Revelstoke Community Forest Corporation
Management Plan #4

<u>Analysis Report</u>

Version 1.2

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Executive Summary

This report documents the Management Plan 4 (MP4) timber supply analysis completed for Tree Farm Licence 56 (TFL 56), held by the Revelstoke Community Forest Corporation (RCFC). The purpose of the review is to examine the short- and long-term effects of the current forest management practice on the availability of timber for harvesting in the TFL. A review of this type is typically completed every 5 years in order to capture changes in data, practices, policy, or legislation influencing forest management in the TFL. The previous analysis (MP 3) was completed in October 2000 with a final Annual Allowable Cut (AAC) determination on March 28, 2001. The Deputy Chief Forester signed an AAC review postponement order on December 13, 2005 extending the MP3 AAC determination. The current analysis process (MP 4) is working toward a new AAC determination to be in place by May 31, 2009.

The current allowable annual cut (AAC) for the TFL is 100,000 m³/yr and no partitions exist.

The TFL 56 MP4 Information Package, a document providing detailed technical information and assumptions regarding current forest management practices, policy and legislation for use in this analysis, was released in August 2008 and the final version that was accepted by the Forest Analysis and Inventory Branch on January 6, 2009. The release of this Analysis Report is the next step in the timber supply analysis process. Its purpose is to summarize the results of the timber supply analysis, provide a focus for public discussion, and provide British Columbia's Chief Forester with much of the information that is needed to make an informed AAC determination for the TFL.

This report focuses on a forest management scenario that reflects current management practices in the TFL (the "Base Case" scenario). Sensitivity analyses based on this scenario are used to assess how results might be affected by uncertainties in data or assumptions. Together these analyses form a solid foundation for discussions around the determination of an appropriate timber harvesting level.

TFL 56 covers an area of approximately 119,820 hectares and is situated north of the town of Revelstoke. The area of the TFL considered available for timber production and harvesting under current management practices is called the timber harvesting land base (THLB). The THLB area determined for this analysis is 22,575 hectares. This area includes the spatially mapped Old Growth Management Areas (OGMA's) because they are not permanent spatial reserves and areas required to meet mature+old seral objectives. If these areas are also removed from the THLB in order to allow a fair comparison with the MP3 THLB (30,702 - 9,074 MFRA's = 21,628 ha), the MP4 area drops to 21,556 ha. Thus, the effective THLB in MP4 is 72 ha (0.3%) smaller than the THLB in the previous management plan.

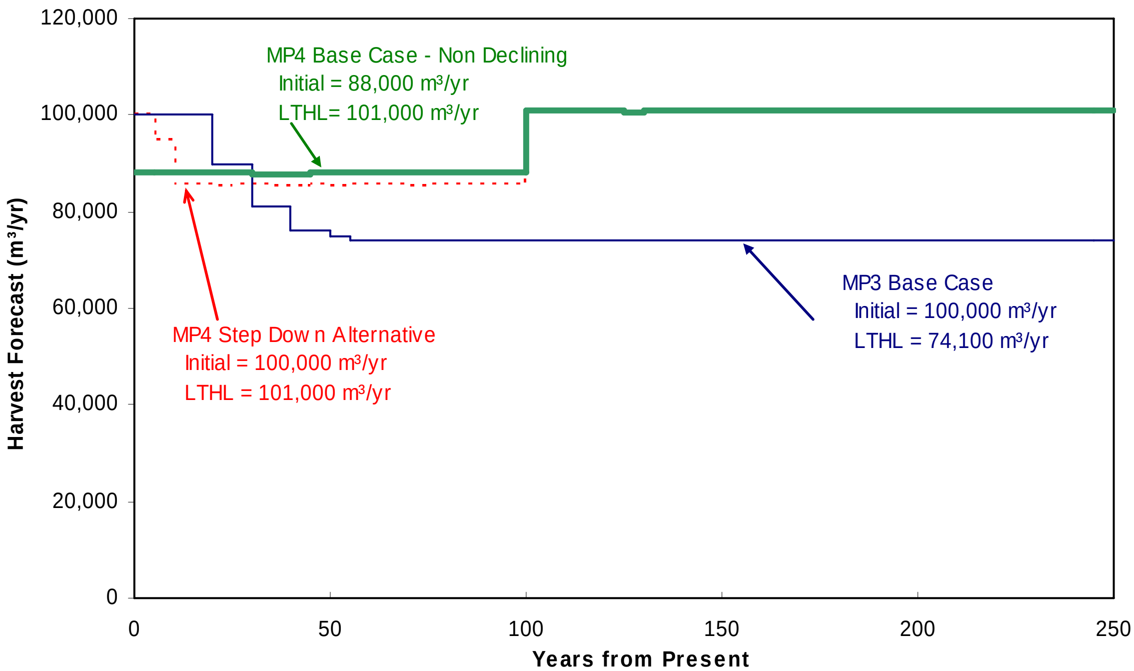
Since the last timber supply analysis for TFL 56, many changes affecting forest management have occurred. The major changes from MP3 are:

- The inventory was updated in 2002 to VRI standards (Phase 1 only). Forest cover attributes were updated to 2008.
- As a result of the new inventory, the definition of the non-productive forest was revised to be based on the VRI inventory attributes as well as the logging history.
- The Higher Level Plan Order (HLPO, October 26, 2002) has given legal status to Landscape Units, Biodiversity Emphasis Options with Old and Mature Retention Targets, Connectivity Corridors, Caribou Management Areas, and Scenic Corridors.
- Spatially explicit Old Growth Management Areas (OGMA's) have been developed to satisfy Old landscape biodiversity requirements set out in the Revelstoke Higher Level Plan.
- The Species at Risk Coordination Office (SaRCO) has drafted caribou management guidelines (Draft GAR Order #U-3-005) and associated spatially explicit reserves which were removed from the timber harvesting land base (approximately 7,984 ha impact – status quo and incremental reserves).
- MP3 modeled retention requirements for Ungulates (Deer and Moose); however with the approval of the HLPO, the need to manage for ungulate was no longer mandated.

- Operability was reviewed in 2008 by RCFC and resulted in a reduction of operable area relative to the 1999 operability.
- Wildlife Habitat Areas (WHA's) have been established since MP3.
- Use of select seed with associated volume gains was applied to future managed stands (1.4% for Douglas-fir and 13.0% for Spruce).
- SIBEC adjusted site indexes have been used in the ICH for managed stand yields. The use of SIBEC adjusted yields for the ICH was approved because the new PEM passed the accuracy assessment in the ICH. Growth intercept information from silviculture surveys was also used where available.

Results show the base case harvest flow starting at 88,000 m³/yr. This harvest level, which is 12% below the current AAC, is sustained for the first 10 decades and then increases to 101,000 m³/yr in the long term. This harvest flow was selected over the alternative where a series of downward reductions would occur over the next 10 years because it was considered preferable to move to a stable harvest level immediately. In all cases, a strong pinch point exists 45-55 years from now when the transition from natural to managed stands is first occurring in a significant way.

Base Case Scenario



The dramatic change in the harvest flow relative to MP3 is primarily a result of:

- Reduced starting available growing stock (new inventory attributes from VRI, 8 years of harvest have occurred since the MP3 projection).
- Helicopter harvest limited to 8% of the harvest volume in each period.
- Increased managed stand yields resulting from improved site index estimates (SIBEC) in the ICH and the use of improved (class A) seed.
- Minimization of very small (<3 ha) and very large (>250 ha) patches (played a small role).

In order to assess the impacts of potential changes to modeling assumptions, and gain further understanding of the dynamics at work in the base case forecast, a series of sensitivity analyses were completed.

Uncertainties that significantly altered the short-term harvest level were:

- Increase the size of the timber harvesting land base by 10% (+6%),
- Decrease the size of the timber harvesting land base by 10% (-10%),
- Limiting the pulp profile to 20% of the harvest volume each period (-14%),
- Increase of minimum harvest ages by 10 years (-12%),
- Reduction of natural stand yields (-13%),
- Increase of natural stand yields (+5%),
- Exclusion of hemlock leading stands greater than 80% (-7%),
- No management for mountain caribou (+18%)
- Only Status Quo caribou reserves – no incremental reserves (+6%)

Uncertainties that significantly altered the long-term harvest level were:

- Removal of SIBEC site index adjustments (-21%)
- Decrease in allowable pulp limit (-8%)
- Changes to the size of the timber harvesting land base (+/-10%),
- Decrease of future managed yield curves by 10% (-10%)
- Increase of future managed yield curves by 10% (+ 9%)
- Increase of minimum harvest ages by 10 years (-5%)
- No management for mountain caribou (+16%)
- Only Status Quo caribou reserves – no incremental reserves (+5%)

The short term harvest flow is very sensitive to decreases in natural stand volume or delays in when managed stands come online.

Based on the results presented here, RCFC requests a decrease in the AAC for TFL 56 to 88,000 m³/yr for the next 5-year term. This harvest level is felt to best reflect the community's desire for a balance between sustainable forest management and revenue generation.

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1.0 Introduction

Timber supply is the amount of timber available for harvest over time. Assessing timber supply involves consideration of a wide range of physical, biological, social, and economic factors that can influence the acceptable rate of timber harvesting within a management unit. These factors encompass both the timber and non-timber values found in our forests and ensure that timber harvesting objectives are balanced against social and ecological values such as wildlife, biodiversity, watershed health, recreational opportunities, etc.

This document contains a timber supply analysis specific to Tree Farm License 56 (TFL 56) and is an important part of the provincial Management Plan (MP) process for TFL's. The general objective of the analysis process is to examine the short and long-term effects of current forest management practices on the availability of timber for harvesting in the TFL. A review of the projected timber supply is typically completed once every five years in order to capture changes in data, practices, policy, or legislation influencing forest management in the TFL. The previous analysis (MP 3) was completed in October 2000 with a final Annual Allowable Cut (AAC) determination on March 28, 2001. The Deputy Chief Forester signed an AAC review postponement order on December 13, 2005 extending the MP3 AAC determination. The current analysis process (MP 4) is working toward a new AAC determination to be in place by May 31, 2009.

The TFL 56 MP4 Information Package, a document providing detailed technical information and assumptions regarding current forest management practices, policy and legislation for use in this analysis, was released in August 2008[1] and the final version was accepted by the Forest Analysis and Inventory Branch on January 6, 2009. The release of this Analysis Report is the next step in the timber supply analysis process. Its purpose is to summarize the results of the timber supply analysis, provide a focus for public discussion, and provide British Columbia's Chief Forester with much of the information that is needed to make an informed AAC determination. This report does not define a new AAC – it is intended only to provide insight into the likely future timber supply of TFL 56 and recommend a future course of action to the Chief Forester. The final harvest level will be determined by the Chief Forester and published along with his rationale in an AAC Determination document.

This report focuses on a forest management scenario that reflects current management practices in TFL 56. This "Base Case Option" becomes the basis for sensitivity analyses that assessed how results might be affected by uncertainties in data or assumptions. Together these analyses form a solid foundation for discussions with the government and stakeholders in the determination of an appropriate timber harvesting level.

2.0 Description of TFL 56

TFL 56 covers an area of approximately 119,820 hectares and is situated north of Revelstoke. It is bounded on the west by the Lake Revelstoke reservoir, on the east by the height-of-land of the Selkirk Mountains, on the north by the Goldstream River and on the south by the Downie-Carnes height-of-land. The nearest settlement is Revelstoke, 40 kilometres to the south.

The land base is extremely rugged and dominated by two roughly east-west valleys – those of Downie Creek and Goldstream River – and one north-south valley, that of the Columbia River (Lake Revelstoke Reservoir). Elevation ranges from 573 metres at reservoir level to 3050 meters at Carnes Peak.

[1] The Tree Farm License 56 Data Package v1.0 was released in August 27, 2008 and was used to solicit public and First Nations review and comment. Version 2.0 was submitted to government for acceptance on December 29, 2008 and accepted by government staff on January 6, 2009.

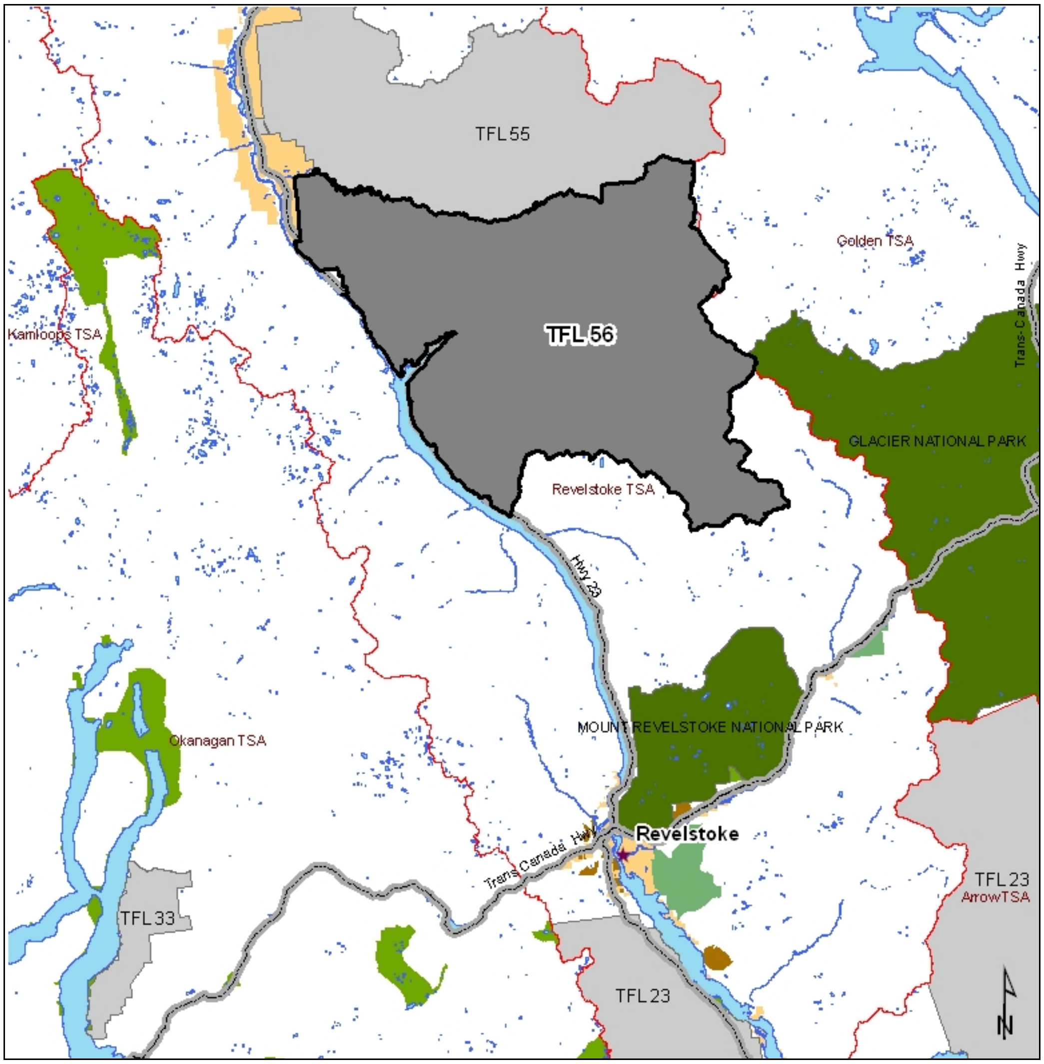


Figure 1. TFL 56 Overview Map

Only a small portion of the TFL's total areas is forested and an even smaller portion is suitable for timber harvesting. Most harvesting is confined to valley bottoms and sidewalls. The remaining "high country" is too rugged or does not support marketable timber.

The ruggedness has minimized human use, hence there are no settlements, little private land, and until recently little recreation use. One highway (Hwy 23N) traverses the TFL. Traffic is light and dominated by logging and other industrial traffic. Recreation use has increased in recent years and is dominated by three major groups. The first group consists of sport fishers and hunters. The second group consists of helicopter skiers and the third major group is composed of snowmobile recreationists. A fourth user group composed of self-propelled backcountry users is increasing as the area becomes more widely known and nearby parks become increasingly crowded.

Wildlife use in the TFL is extensive. Grizzly bears, black bears, moose, deer, and caribou are common. Caribou have become a very important management issue as they have been extirpated over much of their former range.

Wildlife species at risk due to declining populations across the province that occur or have the potential to occur in the TFL and are shown in (Table 1). There are 9 red-listed (Endangered or Threatened) and 26 blue-listed (Species of Concern) species.

Table 1. Red & Blue listed species that occur or have the potential to occur in TFL 56

Red-Listed (Endangered or Threatened)		**Blue-Listed (Species of Concern)**	
Scientific Name	English Name	Scientific Name	English Name
Acipenser transmontanus pop. 2	White Sturgeon (Columbia River population)	*Ardea herodias herodias*	Great Blue heron, herodias subspecies
Argia vivida	Vivid Dancer	*Asio flammeus*	Short-eared Owl
Papilio machaon hudsonianus	Old World Swallowtail, hudsonianus subspecies	*Boloria alberta*	Albert's Fritillary
Physella columbiana	Rotund Physa	*Botaurus lentiginosus*	American Bittern
Rana pipiens	Northern Leopard Frog	*Chlosyne whitneyi*	Rockslide Checkerspot
Rangifer tarandus pop. 1	Caribou (southern population)	*Chrysemys picta pop. 2*	Western Painted Turtle - Intermountain - Rocky Mountain Population
Speyeria mormonia eurynome	Mormon Fritillary, eurynome subspecies	*Colias meadii*	Mead's Sulphur
Sphaerium occidentale	Herrington Fingernailclam	*Colias pelidne*	Pelidne Sulphur
Vertigo elatior	Tapered Vertigo	*Euphagus carolinus*	Rusty Blackbird
		Grus canadensis	Sandhill Crane
		Gulo gulo luscus	Wolverine, luscus subspecies
		Hemphillia camelus	Pale Jumping-slug
		Hirundo rustica	Barn Swallow
		Magnipelta mycophaga	Magnum Mantleslug
		Martes pennanti	Fisher
		Myotis septentrionalis	Northern Myotis
		Oeneis jutta chermocki	Jutta Arctic, chermocki subspecies
		Oncorhynchus clarkii lewisi	Cutthroat Trout, lewisi subspecies
		Oreohelix strigosa	Rocky Mountainsnail
		Oreohelix subrudis	Subalpine Mountainsnail
		Ovis canadensis	Bighorn Sheep
		Patagioenas fasciata	Band-tailed Pigeon
		Polites themistocles themistocles	Tawny-edged Skipper, themistocles subspecies
		Salvelinus confluentus	Bull Trout
		Somatochlora forcipata	Forcipate Emerald
		Ursus arctos	Grizzly Bear

Source: Conservation Data Center database query, January 9, 2009.

2.1 First Nations

The following First Nations groups have asserted traditional territories within the TFL: the Akisq'nuk First Nation, the Okanagan Indian Band, the Shuswap Indian Band, the Splatsin First Nation, the Ktunaxa Nation Council, the Okanagan Nation Alliance, and the Shuswap Nation Tribal Council.

The following bands have conducted traditional use studies on or near the TFL: the Neskonlith Indian Band, The Adams Lake Indian Band and the Little Shuswap Indian Band. Archaeological Overview Assessments and Traditional Use Surveys are conducted as required to ensure the protection of cultural heritage resources. Archaeological sites can often occur in riparian areas that are already deducted from the timber harvesting land base, and where this does not occur, sensitive sites are currently protected using management practices such as wildlife tree retention, machine free zones, or winter logging. RCFC actively participates in information sharing with First Nations. To date, there have been 14 areas that have had Archaeological Impact Assessments (AIA) conducted which have found no significant archaeological sites.

It is recognized that ongoing treaty negotiations with First Nations have the potential to impact timber supply in the TFL, however no settlement has yet been reached. This timber supply analysis does not limit, nor is it intended to limit ongoing treaty negotiations between First Nations groups and the governments of British Columbia and Canada.

2.2 The Environment

The TFL contains three biogeoclimatic zones: Interior Cedar Hemlock (ICH), Engelmann Spruce-Subalpine Fir (ESSF), and Interior Mountain Alpine (IMA). The majority of the TFL's timber harvesting occurs in the ICHvk 1, ICHwk1, and ESSFvc. See Figure 2 for a full area breakdown.

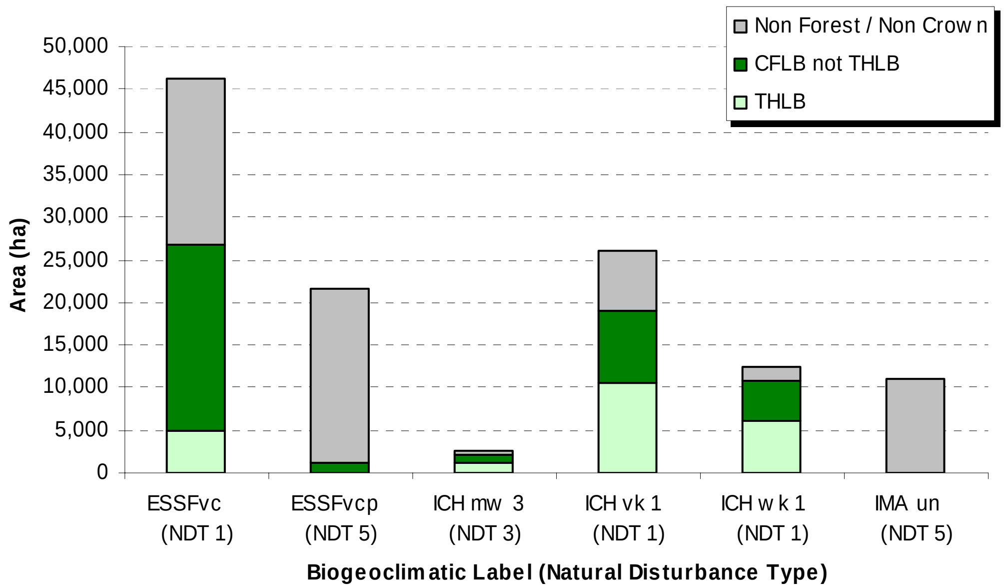


Figure 2. Biogeoclimatic variant and Natural Disturbance Type by land classification

2.3 Integrated Resource Management Considerations

Integrated resource management is a basic premise for the practice of forestry in TFL 56. Timber harvesting is planned and managed in such a way that allows a wide range of other values to co-exist on the land base. The manner in which each value is considered is dictated by federal or provincial legislation or BC government policy and described by RCFC's Management Plans. Examples of these are the federal Fisheries Act, the Forest and Range Practices Act, and the Revelstoke Higher Level Plan Order.

These documents address the legislated requirements for a wide range of non-timber issues. The most significant issues influencing forest management in TFL 56 are:

- Mountain Caribou
- Biodiversity
- Riparian / Fish Habitat
- Grizzly Bear

The areas affected by each of these non-timber resource values and the specific forest management practices required to address them are discussed in Section 3.3.1.

