TFL 47 TIMBER SUPPLY ANALYSIS

Prepared for:

TimberWest Forest Corp. Ltd.

Prepared by:

Ecora Resource Group Limited

12 June 2012

File: BC0210509

15 December 2011

TimberWest Forest Corp.
Campbell River, BC

Attention: Gary Lawson, RPF

Re: TFL 47 Timber Supply Analysis Report

Dear Gary;

Here is the final draft of the Timber Supply Analysis Report for TFL 47. I have incorporated all of the feedback that you have provided through several revisions. Please let me know if you would like to see any further changes to the document.

Yours truly,

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EXECUTIVE SUMMARY

This timber supply analysis has been completed in support of the preparation of Management Plan #4 for TFL 47. TFL 47 comprises two management units (MU) located on northern Vancouver Island near Port McNeill (Bonanza Lake MU) and parts of the coastal mainland and islands in the Johnstone Strait (Johnstone Strait MU) (Figure 1). The total TFL area is 125,004 hectares. The total productive area of the TFL is 115,444 hectares. Of this, 84,601 hectares is available for timber harvesting.

Since the completion of the timber supply analysis conducted for the last Management Plan, several significant changes have occurred. These include:

- The area of the TFL has been reduced by the take-backs that have occurred under Instrument 16, Bill 24 (2007) and subsequent Forestry Revitalization Act removals.
- Four Timber Licences have reverted to the TFL and have been incorporated into the spatial dataset for this analysis.
- TimberWest carried out a Vegetation Resource Inventory (VRI) program for TFL 47. The Phase I inventory was completed in March 2007 using 2006 aerial photos. Phase II ground sampling was carried out in between 2007 and 2010, and the inventory attribute information and volumes were adjusted.
- Much of the TFL (all areas except Bonanza Lake and Quadra Island) are subject to the South Central Coast Order (SCCO) which requires that an Ecosystem-based Management (EBM) approach be taken to managing the forest.
- A site index adjustment (SIA) program was completed on TFL 47 to provide improved site index estimates for managed stands, based on a field data collection program together with a Terrestrial Ecosystem Mapping (TEM). These estimates of site productivity have been used to develop yield curves for existing and future managed stands.

To complete this analysis spatial data describing the landbase was assembled and overlaid. Yield curves were built to forecast the growth of natural and managed stands. From these datasets the forest estate model input files were produced. A base case scenario, alternative harvest flow scenario, and several sensitivity analysis runs were conducted.

The base case model was set up to find the highest even-flow harvest level that is possible while adequately managing for non-timber resources. The rate of old growth harvesting was limited to current average levels. This sustainable harvest level was found to be 617,500 cubic metres per year.

An alternative harvest flow scenario was prepared. The initial harvest level was set at the currently approved AAC level of 647,000 cubic metres per year. Attempts were made to continue this level for as long as possible. After 30 years, the level had to be decreased to the base case harvest level of 617,500 m^3/year. This is the scenario that is being recommended as the basis for the AAC determination.

Several sensitivity analysis runs were completed. The results are summarized in the table below.

Model Run	Even-Flow Harvest Level	% of Base Case
Base Case	**617,500**	**100%**
Alternative VDYP Volume Adjustment	622,000	101%
Future Yield Plus 10%	660,000	107%
Future Yield Minus 10%	588,000	95%
TIPSY Yield Using OAF1 13%	647,000	105%
TIPSY Years-to-Breast-Height	612,500	99%
SIBEC Site Index	535,000	87%
MHA Minus 10 Years	617,500	100%
MHA Plus 10 Years	612,500	99%
VQO Green-up Minus 1 Metre	619,000	100%
VQO Green-up Plus 1 Metre	612,000	99%
Reduce Stump Height	624,000	101%
Immediate EBM Old Seral Targets	545,000	88%

The sensitivity analysis runs point to several potential upward pressures on the base case harvest level. Although two potential significant downward pressures exist, credible arguments for disregarding them in establishing the AAC for the next ten years exist. Even in light of this uncertainty, robust growing stock levels and a well-balanced age class distribution would support the proposed harvest level of 647,000 m^3/year for the next ten years.

Two sensitivity analyFurthermore, two of the sensitivity analyses that provide upward pressure ('TIPSY yield using OAF1 13%' and 'Reduce stump height') are based on data collected on TFL 47. The 'Alternative VDYP Volume Adjustment' is also a very logical and defensible alternative to the default yield curve adjustment process. The combined impact of these three sensitivity analysis would raise the proposed harvest to 687,500 m^3/year.

1 INTRODUCTION

TimberWest Forest Corp. must complete a timber supply analysis for TFL 47 in conjunction with the Management Planning process that is required by legislation and the terms of the licence. An Information Package describing the spatial data, yield forecasts and management assumption that would underpin the timber supply analysis was prepared and submitted to the Ministry of Forest, Lands and Natural Resource Operations. It was accepted by the Ministry on 25 May 2011 as an adequate basis upon which to prepare timber supply forecasts for the TFL.

In accepting the Information Package, the Ministry required that the natural stand yield tables be modified. The Phase 2 volume adjustment had been applied as a constant ratio over the entire yield curve. This has been changed so that the volume adjustment factor has a diminishing impact on volume in the years following the adjustment year of 2008. These updated natural stand yield tables have been approved by the MFML.

The next step in the timber supply analysis process is the preparation of a base case. This has been done using Patchworks, a forest estate model that facilitates the preparation of data, application of management practices and other rules, and produces outputs describing the harvest flow and the future condition of the landbase with respect to timber and other resource values. The results are presented in this document, which will evolve into the Timber Supply Analysis Report that will be submitted to the Ministry of Forest, Lands and Natural Resource Operations.

Timber supply is the quantity of timber available for harvest over time. It is dynamic, not only because trees naturally grow and die, but also because conditions that affect tree growth, and the social and economic environment that affect the availability of timber for harvest, change with time. Timber supply analysis is the process of assessing and predicting the current and future supply from a management unit. This information will be used by the Chief Forester of British Columbia in determining a permissible harvest level for TFL 47.

This document presents the results of the timber supply analysis. It is based on the best available information and current management practices and represents the most likely outcome. This information, and the management assumptions that underlie the forest estate modeling, were described in the Information Package that was submitted to the Ministry of Forest, Lands and Natural Resource Operations.

2 DESCRIPTION OF THE TFL

TFL 47 if composed of two[1] management units (MU) located on northern Vancouver Island near Port McNeill (Bonanza Lake MU) and parts of the coastal mainland and islands in the Johnstone Strait (Johnstone Strait MU) (Figure 1).

[1] A third unit (Moresby Island MU) has been removed from TFL 47 since the submission of the last Management Plan.

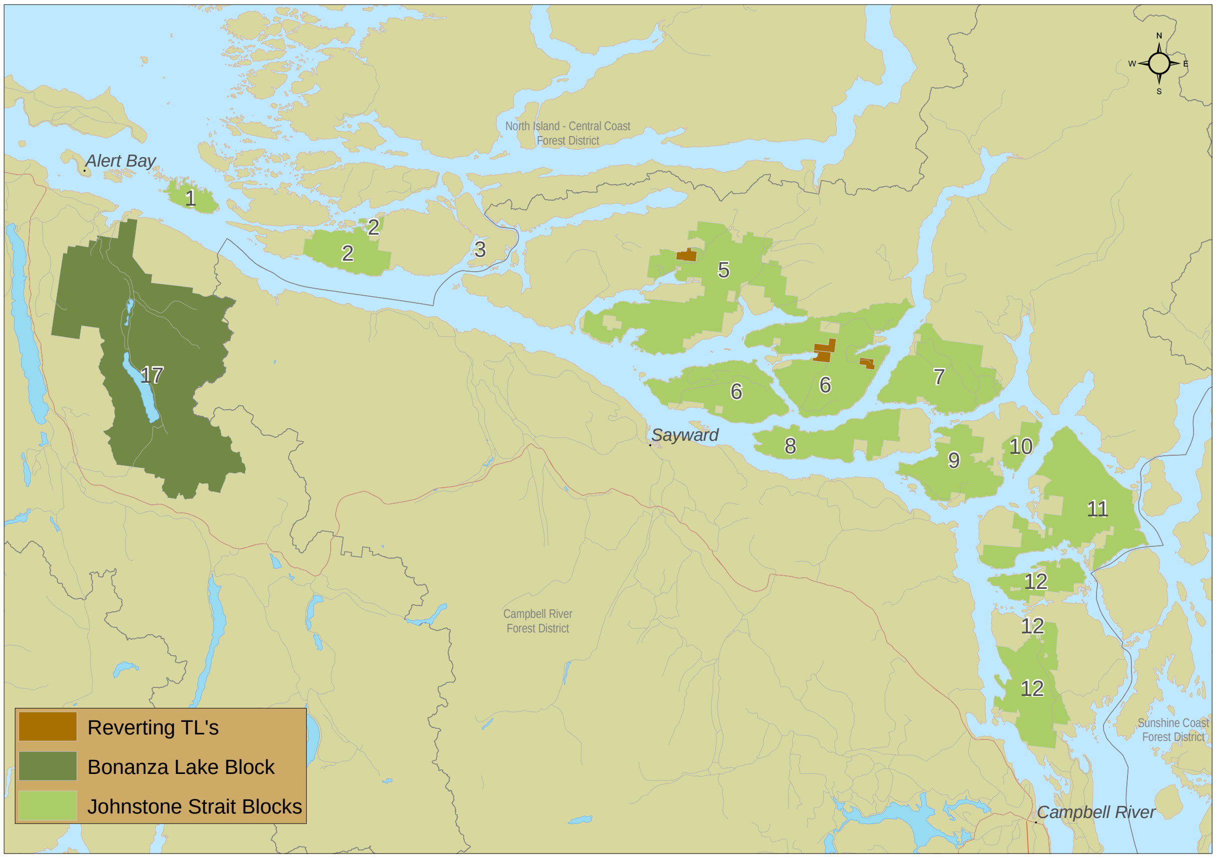

Figure 1: Location of TFL 47 Blocks

The total area of TFL 47 is 125,004 hectares. Of this, 115,444 hectares is productive[2] and 84,601 hectares is available for timber production. Table 1 shows the derivation of the timber harvesting land base (THLB) area.

[2] This excludes the productive area of Hanson Island, which is no longer managed as part of the TFL.

Table 1: Timber Harvesting Landbase Determination

	Total Area (Ha)	Productive Area (Ha)	Area Removed (Ha)
TFL Area	**125,004**	**115,444**	
Hanson Island	1,385		1,385
Non Forest	6,281	-	6,264
Roads	2,465	-	1,876
Landslides	n/a	-	34
Inoperable	12,734	10,300	10,299
Unstable Terrain	16,349	15,833	3,840
Problem Forest Type	1,261	1,253	802
Low Site	5,024	4,659	3,822
Recreation	4,442	2,535	1,100
Wildlife Habitat	2,647	2,512	2,187
Red/Blue Listed Ecosystems	4,010	3,977	2,062
ESAs	12,350	9,538	903
Marine Buffer	1,253	1,104	714
Riparian	18,496	17,691	4,427
Wildlife Tree Patches	1,512	1,475	602
Cultural Retention	n/a		85
Timber Harvesting Landbase			84,601

The TFL is distributed across seven landscape units, with over three-quarters of the area falling within the Bonanza, Fulmore and Thurlow LU's as shown in Figure 2 below.

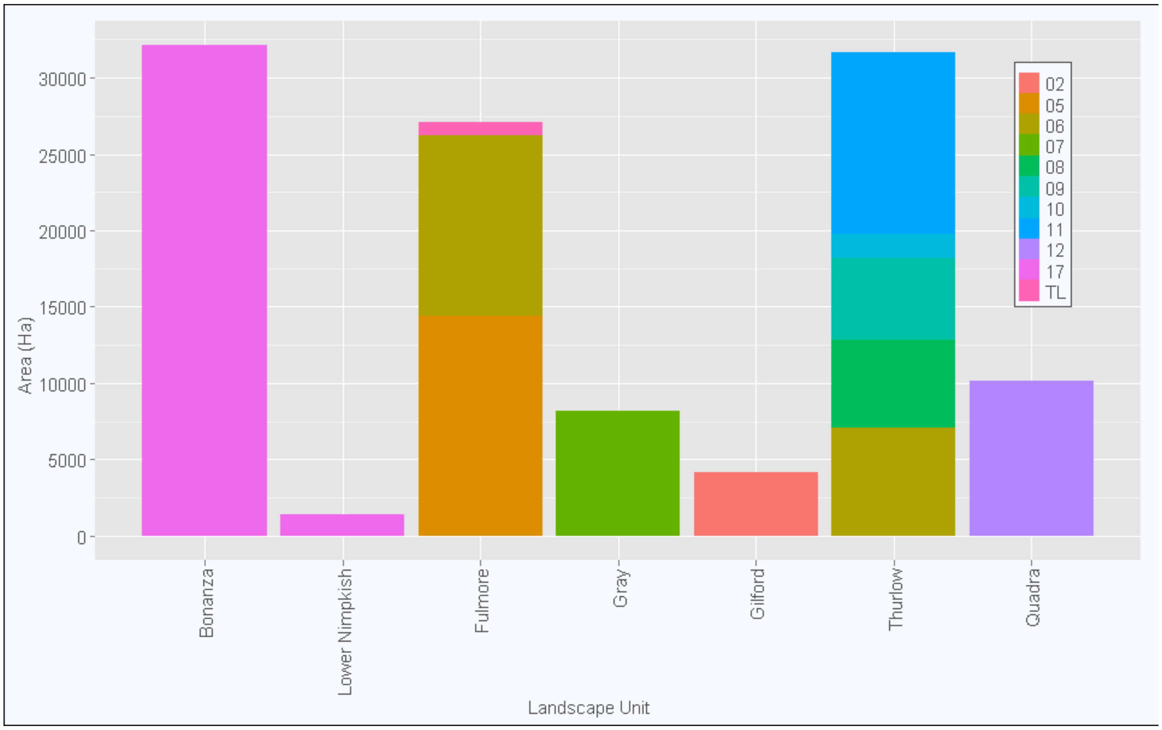

Figure 2: Productive Forest Area (ha) by Landscape Unit and Block

Only a portion of the THLB within each LU falls within the timber harvesting landbase.

