TIMBER SUPPLY ANALYSIS REPORT

OKANAGAN TREE FARM LICENCE (TFL 49)
MANAGEMENT PLAN NO. 4

Version 3

Prepared for:

Riverside Forest Products Limited

Kelowna, B.C.

Prepared by:

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Reference: 4041006

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Attention: Robert Kennett, RPF
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Reference: *TFL 49 MP No. 4 Timber Supply Analysis Report*

Enclosed please find the *Timber Supply Analysis Report* in support of the Management Plan No. 4 for Riverside's TFL 49. The document has been placed on the Management Plan No. 4 website for viewing by interested parties. A paper copy has been forwarded to MoF Timber Supply Branch in Victoria.

Please call if you have any questions or comments related to the document or any other aspect of the analysis. Thank you for your input during the preparation of the *Analysis Report*.

Yours truly,
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DOCUMENT HISTORY

Revision Number	Description	Submittion Date	Submitted By
1	Initial submission to MoF	August 2004	Bill Kuzmuk
2	Additional MPB uplift scenarios	September 2004	Bill Kuzmuk
3	Final submission to MP No. 4	September 2004	Bill Kuzmuk

EXECUTIVE SUMMARY

The supply of timber on Riverside Forest Products Limited's (Riverside) Okanagan Tree Farm Licence (TFL 49) has been reviewed as part of the Management Plan No. 4 (MP No. 4) process. The analysis evaluates how current management affects the supply of timber available for harvesting over the next 250 years. It also attempts to quantify the sensitivity of the results to uncertainties about forest growth and management activities. This analysis provides the technical basis for the provincial Chief Forester to determine an allowable annual cut for TFL 49 over the next five years.

All of the information and assumptions used in the TFL 49 MP No. 4 timber supply analysis are current with respect to Forest Practices Code and new Okanagan-Shuswap Land and Resource Management Plan guidelines, although changes to both of these may occur in the future. Two primary analysis options were completed:

- Base Case; and
- Mountain Pine Beetle (MPB).

The Base Case indicates that a harvest rate of 385,900 m^3/year, 1.5% higher than the current AAC, is sustainable for the next 70 years. After that time a significant increase of 27% to 488,600 m^3/year is possible for the duration of the 250-year planning horizon.

The main factors which contribute to the improved Base Case harvest level include:

1. Mature volume adjustments. The initial mature volume is increased by 9.3% with improvements to the mature natural stand yields as documented in *Vegetation Resources Inventory Phase 2 Adjustment Procedure* (Timberline, 2002) .
2. Site index adjustments for managed stands. Recent work has provided improved site index estimates for managed stands. The findings of this study, outlined in *Site Index Correlated to Ecosystems – TFL 49* (Timberline, 2002b) allowed an average increase of four metres (26%) in site index.
3. Genetic gains for managed stands. Long-term genetic gains for each planted species were included in the future managed stand yield tables. These gains range from 12 to 26%, with an average of approximately 16% compared to planting stock without any improvements (Timberline, 2003).
4. Twenty cm stump height. An increase of 1.9% was applied to all yield tables to reflect harvesting down to a 20cm stump height.
5. Old forest requirements. The Okanagan-Shuswap Land and Resource Management Plan assigns specific area retention targets for old forest within each landscape unit-biogeoclimatic ecological classification variant. These are further split into timber harvesting and non-timber harvest land base components. Within the timber harvesting land base the average old forest requirement is only 1.9%, considerably less than the requirement modelled in MP No. 3.

The results of the timber supply analysis indicate that the primary factors affecting the timber supply for the next 70 years are:

- Lack of stands currently 40 to 60 years of age; and
- Timing of availability of existing managed stands 50 to 80 years into the future.

Given this age class gap, the transition to second growth is a critical element for estimating timber supply. This is clearly demonstrated by changes to minimum harvest age and managed volume. If managed stands become available sooner than indicated for the Base Case, there is a considerable improvement to the harvest over the next 70 years. Conversely, any additional delay can have a negative affect on the harvest during this time period.

It is therefore important to have managed stands available as modelled, 50 to 70 years into the future. 95% of culmination of mean annual increment was used as the basis for minimum harvest age and there is the possibility of reducing this age for some forest types to enhance the short-term supply without compromising the long-term harvest.

Figure E.1 summarizes the annual harvest and growing stock levels for the MP No.4 Base Case.

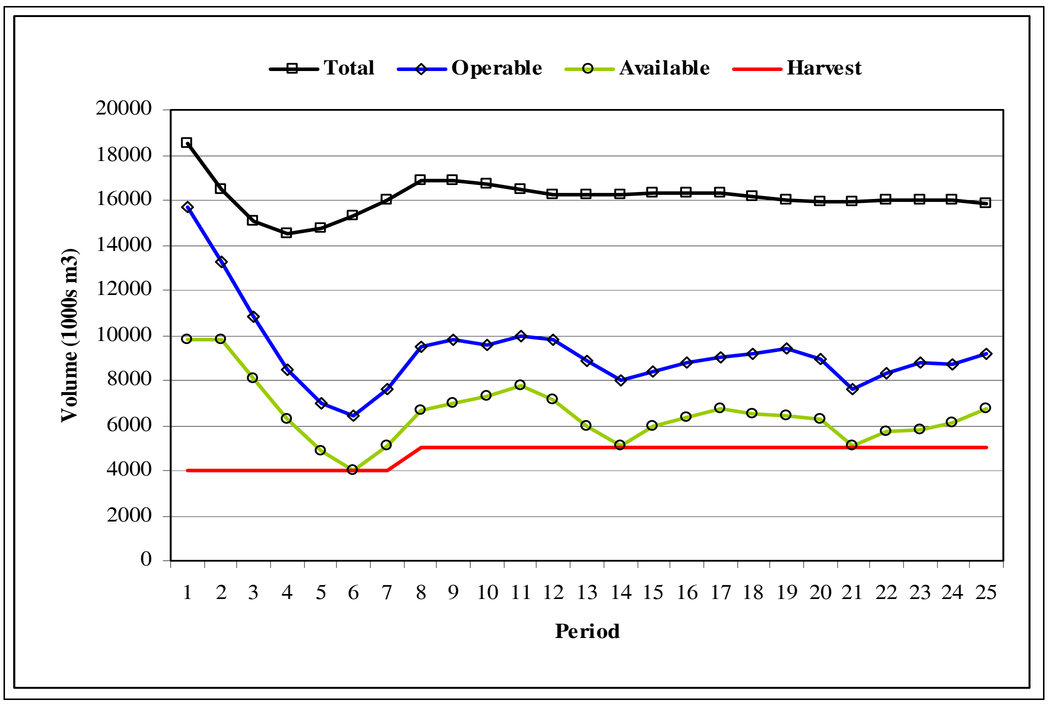

Figure E.1 – Base Case annual harvest and growing stock

Increases to managed stand volumes (MSYT) improve the short-term harvest by less than 2%. However, the transition to the long-term level begins 10 years earlier, and the long-term harvest level is 9% higher than in the Base Case. Conversely reducing managed stand volumes forces the harvest downward by 5% during the critical phase 50 to 70 years into the future. Managed stand volumes are based on recent ecologically-based site index values, updated genetic gains information, and new silviculture regimes. This information is based upon recent studies for TFL 49, which improves the reliability of the results.

Adjusting natural stand yields (NSYT) has a considerable impact on the short-term harvest rate. The new phase 2 adjustment process recently completed for TFL 49 provided volume adjustments for the Base Case natural stand yields. The natural stand volume inputs are the most reliable used for a timber supply analysis on the TFL to date.

Figure E.2 compares the annual harvest rate for the Base Case with the volume adjustment sensitivity analyses.

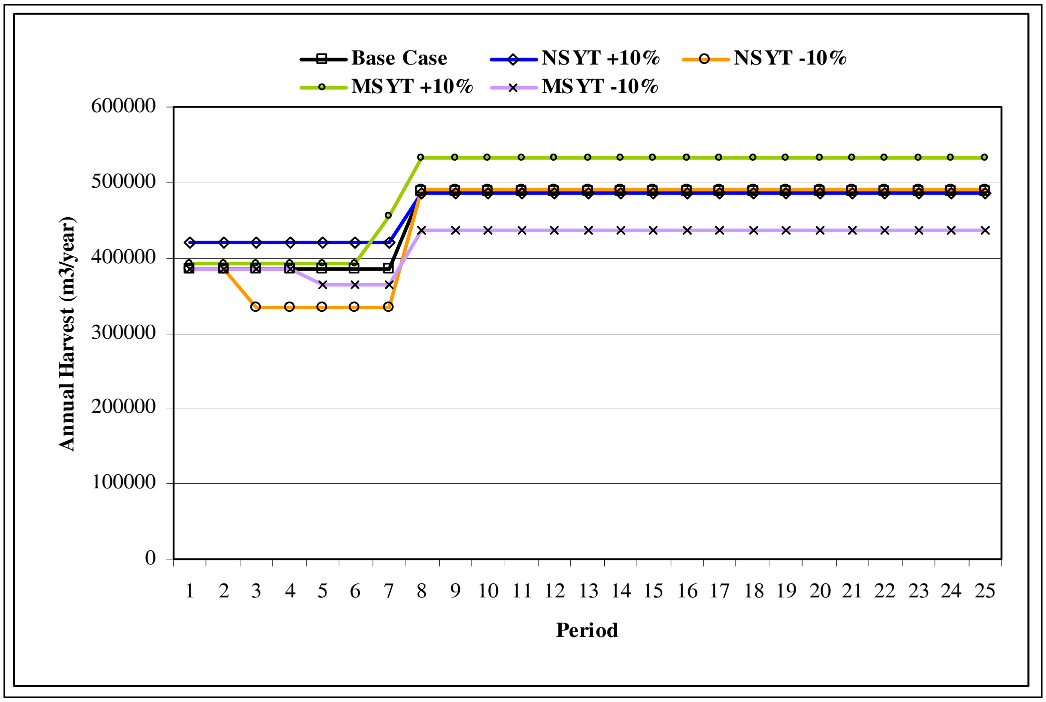

Figure E.2 – Base Case yield table sensitivity annual harvest

Regeneration delay has a similar impact to changing managed stand yield minimum harvest age. Increasing regeneration delay by five years reduces the mid-term harvest by up to 6% and the long-term harvest by 8%. Small increases in harvest are achieved by removing any regeneration delay. In general it will be important to maintain regeneration delay at or lower than the current level to ensure the mid-term harvest is sustainable and provide flexibility in harvesting opportunities 50 to 70 years into the future.

Many visually sensitive areas, lakeshore management, and mule deer winter range resource emphasis areas reach the limit of disturbance during many periods of the simulation. Similarly, the community watersheds, of which Lambly Creek is the largest, influence the harvest during the critical period 70 years from now. Therefore adjustments to the maximum disturbance for these non-timber resource types influence the harvest during the mid-term. Short and long-term harvest rates are not affected by adjustments to these disturbance constraints.

Similarly, increasing green-up height by one metre reduces the mid-term harvest by 3%, but the short and long-term harvest is unaffected by this variation to the modelling inputs. Reducing green-up height by one metre allows a minor 1% increase in the early harvest rate but has no impact on the long-term level. Changes to the disturbance limit in integrated resource management resource emphasis areas have no impact on the harvest level at any timber during the 250-year planning horizon. Figure E.3 compares the annual harvest rate for the Base Case with the disturbance sensitivity analyses.

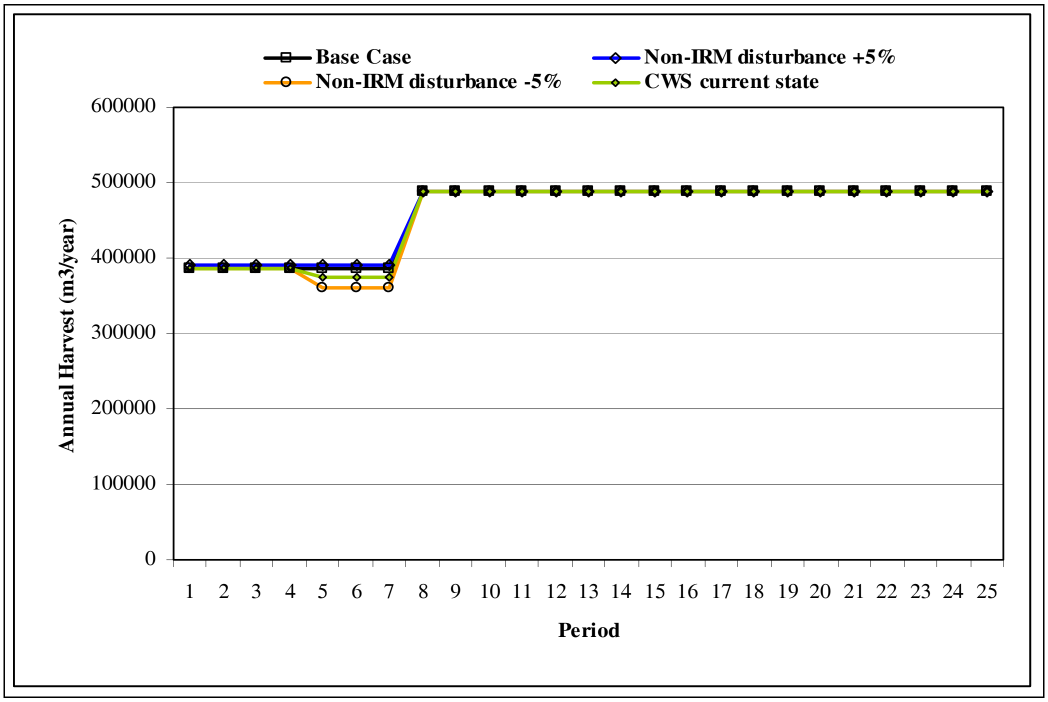

Figure E.3 – Base Case disturbance sensitivity annual harvest

Additional old forest retention requirements for wildlife habitat reduces mid-term harvest levels by 4%, but there is no affect on the short and long-term. Relaxing old forest requirements changes the harvest level by less than 1% over the planning horizon.

Modification to the THLB also affects timber supply in both the short and long term. Increasing or decreasing the harvestable land base makes a proportional change to the annual harvest rate throughout the planning horizon. It is possible to drop the harvest in selected periods over the first seven decades to account for the loss of THLB, thereby allowing the short-term harvest to be maintained for up to 30 years.

The sensitivity analyses indicate the growth and yield inputs, stand volume, and minimum harvest age, are more important in estimating the timber supply on TFL 49 than assumptions related to non-timber resources.

The most important issue facing the TFL 49 land base is the current mountain pine beetle epidemic. Many lodgepole pine stands have been attacked and there is a significant area of high-risk stands that are susceptible to attack over the next few years. A number of analysis scenarios reviewed the impact of directing the harvest over the first five to ten years of simulation into high-risk pine stands.

It is possible to direct the entire harvest into vulnerable pine stands during the first decade without impacting the harvest schedule or non-timber resources for the remainder of the planning horizon. Uplift scenarios were modelled that added up to 1,000,000 m^3 of high-risk pine volume to the harvest during the initial 10 years of simulation (200,000 m^3/year uplift for five years). There was a minor impact, approximately 5% on the mid-term harvest with this uplift scenario. In all

MPB scenarios the full compliment of Base Case management assumptions for non-timber resources were enforced. This indicates that uplift is possible without having any measurable influence on the harvest, or placing additional impact on non-timber interests, for the remainder of the planning horizon. Table E.1 summarizes the results of the key Base Case and Mountain Pine Beetle options completed for Riverside's MP No. 4 timber supply analysis for TFL 49.

Table E.1 – TFL 49 MP No. 4 timber supply analysis results

Period	Base Case	Maximum 10-Year MPB Harvest	Uplift 50,000 m^3/yr for 5 years	Uplift 100,000 m^3/yr for 5 years	Uplift 200,000 m^3/yr for 5 years
1 (year 1 – 5)	385,900	385,900[1]	435,900[1]	485,900[1]	585,900[1]
1 (year 6 – 10)	385,900	385,900[1]	385,900	385,900	385,900
2	385,900	380,100	382,400	379,000	365,000
3	385,900	380,100	382,400	379,000	365,000
4	385,900	380,100	382,400	379,000	365,000
5	385,900	380,100	382,400	379,000	365,000
6	385,900	380,100	382,400	379,000	365,000
7	385,900	380,100	382,400	379,000	365,000
8 - 25	488,600	488,900	488,900	488,900	488,900

[1] Harvest volume is entirely high risk lodgepole pine stands.

Figure E.4 compares the annual harvest rate for the Base Case with the mountain pine beetle uplift scenarios.

