Revelstoke Timber Supply Area
Timber Supply Review #4

Analysis Report

DRAFT

February 23, 2010

Prepared for:

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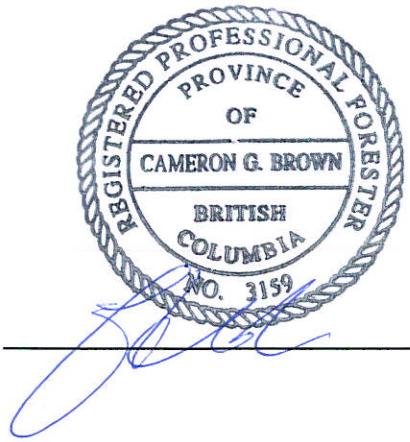
Revelstoke TSR4
Timber Supply Analysis Report

PROFESSIONAL FORESTER CERTIFICATION

This Report was prepared by:



An original, master hardcopy is signed, stamped and archived at the office of the Forest Analysis and Inventory Branch, Ministry of Forests and Range, Victoria, B.C.

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More Information on the Timber Supply Review Process

This document was prepared to support an allowable annual cut determination by British Columbia's Chief Forester. To learn more about this process please visit the following website:

http://www.for.gov.bc.ca/hts/

Or contact:

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Comments and Questions

Input from First Nations and public is an important part of the Timber Supply Review process and you are encouraged to review the information in this document and forward any comments to Cam Brown, RPF or Jeremy Hachey, RPF at Forsite in Salmon Arm by **April 26, 2010**.

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If you have any questions or would like further information, please contact Cam Brown, RPF or Jeremy Hachey, RPF at the Forsite office at (250) 832-3366.

Additional copies of this document are available on the web at http://forsite.ca/RevelstokeTSR4/

Acknowledgements

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All licensees provided local knowledge, data used to develop the Data Package and produce the Revelstoke GIS land base file, as well as extensive input into the assumptions used throughout the analysis.

We thank and acknowledge **Derek De Biasio** of Crane Management Consultants Ltd for the completion of the socio-economic analysis included in this document.

Executive Summary

This document contains a timber supply analysis and socio-economic analysis specific to the Revelstoke Timber Supply Area (TSA). These analyses are an important part of the provincial Timber Supply Review (TSR) process. The purpose of the review is to examine the short- and long-term effects of current forest management practices on the availability of timber for harvesting in the TSA. A review of this type is completed at least once every ten years in order to capture changes in data, practices, policy, or legislation influencing forest management in the TSA.

The previous timber supply review (TSR3) was completed in September 2004 with a final Annual Allowable Cut (AAC) of 230,000 m³/yr determination occurring on September 1, 2005. This AAC volume is currently allocated to Downie Street Sawmills Ltd., BC Timber Sales, Joe Kozek Sawmills Ltd., Stella-Jones Canada Inc., and Selkirk Forest Products Company. This current review (TSR4) is working toward a new AAC determination to be in place as early as August 31, 2010. However, it is recognized that this date could change due to the recent revisions to Section 8 of the Forest Act, which allows the Chief Forester to determine an AAC at least once every 10 years after the date of the last determination.

The current Revelstoke TSA Timber Supply Data Package provides the detailed technical information and assumptions regarding current forest management practices, policy, and legislation which were used in this analysis. Based on the details in the Data Package, the TSA covers approximately 527,000 hectares in the Southeastern portion of British Columbia. The portion of this area considered available for timber production and harvesting under current management practices is called the timber harvesting land base (THLB). The THLB has been estimated through the analysis of spatial map layers and assumptions detailed in the Data Package report. Based on these inputs, the current THLB is estimated to be 57,908 hectares (11% of the TSA).

Since TSR3, several input datasets and assumptions have changed, and result in differences in the size of the timber harvesting land base. A summary of these changes is provided below:

- New legal caribou requirements (GAR Order #U-3-005) provide for spatially explicit reserves that include incremental reserves beyond what was previously required under the Revelstoke Higher Level Plan Order. Excluding these reserves from the THLB causes a very significant reduction in THLB area relative to TSR3 although only the incremental reserves are likely to result in true timber supply impacts. Without the caribou reserves, the THLB in this analysis would have been within ~1000 ha of the TSR3 THLB area.
- Operable area for the TSA was reviewed in 2008 to confirm physical operability. A new operable area was identified after small areas were both removed and added to the old operability line. The net impact on THLB is dependant on how additions and subtractions are dealt with in the netdown process.
- Where terrain stability mapping (Level B or Level D mapping) was complete in the TSA, it was used in place of the older Environmentally Sensitive Area (ESA) soils mapping. ESA soils mapping was used in only 26% of the operable CFLB land base. This approach was less constraining than the approach used in TSR3.
- Wildlife Habitat Areas (WHAs) have been designated.
- Boundaries for the Revelstoke Mountain Resort have been established and excluded.
- Ownership has changed slightly - Woodlots have been expanded.
- Recognition and protection of active Permanent Sample Plots (PSPs).
- Exclusions for drinking water intakes.
- Management of riparian area retention to FPPR defaults resulting in smaller effective riparian buffers.
- Removal of mapped registered archeological sites.
- Timber License areas no longer exist and are part of the TSA from the start of the planning horizon.

The THLB determined in TSR3 was 78,018 ha. As a result of the listed differences from TSR3, the THLB area used here dropped by 20,110 ha (25.8%). Spatial Caribou reserves make up the vast majority of the difference but will not translate proportionately into timber supply impacts because the Revelstoke Higher Level Plan caribou were modeled in TSR3 as constraints.

Other non-THLB related changes since TSR3 include:

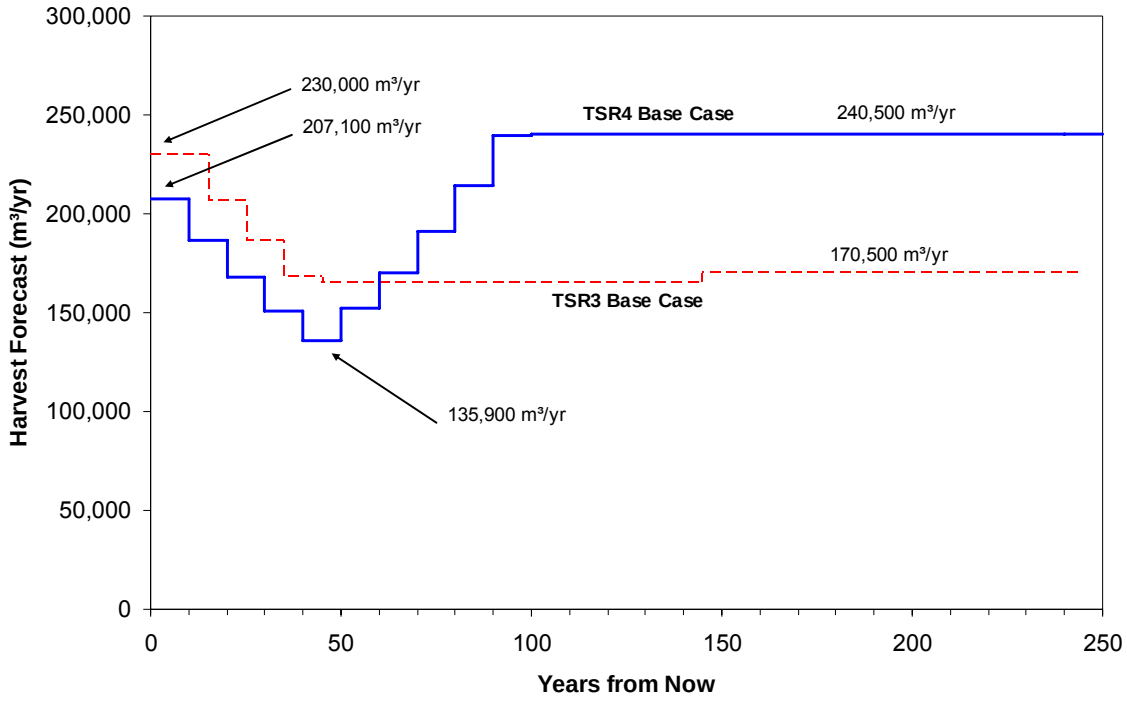
- Forest Cover attributes (ht, volume, age) have all been projected using VDYP7. The Forest Cover for the previous TSR was projected with VDYP v.6.5a. This appears to result in a ~7.4% reduction in total standing volume on the THLB relative to VDYP 6, which was used for TSR3
- Predictive Ecosystem Mapping (PEM) has been completed for the TSA. Managed stand site index values have been adjusted in the Base Case using SIBEC relationships in ICH variants only. ESSF variants did not have sufficient mapping accuracy to support a site index adjustment.
- Biogeoclimatic mapping has been updated (Version 7). Of note is that the ICHmw3 has been re-classified as NDT2. Previously, it was classified as NDT3.
- Revision of regeneration assumptions including:
    - Minor changes in species composition.
    - Inclusion of select seed gains for Spruce, Larch, and Douglas-fir.
- A new UWR GAR order for Mule Deer and Moose (U-4-001) exists and requires from 10-40% of the habitat in each Management Unit (MU) to be >60-100 yrs old and Maximum 40% <21 years old at any time. TSR3 required a minimum of 40% > 120 yrs old and maximum of 25% <2m so the current version appears to be less constraining.
- Use of spatially explicit Old Growth and Mature Management Areas (OGMAs and MOGMAs) to satisfy Old and Mature requirements set out in the Revelstoke Higher Level Plan Order for the first 10 years. TSR3 used percentage targets to meet the same objective for the entire planning horizon.
- Visual Quality Objectives (VQO's) were legally established for the TSA in 2000. Additional updates were made in 2007. Assumptions for managing for visuals have also been revised.
- Revision of assumptions for modeling disturbance in the inoperable.
- Revision of assumptions for future wildlife tree retention – 0.27% reduction applied to all yield curves.
- Revision of assumptions to account for future roads trails and landings (RTLs). The same percentage was used to account for future RTLs however, it was only applied to the areas of the THLB that were at least 300 m away from currently existing roads and only applied to stands >30 years old. This area was then calculated as percentage of the total area of the future managed stand yield curves and implemented as a volume reduction on these curves.
- Use of Forest Planning Studio (FPS-ATLAS) to conduct timber supply modeling.

The release of this Revelstoke TSA TSR4 Analysis Report is the next step in the TSR4 process. Its purpose is to summarize the results of the timber supply analysis and provide a focus for public discussion. The contents of this Analysis Report will provide British Columbia's Chief Forester with a large portion of the information that is needed to make an informed AAC determination.

This report focuses on the Base Case Option, which represents current management practices in the Revelstoke TSA. It presents a Base Case harvest flow starting at 207,100m³/yr (9.9% below the current AAC). This flow is maintained at this level for one decade before decreasing for 40 years at a rate of 10% per decade to a low of 135,900 m³/yr. This minimum harvest level is just over the theoretical Long Run Sustained Yield (LRSY) for natural stands of 134,145 m³/yr. It remains at that level for 1 decade before climbing by 12% increments for 5 decades, followed by slight increase of 0.4% to a long-term harvest level of 240,500 m³/yr.

The primary reasons why the short-term harvest levels projected here are lower than the previous TSR are the imposition of 'incremental' caribou reserves and reduced estimates of mature standing volume in the TSA.

Base Case Harvest Flow:



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

Uncertainties that altered the short-term harvest level were:

- changes to the size of the timber harvesting landbase,
- changes to existing natural stand yields,
- increases in the minimum harvest ages,
- increases in the expected "age to greenup heights",
- removal of high proportion hemlock stands (Hw > 79%) from the THLB,
- removal of Mature seral requirements from Caribou landscape units,
- adopting the Provincial Non-spatial Old Growth Order in place of the Revelstoke Higher Level Plan objectives for Old and Mature+Old seral requirements, and
- turning off the 'incremental' portion of the Caribou GAR spatial reserves.

Uncertainties that altered the long-term harvest level by at least 3% were:

- changes to the size of the timber harvesting landbase,
- changes to existing and future managed stand yields,
- reduction of minimum harvest ages by 10 years,
- inclusion of low severity *Armillaria* root rot for Douglas-fir in the ICH for managed stand yields,
- adoption of the Provincial Non-spatial Old Growth Order in place of the Revelstoke Higher Level Plan objectives for Old and Mature+Old seral requirements,
- relaxation of percent disturbance constraints in visually sensitive areas, and
- turning off the 'incremental' portion of the Caribou GAR spatial reserves.

After implementing the original base case and its sensitivity analyses, a key point surrounding greenup ages was acknowledged. It is likely that the approach taken to derive the greenup ages for the original greenup assumptions produced ages that were not reflective of what is actually occurring in the TSA. These ages led to an unrealistic availability of harvest in the second decade. As a result, the approach used to determine age to green up heights was refined and subsequently incorporated into the base case assumptions and the sensitivities were redone to align with the updated base case (shown above).

A socio-economic assessment of the importance of the forest industry to the Revelstoke TSA and the province was also completed. Based on the facts and data collected, it was concluded that the base case harvest forecast could annually generate key economic impacts:

There are increasingly negative differences in potential economic activity over the short- and medium-terms between the current AAC and the base case forecast because of the decreasing timber supply of the latter. The gap in estimated economic activity between the first decade of the base case and a current AAC scenario is 9.9% on an annual basis. This gap widens in the second and third decades of the base case to 18.9% and 27.0%, respectively.

- 1st decade – reduction of 32 PYs of total employment at the TSA level and 49 PYs at the provincial level and reduction of $1.5 million of total employment income at the TSA level and $2.3 million at the provincial level.
- 2nd decade – reduction of 62 PYs of total employment at the TSA level and 93 PYs at the provincial level and reduction of $2.9 million of total employment income at the TSA level and $4.4 million at the provincial level
- 3rd decade – reduction of 88 PYs of total employment at the TSA level and 132 PYs at the provincial level and reduction of $4.1 million of total employment income at the TSA level and $6.2 million at the provincial level

BC Government stumpage revenues would decline by approximately $300 000 in the first decade of a base case timber supply implementation, $400 000 in the second decade and $600 000 in the third decade.

These estimates of economic activity assume that harvesting and wood processing employment would decrease in concert with the AAC decrease. Harvesting employment, including logging, road building, log transport, and silviculture employment, will decline in the TSA as a smaller amount of timber is available for harvest and may decline within the province if the gap between the current AAC and base case timber supply cannot be closed by harvesting economical timber outside of the TSA.

Employment associated with wood processing at the TSA and provincial levels is much less likely to drop in lockstep with a lower TSA timber supply. There is one large wood processor in the TSA and a few small ones. The largest processor, Downie Street Sawmills Ltd., currently sources a large portion of the cedar logs for its integrated operation from outside the TSA, in part because it trades local Douglas fir, hemlock and spruce logs for needed cedar logs. As the AAC drops in the TSA, Downie and the smaller mills will look to other economic log supply sources to fill the gap. As the US housing industry recovers there will be more demands on non-Revelstoke TSA timber supply and an accompanying upward price pressure on regional log markets. The drop in Revelstoke TSA timber supply from implementing the base case will add to this upwards price pressure. It is likely that local wood processors will pay a higher price for the replacement non-TSA timber than they would have paid for the TSA timber foregone because of a lower AAC.

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1.0 Introduction

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

A timber supply analysis and a socio-economic analysis specific to the Revelstoke Timber Supply Area (TSA) is contained within this document. These analyses are an important part of the provincial Timber Supply Review (TSR) process. The general objective of the TSR process is to examine the short- and long-term effects of current forest management practices on the availability of timber for harvest in the TSA. Prior to November 26,2009, a review of this type was completed typically once every five years in order to capture changes in data, practices, policy, or legislation influencing forest management in the TSA. The previous timber supply review (TSR3) was completed in September 2004 with a final Annual Allowable Cut (AAC) determination on September 1, 2005. This current review (TSR4) is working toward a new AAC determination to be in place by August 31, 2010. However, it is recognized that this date could change due to the recent revisions to Section 8 of the Forest Act, which allows the Chief Forester to determine an AAC at least once every 10 years after the date of the last determination.

The Data Package, a document providing detailed technical information and assumptions regarding current forest management practices, policy and legislation for use in this analysis, was released in March 2009. The release of this Analysis Report is the next step in the TSR process. Its purpose is to summarize the results of the timber supply analysis and provide a focus for public discussion. The contents of this report will provide British Columbia's Chief Forester with only a portion of the information that is needed to make an informed AAC determination. **This report does not define a new AAC – it is intended only to provide insight into the likely future timber supply of the Revelstoke TSA and recommend a future course of action to the Chief Forester.** The final harvest level decision will be made by the Chief Forester and published along with his rationale in an AAC Determination document.

The report focuses on a single forest management scenario that reflects current management practices in the TSA. An assessment of how results might be affected by uncertainties has also been completed using a number of sensitivity analyses and critical issue analyses. Together, these analyses and the base case form a solid foundation for discussions among stakeholders and decision makers about appropriate timber harvesting levels in the Revelstoke TSA.

1.1 Background

Upon invitiation from the Forest Analysis and Inventory Branch, the Revelstoke TSA licencee / BCTS group chose to accept the on the responsibility of leading the Revelstoke TSR4 process commencing in 2008. The group consists of Downie Street Sawmills Ltd. (Downie), Joe Kozek Sawmills Ltd., Stella -Jones Canada Inc., and British Columbia Timber Sales (BCTS, Okanagan Columbia) with Downi administering the project work through funding from the Forest Investment Account (FIA). To deliver on this commitment, the planning and analysis work associated with this TSR was tendered and subsequently awarded to Forsite Consultants Ltd.

Government agencies still play a key role in this TSR process – they set and enforce standards and are responsible for approval of the final Data Package and Analysis Reports. The Ministry of Forests and Range (MFR) provides technical support, facilitates resolution of issues, and validates technical information. Various resource specialists in the Ministries of Agriculture and Lands (MoAL) and Environment (MoE) also contribute their knowledge and experience.

Under contract to the Licencee / BCTS group, Forsite prepared the Data Package that was released for public and First Nations review in March 2009. The Data Package (most of which is provided in Appendix A) reflects the final inputs and assumptions used during modeling. Forsite has now completed the analysis work and compiled this report.

2.0 Description of the Revelstoke TSA

2.1 Location

The Revelstoke Timber Supply Area (TSA) is in southeastern British Columbia and falls within the Southern Interior Forest Region. It is administered from the Columbia Forest District office in Revelstoke. It is bounded by the Monashee Mountains to the west and the Selkirk Mountains to the east, and straddles the Columbia River valley from the Mica Dam in the north to Monashee Provincial Park and Arrowhead in the south. The Trans-Canada Highway passes through the southern part of the area, providing easy access to an area of outstanding mountain scenery. Nearby are Mount Revelstoke National Park, a portion of Glacier National Park, and several smaller provincial parks (Figure 1). There are three Tree Farm Licenses (TFLs) that are technically not part of the TSA.

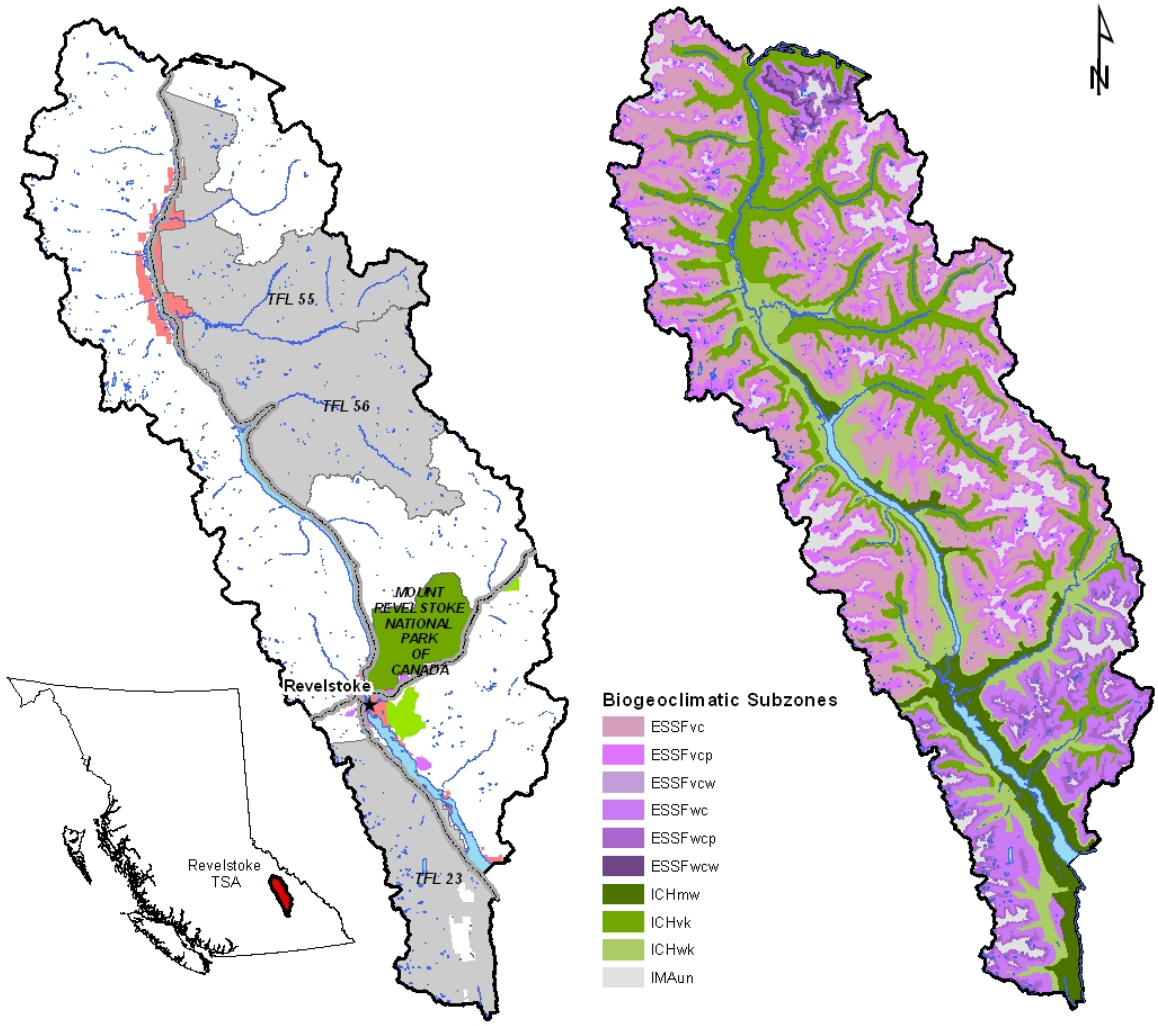


Figure 1. Revelstoke Timber Supply Area and Associated Biogeoclimatic Subzones

The Revelstoke TSA is just over 527,000 hectares in size once the TFL's and other non-TSA ownership classes are removed. Approximately 55% of this area is non-forested land (alpine, lakes, swamp, brush, rock, etc) and only 10% is currently suitable to support timber harvesting activities.

2.2 Wildlife

There are wildlife species in the TSA that are at risk due to their declining populations across the province. There are 12 red-listed (Endangered or Threatened) and 37 blue-listed (Species of Concern) fauna species found in the Revelstoke TSA (Table 1). Additionally, there are 37 red-listed species and 90 blue-listed flora species found in the Revelstoke TSA (for a complete listing of these visit the BC Species and Ecosystems Explorer online at: http://a100.gov.bc.ca/pub/eswp/)

Table 1. Red & Blue listed fauna species that occur or have the potential to occur in the Revelstoke TSA

Red-Listed (Endangered or Threatened)		**Blue-Listed (Species of Concern)**	
Scientific Name	English Name	Scientific Name	English Name
Acipenser transmontanus pop. 2	White Sturgeon (Columbia River population)	*Chrysemys picta pop. 2*	Western Painted Turtle - Intermountain - Rocky Mountain Population
Rangifer tarandus pop. 1	Caribou (southern population)	*Acrocheilus alutaceus*	Chiselmouth
Aechmophorus occidentalis	Western Grebe	*Ammodramus leconteii*	Le Conte's Sparrow
Coturnicops noveboracensis	Yellow Rail	*Asio flammeus*	Short-eared Owl
Rana pipiens	Northern Leopard Frog	*Botaurus lentiginosus*	American Bittern
Recurvirostra americana	American Avocet	*Buteo platypterus*	Broad-winged Hawk
Rhinichthys umatilla	Umatilla Dace	*Catostomus platyrhynchus*	Mountain Sucker
Argia vivida	Vivid Dancer	*Contopus cooperi*	Olive-sided Flycatcher
Physella columbiana	Rotund Physa	*Cottus bairdii*	Mottled Sculpin
Sphaerium occidentale	Herrington Fingernailclam	*Cottus confusus*	Shorthead Sculpin
Vertigo elatior	Tapered Vertigo	*Dolichonyx oryzivorus*	Bobolink
Speyeria mormonia eurynome	Mormon Fritillary, eurynome subspecies	*Euphagus carolinus*	Rusty Blackbird
		Hirundo rustica	Barn Swallow
		Hydroprogne caspia	Caspian Tern
		Martes pennanti	Fisher
		Myotis septentrionalis	Northern Myotis
		Numenius americanus	Long-billed Curlew
		Ovis canadensis	Bighorn Sheep
		Salvelinus confluentus	Bull Trout
		Salvelinus malma	Dolly Varden
		Ursus arctos	Grizzly Bear
		Ardea herodias herodias	Great Blue heron, herodias subspecies
		Gulo gulo luscus	Wolverine, luscus subspecies
		Oncorhynchus clarkii lewisi	Cutthroat Trout, lewisi subspecies
		Boloria alberta	Albert's Fritillary
		Chlosyne whitneyi	Rockslide Checkerspot
		Colias meadii	Mead's Sulphur
		Colias pelidne	Pelidne Sulphur
		Danaus plexippus	Monarch
		Hemphillia camelus	Pale Jumping-slug

Red-Listed (Endangered or Threatened)		Blue-Listed (Species of Concern)	
Scientific Name	English Name	Scientific Name	English Name
		Magnipelta mycophaga	Magnum Mantleslug
		Oreohelix strigosa	Rocky Mountainsnail
		Oreohelix subrudis	Subalpine Mountainsnail
		Somatochlora forcipata	Forcipate Emerald
		Oeneis jutta chermocki	Jutta Arctic, chermocki subspecies
		Polites themistocles themistocles	Tawny-edged Skipper, themistocles subspecies
		Speyeria zerene garretti	Zerene Fritillary, garretti subspecies

Source: Conservation Data Center database query, May 28, 2009.

2.3 First Nations

Currently there are no First Nation communities or Indian Reserves in the TSA but it does fall within the asserted traditional territories of the Ktunaxa Nation, the Shuswap Nation (Secwepemc), and the Okanagan Nation (Sylix). In total there are twelve (12) First Nation groups - 3 tribal councils and 9 bands, who have an interest in the Revelstoke TSA.

The Shuswap Nation is represented by the Shuswap Nation Tribal Council (SNTC) in Kamloops. Affiliated bands with interests in the Revelstoke TSA include the Shuswap Indian Band in Invermere, the Simpcw First Nation (formerly North Thompson Indian Band) in Barriere, the Little Shuswap Indian Band, Adams Lake Indian Band, and the Neskonlith Indian Band in Chase, as well as Splatsin (formally Spallumcheen) in Enderby. Note, the Shuswap Indian Band was previously affiliated as a member band of the Ktunaxa Nation, but realigned with the SNTC in 2006.

The Okanagan Nation is represented by the Okanagan Nation Alliance (ONA) in Westbank. Affiliated bands are the Okanagan Indian Band (OKIB) in Vernon and the Lower Similkameen in Keremeos.

The Ktunaxa Nation is represented by the Ktunaxa Nation Council (KNC) in Cranbrook. The KNC were formerly known as the Ktunaxa/Kinbasket Tribal Council (KKTC). The Akisq'nuk First Nation (formerly the Columbia Lake Band) in Windermere is an affiliated member of the KNC.

The Ministry of Forest and Range (MoFR) Traditional Use Study (TUS) data website identifies three TUS inventories in the Revelstoke TSA, having been prepared by the “Ktunaxa/Kinbasket Trial Council (KKTC, 1998), the “Adams Lake and Neskonlith Secwepemc” (March 1999). And the “Little Shuswap Indian Band” (March 2000). Use or disclosure of information in these studies is subject to a confidentiality agreement between government and each respective First Nation. In addition, other FN groups with an interest in Revelstoke TSA may also have their own separate cultural heritage resource inventories but are not prepared to share with government at this time.

The Ktunaxa Nation is a participant in the BC Treaty process. The Revelstoke TSA is within the Ktunaxa Nation area of interest. It is not known whether a treaty settlement will be made prior to the CF's determination on this TSR. Forest and Range Opportunity Agreements (FROs) have been signed with all First Nations groups except for the SNTC and ONA. Development of consultation protocols under the FRO agreements were initiated with most of these First Nations however there are no approved protocols in place at this time.

2.4 Environment

The Revelstoke TSA lies in the interior-wet belt of the province and includes three biogeoclimatic zones: interior-cedar-hemlock (ICH), Engelmann spruce-subalpine fir (ESSF) and the alpine tundra-interior mountain-heather alpine zone (AT-IMA). Figure 1 on page 2 shows the spatial distribution of these biogeoclimatic zones while Figure 2 shows an area breakdown by biogeoclimatic zone and land base classification.

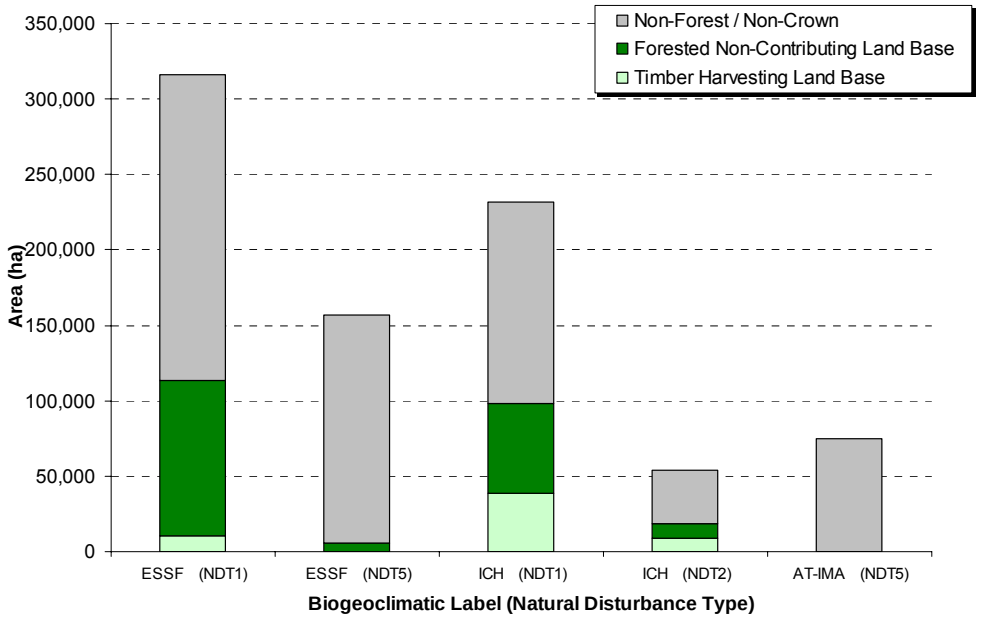


Figure 2. Biogeoclimatic Ecosystem Classification within the Revelstoke TSA.

The **Interior Cedar - Hemlock zone (ICH)** occurs at lower to middle elevations. The ICH occupies the lower slopes of the Columbia Mountains (where it is commonly called the Interior Wet Belt). The ICH has cool wet winters and warm dry summers. This zone is one of the wettest in the interior of the province, and has the highest diversity of tree species of any zone in the province. The climax forests are dominated by western redcedar and western hemlock. White spruce, Engelmann spruce, and subalpine fir are common and can form a part of climax stands with either western hemlock or redcedar, especially in areas of cold air drainage or at higher elevations[1]. The majority of the timber harvesting land base in the Revelstoke TSA occurs in this zone.

The **Engelmann Spruce-Subalpine Fir (ESSF)** zone is the uppermost forested zone, usually in steep and rugged terrain. It lies below the Alpine Tundra zone and above the Interior-Cedar-Hemlock zone. Growing seasons are cool and short while winters are long and cold. Forests are continuous at the lower elevations of this zone, but at higher elevations clumps of trees occur within areas of heath, meadow and grassland. Engelmann spruce and subalpine fir are the dominant climax tree species, while lodgepole pine is common after fires. At lower elevations of this zone, western white pine, Douglas-fir, western hemlock and western red cedar can also be found.

The **Alpine Tundra Zone** lies above the Engelmann Spruce-Subalpine Fir Zone, and is by definition treeless although stunted (or krummholz) trees are common at the lower elevations of this zone. Overall, this zone is dominated by rock, ice and grassy meadows.

2.5 Integrated Resource Management Considerations

Integrated resource management is the basic premise for the practice of forestry in the Revelstoke TSA. Timber harvesting is planned and managed in such a way that allows a wide range of other values to co-exist on the land base. The manner in which each value is considered is dictated by federal legislation, provincial legislation, and policy. Examples of these are the federal Fisheries Act, the Forest and Range Practices Act, and several Columbia Forest District Policies. These documents address requirements for a wide range of non-timber issues.

The most significant issues influencing forest management in the Revelstoke TSA are:

- Biodiversity

[1] Meidinger, Del and Jim Pojar, eds. 1991. Ecosystems of British Columbia. BC Ministry of Forests, Special Report Series 6, February 1991.

- Caribou
- Riparian habitat
- Ungulate winter range (mule deer, moose, caribou)
- Identified wildlife
- Domestic watersheds
- Viewscapes in scenic corridors
- Recreation (RMR)

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

2.6 Current Attributes of the TSA

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

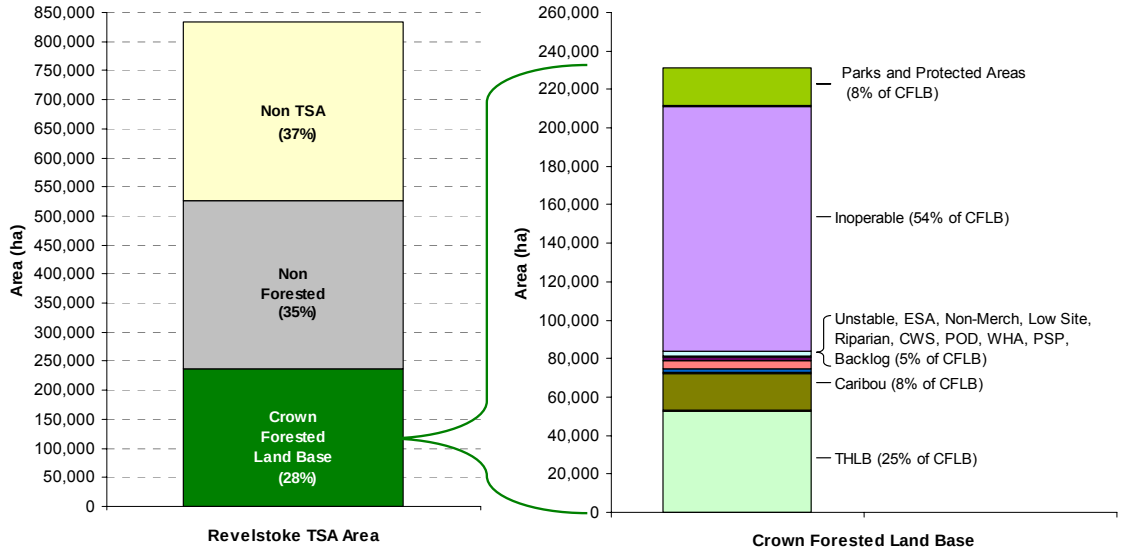


Figure 3. Revelstoke TSA: Land Base Summary

Approximately 45% of the total area of the Revelstoke TSA is considered Crown Forested Land Base (CFLB). The remaining 55% is considered non productive (i.e. rock, ice, alpine, etc), or is not managed by the B.C. Forest Service (i.e. private, First Nations, woodlots, etc). Within the CFLB, only about 25% is considered available for timber harvesting (11% of the total TSA).

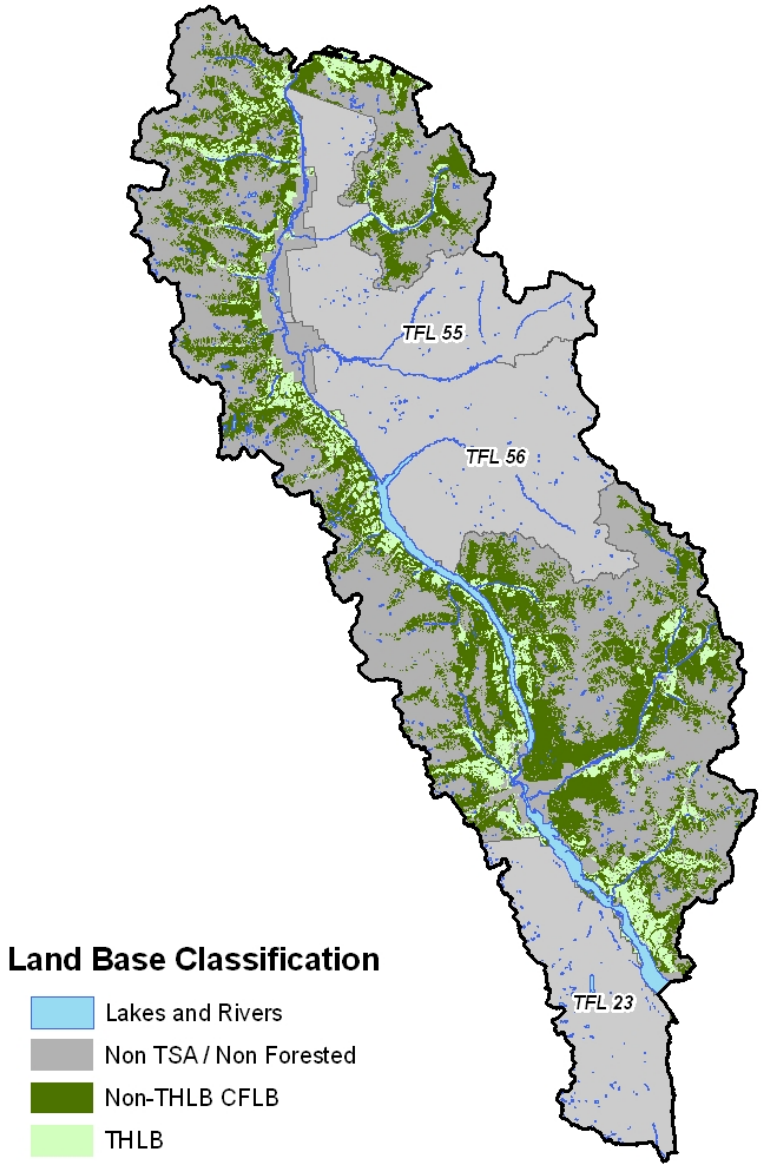


Figure 4. Revelstoke TSA Land Base Definition Map

The forests of the Revelstoke TSA are dominated by Engelmann spruce (31%), Hemlock (23%), Cedar (22%), and Douglas-fir (18%). Other species that occur less commonly are logdepole pine, larch, and several deciduous species (i.e. cottonwood, birch and aspen). Figure 5 indicates that approximately 38% of the THLB is currently older than the minimum harvest ages defined in this document.

Figure 6 indicates that a large portion of the THLB exists in younger age classes (0-40 years), and older age classes (141+), while relatively little area exists in stands between the ages of 41 and 140 years. Stands dominated by cedar, hemlock, Engelmann spruce, and balsam fir tend to make up a large component of the older age classes.

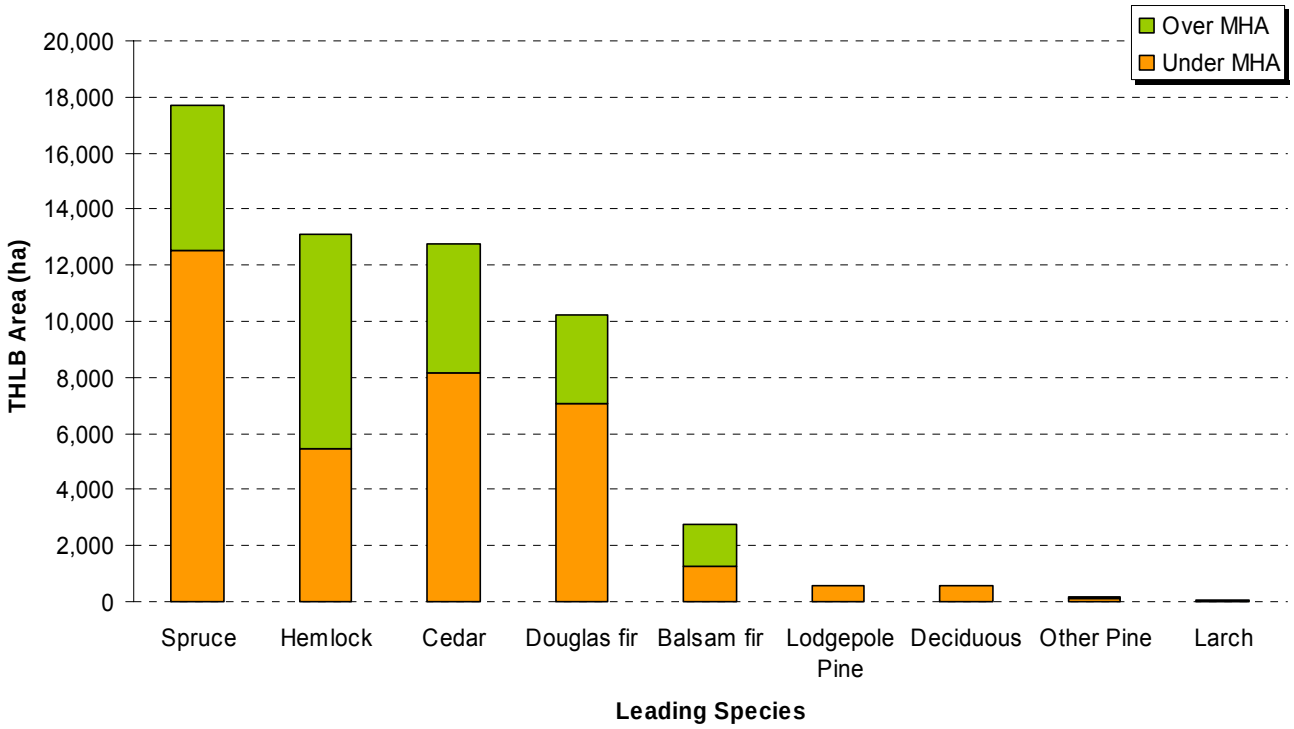


Figure 5. THLB by dominant tree species relative to minimum harvest age

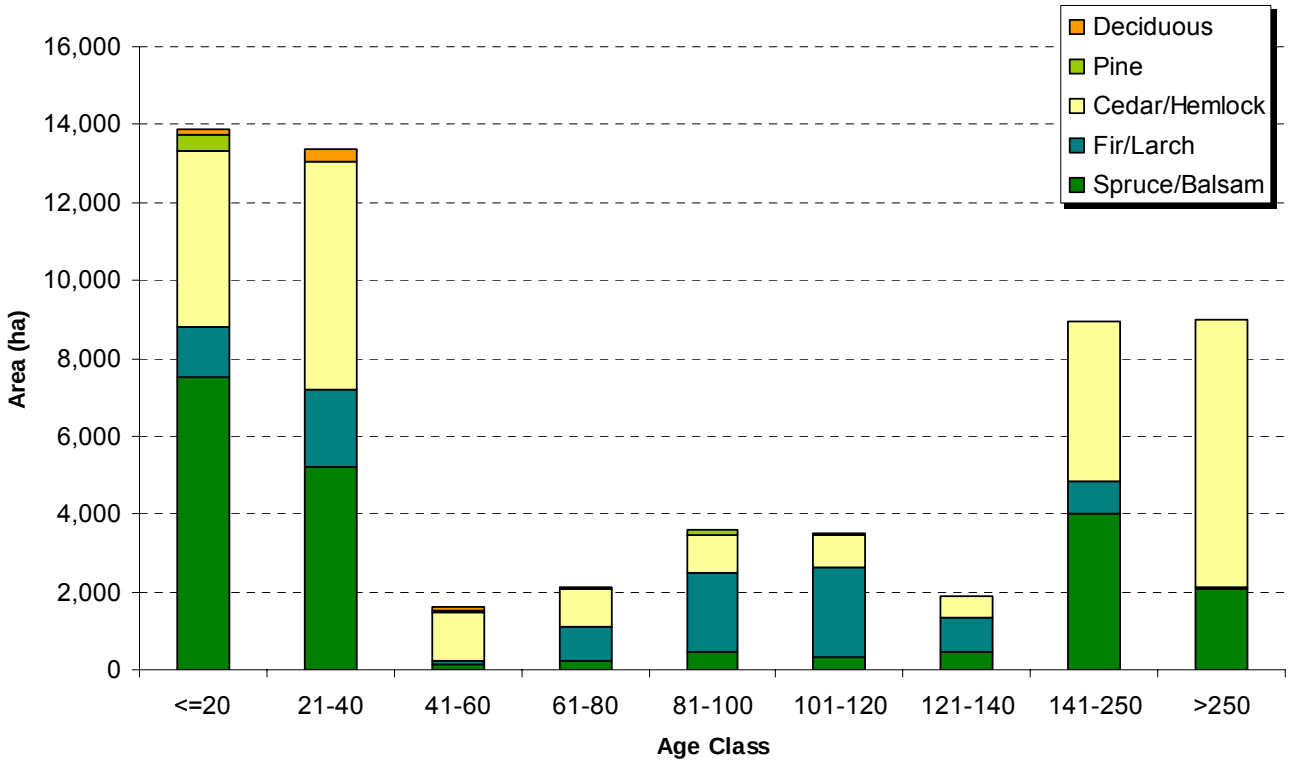


Figure 6. THLB area by age class and leading species

The age class structure over the entire CFLB is shown in Figure 7. The majority of the THLB area exists in stands younger than 40 years (almost 52%), while approximately 26% exists in stands older than 140 years. The remaining THLB area (~22%) exists in ages between 40 and 140 years.

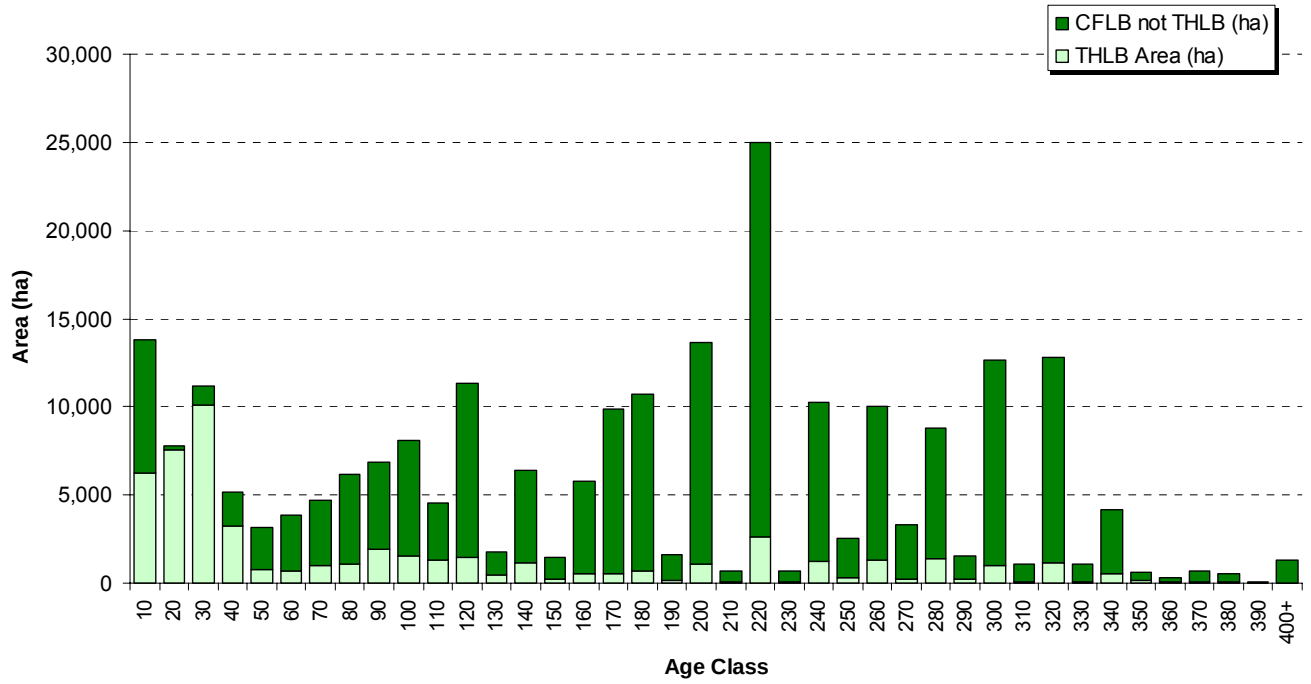


Figure 7. CFLB area by Age Class

The distribution of site productivity (inventory site index) is shown in Figure 8 while the adjusted site index distribution is shown in Figure 9. In both cases, the THLB portion is skewed toward the higher site indexes. Little of the THLB area has a site index less than 9. This is consistent with the low site index net down criteria described in the Data Package (Appendix A). The average site index of the THLB, based on the forest inventory, is 16.0 m. This increases by 2.5 m to 18.5 when SIBEC adjusted SI's are used for ICH stands. This later average is only relevant when all the THLB stands have transitioned to managed stand yield curves (i.e. they have been harvested and subsequently planted).