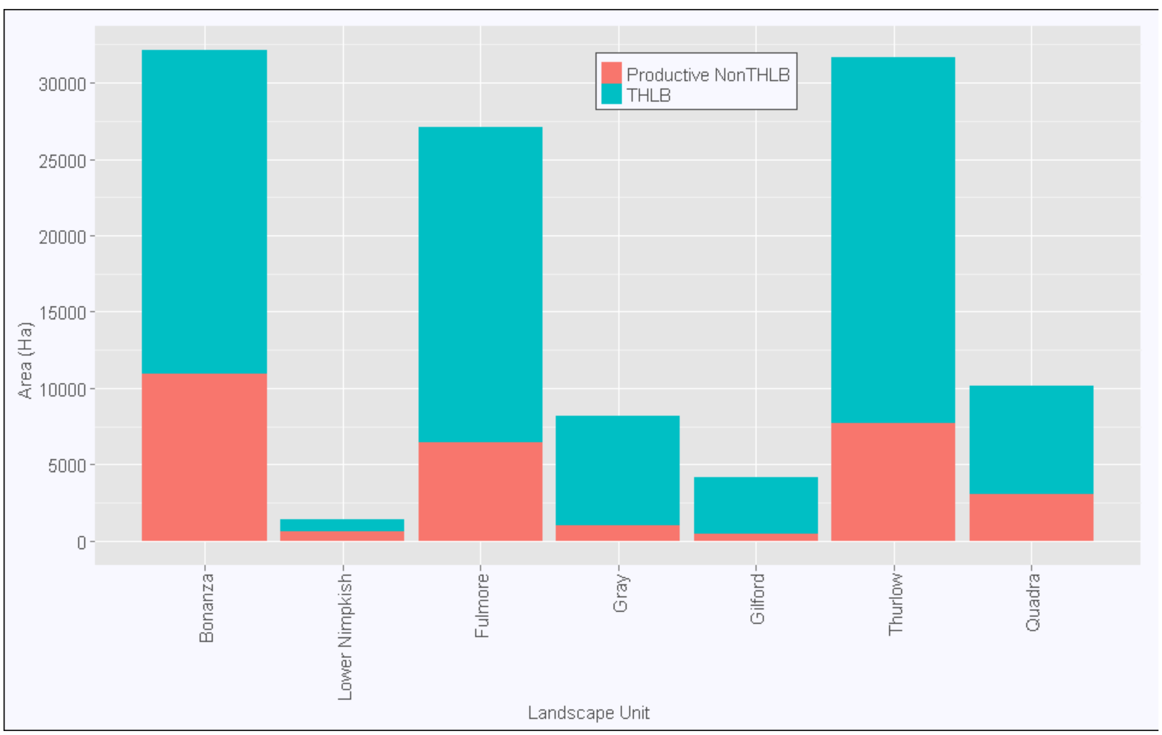

Figure 3: Productive and Timber Harvesting Landbase Area (ha) by Landscape Unit

The proportion of the productive area that falls within the THLB varies between 59% and 89%, with these extremes occurring in the smaller LU's. For the three LU's that comprise the bulk of the TFL, the THLB proportion falls between 66% and 76%.

The forested areas of TFL 47 are predominantly within the Coastal Western Hemlock (CWH) biogeoclimatic subzone at low and moderate elevations, and are bounded at the upper elevations by the Mountain Hemlock (MH) biogeoclimatic zone. Most of the productive land within TFL 47 – and virtually all of the THLB (over 90%) – falls within the CWH biogeoclimatic zone. This falls primarily into the vm1, xm, dm and vm2 subzones. Figure 4 shows this distribution.

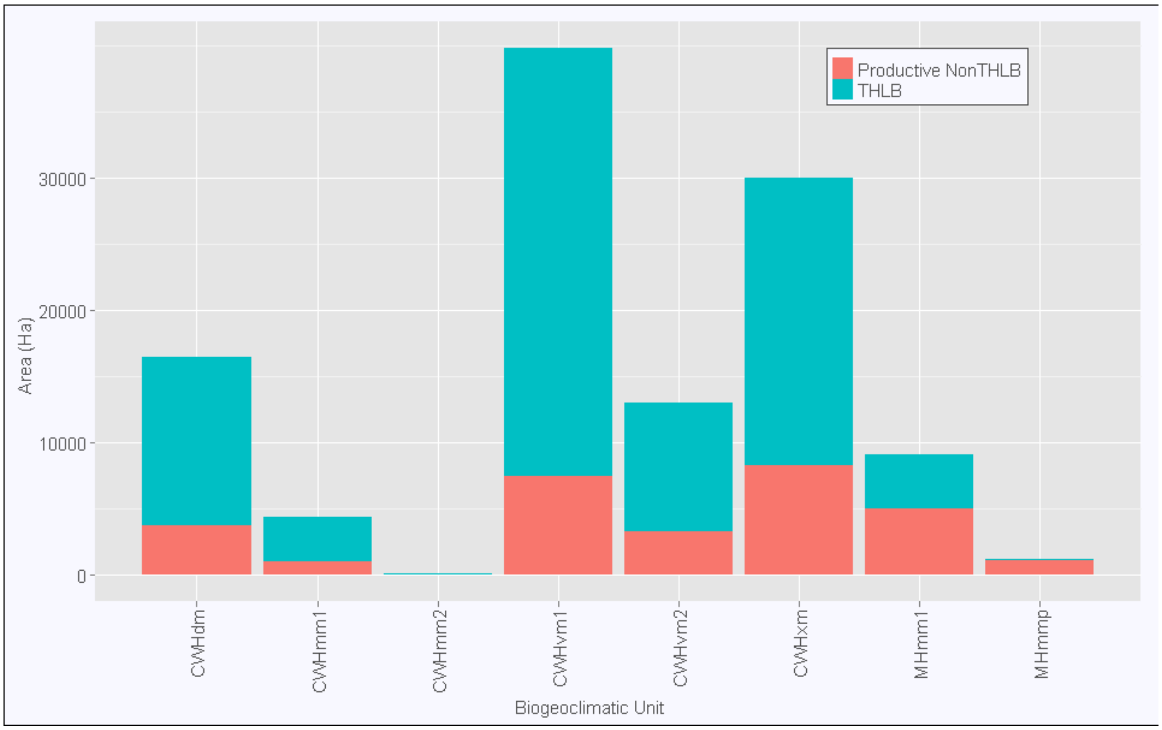

Figure 4: Productive and THLB Area by BGC Zone, Subzone and Variant

In the CWH Zone western hemlock tends to be the climax and best-adapted tree species. Not surprisingly, much of the TFL (two-thirds of the THLB) is occupied by hemlock-leading stands. Balsam-leading stands account for an additional 2% of the THLB area. According to the forest inventory data, only 18% of stands within the THLB have Douglas-fir as a leading species. As noted in the Information Package, this significantly understates the Douglas-fir proportion of the eventual harvest; the inventory labels for many immature stands include a significant component of western hemlock that will eventually be overtopped and suppress by the planted Douglas-fir. This effect was accounted for in preparing the yield tables for these stands. Most of the remaining stands on the THLB (11%) are either cedar- or cypress-leading. Figure 5 shows this distribution.

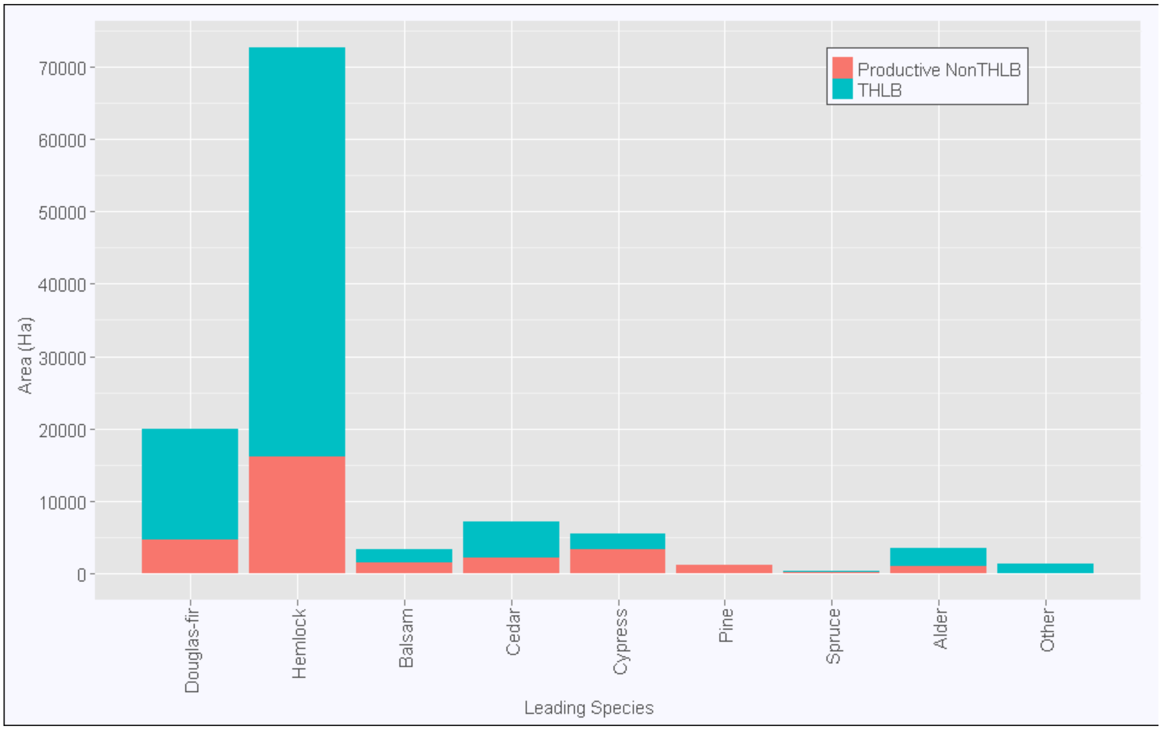

Figure 5: Leading Species Distribution of the Timber Harvesting Landbase

The productivity of the TFL is assessed by summarizing the site index for each stand in the THLB[3]. Figure 6 shows the distribution that results from summarizing the THLB and other productive area by six site productivity classes. Over 80% of the THLB area has a site index of between 20 and 35 metres. Most of the remaining area is lower productivity, with SI between 10 and 20 metres. Less than one percent of the THLB has a site index greater than 35 metres.

[3] For existing natural stands, the Phase 1 VRI site index was used. TEM-based SI was used for existing and future managed stands.

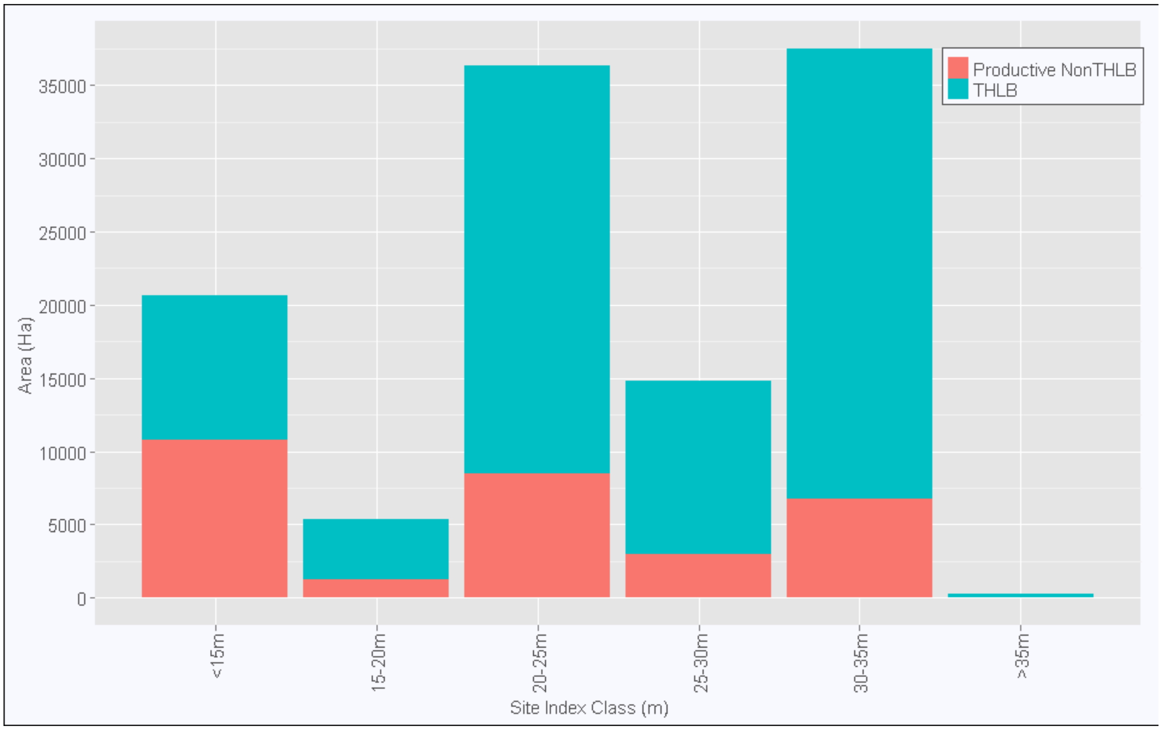

Figure 6: Site Index Distribution on the Timber Harvesting Landbase

The age class distribution of the THLB and productive non-THLB landbase is shown in Figure 7.