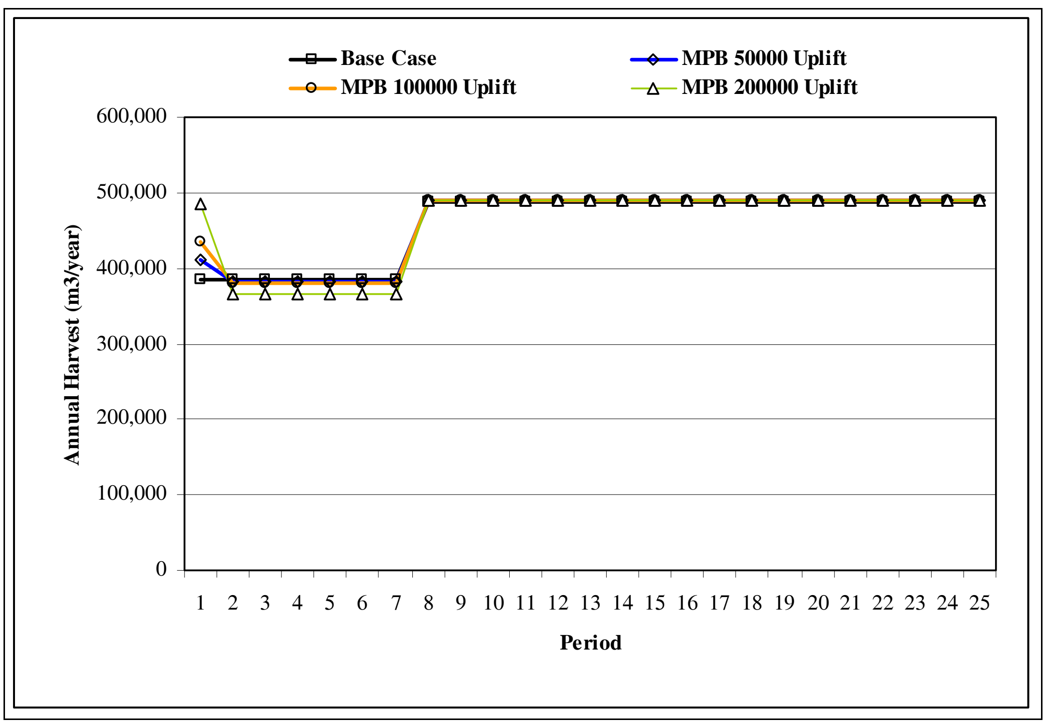

Figure E.4 – Base Case & mountain pine beetle uplift annual harvest

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1.0 INTRODUCTION

A timber supply analysis for the Okanagan Tree Farm Licence (TFL 49) has been completed on behalf of Riverside Forest Products Limited of Kelowna (Riverside) as part of the Management Plan No. 4 (MP No. 4) submission. The analysis has considered current management requirements, and guidelines associated with the Forest Practices Code (FPC), Forest and Range Practices Act (FRPA), and the Okanagan-Shuswap Land and Resource Management Plan (OS-LRMP; B.C. MSRM 2001).

Timber supply is the rate of timber availability for harvest over time. The methodology includes use of a forest-level simulation model, which predicts the development of a forest over a 250-year planning horizon. The model uses a description of initial forest conditions, expected patterns of growth, and a set of rules related to harvesting and regenerating the forest. In addition, management assumptions related to non-timber forest resources are included in the analysis process.

The Chief Forester of British Columbia uses results of the timber supply analysis in determining the allowable annual cut (AAC) for the management unit. However, because of the dynamic nature of forest inventories, and uncertainty surrounding both the information used in analysis and future forest management objectives, these projections are not viewed as static or prescriptive. They remain relevant only as long as the information in them is current. TFL licensees are therefore required to re-evaluate timber supply every five years.

Two options were evaluated during the analysis:

- Base Case; and
- Mountain Pine Beetle (MPB).

For the Base Case and MPB options, a number of sensitivity analyses and alternative scenarios were completed. This provided further understanding of the impacts of changes in management and/or analysis inputs. The *Timber Supply Analysis Information Package Okanagan Tree Farm Licence (TFL 49) Management Plan No. 4 (Information Package)* (Timberline, 2004) provides complete descriptions of the inputs and assumptions used in each of the analysis options and sensitivity analyses. The *Information Package* is provided in Appendix I of this document.

The sensitivity analysis, which proposed to model the entire TFL as a single landscape unit, has not been completed, as this approach does not reflect a possible management approach.

Timber supply analysis involves three main steps:

- Collection and preparation of information and data. This information has been documented in the *Information Package,* which was accepted by MoF Forest Analysis Branch, August 18, 2004;
- Using the data in Timberline's CASH simulation model (version 6.2l) to develop harvest forecasts and complete sensitivity analyses; and
- Interpretation and reporting of results.

The following sections outline the TFL 49 MP No. 4 timber supply analysis.

2.0 DESCRIPTION OF LICENCE AREA

TFL 49 is located west of Okanagan Lake and covers approximately 144,000 ha (see Figure 2.1). The TFL was designated as a result of an amalgamation in 1984 of Tree Farm Licences No. 9 (Block A), No. 16 (Block B), and No. 32 (Block C). Management on this area-based licence has been conducted for over 50 years.

Block A is situated west of Okanagan Lake to the height of land between the Okanagan and Nicola drainages, and north of Lambly Creek, to the Naswhito Creek drainage. Block B adjoins the north west portion of Block A, runs west of Bouleau Lake, bounded on the south by the Salmon River drainage, to Salmon Lake, north to Monte Lake and west to the Monte Hills and Weyman Creek drainage. Block C is separate from the rest of the TFL. It is located north of Falkland and east of Pillar Lake towards the Salmon River.

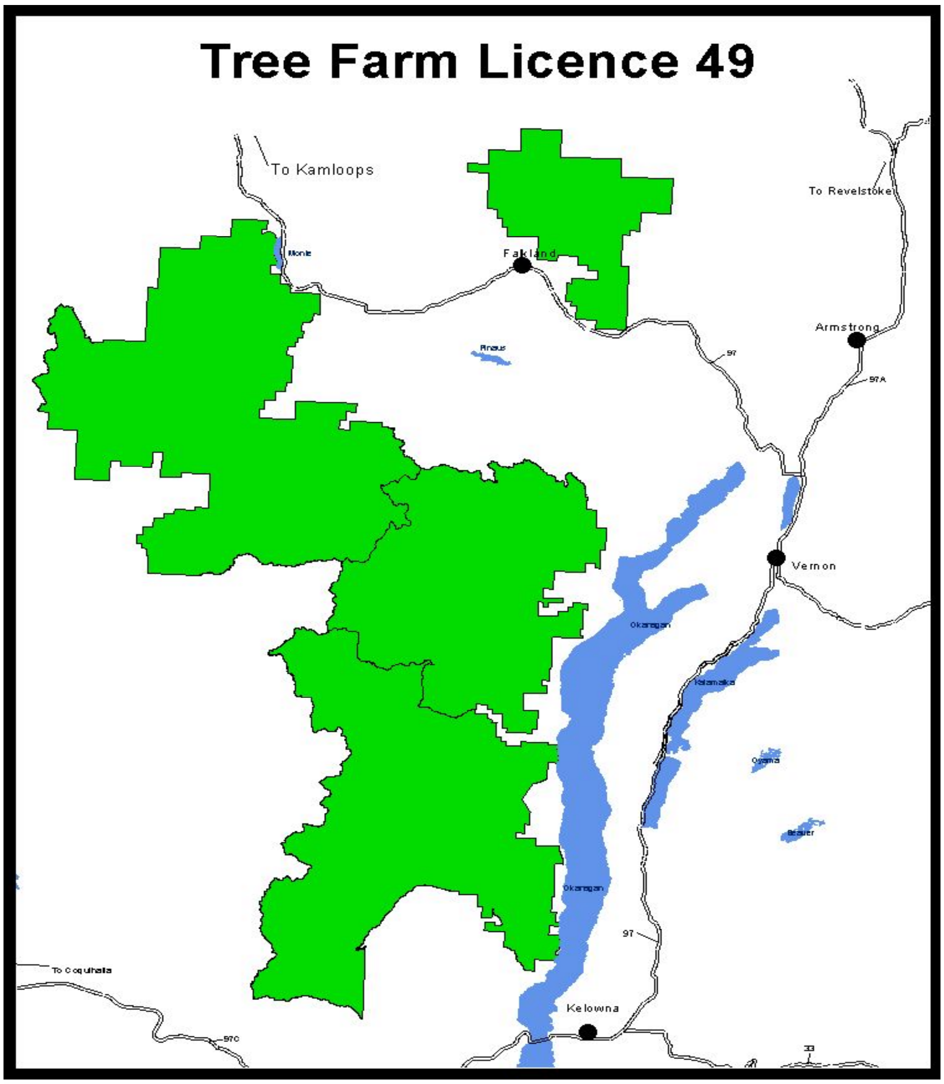

Figure 2.1 – TFL 49 location

3.0 INFORMATION PREPARATION

Many pieces of information are required to conduct a timber supply analysis. Each piece falls into one of three categories:

- Land base inventory;
- Timber growth and yield; or
- Management practices.

3.1 Land Base and Inventory

Land base inventory information used in this analysis comes from Riverside's digital map database, which is maintained to MoF standards. Forest cover updates, including stand volumes, and silviculture and disturbance are current to September 2003. A complete description of the data is summarized in the *Information Package*.

The digital database contains information for all land within TFL 49 including areas where harvesting operations are not likely to occur. The net timber harvesting land base (THLB) consists of all the productive forest within the TFL that is, or will be, available for timber management over the long term. Table 3.1 summarizes the netdowns for the Base Case land base.

Table 3.1 – Base Case timber harvesting land base determination

Description	Area (ha)			Net Merchantable Volume (000m^3)		
	Schedule A	Schedule B	Total	Schedule A	Schedule B	Total
Total Area	**794**	**143,551**	**144,345**	**92**	**22,095**	**22,187**
Goal 1 parks	0	2,951	2,951		282	282
Non-forest, non-productive	84	7,049	7,133			0
Existing roads & trails	13	1,765	1,778	1	123	124
Existing landings	0	48	48		6	6
Productive forested land base	**697**	**131,738**	**132,435**	**91**	**21,684**	**21,775**
Reductions to the productive forest:						
Non-commercial	0	75	75			0
Recreation reserves	0	306	306		65	65
Deciduous	25	1,170	1,195	1	23	24
Low volume	10	1,091	1,100	1	77	78
Low productivity	0	210	210		5	5
Overstocked pine	0	285	285		36	36
ESAs	4	1,706	1,710		301	301
Riparian reserves	44	3,072	3,116	11	701	712
Wildlife tree patches	0	670	670		165	165
Kelowna Dirt Bike Club	0	11	11		2	2
Current THLB	**614**	**123,142**	**123,757**	**78**	**20,309**	**20,387**
Less future roads	4	726	730			
Plus Kelowna Dirt Bike Club	0	11	11			
Long-term THLB	**610**	**122,427**	**123,038**			

Figure 3.1 provides a graphic description of the land base classification for the Base Case.

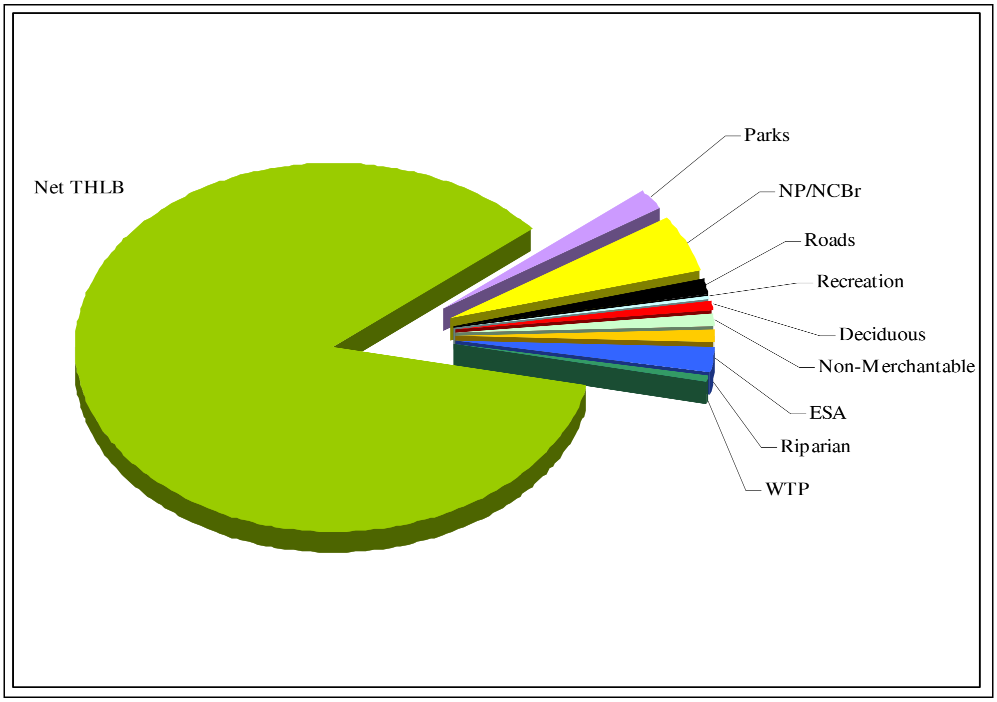

Figure 3.1 – Land base classification

Figure 3.2 summarizes the current age class distribution by leading species.

Figure 3.2 – THLB age class distribution by leading species

3.2 Timber Growth and Yield

Growth and yield in the analysis reflects the growth and development of individual stands of trees over time. Stands were grouped into analysis units, based on leading species, site productivity, biogeoclimatic ecological classification (BEC) site series, and management objectives. Yield tables were then developed for each analysis unit for input to CASH6.2.

The MoF model Batch VDYP version 6.6d was used for developing natural stand yield tables (NSYT), while Batch TIPSY version 2.1 was use for managed stand yield tables (MSYT).

Table 3.2 summarizes the theoretical long-term sustainable yield (LRSY) estimates for the yields used in the MP No. 4 analysis. The long-term THLB, 123,038 ha, is used for each of the estimates provided in Table 3.2.

Table 3.2 – Theoretical long-term harvest (LRSY) estimates

Description	Natural	Managed
= Long term THLB (ha)	123,038	123,038
* average MAI at culmination (m^3/ha)	1.92	4.68
= theoretical gross LRSY (m^3/yr)	237,613	578,682
- wildlife tree patch retention (m^3/yr)	14,851	34,652
- non-recoverable losses (m^3/yr)	15,600	15,600
= theoretical net LRSY (m^3/yr)	207,162	528,430

3.3 Management Practices

Timber supply is directly linked to forest management activities. Current practices are modelled by matching inputs to actual activity using the functionality in the timber supply model. Forest cover constraints were modelled for the following:

- Resource emphasis areas (REA) including visual quality, wildlife habitat, and community watersheds; and
- Landscape level biodiversity (seral or old forest constraints) based on the requirements outlined in the OS-LRMP for each landscape unit BEC variant in the THLB and non-THLB components of the TFL.

In order to model landscape level biodiversity objectives (seral or old forest constraints) the land base was assigned to units based on landscape unit, BEC (variant) and natural disturbance type using the provincial BEC mapping. OS-LRMP seral objectives are based on this classification, so it was necessary to use it for this component of the analysis. Riverside's predictive ecosystem mapping (PEM) was used for all other aspects of the analysis which referenced ecological classification.

A complete list of the REAs and landscape unit-BEC units modelled in the analysis are provided in the *Information Package*.

4.0 ANALYSIS METHODS

4.1 Model Description

Timberline's proprietary simulation model CASH6 (**C**ritical **A**nalysis by **S**imulation of **H**arvesting), Version 6.2l was used to develop harvest schedules for the TFL 49 MP No. 4 timber supply analysis.

This model uses an aspatial and spatial geographic approach to land base and inventory definition in order to adhere as closely as possible to the intent of forest cover requirements on harvesting. CASH6 can simulate the assignment of overlapping forest cover objectives on timber harvesting and resultant forest development. These objectives are addressed by placing restrictions on the age distribution, and defining maximum or minimum limits on the amount of area in young and old age classes found in specified areas. For the purposes of this analysis forest cover objectives fall into two categories:

1. Disturbance (green-up)

The disturbance objective is defined as the total area below a specified green-up height or age. The total disturbed area is to be maintained below a specified maximum percent. The effect is to ensure that at no time will harvesting cause the disturbed area to exceed this maximum percent. This category is typically used to model adjacency, visual quality, wildlife or hydrological green-up requirements in resource emphasis areas, and early seral stage requirements at the landscape unit level.

2. Retention (old growth)

The retention objective is defined as the total area above a specified age. This retention area is to be maintained above a specified minimum percent. The effect is to ensure that at no time will harvesting cause the retention area to drop below this minimum percent. This category is typically used to model thermal cover and/or old growth requirements in wildlife management resource emphasis areas, and mature and old growth seral stage requirements at the landscape unit level.

The model projects the development of a forest, allowing the analyst to impose different harvesting/silviculture strategies on its development, in order to determine the impact of each strategy on long-term resource management objectives. All harvest schedules developed in the analysis incorporate all integrated resource management considerations.

In these analyses, timber availability is forecast in decadal time steps (periods). The main output from each analysis is a projection of the amount of future growing stock, given a set of growth and yield assumptions, and planned levels of harvest and silviculture activities. Growing stock is categorized into the following classes:

- Total – the total inventory on the THLB regardless of age;
- Operable – the inventory on the THLB older than minimum harvest age (merchantable); and
- Available – maximum merchantable volume that could be harvested in a given decade without violating forest cover constraints.

A 250-year time horizon was employed in these analyses to ensure that short and medium-term harvest targets do not compromise long-term growing stock stability. Also, modelled harvest levels included allowances for non-recoverable losses (NRLs). Harvest figures reported here exclude NRLs unless otherwise stated.

Over the next rotation it may be necessary to reduce harvest levels prior to achieving the long-term level. Unless otherwise stated in the timber supply forecasts that follow, the decadal rate of decline was limited to 10%, and the mid-term harvest level was not permitted to drop below a level reflecting the basic productive capacity of the land base. The long-term steady harvest level will always be slightly below the theoretical long-term level, attainable only if all stands are harvested at the age when mean annual increment (MAI) maximises. This is due to the imposition of minimum harvest ages and forest cover requirements, which affect time of harvest.

