Tree Farm Licence #18

Timber Supply Analysis
Information Package—Revised
October 28, 2004

A project submitted by: Forest Ecosystem Solutions Ltd.
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Summary of Changes to the Information Package

Several changes were made to the information package during review by MoF and MSRM. The following table is a summary of the major changes to the methodology and documentation.

Section	Pg.	Topic	Concerns	Summary of changes
6.1.3	13	Existing roads		Increased netdown for existing, proposed and future roads base on a recently-completed sampling program.
6.1.14.1	18	Non-merchantable	Inadequate documentation of 125 m^3/ha minimum merchantable volume.	Demonstrated average harvest in cutblocks as low as 160 m^3/ha, with individual stands as low as 80 m^3/ha inventory volume.
6.1.15.2	20	Future WTR	Localized WTR Targets are not available from MSRM-Kamloops.	Used the standard methodology for WTR targets, scaled to 1% of the THLB. Reserves buffered by 500m and LUPG table A3.1 used to calculate targets.
8.2	28	Managed vs. natural stands	Insufficient rationale for modeling all stands <41 years old with TIPSY.	Documented planting since 1961 and transition to widespread planting between 1964 and 1971. Demonstrated low risk of error during the transition period.
8.5.4	36	G&Y for deciduous stands	Canfor is responsible for ensuring free-growing coniferous conditions on all stands established after 1986.	Polygons <18 years old labelled in the inventory as deciduous-leading will be grown on a coniferous MSYT curve.
8.6.1	37	Genetic gain allowances	Insufficient documentation of proportion of seed stock in each genetic class.	Provided proportion of seed stock in each genetic class for 2004 sowing year. Also provided more information on how genetic worth is prorated into analysis units.
8.6.3	41	Analysis units for future stands	Future MSYTs are linked to site series assumptions, and must be pro-rated into TEM polygons, creating the need for further aggregation.	Future MSYTs were pro-rated into TEM polygons based on the decile proportion of each site series in the polygon. The resulting unique yield tables were then clustered into 10 analysis units based on similarities in volume growth.
10.2.1	54	Harvest scheduling rules		"Relative poorest first" scheduling, an innovative harvest rule recently developed by FESL, will be used for the base case.
10.2.3	57	Minimum Harvest Age	Culmination-based minimum harvest ages were artificially constraining harvest.	Minimum harvest ages were set to the minimum merchantable volume (125 m^3/ha) in conjunction with changing to the "Relative poorest first" scheduling rule.
6.1.8, 6.1.10	16	Terrain and difficult regen	Insufficient documentation of performance.	Added text.
8.4.2	33	OAF1	OAF1 was incorrectly set to 10% during generation of the MSYTs.	Yield tables were redone using OAF1 of 15%. All MSYT statistics reported in the information package were updated.
Appendix E		Yield Tables	Volumes reported were total volume	Table updated to show net volumes pro-rated for close utilization of Pl. These are the yield tables used for analysis.

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Table of Acronyms

AAC	Allowable Annual Cut
AU	Analysis Unit
BEC	Biogeoclimatic Ecosystem Classification
BEO	Biodiversity Emphasis Option
DBH	Diameter at Breast Height
DFA	Defined Forest Area
DIB	Diameter Inside Bark
DWB	Decay, Waste, and breakage
ECA	Equivalent Clearcut Area
ESA	Environmentally Sensitive Area
EVC	Existing Visual Condition
FDP	Forest Development Plan
FESL	Forest Ecosystem Solutions Ltd.
FIZ	Forest Inventory Zone
FPC	Forest Practices Code
FSOS	Forest Simulation Optimization System
GIS	Geographic Information Systems
HLPO	Higher Level Plan Order
ITG	Inventory Type Group
LMZ	Lakeshore Management Zone
LU	Landscape Unit
LUPG	Landscape Unit Planning Guide
MAI	Mean Annual Increment
MHA	Minimum Harvestable Age
MoF	British Columbia Ministry of Forests
MP	Management Plan
MPB	Mountain Pine Beetle
MSRM	British Columbia Ministry of Sustainable Resource Management
MSYT	Managed Stand Yield Table
NCLB	Non-Contributing Land Base
NSR	Not Satisfactorily Restocked
NSYT	Natural Stand Yield Table
OAF	Operational Adjustment Factor
OGMA	Old Growth Management Area
OGSI	Old Growth Site Index
OPR	Operational Planning Regulation
PSI	Potential Site Index

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RMZ	Riparian Management Zone
RRZ	Riparian Reserve Zone
RVQC	Recommended Visual Quality Class
SFMP	Sustainable Forest Management Plan
SI_{50}	Site Index for age 50
SIA	Site Index Adjustment
SIBEC	Site index Biogeoclimatic Ecological Classification
SMZ	Special Management Zone
TEM	Terrestrial Ecosystem Map
TFL	Tree Farm Licence
THLB	Timber Harvesting Land Base
TIPSY	Table Interpolation Program for Stand Yields
TSA	Timber Supply Area
TSIL	Terrain Survey Intensity Level
TSR	Timber Supply Review
UWR	Ungulate Winter Range
VAC	Visual Absorption Capacity
VDYP	Variable Density Yield Prediction
VEG	Visually Effective Green-up
WHA	Wildlife Habitat Area
WTP	Wildlife Tree Patch
WTR	Wildlife Tree Retention

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1 Introduction

Canadian Forest Products Ltd. (Canfor) is currently preparing Management Plan #10 for Tree Farm Licence #18 (TFL 18). As part of the management plan process, Canfor is responsible for preparing a timber supply analysis showing the long-term, strategic timber supply for the land base. This information package documents the procedures, assumptions, data and model to be used in the analysis. Forest Ecosystem Solutions Ltd. (FESL) has been engaged to prepare the information package and conduct the timber supply analysis on behalf of Canfor. This package follows the format of the *Provincial Guide for the Submission of Timber Supply Information Packages for Tree Farm Licences, Version 4*.

The purpose of this Timber Supply Analysis Information Package is to:

- Provide a detailed account of the factors related to timber supply that the Chief Forester must consider under the Forest Act when determining an allowable annual cut (AAC) and how these factors will be applied in the timber supply analysis;
- Provide a means for communication between staff from Canfor, Ministry of Forests, Ministry of Sustainable Resource Management and Ministry of Water, Land, and Air Protection;
- Provide staff of the different ministries with the opportunity to review data and information that will be used in the timber supply analysis before it is initiated;
- Ensure that all relevant information is accounted for in the analysis to an acceptable standard;
- Reduce the risk of having analyses rejected because input assumptions and analysis methods were not agreed upon in advance.

Analysis will use FESL's Forest Simulation and Optimization System (***FSOS***), a spatial, time-step forest estate simulation and heuristic model in conjunction with FESL's data preparation and analysis approach.

Upon acceptance by the Forest Analysis Branch, the assumptions used in this information package will be used to guide the development of the timber supply analysis. During the analysis, various sensitivity analyses, harvest flow alternatives, and management options will be tested to determine the influence of various factors on harvest levels. All analyses and the final proposed option will be submitted to the Chief Forester for determination of the AAC.

2 Process

This information package will be included as an appendix to the Timber Supply Analysis Report of TFL 18 Management Plan (MP) #10. Its contents reflect current legislation and policies. Where feasible, comments from public and resource agency review of the previous management plan were considered in preparing this information package.

Forest resource and land base data come from several inventories conducted by Canfor and provincial resource ministries. This information has been compiled into a GIS database maintained by Canfor, and is the source for all summaries in the information package, unless where otherwise stated.

The Ministry of Forests (Forest Analysis Branch) will review the technical details in this information package. The Headwaters Forest District and the Southern Interior Forest Region will review the analysis assumptions presented in this document.

2.1 Data Preparation and Missing Data

FESL created a master database with a complete resultant polygon list from spatial information through a series of GIS overlays. In the master database each polygon has a unique identification number. The data described in this document is only as reliable as the databases that were used to generate it. Though the data is believed to be accurate, an exact match was not always possible between overlapping coverages. Some had to be manipulated to approximate a best fit. Although the final resultant is a close approximation of the actual landscape, caution should be used when viewing geographic data results.

With the consent of Canfor, FESL may modify any data, netdown order or calculation in the future, if it will enhance the accuracy of this analysis. Any modifications to the dataset will be documented in subsequent versions of the information package.

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3 Timber Supply Scenarios and Sensitivity Analyses

This section describes the Base Case, sensitivity analyses, and management scenarios that will be presented in the Timber Supply Analysis Report.

3.1 Base Case

The Base Case reflects best available knowledge about current management activities and forest development in TFL 18. Major attributes of the base case are:

- Time-step simulation using the proprietary timber supply model, ***FSOS;***
- Rectified forest cover inventory (FC1 format), projected to January 1, 2004 and updated for depletions;
- Spatially-explicit netdowns for riparian reserve zones;
- Standard non-spatial wildlife tree retention assumptions;
- TIPSY yields for stands younger than 41 years old;
- Custom growth and yield assumptions for IU Balsam stands;
- TEM-based potential site index for existing and future managed stands;
- OAF1 of 15% and OAF2 of 5%;
- Ecosystem-based regeneration assumptions using TEM;
- Genetic gain for pine and spruce components of future stands, adjusted for ingress and proxy species;
- Unsalvaged losses of 3000 m^3/yr;
- Forest cover requirements for VQOs and Lakes LRUP management objectives;
- Maximum 10% forest health harvests in OGMAs and Preservation VQOs;
- Forest cover requirements for riparian management zones;
- Harvest scheduling using the "relative poorest first" rule;
- Minimum harvest ages based on minimum merchantable volume of 125 m^3/ha; and
- Fixed harvest of FDP blocks during the first period.

An epidemic infestation of mountain pine beetle is expected on TFL 18 in the next 5 years. FESL and Canfor are currently developing a set of assumptions for modeling this infestation in timber supply analysis. These assumptions may be incorporated into the base case or, alternately, investigated as a separate management scenario.

3.2 Sensitivity Analyses

Sensitivity analyses are used to assess issues that have some degree of uncertainty associated with them, and to test the impact of specific management policies. For the base case scenario, sensitivity analyses test assumptions related to the land base alterations, growth and yield, forest cover requirements and harvest objectives. Sensitivity analyses to be included in the analysis report are listed in Table 1.

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Table 1: Sensitivity analyses

Category	Sensitivity Analysis
Land base alterations	Model OGMAs as a 100% netdown reduction
	Model No Harvest LMZs as a 100% netdown reduction
	Apply riparian management zones as a partial netdown reduction
	Remove netdown for future wildlife tree retention
Growth and yield	Standard VDYP methodology for IU Balsam Stands
	Inventory site index for Managed Stand Yield Tables
	Adjust existing stand volumes +/- 10%
	Adjust regenerated stand volumes +/-10%
	Exclude deciduous volume from harvest
	Deciduous NSYTs for young deciduous stands
Forest cover requirements and harvest objectives	Adjust Lakeshore management zones +/- 1 Lake Class
	"Relative oldest first" scheduling (MHA at 90% culmination age)
	Turn off VQOs
	Turn off OGMAs
	Turn off all forest cover requirements
	Turn off all forest cover requirements and productive forest netdowns
	Increase minimum merchantable volume to 150 m3/ha

4 Model

The following modeling software will be used in the timber supply analysis for TFL 18:

Landscape Design Model - *FSOS*

Model Name: ***FSOS***
Model Developer: Dr. Guoliang Liu
Model Development: UBC, Hugh Hamilton Limited, Forest Ecosystem Solutions Ltd.
Model Type: Landscape Design Model

FSOS (Forest Simulation Optimization System) uses C++ programming language and can be run with both Windows 95 and higher operating systems. The model interfaces directly with Microsoft Access for data management. Although FSOS has both simulation and heuristic (psuedo-optimization) capabilities, the time-step simulation mode will primarily be used in this analysis. Time-step simulation grows the forest based on growth and yield inputs and harvests resultant polygons based on user-specified harvest rules and constraints that cannot be exceeded. Using "hard" constraints and harvest rules instead of targets (as would be applied in the heuristic mode of FSOS) gives results that are repeatable and more easily interpreted.

A formal comparison of FSOS and FSSIM using a benchmark dataset was performed and submitted to the Ministry of Forests Timber Supply Branch in 1998 (Hugh Hamilton Limited 1998a). Acceptance notification correspondence was provided to Dave Waddell (currently Systems Forester, MoF Development & Policy Section) in September 1998, authorizing FSOS for use in Timber Supply Analysis to support AAC determinations in British Columbia.

From GIS overlay, the land base is divided into resultant polygons, each with a unique set of attributes. Constraints and harvest criteria are applied to each polygon based on these attributes. Constraints and harvest criteria can be defined by analysis unit, forest type, forest age, silvicultural treatment, user allocation, site index, non-timber resource objectives or any other parameter.

FSOS uses individual stand ages to project the current age structure of stands in the analysis area. As stands age, they move into and out of age classes established as a basis for meeting target objectives.

Generally, ***FSOS*** runs utilize 5-year periods, as the output is intended to be operationally applicable and reflect 5-year management plan objectives, but 1,10 or 20 year periods can easily be assigned. The middle of the period (year 3 for 5-year periods) is used for reporting.

The planning horizon length can vary as required. ***FSOS*** can produce spatially and temporally explicit plans over 20 years or for multiple rotations. A unique feature of ***FSOS*** is its ability to integrate strategic, tactical and operational planning phases into one process. Analysis runs include harvest timing and location for each period, as well as long-term sustainable harvest levels.

The reporting functions of ***FSOS*** are extensive. The data for each period is easily accessible for any analysis unit, zone, polygon, landscape unit, etc. and gives an overview of the forest state at any point in time. Species compositions, age structure, patch distribution, harvest scheduling, and many other variables are tracked and reported by period. Reporting functions are highly effective for the direct comparison of differing sensitivity analysis scenarios. ***FSOS*** is linked directly to the powerful ArcMap environment for high-quality map production.

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5 Forest Resource Inventory

5.1 Forest Cover Inventory

A Vegetation Resources Inventory has not been performed in TFL 18. The forest cover inventory for TFL 18 has undergone substantial spatial and thematic modification that improves its accuracy relative to the inventory used in previous timber supply analyses. The modifications described below have been reviewed and approved by MSRM – Kamloops.

5.1.1 Inventory Audit

MoF Resources Inventory Branch conducted an inventory audit of the TFL18 Forest Cover Inventory in 1995 (BC MoF 1997). The ratio of means between the average stand volume of the audit and the inventory was 91%. However, this difference was not significant at a confidence level of 95%, meaning there is no statistical difference between the inventory and the audit. A sensitivity analysis will be performed to test the impact of a +/-10% change in the inventory volume.

5.1.2 Silvatech Forest Inventory Rectification Project

A forest inventory rectification project was completed for TFL18 in December 2003 (Silvatech 2003b). The following text from the final report of this project describes the rationale for the rectification and the general approach used. The final report for the TFL 18 forest inventory rectification project is included in Appendix A.

> In early 2002, Slocan Forest Products- Vavenby Division (now Canfor) approached Silvatech Consulting Ltd. (Silvatech) of Salmon Arm BC, to update forest cover history for Tree Farm Licence 18, in advance of pending planning initiatives.
>
> After a comprehensive review of the forest cover, Slocan and Silvatech agreed that prior to conducting history updates, the spatial accuracy of the existing forest cover data should be corrected. Once the forest cover map base was positionally rectified, opening and road updates could then be added to the spatially correct forest cover map base. At the onset of the project, it became apparent that spatial inaccuracies, inherent in the existing forest cover base mapping, were the direct result of inadequate georeferencing (control) during the transfer of inventory lines from the typed aerial photography to digital forest cover base mapping. These problems were then compounded by several years of "rubber sheeting" (stretching) to make new linework fit the positionally inaccurate forest cover base mapping.
>
> Following the collection of all available information and after assessing the scope of the problem and possible approaches, the recapture and control of the existing 1992 forest inventory photo stratification (1974 photography) was selected as the most cost-effective solution. This process included digitizing (monorestitution-Microstation™) and the accurate georeferencing of the inventory photos to established British Columbia TRIM control. Upon completion of the existing forest cover rectification, the positionally correct base was then updated with post-1992 openings and roads, using a combination of orthorectified 5 meter IRS™ satellite imagery, 1996 ortho-photography and information provided by Slocan, to update harvesting and road history to January 2002.
>
> Upon completion of the spatial update, Slocan initiated the normalization of the forest cover database to an MSRM standard format. In the latter stages of this process, a process was developed to link Slocan- Vavenby's internal silviculture record keeping system (Phoenix) and

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Ministry of Forests ISIS system to the Forest Cover database. From the updated FC database, a process to update the spatial FC opening linework and labels followed.

5.1.3 Other modifications to the forest cover inventory

Overall, the quality of the forest inventory provided was high. However, a detailed evaluation of the forest inventory provided identified some problem attributes for polygons that were previously updated from Canfor's Phoenix database. To correct and update the attributes for the polygons identified, Canfor and FESL collaborated to verify and update selected forest cover attributes based on Canfor's Phoenix database. Identified problems included polygons where species composition, stocking class, crown closure, and/or site index were missing.

For about five records, the decision was to change the linkage between the forest inventory and the Phoenix database based on a visual comparison with a georeferenced digital aerial photography mosaic ("air photos" hereafter) provided by Canfor. Occasionally, it was necessary to assign attributes from a different Phoenix layer (rank not being 1) to the forest inventory as the visual comparison with the air photos would clearly indicate that incorrect layer attributes had been assigned to the forest inventory.

In addition, for a total of 9 polygons no forest cover attributes were available. Forest inventory attributes could be assigned to 4 polygons, but a further 5 polygons representing a total of about 20ha remained without attributes.

5.1.3.1. Updates for depletions

Canfor had provided air photos current to August or September of 2003. These images were used to further verify the inventory and the depletion coverages provided. A comparison of these sources (depletion data was provided by both Canfor and by BCTS) identified further problems. This time, the inventory and depletion data was compared to the information provided by the digital air photos, and areas of conflict were identified, such as the inventory or depletion data indicating NSR but the air photos showing mature forest.

While Canfor's forest inventory, depletion coverage and 2004 Forest Development Plan matched the air photos very well, the depletion and 2004 Forest Development Plan provided by BCTS was associated with spatial shifts and other inaccuracies. In addition, while the two Forest Development Plans contained often the same blocks, the shape and the attributes were not well matched. To correct the problems introduced by updating the forest inventory from depletion data, the following decisions were made:

- Accept Canfor depletion data for blocks that exist in both depletion or Forest Development Plans as correct (based on a visual check with the air photos);
- Accept Canfor depletion data for NSR blocks even if the digital air photos show standing timber, provided that the date of logging was after September 2003 (more recent than the air photos); or
- Where BCTS blocks could not be verified using the air photos and/or input from Dean Christianson (BCTS Practices Forester, BC MoF), the decision was made to remove the BCTS blocks.

5.1.3.2. Inventory projection

The updated forest cover inventory was projected to January 1, 2004 using *BatchVDYP version 6.6d*. Volumes and heights for each polygon were interpolated from the output yield tables to ensure that yields are precise to the current age of the stand. A current age (as of January 1, 2004 was calculated

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based on projected age for records that were not previously linked to Silvatech, and which had remained projected to 2001. The current age for all other records, i.e. Phoenix records, was based on the inventory age and the inventory reference age. With current age being available, together with all other required key forest inventory attributes, volumes and heights were projected using *BatchVDYP version 6.6d*, as indicated.

5.2 Forest Resource Inventories

Table 2 documents the source and status of the forest resource inventories used in this timber supply analysis. Approximate dates of completion and other information are provided.

Table 2: Standard resource inventory status

Inventory Category	Description	Approval Date	Agency Approval/Comments
Forest Inventory	Base	1994	Audit completed 1997, MoF Resources Inventory Branch.
	Depletions Update	-	Updated to January 2002
	Spatial Correction	2003	Reviewed by Linda Sapinski, GIS Analyst MSRM – Kamloops.
ESA's	Recreation, Regeneration, Avalanche	1994	Part of 1994 Forest Inventory
Recreation	Opportunity Spectrum	1998	
	Features	1998	
	Sites	2004	Reviewed with Headwaters District
Visual Inventory	TFL 18	1996	-
	Headwaters District	-	Draft VLI – 2002/03
	Blended	2004	Reviewed blended inventory and potential management polygons with Kamloops Forest Region and Headwaters District.
Terrain	Terrain Stability	2003	Terrain Survey Intensity Level "C"
Ecosystem	Terrestrial Ecosystem Mapping	2001	Review by Dennis Lloyd, Research Ecologist, MoF Forest Sciences, Kamloops
	Old Growth Management Areas	Draft	Current Management
	Biogeoclimatic mapping	2001	Included with TEM
Fisheries	Lake Inventories	1996	Reconnaissance surveys
	Streams	1996	Local Area Agreement
Lakes	LRUP classifications	2003	Reviewed with Headwaters District
Cultural Heritage Resources	AOA Model	2003	Revised and updated LRMP AOA model provided by AOA Sub-committee.

