# P14 2009-2018
# Forest Management Plan

## Appendix IV:
## Yield Curve Development

**October, 2009**

# EXECUTIVE SUMMARY

Timber yield curves are a primary input of the forecasting required in the development of Forest Management Plans (FMP). This document describes the development of timber yield curves for Forest Management Unit P14 for application in forecasting of the 2009-2018 Forest Management Plan.

Plot data were collected in 2004 under an Alberta Sustainable Resource Development (SRD) program. The FMP yield strata, the strata total area, the total number of plots measured, and the number of plots eligible for curve development in each stratum are presented in Table 1.

**Table 1. Yield strata description, total area by stratum, total and eligible plots by stratum.**

| Landbase | Broad Cover Group | FMP Yield Stratum | Description | Total Area (ha) | Percent Area (%) | Total Plots | Eligible | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Coniferous | Deciduous |
| Deciduous | D | D | Deciduous | 43,461 | 49.5% | 72 | 62 | 62 |
| Coniferous | DC | DC | Deciduous leading mixedwood | 8,578 | 9.8% | 48 | 36 | 36 |
| | CD | CD | Coniferous leading mixedwood | 4,594 | 5.2% | 35 | 35 | 35 |
| | C | C-SB | Black spruce leading conifer | 1,985 | 2.3% | 47 | 17 | 39 |
| | | C-SW | White spruce leading conifer | 13,490 | 15.4% | 105 | 90 | 90 |
| | | DU | Deciduous overstory with coniferous understory | 15,720 | 17.9% | 57 | 55 | 52 |
| | | Plots Unassigned | - | - | - | 8 | - | - |
| Total | | | | 87,827 | 100.0% | 372 | 295 | 314 |

Empirical volume over age yield curves for conifer and deciduous volume components were fit using widely accepted methods for each of the six strata to 15/11 and 15/10 utilization standards respectively (Table 2).

**Table 2. Utilization standards by species group.**

| Utilization Criterion | Conifer Species | Deciduous Species |
|---|---|---|
| Stump height | 30 cm | 30 cm |
| Minimum log length | 2.66 m | 2.66 m |
| Minimum stump diameter outside bark | 15 cm | 15 cm |
| Minimum top diameter inside bark | 11 cm | 10 cm |

Due to plot limitations, the volume relationships for some strata were unrealistic and were capped for use in forecasting. Capping of yield curves occurred within the data range for coniferous component in the D stratum. Curves were fit for only the standing volume conditions representing all densities and were used to represent both the standing and regenerated stand conditions. Different yield curves were not created for regenerated stand conditions.

To aid in future comparisons and with other areas, area weighted composite yield curves were created for each of the 4 broad cover groups (D, DC, CD, and C), coniferous landbase, and the entire forest management unit. Overall the yield curve volumes are lower or similar to those observed for the adjacent forest management units (P16).

This document describes information and the methods used to fit empirical volume-age timber yield curves to six different strata, including:

- Rules for polygons' stratification;
- Plot assignment to yield strata;
- Plot deletions;
- Volume compilation; and
- Curve fitting techniques.

Included with graphs of the yield curves, are tables with the equations' forms and parameters, as well as fit statistics.

# Table of Contents

## List of Tables



## List of Figures

# 1. Overview

## 1.1 Background

The Alberta Sustainable Resource Development (SRD) Forest Management Planning Standard (Planning Standard) (SRD 2006) lists the requirements for the development of timber yield curves for use in forecasting and Forest Management Plans (FMP). This report documents the development of yield curves for Forest Management Unit (FMU) P14's 2009-2018 Forest Management Plan.

The complete yield curve submission package consists of:

- Yield curve development document;
- Registered Forestry Professional (RFP) checklist derived from the Planning Standard yield curve development, documentation and submission requirements;
- Plot data set with compiled individual tree and plot level volumes;
- All datasets and SAS programs used in the yield curve development;
- Digital versions of the yield curves; and
- Data dictionaries for all the datasets submitted.

The term "forecasting" will be used throughout this document instead of the term "timber supply analysis" to reflect the greater range of values considered in the development of the 2009-2018 FMP. Timber supply analysis is one component of forecasting.

## 1.2 Yield Curve Development Summary

A temporary sampling plot program designed to characterize the standing timber was initiated by SRD. The program sampled 372 plots in 2004. Stands were selected for sampling based on stratified random sampling.

The term FMP yield stratum refers to the yield stratification used within the 2009-2018 FMP. Six yield strata were identified. The yield strata were assigned based on broad cover group, leading coniferous species group and, in deciduous stands, the presence of a coniferous understory. Due to data limitations, density was not used as a stratification factor. A generalized description of the stratification rules is presented in Table 3.

**Table 3. Yield stratum generalized description.**

| FMP Yield Stratum | Description | Overstory | | Understory |
|---|---|---|---|---|
| | | Broad Cover | Lead Conifer | Broad cover |
| D | Deciduous | D | - | D or blank |
| DC | Deciduous leading mixedwood | DC | - | - |
| CD | Coniferous leading mixedwood | CD | SW, SB, LT, FB, PL | - |
| C-SW | White spruce leading conifer | C | SW, FB | - |
| C-SB | Black spruce leading conifer | C | SB, LT, PL | - |
| DU | Deciduous overstory with coniferous understory | D | - | C, CD, DC |

# 1.3 Yield Curves

A series of three empirical volume over age yield curves[1] were developed for each stratum and management condition. Three general types of curves were required.

**Natural Stand Yield Curves** were developed for each of the six FMP yield strata. Deciduous and coniferous volumes were fit as a function of stand age. FMP yield stratum and the stand age were taken from the defining inventory layer.

**Regenerated Stand Yield Curves** were the same as the natural stand yield curves. There was no adjustment from the natural curves for density or management intensity.

**Composite Yield Curves** were developed for comparison purposes. Six composite yield curves (natural stands area-weighted yield curves) were developed: one for each of the four broad cover groups (i.e., D, DC, CD, and C), one to represent the combined coniferous (C/CD/DC/DU) landbase, and one to represent the total managed landbase (C/CD/DC/D). Composite yield curves were developed from natural yield curves.

The curves presented in this document represent gross merchantable volume. Cull deductions to obtain net merchantable volume and, for the regenerated stands, regeneration delay were applied to the curves before use in Forecasting.

[1] The term yield curve is used to represent a set of three separate curves: a curve for coniferous volume component, a curve for deciduous volume component, and a curve for the total of coniferous and deciduous volume.

# 2. Landbase Stratification

## 2.1 Overview

FMP yield strata are the basic units for forest management in the 2009-2018 FMP and the units upon which the yield curves are based. Since yield curves are assigned to landbase polygons, the rules for assigning attributes to plots need to be consistent with the rules used to assign attributes to the landbase polygons. To achieve this, volume sampling plots were assigned to polygons in the forecasting landbase file and yield curve stratification was based on the process used in the development of the landbase.

The gross landbase represents all lands within the outer boundaries of FMU P14. The managed landbase represents that portion of the gross landbase that is available for forest management activities and is comprised of the combined coniferous and deciduous landbases. The managed landbase is commonly referred to as the timber harvesting landbase, net landbase, contributing landbase, or active landbase.

This section summarizes the methods used in the landbase creation to determine yield strata. Refer to P14 2009-2018 Forest Management Plan Appendix III: Development of the Landbase (The Forestry Corp. 2009) for a detailed description of the process. Section 3, describes how the volume sampling plots were linked to landbase polygons.

Figure 1 provides an overview of the process flow for assigning the FMP yield strata to the landbase. The following subsections describe in detail each step of the process.

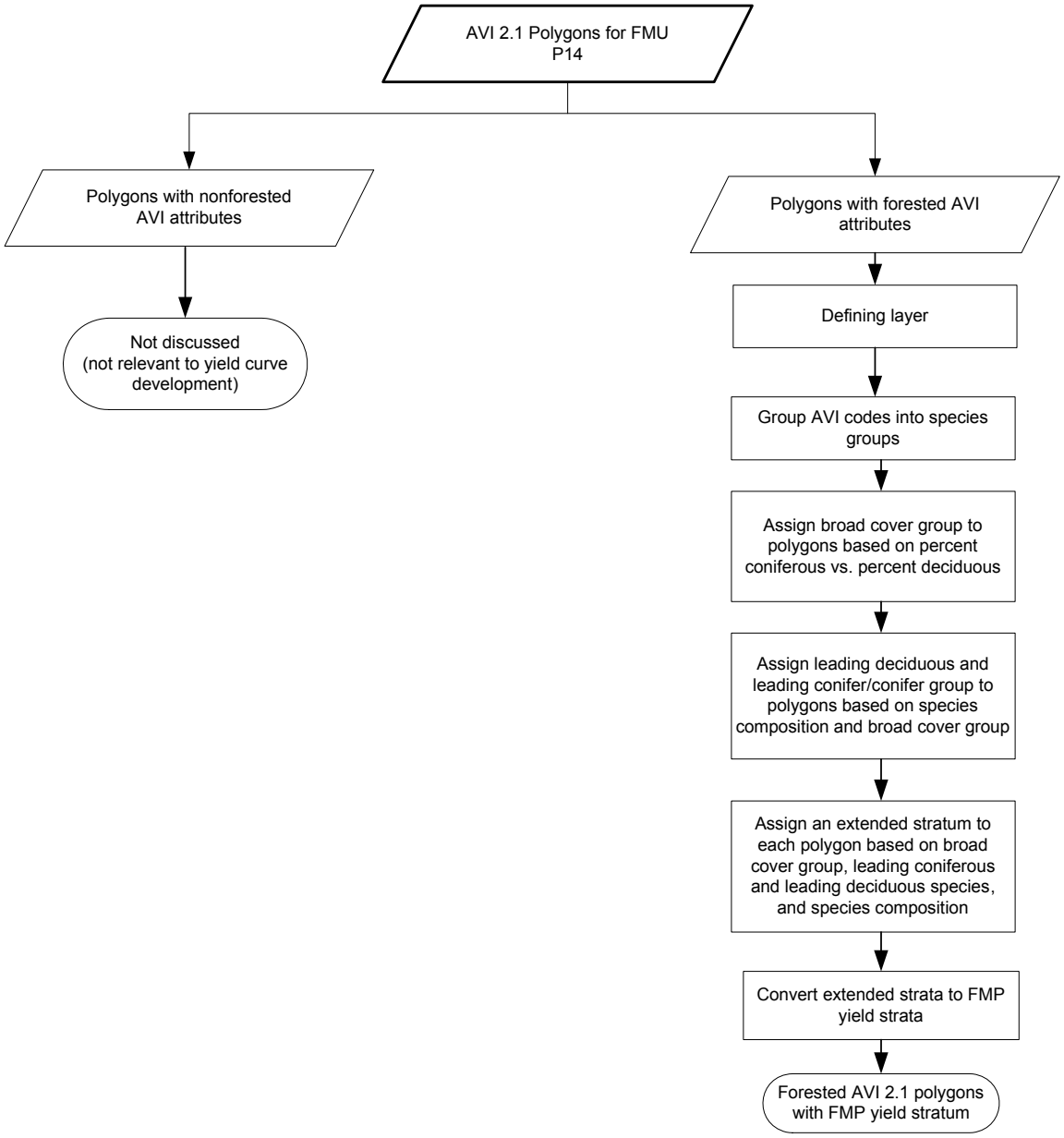



**Figure 1. Overview of the FMP yield stratum assignment process**

# 2.2 Identifying forested polygons

Stratification was based on the Alberta Vegetation Inventory (AVI) 2.1 polygon attributes (Alberta 1991). FMP yield strata were assigned only to forested polygons since they represent the area that will potentially be managed for timber. The polygons with a natural or an anthropogenic non-forested code in the defining layer were deemed not forested and were excluded from the yield stratum assignment process. All other polygons were deemed forested and were assigned to an FMP yield stratum as described in the following sections.

# 2.3 Selecting a Defining Layer

## 2.3.1 AVI Defining Layer

In order to classify the forested polygons, a defining layer (layer used for stratification) was identified. The defining layer was represented by either the overstory layer or the understory layer and was the one used to stratify polygons.

A single defining layer was identified for each AVI polygon. This was the layer that best characterized the stand: layer 1 (overstory, AVI_STORY 1) or layer 2 (understory, AVI_STORY 2). The layer was selected based on the following AVI attributes: stand structure (single storied or two storied stand), crown closure class (density), height, and presence of forested species. A value of 3 for variable AVI_STORY was used to represent deciduous stands with a coniferous understory component. The defining layer for stands with AVI_STORY = 3 was layer 1, overstory.

Figure 2 presents a flow chart that describes the process used for assigning the defining layer.

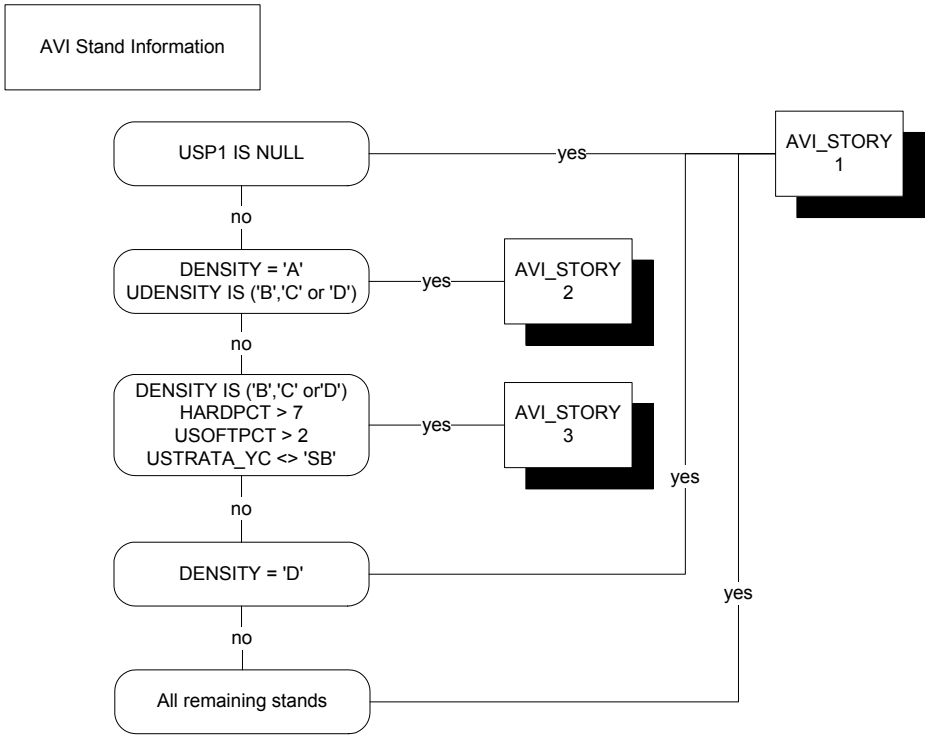



**Figure 2. Rules for determining the defining layer**

Yield stratum assignment was generally based on layer 1 (overstory) characteristics:
When the overstory density was B, C, or D.
When the overstory density was A and the understory density was A or there was no understory.

In some cases layer 2 (understory) was used:

Where stands had an A density overstory and a B, C, or D density understory, the understory layer attributes were used to define the yield stratum.

The criteria used to select the defining layer are presented in Table 4. The layer used for assigning the yield strata is referred to as the defining layer.

**Table 4. AVI layer selection.**

| Crown Class | | Defining |
|---|---|---|
| Overstory | Understory | Layer |
| A | A, NONE | OVERSTORY |
| A | B,C,D | UNDERSTORY |
| B,C,D | - | OVERSTORY |

### 2.3.2 Multi-storied Stands with Forested Understory

Stands with a forested understory were evaluated to determine the appropriate layer to use for classification. Multi-storied stands with a forested understory also use density to assign the defining layer.

Multi-storied stands with an overstory density of 'B','C' or 'D' were classified using layer 1. Multi-storied stands with an overstory density of A, an understory density of 'B', 'C' or 'D', and with no understory subjective or productivity deletions assigned were classified by layer 2. Multi-storied stands with an overstory density of A, an understory density of A, or no understory were classified by layer 1. Figure 2 describes the process used to determine the defining layer.

## 2.4 Assigning an FMP Stratum to the Defining Layer

The following steps were taken in order to assign FMP yield strata:

- Similar species were grouped into species groups;
- Broad cover group was assigned to species groups;
- SRD extended strata were assigned; and
- FMP yield stratum was assigned from SRD extended strata.

### 2.4.1 Species Group

For the purpose of amalgamating similar species, individual species (AVI species codes) were combined into species groups within species types (deciduous and coniferous) (Table 5).

The species percents from AVI where AVI species codes matched the species group were summed to generate the species distribution. Percent values were the same as AVI classes (SP1P to SP5P) where classes 1 to 10 represent values 1 to 100 and each class represents 10 percent.

**Table 5. Assignment of species group.**

| Species Type | Species Group | Description | AVI Species Codes |
|---|---|---|---|
| Deciduous | AW | Aspen | A, Aw |
| | BW | Birch | Bw |
| | PB | Poplar | Pb |
| Conifer | FB | True fir | Fb, Fa |
| | FD | Douglas-fir | Fd |
| | LT | Larch | Lt, La, Lw |
| | PL | Pine | P, Pl, Pj, Pa, Pf |
| | SB | Black spruce | Sb |
| | SW | White spruce | Sw, Se |

### 2.4.2 Species Order

The stratification rules in the following section consider the order of species as one of the decision criteria. To simplify coding the appropriate species order value was updated for each of the species in SP1 to SP5 fields. When a species was not present it was assigned an order value of 9.

### 2.4.3 Species Type Percent

Deciduous species types (see Table 5) were summed to generate the deciduous (HARDPCT) species percent, and coniferous (SOFTPCT) species percent was calculated as (100 – HARDPCT).

### 2.4.4 Leading Species by Species Type

The first listed deciduous species was stored as LEAD_DEC and can be identified as the minimum species order among AW_PCT, BW_PCT, and PB_PCT. Where HARDPCT was 0, 'NO' was listed as the leading deciduous species. The first listed conifer species was stored as LEAD_CON and calculated as the minimum order among conifer species. Where SOFTPCT was 0, 'NO' was listed as the leading conifer species.

### 2.4.5 Broad Cover Group

The species group and the species distribution (as calculated from the AVI species percent classes) were used to calculate the broad cover group for a forested layer (Table 6).

**Table 6. Broad cover group assignment using deciduous and coniferous species percent.**

| Broad Cover Group | Percent Deciduous | Percent Coniferous | Description |
|---|---|---|---|
| D | ≥80 | ≤20 | Deciduous |
| DC[1] | 50-79 | 21-49 | Deciduous-leading mixedwood |
| CD[1] | 21-49 | 50-79 | Coniferous-leading mixedwood |
| C | ≤20 | ≥80 | Coniferous |

[1] A 50/50 split is assigned to CD if SP1 is coniferous and DC if SP1 is deciduous

### 2.4.6 SRD Extended Strata

Extended strata are defined in the Alberta Forest Management Planning Standard (SRD 2006). In order to assign extended strata, an intermediary step was required. This step identified

leading deciduous species (DRULE) and the leading coniferous species or combination of coniferous species (CRULE) as a function of broad cover group and species composition.

The first listed deciduous species was deemed the leading deciduous species. The assignment of leading coniferous species was more complex, and was based on relative percent composition by species. The rules for assignment are presented in Table 7 and Table 8.