The following objectives were used in developing harvest schedules during the modelling simulations:

- To sustain a harvest level as high as the current AAC of 380,000 m^3/year plus 15,600 m^3/year of non-recoverable losses for as long as possible.
- To achieve the maximum long-term flow of timber without compromising the total inventory of timber on the TFL.
- To manage the land base in a manner consistent with the principles of integrated resource use, including requirements outlined in FPC, FRPA, and the OS-LRMP.

4.2 Interpretation of Availability

Harvest flow has traditionally been the key indicator used to evaluate the timber supply impacts of various management scenarios. However the harvest flow for a given scenario does not necessarily reveal the complete timber supply picture. Another useful indicator is timber availability, which is the total volume of merchantable timber that could be harvested in any given period without violating any forest cover requirements (over minimum harvest age and not needed for any land base requirements). The profile of timber availability provides valuable information regarding the timber supply dynamics of a given scenario. In general, the periods with the least amount of timber available control the resulting harvest flow.

Conventional TSR harvest schedules are generally controlled by ‘pinch points’, which are periods in which there is virtually no surplus timber available beyond the simulated harvest level.

5.0 BASE CASE RESULTS

5.1 Harvest Level and Growing Stock

Results for the Base Case option, as described in the previous sections and in the *Information Package*, are provided in Table 5.1. A number of alternative harvest flow alternatives were modelled in this option.

Table 5.1 – Base Case annual harvest alternatives (m^3/year)

Period	Base Case	Evenflow	Increase Initial
1	385,900	385,900	425,900
2	385, 900	385, 900	376, 900
3	385,900	385,900	376,900
4	385,900	385,900	376,900
5	385,900	385,900	376,900
6	385,900	385,900	376,900
7	385,900	385,900	376,900
8	488,600	385,900	488,600
9	488,600	385,900	488,600
10 - 25	488,600	385,900	488,600

The "Evenflow" harvest schedule is an unreasonable choice because it does not utilize the productive capacity of the land base in the long term. Similarly the "Increase Initial" scenario is not the best solution because there is a mid-term decline in harvest to offset the short-term increase in during the first decade. However, the mid-term reduction is not significant and this is important to note considering the concerns over mountain pine beetle (MPB) on TFL 49.

The harvest flow labeled "Base Case" in Table 5.1 was selected because it represents a suitable harvest flow over the entire 250-year planning horizon. Initially, the harvest is greater than the current AAC of 380,000 m^3/year, harvest, with a 27% increase in the long-term after conversion to managed stands. This harvest schedule was used for developing all other analysis scenarios and sensitivity analyses. A full description of the Base Case is provided in the figures and text below.

Figure 5.1 displays the change in growing stock and harvest over the 250-year planning horizon.

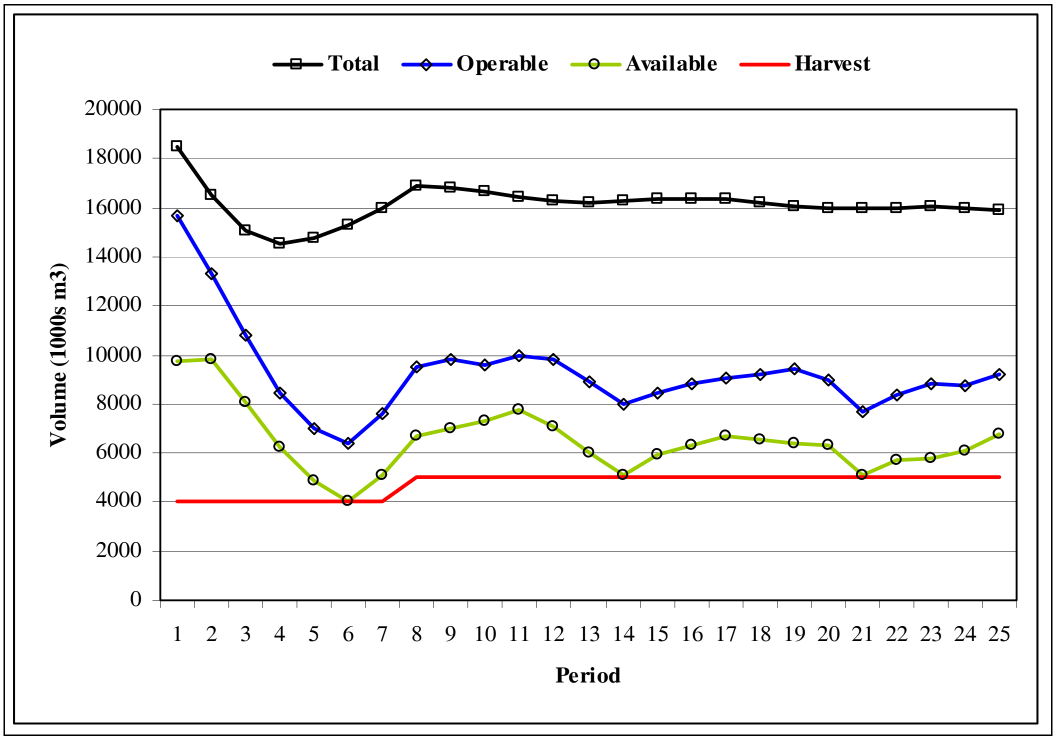

Figure 5.1 – Base Case growing stock and harvest

The short and mid-term harvest is dictated by the shortage of available timber in decade six. This is a critical period, or "pinch point" for the overall timber supply. The shortage of stands currently 40 to 60 years old (see Figure 5.2), combined with the requirement for old forest in some wildlife REAs and seral zones limits the harvest during decade six. It is during periods five and six that managed stands begin contributing to the annual harvest. These stands have less volume per hectare than the existing natural stands that supplied timber during the initial 40 years of simulation.

Beyond decade seven, at which time numerous managed stands are growing to merchantable age, the harvest is able to increase significantly over the short-term level. A number of factors contribute to this improvement in long-term harvest, including:

1. Site index adjustments for managed stands. The recent SIBEC project provided improved site index estimates for managed stands. The findings of this study allowed an average increase of four metres (26%) in site index.
2. Genetic gains for managed stands. Long-term genetic gains for each planted species were included in the future managed stand yield tables. These gains range from 12 to 26%, with an average of approximately 16% compared to planting stock without any improvements.
3. Twenty cm stump height. An increase of 1.9% was applied to all yield tables to reflect harvesting down to a 20cm stump height.

Average minimum harvest age for managed stands is 67 years, and this is approximately the frequency of the low availability over the entire planning horizon.

The total growing stock is stable over the long-term after the initial decline as existing mature stands are utilized in the first 50 years of simulation. The total growing stock decade 25 is 86% of initial level.

Figure 5.2 shows the current age class distribution for TFL 49.

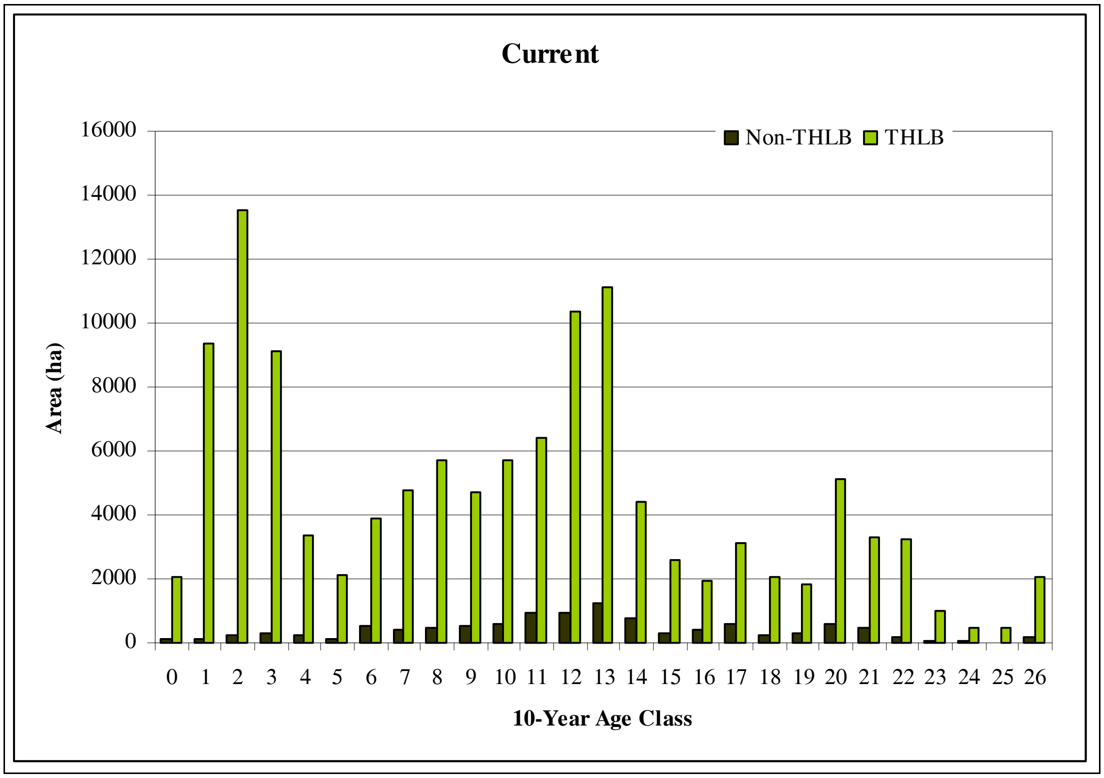

Figure 5.2 – Current age class distribution

Figure 5.3 displays the age class distribution of the forest at selected periods.

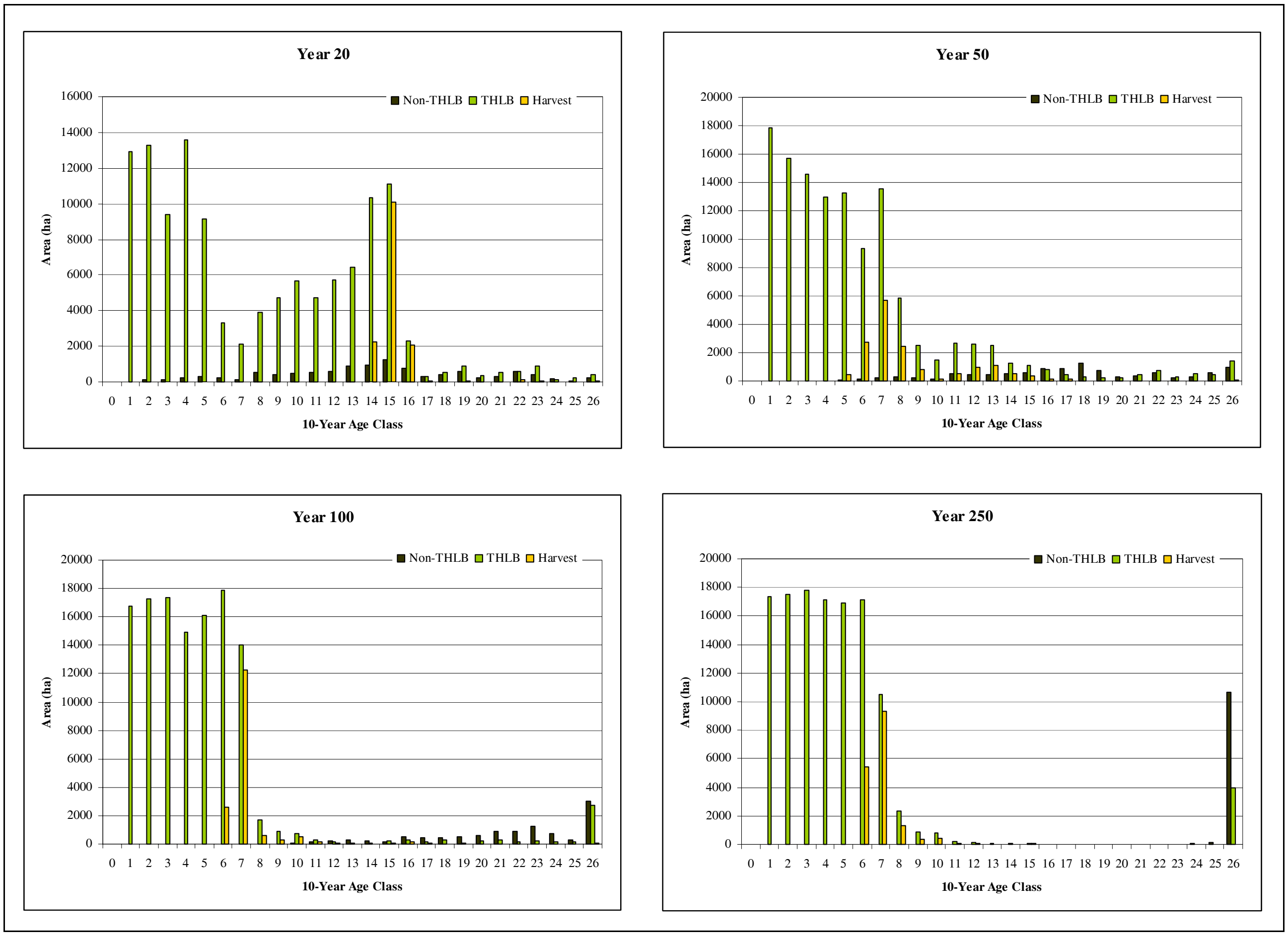

Figure 5.3 – Age class distributions at selected periods

With minimal second growth timber available prior to year 50, existing natural stands must support both the harvest and old forest cover requirements. In addition, because 93% of the productive forest is THLB, there is always a need for some of the THLB to be placed in reserve to satisfy old forest cover constraints.

At year 50 the harvest has shifted to younger stands as indicated in Figure 5.3. The younger age classes are becoming much more balanced and this contributes to the stable harvest flow from decade eight forward.

Similar trends are noted at years 100 and 250. Most harvesting is in stands that have just reached minimum harvest age. The non-THLB has all grown to old status, as well as a portion of the THLB, which has been reserved to accommodate forest cover objectives for wildlife. Disturbance in the non-THLB was not modelled in this analysis, so the component of old forest may be overestimated. However, given that only 7% of the productive forest is non-THLB, this is not a significant issue with respect to long-term timber supply.

Figure 5.4 presents the distribution of the periodic harvest among natural and managed stands.

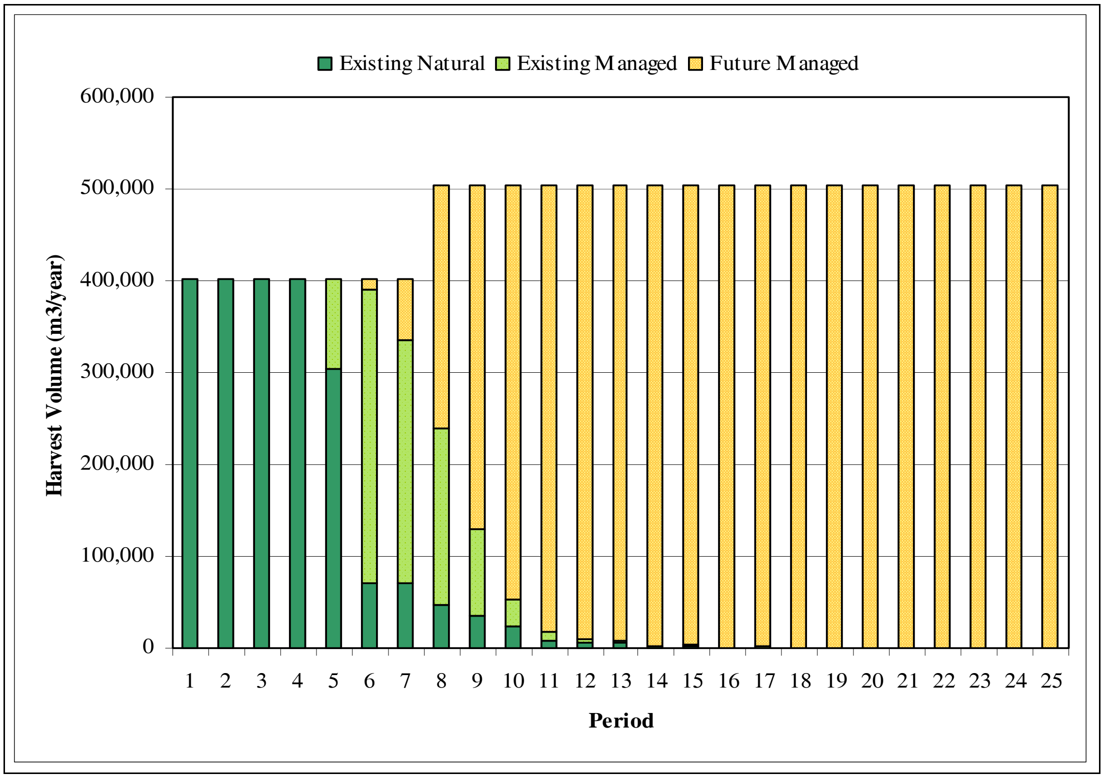

Figure 5.4 – Annual harvest by stand type

Existing natural stands comprise all of the harvest during the initial four decades of simulation. In period five existing managed stands begin to support a minor (25%) portion of the harvest. However, in period six and beyond, managed stands make up virtually all of the harvest.

The availability of existing managed stands is important to the short and mid-term timber supply. If all management assumptions included in the analysis are correct for these stands and they reach merchantable status 50 years into the future, the harvest level can be maintained without any disruptions in supply.

In the long-term future managed stands support the entire harvest. These stands are high volume, fast growing types and allow an increase in the periodic harvest at a sustainable level.

