MANNING DIVERSIFIED FOREST PRODUCTS LTD.

Timber Supply Analysis

2007 – 2017 Forest Management Plan for FMA 0200041

May 31, 2007

Prepared by:
The Forestry Corp.

2007 – 2017 FMP FOR FMA 0200041

Forest Landscape Metrics forms one of 10 sections of the 2007 – 2017 Forest Management Plan for Manning Diversified Forest Products Ltd.'s Forest Management Agreement (FMA) 0200041. The Forest Management Plan (FMP) includes the following sections:

1. **Introduction and Plan Development** – Introduces the companies operating on the FMA and describes the FMP development process, including the public consultation process. Includes the FMP Standards Checklist.
2. **FMA Area** – Describes the physical environment of the FMA Area.
3. **FMA Resources** – Describes the natural resources within the FMA Area.
4. **Values, Objectives, Indicators and Targets** (VOITs) – Details the values, objectives, indicators and targets that were instrumental in selecting the Preferred Forest Management Strategy and in developing forest management strategies for the FMP.
5. **Forest Landscape Metrics** – Presents specific information regarding forest vegetation composition and natural disturbance within the FMA Area and/or northwestern Alberta to address VOIT requirements.
6. **Landbase Netdown** – Provides a detailed description of the landbase netdown process, in preparation for the Timber Supply Analysis.
7. **Yield Curves** – Documents the volume sampling and yield curve development process.
8. **Timber Supply Analysis** – Describes how the Preferred Forest Management Strategy, which was selected to meet Values and Objectives, was incorporated into the Timber Supply Analysis and provides an Annual Allowable Cut for both the coniferous and deciduous landbases.
9. **Implementation** – Describes the forest management strategies and operations that will be used to implement the FMP and help ensure that indicators and targets are met.
10. **Monitoring and Research** – Describes monitoring commitments required to ensure indicators and targets are tracked and describes Manning Diversified's approach to supporting research.

Executive Summary

Manning Diversified Forest Products (MDFP) Ltd.'s Forest Management Agreement (FMA) Area includes two Forest Management Units (FMUs), P6 and P9, which are currently referred to as FMU P16 (FMA 0200041). For the 2007-2017 FMP, an updated timber supply analysis was conducted to determine a PFMS.

Using the spatial harvest model called Patchworks, the Core Planning Team selected a PFMS which resulted in the following AAC recommendation for FMU P16 for the 2007-2017 FMP. The table below lists the harvest level from the PFMS for FMU P16 for the 2007-2017 FMP, as well as the current approved AAC. The effective date for this harvest level is May 1, 2007.

Recommended P16 AAC.

Volume Source	Coniferous Harvest Volume (m^3/yr)			Deciduous Harvest Volume (m^3/yr)		
	Primary Evenflow	Secondary 20yr avg.	Total	Primary Evenflow	Secondary 20yr avg.	Total
PFMS (Scenario P16_P9003)	301,817	12,736	314,553	73,619	179,298	252,917
Current Approved AAC	196,897	14,404	211,301	129,849	42,692	172,541

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1. Introduction

Manning Diversified Forest Products Ltd. (MDFP) has a Forest Management Agreement (FMA) Area that originally consisted of two FMU's, P6 and P9, which are now referred to as FMU P16[1]. As part of the FMP development, a Timber Supply Analysis was conducted. The TSA process involved evaluation of management alternatives and selection of a PFMS, with an associated AAC. This document describes the process used to derive the PFMS and determine the associated AAC.

[1] For the purposes of this document, all three FMU titles are used where appropriate.

2. Landbase

The Landbase Version 4 was used to derive the Preferred Forest Management Scenario (PFMS). The landbase creation is described in the FMP Landbase Netdown, however a summary of the final values is presented in Table 2-1 and Table 2-2 and graphically in Figure 2-1 and Figure 2-2. The effective date of the landbase is May 1, 2005.

Table 2-1. Landbase deletion hierarchy.

Landbase Category		Area (ha) FMU P6	FMU P9	Total	% Gross Area
Gross Landbase		297,531	298,147	595,677	100%
Patented Land (D_STATUS)					
PSP	SRD PSP Buffer	239	-	239	0%
PATENT	Protected Areas	270	-	270	0%
Total Patented Land		509	-	509	0%
Running Sum of Area Deleted		509	-	509	0%
Landbase Remaining		297,022	298,147	595,169	100%
Access (D_ACCESS, D_SEISMIC)					
ROAD	Roads	2,394	755	3,149	1%
PIPE	Pipelines	1,037	1,009	2,045	0%
SEISMIC	Seismic Lines	5,154	6,326	11,479	2%
Total Access		8,584	8,089	16,674	3%
Running Sum of Area Deleted		9,093	8,089	17,182	3%
Landbase Remaining		288,438	290,057	578,495	97%
Non-Forested (D_NONFOR)					
WATER	Water Body	3,163	635	3,798	1%
ANTHRO	Anthropogenic Non-Vegetated	997	718	1,716	0%
NNF	Non-Forested	36,934	20,979	57,913	10%
NNV	Naturally Non-Vegetated	3,670	4,136	7,806	1%
Total Non-Forested		44,765	26,468	71,233	12%
Running Sum of Area Deleted		53,858	34,558	88,416	15%
Landbase Remaining		243,673	263,589	507,262	85%
Recent Burns (D_BURN)					
BURN	Recent Burn	319	2	321	0%
Total Burn		319	2	321	0%
Running Sum of Area Deleted		54,177	34,559	88,736	15%
Landbase Remaining		243,354	263,587	506,941	85%
Non-Productive (D_TPR)					
U	Unproductive	1,790	185	1,975	0%
F	Decid TPR = F	1,106	1,776	2,881	0%
Total Non-Productive		2,896	1,960	4,856	1%
Running Sum of Area Deleted		57,073	36,520	93,592	16%
Landbase Remaining		240,458	261,627	502,085	84%
Water Buffers (D_BUF)					
RIVBK	River Breaks	8,384	14,647	23,031	4%
SWAN	Swan Lake Buffer	137	-	137	0%
WBUF	Water Buffers	639	618	1,257	0%
Total Water Buffers		9,160	15,265	24,425	4%
Running Sum of Area Deleted		66,233	51,785	118,017	20%
Landbase Remaining		231,298	246,362	477,660	80%
Subjective Deletions (D_SUBJ, D_ISO)					
WETLAND	Wetland	54,160	115,774	169,934	29%
ADENS	A Density Stands	3,071	5,084	8,155	1%
LARCH	Larch	70	22	92	0%
SBLEAD	Sb Leading and TPR < G	1,835	847	2,682	0%
CBUSB	APM Area Black Spruce	340	-	340	0%
CBUSW	APM Area White Spruce	1,166	-	1,166	0%
CBUPL	APM Area Lodgepole Pine	-	-	-	0%
ISO	Isolated Stands	0	-	0	0%
Total Subjective Deletions		60,641	121,727	182,369	31%
Total Area Deleted		126,874	173,512	300,386	50%
Active Landbase		170,657	124,634	295,291	50%

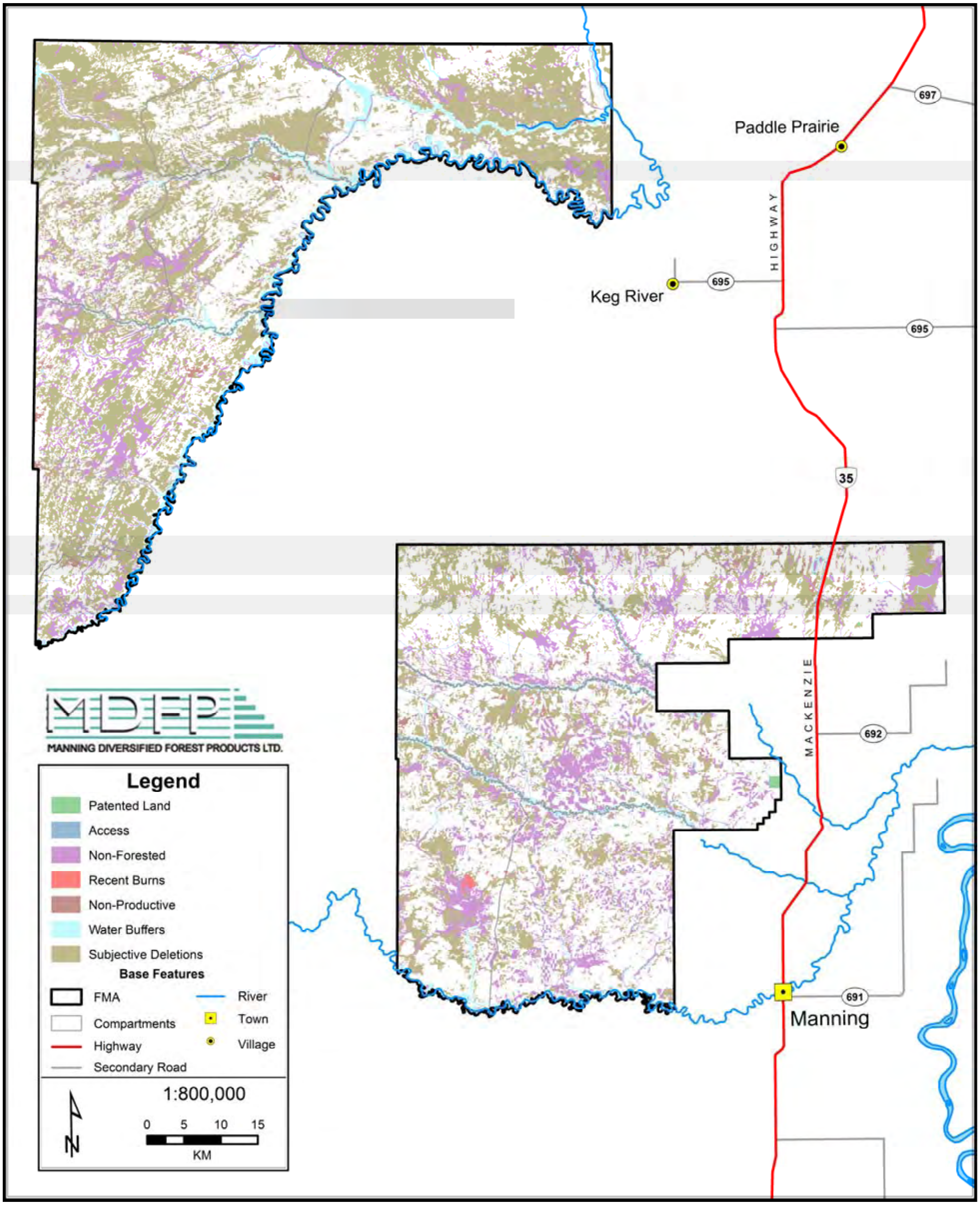


Figure 2-1. Passive landbase by deletion category (seismic is not shown).

Table 2-2. Active landbase yield strata.

Status	Strata	Overstory Density B	Overstory Density CD	Understory Density A	Understory Density BCD	Total
FMU P6						
Natural	D	2,921	6,881	-	-	9,802
	DC	1,083	1,709	-	-	2,793
	DCU	3,805	5,633	-	-	9,438
	CD	1,609	2,089	-	-	3,699
	CDU	3,258	2,205	-	-	5,463
	PL	3,079	4,011	-	-	7,090
	SB	415	1,935	-	-	2,350
	SW	22,268	20,737	-	-	43,005
	DUX	141	104	-	-	245
	DUSW	-	-	44,302	26,950	71,252
	Total	38,580	45,304	44,302	26,950	155,136
Managed	D	412	1,658	-	-	2,070
	DC	264	534	-	-	798
	DCU	9	26	-	-	35
	CD	1,097	3,929	-	-	5,027
	CDU	0	9	-	-	9
	PL	208	386	-	-	594
	SB	15	49	-	-	64
	SW	2,003	1,477	-	-	3,480
	DUX	11	191	-	-	202
	DUSW	-	-	1,644	1,598	3,242
	Total	4,019	8,260	1,644	1,598	15,521
P6 Total		42,600	53,563	45,946	28,548	170,657
FMU P9						
Natural	D	12,592	47,289	-	-	59,880
	DC	768	1,823	-	-	2,591
	DCU	1,298	3,037	-	-	4,335
	CD	462	1,583	-	-	2,045
	CDU	947	1,336	-	-	2,283
	PL	3,068	15,659	-	-	18,726
	SB	749	1,098	-	-	1,847
	SW	5,189	3,765	-	-	8,954
	DUX	812	1,182	-	-	1,994
	DUSW	-	-	11,500	8,039	19,539
	Total	25,885	76,771	11,500	8,039	122,195
Managed	D	-	-	-	-	-
	DC	13	10	-	-	24
	DCU	-	-	-	-	-
	CD	-	-	-	-	-
	CDU	-	-	-	-	-
	PL	-	-	-	-	-
	SB	-	-	-	-	-
	SW	-	-	-	-	-
	DUX	-	-	-	-	-
	DUSW	-	-	-	2,416	2,416
	Total	13	10	-	2,416	2,440
P9 Total		25,898	76,782	11,500	10,455	124,634
FMA Total		68,498	130,345	57,446	39,003	295,291

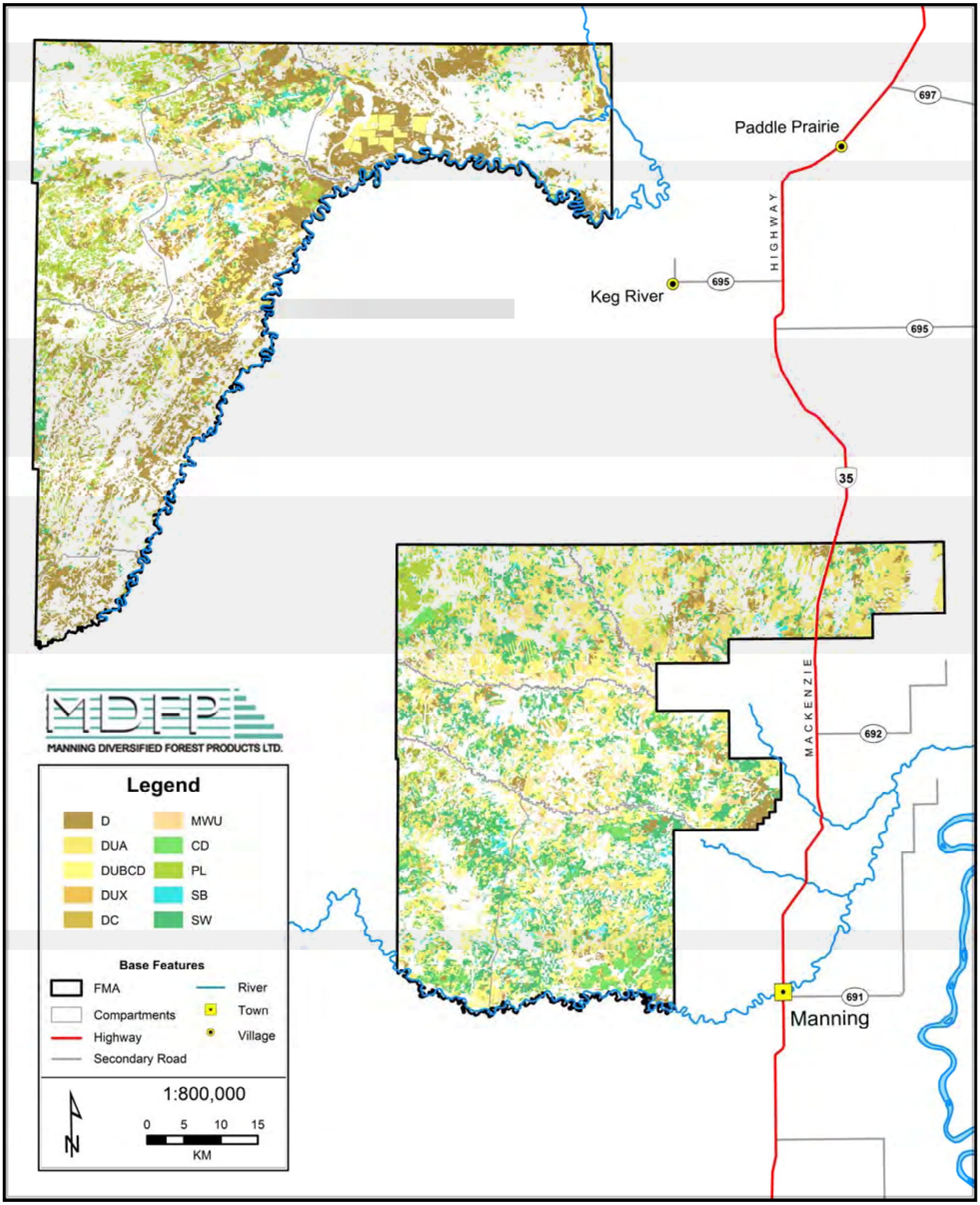


Figure 2-2. Active landbase by Yield Strata.

3. Yield Curves

Yield curve development is described in the FMP Yield Curve Development. The yield curves were used exactly as presented in the Yield Curve Development; no modifications were made in the timber supply model. The final yield curves are presented in this section for reference.

Utilization standards associated with the yield curves is presented in Table 3-1. All curves are reduced for cull. The Post-91 Managed curves have been modified to account for regeneration lag. Natural stand yield curves are shown in Figure 3-1. Pre-91 Managed curves are shown in Figure 3-2. Post-91 Managed curves are shown in Figure 3-3. Figure 3-4 shows the understory protection post-treatment curve, however this treatment was not used in the PFMS. Tree improvement curves are shown in Figure 3-5.

Table 3-1. Minimum utilization standards by species type.

Species Type	Log Length (m)	Stump Diameter (cm)	Top Diameter (cm)	Stump Height (m)
Coniferous	2.6	15.0	11.1	0.3
Deciduous	2.6	15.0	10.0	0.3

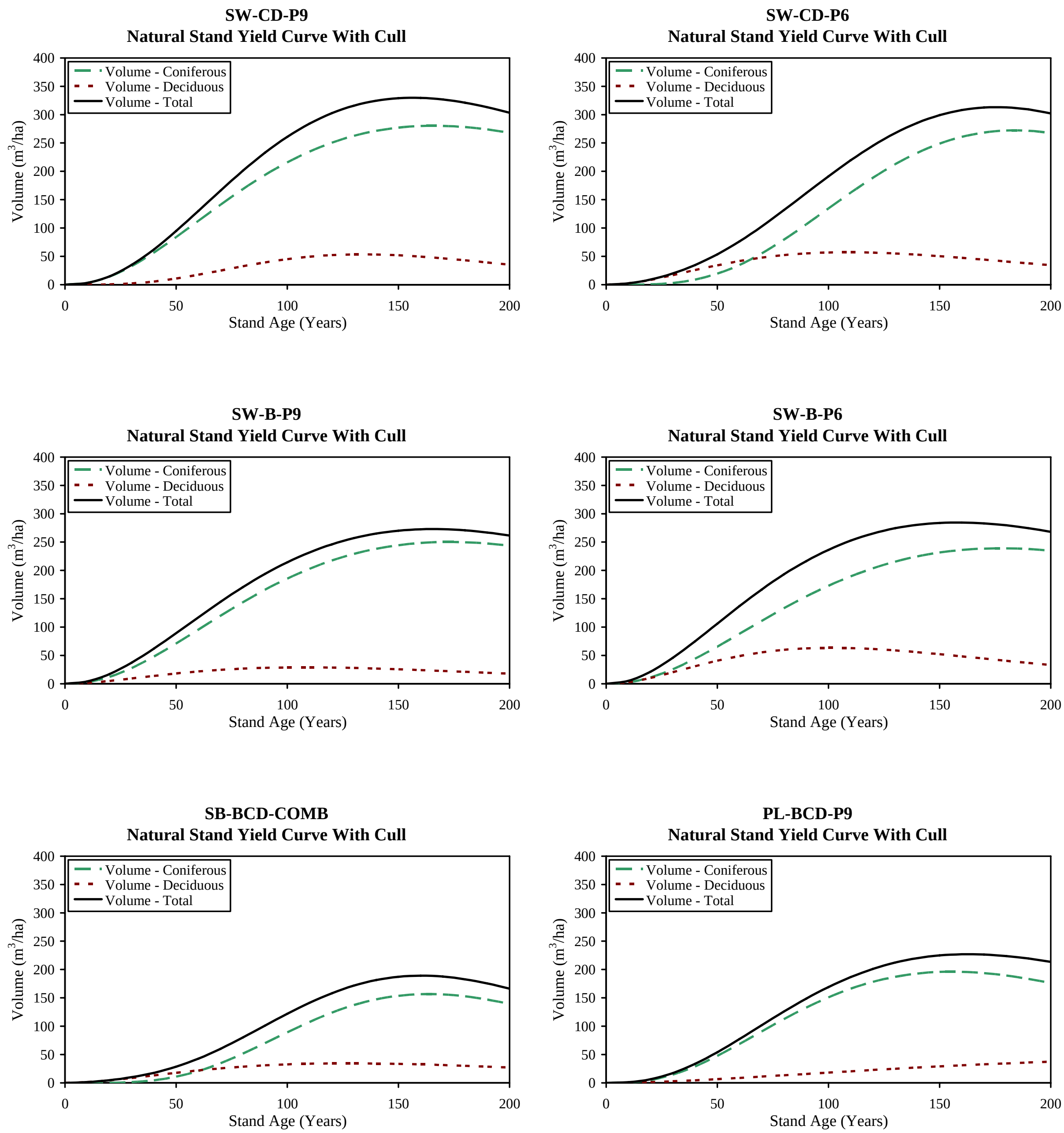


Figure 3-1. Natural stand yield curves.

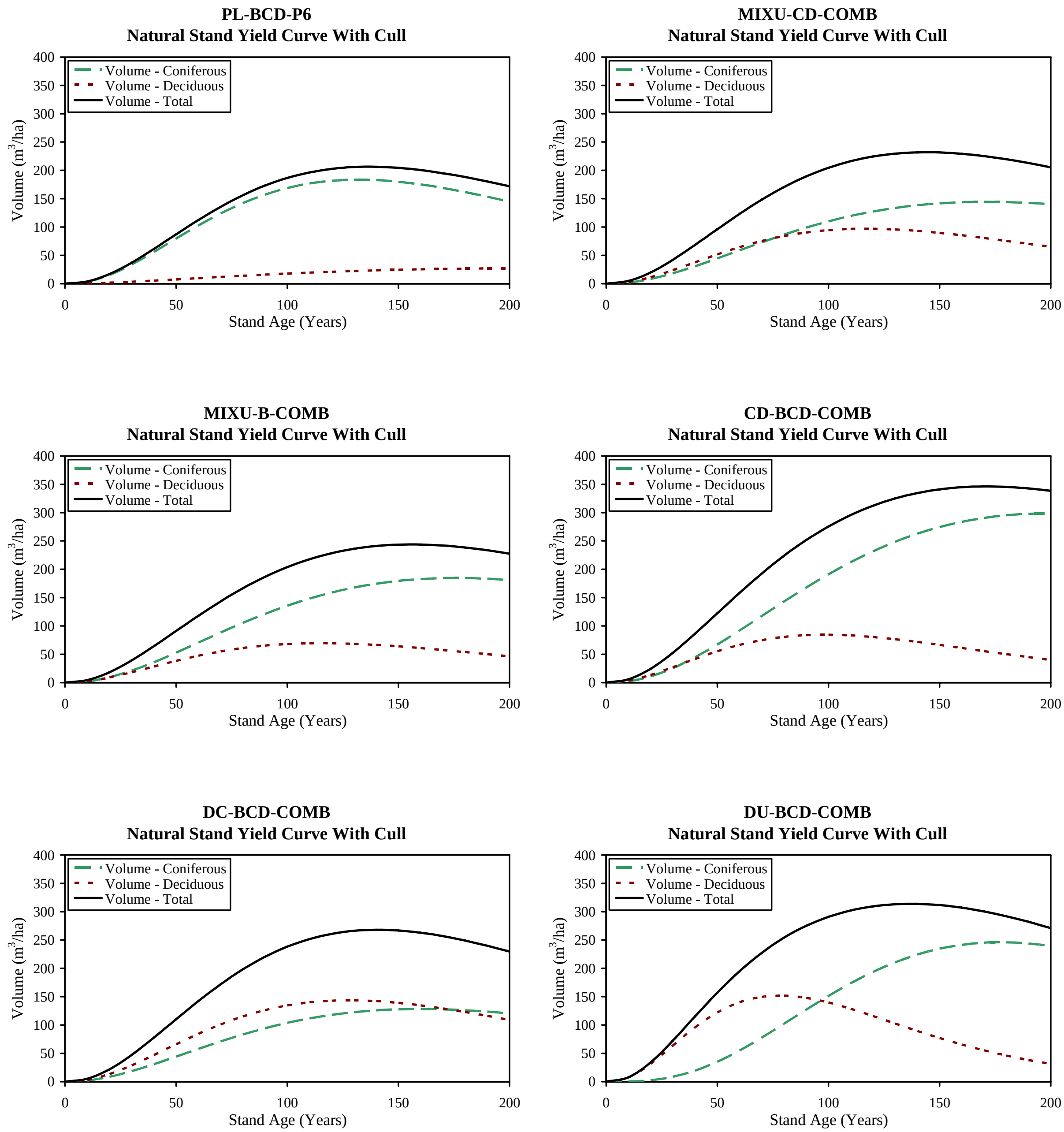
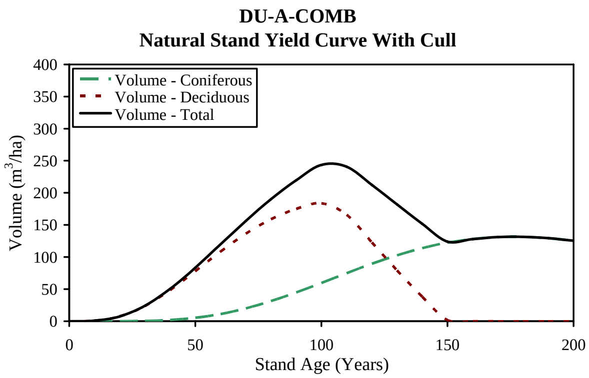
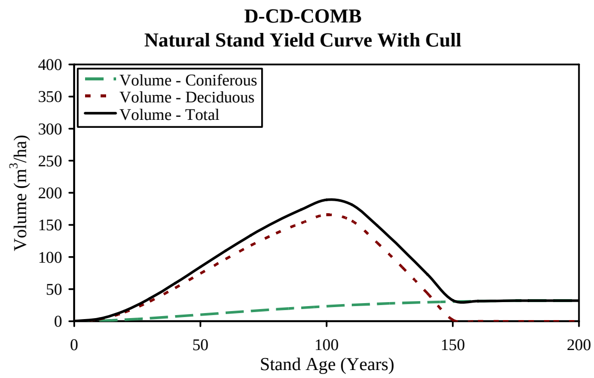


Figure 3-1. Natural stand yield curves. (Continued)





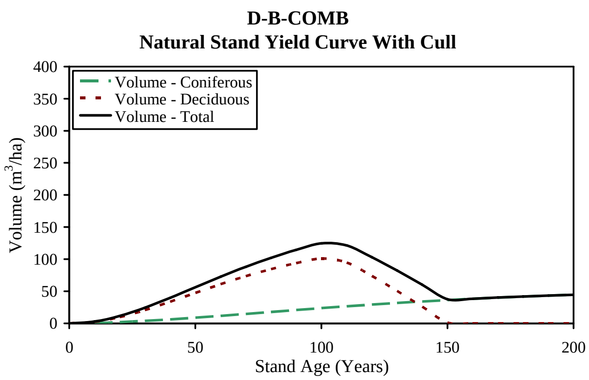


Figure 3-1. Natural stand yield curves. (Continued)

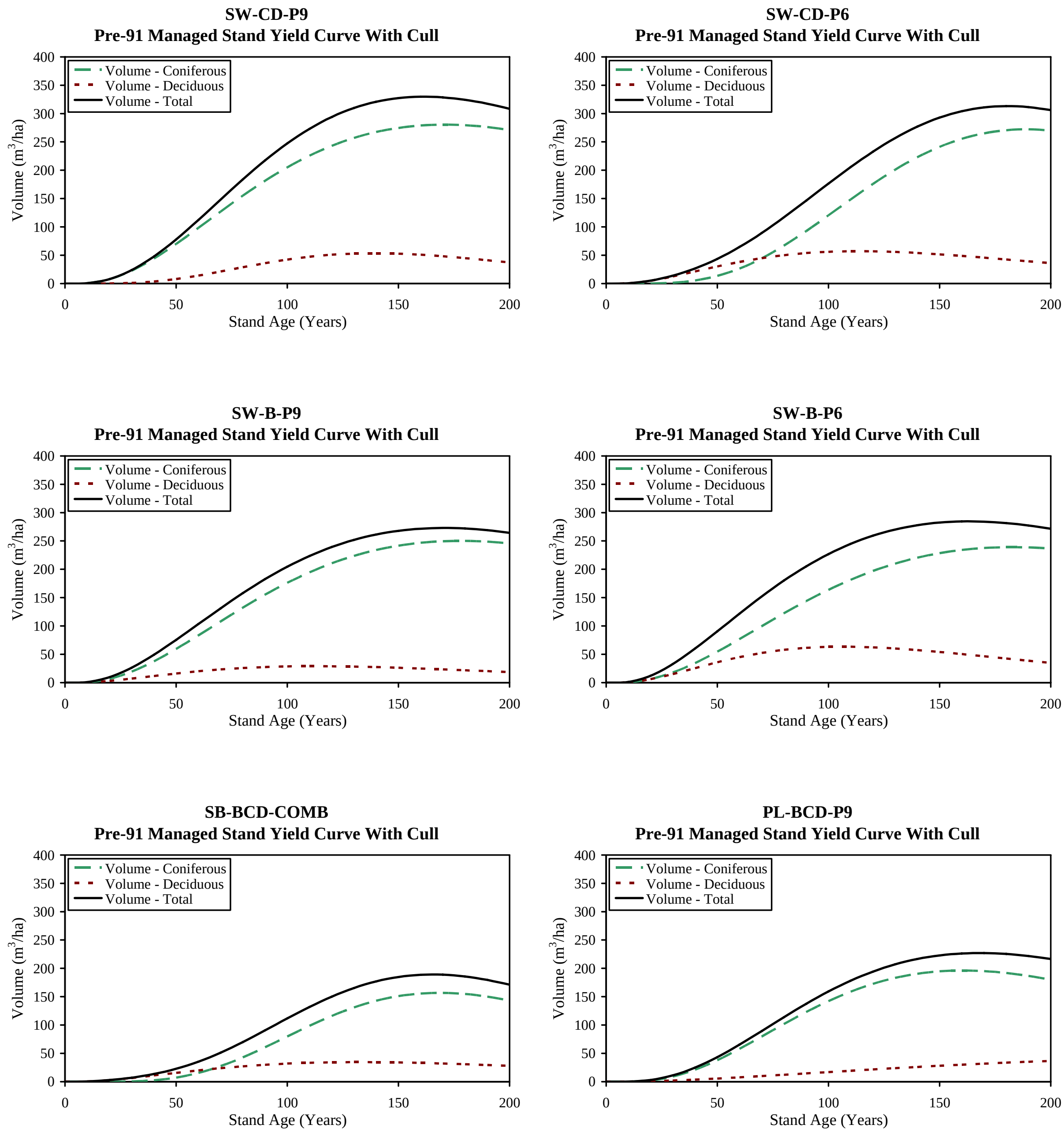


Figure 3-2. Pre-91 Managed stand yield curves.