2.4 Current Attributes of TFL 56

This section of the document describes the current state of the TFL and provides descriptions and statistics useful for understanding the timber supply analyses presented later in the document. The Timber Harvesting Land Base (THLB) and the Crown Forest Land Base (CFLB) are referenced in this section and defined in detail in Section 3.1.

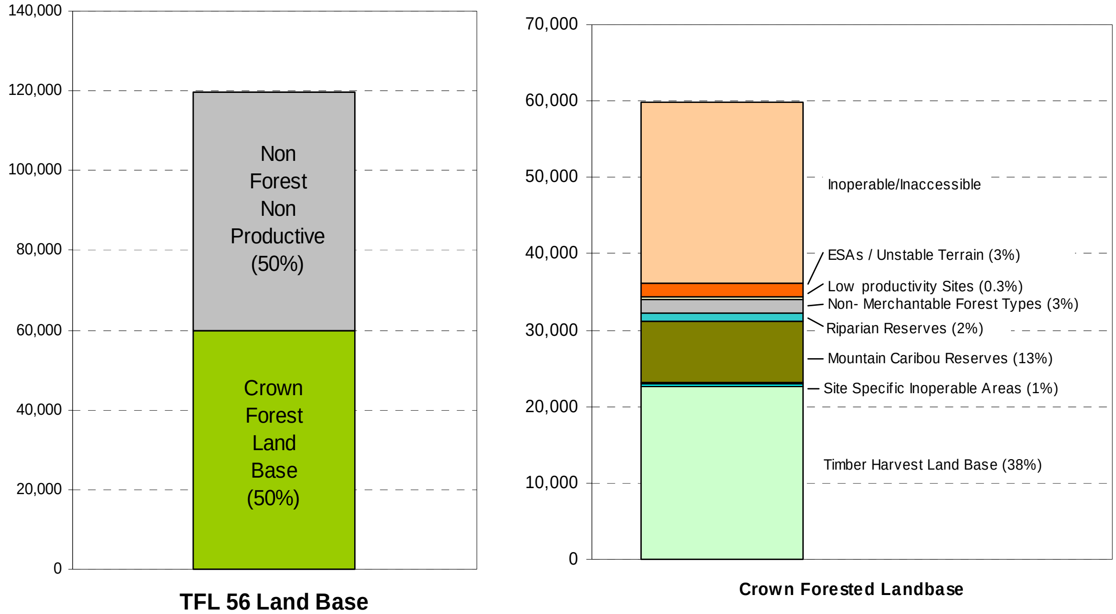


Figure 3. TFL Land Base Breakdown

Approximately 50% of the total area of the TFL is considered productive forest land. The remaining 50% is considered non productive (i.e. rock, ice, alpine, etc.). Within the TFL's productive land base, 38% (19% of the total TFL area) is considered available for timber harvesting (Figure 3).

A coarse map illustrating the locations of CFLB and THLB in the TFL is shown in Figure 4.

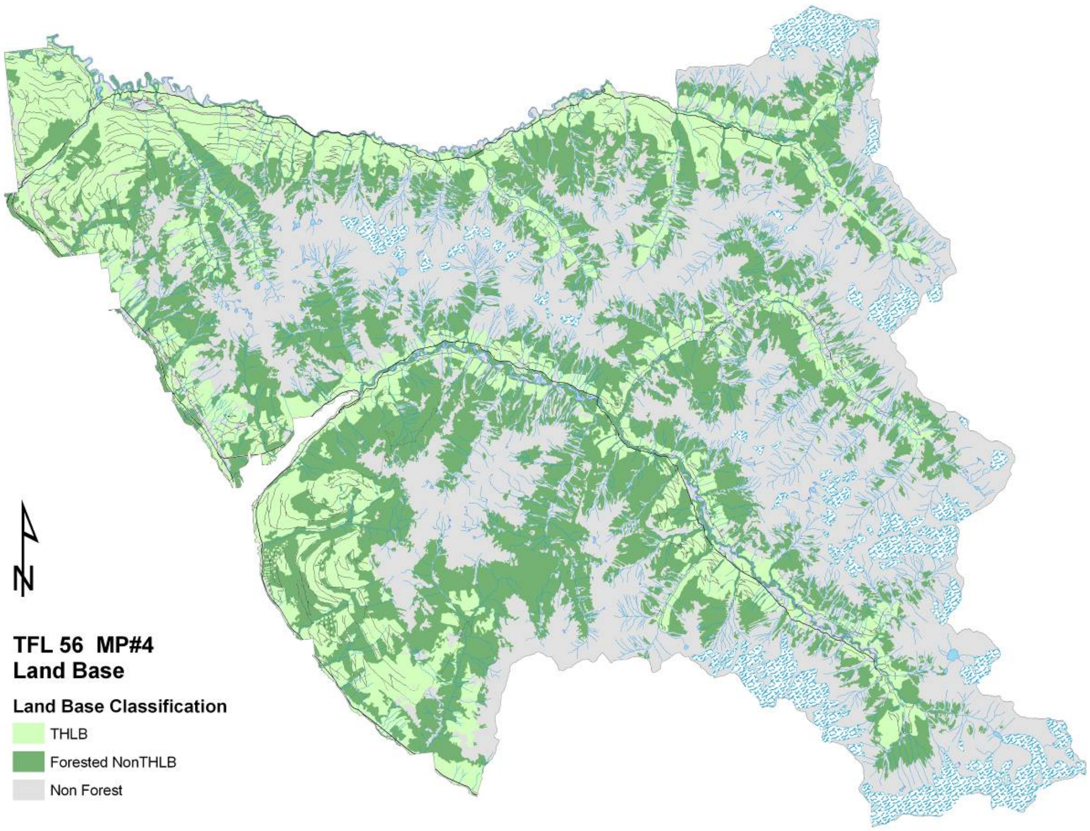
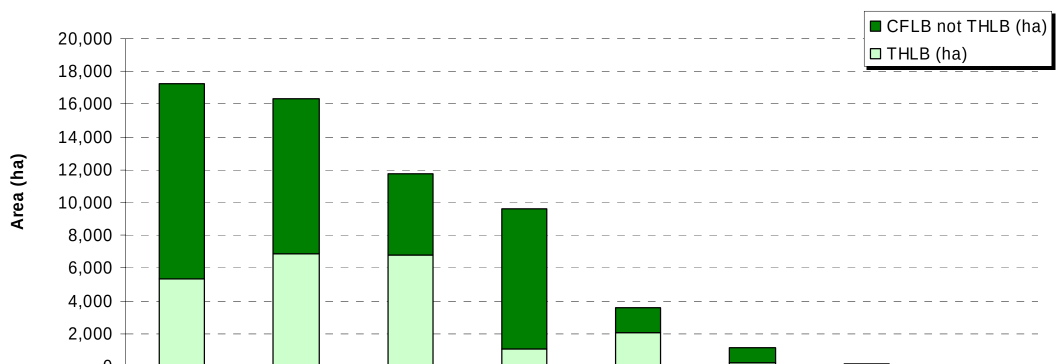


Figure 4. TFL 56 Land Base Classification Map

The forests of the TFL are dominated by hemlock, Engelmann spruce, western red cedar, subalpine fir, and Douglas-fir. Other species that occur less commonly include white pine, cottonwood, birch, aspen, and lodgepole line. An overview of the area by leading species for TFL 56 in 2008 is provided in Figure 5.



	Hemlock	Spruce	Cedar	Balsam	Douglas-Fir	Deciduous	White Pine	Lodgepole Pine
CFLB not THLB (ha)	11,912	9,506	4,963	8,493	1,522	881	3	0
THLB (ha)	5,330	6,862	6,822	1,106	2,061	249	134	11

Leading Species

Figure 5. TFL 56 current area by leading species

The age class structure over the entire productive land base is shown in Figure 6. Area is distributed across a wide range of age classes, with most THLB area falling within 0-100 and 230-320 years old.

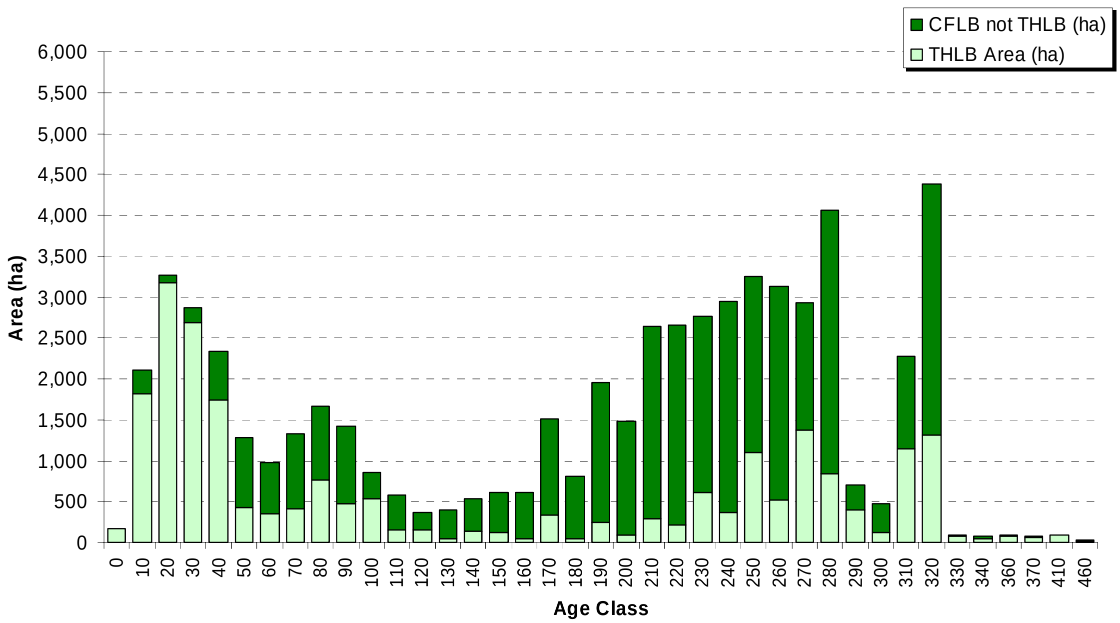


Figure 6. TFL 56 age class distribution in 2008

The inventory site index distribution is provided in Figure 7 while the SIBEC adjusted site index distribution is shown in Figure 8. Overall, the weighted average inventory site index on the THLB is 16.7m. This increases by 2.5m to 19.2m when SIBEC adjusted SI's are used in ICH stands[2]. This adjusted SI average would only be relevant when all stands have transitioned to managed stand yield curves post harvesting.

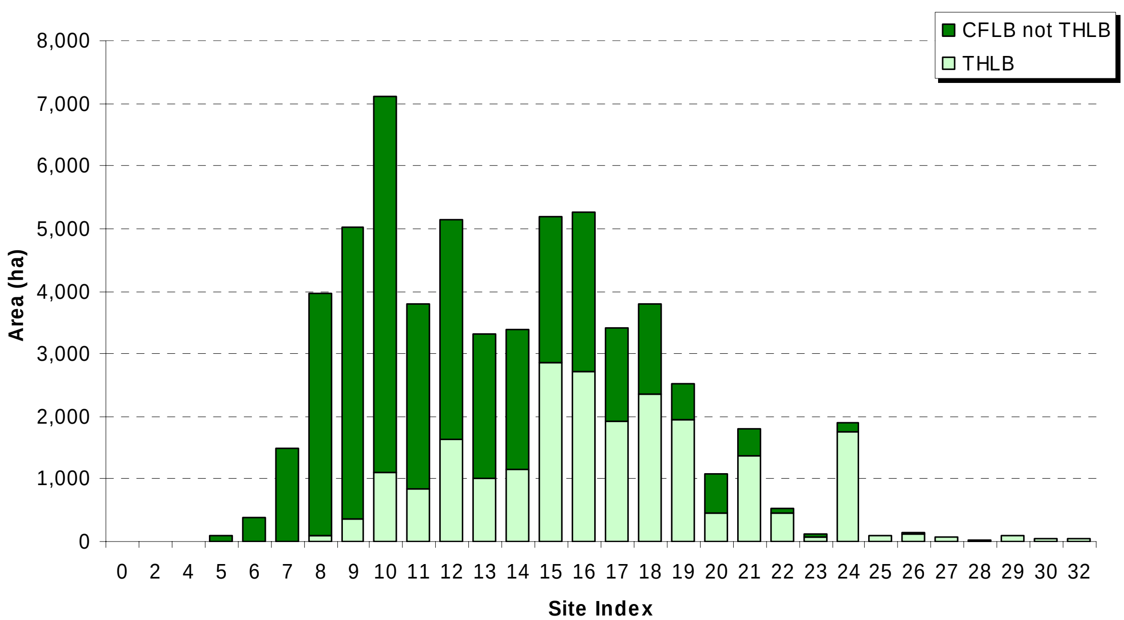


Figure 7. TFL 56 site index distribution (inventory)

2 Only the ICH portion of the land base was adjusted (described in detail in section 6.2.3 of Appendix 2)

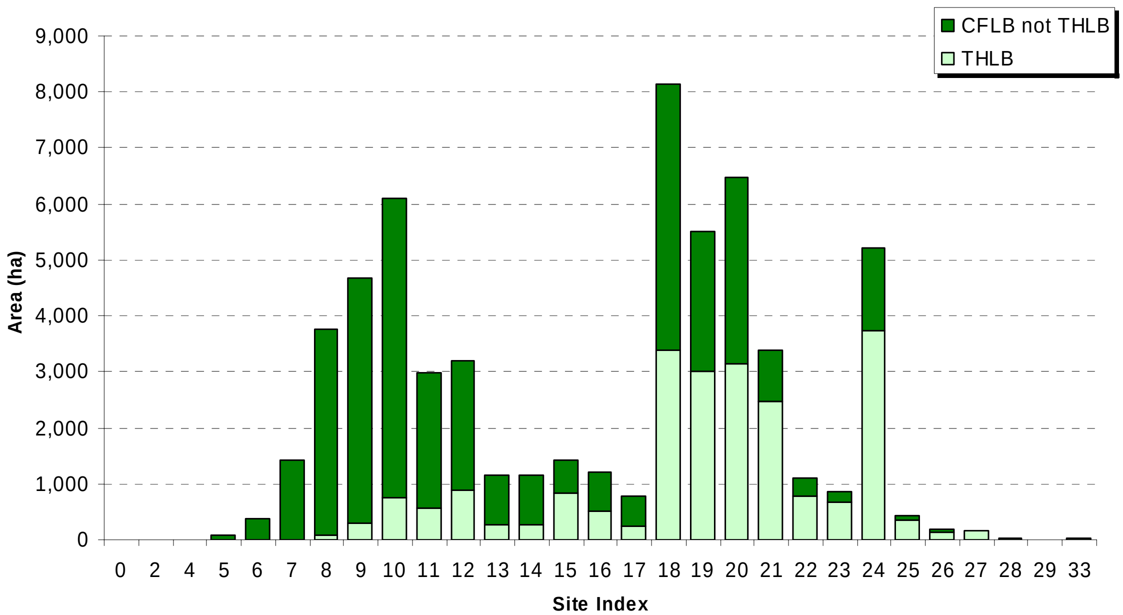


Figure 8. TFL 56 SIBEC adjusted site index distribution (only ICH stands adjusted)

3.0 Timber Supply Analysis Methods

A large amount of information is required to complete a timber supply analysis. Information must be obtained in four broad categories: land base, forest inventory, management practices, and forest dynamics. This information is then translated into a model formulation that can explore sustainable rates of harvest in the context of integrated resource management. This section provides a brief summary of the data inputs, assumptions, and modeling procedures fully described in Appendix 2.

3.1 Land Base Definition

The Crown Forest Land Base (CFLB) is the subset of the TFL that is considered forested and able to contribute toward non timber values such as biodiversity. The CFLB excludes non-crown land, woodlots, non-forest and non-productive areas. It also generally excludes federal crown lands such as First Nation Reserves. TFL 56 is composed almost entirely of Schedule B land (provincial land in TFL) but also contains a small amount of Schedule A land (5 small Timber Licenses) covering 1190 ha (~103 ha of un-reverted THLB). RCFC is currently in the process of eliminating all TL's in the TFL.

The Timber Harvesting Land Base (THLB) is the subset of the TFL where timber harvesting is anticipated to occur now or in the future. The timber harvesting land base excludes areas that are inoperable or uneconomic for timber harvesting, or are otherwise reserved for non-timber values. The THLB is contained entirely within the CFLB. Table 2 summarizes the land base for TFL 56 and includes both Schedule A and B land.

Table 2. Timber harvesting land base area netdown summary

Factor	Total area (ha)	Effective Area (ha)*	% of TFL	% of Crown forest
Total TFL Area		**119,823**	**100.0%**	
Non-forest / Non-productive forest		58,822	49.0%	
Existing roads, trails and landings		1,146	1.0%	
Total Crown Forested Land Base (CFLB)		**59,855**	**50.0%**	**100.0%**
Less:	In CFLB:			
Parks / LRUP Reserves		0	0.0%	0.0%
Inoperable/Inaccessible	23,770	23,770	19.8%	39.7%
ESAs / Unstable Terrain	1,822	1,741	1.5%	2.9%
Low Productivity Sites	3,540	360	0.3%	0.6%
Non-Merchantable Forest Types	2,503	1,725	1.4%	2.9%
Riparian Reserves	1,492	1,124	0.9%	1.9%
Wildlife Habitat Areas	2	2	0.0%	0.0%
Downie Saltlick	19	14	0.0%	0.0%
Mountain Caribou Reserves	10,611	7,984	6.7%	13.3%
Isolated THLB	123	123	0.1%	0.2%
Site Specific Inoperable Areas	669	437	0.4%	0.7%
Timber Harvesting Land Base –THLB (ha)		**22,575**	**18.8%**	**37.7%**
Less Other Removals:				
Estimate of Future Roads, Trails, and Landings		459	0.4%	0.8%
Wildlife Tree Patches		388	0.3%	0.6%
Old Growth Management Areas**		355	0.3%	0.6%
Effective Long-term THLB (ha)		**21,372**	**17.8%**	**35.7%**

* Effective netdown area represents the area that was actually removed as a result of a given factor. Removals are applied in the order shown above, thus areas removed lower on the list do not contain areas that overlap with factors that occur higher on the list. For example, the unstable terrain netdown only removes area from the crown, operable forested land base.

** The use of spatial OGMA's for the first 80 years serve to further decrease the THLB by 355 ha for an effective short-term THLB of 22,219 or long term THLB of 21, 372 ha. More detail on how landscape level biodiversity is modeled can be found in Section 10.5.1 of Appendix 2.

3.2 Forest Cover Inventory

The forest cover inventory is a key input to the timber supply review. The current vegetation inventory in TFL 56 meets VRI standards and has the following characteristics:

- Polygons and attributes updated in 2002 to Vegetation Resource Inventory (VRI) Standards using 1997 photos. This file has been updated for disturbances to Jan 2008 using RCFC data for logged areas. All logged areas were set to an age of 2 years and placed on existing managed yield curves.
- The forest cover attributes have been projected to January 1, 2008.
- No VRI Phase 2 adjustments currently exist for the inventory.
- Site indices for managed stands have been updated using Growth Intercept values from silviculture surveys where possible, and then SIBEC correlations (See Appendix 2 – Section 6.2) were used to adjust the remaining area (ICH stands only due to PEM accuracy issues in the ESSF).

3.3 Management Practices

Management practice assumptions can be grouped into three broad categories: Integrated Resource Management, Silviculture, and Harvesting.

3.3.1 Integrated Resource Management

Forest cover requirements are applied within the timber supply model to accommodate timber and non-timber resource objectives. These requirements maintain appropriate levels of specific forest types needed to satisfy the objectives for wildlife habitat, biological diversity, etc. Forest cover requirements are used by the model to limit harvesting within the THLB.

The type of objectives modeled and the size of the land base affected by each objective are summarized in Figure 9 and Table 3. The specific forest cover requirements modeled for each objective are provided in Appendix 2 – Section 10.0

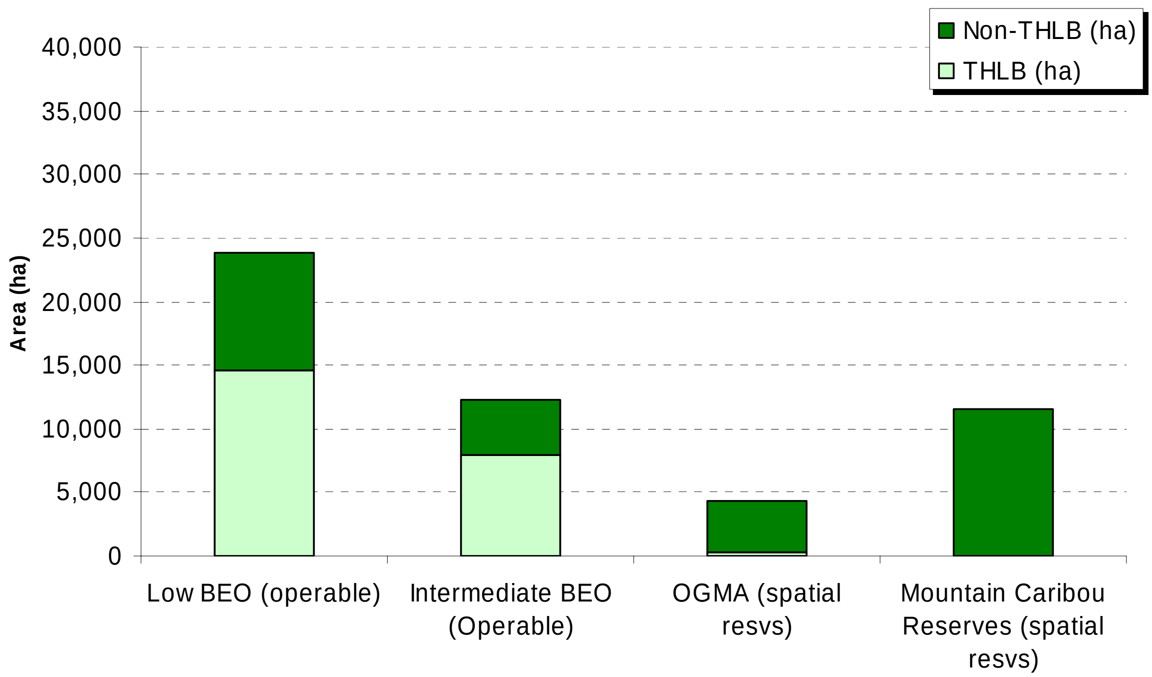


Figure 9. Integrated Resource Values: Operable Area Summary by Land Base Type

A summary of the areas over which various non-timber resource values occur is provided in Table 3. These areas cannot be summed to determine the total area affected because values overlap.

