Appendix 4

The *Timber Supply Analysis Report* is provided under separate cover

Revelstoke Community Forest Corporation

Revelstoke
Community
Forest
Corporation

Timber Supply Analysis Report:

Tree Farm Licence 56

Management Plan # 3

Final
October 27, 2000

Completed by:

Silvatech
CONSULTING LTD.

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Executive Summary

Revelstoke Community Forest Corporation (RCFC), the holder of Tree Farm Licence (TFL) 56, is currently producing Management Plan #3. As a part of this planning process, a timber supply analysis has been completed to project short and long-term timber supply based on current information, management practices, and economic factors. This analysis will be used by the Chief Forester as one component in his determination of the Annual Allowable Cut (AAC) for the 5-year period addressed by MP#3.

TFL 56 is 119,747 ha in size and contains a significant amount of non-forested area (51%), mostly in the form of alpine parkland, alpine tundra, rock, and ice. Approximately 31% of the TFL is considered operable forest (37349 ha), and only 25% (30702 ha) is suitable for the practice of forestry (THLB). In order to address forest cover constraints for other resource values, mature forest retention areas (MFRA's) have been identified that further reduce the THLB to a working land base of 17% of the TFL area (20513 ha).

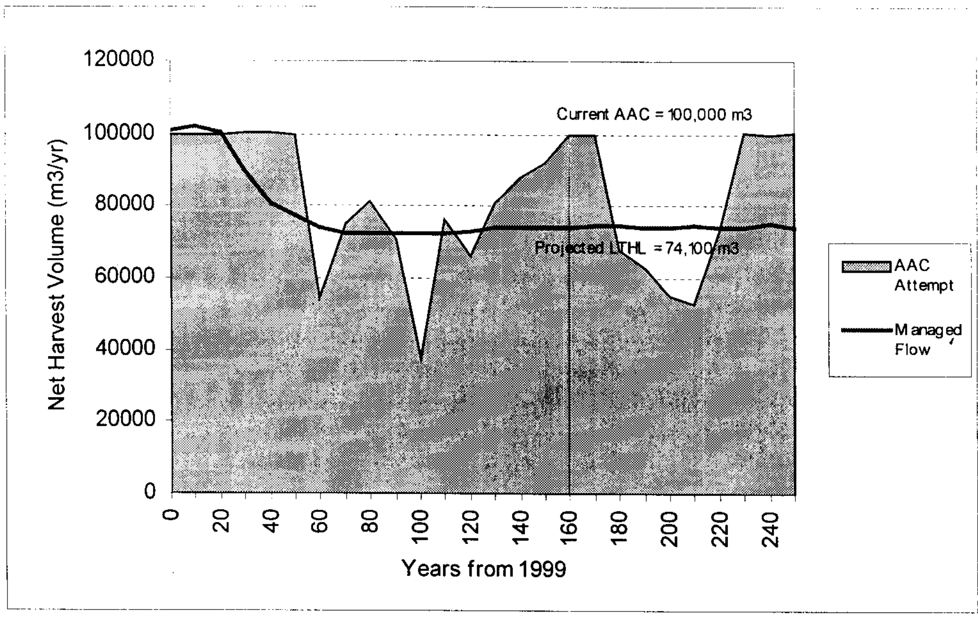
Since the approval of the previous Management Plan (MP#2), significant changes in the rules governing the practice of forestry in TFL 56 have occurred. BC's Forest Practices Code has been implemented and the Revelstoke Minister's Advisory Committee's strategy is now recognized in the operational planning process. In an effort to address these and other issues, RCFC has systematically completed a series of planning and inventory initiatives (Total Chance Plans, landscape level forest retention strategies, avalanche hazard mapping, etc.) that have left them well equipped to practice sustainable forest management. The spatially explicit timber supply model used in this analysis relied heavily on these tools to define the working land base and provide operational realism to this strategic analysis. The amount and quality of planning provided as inputs to the model meant that very few strategic decisions were required of the model – it simply implemented RCFC's vision of land management for TFL 56. This resulted in harvest projections that are closely linked to operational reality.

Although the MAC strategy is not yet a legally established higher-level plan, it is considered current management in the Revelstoke area and has been part of the FDP process for several years. The guidelines in the MAC strategy were applied in the base case and were instrumental in developing RCFC's reserve strategy. This reserve strategy serves to address all of the forest cover constraints on the operable land base and leaves the remaining area essentially unconstrained – only patch size distribution and stand level biodiversity requirements are left to be addressed within the working portion of the THLB.

Patch size distribution targets were used in place of adjacency rules to control the spatial distribution of harvest throughout the TFL. This was done to better mimic natural disturbance patterns and to mitigate the timber supply impact of adjacency constraints. The patch size distributions created by the base case generally resulted in a higher percentage of small (< 40 ha) openings than those suggested for Natural Disturbance Types 1&3 by the Landscape Unit Planning Guide [MoF, March 1999]. This was considered acceptable because the creation (harvesting) of larger openings was often not possible due to forest cover constraints, existing landscape patterns, steep terrain, and partial cutting strategies. In the final analysis, the patch size distributions projected for TFL 56 are an artifact of managing for other values that take precedence over patch size.

When patch size distributions and RCFC's MFRA's are modeled in the base case, the current AAC (100,000 m^3/yr) can be sustained for 20 years before it falls at 10% per decade to a mid-term trough of 72,000 and then recovers to a long-term harvest level of 74,100 m^3/yr.

Base Case Harvest Projection for TFL 56.



Short-term timber supply in the base case is heavily influenced by the existing age class structure in the working portion of the THLB. Significant volumes of older stands have been placed into reserve and significant volumes of managed stands do not become available for 50-60 years. This requires the harvest of the eligible older stands to be spread out over this time frame. Any factors that influence the volumes available from these older stands or when managed stands become eligible for harvest will impact short term harvest levels.

RCFC's reserve strategy had the most significant impact on both short and long-term harvest levels because it reduced the working portion of the THLB. Old and mature areas assigned as reserves have the effect of limiting harvesting options in the short term and reducing the productive land base that determines long-term harvest levels. The current strategic plan diverts approximately 9226 ha (30%) of the THLB to reserve, however there is opportunity to refine the reserve strategy to restrict less of the land base and put an upward pressure on timber supply.

In summary, sensitivity analyses indicate that only an overestimate of existing natural volumes by 10% would result in an immediate reduction in AAC. All other sensitivity analyses showed at least 10 years of harvest at the current AAC.

The scenario that is believed to best represent the future timber supply in TFL 56 is the base case with an optimized reserve strategy and revised site indices for old growth stands (OGSI). This would see the current harvest level maintained for at least 30 years, with a long-term harvest level of at least 90,000 m^3/yr.

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1.0 Introduction

Timber supply is defined as the rate at which timber becomes available for harvest through time in response to a given set of biological, social, economic, and environmental factors. Timber supply will change over time in relation to changes in these factors. Our current understanding of these factors can be modeled into the future in an attempt to ensure sustainable harvest levels but it is important to revisit the projections periodically in order to incorporate new information, changes in management direction, and new economic factors. Uncertainty around the set of parameters that drive a timber supply model can be addressed through sensitivity analyses, which provide a measure of the potential impact of incorrect information.

Revelstoke Community Forest Corporation (RCFC), the holder of Tree Farm Licence (TFL) 56, is currently producing Management Plan #3. As a part of this planning process, a timber supply analysis has been completed to project short and long-term timber supply based on current information, management practices, and economic factors. This analysis is used by the Chief Forester as one component in determining the Annual Allowable Cut (AAC) for the 5-year period addressed by MP#3.

This document describes the methodologies and results of the timber supply analysis completed for TFL 56 in the fall of 2000. The Information Package approved August 1, 2000 describes all of the data and assumptions used in detail. A summary of these inputs is provided in section 3.0 of this document.

The timber supply modeling completed for MP#3 was completed using a spatially explicit model (FPS-ATLAS) that links strategic and operational planning. The spatial detail permitted in the model allowed RCFC's total chance harvest planning and landscape unit planning to be implemented explicitly and meant that the model did not have to decide where to place reserves or cutting boundaries. These inputs were given to the model so that the output of harvest schedules and locations was as operationally feasible as possible. This is an excellent example of bottom up planning – operational detail is used to drive a strategic level plan.

2.0 Licence Area Description \ Current Attributes

TFL 56 is located 40 km north of Revelstoke and is bounded by the Revelstoke Reservoir to the west and the Selkirk Mountains to the east. The land is extremely rugged and dominated by two roughly east-west valleys, Downie Creek and Goldstream River, which join into the Columbia River valley (Lake Revelstoke Reservoir). Elevation ranges from 573 meters at reservoir level to 3050 meters at Carnes Peak. Most harvesting is confined to valley sidewalls and valley bottoms. The remaining "high country" is too rugged or does not support marketable timber.

TFL 56 has two landscape units: R12 and R19. R12 is completely within TFL 56 and comprises the Downie valley and a portion of the "Columbia face". R19 is shared with TFL 55 and comprises the Goldstream Valley and a portion of the Columbia face. By agreement with the local Forest Service and Ministry of Environment staff, the portion of R19 within TFL 56 is managed independently of the TFL 55 portion.

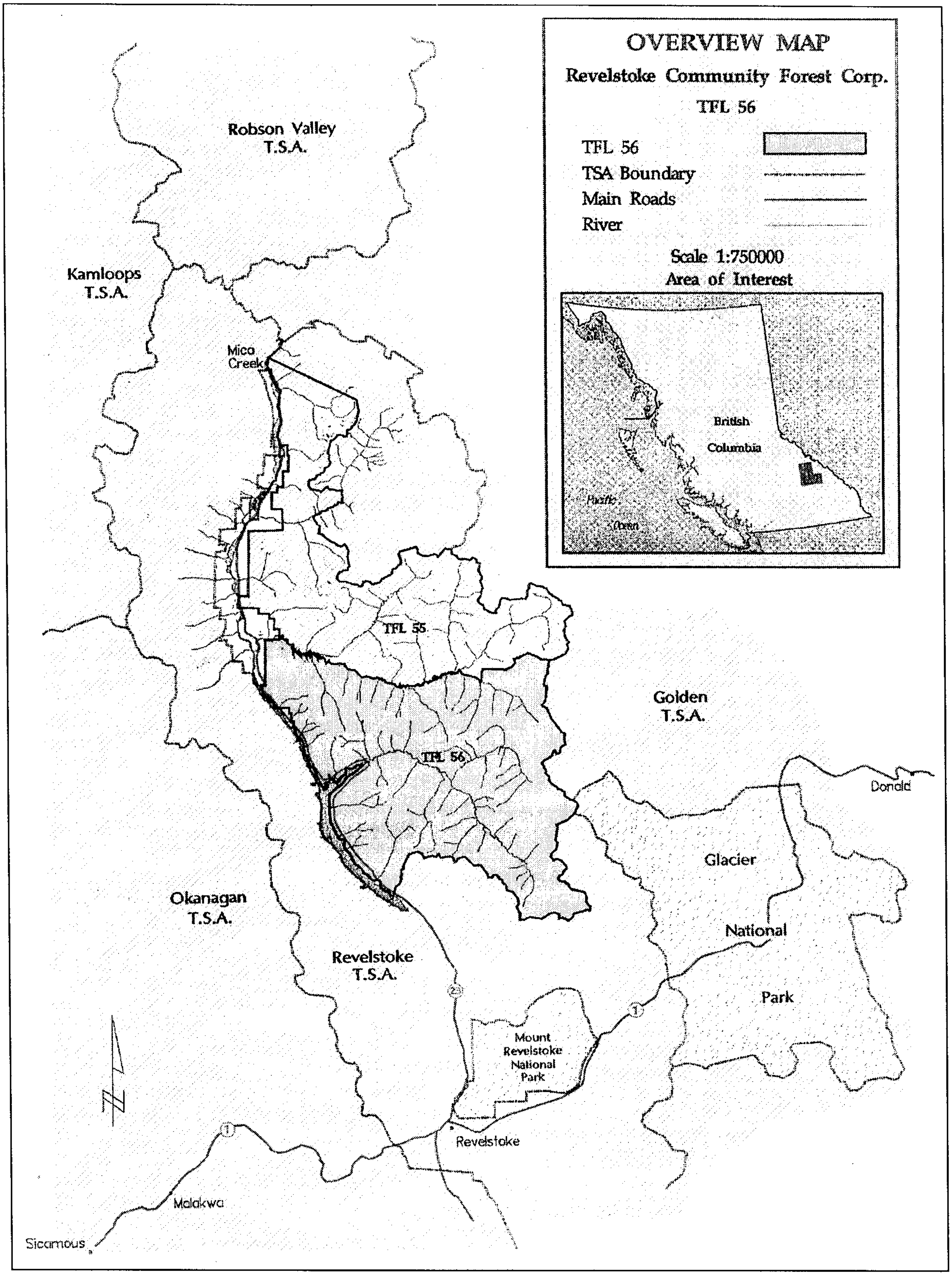

OVERVIEW MAP
Revelstoke Community Forest Corp.
TFL 56
TFL 56
TSA Boundary
Main Roads
River
Scale 1:750000
Area of Interest
British
Columbia
Robson Valley
T.S.A.
Kamloops
T.S.A.
Mica
Creek
TFL 55
Golden
T.S.A.
TFL 56
Donald
Glacier
National
Park
Okanagan
T.S.A.
Revelstoke
T.S.A.
Mount
Revelstoke
National
Park
Revelstoke
Malakwa
Sicamous

Figure 1. Location Map for TFL 56.

TFL 56 is 119,747 ha in size and contains a significant amount of non-forested area (51%), mostly in the form of alpine parkland, alpine tundra, rock, and ice. Approximately 31% of the TFL is considered operable forest and only 25% is suitable for the practice of forestry (THLB). In order to address forest cover constraints for other resource values, forested retention areas (MFRA's) have been identified that further reduce the THLB to a working land base of 17% of the TFL area. A detailed breakdown of the land base can be found in Section 3.1.

TFL 56 is composed almost entirely of Schedule B land (provincial land in TFL) but does contain two small Timber Licences (Schedule A land) totaling 754 hectares.

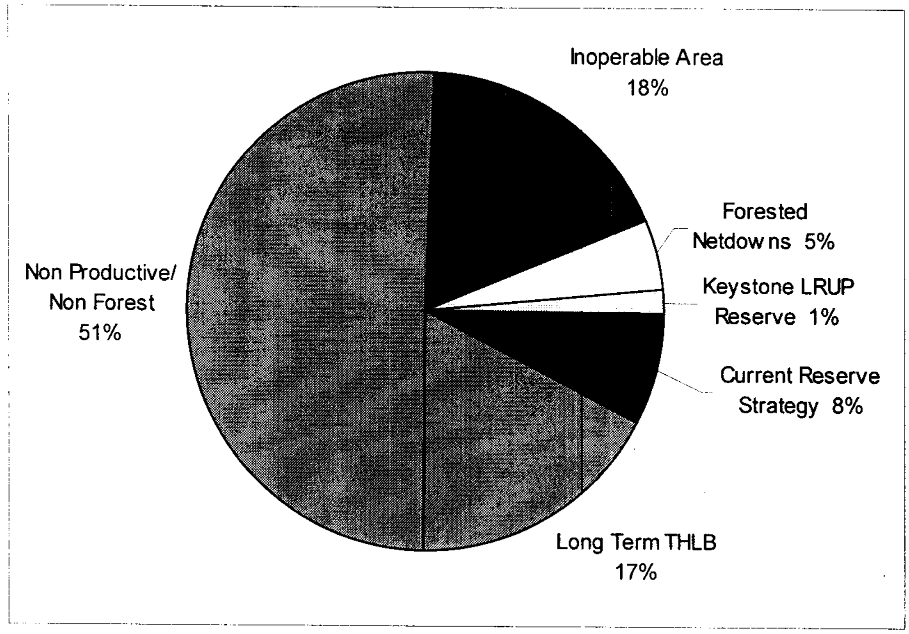


Figure 2. TFL 56 Area Breakdown

The current AAC for the TFL is 100,000 m3/yr. The Columbia District Small Business Forest Enterprise Program is allotted approximately 12,000 m^3 of the AAC and the remainder is assigned to RCFC. As a condition of tenure, RCFC must provide 50% of their cut volume to two local mills while the remainder of their volume is sold through the open market at their sort yard in Revelstoke.

Cable harvesting is the dominant harvest method used in the TFL but ground based and alternative harvest systems (long line cable and helicopter) are also currently employed.

The current age class structure in the TFL is heavily skewed toward older forests, although the accuracy of the older stand ages appears to be poor. The inventory indicates that all stands over 215 years are either 225 or 325 years old. Refer to Figure 3 below.

Figure 4 shows the working portion of the THLB area by site class. Site class is a relative ranking that describes a given site's potential to grow trees. The three classes shown are groupings of individual site indices (tree height at 50 yrs breast height age) for the stands in the working portion of the THLB. Roughly 42% of the working THLB is in the good site class, while 38% is in medium and 20% is in poor. Figure 4 also shows the amount of area in each site class that is currently old enough to harvest. Because harvesting has historically favored better sites, the proportion of eligible stands is lower for these sites and higher for poorer sites.

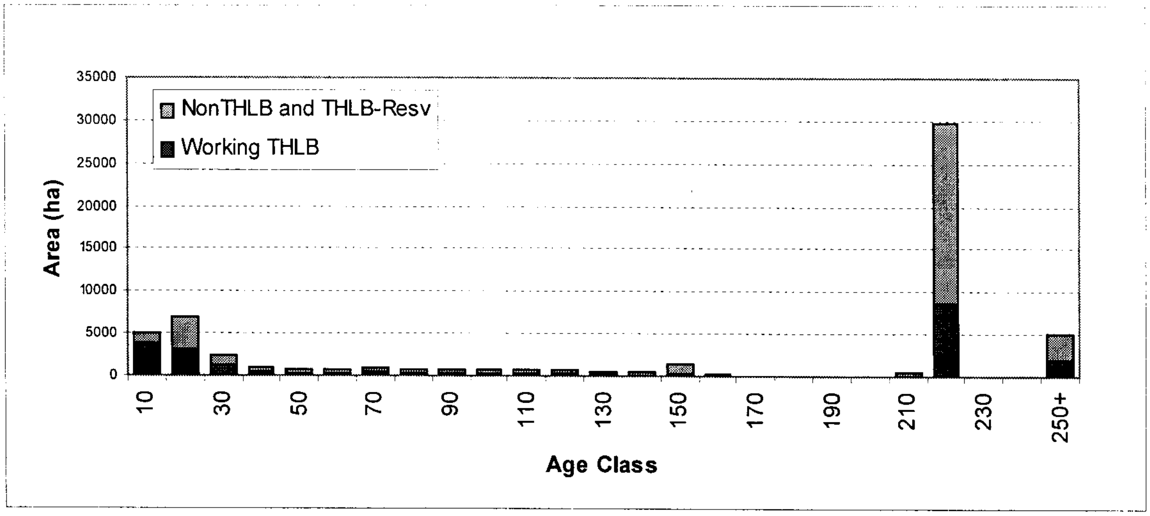


Figure 3. Current (1999) age class composition of the forested area in TFL 56.

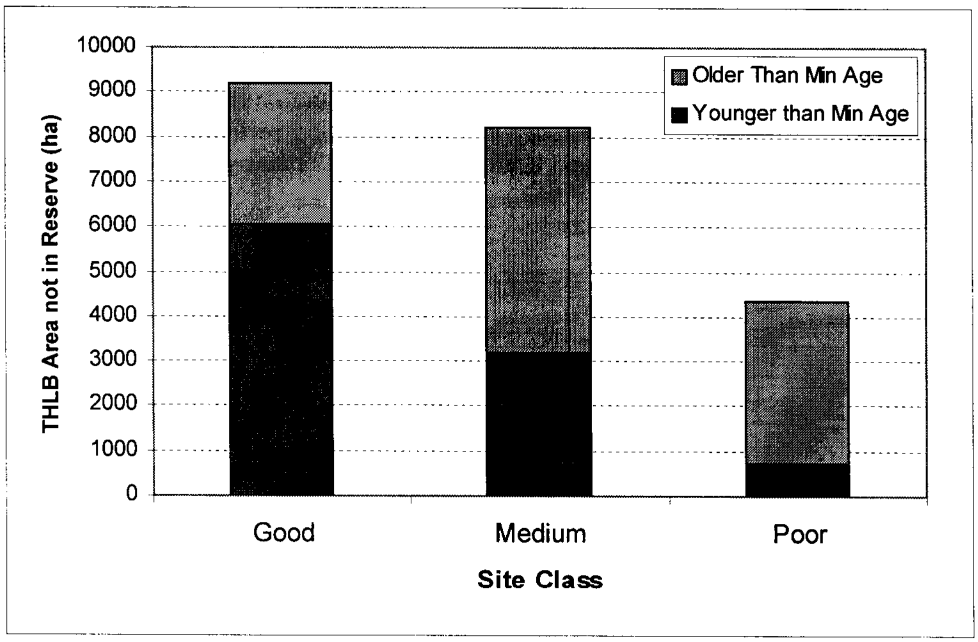


Figure 4. Site class summary for the working portion of the THLB.

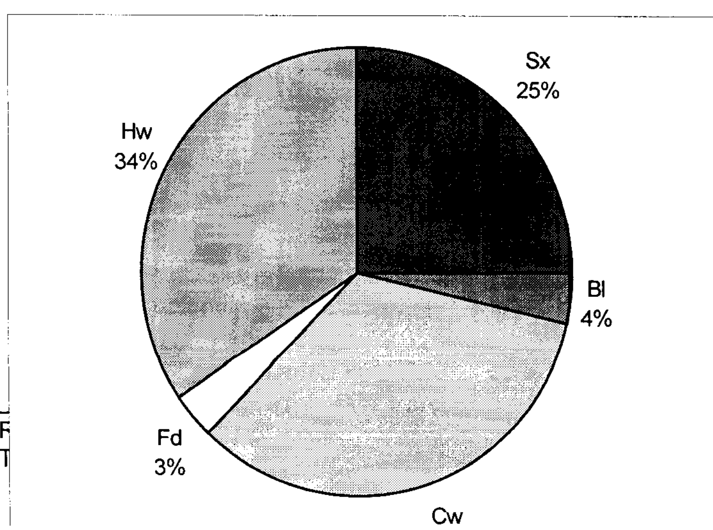


Figure 5 shows the TFL's species composition by volume for the forested area below the operability line. The vast majority of this area has stands with Sx (25%) or Cw (34%) or Hw (34%) leading. A small area has Bl leading stands, while several Fd leading stands exist generally in new plantations.