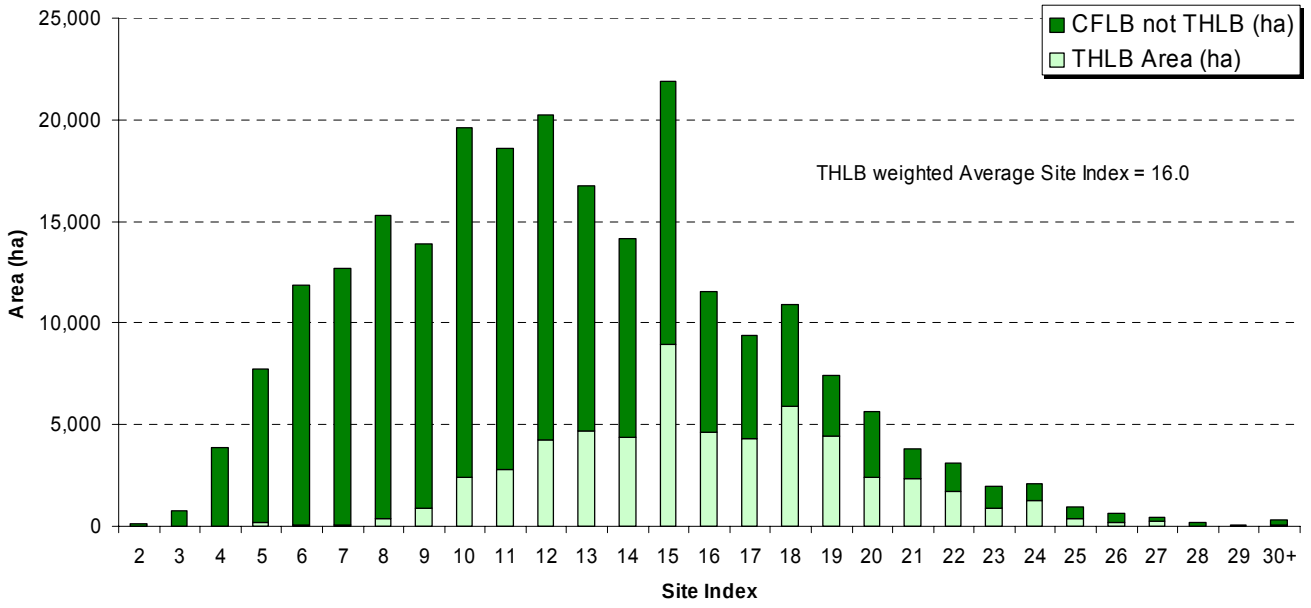


Figure 8. Site Productivity by Land base Type (SI Source = Forest Inventory)

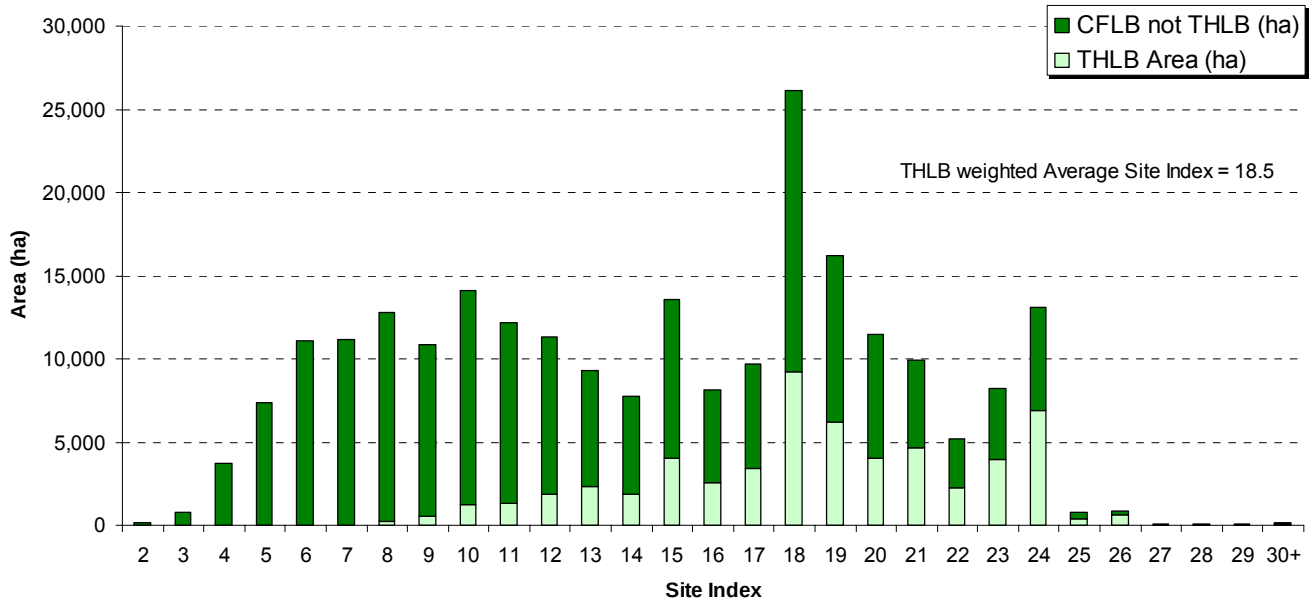


Figure 9. Site Productivity by Land base Type (SI Source = combination of Forest cover, SIBEC, and growth intercept)

3.0 Timber Supply Analysis Methods

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

3.1 Land Base Definitions

The Crown Forested Land Base (CFLB) is the area of productive forest under crown ownership. This is the land base that contributes to landscape level objectives for biodiversity and resource management. The crown forested land base excludes non-crown land, woodlots, non-forest and non-productive areas.

The Timber Harvesting Land Base (THLB) is the portion of the TSA where forest licensees under license to the province of BC are expected to harvest timber. The THLB excludes areas that are inoperable, uneconomic, or are otherwise off-limits to timber harvesting. The THLB is a subset of the CFLB. Table 2 summarizes the land base for the Revelstoke TSA.

Table 2. Timber harvesting land base area netdown summary

Land Base Element	Total area (ha)	Effective Netdown* Area (ha)	% of TSA	% of Crown forest
Total area	**833,444**			
Less:				
Tree Farm Licenses		283,006		
Private Land, Woodlots, etc		23,433		
Total TSA Area		**527,005**	**100.0%**	
Less:				
Non-forest / Non-productive forest	286,995	286,995	54.5%	
Non-Commercial Brush	108	108	0.0%	
Unclassified existing roads, trails and landings	9,806	3,777	0.7%	
Total Crown Forested Land Base (CFLB)		**236,126**	**44.8%**	**100.0%**
Less:	In CFLB:			
Parks and Reserves	31,094	19,310	3.7%	8.2%
Specific Geographically Defined Areas	635	635	0.1%	0.3%
Inoperable/Inaccessible	144,715	127,252	24.1%	53.9%
Unstable Terrain	57,892	2,265	0.4%	1.0%
Environmentally Sensitive Areas	23,772	944	0.2%	0.4%
Non-Merchantable	2,764	1,923	0.4%	0.8%
Low Sites	46,539	4,197	0.8%	1.8%
Riparian Management Areas	3,129	1,616	0.3%	0.7%
Community Watersheds	4,449	255	0.0%	0.1%
Drinking Water Intakes	59	25	0.0%	0.0%
Wildlife Habitat Areas	6	4	0.0%	0.0%
Permanent Sample Plots	264	179	0.0%	0.1%
Backlog NSR	412	300	0.1%	0.1%
Cultural Heritage	0	0	0.0%	0.0%
Mountain Caribou Reserves	66,098	18,909	3.6%	8.0%
Existing Wildlife Tree Patches	690	404	0.1%	0.2%
Timber Harvesting Land Base –THLB (ha)		**57,908**	**11.0%**	**24.5%**
Less Temporary Reserves:				
Spatial Old Growth Management Areas (OGMAs) and Mature+Old Growth Management Areas (MOGMAs)	84,405	5,549	1.1%	2.4%
Effective Timber Harvesting Land Base –THLB (ha)		**52,358**	**9.9%**	**22.2%**
Volume Reductions:				
Future Wildlife Tree Patches (%)		215	0.0%	0.1%
Future roads, trails and landings		1,100	0.2%	0.5%
Long-term Timber Harvesting Land Base (ha)		**51,044**	**9.7%**	**21.6%**

* Effective netdown area represents the area that was actually removed as a result of a given factor. Removals are applied in the order shown above, thus areas removed lower on the list do not contain areas that overlap with factors that occur higher on the list. For example, the parks netdown does not include any non forested area.

3.2 Forest Inventory Data

The forest inventory is a key component to the timber supply review of the TSA. Several updates have been performed on the forest inventory in the Revelstoke TSA can be summarized as follows:

- The inventory data is based on 1991-1992 photography and is currently in a FIP Rollover format.
- A single flat file was obtained from the LRDW in Feb 2009 that includes only Rank 1 stand information. Attributes were projected to January 1, 2008 using VDYP7. This file also had RESULTS information (depletions and stand attributes) incorporated through the VRIMS process.
- Disturbances from harvesting and fire were further updated in the GIS resultant to March 2008 using additional datasets supplied by licensees and the MFR.
- Ground sampling (Phase 2 work) is currently underway to assess the accuracy of the inventory attributes but was not completed in time to be incorporated in this analysis.
- Using the Revelstoke Predictive Ecosystem Mapping (PEM) [2], site index adjustments were applied to generate managed stand site index values in the ICH only - based on advice from MFR Regional Ecologists[3]. Existing inventory site indices have been used for natural stands yield projections.

The Revelstoke TSA TSR4 is one of the first TSRs to use attributes projected with VDYP7. Adopting VDYP 7 as the growth and yield model for natural stands for TSR4 resulted in a ~7.4% reduction in total standing volume relative to VDYP 6 (see Section 4.7.3 on page 36 for how this was determined).

3.3 Management Practices

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

3.3.1 Integrated Resource Management

Forest cover requirements are applied within the timber supply model to accommodate the timber and non-timber resource objectives. These requirements maintain appropriate levels of specific forest types needed to satisfy the objectives for wildlife habitat, visual quality, biological diversity, etc. Forest cover requirements are used by the model to limit harvesting within the THLB. A summary of the areas over which various non-timber resource values occur is provided in Table 3 and Figure 10.

Table 3. Summary of Management Issues and Modelling Assumptions

Resource Issue	CFLB Area (ha)	THLB Area (ha)	Forest Resource Requirements
Green-up / Adjacency	N/A	57,908	Maximum of 25% < 2m tall. Applied to the THLB within each LU.
Visuals	40,257	16,222	Maximum disturbance limit defined by VQO and VAC. VEG height defined by avg slope of VQO polygon. Modeled as a disturbance limit (i.e. max 15% < 6m tall) on the CFLB portion of each VQO polygon.
Community Watersheds	4,449	N/A	Applied as a spatial reserve (i.e. Netdown)
Mountain Caribou Habitat	66,098	N/A	Caribou GAR (UWR U-3-005) reserves applied as spatial reserves (HLP + Incremental).
Mule Deer	4,755	2,343	Minimum of 40% ≥101 yrs old and maximum of 40% <21 years old at any time. To be met within the CFLB of the mapped habitat areas in each MU as per GAR U-4-001
Moose	999	752	Minimum of 20% ≥61 years and maximum of 40% <21 years old at any time as per GAR U-4-001.

[2] Jones. C., Stehle, K., and E.Valdal. Silvatech. 2006. Revelstoke Predictive Ecosystem Mapping Final Report (BAPID #4316). Prepared for Mount Revelstoke National Park, Revelstoke Community Forest Corporation and BC Ministry of Forests and Range – Small Business Program

[3] Deb MacKillop / Del Meidenger's email approving the use of the Revelstoke PEM to adjust ICH stands. (Title: Accuracy Assessment of the Revelstoke PEM for use in TSR. Sent: November 18, 2008 by Deb Mackillop)

Resource Issue	CFLB Area (ha)	THLB Area (ha)	Forest Resource Requirements
Ungulate Forage Area	243	123	Minimum of 10% ≥81 years old at any time as per GAR U-4-001. To be met on the CFLB portion of the identified area.
Identified Wildlife	6	N/A	Applied as a spatial netdown.
Landscape Level Biodiversity	48,272	5,549	Spatial Old Growth Management Areas (OGMA's) and Mature + Old Management Area (MOGMA's) locked up for the first 10 years and then applied as forest cover constraints based on requirements set out in Revelstoke HLPO.
Stand Level Biodiversity – Wildlife trees and wildlife tree patches	690	215	Current and planned Wildlife tree patches applied as a spatial Netdown. Future WTP's applied as a yield curve reduction.

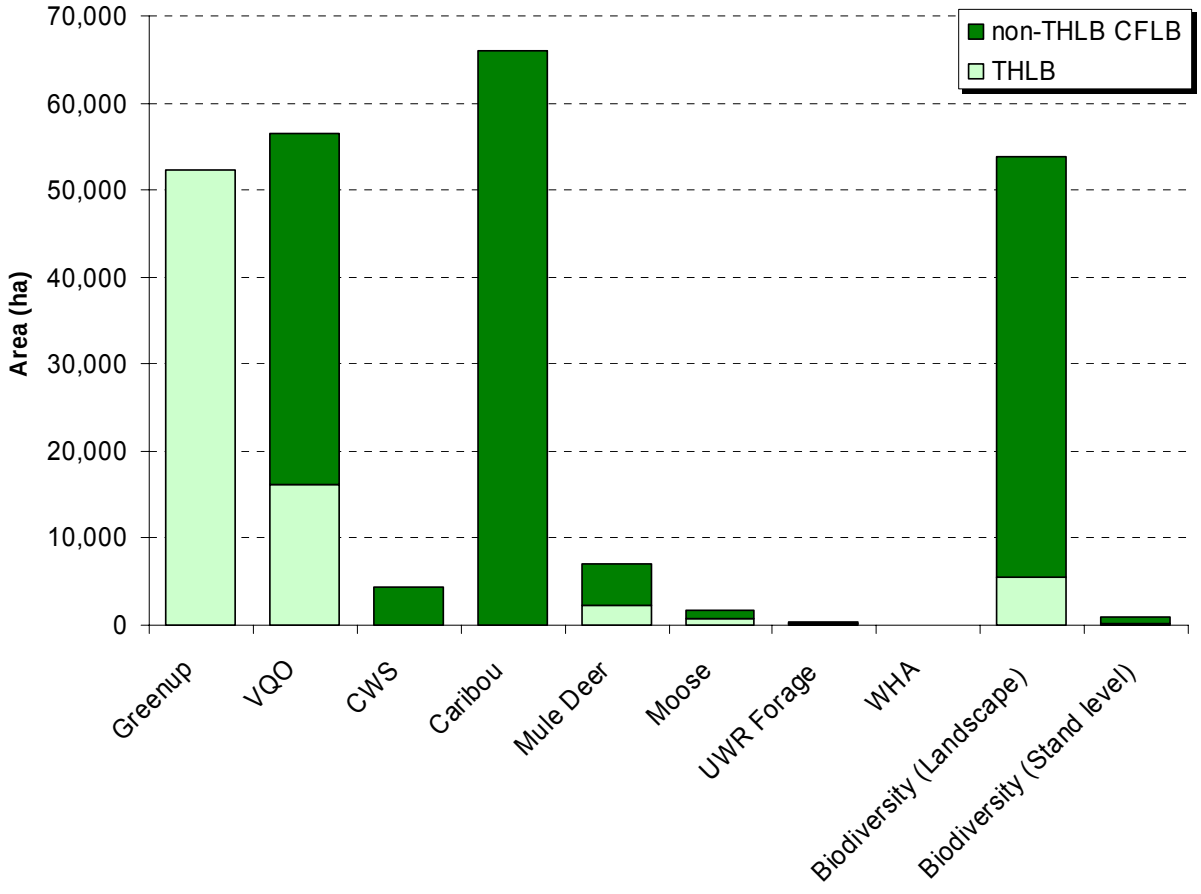


Figure 10. Summary of Management Issues by Land Base Classification

3.3.2 Silviculture

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

- Silvicultural systems,
- Regeneration assumptions (establishment method, species distribution, and establishment density),
- Regeneration delay (time between harvesting and when the site is stocked with crop trees), and
- Use of select seed.

All harvesting was modeled as clear-cut with reserves. For additional details, refer to Appendix A.

3.3.3 Timber Harvesting

Assumptions around timber harvesting practices have also been included in the model. These include the following (see Appendix A for details):

- A minimum harvest age to ensure a viable log is produced and long term volume production is maximized.
- Several minimum economic criteria for log size and stand volumes.
- Land base definition criteria (unstable slopes, inoperable areas, low sites, etc.).
- Harvest priorities across the land base.

3.4 Forest Dynamics

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

3.4.1 Growth and Yield Projections

Timber growth and yield refers to the prediction of the growth and development of forest stands over time, and of particular interest, the volume and size of trees that would occur at the time of harvest. For modeling purposes, stands of similar characteristics, growth rates, and management are grouped together into Analysis Units (AUs). Analysis Units are described in Appendix A. The attributes of each analysis unit are input into growth and yield models to predict gross and net volume per hectare at various stand ages. The estimate of net timber volume in a stand assumes a specific utilization level, or set of dimensions, that establishes the minimum tree and log sizes that are removed from a site. Utilization levels used in estimating timber volumes specify minimum diameters near the base and the top of a tree.

Two growth and yield models were used to estimate the yield curves used in the Revelstoke TSA timber supply analysis. The Variable Density Yield Prediction model (VDYP7 v 7.17d), supported by the Forest Analysis and Inventory Branch, was used for estimating timber volumes for all existing natural stands. The Table Interpolation Program for Stand Yields model (BatchTIPSY 4.1d), developed by the MFR Research Branch, was used to estimate timber volumes for both existing and future managed stands. Existing managed stands are those that are currently under 30 years of age with a history of logging. Future managed stands are stands that will regenerate after they are harvested by the model during the planning horizon.

Based on forest inventory estimates, the current timber inventory or growing stock on the timber harvesting land base is approximately 10 million cubic meters. Approximately 90% of this growing stock (9.0 million m^3) is currently merchantable, i.e. in stands older than their minimum harvest age.

3.4.2 Disturbances

The timber supply model relies upon three mechanisms to disturb stands. Harvesting is the most common method of disturbance in the model (either clear-cut or partial cut) and occurs only within the timber harvesting land base. In order to recognize that natural disturbances also occur on the land base, the following are also modeled.

Natural disturbances in the timber harvesting land base:
Each year timber volume is damaged or killed on the THLB and not salvaged or accounted for by other factors. These losses are due to a number of factors that cause tree mortality, including insects, disease, blowdown, snowpress, wildfires, etc. In order to address losses from catastrophic natural events in the THLB, the model 'harvests' an extra volume of timber in each time period that is not counted toward harvest levels. Endemic pest losses are dealt with through factors applied in the growth and yield models. The annual unsalvaged loss applied in this analysis was 6,550 m^3/yr. Unsalvaged loss estimates address only the loss of merchantable volume from mature stands. The losses associated with immature stands also impact the rate at which timber becomes available in the TSA but little data is available to estimate the extent or impact of these losses. These disturbances are not modeled, but are captured during periodic inventory updates and are therefore reflected in subsequent timber supply analyses.

Natural disturbances outside the timber harvesting land base:
Because stands outside of the THLB contribute toward several forest cover objectives (i.e. landscape level biodiversity), it is important that the age class distributions in these stands are also modeled in a manner that is consistent with natural processes. By simulating natural disturbance in these stands, a more natural age class distribution can be maintained in the model and a realistic contribution toward seral goals ensured. An area of approximately 405 ha is disturbed each year in the analysis to prevent age classes in the non-THLB from becoming unrealistically old during modeling (forest cycles every 440 yrs).

3.5 Timber Supply Model

Forest Planning Studio (FPS) version 6.0.2.0 was used to complete the timber supply analysis. This model has been used previously in the timber supply analysis of other units, for example: TFL 14 (MP#9, 2008), TFL 56 (MP#3, 2001), the Lillooet TSA (TSR 3, 2005), and the Golden TSA (TSR4, 2009).

FPS was developed by Dr. John Nelson at the University of British Columbia (UBC) and is a spatially explicit forest estate simulation model. All events in the model are directly linked to stand level polygons or harvest units and thus allow tracking of individual stand attributes and spatial relationships through time. Each polygon belongs to a specific stand type (Analysis Unit) and has attributes such as age, harvest system, and land base status (THLB or Non THLB). Results are typically aggregated for reporting at higher levels (i.e harvest flow for entire unit).

A wide range of constraints can be modeled on the land base: harvest exclusion, spatial adjacency/maximum cutblock size, maximum disturbance/young seral, minimum mature/old seral, and equivalent clearcut area (ECA) limits. Constraints are applied to groups of polygons (cliques) and harvest is restricted if a constraint is not satisfied. A single polygon can belong to many overlapping cliques and each of them must be satisfied in order to allow harvest of the polygon. Where a mature or old cover constraint is not met, harvesting may still occur if there are any eligible stands remaining after the oldest stands are reserved to meet the constraint.

Harvest is implemented using a set of priorities to queue stands for harvest. In each period, the model harvests the highest priority eligible stands until it reaches the harvest target or exhausts the list of opportunities. Harvest can be implemented in single years, multiple year periods or a combination of these. Where periods are used, the midpoint of the period is typically used as the point where harvest opportunity is evaluated because it is a good balance between the start of the period (pessimistic) and the end of the period (optimistic).

The purpose of this analysis is to examine both the short- and long-term timber harvesting opportunities in the Revelstoke TSA. The dominant scenario presented in this report is the base case or current management scenario. Modeling was completed for 500 years for each scenario but only the first 250 years are presented in the report because the harvest level remains constant after that time.

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

3.6 Major Changes from the Previous Timber Supply Analysis

Since TSR3, several input datasets and assumptions have changed, and result in differences in the size of the timber harvesting land base. A summary of these changes is provided below:

- New caribou management guidelines (GAR Order #U-3-005) provide for spatially explicit reserves that include incremental reserves beyond what was previously required under the Revelstoke Higher Level Plan Order. **Excluding these reserves from the THLB causes a very significant reduction in THLB area relative to TSR3 although only the incremental reserves are likely to result in true timber supply impacts.** Without the caribou reserves, the THLB in this analysis would have been within ~1000 ha of the TSR3 THLB area.
- Operable area for the TSA was reviewed in 2008 to confirm physical operability. A new operable area was identified after small areas were both removed and added to the old operability line. The net impact on THLB is dependant on how additions and subtractions are dealt with in the netdown process.
- Where terrain stability mapping (Level B or Level D mapping) was complete in the TSA, it was used in place of the older Environmentally Sensitive Area (ESA) soils mapping. ESA soils mapping was used in only 26% of the operable CFLB land base. This approach was less constraining than the approach used in TSR3.
- Wildlife Habitat Areas (WHAs) have been designated.
- Boundaries for the Revelstoke Mountain Resort have been established and the area excluded.
- Ownership has changed slightly - Woodlots have been expanded.
- Recognition and protection of active Permanent Sample Plots (PSPs).
- Exclusions for drinking water intakes.
- Management of riparian area retention to FPPR defaults resulting in smaller effective riparian buffers.
- Removal of mapped registered archeological sites.
- Timber License areas no longer exist and are part of the TSA from the start of the planning horizon.

The THLB determined in TSR3 was 78,018 ha. As a result of the listed differences from TSR3, the THLB area used here dropped by 20,110 ha (25.8%). Spatial Caribou reserves make up the vast majority of the difference but will not translate proportionately into timber supply impacts because the HLP caribou were modeled in TSR3 as constraints.

Other non-THLB related changes since TSR3 include:

- Forest Cover attributes (ht, volume, age) have all been projected using VDYP7. The Forest Cover for the previous TSR was projected with VDYP v.6.5a. This appears to result in a ~7.4% reduction in total standing volume on the THLB relative to VDYP 6, which was used for TSR3
- Predictive Ecosystem Mapping (PEM) has been completed for the TSA. Managed stand site index values have been adjusted in the Base Case using SIBEC relationships in ICH variants only. ESSF variants did not have sufficient mapping accuracy to support a site index adjustment.
- Biogeoclimatic mapping has been updated (Version 7). Of note is that the ICHmw3 has been re-classified as NDT2. Previously, it was classified as NDT3.
- Revision of regeneration assumptions including:
    - Minor changes in species composition.
    - Inclusion of select seed gains for Spruce, Larch, and Douglas-fir.
- A new UWR GAR order for Mule Deer and Moose (U-4-001) exists and requires from 10-40% of the habitat in each Management Unit (MU) to be >60-100 yrs old and Maximum 40% <21 years old at any time. TSR3 required a minimum of 40% > 120 yrs old and maximum of 25% <2m so the current version appears to be less constraining.
- Use of spatially explicit Old Growth and Mature Management Areas (OGMAs and MOGMAs) to satisfy Old and Mature requirements set out in the Revelstoke Higher Level Plan Order for the first 10 years. TSR3 used percentage targets to meet the same objective for the entire planning horizon.

- Visual Quality Objectives (VQO's) were legally established for the TSA in 2000. Additional updates were made in 2007. Assumptions for managing for visuals have also been revised.
- Revision of assumptions for modeling disturbance in the inoperable.
- Revision of assumptions for future wildlife tree retention – 0.27% reduction applied to all yield curves.
- Revision of assumptions to account for future roads trails and landings (RTLs). The same percentage was used to account for future RTLs however, it was only applied to the areas of the THLB that were at least 300 m away from currently existing roads and only applied to stands >30 years old. This area was then calculated as percentage of the total area of the future managed stand yield curves and implemented as a volume reduction on these curves.
- Use of Forest Planning Studio (FPS-ATLAS) to conduct timber supply modeling.

4.0 Base Case Analysis (Current Practice)

The current practice base case scenario is largely consistent with the definition in the March 2009 Data Package and reflects current management practices in the TSA. The two main departures are that:

- OGMA and MOGMA requirements are now satisfied using the spatial reserves for 10 years (instead of 80 years) before converting to percentage constraints in the model.
- A SIBEC application error has been corrected and the result is that the area weighted average site index for managed stands on the THLB has risen to 18.5m (previously 17.2m). This affected yield curves and minimum harvest ages.
- The age to green-up height for IRM greenup has been changed from 17 years to 13 years based on what is considered to be better information. It is now more reflective of what has been occurring in the TSA. Ages used to define Visually Effective Greenup (VEG) were also reduced by 4 years. For more information of this see Section 4.6 on page 30.

The current allowable annual cut (AAC) for the Revelstoke TSA is 230,000 m³ (set September 1, 2005). Non-recoverable losses of timber on the THLB are estimated to be 6,550 m³/yr. This volume has been subtracted from the graphs, tables, and harvest forecasts in this report.

4.1 Alternative Harvest Flow Scenarios

Numerous alternative harvest forecasts are possible for a given set of modelling assumptions. These alternative flows represent tradeoffs between short-, mid-, and long-term harvest level objectives. Figure 11 shows three potential harvest flows for the Revelstoke TSA base case assumptions.

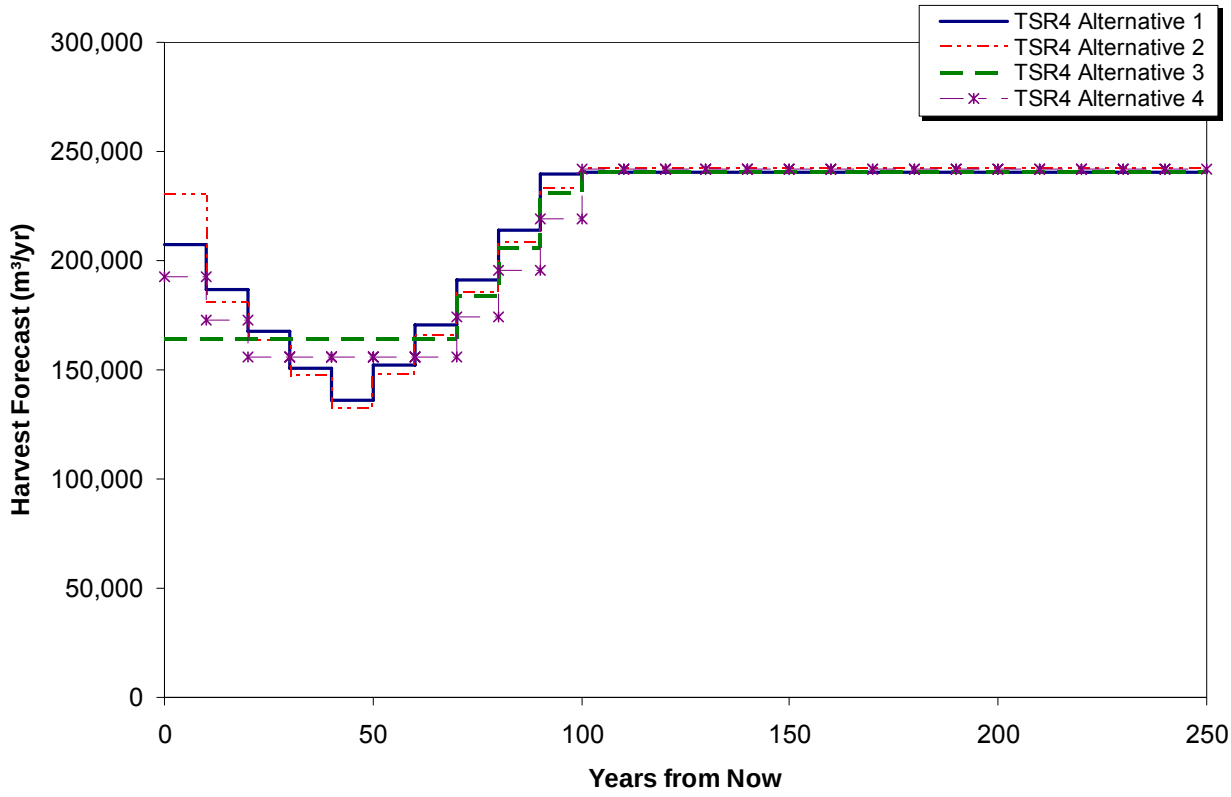


Figure 11. Alternative harvest forecasts for the Revelstoke TSA (Current Practice).

Alternative 1 illustrates the highest initial harvest rate possible (207,100 m³/yr) while limiting decadal drops to 10%. The harvest flow begins 9.9% below the current AAC, and then decreases for the next 40 years at a rate

of 10% per decade to a low of 135,900 m³/yr. This minimum harvest level is just over the theoretical Long Run Sustained (LRSY) for natural stands of 134,145 m³/yr. It then climbs for 50 years at a rate of 12% per decade, followed by a slight 0.4% increase before reaching a long-term harvest level of 240,500 m³/yr.

Alternative 2 illustrates the resulting harvest flow if the current AAC level of 230,000m³ is maintained for the first decade of the planning horizon. Limited harvest availability in future means that the harvest level must drop by 21.3% in the second period. The harvest level continues to drop for the following 30 years at a rate of 10% per decade to a mid-term low of 132,180 m³/yr. It then begins climbing by 12% increments for 5 decades followed by a 3.9% increase to a long-term harvest level of 242,000 m³/yr.

Alternative 3 illustrates a non-declining harvest flow where the initial harvest level of 164,300 m³/yr is maintained for 70 years before stepping up in 12% increments for 3 decades, followed by a 4.2% increase to a long-term harvest level of 240,500 m³/yr.

Alternative 3 presents a trade off of short-term volume for midterm volume. Reducing the initial harvest to 192,300 m³/yr (16.4% below current AAC) results in a higher mid-term flow (155,700 m³/yr) achieved after 2 10% reductions. This level is maintained for 50 years before increasing in 12% increments for 4 decades to a long-term harvest level of 242,000 m³/yr.

4.2 Base Case Harvest Flow

Alternative 1 from Figure 11 above was selected as the recommended base case flow and is shown in detail in Figure 12. This flow most equitably spreads the current and subsequent step downs in harvest between the early decades in the planning horizon. It also ensures a managed and gradual transition from short- to mid- to long-term, by avoiding large and abrupt disruptions in timber supply, which was considered very important to the Revelstoke licensee/BCTS group considering that the Revelstoke economy relies heavily on forestry. All of the harvest and forest level attributes presented in this section correspond with the base case harvest forecast.

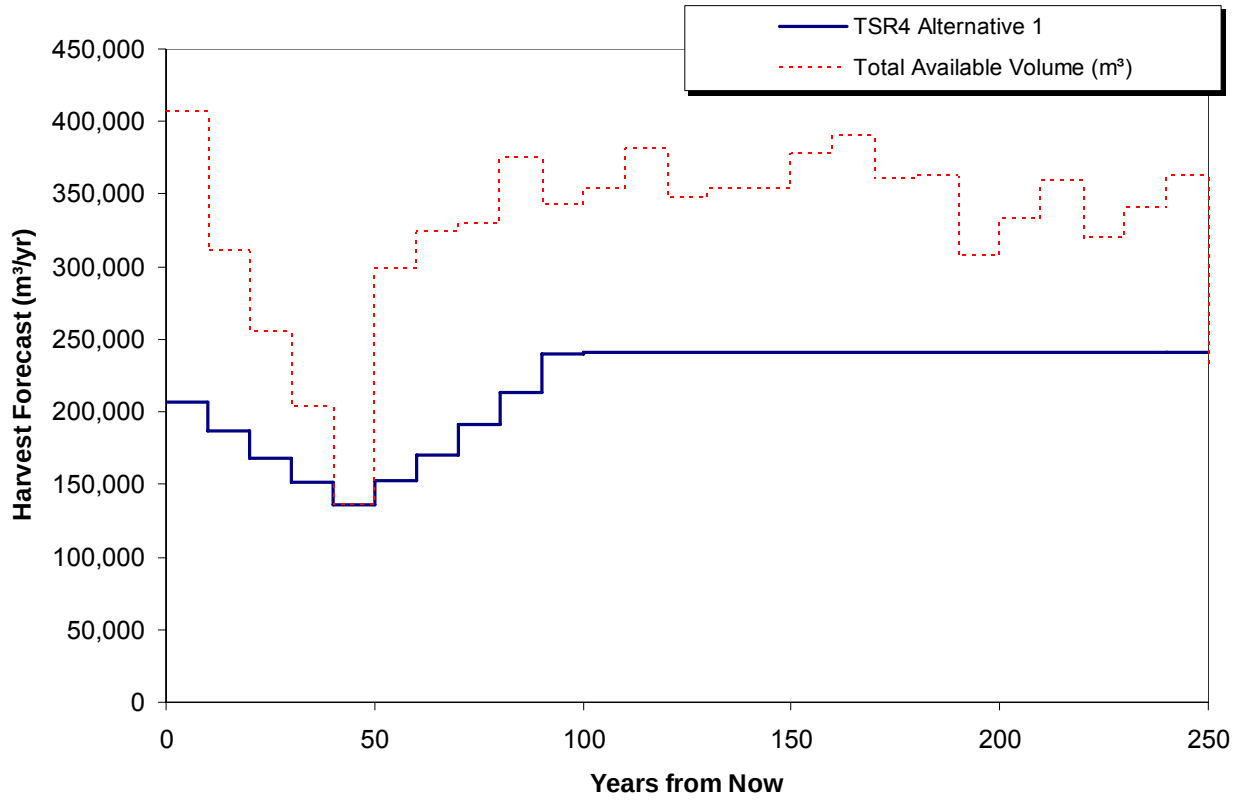


Figure 12. Base case harvest forecast for the Revelstoke TSA

The dotted red line in Figure 12 shows the total volume available for harvest in any given decade assuming the base case flow was followed until that time. This clearly illustrates that the short- and mid-term harvest level is driven by the available harvest volume 5 decades from now. Any excess volume available in the fourth period is required in the fifth period, which limits the first period because of decadal harvest rate of change constraints.

4.3 Base Case Attributes

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

4.3.1 Growing Stock

The total, merchantable, and available volume of timber on the timber harvesting land base throughout the 250 year planning horizon is shown in Figure 13. The total growing stock is the net volume of all stands containing trees larger than the specified minimum tree diameters (i.e. trees >12.5 or 17.5 cm dbh depending on the species). The merchantable growing stock is the subset of the total volume that comes from stands that are older than their minimum harvest ages. The available growing stock is the subset of the merchantable volume that is actually available for harvest considering integrated resource management constraints (i.e. visuals, landscape level biodiversity, ungulate winter range, etc.). Typically, a flat growing stock in the long-term is desirable because it signals that the rate of harvest is more or less equal to the rate of forest growth.

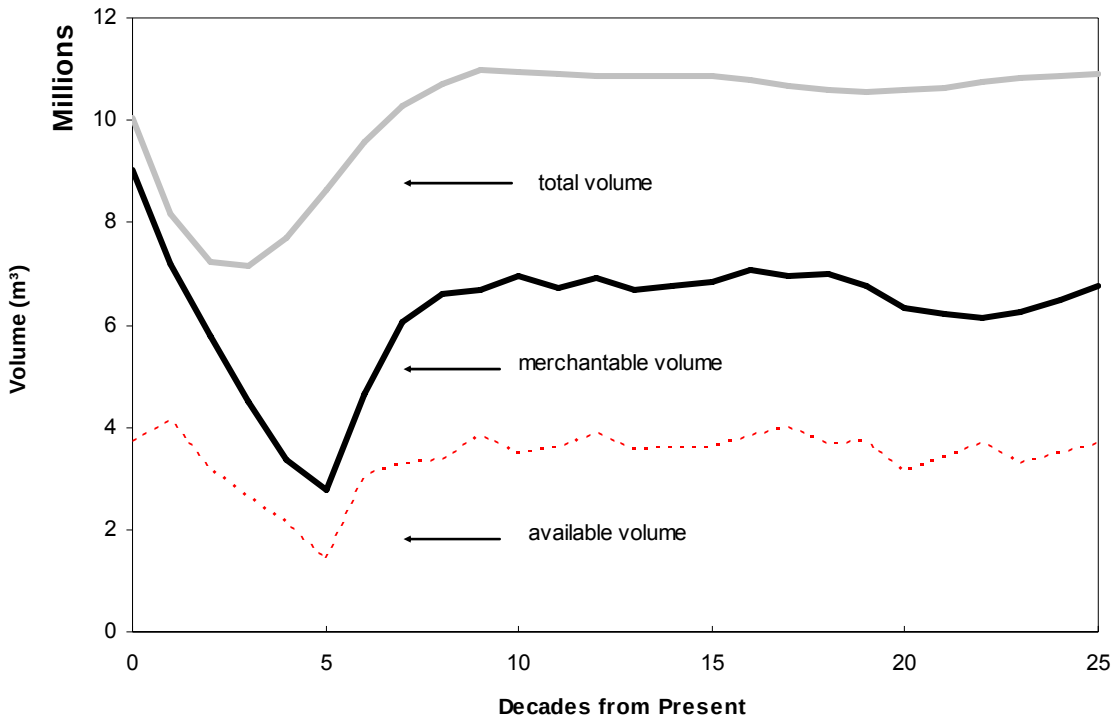


Figure 13. Total, merchantable, and available growing stocks on the Revelstoke TSA THLB

Of the total current volume (10.03 million m³) on the THLB, approximately 9.03 million m³ is currently merchantable (older than minimum harvest ages). By comparison, the published TSR3 base case total growing stock was approximately 21.5 million m³ and the merchantable growing stock was approximately 20.5 million m³. The significant difference in these values is largely a result of implementing the spatially explicit caribou GAR reserves (less THLB) and the use of VDYP 7 for the current TSR (less volume in natural stands). In TSR3,

caribou was accounted for via landbase constraints so any areas managed for Caribou remained in the THLB. By contrast, the Caribou GAR order completely removes areas managed for Caribou from the THLB which ties up approximately 7.76 million m³. Adopting VDYP 7 as the growth and yield model for natural stands for TSR4 resulted in a ~7.4% reduction in total standing volume relative to VDYP 6, which was used for TSR3. Other contributing factors include the 5 years of harvest since the last TSR (~1.15 million m³), 5 years of growth, and THLB differences due to changes in other landbase factors such as the exclusion of the Revelstoke Mountain Resort, expansion of Woodlots, etc.

4.3.2 Harvest Attributes

Figure 14 shows the contribution of both natural and managed stands to the base case harvest forecast. In the first 3 decades, the harvest of timber is almost exclusively from existing natural stands. In the 5th decade, existing managed stands begin to contribute to the harvest forecast as they become available for harvest. In the 7th decade their contribution rises sharply and they make up more than half of the harvest volume. By the 10th decade, the harvest comes primarily from managed stands, and the base case harvest forecast transitions up to the long-term harvest level.

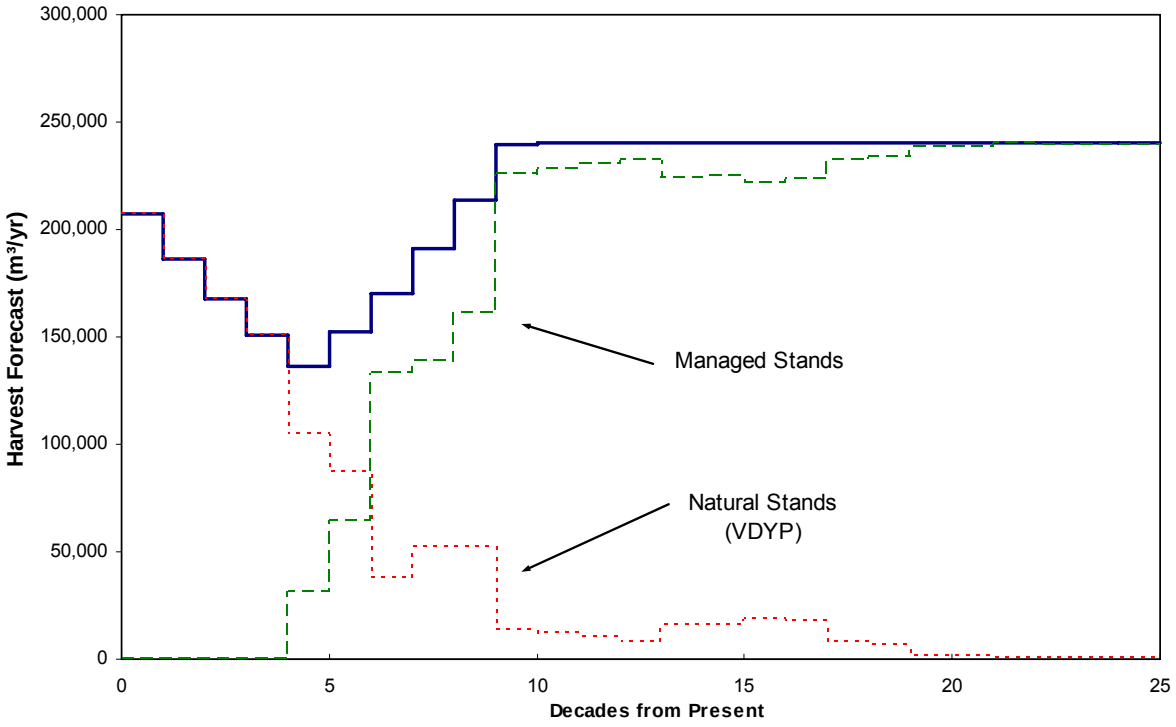


Figure 14. Contribution of natural and managed stands to the base case

The base case harvest has various species and stand types contributing to the overall harvest, often at different times. Figure 15 shows the contribution of the 5 key stand types over the planning horizon.

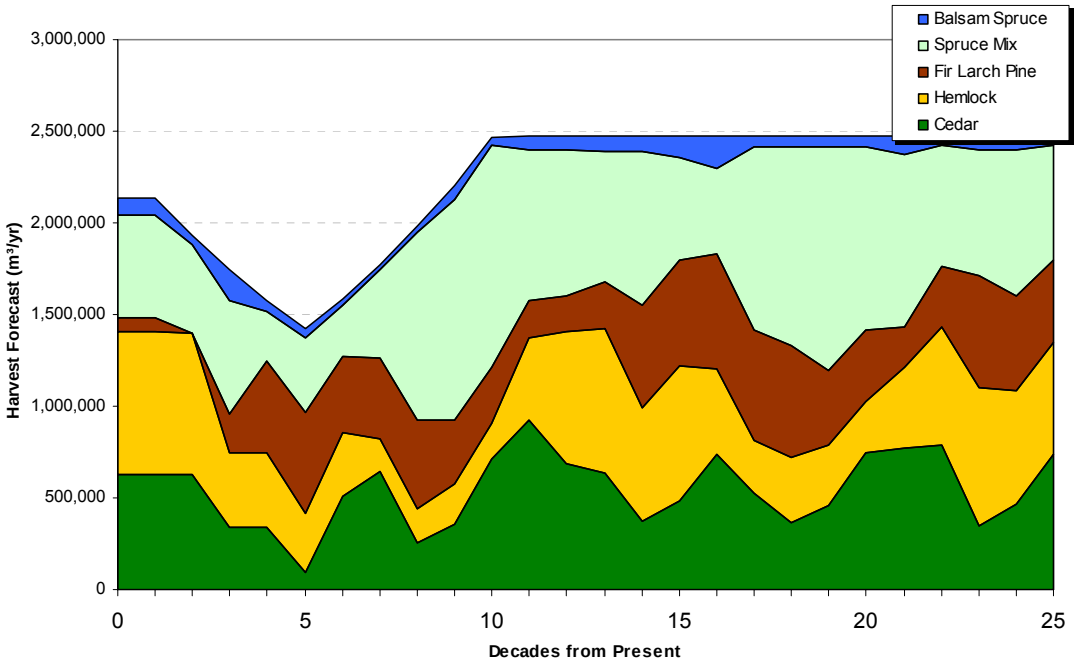


Figure 15. Contribution of species groups to the base case

Mean harvest age provides an indicator of the type and age of stands harvested over time. The timber harvesting land base currently has areas of older natural stands that are being replaced by younger managed stands over the next 50-60 years. Figure 16 shows that in the short-term, mean harvest age is above 250 years old. This high initial harvest age is primarily due to the presence of old and mature timber stands on the land base and the 'oldest-first' harvest priority. The harvest age declines gradually as these mature timber stands are harvested and replaced with managed stands. The long-term harvest ages are typically 110-120 years old (average of 113 years) as managed stands are typically cycling near their minimum harvest ages.

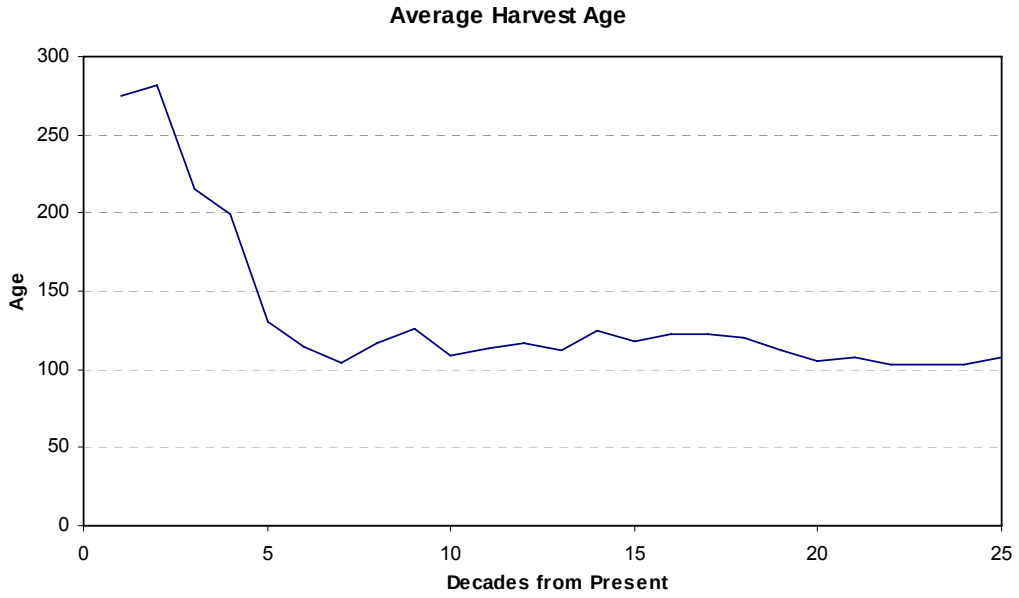


Figure 16. Mean harvest age over time for the base case

Figure 17 provides the mean harvest volume/hectare over time for the base case. The mean average volume per hectare starts off higher at the beginning of the planning horizon because older stands are being harvested that have had a long time to accrue volume. However, the application of the PEM/SIBEC for future managed

stands along with gains from select seed have resulted in faster growing and higher yielding managed stands. This results in the mean harvest volume per hectare actually increasing in the long-term (average of 471 m³/ha) relative to the first 50 years (390 m³/yr). The average volume per hectare of harvested stands averages 442 m³/ha over the entire planning horizon.