Figure 5.5 shows the average harvest attributes for the Base Case over the planning horizon.

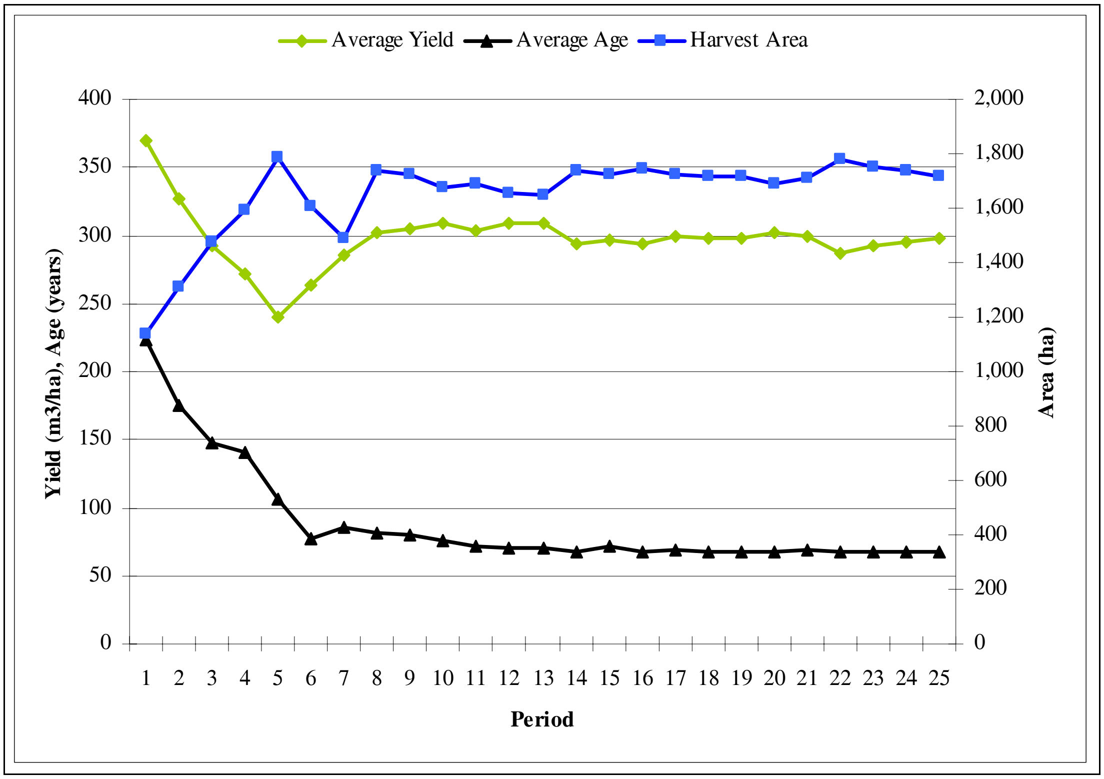

Figure 5.5 – Average attributes for harvested stands

Initially, the average harvest age is 223 years as the model attempts to harvest the oldest stands on the land base. As these stands are utilized age declines to approximately 70 years of age in period six and beyond. This indicates that managed stands are being harvested as soon as they reach minimum harvest age, which is based on 95% of culmination MAI.

Average harvest area increases as the younger stands begin to contribute to the annual harvest. Although these stands express higher productivity than the natural stands they are replacing, they are considerably younger and therefore provide reduced volumes at time of harvest.

Average yield (m^3/ha) shows opposite trends to the harvest area. With lower yields per hectare, more area must be harvested to achieve the harvest target.

Period five demonstrates an important time in the planning horizon with respect to average attributes for the harvested stands. The available, higher volume natural stands have been utilized and the harvest is partly supported by existing managed stands. This reduces the average yield and increases the area harvested to their respective minimum and maximum for the planning horizon.

In the long-term average yield is approximately 300 m^3/ha, and average harvest area is approximately 1,700 ha/year.

5.2 Non-Timber Resourcess

A number of non-timber resources were modelled in the timber supply analysis to address the needs of wildlife, watersheds, visual quality, and landscape level biodiversity. Figures 5.6 to 5.9 provide a graphic summary related to the forest state for resource emphasis areas which only have a disturbance requirement.

When interpreting the disturbance state for a given REA, the "current area" should be lower than the "target area", indicating that the maximum disturbance constraint has not been violated. The "Base Area" represents the total area of the REA group that was modelled in CASH6.2. In some cases it includes only THLB (*eg*. IRM), while in other cases it includes all productive land (*eg*. moose habitat). Note that the summaries represent the total area and status for each REA group. Individual REAs were assigned by resource polygon or landscape unit for modelling in CASH6.2.

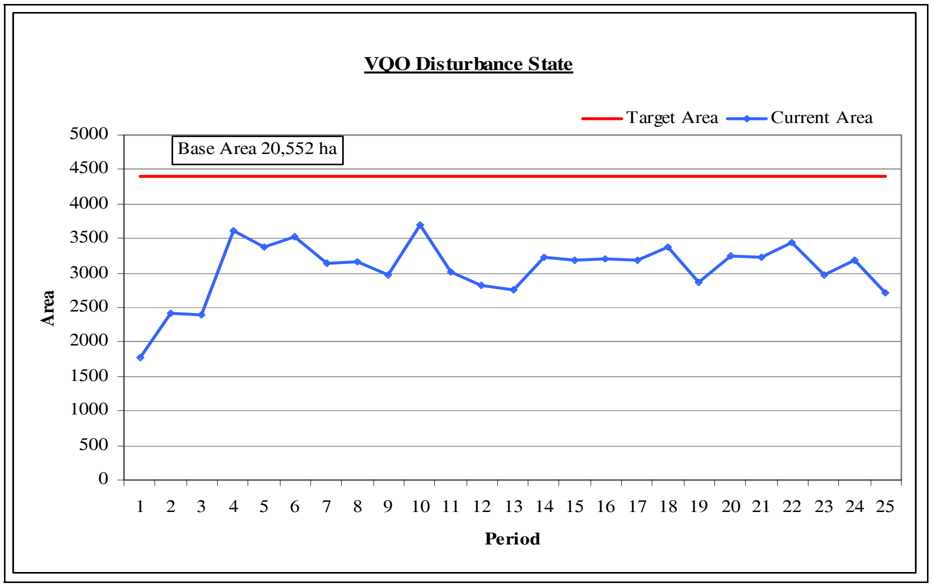

Figure 5.6 – Disturbance state for visual quality

Approximately 16% of TFL 49 lies within areas requiring management for visual quality. Each of the 101 visual quality polygons was modelled individually. For many of the simulation periods, harvesting was suspended in a large number of these polygons because disturbance limits were reached.

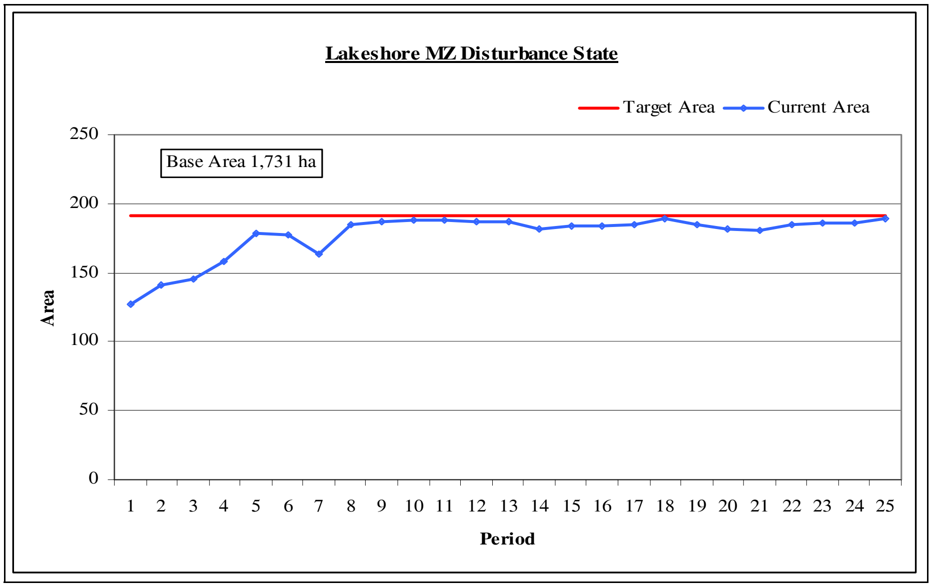

Figure 5.7 – Disturbance state for lakeshore management

Lakeshore management zones, like visual quality areas, were modelled individually to limit disturbance. Although these areas were at the limit of disturbance for the majority of the planning horizon, they represent only 1.3% of the productive land base and therefore do not play a significant role in determining the timber supply.

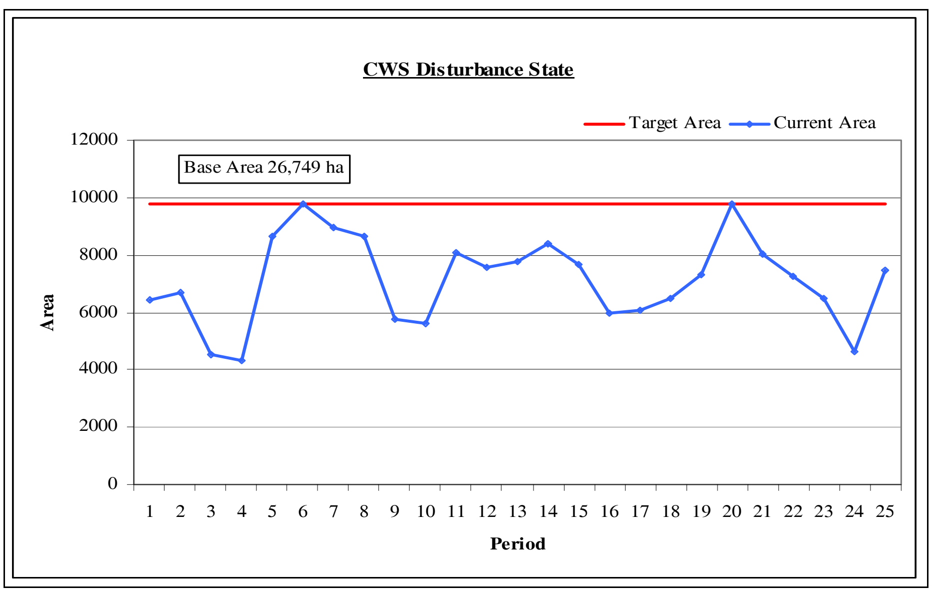

Figure 5.8 – Disturbance state for community watersheds

Community watersheds account for more than 20% of the TFL productive land base, and therefore play an important role in timber supply. These areas reach the limit of disturbance during the critical phase of the planning horizon 60 years into the future, which places limits on the location of the harvest. A similar situation takes place late in the planning horizon in period 20.

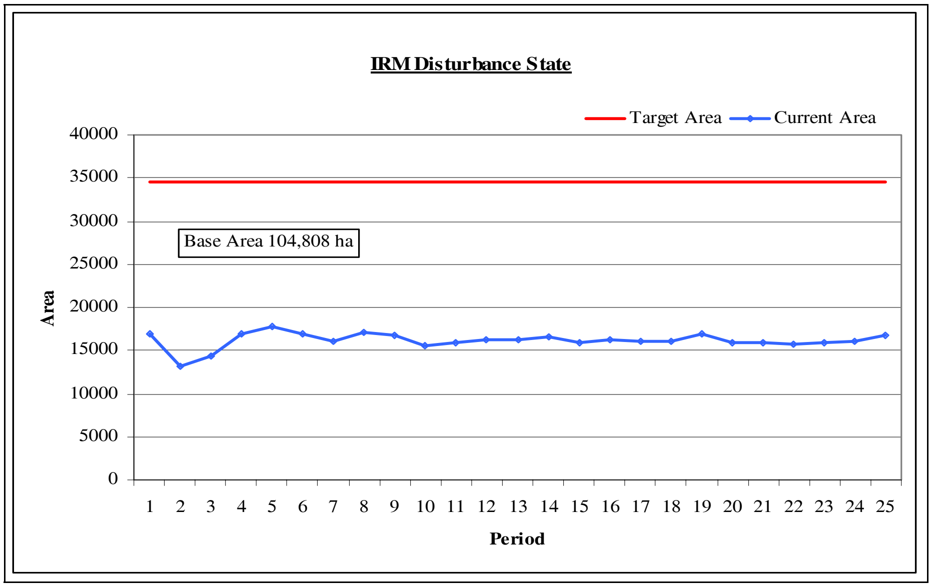

Figure 5.9 – Disturbance state for IRM

The IRM, or general forestry areas do not limit the annual harvest at any time during the planning horizon. The management requirement is a maximum 33% less than 2 metres tall. Managed stands achieve this height in less than 10 years on most sites within TFL 49.

Figures 5.10 through 5.13 summarize the forest state for wildlife habitat REAs, which in most cases included specific management objectives for both maximum disturbance and minimum retention of old forest. When interpreting the retention state for a given REA, the "current area" should be above than the "target area", indicating that the minimum retention constraint has been maintained.

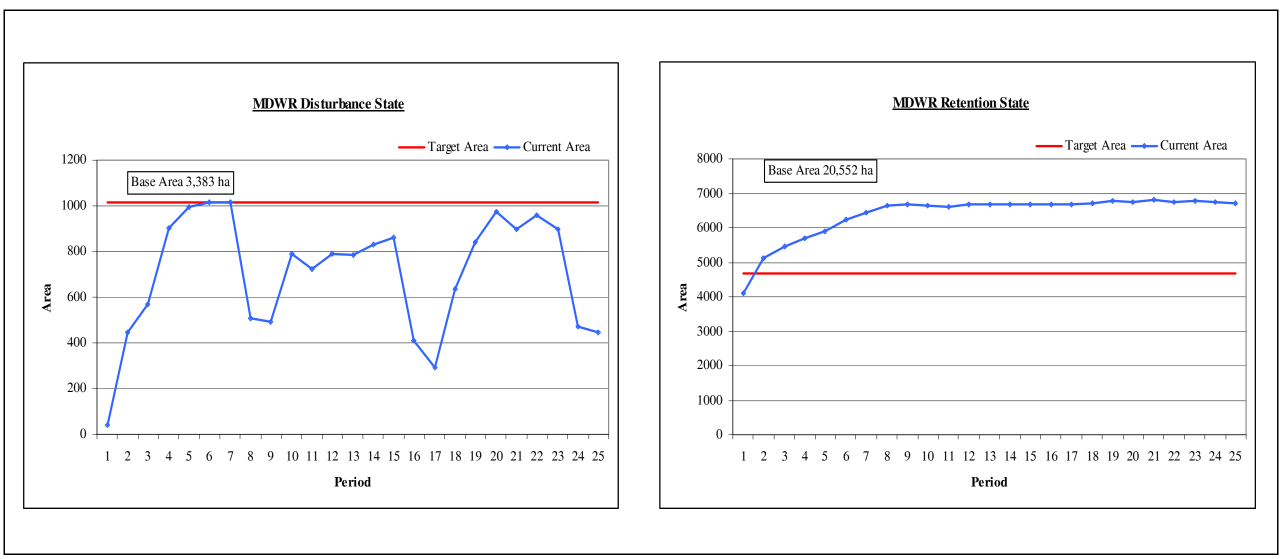

Figure 5.10 –Forest state for mule deer winter range

Only shallow snowpack areas of the mule deer winter range (MDWR) have a specific disturbance constraint assigned in the analysis. Other areas are assigned the IRM constraint of a maximum of 33% less than 2 metres tall. However, the shallow snowpack areas become limiting during the pinch point in decades six and seven, which combined with other growing stock issues limits the harvest in the early decades. In the long-term these areas do not impact timber supply significantly.

Initially, the MDWR retention objective is in deficit, and therefore harvesting is limited in these areas unless sufficient area can be placed in reserve to accommodate the management objective in the future. This modelling condition is known as "recruitment" of old forest stands. After period two localized MDWR areas are in deficit and have limited harvesting.

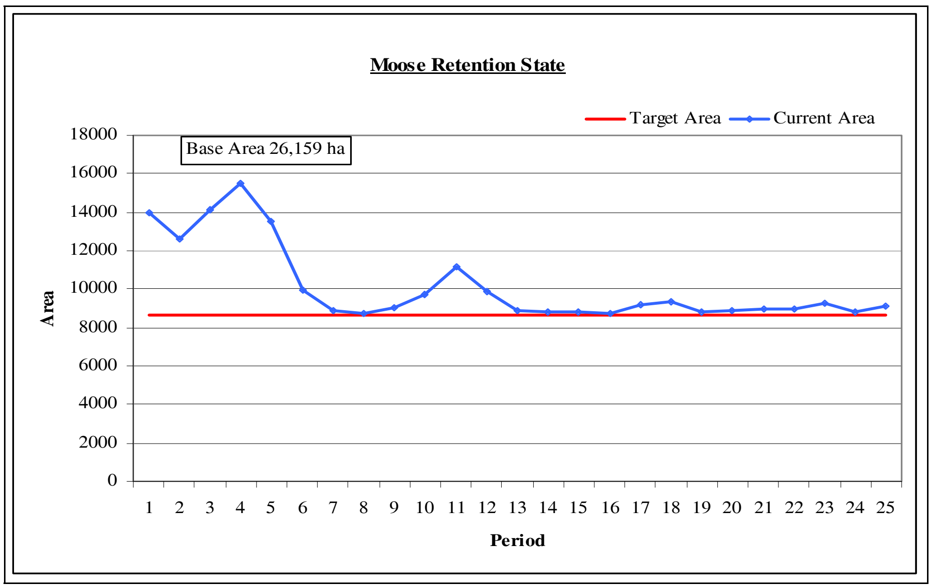

Figure 5.11 – Forest state for moose habitat

In the early decades, moose forest cover requirements do not limit harvesting. However, during the critical period 70 years into the future, old forest must be reserved to address moose habitat needs, and this places a limit on harvesting in this area of TFL 49. For many of the later periods moose habitat requirements suspend harvesting, as noted in the periods when the current and target areas are the same in Figure 5.11. Given that moose habitat accounts for 20% of the TFL area, this is an important species on the TFL with respect to timber supply.