**Table 7. Rules for assigning DRULE based on BCG and species composition.**

| *DRULE* | Description | Selection Criteria |
|---|---|---|
| 'AW_LEAD' | Aspen leading deciduous | *HARDPCT* > 0 and *AW_ORD* < *BW_ORD* and *AW_ORD* < *PB_ORD* |
| 'BW_LEAD' | Birch leading deciduous | *HARDPCT* > 0 and *BW_ORD* < *AW_ORD* and *BW_ORD* < *PB_ORD* |
| 'PB_LEAD' | Poplar leading deciduous | *HARDPCT* > 0 and *PB_ORD* < *AW_ORD* and *PB_ORD* < *BW_ORD* |
| 'NO_D' | No deciduous present | *HARDPCT* = 0 |

**Table 8. Rules for assigning CRULE base on BCG and species composition.**

| *CRULE* | Description | Selection Criteria |
|---|---|---|
| 'FBFD_LEAD_MW' | True fir or Douglas-fir leading conifer in mixedwood | *C_CODE* = ('DC', 'CD') and (((*FB_PCT* + *FD_PCT*) > *PL_PCT* and (*FB_PCT* + *FD_PCT*) > (*SB_PCT* + *LT_PCT*) and (*FB_PCT* + *FD_PCT*) > *SW_PCT*) or (*LEAD_CON* = ('FB','FD') and (*FB_PCT* + *FD_PCT*) >= *PL_PCT* and (*FB_PCT* + *FD_PCT*) >= (*SB_PCT* + *LT_PCT*) and (*FB_PCT* + *FD_PCT*) >= *SW_PCT*)) |
| 'PL_LEAD_MW' | Pine leading conifer in mixedwood | *C_CODE* = ('DC', 'CD') and ((*PL_PCT* > (*FB_PCT* + *FD_PCT*) and *PL_PCT* > (*SB_PCT* + *LT_PCT*) and *PL_PCT* > *SW_PCT*) or (LEAD_CON = 'PL' and *PL_PCT* >= (*FB_PCT* + *FD_PCT*) and *PL_PCT* >= (*SB_PCT* + *LT_PCT*) and *PL_PCT* >= *SW_PCT*)) |
| 'SBLT_LEAD_MW' | Black spruce or larch leading conifer in mixedwood | *C_CODE* = ('DC', 'CD') and (((*SB_PCT* + *LT_PCT)* > (*FB_PCT* + *FD_PCT*) and (*SB_PCT* + *LT_PCT*) > *PL_PCT* and (*SB_PCT* + *LT_PCT*) > *SW_PCT*) or (*LEAD_CON* = ('SB', 'LT') and (*SB_PCT* + *LT_PCT*) >= (*FB_PCT* + *FD_PCT*) and (*SB_PCT* + *LT_PCT*) >= *PL_PCT* and (*SB_PCT* + *LT_PCT*) >= *SW_PCT*)) |
| 'SW_LEAD_MW' | White spruce leading conifer in mixedwood | *C_CODE* = ('DC', 'CD') and ((*SW_PCT* > (*FB_PCT*+*FD_PCT*) and *SW_PCT* > *PL_PCT* and *SW_PCT* > (*SB_PCT* + *LT_PCT*)) or (*LEAD_CON* = 'SW' and *SW_PCT* >= (*FB_PCT*+*FD_PCT*) and *SW_PCT* >= *PL_PCT* and *SW_PCT* >= (*SB_PCT* + *LT_PCT*))) |
| 'FB_LEAD' | True fir leading conifer in pure stand | *C_CODE* = ('C', 'D') and ((*FB_PCT* > *FD_PCT* and *FB_PCT* > *LT_PCT* and *FB_PCT* > *PL_PCT* and *FB_PCT* > *SB_PCT* and *FB_PCT* > *SW_PCT*) or (*LEAD_CON* = 'FB' and *FB_PCT* >= *FD_PCT* and *FB_PCT* >= *LT_PCT* and *FB_PCT* >= *PL_PCT* and *FB_PCT* >= *SB_PCT* and *FB_PCT* >= *SW_PCT*)) |
| 'FD_LEAD' | Douglas-fir leading conifer in pure stand | *C_CODE* = ('C', 'D') and ((*FD_PCT* > *FB_PCT* and *FD_PCT* > *LT_PCT* and *FD_PCT* > *PL_PCT* and *FD_PCT* > *SB_PCT* and *FD_PCT* > *SW_PCT*) or (*LEAD_CON* = 'FD' and *FD_PCT* >= *FB_PCT* and *FD_PCT* >= *LT_PCT* and *FD_PCT* >= *PL_PCT* and *FD_PCT* >= *SB_PCT* and *FD_PCT* >= *SW_PCT*)) |
| 'LT_LEAD' | Larch leading conifer in pure stand | *C_CODE* = ('C', 'D') and ((*LT_PCT* > *FB_PCT* and *LT_PCT* > *FD_PCT* and *LT_PCT* > *PL_PCT* and *LT_PCT* > *SB_PCT* and *LT_PCT* > *SW_PCT*) or (*LEAD_CON* = 'LT' and *LT_PCT* >= *FB_PCT* and *LT_PCT* >= *FD_PCT* and *LT_PCT* >= *PL_PCT* and *LT_PCT* >= *SB_PCT* and *LT_PCT* >= *SW_PCT*)) |
| 'PL_LEAD' | Pine leading conifer in pure stand | *C_CODE* = ('C', 'D') and ((*PL_PCT* > *FB_PCT* and *PL_PCT* > *FD_PCT* and *PL_PCT* > *LT_PCT* and *PL_PCT* > *SB_PCT* and *PL_PCT* > *SW_PCT*) or (*LEAD_CON* = 'PL' and *PL_PCT* >= *FB_PCT* and *PL_PCT* >= *FD_PCT* and *PL_PCT* >= *LT_PCT* and *PL_PCT* >= *SB_PCT* and *PL_PCT* >= *SW_PCT*)) |
| 'SB_LEAD' | Black spruce leading conifer in pure stand | *C_CODE* = ('C', 'D') and ((*SB_PCT* > *FB_PCT* and *SB_PCT* > *FD_PCT* and *SB_PCT* > *LT_PCT* and *SB_PCT* > *PL_PCT* and *SB_PCT* > *SW_PCT*) or (*LEAD_CON* = 'SB' and *SB_PCT* >= *FB_PCT* and *SB_PCT* >= *FD_PCT* and *SB_PCT* >= *LT_PCT* and *SB_PCT* >= PL_*PCT* and *SB_PCT* >= *SW_PCT*)) |
| 'SW_LEAD' | White spruce leading conifer in pure stand | *C_CODE* = ('C', 'D') and ((*SW_PCT* > *FB_PCT* and *SW_PCT* > *FD_PCT* and *SW_PCT* > *LT_PCT* and *SW_PCT* > *PL_PCT* and *SW_PCT* > *SB_PCT*) or (*LEAD_CON* = 'SW' and *SW_PCT* >= *FB_PCT* and *SW_PCT* >= *FD_PCT* and *SW_PCT* >= *LT_PCT* and *SW_PCT* >= PL_*PCT* and *SW_PCT* >= *SB_PCT*)) |
| 'NO_C' | No coniferous present | *SOFTPCT* = 0 |

Based on CRULE, DRULE, broad cover group and species composition, forested polygons were then assigned to an extended stratum (Table 9).

## Table 9. Assigning SRD extended strata based on DRULE, CRULE, BCG and species composition.

| STRATA_SRD | Description | Selection Criteria |
|---|---|---|
| 'D1' | Pure aspen | *C_CODE* = 'D' and *AW_PCT* >= 9 |
| 'D2' | Aspen leading with poplar | *C_CODE* = 'D' and *DRULE* = 'AW_LEAD' and *AW_PCT* < 9 and *PB_PCT* > 1 |
| 'D3' | Aspen leading without poplar | *C_CODE* = 'D' and *DRULE* = 'AW_LEAD' and *AW_PCT* < 9 and *PB_PCT* <= 1 |
| 'D4' | Poplar leading | *C_CODE* = 'D' and *DRULE* = 'PB_LEAD' |
| 'D5' | Birch leading | *C_CODE* = 'D' and *DRULE* = 'BW_LEAD' |
| 'DC1' | Aspen/white spruce | *C_CODE* = 'DC' and *DRULE* = 'AW_LEAD' and *CRULE* = 'SW_LEAD_MW' |
| 'DC2' | Aspen/pine | *C_CODE* = 'DC' and *DRULE* = 'AW_LEAD' and *CRULE* = 'PL_LEAD_MW' |
| 'DC3' | Aspen/black spruce | *C_CODE* = 'DC' and *DRULE* = 'AW_LEAD' and *CRULE* = 'SBLT_LEAD_MW' |
| 'DC4' | Aspen/fir | *C_CODE* = 'DC' and *DRULE* = 'AW_LEAD' and *CRULE* = 'FBFD_LEAD_MW' |
| 'DC5' | Poplar/white spruce | *C_CODE* = 'DC' and *DRULE* = 'PB_LEAD' and *CRULE* = 'SW_LEAD_MW' |
| 'DC6' | Poplar/pine | *C_CODE* = 'DC' and *DRULE* = 'PB_LEAD' and *CRULE* = 'PL_LEAD_MW' |
| 'DC7' | Poplar/black spruce | *C_CODE* = 'DC' and *DRULE* = 'PB_LEAD' and *CRULE* = 'SBLT_LEAD_MW' |
| 'DC8' | Poplar/fir | *C_CODE* = 'DC' and *DRULE* = 'PB_LEAD' and *CRULE* = 'FBFD_LEAD_MW' |
| 'DC9' | Birch/white spruce | *C_CODE* = 'DC' and *DRULE* = 'BW_LEAD' and *CRULE* = 'SW_LEAD_MW' |
| 'DC10' | Birch/pine | *C_CODE* = 'DC' and *DRULE* = 'BW_LEAD' and *CRULE* = 'PL_LEAD_MW' |
| 'DC11' | Birch/black spruce | *C_CODE* = 'DC' and *DRULE* = 'BW_LEAD' and *CRULE* = 'SBLT_LEAD_MW' |
| 'DC12' | Birch/fir | *C_CODE* = 'DC' and *DRULE* = 'BW_LEAD' and *CRULE* = 'FBFD_LEAD_MW' |
| 'CD1' | White spruce/aspen | *C_CODE* = 'CD' and *CRULE* = 'SW_LEAD_MW' and *DRULE* = 'AW_LEAD' |
| 'CD2' | White spruce/poplar | *C_CODE* = 'CD' and *CRULE* = 'SW_LEAD_MW' and *DRULE* = 'PB_LEAD' |
| 'CD3' | White spruce/birch | *C_CODE* = 'CD' and *CRULE* = 'SW_LEAD_MW' and *DRULE* = 'BW_LEAD' |
| 'CD4' | Pine/aspen | *C_CODE* = 'CD' and *CRULE* = 'PL_LEAD_MW' and *DRULE* = 'AW_LEAD' |
| 'CD5' | Pine/poplar | *C_CODE* = 'CD' and *CRULE* = 'PL_LEAD_MW' and *DRULE* = 'PB_LEAD' |
| 'CD6' | Pine/birch | *C_CODE* = 'CD' and *CRULE* = 'PL_LEAD_MW' and *DRULE* = 'BW_LEAD' |
| 'CD7' | Black spruce/aspen | *C_CODE* = 'CD' and *CRULE* = 'SBLT_LEAD_MW' and *DRULE* = 'AW_LEAD' |
| 'CD8' | Black spruce/poplar | *C_CODE* = 'CD' and *CRULE* = 'SBLT_LEAD_MW' and *DRULE* = 'PB_LEAD' |
| 'CD9' | Black spruce/birch | *C_CODE* = 'CD' and *CRULE* = 'SBLT_LEAD_MW' and *DRULE* = 'BW_LEAD' |
| 'CD10' | Fir/aspen | *C_CODE* = 'CD' and *CRULE* = 'FBFD_LEAD_MW' and *DRULE* = 'AW_LEAD' |
| 'CD11' | Fir/poplar | *C_CODE* = 'CD' and *CRULE* = 'FBFD_LEAD_MW' and *DRULE* = 'PB_LEAD' |
| 'CD12' | Fir/birch | *C_CODE* = 'CD' and *CRULE* = 'FBFD_LEAD_MW' and *DRULE* = 'BW_LEAD' |
| 'C1' | Pure white spruce | *C_CODE* = 'C' and *SW_PCT* >= 9 |
| 'C2' | White spruce leading with pine | *C_CODE* = 'C' and *CRULE* = 'SW_LEAD' and *SW_PCT* < 9 and *PL_PCT* > 1 |
| 'C3' | White spruce leading without pine | *C_CODE* = 'C' and *CRULE* = 'SW_LEAD' and *SW_PCT* < 9 and *PL_PCT* <= 1 |
| 'C4' | Pure pine | *C_CODE* = 'C' and *PL_PCT* >= 9 |
| 'C5' | Pine leading with white spruce | *C_CODE* = 'C' and *CRULE* = 'PL_LEAD' and *PL_PCT* < 9 and *SW_PCT* > 1 and *SW_ORD* < *FB_ORD* and *SW_ORD* < *SB_ORD* |
| 'C6' | Pine leading with black spruce | *C_CODE* = 'C' and *CRULE* = 'PL_LEAD' and *PL_PCT* < 9 and *SB_PCT* > 1 and *SB_ORD* < *FB_ORD* and *SB_ORD* < *SW_ORD* |
| 'C7' | Pine leading with fir | *C_CODE* = 'C' and *CRULE* = 'PL_LEAD' and *PL_PCT* < 9 and *FB_PCT* > 1 and *FB_ORD* < *SB_ORD* and *FB_ORD* < *SW_ORD* |
| 'C8' | Pine leading without spruce and fir | *C_CODE* = 'C' and *CRULE* = 'PL_LEAD' and *PL_PCT* < 9 and *FB_PCT* <= 1 and *SB_PCT* <=1 and *SW_PCT* <= 1 |
| 'C9' | Pure black spruce | *C_CODE* = 'C' and *SB_PCT* >= 9 |
| 'C10' | Black spruce leading with pine | *C_CODE* = 'C' and *CRULE* = 'SB_LEAD' and *SB_PCT* < 9 and *PL_PCT* > 1 |
| 'C11' | Black spruce leading without pine | *C_CODE* = 'C' and *CRULE* = 'SB_LEAD' and *SB_PCT* < 9 and *PL_PCT* <= 1 |
| 'C12' | Larch leading | *C_CODE* = 'C' and *CRULE* = 'LT_LEAD' |
| 'C13' | Pure Douglas-fir | *C_CODE* = 'C' and *FD_PCT* >= 9 |
| 'C14' | Douglas-fir leading | *C_CODE* = 'C' and *CRULE* = 'FD_LEAD' and *FD_PCT* < 9 |
| 'C15' | Pure balsam fir | *C_CODE* = 'C' and *FB_PCT* >= 9 |
| 'C16' | Balsam fir leading with pine | *C_CODE* = 'C' and *CRULE* = 'FB_LEAD' and *FB_PCT* < 9 and *PL_PCT* > 1 |
| 'C17' | Balsam fir leading without pine | *C_CODE* = 'C' and *CRULE* = 'FB_LEAD' and *FB_PCT* < 9 and *PL_PCT* <= 1 |
| 'XX0' | Non-forested | *C_CODE* = NULL |

### 2.4.7 FMP Yield Strata

Extended strata were aggregated into FMP yield strata based on the rules in Table 10.

**Table 10. Conversion of extended strata to FMP yield strata.**

| Broad Cover Group | Species Stratum (YC) | | SRD Extended Stratum (SRD) |
|---|---|---|---|
| D | DEC | | D1, D2, D3, D4, D5 |
| DC | DC | | DC1 - DC12 (All DC types) |
| CD | CD | | CD1 - CD12 (All CD types) |
| C | PL | | C4, C5, C6, C7, C8 |
| | SB | | C9, C10, C11 |
| | SW | | C1, C2, C3, C13, C14, C15, C16, C17 |
| | LT | | C12 |
| D(Layer1) | DU | Layer1 | D1, D2, D3, D4, D5 |
| C,CD,DC (Layer 2) | | Layer2 | DC1 - DC12, CD1 - CD12, C1-C8 |

The FMP yield strata ‘PL’, ‘SW’, ‘LT’ were all grouped under ‘C-SW’ yield stratum. The landbase code was assigned from the broad cover group values from the AVI defining layer. Deciduous cover groups are assigned a landbase code of ‘D’ and mixedwood and conifer cover groups are assigned to ‘C’. The DU stratum is assigned to the broad cover group of ‘C’.

# 3. Plot Attribute Assignment and Volume Compilation

## 3.1 Overview

This section describes how data were prepared for use in yield curve development. Data sources and the initial number of plots are described. The method of assigning landbase attributes to plots is then described, along with dataset deletions. Finally, the methods used for compiling gross merchantable stand volume ($m^3$/ha) for each eligible plot are described.

## 3.2 Data Sources

A temporary volume sample plot program was established in 2004 for FMU P14 by SRD. Temporary sample plots (TSPs) were established throughout the FMU area using stratified random sampling (SRD 2004) based on broad cover groups. A total of 372 plots were sampled with 288 plots located in coniferous stands and 84 located in deciduous stands.

### 3.2.1 P14 TSP Data

The plots were located in clusters of three radiating in three directions ($0^o$, $135^o$, and $225^o$) from the stand centre. Plots were relocated if they fell within less than 5 m from the stand boundary, if they fell within an anthropogenic disturbance, or a naturally non-vegetated area.

Fixed radius, circular TSPs were used to sample trees at each location. Circular 200 $m^2$ plots (7.98 m in radius) were used to sample trees ≥ 7.1 cm in DBH. A smaller 25 $m^2$ circular plot (2.82 m in radius), nested within the larger plot, was used to sample all trees > 1.3 m in height and < 7.1 cm in DBH. The small plot was centred in the centre of the large plot.

All live and dead trees ≥ 7.1 cm in DBH were measured in the large plot. The species, dbh, and crown class were recorded for each individual tree. In plots with uniform height distribution the

height of at least two healthy trees was measured while the rest of the heights were estimated. In plots with a more variable height distribution, up to 5 trees were measured and used as a reference for estimating the heights of the remaining trees. Actual and estimated heights were assigned to each individual tree in the dataset.

Condition codes were recorded for each individual tree up to a maximum of three codes per tree. In single story stands two dominant or co-dominant trees were selected for breast height age measurements in each dominant species up to a maximum of six trees. In two story stands, 4 overstory dominant or co-dominant trees were measured in the overstory and 2 trees were measured in the understory. In complex stands up to six trees were selected for age measurements with sizes that described the size distribution within plot. These plot ages were not used in the development of the yield curves.

The increment cores for sampled breast height age were measured to the nearest millimetre between the cambium and the $10^{th}$ growth ring and between the $11^{th}$ growth ring and the $20^{th}$ growth ring.

# 3.3 Plot Attribute Assignment and Submission

## 3.3.1 Attribute assignment

Precise GPS plot locations recorded during the sampling process were not available for the FMU P14 TSP data. However, each plot had longitude and latitude generated in the office that were used by the sampling crews to locate the plot within the stand. This information was considered the actual plot location and was used to position the plots within landbase polygons.

The plots were linked spatially to the landbase polygons using the provided longitude and latitude. Plot FMP yield stratum and stand origin were derived from the polygon's associated AVI attributes.

## 3.3.2 Plot Relocation

Plots were not relocated when individual plots within a three plot cluster fell within different AVI polygons according to the provided longitude and latitude. Four exceptions to this were as follows:

- Plot 67-2 had no longitude nor latitude, therefore the plot was assigned the same stand age and FMP yield stratum as plots 67-1 and 67-3;
- Plot 126-2 fell outside the FMU P14 boundaries. The plot was assigned the same stand age and FMP yield stratum as plot 126-1; and
- Plots 66-2 and 66-1 fell outside the FMU P14 boundaries. Both plots were assigned the same stand age and FMP yield stratum as plot 66-3.

## 3.3.3 Plot Deletions

The following criteria were used to determine if a plot was eligible for use in the natural (standing timber) empirical yield curve development:

1. The plot was located within the managed landbase; and

2. The plot was established in a polygon that had not been burned since sampling or had not been harvested before 2009.

Deciduous volumes from 3 plots were removed as outliers and were not used in the fitting of the curves. The total number of sampled plots, the total number of deletions, and the total number of eligible plots by yield stratum are discussed in Section 3.6.

### 3.3.4 Age Assignment

Stand age was determined from AVI attributes using the defining layer and the reference year of 2009 (field F_AGE). The stand age at the year of measurement (2004) was calculated as the stand age in 2009 minus the number of years between the reference year and the TSP measurement year.

$$Age_{obs} = Age_{2009} - (2009 - MsmtYear)$$

Where:

$Age_{obs}$ = stand age at measurement year

$Age_{2009}$ = standage in 2009 (F_AGE)

*MsmtYear* = measurement year of the TSP (2004)

## 3.4 Data Distribution

The distribution and the percent of plots sampled within FMU P14 as well as the total managed landbase area are presented by FMP yield stratum in Table 11. The distribution by FMP yield stratum of the sampled plots differs from the distribution of the managed landbase. When compared to the managed landbase, the D stratum is underrepresented while the C-SW, CD, DC strata are overrepresented.