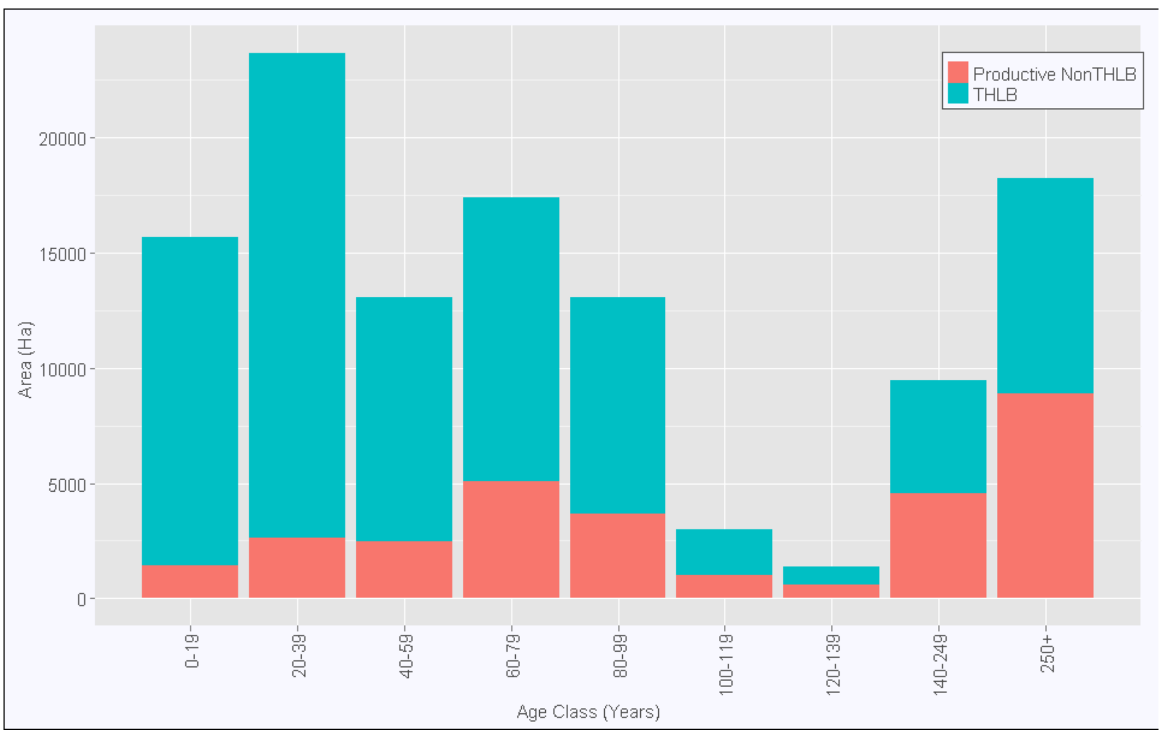

Figure 7: Age Class Distribution on the Timber Harvesting Landbase

This age class pattern is typical of Coastal forests that have a history of harvesting. Since natural stand-regenerating events are uncommon and limited in area when they do occurs, most stands reach very high ages. This is reflected by the right-most bar in Figure 7, which shows that 11% of the THLB is in the 250+ age class and that any additional 6% is older than 140 years. Stands younger than this almost always originate from past harvesting. This is particularly true for stands less than 100 years of age (the first five bars in Figure 7) which account for 80% of the THLB.

Management objectives for TFL 47 recognize the importance of non-timber resources such as biodiversity, wildlife habitat and visual quality. In some areas, protection of these resources requires will have an impact on timber harvesting. Stands in the timber harvesting landbase are not unconditionally available to contribute to timber supply once they achieve minimum merchantability criteria. Within the forest estate model, constraints have been applied to address these objective, which are listed in Table 2

Table 2: Management Objectives

Objective	Land Base Definition
Seral Stage Targets – Non-EBM	Productive land within each LU-BGC Subzone/Variant
Seral Stage Targets - EBM	Productive land within each site series surrogate
Visual Quality Objectives (VQO)	CFLB within each LU / VQO class
Fisheries Sensitive Watersheds	Productive land within the identified fisheries sensitive watersheds
Integrated Resource Management (IRM)	THLB without VQO targets within each LU

3 BASE CASE RESULTS

Timber supply analysis has been conducted using the Patchworks spatial optimization model. Patchworks is a spatially explicit harvest scheduling optimization model developed by Spatial Planning Systems in Ontario. It is capable of developing spatially explicit harvest allocations that explore trade-offs between a broad range of conflicting management and harvest goals.

For this analysis Patchworks has been formulated to schedule blocks for harvesting based on maximizing harvest volume over the long-term subject to meeting non-timber and other management objectives on the land base. The model has been run over planning horizon of 250 years (starting in 2010) using five-year planning periods.

Patchworks uses a simulated annealing approach to harvest scheduling. Consequently, there are no harvest rules in the conventional sense (e.g. oldest-first or minimize growth loss). However, merchantability limits are set up such that no stands may be harvested before they have achieved a harvestable volume and an average stand diameter of 30 centimetres. The harvestable volume threshold was 150 m^3/hectare on slopes up to 30% and 250 m^3/hectare on slopes above 30%. In addition, stands must reach at least 90% of culmination mean annual increment (MAI) before they can be scheduled for harvest.

Growing stock constraints have been applied to the last 50 years of the planning horizon to ensure that the harvest forecast is sustainable. Normal growing stock levels were calculated based on the future managed stand yield tables, and under the assumption that for each of the 17 analysis units stand area would eventually be evenly distributed between age zero and culmination age. The growing stock level was determined to be 23.4 million cubic metres (for the THLB only). The constraint applied prevented the growing stock from falling below this level at the end of the planning horizon.

Preliminary forest estate model runs resulted in high harvest level in old growth timber. TimberWest staff did not feel that this was realistic based on current market conditions and operational practice. For the final base case run documented here, a limit of 20% was applied to harvesting in old growth[4].

No allowance has been made for non-recoverable losses. These are adequately accounted for by the operational adjustment factors that have been applied during the construction of the managed stand yield tables.

3.1 Harvest Level

The model has been set up to find the highest even-flow harvest level that is possible while adequately managing for non-timber resources. This level was found to be 617,500 cubic metres per year. Long run sustained yield calculations demonstrate that, in the absence of non-timber constraints, a long term harvest level of 774,000 m^3/year would be possible.

Figure 8 shows this harvest flow. It also shows how harvesting proceeds from Existing Natural to Existing Managed to Future Managed stands. Initially, the entire harvest comes from Existing Natural stands which, by definition, were established prior to 1975. A proportion of these are old growth stands to which a harvest limit of 128,000 m^3/year has been applied. Existing Natural

[4] This 20% limit was based on the current AAC of 640,000 cubic metres per year, resulting in an old growth quota (stands older than 250 years) of 128,000 m^3/year. This is not a requirement that 20% old growth be harvested in each period, but rather a limit on the maximum amount of old growth that can be harvested in any period. Old growth outside of the THLB will, of course, not be scheduled for harvest.

stands represent a steadily decreasing proportion of the harvest up to period 20, at which point they contribute only 2%. Between periods 27 and 29 – and again between periods 37 and 41 - the proportion rises slightly as stands that were tied up to meet non-timber resource constraints become available. From period 25 to period 50, Existing Natural stands account for about slightly over 2% of the harvest on average.

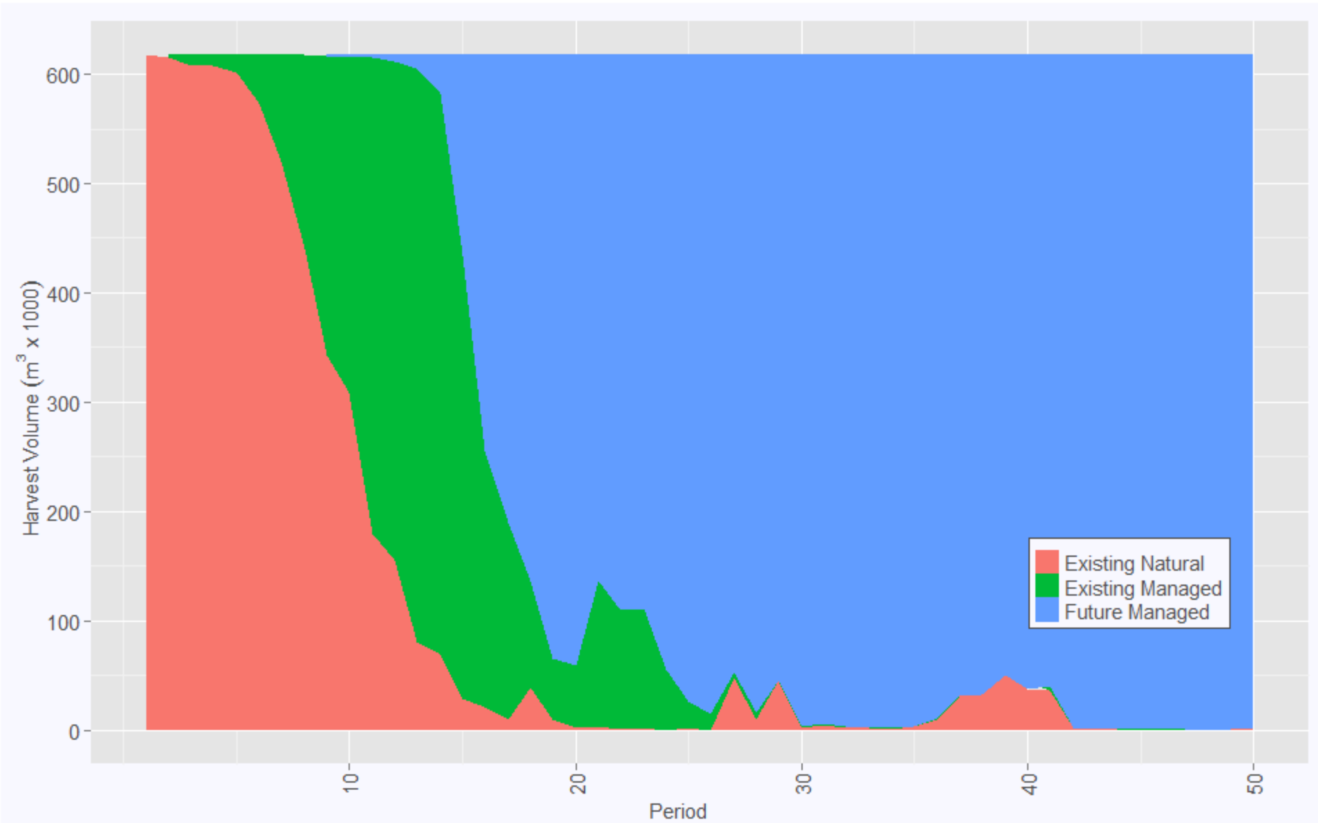

Figure 8: Base Case Harvest Flow – Cubic Metres per Year

Existing Managed stands are those established after 1975. As such, the oldest of them are 35 years of age at the start of the simulation. Those on the most productive sites reach a merchantable condition very early in the planning horizon.

The long-term harvest level is determined by the productive capacity of the landbase. If timber were the only resource value being managed, the timber supply model would find a long-term harvest level very close to LRSY. The LRSY value for TFL 47, based on managed stand yield tables that incorporate genetic gain estimates, is approximately 774,000 cubic metres annually. The base case harvest falls well short of this level. This is due primarily to the fact that harvest rates are limited by old seral constraints (both inside and outside of the EBM area) and the need to protect visual resources.

Attempts were made to increase harvest levels above 617,500 m^3/year, but these failed. Many stands that are currently merchantable cannot be harvested due to the non-timber constraints mentioned above. In addition, the requirement that no more than 128,000 cubic metres be harvested from old growth stands in any year further limits the supply of timber slightly through the first several planning periods.

3.2 Growing Stock Trends

Figure 9 show how growing stock levels vary over time. The blue region represents stands outside of the THLB. The red and green regions show the volume in stands on the THLB – above and below minimum harvest age respectively. The TFL has a significant amount of growing stock volume above MHA throughout the planning horizon. At no point does it fall below twenty million cubic metres. This result follows from a good starting age class distribution and limitations on the rate of harvest that are required to meet non-timber resource objectives. Timber supply on TFL 47 is never constrained by a lack of timber above MHA; there is not obvious pinch-point in merchantable stands.

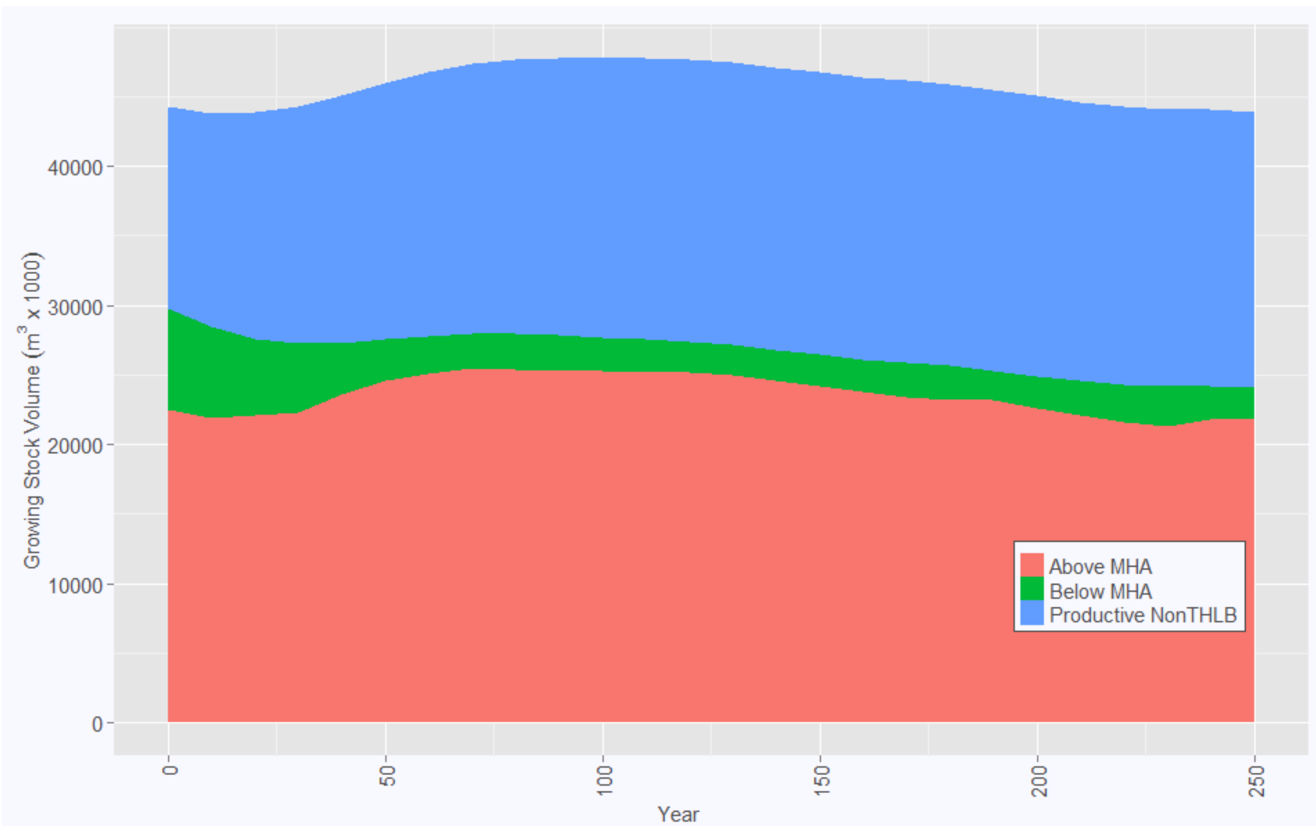

Figure 9: Base Case Growing Stock Trends

3.3 Harvest Statistics

Three harvest statistic summaries are particularly useful and commonly examined when considering timber supply dynamics for a forest tenure: average annual harvest area, average volume per hectare harvested, and average harvest age. Changes in these parameters over the entire planning horizon are presented in the following three charts.

