TREE FARM LICENCE 41

MANAGEMENT PLAN 7

Skeena Sawmills Ltd.,
a wholly owned subsidiary of

RocHoldings Ltd.

PREAMBLE

This Management Plan has been prepared by Skeena Sawmills Ltd., a wholly owned subsidiary of Roc Holdings Ltd., with principal assistance from TECO Natural Resource Group Ltd. (formerly Timberline). TECO are the authors of the Timber Supply Analysis Information Package and Timber Supply Analysis Report which were compiled with input and direction provided by Skeena Sawmills Ltd.

Individuals who made significant contribution to completing this plan include L. Loggin RPF, S. Jay RPF , J. Greenfield RPF and J. Miehm RPF.

This Management Plan was prepared under the supervision of:

Jerry Miehm, RPF.
Senior Resource Analyst
TECO Natural Resource Group Ltd.

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1.0 INTRODUCTION

When approved by the Province's Chief Forester, the Management Plan, along with other pertinent information and input, will be used in the Chief Forester's determination of the allowable annual cut (AAC) from Tree Farm Licence (TFL) #41. The AAC determination will be appended to this document once it is completed.

This Management Plan has been compiled to meet with content requirements specified in the *Tree Farm Licence Management Plan Regulation (B.C. 280/2009).* The regulations have replaced content requirements that were specified in past TFL agreements. Management objectives and strategies that pertain to operations on the TFL are specified in the Forest Stewardship Plan in accordance with the *Forest and Range Practices Act*, and are taken into account in the timber supply analysis that is included in this Management Plan.

2.0 DESCRIPTION OF TFL 41

TFL 41 is situated in north-western British Columbia, approximately 100 km inland from Prince Rupert, in the lee side of the Coast Mountains encompassing a portion of the Kitimat Ranges. Subsequent to the impending area deletion that will account principally for volume re-allocation pursuant to the *Forest Revitalization Act*, the residual gross area of TFL 41 will be approximately 202,000 hectares. The area encompasses the upper headwaters and major tributaries of Kitimat River, drainages adjacent to the west boundary of the District of Kitimat, and an area surrounding Clio Bay at the entrance to Kildala Arm. Figure 1 provides a map showing the TFL location and surroundings.

The topography is steep and mountainous with narrow valleys. Numerous streams support resident and anadromous fish populations. Major wildlife species include black bear, grizzly bear and moose.

The local climate is influenced strongly by coastal weather patterns, but as the area is inland from the outer coast, it also displays some characteristics of an interior climate. The forested areas of TFL 41 are predominantly within the wetter submaritime Coastal Western Hemlock (CWHws) biogeoclimatic subzone to the north and the very wet maritime Coastal Western Hemlock (CWHvm) biogeoclimatic subzone to the south. The foregoing subzones are bounded in the upper elevations by the Mountain Hemlock (MH) biogeoclimatic zone. The climatic conditions of the predominant subzones are described in the BC Ministry of Forests Land Management Handbook 26 (1993) as follows:

- The CWHws is the inland subzone. The climate is described as submaritime because it is drier, with colder winters, hotter summers and more frequent forest fires than a true maritime climate.
- The CWHvm has a wet humid mild oceanic climate.

The 1971-2000 weather data from the Environment Canada Kitimat town site station lists average annual rainfall at 1770 mm (182 days) and snowfall at 420 cm (45 days). The extreme recorded temperatures were in July at 36 ºC and in December at (–25 ºC). The Kitimat station is located within the CWHvm subzone which covers the southern portion of TFL 41.

Although the majority of the area is extensively forested, the operable merchantable forest is largely confined to the valley floors and mid-slopes. The dominant timber species is western hemlock occurring generally in admixture with a significant component of amabilis fir. Western redcedar is a significant minor species throughout the TFL. Mountain hemlock occurs at the higher elevations. Other minor species in descending order of abundance include Sitka spruce, yellow cedar and lodgepole pine. The forest structure has largely developed without the influence of wildfires, which have been infrequent. As a consequence, timber stands are predominantly older than 200 years with variable timber quality and tending to have higher pulp log content than younger stands.

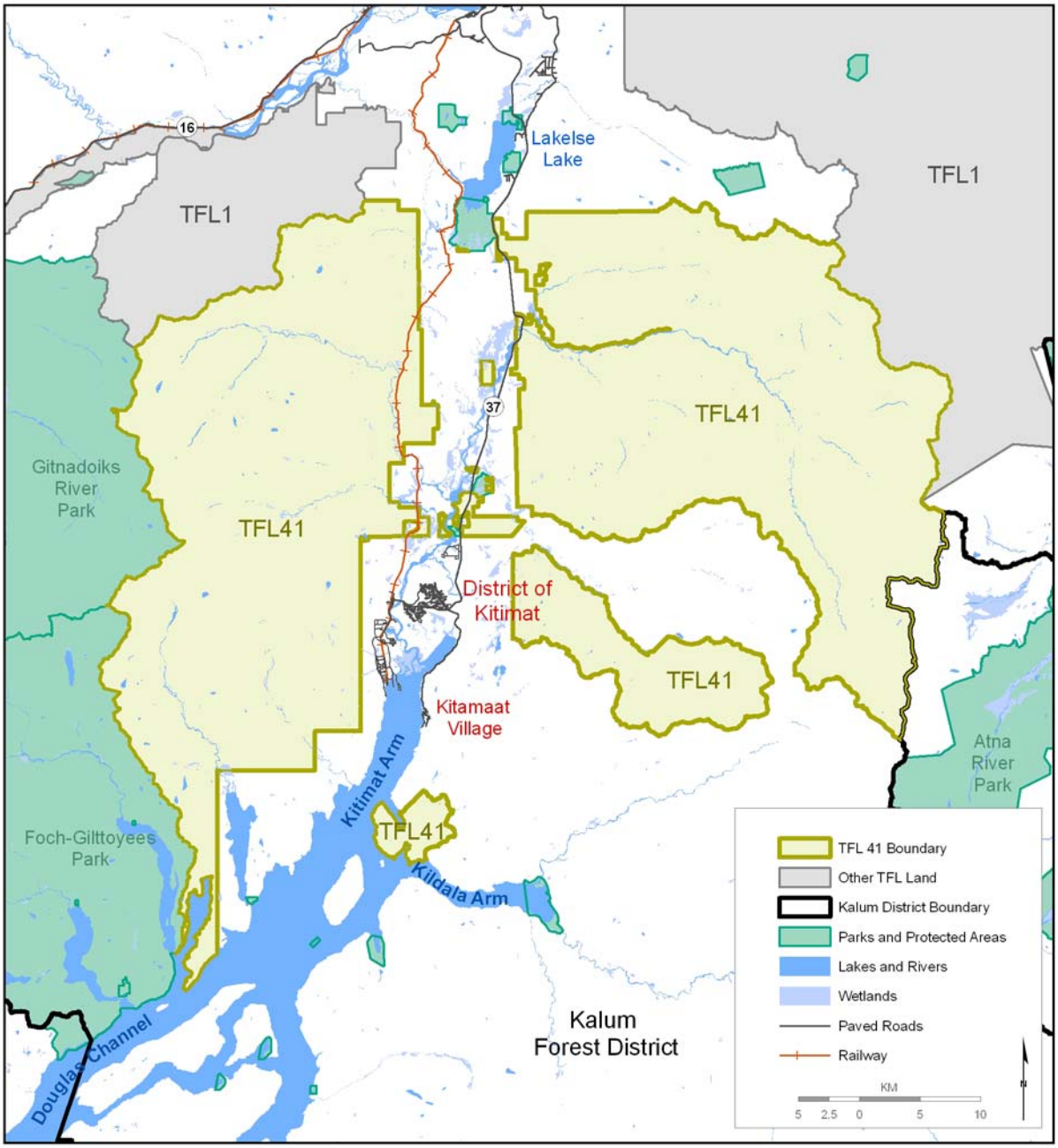

Figure 1: TFL 41 Key Map

3.0 TFL 41 LICENCE HOLDER HISTORY

TFL 41 was granted to Eurocan Pulp and Paper Company Ltd. on December 12, 1966. Eurocan was a joint-venture company between two major Finnish forest companies, Enso-Gutzeit Osakeyhtio and Kymin Osakeyhtio - Kymmene Aktiebolag, and Ben Ginter (businessman).

In 1981, West Fraser Mills Ltd. acquired a major share in Eurocan by purchasing the shares of Kymin Osakeyhtio - Kymmene Aktiebolag whereby the licensee became Eurocan Pulp and Paper Company, a joint venture of West Fraser Mills Ltd. and Enso Forest Products Ltd. In 1984 West Fraser increased its ownership in Eurocan to 50%.

West Fraser subsequently purchased Enso-Gutzeit's shares in 1993 and the name of the licensee was changed to West Fraser Mills Ltd.

TFL 41 was transferred from West Fraser Mills Ltd. to Skeena Sawmills Ltd., a wholly owned subsidiary of West Fraser Mills Ltd. on April 25, 2011. On July 19, 2011, Roc Holdings Ltd. acquired the outstanding shares of Skeena Sawmills Ltd.

4.0 TFL 41 CONSOLIDATION AND SUBDIVISION

There has been no consolidation or subdivision of TFL 41.

5.0 MAJOR BOUNDARY CHANGES TO TFL 41

The original area of TFL 41 was 1,019,740 hectares. A major revision to create the Kitlope Heritage Conservancy in 1996 reduced the area by 321,120 hectares. As of March 1, 2010, the effective date of the current licence agreement, the area of TFL 41 is 703,745 hectares. Impending area amendments will reduce the gross area to 201,939 hectares which pertain to the current timber supply analysis. The historic and pending amendments involving area over 200 hectares on TFL 41 include:

- Removal of the Kitlope drainage in 1996 to create the Kitlope Heritage Conservancy: 321,120 hectares;
- Addition of expired Timber Licence TO 991 in 1997: 1,083 hectares;
- Pending amendment for area deletion to account for *Forest Revitalization Act (2003)* volume take-back and prior volume apportionments to BC Timber Sales: estimated at 443,000 hectares; and

- Pending amendment for the creation of protected areas under the *Parks and Wilderness Act (2004)* as a result of the cabinet approval of the Kalum Land and Resource Management Plan (2002): estimated at 59,000 hectares

6.0 TFL 41 PLANNING DOCUMENTS

Table 1 lists the publicly available planning documents that are used to guide forest management and operations in the TFL 41 area.

Table 1. Publicly available planning documents

Plan Title	Availability	Description
Kalum Sustainable Resource Management Plan (April 2006)	http://archive.ilmb.gov.bc.ca/slrp/srmp/north/kalum/plan/Kalum_SRMP.pdf	The Kalum SRMP implements the objectives and strategies of the Kalum Land and Resource Management Plan (May 2002) that relate to forestry development and the *Forest and Range Practices Act (FRPA)* through the legal establishment of Land Use Objectives.
Forest Stewardship Plan for TFL 41 and FLA16885 (September 2007)	Available from the licensee upon request.	The Forest Stewardship Plan (FSP) specifies results and strategies required to meet resource management and land use objectives that apply to TFL 41 area in accordance with the *Forest and Range Practices Act (FRPA).* The FSP is the primary planning document used to guide operations.

The FSP will be reviewed to ensure that it remains consistent with management objectives and regulatory requirements. If any changes are made to the FSP, the updated document will be subject to the required review and approval processes.

7.0 TIMBER SUPPLY ANALYSIS

As stated in the *Tree Farm Licence Management Plan Regulation*, the Management Plan must contain a timber supply analysis that analyzes the short term and long term availability of timber for harvesting in the tree farm licence area, including the impact of management practices on the availability of timber. The TFL 41 Timber Supply Analysis Report is attached in Appendix A. The supporting documentation for the timber supply analysis is summarized in the TFL 41 Timber Supply Analysis Information Package attached in Appendix B. The following is a brief summary of the results from the base case analysis as documented in the attached timber supply analysis report.

The base case in the timber supply analysis was set to maintain the current allowable annual cut (AAC) for as long as possible. The results indicate that the present AAC of 122,926 m^3, which is currently apportioned to Skeena Sawmills Ltd. under TFL 41, can be maintained indefinitely on the land base described herein. Furthermore, as extensive managed stands develop and reach merchantability criteria, the harvest level can be increased. At 45 years in the future, the harvest level can begin to climb towards the long

term sustainable harvest level of 222,000 m^3 per year. Based upon managed stand yield tables, the analysis indicates that the productive capacity of the timber harvesting land base is approximately 260,000 m^3 per year. The long term sustainable harvest rate determined by the analysis falls short of the productive capacity of the land base as timber is not the only resource value being managed. As reported, limitations to the timber harvest rate are primarily due to requirements to manage grizzly bear habitat, viewscapes and to meet biodiversity objectives.

8.0 PUBLIC REVIEW STRATEGY

8.1 Timber Supply Analysis Information Package Review

The timber supply analysis Information Package (IP) summarizes the technical information and management practices that formed the basis for the timber supply analysis.

An invitation for public review was published in a notice in the July 9, 2010 edition of the local Northern Connector newspaper. Copies of the IP were to be provided upon request by mail, email or phone. Copies of the IP were requested and made available to two members of the public. No public comments have been received.

The Ministry of Forests and Range (now the Ministry of Forests, Lands and Natural Resource Operations: FLNR) provided copies of the IP to several First Nations groups including the Metlakatla Band, Kitselas Band Council, Lax Kw'alaams Band, Hartley Bay Band Village Council and Kitamaat Village Council. An offer was made to have Ministry and licensee personnel available to meet with each group. The groups were invited to review and provide comments or concerns regarding the information contained in the Information Package and to inform the Ministry of any aboriginal interests that may be impacted by an allowable annual cut (AAC) decision. A request was made to provide the comments prior to September 10, 2010.

In the letter dated November 22, 2010 from the Ministry of Forests, Mines and Lands (now FLNR) accepting the IP with conditions, it was stated that no comments have yet been received from the First Nations consultation.

8.2 Management Plan Review

This Management Plan, including the updated Information Package (Appendix B) and the TFL 41 Timber Supply Analysis Report (Appendix A), were posted on behalf of the licensee on the Ministry of Forests, Lands and Natural Resource Operations, Kalum District internet site and made available for public review and comment for a period of 60 days commencing May 16, 2011. A notice inviting public review was published in two consecutive editions of the Northern Connector, with the first publication occurring prior to the commencement of the 60 day review period. No feedback was received from the public.

As with the review of the Timber Supply Analysis Information Package detailed in the previous section, the Ministry of Forests, Lands and Natural Resource Operations conducted consultation with First Nations. No feedback was received regarding the Management Plan.

APPENDICES

A. TFL 41 Timber Supply Analysis Report

B. TFL 41 Timber Supply Analysis Information Package

C. AAC Determination

APPENDIX A

TFL 41 Timber Supply Analysis Report

TFL 41 TIMBER SUPPLY ANALYSIS REPORT

Prepared for:

Skeena Sawmills Ltd., a wholly owned subsidiary of

West Fraser Mills Ltd.

Prepared by:

TECO Natural Resource Group Limited
301 · 958 West 8th Avenue
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12 August, 2011

File: BC0210509

TECO Natural Resource Group Limited

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File: BC0210509

June 13, 2011

Skeena Sawmills Ltd.
Terrace, BC

Attention: Sonny Jay, RPF

Re: TFL 41 Timber Supply Base Case

Dear Sonny;

Here is the final draft of the Timber Supply Analysis Report for your consideration.

Yours truly,

Jerry Miehm
Senior Resource Analyst
jerry.miehm@tecogroup.ca
(604) 714-2872

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1 EXECUTIVE SUMMARY

The licensee Skeena Sawmills Ltd., a wholly owned subsidiary of West Fraser Mills Ltd., must complete a timber supply analysis for Tree Farm Licence (TFL) 41 in conjunction with the Management Planning process that is required by legislation. An Information Package describing the spatial data, yield forecasts and management assumption that would underpin the timber supply analysis was prepared and submitted to the Ministry of Forests, Lands and Natural Resource Operations. It was accepted by the Ministry on November 22, 2010 as an adequate basis upon which to prepare timber supply forecasts for the TFL.

The next step in the timber supply analysis process is the preparation of a base case. This has been done using Patchworks, a forest estate model that facilitates the preparation of data, application of management practices and other rules, and produces outputs describing the harvest flow and the future condition of the landbase with respect to timber and other resource values. The results are presented in this document.

The harvest levels found in the base case run are summarized in Table 1 and Figure 1.

Table 1: Base Case Harvest Flow

Period	Harvest Level (m^3/year)
2010 - 2054	123,000
2055 - 2064	133,000
2065 - 2074	145,000
2075 - 2084	157,000
2085 - 2094	169,000
2095 - 2104	181,000
2105 - 2114	193,000
2115 - 2124	205,000
2125 - 2134	217,000
2135 - 2259	222,000

The initial harvest level is set to the existing allowable annual cut (AAC) apportionment of approximately 123,000 cubic metres per year under which Skeena Sawmills Ltd. is operating within the landbase that will remain subsequent to area deletions that are set to occur in 2011. The deletions are to account for the AAC apportionments to other parties as a result of volume take-back under the Forest Revitalization Act (FRA) as well as pre-FRA BC Timber Sales volume. This harvest level is sustainable for 45 years. At that point, higher volume managed stands begin to reach minimum harvest criteria. The harvest level begins to climb at about 10% per decade until the long term sustainable harvest level of 222,000 cubic metres per year is achieved.

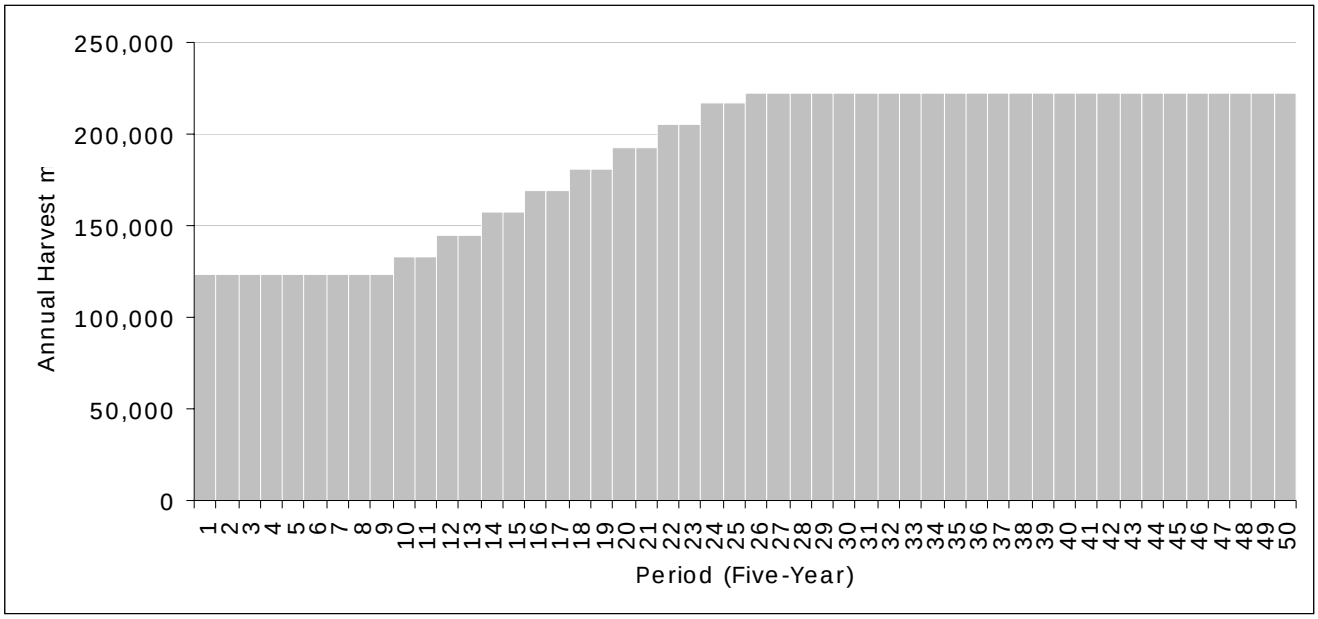

Figure 1: Base Case Harvest Flow – Cubic Metres per Year

2 INTRODUCTION

Timber supply is the quantity of timber available for harvest over time. It is dynamic, not only because trees naturally grow and die, but also because conditions that affect tree growth, and the social and economic environment that affect the availability of timber for harvest, change with time. Timber supply analysis is the process of assessing and predicting the current and future supply from a management unit. This information will be used by the Chief Forester of British Columbia in determining a permissible harvest level for Tree Farm Licence (TFL) 41.

This document presents the results of the timber supply analysis. It is based on the best available information and current management practices. The Base Case Results (Section 4) present the most likely outcome; potential sources of uncertainty are discussed under Sensitivity Analysis (Section 6). This information, and the management assumptions that underlie the forest estate modeling, were described in the Information Package that was submitted to the Ministry of Forests, Lands and Natural Resource Operations. It was accepted by the Ministry on November 22, 2010 as an adequate basis upon which to prepare timber supply forecasts for the TFL.

In accepting the Information Package, the Ministry attached several conditions including:

- clarification of adjacent and contained non-TFL areas being excluded from the analysis;
- further detail regarding the non-conventionally operable landbase;
- a rationale for the methods chosen to account for natural disturbance outside of the Timber Harvesting Landbase (THLB);
- confirmation that genetic gains were only incorporated into yield curves for future managed stands; and
- an explanation of the harvest queuing approach used in the forest estate model and its relationship to operational practice.

These matters have been addressed, either in this document or the updated version of the Information Package that is dated April 15, 2011.

3 DESCRIPTION OF THE TFL

TFL 41 is situated in north-western British Columbia, approximately 100 km inland from Prince Rupert, in the lee side of the Coast Mountains encompassing a portion of the Kitimat Ranges. The area encompasses the upper headwaters and major tributaries of Kitimat River, drainages adjacent to the west boundary of the District of Kitimat, and an area surrounding Clio Bay at the entrance to Kildala Arm. The total area of TFL 41 is approximately 202,000 hectares. The area of the TFL that is available for timber harvesting is 31,558 hectares. This was determined by removing portions of the land base that are not considered harvestable. The results are shown in Table 2 below.

Table 2: Timber Harvesting Landbase Determination

Classification	Total Area (ha)	Net Area Removed (ha)	Net Volume Removed (m^3)
Gross Area Within TFL 41 Boundary	**201,939**		
Landbase Reductions:			
Non-TFL	104	104	1
Non Productive	93,046	93,046	412,174
Old Growth Management Areas	10,366	10,071	3,670,370
Avalanche - ESA1	1,380	1,295	274,393
Soils-ESA1	4,533	3,303	1,077,687
Soils-ESA2	7,594	1,087	372,313
Terrain Class V	5,542	3,799	1,607,409
Terrain Class IV	13,782	1,222	499,482
Recreation Sites and Trails	74	43	9,099
Inoperable Stands	156,841	47,883	13,721,395
Non-Merchantable Mature Stands	13,865	619	159,298
Non-Merchantable Immature Stands	99,440	618	82,518
Problem Forest Types[1]	4,882	1,215	569,039
Archaeological Sites	4	1	425
Wildlife Habitat – Tailed Frog	62	7	3,780
Wildlife Habitat – Goat	5,269	235	98,582
Riparian Reserve Zones - Spatial - S1	2,521	854	338,722
Riparian Reserve Zones - Spatial - Other Stream Classes	1,221	446	247,285
Riparian Reserve Zones - Unclassified Streams	148,994	2,107	475,044
Wildlife Tree Patch	154,707	103	19,518
Roads - Existing	19,050	991	15,887
Total Landbase Reductions	**169,058**		**23,654,423**
Current Timber Harvesting Landbase	**32,881**		**8,096,900**
Future Reductions			
Future Roads		1,324	
Long Term Timber Harvesting Landbase	**31,558**		

[1] includes 906 hectares of net area removed for isolated mature stands that won't be harvested.