Figure 5. Current volume summary by leading species (1999 operable area).

Figure 6 shows that the TFL has only two forested biogeoclimatic zones (ICH and ESSF) and that they are broken down into 4 variants on the operable land base. This breakdown uses the new (1999) ecosystem data for the Columbia District provided by the Ministry of Forests, Nelson Region. Prior to this update, the TFL consisted entirely of Natural Disturbance Type 1 (NDT 1) variants but the addition of ICH mw3 added a small area of NDT 3 and its different management considerations. The Revelstoke Minister's Advisory Committee's biodiversity strategy does not address management in NDT3 so the Landscape Unit Planning Guidebook was used to fill in the gaps.

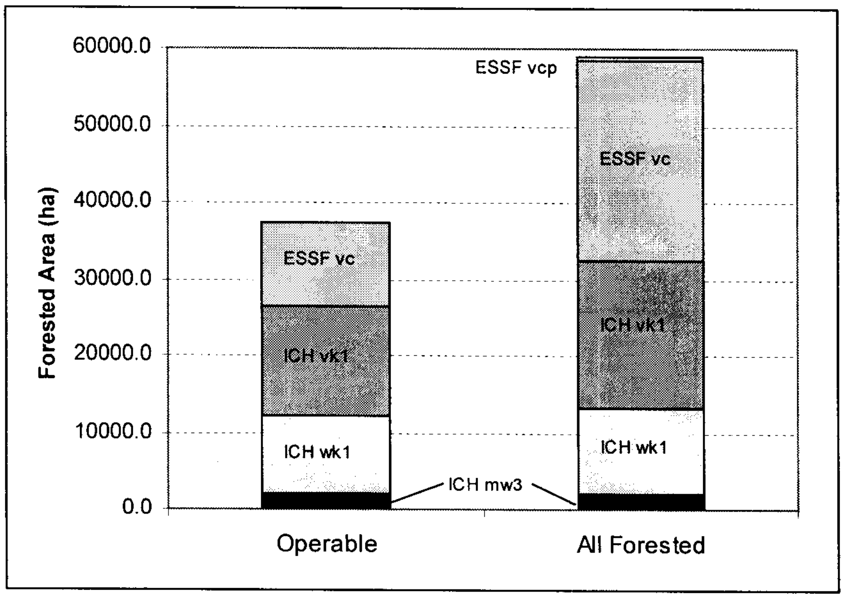


Figure 6. Forested area summary by biogeoclimatic zone/variant.

Biodiversity and habitat requirements for caribou, deer, and moose are the significant non-timber resource values that affect harvesting in the area. Other values with less significant impacts on harvesting in the TFL are visuals, grizzly bear, water, and recreation. Where possible, each of these issues has been address in the timber supply model and are discussed in section 2.3.1.

Further descriptions of the land base, forest inventory, and forest management practices can be found in Section 3.0.

3.0 Analysis Data and Assumptions

This section summarizes the data inputs and assumptions documented in the Information Package. The information has been divided into three categories: Landbase, Inventory, and Management data and assumptions. For a more detailed description of this information, refer to the completed Information Package report dated July 10, 2000.

3.1 Land Base Data and Assumptions \ Netdowns

In order to determine the timber harvesting land base, a netdown process was completed that sequentially removed lands not suitable or ineligible for the practice of forestry. This was completed using the ArcInfo GIS and allowed a spatial depiction of where the netdowns occurred (refer to netdown map in Information Package). Only wildlife trees and future roads were not spatially removed from the land base – they were implemented using percentage reductions.

Table 1. Land Base Netdown Summary.

	Area (ha)[1]			Coniferous m3 [2]
	Operable 99	Inoperable	TFL 56	TFL 56
TOTAL	42778.7	76968.9	119747.6	16,616,361
Non Productive/ Non Forest	4472.2	55307.0	59779.2	0
Non Classified Roads	957.8		957.8	141,487
Productive Forest	37348.7	21661.9	59010.6	16,474,874
Less				
Inoperable		21661.9	21661.9	5,526,325
Keystone LRUP Reserve	1745.1		1745.1	443,078
Unstable Terrain	1979.2		1979.2	777,280
Low Sites	298.7		298.7	62,325
Problem Forest Types	247.6		247.6	44,271
Deciduous Forest Types	837.0		837.0	0
Riparian Reserves	1049.8		1049.8	373,887
Long-term Low Stocking	223.1		223.1	
Wildlife Tree Patches	266.0		266.0	79,800
Timber Harvesting Land Base	30702.2	0.0	30702.2	9,167,908
Less Long-term Removals				
Future Roads	963.0		963.0	305,790
Retention Areas	9226.3		9226.3	3,440,892
Long-term THLB	20513.1	0.0	20513.1	5,421,256

The long-term THLB is lower than that shown in the Information Package because additional area was placed into the retention strategy in order to meet forest cover requirements.

[1] The areas presented above do not include any overlap between classifications. Deductions were made in the order presented above such that overlapping classifications are removed by the net down occurring first on the list.

[2] Volumes are coniferous net volumes based on minimum 17.5 cm dbh utilization standard.

The spatial netdowns were combined with RCFC's recently completed mature forest retention strategy (refer to section 3.3.6) to define the actual areas on which forest harvesting would be modeled through time. This area is further reduced as new roads are built until the long-term THLB is reached.

A detailed description of each of the netdowns can be found in the Information Package, but a summary of each can be found below.

Non-productive / Non-forest area includes all areas in the forest cover inventory file with a non-forest descriptor (water, ice, rock, alpine, roads, mining areas, etc.) or a non-productive descriptor (NP, NP Brush, NP Burn, NC Brush).

Non-Classified Roads are existing roads that are not represented by a polygon in the forest cover inventory file. These roads were buffered using the GIS and spatially removed from the land base used in the timber supply model. Primary logging roads were assumed to have an average unproductive width of 20m. Secondary roads were assumed to have an average unproductive width of 15.9m but an additive for existing non-productive landings and skid trails (3.6m) resulted in a 19.5m net width applied to these roads.

Inoperable area includes forested land that is not available for harvest because it is physically or economically inaccessible. A new operability line was approved just prior to the submission of the information package that expanded the operable forested land base by 12,036 ha (47%) from the previous (1994) operability line. The revised line is based on comprehensive total chance planning.

Keystone LRUP Wilderness area was removed because it excludes forest harvesting. While most of the wilderness area is in alpine parkland, 1745 ha is within the 1999 operable forest.

Unstable Terrain is defined as polygons identified during TSIL 'D' mapping as likely to be "unstable". However, not all polygons identified as "unstable" preclude the practice of forestry – the label is meant to raise a warning flag for closer scrutiny in the field. The THLB polygons were reviewed in conjunction with total chance planning, existing field assessments and past experience on the TFL. The end result was that 49% of TSIL "D" unstable areas in the forested operable land base were removed.

Low Sites are areas not suitable for harvest due to poor timber growing potential. Thresholds have been set independently for aerial harvest polygons and non-aerial harvest polygons due to the higher rate of return required for aerial harvesting. Aerial harvest polygons with a SI_{50} from 0 to 8 (SI_{50} is projected height in meters at age 50) are removed from the land base. Non-aerial harvest polygons with an SI_{50} from 0 to 7 are also removed from the land base.

Problem Forest Types are currently uneconomic to log due to species mix or stand attributes. For this analysis, deciduous leading stands, all stands with stocking class 2 (< 76 sph with dbh of 27.5+), and any stands that are over 120 years and less than 19.5m tall were removed. Using the total chance plan to identify the operability line excluded areas of hemlock leading stands, especially when they required helicopters to harvest. Thus, no blanket removal of hemlock leading stands was implemented as it was felt that the blocks remaining in the TCP were economically viable.

Riparian Reserves were derived spatially using riparian classifications from the "Lake, Wetland, and Stream Classification" mapping completed in 1998. This mapping used size to classify lakes/wetlands. Sampling information and gradient were used to provide stream riparian classes (S1-S6) or categories (S1-S4, S5-S6). Areas without a specific class were assigned one through a rule set devised specifically for TFL 56. Each stream was buffered with the net reserve width (Table 2) for its riparian class in order to identify the netdowns spatially.

Table 2. Riparian Reserve Width Summary.

Riparian Type	Riparian Class	Stream length (km)	Reserve width (m)	Mgt zone width RMZ (m)	Removal % in RMZ	Net reserve width (each side)
Streams						
S1 streams	S1	12.1	50	20	50%	60
S2 streams	S2	44.9	30	20	50%	40
S3 streams	S3	92.2	20	20	50%	30
S4 streams	S4	107.4	0	30	50%	15
S5 streams	S5	56.7	0	30	83%	5
S6 streams	S6	2187.2	0	20	95%	1
Sorcerer Crk	S5	In S5	0	30	50%	15
Brewster Crk	S5	In S5	10	20	50%	15
Wetlands						
W1 wetlands	W1		10	40	75%	20
W3 wetlands	W3		0	30	66%	10
W5 wetland complexes	W5		10	40	75%	20
Lakes						
Lake Revelstoke	L1 >1000 ha		0	20	0%	20
L3 lakes	L3		0	30	50%	15

Long-term Low Stocking areas currently have less than 300 well-spaced coniferous stems per hectare and were harvested prior to 1994. These areas are not likely to provide a harvest of coniferous timber within a reasonable time frame so they are currently excluded from the land base.

Wildlife Tree Patches (WTPs) were implemented on the land base where existing reserves or forested net-downs were unable to meet the spacing requirements – the landscape level reserves more than made up the percentage requirements for WTPs. All forested areas not part of the THLB were buffered by 250m in order to identify areas in the THLB that do not meet the 500m spacing rule for WTPs. Any areas not covered by the buffer (4433 ha) are assumed to require WTPs of 6%. This should be considered to be an overestimate of the actual amount required in WTPs as the percentage in forested reserve is well in excess of 6% for each BEC variant in each landscape unit. An amount less than 6% retention would likely be considered acceptable to meet the spacing requirements.

Future Roads, trails and landings are those that will be built to harvest undeveloped timber in the future. To estimate the site occupancy of these structures, samples of existing roads and landings as well as a sample of Silviculture Prescriptions (SP's) completed in the last three years was taken and resulted in a 6.9% average reduction in productive area. Future permanent access structures are accounted for through a reduction in yield curves because of timing. To include the volume (area) associated with the new roads and landings when a polygon is harvested for the first time, an area reduction for future PAS would have to occur after the first harvest. This is difficult to achieve in the timber supply model so the strategy is to allow the polygon to receive the full volume on the first harvest (natural stand curves) and subsequent harvests will use a managed stand yield curve that has been reduced by 6.9% to account for the reduction in productive area. The area reduction shown in Table 1 serves only to provide an estimate of the long-term THLB.

Environmentally Sensitive Areas are identified on the forest inventory files as "ESA's". The ESA system uses the following categories: soil (Es), forest regeneration problems (Ep), snow avalanche (Ea), recreation (Er), wildlife (Ew), water (Eh), and fisheries (Ef).

ESA's were not used in the netdown process, as better information was available or management practices were deemed sufficient to address the issue.

- TSIL D mapping was used instead of Es polygons (although all Es polys were removed).
- Regeneration issues were addressed through the use of group selection systems in Ep area.
- Avalanche Hazard mapping was used in place of Ea polys. Group selection systems were applied to areas of high or very high avalanche likelihood after harvest.
- Recreation concerns (Er) were not identified in TFL 56.
- Wildlife issues (Ew) are addressed through forest cover constraints.
- Water concerns (Ew) were not identified in TFL 56.
- Fisheries concerns (Ef) were not identified in TFL 56 – FPC riparian management is considered to address this issue.

3.2 Inventory Data and Assumptions

The current forest cover inventory was updated in 1999 to accurately reflect all harvesting and roading activity to July 24th, 1998 using 1:20,000 digital orthophotos. This digital data was submitted to the Ministry of Forests Resources Inventory Branch in mid-1999 and was approved in January 2000. Discrepancies in the designation of forested vs non-forested areas were identified by RCFC when using the orthophotos to update the inventory file but this data was not used in the model because of time limitations.

Time zero for the timber supply analysis will be January 1, 1999 as the openings from July 24, 1998 to Jan 1999 have been included in the model database.

3.2.1 Stand Groups (Analysis Units)

In order to reduce the complexity and size of the model, like stands were grouped based on management regime, species, age, and site index. Each stand group is assigned a yield curve, minimum/maximum harvest age, and a subsequent yield curve to follow after treatment.

Three main sets of stand groups have been created for the purposes of timber supply modeling:

- Managed stands,
- Natural stands ≤140 years of age,
- Natural stands over 140 years of age.

Natural and managed stands are differentiated because different growth models are used to produce their yield curves. Natural stands are defined as those that regenerated naturally after a disturbance with no assistance in achieving the potential of the site. For the purposes of this management plan, any stand established more than 20 years ago (before 1980) will be treated as a natural stand and will use the MoF's Variable Density Yield Prediction (VDYP) model to supply the yield curves. Managed stands are defined as those established less than 20 years ago and will use yield curves supplied by the MoF's Table Interpolation Program for Stand Yields (TIPSY).

The natural stands are further subdivided into two age categories (≤140 and >140 years). This is required in order to apply Old Growth Site Index (OGSI) adjustments during sensitivity analyses. Only site indexes for stands in excess of 140 years of age are eligible for the adjustments.

The stands managed with a group selection silviculture system (i.e. Lookout Mountain, avalanche prone slopes, Ep areas, high elevation ESSF) will utilize the standard yield curves with a 5% volume reduction to address productivity losses from increased shading and edge. The areas where group selection is to be applied are explicitly identified on the landbase and have been broken up into approximately one-hectare patches. Thus, when a polygon is eligible to be harvested, it will be harvested in its entirety. The model, using adjacency constraints, will manage the spatial distribution of harvest within the group selection areas.

All volumes used in the model are net coniferous volumes based on a minimum diameter at breast height of 17.5 cm and the default factors for decay, waste, and breakage found in VDYP and TIPSY (OAFs of 15% and 5%).

Deciduous leading stands were netted out and the deciduous component of coniferous leading stands was ignored.

Table 3. Stand Group Definitions

Stand Group ID	Stand Group Name	Age Range	Species	Inv Type Groups	Site Class	SI Range	G&Y Model
Existing Managed Stands							
1	Low stocking (300-700 ws sph)	Any	Any	Any	M	7+	TIPSY
2	Exist-Man-CwHw-G	Existing <20	CwHw	9-17	G	18+	TIPSY
3	Exist-Man-CwHw-M				M	<18	TIPSY
4	Exist-Man-Fd	Existing <20	Fd Leading	1-8, 27-34	All	>7	TIPSY
5	Exist-Man-SxBl-G	Existing <20	SeBl	18-26	G	18+	TIPSY
6	Exist-Man-SxBl-M				M	<18	TIPSY
1002 –1006	2-6 reduced by 5% for GS						TIPSY
2222-6666	2-6 that transfer to 1002-1006						TIPSY
Existing Natural Stands							
10	Nat-Fd-G	20+	Fd leading	1-8,27,28	G	>21	VDYP
11	Nat-Fd-M				M	16-21	VDYP
12	Nat-Fd-P				P	<16	VDYP
20	Nat-Mat-Bl-G	20-140	Bl leading	18-20	G	14+	VDYP
21	Nat-Mat-Bl-M				M	<14	VDYP
30	Nat-Mat-Cw-G	20-140	Cw leading	9-11	G	>18	VDYP
31	Nat-Mat-Cw-M				M	14-18	VDYP
32	Nat-Mat-Cw-P				P	<14	VDYP
40	Nat-Mat-Hw-G	20-140	H leading	12-17	G	>16	VDYP
41	Nat-Mat-Hw-M				M	13-16	VDYP
42	Nat-Mat-Hw-P				P	<13	VDYP
50	Nat-Mat-Sx-G	20-140	Sx leading	21-26	G	>21	VDYP
51	Nat-Mat-Sx-M				M	15-21	VDYP
52	Nat-Mat-Sx-P				P	<15	VDYP
25	Nat-Old-Bl-G	>140	Bl leading	18-20	M	14+	VDYP
26	Nat-Old-Bl-M				P	<14	VDYP
35	Nat-Old-Cw-G	>140	Cw leading	9-11	G	>18	VDYP
36	Nat-Old-Cw-M				M	14-18	VDYP
37	Nat-Old-Cw-P				P	<14	VDYP
45	Nat-Old-Hw-G	>140	H leading	12-17	G	>16	VDYP
46	Nat-Old-Hw-M				M	13-16	VDYP
47	Nat-Old-Hw-P				P	<13	VDYP
55	Nat-Old-Sx-G	>140	Sx leading	21-26	G	>21	VDYP
56	Nat-Old-Sx-M				M	15-21	VDYP
57	Nat-Old-Sx-P				P	<15	VDYP
58	Nat-Old-Sx-P GS 1st Entry				P	<15	VDYP
59	Nat-Old-Sx-P GS 2nd Entry				P	<15	VDYP
60	Nat-Old-Sx-P GS 3rd Entry				P	<15	VDYP
1010 - 1057	10-57 that transfer to 1100-1520						VDYP
Future Managed Stands							
100	Man-Fd-G	Regen	Fd leading	1-8,27,28	G	>21	TIPSY
110	Man-Fd-M				M	16-21	TIPSY
120	Man-Fd-P				P	<16	TIPSY
200	Man-Bl-G	Regen	Bl leading	18-20	G	14+	TIPSY
210	Man-Bl-M				M	<14	TIPSY
300	Man-Cw-G	Regen	Cw leading	9-11	G	>18	TIPSY
310	Man-Cw-M				M	14-18	TIPSY
320	Man-Cw-P				P	<14	TIPSY
400	Man-H-G	Regen	H leading	12-17	G	>16	TIPSY
410	Man-H-M				M	13-16	TIPSY
420	Man-H-P				P	<13	TIPSY
500	Man-Sx-G	Regen	Sx leading	21-26	G	>21	TIPSY
510	Man-Sx-M				M	15-21	TIPSY
520	Man-Sx-P				P	<15	TIPSY
1100 to 1520	100-520 reduced by 5% (GS)						TIPSY

3.2.2 Unsalvaged Losses

Volume lost to insects, disease, fire, and windthrow must be accounted for in the timber supply process. Minor endemic losses are dealt with using volume reductions in the yield curves :

TIPSY: The OAF2 of 5% reduces gross volumes to account for losses toward maturity such as decay, and endemic forest health issues like minor infestations.

VDYP: The model predicts actual average yields from appropriate inventory plots. Endemic losses are inherently recognized in the averages.

Catastrophic events like fires or major pest epidemics can affect significant areas and volumes. A estimate of annual unsalvaged losses from these types of events for TFL 56 is as follows:

Table 4. Unsalvaged Losses Breakdown

Description	Gross losses (m^3/year)	Annual unsalvaged volume (m^3/year)
Fire losses (20 year avg)	2309 m^3	452 m^3
Windthrow (5 year avg)	852 m^3	136 m^3
Pest (epidemics only, 7 yr avg)	2506 m^3	367 m^3
Other	0 m^3	0 m^3
Total	5667 m^3	955 m^3

Unsalvaged losses (955 m^3/yr) have been deducted from all harvest forecasts shown in this report.

3.3 Land Management Assumptions

Timber supply is greatly influenced by how the land base is managed for timber and non-timber values. The introduction of rules and constraints that dictate required forest conditions can constrain timber supply by influencing when or if timber becomes available for harvest. The base case harvest forecast is based on current management practices as defined by the most recent Forest Development Plan process. This includes the Revelstoke Minister's Advisory Committee's (MAC) draft recommendations. Final recommendations became available in early 1999 and the changes have been included in the base case.

3.3.1 Revelstoke MAC Guidelines

The MAC guidelines are the result of many years of trying to adapt the Kootenay Boundary Land Use Plan within the Revelstoke portion of the Columbia Forest District so that it was locally relevant and addressed local concerns. In general, these guidelines provide TFL 56 with the following:

- Identified areas for management of caribou, deer, moose, and biodiversity. Landscape units were broken up into both low and intermediate biodiversity emphasis in order to provide corridors along valley bottoms.
- Forest cover requirements meant to address the maintenance of wildlife habitat and biodiversity.
- Patch size distribution targets to guide the spatial distribution of harvest so that it better reflected natural disturbance patterns.

Table 5. Forest Cover Requirements –TFL 56

Requirement to Manage for:	Forest Cover Requirements Applied within the Zone
Primary Caribou	**Below 1994 operability:** At least 40% (slopes <80%) older than 140 years with at least 10% older than 250 years. To be met on the forested portion of each BEC zone in each landscape unit. **Above 1994 operability** Interim strategy: At least 70% of the productive area between the 1994 operability line and parkland forest must be >140 years. To be met in each landscape unit.
Intermediate Caribou	Manage as per intermediate biodiversity. These zones will be modeled independently from the intermediate biodiversity zones.
Recruitment Caribou	Recruitment plan must be in place to achieve the cover requirements set out in primary caribou over time. To be met in each BEC zone and landscape unit.
ICH Low Biodiversity (NDT 1)	**Green-up:** n/a (Target of 1/3 of area in each patch size group: 0-40, 40-80, 80-250) **Early seral:** n/a **Old and mature**: Not applicable[3] **Old**: More than 13% older than 250[4] To be met on the forested portion of each BEC variant in each landscape unit.
ESSF Low Biodiveristy (NDT 1)	**Green-up:** n/a (Target of 1/3 of area in each patch size group: 0-40, 40-80, 80-250) **Early seral:** n/a **Old and mature**: Not applicable[4] **Old**: More than 19% older than 250 years[5] To be met on the forested portion of each BEC variant in each landscape unit.
ICH Intermediate Biodiversity (NDT 1)	**Green-up:** n/a (Target of 1/3 of area in each patch size group: 0-40, 40-80, 80-250) **Early seral:** n/a **Old and mature**: More than 34% older than 100 years **Old**: More than 13% older than 250 years To be met on the forested portion of each BEC variant in each landscape unit.
ICH Low Biodiversity NDT 3	**Green-up:** n/a (Target of 1/3 of area in each patch size group: 0-40, 40-80, 80-250) **Early seral:** n/a **Old and mature**: Not applicable[4] **Old**: More than 14% older than 140 years To be met on the forested portion of each BEC variant in each landscape unit.
ICH Intermediate Biodiversity NDT 3	**Green-up:** n/a (Target of 1/3 of area in each patch size group: 0-40, 40-80, 80-250) **Early seral:** n/a **Old and mature**: More than 23% older than 100 years **Old**: More than 14% older than 140 years To be met on the forested portion of each BEC variant in each landscape unit.
ESSF Intermediate Biodiversity	**Green-up:** n/a (Patch size distribution) **Early seral:** n/a **Old and mature**: More than 36% older than 120 years **Old**: More than 19% older than 250 years To be met on the forested portion of each BEC variant in each landscape unit.
Ungulate Deer	**Mature:** At least 40% cover older than 120 years. Retained forest cover must be greater than 20 ha in size and provide >60% crown closure every 250 ha.
Ungulate moose	**Mature:** At least 34% cover older than 100 years. Retained forest cover area must be greater than 20 ha in size and provide >70% crown closure every 500 ha.