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6 Description of the Land Base

6.1 Definition of the Timber Harvesting Land Base

The timber harvesting land base (THLB) is determined by the netdown process, in which stands ineligible for harvest are sequentially removed from the total land base. Table 3 summarizes this procedure. The rest of this section is dedicated to the details of each reduction and a description of the attributes of the resulting THLB.

The netdown is an exclusionary procedure. Once an area has been removed, it cannot be deducted further along in the process. For this reason, the gross area of netdown factors (e.g. Non-merchantable forest) is often greater than the net area removed; a result of overlapping resource issues. Portions of the land base that are reserved from harvest may still contribute to forest cover objectives.

6.1.1 Overview

The area of TFL 18 is 74,542 ha, of which 67,315 ha is productive forest. The current Timber Harvesting Land Base is 63,812. Proposed and future road reductions are not deducted from the current Timber Harvesting Land Base because the volume associated with these features will contribute to the first harvest. These future reductions are applied once the polygon has been harvested. After all future reductions have been applied, the long-term Timber Harvesting Land Base is 63,184 ha.

Table 3: Timber harvesting land base determination.

Land Classification	Total Area (ha)[1]	Net Reduction Area (ha)	Net Reduction Volume ('000s m[3])
Total Area of TFL 18		**74,542**	**13,514**
Non-forest and Non-productive forest	5,834	5,834	6
Non-Commercial Brush	13	12	0
Existing Roads	1,402	1,381	132
Total NP reductions		7,227	138
Total Productive Forest		**67,315**	**13,376**
Protected Areas	282	268	73
Riparian Reserve Zones	1991	1879	520
Class V (unstable) terrain	39	36	4
Difficult regeneration	901	741	129
Permanent sample plots	50	46	6
Non-merchantable stands	175	37	1
Future wildlife tree retention	513	496	90
Total Reductions to Productive Forest		3,503	823
Current THLB		**63,812**	**12,553**
Future reductions			
Proposed roads		102	n/a[2]
Future roads		526	n/a[2]
Long-term THLB		**63,184**	**12,553**

[1] Total Area of TFL 18 covered by a given land classification.

[2]Volume for proposed/future roads is not removed from the THLB, since it will contribute to harvest.

[3]the area of the land type, excluding all other netdown reductions. This shows the true net effect of each reduction on the THLB.

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6.1.2 Non-Forest and Non-Productive Forest

Areas classed as non-forest or non-productive forest are removed from the timber harvesting land base. The distribution of non-forested area removed from the THLB, by class, is given in Table 4.

Table 4: Reductions for non-forest and non-productive forest

Symbol	Non Forest Descriptor	Total Area (ha)	Net Area Removed (ha)
A	Alpine	376	376
C	Clearing	6	6
GR	Gravel Pit	10	10
L	Lake	1,347	1,347
M	Meadow	38	38
NP	Non-Productive	163	163
NPBR	Non-Productive Brush	30	30
R	Rock	182	182
SWAMP	Wetlands	3,667	3,667
U	Urban	15	15
TOTAL		**5,833**	**5,833**

6.1.3 Existing Roads and Related Disturbances

Roads are not identified in the forest cover inventory and need to be accounted for separately in the determination of the timber harvesting land base. Road linework was buffered in GIS by the road class-specific degraded width to estimate the area of existing roads.

Canfor completed a sampling program to estimate average road width on TFL 18 in June, 2004. JS Thrower & Associates analyzed the resulting digital database of 120 road width measurements, and used two different methods were used to calculate road area by road class:

Method 1. Assume toe fill is always unfavourable for tree growth. (JS Thrower & Associates 2004).

Road Class	Road width calculation	Notes
1	Width = total R/W width	Where R/W width is missing, assign R/W = 30m
2 – 4	Width = running_surface + ditch_L + ditch_R + (top_cut_L or toe_fill_L) + (top_cut_R or toe_fill_R) + push_out + borrow_pit	Where a measurement is missing, assign = zero.

Method 2. Include toe fill width in road class 4 only if unfavourable for tree growth. (JS Thrower & Associates 2004).

Road Class	Road width calculation	Notes
1	Width = total R/W width	Where R/W width is missing, assign R/W = 30m
2 – 3	Width = running_surface + ditch_L + ditch_R + (top_cut_L or toe_fill_L) + (top_cut_R or toe_fill_R) + push_out + borrow_pit	Where a measurement is missing, assign = zero.
4	Width = running_surface + ditch_L + ditch_L + (top_cut_L or toe_fill_L*) + (top_cut_R or toe_fill_R*) + push_out + borrow_pit	Where a measurement is missing, assign = 0 *Only add toe_fill width if classed unfavourable to tree growth.

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Calculations for road width and area include roads, landings, and borrow pits. The two computed methods help quantify the (potentially) subjective assessment if the toe fill is favourable for tree growth.

Table 1 summarizes statistics for length, width, and area by road class (including landings and borrow pits), and across all road classes for the two methods. Also included are the additional samples required to achieve a 15% and 10% sampling error by road class. Table 2 summarizes the overall proportion of the TFL 18 land base accounted for by roads, landings, and borrow pits.

Table 5: Summary statistics for road classes 1 to 4, and averaged across all road classes in TFL 18 (Adapted from JS Thrower & Associates 2004).

Road Class	Sampling Method	Sample size (n)	Total road length (m)	Average road width (m)	95% CI road width (m)	Sampling error (%)
1		30	35,140	24.9	[22.1, 27.7]	11%
2		30	135,595	13.6	[11.6, 15.7]	15%
3		30	168,387	13.5	[11.7, 15.3]	14%
4	Method 1	30	1,002,069	10.9	[8.8, 13.1]	19%
4	Method 2	30	1,002,069	9.6	[7.9, 11.3]	18%
Total	Method 1	120	1,341,191	11.9	[10.3, 13.5]	13%
Total	Method 2	120	1,341,191	10.9	[9.4, 12.3]	13%

The average road widths reported above were used to buffer road linework in a GIS environment. The midpoint between the road width calculated by method 1 and method 2 was used as the road width for class 4. The area reductions for each road class are given in Table 6. Proposed roads are applied as a future reduction, allowing the volume of the existing stand to contribute to timber supply before the roads are removed from the THLB.

Table 6: Reductions for existing roads

Road Class	Degraded Width (m)	Length (km)	Gross Area (ha)	Net Reduction Area (ha)
Class 1	24.9	35	87	83
Class 2	13.6	135	183	176
Class 3	13.5	157	211	215
Class 4	10.2	906	921	907
Total Existing Roads		**1,233**	**1,402**	**1,381**
Class 3 (proposed)	13.5	9	12	12
Class 4 (proposed)	10.2	90	93	90
Total Proposed Roads		**99**	**105**	**102**

6.1.4 Non-commercial Cover

Non-commercial cover is removed from the THLB and is identified in the forest inventory database information as type identity 5. As shown in Table 3, there are only 13 ha of non-commercial brush in the TFL, which corresponds to a net area removal of 12 ha.

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6.1.5 Parks

Taweel Park covers a total of 282 ha in the southern portion of the TFL, 268 ha of which is productive forest. Although this protected area contributes to some forest cover objectives for TFL 18, it is not available for timber harvesting and is excluded from the timber harvesting land base.

6.1.6 Physically Inoperable

Specific areas where harvesting is not practised for reasons of accessibility or worker safety are described as physically inoperable. Due to the moderate terrain of TFL18, no area removals are required for physical inoperability.

6.1.7 Riparian Reserves and Management Zones

Table 7 shows the calculation of total riparian management area buffer width by stream class. The RMA buffer widths and basal area retention levels are consistent with the FPC *Riparian Management Area Guidebook.* A GIS buffer function was used to determine the spatial distribution of riparian reserve zones (RRZs) and riparian management zones (RMZs). Where buffers of different riparian classes overlap, the larger buffer takes precedence.

Table 7: Calculation of total riparian buffer widths for streams, lakes, and wetlands

	Riparian Management Zones				Riparian Reserve Zones		
Riparian Class	**RMZ Width (m)**	**RMZ BA retention %**	**Total RMZ Area (ha)**	**net RMZ removals (ha)**	**RRZ Width (m)**	**Total RRZ Area (ha)**	**net RRZ removals (ha)**
S1	20	50%	103	0	50	316	280
S2	20	50%	131	0	30	229	221
S3	20	50%	465	0	20	507	483
S4	30	25%	190	0	0	0	0
S5	30	25%	1,200	0	0	0	0
S6	20	5%	2,998	0	0	0	0
Streams			**5,087**	**0**		**1,052**	**985**
L1	40	25%	361	0	10	118	105
L3	30	25%	133	0	10	29	22
Lakes			**494**	**0**		**147**	**127**
W1	40	25%	1,503	0	10	495	480
W3	30	25%	949	0	0	0	0
W5	40	25%	975	0	10	297	287
Wetlands			**3,427**	**0**		**792**	**767**
Total RMA Reductions			**9,008**			**1,990**	**1,879**

6.1.7.1. Riparian reserve zones

Riparian reserve zones occupy a total area of 1990 ha of the TFL, and the entire area of riparian reserve zones is removed from the timber harvesting land base. This corresponds to a net area removal of 1,879 ha.

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6.1.7.2. Riparian Management Zones

Riparian management zones occupy 9008 ha of the TFL. Consistent with the recommendations of the *Riparian Management Area Guidebook,* various levels of harvesting retention are practised within RMZs. However, partial retention in RMZs is not uniform: the amount of retention on any given site depends on the state of adjacent stands, windfirmness, and riparian sensitivity to harvesting. stem retention in RMZs will be modelled in this timber supply analysis as a forest cover requirement (Section 10.1.5: Riparian Management Zones) to reflect the spatially and temporally dynamic nature of retention in the RMZs of TFL18. Consequently there are no net area removals associated with RMZs.

6.1.8 Unstable Terrain

Terrain stability mapping has been completed for TFL 18 at a scale of 1:15,000 and a Terrain Survey Intensity Level C (TSIL-C). It identified areas of potential (class IV) and active (class V) instability. Percent reductions for these classes are based on an operational review completed by Canfor staff in August 2004. Terrain polygons were plotted on a 1:40000 map depicting the harvest history, road networks, terrain, and riparian features. Each class IV and V polygon was reviewed in relation to geographic attributes to determine if current or readily available harvest methods could access and harvest each polygon. Polygons were assessed for the likelihood that road access through the polygon would be required. Very few of the areas mapped had past harvest history. Class IV terrain polygons have a reasonable likelihood of being harvested, subject to timber values and on-site terrain assessment results. Class V terrain polygons represent the landscape extreme on TFL 18, and are generally located on gully headwalls or on steep slopes. Given the total area of these polygons, and the risks associated with harvest and/or road construction on them, it is likely that any development incorporating these polygons would remove them from the harvest area.

Based on this review, Class IV terrain was not removed from the THLB and Class V terrain was given a full netdown. Netdown removals of unstable terrain are shown in Table 8.

Table 8: Reductions for unstable terrain

Slope Stability Class	Description	Gross Area (ha)	% reduction to THLB	Net Reduction Area (ha)
I, II, or III	Stable	73,568	0	0
IV	Potentially unstable	935	0	0
V	Unstable	38	100	36

6.1.9 Permanent Sample Plots

There are 198 permanent sample plots in TFL 18. These plots are part of an ongoing sampling program that supplement provincial growth and yield data. To reflect harvest restrictions around PSPs (Bob MacDonald, Growth & Yield Forester, MSRM, pers. comm..) a 50-m GIS buffer was created around 64 plots classified as growth and yield PSPs. This corresponds to a total area of 50 ha and a net THLB reduction of 45 hectares.

6.1.10 Difficult regeneration

The Environmentally Sensitive Areas (ESA) classification from the Forest Cover Inventory was used to identify areas associated with a high probability of regeneration failure (ESA-P). As part of an operational performance review conducted internally by Canfor, ESA P & SP polygons were plotted on a 1:40000 map depicting the harvest history, road networks, terrain, and riparian features. Polygons

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were assessed for regeneration issues that may evolve if the area was harvested. It is clear that the majority of ESA "high" polygons are at the ecological extremes of the TFL – generally cold, high elevation, possibly colluvial rock, and either hygric or xeric site extremes. Harvest history is virtually absent within the polygons reviewed.

Areas with high regeneration sensitivity (ESA1-P) are assumed to be avoided for harvest and receive a 100% reduction in the Netdown. Moderate regeneration sensitivity (ESA2-P) is assumed to be addressed through modified silviculture practices rather than harvest avoidance, and is not included in the netdown. Table 9 summarizes the netdown for sites associated with difficult regeneration.

Table 9: Summary of the netdown for difficult regeneration

ESAHIGH	ESALOW	Gross Area (ha)	% reduction to THLB	Net Reduction Area (ha)
P		176	100%	170
SP[1]		724	100%	571
	P	681	0%	0
	SP	238	0%	0
Total		**1,819**		**741**

[1]SP indicates that the polygon has an ESA designation for both sensitive soils (S) and difficult regeneration (P). Since sensitive soils are addressed through terrain stability mapping, and ESA-SP designation is equivalent to ESA-P.

6.1.11 Campsites/Recreation Areas

Although several campsites and recreation areas are located in TFL 18, no associated harvest exclusions are expected. Visual quality management for recreation quality is addressed as a suite of forest cover requirements (Section 10).

6.1.12 Cultural Heritage Resource Reductions

To date, no significant modifications to harvesting plans have been necessary for protection of cultural heritage resources. Protection of these features in the future is expected to be accommodated using riparian and wildlife tree reserves. Consequently, there are no associated area reductions to the timber harvesting land base.

6.1.13 Not-Satisfactorily Restocked Conditions

Canfor is committed to prompt regeneration of all current NSR. As a result, NSR lands are not excluded from the land base. A summary of the distribution on NSR lands is given in Section 8.6.4.

6.1.14 Non-merchantable sites

Various combinations of site index, tree species, and stand height were used in MP9 timber supply analysis (Hugh Hamilton Ltd. 1998) to identify netdown reductions for low productivity sites and non-merchantable stands. These criteria were deemed overly complicated and difficult to demonstrate during the development of netdown assumptions for MP10. Canfor staff identified existing stand volume as the primary determinant of merchantability, and identified 125 m^3/ha as the minimum merchantable volume in TFL 18. Natural stand yield tables (Section 8: Growth and Yield) were used to identify stands that are not projected to attain this threshold within the 250-year planning horizon. These stands were removed from the Timber Harvesting Land Base. Stands less than 41 years old are assumed to originate from timber harvesting and were maintained within the timber harvesting land base. Table 10 summarizes reductions for non-merchantable stands.

Table 10: Reductions for Non-merchantable stands

Leading Species	Current Age	Projected Maximum Net Volume	Gross Area (ha)	Net Reduction Area (ha)
Deciduous	>40 Years	<125 m^3/ha	11	11
Subalpine fir			89	19
Western redcedar			0	0
Douglas-fir			0	0
Lodgepole pine			67	0
Spruce			8	8
Total			**175**	**38**

The netdown reduction for non-merchantable stands is substantially less than the corresponding area in the MP9 analysis. This is a result of using a dynamic attribute, natural stand yield table (NSYT) volume, to define merchantability rather than static forest inventory attributes such as height, species, and site index. As shown in Table 10, most stands are projected to attain volumes of greater than 125 m^3/ha within the planning horizon. Nevertheless, many stands in the timber harvesting land base are currently non-merchantable because their volume is below 125 m^3/ha. These stands will be harvested throughout the planning horizon as they become merchantable. Further discussion of merchantability and minimum harvest ages is given in Section 10.2.3. A sensitivity analysis will test the timber supply impact of increasing the volume threshold for minimum merchantability.

Table 11: Area of currently non-merchantable stands by age class

Age Class	Productive Area (ha)	Net Area (ha)
3 41-60 years	1	1
4 61-80 years	20	18
5 81-100 years	0	0
6 101-120 years	55	11
7 121-140 years	0	0
8 141-250 years	91	0
9 >250 years	8	8
Total	**175**	**38**

6.1.14.1. Performance

Figure 1 shows the volume profile of TFL 18, and the volume profile of planned cutblocks (CP, AA, or PA status). Two cutblock profiles are shown: (1) the volume of individual forest cover polygons, and (2) the average volume of each cutblock. The total sample size is 81 planned cutblocks with a net area

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of 2406 ha. All CP, PA, and AA blocks were included in the sample, except for Balsam IU stands which were excluded because inventory volume is unreliable for these stands.

96% of cutblocks had average inventory volumes between 200 and 500 m3/ha. The lowest harvest volume in any cutblock was 160m^3/ha, suggesting that 150 m^3/ha would be an appropriate minimum for overall cutblock merchantability. However, the profile of forest cover polygons shows that individual stands within planned cutblocks had inventory volumes as low as 80m^3/ha. This result indicates that small areas of very low-volume stands may be harvested if they are within a matrix of merchantable stands. For the purposes of modeling, it is important to recognize small contributions of lower volume stands to harvest. Setting minimum merchantable volume at 125m^3/ha will allow some of these stands to be harvested. The Analysis Report will document the harvest of stands between 125 and 200 m^3/ha, and a sensitivity analysis will test the impact of setting minimum merchantable volume at 150 m^3/ha.

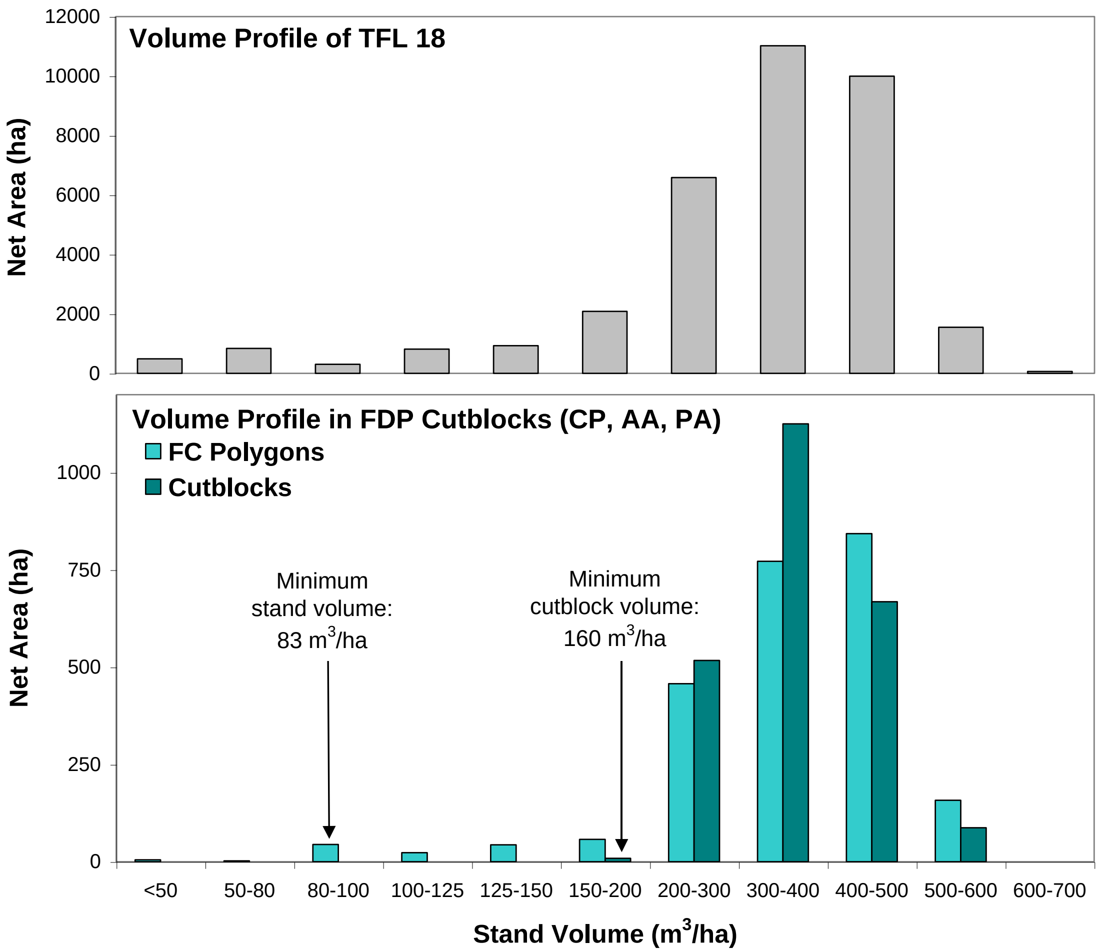

Figure 1: Current harvesting performance with respect to stand volume reported in the forest cover inventory

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6.1.15 Wildlife Tree Retention

6.1.15.1. Existing wildlife tree patches

Canfor has left wildlife tree patches in all cutblocks since 1995 in accordance with the Biodiversity Guidebook and the Landscape Unit Planning Guide. Based on a landscape-level analysis of WTP requirements, Canfor has also designated a network of spatially explicit future wildlife tree patches across TFL 18. However, the MSRM is scheduled to release new draft wildlife tree retention (WTR) targets for the Kamloops LRMP area in early 2005. These new targets are expected to substantially alter management for WTR in TFL 18, essentially nullifying the existing wildlife tree patches. To ensure that the timber supply analysis is consistent with the management regime for the period of Management Plan 10 (2005-2010), the netdown for wildlife tree retention will reflect only the forthcoming MSRM targets. Consequently, there are no THLB removals associated with existing wildlife tree patches.