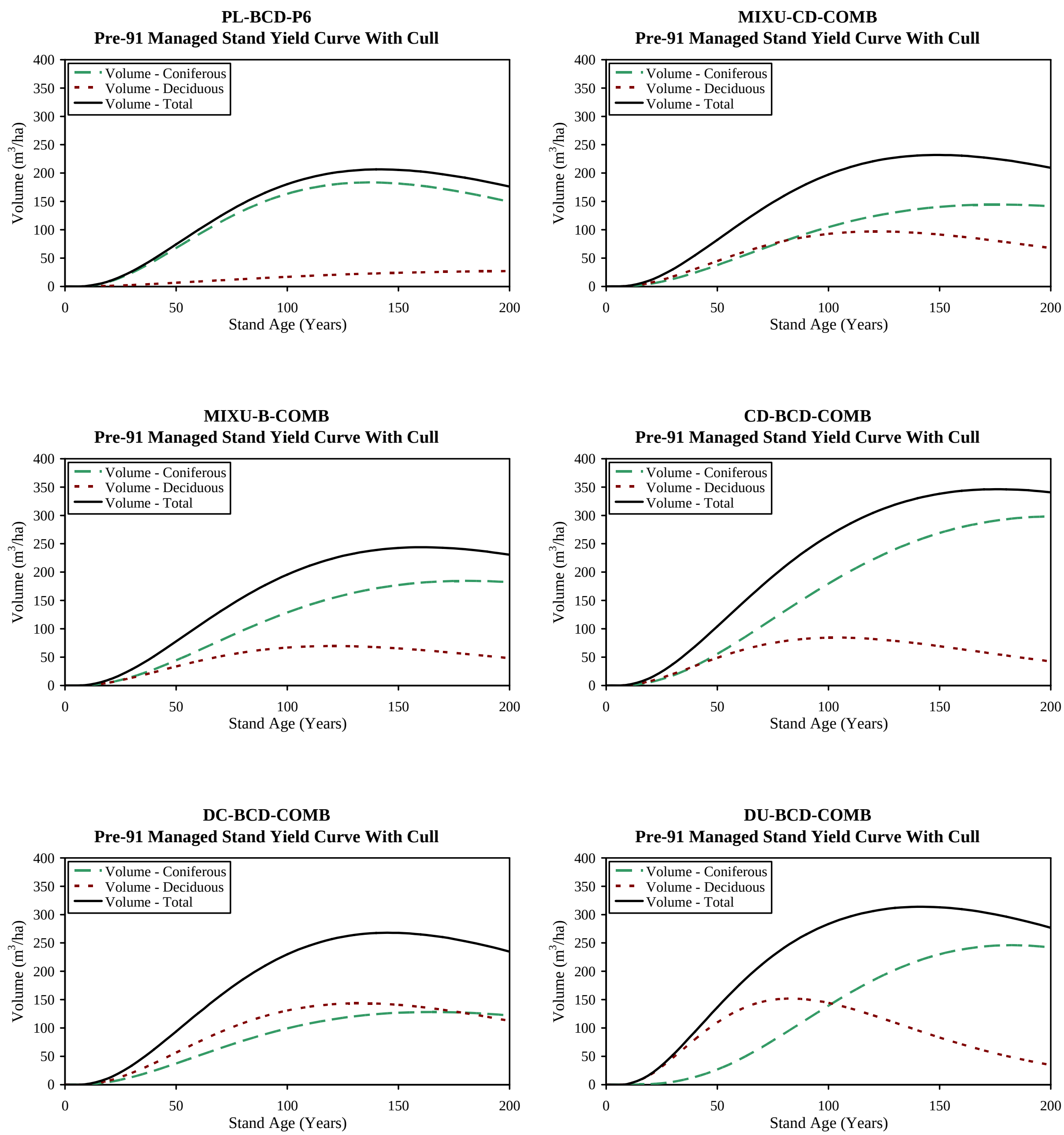
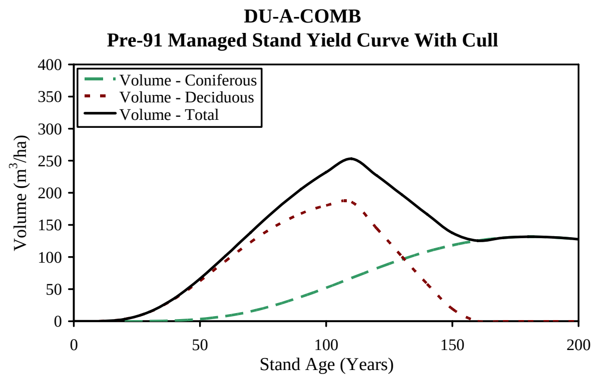
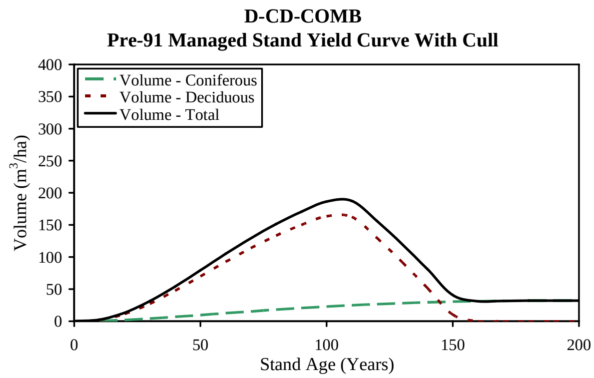


Figure 3-2. Pre-91 Managed stand yield curves. (Continued)





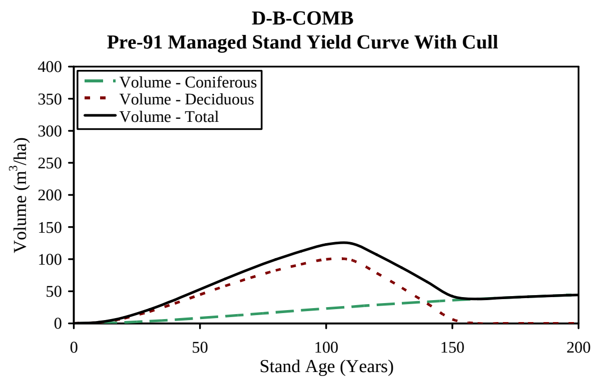


Figure 3-2. Pre-91 Managed stand yield curves. (Continued).

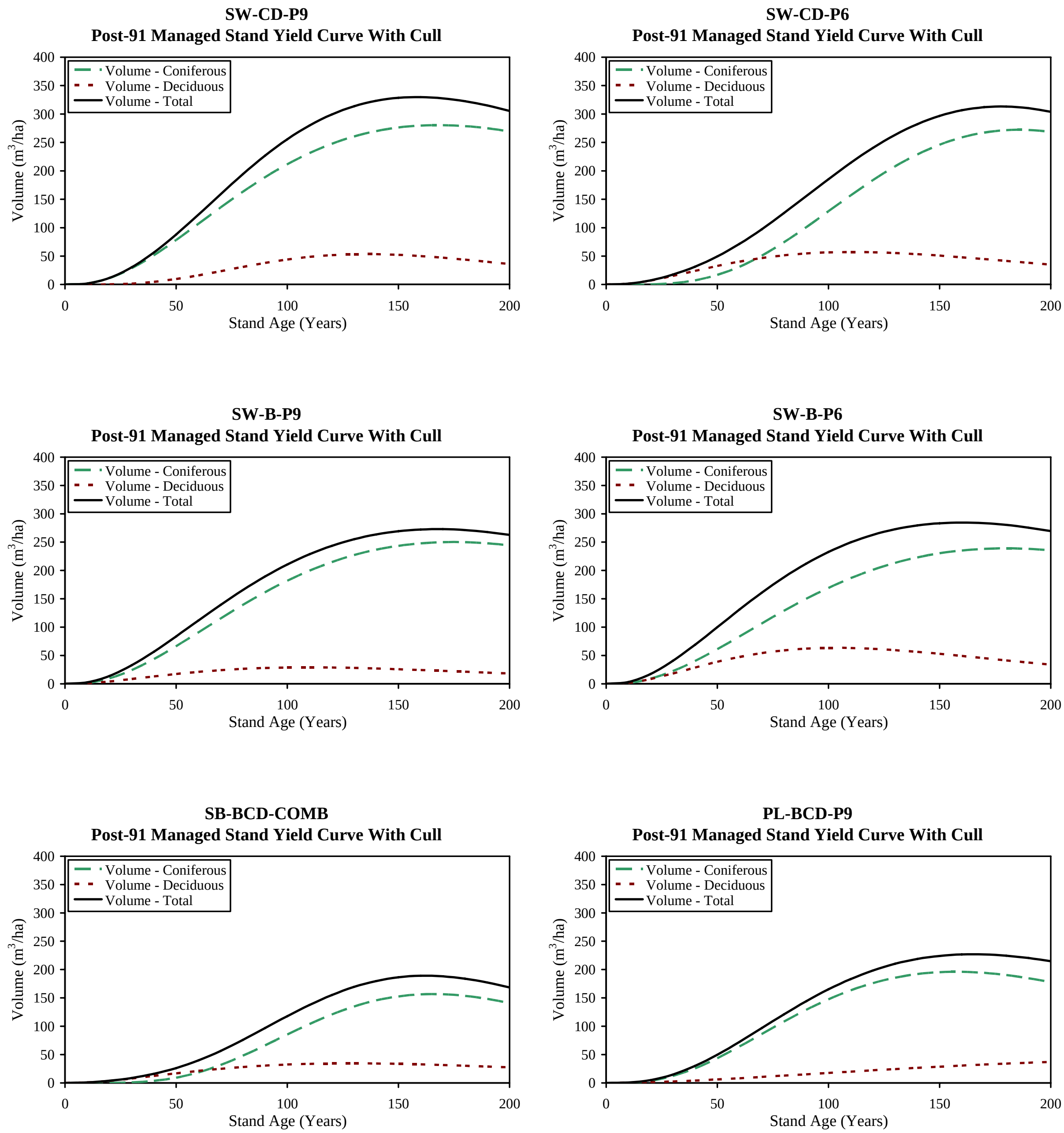


Figure 3-3. Post-91 Managed stand yield curves.

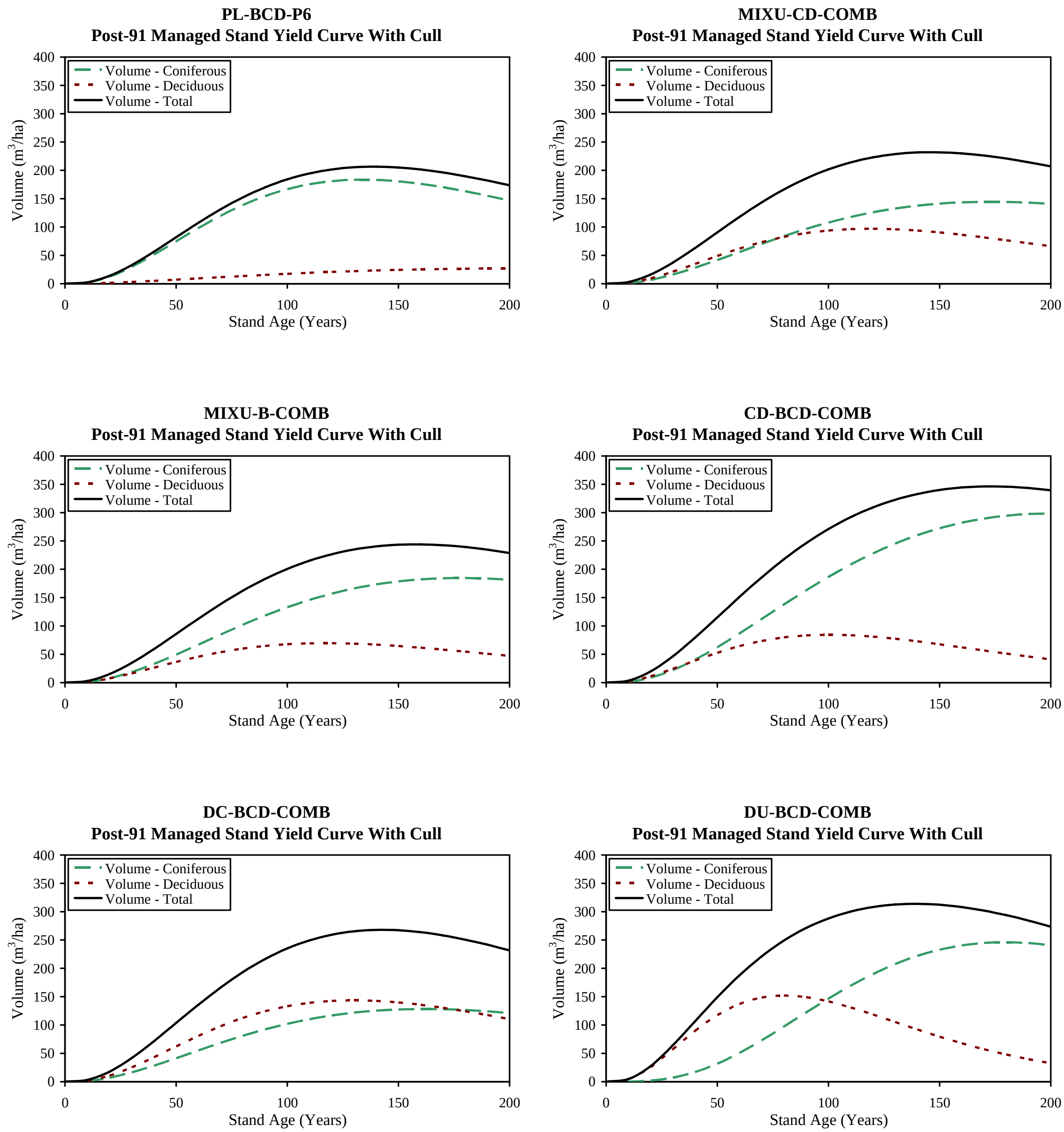
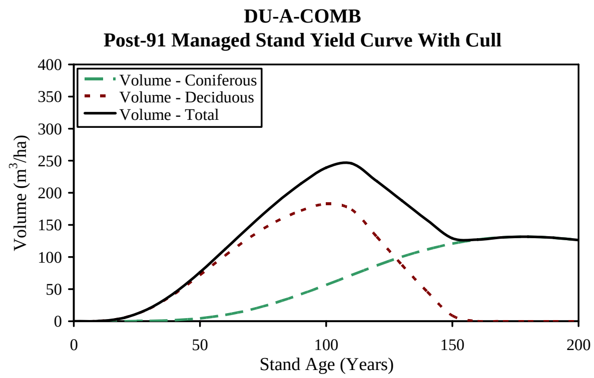
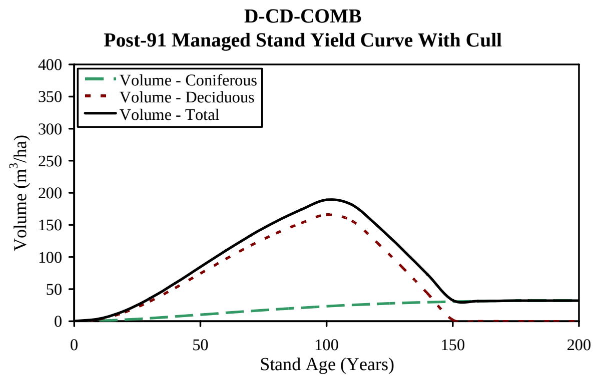


Figure 3-3. Post-91 Managed stand yield curves. (Continued)





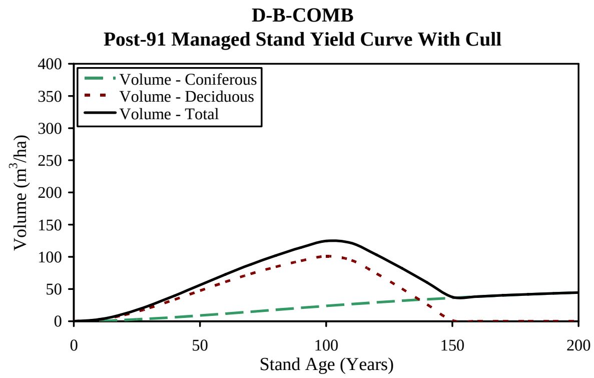


Figure 3-3. Post-91 Managed stand yield curves. (continued)

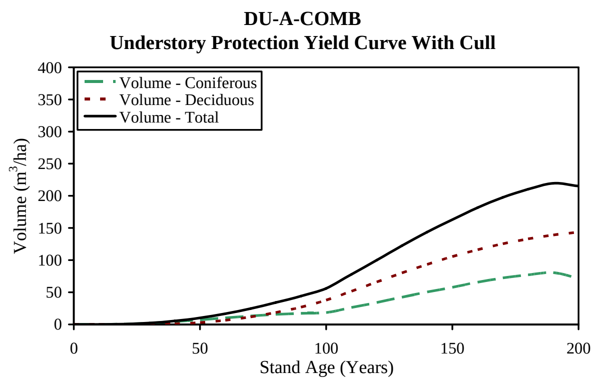


Figure 3-4. Understory protection yield curve.

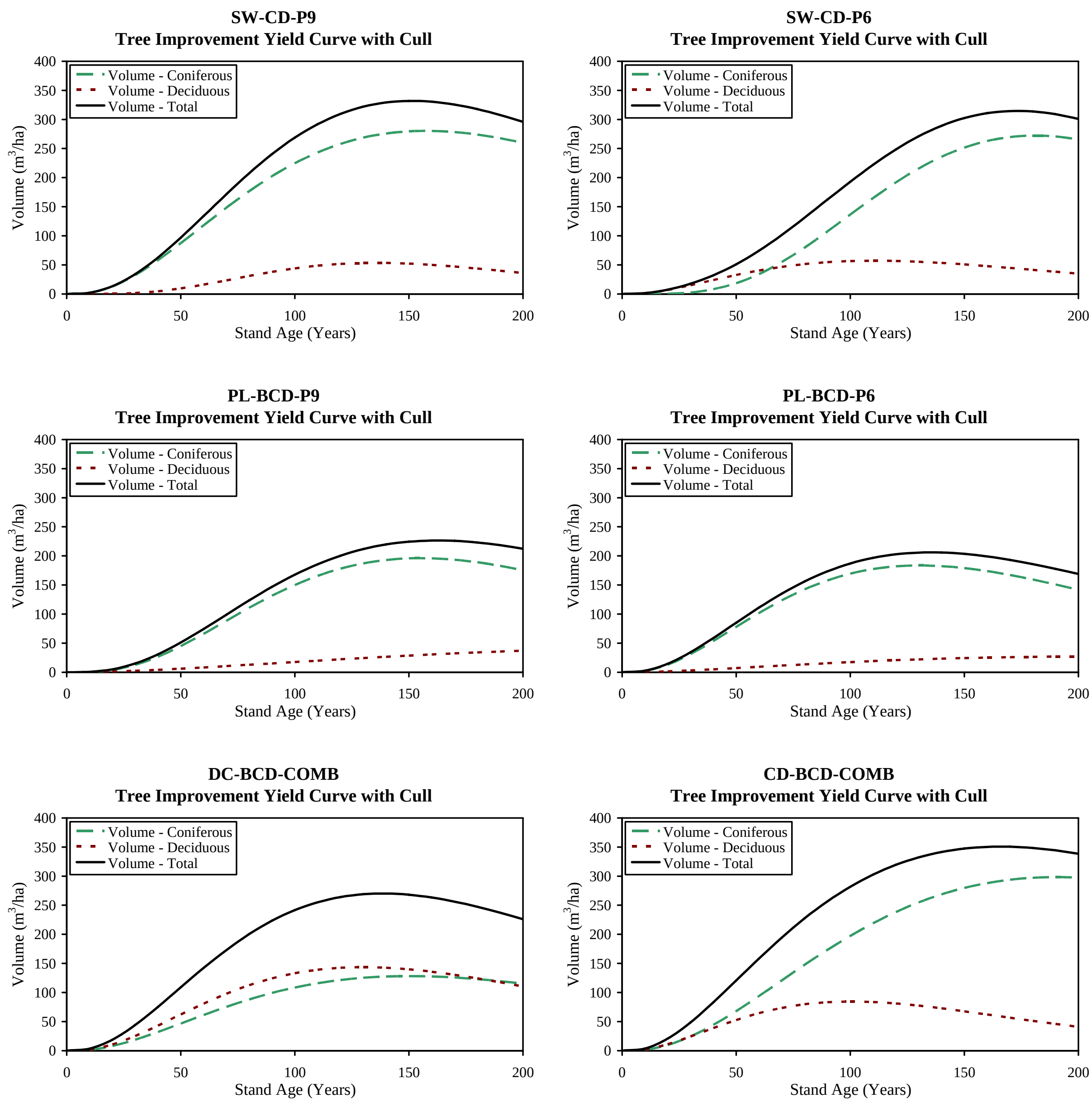


Figure 3-5. Tree improvement yield curves.

4. Modeling Tools

Two timber supply modeling tools were used: Woodstock© for non-spatial analysis and Patchworks© for spatial analysis. The Patchworks interface allows the conversion of Woodstock models into Patchworks format, therefore common datasets were utilized to ensure continuity and meaningful comparison of results.

Woodstock was used for strategic, non-spatial analysis to test and compare different management assumptions. Many scenarios in Patchworks dealing with spatial issues were also compared, and for this TSA, the recommended harvest level and the spatial harvest sequence were set using a scenario developed in Patchworks.

4.1 Woodstock

Woodstock is a strategic forest estate-modeling tool developed by Remsoft[2]. It was used for strategic analysis of timber supply and comparisons of alternative strategies and formulations. This strategic analysis provides insight for the resolution of specific issues including growing stock, minimum harvest age and harvest flow.

Woodstock is non-spatial, therefore every unique type is rolled up into forest classes (TSA themes by age class). The model can then apply treatments to all or a portion of that unique forest class. Post-treatment transitions representing one to many relationships are handled using percentages. The optimizer selects the optimal combination of treatments throughout the entire planning horizon to solve the objective function.

Woodstock can be formulated as either:

- basic optimization where there is one modeling objective with rigid constraints; or
- goal programming where the modeling objective is to minimize deviations from a goal or target.

[2] Remsoft Inc. 332 Brunswick Street, Fredericton, NB E3B 1H1

Goal programming requires the identification of a weighting, which is the penalty for deviating from the goal, to allow the model to rank the goals. Typically, a high weighting results in a small deviation from the goal.

For this timber supply analysis, only one Woodstock formulation was used:

- the basic optimization, where the modeling objective was to maximize harvest volume subject to constraints such as evenflow harvest volume and minimum ending growing stock.

Woodstock uses a mathematical technique called linear programming to quickly determine the absolute answer to the management assumptions.

A structured, progressive approach was used in the development and analysis of Woodstock scenarios. Increasing levels of constraints were applied in successive scenarios to meet forest management objectives and to answer specific management questions and issues. The end result of the Woodstock stage was scenarios that met all of the non-spatial key objectives.

Woodstock runs and reports in 5-year periods in this analysis.

4.1.1 Linear Programming

Linear programming is a commonly used mathematical tool used in forest management. Davis et al (2001) "Problems that are linear with respect to the relationships between the decision variables can be solved by a technique called linear programming. By linear we mean the operators are restricted to plus or minus." Linear programming is important largely due to its speed and accuracy in finding the 'optimal' solution with regards to a single objective and several constraints.

4.2 Patchworks

Patchworks is relatively new to forest management planning in Alberta. It is a spatially-explicit wood supply modeling tool developed by Spatial Planning Systems[3]. Patchworks was designed to provide the user with operational-scale decision-making capacity within a strategic analytical environment. Trade-off analysis of alternative operational decisions are quickly determined and visually displayed.

Patchworks operates at the polygon level. In Patchworks terminology polygons are the smallest element, which in this case are the subdivided AVI stands in the TSA Landbase. The treatments applied to each polygon are an *all or nothing* decision for the model. There is only one post-treatment transition for each polygon. When Patchworks operates, one or more polygons adjacent to each other that meet specific criteria can be combined to form "patches". The TSA Landbase is made up of many small polygons to allow for more options in creating patches.

The tool is fully spatial through time and the impact on an adjacent polygon 190 years into the future is considered in the first year of the simulation. Patchworks decision space can be thought of as a matrix consisting of each polygon and each potential outcome for every time slice in the planning horizon.

Patchworks is a heuristic model that attempts to achieve close to an optimal solution for the defined targets (similar to the goal-programming in Woodstock). Its modeling objective is to minimize deviation

[3] Spatial Planning Systems. 134 Frontenac Cres., Box 908, Deep River, ON K0J 1P0

from the modeling targets. The term *goal* will be used in this document to define the modeling targets used in both Patchworks and Woodstock models, to distinguish them from other types of targets. Patchworks uses a stochastic solving technique called simulated annealing. Unlike Woodstock, spatial relationships (*i.e.* patch size distributions) can be applied in the objective function.

In this analysis, a variety of goals were defined such as harvest levels, minimum growing stock levels, minimum seral stage areas, maximum block size and range of regeneration patch sizes by period. Goals were represented by different features (*e.g.* cubic meters or hectares) and weighting factors, which ranked the importance and contribution of each feature towards the modeling objective. Patchworks allows planners to explore the interactions between attributes such as physical wood supply, harvesting economics and other values.

Patchworks solves in annual periods, however, for this analysis it was set up to model and report in 1 two year period and 40 five year increments to match Woodstock reporting. The initial two year period represents the 'hard coded' 2005 and 2006 harvest years, so that the model begins forecasting in 2007.

Patchworks scenarios were developed from Woodstock, to ensure identical assumptions, including landbase, yield curves, treatments and responses.

4.2.1 Simulated Annealing

A description of simulated annealing from Davis et al. (2001) is:

> *an algorithm that simulates the cooling of materials in a heat bath – a process known as annealing. Essentially, (the) algorithm simulates the change in energy of a metal during the cooling process, and models the rate of change until it converges to a steady "frozen" state. Searching the feasible regions of a planning problem with the objective of converging on an optimal solution (a steady state) is the goal of simulated annealing. The technique moves from one "good" solution to a neighbouring solution, generally by randomly changing a single piece of the solution, perhaps the harvest prescription for a management unit.*

Davis further describes the process in which a random starting point is chosen (feasible or infeasible) and then as new choices are made, the model decides if the new treatment selection is better than the current treatment selection. If the new selection is better, then it replaces and becomes the current solution. This process is repeated many times until no new choices provide a better solution set than what is currently being used. Furthermore, Lockwood and Moore (1993) state that "a simulated annealing procedure mimics this slow cooling process by gradually rearranging the elements of a system from a disordered state to an ordered, or nearly optimal state."

The comparison to linear programming is difficult, but at least one study has examined the differences between the different modeling techniques. Boston and Bettinger (1999) compared simulated annealing with Monte Carlo Integer programming and with Tabu search heuristics, and then compared all three with linear programming solutions to four different problems. They concluded that "Simulated annealing found the highest solution value for three of the four planning problems, and was less than 1% from the highest objective function value in the fourth problem."

5. Assumptions and Inputs

5.1 Overview

Forecasting timber supply is a complex process that requires many inputs and assumptions. The purpose of this section is to explicitly describe the final inputs and assumptions used in the forecasting for the Manning Diversified FMA FMP. In many cases sensitivity analysis was completed to compare different sets of assumptions. The results of these analyses allowed the Core Planning Team to make decisions on which set of assumptions or inputs to use in the FMP. This section shows only the final set of assumptions and inputs used in the analysis. To allow them to be implemented in a TSA model, certain assumptions and inputs represent simplifications of natural systems.

The Preferred Forest Management Scenario was derived using a spatial modeling tool, therefore a Spatial Harvest Sequence (SHS) showing the timing and treatments of all stands throughout the planning horizon is available. The first 20 years of the SHS identifies the stands scheduled for harvest. Maintaining the sustainable harvest level and other values is assured by following the 20-year spatial harvest sequence.

This section describes the key objectives of the analysis, the desired future forest condition and the inputs and outputs of the many scenarios that were analyzed.

5.2 Modeling Objectives

5.2.1 Deciduous Overstory With Conifer Understory.

The DU stratum comprises over 30% of the active landbase, and is legally part of the coniferous landbase as identified in the FMA agreement. It makes up a significant portion of the secondary deciduous volume that DMI receives under their Deciduous Timber Allocation (DTA), along with providing significant volume to the primary conifer AAC.

The DU stratum can be difficult to manage because the highest deciduous volume is attained when it is harvested between the ages of 80 – 110 years old, while the highest conifer volume is attained when it is harvested older than 140 years old. MDFP and DMI have developed a strategy to allocate the DU strata in a manner that benefits both companies.

5.2.1.1 Refined strata

The first step was to further refine the DU stratum into three separate strata.

- DUA stratum – Understory leading species is white spruce and understory density is A.
- DUBCD stratum – Understory leading species is white spruce and understory density is B, C, or D. (referred to as DUSW in model)
- DUX stratum – Understory leading species is not white spruce.

5.2.1.2 Clearcut Treatments

Clearcutting the DU strata is the main harvest option available to MDFP and DMI. Two clearcut treatments were defined in the model:

- Deciduous Priority Clearcut – Clearcut when deciduous is merchantable and subsequently plant conifer to create mixedwood stands. The expectation is that most of the existing conifer understory will be left standing and that deciduous will sucker and regenerate on its own to create a stand transition to the DC stratum.
- Conifer Priority Clearcut – Clearcut when the conifer understory is merchantable and subsequently plant conifer to create mixedwood stands. The expectation is that deciduous will sucker and regenerate on its own and transition to the DC stratum.

MDFP and DMI agreed on using a combination of these two treatments. Table 5-1 shows the treatment to be applied to the DU strata.

Table 5-1. Clearcut treatments based on understory condition.

Understory			
Species	**Density**	**Strata**	**Treatment**
SW	**A**	**DUA**	Either Conifer or Deciduous priority based on individual stand characteristics.
SW	**BCD**	**DUBCD**	Conifer priority only.
Other	**ABCD**	**DUX**	Deciduous priority only.

The DUA stands are eligible for two treatments, deciduous priority and coniferous priority clearcut. A maximum of 50% of the DUA strata are scheduled for deciduous priority and the remainder is scheduled for coniferous priority. For each treatment, a limit of 800 ha/year was set.

For operational efficiencies and to reduce conifer mortality, the model was encouraged to schedule most of the deciduous priority treatments on stands with an understory height less than 12 meters. The height class of the understory is very difficult to predict as a function of overstory age, so this division of stands is based on original stand conditions. No attempt was made to ‘grow’ the understory height.

5.2.1.3 Understory Protection Treatments

The stands that would be eligible for understory protection are difficult to determine from AVI and will only be chosen on a site specific basis. As such, the PFMS did not use this treatment.

5.2.2 Caribou Habitat

The FMP incorporates both the Provincial Caribou Zone and the Alternative Patch Management Area (APMA). Within the Caribou Zone and the APMA, forest management strategies to support caribou habitat considerations are implemented. The Caribou Zone and APMA is shown in Figure 5-1.

5.2.2.1 30-20 Rule

TSA constraints were introduced to reduce the habitat for ungulates other than caribou in an effort to reduce the predator population. Habitat preferred by other ungulates was generalized as deciduous or mixedwood covertypes (D, DU, DC, DCU, CD or CDU) less than 30 years old. To ensure ungulate habitat was maintained at an acceptable level within the Caribou Zone and the APMA, the area of the landbase under 30 years old was constrained to less than 20% of the gross landbase within each FMU, for each of the following covertype categories: D, DU, DC, DCU, CD and CDU. This strategy also helped ensure significant areas of Mature and Old seral stage forests were retained.

5.2.2.2 Patch Size

Availability of contiguous habitat (i.e., large patches) was identified as significant in determining the quality of woodland caribou habitat. The TSA targeted a larger patch size for harvest within the Caribou Zone and APMA in FMU P6 and in the Caribou Zone in FMU P9. This was accommodated in the model by maximizing harvest patches greater than 300 hectares. This strategy also served to minimize the amount of access required.

5.2.2.3 Access Control

Reducing the number of access entries was accomplished by controlling the number of entries into the Caribou Zone and APMA. Within P6, these areas are bisected by both the Hotchkiss and the Meikle Rivers. The TSA constrained the access to these three sub-zones to permit only one to be open in each ten-year harvest period. In addition, harvesting a number of small or isolated stands (patches) was deferred until surrounding stands met minimum merchantability criteria. In the Caribou Zone in P9, the TSA was constrained so that harvesting was deferred from a large portion of the Caribou Zone. The mature timber being sequenced was sparse, which would have resulted in opening significant access and requiring multiple entry periods to recover relatively small timber volumes.