**Table 11. Total managed area, percent total area, total and eligible number of plots, and percent eligible plots by FMP yield stratum.**

| | Broad | FMP Yield | Total | Percent | Eligible | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| Landbase | Cover Group | Stratum | Area (ha) | Area (%) | Con. | Con.(%) | Dec. | Dec. (%) | Plots |
| Deciduous | D | D | 43,461 | 49.5% | 62 | 21.0% | 62 | 19.7% | 72 |
| Coniferous | DC | DC | 8,578 | 9.8% | 36 | 12.2% | 36 | 11.5% | 48 |
| | CD | CD | 4,594 | 5.2% | 35 | 11.9% | 35 | 11.1% | 35 |
| | C | C-SB | 1,985 | 2.3% | 17 | 5.8% | 39 | 12.4% | 47 |
| | | C-SW | 13,490 | 15.4% | 90 | 30.5% | 90 | 28.7% | 105 |
| | | DU | 15,720 | 17.9% | 55 | 18.6% | 52 | 16.6% | 57 |
| | | Plots Unassigned | - | - | - | - | - | - | 8 |
| Total | | | 87,827 | 100.0% | 295 | 100% | 314 | 100% | 372 |

The number and percent plots by FMP yield stratum and AVI defining layer are presented in Table 12. The plots show a reasonable distribution relative to the distribution of landbase area (landbase file LB3_TSA_DESC) for all strata. The exception is stratum C-SB which has a higher representation of stands described based on the overstory as a defining layer compared to the landbase percent.

## Table 12. Distribution of plots and managed landbase areas by FMP yield stratum and defining AVI layer.

| FMP Yield Stratum | Defining Layer | Observations | | Net Landbase Area (ha) | | | Percent Net Landbase Area (ha) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Total | % | Natural | Managed | Total | Natural | Managed | Total |
| D | Overstory | 51 | 82% | 35,416 | 3,479 | 38,895 | 89% | 100% | 89% |
| | Understory | 11 | 18% | 4,566 | 0 | 4,566 | 11% | 0% | 11% |
| | Total | 62 | 100% | 39,982 | 3,479 | 43,461 | 100% | 100% | 100% |
| DC | Overstory | 36 | 100% | 5,981 | 1,231 | 7,212 | 81% | 100% | 84% |
| | Understory | - | - | 1,366 | 0 | 1,366 | 19% | 0% | 16% |
| | Total | 36 | 100% | 7,347 | 1,231 | 8,578 | 100% | 100% | 100% |
| CD | Overstory | 30 | 86% | 2,377 | 1,469 | 3,846 | 76% | 100% | 84% |
| | Understory | 5 | 14% | 748 | 0 | 748 | 24% | 0% | 16% |
| | Total | 35 | 100% | 3,125 | 1,469 | 4,594 | 100% | 100% | 100% |
| C-SB | Overstory | 4 | 24% | 128 | 0 | 128 | 6% | 0% | 6% |
| | Understory | 13 | 76% | 1,857 | 0 | 1,857 | 94% | 0% | 94% |
| | Total | 17 | 100% | 1,985 | 0 | 1,985 | 100% | 0% | 100% |
| C-SW | Overstory | 70 | 78% | 9,404 | 1,141 | 10,546 | 76% | 100% | 78% |
| | Understory | 20 | 22% | 2,945 | 0 | 2,945 | 24% | 0% | 22% |
| | Total | 90 | 100% | 12,349 | 1,141 | 13,490 | 100% | 100% | 100% |
| DU | Overstory | 55 | 100% | 15,720 | 0 | 15,720 | 100% | 0% | 100% |
| | Understory | - | - | 0 | 0 | 0 | 0% | 0% | 0% |
| | Total | 55 | 100% | 15,720 | 0 | 15,720 | 100% | 0% | 100% |
| Grand Total | | 295 | | 80,507 | 7,320 | 87,827 | | | |

The number and percent of plots by FMP yield stratum and height class is presented in Table 13. The table also presents the distribution of the managed landbase area (natural and managed) by FMP yield stratum and height class. With two exceptions, strata C-SB and DU, the plot distribution is proportional to the stands' distribution across the landbase.

For strata C-SB the percent of plots in the 11-20 m class is greater than the landbase percent in the same height class. This may lead to an overestimation of yields when compared to landscape values. However, the area that the C-SB stratum represents is only 2.3% of the managed landbase and therefore the impact is limited.

For the DU stratum the height class stratum 11-20 m is overrepresented. A potential negative bias could be associated with the curve development (lower predicted yields than actual).

**Table 13. Distribution of plots and managed areas by FMP yield stratum and height class.**

| FMP Yield Stratum | Height Class | Observations | | Net Landbase Area (ha) | | | Percent Net Landbase Area (ha) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Total | % | Natural | Managed | Total | Natural | Managed | Total |
| D | 0-10 | 3 | - | 1,327 | 3,438 | 4,766 | 3% | 99% | 11% |
| | 11-20 | 36 | 58% | 18,959 | 28 | 18,988 | 47% | 1% | 44% |
| | 21+ | 23 | 37% | 19,695 | 12 | 19,707 | 49% | 0% | 45% |
| | Total | 62 | 100% | 39,982 | 3,479 | 43,461 | 100% | 100% | 100% |
| DC | 0-10 | - | - | 240 | 1,230 | 1,471 | 3% | 100% | 17% |
| | 11-20 | 14 | 39% | 2,815 | 0 | 2,816 | 38% | 0% | 33% |
| | 21+ | 22 | 61% | 4,291 | 0 | 4,291 | 58% | 0% | 50% |
| | Total | 36 | 100% | 7,347 | 1,231 | 8,578 | 100% | 100% | 100% |
| CD | 0-10 | - | - | 288 | 1,469 | 1,757 | 9% | 100% | 38% |
| | 11-20 | 18 | 51% | 1,080 | 0 | 1,080 | 35% | 0% | 24% |
| | 21+ | 17 | 49% | 1,756 | 0 | 1,756 | 56% | 0% | 38% |
| | Total | 35 | 100% | 3,125 | 1,469 | 4,594 | 100% | 100% | 100% |
| C-SB | 0-10 | 9 | 53% | 1,720 | 0 | 1,720 | 87% | 0% | 87% |
| | 11-20 | 8 | 47% | 266 | 0 | 266 | 13% | 0% | 13% |
| | 21+ | - | - | 0 | 0 | 0 | 0% | 0% | 0% |
| | Total | 17 | 100% | 1,985 | 0 | 1,985 | 100% | 0% | 100% |
| C-SW | 0-10 | - | - | 443 | 1,141 | 1,585 | 4% | 100% | 12% |
| | 11-20 | 44 | 49% | 4,798 | 0 | 4,798 | 39% | 0% | 36% |
| | 21+ | 46 | 51% | 7,108 | 0 | 7,108 | 58% | 0% | 53% |
| | Total | 90 | 100% | 12,349 | 1,141 | 13,490 | 100% | 100% | 100% |
| DU | 0-10 | - | - | 74 | 0 | 74 | 0% | 0% | 0% |
| | 11-20 | 39 | 71% | 7,120 | 0 | 7,120 | 45% | 0% | 45% |
| | 21+ | 16 | 29% | 8,527 | 0 | 8,527 | 54% | 0% | 54% |
| | Total | 55 | 100% | 15,720 | 0 | 15,720 | 100% | 0% | 100% |
| Grand Total | | 295 | | 80,507 | 7,320 | 87,827 | | | |

Table 14 presents the plot distribution by FMP yield stratum and age class. The table also presents the distribution of landbase areas (managed and natural) by FMP yield stratum and age class. With two exceptions, stratum C-SB and DU, the number of plots is proportional to the distribution of the managed landbase area by FMP yield stratum and age class.

In the C-SB stratum the 80-119 years age class is overrepresented, while in the DU stratum the 40-79 age class is overrepresented.

**Table 14. Distribution of plots and managed areas by FMP yield stratum and age class.**

| FMP Yield Stratum | Age Class | Observations | | Net Landbase Area (ha) | | | Percent Net Landbase Area (ha) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Total | % | Natural | Managed | Total | Natural | Managed | Total |
| D | 0-39 | 3 | 5% | 517 | 3,467 | 3,984 | 1% | 100% | 9% |
| | 40-79 | 33 | 53% | 19,156 | 12 | 19,168 | 48% | 0% | 44% |
| | 80-119 | 26 | 42% | 18,649 | 0 | 18,649 | 47% | 0% | 43% |
| | 120+ | | - | 1,659 | 0 | 1,659 | 4% | 0% | 4% |
| | Total | 62 | 100% | 39,982 | 3,479 | 43,461 | 100% | 100% | 100% |
| DC | 0-39 | - | - | 82 | 1,230 | 1,312 | 1% | 100% | 15% |
| | 40-79 | 12 | 33% | 2,543 | 0 | 2,543 | 35% | 0% | 30% |
| | 80-119 | 24 | 67% | 4,133 | 0 | 4,133 | 56% | 0% | 48% |
| | 120+ | - | - | 589 | 0 | 589 | 8% | 0% | 7% |
| | Total | 36 | 100% | 7,347 | 1,231 | 8,578 | 100% | 100% | 100% |
| CD | 0-39 | - | - | 43 | 1,469 | 1,512 | 1% | 100% | 33% |
| | 40-79 | 7 | 20% | 804 | 0 | 804 | 26% | 0% | 18% |
| | 80-119 | 25 | 71% | 1,983 | 0 | 1,983 | 63% | 0% | 43% |
| | 120+ | 3 | 9% | 294 | 0 | 294 | 9% | 0% | 6% |
| | Total | 35 | 100% | 3,125 | 1,469 | 4,594 | 100% | 100% | 100% |
| C-SB | 0-39 | - | - | 7 | 0 | 7 | 0% | 0% | 0% |
| | 40-79 | 6 | 35% | 1,591 | 0 | 1,591 | 80% | 0% | 80% |
| | 80-119 | 11 | 65% | 384 | 0 | 384 | 19% | 0% | 19% |
| | 120+ | - | - | 4 | 0 | 4 | 0% | 0% | 0% |
| | Total | 17 | 100% | 1,985 | 0 | 1,985 | 100% | 0% | 100% |
| C-SW | 0-39 | - | - | 6 | 1,141 | 1,147 | 0% | 100% | 9% |
| | 40-79 | 12 | 13% | 2,316 | 0 | 2,316 | 19% | 0% | 17% |
| | 80-119 | 57 | 63% | 6,323 | 0 | 6,323 | 51% | 0% | 47% |
| | 120+ | 21 | 23% | 3,704 | 0 | 3,704 | 30% | 0% | 27% |
| | Total | 90 | 100% | 12,349 | 1,141 | 13,490 | 100% | 100% | 100% |
| DU | 0-39 | - | - | 76 | 0 | 76 | 0% | 0% | 0% |
| | 40-79 | 35 | 64% | 7,434 | 0 | 7,434 | 47% | 0% | 47% |
| | 80-119 | 18 | 33% | 7,312 | 0 | 7,312 | 47% | 0% | 47% |
| | 120+ | 2 | 4% | 897 | 0 | 897 | 6% | 0% | 6% |
| | Total | 55 | 100% | 15,720 | 0 | 15,720 | 100% | 0% | 100% |
| Grand Total | | 295 | | 80,507 | 7,320 | 87,827 | | | |

# 3.5 Volume Compilation

Each plot in the dataset was compiled for gross merchantable stand volume. The term gross volume indicates that no deduction for cull was applied.

For each sample plot, the merchantable length of each live tree with a minimum stump diameter of 15.0 cm was calculated. This calculation was based on the height of the tree, a 30.0 cm stump height, minimum stump diameter/top diameter (by species type), and log length as defined in Table 15.

**Table 15. Minimum utilization standards by species type.**

| Utilization Criterion | Conifer Species | Deciduous Species |
|---|---|---|
| Stump height | 30 cm | 30 cm |
| Minimum log length | 2.66 m | 2.66 m |
| Minimum stump diameter outside bark | 15 cm | 15 cm |
| Minimum top diameter inside bark | 11 cm | 10 cm |

Dead trees based on condition codes (i.e. 15, 25, 29, and 61), trees with missing species or trees with missing DBH and height were excluded from compilation.

Gross volume calculations involved the iterative process presented in "Ecologically Based Individual Tree Volume Estimation for Major Alberta Tree Species" (Huang 1994b). First, the merchantable length of each tree was divided into 30 sections of equal length. Diameters were determined for the top, middle and bottom of each section using Kozak's variable exponent taper equation (Kozak 1988) and ecoregion/tree species-specific coefficients for the province of Alberta (Huang 1994a). The following equation was used to determine section diameters:

$$dib = a_0 DBH^{a_1} * a_2^{DBH} * X^{b_1 Z^2 + b_2 \ln(Z+0.001) + b_3 \sqrt{Z} + b_4 e^Z + b_5 \left(\frac{DBH}{H}\right)}$$

Where:

*dib* = stem diameter inside bark (cm) at height h (m)

*DBH* = diameter at breast height outside bark (cm)

*H* = total tree height (m)

$X = \dfrac{1-\sqrt{h/H}}{1-\sqrt{p}}$

*Z* = h/H

*h* = stem height (m)

*p* = relative height of inflection point from the ground

$a_0$, $a_1$, $a_2$, $b_1$, $b_2$, $b_3$, $b_4$, $b_5$ = coefficients

For each tree, volumes for each section were calculated using Newton's equation (Husch et al. 1982):

$$MV = \frac{ML/10}{6} * (0.00007854) * (d_0^2 + 4d_1^2 + d_2^2)$$

Where:

*MV* = merchantable volume ($m^3$)

*ML* = merchantable length (m)

$d_0$ = diameter at bottom of section (cm)

$d_1$ = diameter at middle of section (cm)

$d_2$ = diameter at top of section (cm)

Gross merchantable tree volumes were then determined by summing individual section volumes for each tree. Tree volumes were converted to gross merchantable stand volume (volume per hectare) using the appropriate tree factor. Plots with no merchantable trees were assigned zero gross merchantable volume (0 $m^3$/ha) and retained within the dataset.

For each plot, the total coniferous gross merchantable stand volume was calculated by summing the $m^3$/ha estimates for each live coniferous tree within the plot. The total deciduous gross merchantable stand volume was calculated by summing the $m^3$/ha estimates for each live deciduous tree within the plot.

# 3.6 Plot Deletions

## 3.6.1 Total Number of Plots

Eligible plots were determined based on criteria presented in Section 3.3.1. Table 16 presents the total number of sampled plots and the number of plots used in the curve development, eligible plots, by FMP yield stratum.

**Table 16. Total number of TSPs sampled.**

| Data Source | Data Type | Yield Stratum | Total Number of Plots | Eligible | |
|---|---|---|---|---|---|
| | | | | Coniferous | Deciduous |
| P14 FMU | TSP | D | 72 | 62 | 62 |
| | | DC | 48 | 36 | 36 |
| | | CD | 35 | 35 | 35 |
| | | C-SB | 47 | 17 | 39 |
| | | C-SW | 105 | 90 | 90 |
| | | DU | 57 | 55 | 52 |
| | | Unassigned | 8 | - | - |
| **Total** | | | 372 | 295 | 314 |

## 3.6.2 Additional Deletions

Three plots with deciduous volumes greater than 500 $m^3$/ha were removed from the yield curve development in the DU yield stratum. The deletion was only applied to the deciduous volumes.

Table 17 presents the list of plots removed with their merchantable volume, yield stratum, stand age, deletion, and the reason for the deletion.

**Table 17. Influential points, deletion type and reason for deletion.**

| Polygon ID | Plot ID | FMP Yield Stratum | Stand Age | Merchantable Volume ($m^3$/ha) | | | Deletion | Reason for Deletion |
|---|---|---|---|---|---|---|---|---|
| | | | | Coniferous | Deciduous | Total | | |
| 9677 | 15-1 | DU | 74 | 0 | 518 | 518 | Deciduous | Outlier |
| 6285 | 25-2 | DU | 134 | 85 | 556 | 641 | Deciduous | Outlier |
| 6285 | 25-3 | DU | 134 | 54 | 537 | 591 | Deciduous | Outlier |

### 3.6.3 Final Number of Plots

The number of plots used in the development of the empirical natural yield curves is presented in Table 18. Eligible plots are those used for curve fitting.

**Table 18. Number of eligible and ineligible plots, and influential points by yield stratum.**

| Data Source | Data Type | Stratum | Natural stands | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Coniferous | | | | Deciduous | | | |
| | | | Eligible | Ineligible | Outliers | Total | Eligible | Ineligible | Outliers | Total |
| P14 FMU | TSP | D | 62 | 10 | - | 72 | 62 | 10 | - | 72 |
| | | DC | 36 | 12 | - | 48 | 36 | 12 | - | 48 |
| | | CD | 35 | - | - | 35 | 35 | - | - | 35 |
| | | C-SB[1] | 17 | 30 | - | 47 | 39 | 8 | - | 47 |
| | | C-SW | 90 | 15 | - | 105 | 90 | 15 | - | 105 |
| | | DU | 55 | 2 | - | 57 | 52 | 2 | 3 | 57 |
| | | Unassigned | - | 8 | - | 8 | - | 8 | - | 8 |
| **Total** | | | 295 | 77 | - | 372 | 314 | 55 | 3 | 372 |

[1]Regression to fit the deciduous volumes would not converge (N = 17). Instead 22 unproductive plots (SB_WET) were added to make the regression converge ($N_{decid}$ = 17+ 22)

# 4. Base Yield Curves

## 4.1 Overview

Natural stand empirical curves were fit for each of the six FMP yield strata to represent standing timber volumes for FMU P14. Conifer and deciduous volumes were fit separately as a function of stand age using nonlinear regression techniques. Regenerated stand yield curves were not developed from plot data.

## 4.2 Natural Stand Yield Curves

TSP data were used to fit natural stand yield curves (see Section 3.3 for information on data preparation) using one of three models:

**2-parameter model (2P):**

$$Volume = a(Age)^{b} e^{(-a*Age)}$$

**2-parameter model with constant (2P+k):**

$$Volume = a(Age)^{b} e^{\left(-Age/k\right)}$$

**3-parameter model (3P):**

$$Volume = a(Age)^{b} e^{(-c*Age)}$$

Where: *Volume* = gross merchantable stand volume ($m^3$/ha)

*Age* = stand age at year of measurement

*a, b, k, c* = coefficients

Conifer and deciduous volume were modelled separately using one of the three equations. Where the constant k was required to achieve biologically reasonable curve form, values between 10 and 100 were tested to achieve the most biologically reasonable fit that also fit to the data. Total volume was calculated by summing conifer and deciduous volume at corresponding ages.

Model selection was qualitatively based on goodness-of-fit. Final sample size, model form, and coefficients used to develop each yield curve are presented in Table 19. Yield curves are presented in Appendix I.

