Tree Farm Licence 46

Timber Supply Analysis Report

Management Plan #5

Timber Supply Analysis

March 2010

The Teal-Jones Group

Table of Contents

List of Tables

List of Figures

Appendices

Executive Summary

Timber supply reviews are conducted every five years and an allowable annual cut (AAC) determination is made by the B.C. Forest Service's Chief Forester. The key documents supporting AAC determination are an *Information Package* describing the inputs to the timber supply analysis and an *Analysis Report* describing the results. The *Information Package*, which was approved by the Ministry of Forests and Range (MFR) in August, 2009, is included as Appendix I to this *Analysis Report*, which presents the timber supply analysis results.

The allowable annual cut for TFL 46 was set at 499,000 m^3/year at the last determination in 2003. At that time the TFL was held by TimberWest Forest Ltd., and they completed the timber supply analysis and submitted the required documents. Since then the tenure has been transferred to Teal Cedar Products Ltd. (Teal Cedar), the area of the TFL has decreased, and the AAC has been modified through administrative adjustments to its current level of 367,363 m^3/year. Teal Cedar has prepared this timber supply analysis to support a new determination of the (AAC) for TFL 46.

A base case timber supply analysis has been prepared using the most current data sources and management assumptions and is based on current operational practice. The inputs to this analysis are documented in the *Information Package*. The base case initial harvest level was set at the currently approved AAC (367,363 m^3/year). This level can be sustained for five decades, at which point it must be reduced to the maximum long-term sustainable harvest level of 332,500 m^3/year for the remainder of the planning horizon. The resulting harvest flow pattern differs markedly from that observed in base case for the last analysis, where the harvest level was constant for the entire planning horizon. This change in timber flow pattern is due primarily to the use of inventory site index (as opposed to ecosystem-based site index) to develop yield forecasts for managed stands.

Estimates of site productivity are the main determinant of future stand yields and are consequently a primary driver of timber supply forecasts. For this base case, the inventory site index from the recently-completed VRI has been used to develop yield tables for all existing and future stands. Managed stand yield curves for the base case scenario in the last timber supply analysis for TFL 46 were based on second growth site index (SGSI) derived from Terrestrial Ecosystem Mapping (TEM) and a field data collection program. These ecologically-based site index estimates were used for stands that regenerated after 1955. The derivation of these site indices is described in the report *Second Growth Site Index Estimates for Douglas-fir, Western Hemlock, Pacific Silver Fir and Western Redcedar on TFL 46*.[1]

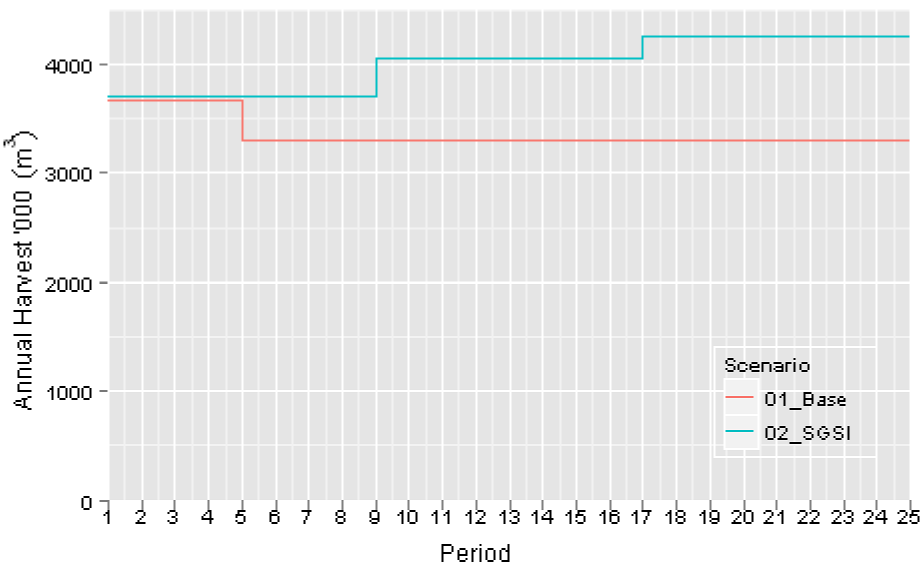
A change in government policy precludes the use of these TEM-based SGSI's for the base case scenario for this analysis. The MFR has insisted that this analysis use inventory site index to construct all yield curves for the base case. The TEM upon which the second growth site index estimates were based has not yet been independently assessed for accuracy. A new MFR policy requires that this assessment be completed before ecologically-based site index estimates can be used for a base case analysis. To gauge the impact on timber supply of this change, this sensitivity analysis using SGSI-based yield curves has been completed. SGSI estimates have been input to TIPSY to generate future managed stand yield tables for this sensitivity analysis.

These yield curves resulted in higher volumes for second growth stands. Due to the increased growth rates, these stands reached a harvestable condition at a younger age than that forecast by the base case yield curves. Minimum harvest ages were recalculated for this sensitivity analysis. The forest estate model was rerun with these amended inputs.

The sustainable long-term harvest level is 28% higher than for the base case, increasing from 332,500 m^3/year to 425,000 m^3/year. This increase occurs in two steps, from an initial harvest level of 370,000 m^3/year. This initial harvest level is less than one percent higher than the base case starting level of 367,363 m^3/year.

The chart on the next page shows how sustainable harvest levels change if SGSI is used to forecast the yield from future managed stands.

[1] J. S. Thrower & Associates Consulting Foresters Ltd. 2000. *Second-Growth Site Index Estimates for Douglas-fir, Western Hemlock, Pacific Silver Fir, and Western Redcedar on TFL 46.*



A strong case can be made for basing yield estimates for future stands on ecosystem based site index. It is widely accepted that SI values based on the height/age measurements of existing stands underestimate the productivity that those sites will exhibit when they support intensively managed plantations. Ecologically-based estimates of SI have been accepted for use in the base case on other tenures, including the adjacent Arrowsmith TSA (for which no TEM mapping exists).

Additional sensitivity analyses were conducted to explore the risk associated with various sources of uncertainty in the modelling assumptions and data. The table below summarizes the results of each sensitivity analysis with comparison to the base case. In comparing the sensitivity results to the base case, both short term and long term harvest level differences are stated. For most scenarios, 'short term' refers to the period up to the end of the sixth decade, and 'long term' refers to the remainder of the planning horizon.

Summary of Timber Supply Analysis Results

	Short Term Harvest Level		**Long Term Harvest Level**	
Scenario	**m^3/year**	**% of Base Case**	**m^3/year**	**% of Base Case**
Base Case	367,363	100.0%	332,500	100.0%
Post-Harvest SI Uncertainty				
Second Growth Site Index	370,000	100.7%	425,000	127.8%

	Short Term Harvest Level		Long Term Harvest Level	
Scenario	**m³/year**	**% of Base Case**	**m³/year**	**% of Base Case**
Alternate Harvest Rules				
Minimize Volume Lost	367,363	100.0%	315,000	94.7%
Highest Volume First	367,363	100.0%	325,000	97.7%
Landbase Uncertainty				
THLB Minus 10%	338,000	92.0%	297,500	89.5%
THLB Plus 10%	411,000	111.9%	364,000	109.5%
Stand G/Y Uncertainty				
Existing Volume Plus 10%	412,000	112.2%	332,500	100.0%
Existing Volume Minus 10%	330,000	89.8%	332,500	100.0%
Future Volume Plus 10%	367,363	100.0%	365,000	109.8%
Future Volume Minus 10%	367,363	100.0%	307,000	92.3%
Minimum Harvest Age Uncertainty				
MHA Minus 10 Years	372,000	101.3%	332,500	100.0%
MHA Plus 10 Years	338,000	92.0%	340,000	102.3%
MHA Plus 20 Years	292,000	79.5%	353,000	106.2%
Disturbance Limit Uncertainty				
VQO Greenup Plus 1m	367,363	100.0%	332,500	100.0%
VQO Greenup Minus 1m	374,000	101.8%	332,500	100.0%
IRM Disturbance Minus 5%	367,363	100.0%	332,500	100.0%
IRM Disturbance Plus 5%	373,500	101.7%	332,500	100.0%
IRM Greenup Plus 1m	367,363	100.0%	332,500	100.0%
IRM Greenup Minus 1m	372,500	101.4%	332,500	100.0%

Most of the rows in this table show deviations from the base case that are minor and/or entirely intuitive. The exception is the use of second growth site index when forecasting the yield of future stands. In that case, a small increase in short-term harvest level and a large increase in long-term harvest level are possible.

The next AAC determination for TFL 46 will be in force for between five and ten years, barring any significant alterations to landbase or changes in management practices. An AAC of 370,000 cubic metres per year is quite defensible based on the information presented is this document. This is the initial harvest level that could be sustained using the yield curves based on SGSI. It represents a slight increase from the current administratively-adjusted AAC that was used as the starting level in the base case. The risk of establishing the AAC at this level is small; if the VRI site index estimates are in fact accurate, harvest shortfalls will not occur for fifty years. In the meantime, further work can be done to verify site index estimates for the timber harvesting landbase.

1 Introduction

This Timber Supply *Analysis Report* has been prepared in order to provide the Chief Forester with information to assist in his determination of an AAC for the TFL. At the outset of this project, it was intended that the timber supply analysis would be carried out in concert with the completion of a new Management Plan, and would provide input to that process. Due to changes that have occurred subsequently in the legislation related to Management Plans, the current Plan will continue in force. The requirement for a new AAC determination remains in force, and this document is submitted to inform that decision.

Timber supply is the rate of timber availability for harvest over time. The methodology used to forecast this 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 allowable annual cut for TFL 46 was last determined in 2003. At that time the TFL was held by TimberWest Forest Ltd., and they completed the timber supply analysis and submitted the required documents. The Chief Forester reviewed this material and other information, and set the AAC at 499,000 m^3/year. The 'Implementation' section of the AAC Rationale document made a number of recommendations for monitoring (deciduous harvest, retention levels), strategy development (elk and deer conservation, old growth cedar), and landscape unit planning. Progress has been made in most of these areas.

Since the last AAC determination, the tenure has been transferred to Teal Cedar Products Ltd. (Teal Cedar), the area of the TFL has decreased, and the AAC has been modified through administrative adjustments to its current level of 367,363 m^3/year. Teal Cedar has prepared this timber supply analysis to support a new determination of the (AAC) for TFL 46.

Timber supply analysis involves three main steps:

1. Assembling data and preparing information about the landbase;
2. Using the data in a forest estate model to develop harvest forecasts and test the sensitivity of those forecasts to small changes in the input data and assumptions; and
3. Interpreting and reporting the results.

The *Information Package* was the first document published in support of the current TSR process. It was submitted to the MFR and was also made available for a public and First Nations review over a period of two months, and was accepted by Ministry of Forests and Range (MFR) Forest Analysis Branch, August 6, 2009. The information provided there has been used to define and model several timber supply scenarios. Those results are presented in this report. A base case scenario is described and the results are presented. The results of several sensitivity model runs are also summarized; these provide an indication of the stability of the base case harvest level forecast relative to the uncertainty inherent in the data and assumptions upon which it is based.

The Chief Forester will consider the timber supply *Analysis Report* and other sources of information in order to make a new AAC determination. This determination will be published by the MFR in a report entitled '*Tree Farm Licence 46 – Rationale for AAC Determination*'.

2 Description of the Licence Area

Tree Farm Licence (TFL) 46 is located on Vancouver Island between Cowichan Lake, Nitinat Lake and Port Renfrew on southern Vancouver Island. It is roughly bounded by the San Juan River in the South and the E&N Land Grant boundary to the northeast. Figure 1 shows the location of the TFL.

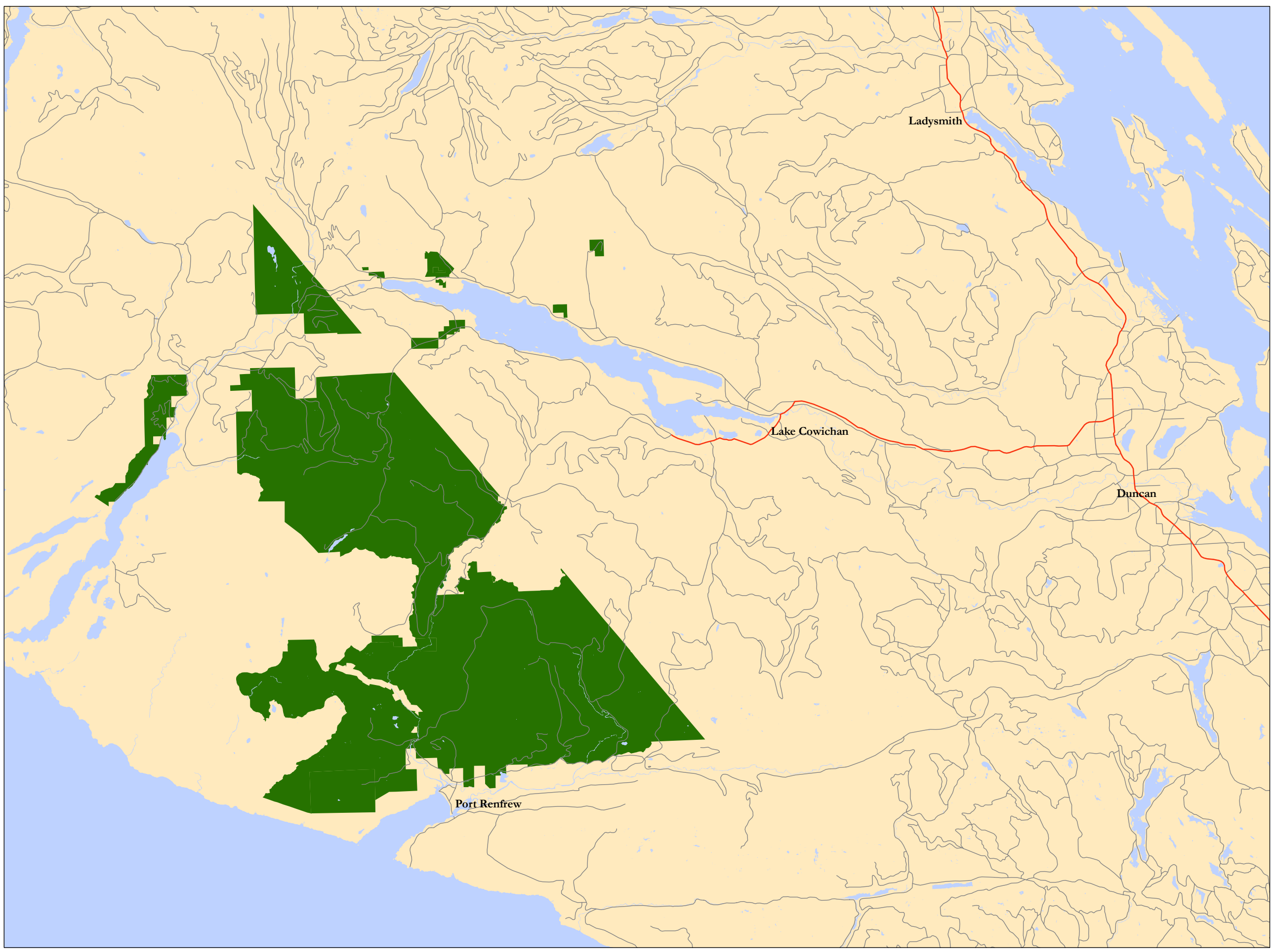


Figure 1. Location of TFL 46

Most areas of the TFL are located in watersheds with rivers running westward towards the west coast of the Island. Slopes vary from flat, alluvial river valleys to steep and rugged terrain. The portions of the TFL in the Cowichan Valley have more gentle topographic features. The terrain varies from lowland to mountainous.

Most of the productive forest land falls within the Coastal Western Hemlock (CWH) biogeoclimatic zone. Cool wet summers and mild winters support stands with a significant hemlock component. Douglas-fir is the other major tree species; true fir and western red cedar occur in lesser amounts. Less than three percent of the TFL area falls into the Mountain Hemlock zone, which occurs at higher elevations.

A significant portion of the TFL has been previously logged and now supports second growth stands ranging up to 80 years in age.

3 Information Preparation

3.1 Land Base

This section describes the steps taken to determine the THLB for TFL 46. The THLB for Management Plan #4 was 63,777 hectares, out of a total TFL area of 83,545 hectares. It is smaller now due to the various take-backs that have occurred over the past five years. Table 1 lists the changes that have taken place since the last MP.

Table 1. Summary of Land Base Changes Since MP #4

	Area(Ha)
TFL 46 Area at MP 4 (net of 7,325 ha Parks)	***83,545***
less:	
Forest Revitalization Act Orders (Instruments 22, 24, 25)	7,167
3(4)21-1 (PFN woodlot (Pixie Lake))	398
3(4)21-2 (Muir Creek)	259
3(4)21-3 (Shawnigan)	974
Bill 28 Dispositions (Instruments 28, 29 30)	
Rossander (remaining area except 33.3ha of CP41A)	2,291
San Juan BCTS (estimated)	10,479
San Juan Woodlot	600
Hill 60 (remaining area)	3,501
Mapping Error / Boundary Adjustments	(179)
TFL46 Area at MP 5	***58,055***
TO057 Area	1,536
A07065 Area	293
Total Area - Timber Supply Analysis	***59,884***

Boundaries for areas impacted by Forest Revitalization Act Orders (Instruments 22, 24, 25) were available at the start of the analysis and were incorporated into the spatial resultant. Boundaries for disposition under later Instruments were not available at that time. However, negotiations were well advance and the areas in question were known and agreed upon. These provisional boundaries were used to update the TFL boundary for this analysis. When Instruments 28, 29 and 60 came into force, the legal boundaries were compared to those that had been used in constructing the spatial dataset, and they were found to be in agreement.

The Hill 60 parcel has not yet been alienated from the TFL under Bill 28, though it is expected that this will happen in the near future. In the meantime, Teal Cedar is precluded from operating in this area, and it has been excluded from the landbase for the purpose of this analysis.

TFL boundary updates related to Instrument 26 have not been applied to the dataset used for this analysis. This is a 50-metre wide right of way along an existing mainline road that was taken for the Pacific Marine Circle Route Highway. This would have only a minor impact on the THLB, as most of the excluded area would overlay the existing road surface, ditch lines and clear portions of the R/W.

The starting landbase for the analysis is all land within the TFL 46 boundary, and all lands in Timber Licence TO057 and Timber Sale Licence A07065. All scheduled take-back areas will be excluded. These take-back lands will not be included in the base case, or in any sensitivity analyses. Timber License TO910, which is surrounded by TFL 46, has not been included in this analysis. The total TFL area for this analysis is 59,844 hectares.

Table 2 shows the netdown process by which the timber harvesting landbase has been determined. The order of the entries in the table corresponds to the sequence in which the land base classifications were applied. In some cases individual areas may have several classification attributes. For example, stands within riparian reserve boundaries might also be classified as non-commercial. These areas would have been classified on the basis of this latter attribute, prior to the riparian classification. Therefore, in most cases the net reduction will be less than the total area in the classification.

Table 2. Timber Harvesting Land Base Determination

	Total Area (Ha)	Productive Area (Ha)	Net Area Removed (Ha)
Total Area	***59,884***	***56,600***	
less:			
Non-Forest	1,597	-	1,538
Roads	1,785	-	1,746
Total Non-Forest Removed			***3,285***
Productive Forest Land			***56,600***
less:			
Inoperable	2,293	1,683	1,683
Unstable Terrain	6,722	6,284	5,802
Non-Commercial	80	71	71
Low Site	1,392	1,159	743
Community Watersheds	2	2	2
Riparian Reserve Zones	970	847	593
Riparian Management Zones	7,654	7,166	1,345
Environmentally Sensitive Areas	951	588	90
Old Growth Management Areas	6,751	6,211	3,109
Habitat	3,341	3,029	467
Recreation	464	362	186
Total Productive Removed			***14,092***
Timber Harvesting Land Base			***42,508***
Future Roads[2]			***498***
Long-term Landbase			***42,010***

3.2 Timber Growth and Yield

Forest growth and yield refers to the prediction of the growth and development of individual stands over time. Stand growth in terms of height, diameter, and volume is

[2] The area of road required to access undeveloped parts of the TFL has been estimated, and an appropriate reduction has been applied to future yield curves to account for this loss of productive landbase.

projected over time through the use of yield models. Yield tables are categorized into either natural stands or managed stands because of distinct growth pattern differences between the two types of stands. Existing natural and managed stands are differentiated based on stand age. The parameters used to define the yield table inputs were identified in the approved TFL 46 Timber Supply Analysis *Information Package*.

3.2.1 Natural Stands

Natural stand yield tables were developed for 30 analysis units as described in the *Information Package*. Inputs into the yield tables included inventory site index, species composition, stocking class, and crown closure. The yield tables were developed using the batch version of the MFR model Variable Density Yield Prediction (VDYP), version 6.6d. Yield curves were generated for each stand in the inventory, and these curves were used to create a single yield curve for each analysis unit.

For stands older than 120 years of age, previously developed Average Volume Lines (AVL) were used to assign volumes. These volumes are considered to be unchanging.

3.2.2 Managed Stands

Managed stand yield tables were developed for 30 analysis units identified in the *Information Package*. Inputs included species composition from the inventory (compiled by analysis unit), silviculture regimes by analysis unit, and Phase 2-adjusted site index estimates from the inventory. The yield tables were developed using the MFR BatchTIPSY (version 4.1c) program for managed stands. As for the natural stand yield tables, a yield curve was generated for each managed stand in the inventory, and these curves were used to create a single yield curve for each analysis unit.