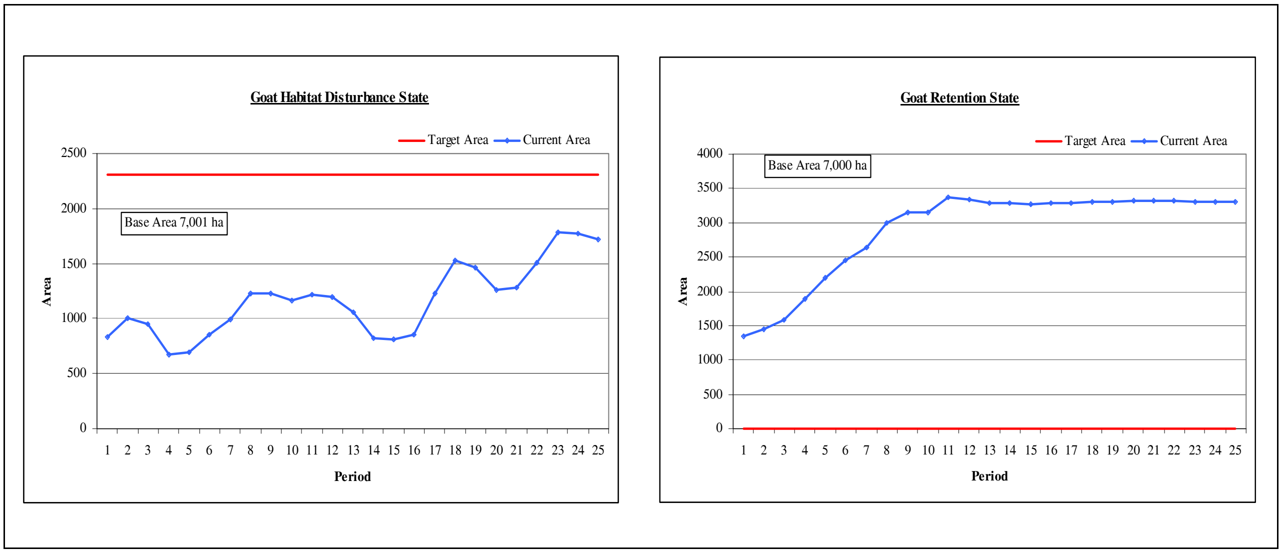

Figure 5.12 – Forest state for mountain goat winter range

Goat winter range is never limiting on timber supply at any time during the 250-year planning horizon. Maximum disturbance is never reached. The retention objective is modelled by the extended rotation ages (100 years for pine, 150 for other conifers). The goat habitat was monitored for old forest state to demonstrate how much area was maintained in this condition during the planning horizon. As shown in Figure 5.12 approximately 47% of the goat winter range area is older than 150 years beyond decade seven of the simulation.s

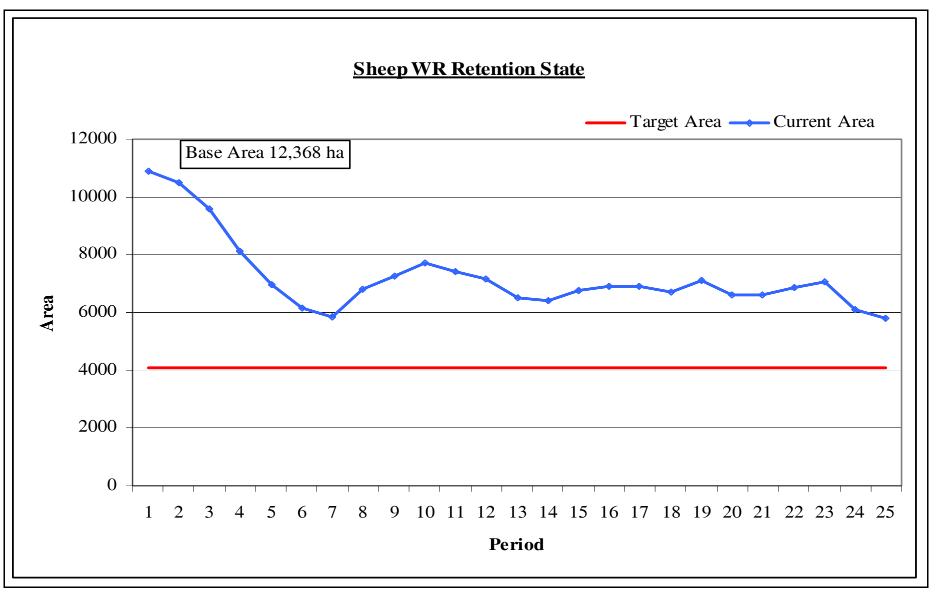

Figure 5.13 – Forest state for sheep winter range

Sheep winter range is not limiting on timber supply at any time during the 250-year planning horizon. Many sheep areas overlap with other constraint types (VQO, MDWR) which indirectly limit harvest in the sheep areas.

The OS-LRMP provides specific area targets for landscape level biodiversity. Targets were defined separately for the THLB and non-THLB ("NC" in Table 5.2) component of each landscape unit-BEC variant (LU-BEC/NDT). Note it is feasible for to have a target of "0%", which indicates sufficient old forest exists throughout the LU-BEC/NDT. Three landscape units lie within TFL 49, all of which are classified as "low" biodiversity emphasis. Table 5.2 summarizes the forest state for landscape level biodiversity at selected intervals of the planning horizon.

Table 5.2 – Landscape level biodiversity status at selected periods

LU-BEC/NDT & Analysis ID	Base Area (ha)	Old Target (% > years)	Old Status at Selected Periods (%)				
			1	50	100	150	250
1 - OK_WSide-ESSFdc2/NDT3	8,399	2 > 140	14	2	2	2	2
2 - OK_WSide-ESSFxc/NDT3	734	0 > 140	14	0	0	0	0
3 - OK_WSide-ICHmk2/NDT3	5,012	4 > 140	10	4	4	4	4
4 - OK_WSide-IDFmw1/NDT4	6,956	1 > 250	1	5	9	9	9
5 - OK_WSide-IDFxh1/NDT4	963	0 > 250	6	6	4	4	4
6 - OK_WSide-MSdm2/NDT3	6,438	1 > 140	13	2	1	1	1
31 - OK_WSide-ESSFdc2/NDT3-NC	375	63 > 140	61	90	94	100	100
32 - OK_WSide-ESSFxc/NDT3-NC	97	28 > 140	58	98	98	100	100
33 - OK_WSide-ICHmk2/NDT3-NC	306	13 > 140	60	69	94	100	100
34 - OK_WSide-IDFmw1/NDT4-NC	1,192	0 > 250	0	8	22	51	100
35 - OK_WSide-IDFxh1/NDT4-NC	518	0 > 250	0	0	13	20	100
36 - OK_WSide-MSdm2/NDT3-NC	384	61 > 140	52	78	88	100	100
7 - Trepanier-ESSFdc2/NDT3	8,738	0 > 140	25	1	0	0	0
8 - Trepanier-ESSFxc/NDT3	2,200	0 > 140	19	0	0	0	0
9 - Trepanier-IDFdk2/NDT4	5,178	4 > 250	0	1	4	4	4
10 - Trepanier-IDFmw1/NDT4	1,220	0 > 250	0	3	3	3	3
11 - Trepanier-IDFxh1/NDT4	1,596	5 > 250	1	4	5	5	5
12 - Trepanier-MSdm2/NDT3	18,411	1 > 140	17	1	2	1	1
13 - Trepanier-PPxh1/NDT4	689	6 > 250	2	6	6	6	6
37 - Trepanier-ESSFdc2/NDT3-NC	436	84 > 140	64	69	73	100	100
38 - Trepanier-ESSFxc/NDT3-NC	141	78 > 140	53	67	86	100	100
39 - Trepanier-IDFdk2/NDT4-NC	522	13 > 250	0	1	11	48	99
40 - Trepanier-IDFmw1/NDT4-NC	1,485	94 > 250	0	2	11	76	100
41 - Trepanier-IDFxh1/NDT4-NC	373	6 > 250	0	3	32	54	100
42 - Trepanier-MSdm2/NDT3-NC	1,275	56 > 140	44	68	82	100	100
43 - Trepanier-PPxh1/NDT4-NC	146	0 > 250	0	0	77	94	100
14 - U_Salmon-ESSFdc2/NDT3	5,405	0 > 140	16	4	1	1	1
15 - U_Salmon-ESSFxc/NDT3	5,197	3 > 140	21	3	3	3	3
16 - U_Salmon-IDFdk1/NDT4	11,328	3 > 250	0	1	3	3	3
17 - U_Salmon-IDFdk2/NDT4	10,654	3 > 250	0	3	3	4	4
18 - U_Salmon-IDFmw2/NDT4	2,432	5 > 250	0	3	5	5	8
19 - U_Salmon-IDFxh2/NDT4	3,217	4 > 250	1	1	15	18	21
20 - U_Salmon-MSdm2/NDT3	12,600	4 > 140	8	4	4	4	4
21 - U_Salmon-MSxk/NDT3	6,386	0 > 140	13	0	0	0	0
44 - U_Salmon-ESSFdc2/NDT3-NC	224	100 > 140	73	93	93	100	100
45 - U_Salmon-ESSFxc/NDT3-NC	247	38 > 140	29	87	88	100	100
46 - U_Salmon-IDFdk1/NDT4-NC	679	25 > 250	0	4	29	66	97
47 - U_Salmon-IDFdk2/NDT4-NC	742	20 > 250	1	4	17	76	97
48 - U_Salmon-IDFmw2/NDT4-NC	197	2 > 250	1	1	6	10	100
49 - U_Salmon-IDFxh2/NDT4-NC	243	6 > 250	0	0	45	77	100
50 - U_Salmon-MSdm2/NDT3-NC	852	11 > 140	40	74	82	100	100
51 - U_Salmon-MSxk/NDT3-NC	461	67 > 140	21	72	95	100	100

Many of the LU-BEC/NDTs listed in Table 5.2 exceed the old forest targets compared with the OS-LRMP targets. All areas within the THLB meet the old forest objectives by year 80 of the simulation, less than one rotation. Non-THLB take longer to achieve the full old forest target, but given the small area they represent collectively on TFL 49, this does not represent a major issue for the TFL.

As shown in the summaries for the Base Case, there is a dramatic increase in the harvest level estimated for TFL 49. The following is a summary of the key factors which contribute to the improved Base Case harvest level.

1. Mature volume adjustments. The initial mature volume is increased by 9.3% with improvements to the mature natural stand yields as documented in *Vegetation Resources Inventory Phase 2 Adjustment Procedure* (Timberline, 2002) .
2. Site index adjustments for managed stands. The recent SIBEC project provided improved site index estimates for managed stands. The findings of this study, outlined in *Site Index Correlated to Ecosystems – TFL 49* (Timberline, 2002b) allowed an average increase of 4 metres (26%) in site index.
3. Genetic gains for managed stands. Long-term genetic gains for each planted species were included in the future managed stand yield tables. These gains range from 12 to 26%, with an average of approximately 16% compared to planting stock without any improvements *Tree Farm Licence 49 – Implementation Strategy for Forest Level Modelling of Genetic Gains* (Timberline, 2003).
4. Twenty cm stump height. An increase of 1.9% was applied to all yield tables to reflect harvesting down to a 20cm stump height.
5. Old forest requirements. The OS-LRMP assigns specific area retention targets for old forest within each LU-BEC variant. These are further split into THLB and non-THLB components. Within the THLB the average old forest requirement is only 1.9%, considerably less than the requirement modelled in MP No. 3.

6.0 MOUNTAIN PINE BEETLE OPTION

Mountain pine beetle (*Dendroctonus ponderosae*) (MPB) is currently attacking stands at epidemic levels across B.C. Lodgepole pine stands on TFL 49 are being affected by this outbreak. This analysis option evaluates the impact on timber supply of harvesting, at an accelerated rate during the first decade, those pine stands that are at serious risk to attack.

It is assumed that these pine stands will be harvested as a preventative measure or as part of salvage operations to recover attacked timber. No adjustments to the pine yields were included in the analysis. Susceptible pine stands are defined by the following characteristics:

- Pine composition of 40% or higher based on the forest cover label;
- At least 80 years of age; and
- Within Blocks A and B of the TFL.

A number of analysis scenarios were modelled in the MPB option including:

- Direct the harvest to susceptible pine stands during the first decade;
- Maximize the harvest of susceptible pine during the first decade, without any adjustments to other modelling assumptions; and
- "Uplift" scenarios in which the harvest of pine during period one is increased above the Base Case level. This provides an understanding of the mid and long-term impacts of increased salvage operations in response to higher incidence of beetles.

Pine stands from outside the THLB were also available for harvest. However, after the initial salvage of these NTHLB stands they were not available for any further harvest. Table 6.1 summarizes the harvest rates.

Table 6.1 – MPB scenarios annual harvest (m^3/year)

Period	Base Case	No MPB Target	Maximum 10-Year MPB Harvest	Uplift 50,000 m^3/yr for 5 years	Uplift 100,000 m^3/yr for 5 years	Uplift 150,000 m^3/yr for 5 years	Uplift 200,000 m^3/yr for 5 years
1 (yr 1 – 5)	385,900	381,500 (166,300) [1]	385,900	435,900	485,900	535,900	585,900
1 (yr 6 – 10)	385,900	381,500 (166,300) [1]	385,900	385,900	385,900	385,900	385,900
2	385,900	381,500	380,100	382,400	379,000	385,900	385,900
3	385,900	381,500	380,100	382,400	379,000	370,600	365,000
4	385,900	381,500	380,100	382,400	379,000	370,600	365,000
5	385,900	381,500	380,100	382,400	379,000	370,600	365,000
6	385,900	381,500	380,100	382,400	379,000	370,600	365,000
7	385,900	381,500	380,100	382,400	379,000	370,600	365,000
8	488,600	491,100	488,900	488,900	488,900	370,600	365,000
9	488,600	491,100	488,900	488,900	488,900	488,900	488,900
10 - 25	488,600	491,100	488,900	488,900	488,900	488,900	488,900

[1] 166,300 m^3/year represents the MPB high-risk stands harvested by the model. The first period harvest was entirely MPB stands in all other MPB scenarios.

In the "No MPB Target" scenario, there was no specific harvest target assigned to MPB high-risk areas. The minor change in annual harvest rate is due to the introduction of harvest partitions for MPB and non-MPB areas of the TFL land base. For all other MPB scenarios the first period harvest was made up entirely of high-risk pine stands.

In all other scenarios there were MPB volume targets in place for the first decade of simulation. Maximizing the MPB harvest during the first period indicates that the entire Base Case harvest can be directed to pine stands at risk or requiring salvage with less than 2% impact on the mid-term harvest. The mid-term harvest rate is still at the current AAC for the TFL. Long-term improvements are not compromised by forcing early harvesting to the MPB stands.

The "uplift" scenarios were modelled to increase the harvest of MPB stands by up to 200,000 m^3/year for the first five years of simulation. Harvest targets for period one were adjusted to account for the 10-year modelling periods used for all other analysis scenarios. Within the high risk stands identified for the analysis there is approximately 80% pine/20% non-pine volume.

The mid-term harvest declines by as much as 5% for the uplift scenarios compared with the Base Case. These harvest levels were developed without adjusting any of the other management requirements for wildlife, visual quality, watersheds or landscape level biodiversity. The high-risk pine stands regenerate to productive stand types and therefore reach merchantable age sooner than stands harvested during the first decade in the Base Case, which allows the mid-term harvest rate to be maintained.

Figures 6.1 to 6.5 provide a summary of the growing stock levels for the MPB scenarios modelled for the analysis. The Base Case availability is included for comparison.