**Table 19. Model form and model coefficients, base natural yield curves.**

| FMP Yield Stratum | Number of Observations | Species Type | Model Form | Model Coefficients a | b | c | K | $R^2$ |
|---|---|---|---|---|---|---|---|---|
| D | 62 | Coniferous | 2P+K | 1.15653E-14 | 9.40432703 | - | 15 | 0.17 |
| | 62 | Deciduous | 2P+K | 0.000140698 | 4.07095076 | - | 20 | 0.11 |
| DC | 36 | Coniferous | 2P+K | 5.37626E-19 | 11.77454 | - | 13 | 0.24 |
| | 36 | Deciduous | 2P+K | 3.81126E-16 | 10.5840653 | - | 12 | 0.31 |
| CD | 35 | Coniferous | 2P | 0.026962273 | 2.39551771 | - | - | 0.01 |
| | 35 | Deciduous | 2P+K | 5.69368E-09 | 6.19708598 | - | 20 | 0.13 |
| C-SB | 17 | Coniferous | 2P+K | 4.81383E-17 | 11.0502513 | - | 12 | 0.26 |
| | 39 | Deciduous[1] | 2P+K | 2.06094E-06 | 4.72045297 | - | 20 | 0.03 |
| C-SW | 90 | Coniferous | 2P+K | 0.000154228 | 3.56134476 | - | 40 | 0.10 |
| | 90 | Deciduous | 3P | 0.001012384 | 2.7797789 | 0.02214053 | - | 0.01 |
| DU | 55 | Coniferous | 2P | 0.009416393 | 2.06980375 | - | - | 0.03 |
| | 52 | Deciduous | 2P+K | 2.06849E-11 | 8.23592263 | - | 12 | 0.13 |

[1]Regression to fit the deciduous volumes would not converge (N = 17). Instead 22 unproductive plots (SB_WET) were added to make the regression converge ($N_{decid}$ = 17+ 22)

# 4.3 Composite Yield Curves

Composite yield curves provide an area-weighted estimate of volume over time across natural stands within the FMU P14 managed landbase. These curves are useful to provide comparisons from one FMP to the next. Composite yield curves were created for all natural stands within the FMU P14 managed landbase.

Six area-weighted curves were developed for natural stands: four to represent each broad cover group (D, DC, CD, and C), one overall composite for the coniferous landbase (C, CD, DU, and DC combined), and one overall composite for the whole landbase (C, CD, DC, DU and D combined).

Each natural stand yield curve was weighted by the proportion of the natural managed landbase area represented by that yield stratum. The total area of the natural stands by FMP yield stratum used for area-weighting was obtained from the landbase (landbase file LB4_TSA_DESC) and is provided in Table 20. Composite yield curves were developed by summing all area-weighted natural stand yield curves at each age. The composite yield curves are presented in Appendix II.

**Table 20. Total area of natural stands by FMP yield stratum.**

| Landbase | Broad Cover Group | FMP Yield Stratum | Natural Area (ha) | Percent |
|---|---|---|---|---|
| Deciduous | D | D | 39,982 | 49.7% |
| Coniferous | DC | DC | 7,347 | 9.1% |
| | | DU | 15,720 | 19.5% |
| | CD | CD | 3,125 | 3.9% |
| | C | C-SB | 1,985 | 2.5% |
| | | C-SW | 12,349 | 15.3% |
| Total | | | 80,507 | 100.0% |

# 5. Growth and Yield Issues

## 5.1 Yield Curves for Forecasting

P14 is a small unit without the ranges in ages and stand types typical in larger units. This limited the age range of the plot data which resulted in cases where the greatest volume was outside the data range and in inconsistencies between strata. Adjustments were made to the yield curves to address this weakness.

The coniferous yield curve in the D stratum peaks at 155 $m^3$/ha at age 140. This was more coniferous volume than was predicted for the CD curve and was mainly due to the concentration of plots below 105 years in the D stratum. The top and back end of the coniferous D stratum yield curve is not anchored in actual data, but it is modeled as a result of the data from the front end of the curve. The lack of data past 105 years coupled with higher volumes at younger ages lead to unreasonable high coniferous volumes in the D stratum. Attempts were made to fit a more realistic curve shape and volumes but they were unsuccessful.

Therefore, for forecasting, the decision was made to cap the coniferous yield curve in the D stratum at 50 $m^3$/ha to address the unrealistically high volume present in the empirical yield curve. The selection of 50 $m^3$/ha was arbitrary but the operators felt this better represented volumes in these stands. Refer to the Forecasting chapter for the sensitivity analysis undertaken on this issue.

Table 21 presents the stratum and the yield curves used for forecasting. Appendix III presents the stratum capped yield curves.

**Table 21. Yield curves by FMP yield stratum used for forecasting both managed and natural stands.**

| Stand Type | FMP Yield Stratum | Yield Curve Code | Curve Type |
|---|---|---|---|
| All | D | D_N | Base natural, coniferous curve capped at 50 $m^3$ |
| | DC | DC_N | Base natural |
| | CD | CD_N | Base natural |
| | C-SB | C_SB_N | Base natural |
| | C-SW | C_SW_N | Base natural |
| | DU | DU_N | Base natural |

# 5.2 Cull Deductions

Cull deductions are applied to yield curves to account for losses from defects, decay or damage. The Planning Standard requires that cull be applied as a percent reduction to yield curves, rather than as a reduction to the harvest level in forecasting. This section describes the methods by which cull was derived.

## 5.2.1 Methods

Boucher Brothers FMU P14 scaling data (gross scaled volume, cull volume, and net volume) were used to determine coniferous cull. Scaling cull data for the 2005/06, 2006/07, 2007/08, and 2008/09 timber years (64 records) were used.

Cull was determined by calculating the percent cull for each record. Each record was then weighted by gross scaled volume, so that records representing more scaled volume had a higher influence on the cull calculation. All records were then summed to obtain percent cull.

$$PctCull = \sum_{i=1}^{n} \left( \left( \frac{CullVol_i}{GrossVol_i} \right) * \left( \frac{GrossVol_i}{GrossVol_{tot}} \right) \right) * 100$$

which reduce to $$PctCull = \frac{\sum_{i=1}^{n} CullVol_i}{GrossVol_{tot}} * 100$$

Where: *PctCull* = percent cull
*CullVol* = cull volume ($m^3$)
*GrossVol* = gross scaled volume ($m^3$)

## 5.2.2 Results

A 3.26% coniferous cull was obtained from the results of calculations.

A 3.26% reduction was applied to the coniferous component of the yield curve to produce net merchantable volume. Cull was applied to yield curves during the forecasting process and therefore cull reduced yield curves are not presented here. Deciduous cull was not determined

from local scale data but rather the 9% deciduous cull from the adjacent P15 unit was applied. Refer to the Forecasting chapter for more information.

# 5.3 Piece Size Curves

Piece size curves were required to provide an estimate of how piece size (number of trees per cubic meter of gross merchantable tree volume) changes over time.

## 5.3.1 Methods

The TSP dataset used in yield curve development was used for piece size curve development. All plots that were eligible for empirical yield curve development were used in piece size development. Plot attributes were the same as previously defined, and volumes compiled for yield curve development were retained for use in this analysis.

For each plot, coniferous and deciduous trees per $m^3$ were calculated by dividing the total number of merchantable trees in the plot by the gross merchantable plot volume. An equation to predict trees per $m^3$ as a function of age was then fit directly using plot data:

$$PieceSize = a_0 + \frac{a_1}{Age}$$

Where: *PieceSize* = number of trees per $m^3$ of gross merchantable tree volume

*Age* = age at year of measurement

$a_0$, $a_1$ = coefficients

Plots with no volume were excluded, since piece size could not be calculated (dividing by zero). The final number of plots by FMP yield stratum was different for coniferous and deciduous curves, since there could be coniferous volume with no deciduous volume, or vice versa. The number of plots used to develop piece size curves is summarized in Table 22.

**Table 22. Number of deciduous and coniferous plots used to create piece size curves.**

| FMP Yield Stratum | Natural Stands | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coniferous | | | | | Deciduous | | | | |
| | Eligible | Ineligible | Zero $m^3$ | Outliers | Total | Eligible | Ineligible | Zero $m^3$ | Outliers | Total |
| D | 27 | 10 | 35 | - | 72 | 58 | 10 | 4 | - | 72 |
| DC | 29 | 12 | 7 | - | 48 | 30 | 12 | 6 | - | 48 |
| CD | 28 | - | 7 | - | 35 | 28 | - | 7 | - | 35 |
| C-SB[1] | 15 | - | 2 | - | 17 | 20 | 8 | 19 | - | 47 |
| C-SW | 79 | 15 | 11 | - | 105 | 50 | 15 | 40 | - | 105 |
| DU | 39 | 2 | 16 | - | 57 | 47 | 2 | 5 | 3 | 57 |
| Unassigned | - | - | - | - | 8 | - | - | - | - | 8 |
| Total | 217 | 39 | 78 | 0 | 342 | 233 | 47 | 81 | 3 | 372 |

[1]Regression to fit the deciduous volumes would not converge (N = 17). Instead 22 unproductive plots (SB_WET) were added to make the regression converge ($N_{decid}$ = 17+ 22)

### 5.3.2 Results

Piece size model coefficients are presented in Table 23, while piece size curves are provided in Appendix IV.

**Table 23. Model coefficients for piece size curves.**

| FMP Yield Stratum | Species Type | Model Coefficients | |
|---|---|---|---|
| | | $a_0$ | $a_1$ |
| D | Conifer | -5.073071 | 893.30591 |
| | Deciduous | 4.213361 | 49.27398 |
| DC | Conifer | -10.532336 | 1652.55642 |
| | Deciduous | -11.622637 | 1664.07108 |
| CD | Conifer | 3.478323 | 22.25867 |
| | Deciduous | 4.377159 | 185.67967 |
| C-SB | Conifer | 0.760094 | 641.67602 |
| | Deciduous | 8.145876 | -114.64753 |
| C-SW | Conifer | -2.665831 | 687.63954 |
| | Deciduous | 2.108686 | 293.23750 |
| DU | Conifer | 1.955226 | 542.24413 |
| | Deciduous | 0.598192 | 362.63801 |

$a_0$, $a_1$ coefficients from piece size model

### 5.3.3 Piece Size Curves for Forecasting

The piece size curves had negative values at higher ages for some strata as well as negative values at younger ages due to the limited dataset used to fit the curves. The decision was made to floor the curves for the strata where the model fit resulted in negative values.

The deciduous curve for the C-SB stratum was set to 0 trees/$m^3$ where the age of the deciduous component was smaller than 20 years. Both the deciduous and the coniferous curves in the DC stratum were floored at 2 trees/$m^3$. The coniferous curve in the D stratum was also floored at 2 trees/$m^3$.

# 6. References

Alberta Forestry, Lands and Wildlife. 1991. Alberta Vegetation Inventory Standards Manual Version 2.1. Land Information Services Division, Resource Information Branch. Edmonton, AB.

Alberta Sustainable Resource Development. 2004. Volume Sampling Specifications for FMU P14.

Alberta Sustainable Resource Development. 2006. Alberta Forest Management Planning Standard. Version 4.1 - April 2006. Forest Management Branch, Public Lands and Forests Division, Alberta Sustainable Resource Development, Edmonton, Alberta.

Huang, S. 1994a. Ecologically-Based Individual Tree Height-Diameter Models For Major Alberta Tree Species. Report #2. Alberta Environmental Protection, Land and Forest Services. Forest Management Division. Publication T/291. Edmonton, AB.

Huang, S. 1994b. Ecologically-Based Individual Tree Volume Estimation For Major Alberta Tree Species: Methods Of Formulation And Statistical Foundations. Report #1. Alberta Environmental Protection, Land and Forest Services. Forest Management Division. Publication T/288. Edmonton, AB.

Husch, B., C.I. Miller and T.W. Beers. 1982. Forest Mensuration. John Wiley & Sons, New York.

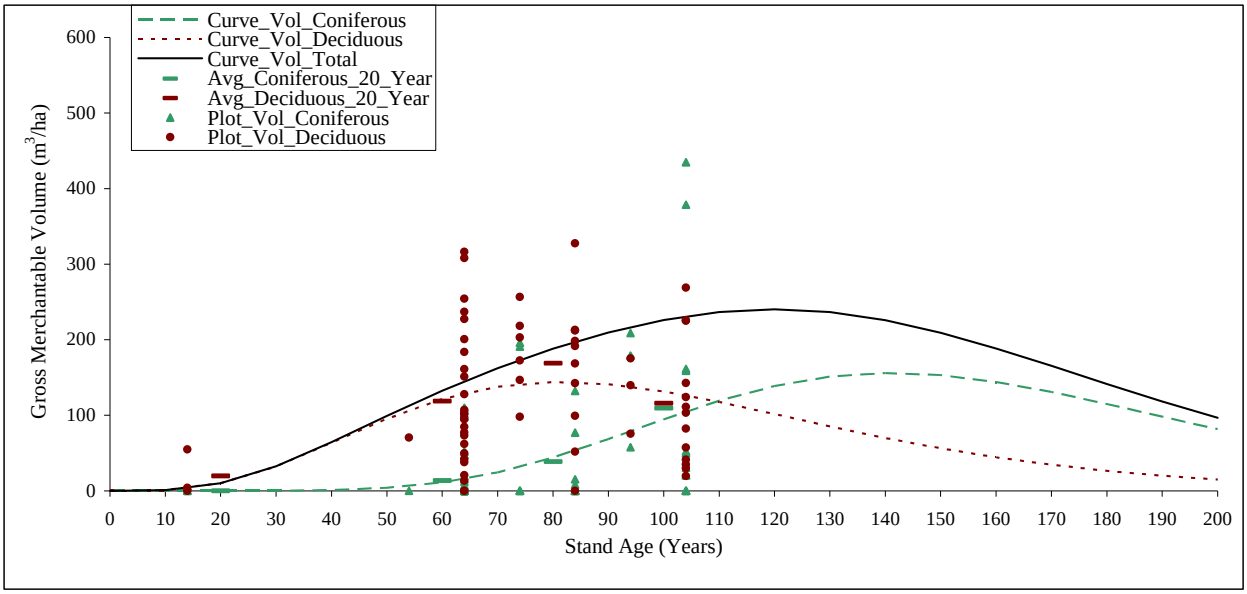
Kozak, A. 1988. A Variable-Exponent Taper Equation. Can. J. For. Res. 18: 1363-1368.

# Appendix I Natural Stand Yield Curves

The base natural stand yield curves representing gross merchantable volume in this appendix are:

- Pure deciduous (D);
- Deciduous leading mixedwood (DC);
- Coniferous leading mixedwood (CD);
- Pure conifer, black spruce leading (C_SB);
- Pure conifer, white spruce leading, (C_SW); and
- Deciduous with conifer understory (DU).

## D STRATUM / Base Natural Stand Yield Curve




**2-PARAMETER EQUATION (2P): volume = $a(age)^b e^{(-a*age)}$**

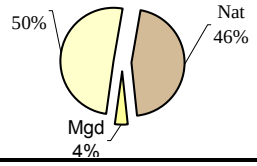
**2-PARAMETER EQUATION WITH CONSTANT (2P+k): volume = $a(age)^b e^{(-age/k)}$**

| Parameter Estimates: | | |
|---|---|---|
| Coniferous | a | 1.157E-14 |
| *Eqn: 2P+K* | b | 9.4043270 |
| | k | 15 |
| Deciduous | a | 1.407E-04 |
| *Eqn: 2P+K* | b | 4.0709508 |
| | k | 20 |

| Utilization Standards: | |
|---|---|
| Con. Top Diameter (cm): | 11.0 |
| Dec. Top Diameter (cm): | 10.0 |
| Con. Min. Log Length (m): | 2.66 |
| Dec. Min. Log Length (m): | 2.66 |
| Stump Diameter (cm): | 15.0 |
| Stump Height (cm): | 30.0 |

| Stratum Summary: | |
|---|---|
| Total Number of Plots: | 62 |
| Nat. Stand Area (ha): | 39,982 |
| Mgd. Stand Area (ha): | 3,479 |

**Stratum as a % of the managed landbase:**

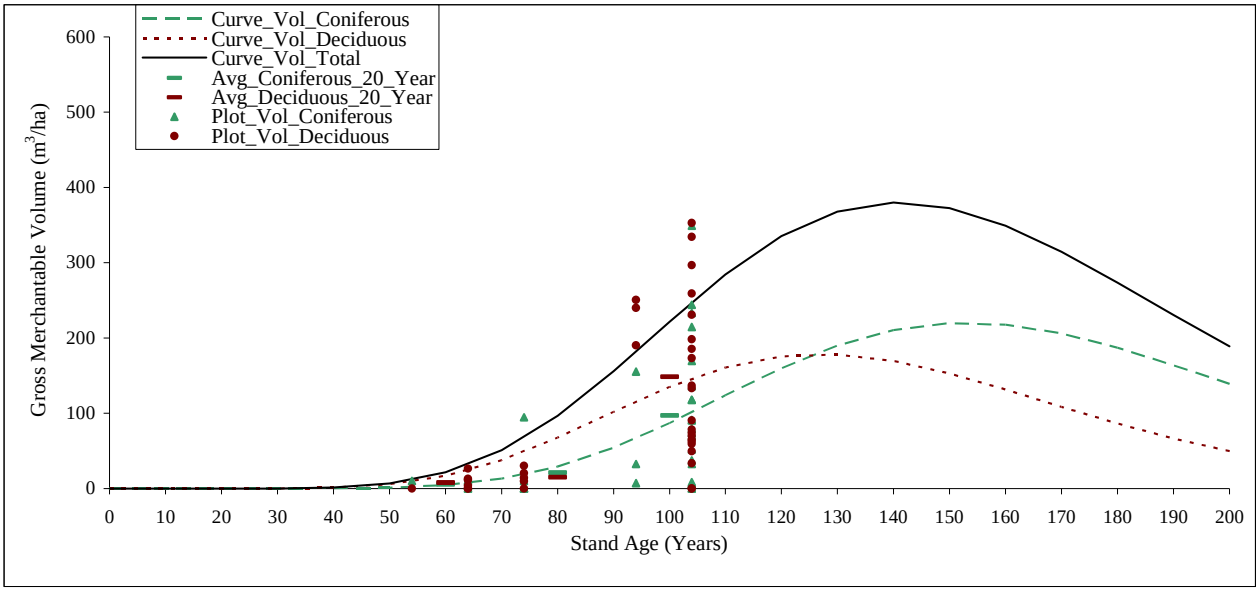



| Stand Age | Number of Plots | Predicted Gross Merchantable Volume[1] ($m^3$/ha) | | | Mean Annual Increment ($m^3$/ha/year)[2] | | |
|---|---|---|---|---|---|---|---|
| | | Conifer | Deciduous | Total | Conifer | Deciduous | Total |
| 0 | 0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.000 | 0.000 |
| 10 | 3 | 0.0 | 1.0 | 1.0 | 0.000 | 0.100 | 0.100 |
| 20 | 0 | 0.0 | 10.2 | 10.2 | 0.000 | 0.512 | 0.512 |
| 30 | 0 | 0.1 | 32.4 | 32.5 | 0.004 | 1.079 | 1.083 |
| 40 | 0 | 0.9 | 63.3 | 64.3 | 0.023 | 1.583 | 1.607 |
| 50 | 1 | 3.9 | 95.3 | 99.2 | 0.078 | 1.905 | 1.984 |
| 60 | 26 | 11.2 | 121.4 | 132.6 | 0.186 | 2.023 | 2.209 |
| 70 | 6 | 24.5 | 137.9 | 162.4 | 0.349 | 1.970 | 2.319 |
| 80 | 10 | 44.1 | 144.0 | 188.1 | 0.551 | 1.801 | 2.351 |
| 90 | 3 | 68.5 | 141.1 | 209.6 | 0.761 | 1.568 | 2.329 |
| 100 | 13 | 94.7 | 131.4 | 226.2 | 0.947 | 1.314 | 2.262 |
| 110 | 0 | 119.2 | 117.5 | 236.7 | 1.084 | 1.068 | 2.152 |
| 120 | 0 | 138.7 | 101.6 | 240.3 | 1.156 | 0.846 | 2.002 |
| 130 | 0 | 151.2 | 85.3 | 236.5 | 1.163 | 0.656 | 1.819 |
| 140 | 0 | 155.8 | 70.0 | 225.8 | 1.113 | 0.500 | 1.613 |
| 150 | 0 | 153.1 | 56.2 | 209.3 | 1.020 | 0.375 | 1.395 |
| 160 | 0 | 144.2 | 44.3 | 188.5 | 0.901 | 0.277 | 1.178 |
| 170 | 0 | 130.9 | 34.4 | 165.3 | 0.770 | 0.202 | 0.973 |
| 180 | 0 | 115.1 | 26.3 | 141.4 | 0.639 | 0.146 | 0.786 |
| 190 | 0 | 98.2 | 19.9 | 118.1 | 0.517 | 0.105 | 0.622 |
| 200 | 0 | 81.7 | 14.9 | 96.6 | 0.408 | 0.074 | 0.483 |