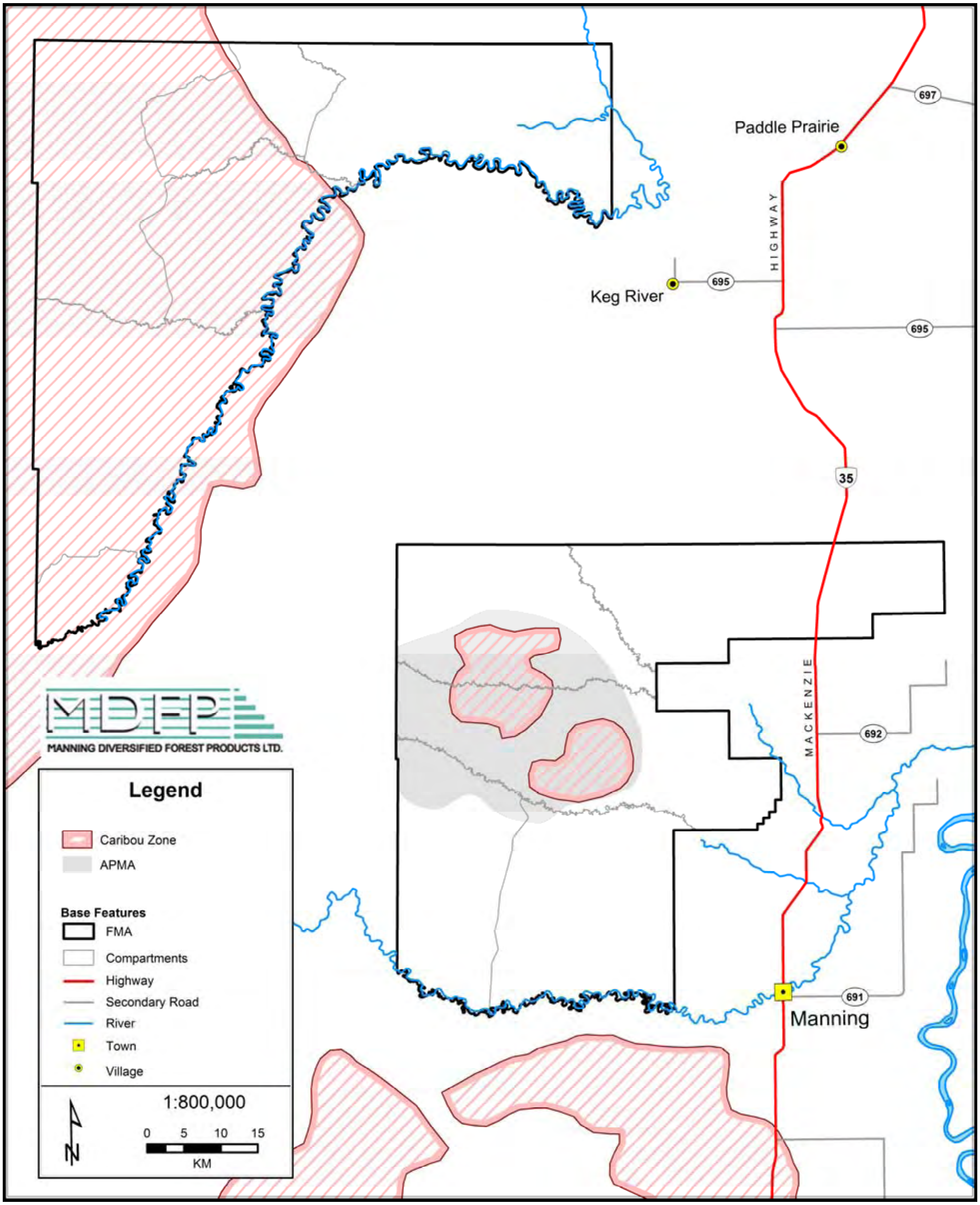


Figure 5-1. Caribou Zone and APMA.

5.2.3 Landbase Losses

Two mechanisms account for large scale productivity losses on the landbase. The first is an AAC recalculation trigger. When the harvest level or managed landbase is reduced by more than 2.5% from the current level, MDFP may be required to recalculate their harvest level based on the new reduced landbase. This mechanism is designed to deal with catastrophic losses.

The second mechanism is based on the historical method of dealing with fire within the TSA. Burnt areas are not included in the active landbase for the TSA until the area is inventoried or surveyed to confirm regeneration. These areas are not in the active landbase even though they are very likely to regenerate to forest, since most of the forest types in Alberta are adapted to frequent fires. It can be assumed that as fires are burning on the landbase area and are 'removed from the landbase' due to fire for the next recalculation, and that other areas that have previously been burned and removed from the landbase will be returning to the landbase. Therefore fire has inherently been accounted into the harvest level calculations through both a recalculation trigger and post fire area removal.

5.2.4 Natural Disturbance

In the Patchworks model, patch size targets were used to control the spatial harvest patterns. The patch size of 60-200 ha was maximized to encourage the model to group operations and to mimic the range natural disturbances. Smaller patch sizes automatically happen on the landscape, as the spatial arrangement of existing forest structure requires some smaller patches to be harvested. Larger patch sizes greater than 200 ha also occur in limited quantities.

5.2.5 Mountain Pine Beetle

In recent years, Mountain Pine Beetle has made large advances across British Columbia and Alberta. These advances are causing massive mortality in mature pine, and must be considered in the planning process.

SRD's Mountain Pine Beetle Rating system, which includes three components, was used to assess the PFMS. The first component to the rating system was the 'Pine Rating' or Stand Susceptibility Index (SSI) of the stands (0 - 100). The second component of the rating system was the 'Compartment Risk' (High, Moderate, Low). The final component to the risk assessment was the climate factor (0 - 1.0). All three of these were combined to find the rank (1, 2, or 3 with 1 being the highest rank) of the stand (Table 5-2).

Table 5-2. Pine stand rank calculation

		SSI			
Climate Factor (per stand)	**Compartment Risk**	**0 to 30**	**31 to 50**	**51 to 80**	**81 to 100**
Very Suitable 1.0	High	1	1	1	1
	Moderate	2	1	1	1
	Low	2	2	1	1
Highly Suitable 0.8	High	1	1	1	1
	Moderate	2	2	1	1
	Low	2	2	2	1
Moderately Suitable 0.5	High	2	1	1	1
	Moderate	2	2	2	1
	Low	3	2	2	2
Low Suitability 0.2	High	2	1	1	1
	Moderate	3	2	2	2
	Low	3	2	2	2
Very Low Suitability 0.1	High	3	2	2	2
	Moderate	3	3	2	2
	Low	3	3	3	3

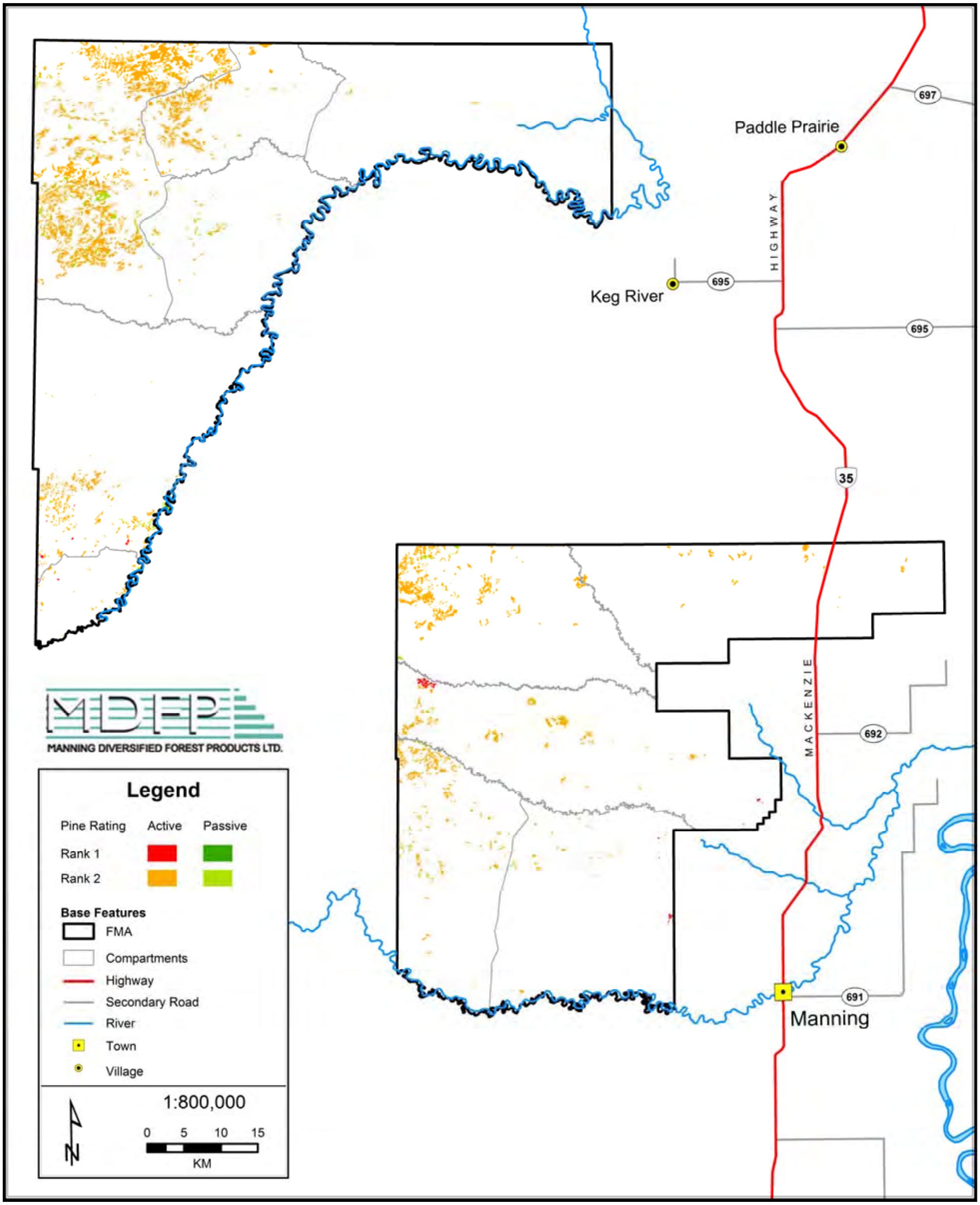


Figure 5-2. P16 pine stand rankings.

The SSI of the stands was calculated using the ASRD Pine Rating model. All of the default input parameters with the effective date of 2007 were used in the SSI. Compartment Risk was determined by an ASRD representative and is based on proximity to existing populations of MPB infestations. The final component of the mountain pine beetle rating was the 'Climate Factor'. 'Climate Factor' is a measure of the effect that climate will have on beetle development, or the probability that they will undergo one year lifecycles.

The Climate Factor and Compartment Risk comprise the main effect of the MPB ranking since a climate factor of >= 0.8 with a high compartment risk will automatically result in a Rank 1 stand even if there is only 10% pine in the stand. Alternatively if the Compartment rank is Low and the Climate Factor is <= 0.5 the highest the MPB Rank would be is 2 even if the SSI is 100 (highest SSI possible).

ASRD provided programming that assigns the SSI and Climate Factor to the landbase. This program uses AVI attributes to assign the SSI to the forest, once the start year has been decided. Because this program does not include updates for fires or harvesting that occurred after AVI, a process was undertaken to assign the SSI's to the landbase polygons and update this information for fires and harvesting.

The model prioritized harvesting towards the high risk Rank1 and Rank2 stands. A map of the all stands assigned to Rank1 or Rank2 is shown in Figure 5-2. Most of the pine in FMU P9 is currently too young to be merchantable.

5.2.6 FireSmart

The FireSmart Management section in Annex 3 of the Alberta Forest Management Planning Standard describes the four-step process to forecast the relationship between the harvest sequence and the Fire Behaviour Potential (FBP). The four-step process is applied to the results of the harvest sequence, but does not include provisions for controlling the model while it is running. The four step process was completed after the PFMS was complete.

In an attempt to incorporate a FBP proxy into the TSA, The Forestry Corp., in conjunction with ASRD developed a set of curves that were used to influence the model to reduce the Fire Behaviour Potential. These curves assigned a FPB code to each age of each yield strata. This allowed the creation of patch targets to reduce the size of contiguous patches of susceptible fuel types.

5.2.6.1 FBP Codes

The FBP codes were loaded into the model as yield curves for each of the strata types. The code for each strata changes over time. Table 5-3 shows the yield strata to FBP code relationship and Table 5-4 shows the initial state of the forest with regard to the FBP codes.

Table 5-3. FBP Code assignments by Strata.

	FBP Code								
Density	**o1b (years)**	**d1 (years)**	**m1-25 (years)**	**m1-75 (years)**	**c1 (years)**	**c2 (years)**	**c3 (years)**	**c4 (years)**	**c6 (years)**
D Strata									
AB	0-20	21+							
CD	0-10	11+							
DU Strata									
X_AB	0-20	21-40	41+						
X_CD	0-10	11-40	41+						
DC Strata									
AB	0-20	21-40	41+						
CD	0-10	11-40	41+						
CD Strata									
ABCD	0-20			21+					
PL Strata									
AB	0-20						41+	21-40	
CD	0-10						41+	11-40	
SW Strata									
AB	0-30					31+			
CD	0-20					31-60	61+		21-30
SB Strata									
AB	0-30				31+				
CD	0-20				21-40	41+			

Table 5-4. Year zero (baseline) FBP codes.

	Active Landbase			Passive Landbase			Gross Landbase		
FBP Code	**P6 (ha)**	**P9 (ha)**	**FMA (ha)**	**P6 (ha)**	**P9 (ha)**	**FMA (ha)**	**P6 (ha)**	**P9 (ha)**	**FMA (ha)**
c1	452	751	1,203	29,241	89,319	118,560	29,693	90,070	119,763
c2	24,650	7,184	31,834	28,677	10,699	39,376	53,327	17,883	71,211
c3	24,694	21,547	46,241	2,145	1,723	3,868	26,839	23,270	50,109
c4	1,545	45	1,590	2,843	50	2,892	4,387	95	4,482
c6	469	-	469	34	-	34	503	-	503
d1	13,103	62,329	75,432	7,604	24,260	31,864	20,707	86,589	107,296
o1b	10,273	24	10,297	32,213	23,271	55,484	42,486	23,295	65,781
m1-25	72,999	22,097	95,096	3,251	4,768	8,019	76,251	26,865	103,115
m1-75	7,477	2,045	9,522	544	3,079	3,623	8,021	5,124	13,146
NONE	14,995	8,612	23,607	13,389	10,016	23,405	28,384	18,629	47,012
Total	170,657	124,634	295,291	119,941	167,186	287,127	290,598	291,821	582,418
Non-Forested	-	-	-	5,153	8,105	13,258	5,153	8,105	13,258
Grand Total	170,657	124,634	295,291	125,094	175,292	300,386	295,751	299,926	595,677

5.2.6.2 Patch Sizes of ‘C’ FBP Code Types

For the purposes of addressing wildfire threat reduction Objective 5.2.1.1, the TSA model tracks the patch size of the ‘C’ types. The ‘C’ types are FBP code c1, c2, c3, c4 and c6. Table 5-5 shows the patch size of the forest that is in the five ‘C’ types at year zero.

Table 5-5. Year zero patch sizes of 'C' FBP code types.

FMA	Patch size of ''C' FBP code types (ha) 0-500 (ha)	500 - 1000 (ha)	1000 - 2000 (ha)	2000+ (ha)	Total (ha)	Patch size of None 'C' FBP type (ha)	Grand Total (ha)
Active Landbase							
P6	21,921	5,429	6,422	18,038	51,810	118,847	170,657
P9	9,713	1,393	1,710	16,712	29,527	95,107	124,634
FMA	31,633	6,822	8,131	34,750	81,337	213,954	295,291
Passive Landbase							
P6	22,931	8,874	10,864	20,270	62,939	62,155	125,094
P9	26,882	6,210	8,775	59,924	101,792	73,500	175,292
FMA	49,814	15,083	19,639	80,194	164,731	135,655	300,386
Gross Landbase							
P6	44,852	14,303	17,286	38,308	114,749	181,002	295,751
P9	36,595	7,603	10,485	76,636	131,319	168,607	299,926
FMA	81,447	21,906	27,771	114,944	246,067	349,609	595,677

5.2.7 Seral Stages

Seral stages were built into the model using the parameters in Table 5-6. The seral stages were used to monitor the 'Old', 'Old plus Mature' and 'Regeneration' requirements in Objective 1.1.1.1.

Table 5-6. Seral Stage age categories.

Strata	Seral Stage Regeneration	Young	Mature	Old
D	0-15	16-60	61-100	101+
DU	0-15	16-60	61-100	101+
MW	0-15	16-70	71-110	111+
MWU	0-15	16-70	71-110	111+
PL	0-15	16-70	71-120	121+
SB	0-15	16-105	106-160	161+
SW	0-15	16-105	106-150	151+

5.2.8 Old Interior Forest

The TSA model defines Old Interior forest patches as any patch greater than 120 ha that is comprised of stands greater than 120 years old. Patches are composed of both the active and passive landbase and include all strata.

5.2.9 Green-up

Greenup was not used in the MDFP model. The green-up strategy for the FMP is presented in Section 3.6 in Implementation.

5.3 Harvest and Planting Actions

Three types of actions are built into the timber supply model: Clearcut, Understory Protection and Tree Improvement Planting.

5.3.1 Clearcut

The clearcut action is the most basic of all actions in the model. It is a stand replacing action in that the age of the stand is reset to zero years of age and all of the volume existing on the yield curve is removed from the stand. Cull reductions and regeneration delays are incorporated in the yield curves, therefore these reductions are integrated into the model.

In the DU stratum, two clearcut treatments were created to allow different entry options based on the species desired. As MDFP and DMI have agreed to joint access of these stand types, and the individual timing of entry is very different for each company due to coniferous and deciduous tree ages, two separate treatments were created. The two actions are called "Clearcut DU for Conifer Priority" and "Clearcut DU for Deciduous Priority". The difference between these treatments is the age range at which a clearcut action is allowed on the DUA density stands. The BCD density stands are included in the conifer priority while the DUX stratum is included in the deciduous priority. The DUX stratum is the DU stands where the leading conifer understory species is not white spruce. Each strata has defined ages for harvest as identified in Table 5-7.

Table 5-7. Clearcut harvest ages

	Harvest Age	
Strata	**Minimum (years)**	**Maximum (years)**
Clearcut Action		
D	80	130
DC	80	N/A
CD	80	N/A
MWU	80	N/A
PL	80	N/A
SB	80	N/A
SW	80	N/A
Clearcut DU with Deciduous Priority Action		
DUA	80	130
DUX	80	130
Clearcut DU with Conifer Priority Action		
DUA	140	N/A
DUBCD	110	N/A

5.3.2 Understory Protection

The understory protection treatment was developed to allow a partial removal of the deciduous overstory species while allowing most of the understory species to remain behind. However, the understory protection treatment was not used in the PFMS and therefore is not part of the SHS. The treatment is only explained here as it was used in many of the scenarios leading up to the PFMS.

The on ground application of this treatment is difficult and expensive and has limited benefits. Sustainability of a stand for understory protection is very specific and can only be assessed on the ground. For these reasons, the treatment was initially used on a limited basis, to a maximum of 200 ha per year.

This treatment is a partial harvest treatment, meaning it does not reset the stand age and only part of the volume is removed from the stand. Table 5-8 shows the harvest ages in which the treatment could be applied by the model.

Table 5-8. Understory protection harvest ages

	Harvest Age	
Strata	**Minimum (years)**	**Maximum (years)**
Understory Protection Initial Removal Action		
DUA	80	90
Understory Protection Final Clearcut Action		
DUA	120	N/A

5.3.3 Tree Improvement Planting

The tree improvement planting action allows the model to simulate the planting of improved planting stock. It is applied within five years from a clearcut action and does not reset the age of the stand. It simply moves the stand from the normal regeneration curve to the tree improvement curve. It can only be implemented within the white spruce (region G2) and lodgepole pine (region J) tree improvement breeding regions.

5.4 Strata Transitions

Each stand that has an action applied to it has a defined stratum to which it transitions to. Most strata transition back to the fully stocked versions (BCD or CD density) of the original strata, while the understory strata transition to either the conifer leading mixedwood or the deciduous leading mixedwood strata. Table 5-9 shows the individual strata transitions for each treatment type.

Table 5-9. Strata transitions due to harvest activities.

Original Strata			Post-Treatment Strata	
Species	**Overstory Density**	**Understory Density**	**Species**	**Overstory Density**
Clearcut Treatment				
D	B	-	D	CD
D	CD	-	D	CD
DU	BCD	BCD	CD	BCD
DC	BCD	-	DC	BCD
CD	BCD	-	CD	BCD
DCU	B	-	DC	BCD
DCU	CD	-	DC	BCD
CDU	B	-	CD	BCD
CDU	CD	-	CD	BCD
PL	BCD	-	PL	BCD
SB	BCD	-	SB	BCD
SW	B	-	SW	CD
SW	CD	-	SW	CD
Clearcut DUA with Deciduous Priority Treatment				
DU	BCD	A	DC	BCD
Clearcut DUA with Conifer Priority Treatment				
DU	BCD	A	DC	BCD
Understory Protection Treatment				
DU	BCD	A	CD	BCD

5.5 Access Control

Each scenario is also controlled by the Access Control table (Table 5-10). This table outlines the polygon availability in each period. The first column shows the item value which is being controlled. The field in the landbase that is used for the access control is called *Access_C4.*

The columns with colour represent the status in each period. The first period is 2 years long while all other periods are 5 years long. The three colours represent three actions that the model can take, and the values in each of the cell represent the area harvested in each in the PFMS.

- Pink – No harvest activities are allowed,
- Yellow – Harvest actions as defined by the pre-schedule must be followed unless stand in inoperable,
- Green – Any harvest activity is allowed.

The Access Control is also shown in a series of maps in Figure 5-3, Figure 5-4, Figure 5-5 and Figure 5-6.

Table 5-10. Access Control used in PFMS.

ACCESS_C4	Hectares harvested in each time period (Ha)																
	Year																
	1-2	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80
LV410_C0_CBOUT				0	0	0	0	0	0	0	0	0	0	0	0	0	0
NONE_C0_CBOUT																	
DECID_C1_CBIN						0	0					0	0	0	0	0	0
LV410_C1_CBIN						0	0					11	43	0	0	1	0
CONIF_C1_CBOUT		296	2,725			1,444	1,979	415	484	576	668	755	405	349	266	269	327
DECID_C1_CBOUT		1,335	213			190	140	58	49	168	26	200	128	262	94	37	165
LV410_C1_CBOUT						1,122	978	474	777	729	541	976	496	84	439	1,056	740
LV420_C1_CBOUT						50	57	0	9	24	114	254	9	0	0	0	24
NONE_C1_CBOUT																	
PRE_C1_CBOUT	0	925				0	11	0	32	0	0	0	1	6	0	75	43
CONIF_C2_CBIN						347	247					0	434	208	346	0	81
DECID_C2_CBIN						73	4					0	250	18	170	0	58
LV410_C2_CBIN						3	1					0	1	37	12	0	0
LV420_C2_CBIN						9	0					0	0	0	2	0	0
NONE_C2_CBIN																	
CONIF_C2_CBOUT				2,993	3,212	311	237	442	382	280	448	470	398	157	511	510	244
DECID_C2_CBOUT				405	785	7	11	32	12	140	56	103	38	181	68	120	56
LV410_C2_CBOUT				13	13	0	0	0	3	7	0	2	8	0	28	5	0
LV420_C2_CBOUT						33	16	187	264	113	35	248	66	123	68	117	13
NONE_C2_CBOUT																	
PRE_C2_CBOUT	0			0	25	0	0	13	5	0	0	0	0	0	0	0	0
CONIF_C3_CBIN		759	973					566	968					739	605	231	502
DECID_C3_CBIN		930	20					138	144					173	157	210	247
LV410_C3_CBIN								205	305					36	164	88	163
LV420_C3_CBIN								49	77					51	29	23	19
NONE_C3_CBIN																	
PRE_C3_CBIN	70	1,893				0	0	0	15	0	0	0	0	8	8	137	35

Table 5-10. Access Control used in PFMS. (continued).

ACCESS_C4	Hectares harvested in each time period (Ha) – Year 1-2	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80
CONIF_C3_CBOUT		441	765			163	119	541	183	428	89	456	390	399	102	324	151
DECID_C3_CBOUT		1,120	65			28	7	115	114	92	65	16	328	128	72	18	287
LV410_C3_CBOUT						5	19	143	145	59	0	3	102	2	63	6	34
LV420_C3_CBOUT						73	14	36	22	52	0	44	0	83	1	119	21
NONE_C3_CBOUT																	
PRE_C3_CBOUT	2,816	493				0	0	1	4	112	40	14	12	23	15	11	9
CONIF_C4_CBIN				381	790					226	145			189	10	335	124
DECID_C4_CBIN				107	417					26	138			230	5	140	131
LV410_C4_CBIN				1	12					3	1			3	0	2	0
LV420_C4_CBIN										3	4			10	0	48	17
NONE_C4_CBIN																	
PRE_C4_CBIN	0	0		1,285	47	0	0	0	0	25	0	0	0	3	0	54	54
CONIF_C4_CBOUT		1,329	758			1,032	323	461	499	551	419	250	538	673	197	0	721
DECID_C4_CBOUT		1,279	187			43	0	3	178	128	96	8	370	85	86	18	44
LV410_C4_CBOUT						99	32	124	204	7	2	0	12	109	3	0	0
LV420_C4_CBOUT						54	42	9	66	104	28	0	30	82	7	0	3
NONE_C4_CBOUT																	
PRE_C4_CBOUT	0	781				31	36	0	0	16	0	0	31	0	0	0	0
CONIF_C5_CBOUT				1,496	2,480	361	611	566	373	429	822	705	322	289	461	564	355
DECID_C5_CBOUT			5,575	1,261	1,596	91	51	553	550	334	480	638	363	265	578	848	610
LV410_C5_CBOUT				1,204	616	211	74	197	259	502	292	584	59	207	366	207	223
LV420_C5_CBOUT						135	144	49	28	122	92	107	80	58	43	62	32
NONE_C5_CBOUT																	
PRE_C5_CBOUT	0	1,093		0	7	0	0	0	0	0	0	0	0	0	0	0	0
CONIF_C6						6	22	37	0	55	36	50	39	0	0	32	0
DECID_C6						328	235	0	0	128	158	133	251	197	24	340	121
LV410_C6						5	2	0	0	0	0	1	1	0	1	0	0
LV420_C6						0	0	3	0	0	0	0	0	0	0	0	0
NONE_C6																	

Table 5-10. Access Control used in PFMS. (Continued).

	Hectares harvested in each time period (Ha)																
	Year																
ACCESS_C4	1-2	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80
LV420_C7						0	0	0	0	0	0	0	11	0	0	1	2
NONE_C7																	
CONIF_C8						1,524	1,821	1,649	561	1,558	1,175	665	729	853	686	785	912
DECID_C8						291	449	759	234	452	186	169	307	248	104	318	195
LV410_C8						4	10	9	0	4	4	2	4	3	3	2	5
LV420_C8						9	8	0	0	5	4	0	0	0	0	0	7
NONE_C8																	
CONIF_C9						1,320	441	35	632	502	1,168	845	442	528	1,020	603	401
DECID_C9						140	442	480	754	306	469	698	224	606	947	1,030	190
LV410_C9						9	0	3	6	3	1	15	0	3	12	9	0
NONE_C9																	
CONIF_C10				1,762	343	330	9	881	485	113	463	234	532	161	275	407	389
DECID_C10				1,369	1,140	199	149	159	294	7	443	100	194	43	457	331	270
LV410_C10				5	10	4	0	0	2	0	6	0	3	0	3	5	1
LV420_C10						0	0	31	4	3	25	22	6	0	0	18	8
NONE_C10																	
CONIF_C11				179	34	108	632	66	96	247	203	710	518	417	0	0	323
DECID_C11				1,101	1,437	1,042	1,098	632	243	519	488	968	1,438	1,015	1,312	1,103	1,801
LV410_C11				3	6	5	3	3	1	3	4	6	5	14	5	5	10
LV420_C11						127	191	54	113	365	161	203	327	268	0	0	100
NONE_C11																	
PRE_C11	0	0		86	0	0	0	0	0	0	0	0	0	0	0	0	0

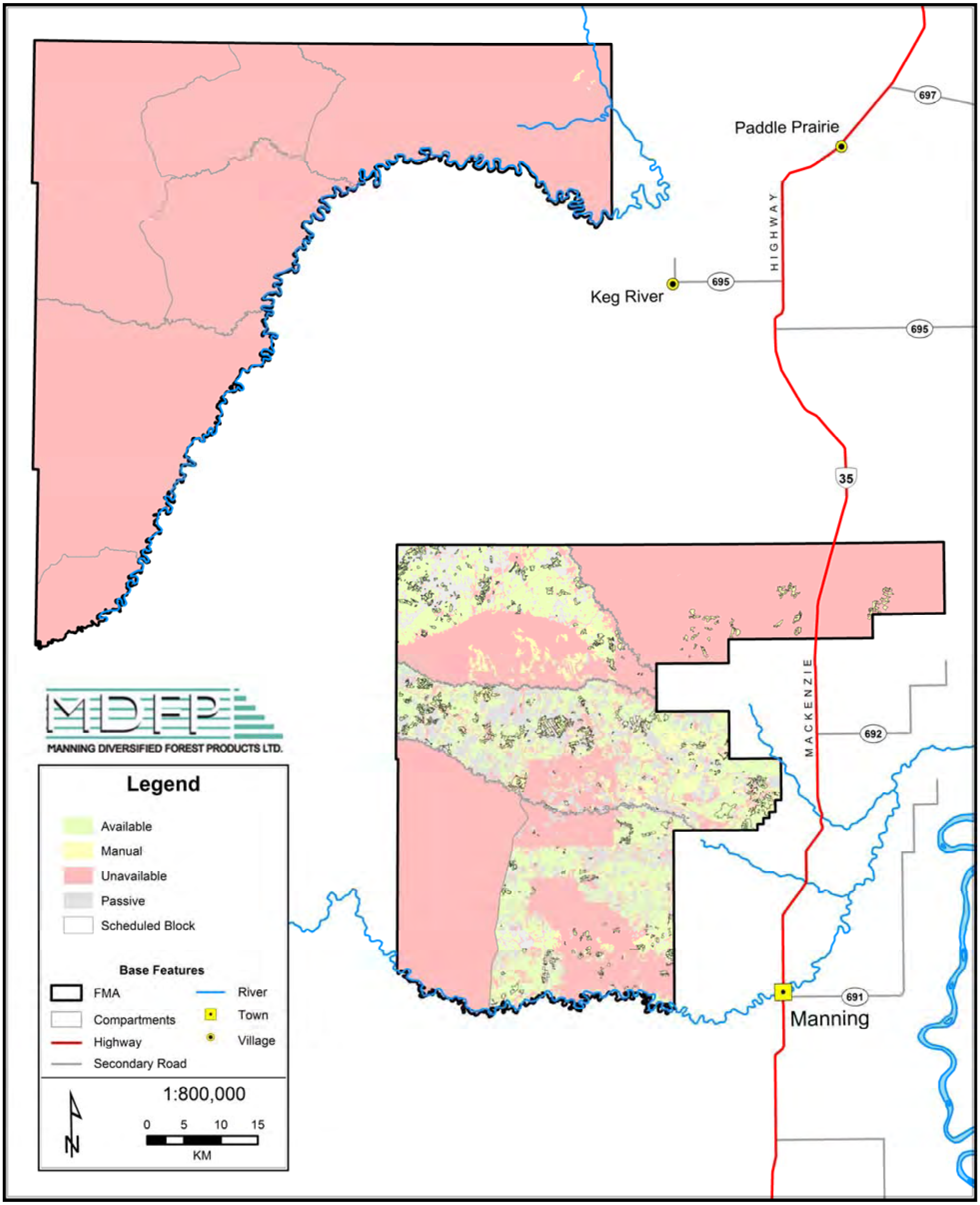


Figure 5-3. Access Control in years 1-5.