Table 3. Integrated Resource Values: Area Summary by Land Base Type

Value	CFLB (ha)	THLB (ha)	% of Total THLB	Non-THLB (ha)	% of total Non-THLB	Description
Low BEO (operable)	23,824	14,537	64.5	9,287	68.8	Biodiversity Emphasis Options (BEO's) define the amount of old and/or mature that must be retained in each LU/BEC variant combination. Mature+Old requirements not applied in low BEO areas (as per HLPO).
Intermediate BEO (Operable)	12,226	8,008	35.5	4,219	31.2	
OGMA (spatial resvs)	4,337	356	1.6	3,981	10.7	Spatially explicit OGMA's used for first 80 years.
Mountain Caribou Reserves (spatial resvs)	11,507	0	0.0	11,507	30.9	Applied as a land base netdown.

3.3.2 Silviculture

Historical and current silvicultural practices in the TFL have been included in the model. These include:

1. Silvicultural systems (only clearcut modeled) [Appendix 2 – Section 7.1]
2. Regeneration assumptions such as establishment method, species distribution, and establishment density (Appendix 2 – Section 7.2)
3. Regeneration delay (time between harvesting and when the site becomes stocked with crop trees) [Appendix 2 – Section 7.2], and
4. Use of select seed (Appendix 2 – Section 7.4).

3.3.3 Timber Harvesting

Assumptions around timber harvesting practices have also been included in the model and include:

- Minimum harvest ages that ensure a viable log are produced and long term volume production is not compromised. (Appendix 2 – Section 8.1)
- Minimum economic criteria for log size and stand volumes (Appendix 2 – Section 8.1).
- Land base definition criteria (unstable slopes, inoperable areas, low sites, etc.). These assumptions are outlined in detail in Appendix 2 - Section 5.0.
- Harvest priorities across the land base. Harvesting on the TFL was split into 3 main stratums: Regular harvest, Pulpwood harvest, and Aerial harvest. Dynamic limits were placed on the pulpwood volume (35%) and aerial harvest volume (8%) in each 5 year period to ensure the harvest volumes coming from each of these stratums were operationally realistic. (Appendix 2 – Section 11.4)

3.4 Forest Dynamics

Forest dynamics refers to the changing state of the forest through time. Changes occur as the forest ages, or when natural or human caused disturbances occur. The way in which the model addresses these issues is described below.

3.4.1 Growth and Yield

Timber growth and yield refers to the prediction of the growth and development of forest stands over time, and of particular interest, the volume and size of trees that would occur at the time of harvest. For modeling purposes, stands of similar characteristics, growth rates, and management are grouped together into Analysis Units (AU's). Analysis Units are described in Appendix 2 – Section 6.0.

Each analysis unit is associated with its own yield curve, which is a prediction of the gross and net volume per hectare at various stand ages. Minimum harvest ages are determined by comparing the yield curves to merchantability criteria, such as the minimum volume per hectare, or minimum stand diameter that must be reached before the stand will be eligible for harvest.

Two growth and yield models were used to estimate the yield curves used in the TFL 56 analysis. The Variable Density Yield Prediction (BatchVDYP 6.6d) model, supported by the Forest Analysis and Inventory Branch, was used for estimating timber volumes for all existing natural stands. The Table Interpolation Program for Stand Yields (BatchTIPSY 4.1c), developed by the Research Branch was used to estimate timber volumes for both existing and future managed stands. Existing managed stands are those that are currently under 28 years of age (established after 1980). Future managed stands are stands that will regenerate after they are harvested by the model during the planning horizon.

Based on timber volume estimates, the current timber inventory or growing stock on the timber harvesting land base is approximately 4.98 million cubic meters. Approximately 92% of this growing stock (4.5 million m^3) is currently merchantable (i.e. in stands older than their minimum harvest age).

3.4.2 Disturbances

Each year timber volume is damaged or killed on the THLB and not salvaged or accounted for by other factors. These losses are due to a number of factors that cause tree mortality, including insects, disease, blowdown, snowpress, wildfires, etc. In order to address losses from catastrophic natural events in the THLB, the model 'harvests' an extra volume of timber in each time period that is not counted toward harvest levels. Endemic pest losses are dealt with through factors applied in the growth and yield models. The annual unsalvaged loss applied in this analysis was 938m^3/yr. See Appendix 2- Section 9.1 for more detail.

Unsalvaged loss estimates address only the loss of merchantable volume from mature stands. The losses associated with immature stands also impact the rate at which timber becomes available in the TFL but little data is available to estimate the extent or impact of these losses. These disturbances are not modeled, but are captured during periodic inventory updates and are therefore reflected in subsequent timber supply analyses.

<u>Natural disturbances outside the timber harvesting land base:</u>
Because stands outside of the THLB contribute toward several forest cover objectives (i.e. landscape level biodiversity), it is important that the age class distributions in these stands are also modeled in a manner that is consistent with natural processes. By simulating natural disturbance in these stands, a more natural age class distribution can be maintained in the model and a realistic contribution toward seral goals ensured. An area of 70 ha is disturbed each year in the analysis to prevent age classes in the non-THLB from becoming unrealistically old during modeling. (Appendix 2 – Section 9.2). This disturbance causes the non-THLB stands to be turned over, on average, every 567 years.

3.5 Timber Supply Analysis Methods

Patchworks^{TM} modeling software was used to complete the timber supply analysis. Patchworks^{TM} is a fully spatial forest estate model that can incorporate real world operational considerations into a strategic planning framework. It utilizes a goal seeking approach and an optimization heuristic to schedule activities across time and space in order to find a solution that best balances the targets/goals defined by the user. Targets can be applied to any aspect of the problem formulation. For example, the solution can be influenced by issues such as mature/old forest retention levels, young seral disturbance levels, patch size distributions, conifer harvest volume, growing stock levels, snag densities, CWD levels, ECA's, specific mill volumes by species, road building/hauling costs, delivered wood costs, net present values, etc. Patchworks™ continually generates alternative solutions until the user decides a stable solution has been found. Solutions with attributes that fall outside of specified ranges (targets) are penalized and the goal seeking algorithm works to minimize these penalties – resulting in a solution that reflects the user objectives and priorities. Weightings are designed such that hard constraints are either met immediately or as soon as possible given the initial conditions.

The purpose of this analysis is to examine both the short- and long-term timber harvesting opportunities in TFL 56, in light of current forest management practices. Modeling assists the timber supply analyst in assessing the harvest flows associated with various scenarios. Management scenarios are groups of assumptions that define the extent of the timber harvesting land base, timber volumes, and the management regimes. The dominant scenario in this report is the Base Case Option, or current management scenario. Modeling was completed for a minimum of 300 years for each scenario to confirm that the harvest and growing stock levels remain stable.

The results of the analysis are an important part of the annual allowable cut determination process and aim to document future harvest flows that will not restrict future options in the TFL. The results presented here do not define a new AAC – they are intended only to provide insight into the likely future timber supply of Tree Farm License 56. The final harvest level decision will be made by the Chief Forester and published along with his rationale in an AAC Determination document.

3.6 Major Changes from Previous Timber Supply Review (MP3)

Changes have occurred in both the input data and management assumptions since the last timber supply analysis for the TFL (Management Plan 3 - MP 3). The major changes or differences from the last analysis are:

Land Base Definition changes:

- Updated Inventory. The inventory was updated in 2002 to VRI standards (Phase 1 only). Forest cover attributes growth and depletions to January 2008.
- Non-productive Forest Definition. As a result of the new inventory, the definition of the non-productive forest was revised to be based on the VRI inventory attributes as well as the logging history.
- Operability map. Operability was reviewed in 2008 by RCFC and resulted in a reduction of operable area relative to the 1999 operability linework.
- Downie Saltlick. The saltlick near the confluence of the Downie and Sorcerer creeks was excluded (approximately 19 ha in size)
- Exclusion of Heli-Hemlock. Helicopter access Hemlock leading stands were fully excluded as non-merchantable stands.
- Exclusion of WHAs. Wildlife Habitat Areas (WHAs) have been established since MP3 and were excluded from the timber harvesting land base (approximately 2 ha impact)
- Keystone LRUP Zone Ignored. In MP3 reductions were made for the then proposed Keystone Local Resource Use Plan (LRUP), however this plan was never made legal so no specific reductions were made. However, this has no effect because the area was removed through caribou reserves.
- SaRCO Caribou Management. The Species at Risk Coordination Office (SaRCO) has drafted caribou management guidelines (Draft GAR Order #U-3-005) and associated spatially explicit

reserves which were removed from the timber harvesting land base (approximately 7,984 ha impact – includes both status quo and incremental reserves)

- Old Growth Management Areas (OGMA's). Spatially explicit Old Growth Management Areas (OGMA's) were used to satisfy old seral landscape biodiversity requirements set out in the Revelstoke Higher Level Plan for the first 80 years, after which percent constraint targets were applied.
- Mature Forest Retention Areas (MFRA's). Mature Forest Retention areas were no longer used because they have been replaced by spatial OGMA's, Caribou reserves, and % constraints for mature + old seral objectives – and retention for ungulate winter range is no longer required.

When compared to the THLB from MP3 (30,702 - 9,074 MFRA's = 21,628 ha), the new effective THLB, which includes reductions for Caribou, spatial OGMA's, and area needed to satisfy mature+old requirements (22,575 -355 -664 =21,556 ha) is smaller by **72 ha (0.3%).**

Other Differences include:

- SIBEC and Growth intercept site index adjustments. Growth intercept information from silviculture surveys was considered the best possible information and used whenever possible. SIBEC adjusted site indexes were used in the ICH for post harvest regenerating stand yields. The use of SIBEC adjusted yields was limited to the ICH because of PEM accuracy issues in the ESSF. MP3 had conducted sensitivity analyses using Old Growth Site Index (OGSI) adjusted site indexes but had no SI adjustment in the base case.
- Revision of regeneration assumptions. Minor changes in species composition of regeneration species composition from MP3 as well as inclusion of select seed gains (described below).
- Select seed gains. Volume gains attributed to the use of improved (Class A) seed were included in the future managed stand yields (1.4% for Douglas-fir and 13.0% for Spruce).
- No Longer Modeling Complex Stand Yields. The analysis for MP3 modelled group selection silviculture on a subset of the land base (caribou areas) but this no longer considered best practices in these areas. Explicit caribou reserves have been defined and the areas outside of the reserves will be managed using clearcut with reserves silviculture systems.
- Non-recoverable losses. The estimate of NRL's in this analysis (938 m^3/yr) is 17 m^3/year lower than the MP3 analysis (955 m^3/yr).
- Revision of assumptions for Wildlife Tree Retention. A 1.75% reduction was applied to all yield curves. This reduction factor was determined by identifying the area of THLB further than 250m from forested areas not part of the THLB (~5,548 ha) and multiplying by the 7% WTR target (388 ha required or 1.75% of the THLB).
- No management of Ungulate Winter Range (UWR). Ungulate winter range (Deer and Moose) was managed for in MP3. However, ungulate winter range requirements are no longer required within the TFL.
- Patch size. Limits were placed on the creation of very small patch sizes (<3 ha) and very large patch sizes (>250 ha) in order to ensure operationally realistic harvest units in the modelling. Patches were defined as contiguous areas less than 20 yrs of age. This served to reduce the overall volume available to the model in MP4. MP3 implemented patch size using a non constraining approach.
- Pulpwood and aerial harvest controls. Limits were placed on the amount of pulpwood harvest (<35%) and aerial harvest (<8%) volume in each 5 year period to ensure operationally realistic harvest schedules were produced.
- Biodiversity. The Higher Level Plan Order (HLPO, October 26, 2002) has given legal status to Landscape Units, Biodiversity Emphasis Options with Old and Mature Retention Targets, Connectivity Corridors, Caribou Management Areas, and Scenic Corridors.
- Disturbance of the non-THLB. MP3 did not model disturbance of the non-THLB. In this analysis an average disturbance rate of 0.37% was applied (land base turned over every 567 yrs).

- No Ungulate winter range: MP3 modeled retention requirements for Ungulates (Deer and Moose); however with the approval of the HLPO, the need to manage for ungulate was no longer mandated.
- Use of Patchworks™. Patchworks™ was used to conduct timber supply modeling. This meant harvest and growth was evaluated annually within each period and consideration of operationally relevant factors such as block sizes and pulp/aerial profiles could be addressed directly.

4.0 Base Case Analysis

The base case scenario presented in this report is based on the best information currently available and reflects current management practices in the TFL. The current allowable annual cut (AAC) for TFL 56 is 100,000 m³/yr. This AAC was made effective April 18, 2001. Non-recoverable losses in the THLB are estimated to be 938 m³/yr and have, except where noted, been subtracted from the graphs, tables, and harvest forecasts in this report.

4.1 Alternative Harvest Flow Scenarios

Numerous alternative harvest forecasts are possible for a given set of modeling assumptions (i.e. the base case defined in Section 3.0). These alternative flows represent tradeoffs between short, mid, and long term harvest level objectives. Figure 10 shows two potential harvest flows for the TFL base case as well as the harvest flow from the previous timber supply review (MP3).

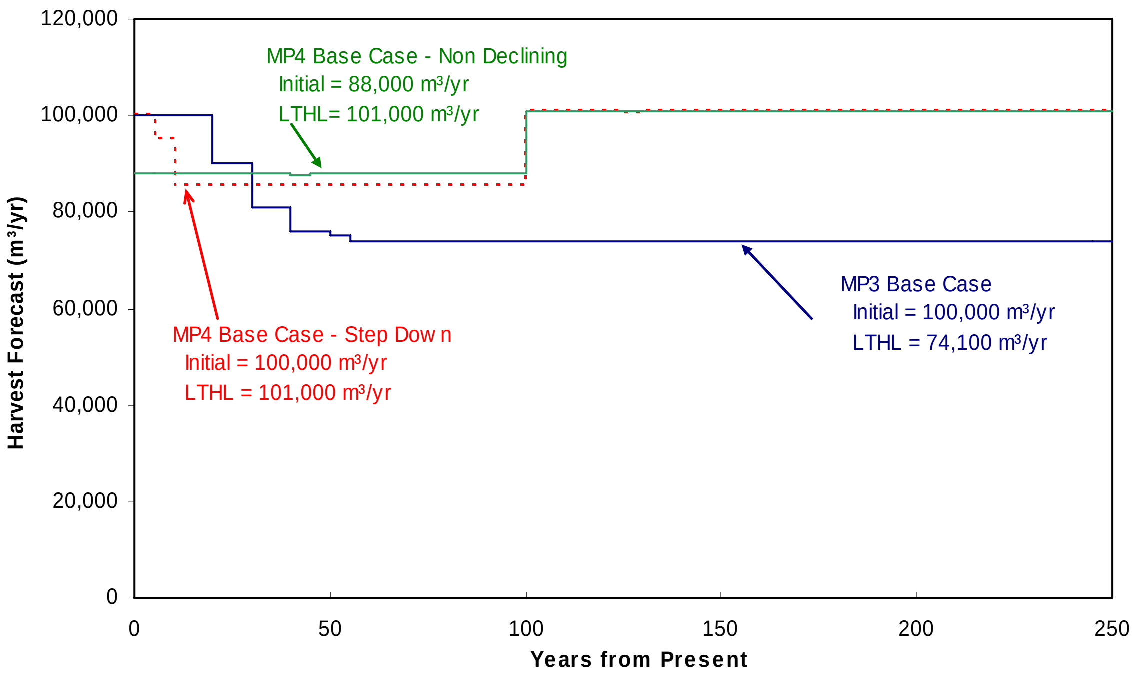


Figure 10. Alternative base case harvest forecasts for TFL 56

Alternative 1 (MP4 Base Case – Step Down) maintains the current AAC (100,000 m³/yr) for the first five years before declining to 94,900 m³/yr (5% drop) for the next 5 years, and then finally falling to the midterm level of 85,500 m³/yr by year 10. This harvest level is maintained for the next nine decades before it rises to the long term harvest level of 101,000 m³/yr.

Alternative 2 (MP4 Base Case – Non Declining) is a non-declining harvest scenario with a consistent harvest of 88,000 m³/yr for the first 100 years of the planning horizon. This harvest level, which is 12% below the current AAC allows for a slightly higher mid term harvest flow relative to the step down alternative presented above. Both alternatives result in a long term harvest level of 101,000 m³/yr.

For reference, the MP3 Base Case maintained a harvest of 100,000 m³/yr for as long as possible, and then stepped down to a sustainable long-term harvest level. It was able to maintain the current AAC for two decades before decreasing over the next 35 years to a low of 74,100 m³/yr in decade five. It then maintained this harvest level (26% below the current AAC) for the long term.

The change in the harvest flow relative to MP3 is primarily a result of:

- Short term harvest difference: A reduction in starting available growing stock (even though the THLB is slightly larger) because of new inventory attributes from VRI work, 8 years of harvest occurring since the MP3 projection, and increased caribou reserves being implemented.
- Long term harvest difference: Managed stand yields increased significantly from improved site index estimates (SIBEC) and the use of improved (class A) seed.

4.2 Selected Base Case Harvest Flow

The non-declining base case alternative (#2) shown in Figure 10 was selected as the preferred Base Case flow by RCFC. It was considered preferable to start with a lower but sustainable harvest level rather than having a fall down shortly after the start of the planning horizon. Also, this alternative allows a 3% higher harvest level during the subsequent 90 years relative to alternative one.

The harvest and forest level attributes presented in this section correspond with this base case harvest forecast. The sensitivity analyses that follow are all compared to this base case harvest forecast.

4.3 Base Case Attributes

In order to understand and evaluate the base case harvest forecast, this section describes the stands being harvested and the state of the forest over time. Numerous forest management assumptions have been modeled in the base case, many of which impact the condition of the forest through time. Using the information presented in this section, it is possible to validate these assumptions and review their impact on the overall composition of the forest.

4.3.1 Growing Stock

The total volume currently on the timber harvesting land base is nearly 5 million cubic meters (Figure 11). Approximately 4.1 million cubic meters (82%) of this is currently merchantable. By comparison, the MP3 base case (2000) showed a total growing stock of approximately 5.5 million cubic meters. These values are difficult to compare because 8 year of harvest and growth have occurred and a new land base definition is now in place. The important point is that there is less volume to be metered out until managed stand are able to come online.

Both the total growing stock and the merchantable volume show a steady drop during the first 50 years of the planning horizon. This is explained by the transition of mainly old growth forest to younger managed stands with lower volumes initially. As the managed stands begin to produce volume in merchantable diameter classes, growing stock begins to rise and stabilizes at around 4.5 million m³ for the long term.

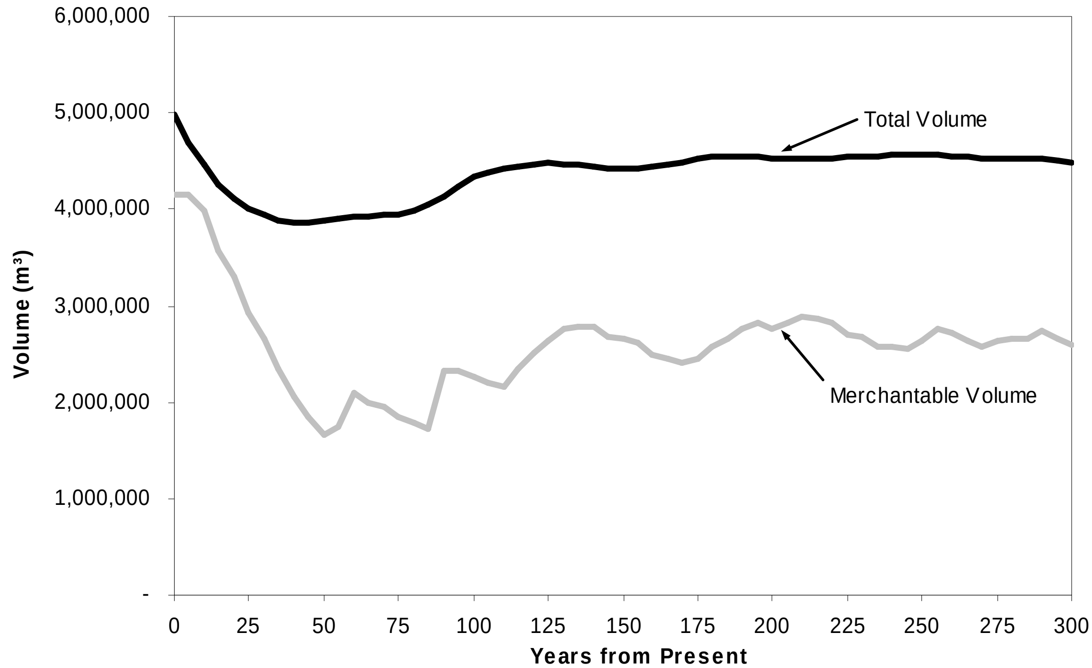


Figure 11. THLB merchantable and total growing stock for the base case harvest flow

4.3.2 Harvest Attributes

Figure 12 shows the dominant transition from harvesting natural stands to managed stands occurs fifty years into the planning horizon. The first significant amount of managed stand volume is harvested in years 40-45 but by years 50-55 over half of the harvest is coming from managed stands. This point in the TFL's future is critical in defining short term timber supply because the current stock of merchantable volume must be metered out until these managed stands come online. Because of their age, the existing natural stands are not putting on any significant volume over time and thus the existing volume must be rationed until managed stands are ready for harvest.

By year 100, managed stands dominate the harvest forecast and allow an increase in harvest level. This occurs because the managed stands have significantly increased volume production relative to natural stands as a result of improved site index estimates, better site occupancy (fewer gaps), and gains associated with the use of class A seed.

The long term harvest flow of 101,000 m^3/yr is below the LRSY calculated for the future managed stands. This is an expected result because proposed harvest flow should lie below this theoretic maximum for two main reasons. The first reason is that not all stands become managed stands - some natural stands never get harvested in order to satisfy non timber goals. Second, a model subject to a set of constraints will always lead to a lower harvest flow because of the harvest rate is reduced.