6.1.15.2. Future wildlife tree retention

The methodology for determining area removals for wildlife tree retention was prescribed by Dave Mcbeth (Planning Officer, MSRM Kamloops) in an email sent July 29, 2004. To determine the portion of the TFL that requires wildlife tree retention (Zone A), a 500-meter GIS buffer was applied to existing reserves (defined as >75% total reduction) that are age class 4 or greater. OGMAs were included as existing reserves for the purpose of this exercise, even though they are modeled using forest cover requirements rather than a netdown removal.

Draft WTR targets for the biogeoclimatic subzones of the Clearwater landscape unit were provided by Susan Omelchuk, Sustainable Resource Management Planner, MSRM-Kamloops (pers. comm.. October 21, 2004). However, assumptions were required to address two areas of uncertainty around the WTR requirements in TFL18:

1. **The distribution of these targets within TFL18 as opposed to outside TFL18 is not yet determined.** Distribution was assumed to be even for the purposes of timber supply analysis, meaning that the target for TFL18 is based on the proportion of each BGC subzone that occurs within TFL18.
2. **The proportion of these targets that is to be withdrawn from the THLB is not specified for each BGC subzone.** Overall, the THLB should provide 48.3% of the WTR targets in the Clearwater LU. This percentage was applied to all BGC subzones, consistent with guidance from Susan Omelchuk (pers. comm.. October 21, 2004).

Table 11 summarizes the process for determining the netdown for wildlife tree retention. Total WTR targets for each BGC subzone were multiplied by 48.3% to estimate the THLB target. The THLB target in TFL 18 was estimated by multiplying the Clearwater LU THLB target with the proportion of the total area of each BGC subzone that is located within TFL18. This area was netted out of the THLB by applying a uniform % reduction to Zone A—the THLB requiring wildlife tree patches.

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Table 12: Future wildlife tree patch requirements

BGC Subzone	Total area in Clearwater LU (ha)	WTP area target (ha) Total	WTP area target (ha) THLB[1]	% of total area in TFL 18	THLB Target in TFL18	Zone A—THLB requiring WTR (ha)	WTR reduction within Zone A
ESSFdc	6,185	48	23	54%	13	1,232	1.0%
ESSFvv	2,054	0	0	100%	0	151	0.0%
ESSFwc	38,427	868	419	78%	325	6,678	4.9%
ICHmk	10,540	204	99	58%	57	1,566	3.7%
ICHmw	25,711	121	58	19%	11	2,456	0.5%
SBSdw	1,564	7	3	100%	3	49	6.9%
SBSmm	23,912	182	88	87%	76	2,174	3.5%
Total	108,393	1,430	691	63%	486	14,306	3.4%

[1]THLB target is assumed to be 48.3% of the total target (Susan Omelchuk, pers. Comm. October 21, 2004)

6.1.16 Future Roads

To estimate future access requirements (beyond proposed roads), road density in recent cutblocks is extrapolated to the currently inaccessible timber harvesting land base. This procedure follows the steps described below.

Step 1—Buffer the existing road network

To estimate the areas that are currently accessible with current and proposed roads, a 275-meter buffer was applied to the current and proposed road network. This buffer width was estimated by Canfor Staff and approximates the average yarding distance observed on the existing road network of TFL 18. All logging roads were buffered because even though mainlines do not contribute to the future reductions, they contribute to accessibility.

Step 2—Calculate future roads reduction outside the buffered area

The total length of each road class was determined within recent cutblocks (1999-2004). The average degraded width for future roads is the average degraded width of existing class 2-4 roads. The procedure for determining this average is shown in Table 13. For the purposes of this calculation, it is assumed that current levels of deactivation and rehabilitation will persist into the future. This road density was applied as a partial netdown to all areas outside the 275-m buffer.

Table 13: Calculation of the future roads reduction outside accessed (buffered) areas.

Class	Length in recent blocks (km)	Degraded width (m)	Area in-block roads (ha)	Area of blocks (ha)	Future road density
1	0.5	24.9	1.3	9	14.4%
2	12.8	13.6	17.4	509	3.4%
3	19.4	13.5	26.2	601	4.4%
4	39.8	10.2	40.6	1402	2.9%
unroaded	0.0	0	0.0	693	0.0%
All	**72**	**11.8**	**85**	**3,215**	**2.66%**

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Step 3--Calculate future roads reduction inside the buffered area

In addition to future road requirements within non-accessed areas, a small reduction is required in the currently accessed land base to account for access into the non-accessed areas. These non-accessed areas are primarily small isolated patches surrounded by accessed areas. The procedure for calculating the netdown reduction for access into non-buffered areas is summarized in Table 14.

Access roads are assumed to cross the 275-m buffer at an angle of 45 degrees, so each access road is assumed to be 388 m long (the hypotenuse of a 275-m right triangle). The degraded width of these access roads is assumed to be 11m. It was assumed that each non-buffered patches less than 100 ha in size would require one access road, patches between 100 and 1000 ha would require 2 access roads, and patches greater than 1000 ha would require 3 access roads.

The future road reduction was found by dividing the area of future access roads by the gross THLB area inside the 275m buffer. The gross THLB is the sum of the total area of polygons that are wholly or partially available for harvest. It excludes all polygons that have a 100% netdown reduction (e.g. parks) but includes the total area of any polygons that have been partially netted down. The gross THLB is used instead of the net THLB because the length of road required to access a polygon is assumed to be independent of any partial reductions that apply to that polygon. The associated percent reduction is applied to the currently accessed THLB.

Table 14: Procedure for determining the future roads reduction inside currently accessed areas.

Size of contiguous non-accessed Patches	number of patches	number of access roads required per patch	total number of access roads required	Area of Access Roads (ha)	Area inside 275m buffer (ha)	future road reduction within the 275m buffer (ha)
<100 ha	236	1	236			
100-1000 ha	39	2	78			
>1000 ha	5	3	15			
Total	**280**	**1.2**	**329**	**140**	**45761**	**0.31%**

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6.2 Description of the Timber Harvesting Land Base

This section describes the attributes of the THLB. The age distributions by area and volume for the net productive land base and the current timber harvesting land base are given in Table 15, and shown graphically in Figure 2. Ages are projected to January 1, 2004.

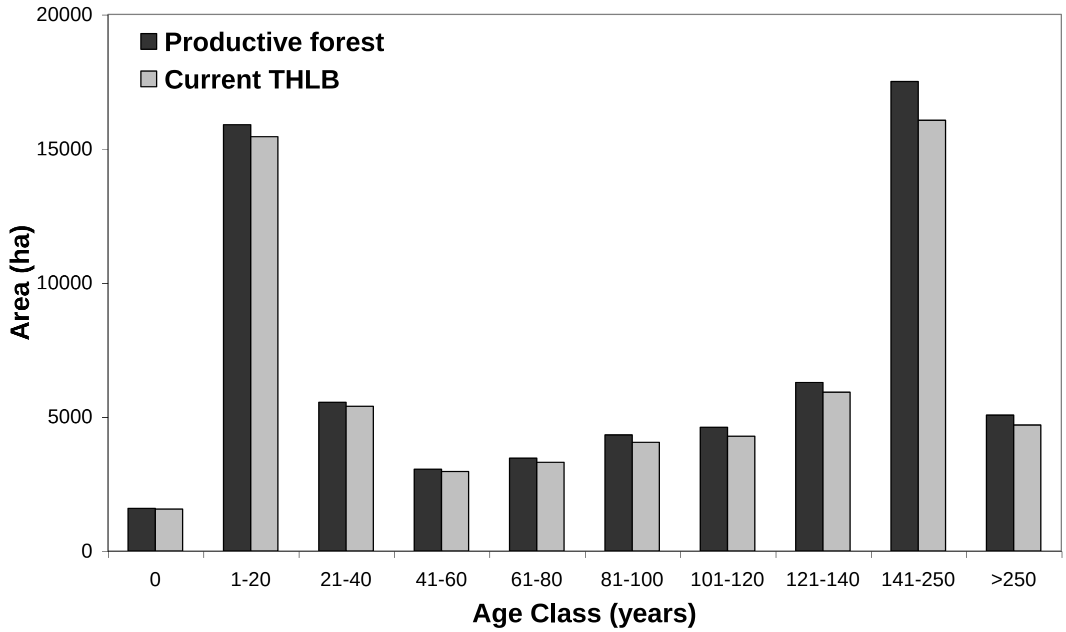

Figure 2: Age distribution by area

Table 15: Age distribution of the THLB by area

	Age Class	THLB Net Area ha	THLB Net Area %	THLB Net Volume m^3	THLB Net Volume %
0	NSR	1,567	2%	0	0%
1	1-20 years	15,464	24%	3,882	0%
2	21-40 years	5,406	8%	52,625	0%
3	41-60 years	2,968	5%	102,083	1%
4	61-80 years	3,321	5%	473,225	4%
5	81-100 years	4,074	6%	732,171	6%
6	101-120 years	4,289	7%	1,266,069	10%
7	121-140 years	5,932	9%	2,113,299	17%
8	141-250 years	16,087	25%	5,835,816	46%
9	>250 years	4,704	7%	1,973,198	16%
	Total	**63,812**	**100%**	**12,552,368**	**100%**

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7 Inventory Aggregation

7.1 Management zones and Multi-Level Objectives

Multiple resource issues may be present on the same forest area. ***FSOS*** can accommodate multiple overlapping resource layers, and therefore does not require that these layers be aggregated into mutually exclusive management zones. A description of the overlapping resource management zones is provided in Section 10—Integrated Resource Management.

7.2 Yield Populations and Analysis Units

Analysis Units are created in order to simplify modeling and interpretation by classifying the inventory into a manageable number of groups with distinct growth and yield attributes. However, aggregating stands into Analysis Units involves averaging of yield curves, and this can create biases in timber supply dynamics. Stands that have fundamentally different roles in timber supply dynamics (e.g. immature versus mature; constrained vs. non-constrained) are separated into exclusive populations to ensure that they do not bias each other during weighted averaging. The process of defining populations for aggregation facilitates yield table averaging while maintaining the integrity of timber supply dynamics.

The following criteria were used to classify the productive land base into populations for development of Analysis Units. The hierarchical classification of the inventory into populations is shown in Table 16.

- **Growth & Yield Model**—Age is the primary criterion that distinguishes modeling with TIPSY and modeling with VDYP. Stands greater than 40 years old are considered naturally regenerated, while stands less than or equal to 40 years old are considered to have been regenerated under managed conditions that makes them better suited to TIPSY modeling. Intermediate Utilization (IU) Balsam stands are spruce and balsam leading stands that were partially cut before 1980. Growth and yield of IU Balsam stands is modeled using a custom methodology developed by JS Thrower and Associates Ltd.
- **Constrained/Non-Constrained**—This criterion is designed to facilitate growth and yield modeling of stands in the non-harvestable land base (100% netdown reduction) and stands that are heavily constrained in OGMAs and No Harvest Lakeshore Management Zones. If the constrained stands were not separated from the non-constrained stands, they would be given equal weight in the averaging yields for Analysis Units even though their contribution to timber supply is minor. This could bias timber supply projections.
- **Age**—Stand growth is dynamic and variable during stand ages of 40-140 years, while growth beyond this age range is characterized by gradual approach to a flat-line volume yield. To avoid mutual bias effects during yield table aggregation, non-constrained VDYP stands are split into immature (41-100 years old) and mature (>100 years) populations. Immature NSYTs are aggregated based on yield table similarity in the 41-140 year range, while Mature NSYTs are aggregated based on yields at age >140 years. This approach ensures that stands are aggregated based on the section of the yield curve that they would likely get harvested on (i.e. the >140 year section of the yield table is essentially irrelevant to 41-100 year old stands).
- **Deciduous**—TIPSY does not model growth and yield of deciduous species, and is not calibrated for growth of minor coniferous cover in mixed stands. Stands leading in deciduous tree species are modeled using VDYP and are isolated for this purpose in a separate

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population. The exception to this rule is deciduous-leading stands that are less than 21 years old: Although the inventory reports deciduous cover, Canfor is required by law to establish free-growing coniferous stands on these polygons. Consequently, these young deciduous stands are excluded from the Deciduous NSYT population and are transferred to the Existing MSYT population. Growth and Yield assumptions for young deciduous stands are given in Section 8.5.4.

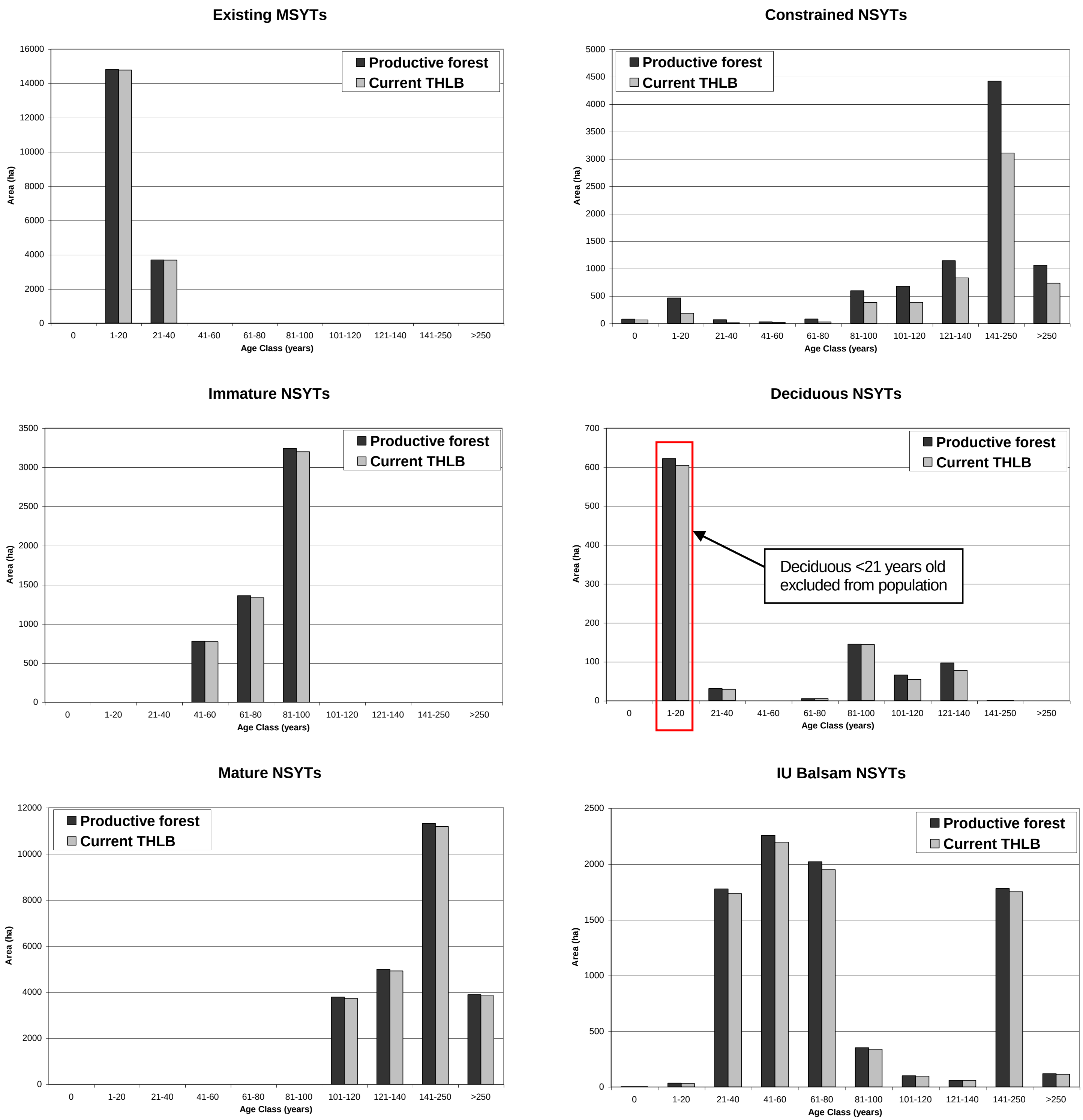
Table 16: Criteria used to classify the productive land base into populations for development of Analysis Units.

Constraint[1]	Leading Tree Species	Age	Population	Growth & Yield Model
Non-Constrained	n/a	0	Future MSYTs	TIPSY
	Conifer-leading	1-40	Existing MSYTs	
		41-100	Immature NSYTs	VDYP
		>100	Mature NSYTs	
	Deciduous-leading	>21	Deciduous NSYTs	
	Sx/Bl with Partial cutting history	All	IU Balsam	Custom
Constrained	Any	All	Constrained NSYTs	VDYP

*Constrained indicates that the stand is generally non-harvestable due to 100% netdown reduction or placement in OGMAs or "No Harvest" Lakeshore Management Zones.

The current age structure of these populations is shown in Figure 3. Development of the Natural and Managed Stand Yield Tables was integral to the process of aggregating the inventory into Analysis Units. For this reason, the methods and results for Analysis Units are described in Section 8—Growth and Yield.

Figure 3: Current age structure of the yield populations.



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8 Growth and Yield

This section describes the models and assumptions used to create yield tables and Analysis Units. Natural and Managed Stand Yield Tables for all Analysis Units are provided in Appendix E.

8.1 General Growth and Yield Assumptions

This section describes growth and yield issues that apply to both Natural and Managed Stand Yield Tables.

8.1.1 Utilization Levels

Table 17 identifies the utilization levels that will be used in the development of the yield tables. Indicated values reflect current operational practices.

Table 17: Utilization levels for both natural and managed stands

Species	Min DBH (cm)	Utilization Stump Height (cm)	Top DIB (cm)	Firmwood Standard (%)
Lodgepole pine	12.5	30	10	50
Other species	17.5	30	10	50

8.1.2 Volume Reductions

Volume reductions are typically used in timber supply analysis to account for non-merchantable components of otherwise merchantable stands. DWB and OAF 2 reductions to VDYP and TIPSY curves, respectively, account for coniferous non-merchantable species groups. Delivered volumes of deciduous wood for TFL 18 are shown in Table 18.Canfor utilizes the deciduous component within economic conifer stands, and so there are no deciduous volume reductions. The base case will include utilization of deciduous volume, and a sensitivity analysis will test the impact of this assumption on timber supply.

Table 18: Delivered deciduous volume on TFL18 for the period 1998-2003

Year	AS Stratum Sales (m^3)
1998	1,709
1999	4,317
2000	310
2001	35
2002	1,088
2003	8,338
Total	**15,797**
Annual Average	**2,633**

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8.2 VDYP vs. TIPSY for Existing Stands

VDYP is calibrated to project stands according to the average volume yields observed in british Columbia. In contrast, TIPSY projects stand growth according to the full potential of the site. As a result, VDYP returns lower volumes for a given species and site quality than TIPSY, and the decision between models is an important one. Planting activity was the primary criterion used to determine the age at which stands will be modeled with TIPSY. Figure 4 shows the net area of stands established after 1960 and the proportion of this area reported as planted in silviculture records. Although these data are not reliable for exact information, they can be used to draw some general conclusions.

Planting was first performed on a substantial proportion of harvested area in 1964, on stands that are now 40 years old. After 1971, planting was consistently conducted on more than 50% of harvested areas. This 7-year period can be considered a transition between natural and managed stand conditions. The correct choice of model for these stands is ambiguous, and TIPSY was chosen under the assumption that these stands may have received stand tending management during the 1970s and 1980s. The risk associated with an error in this assumption is small since stands in the 34-40 year age range cover only 1,486 ha, which represents 6.6% of stands <40 years old and 2.3% of the net area of TFL18.