[3] There are no mature requirements in low biodiversity emphasis areas in TFL 56.
[4] One third of the old requirement is initially required in low biodiversity emphasis areas. The old requirement will increase linearly to its full value at 210 years.

Figure 7 provides an area breakdown of the forest cover requirements applied to the operable forested area of TFL 56. It shows that:

- 44% of the forested operable area has caribou requirements,
- 28% of the forested operable area has ungulate winter range requirements,
- 43% of the forested operable area has intermediate biodiversity requirements, and
- Only 25% of the forested operable area has only low biodiversity requirements.

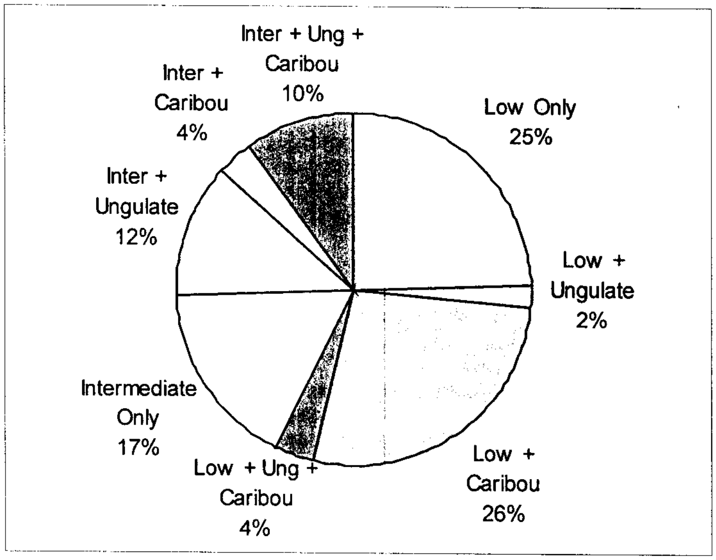


Figure 7. Forest cover requirements by area summary – forested operable land base.

Patch Size Targets

The MAC guidelines require harvesting to strive toward a more natural spatial distribution of openings than the 40 ha cut/leave pattern typically employed since the Forest Practices Code was introduced. Thus, explicit green-up has been replaced with modeling a transition to the patch-size distributions suggested in the Landscape Unit Planning Guidebook. It describes the desired future condition for the managed landscape as follows:

Table 6. Patch Size Distribution Targets for NDT1 and NDT 3

Patch Size	Size Range (ha)	NDT 1 % Of Young Seral Area	NDT 3 (with Douglas-fir) % Of Young Seral Area
Small	(0-40 ha)	30-40% of area <20 yrs	20-30% of area <20 yrs
Medium	(40-80 ha)	30-40% of area <20 yrs	25-40% of area <20 yrs
Large	(80-250 ha)	20-40% of area <20 yrs	30-50% of area <20 yrs

The modeling process strives to move the current patch size distribution toward one third of the managed land base in each of the patch sizes shown above (NDT 1 and 3). This strategy is only applied where it makes ecological sense within the unique landscapes found in TFL 56. Very large openings are generally avoided in steep narrow valleys with frequent slide chutes, but are preferred on rounded landforms where fires naturally would create large openings. This ecological rationale is given higher priority than meeting the generic patch size distribution numbers given above. Patch size targets are used as a background influence on harvest block creation while all other management goals are considered higher priority (caribou/biodiversity, etc). Thus, the resulting patch sizes are an artifact of managing for other resource values within the context of the existing age class structure and spatial harvest history. Refer to section 4.3 for modeling specifics.

3.3.2 Keystone LRUP

The Keystone Standard Basin Local Resource Use Plan (LRUP) also specifies forest cover requirements but they are generally covered off by the MAC plan, as it is more restrictive.

3.3.3 Forest Practices Code Requirements

There are two management practices in BC's Forest Practices Code that are not addressed through the MAC guidelines, but have an impact on timber supply: Riparian management around streams and retention of Wildlife Tree Patches (WTP's). The modeling of these practices is discussed in section 3.1 above.

3.3.4 Minimum Harvest Ages

Minimum harvest ages were set using a combination of rules and professional judgment for each stand group. The "rules" used were:

- The stand must achieve a volume of at least 150m^3/ha.
- The stand must be at least 80 years old.
- The stand is to be under the age of MAI maximization.
- The stand should achieve an average diameter of 25 cm dbh. However if age of maximization of MAI is less than age to achieve 25 cm dbh, then the minimum harvest age may be reduced by up to 30 years below achievement age of 25 cm dbh.

The application of these rules provides a "window" of possible minimum harvest ages. Professional judgment was applied to set the minimum harvest age within this window

The following table summarizes the resultant minimum harvest ages.

Table 7. Minimum Harvest Ages

Description	Species	Min. Harvest Age by Site Class Good	Medium	Poor
Low Stocking	All		120	
Existing Managed	CwHw	80	120	
	Fd	80		
	SxBl	80	110	
Future Managed	Fd	80	90	140
	Bl	110	140	
	Cw	80	110	130
	H	90	110	150
	Sx	80	100	150
Natural	Fd	80	100	130
Natural ≤140 yrs	Bl	100	130	
	Cw	80	90	120
	Hw	80	100	130
	Sx	80	90	120
Natural >140 yrs	Bl	110	120	
	Cw	80	100	130
	Hw	90	110	130
	Sx	80	110	130

3.3.5 Silviculture Systems

The clearcut silviculture system is the most commonly applied system in TFL 56 but group selection is also used on a significant area of the land base (4192 ha). Group selection, as practiced on TFL 56, involves the use of a 3-pass system and openings of 1/4 to 1 hectare in size. Group selection is used for several reasons including wildlife habitat enhancement or protection, visual resource protection, avalanche likelihood reduction, and at higher elevations, regeneration enhancement.

Table 8. Silviculture Systems

Silviculture System	Location in TFL	% of THLB Area	# of entries	Time between entries
Clearcut	All areas not listed below	81%	1	--
Group selection	Front of Goldstream Valley	13%	3	35 years
	Avalanche-prone areas or areas with regeneration concerns	7%	3	50 years

3.3.6 RCFC LU Plan

RCFC has completed a landscape level plan that addresses the forest cover requirements mentioned above. Mature Forest Retention Areas (MFRA's) were designated such that they contribute toward meeting forest cover requirements while addressing connectivity and minimizing the impact on the THLB. The MFRA's are spatially explicit within the model and replace the need for the model to select mature/old retention areas. This ensures a more logical, operationally feasible plan. The MFRA's do not move during the model's planning horizon but should be considered "portable" during operational implementation if suitable replacement stands are available.

The district MoE and MoF staff have reviewed and approved the plan as a means of addressing forest cover constraints in the TFL.

The MFRA's exclude harvesting from a large portion of the THLB (29.6%) because the forested area outside the THLB is not able to fully meet the requirements for wildlife habitat and biodiversity. When MFRA's (9226 ha) are combined with forested netdowns (6646 ha), harvesting is excluded from 42% of the forested operable area in the TFL.

There is a possibility that the MFRA's can be better optimized in the future to restrict less of the land base. The table below shows that many of the analysis areas have excess area in reserve – although not all analysis areas could get down to the minimum required because of overlapping requirements and/or significant amounts of forested netdowns.

Table 9. Proportion of Each Analysis Area Reserved From Harvesting

Description	Clique_Id	Total Area	Required Rsv's		Modelled Reserves	
			ha	%	ha	%
Downie - Low BioD - ICH mw3 -operable	1	255	36	14%	124	49%
Downie - Low BioD - ICH wk1-operable	2	4184	544	13%	2018	48%
Downie - Low BioD - ICH vk1-operable	3	3204	416	13%	947	30%
Downie - Low BioD - ESSF vc-operable	4	7137	1356	19%	3966	56%
Downie - Inter BioD - ICH mw3-operable	5	1731	398	23%	686	40%
Downie - Inter BioD - ICH wk1-operable	6	2936	998	34%	1343	46%
Downie - Inter BioD - ICH vk1-operable	7	3782	1286	34%	1518	40%
Downie - Inter BioD - ESSF vc-operable	8	151	54	36%	72	48%
Goldstream - Low BioD - ICH wk1-operable	9	2115	275	13%	789	37%
Goldstream - Low BioD - ICH vk1-operable	10	4433	576	13%	1308	30%
Goldstream - Low BioD - ESSF vc-operable	11	3356	638	19%	1143	34%
Goldstream - Inter BioD - ICH wk1-operable	12	900	306	34%	378	42%
Goldstream - Inter BioD - ICH vk1-operable	13	2999	1020	34%	1246	42%
Goldstream - Inter BioD - ESSF vc-operable	14	147	53	36%	54	37%
Downie - Deer	15	1951	781	40%	838	43%
Downie - Moose	16	4350	1479	34%	1948	45%
Goldstream - Moose	17	4226	1437	34%	1714	41%
Downie - Caribou - ICH - 94 Op	18	4643	1857	40%	2061	44%
Downie - Caribou - ESSF - 94 Op	19	2051	820	40%	906	44%
Downie - Caribou - ESSF - above 94 Op	21	1414	990	70%	1258	89%
Downie - Recruit. Caribou - ICH	22	2632	1053	40%	1489	57%
Downie - Recruit. Caribou - ESSF	23	973	389	40%	545	56%
Downie - Inter Caribou - ICH	24	2716	923	34%	1010	37%
Downie - Inter Caribou - ESSF	25	2155	776	36%	1445	67%
Goldstream - Caribou - ICH - 94 Op	26	1141	456	40%	456	40%
Goldstream - Caribou - ESSF - 94 Op	27	731	293	40%	294	40%
Goldstream - Caribou - ESSF - above 94 Op	28	423	296	70%	305	72%
Goldstream - Recruit. Caribou - ICH	29	2666	1067	40%	1085	41%
Goldstream - Recruit. Caribou - ESSF	30	55	22	40%	22	41%

■ Shading indicates that the % in reserve is no more than 3% over the required amount.

4.0 Analysis Methods

4.1 Timber Supply Modeling

Forest Planning Studio (FPS-ATLAS), was used to provide timber supply forecasts. It is a spatially explicit, forest-level simulation model that was developed by Dr. John Nelson at the University of British Columbia.

FPS-ATLAS is designed to schedule harvests according to a range of spatial and temporal objectives (i.e. harvest flows, opening size, riparian buffers, seral stage objectives and patch size distributions). Silviculture systems, rotation ages and growth and yield curves are assigned to each polygon. At each time step, polygons are first ranked according to a cutting priority (e.g. oldest first). Polygons are then harvested from this queue subject to constraints designed to meet forest level objectives (e.g. opening size and seral stage targets). Polygons are harvested until either the queue is exhausted or the periodic harvest target is met. At this stage the forest is aged to the next time period, and the process is repeated. At each time period, the model reports the status of every polygon in the forest estate.

Polygons are grouped to form analysis areas called cliques that can have constraints applied. Overlapping constraints are easily applied by allowing polygons to belong to several cliques. Harvesting will not occur in a clique if it will violate a constraint. For TFL 56, all forest cover constraints are evaluated at the mid point of each period. If ages were distributed evenly within a 10-year period, half of the stands would reach a possible critical age in the middle and become eligible for harvest, while the other half would have to wait until the next period. If a constraint is not met in a given period, no harvesting is allowed in the area to which the constraint applies.

Any forested area within a clique can contribute toward seral goals applied to the clique. Areas outside/adjacent to a clique have no influence on seral goals within the clique.

Forest cover polygons and RCFC's landscape level plan (Total Chance Plan harvest blocks and Mature Forest Retention Areas) form the basic building blocks for the model's polygons. The line work for these polygons was merged along with any management zone line work (e.g. Landscape Units, Caribou Habitat, Biodiversity Zone, Ungulates Range). This results in many small polygons but each one falls entirely within a single forest cover polygon, harvest block, and combination of management zones – making the evaluation of management zone constraints straight forward.

Harvesting is implemented by grouping polygons to form blocks similar to those in the original total chance plan. This ensures that the proposed harvest units are as realistic as possible. The blocks currently in the FDP are hardwired into the model so that they are harvested regardless of constraints.

4.2 Harvest Flow Parameters

The general harvest flow objective will be to maintain the current AAC for as long as possible without compromising long-term sustainability or causing the rate of decline to exceed a reasonable level. This will be accomplished using the following rules:

- Limit any harvest declines to no more than a 10% per period;
- Harvest levels cannot drop more than 15% below the Long-term Harvest Level (LTHL).

The intent is to use the current AAC until it must be reduced down to the LTHL level, ideally with no drop below LTHL. A constant AAC harvest flow scenario (always try to harvest AAC) will also be run to provide additional understanding around the timing of timber availability.

4.3 Patch Size Modeling and Analysis

As discussed at the end of section 3.3.1, patch size distribution targets are used to guide the spatial distribution of harvest through time (instead of adjacency constraints). Calculation of patch size statistics is therefore necessary to quantify the existing landscape pattern and assess future landscape patterns projected by the model. The methodology for calculating these statistics is presented below.

Patches were defined by structural seral stages that would theoretically be noticeably different to wildlife moving across the land base. For ease of application, ages were assigned to each seral stage as a surrogate for the stand attributes that are found in each seral stage. Patch statistics were calculated for all seral stages in order to fully understand the landscape patterns that were occurring.

Patch Definitions

Code	Seral Stage	Age Range
PL	Plantation	0-20 yrs
YS	Young Seral	21-40 yrs
IM	Immature	41-80 yrs
Mat	Mature	81-140yrs
Tran	Transitional	141-250
Old	Old	250+

For each snapshot in time that was analyzed, forested polygons were assigned to one of the defined seral stages and then adjacent like polygons were dissolved to form "patches". LU and BEC boundaries were ignored. A patch size was then assigned to each patch :

Small (<40 ha), Medium (40-80 ha), Large (80-250 ha), Very Large(250+ ha)

The actual area of each patch was then assigned to the appropriate basket (Patch Size / Seral Stage / LU / BEC combination). Because patches were not broken along LU or BEC boundaries, some patches spanned LU's and/or BEC zones. Where this occurred, the patch size remained the same but the area of the patch was prorated into each basket. For example, a very large patch (300 ha) spans three LU/BEC combinations:

20 ha is attributed to the 250+ ha category of ICH vk1 in the Downie LU.

70 ha is attributed to the 250+ ha category of ICH vk1 in the Goldstream LU.

210 ha is attributed to the 250+ ha category of ESSF vc in the Goldstream LU.

If the LU and BEC linework had split this patch, it would have been treated as three patches – small, medium, and large – instead of one very large patch. In order to avoid under-representing large patches on the land base, the above-mentioned technique of prorating areas was used.

Priority zoning was used to guide the model toward the patch size targets. Once the initial condition was established for each LU/BEC combination, zoning was structured to move it toward the identified targets. Five abstract "zones" were identified across the TFL in a dispersed pattern that effectively represented passes in a multi pass harvest scenario. The size and location of zones was used to influence the creation of patches. These "zones" were assigned a harvest priority so that all 1st pass areas have priority over all other areas, all 2nd pass areas have priority over 3rd, 4th and 5th pass areas, and so on. This enables a spatial distribution of harvest to be realized without applying a hard constraint such as adjacency/green-up.

5.0 20 Year Plan

Timber supply analysis has traditionally been completed aspatially and a 20 year plan was needed to present the first 20 years of projected harvest spatially on the landbase. RCFC has chosen to utilize a spatial timber supply model that projects the entire planning horizon in a spatially explicit form. As a result, the entire planning horizon can be viewed spatially with its associated timber and non-timber outputs. The 20-year plan presented in Appendix A is simply a summary of the first 20 years of model results. The assumptions and data used in the 20-year plan are therefore the same as those documented for the base case. Harvest forecasts and non-timber outputs (seral stages, patch size, etc) associated with the 20 year plan are also consistent with the base case and can be found in Section 6.4.

6.0 Base Case Analysis

The base case analysis presented in this report reflects both current and expected future management within TFL 56. The completion of the Minister's Advisory Committee's (MAC) strategy has provided a clear framework to guide forest management practices in the TFL. The last two Forest Development Plans have followed the draft MAC recommendations and it is therefore considered current practice. The designation of the final MAC strategy as a Higher Level Plan under the Forest Practices Code is currently pending regulatory approval.

6.1 Base Case Definition

The base case was modeled as follows:

- Land base, inventory, and management assumptions described in Section 3.
- Forest cover constraints were turned off in the model (except Downie Deer and Goldstream Moose) because the "Mature Forest Retention Areas" identified in RCFC's landscape unit plan were deemed to meet the criteria necessary for MAC forest cover requirements. Downie Deer and Goldstream moose constraints were left on because the LU plan by itself resulted in some minor variations from the seral stage targets. Recruitment caribou also showed variations from the seral targets but the local ministries (MoE/MoF) have approved the recruitment strategy found in RCFC's LU plan. Where constraints were not used, dummy constraints were put in place for reporting purposes - see Section 6.4 for base case seral goal results over the planning horizon.
- Harvest priorities were applied first to zones and then to stand age. Thus, the highest priority zone was selected and then the oldest stands within that zone would have 1st priority for harvest. If no zone 1 stands were eligible for harvest, the oldest stands in zone 2 would have next highest priority, and so on.
- An initial harvest level of 100,000 m^3/yr (current AAC) was used.

6.2 Base Case Harvest Profile and Interpretation

The base case harvest projection in Figure 8 shows that the current AAC (100,000 m3/yr) can be maintained for twenty years before dropping to a long-term harvest level (LTHL) of 74,100 m3/yr. Non-recoverable volume losses due to catastrophic events (fires, pests, disease) have been subtracted from the harvest forecasts.

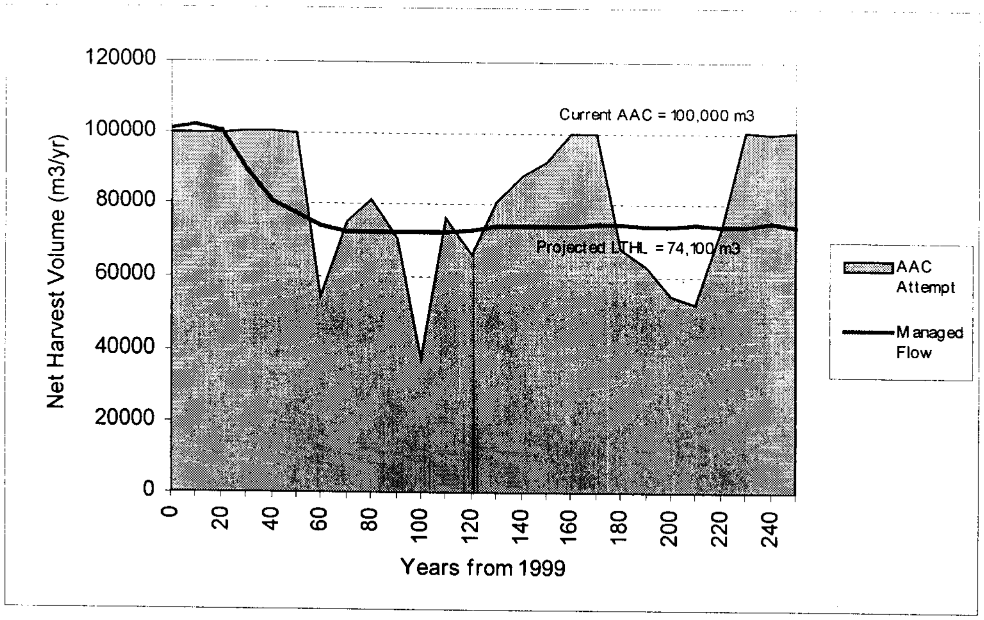


Figure 8. Base case harvest forecast for TFL 56.

Figure 8 also shows a harvest projection that attempts to cut the AAC for the entire planning horizon. This indicates that the current AAC could be harvested for 50 years before falling sharply in the sixth decade. Other significant troughs in the harvest projection occur in the 10th and 21st decade due to a lack of available timber. This harvest projection helps to illustrate the pattern of timber availability during the planning horizon under the current set of constraints.

Figure 9 shows that managed, second growth stands are required for harvest starting in the 7th decade of the base case harvest projection. Existing natural stands will supply the entire AAC for the first 60 years and provide a much smaller contribution to the AAC volume after that. For the purposes of this analysis, natural stands are defined as stand established prior to 1980.

