stem (>=10cm DIB at Break)(NO CC)
60 - Standing Dead (DBH>9.1cm)(NO CC)
61 - Dead and Down (NO CC)(DBH>9.1cm)
62 - Stem Insects (Bark + Sawyer Beetles - DBH>9.1cm)
63 - Stem Disease (Cankers, DBH>9.1cm)
66 - Stem Form Defect (>=7.0cm DIB at point where stem form begins)
67 - Closed Scars (DBH 9.1cm)
68 - Atropellis canker
69 - Comandra Blister Rust
70 - Elytroderma needle cost of pine
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 Rust
82 - Yellow Headed Spruce Sawfly
83 - Large Aspen Tortrix
91-96 Hawksworth Mistletoe Rating System
98 - Data changed by office

| Condition Code | | Description |
|---|---|---|
| 00 | | Healthy - No Defect. |
| 01 | Insects | Damage or mortality due to destruction of plant parts or tissue by insects. Look for evidence of eggs, egg cases, nests, chewed plant parts, etc. Similar signs on plants located off site may aid in identification of insect mortality. |
| 02 | Disease | Damage or mortality caused by disease or fungi. Cankers, discoloration, rust spotting, fungal coverings, etc. help to identify mortality under this code. |
| 03 | Rabbit Browsing | Trees killed or damaged by rabbits can be identified by clean, sharp cut marks along the branches and stems (approximately 45° angles). Chewed bark and needles also indicate rabbit damage. |
| 04 | Shepherd's Crook | Damage results in blackening and wilting of young shoots and leaves. Tips of the blackened shoots often bend back. On older leaves brownish black, irregularly shaped spots appear. |
| 05 | Browsing (other animals) | Mortality or damage due to browsing by ungulates or other animals (e.g. moose, cattle, beavers). Look for chewed tops with rough cuts or breaks. |
| 06 | Fire | Mortality or damage due to actual burning of the seedling or scorching by nearby flames. **Not to be used when seedlings are killed by sun scald**. |
| 07 | Mechanical | Trees killed or damaged by mechanical or physical means such as scarification machinery, trampling or crushing by animals, etc. Stem scars and rough breakage help to identify mortality under this code. |
| 8 | Wind Throw | Damage or mortality due to crushing by fallen or displaced logs, snags, branches, uprooted trees, etc. |
| 09 | Climate | Trees damaged or killed solely by climatic factors. These include death by freezing, sun scald, severe desiccation, ice accumulation, red belt, etc. |

| | | |
|---|---|---|
| 10 | Flooding | Trees damaged or killed by drowning alone. Look for evidence of high water marks on the seedling, or in the immediate area. Pull tree out of ground and check roots to see if the root outer coverings is falling off and is blackened. |
| 11 | Poor Planting | Damage or mortality due to improper placement of nursery stock (hand or mechanical planting). Trees may have been planted too deep, too shallow, too loosely, or at an acute angle. |
| 12 | Suppression | Trees which have been suppressed by the surrounding vegetation for a period of time long enough to damage or kill them. Mortality may be due to severe lack of light, water, nutrients (removed by the competition) or by physical smothering (i.e. heavy grasses). Reference to the previous year's damage tally may help in determining this mortality call. A tree that is over topped by grass or shrubs is not necessarily suppressed. Look for a spindly main stem with very few long needles spaced wide apart or evaluate the last five increments. If the tree has only grown 1cm a year, it is probably suppressed. |
| 13 | Frost Heaving | This code is used only when mechanical frost action can be clearly identified as the direct cause of damage or mortality. Usually upheaval and separation of the seedling's root system from the soil occurs as a result of ice lens formation. This is most commonly associated with containerized seedlings planted in silty soil. |
| 14 | Erosion | Damage or mortality due to the removal of the seedling's seedbed, by the forces of water, wind or soil slumping. Trees killed by partial or total burial (deposited soil or organic matter) would also be tallied using this code. |
| 15 | Missing | This code is to be used when a seedling from the previous year's measurement cannot be located. It can also be used where the seedling was removed from the site and probably died (i.e. tag found, no morphological signs of live seedling remaining). Using in conjunction with code 25 **ONLY**. |
| 16 | Dead top/Dieback | Top is dead (die back) without any indication of insect or climate (frost) damage. |

| | | |
|---|---|---|
| 17 | Poor Seedbed | This code is to be used only when the cause of death or damage for a seedling can be traced to the type of seedbed on which it is growing. In most cases the seedling will show signs of desiccation due to the poor moisture holding capacity of the seedbed material (e.g. rotten logs, dry clay). |
| 18 | Herbicide | Should only be used when the cutblock (or parts of the cutblock) has received a recent herbicide treatment; either before or after the stock was in place. Spruce seedlings exhibit needle loss and/or reddish brown coloration of stems and foliage. Deciduous species exhibit yellowish/brown leaf mottling and dieback of terminal growth. Hexazinone causes reddish brown coloration of conifer foliage and needle loss. Deciduous foliage turns red to black. Glyphosate causes chlorosis especially in new growing shoots. 2,4-D causes rapid growth and spiralling and twisting. If applied during conifer flush bad dieback similar to frost damage may occur. Often chemical damage will also be indicated by phytotoxicity spotting on exposed foliage. |
| 19 | Western Gall Rust (only in Pine) | This code is used when Lodgepole pine damage or death can be attributed to Western Gall Rust. This is usually clearly identifiable due to swelling of succulent tissue (and subsequent formation of a gall) and the bright orange spores produced in that affected area. This gall can be on the main stem or a lateral branch. |
| 20 | Armillaria Root Rot | This code is utilized when a seedling is damaged or killed by Armillaria Root Rot. Identification of the disease is in recognizing mycelial fans of the cambium of damaged and dead trees. Pull tree out of ground and examine root collar. |
| 21 | Moldy Planting Stock | This code is usually used on Bareroot Planting Stock. Grey mold will usually be found around the root collar and lower branches. |
| 22 | Multiple Leader | This damage code is commonly used on planted stock. When a tree has two or more leaders, but is otherwise healthy this code should be entered. The tree is considered multiple leadered if all leaders are within 5cms (height) of each other. This code also applies to saplings and regeneration that appear forked. Be aware of normal branching of deciduous trees. |

| | | |
|---|---|---|
| 23 | Poor Form | This code is used on trees which exhibit a general poor form, due to previous damage. It is commonly used with Advanced stock which was damaged by scarification activity. |
| 24 | Broken Top (New or Old) | It should be used as long as the broken top is noticeable and has some effect on the growth of the tree. |
| 25 | Dead Tree | Tree has no signs of being alive. |
| 26 | Snow Press | This code is normally used for trees that show signs of being pressed down to the ground for a few years after germinating or being planted. |
| 27 | Dead Top Dieback with New Leader | This refers to stems that have had previous leader damage and a new leader has formed. |
| 28 | Sucker(s) (From Old Stump) | Refers to stems that have been cut-down through thinning and have started to sucker. Do not re-use the previous stem number, but assign a new number to each sucker. |
| 29 | Cutdown | Self explanatory. |
| 30 | Terminal Weevil | Terminal leaders of Pine or Spruce bend over and die. Two or more years growth are affected. <u>Bore Holes</u> which are exit holes for the larvae <u>MUST</u> be present to use this code. |
| 31 | Spruce Gall Aphid | Galls located at the end of new growth and may persist for many years. |
| 32 | Forest Tent Caterpillar | A tent of a silk forms on the tree and the caterpillars defoliate the tree. |
| 33 | Root Collar Weevil | This weevil feeds mainly on Sw, Pj and Pl. They feed in the bark and cambial area of the host tree at or below the duff surface, causing copious flows of resin. The tunnels often girdle small trees. This insect allows root rots to enter the tree. |
| 34 | J-Root | This code is used after the tree has had a poor planting code in the previous measurement. |
| 35 | Leaning | Tree leaning more than 20% off of vertical axis. |

| | | |
|---|---|---|
| 36 | Same Stump | Used when 2 or more trees can be distinguished above ground level but below DBH. Used a lot on Deciduous that have been cutdown and resprouted at stump. |
| 37 | Unknown | This condition code is to be used only when there appears to be something affecting the tree but the other condition codes do not describe the situation. This would include burnt trees etc. A description of what is affecting the tree should be included as well in the comments column. In the event that this code is used for more than 5% of the tallies, it is up to the crew leader or a forester to decide on the cause of the condition. |
| 38 | Pitch Moth | Primary host is Lodgepole Pine. May weaken or kill the terminal leader, resulting in stem deformities and height growth reduction. Blisters are mainly on main stem and are characteristic resin coated up to 20mm in diameter. |
| 39 | DBH Taken on New Leader | |
| 40 | Nutrient Deficiency | This may occur on blocks that have had the humus layer removed by scarification (i.e.; Blade). Trees are chlorotic and usually in bare mineral soil. Usually noted on spruce. May be confused with flooding damage. |

51 Conk/Blind Conk

Conks appear most frequently on the underside of dead branch stubs or on the underside of live branches in the crown. Conks, by definition, are woody, shelflike basidiocarps (fruiting bodies) of wood-rotting fungi.

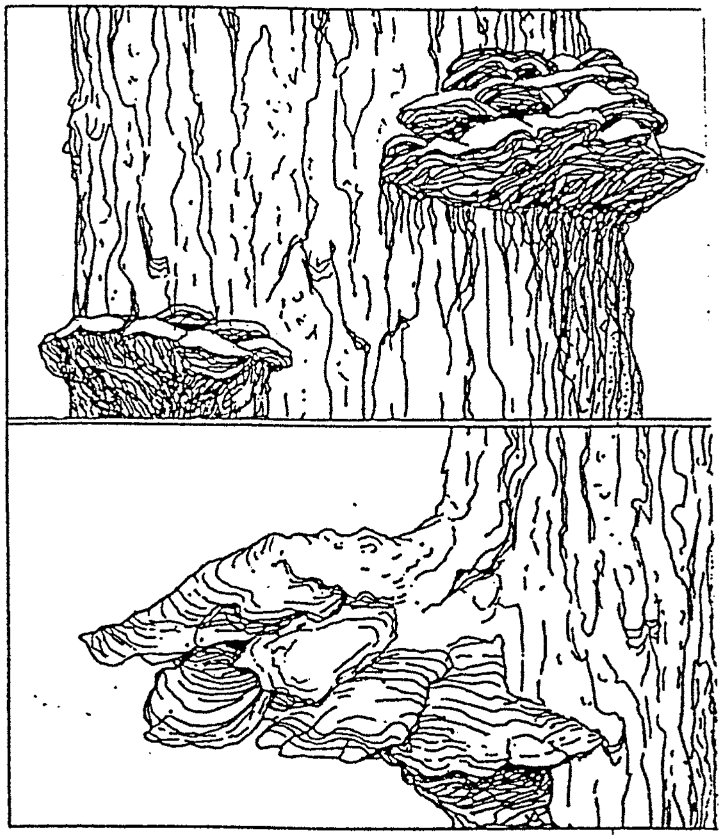


**FIGURE 4.3 CONKS AND BLIND CONKS**

52 Open Scars

Open scars are wounds which have been penetrated through to the cambium. These wounds must not be healed over and may be caused by a variety of reasons such as fire, lightning, old blazing, machinery, animals, etc. Scars are considered to be entry points for decay fungi. Open scars are illustrated in Figure 4.4. Animal damage usually penetrates the cambium therefore code as an open scar. A common mistake is to call stem disease such as atropellis canker an open scar.

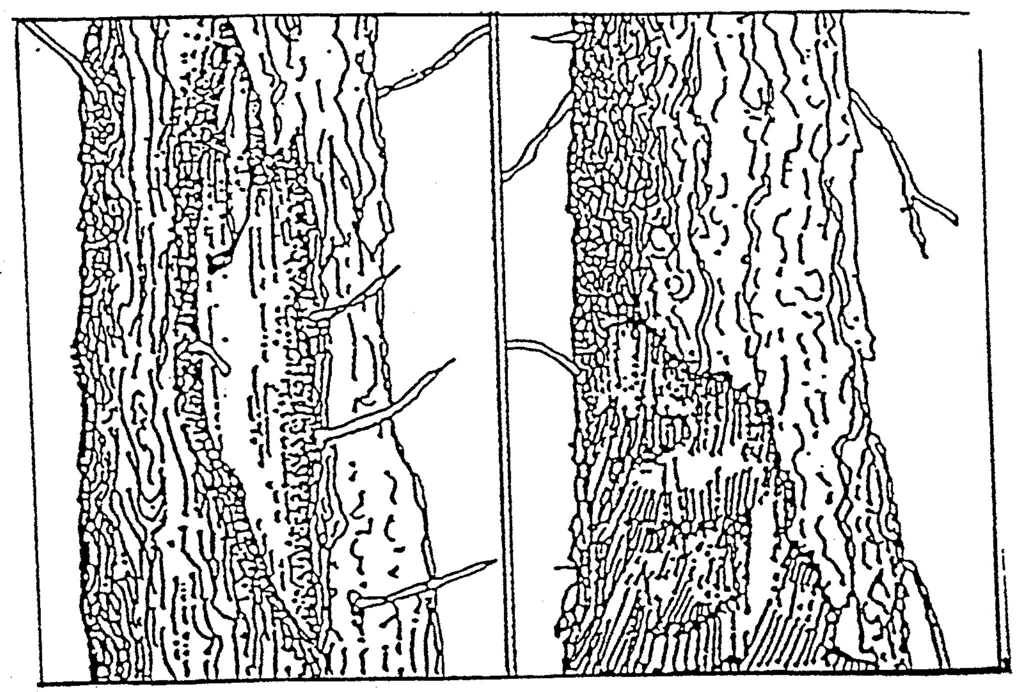


FIGURE 4.4 OPEN SCARS

53 Burls and Galls

Burls are abnormal swelling of the main stem or branches resulting from abnormal wood cell development following disturbance to the cambial layer. A burl is illustrated in Figure 4.5.

Galls are localized trunk and branch swelling of mainly tissue. There is little or no damage to the underlying wood.

Do not mistake western gall aphid for a gall, it is a foliar insect.