The productive area of the TFL is 108,789 hectares. This is distributed across six landscape units, with three-quarters of the area falling within the Kitimat and Wedeene Landscape Units (LU) as shown in Figure 2 below.

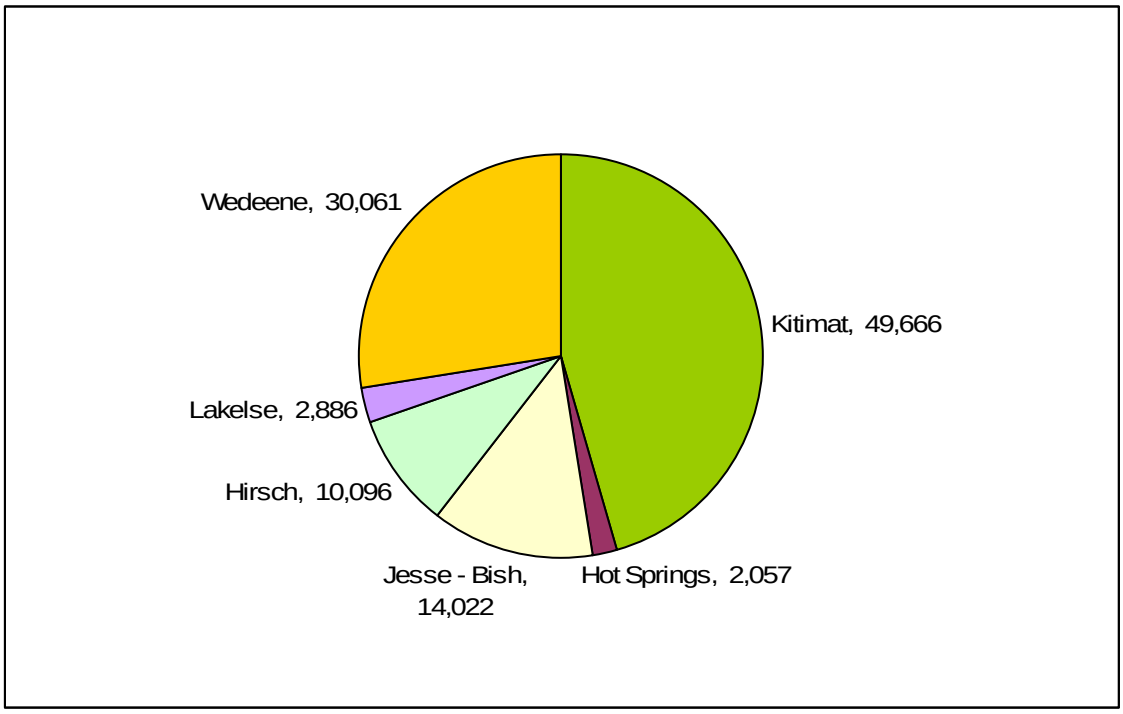

Figure 2: Productive Forest Area (ha) by Landscape Unit

Only a portion of the productive forest within each LU falls within the timber harvesting landbase (THLB).

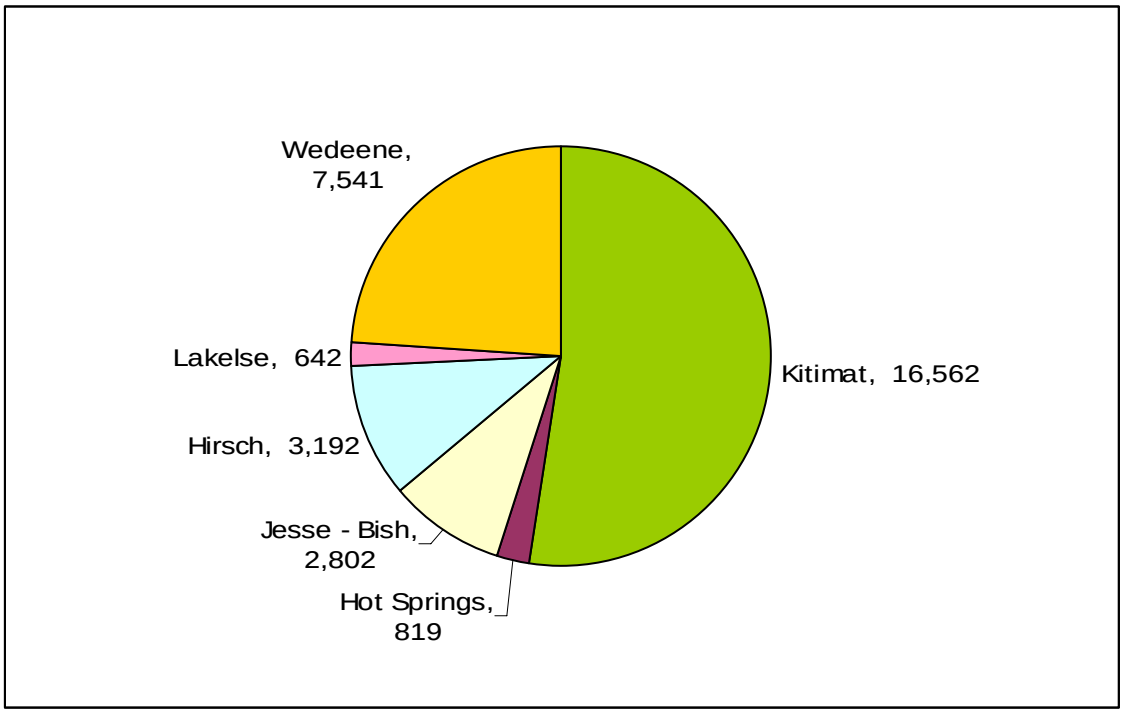

Figure 3: Timber Harvesting Landbase Area (ha) by Landscape Unit

In the Kitimat LU, one-third of the productive forest is available for timber harvesting. For the Wedeene LU the ratio is lower: one-quarter of the productive forest is classified as THLB. For the smaller landscape units the ratio ranges from 20% to 40%.

The forested areas of TFL 41 are predominantly within the wetter submaritime Coastal Western Hemlock (CWHws) biogeoclimatic subzone (BEC) to the north and the very wet maritime Coastal Western Hemlock (CWHvm) biogeoclimatic subzone to the south. Most of the productive land within TFL 41 – and virtually all of the THLB – falls within the Coastal Western Hemlock (CWH) biogeoclimatic zone. The CWH is bounded in the upper elevations by the Mountain Hemlock (MH) biogeoclimatic zone. Approximately 28% of the productive area falls within the Mountain Hemlock BEC zone. Figure 4 shows this distribution.

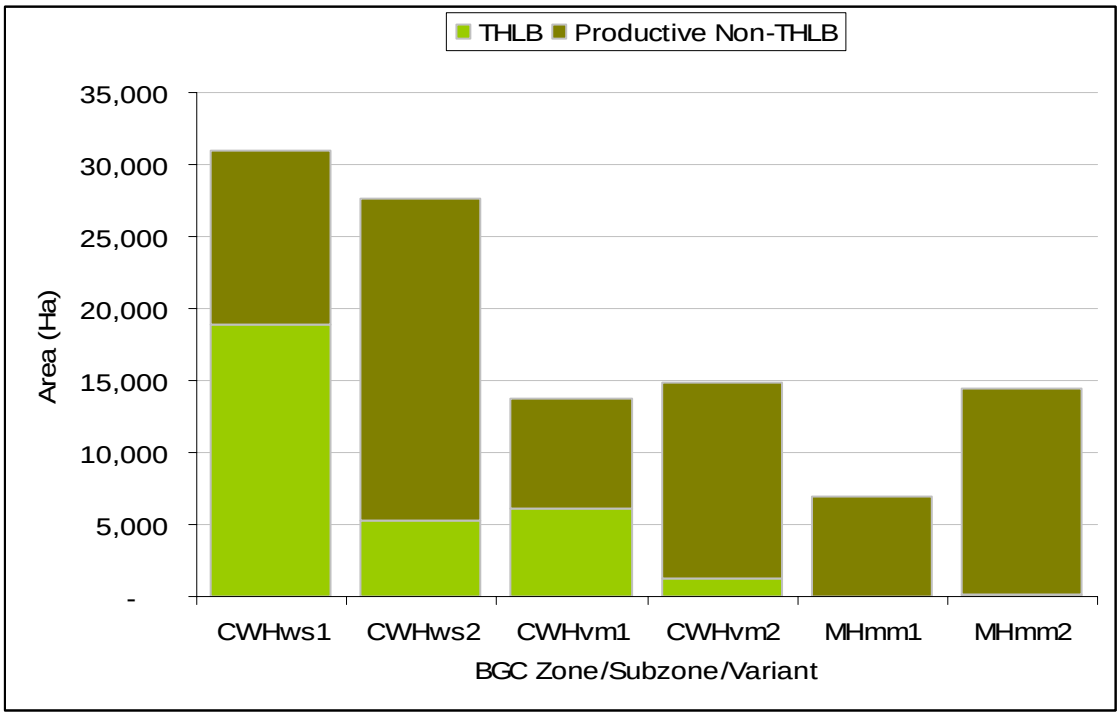

Figure 4: Productive and THLB Area by BEC Zone, Subzone and Variant

In the wetter subzones of the CWH Zone, western hemlock tends to be the climax and best-adapted tree species. Not surprisingly, much of the TFL (80% of the THLB) is occupied by hemlock-leading stands. Balsam-leading stands account for over half of the remaining area, with western redcedar, Sitka spruce, lodgepole pine and deciduous leading stands covering less than eight percent of the landbase. Figure 5 shows this distribution.

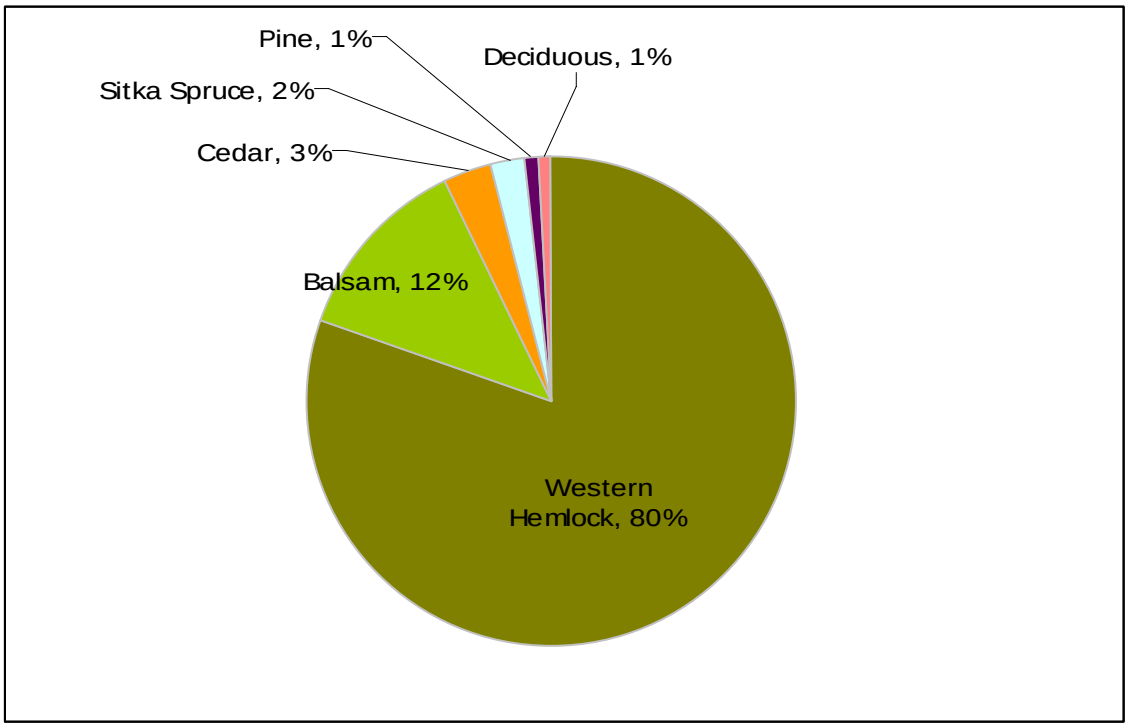

Figure 5: Leading Species Distribution of the Timber Harvesting Landbase

The productivity of the TFL is assessed by summarizing the site index for each stand in the THLB. The forest inventory site index was used for most stands. However, the SI for some hemlock stands was adjusted based on the results of a paired plot old-growth site index study that was completed in the Kalum Forest District[1]. This adjustment was applied to western-hemlock leading stands only with an inventory SI between 8 and 18 metres. The THLB area for which the site index was adjusted was 9415 hectares.

Figure 6 shows the distribution that results from summarizing the THLB area by five site productivity classes, for both the inventory SI and the adjusted SI that was used in the development of the yield curves. Just over three-quarters of the area has an adjusted site index of between 20 and 30 metres. Most of the remaining area is lower productivity, with SI between 10 and 20 metres. Less than two percent of the THLB has a site index greater than 30 metres.

[1] *Site index adjustment for old-growth coastal western hemlock stands in the Kalum Forest District*. 1997. Ministry of Forests (G.D. Nigh and B. Love)

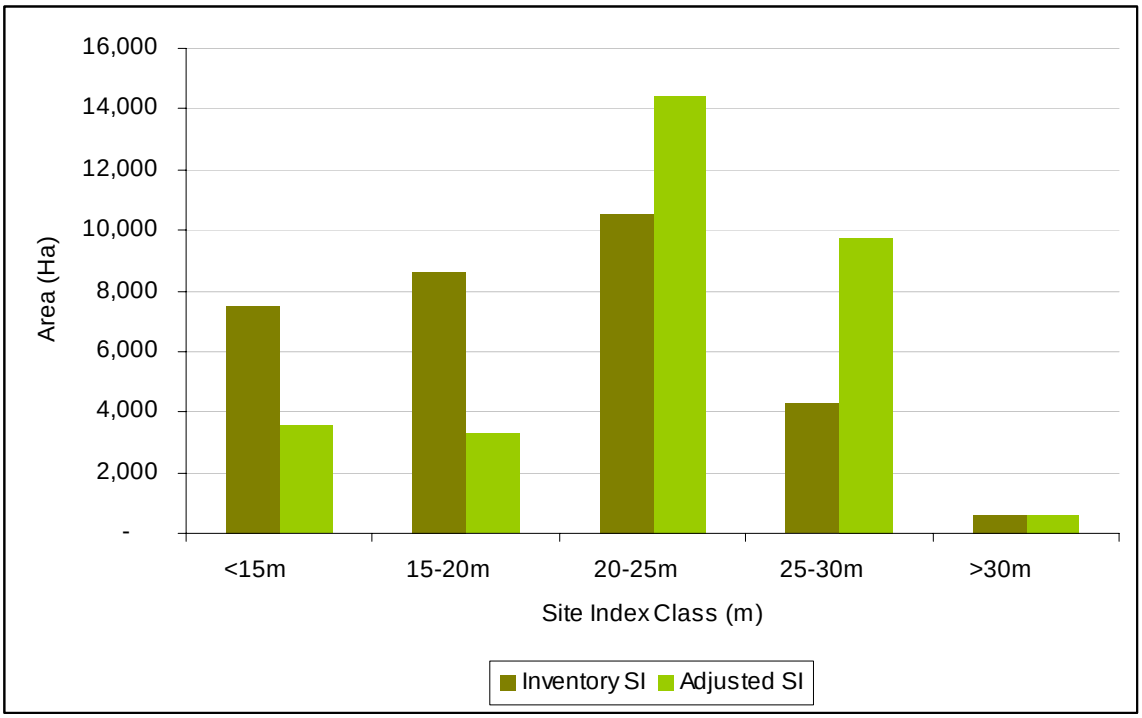

Figure 6: Site Index Distribution on the Timber Harvesting Landbase

The age class distribution of the THLB is shown in Figure 7.

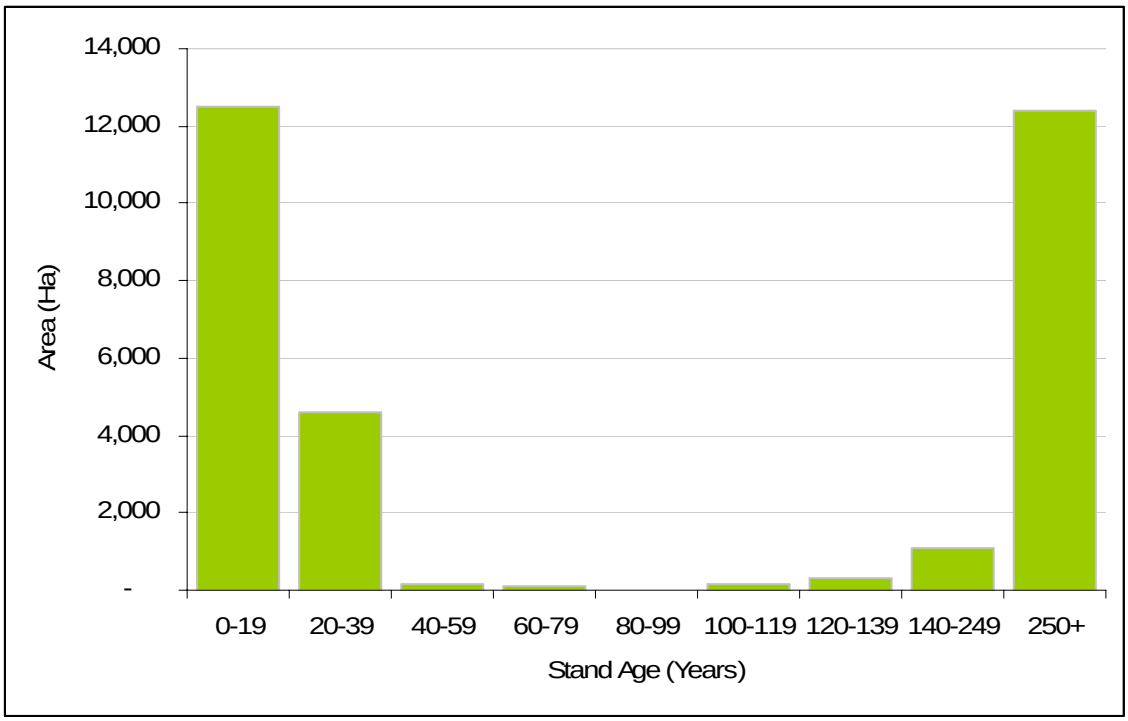

Figure 7: Age Class Distribution on the Timber Harvesting Landbase

This bimodal age class pattern is typical of Coastal forests that do not have a long history of harvesting. Since natural stand-regenerating events are uncommon and limited in area when they do occur, most stands reach very old ages. This is reflected in Figure 7, which shows that almost 40% of the THLB is in the 250+ age class. Stands that originate from harvesting – mostly within the last 30 years – fall within the first two age classes. The proportion of the area in the first two age classes is higher than would be expected because much of the area removed from the TFL over the years has been unharvested. The AAC has fallen accordingly, but the residual TFL landbase has retained a disproportionate share of the previously logged blocks.

Management objectives for TFL 41 recognize the importance of non-timber resources such as biodiversity, wildlife habitat and visual quality. In some areas, protection of these resources will have an impact on timber harvesting. Stands in the timber harvesting landbase are not unconditionally available to contribute to timber supply once they achieve minimum merchantability criteria. Within the forest estate model, constraints have been applied to address these objectives, which are listed in Table 3

Table 3: Management Objectives

Objective	Land Base Definition
Grizzly Bear Habitat	CFLB[2] within McKay-Davies grizzly bear identified watershed
Seral Stage Targets	CFLB within each LU-BEC
Visual Quality Objectives (VQO)	CFLB within each LU / VQO class
Identified Watersheds	CFLB within the identified BEC site series within the Jesse and Emsley watersheds
Patch Size Distribution / Integrated Resource Management (IRM)	THLB without VQO targets within each LU

Grizzly bear habitat, seral stage targets and identified watersheds management objectives are as specified in the Kalum Sustainable Resource Management Plan (SRMP) and defined in the TFL 41 Forest Stewardship Plan (FSP). The productive and net area of the TFL that are classified within the grizzly bear identified watershed is shown in Table 4.

Table 4: McKay-Davies Grizzly Bear Identified Watershed - Productive and THLB Area

	Productive Area (ha)	THLB Area (ha)
Grizzly Bear Identified Watershed	26,262	9,457

[2] Crown Forest Land Base – the productive forest area within the TFL

Seral stage requirements are established by the Kalum SRMP, and specific commitments are made in the TFL 41 FSP. These targets are modeled by landscape unit and BEC subzone / variant as shown in Table 5.

Table 5: THLB Area by Landscape Unit and BEC Subzone / Variant

	Biogeoclimatic Subzone / Variant						
Landscape Unit	CWHws1	CWHws2	CWHvm1	CWHvm2	MHmm1	MHmm2	Total
Hirsch	0	1,195	1,983	0	13		3,190
Hot Springs	729	89				0	819
Jesse – Bish			2,331	471	0		2,798
Kitimat	12,356	3,802	264	69	0	80	16,562
Lakelse	610	32				0	642
Wedeene	5,257	120	1,520	644	0	0	7,541
Total	18,945	5,238	6,098	1,184	13	80	31,558

Visual quality objectives are as defined in the TFL 41 FSP. These are modeled by landscape unit and VQO class (either 'Modification' or 'Partial Retention'). The affected areas are shown in Table 6.

Table 6: THLB Area by Landscape Unit and Visual Quality Objective

	Visual Quality Objective		
Landscape Unit	M	PR	Total
Hirsch		117	117
Hot Springs	75	83	159
Jesse – Bish	0	428	428
Kitimat	938	862	1,799
Lakelse	201		201
Wedeene	401	145	545
Total	1,615	1,635	3,249

The Kalum SRMP specifies old seral stage forest targets by site series within identified watersheds. On TFL 41, the Jesse and Emsley watersheds are impacted by this objective. Seral targets are modeled by BEC subzone and variant within each watershed. Table 7 shows the areas that are impacted by these old seral targets.

Table 7: THLB Area by Identified Watershed, BEC Unit and Site Series

		Site Series						
Watershed	BEC Unit	1	3	5	6	8	14	Total
Emsley	CWHvm2	1	0	4	10	1		16
Jesse	CWHvm1	358	14	11	244	60	13	699
Jesse	CWHvm2	32	3	2	24	17		78
Total		391	17	17	278	78	13	793

The patch size distribution requirement is modelled using a proxy for cutblock adjacency. This is applied to the integrated resource management (IRM) area outside of special management zones, community watersheds and areas with VQO's. Unlike previously described constraints, the IRM constraint applies to the THLB only. Table 8 shows THLB area by landscape unit.

Table 8: THLB Area by Landscape Unit

Landscape Unit	THLB Area (ha)
Hirsch	3,192
Hot Springs	819
Jesse - Bish	2,802
Kitimat	16,562
Lakelse	642
Wedeene	7,541
Total	31,558

4 BASE CASE RESULTS

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

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

Patchworks uses a simulated annealing approach to harvest scheduling. Consequently, there are no harvest rules in the conventional sense (e.g. oldest-first or minimize growth loss). However, merchantability limits are set up such that no stands may be harvested before they have achieved a volume of 250m^3/hectare, a height of at least 19.5 metres and an average stand diameter of 25 centimetres. Growing stock constraints have been applied to the last 50 years of the planning horizon to ensure that the harvest forecast is sustainable. This was done by observing growing stock levels in the absence of any constraint and then interactively setting a lower limit that prevents any decline in growing stock over the last five decades. Without this constraint, the model would harvest excessively at the end of the planning horizon because harvest shortfalls beyond 250 years have no impact on the optimization algorithm.

The model has been set up to maintain the current harvest level (the existing AAC apportionment of approximately 123,000 m^3 that Skeena Sawmills will be operating under until the next AAC determination) for as long as possible. Long run sustained yield calculations demonstrate that, in the long term, a significantly higher harvest level is possible. The harvest level has been increased from the starting level to the long term level in steps that are 10% (or less) within each decade.