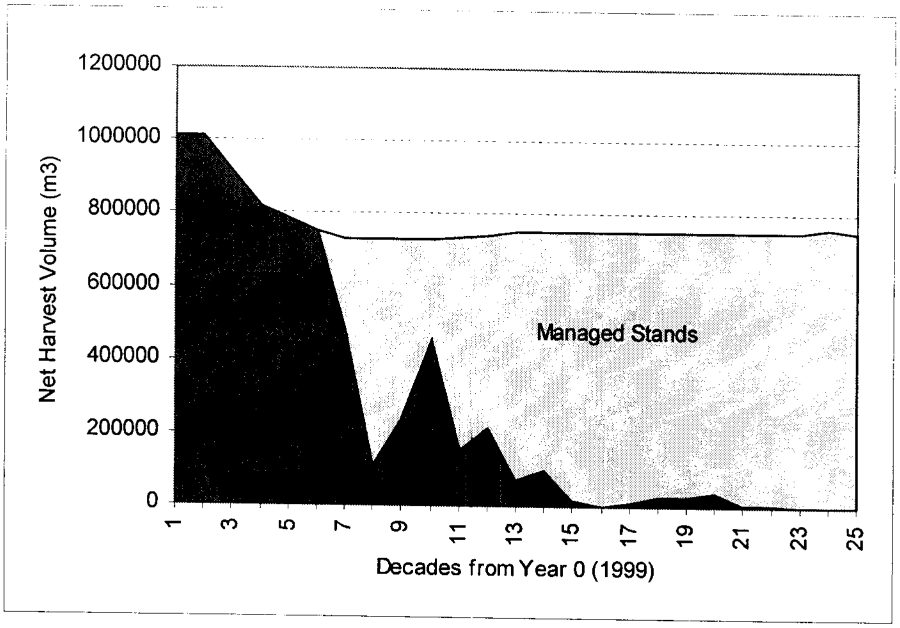


Figure 9. Projected harvest of natural vs. managed stands through time.

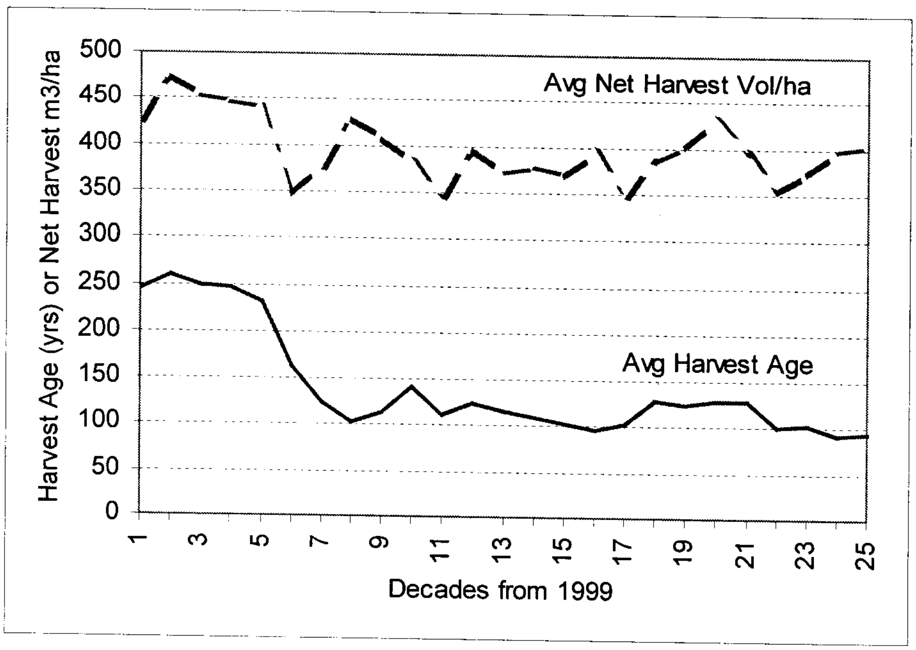
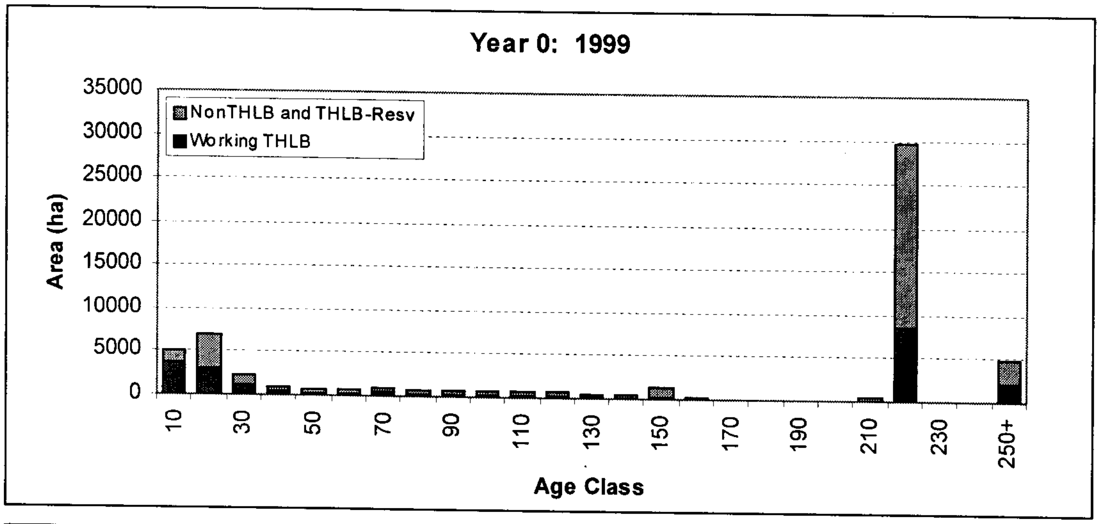
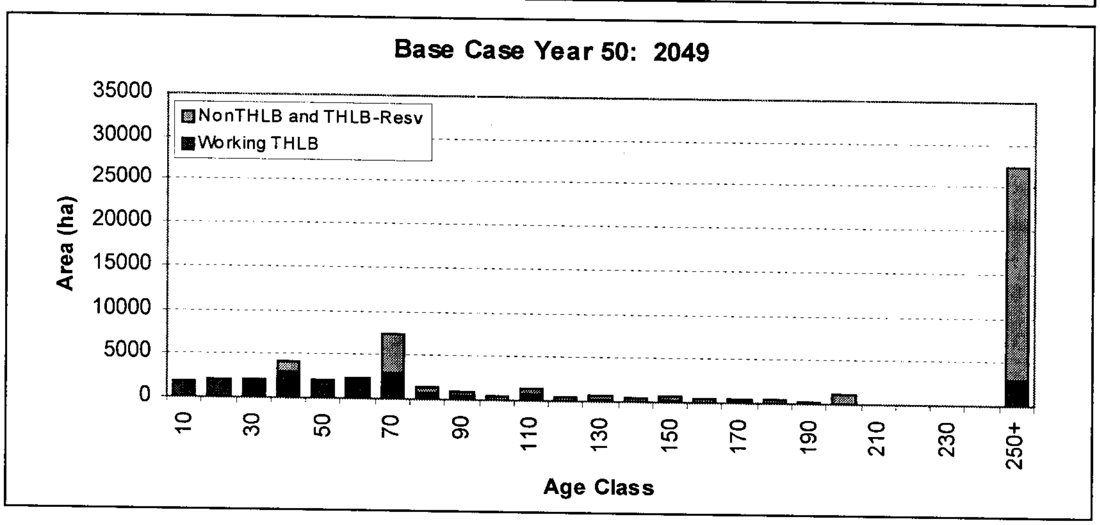


Figure 10. Average harvest age and volume through time.

Figure 10 illustrates the average harvest age in each period. The decline in average age through time is consistent with the transition to harvesting managed stands, which are typically harvested near their minimum allowable harvest age. The graph shows that harvest ages average between 80 and 140 years after the 7th decade – coincident with the transition to managed stands shown in Figure 9. Figure 10 also shows the average net harvest volume (m3/ha) in each period. The vol/ha harvested is also seen to decline with the transition from harvesting older, natural stands (450m3/ha initially) to younger, managed stands (long-term average of 390 m3/ha).

Figure 11 shows how the age class profile for the forested land base changes through time under the base case timber supply forecast. Age class distributions are provided at 50 year intervals and show the working forest becoming more normalized and the reserved forest continuing to age.





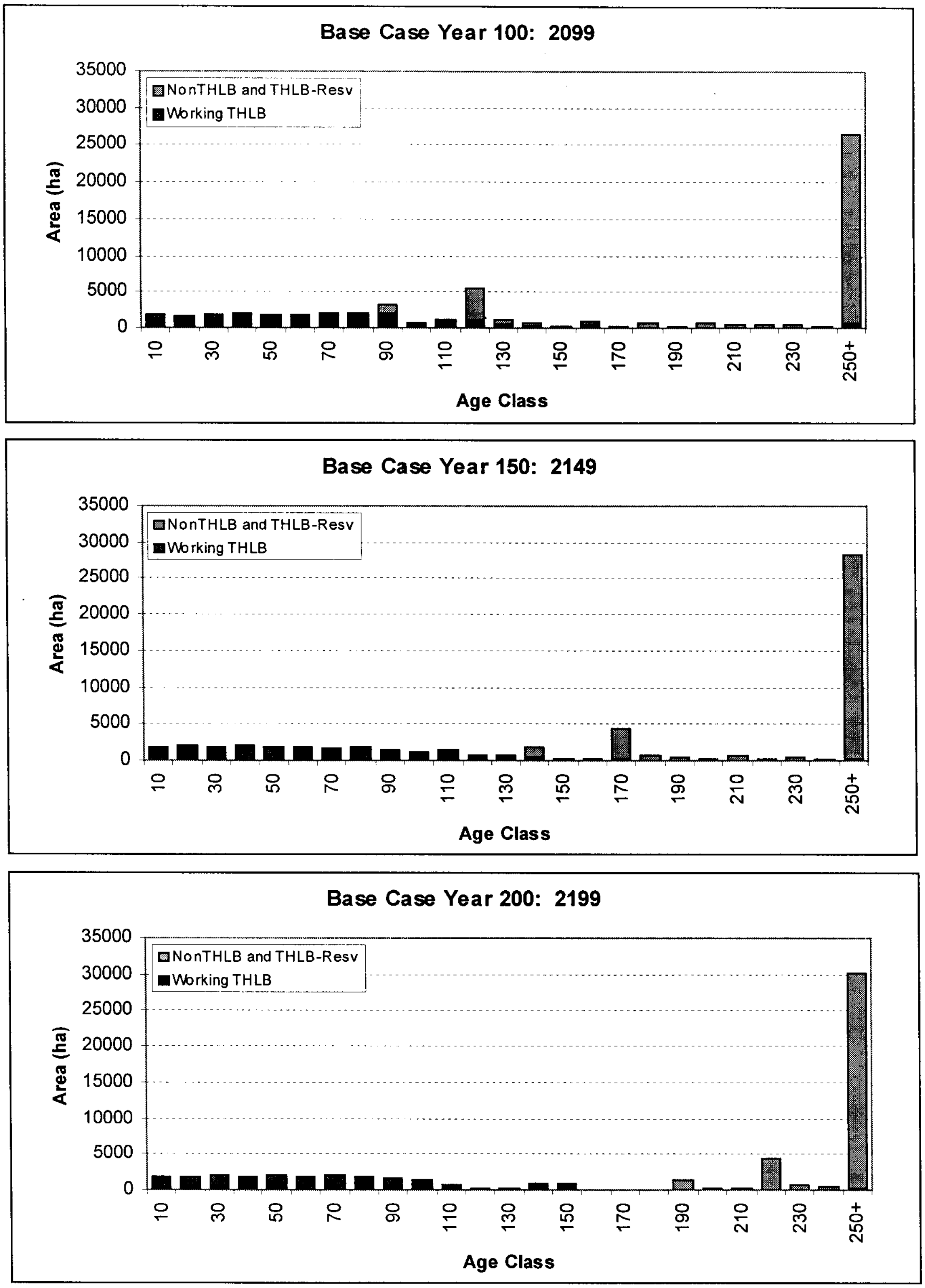


Figure 11. Age Class distribution on forested land base over time – TFL 56 Base Case.

Figure 12 illustrates the changes to growing stock through time for the total forested area and the working portion of the THLB (reserves excluded). The growing stock on the working portion of the THLB stock declines initially when the rate of harvest is at the current AAC but then stabilizes as the cut reaches the long-term harvest level (harvest = growth). However, the total growing stock on the forested land base increases with time as the substantial area of forest not in the working THLB grows and puts on volume.

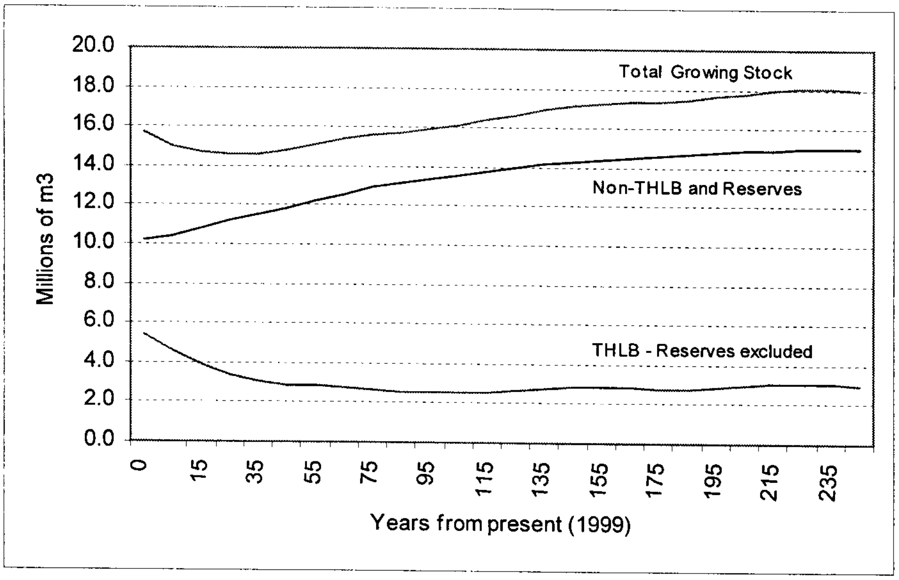


Figure 12. Timber growing stock through time [5]

In summary, the base case harvest projection is a result of the size of the working land base and the existing age class structure within that area. Harvesting occurs generally unconstrained within this area because all forest cover constraints have been addressed through land base reductions/reserves. WTP retention, patch size goals and group selection harvest systems are the only management issues left to influence how and where harvesting occurs in the working portion of the THLB, and they have only minor impacts on timber supply.

The transition from natural[6] to managed stands is the major factor that shapes timber supply in the short to mid-term. Significant volumes of managed stands do not become available until the 7th decade. This forces the volume of natural stands to be meted out so that a reasonable cut level can be maintained until then. The lowest timber availability in the planning horizon occurs between the 6th and 8th decade.

[5] The Atlas volume curves were built using the THLB area only. The non-THLB volumes in this graph are underestimated relative to the FIP file because a generic curve was applied to inoperable polygons. The THLB curves were applied to the other netdown areas (Low sites, problem forest, riparian, etc) and generally resulted in an overestimate of volume on these small areas. Thus, the THLB volumes in the graph are accurate but the non-THLB volumes are underestimated by about 10%.

[6] Natural stands are defined as stands that regenerated prior to 1980 and are assumed to have had little assistance in achieving the productivity of the site. Thus, some second growth stands are considered "natural" in this analysis.

6.3 Comparison to Management Plan #2

Comparison of harvest schedules between the base case and the Planned Management Option in MP#2 can only be done at an overview level due to huge differences in data, assumptions, and modeling methods.

In general, the harvest projections are somewhat similar - they both show an initial period (20yrs) at the current harvest level and long-term harvest levels around 30-35% lower. This similarity in harvest projections is not a result of similar inputs or processes. A brief summary of the differences is outlined below:

Table 10. Comparison with Management Plan #2.

MP#2 Planned Management Option	MP#3 Base Case
TIMSIM model used (non spatial)	FPS-Atlas model used (spatially explicit)
Keystone wilderness area not removed.	Keystone wilderness area removed.
Forested operable area = 26,326 ha Long-term THLB = 24,747 ha	Forested operable area = 37,348 ha THLB = 30,702 ha THLB less reserves = 20,513 ha
Netdowns were non-spatial and no netdowns for riparian areas or WTPs were used.	Netdowns applied spatially to the land base. Netdowns for riparian areas and WTPs were implemented.
Caribou rules applied (10%> 140yrs)	Revelstoke MAC guidelines for ungulate, caribou and biodiversity modeled using RCFC's mature forest retention areas.
3m greenup / adjacency modeled (non spatially).	Patch size management used in place of greenup/adjacency.
Only clearcut systems modeled.	Clearcut and group select modeled.
Unsalvaged Losses = 3480 ha/yr	Unsalvaged Losses = 995 ha/yr

Thus, the land base increased significantly for MP#3 but forest cover constraints imposed by the Revelstoke MAC resulted in a smaller working forest than in MP#2. However, harvesting is generally unconstrained on this smaller land base as all of the significant constraints were dealt with through RCFC's mature forest retention areas (reserves strategy).

6.4 Non Timber Values Reports

The graphs in this section show the seral stage percentages relative to their targets for each forest cover constraint on the land base. The base case modeled RCFC's reserve strategy in place of forest cover constraints and achieved the following results.

6.4.1 Caribou

Primary caribou results for mature seral goals (140 yrs) are shown below and indicate a general pattern of harvesting mature timber down to the minimum allowed (40%) by 100 yrs. After this point, the amount of mature timber in each zone is in excess of the requirement by 5-10% (40-44% in reserve status).

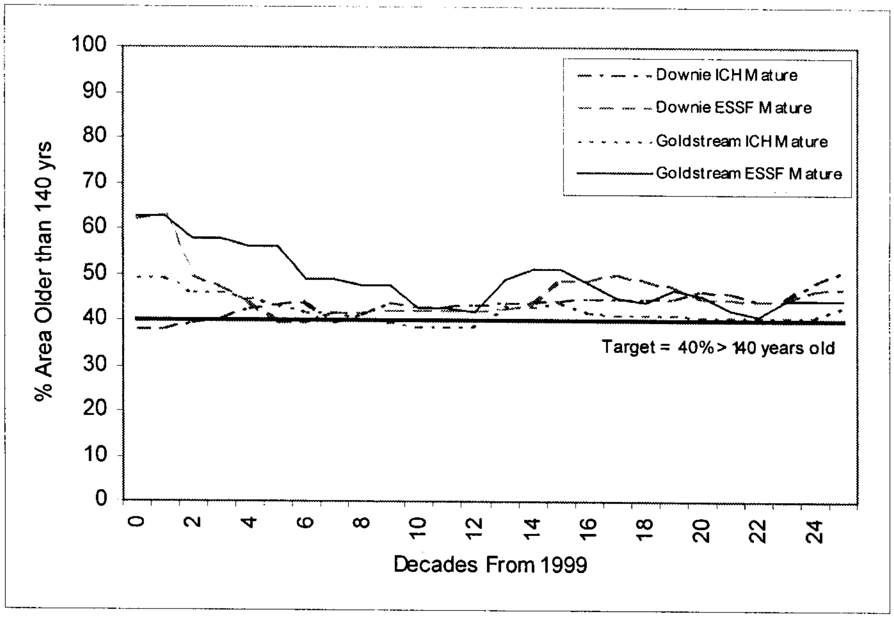


Figure 13. Primary Caribou mature seral forest through time.

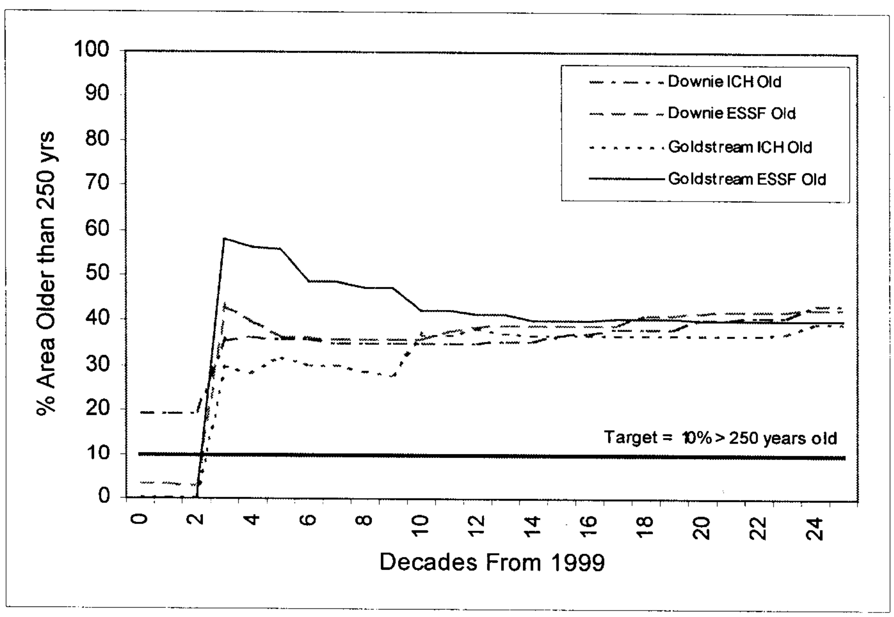


Figure 14. Primary Caribou old seral forest through time.

Figure 14 shows that only the Downie ICH primary caribou zone currently meets the requirement of 10% > 250 years old. The other three zones achieve the requirement in the 3rd decade and are well in excess of the requirement for the remainder of the planning horizon. This initial deficit is a result of the inaccurate age class typing for older stands in the inventory file. The inventory indicates that all stands over 215 years are either 225 or 325 years old and there are no stands over 225 years old mapped on the Goldstream mapsheets.

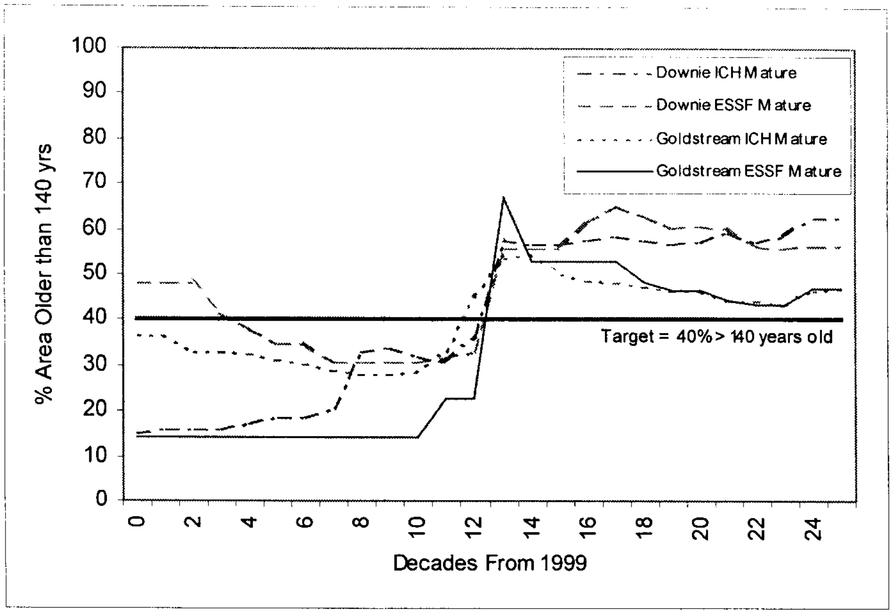


Figure 15. Recruitment Caribou mature seral forest through time.