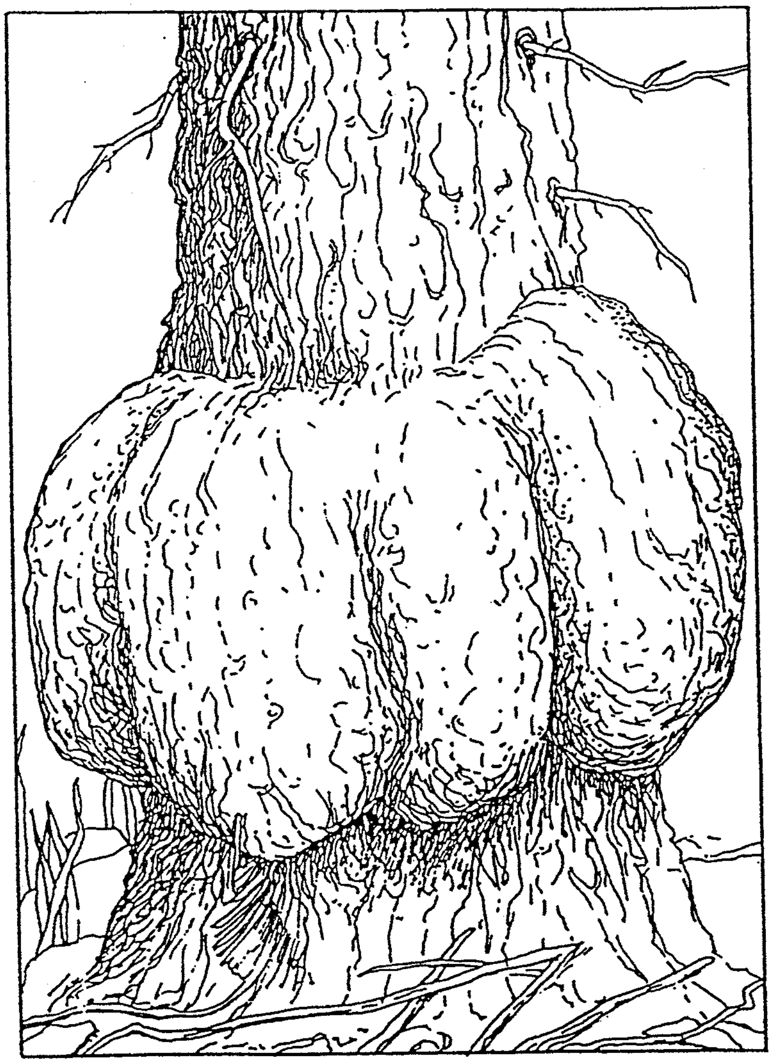
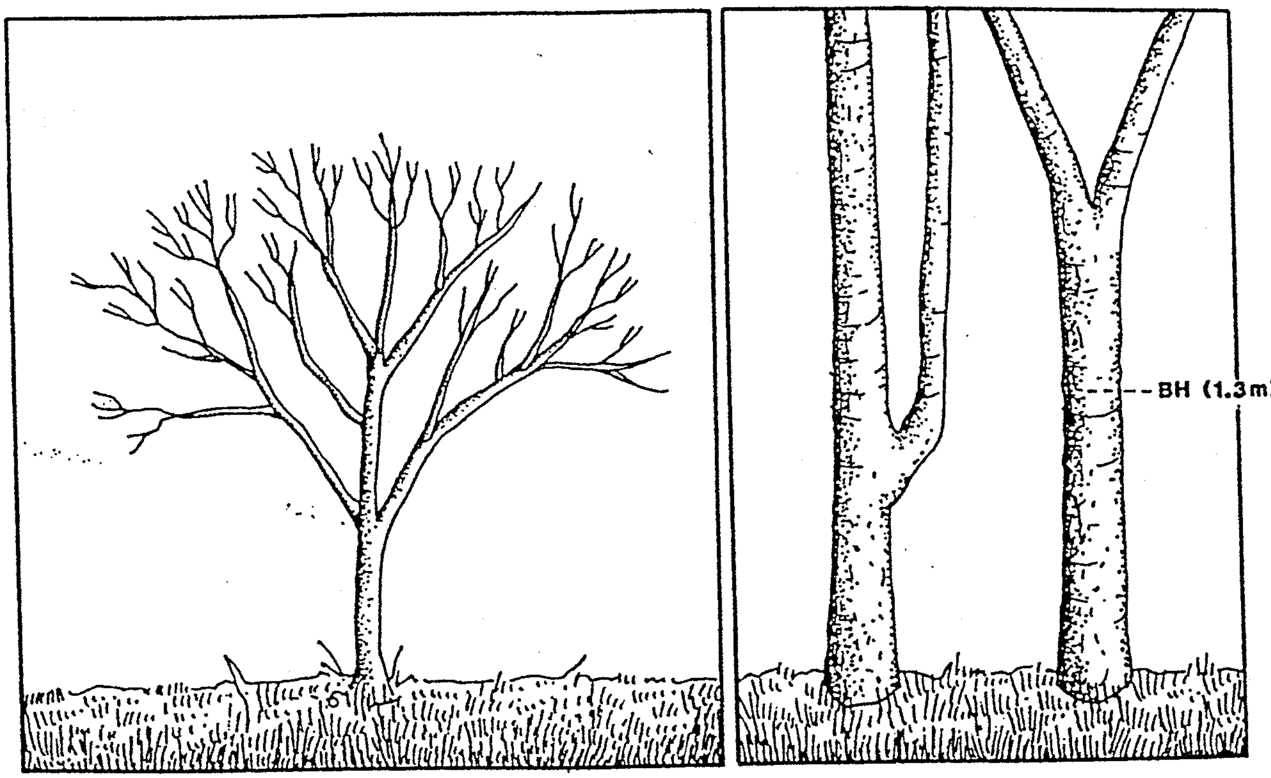


**FIGURE 4.5 LARGE BURL ON MAIN STEM**

54 Fork

Forks usually develop when there is malformation, injury or death of the terminal leader. Forks tend to be V-shaped and will only be recorded when above 1.3 m (DBH level). Forks below this point are recorded as same stump (condition code 28). Natural branching on deciduous trees is not to be recorded. A fork must be at least 7.0 cm DIB, 2.5 m past the fork to be considered. Figure 4.6 demonstrates the difference between forks and natural branching.




**Natural Branching** **Fork**

**FIGURE 4.6 FORKS**

55 Pronounced Crook
DBH ≥ 9.1 cm

This condition develops from the death of the terminal leader or the breaking off of a forked leader. When this occurs, a lateral branch takes over apical dominance as shown in Figure 4.7. A crook is recorded when the inside bark diameter is at least 7.0 cm, 2.5 m above the defect.

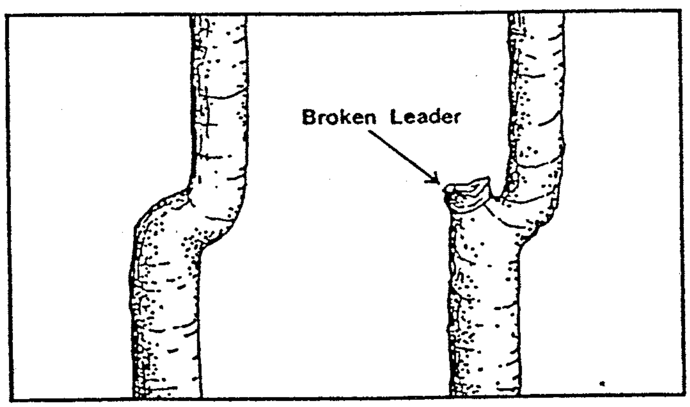



FIGURE 4.7 PRONOUNCED CROOK

56 Broken Top
DBH ≥ 9.1 cm

Broken tops are recorded when the tree bole is <u>less than</u> 10 cm DIB (diameter inside bark) at the break. <u>No Crown Class</u>.

57 Limby

A tree is recorded as limby if more than 75% of the tree has live, low sweeping branches. In general, if the majority of the trees in a plot are limby then this code is not recorded.

58 Leaning

A tree is considered leaning if it is standing greater than 20° off of vertical (see Figure 4.8). If the angle is greater than 45° to the ground, the tree has a severe lean. **No crown class if severe**.

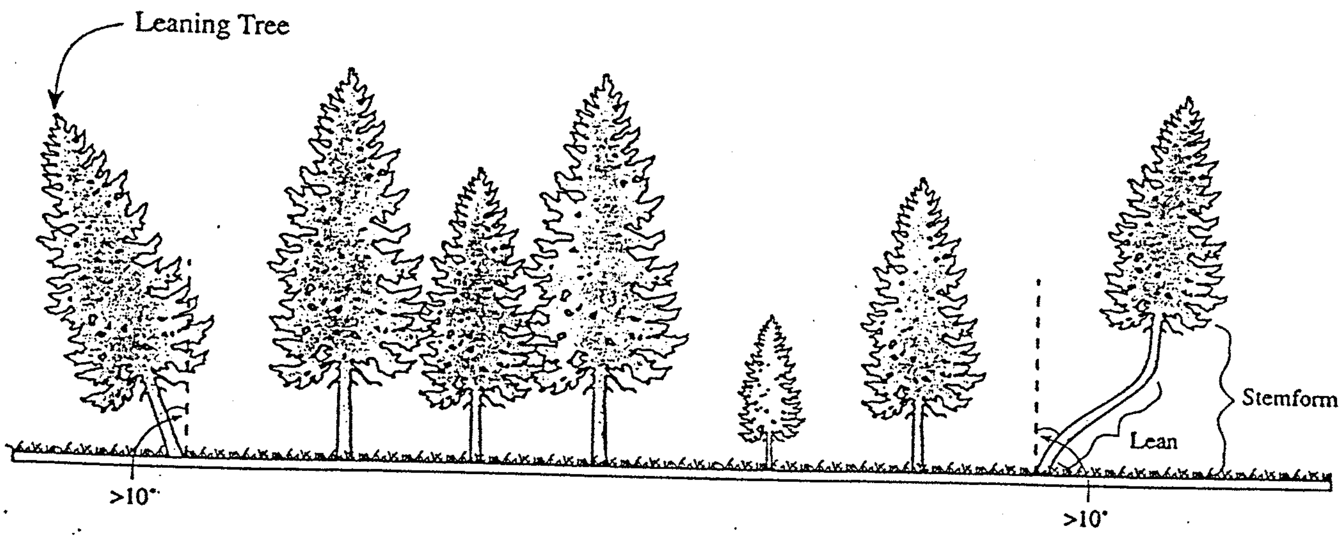



FIGURE 4.8 LEANING TREE

59 Broken Stem

A broken stem is recorded if the tree bole is greater than 10 cm DIB at the break. No crown class.

60 Standing Dead

A standing dead tree is one that is dead but still standing. No green foliage or buds present. The tree must be able to withstand a firm push. Record a diameter and species but do not record height. Pound nail into tree. **No crown class**.

61 Dead or Down

A dead and down tree is one that was previously tagged and measured in a PSP plot but at the present time is now dead and no longer standing. The cause of death must be by natural causes (i.e. windfall, beavers, insect or disease, etc.). **No crown class**.

62 Stem Insects

This code is recorded when there is evidence of an insect infestation attacking the bole of the tree. Bark beetles are the most prevalent stem insects but sawyer beetles and others are included.

Bark beetles, Dendroctonus spp., are a very serious problem in Alberta. The adult female enters the bark in early summer and lays eggs in the tree's cambium. The eggs overwinter and hatch as larvae in the early spring. Damage to the tree is done by the larvae eating the cambium and usually results in death. The tree will not turn red until the next summer. Other symptoms of attack are piles of "sawdust" (frass) at the base of the tree, entry holes in the bark, and pitch tubes (the tree tries to push the beetles out with resin). The beetles also carry a blue stain that causes further deterioration of wood quality. Beetles attack all species of pines, spruce, and Douglas fir.

Sawyer beetle infestations are common in burned timber.

63 Stem Disease

All diseases that infect the main stem are documented with this code. Included in this code are cankers, rusts, rotten branches and root rot.

Stem cankers are caused by fungi that invade stems and branches resulting in localized areas of infection in the bark and underlying wood tissue. Cankers may be annual or perennial. In perennial cankers the infected area may be eventually exposed to the underlying wood when the deadbark sloughs off. A common stem canker on lodgepole pine is Atropellis piniphila (Figure 6.10). Exudation of resin from the bark surface is the first external symptom. They are sunken elongated on one side of the trunk and indicate resin flow. This can cause a distortion in growth and a blue-black stain on the wood.

Stem rusts are also included in this condition code. Rusts are host specific parasitic fungi usually requiring two alternating living hosts. Stems and branches may be girdled resulting in large malformations or even death. In particular, Endrocronartium harknessii on young pines is a serious problem in Alberta. Spruce broom rust, Chrysomyxa arctostaphi (see Figure 4.10), can also be noted but only if the broom is no longer green (i.e. red or missing needles).

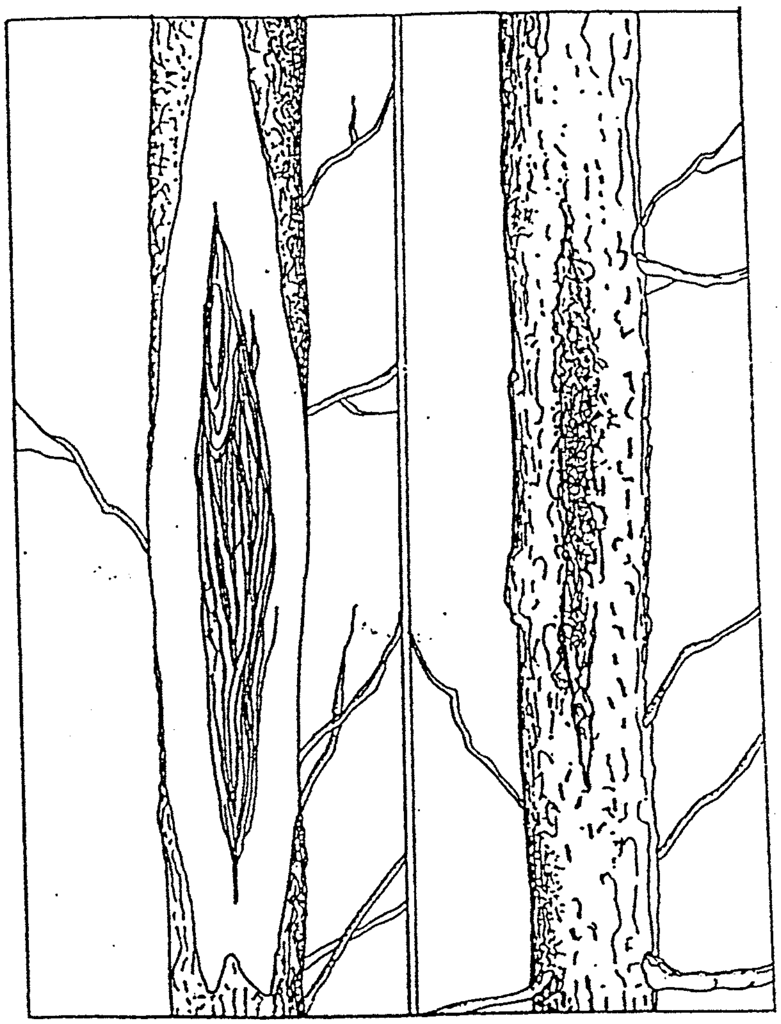


FIGURE 4.9 ATROPELLIS CANKER ON LODGEPOLE PINE

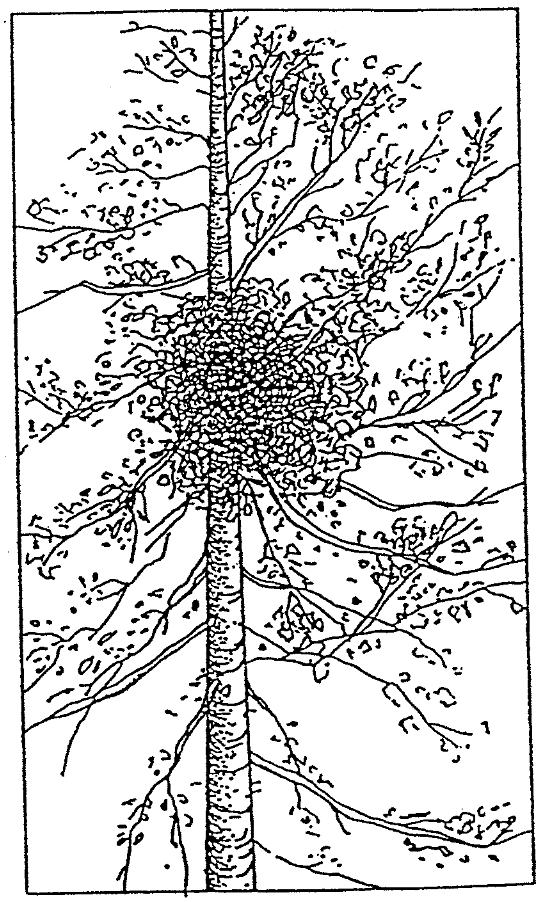


FIGURE 4.10 WITCHES BROOM ON SPRUCE

Large rotten branches typically appear on overmature, decadent trees and can be indicative of decay. Large rotten branches are those well below the base of the live Crown and are > 5 cm in diameter, are unweathered, appear punky, and are weeping (see Figure 4.11). Often a black ring appears on the stem surrounding the branch.