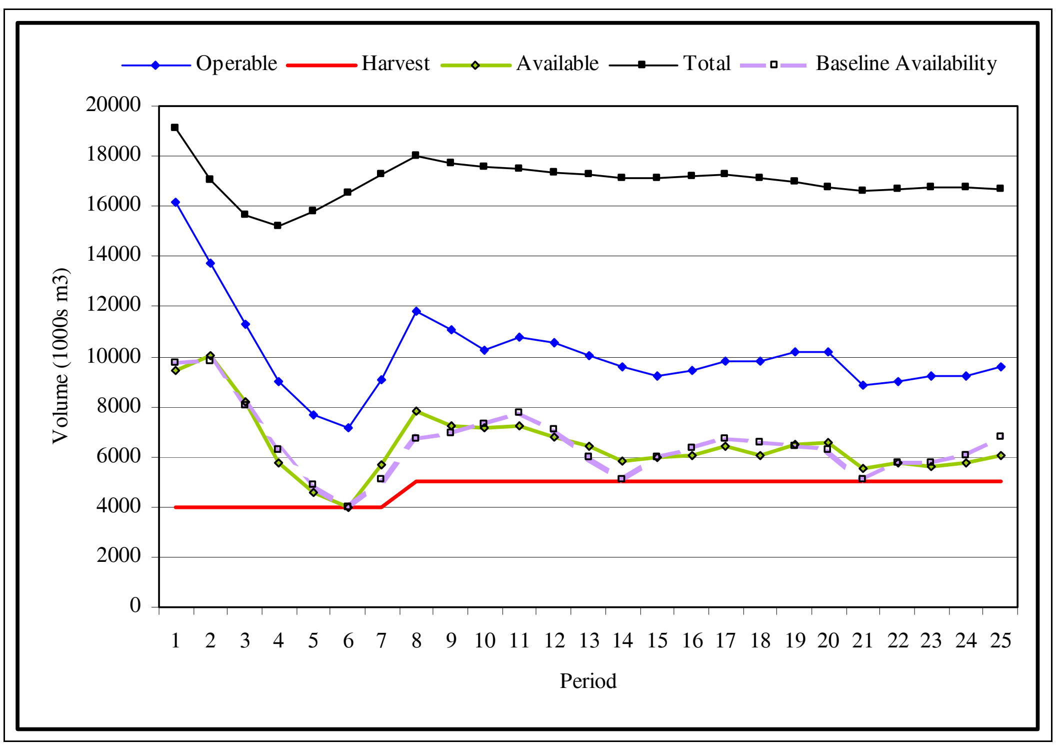

Figure 6.1 – Maximum 10-year MPB harvest growing stock and harvest

The timber availability exhibited by this scenario is similar to that of the Base Case. By forcing harvest into the pine stands there is an improvement in volume, and therefore available timber, during the critical period at decades seven and into period eight. As noted for the Base Case, growing stock is stable through the long-term.

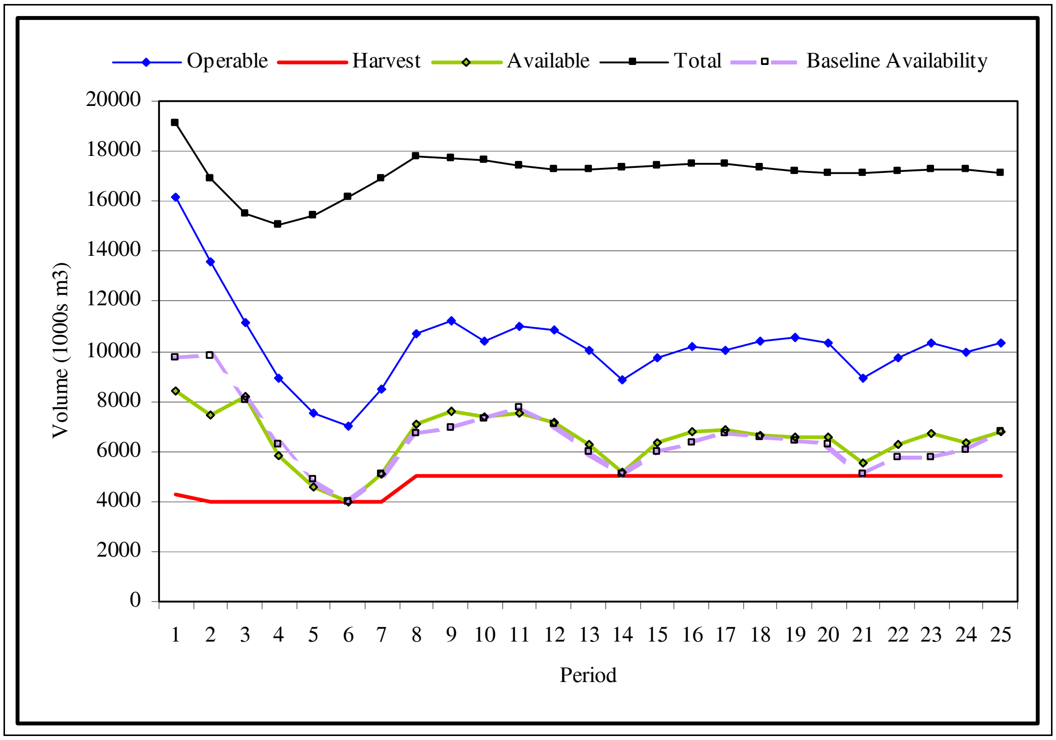

Figure 6.2 – Uplift 50,000 m^3/year growing stock and harvest

In this scenario the availability at the end of period one declines compared to the Base Case as a result of increased harvesting in pine areas, an additional 250,000 m^3. However, many of the stands that were harvested during the first decade in the Base Case were higher volume mature stands, and these become available over the next 40 to 60 years.

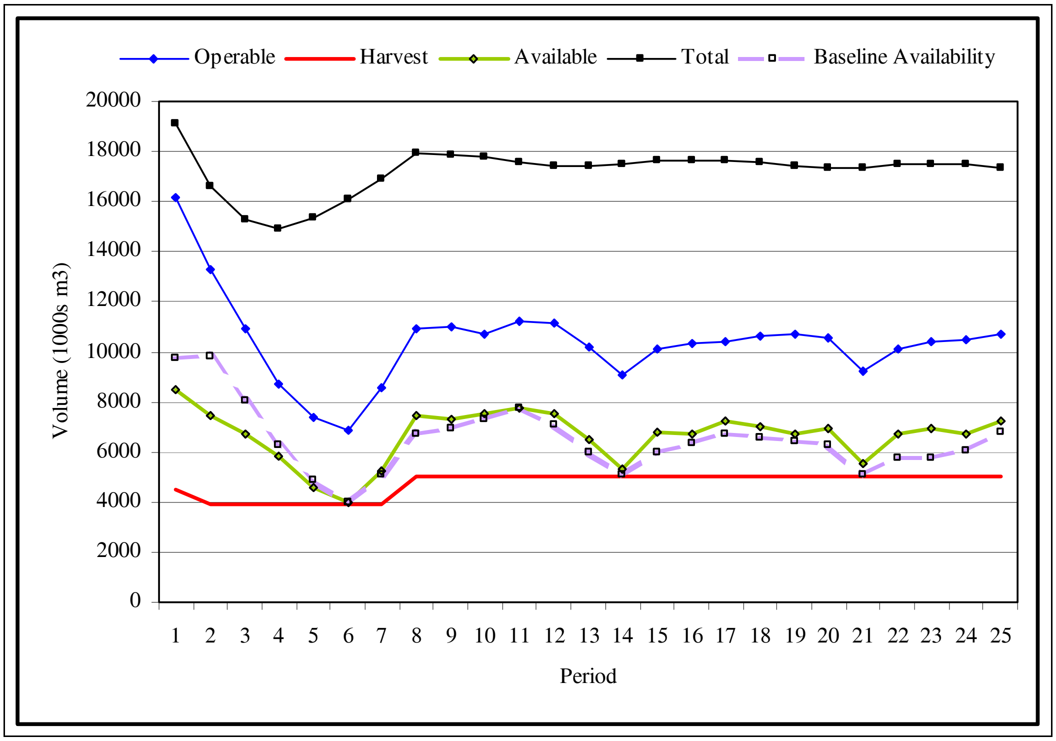

Figure 6.3 – Uplift 100,000 m^3/year growing stock and harvest

Increasing the uplift to 100,000 m^3/year, or 500,000 m^3 during period one drops the short-term availability compared to the Base Case results. The pinch point and subsequent improvement in availability over the following decades are similar for this uplift scenario and the Base Case.

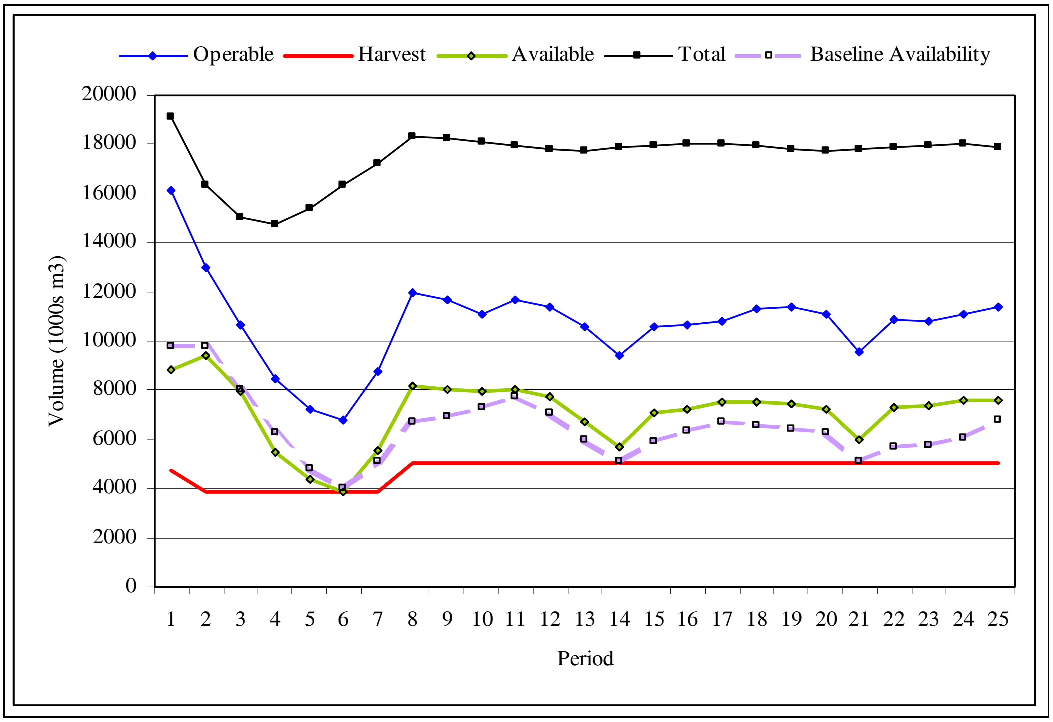

Figure 6.4 – Uplift 150,000 m^3/year growing stock and harvest

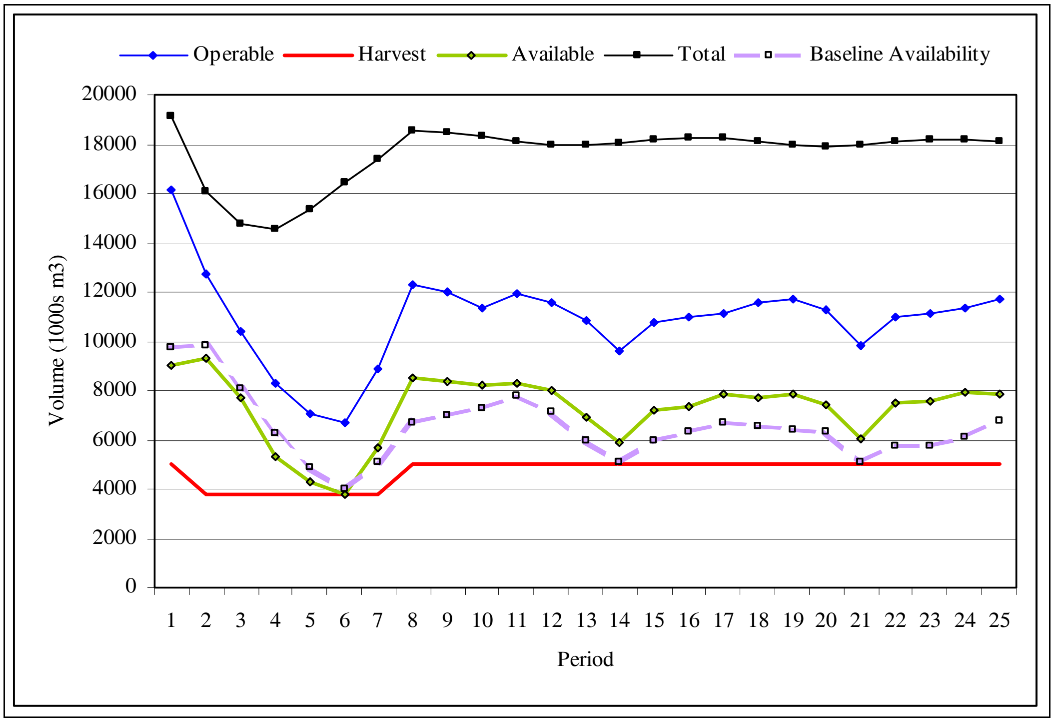

Figure 6.5 – Uplift 200,000 m^3/year growing stock and harvest

In both the 150,000 m^3/year and 200,000 m^3/year Uplift scenarios, timber availability increases during the second decade of simulation. By forcing so much harvesting into pine stands during the first 10 years of modelling, other non-pine leading stands (mainly Douglas-fir and spruce) are left to grow and accumulate more volume, which is available for harvest during the second period.

Increasing the harvest target but such a significant amount during the first period, up to 1,000,000 m^3 in the 200,000 m^3/year scenario, results in a decline in the mid term harvest rate. This drop is approximately 4% in the 150,000 m^3/year scenario, and 5% in the 200,000 m^3/year uplift scenario. However, these declines are not significant considering the volume that has been utilized rather than lost to beetle attack in these scenarios.

The importance of the MPB scenarios is that they demonstrate that harvesting over the next five to ten years can be directed entirely to high-risk pine stands, and even increased to address salvage requirements, with minimal impact on the mid and no impact on the long-term timber supply for TFL 49.

The fact that pine stands mature more quickly and regenerate to stand types that have shorter rotations contributes to the ability to harvest increased timber without compromising mid-term harvest levels. Typically, the regeneration types associated with many existing pine stands reach culmination age earlier than other species on TFL 49.

In all scenarios forest cover objectives were maintained as per the Base Case, which provides an increased level of comfort to forest managers that accelerating the salvage of pine stands to address MPB will not impact negatively on other forest resources.

7.0 SENSITIVITY ANALYSIS

In order to test the impacts of changing inputs to timber supply, a number of sensitivity analyses were completed for the Base Case. These were grouped into three categories:

- Land base;
- Growth and yield; and
- Forest cover constraints.

The results of the sensitivity analyses are listed in the following sections.

7.1 Land Base

Table 7.1 summarizes the results of the analysis simulations in which the THLB is increased and decreased by 5%. In both scenarios the total area of the TFL is maintained.

Table 7.1 – Land base sensitivity annual harvest (m^3/year)

Period	Base Case	Increase THLB 5%	Decrease THLB 5%
1	385,900	403,200	385,900
2	385,900	403,200	385,000
3	385,900	403,200	385,000
4	385,900	403,200	347,700
5	385,900	403,200	347,700
6	385,900	403,200	347,700
7	385,900	403,200	347,700
8	488,600	510,800	464,600
9	488,600	510,800	464,600
10 - 25	488,600	510,800	464,600

Increasing the THLB component of the TFL the land base allows an improvement in the annual harvest of approximately 4.5% throughout the planning horizon. This indicates that areas that are part of the non-THLB in the Base Case only play a minor role in addressing the needs of non-timber resources. Otherwise shifting areas to the harvesting component of the land base would compromise non-timber conditions and limit the improvement of the annual harvest potential.

Reducing the THLB by 5% forces a 10% drop in harvest during periods four through seven. The long-term harvest level is 5% lower than the Base Case.

Figure 7.1 compares in graphic form, the annual harvest of the THLB adjustment sensitivity analyses with the Base Case annual harvest.

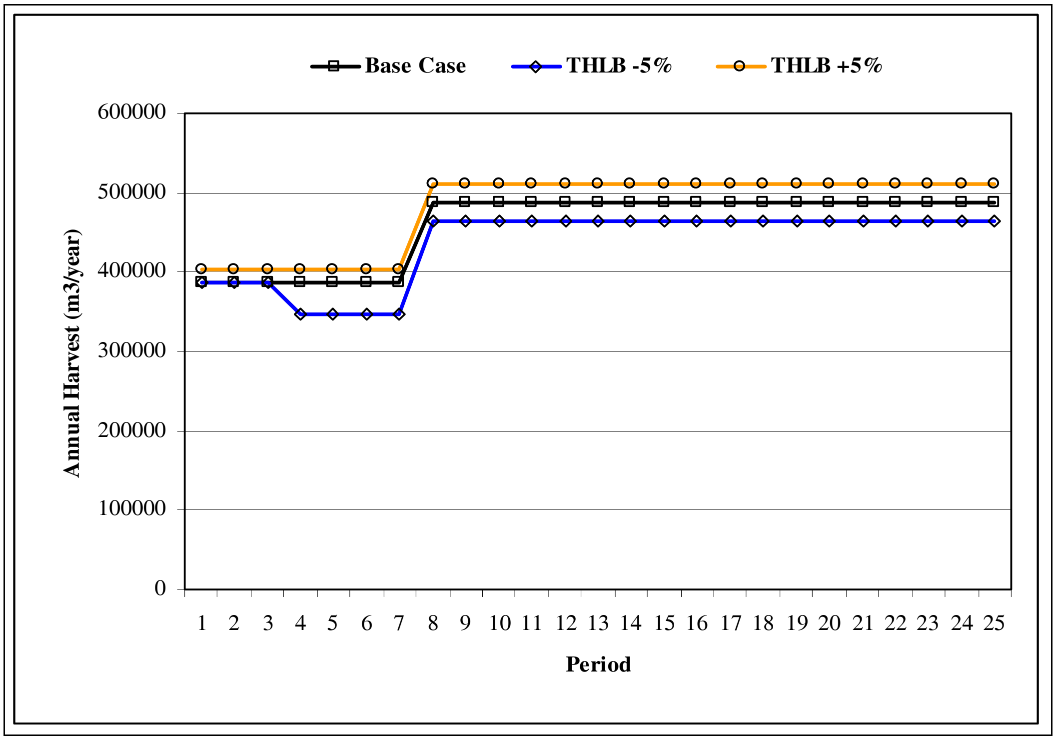

Figure 7.1 – Land base sensitivity annual harvest

7.2 Growth and Yield

A number of sensitivity analyses were completed which modified growth and yield inputs including:

- Natural stand (NSYT) and managed stand (MSYT) volume;
- Minimum harvest age (MHA); and
- Regeneration delay.