Copies of the yield tables for natural and managed stands can be found in the Appendices of the *Information Package*.

3.2.3 Harvest System

Clearcutting was assumed to be the predominant harvesting system. Reductions were applied to yield curves to account for retention left to meet wildlife tree requirements.

3.2.4 Minimum Harvest Ages

MHA is established for each analysis unit. An AU is first harvestable when it meets all three of the following criteria:

- Minimum volume per hectare of 300 m^3/hectare;
- Minimum quadratic mean diameter (QMD) of 25 centimetres; and
- Within 90% of maximum mean annual increment (MAI).

The MHA's that result from the application of these rules can be found in the *Information Package*.

3.2.5 Site Productivity

The rate at which a stand grows is determined by the underlying site productivity, and the chosen stand management regime. The productivity of a stand is measured using a site index. Three separate estimates of site index exist for TFL 46. These are:

1. a site index attribute on the old forest cover data that was inherited from TimberWest;
2. an estimate of site index for each VRI polygon based on its Phase 2-adjusted height and age, assigned using MFR-standard SI tables; and
3. a TEM-based estimate that was developed by sampling second-growth site index in the field.

Table 3 shows these estimates. The area-weighted average SI (using stands in the timber harvesting landbase only) has been calculated using each of the three stand-level SI estimates.

Table 3. SI Estimates for TFL 46

Area-weighted Average Site Index		
Old Forest Cover	VRI – Phase 2 Adjusted	TEM-based
26.7	25.0	30.3

An inventory audit conducted prior to the completion of the VRI found that "site indices for stands between free growing and 60 years of age are underestimated using the inventory data."[3] However, when the VRI Phase 2-adjusted site indices are compared to the site indices in the original forest inventory for the subset of stands that were 60 years or less in age at the time of the VRI photography, an opposite conclusion is reached. Table 4 shows that all three SI estimates are higher for second growth stands, but that the VRI estimate is still the most conservative of the three.

[3] from the VSIP

Table 4. SI Estimates for TFL 46 – Stands Less than 61 Years Old

Area-weighted Average Site Index		
Old Forest Cover	VRI – Phase 2 Adjusted	TEM-based
27.3	26.9	31.4

In spite of the fact that the VRI appears to underestimate the productivity of the TFL, it has been used to generate base case harvest forecasts. The inventory site index from the VRI forest cover database was used to develop yield tables for all existing stands, and for future managed stands as well.

3.3 Management Practices

The productive land base was assigned to resource emphasis areas (REA's) to facilitate the modelling of management requirements. These REA's were set up to model management practices that protect:

- visual quality objectives
- fisheries sensitive watersheds
- goshawk habitat
- old seral forest[4]

Polygon-based visual quality objective (VQO) zones are incorporated into the analysis as REA's. A total of 92 VQO polygons were contained in the source data sets. VQO's comprise 10,750 productive hectares, of which 7,512 hectares fall within the THLB. Both THLB and productive non-contributing land contributes to the management requirements within the VQO polygon.

Any area within the THLB that is not classified as visually sensitive was assigned to the integrated resource management (IRM) REA. These areas may be non-visible or visible but are not considered to be visually significant, and therefore have fewer restrictions on harvesting. For modelling purposes the IRM areas were aggregated within each landscape unit, resulting in six discreet units. Within these areas a 3-metre green-up requirement was applied.

[4] in the Cowichan landscape unit only – OGMA's have been established in all other LU's

The rate of harvesting has been controlled in the three fisheries sensitive watersheds that overlap the TFL. These watersheds cover a productive area of 22,952 hectares and 16,559 hectares of THLB. The modelling objective for these areas was to limit the ECA impact of harvesting to 20%, where ECA decreases based on stand height from 100% at zero metres to zero percent and nine metre in height. This was translated into a rate of cut restriction of 20% under three metres in height for modelling purposes. This limit was arrived at be using managed stand height growth for a stand of average site index. The maximum constant rate of harvest at this limit also leads to an ECA level of 20%.

Two modelling measures were taken to account for the management of goshawk foraging habitat:

1. at least 20% of the area had to be greater than 80 years of age

2. no more than 20% of the area could be less than 20 years of age

These constraints were applied to the 1627 hectares of productive forest classified as foraging habitat. However, only 788 hectares fall with the THLB. Nesting and fledging habitat were netted out of the THLB entirely.

Old seral constraints of were applied in the Cowichan LU. These are normally applied at the BEC variant level, but because of the small areas involved, variants were combined by natural disturbance type. This resulted in one constraint being applied to the CWHvm1/vm2 variants and another to the CWHxm. It total, 738 hectares of productive area and 451 hectares of THLB area were affected by this constraint.

A more detailed description of the REA's modelled in this analysis is provided in the *Information Package*.

4 Analysis Methods

4.1 Forest Estate Model

Timberline's simulation model CASH6 (*Critical Analysis by Simulation of Harvesting*) was used to develop harvest schedules integrating all resource management considerations. The model uses a geographic approach to land base and inventory organization in order to adhere as closely as possible to the intent of forest cover requirements. Maximum disturbance and minimum thermal and old growth retention forest cover requirements, as well as biodiversity seral stage requirements, can be explicitly implemented if required. For this analysis disturbance constraints have been applied to control the rate of harvest in visually important areas and in fisheries sensitive watersheds. Retention constraints have been less widely employed – to retain old seral forests and protect goshawk habitat.

A variable degree of spatial resolution is available depending on inventory formulation and resource emphasis area definitions. Forest stands in refuges such as environmentally sensitive and inoperable areas that do not contribute to the periodic harvest can be included to better model forest structure at the landscape level.

Forest cover objectives are applied to specific areas or zones, so they require an explicit control area over which to operate. The control area for a constraint should correspond to a realistic element in the landscape. For example, the requirements associated with visual quality objectives (VQO) are designed to operate on the scene visible from discrete sets of viewpoints. The objective is to identify the "natural" constituency for forest cover constraints. CASH6 contains a hierarchical land base organisation to assist in implementing control areas. Numerous levels of land aggregation are used to define both geographically separate areas and areas of similar management regime. Forest cover constraints can be applied at up to five overlapping levels.

4.2 Timber Flow Objectives

The objective of the analysis is to determine the capacity of the TFL 46 land base to sustain a timber flow, and any risks to this flow resulting from uncertainty in the underlying assumptions. The analysis goes beyond a simple calculation of capturing the growth potential of the land base. Many management objectives with overlapping and potentially conflicting goals must be met. The maximum sustainable timber flow must ensure that these objectives are met while capitalizing on the growth potential of the land base.

A number of alternative harvest flows are possible. For this analysis, the objective was to achieve a balance of the following timber flow objectives:

- Maintain the existing AAC of 367,363 cubic metres per year for as many decades as possible;
- Decrease the periodic harvest rate in acceptable steps (no more than ten percent per decade) when declines are required to meet all objectives associated with the various resources on the land base;
- Ensure that over the next ten years 180,000 cubic metres per year is harvested from second growth stands on the TFL; and
- Achieve a maximum even-flow long-term supply where the total forest growing is stable.

4.3 Presentation of Results

Analysis results are provided in both tabular and graphic format for all scenarios modelled. The base case is presented in Section 5) and is described in detail. Harvest level and profiles, and growing stock forecasts are included. The relationship between the base case harvest level and other resource values is discussed.

The use of SGSI to generate future managed stand yield tables is the first of the sensitivity analyses presented. It is described (in Section 6) to the same level of detail as the base case, with the intention that it will be seriously considered as an alternative to the base case as the foundation for the AAC determination. As noted previously, SGSI was included for the base case for the last timber supply analysis.

For the remaining sensitivity analysis scenarios, the annual harvest levels are provided with comparison to the base case Harvest Level results. The report finishes with 'Discussion and Conclusions' in Section 7.

5 Base Case Results

The base case scenario is designed to find the harvest level that can be achieved under the assumption that current management practices are continued into the future. It is based on current performance and so provides a reference timber supply forecast against which timber supply implications of different management assumptions may be measured. The base case is used as the baseline to assess risk associated with any of the assumptions in the sensitivity analysis.

The harvesting rule employed was ‘relative oldest first’. Stands that had aged the greatest number of years past their minimum harvest age were scheduled for harvest first. Alternative harvest rules are considered below.

If harvest scheduling had been based only on ‘relative oldest first’, most of the harvest in the early years of the planning timeframe would have occurred in old growth stands. In reality, a significant amount of harvesting is planned for second growth stands, due to market conditions and operational issues. For the base case model run, an annual quota for second growth logging of 180,000 m^3 was established. This was applied for the first planning period – ten years in total.

5.1 Harvest Level and Growing Stock

The initial harvest rate has been set at 367,363 m^3/year. This represents the AAC level set at the last AAC determination, administratively adjusted for area that has since been removed from the TFL. This harvest level is sustainable for fifty years, at which point it must fall to the long term sustainable level of 332,500 m^3/year. This represents a drop in harvest level of 9.9%, the maximum single-period decline permitted. Figure 2 shows this harvest level pattern.

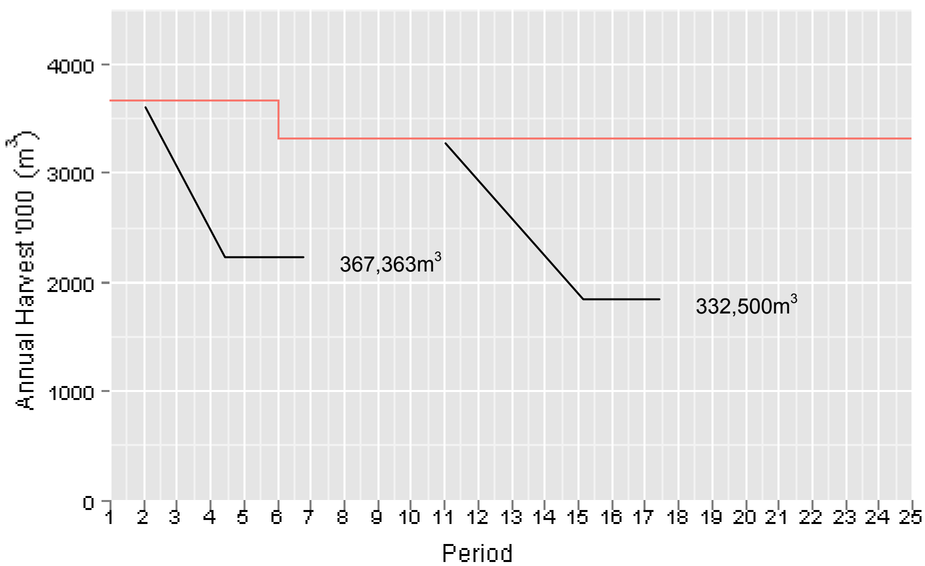


Figure 2. Base Case Harvest Level

In order to ensure that proposed harvest levels are sustainable, several metrics in addition to harvest volume need to be assessed. The first of these metrics is growing stock level. Figure 3 shows how total, operable and available growing stock levels vary over the planning horizon as a result of the base case harvesting regime.

Total growing stock represents the sum of the net merchantable volumes of all stands in the THLB. Operable volume, which is lower, only includes the volume from stands that are above their minimum harvest age. Available growing stock excludes stands that cannot be harvested without violating a cover constraint. This is assessed at the beginning of each period; additional stands may also become unavailable are a result of harvesting that occurs during the period.

This graph shows that the pinch-point in timber supply occurs in period five. After that, growing stock levels rebound. This is also the point at which the harvest level is decreased to the sustainable level. Long term growing stock levels are stable, with operable and available volumes rising slightly at the end of the planning horizon. The harvest level could not be increased any further at period nine without generating a harvest shortfall, but a small increase might be possible later in the planning horizon.

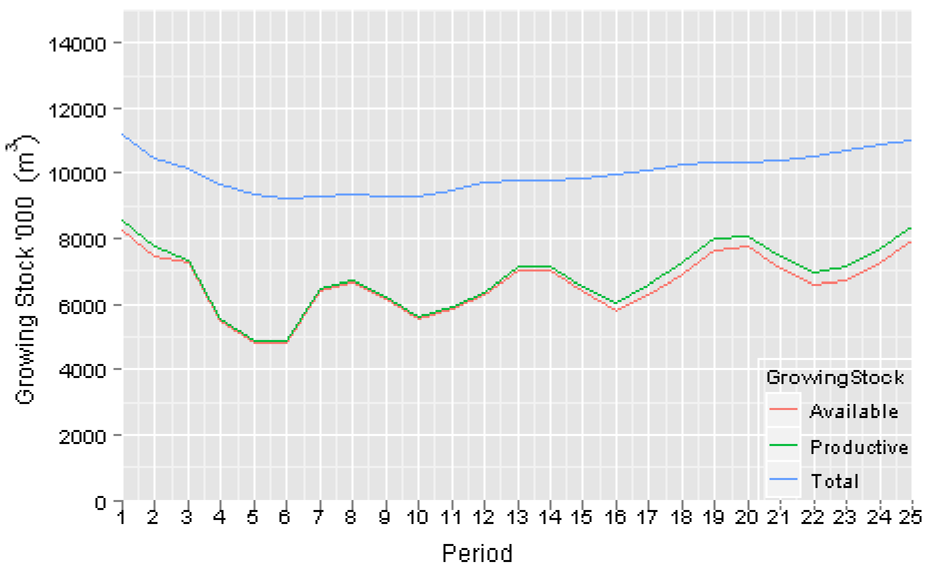


Figure 3. Base Case Growing Stock Levels

Figure 4 shows the progression of harvesting through the three types of stands – Existing Natural, Existing Managed and Future Managed. Existing Natural stands are comprised of old growth and second growth stands established prior to 1955. Some existing stands – both natural and managed – are not harvested until late in the planning period either because they are needed to meet old seral requirements, or because they fall within very restrictive VQO constraints.

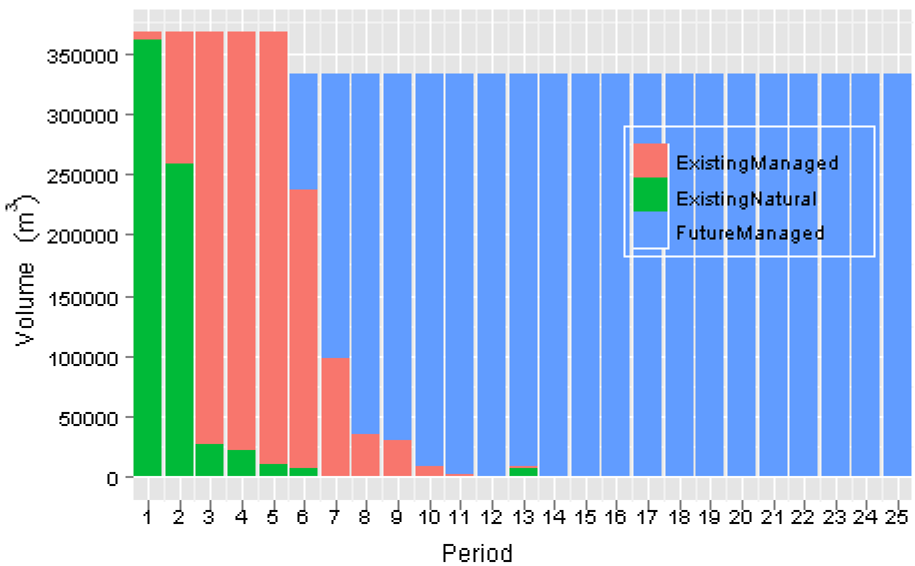


Figure 4. Harvest Contribution from Existing and Future Stands

Trends in annual area harvested, average harvest age, and average harvested volume are also useful in attempting to understand the dynamics of the forest under the base case scenario. The average annual area harvested is shown in Figure 5. This graph shows a stable trend, with area harvest falling between 600 and 800 hectares per year for most of the planning horizon. Over the entire planning horizon, an average of 671 hectares is harvested each year.

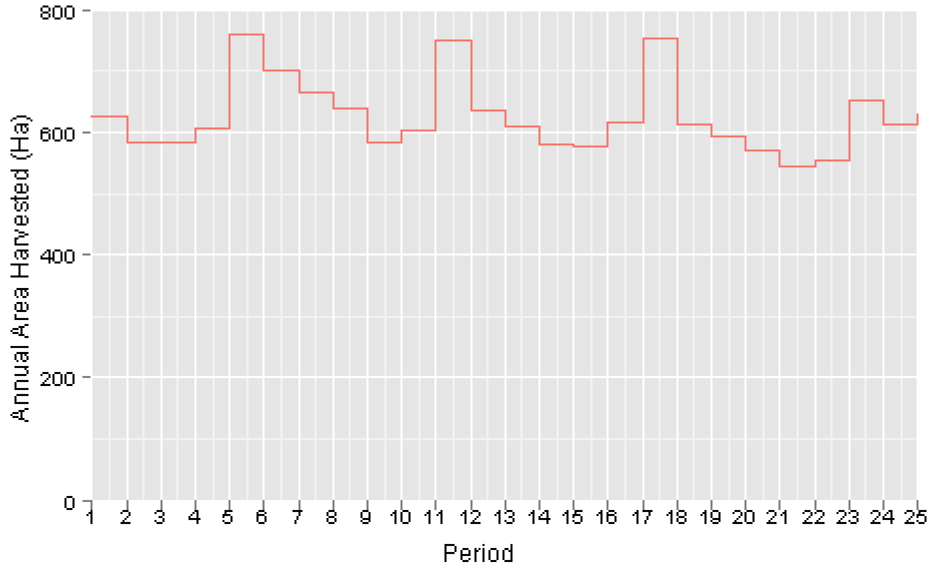


Figure 5. Average Annual Area Harvested

The average age of harvested stands is high in the early portion of the planning horizon – it averages 170 years for the first two ten-year periods. The harvest for each of these periods is made up of a mixture of old growth and second growth stands. In the first period this is driven by the quota of 50% that was applied to harvest in second growth. In the second period no quota was applied, but the remaining stock of available old growth is depleted and harvesting necessarily moves to second growth. The average harvest age falls sharply at this point. Figure 6 shows this trend. The average harvest age after the second period is 62 years, and is very stable. This average age is slightly lower than the average found in the base case from the previous timber supply analysis.

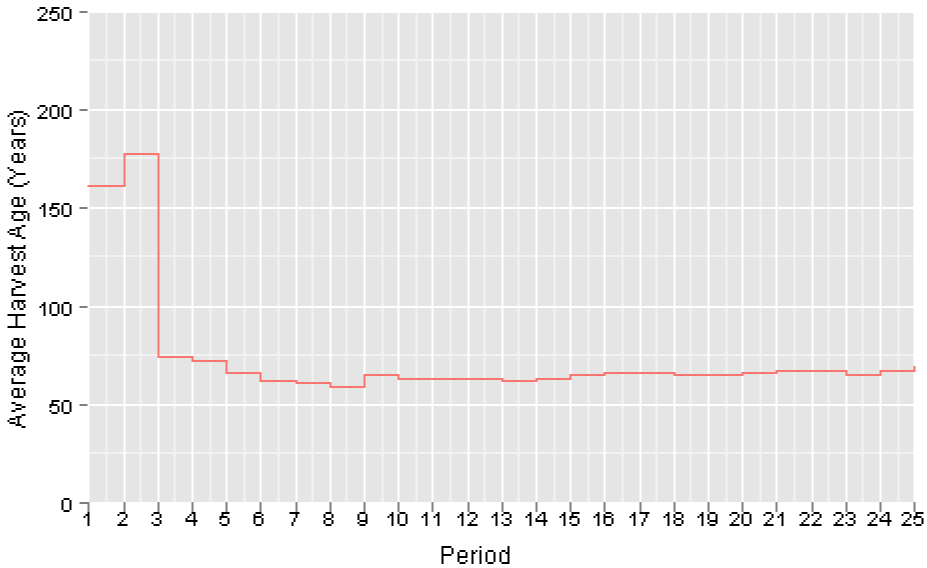


Figure 6. Average Age of Harvested Stands

The average volume of harvest stands (Figure 7) exhibits a fairly steady trend, with only a slight decline during the transition from old growth to second growth logging. The average for the entire planning horizon is 506 m^3/hectare. There appears to be a transition to logging second growth stands near their rotation age. The average harvest volume prior to this point is 606 m^3/hectare; afterwards it is 487 m^3/hectare. This is lower than the results for the previous timber supply analysis – the average harvest volume per hectare varied between 700 m^3/hectare and 800 m^3/hectare for most of the planning horizon.