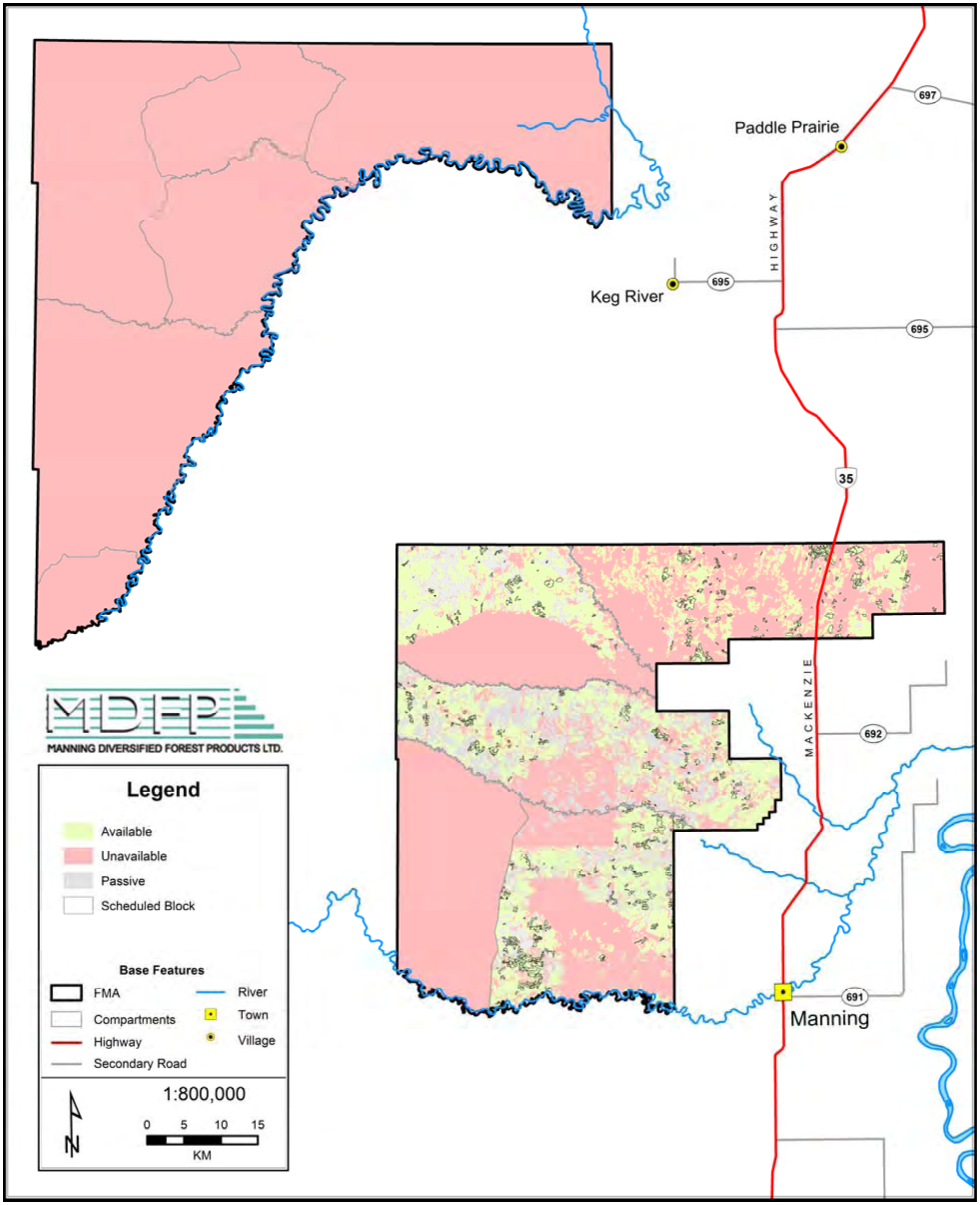


Figure 5-4. Access Control in years 6-10.

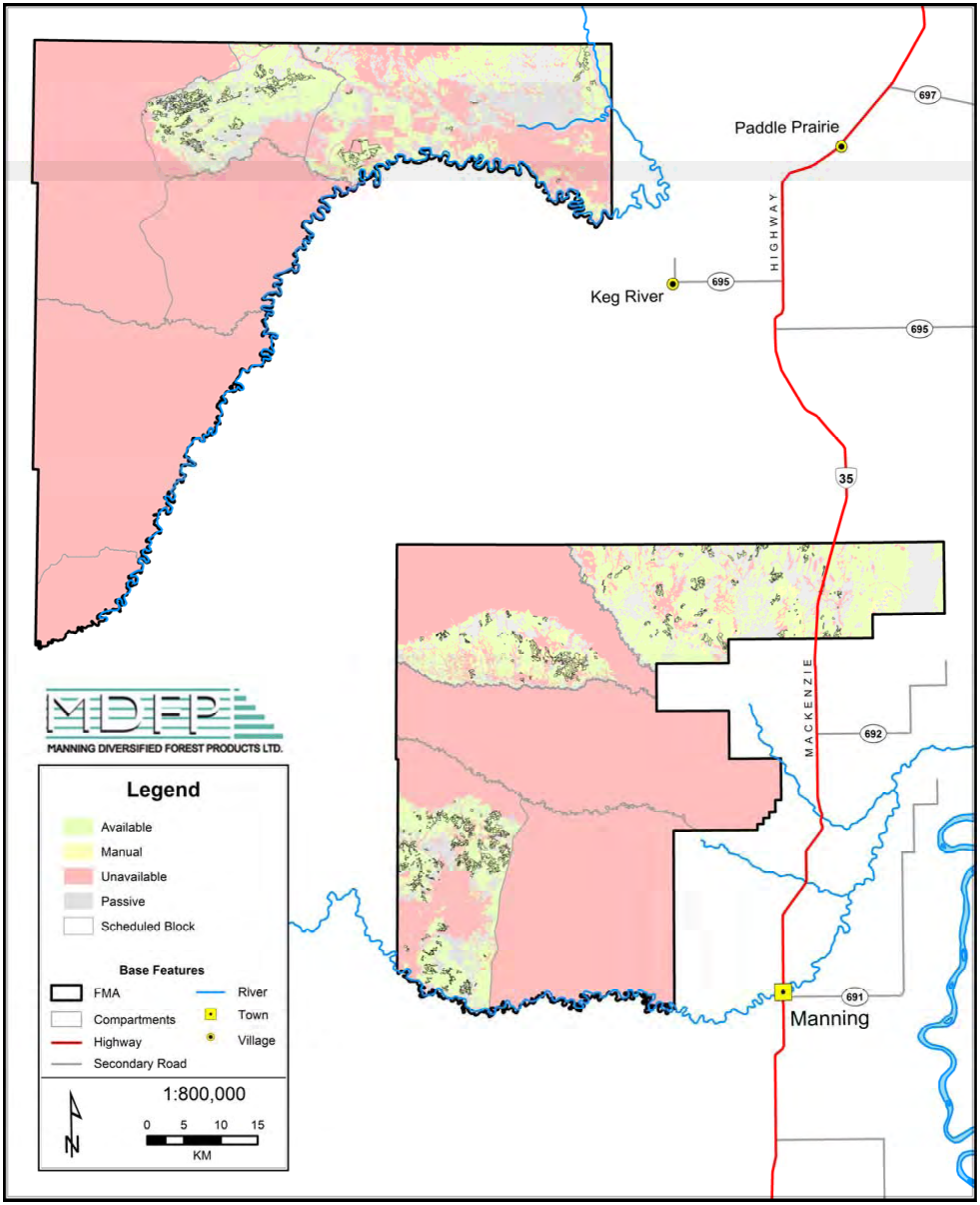


Figure 5-5. Access Control in years 11-15.

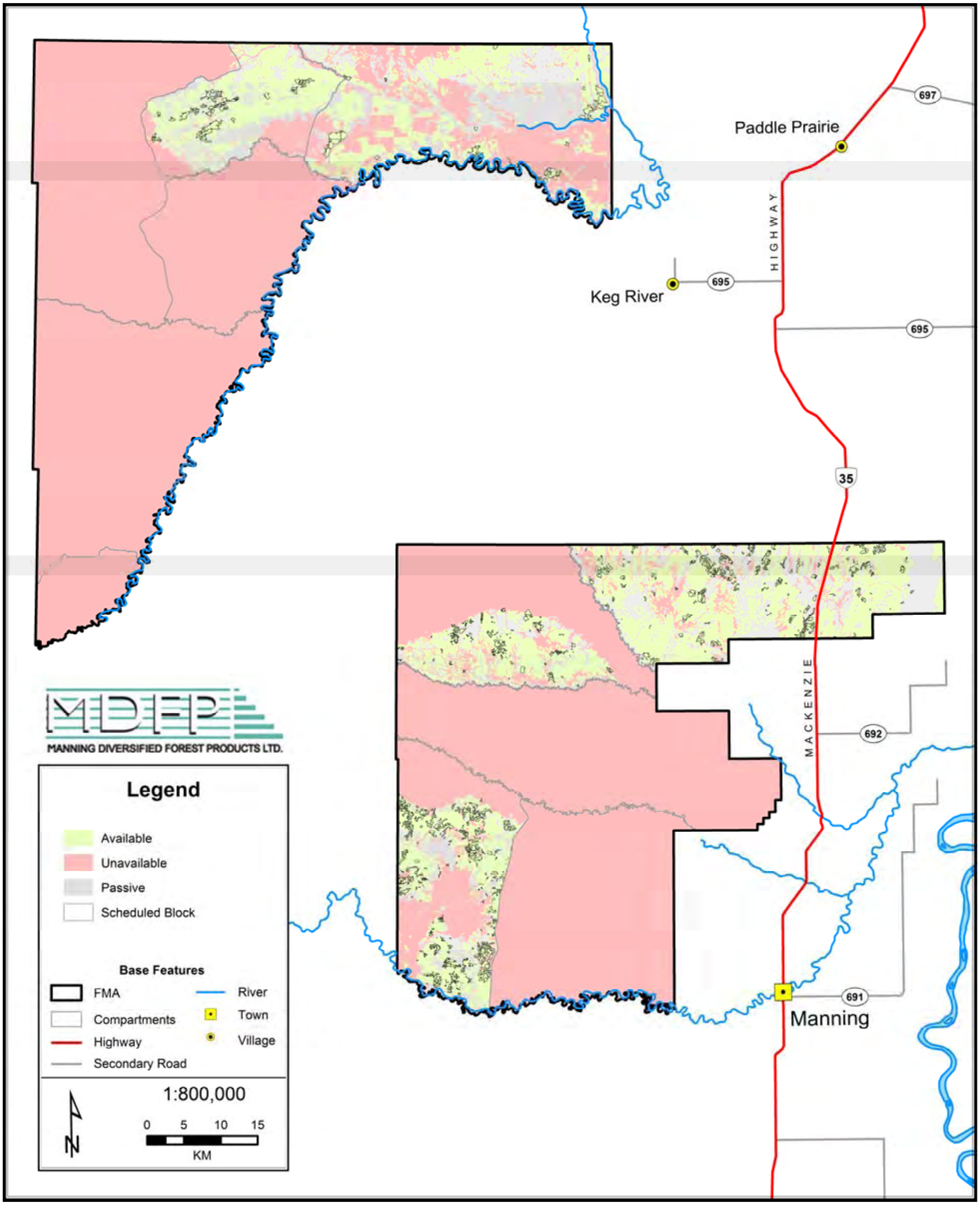


Figure 5-6. Access Control in years 16-20.

6. PFMS

The Preferred Forest Management Scenario (PFMS) for PMU P16 was chosen to retain the existing mixedwood focused landbase and to retain the caribou habitat within the caribou zone. The PFMS is based on the Patchworks scenario number P16_P9003. A comparison of the strata harvested in the SHS as compared to the Active landbase strata is presented in Table 6-1. A breakdown of the SHS strata by compartment and age class for each of the first two 10 year periods is presented in Table 6-2 and Table 6-3. The results of the PFMS's are spatially explicit harvest patterns, including a 20 year spatial harvest sequence (SHS) as shown in Figure 6-1 and Figure 6-2. A list of major changes to the Patchworks model in each Round of scenarios is in Appendix I and outputs of other scenarios are in Appendix II.

Table 6-1. Comparison of SHS strata harvested with strata profile.

	Strata Harvested											
Category	D ha	DUA ha	DUSW ha	DUX ha	DC ha	CD ha	MWU ha	PL ha	SB ha	SW ha		Total ha
Total Active Landbase Area	71,753	57,356	38,911	2,441	6,503	11,125	21,093	26,411	4,260	55,244		295,096
Years 1-10												
SHS Area Harvested	5,657	6,428	99	57	416	573	1,101	1,685	51	7,888	0	23,957
Percent Harvested	7.9%	11.2%	0.3%	2.3%	6.4%	5.2%	5.2%	6.4%	1.2%	14.3%		8.1%
Years 11-20												
SHS Area Harvested	5,843	6,461	324	96	636	890	2,321	2,419	330	7,303	0	26,622
Percent Harvested	8.1%	11.3%	0.8%	3.9%	9.8%	8.0%	11.0%	9.2%	7.7%	13.2%		9.0%
Total SHS (1-20)												
SHS Area Harvested	11,500	12,889	423	152	1,052	1,464	3,422	4,104	382	15,192	0	50,579
Percent Harvested	16.0%	22.5%	1.1%	6.2%	16.2%	13.2%	16.2%	15.5%	9.0%	27.5%		17.1%
Average of two decades	8.0%	11.2%	0.5%	3.1%	8.1%	6.6%	8.1%	7.8%	4.5%	13.7%		8.6%

Table 6-2. SHS strata harvested by compartment and age class in years 1-10.

		Strata Harvested										
W.C.	Age Class	D ha	DUA ha	DUSW ha	DUX ha	DC ha	CD ha	MWU ha	PL ha	SB ha	SW ha	Total ha
Years 1-10												
1	080-099	404	651				7	7	39		23	1,131
	100-119	138	518				5	99	40	9	25	834
	120-139	37	7			37	102	28			775	986
	140-159						34	33			1,598	1,666
	160-179										817	817
	180-199										18	18
	200++							25			18	43
	Total	579	1,176			37	149	191	80	9	3,275	5,496
3	080-099	384	483		30	8	4	1	5		76	991
	100-119	1,167	355	7	27	7	6	13	175		164	1,920
	120-139	197	325	6		29	43	35			464	1,099
	140-159	56	17	14		68	2	239	123		658	1,177
	160-179		63	9		14	152	36	213		1,016	1,504
	180-199						43	65	124		537	769
	Total	1,804	1,243	36	57	126	249	390	641		2,914	7,459
4	080-099	165	178			13	8	46	152		25	585
	100-119	333	1,023	63		7	5	220	762		168	2,582
	120-139		9			6	34	84	48		43	224
	140-159									42	191	234
	160-179						49		3		489	540
	180-199						5	28			45	78
	200++										91	91
	Total	498	1,210	63		25	101	378	965	42	1,052	4,334
5	080-099	1,541	1,785			185		54			34	3,600
	100-119	979	1,013			43	55	31			362	2,485
	120-139	255					19				123	397
	140-159							57			3	61
	160-179										125	125
	Total	2,776	2,799			228	75	143			648	6,668
Years 1-10 Total		5,657	6,428	99	57	416	573	1,101	1,685	51	7,888	23,957

Table 6-3. SHS strata harvested by compartment and age class in years 11-20.

		Strata Harvested										
W.C.	Age Class	D ha	DUA ha	DUSW ha	DUX ha	DC ha	CD ha	MWU ha	PL ha	SB ha	SW ha	Total ha
Years 11-20												
2	080-099	75	368			12	56	98	22	20	889	1,540
	100-119	53	510			32	80	288	81	24	562	1,630
	120-139	84	99			112	70	36	299	217	825	1,741
	140-159	7				6	99	108	0	2	1,194	1,417
	160-179							30			973	1,004
	180-199										54	54
	200++										61	61
	Total	219	977			162	305	560	401	263	4,559	7,447
4	080-099	48	154				53				34	289
	100-119	29	365	149			0	50	27		132	752
	120-139	25	111	73			0	300	33		433	976
	140-159	40		102			91	133			163	529
	160-179	16					156	53			113	339
	180-199										127	127
	200++										28	28
	Total	158	631	324			300	537	60		1,029	3,040
5	080-099	405	2,249		87	35	52	283	341	47	277	3,775
	100-119		949			53	6	94	171	20	276	1,569
	120-139	1	825			243	18	454	393		414	2,348
	140-159					0	33	64	62		275	434
	160-179					6	31	10			169	216
	180-199						31	31			244	307
	200++						11					11
	Total	406	4,023		87	337	182	936	967	67	1,655	8,660
10	080-099	2,164	654		8	137	60	237	939		16	4,215
	100-119	318						44	15		0	377
	120-139	36										36
	Total	2,518	654		8	137	60	281	955		16	4,629
11	080-099	2,147	146						19			2,312
	100-119	356						6	18		13	393
	120-139	38	30								9	77
	140-159						40				8	49
	160-179						3				13	16
	Total	2,541	176				43	6	36		44	2,847
Years 11-20 Total		5,843	6,461	324	96	636	890	2,321	2,419	330	7,303	26,622

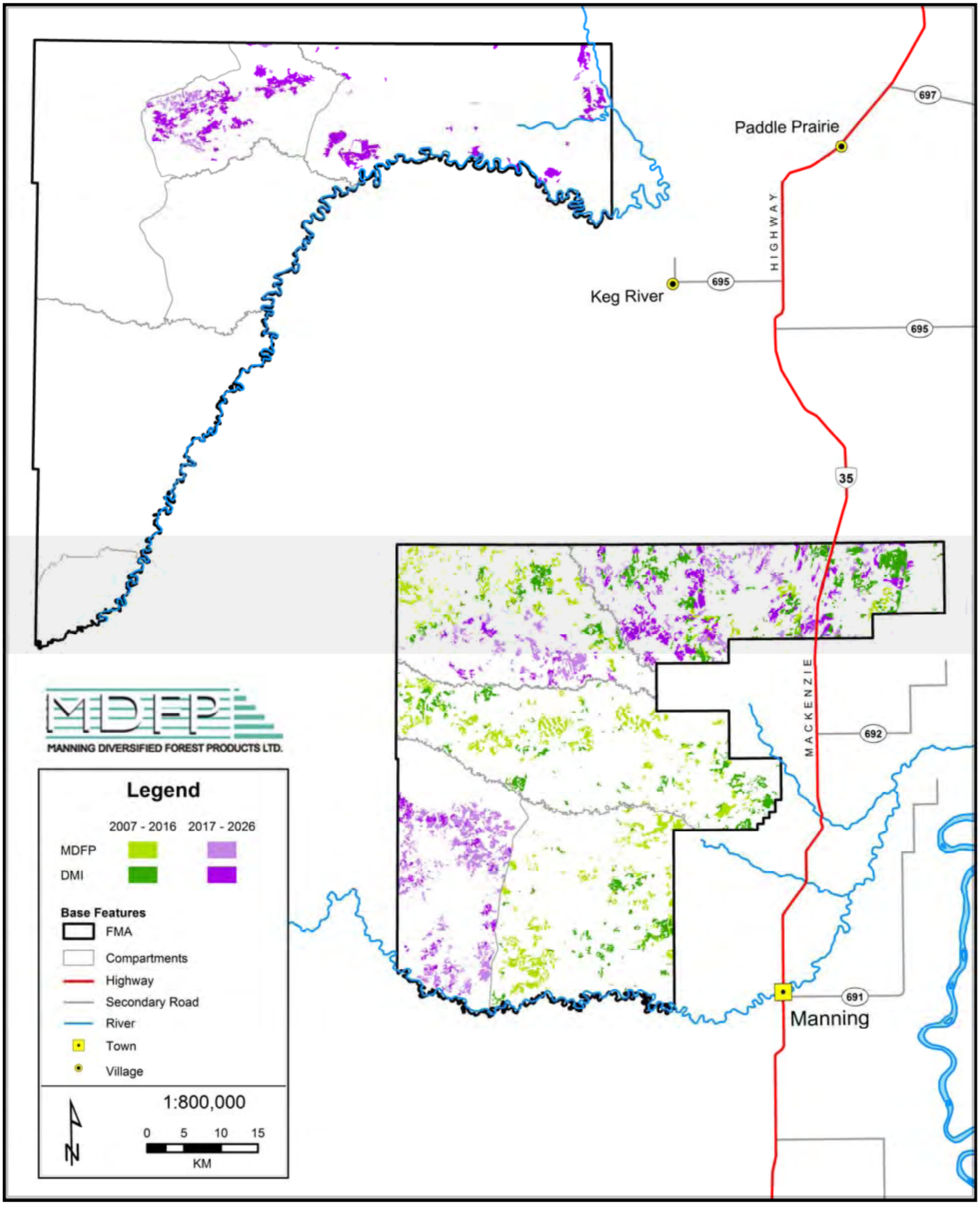


Figure 6-1. Twenty year SHS by company.

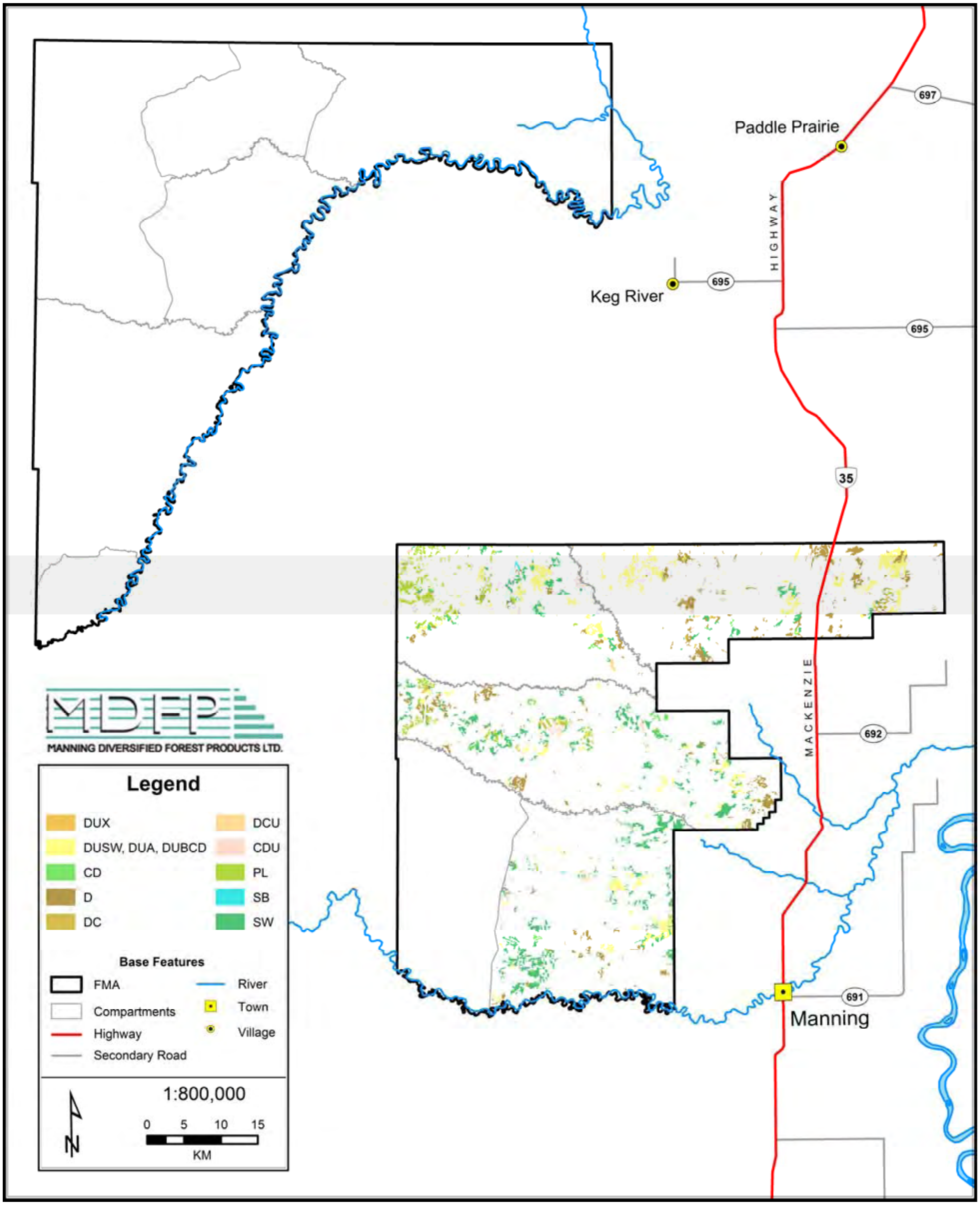


Figure 6-2. Ten year SHS by strata.

This section outlines the specific targets and outputs used in the selection of the PFMS.

Each target that is constrained in the model has a graph that represents the minimum (red line) and maximum (blue line) values targeted and the resulting actual (black line) value achieved by the model. If a blue line or red line do not appear then either the minimum or maximum value is not constrained. The name of the actual target used in the model is listed below each figure in the bullet point.

6.1 Harvest Volume

The harvest volume is the main target of the analysis. Both coniferous and deciduous primary volumes are even flow, while both secondary volumes are unregulated (Figure 6-3). All volumes in the model are reduced for cull and defect and are adjusted for regeneration delay, but are not reduced for stand retention.

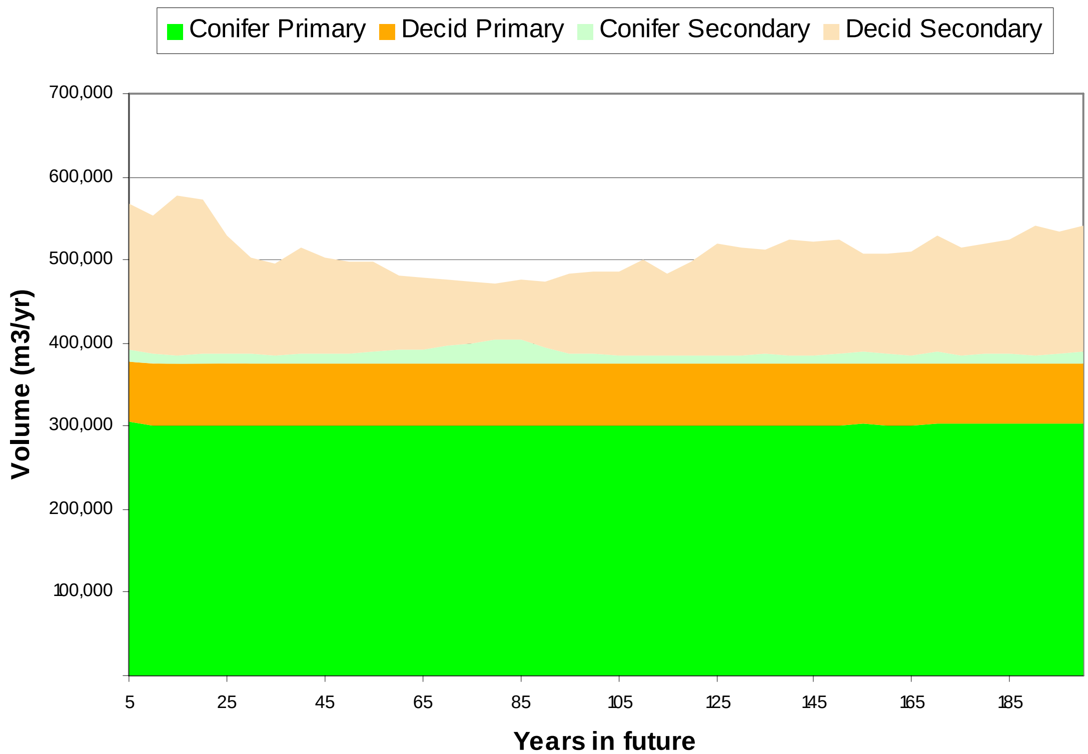


Figure 6-3. Volume Harvested.

6.1.1 Conifer Primary

The conifer primary volume is an even flow target as shown in Figure 6-4. It shows an even flow volume of 301,817 m^3/year from the coniferous landbase (i.e., is all strata except the D strata).

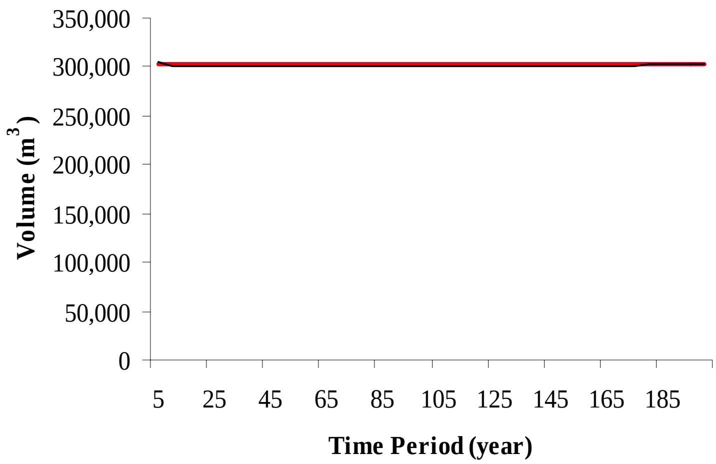


Figure 6-4. Conifer primary harvest volume.

- product.FMPVol.mlb.VolSum.Conif.Primary

6.1.2 Deciduous Primary

The deciduous primary harvest volume is also an even flow target. In this landbase, the D stratum is the only stratum that contributes to the deciduous primary harvest volume. Due to the landbases age class structure, the first 10 years are the limiting factor in deriving volume, limiting even flow volume to 73,619 m^3/year (Figure 6-5).

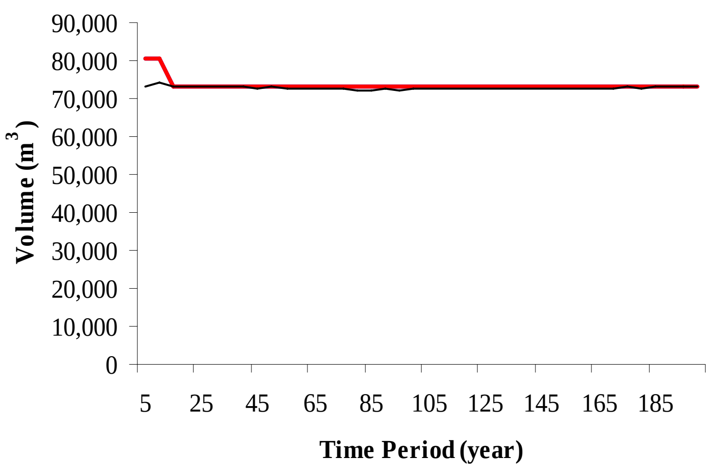


Figure 6-5. Deciduous primary harvest volume.

- product.FMPVol.mlb.VolSum.Decid.Primary

6.1.3 Deciduous volume from D and DUA strata

The DUA stratum is the largest stratum in the active landbase and both companies harvest a significant amount of volume from the stratum. As a result, an agreement for this FMP was reached were DMI would harvest a maximum of 50% of the DUA stands when the deciduous volume was the primary product (stand age 80 – 130 years), and MDFP would harvest the remaining stands when the coniferous volume was the primary volume (stand age greater than 140 years) (see Table 5-7). It is important to note that the deciduous volume from the DUA stratum is not sustainable after the first 20 years.

DMI requested that the total deciduous volume coming from the deciduous landbase and the deciduous priority DU harvest would equal their current DTA for the first 20 years. Their current DTA provided a commitment of 172,000 m^3/yr of deciduous volume. The deciduous volume coming from the deciduous priority stands plus the deciduous primary volume are added together into one target and constrained to 179,730 m^3/year for the first 20 years. This value factored in the original 4% reduction for stand retention, even though the actual value for stand retention of 6% will be used for the AAC calculation. This discrepancy is due to a last minute change in the deciduous stand retention amount. Figure 6-6 shows the target values.