Average annual harvest area averages 882 hectares over the entire 250-year planning horizon. The lowest annual harvest area is 718 hectares in period 11. Excluding the first two and last six periods, it is below 1000 hectares per year in each five-year planning period. Figure 10 shows these trends.

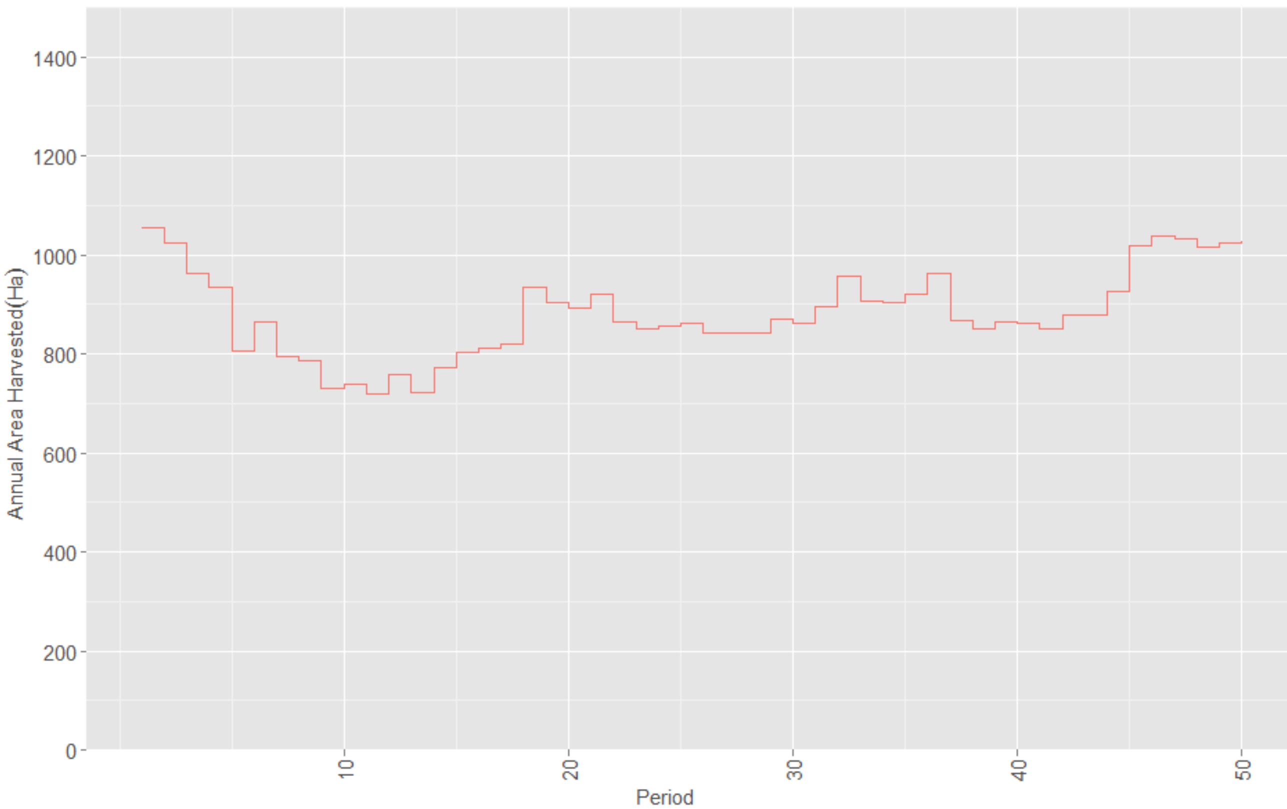

Figure 10: Average Annual Area Harvested

The trend in average annual volume per hectare harvested is shown in Figure 11. In broad terms, it is approximately 697 m^3/hectare over the planning horizon. It is depressed slightly in the first few periods as the model schedules lower-volume old growth stands for harvest and converts these sites to higher-performing managed stands. It falls again at the end of the planning horizon as harvesting moves into younger, lower volume stands. Otherwise, it is quite stable, ranging only 16% below and 22% above the average level.

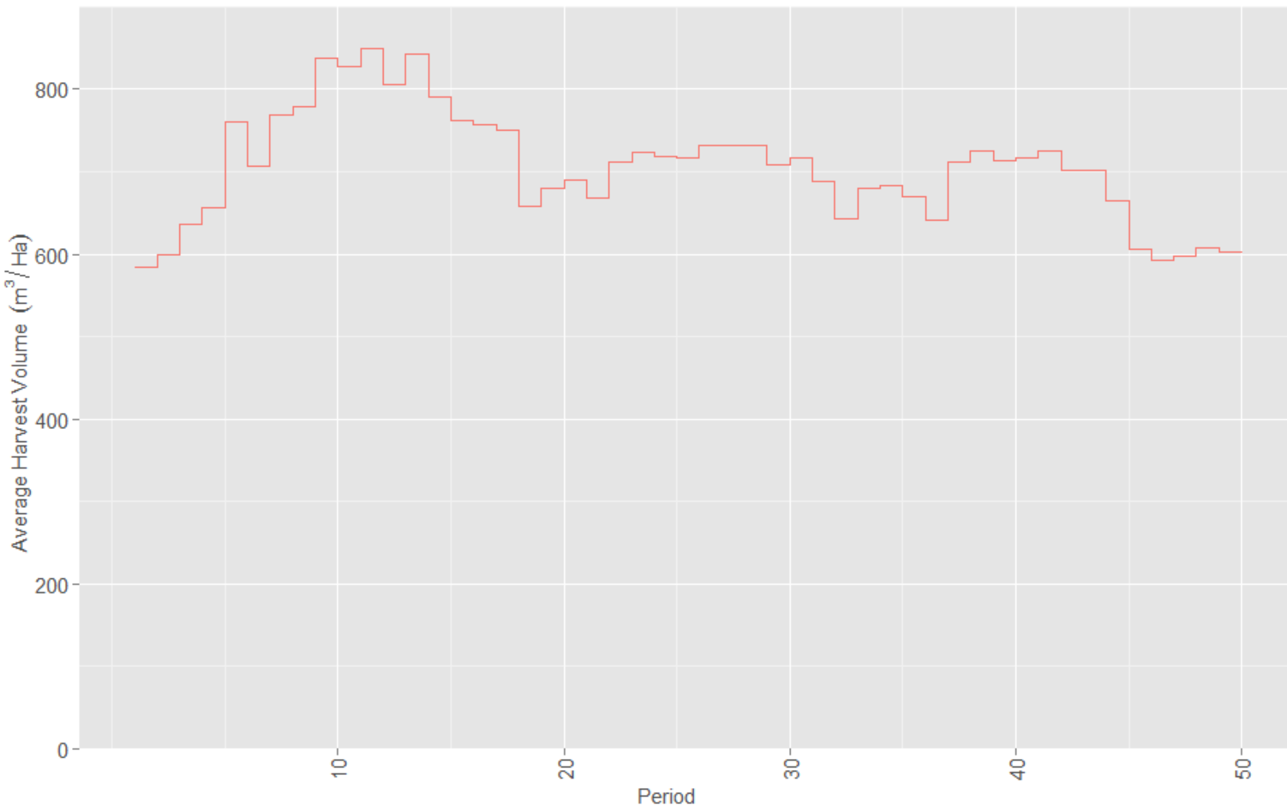

Figure 11: Average Volume per Hectare Harvested

Figure 12 shows the trend in average harvest age. It is high initially as remaining old growth stands on the timber harvesting landbase are logged. It declines steadily as the oldest of these stands are logged. It falls significantly at period 10 once the last of the remaining old growth is harvested. Without this restriction on the rate of old growth harvesting, harvest age would start out higher and decline more rapidly. After period 10, harvest age averages 87 years, ranging between 62 and 107 years. Over the last 50 years of the planning horizon, average harvest age is 80 years.

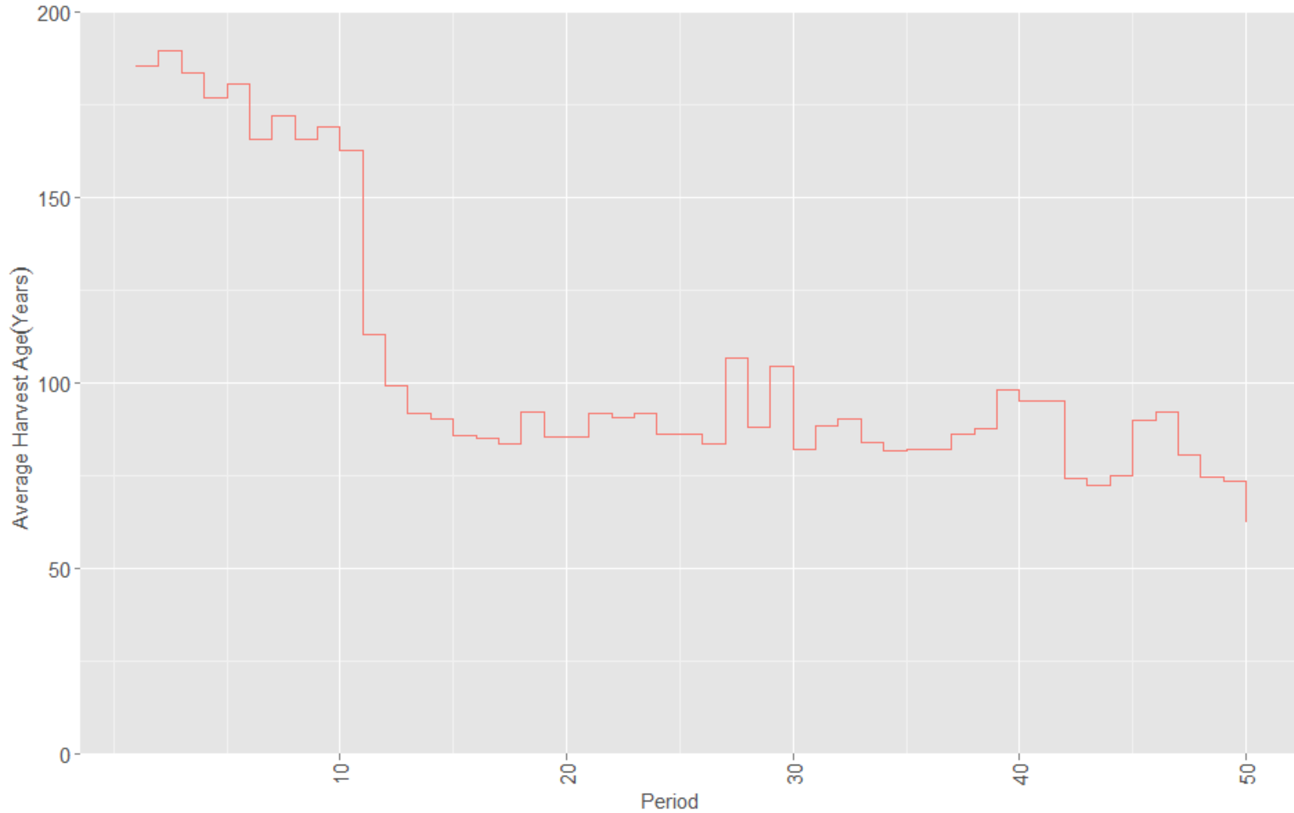

Figure 12: Average Harvest Age

3.4 Future Age Class Distribution

The impact of the proposed base case harvest level on the landbase can be evaluated by observing how the age class distribution of the timber harvesting landbase changes over time. Harvesting at fixed rate should serve to normalize the age class distribution over time. By the end of the planning horizon, 82 percent the THLB area is well distributed among the first four twenty-year age classes. The remaining 18 percent is carried for a longer rotation to meet biodiversity requirements. Figure 13 shows this growing stock pattern on TFL 47.

The productive forest landbase outside of the THLB continues to age throughout the planning horizon. As such, it is largely in an old growth condition by the end of the simulation. Figure 14 shows the current and future age class distribution for the entire productive landbase – both the THLB and productive non-THLB lands.

A harvest target at or near LRSY (subject to retention requirements to meet other resource objectives) should limit the number of stands carried past classical rotation age. Because the base case harvest level is well below LRSY, most stands are being harvested at ages beyond the point at which MAI culminates.