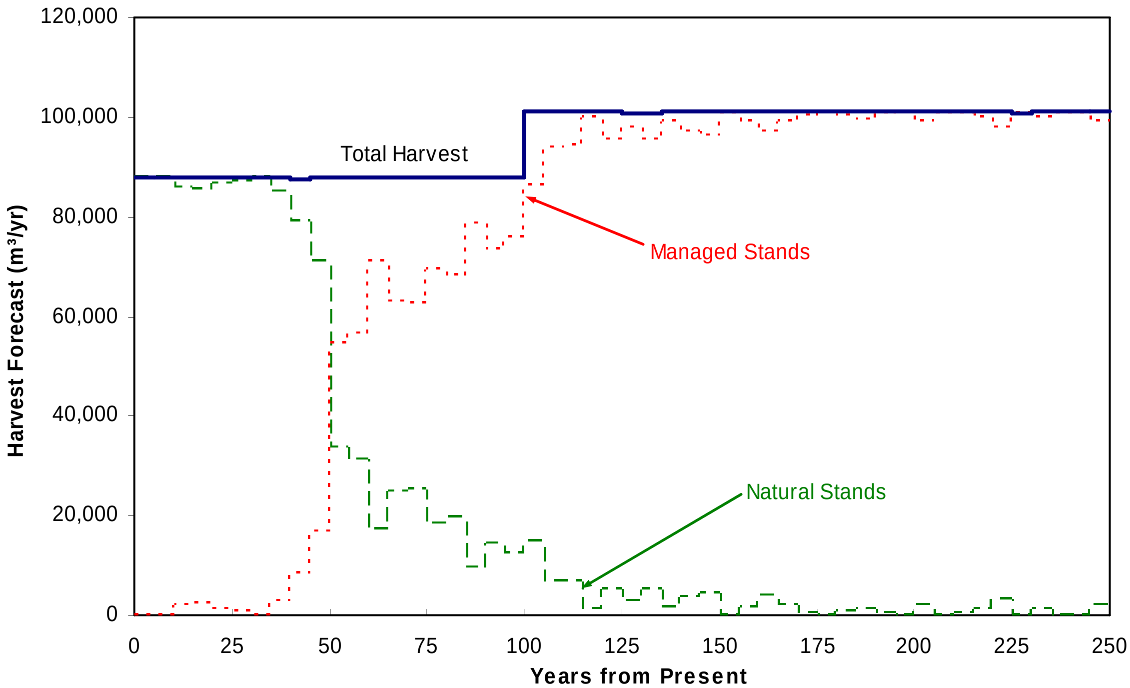


Figure 12. Transition of natural stands to managed stands

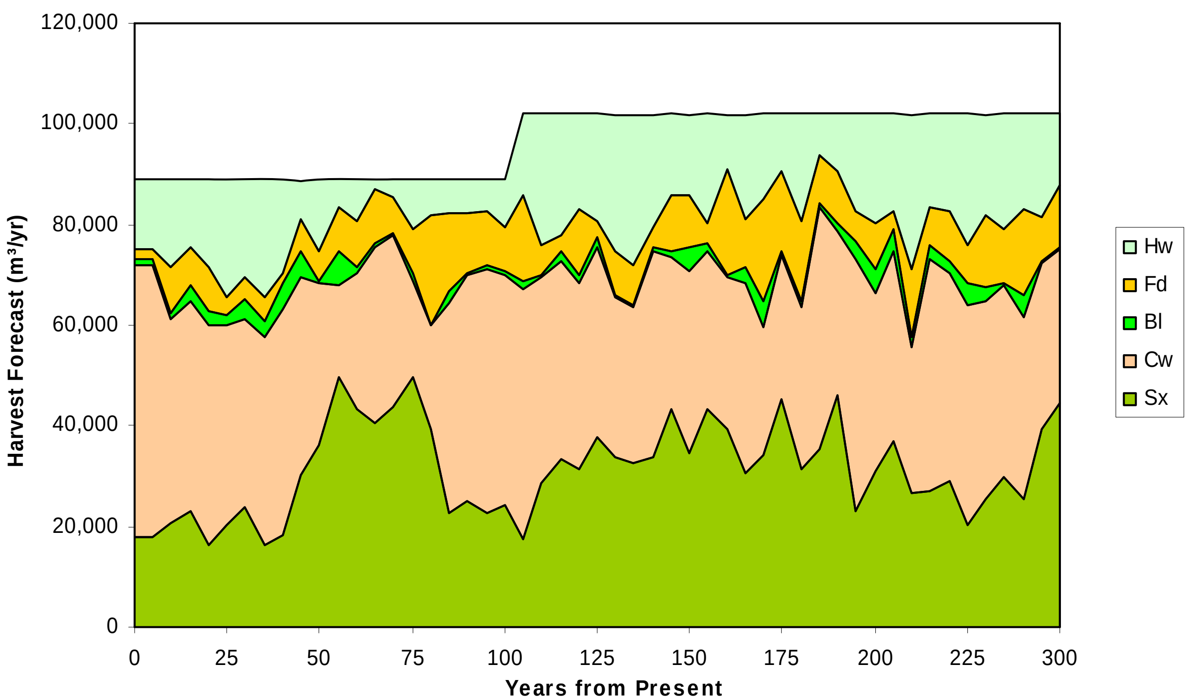


Figure 13. Base case harvest flow by leading species

Spruce and cedar leading stands are the two major components of the harvest flow (Figure 13). This is an expected result because these two stand types are also the major component of the THLB, covering 61% of the THLB. On average, spruce and western red cedar compose 71% of the harvest volume followed by interior western hemlock with 17%. Douglas fir and subalpine fir make up minor components of the harvest flow. It should be noted that during the transition to managed stands at year 50-75, an increase in spruce harvest occurs. This time frame is probably the most complex in terms of achieving the timber supply requirements. During this time, natural stands are going to become scarce and managed stands are going to be just above their minimum harvest ages. These conditions create a sensitive scenario and it appears that spruce leading stands will be critical to meeting the harvest levels during these periods.

Figure 14 below shows the average area harvested per year, the average harvest age, and the average harvest volume/ha over time. The amount of area harvested over time ranges between 200 and 245 ha/yr with an average of 217 ha. The amount of area harvested can be seen to decrease when managed stands being to come online but when the total harvest volume increases significantly at year 100, a corresponding rise in harvest area can be seen. This is directly related to the increase in average volume/ha that can be seen in the graph over time. Existing natural stands harvested at 200-250 years of age are typically yielding 400 m^3/ha, while the managed stands, typically harvested at 100-110 yrs of age, are producing 450-475 m^3/ha.

It should also be noted that the period where the largest amount of area is harvested (with lowest vol/ha) immediately precedes the transition to managed stands. This period 40-50 years in the future will the most challenging for the TFL because options for harvest will be very limited.

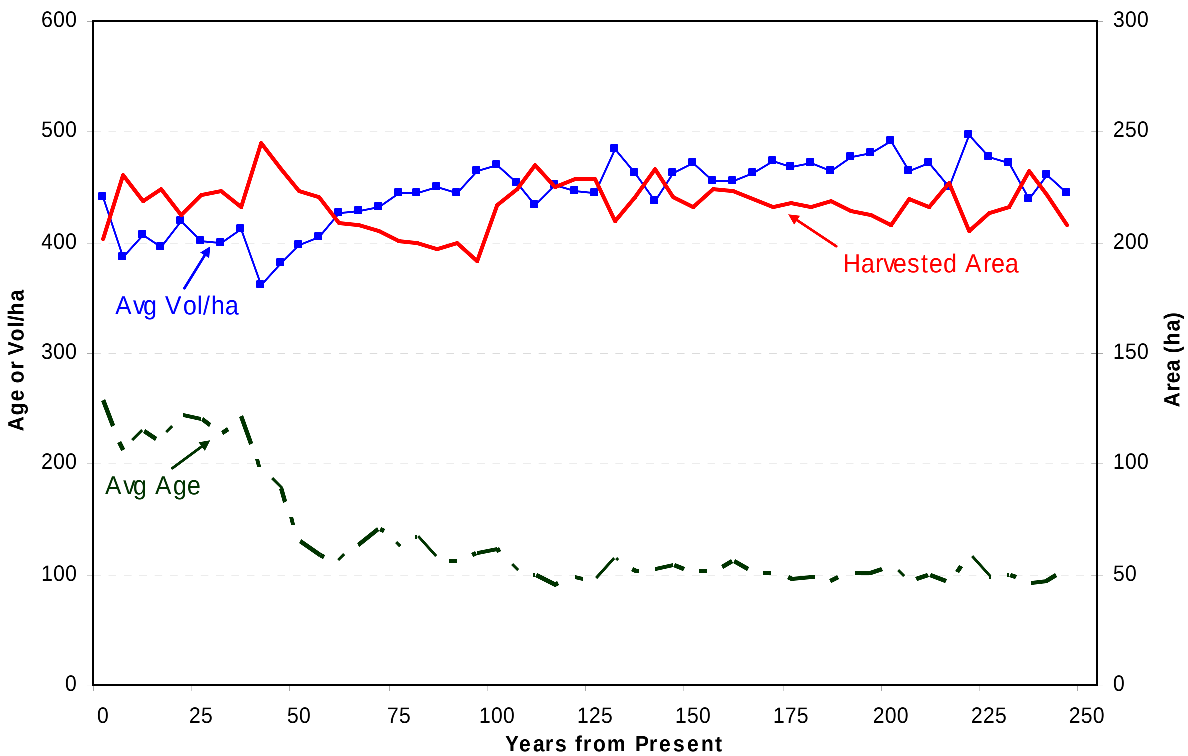


Figure 14. Average harvest age, area, and vol/ha for the base case

4.3.3 Age Class Distribution

Figure 15 provides a temporal forecast of the age class distribution for the TFL showing both the THLB and non-THLB land bases in 50 year increments. For the non THLB, the present day stand ages are highly concentrated in older ages - the majority is older than 180 years. On the other hand, the THLB tends to be skewed toward younger ages from to past harvesting, and there is a distinct lack of THLB area the middle age classes. This behaviour is typical for land bases that are under a conversion process from a natural old growth forest to a commercially managed forest.

The figures also demonstrate the natural disturbance succession being modeled in the non-THLB. On average 70 ha were disturbed each year and this area continues to show up in the younger age classes as the modeling timeframe progresses. The big stack at the end (age class 300+) has yet to succeed because the disturbance rate occurs up to a 600 year cycle. The 200 yr graph shows a 'regulated' forest structure where stands in the THLB are relatively even distributed in age classes between 0-100 yrs as this is the typical harvest age. The 200 yr graph also shows that some of the THLB remains as old-growth to satisfy old growth requirements.

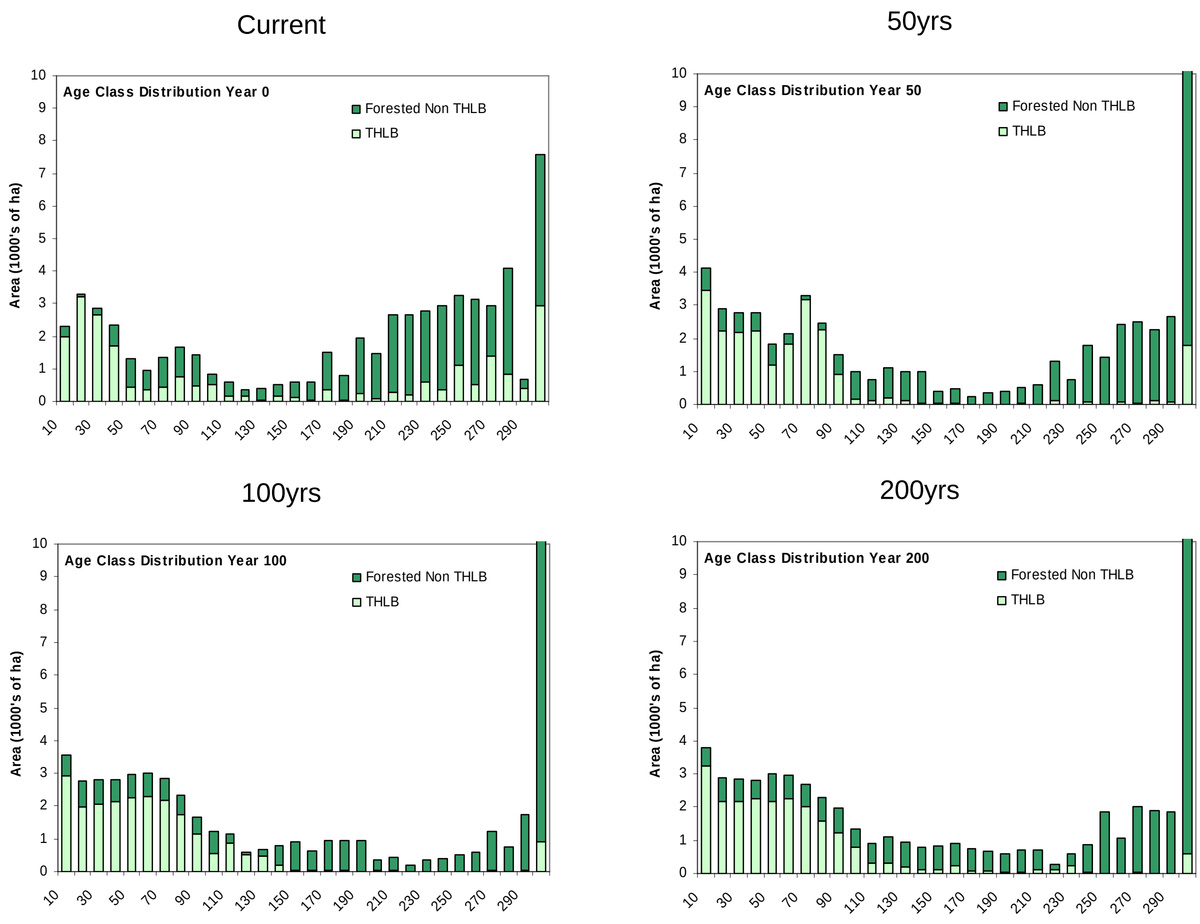


Figure 15. Age class distributions at 50 year intervals for the TFL 56 base case

4.4 Constraints Analysis

4.4.1 Harvest Priorities

The base case harvest constrained the volume of pulpwood harvested in each period to a level consistent with past performance in the TFL (max 35% pulp per 5 yr period). A similar restriction was place on the amount of aerial harvest allowed (max 8% of the harvest volume in each 5 yr period).

Figure 16 shows the resulting levels of harvest for pulpwood and aerial harvest with their respective targets. It can be seen that pulpwood was only a potentially limiting factor during early stages of the planning horizon when older natural stands were being harvested, but it never reached the 35%

ceiling that was imposed – although it came very close in years 20-25. Pulp volume is not an issue once managed stands are contributing to the harvest forecast because these stands are harvested at younger ages before any significant amount of pulp exists in the stand.

The aerial harvest ceiling can be seen to be a major limiting factor in the harvest forecast. The amount of aerial harvest is actively being limited to ~8% (constraint is tight) over much of the planning horizon. This factor is especially limiting in the first five decades, probably because of the location of the remaining natural stands in the landscape. This result is consistent with the land base profile of TFL 56 as ~8% of the THLB is assigned to aerial harvest systems.

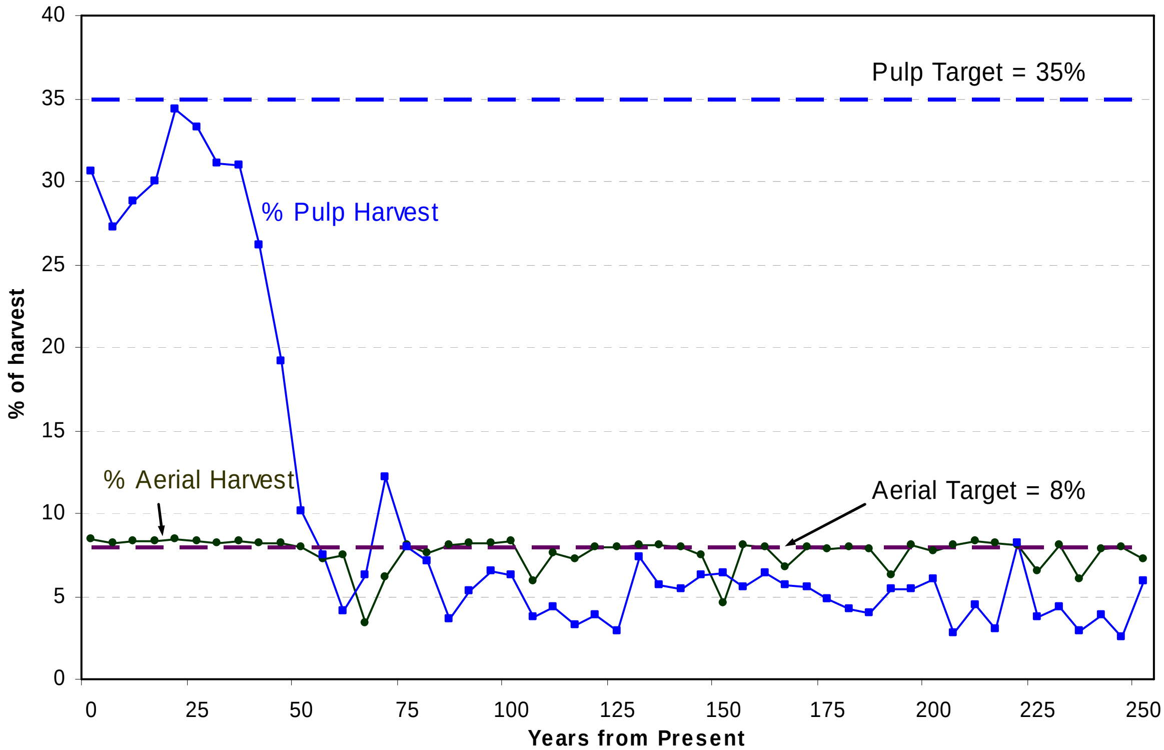


Figure 16. Percentage of pulpwood harvest and aerial harvest with their respective targets

4.4.2 Young Seral Patch Size Distributions

TFL 56's forested land base is 95% classified as Natural Disturbance Type one (NDT1). The recommended patch size distribution outlined in the *Landscape Unit Planning* Guidebook for <20 yrs old stands in this NDT is*:*

- 30 to 40% in small patches (0 to 40 ha)
- 30 to 40% in medium patches (41 to 80 ha)
- 20-40% in large patches (80-250 ha)
- 0% in very large patches (>250 ha)

While these patch categories work well to address biodiversity considerations, it was felt that the small patch category should be subdivided into 0-3 ha and >3-40 ha so that small fragmented harvest units could be discouraged within the TFL. The resulting modeling approach was an attempt to mimic operational block size objectives (keep patches between 3 ha and 250 ha – penalize patches above of below this sizes).

Figure 17 shows the patch size distributions achieved in the base case over time for <20 yr old patches. It can be seen that small patches were over represented on the land base (60-70%) while medium and large patches were under represented (10-15%). The area of <3 ha patches could not be eliminated because they were dominantly small polygons undergoing succession in the non THLB and the model had no means to change the succession pattern (it was hardwired into the model).

TFL 56 has a very rugged and fractured landscape which limits the creation of larger patches. Large openings are generally avoided in the steep narrow valleys with frequent slide chutes. Smaller openings are better suited to reduce the potential for destructive avalanches. In general terms, it is impractical to meet the patch targets in the TFL but the use of patches does allow flexibility around block sizes. In the modeling process, it also helps to spatially distribute harvest across the land base and works to eliminate infeasible concentrations of harvest.

The present base case scenario was modeled using a moderate penalty for very small and very large patches, in an attempt to produce operationally realistic results. The low proportion of very large patches and the low and relative constant amount of very small patches shown in Figure 17 is the result of the targets set for these two patch sizes.

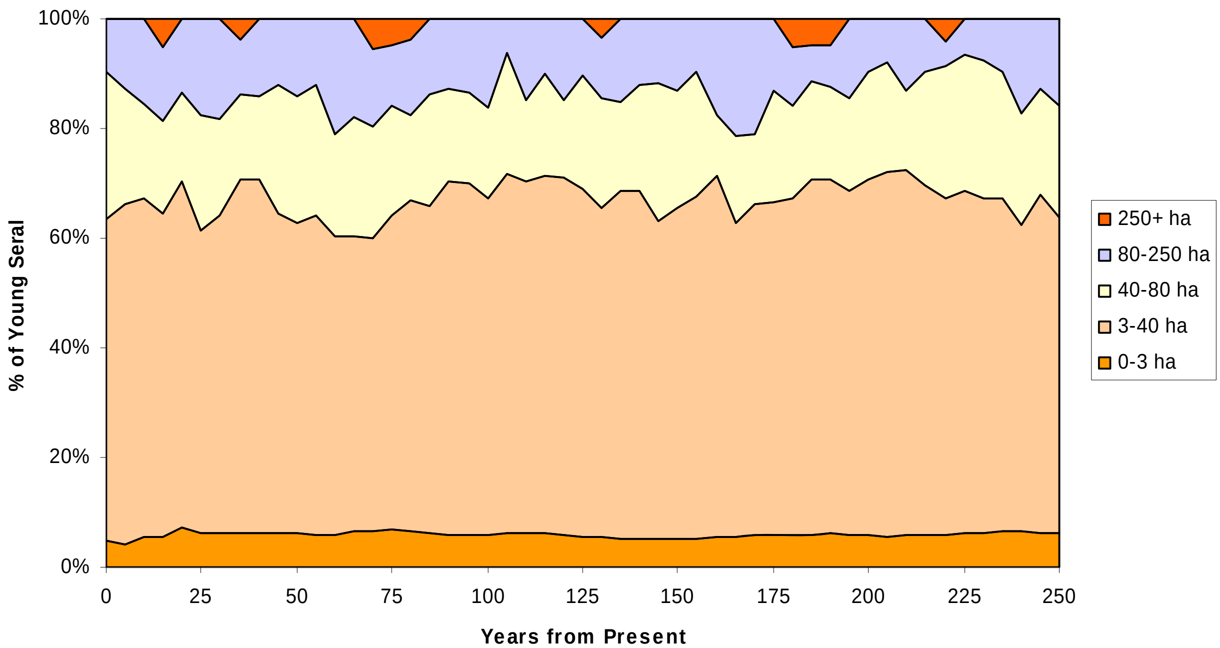


Figure 17. Very young seral (<20 yrs old) patch size distribution for the base case over time

4.4.3 Mature and Old Seral Goals

There is a specific amount of old and mature forest that must be maintained within each Landscape Unit (LU) / BEC variant combination. Figure 18 shows a rollup up result for all of these units in the TFL over the planning horizon, indicating the amount of mature and old area relative to the required amount. Note that in these and subsequent figures, the crossed green lines depict the total area of forest that the constraint is applied against. This line provides an indication of how influential this constraint may be to the harvest flow. Management zones with larger area generally have more impact on the TFL harvest flow than those with smaller areas.

For the TFL as a whole, a significant surplus can be seen at all times relative to the required amount of mature and old. This is partially explained by the fact that low Biodiversity Emphasis Option (BEO) areas contribute to the total amount of mature and old area but they do not have any minimum requirements. The minimum target of 11% shown in Figure 18 is an average of the overall target for the CFLB where the Low BEO has a 0% target and the Intermediate BEO area have an average target of 23%.