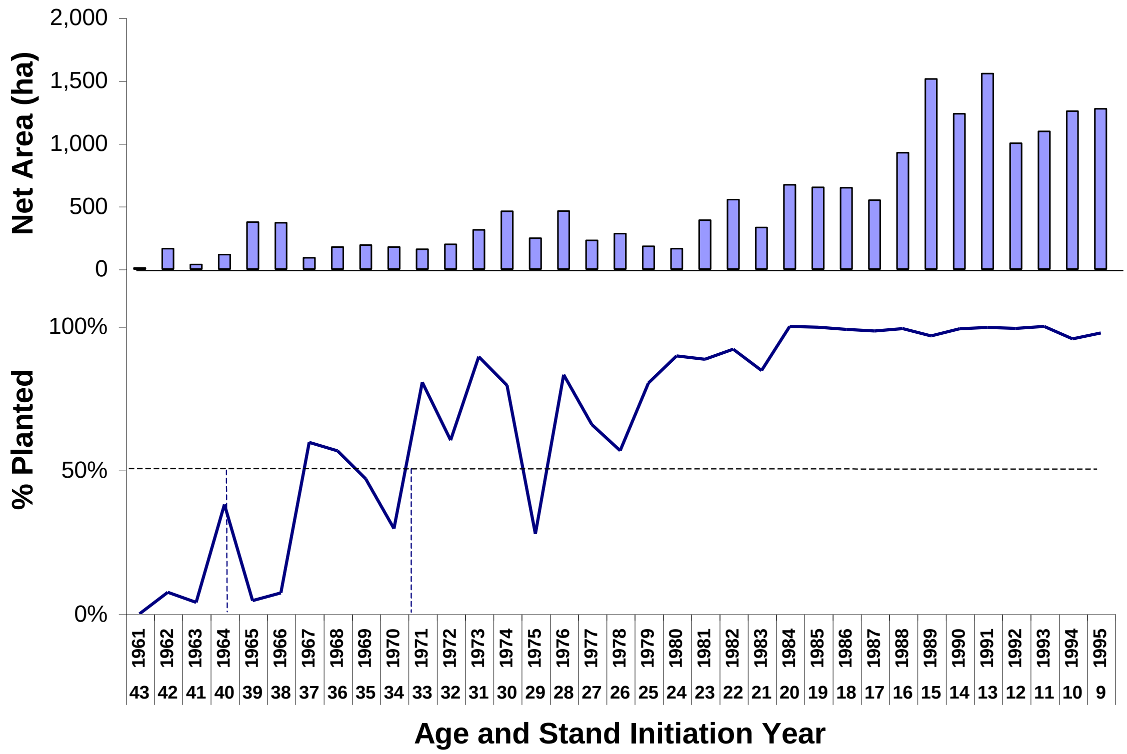

Figure 4: THLB Area of stands established after 1960, and the proportion of this area reported as planted in silviculture records. The period 1964-1971 shows a transition from natural to managed stands.

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8.3 Natural (Unmanaged) Stand Yield Tables

The following section describes the methods used to develop the natural stand yield tables that will be used in the timber supply analysis for TFL 18. Natural stands are defined as all polygons that were established 1963 or earlier (>40 years old), or leading in deciduous species.

8.3.1 Existing Natural Timber Volumes

Mature and unmanaged immature stand volumes reported in this information package were projected to January 1, 2004 using *BatchVDYP version 6.6d*.

8.3.2 Site Index Estimates for Natural Stands

Site index estimates for Natural Stands are calculated within the Forest Cover Inventory based on height and age. Table 19 describes the source of the site index equations utilized in VDYP, Version 6.6d to generate yield information for the TFL.

Table 19: Source of site index equations

Species	Code	Site Curve Reference
Lodgepole pine	Pli	Goudie (1984)
White spruce	Sw	Goudie (1984)
Douglas-fir	Fdi	Thrower and Goudie (1991)
Balsam	Bl	Kurucz (1982)
Western hemlock	Hw	Wiley (1978)
Western redcedar	Cw	Kurucz (1985)
Western white pine	Pw	Curtis *et al.* (1990)
Western larch	Lw	Milner (1989)
Trembling aspen	At	Alberta Forest Service (1985)
Paper birch	Ep	Alberta Forest Service (1985)

8.3.3 Decay, Waste and Breakage (DWB)

Inventory and yield table volumes generated using VDYP are net of DWB using forest inventory zone (FIZ) G and loss factors for special cruise 318.

8.3.4 IU Balsam Stands

In his rationale for the MP9 AAC determination, the Chief Forester noted the uncertainty associated with the growth and yield of residual spruce and balsam stands originating from Intermediate Utilization (IU Balsam stands). To address these concerns, Canfor initiated a multi-year growth and yield project in 2001 to support the timber supply analysis for MP10. This project culminated in the development of custom yield tables for the IU Balsam population, which covers 12.5% of the productive area TFL. The final report for the IU Balsam Yield curves, plus documentation of the agency review and approval process, are attached as Appendix B.

8.3.5 Analysis Units

The yield tables created in *BatchVDYP version 6.6d* to project the inventory are also used as the basis for timber supply modeling of natural stands. Given that there is one yield curve for every forest cover polygon, it is pragmatic to aggregate similar yield curves into Analysis Units. The objective of NSYT aggregation was to reduce the number of yield tables to a manageable number while still maintaining the spatial variability of productivity on the land base. The approach of compiling a yield table for each forest cover polygon and using these to define the analysis unit ensures that variability of yields within the Analysis Units is minimized. Development of the NSYT Analysis Units proceeded in the following steps:

1. Polygons were classified in inventory populations (see Section 7—Inventory Aggregation);
2. Polygon NSYTs within each inventory population were mathematically aggregated into 5 or 6 Analysis Units based on their similarities in volume yield (K-means clustering);
3. Averaged NSYTs were calculated for each analysis unit. Productive area was used as the basis for area weighting. Isolating the non-harvestable (non-THLB) polygons in the "Constrained" population of yield tables means that the net area of the other populations is almost identical to the productive area (see Figure 3 in Section 6.2). This approach ensures that there are minimal aggregation errors associated with using productive area vs. net THLB area for area weighting.

Each NSYT Population was classified into 5 or 6 productivity groups, except for the IU Balsam population, which was split into 12 groups. The higher refinement of the groupings in the IU Balsam population is required because the origin of the curves in this population occurs throughout the 300-year age range of the yield tables. This is an artefact of the methodology used to create the IU Balsam (see Appendix B).

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Table 20:Summary statistics for the NSYT Analysis Units. Naming conventions are based on population and productivity

NSYT Population	Productivity Class	AU	Productive Area (ha)	Culmination MAI (m^3/ha/yr)	Maximum Volume (m^3/ha)
Constrained	Marginal	**11**	1,025	0.8	204
	Very low	**12**	2,012	1.4	324
	Low	**13**	1,891	2.0	405
	Medium	**14**	1,805	2.4	459
	High	**15**	1,470	3.0	520
	Very high	**16**	393	3.9	593
Deciduous	Very low	**21**	79	0.8	144
	Low	**22**	117	1.6	242
	Medium	**23**	320	2.2	331
	High	**24**	274	2.6	380
	Very high	**25**	177	3.2	433
Immature	Very low	**31**	561	1.1	258
	Low	**32**	2,040	1.8	381
	Medium	**33**	1,060	2.4	427
	High	**34**	1,345	3.0	490
	Very high	**35**	368	4.1	575
IU Balsam	n/a	**41**	565	1.1	288
		42	101	0.7	326
		43	914	3.6	338
		44	17	0.5	342
		45	638	1.3	348
		46	651	1.6	393
		47	2,159	2.1	402
		48	1,746	2.4	413
		49	43	4.9	458
		50	1,219	3.3	459
		51	378	3.8	500
		52	43	2.2	500
Mature	Marginal	**61**	1,352	1.2	275
	Very low	**62**	5,315	1.8	373
	Low	**63**	7,411	2.3	425
	Medium	**64**	5,113	2.7	485
	High	**65**	3,780	3.5	538
	Very high	**66**	1,001	3.9	658

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8.4 Managed Stand Yield Tables

This section describes the data sources and methods used to develop both existing and future managed stand yield tables (MSYTs). Sections 8.5 and 8.6 describe methods that are specific to existing and Future MSYTs, respectively.

8.4.1 Site Index Estimates for Existing and Future Managed Stands

As part of the Site Index Adjustment (SIA) project, Canfor has developed improved estimates of potential site index (PSI) (J.S. Thrower & Associates Ltd. 2002). documentation of the agency review and approval process is included in Appendix B. The yield tables for existing and future managed stands incorporate PSI, except in stands >1550 meters in elevation where inventory site index is used.

The site index adjustment involves three major steps:

(1) Using expert judgement to make preliminary estimates of site index for each site series. This step creates variability based on expert's subjective understanding of how site index varies with site series;
(2) Field sampling to measure the actual site index in regenerating young stands of known site series; and
(3) Adjusting the preliminary estimates of potential site index based on the field sample. Because a single adjustment factor is applied, this step corrects for bias in the preliminary estimates but does not alter the pattern of variability between site series.

An adjustment equation was developed for Pl and applied to the target population of site series below 1550 meters in elevation (eqn. 1). MoF site index conversion equations were used to estimate the PSI for Sx, Bl, and Fdi based on the PSI estimates for Pl. The adjusted PSI for Pl is shown for each site series in Table 21.

$$\text{[eqn. 1] adj. } PSI_{Pl} = 1.047 * \text{Prelim. } PSI_{Pl}$$

Table 21: Adjusted Potential Site Index for Pl growing at elevations <1550m, by site series

Site Series	ESSFwc2	ESSFdc2	SBSmm	SBSdw1	ICHmk2	ICHmw3
01	18.8	18.3	22.0	22.0	22.0	22.0
02	13.6	12.6	14.7		15.7	16.8
03	16.8	16.8	17.8	17.8	17.8	19.9
04	17.8	17.8	20.9	19.9	23.0	20.4
05	17.8	17.8	19.4	20.9	24.6	22.0
06	19.4	19.9	21.5	23.6	19.9	23.0
07	20.9	18.8	23.0	22.5		25.1
08	17.8	16.8	19.9	25.1		20.9
09	12.6		12.6	19.9		12.6
10	11.5					
91		13.6				
93	18.8					
94	17.8					

Site Index is a species-specific measure, and a "common currency" must be established before finding the average site index within a population that contains more than one leading species. To find the average site index for each MSYT analysis unit, all site indices were first converted to Pl site index. Pl was used as the site index reference species for all stands during data entry into WinTIPSY.

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8.4.1.1. Accounting for conflicts between TEM and the Forest Cover

Both Terrestrial Ecosystem Mapping and the Forest Cover Inventory are used to develop the yield tables for this analysis. Non-productive areas such as lakes and rock outcrops are identified by both Terrestrial Ecosystem Mapping and the Forest Cover Inventory. However, due to the subjectivity of air photo delineation, there are some small discrepancies in the linework delineating non-productive areas. To ensure consistency between the TEM and the forest cover inventory, the forest cover is used as the sole basis for identification of non-productive areas. The distribution of productive site series in TEM polygons was adjusted to avoid double counting of non-productive areas.

8.4.2 Operational Adjustment Factors

The TIPSY program allows the use of operational adjustment factors (OAFs) to reduce the gross volumes of regenerated stands. There are two OAFs applied in TIPSY: OAF1 and OAF2. OAF1 allows for yield reductions associated with uneven spacing of crop trees (clumping), and endemic and random loss. OAF2 allows for volume losses due to maturity, attributable to DWB factors. In the construction of the MSYTs, standard OAFs were applied as follows:

- OAF 1: 15% for all species; and
- OAF 2: 5% for all species.

8.4.3 Silviculture Management Regimes

Spacing and fertilization are not practiced on TFL 18 at scales that warrant incorporation into managed stand yield tables (Canfor, Management Plan 10, Section 4.6—Silviculture).

8.4.4 Regeneration Delay

Net Regeneration delay in timber supply analysis is the time gap between harvest and seedling germination of post-harvest regenerating trees. Current practices regarding regeneration delay were assessed from silviculture survey records for the period 1999-2003. A summary of the assessment of regeneration delay is given in Table 22. The following general comments can be made about regeneration delay on TFL 18:

- Blocks planted with 1+0 stock achieve regenerated status after approximately 2 years. Accounting for the age of the planted seedlings, this corresponds to a regeneration delay of one year;
- Blocks planted with 2+0 stock achieve regenerated status after approximately 1.5 years. Accounting for the age of the planted seedlings, this corresponds to a regeneration delay of zero years;
- Blocks in the ESSF biogeoclimatic zone are predominantly planted with 2+0 stock. 2+0 stock is also regularly planted in the SBSmm variant, but other biogeoclimatic units are predominantly planted with 1+0 stock.
- Regeneration delay for MSYT Analysis Units will reflect the weighted average net regeneration delay of the biogeoclimatic units that make up the analysis unit.

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Table 22: Calculation of weighted average regeneration delay by BGC Variant

BGC Variant	1 + 0 Stock Regen Delay (months)	1 + 0 Stock Net Delay* (months)	1 + 0 Stock # Sample Areas	2 + 0 Stock Regen Delay (months)	2 + 0 Stock Net Delay* (months)	2 + 0 Stock # Sample Areas	Average Net Delay Months	Average Net Delay Years
SBSmm	26	14	40	17	-7	17	8	1
SBSdw1	21	9	14	-	-	-	9	1
ICHvk1	19	7	2	31	7	1	7	1
ICHmw3	19	7	9	-	-	-	7	1
ICHmk2	24	12	20	11	-13	2	10	1
ESSFwc2	17	5	9	17	-7	20	-3	0
ESSFdc2	23	11	1	18	-6	2	0	0
SBS/ICH	24	12	85	17	-7	20	8	**1**
ESSF	18	6	10	17	-7	22	-2	**0**

8.5 Existing Managed Stand Yield Tables

8.5.1 Existing Managed Timber Volumes

Timber volumes reported in this information package are derived from the inventory, which has been projected using *BatchVDYP version 6.6d*. However, growth and yield of managed stands for timber supply analysis is modeled using WinTIPSY version 3.0. Using different models to calculate volume for the inventory and the timber supply projection creates a discrepancy between reported immature growing stock and the initial growing stock at the first period of the planning horizon. Further details on this difference are provided in Section 8.7—Existing Timber Volume Check

8.5.2 Existing MSYT Analysis Units

Analysis Units for Existing MSYTs were developed using K-means clustering, a multivariate statistical method that groups objects based on similarities in selected attributes. Clustering proceeded in two stages. First, resultant polygons were classified into three groups based on coniferous species composition: pine-dominated (4,123 ha); spruce/balsam-dominated (9,557 ha), and mixed (4,815 ha). The species groups were then classified based on site index (decile-weighted Potential Site Index except for stands located above 1550m elevation) into 8 groups each. Groups with very high and very low site index tended to be very small (<100 ha), and so were grouped with their nearest neighbour. Grouping high and low sites resulted in 5 to 6 site groups per species group, for a total of 17 Existing MSYT Analysis Units. The average site index and species composition of these Analysis Units is shown in Table 23.

8.5.3 Stand Assumptions

Site index was assigned to individual resultant polygons based on the component site series in that polygon. Polygons located above 1550m were assigned site index based on the inventory site index for leading species, and converted to Pl site index using MoF site index conversion equations. Site index of Analysis Units is the area-weighted average of the resultant polygons in each AU.

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The deciduous component of Existing MSYTs is modeled in VDYP. Consequently, species composition was separated into the coniferous and deciduous components of each polygon, and the coniferous percents were adjusted to add up to 100 percent for input into TIPSY. The final Analysis Unit yield table is the weighted average of the deciduous and coniferous yield tables modeled separately in TIPSY and VDYP.

Table 23: Average site index and species composition of the Existing MSYT Analysis Units

Analysis Unit	Net Area[1] (ha)	Site Index (m)	Species Composition of Coniferous Component (%)[2] Pl	Sx	Bl	Fd	Hw	Cw	Total Conifer %	Total Decid %
102 Existing Pine very low	157	15.3	92	3	5	0			100%	0%
103 Existing Pine low	682	17.9	92	5	3	0			97%	3%
104 Existing Pine medium	508	19.2	90	6	3	1		0	94%	6%
105 Existing Pine high	2,044	21.7	89	6	3	2	0	0	93%	7%
106 Existing Pine very high	732	22.5	86	7	3	2		1	92%	8%
107 Existing Spruce marginal	401	11.1	2	62	35	0			100%	0%
108 Existing Spruce very low	1,778	14.3	1	72	27	0			99%	0%
109 Existing Spruce low	1,973	18.1	3	70	25	1		0	99%	1%
110 Existing Spruce medium	2,671	19.0	2	77	20	0		0	99%	1%
111 Existing Spruce high	2,453	22.0	7	71	20	1	0	1	95%	5%
112 Existing Spruce very high	281	23.8	4	72	15	7	0	3	90%	3%
113 Existing Mixed marginal	43	13.5	40	42	12	6			98%	2%
114 Existing Mixed very low	381	17.8	37	34	17	7	1	5	99%	1%
115 Existing Mixed low	885	18.9	41	35	18	4	0	2	98%	2%
116 Existing Mixed medium	2,701	21.9	30	29	14	19	0	8	93%	6%
117 Existing Mixed high	631	22.6	33	29	18	17	0	4	93%	7%
118 Existing Mixed very high	175	24.1	29	24	21	19	0	7	95%	5%

[1]THLB area prorated to the decile proportion of each site series in TEM polygons.

[2]TIPSY models only coniferous species. The deciduous component is modeled separately in VDYP. The final AU yield table is the weighted average of the deciduous and coniferous components.

Deciduous volumes are modeled using a single yield table that reflects the average attributes of deciduous stands in TFL18. The WinVDYP1.1 inputs and outputs for this deciduous table are shown in Table 24.

Table 24: WinVDYP1.1 inputs and outputs for the yield table used to model the deciduous component of MSYT analysis units

Stand Attribute	WinVDYP Input
Species composition:	At91Ep8Dr1
Site Index (m)	20.3
Crown Closure	57%
Stocking Class	0
Utilization (cm)	12.5+

Stand Attribute	WinVDYP Output
Culmination Volume (m^3/ha)	176.0
Culmination Age (years)	86
Culmination MAI (m^3/ha/yr)	2.47
Maximum Volume (m^3/ha)	236.2

All Existing MSYTs are assumed to be planted, with subsequent ingress equivalent to an initial density of 2000 stems per hectare (20-25% ingress). Regeneration delay was set at zero for all analysis units, as inventory age should reflect age of germination.

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Zero genetic gain is assumed for Existing MSYT analysis units. Although recent planting programs have incorporated genetically improved stock, associated genetic gains associated with Existing MSYT analysis units are assumed to be insignificant for the purposes of timber supply analysis.

8.5.4 Deciduous Stands <21 Years Old

As noted in Section 7.2, Canfor is required by law to establish free-growing coniferous stands on cutblocks harvested during and after 1987. Although the inventory may report leading deciduous cover, these stands are more appropriately modeled using a conifer-leading TIPSY yield table.

The attributes of the deciduous-leading NSYT analysis units are shown in Table 25. Although inventory site index was highly variable within the deciduous NSYT population, average Potential Site Index is similar across all young deciduous AUs. The average conifer composition is also similar across deciduous analysis units. Uniform site index and conifer composition means that all five deciduous analysis units can justifiably be modeled using a single MSYT. Rather than creating a special TIPSY curve for these stands, the MSYT for "existing_mixed_medium" analysis unit (AU 116) was assigned to the young component of deciduous analysis units. Table 25 shows that the TIPSY inputs for AU 116 are sufficiently close to the average attributes of the Deciduous NSYTs.

Table 25: Average attributes of the young (<21 year old) stands within Deciduous NSYT Analysis Units. TIPSY inputs for the AU 116 (existing_mixed_medium) MSYT are also shown for comparison.

Analysis Unit (age <21 years only)	**Net Area (ha)**	**Deciduous %**	**Average PSI (m)**	**Average Conifer Composition**					
				Pl	**Sx**	**Bl**	**Fd**	**Hw**	**Cw**
Deciduous_very low	28	36%	22.0	38%	11%	8%	38%	0%	6%
Deciduous_low	44	56%	21.8	55%	35%	2%	8%	0%	0%
Deciduous_medium	199	48%	22.1	35%	36%	12%	14%	1%	0%
Deciduous_high	208	49%	22.2	39%	30%	21%	10%	0%	0%
Deciduous_very high	123	50%	21.7	40%	33%	6%	21%	0%	0%
Deciduous Average	**602**	**49%**	**22.0**	**39%**	**32%**	**13%**	**15%**	**0%**	**1%**
Existing_mixed_medium	2,701	6%	21.9	30%	29%	14%	19%	0%	8%

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8.6 Future Managed Stand Yield Tables

8.6.1 Genetic Gain Allowances

As a result of an on-going tree improvement program, a volume increase is expected for stands regenerating from genetically improved stock. The seed planning and registry (SPAR) system was used to summarize the genetic worth of seedlings ordered for TFL18 in the 2004 sowing year. Table 26 shows the weighted average volume adjustments applied to Future MSYTs.