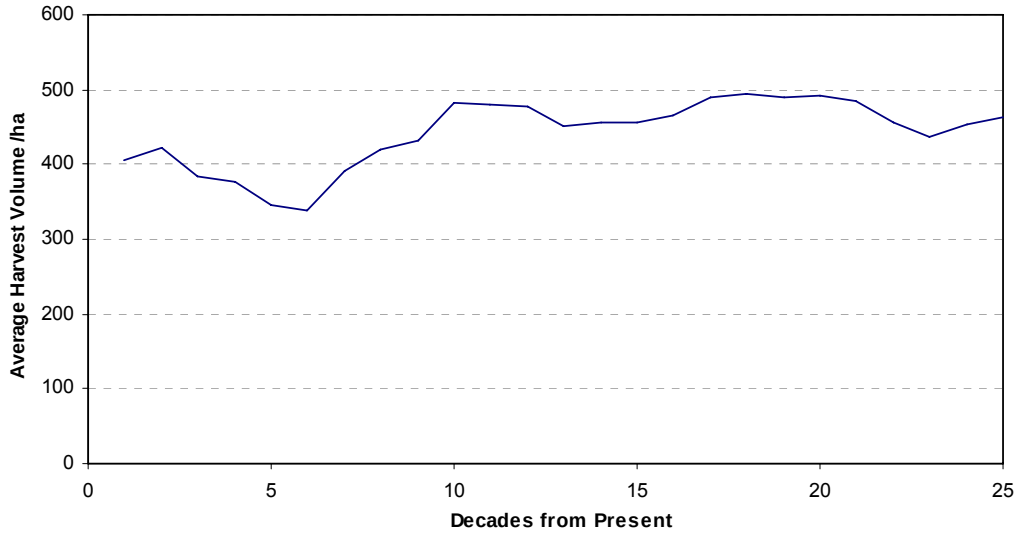


Figure 17. Mean harvest volume/ha for the base case

Harvest area has an inverse relationship with harvest volume per hectare. As harvest volumes/ha goes up, the less area is needed to support a common harvest level. Figure 18 shows the annual harvest area for the TSA projected in the base case. The inverse relationship with volume/ha is obscured here because the significant rise in the long-term harvest level requires more area to be harvested each year.

Over the entire planning horizon, the annual harvest area averages 487 ha. Within the first 100 years the annual harvest area averages 468 ha and increases to 527 ha over the remainder of the planning horizon.

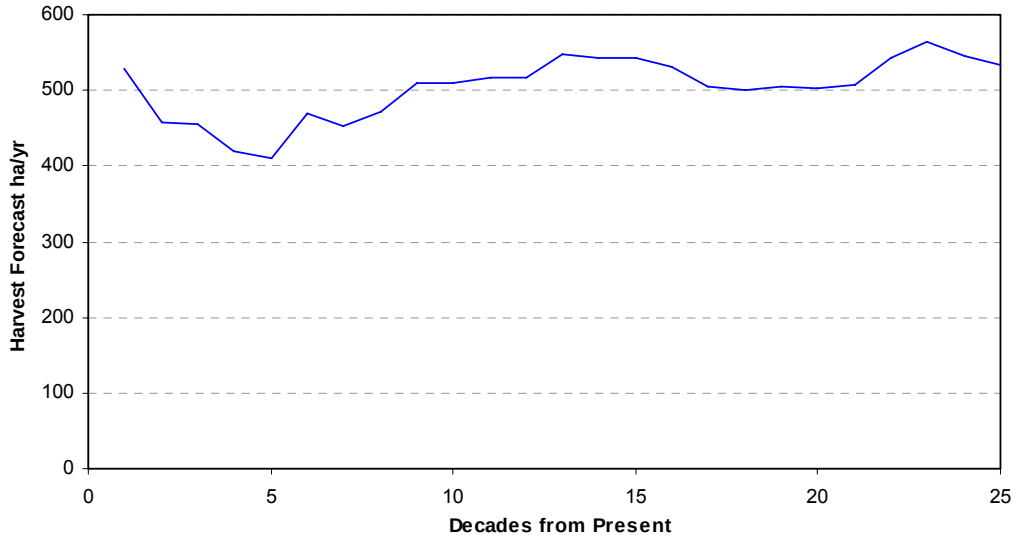


Figure 18. Total harvest area per year for the base case

4.3.3 Age Class Distribution

Figure 19 provides a time-series showing the age class distribution of the TSA's forest in 50 year increments. The area of THLB that is +250 years in the long term is a result of old and mature landscape level biodiversity constraints. A large area of non-THLB >250 years is present in the long-term because the natural disturbance regime is designed to turn over the non-THLB landbase every 395-490 years so considerable forest area is between the ages of 250 and 490.

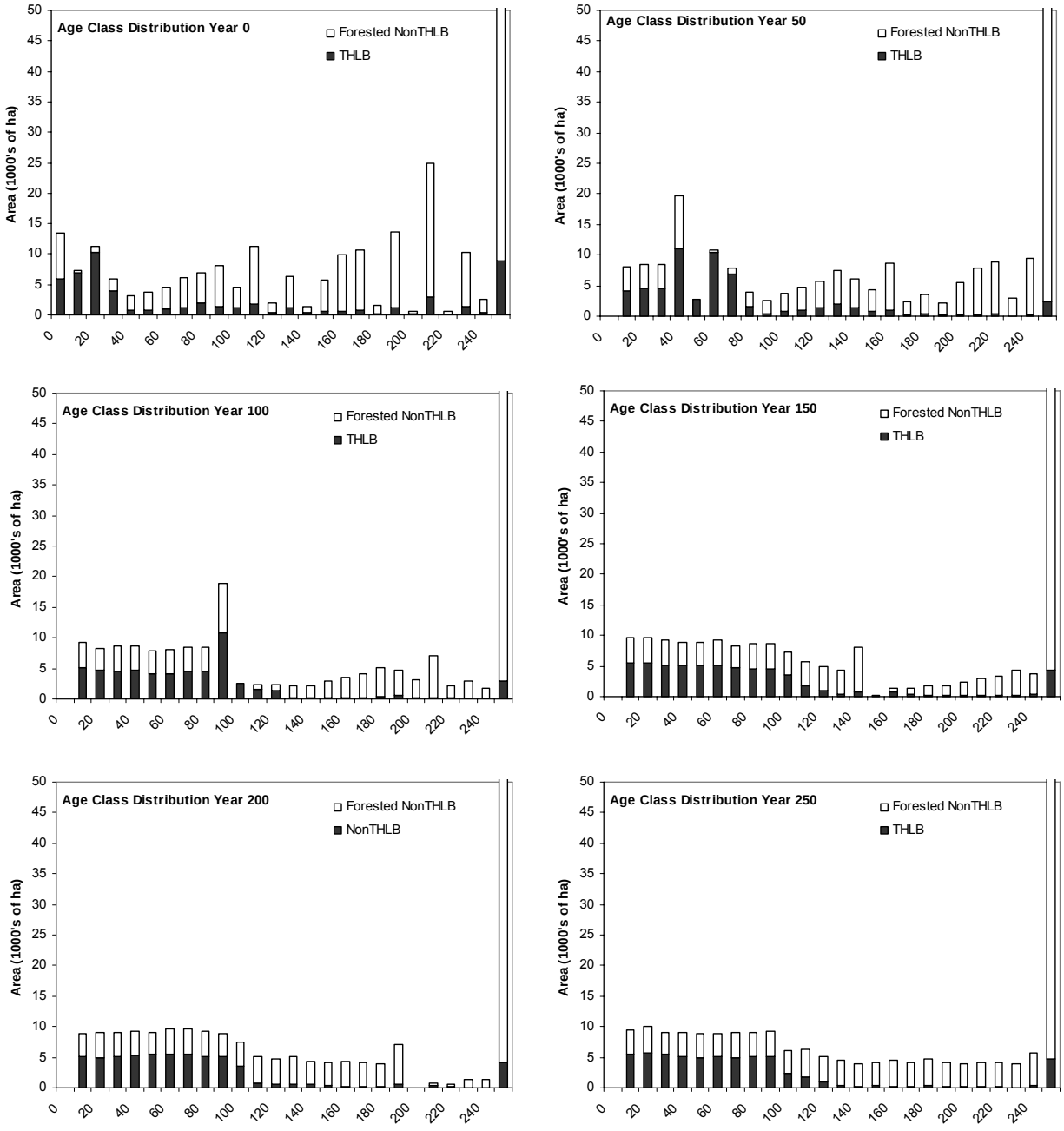


Figure 19. Age class composition for the base case at yrs 0, 50, 100, 150, 200, 250

4.4 Constraint Analysis

In the base case, several cover constraints are modelled to ensure that non-timber values are represented on the land base. These constraints address issues related to wildlife habitat, visual quality and mature & old growth representation (described in Section 3.3.1). This section of the report provides a status summary of the most significant cover constraints modelled in the base case over the 250 year planning horizon.

4.4.1 Landscape Level Biodiversity

Spatial OGMAs (for old seral) and MOGMAs (for mature-plus-old) were used in the model to meet Revelstoke HLPO biodiversity objectives[4] for the first 10 years of the planning horizon. They act like netdowns during modeling so that no harvest occurs in those stands. After the first 10 years, these spatially explicit OGMAs and MOGMAs were turned off and % minimum old forest retention requirements (aspatial constraints) were implemented.

Figure 20 and Figure 21 show that the when all units (LU-BEC variants) are combined, actual old and mature + old area is generally well above target. Individual units are discussed below. The status is not shown for the first decade because OGMAs and MOGMAs are used in the first decade to satisfy old seral biodiversity requirements.

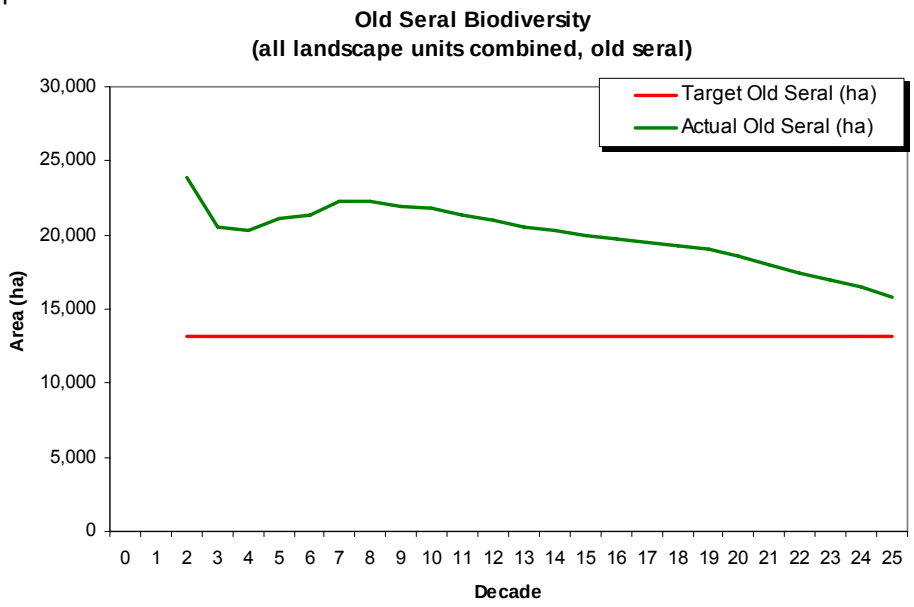


Figure 20. Target and actual old seral within all landscape units combined

[4] The only exception is the ICHmw3 because this BEC variant has been reclassified to NDT2 from NDT3 – so it was modeled with a %.

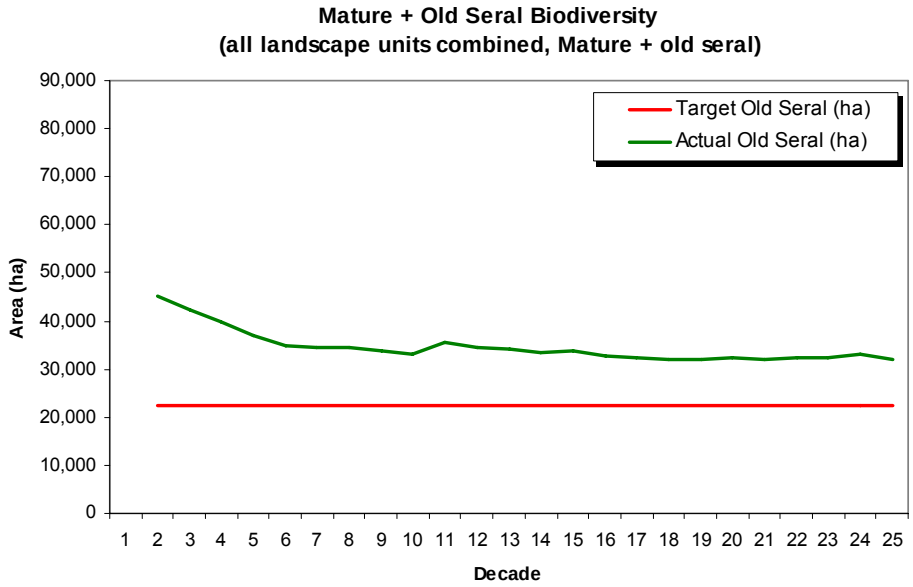


Figure 21. Target and actual mature+old seral within all landscape units combined

Although the actual Old and Mature+Old conditions are well above targets when considered over the entire TSA, harvest is still being limited by these biodiversity constraints at the LU/BEC variant level. Figure 22 shows that approximately 23,000 ha and 11,000 ha of THLB are considered to be 'tight' relative to constraints across the planning horizon for Old and Mature+Old seral constraints, respectively. This indicates that harvest is being limited within these areas to some extent.

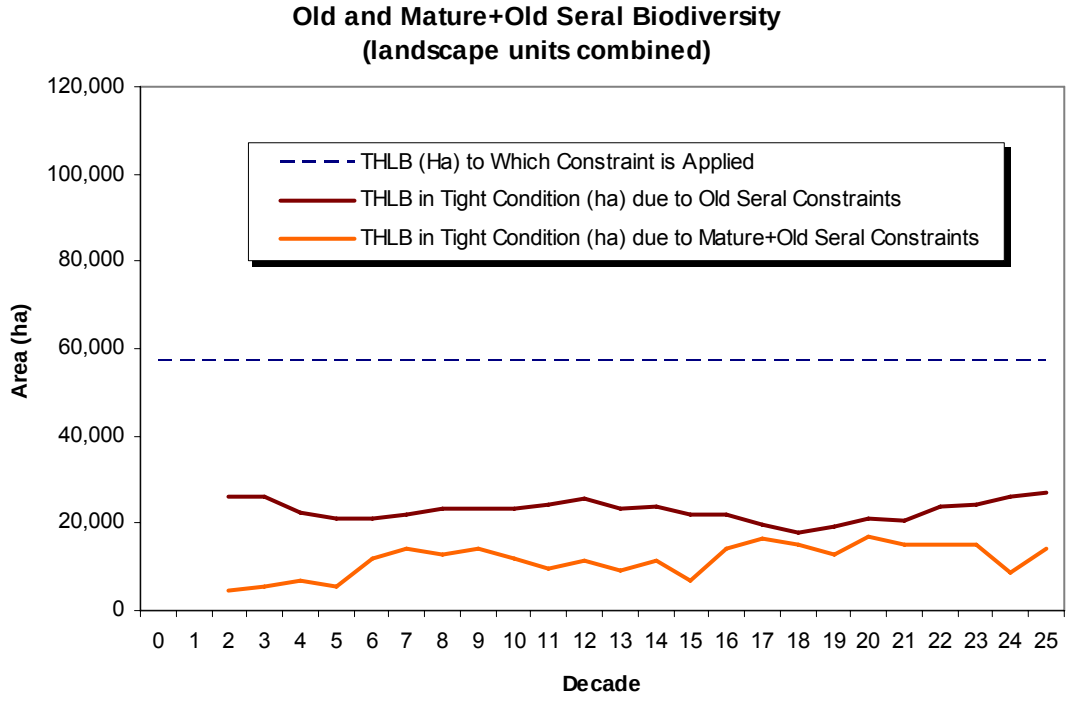


Figure 22. Total area in tight condition due to Old seral and Mature+Old Seral Constraints - all THLB within all Landscape Units combined

4.4.2 IRM Greenup

A 'Greenup' constraint was applied in the model with the objective of dispersing harvesting across the landscape and limiting the rate of cut within each landscape unit. Operationally, greenup is thought of as the condition a logged cutblock must achieve before an adjacent area can be harvested. As a surrogate for this, a maximum of 25% (i.e. 4 pass system) of the THLB in each LU was allowed to be less than the greenup age (13 years old. Figure 23 indicates that when all units are aggregated in general, the actual young seral is below the seral limits. When individual units are examined, Figure 24 shows that greenup is constraining harvest in a number of landscape units during the planning horizon (graph shows THLB area in 'tight' LU's).

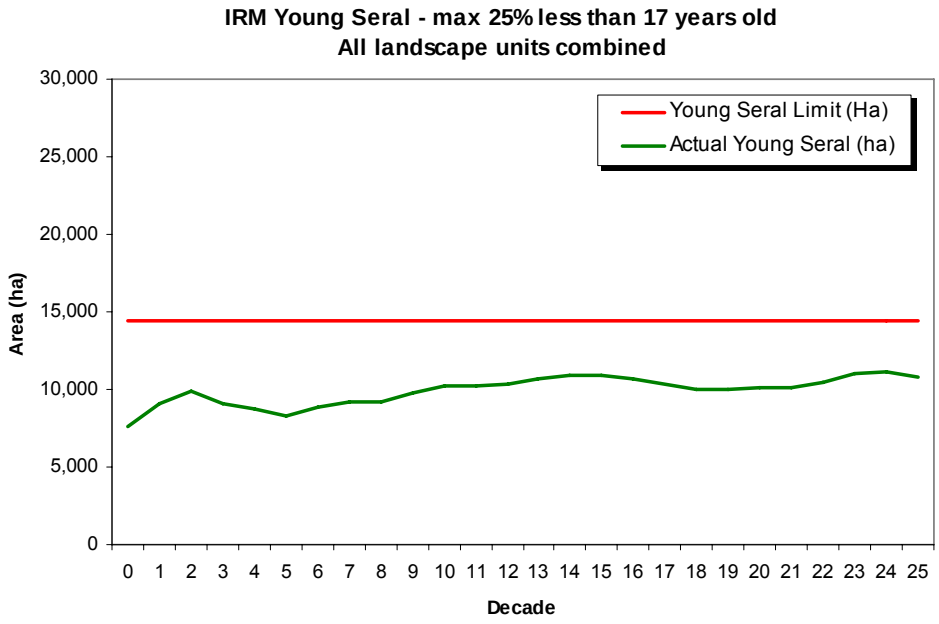


Figure 23. Maximum allowed IRM early seral greenup - all Landscape Units combined

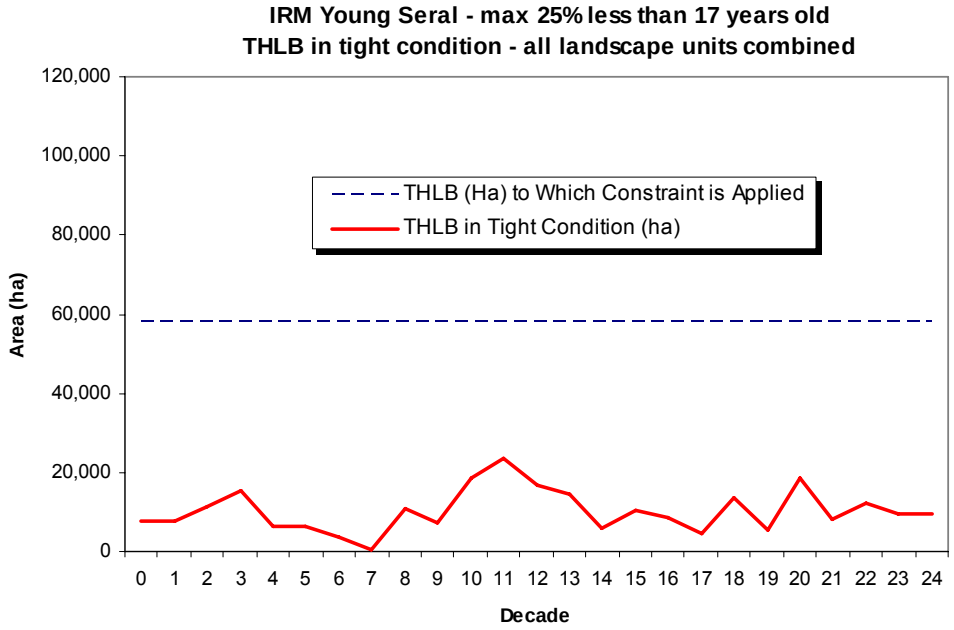


Figure 24. Area of THLB in tight condition associated with IRM early seral greenup requirements

4.4.3 Visual Quality Objectives

Visual Quality Objectives (VQOs) were implemented as maximum disturbance constraints. Figure 25 shows that a large portion of the VQO area was pushed close to the threshold levels. Of the 16,222 hectares of THLB covered by VQOs, a substantial portion is in 'tight' condition from the 4th decade onwards (Figure 26). This indicates that VQOs are a significant factor in restricting harvesting in the mid- and long-term portions of the planning horizon.

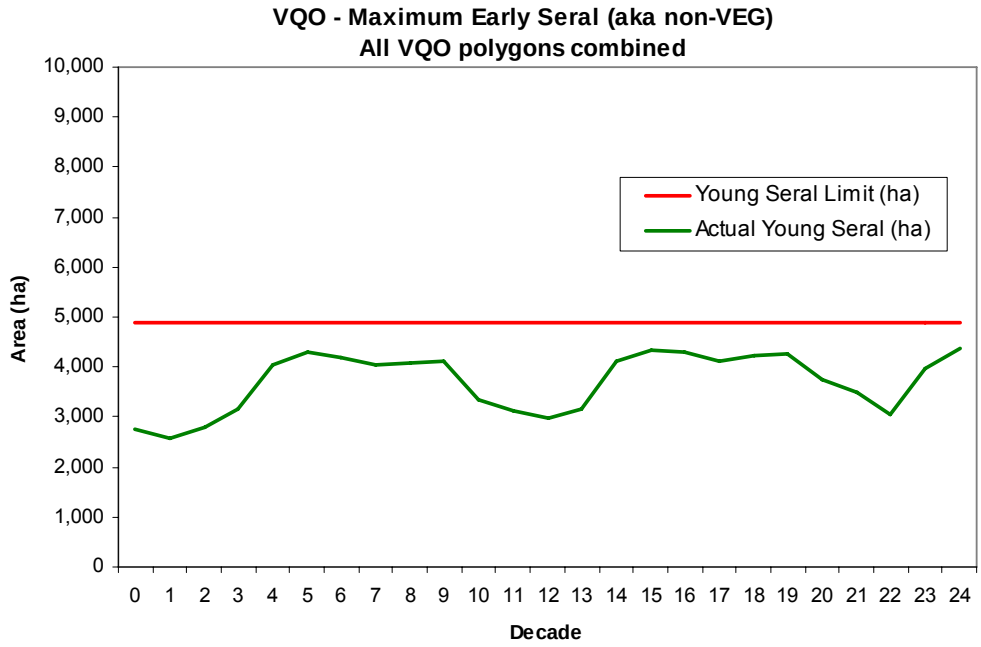


Figure 25. Existing early seral and VQO-type early seral limit for all VQO classes combined

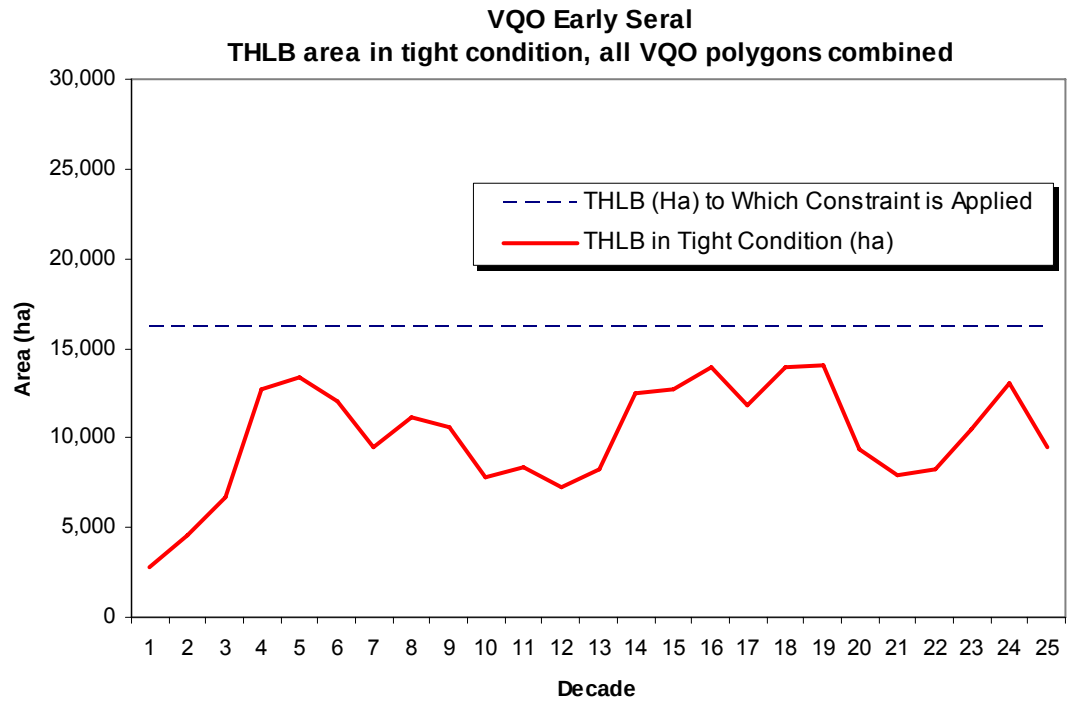


Figure 26. THLB in tight condition associated with all VQO classes and polygons combined

4.5 Base Case Differences from TSR3

Relative to TSR3, the base case presented here shows a significantly lower harvest flow in the short- and mid-term and an improved harvest flow in the long-term. This section is meant to summarize and explain, where possible, the key factors that caused the differences between the harvest flows.

The TSR3 base case starts at a harvest level of 230,000 m³/yr for 15 years before stepping down to a mid-term level of 165,000 m³/yr by the fifth decade. A long-term harvest level of 170,500m³/yr is achieved in about 140 years. It is important to note that 5 years have passed since this harvest flow was determined and that this has been reflected in the figure by subtracting 5 years from the front end.

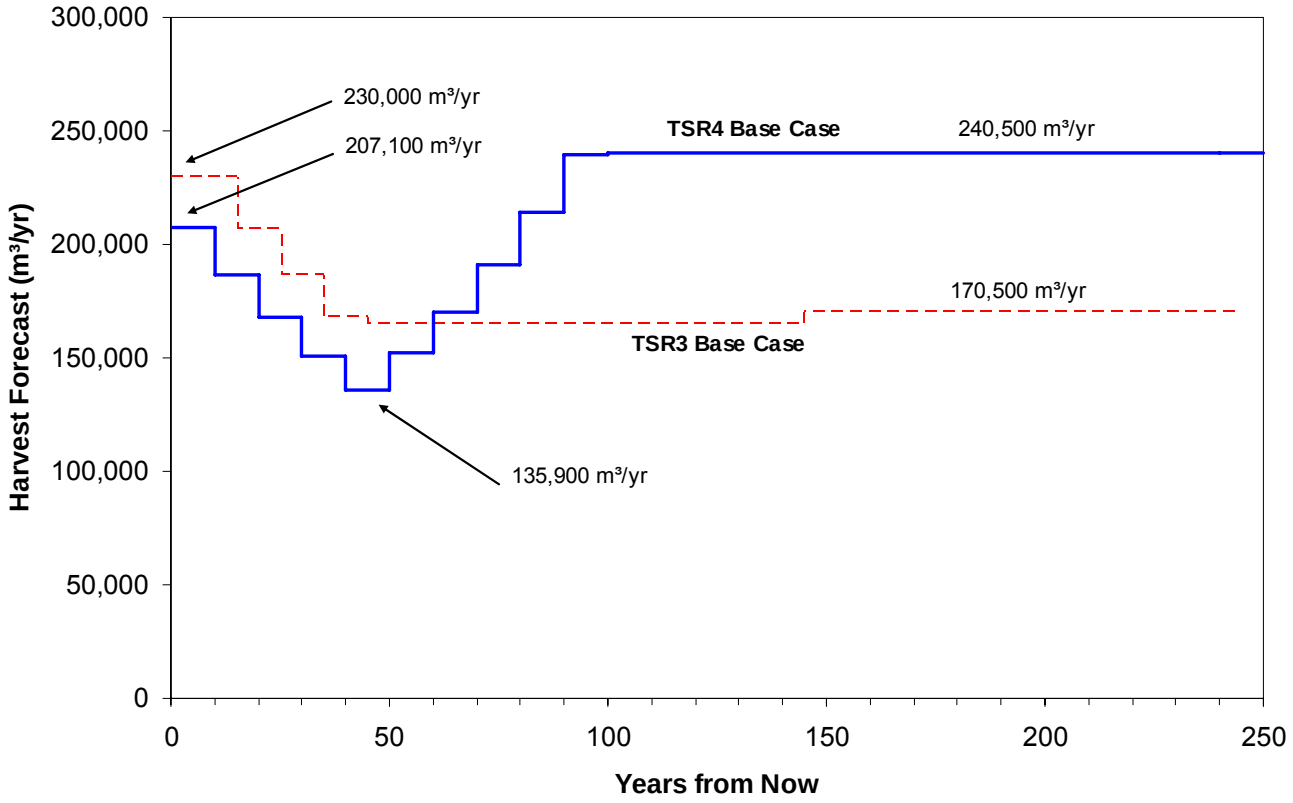


Figure 27. TSR4 Base Case comparison to TSR3 Base Case

The TSR4 base case harvest flow differs significantly from the TSR3 projection. The short-term harvest level is 9.9% (22,900 m³/yr) lower while the long-term is 41.1% (70,000 m³/yr) higher than TSR3. The large drop in total and available mature growing stock from TSR3 explains the majority of the differences in the short-term harvest level. This drop is a result of the use of VDYP 7 to project natural stand volumes, and a reduced THLB area attributable primarily to caribou reserves (almost all of which impacted mature stand types).

The transition from using VDYP 6 to VDYP 7 resulted in an overall reduction in natural stand volumes by approximately 7.4% (for more details on how this comparison was made, see Section 4.7.3 on Page 36). This occurred in part because VDYP7 uses updated site index curves from new research projects. For example, new site index curves for cedar (Nigh, 2000) generated from interior trees only are used in VDYP 7 while VDYP 6 had historically used site index curves for cedar generated from coastal cedar trees (Kurucz, 1978)[5]. This change alone caused significant reductions in site indexes for cedar leading stands.

[5] Mulvihill, Chris. "Re: SI in VDYP7" Email to Cam Brown. 30 March 2009.

Table 4 summarizes the netdown elements that had negative and positive pressures on the THLB relative to TSR3.

Table 4. Downward and Upward pressures on the THLB relative to TSR3

Downward pressures on THLB relative to TSR3	Upward pressures on the THLB relative to TSR3
- Incremental Caribou reserves - Revelstoke Mountain Resort - Drinking water Intakes - Permanent Sample Plots - Woodlot Expansions - Wildlife Habitat Areas - Backlog NSR	- Updated Operability - Unstable terrain - Environmentally sensitive areas - Effective riparian buffers - Timber Licenses

Since TSR3 considered HLPO or 'status quo' Caribou percent constraints rather than fully spatial netdowns for Caribou, one way to attempt to compare the net difference in THLB is to subtract the 'status quo' portion of the Caribou GAR reserves from the TSR3 THLB (78,018 ha TSR3 THLB - 14,794 ha Status quo reserves = 63,224 ha approximate effective TSR3 THLB). Comparing these THLB areas shows a 5,316 ha (8.4%) reduction between TSR3 and TSR4 (63,224 ha approximate effective TSR3 THLB – 57,908 ha TSR4 THLB). Incremental Caribou reserves were the largest factor in this decrease and account for 4,077 ha of this area.

The reduction in THLB caused significant changes in the age class structure of the THLB as the major netdown elements that reduced the THLB (i.e. Caribou reserves) were dominantly concentrated in mature and old stands. This disproportionately reduced the THLB in older age classes and had a disproportionate impact on the short-term harvest level compared to reducing the THLB in all age classes. The initial THLB area is now either very old or quite young, and much of the THLB that is old is deferred from harvest by old and mature seral constraints.

The large increase in the long-term harvest level is explained by the application of SIBEC adjusted site index values (ICH variants only) based on recent Predictive Ecosystem Mapping completed for the TSA and volumes gains from the use of select seed occurring in existing and future managed stands.

4.6 Discoveries Made During the Development of This Report

The approach documented in the originally approved data package to determine the greenup ages (IRM greenup and Visually Effective greenup) relied on Site Tools software. A document[6] produced in 2000, compared actual silviculture data on the age to greenup heights to those produced by Site Tools for several regions of British Columbia. This data is considered to be a more accurate reflection of the actual age to green-up and has been recommended to be used in Timber Supply projects over the Site Tools method. The revised greenup age derivation is documented in Section 8.1 of Appendix A (the Data Package).

The base case and subsequent sensitivities were originally modeled with greenup ages determined from Site Tools. Under these assumptions, the availability of timber in the second period was severely limited and short term harvest levels were impacted significantly. In an effort to distribute the large timber supply impact evenly across the first few decades under these assumptions, it was requested and ultimately approved by Forest Analysis and Inventory Branch to increase the allowable decadal harvest change limit of 10% to 15%.

As a result of the findings from the original greenup sensitivity (refined greenup ages), it was determined that the base case should include the refined greenup ages. Subsequently, the base case assumptions and all sensitivities were updated to include this development. Figure 28 shows the original base case relative to the base case with refined greenup ages. Additional insight around greenup age assumptions can also be found in the Greenup Sensitivity section (Section 4.7.10 on page 44).

[6] B.C. Ministry of Forests. 2000. Age to Green-up Height: Using Regeneration Survey Data by Region, Species and Site Index. Available at:: http://www.for.gov.bc.ca/hre/pubs/docs/age-to-greenup.pdf

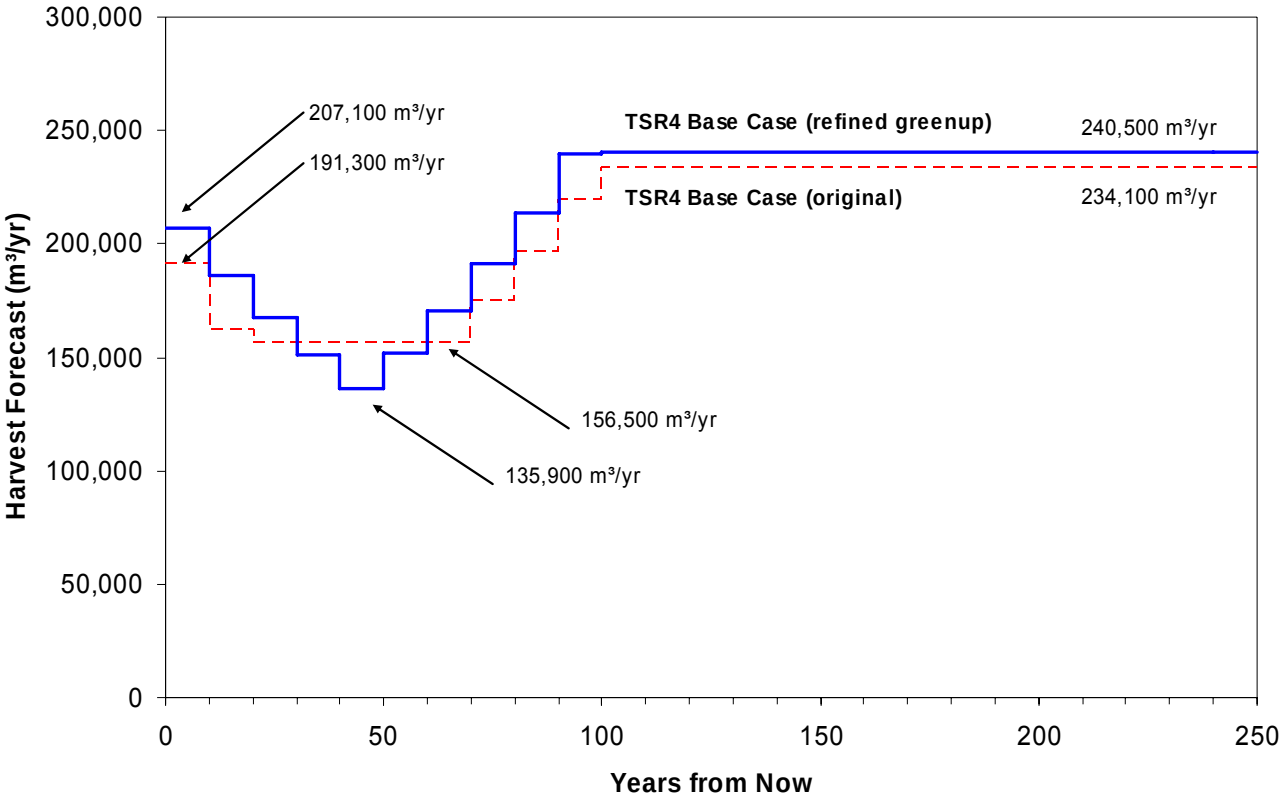


Figure 28. Original Base Case vs. refined greenup ages Base Case

The flexibility afforded by the refined greenup assumptions means that there is no longer any need to increase the percent change allowance to 15% because harvest availability in the second period is no longer limiting. However, the mid-term low has decreased by 13.2% to 135,900 m³/yr. The long-term harvest level increased by 2.7% to 240,500 m³/yr as a result of the greenup changes.

4.7 Base Case Sensitivity Analysis

The data and assumptions used in any timber supply analysis are often subject to uncertainty. To provide perspective on the sensitivity of changes to modelled assumptions, sensitivity analyses are commonly performed. Typically only one variable (data or assumption) from the information used in the base case is changed in order to explore the sensitivity of that variable. Sensitivity analyses help to frame the potential impacts of uncertainty by analyzing scenarios that are more pessimistic and more optimistic than the base case.

The sensitivities listed in Table 5 were performed on the base case and the results are presented below. Where relevant, any crashes that occur while attempting to achieve the base case harvest flow are also shown.

Table 5. Sensitivity analyses completed on the current practice base case

Sensitivity analysis	Zone/ group / analysis unit subject to uncertainty	Changes made in Sensitivity Run
Size of Timber Harvesting Land base	Timber Harvesting Land Base (THLB)	The timber harvesting land base will be increased and decreased by +/– 10%.
Managed Stand Yields	Managed Stands	The volume associated with managed stands will be increased and decreased by +/- 10%
PEM site Indices in ESSF	Managed Stands in ESSF	Apply SIBEC correlations to ESSF based on current PEM site series classifications
Natural Stand Yields	Natural Stands	The volume associated with natural stands will be increased and decreased by +/- 10%
VDYP6	Natural Stands	Compare initial growing stock (on THLB) between VDYP 6 and VDYP 7 projected inventory.
Minimum Harvest Ages	All Stands	Minimum Harvest ages will be increased and decreased by +/- 10 years.
Armillaria Root rot	Managed Stands	TIPSY low severity *Armillaria* OAF 2 applied to Douglas-fir in the ICH
2019 Genetic Gains	Future Managed Stands	The genetic gains projected for 2019 (10 years out) will be applied to all future managed stands.
VQO's	Visuals	Shift disturbance allowance up by one class
Exclude Hw stands(>79% volume)	All stands	Remove all Hw stands (>79% volume) from the THLB
Greenup Heights	All Landscape Units	Increase age to greenup height assumptions by 4 years (visually effective greenup heights and IRM greenup heights)
No Mature Biodiversity in Caribou LU's	Caribou Landscape units	Remove Mature biodiversity requirements in Caribou Landscape Units.
Provincial Aspatial Old Growth Order	All Landscape Units	Adopt the provincial old growth order in place of Revelstoke HLPO biodiversity requirements.
Remove operability line condition from HLPO biodiversity	All Landscape Units	Remove the condition that disallows forests above the operability line from contributing to old and mature targets below the operability line.
Remove 'Incremental' Caribou	All Caribou Landscape Units	Remove the 'incremental' portion of the Caribou GAR.
UWR Forest Cover Requirements	All non-caribou UWR management units	Remove all non-caribou UWR Forest Cover Requirements.

4.7.1 Size of the Timber Harvesting Land Base

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

In order to understand the risks associated with THLB estimation, two sensitivity runs have been completed. These runs increase and decrease the size of the THLB by 10%.

How was it Analyzed?

Table 6. Timber harvesting land base increased and decreased by 10%

Scenario	THLB (ha)	Non-THLB (ha)	CFLB (ha)
Base	57,908	178,218	236,126
THLB +10%	63,698	172,427	236,126
THLB -10%	52,117	184,009	236,126

Run	How was it Analyzed?
Timber harvesting land base + 10%	The size of each THLB polygon was increased by 10%, while the size of Non-THLB polygons were decreased by the corresponding percentage that maintained the correct total land base area. The modeled THLB was 63,698 ha in size.
Timber harvesting land base - 10%	The size of each THLB polygon was decreased by 10%, while the size of Non-THLB polygons were increased by the corresponding percentage that maintained the correct total land base area. The modeled THLB was 52,117 ha in size

Results

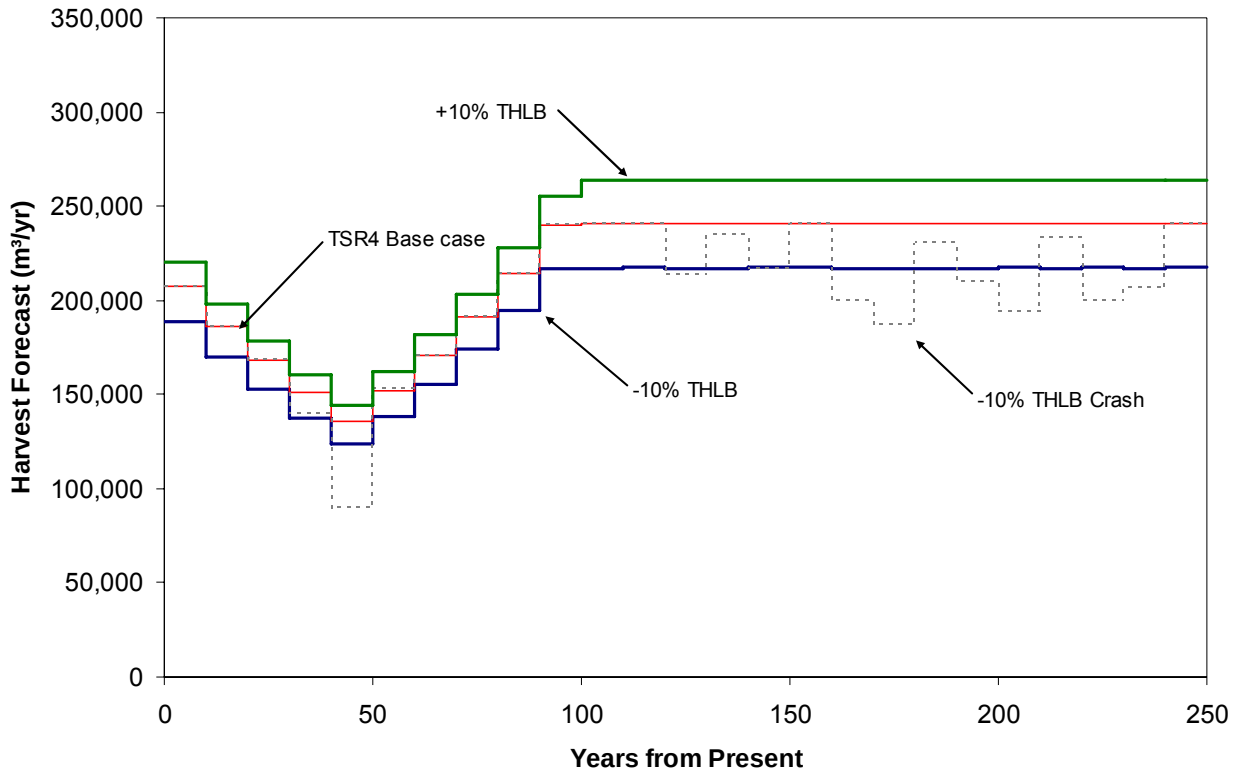


Figure 29. Timber harvesting land base increased and decreased by 10%

Run	Short Term	Mid Term	Long Term
Timber harvesting land base + 10%	Increase in the short-term harvest level of 6.4% to 220,500 m³/yr	Increase of in the mid-term low of 6.4% to 144,800 m³/yr	The LTHL increases by 9.7% to 263,800 m³/yr
Timber harvesting land base - 10%	Decrease in the short-term harvest level of 9.0% to 188,500 m³/yr	Decrease in the mid-term low of 8.9% to 123,800 m³/yr	The LTHL decreases by 9.7% to 217,200 m³/yr

A percentage increase or decrease in the THLB typically has a proportional impact on the harvest flow. When the THLB was reduced by 10%, the initial harvest level drops by 9.0% and the long-term level drops 9.7%. When the THLB was increased by 10%, only a 6.4% increase in the short- and mid-term harvest flow was found. This likely occurred because the reduction in forested non-THLB area meant that % seral goals were now met less in the non-THLB and more in the THLB. This prevented a portion of the increased THLB area from providing volume to the harvest forecast.

4.7.2 Yields from Natural and Managed Stands

Stand yields are a critical input into timber supply analysis. The short and mid-term timber supply is heavily influenced by the availability of timber in natural stands that make up the current growing stock. The current standing and mature timber provide all of the timber harvesting opportunities before managed stands begin to come online for harvest.

Uncertainty in timber yields can result from many different factors. Natural stand yields are based on the VDYP yield model, which predicts yields from stand attributes in forest inventory maps. Inaccuracies in the model, in decay estimates, or stand attributes can create uncertainties around actual stand yields. (See 4.7.3 for an example)

Managed stand yields are based on the TIPSY model, which predicts yields for managed stands using site index and stand attributes such as species, density, operational adjustment factors, and expected gains from planting stock grown from select seed. The over- or under-estimation of any of these factors can lead to uncertainties in the yields of these future stands.

How was it Analyzed?

Run	How was it Analyzed?
Natural Stands + 10% (VDYP + 10%)	The yield associated with each natural stand analysis unit (100 series) was increased by 10%.
Natural Stands - 10% (VDYP – 10%)	The yield associated with each natural stand analysis unit (100 series) was decreased by 10%.
Managed Stands + 10% (TIPSY + 10%)	The yield associated with each existing managed and future managed stand analysis unit (200, 500, 600 series) was increased by 10%.
Managed Stands - 10% (TIPSY – 10%)	The yield associated with each existing managed and future managed stand analysis unit (200, 500, 600 series) was decreased by 10%.