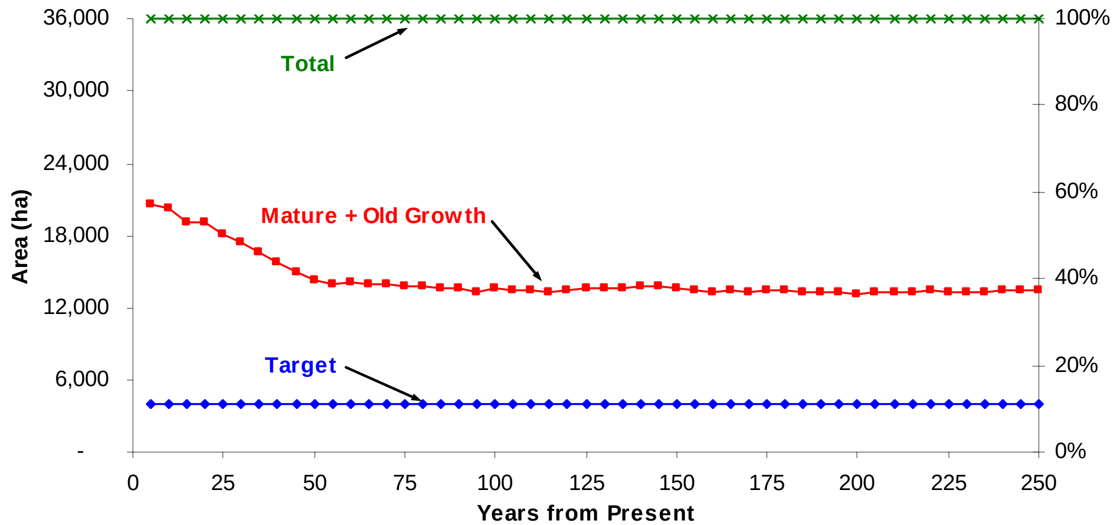


Figure 18. Mature and old growth retention relative to aggregated target (TFL 56 CFLB)

Evaluation at a finer scale provides a better view the effect of the minimum requirements for each unit. This section provides a summary of some of the most significant cover constraints in the base case using a few examples that are limiting harvest. Figure 19 presents the Mature plus old growth seral stages for the all intermediate BEO units in the Goldstream Landscape Unit (R19) and Figure 20 further subsets this down to only the ICH units. The Intermediate BEO has a weighted average of 33% and the total Mature or Older becomes closer to this target with an average of 37% (Figure 19).

Figure 20 shows how the minimum requirements become tighter at this level, with some of the periods diving marginally below the target. The R19, ICH BEC zone for the intermediate BEO is the most constrained unit in the TFL and all other zones had more relaxed outputs.

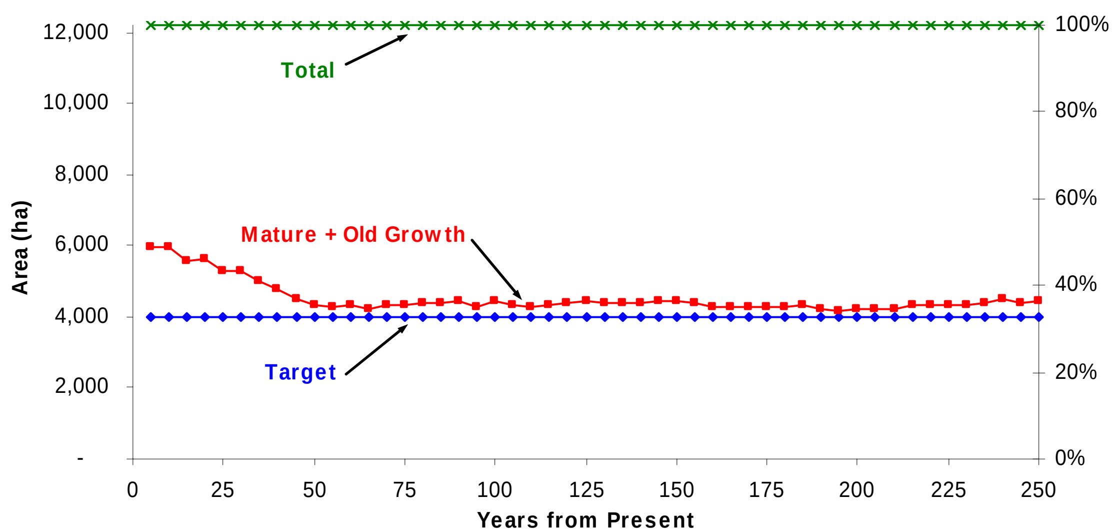


Figure 19. Mature and old growth retention relative to aggregated target (Goldstream Inter BEO)

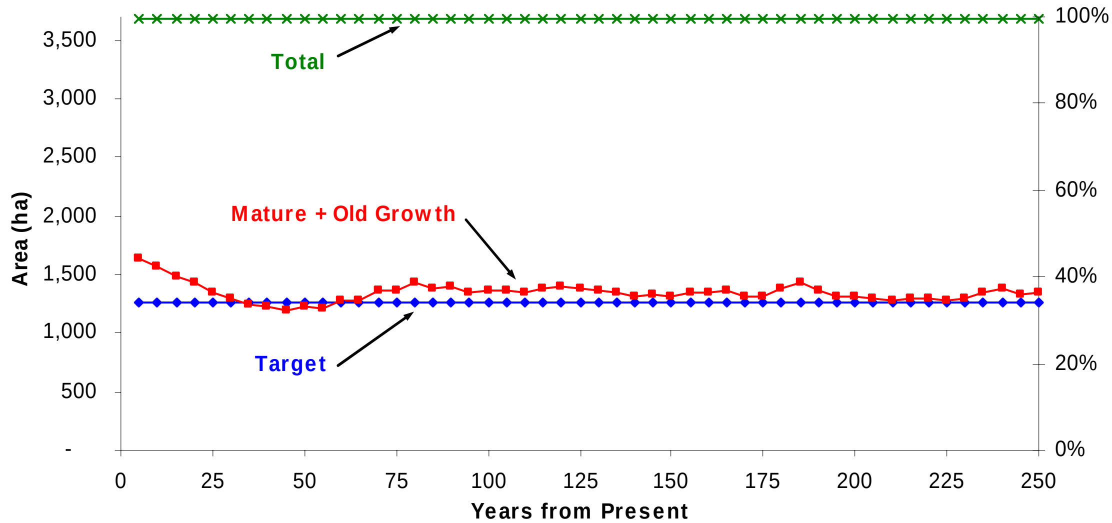


Figure 20. Mature+old growth retention relative to aggregated target (Goldstream Inter BEO ICH)

4.4.4 Landscape-level Biodiversity Old Seral

Similar to the mature plus old requirements, old seral requirements are met for the TFL as-a-whole (Figure 21) with a surplus over the whole planning horizon. However, specific LU/BEC units are tight (Figure 22 and Figure 23). At the TFL level, the old seral targets become increasingly tighter over the planning horizon, and more LU/BEC units are limiting harvest.

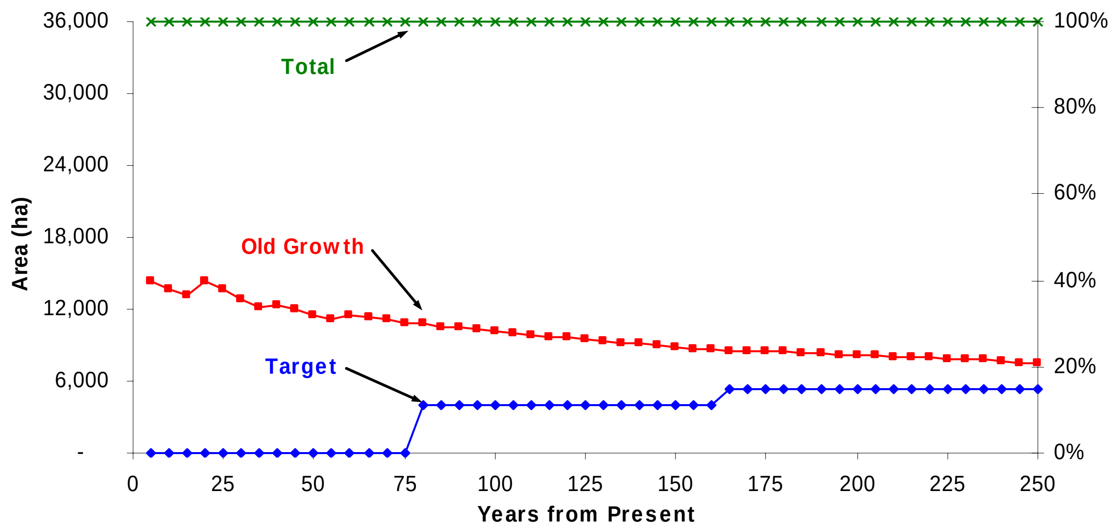


Figure 21. Old seral requirements for the TFL CFLB.

Figure 22 and Figure 23 have different minimum target requirements. Intermediate BEO units had a constant target triggered after the first rotation (first third of the planning horizon). Low BEO units have increasing targets over time, with the goal of achieving full target values by the end of three rotations.

Figure 22 and Figure 23 present the most limiting cases and also correspond to the Goldstream Landscape Unit. The most critical periods are around 200 years from the present for both cases. All three figures show a sustained decrease in the amount of old growth along the planning horizon that result in a constraining condition during the later periods. In general, the old seral requirements are not constraining when mature plus old constraints are in place as they tend to be more limiting (higher percent requirements).

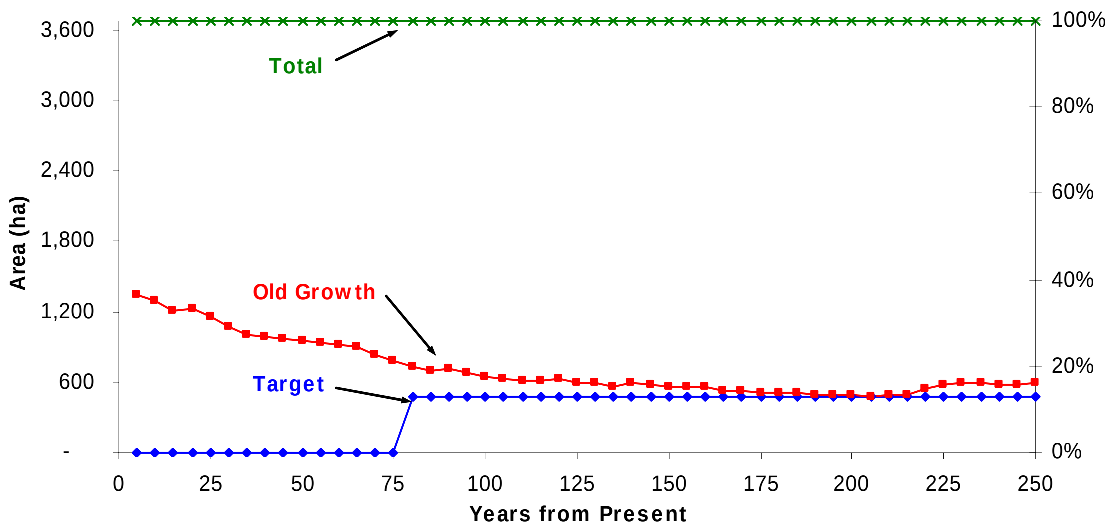


Figure 22. Old seral requirements for R19 - Inter BEO- ICH

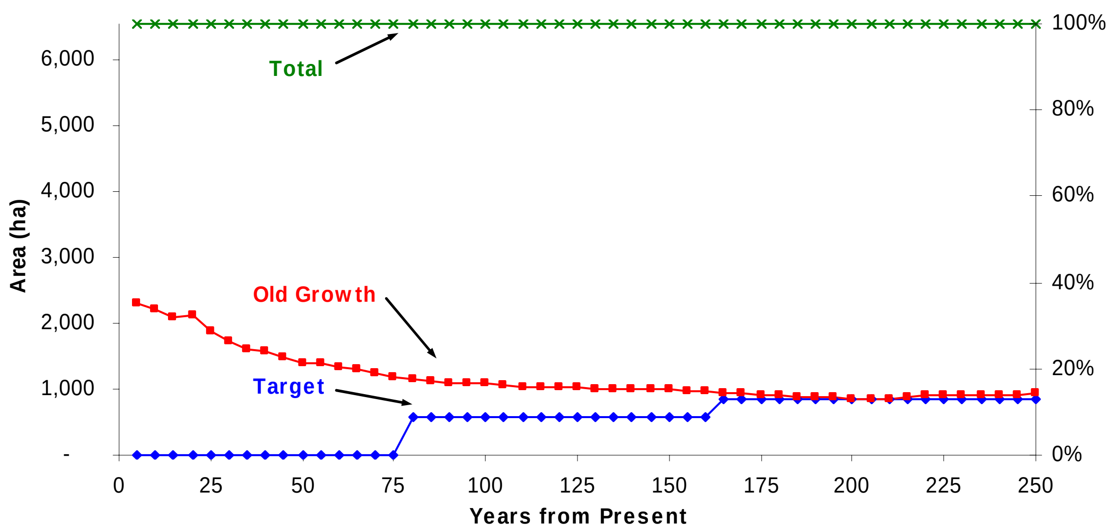


Figure 23. Old seral requirements for R19 - Low BEO- ICH

It should be noted that, although the first 80 years appear not have any old or mature minimum targets in the graphs, the old and mature requirements were modeled using spatial OGMA's (reserves) for the first 80 years. These spatial reserves had a maximum target of zero ha to be logged in each period. The actual modeled outcome for the base case is shown below.

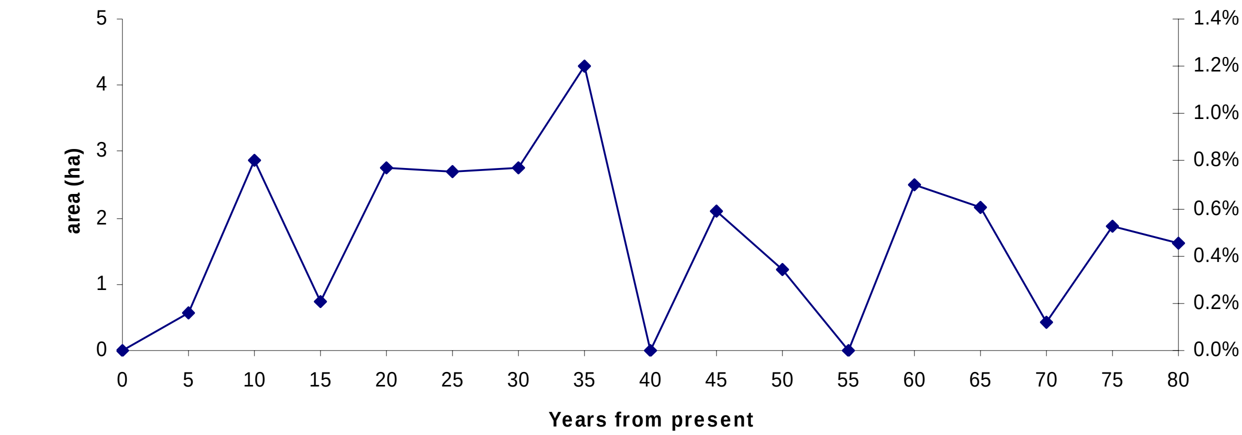


Figure 24. Harvested area and percentage of total THLB OGMA's for the first 80 years

Figure 24 shows the total harvest occurred in Spatial Old Growth Management Areas within the THLB, with a maximum of 4.2 hectares harvested between years 30-35. This amount of harvested area is less than 1.2% of the total OGMA area within the THLB and less then 0.1% of all OGMA's.

5.0 Base Case Differences from MP3

Relative to MP 3, the base case presented here shows a reduced short term harvest but a much improved long term harvest forecast. This section summarizes and explains, where possible, the differences between the harvest flows. More details on the different inputs and assumptions included in the two analyses can be found in Section 3.6.

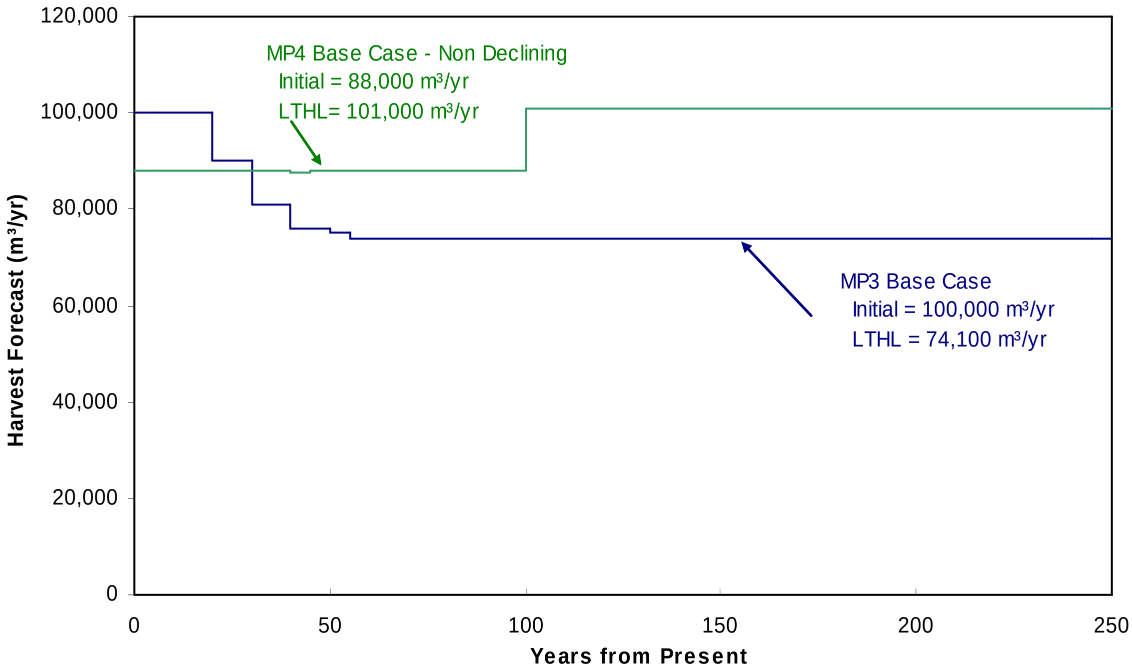


Figure 25. TFL 56 MP3 and MP4 base case harvest projections

Comparisons made below are relative to the MP3 revised Current Management run shown in Figure 25. It should be noted that time zero in the MP3 run is 8 years earlier than time zero in the Base Case FRPA Option although the graph presents them both using 2008 as time zero.

Downward pressures on MP4 base case timber supply relative to MP3

- Reduced growing stock at the start of the planning horizon (8 years of harvest depletions). This should not be viewed as a downward pressure if the first 8 years of the MP3 harvest flow was removed in the graph (its not).
- Heli-logging limited to 8% of the harvest in each period. Pulp was also limited to 35% in each period but it was almost never constraining at this level.
- Limits were placed on the creation of very small (<3 ha) and very large (>250 ha) patch sizes in MP4.
- Slightly smaller effective THLB (-72 ha or 0.3%)

Upward pressures on MP4 base case timber supply relative to MP3

- Use of SIBEC adjusted site indexes in the ICH for managed stand yields. Overall, the weighted average inventory site index on the THLB increases by 2.5m, from 16.7 m to 19.2 m, when SIBEC adjusted SI's are used for all ICH stands. This is one of the most relevant differences with respect to the MP3 and some sensitive analysis was done to explore its impact on the timber supply analysis.
- Use of improved seed and the associated genetic gains were assessed to apply a Net Genetic worth to future managed stands (1.4% for Douglas-fir and 13.0% for Spruce).
- Ungulate winter range (Deer and Moose) was managed for in MP3. However, ungulate winter range requirements are no longer required within the TFL.
- The estimate of NRL's in MP4 (938 m^3/yr) is 17 m^3/year lower than the MP3 analysis (955 m^3/yr).

Unknown influence on timber supply relative to MP3

- New inventory information resulted in new yield estimates for existing natural stands.
- The definition of the non-productive forest was revised to be based on the VRI inventory attributes as well as the logging history.
- There are other differences between the MP4 and MP3 analyses as listed in Section 3.6 but their impact on timber supply is unclear or very small.

6.0 Base Case Sensitivity Analyses

The data and assumptions used in timber supply analysis are often subject to uncertainty. To provide perspective on the impacts of changes to data or assumptions, sensitivity analyses are commonly performed. Usually only one variable (data or assumption) from the information used in the base case is changed in order to explore the sensitivity of that variable. Sensitivity analysis is a key component of any timber supply analysis process as it permits the determinant (the Chief Forester) to gauge the potential impact of uncertainty around assumptions and data that make up the base case. Sensitivity analyses help to frame the potential impacts of uncertainty by analyzing scenarios that are more pessimistic and more optimistic than the base case.

Table 4 provides a list of the sensitivity analyses completed on the TFL 56 MP4 base case.

All the sensitivity scenarios present the temporal results based on a short, mid and long term scale subdivision (or Initial, Middle and LTHL in the figures, respectively). This temporal subdivision do not have a fix range and it only tries to reflect average values after a significant change occurred on the harvest flow. There is significant break point around five decades from present which defines, for this Timber Supply Review, a short term period generally referring to the first 5 decades, a mid term period generally referring to decades 6 to 10, and a long term period generally referring to decade 11 or further on.

All the sensitivity analyses were modelled aiming for a non declining harvest flow where possible. This objective is another set of constraints by itself and might camouflage some of the effects of the specific analyzed variables of each case. This approach maintains the consistency of the non declining harvest flow selected for the Base Case.

Table 4. MP4 sensitivity analyses

Section	Sensitivity analysis	Zone/ group / analysis unit subject to uncertainty	Description of the Changes in Sensitivity Run
6.1	Size of THLB	Timber Harvesting Land Base (THLB)	The timber harvesting land base is increased and decreased by +/– 10%.
6.2	Managed Stand Yields	Managed Stands	The volume associated with managed stands is increased and decreased by +/- 10%.
6.2	Natural Stand Yields	Natural Stands	The volume associated with natural is increased and decreased by +/- 10%.
6.3	Minimum Harvest Ages (+/- 10 yrs)	All Stands	Minimum harvest ages is increased and decreased by +/- 10 years.
6.4	Seral Constraints in Place of Spatial OGMA's	Timber Harvesting Land Base (THLB)	Remove spatial OGMA's and use % Landscape Level Constraints in place.
6.5	Revelstoke HLPO Status Quo Caribou and Incremental Constraints	Timber Harvesting Land Base (THLB)	Eliminate SaRCO Spatial Reserves that Satisfy Status Quo and Incremental Caribou.
6.6	Full SIBEC Site Productivity Estimates	Managed Stands	Use SIBEC SI's in ESSF stands.
6.7	No SIBEC	Managed Stands	Remove SIBEC adjusted SI's.
6.8	*Armillaria* Root rot	Managed Stands	TIPSY low severity *Armillaria* OAF 2 applied to Douglas-fir in the ICH.
6.9	Exclude Hw leading (>80%)	All Stands	Remove Hw (>80%) areas from THLB.
6.10	Change pulp % limits	All Stands	Change pulp contribution to max 20% and/or max 30%.
6.11	Change Aerial Harvest Contribution limits contribution allowance	Timber Harvesting Land Base (THLB)	Change the percent contribution controls to minimize (0%) and unlimited.
6.12	No Patch Size Constraint for patches < 3 ha or patches > 250 ha	All Stands	A relaxation of the base case.