Table 26: Genetic gain forecasts for seed stock ordered for TFL 18 for the 2004 sowing year.

		Seedlings requested (000's)					
Species	**Seed Planning Zone**	**Class A**	**Class B+**	**Class B**	**Total**	**% improved seed**	**Genetic Worth***
Pli	PG	0	456.7	0	456.7	100%	3%
Sx	PGN	400.7	0	0	400.7	100%	12%
		400.7	456.7	0	857.4	100%	

*Weighted average genetic worth for all seedlots

8.6.2 Regeneration Assumptions

Regeneration assumptions for future managed stands in previous timber supply analyses were linked to the attributes of the harvested stand. Terrestrial Ecosystem Mapping provides the opportunity to assign ecosystem-based regeneration assumptions to post-harvest regenerated stands in timber supply modeling. FESL and Canfor staff collaborated to develop regeneration assumptions for each site series on TFL 18 using silvicultural data and expert opinion of Canfor field staff. Site series-specific species composition and stand density information are provided in Appendix C.

8.6.2.1. Yield Groups

There are 50 site series that contribute to timber supply in TFL18. To simplify the process of developing yield tables, site series with similar TIPSY inputs were combined. Site series aggregation produced 18 "yield groups" based on similarities in regeneration assumptions, namely species composition, initial density, and productivity (Potential Site Index). The process of aggregation was exploratory and included mathematical methods (hierarchical clustering) and subjective judgement. Membership of site series in yield groups is given in Appendix C. Yield groups are labelled using the letters *a* through *r* and are named after the site series with the largest net area.

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8.6.2.2. Species composition

Species composition of Future Analysis Units was calculated in the same way as Existing MSYT Analysis Units: species composition was separated into the coniferous and deciduous components of each polygon, and the coniferous percents were adjusted to add up to 100 percent for input into TIPSY. The final Analysis Unit yield table is the weighted average of the deciduous and coniferous yield tables modeled separately in TIPSY and VDYP. Species composition of Future MSYTs is shown in Table 27.

Table 27: Average species composition of the Future MSYT Analysis Units

Yield Group	Primary Site Series	Net Area[1] (ha)	Species Composition of Coniferous Component (%)[2] Pl	Sx	Bl	Fd	Cw	Hw	Total Conifer %	Total Decid %
a	ESSFvv/all	1,548		50	50				100	
b	ICHmw3/04	860	57	1		38	5		88	12
c	ESSFwc2/02/09	308	81	1	18	0			100	
d	ESSFdc2/01	2,485	97	2	1	1			100	
e	ICHmw3/01	2,569	19	31		50	0		100	
f	ICHmw3/06	1,221	7	11		21	51	10	98	2
g	ESSFwc2/01	20,528	5	76	19		0		100	
h	ICHmk2/01	4,984	18	72	1	8			100	
I	SBSdw1/08/09	140	20	60	15	5			100	
j	SBSdw1/01	888	40	40		20			100	
k	SBSmm/01	16,873	44	51	4	1			99	1
l	ESSFwc2/08	1,510	20	40	40				100	
m	ESSFwc2/05	5,063	40	20	40				100	
n	ICHmk2/03	717	50			50			100	
o	ESSFdc2/05	793	74	25	1				100	
p	SBSmm/08	1,034	45	45	10				100	
q	SBSmm/05	1,191	45	52	3				97	3
r	ICHmw3/05	345	3	1		96			100	

[1]THLB area of the component site series taking into account the proportion (decile) of each TEM polygon occupied by the site series
[2]TIPSY models only coniferous species. The deciduous component is modeled separately in VDYP.

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8.6.2.3. Stand Density and Regeneration Delay

Regeneration delay was calculated as the weighted average of the regeneration delay associated with the biogeoclimatic variants in each analysis unit (see Table 22). Initial density was estimated based on site series specific silviculture surveys and local knowledge of free growing stands. To facilitate modeling of genetic gains from planted seedlings, all yield tables were modeled as "planted" in TIPSY, but genetic worth was prorated to reflect the amount of ingress in each analysis unit. Regeneration inputs for Future MSYT Analysis Units are summarized in Table 28.

Table 28: Calculation of average stand attributes of the Future MSYT Analysis Units

Yield Group	Primary Site Series	Regen Delay (years)	Planted Density (sph)	Estimated % Ingress[2]	Initial Density (sph)[1]	Prorated genetic worth	
						Pl	SxBl[3]
a	ESSFvv/all	0	1500	0%	1500	3.0%	6.0%
b	ICHmw3/04	1	1216	12%	1374	2.7%	10.6%
c	ESSFwc2/02/09	0	1497	0%	1497	3.0%	0.4%
d	ESSFdc2/01	0	1492	0%	1492	3.0%	8.5%
e	ICHmw3/01	1	1200	42%	2083	1.7%	6.9%
f	ICHmw3/06	1	1200	55%	2653	1.4%	5.4%
g	ESSFwc2/01	0	1498	40%	2486	1.8%	5.8%
h	ICHmk2/01	1	1224	56%	2791	1.3%	5.2%
I	SBSdw1/08/09	1	1400	0%	1400	3.0%	9.6%
j	SBSdw1/01	1	1400	21%	1770	2.4%	9.5%
k	SBSmm/01	1	1400	34%	2110	2.0%	7.4%
l	ESSFwc2/08	0	1500	0%	1500	3.0%	6.0%
m	ESSFwc2/05	0	1500	68%	4634	1.0%	1.3%
n	ICHmk2/03	1	1200	46%	2225	1.6%	
o	ESSFdc2/05	0	1500	0%	1500	3.0%	11.5%
p	SBSmm/08	1	1400	0%	1400	3.0%	9.8%
q	SBSmm/05	1	1400	53%	2953	1.4%	5.4%
r	ICHmw3/05	1	1200	29%	1692	2.1%	8.5%

[1]the estimated initial density of crop trees based on silviculture records of total, well-spaced, and free-growing density at free-growing age.

[2]The estimated proportion of the initial density that results from natural regeneration

[3]Sx is used as a proxy for Bl in TIPSY. However, Bl seedlings have no genetic gain and the genetic worth entered into TIPSY must be reduced to account for the proportion of Sx that represents Bl. Therefore genetic worth of Sx is prorated both for ingress and for species composition.

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8.6.2.4. Site Index

Inventory site index is used for stands above the 1550m elevation boundary. Several Existing Managed MSYT and Future MSYT Analysis Units cross the 1550m elevation boundary. Where this occurs, the Analysis Unit site index is the average of inventory SI and PSI weighted by the relative area above and below 1550m. A summary of this calculation for Future MSYT Analysis Units is shown in Table 29

Table 29: Calculation of Average Site index for Future MSYT Analysis Units, incorporating inventory site index for stands located above 1550m elevation.

Yield Group	Primary Site Series	PSI of Pl (m)	Average inventory Pl site index >1550m	% of net area >1550m	Weighted average Reference Site Index (m)
a	ESSFvv/all		13.8	100%	**13.8**
b	ICHmw3/04	17.6			**17.6**
c	ESSFwc2/02/09	16.3	14.9	40%	**15.7**
d	ESSFdc2/01	16.6	14.3	50%	**15.5**
e	ICHmw3/01	18.3			**18.3**
f	ICHmw3/06	18.7			**18.7**
g	ESSFwc2/01	16.9	14.9	35%	**16.2**
h	ICHmk2/01	18.9	11.0	1%	**18.7**
I	SBSdw1/08/09	20.1			**20.1**
j	SBSdw1/01	19.5			**19.5**
k	SBSmm/01	18.6			**18.6**
l	ESSFwc2/08	16.5	13.6	30%	**15.6**
m	ESSFwc2/05	16.6	15.2	47%	**15.9**
n	ICHmk2/03	17.6			**17.6**
o	ESSFdc2/05	15.3	14.3	65%	**14.7**
p	SBSmm/08	19.6			**19.6**
q	SBSmm/05	17.6			**17.6**
r	ICHmw3/05	16.9			**16.9**

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8.6.3 Analysis Units for Future Managed Stands

Each site series is in a Yield Group and has an associated future MSYT. However, resultant polygons in the TFL18 database have up to three site series in varying proportions, due to the conventions of terrestrial ecosystem mapping. There are hundreds of combinations of yield groups in the database, so pro-rating the yield groups into the resultant polygons produces hundreds of yield tables. To simplify analysis, these tables were aggregated into analysis units using a similar method used for the NSYTs: Polygon MSYTs were mathematically aggregated into 12 Analysis Units based on their similarities in volume yield (K-means clustering), and net area-weighted average MSYTs were calculated for each analysis unit. Aggregation results are shown in Table 30 and Figure 5.

Table 30: Summary of Analysis Unit yield tables derived by aggregating polygon Future MSYTs.

Analysis Unit	Net Area (ha)	Culmination MAI (m^3/ha/yr)	Culmination Age (years)	Culmination Volume (m^3/ha)	Culmination Height (m)
201Future_submarginal	82	0.7	100	69	5
202Future_marginal	87	1.4	90	123	9
203Future_very low	347	2.1	100	211	16
204Future_low_late	4,671	2.7	100	271	21
205Future_low_early	5,518	2.9	110	322	24
206Future_medium_late	23,062	3.2	105	340	25
207Future_medium_mid	4,753	3.3	95	315	25
208Future_medium_early	23,146	4.0	85	340	24
209Future_high	1,321	3.6	105	375	27
210Future_very high	748	4.2	110	465	28
Average	**63,734**	**3.46**	**97**		

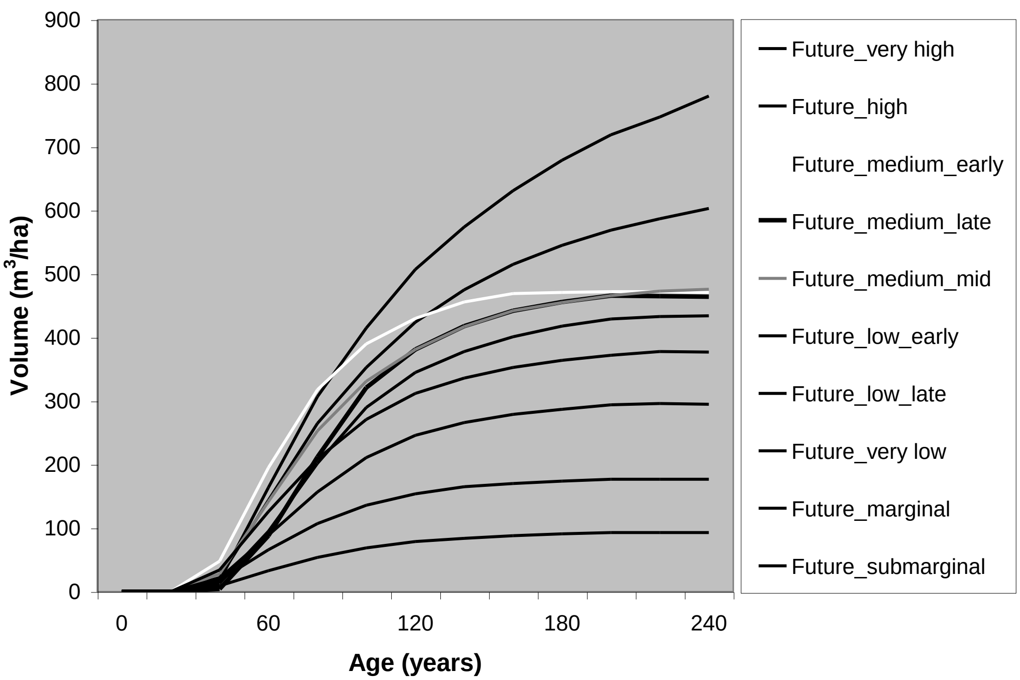

Figure 5: average MSYTs assigned to Future MSYT Analysis Unit

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8.6.4 Not Satisfactorily Restocked (NSR)

Canfor has successfully regenerated all backlog NSR (harvested pre-1987) in TFL 18. The net area of current NSR is 1,520 ha. For the purposes of Timber Supply Analysis, all current NSR will be regenerated according to the site series-based Future MSYT Analysis Units. A summary of current NSR is provided in Table 31.

Table 31: Area of current NSR by BGC Variant

BGC variant	Productive Area (ha)	Net Area (ha)
ESSFdc2	80	80
ESSFvv	1	1
ESSFwc2	307	306
ICHmk2	270	270
ICHmw3	17	17
SBSdw1	266	266
SBSmm	585	580
Total	**1,525**	**1,520**

8.7 Existing Timber Volume Check

Aggregation of yield tables or inventory attributes into Analysis Units can create biases in reported volumes if not done correctly. An existing timber volume check provides a simple means of verifying that unacceptable biases have not been created during the creation of Analysis Units and their yield tables. This check involves finding the interpolated volume of resultant polygons on their respective analysis unit yield tables, and comparing this volume to the inventory. A total difference of less than 2% across the land base is generally considered acceptable.

Table 32: Existing inventory check.

	Productive volume (1000 m^3)		% Difference from
Population	Inventory	AUs	inventory
NSR	0	0	n/a
Existing MSYTs	16	48	195%
Deciduous NSYTs	74	68	-7%
Immature NSYTs	900	907	0.8%
Mature NSYTs	8,926	8,764	-1.8%
IU Balsam	956	1,154	21%
Constrained NSYTs	2,520	2,481	-1.5%
Total	**13,391**	**13,423**	**0.2%**

The results of the existing timber volume check between the analysis unit volumes and the polygon-specific inventory volumes are summarized by analysis unit populations in Table 32. Overall, there is a 0.2% difference between current volume reported in the inventory and calculated from the analysis unit yield tables. Analysis unit volumes for Existing MSYTs are three times greater than the inventory. This likely reflects the difference between stand modeling with TIPSY and potential site index (PSI) for the Existing MSYTs, as opposed to VDYP and inventory site index used for inventory projection. Immature NSYTs show a small overestimate, while deciduous, mature and constrained NSYTs tend to slightly underestimate volume. Volume of IU Balsam AUs is 21% higher than the VDYP-generated inventory: a result of the different methodology used to create the IU Balsam yield tables.

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9 Protection

9.1 Unsalvaged Losses

Unsalvaged losses result from natural events that are epidemic in origin. Endemic losses are accounted for by operational adjustment factors (OAFs) in the managed stand yield tables and decay, waste, and breakage (DWB) factors in the natural stand yield curves. Net available volume (i.e. the allowable annual cut) will be determined by removing unsalvaged losses from modeled harvest levels. Table 33 shows unsalvaged losses on the TFL, which total 3000 m^3/year.

Table 33: Unsalvaged losses

Agent	Unsalvaged Loss (m^3/year)
Fire	300
Bark beetles	2200
Windthrow	500
Spruce budworm	0
Other	0
Total	**3000**

The rationale for these estimates is given below. The primary unsalvaged epidemic losses in TFL 18 are insect infestations, windthrow, and fire. Bark Beetle infestations have escalated to epidemic levels, and windthrow continues to be a major management issue due to the exposed position of the TFL. Other agents that reduce the commercial productivity of the TFL, such as spruce budworm and root rot, are endemic and are assumed to be adequately accounted for by standard adjustment factors in the yield tables.

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9.1.1 Bark Beetles and Windthrow

Detection and salvage of windthrow and beetle-affected stands is aggressively practiced in TFL18 to limit the impact and propagation of spruce beetle (IBS), balsam beetle (IBB) and, more recently, mountain pine beetle (IBM). The extensive road system in TFL 18 allows for considerable salvage of windthrow and beetle affected stands. In addition, windthrow generally occurs in standing timber at the edge of cutblocks, and consequently there is a high salvage rate for windthrow. Table 34 shows the volumes of susceptible or infested timber delivered (salvaged) during the last 5 years. Although records of volume losses associated with bark beetle and windthrow are not available, Canfor estimates that approximately 95% of the potential losses within the timber harvesting land base are salvaged. The unsalvaged losses associated with windthrow and bark beetles are estimated as 5% of the 5-year average salvage volume.

Table 34: Salvage of timber volume that is susceptible or infested by bark beetle during the period 1999-2003

	Susceptible and infested volume salvaged (m^3)					
Agent	**1999**	**2000**	**2001**	**2002**	**2003**	**Total**
Mountain Pine Beetle					16,451	16,451
Spruce beetle		113,757	19,595	2,636	61,590	197,578
Balsam Bark Beetle					3,178	3,178
Windthrow	17,515	1,927		26,422	2,052	47,916
Total	17,515	115,684	19,595	29,058	83,271	265,123
Five-year average						53,025
5% of Five-year average						**2,651**
Bark Beetles						2,172
Windthrow						479

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9.1.2 Fire

Table 35 summarizes volume salvage rates for TFL18 provided by the Fire Management Analysis & Development Section of the BC Ministry of Forests. These data indicate that approximately 300 m^3/yr of mature timber was lost from TFL18 due to fire in the period 1979-2003. This corresponds to a 77% volume salvage rate.

Table 35: Historic records of unsalvaged losses to fire (pre-1979 volume data not available)

Fire Year	Fire Number	Total Area Destroyed (ha)	Total Volume Destroyed (m^3)	Percent Salvage	Area Destroyed within TFL 18 (ha)	Unsalvaged volume (m^3)
1979	K20038	383	109,472	28	0.4	82
1979	K20041	109	0	0	0.1	0
1979	C20006	15	310	50	0.1	1
1982	K10008	10	2,800	100	0.1	0
1983	K10003	16	9,402	0	0.1	59
1985	K10007	10	50	100	0.1	0
1985	K10097	398	39,714	0	0.1	10
1986	K10023	22	4,814	100	22	0
1986	K10046	8	2,547	74	0.1	8
1986	K10072	10	4,593	100	10	0
1986	K10073	20	1,500	100	20	0
1987	K10096	5	1,750	98	5	35
1987	K10098	5	500	0	0.3	33
1987	K10109	22	1,980	0	1	90
1987	K10122	12	3,600	99	12	36
1987	C40060	120	25,485	89	0.1	2
1987	C40060	8	320	0	0.1	4
1988	K10036	5	35	0	0	0
1989	K10012	2	500	90	0.1	3
1989	K10030	4	836	0	0.1	24
1989	K10057	15	4,500	99	15	45
1990	K10134	8	1,600	90	8	160
1990	K10141	16	6,400	60	16	2,560
1991	K10002	35	200	0	0.1	1
1992	K10002	3	105	0	0.1	4
2002	K10530	1	250	100	1	0
2003	C40469	60	7,200	25	60	5,400
Total	**27**		**230,463**	**77%**	**172**	**8,557**
Annual Rate						**317**

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10 Integrated Resource Management

This section provides details on how the modeling methodology will integrate non-timber resource values with timber objectives.

10.1 Management Zones and Forest Cover Requirements

Management zones are geographically specific areas that require unique management considerations. Multiple resource issues may be present on the same forest area. ***FSOS*** can accommodate multiple overlapping resource layers by establishing target levels for each layer. The model then schedules harvest units which best meet the target levels for all resource layers as a whole. This section describes attributes of the resource management layers and the rationale for the constraints applied to them.

Timber supply analysis will account for forest cover objectives at the landscape level. Forest cover management aims to protect biodiversity, identified wildlife habitat, and visual quality by specifying target height and age distributions. Table 36 is a summary of forest cover targets in TFL 18.

Table 36: Forest cover objectives – Base Case scenario

			Applied to:	
Resource	**Criteria**	**Cover requirement**	**Zone**	**Cover type**
Landscape green-up	Green-up height	No more than 33% of stands can be less than 3 meters in height.	TFL18	THLB
Visual quality	% denudation and visually effective green-up	No more than a specified percentage of each visual quality polygon can be less than the visually effective green-up height.	Visual quality polygons	Productive Forest
			Lakeshore Management Zones	Productive Forest
	% denudation and adjacency green-up	No more than a specified percentage of each Lakeshore Management Zone may be less than the cutblock adjacency green-up height of 3 meters.	Lakeshore Management Zones	Productive Forest
Landscape level biodiversity	Old Growth Management Areas	On average, at least 90% of the OGMAs in each BGC variant must be in old seral condition (minimum percent depends on variant).	OGMAs by BEC variants	Productive Forest
Riparian ecosystem functions	% mature forest in riparian management zones	mature forest cover must be at least equal to the basal area retention levels recommended in the Riparian Management Area Guidebook.	Riparian Management Zones by Class	Productive Forest
Water quality	Equivalent Clearcut Area	Equivalent Clearcut Area should be kept below a specified threshold. *For monitoring purposes only: Not a constraint.*	IWAP Watersheds	Productive Forest

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10.1.1 Adjacent Cutblock Green-up and Patch Management

During 2003 Canfor participated in a FIA project to develop an approach to managing the biodiversity targets for Patch Size distribution in the landscape units of the Headwaters Forest District. This report was adopted in 2003 by the Headwaters Forest District as known information for operational planning. Standard objectives for adjacent cutblock green-up may be overridden where necessary to achieve patch size distribution targets.