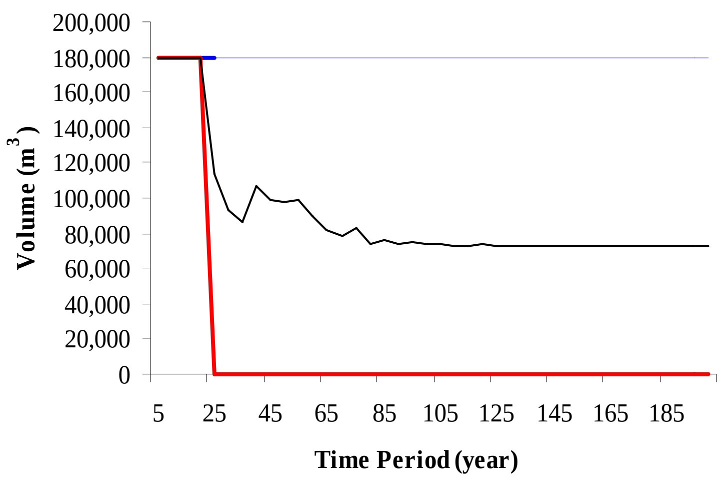


Figure 6-6. Deciduous harvest volume from D and DUA strata.

- product.FMPVol.mlb.VolSum.Decid.DMI

6.2 Growing Stock

The growing stock levels of the primary volumes are generally controlled in a TSA to prevent a precipitous drop in growing stock at the end of the planning horizon. In the FMA, the conifer growing stock was controlled, while the deciduous was not. Due to the current age class structure driven by the 1950 fire in P9, the growing stock on the deciduous landbase is lower at the beginning of the scenario than at any other time, as shown in Figure 6-8. Overall, growing stock decline in either the deciduous or coniferous landbase was not a major concern in this TSA.

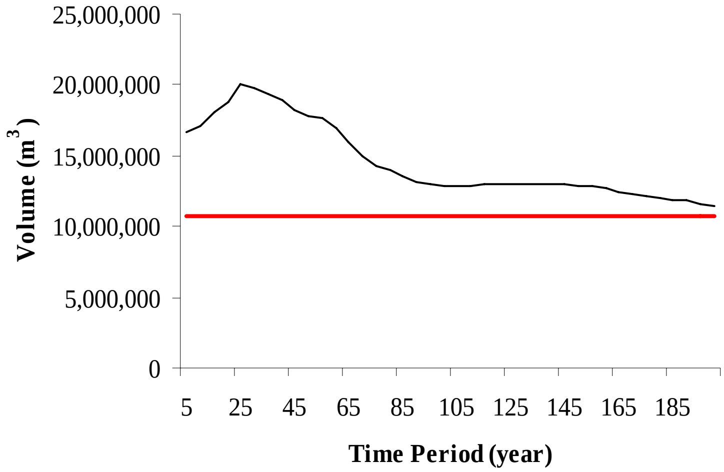


Figure 6-7. Coniferous landbase merchantable growing stock.

- feature.MerchVol.mlb.VolSum.Conif.Primary

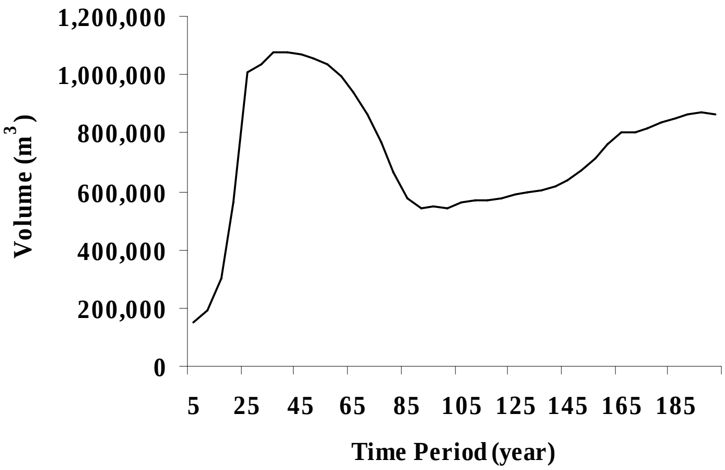


Figure 6-8. Deciduous landbase merchantable growing stock.

- feature.MerchVol.mlb.VolSum.Decid.Primary

6.3 Harvest Type

6.3.1 DUA strata

The DUA stratum was constrained to provide the best mix of DUA stands to MDFP and DMI. Both the total deciduous priority clearcut and conifer priority clearcut were capped at 800 ha/year, and the conifer priority was minimized in the first 20 years (Figure 6-9 and Figure 6-10). Furthermore, within the deciduous priority stands, height class was constrained to favour stands where the understory height class was less than 12 m by minimizing the area harvested in taller height classes as shown in Figure 6-11 and Figure 6-12.

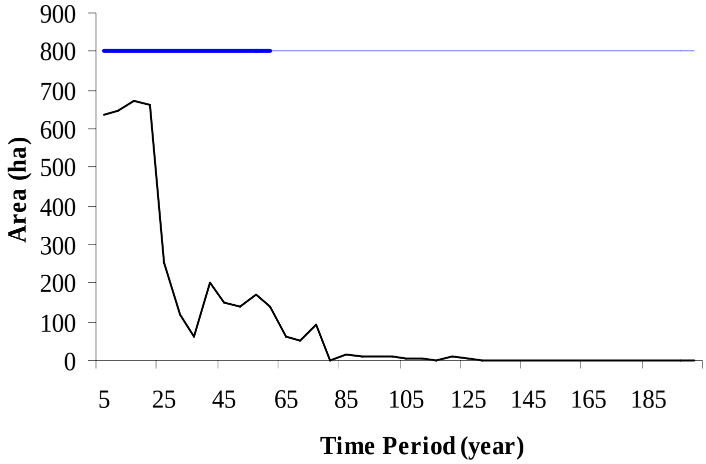


Figure 6-9. Deciduous Priority clearcut of DUA strata (ha/year).

- product.Treated.CCDUDEC

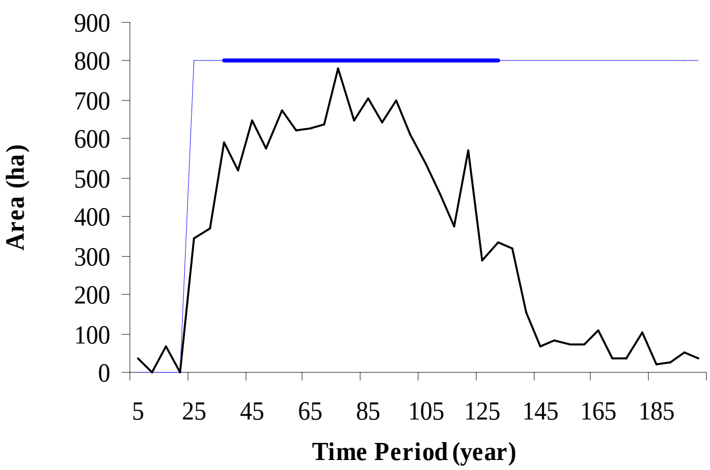


Figure 6-10. Conifer Priority clearcut of DUA strata (ha/year).

- product.Treated.CCDUCON

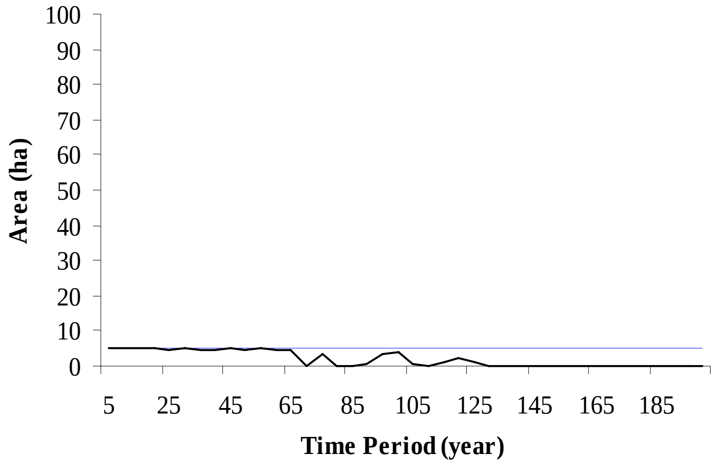


Figure 6-11. Deciduous Priority clearcut of DUA strata, understory height between 12 and 15 m (ha/year).

- product.Treated.CCDUDEC.DUA_12_15

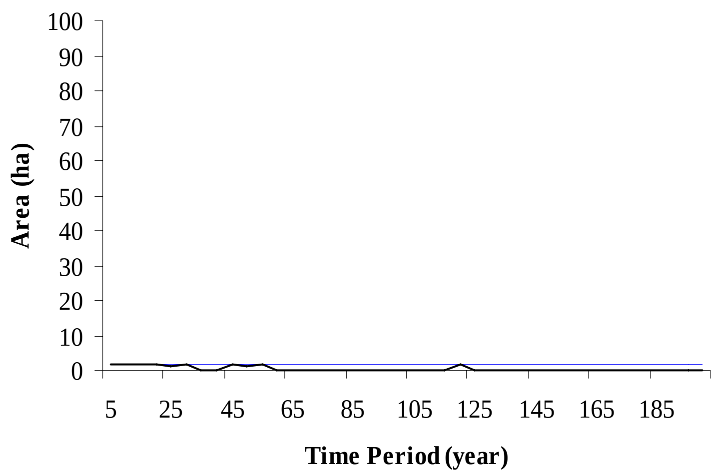


Figure 6-12. Deciduous Priority clearcut of DUA strata, understory height greater than 15 m (ha/year).

- product.Treated.CCDUDEC.DUA_16+

6.3.2 Understory Protection

In the final PFMS scenario, all understory protection harvest was manually turned off. This was due to the combination of difficulty in identifying appropriate candidate stands and the high operational costs. Understory protection may be undertaken on a site specific basis on the ground, but it was not modeled. Figure 6-13 outlines this strategy, where all periods show a zero area harvested.

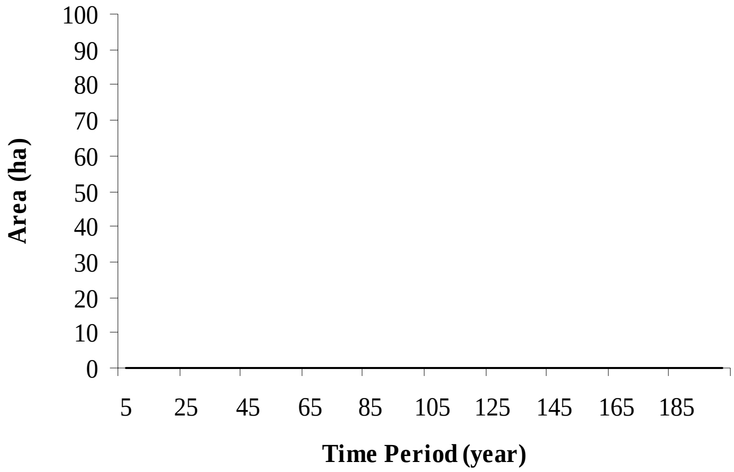


Figure 6-13. Understory Protection harvest area (ha/year).

- product.Treated.PROTECTION

6.4 Age Class

The age class structure is shown in Figure 6-14. It indicates a typical movement towards a regulated age class structure.

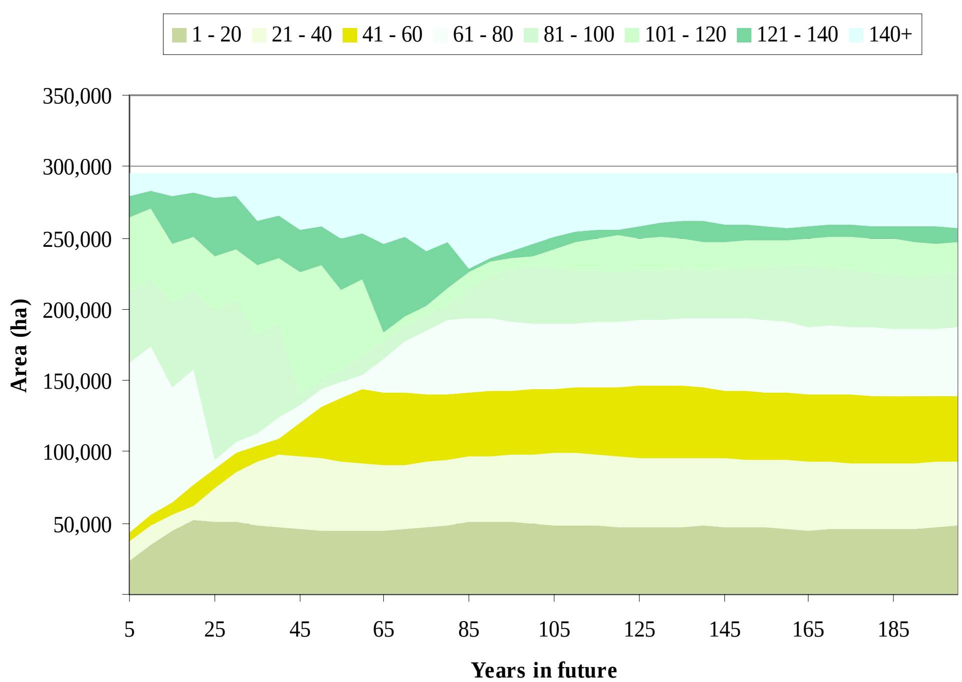


Figure 6-14. Active landbase age class structure.

6.5 Seral Stage

Since there were many other age based targets controlled in the model, the acceptable levels for Old and Mature seral stages were achieved without direct control in the model. Figure 6-15 shows the progression of seral stages on the active landbase over time.

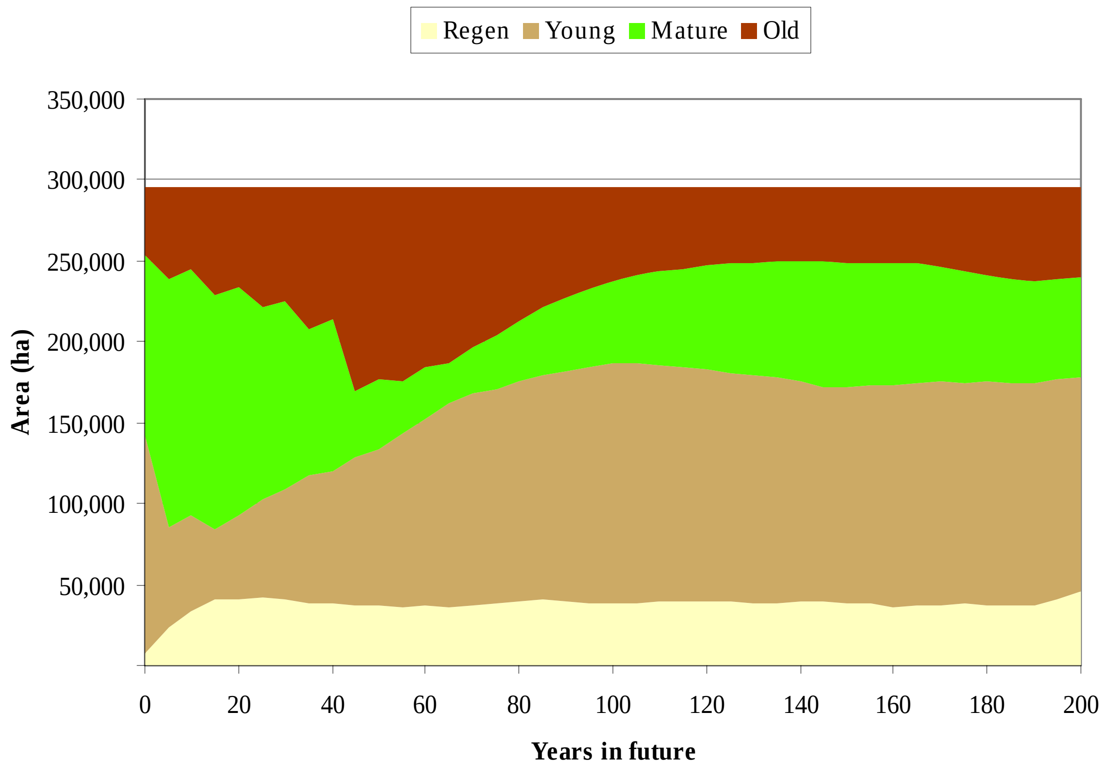


Figure 6-15. Active landbase seral stages.

6.6 White Spruce TPR F

An operational criteria to limit the area of Fair white spruce stands cut in each period was set to harvesting a maximum of 50 ha/year. This was to help the mill achieve a better piece size distribution.

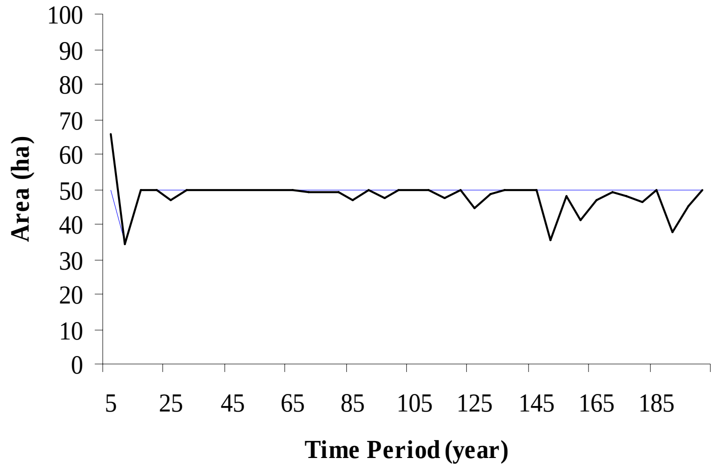


Figure 6-16. Area harvested of fair white spruce (ha/year).

- product.FMPArea.mlb.SpS.4SWF

6.7 Conifer Flow from FMU P9

This target was created to aggregate operations in FMU P9 into areas that are consistent with annual wood requirements. This means that it is desirable to provide harvest areas in the SHS in multiples of the annual harvest area. As a result, the harvest area was set to a total of 3,000 ha (1,500 ha per year for two years) for the years 11-20 in P9. This will allow MDFP to harvest in P9 for two full years in the second decade of the SHS, which will minimize the number of entries into P9.

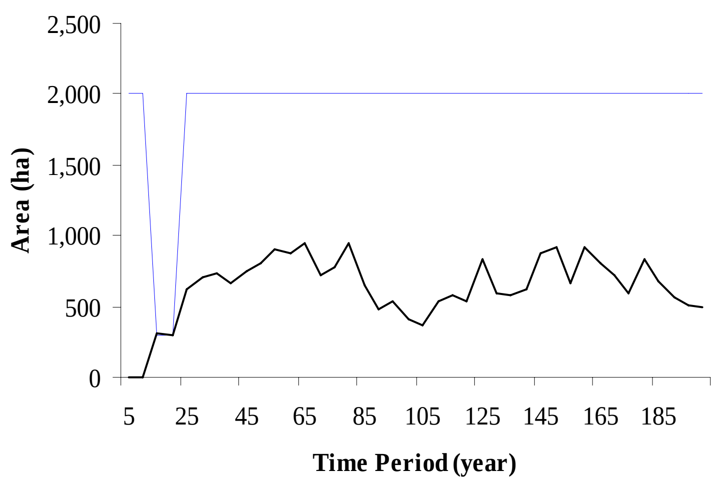


Figure 6-17. MDFP area harvested in P9.

- product.FMPArea.mlb.FMU.P9MDFP

6.8 PSP

MDFP’s grid based PSP plots were buffered 100m and were excluded from harvest for the first 10 years. This harvest control was done by using a target and by using the Access Control table. The effect is summarized in Figure 6-18.

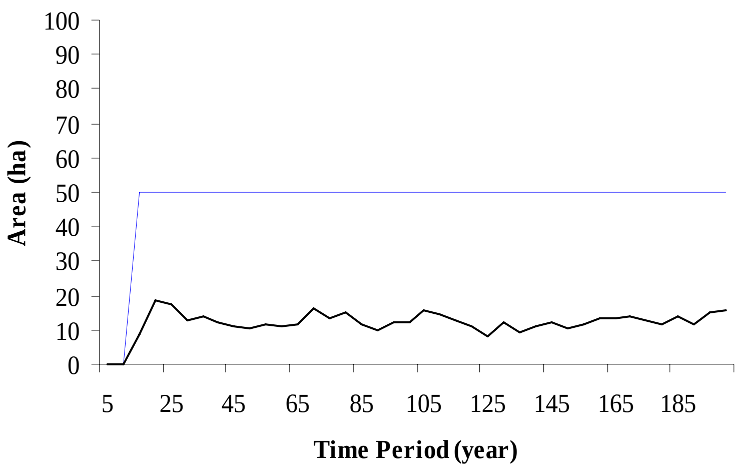


Figure 6-18. Area harvested within MDFP’s PSP plots.

- product.FMPArea.mlb.PSP

6.9 Roads

The roading module built into Patchworks is not intended to generate a road network or a cost structure of building the roads. Instead, it is simply included to push the model towards grouping stands to allow more efficient harvesting. The only roading constraint used in the model is the maintenance cost, which is the cost incurred of using a road each year it is open. By minimizing the road cost in the first 20 years, the model trends towards grouping harvest blocks.

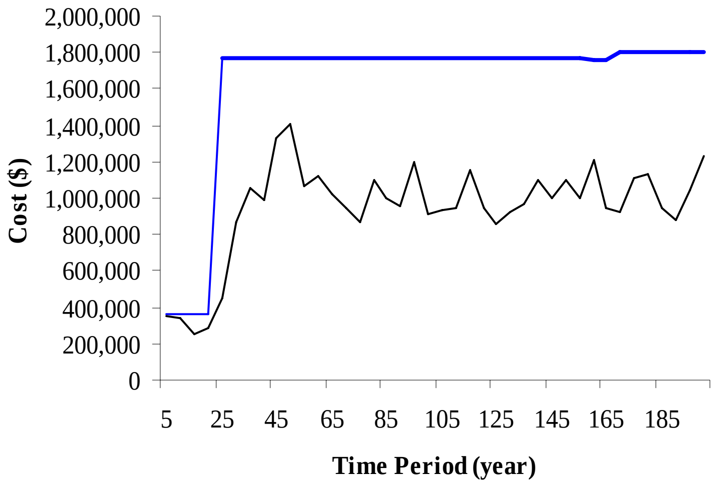


Figure 6-19. Road maintenance costs ($/year).

- route.Conif.maintain

6.10 Operating Units

Operating units were assigned to the landbase to further group operations. Late in the TSA process, a methodology was developed to allow the model to pick which operating units would be open in any given period. These operational units are small contiguous areas within each compartment, further split by coniferous and deciduous landbase. The operating units were manually chosen in FMU P6 by selecting polygons in the TSA landbase that approximated the amount of area one operator could harvest in one year. The operating units for FMU P9 are simply the existing compartments. The operating units are shown in Figure 6-20.

Each operating unit was assigned a value of its total active landbase * 1000. The model then tracked the area accessed in each period and attempted to minimize it. The target control restricts the model to only opening a certain area of active landbase but allows the model to choose which units with the constraints of the Access Control table (see Section 5.5).

Figure 6-21 shows the relative amount of operating units open in each period.

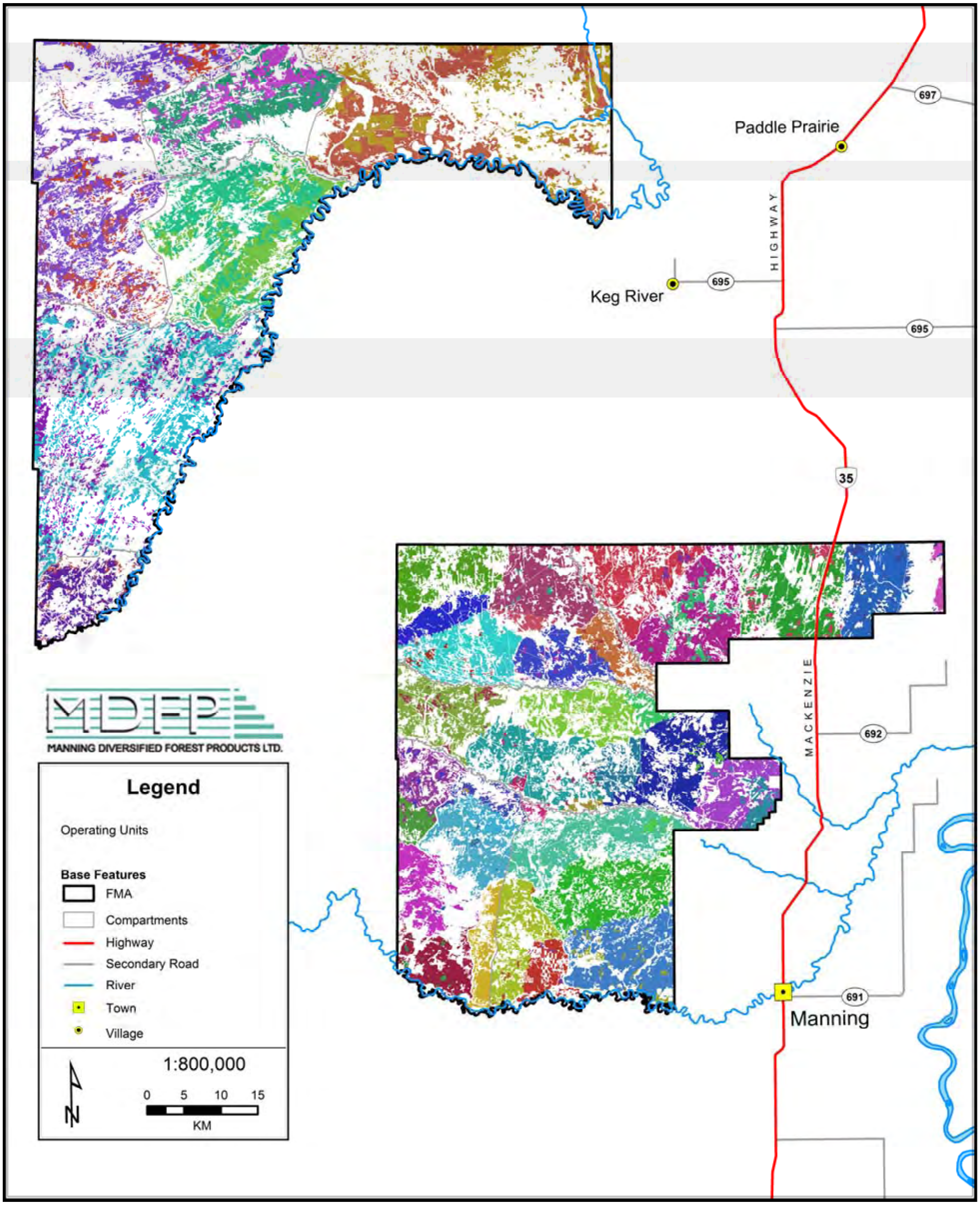


Figure 6-20. Operating units.

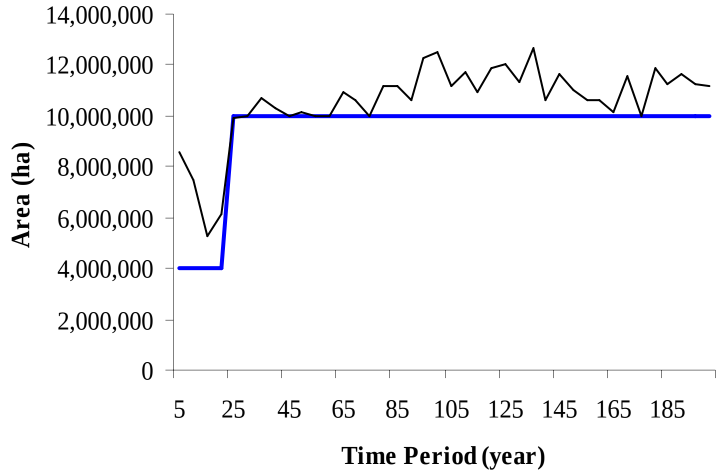


Figure 6-21. Area of operating units open in each period.

- Access.UnitsOpen.Conif

6.11 Tree Improvement Planting

The model had the option to plant improved stock on recently harvested polygons which moves the stand to a slightly higher yield curve. When unconstrained, the model plants some of the stands, but the volume gain allowed for the enhanced curve is conservative, which limits the model's utilization of this option. To ensure the FMA derives the yield benefits expected from planting of improved stock, two targets were used to force the planting of improved stock in the first 30 years as shown in Figure 6-22 and Figure 6-23.

Even with targets in place, many stands that could have been planted with improved stock were not, because of access control limitations. An access control limitation is created because the planting action in the model takes place 5 years after the clearcut action. If the compartment is turned off the period following after harvest, the planting action is not allowed, since no actions are allowed when a compartment is turned off.

As a result, MDFP reserves the right to plant more improved stock than indicated in the model in the first 20 years, because of the extensive use of access control in the model during this period of time.

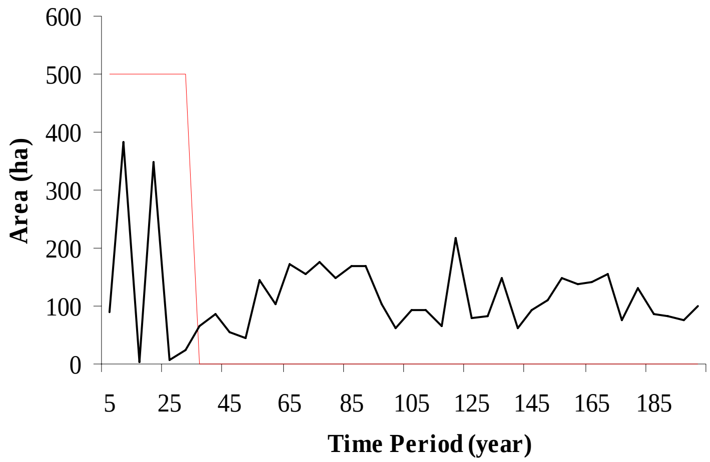


Figure 6-22. Tree improvement planting area in Breeding Region J (Pine).

- product.Treated.PLANTJ

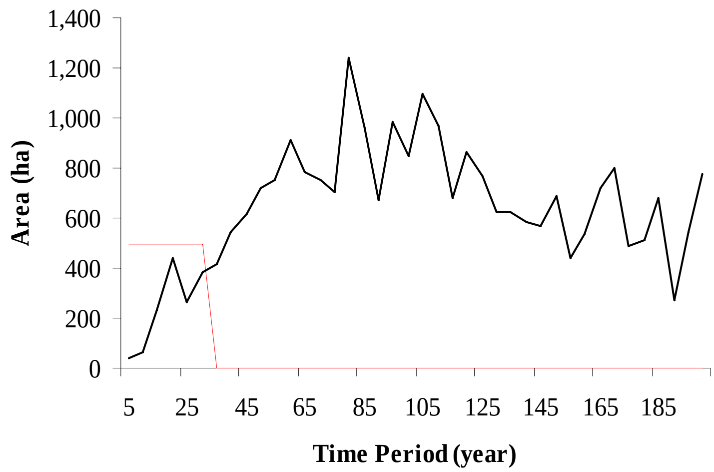


Figure 6-23. Tree improvement planting area in Breeding Region G2 (Spruce).

- product.Treated.PLANTG

6.12 Conifer Trees per Cubic Metre (TPM)

Coniferous trees per metre was constrained in the PFMS to ensure appropriate piece size. Each strata in the coniferous landbase has a conifer TPM curve. This curve is then used to determine the average conifer TPM for all conifer volume harvested from the conifer landbase in each period.

The PFMS has the maximum average conifer TPM set at 2.2 for the first 10 years and then it rises to a maximum average of 2.6 for the remainder of the planning horizon.

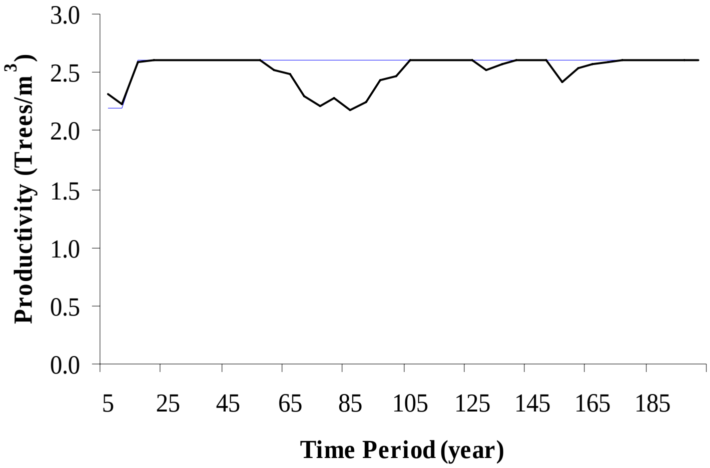


Figure 6-24. Conifer trees per cubic metre.