Table 9 shows the harvest flow that results from this model setup. Figure 8 shows this graphically. The following sections address the details of the short-, mid- and long-term harvest levels that were found.

Table 9: Base Case Harvest Flow

Period	Harvest Level (m^3/year)
2010 - 2054	123,000
2055 - 2064	133,000
2065 - 2074	145,000
2075 - 2084	157,000
2085 - 2094	169,000
2095 - 2104	181,000
2105 - 2114	193,000
2115 - 2124	205,000
2125 - 2134	217,000
2135 - 2259	222,000

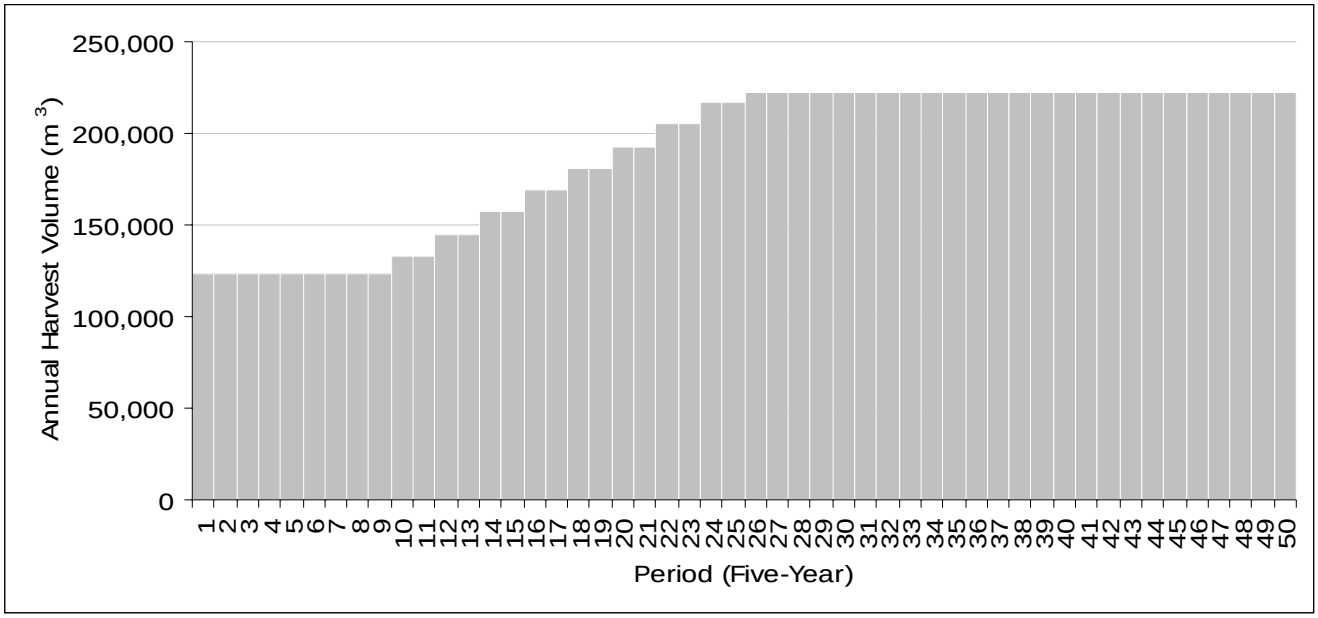

Figure 8: Base Case Harvest Flow – Cubic Metres per Year

Timber supply dynamics on the TFL are primarily influenced by the transition from harvesting in old growth stands to harvesting in younger stands. This pattern is shown in Figure 9 which shows the decrease in the proportion of old growth harvested as more and more second growth stands reach minimum harvest age.

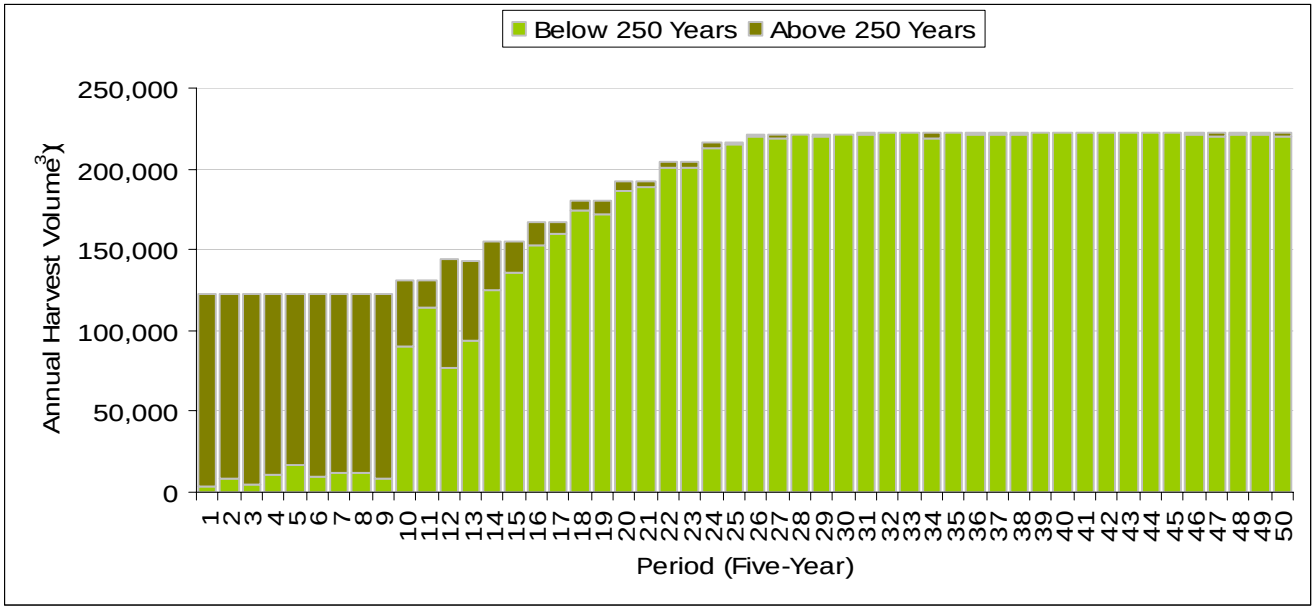

Figure 9: Harvest Volume from Stands Above and Below 250 Years of Age

In this chart, old growth is defined as stands older than 250 years. These stands make up the majority of the harvest volume for the first 45 years. After this point, there is a fairly sharp transition to second growth harvesting. For the first nine five-year periods, over 96% of the harvest volume is from stands older than 140 years of age; and most of this volume is from stands older than 250 years.

4.1 Short Term Harvest Level

The short term harvest level has been set at the current AAC of 123,000 cubic metres annually. This level is achievable for 45 years. Preliminary versions of the base case harvest schedule were reviewed by Skeena Sawmills staff. This review identified some mature stands within the THLB that, although mapped originally as operable, are likely inoperable as they appear to have been isolated at the time the surrounding areas were harvested. A description of these areas is provided in the Information Package document under Section 3.9 (Problem Forest Types). On subsequent model runs, these stands were deleted from the timber harvesting landbase. The land base netdown has been updated accordingly (see Table 2). Although it is reasonable to assume there is likely additional area that would fall under this category, the areas cannot yet be identified as isolated where they are within large contiguous patches of mature timber that have not had extensive harvesting incursions. The impact on THLB for currently identified isolated mature timber is 903 ha. A portion of this area has accounted for wildlife tree patch (WTP) requirements, however, 103 ha of additional netdown is required for WTP. The operable landbase that remains under larger contiguous patches of mature timber is significantly less than half of the THLB, and where areas do become isolated and potentially inoperable, these areas would also be available to potentially offset a portion of the remaining netdown required for WTP requirements. For the foregoing reasons, the impact of additional area for future isolated mature timber would likely be less than that currently identified.

4.2 Mid-Term Harvest Level

The mid-term is a period of increasing harvest levels. This is possible because higher-volume managed stands become harvestable and begin to contribute to timber supply. Attempts were made to start increasing harvest levels earlier in the planning horizon, but these failed. Period 10 (beginning at year 46) was the earliest point at which increase harvesting could be sustained. Subsequent increases in harvest level were limited to a maximum of ten percent in each decade. The long-term harvest level is reached after nine harvest level increases spread over eighty years.

4.3 Long-Term Harvest Level

The long-term harvest level is determined by the productive capacity of the landbase. If timber were the only resource value being managed, the timber supply model would find a long-term harvest level very close to the theoretical long-run sustained yield (LRSY). The LRSY value for TFL 41, based on managed stand yield tables that incorporate genetic gain estimates, is approximately 260,000 cubic metres annually. The long term harvest level achieved by Patchworks is 222,000 m^3/year – short of the LRSY level. This is due primarily to the fact that harvest rates are limited for management of grizzly habitat and viewscapes, and to meet biodiversity objectives.

The long term harvest level is higher than the level that is sustainable in the short term as managed stands become harvestable and begin to contribute to timber supply. In part, a higher harvest level is attained as the managed stands, where allowed to develop beyond the minimum harvest age, contribute higher volume per unit area than current old growth stands. More significantly, the current land base subject to this analysis had been part of a larger TFL area whereby the current residual portion had been subject to a much higher rate of harvest than the current AAC. This occurred in particular during the second decade of TFL harvesting history. Therefore, the full productive capacity of the land-base is not realized until the age class structure has normalized and is not skewed towards a higher proportion of immature age classes. It is therefore likely that a further small increase in harvest level would be possible in the very long term (beyond 250 years) and that the gap to the theoretical LRSY would be reduced.

4.4 Harvest Statistics

A closer examination of the harvest flow produced by the base case model run provides some confidence that the model setup is realistic and that the results concur with operational experience in the short term and common sense in the long term. Three summaries are particularly useful and commonly produced and examined: average annual harvest area, average volume per hectare harvested, and average harvest age. Changes in these parameters over the entire planning horizon are presented in the following three charts.

Average annual harvest area averages 246 hectares for the first 50 years. After that, there is a brief spike to 363 hectares when the pinch point in the timber supply is reached and the transition to second growth logging begins in earnest. From that point if falls briefly to 250 hectares, then climbs slightly to a reasonably stable level at around 325 hectares per year. Figure 10 shows these trends.

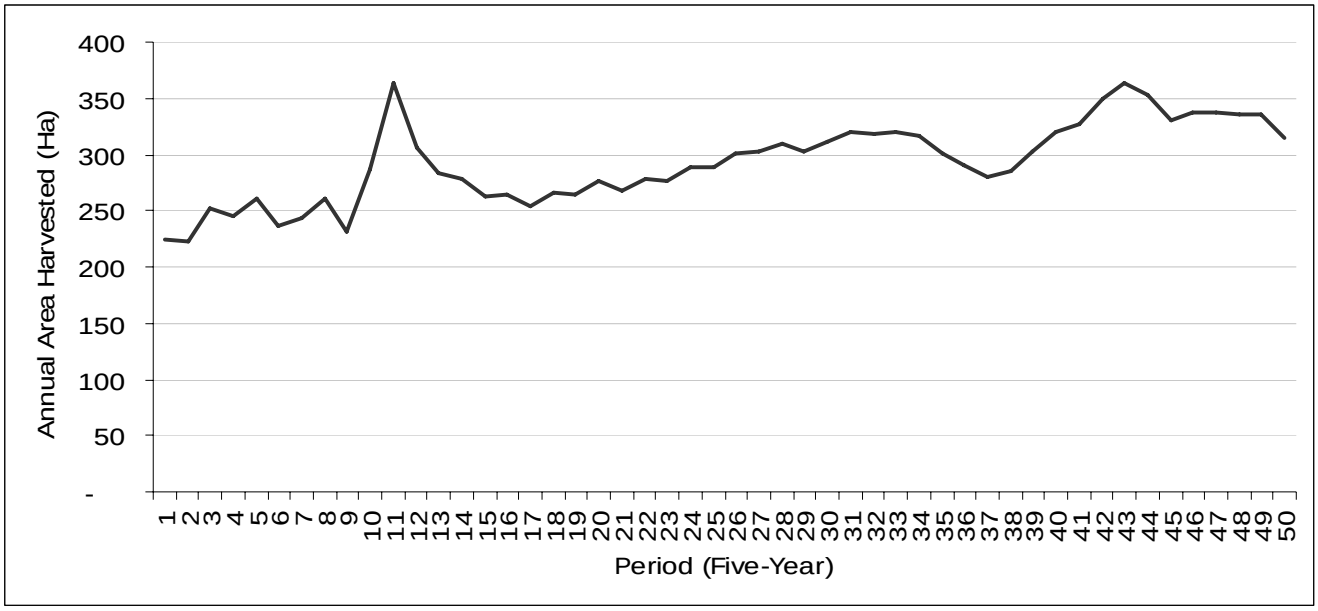

Figure 10: Average Annual Area Harvested

The trend in average annual volume per hectare harvested is shown in Figure 11. In broad terms, it is approximately 500 m^3/hectare in the short term (up to 50 years). After that, it falls as harvesting moves into second growth. The first of these stands harvested are younger and near the minimum merchantability limits. Following this minimum, it climbs to between 600 and 800 cubic metres per year the long term.

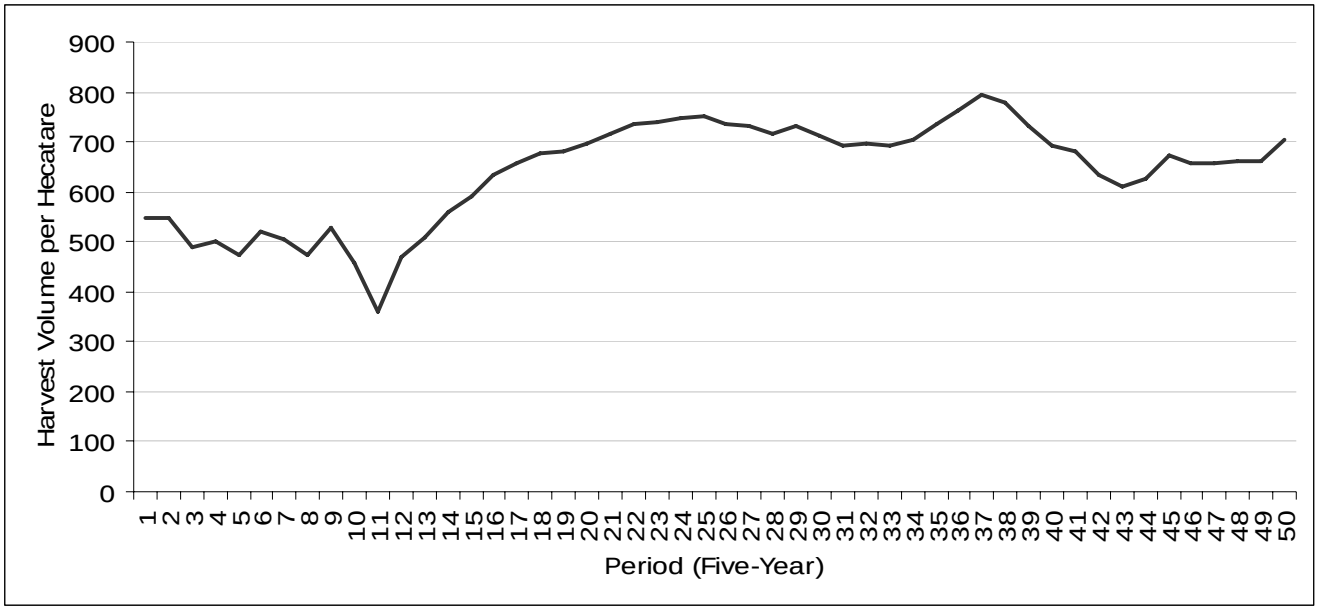

Figure 11: Average Volume per Hectare Harvested

Figure 12 shows the trend in average harvest age. It is high initially as remaining old growth stands on the timber harvesting landbase are logged. It averages 345 years over the first 45 years, at which point it falls significantly. It reaches a minimum of 102 during the early transition to second growth harvesting, and then rebounds as old growth that was previously constrained becomes available. The main constraint that limits timber supply during this transition period is the requirement that, within the McKay-Davies grizzly bear identified watershed unit, no more than 30% of the forested land base be between 25 and 100 years old. This identified habitat includes almost 9,500 hectares of THLB, and the area in the target age class is at or near the limit from period 9 to period 17. A few other constraints also approach their limits during the transition period, but their impact on timber supply is lower because they cover less THLB. These include: IRM in the Jesse-Bish LU, old seral in the Hirsch LU CWHvm1 and the Lakelse LU CWHws1 and VQO (PR) in the Kitimat LU. Harvest age increases slightly until these constraints become less limiting, and averages 105 years over the latter 30 periods of the planning horizon.

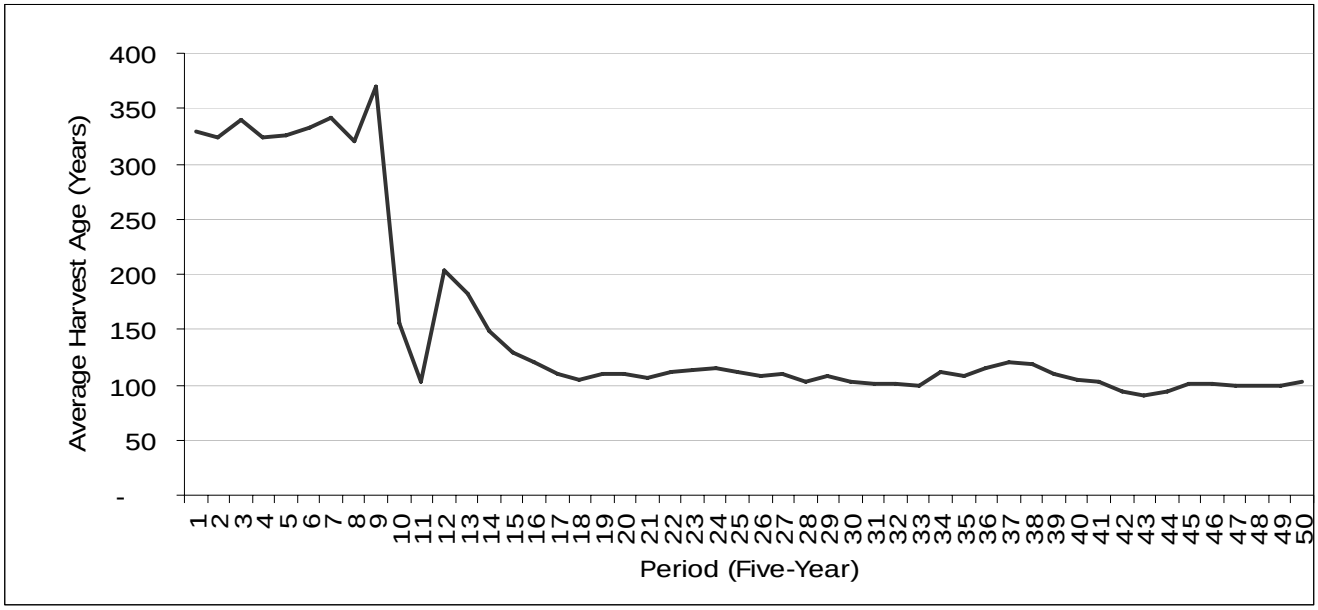

Figure 12: Average Harvest Age

4.5 Future Forest Inventory

With the base case harvest schedule established, the condition of the future forest can be predicted by simulating growth and harvesting, and summarizing the results by period. Future growing stock levels are shown in Figure 13. Total growing stock is the sum of the stand volumes for all productive forest within the TFL. The THLB volume includes only those stands that are available for harvesting. Of these, only some are above MHA at a given point in the planning horizon: this is indicated by the third and lowest line on the graph. This line confirms the pinch point in timber supply at approximately 45 years in the future.

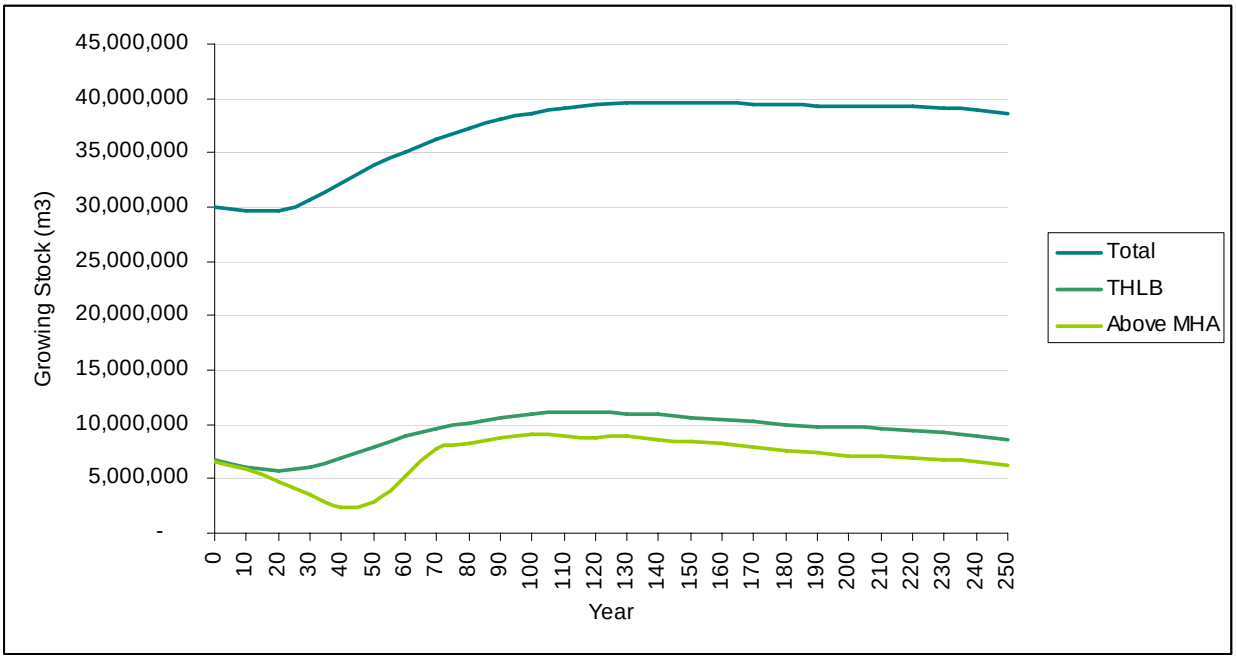

Figure 13: Future Growing Stock Levels

The impact of the proposed base case harvest level on the landbase can be further evaluated by observing how the age class distribution of the timber harvesting landbase changes over time. Harvesting at fixed rate (the long-term harvest level) should serve to normalize the age class distribution over time. Setting a harvest target at or near LRSY (subject to retention requirements to meet other resource objectives) should limit the number of stands carried past classical rotation age. Figure 14 shows both of these patterns occurring on TFL 41. By the end of the planning horizon, 80 percent the THLB area is well distributed among the first four twenty-year age classes. The remaining 20 percent is carried for a longer rotation to meet biodiversity requirements.