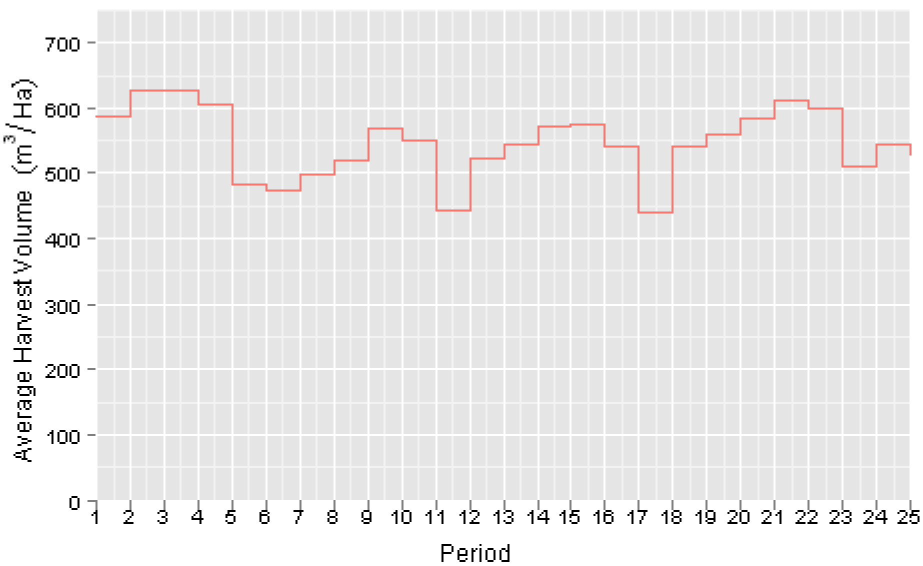


Figure 7. Average Volume of Harvested Stands

A final assessment of the base case scenario can be made by reviewing how the age class distribution of the forest changes over the planning horizon. The six charts that begin on the following page show these changes. The current distribution (Period 1) has a large component of old growth, but over half of that is outside of the THLB – reserved for habitat and biodiversity purposes. Half of the harvesting in the first period is in the oldest age class. The 180,000 cubic metre annual quota that was applied to second growth stands forces harvest in some younger stands as well. This is concentrated in the 60-year age class, with smaller volumes being harvested from the 50 and 70-year age classes.

By period five, all of the old growth in the THLB has been harvested. In fact, most of the old growth is harvested by the end of period two. Since no effort has been made to model disturbance in the productive non-contributing land base, the first four age classes contain only THLB land.

Most of the THLB is less than 60 years of age by period ten, though some THLB remains in old age classes to satisfy old-seral, habitat and visual constraints. Some stands are being harvested at 50 years of age, reflecting the rapid growth of future managed stands. Most harvesting occurs at ages less than 80 years, though some stands – those on poor sites or constrained – are harvested at older ages.

The remaining three distributions – for periods fifteen, twenty and twenty five show a consistent pattern: the THLB uniformly distributed in the first seven age classes; harvesting occurs at between 50 and 80 years of age; and the non-contributing landbase ages steadily rightward on the chart.

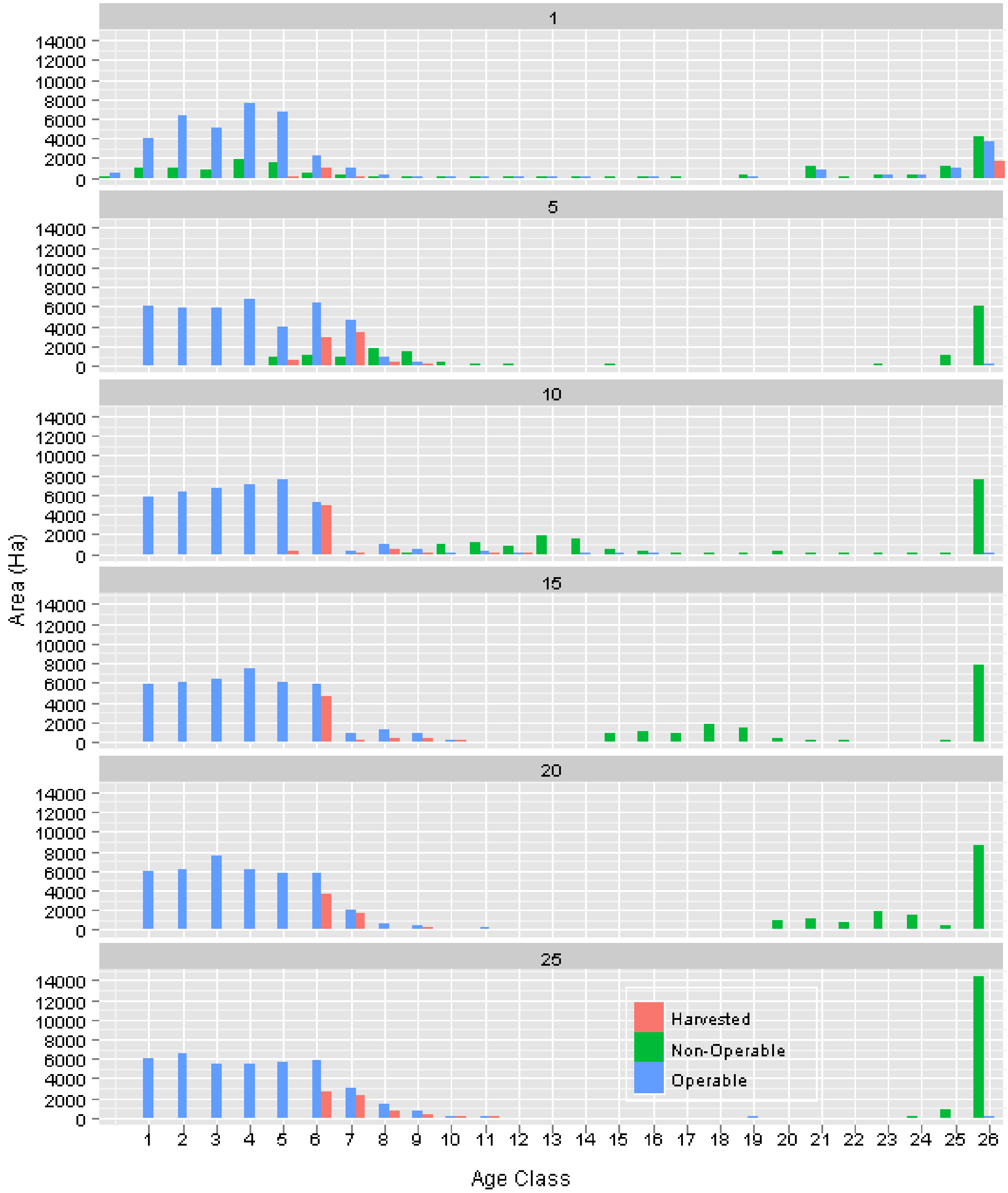


Figure 8. Age Class Distribution Throughout the Planning Horizon

5.2 Alternative Harvest Flows

The base case used a 'Relative Oldest First' harvest rule, subject to a quota on second growth to ensure that the resulting harvest schedule is consistent with current practice. In order to evaluate the stability of the timber supply to departures from this queuing rule, two additional harvest rules were tried.

The first of these was 'maximize replacement increment'. Harvest was directed to those stands that would regenerate to the fast growing stands. The base case harvest levels can be achieved in the short term, but a small harvest volume deficit occurs in period 17 and recurs in period 22. The long term harvest level must be reduced by 16,000 cubic metres annually to 315,000 m3/year.

The second alternative harvest rule tried was 'maximize volume per hectare'. Stands with the highest volume per hectare were selected first for harvesting. Using the base case harvest request, a significant shortfall occurs at period 18 and is an issue for most subsequent periods until the end of the planning horizon. The long-term harvest level must be reduced by 6000 cubic metres annually in order to be sustainable.

Figure 9 shows the harvest levels that are sustainable under the base case and two alternative harvest queuing rules.

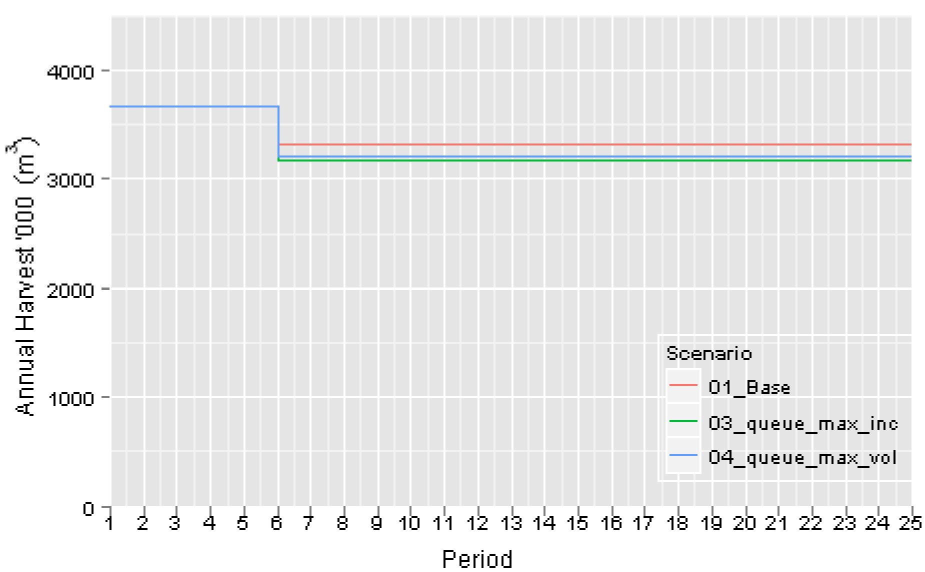


Figure 9. Alternative Harvest Scheduling Rules

6 Sensitivity Analysis Results

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. Table 5 summarizes the sensitivity analyses that have been performed for this analysis.

Table 5. List of Sensitivity Analyses

Issue	Sensitivity Analysis	Level to be Tested
Post-Harvest SI Uncertainty		
VRI does not accurately reflect future site productivity	Use SGSI to build yield curves	n/a
Landbase Uncertainty		
Impact of changes in area available for harvest	Area of THLB	+/- 10%
Stand G/Y Uncertainty		
Inventory volumes not realized at harvest	Existing Stand Volume	+/- 10%
Future stands do not perform as forecast	Future Stand Volume	+/- 10%
Stands become economical to harvest sooner or later than predicted	Minimum Harvest Age	-10 years, +10, +20 years,
Disturbance Limit Uncertainty		
Visual Constraints	Green-up Height	+/- 1 metre
Integrated Resource Management (IRM)	Disturbance Limit	- 5% (20%) + 5% (30%)
Integrated Resource Management (IRM)	Green-up Height	+/- 1 metre

6.1 Site Index – Post Harvest

Estimates of site productivity are the main determinant of future stand yields and are consequently a primary driver of timber supply forecasts. The timber supply analysis completed for the last Management Plan and AAC determination was based on different estimates of site productivity than have been used for this analysis. For this base case, the inventory site index from the VRI has been used to develop yield tables for all existing and future stands. Managed stand yield curves for the base case scenario in the last timber supply analysis for TFL 46 were based on second growth site index derived from Terrestrial Ecosystem Mapping (TEM) and a field data collection program. These ecologically-based site index estimates were used for stands that regenerated after 1955. The derivation of these site indices is described in the report *Second Growth Site Index Estimates for Douglas-fir, Western Hemlock, Pacific Silver Fir and Western Redcedar on TFL 46*.[5] This is referred to as second-growth site index (SGSI).

A change in government policy precludes the use of these TEM-based SI's for the base case scenario for this analysis. The MFR has insisted that this analysis use inventory site index to construct all yield curves for the base case. The TEM upon which the second growth site index estimates were based has not yet been independently assessed for accuracy. A new MFR policy requires that this assessment be completed before ecologically-based site index estimates can be used for a base case analysis. To gauge the impact on timber supply of this change, this sensitivity analysis using SGSI-based yield curves has been completed. TEM-based estimates have been input to TIPSY to generate future managed stand yield tables for this sensitivity analysis.

These yield curves resulted in higher volumes for second growth stands. Due to the increased growth rates, these stands reached a harvestable condition at a younger age than that forecast by the base case yield curves. Minimum harvest ages were recalculated for this sensitivity analysis. The forest estate model was rerun with these amended inputs.

The sustainable long-term harvest level is 28% higher than for the base case, increasing from 332,500 m^3/year to 425,000 m^3/year. This increase occurs in two steps, from an initial harvest level of 370,000 m^3/year. This initial harvest level is less than one percent higher than the base case starting level of 367,363 m^3/year. Figure 10 compares the harvest level for this sensitivity analysis to the base case harvest flow.

---

[5] J. S. Thrower & Associates Consulting Foresters Ltd. 2000. *Second-Growth Site Index Estimates for Douglas-fir, Western Hemlock, Pacific Silver Fir, and Western Redcedar on TFL 46.*

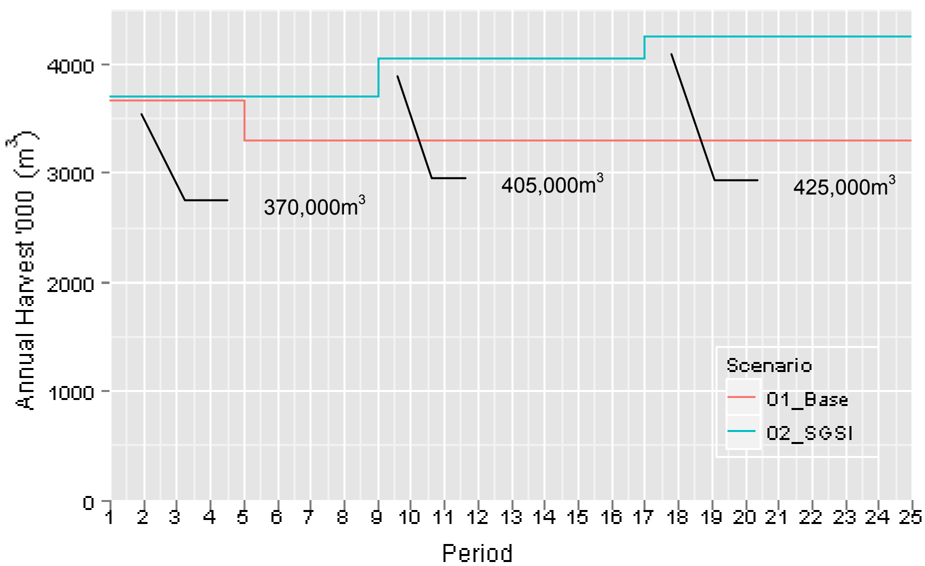


Figure 10. SGSI Harvest Level

Initial growing stock levels are identical to the base case. Once stands regenerate to the new managed stand yield curves, growing stock levels begin to increase, relative to base case levels. Figure 11 show these growing stock trends. Levels still decrease for the first 60 years however; the trough at this point is almost as deep as for the base case. The increase growth is offset somewhat by the higher harvest levels. In the long term, growing stock levels are significantly higher. The increased volume cannot be harvested due to IRM, watershed and visual quality disturbance constraints.

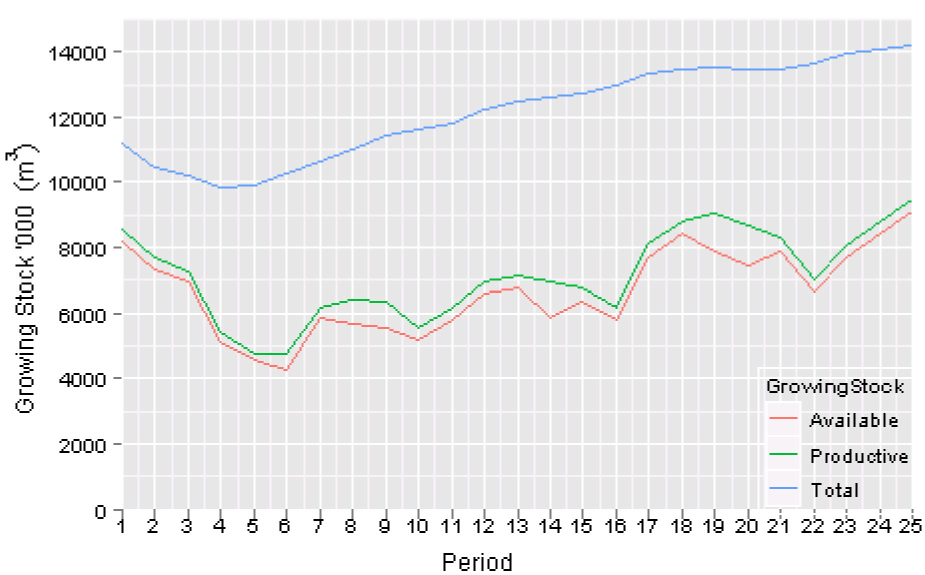


Figure 11. SGSI Growing Stock Levels

The transition from harvesting in existing to harvesting in future managed stands is similar to the pattern seen in the base case, and is shown in Figure 12.

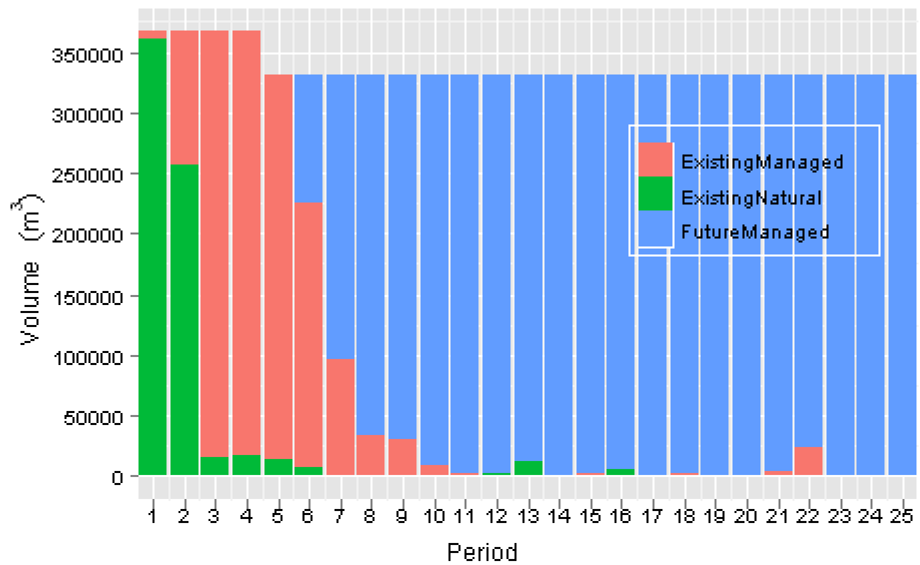


Figure 12. Harvest Contribution from Existing and Future Stands

Compared to the base case, average annual area harvested is greater in the midterm (50-80 years) as the higher initial harvest level forces harvest into younger stands. In the long term, however, annual area harvested is lower because the managed stands being harvested are generating a higher volume per hectare. Figure 13 shows this pattern.

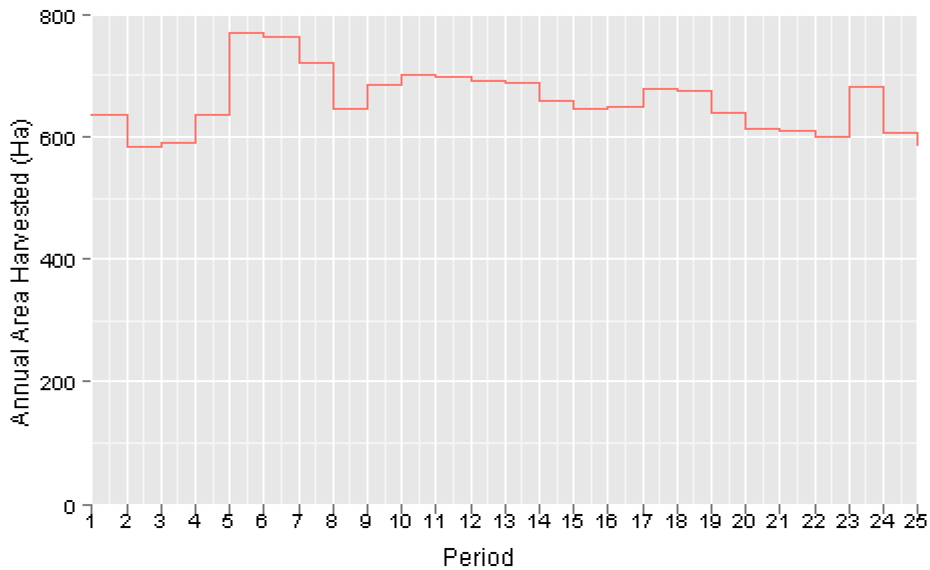


Figure 13. Average Annual Area Harvested

The average harvest age pattern (Figure 14) is very similar to the base case. However, the age is slightly higher in the long term. Over the last five periods, the average harvest age is 67 year, as opposed to 62 years in the base case.

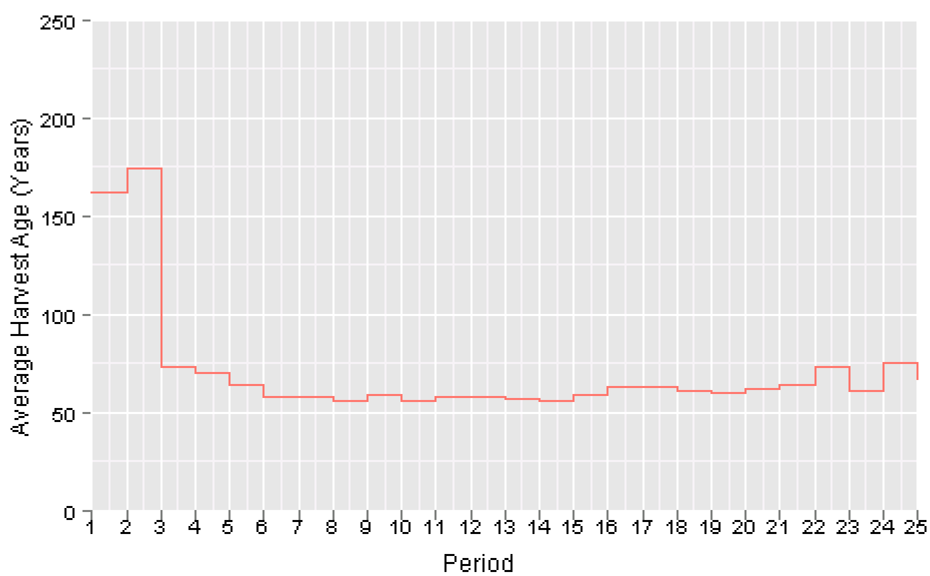


Figure 14. Average Age of Harvested Stands

The average harvest volume achieve is similar to that seen in the base case in the short term. However, whereas harvest volumes fall and stabilize at just below 500 m^3/ha in the base case, long term harvest level in this case approach 650 m^3/ha as higher yielding managed stands come on line. Figure 15 shows this pattern.