7.2.1 Stand Volume

Table 7.2 lists the annual harvest rates developed for the sensitivity analyses, which evaluated adjustments to stand volumes.

Table 7.2 – Stand volume sensitivity annual harvest (m^3/year)

Period	Base Case	Increase NSYT Volumes 10%	Decrease NSYT Volumes 10%	Increase MSYT Volumes 10%	Decrease MSYT Volumes 10%
1	385,900	419,800	385,900	392,500	385,900
2	385,900	419,800	385,900	392,500	385,900
3	385,900	419,800	334,100	392,500	385,900
4	385,900	419,800	334,100	392,500	385,900
5	385,900	419,800	334,100	392,500	364,700
6	385,900	419,800	334,100	392,500	364,700
7	385,900	419,800	334,100	455,700	364,700
8	488,600	485,100	490,600	532,600	437,600
9	488,600	485,100	490,600	532,600	437,600
10 - 25	488,600	485,100	490,600	532,600	437,600

Increasing natural stand yields provides an immediate 9% increase in the annual harvest. These stands are the source of all harvesting during the first 40 years of simulation, so any improvement to these volumes will provide additional periodic harvest. Increased volumes in natural stands can also reduce the area harvested each period which will reduce the impact on disturbance and create harvesting opportunities.

Conversely, reducing natural stand volumes impacts on the short-term harvest potential. There is a drop of approximately 9% during years 21 to 70 of the simulation. The Base Case harvest is maintained during the first two decades. Long-term harvest is virtually the same as the Base Case. Recent studies associated with the vegetation resources inventory (VRI) phase 2 produced adjustments for mature stand volumes, so the estimates used in the timber supply analysis are more reliable than estimates used in previous analyses.

Adjustments to the managed stand yields have more impact in the long-term compared with the results for the NSYT adjustments. Increasing MSYT volumes provides additional harvesting opportunities during the pinch point and allows more of the existing mature volume to be harvested during the first six decades. The transition to the long-term harvest level takes place 10 years earlier in this scenario compared with the Base Case. Long-term harvest is approximately 9% higher than in the Base Case.

Reducing managed stand volumes impacts the mid-term harvest when the transition to harvesting second growth timber commences. The harvest is 10% lower than the Base Case during decades five through seven. Similarly, the long-term harvest drops by approximately 9%.

Figure 7.2 displays the annual harvest of the stand volume adjustment sensitivity analyses with the Base Case annual harvest.

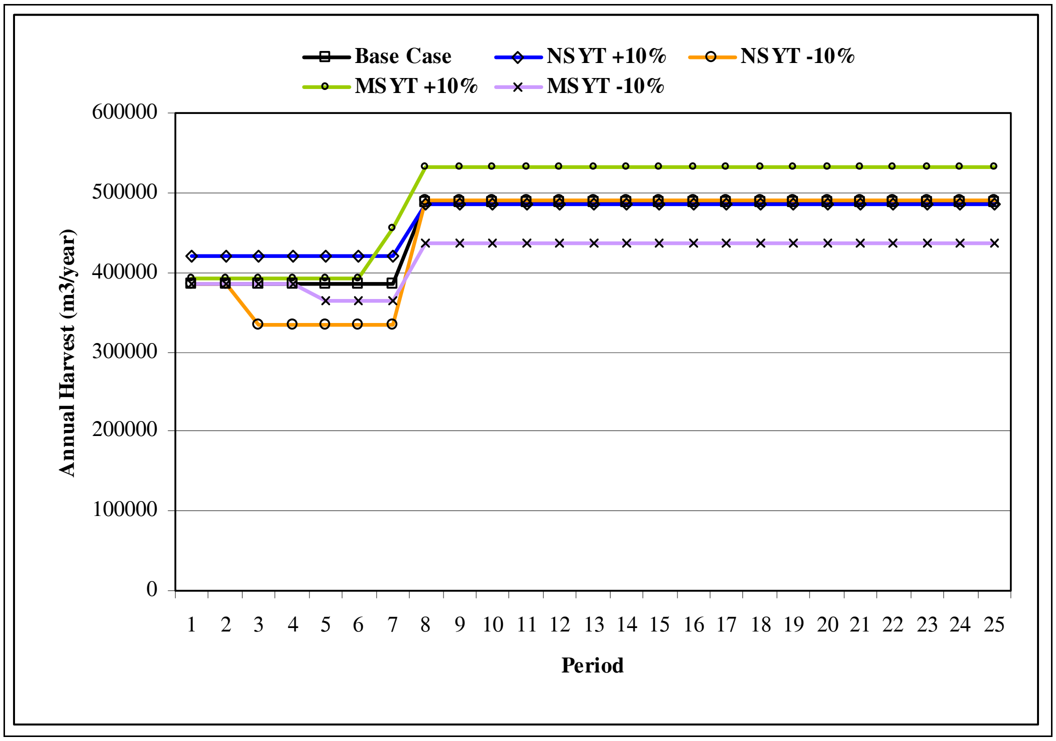

Figure 7.2 – Stand volume sensitivity annual harvest

7.2.2 Minimum Harvest Age

Table 7.3 summarizes the sensitivity analyses associated with changes to minimum harvest age.

Table 7.3 – Minimum harvest age sensitivity annual harvest (m^3/year)

Period	Base Case	NSYT MHA +10 years	NSYT MHA -10 years	MSYT MHA +10 years	MSYT MHA -10 years
1	385,900	385,900	388,100	385,900	423,900
2	385,900	385,900	388,100	385,900	423,900
3	385,900	385,900	388,100	334,700	423,900
4	385,900	385,900	388,100	334,700	423,900
5	385,900	375,200	388,100	334,700	423,900
6	385,900	375,200	388,100	334,700	423,900
7	385,900	375,200	388,100	334,700	448,600
8	488,600	488,600	488,600	488,600	448,600
9	488,600	488,600	488,600	488,600	448,600
10 - 25	488,600	488,600	488,600	488,600	448,600

Modifying the minimum harvest ages for natural stands does not have a significant impact on annual harvest compared with the Base Case. Increasing MHA forces a decrease of approximately 3% during simulation years 41 to 70. The remainder of the planning horizon is not affected. Reducing MHA for natural stands improves the short and mid-term harvest by less than 1%. These results indicate that many of the existing natural stands are older than the minimum harvest ages specified for the analysis.

Increasing managed stand (both existing and future) MHA results in a 3% decline in the mid-term harvest. However, there in no impact in the long-term indicating that stands are not harvested immediately after they reach merchantability, which is the case during decades five through seven. This demonstrates that there is some flexibility in harvesting in the highly productive managed stands in the long-term.

Reducing minimum harvest age for managed stands allows considerable improvement in the short and mid-term harvest. This is a result of existing managed stands becoming available in decade four compared with decade five in the Base Case. However, in the long-term the periodic harvest declines by 9% compared to the Base Case. By harvesting stands earlier than don't reach their productive potential and provide less volume per hectare. Therefore more area must be harvested to achieve the overall target and this pushes the disturbance levels to their limits sooner than in the Base Case.

Figure 7.3 summarizes the minimum harvest age sensitivity analysis annual harvest levels graphically.

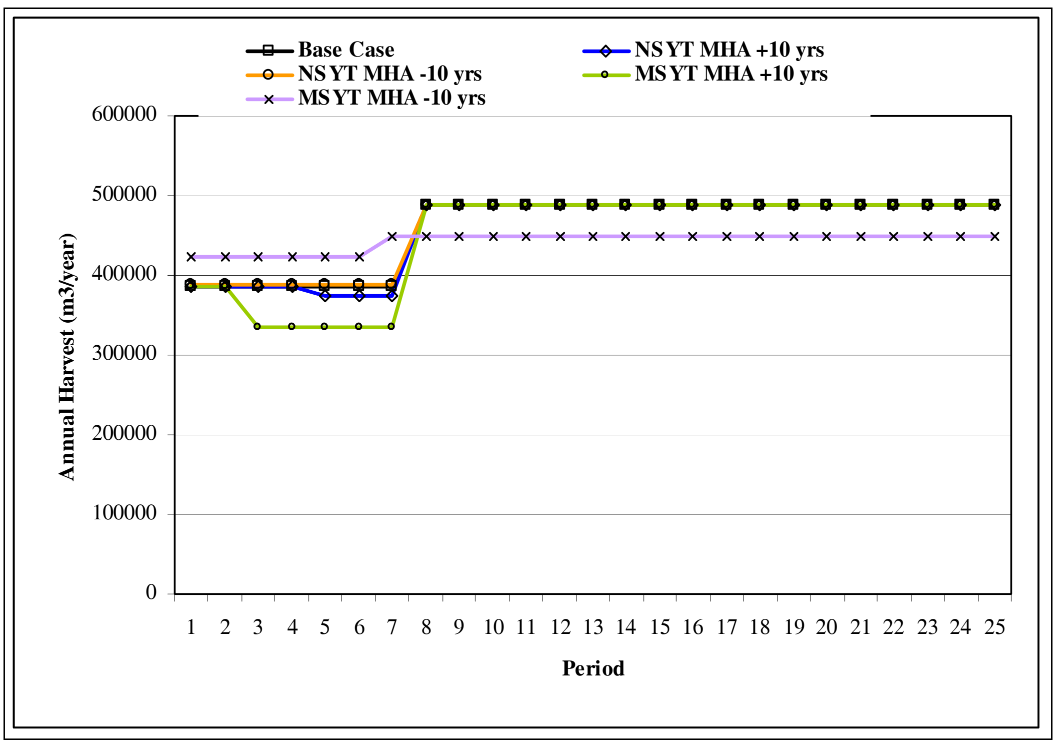

Figure 7.3 – Stand minimum harvest age sensitivity annual harvest

7.2.3 Regeneration Delay

Table 7.4 summarizes the sensitivity analyses associated with changes to regeneration delay.

Table 7.4 – Regeneration delay sensitivity analysis annual harvest (m^3/year)

Period	Base Case	Regeneration Delay +5 years	Regeneration Delay 0 years
1	385,900	385,900	390,900
2	385,900	385,900	390,900
3	385,900	385,900	390,900
4	385,900	385,900	390,900
5	385,900	364,000	390,900
6	385,900	364,000	390,900
7	385,900	364,000	390,900
8	488,600	364,000	502,600
9	488,600	453,200	502,600
10 - 25	488,600	453,200	502,600

Changes to regeneration delay have similar impacts to modifying minimum harvest age. However with regeneration delay it affects the stand achieving its specified green-up condition. Therefore small changes to regeneration delay can have a more significant impact on timber supply than similar changes to minimum harvest age.

Increasing regeneration delay by five years reduces the mid-term harvest by approximately 6% compared with the Base Case. The long-term harvest is reduced by 8%, which is caused by the influence of this adjustment on green-up requirements as well as the additional time to reach merchantable age. However the long-term harvest is still 20% above the current AAC.

Assuming regeneration delay is zero years allows a short and mid-term increase of 1% and a 3% improvement in the long-term harvest rate compared with the Base Case. Because the minimum harvest ages are the same as in the Base Case, there is no loss of productive potential as noted when the MSYT minimum harvest ages were reduced. Stands achieve green-up in less time which has a positive impact on timber availability.

Figure 7.4 displays the annual harvest levels for the regeneration delay sensitivity analyses.

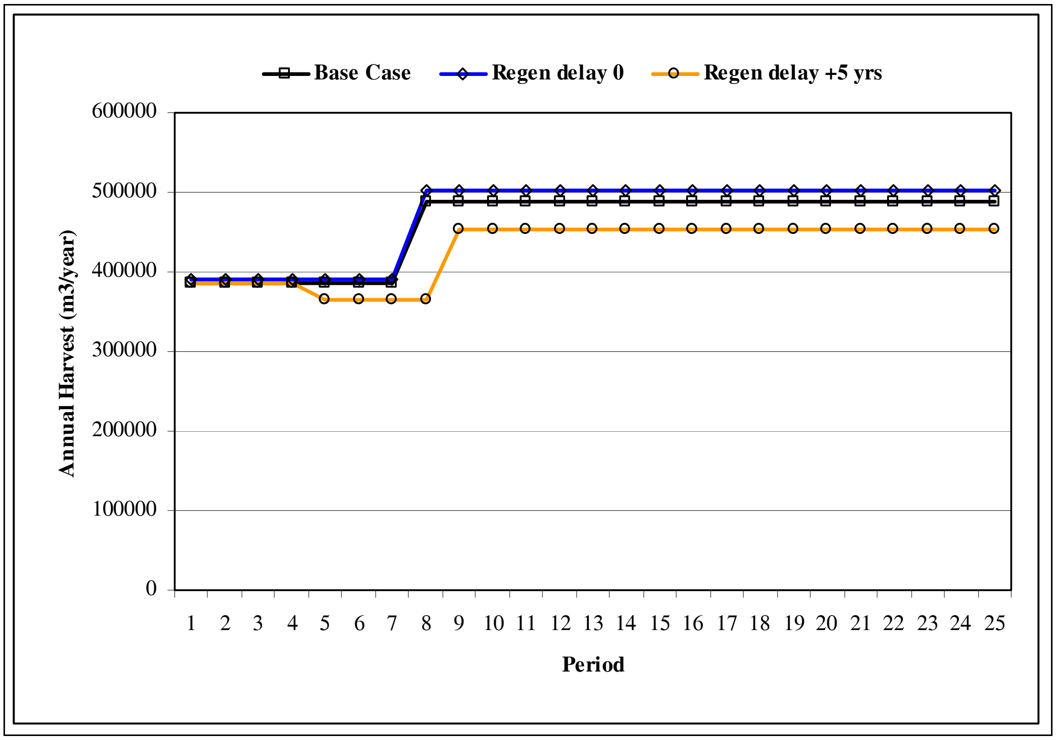

Figure 7.4 – Stand minimum harvest age sensitivity annual harvest

7.3 Forest Cover Constraints

A number of sensitivity analyses were completed which reviewed the impacts of changing forest cover constraint assumptions, including:

- Green-up height;
- Maximum disturbance percentage; and
- Minimum retention percentage.

7.3.1 Green-up Height

Disturbance constraints for many REAs were based on limits for the area less than a minimum green-up height. Table 7.5 summarizes the results of the sensitivity analyses which reviewed changes to green-up height.

Table 7.5 – Green-up height sensitivity analysis annual harvest (m^3/year)

Period	Base Case	Green-up Height +1 metre	Green-up Height -1 metre
1	385,900	385,900	390,400
2	385,900	385,900	390,400
3	385,900	385,900	390,400
4	385,900	385,900	390,400
5	385,900	374,000	390,400
6	385,900	374,000	390,400
7	385,900	374,000	390,400
8	488,600	486,600	488,600
9	488,600	486,600	488,600
10 - 25	488,600	486,600	488,600

Growth of one metre in young stands can take as little as two years or up to 11 years based on the productivity estimates used for the analysis, and the growth phase of the stand.

Increasing green-up height by one metre reduces mid-term harvest by 3%, but has minimal impact on long-term harvest. Disturbance constraints are at their upper limits in some VQO, community watersheds, and MDWR REAs during the first 70 years of simulation. Placing additional green-up requirements on these areas exaggerates this condition and forces the minor drop in harvest. Long-term harvest is not affected because the fast growing managed stands reach green-up more quickly than most stands currently established on the TFL. Also the normalized age class distribution provides a stable flow of timber for harvesting.

Reducing green-up has a minimal impact on the harvest level, allowing an increase of only 1% in the short and mid-term. This indicates that growth and yield assumptions (minimum harvest age and stand volume) are more important to the timber supply than green-up.

Figure 7.5 compares the annual harvest level for the green-up sensitivity analyses to the Base Case.