1 Gross volume is calculated at the utilization standards specified on this page with no deductions for cull.

2 Maximum MAI highlighted in light yellow.

## DC STRATUM / Base Natural Stand Yield Curve




**2-PARAMETER EQUATION (2P): volume = $a(age)^b e^{(-a*age)}$**

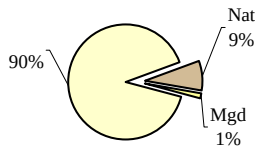
**2-PARAMETER EQUATION WITH CONSTANT (2P+k): volume = $a(age)^b e^{(-age/k)}$**

| Parameter Estimates: | | |
|---|---|---|
| Coniferous | a | 5.376E-19 |
| *Eqn: 2P+K* | b | 11.7745400 |
| | k | 13 |
| Deciduous | a | 3.811E-16 |
| *Eqn: 2P+K* | b | 10.5840653 |
| | k | 12 |

| Utilization Standards: | |
|---|---|
| Con. Top Diameter (cm): | 11.0 |
| Dec. Top Diameter (cm): | 10.0 |
| Con. Min. Log Length (m): | 2.66 |
| Dec. Min. Log Length (m): | 2.66 |
| Stump Diameter (cm): | 15.0 |
| Stump Height (cm): | 30.0 |

| Stratum Summary: | |
|---|---|
| Total Number of Plots: | 36 |
| Nat. Stand Area (ha): | 7,347 |
| Mgd. Stand Area (ha): | 1,231 |

**Stratum as a % of the managed landbase:**

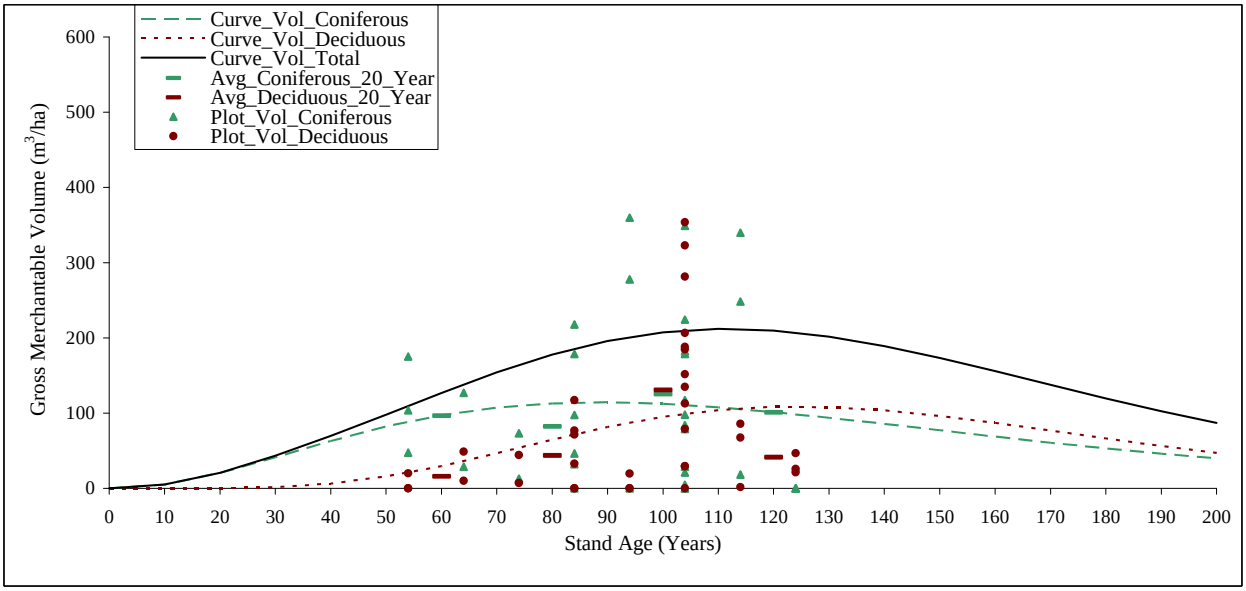



| Stand Age | Number of Plots | Predicted Gross Merchantable Volume[1] ($m^3$/ha) | | | Mean Annual Increment ($m^3$/ha/year)[2] | | |
|---|---|---|---|---|---|---|---|
| | | Conifer | Deciduous | Total | Conifer | Deciduous | Total |
| 0 | 0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.000 | 0.000 |
| 10 | 0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.000 | 0.000 |
| 20 | 0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.000 | 0.000 |
| 30 | 0 | 0.0 | 0.1 | 0.1 | 0.000 | 0.004 | 0.005 |
| 40 | 0 | 0.2 | 1.2 | 1.4 | 0.005 | 0.031 | 0.035 |
| 50 | 1 | 1.2 | 5.7 | 6.8 | 0.023 | 0.113 | 0.137 |
| 60 | 6 | 4.6 | 17.0 | 21.6 | 0.077 | 0.283 | 0.360 |
| 70 | 5 | 13.1 | 37.7 | 50.8 | 0.187 | 0.539 | 0.726 |
| 80 | 0 | 29.2 | 67.3 | 96.6 | 0.365 | 0.842 | 1.207 |
| 90 | 3 | 54.2 | 101.8 | 156.0 | 0.602 | 1.131 | 1.733 |
| 100 | 21 | 86.9 | 134.9 | 221.8 | 0.869 | 1.349 | 2.218 |
| 110 | 0 | 123.6 | 160.8 | 284.4 | 1.124 | 1.462 | 2.586 |
| 120 | 0 | 159.6 | 175.5 | 335.1 | 1.330 | 1.463 | 2.793 |
| 130 | 0 | 189.8 | 178.0 | 367.7 | 1.460 | 1.369 | 2.829 |
| 140 | 0 | 210.4 | 169.5 | 379.9 | 1.503 | 1.210 | 2.714 |
| 150 | 0 | 219.7 | 152.9 | 372.6 | 1.465 | 1.019 | 2.484 |
| 160 | 0 | 217.7 | 131.5 | 349.2 | 1.360 | 0.822 | 2.183 |
| 170 | 0 | 205.9 | 108.6 | 314.5 | 1.211 | 0.639 | 1.850 |
| 180 | 0 | 187.1 | 86.4 | 273.5 | 1.039 | 0.480 | 1.519 |
| 190 | 0 | 163.8 | 66.6 | 230.4 | 0.862 | 0.350 | 1.213 |
| 200 | 0 | 138.9 | 49.8 | 188.6 | 0.694 | 0.249 | 0.943 |

1 Gross volume is calculated at the utilization standards specified on this page with no deductions for cull.

2 Maximum MAI highlighted in light yellow.

## CD STRATUM / Base Natural Stand Yield Curve




**2-PARAMETER EQUATION (2P): volume = $a(age)^b e^{(-a*age)}$**

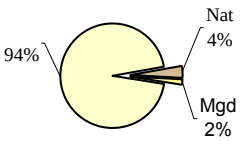
**2-PARAMETER EQUATION WITH CONSTANT (2P+k): volume = $a(age)^b e^{(-age/k)}$**

| Parameter Estimates: | | |
|---|---|---|
| Coniferous | a | 2.696E-02 |
| *Eqn: 2P* | b | 2.3955177 |
| | k | N/A |
| Deciduous | a | 5.694E-09 |
| *Eqn: 2P+K* | b | 6.1970860 |
| | k | 20 |

| Utilization Standards: | |
|---|---|
| Con. Top Diameter (cm): | 11.0 |
| Dec. Top Diameter (cm): | 10.0 |
| Con. Min. Log Length (m): | 2.66 |
| Dec. Min. Log Length (m): | 2.66 |
| Stump Diameter (cm): | 15.0 |
| Stump Height (cm): | 30.0 |

| Stratum Summary: | |
|---|---|
| Total Number of Plots: | 35 |
| Nat. Stand Area (ha): | 3,125 |
| Mgd. Stand Area (ha): | 1,469 |

**Stratum as a % of the managed landbase:**

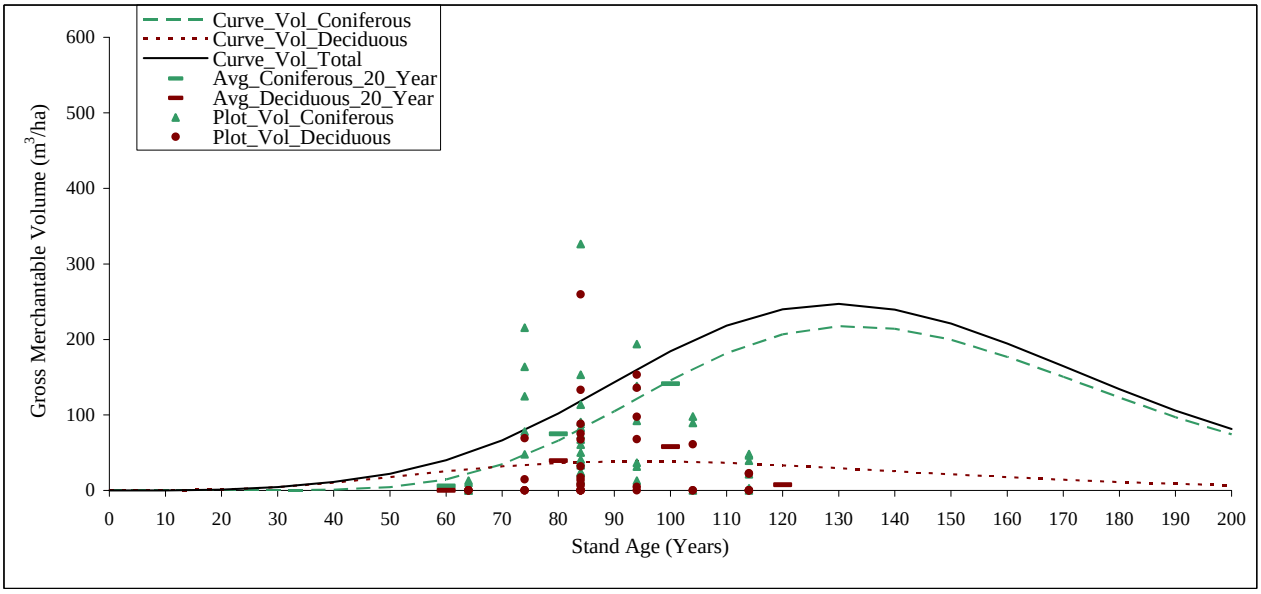



| Stand Age | Number of Plots | Predicted Gross Merchantable Volume[1] ($m^3$/ha) | | | Mean Annual Increment ($m^3$/ha/year)[2] | | |
|---|---|---|---|---|---|---|---|
| | | Conifer | Deciduous | Total | Conifer | Deciduous | Total |
| 0 | 0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.000 | 0.000 |
| 10 | 0 | 5.1 | 0.0 | 5.1 | 0.512 | 0.001 | 0.512 |
| 20 | 0 | 20.6 | 0.2 | 20.8 | 1.028 | 0.012 | 1.041 |
| 30 | 0 | 41.5 | 1.8 | 43.3 | 1.383 | 0.060 | 1.443 |
| 40 | 0 | 63.1 | 6.5 | 69.6 | 1.578 | 0.163 | 1.741 |
| 50 | 3 | 82.3 | 15.8 | 98.0 | 1.645 | 0.316 | 1.961 |
| 60 | 2 | 97.2 | 29.6 | 126.9 | 1.620 | 0.494 | 2.114 |
| 70 | 2 | 107.4 | 46.7 | 154.1 | 1.534 | 0.668 | 2.202 |
| 80 | 6 | 112.9 | 64.8 | 177.8 | 1.412 | 0.810 | 2.222 |
| 90 | 3 | 114.4 | 81.6 | 196.0 | 1.271 | 0.907 | 2.177 |
| 100 | 13 | 112.4 | 95.1 | 207.5 | 1.124 | 0.951 | 2.075 |
| 110 | 3 | 107.9 | 104.1 | 212.0 | 0.981 | 0.946 | 1.927 |
| 120 | 3 | 101.5 | 108.3 | 209.7 | 0.846 | 0.902 | 1.748 |
| 130 | 0 | 93.9 | 107.8 | 201.7 | 0.722 | 0.830 | 1.552 |
| 140 | 0 | 85.6 | 103.5 | 189.1 | 0.611 | 0.740 | 1.351 |
| 150 | 0 | 77.1 | 96.3 | 173.4 | 0.514 | 0.642 | 1.156 |
| 160 | 0 | 68.7 | 87.1 | 155.9 | 0.430 | 0.545 | 0.974 |
| 170 | 0 | 60.7 | 76.9 | 137.6 | 0.357 | 0.453 | 0.810 |
| 180 | 0 | 53.2 | 66.5 | 119.7 | 0.295 | 0.369 | 0.665 |
| 190 | 0 | 46.2 | 56.4 | 102.6 | 0.243 | 0.297 | 0.540 |
| 200 | 0 | 39.9 | 47.0 | 86.9 | 0.200 | 0.235 | 0.435 |

1 Gross volume is calculated at the utilization standards specified on this page with no deductions for cull.

2 Maximum MAI highlighted in light yellow.

## C_SB STRATUM / Base Natural Stand Yield Curve




**2-PARAMETER EQUATION (2P): volume = $a(age)^b e^{(-a*age)}$**

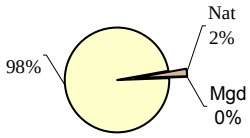
**2-PARAMETER EQUATION WITH CONSTANT (2P+k): volume = $a(age)^b e^{(-age/k)}$**

| Parameter Estimates: | | |
|---|---|---|
| Coniferous | a | 4.814E-17 |
| *Eqn: 2P+K* | b | 11.0502513 |
| | k | 12 |
| Deciduous | a | 2.061E-06 |
| *Eqn: 2P+K* | b | 4.7204530 |
| | k | 20 |

| Utilization Standards: | |
|---|---|
| Con. Top Diameter (cm): | 11.0 |
| Dec. Top Diameter (cm): | 10.0 |
| Con. Min. Log Length (m): | 2.66 |
| Dec. Min. Log Length (m): | 2.66 |
| Stump Diameter (cm): | 15.0 |
| Stump Height (cm): | 30.0 |

| Stratum Summary: | |
|---|---|
| Total Number of Plots: | 17 |
| Nat. Stand Area (ha): | 1,985 |
| Mgd. Stand Area (ha): | 0 |

**Stratum as a % of the managed landbase:**

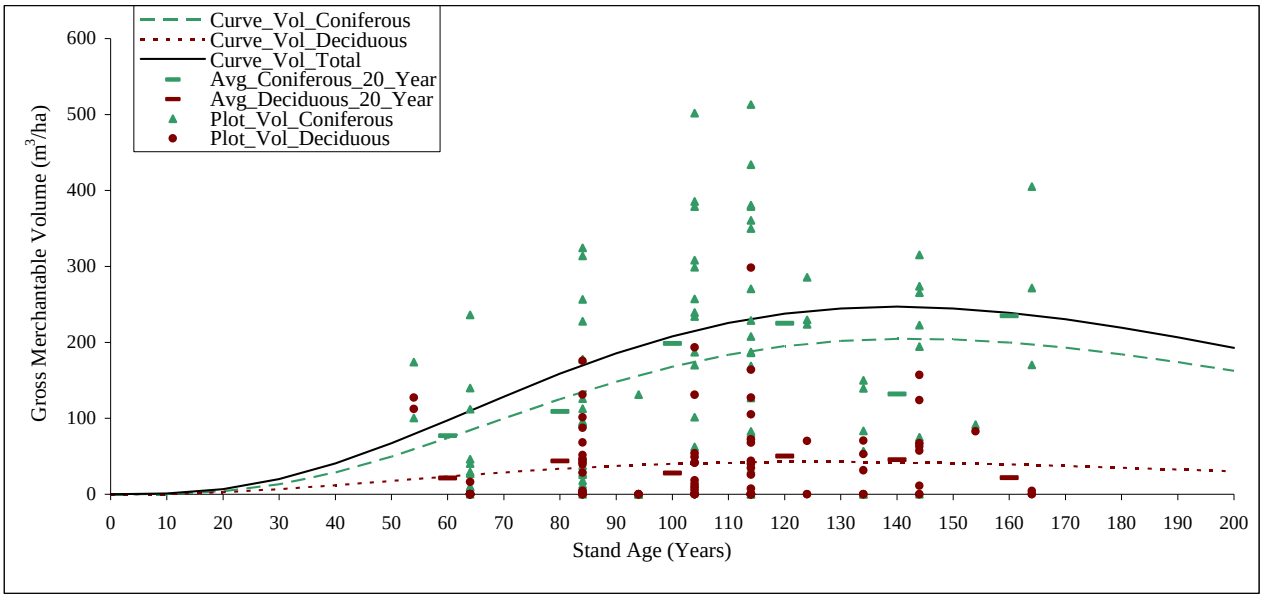



| Stand Age | Number of Plots | Predicted Gross Merchantable Volume[1] ($m^3$/ha) | | | Mean Annual Increment ($m^3$/ha/year)[2] | | |
|---|---|---|---|---|---|---|---|
| | | Conifer | Deciduous | Total | Conifer | Deciduous | Total |
| 0 | 0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.000 | 0.000 |
| 10 | 0 | 0.0 | 0.1 | 0.1 | 0.000 | 0.007 | 0.007 |
| 20 | 0 | 0.0 | 1.1 | 1.1 | 0.000 | 0.053 | 0.053 |
| 30 | 0 | 0.1 | 4.3 | 4.4 | 0.003 | 0.144 | 0.147 |
| 40 | 0 | 0.9 | 10.2 | 11.1 | 0.022 | 0.255 | 0.276 |
| 50 | 0 | 4.4 | 17.7 | 22.1 | 0.089 | 0.354 | 0.443 |
| 60 | 4 | 14.5 | 25.4 | 39.9 | 0.241 | 0.423 | 0.664 |
| 70 | 2 | 34.5 | 31.9 | 66.4 | 0.493 | 0.456 | 0.949 |
| 80 | 8 | 65.6 | 36.3 | 101.9 | 0.820 | 0.454 | 1.274 |
| 90 | 3 | 104.7 | 38.4 | 143.2 | 1.164 | 0.427 | 1.591 |
| 100 | 0 | 145.8 | 38.3 | 184.2 | 1.458 | 0.383 | 1.842 |
| 110 | 0 | 181.7 | 36.5 | 218.2 | 1.652 | 0.331 | 1.983 |
| 120 | 0 | 206.5 | 33.3 | 239.9 | 1.721 | 0.278 | 1.999 |
| 130 | 0 | 217.4 | 29.5 | 246.9 | 1.672 | 0.227 | 1.899 |
| 140 | 0 | 214.3 | 25.4 | 239.7 | 1.531 | 0.181 | 1.712 |
| 150 | 0 | 199.6 | 21.3 | 220.9 | 1.331 | 0.142 | 1.473 |
| 160 | 0 | 177.0 | 17.5 | 194.5 | 1.106 | 0.110 | 1.216 |
| 170 | 0 | 150.3 | 14.2 | 164.5 | 0.884 | 0.083 | 0.968 |
| 180 | 0 | 122.9 | 11.3 | 134.1 | 0.683 | 0.063 | 0.745 |
| 190 | 0 | 97.0 | 8.8 | 105.9 | 0.511 | 0.046 | 0.557 |
| 200 | 0 | 74.3 | 6.8 | 81.1 | 0.372 | 0.034 | 0.406 |

1 Gross volume is calculated at the utilization standards specified on this page with no deductions for cull.

2 Maximum MAI highlighted in light yellow.

## C_SW STRATUM / Base Natural Stand Yield Curve




**3-PARAMETER EQUATION (3P): volume = $a(age)^b e^{(-c*age)}$**

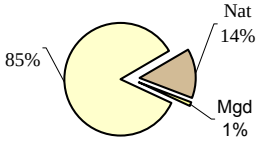
**2-PARAMETER EQUATION WITH CONSTANT (2P+k): volume = $a(age)^b e^{(-age/k)}$**

| Parameter Estimates: | | |
|---|---|---|
| Coniferous | a | 1.542E-04 |
| *Eqn: 2P+K* | b | 3.5613448 |
| | k | 40 |
| Deciduous | a | 1.012E-03 |
| *Eqn: 3P* | b | 2.7797789 |
| | c | 0.033002 |

| Utilization Standards: | |
|---|---|
| Con. Top Diameter (cm): | 11.0 |
| Dec. Top Diameter (cm): | 10.0 |
| Con. Min. Log Length (m): | 2.66 |
| Dec. Min. Log Length (m): | 2.66 |
| Stump Diameter (cm): | 15.0 |
| Stump Height (cm): | 30.0 |

| Stratum Summary: | |
|---|---|
| Total Number of Plots: | 90 |
| Nat. Stand Area (ha): | 12,349 |
| Mgd. Stand Area (ha): | 1,141 |