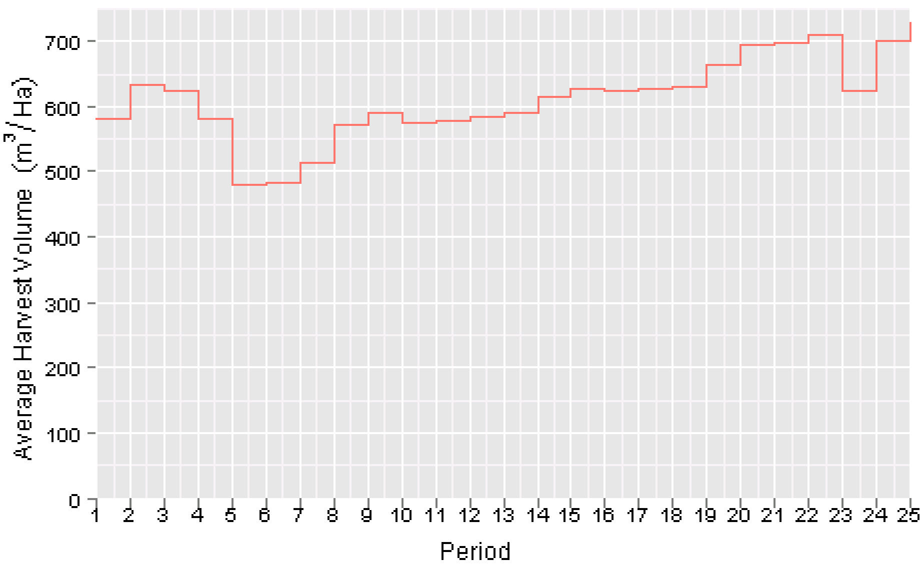


Figure 15. Average Volume of Harvested Stands

The age class distribution of the forest over time is similar to that seen in the base case. However, because the long-term average harvest age is slightly higher, more area accumulates in the 60-70 year age class. As with the base case, no allowance has been made for natural disturbance in areas outside of the THLB, so by the end of the planning horizon all of the non-contributing landbase is over 250 years of age.

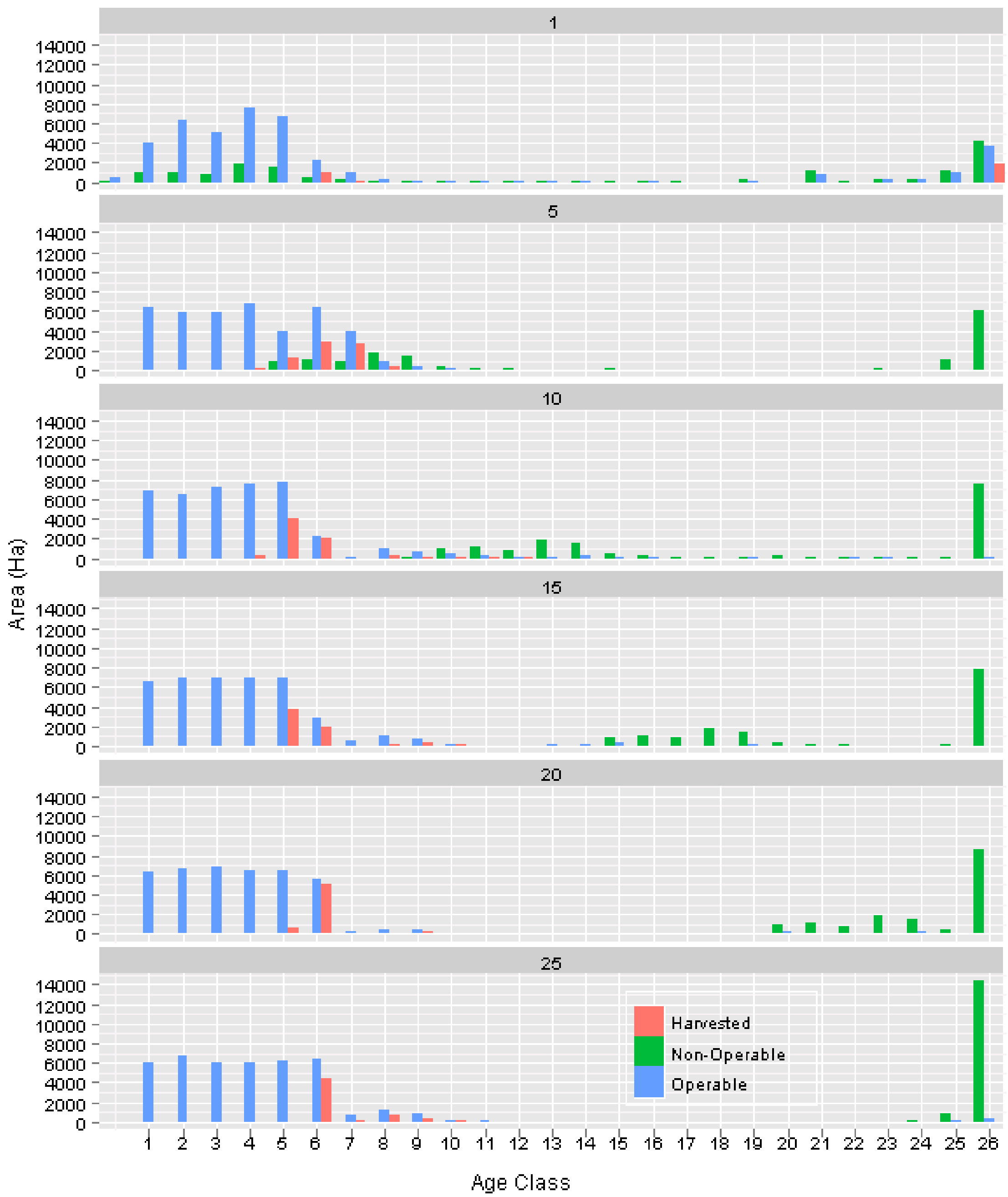


Figure 16. Age Class Distribution Throughout the Planning Horizon

6.2 Landbase Uncertainty

The actual size of the timber harvesting landbase is generally a source of uncertainty. The size of the landbase that could be harvested at any point it time varies with market conditions and with evolving objectives for non-timber resource values. The THLB determination completed in the *Information Package* was based on the best available resource information; if underlying inventories, management assumptions or log prices change, the size of the THLB will be affected. To gauge the potential impact of landbase changes on timber supply, the THLB has been increased and decreased by 10%. The area in productive non-contributing land was increased 30.2% - the amount needed so that the total size of the productive landbase remained the same as for the base case.

If the size of the THLB is decreased by 10% (and the productive, non-contributing area is increased by a corresponding amount), timber supply is significantly affected in both the short and long term. The initial harvest level falls by 8.0% to 338,000 m^3 annually. The sustainable long-term level is 297,500 m^3 – a decrease of 10.5% from the base case.

If the size of the THLB is increased by 10%, the short-term harvest level increases by 11.9% to 411,000 m^3/year. The long-term level rises to 364,000 m^3/year – an increase of 9.5%. The long-term increase is slightly less than the increase in the size of the THLB because less non-contributing area is available to meet biodiversity constraints (since the size of the productive landbase is fixed).

The results of all landbase uncertainty runs are summarized in Figure 17 below.

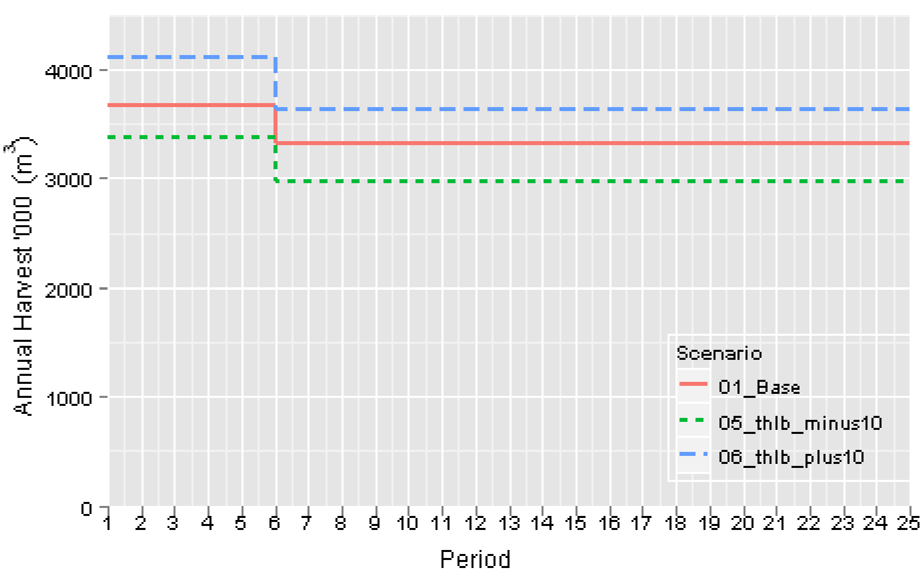


Figure 17. Harvest Level Sensitivity to Landbase Uncertainty

6.3 Growth and Yield Uncertainty

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. Two pairs of 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.

6.3.1 Existing Stand Volume

Existing natural stand yields were estimated using VDYP; existing managed stands were modeled with TIPSY. The impact on timber supply of increasing or reducing these estimates by 10% has been examined.

When existing stand volumes are increased by 10%, short term harvest levels climb by 12.2% from the base case harvest level of 367,363 m^3 to 412,000 m^3/year.

When existing stand volumes are reduced by 10%, the harvest level falls by 10.2%; the base case harvest level of 367,363 is reduced to 330,000 m^3/year. In both cases, long term harvest levels are essentially unchanged; a 500 m^3/year reduction is needed in the latter case so that long-term growing stock levels stabilize. The results are summarized in Figure 18.

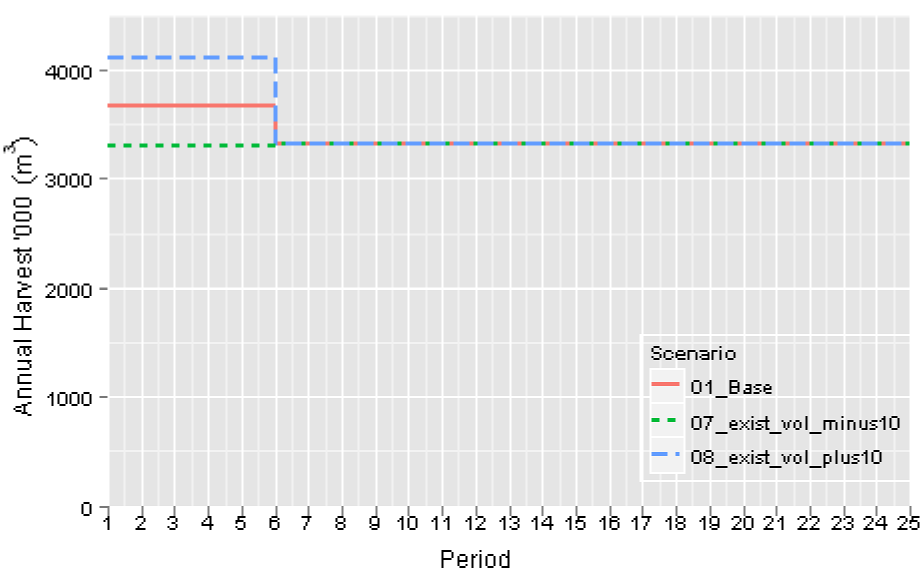


Figure 18. Harvest Level Sensitivity to Existing Stand Yield Uncertainty

6.3.2 Future Stand Volumes

In a similar fashion, uncertainty in future stand yields has been considered. They were increased by 10% for the first sensitivity analysis, and reduced by 10% for the second. Neither change had any impact on short term harvest levels.

When future stand volumes are increased by 10%, the long-term harvest level increases by 9.8% to 365,000 cubic metres annually. When they are reduced by 10%, the harvest level falls by 7.7% to 307,000 m^3/year. The results are summarized in Figure 19.

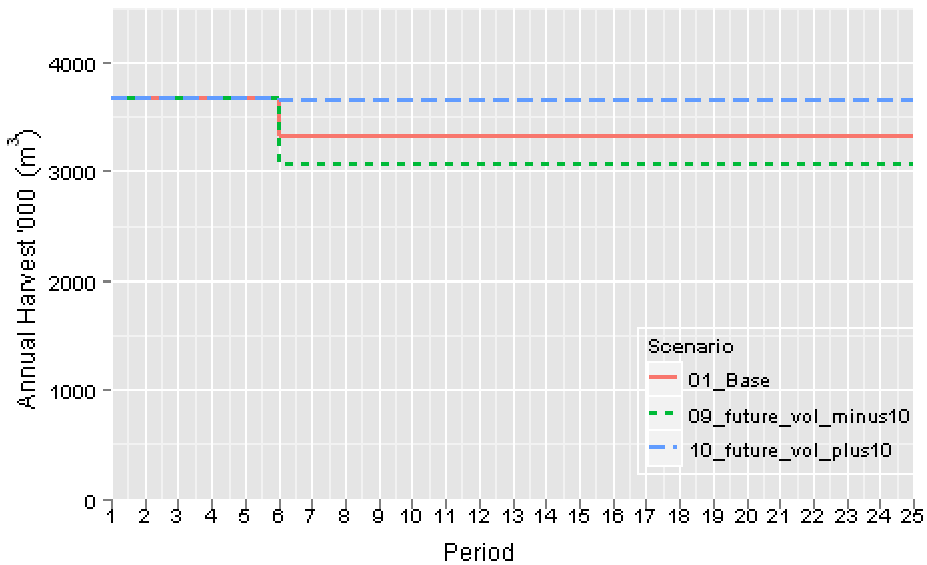


Figure 19. Harvest Level Sensitivity to Future Stand Yield Uncertainty

6.3.3 Minimum Harvest Age

The minimum harvest age was established for each yield curve as the youngest age at which it meets all three of the following criteria:

- Minimum volume per hectare of 300 m^3/hectare;
- Minimum QMD of 25 centimetres; and
- Within 90% of maximum 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, short term harvest rises by 1.3% to 372,000 m^3/year. Any increase in harvest above this level results in a shortfall at the end of the planning horizon. The long term harvest level remains unchanged at 332,500 m^3/year.

In a second sensitivity analysis, MHA was increased by 10 years. This resulted in a short term decrease in harvest of 8.0%, to a level of 338,000 cubic metres per year. The long term harvest level actually increases slightly – by 2.3% to 340,000 m^3/year.

In the final sensitivity analysis of this set, MHA was increased by 20 years. This resulted in a short-term decrease in harvest level of 20.5% to 292,000 m^3/year and a long-term increase of 6.2% to 353,000 m^3/year. Figure 20 shows these trends.

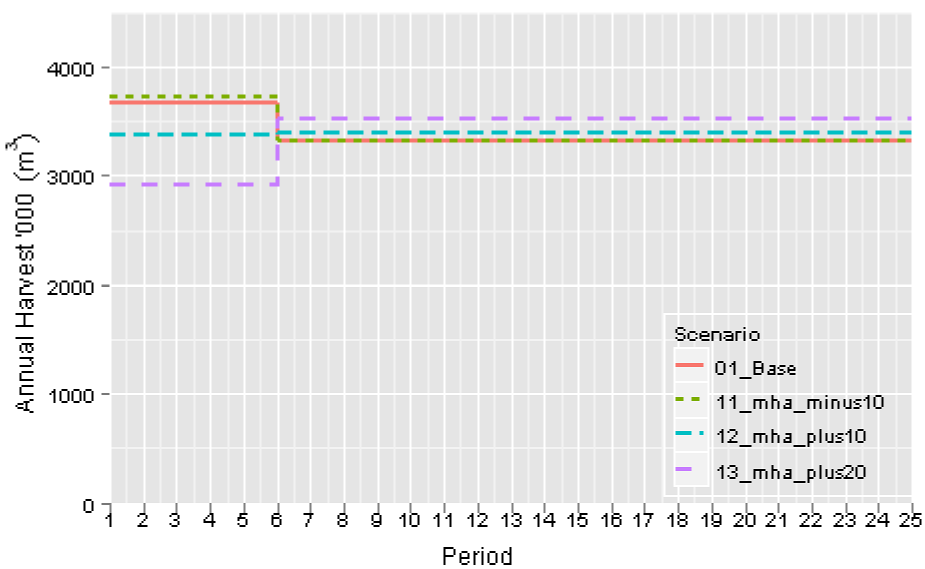


Figure 20. Harvest Level Sensitivity to MHA Uncertainty

6.4 Disturbance Limit Uncertainty

6.4.1 Visual Green-up

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 had no impact on harvest levels in either the short or long term. Decreasing green-up requirements led to slightly increased harvest levels (1.8% to 374,000 cubic metres annually) in the short term. The long-term harvest level remained unchanged. Figure 21 shows these results.

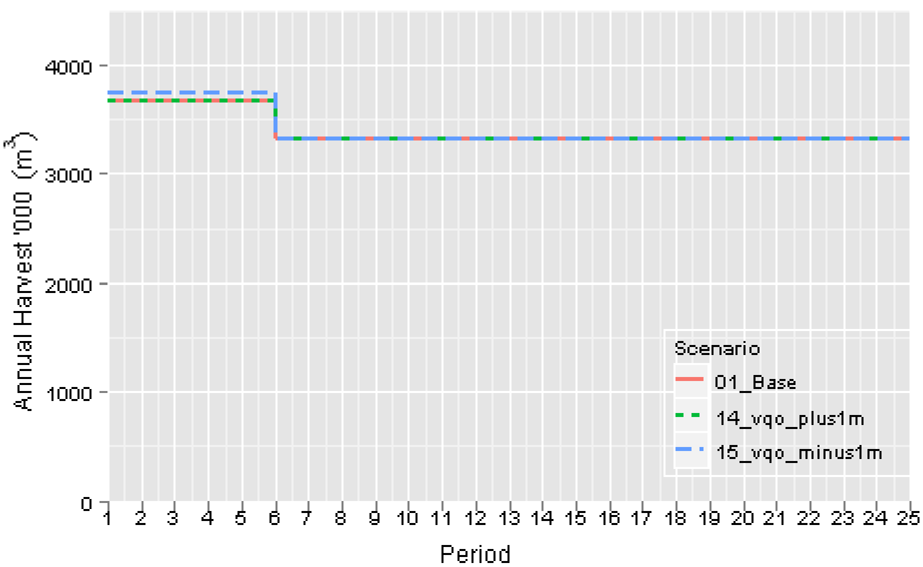


Figure 21. Harvest Level Sensitivity to Visual Green-up Uncertainty

6.4.2 Integrated Resource Management

In areas that are not subject to visual quality management, disturbance constraints have been applied as a proxy for adjacency. No more than 25% of a landscape unit can be less than three metres in height. This constraint is applied to the THLB only. Sensitivity runs were conducted on both parts of this constraint – the proportion and the height. The results are summarized in Figure 22 below.

A decrease in the maximum proportion of the area allowed to be below three metres (from 25% to 20%) stand height had no impact on harvest levels. When the limit was increased to 30% a short-term increase in harvest level was possible; it rose by 1.7% to 373,500 m^3/year.

Changes in the green-up height limit likewise had little effect on harvest levels. Increasing the green-up height to four metres had no impact on in either the short or long term. Long term harvest level did not change when the height limit was decreased to two metres, but the short-term harvest level increase slightly (by 1.4%) to 372,500 cubic metres per year.

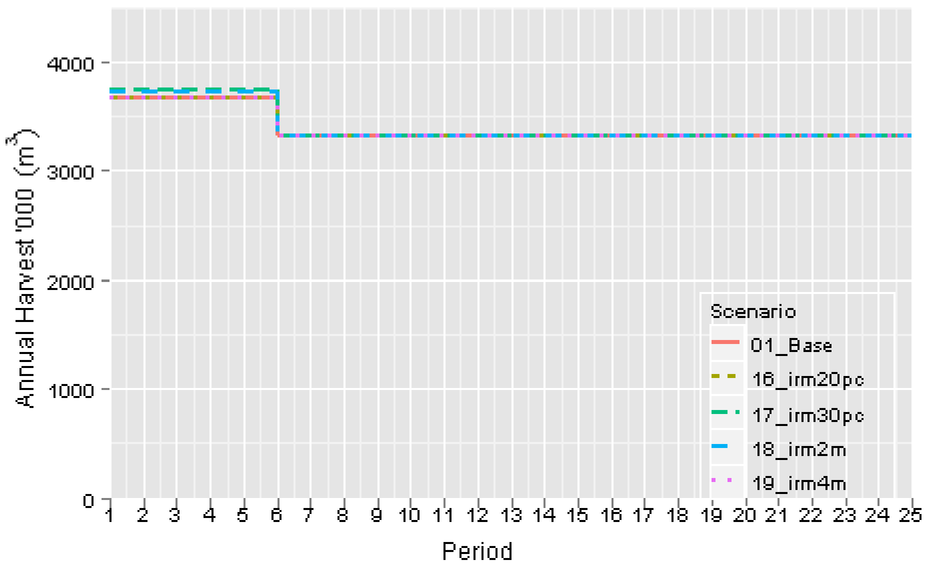


Figure 22. Harvest Level Sensitivity to IRM Uncertainty

7 Discussion and Conclusions

The analyses described in this report were developed to provide input into the process of determining the AAC for TFL 46. In doing so, a timber supply harvest rate was sought that would maintain the existing AAC for as long as possible while achieving a stable long-term supply and growing stock. Under the base case scenario, it was possible to maintain the current harvest rate for fifty years. At that point, it must fall to the long-term sustainable level of 332,500 m^3/year. Attempts to increase the short term harvest above the current level resulted in a harvestable growing stock shortfall at the end for the fifth decade.