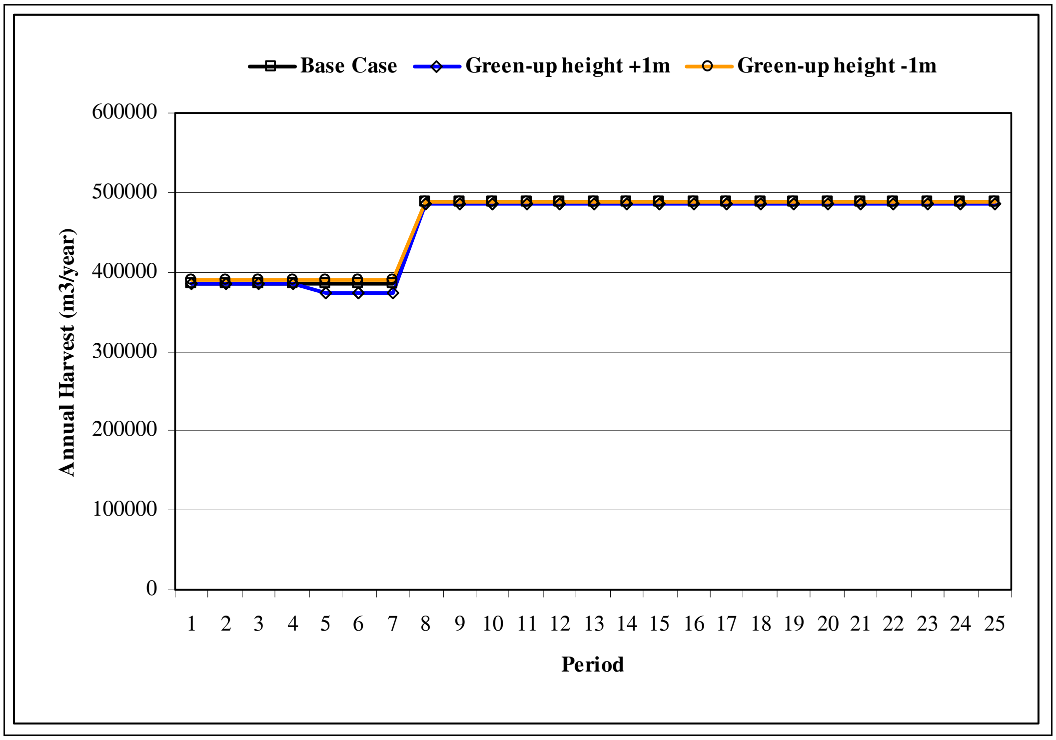

Figure 7.5 – Green-up sensitivities annual harvest

7.3.2 Maximum Disturbance

Maximum disturbance was modified in the IRM REA and remaining REAs in separate analysis simulations. In addition the community watersheds were assigned a maximum disturbance based on the current state of disturbance in and additional scenario. The results of these sensitivity analyses are presented in Table 7.6

Table 7.6 – Maximum disturbance sensitivity annual harvest (m^3/year)

Period	Base Case	IRM Disturb +5% & -5%	CWS Current State	Non-IRM Disturb +5%	Non-IRM Disturb -5%
1	385,900	385,900	385,900	391,400	385,900
2	385,900	385,900	385,900	391,400	385,900
3	385,900	385,900	385,900	391,400	385,900
4	385,900	385,900	385,900	391,400	385,900
5	385,900	385,900	374,900	391,400	359,900
6	385,900	385,900	374,900	391,400	359,900
7	385,900	385,900	374,900	391,400	359,900
8	488,600	488,600	488,600	488,600	487,600
9	488,600	488,600	488,600	488,600	487,600
10 - 25	488,600	488,600	488,600	488,600	487,600

Modifying the disturbance limits for the IRM areas, which cover 85% of the TFL, has no impact on the annual harvest rate. As shown in the Base Case results (Figure 5.9) the disturbance well below the acceptable limit for the entire planning horizon for the IRM REAs. Therefore adjusting this constraint by only 5% does not affect the timber supply.

Recent studies on some community watersheds suggest maximum limits on disturbance should not exceed the current level of disturbance. No change was required for Lambly Creek, while Hope and Norris Creek were reduced to a maximum of 1%. Powers dropped to 30%, and Silver Creek was set at 5%. These changes reduced the mid-term harvest by 3%, with no other changes in the long-term. Lambly Creek, the largest of the community watersheds, was at the disturbance limit in the early decades of the Base Case. As there was no change to the constraint for this area, the results are not significantly different from the Base Case.

Increasing the allowable disturbance in the non-IRM REAs (VQOs, watersheds, wildlife) allows a minor (1%) improvement in the short-term harvest. Some VQOs, MDWR and the Lambly community watershed are at the disturbance limit in the critical period 60 to 70 years into the future and this additional disturbance provides some additional harvesting opportunities in these areas.

Conversely, reducing non-IRM disturbance requires the mid-term harvest to decline by 7%. Additional areas reach the disturbance limit during the early decades of the simulation and therefore reduce the opportunities for harvesting until faster growing managed stands make up the majority of the TFL 90 years into the future.

During the early decades many of the non-IRM REAs are in a period of adjustment because management assumptions have changed in recent years and disturbance limits have been reduced on some areas. Similarly, green-up heights have increased. Therefore some areas must have sufficient growth of managed stands to overcome the new disturbance and green-up rules prior to further harvesting taking place. This introduces some restrictions on harvesting over the first seven decades of simulation.

Figure 7.6 compares the annual harvest level for the maximum disturbance sensitivity analyses.

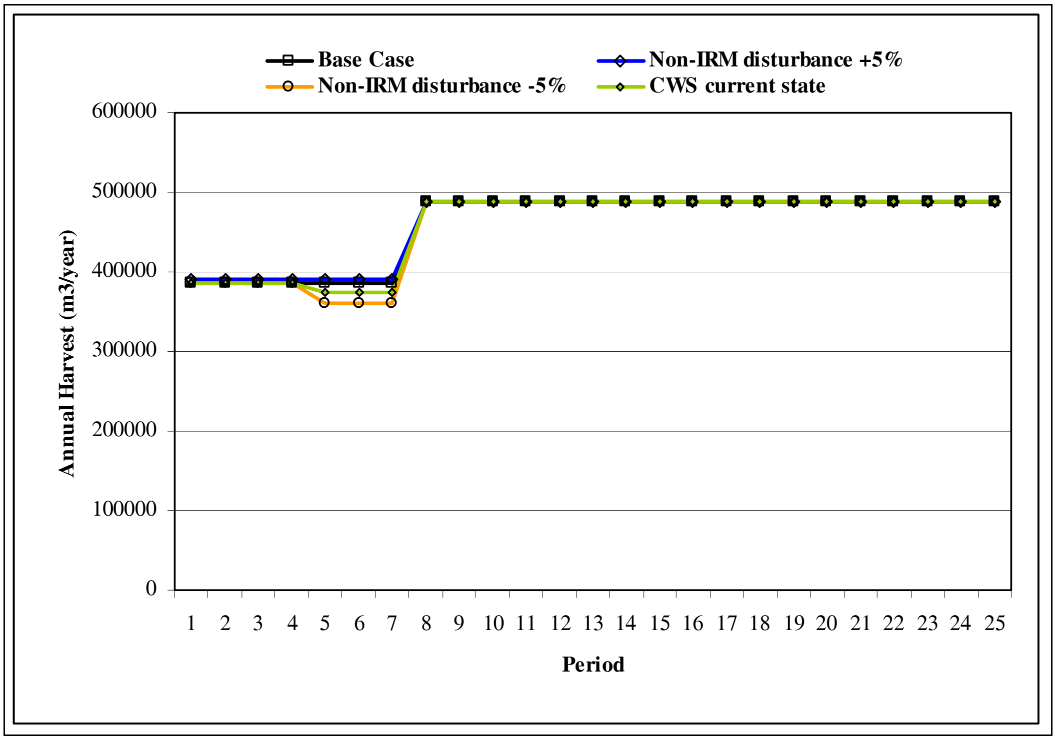

Figure 7.6 – Maximum disturbance sensitivities annual harvest

7.3.3 Minimum Retention

Table 7.7 summarizes the annual harvest rates developed for the minimum retention in wildlife REAs sensitivity analyses.

Table 7.7 – Minimum retention sensitivity analysis annual harvest (m^3/year)

Period	Base Case	Minimum Retention +5%	Minimum Retention -5%
1	385,900	385,900	389,400
2	385,900	385,900	389,400
3	385,900	385,900	389,400
4	385,900	385,900	389,400
5	385,900	371,100	389,400
6	385,900	371,100	389,400
7	385,900	371,100	389,400
8	488,600	485,600	491,100
9	488,600	485,600	491,100
10 - 25	488,600	485,600	491,100

Increasing the amount of old forest required in the wildlife REAs forces the mid-term harvest to decline by 4%. The long-term harvest level is essentially the same as the Base Case. The modest drop in mid-term harvest is caused by the requirement to place additional old timber in reserve during the first 70 years of simulation. During this same period these old stands must support the harvest prior to managed stands, currently less than 35 years old, becoming available.

There is little change in periodic harvest, less than 1%, over the 250-year planning horizon. This result indicates that other factors are more important in supporting the harvest on TFL 49, namely growth and yield inputs.

Figure 7.7 presents the annual harvest for the minimum retention sensitivity analyses in graphich format.

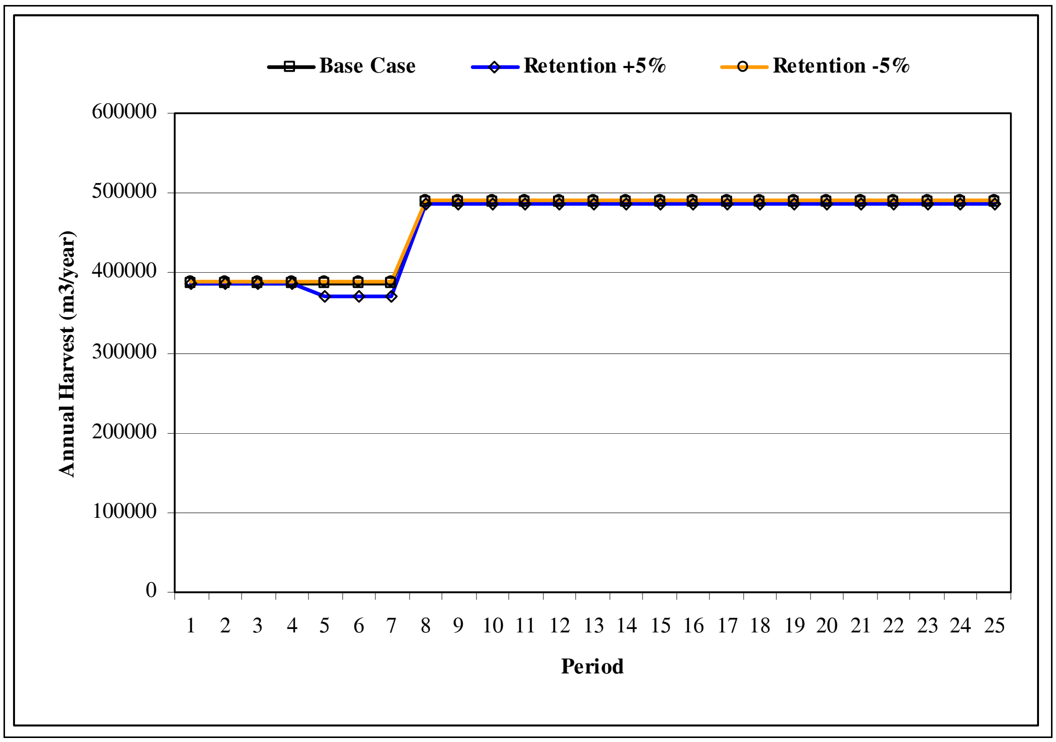

Figure 7.7 – Minimum retention sensitivities annual harvest

8.0 DISCUSSION AND CONCLUSION

All of the information and assumptions used in the TFL 49 MP No. 4 timber supply analysis are current with respect to FPC, FRPA, and new OS-LRMP guidelines, although changes to both of these may occur in the future. The Base Case indicates that a harvest rate of 385,900 m^3/year, 1.5% higher than the current AAC, is sustainable for the next 70 years. After that time a significant increase of 27% to 488,600 m^3/year is possible for the duration of the 250-year planning horizon.

As documented for the Base Case (Section 5), there is a significant increase in the harvest level estimated for TFL 49. The main factors which contribute to the improved Base Case harvest level include:

1. Mature volume adjustments. The initial mature volume is increased by 9.3% with improvements to the mature natural stand yields as documented in *Vegetation Resources Inventory Phase 2 Adjustment Procedure* (Timberline, 2002) .
2. Site index adjustments for managed stands. The recent SIBEC project provided improved site index estimates for managed stands. The findings of this study, outlined in *Site Index Correlated to Ecosystems – TFL 49* (Timberline, 2002b) allowed an average increase of four metres (26%) in site index.
3. Genetic gains for managed stands. Long-term genetic gains for each planted species were included in the future managed stand yield tables. These gains range from 12 to 26%, with an average of approximately 16% compared to planting stock without any improvements *(Tree Farm Licence 49 – Implementation Strategy for Forest Level Modelling of Genetic Gains)* (Timberline, 2003.
4. Twenty cm stump height. An increase of 1.9% was applied to all yield tables to reflect harvesting down to a 20cm stump height.
5. Old forest requirements. The OS-LRMP assigns specific area retention targets for old forest within each LU-BEC variant. These are further split into THLB and non-THLB components. Within the THLB the average old forest requirement is only 1.9%, considerably less than the requirement modelled in MP No. 3.

The results of the timber supply analysis indicate that the primary factors affecting the timber supply for the next 70 years are:

- Lack of stands currently 40 to 60 years of age; and
- Timing of availability of existing managed stands 50 to 80 years into the future.

Given this age class gap, the transition to second growth is a critical element for estimating timber supply. This is clearly demonstrated by changes to minimum harvest age and managed volume. If managed stands become available sooner than indicated for the Base Case, there is a considerable improvement to the harvest over the next 70 years. Conversely, any additional delay can have a negative affect on the harvest during this time period.

It is therefore important to have managed stands available as modelled, 50 to 70 years into the future. 95% of culmination of MAI was used as the basis for minimum harvest age and there is the possibility of reducing this age for some forest types to enhance the short-term supply without compromising the long-term harvest.

Increases to managed stand volumes improve the short-term harvest by less than 2%. However, the transition to the long-term level begins 10 years earlier, and the long-term harvest level is 9% higher than in the Base Case. Conversely reducing managed stand volumes forces the harvest downward by 5% during the critical phase 50 to 70 years into the future. Managed stand volumes are based on recent SIBEC site index values, updated genetic gains information, and new silviculture regimes. This information is based upon recent studies for TFL 49, which improves the reliability of the results.

Regeneration delay has a similar impact to changing managed stand yield minimum harvest age. Increasing regeneration delay by five years reduces the mid-term harvest by up to 6% and the long-term harvest by 8%. Small increases in harvest are achieved by removing any regeneration delay. In general it will be important to maintain regeneration delay at or lower than the current level to ensure the mid-term harvest is sustainable and provide flexibility in harvesting opportunities 50 to 70 into the future.

Adjusting natural stand yields has a considerable impact on the short-term harvest rate. The new phase 2 adjustment process recently completed for TFL 49 provided volume adjustments for the Base Case natural stand yields. The natural stand volume inputs are the most reliable used for a timber supply analysis on the TFL to date.

Many VQO, lakeshore management, and MDWR REAs reach the limit of disturbance during many periods of the simulation. Similarly, the community watersheds, of which Lambly Creek is the largest, influence the harvest during the critical period 70 years from now. Therefore adjustments to the maximum disturbance for these non-timber resource types influence the harvest during the mid-term. Short and long-term harvest rates are not affected by adjustments to these disturbance constraints.

Similarly, increasing green-up height by 1 metre reduces the mid-term harvest by 3%, but the short and long-term harvest is unaffected by this variation to the modelling inputs. Reducing green-up height by 1 metre allows a minor 1% increase in the early harvest rate but has no impact on the long-term level.

Changes to the disturbance limit in IRM REAs have no impact on the harvest level at any timber during the 250-year planning horizon.

Additional old forest retention requirements for wildlife habitat reduces mid-term harvest levels by 4%, but there is no affect on the short and long-term. Conversely, relaxing old forest requirements changes the harvest level by less than 1% over the planning horizon.

Modification to the THLB also affects timber supply in both the short and long term. Increasing or decreasing the harvestable land base makes a proportional change to the annual harvest rate throughout the planning horizon. It is possible to drop the harvest in selected periods over the first seven decades to account for the loss of THLB, thereby allowing the short-term harvest to be maintained for up to 30 years.

The sensitivity analyses indicate the growth and yield inputs, stand volume and minimum harvest age, are more important in estimating the timber supply on TFL 49 than assumptions related to non-timber resources.

The most important issue facing the TFL 49 land base is the mountain pine beetle epidemic. Many lodgepole pine stands have been attacked and there is a significant area of high-risk stands that are susceptible to attack over the next few years. A number of analysis scenarios reviewed the impact of directing the harvest over the first five to ten years of simulation into high-risk pine stands.

It is possible to direct the entire harvest into vulnerable pine stands during the first decade without impacting the harvest schedule or non-timber resources for the remainder of the planning horizon. Uplift scenarios were modelled that added up to 500,000 m^3 of high-risk pine volume to the harvest during the initial 10 years or simulation. Again there was a minimal impact, less than 2% on the mid-term harvest. In all MPB scenarios, the full compliment of Base Case management assumptions for non-timber resources were enforced. This indicates that uplift is possible without having any measurable influence on the harvest, or placing additional impact on non-timber interests, for the remainder of the planning horizon.

8.1 Conclusions

Riverside has provided improved inventory and growth and yield inputs for the MP No. 4 timber supply analysis. Updated growth and yield inputs have been used for all natural and managed stands. Managed stands incorporate revised site index estimates. In addition management assumptions have been revised since MP No. 3 to satisfy habitat and landscape level biodiversity objectives, according to the OS-LRMP.

The primary issue for TFL 49 is the mountain pine beetle outbreak, which is dictating where harvesting is taking place. It is expected that harvesting on the TFL over the next few years will focus on salvage operations in beetle-attacked timber and stands that are at risk of being attacked.

Regardless of how much influence the pine beetle has on harvesting operations for TFL 49, the current AAC of 380,000 m^3/year can be maintained for the next 70 years in a way that sustains both timber and non-timber resources. Based on the improved growth and yield estimates, the long-term harvest will likely improve dramatically once the transition to second growth is complete.

9.0 REFERENCES

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APPENDIX I

TIMBER SUPPLY ANALYSIS INFORMATION PACKAGE

OKANAGAN TREE FARM LICENCE (TFL 49)

MANAGEMENT PLAN NO. 4

RIVERSIDE
Forest Products Limited

Timberline
Forest Inventory Consultants