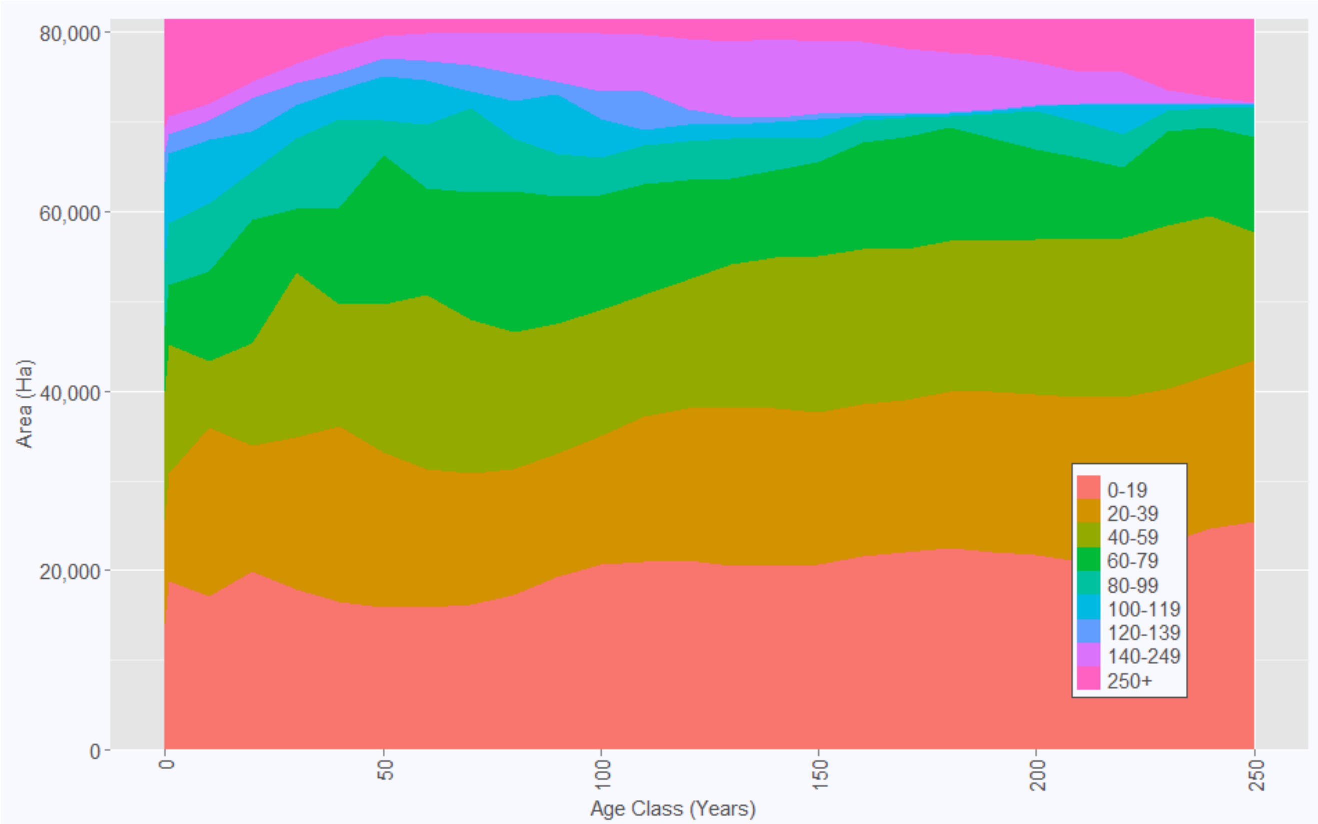

Figure 13: Current and Future Age Class Distribution - THLB

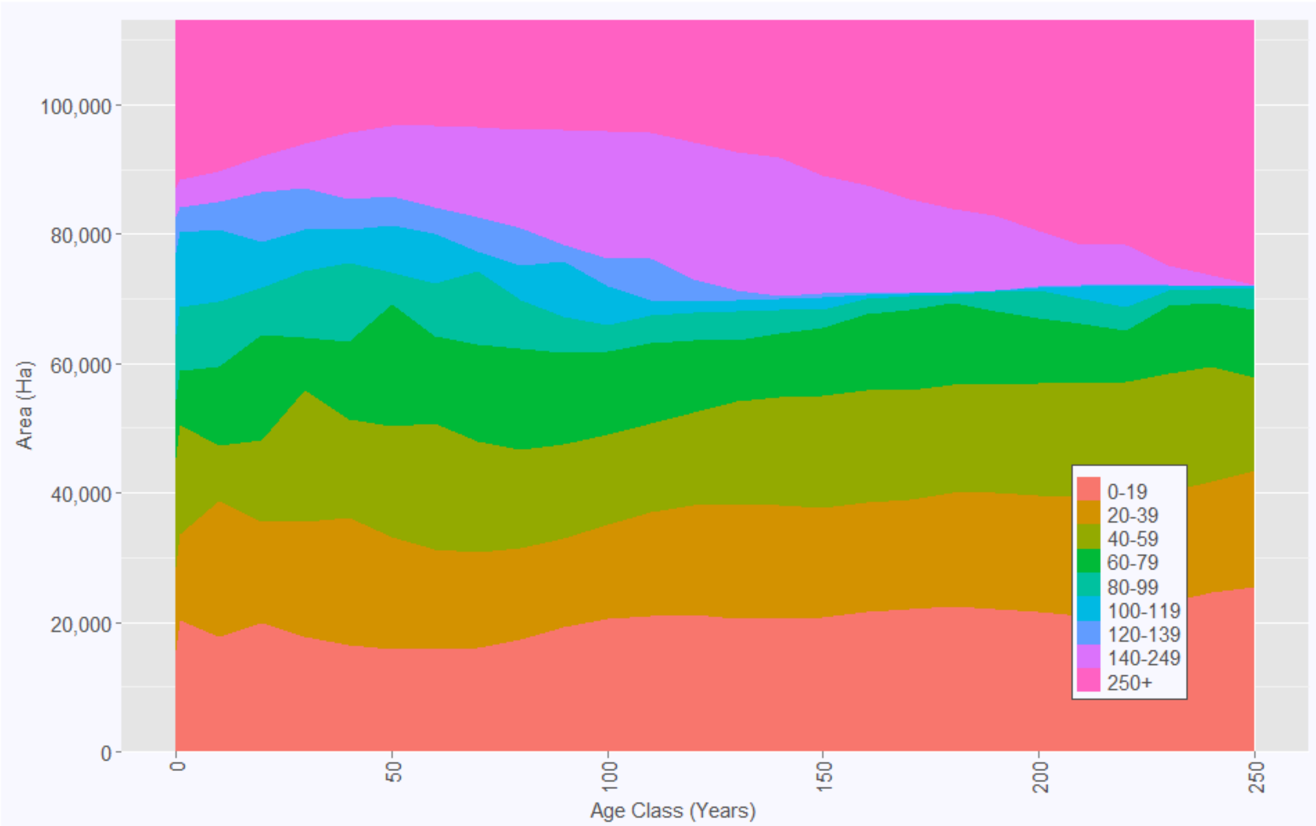

Figure 14: Current and Future Age Class Distribution – Productive Land

3.5 Mid and Old Seral Trends in the EBM Area

Within the area subject to the SCCO, mid and old seral targets must be achieved. These are applied by landscape unit, biogeoclimatic subzone and variant and leading species.

Mid seral target have been applied to all periods in the planning horizon. Generally speaking, this constraint impacts better sites (site class G) and not poorer sites; medium sites occasionally reach the disturbance limit. The limit is reached more often in fir than in hemlock and cedar stands. Only a very small area is up against the limit at the start of the planning horizon. When the disturbance limit is reached, it tends to happen between period 6 and period 12 – from 30 to 60 years in the future. The mid-seral constraint does not appear to impact timber supply in the long term – that is any time after period 15.

Old seral targets in the EBM area impact timber supply significantly. For those units in a deficit condition, existing old seral is unavailable for harvest for the entire planning horizon. The old seral target is only applied for the final five-year planning period. It is clear, in reviewing the individual constraint graphs, that the forest estate model is scheduling harvesting is such a way that the target is only just met in the final period. This trend is more pronounced on better sites. On poorer sites a larger component of the old seral requirement is met from the productive, non-contributing landbase (since lower sites are more likely to have been netted out of the THLB).

For those areas not currently in deficit, the old seral limit is approached over the first half of the planning horizon. In many cases (most commonly on better sites) harvesting keeps the actual value very near the target value for the remainder of the planning horizon.

4 ALTERNATIVE HARVEST FLOW

Given the balanced age class distribution of the TFL and the need to manage for non-timber resource values, the options for alternative harvest flows are limited. A slightly elevated initial harvest level has been examined for two reasons:

1) Timber yield from the TFL would be improved slightly if the standing volume on the TFL could be reduced to ‘normal’ growing stock levels more quickly than occurs in the base case.
2) The base case harvest level is below the current administratively adjusted AAC.

Only a small increase in initial harvest level was possible; it can be raised to 647,000 cubic metres per year (approximately the current administratively adjusted AAC) for 30 years without jeopardizing long term harvest levels or adversely impacting non-timber values. Figure 15 shows this flow compared to the base case harvest level of 617,500 m3/year.

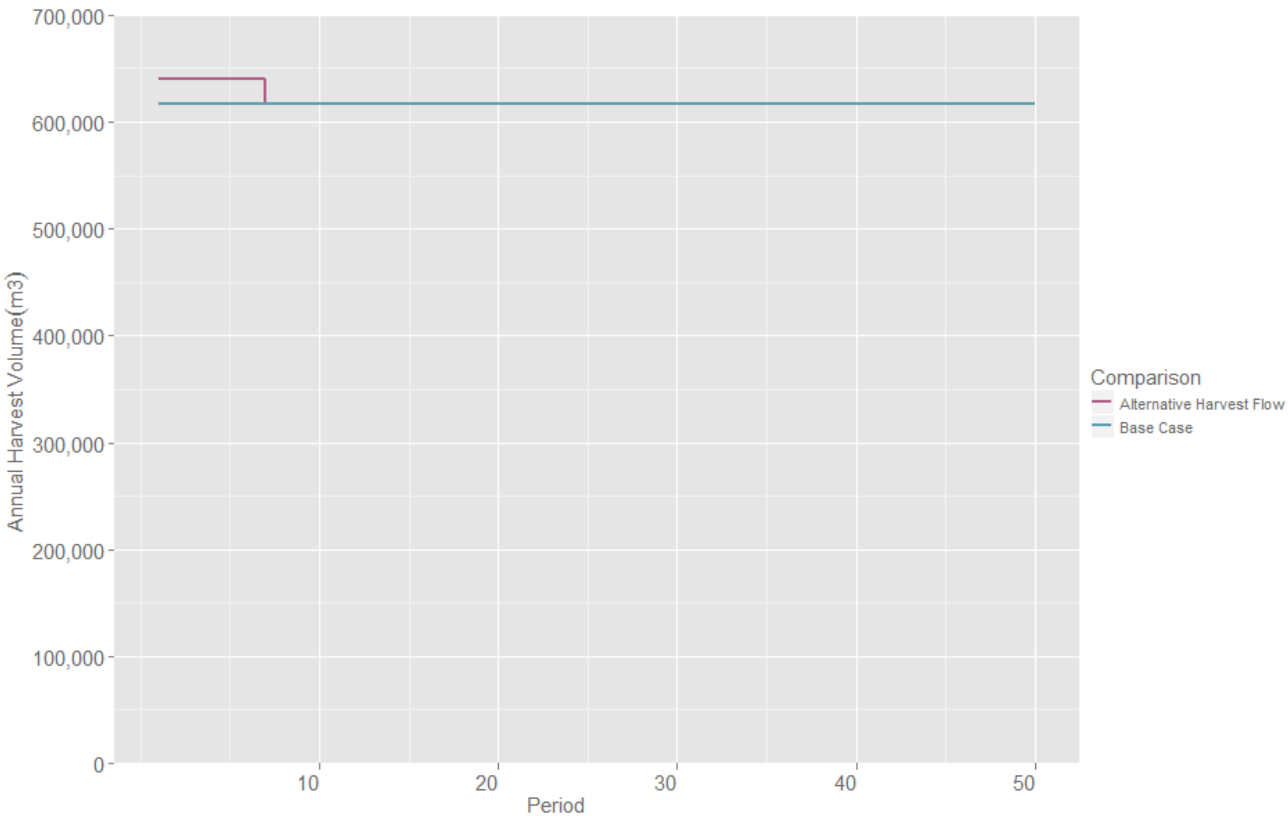

Figure 15: Alternative Harvest Flow

5 SENSITIVITY ANALYSES

Sensitivity analysis provides a measure of the upper and lower bounds of the base case harvest forecast that reflects the uncertainty in the data and/or the management assumptions made in the base case. The magnitude of the increase and decrease in the sensitivity variable reflects the degree of uncertainty surrounding the assumption associated with that specific variable. The results of the sensitivity analyses that were conducted are summarized in Table 3.

5.1 Stand Yield Variation

Estimates of stand yield form the core of a timber supply analysis. Stand yield forecasts for this analysis were developed using VDPY and TIPSY. These yields, for existing and future stands, are subject to uncertainties that arise from inventory inputs, changing silvicultural practices, uncertain site productivity and the limitations of the individual models.

Five sensitivity analyses were run in an effort to present the potential impacts on timber supply of the uncertainty attached to estimates of individual stand yield. These are:

1) Alternative VDYP Phase 2 Adjustment
2) Future stand yields +/- 10%;
3) Managed stand yields based on a TIPSY OAF1 of 13%;
4) Managed stand yields based on SIBEC; and
5) TIPSY default years-to-breast height.

5.1.1 Alternative VDYP Phase 2 Adjustment

The method for applying the Phase 2 volume adjustment to the natural stand yield tables was the subject of considerable discussion with the Forest Analysis and Inventory Branch staff during the course of this analysis. The yield curve volume adjustment protocol used with for VDYP6 resulted in a constant volume adjustment ratio being applied across the entire curve. With VDYP7 the adjustment factor varies with age. It is greatest for each stand in the year that the Phase 2 data was collected, and decreases after that point. This causes the yield curve to steadily revert to the unadjusted VDYP7 volumes over a period of time.

While this approach seams reasonable for thrifty second growth stands – where self-thinning and in-growth might cause a stand to return to a 'normal' condition – it leads to an odd result for odd growth stands. Because the volume adjustment factor is less than one, the volume of these stands declines beginning in 2008[5]. The starting age for this decline is arbitrary – whatever age the stand happened to be in 2008.

To counteract this decline, for this sensitivity analysis the Phase 2 volume adjustment factors was applied in a constant fashion to any existing stands 200 years of age or older. At the start of the planning horizon these stands would have the same volume. In the base case, the volumes

[5] Anomalous results would also result if the adjustment factor is greater than one. Volumes would begin to increase starting in 2008.

decline to the Phase 1 attribute adjusted level (unless the stand is harvested first). For this sensitivity the volumes do not decline. This makes slightly more volume available in the short term while old growth stands are being scheduled for harvest. When the model is rerun with these adjusted yield curves, an increased harvest level of 622,000 m^3/year is possible. Figure 16 shows this result.