Some of the typical symptoms of Armillaria root rot are reddish brown or yellowish foliage; mycelial fans form between the bark and wood around the base; fungal (shoestring) strands in the soil surrounding the diseased roots and honey mushrooms growing around the base of the diseased tree.

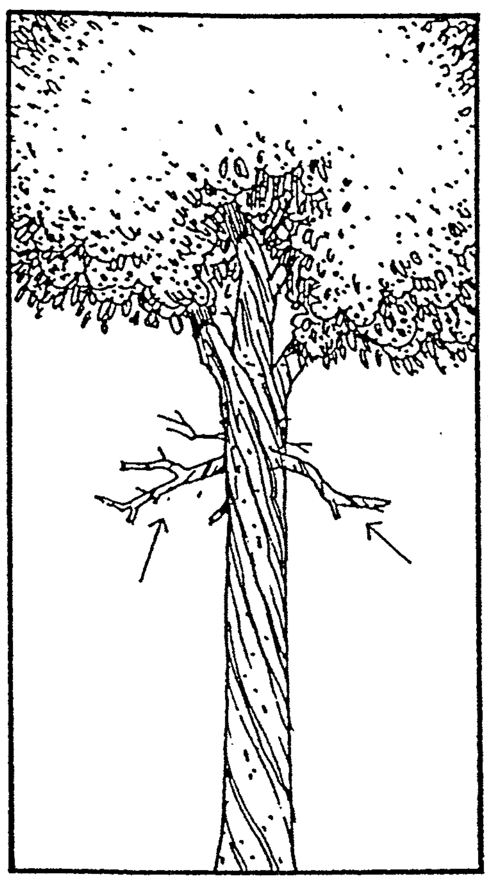


**FIGURE 4.11 ROTTEN BRANCHES**

64 Foliar Insects

This condition code pertains to all insects that infest parts of the tree off the main stem. Included in this category are the tent caterpillar, spruce budworm, jack pine budworm, spruce gall aphid, etc.

The forest tent caterpillar, Malacasoma disstria, causes severe defoliation in hardwood stands in Alberta resulting in a significant reduction in annual growth.

The spruce budworm, Choristoneura fumiferana, infests mature white and black spruce, and balsam fir stands. This insect attacks the buds and new needles. Their feeding spreads to old needles and eventually kills the tree.

The jack pine budworm, Choristoneura pinus, attacks stands of jack and lodgepole pine and is a relatively new forest pest in Alberta. This insect feeds and spreads in the same manner as the spruce budworm.

65 Foliar Disease

This code is used for all diseases that infect parts of the tree off the main stem. Needle casts and blights, and needle rusts are included in this condition code.

66 Stem Form Defects
DBH $\geq$ 9.1 cm

This condition code is used when there is damage or a distortion resulting in a loss of volume. The point at which the stem form begins must be at least 7.0 cm DIB. Included in this category are defects such as sweeps and bends, spiral grain, frost cracks, and windshake.

A sweep or bend is the gradual bowing or curving of the main tree stem. If has no decay significance, but may cause a loss of volume in a sawlog.

Spiral grain is the twisting of the grain seen in exposed wood or in the direction of the bark fissures. Spiralling frost cracks and scars also indicate the presence of spiral grain.

A frost crack is a deep radial splitting of the trunk caused by uneven shrinkage of the wood after a sudden drop in temperature. The cracks usually start at the base and extend up the trunk. They may be reopened repeatedly by wind stresses or low temperatures.

Windshake is a splitting in the wood along the grain or less frequently within an annual growth layer. It is caused by wind or snow stresses and is also known as ringshake.

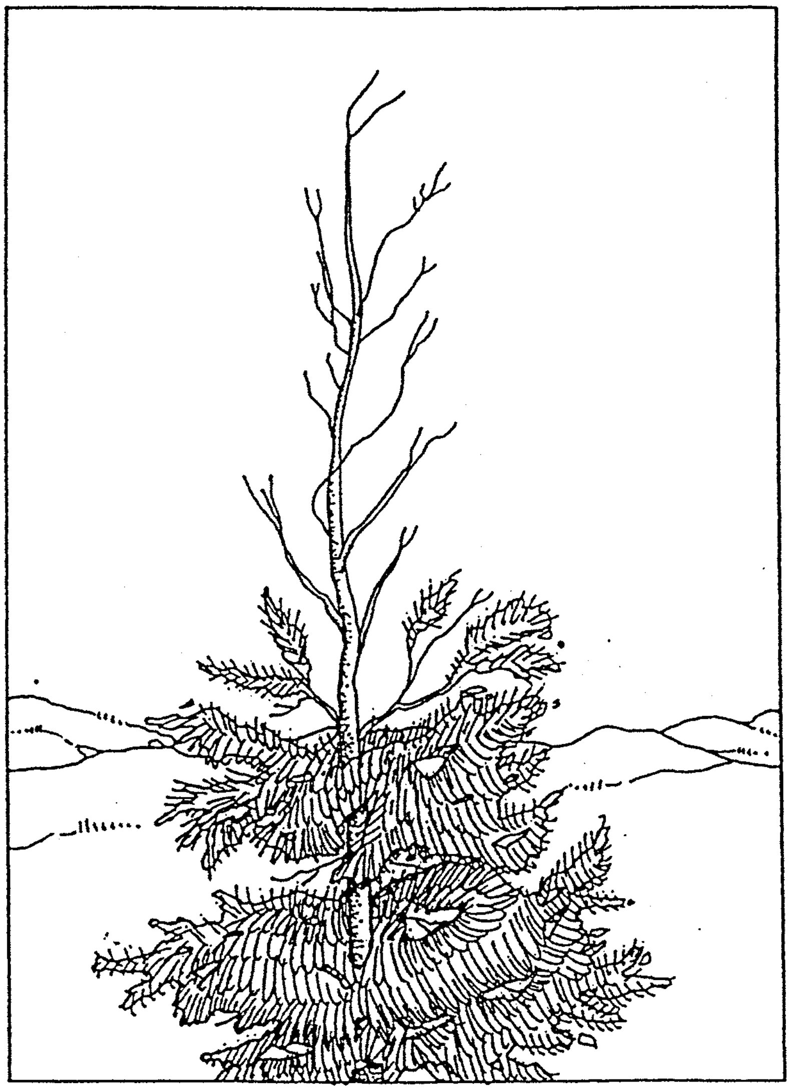


**FIGURE 4.12 DIEBACK**

67 Closed Scars

Wounds that had penetrated the cambium but have now healed over are considered closed scars. A closed scar is characterized by an irregular indentation in the bole of the tree that would result in loss of volume due to poor wood quality. Before healing over, the scar provided an entry point for disease. Frost crack is not included in this code.

68 Atropellis Canker

Widespread on pine, from small to large trees. Symptoms are elongated, sunken, cankers on the stem with copious yellowish resin flow. Wood is discoloured blue/black.

69 Comandra Blister Rust

Pl and Pj are hosts. Local occurrence only. Infected stems are spindle-shaped with conspicuous swelling of the bark. Fungus is orange-yellow in early summer. Cankers are circular and grow laterally as quickly as longitudinally. They thus girdle the stem faster than stalactiform. It should not be confused with western gall rust which is mainly a swelling of the wood. Alternate host is Indian Paint Brush.

70 Elytroderma Needle Cast

Mostly on Pl. Current years needles turn red in fall. In severe cases only current needles remain, giving branches a "lion's tail" appearance.

71 Hypoxylon Canker

Hosts are aspen and balsam poplar. Canker starts as a slightly sunken orange-yellowish area on stem. Eventually girdles the stem and has an orange/black appearance. A mycelial fan on the cambium is a reliable field symptom.

72 Spruce Cone Rust

Rust is <u>only</u> on spruce cones. Cones become prematurely brown then orange-yellow. When spores are abundant the forest floor has an orange colour.

73 Stalactiform Blister Rust

Pl and Pj are hosts. Local occurrence. Causes slight swelling of bark. Orange-yellow in summer. Cankers are elongated and grow faster longitudinally compared to Comandra. Alternate host is Bastard Toad Flax.

74 Tomentosus Root Rot

Most important on Sw and Sb. Symptoms are excessive branch mortality, thinning of crown and openings in the stand. Disease develops slowly (over 15-20 years) so is not so obvious in regenerating stands.

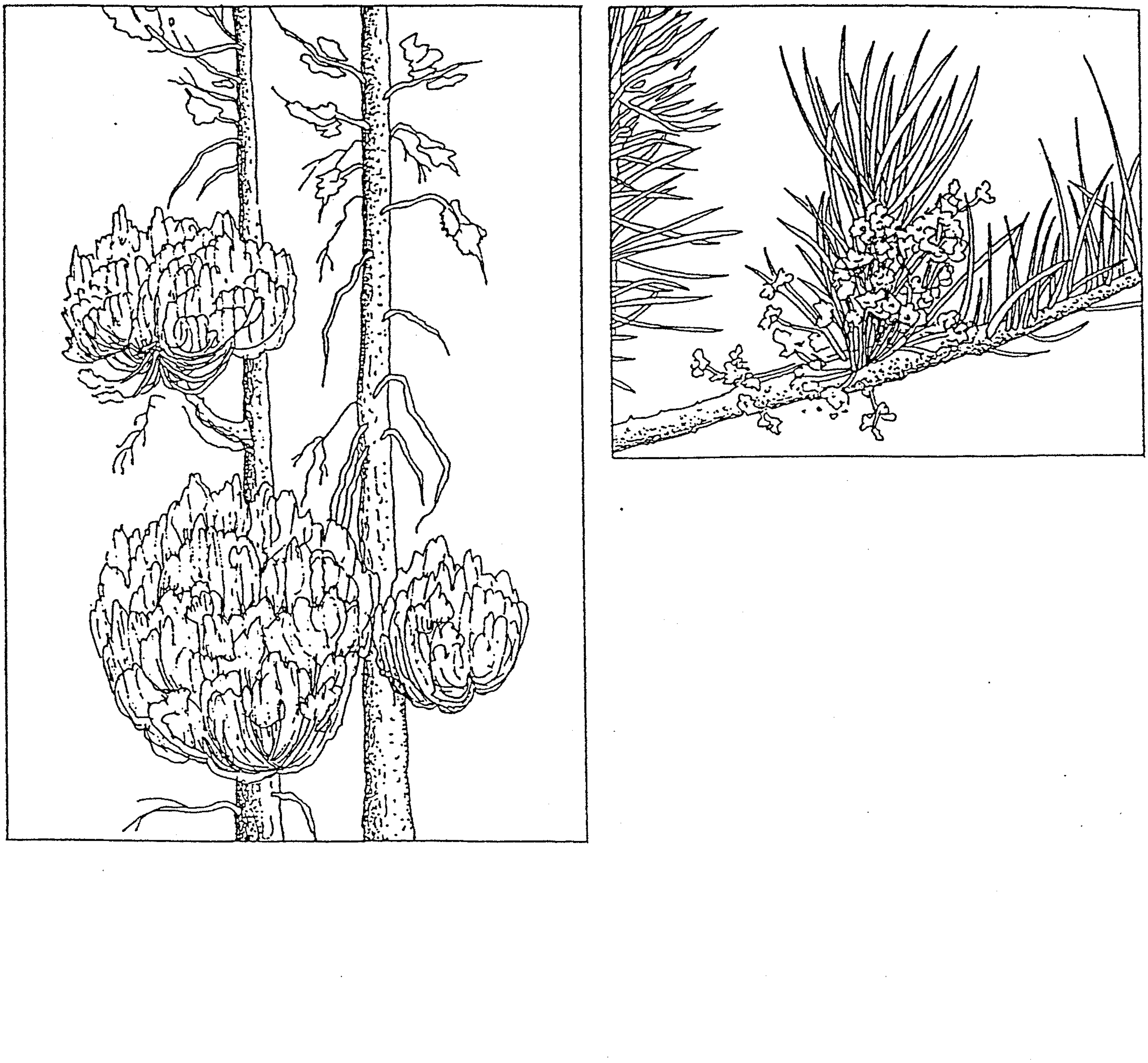
| | |
|---|---|
| 75 Spruce Spanworm | Chiefly affects aspen. Damage shows mostly as holes in the leaves. Resembles forest ten caterpillar but no pupal cases or egg masses on the foliage. Caterpillars are typically light-green and have one prominent and two indistinct yellowish lines along each side of the body. The head is dark-brown. |
| 76 Spruce Cone Maggot | No external symptoms. Dissected cone shows frass-filled spiral tunnel around the central axis. |
| 77 Spruce Cone Worm | Feeding larvae expel frass which adheres to silken webbing on cone surface. |
| 78 Eastern Spruce Budworm | First symptoms are webbing and frass in buds or on previous year's needles. Later, webbing is spun on branch tips. By late June tree crowns appear rust brown. |
| 79 Mountain Pine Beetle | Main host is Pl. Symptoms are standing dead trees with beetle exit boles about eye-level. Accumulations of pitch or sawdust are conspicuous around entrance holes bored into the bark of trees by adult beetles from mid-July to mid-August. |
| 80 Spruce Beetle | Host are Sw and Se. Symptoms are standing dead trees with beetle exit holes about eye-level. Conspicuous boring dust accumulates on bark below holes until the wind blows it away. |
| 81 Yellow-headed Spruce | Feed on needles in the upper crown of the tree. Partly chewed needles and needle stubs impart a brownish color and ragged appearance to the foliage. No webbing present. Found on all spruce. |
| 82 Spruce Beetle Rust | Discoloration of needles. May find dotlike sexual fruiting structures on needles. Infected needles drop prematurely. |
| 83 Large Aspen Tortrix | Affected foliage has a clumped, irregular appearance and leaves do not move as freely in the wind as uninfested leaves. Larval instars feed within rolled leaves or within 2 or more leaves pulled together and secured with silken webbing. |

91-96 Dwarf mistletoes are parasitic flowering plants requiring living hosts. Mistletoe is usually recognized by swellings on branches and stems or by witches brooms. Heavy infestation makes trees susceptible to secondary attack (such as bark beetles), lower wood quality and growth losses (can be from 30-60%). The major tree hosts in Alberta are: lodgepole pine, Douglas fir and larch. Figure 4.13 illustrates the effect resulting from mistletoe infestations and the individual flowering plant.