6.1 Size of Timber Harvesting Land Base

Several factors that determine of the size of the THLB have uncertainty around their definitions (operable area, problem types, low sites, riparian management, impacts from trails and landings, etc). Different market conditions in the future or changes in harvesting or milling technology can also serve to reduce or expand the land base considered to be economical.

It is not known if the THLB used in this analysis is over or under-estimated, so two sensitivity runs have been completed. These runs increase and decrease the size of the THLB by 10%.

Methodology

Run	How was it Analyzed?
Timber harvesting land base +10%	The modeled size of each polygon in the THLB was increased by 10% to a total of 24,831 ha. The size of each non-THLB polygon was reduced by an offsetting percentage that kept the total CFLB area the same.
Timber harvesting land base -10%	The modeled size of each polygon in the THLB was decreased by 10% to a total of 20,317 ha. The size of each non-THLB polygon was reduced by an offsetting percentage that kept the total CFLB area the same.

Table 5. Land base areas for the THLB +-10% sensitivity analysis

THLB (ha)	Non - THLB (ha)	CFLB (Ha)	Scenario
22,575	37,280	59,855	Base Case
24,832	35,023	59,855	THLB Plus 10%
20,317	39,538	59,855	THLB Minus 10%

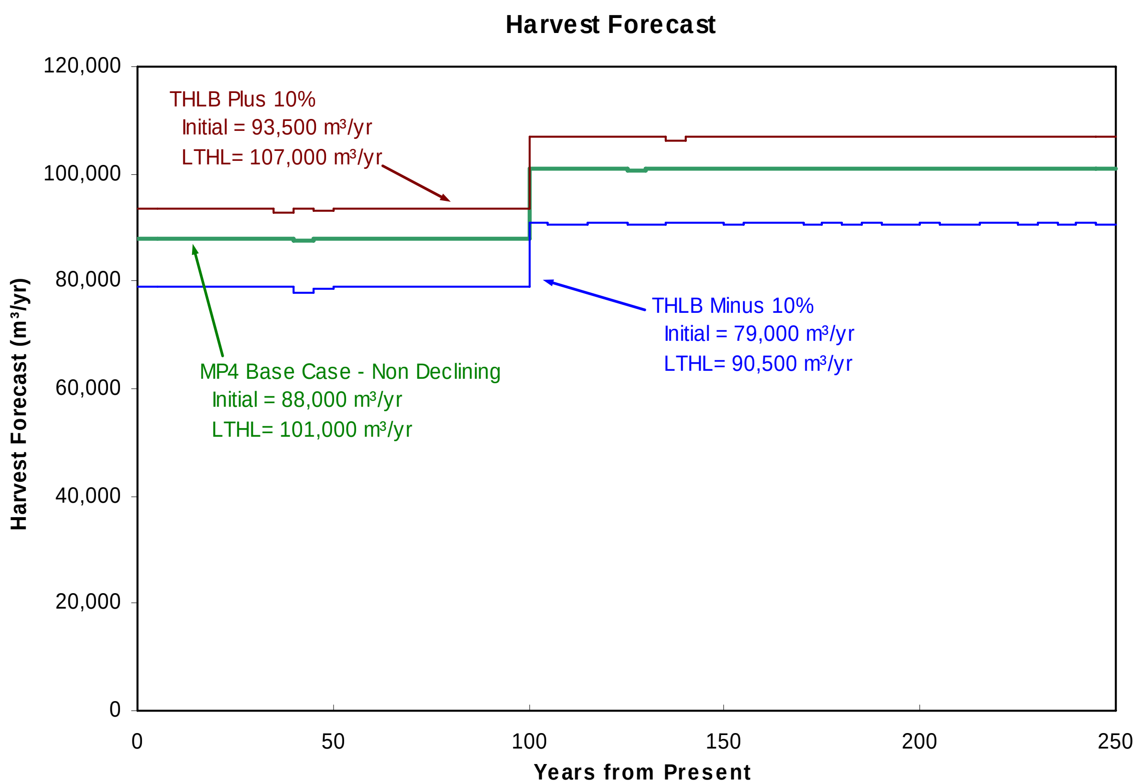


Figure 26. Timber harvesting land base increased and decreased by 10%

Results

Run	Short Term	Long Term	Overall
Timber Harvesting Land Base + 10%	Average increase in the short term harvest level of 6.3% to 93,500 m³/yr.	Average increase in the long term harvest level of 5.9% to 107,000 m³/yr.	Higher than base case on average by ~6%.
Timber Harvesting Land Base - 10%	Average increase in the short term harvest level of 10% to 79,000 m³/yr.	Average decrease in the long term harvest level of 10% to 90,500 m³/yr.	Lower than base case on average by 10%.

A percentage increase or decrease in the THLB typically has a proportional impact on the harvest flow. This result was achieved when the area of the THLB was reduced by 10% but when it was increased by 10%, only a ~6% increase in harvest flow was found. This occurred because the reduction in forested non-THLB area meant that % seral goals were now met less in the non-THLB and more in the THLB. This prevented a portion of the increased THLB area from providing volume into the harvest forecast.

6.2 Yields from Natural and Managed Stands

Stand yields are a critical input into timber supply analysis. The short and mid-term timber supply is heavily influenced by the availability of timber in natural stands that make up the current growing stock. The current standing and mature timber provide the timber harvesting opportunities before managed stands come online for harvest. Figure 12 (Page 18) indicated that the harvest of natural stands diminishes very quickly after the 5th decade, at which time managed stands start to become more important to the timber harvest profile.

Uncertainty in timber yields can result from many different factors. Natural stand yields are based on the VDYP yield model, which predicts yields from stand attributes in forest inventory maps. Inaccuracies in the model, in decay estimates, or stand attributes can create uncertainties around actual stand yields. Managed stand yields are based on the TIPSY growth model, which predicts yields from estimates of site index, and stand attributes such as species, density, and expected gains from planting stock grown from select seed. The over or under estimation of any of these factors can lead to uncertainties in the yields of these future stands.

Methodology

Run	How was it Analyzed?
Natural Stand Yields plus 10%	The yields associated with each natural stand analysis unit were increased by 10% (100 series AU's).
Natural Stand Yields minus 10%	The yields associated with each natural stand analysis unit were decreased by 10% (100 series AU's).
Managed Stand Yields plus 10%	The yields associated with each managed stand analysis unit were increased by 10% (>100 series AU's).
Managed Stand Yields minus 10%	The yields associated with each managed stand analysis unit were decreased by 10% (>100 series AU's).

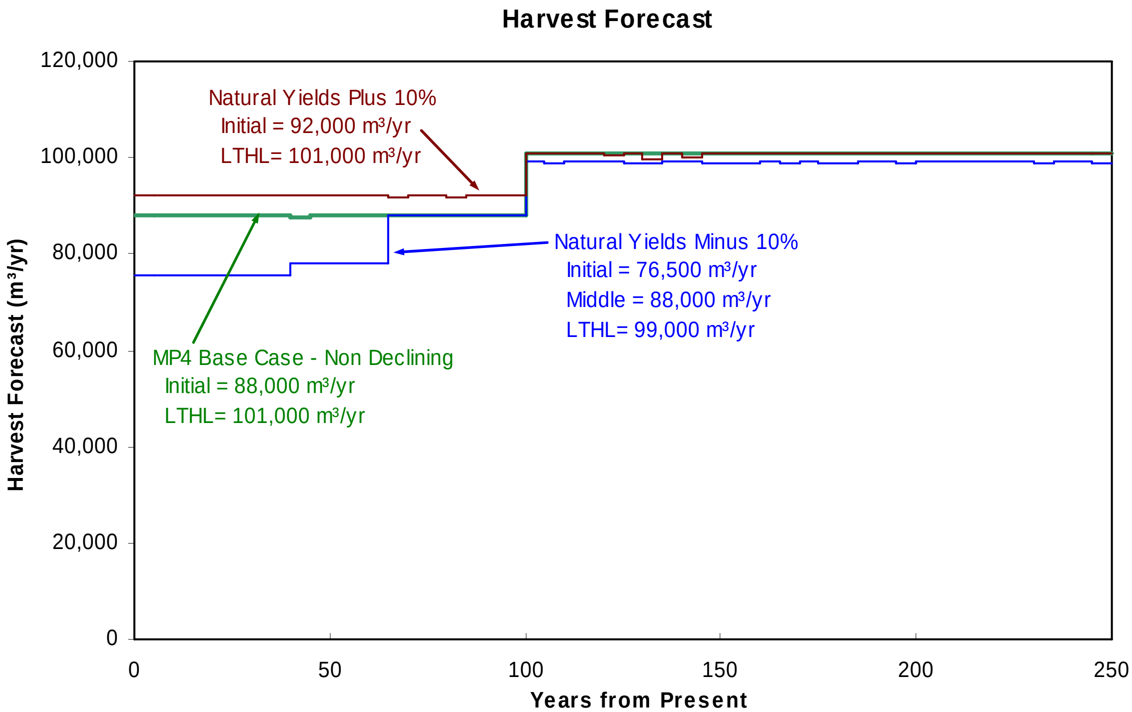


Figure 27. Natural stand yields increased (dark red) and decreased (blue) by 10%

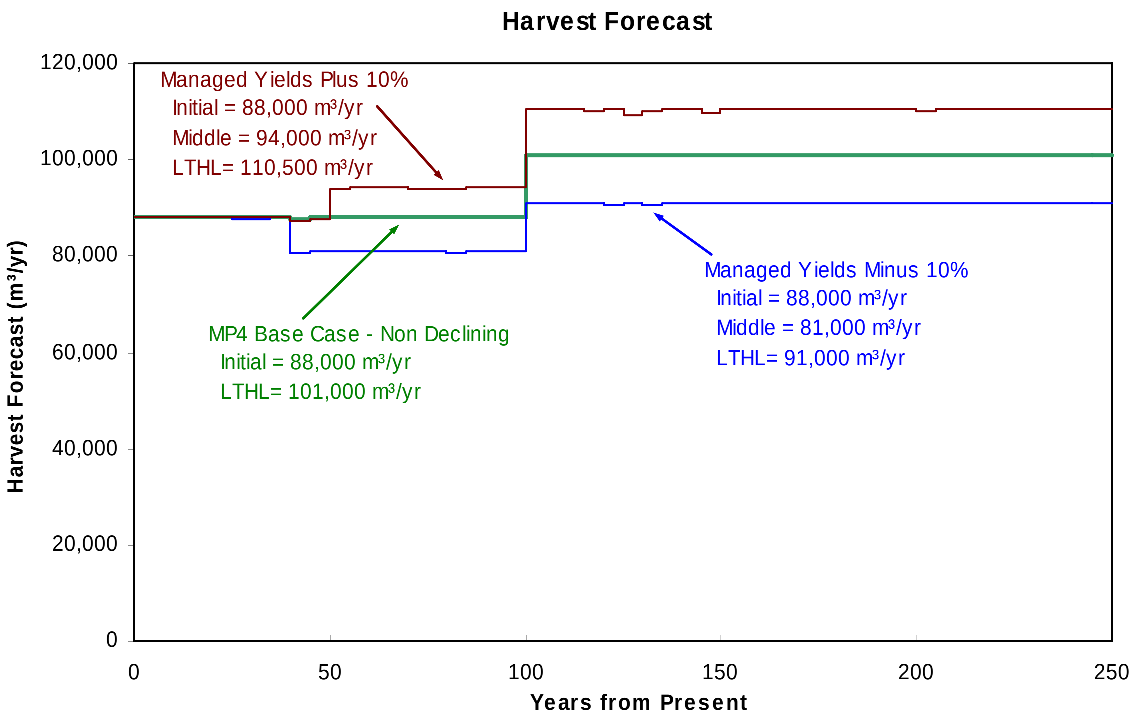


Figure 28. Managed stand yields increased (dark red) and decreased (blue) by 10%

Results

Run	Short Term	Mid Term	Long Term
Natural Stand Yields plus 10% (Figure 27)	Increases by 4.5% to 92,000 m³/yr and is maintained for 10 decades.		Same as Base Case.
Natural Stand Yields minus 10% (Figure 27)	Decreases by 13% to 76,500 m³/yr and is maintained for 65 years.	Same as Base Case.	Decreases by 2% to 99,000 m³/yr.
Managed Stand Yields plus 10% (Figure 28)	Same as Base Case until decade 5.	Increases by 7% to 94,000 m³/yr until decade 10.	Increases by 9% to 110,500 m³/yr.
Managed Stand Yields minus 10% (Figure 28)	Same as Base Case until decade 4.	Decreases by 8% to 81,000 m³/yr.	Decreases by 10% to 91,000 m³/yr.

The impact of these set of sensitivity runs is well correlated with the transition from natural to managed stands previously shown in Figure 12 (Page 18). Natural stands are the main source of volume during the first 5 decades and a decrease in their yields has an immediate impact on short term harvest flow. A 10% decrease in natural yields results in a 13% drop in harvest flow relative to the base case for the first 6 decades (Figure 27). In the longer term, the harvest flow eventually rises to the almost the base case level because managed stand volume dominates during this time period.

A 10% increase in the natural stand yields translated into a 5% rise in harvest level for the first ten decades. This occurs because additional volume is available only on the portion of the harvest profile coming from natural stands. This is almost all of the harvest in the first 5 decades and then only 10-40% of the harvest in decades 6-10. A larger increase in harvest could have been implemented over a shorter period of time with a subsequent drop down to the base case level but a decision was made to mimic the flow regime of the base case. This meant finding a flow that would not decline before rising to the long term level. Thus, the resulting harvest flow has all 10 decades only receiving a 5% increase in relative to the base case.

The managed stand sensitivity analysis shows similar behaviour, but it impacts harvest flows later in the planning horizon. Since managed stands play a minor role during the first 50 years of the planning horizon no impacts are seen in the short term (Figure 28). In the long term, both show harvest flow changes that are roughly proportional to the change in yields (+9% and -10%). The scale of change is less in the midterm because only a portion of the harvest flow is coming from managed stands in these periods.

These scenarios reinforce the point that the periods where harvest is transitioning from natural to managed stands are key pinch points. Timber availability between 45-55 years from now will be very limited and play a very large role in defining harvest levels in the short term.

6.3 Minimum Harvest Ages

Uncertainty around the age that stands become merchantable for harvest is linked to both our ability to predict the future growth of stands and our ability to understand future conditions that will define merchantability (markets / products). The minimum harvest age was selected based on achieving a minimum vol/ha and a minimum DBH, while ensuring harvest was relatively close to maximum MAI age.

The large majority of minimum harvest ages used in the base case scenario were driven by the 95% of maximum mean annual increment (MAI) goal. This age almost always delivered the minimum stand and log requirements (vol/ha, avg. dbh) but these economic criteria occasionally did push the harvest ages higher.

The use of minimum harvest ages associated with maximum MAI's tends to optimize long term harvest levels, but allowing stands to be harvested when the are first merchantable provides flexibility in the transition from short to long term harvest levels. The transition from short to midterm harvest levels in the TFL is heavily influenced by when managed stand volumes become available in significant quantities. It is unknown if there are more appropriate minimum harvest ages than what those used in the base case, so sensitivity runs have been completed to explore the impact of both higher and lower harvest ages.

Methodology

Run	How was it Analyzed?
Min Harvest Ages decreased by 10 yrs	Minimum harvest ages for each AU were decreased by 10 years.
Min Harvest Ages increased by 10 yrs	Minimum harvest ages for each AU were increased by 10 years.

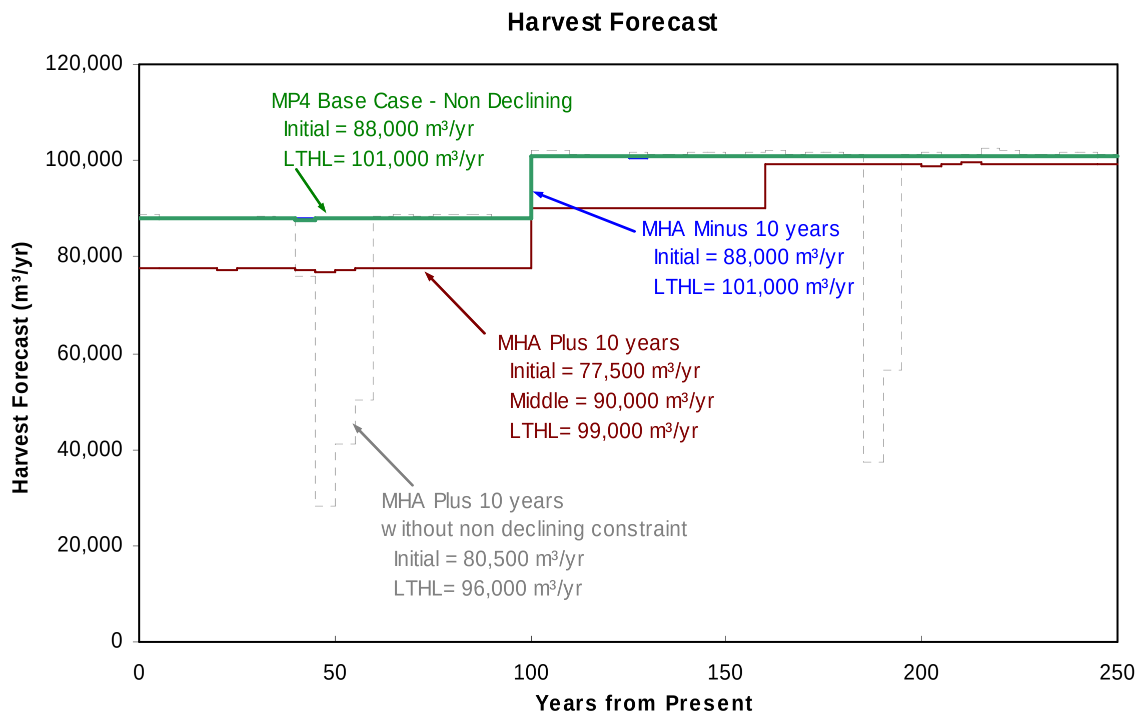


Figure 29. Minimum harvest ages increased and decreased by 10 years

Results

Run	Short Term	Mid Term	Long Term
Min Harvest Ages decreased by 10 yrs	Same as Base Case.	Same as Base Case.	Same as Base Case.
Min Harvest Ages increased by 10 yrs	Decreases by 12% to 77,500 m³/yr for 10 decades.		Decreases by 1% to 100,000 m³/yr.

Figure 29 shows that decreasing harvest ages by 10 yrs has almost no impact in the harvest flow. The only minor change that can be noted is that there is slightly more flexibility to reach the harvest request during some critical periods like at the end of the fifth decade. The increased access to younger stands in the midterm does not lead to an improvement in harvest flow because these stands would have to be harvested with lower volume/ha – offsetting any gains from having these stands available.

A substantial (12%) decrease in short term harvest flow occurs as a result of increasing minimum harvest ages by 10 years. The non smoothed harvest flow in Figure 29 shows that there is no decrease in availability of existing natural stands but there are no longer enough managed stands coming online in years 45-60. In order to fill this hole and deal with the continued delay of these stands coming online, the entire short and midterm flow must be reduced by 12%. Once the forest is normalized, the rise to the long term can occur and a slight (1%) reduction from the base case level is seen. This occurs because stands are being harvested slightly further from their maximum MAI age.

Again, the timing of the transition from natural to managed stands is a critical point in this harvest forecast. Any delay in managed stands coming online has the potential to significantly impact the harvest flow.

6.4 Percent Seral Constraints in Place of Spatial OGMA's

The retention of old seral forest is required in each Landscape Unit (LU) and biogeoclimatic (BEC) variant combination within the CFLB (above and below the operability line separately). Spatial Old Growth Management Areas (OGMA's) developed by MoAL – Integrated Land Management Bureau (ILMB) were reserved from harvest for the first 80 years in the base case to meet the objectives of this requirement. This sensitivity is designed to explore the implications of applying percent seral goals to each LU-BEC variant instead of the locking down the spatial OGMA's. This provides the model with flexibility to find better locations to locate the reserve areas.

Methodology

Run	How was it Analyzed?
Percent Seral Constraints instead of Spatial OGMA's	Spatial OGMA's were ignored and seral constraints were applied at the landscape unit / BEC variant level. Constraints were applied to the operable CFLB portion of each LU_BEC variant as outlined in the Revelstoke Higher Level Plan Order.

Results

Run	Short Term	Mid Term	Long Term
Percent Seral Constraints instead of Spatial OGMA's	No change.	No Change.	No change.

No difference was found between the base case scenario and this sensitivity. Table 6 summarizes the percentage of OGMA achievement by LU/BEO/BEC unit (operable area only). On average, there is a 1% overachievement in the spatial OGMA deployment but very little of this occurs on the THLB. OGMA's define less than 2% of the total THLB because of their overlap with spatial caribou reserves (treated as Non-THLB). The two scenarios do result in a somewhat different spatial harvest pattern but there is no effect on the overall harvest flows.

Table 6. Old seral forest requirements for TFL 56

LU	BEO	BEC Variant	Operable CFLB (ha)	% Old Required	% OGMA/MMA Established
Downie (R12)	Inter	ESSFvc	71	19%	0.7%
		ICH mw 3	1,668	14%	13.6%
		ICH vk 1	3,879	13%	12.8%
		ICH wk 1	2,757	13%	13.9%
	Low	ESSFvc	6,519	6.3%	11.5%
		ICH mw 3	284	4.6%	2.2%
		ICH vk 1	3,190	4.3%	4.6%
		ICH wk 1	4,077	4.3%	5.0%
Goldstream (R19)	Inter	ESSFvc	171	19%	16.2%
		ICH mw 3	22	17%	18.3%
		ICH vk 1	2,812	13%	12.1%
		ICH wk 1	847	13%	14.2%
	Low	ESSFvc	3,202	6.3%	7.2%
		ICH vk 1	4,496	4.3%	4.8%
		ICH wk 1	2,063	4.3%	4.7%
		Totals	**36,057**	**8%**	**9%**

6.5 Revelstoke HLPO Status Quo and Incremental Caribou

Prior to the establishment of the 'status quo' spatial caribou reserves, the Revelstoke Higher Level Plan Order (HLPO) had guided management for the Mountain Caribou though specific percent retention and age requirements within mapped zones. The status quo spatial reserves served to spatialize reserve areas that would be used to meet the management guidelines for caribou under the HLPO. In additional to the status quo habitat reserve areas, a recent initiative of the Species at Risk Coordination Office (SaRCO) was to develop 'incremental' caribou reserves. Both status quo and incremental reserves were spatially removed from the THLB in the base case.

Two sensitivity analyses were completed in relation to their caribou reserves. Once examines the implications of using only the status quo reserves (i.e. no incremental reserves) and the other examines the implication of not managing for caribou at all (i.e. no status quo or incremental reserves). This later scenario was run to illustrate the scale of impact caribou management has on the TFL.