Figure 15 shows that in the Goldstream ESSF recruitment caribou zone, the mature seral goal is met as soon as possible. The Downie ICH / ESSF and Goldstream ICH zones show declines due to harvesting in the first 100 years but then jump well above required levels as younger reserves reach the critical age (140 yrs old). At no point do mature seral levels drop below 30% as a result of harvesting. The inclusion of younger reserve areas in these zones was identified as part of RCFC's approved reserve strategy (Goldstream = 41% reserved, Downie = 56% reserved).

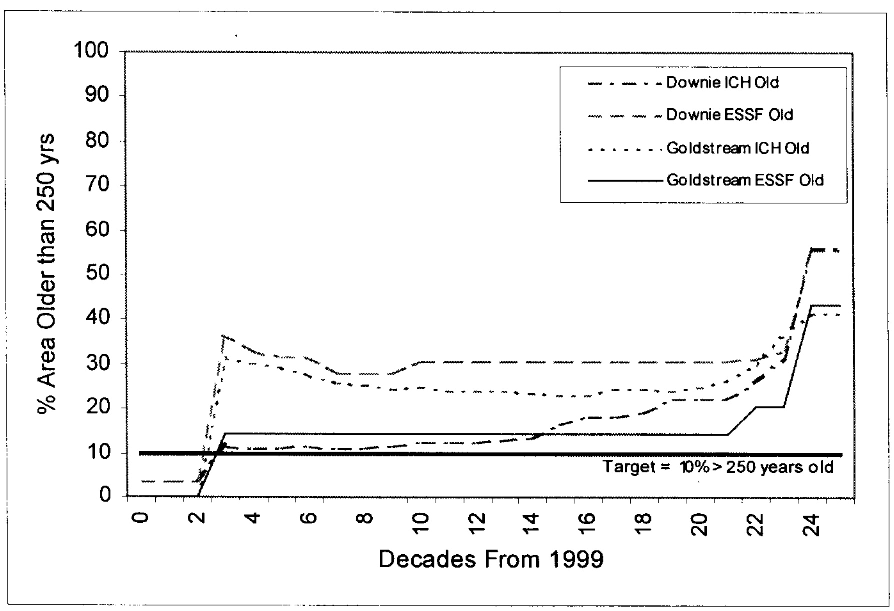


Figure 16. Recruitment Caribou old seral forest through time.

Figure 16 shows that old seral targets for recruitment caribou zones are met as soon as possible. Similar to primary caribou, the old requirement is met in the third decade due to inaccuracies in inventory file ages for older stands. After the 3rd decade, the amount of old seral is well in excess of the requirement because much of the forest reserved to meet mature seral requirements also meets the old criteria. The sudden jump at 240 years is a result of young reserve stands reaching the old seral age requirement.

Figure 17 below shows that the mature seral target for primary caribou above the 1994 operability line is met at all times. The Goldstream zone is harvested down to the minimum allowable (72% in reserve) and has sporadic ingrowth through time. The Downie zone has 89% in reserve but not all of it reaches 140 years old until 130 years into the planning horizon. The excess reserve is due to a lack of operable area and the presence of the Keystone wilderness area.

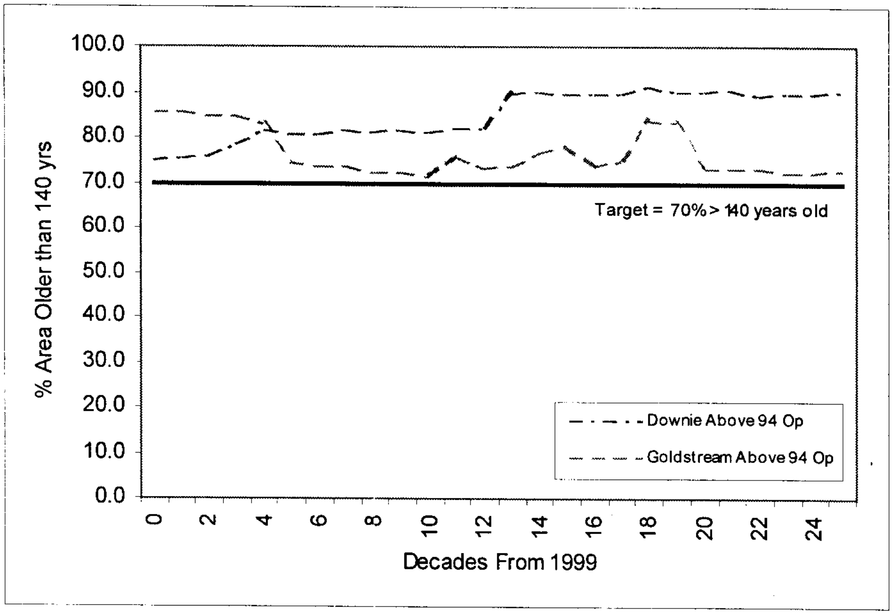


Figure 17. Primary Caribou above 1994 Operability - seral goal through time.

6.4.2 Ungulate

Figures 18 shows the mature seral target for deer is met as soon as possible (4th decade) and then averages 45%. The excess mature forest in the later periods of the planning horizon results from overlapping constraints. The constraint was actively modeled in this zone because the reserve strategy alone did not meet the seral target as soon as possible. Approximately 43% of this zone is in reserve.

Figure 19 shows that the mature seral goal for moose are achieved throughout the planning horizon and are generally well in excess of the 34% target (avg of 55% after 100 yrs). The constraint was actively modeled in the Goldstream zone because the reserve strategy alone did not meet the seral target as soon as possible. The Downie and Goldstream zones have 45% and 41% of their area in reserve respectively.

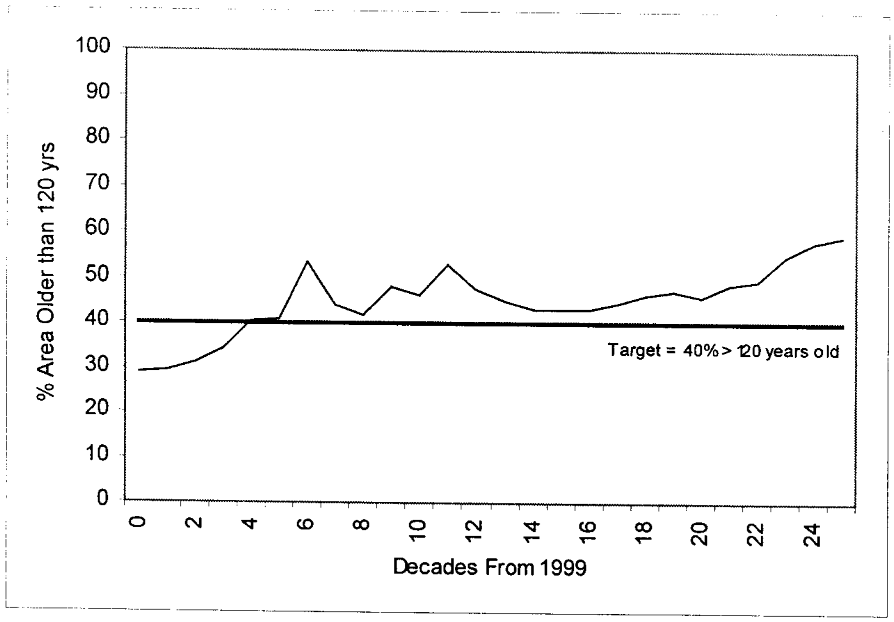


Figure 18. Downie Deer mature seral forest through time.

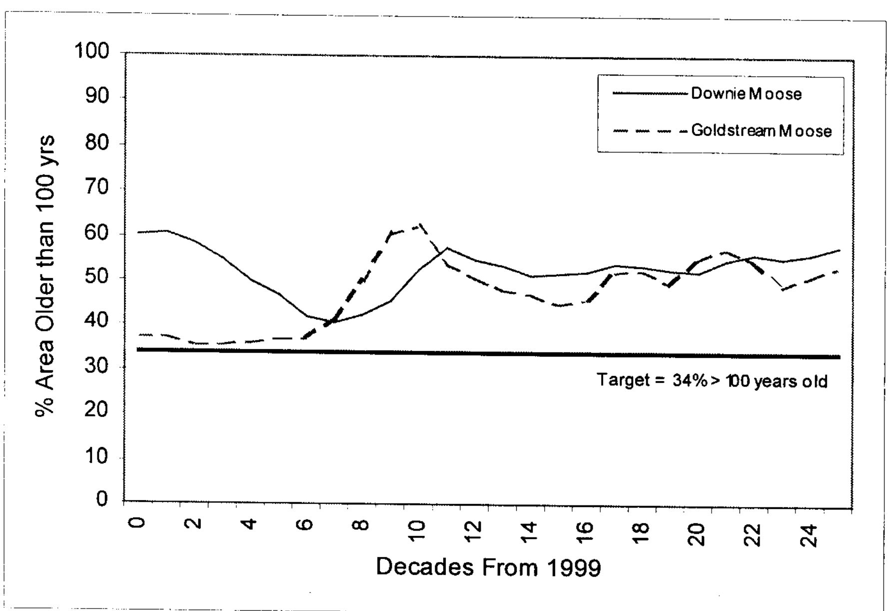


Figure 19. Moose mature seral forest through time.

6.4.3 Biodiversity - Seral Stage Targets

The Revelstoke MAC strategy requires that biodiversity seral stage targets be met on the operable and forested land base. The graphs presented below represent the results for the operable land base only - the forested land base was confirmed to be the same or better at meeting the seral goals.

Figure 20 shows the old seral forest for the ICH (NDT1) Low Biodiversity zones through time. They are very similar to the other zones with old seral requirements, as they lack stands over 225 years of age on the Goldstream map sheets. When the 225 year old stands reach 250 years old in the 3rd decade, the old seral target is greatly exceeded (averages 30-40%). The amount of old seral is well in excess of the requirement (full old by 210 yrs) because 30-48% of these zones are in reserve status. There is likely opportunity here to refine RCFC's plan and reduce the amount of reserves in these zones. No mature seral goals are propping up the percentage because no mature seral goals are required in Low Biodiversity zones.

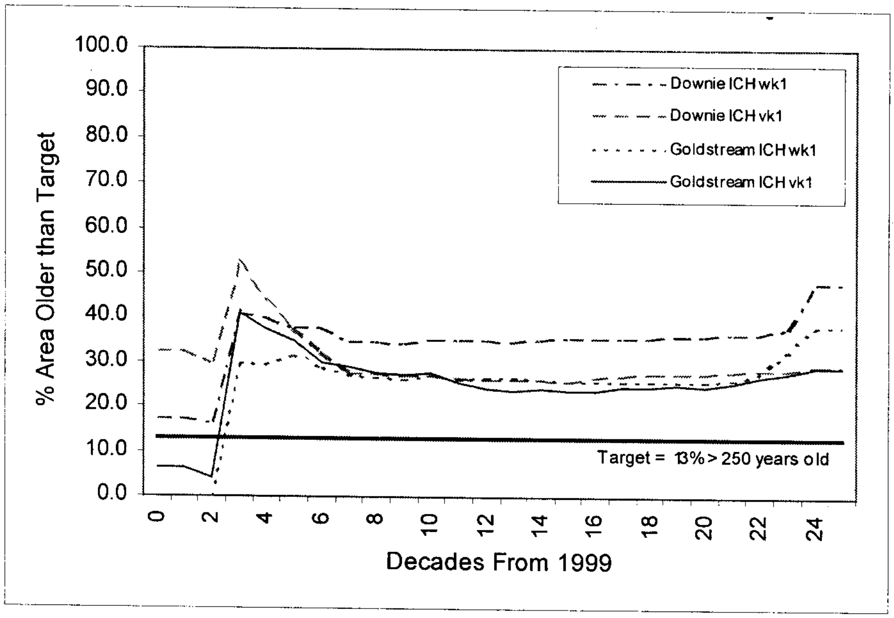


Figure 20. Low Biodiversity: ICH (NDT1) old seral forest through time.

Figure 21 shows the amount of old seral forest in the ICH (NDT3) and ESSF Low Biodiversity zones through time. The ESSF zone displays the same characteristics as described in Figure 20 above. The ICH mw3 zone uses a lower definition of old (140 yrs) because it falls within NDT3. It is initially in deficit due to past harvesting and is not able to gain enough old stands through ingrowth until the 4th decade. Its long-term level is close to 49% because roughly 49% of this zone is in reserve status. As all of the stands in reserve crest 140 yrs of age (13th decade) then the amount of old is equal to the reserve area.

All of the Low Biodiversity zones were given the option to initially drop to 1/3 of the seral target as long as they increased steadily to meet the full target by 210 years. This flexibility was not utilized because the amount of reserves in these zones provided more than enough old seral forest to fully meet the target in 30-40 years.

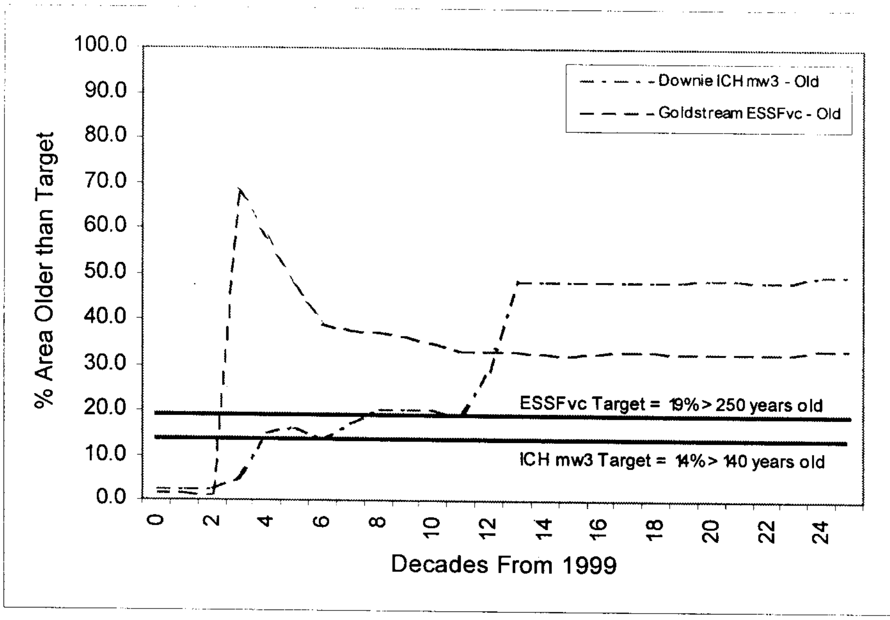


Figure 21. Low Biodiversity: ESSF and ICH (NDT3) old seral forest through time.

Figure 22 shows the amount of mature seral forest in the ICH (NDT1) Intermediate Biodiversity zones through time. All of the zones except for Goldstream ICH wk1 meet the mature target throughout the planning horizon and, after the 7th decade are well in excess of the target. They are in excess because of the amount of reserves (40-46%), the presence of overlapping constraints, and the use of group selection silviculture systems with rotation ages of 105-150 yrs.

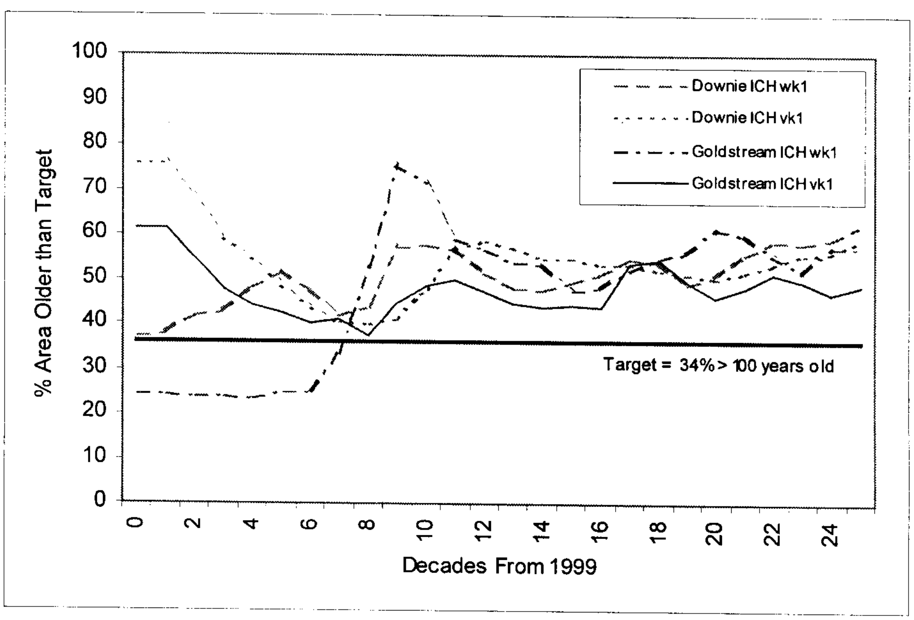


Figure 22. Intermediate Biodiversity: ICH (NDT1) mature seral forest through time.

Figure 23 shows the amount of old seral forest in the ICH (NDT1) Intermediate Biodiversity areas through time. Similar to other zones with a 250 yr old requirement, the requirement is not met until the third decade due to inaccuracies in inventory file ages for older stands. After this point, the amount of old seral is well in excess of the requirement because much of the forest reserved to meet mature seral requirements also meets the old criteria.

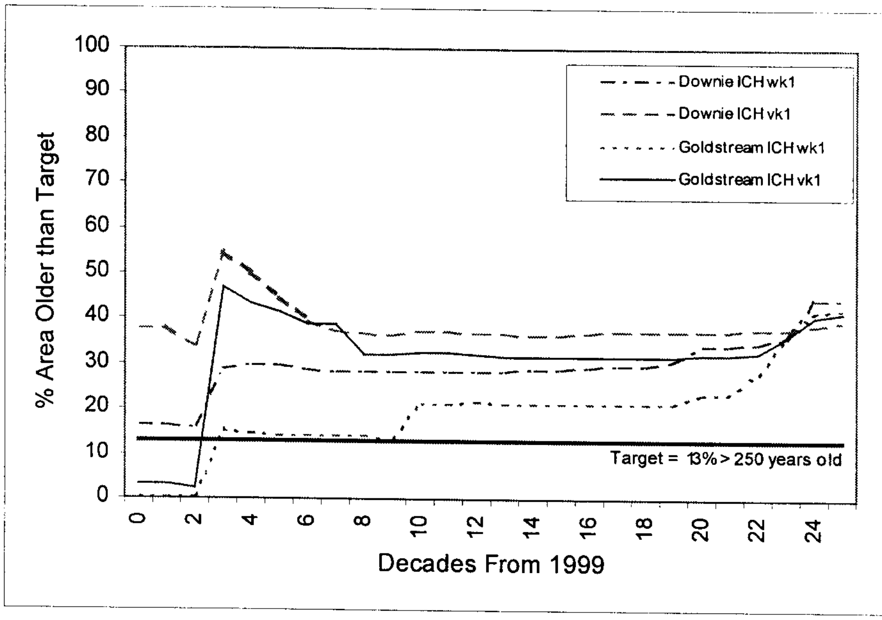


Figure 23. Intermediate Biodiversity: ICH (NDT1) old seral forest through time.

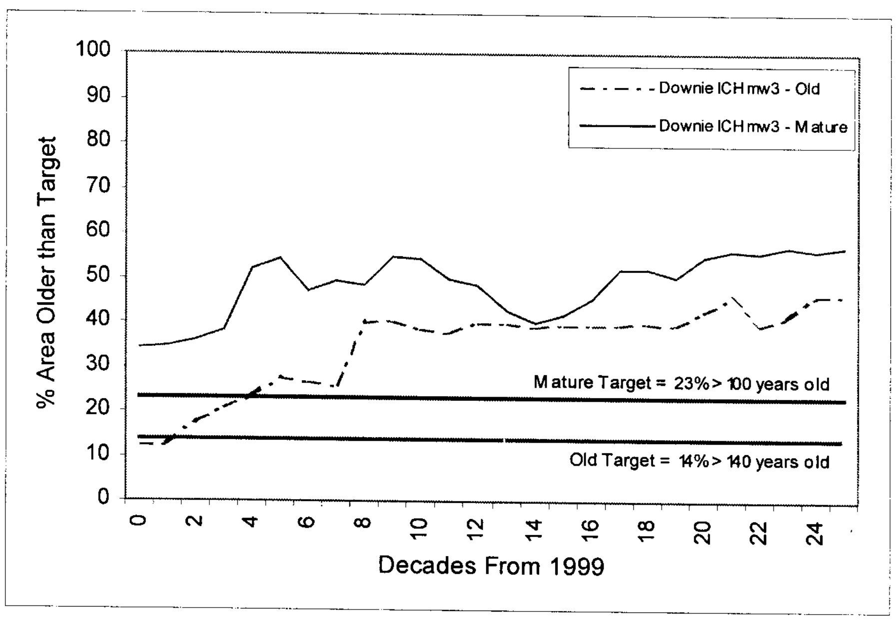


Figure 24. Intermediate Biodiversity: ICH mw3 (NDT3) mature and old forest through time.

Figure 24 shows the amount of mature and old forest in the ICH (NDT3) Intermediate Biodiversity zone through time. The mature requirement is met at all times while the old requirement is not met until the glut of 225 year old stands reach 250 years in the 3rd period. The excess area in old seral forests in this zone is a result of the amount of reserve (40%) and the excess mature is a result of reserves plus rotation ages over 100 yrs in lower site classes.