The Hawksworth Rating System for mistletoe is used to determine the severity of mistletoe infestation on individual trees. Figure 6.15 outlines instructions and gives an example of the use of the 6-class mistletoe rating systems (Hawksworth 1961, 1977). If a tree has mistletoe, record only the 90 series code, do not record 33 unless there is a second distinct foliar disease.

98 Data changed by office

**FIGURE 4.13 MISTLETOE**



# APPENDIX II

# VOLUME SAMPLING FOR THE
# B9B/B9 FOREST MANAGEMENT UNITS (SUNPINE)

SUNPINE FOREST PRODUCTS

# TIMBER CRUISE MANUAL

## FOR INVENTORY VOLUME SAMPLING

MARCH 6, 1998

# INTRODUCTION

Sunpine Forest Products Ltd. has made a commitment to establish a Temporary Sample Plots (TSP) program as part the Forest Management Agreement. The TSP program represents a long-term commitment on the part of Sunpine to quantify the forest inventory and to develop growth and yield relationships for the forests within the FMA.

The TSP field procedures are based, to a large extent, on the operation volume sampling methodologies. The plot configuration has been modified slightly to facilitate some revisions and additions to the data collection procedures.

This manual outlines the procedures used for TSP plot allocation and establishment. It is designed to be used by field crews when establishing plots. This manual also describes the stratification used in allocating plots or the criteria used to establish plot locations within the selected stands.

Sample tally sheets used in the TSP program are provided in Appendix 1.

In some cases stem sectioning data will be required. Not all plots will require stem sectioning data. A list will be required of then plots required sectioned data.

# PLOT ALLOCATION

The volume sampling program is designed to provide data suitable for development of stand volume and stock tables, and yield relationships. The most current forest inventory has been used in to stratify the landbase.

There are three natural subregions in the FMA: Sub-alpine, Upper Foothills and Lower Foothills. The Sub-alpine occupies a relatively small area and is generally of lower commercial value. Development of products related to growth, yield and site productivity from the inventory is based on natural subregion variation.

Stratification is generally based on Natural Subregion, species composition, density and height class. Within each stratum, plots were distributed across the range of potentially merchantable height classes.

## STAND AND PLOT SELECTION

The initial step in the plot allocation procedure was to define a central sampling location within the population of stands to be sampled. A list of randomly selected townships was produced, with township selection weighted by the relative area of the stands to be sampled in each township. For each township selected, a list of five randomly selected quarter section centers was generated.

Using the first randomly selected quarter section centre, attempts are made to locate three or four stands requiring sampling within a distance of approximately 1.5 km. If these stands can not located in this area, then the next randomly selected quarter section centre is examined. Once the stands were located within the proximity of a quarter section centre, stand selection was continued to the next randomly selected township.

Each selected stand will be sampled with a three plot cluster. If a stand to be sampled is at the central sampling location (i.e., the quarter section centre), this point will be used as the first plot in a three plot cluster. The locations for the first plots in other stands will be randomly selected. A 100 m $\times$100 m grid will be overlaid on a chosen stand and one of the intersections on the grid randomly chosen. The corresponding intersection point will be used as the first plot in the cluster.

Maps will be generated that will provide locations of the first plot in the plot cluster. The second and third plots within each cluster are to be systematically chosen. Locations will be based on stand configuration. THE PLOTS WILL BE LAID OUT PRIOR TO THE FIELD PROCEDURES. The following list indicates the priorities used for locating the second and third plots:

1. second plot 100 m west of first plot and third plot 100 m south of second plot;
2. second plot 100 m east of first plot and third plot 100 m south of second plot;
3. second plot 100 m east of first plot and third plot 100 m north of second plot;.
4. second plot 100 m west of first plot and third plot 100 m north of second plot;

If the plots could not be located in any of the above locations, the second and third plots will be placed on a transect and the transect arbitrarily located in the stand.

The inventory is intended to estimate the merchantable volume of the current forest crop with a precision of ± 10% at the 90% confidence level. Clusters having EXTREMELY poor access will be substituted with clusters having better access. The number of plots allocated per stratum is generally proportional to area of the stratum. In strata having relatively large areas it was necessary to impose maximums on the number of plots to ensure that other strata would be represented with sample data

The approach used for sampling is based on a combination of Phase 3 and AVI stand classification. As the inventory will eventually be used in conjunction with both Phase 3 and AVI classification, it will be necessary to be able to relate the sampling locations to AVI types. By recording the field location of each plot using a Global Positioning System (GPS) it will be possible to subsequently determine the AVI stand in which the plot was located.

The sampling design proposed is a multi-stage stratified design. The plots within each stand are not truly independent units of analysis. However, given the relatively high, within stand, variability and the low number of plots in each stand, it is likely that the plots can be considered independent for the purpose of analysis. An analysis to test this assumption will be made once the program has been initiated. If the assumption of independence cannot be used, then the three plots in each cluster will be averaged and considered as a single plot. This will tend to reduce plot variation as well as reduce sample size, so the effect on precision is likely to be minimal.

Statistics appropriate for the unequal probability of stand selection will be used in the analysis of the volume sampling data.

# PLOT ESTABLISHMENT

## TIE POINTS

The tie point or photo tie is the starting point of the cruise line. It is defined as a point tied to a ground feature that can be identified on aerial photographs or orthomaps. Photo ties are chosen for their ease of recognition or nearness to the cruise line.

In the field, tie points must be clearly marked  in such a way that they may be found at a future date. Plastic seismic ribbon must be tied to strong vegetation, preferable a full sized tree. The date, crew initials, directions to the first plot and plot number must be written in black permanent felt marker on the ribbon. Each cruiser will number their tie points according to their initials and the next consecutive number after their last tie point.. These tie points must be clearly marked on the base map once they have been established.

## CRUISE LINE

The cruise line is run with a compass, % clinometer, and a metric hipchain or tight chain. Slope correction will be necessary since we measure the horizontal distance from a map; whereas, the distance actually traveled on the ground is slope distance (Appendix 1). The horizontal distance is less than the slope distance; therefore, slope corrections must be made. Only when the slope is 0% will the horizontal distance = the slope distance. There is a very; small correction for anything under 10%.

PLOTS WHICH OCCUR IN VOIDS WITHIN STANDS SHOULD NOT BE MOVED.  Plots should be moved if they fall on a seismic line to a location within the same stand.  Move the plot 100 m perpendicular to the seismic line to the east or north if possible.  If this is not possible because of the stand shape, then move the plot south or west.  If a plot falls on a wellsite, move the plot within the same stand, 100m south of the closest wellsite boundary.  If a plot falls on an intermittent or ephemeral stream, do not move the plot.

## LOCATION OF PLOT CENTER

When a plot center has been reached a sturdy stake, > 50 cm,  is driven into the ground to mark the point, a long orange ribbon with the date, crew and plot # is attached to the stake.  The point at which the stake enters the ground is considered plot center.

A plot size of 160 m2 will be used. All trees of 7.0 cm dbh or greater will be measured on each plot. A subplot of 0.001 ha will be used for sampling stems less than 7 cm and greater than 1 cm dbh (referred to as the understorey plot and tallied in the undersize section on the back of the tally card).

## PLOT DATA

General information collected for the plot is required. This includes:

- date - Year month day
- name - The cruiser or note taker will always put their initials followed by the compassman's initials.
- Location - LS Sec Twp Rge M
- Development Area - Compartment name e.g. Rapid Creek or Forest Management Unit.
- Plot number - Sunpine will allocate and number the plot cluster. Individual plots in the cluster will be numbered using the cluster number and plot numbers 1 to 3. (e.g. if the plot number on the map is 234 then plot numbers are recorded as 2341,2342 and 2343). DO NOT USE ALPHABETIC CHARACTERS.
- Plot area - will be 160 m2.
- GPS - In this situation the GPS file number will be placed in this box to indicate that there is a GPS file for that plot.
- Stand number - Enter the Phase 3 or AVI stand number It is **crucial** that the stand number which the plot falls in is entered correctly.
- Overstorey - The overstorey can be defined as the uppermost layer of trees within the forest. Sunpine will supply a list of stand AVI map calls with corresponding stand and plot numbers. Field - AVI field call (see AVI standards manual). Final field call for that polygon based on all plots within that particular stand.
- Understorey - The understorey is the second layer of trees within the forest.
- Map - AVI map call.
- Field - AVI field call (see AVI standards manual).
- Final - Final field call for that polygon.
- Tree numbering - Tree one will always be the closest talliable tree to plot center and tree two is the first tree on the clockwise side of the cruise line where you entered the plot. All trees must be clearly numbered with florescent orange paint with the numbers always facing plot center.

## TREE MEASUREMENTS

The following trees measurements will be recorded for **all** trees greater than or equal to 7cm dbh.:

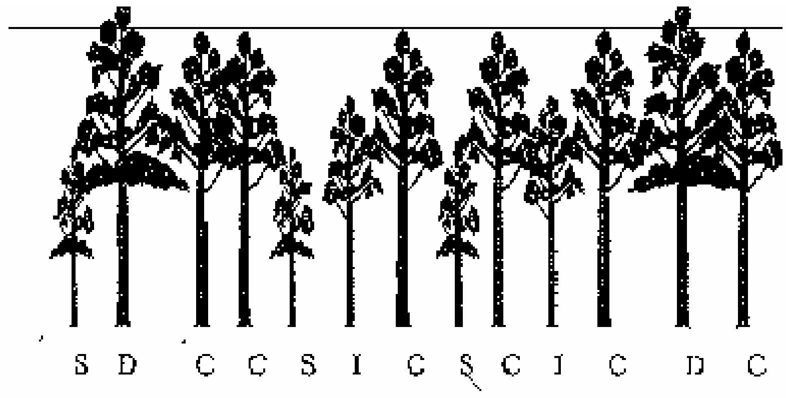
- Species - Recorded as two capitalized letters. The following species may be found in Sunpine's FMA:

*Table 1 Acceptable species and codes*

| Species | Species Code |
|---|---|
| White Spruce *(Picea glauca)* | SW |
| Black Spruce *(Picea mariana* | SB |
| Engelmann Spruce *(Picea englemannii)* | SE |
| Sub Alpine Fir *(Abies lasiocarpa)* | FA |
| Balsam Fir *(abies balsamea)* | FB |
| Douglas Fir *(Pseudotsuga menziesii)* | FD |
| Lodgepole pine *(Pinus contorta)* | PL |
| Whitebark pine *(Pinus albicaulis)* | PW |
| Limber pine *(Pinus flexilis)* | PF |
| Tamarack *(Larix laricina)* | LT |
| Trembling Aspen *(Populus Tremuloides)* | AW |
| Balsam Poplar *(Populus balsamifera)* | PB |
| White birch *(Betula papyrifera* | BW |
| Dead Coniferous | DC |
| Dead Deciduous | DD |

- DBH - minimum DBH for a tree to be tallied is 7.0 cm. Breast height = 1.3 metres above the <u>high point</u> of the ground. Diameter may be moved if there are factors that will be misleading as to the true size of the stem including abnormal swelling, scars, branching, and conks. When moving the diameter, find the closest point to what the true diameter would have been, an explanation, as to why you moved the diameter and where it was moved to, will be clearly stated in the comments.
- HEIGHT - height measurements are taken on every fifth tree in the plot. With a minimum of two heights per species per plot. Included in these measurements are the heights of the largest diameter trees of each species in the plot (top height trees). If the largest diameter trees have a severe lean or are very unhealthy then they should not be selected as the top height trees. ENSURE THAT SLOPE CORRECTIONS HAVE BEEN MADE ON HEIGHT MEASUREMENTS IN STEEP TOPOGRAPHY.
- CROWN CLASS - crown class is the position of an individual tree crown within a particular stand. When determining crown class, the entire visible portion of the stand must be taken into consideration. For example, a dominant tree must be dominant to the entire visible portion of the stand not just the surrounding trees. In case of a broken top estimate where the top would have been, if it was not broken, before determining crown class. This will give an accurate description of the stem size.
    - Dominant - crown extends above the general level of the canopy.
    - Co-dominant - crown forms the general level of the canopy.
    - Intermediate - crown is just below the general canopy level, but is still somewhat healthy.
    - Suppressed - crown is below the general canopy level and is being overcome by the surrounding trees.

*Figure 1 Crown Classes*




- VISIBLE SAW DEFECT - not required in this program.
- CULL SUSPECT CLASS - Cull suspect class is used to indicate a level of internal decay. Listed below are the four acceptable codes in order of importance.
    - **C (**Conks and Punks) - Conks usually appear on the underside of branches or branch stubs. They can be described as plate like fruiting bodies growing from the stem of an infected tree. Punk knots, swollen knots, and blind conks appear as swellings when a tree heals over an aborted conk. These types of swellings must be cut into in order to positively identify them. Deep woodpecker holes in rotten stems are also recorded as "C".
    - **S (**Scars and others) - Scars and other wounds can be defined as a wound that penetrates through the cambium below 10 cm top diameter. Die back is also recorded as "S".
    - **O (**Old broken tops) - Old broken top is used when the top is broken below 10 cm top diameter.
    - **N (**Non suspect) - Decay is not suspected.
    - Cull suspect is not recorded for DD and DC.
- DEFECT TYPE - acceptable codes are:
    - **C =** Frost Creek
    - **G =** Spiral Grain
    - **W** = Weeping knots
    - **K =** Crooks/Sweep
    - **F =** Forks
    - **L =**Limby
- INSECT OR DISEASE - indicate the presence of the following insects and diseases with the associated codes listed in Table 2.