The results of the sensitivity analyses that were completed in order to test the robustness of the base case harvest levels to changes in landbase, yield and management practice assumptions are presented in Table 6.

Table 6. Base Case and Sensitivity Harvest Level Summary

		Short Term Harvest Level		**Long Term Harvest Level**	
Scenario		**m^3/year**	**% of Base Case**	**m^3/year**	**% of Base Case**
Base Case	01	367,363	100.0%	332,500	100.0%
Post-Harvest SI Uncertainty					
Second Growth Site Index	02	370,000	100.7%	425,000	127.8%
Alternate Harvest Rules					
Minimize Volume Lost	03	367,363	100.0%	315,000	94.7%
Highest Volume First	04	367,363	100.0%	325,000	97.7%
Landbase Uncertainty					
THLB Minus 10%	05	338,000	92.0%	297,500	89.5%
THLB Plus 10%	06	411,000	111.9%	364,000	109.5%
Stand G/Y Uncertainty					
Existing Volume Plus 10%	08	412,000	112.2%	332,500	100.0%
Existing Volume Minus 10%	07	330,000	89.8%	332,500	100.0%
Future Volume Plus 10%	10	367,363	100.0%	365,000	109.8%
Future Volume Minus 10%	09	367,363	100.0%	307,000	92.3%
Minimum Harvest Age Uncertainty					

		Short Term Harvest Level		Long Term Harvest Level	
Scenario		**m^3/year**	**% of Base Case**	**m^3/year**	**% of Base Case**
MHA Minus 10 Years	11	372,000	101.3%	332,500	100.0%
MHA Plus 10 Years	12	338,000	92.0%	340,000	102.3%
MHA Plus 20 Years	13	292,000	79.5%	353,000	106.2%
Disturbance Limit Uncertainty					
VQO Greenup Plus 1m	14	367,363	100.0%	332,500	100.0%
VQO Greenup Minus 1m	15	374,000	101.8%	332,500	100.0%
IRM Disturbance Minus 5%	16	367,363	100.0%	332,500	100.0%
IRM Disturbance Plus 5%	17	373,500	101.7%	332,500	100.0%
IRM Greenup Plus 1m	18	367,363	100.0%	332,500	100.0%
IRM Greenup Minus 1m	19	372,500	101.4%	332,500	100.0%

7.1 Second Growth Site Index

The base case yield curves were developed using the site index from the VRI. This is lower than the site index in the old forest cover, and significantly lower than the TEM-based SI. This conservative estimate of productivity results in significant downward pressure on timber supply in the long term. When yield curves based on SGSI are used to forecast the development of future managed stands, a 27% increase in long term harvest level is possible. A small increase (slightly less than 1%) is also possible in the short term because future stands become harvestable at a younger age.

7.2 Landbase and Yield Issues

The proportion of the TFL landbase that is available for harvesting – physically accessible, economically viable and free of regulatory restrictions – is a primary driver of timber supply. The *Information Package* presented and justified a netdown of the total TFL landbase (of 59,844 hectares) to a timber harvesting landbase of 42,508 hectares. This was done using the most current information available and was based on current management practices. To the extent that the actual area available for harvesting departs from this estimate, the timber supply will be impacted. If the THLB were to increase in size by 10%, short-term timber supply would rise by 11.9% and long-term supply would increase by 9.5%. Conversely, if the area of the THLB is reduced by 10% short- and long-term timber supply fall by 8.0% and 10.5% respectively.

The short-term timber supply is moderately sensitive to changes in the yield estimates for natural mature stands. The increase or decrease in timber flow is approximately proportional to assumptions about changes in yield. Reducing the volume estimates for natural stands by 10% forces the annual harvest to drop by 10.2% from the base case level. Conversely, increasing volumes in natural stands by 10% allows the current AAC to climb by 12.2%. The long-term harvest level is unaffected by changes in the yield of existing stands.

Changing the yield of future stands has no impact on initial harvest levels. The change in long-term levels is roughly proportional to changes in future yield curves. Adjusting future yield curves up by 10% resulted in a corresponding increase of 9.8% in long-term harvest levels. A 10% reduction in future yield reduces long-term timber supply by 7.7%.

If future yield curves are unaltered, but MHA is increased by 10 years, short-term timber flow falls by 8.0% and long-term timber supply increases by 2.3%. These trends are magnified if MHA is increased by 20 years. Short-term harvest levels must fall by 20.5% and long-term timber supply increases by 6.2%. However, if MHA is decreased by 10 years, the initial harvest level increases by only 1.3% – an indication the short-term supply is also limited by disturbance and retention constraints, and not just the availability of timber above minimum harvest age. Long-term harvest level is unaffected.

7.3 Management Practices

The variations in timber supply discussed above are due to uncertainty about the data upon which the base case timber supply is founded. The other major source of uncertainty considered in the sensitivity analyses was that related to forest management practices. The complex operational decision making that occurs on a day-to-day basis in order to meet competing resource objectives in a shifting economic and social environment must be reduced to a somewhat simple set of cover constraints that can be applied during forest estate modeling. If actual management practices differ from these assumptions, changes in sustainable timber supply will result.

A cover constraint enforces a limitation on harvesting over a specified area or zone. For this analysis, zones were created to model:

- visual quality objectives;
- goshawk habitat;
- biodiversity (in the Cowichan LU only); and
- fisheries sensitive watersheds

and also at the landscape unit level as an alternative to modeling strict cutblock adjacency (an IRM constraint). Sensitivity analyses were conducted around the first and last of these issues – VQO and IRM constraints.

Changes in the constraints applied to protect VQO's have virtually no impact in harvest levels in either the short or the long-term. Five VQO polygons currently exceed the harvest limit specified for the VQO class into which they fall, but the forest estate model does not schedule future harvesting in these areas until they are sufficiently recovered.

IRM constraints are, for the most part, not limiting on timber supply. Small short-term increases in harvest level are possible (less than 2%) if the green-up height is reduced or the harvest area limit is increased, but the long-term harvest level is unchanged under all of the IRM sensitivities model. The Cowichan LU is in violation of its IRM constraint at the start of the planning horizon, but recovers within twenty years. The area of this LU that falls within TFL 46 is small, so it has a negligible impact on the overall timber supply situation. The Walbran is the only other LU that approaches the IRM limit – this occurs at 60 years and the harvested area is slightly over 90% of the available area.

No sensitivity analyses were conducted for goshawk habitat or for biodiversity in the Cowichan LU. Although these resource values are important, the area of the TFL that falls into each of these zones is too small for the sensitivities that are typically examined for these issues to show meaningful timber supply impacts.

7.4 Conclusions

Most of the sensitivity analyses completed show that the TFL 46 timber supply is relatively insensitive to small changes in the underlying data or varying assumptions about future management practices. The exception to this is belief about true site productivity of the TFL, and the significant impact that this has on the yield and MHA forecasts for second growth stands. Even in this case, the differences in projected timber supply are small in the short term. It is only in the long term that these forecasts depart from one another significantly.

The next AAC determination for TFL 46 will be in force for between five and ten years, barring any significant alterations to landbase or changes in management practices. An AAC of 370,000 cubic metres per year is quite defensible based on the information presented is this document. This is the initial harvest level that could be sustained using the yield curves based on SGSI. It represents a slight increase from the current administratively-adjusted AAC that was used as the starting level in the base case. The risk of establishing the AAC at this level is small; if the VRI site index estimates are in fact accurate, harvest shortfalls will not occur for fifty years. In the meantime, further work can be done to verify site index estimates for the timber harvesting landbase.

8 Glossary

AAC	Allowable Annual Cut
BEC	Biogeoclimatic Ecosystem Classification
CASH6	Critical Analysis by Simulation of Harvesting
ESA	Environmentally Sensitive Area
FPPR	Forest Planning and Practices Regulation
FSP	Forest Stewardship Plan
GIS	Geographic Information System
IP	Information Package
IRM	Integrated Resource Management
IRM	Integrated Resource Management
LU	Landscape Unit
MHA	Minimum Harvestable Age
MFR	Ministry of Forests and Range
MP	Management Plan
NSR	Not Satisfactory Restocked
OAF	Operational Adjustment Factor
OGMA	Old Growth management Area
PSYU	Public Sustained Yield Unit
QMD	Quadratic Mean Diameter
RFI	Recreation Features Inventory
RMZ	Riparian Management Zone
RRZ	Riparian Reserve Zone
RVQC	Recommended Visual Quality Class

SGSI	Second Growth Site Index
SI	Site Index
SRMZ	Special Resource Management Zone
TEM	Terrestrial Ecosystem Mapping
THLB	Timber Harvesting Land Base
TIPSY	Table Interpolation Program for Stand Yields
TL	Timber Licence
UWR	Ungulate Winter Range
VDYP	Variable Density Yield Prediction
VILUP	Vancouver Island Land Use Plan
VLI	Visual Landscape Inventory
VQO	Visual Quality Objective
VRI	Vegetative Resources Inventory
WHA	Wildlife Habitat Area

9 References

Abbott, George. 2004. *Order Establishing Provincial Non-Spatial Old Growth Objectives.* Ministry of Sustainable Resource Management.

Baker, Ken. 2003. *Tree Farm Licence 46 – Rationale for Allowable Annual Cut (AAC) Determination.* B.C. Ministry of Forests.

Baker, Ken. 2004. *Chief Forester Order – Section 173 of the Forest Act (concerning Hill 60).* B.C. Ministry of Forests.

B.C. Ministry of Forests. 2001. *Guide for Tree Farm Licence Management Plans (20-month) and Calendar Year Reports.* Resource Tenures and Engineering Branch / Timber Supply Branch

B.C. Ministry of Forests. 2002. *TFL 46 License Agreement.* (Contract between the Province of British Columbia and TFL Forest Ltd.)

B.C. Ministry of Forests. 2003. *Supplemental Guide for Preparing Timber Supply Analysis Information Packages.* Forest Analysis Branch

B.C. Ministry of Forests. 2004. *Interim Standards for Information Package Preparation and Timber Supply Analysis - Defined Forest Area Management Initiative.* Forest Analysis Branch

Cowichan Lake Community Forest Cooperative Ltd. and The Teal-Jones Group. 2006. *Forest Stewardship Plan*.

Dryburgh, Jack. 2005. *Order to Establish Visual Quality Objectives for the South Island Forest District.* Ministry of Forests and Range.

Government of British Columbia. 2001. *Vancouver Island Summary Land Use Plan.*

Government of British Columbia. 2006. *Website. Forest Planning and Practices Regulation*. (http://www.for.gov.bc.ca/tasb/legsregs/frpa/frparegs/forplanprac/fppr.htm)

J. S. Thrower & Associates Consulting Foresters Ltd. 2000. *Second-Growth Site Index Estimates for Douglas-fir, Western Hemlock, Pacific Silver Fir, and Western Redcedar on TFL 46.*

Macatee, Gordon. 2003a. *Order – Ungulate Winter Range #U1-002.* Ministry of Water, Land and Air Protection.

Macatee, Gordon. 2003b. *Order – Ungulate Winter Range #U1-017.* Ministry of Water, Land and Air Protection.

Teal Jones Forest Ltd. et. al. 2006. *Renfrew Aggregate Landscape Unit Plan (Draft V6).* B.C. Integrated Land Management Bureau.

The Teal-Jones Group. 2006. *Sustainable Forest Management (SFM) Plan.*

TFL Forest Ltd. (TimberWest). 2001. *Tree Farm Licence No. 46 – Management Plan No. 4.*

Timberline Natural Resource Group. 2008. *Tree Farm Licence 46 – Vegetation Resources Inventory Statistical Adjustment.*

Appendices

Appendix I

Information Package

Tree Farm Licence 46

Information Package

Management Plan #5

Timber Supply Analysis

May 2009

The Teal-Jones Group

Table of Contents

List of Tables

List of Figures

Appendices

Existing Mature Average Volume Lines
Existing Natural Yield Curves
Existing Managed Yield Curves
Future Yield Curves
Site Index Adjustment Report
VRI Phase II Adjustment Report

1 Introduction

This document provides a summary of the inputs and assumptions made in preparing the timber supply analysis data set and model. Included are inventory and land base summaries, growth and yield information and management assumptions for timber and non-timber resources as they relate to timber supply.

The Information Package allows the reader to consider the inputs and assumptions to be used in the timber supply analysis. These include:

- The documentation of inventory data and sources;
- Classification of the land base according to each hectare's contribution to management (harvest, resource management for wildlife, etc.);
- Land productivity estimates and prediction of stand growth and timber yield;
- Silviculture and harvesting regimes;
- Action taken to model multi-resource requirements; and
- Timber supply scenarios and sensitivity analyses to be evaluated.

The document has been prepared to identify management issues on Tree Farm License (TFL) 46 that are relevant in determining a sustainable harvest level, and has been prepared in accordance with the guidelines set out in the document "*Provincial Guide for the Submission of Timber Supply Analysis Information Packages for Tree Farm Licences*". In addition to describing the scope and broad objectives of the timber supply analysis, this report will serve as a communication instrument in dealing with people and organizations who have an interest in the project, but who will not be involved at a technical level. Upon acceptance by the Ministry of Forests and Range (MFR) Timber Supply Analyst, the assumptions and methodology provided in the Information Package will be used to prepare and submit a timber supply analysis to the MFR.

This Information Package has been prepared in support of the Timber Supply Analysis for Management Plan No. 5 for TFL 46 and will be provided as an Appendix to the Timber Supply Analysis Report.

Figure 1-1shows the location of TFL 46 between Cowichan Lake, Nitinat Lake and Port Renfrew on southern Vancouver Island.

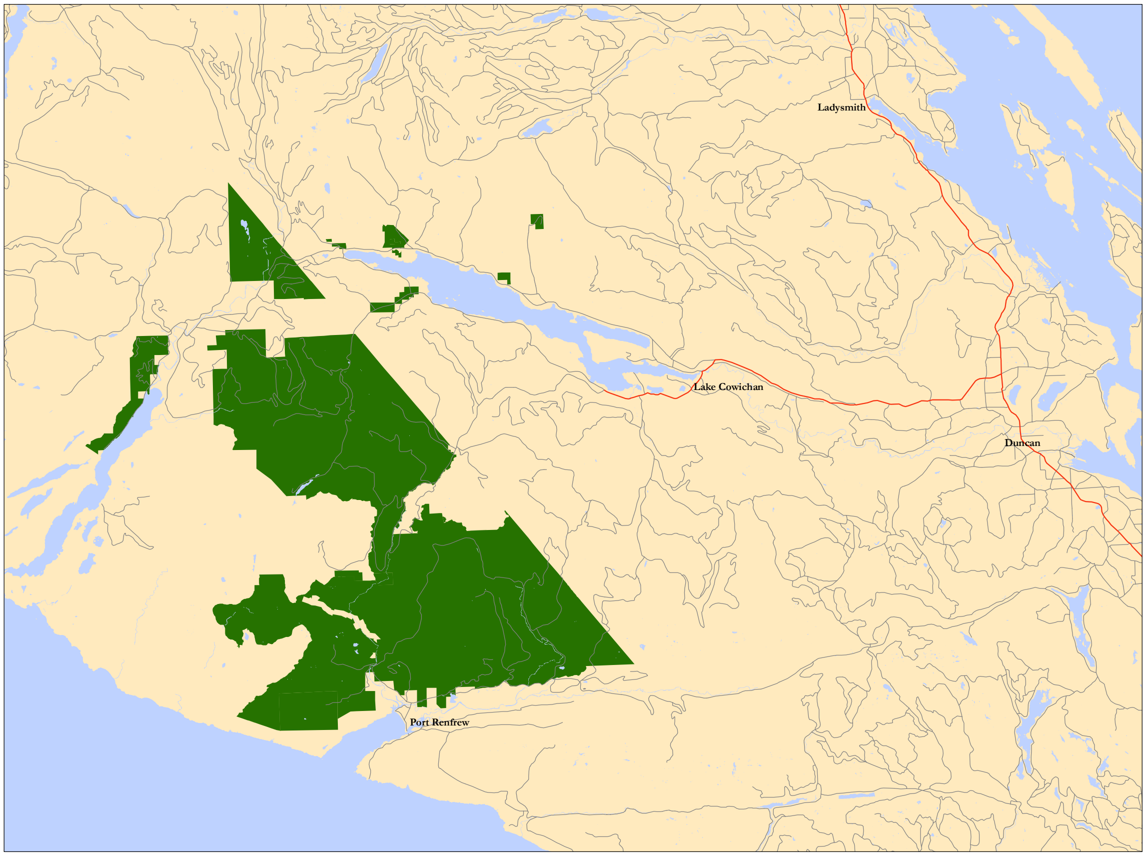


Figure 1-1. Location of TFL46

2 Process

2.1 Overview

The data summarized in this document is the most current available. Any assumptions made for modelling and forecasting purposes are consistent with current forest management practices on the TFL.

The contents of this document will be reviewed with staff from MFR Forest Analysis and Inventory Branch (FAIB) before starting any forest estate modelling.

This report will be included as Appendix I of the Timber Supply Analysis Report.

2.2 Growth and Yield

This section describes the issues, information sources, assumptions, methods, and any relevant processing or adjustments related to growth and yield estimates for existing and future stands. Yield tables for natural stands were developed with the MFR program Variable Density Yield Predictor (VDYP). For old stands, these values were overridden with Average Volume Line (AVL) information taken from the previous forest inventory database. Managed stands used the MFR Table Interpolation Program for Stand Yields (TIPSY) growth and yield model.

Copies of these yield tables can be found in Appendices I through IV.

2.2.1 Site index

Yield curves for the base case scenario in the last timber supply analysis for TFL 46 were based on adjusted site index derived from Terrestrial Ecosystem Mapping (TEM) and a field data collection program. A change in government policy precludes the use of this information for the base case scenario for this analysis. Instead, yield curves based on adjusted site index will be used for one of the sensitivity analysis runs. This issue is discussed further in Section 8.1. The report describing the site index adjustment process[1] can be found in Appendix V.

[1] Second-Growth Site Index Estimates for Douglas-fir, Western Hemlock, Pacific Silver Fir, and Western Redcedar on TFL 46. 2000. J. S. Thrower and Associates Ltd. Consulting Foresters.

3 Timber Supply Forecasts

This section summarizes the harvest forecasts that will be provided. The assumptions pertaining to each option and sensitivity analysis are detailed in later sections.

3.1 Base Case

The base case analysis uses the best available information and assumes that current management practices will be carried on throughout the entire 250 year planning horizon. It is intended to model 'What is?' rather than 'What if?'. Major forest management considerations and issues incorporated into this base case analysis are:

- new Vegetation Resources Inventory (VRI), including the Phase II adjustment;
- minimum harvest ages based on volume and piece size criteria;
- exclusion of harvesting within Old Growth Management Areas, Ungulate Winter Range (UWR), Riparian Reserves Zones (RRZ) and other areas with high habitat or recreational values;
- buffering of all unreclaimed roads in the road inventory to accurately reflect the loss of productive area;
- constraints on harvest rates in order to protect biodiversity and visual values at the landscape level;
- retention of trees to meet stand level biodiversity and riparian requirements; and
- regeneration and silvicultural assumptions that reflect current practices.

It is based on current performance and so provides a reference timber supply forecast against which timber supply implications of different future management options may be measured. The objective of the base case will be to:

- Maintain or increase the current harvest for as long as possible;
- Limit changes in harvest level to less than 10% per decade;
- Balance old growth and second growth harvest to meet industrial requirements; and
- Achieve stability in the long-term harvest level and growing stock profiles.

3.2 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. Table 3.1 summarizes the sensitivity analyses that will be performed for this analysis.

Table 3-1. List of Sensitivity Analyses

Issue	Sensitivity Analysis	Level to be Tested
Landbase Uncertainty		
Impact of changes in area available for harvest	Area of THLB	+/- 10%
Stand G/Y Uncertainty		
Inventory volumes not realized at harvest	Existing Stand Volume	+/- 10%
Future stands do not perform as forecast	Future Stand Volume	+/- 10%
Stands become economical to harvest sooner or later than predicted	Minimum Harvest Age	-10 years, +10, +20 years,
Disturbance Limit Uncertainty		
Visual Constraints	Green-up Height	+/- 1 metre
Integrated Resource Management (IRM)	Disturbance Limit	- 5% (20%) + 5% (30%)
Integrated Resource Management (IRM)	Green-up Height	+/- 1 metre
Post-Harvest SI Uncertainty		
VRI does not accurately reflect future site productivity	Use Adjusted Site Index to build yield curves	n/a

3.3 Alternative Harvest Flows

The base case will use a 'Relative Oldest First' harvest rule, subject to a quota on second growth to ensure that the resulting harvest schedule is consistent with current practice. In addition, the following harvest rules will be used to gauge the strategic implications of different harvest queuing options:

- Oldest First
- Highest Volume First
- Minimize Growth Loss

A number of different harvest flows will be explored, based on tradeoffs between short and mid-term harvest levels. In particular, the balance between old growth and second growth harvesting will be varied to gauge the impact on sustainable harvest levels and non-timber resource values.