Figure 25 shows the amount of old and mature forests in ESSF Intermediate Biodiversity zones through time. Mature goals are met throughout the planning horizon with the Goldstream zone showing little excess after the fifth decade, and the Downie showing considerable excess mature forest throughout the planning horizon. This excess is because 48% of this zone is in reserve. Old seral goals are again in deficit for the first two decades and then jump well above the target when the 225 year old stands reach 250 years in the 3rd decade. The amount of old seral is well in excess of the requirement because much of the forest reserved to meet mature seral requirements also meets the old criteria.

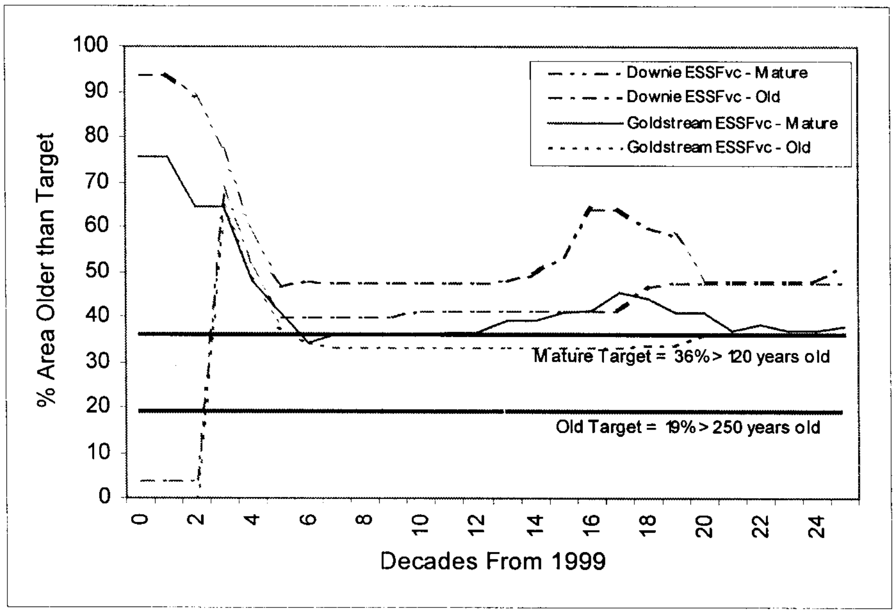


Figure 25. Intermediate Biodiversity: ESSF (NDT1) mature and old forest through time.

6.4.4 Biodiversity – Patch Size

A description of the patch size targets and rationale for TFL 56 is provided in section 3.3.1. A description of the modeling techniques is discussed in section 4.2. Patch size results from the base case are provided below.

The LU planning guidebook states that the percentage area targets are to be applied only to young seral (≤20 yrs old) patches. Applied through time with a consistent harvest level, this would create an even distribution of patch sizes in every 20 year age class interval. Unfortunately, the operational application of this concept is made difficult by existing age classes, spatial harvesting history, and any forest cover constraints applied to the land base. Thus, the young seral patch size statistics can fluctuate widely as other resource values dictate what can occur on the land base in the 20-40 years prior to the snapshot. The young seral statistics are still useful information but shed little light on what is happening on the land base as a whole. The young seral statistics should be seen as guiding implementation whenever possible - while stats that look at all seral stages are likely best to provide context and evaluate ongoing results.

The patch size targets provided by the LU Planning Guide for NDT 1&3 apply only to young seral openings less than 250 ha. In order to have target distributions for patches of all ages, this analysis will assume that very large patches (>250 ha) are part of the 80-250 ha targets.

The patch size distributions were assessed at year 0 (existing condition) and then at four intervals in the future (50 yrs apart).

Young Seral Patch Results:

Relative to the targets, an over abundance of small openings (<40 ha) has been created in recent years. This does not appear to improve in any of the 4 snapshots in time that were analyzed and in some cases the proportion of small openings created was higher.

On average, each of the snapshots show that in the preceding years, approximately 70-80% of the area harvested was in small patches. The remainder is split between medium and large patches, depending on the zone and time frame in question.

Certain periods had significant areas of medium and large patches being created but consistent creation of these patches was not possible due to age class issues, terrain issues, and forest cover constraints.

Table 11. Young Seral (<20 yrs) Patch Size Statistics at Year 0 and 200

YOUNG SERAL PATCHES	YEAR 0 Young Seral Patch sizes (ha)				YEAR 200 Young Seral Patch sizes (ha)			
	0-40	41-80	81-250	250+	0-40	41-80	81-250	250+
Downie LU								
ICH (NDT3)	48%	0%	52%	0%	84%	16%	0%	0%
ICH (NDT1)	69%	25%	6%	0%	87%	8%	5%	1%
ESSF (NDT1)	70%	18%	12%	0%	58%	18%	0%	25%
All Downie	67%	21%	12%	0%	76%	12%	3%	9%
Goldstream LU								
ICH (NDT1)	78%	9%	13%	0%	73%	22%	5%	0%
ESSF (NDT1)	75%	9%	16%	0%	96%	4%	0%	0%
All Goldstream	77%	9%	14%	0%	80%	17%	4%	0%
All TFL	71%	16%	13%	0%	78%	14%	3%	5%

The very large patch identified in year 200 (Downie 250+ ha = 9%) is 283 ha in size and is mostly within the ESSF. This patch was allowed to occur even though it is over 250 ha because it was not significantly over the size target and there was a need to create large patches. The graphs below show that another very large young seral patch (287 ha) was created in year 100 as well. It was allowed to occur for the same reasons.

The consistent creation (harvesting) of the full range of patch sizes is not possible because forest cover constraints, existing age class distributions, and terrain quite often limit the ability to implement large openings. Portions of TFL 56 have historically been heavily fragmented as a result of its terrain (steep valleys, avalanche chutes). Smaller openings are better suited to manage this type of terrain as it reduces the potential for destructive avalanches. The creation of large openings fit well within the Keystone face and the front of the Goldstream valley because of their more gentle terrain. Unfortunately, these areas have significant harvesting histories and seral stage constraints applied for caribou that severely limit the opportunities to create aggregate blocks in the short term. In addition, the front of the Goldstream has been designated for partial cutting strategies that generally exclude the creation of large openings.

TFL 56 is a unique land base to which the generic provincial targets are not well suited. The young seral patch size distributions projected in the base case are heavily skewed toward smaller openings.

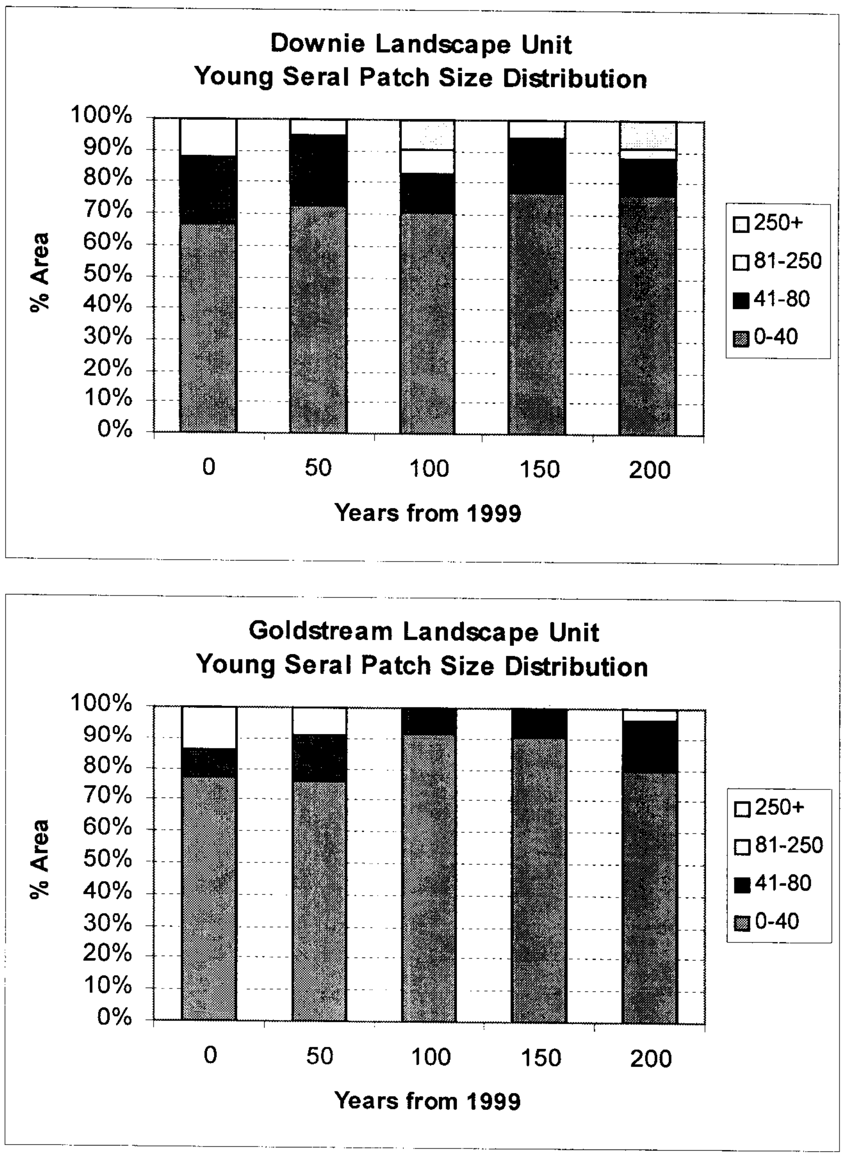


Figure 26. Young seral patch size distributions through time - Base Case.

Refer to the patch size distribution for all seral stages to see how the large patches of older forest in each LU affect the distributions over time.

All Seral Stages Results:

The general trend through time is to reduce the area in very large patches and increase the area in small patches.

Downie: Although the amount of small patch area increases over time from 29 to 40%, the Downie zones continue to provide about 60% of their area in patches over 40 ha in size. The ESSF zone maintains 70% of its area in patches over 40 ha because the majority of the zone is outside the THLB (82%).

Goldstream: Small patch area increases from 31% to 55% by the end of 200 years because the areas geographically suited for large openings are predominately being managed under partial cutting prescriptions (1 ha openings). Approximately 45% of the area still remains in larger openings. The ESSF zone shows the least increase in small openings because only a small portion of this zone (27%) is in the THLB and the rest is not affected by logging.

In all of the zones, patch size is not evenly distributed throughout the age classes because forest cover constraints, existing age class distributions, and terrain limit the ability to consistently implement the full range of openings in each 20 year period.

Table 12. Patch Size Statistics at Year 0 and 200 - All Forested Area.

ALL SERAL PATCHES	YEAR 0				YEAR 200			
	All Seral Patch sizes (ha)				All Seral Patch sizes (ha)			
	0-40	41-80	81-250	250+	0-40	41-80	81-250	250+
Downie LU								
ICH (NDT3)	38%	17%	15%	30%	49%	22%	14%	15%
ICH (NDT1)	34%	19%	20%	26%	51%	11%	17%	21%
ESSF (NDT1)	23%	9%	18%	50%	27%	9%	17%	48%
All Downie	29%	14%	19%	37%	40%	11%	17%	33%
Goldstream LU								
ICH (NDT1)	45%	19%	18%	18%	75%	6%	10%	10%
ESSF (NDT1)	24%	8%	12%	55%	44%	6%	18%	32%
All Goldstream	31%	10%	15%	44%	55%	9%	14%	22%
TFL	30%	13%	18%	39%	45%	10%	16%	29%

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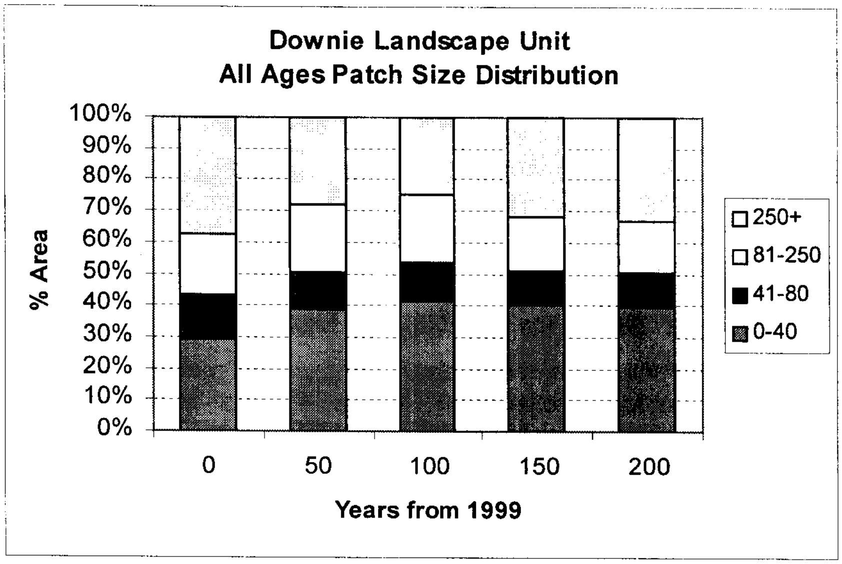

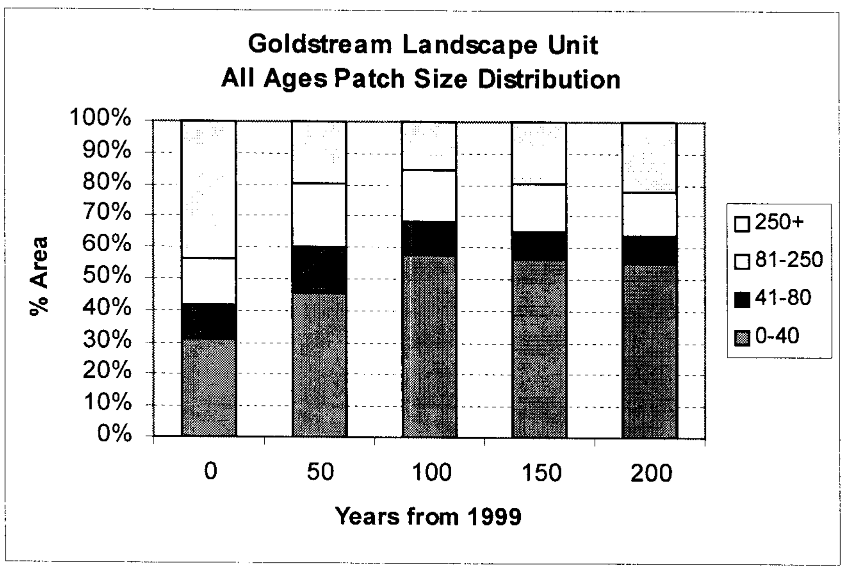

Figure 27. All seral patch size distribution through time – Base Case.

Figure 27 shows that in both landscape units, patch size stabilizes after 100 yrs when the landscape patterns have been fully implemented. After this point, the pattern simply repeats itself as second growth stands reach rotation age and are harvested. The figure also shows that there is a moderate increase in the amount of small patches over the first 100 years, but that a reasonable representation of all patch sizes is maintained.

In summary, the patch size distributions created during the modeling of MP#3 have a higher percentage of small openings than suggested by the generic targets for NDT 1&3. This is acceptable because the creation (harvesting) of larger openings is often not possible due to forest cover constraints, existing landscape patterns, steep terrain, and partial cutting strategies. The patch size results presented here are an artifact of managing for other values that take precedence over patch size.

7.0 Sensitivity Analyses

7.1 Alternative Harvest Profiles and Interpretations

Three alternative harvest profiles for the base case are shown in Figure 28.

The first alternative harvest flow (Max Start) increases the initial harvest level without compromising mid-term or long-term harvest levels. The result is a slightly higher harvest level in the first decade (115,000 m^3/yr) and a slightly lower harvest level in the mid-term (70,000 m^3/yr). There is little difference between this scenario and the base case because the two decades of existing AAC in the base case do not give much room to increase the initial harvest.

The second alternative harvest flow (AAC Attempt) illustrates the amount of timber that would be available through time if the current AAC (100,000 m^3/yr) was requested indefinitely. This harvest flow was not constrained beyond providing an upper limit and resulted in an erratic flow of timber. The harvest flow remained at the current AAC for 5 decades and then fell sharply into a fluctuating trough for 80 yrs. This was a result of harvesting all of the currently mature timber before significant amounts of second growth forest came on line. The peaks and valleys at the back end of the harvest profile are roughly coincident with the second and third rotations of the volume harvested in the first 100 years.

The third alternative harvest flow (One Drop) forces the harvest level to continue at the current AAC until it must be decreased to the LTHL in one large step. This resulted in the current AAC being harvested for 4 decades and then a 30% drop to 70,000 m^3/yr was required. The LTHL was 74,000 m^3/yr.

The fourth alternative flow (Immediate LTHL) shows the harvest level dropping immediately to the highest level that could be maintained throughout the planning horizon. This resulted in a consistent harvest of 75,500 m^3/yr and is limited by harvest volume in the last 40 years of the planning horizon. This scenario trades off substantial volume in the short term in order to eliminate the mid term trough. The LTHL (75,500 m^3/yr) is only 2% higher than in the base case LTHL (74,100 m^3/yr)

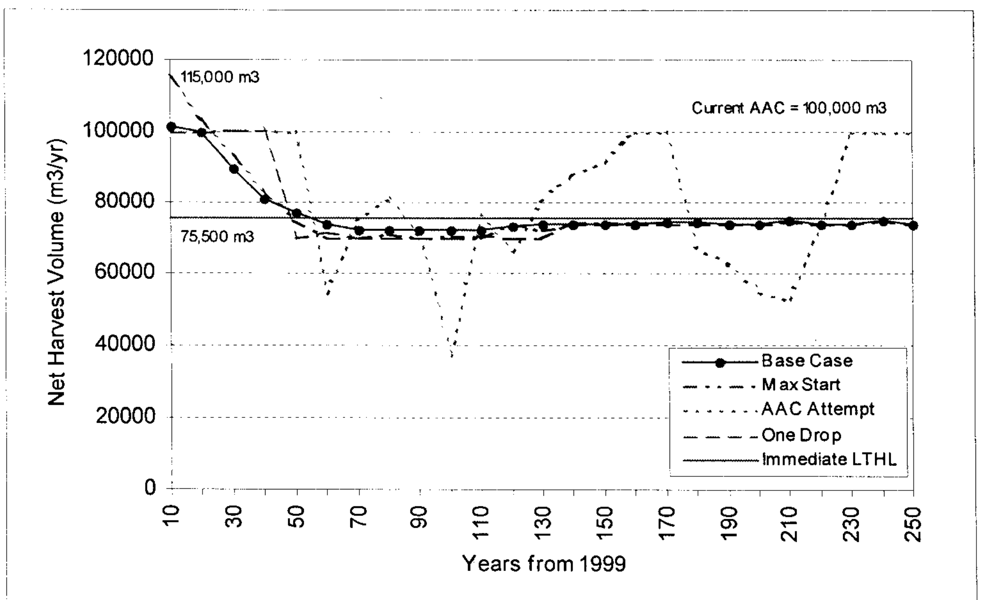

Figure 28. Alternative harvest profiles for the base case.

To assist in putting the base case harvest scenario in perspective, a biological potential harvest scenario has also been completed and is shown below. This scenario is NOT a possible option for the management of TFL 56 because it does not address any of the non-timber values on the land base – but it does provide an upper bound on potential timber production assuming physical, biological, and economic constraints.

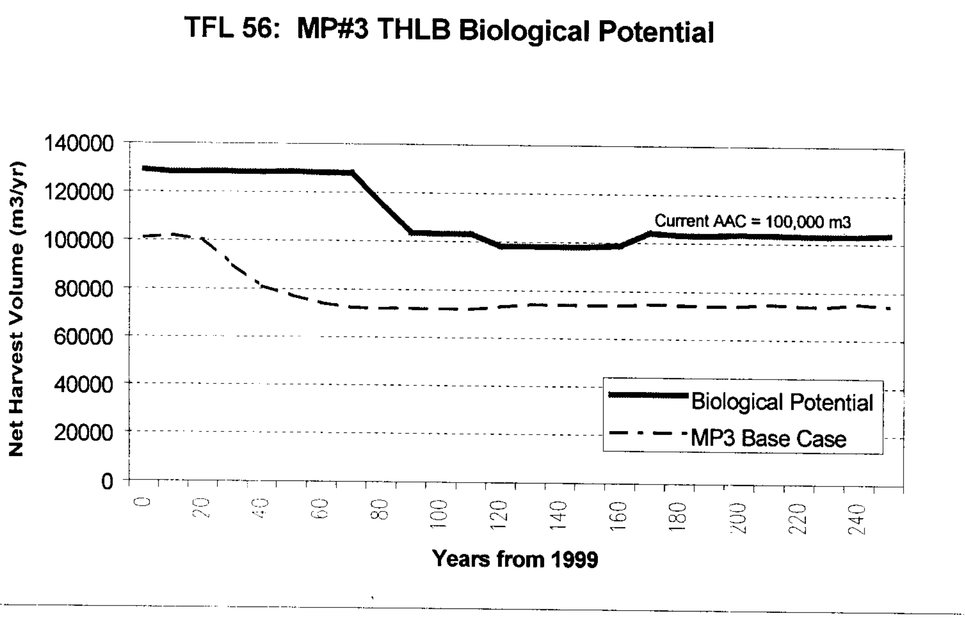

Figure 29. Biological potential for the THLB.

This scenario was run by eliminating RCFC's retention areas (MFRA's) and using all of the THLB (30968 ha) to grow and harvest timber. No constraints were applied to harvesting within the THLB. This likely represents an optimistic view of the economic land base as RCFC's MFRA's included areas that were unlikely to be harvested for economic or environmental reasons – but are in the THLB for this scenario.

7.2 Old Growth Site Indexes (OGSI)

Estimating the productivity of sites currently occupied by old growth stands (> 140 yrs old) is difficult because of the age of the stands. The most accurate estimates of site productivity come from stands between 30 and 140 years old. During the inventory process, old growth stands were assigned site indexes based on the best available information, but it has since become well understood these site indexes underestimate the potential of future regenerated stands. Studies have been completed to estimate site index correction factors for old growth stands[7].

This sensitivity analysis adjusted the site index for all old growth stands (>140 years of age) once they were harvested based on the correction factors supplied by the OGSI studies. The adjustments were only applied to polygons within the old growth site index ranges indicated, and used the formulas in Table 13 below.