*Table 2 Acceptable diseases, codes and descriptions.*

| Disease | Code | Symptoms |
|---|---|---|
| Dwarf Mistletoe | DM | - PL only, witches Brooms, branch and stem swelling |
| Atropellis canker | AC | - PL only, slight resin flow, circular black spot, bark rupture and profuse resin, enlarged canker longitudinally, sunken canker area. |
| Needle Cast | NC | dark fruiting bodies on foliage, red grown discoloration, premature casting of needles, healthy needles are found in clupms near the end of branches |
| Armillaria Root Rot | AR | yellowing of foliage,, basal resin flow, white mycelia fans under bark, rhizomorphs under bark, dead and down trees will have a ball like structure at the stump of the tree where the roots have all rotted off. |
| Yellow Witches Broom | YW | witches broom, typical ball shape, primarily on SB, occasionally found on other spruce. |
| Western Gall Rust | WG | globose galls on stems and branches |
| Root Collar Weevil | DW | copious flows of resin, roots and stems over 25 mm diameter are tunneled by larvae, infects trees in a circular pattern, carpenter ants |
| Adelgid Galls | AG | cone shaped galls formed on last year's branch growth of spruce |
| Terminal Weevil | TW | death of the leader on Spruce or Pine, repeated attack causes crooked and bushy tree |

- DMR - Hawksworth's mistletoe rating will be assessed for all pines trees. Dwarf Mistletoe Rating Code. Sunpine uses the Hawksworth rating system in rating the severity of mistletoe infection, there are three steps in this rating system:

    1. Break the live crown into three sections

    2. Numerically rate each section accordingly
        0 - no sign
        1 - light infection
        2 - heavy infection

    3. The sum of the three sections equals the DMR.

- AGE DATA
  Two DBH ages will be recorded from the largest diameter trees of each species type (i.e., coniferous or deciduous) through the use of increment cores. Only dominant or co-dominant trees will be selected for aging. MAKE NO CORRECTION FOR DBH AGE. These will be made at the time of plot compilation. All cores will be retained for ageing in an office environment. In order to get an accurate count, the pith should be included in your core samples. If the pith is missed it is acceptable to have a middle ring the size of a dime, if the pith is missed any further than this the tree must be re-bored. Every tree that is aged must also have its height and diameter recorded. Increment measurements must be taken at every plot on a co-dominant or dominant tree at breast height. Increment measurements will be 0-10 years, and 10-20 years.

- STUMP DIAMETER- stump diameter is taken at 0.3 m above the high point of the tree for every aged tree in the plot.

- Miscellaneous- This section is to be left blank unless otherwise requested.

- UNDERSIZED TALLY - Dot tally, in the appropriate height class column, all stems that are < 7 cm DBH and > 30 cm tall.
- STANDING DEAD WITH LOOSE BARK - Dot tally by crown class (dominant, co-dominant., intermediate, or suppressed) all standing dead conifer (CS) or deciduous (DS) which do not have sound enough bark to be tallied as DC or DD.

**STAND ASSESSMENT**

OVERSTOREY CONDITION ASSESSMENT

The overstorey condition assessment is very important in the planning process. Therefore, accurate information is crucial. If the following explanations are not clear or if you have questions please contact the quality control person.

- Damaged- > 25% of stems have environmental or animal damage
- Diseased- > 25% of stems are infected with insects or disease
- Unstable > 25% of stems have blown down or fallen down over a long period of time, shallow rooting
- Stable - stand is relatively healthy, not likely to lose significant volume
- Immature- tree exhibits moderate to good radial and /or height growth
- Stagnant - stand is growing very slowly due to it's environment
- Decadent- stand is growing very slowly due to age, usually overstorey has high numbers of dead, broken, or dying stems

PRODUCT POTENTIAL %

Not required.

DECIDUOUS CONTENT %

This is an assessment of the deciduous components. Tally Bw as Pb.

UNDERSTOREY:

Understorey is the second canopy found within the stand. There must be a minimum of 3 metres difference between the overstorey and the understorey. The understorey can be any height greater than 1 meter. Remember a canopy must have a minimum of 6% crown closure in order to be a separate layer.

a) Stems/ha this will come with experience Remember average optimum planting density is 1500 stems/ha. Based on 2.9 meter spacing.

b) Merchantability: Determine the average stem diameter of the understorey

c) Distribution:

Even - The understorey is evenly spread out throughout the stand.

Patchy - The understorey is found in small or large clumps throughout the stand.

d) Age (years) If there is a map AVI understorey call, or if a field call of a "B" density or greater is made, then an age for the understorey is required. A total age must be taken if the average size is > 7 cm DBH or greater, otherwise counting nodes is acceptable.

e) Vigor

Healthy- better than average growth

Stagnant - below average growth

Suppressed- the understorey is overcome by the overstorey and growth is being affected.

Damaged- > 25% of the understorey have sustained environmental or animal damage.

Diseased - > 25% of the understorey is infected with disease or insects.

REGEN:

This section is not for tallying "regen". This section is for defining a third layer within the forest. The only situation when there should be regen stems without an understorey is if the second layer is < 1 m.

SITE INFORMATION:

### *Aspect*

N, NE, NW, S, SW, etc. Azimuth is not necessary. Aspect is the direction water would generally flow on the overall slope.

### *Slope %*

Average % slope from the plot centre.

### *Slope type*

- Benched - the slope occasionally flattens out in an otherwise uniform slope.
- Uniform - the slope does not drastically change.

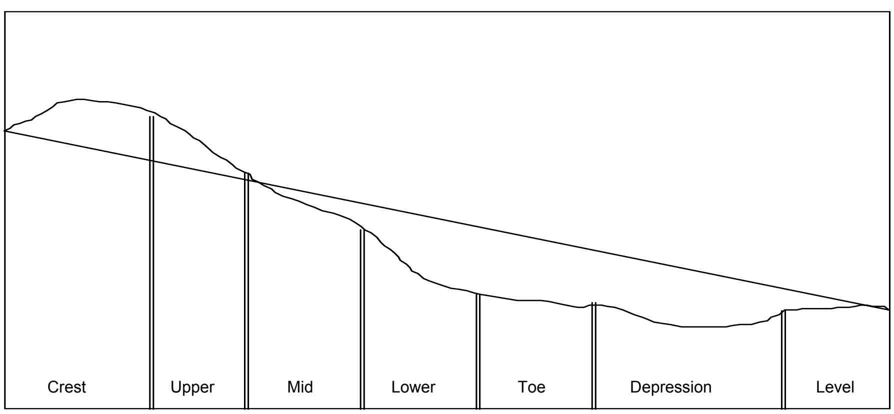
- Undulating- operable gullies (< 45%) found across slope.
- Gullied - inoperable gullies (> 45%) found across slope that may otherwise be operable.
- Broken- soil has sluffed or been washed away.

### *Slope Position*

The position of the plot on the overall slope. Valid codes are:

- Crest - C
- Upper -U
- Mid - M
- Lower- L
- Toe -T
- Depression -D
- Level - E

*Figure 2 Slope Positions*




### *Erosion Potential*

Erosion potential is the chance of water eroding down or into the mineral soil, based on water flow, slope, and soil type.

- Light- 0 - 25% of the area is or could be eroded in a heavy rain situation.

- Moderate - 26 - 75% of the area is or could be eroded in a heavy rain situation.
- High - more than 75% of the area is or could be eroded in a heavy rain situation.

### *Duff depth*

Measured in cm from the top of the litter to the mineral soil.

### *Tree Productivity Rating (TPR)*

The TPR is the potential timber productivity of a stand based on height, and age of the predominant species.

### *Leader Growth*

A visual inspection of the average leader growth of the mature stems in the stand. Good- > 30 cm leader, in general the crowns are slender and very conical when compared to other trees of the same species.

- Fair - Between 10cm and 30cm
- Poor- < 10 cm average leader, in general the crown shape is more blunt and rounded.

### *Windfall Severity*

- Low- <5% of stems have blown or fallen down.
- Moderate- between 5% and 25% of stems have blown or fallen down.
- High- > 25% of stems have blown or fallen down.

## WATERSHED FEATURE ASSESSMENT

Watershed features such as creeks (Table 3), seepage's, springs, and mineral licks, will be recorded with the following details considered and recorded for each one:

- exact location from the previous plot or tie point
- size of feature
- presence and size of the channel (depth and width)
- structure of the channel bottom (sand, silt, clay, course fragments)- depth, slope, and width of the valley

- whether or not the stream is fish bearing
- whether or not the feature will be a barrier to roading/logging
- suggested buffers
- any other concerns that should be considered while making the harvest plans

*Table 3 Watershed features*

| Feature | Descriptions |
|---|---|
| Ephemeral | Distinct passage through trees, typically grass covered, but no developed channel. Only flows during heavy rainfall or spring runoff |
| Intermittent | Developed channel and flows during rainfall and runoff |
| Permanent | Developed channel and flow year round |

This area does not only cover your cruise line. If you know of a feature close by, or down seismic lines, or outside the block mention it.

Watershed features should always be filled out, if there are no significant features record that.

## OPERABILITY/ROADING CONCERNS

This section does not have to completed.

## WILDLIFE AND FISHERIES

Explain the presence and the degree of usage of mineral licks, wildlife trails, nests, heavy browsing, dens, rare species sightings, or make suggestions on wildlife habitat development.

## START OR TIE POINT

All tie points must be clearly explained from start to finish. example: 0+100 @ 50$^o$, from intersection of seismic lines (180$^o$ & 20$^o$), NW corner

Sec. 6 Twp. 32, (C1) to plot 70 or 0+150 @ 50$^o$ from plot 70 to plot 71

## TRAVERSE MAP

The traverse map must <u>always</u> contain the following information in order to draw an accurate picture of the area to someone that may not have covered that portion of the compartment:

## COMMENTS

Comments must finish drawing the mental picture of the area for the Forest Planner. Comment on anything that may aid in the harvest planning or anything that has already been mentioned but needs further explanation. The following details must be included:

- stand condition
- further comments on blowdown:
- age
- cause
- size of area
- if plot is not representative of the stand, explain why.

## STEM SECTIONING

If the plot has been selected for stem sectioning then select the first height tree selected if it is in the co-dominant or dominant height class. It does not have to be the top height tree. LFS stem analysis procedures will be used (See Appendix 2).

# QUALITY CONTROL

Quality Checks are done to ensure that Sunpine's standards are being met. Quality checks will be performed as a method of identifying human errors that occur due to lack of care or knowledge in field procedures. Sunpine's goal is to develop high performance proficient crews that require little supervision; therefore, cruise cards must be completed and given to the quality control person on a regular bases (at lease once per week).

## INSPECTION PROCEDURE

### OFFICE INSPECTION

Tally sheets will be checked in the office to ensure all the columns have been filled. The quality control person will not take possession of the cruise cards until all necessary spaces have been completely filled in. If the top and bottom shots and horizontal distance have been recorded, the total height can be recalculated. Plots will be selected for check cruise if they lack certain data or if the data looks suspicious. More plots will be inspected (10% - 15%) when a new crew begins cruising in order to monitor training needs. Once the crew has become more proficient, 4% - 8% of all plots will be inspected.

Check cruise plots will not always be the easiest and closest plots to the road.

### FIELD INSPECTION

The field inspections will consist of checking all items. All of the allowable errors below will be left up to the final judgment of the quality control person:

*Table 4 Summary of allowable errors*

| Item | Tolerance |
|---|---|
| Location of plot centre point and cruise line | $\pm$ 2% of the cruise line horizontal distance |
| Species | There will be no tolerance for incorrect identification. Difficult identifications will be left to the judgment of the quality control person. |
| No. of trees tallied | There will be no tolerance for missed trees within the plot or tallied trees outside the plot. |
| Diameter | $\pm$ 1%. |
| Total Height | All heights must be within $\pm$ 2.5%. All heights between 2.5% and 5.0% will be discussed with the cruiser. All heights greater than $\pm$ 5.0% will be automatic failure of the plot. |
| Crown Class | 95% of all stems checked must have correct crown classes |

| Item | Tolerance |
|---|---|
| Visible Saw Defect | ± 90% of all stems checked must be within ± 10% of the true saw defect. |
| Cull Suspect Class | 5% of stems checked may have incorrect cull suspect class but there is no tolerance for made up codes |
| Defect Type | 5% of stems checked may have incorrect defect type but there is not tolerance for made up codes. |
| Total Age | Conifers must be within ± 5% and deciduous within ± 10%. |
| Product Code | 95% of all stems checked must have correct product codes. |
| DMR | 90% of all stems with DM must be rated within ± 1 point. |
| Diseases/Insects | There will be no tolerance in severe or prominent cases. Creation of new codes will result in the return of plots. |
| Increment Width | ± 10% for each set of years. |
| Field Timber Type | Density, Height ± 10% of actual canopy level.<br>Species ± 10% of actual composition |
| Overstorey Condition Assessment | |
| Product Potential | All plots that are checked must be within ± 10% of the checkers reasonable call. |
| Deciduous Content | All plots that are checked must be within ± 10% of the checkers reasonable call. |
| Understory | Stems/ha must be within ± 25%. Age 90% of the stems checked must be within ± 5%. All space must be completely filled out |
| Regen | Stem/ha must be within ± 25%. If an incorrect call is made it will result in the rejection of the plot. Undersize Tally 90% of the stems checked must be accounted for. |
| Aspect | ± 45° of the true aspect. |
| Slope % | ± 5% of the true slope |
| Slope Type | No tolerance for prominent features |
| Slope Position | ± 1 slope position. |
| Erosion Potential | This information is critical to the planner; therefore, there is little or no tolerance for inaccurate call. |
| Duff Depth | The duff measurement must be within ± 20%. |
| Tree Productivity Rating | No tolerance |

There will be absolutely no tolerance for incorrect calls on watershed, roading, wildlife and fisheries, start or tie point, traverse map, or the comments. As long as everything that has been asked for in this manual is addressed there should be absolutely no reason for incorrect or missing information.

Each plot is evaluated individually. Once a single plot is rejected two more plots within that days work will be checked, it one or two of these plots fail, then the entire day work must be done.

The cruise cards will be returned only if there are space left blank or if there are made up codes that need to be corrected. All rejected plots for other reasons must be completely redone.

The quality control person will have the final decision on all errors. All situations are open to calm

rational and justifiable discussion. Sunpine reserves the right to request the removal of any crew that consistently submits poor, inaccurate, or erroneous data.