**Stratum as a % of the managed landbase:**

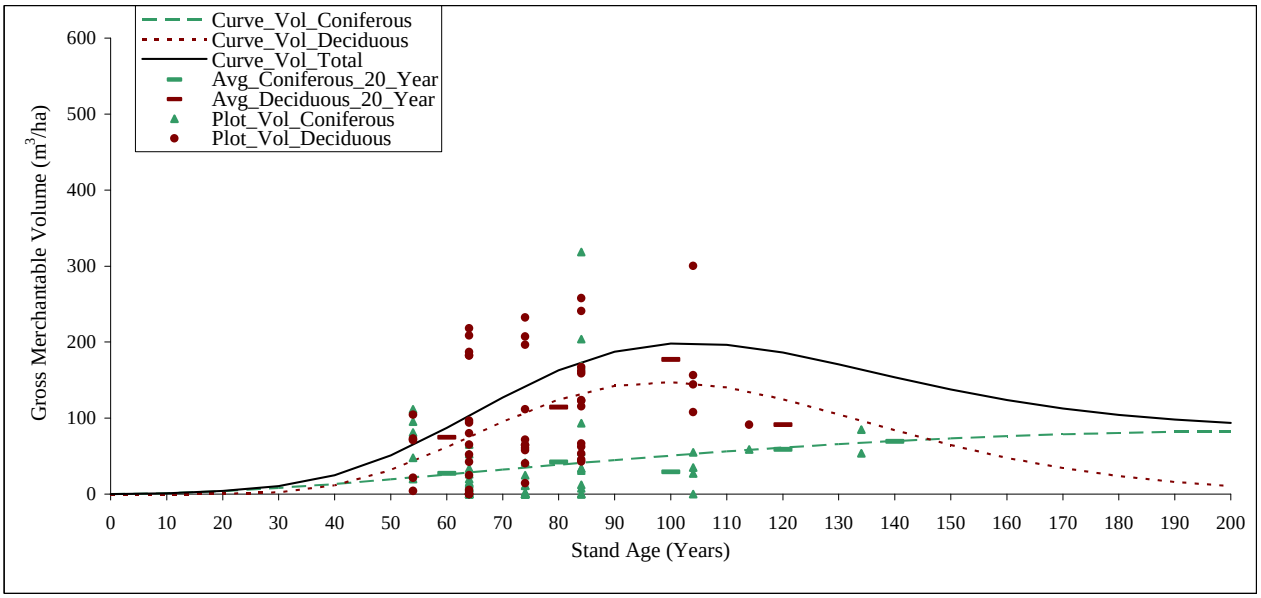



| Stand Age | Number of Plots | Predicted Gross Merchantable Volume[1] ($m^3$/ha) | | | Mean Annual Increment ($m^3$/ha/year)[2] | | |
|---|---|---|---|---|---|---|---|
| | | Conifer | Deciduous | Total | Conifer | Deciduous | Total |
| 0 | 0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.000 | 0.000 |
| 10 | 0 | 0.4 | 0.5 | 0.9 | 0.044 | 0.049 | 0.093 |
| 20 | 0 | 4.0 | 2.7 | 6.7 | 0.201 | 0.134 | 0.336 |
| 30 | 0 | 13.3 | 6.7 | 19.9 | 0.442 | 0.222 | 0.664 |
| 40 | 0 | 28.8 | 11.9 | 40.7 | 0.720 | 0.297 | 1.016 |
| 50 | 2 | 49.6 | 17.7 | 67.3 | 0.993 | 0.353 | 1.346 |
| 60 | 10 | 74.0 | 23.5 | 97.5 | 1.234 | 0.392 | 1.625 |
| 70 | 0 | 99.8 | 28.9 | 128.7 | 1.426 | 0.413 | 1.839 |
| 80 | 19 | 125.1 | 33.6 | 158.7 | 1.563 | 0.420 | 1.983 |
| 90 | 5 | 148.2 | 37.4 | 185.5 | 1.646 | 0.415 | 2.061 |
| 100 | 15 | 167.9 | 40.1 | 208.0 | 1.679 | 0.401 | 2.080 |
| 110 | 18 | 183.6 | 41.9 | 225.5 | 1.669 | 0.381 | 2.050 |
| 120 | 3 | 195.0 | 42.8 | 237.7 | 1.625 | 0.356 | 1.981 |
| 130 | 6 | 201.9 | 42.8 | 244.7 | 1.553 | 0.329 | 1.883 |
| 140 | 8 | 204.8 | 42.2 | 246.9 | 1.463 | 0.301 | 1.764 |
| 150 | 1 | 203.9 | 40.9 | 244.8 | 1.359 | 0.273 | 1.632 |
| 160 | 3 | 199.8 | 39.2 | 239.1 | 1.249 | 0.245 | 1.494 |
| 170 | 0 | 193.1 | 37.2 | 230.3 | 1.136 | 0.219 | 1.355 |
| 180 | 0 | 184.3 | 35.0 | 219.3 | 1.024 | 0.194 | 1.218 |
| 190 | 0 | 174.1 | 32.6 | 206.6 | 0.916 | 0.171 | 1.088 |
| 200 | 0 | 162.7 | 30.1 | 192.8 | 0.814 | 0.151 | 0.964 |

1 Gross volume is calculated at the utilization standards specified on this page with no deductions for cull.

2 Maximum MAI highlighted in light yellow.

## DU STRATUM / Base Natural Stand Yield Curve




**2-PARAMETER EQUATION (2P): volume = $a(age)^b e^{(-a*age)}$**

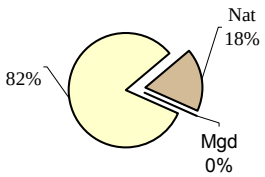
**2-PARAMETER EQUATION WITH CONSTANT (2P+k): volume = $a(age)^b e^{(-age/k)}$**

| Parameter Estimates: | | |
|---|---|---|
| Coniferous | a | 9.416E-03 |
| *Eqn: 2P* | b | 2.0698038 |
| | k | N/A |
| Deciduous | a | 2.068E-11 |
| *Eqn: 2P+K* | b | 8.2359226 |
| | k | 12 |

| Utilization Standards: | |
|---|---|
| Con. Top Diameter (cm): | 11.0 |
| Dec. Top Diameter (cm): | 10.0 |
| Con. Min. Log Length (m): | 2.66 |
| Dec. Min. Log Length (m): | 2.66 |
| Stump Diameter (cm): | 15.0 |
| Stump Height (cm): | 30.0 |

| Stratum Summary: | |
|---|---|
| Total Number of Plots[3]: | 55 |
| Nat. Stand Area (ha): | 15,720 |
| Mgd. Stand Area (ha): | 0 |

**Stratum as a % of the managed landbase:**




| Stand Age | Number of Plots | Predicted Gross Merchantable Volume[1] ($m^3$/ha) | | | Mean Annual Increment ($m^3$/ha/year)[2] | | |
|---|---|---|---|---|---|---|---|
| | | Conifer | Deciduous | Total | Conifer | Deciduous | Total |
| 0 | 0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.000 | 0.000 |
| 10 | 0 | 1.0 | 0.0 | 1.0 | 0.101 | 0.000 | 0.101 |
| 20 | 0 | 3.8 | 0.2 | 4.0 | 0.192 | 0.010 | 0.202 |
| 30 | 0 | 8.1 | 2.5 | 10.6 | 0.270 | 0.083 | 0.353 |
| 40 | 0 | 13.4 | 11.5 | 24.9 | 0.334 | 0.289 | 0.623 |
| 50 | 5 | 19.3 | 31.5 | 50.8 | 0.386 | 0.631 | 1.017 |
| 60 | 18 | 25.6 | 61.5 | 87.1 | 0.427 | 1.025 | 1.452 |
| 70 | 12 | 32.1 | 95.1 | 127.2 | 0.459 | 1.359 | 1.818 |
| 80 | 13 | 38.5 | 124.2 | 162.7 | 0.482 | 1.552 | 2.034 |
| 90 | 0 | 44.7 | 142.4 | 187.1 | 0.497 | 1.582 | 2.079 |
| 100 | 4 | 50.6 | 147.4 | 198.0 | 0.506 | 1.474 | 1.980 |
| 110 | 1 | 56.1 | 140.4 | 196.5 | 0.510 | 1.276 | 1.787 |
| 120 | 0 | 61.2 | 124.9 | 186.1 | 0.510 | 1.041 | 1.551 |
| 130 | 2 | 65.7 | 105.0 | 170.7 | 0.506 | 0.807 | 1.313 |
| 140 | 0 | 69.7 | 84.0 | 153.7 | 0.498 | 0.600 | 1.098 |
| 150 | 0 | 73.2 | 64.4 | 137.6 | 0.488 | 0.430 | 0.918 |
| 160 | 0 | 76.1 | 47.6 | 123.8 | 0.476 | 0.298 | 0.774 |
| 170 | 0 | 78.6 | 34.1 | 112.7 | 0.462 | 0.201 | 0.663 |
| 180 | 0 | 80.5 | 23.7 | 104.2 | 0.447 | 0.132 | 0.579 |
| 190 | 0 | 81.9 | 16.1 | 98.0 | 0.431 | 0.085 | 0.516 |
| 200 | 0 | 82.9 | 10.7 | 93.6 | 0.415 | 0.053 | 0.468 |

1 Gross volume is calculated at the utilization standards specified on this page with no deductions for cull.

2 Maximum MAI highlighted in light yellow.

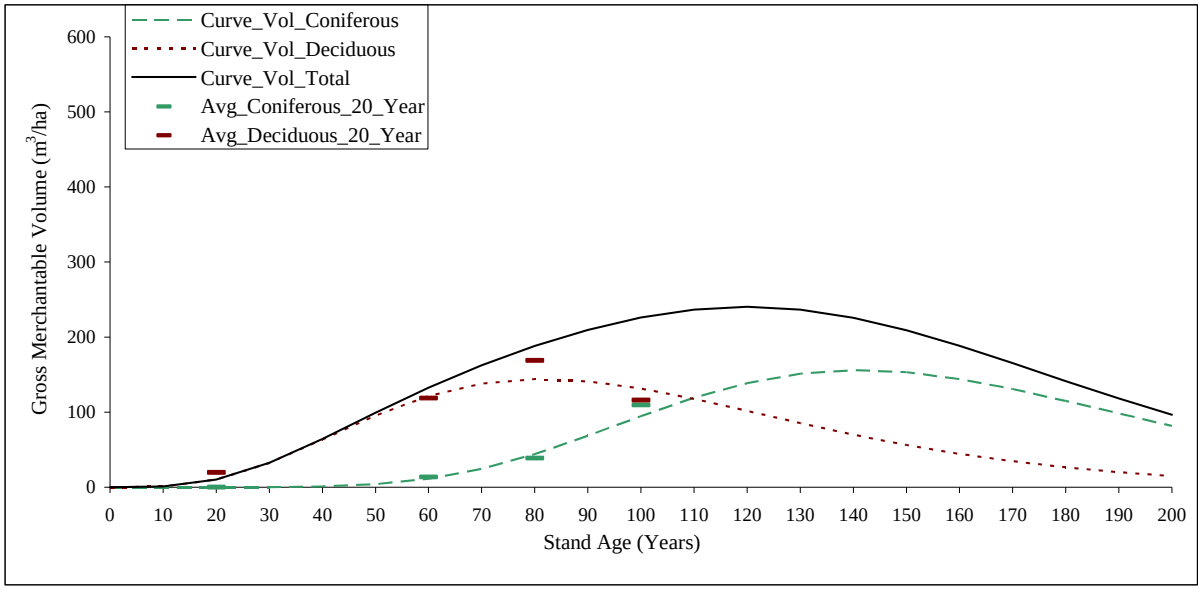
3 For the deciduous curves 3 plots were removed.

# Appendix II Composite Yield Curves

The base composite yield curves representing gross merchantable volume by broad cover group in this appendix are:

- Pure deciduous (D);
- Deciduous leading mixedwood (DC, DU);
- Coniferous leading mixedwood (CD);
- Pure coniferous (C-SW, C-SB);
- Conifer landbase (DC, CD, C-SW, C-SB, DU); and
- Managed landbase (D, DC, CD, DU, C-SW, C-SB).

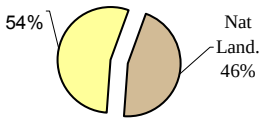
## Base Composite Yield Curves for Managed Landbase/D Broad Cover Group




| Utilization Standards: | |
|---|---|
| Con. Top Diameter (cm): | 11.0 |
| Dec. Top Diameter (cm): | 10.0 |
| Con. Min. Log Length (m): | 2.66 |
| Dec. Min. Log Length (m): | 2.66 |
| Stump Diameter (cm): | 15.0 |
| Stump Height (cm): | 30.0 |

| Stratum Summary: | |
|---|---|
| Nat Landbase Area (ha): | 39,982 |
| Mgd. Stand Area (ha): | n/a |

**Stratum as a % of the managed landbase:**

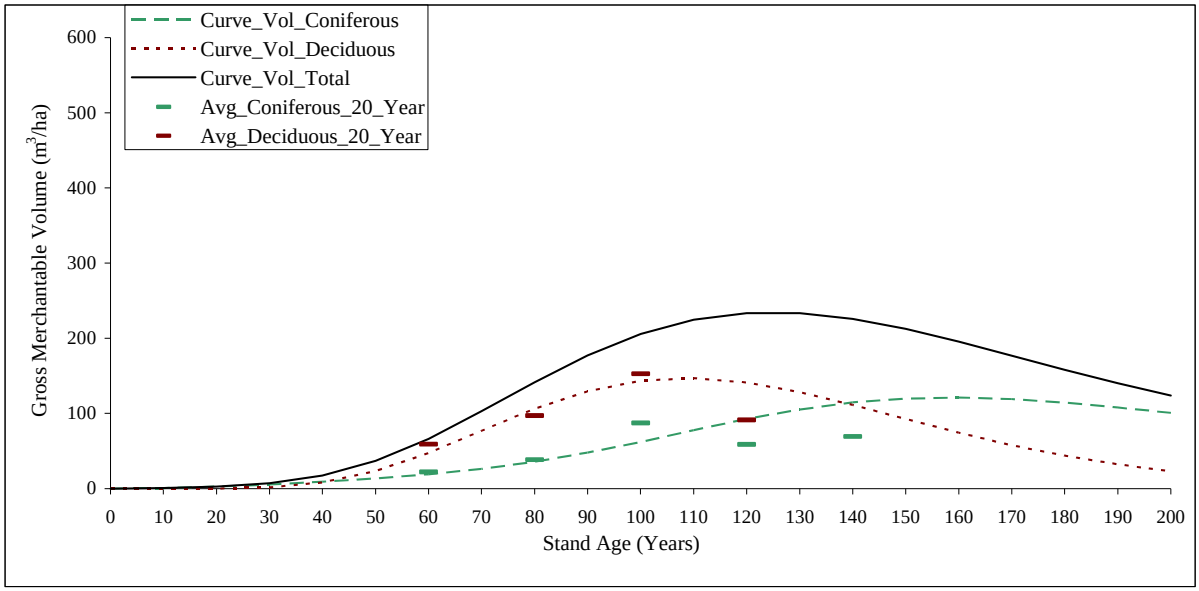



| Stand Age | Predicted Gross Merchantable Volume[1] ($m^3$/ha) | | | Mean Annual Increment ($m^3$/ha/year)[2] | | |
|---|---|---|---|---|---|---|
| | Conifer | Deciduous | Total | Conifer | Deciduous | Total |
| 0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.000 | 0.000 |
| 10 | 0.0 | 1.0 | 1.0 | 0.000 | 0.100 | 0.100 |
| 20 | 0.0 | 10.2 | 10.2 | 0.000 | 0.512 | 0.512 |
| 30 | 0.1 | 32.4 | 32.5 | 0.004 | 1.079 | 1.083 |
| 40 | 0.9 | 63.3 | 64.3 | 0.023 | 1.583 | 1.607 |
| 50 | 3.9 | 95.3 | 99.2 | 0.078 | 1.905 | 1.984 |
| 60 | 11.2 | 121.4 | 132.6 | 0.186 | 2.023 | 2.209 |
| 70 | 24.5 | 137.9 | 162.4 | 0.349 | 1.970 | 2.319 |
| 80 | 44.1 | 144.0 | 188.1 | 0.551 | 1.801 | 2.351 |
| 90 | 68.5 | 141.1 | 209.6 | 0.761 | 1.568 | 2.329 |
| 100 | 94.7 | 131.4 | 226.2 | 0.947 | 1.314 | 2.262 |
| 110 | 119.2 | 117.5 | 236.7 | 1.084 | 1.068 | 2.152 |
| 120 | 138.7 | 101.6 | 240.3 | 1.156 | 0.846 | 2.002 |
| 130 | 151.2 | 85.3 | 236.5 | 1.163 | 0.656 | 1.819 |
| 140 | 155.8 | 70.0 | 225.8 | 1.113 | 0.500 | 1.613 |
| 150 | 153.1 | 56.2 | 209.3 | 1.020 | 0.375 | 1.395 |
| 160 | 144.2 | 44.3 | 188.5 | 0.901 | 0.277 | 1.178 |
| 170 | 130.9 | 34.4 | 165.3 | 0.770 | 0.202 | 0.973 |
| 180 | 115.1 | 26.3 | 141.4 | 0.639 | 0.146 | 0.786 |
| 190 | 98.2 | 19.9 | 118.1 | 0.517 | 0.105 | 0.622 |
| 200 | 81.7 | 14.9 | 96.6 | 0.408 | 0.074 | 0.483 |

1 Gross volume is calculated at the utilization standards specified on this page with no deductions for cull.

2 Maximum MAI highlighted in light yellow.

## Base Composite Yield Curves for Managed Landbase, DC Broad Cover Group




| Utilization Standards: | |
|---|---|
| Con. Top Diameter (cm): | 11.0 |
| Dec. Top Diameter (cm): | 10.0 |
| Con. Min. Log Length (m): | 2.66 |
| Dec. Min. Log Length (m): | 2.66 |
| Stump Diameter (cm): | 15.0 |
| Stump Height (cm): | 30.0 |

| Stratum Summary: | |
|---|---|
| Nat Landbase Area (ha): | 23,067 |
| Mgd. Stand Area (ha): | n/a |