The process of working towards a target patch size distribution is inherently spatial, and so will not be directly incorporated into the non-spatial simulations for the Base Case. A landscape green-up constraint will be used as a proxy for the reductions to harvesting flexibility associated with patch management. This constraint specifies that no more than 33% of the total land base can be less than the green-up height of 3 metres originally specified in Section 68(5) of the Operational Planning Regulation (OPR).

10.1.2 Visual Resources

The area to be managed through established visual quality objectives is not defined for TFL 18. In 2001, Canfor initiated steps to clarify the linkages between visually sensitive areas (scenic areas) and visual quality objectives (VQO's) as set out in legislation, the Kamloops LRMP, and the Lakes LRUP.

In September, 2004 the Ministry of Forests – Headwaters Forest District, working with Canfor and the Lakes LRUP sub-committee developed agreement on draft polygons for the management of visual quality. The resolution of where VQO's will likely be managed on TFL 18 brings much needed certainty to both timber supply and the expectation of the general public regarding visual resource management.

Once the visually sensitive areas (scenic areas) are defined and amended, it is Canfor's objective to manage the visual resource consistent with the "Acts and regulations". This objective will be met using visual resource design principles and guidance provided in Appendix 8 of the Kamloops LRMP in a manner that minimizes timber supply impacts.

Pending further direction from the Ministry of Forests, assumptions around forest cover requirements will be based on the VLI and follow the approach specified in the *Procedures for Factoring Visual Resources into Timber Supply Analyses* (BC Ministry of Forests *et al.* 1998).

Visual absorption capacity (VAC) and Recommended Visual Quality Classes (RVQC) are defined for 69 visual quality polygons in TFL 18. Based on these two attributes, two visual forest cover requirements—percent denudation and visually effective green-up—are determined separately for each visual quality polygon.

10.1.2.1. Percent Denudation

The *Procedures for Factoring Visual Resources into Timber Supply Analyses* (BC Ministry of Forests *et al.* 1998) specifies area-based percent denudation ranges for each visual quality class. For the purpose of timber supply analysis in TFL 18, the VAC rating was used to refine the percent denudation range to a single value for each combination of RVQC and VAC, as shown in Table 37. Percent denudation values are consistent with Table 4 in the *Procedures.* Clearcutting is the silvicultural system assumed for all visual quality analysis. Percent denudation applies to the crown forested land base, which includes roads as well as all productive forested land.

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Table 37: Calculation of percent denudation for each combination of VQC and VAC.

VAC[2]	RVQC[1]	Productive Area (ha)	Percent denudation[3]
L	M	250	15.1
L	PR	1,621	5.1
L	R	236	1.1
L	P	69	0
M	M	950	20
M	PR	4,990	10
M	R	152	3
M	P	0	0.5
H	M	361	25
H	PR	674	15
H	R	271	5
H	P	89	1

[1]Recommended Visual Quality Class: PR = partial retention; M = modification; MM=maximum modification.

[2]Visual Absorption Capacity: H=high; M = medium; L = low.

[3]VAC-specific percent denudation figures are taken from Table 4 in the *Procedures for Factoring Visual Resources into TSAs.*

10.1.2.2. Visually Effective Green-up

Percent denudation refers to the proportion of a visual sensitivity unit that is below the visually effective green-up (VEG) height. As noted in the *Procedures for Factoring Visual Resources into Timber Supply Analyses*, VEG height is highly dependent on slope. To account for this effect, the *Procedures* specify VEG tree heights for seven slope classes. This timber supply analysis will use the area-weighted average of these slope classes to calculate VEG height for each visual quality polygon. There are 124 visual quality polygons included in this analysis. Table 38 shows the calculation of the overall area-weighted average VEG tree height for the combined visual quality polygons.

Table 38: Sample calculation of VEG tree height for visual quality polygons

	Area (ha) by slope class (%) and associated VEG height (m)[1]							Area-weighted
Slope Class	0-10%	11-20%	21-30%	31-40%	41-50%	51-60%	>61%	VEG tree height
Associated VEG height	**3m**	**4m**	**5m**	**6m**	**7m**	**8m**	**8.5m**	**4.9**
Crown Forested Area (ha)	844	2,947	3,024	1,777	639	218	68	9,518

[1] This table shows the calculation of the average VEG tree height for all visual quality polygons. Timber Supply analysis will use the same method to calculate VEG height separately for each visual polygon (Appendix F).

10.1.3 Lakeshore Management Zones

Canfor has participated in the Lakes Local Resource Use Plan for the Clearwater Forest District, which published Lakeshore Management Guidelines in 2001. Forestry operations within the Forest District must comply with the plan, as required by the Kamloops Land and Resource Management Plan. These guidelines prescribe a suite of practices within 200-meter Lakeshore Management Zones, including maximum harvest areas and visual quality objectives that vary depending on the class of the lake. These guidelines will be modelled as forest cover constraints in this timber supply analysis. The maximum harvest area and visual quality guidelines will be applied simultaneously, meaning that the more constraining rule will apply at any given time for each Lakeshore Management Zone.

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10.1.3.1. LMZ Maximum Harvest Guidelines

The lakes LRUP Lakeshore Management Guidelines specify recommendations for selection harvesting and clearcutting including basal area retention, maximum cutblock size, and maximum area harvested during each harvest pass. Selection harvesting is not currently practised in TFL 18 to any significant degree, so guidelines for clearcuts will be applied in timber supply analysis. Table 39 shows the harvest specifications from the Lakeshore Management Guidelines and the assumptions that will be applied for timber supply analysis.

The harvest guidelines for clearcuts specify a maximum proportion of area that may be harvested during each pass. "Area" is assumed to be productive forest area. "Pass" is the length of time required for the clearcut areas to achieve 3-meter green-up, and is calculated as the average age that Future MSYTs reach 3 meters in height in each LMZ.

The Lakeshore Management Guidelines state that harvesting is excluded from Class A LMZs "except for the management of pests, disease, fire and other natural occurrences that threaten the integrity of adjacent commercial timber stands and/or recreation site safety." To account for these minor harvest entries in timber supply analysis, a similar approach is taken for Class A and No Harvest LMZs as was taken for OGMAs: no more than 10% of these zones can be less than the age of old growth specified in the Landscape Unit Planning Guide (140 years in the ESSFvv/wc2 and 120 in all other BGC variants).

Table 39: Maximum allowable harvest guidelines for Lakeshore Management Zones.

		Selection Systems		Clearcuts		Data Package Assumptions[1]	
Lakes LRUP Class	**THLB Net Area (ha)**	**Minimum Basal Area Retention**	**Maximum harvest per pass (% of area)**	**Maximum cutblock size (ha)**	**Maximum harvest per pass (% of area)**	**Maximum harvest per pass (% of area)**	**Duration of harvest passes (years)[3]**
No Harvest	76	n/a	n/a	n/a	0%	**10%[2]**	**120-140**
A	287	n/a	n/a	n/a	0%	**10%[2]**	**120-140**
B	742	40%	50%	10	10-20%	**20%**	**15-25**
C	1,573	variable	50%	15	25%	**25%**	**15-25**
D	243	variable	70%	20	40%	**40%**	**15-25**
E	64	variable	100%	30	50%	**50%**	**15-25**

[1]Assumptions that will be applied as forest cover constraints for timber supply analysis.
[2]A small percentage of harvest is assumed for management of natural disturbance and safety.
[3]the duration of harvest passes is calculated separately for each LMZ based on BGC variant (for No Harvest and Class A LMZs) and Future MSYT productivity (passes are defined by attainment of 3-meter green-up height.

10.1.3.2. LMZ Visual quality objectives

Table 40 gives a summary of forest cover requirements for visual quality objectives in Lakeshore Management Zones. A visual absorption capacity of moderate (M) is assumed in all lakeshore management zones. Some portions of LMZs are excluded from harvest, as specified in the Lakes LRUP. These are modeled with a forest cover requirement of 100% stem retention (0% denudation). Percent Denudation and VEG tree height are calculated using the same methods as the other visual quality polygons, and a detailed summary of these calculations for individual Lakeshore Management Zones is given in Appendix G.

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Table 40: Summary of forest cover requirements for visual quality objectives in LMZs

Lakes LRUP Class	Total Area (ha)	CFLB Area (ha)	Visual Quality Objective	Percent Denudation	Average VEG tree height
A	109	103	Preservation (P)	0.5%	3.4
B	318	315	Retention (R)	3%	3.5
C	803	788	Partial Retention (PR)	10%	3.5
D	1,698	1,640	Modification (M)	20%	3.5
E	261	255	Modification (M)	20%	3.1
No Harvest	70	68	No Harvest	n/a	n/a
Total	3,150	3,067			3.5

10.1.4 Biodiversity

To implement the biodiversity objectives of the Kamloops LRMP, and based on priorities set by Government, the Ministry of Sustainable Resource Management (MSRM) created a biodiversity working group in 2001. Canfor participated in this working group, which developed an implementation strategy to meet the LRMP objectives while limiting the impact of landscape unit biodiversity requirements to no more than 4% of the level of timber harvesting in the LRMP over the short and long term. As part of this process, it was concluded that the 4% impact limitation specified in the Kamloops LRMP includes all elements of biodiversity as defined in the Biodiversity Guidebook.

10.1.4.1. Landscape Units

TFL 18 falls within the Clearwater Landscape Unit (LU 18), as defined by the Kamloops LRMP. The Clearwater Landscape Unit has been assigned a low biodiversity emphasis option as an outcome of the Kamloops LRMP.

10.1.4.2. Old Growth Management Areas

During 2002 and 2003 a strategy was implemented to place Old Growth Management Areas (OGMAs) on the landscape. Canfor led this process for the Clearwater Landscape Unit, and provided draft OGMAs to MSRM in 2003. Canfor continues to work with MSRM to finalize OGMA placement. However, the 2003 draft OGMAs will be used in the base case to model forest cover requirements for old seral forest, as they currently represent the old growth management strategy for TFL 18.

OGMAs are managed as permanent reserves on TFL 18 and represent the most significant harvest exclusion on TFL 18. However, they are not included in the netdown because a small portion (<10%) of OGMAs may be harvested for forest health reasons. To model these management intrusions into OGMAs over the planning horizon, an average 90% old seral forest cover requirement will be applied to OGMAs. The forest cover requirement will be applied separately to OGMAs of each biogeoclimatic (BGC) variant, so that the harvest is proportionately allocated across each variant. The forest cover requirement for each variant is adjusted slightly for current susceptibility, defined as stands leading in pine or spruce that are >140 years old. This allows a higher harvest level in variants with higher rates of susceptibility. The forest cover requirements for OGMAs are shown in Table 41.

Spatial location of OGMAs is fixed throughout the planning horizon, and there is no replacement for sanitation harvests that occur within OGMAs.

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Table 41: Calculation of the forest cover requirement within OGMAs of each BGC Variant

BGC Variant	CFLB Area (ha)	OGMA area (ha)	Pl/Sx >140 years old (ha)	Susceptible %	Proportional allocation of 90% old seral forest cover requirement	Age definition of old seral[1] (years)
ESSFdc2	3,347	587	326	56%	**91%**	120
ESSFvv	2,042	835	406	49%	**92%**	140
ESSFwc2	29,270	2,752	1,718	62%	**89%**	140
ICHmk2	5,978	772	167	22%	**96%**	120
ICHmw3	4,907	277	87	31%	**95%**	120
SBSdw1	1,520	201	26	13%	**98%**	120
SBSmm	20,245	2,676	2,055	77%	**87%**	120
Total	**67,309**	**8,100**	**4,786**	**59%**	**90%**	

[1] Age definition of old seral consistent with KLRMP OGMA process agreement

10.1.5 Riparian Management Zones

Riparian management zones occupy 9008 ha of the TFL. Consistent with the recommendations of the *Riparian Management Area Guidebook,* various levels of harvesting retention are practised within RMZs. However, partial retention in RMZs is not uniform: the amount of retention on any given site depends on the state of adjacent stands, windfirmness, and riparian sensitivity to harvesting. Stem retention in RMZs will be modelled in this timber supply analysis as an old seral forest cover requirement to reflect the spatially and temporally dynamic nature of retention in the RMZs of TFL18.

Mature seral forest cover requirements for riparian management zones are shown in Table 42. forest cover targets are applied separately to each riparian class (i.e. S1, S2, L1, etc…) to ensure proportional representation of mature forest in each riparian class. The minimum age at which a stand is eligible to contribute to the forest cover target is the age of maturity for NDT3 climates, as defined in table 10 of the Biodiversity Guidebook (BC MoF 1995).

Table 42: Mature seral forest cover requirements for riparian management zones (RMZs).

Riparian Class	RMZ Width (m)	RMZ Area (ha)--PFLB	Forest cover requirement	Minimum age to meet cover target (years)
S1	20	103	50%	100
S2	20	131	50%	100
S3	20	465	50%	100
S4	30	190	25%	100
S5	30	1,200	25%	100
S6	20	2,998	5%	100
Streams		**5,087**		
L1	30	361	25%	100
L3	30	133	25%	100
Lakes		**494**		
W1	40	1,503	25%	100
W3	30	949	25%	100
W5	40	975	25%	100
Wetlands		**3,427**		
Total RMA Reductions		**9008**		

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10.1.6 Watershed Management

Gill Creek Watershed has been formall de-registered as a community watershed, and there consequently are no special legal constraints on watershed management in TFL 18. Headwaters District staff is in the process of reviewing the status of all watersheds in TFL 18. This process is expected to be concluded in June, 2004 and any new direction provided will be incorporated into timber supply analysis if it becomes available before the initiation of timber supply analysis. In the event that no further direction is provided, modeled harvest through the planning horizon will not be constrained by watershed objectives, but equivalent clearcut area (ECA) of the watersheds of TFL18 will be monitored. Table 43 shows the threshold ECA proportions that will be used to monitor watershed management in the timber supply modeling.

Table 43: Summary of TFL18 watershed areas and equivalent clearcut area (ECA) thresholds

Watershed Name	ECA	Total Area (ha)	Productive Area (ha)	Net Area (ha)	Reference*
n/a		1,014	963	718	
Brookfield	30%	9,560	8,330	7,734	1
Canimred	35%	17,738	16,094	15,425	2
Gill	25%	1,329	1,108	1,057	3
Goodwin	35%	2,000	1,908	1,847	6
Italia	35%	5,745	5,140	4,927	6
Lolo	35%	96	82	81	6
Mann North	30%	12,487	11,161	10,537	4
Mann Residual	30%	7,753	7,057	6,667	4
Mann West	32%	4,700	4,343	4,080	4
Maury	35%	4,378	3,929	3,735	5
McKenzie	35%	608	570	557	6
Robinson	35%	1,813	1,596	1,532	6
Sock	35%	2,086	1,967	1,924	6
Wylie	35%	3,235	3,067	2,991	6
Total		**74,541**	**67,314**	**63,812**	

***Source of "red-flag" ECA threshold**

1. Level 2 Watershed Assessment of Brookfield Creek Watershed, March 1999
2. Canimred Creek Level 2 Watershed Assessment, 1999
3. Reconnaisance Watershed Assessment of Gill Creek Watershed, May 2000
4. Mann Creek Watershed Advisory Committee Minutes, October 25, 1999
5. Maury Creek Watershed Assessment Update, December, 2002
6. No Red Flag ECA Set - Set at 35% arbitrarily

Equivalent Clearcut Area (ECA) is essentially the proportion of the watershed that has been harvested, with a reduction factor applied to account for hydrological recovery as harvest blocks regenerate. The MoF is in the process of developing improved hydrological recovery curves that will apply to the Headwaters District (Rita Winkler, MoF Research Hydrologist, pers. comm. October 2004), but these numbers are not expected to be available at the initiation of analysis. In the absence of local information, the standard recovery curve provided in the Watershed Assessment Procedure Guidebook (BC MoF 1999, 28) will be used instead (Table 44). The heights required to calculate the recovery for stands within the watershed will be based on MSYTs for each analysis unit.

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Table 44: Default Hydrological Recovery Curve

Average Stand Height (m)	% Recovery
0 - 2.9 m	0%
3.0 -4.9 m	25%
5.0 – 6.9 m	50%
7.0 – 8.9	75%
9.0 m +	90%

10.1.7 Wildlife

There are no forest cover requirements for individual wildlife species. The Kamloops LRMP recognized an area of critical moose winter range covering 2126 ha of productive land in the lower Mann creek watershed at the southern portion of TFL18. Although there are no forest cover requirements for moose winter range, 20% of the productive area of this range is allocated to OGMAs.

10.2 Timber Harvesting

10.2.1 Harvest Scheduling Rules—Short Term

Simulation models are rule-driven, and require harvest scheduling rules to control the order in which stands are harvested. There are two measures taken in this analysis to ensure that simulated harvests in the short term are consistent with current harvesting practices. First, Canfor's FDP is used to allocate harvests in the first five years (period 1: 2004-2008). Subsequently, harvest priority is assigned to stands based on their assumed susceptibility to attack by mountain pine beetle. Once these stands have been harvested, normal scheduling is resumed as described in Section 10.2.2.

10.2.1.1. Fixed FDP blocks

Cutblocks with category A approved/proposed or CP status will be fixed for harvest in the first period of the planning horizon. These blocks, summarized in Table 45, are comprised of both Canfor and BCTS forest development plans. The total volume of the fixed harvest corresponds to a harvest rate of 176,134 m^3/yr, which is slightly less than the current allowable annual cut of 177,650 m^3/yr. FSOS will harvest additional volume to make up the difference.

Table 45: Area and volume summary of FDP blocks that will be fixed for harvest during the first period of the planning horizon.

Approval Status	Description	Net Area (ha)	Net Volume (m3)
AA	Approved Category "A"	1,713	606,725
CP	Cutting permit issued	411	159,670
PA	Proposed Category "A"	376	114,274
Total		**2,499**	**880,668**
Total/year during first 5-year period		500	176,134

10.2.1.2. Harvest priority based on susceptibility to beetle attack

Salvage of beetle-attacked pine stands is currently the primary consideration driving harvest in TFL18, and it is desirable that timber supply modeling reflects this strategy in the short term. Canfor provided a susceptibility rating based on the stand age and component of lodgepole pine (Table 46). Using this rating system, polygons were assigned a harvest priority multiplier that increases the emphasis that a stand receives within the scheduling rule ("relative poorest first" in the base case, described below). This method gives harvesting flexibility to harvest lower priority stands if high priority stands are not available. Appropriate harvest priority multipliers are shown in Table 46.

Table 46: Harvest Priority Multipliers used as weights for harvest scheduling.

Susceptibility	Susceptibility Criteria	Priority Multiplier
Low	Pl 20-40%, Age Class 5	3
	Pl 20-40%, Age Class 6	4
	Pl 20-40%, Age Class 7	5
	Pl 20-40%, Age Class 8	6
	Pl 20-40%, Age Class 9	7
Medium	Pl 40-60%, Age Class >4	12
High	Pl >60%, Age Class >4	20

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10.2.2 Harvest Scheduling Rules—Long Term

It is difficult to predict harvest practices beyond the short term, so harvest scheduling rules are applied in simulation models organize the timing of harvests. In order to understand the impacts of the timber supply assumptions and constraints, it is important that these rules are able to structure the harvest in a way that realizes the productive potential of the land base. Poorly designed harvest scheduling rules contain inherent constraints to harvest, which can either reduce or exacerbate the effect of intended constraints. Harvest scheduling is therefore fundamental to effective timber supply modeling.

"Relative poorest first" scheduling, an innovative harvest rule that has recently been developed by FESL, will be used for the base case in this analysis. this scheduling rule provides a more systematic and flexible approach to harvesting than other scheduling rules. Because "relative poorest first" scheduling is recently developed, a sensitivity analysis will show base case harvest levels using the more commonly used "relative oldest first" rule. The two rules are discussed in more detail below.

10.2.2.1. "Relative oldest first" scheduling

The "relative oldest first" rule is a commonly used rule that will be used as a sensitivity analysis against relative poorest first scheduling. In this rule, the age of a stand is related to its minimum harvestable age. Stands that have the greatest proportional difference between their actual age and their minimum harvest age are given priority for harvest, subject to forest cover requirements.