## APPENDIX 1 CRUISE TALLY CARD

# CRUISE TALLY CARD

Page ____ of ____

SUNPINE FOREST PRODUCTS

Date YR | MO | DAY

Name

| LS | Sec | Twp | Rge | M |
|---|---|---|---|---|
| | | | | |

Development Area

| Plot No. | Area M² | GPS File No. | Stand or Block No. |
|---|---|---|---|
| | | | |

| | Overstory | Understory |
|---|---|---|
| Map | | |
| Field | | |
| Final | | |

| Tree No. | Species | DBH | Total Height | Crown Class | Visible Saw Defect % | Cull Suspect Class | Defect Type | Stump Diameter | Product | DMR | Insect or Disease | Miscellaneous |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | | | | | | | | | | | | |
| 02 | | | | | | | | | | | | |
| 03 | | | | | | | | | | | | |
| 04 | | | | | | | | | | | | |
| 05 | | | | | | | | | | | | |
| 06 | | | | | | | | | | | | |
| 07 | | | | | | | | | | | | |
| 08 | | | | | | | | | | | | |
| 09 | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | |
| 21 | | | | | | | | | | | | |
| 22 | | | | | | | | | | | | |
| 23 | | | | | | | | | | | | |
| 24 | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | |

Height Calculations

| Tree No. | Sample Tree Increment and Age 0-10 | 11-20 | DBH Age | Stump Age |
|---|---|---|---|---|
| | | | | |

| Page No. | Tree No. | Species | DBH | Total Height | Crown Class | Saw Defect % | Cull Suspect Class | Defect Type | Stump Diameter | Product | DMR | Insect or Disease | Miscellaneous |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 26 | | | | | | | | | | | | |
| | 27 | | | | | | | | | | | | |
| | 28 | | | | | | | | | | | | |
| | 29 | | | | | | | | | | | | |
| | 30 | | | | | | | | | | | | |
| | 31 | | | | | | | | | | | | |
| | 32 | | | | | | | | | | | | |
| | 33 | | | | | | | | | | | | |
| | 34 | | | | | | | | | | | | |
| | 35 | | | | | | | | | | | | |
| | 36 | | | | | | | | | | | | |
| | 37 | | | | | | | | | | | | |
| | 38 | | | | | | | | | | | | |
| | 39 | | | | | | | | | | | | |
| | 40 | | | | | | | | | | | | |

**A. UNDERSIZED TALLY**

| Species | 0.3 - 1.0 m | 1.1 - 5.0 m | 5.1 - 10.0 m | > 10.1 m |
|---|---|---|---|---|
| Sw | | | | |
| Pl | | | | |
| Fb | | | | |
| Aw | | | | |
| Sb | | | | |

**B. STANDING DEAD WITH LOOSE BARK TALLY**

| Species | D | C | I | S |
|---|---|---|---|---|
| CS | | | | |
| DS | | | | |

**C. STAND ASSESSMENT**

1) Overstory Condition Assessment

Damaged Diseased Unstable Stable Immature Stagnant Decadent

2) Product Potential (No. of Stems)

Pole ________ (%) Peeler________ (%) Sawlog ________ (%) Post ________ (%)

3) Deciduous Content

Aw ___________ % Pb __________ % a)Distribution: Patchy Scattered

b) Condition: Healthy Diseased c) Recommendation: Harvest Leave

4) Understory

a) Stems/Ha ______________________

b) Merchantability: 0-10 cm 10-15 cm 15 cm +

c) Distribution Even Patchy d) Age __________ yrs.

e) Vigor: Healthy Suppressed Damaged Diseased

f) Retain: yes no

5) Regen

a) Stems/ha ________ b) Height: ________ m

c) Distribution: Even Patchy

d) Vigor: Healthy Suppressed Damaged Diseased

**D. SITE INFORMATION**

1) Aspect ____________ 2) Slope ________ %

3) Slope Type: Benched Uniform Undulating Gullied Broken

4) Slope Position C U M L T D L O 5) Erosion Potential L M H

6) Duff Depth ________ cm 7) Tree Productivity Rating U F M G

8) Leader Growth G F P 9) Windfall Severity L M H

**E. WATERSHED FEATURE ASSESSMENT**

Significant Features ____________

Location: Between ________ & ________ at ________ ° bearing

Feature: ex. creek, spring, buffer width etc.

Significance: ex. Operational concern, flow, habitat, sensitivity etc.

Location: Between ________ & ________ at ________ ° bearing

Feature: ____________

Significance ____________

**F. OPERABILITY/ROADING CONCERNS:** Ex. Type of crossing required, rock out crop etc.

**G. WILDLIFE & FISHERIES HABITAT**

| Species | Evidence | Habitat Type | Usage |
|---|---|---|---|
| ex: Marten, Elk Moose, Owl | ex. Rubs, scat, trails etc. | ex. Forage, Thermal Cover Mineral Licks, snags, etc. | (L M H) |

Comments: ____________

Eg. numerous open grassy areas S-SW slopes with dense canopy, openings with heavy willow.

**H. Start or Tie Point** ____________

**I. Traverse Map** ____________

**J. General Comments** ____________

# APPENDIX III

# B7 PLOT SUMMARY FOR INSIDE VERSUS OUTSIDE FOREST MANAGEMENT AGREEMENT AREA

## Table III.1
## Plots by Forest Management Agreement Area, Leading Species and Crown Class for B10B

| Leading Species | Inside FMA Area | | | | | Outside FMA Area | | | | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | Blank | A | B | C | D | Blank | |
| Deciduous | 0 | 2 | 10 | 1 | | 6 | 5 | 36 | 11 | | **71** |
| Mixedwood | 5 | 6 | 3 | 0 | | 3 | 0 | 0 | 3 | | **20** |
| Pine | 13 | 5 | 78 | 26 | | 3 | 7 | 39 | 21 | | **192** |
| White Spruce / Fir | 8 | 23 | 51 | 7 | | 28 | 18 | 54 | 2 | | **191** |
| Non Forested | | | | | 12 | | | | | 24 | **36** |
| Grand Total | **26** | **36** | **142** | **34** | **12** | **40** | **30** | **129** | **37** | **24** | **510**[1] |

## Table III.2
## Number of Plots Inside and Outside the Forest Management Agreement Area by Yield Strata in FMU B10B

| FMU | Broad Cover Group | Leading Species | Strata | Strata Number | Inside FMA Area | | Outside FMA Area | | Total # of Plots[2] |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Number of Plots | % of Plots in Strata | Number of Plots | % of Plots in Strata | |
| B10B | Conifer | Pine | B10B-C–PL | 3 | 122 | 65 | 66 | 35 | **188** |
| B10B | Conifer | Spruce/Fir | B10B-C–SW | 4 | 72 | 52 | 67 | 48 | **139** |
| FMA | Mixedwood | n/a | FMA-MX-n/a | 5 | 50 | 89 | 6 | 11 | **56** |
| FMA | Deciduous | n/a | FMA-D–n/a | 6 | 50 | 47 | 56 | 53 | **106** |
| Grand Total | | | | | 294 | 60 | 195 | 40 | **489** |

[1] The 28 plots cruised in 1999 had no spatial data associated with them and therefore their location as inside or outside the forest management agreement area could not be accurately determined. Therefore they are not included in this table.

[2] The 28 plots cruised in 1999 had no spatial data associated with them and therefore their location as inside or outside the forest management agreement area could not be accurately determined. Therefore they are not included in this table. These totals will not match with the totals given in Table 1 since these are do not include the plots deleted from the analysis (*i.e.*, TPR = "U", Non-forested, SB/LT leading).

# APPENDIX IV

# DATA DICTIONARY

File name: Raw_Tree_Data.dbf
Number of records: 16,015

| Field name | Type | Decimals | Valid codes | Description |
|---|---|---|---|---|
| fmu | Character | | B10B; B9B. | Identifies which Forest Management Unit the plot is located in. |
| plot | Numeric | 0 | | Plot number. |
| stand | Numeric | 0 | | Stand number from the GPS points match to the AVI. |
| nregion | Numeric | 0 | 0 – None;<br>7 – Alpine;<br>8 – Sub-alpine;<br>9 - Montane;<br>10 – Upper Foothills;<br>11 – Lower Foothills;<br>14 – Foothills Parkland;<br>17 – Dry Mixedgrass[1]. | Natural Sub-region. |
| trm | Numeric | 0 | | Concatenation of the Township, Range and Meridian. |
| tree | Numeric | 0 | | The tree number. |
| sp | Character | | AW – Aspen;<br>FA – Sub-alpine Fir;<br>FB – Balsam Fir;<br>FD – Douglas Fir;<br>LA – Alpine Larch;<br>LT - Tamarack;<br>PA – Whitebark Pine;<br>PB – Balsam Poplar;<br>PF – Limber Pine;<br>PL – Lodgepole Pine;<br>SB – Black Spruce;<br>SE – Engelmann Spruce;<br>SW – White Spruce. | Identifies the tree species. |
| dbh | Numeric | 1 | | Measured diameter at breast height (1.3 m). |
| ht | string | | | Measured tree height. |
| stump | string | | | Measured diameter at stump height (0.3 m). |

[1] Natural Region 0 is used for trees that use the provincial average to calculate tree volumes (sp = “FD”; “LA”; “LT”; “PA”; “PF”; and “SE”). Natural Region 17 is likely a data entry error, however the trees were still compiled using the provincial parameters.

File name: Compiled Tree Volumes (15-11) new.dbf
Number of Records: 13,754

| Field name | Type | Decimals | Valid codes | Description |
|---|---|---|---|---|
| fmu | Character | | B10B; B9B. | Identifies which Forest Management Unit the plot is located in. |
| plot | Numeric | 0 | | Plot number |
| stand | Numeric | 0 | | Stand number from the GPS points match to the AVI. |
| nregion | Numeric | 0 | 0 – None;<br>7 – Alpine;<br>8 – Sub-alpine;<br>9 - Montane;<br>10 – Upper Foothills;<br>11 – Lower Foothills;<br>14 – Foothills Parkland;<br>17 – Dry Mixedgrass[2] | Natural Sub-region. |
| trm | Numeric | 0 | | Concatenation of the Township, Range and Meridian. |
| tree | Numeric | 0 | | The tree number. |
| sp | Character | | AW – Aspen;<br>FA – Sub-alpine Fir;<br>FB – Balsam Fir;<br>FD – Douglas Fir;<br>LA – Alpine Larch;<br>LT - Tamarack;<br>PA – Whitebark Pine;<br>PB – Balsam Poplar;<br>PF – Limber Pine;<br>PL – Lodgepole Pine;<br>SB – Black Spruce;<br>SE – Engelmann Spruce;<br>SW – White Spruce; | Identifies the tree species. |
| dbh | Numeric | 1 | | Measured diameter at breast height (1.3 m). |
| ht | Numeric | 2 | | Tree height. Unless this was measured in the field, this value is estimated using the height-diameter model[3]. |
| stump | Numeric | 8 | | Diameter at stump height (0.3 m). Unless this was measured in the field, this value is estimated using the stump diameter model.[4] |
| species | Character | | AW – Aspen;<br>FA – Sub-alpine Fir;<br>FB – Balsam Fir;<br>FD – Douglas Fir;<br>LT - Tamarack;<br>PB – Balsam Poplar;<br>PJ – Jack Pine<br>PL – Lodgepole Pine;<br>SB – Black Spruce;<br>SE – Engelmann Spruce;<br>SW – White Spruce; | This is the species assignment used in the SAS analysis.<br><br>Cases where this was needed were:<br><br>sp = PA or PF --> PJ (provincial)<br>sp = LA --> LT (provincial)<br><br>All other trees were modelled by their original species designation (i.e. "sp"). |
| merchht | Numeric | 2 | | This is the merchantable height calculated in SPSS to an 11 cm top. |
| merchlen | Numeric | 8 | | This is the merchantable length calculated in SPSS to an 11 cm top. |
| vol_1511 | Numeric | 8 | | This is the 15/11 tree volume calculated in SPSS. |
| key | Character | | | Unique identifier used to match trees back to the original LFD compiled tree file for quality assurance. |

[2] Natural Region 0 is used for trees that use the provincial average to calculate tree volumes (sp_model = “FD”; “LT”; “PJ”; and “SE”). Natural Region 17 is likely a data entry error, however the trees were still compiled using the provincial parameters.

[3] Dr. Shongming Huang. “Ecologically-based Individual Tree Volume Estimation for Major Alberta Tree Species. Report # 1. Individual Tree Volume Estimation Procedures for Alberta: Methods of Formulation and Statistical Foundations”. Alberta Environmental Protection. Edmonton. 1994.

[4] Dr. Shongming Huang. “Ecologically-based Individual Tree Volume Estimation for Major Alberta Tree Species. Report # 1. Individual Tree Volume Estimation Procedures for Alberta: Methods of Formulation and Statistical Foundations”. Alberta Environmental Protection. Edmonton. 1994.