- product.Tpm.Avg.Conif

6.13 Mountain Pine Beetle

ASRD has issued a TSA related directive concerning mountain pine beetle, and the spirit of this directive has been implemented. Due to the small amount of pine in P16, the full analysis under the directive was not required.

The official strategy from Alberta regarding the current situation for Mountain Pine Beetle (MPB) is to harvest 75% of the operable Rank 1 and Rank 2 stands within the first 20 years. In the P16 landbase, the amount of merchantable stands that fall within the Rank 1 and Rank 2 status is a very small percentage of the overall active landbase. As such, MDFP's strategy is to cut all of the Rank 1 and Rank 2 stands that meet minimum operability guidelines (harvest age, piece size) and are available in the compartment sequence. This strategy had no effect on the harvest levels or any of the other major indicators, yet allowed MDFP to comply with the Provincial strategy.

Rank 1, 2 and 3 stands were identified on the landbase using SRD criteria. Stands with the pine component less than or equal to 20 % in the defining layer of the AVI were removed from the ranking. The defining layer (Section 4.2.4 in Landbase Netdown) is the overstory in most cases, but defers to the understory layer if the overstory layer is A density. This rule removed all of the D and DU strata from the ranking criteria.

The only potential impact to long-term AAC is the current amount of pine in FMU P9 that is below the operable age limit. An average of 180 ha/year is expected to be harvested from the P9 Rank 2 stands after the first 20 years. If the pine in these stands is killed before maturity, subsequent conifer AAC may be impacted.

Figure 6-25 through to Figure 6-28 show the harvest levels of the Rank 1 and Rank 2 stands in P6 and P9.

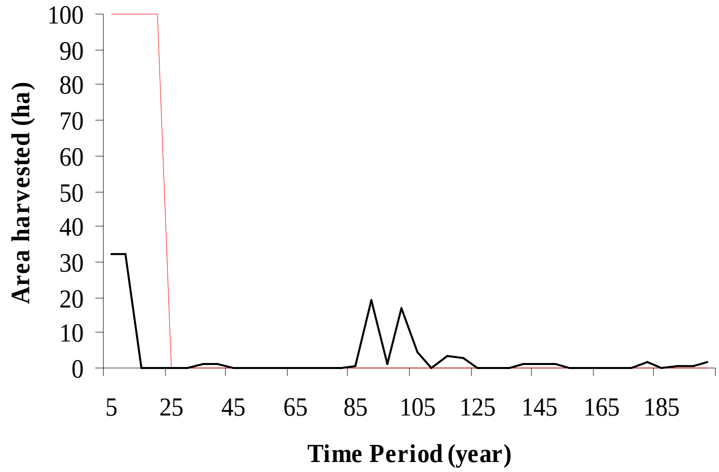


Figure 6-25. P6 Rank 1 area harvested.

- product.FMPArea.mlb.MPB.P6Rank1

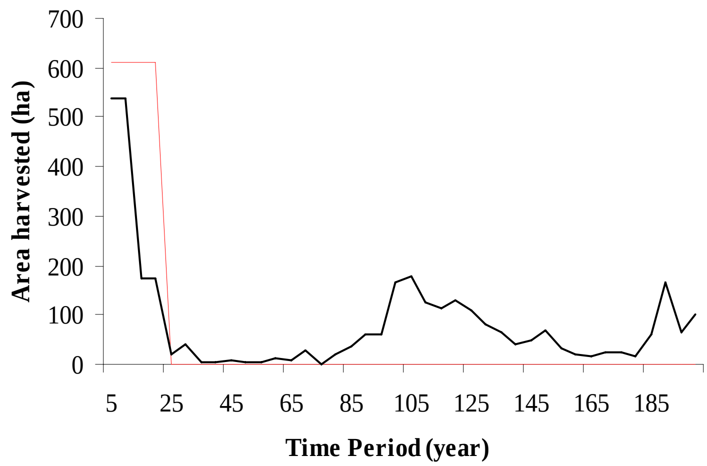


Figure 6-26. P6 Rank 2 area harvested.

- product.FMPArea.mlb.MPB.P6Rank2

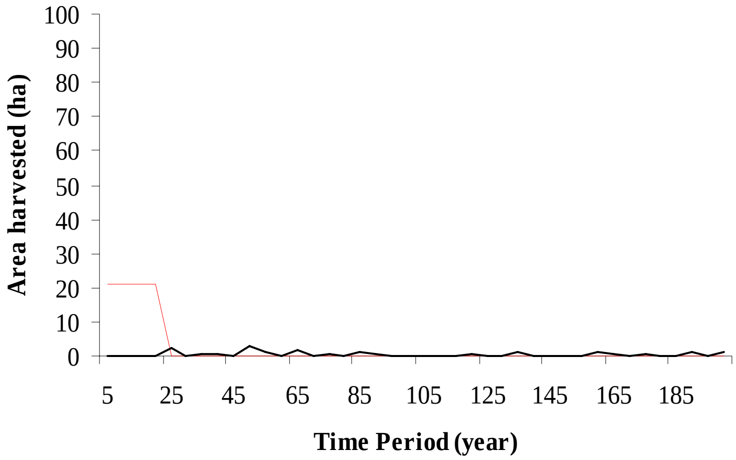


Figure 6-27. P9 Rank 1 area harvested.

- product.FMPArea.mlb.MPB.P9Rank1

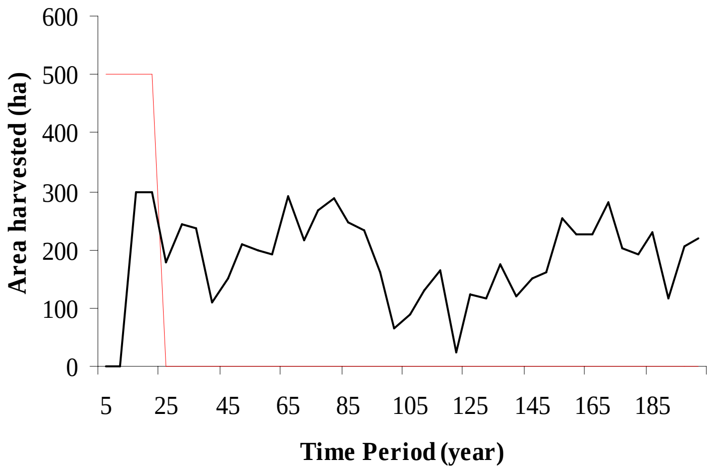


Figure 6-28. P9 Rank 2 area harvested.

- product.FMPArea.mlb.MPB.P9Rank2

6.14 Caribou 30/20 Rule

Within the Caribou Zone and the Alternative Patch Management Area (APMA), the 30/20 rule was applied to help reduce the habitat for ungulates other than caribou in an effort to reduce the predator population. Other ungulate habitat includes all deciduous and mixedwood strata (D, DU, DC, DCU, CD or CDU strata) that is less than 30 years old.

The target in each FMU was set so that the area less than 30 years old of the deciduous and mixedwood strata was no more than 20% of the total stratum area. These targets did not excessively constrain the model, and sensitivity analysis showed minimal changes to the outputs when they were turned off.

Figure 6-29 and Figure 6-30 show the 20% targets and the actual area within the deciduous and mixedwood strata in P6 and P9.

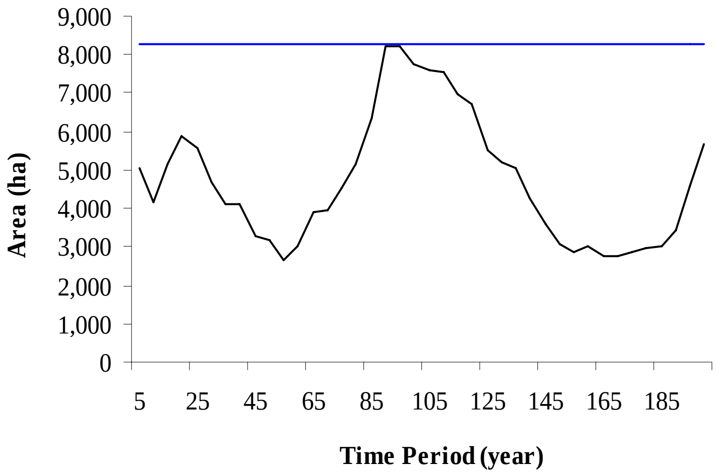


Figure 6-29. Caribou 30/20 rule in P6 combined Caribou Zone and APM Area.

- feature.FMPArea.mlb.under30yrs.P6

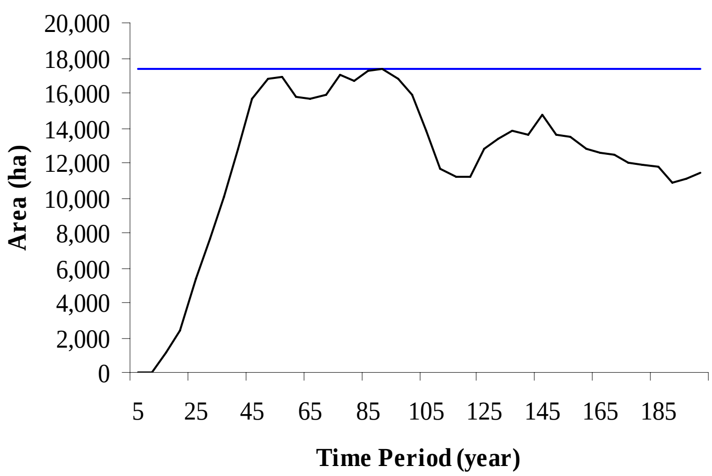


Figure 6-30. Caribou 30/20 rule in P9 combined Caribou Zone and APM Area.

- feature.FMPArea.mlb.under30yrs.P9

6.15 Alternative Patch Management Patches

Within the combined Caribou Zone and APMA, the stands included in or addressed by the 30/20 rule were also controlled spatially. Patch sizes greater than 300 ha were maximized to increase the grouping of blocks within the Caribou Zone and the APMA.

The target weighting for the patch size was set so as to reduce the number of patches in the 0-300 ha range, not to eliminate them. Throughout the planning horizon, the patch target was effective in increasing the average patch size when compared to areas outside of the APM Area. Figure 6-31 shows the reduction in percent of area that is in patches less than 300 ha.

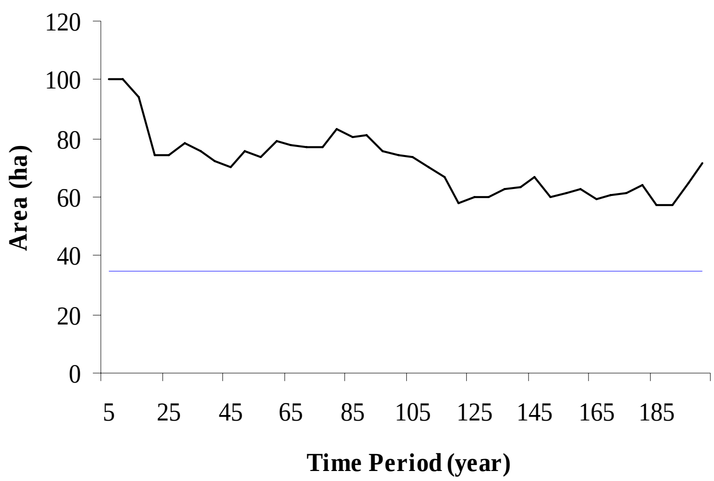


Figure 6-31. Percent of Alternative Patch Management in the combined Caribou Zone and APMA.

- patch.Caribou.mlb.under30yrs.P16.0-300.size

6.16 Disturbance Patches

Disturbance patches are used to describe the patch sizes of any part of the active landbase that is less than 20 years old, regardless of strata. The patches are further broken down into size ranges of 0-7 ha, 8-60 ha, 61-200 ha and 201+ ha. The only patch size constraint used in the model is to maximize the number of harvest blocks that make up 60 to 200 ha patches, using a 15 m topology distance. The TSA landbase does not include the linework from the seismic layer, as thus the topology distance was chosen to not cross permanent roads or water course buffers, but to allow the model to cross other small features with the landbase.

The goal is set to achieve 75% of the total area less than 20 years old to fall within the 61-200 ha patch size. Figure 6-32 shows the 61-200 ha patch size class as a percentage of the total active landbase less than 20 years old, while Figure 6-33 shows the total area in each size class.

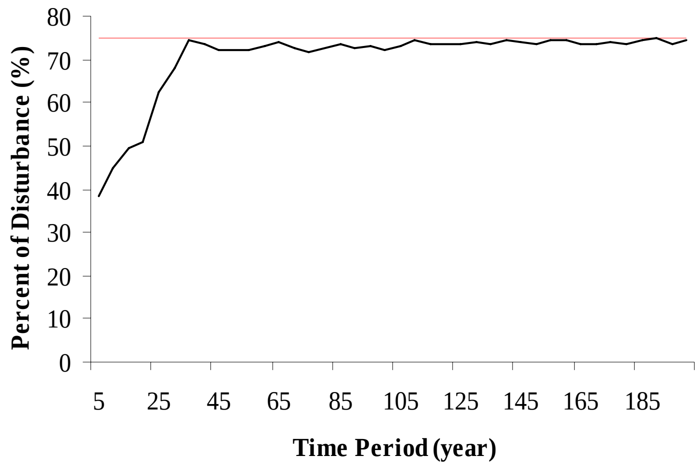


Figure 6-32. Percent of Disturbance patches in size class 60-200 ha.

- patch.Disturbed.mlb.60_200.size

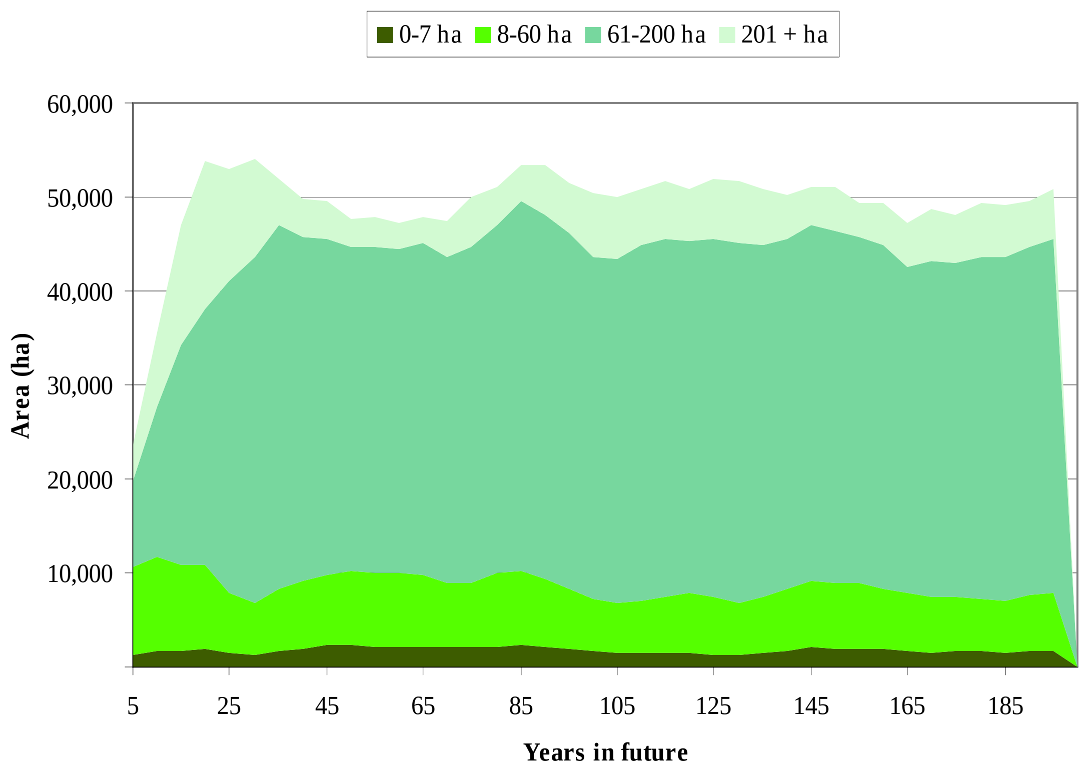


Figure 6-33. Disturbance patches in all size classes.

6.17 Old Interior Forest Patches

The Old Interior forest patch target strives to increase the number of patches greater than 120 ha that are composed of stands greater than 120 years old regardless of strata. It is applied to the gross landbase (active and passive). The goal is to maintain 75% of the total area greater than 120 years old in patches larger than 120 ha as a proxy to the true 100 ha required in Objective 1.1.1.2.

Initially there was some concern that this target would conflict with the Caribou Zone and APMA patch target. Fortunately, this target actually compliments the Caribou Zone and APMA patch target, as larger blocks contribute to larger old patches in the future.

Figure 6-34 shows the percent of Old Interior forest patches greater than 120 ha and Figure 6-35 shows the area in each patch size class.

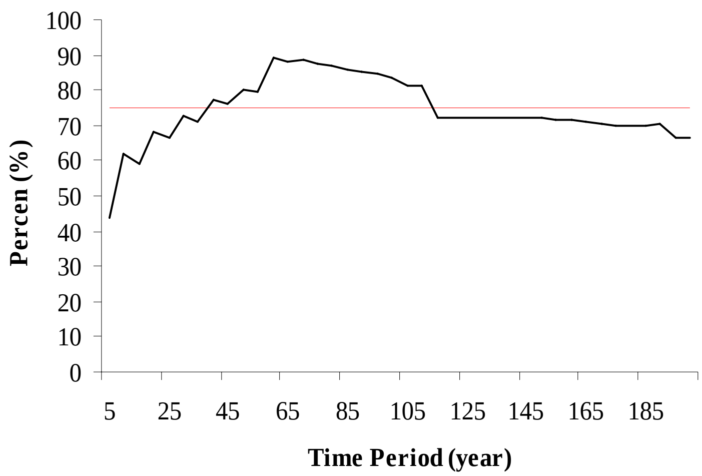


Figure 6-34. Percent of Old Interior forest patch size greater than 120 ha.

- patch.Interior.glb.Old.120+.size

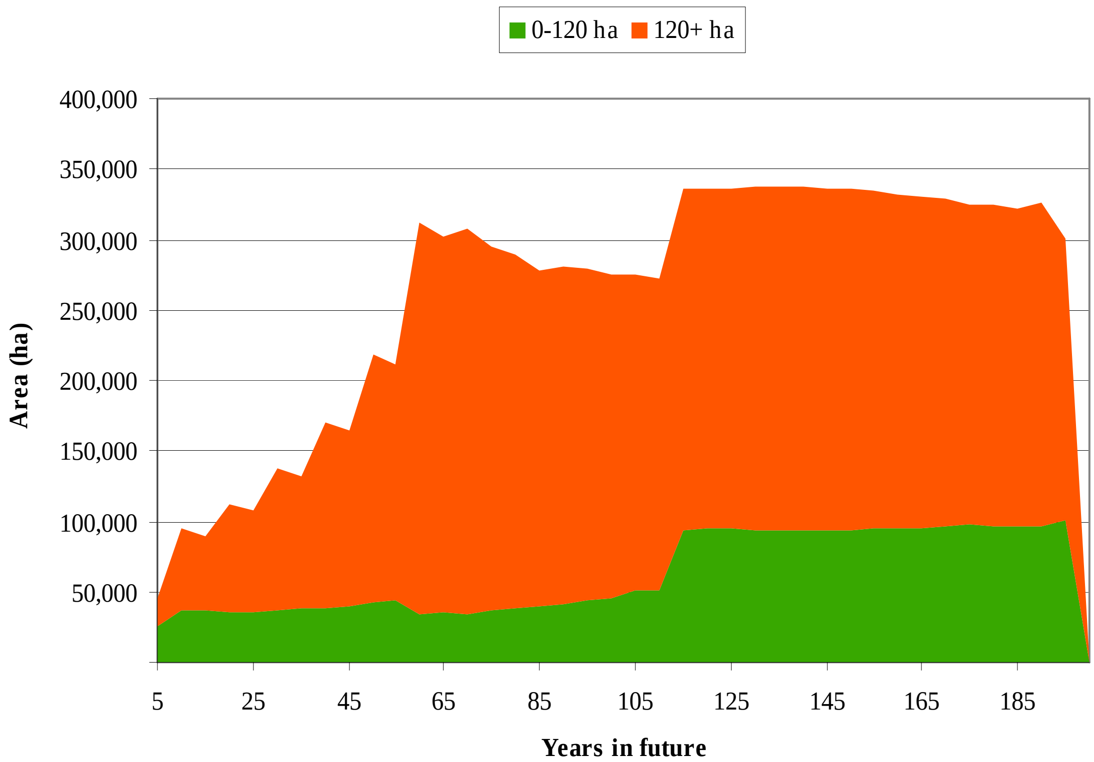


Figure 6-35. Old Interior forest patch size distribution.

6.18 FireSmart Patches

The FireSmart patch target was included in the TSA to reduce the number of patches greater than 1000 ha within the FMA area. The goal selected by the Core Planning Team is to reduce the area in FireSmart patches larger than 1000 ha to 35% of the total FireSmart area. A FireSmart patch is composed of all 'c' FBP types together.

There was some concern that the desire to reduce these patch sizes might not be feasible given the emphasis for larger blocks within the Caribou Zone and APMA, but this was not the case. The strata used in the FireSmart patches are primarily conifer, along with the conifer dominated mixedwoods, while the patches in the Caribou Zone and APMA were deciduous and mixedwood stratum. As a result, there was very little overlap in the patches that were being controlled by the two different patch targets.

The goal of the FireSmart patch target is to reduce the number of patches greater than 1000 ha, while the goal of the Caribou Zone and APMA patches is to maximize the number of patches greater than 300 ha. As a result, there is a significant amount of flexibility between the two size targets.

Figure 6-36 shows the percent of FireSmart patches greater than 1000 ha and Figure 6-37 shows the area in each patch size class.

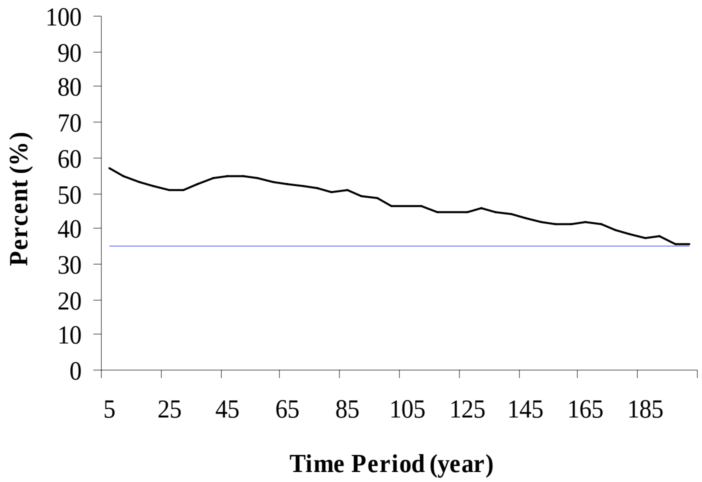


Figure 6-36. Percent of FireSmart patches greater than 1000 ha.

- patch.FireSmart.glb.c.1000+.size

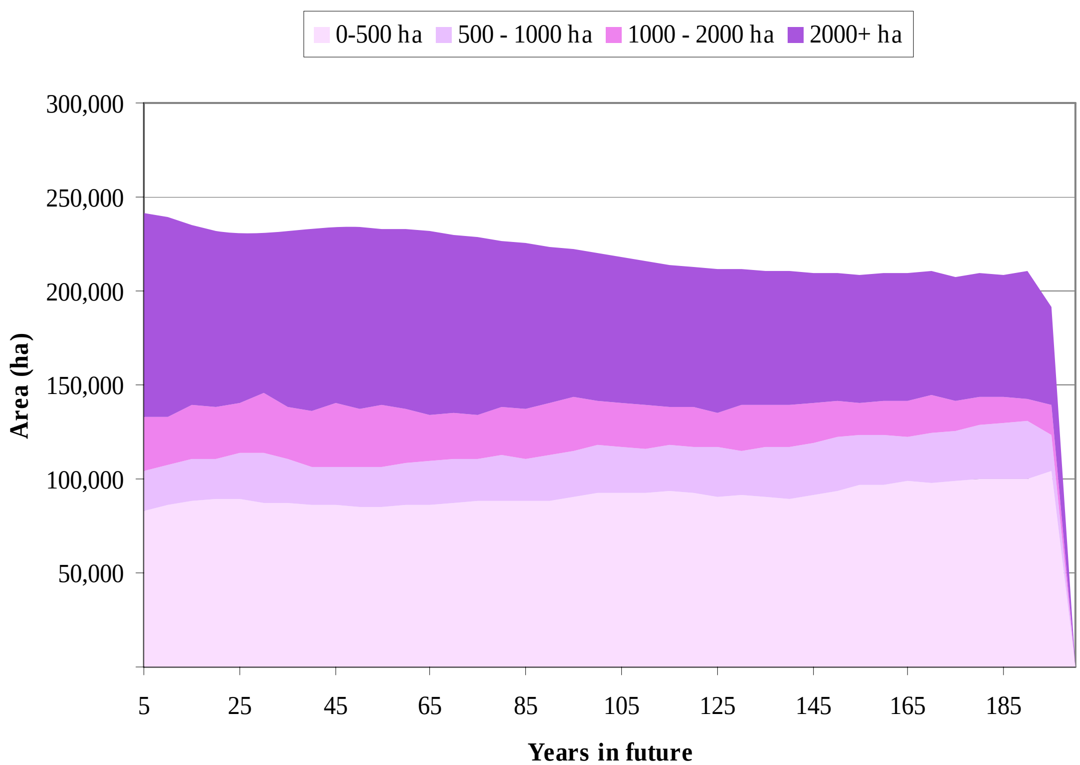


Figure 6-37. FireSmart patch size classes.

6.19 FireSmart Analysis

Annex 3 of the ASRD Forest Management Planning Standard describes the four-step process for FireSmart reporting requirements. These requirements are summarized as follows:

1. Using the most current regional wildfire threat assessment model, complete an assessment of the FMA area.
2. Create new Fire Behavior Potential (FBP) fuel grid layers that incorporate all SHS blocks for 0, 10, 20 and 50 years.
3. Create the forecasted fire behavior potential grid layers based on the FBP fuel layers created in Step 2. These new layers are the HFI grid layer, the CroSuM grid layer and the Fire Behavior Potential grid layer.
4. Examine the changes to fire behavior potential from the proposed SHS and modify if required.

MDFP has completed steps 1 through 4 and have provided these on the data DVD. Maps of the FireSmart analysis are in Section2 of **VOITS**.

6.20 Watershed Analysis

A watershed analysis was done by Watertight Consulting, on a selected set of watersheds using the WRENS watershed model. The watersheds chosen for the analysis are watersheds that represent the harvest activity in the first 20 years. The selected set of watersheds are shown in Figure 6-38. Unfortunately, due to the length of time it takes to perform the watershed analysis and the complexities in choosing the PFMS, the watershed analysis was not performed on the final PFMS, but on scenario P16_P7001. In Dr. Rothwell's professional opinion, the changes in the SHS between scenario P16_P7001 and the PFMS scenario did not warrant re-running the watershed analysis.

Standard 5.9.13 of the Alberta Forest Management Planning Standard, version 4.1 outlines the requirements for watershed analysis as the following:

> The impacts on water yield must be predicted. Watershed modeling and analysis will determine an acceptable target for water yield increase following harvesting for third order watercourses. The ToR will describe the models to be used and assessments to be completed.

To comply with the standard, the watercourses that were analyzed are broken down by order. Along with the third order watersheds, several second order and fourth order watersheds were also analyzed. The predicted water yield for the watersheds is shown in Table 6-4. The total watershed area analyzed is 2,495 km^2, and of that 243 km^2 (9.7%) exceeded the upper 95% confidence interval for average water yield.

Several of the second and third order watersheds had yield increases that exceed the 95% confidence interval. These were generally a result of either the caribou strategy (where operations were concentrated temporally) or the pine beetle strategy. In some cases it was simply a reflection of operating in a watershed that is extremely small (i.e., relatively few blocks represent a large portion of the watershed). However, the Core Team realizes that the TSA process requires compromises and changing the PFMS to remove the impact on the watersheds would require many modifications to the whole SHS strategy.

Table 6-4. Watershed Water Yield Predictions for Scenario P16_P7001.

Basin Order	Watershed	Area (Km^2)	Area Harvested (%)	Yield Increase (mm)	Maximum Increase in Annual Water Yield (%)
P9 Watersheds					
4th	5	571.6	3.3	4.1	4.5
3rd	3_1	166.4	9.3	9.1	9.9
	5_2	22.2	31.3	46.9	**51.2**
2nd	5_1	19.9	15.1	19.3	21
P6 Watersheds					
4th	16	720	17.3	15.1	15.8
	23-2	197.5	15.8	14.8	15.5
3rd	22-1	301.6	11.7	9.5	10
	13_1	231.4	11.6	10.6	11.1
	16_1	65	29.8	34.5	**36**
	20-1	59.2	26.9	26.1	**27.3**
	12_2	42.4	19.5	28.2	**29.5**
	16-2	36.5	28.2	25.8	**27**
2nd	12_1	43.6	17.6	13.9	14.5
	23-1	18.4	45.5	53.1	**55.5**

Bolded numbers indicate water yield exceeds upper 95% confidence interval.

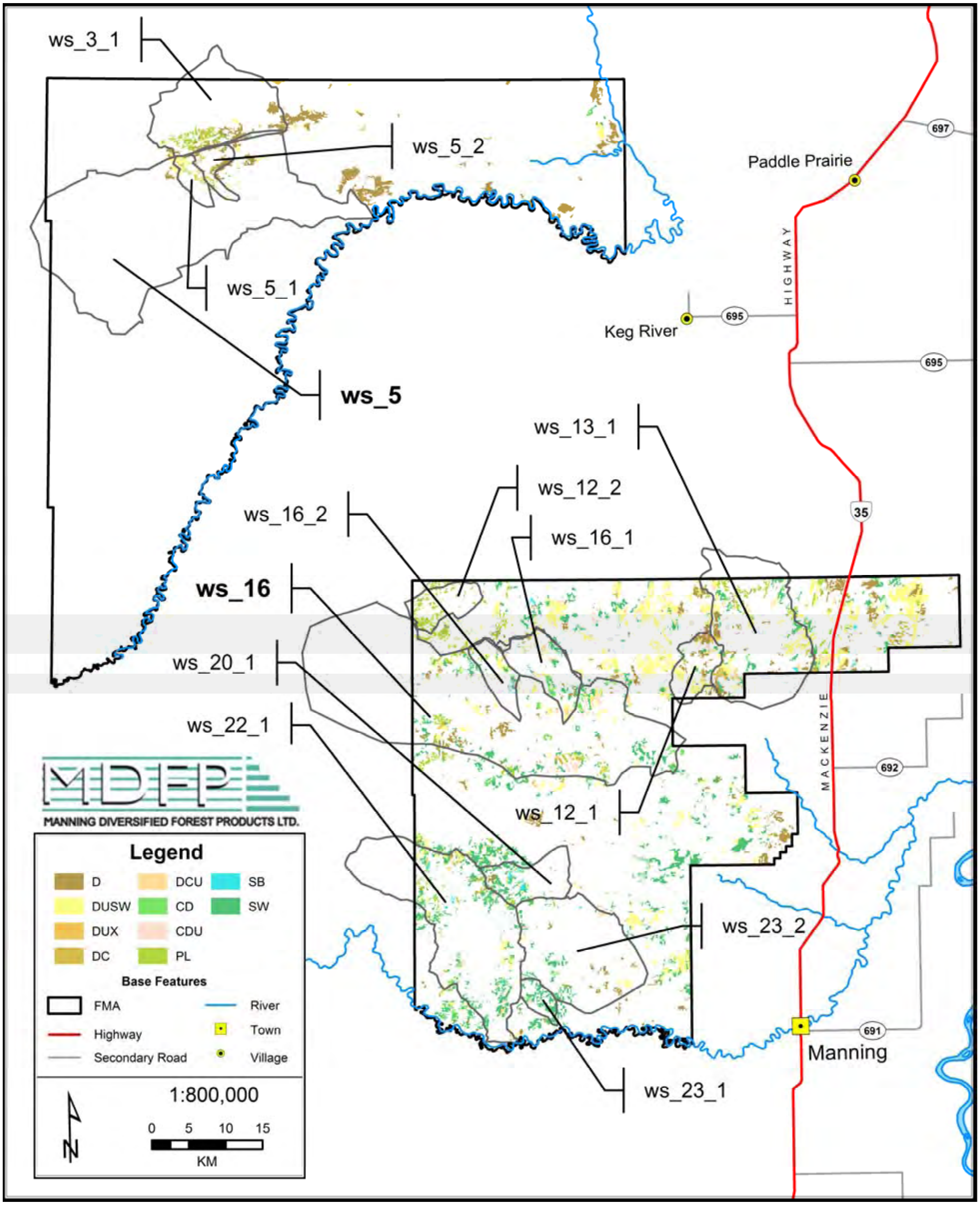


Figure 6-38. Watersheds chosen for analysis with 20 year SHS.