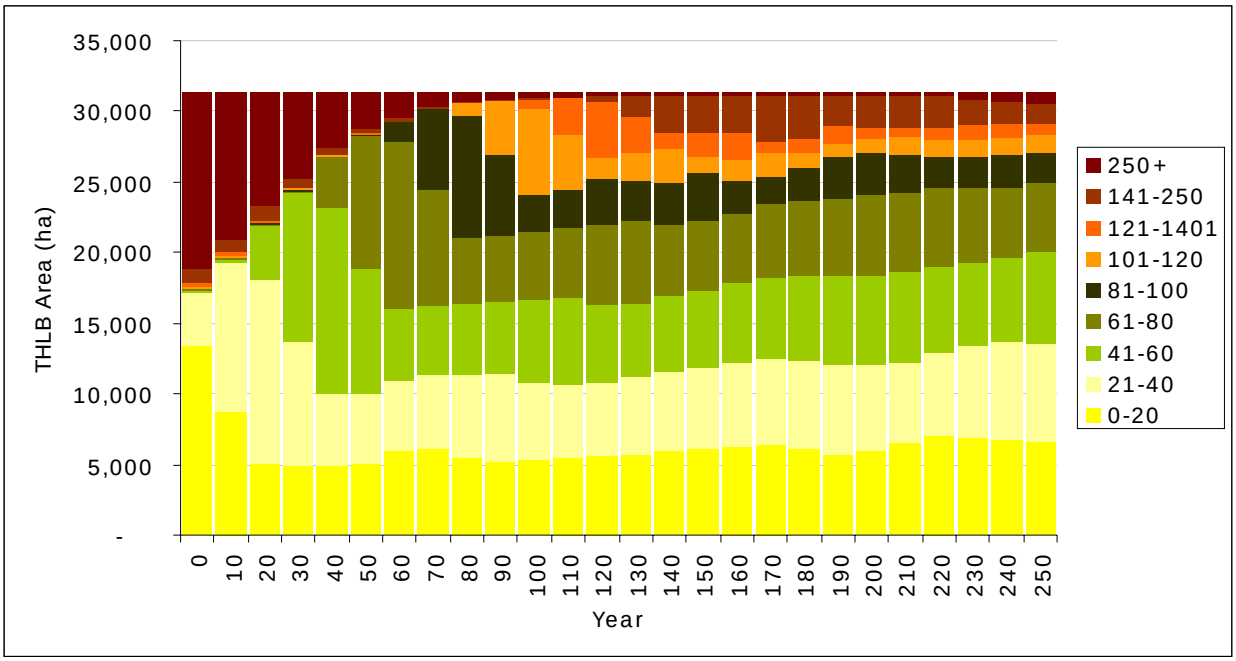

Figure 14: Current and Future Age Class Distribution of the Timber Harvesting Land Base

4.6 Non Timber Resources

Rate-of-cut constraints have been applied during forest estate modelling to ensure that management objectives for non-timber resources such as biodiversity, wildlife habitat and visual quality are met. These objectives are listed in Table 3 on page 10.

Grizzly Bear Habitat in the McKay-Davies identified watershed is managed by requiring that no more than 30% of the productive forest area be between 25 and 100 years old. This appears to be constraining timber supply between period 9 and period 17. Timber supply is most limited in this timeframe, and since almost one-third of the THLB falls within the grizzly-constrained area, it has an impact on the timing of the step up to the long term timber supply. It is the main reason that available old growth timber is deferred from harvest in periods 10 and 11 until later periods (see Figure 9), forcing harvesting into younger second growth stands (Figure 12).

Seral stage objectives are established by the Kalum SRMP, and are described in Section 4.9.1 of the Information Package. Seral stage requirements for early and mature-plus-old are applied on the productive forest land base, by landscape unit and biogeoclimatic subzone, in the forest estate model. For the early seral requirements, a deviation from target is allowed.

For the mature-plus-old targets, only the lower-elevation subzones (CWHvm1 or CWHws1) tend to be an issue from a timber supply stand point. These targets are limiting on timber supply in period 9 and 10 in the Hirsch, Wedeene and Lakelse landscape units. In the Hirsch LU this constraint is the most acute; it persists from period 8 to period 12, and it remains limiting in the long term. The higher-elevation subzones have sufficient productive land outside of the THLB to satisfy old seral requirements, so timber supply impacts are

negligible.

The impact of early seral constraint is also felt mainly in the low elevation subzones. It is applied in the Hirsch, Wedeene and Lakelse landscape units (unlike the mature-plus-old objective, which is applied everywhere). Generally speaking it is not limiting on timber supply in the long-term and is not an issue during the period in which the harvest is stepped up to the long term level. However, in some cases it is exceeded in the short term, as is permitted by the transitional provisions specified in the Kalum SRMP and summarized in Table 27 of the Information Package. The Lakelse CWHws1 and the Wedeene CWHvm1 meet the early seral objective by period 4, and the Wedeene CWHws1 meets the objective by period 5.

Visual Quality Objectives (VQO) are applied by landscape unit and VQO class (either 'Modification' or 'Partial Retention'). The limitations for 'Modification' are less severe and do not impact timber harvesting (in a strategic sense). The 'Partial Retention' zones do affect harvest scheduling periodically, but areas involved are small relative to the size of the THLB, so timber supply impacts are minimal. Only the Kitimat LU is noteworthy because the PR objective appears to be restrictive from periods 10 to 15 when harvesting alternative are most limited.

The 'old seral' requirements (by site series) in Identified Watersheds are high on a proportional basis, but the objectives are easily met by productive forest stands outside of the THLB. In addition, only a small amount of THLB falls within these watersheds. This constraint has no impact on strategic timber supply.

As a proxy for directly modeling cutblock size and adjacency constraints, an integrated resource management (IRM) constraint has been applied at the landscape unit level. No more than 35% of the THLB that is not being managed for visual quality can be less than 3 metres in height. This does not impact harvest level in any landscape unit.

5 DISCUSSION

The base case harvest forecast presents a very clear picture of the timber supply dynamics on TFL 41. The existing old growth growing stock must last until second growth stands that have originated from past logging reach minimum merchantability criteria. Figure 7: Age Class Distribution on the Timber Harvesting Landbase) and Figure 9: Harvest Volume from Stands Above and Below 250 Years of Age) demonstrate the reliance on old growth timber to support harvesting in the short and medium term.

The base case harvest flow presented in this document has been selected, in part, to emphasize the fundamental importance of managed, second growth stands to reaching the long-term productive capacity of the landbase. Conversely, the short term harvest level is limited by the requirement that the existing old growth timber last until the second growth timber is harvestable. Repeated forest estate model runs were made to find the earliest point at which the step-up from the initial harvest level to the long-term harvest level could begin. This established that the existing old growth timber must be made to last at least 45 years. After this, second growth stands begin to make up a significant component of the harvest volume and harvest levels can be increased.

In fact, an argument could be made for delaying the increase in harvest levels for a further five or ten years. The harvest statistics graphs (Figure 10 to Figure 12) show that increasing the harvest level beginning after 45 years is aggressive. Increasing the harvest at this point causes a spike in area harvested, and troughs in volume per hectare and average harvest age – all at period 11. This could be mitigated by delaying any increase in harvest level for a few more years. However, this harvest flow pattern has been selected and presented as the base case precisely because of the clarity that it provides regarding the underlying timber supply dynamics.

The initial harvest level of 123,000 cubic metres per year being proposed in the base case is prudent and defensible. The existing stock of homogeneous old growth timber provides considerable operating flexibility over the next ten years – the period for which the upcoming AAC determination will be in effect.

6 SENSITIVITY ANALYSIS

It is usual, when presenting timber supply analysis results, to show alternative potential harvest flow patterns and to conduct sensitivity analyses in order to gauge the impact of uncertainties in the input data and assumptions. The magnitude of the increase and decrease in the sensitivity variable reflects the degree of uncertainty surrounding the assumption associated with that specific variable. In the Information Package upon which this analysis has been based, several potential sensitivity analyses were proposed. After reviewing the base case results, it is felt that these additional analyses would not provide any additional, useful information for the AAC determination process.

Alternative harvest flows were considered. However, it is obvious from the base case results that no increase in initial harvest level is possible without suffering a mid-term harvest level reduction until second growth stands become available for harvesting. Conversely, nothing can be gained by lowering the initial harvest level. All non-timber resource values can be met if the current AAC is continued, and lowering the initial harvest level can do nothing to accelerate the development of the second growth stands upon which the increased long-term harvest level will rely.

In the Information Package, a sensitivity analysis to gauge the impact of basing managed stand yield tables on SIBEC site index estimates[3] (as opposed to OGSI-adjusted inventory SI) was proposed. However, this additional work could only impact long term harvest levels. It would have no affect on the current harvest level and would only change the timing of the step-up in harvest level only slightly – if at all. This, coupled with the fact that the underlying PEM has not met accuracy assessment standards for timber supply analysis, suggests that this sensitivity analysis would provide little useful information to the AAC determination process.

In the past on the original larger TFL landbase, the contribution of non-conventional operable stands (helicopter or skyline) to harvest levels, particularly in the short term, has been a concern as 7.6 % of the THLB was classified in the non-conventional category. However, within the current TFL boundaries, and after accounting for other netdowns to the landbase, less that one percent of the THLB area (only 289 hectares) falls into this category. The forest estate model would be unlikely to show significant harvest level changes with this small change to the landbase should the non-conventional portion of the THLB be excluded.

Sensitivity analyses related to minimum harvest age would undoubtedly have an impact on the timing of the increases to future higher harvest levels. However, the MHA's used for the base case are operationally realistic and no obvious reason for adjusting them up or down exists. Given the simplicity of the underlying age class distribution, the impact on short term harvest levels could be readily estimated without the considerable effort needed to complete additional forest estate model runs. In fact, since the harvest volume for the first nine periods is comprised almost entirely of old growth (i.e. stands well above MHA), there is no reason to believe that adjusting MHA either upwards or downwards would have any impact on the short-term harvest level.

Finally, sensitivity runs related to green-up ages in visually sensitive area were considered in the Information Package. These green-up ages are based on the expect height growth of individual managed stands as predicted by TIPSY. No better green-up information is readily

[3] For technical details, see http://www.for.gov.bc.ca/hre/sibec/

available. In addition, only 10% of the THLB falls in visually constrained areas; half of this is classified as 'Modification' VQO, which is not constraining in any landscape unit at any point in the planning horizon. To the extent that a sensitivity analyses around green-up ages would show any impact, it would be at most a very small harvest level reduction.

The Information Package indicated that sensitivities related to an earlier commencement of second growth harvesting would be considered. However, upon review of the base case results (and inventory summaries) it became clear that conclusions about second growth harvesting could be drawn without running separate sensitivity analyses. Figure 15 confirms that, in the base case, the transition to second growth harvesting is abrupt at 45 years. Until that time only a small proportion of the harvest come from (naturally regenerated stands less than 140 years of age.

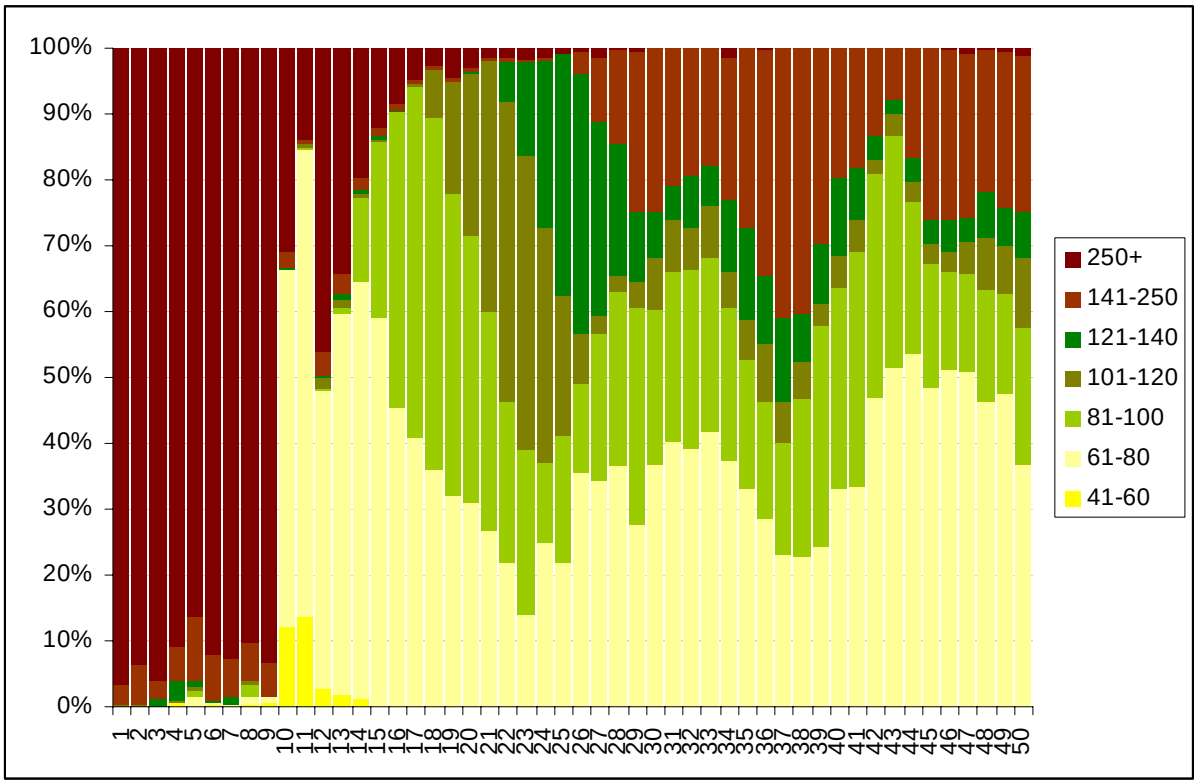

Figure 15: Age Class Distribution of the Base Case Harvest Volume

Just over 17,000 hectares of the THLB is currently below minimum harvest age. Only an additional 332 hectares reaches MHA within the first 40 years of the planning horizon. Between 40 and 50 years in the future, 4,500 hectares of second growth reaches MHA. This clearly demonstrates that an earlier transition to second growth harvesting than was found in the base case is not possible given the age class distribution of the THLB and rules applied to set MHA.

APPENDIX B.

TFL 41 Timber Supply Analysis Information Package

TREE FARM LICENCE 41

TIMBER SUPPLY REVIEW

INFORMATION PACKAGE

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3.3	October 12, 2010	Revised MFR Submission
4.1	April 8, 2011	Draft Analysis Report Version
4.4	August 12, 2011	Final Analysis Report Version

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1.0 Introduction

The most recent timber supply review (TSR) and Allowable Annual Cut (AAC) rationale for Tree Farm Licence (TFL) 41 was completed in 1999, at which time the AAC was set at 400,000 m^3 on a gross land base area of 703,745 hectares. This AAC includes 220,000 m^3 partitioned to the offshore portion of the TFL, with the 180,000 m^3 balance partitioned to the inshore portion. Without specification to either portion, 34,000 m^3 of the total AAC is partitioned for non-conventional harvest methods.

Land is being deleted from TFL 41 as a result of volume re-allocation under the *Forest Revitalization Act*. The deletions have not been completed, but areas have been identified for deletion and the process should be completed in 2011. This analysis will consider the residual land base following the land deletions from the TFL that are required in order to accommodate the AAC apportionments to other parties, as well as the productive capacity of , and current management on, the residual land base. Skeena Sawmills will be operating on the residual land base following the proposed land deletions under its AAC apportionment of 122,926 m^3 annual harvest subject to the next AAC determination.

The purpose of this Information Package is to document the information sources and assumptions to be used in the base case timber supply analysis and to discuss potential sensitivity analysis scenarios. The base case will reflect current management, including management objectives, the land base available for timber harvesting, and harvesting and silviculture practices.

2.0 Inventory Information

2.1 Forest Cover

The TFL 41 inventory was completed in 1998 using aerial photography taken in 1996 and 1997 and was completed on a TRIM base to the forest inventory standard of the day. As such, the current inventory was not completed under the Vegetation Resources Inventory (VRI) program. It was conducted under terms of reference developed in consultation with the Ministry of Forests Resources Inventory Branch (RIB) with the sample design and methodology approved by RIB in 1996 as stated in the 1999 TFL 41 Management Plan 6 Information Package. The Deputy Chief Forester's Rationale for Allowable Annual Cut Determination in 1999 states that the 1998 inventory was developed to meet acceptable standards.

Inventory depletions that occurred after the date of the photography were updated to 1998 in the original inventory database. Subsequent harvest depletions have been mapped separately and incorporated into the GIS resultant dataset created for this project. The inventory has been updated for depletions and projected to January 1st, 2010. Stand age has been reset based on the year of harvest. Species composition for regenerated stands will be assigned based on biogeoclimatic subzone, variant and site series (see Table 31). Site productivity estimates for all stands are from the inventory database. For stands older than 30 years of age, site index (SI) is determined based on stand height and age using MFR-specified site index curves. SI for younger stands was estimated by the photointerpretter, and growth intercept data was used where available.

Inventory volumes for all unharvested stands have been projected to 2010 using VDYP (Batch Version 6.6d). For mature stands only (older than 140 years), these volumes have been adjusted using the localization factors shown in Table 1

Table 1: Mature Stand Volume Localization Factors

Species	Ratio
Hemlock	0.8057
Balsam	0.7170
Cedar	0.8446

The derivation of these factors is described in the '*Report of the Re-Inventory of Tree Farm Licence 41*', a copy of which has been provided in Appendix I.

An Inventory audit (sample-based field audit) was completed in 1997 on the previous inventory. Neither an inventory audit nor a VRI Phase II program has been completed on the current inventory. Statements regarding the accuracy of the current inventory are made in the *Report on the Re-inventory of TFL 41 1996-98* (1999) as follows:

> "… The 1997 MoF inventory audit of mature timber on the operable area reported an average ground volume of 506 m^3/ha. The operability classification was revised in 1998. If it is assumed that the operable area sampled in the audit corresponds approximately to the 1998 conventional operability class then the localized VDYP average volume of 522 m^3/ha is comparable to the audit average. The localised volume is close to the mean and well within the audit confidence interval of 452 m^3/ha to 560 m^3/ha. The audit volumes quoted here are gross volume less DWB for tree classes 1 and 2, 17.5 cm+ DBH"

2.2 Data Sources

Table 2 provides a list of data sources used in this analysis.

Table 2: Data Sources

Description	Data Source / Custodian	Vintage of Data (Update)
TFL Boundary (Excluding all area proposed as deletions)	Timberline	2010
Parks and Protected Areas	LRDW	2008
TFL 41 PEM	LRDW	2004
Forest Cover	WFM	1996 / 1997
Riparian Classification Mapping	WFM	2010
Fish Stream Inventory Mapping	WFM	2000+
Water	WFM	1999
First Nations House And Territory Boundaries	MFR Northern Interior Forest Region and Skeena Stikine District	2009
Ownership	MFR Forest Analysis and Inventory Branch	2009
Forest Recreation Sites And Trails	LRDW	2009
Depletion Layer	WFM / RESULTS	2010
Environmentally Sensitive Areas (ESA)	WFM	1984 (1998)
Terrain Stability Mapping	WFM	1996+
Areas Without Terrain Stability Mapping	Timberline	2010
Operability Mapping	WFM	1998
Wildlife Habitat Areas – Tailed Frog	LRDW	2004-2006
Ungulate Winter Ranges – Mountain Goat	LRDW	2008
Kalum SRMP Special Resource Management Zones, Grizzly Bear Identified Watershed, Connectivity Corridors, Undeveloped Watershed	ILMB data warehouse	2006
Community Watersheds	LRDW	2006
Scenic Areas	LRDW	2000
Landscape Units	LRDW	2006
Biogeoclimatic Ecosystem Classification	LRDW	2009
Old Growth Management Areas	LRDW	2008
Archaeological Overview Inventory	WFM	1998
Watersheds	LRDW	2005

The TFL boundary was retrieved from the LRDW. Licencee data was used to exclude areas that will be deleted to account for Forest Revitalization Act (FRA) and pre-FRA BC Timber Sales volume and other minor discrepancies found in the LRDW version of the boundary. No parks and protected areas exist within the TFL boundary. Parks and protected areas that are peripheral and adjacent to the TFL boundary are identified. One polygon that is not part of the TFL falls within the TFL boundary. It is removed as the first step in the netdown.

Predictive ecosystem mapping (PEM) was completed for TFL 41 in 2004 as part of a larger project within the Kalum Forest District. An accuracy assessment conducted in 2007 found that scores were not

sufficiently high to permit its use for predicting site productivity in timber supply analysis. As described in the relevant sections of this document, the TFL 41 PEM is used in this project in order to:

- define silviculture regimes by site series to be applied post harvest;
- augment the identification of areas to be classified as non-forest and non- productive forest in addition to that provided by forest cover data; and
- provide the site series classification in order to model the forest cover constraints required to meet management objectives for the identified watersheds specified in the TFL 41 Forest Stewardship Plan (FSP).

Riparian classification mapping identifies known S1-B stream reaches (large fish bearing streams) based upon a combination of operational knowledge, existing fisheries inventories, and TRIM map features. Lakes and rivers are identified from the forest cover mapping, and are 100% consistent with TRIM map features. Wetlands were also extracted from the forest cover, but these do not match the TRIM data. TRIM wetlands were ignored.

Fish stream inventory mapping has been completed in several watersheds and identify all fish bearing stream reaches within the applicable watersheds. This information is used to assist in developing the netdowns necessary to account for riparian reserve zones and riparian management zone retention in areas outside the riparian management area of the classified S1-B stream reaches.

Harvest depletions were identified from licencee-maintained cutblock data. These were spot-checked against RESULTS information.

Forest Recreation Sites and Trails are administered by the Ministry of Tourism, Culture and Arts and have management objectives that have been established by government.

The soils portion of Environmentally Sensitive Areas (ESA) mapping was undertaken in 1984 which identified terrain that is unstable or potentially unstable. The mapping was completed under contract by the Land Use Planning Advisory Team (LUPAT) of MacMillan Bloedel Ltd. as described in their report (1985) and is a reliable source of information for use in timber supply analysis.

Terrain stability mapping (TSM) is an amalgamation of various projects starting from 1996 that focused on covering the operable land-base with more up to date terrain classification. The amalgamated map identifies areas that are outside of TSM boundaries where ESA mapping for sensitive soils will be used in this TSR.

Operability mapping defines the areas that are deemed to be physically accessible for timber harvesting. Areas mapped as operable are subject to all the various net-downs and constraints necessary to meet management objectives and requirements for various forest resources (e.g. riparian, sensitive soils). The projection of the operable area was revised for MP 6 based on the 1998 inventory and updates the previous operability mapping that was last done in 1982. The classification was completed under a terms of reference approved by the district manager on March 5, 1998. A report entitled Operability Report for TFL #41 (1998) was submitted to the district manager. The revised mapping recognizes use of helicopter yarding and improvements in cable yarding techniques. No new techniques or advance in methods have occurred since that time. Economic conditions have constrained access in portions of the operable land base; however the terms of reference remain appropriate in defining operability.

Wildlife habitat areas and ungulate winter ranges are mapped and established by the Ministry of Environment and are distributed on the LRDW.

As described in the Kalum TSA TSR Data Package (2010), the Kalum Sustainable Resource Management Plan (SRMP) was approved on April 28, 2006. It legally implements some of the recommendations from the Kalum Land and Resource Management Plan (LRMP). Its mapping products and objectives are used to apply forest management requirements. These include the requirements for the McKay-Davies grizzly bear identified watershed, seral stage targets by landscape unit and biodiversity requirements for the Jesse and Emsley identified watersheds.

The Wathl Creek Community Watershed, within TFL 41 in the last TSR, is within the area to be deleted from the TFL area and not part of the area subject to this timber supply review.

The scenic areas map (2000) identifies scenic areas and visual quality objectives. Although more recent landscape inventories exist, the scenic areas mapped in 2000 were grand-parented under the *Forest and Range Practices Act* for which results and strategies are specified in the current TFL 41 FSP.

As stated in the Kalum Timber Supply Area Data Package (2010), old growth management areas (OGMA's) were established in 2006 through the Kalum SRMP, and subsequently amended in May 2007. The OGMA's represent "old" seral requirements put forward in the Kalum SRMP.

The Archaeological Overview Inventory identifies the location of archaeological sites that were known to exist in 1998. These sites are subject to conservation requirements under the *Heritage Conservation Act.*

Watershed data was retrieved from the LRDW, and has been used to help define riparian buffering, as described in Section 3.12.

3.0 Timber Harvesting Land Base Definition

The timber harvesting land base is determined by removing components of the land base that are not considered harvestable. Table 3 shows how the THLB was derived.