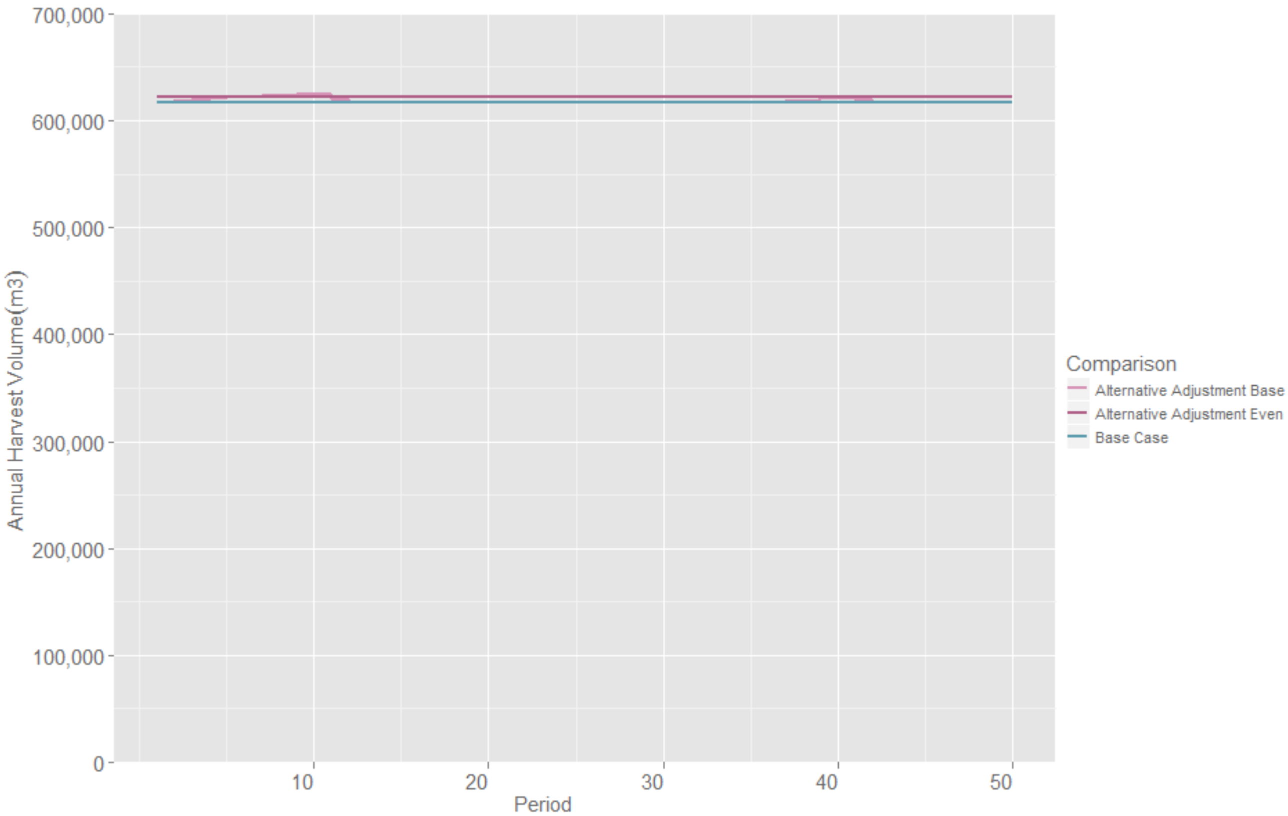

Figure 16: Sensitivity – Unadjusted Volumes for Stands 200 Years or Older

5.1.2 Future Stand Volumes Plus / Minus 10%

When future stand volumes are increased by 10%, the harvest level increases by 6.9% to 660,000 cubic metres annually. When they are reduced by 10%, the harvest level falls by 4.8% to 588,000 m^3/year. The results are summarized in Figure 17.

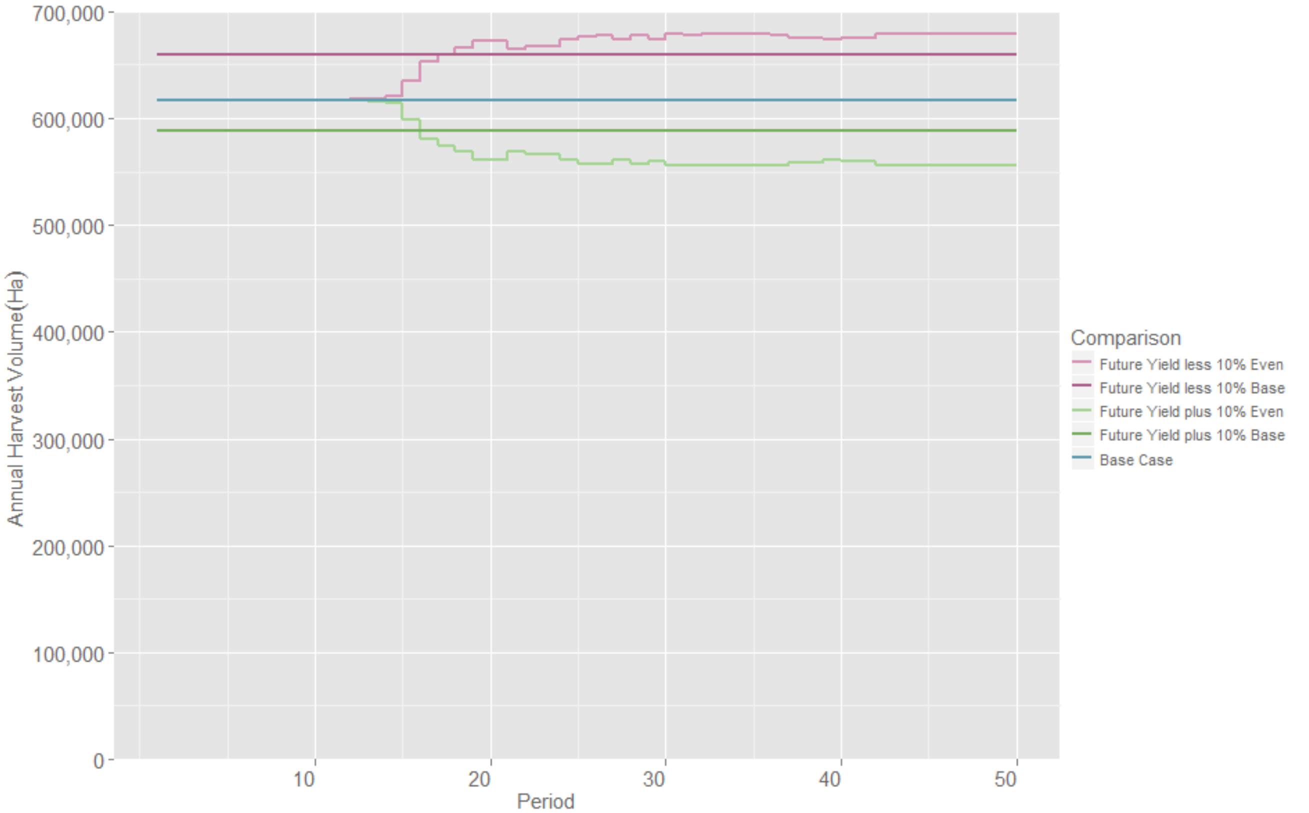

Figure 17: Sensitivity – Future Yield Plus/Minus 10%

The blue line represents the base case harvest level. The dark lines show the even flow harvest levels that were achieved when future stand yields were increased and decrease by 10%. This was accomplished be preparing an adjusted set of yield tables for each case. The lighter coloured lines on this chart show the volume that flows from the base case harvest schedule when these alternative yield tables are applied to the base case.

5.1.3 Managed Stand Yields Based on OAF1 of 13%

Both field survey data and operational experience support the notion that managed stands are more fully and evenly stocked than the default managed stand yield tables would indicate. TIPSY accepts as input two operational adjustment factors to account for gaps in the stand (OAF1) or growth reductions (OAF2). The default values generally used for timber supply analysis are 15% and 5% respectively. This default OAF1 values is very conservative and is not reflective of the condition of managed stands on TFL 47. TimberWest compiled recently collected survey information to show that an OAF1 value of 13% can easily be justified. TIPSY was rerun with this OAF1 value as input and an alternative set of yield tables was produced. These were used for this sensitivity analysis. Stand yield increase by an average of 4.1% at culmination, and this led to a 4.8% increase in timber supply. The harvest level increased 29,500 cubic metres per year. This result is shown in Figure 18.

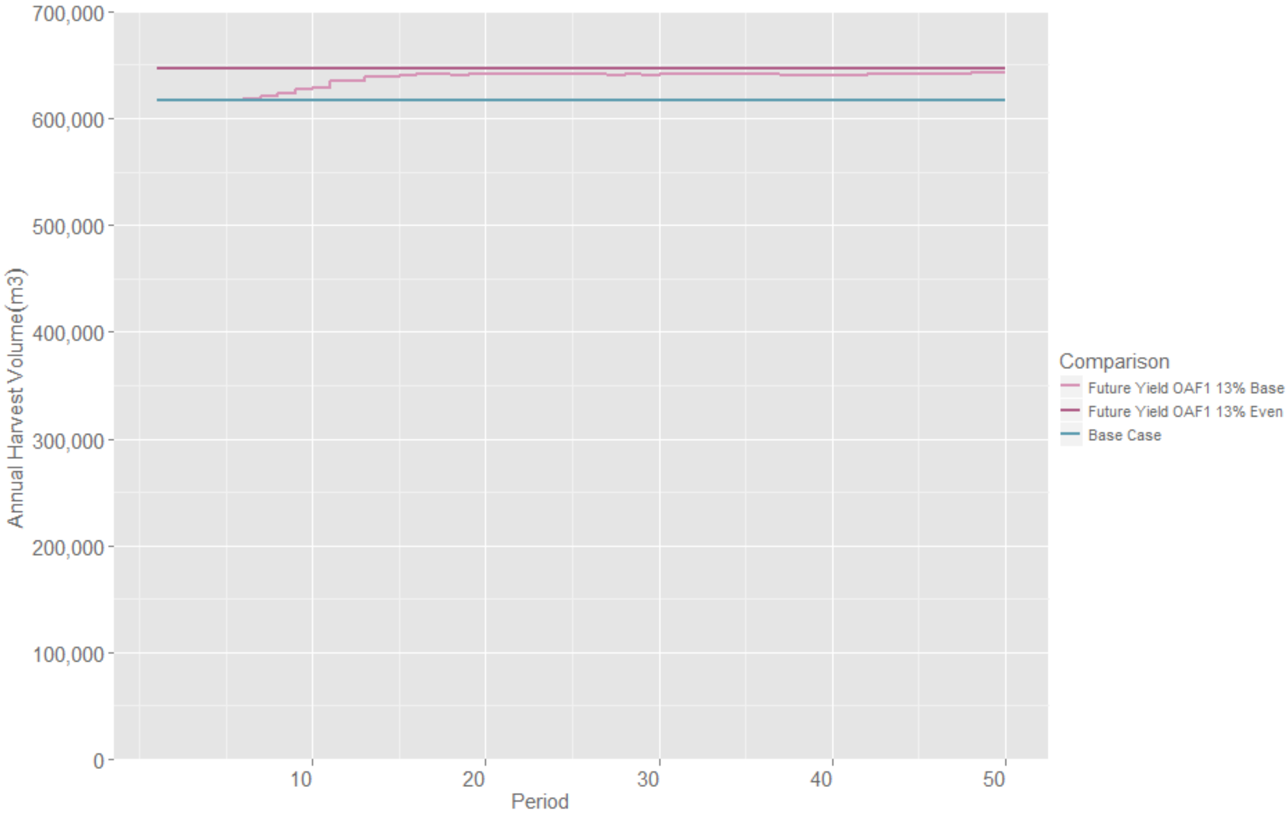

Figure 18: Sensitivity – Managed Stand Yields Using OAF1 of 13%

The dark line shows the increased even-flow harvest level. The lighter line shows the volume that results from the base case harvest schedule when the modified managed stand yield tables are applied.

5.1.4 Managed Stand Yields Based on SIBEC

For the base case, site productivity for the creation of managed stand yield tables was derived from the terrestrial ecosystem mapping (TEM). A subsequent field survey developed SI estimates by site series using data collected on the TFL. The area-weighed TEM SI was input to TIPSY instead of the VRI site index. At the request of the Ministry, a sensitivity analysis has been completed to replace TEM SI with estimate from the provincial SIBEC database. SIBEC was determined for each stand in the TFL. The area-weighted SIBEC value for each analysis unit was calculated from this data. This site index value was then used to develop an alternative set of managed stand yield tables that were input to the forest estate model for this sensitivity run. The results are shown in Figure 19.

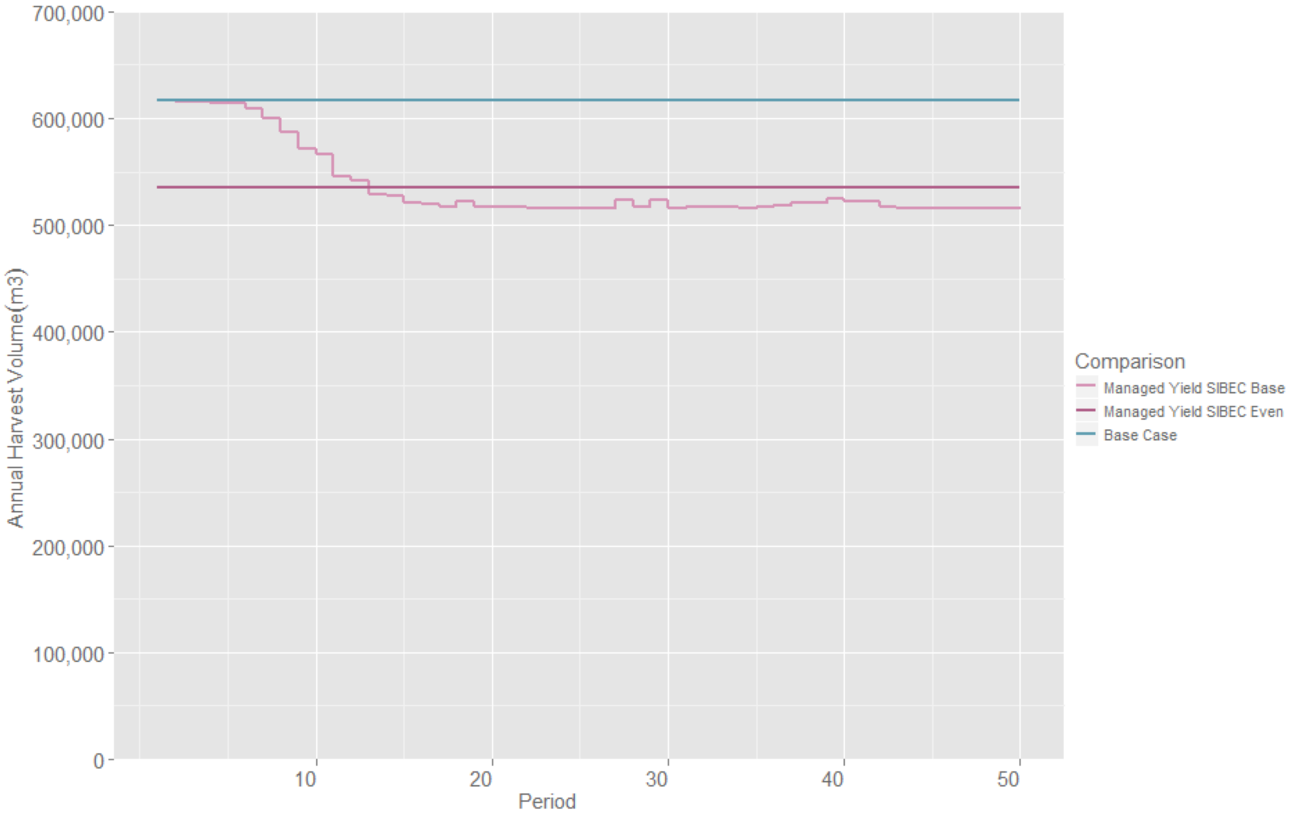

Figure 19: Sensitivity – Managed Stand Yields Based on SIBEC

The harvest level falls significantly: the reduction is 82,500 m^3/year or 13.4% to a level of 535,000 cubic metres annually. The dark like above shows this new level. The lighter line shows combination of the base case harvest schedule and the SIBEC managed stand yield tables.