The veteran trees' equation for Cw was considered to be unrepresentative, as all SI's between 11.6 and 23.2 would be adjusted to 20.7. A conservative and more realistic adjustment of increasing site indexes at the low end of the range (7-18) by a nominal 4m was used. Average gain in the veteran study was 5m for Cw, with much larger gains occurring below SI_{OG} 15.7

Table 13. OGSI Adjustment Formulas

[7] "Site index adjustments for old growth stands based on paired plots" (Nussbaum 1998) and "Site index adjustments for old growth stands based on veteran trees" (Nigh 1998). BC Ministry of Forests, Research Branch, Victoria, BC.

Species	Source Study	Equation	SI_{OG} Range
Sx	Paired Plot	New SI = 17.46 + 0.1948 * SI_{OG}	5.7 - 25.4
Cw	None	New SI = SI_{OG} + 4	7 – 18
Bl	Veteran Trees	New SI = 8.824 + 0.5682 * SI_{OG}	4.5 - 22.0
Hw	Veteran Trees	New SI = 11.42 + 0.5430 * SI_{OG}	4.7 - 17.5

The end result was to adjust the poor and moderate site class curves for 4 species groups. The good site class curves were outside the SI accepted range.

Table 14. OGSI Adjustments to Stand Groups.

Curve ID	Description	Base Case SI	Adjusted SI	Change (m)	% SI Change	% Vol Change at Min harvest	Base Case Minimum Harvest Age	THLB Area
250	OGSI Man-Bl-G	14.8	17.2	2.4	16%	13%	110	70.1
260	OGSI Man-Bl-M	12.0	15.6	3.6	30%	34%	140	324.2
360	OGSI Man-Cw-M	15.9	19.9	4.0	25%	51%	110	2020.5
370	OGSI Man-Cw-P	13.0	17.0	4.0	31%	59%	130	412.0
460	OGSI Man-H-M	14.8	19.5	4.7	32%	79%	110	2257.4
470	OGSI Man-H-P	11.2	17.5	6.3	56%	88%	150	975.5
560	OGSI Man-Sx-M	15.1	20.4	5.3	35%	37%	100	329.3
570	OGSI Man-Sx-P	11.5	19.7	8.2	71%	70%	150	1662.8
					41%	66%		8051.8

The new curves increased the volume at minimum harvest age (base case) from 13 to 88% depending on the curve. All of the curves combined to produce a potential average (weighted by area) increase in volume at minimum harvest age of 66% over the area to which the OGSI adjustments were applied. Because this area only represents 37% of the working THLB, the potential increase in the LTHL is only 25%.

The first OGSI scenario shown in Figure 29 below used the increased volume curves but did not change the minimum harvest ages. In the second OGSI scenario, minimum harvest ages were dropped to the age at which maximum MAI occurs on these curves (90-120 yrs). This illustrates the benefits of having additional volume available sooner in the harvest profile. In both cases, OGSI gains do not show up in the harvest profile until existing old growth stands have been logged and the regenerated stands have grown for a full rotation.

Neither OGSI scenario had any impact on short-term harvest levels because no additional timber is provided during the mid-term deficit. The existing old growth stands must still be meted out over the first 50-60 years in order to give significant areas of regenerated stands time to reach minimum harvest ages.

When only the volume portion of OGSI was implemented, the LTHL increased from 72,200 m^3/yr to 85,100 m^3/yr (18%). A slightly higher LTHL was achieved when the minimum harvest ages were also adjusted because stands were then harvested closer to the age of maximum MAI.

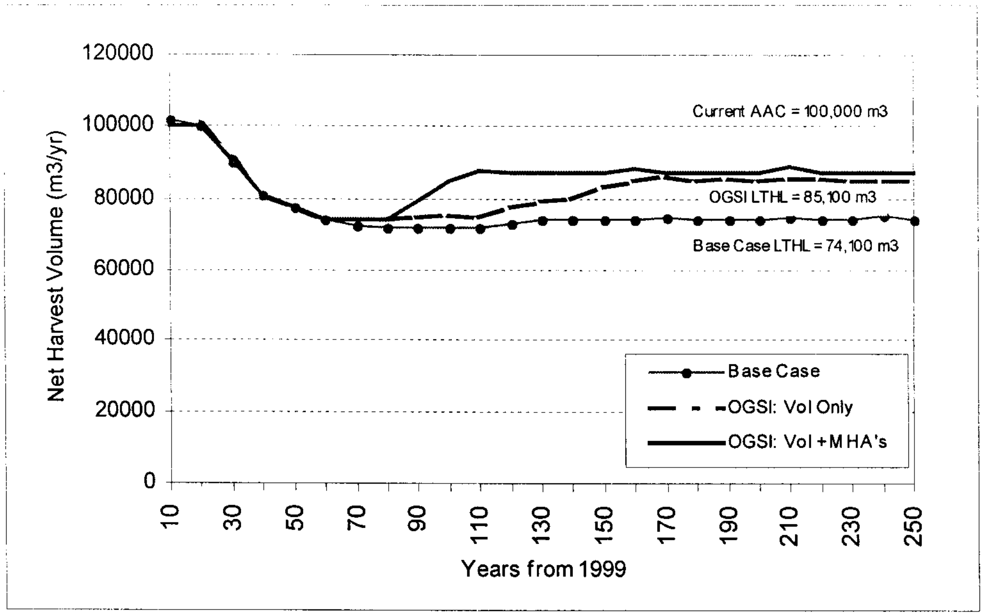

Figure 30. Harvest Projections using OGSI adjustments.

7.3 Min Harvest Ages

Minimum harvest ages are set to ensure that economic harvest conditions exist and that long-term yields are not unduly compromised. Uncertainty around the minimum ages used for each stand type has been addressed by adjusting the base case ages up and down by 10 years. The results are presented in the Figure 31 below.

Increasing the MHAs by 10 years caused the initial harvest level to drop after the first decade and produced a slightly lower mid-term harvest level that persisted for a longer period of time. This is a result of regenerated stands taking 10 years longer to become available for harvest and forcing the existing old stands to be meted out over an additional decade. Once the mid term trough is over, the LTHL is the same as for the base case. The LTHL was not impacted because the increase in harvest ages generally moved medium/poor stand curve harvest ages closer to maximum MAI and good stand curves further away.

Decreasing the MHAs by 10 years allowed the initial harvest level to be maintained for an additional decade, and then drop consistent with the base case. This is a result of regenerated stands becoming available 10 years earlier and allowing a faster rate of harvest on the existing old stands. LTHL was not impacted for the same reasons as mentioned above.

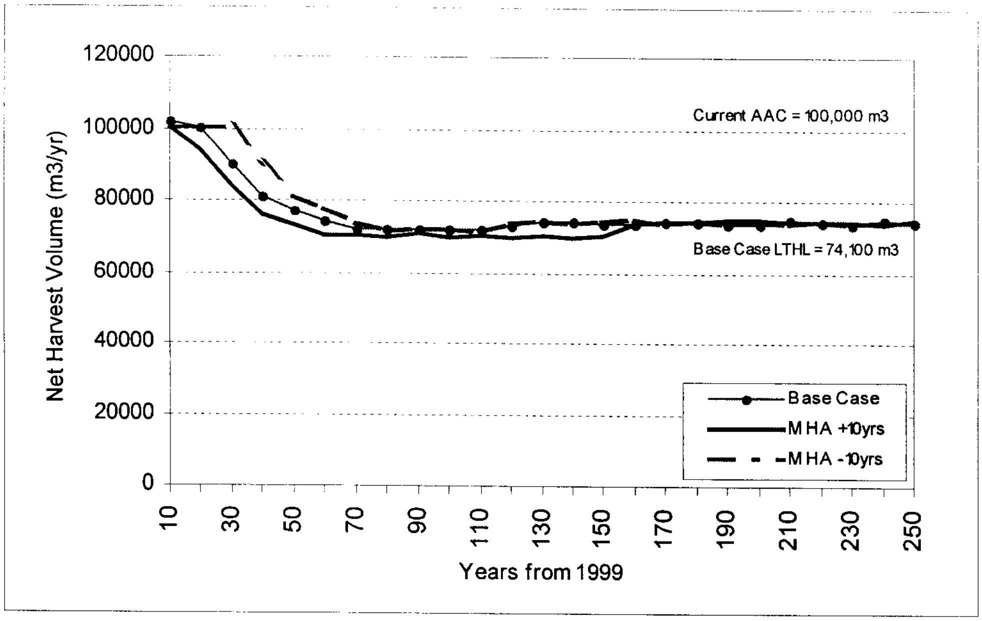

Figure 31. Minimum harvest ages ± 10 yrs from base case.

In summary, short-term harvest levels are sensitive to the age at which regenerated stands become available for harvest. The base case harvest level requires that significant areas of newly regenerated stands be available 60 –70 years from now (see table below).

Decade from 1999	Base case harvest area within 10 yrs of Minimum Harvest Ages (ha)
1	38
2	11
3	45
4	93
5	348
6	1052
7	1566
8	1565
9	1502
10	753

7.4 Natural Stand Volumes

Natural existing stand volumes are subject to uncertainties in forest inventory data (heights and ages) and the statistical process used to derive the equations in the growth and yield model (VDYP). Although no issues related to existing volumes were identified in the recent inventory audit for TFL 56, standard sensitivity analyses were completed to address the possibility of volume estimates being off by 10%.

When volumes for existing stands were decreased by 10%, the two decades of current AAC shown by the base case were no longer available. The initial harvest level dropped to 89,900 m^3/yr and then transitioned to the LTHL of 74,100 m^3/yr. This result occurs because the existing old stands now provide less volume and must be harvested at a slower rate in order to mete out the available volume until significant areas of regenerated stands come on line in the 6th decade.

When volumes for existing stands were increased by 10%, there were two additional decades of harvest at the current AAC when compared to the base case. The initial harvest level remained at 100,000 m^3/yr for four decades and then dropped down to the LTHL of 74,100 m^3/yr at the same rate as the base case. This result occurs because the existing old stands now provide more volume and can be harvested at a slower rate to provide the current AAC for a longer period of time. This additional time allows more regenerated stands to become available and gives a mid term harvest level that is 1000 m^3/yr higher.

In summary, short-term harvest levels are highly sensitive to estimates of existing stand volume.

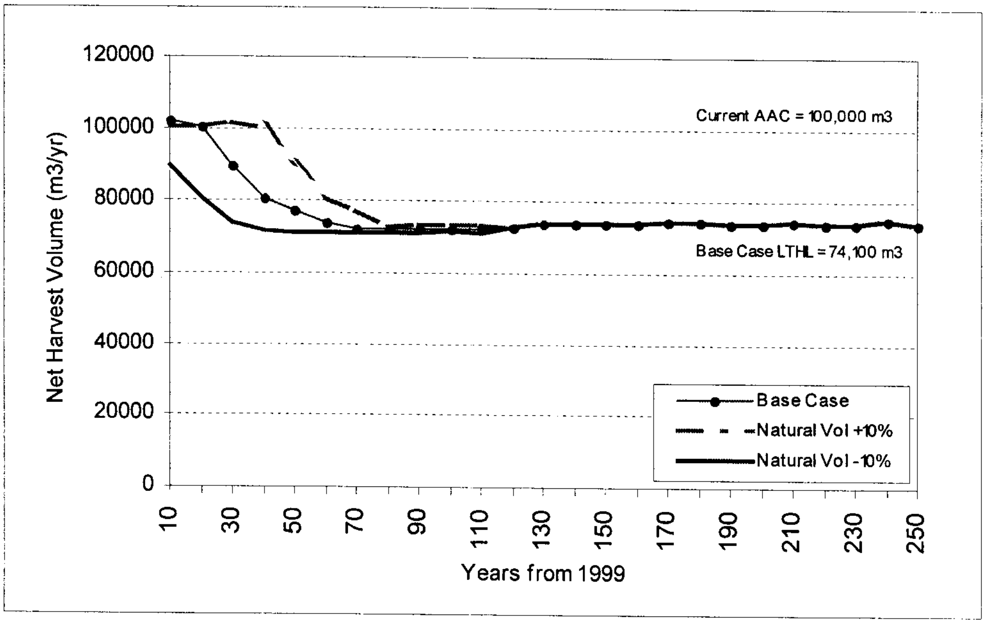

Figure 32. Effects of increasing / decreasing natural stand volumes by 10%.

7.5 Managed Stand Volumes

Uncertainty around managed stand yields exist for the same reasons listed for natural stand yields (inventory data and G&Y model equations). The limited amount of experience with regenerated managed stands in the Revelstoke area results in additional uncertainty when predicting future harvest volumes. Sensitivity analyses were completed to address the possibility of volume estimates being off by 10%.

When managed stand volumes were decreased by 10%, the mid and long-term harvest levels were decreased to 67,600 m^3/yr (9% drop in LTHL). This occurred because the regenerated stands that came available through time provided less volume. The short-term harvest level did not change, as it is entirely made up of existing natural stands.

When managed stand volumes were increased by 10%, the mid term harvest levels increased by 3% to 74,500 m^3/yr and long-term harvest levels increased by 10% to 82,500 m^3/yr. This occurred because the regenerated stands that came available through time provided more volume. The short-term harvest level did not change, as it is entirely made up of existing natural stands.

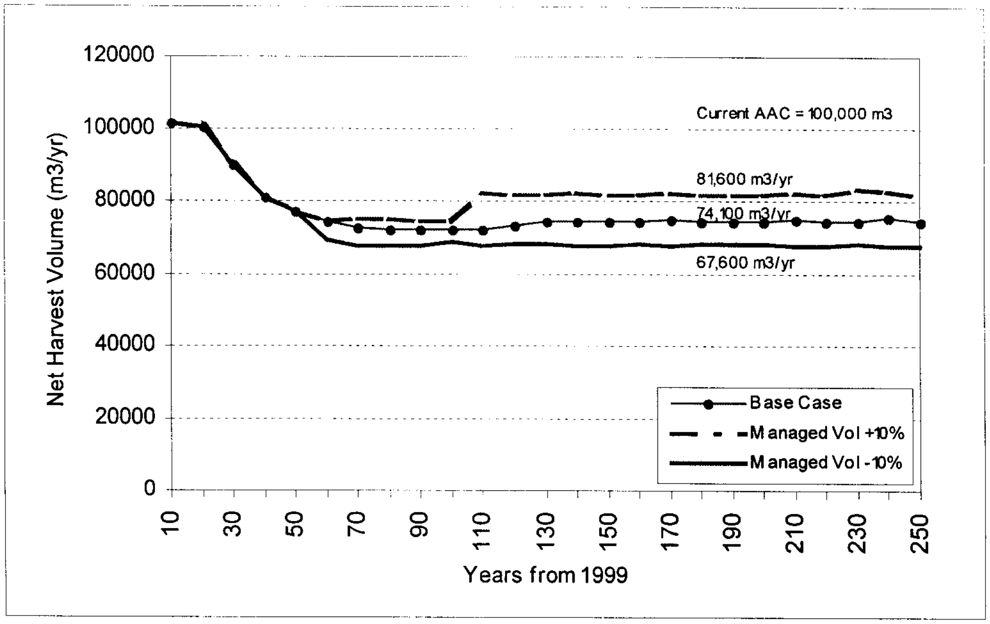

Figure 33. Effects of increasing / decreasing managed stand volumes by 10%.

In summary, fluctuations in managed stand volumes have a small effect on mid-term harvest levels and a significant effect on long-term harvest levels.

7.6 Landscape Level Biodiversity (Seral Goals)

As directed by Timber Supply Branch in a December 1, 1997 memo titled "Incorporating Biodiversity and Landscape Units in the Timber Supply Process", the modeling of landscape level biodiveristy requirements is to be applied through a weighted average of all three emphasis options (45% low, 45% inter, 10% high) for each BEC zone in each draft landscape unit. This is designed to allow modeling of landscape level biodiversity when landscape units and objectives have not yet been legally established. This method of modeling biodiversity requirements is significantly different than the MAC strategy used in the base case. This sensitivity analysis illustrates the change in harvest flow associated with using the provincial biodiversity modeling strategy. Differences between the two modeling strategies are shown in Table 15 below.

Table 15. Modeling Seral Goals for Biodiversity: Provincial Strategy vs Base Case.

Issue	Provincial Biodiversity Sensitivity Analysis	Base Case (Revelstoke MAC strategy)
Biodiversity Emphasis Option (BEO) Assignment	Each LU is given a weighted average target based on 45% low / 45% inter / 10% high.	MAC designated Intermediate BEOs in valley bottom corridors and Low BEOs elsewhere. No High BEOs were identified.
Contributing Area	All forested area within each BEC variant contributed toward meeting seral goals. (7 zones modeled)	Seral goals had to be met in both the operable and total forested areas of each BEC variant / BEO combination. (28 zones modeled)
Mature Seral Goals	None required.	Required in Intermediate BEO areas.
Old Seral Goals	One third old in Low BEO initially with gradual increase to full old by 210 years. Full old in Intermediate and High BEOs. See Table 16 below for weighted average seral percentages.	One third old in Low BEOs initially with gradual increase to full old by 210 years. Full old in Intermediate BEOs. Actual values applied to appropriate BEO.
RCFC Reserve Strategy	Reserve areas falling only within biodiversity zones (no caribou or ungulate) were placed back into the working land base (1896.4 ha)	Fully implemented to meet MAC guidelines. May be room to optimize reserve area.

Table 16. Seral Goals Modeled in Each BEC Variant for Provincial Biodiversity.

	OLD Seral Age	LU Guide Old Seral Targets				Weighted Average* Old seral % by time (yrs)		
		Low	Inter	High		0-105	106-209	210+
ICH mw3	140	14%	14%	21%	→	*10.5%*	*12.6%*	*14.7%*
ICH wk1	250	13%	13%	19%	→	*9.7%*	*11.6%*	*13.6%*
ICH vk1	250	13%	13%	19%	→	*9.7%*	*11.6%*	*13.6%*
ESSF vc	250	19%	19%	28%	→	*14.2%*	*17.0%*	*19.9%*

* The weighted average assumes 45% of the area is in low, 45% in inter, 10% in high and also factors in the transition from 1/3 low to full low by 210 years.

For example, the ICH mw3 in each landscape unit must have:

- 10.5% of its stands older than 140 years old during the first 105 years,
  (14%*.33*.45 + 14%*.45+ 21%*.10 = 10.5%)
- 12.6% of its stands older than 140 years during the next 105 years,
  (14%*.66*.45 + 14%*.45+ 21%*.10 = 12.6%)
- 14.7% of its stands older than 140 years after 210 years.
  (14%*1.0*.45 + 14%*.45+ 21%*.10 = 14.7%)

The most significant differences in how the seral goals were modeled was the lack of mature seral goals in intermediate biodiversity and the ability to use inoperable forest to contribute to seral goals. These two items allowed all of RCFC's retention areas that fell outside of caribou and ungulate zones to be dropped – the forested netdowns and inoperable areas were more than sufficient to meet the provincial old seral goals. As seen in Figure 34 below, the addition of this 1896 ha to the working land base allowed 2 more decades at the current AAC and higher mid (80,000 m^3/yr) and long-term (82,500 m^3/yr) harvest levels.

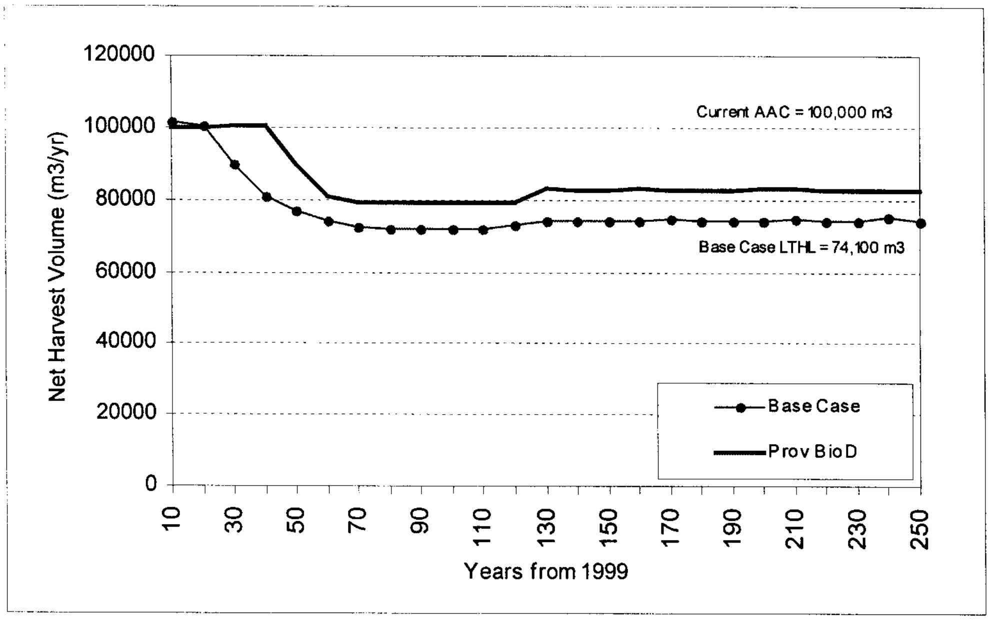

Figure 34. Provincial biodiversity modeled instead of MAC biodiversity guidelines.

This scenario likely represents an optimistic view of the economic land base as RCFC's reserve strategy included areas that were unlikely to be harvested for economic or environmental reasons – but are in the working portion of the THLB for this scenario.

7.7 Aerial Hw Blocks Removed

The base case THLB includes 656 ha of old (>140 yrs) hemlock-leading stands that contributed approximately 2½ years of volume to the harvest profile through helicopter logging. In order to assess the sensitivity of the base case around the harvesting of these stands, a run was completed where they were removed from the THLB. The results in Figure 35 below show that short-term harvest levels are approximately 5% less than in the base case, with long-term harvest levels slightly lower at 72,200 m^3/yr. This result occurs because there is less old forest to mete out until regenerated stands come on line in the 6th decade and the smaller net land base provides less volume in the long-term. Optimizing RCFC's MFRA's to utilize these stands in place of economically viable polygons could reduce this impact. This would only be possible where the additional reserves from Heli-Hw stands create a surplus in a forest cover requirement zone.