Table 3: Timber Harvesting Landbase Determination

Classification	Total Area (ha)	Net Area Removed (ha)	Net Volume Removed (m^3)
Gross Area Within TFL 41 Boundary (excludes all parks and protected areas)	**201,939**		
Landbase Reductions:			
Non-TFL	104	104	1
Non Productive	93,046	93,046	412,174
Old Growth Management Areas	10,366	10,071	3,670,370
Avalanche - ESA1	1,380	1,295	274,393
Soils-ESA1	4,533	3,303	1,077,687
Soils-ESA2	7,594	1,087	372,313
Terrain Class V	5,542	3,799	1,607,409
Terrain Class IV	13,782	1,222	499,482
Recreation Sites and Trails	74	43	9,099
Inoperable Stands	156,841	47,883	13,721,395
Non-Merchantable Mature Stands	13,865	619	159,298
Non-Merchantable Immature Stands	99,440	618	82,518
Problem Forest Types	4,882	1,215	569,039
Archaeological Sites	4	1	425
Wildlife Habitat – Tailed Frog	62	7	3,780
Wildlife Habitat – Goat	5,269	235	98,582
Riparian Reserve Zones - Spatial - S1	2,521	854	338,722
Riparian Reserve Zones - Spatial - Other Stream Classes	1,221	446	247,285
Riparian Reserve Zones - Unclassified Streams	148,994	2,107	475,044
Wildlife Tree Patch	154,707	103	19,518
Roads - Existing	19,050	999	15,887
Total Landbase Reductions		**169,058**	**23,654,423**
Current Timber Harvesting Landbase		**32,881**	**8,096,900**
Future Reductions			
Future Roads		1,324	
Long Term Timber Harvesting Landbase		**31,558**	

The following sections describe assumptions associated with each of these exclusions.

3.1 Non-TFL Area

The total residual area of TFL 41 is based on the original TFL area less deletions and therefore is substantially different from the land base in the 1999 analysis. All deletion areas are excluded from the data set, though not all were reflected in the LRDW version of the data. The boundary was assembled from the LRDW TFL boundary data (tfl boundary, tfl additions and tfl deletions layers) and updated for the takeback areas and other minor discrepancies, including one non-TFL polygon that is completely surrounded by the TFL. These areas and corrections were provided by the licensee and are excluded from the THLB, as presented in Table 4 below. Former Timber Licence T0991 has reverted to Schedule B status, thus there are no Schedule A lands included within the TFL. The gross TFL area in the 1999 analysis was 703,745 hectares; for this analysis it has fallen to 201,939 hectares.

Table 4: Non-TFL Area

Description	Data Source	Reduction %
Excluded Area	TFL Boundary	100

Data Source and Comments:

- The TFL boundary file from the LRDW was downloaded in April 2010 and was updated with deletion areas provided by the MFR. The revised boundary file was reviewed and approved by WFM.
- One non-TFL polygon that is shown as TFL area in the LRDW version of the data is the only area netted out at this step.
- No salt water falls within the TFL boundary.
- A License of Occupation, held by the District of Kitimat, overlaps a small portion of the TFL near Claque Mountain. This licence does not confer any rights to timber, and would not limit harvesting in the area. Consequently, it has been disregarded for the purpose of this timber supply analysis

3.2 Non-Forest and Non-Productive Forest

Non-forest and non-productive areas are defined using both the forest cover and the PEM. Table 5 summarizes the forest cover criteria for non-forest and non-productive classifications. Areas with a logging history are assumed to be forested and / or capable of supporting a forest stand and are therefore not removed from the THLB. Table 6 shows the site series from the PEM that are classed as non-forest and non-productive and are removed from the THLB, with these exclusions occurring regardless of logging history.

Table 5: Non-Forest and Non-Productive – Forest Cover

Logging History	Projected Type ID	Description	Reduction (%)	Reduction Category
No	0	No projected type ID	100	Non-Forest
	5	Non-commercial	100	Non-commercial
	6	Non-productive	100	Non-Productive
	8	No-typing available	100	Non-Forest

Table 6: Non-Forest and Non-Productive – PEM

BGC Label	Site Series Code	Site Series Description	Reduction (%)
All Variants	AW	Alder Willow	100
	DV	Urban Development	100
	ET	Estuary	100
	GL	Glacier	100
	HG	Heath / Grassland	100
	HM	Herbaceous Meadow	100
	LA	Lake	100
	ME	Wet Meadow	100
	MN	Moraine	100
	MU	Mudflat	100
	OC	Ocean	100
	PF|KR	Parkland or Krummholz	100
	RI	River	100
	RO	Rock	100
	RS	Riparian shrub	100
	RS|09	complex of Riparian Shrub and 09	100
	SA	Slide/Avalanche	100
	SB	Sand Bar	100
	TA	Talus	100
	WL	Undifferentiated Wetland	100

Data Source and Comments:

- Site series are defined from the 2004 TFL 41 PEM
- Water bodies are excluded based on where the site series is coded as Lake, River or Wetland, and also based on forest cover mapping.

3.3 Old Growth Management Areas

Areas identified as old growth management areas (OGMA) are removed from the THLB.

3.4 Terrain Stability

Certain categories of ESA-rated lands, listed below in Table 7, are removed from the THLB. Further, terrain stability mapping (TSM) is used where available in place of ESA ratings as TSM is a more current assessment of terrain stability. Terrain stability mapping (TSM) covers the majority of the THLB. Notwithstanding, the original soil sensitive area (ES) inventory, conducted under contract by the Land Use Planning Advisory Team (LUPAT 1985) of MacMillan Bloedel Ltd., is still a reliable source of data that can be used in similar fashion as TSM.

Table 7: Environmentally Sensitive Areas and Terrain Stability Classes

Logging History	ESA Category	Reduction (%)
No	Ea	100
	Es1	90
	Es2	20
	TSM Class V	80
	TSM Class IV	10

Data Source and Comments:

- The reduction values for the ESA categories are consistent with the Management Plan (MP) 6 analysis. These reduction values were found to be reasonable based on an analysis considered in the Chief Forester AAC Postponement Order for TFL 41 dated March 20, 2003 which reviewed the ESA categories of areas that were subject to on-the-ground terrain stability field assessments and subsequently harvested based on actual prescriptions. The reduction values for the TSM categories are based on the analysis outlined above which also compared the TSM and ESA categories of areas that were subject to on-the-ground terrain stability field assessments and subsequently harvested based on actual prescriptions.

3.5 Areas With High Recreation Values

The TFL 41 FSP specifies that certain recreation sites and trails be designated for protection. Recreation sites are wholly excluded from the THLB. Similarly, recreation trails will be buffered and removed from the THLB. Table 8 details the exclusions required for the recreation sites and trails within TFL 41.

Table 8: Areas with High Recreation Value

Feature	Description	Excluded Area	Reason For Exclusion
Forest Recreation Sites	Enso Recreation Site Kitimat River Recreation Site Onion Lake Recreation Site	All areas within the site	No harvest or salvage
Forest Recreation Trails	Claque Mountain Recreation Trail Robinson Ridge Recreation Trail	All portions of the trail and 10m buffer	No harvest or salvage

Data Source and Comments:

- Area exclusion parameters are consistent with the TFL 41 FSP

- The TFL 41 recreation inventory completed in 1998 identified recreation sites and trails and was used in the 1999 TFL TSR. This inventory has been superseded by the designation of recreation sites and trails and management objectives under the *Forest Practices Code of BC Act* which were grand-parented under the *Forest and Range Practices Act.*

3.6 Inoperable Areas

Table 9 below lists and defines the operability classes that continue from MP 6, along with the proportions that are removed from the THLB.

Table 9: Inoperable Areas

Logging History	Operability	Definition	Reduction (%)
No	Conventional	Ground-based, cable, A-frame.	0%
	Non-conventional	Helicopter and skyline, where SI < 10m or height < 28.5m or Hemlock > 50%	100%
	Inoperable	Physically and economically inaccessible	100%

Data Source and Comments:

- The projection of the operable area was revised for MP 6 based on the 1998 inventory and updates the previous operability mapping that was last done in 1982.
- Consistent with the 1999 TFL TSR, a portion of the area identified as operable for non-conventional harvesting methods is excluded. Areas that have site index 10 or below, height class below 4 and species composition of greater than 50% hemlock are excluded.
- The proportion of operable area that is classified as non-conventional is considerably less significant than the case in the 1999 TFL TSR where 7.6% of the initial THLB was identified as non-conventional area. These areas were predominantly in the "offshore" partition portion of land base that will be deleted from the TFL and not considered in this TSR.
- Although helicopter harvesting performance has been largely in the "offshore" partition areas where the non-conventional areas predominant, limited helicopter yarding has been performed within (or in conditions similar to) the current TSR land-base (Table 10).

Table 10: Recent Helicopter Logging

Year	Licence Area	Location	Block	Area (ha)	Volume (m^3)	Comments
1995	TFL 41 (Onshore)	Hirsch Cr	6-200-6	3	1,500	Onshore AAC partition, in deleted area
		Kitimat R	5-1000-30	15	7,577	Onshore AAC partition, residual area
	FL A16885	Minette Bay	75-3	2	1,000	Forest Licence similar timber
1996	TO955	Lakelse	36-5 / 36-5A	51	25,559	Timber Licence similar timber
	TFL 41 (Onshore)	Kitimat R	5-200-3A	15	8,694	Onshore AAC partition, residual area
2000	FL A16885	Bish Creek	M-M-10	2	1,000	Forest Licence similar timber
			M-A-1	16	8,000	Forest Licence similar timber

Year	Licence Area	Location	Block	Area (ha)	Volume (m^3)	Comments
2002	TFL 41 (Onshore)	Kildala Arm	41-10-1/2	76	38,397	Onshore AAC partition, in deleted area
2008	TFL 41 (Onshore)	Miskatla Inlet	41-40-X	78	39,000	Onshore AAC partition, residual area
	FL A16885	Miskatla Inlet	41-40-X	18	9,000	Forest Licence similar timber
Total				**276**	**139,727**	

3.7 Non-Merchantable Mature Stands

Table 11 below defines the criteria used to identify sites with non-merchantable mature stands older than 200 years of age with low volumes and low timber growing potential that are excluded from the THLB.

Table 11: Non-Merchantable Mature Stands

Logging History	Leading Species	Age (yrs)	Volume (m^3/ha)	Height (m)	Reduction (%)
No	All	>= 200	<300	< 19.5	100

Data Source and Comments:

- Inventory age, heights and volumes are projected to 2010
- These criteria are consistent with the Kalum TSR used to identify sites that have low timber growing potential. The residual TFL area that will be subject to this TSR is located within the same general locale as the FIZ A portion of the Kalum TSA The merchantability criteria used here correspond to similar criteria that are described in the Terms of Reference for TFL 41 Operability (1998).

3.8 Non-Merchantable Immature Stands

The criteria used to identify mature stands with low volumes and low timber growing potential are also applied to younger stands. Volumes and heights for unharvested stands younger than 200 years are projected to age 200. Stands in which the merchantability criteria are not achieved by age 200 are excluded from the THLB.

Table 12: Non-Merchantable Immature Stands

Logging History	Leading Species	Age (yrs)	Volume (m^3/ha)	Height (m)	Reduction (%)
No	All	< 200	<300	< 19.5	100

Data Source and Comments:

- Inventory age, heights and volumes are projected to a stand age of 200 years.

3.9 Problem Forest Types

Problem forest types (PFT) are stands that are not currently utilized or have marginal merchantability, but are physically operable and exceed low site criteria. As per the criteria in Table 13 below, these stands are excluded from the THLB.

Table 13: Problem Forest Types

Logging History	Description	Current Age (yrs)	Crown Closure (%)	Reduction (%)
No	Deciduous leading			100
	Low crown closure	> 60	0-25	100
	Spatially identified mature timber patches less than 25 ha isolated by previous harvesting	>250		100

Data Source and Comments:

- The distribution of the current mature conventional operable area was reviewed. There exists certain small patches of mature timber that is surrounded and isolated by previous harvesting, but shown as operable based upon classification as per the 1999 TSR. Some of these patches are located in areas such as within gullies or at cut-block edges appearing to be out of cable yarding reach from the established road locations. Such timber is not likely to be operable in the future. Other small patches evident may have been isolated at the time of harvesting due to merchantability constraints or other operational aspects and are also not likely to be operable in the future. A GIS exercise was conducted to estimate the extent of these areas which are then removed from the THLB for this TSR. The patch size was limited to less than 25 ha and a review of the map verified the reasonableness of the parameters used.

3.10 Archaeological Sites

Table 14 below defines and describes the specific, geographically defined areas that are excluded from the THLB.

Table 14: Archaeological Sites

Feature	Description	Excluded Area	Reason For Exclusion
Archaeological Site	Buffered archaeological sites	All	No harvest

Data Source and Comments:

- An archaeological overview inventory of TFL 41 has been completed. Management zones have been defined for sites that were identified in the inventory. Management zones were created for all sites using a 50 metre circular buffer.
- Within the residual TFL 41 area subject to this TSR, seven sites have been buffered. Information on these sites can be requested from Archaeology Branch subject to an access to archaeological site information policy.
- In addition to the above archaeological sites, there are culturally modified tree (CMT's) sites that have been identified within the land-base and future sites that will likely be encountered. Many of these sites are left unaltered within riparian reserves, riparian retention areas or within wildlife tree patches. Other CMT sites have been harvested under permits issued by the Archaeology Branch subsequent to archaeological impact assessments. As also indicated in the Kalum TSA TSR Data Package, management of CMT sites has not impacted timber harvesting landbase to any significant extent and it would be reasonable that this would continue to be the case.

3.11 Wildlife Habitat Areas

Wildlife habitat areas will be removed from the THLB as per the criteria listed in Table 15 below.

Table 15: Wildlife Habitat Exclusions

Wildlife Species	Inventory Description	Reduction (%)
Tailed frog	Wildlife habitat area 6-067 core area	100
	Wildlife habitat areas 6-067 special management zone	70
Mountain goat	Mountain goat ungulate winter ranges	100

Data Source and Comments:

- As stated in the Kalum TSA TSR Data Package, ungulate winter range for mountain goat and wildlife habitat areas for tailed frog have been legally established under the Forest and Range Practices Act and are in effect within TFL 41 as well. Management requirements are specified within the legal orders.
- The special management zone for WHA #6-067 requires the maintenance of 70% residual stand volume evenly dispersed. Consistent with the rationale stated in the Kalum Data Package, the area is small and would be uneconomic to implement harvest return subsequent to initial entry, therefore a 70% land-base reduction is applied instead.

3.12 Riparian Management Areas

Table 16 defines the riparian reserve zone (RRZ) and riparian management zone (RMZ) requirements for each type of riparian feature. The reserve zone and management zone together make up the riparian management area for riparian features within which a netdown of the land base is required. For this analysis, riparian reserve zone netdown areas are extended to account for additional retention in the RMZ. These buffer widths, shown in Table 16, are calculated as follows:

$$\textit{Netdown Width} = \textit{RRZ Width} + (\textit{RMZ Width} * \textit{RMZ Retention \%})$$

All buffered areas are excluded from the THLB.

Table 16: Riparian Reserve and Management Areas

Stream, Wetland or Lake Class	Reserve Zone Width (m)	Reserve Zone Reduction (%)	Management Zone Width (m)	Management Zone Retention (%)	Netdown Width (RRZ + RMZ * RMZ Retention)
Streams					
S1-A	0	n/a	100	20	20
S1-B	50	100	20	20	54
S2	30	100	20	20	34
S3	20	100	20	20	24
S4	0	n/a	30	10	3
S5	0	n/a	30	10	3
S6	0	n/a	20	0	0
Lakes					
L1-A	0	n/a	0	n/a	0
L1-B	10	100	0	n/a	10
L3	0	n/a	30	10	3
Wetlands					
W1	10	100	40	10	14
W3	0	n/a	30	10	3
W5	10	100	40	10	14

Data Source and Comments:

- RRZ and RMZ widths are consistent with the *Forest Practice and Planning Regulations*
- The RMZ retention percentages indicated in Table 16 are as per the Kalum TSR and meet the requirements as specified in the TFL 41 FSP. In specific areas where assessments justify the variation in accordance to the FSP, the actual riparian management zone retention percentage required in practice may be lower than specified above
- Lakes and rivers are classified on the basis of forest cover data, and are consistent with TRIM mapping.
- Wetlands are classified on the basis of forest cover data, and are **not** consistent with TRIM mapping.
- In TFL 41, with the exception of the S1-B reaches stream classification is incomplete. However, for certain watersheds there are data identifying fish presence and absence for all streams within the applicable watersheds. Based upon the available information, the netdown for stream riparian management area is derived as follows:
    - In general, the locations of all fish bearing streams with reaches classified as S1-B are known through existing inventories or operational knowledge. Where the upper extent of the S1 reach has not been confirmed, the extent is estimated based on where TRIM maps identify the stream as a “double-line/bank” feature. For the riparian management area (riparian reserve zone plus riparian management zone) of all S1-B streams, a spatial netdown width of 54 m is applied in accordance to Table 16.

Fish stream inventories conducted within the Jesse Creek, and Upper Kitimat-Hoult-Davies watersheds, and a tributary watershed of Chist Creek, have categorized all stream reaches in accordance to the presence or absence of fish. In the foregoing watersheds, in addition to areas surrounding the S1-B reaches, a spatial netdown is also applied to the riparian management area of these remaining streams. As shown in Table 17, the estimate of the distribution of stream classes combined with the buffer information from Table 16 is used to estimate average riparian netdown widths to be applied to those streams that are located outside the riparian management area of the S1-B reaches. The estimated distribution of stream classes outside of S1-B reaches within the aforementioned watersheds is based upon professional judgement.

The result is that the required riparian netdown for the area within these watersheds is accomplished entirely through a spatial netdown.

Table 17: Netdown Width for Unclassified Streams – Watersheds with Known Fish Presence / Absence

Fish Presence	Estimated Distribution (%)	Netdown Width (RRZ + RMZ * RMZ Retention)	Weighted Netdown Width (m)
Fish present (no width info)			
	S2:30	34	10.2
	S3:40	24	9.6
	S4:30	3	0.9
Total			**20.7**
Fish not present (no width info)			
	S5:50	3	1.5
	S6:50	0	0.0
Total			**1.5**

- For areas outside of the watersheds identified above, an aspatial reduction factor is applied to each polygon for area that is outside of that associated with the riparian management area (RMA) of S1-B reaches. This reduction factor is based on an assessment of the percentage of the operable forest land base removed, outside of the RMA of S1-B reaches, within the Upper Kitimat-Hoult –Davies watershed where netdowns required have been applied spatially. The Upper Kitimat-Hoult –Davies is the largest watershed based area where fish stream inventory information is complete.

3.13 Wildlife Tree Patches

Table 18 describes the wildlife tree retention criteria required for each landscape unit and BEC variant. These criteria ensure the maintenance of structural diversity in managed stands so that objectives established under the Kalum SRMP are met.

Table 18: Wildlife Tree Patch Requirements

Landscape Unit	BEC Subzone	Target WTP Retention (% of cut-block area)
Hirsch	CWHvm	5
	CWHws	11
	MHmm	0
Lakelse	CWHws	7
	MHmm	0
Wedeene	CWHvm	3
	CWHvh	2
	CWHws	10
	MHmm	3
Hot Springs	CWHws	7
	MHmm	0.5
Jesse Bish	CWHvm	1
	MHmm	0
Kitimat	CWHvm	5
	CWHws	7
	MHmm	0

Operationally, there is significant overlap between WTP retention and other retention areas such as riparian reserve zones, terrain stability zones, OGMA's and inoperable areas. To take two examples, approximately 5000 hectares of productive forest within the area defined as operable are netted out to account for potential slope stability issues, and an additional 8500 hectares falls within riparian reserve zones. These areas are distributed throughout the operable area of TFL, and taken together amount to an effective retention level of almost 20%. These levels of retention well exceed the requirements listed in Table 18 above. In order to take advantage of these areas when allowing for future WTP retention, they will be buffered and the portion of the THLB that falls within this buffer will be noted. The full WTP requirements listed above will be applied to areas outside of this buffer (after allowing for partial, non-spatial netdowns for Terrain Class IV, sensitive soils [Es2] and aspatial riparian netdowns).

The Kalum SRMP provides guidance that distances between WTP (or to other suitable habitat leave areas outside of cut-blocks) should not normally exceed 500m. Consistent with the Kalum SRMP, the TFL 41 FSP provides details on wildlife tree patch requirements which afford flexibility in terms of spatial distribution as follows:

1. a wildlife tree patch can contain a single tree or a group reserve;

2. retention is by cut-block, but the target can be shifted or varied within a cut-block aggregate, subject to risks to biodiversity, where a cut-block aggregate are a group of cut-blocks within 10 km radius of each other; and

3. WTP can be internal or external to a cut-block.

Areas deemed suitable as wildlife tree habitat, and predominantly reserved from harvest in the analysis model, are buffered by a 250 metre radius. Areas within the 250 metre radius are deemed to have wildlife tree retention requirements fully met by the adjacent suitable habitat. Areas outside of this buffered area would be defined as areas that would require additional net-down to meet wildlife tree retention requirements. Partial net-downs that already apply, including the aspatial riparian requirements, ES2 and Terrain class IV, will be taken into account, and additional net-down applied to meet the requirements in Table 18.

Areas that are deemed suitable to contribute to wildlife tree requirements and predominantly reserved from harvest within the analysis model are defined as follows:

1. mature productive coniferous forest older than 80 years of age;

2. outside of the THLB including inoperable areas as well as areas that have 80% plus netdown (e.g. ES1 Terrain Class V, riparian reserves, OGMA's); and

3. at least 2 hectares contiguous area in size.

3.14 Roads, Trails and Landings

Loss of productive forest land due to existing and future road, trails and landings (RTL) are estimated separately. The 1999 TFL 41 AAC Rationale accepted existing RTL reductions (as of 1998) as 6% and future RTL reductions (post-1998) is 7.8%. The age break of 35-years as of 1999 has been updated to 46 years for this analysis. Existing RTL estimates are removed from the THLB. Two different netdowns, based on stand age, have been applied to estimate the area covered by existing roads. Future RTL reductions are applied in the timber supply model after stands have been harvested for the first time. Existing and future RTL reductions are shown in Table 19.

Table 19: Roads, Trails and Landings

Road, Trails and Landings	Stand Age (years)	Operability	Logged	Reduction (%)
Existing	0 - 11	All	Yes	8.0
	12 - 46	All		6.0
Future	> 46	Conventional	-	8.0

Data Source and Comments:

- The reduction values continue from the 1999 TFL 41 AAC Rationale.
- No future road reduction has been applied to non-conventional areas

- As stated in the 1999 TFL 41 AAC Rationale: "…A 1996 BCFS report on measured site disturbance showed that roads, trails and landings on TFL 41 reduced the productive forest by 7.8 percent. District staff indicated that, while 6% may be appropriate for existing roads, trails and landings, 7.8 % is more likely indicative of the road area that will be required in the terrain types where the licencee will be operating in the future…." The foregoing report indicated that offshore areas, which are now excluded from the area subject to the TSR, have higher amount of area occupied by roads than inshore areas. Although based upon a limited sample size, this would support the statement in the 1999 TFL 41 AAC Rationale that it is likely that the actual percent of area occupied by roads in the future will fall between six and eight percent, as the area defined as the offshore portion of TFL 41 will be deleted and not subject to this TSR.

4.0 Current Forest Management Assumptions

4.1 Management Objectives

The area to which a particular management objective applies must be defined in order to address the objective in the forest estate model. Table 20 identifies the management objectives addressed through this analysis and provides a summary of how these are defined. The productive and THLB areas within each zone are also provided.