3.4 Other Options

No other analysis scenarios are anticipated.

4 Forest Estate Model

Timberline's simulation model CASH6 (*Critical Analysis by Simulation of Harvesting*) will be used to develop harvest schedules integrating all resource management considerations. The model uses a geographic approach to land base and inventory organization in order to adhere as closely as possible to the intent of forest cover requirements. Maximum disturbance and minimum thermal and old growth retention forest cover requirements, as well as biodiversity seral stage requirements, can be explicitly implemented if required.

A variable degree of spatial resolution is available depending on inventory formulation and resource emphasis area definitions. Forest stands in refuges such as environmentally sensitive and inoperable areas that do not contribute to the periodic harvest can be included to better model forest structure at the landscape level.

In their current implementation, forest cover objectives require a control area over which to operate. The control area for a constraint set should correspond to a realistic element in the landscape. For example, the requirements associated with visual quality objectives (VQO) are designed to operate on the scene visible from discrete sets of viewpoints. The objective is to identify the "natural" constituency for forest cover constraints. CASH6 contains a hierarchical land base organisation to assist in implementing control areas. Numerous levels of land aggregation are used to define both geographically separate areas and areas of similar management regime. Forest cover constraints can be applied at up to five overlapping levels.

5 Current Forest Cover Inventory

A Vegetation Resources Inventory (VRI) Phase I was completed to MFR standards in 2006. Almost the entire area was covered by aerial photography acquired in 2002. Disturbance updates between 2002 and the year prior to inventory were captured from silvicultural and logging records. All of the area included in the current analysis was covered by this Phase I inventory.

Phase II field sampling was conducted in 2007; ninety sample plots were established. Based on this data, a statistical adjustment of height, age and volume was completed[2]. The results of the adjustment are summarized in Table 5-1. The complete adjustment report can be found in Appendix VI.

Table 5-1. VRI Phase II Adjustment Ratios

	Adjustment Ratio		
	Height	**Age**	**Volume**
Second Growth	0.975	1.084	0.812
Old Growth	0.937	1.078	1.204

Using this information, adjusted height and age were calculated for every stand in the inventory, and these adjusted values were used to derive the inventory site index. VRI site index is one of the primary drivers of the models used to produce stand yield curves.

5.1 Updates

The inventory has been updated for depletion until the end of 2006; growth has been projected to the same date.

[2] Tree Farm Licence 46 - Vegetation Resources Inventory Statistical Adjustment. 2008. Timberline Natural Resource Group.

6 Description of Land Base

This section describes the methodology used to define the productive forest considered to contribute to, and be available for, long-term timber supply from within the total land base of TFL 46.

The Teal Jones Group (Teal) acquired the TFL 46 tenure from TimberWest in May 2004. T0057 (Camper Creek) and A07065 are in the process of being amalgamated into TFL 46, however the transfer in still in process; these areas are considered to be part of the TFL for the purposes of this analysis. Timber Licence T0910 is managed in cooperation with the TFL, but is not part of TFL 46 and is not included in this analysis. Table 6-1 shows how the TFL land base has changed since the last Management Plan.

Table 6-1. Summary of Land Base Changes Since MP #4

	Area(Ha)
TFL 46 Area at MP 4 (net of 7,325 ha Parks)	***83,545***
less:	
Instruments 22, 24, 25	7,167
Forest Revitalization Act Orders	
3(4)21-1 (PFN woodlot (Pixie Lake))	398
3(4)21-2 (Muir Creek)	259
3(4)21-3 (Shawnigan)	974
Proposed Sec 39.1 Takeback Areas	
Rossander (remaining area except 33.3ha of CP41A)	2,291
Hill 60 (remaining area)	3,501
San Juan BCTS (estimated)	10,479
San Juan Woodlot	600
Mapping Error / Boundary Adjustments	(179)
TFL46 Area at MP 5	***58,055***
TO057 Area	1,536
A07065 Area	293
Total Area - Timber Supply Analysis	***59,884***

The above table does not account for deletions under Instrument 26, which removes a 50 metre right-of-way through the TFL for the Pacific Marine Circle Route Highway. Much of the 107 hectares to be removed is identified as non-productive right-of-way in the existing spatial database.

6.1 Timber Harvesting Land Base

This Information Package includes a description of issues, information sources, assumptions, and criteria used to estimate the land base available for timber harvesting, including any relevant data processing or adjustments. Land is classified as either 'Productive' or 'Non-Productive'; the productive landbase is then netted down to determine the Timber Harvesting Land Base (THLB). Figure 6-1 shows the relationship of the total, productive and timber harvesting landbases on TFL 46.

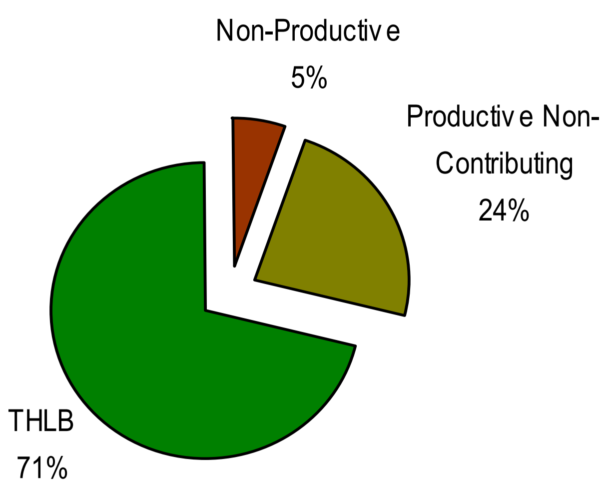


Figure 6-1. Land Base Summary

6.1.1 Timber Harvesting Land Base Determination

This section describes the steps taken to determine the THLB for TFL 46. The THLB for Management Plan #4 was 63,777 hectares. It is smaller now due to the various take-backs that have occurred over the past five years.

The starting landbase for the analysis is all land within the TFL 46 boundary, and all lands in Timber Licence TO057 and Timber Sale Licence A07065. All scheduled take-back areas will be excluded. These take-back lands will not be included in the base case, or in any sensitivity analyses.

For clarity: Timber License TO910, which is surrounded by TFL 46, will not be included in any of these analyses.

In some cases individual areas may have several classification attributes. For example, stands within riparian reserve boundaries might also be classified as non-commercial. These areas would have been classified on the basis of this latter attribute, prior to the riparian classification. Therefore, in most cases the net reduction will be less than the total area in the classification. Table 6-2 shows the netdown process through which the timber harvesting landbase has been determined. The order of the entries in the table corresponds to the sequence in which the land base classifications were applied.

Table 6-2. Timber Harvesting Land Base Determination

	Total Area (Ha)	Productive Area (Ha)	Net Area Removed (Ha)
Total Area	***59,884***	***56,600***	
less:			
Non-Forest	1,597	-	1,538
Roads	1,785	-	1,746
Total Non-Forest Removed			***3,285***
Productive Forest Land			***56,600***
less:			
Inoperable	2,293	1,683	1,683
Unstable Terrain	6,722	6,284	5,802
Non-Commercial	80	71	71
Low Site	1,392	1,159	743
Community Watersheds	2	2	2
Riparian Reserve Zones	970	847	593
Riparian Management Zones	7,654	7,166	1,345
Environmentally Sensitive Areas	951	588	90
Old Growth Management Areas	6,751	6,211	3,109
Habitat	3,341	3,029	467
Recreation	464	362	186
Total Productive Removed			***14,092***
Timber Harvesting Land Base			***42,508***
Future Roads[3]			***498***
Long-term Landbase			***42,010***

[3] The area of road required to access undeveloped parts of the TFL has been estimated, and an appropriate reduction will be applied to future yield curves to account for this loss of productive landbase.

6.1.2 Age Class Distribution

The age class distribution of the distribution of the productive and THLB landbases is shown in Table 6-3 and Figure 6-2.

Table 6-3. Age Class Distribution

Age Class	Productive Area (Ha)	THLB Area (Ha)
0-9	2,378	2,198
10-19	4,114	3,714
20-29	7,806	6,720
30-39	6,959	6,057
40-49	10,104	8,236
50-59	5,228	4,503
60-69	2,484	2,129
70-79	736	566
80-89	313	237
90-99	224	179
100-109	351	130
110-119	225	133
120-129	131	90
130-139	113	69
140-149	95	29
150-159	169	93
160-249	6,486	3,149
250+	8,683	4,276
Total	**56,600**	**42,508**

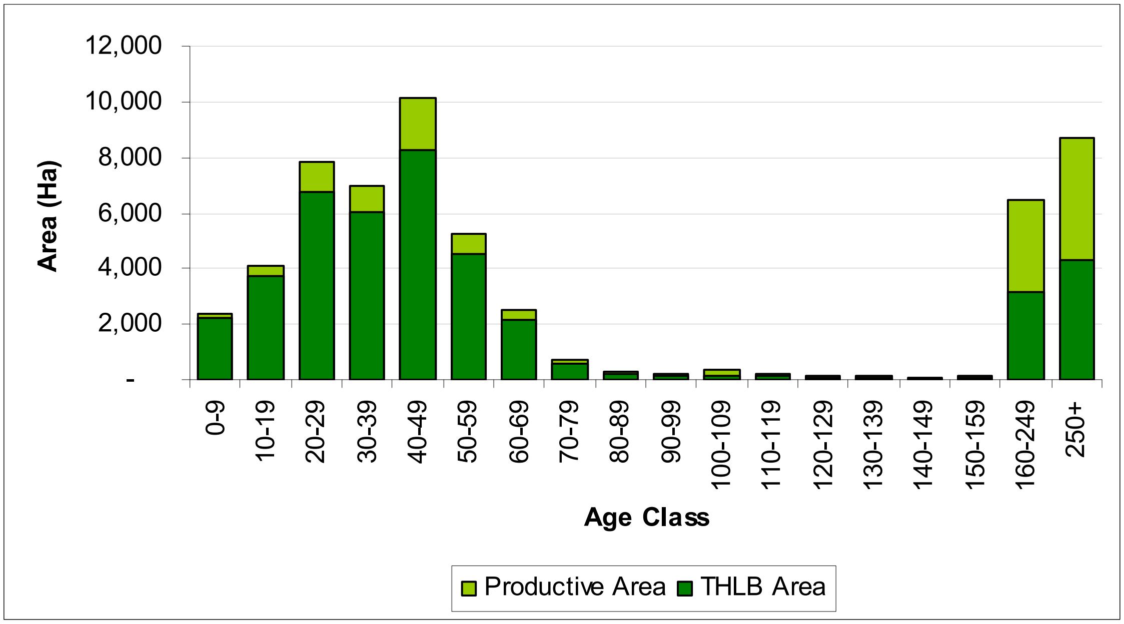


Figure 6-2. Age Class Distribution

Figure 6-3 shows that TFL 46 is comprised mainly of Douglas-fir and hemlock leading stands. Cedar, balsam and deciduous leading stands together comprise just under twenty percent of the productive land in the TFL.

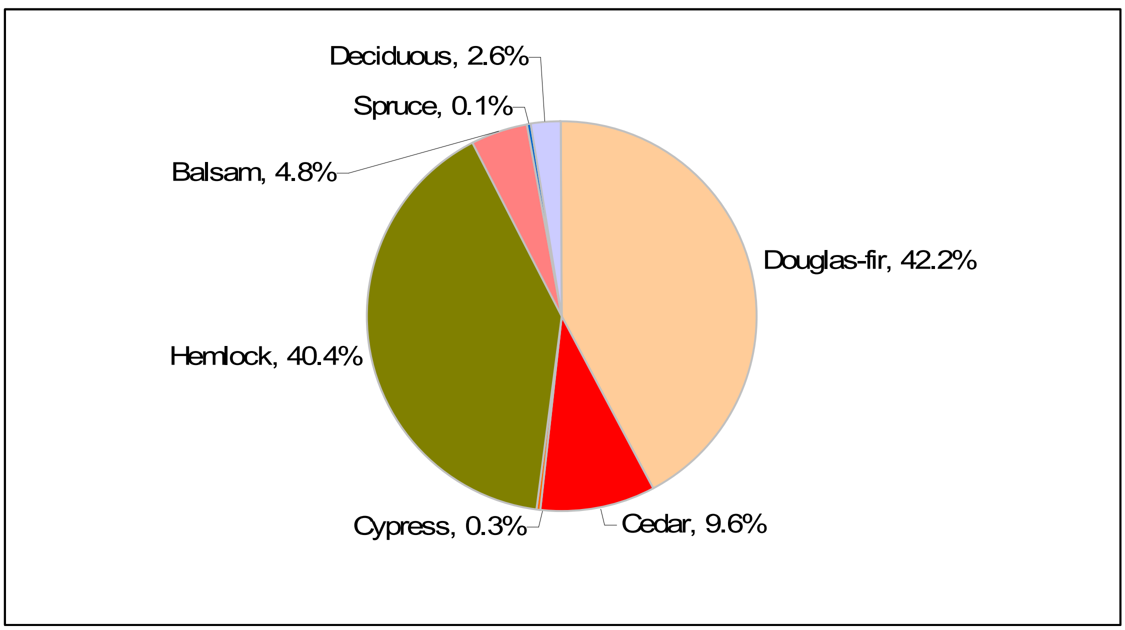


Figure 6-3. Leading Species Distribution

6.2 Total Area

The total area of TFL 46 is 59,884 hectares.

6.3 Non-Forest Area

Non-forest land includes areas in the forest cover that are either non-vegetated (such as lakes, rocks, shrubs that occupy less than 5% of the land, etc.), or are unreported. Non-forest land also includes vegetated areas where less than 10% of the area is occupied by trees. With the exception of recently logged areas classified as bare ground or having little tree cover, all these non-forest areas are considered non-contributing to timber supply and are excluded. This determination was made based on the old forest cover data, using the 'npcode' field. Polygon sizes are smaller than in the VRI, and the classification applies to the entire polygon area. These exclusions are shown in Table 6-4.

Table 6-4. Non-Forest Area

Land Classification	Code	Reduction (%)	Total Area (Ha)	Area Removed (Ha)
Brush	BR	100	3	3
Gravel Pit	GP	100	7	7
Island	IS	100	3	3
Lake	LA	100	137	137
Non Commercial Brush	NCBR	100	5	5
River	RI	100	160	160
Rock	RK	100	329	329
Swamp	SW	100	125	125
Total			769	769

6.4 Non-Productive Area

Non-productive forest areas are portions of the land base that are capable of supporting vegetation, but are considered unsuitable for growing commercial tree species. These areas were also identified from the old forest cover data. Table 6-5 shows the land categories that have been excluded from the THLB.

Table 6-5. Non-Productive Forest Area

Land Classification	Code	Reduction (%)	Total Area (Ha)	Area Removed (Ha)
Non Productive	NP	100	745	745
Non Productive Forested	NPFO	100	1	1
Non Typing Available	NTA	100	23	23
Total			770	770

6.5 Existing Roads, Trails and Landings

Road and landings are considered in three categories - those that:

1) are classified in the VRI;
2) are identified by buffering the roads coverage; and

6.5.1 Classified Roads, Trails and Landings

The VRI land classification system has categories for roads and landings. However, using them for netdown purposes is problematic for two reasons:

1) Most road R/W and landing polygons are too small in size to be captured by the VRI; and
2) The classification often applies to only a portion of the polygon, making it difficult to reconcile with other fully spatial netdowns.

The VRI for TFL 46 shows only 27 hectares in roads and landings, and this area is largely captured through the road buffering process described below. Therefore, no netdown has been applied for classified roads, trails and landings.

6.5.2 Unclassified Roads

The process for identifying unclassified roads is based on the road coverage maintained by Teal. Each road that has not been deactivated has been buffered to a ten metre total width (five metres each side of the centreline) to create a polygon coverage. This area has been removed from the THLB.

Table 6-6. Area in Classified Roads

Classification	Reduction %	Total Area (Ha)	Productive Area (Ha)	Net Area Removed (Ha)
10-metre Road Buffer	100	1,761	0.00	1,746

The area removed is slightly smaller than the total area because some roads pass through non-productive areas previously netted out of the THLB.

6.6 Inoperable / Inaccessible

The current operability map for the TFL was completed in 1993 by an experienced engineer, and reviewed by licencee staff for this project. It identifies large, contiguous areas that are uneconomical to harvest based on a combination of accessibility and timber value, and is considered to be accurate and suitable for strategic planning purposes. Inoperable areas were identified using this mapping. The total area that is considered inoperable or inaccessible is shown in Table 6-7.

Table 6-7. Inoperable Area

Classification	Code	Reduction (%)	Total Area (Ha)	Productive Area (Ha)	Area Removed (Ha)
Inoperable	I	100	2,273	1,683	1,683
Total			2,273	1,683	1,683

Areas with an 'Inoperable' designation that have been previously logged are considered to be operable. The remaining operable landbase has been further classified according to yarding system. This breakdown is shown in Table 6-8.

Table 6-8. Area by Yarding Method

Classification	Total Area (Ha)	Productive Area (Ha)	THLB Area (Ha)
Conventional	52,521	49,999	39,339
Helicopter	3,391	3,318	1,674
Not Classified	1,699	1,600	1,495

A further reduction to the operable land base was made; areas of 'Unstable' terrain were mapped, and these polygons have also been excluded from the THLB. Table 6-9 shows the total and productive area involved, and the impact on THLB.

Table 6-9. Unstable Terrain

Classification	Code	Reduction (%)	Total Area (Ha)	Productive Area (Ha)	Area Removed (Ha)
Unstable Terrain	U	100	6,655	6,284	5,802
Total			6,655	6,284	5,802

6.7 Non-Commercial

Alder-leading stands are considered to be merchantable for this analysis. Stands with a significant non-commercial component (deciduous other than alder – mainly maple) are netted out of the land base. The area excluded is shown in Table 6-10.

Table 6-10. Non-Commercial Area

Leading Species	Code	Reduction (%)	Total Area (Ha)	Productive Area (Ha)	Area Removed (Ha)
Maple	MB	100	80	71	71
Total			80	71	71

6.8 Low Site

Low site stands are not likely to achieve a harvestable volume over a reasonable time horizon. Sites may fall into this category in two ways: they are inherently unproductive due to soil moisture and nutrient regimes (*i.e.* low site index); or the sites might not be fully occupied with commercial tree species. At this stage, the following stand types are netted out of the THLB:

- Coniferous stands that will have a volume of less than 250 m3/ha at 150 years of age; and
- Deciduous stands with a site index less than 15 metres.

This reduction is applied after maple-leading stands have been netted out of the land base as being non-commercial. In order to apply this reduction, stand volume at 150 years of age was forecast using Variable Density Yield Predictor (VDPY). The area that was netted out due to low growing potential is shown in Table 6-11 broken down by leading species.

Table 6-11. Areas With Low Site – By Leading Species

Leading Species	Code	Reduction (%)	Total Area (Ha)	Productive Area (Ha)	Area Removed (Ha)
Balsam	BA	100	106	89	53
Cypress	YC	100	142	90	43
Douglas Fir	FD	100	150	128	104
Red Alder	DR	100	12	11	5
Western Hemlock	HW	100	712	652	399
Western Red Cedar	CW	100	263	190	137
Total			1,385	1,159	743

6.9 Community Watersheds

The only Community Watershed in the TFL is the Malachan, which serves Nitinat Village. Since the FSP states that no 'primary forest activities' will occur, it has been netted out of the THLB. Table 6-12 shows this removal from the THLB.

Table 6-12. Community Watershed

Community Watershed	Code	Reduction (%)	Total Area (Ha)	Productive Area (Ha)	Area Removed (Ha)
Malachan CW	930.013	100	2	2	2
Total			2	2	2

6.10 Riparian Reserve and Management Zones – Streams

The FSP states that FPPR regulations will be followed with respect to riparian buffers. These are listed (for streams) in Table 6-13. Streams have been buffered according to their riparian class and the resulting area has been netted out of the THLB.

Table 6-13. FPPR Riparian Zone for Streams

Riparian Class	Riparian Management Area (metres)	Riparian Reserve Zone (metres)	Riparian Management Zone (metres)
S1-A	100	0	100
S1-B	70	50	20
S2	50	30	20
S3	40	20	20
S4	30	0	30
S5	30	0	30
S6	20	0	20

Table 6-14 shows the Riparian Reserve Zones (RRZ) and Riparian Management Zones (RMZ) that result when these rules are applied to the mapped streams in TFL 46. RRZ's are entirely netted out of the THLB, but only 25% of the area in RMZ's is removed.

Table 6-14. Riparian Reserve and Management Zones – Streams

Riparian Zone	Reduction (%)	Total Area (Ha)	Productive Area (Ha)	Area Removed (Ha)
Stream RRZ	100	898	839	587
Stream RMZ	25	7,533	7,164	1,345
Total		8,430	8,003	1,932

6.11 Riparian Reserve Zones – Lakes and Wetlands

Lakes and wetlands are less common on the TFL than are streams, but the management of riparian areas around these features does have a small impact on the THLB. The FRPA guidelines for riparian management of lakes and wetlands are shown in Table 6-15, and the resulting riparian zones and THLB impacts are shown in Table 6-16.