5.1.5 TIPSY-Generated Years-to-Breast-Height

Some of the TIPSY-generated managed stands yield tables used in the base case were adjusted to account for the fact that stands reach breast height more quickly than predicted by the yield model. The extent of, and rationale for, this shift was presented in the Information Package. For this sensitivity analysis this shift was removed from those yield tables to which it was applied. The impact on harvest levels was small, as shown in Figure 20.

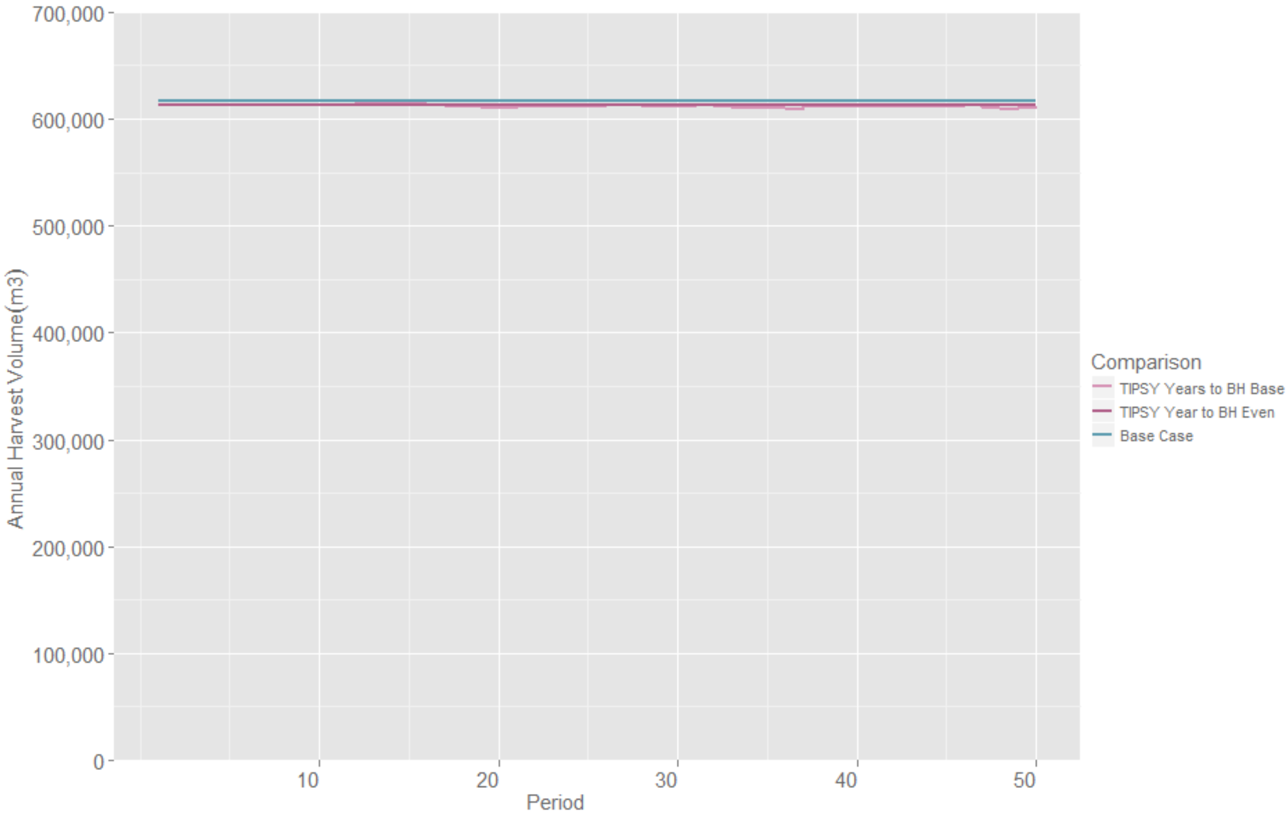

Figure 20: Sensitivity – Unadjusted TIPSY Yields for Managed Stands

The harvest level is reduced by 5000 m3/year to 612,500 m^3/year, or slightly less than one percent.

5.2 Management Practices

5.2.1 Minimum Harvest Age Uncertainty

Minimum harvest age is established based on stand volume, quadratic mean diameter and culmination MAI. This is not a 'rotation' age, but rather the earliest age at which the stand would be available for harvest. Three sensitivity analyses have been run to test the impact on timber supply of varying MHA. When MHA is decreased by 10 years no change in harvest level occurs. When MHA was increased by 10 years, the harvest level falls by 5000 m^3/year - a decrease of less than one percent. Figure 21 shows these trends.

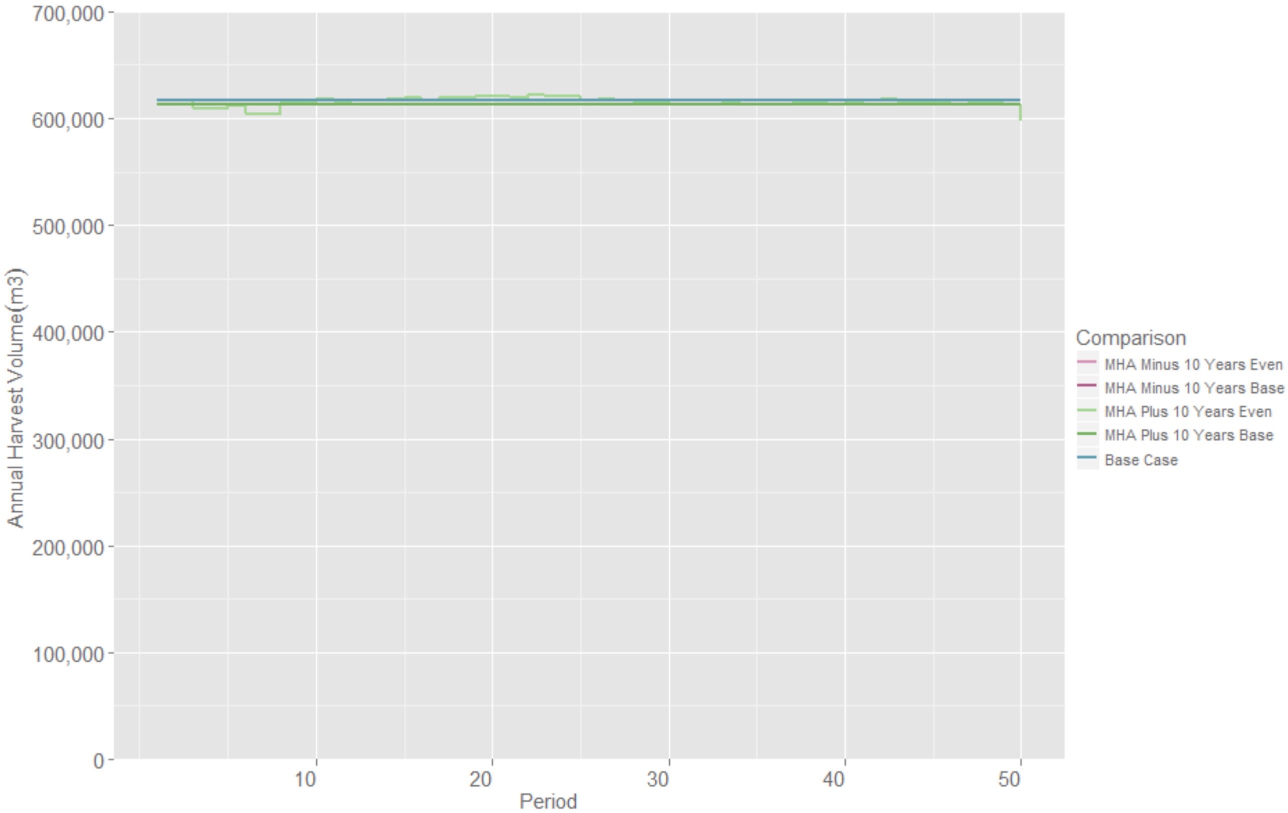

Figure 21: Sensitivity – Minimum Harvest Age Plus/Minus 10 Years

5.2.2 Visual Quality Uncertainty

The rate of harvesting in visually sensitive areas is controlled so that viewscapes are not excessively impacted. For each visually sensitive polygon, no more than a certain proportion of the area can be below a specified height (the visually effective green-up height). The height limits and proportions allowed are described in the information package.

The first sensitivity analyses examined the impact of increasing green-up height by one metre. This reduced the harvest level by 5,500 m^3/year to 612,000 cubic metres annually. Decreasing green-up requirements led to very slightly increased harvest levels (0.8% to 619,000 cubic metres annually. Figure 22 shows these results.

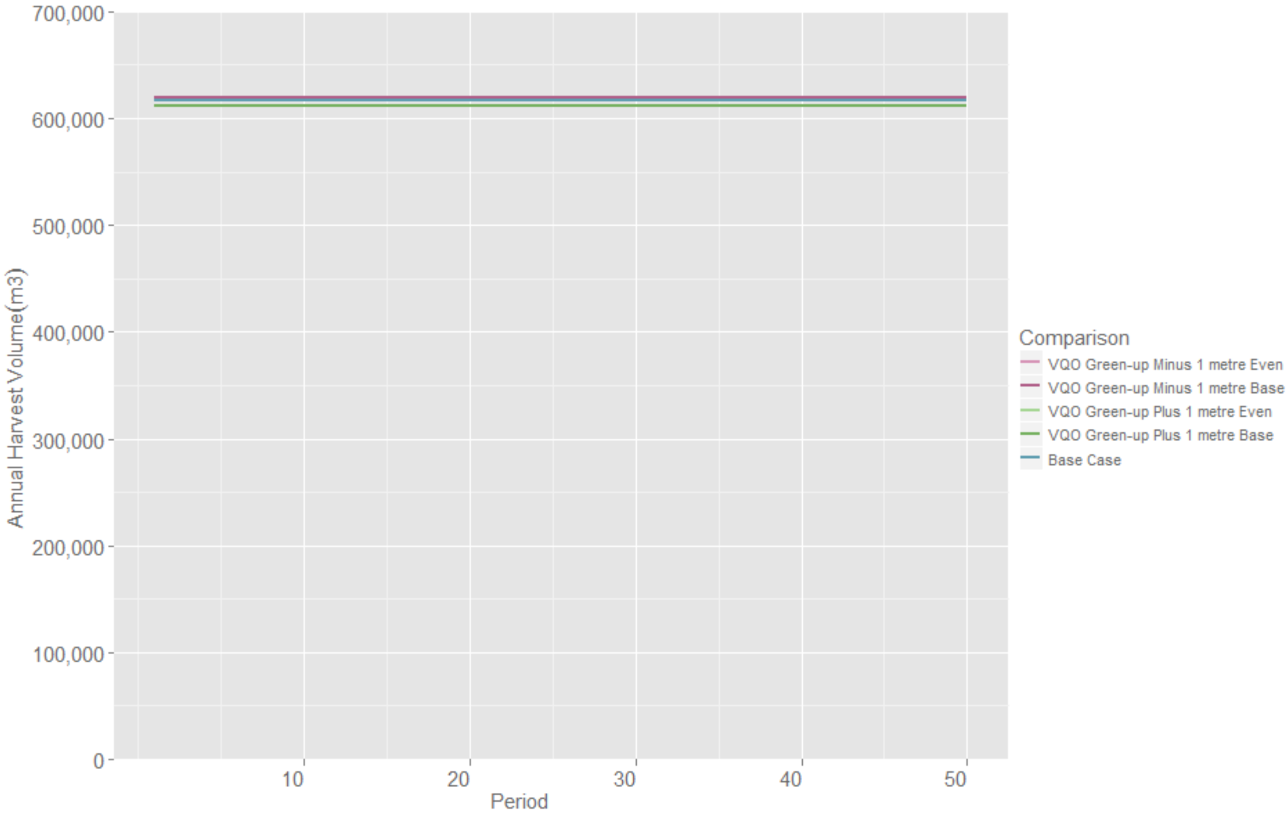

Figure 22: Sensitivity – VQO Green-up Height Plus/Minus 1 Metre

5.2.3 Immediate Old Seral Recruitment

For those units in the EBM area that are currently in old seral deficit, no harvesting of old seral stands was permitted for the entire planning horizon. Also, the model was set up to ensure that the old seral target for the unit was achieved by the final five-year period of the 250-year planning horizon. For this sensitivity analysis the old seral target was enforce for every planning period. The impact on harvest level is significant. It falls by 72,500 m^3/year (11.7%) to 545,000 cubic metres annually.