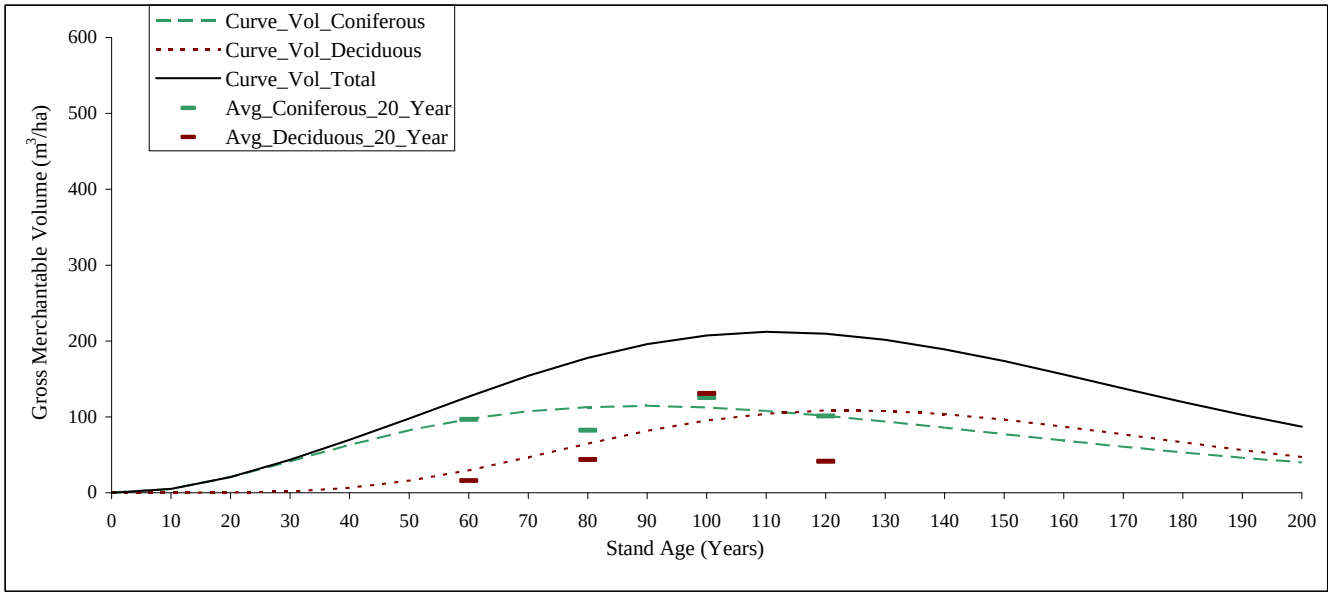
**Stratum as a % of the managed landbase:**


| Stand Age | Predicted Gross Merchantable Volume[1] ($m^3$/ha) | | | Mean Annual Increment ($m^3$/ha/year)[2] | | |
|---|---|---|---|---|---|---|
| | Conifer | Deciduous | Total | Conifer | Deciduous | Total |
| 0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.000 | 0.000 |
| 10 | 0.7 | 0.0 | 0.7 | 0.069 | 0.000 | 0.069 |
| 20 | 2.6 | 0.1 | 2.8 | 0.131 | 0.007 | 0.138 |
| 30 | 5.5 | 1.7 | 7.3 | 0.184 | 0.058 | 0.242 |
| 40 | 9.2 | 8.3 | 17.4 | 0.229 | 0.207 | 0.436 |
| 50 | 13.5 | 23.3 | 36.8 | 0.271 | 0.466 | 0.736 |
| 60 | 18.9 | 47.3 | 66.3 | 0.316 | 0.789 | 1.104 |
| 70 | 26.1 | 76.8 | 102.9 | 0.372 | 1.098 | 1.470 |
| 80 | 35.6 | 106.1 | 141.6 | 0.445 | 1.326 | 1.770 |
| 90 | 47.8 | 129.4 | 177.2 | 0.531 | 1.438 | 1.969 |
| 100 | 62.2 | 143.4 | 205.6 | 0.622 | 1.434 | 2.056 |
| 110 | 77.6 | 146.9 | 224.5 | 0.706 | 1.335 | 2.041 |
| 120 | 92.5 | 141.0 | 233.6 | 0.771 | 1.175 | 1.946 |
| 130 | 105.2 | 128.2 | 233.5 | 0.809 | 0.986 | 1.796 |
| 140 | 114.5 | 111.2 | 225.8 | 0.818 | 0.794 | 1.613 |
| 150 | 119.9 | 92.6 | 212.5 | 0.799 | 0.617 | 1.416 |
| 160 | 121.2 | 74.4 | 195.6 | 0.758 | 0.465 | 1.222 |
| 170 | 119.1 | 57.8 | 177.0 | 0.701 | 0.340 | 1.041 |
| 180 | 114.4 | 43.7 | 158.1 | 0.636 | 0.243 | 0.879 |
| 190 | 108.0 | 32.2 | 140.2 | 0.569 | 0.169 | 0.738 |
| 200 | 100.7 | 23.1 | 123.9 | 0.504 | 0.116 | 0.619 |

1 Gross volume is calculated at the utilization standards specified on this page with no deductions for cull.

2 Maximum MAI highlighted in light yellow.

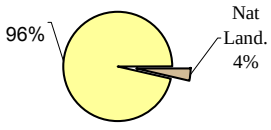
## Base Composite Yield Curves for Managed Landbase, CD Broad Cover Group




| Utilization Standards: | |
|---|---|
| Con. Top Diameter (cm): | 11.0 |
| Dec. Top Diameter (cm): | 10.0 |
| Con. Min. Log Length (m): | 2.66 |
| Dec. Min. Log Length (m): | 2.66 |
| Stump Diameter (cm): | 15.0 |
| Stump Height (cm): | 30.0 |

| Stratum Summary: | |
|---|---|
| Nat Landbase Area (ha): | 3,125 |
| Mgd. Stand Area (ha): | n/a |

**Stratum as a % of the managed landbase:**

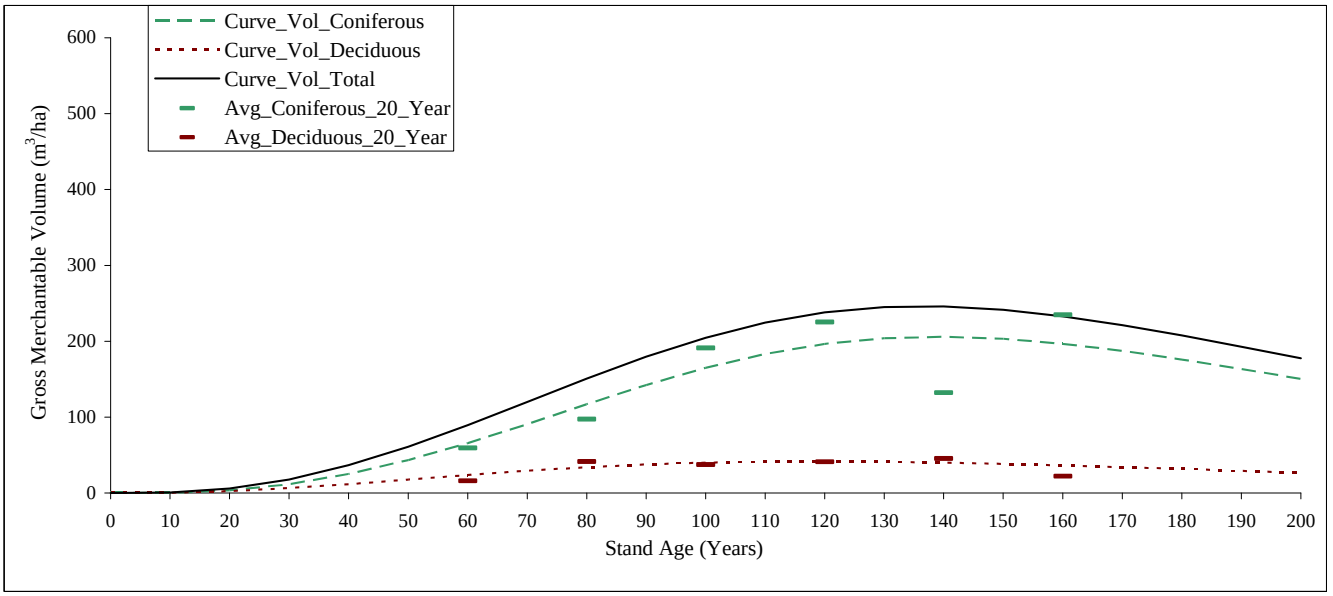



| Stand Age | Predicted Gross Merchantable Volume[1] ($m^3$/ha) | | | Mean Annual Increment ($m^3$/ha/year)[2] | | |
|---|---|---|---|---|---|---|
| | Conifer | Deciduous | Total | Conifer | Deciduous | Total |
| 0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.000 | 0.000 |
| 10 | 5.1 | 0.0 | 5.1 | 0.512 | 0.001 | 0.512 |
| 20 | 20.6 | 0.2 | 20.8 | 1.028 | 0.012 | 1.041 |
| 30 | 41.5 | 1.8 | 43.3 | 1.383 | 0.060 | 1.443 |
| 40 | 63.1 | 6.5 | 69.6 | 1.578 | 0.163 | 1.741 |
| 50 | 82.3 | 15.8 | 98.0 | 1.645 | 0.316 | 1.961 |
| 60 | 97.2 | 29.6 | 126.9 | 1.620 | 0.494 | 2.114 |
| 70 | 107.4 | 46.7 | 154.1 | 1.534 | 0.668 | 2.202 |
| 80 | 112.9 | 64.8 | 177.8 | 1.412 | 0.810 | 2.222 |
| 90 | 114.4 | 81.6 | 196.0 | 1.271 | 0.907 | 2.177 |
| 100 | 112.4 | 95.1 | 207.5 | 1.124 | 0.951 | 2.075 |
| 110 | 107.9 | 104.1 | 212.0 | 0.981 | 0.946 | 1.927 |
| 120 | 101.5 | 108.3 | 209.7 | 0.846 | 0.902 | 1.748 |
| 130 | 93.9 | 107.8 | 201.7 | 0.722 | 0.830 | 1.552 |
| 140 | 85.6 | 103.5 | 189.1 | 0.611 | 0.740 | 1.351 |
| 150 | 77.1 | 96.3 | 173.4 | 0.514 | 0.642 | 1.156 |
| 160 | 68.7 | 87.1 | 155.9 | 0.430 | 0.545 | 0.974 |
| 170 | 60.7 | 76.9 | 137.6 | 0.357 | 0.453 | 0.810 |
| 180 | 53.2 | 66.5 | 119.7 | 0.295 | 0.369 | 0.665 |
| 190 | 46.2 | 56.4 | 102.6 | 0.243 | 0.297 | 0.540 |
| 200 | 39.9 | 47.0 | 86.9 | 0.200 | 0.235 | 0.435 |

1 Gross volume is calculated at the utilization standards specified on this page with no deductions for cull.

2 Maximum MAI highlighted in light yellow.

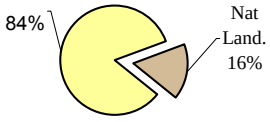
## Base Composite Yield Curve for Managed Landbase, C Broad Cover Group




| Utilization Standards: | |
|---|---|
| Con. Top Diameter (cm): | 11.0 |
| Dec. Top Diameter (cm): | 10.0 |
| Con. Min. Log Length (m): | 2.66 |
| Dec. Min. Log Length (m): | 2.66 |
| Stump Diameter (cm): | 15.0 |
| Stump Height (cm): | 30.0 |

| Stratum Summary: | |
|---|---|
| Nat Landbase Area (ha): | 14,334 |
| Mgd. Stand Area (ha): | n/a |

**Stratum as a % of the managed landbase:**

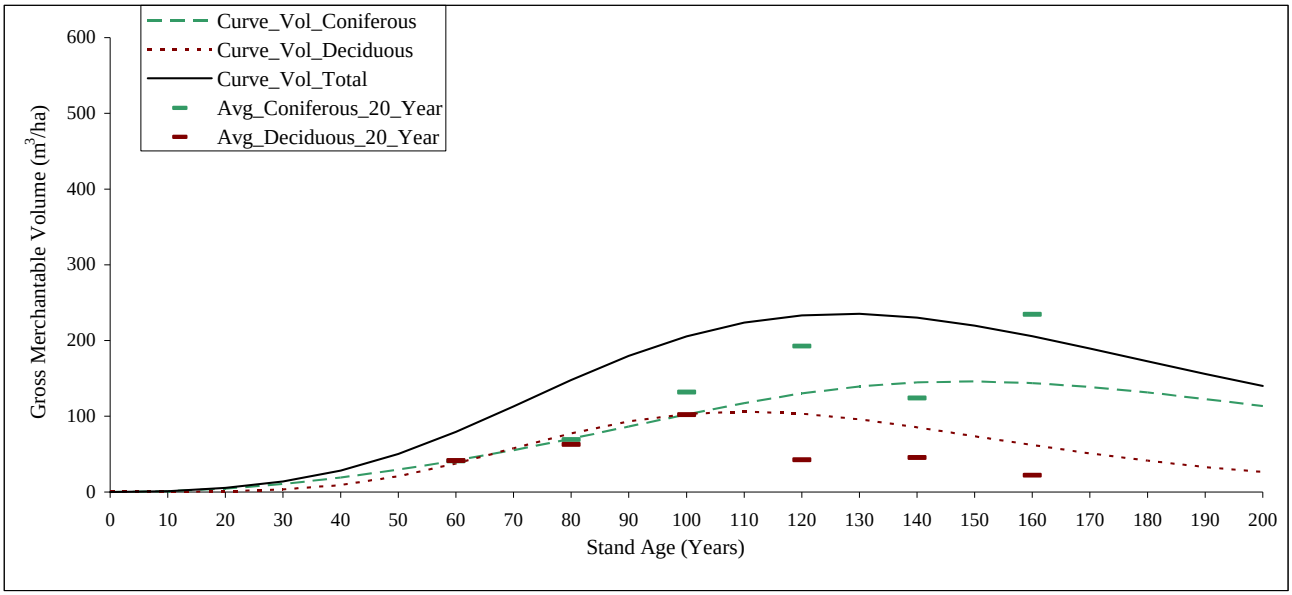



| Stand Age | Predicted Gross Merchantable Volume[1] ($m^3$/ha) | | | Mean Annual Increment ($m^3$/ha/year)[2] | | |
|---|---|---|---|---|---|---|
| | Conifer | Deciduous | Total | Conifer | Deciduous | Total |
| 0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.000 | 0.000 |
| 10 | 0.4 | 0.4 | 0.8 | 0.038 | 0.043 | 0.081 |
| 20 | 3.5 | 2.5 | 5.9 | 0.173 | 0.123 | 0.296 |
| 30 | 11.4 | 6.3 | 17.8 | 0.382 | 0.211 | 0.593 |
| 40 | 24.9 | 11.6 | 36.6 | 0.623 | 0.291 | 0.914 |
| 50 | 43.4 | 17.7 | 61.1 | 0.868 | 0.354 | 1.221 |
| 60 | 65.8 | 23.8 | 89.5 | 1.096 | 0.396 | 1.492 |
| 70 | 90.8 | 29.3 | 120.1 | 1.297 | 0.419 | 1.716 |
| 80 | 116.8 | 34.0 | 150.8 | 1.460 | 0.425 | 1.885 |
| 90 | 142.1 | 37.5 | 179.6 | 1.579 | 0.417 | 1.996 |
| 100 | 164.9 | 39.9 | 204.7 | 1.649 | 0.399 | 2.047 |
| 110 | 183.4 | 41.1 | 224.5 | 1.667 | 0.374 | 2.041 |
| 120 | 196.6 | 41.5 | 238.0 | 1.638 | 0.346 | 1.984 |
| 130 | 204.1 | 41.0 | 245.0 | 1.570 | 0.315 | 1.885 |
| 140 | 206.1 | 39.8 | 245.9 | 1.472 | 0.285 | 1.757 |
| 150 | 203.3 | 38.2 | 241.5 | 1.355 | 0.255 | 1.610 |
| 160 | 196.7 | 36.2 | 232.9 | 1.229 | 0.227 | 1.456 |
| 170 | 187.2 | 34.0 | 221.2 | 1.101 | 0.200 | 1.301 |
| 180 | 175.8 | 31.7 | 207.5 | 0.977 | 0.176 | 1.153 |
| 190 | 163.4 | 29.3 | 192.7 | 0.860 | 0.154 | 1.014 |
| 200 | 150.5 | 26.9 | 177.4 | 0.752 | 0.134 | 0.887 |

1 Gross volume is calculated at the utilization standards specified on this page with no deductions for cull.

2 Maximum MAI highlighted in light yellow.

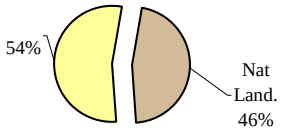
## Base Composite Yield Curves for Mgd. Landbase, C/CD/DC Broad Cover Groups




| Utilization Standards: | |
|---|---|
| Con. Top Diameter (cm): | 11.0 |
| Dec. Top Diameter (cm): | 10.0 |
| Con. Min. Log Length (m): | 2.66 |
| Dec. Min. Log Length (m): | 2.66 |
| Stump Diameter (cm): | 15.0 |
| Stump Height (cm): | 30.0 |

| Stratum Summary: | |
|---|---|
| Nat Landbase Area (ha): | 40,526 |
| Mgd. Stand Area (ha): | n/a |

**Stratum as a % of the managed landbase:**

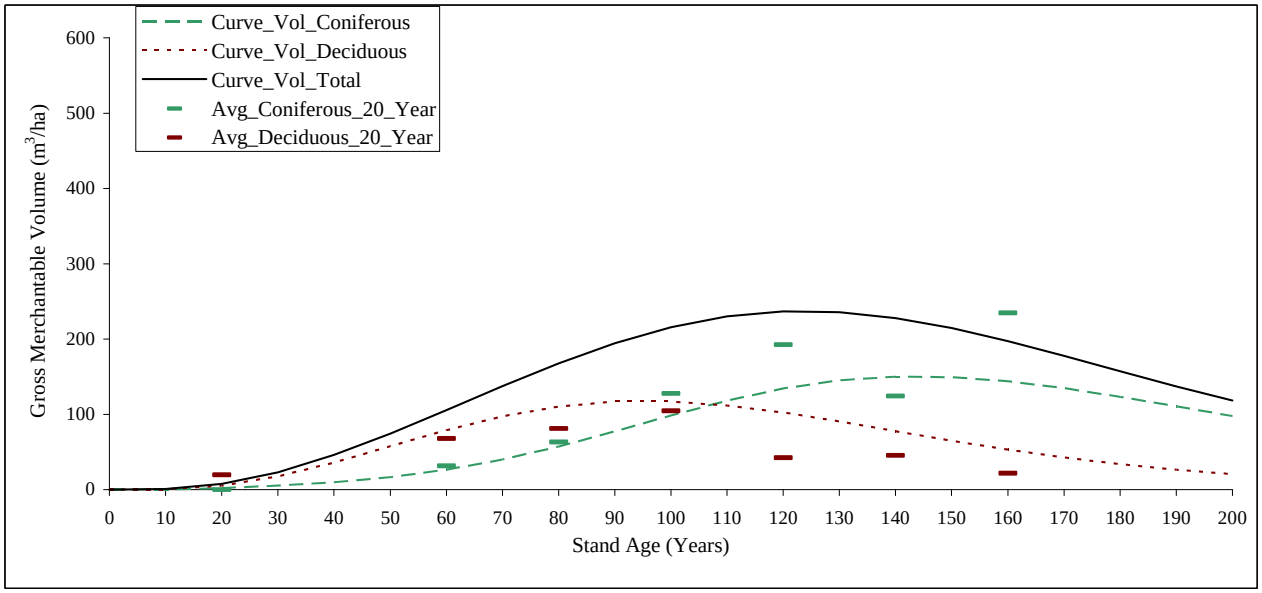



| Stand Age | Predicted Gross Merchantable Volume[1] ($m^3$/ha) | | | Mean Annual Increment ($m^3$/ha/year)[2] | | |
|---|---|---|---|---|---|---|
| | Conifer | Deciduous | Total | Conifer | Deciduous | Total |
| 0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.000 | 0.000 |
| 10 | 0.9 | 0.2 | 1.1 | 0.092 | 0.015 | 0.107 |
| 20 | 4.3 | 1.0 | 5.3 | 0.215 | 0.048 | 0.264 |
| 30 | 10.4 | 3.4 | 13.8 | 0.346 | 0.112 | 0.459 |
| 40 | 18.9 | 9.3 | 28.2 | 0.473 | 0.233 | 0.706 |
| 50 | 29.4 | 20.7 | 50.1 | 0.588 | 0.415 | 1.002 |
| 60 | 41.5 | 37.6 | 79.2 | 0.692 | 0.627 | 1.319 |
| 70 | 55.2 | 57.7 | 112.9 | 0.789 | 0.825 | 1.613 |
| 80 | 70.3 | 77.4 | 147.7 | 0.878 | 0.967 | 1.846 |
| 90 | 86.3 | 93.2 | 179.5 | 0.959 | 1.036 | 1.995 |
| 100 | 102.4 | 103.1 | 205.4 | 1.024 | 1.031 | 2.054 |
| 110 | 117.4 | 106.2 | 223.6 | 1.067 | 0.965 | 2.032 |
| 120 | 130.0 | 103.3 | 233.3 | 1.083 | 0.861 | 1.944 |
| 130 | 139.3 | 95.8 | 235.1 | 1.072 | 0.737 | 1.808 |
| 140 | 144.7 | 85.4 | 230.1 | 1.033 | 0.610 | 1.643 |
| 150 | 146.1 | 73.6 | 219.7 | 0.974 | 0.491 | 1.465 |
| 160 | 143.9 | 61.9 | 205.7 | 0.899 | 0.387 | 1.286 |
| 170 | 138.7 | 50.9 | 189.6 | 0.816 | 0.299 | 1.115 |
| 180 | 131.4 | 41.2 | 172.6 | 0.730 | 0.229 | 0.959 |
| 190 | 122.8 | 33.0 | 155.9 | 0.647 | 0.174 | 0.820 |
| 200 | 113.6 | 26.3 | 139.9 | 0.568 | 0.131 | 0.700 |