Table 6-15. FPPR Riparian Zone for Lakes and Wetlands

Riparian Class	Riparian Management Area (metres)	Riparian Reserve Zone (metres)	Riparian Management Zone (metres)
W1	50	10	40
W2	30	10	20
W3	30	0	30
W4	30	0	30
W5	50	10	40
L1-A	0	0	0
L1-B	10	10	0
L2	30	10	20
L3	30	0	30
L4	30	0	30

Table 6-16 Riparian Reserve and Management Zones – Lakes and Wetlands

Riparian Zone	Reduction (%)	Total Area (Ha)	Productive Area (Ha)	Area Removed (Ha)
Lake	100	12	9	7
Wetland	100	2	1	0
Total		14	10	7

6.12 Environmentally Sensitive Areas

Some productive land is classified as environmentally sensitive and/or significantly valuable for other resources. For timber supply analysis purposes, Environmentally Sensitive Areas (ESA's) are identified and delineated through forest cover polygons in the old forest cover data, and are applied as reductions to the THLB. Three categories of ESA's are considered: high value fish habitat, sites with suspected regeneration problems, and avalanche areas. Two ESA classes are recognized within each category: highly sensitive (1) and moderately sensitive (2). Reductions to the THLB due to these ESA's are shown in Table 6-17.

Table 6-17. ESA Areas – By ESA Category

ESA Category	Code	Reduction (%)	Total Area (Ha)	Productive Area (Ha)	Area Removed (Ha)
Regeneration	Ep1	90	189	69	23
Regeneration	Ep2	50	76	49	2
~~Avalanche~~	~~Ea1~~	~~20~~	~~671~~	~~468~~	~~66~~
Fish	Ef2	50	14	1	-
Total			951	588	90

For the last Management Plan, areas of sensitive soils were removed at this stage. That ESA mapping has been replaced by terrain mapping. Areas of unstable terrain were netted out above in conjunction with inoperable areas.

6.13 Old Growth Management Areas

For those Landscape Units covered by the Renfrew Aggregate Landscape Unit Plan, the designated Old Growth Management Areas (OGMA's) will be used for the base case and all sensitivity analyses – landscape-level biodiversity cover constraints based on the Biodiversity Guidebook will not be modelled. The area in OGMA's, by Landscape Unit, is shown in Table 6-18.

Table 6-18. Old Growth Management Area by LU

Landscape Unit	Reduction %	Total Area (Ha)	Productive Area (Ha)	Net Area Removed (Ha)
Caycuse	100	1,274	1,239	608
Gordon	100	2,022	1,957	965
Nitinat	100	60	57	49
San Juan	100	2,481	2,321	1,238
Walbran	100	693	638	249
Total		6,530	6,211	3,109

6.14 Habitat Reductions

Marbled Murrelet and deer are the main species for which habitat areas are managed within the TFL. Since the last Management Plan, many ungulate winter range (UWR) and wildlife habitat areas (WHA) have been identified. One WHA has also been designated for the northern goshawk. Harvesting is prohibited in these areas, so they are netted out of the THLB. The lone WHA for Scouler's Corydalis was recently approved and has also been removed from the THLB.

Reductions for wildlife (and other) habitat are summarized in Table 6-19 and Table 6-20

.

Table 6-19. Ungulate Winter Range

Species	Code	Reduction %	Total Area (Ha)	Productive Area (Ha)	Net Area Removed (Ha)
Ungulate Winter Range	DEER	100	1,167	1,123	204
	ELK	100	52	51	47

Table 6-20. Wildlife Habitat Areas

Species	Code	Reduction %	Total Area (Ha)	Productive Area (Ha)	Net Area Removed (Ha)
Ungulate Winter Range	DEER	100	1,167	1,123	204
	ELK	100	52	51	47
Marbled Murrelet	1-007	100	48	48	-
	1-008	100	4	4	-
	1-097	100	230	229	-
	1-099	100	125	123	0
	1-100	100	605	587	-
	1-101	100	330	318	0
	1-102	100	128	120	45
	1-103	100	171	171	1
Northern Goshawk	Fledgling	100	213	208	141
	Nesting	100	21	20	6
Scouler's Corydalis	Buffer	100	10	10	8
	Core	100	17	16	15

6.15 Cultural Heritage Resource Reductions

Cultural heritage resources can be adequately protected through operational planning measures. When culturally modified trees are found, they will be dealt with through the operational planning process. Consequently, the impact on strategic timber supply is negligible; no area reduction has been applied for this analysis.

6.16 Recreation Reductions

Protection of recreation values on the TFL does not fit into any of the foregoing categories. Two types of netdowns have been applied to protect recreation resources:

1) Features in the Recreation Inventory that were categorized has having 'High' or 'Very High' significance have been removed from the landbase. The exception to this rule is karst features. The Recreation Inventory drew broad polygons around karst features; however Teal staff feel that harvesting operations can be managed in a way that will protect these features without any negative impact on strategic timber supply.

2) Identified recreation sites have been netted out of the THLB.

Table 6-21 shows the total and productive area covered by recreation features, and the THLB impacts of protecting them.

Table 6-21. Recreation Resources

Recreation Feature	Reduction %	Total Area (Ha)	Productive Area (Ha)	Net Area Removed (Ha)
Recreation Inventory	100	417	332	163
CAMPSITE	100	3	2	0
CAVE	100	27	26	23
RECPOINT	100	2	1	-
Total		448	362	186

6.17 Problem Forest Types

No problem forest types have been indentified within TFL 46.

6.18 Future Roads

The portion of the TFL that is currently roaded (could be conventionally harvested from the existing road network) has been delineated by buffering the road network by a distance of 200 metres on each side of the road. This shows that 46,687 hectares of the TFL is currently accessible for conventional harvesting. The area of road needed to accomplish this is 1,761 hectares, or about 3.8% of the roaded landbase. In order to develop a similar level of access on the unroaded portion of the TFL (13,197 hectares), an additional 498 hectares of road will be required. These calculations are summarized in Table 6-22.

Table 6-22. Future Road Requirements

TFL Area (Ha)	59,884
Roaded Area (Ha)	46,687
Existing Road Area (Ha)	1,761
% Roaded in Roads	3.8%
Unroaded Area (Ha)	13,197
Future Roads Required (Ha)	498

For this analysis, these areas will not be removed from the THLB, but rather, a 3.8% reduction will be applied to future stand volumes in unroaded areas to account for this netdown.

6.19 Exclusion of Specific Geographically Defined Areas

No other specific geographically defined areas have been excluded from this analysis.

6.20 Any Other Land Base Exclusions

Wildlife Tree Patches (WTP) are difficult to deal with as a spatial netdown, in spite of the fact that they do result in spatial reserves. Also, the fact that the location of future WTP's cannot be predicted makes them difficult to deal with as a landbase exclusion. They are mentioned here nevertheless, even though they will be modeled as a yield reduction for this analysis.

6.20.1 Wildlife Tree Patches

No existing wildlife tree patches (WTP) are mapped, so they cannot be spatially removed from the THLB. To account for these, and for future WTP requirements, a yield curve reduction will be used.

Stand-level biodiversity is managed operationally through wildlife tree retention to a target of 7%, as set out by the FSP and FPPR. This will be adjusted to account for the WTP requirements that are met by the productive, non-contributing landbase. This consists of the productive areas within: OGMA's, RRZ, UWR and other habitat areas, and within unstable and inoperable areas that have been excluded from the THLB. When these areas are aggregated and buffered to a distance of 250 metres, the resulting coverage is 32,917 hectares in size, or 55% of the TFL. No WTP allowance needs to be made for THLB within this area; that requirement is met from the productive non-contributing landbase. For the remaining 45% of the THLB, a 7% WTP requirement applies. This would amount to an area of 1,340 hectares if it could be applied spatially. Since it cannot, a 3.2% reduction (45% x 7%) will be applied to all existing and future yield curves.

6.21 Area Additions

It is not anticipated that any area will be added to the TFL.

7 Inventory Aggregation

7.1 Management Zones and Multi-Level Objectives

Inventory aggregation allows stands with similar mensurational characteristics and ecological values to be modeled as a single unit, which significantly increases modelling efficiency. This does not preclude the tracking of individual stands for harvest scheduling.

Most TFL 46 resource values other that timber are protected by removing land from the THLB. However, it is still necessary to manage the timing and distribution of harvest within the THLB to adequately address some non-timber resource values. To accomplish this, several management zones have been established (solely for timber supply modelling purposes).

These are shown in Table 7-1.

Table 7-1. Modelling Zones

Zone	Name	Criteria	Rationale
Zone 1	Visual Quality	Polygons classified as 'R' 'PR' or 'M' in the Visual Landscape Inventory (VLI)	Limit denudation to protect visual resources
Zone 3	Watershed Protection	Gordon, Hatton and fisheries sensitive watersheds	Manage Equivalent Clearcut Area to maintain water quality
Zone 3	Goshawk Habitat	Area in Northern Goshawk WHA	Manage seral targets to maintain goshawk foraging habitat
Zone 4	Normal Management	All THLB not in Zone 1	Limit denudation by applying an IRM constraint at the Landscape Unit level as a proxy for adjacency

7.2 Analysis Units

Stands are grouped into analysis units so that individual stand yield curves can be aggregated for modelling purposes. This grouping has been done on the basis of species composition and site index. Table 7-2 shows the THLB area for each of the resulting Analysis Units.

Table 7-2. THLB Area by Analysis Unit

	Area (Hectares)					
	Site Class					
Species Group	**L (SI<20)**		**M (SI 20-30)**		**H (SI>30)**	
Fir	AU#1:	463	AU#2:	3,838	AU#3:	4,562
Fir-Cedar	AU#4:	75	AU#5:	120	AU#6:	30
Fir-Hemlock	AU#7:	919	AU#8:	5,312	AU#9:	4,198
Fir-Alder	AU#10:	20	AU#11:	65	AU#12:	169
Cedar-Conifer Mix	AU#13:	2,657	AU#14:	782	AU#15:	36
Hemlock	AU#16:	3,655	AU#17:	4,971	AU#18:	406
Hemlock-Fir	AU#19:	853	AU#20:	3,391	AU#21:	1,166
Hemlock-Cedar	AU#22:	2,539	AU#23:	1,360	AU#24:	22
Alder	AU#24:	29	AU#26:	581	AU#27:	9
Alder-Conifer Mix	AU#28:	30	AU#29:	216	AU#30:	37

7.3 Detailed Land Base Information Requirements

All resultant spatial datasets, stand and analysis unit yield curves, and forest estate model input files will be made available to the Ministry of Forests and Range upon request.

8 Growth and Yield

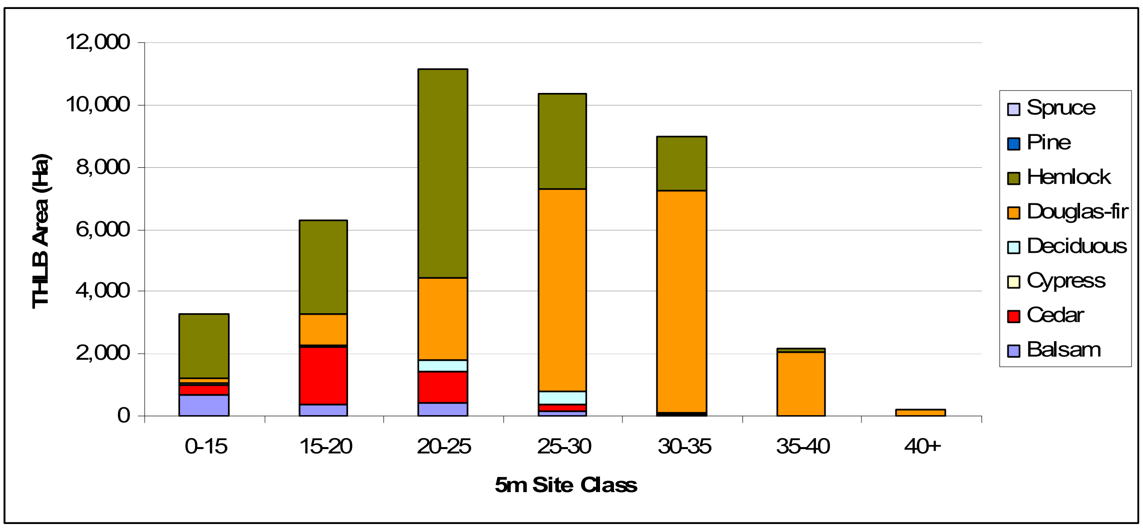
8.1 Site Index Assignments

Site Index (SI) is a measure of productivity used during yield analysis. It is an estimate of potential height growth on a site over a fixed period of time, normally 50 years. The productivity of a site largely determines how quickly trees grow and when rotation age and minimum harvest age (MHA), are reached.

The inventory site index from the VRI has been used to develop yield tables for all existing and future stands. This is a change from the last timber supply analysis. In that case, an ecologically-based site index estimate (adjusted site index) was used for stands that regenerated after 1955. The MFR has insisted that this analysis use inventory site index for the base case. The Terrestrial Ecosystem Mapping upon which the adjusted site index estimates were based has not yet been independently assessed for accuracy. A new MFR policy requires that this assessment be completed before ecologically-based site index estimates can be used for a base case analysis. To gauge the impact on timber supply of this change, a sensitivity analysis using adjusted site index will be conducted.

Figure 8-1 shows the site index (VRI) distribution of the THLB, by leading species.

Figure 8-1. Site Index Distribution of the THLB



8.2 Utilization Level

The utilization level defines the maximum height of stumps that may be left on harvested areas and the minimum top diameter (inside bark) and minimum diameter (dbh) of stems that must be removed from harvested areas. These factors are needed to calculate merchantable stand volume for use in the analysis. The levels used in the analysis reflect current operational practice.

Table 8-1. Utilization Levels

Leading species	Utilization		
	Minimum dbh (cm)	**Maximum stump height (cm)**	**Minimum top dib (cm)**
Mature (>200 years of age)	17.5	30.0	15.0
Immature Conifer (<200 years of age)	12.0	30.0	10.0
Alder	12.0	30.0	10.0

8.3 Decay, Waste and Breakage for Unmanaged Stands

Decay, waste and breakage (DWB) factors that are applied to unmanaged stand yield tables to obtain net volume per hectare. These factors are assigned to natural stand volumes automatically in VDYP based on the Public Sustained Yield Unit (PSYU) location. For volume estimates at the 12.0 cm utilization level, net volume cannot be produced directly by VDYP. Gross volume can be output, so these are prorated using the net volume / gross volume ratio taken from the 17.5 cm utilization yield tables.

Licensee experience suggests that hemlock volumes are being underestimated because decay, waste and breakage factors are too high. However, no data is available to support this assumption, so the default PSYU factors have been used in this analysis. A Net Volume Adjustment Factor (NVAF) field program is currently underway and will be completed after the 2009 field season. Better DWB information will be available for the next timber supply analysis.

8.4 Operational Adjustment Factors for Managed Stands

Operational adjustment factors (OAF's) are applied in order to adjust managed stand yields generated by TIPSY to reflect such factors as gaps in stands and decay in trees. The default factors most commonly used are an OAF1 of 15 percent and an OAF2 of 5 percent. OAF1 is a constant percentage reduction to account for openings in stands, distribution of stems, endemic pests and diseases, and other risks to potential yield. OAF2 is an increasing percentage reduction that can be applied to account for decay, waste and breakage. For the last TFL Management Plan (MP) an OAF1 of 15% was applied to account for less than optimal tree distribution, small NP, endemic pests and windfall. An OAF of 5% was used for most existing managed stands.

An adjustment of OAF2 is needed in recognition of the fact that existing and future managed Douglas-fir stands suffer volume losses due to root disease. Laminated and armillaria root diseases are prevalent in the CWHxm subzone/variant. Within TFL 46, 884 hectares of the THLB falls into this ecosystem. The resulting stand volume losses are accounted for in managed stands through revised OAF2 values which are based on work conducted by the Regional Pathologist. 87% of the fir-leading stands were found to suffer a volume reduction that can be modelled by increasing OAF2 by 8.86%. To account for that loss in this analysis, OAF2 has been increased from 5% to 12.7% for existing managed Douglas-fir stands in the CWHxm. This is calculated as follows:

884	ha	(area in CWHxm, Fd-leading less than 50 years old)
87	%	(will experience volume loss)
8.86	%	(additional OAF2 to account for lost volume in these stands)
5	%	(default OAF2 for healthy stands)
12.71	%	(adjusted OAF2 - 5% plus 87% of 8.86%)

8.5 Volume Deductions

No other volume deductions have been applied to the yield curves for biological reasons. However, for timber supply modelling purposes, yield reductions will be applied to account for wildlife tree retention and future roads.

8.6 Yield Table Development

Yield tables are used to forecast the development over time of existing stands, and of future stands that will be established following harvesting.

8.6.1 Base Yield Tables

Separate yield tables have been compiled for each stand identified in the VRI. One of three approaches was taken, depending on the age of the stand:

1. For stands older than 200 years, the average volume lines (AVL's) compiled for the last Management Plan have been used. This is the best available information for these stands, since it is based on substantial field data, and though it is dated, these stands are no longer increasing in volume over time.

2. For stands established before 1955, but younger than 200 years of age, VDYP has been used.

3. For stands established since 1955, TIPSY has been used.

8.6.2 Aggregated Yield Tables

For timber supply modelling purposes, base yield tables have been aggregated into the Analysis Units shown in Table 7-2.

8.7 Yield Tables for Unmanaged Stands

8.7.1 Existing Mature Timber Volumes

The previous forest inventory grouped mature stands greater than 200 years of age into strata based on species composition and volume class. For the last Management Plan, volume estimates, based on field data, were devised for each of these strata. These volumes will be used for this analysis as well. These AVL's are presented in Appendix II.

8.7.2 Yield Tables for Unmanaged Immature Stands

VDYP was used to derive yield curves for each stand between 52 and 200 years of age. These were then aggregated into analysis unit yield tables. These tables are shown in Appendix III.

8.8 Yield Tables for Managed Stands

Any stand that is 52 years of age or younger in 2007 is deemed to be a managed stand and will have a yield predicted using TIPSY. The current species composition and inventory site index is used to develop this yield curve. A planting density of 1000 stems per hectares has been assumed for all existing managed stands.

8.8.1 Silviculture Regimes

The current species composition of each stand will be used to develop its yield curve. The silviculture assumptions used for existing managed stands are shown in Table 8-2.

8.8.2 Regeneration Delay

Regeneration delays of zero years on all sites will be used. A one-year regeneration delay was considered, but was felt to be an overly conservative estimate, since most blocks are planted within one year using one-year old stock – an effective regeneration delay of zero years. The FSP specifies regeneration delays of either three years or six years, depending on the site series, but these are maximum delays for regulatory purposes, and not common operational practice. Rather than factoring regeneration delay into the yield curves, it will be applied – if and where necessary – during the forest estate model runs.

Table 8-2. Silviculture Regimes

AU#	Species Group	THLB Area (Ha)	Avg SI	Leading Species	Second Species	Wght	Estab. Density	Regen Delay
1	Fir	463	17.6	Fd			1000	0
2	Fir	3,838	26.7	Fd	Cw	80/20	1000	0
3	Fir	4,562	33.9	Fd	Cw	80/20	1000	0
4	Fir-Cedar	75	17.9	Fd	Cw	70/30	1000	0
5	Fir-Cedar	120	23.9	Fd	Cw	70/30	1000	0
6	Fir-Cedar	30	32.0	Fd	Cw	70/30	1000	0
7	Fir-Hemlock	919	18.2	Fd	Cw	70/30	1000	0
8	Fir-Hemlock	5,312	26.3	Fd	Cw	70/30	1000	0
9	Fir-Hemlock	4,198	33.4	Fd	Cw	70/30	1000	0
10	Fir-Alder	20	13.0	Fd			1000	0
11	Fir-Alder	65	25.3	Fd	Cw	70/30	1000	0
12	Fir-Alder	169	34.0	Fd	Cw	70/30	1000	0
13	Cedar-Conifer Mix	2,657	17.2	Cw	Fd	80/20	1000	0
14	Cedar-Conifer Mix	782	23.6	Cw	Fd	80/20	1000	0
15	Cedar-Conifer Mix	36	32.7	Cw	Fd	80/20	1000	0
16	Hemlock	3,628	15.9	Cw	Fd	60/40	1000	0
17	Hemlock	4,971	23.8	Cw	Fd	60/40	1000	0
18	Hemlock	406	33.1	Cw	Fd	60/40	1000	0
19	Hemlock-Fir	853	16.6	Fd	Cw	80/20	1000	0
20	Hemlock-Fir	3,391	25.2	Fd	Cw	80/20	1000	0
21	Hemlock-Fir	1,166	32.7	Fd	Cw	80/20	1000	0
22	Hemlock-Cedar	2,539	16.2	Cw	Fd	60/40	1000	0
23	Hemlock-Cedar	1,360	23.0	Cw	Fd	60/40	1000	0
24	Hemlock-Cedar	22	32.0	Cw	Fd	60/40	1000	0
25	Alder	29	19.0	Dr			1000	0
26	Alder	581	25.2	Dr			1000	0
27	Alder	9	37.6	Dr			1000	0
28	Alder-Conifer Mix	30	19.5	Fd	Cw	80/20	1000	0
29	Alder-Conifer Mix	216	24.8	Fd	Cw	80/20	1000	0
30	Alder-Conifer Mix	37	30.9	Fd	Cw	80/20	1000	0

8.8.3 Regeneration Assumptions

While a separate yield curve was developed for each existing stand, future stand yield curves will be developed for each Analysis Unit (AU). All stands in an AU will regenerate to the same yield curve. A total of thirty future yield curves have been developed, and are listed in Table 8-2. The site index used to drive the yield forecast for each AU is the area-weighted average SI (VRI Phase II adjusted height and age) of all of the stands that comprise the AU. All regeneration assumptions are listed in Table 8-2.