Table 20: Management Objectives

Objective	Land Base Definition
Grizzly Bear Habitat	CFLB within McKay-Davies grizzly bear identified watershed
Seral Stage Targets	CFLB within each LU-BEC
Visual Quality Objectives (VQO)	CFLB within each LU / VQO class
Identified Watersheds	CFLB within the identified BEC site series within the Jesse and Emsley watersheds
Patch Size Distribution / Integrated Resource Management (IRM)	THLB without VQO targets within each LU

Grizzly bear habitat, seral stage targets and identified watersheds management objectives are as specified in the Kalum SRMP and defined in the TFL 41 FSP. Visual quality objectives are as defined in the TFL 41 FSP.

The patch size distribution requirement is modelled using a proxy for cutblock adjacency. This is applied to the integrated resource management (IRM) area outside of special management zones, community watersheds and areas with VQO's. IRM areas are generally large contiguous patches of harvestable forest and the maximum disturbance of 35 percent adequately describes the cutting pattern used at this time.

Table 21 shows the amount of area that falls within each Management Zone. Only those zones that contain some THLB area listed in the table. For modelling purposes, zones that have less than 25 hectares of THLB will be combined with larger, similar zones.

Table 21: Management Zone Areas

Management Zone	Productive Area (ha)	THLB Area (ha)
Grizzly Bear Habitat		
McKay – Davies	26,262	9,607
Seral Stage Targets		
Hirsch – CWH vm 1	2,812	2,011
Hirsch – CWH vm 2	3	2
Hirsch – CWH ws 1	2	1
Hirsch – CWH ws 2	3,731	1,232
Hirsch – MH mm 1	3,545	14
Hot Springs – CWH ws 1	1,308	921
Hot Springs – CWH ws 2	549	92
Jesse – Bish – CWH vm 1	6,528	2,436
Jesse – Bish – CWH vm 2	6,487	479
Jesse – Bish – MH mm 1	999	0
Kitimat – CWH vm 1	316	266
Kitimat – CWH vm 2	97	75
Kitimat – CWH ws 1	19,139	12,607
Kitimat – CWH ws 2	18,332	3,903
Kitimat – MH mm 2	11,779	81
Lakelse – CWH ws 1	1,015	640
Lakelse – CWH ws 2	1,008	32
Wedeene – CWH vm 1	4,102	1,657
Wedeene – CWH vm 2	8,272	672
Wedeene – CWH ws 1	9,562	5,524
Wedeene – CWH ws 2	4,065	131
Visual Quality Objectives		
Hirsch – PR	689	129
Hot Springs – M	229	86
Hot Springs – PR	446	99
Jesse – Bish – M	8	–
Jesse – Bish – PR	1,219	449
Kitimat – M	3,645	963
Kitimat – PR	2,019	878
Lakelse – M	801	201
Wedeene – M	3,392	417
Wedeene – PR	1,101	150
Identified Watersheds		
Emsley – CWHvm2 – 01	69	1
Emsley – CWHvm2 – 05	28	4
Emsley – CWHvm2 – 06	83	10
Jesse – CWHvm1 – 01	1,237	380
Jesse – CWHvm1 – 03	153	14
Jesse – CWHvm1 – 05	68	11
Jesse – CWHvm1 – 06	830	254

Management Zone	Productive Area (ha)	THLB Area (ha)
Jesse – CWHvm1 – 08	306	64
Jesse – CWHvm1 – 12	33	1
Jesse – CWHvm1 – 14	25	13
Jesse – CWHvm2 – 01	1,230	32
Jesse – CWHvm2 – 03	462	4
Jesse – CWHvm2 – 05	199	2
Jesse – CWHvm2 – 06	603	25
Jesse – CWHvm2 – 08	149	17
Jesse – CWHvm2 – 09	70	3
IRM		
Hirsch	10,096	3,263
Hot Springs	2,057	1,013
Jesse – Bish	14,022	2,919
Kitimat	49,666	16,933
Lakelse	2,886	672
Wedeene	30,061	7,984

4.2 Utilization Levels

The utilization specifications define the minimum diameter breast height (DBH), the maximum stump height and the minimum top diameter inside bark (DIB). Table 22 lists the utilization levels used to calculate merchantable volume.

Table 22: Utilization Standards

Analysis Unit	Maximum Stump Diameter (cm)	Corresponding Minimum DBH (cm)	Maximum Stump Height (cm)	Minimum Top DIB (cm)
Pine	15	12.5	30	10
Cedar	20	17.5	30	15
All Other	20	17.5	30	10

4.3 Volume Exclusions For Mixed-Species Stands

The amount of THLB containing a significant component of deciduous species is limited. All deciduous species are considered non-merchantable and are not harvested. As such, the deciduous volume from natural stands will be excluded from the merchantable volume portion of natural stand yield curves.

Table 23: Volume Exclusions For Mixed Species Stands

Species	Volume Exclusion (%)
All deciduous species	100

4.4 Minimum Harvest Ages

The minimum harvest age (MHA) is the earliest age at which a stand is considered merchantable. The criteria for the determination of MHA are presented in Table 24 below.

Table 24: Minimum Harvest Ages

Analysis Unit	Height (m)	Volume (m^3/ha)	Mean Diameter (All Stems) (cm)
All species	19.5	250	25

Data Source and Comments:

- Height is the inventory leading species projected height
- Volume is the VDYP derived merchantable stand volume
- The criteria used in the 1999 TFL 41 TSR used a minimum mean stand diameter (all stems) of 30 cm and a minimum stand volume of 300 m^3 / ha . The 1999 TFL 41 AAC Rationale commented that the foregoing criteria may too conservative. The 1999 TSR included land base from more remote offshore areas which may justify a conservative approach considering the increased handling costs associated with smaller piece sizes. However, these same offshore areas are not subject to the current TSR.
- The criteria used in the current TSR is as per the Kalum TSA Data Package as follows:
    - the 19.5 m top height is based upon the requirement to produce an adequate log length of 7-10 m; and
    - the minimum average diameter criterion of 25 cm dbh is based upon the report *Potential financial returns from alternate silvicultural prescriptions in second-growth stands of coastal British Columbia* (Howard and Temesgen, 1997) where marginal tree size for harvesting was determined to be between 22 and 28 cm.

4.5 Silviculture Systems

The base case and sensitivity analyses will assume clear cut harvesting with reserves (for WTP and riparian areas only) in all stands.

4.6 Unsalvaged Losses

Unsalvaged losses account for merchantable volume that is lost due to wind, fire, disease, insects, and other events that are not otherwise captured through this analysis. Unsalvaged losses are removed from the harvest volume from each timber supply forecast.

Table 25: Unsalvaged Losses

Cause of Loss	Annual Unsalvaged Loss for the Kalum TSA (m^3/yr)	Relative Size of THLB in TFL 41 to the Kalum TSA	TFL 41 Unsalvaged Losses (m^3/yr)
All sources	5,000	35.8%	1795

Data Source and Comments:

- Unsalvaged loss estimates as per the Kalum TSA TSR Data Package are applied pro-rata to the TFL as described in Table 25.
- Kalum Forest District staff reviewed the unsalvaged loss estimate and found it to compare favourably to the results of Forest Health overview surveys conducted in the Kalum District from 2004-2009.

4.7 Natural Disturbances

Forest ecosystems on TFL 41 fall within Natural Disturbance Types (NDT) 1 and 2. In NDT 1, small gap disturbances are created by the death of individual trees or small patches of trees. When disturbances such as wind, fire, and landslides occur, they are generally small and result in irregular edge configurations and landscape patterns. In NDT 2, infrequent fires disturb areas ranging in size from 20 hectares to 1000 hectares. In both of these types, stand initiating events occur seldomly and are of limited extent. However, in is not reasonable to assume that – for modeling purposes – stands outside of the THLB will continue to age indefinitely and thereby fulfill an increasing portion of the biodiversity requirements that were previously met by THLB stands.

The impacts of natural disturbances outside of the THLB will be assessed based on stand disturbance information from the *Biodiversity Guidebook* using the guidance provided in the MFR document, *Modelling Options for Disturbance of Areas Outside of the Timber Harvesting Land Base*. Option #2 from that document – 'Static Contribution from the Non-Timber Harvesting Landbase' – will be applied. For each zone listed in Table 21, the current contribution (to the seral stage targets) of the non-contributing landbase will be calculated. The difference between that and the target is the amount (i.e. the number of hectares) that will be required from the THLB throughout the entire planning horizon in order to satisfy the constraint. This is the simplest option available and, because disturbance in the non-THLB area are historically infrequent, it will provide acceptable results for this analysis.

4.8 Not Satisfactorily Restocked (NSR) Areas

There is no backlog NSR on the TFL. If forest cover attributes are missing as a result of harvesting updates to the spatial data, they will be populated based on regeneration assumptions in Table 31. If site index is missing, the stand will be assigned an average SI based on BEC zone/subzone/variant and leading site series.

4.9 Forest Cover Requirements

Modelling integrated resource management (IRM) objectives will be accomplished through the use of forest cover constraints. These constraints are summarized in Table 26 and are described in greater detail in the sections below.

Table 26: Summary of Forest Cover Requirements

Resource Objective	Area Target (%)	Condition Target	Affected Land Base
Seral Stage Targets	As specified in Table 28	As specified in Table 27	CFLB
VQO	As specified in Table 29		CFLB
Grizzly Bear	Maximum 30%	Between 25 and 100 years old	CFLB within McKay-Davies Watershed
Identified watersheds	As specified in Table 30	Age >=250 years	CFLB within identified watersheds
IRM / Patch Size	Maximum 35%	Height <=3m	THLB by LU.

4.9.1 Seral Stage Targets

The seral stage requirements established by the Kalum SRMP, and as specified in the TFL 41 FSP, are duplicated below in Table 27 and Table 28. Table 27 defines the age ranges of seral stages. Table 28 defines the seral stage distribution for early, mature plus old, and old forest as well as the allowable deviation from target for the early seral stage.

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Table 27: Seral Stage Definition By Biogeoclimatic Unit

BEC Unit	NDT (%)	Forest Stand Age (years)		
		Early	Mature	Old
CWH vm, vm1, vm2	1	< 40	> 80	> 250
MH mm1, mm2	2	< 40	> 120	> 250
CWHws1, ws2	2	< 40	> 80	> 250

Table 28: Seral Stage Distribution Targets

Landscape Unit	Biodiversity Emphasis Option	BEC Variant	Seral Stage Distribution (% of forested land base)			
			Early	Maximum Early	Mature + Old	Old
Hirsch	Intermediate	CWHvm	<30	<40	>36	>13
		CWHws1	<36	<51	>34	>9
		CWHws2	<36	<46	>34	>9
		MHmm1	<22	<32	>36	>19
Lakelse	Intermediate	CWHws1	<36	<51	>34	>9
		CWHws2	<36	<46	>34	>9
		MHmm2	<22	<32	>36	>19
Wedeene	Intermediate	CWHvh2/vm	<30	<40	>36	>13
		CWHws1	<36	<51	>34	>9
		CWHws2	<36	<46	>34	>9
		MHmm1/mm2	<22	<32	>36	>19
Hot Springs	Low	CWHws1/ws2	n/a	n/a	>17	>9
		MHmm2	n/a		>19	>19
Jesse Bish	Low	CWHvm	n/a	n/a	>18	>13
		MHmm1	n/a		>19	19
Kitimat	Low	CWHvm	n/a	n/a	>18	>13
		CWHws1/ws2	n/a		>17	>9
		MHmm1/mm2	n/a		>19	>19

Data Source and Comments:

- As stated in the Kalum TSA TSR Data Package old seral stage requirements established by the Kalum SRMP have been fully implemented by legally established old growth management areas (OGMA's) and these are removed from the THLB as per Section 3.3. These OGMA's are used instead of the old seral stage requirements.
- The Kalum SRMP specifies transition measures for implementation of seral stage targets intended to minimize impacts on timber supply as follows:
  - the early and mature plus old seral stage targets will be achieved in the shortest time possible;
  - the early seral stage proportion of the forested land-base may exceed the target up to the maximum specified in Table 28; and
  - where the above transitional measures are used, the time frame to achieve target will be stated in the Analysis Report

- All seral requirements will be met from the TFL 41 landbase. No credit will be taken for existing old seral stands in adjacent parks and protected areas.

4.9.2 Visual Quality Objectives

Visually effective green-up (VEG) heights and plan-to-perspective (P2P) ratios will be used to model scenic areas and visual quality objectives (VQO), as per the *Procedures for Factoring Visual Resources into Timber Supply Analyses*, and the update bulletin, *Modelling Visuals in TSR III*.

A digital elevation model was used to derive average slope for each VQO polygon. The predicted P2P ratios and VEG heights are based on Table 26 of the *Kalum Timber Supply Area Timber Supply Review Updated Data Package (March 2010)*. According to the data package P2P ratios were calculated from *Predictive Models for Plan-to-Perspective (P2P) Ratios* and VEG tree heights were derived based on Table 6 of *Procedures for Factoring Visual Resources into Timber Supply Analyses*. Table 29 shows the P2P ratios and the VEG tree heights calculated for this analysis.

Consistent with the *Kalum TSA Data Package*, maximum percent visible disturbance for each VQO is calculated based on the approach detailed in *Modelling Visuals in TSR III*. To determine maximum permissible disturbance in plan view, the perspective number was converted to an area weighted average slope for each VQO category and the corresponding P2P ratio for that slope class is applied. This number is then multiplied by the percent alteration, to derive a planimetric number for modelling purposes. Finally, an area-weighted average VEG tree height was determined for each VQO as well. These values are also displayed in Table 29.

Visual quality objective targets will be modelled for each landscape unit / VQO class combination using the maximum percent alteration percentages (plan view) and VEG heights from Table 29.

Table 29: VQO Assumptions

VQO Class	Average Slope (%)	Max. Percent Alteration (Perspective View)	P2P Ratio	Max. Percent Alteration (Plan View)	VEG Height (m)
PR	47	7.0	1.6	11.2	7.0
M	50	18.0	1.6	28.4	7.0

Data Source and Comments:

- Maximum alteration percentages have been calculated based on average slope information in the resultant database.
- VEG heights are based on average slope using the lookup table in the Kalum TSA Data Package. Height will be modelled on a stand-by-stand basis using the height curves for the managed stands analysis units.
- The upper end of the permissible alteration range has been used, but other limits will be tested in sensitivity analyses.

4.9.3 Identified Watersheds

Table 30 below identifies the old seral stage forest targets within each identified watershed as specified in the Kalum SRMP.

Table 30: Target Old Seral Stage Forest within Identified Watersheds

Identified Watershed	BEC Variant	Site Series	Old Forest Predicted By Natural Disturbance (%)	Old Seral Forest Target (% forested land base within each site series)
Jesse, Emsley	CWHvm	01	89	27
		03	93	28
		05	73	22
		06	88	26
		08	73	22
		09	70	21
		12	93	28
		13	93	28
		14	78	23
	CWHvm2	01	89	27
		03	93	28
		05	73	22
		06	88	26
		08	73	22
		09	70	21
		10	70	21
	MHmm1	01	86	26
		02	93	28
		03	86	26
		04	93	28
		06	93	28

Data Source and Comments:

- The target values are as per the TFL 41 FSP and are consistent with the Kalum SRMP
- TFL 41 PEM is used to identify the site series to ensure the TSR model accounts for this management objective.

4.9.4 Grizzly Bear Habitat

As identified in the FSP and consistent with the Kalum SRMP, within the McKay-Davies grizzly bear identified watershed unit no more than 30% of the forested land base, excluding hardwood, will be between 25 and 100 years old.

4.9.5 Integrated Resource Management / Patch Size Objectives

The Kalum SRMP sets objectives for the temporal and spatial distribution of cutblocks. This element of biodiversity is often referred to as "patch size distribution". The goal of this objective is to create and maintain a pattern of forest seral stages distributed across the landscape that reflect the natural disturbance regime. For this analysis, the rate of harvesting in each landscape unit will be limited using a maximum disturbance constraint of 35%. No more than 35% of the THLB that is not being managed for visual quality can be less than 3 metres in height (consistent with the approach taken in the Kalum TSA). Height will be modelled on a stand-by-stand basis using the height curves for the managed stands analysis units. This is the same approach that was used for the Kalum TSA timber supply analysis.

5.0 Growth and Yield

5.1 Natural Stand Yield Tables

All stands without logging history information will be assumed to follow natural stand yield curves. Logging history was taken from historical cutblock mapping maintained by the licencee. All previous harvest blocks now support managed stands – they are modelled as described in the next section.

Projected height, projected age, stocking class, crown closure, PSYU and species composition from the inventory database are used to generate natural stand yield tables for each polygon using the Variable Density Yield Prediction (VDYP) model version 6.6d. These polygon-level yield tables are then incorporated into the timber supply model. Default decay, waste and breakage (DWB) values from VDYP 6 will be utilized. As no Phase II or NVAF programs have been completed on the TFL, this is still the best available DWB information.

Yield curves for hemlock, balsam and cedar-leading stands older than 140 years will be adjusted using the localization factors shown in Table 1.

5.2 Managed Stand Yield Tables

Stands with logging history information will be considered as managed stands and will follow managed stand yield curves. Growth and yield for all managed stands will be modelled with the Table Interpretation Program for Stand Yields (TIPSY) 4.1d.

Managed stand analysis units (AU) are defined using PEM site series as defined in the regeneration assumptions from Table 31. Regeneration delay reflects the amount of time required to regenerate a stand after logging such that the stand is at the zero age point on the yield curve. Under this definition a stand planted with two year old stock two years after harvesting would have a regeneration delay of zero.

A review of historical silviculture practices on the TFL suggests that the regeneration assumptions listed in Table 31 accurately reflects the growth and yield on both existing and future managed stands and is therefore used for both stands. The exception to this is the past application of spacing treatments on the TFL which will be addressed through adjusted managed stand yield curves as described in Section 5.2.1 below.

Table 31: Regeneration Assumptions

BGC Variant	Leading Site Series	SP1	SP1 %	SP2	SP2 %	SP3	SP3 %	Initial Density	Regen Delay	Method Type	%
CWHvm1	01	Ba	50	Hw	40	Cw	10	2500	1	Planted	5
CWHvm1	01	Hw	60	Ba	35	Cw	5	5000	0	Natural	95
CWHvm1	02	Hw	60	Ss	10	Cw	10	1500	1	Planted	50
CWHvm1	02	Hw	60	Ba	35	Cw	5	2000	2	Natural	50
CWHvm1	03	Ba	50	Hw	40	Cw	10	2000	1	Planted	10
CWHvm1	03	Hw	60	Ba	35	Cw	5	4500	2	Natural	90
CWHvm1	04	Ba	50	Hw	40	Cw	10	2000	1	Planted	20
CWHvm1	04	Hw	60	Ba	35	Cw	5	4000	2	Natural	80
CWHvm1	05	Ba	50	Hw	40	Cw	10	2000	1	Planted	70
CWHvm1	05	Hw	60	Ba	35	Cw	5	2000	2	Natural	30
CWHvm1	06	Ba	50	Hw	40	Cw	10	1500	1	Planted	70
CWHvm1	06	Hw	60	Ba	35	Cw	5	2000	2	Natural	30
CWHvm1	08	Ba	50	Hw	40	Ss	10	1500	1	Planted	30
CWHvm1	08	Hw	60	Ba	35	Ss	5	2000	2	Natural	70
CWHvm1	09	Ba	50	Hw	40	Ss	10	1500	1	Planted	90
CWHvm1	09	Hw	60	Ba	35	Ss	5	2000	2	Natural	10
CWHvm1	10	Cw	60	Ba	20	Hw	20	1500	1	Planted	90
CWHvm1	10	Cw	60	Ba	20	Hw	20	2000	2	Natural	10
CWHvm1	12	Cw	60	Ba	20	Hw	20	1500	1	Natural	50
CWHvm1	12	Cw	60	Ba	20	Hw	20	1500	2	Planted	50
CWHvm1	13	Cw	60	Ba	20	Hw	20	1500	1	Natural	50
CWHvm1	13	Cw	60	Ba	20	Hw	20	1500	1	Planted	50
CWHvm1	14	Cw	60	Ba	20	Hw	20	1500	1	Natural	50
CWHvm1	14	Cw	60	Ba	20	Hw	20	1500	1	Planted	50
CWHvm2	01	Ba	50	Hw	40	Cw	10	2500	1	Planted	5
CWHvm2	01	Hw	60	Ba	35	Cw	5	5000	0	Natural	95
CWHvm2	02	Cw	40	Hw	30	Pl	30	1000	1	Planted	50
CWHvm2	02	Pl	40	Cw	40	Hw	20	1500	2	Natural	50
CWHvm2	03	Hw	60	Cw	40			2000	1	Planted	10
CWHvm2	03	Hw	60	Cw	40			4500	2	Natural	90
CWHvm2	05	Ba	60	Hw	35	Ss	5	2000	1	Planted	30
CWHvm2	05	Hw	60	Ba	35	Ss	5	4000	2	Natural	70
CWHvm2	06	Ba	60	Hw	35	Ss	5	1500	1	Planted	40
CWHvm2	06	Hw	60	Ba	35	Ss	5	2000	2	Natural	60
CWHvm2	08	Ba	60	Hw	35	Ss	5	1500	1	Planted	80
CWHvm2	08	Hw	60	Ba	35	Ss	5	2000	2	Natural	20
CWHvm2	09	Hw	70	Cw	30			1500	1	Planted	70
CWHvm2	09	Hw	70	Cw	30			2000	2	Natural	30
CWHvm2	10	Pl	60	Hm	20	Yc	20	1000	1	Planted	50
CWHvm2	10	Pl	60	Hm	20	Yc	20	1500	2	Natural	50
CWHvm2	11	Cw	60	Hm	20	Yc	20	1500	1	Planted	50
CWHvm2	11	Cw	60	Hm	20	Yc	20	2000	2	Natural	50
CWHws1	01	Ba	50	Hw	40	Cw	10	2000	1	Planted	30
CWHws1	01	Hw	65	Ba	30	Cw	5	5000	2	Natural	70
CWHws1	02	Hw	80	Cw	10	Ss	10	1000	1	Planted	50
CWHws1	02	Hw	75	Ba	20	Cw	5	1500	2	Natural	50
CWHws1	03	Ba	50	Hw	40	Cw	10	2000	1	Planted	70
CWHws1	03	Hw	60	Ba	35	Cw	5	4000	2	Natural	30
CWHws1	04	Ba	50	Hw	40	Cw	10	2000	1	Planted	40
CWHws1	04	Hw	60	Ba	35	Cw	5	3500	2	Natural	60
CWHws1	05	Ba	50	Hw	40	Cw	10	1500	1	Planted	60
CWHws1	05	Hw	60	Ba	35	Cw	5	3000	2	Natural	40
CWHws1	06	Ba	50	Hw	40	Cw	10	1500	1	Planted	70
CWHws1	06	Hw	60	Ba	35	Ss	5	2500	2	Natural	30
CWHws1	07	Ba	40	Hw	40	Ss	20	1500	1	Planted	90
CWHws1	07	Hw	60	Ba	35	Ss	5	2500	2	Natural	10
CWHws1	08	Ba	40	Cw	30	Hw	30	1400	1	Planted	90
CWHws1	08	Ba	50	Hw	30	Ba	20	1600	2	Natural	10
CWHws1	10	Pl	60	Hw	40			800	1	Planted	50