Methodology

Run	How was it Analyzed?
Only Status Quo Caribou Reserves (i.e. no incremental rsvs)	SaRCO caribou spatial 'Incremental' reserves were converted back to THLB where no other netdown existed. This resulted in a 1,316 ha increase in the THLB (from 22,575 to 23,891 ha).
No Caribou Management Constraints (No Status Quo or Incremental rsvs)	Both 'Status Quo' reserves and 'Incremental' reserves were converted back to THLB where no other netdowns existed. This resulted in a 7,984 ha (6,668 + 1,316) increase in the THLB (from 22,575 to 30,559 ha). Spatial OGMA's were not implemented as netdowns in the base case (or here) but they did overlap with 2,077 ha of Status Quo reserves so the impact of the OGMA's grew to 2,432 ha of THLB (previously was 355 ha).

Results

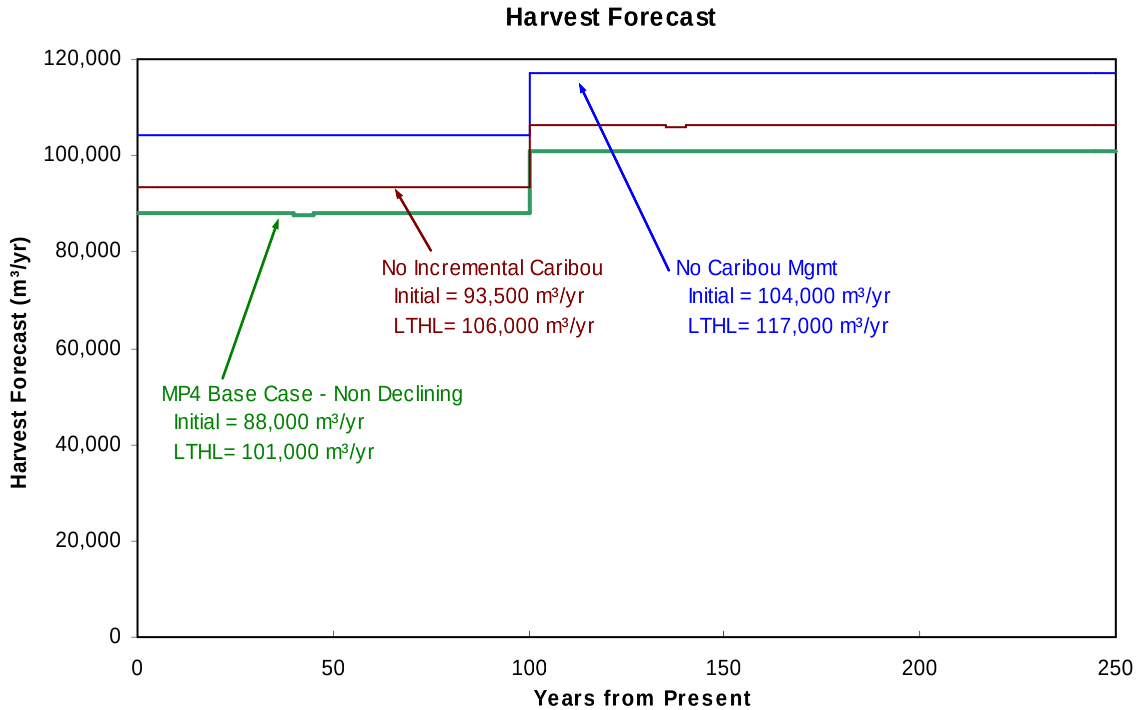


Figure 30. Revelstoke HLPO Status Quo and Incremental Caribou impact on the harvest flow

Run	Short Term	Mid Term	Long Term
Only Status Quo Caribou Reserves (i.e. no incremental rsvs)	Increases by 6% to 93,500 m³/yr.		Increases by 5% to 106,000 m³/yr.
No Caribou Management Constraints (No Status Quo or Incremental Rsvs)	Increases by 18 % to 104,000 m³/yr.		Increases by 16% to 117,000 m³/yr.

Figure 30 shows that when 'Incremental' caribou reserves are placed back into the THLB an effective increase of 6% is realised in both the THLB size (+1316 ha) and the harvest flow.

When the 'Status Quo' and 'Incremental' areas are both placed back into the THLB, a net increase of 20% is realized in the size of the THLB (+4,591 ha) and the harvest flow increases by 18% in the short to midterm and increases by 16% in the long term. The full 20% increase is not realized because mature+old seral constraints are preventing some of the additional THLB from being harvested.

6.6 Full SIBEC Site Productivity Estimates (ESSF included)

SIBEC site index adjustments were not applied to the ESSFvc in the base case because the Predictive Ecosystem Map (PEM) did not meet accuracy assessment requirements in this Biogeoclimatic variant. Applying SIBEC site index adjustments to the ESSFvc has the potential to further increase the site index of the land base thereby increasing yields for managed stands and in turn reducing the time to reach minimum volume and diameter thresholds.

Methodology

Run	How was it Analyzed?
SIBEC site index adjustment applied in the ESSF	SIBEC site index adjustments were added to stands in the ESSFvc below 1550m in elevation[3] and new yield tables for managed stands (TIPSY curves) were generated. This resulted in a slight increase in the weighted average SI of the THLB (+0.2 m from 19.2 to 19.4) for managed stands. Minimum harvest ages were adjusted to align with the new curves. The adjustment changed site indexes on 1,970 ha or 9% of the THLB.

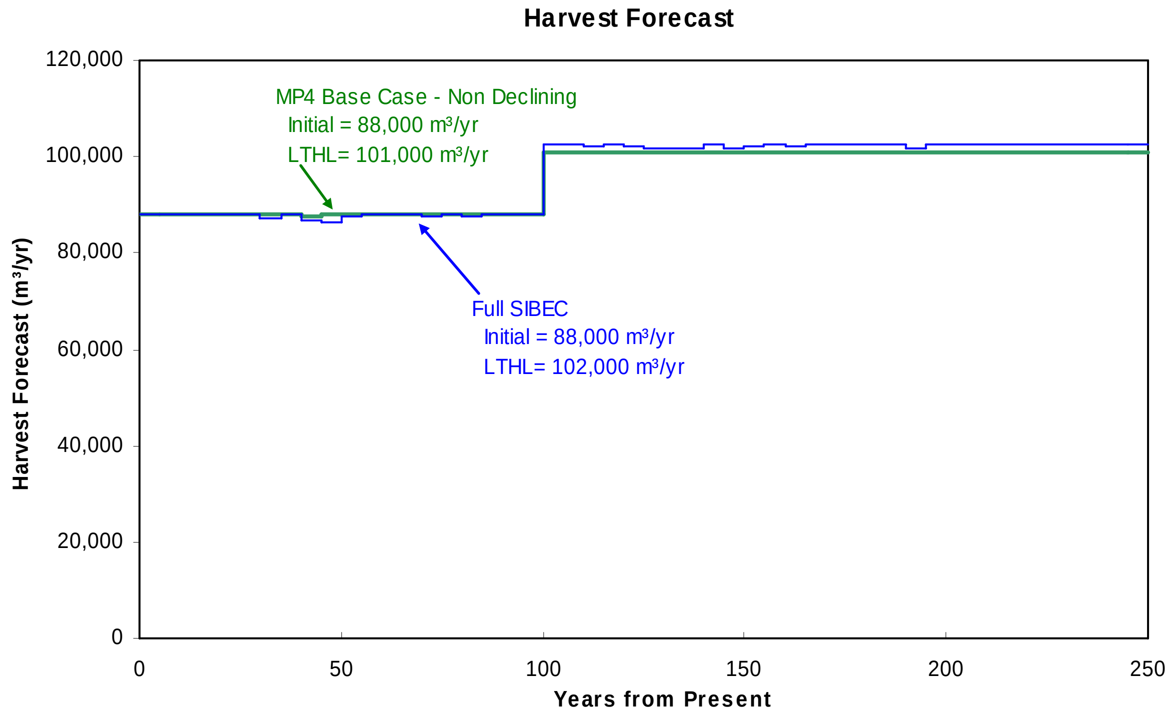


Figure 31. Harvest forecast after including SIBEC adjustments for the ESSF biogeoclimatic zone

Results

Run	Short Term	Mid Term	Long Term
SIBEC site index adjustment applied in the ESSF	No change.	No change.	Increases by 1% to 102,000 m³/yr.

This factor only influenced a subset of the future managed stands and thus did not affect the short-term harvest flow. Figure 31 shows a 1% increase in harvest flow over the long term.

[3] As recommended in: Mah, S. and G.D. Nigh. 2003. SIBEC site index estimates in support of forest management in British Columbia. Res. Br., B.C. Min. For., Victoria, B.C. Tech. Rep. 004.

6.7 No SIBEC Site Productivity Estimates

SIBEC site index adjustment factors significantly increased the site index of the land base. This has the effect of increasing the yields for managed stands, and in turn reducing the time to reach minimum volume and diameter thresholds. This sensitivity demonstrates the impact of removing the SIBEC adjustment completely and using only inventory and growth intercept site index values to generate managed stand yields.

Methodology

Run	How was it Analyzed?
No SIBEC site index adjustment	TIPSY curves were recreated using only inventory site index values (or growth intercept values where they existed). This resulted in a decrease of the weighted average site index on the THLB of 2.4 m (19.2 to 16.7) for managed stands. Minimum harvest ages were adjusted to align with the new yield curves.

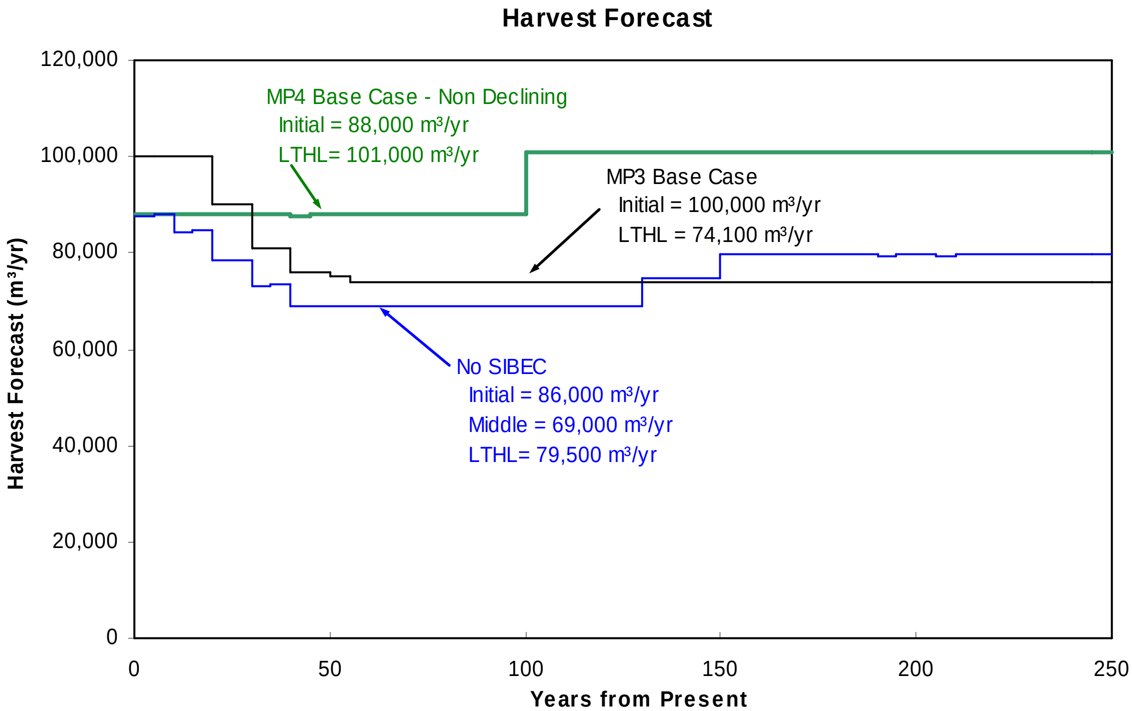


Figure 32. Harvest forecast after removing SIBEC gains

Results

Run	Short Term	Mid Term	Long Term
No SIBEC site index adjustment	No change.	Decreases by 22% to 69,000 m³/yr.	Decreases by 21% to 79,500 m³/yr.

SIBEC adjusted yields for managed stands have a very large impact on both mid and long term harvest levels (Figure 32). Without the increased yields (and sooner availability) from managed stands, the midterm harvest level is forced to fall 22% before rising to a long term level 21% below the base case.

The yield gains associated with the SIBEC adjustments have by far the biggest impact on the harvest levels when compared to other sensitivity analyses in this report.

It should be noted that the 'No SIBEC' harvest flow looks similar to the MP3 harvest flow but is shifted forward 10-20 years. The MP4 projection shows a higher long term level than MP3 because of the inclusion of gains associated with class A seed in MP4.

6.8 *Armillaria* Root Rot

Armillaria ostoyae (Armillaria) is a root disease which affects a portion of managed and natural forest stands of the southern 1/3 of British Columbia. In his last determination for the TFL, the Deputy Chief Forester expressed concern for the lack of consideration for *Armillaria* root disease and encouraged the collection of data to better estimate volume losses resulting from *Armillaria*. However, no data has been collected to date. This sensitivity is designed to explore the potential impacts of Armillaria on the timber supply using provincial average impact estimates.

Methodology

Run	How was it Analyzed?
Armillaria Root Rot	TIPSY *Armillaria* OAF functionality (low incidence level) was used to generate yield curves. TIPSY only applies *Armillaria* OAF's to Douglas-fir in the ICH so only AU's with Douglas-fir were affected (i.e. AU's: 201,202,203,601,604). Yields were generated assuming the entire THLB of each AU was impacted by *Armillaria* (in the ICH) and then a prorated yield curve was calculated by determining the proportion of the land base that falls within the ICH for each AU. Overall, approximately 11.5% of the THLB had a 6.7% reduction in yield at time of MHA.

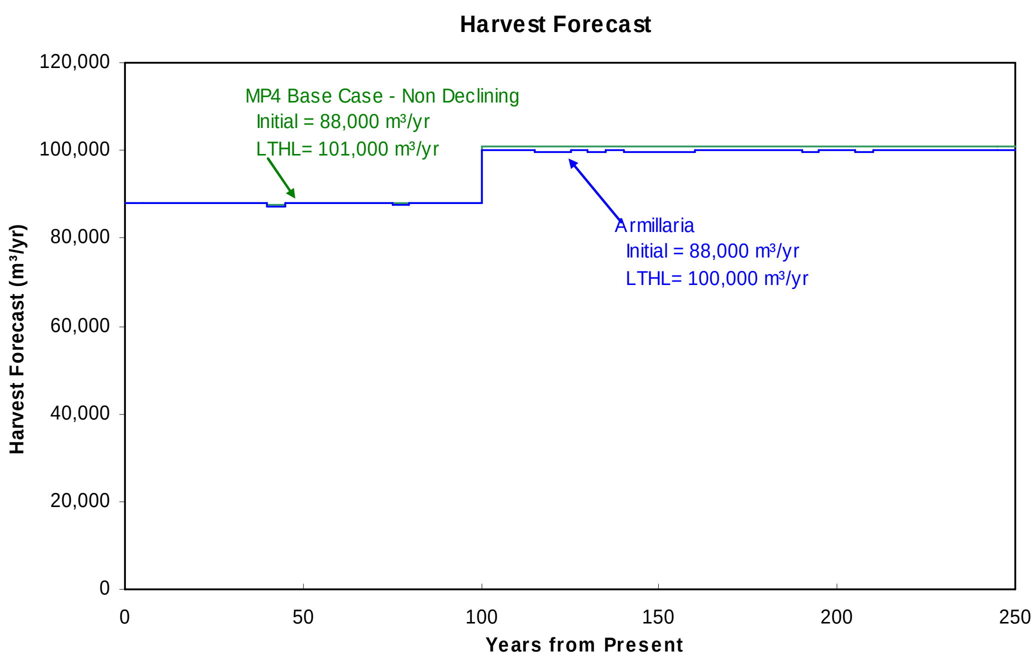


Figure 33. Harvest forecast after including Armillaria reductions

Results

Run	Short Term	Mid Term	Long Term
Armillaria – low incidence	No change.	No change.	Decrease in the long term harvest level of 1% to 100,000 m³/yr.

Figure 33 shows that the assumed levels of *Armillaria* lead to a 1% reduction in long term harvest levels. Even though impacts were around 30% for Fd in the ICH, when reductions are applied only to the Fd portion of the stands that fall in the ICH, the result for the THLB as a whole were small and only occurred in managed stands.

6.9 Exclude Hw Leading (>80%)

Stands with high proportions of hemlock can sometimes be uneconomical due to the poor market conditions because they have relatively high proportions of pulp volume. This scenario has been designed to explore the timber supply implications of not harvesting in high % Hw stands (>80% Hw). These stands were left in the base case because the pulp issue was assumed to be addressed by limiting the harvest profile in any period to 35% pulp.

Methodology

Run	How was it Analyzed?
Exclude Hw leading (>80%)	Stands that have >80% hemlock component were removed from harvest eligibility. This resulted in approximately a 642 ha (3%) reduction from the base case THLB (down to 21,933 ha from 22,575 ha).

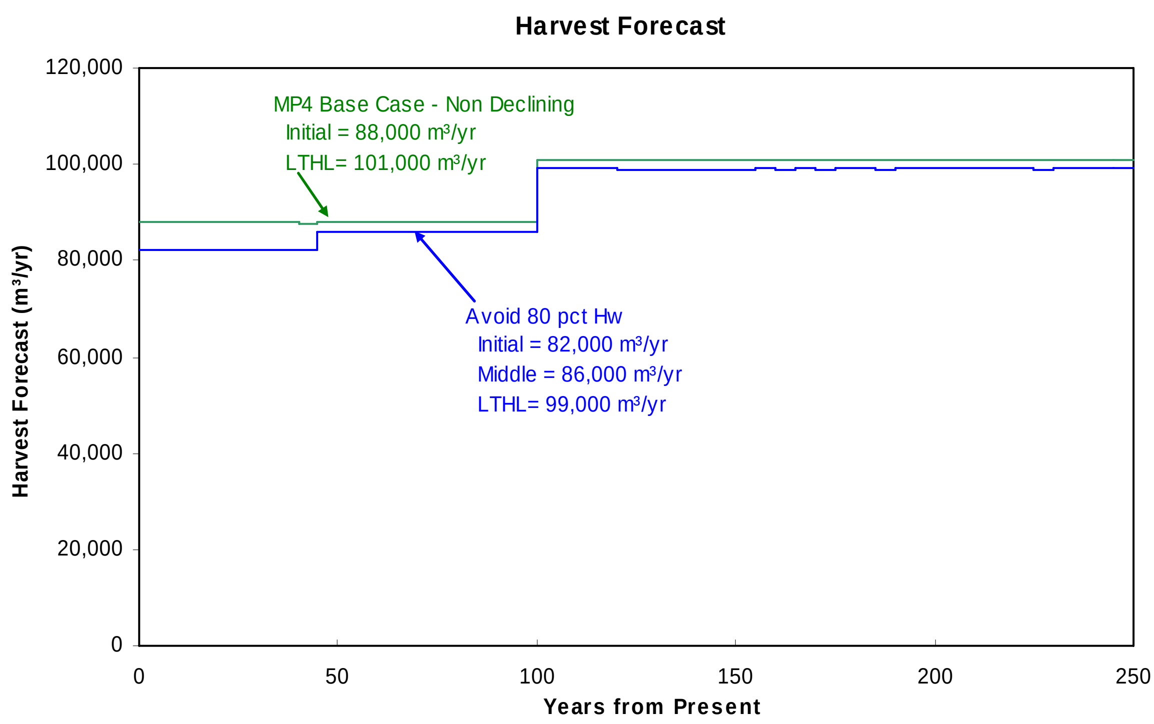


Figure 34. Exclude hemlock (Hw) leading stands over 80% from the harvest flow

Results

Run	Short Term	Mid Term	Long Term
Exclude Hw leading (>80%)	Decreases by 7% to 82,000 m³/yr.	Decreases by 2% to 86,000 m³/yr.	Decreases by 2% to 99,000 m³/yr.

Excluding >80% hemlock stands reduces the THLB and the mature growing stock available to support harvest until managed stands come online. Figure 34 shows a 7% reduction in the short term based on a 3% THLB reduction. This occurs because of the very sensitive nature of the pinch point in years 45-55. The percentage of the full THLB covered by these stands (3%) is less than the percentage of the existing mature volume that needs to be metered out until managed stands come online.

Over the long run this scenario shows an expected 2% reduction in the harvest flow as a result of a 3% reduction in land base.

It should be noted that it is desirable to leave these stands in the THLB and harvest them under appropriate markets because they often occupy good growing sites and once harvested come back as more valuable stands containing cedar and spruce (with little pulp volume). As long as the pulp percentage in each period is reasonable, these stands can be addressed economically over time.

6.10 Change Pulp Percentage Limits

Decisions to harvest or not to harvest in high percent pulp stands are highly dependant on pulp market conditions. The base case limited the contribution of pulp to the harvest profile to 35% in each 5 year period. This scenario was designed to explore the sensitivity of the harvest flow when pulpwood volume is limited to lower levels. Higher levels were not explored because the 35% used in the base case proved to be essentially non-constraining.

Methodology

Run	How was it Analyzed?
Change Pulpwood limit to a maximum of 20% of the periodic harvest	Change the pulp contribution limits to allow a maximum of 20% to the harvest profile in each period.
Change Pulpwood limit to a maximum of 30% of the periodic harvest	Change the pulp contribution limits to allow a maximum of 30% to the harvest profile in each period.

Table 7. Pulpwood proportion of the total growing stock at the beginning of the planning horizon

Product	Growing Stock at the beginning of the planning horizon (Period 0)	Percentage
Pulpwood	1,635,434 m³	33%
Total	4,982,440 m³	100%

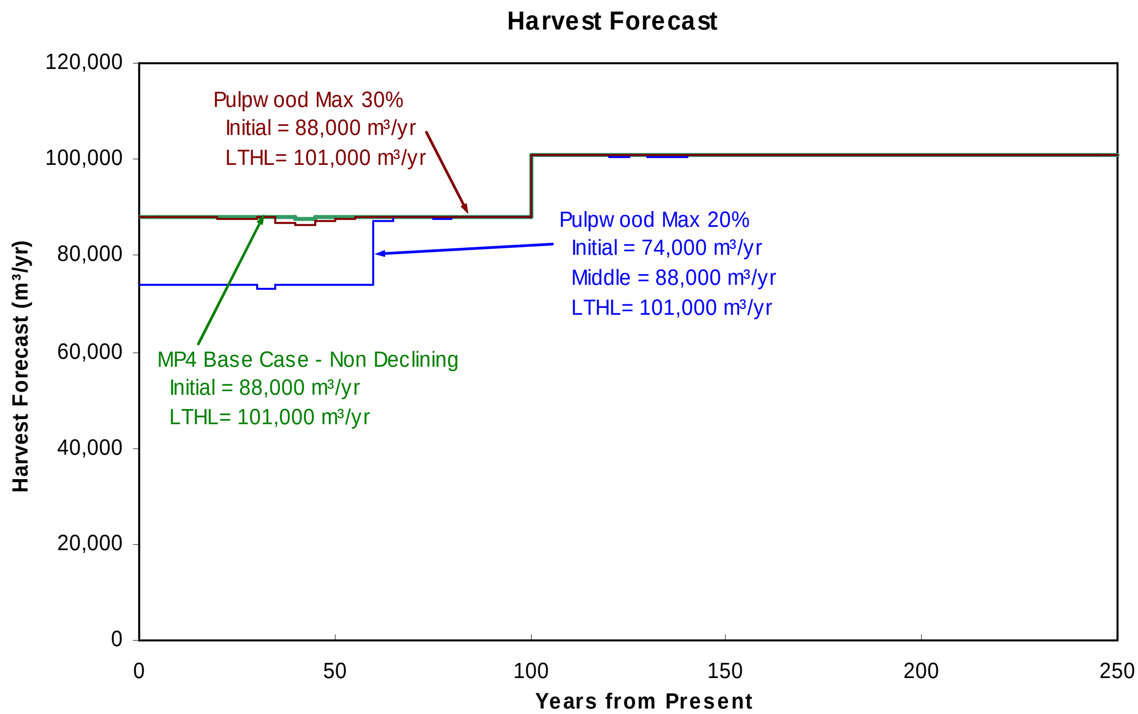


Figure 35. Harvest forecast for alternative pulpwood volume limits

Results

Run	Short Term	Mid Term	Long Term
Change Pulp to 20% Limits	Decreases by 16% to 74,000 m³/yr.	Same as Base Case.	No change.
Change Pulp to 30% Limits	Minor changes and no changes on average values.		No change.