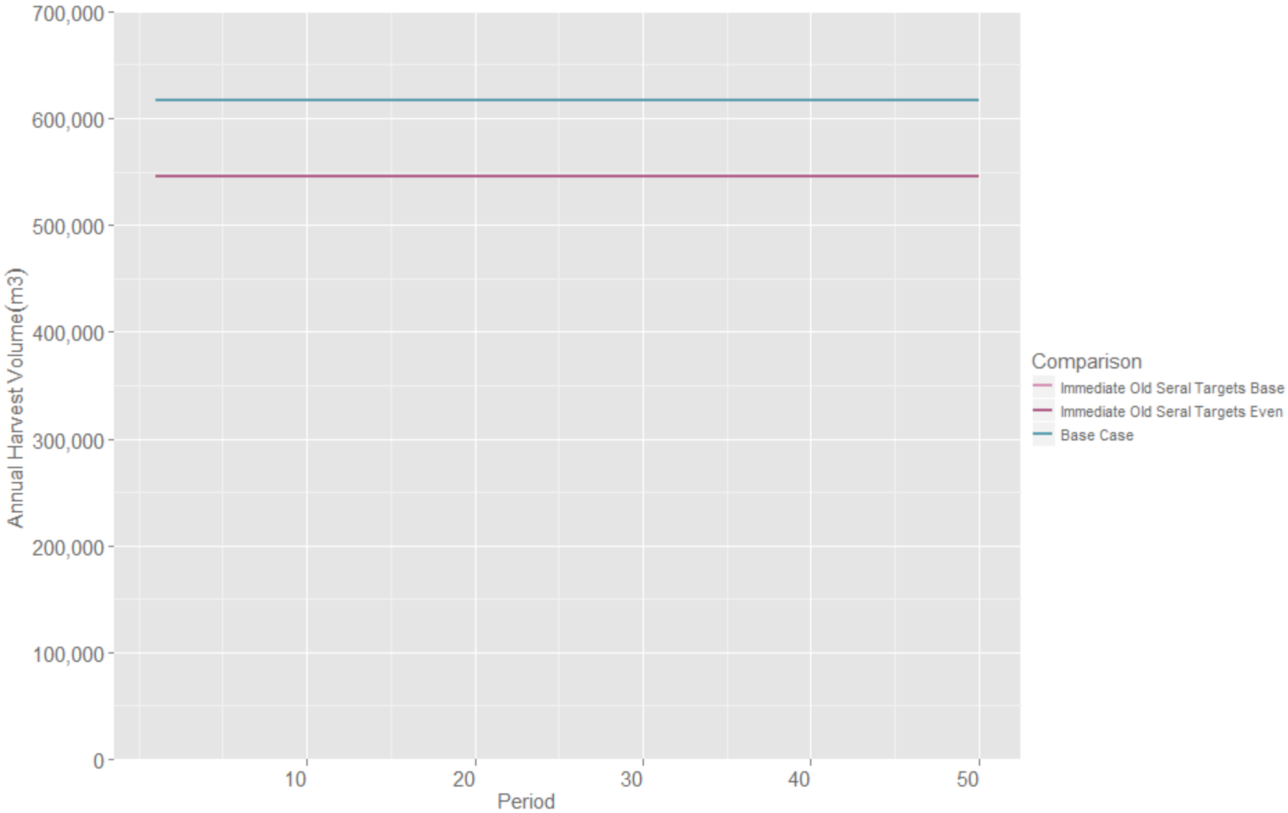

Figure 23: Sensitivity – Enforce EBM Old Seral Target for Entire Planning Horizon

5.2.4 Lower Stump Height

Standard yield tables assume a stump height of 30 centimetres when calculating net merchantable volume. On areas of the TFL where mechanized harvesting occurs, stumps are typically much shorter. For this sensitivity analysis a stump height of 17 cm has been used for all stands on slopes of less than 30%. An adjustment factor was applied to the yield curves to account for this change. This factor was calculated by running ‘typical’ trees of a range of diameter through a cruise compiler to generate net tree volumes. This was done using both a 30 cm and 17 cm stump height. This factor was attached to each yield curve based on QMD, and the net volume was adjusted. Generally, the impact was proportionally larger for smaller trees. At a forest estate level, this resulted in a 1.1% increase in harvest levels. Under this scenario, a harvest of 624,000 m^3/year was possible.

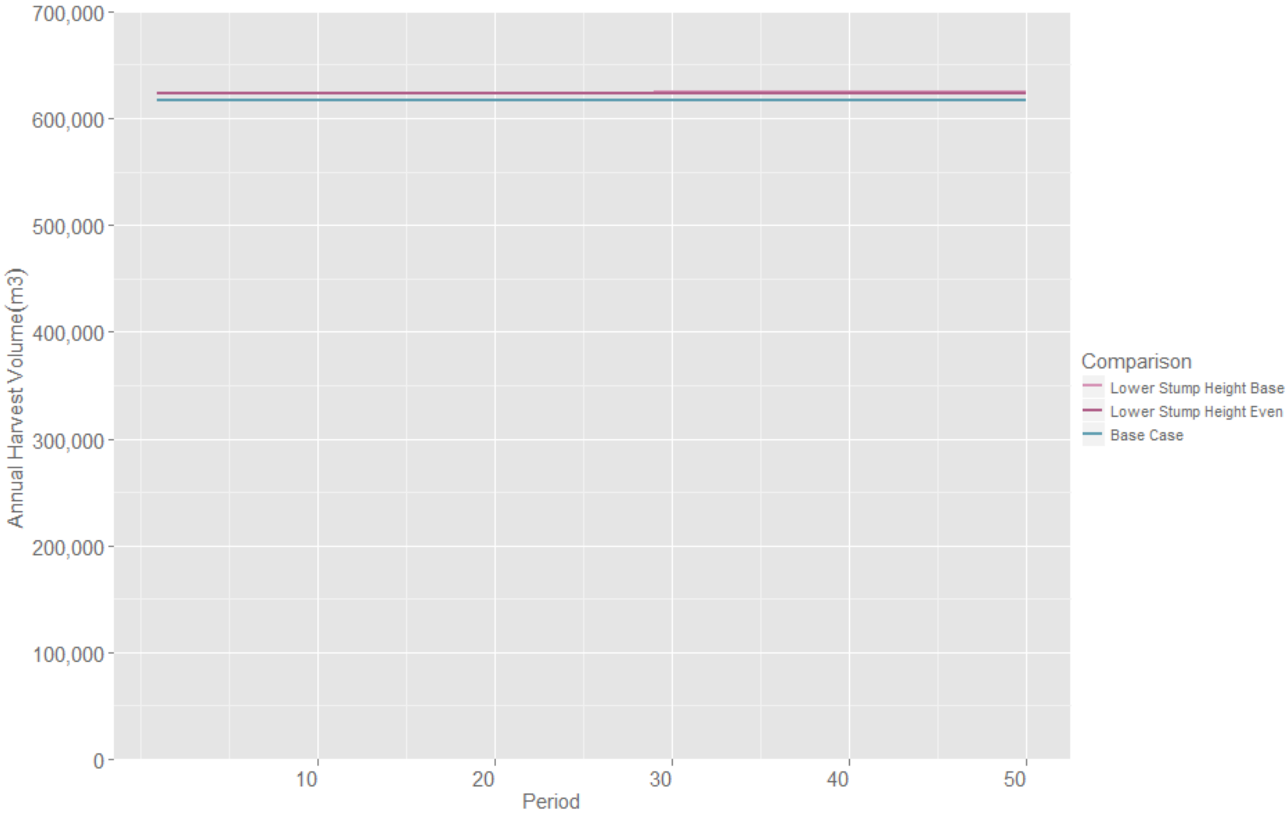

Figure 24: Sensitivity – Improved Utilization Due to Lower Stump Heights

6 DISCUSSION

6.1 Harvest Flow

The harvest level presented in the base case has been set at the highest even flow that can be achieved. From the outset of the analysis it was expected that the eventual base case harvest flow would be constant over the entire planning horizon. This is the result that was found in the timber supply analysis that was completed in conjunction with Management Plan #3. Although the landbase has changed slightly, the TFL still supports a forest with a reasonably well balanced age class distribution (see Figure 7). Area is well distributed among the first five twenty-year age classes, and a significant amount of harvestable old growth still exists. On this basis at least it is reasonable to expect that no near-term timber supply pinch-point will exist.

The only significant timber flow constraint placed on the base case was the requirement that old growth harvesting not exceed 128,000 cubic metres per year. This is consistent with the proportion of the harvest volume that currently comes from old-growth stands. Given that this level has been achieved over the past few years while the log market has been somewhat depressed, the assumption is probably somewhat conservative; higher levels of old growth harvesting will likely be possible sometime over the next ten years. Short- and long-term timber supply would both be improved by converting these sites to managed stands sooner rather than later.

This is noteworthy because the forest estate model harvests the maximum allowable old growth volume in each of the first ten five-year periods, indicating that the restriction on old growth harvesting is limiting on timber supply. At fifty years, all of the available old growth is depleted. Some old growth becomes available later in the planning horizon as old seral constraints are satisfied by maturing stands. However, some old seral stands within the THLB never become available for harvest.

The highest even-flow harvest level possible was found to be 617,500 m^3/year. Although an excess merchantable growing stock exists, a higher even-flow harvest level could not be maintained. Many of these mature stands are required to meet old seral requirements both inside and outside of the EBM area.

Alternative harvest flows are possible. An analysis was done in which the initial harvest level was raised to the current AAC of 646,793 m^3/year cubic metres per year (actually set to 647,000 m^3/year for modelling purposes). This level could be sustained for 30 years before falling back to the base case harvest level of 617,500 m^3/year.

6.2 Sensitivity Analyses

Several sensitivity analyses were run to test assumptions and data that are uncertain. Some of these were completed to provide TimberWest staff further insight into the timber supply dynamics of the TFL, and others were completed at the request of Ministry staff. In all cases the sensitivity was set up to find the highest even-flow harvest level that could be sustained. The results of the base case, alternative harvest flow and sensitivity analyses are summarized in Table 3.

Table 3: Sensitivity Analysis Results Summary

Model Run	Even-Flow Harvest Level	% of Base Case
Base Case	617,500	100%
Alternative VDYP Volume Adjustment	622,000	101%
Future Yield Plus 10%	660,000	107%
Future Yield Minus 10%	588,000	95%
TIPSY Yield Using OAF1 13%	647,000	105%
TIPSY Years-to-Breast-Height	612,500	99%
SIBEC Site Index	535,000	87%
MHA Minus 10 Years	617,500	100%
MHA Plus 10 Years	612,500	99%
VQO Green-up Minus 1 Metre	619,000	100%
VQO Green-up Plus 1 Metre	612,000	99%
Reduce Stump Height	624,000	101%
Immediate EBM Old Seral Targets	545,000	88%

The manner in which the Phase 2 volume adjustment has been applied to the natural stand yield tables also a slight downward pressure on short-term timber supply. These stands start out at their adjusted volume in 2008 (the field data collection date), but immediately begin to ‘grow’ back to their unadjusted (and lower) volume. This results in less volume being available from these stands as the planning horizon progresses. As noted above, many of theses stands persist for a significant amount of time due to the restriction on the rate of old growth harvesting. When the yield curve adjustment process is changed so that old stands do not loose volume due only to the adjustment, a higher even-flow harvest level is possible. On this basis it is reasonable to conclude that the base case slightly underestimates the sustainable harvest level.

Uncertainty about the yield from future stands (stands not yet established) was examined by increasing and decreasing yields by 10%. Predictably, the harvest level rises and falls respectively. The impact is less than 10% however, most likely due to the current excess of available growing stock and the well-balanced age class distribution at the start of the planning horizon. While the impact on harvest level is significant, in the absence of any specific reason to question future yields no case exists to adjust the base case harvest level in either direction.

Field data collected during the site index adjustment project identified unmapped non-productive patches within stands. This survey data shows that stocking levels in existing managed stands are high enough to justify using a reduced OAF1 when compiling all managed stand yield tables – both existing and future. The sensitivity run based on an OAF1 value of 13% indicates that the base case may, in fact, underestimate the sustainable harvest level by as much as 5%.

TimberWest staff have also observed that managed stands reach breast height sooner than would be expected based on TIPSY height growth forecasts. On this basis – and with Ministry approval – some managed stand yield tables were adjusted (for the base case) to account for this. The adjustment was calculated for fir-leading prescriptions on those sites series where sufficient silvicultural survey data existed. Slightly over half of the THLB was impacted by this yield curve adjustment (a leftward shift along the x-axis by one or two years). This sensitivity analysis removed this shift (i.e. used TIPSY predicted height growth to determine years-to-breast height). This resulted in a one percent decrease in harvest levels. In fact, other site series and hemlock and cedar-leading stands are probably achieving breast height sooner than is indicated by the

TIPSY forecasts, though no data was available to substantiate this belief and no adjustment was applied in the base case. Although it is difficult to quantify, the base case harvest level is probably slightly underestimated for this reason.

At the request of Ministry staff, managed stand yield tables were recompiled using SIBEC as the basis for stand productivity estimates. These regional estimates were used in place of the adjusted site index values based on TEM spatial information and locally collected field data. The harvest level decrease is a very significant 13%. However, the site index estimates used to construct the managed stand yield tables are statistically sound and quite defensible.

Uncertainty about minimum harvest age is commonly tested in sensitivity analyses. For TFL 47, the impact is very small. This is because there is no real pinch point in timber supply and due to the fact harvest age in the base case stays above minimum levels for most of the planning horizon. Similarly, changes in the assumptions about the age of visually effective green-up had little impact on harvest levels in spite of the fact that a significant portion of the THLB is managed to protect viewscape resources.

Much of the terrain on the TFL is flat or only moderately sloping. These areas are suitable for mechanical harvesting – especially in second growth stands. With feller/bunchers, stump height is typically lower than the 30 centimetres assumed in the construction of the base case yield curves. When stump height is reduced to 17 centimetres in suitable stands, a one percent increase in harvest levels results.

Finally, a sensitivity analysis was conducted to gauge the impact of immediately enforcing old seral constraints for those EBM units currently in deficit[6]. In the base case, the constraint was enforced only in the final period of the planning horizon – though no harvesting of old seral was permitted in the interim. It is difficult to decide whether any base case adjustment is required on this account. However, the approach taken in the base case is consistent with the 'letter of the law'. The approach to measuring and protecting biodiversity in the area covered by the SCCO is evolving and discussions continue. TimberWest participates in these discussions and is committed abiding by the spirit of the SCCO and an EBM approach.

6.3 Recommendations

Although the base case presented shows an even-flow harvest level, the alternative flow scenario, under which the current AAC is continued for 30 years, is being recommended as the basis for the determination of the AAC for the next ten years.

Growing stock levels are robust and the age class distribution is well balanced, and can support a higher initial harvest level. This was demonstrated in the alternative-flow case presented.

Several potential upward pressures in the base case harvest level have been identified and discussed above. The actual sustainable even-flow harvest level may be higher than proposed in the base case on this account. TimberWest is committed to further investigating and attempting to quantify some of these factors.

Though two potential significant downward pressures on harvest level exist (immediate enforcement of old-seral targets in the EBM area and SIBEC-based yield tables), the extent to which they should influence the AAC determination is unclear. The approach to biodiversity management is in flux, and the SIBEC estimates are no more valid than the locally developed SI estimates. In any event, even if these reductions are conceded, sufficient merchantable growing

[6] For those EBM units not currently in old-seral deficit, the constraint was enforced for the entire planning horizon so that they would not be logged into a deficit condition.

stock now exists that an orderly, decadal step-down from the current AAC level to a lower long-term level could be easily supported.

Two of the sensitivity analyses that provide upward pressure ('TIPSY yield using OAF1 13%' and 'Reduce stump height') are based on data collected on TFL 47. The 'Alternative VDYP Volume Adjustment' is a very logical and defensible alternative to the default yield curve adjustment process. The combined impact of these three sensitivity analysis would raise the proposed harvest to 687,500 m^3/year.

Appendix I - Information Package