BGC Variant	Leading Site Series	SP1	SP1 %	SP2	SP2 %	SP3	SP3 %	Initial Density	Regen Delay	Method Type	%
CWHws1	10	Pl	50	Hw	50			1000	2	Natural	50
CWHws1	11	Cw	50	Ss	30	Hw	20	1400	1	Planted	50
CWHws1	11	Cw	40	Hw	30	Ss	30	1600	2	Natural	50
CWHws2	01	Ba	50	Hw	40	Ss	10	2500	1	Planted	30
CWHws2	01	Hw	65	Ba	30	Ss	5	5000	2	Natural	70
CWHws2	02	Hw	80	Pl	20			1000	1	Planted	50
CWHws2	02	Hw	60	Pl	30	Cw	10	1500	2	Natural	50
CWHws2	03	Hw	80	Pl	10	Hm	10	2000	1	Planted	70
CWHws2	03	Hw	70	Pl	20	Hm	10	4000	2	Natural	30
CWHws2	04	Ba	50	Hw	40	Ss	10	2000	1	Planted	40
CWHws2	04	Hw	60	Ba	35	Ss	5	3500	2	Natural	60
CWHws2	05	Ba	50	Hw	40	Ss	10	1500	1	Planted	70
CWHws2	05	Hw	60	Ba	35	Ss	5	3000	2	Natural	30
CWHws2	06	Ba	50	Hw	30	Ss	20	1500	1	Planted	90
CWHws2	06	Hw	60	Ba	35	Ss	5	2000	2	Natural	10
CWHws2	07	Ba	50	Hw	40	Ss	10	1500	1	Planted	90
CWHws2	07	Hw	60	Ba	35	Ss	5	2000	2	Natural	10
CWHws2	08	Ba	50	Hw	40	Ss	10	1500	1	Planted	90
CWHws2	08	Hw	60	Ba	35	Ss	5	2000	2	Natural	10
CWHws2	10	Pl	60	Cw	30	Hm	10	1000	1	Planted	50
CWHws2	10	Pl	50	Hm	30	Cw	20	2000	2	Natural	50
CWHws2	11	Cw	40	Ss	30	Hw	30	1000	1	Planted	90
CWHws2	11	Cw	40	Ss	30	Hw	30	2000	2	Natural	10

BGC Variant	Leading Site Series	SP1	SP1 %	SP2	SP2 %	SP3	SP3 %	Initial Density	Regen Delay	Method Type	%
MHmm1	01	Ba	60	Hm	40			2000	1	Planted	40
MHmm1	01	Hm	60	Ba	40			4500	2	Natural	60
MHmm1	02	Hm	70	Ba	30			2000	1	Planted	50
MHmm1	02	Hm	40	Ba	30	Yc	20	2000	2	Natural	50
MHmm1	03	Ba	60	Hm	30	Yc	10	2000	1	Planted	30
MHmm1	03	Hm	60	Ba	30	Yc	10	3000	2	Natural	70
MHmm1	04	Ba	60	Hm	30	Yc	10	2000	1	Planted	30
MHmm1	04	Hm	60	Ba	30	Yc	10	3500	2	Natural	70
MHmm1	05	Ba	60	Hm	30	Yc	10	1100	1	Planted	30
MHmm1	05	Hm	60	Ba	30	Yc	10	1400	2	Natural	70
MHmm1	06	Hm	90	Yc	10			900	1	Planted	70
MHmm1	06	Hm	70	Yc	30			1100	2	Natural	30
MHmm1	07	Ba	60	Hm	30	Yc	10	1100	1	Planted	50
MHmm1	07	Hm	60	Ba	30	Yc	10	1400	2	Natural	50
MHmm1	08	Hm	60	Hw	30	Yc	10	800	1	Planted	50
MHmm1	08	Hm	60	Yc	30	Hw	10	900	2	Natural	50
MHmm1	09	Hm	70	Ba	20	Yc	10	1000	1	Planted	50
MHmm1	09	Hm	60	Yc	30	Ba	10	1100	2	Natural	50
MHmm2	01	Ba	60	Hm	40			1100	1	Planted	30
MHmm2	01	Hm	60	Hm	40			1600	2	Natural	70
MHmm2	02	Hm	60	Ba	40			1000	1	Planted	40
MHmm2	02	Hm	80	Ba	20	Yc	10	1100	2	Natural	60
MHmm2	03	Ba	60	Hm	40			1100	1	Planted	30
MHmm2	03	Hm	60	Ba	40			1600	2	Natural	70
MHmm2	04	Ba	60	Hm	40			1100	1	Planted	30
MHmm2	04	Hm	60	Ba	40			1600	2	Natural	70
MHmm2	05	Ba	60	Hm	40			1100	1	Planted	30
MHmm2	05	Hm	60	Ba	40			1400	2	Natural	70
MHmm2	06	Hm	80	Yc	20			900	1	Planted	70
MHmm2	06	Hm	60	Yc	40			1100	2	Natural	30
MHmm2	07	Ba	70	Hm	20	Yc	10	1000	1	Planted	50
MHmm2	07	Ba	60	Hm	20	Yc	20	1100	2	Natural	50
MHmm2	08	Hm	70	Ba	30			800	1	Planted	50
MHmm2	08	Hm	80	Ba	20			900	2	Natural	50
MHmm2	09	Hm	70	Ba	30			800	1	Planted	50
MHmm2	09	Hm	80	Ba	20			900	2	Natural	50

Data Source and Comments:

- The proportion of regeneration method specified is based upon the historic performance of natural regeneration in different biogeoclimatic zones and site series. Where there has been little harvesting history, professional judgment has been applied.
- The regeneration delay for naturally regenerated stands reflects the presence of advanced regeneration and rate of ingress. On zonal (01) sites within the CWHvm1/vm2, experience has shown that adequate advanced regeneration is present at time of harvest hence the regeneration delay is 0.
- The regeneration delay for planted stands generally reflects normal practice where most areas identified as requiring planting are planted within 2 years of harvest with one-year old stock. This is notwithstanding that planting is often completed within one year following harvest and in some cases fill-planting is conducted beyond 2 years due to failure of natural or planted regeneration.
- Species composition is based upon management towards meeting the FSP stocking standards by site series while taking into account the natural rate of ingress of hemlock.

- For forest estate modelling, a single yield curve will be compiled for each AU. To do this, two TIPSY curves will be generated – one managed and one natural. These will be combined using the weighting shown in the last column of the table.
- Site index for each AU will be the area-weighted average inventory (adjusted) site index of all stands that fall within the AU.
- TIPSY default site index curves will be used
- A site index adjustment of plus 10 metres has been applied to all Hw-leading stands in the CWH with an inventory SI of between 8 and 18 metres. This factor is based on the report OGSI site index study completed in the Kalum District.

5.2.1 Juvenile Spacing History

A review of silviculture history on the TFL indicates that juvenile spacing has been applied to approximately 1,452 ha between 1998 and 2009 whereby stands were treated at an average age of 18 years to a post-treatment density of approximately 1,000 stems per hectare. Spacing treatment applied prior to 1998 would be captured in the existing TFL inventory where stocking treatment is spatially defined. The post 1997 treatments were predominantly applied to the CWHws-01 and CWHvm1-01 site series according to the area figures in Table 32. This will be captured in the analysis by modelling the growth and yield of this spacing treatment using TIPSY and applying it *pro rata* to the yield curves for existing managed stands within these site series based on the relative proportion within each of these analysis units (site series).

Table 32: Spaced Stands

BGC Variant	Leading Site Series	Area Treated (ha)
CWHvm1	01	461
CWHws1	01	991
Total		1,452

Data Source and Comments:

- Historical spacing is based on licencee records and maps.
- RESULTS data is not available for areas treated prior to 2005

5.2.2 Operational Adjustment Factors

Standard operational adjustment factor (OAF) values of 0.85 and 0.95 will be used to reflect OAF 1 and 2 respectively.

5.2.3 Site Productivity Estimates

A Predictive Ecosystem Mapping (PEM) project was completed for the TFL in 2004 however this PEM did not meet the provincial minimum accuracy assessment percentages to include SIBEC site productivity estimates in the Base Case.

A paired plot old-growth site index study – *Site index adjustment for old-growth coastal western hemlock stands in the Kalum Forest District* by G.D. Nigh and B. Love, 1997 – confirmed that site index is underestimated by 10 metres when hemlock-leading stands currently greater than 140 years of age are harvested and replaced with managed hemlock stands. A site index adjustment of 10 metres is applied in the base case to hemlock-leading stands currently older than 153 years in the CWH biogeoclimatic zone after they are harvested in the model (this study was done in 1997 and the inventory from that time has been projected in age to 2010, so the 140-year age boundary is interpreted to mean 140 + 13 = 153 years of current inventory age in 2010).

This adjustment was applied to western-hemlock leading stands with an inventory SI between 8 and 18. Stands of all other leading species – including mountain hemlock – were left unadjusted and the inventory site index was used to generate yield curves.

5.2.4 Genetic Gains

The Chief Forester's stocking standards require the use of Class A seed when available. Class A seed has been used on the TFL since 2005 in the following percentages: Hw 11%, Cw 65% and Ss 53%. By 2020 it is expected that 100% of the planted Cw will be Class A with a 12% gain and 70% of the Hw will be class A with a 15 % gain. Although Ss has Class A status, breeding has been for forest health reasons which may result in growth gains, but this benefit has not been quantified to date. No Ba Class A seed is expected for the foreseeable future. Due to very limited use and supply, no Class A Yc or Pl will be utilized.

Based on this, genetic gains will be applied to all future, planted Cw and Hw stems using 11.5% and 14.4%. These percentages are based on the phase in of the full genetic gains over the first 10 years of the planning horizon.

6.0 Forest Estate Model

This timber supply analysis will be conducted using the Patchworks spatial optimization model. Patchworks is a spatially explicit harvest scheduling optimization model developed by Spatial Planning Systems in Ontario. It is capable of developing harvest allocations and exploring trade-offs between a broad range of conflicting management and harvest goals. Modelling will use 10-year periods for cut control purposes, but forest growth and harvest volumes will be compiled annually.

Patchworks will be formulated to maximize harvest volume while meeting all the management objectives listed in this document. Harvest scheduling decisions are based on maximizing the value of an objective function that incorporates volume harvested and the achievement of other management objectives on the land base. As such, there are no explicit harvest rules, other than minimum merchantability limits, applied to the model. Merchantability limits are set up such that no stands may be harvested before they have achieved the minimum harvest age (MHA) criteria set out in Section 4.4 above. Maps of scheduled harvesting and harvest statistical summaries will be produced and reviewed by the licencee to ensure that model results are realistic.

The current available mature timber, consisting almost exclusively of old-growth, is distributed throughout the entire land-base with many operating areas having experienced extensive past harvesting. In order to reflect operationally feasible harvest scheduling practices for the first 50 years of harvest, before second growth is anticipated to be abundantly available, a constraint will be placed on the model to limit harvesting to only discrete contiguous portions of the land-base at a time. This will simulate an operating area concept which is concentrated on a portion of the land base commensurate with the current AAC level of harvest. In this way the model cannot unrealistically maximize harvest by being able to select harvesting units from across the entire land-base during any one harvest period to get around adjacency and seral stage requirements during a stage when these issues may well be most constraining on the availability of mature timber.

The forest estate model will be used to find a long-term harvest level that meets all resource objectives and results in a stable forest growing stock over the final 50 years of the 250-year planning horizon.

Based on the substantial deletions from the TFL that have occurred since the last analysis, the initial harvest level will have to be determined through preliminary analysis. A logical starting point for analysis would be the existing AAC apportionment of 122,926 m^3 that Skeena Sawmills will be operating under within the residual land base subject to the next AAC determination. In determining the base case harvest forecast the following principles will be applied:

- the long term harvest level is not compromised to meet short-term needs (by ensuring that growing stock levels do no fall below a minimum value after the THLB age class distribution has become balanced), and

- any reduction in harvest levels should not exceed 10% per decade

Due to the small proportion of non-conventional operable area within the residual land-base, these areas will be lumped with the conventional land-base and no separate flow constraints will be applied.

Patchworks is approved for use in Timber Supply Review and Management Plan analysis by the Ministry of Forest and Range Forest Analysis and Inventory Branch.

7.0 Sensitivity Analysis

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 33 summarizes the sensitivity analyses that will be performed for this analysis. Examination of the base case analysis results will determine the nature of any sensitivity analysis that are required.

Table 33: Potential Sensitivity Analysis Scenarios

Issue To Be Tested	Description
Harvest flow alternatives	Various alternatives to the base case, including maximum even flow and maximum initial harvest level.
SIBEC site productivity estimates	PEM SIBEC values will used to assess site productivity on managed stands.
Operability	Remove all of the non-conventional area (skyline and heli) from the timber harvesting land-base
Minimum merchantability criteria	Reduce volume, height and diameter criteria by 20%, alone.
Management for visual quality	Visually effective green-up height of five metres and nine metres

Modelling alternative harvest flows will give the licencee and Chief Forest valuable information about timber supply dynamics – in particular the timing and duration of timber supply shortfalls. Second growth will comprise an increasing portion of the harvest as time progresses. The timber supply and resource implications of accelerating the move of harvesting into second growth may also be examined.

Although SIBEC site index estimate are not being used for the base case (because the underlying PEM did not meet the required accuracy standards), it may in fact be a better estimate of the true long-term productivity of the TFL. Managed stand yield tables will be recompiled using these SI estimates, and the resulting change in timber supply will be examined.

Since the base case will not generate separate harvest rates by operability class, a sensitivity analysis on removing the non-conventional timber harvesting land-base should determine the level of effect that may result if the non-conventional THLB is not accessed on proportionate basis.

If minimum merchantability criteria are reduced, existing second growth stands will become available earlier in the planning horizon. For this sensitivity test, the minimum merchantability applied for the corresponding Kalum TSA TSR sensitivity run will be applied. The minimum volume, height and diameter criteria will be reduced by 20%.

Management for visual quality is important along the highway corridor and in cases where harvesting is visible from recreational areas commonly used by the public. VEG height for the base case is 7 metres. This will be relaxed to 5 metres, and increased to 9 metres.

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Appendix I

Report on the Re-Inventory of TFL 41 1996-1998

REPORT ON THE RE-INVENTORY OF TREE FARM LICENCE 41 1996-98

February, 1999

Sterling Wood Group Inc.
Victoria, BC

TABLE OF CONTENTS

INTRODUCTION

In 1995 Skeena Sawmills, a division of West Fraser Mills Ltd., initiated a re-inventory of TFL 41. The previous inventory was completed in 1976 and had become outdated. The inventory area/volume data had been updated regularly for depletion and reclassification of harvested areas but the forest cover maps had not. Furthermore, the 1976 vintage inventory did not meet revised Ministry of Forests (MoF) inventory standards.

The re-inventory was completed between 1996 and 1998. Stratification and classification was done using photography taken in 1996 and 1997. Field volume sampling and classification was undertaken in 1997. Digital map production and the area/volume compilation were completed in 1998. The re-inventory is nominally current to 1997 based on the date of field sampling.

This report presents the objectives and specifications, methodology and results of the inventory. The introduction includes a description of the TFL area and previous inventory to provide context for the re-inventory.

AREA DESCRIPTION

TFL 41 lies to the south of Terrace (figure 1). The northern portion encompasses the main side drainages of the Kitimat valley. This portion is accessible by road from the communities of Terrace and Kitimat. The southern portion encompasses main drainages along sections of Douglas Channel and Gardner Canal, the Kemano valley, including the township of Kemano, and the Kowesas drainage to the Kitlope Conservancy Area. The south is only accessible by air or water.

The TFL has common boundaries with the North Coast, Kalum and Morice TSAs and TFL 1. These areas have been re-inventoried within the past eight years. The TFL is also adjacent to the Kitlope Conservancy Area. This 321,120 ha drainage was previously part of TFL 41 but was relinquished by West Fraser in 1996 to the provincial government. Other Crown land parcels within or adjacent to the TFL include the Kitimat Provincial Forest, the Municipality of Kitimat, east Coste Island, south Hawkesbury Island and several older TSXs and TLs, including the Weewanie block, and several Indian Reserves.

The relief varies considerably within the TFL. It ranges from low elevation benches and narrow river valleys to steep, rocky mountains. Much of the area is non-productive or inoperable due to the high elevation and rugged, mountainous terrain.

Placeholder for key map here

Most of the TFL is within the Coastal Western Hemlock (CWH) biogeoclimatic zone. There is significant area of Mountain Hemlock (MH) and Alpine Tundra (AT) zones at higher elevations. The forest is mostly very old Western hemlock and Amabilis fir. Smaller amounts of Western red cedar, Sitka spruce, Yellow cedar, Douglas fir, Lodgepole pine, cottonwood and Red alder also occur. Summaries of the area distribution by age and leading species are included in the results.

PREVIOUS INVENTORY

The previous inventory of TFL 41 was completed between 1972-76 for Eurocan Pulp and Paper Co. Ltd. BC Forest Service inventory standards current at the time were followed. The inventory was a co-operative effort between the company and Horth Forestry Ltd. Company personnel stratified and classified aerial photos and performed all field work. Horth Forestry (now Sterling Wood Group Inc.) undertook kail plotting, map production and compilation of the inventory area/volume database. The inventory was in imperial units.

Field work included establishment of air and ground calls for classification and measurement of temporary sample plots for volume estimation. The temporary volume plots were established in 1974 along 200 strip lines that were located perpendicular to the contours. Plots were located across the full range of forest types and elevation found within the TFL. A map of the strip lines (Appendix I) is provided below.

Stratification and classification was done using black and white, 1: 20 chain (1:15, 840) aerial photos taken between 1968 and 1972. Mylar maps were produced on an NTS grid. Volume estimates were assigned to average volume lines using a procedure suggested by Dr. A. Kozak (UBC, Faculty of Forestry).

Additional resource inventory classifications have been undertaken to compliment the 1976 forest inventory. These include:

1978	:	Classification of the TFL into three environmental protection forest (EPF) zones.
1984	:	Biogeoclimatic mapping of the north half.
1985	:	ESA mapping (Es and Ef) of the north half.
1988	:	Biogeoclimatic mapping of the south half.
1988	:	ESA mapping (Es, Ew, Ea and Ep) of the south half.
1991	:	ESA mapping (Ep, Ew and Ea) of the north half.
1993	:	Recreation and visual landscape feature inventory.

The ESA maps were produced as mylar overlays to the forest cover maps. The biogeoclimatic maps were produced on mylar at 1:100,000 scale for the north half of the TFL and 1:50,000 for the south half. The recreation and landscape maps were produced as 1:50,000 scale transparent overlays.

The 1976 forest inventory has been updated and modified over the years. In 1979 the inventory database was converted to metric units and the forest cover maps re-labelled from 1 : 20 chain to 1:15,000 scale. The database was also updated regularly for harvest depletion, wildfire denudation and reclassification of harvested areas. The last update was to December 31, 1990. Updates were mapped on a 1:5,000 scale operational map series and transferred to the 1:15,000 inventory series. Areas by inventory type were summarized from the 1:5,000 scale map and used to update the database. Attributes in the database were projected to 1990 but the map labels on the inventory mylars were not updated.

Since 1976, MoF standards and procedures for forest inventory have changed significantly. The previous inventory had become outdated and was limited in its utility for resource planning. ESA designations and overlays of other resource data are at various map scales and not displayed on the forest cover maps. Operational maps at 1:5,000 scale had been used for preparing update information but the updates had not been 'photo confirmed'. The methods used to map the updates ranges from sketch mapping to traverse and the reliability varies accordingly.

In approving Management Plan 5 (MP 5) in 1994, the provincial Chief Forester acknowledged the commitment by the Skeena Sawmills to undertake a re-inventory which could be used in preparing the next management plan.

OBJECTIVES

Skeena Sawmills retained Sterling Wood Group Inc. (Sterling Wood) to manage the re-inventory. A pre-inventory assessment (Appendix II) was completed by Sterling Wood in July, 1995 and reviewed by the MoF, also in 1995. The assessment included a review of the previous inventory, identification of strengths and deficiencies compared to current standards and recommendations for a re-inventory.

The recommendations developed from the pre-inventory assessment were incorporated into terms of reference for the re-inventory (Appendix III). The objective the re-inventory was to produce an updated timber inventory. Specific requirements were to:

- Meet or exceed MoF standards for a *standard forest inventory* (as opposed to a vegetation inventory).
- Map the forest cover on the provincial NAD 83, 1:20,000 scale TRIM base.
- Stratify the TFL into homogeneous land units from new 1:15,000 scale black and white photography using well-defined, standard criteria.
- Control the aerial photos to the TRIM base and transfer the forest cover types and planimetric updates by monorestitution. This method meets MoF accuracy standards for digital maps.
- Classify and label the forest cover following MoF procedures.
- Establish air and ground calls to provide references for classification.
- Establish temporary volume samples in types previously sampled in 1974.
- Develop localized over-mature volume estimates using ratio analysis.
- Produce digital overlays of all available non-timber resource information, to MoF specifications where applicable.
- Produce a digital inventory to MoF specifications for Forest Inventory and Planning (FIP) database files and forest cover (FC1) map files.

In late 1996 Sterling Wood requested proposals from six qualified forest inventory contractors and received proposals from three. The proposals were evaluated on the basis of qualifications, personnel, methodology, schedule and price. Forest Mensuration Services Inc. (FMS) of Cobble Hill, BC was awarded a contract to undertake the re-inventory in April 1997. FMS subcontracted the digital map production to Geosoft Systems Inc. of Nanaimo, BC.

METHODS

The re-inventory was done as a series of tasks and included the following: Acquire new black and white aerial photography.

- Assemble all existing inventory data for reference by the classifiers.
- Prepare a preliminary forest cover map by stratifying and classifying the new photos.
- Convert TRIM base maps to MoF digital FC1 format.
- Plot working maps. The working maps showed the TFL boundary as supplied in the MoF/TRIM files.
- Undertake field work to establish air and ground class for classification and temporary volume plots for localizing the over-mature volume estimates.
- Revise the preliminary forest cover polygons and labels based on the field experience.
- Produce digital FC1 Files and mylar forest cover maps and overlays on the TRIM base.
- Produce forest inventory and planning (FIP) files containing the forest cover attributes.
- Calculate Variable Density Yield Prediction (VDYP) inventory volumes and localize the over-mature volumes.

Some of these steps were done concurrently. Details of the inventory design, implementation and quality control procedures follow.

AERIAL PHOTOS AND BASE MAPS

Skeena Sawmills ordered new aerial photography for the re-inventory in 1995 but cloudy weather prevented flying. In 1996, photos covering the southern portion of the TFL were taken by Selkirk Remote Sensing Ltd. Again Selkirk was not able to obtain complete coverage due to weather. In 1997 aerial photography for the northern portion was completed but not until October. A flight line index (Appendix IV) is provided below.

The new, black and white photography is at approximately 1: 15,000 scale. The 1996 photography is of good quality. Some of the 1997 photos were taken later in the year than was desirable, resulting in shadow on north aspects, but are adequate quality for forest classification.

Gaps in the coverage along the western boundary of the TFL were filled-in with BC government photography taken in 1992. These black and white photos had been used in the North Coast TSA re-inventory.

BCGS 1:20,000 scale TRIM base maps were used for the re-inventory. The new air photos were controlled to the TRIM base using high elevation TRIM photos. TRIM digital files were converted to FC1 file specifications by Geosoft and by the MoF Resource Inventory Branch (RIB). MoF RIB converted letter block 103I.

The digital base maps included overlays of the cadastre and MoF administrative boundaries that define the TFL boundary. The most recent cadastre was only available for some of the maps. During the re-inventory, errors, omissions and changes in the TFL boundary were identified and corrected using the best available information. The problems ranged from simple edge matching across mapsheets to adding sections of the Alcan powerline right-of-way. A list of the edits to the cadastre is described in the digital map production section of the report.

STRATIFICATION AND CLASSIFICATION

Preliminary homogeneous strata were stratified by stereoscopic air photo interpretation. Procedures from the Forest Inventory Manual, Volume 2 and 4, were followed. Minimum polygon sizes of 2 ha and 0.5 ha were used for forest types and non-forest types respectively. The minimum size was not applied to polygons with history information. The stratification was finalized after completing the field work.

Forest cover polygons were classified using the procedures documented in the MoF Forest Inventory Manual (1991), Chapter 3. This manual includes a classification schema that defines the attributes that are assigned to various land cover types. A summary of the classification procedures and schema follows.