Figure 35 indicates that a 30% pulp limit has almost no impact on the base case harvest flow, while a 20% pulp limit has a very significant impact on the short term harvest flow (-16%). Much of the existing natural stand volume is very old and contains pulp volume. Limiting the amount of pulp to 20% crosses a threshold where stands are forced to wait until they can be mixed in with second growth stands that have little to no pulp content. Eventually all stands harvested in the base case get harvested in this scenario because the long term harvest level remains the same as the base case.

There is a significant proportion of pulpwood in the initial growing stock (Table 7). This initial proportion will certainly have an impact in the expected harvest flow if the pulpwood is limited to any percentage below the original 35%. This initial target of 35% applied for the Base Case does not have any impact and the model does not reach this target (Figure 36). A scenario with a 30% target becomes more restricted but still does not show any significant change because it is able to shift harvest timing to remain consistent with the required proportion (Figure 36). However, a scenario with a 20% pulpwood limit is very restrictive in the first 45 years and directly limits harvest flow (Figure 36).

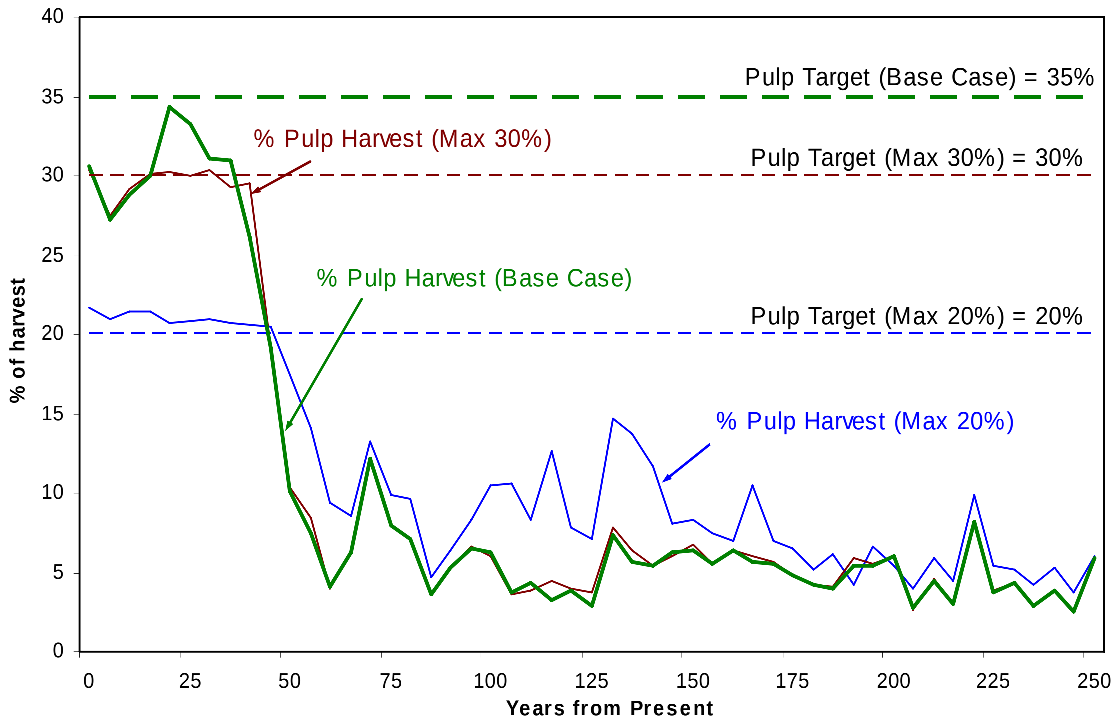


Figure 36. Pulpwood harvest volumes for the base case and pulpwood sensitivity runs

6.11 Change Aerial Harvest Contribution limits

As with pulp, the decisions to harvest or not in aerial harvest stands are highly subject to market condition. Fuel prices also influence costs and overall economics for these blocks. Total chance plan mapping on the TFL indicates that approximately 8% of the THLB is considered aerial harvest. Additionally, RCFC has demonstrated aerial harvest performance that is consistent with the profile of heli-access area (8%) on the land base over the past 12 years. Therefore, the Base Case limited the contribution of aerial harvest to 8%. However, uncertainty exists in the actual amount of aerial harvest that will be conducted in the future due to both lumber markets as well as logging costs. This sensitivity is designed to examine the implications of allowing higher (no limit) and lower (no aerial harvest) limitations on harvest volume coming from areas identified as aerial access.

Methodology

Run	How was it Analyzed?
Increase the aerial harvest contribution	Change the aerial harvest contribution limits to allow an unlimited aerial harvest proportion of the annual harvest flow.
Minimize the aerial harvest contribution	Change the aerial harvest contribution limits to minimize harvest coming from aerial harvest systems (target of zero m3/yr).

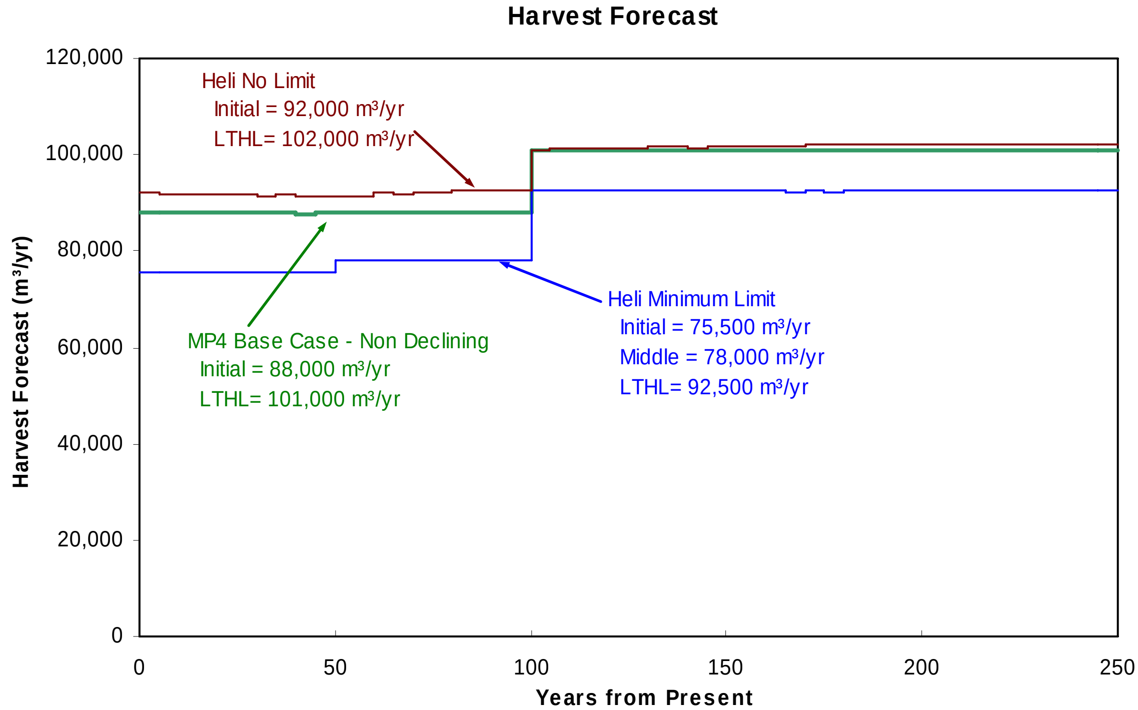


Figure 37. Harvest forecasts for alternative aerial harvest volume limits

Results

Run	Short Term	Mid Term	Long Term
Minimize aerial allowable harvest contribution to the harvest profile	Decreases by 14% to 75,500 m³/yr.	Decreases by 11% to 78,000 m³/yr.	Decreases by 8% to 92,500 m³/yr.
Allow unlimited contribution of aerial harvest to the harvest profile	Increases by 5% to 92,000 m³/yr. .		Increases by 1% to 102,000 m³/yr.

Figure 37 illustrates the significant decrease (-14%) in short term harvest flow associated with essentially eliminating the aerial harvest areas from the THLB. As these make up only 8% of the land base, the 14% impact can be explained by sensitivity of the pinch point to losses of mature volume and the fact that 87% of the aerial blocks are existing natural stands at the start of the planning horizon. The long term impact is directly in line with the loss of 8% of the land base.

Figure 37 also shows a moderate increases in short term harvest levels if the amount of aerial harvest in each period is left unconstrained. This additional flexibility to schedule harvest volume in the short term allows a 5% increase in harvest levels over the short and midterm. It doesn't appear that any additional area is being added to the land base because the long term harvest level remains the same.

Although, a zero target was defined for the minimization of the aerial harvest a minor proportion (1%) is still coming out of aerial harvested stands (Figure 38). This is a result of the goal seeking / soft constraints approach used in the Patchworks model.

Figure 38 also shows the redistribution of the aerial harvest proportions over time when they are unconstrained and the tight adherence to 8% in the base case scenario.

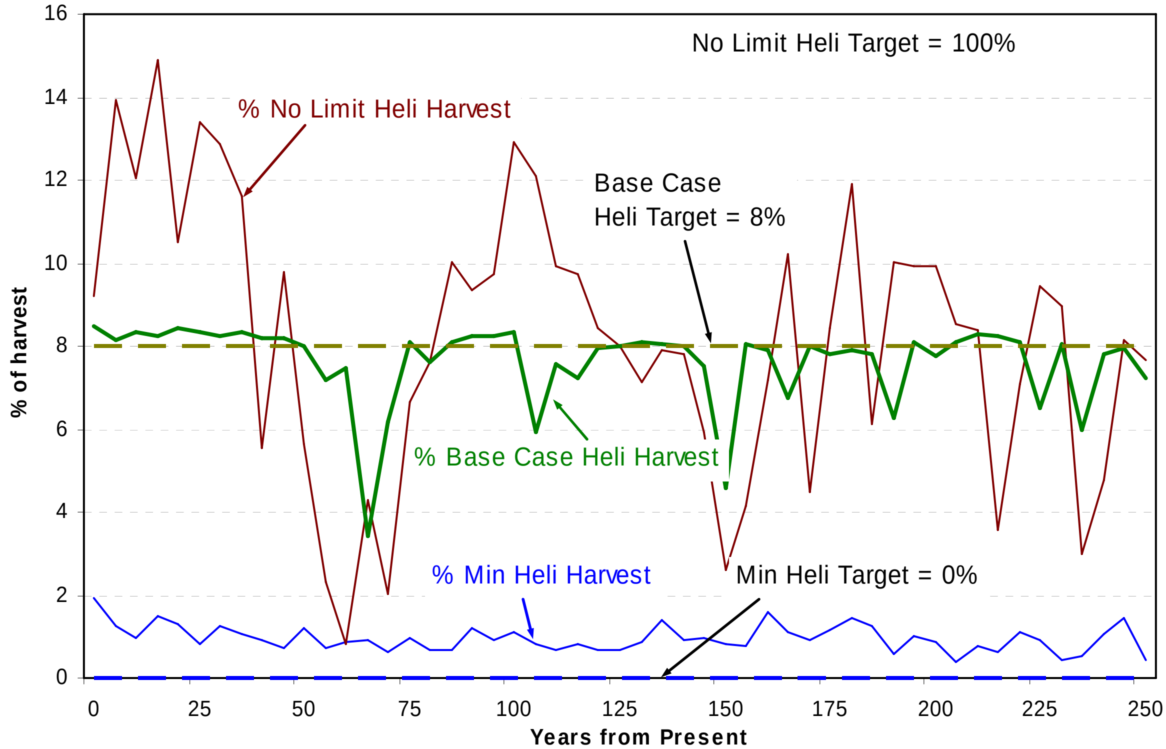


Figure 38. Aerial harvest volumes for the base case and aerial harvest sensitivity runs

6.12 No Patch Management

As explained in the results for the Base Case scenario in Section 4.4.2 (Page 21), targets were applied only to manage for discourage very small (<3 ha) and very large (>250 ha) young patch sizes (<20 yrs old). To explore the potential impact of the patch targets on the base case, they were turned off for this scenario.

Methodology

Run	How was it Analyzed?
No limitation on the patch size distribution.	Targets were turned off – no consideration of patch sizes was included in the solution generation process.

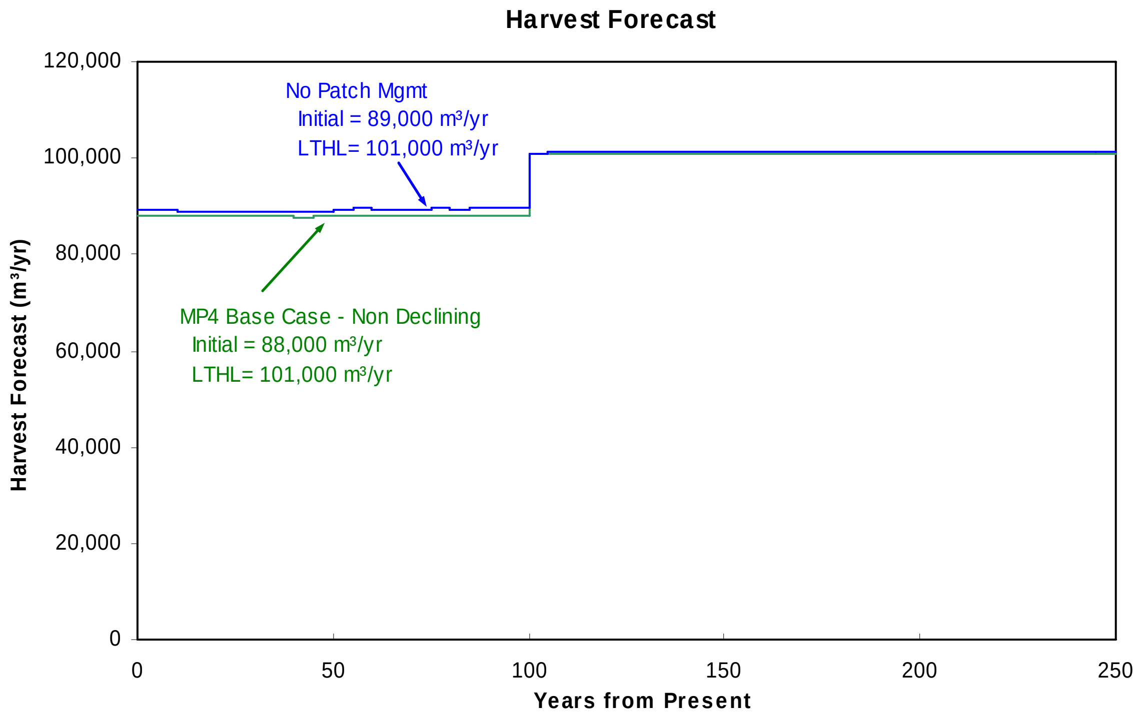


Figure 39. Harvest forecast with no patch size constraints

Results

Run	Short Term	Mid Term	Long Term
No patch size limitation	Increases by 1% to 89,000 m³/yr.	Increases by 1% to 89,000 m³/yr.	No significant change.

A relaxation of the patch size targets results in a minor (1%) increase in the short to midterm harvest flow. No significant changes are reflected over the long run although there is a very minor increase in the harvest levels. By releasing the patch size constraint the very small patch sizes (< 3 ha) proportion increases from an average of 6% to 9% and the very large patch size proportion (>250 ha) remains the same. The results can be attributed to allowing this small fragments of area to be more easily scheduled during the short-midterm and allowing an even smaller amount of area to be harvested that wasn't able to be harvested in the base case (long term impact).

7.0 Summary and Recommendations

This analysis report presents a base case harvest flow with a non declining timber supply. Given the inputs and assumptions in the base case, the initial harvest of 88,000 m^3/yr can be maintained for 100 years before increasing to an average of 101,000 m^3/yr. The short term harvest level is below the current AAC by 12% but the long term level is 1% higher then the current AAC.

The short and midterm harvest levels are heavily influenced by a pinch point that exists 45-55 years into the future. This is the point where natural stands are no longer dominating the harvest and managed stands are just being to come online in a substantial way.

The base case flow is substantially different from MP3 results because of changes in assumptions and data used. The short term flow is lower by 12% because of reduced mature growing stock and aerial harvest limits, while the long term flow is higher by 27% because of SIBEC adjusted site indexes and the use of class A seed.

In order to assess the impacts of potential changes to modeling assumptions, and gain further understanding of the dynamics at work in the base case forecast, a series of sensitivity analyses were completed and are summarized below, ordered from the most significant impact to the least significant impact and by the type of impact whether positive, negative or neutral (Table 8).

Table 8. Summary of Sensitivity Analysis Results

Run	% Change to Harvest Forecast		
	Short term	**Mid term**	**Long term**
Negative Impacts			
No SIBEC site index adjustment	marginal	-22%	-21%
Limit aerial harvest contribution to 0% of the harvest profile	-14%	-11%	-8%
Timber harvesting land base minus 10%	-10%	-10%	-10%
Minimum harvest ages increased by 10 yrs	-12%	-12%	-5%
Natural stand yields minus 10%	-13%	0%	-2%
Exclude hemlock > 80% stands	-7%	-2%	-2%
Managed stand yields minus 10%	none	-8%	-10%
Decrease pulp limit to 20% of annual harvest	-16%	none	none
Positive Impacts			
No caribou management constraints (No Status Quo or Incremental caribou reserves)	+18%	+18%	+16%
Timber harvesting land base plus 10%	+6%	+6%	+6%
Only Status Quo caribou reserves (no Incremental caribou)	+6%	+6%	+5%
Natural stand yields plus 10%	+5%	+5%	none
Managed stand yields plus 10%	none	+7%	+9%
Allow unlimited contribution of aerial harvest to the harvest profile	+5%	+5%	+1%
No patch size constraints	+1%	+1%	none
Neutral Impacts			
SIBEC site index adjustment applied in the ESSF	none	marginal	+1%
Armillaria – low incidence	none	none	-1%
Decrease pulp limit to 30% of annual harvest	marginal	marginal	none
Minimum Harvest Ages decreased by 10 yrs	none	none	none
Seral constraints in place of spatial OGMA’s	none	none	none

All scenarios were targeting a regular and stable harvest flow not only for the near future but also for the long term. Base case sensitivity analyses revealed that the short-term harvest level is stable but it is highly depend on achieving projected volumes. Any factors that could delay managed stands from become eligible for harvest or reduce the amount of natural stand volume on the land base will impact short term harvest levels.

This analysis points to a reduction in the current AAC for TFL 56. RCFC's preference is for the reduction to be done immediately and down to a level that will sustainable going forward. Thus, the new AAC would ideally be set at 88,000 m^3/year. This harvest flow will rise to 101,000 m^3/year over the long run once managed stands dominate the harvest profile. This proposed harvest flow fully addresses the limitations and other constraints explicitly covered during this analysis.

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Appendix 1 — Acronyms

AAC	Allowable Annual Cut
Analysis	Timber Supply Analysis
AU	Analysis Unit
BCTS	BC Timber Sales (Formerly Small Business Forest Enterprise Program)
BEC	Biogeoclimatic Ecosystem Classification
BEO	Biodiversity Emphasis Options
BGB	Biodiversity Guidebook
BL	Balsam Fir
CF	Chief Forester
CFLB	Crown Forested Land base
CW	Western Red Cedar
DBH	Diameter at breast height (1.3m)
DFO	Department of Fisheries and Oceans
DM	District Manager
ESA	Environmentally Sensitive Area
FD	Douglas Fir
FIP/FC1	Old Forest Cover Digital Files
FIZ	Forest Inventory Zone
FPC	Forest Practices Code
FRPA	Forest and Range Practices Act
GIS	Geographic Information System
HLPO	Higher Level Plan Order
HW	Western Hemlock
ILMB	Integrated Land Management Bureau
KBHLPO	Kootenay Boundary Higher Level Plan Order
LA	Alpine Larch
LRMP	Local Resource Management Plan
LU	Landscape Unit
LW	Western Larch
MoAL	Ministry of Agriculture and Lands
MoE	Ministry of Environment
MoF	Ministry of Forests
MSY	Maximum Sustained Yield
MSYT	Managed Stand Yield Tables
MP	Management Plan
NCC	Non-Commercial Cover
NDT	Natural Disturbance Type
NP	Non Productive
NRL	Non-Recoverable Losses
NSR	Not Satisfactorily Restocked
NSYT	Natural Stand Yield Tables
OAF	Operational Adjustment Factor
OGMA	Old-Growth Management Areas
PA	Whitebark Pine
PEM	Predictive Ecosystem Mapping
PL	Lodgepole Pine
PSP	Permanent Sample Plot
PSYU	Public Sustained Yield Unit
PW	White Pine
PY	Ponderosa Pine
RIC	Resources Inventory Commission
RM	Regional Manager
RMZ	Riparian Management Zone
ROS	Recreation Opportunity Spectrum
RTEB	Resource Tenures and Engineering Branch
TFL	Tree Farm License
THLB	Timber Harvesting Land base
TIPSY	Table Interpolation Program for Stand Yields (growth and yield model)
TSA	Timber Supply Area
TSR	Timber Supply Review
UREP	Use, Recreation, and Enjoyment of Public
VDYP	Variable Density Yield Predictor (growth and yield model)
VEG Ht	Visually Effective Greenup Height
VQO	Visual Quality Objective

Appendix 2 – Data Inputs and Modeling Assumptions

See accompanying document titled "RCFC_MP4_Info_Package_v2.1_Feb_11_09.pdf"