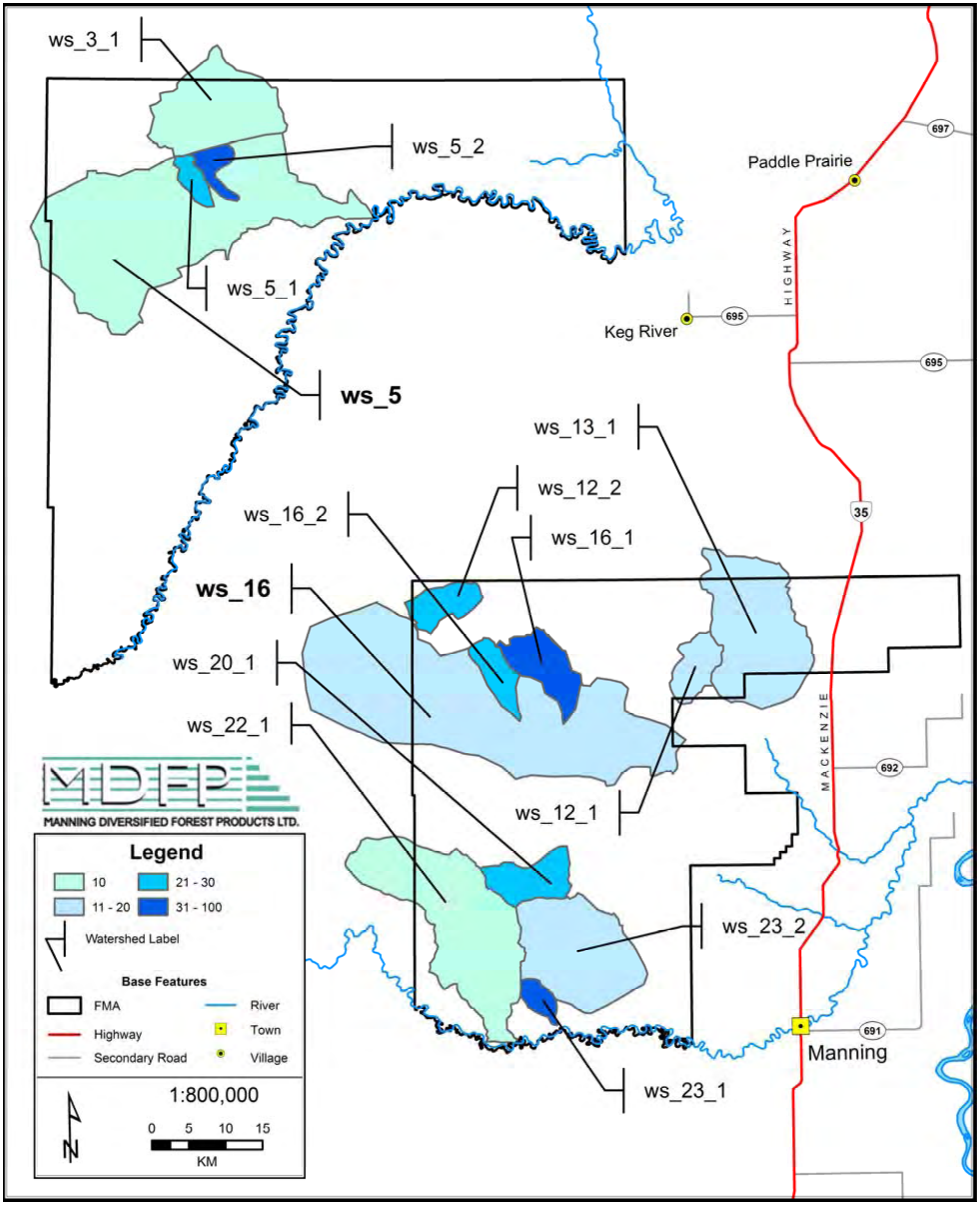


Figure 6-39. Watersheds and Percent Water Yield Increase.

7. AAC Recommendations

7.1 Recommended AAC

The Core Planning Team selected a PFMS which resulted in the following AAC recommendation for FMU P16 for the 2007-2017 FMP. Table 7-1 lists the harvest level from the PFMS for FMU P16 for the 2007-2017 FMP, as well as the current approved AAC. The effective date for this harvest level is May 1, 2007.

Table 7-1. Recommended P16 AAC.

Volume Source	Coniferous Harvest Volume (m^3/yr)			Deciduous Harvest Volume (m^3/yr)		
	Primary Evenflow	Secondary 20yr avg.	Total	Primary Evenflow	Secondary 20yr avg.	Total
PFMS (Scenario P16_P9003)	301,817	12,736	314,553	73,619	179,298	252,917
Current Approved AAC	196,897	14,404	211,301	129,849	42,692	172,541

7.2 Recommended Allocation

Annex 1, Section 5.12 of the Planning Standard requires the specification of AAC Allocation by Company. The historic allocation is presented in Table 7-2 and the recommended allocation, based on the PFMS, is presented in Table 7-3.

Table 7-2. Historic P16 AAC Allocation.

Allocation	Coniferous Harvest Volume (m³/yr)					Deciduous Harvest Volume (m³/yr)				
	Primary Evenflow		Secondary 20yr avg.		Total	Primary Evenflow		Secondary 20yr avg.		Total
	%	m3	%	m3	m3	%	m3	%	m3	m3
MDFP	100%	196,897	100%	14,404	211,301	0%	0	0%	0	0
DMI	0%	0	0%	0	0	100%	129,849	100%	42,692	172,541

Table 7-3. Recommended P16 AAC Allocation.

Allocation	Coniferous Harvest Volume (m³/yr)					Deciduous Harvest Volume (m³/yr)				
	Primary Evenflow		Secondary 20yr avg.		Total	Primary Evenflow		Secondary 20yr avg.		Total
	%	m3	%	m3	m3	%	m3	%	m3	m3
MDFP	100%	301,817	100%	12,736	314,553	0%	0	0%	0	0
DMI	0%	0	0%	0	0	100%	73,619	55%	98,922	172,541
Unallocated	0%	0	0%	0	0	0%	0	45%	80,376	80,376

7.3 Changes from Current Approved AAC

When compared to the current approved AAC, the recommended AAC is significantly different. This is due to a new AVI inventory, new yield curves based on new plot data, and a timber supply that considers caribou, mountain pine beetle, spatial harvest patterns and other considerations as outlined in this FMP.

The current AAC was assigned by SRD upon completion of a non-spatial analysis using Phase III inventory. As shown in Table 7-4, the landbase changed when the AVI inventory was completed. The new inventory resulted in more coniferous stratum and a corresponding drop in the pure D strata. This directly results in a smaller deciduous landbase and a larger conifer landbase. Furthermore, since the majority of the deciduous landbase loss occurred in FMU P6, the proportion of deciduous landbase that is currently younger than the minimum operability age dramatically increased, resulting in a wood flow issue in the first 10 years of the SHS (as shown in the deciduous growing stock in section 6.2).

Table 7-4. Comparison of Phase III landbase to AVI landbase.

Strata	Managed Landbase			
	Phase III	AVI	Decrease (Increase)	
	ha	ha	ha	%
P6				
D	18,570	11,872	6,698	36%
DU	77,854	74,941	2,913	4%
DC	11,365	13,064	(1,699)	-15%
CD	19,732	14,197	5,534	28%
SW/PL	38,565	54,168	(15,603)	-40%
SB	5,641	2,414	3,228	57%
Total	171,727	170,657	1,071	1%
P9				
D	60,118	59,880	238	0%
DU	28,514	23,949	4,565	16%
DC	7,108	6,949	159	2%
CD	4,239	4,329	(90)	-2%
SW/PL	25,240	27,681	(2,441)	-10%
SB	5,261	1,847	3,415	65%
Total	130,481	124,634	5,847	4%
P16				
D	78,689	71,753	6,936	9%
DU	106,368	98,890	7,478	7%
DC	18,473	20,013	(1,540)	-8%
CD	23,971	18,526	5,444	23%
SW/PL	63,805	81,849	(18,044)	-28%
SB	10,903	4,260	6,643	61%
Total	302,208	295,291	6,917	2%

8. Issue Resolution

This section outlines several of the issues that were resolved during the PFMS selection. These “Issue Statements” are formatted as stand-alone documents, and as such they may present redundant information that is also presented elsewhere in this document.

8.1 DUA Harvest Levels

8.1.1.1 Question

What is the impact on the conifer AAC when the proportion of deciduous priority DUA harvest increases?

8.1.1.2 Background

The DUA strata is a large component of the landbase in P16 and contains significant coniferous and deciduous volume. Both MDFP and DMI are reliant on the volume in the strata, while MDFP holds legal rights to the landbase. Through verbal agreements, the two companies have agreed to share the resource, allowing DMI to harvest up to 50% of the DUA strata using deciduous priority clearcut. As the conifer component in the DUA strata contributes to the coniferous AAC, the impact of the agreement has the potential to be a very contentious issue.

8.1.1.3 Results

When compared to the PFMS, Scenario #P16_P9010 is the exact same except that the deciduous priority harvest level is unconstrained. Table 8-1 shows the change of AAC level.

Table 8-1. Comparison of PFMS scenario to P16_P9010.

	Conifer Harvest Volume (m³/yr)		Deciduous Harvest Volume (m³/yr)		Deciduous Secondary 20yr avg. Volume Source (m³/yr)	
	Primary Evenflow	Secondary 20yr avg.	Primary Evenflow	Secondary 20yr avg.	DUA	Other
PFMS	301,817	12,736	73,619	179,298	106,457	72,841
P16_P9010	305,756	12,605	72,308	145,762	63,620	82,142
Difference	-3,939	131	1,311	33,535	42,837	-9,301

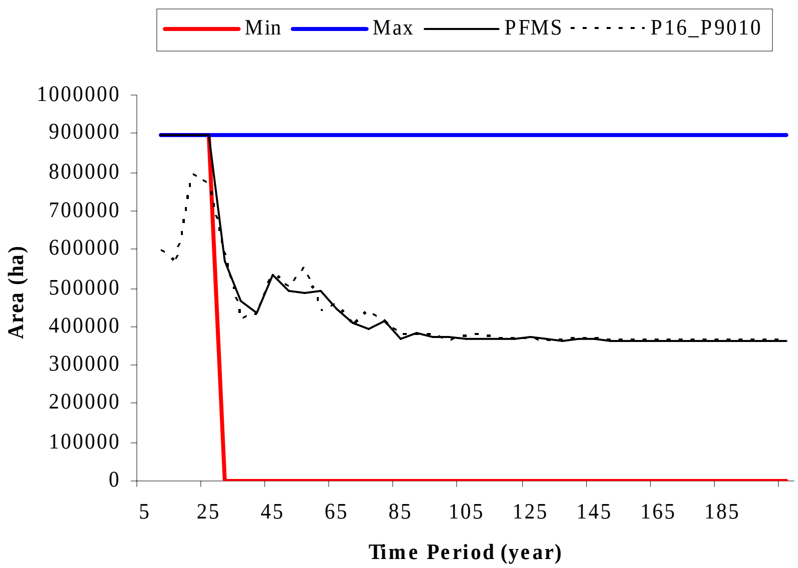


Figure 8-1. Comparison of Deciduous harvest volume from D and DUA strata (m3/year).

- product.FMPVol.mlb.VolSum.Decid.DMI

8.1.1.4 Discussion

There is a small negative impact on the conifer even-flow harvest levels when the DUA area harvested by deciduous priority approaches 50%, however, MDFP agreed to allow DMI to harvest up to 50% of the DUA stratum.

8.2 Caribou Habitat Controls

8.2.1.1 Question

What is the impact on AAC levels resulting from using the caribou habitat controls?

8.2.1.2 Background

Several controls have been added to the model to enhance the caribou habitat in P16 within the Caribou Zone and APMA. The main controls are:

- 30/20 rule – In the deciduous and mixedwood stratum, a maximum of 20% is allowed to be under 30 years old.
- Patch target – A patch target that tended towards patches (under 30 years old) larger than 300 ha.

8.2.1.3 Results

Scenario P16_P9020 was based on the PFMS but with the caribou targets turned off. The removal of these targets had little impact on the harvest levels when compared to the PFMS scenario as shown in Table 8-2, but allowed the model to violate the 30/20 rule and also allow smaller patches within the Caribou Zone and APMA (Figure 8-2, Figure 8-3 and Figure 8-4).

Table 8-2. Comparison of PFMS scenario to P16_P9020.

	Conifer Harvest Volume (m^3/yr)		Deciduous Harvest Volume (m^3/yr)		Deciduous Secondary 20yr avg. Volume Source (m^3/yr)	
	Primary Evenflow	Secondary 20 yr avg.	Primary Evenflow	Secondary 20 yr avg.	DUA	Other
PFMS	301,817	12,736	73,619	179,298	106,457	72,841
P16_P9020	302,070	12,556	72,269	179,958	107,218	72,739
Difference	-253	180	1,350	-660	-761	101

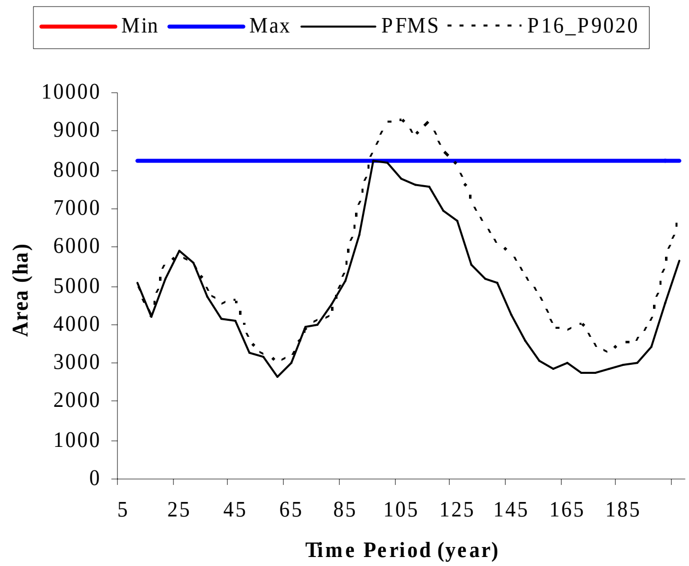


Figure 8-2. Comparison of Caribou 30/20 rule in P6 combined Caribou Zone and APM Area.

- feature.FMPArea.mlb.under30yrs.P6

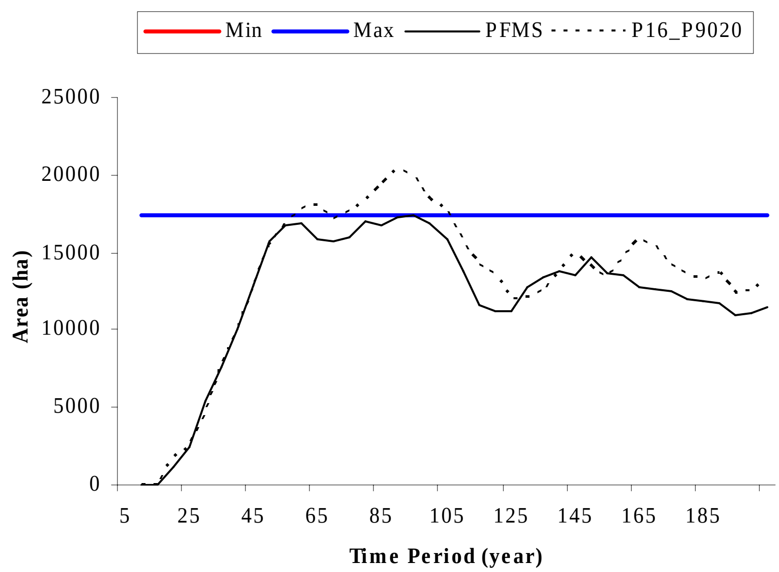


Figure 8-3. Comparison of Caribou 30/20 rule in P9 combined Caribou Zone and APM Area.

- feature.FMPArea.mlb.under30yrs.P9

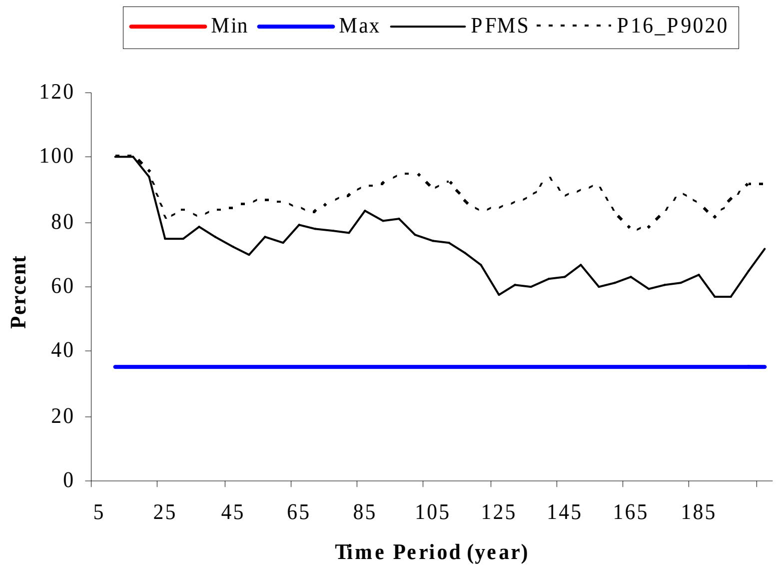


Figure 8-4. Comparison of Percent of Alternative Patch Management in the combined Caribou Zone and APM Area.

- patch.Caribou.mlb.under30yrs.P16.0-300.size

8.2.1.4 Discussion

There was no significant impact on the harvest levels with the implementation of the Caribou constraints. The Core Team agreed to include the caribou constraints in the model to address the importance of caribou habitat in the Caribou Zone and APMA.

8.3 Mountain Pine Beetle

8.3.1.1 Question

What is the impact of imposing Mountain Pine Beetle constraints?

8.3.1.2 Background

The official strategy from Alberta regarding the current situation for Mountain Pine Beetle (MPB) is to harvest 75% of the operable Rank 1 and Rank 2 stands within the first 20 years. In the P16 landbase, the amount of merchantable stands that fall within the Rank 1 and Rank 2 status is a very small percentage of the overall active landbase. As such, MDFP's strategy is to cut all of the Rank 1 and Rank 2 stands that fall within their normal course of operations and compartment sequencing.

8.3.1.3 Results

Scenario P16_P9030 is based on the PFMS but without using the pine beetle targets. The removal of these targets has little impact on the over AAC levels as shown in Table 8-3. The harvest levels in each of the targets is shown in Figure 8-5, Figure 8-6, Figure 8-7 and Figure 8-8.

Table 8-3. Comparison of PFMS scenario to P16_P9030.

	Conifer Harvest Volume (m^3/yr)		Deciduous Harvest Volume (m^3/yr)		Deciduous Secondary 20yr avg. Volume Source (m^3/yr)	
	Primary Evenflow	Secondary 20 yr avg.	Primary Evenflow	Secondary 20 yr avg.	DUA	Other
PFMS	301,817	12,736	73,619	179,298	106,457	72,841
P16_P9030	301,747	12,585	72,250	185,201	107,187	78,013
Difference	70	151	1,369	-5,903	-730	-5,172

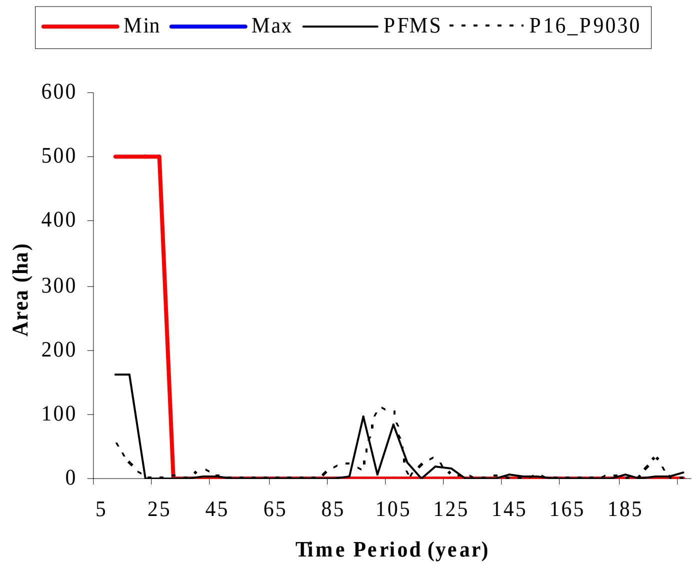


Figure 8-5. Comparison of P6 Rank1 area harvested.

- product.FMPArea.mlb.MPB.P6Rank1

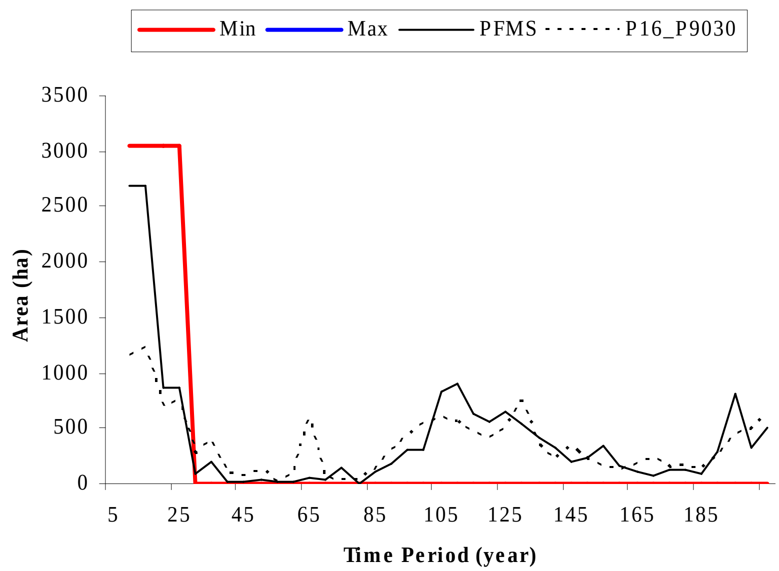


Figure 8-6. Comparison of P6 Rank2 area harvested.

- product.FMPArea.mlb.MPB.P6Rank2

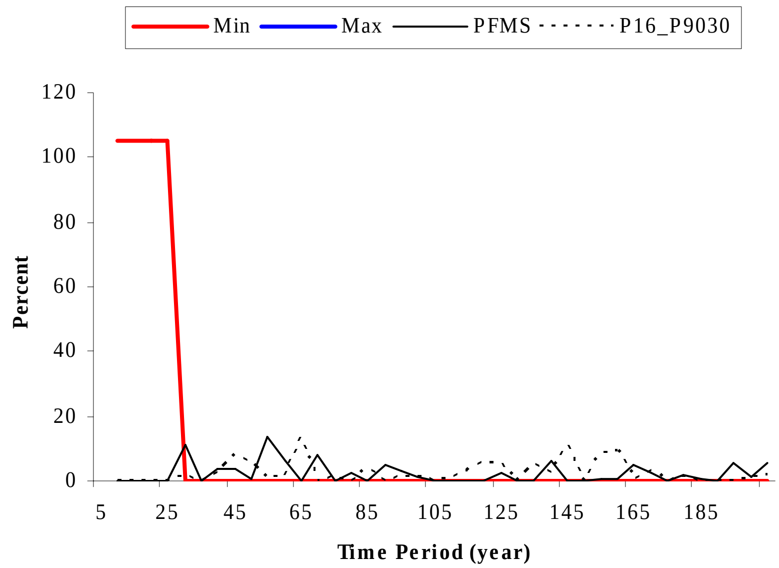


Figure 8-7. Comparison of P9 Rank1 area harvested.

- product.FMPArea.mlb.MPB.P9Rank1

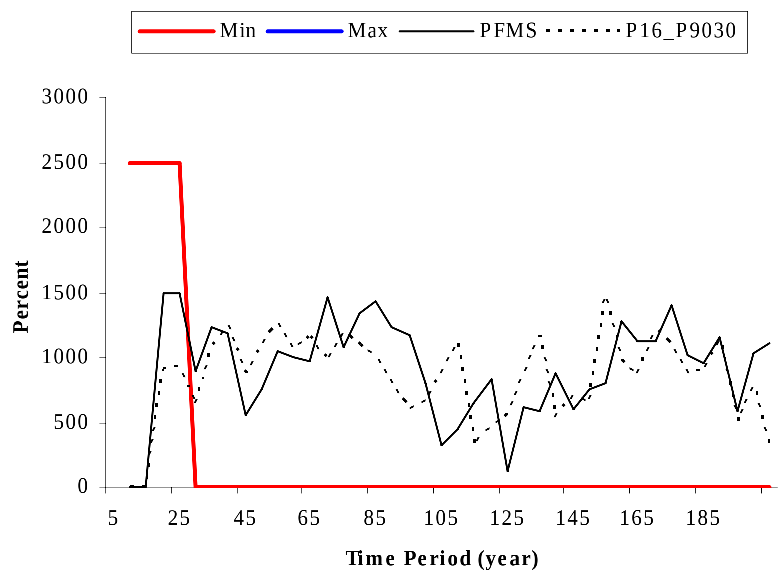


Figure 8-8. Comparison of P9 Rank2 area harvested.

- product.FMPArea.mlb.MPB.P9Rank2

8.3.1.4 Discussion

The amount of MPB susceptible pine in the FMA is small (< 8% of active landbase) and is in fairly concentrated groups. Because of this, re-aligning the SHS to capture MPB susceptible stands in the first 20 years had an insignificant impact on all harvest levels.

9. References

Boston, K. and Bettinger, P. 1999. An Analysis of Monte Carlo Integer Programming, Simulated Annealing , and Tabu Search Heuristics for Solving Spatial Harvest Scheduling Problems. For. Sci. 45(2): 292-301.

Davis, Johnson, Howard and Bettinger. 2001. Forest Management to Sustain Ecological, Economic and Social Values, Fourth Edition. McGraw-Hill Companies Inc. New York, NY.

Lockwood, C. and Moore, T. 1993. Harvest scheduling with spatial constraints: a simulated annealing approach. Can J. For. Res. 23: 468-478.

Appendix I Model Round Changes

Through the course of developing the final timber supply model, several rounds of Patchworks models was implemented. The major changes that required a new round of models is listed below.

I.I. Round1 – Initial Patchworks model.

Woodstock_model_v5.xls

I.II. Round2

Woodstock_model_v6.xls
Added the road component,
Added control over alternative patch management zone,
Added control over management zones and working circles.

I.III. Round3

Woodstock_model_v7.xls
Implemented Transition_matrix_2006_02_21,
Added tree improvement actions,
Added deciduous and conifer priority actions for DU A density Understory Stands,
Added FireSmart yield curves and patching targets,
Added caribou 30-20 rule,
Updated yield curves to set as submitted in July, 2006,
Updated landbase to Version4 as submitted in July, 2006.

I.IV. Round4

Woodstock_model_v10.xls
Increased DU BCD density understory minimum harvest age from 80 to 110 years old as a result of field checking preliminary SHS.

I.V. Round5

Woodstock_model_v11.xls
Reduced deciduous landbase curves by 4% to allow for structural retention.
Implemented Transition_matrix_2006_10_20 – only change is DU A density understory stands now all transition to DC strata,
Revised FireSmart yield curves,
Added mountain pine beetle ranking system, allows control and reporting,
Added second topology file (120m proximal distance instead of 15m) to allow reporting for VOIT,
Added split between conifer and deciduous landbases for access control.

I.VI. Round 6

Woodstock_model_v11.xls
Added targets to allow for accounting of DMI harvest of DU A density stands,

Added target to allow control of harvesting of SW fair stands (capped at 50ha / year),
Added operational units to force the model to group operations even more.

I.VII. Round 7

Woodstock_model_v12.xls
Removed the 4% structural retention reduction from deciduous landbase curves, (SRD does not allow this).

I.VIII. Round 8

Woodstock_model_v13.xls
Fixed major error in accounting of DU stands. Previous rounds included the DU BCD density in the deciduous priority, when they are actually part of the conifer priority.

I.IX. Round 9

Woodstock_model_v13.xls
Fixed duplicated road segments in operating units functionality.
Added targets for P6 and P9 MDFP conifer harvest area.
Added more polygon level control on the conifer harvest in the preblock schedule.