One of the main drawbacks of the "relative oldest first" rule is it's dependence on high minimum harvest ages. Minimum harvest age has two roles in "relative oldest first" simulations: (1) Establish a minimum merchantable age below which harvest is not allowed; and (2) Provide a target age for harvest scheduling. These are conflicting roles. Setting minimum harvestable age at minimum merchantability can negatively impact growing stock in the long term because it allows persistent harvest below culmination age. On the other hand, setting MHA close to culmination age can constrain the medium term because it exacerbates the shortage of available volume at pinch points. Harvest flows are artificially constrained by the necessity to compromise between the two roles of MHA, which limits the ability of "relative oldest first" scheduling to realize the productive potential of the land base.

10.2.2.2. "Relative poorest first" scheduling

"Relative poorest first" scheduling was designed to address the problems associated with the "relative oldest first" rule. Specifically, it schedules harvests strategically to maximize yields from each polygon and is independent of minimum harvest age. "Relative poorest first" scheduling provides a more rational approach to harvest scheduling that better reflects the opportunities available to forest planners.

The premise of "relative poorest first" scheduling is that the productivity of the future stand is the best indicator of when to harvest the existing stand on any given polygon. Culmination age is often thought of as the optimal time to harvest a stand if you're trying to maximize volume flows over the planning horizon. However, harvesting the current stand at culmination age is optimal only if the existing stand is on the same curve that it will regenerate to after harvest. This is not the case in TFL18: yields for natural and existing managed stands are usually quite different from future managed stand yields. In this situation, the culmination age of the existing stand is irrelevant to decisions of when to harvest that stand. What matters is the growth rate of the existing stand relative to the maximum growth rate of the future stand that it will regenerate to. A stand that is currently growing faster than the culmination growth rate of the future stand should be deferred from harvest until its growth rate has dropped to the level of the future stand. Conversely, a slow-growing stand that will be replaced by a fast-growing future stand should be harvested as soon as possible. Scheduling harvests according to the culmination volume of the regenerated stand instead of the existing stand can result in subtle increases in timber supply because it attempts to maximize the average volume production on each polygon.

The central concept is "Relative Productivity": measuring the current growth of a stand based on the growth of the stand that will follow it. At any period *i* in the planning horizon, Relative productivity (RP_i) can be expressed in terms of the current annual increment (CAI) of the existing stand and the culmination MAI of the future stand:

$$RP_i = CAI_i - culmMAI_{future}$$

Where:

CAI_i is Current Annual Increment of the existing stand at cutting period *i*
$CAI_i = (MAI_i - MAI_{i-1})/DeltaX$
DeltaX is the length of the periods (e.g. 5 years)
MAI*i* is the mean annual increment of the existing stand at period *i*
$culmMAI_{future}$ is the culmination MAI of the future PHR stand

When RP_i is >0, the existing stand is growing faster than the average growth rate of the future stands, and harvest should be deferred. When RP_i is <0, the existing stand is growing slower than the future stands, and this stand should be made eligible for harvest to realize the potential of the site. The relative productivity concept is illustrated in Figure 6.

The relative productivity concept is a rational basis for harvest scheduling. Harvesting stands with large negative RP_i values before stands with small-negative or positive RP_i values will realize more volume during the planning horizon. This scheduling strategy is called "relative poorest first" because it prioritizes stands that are growing slowest relative to their future stand.

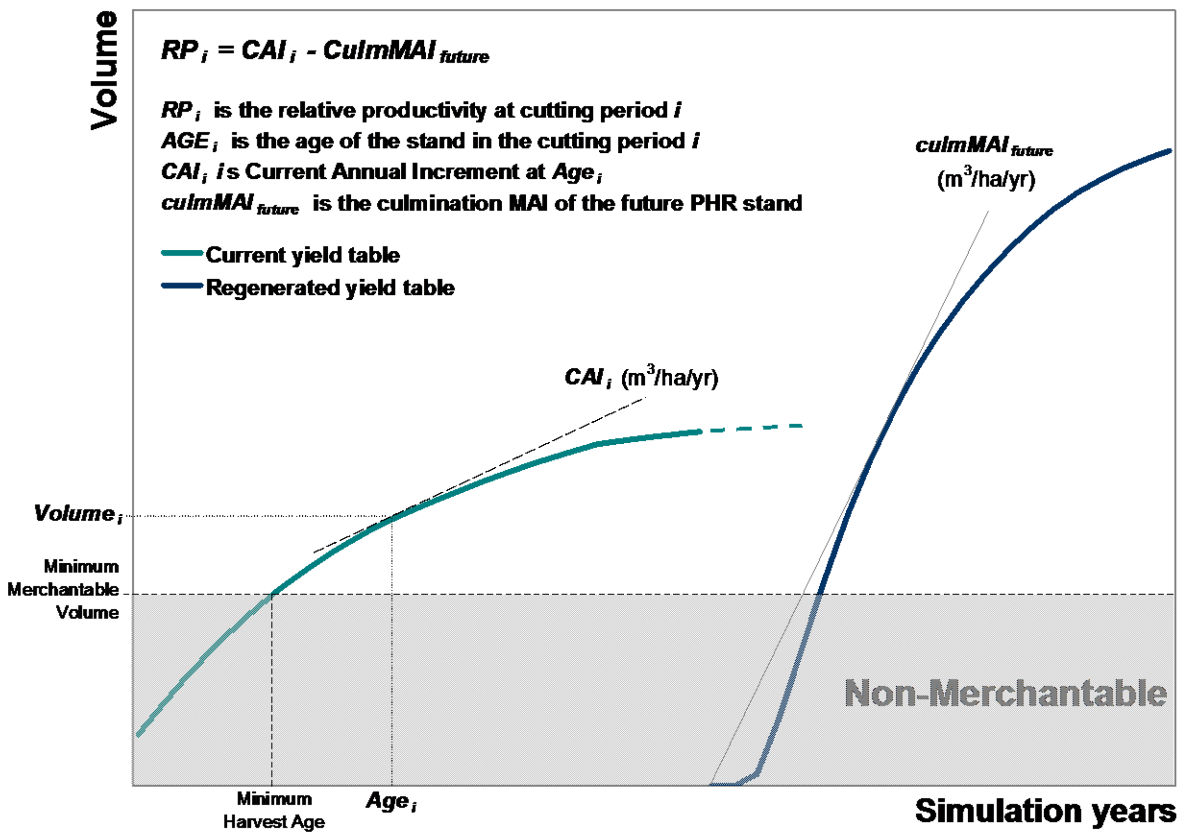

Figure 6: illustration of the "relative productivity" concept. In this example, RP_i is always negative, so the stand would be a priority for harvest as soon as it reaches minimum harvest age.

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10.2.3 Minimum Harvest Age

Minimum harvest age is the age at which stands become eligible for harvest. Traditionally, minimum harvest age has been set at or just below culmination age. This can create inflexibilities in harvest scheduling because stands are not available for harvest until they reach culmination age. This is an artificial constraint because it is unlikely that a company would forego a merchantable stand during a timber supply shortage simply because that stand is below culmination age.

An advantage of "relative poorest first" scheduling is that it is independent of minimum harvest age. Minimum harvest age under this rule can be defined as the true "bare minimum" that Canfor would harvest: the age at which each analysis unit reaches the minimum merchantable volume of 125 m^3/ha. Stands are targeted for harvest based on culmination age of future stands, but the model will be able to harvest stands that are well below culmination age in order to meet volume targets during a brief timber supply shortage. Using a "minimum merchantability" definition for minimum harvest age better reflects the flexibilities available to forest planners in real harvest scheduling exercises.

Setting minimum harvest age below culmination age can allow growing stock to be depleted in the long term. As part of base case development, timber flows will be tested over a planning horizon of 500 years to ensure long-term stability of the growing stock. Minimum harvest ages for NSYT and MSYT analysis units are given in Table 47 and Table 48, respectively.

Table 47: Minimum harvest age based on minimum merchantable volume (NSYTs)

Analysis Unit	Age of Merchantability (years)	Analysis Unit	Age of Merchantability (years)
11 Constrained_marginal	165	42 IU Balsam_2	275
12 Constrained_very low	105	43 IU Balsam_3	45
13 Constrained_low	80	44 IU Balsam_4	290
14 Constrained_medium	70	45 IU Balsam_5	180
15 Constrained_high	60	46 IU Balsam_6	140
16 Constrained_very high	50	47 IU Balsam_7	65
21 Deciduous_very low	170	48 IU Balsam_8	70
22 Deciduous_low	85	49 IU Balsam_9	30
23 Deciduous_medium	70	50 IU Balsam_10	45
24 Deciduous_high	65	51 IU Balsam_11	40
25 Deciduous_very high	55	52 IU Balsam_12	115
31 Immature_very low	120	61 Mature_marginal	115
32 Immature_low	85	62 Mature_very low	90
33 Immature_medium	65	63 Mature_low	75
34 Immature_high	55	64 Mature_medium	65
35 Immature_very high	45	65 Mature_high	50
41 IU Balsam_1	210	66 Mature_very high	55

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Table 48: Minimum harvest age based on minimum merchantable volume (existing and future MSYTs)

Analysis Unit	Age of Merchantability (years)
102 Existing Pine very low	60
103 Existing Pine low	45
104 Existing Pine medium	45
105 Existing Pine high	40
106 Existing Pine very high	35
107 Existing Spruce marginal	110
108 Existing Spruce very low	80
109 Existing Spruce low	60
110 Existing Spruce medium	55
111 Existing Spruce high	50
112 Existing Spruce very high	45
113 Existing Mixed marginal	80
114 Existing Mixed very low	55
115 Existing Mixed low	50
116 Existing Mixed medium	45
117 Existing Mixed high	45
118 Existing Mixed very high	40

Analysis Unit	Age of Merchantability (years)
201 Future_submarginal	n/a
202 Future_marginal	95
203 Future_very low	70
204 Future_low_late	60
205 Future_low_early	70
206 Future_medium_late	70
207 Future_medium_mid	60
208 Future_medium_early	55
209 Future_high	60
210 Future_very high	60

10.2.4 Initial Harvest Rate

The initial harvest rate for the Base Case will be the current AAC for TFL 18 plus unsalvaged losses, as shown in Table 49. Harvest rates reported in the analysis report will be net of unsalvaged losses.

Table 49: Initial annual harvest rate

Volume Allocation	Harvest rate (m3/year)
Current AAC	177,650
Unsalvaged losses	3,000
Initial harvest level	180,650

10.2.5 Harvest Flow Objectives

Several harvest flow objectives will be incorporated into the Base Case:

- Sustain even flow in the short and medium term until reductions are necessary for long-term sustainability;
- Where decreases in the harvest rate are necessary, volume harvested will decrease by no more than 10% per ten-year period; and
- Maintain even flow in the long term.

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Appendix A: Final Report for Inventory Rectification

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Appendix B: Final Report for IU Balsam Yield Tables

- Summary of project timeline and approval process
- Final Report

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Appendix C: Future regeneration assumptions

Yield Group	Site Series	Net Decile Area (ha)	Pl Site Index (PSI)	Ep	At	Hw	Bl	Cw	Fd	Pl	Sx	Planting Density (sph)	Total crop density at FG (sph)	FG Density of Crop Trees at FG (sph)	TIPSY FG Density	Apprx age at FG	>40% Ingress
a	ESSFvv/01	1,042	13				50				50	1,500	1,000	900	950	15	No
a	ESSFvv/02	42	12				50				50	1,500	900	900	900	20	No
a	ESSFvv/03	163	13				50				50	1,500	1,000	900	950	20	No
a	ESSFvv/04	297	12				50				50	1,500	900	900	900	20	No
a	ESSFvv/92	5	11				50			0	50	1,500	1,000	900	950	15	No
b	ICHmk2/02	51	16						50	50		1,200	2,000	900	1,450	14	No
b	ICHmw3/02	29	17						50	50		1,200	1,000	800	900	14	No
b	ICHmw3/03	19	20						50	50		1,200	1,100	900	1,000	14	No
b	ICHmw3/04	691	20	15				5	20	50		1,200	1,897	918	1,408	11	No
b	SBSdw1/03	12	18						40	60		1,400	1,500	800	1,150	14	No
b	SBSdw1/04	57	20						40	50	10	1,400	1,800	850	1,325	12	No
c	ESSFdc2/02	43	13				20			80		1,500	900	900	900	20	No
c	ESSFdc2/08	13	17				6			85	9	1,500	1,000	900	950	20	No
c	ESSFdc2/91	6	14				6	0	0	85	9	1,500	1,000	900	950	20	No
c	ESSFwc2/02	134	14				20			80		1,500	900	900	900	20	No
c	ESSFwc2/09	101	13				20			80		1,500	700	600	650	20	No
c	SBSmm/02	10	15						10	90		1,400	700	600	650	14	No
d	ESSFdc2/01	1,611	18							99	1	1,500	2,325	1,100	1,713	10	No
d	ESSFdc2/03	30	17							100		1,500	1,500	1,120	1,310	15	No
d	ESSFdc2/06	458	20				2			95	3	1,500	1,500	1,100	1,300	10	No
d	ESSFdc2/07	187	19				4			90	6	1,500	1,300	1,000	1,150	15	No
d	SBSmm/03	149	18						10	90		1,400	1,200	700	950	12	No
d	SBSmm/04	49	21						10	90		1,400	3,000	800	1,900	12	Yes
e	ICHmk2/04	120	23					10	40		50	1,200	3,000	1,000	2,000	10	Yes
e	ICHmw3/01	2,450	22						50	20	30	1,200	3,252	923	2,088	13	Yes
f	ICHmw3/06	699	23			10		50	25	5	10	1,200	5,360	845	3,103	9	Yes
f	ICHmw3/07	488	25	5		10		50	15	10	10	1,200	3,224	971	2,098	11	Yes
f	ICHmw3/08	35	21			20		45		10	25	1,200	2,000	800	1,400	14	No
g	ESSFwc2/01	11,075	19				20			5	75	1,500	3,968	980	2,474	10.5	Yes
g	ESSFwc2/03	846	17				15			10	75	1,500	5,183	925	3,054	10	Yes
g	ESSFwc2/04	0	18				15			5	80	1,500	2,211	911	1,561	10	No
g	ESSFwc2/06	4,418	19				18			2	80	1,500	3,744	923	2,334	10	Yes
g	ESSFwc2/93	2,612	19				20			5	75	1,500	3,968	980	2,474	11	Yes
g	ESSFwc2/94	1,448	18				15			10	75	1,500	5,183	925	3,054	10	Yes
g	ICHmk2/06	128	20				10	10		20	60	1,200	3,500	1,000	2,250	14	Yes
h	ESSFwc2/07	398	21								100	1,500	3,212	894	2,053	11	Yes
h	ICHmk2/01	3,353	22						10	20	70	1,200	4,467	1,015	2,741	9	Yes
h	ICHmk2/05	1,233	25				3		7	20	70	1,200	5,228	1,104	3,166	9	Yes
I	SBSdw1/08	72	25				10		10	20	60	1,400	1,000	800	900	12	No
I	SBSdw1/09	68	20				20			20	60	1,400	1,000	600	800	14	No
j	SBSdw1/01	858	22						20	40	40	1,400	2,500	1,050	1,775	10	No
j	SBSdw1/05	8	21						20	40	40	1,400	2,000	900	1,450	10	No
j	SBSdw1/06	22	24						10	50	40	1,400	2,300	1,100	1,700	10	No
k	SBSdw1/07	342	23				5		10	40	50	1,400	2,500	900	1,700	10	No
k	SBSmm/01	10,281	22		2		2		2	44	44	1,400	3,520	1,001	2,261	10	Yes
k	SBSmm/06	2,648	21				2			50	50	1,400	2,676	1,144	1,910	9	Yes
k	SBSmm/07	3,602	23				10			40	50	1,400	2,783	949	1,866	9	Yes
l	ESSFwc2/08	1,510	18				40			20	40	1,500	900	800	850	20	No
m	ESSFwc2/05	5,063	18				40			40	20	1,500	8,187	1,080	4,634	10	Yes
n	ICHmk2/03	717	18						50	50		1,200	3,500	950	2,225	12	Yes
o	ESSFdc2/05	793	18				1			74	25	1,500	1,516	1,120	1,318	10	No
p	SBSmm/08	1,034	20				10			45	45	1,400	1,500	800	1,150	14	No
q	SBSmm/05	1,191	19		3		3			44	50	1,400	4,961	944	2,953	10	Yes
r	ICHmw3/05	345	22						96	3	1	1,200	2,333	1,050	1,692	11	No

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Appendix D: Existing Volume Check by AU

Analysis Unit	Productive Area (ha)	Net Area (ha)	Volume (1000's m^3) Inventory	AUs	% Difference from inventory
11 Constrained_marginal	1,025	436	143,098	132,637	-7%
12 Constrained_very low	2,012	1,568	450,621	450,358	0%
13 Constrained_low	1,891	1,382	584,273	578,472	-1%
14 Constrained_medium	1,805	1,125	618,693	609,873	-1%
15 Constrained_high	1,470	1,003	536,681	527,833	-2%
16 Constrained_very high	393	289	186,182	182,224	-2%
21 Deciduous_very low	79	50	5,155	4,739	-8%
22 Deciduous_low	117	117	12,950	12,650	-2%
23 Deciduous_medium	320	304	23,188	19,867	-14%
24 Deciduous_high	274	273	18,264	17,601	-4%
25 Deciduous_very high	177	177	13,969	13,370	-4%
31 Immature_very low	561	561	32,878	33,417	2%
32 Immature_low	2,040	2,040	220,665	220,534	0%
33 Immature_medium	1,060	1,060	197,419	198,790	1%
34 Immature_high	1,345	1,345	327,261	333,678	2%
35 Immature_very high	368	368	121,597	121,015	0%
41 IU Balsam_1	565	554	144,012	102,214	-29%
42 IU Balsam_2	101	101	32,918	19,458	-41%
43 IU Balsam_3	914	904	5,996	107,575	1694%
44 IU Balsam_4	17	15	5,979	2,866	-52%
45 IU Balsam_5	638	634	181,038	121,861	-33%
46 IU Balsam_6	651	648	188,996	145,646	-23%
47 IU Balsam_7	2,159	2,104	153,809	250,063	63%
48 IU Balsam_8	1,746	1,702	182,107	231,755	27%
49 IU Balsam_9	43	40	0	3,886	#DIV/0!
50 IU Balsam_10	1,219	1,198	24,732	116,758	372%
51 IU Balsam_11	378	370	18,799	41,135	119%
52 IU Balsam_12	43	43	17,627	10,532	-40%
61 Mature_marginal	1,352	1,352	289,484	268,991	-7%
62 Mature_very low	5,315	5,315	1,654,944	1,625,971	-2%
63 Mature_low	7,411	7,411	2,672,252	2,613,008	-2%
64 Mature_medium	5,113	5,113	2,122,015	2,081,095	-2%
65 Mature_high	3,780	3,780	1,692,410	1,669,150	-1%
66 Mature_very high	1,001	1,001	494,813	505,599	2%
102 Existing Pine very low	157	157	0	2	4609%
103 Existing Pine low	682	682	21	296	1316%
104 Existing Pine medium	508	508	265	815	208%
105 Existing Pine high	2,044	2,044	498	12,101	2331%
106 Existing Pine very high	737	737	473	4,052	756%
107 Existing Spruce marginal	401	401	41	0	-100%
108 Existing Spruce very low	1,778	1,778	851	0	-100%
109 Existing Spruce low	1,973	1,973	1,035	257	-75%
110 Existing Spruce medium	2,671	2,671	1,261	1,132	-10%
111 Existing Spruce high	2,453	2,453	2,015	6,529	224%
112 Existing Spruce very high	281	281	248	2,351	848%
113 Existing Mixed marginal	43	43	0	0	-100%
114 Existing Mixed very low	396	392	138	303	119%
115 Existing Mixed low	885	885	638	421	-34%
116 Existing Mixed medium	2,701	2,701	8,042	14,868	85%
117 Existing Mixed high	631	631	770	3,593	367%
118 Existing Mixed very high	175	175	77	1,593	1971%

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Appendix E: Yield Tables for Natural and Managed Stands