The landbase is first stratified as forest land, unproductive forest land and non-forest land. Forest land is further stratified by species composition, age, height, site class, crown closure, stand structure, density, environmental sensitivity (ESA) and history. The attributes assigned to forest land are as follows:

Species Composition: Estimated in tens of percent and listed in order of predominance. Percentage of gross volume for stands with an average DBH > 7.5 cm or of total stems otherwise. The following species codes were used:

Code	Common Name	Code	Common Name
B	Balsam	S	Spruce
BA	Amabalis fir	SE	Englemann spruce
BL	Subalpine fir	SS	Sitka spruce
CW	Western red cedar	SW	White spruce
FD	Douglas-fir	YC	Yellow cedar
H	Hemlock	AC	Cottonwood
HM	Mountain hemlock	AT	Aspen
HW	Western hemlock	DR	Red alder
LW	Western larch	EP	Birch
PL	Lodgepole pine		

Age*:* Estimated average age for the 100 largest diameter (DBH) trees per hectare of the leading species. Age is in years but has been estimated to the nearest decade unless field or history data were available. For uneven aged stands the age range is estimated. Age was grouped as follows:

Age Code	Class Limits (years)
1	1 - 20
2	21 - 40
3	41 - 60
4	61 - 80
5	81 - 100
6	101 - 120
7	121 - 140
8	141 - 250
9	251 +

Height*:* Estimated average height in metres for the 100 largest diameter (DBH) trees per hectare of the leading species. The following height class groupings were used:

Height Code	Class Limits (m)
1	0.1 - 10.4
2	10.5 - 19.4
3	19.5 - 28.4
4	28.5 - 37.4
5	37.5 - 46.4
6	46.5 - 55.4
7	55.5 - 64.4
8	64.5 +

Site Index*:* Calculated from age and height using MoF site index equations for stands 30 years and older and from growth intercept equations for stands less than 30 years. All site indices are for reference age 50 at breast height. A "special" site was assigned where site could not be accurately derived from age and height, for example for stands less than 10 years old, not restocked (NSR) and brush (NCBr) types, and previously suppressed stands.

Crown Closure*:* Estimated to the nearest five percent. Crown Closure was grouped as follows:

Code	Limits (%)
0	0 - 5
1	6 - 15
2	16 - 25
3	26 - 35
4	36 - 45
5	46 - 55

Code	Limits (%)
6	56 - 65
7	66 - 75
8	76 - 85
9	86 - 95
10	96 - 100

Density and Stocking Class*:* Density is the estimated stems per hectare. The following standard stocking class groupings were used:

Stocking Code	Applies To	Class Limits
0	Immature types	None
1	Mature types	>= 76 stems/ha, 27.5+ cm DBH
2	Mature types	< 76 stems/ha, 27.5+ cm DBH
3	Leading PL types	>= 311 stems/ha, 17.5+ cm DBH, and > 50% of stems 7.5+ cm DBH are > 12.5 cm DBH
4	Leading PL types	< 311 stems/ha, 17.5+ cm DBH or >=311 stems/ha, 17.5+ cm DBH and < 50% of stems 7.5+ cm DBH are > 12.5 cm DBH

Stand Structure*:* A multi-layered stand has more than one distinct layer that is discernible through air photo interpretation. All applicable stand attributes are classified for each layer.

Stand History*:* Disturbances, site preparation, regeneration and stand tending history were recorded in the forest cover database. History attributes include activity code, year and degree of disturbance. On the forest cover maps, history is shown using standard MoF Inventory Branch symbology.

ESA*:* Environmental sensitive areas were classified in accordance with the procedures in Chapter 2 of the Forest Inventory Manual. These areas may be sensitive to environmental modification or contain one or more significant non-forest resources. ESA polygons were classified as high and moderate for the following categories and wildlife species:

ESA Code	Category
A	Snow Avalanche
H	Water
P	Forest Regeneration (difficulty)
R	Recreation
S	Soil
W	Wildlife

The following wildlife species codes were assigned to Ew polygons:

Wildlife Code *	Species
B	Bear
G	Goat
M	Moose

A fisheries category was used to classify streams for fisheries value and stream sensitivity. The fisheries classification is recorded on the forest cover map using symbols, not as a polygon attribute.

PHOTO PREPARATION AND DATA TRANSFER

Data transferred included about 1,600 temporary sample plots (TSP) from the previous inventory and 34 permanent sample plots (PSP). None of the air call information from the previous inventory was available as it was not recorded on the inventory photos or formally documented.

TSP data were stereoscopically transferred from the original photos to the new photos. PSP locations were transferred from maps. All transfer work was done to MoF specifications as per the Forest Inventory Manual (1991). All data transferred was assessed for accuracy by certified photo interpreters.

Cutblock boundaries were mapped from the aerial photos using monorestitution. Internal silviculture stratum boundaries were transferred from silviculture maps and labels assigned from silviculture records. Each opening was checked and adjustments made where the inventory label differed significantly from the silviculture label. A common adjustment was to add non-productive types that could be seen on the air photos.

FIELD WORK

Field work was undertaken in 1997 during three periods: July 15 to August 5, September 6 to 23 and November 27 to December 2. A total of 276 ground calls and 900 air calls were established. The plot location, sample number and year of these samples are included in the FC1 files and shown on the forest cover mylars. Sample locations have also been recorded on the new air photos.

Ground and air samples were established according to a sampling plan to:

- Support the stratification and classification by air photo interpretation.
- Provide ground estimates for localizing volume estimates.
- Provide ground measurements for estimating the site index of immature stands.

Ground Sampling Plan

The inventory sampling was designed to provide data for three age groups. The age groups and allocation of samples is shown in the following table.

Ground Samples by Age Group

Sample Type	Age Group	Age Classes	No. of Samples
Volume sample	Over-mature	8-9	200
Ground call (volume sample)	Older immature/mature	3-7	78
Ground call (site index sample)	Immature	1-2	198
Total			476

Over-mature Volume Samples

Volume samples were established in stands that had been sampled in 1974. Thirty strips were randomly selected from the original 200 strips. Two hundred prism plots were established along the strips in the same types that were previously sampled. The 1997 ground samples were used to update and localize inventory volumes using a two step procedure that is described in the area/volume compilation section of the report.

The strips lie approximately perpendicular to the contours and cross a wide range in elevation, from valley bottom to alpine forest. Most plots are located in age class 8 and 9, hemlock/balsam stands, as these are the predominant timber types. A map showing the strips from the previous inventory, indicating those which were re-visited is provided in Appendix I. The volume samples plot location, sample number and year are shown on the forest cover maps.

During the field sampling it was not possible to relocate the original strips and plots exactly. The strip lines and plots are shown on the 1976 inventory maps. Obvious tie-points were selected and the distance and bearing to the start of the strip determined from the forest cover maps. From the starting point, the original bearings and distances were followed and plots established at the approximate location of the 1974 sample.

Older Immature/Mature Volume Samples

Seventy-eight one-point ground samples (prism plots) were established in older immature/mature stands (age class 3 to 7). A comparison between ground and inventory VDYP volumes is included in the area/volume section of the report.

Immature Sampling

Fixed radius plots (198) were established in plantations and naturally regenerated areas. Top height, age and dbh at breast height of sample trees were measured. Hemlock and Sitka spruce growth intercept equations were used to calculate site index from the measurements. A comparison between immature and over-mature site indices is included in the results section of the report.

DIGITAL MAP PRODUCTION

The 82 digital maps produced for the inventory are standard MoF FC1 files containing the new forest cover and a series of overlay levels on the TRIM base. The new air photos were controlled to TRIM high elevation photos following MoF specifications for quality control. Forest cover line transfer was done using monorestitution to meet MoF specifications for TRIM base maps.

The BCGS at 1:20,000 scale TRIM base maps included the following overlays:

- Forest inventory region and compartment.
- Timber supply area and block.
- Land ownership.
- Forest region and district.
- PSYU, parks, etc.
- Agriculture land reserves.
- Provincial forest.
- Range
- Biogeoclimatic ecological classification.

As mentioned above, the most recent cadastre was only available for some of the maps. Significantly, the MoF RIB advised that cadastre for the Kitimat Municipality or the Kitimat Provincial Forest was not adequately controlled. Errors and omissions were identified and corrected during the re-inventory. Boundaries edits were made from 1:15,000 forest cover maps except for the Alcan powerline right-of-way between Kitimat and Kemano. The right-of-way was interpreted as the cleared area on the air photos and transferred to the map by monorestitution. The cleared area may differ from the legal boundary.

The MoF Resource Tenures and Engineering Branch has said that it intends to produce a digital version of the TFL boundary when the TRIM files are updated, but were unable to provide a date. The TFL boundary produced for this 1997 inventory should be reconciled to the MoF boundary when it becomes available.

The changes were made to the TFL boundary supplied by the MoF RIB are listed below.

Revision	Property	Mapsheet	Method
Excluded from the TFL area	Alcan powerline R/W	093E051,61, 103H070,78, 79,80,88,97, 103H098	Transferred from air photo using monorestitution. Follows cleared area that may differ from legal survey.
	TSX A03635 (Interfor TSX A16841)	103H067,68, 103H077,78	Digitized from 1:15,000 maps and registered to local features.
	TSX 83033, 86734	103H088	As above
	I.R. No. 4	103H088	As above
	Lot 3131(Alcan)	103H088	As above
	Lot 3059	103H088	As above
	Lot 98 (Marina)	103H097	As above
	I.R. No. 12	103H087	As above
Changed boundary	TSX80482 ,TSX92675 and TSX92614	103I028	Changed boundaries in accordance with Exhibit ‘A’ maps
	TFL boundary	103H048,58	Edge-matched boundary across mapsheets.
	TFL boundary	103H075,85	As above

Three other overlays were produced and included in the FC1 files. These are:

***Planning cells*:** Logical operating units were mapped from TRIM topography and ownership.

Operability: Operability maps were prepared by Skeena Sawmills using the new forest cover maps and TRIM topography. A report on the operability mapping has been filed with the Kalum Forest District Manager.

***Recreation inventory and visual landscape features*:** A recreation inventory of TFL was completed by Simons Reid Collins in 1998. Map overlays of recreation and visual landscape were produced in NAD 27 on an NTS grid at 1:50,000 scale. The overlays were digitized and converted to NAD 83, BCGS 1:20,000 scale overlays and incorporated in the FC1 files.

QUALITY CONTROL

Stratification and Classification

Sterling Wood checked the stratification for six mapsheets against the MoF guidelines for quality control (Appendix 31 of the Forest Inventory Manual). The stratification clearly met the MoF guidelines.

The final classification was checked for eleven mapsheets using the MoF standard rating method. The average rating was 98% and ranged from 96% to 99%. This rating exceeds the MoF minimum requirement of 85%.

Ground Sampling

Sixteen volume plots on three strip lines and twelve prism ground calls for a total of twenty-eight plots were checked in the field. Three plots checked did not meet the 85% acceptance rating, one because an extra tree was measured and two because the estimated tree heights differed from the measured heights by 11-21%. The estimated heights were not used in the inventory as sufficient height measurements were collected. An average rating of 89% was achieved which exceeds the minimum acceptable rating of 85%.

Forest Cover Maps and Attributes

The digital forest cover maps were produced to MoF standards for FC1 files with TRIM bases. The files are in single neatline format and have been vector cleaned. All mapsheets passed the MoF INVSPECS checking process. The FIP files passed the MoF FIPCHECK process including checks for the input, projected and resultant data. Standard quality reports and check plots were produced. The forest cover check plots were at 1:20,000 scale and overlays check plots at 1:50,000.

AREA/VOLUME COMPILATION

Forest cover attributes and files (FIP files) were produced by FMS. Sterling Wood calculated polygon areas and produced resultant records for the FIP files using a GIS. The volume for each polygon was estimated using the Variable Density Yield Prediction (VDYP) program.

Over-mature Volume Localization

Inventory VDYP volumes for over-mature stands were localized using the 1997 field samples in a two step process. First, the 1974 plot volumes were updated to 1997. Thirty sample strips were re-visited in 1997 and plots established in the same types that were sampled in 1974. Ratio analysis of the 1974 and 1997 plot volumes was done from the 176 plots in over-mature (age class 8 and 9) hemlock, balsam and cedar types. The results were used to update 1632 samples established in 1974. A second ratio analysis using these 1632 updated plot volumes was done to localize the VDYP volume.

In the ratio method, an auxiliary variable, x , that is correlated with y is obtained. The aim of this method is to obtain increased precision by taking advantage of the correlation between x and y. In updating the 1974 volume, x is the 1974 plot volume and y is the 1997 volume. The ratio method uses the sample to estimate the relative change in volume (Y/X) that has occurred between the sampling dates. As shown in the following table, the 1997 volume averages about 90% (ratio = 0.9068) of the 1974 volume.

Ratios for updating 1974 volumes

Leading Species	No. of Plots	Gross Volume less DWB (m^3)			Correlation	r^2 at 95%
		∑ 1974 plot volumes	∑ 1997 plot volumes	Ratio		
Hemlock	142	72,024	67,831	0.9418	0.467	0.174*
Balsam	21	13,812	9,869	0.7145	0.204	0.423
Cedar	13	5,776	5,378	0.9311	0.472	0.532
Total	176	91,611	83,078	0.9068		

*** Significant at the 95% probability level**

The decrease in volume ranges from 29% for balsam to 6-7% for hemlock and cedar types. The ratio estimate is only significant for leading hemlock. These ratio estimates were applied to the 1974 inventory plot volumes for leading hemlock, balsam and cedar, age class 8 and 9.

A second ratio analysis was done to localize the VDYP volumes to the updated 1974 plot volumes. In this analysis, x is the updated plot volume and y is the VDYP inventory volume. Again, ratio estimates were derived for hemlock, balsam and cedar, age class 8 and 9 types.

There were 1,632 of the 1974 volume plots in these types that have not been logged. As shown in the table below, the updated ground volume ranges from 72% of the VDYP volume for balsam types to 84% for cedar types.

Ratios for localizing VDYP over-mature volumes

Leading Species	No. of Plots	Gross Volume less DWB (m^3) ∑ VDYP volumes	∑ Updated volumes	Ratio	Correlation	r^2 at 95%
Hemlock	1248	722,521	582,151	0.8057	0.693	0.062*
Balsam	202	142,443	102,136	0.7170	0.475	0.138*
Cedar	182	79,872	67,461	0.8446	0.659	0.159*
Combined	1632	944,836	751,748	0.7956		

*** Significant at the 95% probability level.**

The VDYP inventory volume overestimates the updated ground sample volumes for these types by about 20% on average. The overestimation is about 28% for balsam, 19% for hemlock and 16% for cedar. All of the localization ratio estimates are significant. The localization ratio estimates were applied VDYP inventory volumes for leading hemlock, balsam and cedar, age class 8 and 9 types. The localized volume for various land categories is summarized below.

Average volume

Land Class	Average Volume
Gross, mature area	382 m^3/ha
Mature, operable area	516 m^3/ha
Mature, conventional area	522 m^3/ha

The 1997 MoF inventory audit (Appendix V) of mature timber on the operable area reported an average ground volume of 506 m^3/ha. The operability classification was revised in 1998. If it is assumed that the operable area sampled in the audit corresponds approximately to the 1998 conventional operability class then the localized VDYP average volume of 522 m^3/ha is comparable to audit average. The localised volume is close to the mean and well within the audit confidence interval of 452 m^3/ha to 560 m^3/ha. The audit volumes quoted here are gross volume less DWB for tree classes 1 and 2, 17.5 cm+ DBH.

Older Immature/Mature Volume

The measured ground sample volume for age classes 3 to 7 is compared to the inventory VDYP volume in the following table. The VDYP inventory volume under-estimates the ground sample volumes for these types by about 28%. The difference ranges from 61% higher for balsam types to 1% lower for alder types.

Ratios of VDYP to sample volumes for older immature/mature types

Leading Species	No. of plots	Gross Volume less DWB (m^3) ∑ VDYP Volumes	∑ Ground Volumes	Ratio	Correlation	r^2 at 95%
Hemlock	43	23,615	29,532	1.2506	0.617	0.0304 *
Balsam	5	3,053	4,917	1.6106	0.546	0.7540
Spruce	2	1,375	1,543	1.1225	-	-
Alder	1	245	242	0.9864	-	-
Combined		28,287	36,234	1.2809		

*** Significant at the 95% probability level.**

Only the hemlock localization ratio estimate is significant. These localization ratios have not been used when generating the age class 3 to 7 volumes because of the low sampling intensity. They could be applied as a sensitivity analysis to the mature volume in the timber supply analysis for the next management plans.

RESULTS

The objectives for the TFL 41 re-inventory have been met. The inventory was conducted in accordance with the MoF procedures for a standard forest inventory. Forest cover types have been delineated on new air photos and verified in the field. Stratification resulted in 37,394 polygons in total, or 780 polygons per full mapsheet equivalent. A large area previously classified as non-forest was reclassified as non-productive and productive forest land. Ratio sampling was used to collect field data for volume localization.

The 1997 forest inventory is in a digital format that is compatible with MoF specifications. The forest cover maps have been produced on a TRIM base by transferring type boundaries, including silviculture openings, from recent aerial photos to the map by monorestitution. These mapping techniques meet MoF map accuracy standards. Standard forest cover mylars were produced from the digital data for the 82 mapsheets that cover TFL 41.

Standard map overlays of non-timber resources have been produced and are included in the 82 forest cover map files (FC1). Forest cover polygon and resultant areas have been compiled in a GIS and 82 attribute files (FIP) produced.

The 1997 forest inventory provides a updated, standard database and maps for management and strategic planning.

AREA SUMMARIES

Areas are summarized from the resultant area in the FIP files. Resultant areas in the FIP files are rounded to the nearest tenth hectare but are reported here to the nearest hectare.

The gross land base of TFL 41 is 703,689 ha. This differs from the previous land base of 1,019,740 ha reported in MP 5 due to amendments and re-mapping. TFL 41 had three amendments to the gross area since MP 5:

- 321,120 ha were relinquished for the Kitlope Conservancy area.
- 139.45 ha was relinquished for an addition to the Haisla Indian Reserve No. 2 at Minette Bay.
- Timber Licence T0991 (1,082.94 ha) was added in exchange for the addition to the I.R. No. 2.

The new TFL boundary was provided by the MoF RIB for the re-inventory. Portions of the TFL boundary are defined by the height of land. Previously the height of land was drawn from NTS contour maps. The present height of land is drawn from TRIM contours. The two interpretations of the height of land differ.

The following tables summarize the gross productive and non-productive land. Productive forest land is capable of producing a commercial crop of trees regardless of whether it is currently forested or not. Thus it includes NSR and non-commercial cover. Non-productive forest land includes both non-productive forest types (e.g., alpine forest, swamp forest and non-productive brush) and non-forest types (e.g. rock, swamp and roads).

Land Class	Area (ha)
Productive land	332,910
Non-productive land	370,779
TOTAL TFL 41	**703,689**

Productive forest land by age and site class

Age Class	5 m Site Class (SI_{50})							Total (ha)
	< 10	10-14	15-19	20-24	25-29	30-34	35-39	
9	58,265	97,747	40,762	951		18	3	197,747
8	10,735	13,825	6,756	1,443	175	60	16	33,008
7	2,287	2,034	1,015	471	77	28	40	5,953
6	4,272	1,502	1,484	804	394	104	36	8,598
5	3,980	673	293	359	300	88	19	5,713
4	1,806	668	201	440	645	173		3,934
3	1,508	653	279	570	870	261	48	4,190
2	143	706	1,125	4,741	2,125	502	28	9,370
1		222	644	13,347	2,635	230	10	17,088
NSR/NCC	4,741	19,857	9,455	12,340	917	1		47,311
TOTAL	**87,738**	**137,888**	**62,015**	**35,466**	**8,137**	**1,465**	**201**	**332,910**

Non-productive land

Category	Area (ha)
Alpine, alpine forest	318,549
Lakes, rivers, swamps, tidal	7,055
Rock	6,773
Urban, roads	191
Other (e.g., NP, NPBr)	38,203
TOTAL	**370,779**

The preceding area summaries may not match gross areas reported in the timber supply analysis for management plan 6 due to differences in rounding and modelling criteria.

VOLUME SUMMARIES

The summaries provided below are based on FIP resultant areas and inventory VDYP volumes. The VDYP volumes were localized for over-mature types (age class 8 and 9). Volume is net of decay, waste2 and breakage (DWB) for all species, with compilation limits of DBH 17.5 cm, top diameter (DIB) 10.0 cm and stump height 0.30 m.

The volume is summarized for the gross productive land base. No area reductions have been made for operability, riparian reserves and other factors that affect availability of the timber for harvesting.

Area and Volume by Age Class

	Mature		Immature		NCC/NSR	TOTAL PRODUCTIVE	
Age Class	(ha)	(m^3)	(ha)	(m^3)	(ha)	(ha)	(m^3)
9	197,722	78,474,897			22	197,745	78,474,897
8	33,008	10,536,099				33,008	10,536,099
7	5,951	1,595,315			2	5,953	1,595,315
6	384	115,022	8,214	1,804,492		8,598	1,919,514
5	416	106,439	5,297	468,657		5,713	575,096
4			3,934	599,215		3,934	599,215
3			4,190	488,494		4,190	488,494
2			9,352	297,569	18	9,370	297,569
1			16,738	20,333	351	17,088	20,333
-					47,311	47,311	-
TOTAL	237,481	90,827,772	47,724	3,678,760	47,704	332,908	94,506,532

Mature Volume by Species

Leading Species	Area	Volume		
	(ha)	(m^3)	(%)	(m^3/ha)
Hemlock	192,751	71,831,583	79%	373
Balsam	20,841	9,514,840	10%	457
Cedar	13,859	5,169,498	6%	373
Spruce	3,382	2,622,379	3%	775
Yellow cedar	5,173	1,262,230	1%	244
Deciduous	1,079	301,826	0%	280
Lodgepole pine	316	89,110	0%	282
Douglas fir	79	36,306	0%	458
TOTAL	237,481	90,827,772	100%	382

SITE INDEX COMPARISON

Site index is a measure of site productivity which is the capacity of a site to produce timber volume. Site indices for stands less than 30 years old were derived from age and height measurements taken during silviculture surveys and ground calls. The site index was calculated using growth intercept equations. For stands older than 29 years, site indices were calculated from age and height measurements or estimates using VDYP.

In theory, the site index of an area should not change when a mature stand is harvested. Numerous studies around the province, however, have shown that the site indices assigned to over-mature stands often underestimate productivity. Site index estimates from ground plots are summarized by age groups in the following table. A comparison of the average site indices below shows that those assigned to immature stands (age classes 1 and 2) range from 0.3 m to 12.6 m greater than over-mature stands (age classes 8 and 9).

Leading Species	Age Class 1-2		Age Class 8 -9		Difference
	Average Site Index	No of Polygons	Average Site Index	No of Polygons	Average Site Index
Hemlock	25.9	88	13.3	119	12.6
Balsam	24.9	12	16.4	20	8.5
Cedar	23.0	1	13.9	20	9.1
Spruce	26.3	13	26.1	6	0.3

A similar difference between the over-mature and immature site index was noted by the MoF in a paired-plot study[1] in 1995 for the Kalum Forest District. From 23 paired-plots established in hemlock stands, the mean site index for over-mature stands was 13.5 m and the immature average was 24.7 m, for a difference of 11.5 m.

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[1] *Site Index Adjust for Old-growth Coastal Western Hemlock Stands in the Kalum Forest District* 1997 Gordon D. Nigh and Bobby A. Lowe, Ministry of Forests Research Program

APPENDIX I

MAP OF INVENTORY STRIP LINES

APPENDIX II

PRE-INVENTORY ASSESSMENT

APPENDIX III

RE-INVENTORY TERMS OF REFERENCE

APPENDIX IV

1996/97 AIR PHOTO FLIGHT INDICES

APPENDIX V

MINISTRY OF FORESTS AUDIT OF THE 1976 INVENTORY

APPENDIX C.

TFL 41 Allowable Annual Cut Determination

(to be inserted once completed)