Results

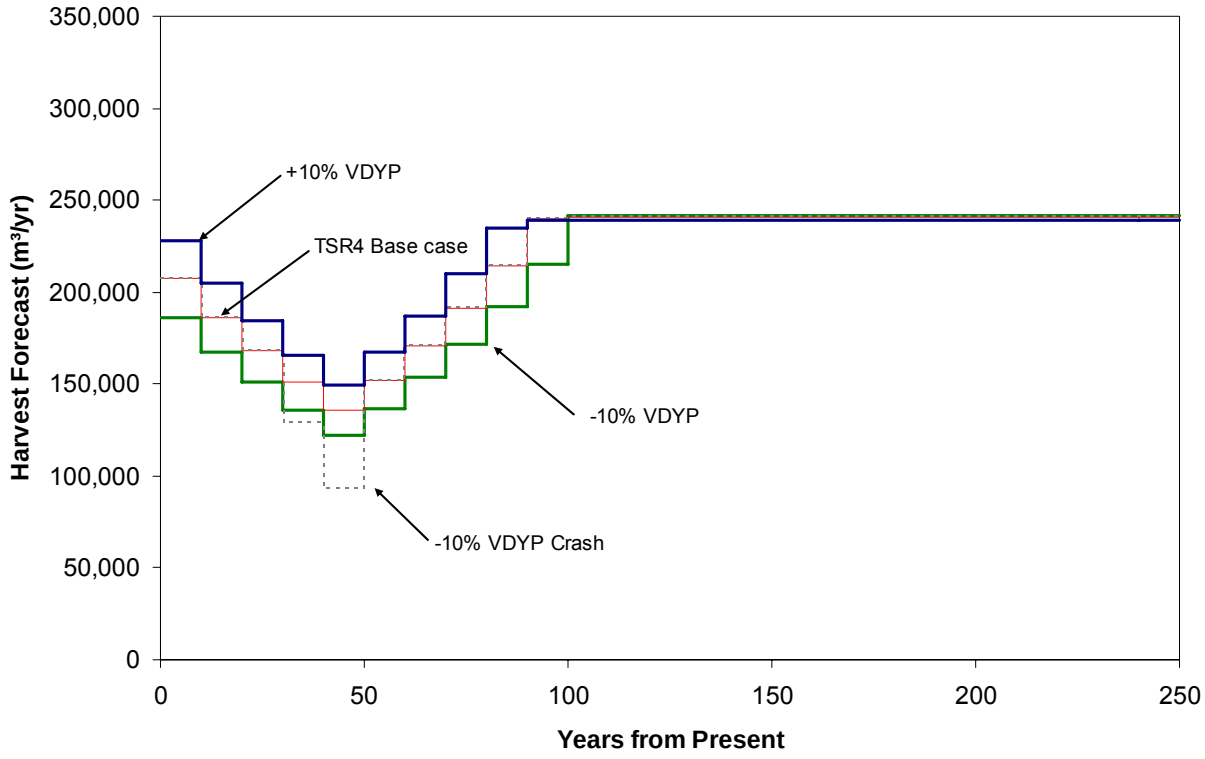


Figure 30. Natural stand (VDYP) yields increased and decreased by 10%

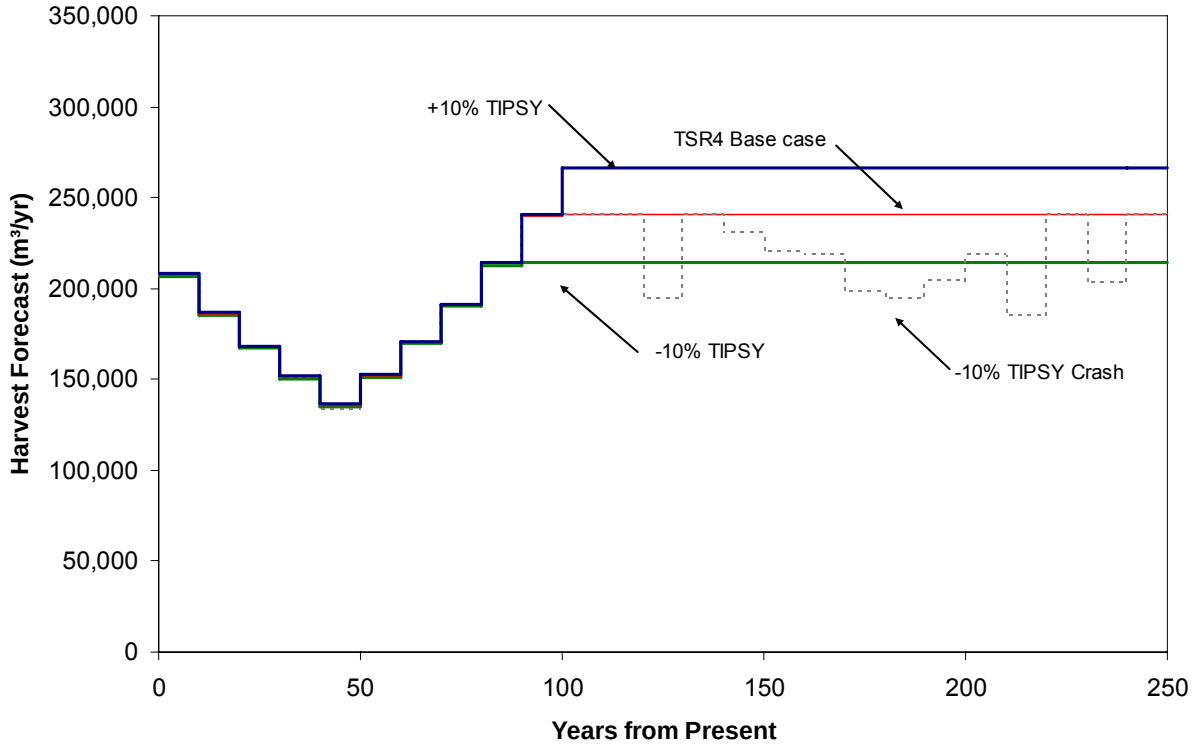


Figure 31. Managed stand (TIPSY) yields increased and decreased by 10%

Run	Short Term	Mid Term	Long Term
Natural Stands +10%	The short-term harvest level increases by 9.9% 227,600 m³/yr	The mid-term low increases by 9.9% to 149,300 m³/yr	A slight decrease (0.6%) to 242,000 m³/yr A slight decrease (0.6%) to 239,000 m³/yr
Natural Stands -10%	The short-term harvest level decreases by 10.1% to 186,300 m³/yr	The mid-term low decreases by 10.1% to 122,200 m³/yr	A slight increase (0.6%) to 242,000 m³/yr
Managed Stands +10%	A slight increase (0.4%) to 207,900 m³/yr	A slight increase (0.4%) in the mid-term low to 136,400 m³/yr	The LTHL increases by 10.8% to 266,500 m³/yr
Managed Stands -10%	A slight decrease (0.5%) to 206,200 m³/yr	A slight decrease (0.5%) in the mid-term low to 135,200 m³/yr	The LTHL decrease by 10.8% to 214,500 m³/yr

Changes to natural stands yields have significant impacts on the short- and mid-term because they are the main source of harvest volume during the first 5 decades. As the harvest volume comes increasingly from managed stands in the future, the harvest level becomes more in line with the base case.

Changes to managed stand yields have insignificant impacts in the short-term but do have significant impacts in the long-term. The scale of the impact is almost directly proportional with the over/under estimation of volume.

4.7.3 VDYP 7 vs. VDYP 6

Since the last TSR, the provincial vegetation inventory file has been projected with an updated natural stand projection model (VDYP7). This new model uses a substantially different approach than the old model (VDYP6), which was used to project volumes for TSR3. This sensitivity explores the differences that result from projecting stand volumes using the new VDYP7 model.

How was it Analyzed?

This sensitivity did not involve timber supply modeling but is rather a comparison of the initial growing stock on the Revelstoke TSA THLB, when projected using VDYP6 vs VDYP7. The following describes how this comparison was made:

- A lookup table was created so that feature id's from the VDYP7 inventory file could be linked with the VDYP6 inventory file using GIS (97%+ of the polygons were identical – only the VRIMS updated polygons were different).
- The forest cover with the VDYP6 volume projections was projected forward by 1 year using VDYP6 batch v.6.6d4 so that the projection year for each Forest Cover was the same (2008).
- Comparisons were only made where there was a one to one relationship between the inventory files and polygons had identical ages and areas.
- The projected age from the resultant (VDYP7 forest Cover) that had depletions reflected was used to limit the volumes being compared to stands >60 years old. This ensured the areas being compared were the same and that depletions applied against the resultant (VDYP7) were reflected in the VDYP6 volumes.
- A total of 23,545 ha over 60 years old was able to be compared. This is approximately 41 % of the THLB area but represents >96% of the area >60 yrs old.

Results

Adopting VDYP 7 as the growth and yield model for natural stands for TSR4 resulted in an approximate 7.4% reduction in standing volume on the THLB relative to VDYP 6 (Table 7). This occurred in part because VDYP7 uses updated site index curves from new research projects. For example, new site index curves for cedar (Nigh, 2000) generated from interior trees only are used in VDYP 7 (SINDEX v.1.43) while VDYP 6 had

historically used site index curves for cedar generated from coastal cedar trees (Kurucz, 1978)[7]. This change alone caused significant reductions in site indexes for cedar leading stands. Table 8 shows the approximate percent difference of VDYP 7 volumes relative to VDYP 6 volumes by species. In general balsam, cedar, hemlock, and spruce volumes are smaller while Douglas-fir and pine volumes are greater using VDYP 7 relative to VDYP6.

Table 7. Comparison of VDYP6 and VDYP7 inventory volumes for the Revelstoke TSA THLB >60 yrs old

Forest Inventory Projection Tool	Area (ha)	Volume (m^3)
VDYP6	23,546	8,501,538
VDYP7	23,546	7,873,863

Table 8. Comparison of VDYP6 and VDYP7 inventory volumes for the Revelstoke TSA THLB >60 yrs old by Leading Species

Leading Species Group	Percent difference relative to VDYP6
Balsam	-4.8%
Cedar	-12.8%
Douglas-fir	10.2%
Hemlock	-17.4%
Pine	3.7%
Spruce	-7.6%

4.7.4 Full SIBEC Site Productivity Estimates (ESSF included)

SIBEC site index adjustments were not applied to the ESSF in the base case because the Predictive Ecosystem Map (PEM) did not meet accuracy assessment requirements in this Biogeoclimatic zone. However, there is a general trend across the province showing the site indexes are also underestimated in ESSF stands and thus it is important to quantify the potential impact of adjusting these stands. Applying SIBEC site index adjustments to the ESSF has the potential to further increase the site index of the land base thereby increasing yields for managed stands and in turn reducing the time to reach minimum volume and diameter thresholds.

How was it Analyzed?

Run	How was it Analyzed?
SIBEC Estimates	SIBEC site index adjustments were added to stands in the ESSFvc below 1550m elevation[8] and new yield tables for managed stands (TIPSY curves) were generated. This resulted in a slight increase in the weighted average SI of the THLB (+0.15 m from 18.5 to 18.65) for managed stands. Minimum harvest ages were adjusted to align with the new curves.

[7] Mulvihill, Chris. "Re: SI in VDYP7" Email to Cam Brown. 30 March 2009.

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

Results

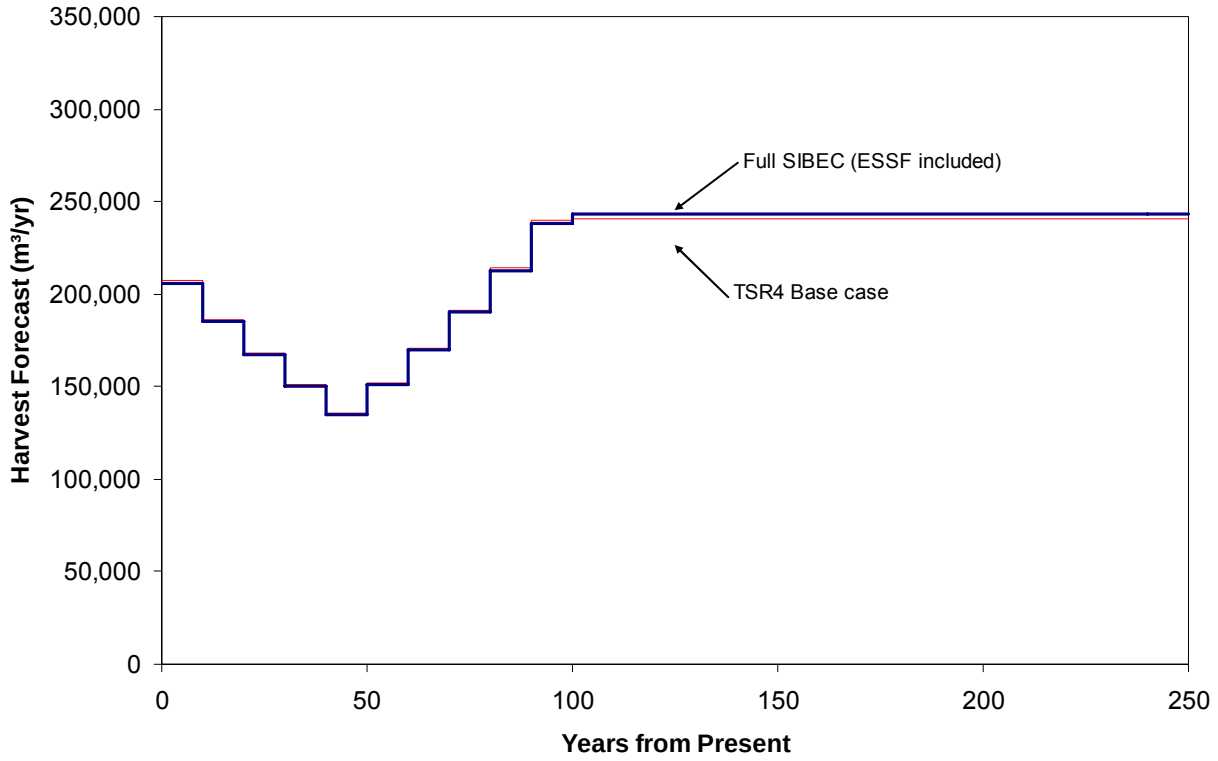


Figure 32. Full SIBEC Site Productivity Estimates (ESSF included)

Run	Short Term	Mid Term	Long Term
SIBEC site index adjustment applied in the ESSF	A slight decrease in the short-term (0.5%) to 207,100 m³/yr	A slight decrease in the mid-term low (0.5%) to 135,200 m³/yr	The LTHL increases by 1.3% to 243.700 m³/yr

This factor only influenced a subset of the future managed stands and only increased site index estimates by a small amount. Overall, the area weighted average site index increased as a result of the SIBEC application in the ESSF, however the Site Index for some Analysis Units (AU's) actually decreases, thereby reducing the volume yield for these AU's. The slight impact on the short- and mid-term indicates that the transition from natural to managed stands is dependant on volume coming from these stand types (Figure 32). In the long-term the overall site index increase resulted in a 1.3% increase in harvest level.

4.7.5 Minimum Harvest Ages

Uncertainty around the age that stands become merchantable for harvest is linked to both our ability to predict the future growth of stands and our ability to understand future conditions that will define merchantability (markets / products). The large majority of minimum harvest ages used in the base case scenario was based on achieving 95% of the stands maximum mean annual increment (MAI). This age almost always delivered the minimum stand and log requirements (vol/ha, avg dbh) but these criteria occasionally pushed the harvest ages higher. It is important to note that minimum harvest ages are only meant to approximate the time when a stand first becomes merchantable, and that harvesting can and does occur well beyond these ages in the model.

The use of minimum harvest ages associated with maximum MAI's tends to optimize long term harvest levels, but the use of younger ages tends to provide flexibility in the transition from short- to long-term harvest levels. The transition from short- to mid-term harvest levels in the Revelstoke TSA is heavily influenced by when managed stand volumes become available in significant quantities. In order to understand the risks associated

with changing minimum harvest ages, sensitivity runs have been completed to explore the impact of both higher and lower ages.

How was it Analyzed?

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

Results

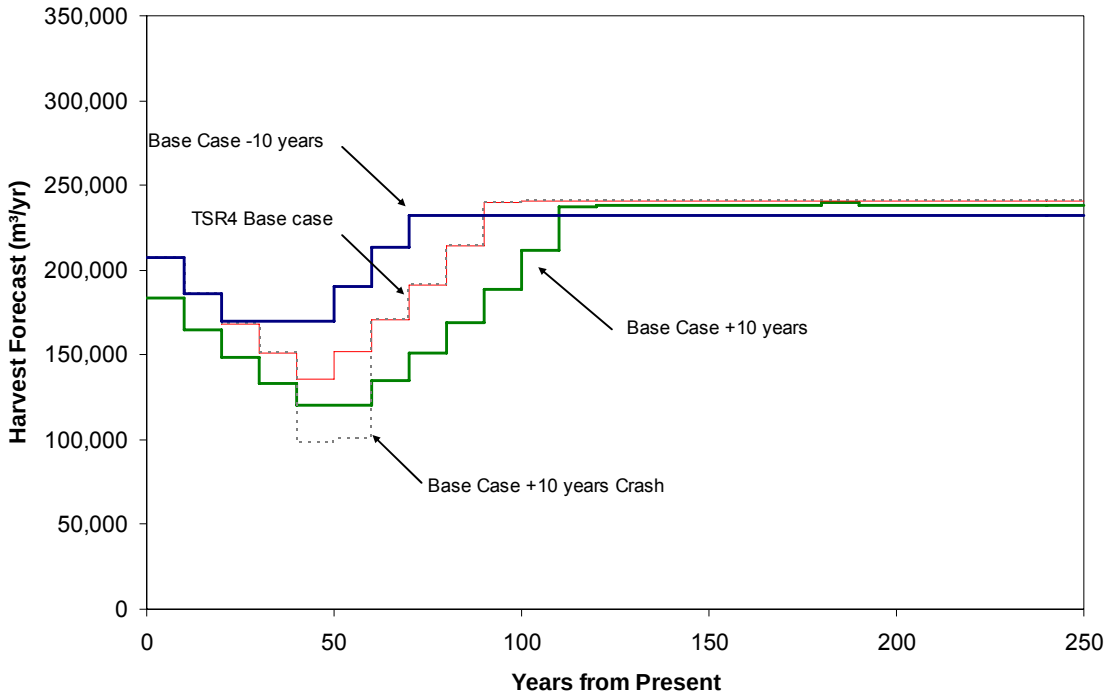


Figure 33. Minimum harvest ages increased and decreased by 10 years

Run	Short Term	Mid Term	Long Term
Min Harvest Ages decreased by 10 years	No Change	The mid-term low is significantly improved by 25% to 170,000 m³/yr	The LTHL is achieved two decades earlier but is lower by 3.4% to 232,300 m³/yr
Min Harvest Ages increased by 10 years	The short-term is decreased by 11.5% to 183,300 m³/yr	The mid-term low decreases by 11.5% to 120,100 m³/yr	The LTHL is achieved two decades later and is slightly lower (1.0%)

Decreasing MHAs by 10 years provided significant flexibility in the midterm and allowed the step up to the long-term to occur two decades sooner. Increasing the MHAs dramatically reduced the short and mid-term harvest levels because the existing natural stands must now be metered out over an extra decade before managed stands become eligible for harvest. The long-term harvest level is achieved two decades later (Figure 33) and is slightly less than the base case because harvesting is not longer occurring near the maximum mean annual increment for each stand type.

4.7.6 *Armillaria* Root Rot

Armillaria ostoyae (Armillaria) is a root disease which affects a portion of the forest stands of the southern 1/3 of British Columbia. In his last determination for the TSA, the Chief Forester expressed concern for the lack of consideration for *Armillaria* root disease and encouraged the collection of data to better estimate volume losses resulting from *Armillaria*. However, very little data has been collected to date. This sensitivity is designed to explore the potential impacts of Armillaria on timber supply using impact estimates built into the TIPSY growth and yield model.

How was it Analyzed?

Run	How was it Analyzed?
Armillaria Root Rot	TIPSY *Armillaria* OAF functionality (low incidence level) was used to generate yield curves. TIPSY only applies *Armillaria* OAF's to Douglas-fir in the ICH so only AU's with Douglas-fir were affected (i.e. AU's: 201-218, 227-230, 501-509, 513-515, 601-609, 613-615). Yields were generated assuming the entire THLB of each AU was impacted by *Armillaria* (in the ICH) and then a prorated yield curve was calculated by determining the proportion of the land base that falls within the ICH for each AU.

Results

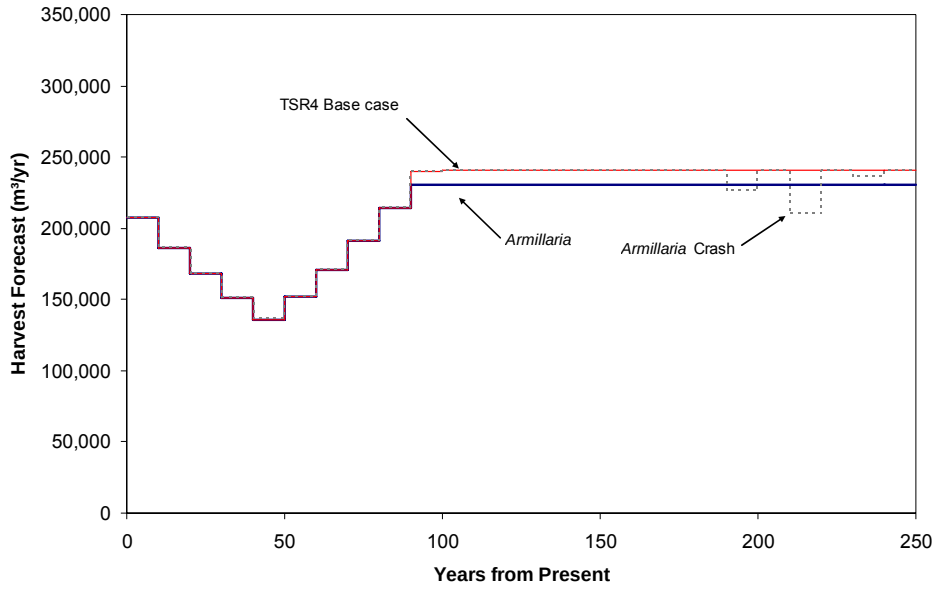


Figure 34. TIPSY Low severity Armillaria root rot applied to Douglas-fir in the ICH

Run	Short Term	Mid Term	Long Term
Armillaria – low incidence	No Change	No change	The LTHL decreases by 4.1% to 230,600 m³/yr

Figure 34 shows that the assumed levels of *Armillaria* lead to a 4.1% reduction in the long-term harvest levels. Even though impacts were around 30% for Fd in the ICH, when reductions are applied to only the Fd volume in managed stands in the ICH, the net reduction for the THLB as a whole was relatively small.

4.7.7 Gains from Select Seed

As required by the Chief Forester's Standards for Seed Use, the TSA uses the best genetic quality seed and vegetative material available for regeneration (>5% gain). The use of select seed from tree breeding programs increases expected future volume yields. TIPSY yields for future managed stands were adjusted in the base case relative to past and current use of select seed (existing Lw-2.7% and Sx-2.3%, future Fd-8.9%, Lw-28%, Sx-13.2%). Ongoing breeding programs in seed orchards are expected to continue to improve the quality of this select seed and deliver even higher gains than the seed planted today.

This sensitivity examines the impact of applying the gains projected at 2019 to all future managed stands (Fd-28.9%, Lw-32%, Sx-17.5%). This overestimates the gains in the first decade but then provides realistic (but unproven) gains for the remainder of the planning horizon.

How was it Analyzed?

Run	How was it Analyzed?
2019 gains from select seed	The expected gains for 2019 seed were applied to all future managed yield tables. As in the base case, area weighted average gains were applied to all occurrences of a species (Fd-28.9%, Lw-32%, Sx-17.5% applied in TIPSY).

Results

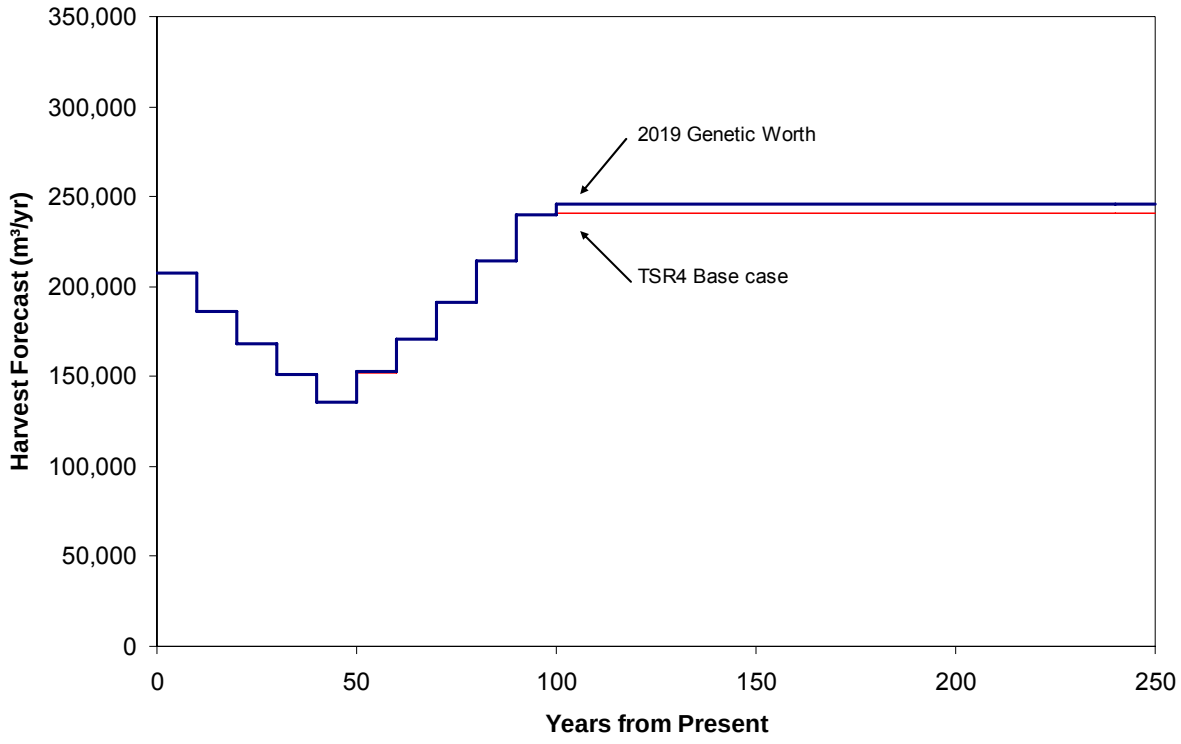


Figure 35. Projected Genetic Worth gains (2019) applied to Managed Stand Yields (TIPSY)

Run	Short Term	Mid Term	Long Term
2019 gains from select seed	No change	Almost no change (0.1% increase)	The LTHL increases by 2.4% to 246,200 m³/yr

Applying the projected 2019 genetic worth values resulted in a 2.4% gain in the long-term relative to the base case (Figure 35). Although genetic gains are significantly higher than the base case gains for some species (e.g. Fd and Lw), they are only applied to a subset of the landbase and a subset of the individual yield curves.

4.7.8 Visuals

The constraint analysis section indicated that VQOs were a significant factor in limiting the base case harvest projection. This scenario tested that conclusion by relaxing the VQO constraints. This was accomplished by reclassifying the VQOs down one class (e.g. PR went to M). These changes effectively increased the early seral limits in each VQO category and allowed more harvest within each VQO.

How was it Analyzed?

Run	How was it Analyzed?
VQO classes re-classified down one class.	All VQO classes were reduced by one class (R to PR, PR to M, M stayed the same).

Results

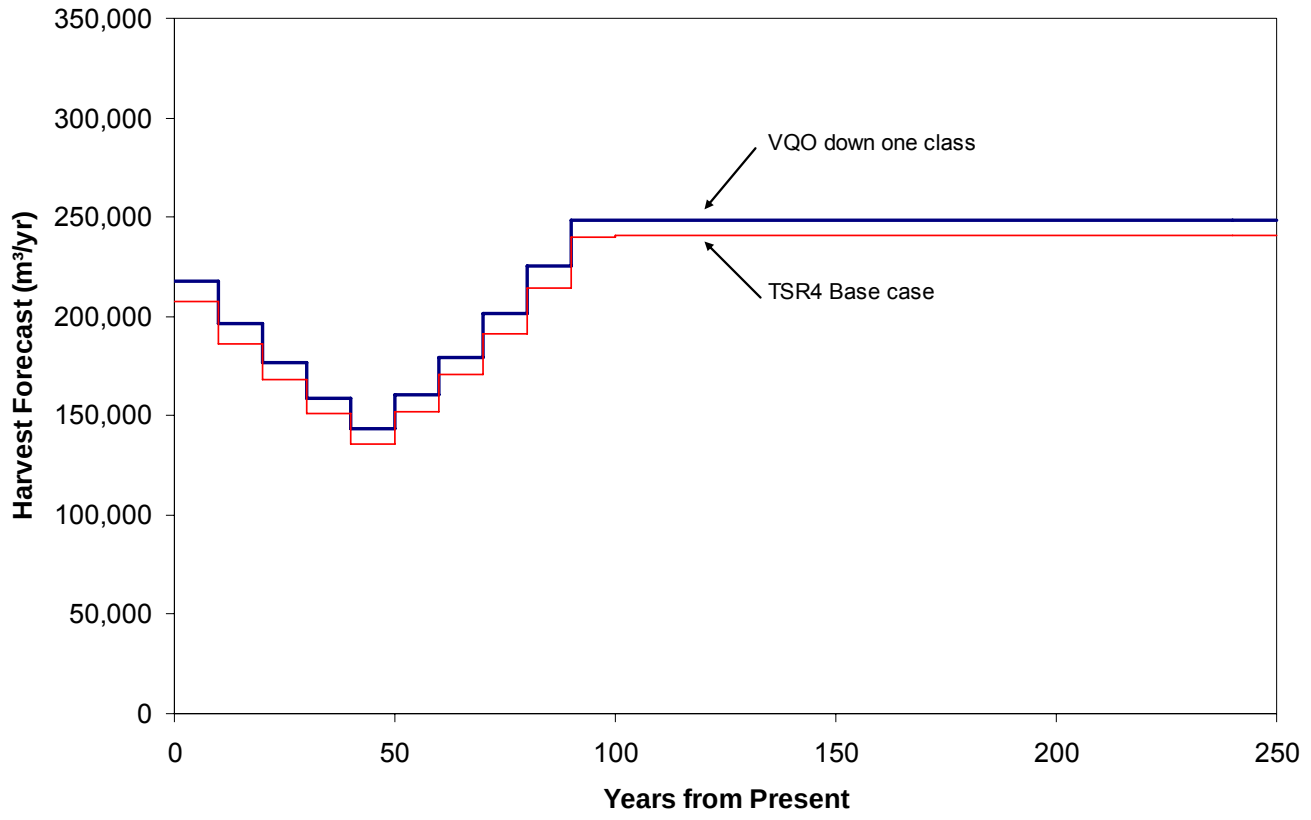


Figure 36. Visual Quality objectives downgraded by one class

Run	Short Term	Mid Term	Long Term
VQO classes re-classified down one class.	The short-term harvest level increases by 5.3% to 218,100 m³/yr	The mid-term low increases by 5.3% to 143,100 m³/yr	The transition to the LTHL starts one decade sooner and the LTHL increases by 3.4% to 248,600 m³/yr

Relaxing maximum disturbance constraints within visual polygons resulted in higher harvest volumes across the entire planning horizon (Figure 36). This is consistent with the conclusions resulting from constraint analysis that shows that visual quality objectives limit the available harvest.

4.7.9 Excluding Dominantly Hemlock Stands

Stands with high proportions of hemlock are uneconomic during poor market conditions because they have relatively high proportions of pulp volume. This scenario has been designed to explore the timber supply implications of not harvesting in high % Hw stands (>79% Hw).

How was it Analyzed?

Run	How was it Analyzed?
Exclude Hw (80+%) stands	Stands that have >79% hemlock component were removed from harvest eligibility. This resulted in a 1,712 ha (3%) reduction from the base case THLB (down to 56,195 ha from 57,907 ha).

Results

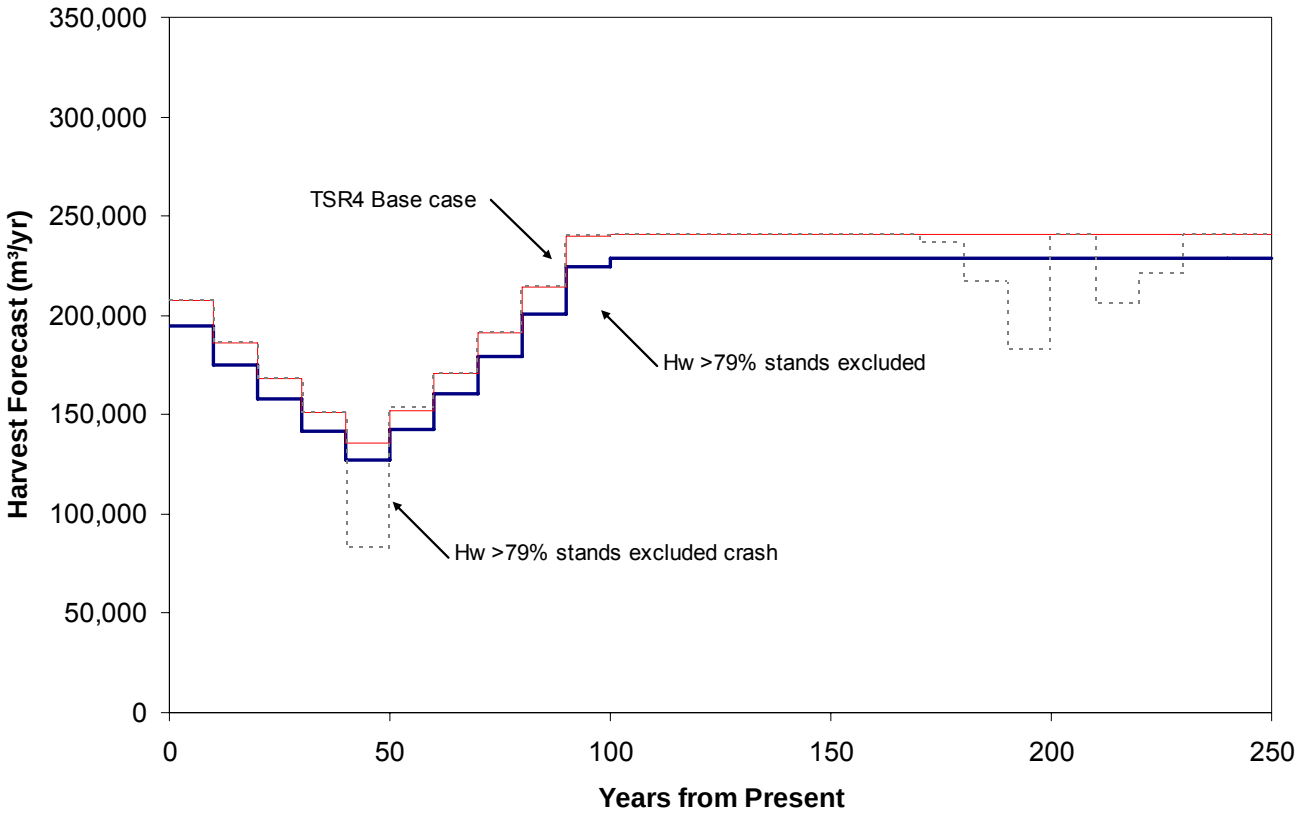


Figure 37. Exclude hemlock (hw) leading stands over 79% from the timber harvesting land base

Run	Short Term	Mid Term	Long Term
Exclude Hw leading (>80%)	The short-term harvest level decreases by 6.1% to 194,500 m³/yr	The mid-term low decreases by 6.1% down to 127,600 m³/yr	The LTHL decreases by 4.7% down to 229,200 m³/yr

Excluding Hw leading stand (>79%) from the timber harvesting land base resulted in a decreases the harvest level over the entire planning horizon (Figure 37). The short- and mid-term harvest flow is heavily dependant on existing stand volumes. Excluding dominant hemlock stands from harvest reduces the mature THLB by ~6% so the short- and mid-term impacts of removing these stands is greater than in the long-term.

4.7.10 Greenup Ages

This scenario was designed to show the impact of increased green-up ages. This could result from stands growing slower than expected or from disturbances that prevent plantations from being successful.

How was it Analyzed?

Run	How was it Analyzed?
Greenup Ages	All greenup ages (IRM greenup age and VEG ages) were increase by 4 years.

Results

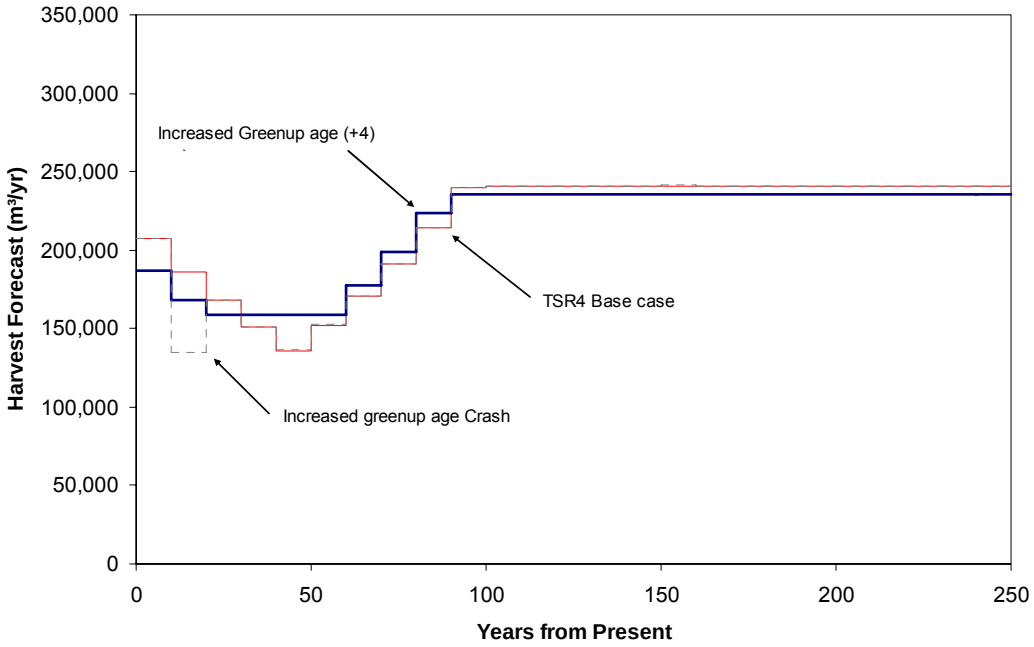


Figure 38. Increase all greenup ages by 4 years

Run	Short Term	Mid Term	Long Term
Greenup Ages	The initial harvest rate decreases by 9.9% to 186,600 m³/yr	The mid-term low is significantly improved by 16.9% to 158,900 m³/yr	The LTHL decreases by 2.0% to 235,600 m³/yr

Increasing the ages to greenup heights significantly reduced harvest availability in the second decade thereby reducing the initial harvest rate to satisfy the maximum decadal harvest flow change policy of no more than 10%. The foregone harvest volume in the first three decades helps to alleviate the mid-term trough during the transition from natural stands to managed stand resulting in a significantly improved mid-term harvest level over the base case.

4.7.11 No Mature Biodiversity in Caribou LU's

This sensitivity explores the timber supply impact of removing the Revelstoke HLPO Mature biodiversity requirements from Landscape units where Caribou is managed for (north of the City of Revelstoke). This sensitivity was completed to understand the implications of allowing the increased caribou requirements in the TSA to replace mature biodiversity constraints.

How was it Analyzed?

Run	How was it Analyzed?
No Mature Biodiversity in Caribou Landscape Units	The mature biodiversity requirements were removed for the Landscape units north of the city of Revelstoke for the entire planning horizon. This includes: Big Eddy, Bigmouth, Downie, French, Frisby Ridge, Goldstream, Horne, Illecillewaet, Jordan, LaForme, Liberty, Mica, Redrock, and Soards. Spatial MOGMAs were also turned off (in the first period) for these landscape units.

Results

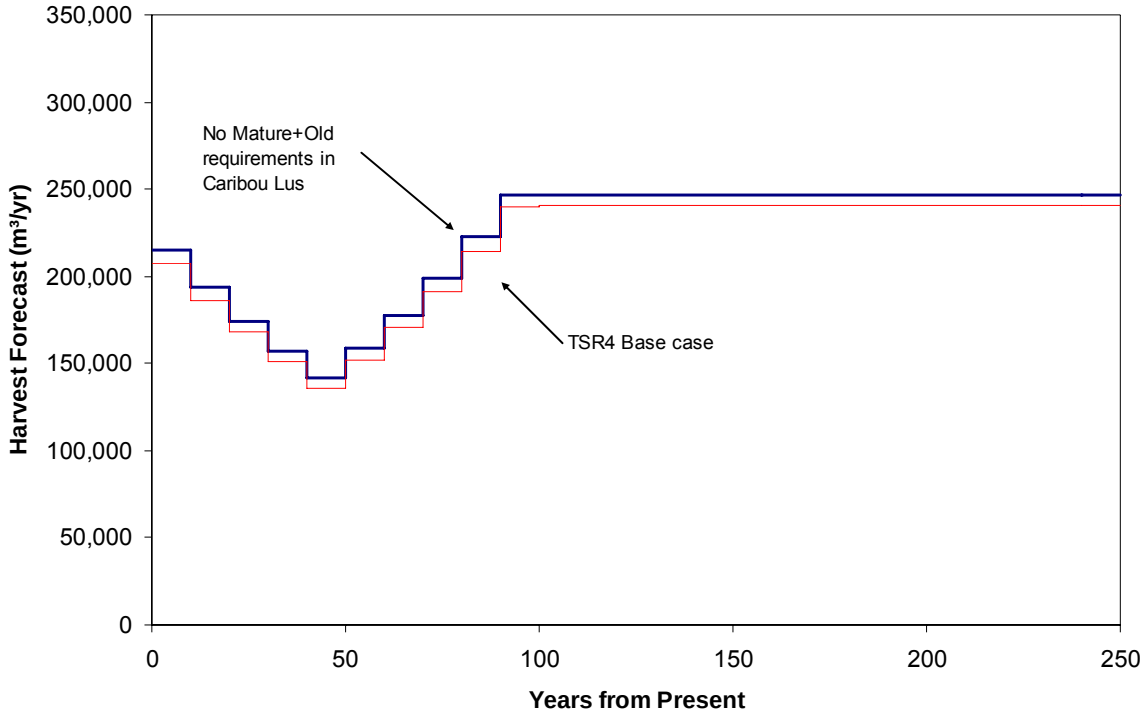


Figure 39. Mature+old seral requirements removed from Landscape Units managed for Caribou

Run	Short Term	Mid Term	Long Term
No Mature Biodiversity in Caribou Landscape Units	The short-term harvest level increases by 4.0% to 215,500 m³/yr	Mid-term low increases by 4,0% to 141,400 m³/yr	The LTHL increases by 2.5% to 246,500 m³/yr

Removing the Revelstoke HLPO mature+old seral requirements from the landscape units that are managed for Caribou resulted in timber supply improvements over the entire 250 year planning horizon (Figure 39).

4.7.12 Provincial Non-Spatial Old Growth Order

This sensitivity explores the potential timber supply impact of adopting the Provincial Non-Spatial Old Growth Order in place of the mature and old biodiversity requirements set out in the Revelstoke Higher Level Plan Order. The key changes that result from implementing the Provincial Order are the removal of all mature targets and allowing old targets in Low Biodiversity Emphasis Landscape Units to drop to 1/3 of the full targets levels for the first rotation (80 yrs). This included dropping the HLPO requirement to meet targets above and below the operability line.

How was it Analyzed?

Table 9. Provincial Old Growth Order Old Growth Objectives for BEC Zones in the Revelstoke TSA

BEC Zone	NDT	Old Age (yrs)	Old Targets				
			Low * 1st Rot	Low * 2nd Rot	Low * 3rd Rot	Intermediate BEO Old	High BEO Old
ESSF	1	>250	6.3	12.6	19	19	28
ICH	1	>250	4.3	8.6	13	13	19
ICH	2	>250	3	6	9	9	13

* Old seral requirements in Low BEO areas start at 1/3 old for first 80 years, 2/3 old for the next 80 years, and full old beyond.

Run	How was it Analyzed?
Provincial Non-Spatial Old Growth Order	Spatial OGMAs/MOGMAs were turned off and the Revelstoke HLPO requirements for mature and old biodiversity were replaced with the requirements set out in the Provincial Non-Spatial Old Growth Order (Table 9).

Results

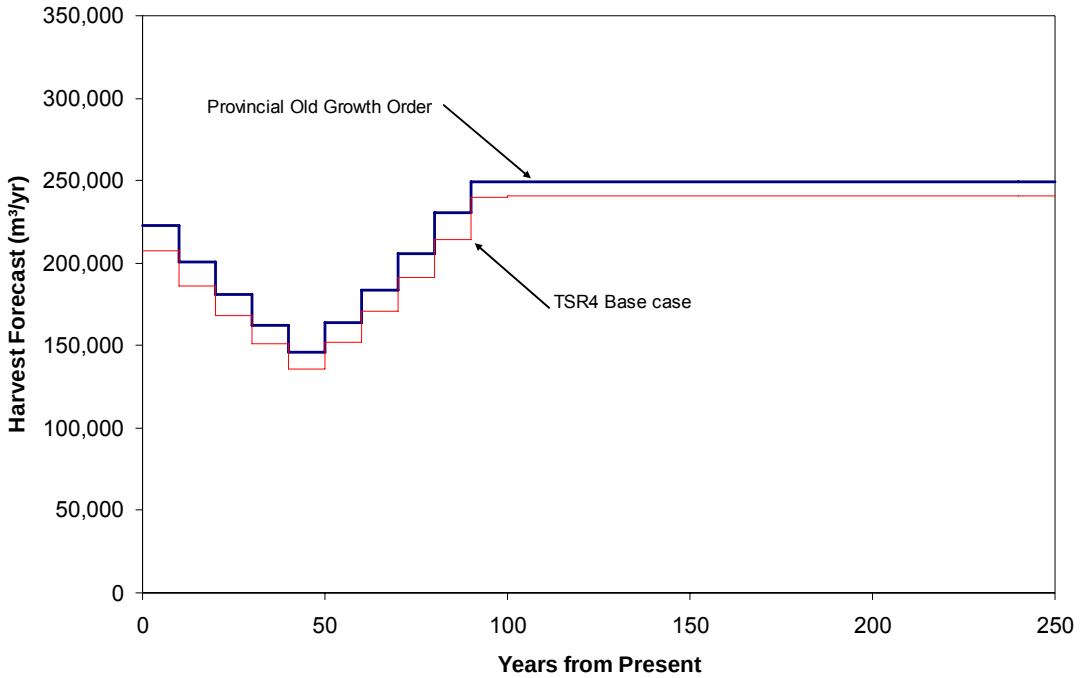


Figure 40. Provincial Old Growth Order in place of Revelstoke HLPO seral requirements

Run	Short Term	Mid Term	Long Term
Provincial Non-spatial Old Growth Order	The initial harvest level increases by 7.6% to	The mid-term low increases by 7.6% to	The LTHL increases by 3.5% to 249,000 m³/yr

	223,000 m³/yr.	146,300 m³/yr

Adopting the Provincial Non-spatial Old Growth Order in place of the Revelstoke HLPO resulted in short-, mid-, and long-term improvements over the base case. Results from this sensitivity are similar to the previous sensitivity (no mature+old requirements in Caribou LUs) because there are no Mature+Old requirements under the Provincial Higher Level Plan Order. Additional improvements were realized under this sensitivity because of the 1/3 low BEO phase in for old seral targets.

4.7.13 Remove Operability Line Condition from HLPO Biodiversity

The Revelstoke Higher Level Plan requires that mature and old biodiversity requirements be met above and below the operability line separately. This scenario explores the impacts of meeting this condition.

How was it Analyzed?

Run	How was it Analyzed?
Remove operability line condition from HLPO Biodiversity.	OGMAs and MOGMAs were turned off completely and HLPO requirements were turned on for the entire planning horizon with the operability condition removed. Forests above the operability line that met the old and mature age criteria were allowed to count towards biodiversity targets over the entire CFLB portion of each landscape unit.

Results

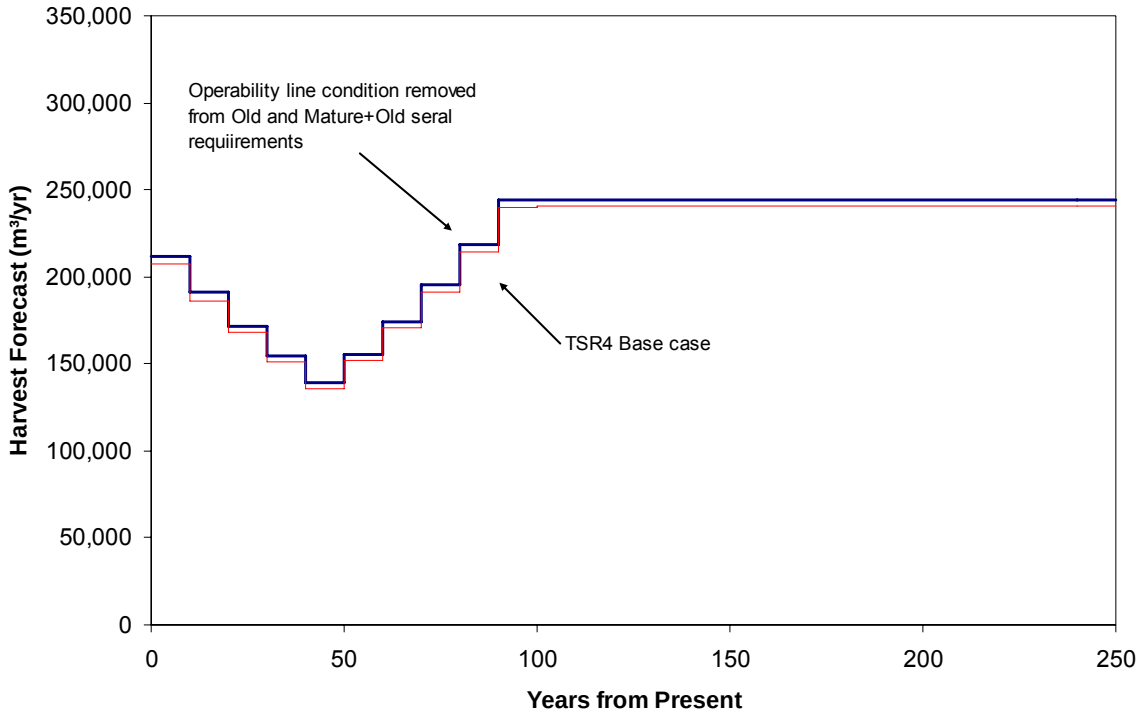


Figure 41. Operability line condition removed from Old and Mature+Old seral requirements

Run	Short Term	Mid Term	Long Term
Operability line condition removed	The initial harvest level increases by 2.3% to 212,000 m³/yr.	The mid-term low increases by 2.3% to 139,100 m³/yr	The LTHL increases by 1.7% to 244,500 m³/yr

Removing the operability line condition allows old and mature forests above the operability line to contribute to the Old and Mature+Old requirements for several LU/BEC variant unit and results in short-, mid-, and long-term improvements over the Base Case (Figure 41).

4.7.14 Remove the 'Incremental' Portion of the Caribou GAR (U-3-005) Reserves

This sensitivity explores the timber supply impact of the 'Incremental' portion of the Caribou GAR reserves.

How was it Analyzed?

Run	How was it Analyzed?
Remove the 'incremental' portion of the caribou GAR reserves	The 'incremental' caribou coverage was used to identify the portions of the Caribou reserves that were implemented in excess of the specialized Revelstoke HLPO 'status quo' datasets. These areas were then added back into the THLB which resulted in a 7% increase in THLB from 57,908 ha to 61,984 ha (+4076 ha).