Table 50: Volume yield summary for NSYT Analysis Units

	Net Volume (m^3/ha) at 20-year age intervals															
Analysis Unit	**0**	**20**	**40**	**60**	**80**	**100**	**120**	**140**	**160**	**180**	**200**	**220**	**240**	**260**	**280**	**300**
11Constrained_marginal	0	0	0	6	29	56	80	104	125	142	158	173	186	195	200	204
12Constrained_very low	0	0	2	22	69	115	155	191	221	245	265	284	301	312	318	324
13Constrained_low	0	0	9	52	126	187	237	279	311	334	352	368	382	393	399	405
14Constrained_medium	0	0	18	84	167	234	288	333	366	389	407	423	437	447	454	459
15Constrained_high	0	0	38	135	228	303	362	409	441	460	474	488	500	509	515	520
16Constrained_very high	0	0	92	216	314	389	445	489	518	536	550	564	576	584	589	593
21Deciduous_very low	0	0	0	12	45	74	97	114	123	129	132	136	140	142	143	144
22Deciduous_low	0	0	11	68	121	163	192	211	222	227	231	235	238	240	241	242
23Deciduous_medium	0	0	23	99	167	221	258	282	297	306	312	319	324	328	329	331
24Deciduous_high	0	0	37	125	202	260	299	325	342	351	359	366	373	377	379	380
25Deciduous_very high	0	0	63	165	253	318	359	385	402	410	416	422	427	431	432	433
31Immature_very low	0	0	1	22	57	95	127	156	179	198	213	228	242	250	255	258
32Immature_low	0	0	7	55	118	169	212	250	280	304	325	344	361	372	376	381
33Immature_medium	0	0	32	111	184	243	291	331	358	375	387	400	412	420	424	427
34Immature_high	0	0	64	160	240	304	355	396	423	440	450	463	475	483	487	490
35Immature_very high	0	1	119	237	327	398	454	498	523	535	541	551	560	567	571	575
41IU Balsam_1	0	0	0	0	0	0	0	0	1	30	91	158	211	253	293	327
42IU Balsam_2	0	0	0	0	0	0	0	0	0	0	0	1	15	75	143	195
43IU Balsam_3	13	42	108	176	229	273	312	349	383	413	438	460	475	479	482	484
44IU Balsam_4	0	0	0	0	0	0	0	0	0	0	0	0	0	12	88	164
45IU Balsam_5	0	0	0	0	0	0	0	12	65	140	204	253	294	332	366	396
46IU Balsam_6	0	0	0	0	7	30	73	141	202	251	293	332	370	404	435	459
47IU Balsam_7	1	13	56	115	170	214	254	292	326	358	386	412	430	439	443	446
48IU Balsam_8	0	0	21	95	173	236	285	331	377	419	457	492	525	549	553	554
49IU Balsam_9	12	93	193	267	322	368	406	436	460	482	500	515	520	525	528	531
50IU Balsam_10	1	31	114	196	260	310	358	402	442	477	510	540	561	565	567	570
51IU Balsam_11	0	33	132	225	298	355	407	456	500	538	574	606	633	638	641	643
52IU Balsam_12	0	0	0	0	0	48	151	244	317	371	423	477	526	571	612	648
61Mature_marginal	0	0	4	28	69	106	138	168	192	211	228	243	258	267	271	275
62Mature_very low	0	0	6	42	105	160	205	245	275	299	318	335	351	361	367	373
63Mature_low	0	0	19	84	160	221	271	311	341	362	377	393	406	415	421	425
64Mature_medium	0	0	35	120	206	274	328	371	402	423	437	452	465	474	480	485
65Mature_high	0	0	72	183	276	347	403	447	474	490	500	512	522	529	534	538
66Mature_very high	0	0	55	187	299	387	453	506	545	574	597	619	638	649	654	658

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Table 51: Volume yield summary for Existing and Future MSYT Analysis Units

	Net Volume (m^3/ha) at 20-year age intervals															
Analysis Unit	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300
102Existing Pine very low	0	0	40	143	221	278	315	337	351	362	370	376	382	379	379	379
103Existing Pine low	0	0.9	90	214	299	347	380	401	414	426	429	428	426	424	424	424
104Existing Pine medium	0	0.8	116	244	328	376	410	430	438	443	445	446	446	446	446	446
105Existing Pine high	0	7.5	170	309	387	436	457	461	461	461	461	461	461	461	461	461
106Existing Pine very high	0	10	185	325	408	449	464	465	465	465	465	465	465	465	465	465
107Existing Spruce marginal	0	0	0	1.2	31	101	180	244	308	352	378	398	413	419	419	419
108Existing Spruce very low	0	0	0	32	139	235	326	382	416	437	452	461	468	470	470	470
109Existing Spruce low	0	0	9	137	275	380	431	464	482	487	487	485	484	482	482	482
110Existing Spruce medium	0	0	17	167	317	408	454	481	494	493	490	492	492	492	492	492
111Existing Spruce high	0	0.1	69	259	397	459	491	492	492	492	492	492	492	492	492	492
112Existing Spruce very high	0	0	103	323	442	477	477	478	478	478	478	478	478	478	478	478
113Existing Mixed marginal	0	0	4.8	47	129	204	266	314	342	359	371	381	389	391	391	391
114Existing Mixed very low	0	0	33	160	274	360	406	438	460	475	480	484	487	486	486	486
115Existing Mixed low	0	0.4	55	199	314	388	431	459	473	477	479	483	483	483	483	483
116Existing Mixed medium	0	0.9	94	260	380	453	499	500	500	500	500	500	500	500	500	500
117Existing Mixed high	0	1.2	110	280	396	459	482	482	482	482	482	482	482	482	482	482
118Existing Mixed very high	0	2.9	140	327	441	479	481	481	481	481	481	481	481	481	481	481
201Future_submarginal	0	0	9	33	54	69	79	84	88	91	93	93	93	93	93	93
202Future_marginal	0	0	18	66	107	136	154	165	170	174	177	177	177	177	177	177
203Future_very low	0	0	21	89	157	211	246	266	279	287	294	296	295	295	294	293
204Future_low_late	0	0	34	126	209	271	312	336	353	364	372	378	377	377	376	376
205Future_low_early	0	0	13	95	202	290	345	378	401	418	429	433	434	434	433	432
206Future_medium_late	0	0	4	88	212	321	381	418	442	456	466	465	464	462	460	458
207Future_medium_mid	0	0	28	142	253	331	381	417	442	455	466	473	476	477	477	476
208Future_medium_early	0	0	48	195	318	390	430	456	469	471	472	472	471	470	470	470
209Future_high	0	0	22	144	265	353	424	475	515	545	569	587	603	607	608	608
210Future_very high	0	0	17	164	307	415	507	574	631	679	719	747	780	786	786	786

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Appendix F: % denudation and VEG for individual visual polygons

Poly_ID	Crown Forested Area (ha)	VAC	VQC/ VQO	% Denudation	Area (ha) by slope class (%) and associated VEG height (m)[1]							Visually Effective GreenUp Height, VEG (m)
					0-10%	11-20%	21-30%	31-40%	41-50%	51-60%	>61%	
					3m	4m	5m	6m	7m	8m	8.5m	
101	21	M	PR	**10.0%**	8	27	36	28	2	0	0	**4.7**
122	8	M	M	**20.0%**	19	6	2	0	0	0	0	**3.3**
123	12	M	R	**3.0%**	29	7	0	0	0	0	0	**3.1**
124	5	M	R	**3.0%**	14	0	0	0	0	0	0	**3.0**
17	250	L	M	**15.1%**	58	397	331	201	82	86	75	**4.9**
21	180	M	M	**20.0%**	36	513	192	9	0	0	0	**4.2**
22	144	M	M	**20.0%**	5	135	166	153	208	152	10	**5.8**
23	7	M	M	**20.0%**	1	9	18	3	0	0	0	**4.7**
25	137	H	M	**25.0%**	0	44	380	207	100	12	0	**5.4**
26	81	M	PR	**10.0%**	83	123	90	24	7	0	0	**4.0**
27	51	L	PR	**5.1%**	89	64	23	1	0	0	0	**3.5**
28	886	L	PR	**5.1%**	88	688	1165	1505	1131	236	87	**5.5**
30	100	M	M	**20.0%**	16	181	110	118	44	8	0	**4.8**
31	14	L	PR	**5.1%**	40	2	0	0	0	0	0	**3.0**
32	66	M	M	**20.0%**	7	94	109	93	20	0	0	**4.9**
33	8	L	R	**1.1%**	7	20	2	0	0	0	0	**3.8**
34	53	L	PR	**5.1%**	13	152	53	0	0	0	0	**4.1**
34A	9	L	PR	**5.1%**	13	21	0	0	0	0	0	**3.6**
35	16	L	PR	**5.1%**	34	17	0	0	0	0	0	**3.3**
36	96	M	M	**20.0%**	11	55	109	196	109	58	6	**5.7**
37	64	H	M	**25.0%**	13	115	100	50	17	3	0	**4.6**
38	11	M	PR	**10.0%**	21	15	0	0	0	0	0	**3.3**
39	23	H	P	**1.0%**	48	29	1	0	0	0	0	**3.3**
42	823	M	PR	**10.0%**	110	484	1300	1864	507	167	8	**5.4**
43'	22	L	PR	**5.1%**	63	3	0	0	0	0	0	**3.0**
44	69	L	P	**0.0%**	205	4	0	0	0	0	0	**3.0**
44A	20	L	PR	**5.1%**	51	10	0	0	0	0	0	**3.1**
45	532	M	PR	**10.0%**	54	1051	786	532	38	2	0	**4.6**
46	8	M	M	**20.0%**	2	27	3	0	0	0	0	**4.0**
47	31	L	PR	**5.1%**	50	34	4	13	13	8	0	**3.9**
48	65	H	M	**25.0%**	20	165	81	4	5	0	0	**4.2**
55	10	L	PR	**5.1%**	22	9	0	0	0	0	0	**3.2**
56	26	M	PR	**10.0%**	5	94	5	0	0	0	0	**4.0**
67	217	M	M	**20.0%**	44	455	325	109	35	0	0	**4.5**
68	175	L	PR	**5.1%**	13	50	115	349	266	246	76	**6.4**
69	19	L	R	**1.1%**	22	39	9	1	0	0	0	**3.7**
71	16	M	PR	**10.0%**	0	60	5	0	0	0	0	**4.1**
72	8	M	PR	**10.0%**	0	6	13	9	17	1	0	**5.7**
73	47	L	PR	**5.1%**	110	33	10	0	0	0	0	**3.3**

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Poly_ID	Crown Forested Area (ha)	VAC	VQC/ VQO	% Denudation	Area (ha) by slope class (%) and associated VEG height (m)[1] 0-10% 3m	11-20% 4m	21-30% 5m	31-40% 6m	41-50% 7m	51-60% 8m	>61% 8.5m	Visually Effective GreenUp Height, VEG (m)
74	33	M	PR	**10.0%**	10	64	68	0	0	0	0	**4.3**
75	94	H	M	**25.0%**	36	167	124	76	22	0	0	**4.5**
76	268	M	PR	**10.0%**	120	342	502	180	75	7	0	**4.6**
77	264	L	PR	**5.1%**	29	343	487	277	76	85	27	**5.0**
78	55	L	R	**1.1%**	132	38	7	3	0	0	0	**3.2**
79	42	L	R	**1.1%**	47	96	13	0	0	0	0	**3.7**
8	102	M	M	**20.0%**	25	208	183	28	5	0	0	**4.4**
80	5	M	M	**20.0%**	15	1	0	0	0	0	0	**3.0**
81	15	M	M	**20.0%**	0	4	44	22	8	0	0	**5.3**
83	24	L	PR	**5.1%**	27	19	40	11	0	0	0	**4.1**
84	3	M	M	**20.0%**	0	2	7	1	3	0	0	**5.3**
VLI-033	8	M	R	**3.0%**	1	24	10	0	0	0	0	**4.2**
VLI-034	38	M	R	**3.0%**	19	71	64	7	0	0	0	**4.2**
VLI-036	26	H	PR	**15.0%**	14	56	23	9	8	0	0	**4.2**
VLI-037	56	M	R	**3.0%**	63	122	20	2	0	0	0	**3.7**
VLI-038	111	L	R	**1.1%**	11	183	248	73	3	0	0	**4.6**
VLI-039	173	H	PR	**15.0%**	0	57	204	487	176	82	11	**5.9**
VLI-040	66	H	P	**1.0%**	13	102	136	53	1	0	0	**4.6**
VLI-041	13	M	PR	**10.0%**	5	26	1	18	10	0	0	**4.7**
VLI-042	109	M	PR	**10.0%**	10	48	198	228	78	18	23	**5.5**
VLI-043	530	M	PR	**10.0%**	59	772	1137	445	98	15	0	**4.8**
VLI-044	271	H	R	**5.0%**	43	246	377	471	152	90	72	**5.4**
VLI-046	289	H	PR	**15.0%**	13	281	345	510	297	76	75	**5.5**
VLI-047	820	M	PR	**10.0%**	98	875	1989	817	179	65	7	**4.9**
VLI-065	34	M	R	**3.0%**	0	13	142	12	0	0	0	**5.0**
VLI-066	290	M	PR	**10.0%**	19	506	716	82	1	0	0	**4.6**
VLI-085	548	M	PR	**10.0%**	111	587	1187	527	190	92	4	**4.9**
VLI-086	186	H	PR	**15.0%**	52	263	302	177	59	33	0	**4.8**
VLI-088	772	M	PR	**10.0%**	144	1107	1133	741	440	200	80	**5.0**
VLI-089	89	M	PR	**10.0%**	43	139	118	48	43	4	14	**4.6**

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Appendix G: % denudation and VEG for LMZs

LMZ ID	CFLB Area (ha)	VAC	VQC/ VQO	% Denudation	Area (ha) by slope class (%) and associated VEG height (m)[1] 0-10% 3m	11-20% 4m	21-30% 5m	31-40% 6m	41-50% 7m	51-60% 8m	>61% 8.5m	Visually Effective Greenup Height, VEG (m)
164	53	M	PR	**10.0%**	67	61	50	34	0	0	0	**4.0**
170	38	M	PR	**10.0%**	65	59	12	0	0	0	0	**3.5**
175	198	M	R	**3.0%**	389	258	24	11	0	0	0	**3.4**
183	39	M	PR	**10.0%**	85	33	10	0	0	0	0	**3.3**
186	31	M	M	**20.0%**	91	2	0	0	0	0	0	**3.0**
201	3	M	XX	**0.0%**	10	1	0	0	0	0	0	**3.0**
214	27	M	R	**3.0%**	81	2	0	0	0	0	0	**3.0**
219	92	M	PR	**10.0%**	187	69	75	9	9	0	0	**3.6**
226	103	M	R	**3.0%**	145	199	27	1	0	0	0	**3.6**
242	56	M	R	**3.0%**	76	111	14	1	0	0	0	**3.6**
250	4	M	XX	**0.0%**	7	10	1	0	0	0	0	**3.5**
269	61	M	PR	**10.0%**	95	107	28	0	0	0	0	**3.6**
286	29	M	PR	**10.0%**	67	32	0	0	0	0	0	**3.3**
290	28	M	R	**3.0%**	73	19	0	0	0	0	0	**3.2**
336	2	M	PR	**10.0%**	4	2	0	0	0	0	0	**3.3**
337	19	M	PR	**10.0%**	42	23	0	0	0	0	0	**3.3**
340	1	M	R	**3.0%**	2	0	0	0	0	0	0	**3.0**
344	27	M	M	**20.0%**	21	48	38	6	0	0	0	**4.1**
360	62	M	R	**3.0%**	169	42	1	0	0	0	0	**3.2**
371	25	M	XX	**0.0%**	39	48	13	3	0	1	0	**3.7**
401	56	M	PR	**10.0%**	72	116	21	0	0	0	0	**3.7**
406	1	M	PR	**10.0%**	0	3	1	0	0	0	0	**4.2**
407	9	M	PR	**10.0%**	0	33	4	0	0	0	0	**4.1**
410	29	M	M	**20.0%**	66	22	7	2	0	0	0	**3.3**
416	1	M	PR	**10.0%**	0	1	5	0	0	0	0	**4.9**
417	9	M	PR	**10.0%**	2	18	22	0	0	0	0	**4.4**
419	23	M	M	**20.0%**	18	60	13	0	0	0	0	**3.9**
428	46	M	PR	**10.0%**	109	38	0	0	0	0	0	**3.2**
451	44	M	PR	**10.0%**	29	67	88	6	0	0	0	**4.2**
556	30	M	PR	**10.0%**	41	61	4	0	0	0	0	**3.6**
564	188	M	PR	**10.0%**	327	269	101	3	0	0	0	**3.6**
592	22	M	M	**20.0%**	65	0	0	0	0	0	0	**3.0**
593	49	M	PR	**10.0%**	73	89	18	0	0	0	0	**3.6**
596	5	M	XX	**0.0%**	13	4	0	0	0	0	0	**3.2**
607	22	M	PR	**10.0%**	57	15	0	0	0	0	0	**3.2**
618	33	M	PR	**10.0%**	54	40	33	0	0	0	0	**3.7**
626	25	M	M	**20.0%**	28	49	25	0	0	0	0	**3.8**
627	3	M	XX	**0.0%**	4	6	1	0	0	0	0	**3.6**
630	26	M	PR	**10.0%**	50	30	15	0	0	0	0	**3.5**
633	45	M	R	**3.0%**	114	36	2	0	0	0	0	**3.2**
637	17	M	PR	**10.0%**	19	45	1	2	0	0	0	**3.7**

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LMZ ID	CFLB Area (ha)	VAC	VQC/ VQO	% Denudation	Area (ha) by slope class (%) and associated VEG height (m)[1] 0-10% 3m	11-20% 4m	21-30% 5m	31-40% 6m	41-50% 7m	51-60% 8m	>61% 8.5m	Visually Effective Greenup Height, VEG (m)
638	22	M	XX	**0.0%**	43	29	8	1	0	0	0	**3.5**
639	67	M	PR	**10.0%**	66	141	49	5	2	0	0	**3.9**
647	59	M	PR	**10.0%**	72	94	6	29	32	12	0	**4.1**
648	20	M	M	**20.0%**	35	22	19	0	0	0	0	**3.6**
650	7	M	XX	**0.0%**	18	6	0	0	0	0	0	**3.2**
669	39	M	PR	**10.0%**	93	29	6	0	0	0	0	**3.2**
678	16	M	PR	**10.0%**	30	26	0	0	0	0	0	**3.4**
684	27	M	R	**3.0%**	50	43	0	0	0	0	0	**3.4**
685	22	M	R	**3.0%**	60	10	1	0	0	0	0	**3.1**
688	182	M	P	**0.5%**	499	55	15	0	0	0	0	**3.1**
696	34	M	PR	**10.0%**	105	1	0	0	0	0	0	**3.0**
736	4	M	XX	**0.0%**	11	0	0	0	0	0	0	**3.0**
745	19	M	R	**3.0%**	41	25	0	0	0	0	0	**3.3**
753	21	M	M	**20.0%**	45	22	5	0	0	0	0	**3.4**
764	100	M	PR	**10.0%**	268	57	0	0	0	0	0	**3.1**
800	67	M	PR	**10.0%**	153	76	0	0	0	0	0	**3.3**
801	51	M	PR	**10.0%**	87	50	38	22	0	0	0	**3.7**
811	4	M	XX	**0.0%**	6	5	2	0	0	0	0	**3.6**
826	29	M	R	**3.0%**	40	64	2	0	0	0	0	**3.6**
831	148	M	PR	**10.0%**	289	185	77	1	0	0	0	**3.5**
838	34	M	PR	**10.0%**	13	52	63	24	6	3	0	**4.6**
841	32	M	R	**3.0%**	32	87	0	0	0	0	0	**3.7**
857	73	M	P	**0.5%**	202	27	1	0	0	0	0	**3.1**
867	26	M	PR	**10.0%**	60	28	0	0	0	0	0	**3.3**
869	42	M	PR	**10.0%**	117	21	0	0	0	0	0	**3.1**
880	4	M	XX	**0.0%**	11	0	0	0	0	0	0	**3.0**
892	39	M	PR	**10.0%**	119	0	0	0	0	0	0	**3.0**
897	4	M	XX	**0.0%**	9	3	0	0	0	0	0	**3.2**
902	54	M	PR	**10.0%**	104	86	4	0	0	0	0	**3.4**
909	1	M	XX	**0.0%**	2	3	0	0	0	0	0	**3.5**
914	4	M	XX	**0.0%**	11	0	0	0	0	0	0	**3.0**
935	56	M	M	**20.0%**	131	57	2	0	0	0	0	**3.3**
950	25	M	M	**20.0%**	77	3	0	0	0	0	0	**3.0**
967	49	M	R	**3.0%**	54	110	21	2	0	0	0	**3.7**
991	39	M	R	**3.0%**	68	57	9	0	0	0	0	**3.5**
1005	32	M	R	**3.0%**	12	55	64	9	0	0	0	**4.4**
1018	53	M	P	**0.5%**	10	66	127	51	0	0	0	**4.7**
1140	44	M	M	**20.0%**	77	57	19	4	0	0	0	**3.5**

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