8.8.4 Stand Rehabilitation

No active stand rehabilitation is currently undertaken. Alder stands regenerate back to alder stands, but Alder-Confer stands are assumed to be converted to Douglas-fir.

8.8.5 Tree Improvement

Improvements in growth due to the use of genetically improved seed will be modeled during yield curve construction. Table 8-3 shows past performance in planting genetically improved stock on TFL 46. Using this information, genetic gain factors of 7.2 and 3.8 percent for Douglas-fir and Western Redcedar have been calculated and used in the construction of future managed stand yield tables.

8.9 Silviculture History

8.9.1 Existing Managed Immature

Any stand regenerated after 1955 is assumed to be managed. Yield estimates are derived using TIPSY. Operational adjustment factors have been used to account for stand openings and for factors that cause sub-optimum growth. These factors are discussed in Section 8.4.

8.9.2 Backlog and Current Non-Stocked Areas

NSR areas originally contained operable timber, were harvested, and have not yet regenerated to commercial species. Current NSR is part of the working forest and is expected to be regenerated on schedule. No backlog NSR exists on TFL 46.

Table 8-3. Tree Improvement History

Douglas-fir Seedlings				Western Red Cedar Seedlings			
2005							
	A		**B**		**A**		**B**
Planting Season	Seedlings (x1000)	Gain	Seedlings (x1000)	Planting Season	Seedlings (x1000)	Gain	Seedlings (x1000)
2006-Summer	111.5	4%		2006-Summer	73.0	5%	106.5
2007-Spring	261.0	9%		2007-Spring	94.4	5%	-
	372.5	8%			167.4	5%	
2006							
	A		**B**		**A**		**B**
Planting Season	Seedlings (x1000)	Gain	Seedlings (x1000)	Planting Season	Seedlings (x1000)	Gain	Seedlings (x1000)
2007-Summer	150.0	7%		2007-Summer	24.0	4%	156.0
2008-Spring	120.0	7%		2008-Spring	120.0	4%	-
	270.0	7%			144.0	4%	
2007							
	A		**B**		**A**		**B**
Planting Season	Seedlings (x1000)	Gain	Seedlings (x1000)	Planting Season	Seedlings (x1000)	Gain	Seedlings (x1000)
2008-Summer	120.0	7%		2008-Summer	50.0	2%	122.0
2009-Spring	150.0	7%		2009-Spring	70.0	2%	-
	270.0	7%			120.0	2%	

9 Protection

9.1 Unsalvaged Losses

Unsalvaged losses are rare on TFL 46. Fire is uncommon and no major insect pests exist. Laminated root rot is a minor problem with Douglas-fir in some areas, but will be accounted for in this analysis through yield curve reductions. Windthrow is a periodic problem, but blowdown volumes are harvested wherever possible.

A one percent allowance for non-recoverable loss of timber was incorporated into the MP 3 timber supply analysis. Given the licencee's recent performance in recovering blowdown volumes, a zero percent allowance for unsalvaged losses will be used for this analysis.

10 Integrated Resource Management

10.1 Forest Resource Inventories

The following inventories are maintained by the licencee, and along with administrative and ecological boundary information obtained from both Teal and the MFR, form the foundation of the spatial database that has been built for this timber supply analysis.

Table 10-1. Resource Inventories

Inventory	Standard / Source	Mapped At	Date Completed
Vegetation Resources Inventory	Vegetation Resources Inventory	1:20,000	2006
Plantation (Ep)	Al Chatterton	1:20,000	1993
Avalanche (Ea)	Al Chatterton	1:20,000	1993
Terrestrial Ecosystem Mapping (TEM)	TEM / Bob Green	1:20,000	1995
Ungulate Winter Range (UWR)	MOE	1:20,000	2003
WHA – Marbled Murrelet	MOE	1:20,000	2005
WHA – Scouler's Corydalis	MOE	1:20,000	2009
Visual Landscape Inventory	RRL Consultants	1:20,000	1999
Recreation Features Inventory (RFI)	RIC Standards / RRL Consultants	1:20,000	2000
OGMA	LUP Planning Process – Renfrew Aggregate LU Plan	1:20,000	2006
Operability	TimberWest	1:20,000	1993

10.2 Non-Timber Forest Resource Management

The document to this point has been primarily focussed on approaches to modelling the timber resource. This section describes the methods that will be used to forecast the future availability of non-timber resources.

10.2.1 Forest Cover Requirements

The rate of harvesting can be limited in order to achieve an age class distribution target by applying forest cover constraints when the forest estate model is run. Cover constraints typically work by capping the amount of area that can be moved to a young age class (i.e. harvested), or by insisting that a minimum amount of old timber exist at all times. Each has the effect of limiting the rate of harvest within the area to which it is applied. Many cover constraints can be enforced within a given model run, and each may apply to all or only to a specified portion of the landbase. Cover constraints will be applied in this analysis to model visual resources, watersheds and landscape level biodiversity. A cover constraint will also be applied at the landscape unit level as an alternative to modelling strict spatial adjacency rules.

10.2.2 Visual Resources

The visual landscape inventory indentifies known scenic areas in TFL 46. Visually sensitive areas are summarized by Recommended Visual Quality Class (RVQC) in Table 10-2. Visual quality will be maintained by limiting the rate of cut for each visually sensitive polygon according to the limits in Table 10-2.

Table 10-2. Maximum Disturbance by RVQC

RVQC	Area (Ha)	Disturbance Limit	Green Up Height
M	4,454	25%	5 m
PR	5,191	15%	6 m
R	164	5%	7 m
Total	9,809		

10.2.3 Recreation Resources

Important recreational resources have been netted out of the THLB. Any remaining recreational values will be managed through the operational planning process. No cover constraints are required.

10.2.4 Wildlife

Most wildlife habitat is managed through a system of reserves and netdowns, so no forest cover constraints are required. The exception is the foraging portion of the goshawk WHA. Disturbance and retention cover constraints will be applied to this area in order to achieve a desired age class distribution. No more than 20% of the area will be permitted to be less than 20 years of age, and at least 20% of the area must be greater than 80 years of age.

10.2.5 Adjacent Cutblock Green-Up

An Integrated Resource Management (IRM) constraint will be applied in order to model cutblock adjacency and green-up. This constraint will be enforced separately for each landscape unit, and will apply to the THLB only. It restricts the proportion of the THLB that is less than three metres in height to less than 25%. This constraint will approximate a four-pass harvesting approach in each LU, without requiring that a spatial total chance plan be defined.

10.2.6 Biodiversity

10.2.6.1 Landscape Level Biodiversity

Biodiversity planning is modelled through the explicit delineation of OGMA's for all landscape units (LU's) with approved Landscape Unit Plans. This covers all LU's except the Cowichan. For the Cowichan LU, the old seral constraints shown in Table 10-3 will be applied:

Table 10-3. Old Seral Targets for the Cowichan LU

Natural Disturbance Type	Biogeo-climatic Zone	Age of Old Forest	Percent Old Forest Retention in Low Biodiversity Emphasis	Productive Area (Ha)	Net Area (Ha)
1	CWH	>250 years	>13	204	187
2	CWH	>250 years	>9	534	364

Seral stage requirements are established at the BEC variant level. All of the productive forest within each LU/BEC contributes to the old growth seral stage requirement.

10.2.6.2 Wildlife Tree Retention

Wildlife tree retention will be dealt with as a yield curve reduction (see Section 6.20.1). No cover constraint is required.

10.2.6.3 Course Woody Debris

There is no need to model future supplies of course woody debris

10.2.6.4 Objectives for Patch Size Distribution

No patch size modelling will be conducted.

10.2.6.5 Objectives for Connectivity

No effort has been made to model connectivity between old seral patches and high value habitat areas.

10.2.6.6 Watersheds

A significant portion of the TFL falls within Fisheries-Sensitive Watersheds, as shown in Table 10-4:

Table 10-4. Area of Fisheries-Sensitive Watersheds

Watershed	Name	Total Area (Ha)	Productive Area (Ha)	Net Area (Ha)
f-1-004	Gordon River	16,536	15,771	11,653
f-1-005	Hatton Creek	1,938	1,887	1,198
f-1-006	Hemmingsen Creek	5,562	5,293	3,708
Total		24,037	22,952	16,559

The licensee commits to managing fisheries-sensitive watersheds in a manner that sustains and protects aquatic habitat. To model this at a strategic level, each fisheries sensitive watershed will be monitored against an equivalent clearcut area (ECA) target of 20%. In order to model this, full hydrological recovery will be assumed when a stand reaches nine metres in height. For each watershed, the average age to achieve that height will be calculated using regenerated stand yield curves. From this, percent hydrological green up per year will be calculated and compared to forest cover constraint of 20% ECA.

The Klanawa watershed overlaps the TFL by only 8 hectares. Although is classified as fisheries-sensitive, the area involved it too small to apply a cover constraint. Any rate-of-cut issues in this watershed will be dealt with through the operational planning process.

The only Community Watershed within the TFL (the Malachan, only two hectares) was dealt with through a netdown.

10.2.6.7 Riparian Management Zones

Riparian areas – both reserve zones and management zones – have been netted out of the THLB. RRZ's have been entirely removed, and twenty-five percent of RMZ's have been removed. No additional constraints are necessary.

10.2.6.8 Higher Level Plans

TFL 46 will be managed in accordance with the Vancouver Island Land Use Plan (VILUP).

10.2.6.9 Any Other Resource Emphasis

No other resource issues apply to TFL 46.

10.3 Timber Harvesting

10.3.1 Minimum Harvest Age

The minimum harvestable age (MHA) is the criterion that forest stands within an analysis unit must meet to be eligible for harvest. In most cases, economic factors will dictate the threshold beyond which stands are available for harvest. For the purpose of timber supply modelling, these characteristics are often expressed in terms of volume per hectare and/or average diameter. Culmination age, the age at which mean annual increment (MAI) reaches a maximum, or some proportion thereof can also be used as the threshold for minimum harvestable age. In timber supply modelling the age at which the minimum threshold is attained is called the “minimum harvestable age” (MHA). These are minimum criteria – not rotation ages or the actual ages at which the stands will be harvested. Some stands may be harvested at the minimum thresholds to meet forest-level objectives; however, other stands may not be harvested until well past the age for “optimal” timber production due to management objectives for other resource values

MHA is established for each analysis unit. An AU is first harvestable when it meets all three of the following criteria:

- Minimum volume per hectare of 300 m3/hectare;
- Minimum QMD of 25 centimetres; and
- Within 90% of maximum MAI.

The MHA that results when these criteria are applied to each analysis unit are shown in Table 10-5 to Table 10-7.

10.3.2 Operability

Inoperable area has been netted out of the THLB. The remaining area is considered to be more or less equally available over the entire planning horizon, so no additional harvest scheduling constraints or quotas are needed.

Table 10-5. Minimum Harvest Age (MHA) – Existing Natural Stands

AU#	Species Group	Site Class	Minimum Harvest Age
1	Fir	L	105
2	Fir	M	55
3	Fir	H	42
4	Fir-Cedar	L	125
5	Fir-Cedar	M	106
6	Fir-Cedar	H	
7	Fir-Hemlock	L	98
8	Fir-Hemlock	M	52
9	Fir-Hemlock	H	40
10	Fir-Alder	L	150
11	Fir-Alder	M	94
12	Fir-Alder	H	55
13	Cedar-Conifer Mix	L	100
14	Cedar-Conifer Mix	M	72
15	Cedar-Conifer Mix	H	47
16	Hemlock	L	104
17	Hemlock	M	52
18	Hemlock	H	38
19	Hemlock-Fir	L	107
20	Hemlock-Fir	M	48
21	Hemlock-Fir	H	37
22	Hemlock-Cedar	L	110
23	Hemlock-Cedar	M	62
24	Hemlock-Cedar	H	
25	Alder	L	
26	Alder	M	105
27	Alder	H	38
28	Alder-Conifer Mix	L	78
29	Alder-Conifer Mix	M	49
30	Alder-Conifer Mix	H	

Table 10-6. Minimum Harvest Age (MHA) – Existing Managed Stands

AU#	Species Group	Site Class	Minimum Harvest Age
1	Fir	L	112
2	Fir	M	55
3	Fir	H	45
4	Fir-Cedar	L	95
5	Fir-Cedar	M	62
6	Fir-Cedar	H	49
7	Fir-Hemlock	L	103
8	Fir-Hemlock	M	58
9	Fir-Hemlock	H	47
10	Fir-Alder	L	150
11	Fir-Alder	M	54
12	Fir-Alder	H	39
13	Cedar-Conifer Mix	L	68
14	Cedar-Conifer Mix	M	59
15	Cedar-Conifer Mix	H	47
16	Hemlock	L	79
17	Hemlock	M	63
18	Hemlock	H	44
19	Hemlock-Fir	L	75
20	Hemlock-Fir	M	57
21	Hemlock-Fir	H	45
22	Hemlock-Cedar	L	73
23	Hemlock-Cedar	M	65
24	Hemlock-Cedar	H	48
25	Alder	L	76
26	Alder	M	46
27	Alder	H	31
28	Alder-Conifer Mix	L	
29	Alder-Conifer Mix	M	62
30	Alder-Conifer Mix	H	33

Table 10-7. Minimum Harvest Age (MHA) – Future Managed Stands

AU#	Species Group	Site Class	Minimum Harvest Age
1	Fir	L	108
2	Fir	M	50
3	Fir	H	43
4	Fir-Cedar	L	88
5	Fir-Cedar	M	57
6	Fir-Cedar	H	48
7	Fir-Hemlock	L	85
8	Fir-Hemlock	M	51
9	Fir-Hemlock	H	44
10	Fir-Alder	L	150
11	Fir-Alder	M	55
12	Fir-Alder	H	44
13	Cedar-Conifer Mix	L	78
14	Cedar-Conifer Mix	M	61
15	Cedar-Conifer Mix	H	49
16	Hemlock	L	98
17	Hemlock	M	59
18	Hemlock	H	47
19	Hemlock-Fir	L	111
20	Hemlock-Fir	M	55
21	Hemlock-Fir	H	44
22	Hemlock-Cedar	L	95
23	Hemlock-Cedar	M	60
24	Hemlock-Cedar	H	50
25	Alder	L	77
26	Alder	M	62
27	Alder	H	26
28	Alder-Conifer Mix	L	77
29	Alder-Conifer Mix	M	55
30	Alder-Conifer Mix	H	48

10.3.3 Initial Harvest Rate

For the base case, the initial harvest rate will be set at 367,363 m3/year. This represents the AAC level set at the last determination, prorated for area that has since been removed from the TFL.

10.3.4 Harvest Rules

Harvest rules are used by the simulation model to rank stands for harvest. A common approach is to harvest oldest first. With this rule, older stands are queued for harvest ahead of younger stands. Harvest rules interact with forest cover constraints to determine the actual order of harvesting within the model. If a higher ranked stand is in a constrained zone and cannot be harvested, then the model will choose the next highest ranked stand that can be harvested. 'Relative oldest first' harvests those stands that are farthest past their rotation age (culmination MAI), and would be the best rule to use for TFL 46, which has a significant component of second growth timber on a range of sites.

10.3.5 Harvest Profile

A harvest quota will be enforced to ensure that a sufficient volume of second growth timber is harvested in each period. This level will be set in consultation with Teal staff.

10.3.6 Silviculture Systems

Silvicultural practices in TFL 46 need to be considered as a prelude to developing yield curves. Clearcutting is the silvicultural system most commonly employed in the TFL. Variable retention silviculture and commercial thinning have been applied on the TFL in the past, but are no longer current practice and will not be considered during this analysis.

Trees are retained when necessary to meet riparian or wildlife habitat objectives. Reductions to account for wildlife tree and other retention will be applied when the forest estate model is run, rather than directly on the yield curves. All yield curves have been built assuming even-aged management of all stands. Any retention that is left is assumed to be permanently lost to harvesting; no second pass volume is taken.

10.3.7 Harvest Flow Objectives

The harvest flow objectives for this analysis will be:

1) To find the highest even flow timber harvest level that can be achieved while meeting all other resource objectives.

2) If the current harvest level cannot be sustained, to maintain the current level for as long as possible and then step down to the long term level in a series of orderly steps that do not exceed 10% of the initial harvest level in each decade.

3) To provide a balanced flow of old growth and second growth timber in each decade until the available old growth timber has been exhausted.

10.4 Other

All forest management issues – for both timber and non-timber resources – have been dealt with in the preceding sections. No other concerns exist.

11 Glossary

AAC	Allowable Annual Cut
BEC	Biogeoclimatic Ecosystem Classification
CASH6	Critical Analysis by Simulation of Harvesting
ESA	Environmentally Sensitive Area
FPPR	Forest Planning and Practices Regulation
FSP	Forest Stewardship Plan
GIS	Geographic Information System
IP	Information Package
IRM	Integrated Resource Management
IRM	Integrated Resource Management
LU	Landscape Unit
MHA	Minimum Harvestable Age
MFR	Ministry of Forests and Range
MP	Management Plan
NSR	Not Satisfactory Restocked
OAF	Operational Adjustment Factor
OGMA	Old Growth management Area
PSYU	Public Sustained Yield Unit
QMD	Quadratic Mean Diameter
RFI	Recreation Features Inventory
RMZ	Riparian Management Zone
RRZ	Riparian Reserve Zone
RVQC	Recommended Visual Quality Class

SI	Site Index
SRMZ	Special Resource Management Zone
THLB	Timber Harvesting Land Base
TIPSY	Table Interpolation Program for Stand Yields
TL	Timber Licence
UWR	Ungulate Winter Range
VDYP	Variable Density Yield Prediction
VILUP	Vancouver Island Land Use Plan
VLI	Visual Landscape Inventory
VQO	Visual Quality Objective
VRI	Vegetative Resources Inventory
WHA	Wildlife Habitat Area

12 References

Abbott, George. 2004. *Order Establishing Provincial Non-Spatial Old Growth Objectives.* Ministry of Sustainable Resource Management.

Baker, Ken. 2003. *Tree Farm Licence 46 – Rationale for Allowable Annual Cut (AAC) Determination.* B.C. Ministry of Forests.

Baker, Ken. 2004. *Chief Forester Order – Section 173 of the Forest Act (concerning Hill 60).* B.C. Ministry of Forests.

B.C. Ministry of Forests. 2001. *Guide for Tree Farm Licence Management Plans (20-month) and Calendar Year Reports*. Resource Tenures and Engineering Branch / Timber Supply Branch

B.C. Ministry of Forests. 2002. *TFL 46 License Agreement*. (Contract between the Province of British Columbia and TFL Forest Ltd.)

B.C. Ministry of Forests. 2003. *Supplemental Guide for Preparing Timber Supply Analysis Data Packages.* Forest Analysis Branch

B.C. Ministry of Forests. 2004. *Interim Standards for Data Package Preparation and Timber Supply Analysis - Defined Forest Area Management Initiative.* Forest Analysis Branch

Cowichan Lake Community Forest Cooperative Ltd. and The Teal-Jones Group. 2006. *Forest Stewardship Plan*.

Dryburgh, Jack. 2005. *Order to Establish Visual Quality Objectives for the South Island Forest District.* Ministry of Forests and Range.

Government of British Columbia. 2001. *Vancouver Island Summary Land Use Plan.*

Government of British Columbia. 2006. *Website. Forest Planning and Practices Regulation*. (http://www.for.gov.bc.ca/tasb/legsregs/frpa/frparegs/forplanprac/fppr.htm)

J. S. Thrower & Associates Consulting Foresters Ltd. 2000. *Second-Growth Site Index Estimates for Douglas-fir, Western Hemlock, Pacific Silver Fir, and Western Redcedar on TFL 46.*

Macatee, Gordon. 2003a. *Order – Ungulate Winter Range #U1-002.* Ministry of Water, Land and Air Protection.

Macatee, Gordon. 2003b. *Order – Ungulate Winter Range #U1-017.* Ministry of Water, Land and Air Protection.

Teal Jones Forest Ltd. et. al. 2006. *Renfrew Aggregate Landscape Unit Plan (Draft V6).* B.C. Integrated Land Management Bureau.

The Teal-Jones Group. 2006. *Sustainable Forest Management (SFM) Plan.*

TFL Forest Ltd. (TimberWest). 2001. *Tree Farm Licence No. 46 – Management Plan No. 4.*

Timberline Natural Resource Group. 2008. *Tree Farm Licence 46 – Vegetation Resources Inventory Statistical Adjustment.*

Appendices

Appendix I

Existing Mature Average Volume Lines

Appendix II

Existing Natural Yield Curves

Appendix III

Existing Managed Yield Curves

Appendix IV

Future Yield Curves

Appendix V

Site Index Adjustment Report

Appendix VI

VRI Phase II Adjustment Report