Results

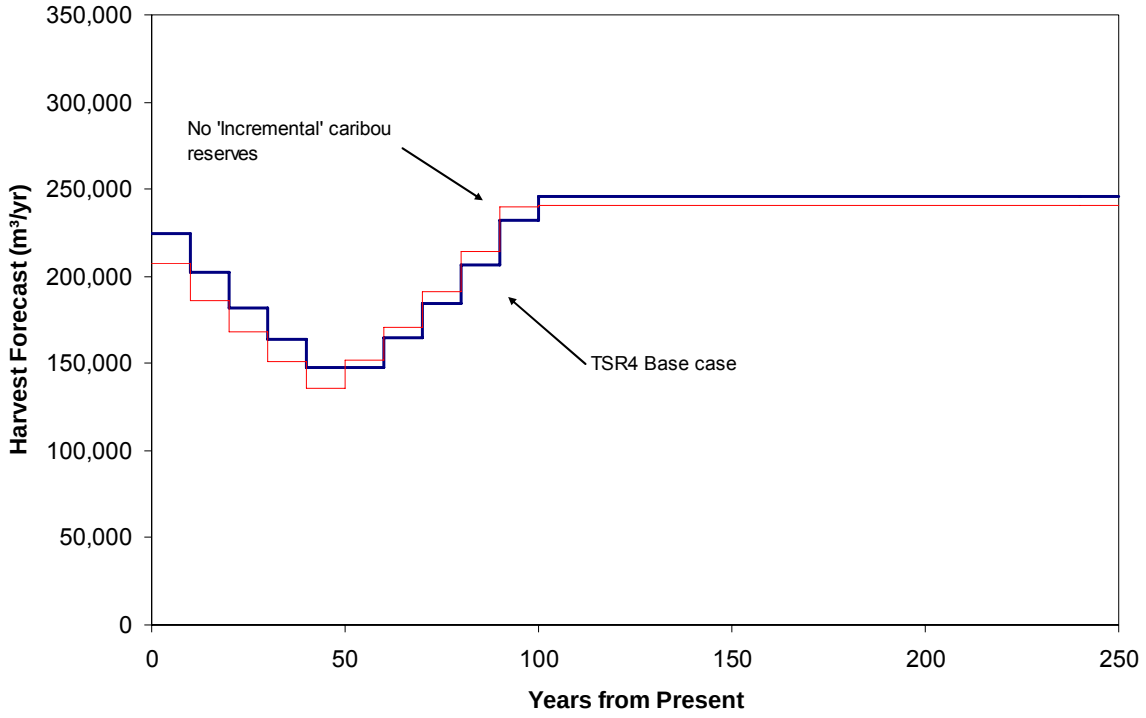


Figure 42. 'Incremental' portion of the Caribou GAR reserves removed

Run	Short Term	Mid Term	Long Term
Remove the 'incremental' caribou GAR reserves	The initial harvest level increases by 8.4% to 224,500	The Mid-term low increases by 8.4% to 147,300 m³/yr	The LTHL is achieved one decade later and increases by 2.2% to 244,800 m³/yr

Removing the 'incremental' portion of the Caribou reserves resulted in a large timber supply improvement in the short and mid-term (8.4%) even though the THLB increase was only 6.6%. This occurred because these reserves contain mostly mature stands that are now available for harvest.

4.7.15 Remove the all Non-Caribou Ungulate Winter Range Requirements

This sensitivity explores the timber supply impact the Ungulate Winter Range (non caribou) forest cover requirements (GAR U-4-001).

How was it Analyzed?

Run	How was it Analyzed?
Remove non-Caribou UWR forest Cover requirements	Remove all forest cover requirements associated with Mule Deer and/or Moose.

Results

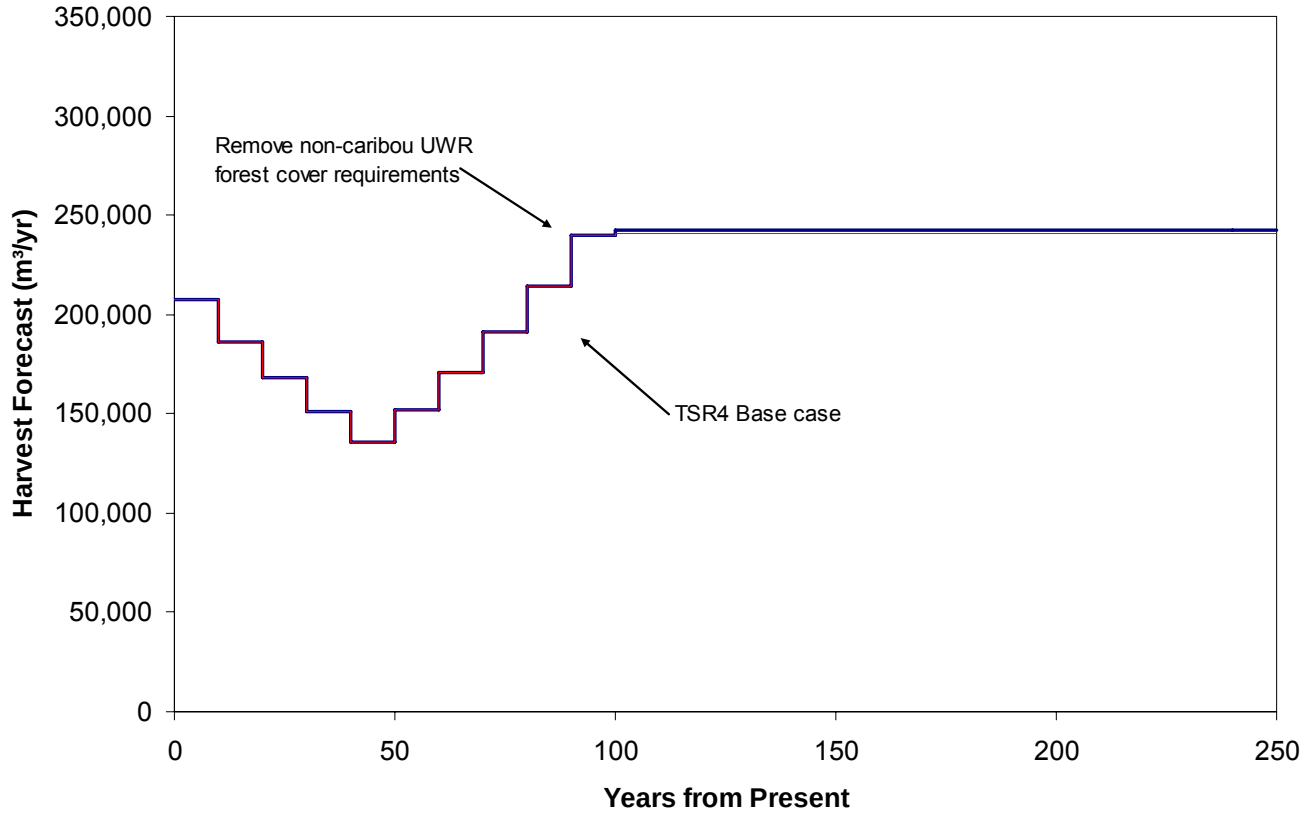


Figure 43. 'Incremental' portion of the Caribou GAR reserves removed

Run	Short Term	Mid Term	Long Term
Remove non-Caribou UWR forest Cover requirements	No Change	No Change	Almost no change. The long-term harvest level increases by 0.7%

Removing the non-caribou UWR forest cover requirements resulted in essentially no change in the timber supply relative to the base case. This indicates UWR constraints are not limiting timber supply in the Revelstoke TSA – likely because other overlapping forest cover constraints are more limiting (i.e. Visuals, IRM greenup). Of the 5,996 hectares of UWR that exist in the Revelstoke TSA, 4711 ha (78.6%) overlap with areas managed for visuals.

5.0 Summary of Base Case Sensitivity Analysis

The results of the sensitivities completed for this project are summarized in Table 10 below.

Table 10. Summary of Analysis Results

Sensitivity	Percent change relative to the Base Case		
	Short Term	Mid Term[9]	Long Term
THLB Increased by 10%	6.4%	6.4%	9.7%
THLB Reduced by 10%	-9.0%	-8.9%	-9.7%
Managed stand yields decreased by 10%	-0.5%	-0.5%	-10.8%
Managed stand yields increased by 10%	0.4%	0.4%	10.8%
Natural stands yields decreased by 10%	-10.1%	-10.1%	0.6%
Natural stand yields increased by 10%	9.9%	9.9%	0.6%
VDYP 7 vs. VDYP6[10]	~ 7.4%	~ 7.4%	~ 0.0%
Full SIBEC site productivity estimates (ESSF included)	-0.5%	-0.5%	1.3%
Minimum harvest ages (MHA) reduced by 10 years	0.0%	25.0%	-3.4%
Minimum harvest ages (MHA) increased by 10 years	-11.5%	-11.5%	1.0%
Low severity *Armillaria* in ICH (Fd only) applied to managed stand yield curves	0.0%	0.0%	-4.1%
Gains from Select Seed (projected Genetic Worth–2019)	0.0%	0.1%	2.4%
VQO classes re-classified down one class	5.3%	5.3%	3.4%
Hw > 79% excluded from the timber harvesting land base	-6.1%	-6.1%	-4.7%
Greenup age +4 years	-9.9%	16.9%	-2.0%
No Mature+Old in Caribou LUs	4.0%	4.0%	2.5%
Provincial Old Growth Order	7.6%	7.6%	3.5%
Operability line condition removed	2.3%	2.3%	1.7%
Remove 'Incremental' portion of the Caribou GAR reserves	8.4%	8.4%	2.2%
Remove all non-caribou UWR Forest Cover Requirements	0.0%	0.0%	0.7%

[9] All values provided are in reference to the period 5 harvest level, the point at which timber supply in the base case is lowest.

[10] This sensitivity did not involve modeling and approximate changes in AAC (m^3.yr) are provided based on the volume difference (m^3) of standing volume.

6.0 Socio-Economic Assessment

6.1 Introduction

To help inform the TSR4 process, this socio-economic assessment (SEA) estimates the likely economic activity associated with the base case timber supply forecast. A region's timber supply is a fundamental determinant of the size of its forest industry, which is often a leading sector in BC regional economies. The Chief Forester determined allowable annual cut (AAC) effectively sets the upper limit on the annual timber supply available for harvest in a TSA. Changes to an AAC can have important economic consequences so gauging their likely impacts provides important decision-making information for TSA stakeholders, including the Chief Forester.

The primary output of this socio-economic analysis is a comparison of employment, employment income and government revenues that the current AAC can support with the levels that could be supported by the base case forecast of this timber supply analysis. This analysis shows the potential incremental change in forest sector employment, employment and government revenues from implementing the short term timber supply of the base case as the AAC. The analysis also includes the following elements.

- Brief socio-economic profile of the Revelstoke TSA
- Brief profile of the Revelstoke TSA's forest industry
- Estimate of employment supported by recent timber harvesting in the TSA

6.2 Socio-economic setting

6.2.1 Population and demographic trends

The Revelstoke TSA is situated in southeastern BC, between the Selkirk Mountains to the east and the Monashee Mountains to the west. The City of Revelstoke is the TSA's largest and only incorporated community and accounts for approximately 90% of the TSA's relatively small population of about 8 000. It is located in the southeast corner of the TSA at the intersection of the Trans-Canada Highway, which bisects the southern half of the TSA, and Highway 23, which carries traffic north and south along the Columbia River between the small community of Mica Creek and the ferry crossing at the north end of the Lower Arrow Lake. Mt. Revelstoke National Park is surrounded by the TSA and Glacier National Park lies outside its southeastern borders. Lake Revelstoke, the reservoir for Revelstoke Dam, runs north and south for 120 km through most of the TSA.

Mica Creek, 148 km north of Revelstoke, was originally a townsite for employees building Mica Dam. Its population peaked at 4 000 in 1973 but is now a very small settlement of approximately 30 residents with a few tourism operators and buildings for temporary accommodation of BC Hydro employees who work at Mica Dam. Its village municipal status was removed in 2005.

There are neither Aboriginal communities nor Indian Reserves in the TSA. The portion of the area's population that self-identifies as Aboriginal is small, approximately 330, or 2%.[11] The following First Nations have claimed traditional territory within all or part of the TSA.

- Ktunaxa Nation Council (KNC)
- Akisq'nuk First Nation
- Shusawp Nation Tribal Council (SNTC)
- Shuswap Indian Band
- Little Shuswap Indian Band
- Splatsin
- Neskonlith Indian Band
- Adams Lake Indian Band
- Simpcw First Nation
- Okanagan Nation Alliance (ONA)
- Okanagan Indian Band
- Lower Similkameen Indian Band

[11] based on data from the 2006 Census

There are three Traditional Use Study Inventory Projects in MOFR's TUS database, which include all or a part of Revelstoke TSA. They are Ktunaxa/KKTC (1998), Adams Lake/Neskonlith Secwpemc (1999) and Little Shuswap Indian Band (March 2000).[12]

The population growth of the City of Revelstoke and the Revelstoke Local Health Area (LHA) has lagged the province-wide performance by a wide margin over the past decade.[13] Over the 1996-2006 Canada Census period, the city's population dropped by 12.8% to 7,288. The Revelstoke LHA's population decreased by a similar amount because the City of Revelstoke accounts for more than 90% of the region's population. In recent years, the city`s population has stabilized; the estimated 2009 population was 7 267, a small decrease of 0.3% over the 2006 level. The northern half of the TSA is mountainous and has only a small number of residents at Mica Creek.

The local population has leveled off since the turn of the century due to stabilization of the local economy after losses in forestry and railway employment in the 1990s. The city's population has become older, with its proportion who are 65 years and older rising from 9.7% to 12.8% over the 1996-2006 period and the share for the group under 14 years of age declining from 22.5% to 17%. **Error! Reference source not found.** presents population data for the City of Revelstoke, Revelstoke Local Health Area (LHA) and the rural-residential areas in the vicinity of Revelstoke.

Table 11. Population (1996 – 2006)

Areas	2006 Population	change '06 over '01	change '01 over '96	change '06 over '96
City of Revelstoke	7 288	7 230	8 355	-1 067 (-12.8%)
Rural-residential	609	980	615	-7 (+1.1%)
Revelstoke Local Health Area	7 897	8 210	8 970	-1 073 (-12.0%)
BC	4 113 487	3 907 738	3 874 317	239 170 (+6.2%)

Source: BC Stats

6.2.2 Economic profile

Employment income data based on the 2006 Census indicates that the public sector has become Revelstoke's main source of employment income (21% share), followed by the forestry (18%) sector, which held the top spot in previous Census years.[14] The following table shows the distribution of the Revelstoke area's employment income over the 1990 to 2005 period.[15]

Table 12. Revelstoke Employment Income (2005, 2000, 1995 and 2000), percentage (%) distribution

Year	Forest	Mining	Fish/trap	Agri	Tourism	Public sector	Other basic	Transfers	ONEI[16]
2005	18	2	0	1	9	21	23	14	12
2000	21	1	0	0	16	17	20	15	11

[12] Site specific use information in all three studies has been retained by the respective First Nations and can only be obtained by contacting that First Nation directly.

[13] There is no population data that corresponds to the TSA boundaries so population data from BC Stats for the Revelstoke Local Health Area (LHA) is used because it has similar boundaries to the Revelstoke TSA.

[14] The size of the Revelstoke accommodation and foodservices sector is likely larger during the winter due to the seasonal employment of the skiing and accommodation operations of Revelstoke Mountain Resort.

[15] The labour force data from the Census has a one year lag because Census respondents are asked about their employment as of June 30 of the previous year; June 30, 2005 in the case of the 2006 Census.

[16] Other Non-Employment Income (ONEI), mainly investment and pension income

Year	Forest	Mining	Fish/trap	Agri	Tourism	Public sector	Other basic	Transfers	ONEI[16]
1995	22	3	0	0	10	20	20	4	9
1990	16	2	0	0	6	16	29	11	17

Source: Horne March 2009

The transportation & warehousing sector, which is an important factor in the local economy based on railway supported employment, is included in the "Other Basic" category of the preceding table. The next table presents labour force numbers for 2005 and 2000 for the City of Revelstoke. The importance of railway employment is seen in the 12.6% share of the labour force held by the transportation & warehousing sector. The relative share of the transportation sector has dropped since 1990 due to shrinkage in local employment by CP Rail. The four sectors of forestry, public sector, tourism (accommodation & food services) and transportation are the main sources of the area's employment.

Table 13. Revelstoke Labour Force (2005 and 2000)

Industry	2005 #	2005 %	2000 #	2000 %	% change 2005 vs 2000
Forestry	490	11.8	510	12.4	-3.9
Mining & mineral products	80	1.9	45	1.1	17.1
Construction	370	8.9	235	5.7	57.4
Transportation & warehousing	525	12.6	545	13.3	-3.7
Non-wood manufacturing	170	4.1	75	1.8	126.7
Retail & Wholesale Trade	485	11.6	420	10.2	15.5
FIRE[17]	110	1.7	100	2.4	10
Public Sector[18]	740	17.7	700	17.1	5.4
Accommodation & Food Services	540	12.9	670	16.3	-19.4
Total	4 170	100.0	4 100	100.0	+1.7

Source: BC Stats and Statistics Canada

Employment in the region's forestry sector dropped between 2005 and 2000; the forestry services and logging labour force shrank by approximately 20% and the wood products manufacturing labour force was down by approximately 10%.

The indirect and induced employment[19] of the logging and wood products manufacturing sectors in the Revelstoke area is much higher than for tourism and slightly higher than for the public sector. The logging industry creates three times the indirect and induced employment of the local tourism sector (0.27 indirect and induced jobs per logging industry job versus 0.09 indirect and induced jobs per tourism sector job). The following table lists indirect and combined indirect and induced multipliers by economic sector for the Revelstoke area.

[17] Finance, Insurance & Real Estate

[18] Defined as including Public Administration, Educational Services, and Health Care and Social Assistance

[19] Generated by the spending of local firms and their employees,

Table 14. Revelstoke TSA employment multipliers (2001)[20]

Industry	Indirect Multiplier	Indirect/ Induced[21] Multiplier
Logging	1.19	1.27
Wood products manufacturing	1.27	1.39
Construction	1.26	1.33
Public Sector	1.12	1.21
Tourism	1.06	1.09

Source: Horne March 2009

Although the Revelstoke tourism sector has the largest share of the local labour force it does not have the largest share of employment income. A BC Stats study of local economic dependencies based on 2006 Census data showed that the tourism sector of the Columbia Forest District[22] had employment and income shares of 26% and 11%, respectively (Horne 2004).[23] The economic importance of the resource extraction industries is more noticeable when the focus is on employment income. This study listed the forestry sector's shares of employment and income in the Columbia Forest District as 22% and 23%, respectively. The lower share of income for the tourism sector (compared to the forest sector) is due to its higher levels of seasonal and part-time employment and lower average hourly and weekly pay rates.

The data on employment and employment income does not take account however of the major expansion of Revelstoke's ski resort operations in 2007. There had been a community owned ski hill operation on Mount MacKenzie since the early 1960s. A group of investors came together in 1991 to try to expand the skiing operation but it wasn't until 2003 that a group of Toronto and Denver developers acquired the community-owned skiing operation and a cat assisted skiing company and started the process of developing a master planned resort operation on Mount MacKenzie.[24] A master plan was prepared and approved by the BC Government in 2005. In January 2009, Northland Properties Corporation (Northland), a private BC owned family corporation became the major investor in Revelstoke Mountain Resort and Selkirk Tangiers Heli-Skiing.[25] Northland's assets include Sandman Hotel Group, and the Chop, Moxie's, Denny's, and Shark Club restaurant chains, as well as other real estate holdings.

The new owners extensively renovated the day lodge, built overnight guest accommodation, started a seasonal resident subdivision, and installed a new quad chair lift and gondola lifts for its inaugural season in 2007-08. For the 2008-09 season, another chair lift was installed and the gondola was extended so that the resort has the longest lift-serviced vertical descent in North America. An estimated $100 million has been spent to date on the expansion of the ski resort's amenities and facilities.[26] Mount MacKenzie is well known for its heavy snowfall of about 6 to 20 metres. The resort is located a relatively short driving time from Revelstoke of 10 minutes and the valley floor and Columbia River can be seen from its quad chairlift. The resort owners envision a four-season, one billion dollar development to be completed over 15 years, which would include more than 5 000 new housing units (1 500 condominiums, 2 000 hotel suites, 850 townhomes and 550 single-family lots), as well as more than 500,000 square feet of commercial and retail space, and destination golf course. There are several other local attractions for visitors located inside or near the TSA's boundaries.

- Three Valley Gap – a 200 room resort hotel and heritage ghost town situated 15 km west of Revelstoke

[20] These multipliers are for the Columbia Forest District, which includes the Revelstoke TSA and the Golden TSA.

[21] Assumes no migration in the event of lay-off

[22] This study was organized by forest district. The Columbia Forest District encompasses the Revelstoke and Golden TSAs.

[23] The figures based on the 2001 Census were 34% of employment and 15% of employment income. The 2006 Census figure does not capture the recent expansions of the Revelstoke Mountain Resort and Kicking Horse Resort.

[24] Pg 15, Brent Harley & Associates August 2004

[25] Pg. 10, *Business in Vancouver*, Feb.24-Mar. 2, 2009.

[26] Ibid

- Craigellachie – a heritage site commerating the location of the "last spike" of the Trans Continental Railway, which is situated 40 km west of Revelstoke
- Revelstoke Dam – has a visitor centre and is located 5 km north of Revelstoke
- Forestry and CPR museums
- Canyon Hot Springs and Halcyon Hot Springs – located 54 km east and 68 km south of Revelstoke, respectively
- Mount Revelstoke and Glacier National Parks
- Snowmobiling – there are several nearby areas (such as Boulder Mt., Frisby Ridge and Keystone Basin) for snowmobiling and local tour operators

Excluding the Greater Vancouver and Victoria, communities, the Revelstoke area ranks among the top four areas in BC in terms of the diversification of its local economy. Similar to Invermere, employment in the Revelstoke area is spread out over the forestry, railway, tourism and public sectors. Based on a calculated diversity index, BC communities have diversity ratings of between 50 and 80; Revelstoke sits at 75 and Invermere enjoys the province's top rating of 79. The Revelstoke area's employment is strongly weighted towards forestry and tourism employment relative to other non-Vancouver communities in the province. Location quotients[27] based on 2006 Census data show location quotients of 1.71 and 1.72 for Revelstoke's forestry and tourism sectors, respectively.[28] Only Squamish, Invermere and Golden have higher tourism location quotients. With the recent expansion at Revelstoke Mountain Resort, the location quotient for Revelstoke's tourism sector is undoubtedly larger than 1.71 indicating the importance and growth of this local sector to the local economy.

The Revelstoke area was the site of several major projects in the early 1980s, including the construction of the Revelstoke Dam, completed in 1984, the Rogers Pass Tunnel Project, the double tracking of the CP Rail line, and the development of the Goldstream Copper Mine. In the late 1980s and 1990s, the local economy experienced turbulence with the temporary closing of the Downie St. sawmill (1985-88), reductions in railway employment, closure of the Goldstream Mine and reduction in public sector employment.

The local economy has three main private sector employers.

- Downie St. Sawmill operates a saw mill, planermill, dry kilns and remanufacturing plant that employ a total of approximately 420.
- CP Rail has a car repair and maintenance facility and railyard that employs approximately 300.
- Revelstoke Mountain Resort and other businesses at this resort employ approximately 200 during the winter ski season.

Despite the upheavals in the American housing market, the Downie Street Sawmill plants have maintained reasonably steady production levels over the past few years.

A recent negative note was sounded in December 2008, when CP Rail announced the temporary lay-off of approximately 100 employees in each of its Revelstoke and Golden operations due to declining freight traffic levels. These laid-off CP Rail employees are being re-called as freight traffic levels increase.

The 2006 average total income of Revelstoke residents ($34 678) is below the province-wide level of $38 523 by a substantial amount, 10.0% (BC Stats September 2009).[29] Almost three-quarters of total income comes from employment sources and there are smaller shares of investment income and self-employed income than for the province as a whole, which is a typical situation for smaller BC communities.

The portion of the working age population in Revelstoke depending on social safety net income assistance has increased sharply in recent months. The most recent data point to a very high rate of almost 10% of those receiving either basic income assistance or Employment Insurance as a percent of the population aged 19-64

[27] A location quotient measures the concentration of an economic sector in a region or community relative to the concentration of that economic sector in the provincial economy.

[28] Pg 25, Horne March 2009

[29] Based on personal taxation statistics

years old.[30] This figure is almost twice the BC average and more than three times the rate in Vancouver-City Centre. Other areas of the province with higher dependence on resource industries have registered slightly higher "social safety net" dependency rates, however. As an example of a more economically stressed community, the March 2009 rate for the Quesnel LHA was 12.5%.

Table 15. Dependency on the social safety net (%)[31]

Region	March 2007	June 2007	Sept 2007	Dec 2007	March 2008	June 2008	Sept 2008	Dec 2008	Mar 2009
Revelstoke LHA	4.2	2.4	2.2	3.5	3.8	4.5	3.0	6.9	9.8
Quesnel LHA	5.4	5.9	4.4	5.4	6.4	10.7	5.0	7.4	12.5
BC	2.8	2.4	2.2	2.9	2.9	3.8	2.4	3.5	5.2

Source: BC Stats

6.3 Revelstoke TSA Forest Industry

6.3.1 Current Allowable Annual Cut (AAC)

The current AAC of 230 000 m^3 became effective September 1, 2005. The AAC has been at this level since 1995. Between 1985 and 1994 the AAC stood at 269 000 m^3.

Downie Street Sawmills Ltd. (Downie) holds the TSA's largest volume replaceable forest licence (FL); its commitment of 132 152 m^3 accounts for almost 60% of the TSA`s AAC. There are no First Nation-based non-replaceable forest licences in the TSA. **Error! Reference source not found.** presents the current apportionment and commitments for the Revelstoke TSA.

Table 16. Revelstoke TSA AAC Apportionment and Commitments (m3 & % of AAC)

Licensee by Form of Agreement	m^3	% of AAC
Forest Licences Replaceable	180 835	78.6
A31102 –Downie Street Sawmills Ltd.	*132 152*	*57.5*
A32826 – Joe Kozek Sawmills Ltd.	*25 869*	*11.2*
A18992 –Stella-Jones Canada Inc..	*19 290*	*8.4*
A78062 –Selkirk Forest Products Company	*3 524*	*1.5*
BCTS Timber Sale Licence/Licence to Cut	44 510	19.4
Forest Service Reserve	4 655	2.0
Total Allowable Annual Cut	230 000	100.0

Source: Revenue Tenures and Engineering Branch, Ministry of Forests and Range September 15, 2009

6.3.2 Revelstoke TSA harvest history

The average annual billed harvest level in the Revelstoke TSA for the 2006-08 period was 221 617 m^3, compared to an AAC of 230 000 m^3. The Revelstoke TSA's harvest has been consistently within 10% of its AAC over the 1999-2008 decade, except for significant under-harvests in 2001 and 2003. The TSA's billed harvest averaged 93% of its AAC for the ten-year 1999-2008 period. The TSA's billed harvest for 2009 totalled 190 392m^3, a significant under-harvest due to the severe weakness in US housing markets since summer 2008. **Error! Reference source not found.** summarizes the TSA's timber billed harvest volume over the 10-year 1999-2008 period and it is portrayed graphically in Figure 1-1.

[30] This figure understates the impact because it includes those who are retired and not looking for work.

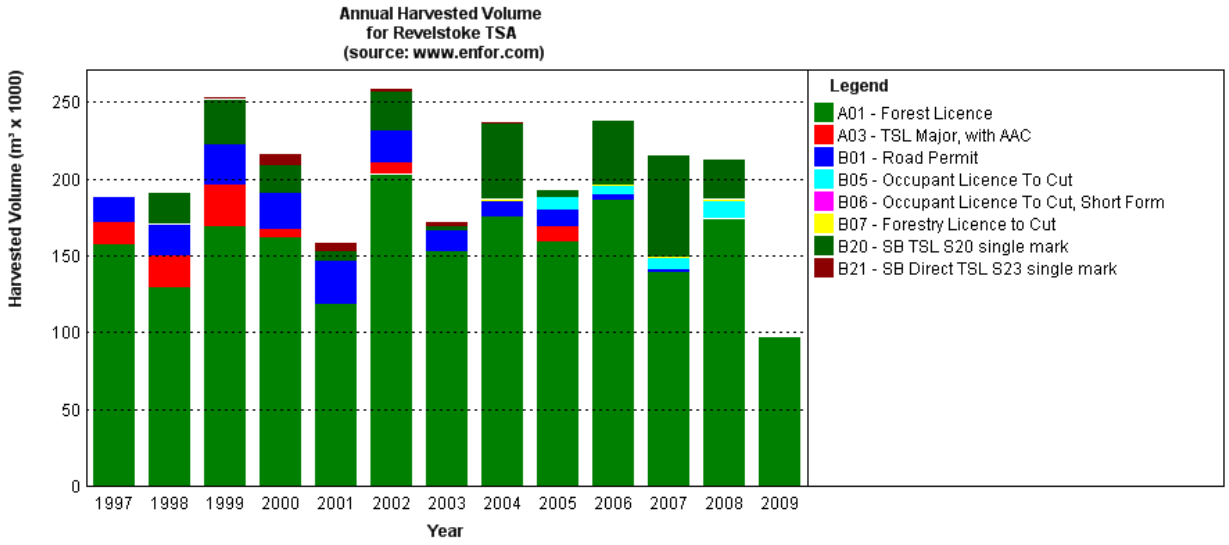
[31] Percentage of the 19-64 year old population receiving either Basic Income Assistance or Employment Insurance

Table 17. Revelstoke TSA Volume (m3) Billed by Form of Agreement (1999-2008)

Tenure	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Forest Licence	168 876	181 705	118 089	202 608	152 716	174 905	158 599	186 152	138 915	173 650
TSL Major with AAC	26 936	5 440	143	7 643		-68	9 969			
Road Permit	26 578	23 287	27 854	20 638	13 250	10 299	11 223	3 861	1 827	168
Occupant Licence to Cut	8	71		61	63		7 791	5 115	8 015	11 923
Forestry Licence to Cut						1 307	194	503	676	773
SB TSL S20 single mark	29 157	18 323	6 201	25 579	3 138	48 869	4 480	41 873	65 914	25 487
SB Direct TSL S23 single mark	1 321	6 884	5 450	1 619	2 949	1 228	42			
Total	252 875	215 710	157 737	258 147	172 117	236 611	192 299	237 504	215 347	212 001
AAC	230 000	230 000	230 000	230 000	230 000	230 000	230 000	230 000	230 000	230 000
AAC variance	22 875	-14 290	-72 263	28 147	-57 883	6 611	-37 701	7 504	-14 653	-17 999
Harvest as % of AAC	110%	94%	69%	112%	75%	103%	84%	103%	94%	92%

Source: BC MOFR data and Enfor Consultants Ltd. compilation

Figure 6-1 Bar Chart of 1999-2008 Revelstoke TSA Annual Billed Harvested Volume ('000 m^3)



6.3.3 Revelstoke TSA major licensees and processing facilities

Downie Street Sawmills Ltd.

Downie Street Sawmills Ltd. is the largest forest industry company operating in the TSA; the company has tenure rights for 57.5% of the TSA's AAC and owns a saw mill, planermill, dry kilns and remanufacturing plant. The value added wood processing facility operates as Selkirk Cedar Ltd., and both the saw mill and it specialize in cedar products. Downie Timber Ltd. is its woodlands subsidiary. Table 1- 8 lists the TSA's wood processing facilities and their locations, main products and estimated annual output capacities.

Table 18. Revelstoke TSA timber processing facilities

Timber Processing Facility	Location	Main Products	Annual output capacity[32]
Downie Street Sawmill Ltd.	Revelstoke	Dimension lumber and boards	95 million bd. ft.
Selkirk Cedar Ltd.	Revelstoke	Decking, tongue and groove paneling, beveled siding	25 million bd. ft.

Source: BC MOFR 2006

The Downie operations have been majority owned by the Gorman family since 1990, and it also owns and operates a Westbank, BC saw mill. Its Revelstoke saw mill dates from the 1940s and the Selkirk Cedar remanufacturing plant began operations in 1999. Since 1991 more than 80 million dollars of capital investments have been made into the sawmill complex making it a modern manufacturing facility. In recent years, capital improvements have focused on updating the planermill, dry kilns and adding a small log line in the saw mill to accommodate 2nd growth logs.

The owners describe their saw mill as a specialty mill, cutting cedar to grade, mainly for their Selkirk Cedar remanufacturing operation. It is the only large-scale cedar product manufacturing operation in the BC Interior and one of the few large-scale, integrated commodity and value added operations in BC. Although there is a significant portion of western red cedar in the region's harvested volume, these Revelstoke operations rely on trucking cedar logs from the BC coast and the Okanagan TSA to feed their timber input requirements. From 20 to 75 truckloads of cedar logs per day come into Revelstoke from the Lower Mainland and the Okanagan TSA.

The amount of clear wood is smaller in the local cedar because it has a much higher proportion of decadent material than coastal cedar logs. Downie trades its spruce, fir and hemlock logs to coastal and regional producers for cedar logs. The byproduct chips are sold to Mercer International's Celgar pulp mill at Castlegar.

In 2005 a community owned steam plant, Revelstoke Community Energy Corporation (RCEC), opened on the Downie property. Downie provided the site for the plant, and has a 20 year agreement to provide biomass fuel for free to the plant and a 20 year agreement to purchase steam from the plant for its dry kilns. The plant has a 1.5MW biomass fueled boiler, fired by about 10% of the Downie operation's biomass waste, and a 1.75 MW propane boiler. Approximately half of its steam energy is directed to Downie's kilns and the other half helps provide hot water via a 1.6 kilometer pipe to several large buildings in the city centre.[33] The RCEC has a project underway to increase the number of its hot water customers and utilize more of the steam plant's capacity.

Downie Timber generated an average of 193.0 PYs of timber harvesting, log hauling, silviculture and processing employment[34] from Revelstoke TSA timber over the 2006-2008 period. There was an average of 63.8 PYs involved with harvesting and re-planting Downie's Revelstoke TSA tenures. The two manufacturing plants in Revelstoke employed an average of 412.7 PYs per annum over the 2006-08 period and 31% of that employment (129.2 PYs) was tied to Revelstoke TSA timber. Almost all of the timber harvesting and processing employees resided in the Revelstoke TSA.

The company's two plants consumed approximately 365 000 m^3 of timber per year on average at 2006-2008 production rates. Approximately one-third of the fibre input for Downie's Revelstoke operation comes from the Revelstoke TSA.

Table 19. Downie's annual average employment and Revelstoke TSA Forest Licence harvests (2006-2008)

	Result
Harvest	**Timber volume (m^3)**

[32] Based on 480 8-hour shifts per year

[33] Information sourced from Natural Resources Canada, http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca/fichier/80717/DE%2003%20Revelstoke%20district%20energy%20PDF%20(ENG)%20for%20web.pdf

[34] Including harvesting, planning, administration, log hauling, road building, silviculture, Downie Street sawmill, Selkirk Cedar's remanufacturing operation and the Revelstoke Community Energy Corporation steam plant.

AAC Commitments	132 152
Annual average billed harvest, 2006-2008	118 941
2009 billed harvest (as of Aug.31 '09)	96 036
Employment (avg. for 2006-2008)	**Person-Years (PYs)**
Harvesting, planning & administration[35]	36.8
Log transport	9.8
Road construction & maintenance	8.9
Silviculture	8.3
Timber processing (in Revelstoke)[36]	129.2
Total	193.0

Source: Survey of licensees, author's calculations and MOFR

Joe Kozek Sawmill Ltd.

Joe Kozek Sawmill Ltd. (Kozek) is a locally-owned custom saw milling operation, which employed approximately 10 PYs on average over the 2006-2008 period. It has operated in Revelstoke since 1955 and manufactures a variety of timber and lumber products from different species depending on customer orders and operates a small log sort yard. Stella-Jones manages timber harvesting under Kozek's timber licence (annual commitment of 25 869 m^3). This saw mill's estimated annual production capacity is 8 million bd. ft. but its recent production has been approximately one-quarter of this level. In addition to its TSA licence, the company has a right to 10% of the annual harvest of TFL 56, owned and managed by Revelstoke Community Forest Corporation. (RCFC).[37]

Stella-Jones Canada Inc.

Stella-Jones Canada Inc. (formerly Bell Pole Canada Inc.) operates a electricity utility pole peeling operation in Revelstoke and holds a Forest Licence with an annual commitment of 19 290 m^3 in the TSA. The company produces approximately 30 000 poles and employs 10 persons on average in recent years, utilizing cedar almost exclusively. The operation dates from the 1950s and its poles are sent to the company's Carseland, Alberta plant for pressure treating. The parent company is Montreal headquartered Stella-Jones Inc., which acquired Bell Pole Company in 2006.

Stella-Jones manages the timber harvest for Kozek's Forest Licence in addition to its own TSA harvest. It generated an average of 12.0 PYs of timber harvesting, log transport and silviculture employment from Revelstoke TSA timber over the 2006-2008 period.[38]

The pole operation consumed approximately 32 000 m^3 per annum on average over the 2006-08 period and about one-quarter of the fibre input came from the Revelstoke TSA.

[35] Woodlands employment is based on harvesting and silviculture operations in the Revelstoke TSA and includes persons residing inside and outside the TSA..

[36] Timber processing employment is based on employment from processing Revelstoke TSA timber

[37] The RCFC was created in 1993 when the City of Revelstoke purchased approximately one-half of TFL 55 and its AAC. Approximately one-third of the cost of the purchase was provided by funds provided by Downie Timber Ltd. (now Downie Street Sawmills Ltd.), Joe Kozek Sawmills Ltd. and Cascade Cedar Ltd. There is a timber removal agreement that specified the volume of the harvest from the new TFL that each of these three companies receives. The allocation is 30% for Downie, and 10% each for Joe Kozek and Cascade. The portion of the harvest that is sold to local wood processors through the RCFC`s sort yard varies from year to year but this TFL provides a secure opportunity for an ongoing local log market.

[38] This figure accounts for employment attached to harvesting of the Stella-Jones and Kozek Forest Licences.

Table 20. Annual average harvesting employment and Revelstoke TSA Forest Licence harvests (2006-2008) for Stella-Jones and Joe Kozek Sawmills Ltd.

	Result
Harvest	**Timber volume (m^3)**
AAC Commitments	45 159
Annual average billed harvest, 2006-2008	48 670
2009 billed harvest (as of Aug.31 '09)	658
Employment (avg. for 2006-2008)	**Person-Years (PYs)**
Harvesting, planning & administration[39]	8.6
Log transport	2.3
Road construction & maintenance	0.3
Silviculture	0.8
Total	12.0

Source: Survey of licensees, author's calculations and MOFR

BC Timber Sales (BCTS)

BCTS has been apportioned 19.4% of the TSA's AAC, 44 510 m^3. The annual BCTS harvest in the TSA averaged 44 425 m^3 over the 2006-08 period. This average was raised by a 2007 billed harvest of approximately 65 000 m^3. The 2009 billed harvest was much smaller than in the recent past, 5 905 m^3, reflecting weak demand from processors.

The level of BCTS sales activity in the TSA has been relatively modest in 2008 and 2009, two sales that attracted bids in 2008 and one in 2009. Nakusp-based Box Lake Products Ltd. was successful with one sale and Revelstoke-based Green Timber Logging Co. Ltd. won the other two sales. The following table presents recent harvesting results for BCTS's Revelstoke TSA Forest Licence.

Table 21. BCTS average annual billed harvest (2006-2008)

	Result
Harvest	**Timber volume (m^3)**
AAC Apportionment	44 510
Annual average billable harvest, 2006-2008	44 425
2009 billed harvest	5 905

Source: BC MOFR

Other Wood Products Manufacturing

There are several smaller wood product companies in the Revelstoke area, including:

- Cascade Cedar Ltd.– It has operated a Revelstoke mill since 1983 which manufactures shake blocks. The mill employed an annual average of 15 persons over the 2006-08 period. Its annual output capacity is approximately 8 500 cords of shake blocks but it has been operating at less than half of this capacity over the 2006-08 period. The parent company is Teal-Jones Group. It relies on its portion of the RCFC`s harvest to acquire cedar logs for its operation.
- Selkirk Forest Products Company (Selkirk) – Selkirk[40] holds a Forest Licence in the TSA with a small commitment volume of 3 524 m^3. This is a utility pole company with a peeling and pressure treatment operation in Galloway (near Cranbrook) and a log sort yard near Nakusp. The company has an

[39] Woodlands employment is based on harvesting and silviculture operations in the Revelstoke TSA.

[40] It should be noted that Selkirk Forest Products Company is not related to Selkirk Specialty Wood Ltd., which is a Downie Timber Ltd. company.

agreement with Tolko for management of Selkirk's Forest Licence and for log trading. Revelstoke TSA cedar logs that meet the company's criteria for poles are transported to its Galloway operation. Selkirk is a subsidiary of Tacoma headquartered McFarland Cascade.

- Karl Beattie Cont. Ltd. – Originally started in the 1960s, this family runs a small saw milling and planing operation that undertakes custom cutting and makes timber frames and prefab log home kits. Its timber needs are met through purchases on the open market. The operation has an annual capacity of 4.8 million bd. ft. but has been operating intermittently over the past few years.
- Selkirk Grazing Inc. - Owned and operated by Ivan Graham, who started a pole peeling and small saw mill operation at Sidmouth on the Columbia River in 1956. They moved their house and saw mill to Twelve-Mile with the construction of the Keenleyside Dam. The mill focuses on cutting timbers, especially special sizes. The mill currently operates approximately three days per week with four full-time persons and one part-time. Its timber needs are met through purchases on the open market, mainly from RCFC`s sort yard. A family member also has a woodlot, which provides some volume for the mill.

6.3.4 Forest sector employment and employment coefficients

The average total direct forest industry employment supported by Revelstoke TSA harvested timber over the 2006-2008 period is 232 PYs in the TSA and 309 PYs province-wide. On a province-wide basis, the TSA's annual harvest supported total[41] employment of approximately 469 PYs in recent years.

Error! Reference source not found. presents estimates of average annual employment over the 2006-08 period supported by the Revelstoke TSA harvest broken down by forest industry activity. Employment is reported as an annual average and as the intensity of employment per '000 m^3 of harvested timber. The latter figure is used to calculate potential employment impacts of alternative timber supply scenarios. The average employment levels and coefficients are reported at TSA and provincial levels.

Table 22. Revelstoke TSA timber employment estimate (2006-2008)

Activity	TSA		Province	
	Employment (PYs)	Employment Coefficient[42] (PYs/'000 m^3)	Employment (PYs)	Employment Coefficient (PYs/'000 m^3)
Direct employment				
Harvesting[43]	71	0.32	92	0.42
Timber processing[44]	161	0.72	217	0.98
Total direct employment	232	1.04	309	1.40
Indirect/induced employment	82	See footnote[45]	160	See footnote[46]
Total employment	314	NA	469	NA

Source: survey of licensee's and author's calculations

[41] Total employment is comprised of direct, indirect and induced employment. Direct employment estimates come from a survey of licensees. Indirect and induced employment estimates are calculated with the aid of multipliers developed by BC Stats, which uses its input/output model and 2006 census results to estimate local and provincial multipliers. For more explanation about the estimates see the Appendix entitled, *Socio-Economic Analysis Background Information*.

[42] The direct employment coefficients are calculated from a survey of Forest Licence holders undertaken by the author for this project. The three main licensees supplied data for the 2006-2008 period.

[43] Includes harvesting, log salvage, log scaling and harvest planning and administration, road building and maintenance, silviculture site preparation, planting, spacing, fertilization, pruning and silviculture planning. Note that employment in log transportation is included in the indirect employment estimates and not in direct employment.

[44] Includes management and administration as well as facility operations

[45] The local indirect/induced co-efficient for timber harvesting is 1.26 and for "Other Wood Processing" (i.e. not pulp & paper manufacturing) it is estimated as 1.39. The indirect employment coefficients were sourced from BC Stats and are based on 2001 Census employment data.

[46] The BC local indirect/induced co-efficient for timber harvesting is 2.05, for pulp & paper manufacturing it is 2.25 and for "Other Wood Processing" (i.e. not pulp & paper manufacturing) it is estimated at 1.91. The indirect/induced employment coefficients for the provincial level were calculated from multipliers reported in a BC Stats publication (Horne March 2008).

Employment, tied to harvesting and processing Revelstoke TSA timber, mainly resides within the boundaries of the TSA. For example, an estimated 97% of Downie's harvest employment and 96% of its manufacturing employment resided in the TSA. Typical of the mobile feature of the tree planting labour force in BC, most of the silviculture employees resided outside of the TSA, 62% in the case of Downie`s Forest Licence generated silviculture employment.

Revelstoke TSA licensees are responsible for basic silviculture (i.e. establishment of a free-growing stand) on areas harvested under major licences. BC MOFR is responsible for silviculture on backlog not satisfactorily restocked (NSR) areas.

The forest sector employment estimates do not include BC MOFR employment in the TSA[47]. Revelstoke TSA, along with Golden TSA, is part of the Columbia Forest District. The Columbia District Office is located in Revelstoke and has a 22 person staff as of December 2009.

6.3.5 Forest sector employment income

On a province-wide basis, the Revelstoke TSA harvest supported an estimated average annual total employment income of $21.8 million in recent years; $15.6 million of direct forest industry employment income and $6.2 million of indirect and induced employment income.

The employment income contribution of the forest industry is high in part because of the industry's relatively higher income levels. Results in **Error! Reference source not found.** suggests that there is about $70 403 of forest industry direct employment income in the province per '000 m^3 of harvested Revelstoke TSA timber.

Table 23. Revelstoke TSA timber supported employment income estimates and employment income coefficients (2006-2008)

Activity	Employment (PYs)	Annual income per PY ($)[48]	Total employment income[49] ($million)	Employment income coefficient ($/'000 m^3)
Direct employment				
Harvesting	92	53 037	4.7	22 094
Timber processing	217	61 328 for pulp & paper and 48 550 for "other wood processing"	10.7	48 308
Sub-total direct employment	309		15.6	70 403
Indirect/induced employment	160	38 889	6.2	28 051
Total employment	469		21.8	98 454

Source: Statistics Canada and author's calculations

6.3.6 Provincial government revenues

There are three main sources of BC Government revenues from the forest sector as follows.

- *Stumpage*[50] – The average Revelstoke TSA stumpage was $7.35/ m^3 over the 1999-2008 decade, and $7.88/$m^3$ in more recent times (2006-2008) and a much lower level 2009 (up to

[47] Ministry of Forests employment is not included as part of direct forest industry employment because it is related to administration and statutory requirements and not to timber harvest levels and would not be affected by marginal timber supply changes. MOF employees are accounted for in the public service sector employment estimates reported in Section 6.2.2.

[48] Sourced from Statistics Canada, CANSIM Table 281-0027, based on 2008 average weekly earnings by 4-digit NAICS code industry

[49] Province-wide basis

[50] Includes BC Timber Sales revenues

August 31) of $3.70/m^3. There is a noticeable difference in per cubic meter stumpage revenues between Forest Licence and BCTS timber. The average revenue for Forest Licence timber over the 2006-08 period was $5.55 per m^3 whereas the average for BCTS timber was considerably higher, $18.12 per m^3.

- *Other forest industry resource taxes and fees* – This category includes harvesting rents and fees, SLA export border tax (only in effect since fiscal 2006/07), logging taxes, and export fee in lieu of manufacture against exported logs. The 2007-08 average for the province was $4.67 per m^3, mostly made up of revenues from the Export Border Tax.
- *Non-resource taxes and fees* – Forest industry employees and employees in the industry's indirect and induced sectors pay sales taxes on their personal purchases and provincial income taxes. The province collects other revenues from forest industry companies such as corporate taxes, sales tax, gas tax, and Workers Compensation Board premiums.

The BC Government collected annual revenues of an estimated $17 million on average over the 2006-2008 period through stumpage, revenues, other resource taxes and fees and non-resource taxes and fees (such as personal income taxes, sales taxes and corporate income taxes) generated from harvesting and processing the TSA's timber. **Error! Reference source not found.** shows estimates of recent average annual BC Government revenues derived from the Revelstoke TSA timber harvest.

Table 24. Average annual BC Government revenues derived from the Revelstoke TSA timber harvest (2006-2008)

BC Government revenue source	Est'd avg. annual revenues ($million)	BC Govt. revenue coefficient ($/'000 m^3)
Stumpage	1.7	7 880
Other resource taxes and fees[51]	1.0	4 670
Non-resource taxes and fees[52]	14.4	64 928
Total revenues	17.2	77 478

6.4 Socio-economic implications of the base case harvest forecast

6.4.1 Introduction

The socio-economic analysis focuses on harvest level changes in the short- to medium-terms (0 – 30 years). Economic impacts are gauged by comparing economic activity that could be supported by the current AAC with activity that could be supported by the base case harvest forecast. Actual harvest levels drive economic impacts, and they have been within 93% on average of the TSA's AAC level over the 1999-2008 decade. Although employment estimates based on AAC timber volume are expressions of possible future forest industry activity, they track closely with the likely activity in the Revelstoke TSA.

The base case timber supply forecast is 207,160 m^3 over its initial decade, decreasing to 186,444 m^3 in the second decade and 167,800 m^3 in the 3rd decade. The AAC reaches its lowest point in the 5th decade at 135 918 m^3.