Appendix II Additional Patchworks Scenarios

TSA Scenario Number	Name	Reference Scenario	Purpose of TSA Scenario	Result
P16_P3000	No Harvest		What is the result of not Harvesting?	Large increase in Old Interior Forest and older age classes
P16_P3001	Base line compartment run	P16_P3000	What is the initial harvest level given certain compartment constraints?	Initial baseline run
P16_P3002	Turn off south P9	P16_P3001	What is the revised harvest level if south P9 is turned off?	Minimal effect on harvest levels and other key indicators
P16_P3003	Fix pre-blocks in caribou zone	P16_P3002	What happens when the pre-blocks in the caribou zone are not forced on?	Minimal effect on harvest levels and other key indicators
P16_P3004	Piece size max 2.2 for 10 years, 2.6 for rest	P16_P3003	What happens when piece size is restricted to 2.2 for ten years and 2.6 for the remaining horizon?	Minimal effect on harvest levels and other key indicators
P16_P3006	Piece size same as 3004 and turned off Understory protection and Deciduous priority clearcut.	P16_P3004	What happens when deciduous priority harvest of Du-A density stands is removed?	Significant impact on conifer primary harvest volume (18% decline) and deciduous secondary harvest volume (52% decline)
P16_P3007	P9 harvest off for 20 years	P16_P3003	What happens when P9 harvest is turned off for 20 years?	Significant change to deciduous primary harvest volume (43% decline) and conifer secondary harvest volume (41% decline)
P16_P3008	P9 harvest off for 10 years	P16_P3003	What happens when P9 harvest is turned off for 10 years?	Small change to deciduous primary harvest volume (10% decline) and conifer secondary harvest volume (5% decline)
P16_P3009	Turn off understory Protection	P16_P3004	What happens when only understory protection is turned off?	Minimal effect on harvest levels and other key indicators
P16_P4001	DU BCD min harvest age increased from 80 to 110 years	P16_P3006	What happens when we increase the min harvest age of DU BCD density stands? (Understory protection and Deciduous priority are also off)	No effect on harvest levels and other key indicators
P16_P4002	Test understory protection when DU Decid priority is not allowed	P16_P4001	What happens when understory protection is allowed but deciduous priority is not allowed?	Small effect on harvest levels and other key indicators
P16_P4003	Add in more pre-blocks and deferals	P16_P4001	What happens when certain stands are locked down or deferred?	Minimal effect on harvest levels and other key indicators
P16_P4006	First MPB Beetle run - remove 50% pine in 5 years	P16_P4003	What happens when we force 50% of operable pine strata to be harvested in the first 5 years? (also now allowing deciduous priority)	Minimal effect on harvest levels and other key indicators
P16_P4007	Second MPB Beetle run - remove 75% pine in 20 years	P16_P4003	What happens when we force 75% of operable pine strata to be harvested in the first 20 years? (also now allowing deciduous priority)	Minimal effect on harvest levels and other key indicators
P16_P5000	Baseline round 5 run - no access control	P16_P4003	What is the maximum harvest volume without access control?	New Baseline shows 8,000m3 harvest level increase for Primary deciduous if no access contol
P16_P5001	P6 Rank1 and Rank2 stands targeted	P16_P5005	What is the effect of changing from Round 4 to Round 5 and targeting Rank1 and 2 stands in P6?	Some increase in Conifer Primary volume, primarily due to shorter rotation of access (10 years insead of 20 years)
P16_P5002	P6 and P9 Rank1 and Rank2 stands targeted	P16_P5001	What is the effect of targeting Rank1 and 2 stands in P6 and P9?	Minimal effect on harvest levels and other key indicators
P16_P5003	Force tree improvement planting	P16_P5002	How much tree improvement planting will occur if the model is forced to do it?	Minimal effect on harvest levels and other key indicators
P16_P5004	Baseline round 5 run - with access control	P16_P4003	What is the effect of changing from Round 4 to Round 5, without mpb constraints?	Minimal effect on harvest levels and other key indicators
P16_P5005	Revised Access Control	P16_P5003	What is the effect of modifying the access control table to allow less control after year 20?	Minimal effect on harvest levels and other key indicators
P16_P6003	New round and new access control	P16_P5005	What is the effect of the new compartment sequence? (P9 off for 10 years, etc)	Minimal effect on harvest levels and other key indicators
P16_P6004	Run for 10 days	P16_P6003	What is the effect of running for an extended period of time?	Minimal effect on harvest levels and other key indicators
P16_P6005	Turn off Caribou 30/20 rule and patch targets	P16_P6004	What is the effect of turning off the caribou constraints?	Minimal effect on harvest levels and other key indicators
P16_P7001	Get Incidental volume for DMI from DUA stands	P16_P6004	Can 100,000m3/yr of deciduous incidental be obtained from DU A density stands?	Yes, with minimal effect on other indicators

TSA Scenario		Reference		
Number	Name	Scenario	Purpose of TSA Scenario	Result
P16_P8002	Make DMI DU incidental from under 12m height understory	P16_P7001	Can we balance the cut with DMI getting most of the DUSW A density volume from stands where the understory is less than 12m?	Yes, with minimal effect on other indicators
P16_P8003	Move more of the DU A density Decid Priority into first 20 years	P16_P8001	Can we move more of the DU A density harvest for DMI into the first 20 years to meet 172,000m3?	Yes, with minimal effect on other indicators
P16_P9001	Refine SHS based on manual deferals	P16_P8003	Refinement of the SHS	Minimal effect on other indicators
P16_P9003	Refine SHS - fixed missing 2006 blocks and removed underplant pre-blocks	P16_P9001	Refinement of the SHS	Minimal effect on other indicators
P16_P9010	Remove control on DUA strata to allow comparison with PFMS	P16_P9003	What happens to SHS when DUA control is removed?	Minimal effect on other indicators
P16_P9020	Remove control on Caribou Habitat to allow comparison with PFMS	P16_P9003	What happens to SHS when Caribou Habitat control is removed?	Minimal effect on other indicators
P16_P9030	Remove control on Pine harvest for Mountain Pine Beetle to allow comparison with PFMS	P16_P9003	What happens to SHS when pine harvest for MPB control is removed?	Minimal effect on other indicators

TSA Scenario			Conifer Harvest Volume (m³/yr)		Deciduous Harvest Volume (m³/yr)	
Number	Name	Years	Primary Evenflow	Secondary 20yr avg.	Primary Evenflow	Secondary 20yr avg.
P16_P3000	No Harvest	2007-2206	-	-	-	-
P16_P3001	Base line compartment run	2007-2206	320,443	12,976	78,340	210,391
P16_P3002	Turn off south P9	2007-2206	321,818	12,791	78,450	213,549
P16_P3003	Fix pre-blocks in caribou zone	2007-2206	320,669	13,239	78,430	199,560
P16_P3004	Piece size max 2.2 for 10 years, 2.6 for rest	2007-2206	319,507	13,209	78,155	190,303
P16_P3006	Piece size same as 3004 and turned off Understory protection and Deciduous priority clearcut.	2007-2206	259,193	12,740	75,330	92,391
P16_P3007	P9 harvest off for 20 years	2007-2206	318,714	7,827	44,118	202,631
P16_P3008	P9 harvest off for 10 years	2007-2206	321,010	12,593	70,346	205,249
P16_P3009	Turn off understory Protection	2007-2206	322,131	13,262	78,300	185,311
P16_P4001	DU BCD min harvest age increased to 110 years	2007-2206	259,311	12,716	75,278	91,349
P16_P4002	Test understory protection when DU Decid priority is not allowed	2007-2206	264,476	13,168	77,687	113,940
P16_P4003	Add in more pre-blocks and deferals	2007-2206	257,113	12,820	74,965	95,966
P16_P4006	First MPB Beetle run - remove 50% pine in 5 years	2007-2206	262,561	12,963	75,870	112,036
P16_P4007	Second MPB Beetle run - remove 75% pine in 20 years	2007-2206	262,181	12,919	75,187	109,479
P16_P5000	Baseline round 5 run - no access control	2007-2206	296,430	13,835	83,449	151,952
P16_P5001	P6 Rank1 and Rank2 stands targeted	2007-2206	262,988	12,484	75,107	136,729
P16_P5002	P6 and P9 Rank1 and Rank2 stands targeted	2007-2206	263,246	12,497	75,403	139,021
P16_P5003	Force tree improvement planting	2007-2206	262,792	12,824	76,977	130,561
P16_P5004	Baseline round 5 run - with access control	2007-2206	262,305	12,399	73,934	154,877
P16_P5005	Revised Access Control	2007-2206	283,183	12,692	74,579	140,418
P16_P6003	New round and new access control	2007-2206	282,556	11,421	62,602	150,593
P16_P6004	Run for 10 days	2007-2206	293,166	12,100	70,630	145,792
P16_P6005	Turn off Caribou 30/20 rule and patch targets	2007-2206	293,325	12,126	70,633	147,128
P16_P7001	Get Incidental volume for DMI from DUA stands	2007-2206	292,777	12,379	71,751	166,222
P16_P8002	Make DMI DU incidental from under 12m height understory	2007-2206	300,893	12,402	71,588	165,729
P16_P8003	Move more of the DU A density Decid Priority into first 20 years	2007-2206	300,951	12,338	71,771	178,677
P16_P9001	Refine SHS based on manual deferals	2007-2206	300,801	12,597	72,292	179,943
P16_P9003	Refine SHS - fixed missing 2006 blocks and removed underplant pre-blocks	2007-2206	301,817	12,736	73,619	179,298
P16_P9010	Remove control on DUA strata to allow comparison with PFMS	2007-2206	305,756	12,605	72,308	145,762
P16_P9020	Remove control on Caribou Habitat to allow comparison with PFMS	2007-2206	302,070	12,556	72,269	179,958
P16_P9030	Remove control on Pine harvest for Mountain Pine Beetle to allow comparison with PFMS	2007-2206	301,747	12,585	72,250	185,201

Note: All scenarios were analyzed using the Patchworks modelling tool.

Indicators highlighted in gray were constrained in the TSA model.

TSA Scenario	Deciduous Secondary 20yr avg. Volume Source (m³/yr)		Primary volume MAI (m³/ha/yr)			Operable Growing Stock at End of PH (m³)		Percent Operable Growing Stock at End of PH compared to time 0 (%)	
Number	DUA	Other	Conifer	Decid	Total	Conifer	Decid	Conifer	Decid
P16_P3000			-	-	-	28,882,138	0	184	0
P16_P3001			1.45	1.09	2.54	10,794,000	3,019,650	69	305
P16_P3002			1.45	1.09	2.55	10,785,005	2,789,708	69	282
P16_P3003			1.45	1.09	2.54	10,782,578	2,788,990	69	282
P16_P3004			1.44	1.09	2.53	10,787,465	3,087,861	69	312
P16_P3006			1.17	1.05	2.22	15,931,887	2,892,542	102	292
P16_P3007			1.44	0.61	2.05	10,783,958	3,190,695	69	322
P16_P3008			1.45	0.98	2.43	10,789,292	2,904,110	69	293
P16_P3009			1.45	1.09	2.54	10,787,673	2,704,888	69	273
P16_P4001			1.17	1.05	2.22	16,134,319	2,655,454	103	268
P16_P4002			1.19	1.08	2.28	14,910,241	3,025,360	95	306
P16_P4003			1.16	1.04	2.20	16,615,721	3,007,211	106	304
P16_P4006			1.18	1.06	2.23	15,696,647	2,888,419	100	292
P16_P4007			1.17	1.05	2.22	15,871,386	3,084,696	101	312
P16_P5000			1.33	1.16	2.49	10,922,494	2,608,744	70	274
P16_P5001			1.18	1.05	2.22	14,101,305	2,596,849	90	273
P16_P5002			1.18	1.05	2.23	13,969,217	2,589,963	89	273
P16_P5003			1.18	1.07	2.25	13,995,274	2,581,300	89	272
P16_P5004			1.17	1.03	2.20	14,520,976	2,959,877	93	311
P16_P5005			1.27	1.04	2.31	12,537,015	2,947,770	80	310
P16_P6003	72,178	78,415	1.26	0.87	2.14	12,453,307	2,647,559	79	279
P16_P6004	64,538	81,262	1.31	0.98	2.30	12,339,048	2,483,151	79	261
P16_P6005	66,359	80,769	1.31	0.98	2.30	12,212,956	2,607,227	78	274
P16_P7001	92,632	73,590	1.31	1.00	2.31	12,186,208	2,667,854	78	269
P16_P8002	91,261	74,468	1.35	1.00	2.34	11,593,404	2,854,661	74	288
P16_P8003	107,351	71,326	1.35	1.00	2.35	11,343,880	3,046,834	72	308
P16_P9001	107,243	72,700	1.35	1.01	2.35	11,269,399	2,791,294	72	282
P16_P9003	106,457	72,841	1.35	1.03	2.38	11,385,819	2,982,478	73	301
P16_P9010	63,620	82,142	1.37	1.01	2.38	10,742,640	2,832,005	68	286
P16_P9020	107,218	72,739	1.35	1.01	2.36	11,012,286	3,048,850	70	308
P16_P9030	107,187	78,013	1.35	1.01	2.36	11,050,734	2,952,002	70	298

TSA Scenario	Du A density Treatments - 20 year average (ha)			Tree Improvement Planting areas - 20 year average (ha)	
Number	Decid Priority	Conifer Priority	US Protect	SW (G)	PL (J)
P16_P3000	0	0	0	0	0
P16_P3001	845	25	105	135	9
P16_P3002	833	24	122	346	16
P16_P3003	760	37	107	201	12
P16_P3004	780	31	64	60	2
P16_P3006	0	42	0	69	8
P16_P3007	820	28	90	149	8
P16_P3008	802	22	115	252	16
P16_P3009	763	23	0	222	16
P16_P4001	0	41	0	257	28
P16_P4002	0	40	135	91	15
P16_P4003	122	44	0	80	5
P16_P4006	335	11	0	20	2
P16_P4007	350	10	0	19	6
P16_P5000	535	11	0	141	120
P16_P5001	481	7	0	98	104
P16_P5002	491	6	0	97	122
P16_P5003	446	4	0	294	179
P16_P5004	641	14	0	29	0
P16_P5005	480	11	0	176	94
P16_P6003	535	11	0	140	85
P16_P6004	490	13	0	153	186
P16_P6005	502	13	0	155	187
P16_P7001	648	10	0	140	190
P16_P8002	560	0	0	146	200
P16_P8003	670	22	0	137	205
P16_P9001	656	25	0	146	203
P16_P9003	654	25	0	193	207
P16_P9010	395	76	0	160	207
P16_P9020	660	25	0	162	207
P16_P9030	660	25	0	214	91

TSA Scenario	Caribou Zone and APMA - D, DC and CD less than 30 years old in patches less than 300 ha (ha)					(%)				
Number	Year 0	10 years	50 years	100 years	200 years	Year 0	10 years	50 years	100 years	200 years
P16_P3000	3,899	1,948	0	0	8,263	100	100	0	0	93
P16_P3001	3,937	4,766	13,461	21,327	9,484	100	78	67	85	64
P16_P3002	3,937	4,814	10,886	18,149	6,291	100	74	58	75	49
P16_P3003	4,304	3,815	11,924	19,090	9,265	93	79	59	79	63
P16_P3004	3,937	5,512	15,409	21,715	15,532	100	87	71	87	80
P16_P3006	3,937	4,953	10,236	20,351	13,295	100	92	66	85	75
P16_P3007	3,937	3,982	10,366	20,084	8,558	100	86	61	81	64
P16_P3008	3,937	3,517	10,778	18,775	6,234	100	81	56	77	50
P16_P3009	3,937	5,430	9,368	15,313	7,285	100	86	51	65	51
P16_P4001	3,937	4,479	7,305	16,226	7,125	100	91	53	74	58
P16_P4002	3,937	5,055	11,153	19,514	13,581	100	92	67	82	67
P16_P4003	3,936	4,379	10,944	22,596	15,309	100	86	66	91	77
P16_P4006	4,100	3,887	7,062	12,046	9,997	100	83	52	67	63
P16_P4007	4,100	3,499	8,047	14,060	13,210	100	76	56	63	67
P16_P5000	4,100	5,067	10,621	14,773	9,533	100	86	55	66	53
P16_P5001	4,100	4,149	7,579	9,882	8,472	100	87	46	55	49
P16_P5002	4,100	4,117	7,717	9,692	8,508	100	86	47	54	49
P16_P5003	4,100	4,460	7,715	9,941	9,625	100	88	46	56	55
P16_P5004	4,101	5,577	11,109	12,911	11,337	100	83	64	64	70
P16_P5005	4,100	5,256	9,955	14,968	10,005	100	94	59	66	64
P16_P6003	4,100	4,904	8,172	12,587	9,108	100	100	61	60	55
P16_P6004	4,100	4,951	9,536	13,230	10,188	100	94	63	67	61
P16_P6005	4,100	5,225	11,581	16,730	11,716	100	100	71	76	69
P16_P7001	4,100	4,988	8,758	13,452	9,469	100	94	55	67	62
P16_P8002	4,077	3,911	16,863	18,539	14,311	100	100	82	79	76
P16_P8003	4,100	4,274	18,101	21,502	17,956	100	100	88	88	86
P16_P9001	4,100	4,106	12,849	18,087	12,372	100	100	71	75	71
P16_P9003	4,100	4,180	15,046	17,605	12,279	100	100	75	74	72
P16_P9010	4,100	4,333	13,555	18,142	12,723	100	100	73	74	71
P16_P9020	4,100	4,138	17,409	24,382	18,233	100	100	87	90	92
P16_P9030	4,100	4,419	14,783	18,088	13,822	100	100	76	73	73

TSA Scenario	Active Landbase (ha)	Active Landbase Old (%)					Active Landbase Old plus Mature (ha)				
Number	295,291	Year 0	10 years	50 years	100 years	200 years	Year 0	10 years	50 years	100 years	200 years
P16_P3000		14%	23%	74%	97%	75%	55%	78%	96%	99%	75%
P16_P3001		14%	17%	36%	15%	16%	54%	68%	52%	33%	38%
P16_P3002		14%	17%	35%	15%	17%	54%	68%	52%	33%	38%
P16_P3003		13%	17%	36%	15%	15%	53%	68%	52%	33%	38%
P16_P3004		14%	17%	36%	15%	14%	54%	69%	52%	33%	37%
P16_P3006		14%	18%	46%	27%	25%	54%	70%	61%	40%	42%
P16_P3007		14%	17%	39%	19%	18%	54%	69%	55%	35%	41%
P16_P3008		14%	17%	36%	15%	16%	54%	68%	52%	33%	38%
P16_P3009		14%	17%	36%	15%	16%	54%	68%	52%	34%	38%
P16_P4001		14%	18%	46%	28%	27%	54%	70%	61%	41%	43%
P16_P4002		14%	18%	44%	26%	25%	54%	70%	60%	39%	40%
P16_P4003		14%	18%	47%	28%	24%	54%	70%	61%	41%	43%
P16_P4006		14%	18%	43%	28%	27%	54%	70%	60%	43%	45%
P16_P4007		14%	19%	44%	27%	26%	54%	70%	60%	44%	46%
P16_P5000		14%	17%	39%	20%	17%	54%	69%	54%	37%	38%
P16_P5001		14%	18%	42%	27%	25%	54%	70%	59%	43%	43%
P16_P5002		14%	18%	42%	27%	25%	54%	70%	58%	43%	43%
P16_P5003		14%	18%	43%	28%	25%	54%	70%	59%	43%	43%
P16_P5004		14%	17%	42%	27%	25%	54%	69%	58%	43%	45%
P16_P5005		14%	17%	41%	23%	22%	54%	69%	57%	40%	41%
P16_P6003		14%	18%	42%	25%	23%	54%	70%	58%	42%	42%
P16_P6004		14%	18%	41%	23%	21%	54%	69%	56%	40%	41%
P16_P6005		14%	18%	40%	22%	20%	54%	69%	56%	39%	41%
P16_P7001		14%	17%	40%	23%	21%	54%	69%	56%	40%	41%
P16_P8002		14%	17%	38%	20%	18%	54%	69%	54%	37%	40%
P16_P8003		14%	17%	39%	19%	16%	54%	69%	54%	37%	38%
P16_P9001		14%	17%	40%	20%	19%	54%	69%	55%	37%	40%
P16_P9003		14%	17%	40%	20%	19%	54%	69%	55%	37%	40%
P16_P9010		14%	18%	41%	20%	17%	54%	69%	55%	36%	38%
P16_P9020		14%	17%	40%	19%	17%	54%	69%	55%	36%	39%
P16_P9030		14%	17%	40%	19%	18%	54%	69%	55%	36%	39%

TSA Scenario	Active Landbase Regen (ha)					Gross Landbase (ha)	Gross Landbase Old (ha)				
Number	Year 0	10 years	50 years	100 years	200 years	595,677	Year 0	10 years	50 years	100 years	200 years
P16_P3000	3%	2%	0%	0%	12%		8%	12%	46%	74%	67%
P16_P3001	3%	12%	14%	14%	15%		7%	10%	27%	34%	38%
P16_P3002	3%	12%	13%	14%	15%		7%	9%	27%	34%	38%
P16_P3003	4%	12%	13%	14%	15%		7%	10%	27%	34%	38%
P16_P3004	3%	11%	14%	14%	14%		7%	10%	27%	34%	37%
P16_P3006	3%	10%	11%	12%	15%		7%	10%	32%	40%	43%
P16_P3007	3%	11%	13%	14%	14%		7%	10%	28%	36%	39%
P16_P3008	3%	12%	14%	14%	15%		7%	10%	27%	34%	38%
P16_P3009	3%	11%	13%	13%	16%		7%	10%	27%	34%	38%
P16_P4001	3%	10%	11%	12%	16%		7%	10%	32%	40%	44%
P16_P4002	3%	10%	12%	13%	15%		7%	10%	31%	39%	42%
P16_P4003	3%	10%	11%	12%	14%		7%	10%	32%	40%	42%
P16_P4006	3%	10%	12%	11%	13%		7%	10%	30%	40%	43%
P16_P4007	3%	10%	11%	11%	12%		7%	10%	31%	40%	43%
P16_P5000	3%	11%	13%	12%	16%		7%	10%	28%	36%	39%
P16_P5001	3%	10%	11%	11%	15%		7%	10%	30%	40%	42%
P16_P5002	3%	10%	11%	11%	15%		7%	10%	30%	40%	42%
P16_P5003	3%	10%	12%	11%	15%		7%	10%	30%	40%	42%
P16_P5004	3%	11%	12%	11%	14%		7%	10%	30%	40%	42%
P16_P5005	3%	11%	12%	12%	14%		7%	10%	29%	38%	41%
P16_P6003	3%	10%	12%	11%	14%		7%	10%	30%	39%	41%
P16_P6004	3%	10%	12%	12%	15%		7%	10%	29%	38%	40%
P16_P6005	3%	10%	12%	12%	15%		7%	10%	29%	37%	40%
P16_P7001	3%	10%	12%	12%	15%		7%	10%	29%	38%	41%
P16_P8002	3%	11%	13%	13%	15%		7%	10%	28%	36%	39%
P16_P8003	3%	11%	13%	14%	16%		7%	10%	28%	36%	38%
P16_P9001	4%	11%	12%	13%	16%		7%	10%	29%	36%	39%
P16_P9003	4%	11%	12%	13%	16%		7%	10%	29%	36%	39%
P16_P9010	4%	10%	13%	13%	16%		7%	10%	29%	36%	39%
P16_P9020	4%	11%	13%	14%	16%		7%	10%	29%	36%	39%
P16_P9030	4%	11%	13%	14%	16%		7%	10%	29%	36%	39%

TSA Scenario	Gross Landbase Old plus Mature (ha)					Gross Landbase Regen (ha)				
Number	Year 0	10 years	50 years	100 years	200 years	Year 0	10 years	50 years	100 years	200 years
P16_P3000	36%	52%	80%	86%	67%	2%	1%	0%	0%	10%
P16_P3001	36%	47%	58%	53%	49%	3%	6%	7%	7%	11%
P16_P3002	36%	47%	58%	53%	49%	3%	6%	7%	7%	12%
P16_P3003	35%	47%	58%	53%	49%	3%	6%	7%	7%	11%
P16_P3004	36%	48%	58%	53%	49%	3%	6%	7%	7%	11%
P16_P3006	36%	48%	63%	56%	51%	3%	5%	6%	6%	11%
P16_P3007	36%	48%	60%	54%	50%	3%	5%	6%	7%	11%
P16_P3008	36%	47%	58%	52%	49%	3%	6%	7%	7%	11%
P16_P3009	36%	47%	58%	53%	49%	3%	6%	7%	7%	12%
P16_P4001	36%	48%	63%	57%	51%	3%	5%	6%	6%	12%
P16_P4002	36%	48%	62%	55%	50%	3%	5%	6%	6%	11%
P16_P4003	36%	48%	63%	56%	52%	3%	5%	6%	6%	11%
P16_P4006	36%	48%	62%	58%	52%	3%	5%	6%	5%	11%
P16_P4007	36%	48%	62%	58%	53%	3%	5%	6%	6%	10%
P16_P5000	36%	48%	59%	55%	49%	3%	6%	6%	6%	12%
P16_P5001	36%	48%	62%	58%	51%	3%	5%	6%	5%	11%
P16_P5002	36%	48%	61%	58%	51%	3%	5%	6%	5%	11%
P16_P5003	36%	48%	62%	58%	51%	3%	5%	6%	5%	11%
P16_P5004	36%	48%	61%	58%	52%	3%	5%	6%	5%	11%
P16_P5005	36%	48%	61%	56%	50%	3%	5%	6%	6%	11%
P16_P6003	36%	48%	61%	57%	51%	3%	5%	6%	6%	11%
P16_P6004	36%	48%	60%	56%	50%	3%	5%	6%	6%	11%
P16_P6005	36%	48%	60%	56%	50%	3%	5%	6%	6%	11%
P16_P7001	36%	48%	60%	56%	51%	3%	5%	6%	6%	11%
P16_P8002	36%	48%	59%	55%	50%	3%	5%	6%	6%	11%
P16_P8003	36%	48%	59%	55%	49%	3%	5%	7%	7%	12%
P16_P9001	36%	47%	60%	55%	50%	3%	6%	6%	7%	12%
P16_P9003	36%	47%	60%	55%	50%	3%	6%	6%	6%	12%
P16_P9010	36%	48%	60%	54%	49%	3%	5%	6%	7%	12%
P16_P9020	36%	47%	60%	54%	49%	3%	6%	6%	7%	12%
P16_P9030	36%	47%	60%	54%	49%	3%	6%	6%	7%	12%

TSA Scenario	Active Landbase greater than 120 years old (ha)			Gross Landbase greater than 120 years old (ha)			Gross Landbase greater than 120 years old and in patches > 120 ha (ha)		
Number	Year 0	10 years	50 years	Year 0	10 years	50 years	Year 0	10 years	50 years
P16_P3000	37,639	74,407	191,764	53,091	113,800	320,652	27,334	80,248	292,042
P16_P3001	35,819	57,422	81,384	51,271	96,816	210,272	25,278	61,833	167,886
P16_P3002	35,819	57,198	81,499	51,271	96,591	210,387	25,278	61,714	167,874
P16_P3003	35,051	56,421	81,615	50,503	95,815	210,504	24,123	59,875	167,700
P16_P3004	35,819	56,072	83,170	51,271	95,466	212,059	25,278	58,351	169,016
P16_P3006	35,819	58,508	106,532	51,271	97,902	235,420	25,278	62,804	195,201
P16_P3007	35,819	57,477	87,659	51,271	96,870	216,547	25,278	61,386	175,578
P16_P3008	35,819	56,959	81,556	51,271	96,353	210,444	25,278	61,079	167,680
P16_P3009	35,819	55,918	82,095	51,271	95,311	210,983	25,278	59,268	167,910
P16_P4001	35,819	58,432	106,137	51,271	97,826	235,025	25,278	62,620	194,752
P16_P4002	35,819	58,053	105,679	51,271	97,447	234,567	25,278	62,562	194,411
P16_P4003	35,839	58,832	107,775	51,291	98,226	236,663	25,278	63,020	196,695
P16_P4006	35,839	58,727	101,249	51,291	98,120	230,137	25,278	61,944	189,501
P16_P4007	35,839	58,950	100,317	51,291	98,344	229,205	25,278	62,600	188,306
P16_P5000	35,839	56,389	88,490	51,291	95,783	217,378	25,278	59,828	174,868
P16_P5001	35,839	58,053	99,136	51,291	97,446	228,025	25,278	61,860	185,410
P16_P5002	35,839	58,065	98,713	51,291	97,458	227,602	25,278	62,324	185,457
P16_P5003	35,839	58,129	100,621	51,291	97,523	229,510	25,278	62,504	186,873
P16_P5004	35,819	57,693	98,485	51,271	97,086	227,373	25,278	61,629	185,340
P16_P5005	35,839	56,736	93,947	51,291	96,130	222,836	25,278	58,356	180,771
P16_P6003	35,839	57,571	95,858	51,291	96,965	224,746	25,278	61,745	184,879
P16_P6004	35,839	56,251	91,052	51,291	95,645	219,940	25,278	59,480	178,018
P16_P6005	35,839	56,276	91,012	51,291	95,670	219,901	25,278	59,549	177,751
P16_P7001	35,839	56,607	90,581	51,291	96,001	219,470	25,278	59,172	177,845
P16_P8002	35,912	56,269	87,048	51,364	95,663	215,937	25,379	59,867	172,659
P16_P8003	35,841	55,896	88,041	51,293	95,289	216,930	25,282	59,511	173,096
P16_P9001	35,333	55,488	88,555	50,786	94,881	217,443	24,593	58,957	174,131
P16_P9003	35,316	55,171	89,227	50,768	94,564	218,115	24,593	58,320	175,308
P16_P9010	35,333	55,543	90,232	50,786	94,937	219,121	24,593	58,877	177,099
P16_P9020	35,333	55,317	88,366	50,786	94,710	217,255	24,593	58,842	174,428
P16_P9030	35,333	55,390	88,145	50,786	94,784	217,033	24,593	57,833	173,708

TSA Scenario	Disturbance patches 20 year average (Active landbase less than 20 years old) (ha)				Firesmart Gross landbase in any 'c' classification (ha)		
Number	0-7 ha	8-60 ha	60-200 ha	200+ ha	Year 0	10 years	50 years
P16_P3000	411	3,239	1,370	284	188,998	229,643	253,511
P16_P3001	1,293	6,608	29,962	3,400	187,924	220,926	238,944
P16_P3002	1,220	6,570	29,732	4,044	187,924	221,569	235,422
P16_P3003	1,234	5,755	29,937	4,388	187,381	219,950	237,685
P16_P3004	1,356	6,759	27,555	3,952	187,924	220,073	239,331
P16_P3006	1,400	6,858	21,739	3,128	187,924	220,074	235,477
P16_P3007	1,311	6,220	26,929	2,794	187,924	220,762	238,737
P16_P3008	1,425	6,216	29,133	3,545	187,924	220,703	237,474
P16_P3009	1,299	6,106	28,319	5,058	187,924	219,221	233,705
P16_P4001	1,269	6,204	22,694	3,013	187,924	219,816	230,832
P16_P4002	1,486	7,217	22,023	2,848	187,924	221,032	238,629
P16_P4003	1,389	7,301	21,636	3,124	187,941	220,150	235,697
P16_P4006	1,136	5,687	23,451	3,394	187,941	220,451	240,251
P16_P4007	1,237	5,367	24,228	3,549	187,941	219,198	239,349
P16_P5000	1,481	6,050	26,720	4,801	246,022	240,305	236,690
P16_P5001	1,275	6,500	22,634	5,080	246,022	241,005	238,846
P16_P5002	1,283	6,276	23,020	5,203	246,022	240,921	238,535
P16_P5003	1,211	7,110	21,614	5,265	246,022	240,741	233,316
P16_P5004	1,132	6,142	23,744	5,650	246,005	243,322	242,633
P16_P5005	1,362	6,308	25,423	4,210	246,022	241,945	234,694
P16_P6003	1,400	7,092	22,120	5,469	246,022	240,654	237,460
P16_P6004	1,438	6,851	23,771	5,192	245,953	239,484	233,114
P16_P6005	1,429	6,785	23,970	5,128	245,953	239,471	233,837
P16_P7001	1,687	8,326	22,426	5,162	245,953	239,913	233,126
P16_P8002	1,841	10,019	19,767	6,679	245,953	239,565	233,769
P16_P8003	1,743	9,881	18,457	9,149	245,953	239,889	233,706
P16_P9001	1,634	9,434	19,172	9,582	245,531	239,363	233,107
P16_P9003	1,670	9,358	18,904	10,105	245,485	239,309	233,758
P16_P9010	1,588	7,548	22,511	6,083	245,531	238,814	232,966
P16_P9020	1,612	9,082	18,382	10,804	245,531	239,260	233,105
P16_P9030	1,293	7,276	22,106	9,465	245,531	240,034	234,881

TSA Scenario	Firesmart Gross landbase in any 'c' classification - Patches > 1000ha (%)			Firesmart Active landbase in any 'c' classification (ha)		
Number	Year 0	10 years	50 years	Year 0	10 years	50 years
P16_P3000	43	53	60			
P16_P3001	43	49	53			
P16_P3002	43	49	51			
P16_P3003	42	48	51			
P16_P3004	43	48	54			
P16_P3006	43	49	53			
P16_P3007	43	49	54			
P16_P3008	43	48	52			
P16_P3009	43	48	49			
P16_P4001	43	49	48	76,825	70,913	61,493
P16_P4002	43	49	51	76,825	72,128	69,290
P16_P4003	43	50	52	76,841	71,247	66,358
P16_P4006	43	48	52	76,841	71,548	70,913
P16_P4007	43	48	53	76,841	70,294	70,010
P16_P5000	58	55	51			
P16_P5001	58	55	51			
P16_P5002	58	55	50			
P16_P5003	58	55	49	81,301	72,390	63,863
P16_P5004	58	57	55	81,284	74,972	73,180
P16_P5005	58	56	49	81,301	73,595	65,242
P16_P6003	58	54	53	81,435	72,427	68,089
P16_P6004	58	53	52	81,367	71,257	63,708
P16_P6005	58	53	52	81,367	71,245	64,480
P16_P7001	58	54	52	81,367	71,686	63,716
P16_P8002	58	55	52	81,368	71,340	64,419
P16_P8003	58	54	53	81,368	71,664	64,392
P16_P9001	58	55	54	80,810	71,012	63,654
P16_P9003	58	55	55	80,765	70,958	64,305
P16_P9010	58	55	54	80,810	70,464	63,513
P16_P9020	58	55	54	80,810	70,910	63,652
P16_P9030	58	56	54	80,810	71,683	65,428

Appendix III Watershed Analysis Report

The Forestry Corp. Project Number: P445
For additional information, please contact:
The Forestry Corp.
Suite 101, 11710 Kingsway Avenue
Edmonton, AB
T5G 0X5
(780) 452-5878
www.forcorp.com

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