1 Gross volume is calculated at the utilization standards specified on this page with no deductions for cull.

2 Maximum MAI highlighted in light yellow.

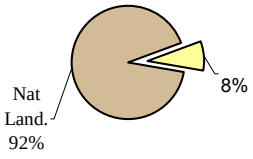
## Base Composite Yield Curves for Mgd. Landbase, C/CD/DC/D Broad Cover Groups




| Utilization Standards: | |
|---|---|
| Con. Top Diameter (cm): | 11.0 |
| Dec. Top Diameter (cm): | 10.0 |
| Con. Min. Log Length (m): | 2.66 |
| Dec. Min. Log Length (m): | 2.66 |
| Stump Diameter (cm): | 15.0 |
| Stump Height (cm): | 30.0 |

| Stratum Summary: | |
|---|---|
| Nat Landbase Area (ha): | 80,507 |
| Mgd. Stand Area (ha): | n/a |

**Stratum as a % of the managed landbase:**




| Stand Age | Predicted Gross Merchantable Volume[1] ($m^3$/ha) | | | Mean Annual Increment ($m^3$/ha/year)[2] | | |
|---|---|---|---|---|---|---|
| | Conifer | Deciduous | Total | Conifer | Deciduous | Total |
| 0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.000 | 0.000 |
| 10 | 0.5 | 0.6 | 1.0 | 0.046 | 0.058 | 0.104 |
| 20 | 2.2 | 5.6 | 7.7 | 0.108 | 0.279 | 0.387 |
| 30 | 5.3 | 17.8 | 23.1 | 0.176 | 0.592 | 0.769 |
| 40 | 10.0 | 36.1 | 46.1 | 0.250 | 0.904 | 1.153 |
| 50 | 16.7 | 57.7 | 74.5 | 0.335 | 1.155 | 1.490 |
| 60 | 26.5 | 79.2 | 105.7 | 0.441 | 1.320 | 1.761 |
| 70 | 39.9 | 97.5 | 137.5 | 0.571 | 1.393 | 1.964 |
| 80 | 57.3 | 110.5 | 167.8 | 0.716 | 1.381 | 2.097 |
| 90 | 77.5 | 117.0 | 194.5 | 0.861 | 1.300 | 2.161 |
| 100 | 98.6 | 117.1 | 215.7 | 0.986 | 1.171 | 2.157 |
| 110 | 118.3 | 111.8 | 230.1 | 1.075 | 1.016 | 2.092 |
| 120 | 134.3 | 102.4 | 236.8 | 1.119 | 0.854 | 1.973 |
| 130 | 145.2 | 90.6 | 235.8 | 1.117 | 0.697 | 1.814 |
| 140 | 150.2 | 77.7 | 228.0 | 1.073 | 0.555 | 1.628 |
| 150 | 149.6 | 65.0 | 214.5 | 0.997 | 0.433 | 1.430 |
| 160 | 144.0 | 53.2 | 197.2 | 0.900 | 0.332 | 1.232 |
| 170 | 134.8 | 42.7 | 177.6 | 0.793 | 0.251 | 1.044 |
| 180 | 123.3 | 33.8 | 157.1 | 0.685 | 0.188 | 0.873 |
| 190 | 110.6 | 26.5 | 137.1 | 0.582 | 0.140 | 0.722 |
| 200 | 97.8 | 20.6 | 118.4 | 0.489 | 0.103 | 0.592 |

1 Gross volume is calculated at the utilization standards specified on this page with no deductions for cull.

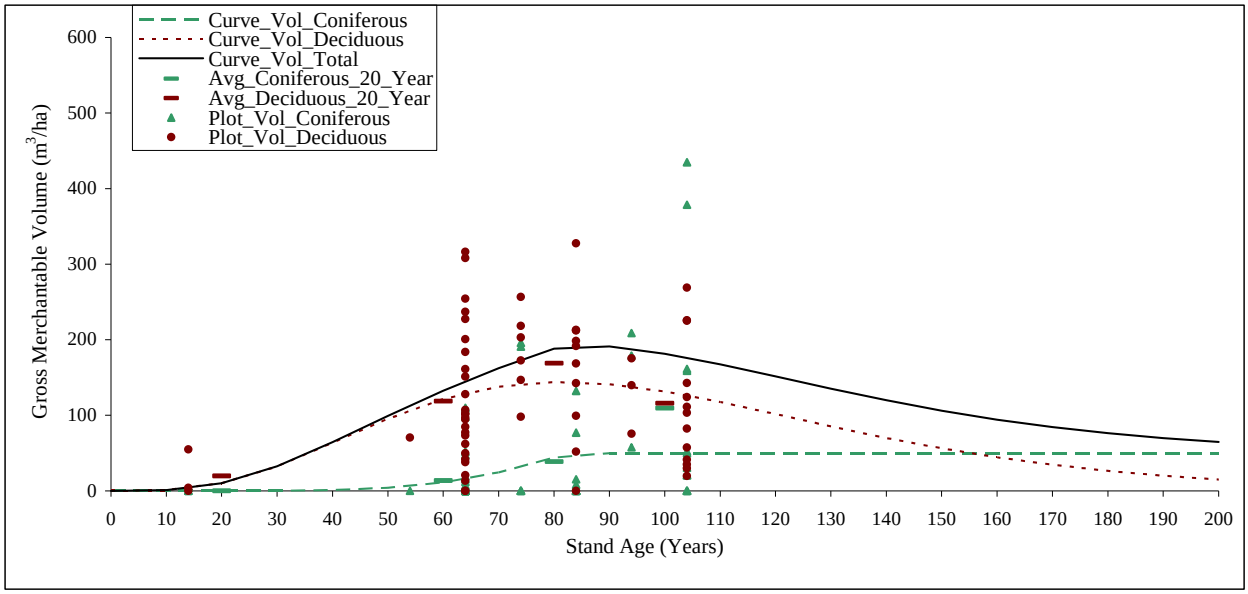
2 Maximum MAI highlighted in light yellow.

# Appendix III Forecasting Adjustments Yield Curves

The forecasting yield curves representing gross merchantable volume in this appendix are:

- Pure deciduous capped (D);

## D STRATUM / Base Natural Stand Yield Curve (capped)




**2-PARAMETER EQUATION (2P): volume = $a(age)^b e^{(-a*age)}$**

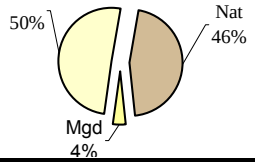
**2-PARAMETER EQUATION WITH CONSTANT (2P+k): volume = $a(age)^b e^{(-age/k)}$**

| Parameter Estimates: | | |
|---|---|---|
| Coniferous | a | 1.157E-14 |
| *Eqn: 2P+K* | b | 9.4043270 |
| | k | 15 |
| Deciduous | a | 1.407E-04 |
| *Eqn: 2P+K* | b | 4.0709508 |
| | k | 20 |

| Utilization Standards: | |
|---|---|
| Con. Top Diameter (cm): | 11.0 |
| Dec. Top Diameter (cm): | 10.0 |
| Con. Min. Log Length (m): | 2.66 |
| Dec. Min. Log Length (m): | 2.66 |
| Stump Diameter (cm): | 15.0 |
| Stump Height (cm): | 30.0 |

| Stratum Summary: | |
|---|---|
| Total Number of Plots: | 62 |
| Nat. Stand Area (ha): | 39,982 |
| Mgd. Stand Area (ha): | 3,479 |

**Stratum as a % of the managed landbase:**




| Stand Age | Number of Plots | Predicted Gross Merchantable Volume[1] ($m^3$/ha) | | | Mean Annual Increment ($m^3$/ha/year)[2] | | |
|---|---|---|---|---|---|---|---|
| | | Conifer | Deciduous | Total | Conifer | Deciduous | Total |
| 0 | 0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.000 | 0.000 |
| 10 | 3 | 0.0 | 1.0 | 1.0 | 0.000 | 0.100 | 0.100 |
| 20 | 0 | 0.0 | 10.2 | 10.2 | 0.000 | 0.512 | 0.512 |
| 30 | 0 | 0.1 | 32.4 | 32.5 | 0.004 | 1.079 | 1.083 |
| 40 | 0 | 0.9 | 63.3 | 64.3 | 0.023 | 1.583 | 1.607 |
| 50 | 1 | 3.9 | 95.3 | 99.2 | 0.078 | 1.905 | 1.984 |
| 60 | 26 | 11.2 | 121.4 | 132.6 | 0.186 | 2.023 | 2.209 |
| 70 | 6 | 24.5 | 137.9 | 162.4 | 0.349 | 1.970 | 2.319 |
| 80 | 10 | 44.1 | 144.0 | 188.1 | 0.551 | 1.801 | 2.351 |
| 90 | 3 | 50.0 | 141.1 | 191.1 | 0.556 | 1.568 | 2.124 |
| 100 | 13 | 50.0 | 131.4 | 181.4 | 0.500 | 1.314 | 1.814 |
| 110 | 0 | 50.0 | 117.5 | 167.5 | 0.455 | 1.068 | 1.523 |
| 120 | 0 | 50.0 | 101.6 | 151.6 | 0.417 | 0.846 | 1.263 |
| 130 | 0 | 50.0 | 85.3 | 135.3 | 0.385 | 0.656 | 1.041 |
| 140 | 0 | 50.0 | 70.0 | 120.0 | 0.357 | 0.500 | 0.857 |
| 150 | 0 | 50.0 | 56.2 | 106.2 | 0.333 | 0.375 | 0.708 |
| 160 | 0 | 50.0 | 44.3 | 94.3 | 0.313 | 0.277 | 0.590 |
| 170 | 0 | 50.0 | 34.4 | 84.4 | 0.294 | 0.202 | 0.497 |
| 180 | 0 | 50.0 | 26.3 | 76.3 | 0.278 | 0.146 | 0.424 |
| 190 | 0 | 50.0 | 19.9 | 69.9 | 0.263 | 0.105 | 0.368 |
| 200 | 0 | 50.0 | 14.9 | 64.9 | 0.250 | 0.074 | 0.324 |

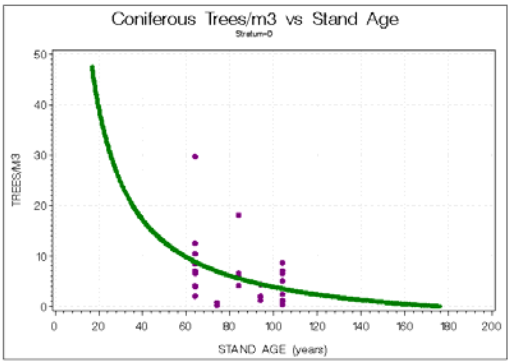
1 Gross volume is calculated at the utilization standards specified on this page with no deductions for cull.

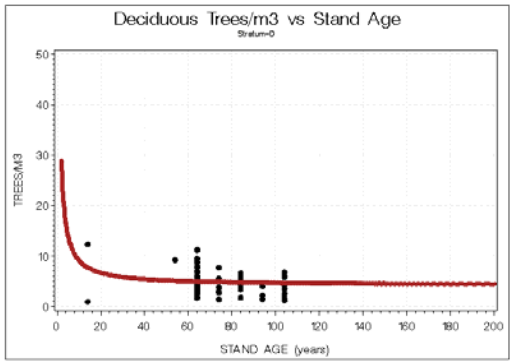
2 Maximum MAI highlighted in light yellow.

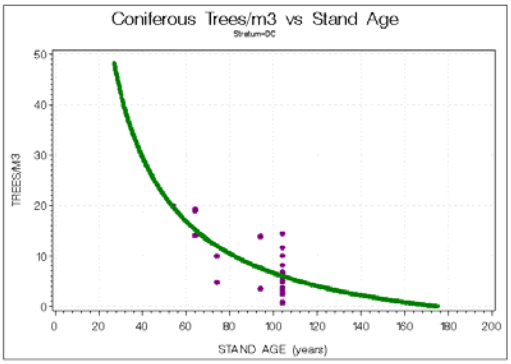
# Appendix IV Piece Size Curves

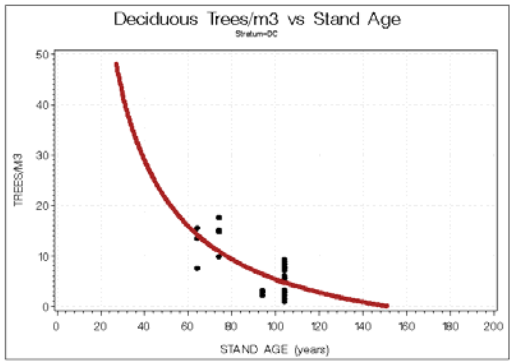
The piece size curves representing trees per unit of gross merchantable volume in this appendix are:

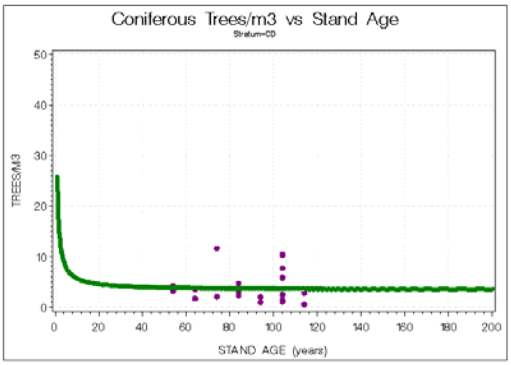
- Pure deciduous (D);
- Deciduous leading mixedwood (DC);
- Coniferous leading mixedwood (CD);
- Pure conifer, black spruce leading (C-SB);
- Pure conifer, white spruce leading, (C-SW); and
- Deciduous with conifer understory (DU).

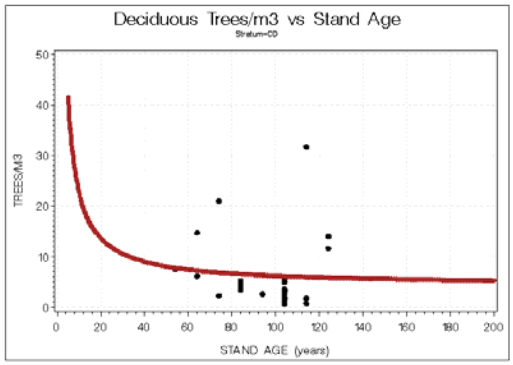

Coniferous Trees/m3 vs Stand Age
Stratum=O
TREES/M3
STAND AGE (years)

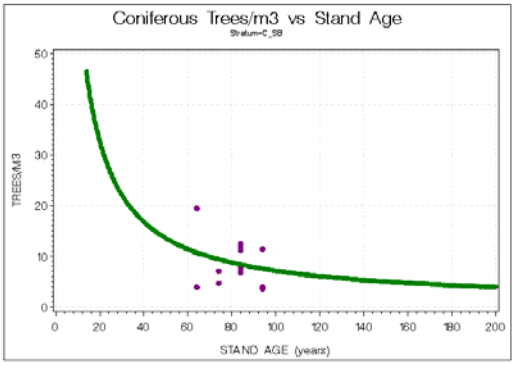

Deciduous Trees/m3 vs Stand Age
Stratum=O
TREES/M3
STAND AGE (years)

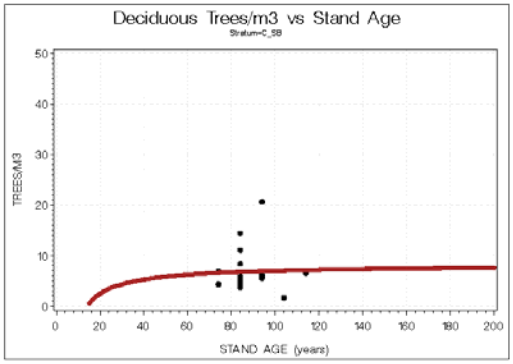

Coniferous Trees/m3 vs Stand Age
Stratum=OC
TREES/M3
STAND AGE (years)

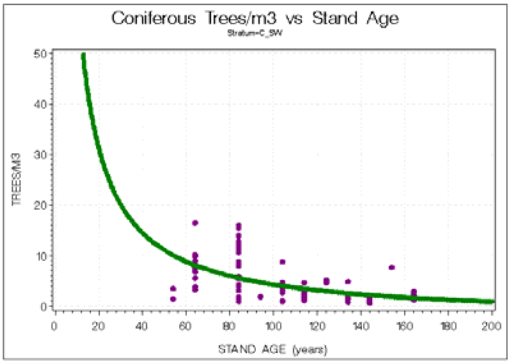

Deciduous Trees/m3 vs Stand Age
Stratum=OC
TREES/M3
STAND AGE (years)

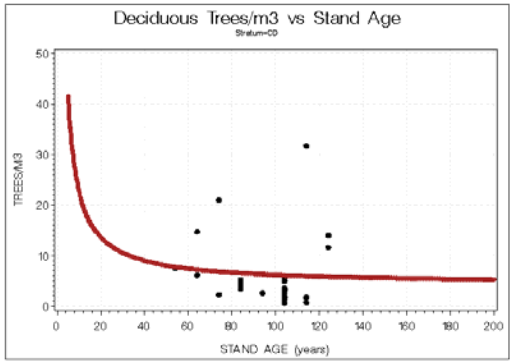

Coniferous Trees/m3 vs Stand Age
Stratum=CO
TREES/M3
STAND AGE (years)

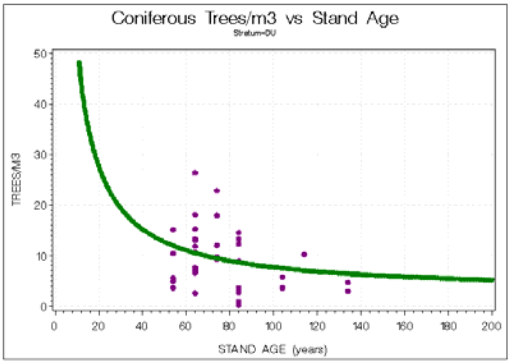

Deciduous Trees/m3 vs Stand Age
Stratum=CO
TREES/M3
STAND AGE (years)

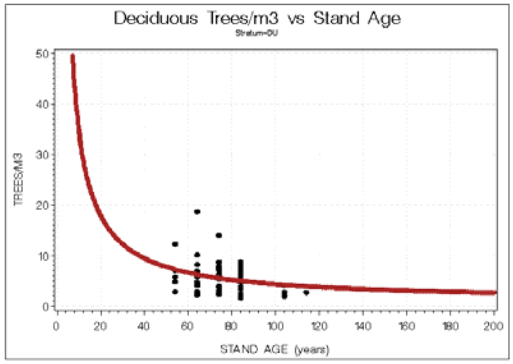

Coniferous Trees/m3 vs Stand Age
Stratum=C_SB
TREES/M3
STAND AGE (years)


Deciduous Trees/m3 vs Stand Age
Stratum=C_SB
TREES/M3
STAND AGE (years)


Coniferous Trees/m3 vs Stand Age
Stratum=C_SW
TREES/M3
STAND AGE (years)


Deciduous Trees/m3 vs Stand Age
Stratum=CD
TREES/M3
STAND AGE (years)


Coniferous Trees/m3 vs Stand Age
Stratum=DU
TREES/M3
STAND AGE (years)


Deciduous Trees/m3 vs Stand Age
Stratum=DU
TREES/M3
STAND AGE (years)

The Forestry Corp. Project Number: P631
For additional information, please contact:
The Forestry Corp.
101-11710 Kingsway Avenue
Edmonton, AB
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(780) 452-5878
www.forcorp.com

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