6.4.2 Short- and Medium-term implications of alternative harvest levels

There is an immediate reduction in projected economic activity as a consequence of implementing the base case timber supply. For the 1st decade, the base case timber supply forecast is 90% of the current AAC, a reduction of 22 840 m^3. The TSA's billed harvest has averaged more than 96% of its AAC in the 2006-08 period. This economic activity reduction in comparison to the current AAC scenario continues in each subsequent

[51] Estimated by using the 2007-08 average for the province, which was $4.67 per m^3, mostly made up of revenues from the Export Border Tax.

[52] Estimated by using BC level provincial taxes multipliers reported in a BC Stats publication (Horne March 2008).

decade and bottoms out in the 5th decade. The difference in estimated economic activity between the base case forecast and the current AAC is as follows.

- 1st decade – reduction of 32 PYs of total employment at the TSA level and 49 PYs at the provincial level.
- 2nd decade – reduction of 62 PYs of total employment at the TSA level and 93 PYs at the provincial level.
- 3rd decade – reduction of 88 PYs of total employment at the TSA level and 132 PYs at the provincial level.

6.4.3 Requirements of BC timber processing facilities

An immediately lower and decreasing timber supply over time means that Revelstoke TSA timber processing facilities would have to rely to an increasingly greater degree on sourcing timber from non-Revelstoke TSA sources. This report does not look into regional or provincial supply and demand issues so no definitive comments can be made about whether a satisfactory supply of economic timber from non-Revelstoke TSA sources can be used to replace the Revelstoke TSA fibre that would no longer be available because the Chief Forester sets a lower AAC. The situation in the Revelstoke TSA is unusual because Downie imports large volumes of cedar logs from southwestern BC and the Okanagan TSA and is not reliant on the Revelstoke TSA for a majority of the cedar fibre needs of its mill. However, its Revelstoke TSA timber is an important source of non-cedar logs for trading for non-TSA cedar logs, as well as for local cedar logs, which can be processed in its Revelstoke operation.

6.4.4 Revelstoke TSA level impacts

The base case timber supply may lead to impacts on the TSA's economy in the short- and medium terms because its projected timber supply is below the current AAC and below the recent current average billed harvest level (221,617 m^3 over the 2006-08 period). Timber harvesting and processing in the Revelstoke area is constrained now by weak end market demand for its products, not by the TSA's AAC level. Even though there is market weakness, the TSA's billed harvest has remained high. The combination of stronger market demand and a lower AAC going forward will likely lead to higher timber prices and challenges for local processors in sourcing suitable, economic timber from non-TSA sources.

6.4.5 Implications of the ``incremental`` Caribou GAR Reserves

In 2007, the BC Government instituted additional land reserves to help sustain mountain caribou herds in southeastern BC. Some of these reserves lay within or overlapped into the Revelstoke TSA. These GAR[53] reserves were supplemental to the reserves set out in the Revelstoke Higher Level Plan Requirements and based on the Mountain Caribou Recovery Implementation Plan of the BC Species at Risk Coordination Office (SaRCO). The timber supply analysis report includes a sensitivity analysis where the THLB in the SaRCO reserves that are incremental (4 076 ha) to the Revelstoke HLPO reserves are added back into the operable THLB. The economic activity implications of this THLB change was examined as well.

When the THLB of the ``incremental`` area of the GAR reserves is added into the TSA`s operable THLB then the timber supply in the 1st decade of the base case scenario rises by 17 340 m^3, 8.4%. The timber supply differences between the 2nd and 3rd decades of the base case and the GAR reserve sensitivity analysis are slightly smaller in absolute terms, +15 606 m^3 (8.4%) and +14 045 m^3 (8.4%), respectively.

The employment implications at the TSA level associated with the ``incremental`` GAR reserves are a difference of +25 PYs on an annual basis in the 1st decade compared to employment estimated for the base case timber supply scenario. This is a difference of +8.4%. It is a +37 PYs difference at the provincial level, also a difference of +8.4%. In the 2nd and 3rd decades, the annual difference in employment is +22 PYs and +19 PYs, respectively, at the TSA level and +33 PYs and +30 PYs, respectively, at the provincial level.

[53] GAR – *Government Actions Regulation*

Table 25. Estimated employment, employment income and government revenue impacts of the "incremental" Caribou GAR Reserves

	1st decade base case timber supply + caribou reserve THLB	1st decade impact of caribou GAR reserve THLB	2nd decade base case timber supply + caribou reserve THLB	2nd decade impact of caribou GAR reserve THLB	3rd decade base case timber supply + caribou reserve THLB	3rd decade impact of caribou GAR reserve THLB
	m^3	m^3	m^3	m^3	m^3	m^3
Annual timber supply	224 500	+17 340	202 050	+15 606	181 845	+14 045
TSA level						
Employment	PYs	PYs	PYs	PYs	PYs	PYs
Direct/Indirect/Induced Total	318	25	286	22	257	19
Employment income	$M	$M	$M	$M	$M	$M
Direct/Indirect/Induced Total	15.0	1.2	13.5	1.0	12.1	0.8
Provincial level						
Employment	PYs	PYs	PYs	PYs	PYs	PYs
Direct/Indirect/Induced Total	475	37	428	33	385	30
Employment income	$M	$M	$M	$M	$M	$M
Direct/Indirect/Induced Total	22.1	1.7	19.9	1.5	17.9	1.4
BC Government revenues	$M	$M	$M	$M	$M	$M
Stumpage revenues	1.8	0.1	1.6	0.1	1.4	0.1
Other forest resource revenues	1.0	0.1	0.9	0.1	0.8	0.1
Non-resource revenues	14.6	1.1	13.1	1.0	11.8	0.9
Total	17.4	1.3	15.7	1.2	14.1	1.1

6.4.6 Regional timber supply implications

There is a significant volume of log movement into and out of the TSA due to the cedar focused consumption of both the Downie mill and remanufacturing plant in Revelstoke and the Stella-Jones pole plant, the high grade Douglas fir requirements of the Louisiana-Pacific operation in Golden and the nearby location of a SPF mill at Radium. A reduction of the TSA`s timber supply will mean that local processors will be seeking to replace that volume from non-Revelstoke TSA sources. By the 3rd decade, there would be a reduction in the regional timber supply of 62 200 m^3 if the Revelstoke TSA base case forecast is implemented.

6.4.7 Summary Comparison Table

Error! Reference source not found.6 shows the estimated impact on employment, employment income and BC Government revenues of implementing the base case timber supply rather than the current AAC of 230 000 m^3.

Table 26. Estimated employment, employment income and government revenue impacts of implementing the base case timber supply

	1st decade Base Case timber supply forecast	1st decade impact of Base Case	2nd decade Base Case timber supply forecast	2nd decade impact of Base Case	3rd decade Base Case timber supply forecast	3rd decade impact of Base Case	Current AAC
	m^3	m^3	m^3	m^3	m^3	m^3	m^3
Annual timber supply	207 160	-22 840	186 444	-43 556	167 800	-62 200	230 000
TSA level							
Employment	PYs	PYs	PYs	PYs	PYs	PYs	PYs
Direct	217	-24	195	-46	176	-65	241
Indirect/induced	77	-8	69	-16	62	-23	85
Total	293	-32	264	-62	238	-88	326
Employment income	$M	$M	$M	$M	$M	$M	$M
Direct	10.8	-1.2	9.7	-2.3	8.8	-3.2	12.0
Indirect/induced	3.0	-0.3	2.7	-0.6	2.4	-0.9	3.3
Total	13.8	-1.5	12.4	-2.9	11.2	-4.1	15.3
Provincial level							
Employment	PYs	PYs	PYs	PYs	PYs	PYs	PYs
Direct	289	-32	260	--61	234	-87	321
Indirect/induced	149	-17	134	-32	121	-45	166
Total	438	-49	394	-93	355	-132	487
Employment income	$M	$M	$M	$M	$M	$M	$M
Direct	14.6	1.6	13.1	-3.1	11.8	-4.4	16.2
Indirect/induced	5.8	0.7	5.2	-1.3	4.7	-1.8	6.5
Total	20.4	2.3	18.3	-4.4	16.5	-6.2	22.7
BC Government revenues	$M	$M	$M	$M	$M	$M	$M
Stumpage revenues	1.6	-0.3	1.5	-0.4	1.3	-0.6	1.9
Other forest resource revenues	1.0	-0.1	0.9	-0.2	0.8	-0.3	1.1
Non-resource revenues	12.5	-2.4	12.1	-2.8	10.9	-4.0	14.9
Total	15.1	-2.8	14.4	-3.4	13.0	-4.9	17.9

6.5 Summary

The TSA's population[54] shrank substantially (12.0%) over the 1996-2006 decade when the provincial numbers climbed by 6.2% but it[55] has since stabilized, a -0.3% decrease for the 2006-2009 period. The expansion of the Mt MacKenzie ski operation into the Revelstoke Mountain Resort over the 2007-09 period has been an important positive element in a local economy challenged by weak outside demand for the products and services of its forestry and rail transport businesses, the longtime drivers of the local economy. The TSA`s main forest industry company, Downie Street Sawmills Ltd., focuses on cedar products and it has one of the few locally integrated harvesting, primary saw mill, and remanufacturing plant operations in the province. This local vertical integration and reasonably steady demand in cedar product markets has helped stabilize employment in the TSA`s forestry sector.

The Chief Forester set the current AAC of 230 000 m^3 in September 2005. It has been at that level since 1995. Under the current AAC apportionment, replaceable forest licences account for 78.6% of the apportionment of the AAC. Downie Street Sawmills Ltd. holds the TSA's largest volume commitment at 132 152 m^3 (which is attached to its replaceable forest licence), accounting for 57.5% of the AAC. This volume represents

[54] Revelstoke LHA population

[55] City of Revelstoke

approximately one-third of the average annual fibre consumption of Downie's integrated Revelstoke sawmill and remanufacturing plant over the 2006-08 period.

The Revelstoke TSA's billed harvest has been consistently close to its AAC in recent years, approximately 96% of the AAC for the 2006-2008 period. The gap widened in 2009, the billed harvest was approximately 85% of its AAC, due to severe weakness in demand from the US housing industry, BC forest industry`s main end market.

The average total direct forest industry employment supported by Revelstoke TSA harvested timber over the 2006-2008 period was 232 PYs in the TSA and 309 PYs province-wide. The TSA's annual harvest supported total employment of approximately 469 PYs in recent years on a province-wide basis.

Several First Nations have traditional territory interests in the Revelstoke TSA, and about 330 persons are of Aboriginal heritage, about 2% of its population, but there are no Indian Reserves or Aboriginal communities in the TSA. There are no Aboriginal owned forestry companies that are active in the TSA.

There are increasingly negative differences in potential economic activity over the short- and medium-terms between the current AAC and the base case forecast because of the decreasing timber supply of the latter. The gap in estimated economic activity between the first decade of the base case and a current AAC scenario is 9.9% on an annual basis. This gap widens in the second and third decades of the base case to 18.9% and 27.0%, respectively.

- 1st decade – reduction of 32 PYs of total employment at the TSA level and 49 PYs at the provincial level and reduction of $1.5 million of total employment income at the TSA level and $2.3 million at the provincial level.
- 2nd decade – reduction of 62 PYs of total employment at the TSA level and 93 PYs at the provincial level and reduction of $2.9 million of total employment income at the TSA level and $4.4 million at the provincial level
- 3rd decade – reduction of 88 PYs of total employment at the TSA level and 132 PYs at the provincial level and reduction of $4.1 million of total employment income at the TSA level and $6.2 million at the provincial level

BC Government stumpage revenues would decline by approximately $300 000 in the first decade of a base case timber supply implementation, $400 000 in the second decade and $600 000 in the third decade.

These estimates of economic activity assume that harvesting and wood processing employment would decrease in concert with the AAC decrease. Harvesting employment, including logging, road building, log transport, and silviculture employment, will decline in the TSA as a smaller amount of timber is available for harvest and may decline within the province if the gap between the current AAC and base case timber supply cannot be closed by harvesting economical timber outside of the TSA.

Employment associated with wood processing at the TSA and provincial levels is much less likely to drop in lockstep with a lower TSA timber supply. There is one large wood processor in the TSA and a few small ones. The largest processor, Downie Street Sawmills Ltd., currently sources a large portion of the cedar logs for its integrated operation from outside the TSA, in part because it trades local Douglas fir, hemlock and spruce logs for needed cedar logs. As the AAC drops in the TSA, Downie and the smaller mills will look to other economic log supply sources to fill the gap. As the US housing industry recovers there will be more demands on non-Revelstoke TSA timber supply and an accompanying upward price pressure on regional log markets. The drop in Revelstoke TSA timber supply from implementing the base case will add to this upwards price pressure. It is likely that local wood processors will pay a higher price for the replacement non-TSA timber than they would have paid for the TSA timber foregone because of a lower AAC.

7.0 Conclusions and Recommendations

This analysis report presents a harvest flow with an initial harvest rate below the current AAC of 230,000 m³/yr. Given the inputs and assumptions in the base case, the initial harvest level of 207,100 m³/yr is maintained for 1 decade before declining over the next four decades at a rate of 10% per decade to a mid-term low of 135,900 m³/yr. This minimum harvest level is just above the theoretical Long Run Sustained Yield (LRSY) for natural stands of 134,145 m³/yr. It then climbs for 50 years at a rate of 12% per decade, followed by a slight 0.4% increase before reaching a long-term harvest level of 240,500 m³/yr.

The amount of timber available for harvest in the 5th decade defines the transition from the initial harvest level to the midterm harvest level and the length of the mid-term trough. This period presents a pinch point in the analysis where little timber is available beyond what is harvested in the base case forecast. Period 5 is primarily limited by the timing of managed stands coming on line. The relatively little area currently in ages between 40-140 years particularly influence the depth and duration of the mid-term timber supply trough. Typically, cover requirements interact with age class structure to limit the availability of timber over the planning horizon. The factors that influence the base case most significantly include the requirements for visuals, seral goals, caribou reserves, and greenup.

As a result of the caribou recovery implementation plan and the subsequent 2009 caribou GAR Order #U-3-005 the impact of the 'incremental' caribou reserves had a significant impact upon the Revelstoke timber supply area. The sensitivity analysis as presented in section 4.7.14 shows that the impact is 8.4% relative to the base case.

The long-term harvest level is now projected to be above the current AAC as a result of two key factors: use of select seed for regeneration and improved site productivity estimates for managed stands.

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

Uncertainties that altered the short-term harvest level were:

- changes to the size of the timber harvesting landbase,
- changes to existing natural stand yields,
- increases in the minimum harvest ages,
- increases in the expected "age to greenup heights",
- removal of high proportion hemlock stands (Hw > 79%) from the THLB,
- removal Mature seral requirements from Caribou landscape units,
- adopting the Provincial Non-spatial Old Growth Order in place of the Revelstoke Higher Level Plan objectives for Old and Mature+Old seral biodiversity requirements, and
- turning off the 'incremental' portion of the Caribou GAR spatial reserves.

Uncertainties that altered the long-term harvest level by at least 3% were:

- changes to the size of the timber harvesting landbase,
- changes to existing and future managed stand yields,
- reduction of minimum harvest ages by 10 years,
- inclusion of low severity *Armillaria* root rot for Douglas-fir in the ICH for managed stand yields,
- adoption of the Provincial Non-spatial Old Growth Order in place of the Revelstoke Higher Level Plan objectives for Old and Mature+Old seral requirements,
- relaxation of percent disturbance constraints in visually sensitive areas, and
- turning off the 'incremental' portion of the Caribou GAR spatial reserves.

The following factors were not captured or fully addressed in the base case analysis:

- Spatial size and distribution of harvest areas over time.
- Climate change and the implications of altered forest productivity and ecosystem shifts as a result.
- Potential for advanced silviculture activities to address the forecasted mid-term timber supply trough.
- The results of the ongoing VRI phase 2 adjustments.

Improving upon the base information and assumptions used in this analysis will allow the next timber supply analysis to provide for improved estimates of harvest flow. Some recommendations for future work to be completed before the next analysis are provided below:

- Monitor managed stand development relative to predicted growth rates.
- Better define the impacts of root rots on stand yields.
- Further improve estimates for unstable terrain netdowns.
- Update the spatial OGMA / MOGMA as required to maximize overlap with other reserves where possible. There is currently very little overlap with the incremental caribou portion of the caribou GAR order spatial reserves.
- Complete the VRI ground samples and NVAF

8.0 Glossary

Allowable annual cut (AAC)	The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic meters of wood per year.
Analysis unit	A grouping of types of forest — for example, by species, site productivity, silvicultural treatment, age, and or location — done to simplify analysis and generation of timber yield tables.
Base case harvest forecast	The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.
Biodiversity (biological diversity)	The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.
Biogeoclimatic (BEC) variant	A subdivision of a biogeoclimatic subzone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.
Biogeoclimatic zones	A large geographic area with broadly homogeneous climate and similar dominant tree species.
Coniferous	Coniferous trees have needles or scale-like leaves and are usually 'evergreen'.
Cutblock	A specific area, with defined boundaries, authorized for harvest.
Cutblock adjacency	The spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.
Deciduous	Deciduous trees shed their leaves annually and commonly have broad-leaves.
Environmentally sensitive areas (ESA)	Areas with significant non-timber values, fragile or unstable soils, impediments to establishing a new tree crop, or high risk of avalanches.
Forest cover objectives	Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see **Cutblock adjacency and Green–up**).
Forest inventory	An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.
Forest and Range Practices Act (FRPA)	Legislation that govern forest practices and planning, with a focus on ensuring management for all forest values.
Forest type	The classification or label given to a forest stand, usually based on its tree species composition. Pure spruce stands and spruce-balsam mixed stands are two examples.
Free-growing	An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.
Green-up	The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.
Growing stock	The volume estimate for all standing timber at a particular time.
Harvest forecast	The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.
Higher level plans	Higher level plans establish the broader, strategic context for operational plans, providing objectives that determine the mix of forest resources to be managed in a given area.

Inoperable areas	Areas defined as unavailable for harvest for terrain-related or economic reasons. Operability can change over time as a function of changing harvesting technology and economics.
Integrated resource management (IRM)	The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.
Landscape-level biodiversity	The *Landscape Unit Planning Guide* provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.
Landscape unit	A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.
Long-term harvest level	A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.
Long Run Sustained Yield	The long run sustainable yield for any timber supply area (TSA) is equal to the culmination of mean annual increment weighted by area for all productive and utilizable forest land types in that TSA.
Mature seral	Forest stands with trees between 80 and 120 years old, depending on species, site conditions and biogeoclimatic zone.
Management assumptions	Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.
Mean annual increment (MAI)	Stand volume divided by stand age. The age at which average stand growth, or MAI, reaches its maximum is called the culmination age (CMAI). Harvesting all stands at this age results in a maximum average harvest over the long term.
Minimum harvestable age (MHA)	The age at which a stand of trees is expected to achieve a merchantable condition. The minimum harvestable age could be defined based on maximize average productivity (culmination of mean annual increment), minimum stand volume, or product objectives (usually related to average tree diameter).
Model	An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.
Natural disturbance type (NDT)	An area that is characterized by a natural disturbance regime, such as wildfires, which affects the natural distribution of seral stages. For example areas subject to less frequent stand-initiating disturbances usually have more older forests.
Not satisfactorily restocked (NSR)	An area not covered by a sufficient number of well-spaced trees of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.
Operational Adjustment Factor (OAF)	OAF1 and OAF2 are TIPSY input parameters that reduce predicted yield to account for factors such as non-productive areas within stands, disease and insects, non-commercial cover, stocking gaps, decay, waste, and breakage.
Operability	Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.
Crown forest land base (CFLB)	All forested crown land in a management unit. Used to support the management of non timber resources. The THLB is a subset of this land base.
Protected area	A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).
Riparian area	Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.

Scenic area	Any visually sensitive area or scenic landscape identified through a visual landscape inventory or planning process carried out or approved by a district manager.
Sensitivity analysis	A process used to examine how uncertainties about data and management practices could affect timber supply. Inputs to an analysis are changed, and the results are compared to a baseline or base case.
Seral stages	Sequential stages in the development of plant communities that successively occupy a site and replace each other over time.
Site index	A measure of site productivity. The indices are reported as the average height, in meters, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 meters above the ground). Site index curves have been developed for British Columbia's major commercial tree species.
Stand-level biodiversity	A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.
Stocking	The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.
Table Interpolation Program for Stand Yields (TIPSY)	A B.C. Forest Service computer program used to generate yield projections for managed stands based on interpolating from yield tables of a model (TASS) that simulates the growth of individual trees based on internal growth processes, crown competition, environmental factors and silvicultural practices.
Timber harvesting land base (THLB)	Crown forest land within the timber supply area where timber harvesting is considered both acceptable and economically feasible, given objectives for all relevant forest values, existing timber quality, market values and applicable technology.
Timber supply	The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)	An integrated resource management unit established in accordance with *Section 7* of the *Forest Act*.
Tree farm license (TFL)	Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.
Ungulate	A hoofed herbivore, such as deer.
Unsalvaged losses	The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) that is not harvested.
Variable Density Yield Prediction (VDYP)	An empirical yield prediction system, supported by the Ministry of Forests and Range, designed to predict average yields and provide forest inventory updates over large areas (i.e., Timber Supply Areas). It is intended for use in unmanaged natural stands of pure or mixed species composition.
Vegetation Resources Inventory (VRI)	An assessment of British Columbia's vegetation resources. It includes computerized maps, a database describing the location and nature of forest information, including timber size, stand age, timber volume, tree species composition, and shrub, herb, and bryoid information. It replaces the older forest inventory.
Visual quality objective (VQO)	Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.
Volume estimates	Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.
Yield projections	See volume estimates
Watershed	An area drained by a stream or river. A large watershed may contain several smaller watersheds.
Wildlife tree	A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.
Woodlot licence	An agreement entered into under the *Forest Act*. It allows for small-scale forestry to be practised in a described area (Crown and private) on a sustained yield basis.

9.0 Acronyms

AAC	Allowable Annual Cut
Analysis	Timber Supply Analysis
AU	Analysis Unit
BCTS	British Columbia Timber Sales
BEC	Biogeoclimatic Ecosystem Classification
BEO	Biodiversity Emphasis Option
CF	Chief Forester
CPR	Canadian Pacific Railway
DFO	Department of Fisheries and Oceans
DM	District Manager
DP	Data Package
ESA	Environmentally Sensitive Area
EVQO	Existing Visual Quality Objective
FAIB	Forest Analysis and Inventory Branch
FIZ	Forest Inventory Zone
FPC	Forest Practices Code
FPPR	Forest Planning and Practices Regulation
FSP	Forest Stewardship Plan
GAR	Government Action Regulation
GIS	Geographic Information System
HLPO	Higher Level Plan Order
ILMB	Integrated Land Management Bureau (Ministry of Agriculture and Lands)
IRM	Integrated Resource Management
LRMP	Land and Resource Management Plan
LU	Landscape Unit
MHA	Minimum Harvestable Age
MOE	Ministry of Environment
MOGMA	Mature + Old Growth Management Area
MFR	Ministry of Forests and Range
MO	Ministerial Order
NCC	Non-Commercial Cover
NDT	Natural Disturbance Type
NRL	Non-Recoverable Losses
NSR	Not Satisfactorily Restocked
OAF	Operational Adjustment Factor
OGMA	Old Growth Management Area
PSP	Permanent Sample Plot
CFLB	Crown Forest Land Base
PSYU	Public Sustained Yield Unit
RMR	Revelstoke Mountain Resort
RMZ	Riparian Management Zone
RRZ	Riparian Reserve Zone
RVQC	Recommended Visual Quality Class
SI	Site Index
TFL	Tree Farm License
THLB	Timber harvesting land base
VAC	Visual Absorption Capability
VQO	Visual Quality Objective
WHA	Wildlife habitat area
UWR	Ungulate winter range

Appendix A – Data Inputs and Modeling Assumptions

Revelstoke Timber Supply Area
Timber Supply Review #4

Data Package

November 23rd, 2009

Prepared for:

Revelstoke Licencee / BCTS Group:

Downie Street Sawmills Ltd.

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British Columbia Timber Sales

Prepared by:

Forsite Consulting Ltd.

Record of Changes since the Public Review version (Draft v3.0 released on March 31, 2009)

Change	Wh
Typos and minor text changes suggested by Dave Stuart, MoFR – FIAB	Jere Hach y

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1.0 Introduction

This document outlines the basic information and assumptions that are proposed for use in the provincial Timber Supply Review (TSR) process currently underway in the Revelstoke Timber Supply Area (TSA). The purpose of the review is to examine the short- and long-term effects of current forest management practices on the availability of timber for harvesting in the TSA. A review of this type is completed at least once every five years in order to capture changes in data, practices, policy, or legislation influencing forest management in the TSA. The previous review (TSR3) was completed in September 2004 with a final Annual Allowable Cut (AAC) determination on September 1, 2005. The current review (TSR4) is therefore working toward a new AAC determination to be in place by August 1, 2010.

This timber supply review will focus on a single forest management scenario that reflects current management practices in the TSA. Thus, the analysis goal is to model "what-is", and not "what-if". In addition to this current management or "Base Case" scenario, an assessment of how results might be affected by uncertainties is completed using a number of sensitivity analyses. Together, the sensitivity analyses and the Base Case form a solid foundation for discussions among government and stakeholders about appropriate timber harvesting levels.

It is recognized that ongoing treaty negotiations with First Nations have the potential to impact timber supply in the TSA. However, "current management" is the underlying assumption for the analysis and no settlement has yet been reached. The final results from treaty negotiations will be modeled in subsequent timber supply reviews that have the benefit of legal direction in this area.

This report is the first of three documents that will be released during the TSR4 process for Revelstoke TSA. This document provides detailed technical information on the upcoming analysis. A separate document called the Analysis Report will summarize the results of the timber supply analysis and will provide a focus for public discussion. The final document will outline the Chief Forester's harvest level decision and the reasoning behind it.

Additional copies of this document are available on the web at www.forsite.ca/RevelstokeTSR4/ or can be requested using the email address below.

If you have any questions or would like more information, please contact Cam Brown, RPF at (250) 832-3366 or cbrown@forsite.ca.

1.1 Purpose of the data package

The purpose of this data package is to:

- provide a detailed account of the land base, growth and yield, and management assumptions related to timber supply that the Chief Forester must consider under the *Forest Act* when determining an allowable annual cut (AAC) for the Revelstoke TSA and how these will be applied and modeled in the timber supply analysis;
- provide the evidentiary basis for the information used in the analysis;

1.2 Roles and Responsibilities

The Revelstoke TSA licencee / BCTS group chose to take on the responsibility of leading the Revelstoke TSR4 process in 2008. The group consists of Downie Street Sawmills Ltd., Stella-Jones Canada Inc., and British Columbia Timber Sales (BCTS, Okanagan Columbia). They have chosen to take on the responsibilities of assessing timber supply with the knowledge that the Forest Investment Account is currently funding the initiatives. To deliver on this commitment, the planning and analysis work associated with the TSR was tendered and subsequently awarded to Forsite Consultants Ltd.

Government agencies still play a key role in this TSR process – they set and enforce standards and are responsible for approval of the final Data Package and Analysis Reports. The Ministry of Forests and Range (MFR) provides technical support, facilitates resolution of issues, and validate technical information. Various resource specialists in the Ministries of Agriculture and Lands (MoAL) and Environment (MoE) contribute their knowledge and experience. The following table shows the general roles and responsibilities associated with the timber supply analysis leading to an AAC determination.

Table 1. Roles and responsibilities

LICENSEE-BCTS GROUP Obligations	Government Obligations	
	Forest Analysis Branch	**District And Regional Staff**
Compile data needed for the timber supply analysis, including forest cover and other data related to forest and land characteristics, administration and management regimes. Provide a summary of the data, management assumptions, and modeling methods to be applied in the timber supply analysis in a Data Package document.	Set standards for the data package	Provide data, information, and knowledge of current practices in the TSA.
Provide information to the public and First Nations and summarize comments received for government.		
Make any necessary changes to the data package and submit for government approval.	Review and accept the data package (focus on how data is to be applied in Timber supply analysis).	Review and accept the data package (focus on confirming current practice).
Perform and document a timber supply analysis according to standards provided by the Ministry of Forests and Range.	Provide technical advice and set standards for the analysis and reporting.	
Submit an Analysis Report and digital file containing the complete dataset used in the timber supply analysis.	Review and accept (together with the chief forester) the analysis report.	Review the analysis report to ensure local issues and current practices are adequately reflected.
Provide information to the public and First Nations and summarize comments received for government.		Formal consultation obligations.
Provide additional information as required by the chief forester.	Compile and prepare information for presentation to the chief forester at the determination meetings.	Assist in compiling and preparing information for presentation to the chief forester at the determination meetings.

1.3 Description of the Land Base

The Revelstoke Timber Supply Area (TSA) is in southeastern British Columbia and falls within the Southern Interior Forest Region. It is administered from the Columbia Forest District office in Revelstoke. It is bounded by the Monashee Mountains to the west and the Selkirk Mountains to the east, and straddles the Columbia River valley from the Mica Dam in the north to Monashee Provincial Park and Arrowhead in the south. The Trans-Canada Highway passes through the southern part of the area, providing easy access to an area of outstanding mountain scenery. Nearby are Mount Revelstoke National Park, a portion of Glacier National Park, and several smaller provincial parks (Figure 1). There are three TFL's that remove significant area from the TSA.

The Revelstoke TSA is just over 527,000 hectares in size once the TFL's and other non TSA ownership classes are removed. Approximately 55% of this area is non-forested land (alpine, lakes, swamp, brush, rock, etc) and only 10% is currently suitable to support timber harvesting activities. The forests of the Revelstoke TSA are dominated by two main biogeoclimatic zones; the Interior Western Hemlock (ICH) at lower elevations and the Engelmann Spruce Subalpine Fir (ESSF) at higher elevations (Figure 1). These ecosystems are dominated by stands of western hemlock, western red cedar, Engelmann spruce, and subalpine fir. To a lesser extent, stands contain Douglas-fir, western white pine, lodgepole pine, larch, cottonwood, birch and aspen.

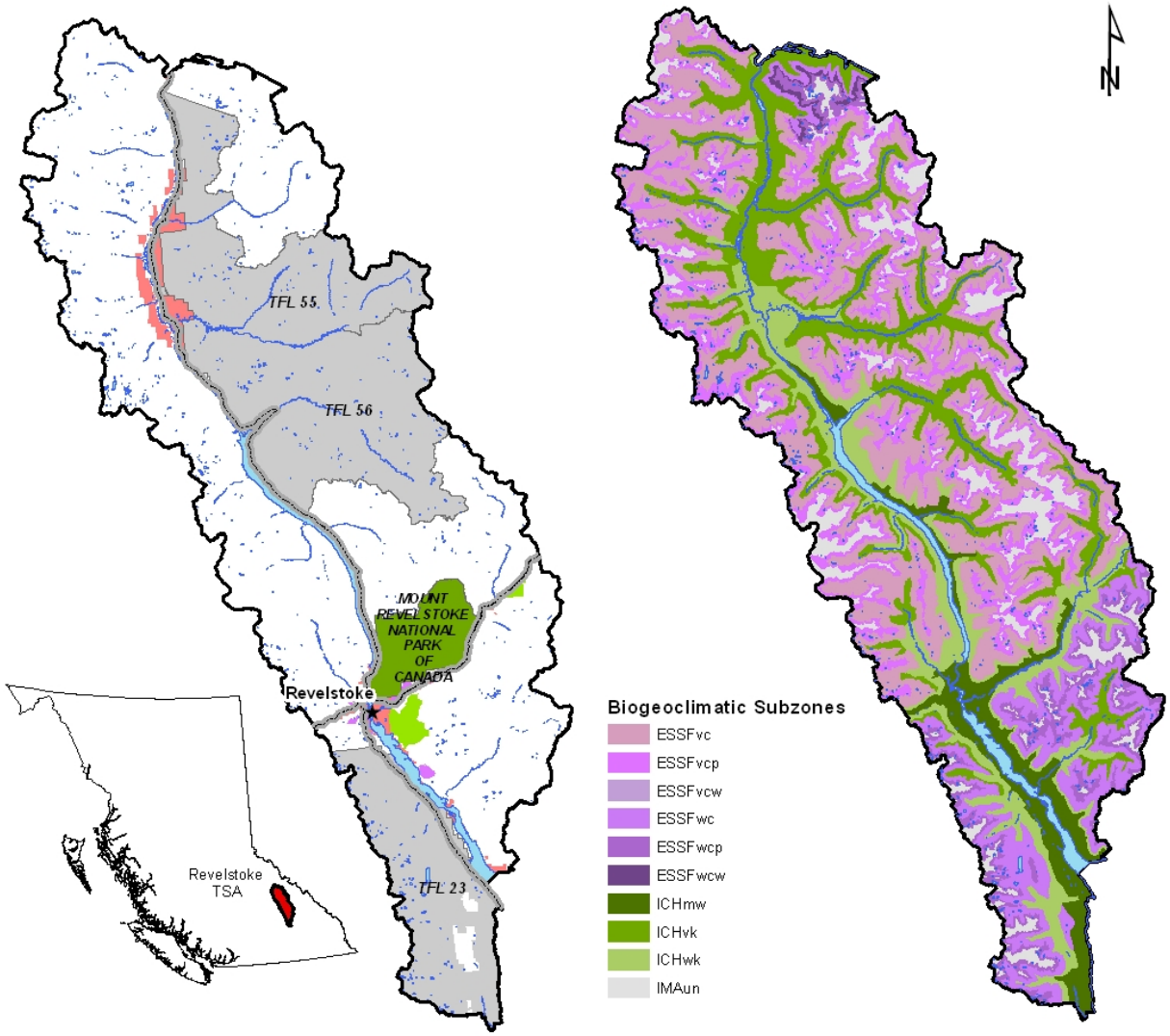


Figure 1. Revelstoke Timber Supply Area and Associated Biogeoclimatic Subzones

1.4 History of the Annual Allowable Cut

The history of the Annual Allowable Cut (AAC) for the Revelstoke TSA is summarized below.

- In 1981, an analysis was completed which resulted in a determination of an allowable annual cut (AAC) of 130,000 m³/yr.
- The timber supply was re-visited in 1985 after additional area, previously in TFL 23, was included in the TSA. The AAC was set at 269,000 m³/yr and remained unchanged until 1995.
- In 1995, the AAC was set at 230,000 m³/yr and has remained unchanged through two subsequent reviews, one in 1999 and one in 2005.

1.5 Current Practice

Within the general TSR process, current management practices are primarily defined by:

- Forest and Range Practices Act (FRPA) and its Regulations (FPPR, etc)
- Higher Level Plan Orders (e.g. Revelstoke Higher Level Plan Order),
- Government Action Regulation Orders (e.g. WHA's, Visuals, UWR, Caribou),
- Standards used to approve or reject Forest Stewardship Plans,
- Other approved BC Forest Service and joint agency forest management practices and policy,
- Current practices of forest tenure holders.

2.0 Thematic Data

2.1 Data Sources

Several resource inventories are used in the modeling process and are summarized in Table 2.

Table 2. Data inputs

Issue or Data	Description, Source	Coverage Name	Version or Date Stamp
Administrative Line Work			
Landscape Units	Landscape Unit Boundaries, LRDW	rtsa_lu	2008
Operability	Operability Line finalized in 2008 by Licensees & Forest District staff	oper_dec08	2008
Ownership	Ownership, KSDP updated by Forsite and Columbia District	owner_feb09	2008
Inventories			
BEC Variants	Biogeoclimatic Variants, Version 7, MFR research branch	rtsa_bgc	2008
NDT Types	Natural Disturbance Types in BGC file, LRDW	rtsa_bgc	2008
BEO	Biodiversity Emphasis Options, KSDP ftp – 2002	rtsa_beo	2002
Slope Classes	0-60%, 60–80%, and >=80% slope classes, Forsite Derived	rtsa_slp_cls	2009
Forest Cover / VEG	Forest Cover Composite Polygons and Rank 1 Layer, LRDW (VDYP7)	rtsa_veg_r1	2009
Terrain Classification	Terrain Classification, compiled by Forsite	rtsa_terrain	2009
ESA's	Environmentally Sensitive Areas, KSDP ftp	rtsa_esa	2005
RESULTS – Growth Intercept	RESULTS FC Inventory, LRDW	rtsa_GI_SI	2009
Management Guidelines			
Community Watersheds	Community Watersheds, LRDW	rtsa_cws	2008
Ungulate Winter Range	Approved UWR (U-4-001), LRDW	rtsa_uwr	2007
Caribou	Approved UWR (U-3-005), MoE FTP	rtsa_caribou	2009
Visual Quality Objectives	Recreational Visual Quality Objectives, LRDW	rtsa_vli	2007
Riparian Buffers	Rivers, wetlands buffered according to classification see details in data package, Forsite	rtsa_rip_buf	2009
Transportation Network	Roads and Railways buffered see details in data package, Forsite	roads_buffer	2009
OGMA	Old growth management areas (non-legal), LRDW	rtsa_ogma	2008
MOGMA	Mature-Old growth Management areas, MoE FTP	rtsa_amog	2007
Other / Special			
Forest Fires	Forest Fires, Forest Analysis and Inventory Branch	rtsa_fires	2008

2.2 Forest Cover Inventory

The forest cover inventory is a key component to the timber supply review of the TSA. The history of the forest cover inventory in the Revelstoke TSA can be summarized briefly as follows:

- The inventory data is based on 1991-1992 photography and is currently in a FIP Rollover format.
- A single flat file was obtained from the LRDW in Feb 2009 that includes only Rank 1 stand information. Attributes were projected to January 1, 2008 using VDYP7. This file also had RESULTS information (depletions and stand attributes) incorporated through the VRIMS process.
- Disturbances from harvesting and fire will be further updated in the GIS resultant to March 2008 using additional datasets supplied by licensees and the MFR.
- Ground sampling (Phase 2 work) is currently underway to assess the accuracy of the inventory attributes but is unlikely to be ready for this analysis.
- Using the Revelstoke Predictive Ecosystem Mapping (PEM) [1], site index adjustments will be applied to generate managed stand site index values in the ICH only - based on based on advice from MFR Regional Ecologists[2]. Existing inventory site indices have been used for natural stands yield projections.

2.2.1 Missing Inventory Information

There were approximately 11,770 ha in the forest cover inventory that was missing inventory attribute information (e.g. species, age, height, site index). These areas were typically associated with historical fires or logged areas that had their attributes removed when the forest cover was depleted to reflect the disturbance. It was necessary to populate these areas with species and site index information for assigning stands to analysis units and to ensure they were not excluded from the productive forest.

Species information was populated using the following hierarchy:

- RESULTS information was used to populate species composition.
- Species listed as the reference for site index was used (if available)
- Application of BEC variant based rules. For example if the dominant species in the ICHmw3 is Hemlock, it was used.

Missing site index information was filled in using the any estimated site index data in the inventory file and then for any remaining areas, a site index of 15.4 was assigned because it was the average site index of the timber harvesting land base prior to the update.

[1] Jones. C., Stehle, K., and E.Valdal. Silvatech. 2006. Revelstoke Predictive Ecosystem Mapping Final Report (BAPID #4316). Prepared for Mount Revelstoke National Park, Revelstoke Community Forest Corporation and BC Ministry of Forests and Range – Small Business Program

[2] Deb MacKillop / Del Meidenger's email approving the use of the Revelstoke PEM to adjust ICH stands. (Title: Accuracy Assessment of the Revelstoke PEM for use in TSR. Sent: November 18, 2008 by Deb Mackillop)

3.0 Timber Harvesting Land Base

3.1 Land Base Definitions

The Crown Forested Land Base (CFLB) is the area of productive forest under crown ownership. This is the land base that contributes to landscape level objectives for biodiversity and resource management. The crown forested land base excludes non-crown land, woodlots, non-forest and non-productive areas.

The Timber Harvesting Land Base (THLB) is the portion of the TSA where forest licensees under license to the province of BC are expected to harvest timber. The THLB excludes areas that are inoperable or uneconomic for timber harvesting, or are otherwise off-limits to timber harvesting. The THLB is a subset of the CFLB. Table 3 summarizes the land base for the Revelstoke TSA.

Table 3. Timber harvesting land base area netdown summary

Land Base Element	Total area (ha)	Effective Netdown* Area (ha)	% of TSA	% of Crown forest
Total area	**833,444**			
Less:				
Tree Farm Licenses		283,006		
Private Land, Woodlots, etc		23,433		
Total TSA Area		**527,005**	**100.0%**	
Less:				
Non-forest / Non-productive forest	286,995	286,995	54.5%	
Non-Commercial Brush	108	108	0.0%	
Unclassified existing roads, trails and landings	9,806	3,777	0.7%	
Total Crown Forested Land Base (CFLB)		**236,126**	**44.8%**	**100.0%**
Less:	In CFLB:			
Parks and Reserves	31,094	19,310	3.7%	8.2%
Specific Geographically Defined Areas	635	635	0.1%	0.3%
Inoperable/Inaccessible	144,715	127,252	24.1%	53.9%
Unstable Terrain	57,892	2,265	0.4%	1.0%
Environmentally Sensitive Areas	23,772	944	0.2%	0.4%
Non-Merchantable	2,764	1,923	0.4%	0.8%
Low Sites	46,539	4,197	0.8%	1.8%
Riparian Management Areas	3,129	1,616	0.3%	0.7%
Community Watersheds	4,449	255	0.0%	0.1%
Drinking Water Intakes	59	25	0.0%	0.0%
Wildlife Habitat Areas	6	4	0.0%	0.0%
Permanent Sample Plots	264	179	0.0%	0.1%
Backlog NSR	412	300	0.1%	0.1%
Cultural Heritage	0	0	0.0%	0.0%
Mountain Caribou Reserves	66,098	18,909	3.6%	8.0%
Existing Wildlife Tree Patches	690	404	0.1%	0.2%
Timber Harvesting Land Base –THLB (ha)		**57,908**	**11.0%**	**24.5%**
Less Temporary Reserves:				
Spatial OGMA's and MOGMA's	84,405	5,549	1.1%	2.4%
Effective Timber Harvesting Land Base –THLB (ha)		**52,358**	**9.9%**	**22.2%**
Volume Reductions:				
Future Wildlife Tree Patches (%)		215	0.0%	0.1%
Future roads, trails and landings		1,100	0.2%	0.5%
Long-term Timber Harvesting Land Base (ha)		**51,044**	**9.7%**	**21.6%**

* Effective netdown area represents the area that was actually removed as a result of a given factor. Removals are applied in the order shown above, thus areas removed lower on the list do not contain areas that overlap with factors that occur higher on the list. For example, the parks netdown does not include any non forested area.

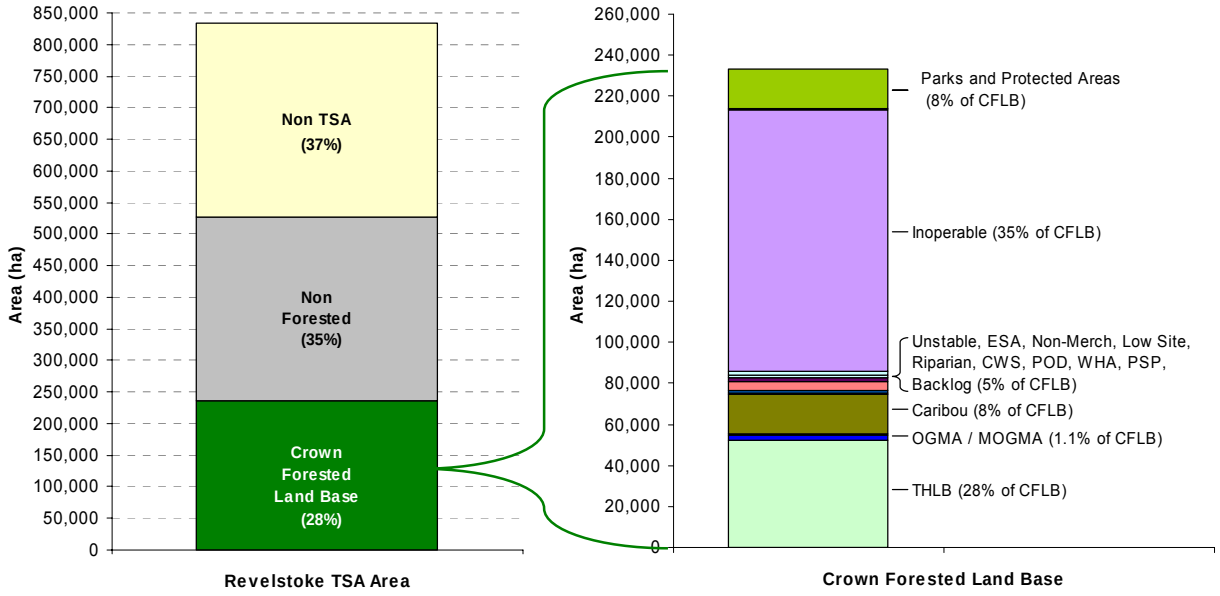


Figure 2. Revelstoke TSA Land Base Summary

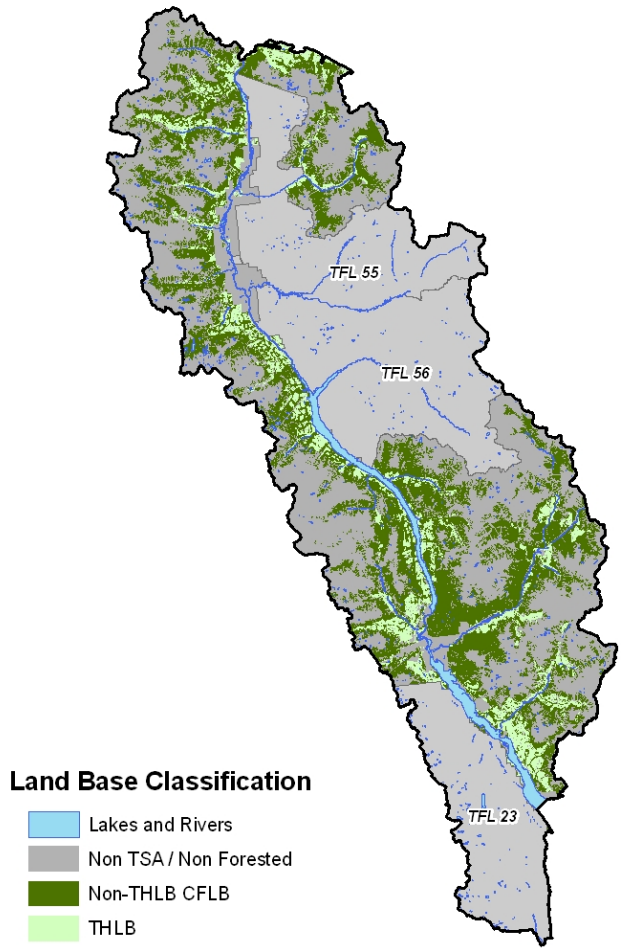


Figure 3. Revelstoke TSA Land Base Definition Map

3.2 Exclusions from the Crown Forested Land Base

3.2.1 Ownership classes not part of the TSA

The area of the Revelstoke Timber Supply Area is divided into ownership classes that describe the nature of ownership of a particular parcel of land. For forest management in the Revelstoke TSA, only those lands that are under crown ownership will contribute to forest management objectives, like landscape level biodiversity. For the purpose of this analysis, Mount Revelstoke National Park is included in the crown forested land base.

Table 4 describes the various ownership codes in the Revelstoke TSA and their contribution to the Crown Forest Land Base, the Timber Harvesting Land Base, or both. Parks and protected areas are described in more detail in Section 3.3.1.

Table 4. Ownership classes not part of the TSA

Ownership Description	Percent Contribution to Crown Forested Land base	Percent Contribution to Timber Harvesting Land base	Total area (ha)
Woodlot Licenses	0%	0%	1,809
Tree Farm Licence (TFL)	0%	0%	283,006
Private	0%	0%	21,624
		Total	**306,439**

The current ownership layer was obtained from the Kootenay Spatial Data Partnership website and updated by Forsite and MFR geomatics staff (Robyn Begley). The ownership is considered current to 2009. Edits were made to the ownership file for TSR4 as follows:

- Woodlot expansions were captured by adding the forest tenure managed license layer to the ownership file.
- Controlled Recreation Areas (Revelstoke Mountain Resort) were confirmed to be excluded from the timber harvesting land base. Expansion areas were specifically excluded from the THLB.
- The Canadian Pacific Railway (CPR) Moratorium area was added to the ownership file and treated as a miscellaneous reserve.

More detail on how the Revelstoke Mountain Resort and the CPR Moratorium are dealt with can be found in Section 3.3.1 and 3.3.2, respectively.

3.2.2 Non-forest and non-productive forest

All land classified as non-forest, non-productive (lakes, swamps, rock, alpine, *etc*.), or non-typed in the forest cover files were excluded from the timber harvesting land base. The non-forest and non-productive areas and codes used in the netdown process are listed in Table 5.

Table 5. Non-forest and non-productive area

Description	Percent Reduction	Total area (ha)	Netdown Area (ha)
Alpine	100%	209,410	209,410
Alpine forest	100%	22,090	22,090
Clearing	100%	54	54
Gravel bar	100%	86	86
Gravel pit	100%	18	18
Lake	100%	18,618	18,618
Meadow	100%	92	92
Non-productive	100%	19,940	19,939

Description	Percent Reduction	Total area (ha)	Netdown Area (ha)
Non-productive brush	100%	9,453	9,453
Non-productive burn	100%	437	437
No Typing Available	100%	97	97
Open range	100%	7	7
Rock	100%	3,000	3,000
River	100%	1,445	1,445
Swamp	100%	237	237
Urban	100%	2,011	2,011
	Total	**286,995**	**286,995**

3.2.3 Non-commercial cover

Non-commercial cover is productive forest land that is otherwise occupied by non-commercial tree or shrub species. This area of land does not currently grow commercial tree species, and is not expected to do so without intervention. This area was therefore excluded from the crown forested land base.