File name: Compiled Plot Volumes (15-11).dbf
Number of Records: 1,012

| Field name | Type | Decimals | Valid codes | Description |
|---|---|---|---|---|
| fmu | Character | | B10; B9B. | Identifies which Forest Management Unit the plot is located in. |
| plot | Numeric | 0 | | Plot number |
| stand | Numeric | 0 | | Stand number from the GPS points match to the AVI. |
| trm | Numeric | 0 | | Concatenation of the Township, Range and Meridian. |
| key | Character | | | A concatenation of FMU, plot, stand, township, range, and meridian used to match the compiled plot data to the appropriate plot GPS point. |
| number | Numeric | 2 | | The number of trees per hectare, as estimated by the sample plot |
| decvol | Numeric | 2 | | deciduous volume (per ha) calculated for each plot |
| convol | Numeric | 2 | | conifer volume (per ha) calculated for each plot |

File name:AVI_match_file.dbf
Number of Records: 1,012

| Field name | Type | Decimals | Valid codes | Description |
|---|---|---|---|---|
| fmu | Character | | B10, B9B | Forest Management Unit the stand is located in. |
| plot | Numeric | 0 | | The plot number. |
| stand | Numeric | 0 | | AVI stand number. |
| trm | Numeric | 0 | | Concatenation of township, range and meridian from the cruise tally sheet |
| avi_trm | Numeric | 0 | | Concatenation of township, range and meridian from the vegetation inventory |
| source | Character | | B10 plots;<br>B10 supplement;<br>B9 plots. | The volume sampling program that the plots were cruised under. |
| township | Numeric | 0 | | The township number. |
| range | Numeric | 0 | | The range number. |
| meridian | Numeric | 0 | | The meridian. |
| poly_num | Numeric | 0 | | A unique identifier for the AVI polygon. |
| moist_reg | Character | | d – dry;<br>m – mesic;<br>w – wet | The moisture regime for the stand. |
| density | Character | | A – 6 - 30% closure;<br>B – 31 – 50% closure;<br>C – 51 – 70% closure;<br>D – 71 - 100% closure | The crown closure for the stand. |
| height | Numeric | 0 | | The average tree height (in meters) for the overstorey of the stand. |
| sp1 | Character | | Aw – Trembling Aspen;<br>FA – Sub-alpine Fir;<br>FD – Douglas Fir;<br>P – Pine;<br>PA – Whitebark Pine;<br>Pl – Lodgepole Pine;<br>SB – Black Spruce;<br>SE – Englemann Spruce;<br>SW – White Spruce | The leading species in the overstorey of the stand. |
| sp1_per | Numeric | 0 | | The percentage of the overstorey composed of species 1 (0 – 10). |
| sp2 | Character | | Aw – Trembling Aspen;<br>FA – Sub-alpine Fir;<br>FD – Douglas Fir;<br>P – Pine;<br>PA – Whitebark Pine;<br>Pl – Lodgepole Pine;<br>SB – Black Spruce;<br>SE – Englemann Spruce;<br>SW – White Spruce | The second species in the overstorey of the stand. |
| sp2_per | Numeric | 0 | | The percentage of the overstorey composed of species 2 (0 – 5). |
| sp3 | Character | | Aw – Trembling Aspen;<br>FA – Sub-alpine Fir;<br>FD – Douglas Fir;<br>P – Pine;<br>PA – Whitebark Pine;<br>Pl – Lodgepole Pine;<br>SB – Black Spruce;<br>SE – Englemann Spruce;<br>SW – White Spruce | The third species in the overstorey of the stand. |
| sp3_per | Numeric | 0 | | The percentage of the overstorey composed of species 3 (0 – 3). |
| sp4 | Character | | Aw – Trembling Aspen;<br>FA – Sub-alpine Fir;<br>FD – Douglas Fir;<br>P – Pine;<br>PA – Whitebark Pine;<br>Pl – Lodgepole Pine;<br>SB – Black Spruce;<br>SE – Englemann Spruce;<br>SW – White Spruce | The fourth species in the overstorey of the stand. |
| sp4_per | Numeric | 0 | | The percentage of the overstorey composed of species 4 (0 – 2). |
| sp5 | Character | | Aw – Trembling Aspen;<br>FA – Sub-alpine Fir; | The fifth species in the overstorey of the stand. |

| Field name | Type | Decimals | Valid codes | Description |
|---|---|---|---|---|
| | | | FD – Douglas Fir;<br>P – Pine;<br>PA – Whitebark Pine;<br>Pl – Lodgepole Pine;<br>SB – Black Spruce;<br>SE – Englemann Spruce;<br>SW – White Spruce | |
| sp5_per | Numeric | 0 | | The percentage of the overstorey composed of species 5 (0 – 2). |
| struc | Character | | C – Composite;<br>H – Horizontal;<br>M – Multi storied | The structure of the stand. |
| struc_va | Numeric | 0 | 1 – 9 | The structure value. |
| origin | Numeric | 0 | | The decade in which the stand originated. |
| tpr | Character | | G – Good;<br>M – Medium;<br>F – Fair;<br>U – Unproductive | The Timber Productivity Rating. |
| initials | Character | | | The initials of the photo interpreter. |
| nfl | Character | | HF = herbaceous forbs;<br>HG = herbaceous grass;<br>SC = closed shrub; and<br>SO = open shrub. | Non-Forested, vegetated land. |
| nfl_per | Numeric | 0 | | % closure for shrub layer (1 - 10). |
| nat_non | Character | | NMR = non-vegetated mineral rock;<br>NWF = non-vegetated water flooded | Natural non-vegetated land. |
| anth_veg | Character | | CP = perennial cropland;<br>CPR = rough pasture land | Anthropogenic vegetated land. |
| anth_non | Character | | AIH = anthropogenic industrial highway | Anthropogenic non-vegetated land. |
| mod1 | Character | | CC = clear cut;<br>CL = clearing;<br>GR = grazing<br>TH = thinned; and<br>WF = windfall. | Modifier to polygon. |
| mod1_ext | Numeric | 0 | | Extent of modification to the stand (1 - 5). |
| mod1_yr | Numeric | | | Year of modification 1. |
| mod2 | Character | | CC = clear cut;<br>CL = clearing;<br>GR = grazing<br>TH = thinned; and<br>WF = windfall. | Modifier to polygon. |
| mod2_ext | Numeric | 0 | | Extent of modification to the stand (1 - 5). |
| mod2_yr | Numeric | | | Year of modification 2. |
| data | Character | | F – interpreter plot;<br>P - PSP | |
| data_yr | Numeric | 0 | | Reference year for data collection |
| key2 | Character | | | A concatenation of FMU, plot, stand, township, range, and meridian used to match the compiled plot data to the appropriate plot GPS point. |

File name: Compiled Plot Volumes (15-11) with AVI (overstorey).dbf
Number of Records: 1,012

| Field name | Type | Decimals | Valid codes | Description |
|---|---|---|---|---|
| plot | Numeric | 0 | | The plot number. |
| stand | Numeric | 0 | | AVI stand number. |
| trm | Numeric | 0 | | Concatenation of township, range and meridian. |
| key | Character | | | A concatenation of FMU, plot, stand, township, range, and meridian used to match the compiled plot data to the appropriate plot GPS point. |
| decvol | Numeric | 8 | | 15/11 Deciduous Plot Volume ($m^3$/ha). |
| convol | Numeric | 8 | | 15/11 Coniferous Plot Volume ($m^3$/ha). |
| source | Character | | B10 plots;<br>B10 supplement;<br>B9 plots. | The volume sampling program that the plots were cruised under. |
| township | Numeric | 0 | | The township number. |
| range | Numeric | 0 | | The range number. |
| meridian | Numeric | 0 | | The meridian. |
| poly_num | Numeric | 0 | | A unique identifier for the AVI polygon. |
| moist_reg | Character | | d – dry;<br>m – mesic;<br>w – wet | The moisture regime for the stand. |
| density | Character | | A – 6 - 30% closure;<br>B – 31 – 50% closure;<br>C – 51 – 70% closure;<br>D – 71 - 100% closure | The crown closure for the stand. |
| height | Numeric | 0 | | The average tree height (in meters) for the overstorey of the stand. |
| sp1 | Character | | Aw – Trembling Aspen;<br>FA – Sub-alpine Fir;<br>FD – Douglas Fir;<br>P – Pine;<br>PA – Whitebark Pine;<br>Pl – Lodgepole Pine;<br>SB – Black Spruce;<br>SE – Englemann Spruce;<br>SW – White Spruce | The leading species in the overstorey of the stand. |
| sp1_per | Numeric | 0 | | The percentage of the overstorey composed of species 1 (0 – 10). |
| sp2 | Character | | Aw – Trembling Aspen;<br>FA – Sub-alpine Fir;<br>FD – Douglas Fir;<br>P – Pine;<br>PA – Whitebark Pine;<br>Pl – Lodgepole Pine;<br>SB – Black Spruce;<br>SE – Englemann Spruce;<br>SW – White Spruce | The second species in the overstorey of the stand. |
| sp2_per | Numeric | 0 | | The percentage of the overstorey composed of species 2 (0 – 5). |
| sp3 | Character | | Aw – Trembling Aspen;<br>FA – Sub-alpine Fir;<br>FD – Douglas Fir;<br>P – Pine;<br>PA – Whitebark Pine;<br>Pl – Lodgepole Pine;<br>SB – Black Spruce;<br>SE – Englemann Spruce;<br>SW – White Spruce | The third species in the overstorey of the stand. |
| sp3_per | Numeric | 0 | | The percentage of the overstorey composed of species 3 (0 – 3). |
| sp4 | Character | | Aw – Trembling Aspen;<br>FA – Sub-alpine Fir;<br>FD – Douglas Fir;<br>P – Pine;<br>PA – Whitebark Pine;<br>Pl – Lodgepole Pine;<br>SB – Black Spruce;<br>SE – Englemann Spruce;<br>SW – White Spruce | The fourth species in the overstorey of the stand. |
| sp4_per | Numeric | 0 | | The percentage of the overstorey composed of species 4 (0 – 2). |
| sp5 | Character | | Aw – Trembling Aspen; | The fifth species in the overstorey of the stand. |

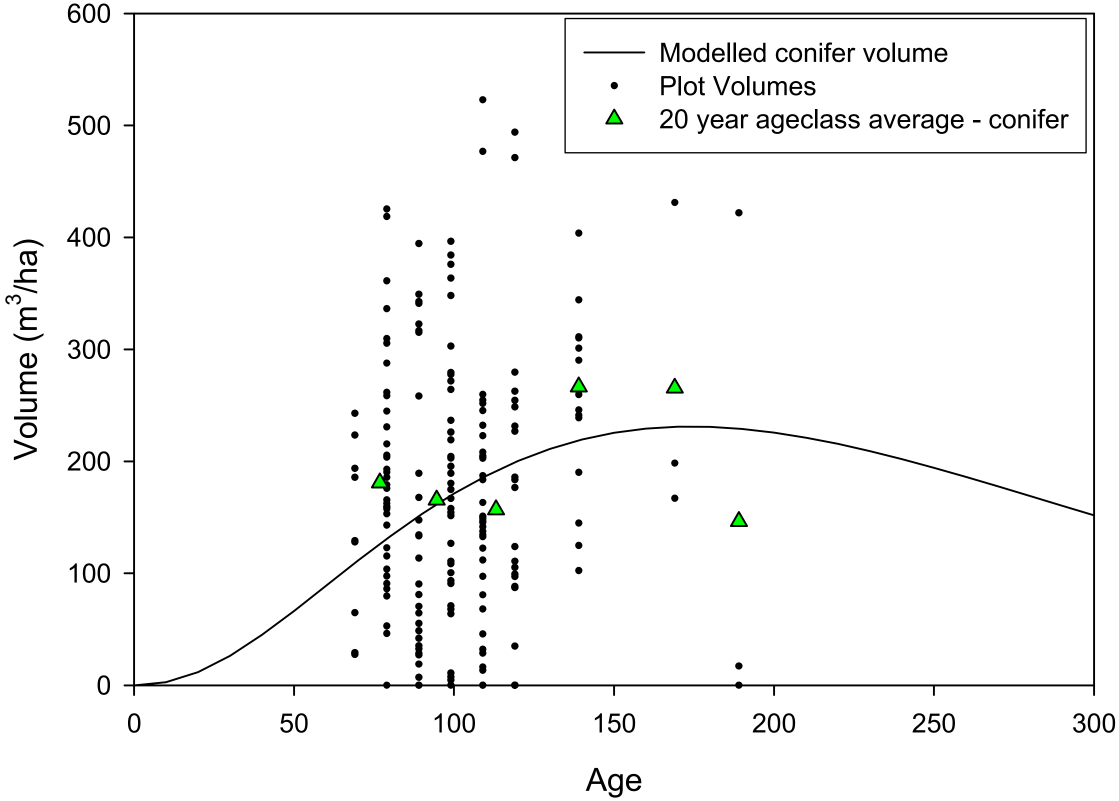
| Field name | Type | Decimals | Valid codes | Description |
|---|---|---|---|---|
| | | | FA – Sub-alpine Fir;<br>FD – Douglas Fir;<br>P – Pine;<br>PA – Whitebark Pine;<br>Pl – Lodgepole Pine;<br>SB – Black Spruce;<br>SE – Englemann Spruce;<br>SW – White Spruce | |
| sp5_per | Numeric | 0 | | The percentage of the overstorey composed of species 5 (0 – 2). |
| struc | Character | | C – Composite;<br>H – Horizontal;<br>M – Multi storied | The structure of the stand. |
| struc_va | Numeric | 0 | 1 – 9 | The structure value. |
| origin | Numeric | 0 | | The decade in which the stand originated. |
| tpr | Character | | G – Good;<br>M – Medium;<br>F – Fair;<br>U – Unproductive | The Timber Productivity Rating. |
| initials | Character | | | The initials of the photo interpreter. |
| nfl | Character | | HF = herbaceous forbs;<br>HG = herbaceous grass;<br>SC = closed shrub; and<br>SO = open shrub. | Non-Forested, vegetated land. |
| nfl_per | Numeric | 0 | | % closure for shrub layer (1 - 10). |
| nat_non | Character | | NMR = non-vegetated mineral rock;<br>NWF = non-vegetated water flooded | Natural non-vegetated land. |
| anth_veg | Character | | CP = perennial cropland;<br>CPR = rough pasture land | Anthropogenic vegetated land. |
| anth_non | Character | | AIH = anthropogenic industrial highway | Anthropogenic non-vegetated land. |
| mod1 | Character | | CC = clear cut;<br>CL = clearing;<br>GR = grazing<br>TH = thinned; and<br>WF = windfall. | Modifier to polygon. |
| mod1_ext | Numeric | 0 | | Extent of modification to the stand (1 - 5). |
| mod1_yr | Numeric | | | Year of modification 1. |
| mod2 | Character | | CC = clear cut;<br>CL = clearing;<br>GR = grazing<br>TH = thinned; and<br>WF = windfall. | Modifier to polygon. |
| mod2_ext | Numeric | 0 | | Extent of modification to the stand (1 - 5). |
| mod2_yr | Numeric | | | Year of modification 2. |
| data | Character | | F – interpreter plot;<br>P - PSP | |
| data_yr | Numeric | 0 | | Reference year for data collection |
| yr_cruz | Numeric | 2 | | Year the plot was cruised in. |
| age | Numeric | 0 | | Age of stand at time of cruising. |
| fmu | Character | 0 | B9B, B10B | Current Forest Management Unit. |
| con_per | Numeric | 2 | | Percent conifer cover in the overstorey |
| dec_per | Numeric | 2 | | Percent deciduous cover in the overstorey |
| bcg | Character | | C – >= 80% conifer;<br>MX – 30 – 70% conifer;<br>D – <= 20% conifer;<br>Nonfor – Non-forested stand | Broad cover group. |
| lead_sp | Character | | SW/FB = FA, FD, SE and SW;<br>PL = P, PA, PL;<br>SB/LT = LA, L, SB; and<br>Dec = AW, BW, PB. | Leading species, used for generation of yield strata. |
| plot_delet | Character | | TPR = “U”;<br>Nonfor;<br>SB/LT leading. | Reason for deleting plot from the yield curve generation. |
| strata | Character | | B9B-C –PL; | Yield strata used in generating yield curves. |

| Field name | Type | Decimals | Valid codes | Description |
|---|---|---|---|---|
| | | | B10B-C –PL;<br>B9B-C –SW;<br>B10B-C –SW;<br>FMA-MX-na;<br>FMA-D –na. | |