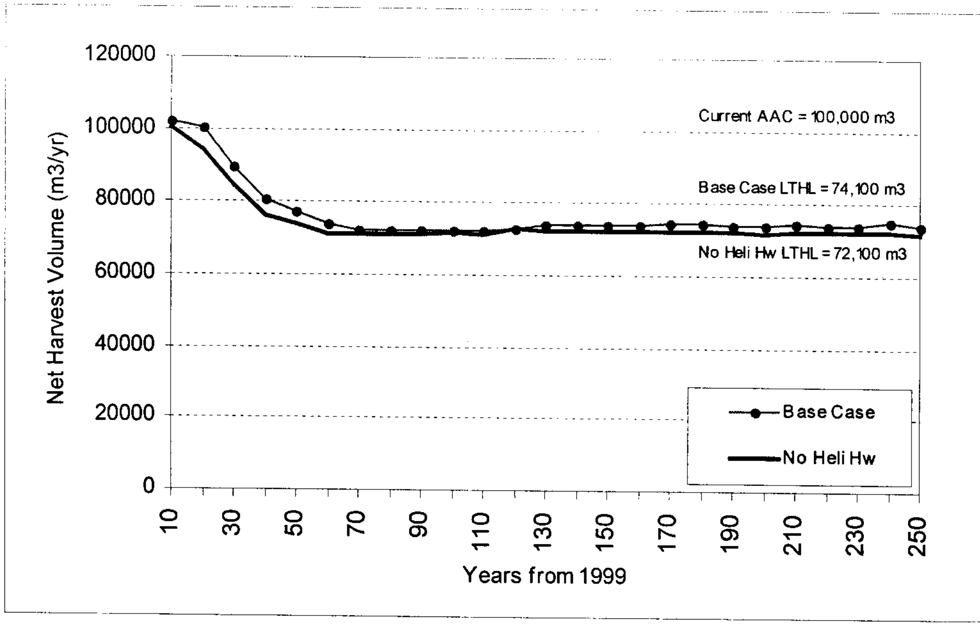

Figure 35. Heli - Hemlock leading stands removed from the THLB.

7.8 Old Seral Ages

In TFL 56, there is considerable question about the actual ages of older stands in the inventory files as all stands over 215 years are presently identified as either 225 or 325 years old (refer to Figure 3). In addition, the map sheets covering the Goldstream LU do not identify any stands over 225 years old. This is not consistent with age data collected during silviculture prescription fieldwork. The accuracy of older stands is potentially an issue because the large area of 225 year old stands does not currently meet the definition of old seral within NDT1.

In the base case, old seral goals were not constraining (tight) in any zone because RCFC's retention areas (MRFA's) included enough of the oldest stands available to ensure that the old seral goals were met as soon as possible (constraints not necessary). In almost all cases, there was a large surplus of old stands because stands reserved for mature seral goals also met the old condition (refer to Figures 14, 16, 20, 21, 23, 25). Thus, lowering the definition of old to 225 years would only change when the old seral goal is officially met but would not alter the reserve strategy or the base case timber supply projection.

In general, as long as the % retention and age requirement (i.e. 10% > 250 yrs) cannot be supplied through standard rotation ages, a reserve strategy will be the most efficient way of meeting the constraint. As long as the oldest available stands are placed into reserve first, the age at which stands are considered "old" will not affect timber supply. This does not hold true if the model is left to select reserve locations because ATLAS-FPS will NOT recruit stands to fill a deficit - lockout occurs.

7.9 Mature Seral Age

Again, as long as the % retention and age requirement (i.e. 34% > 120 yrs) cannot be supplied through standard rotation ages, a reserve strategy will be the most efficient way of meeting the constraint and will have a set impact on the land base (i.e. 150 ha out of production). This area loss will result in a consistent long-term impact on timber supply irrelevant of the mature seral age. However, short-term timber supply may be influenced by the mature seral age by providing flexibility to reserve younger stands with lower volumes and free up older stands with higher volumes.

In the base case, mature seral goals limit harvesting through the application of the MFRA's identified by RCFC. Lowering the age of mature stands has no impact on timber supply unless it allows the retention strategy to be reworked. The amount of area retained was driven by the amount of area required in mature seral goals, while the specific areas available for selection were determined by the mature age definition. If the age of mature was lowered, there could be more flexibility in selecting the location of reserve areas. This is useful because it improves the odds of meeting the mature goal in otherwise constrained areas and/or younger lower volume stands.

A sensitivity analysis was not run to show the impact of different mature seral ages on the base case because it was not feasible to rework RCFC's reserve strategy. If mature ages were changed in the future, it is likely that long-term harvest levels would not change and short-term harvest levels could show small changes.

7.10 Harvest Priorities Altered

Harvest priorities were used in the base case to influence the locations and types of stands to be harvested first. Priority zones were used to provide a spatial distribution of harvest (refer to Section 4.3) and an age priority ensured that the oldest stands were harvested first within these zones.

Changes to harvest priorities had almost no effect on timber supply. When runs were completed without the oldest first priority, several harvest profiles showed a small dip (4%) in the 11^{th} and 12^{th} decade. Changes to the priority zoning showed no change in timber supply but did result in different landscape patterns over time – although the patch size distributions still appeared to have a high percentage of smaller openings.

In summary, the timber supply projection is generally not sensitive to changes in the harvest priorities. However, an oldest first priority should be adhered to operationally whenever possible to eliminate the potential of a small drop in harvest 110 to 120 years from now.

7.11 Seral Goals Met ASAP in Recruitment Caribou

Forest cover requirements were addressed in the base case primarily through the application of RCFC's landscape level MFRA strategy. The MFRA's ensure that the seral goals for each of the management zones are met over time. In several zones, stands too young to currently meet the seral goals were included as MFRA's in order to address long-term connectivity and to give future replacement options. Because of this, seral goals could have been temporarily violated or not achieved as quickly in two ungulate zones and three recruitment caribou zones. In the base case, the ungulate zones had constraints applied to ensure that the seral goals continued to be met or were met as soon as possible. The recruitment caribou zones in the base case used RCFC's MFRA's and had violations occur. This outcome is consistent with MFRA strategy approved by local ministries (MoE / MoF) to deal with the connectivity and recruitment issues in these special zones.

This sensitivity analysis looks at the impacts of using constraints to enforce strict adherence to the seral goals in recruitment caribou zones. The results show a slightly weaker harvest projection (Figure 36). The current AAC can only be maintained for one decade before it drops to slightly lower mid-term levels than the base case. Long-term harvest levels are not affected, as all of the zones are able to contribute timber after 120 years.

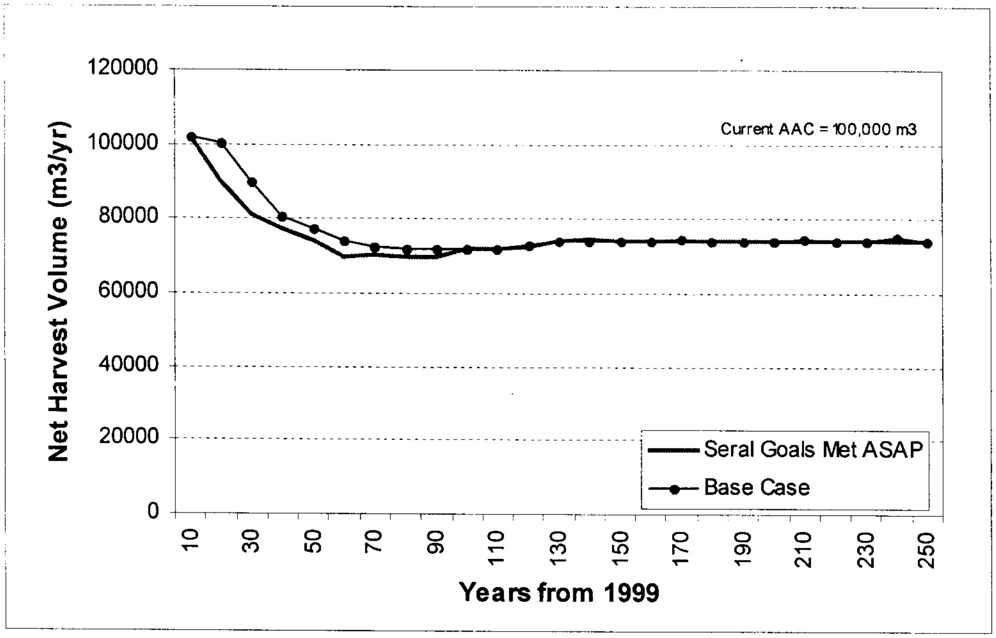

Figure 36. Seral goals met ASAP in Recruitment Caribou Zones

The reduction in available short-term timber is a result of being locked out of three of the four caribou recruitment zones for many decades: Downie ICH (mature met in 80 yrs), Goldstream ICH (mature met in 110 yrs) and Goldstream ESSF (mature met in 130 yrs). The base case allowed some limited harvesting in these areas.

Table 17. Recruitment Caribou Zones: Seral goal result differences from base case.

		Area (ha)	Years Until Mature Seral Goal Met	Lowest Mature Level Achieved	Years Until Old Seral Goal Met	Lowest Old Level Achieved
Downie ICH	Base Case	2632	130	15%	30	4%
	Met ASAP		80	15%	30	4%
Downie ESSF	Base Case	973	130	30%	30	4%
	Met ASAP		0	40%	30	4%
Goldstream ICH	Base Case	2666	130	30%	30	0%
	Met ASAP		110	33%	30	0%
Goldstream ESSF	Base Case	55	130	14%	30	0%
	Met ASAP		130	14%	30	0%

The table above shows that applying the constraints does not result in old seral goals being achieved any sooner than the base case. However, mature seral goals are met sooner or are not allowed to drop below 40%:

Downie ICH: Both scenarios had mature seral as low as 15% but the base case took 5 decades longer to reach the target of 40%.

Downie ESSF: The base case allowed mature seral to drop to 30% and it didn't regain 40% until the 13th decade. When the constraint was applied, mature seral was at least 40% at all times.

Goldstream ICH: There was little difference between mature seral results in this zone. The base case is slightly slower to reach the target (20 yrs) and allows a slightly lower seral goal to occur (30% instead of 33%) in the mid-term.

Goldstream ESSF: There is no difference from the base case in mature seral results for this zone. The constraint had no impact, as the reserve strategy met the requirements as soon as possible.

In summary, constraints used to rigidly enforce seral goals in recruitment caribou zones result in a moderate impact to short term timber supply. Seral goals are generally met sooner than in the base case and they are not allowed to drop below the 40% level at any time. However, the long-term spatial distribution of stands used to meet the seral goals is not as desirable as that of the base case.

7.12 Seral Goals Met Entirely Using Constraints (No Rsvs)

In order to assess the ability of RCFC's retention strategy to provide the necessary forest cover requirements while minimizing the impact on timber supply, a run was completed where all of the reserves were turned off and constraints were turned on. This meant that the model selected reserve locations as required and that no harvesting was allowed in a zone if it did not meet the seral targets applied to it (lockout occurred). Thus, most of the recruitment caribou zones were locked out for extended periods of time.

Figure 37 shows that even with lockout occurring, the initial harvest level could be maintained for an extra decade and then drop to a long-term harvest level of 89,100 m^3/yr.

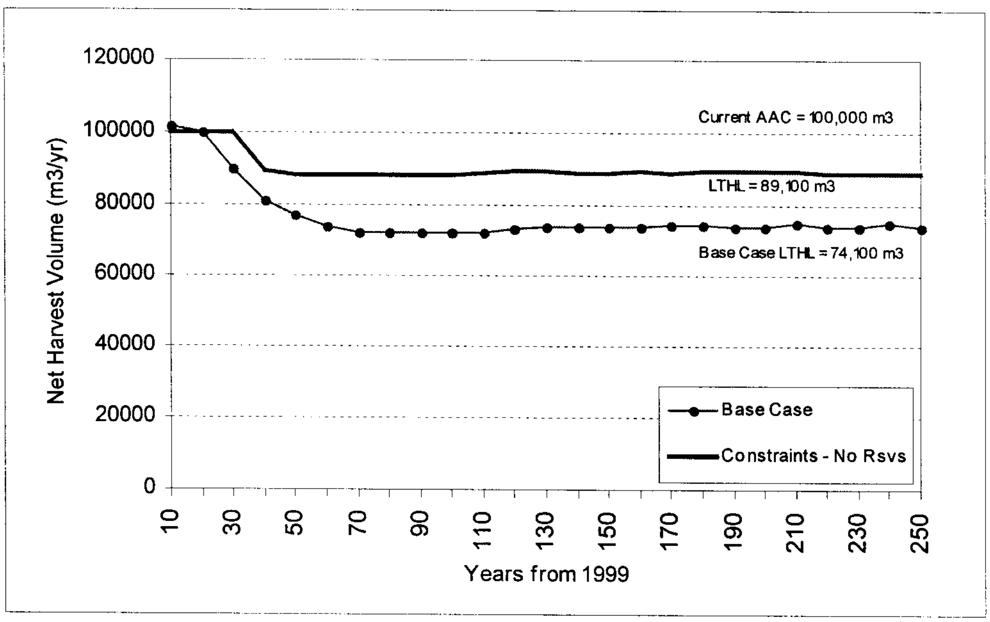

Figure 37. Seral goals met using constraints instead of RCFC's reserve strategy.

This result occurs because there is surplus area designated for retention (MFRA's) in the base case. Table 9 in section 3.3.6 shows that only 7 of the 29 zones with seral goals applied had MFRA levels within 3% of the required level. All other zones had more MFRA area than was required (>3% excess), although not all zones could ever get down to minimums due to overlapping constraints. A very cursory analysis indicated that about 1800 ha (19.5%) could be removed from the retention strategy while still meeting the forest cover requirements for each zone. When the model is allowed to select retention areas, it does not leave surplus old or mature forests and would therefore have realized this gain in the size of the working forest.

The gains in harvest volume realized in this scenario were smaller in the short term (11% increase) than in the long-term (20% increase). In the short term, this scenario does not allow harvesting in zones that have a deficit of old or mature forest (lockout occurring) whereas the MRFA's avoids lockout and uses younger stands to meet the seral requirements. In the long-term, lockout is not an issue and the full impact of the larger working land base (less retention) can be realized.

As a general observation, a more realistic harvest projection is somewhere in between the two shown in Figure 37 because there is room to refine the retention strategy but not all of RCFC's MFRA's are practical for inclusion in the THLB. Detailed planning work completed by RCFC has indicated that there are areas below the operability line that will likely not be harvested, and were therefore treated as reserves in the base case.

The main conclusions from this sensitivity analysis are:

- RCFC's MFRA strategy places more area into retention than when the model is allowed to choose locations.
- RCFC's MRFA strategy can likely be refined to include less area but the practical location of reserves to accommodate operational realities while considering other resource values will generally result in a bigger impact on timber supply than simply modeling percentages.
- The base case harvest projection (RCFC's MFRA's) should be considered a worst-case harvest projection for the impacts of seral goals.

8.0 Summary and Conclusions

Since the approval of the previous Management Plan (MP#2), significant changes in the rules governing the practice of forestry in TFL 56 have occurred. BC's Forest Practices Code has been implemented and the Revelstoke Minister's Advisory Committee's strategy is now recognized in the operational planning process. In an effort to address these and other issues, RCFC has systematically completed a series of planning and inventory initiatives (Total Chance Plans, landscape level forest retention strategies, avalanche hazard mapping, etc.) that have left them well equipped to practice sustainable forest management. The spatially explicit timber supply model used in this analysis relied heavily on these tools to define the working land base and provide operational realism to this strategic analysis. The amount and quality of planning provided as inputs to the model meant that very few strategic decisions were required of the model – it simply implemented RCFC's vision of land management for TFL 56. This resulted in harvest projections that are closely linked to operational reality.

Although the MAC strategy is not yet a legally established higher-level plan, it is considered current management in the Revelstoke area and has been part of the FDP process for several years. The guidelines in the MAC strategy were applied in the base case and were instrumental in developing RCFC's reserve strategy. This reserve strategy serves to address all of the forest cover constraints on the operable land base and leaves the remaining area essentially unconstrained – only patch size distribution and stand level biodiversity requirements are left to be addressed within the working portion of the THLB.

Patch size distribution targets were used in place of adjacency rules to control the spatial distribution of harvest throughout the TFL. This was done to better mimic natural disturbance patterns and to mitigate the timber supply impact of adjacency constraints. The patch size distributions created by the base case generally resulted in a higher percentage of small (< 40 ha) openings than those suggested for Natural Disturbance Types 1&3 by the Landscape Unit Planning Guide [MoF, March 1999]. This was considered acceptable because the creation (harvesting) of larger openings was often not possible due to forest cover constraints, existing landscape patterns, steep terrain, and partial cutting strategies. In the final analysis, the patch size distributions projected for TFL 56 are an artifact of managing for other values that take precedence over patch size.

When patch size distributions and RCFC's MFRA's are modeled in the base case, the current AAC (100,000 m^3/yr) can be sustained for 20 years before it falls at 10% per decade to a mid-term trough of 72,000 and then recovers to a long-term harvest level of 74,100 m^3/yr.

Short-term timber supply in the base case is heavily influenced by the existing age class structure in the working portion of the THLB. Significant volumes of older stands have been placed into reserve and significant volumes of managed stands do not become available for 50-60 years. This requires the harvest of the eligible older stands to be spread out over this time frame. Any factors that influence the volumes available from these older stands or when managed stands become eligible for harvest will impact short term harvest levels.

RCFC's reserve strategy had the most significant impact on both short and long-term harvest levels because it reduced the working portion of the THLB. Old and mature areas assigned as reserves have the effect of limiting harvesting options in the short term and reducing the productive land base that determines long-term harvest levels. The current strategic plan diverts approximately 9226 ha (30%) of the THLB to reserve, however there is opportunity to refine the reserve strategy to restrict less of the land base and put an upward pressure on timber supply.

Sensitivity Analyses Summary

Short-term harvest levels were sensitive to the following factors (ranked highest-lowest):

1. **Natural Stand Volumes**: Increasing volumes by 10% allowed the AAC to be maintained for 40 years because there was more volume to spread out over the first 50-60 years. Decreasing volumes by 10% resulted in an immediate drop in harvest level to 89,900 m^3/yr because there was less volume to spread out over the first 50-60 years.

2. **Landscape Level Biodiversity Modeling**: The provincial modeling methodology was less onerous and allowed the current AAC to be maintained for 40 years. Only old seral goals were required and inoperable forest was allowed to satisfy the goals.

3. **Minimum Harvest Ages**: Increasing MHAs by 10 years allowed the current AAC to be maintained for only 10 years because it took an extra decade for critical volumes of second growth stands to become available. Decreasing MHAs by 10 years allowed the current AAC to be maintained for 30 years because it made critical volumes of second growth stands available sooner.

4. **Seral Goals Met Entirely Using Constraints**: Allowing the model to select retention areas results in less area in retention when compared to RCFC's MFRA strategy. This allows the current AAC to be harvested for 30 years. There is potential to harvest the AAC for more than 30 years if lockout is avoided.

5. **Seral Goals Met ASAP in Recruitment Caribou Zones**: Forcing strict adherence to the seral goals in recruitment caribou zones meant that harvesting was generally locked out of these zones for the first 6 periods. This resulted in less available volume in the short term and allowed the current AAC to be maintained for only 10 years.

6. **Heli-Hw removed from THLB**: The removal of 656 ha of hemlock leading stands with a helicopter logging system meant that there was less mature wood to spread out over the first 50-60 yrs. This allows the current AAC to be harvested for only 10 years.

Long-term harvest levels were sensitive to the following factors (ranked highest-lowest):

1. **Seral Goals Met Entirely Using Constraints**: Allowing the model to select retention areas results in less area in retention when compared to RCFC's MFRA strategy. The long-term harvest level increased by 20% to 89,100 m^3/yr.

2. **Old Growth Site Index Adjustments**: Significant volume increases were realized on OGSI eligible stands (37% of working THLB). The long-term harvest level increased by 15% to 85,100 m^3/yr.

3. **Landscape Level Biodiversity Modeling**: Provincial methodology is much less onerous than MAC requirements and resulted in more area in production. The long-term harvest level increased by 11% to 82,500 m^3/yr.

4. **Managed Stand Volumes**: A 10% increase in managed stand volumes resulted in a 10% increase in the long-term harvest level (81,600 m^3/yr). A 10% decrease in managed stand volumes resulted in a 9% decrease in the long-term harvest level (67,600 m^3/yr).

5. **Heli-Hw removed from THLB**: The removal of 656 ha of hemlock leading stands with a helicopter logging system meant that there was less land contributing to long-term harvest levels. Thus, the long-term harvest level decreased by 3% to 72,100 m^3/yr.

In conclusion, this analysis indicates that based on current inventory, growth and yield projections, and management practices, timber harvests in TFL 56 can be maintained at the current level for two decades. The sensitivity analyses indicate that only an overestimation of existing natural volumes by 10% would result in an immediate reduction of AAC. All other sensitivity analyses showed at least 10 years of harvest at the current AAC.

The scenario that is believed to best represent the future timber supply in TFL 56 is the base case with an optimized reserve strategy and OGSI applied. This would see the current harvest level maintained for at least 30 years, with a long term harvest level of at least 90,000 m^3/yr.

Based on the results presented above, RCFC requests that its AAC remain at 100,000 m^3/yr for the term of Management Plan #3.

In order to mitigate the reduction in harvest levels forecast to occur in 20 years, the following issues should be addressed during the term of MP#3:

- The amount of area in the reserve strategy appears to be excessive. Determine if any reserved areas can be placed back into the working THLB while still meeting forest cover objectives.
- The site indices for stands less than 140 years may not fully reflect their productivity. Old growth stands that were harvested in last 40 years may still have the original old growth site index and are not eligible for the OGSI corrections. The volume contribution and timing of these early second growth stands is critical to short term timber supply.
- The forested area on the digital orthophotos does not match well with the current forest inventory files. A reconciliation of these areas may provide opportunities for reserving forested land outside the THLB.
- The accuracy of the ages of older stands in the inventory files appears to be poor. Refinement of these ages will not likely impact timber supply but it may assist in other forest management decisions.
- Net volumes achieved during helicopter and longline operations are typically 10% higher than indicated in the inventory files due to decreased breakage. The refinement of applicable decay, waste and breakage factors could be warranted.