Table 6. Non-commercial cover

Description	Percent Reduction	Total Area (ha)	Netdown Area (ha)
Non-Commercial Brush (NFOR_Desc=NCBr)	100%	108	108

3.2.4 Roads, trails, and landings

Quantifying the area that is, and will be, disturbed by roads, trails, landings (RTLs) and other access features in the TSA is an important part of determining the THLB. Area expected to remain non-productive was removed from the working land base as outlined below.

3.2.4.1 Existing classified roads

Classified roads are those roads identified in the forest cover inventory. These are frequently large roads or highways with a wide right-of-way and are netted out in Table 5.

3.2.4.2 Existing unclassified roads, trails, and landings

Roads not represented in the forest cover data are considered unclassified. A consolidated dataset was compiled by Forsite in November 2008 by adding recently constructed roads to an existing roads dataset (TRIM). The widths associated with these road features were estimated by members of the Revelstoke TSR technical committee and applied as buffers to these line features (Table 7). The buffered areas are considered unproductive and are netted out of the crown forested land base.

Table 7. Access feature classification

Access feature / class	Road length (km's)	Road width (m)	Percent Reduction	Total Area (ha)*	Netdown Area (ha)
Highway	427	28.0	100%	1,165	56
Operational (Logging Roads & Spurs)	4,246	20.1	100%	8,450	3,718
Railway	82	28.0	100%	191	2
			Total	**9,806**	**3,777**

* This gross area is less than the area obtained by multiplying road lengths and widths. This is because the GIS coverage does not double count overlaps between feature types or the buffer overlaps that occurs at all intersections.

In order to account for in-block trails and landings (3% of all logged areas), buffers were enlarged on existing logging roads so that the equivalent area (e.g. 3.0% * logged area [43,921 ha] = 1317 ha) was added to the buffer.

3.3 Exclusions from the Timber Harvesting Land base

3.3.1 Parks and Protected Areas

Provincial / National parks and other protected areas in the Revelstoke TSA are excluded for the timber harvesting land base (Table 8). Although the Revelstoke Mountain Resort (RMR) does not carry an official park status, it was included here because it will be treated as if it were a park in the analysis.

Table 8. Parks and Protected Areas in Revelstoke TSA

Description	Percent Reduction	Productive Forest Area (ha)	Netdown Area (ha)
Mount Revelstoke National Park of Canada	100%	26,332	15,609
Martha Creek Provincial Park	100%	397	172
Blanket Creek Provincial Park	100%		
Goose Grass Ecological Reserve	100%		
Revelstoke Mountain Resort (RMR)	100%	4,365	3,528
	Total	**31,094**	**19,310**

The areas shown here are able to contribute toward meeting non timber objectives. However, most non-timber objectives in the Revelstoke TSA must be met separately above and below the operability line (i.e. landscape level biodiversity objectives). Since the Mount Revelstoke National Park is considered inoperable, it does not contribute toward meeting biodiversity objectives.

3.3.2 Specific Geographically Defined Areas

A moratorium on development exists on an area near the Canadian Pacific railway just East of Albert Canyon and therefore it was completely excluded from the timber harvesting land base (Table 9). The Downie Slide Moratorium area is another geographically defined area to be excluded from the THLB but is entirely outside the operability line and was therefore left to be addressed using that data source. The CPR moratorium area is also almost entirely outside the operable landbase. Because both these areas are considered inoperable, they cannot contribute to biodiversity objectives applied to the operable land base.

Table 9. Land base reductions for specific, geographically defined areas.

Description	Percent Reduction	Productive Forest Area (ha)	Netdown Area (ha)
CPR Moratorium	100%	635	635

3.3.3 Inoperable/inaccessible

Inoperable areas are areas that are not available for timber harvesting because of adverse terrain characteristics such as steep slopes, unfeasible road access or uneconomic yarding or flight distance. In the Revelstoke TSA, operability was updated in 2008 by forest licensees and approved by MFR District staff.

Table 10. Land base reductions for inoperable areas

Criteria	Percent Reduction	Productive Forest Area (ha)	Netdown Area (ha)
Physically and economically inaccessible with current technology (oper = I, or X)	100%	144,715	127,252

3.3.4 Unstable Terrain

Historically, terrain stability mapping was completed in a variety of projects to various intensities of mapping (Level B, C, and D), largely to satisfy operational and regulatory requirements. Terrain mapping datasets from numerous projects were appended together into a single spatial dataset. The stability attribute from all the separate inventories were compiled into a 'Final_Class' attribute, where the stability class from the most intensive mapping was given precedence over the least intensive mapping when overlaps occurred. As this data is considered more accurate than ESA mapping, it eliminates the need for ESA soils mapping (described below).

There is an acknowledgement that slope stability attributes found in terrain mapping require further refinement in the field during cutting permit development. For example, a portion of the areas mapped as "unstable" or "partially unstable" are typically confirmed to be acceptable for timber harvesting in the field. These mapped attributes best serve as a red flag for field operations and do not automatically exclude these areas from harvest.

In order to determine the appropriate land base reduction to apply to mapped Unstable (U) and Potentially Unstable (P) areas, several factors were considered:

- Harvest performance analysis (Forsite unpublished, 2009) – The proportion of the operable/eligible landbase designated as U or P was compared to the proportion of harvested areas (previous 5 yrs) designated as U or P. The results indicated no avoidance of P areas and slight avoidance of U areas relative to their profile on the land base.
- Harvest performance analysis (Downie unpublished, 2009) – 29 harvested blocks were selected and overlaid with Level D terrain mapping and Level A terrain mapping to determine the areas within each terrain class. The analysis indicated there was significant harvest performance in U and P terrain. It also indicated that about 5% of all the area in the blocks was considered unstable (Level A class V) enough to prevent harvest from occurring. These areas were typically left as WTP's. Because only harvested blocks were assessed, extrapolation to the entire landbase was not possible.
- Approach used in neighboring interior wet-Belt management units – TFL 56, TFL 55, Golden TSA, Kootenay Lake TSA. A detailed review of terrain mapping (polygon by polygon) within TFL 56 was conducted by Terratech staff in 2000. As a result of this assessment, 49% of all the U polygons below the operability line were netted out and 0% of the P polygons were netted out. Since TFL 56 is embedded within the TSA and has nearly identical terrain features, netdown factors applied in this TFL were felt to be representative of conditions experienced throughout the TSA.
- Professional opinion from Joe Alcock and Peter Jordan.

For purposes of modeling, netdowns were performed as per Table 11 – 50% of all polygons below the operability line that were labeled as U was removed on a steepest first basis. This subset of terrain polygons resulted in a netdown of area believed to be consistent with field operations. No netdown was applied to P polygons because experience in TFL 56 as well as the Forsite harvest performance analysis showed no avoidance of harvesting in this terrain stability class. Another factor that was considered was that leave areas that result from field assessments can almost always be accommodated within the stand level netdown budget. Where no terrain mapping existed, the ESA soils designation was used as described in Table 12 below.

Table 11. Land base reductions for unstable terrain

Mapped Terrain Class	Percent Reduction	Productive Forest Area (ha)	Netdown Area (ha)
U (unstable terrain) from Level D mapping	50%	23,424	2,265
P (potentially unstable) from Level D mapping	0%	34,469	0
	Total	**57,892**	**2,265**

3.3.5 Environmentally sensitive areas

Environmentally sensitive sites and areas of significant value for other resource uses have been delineated within the forest cover inventory as Environmentally Sensitive Areas (ESA's). ESA's are attributes assigned to forest cover polygons to indicate sensitivity for unstable soils (E1s), forest regeneration problems (E1p), snow avalanche risk (E1a), and high water values (E1h). As discussed in the previous section, terrain stability mapping provides a better estimate of unstable soils than the E1s mapping, so E1s mapping was only used when no terrain mapping was available. ESA netdown percentages are identical to those used in TSR3 (see Table 12).

Table 12. Land base reductions for Environmentally Sensitive Areas

ESA category	ESA description	Percent reduction	Productive Forest Area (ha)	Netdown Area (ha)
E1a	Severe snow avalanching	**100%**	27	0
E1s (where no terrain mapping exists)	Sensitive / unstable soils >= 60% slope	**100%**	12,261	591
	Sensitive / unstable soils < 60% slope	**25%**	11,484	353
		Total	**23,772**	**944**

3.3.6 Non-merchantable forest types

Non-merchantable forest types are stands that contain tree species not currently utilized, or timber of low quality, small size and/or low volume. Non-merchantable types are entirely excluded from the timber harvesting land base. In defining non-merchantable forest types for TSR4 the following stand types were considered for potential exclusion:

- Predominantly Balsam Stands (>80% B)
- Balsam leading with hemlock as secondary
- Predominantly Hemlock Stands (>80% Hw)
- Hemlock leading with deciduous as secondary
- Deciduous leading ≥30 years

Harvest performance over the past 5 years was assessed on the first three stand types listed and it was found that harvest has occurred consistent with each of the stands type profiles on the operable/eligible land base. As a result, these stand types remained in the land base while the Hw/Deciduous and deciduous leading stands were removed. Thus, non-merchantable forest types for use in TSR4 were the same as TSR3. Table 13 shows the non-merchantable forest types removed from the land base.

Table 13. Land base reductions for Non-merchantable forest types

Species	Inventory type group	Age (years)	Percent Reduction	Productive Forest Area (ha)	Netdown Area (ha)
Deciduous leading	35-42	>30	100 %	2,753	1,923
Hw Leading & Decid.	17	>140	100 %	10	0
			Total	**2,764**	**1,923**

Minimum ages were used to avoid removing young deciduous stands under the assumption that these stands will produce a conifer crop consistent with licensee obligations.

3.3.7 Low productivity sites

Low productivity sites are areas that are not suitable for timber harvesting due to low timber growing potential. These stands have suitable species for timber harvesting but are not expected to contribute to the THLB because they take too long to grow a commercial crop of trees. Low site cutoffs were re-visited in the development of this data package and resulted in no change from TSR3. The site index cutoffs did not apply to stands that have been previously logged.

Table 14. Land base reductions for Low sites

Leading species	Inventory Type Group Number	Site index	Percent Reduction	Productive Forest Area (ha)	Netdown Area (ha)
Douglas-fir	1-8	<9	100	185	31
Cedar	9-11	<9	100	4,941	2,015
Hemlock	12-17	<8	100	14,335	843
Balsam	18,19	<8	100	23,410	921
Spruce	20-26	<8	100	3,507	387
White Pine	27	<8	100	0	0
Lodgepole Pine	28-31	<9	100	25	0
Ponderosa pine	32	<9	100	0	0
Larch	33,34	<9	100	0	0
Deciduous	35-42	<9	100	136	0
			Total	**46,539**	**4,197**

3.3.8 Riparian reserves and management zones

Riparian reserve areas around lakes, wetlands, and streams in the Revelstoke TSA are excluded from the timber harvesting land base and are based on the *Forest Practices and Planning Regulation* (FPPR Sec. 47-52) defaults. Management practices within riparian management zones also resulted in areas excluded from the timber harvesting land base. In the analysis, this has been represented by an additional buffer width that will be 100% excluded. When the reserve zones and the representative portions of the management zones are added together, an "effective" buffer width is defined and ultimately used in the model.

3.3.8.1 Streams

Riparian reserve strategies were implemented in the model by establishing effective reserve buffers around the riparian features inventories (streams, wetlands, lakes) using GIS. See Table 15 for a description of the riparian management netdown assumptions.

Table 15. Land base reductions for riparian reserve and management zones — streams

Stream class*	Reserve Zone (RRZ) (m)	Management zone width (RMZ) (m)	RMZ Basal Area Retention (%)	Effective Buffer Width (m)** (each side)	Productive Forest Area (ha)	Netdown Area (ha)
S1a	0	100	20	20	28	20
S1b	50	20	20	54	1,018	577
S2	30	20	20	34	1,150	606
S3	20	20	20	24	655	261
S4	0	30	10	3	51	23
S5	0	30	10	3	227	93
S6	0	20	0	0	0	0
				Total	**3,129**	**1,579**

* Stream classes are defined in the Riparian Management Guidebook. S1-S4 are fish bearing or in a community watershed, while S5-S6 are non fish bearing.

** Effective width is calculated as Reserve Width (m) + (Management Zone Width x Management Zone Retention)

3.3.8.2 Lakes and Wetlands

Lakes and wetlands in the Revelstoke TSA were obtained from the LRDW, and classified in accordance with the *Riparian Management Area Guidebook* and the *Regional Lake Classification and Lakeshore Management Guidebook*. Similar to the riparian reserves around streams, a buffer around each lake / wetland was created to represent the area deducted from the THLB. Table 16 shows the effective buffer width around each class of lake or wetland.

Table 16. Land base reductions for riparian reserve and management zones — wetlands and lakes

Riparian class*	Reserve width (m)	Management zone width (m)	Management Zone Retention (%)	Effective Buffer Width (m)**	Productive Forest Area (ha)	Netdown Area (ha)
L1 Lakes <= 1000 ha	10	0	10	10	7	1
L3 lakes	0	30	10	3	7	1
W1 wetlands	10	40	10	14	16	4
W3 wetlands	0	30	10	3	38	18
W5 Wetlands	10	40	10	14	29	12
				Total	**96**	**37**

* The table only includes the wetland classes that occur in the TSA.
** Effective width is calculated as Reserve Width (m) + (Management Zone Width x Management Zone Retention).

3.3.9 Community Watersheds

Community watersheds are watersheds that supply communities with domestic water. Within the Revelstoke TSA there are 4 designated community watersheds: Hamilton, Greeley, Bridge, and Dolan Creek. Licencees have avoided and continue to avoid these areas and thus have been completely excluded from the THLB.

Table 17. Land base reductions for community watersheds

Description	Percent reduction	Productive Forest Area (ha)	Netdown Area (ha)
Community Watersheds	100%	4,449	255

3.3.10 Drinking Water Intakes

In order to protect drinking water resources, drinking water intakes or points of diversion (POD's) were buffered by 100 m and completely removed from the timber harvesting land base.

Table 18. Land base reductions for drinking water intakes

Description	Percent reduction	Productive Forest Area (ha)	Netdown Area (ha)
Buffered Drinking Water Intakes (100 m)	100%	59	25

3.3.11 Wildlife Habitat Areas

The provincial *Identified Wildlife Management Strategy* provides for the creation of wildlife habitat areas (WHAs), to protect key habitat features of listed wildlife species. Since the last TSR, five WHAs have been spatially established within the Revelstoke TSA and were therefore excluded from the timber harvesting land base.

Table 19. Land base reductions for Identified Wildlife

Description	Percent reduction	Productive Forest Area (ha)	Netdown Area (ha)
Wildlife Habitat Areas (WHAs)	100%	6	4

3.3.12 Permanent Sample Plots

Permanent sample plots (PSPs) are established throughout the province in order to provide long-term, local data on growth of existing forests. They provide information on rates of growth, mortality, and changes in stand structure from stand establishments to maturity. For this reason, it is important that established permanent sample plots are not disturbed. Therefore, all PSP core areas were removed from the THLB (Table 20).

Table 20. Land base reductions for Permanent Sample Plots

Description	Percent reduction	Productive Forest Area (ha)	Netdown Area (ha)
Permanent Sample Plots	100%	264	179

3.3.13 Backlog NSR

Backlog areas are those harvested prior to October 1987 and are not yet sufficiently stocked according to standards (MFR, 2008). District staff (Barb Wadey) used RESULTS information to identify approximately 412 ha within the Revelstoke TSA that meets this criteria. Backlog NSR areas are identified at the Standards Unit (SU) level which is not reflected spatially in the forest cover. In order to get to an equivalent backlog NSR area, 412 ha were chosen randomly from the Backlog NSR population of openings (Table 21). These backlog areas were 100% removed because it is unclear what volumes will be achieved on these sites and any volume that does materialize can be used to offset the reduced volumes coming from impeded or otherwise lower volume stand from that same era.

Table 21. Land base reductions for Backlog NSR

Description	Percent reduction	Productive Forest Area (ha)	Netdown Area (ha)
Backlog NSR	100%	412	300

3.3.14 Cultural Heritage Resources

A cultural heritage resource is defined in the Forest Act as, "an object, site, or location of a traditional societal practice that is of historical, cultural or archaeological significance to the province, a community, or an aboriginal people". Cultural heritage resources include archaeological sites, structural features, heritage landscape features and traditional use sites.

Archaeological Heritage Resources

The *Heritage Conservation Act* provides for the protection of British Columbia's archaeological sites predating 1846. In accordance with the *Act* (Section 13(2)), archaeological sites may not be damaged, excavated or altered without a permit issued by the Minister or designate. As such, any registered Archaeological site will be 100% excluded from the THLB (Table 22).

Table 22. Land base reductions for Registered Archaeological Sites

Description	Percent reduction	Productive Forest Area (ha)	Netdown Area (ha)
Registered Archeological Sites	100%	0.2	0

Other Cultural Heritage Resources and Values

Other cultural heritage resources and values may be present within the Revelstoke Timber Supply Area. These resources and/or values associated with a land base or forest operation may not have any legal designation. As such they have not been modeled in the base case timber supply analysis. However, such resources and values can be brought forward to the Chief Forester as information to consider in his AAC determination.

3.3.15 Mountain Caribou

Spatial reserves to protect mountain caribou (*Rangifer tarandus caribou*) habitat have been established (GAR Order #U-3-005) and have been in effect since February 12, 2009. Mountain caribou guidelines were amended out of the Revelstoke Higher Level Plan to avoid conflicts with the GAR order. These spatial reserves were therefore completely removed from the THLB in the Base Case.

Table 23. Land base reductions for Mountain Caribou

Description	Percent reduction	Productive Forest Area (ha)	Netdown Area (ha)
Caribou Reserves (GAR UWR 3-005)	100%	66,098	18,909

3.3.16 Existing Wildlife Tree Patches

Existing wildlife tree patches have been excluded from current timber harvesting activities, and are expected to remain on the landscape for a least one rotation. An equivalent area of mature forest is expected to always exist in WTPs so this area was removed from the timber harvesting land base (Table 24). A layer of existing WTPs was compiled from TSA licencee data.

Table 24. Land base reductions for Existing Wildlife Tree Patches

Description	Percent reduction	Productive Forest Area (ha)	Netdown Area (ha)
Existing Wildlife Tree Patches	100%	690	404

3.3.17 Old Growth and Mature+Old Management Areas

The Revelstoke Higher Level Plan Order specifies the percentage requirements of old seral and mature-plus-old seral that must be retained within each LU and BEC combination. The equivalent area of both the old and the mature-plus-old seral has been mapped be ILMB staff. These areas are called OGMA's (old growth management areas) and MOGMA's (mature old growth management areas). They are treated as "no-harvest' zones for the first 80 years of the planning horizon, after which they are released and aspatial cover constraints are applied to satisfy the requirements. Refer to Section 8.5.1 on Page 41 for more detail on biodiversity requirements were handled in the model.

Table 25. Temporary land base reductions for Spatial OGMA's and MOGMA's

Biodiversity Reserve Type	Percent reduction	Productive Forest Area (ha)	Netdown Area (ha)
Old growth management area (OGMA)	100%	36,320	3,249
Mature plus old management area (MOGMA)	100%	48,086	2,301
	Total	**84,405**	**5,549**

3.3.18 Future Land Base Reductions

3.3.18.1 Future wildlife tree retention areas

The licensees' Forest Stewardship Plans are based on retaining the default 7% of each cutblock as wildlife tree retention (WTR) areas. When possible, WTR is placed within existing non-THLB stands, so only a portion of the 7% is an incremental landbase reduction. Wildlife tree retention areas are typically managed so they are a maximum distance of 500 meters apart. Based on these two factors (7.0% of the THLB reserved when beyond the 500m maximum distance spacing) the area of future wildlife tree retention areas (Table 26) was estimated using the following procedure.

- Within the THLB (Table 26, column 1) apply a 250m buffer around all productive, non-THLB that is older than 80 yrs old (column 2);
- The area outside the buffer is the area that requires additional wildlife tree retention (column 3);
- Apply a 7% retention rate to this area to estimate the equivalent area of future wildlife tree retention (column 4);
- Calculate the equivalent, blended rate of retention across the whole THLB (the developed area plus the un-developed area), which is 0.41 % of the THLB (column 5);
- Apply that percentage as a yield curve reduction against all the future managed stand yield curves.

Table 26. Estimate of future wildlife tree retention areas

(1) THLB Area (ha)	(2) THLB Area within 500 meters of Forested Non-THLB (%)	(3) THLB Area requiring additional WT retention (%)	(4) Equivalent THLB Retention Assuming 7% Retention (ha) (7%) X (column 3)	(5) Future THLB Reduction (4) / (1) (%)
52,358	49,289	3,069	215	0.41%

A very small amount of THLB was further than 500m from existing retention because the THLB is geographically fragmented by geography and spatial reserves for OGMA, MOGMA, Caribou, and other netdowns.

3.3.18.2 Future roads, trails and landings

Deductions for future roads are necessary to account for the unproductive area created as new roads, trails and landings are built. A first logging entry into any unroaded area in the TSA will capture all of the timber volume available in that stand. Any subsequent entries will harvest less area, recognizing the unproductive area that would then exist as roads, trails and landings.

TSR3 used a yield reduction of 6.0% to model area lost to future roads, trails, and landings. For this analysis, the same percentage (6.0%) has been used but applied only to areas of the THLB that were at least 300 m from currently existing roads and stands older than 30 yrs old. The area within 300 m can currently be accessed from the existing roads and the 30 yr age is designed to eliminate currently logged blocks (i.e. heli blocks) from having this netdown applied.

Deductions for future roads, trails and landings were applied as a volume reduction to the yield tables of all future managed stand analysis units (200 series AU's). The THLB area meeting the criteria described above (11,995 ha) was multiplied by 6.0% to get an effective area reduction (751 ha). This area was then calculated as percentage of the total area of the future managed stand yield curves (34,644 ha) and implemented as a volume reduction (**2.1%**) on these curves. This percentage is lower than 6.0% because a portion of the area on 200 series AUs can already be serviced by the existing road infrastructure (i.e. within 300 m).

3.4 Changes from TSR3

Since TSR3, several input datasets and assumptions have changed, and result in differences in the size of the timber harvesting land base. A summary of these changes is provided below:

- New caribou management guidelines (GAR Order #U-3-005) provide for spatially explicit reserves that include incremental reserves beyond what was previously required under the Revelstoke Higher Level Plan. Excluding these reserves from the THLB causes a very significant reduction in THLB area relative to TSR3 although only the incremental reserves are likely to result in true timber supply impacts. Without the caribou reserves, the THLB in this analysis would have been within ~1000 ha of the TSR3 THLB area.
- Operable area for the TSA was reviewed in 2008 to confirm the physical operability. A new operable area was identified after areas were both removed and added to the old operability line. The net impact on THLB is dependant on how additions and subtractions are dealt with in the netdown process.
- Where terrain stability mapping (Level B or Level D mapping) is complete in the TSA, it was used in place of the older Environmentally Sensitive Area (ESA) soils mapping. ESA soils mapping was used in only 26% of the operable CFLB land base. This approach was less constraining than the approach used in TSR3.
- Use of spatially explicit Old Growth and Mature Management Areas (OGMAs and MOGMAs) to satisfy Old and Mature requirements set out in the Revelstoke Higher Level Plan for the first 80 years. TSR3 used percentage targets to meet the same objective.
- Wildlife Habitat Areas (WHAs) have been designated (no species listed).
- Boundaries for the Revelstoke Mountain Resort have been established and excluded.
- Ownership has changed slightly - Woodlots have been expanded.
- Recognition and protection of active Permanent Sample Plots (PSPs).
- Exclusions for drinking water intakes.
- Management of riparian area retention to FPPR defaults resulting in smaller effective riparian buffers.
- Removal of mapped registered archeological sites.
- Timber License areas no longer exist and are part of the TSA from the start of the planning horizon.

The THLB determined in TSR3 was 78,018 ha. As a result of the listed differences from TSR3, the THLB area used here dropped by 25,660 ha (32.9%). Spatial Caribou reserves make up the vast majority of the difference followed by the use of spatial OGMAs and MOGMAs to satisfy biodiversity requirements. The scale of this change will not translate proportionately into timber supply impacts because both HLP caribou and OGMA/MOGMA were modeled in TSR3 as constraints. They have simply been made spatial and removed from the THLB for this analysis.

Other non-THLB related changes since TSR3 include:

- Forest Cover attributes (ht, volume, age) have all been projected using VDYP7. The Forest Cover for the previous TSR was projected with VDYP v.6.5a. This appears to results in less standing volume in the TSA.
- Predictive Ecosystem Mapping (PEM) has been completed for the TSA. Managed stand site index values have been adjusted in the Base Case using SIBEC relationships in ICH variants.
- Biogeoclimatic mapping has been updated (Version 7).
- Revision of regeneration assumptions including:

  - Minor changes in species composition.
  - Inclusion of select seed gains for Spruce, Larch, and Douglas-fir.
- A new UWR GAR order for Mule Deer and Moose (U-4-001) exists and requires from 10-40% of the habitat in each Management Unit (MU) to be >60-100 yrs old and Maximum 40% <21 years old at any time. TSR3 required a minimum of 40% > 120 yrs old and maximum of 25% <2m so the current version appears to be less constraining.
- Visual Quality Objectives (VQO's) were legally established for the TSA in 2000. Additional updates were made in 2007. Assumptions for managing for visuals have also been revised.
- Revision of assumptions for modeling disturbance in the inoperable.
- Revision of assumptions for future wildlife tree retention – 0.27% reduction applied to all yield curves.
- Revision of assumptions to account for future roads trails and landings (RTLs). The same percentage was used to account for future RTLs however, it was only applied to the areas of the THLB that were at least 300 m away from currently existing roads and only applied to stands >30 years old. This area was then calculated as percentage of the total area of the future managed stand yield curves and implemented as a volume reduction on these curves.
- Use of Forest Planning Studio (FPS-ATLAS) to conduct timber supply modeling.

4.0 Growth and Yield

This section describes the information/data sources, assumptions, and methods for generating growth and yield estimates for both existing and future stands, under both unmanaged and managed conditions.

4.1 Analysis units

To reduce the complexity and volume of information in the timber supply analysis, individual stands were aggregated into 'Analysis Units' based on dominant tree species (inventory type group), timber growing capability (site index), and silvicultural management regimes. For example, all spruce/balsam stands on moderate growing sites with a clearcut silviculture regime are grouped into a single analysis unit. Each analysis unit has an associated yield table that provides the model with the net merchantable volume available for harvest at various stand ages. Three *sets* of analysis units are created to reflect the level of forest management associated with various time frames:

Existing Natural Stands (100 series – 34,772 ha of THLB)

Stands where forest management (planting/spacing) has been generally absent. This was defined as stands greater than 30 years old with no record of planting or spacing in the forest inventory files.

Existing Managed Stands (500 series – 23,185 ha of THLB)

Stands where forest management (e.g. planting/spacing) has had a positive impact on the regeneration/growth of the stand. This was defined as stands harvested on or after 1979 (≤ 30 yrs old . This set of analysis units is meant to capture past regeneration practices in the TSA that should provide at least a modest improvement over natural stands volumes. Once harvested, these stands will be grown with similar expectations to the future managed stands described below.

Future Managed Stands (200 / 600 series)

Stands harvested from today forward. Once existing natural stands are harvested in the model, they will be assigned to one of these analysis units. They are meant to capture the management/regeneration practices occurring in the TSA today. The 100 series AUs regenerate into the 200 series AUs. The 500 series AUs regenerate into the 600 series AUs.

These broad groups are further sub-divided by criteria of:

- leading species
- Site Index - In order to differentiate the regeneration and growth characteristics.
- Age Range

Table 27. Analysis Unit Descriptions

Analysis Unit Description	Existing Natural Stands AU #	Future Managed Stands* AU#	THLB Area (ha)	SI Inv. Wtd. Avg.	SI Adj Wtd. Avg.	Variable used to define analysis unit		
						Leading Species	Site index range	Age Range (yrs)
Existing Natural Stands								
Fir Larch Pine – Good <141	101	201	1,354	23.3	23.4	Fd, Lw, Pl	≥21	<141
Fir Larch Pine – Good +141	102	201	93	21.9	23.1		≥21	≥141
Fir Larch Pine – Medium <141	103	202	4,406	18.0	20.2		≥15 and <21	<141
Fir Larch Pine – Medium +141	104	202	663	17.2	18.2		≥15 and <21	≥141
Fir Larch Pine – Poor <141	105	203	1,123	13.4	19.3		<15	<141
Fir Larch Pine – Poor +141	106	203	99	12.1	19.8		<15	≥141
Cedar – Good <141	107	204	1,615	19.5	18.6	Cw	≥17.5	<141
Cedar – Good +141	108	204	172	20.1	20.1		≥17.5	≥141
Cedar – Medium <141	109	205	531	15.7	17.7		≥14.5 and <17.5	<141
Cedar – Medium +141	110	205	519	15.8	18.5		≥14.5 and <17.5	≥141
Cedar – Poor <141	111	206	512	11.8	17.9		<15	<141
Cedar – Poor +141	112	206	3,618	11.7	17.6		<15	≥141
Hemlock – Good <141	113	207	2,116	19.9	18.7	Hw	≥18	<141
Hemlock – Good +141	114	207	682	20.0	19.2		≥18	≥141
Hemlock – Medium <141	115	208	2,401	14.8	17.6		≥12 and <18	<141
Hemlock – Medium +141	116	208	4,276	14.4	16.5		≥12 and <18	≥141
Hemlock – Poor <141	117	209	308	10.8	15.4		<12	<141
Hemlock – Poor +141	118	209	1,706	10.4	14.2		<12	≥141
Balsam Spruce – Good <141	119	210	89	18.7	18.7	Bl	≥18	<141
Balsam Spruce – Good +141	120	210	48	18.6	18.6		≥18	≥141
Balsam Spruce – Medium <141	121	211	349	14.9	15.3		≥13 and <18	<141
Balsam Spruce – Medium +141	122	211	426	14.5	14.7		≥13 and <18	≥141
Balsam Spruce – Poor <141	123	212	406	11.3	12.1		<13	<141
Balsam Spruce – Poor +141	124	212	805	10.4	10.7		<13	≥141
Spruce Mix – Good <141	125	213	506	20.9	20.8	Sx	≥18	<141
Spruce Mix – Good +141	126	213	1,490	21.7	22.2		≥18	≥141
Spruce Mix – Medium <141	127	214	710	15.5	20.4		≥14 and <18	<141
Spruce Mix – Medium +141	128	214	1,079	15.9	18.8		≥14 and <18	≥141
Spruce Mix – Poor <141	129	215	361	11.8	14.5		<14	<141
Spruce Mix – Poor +141	130	215	2,259	11.6	14.1		<14	≥141
Natural Subtotal			**34,722**	**15.6**	**17.9**			
Existing Managed Stands*								
Fir Larch Pine – Good	501	601	370	23.5	23.4	Fd, Lw, Pl	≥21	<30
Fir Larch Pine – Med	502	602	2,605	17.2	21.8		≥15 and <21	<30
Fir Larch Pine – Poor	503	603	444	12.4	19.7		<15	<30
Cedar – Good	504	604	3,144	19.6	19.5	Cw	≥17.5	<30
Cedar – Med	505	605	1,704	15.7	17.6		≥14.5 and <17.5	<30
Cedar – Poor	506	606	1,140	11.8	17.3		<15	<30
Hemlock – Good	507	607	703	19.7	18.9	Hw	≥18	<30
Hemlock – Med	508	608	1,037	14.7	16.5		≥12 and <18	<30
Hemlock – Poor	509	609	115	9.0	14.2		<12	<30
Balsam – Good	510	610	91	18.5	18.7	Bl	≥18	<30
Balsam – Med	511	611	432	14.6	14.9		≥13 and <18	<30
Balsam – Poor	512	612	90	10.2	10.2		<13	<30
Spruce Mix – Good	513	613	3,339	20.5	22.2	Sx	≥18	<30
Spruce Mix – Med	514	614	6,126	15.2	19.5		≥14 and <18	<30
Spruce Mix – Poor	515	615	1,845	11.6	16.4		<14	<30
Managed Subtotal			**23,185**	**16.5**	**19.4**			
Total THLB			**57,908**	**16.0**	**18.5**			

* Inventory SI provided only for comparison – Adjusted SI's are used to model these AU's from time zero.

4.2 Site index

Estimates of site productivity are required to predict the rate of growth that will occur on each site throughout the TSA. The height of a "site" tree at age 50 (measured at breast height) is one measure of site productivity and is commonly referred to as "site index".

4.2.1 Site curves

For each tree species, site curves are available to illustrate the relationship between stand height and age for a range of site indices. In all cases, this analysis used the standard site curves recommended by the BC Ministry of Forests and Range as identified in the *Site Tools* software. They are as follows:

Table 28. Site index sources

Species	Source
Douglas Fir (Fdi)	Thrower and Goudie (1992)
Lodgepole Pine (Pli)	Thrower (1994)
Western White Pine (Pw)	Curtis, Diaz, and Clendenen (1990)
Western Red Cedar (Cw)	Nigh (2000)
Western Hemlock (Hwi)	Nigh (1998)
Engelmann Spruce (Se) & Subapline fir (Bl)	Chen and Klinka (2000)
Western Larch (Lw)	Brisco, Klinka, and Nigh 2002
White Spruce (Sw)	Goudie (1984)

4.2.2 Site index adjustments

The Base Case will include adjusted inventory site index values for managed stands (TIPSY curves) in recognition that existing inventory site indexes often do not adequately reflect the potential stand growth experienced by second growth stands. The site index sources used to derive the new estimates are listed by priority below.

1. Growth Intercept from regeneration surveys (0.7% of THLB area),
2. SIBEC 2nd approximation estimates (10.2% of THLB area),
3. SIBEC 1st approximation estimates (45.7% of THLB area),
4. Forest Cover Inventory estimates (43.3% of THLB area).

SIBEC estimates come from the MFR Research Branch's SIBEC project that links productivity estimates to ecological classifications. It is based on the assumption that sites with similar soil moisture and nutrient regimes will have similar rates of productivity. SIBEC adjustments using the Predictive Ecosystem Mapping (PEM) completed for the TSA in March 2006 (Jones, C. et. al., 2008) that identifies ecosystems at the site series level. This PEM has had an accuracy assessment completed in 2007-08 (Timberline, 2008) and as a result only the ICH variants have been approved for use in adjusting site index estimates in the Base Case[3]. The ESSF variants were not approved because they did not meet the minimum requirement for sample size and accuracy as set out by the Forest Analysis and Inventory Branch.

When PEM based site series data is combined with forest cover data, SIBEC relationships can be used to provide updated site index estimates for each stand in the forest cover file. A SIBEC crosswalk table provided by the regional research ecologist (Deb MacKillop) was used to link ecosystems in the SIBEC database (2005 classifications) to ecosystems in the PEM (2007 classifications).

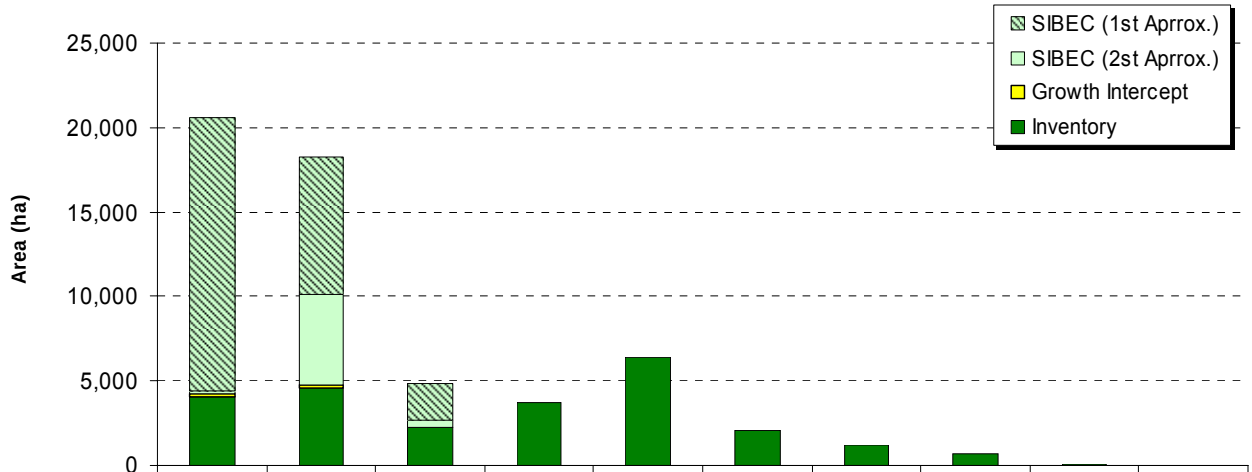
These new estimates will be used to build managed stand yield curves only. Harvest volumes for existing natural stands or site indexes used to define netdowns remain unchanged.

[3] Deb MacKillop / Del Meidenger's email approving the use of the Revelstoke PEM to adjust ICH stands. (Title: Accuracy Assessment of the Revelstoke PEM for use in TSR. Sent: November 18, 2008 by Deb Mackillop)

SIBEC Application Results

Weighted average site index values for each AU (Inventory and SIBEC influenced) can be found in Table 27. In general, the lower site index AU's had the largest increase, while the higher site index AU's remained the same or fell slightly. Overall, the average site index for the THLB area increased by 2.5 m from 16.0 m to 18.5 m (+15.8%).

The site index sources used to derive the new estimates are listed by priority below and are summarized by BEC variant in Figure 4.



	ICH vk 1	ICH wk 1	ICH mw 3	ICH mw 2	ESSFvc	ESSFwc 1	ESSFwc 4	ESSFwc 2	ESSFwcw	ESSFwcp
SIBEC (1st Aprrox.)	16,167	8,181	2,124	0	0	0	0	0	0	0
SIBEC (2st Aprrox.)	110	5,373	449	0	0	0	0	0	0	0
Growth Intercept	240	112	43	0	0	13	0	0	0	0
Inventory	4,031	4,625	2,220	3,704	6,384	2,104	1,239	725	61	3

Figure 4. Site index data sources by BEC variant and THLB area

4.3 Utilization level

Utilization levels define the maximum height of stumps that may be left on harvested areas, the minimum top diameter (inside bark), and the minimum diameter at breast height (dbh) of stems that must be removed from harvested areas. These factors are needed to calculate merchantable stand volume for use in the analysis.

Table 29. Utilization levels

	Utilization		
Species	**Minimum dbh[1] (cm)**	**Maximum stump height (cm)**	**Minimum top dib[2] (cm)**
Pl	12.5	30	10
All Others	17.5	30	10

[1] Diameter breast height
[2] Diameter inside bark

4.4 Decay, waste and breakage for unmanaged stands

Decay, waste and breakage (DWB) factors are applied to natural stand yield tables (VDYP7) to obtain net harvest volumes per hectare. Initial net volume estimates were generated using the adjusted inventory attribute values (age, height, basal area, site index) in VDYP7 with the default decay, waste and breakage factors applied. This work was completed by Forest Analysis and Inventory Branch and supplied to Forsite for inclusion in the analysis.

4.5 Operational adjustment factors for managed stands

Operational Adjustment Factors (OAF's) were applied in order to adjust potential yields generated by the TIPSY growth and yield model down to net operational volumes. This included reductions for such things as gaps in stands, decay/waste/breakage, and endemic forest health losses.

There were two types of OAF's used in the TIPSY model. OAF 1 is a constant percentage reduction to account for openings in stands, distribution of stems or clumpiness, endemic pests and diseases, and other risks to potential yield. OAF 2 is an increasing percentage reduction that can be applied to account for decay, waste and breakage. OAF 2 is applied after OAF 1 and increases linearly over time from 0 percent at age 0 to the specified percentage at 100 years of age.

Standard operational adjustment factors (OAF) were used to model managed stands. OAF1 was set to 0.85 (15% reduction) and OAF2 was set to 0.95 (5% reduction).

4.6 Deciduous Volume reductions

Deciduous volumes are not currently utilized in the Revelstoke TSA. Thus, deciduous leading stands have been removed from the THLB (see Table 13) and any deciduous volumes in coniferous leading stands have been ignored during the compilation of yield curves. Recently logged blocks (<30 yrs old) with a deciduous leading inventory label were allowed to remain in the analysis because licensees have an obligation to ensure a commercially acceptable crop is regenerated and the coniferous stems are likely to overtop the deciduous stems and form the next crop. Deciduous stems in future managed stands were treated as 'holes' in the stand and are addressed by the application of the OAF1 reduction.

4.7 Natural Stand Volume Projections

Yield tables will be derived for existing natural stands using VDYP 7 Batch by staff from the Ministry of Forest and Range – Forest Analysis and Inventory Branch. A yield table will be generated for each polygon and then provided to Forsite for aggregated into one table for each Analysis Unit (AU) using area weighted averages. The yield tables used during modeling are provided in Appendix 2.

The use of VDYP7 in this analysis has resulted in generally lower site index values and volumes for existing natural stands – especially for Cw stands. One of the primary causes is the use of updated site index curves in VDYP7. This issue will be fully quantified in the analysis report but initial indications are that inventory volumes have dropped by ~5% because of the use of VDYP7.

4.8 Managed Stand Yield Tables

All future managed stand AU's have an associated existing stand AU from which it will inherit stands when they are logged in the model. These future managed stand AU's used the area weighted adjusted site indexes for each AU (Table 27) and the regeneration assumption outlined in this document (Section 5.0). These values were input into Batch TIPSY 4.1d to generate a yield curve for each AU.

Existing managed stand yields were also derived using the adjusted site index (Table 27) and the regeneration assumptions outlined in Section 5.0. Existing managed stands are those that currently under 30 (est. 1979) years of age.

The regeneration assumptions required to model managed stands in TIPSY consist of:

- Species composition (See Section 5.1);
- Initial density (See Section 5.1);
- Regeneration method (See Section 5.1);
- Area-weighted average site index (See Section 5.1);
- Area-weighted genetic gains (See Section 5.4);
- Operational adjustment factors (See Section 4.5); and
- Regeneration delay (See Section 5.3).

Once merchantable stand yields were obtained from TIPSY, yield estimates were further reduced to reflect the area lost to future roads and wildlife tree retention (see section 3.3.18). These 'effective' yield tables were used during modelling and are provided in Appendix 2.

4.9 Existing Timber Volume Check

To verify that no errors were made in natural stand yield table aggregation and that no significant aggregation bias exists, the total volume of the current (starting) inventory using polygon-specific inventory volumes was compared to the volume derived using analysis unit yield tables. The results for existing natural (VDYP7) AU's are shown in Table 30 by AU and in Table 31 by age class.

Table 30. Existing timber volume check

AU	THLB Area (ha)	Volume derived from:		Difference	
		Inventory	Yield tables (AU)*	m^3	%
101	1,354	513,246	508,248	-4,998	-1.0%
102	93	49,554	49,696	143	0.3%
103	4,406	888,436	848,155	-40,281	-4.7%
104	663	227,756	230,810	3,054	1.3%
105	1,123	127,555	115,760	-11,795	-10.2%
106	99	26,556	26,529	-27	-0.1%
107	1,615	142,060	116,195	-25,866	-22.3%
108	172	109,818	114,478	4,660	4.1%
109	531	45,752	43,016	-2,736	-6.4%
110	519	283,318	289,014	5,695	2.0%
111	512	23,738	17,467	-6,270	-35.9%
112	3,618	1,722,638	1,763,900	41,262	2.3%
113	2,116	417,351	365,567	-51,784	-14.2%
114	682	337,717	342,981	5,264	1.5%
115	2,401	289,162	255,788	-33,375	-13.0%
116	4,276	1,746,399	1,759,492	13,093	0.7%
117	308	16,951	16,298	-654	-4.0%
118	1,706	582,021	584,816	2,795	0.5%
119	89	11,593	13,461	1,868	13.9%
120	48	19,981	20,165	183	0.9%
121	349	53,036	48,033	-5,003	-10.4%
122	426	144,877	145,968	1,091	0.7%
123	406	50,475	49,666	-809	-1.6%
124	805	197,212	198,674	1,462	0.7%
125	506	85,666	79,825	-5,841	-7.3%
126	1,490	728,821	764,183	35,361	4.6%
127	710	74,288	50,917	-23,371	-45.9%
128	1,079	423,966	439,690	15,724	3.6%
129	361	38,918	33,883	-5,035	-14.9%
130	2,259	729,863	744,448	14,585	2.0%
All VDYP	**34,722**	**10,108,725**	**10,037,122**	**-71,604**	**-0.7%**

Table 31. Existing timber volume check by Age Class

Age Class	THLB Area (ha)	Volume derived from:		Difference	
		Yield tables (AU)	Inventory	m^3	%
0-20	0	0	0	0	0
21-40	4,063	27,067	47,547	20,480	43.1%
41-60	1,608	71,070	83,247	12,177	14.6%
61-80	2,134	301,628	279,875	-21,753	-7.8%
81-100	3,610	746,550	683,459	-63,091	-9.2%
101-120	3,501	1,041,458	921,692	-119,765	-13.0%
121-140	1,872	590,455	546,459	-43,996	-8.1%
141-250	8,951	3,258,892	3,686,709	427,817	11.6%
250+	8,983	4,071,606	3,788,134	-283,472	-7.5%
All VDYP	**34,722**	**10,108,725**	**10,037,122**	**-71,604**	**-0.7%**

Although there is some differences in the timing of volume growth overall, the volumes being generated from the AU yield tables correlate well with the inventory (<1% difference).

5.0 Silviculture

5.1 Silviculture management regimes

Silviculture systems implemented in the Revelstoke TSA are predominately clearcut and clearcut-with-reserves, with less than 10% of harvest coming from alternate silvicultural systems. The latter consists primarily of primarily patchcut / group selection systems (small openings) and are generally treated as even-aged stands. These alternate silvicultural systems are employed primarily within visual landscapes, UWR, and important caribou habitat areas. Due to the relatively small percentage of alternate systems employed in the TSA, which are generally managed as even-aged, it was deemed too minor to model separately. Even age stand management dominates in the TSA.

5.2 Regeneration Assumptions

After harvest, stands in the TSA follow various silvicultural management regimes depending on originating stand type. This section of the data package summarizes the silvicultural management inputs used in the TIPSY growth and yield model for each managed stand AU. Current practices are reflected in the Future Managed Stand AU's (200 series) found in Table 32, while average historical regeneration practices are reflected in the Existing Managed Stand AU's (500 series) in Table 33. When existing managed stands are harvested, they will move onto an additional set of future managed stand AU's (600 series) that are identical to the 500 series but reflect the genetic gains for future managed stands. Species mixes and regeneration assumptions have been reviewed and updated by MFR Columbia District staff (Barb Wadey) to reflect current regeneration practices.