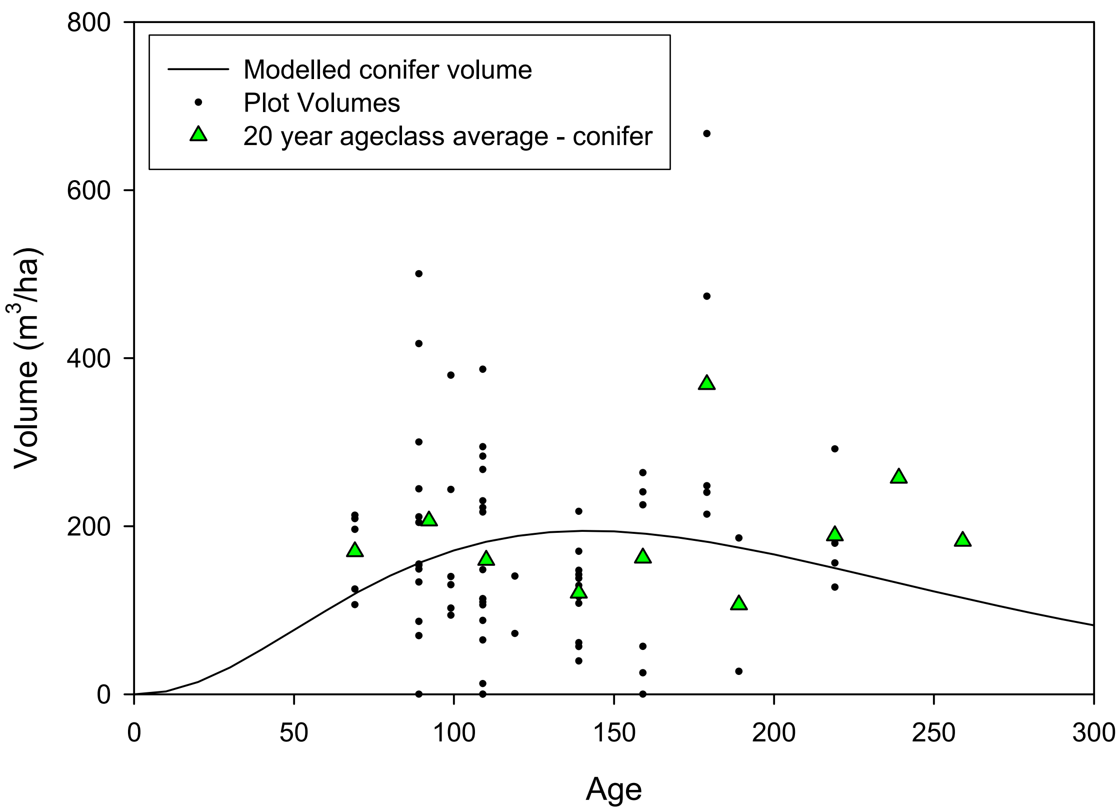
## APPENDIX V

## B10B AND B9B/B9 CONIFER YIELD CURVES
## (PREDICTED AND ACTUAL PLOT VOLUMES)

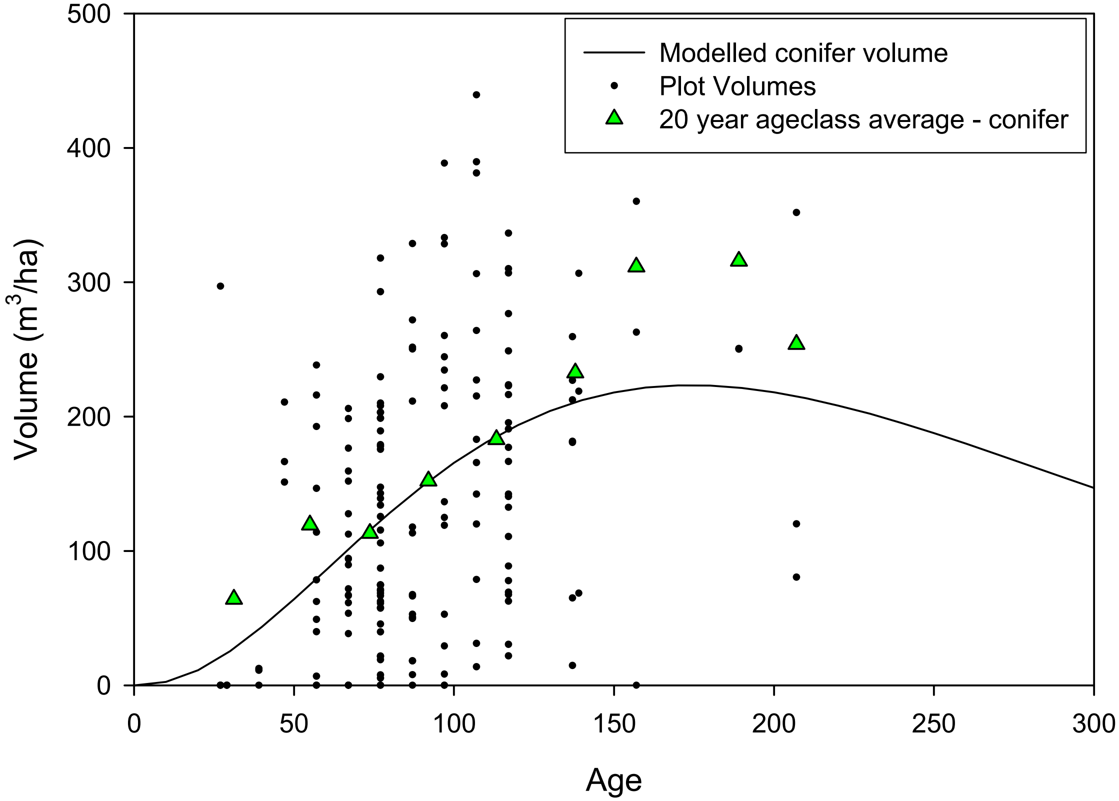
**Strata 1 - B9B/B9 Pine Actual versus Predicted Conifer Volume**



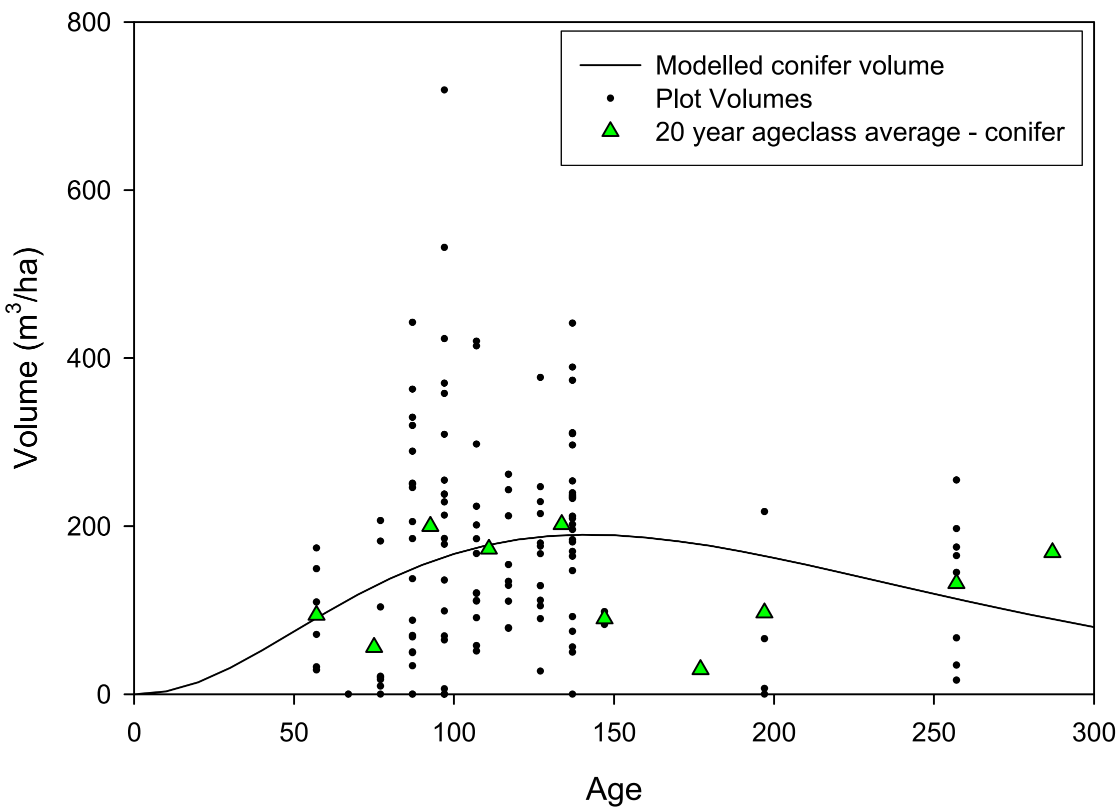
**Strata 2 - B9B/B9 Spruce Actual versus Predicted Conifer Volume**



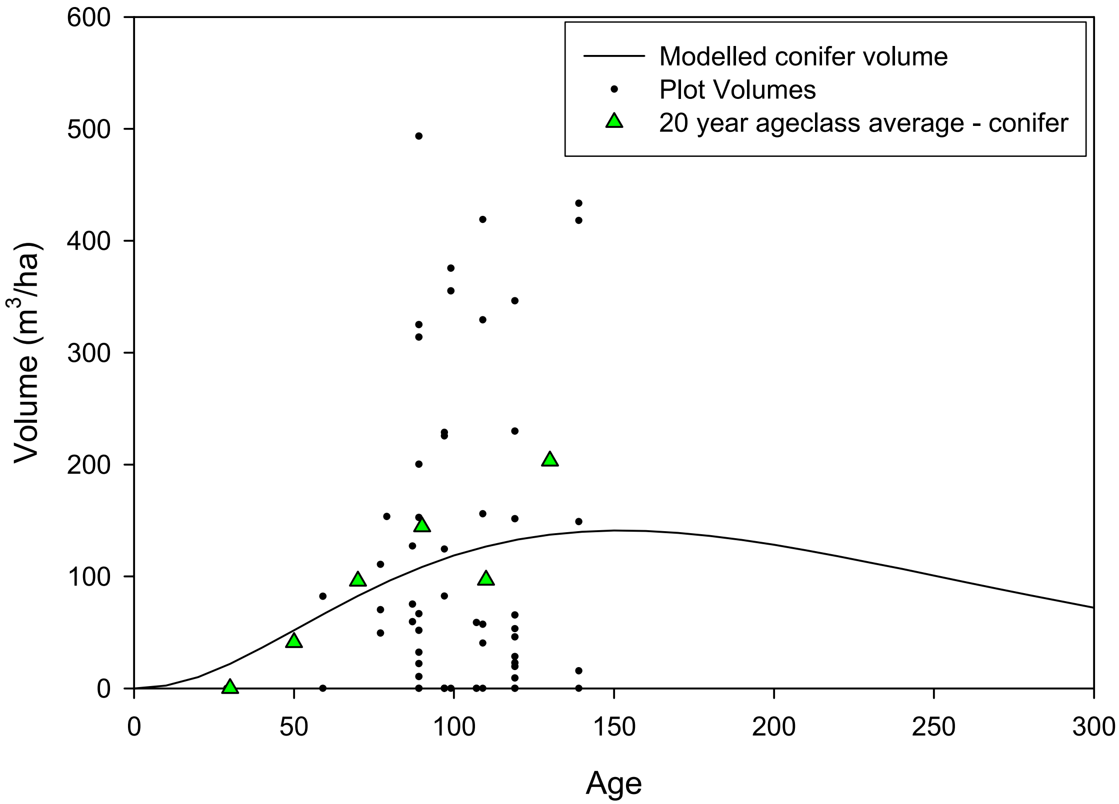
**Strata 3 – B10B Pine Actual versus Predicted Conifer Volume**



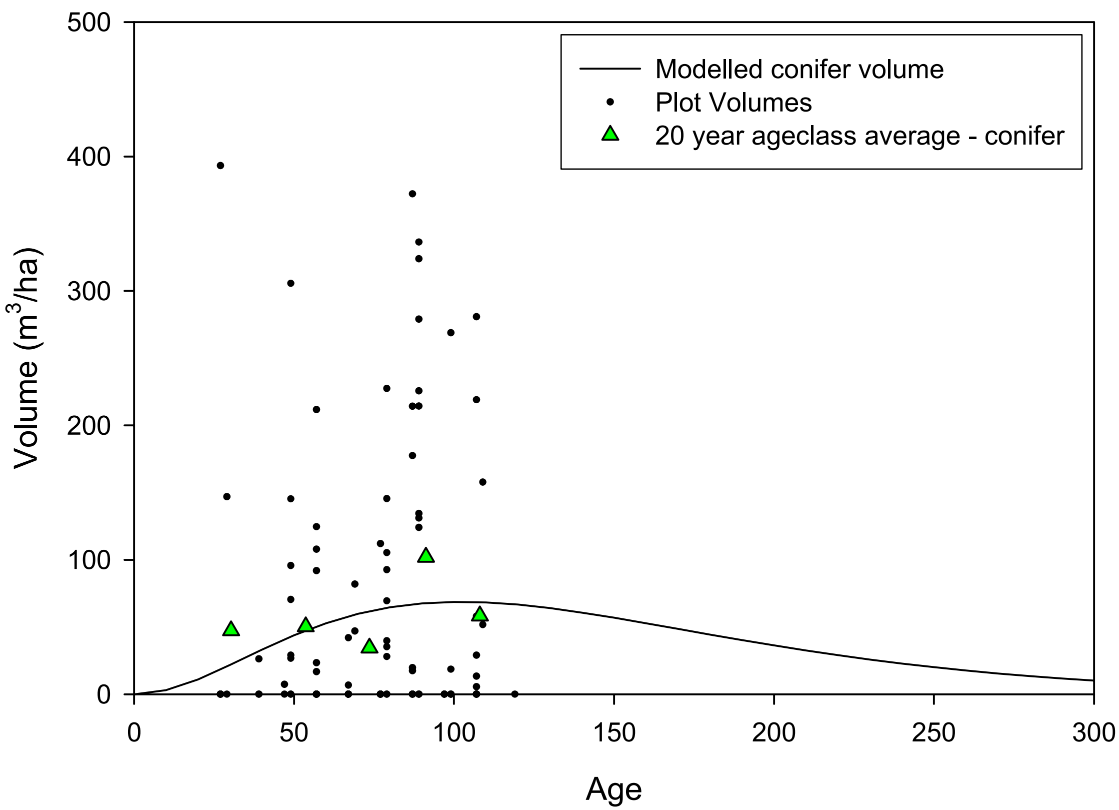
**Strata 4 – B10B Spruce Actual versus Predicted Conifer Volume**



**Strata 5 – FMA Mixedwood Actual versus Predicted Conifer Volume**



**Strata 6 - FMA Deciduous Actual versus Predicted Conifer Volume**



# APPENDIX VI

# SPSS AND SAS CODE FOR PRODUCTION OF YIELD CURVES