Table 32. Regeneration and growth and yield assumptions by analysis unit – future managed stands

Existing AU#	Regen AU #	Description	Regen Method	Regen Species and Weighting (%)	Avg. SI	Initial Competing Density* (stems/ha)	OAF's	Regen Delay (yrs)
101/102	201/202	Douglas fir, larch, pine good	Plant $_{100}$	$Fdi_{40}Sx_{20}Lw_{20}Cw_{10}Pw_{10}$	22.1 / 21.3	2000	15/5	2
103/104	203/204	Douglas fir, larch, pine medium	Plant $_{100}$	$Fdi_{40}Sx_{20}Lw_{20}Pw_{15}Cw_{05}$	19.4 / 18	2000	15/5	2
105/106	205/206	Douglas fir, larch, pine fir poor	Plant $_{100}$	$Fdi_{50}Cw_{30}Pw_{20}$	17.9 / 17.6	2000	15/5	2
107/108	207/208	Cedar good	Plant $_{100}$	$Cw_{50}Sx_{30}Fdi_{10}Hw_{10}$	16.2 / 19.5	2000	15/5	2
109/110	209/210	Cedar medium	Plant $_{100}$	$Cw_{50}Sx_{30}Fdi_{10}Hw_{10}$	15.9 / 17	2000	15/5	2
111/112	211/212	Cedar poor	Plant $_{100}$	$Cw_{50}Sx_{30}Fdi_{10}Hw_{10}$	15.5 / 16.3	2000	15/5	2
113/114	213/214	Hemlock good	Plant $_{100}$	$Sx_{40}Cw_{30}Fdi_{20}Hw_{10}$	17 / 18.1	2000	15/5	2
115/116	215/216	Hemlock medium	Plant $_{100}$	$Sx_{40}Cw_{30}Fdi_{20}Hw_{10}$	16 / 15.3	2000	15/5	2
117/118	217/218	Hemlock poor	Plant $_{100}$	$Sx_{40}Fdi_{30}Cw_{20}Hw_{10}$	12.9 / 13.4	2000	15/5	2
119/120	219/220	Balsam, spruce good	Plant $_{100}$	$Sx_{90}Bl_{10}$	17.3 / 18.6	2000	15/5	2
121/122	221/222	Balsam, spruce medium	Plant $_{100}$	$Sx_{90}Bl_{10}$	14.4 / 14.4	2000	15/5	2
123/124	223/224	Balsam, spruce poor	Plant $_{100}$	$Sx_{90}Bl_{10}$	11.5 / 10.6	2000	15/5	2
125/126	225/226	Spruce (mixed) good	Plant $_{100}$	$Sx_{60}Cw_{40}$	19 / 19.5	2000	15/5	2
127/128	227/228	Spruce (mixed) medium	Plant $_{100}$	$Sx_{60}Cw_{30}Fdi_{10}$	18.4 / 16.5	2000	15/5	2
129/130	229/230	Spruce (mixed) poor	Plant $_{100}$	$Sx_{50}Cw_{40}Hw_{10}$	12.9 / 13.7	2000	15/5	2

Table 33. Growth and yield assumptions by analysis unit – existing managed stands

Existing AU#	Regen AU #	Description	Regen Method	Regen Species and Weighting (%)	Avg SI	Initial Competing Density* (stems/ha)	OAF's	Regen Delay (yrs)
501	601	Douglas fir, larch, pine good	Plant $_{100}$	$Fd_{50}Cw_{20}Sx_{20}Lw_{10}$	22.6	2000	15/5	2
502	602	Douglas fir, larch, pine medium	Plant $_{100}$	$Fd_{50}Cw_{20}Sx_{20}Lw_{10}$	20.4	2000	15/5	2
503	603	Douglas fir, larch, pine fir poor	Plant $_{100}$	$Fd_{50}Cw_{20}Sx_{20}Lw_{10}$	18.6	2000	15/5	2
504	604	Cedar good	Plant $_{100}$	$Cw_{40}Sx_{40}Hw_{10}Fd_{10}$	18.1	2000	15/5	2
505	605	Cedar medium	Plant $_{100}$	$Cw_{40}Sx_{40}Hw_{10}Fd_{10}$	16.4	2000	15/5	2
506	606	Cedar poor	Plant $_{100}$	$Cw_{40}Sx_{40}Hw_{10}Fd_{10}$	15.8	2000	15/5	2
507	607	Hemlock good	Plant $_{100}$	$Sx_{30}Cw_{30}Hw_{30}Fd_{10}$	17.1	2000	15/5	2
508	608	Hemlock medium	Plant $_{100}$	$Sx_{30}Cw_{30}Hw_{30}Fd_{10}$	15.4	2000	15/5	2
509	609	Hemlock poor	Plant $_{100}$	$Sx_{30}Cw_{30}Hw_{30}Fd_{10}$	13.9	2000	15/5	2
510	610	Balsam, spruce good	Plant $_{100}$	$Sx_{90}Bl_{10}$	17.6	2000	15/5	2
511	611	Balsam, spruce medium	Plant $_{100}$	$Sx_{80}Bl_{10}Hm_{10}$	14.4	2000	15/5	2
512	612	Balsam, spruce poor	Plant $_{100}$	$Sx_{80}Bl_{10}Hm_{10}$	10.2	2000	15/5	2
513	613	Spruce (mixed) good	Plant $_{100}$	$Sx_{50}Cw_{30}Hw_{10}Fd_{10}$	20.4	2000	15/5	2
514	614	Spruce (mixed) medium	Plant $_{100}$	$Sx_{50}Cw_{30}Hw_{10}Fd_{10}$	18.2	2000	15/5	2
515	615	Spruce (mixed) poor	Plant $_{100}$	$Sx_{50}Cw_{30}Hw_{10}Fd_{10}$	15.3	2000	15/5	2

5.3 Regeneration delay

Regeneration delay is the time between harvesting and when a new stand is established. The delay incorporates both the time taken to establish a stand, and the age of seedling stock planted, if applicable. For this analysis, a regeneration delay was estimated based on local knowledge of the licensees' silviculture staff.

Existing managed stands:

For existing managed stands, regeneration delay was addressed through the use of actual stand age in the forest inventory file. This age represents the actual age of the stand and not the time since harvesting. For example, a stand may have been harvested 15 years ago but the current stand age is 12 – this implies a 3 year regeneration delay. The use of actual ages eliminated the need to estimate an average regeneration delay for these stands.

Future managed Stands:
A regeneration delay of 2 years was estimated based on the local knowledge of the licensees' silviculture staff. Regeneration delays for future managed stands were input into TISPY and are therefore embedded in the published yield curves.

5.4 Gene resources — use of select seed

Where it is available, licensees use select seed for regeneration purposes because of its superior volume production. This section describes the yield adjustments used to account for the use of select seed (i.e., orchard & superior provenance seed with a known genetic gain as measured by Genetic Worth [GW]).

Historical use of select seed was obtained from the Ministry of Forests Seed Planning & Registry system (SPAR) and the Reporting Silviculture Updates and Landstatus Tracking System (RESULTS), as provided by M. LeRoy (2009) and B. Wadey (2009). This information was used to derive estimates of net genetic gain (Net GW) at the species level for species planted from 1980 to 2007. Table 34 illustrates the weighted average GW for each species [A], the percent improved (class A and B) seed use for each species in the TSA [B], and the

estimated Net GW for each species [C]. The Net GW was calculated by multiplying [A] x [B] and is graphed in Figure 5.

Table 34. Calculation of net genetic worth of species planted over the last 27 years

	Wt Avg* GW by Species (Class A) [A]			% Class A of Total Seedlings Planted [B]			Net GW by Species [C]		
Year	**Lw**	**Sx**		**Lw**	**Sx**		**Lw**	**Sx**	
1980	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1981	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1982	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1983	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1984	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1985	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1986	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1987	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1988	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1989	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1990	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1991	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1992	0.0%	0.0%		0.0%	0.0%		0.0%	0.0%	
1993	0.0%	2.0%		0.0%	2.3%		0.0%	0.0%	
1994	0.0%	8.0%		0.0%	18.0%		0.0%	1.4%	
1995	0.0%	6.0%		0.0%	13.1%		0.0%	0.8%	
1996	0.0%	9.0%		82.6%	43.0%		0.0%	3.9%	
1997	0.0%	8.0%		82.6%	57.6%		0.0%	4.6%	
1998	0.0%	10.0%		82.6%	57.6%		0.0%	5.8%	
1999	0.0%	13.0%		82.6%	57.6%		0.0%	7.5%	
2000	0.0%	17.0%		82.6%	57.6%		0.0%	9.8%	
2001	4.0%	10.0%		82.6%	57.6%		3.3%	5.8%	
2002	9.0%	5.0%		82.6%	57.6%		7.4%	2.9%	
2003	9.0%	5.0%		82.6%	57.6%		7.4%	2.9%	
2004	13.0%	8.0%		82.6%	57.6%		10.7%	4.6%	
2005	21.0%	9.0%		82.6%	57.6%		17.3%	5.2%	
2006	21.0%	10.0%		82.6%	57.6%		17.3%	5.8%	
2007	16.0%	8.0%		82.6%	57.6%		13.2%	4.6%	
11 yr Avg	8.5%	9.4%		82.6%	57.6%		7.0%	5.4%	
28 yr Avg	3.3%	4.6%		32.5%	25.4%		**2.7%**	**2.3%**	

* Weighted average is based on the amount of seed requested from each class “A” SPU occurring in the TSA and its genetic worth (SeedMap Genetic Gain: Report 1 – Genetic Gain of Seedlings Requested by Species and SPZ.) provided by Matthew LeRoy, 2008

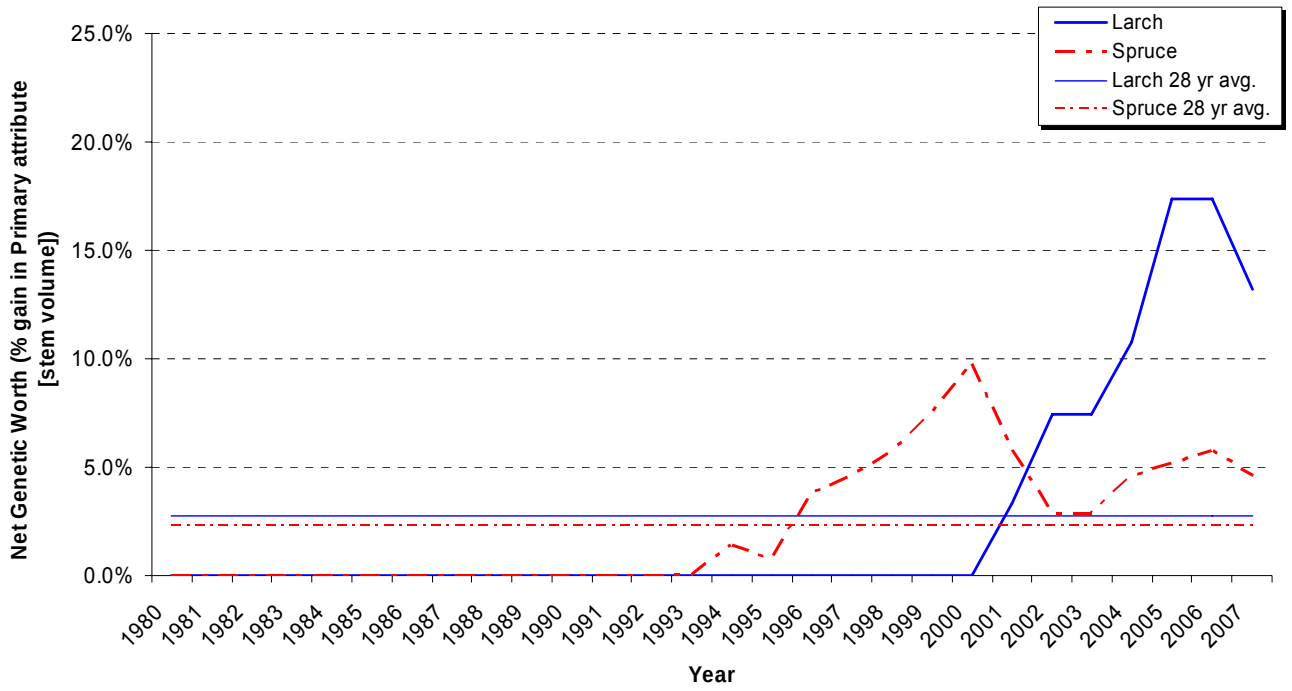


Figure 5. Net Genetic Worth for All Seedlings by Species - Revelstoke TSA

The 28 year average gains shown are suitable for use in generating existing managed stand yields as they reflect a prorated gain associated with 18 years of planting seedlings with no gains followed by 10 years of planting with gains. Genetic gains of 2.7% will be applied to Lw, and 2.1% to Sx. Other species with genetic gains have been planted on the TSA however, they have been planted in such low amounts that it was not worth including.

Seed planning units (SPU's) are polygon features that geographically delineate the appropriate area of seedling use for stock originating from specific seed orchards throughout the province. Each SPU identifies the area and elevation range in which seedlings of a given orchard may be used in regeneration. The SPU's relevant in the Revelstoke TSA are shown in Table 35. Estimates of future genetic worth and seedling availability are provided at the SPU level in Table 36.

Table 35. Seed Planning Units (2008) within the Revelstoke TSA (Class A seed)

Species	Genetic Class "A" Seed Planning Zone	Elevation Band
Interior Douglas-fir	Nelson Low	400-1000
Interior Douglas-fir	Nelson High	1000-1600
Western Larch	Nelson High	700-1400
Spruce	Nelson Mid	1000-1500
Spruce	Nelson High	1500-1900

Table 36. Seed Planning Units (Class A Seed) genetic worth and seed availability

SPU	THLB Area (ha)*	Percent of Total THLB	Genetic Worth Achieved (2008 SPAR)	Percent Class A Seedlings (2008 SPAR)	Planned GW for 2009	Planned Class A Seed Availability for 2009	Projected Future Genetic Worth % (2019)	Projected Class A Seed Availability (2019)
#21 Fdi NE low	21,706	41.5%	27%	43.8%	25%	34.8%	25%	100%
#22 Fdi NE high	27,904	53.3%			29%	28.1%	32%	100%
#37 Fdi QL low	4,103	7.8%			25%	55.5%	28%	100%
#13 Lw NE low	9,317	17.8%	N/A	0%	28%	100%	32%	100%
#44 Sx NE low	13,406	25.6%	6%	100%	20%	100%	26%	100%
# 4 Sx NE mid	40,333	77.0%			11%	100%	15%	100%
# 5 Sx NE high	4,164	8.0%			12%	100%	15%	100%

*The sum of this column is greater than the total THLB area because of overlaps that occur for SPU's of different species.

Table 37. Calculation of net genetic worth by species for future managed stands in Revelstoke

Year	Wtd. Avg GW by Species (Class A) [A]			Anticipated % Class A Available [B]			Net GW by Species [C]		
	Fdi	Lw	Sx	Fdi	Lw	Sx	Fdi	Lw	Sx
2009	27.1%	28.0%	13.2%	32.9%	100%	100%	8.9%	28.0%	13.2%
2019	28.9%	32.0%	17.5%	100%	100%	100%	28.9%	32.0%	17.5%

The application of this data in the timber supply model is summarized in Table 38, and is included in Table 32 and Table 33 for existing and future managed AU, respectively.

Table 38. Net genetic worth by species to be applied in timber supply model

Time Horizon in Model (decades)	Species	2009 Genetic Gains applied in TIPSY for Base Case		2019 Genetic Gains applied in TIPSY for Sensitivity Analysis	
		Existing Managed Stands	Future Managed Stands	Existing Managed Stands	Future Managed Stands
1-25	Fd	0%	8.9	0%	28.9
1-25	Lw	2.7%	28.0	2.7%	32.0
1-25	Sx	2.3%	13.2	2.3%	17.5

In summary, the 28-year historical average from Table 33 will be applied when modeling existing managed stands because this best corresponds with the criteria used to define these stands. When generating the AU yields in TIPSY for these stands, larch will have a 2.7% GW applied while spruce will have a 2.1% GW applied. These values are lower than those applied to future managed stands because the GW realized on present day stock is watered down by historical use of stock with no genetic gain. Future managed stands will have the 2009 Net GW's for Fdi (8.9%), Lw (28.0%), and Sx (13.2%) used in the Base Case.

No adjustment of genetic gains is scheduled during the planning horizon.

A sensitivity analysis is planned to explore the implication of applying forecasted 2019 GW's based on projected orchard gains and projected seed availability (orchard production) for Fd, Lw, and Sx. The projected Net GW for each species will be based on the values shown in Table 38 (prorated by THLB area) and will consider select seed availability as projected in the SPU timelines provided by Tree Improvement Branch. Genetic gains associated with existing managed stands will be unchanged in the sensitivity analysis.

Genetic gains will be incorporated into the growth and yield curves through TIPSY model functionality. When a species identified in Table 38 is included in a managed stand AU, its associated Net GW will be input into TIPSY. This Net GW reflects the genetic gain associated with all seedlings of a given species planted in a typical year. Where surrogate species are used in TIPSY, the GW employed is prorated to reflect the relative GW's of the original species (Sx used for Bl but Sx Gw not applied to Bl proportion).

5.5 Silviculture history (defining existing managed stands)

As discussed in the Analysis Units section above, existing managed stands are defined as those stands regenerated from 1980 forward (currently ≤ 30 yrs old). The 1980 date corresponds with the time period where silvicultural management regimes were regularly utilized in the TSA or management regimes were applied to clean up earlier harvesting (Industry outstanding stands were addressed).

5.6 Backlog and current not satisfactorily restocked areas (NSR)

Backlog NSR is any area not yet fully stocked that was denuded prior to 1987 when basic silviculture became the obligation of licensees. Not satisfactorily restocked (NSR) areas were determined using RESULTS data. NSR areas include both old burns and past harvesting. Current NSR (779 ha) and backlog NSR (412 ha) is summarized in Table 39.

Table 39. Backlog and Current NSR

NSR Type	Total Area (ha)	Netdown Area (ha)
Current NSR	779	0
Backlog NSR	412	412
Totals	1190	412

Backlog NSR was discussed with District silviculture and planning staff. To account for the full breath of these lower productivity sites currently on the landbase (backlog NSR, previously NSR but accepted at lower stocking, and impeded stands), these stands were taken out of the land base as a land base netdown (Section 3.3.13). Current NSR was assigned to standard analysis units and any delay in restocking these sites was reflected in the regeneration delays assigned to these analysis units. These sites have either been reforested but are not yet confirmed in the inventory file, or will be reforested because licencees are under legal obligation to do so.

6.0 Timber harvesting

6.1 Minimum harvestable age / merchantability standards

In order for a stand within the timber supply model to be considered for harvesting, it must achieve a minimum harvest age that ensures it meets reasonable economic criteria and emulates what is generally current practice by forest licensees. Note that these are minimum criteria, not the actual ages at which stands are forecast for harvest. Some stands may be harvested at the minimum thresholds to meet forest-level objectives while other stands may be not be harvested until well past their "optimal" timber production ages due to management objectives for other resource values such as requirements for the retention of older forest, or ungulate winter range.

For this analysis, minimum harvestable ages will be defined by the following economic criteria:

Existing Natural Stands:

- minimum volume per hectare (200 m³/ha for Hw and Cw, 150 m³/ha for all other species), and
- the age at which 95% of the culmination of the mean annual increment (CMAI) is achieved.

Existing Managed and Future Managed Stands:

- minimum volume per hectare (200 m³/ha for Hw and Cw, 150 m³/ha for all other species), and
- minimum piece size (25 cm mean prime DBH [250 largest trees]), and
- the age at which 95% of the culmination of the mean annual increment (CMAI) is achieved.

The minimum harvest age to be utilized for each analysis unit is defined in Table 40. For a detailed description of all analysis unit definitions, see Table 27.

Table 40. Minimum harvest ages

Analysis unit (AU)	AU #	Minimum harvest age (years)		Age to achieve min volume (yrs)		Age to achieve min diameter (yrs)		Age to 95% of Maximum MAI (yrs)	
		Natural	Managed	Natural	Managed	Natural	Managed	Natural	Managed
Natural Stands and Associated Future Managed Stands									
Fir Larch Pine – Good <141	101, 201	**89**	**65**	56	42	N/A	42	89	65
Fir Larch Pine – Good +141	102, 202	**85**	**65**	56	42	N/A	43	85	65
Fir Larch Pine – Medium <141	103, 203	**101**	**75**	86	51	N/A	51	101	75
Fir Larch Pine – Medium +141	104, 204	**106**	**83**	86	59	N/A	59	106	83
Fir Larch Pine – Poor <141	105, 205	**115**	**89**	115	56	N/A	57	114	89
Fir Larch Pine – Poor +141	106, 206	**119**	**88**	106	55	N/A	55	119	88
Cedar – Good <141	107, 207	**87**	**81**	76	57	N/A	52	87	81
Cedar – Good +141	108, 208	**82**	**76**	57	52	N/A	47	82	76
Cedar – Medium <141	109, 209	**103**	**86**	86	60	N/A	55	103	86
Cedar – Medium +141	110, 210	**100**	**82**	77	57	N/A	52	100	82
Cedar – Poor <141	111, 211	**135**	**86**	135	60	N/A	54	120	86
Cedar – Poor +141	112, 212	**124**	**87**	97	61	N/A	55	124	87
Hemlock – Good <141	113, 213	**83**	**78**	76	58	N/A	52	83	78
Hemlock – Good +141	114, 214	**84**	**76**	67	56	N/A	50	84	76
Hemlock – Medium <141	115, 215	**112**	**83**	106	62	N/A	56	112	83
Hemlock – Medium +141	116, 216	**109**	**88**	86	67	N/A	59	109	88
Hemlock – Poor <141	117, 217	**175**	**92**	175	74	N/A	66	141	92
Hemlock – Poor +141	118, 218	**133**	**100**	116	81	N/A	72	133	100
Balsam Spruce – Good <141	119, 219	**85**	**70**	66	51	N/A	48	85	70
Balsam Spruce – Good +141	120, 220	**84**	**72**	66	52	N/A	49	84	72
Balsam Spruce – Medium <141	121, 221	**106**	**88**	86	64	N/A	60	106	88
Balsam Spruce – Medium +141	122, 222	**105**	**92**	86	67	N/A	63	105	92
Balsam Spruce – Poor <141	123, 223	**125**	**113**	115	82	N/A	77	125	113

		Minimum harvest age (years)		Age to achieve min volume (yrs)		Age to achieve min diameter (yrs)		Age to 95% of Maximum MAI (yrs)	
Balsam Spruce – Poor +141	124, 224	**133**	**127**	115	93	N/A	87	133	127
Spruce Mix – Good <141	125, 225	**85**	**67**	66	45	N/A	44	85	67
Spruce Mix – Good +141	126, 226	**78**	**63**	57	41	N/A	41	78	63
Spruce Mix – Medium <141	127, 227	**112**	**67**	95	46	N/A	46	112	67
Spruce Mix – Medium +141	128, 228	**99**	**74**	76	51	N/A	50	99	74
Spruce Mix – Poor <141	129, 229	**129**	**99**	115	67	N/A	66	129	99
Spruce Mix – Poor +141	130, 230	**126**	**102**	96	69	N/A	68	126	102
Existing Managed Stands and Associated Future Managed Stands									
Fir Larch Pine – Good	501, 601	**68**	**65**	44	41	44	42	68	65
Fir Larch Pine – Med	502, 602	**74**	**69**	48	45	48	45	74	69
Fir Larch Pine – Poor	503, 603	**81**	**77**	55	52	55	52	81	77
Cedar – Good	504, 604	**78**	**75**	56	54	50	49	78	75
Cedar – Med	505, 605	**87**	**84**	63	61	56	55	87	84
Cedar – Poor	506, 606	**88**	**85**	64	62	57	56	88	85
Hemlock – Good	507, 607	**80**	**78**	58	56	52	51	80	78
Hemlock – Med	508, 608	**92**	**89**	67	66	60	59	92	89
Hemlock – Poor	509, 609	**107**	**104**	80	79	71	70	107	104
Balsam – Good	510, 610	**76**	**70**	55	51	52	49	76	70
Balsam – Med	511, 611	**98**	**93**	69	66	66	63	98	93
Balsam – Poor	512, 612	**140**	**134**	100	97	95	91	140	134
Spruce Mix – Good	513, 613	**67**	**64**	44	42	43	42	67	64
Spruce Mix – Med	514, 614	**76**	**73**	51	49	50	48	76	73
Spruce Mix – Poor	515, 615	**91**	**87**	62	60	61	59	91	87

6.2 Initial harvest rate

The base case harvest forecast will use the following initial harvest rates in the forecast.
Initial Harvest: Current AAC (230,000 m^3/yr) + Unsalvaged losses (6,550 m^3/yr) = 236,550 m^3/yr.

6.3 Harvest Priorities

Stands within currently planned cutting permits were given first priority for the first decade of the analysis horizon. The remaining stands were harvested according to an oldest first harvest priority for the entire planning horizon.

7.0 Natural Forest Disturbance

It is inevitable that natural disturbances will occur within the forests of the Revelstoke TSA and the implications of these disturbances on forest age classes and volumes are recognized in the timber supply analysis process. Natural disturbances are events caused by factors such as wildfire, wind, snow press, insects, disease and other forest health considerations. Two approaches to addressing these issues are used during modeling; one on the THLB and one on the remainder of the forested area of the TSA.

7.1 Unsalvaged Losses on the THLB

The purpose of this section is to quantify the average annual volume of timber that, in the future, will be damaged or killed on the THLB and not salvaged or accounted for by other factors. This factor is meant to capture catastrophic natural events like the fires that occurred in the Revelstoke TSA in 2003. Endemic pest losses are dealt with through factors applied in the growth and yield models as noted below:

TIPSY: Operational Adjustment Factors 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 ground plots. Endemic losses are inherently recognized in the model data.

The annual unsalvaged losses determined in TSR3 are still considered valid and were used in this analysis with the exception of losses related to fires and broadcast burning. Subsequent to the completion of the TSR3 analysis, district staff reviewed the unsalvaged losses for fires and felt that unsalvaged losses attributable to fires should be 2,500 m³/yr greater. Therefore, these additional losses were included in this analysis. Additionally, broadcast burning for site preparation is no longer used as extensively as in the past (only 146 ha in the past 5 years) so it was felt that NRL's associated with this factor are no longer relevant and were not applied.

Unsalvaged losses in TSR3 were applicable to the THLB area at that time. Since then, several factors have changed that have resulted in a smaller THLB. To account for this change, the TSR3 NRL values were proportionally reduced as follows:

TSR4 NRL (m³/yr) =

TSR4 Effective THLB Area (52,358 ha) * Adjusted TSR3 NRL (9,760 m³/yr) / TSR3 THLB (78,018 ha)

Expected non-recoverable losses for TSR4 are summarized in Table 41. This volume was added to the annual harvest target in order to remove this volume from the land base and cause an appropriate amount of stand area to have its age set to zero. The unsalvaged loss volumes will not be included in reported harvest levels for the TSA.

Table 41. Unsalvaged losses

Description	TSR3 Unsalvaged Loss (hectares/year)	TSR3 Average Volume (m³/ha)	TSR3 Annual unsalvaged volume in the THLB (m³/year)	TSR4 Adjusted Unsalvaged Losses
Wildfires	42.1	209	8800*	5,906
Total Fire	42.1	209	8800	**5,906**
Hemlock Looper	1.5	300	450	302
Spruce Bark Beetle	0	0		0
Douglas-fir bark beetle	0.6	350	210	141
Total Pest / Insects	2.1	650	660	**443**
Windthrow / Blowdown	0.7	328	230	154
Avalanche	0.2	350	70	47
Total Loss	**45**	**1,537**	**9,760**	**6,550**

* TSR3 value of 6,300 m³/yr + 2,500 m³/yr added in Chief Foresters 2005 AAC rationale.

7.2 Disturbance in the non-THLB

As forested stands in the non-THLB contribute toward several forest cover objectives (i.e., landscape level biodiversity, visuals, etc.), it is important that the age class distributions in these stands remain consistent with natural processes. By implementing disturbance in these stands, a natural age class distribution can be maintained in the model and a realistic contribution toward seral goals ensured.

A constant area was disturbed annually in each LU/NDT combination. The amount of disturbance in each LU/NDT combination was based on the BEC variants present and their associated natural disturbance intervals and old seral definitions as outlined in the *Biodiversity Guidebook* (September 1995) and Table 42 below.

Table 42. Calculation of area to be disturbed annually in forested non-THLB by LU/NDT

BEC	NDT	Disturbance Interval (yrs)	"OLD" Defn (yrs)	% Area > OLD*	Effective Rotation Age (yrs)*	Contributing Non-THLB Area (ha)	Annual Area Disturbed (ha) (area/rot age)
ESSF	1	350	250	49%	490	103,666	212
ICH	1	250	250	37%	395	62,844	159
ICH	2	200	250	29%	350	11,804	34
					Total	**178,315**	**405**

* % area old = exp (-[old age / disturbance interval]), Effective rotation age = old age / (1 – % area old)

Using the negative exponential equation, the proportion of the forest that would typically occur as old seral forest can be calculated based on the disturbance interval (% area old = exp(-[old age / interval]). Using this % area in old, the calculation of an effective rotation age associated with this seral distribution was possible (Effective rotation age = old age / (1 – proportion old)). The effective rotation age can then be used to define an annual area of disturbance. For example, ICH variants in NDT2 have a disturbance interval of 200 yrs and an old definition of 250 yrs. This translates into a typical age class distribution where 29% of the area is "old" (>250 yrs) and the oldest stands are around 350 years old. Thus $1/350^{h}$ of the area needs to be disturbed each year to maintain this age class distribution.
The base case includes annual disturbance of the contributing Non-THLB area in each LU/NDT. The area target was achieved by randomly selecting stands (without replacement) to be disturbed in each period and then hardwiring this into the model. Stands of all ages had equal opportunity to be disturbed.

This method is a simplification of Option 4 in *Modeling Options for Disturbance Outside the THLB - Working Paper* (MoF, June 2003). Modeling of disturbance at the LU/BEC variant level was simplified to the LU/NDT level in order to minimize the number of modeled zones while ensuring that each zone would have a single, old seral age. No minimum amount of old was implemented because disturbance was selected randomly - independent of modeled harvest priority.

The disturbance is implemented in the model using a random uniform probability. Each NDT is 'turned over' once during a period equal to its effective rotation age and then once again over the next effective rotation age, etc. There is no guarantee that any particular portion of the landbase will actually be disturbed in any one year. Across the NCLB, approximately 440 ha is disturbed each year (0.23%), resulting in an average 'turning over' of the landbase every ~ 447 years (range is 350 to 490 years).

8.0 Integrated Resource Management

This section of the document describes the range of timber and non-timber management objectives that occur within the Revelstoke TSA and how they will be addressed in the timber supply model. The most common method of inclusion is through the application of forest cover requirements.

Forest cover requirements can:

- Limit disturbance in an area by limiting the amount of forest that can be younger than a specific age (or shorter than a specific height);
- Maintain specific stand types on the land base by ensuring that at least a specified amount of forest older than a specific age (or taller than a certain height) is retained at all times;

Forest cover requirements from several different resource objectives can occur in a common area and result in overlapping constraints within the TSA (e.g. visual constraints inside a community watershed). Each requirement is evaluated independently to ensure that the harvesting of a specific stand does not violate any forest cover requirements.[4]

A summary of all non-timber management issues and modeling approaches is provided in Table 43 and Figure 6 below. Detail on each can be found in either the netdown section of this document (Section 3.3) or in the remainder of this section.

Table 43. Summary of Management Issues and Modelling Assumptions

Resource Issue	Modeling Approach	CFLB Area (ha)	THLB Area (ha)
Green-up /Adjacency	Maximum of 25% < 2m tall. Applied to the CFLB below the operability line within each LU.	90,656	57,404
Visuals	Maximum disturbance limit defined by VQO and VAC. VEG height defined by avg slope of VQO polygon. Modeled as a disturbance limit (i.e. max 15% < 6m tall) on the CFLB portion of each VQO polygon.	40,257	16,222
Community Watersheds	Applied as a spatial netdown - see Section 3.3.9.	4,449	N/A
Mountain Caribou Habitat	GAR (UWR U-3-005) reserves applied as a Spatial Netdown – see Section 3.3.14	66,098	N/A
Mule Deer	Minimum of 40% ≥101 yrs old depending on BEC Subzones and maximum of 40% <21 years old at any time. To be met within the CFLB of the mapped habitat areas in each MU as per GAR U-4-001	4,755	2,343
Moose	Minimum of 20% ≥61 years and maximum of 40% <21 years old at any time as per GAR U-4-001.	999	752
Ungulate Forage Area	Minimum of 10% ≥81 years old at any time as per GAR U-4-001. To be met on the CFLB portion of the identified area.	243	123
Identified Wildlife	Applied as a spatial netdown – see Section 3.3.11 (WHA's)	6	N/A
Landscape Level Biodiversity	Spatial Old Growth Management Areas (OGMA's) and Mature + Old Management Area (MOGMA's) applied as a spatial netdown for the first 80 years. From 80 years onward applied as forest cover constraints based on requirements set out in Revelstoke HLPO.	48,272	5,549
Stand Level Biodiversity – Wildlife trees and wildlife tree patches	Current and planned Wildlife tree patches applied as a spatial Netdown (see Section 3.3.16). Future WTP's applied as a yield curve reduction (See Section 3.3.18.1).	690	215

[4] Where a minimum amount of forest is required and does not exist, some harvesting may still occur if there are any stands old enough for harvest once the oldest available stands have been set aside to meet the objective.

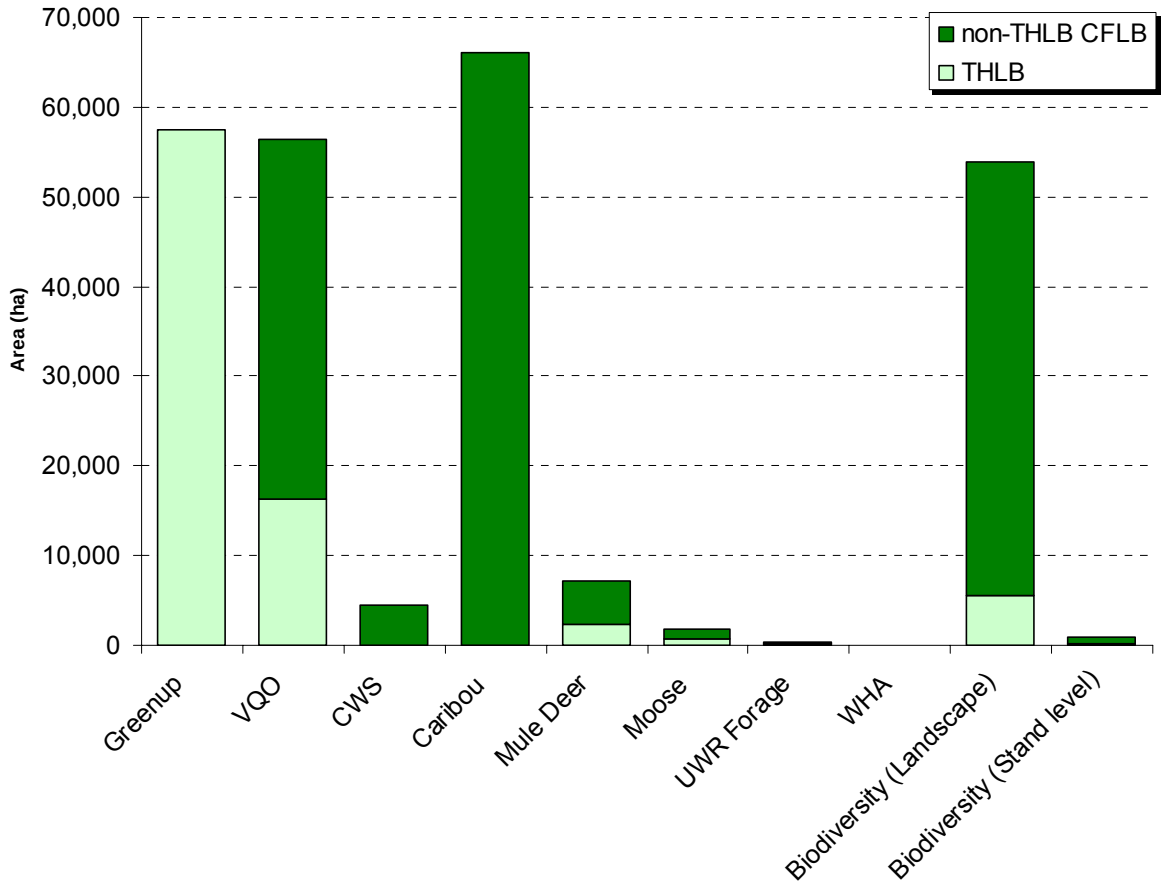


Figure 6. Summary of Management issues by land base classification

8.1 Green-up/adjacency

Green-up requirements specify that a logged block must achieve a specific condition called green-up before adjacent areas can be logged. Green-up refers to the average height of the regenerating forest reaching a specified target. Green-up requirements can often be waived if licensees manage for patch size distributions consistent with biodiversity objectives as described in the Landscape Unit Planning Guide (MoF/MoE 1999). Modeling of green-up requirements was done using forest level objectives, as opposed to block specific objectives, because this was consistent with the operational flexibility afforded by patch size management.

The amount of THLB area less than 2m in height was limited to 25% within each landscape unit (refer to Table 44). This is consistent with the objective applied in TSR 3.

Table 44. Green-up requirements

Management Zone	Green-up Requirement	Modeled Green-up Constraint	Area to which it applies
All TSA THLB	2 m tall trees	Max 25% < 2m in each LU	THLB area within each LU

A document[5] produced in 2000, compared actual silviculture data on the age to greenup heights to those produced by Site Tools for several regions of British Columbia. This data is considered to be a more accurate reflection of the actual age to green-up and has been recommended to be used in Timber Supply projects over the Site Tools method.

[5] B.C. Ministry of Forests. 2000. Age to Green-up Height: Using Regeneration Survey Data by Region, Species and Site Index. Available at:: http://www.for.gov.bc.ca/hre/pubs/docs/age-to-greenup.pdf

Using the Nelson Region species specific estimates from the report, green up ages were localized to the Revelstoke TSA using the planted species proportions over the past 5 years (2003-2007) and pro-rating the greenup age (Table 45). The document provides age to green-up heights from establishment and planted stock typically one year old so a net regeneration delay of one year was added to the greenup agesyr delay -1 yr old stock =1 year effective delay). The pro-rated result is a 13 Greenup age.

Table 45. Proration of Age to Green-up heights for Green-up Ages Sensitivity.

	[A]	[B]	[C]	[D] ([B]+[C])	[E] ([A]*[D])
SPECIES	**5 year Historical proportion planted (2003-2007)**	**Age to greenup***	**Net Regeneration delay**	**Total Age to Greenup**	**Pro-rated green up age**
BL	2.0	14	2	16	0.3
Cw	32.0	10	2	12	3.5
Fdi	12.0	11	2	13	1.4
Hw	2.0	9	2	11	0.2
Lw	2.0	9	2	11	0.2
Sx	50.0	12	2	14	6.5
	100				**13**

*Based on *Age to Green-up height: Using Regeneration data by Region, Species, and Site Index*. Nelson Region tables using SI=18 (Average Revelstoke TSA managed SI=18.5) + 1 year for net regeneration delay

8.2 Visual resources

The District Manger of the Columbia Forest District established new Visual Quality Objectives (VQO's) for the Revelstoke TSA with a letter to licensees on January 31, 2007 (GAR s.7) in addition to those established on October 23, 2000 (GAR s.17). Forest cover requirements aimed at meeting these objectives will be applied so that the amount of younger stands that can occur in visually sensitive areas is limited.

There are 175 VQO polygons within the Revelstoke TSA CFLB (341 in total) with some having as little as 0.2 ha and as much as 2009 ha of CFLB area. The average CFLB area with each polygon is 230 ha. All VQO polygons had maximum planimetric percent disturbance values assigned based on VQO class and visual absorption capability (VAC).

Table 46. Visually sensitive areas: Maximum planimetric disturbance %'s

VQO	**Visual Absorption Capability**								
	Low			**Mod**			**High**		
	Max. Planimetric Disturbance	**CFLB Area (ha)**	**THLB Area (ha)**	**Max. Planimetric Disturbance**	**CFLB Area (ha**	**THLB Area (ha)**	**Max. Planimetric Disturbance**	**CFLB Area (ha)**	**THLB Area (ha)**
Preservation	0%	0	0	0.5%	0	0	1%	0	0
Retention	1%	828	73	3%	3,065	201	5%	1,298	598
Partial Retention	5%	2,177	662	10%	12,102	3,892	15%	1,967	810
Modification	15%	2,441	1,210	20%	15,949	8,646	25%	430	129
Total		**5,446**	**1,945**		**31,116**	**12,739**		**3,695**	**1,537**

Each VQO polygon had the area weighted average slope calculated and an associated "visually effective green-up" (VEG) height calculated according to Table 47; extracted from *Procedures for Factoring Visual Resources into Timber Supply Analyses (MFR 1998)*.

Table 47. Tree heights required for meeting visually effective green-up by percent slope

	Slope Class (%)											
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-45	46-50	51-55	56-60	60+
Tree Height (m)	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.3	8.5

1. Each VQO polygon will have the resulting forest cover objective applied to its crown forested area in the model. For example, a VQO of Retention with a VAC of High and an average slope of 32% would have the following objective: No more than 5% of the crown forested area in the VQO polygon can be less than 6m tall.

The visually effective green-up heights for each polygon were translated into green-up ages for use during modeling. Age to green-up was calculated in SiteTools (v3.3) using a weighted average stand type for each VQO. A comparison of the SiteTools method and the results of the "Age to Green-up Height" report referenced in Section 8.1 showed that greenup ages from the report were approximately 5 less than the SiteTools method for deriving greenup ages. Therefore, all the derived VEG ages from SiteTools were reduced by 4 years.

8.3 Community Watersheds

Community watersheds are watersheds that supply communities with domestic water. Within the Revelstoke TSA there are 4 designated community watersheds: Hamilton, Greeley, Bridge, and Dolan Creek. Licencees have avoided and continue to avoid these areas were therefore completely excluded from the timber harvesting land base. See Section 3.3.9 for more information.

8.4 Wildlife

8.4.1 Mountain Caribou

Spatial reserves to protect mountain caribou (*Rangifer tarandus caribou*) habitat have been established (GAR Order #U-3-005) and have been in effect since February 12, 2009. Mountain caribou guidelines were amended out of the Revelstoke Higher Level Plan to avoid conflicts with the GAR order. These reserves were completely removed from the timber harvesting land base. See Section 3.3.14 for more information.

8.4.2 Grizzly Bear

The Revelstoke Higher Level Plan requires management for grizzly bear through the retention of forest cover adjacent to high value habitat (avalanche chutes). These 50 m buffers on one side of key avalanche chutes have not been explicitly modeled here because the high value habitat areas have not been identified spatially and the impact of these areas is meant to be captured in the old and mature seral retention impacts.

8.4.3 Ungulate winter range – Mule Deer and Moose

In February 2007, an ungulate winter range GAR order was introduced that set general wildlife measures for Mule Deer, and Moose in the Revelstoke TSA (U-4-001). Since these cover requirements reflect current management of UWR in this TSA, they were applied on the CFLB portion of each MU as cover constraints in the model. See Table 48 for details.

Table 48. UWR Cover requirements (GAR #U-4-001) UWR forest cover requirements

UWR Attribute	Species	BEC Subzones	Forest cover objective*
Snow interception Cover	Mule Deer	ICHmw	Min. 40% ≥ 101 yrs in the CFLB of each MU
	Moose	All Subzones	Min. 20% ≥ 61 yrs in the CFLB of each MU
Forage Area	Both Species	All Subzones	Min. 10% ≥ 81 yrs in the CFLB
Forest Cover	Both Species	All Subzones	Max. 40% <21 yrs in the CFLB of each MU

* Order also specifies requirements for evergreen crown closure. However, it is not feasible to assess crown closure as part of constraints in the model so it was ignored for the purpose of this analysis.

8.4.4 Identified Wildlife

The provincial *Identified Wildlife Management Strategy* provides for the creation of wildlife habitat areas (WHAs), to protect key habitat features of listed wildlife species. Since the last TSR, five data sensitive WHAs have been spatially established within the Revelstoke TSA, all of which were removed from the THLB (see Section 3.3.11).

8.5 Biodiversity

Biodiversity is managed at both landscape and stand levels. The primary mechanism for landscape-level management is retention of old and mature seral forest. Stand-level biodiversity is protected through retention of wildlife trees and wildlife patches. The following sections outline how retention of old and mature forest and wildlife trees/patches will be modeled.

8.5.1 Landscape-level biodiversity

Part 1, Section 1 and 2 of the Revelstoke Higher Level Plan Order (March 2005) specify the amount of old and mature forest that must be maintained within each BEC variant inside each Landscape Unit (LU). The requirement must be met independently above and below the operability line, so only the operable portion has been modeled here as it is the only area influenced by forest management. The RHLPO does not indicate the

vintage for the operability line to be used for old seral requirements therefore, the most recent operability will be used (December 2008). Landscape Units have been legally established along with Biodiversity Emphasis Option (BEO) assignments that guide the target level of old/mature forest in each BEC variant. The achievement of the old seral retention targets will be accomplished by using spatial OGMA's for the first 10 years of the planning horizon after which spatial cover constraints will be applied.

Old seral requirements for each BEC/BEO combinations are provided in Table 49. These will be applied as constraints in the model after 10 years so that harvest will be limited in specific LU/BEC/BEO combinations if the cover requirements are not met. Specific LU/BEC BEO management zones are provided in Appendix 1. Any forested area below the operability line including forested non-contributing area (NHLB) such as GAR caribou reserves (pers. comm. Frank Wilmer, 2009) will be allowed to contribute to meeting targets as long as they meet the criteria outlined in Table 8.

Spatial Old Growth Management Areas (OGMA's) and Mature + Old Management Area (MOGMA's) have been developed by MoAL – Integrated Land Management Bureau (ILMB)[6]. These areas will be reserved from harvest in the model for the first 10 years to meet the objectives of the RHLPO requirements. The areas associated with these spatial OGMA's and MOGMA's are included in Appendix 1. Overall, there is a 5.1% deficit in reserved OGMA/MOGMA area relative to target biodiversity requirements. This deficit is largely due to the fact that spatial OGMA's and MOGMA's were developed with the premise that the ICHmw3 variant belonged to NDT3. However, since then ICHmw3 has been re-classified to belong to NDT2, which has an older 'old' seral age definition, lower old seral retention requirements, and higher mature + old requirements, there is not enough mature+old area identified. Therefore, percent constraints will be applied to manage for mature + old requirements in the ICHmw3 for the entire planning horizon.

Table 49. Old and mature forest cover requirements for landscape level biodiversity objectives

BEC Zone	NDT	Mature Age (yrs)	Old Age (yrs)	MATURE + OLD Seral Requirements			OLD Seral Requirements		
				Low	Inter	High	Low	Inter	High
ESSF	1	>120	>250	19	36	54	19	19	28
ICH	1	>100	>250	17	34	51	13	13	19
ICH	2	>100	>250	15	31	46	9	9	13

Summary of Modeling Approach to be used in the Base Case

First 80 Years	81-250 Years in Future
Prevent harvest of old and mature retention areas. (seral requirements are turned off – except for ICHmw3)	Release retention areas and apply aspatial seral cover requirements based.

The RHLPO does not allow for the drawdown of old seral targets in low BEO areas like in other areas of the province. Also, mature+old targets are required in all BEC/BEO units.

8.5.2 Stand-level biodiversity — Wildlife Tree Retention

Wildlife tree retention is one of the primary methods to address stand level biodiversity objectives. The Revelstoke Licensees' FSP's are based on Section 66 (1) of the Forest Planning and Practices Regulation (FPPR). Licensees are retaining, on an area basis, 7% of the total area of their cutblocks. When possible, retention is within non-THLB areas. Existing, mapped WTRA's are removed from the THLB as landbase netdowns (Section 3.3.16). These are within or adjacent to existing cutblocks. The estimate of future WTRA's was described in section 3.3.18.1.

[6] Wilmer, F. 2007. Revelstoke Timber Supply Area Old Growth Management Areas Report. Integrated Land Management Bureau. Ministry of Agriculture and Lands.

9.0 Timber Supply Forecasting

9.1 Timber supply model

Forest Planning Studio (FPS) version 6.0.2.0 will be used to complete the timber supply analysis. FPS was developed by Dr. John Nelson at the University of British Columbia (UBC) and is a spatially explicit forest estate simulation model. All events in the model are directly linked to stand level polygons or harvest units and thus allow tracking of individual stand attributes and spatial relationships through time. Each polygon belongs to a specific stand type (Analysis Unit) and has attributes such as age, harvest system, and land base status (THLB or Non THLB). Results are typically aggregated for reporting at higher levels (i.e. harvest flow for the entire unit).

A wide range of constraints can be modeled on the land base: harvest exclusion, spatial adjacency/maximum cutblock size, maximum disturbance/young seral, minimum mature/old seral, and equivalent clearcut area (ECA) limits. Constraints are applied to groups of polygons (cliques) and harvest is restricted if a constraint is not satisfied. A single polygon can belong to many overlapping cliques and each of them must be satisfied in order to allow harvest of the polygon. Where a mature or old cover constraint is not met, harvesting may still occur if there are any eligible stands remaining after the oldest stands are reserved to meet the constraint.

Harvest is implemented using a set of priorities to queue stands for harvest. In each period, the model harvests the highest priority eligible stands until it reaches the harvest target or exhausts the list of opportunities. Harvest can be implemented in single years, multiple year periods or a combination of these. Where periods are used, the midpoint of the period is typically used as the point where harvest opportunity is evaluated because it is a good balance between the start of the period (pessimistic) and the end of the period (optimistic).

9.2 Harvest Flow Objectives

Harvest flow objectives used during analysis are consistent with MFR policy[7]. The primary objective is to gradually adjust harvest levels, if required, to arrive at the long-term harvest level (LTHL) for the TSA. A wide range of harvest flows are possible but ideally the flows will:

- Achieve an acceptable short-term harvest level beginning at the current AAC whenever possible;
- Where harvest level changes are required, make steps no larger than 10%;
- Do not permit the mid-term harvest level to fall below a level reflecting the productive capacity of the TSA (based on VDYP yield estimates); and
- Achieve a maximum long-term stable harvest level over a 300-year time horizon reflecting the productive capacity of the TSA (based on TIPSY yield estimates). One indicator of a stable long-term harvest level will be a constant long-term total inventory (growing stock on the THLB).

9.3 Sensitivity Analyses

The data and assumptions used in timber supply analysis are often subject to uncertainty. To provide a perspective on the impacts to timber supply of uncertainty in the data or assumptions, sensitivity analyses are commonly performed. Usually only one variable (data or assumption) from the information used in the base case is changed in order to explore the sensitivity of that variable.

Sensitivity analyses are a key component of any Timber Supply Review process. Sensitivity analyses permit the determinant (the Chief Forester) to gauge the potential impact of uncertainty around assumptions and data that make up the base case. Sensitivity analyses help to frame the potential impacts of uncertainty by analyzing scenarios that are more pessimistic and more optimistic than the base case.

Selecting sensitivities to run within the analysis is important, since the sensitivities need to be relevant to the management unit and meaningful to the determination. In the previous TSR, the many of the sensitivities listed

[7] B.C. Ministry of Forests. 2003. Harvest Flow Considerations for The Timber Supply Review: Draft Working Paper. Forest Analysis Branch. http://www.llbc.leg.bc.ca/public/PubDocs/bcdocs/365082/DFAM_harvest_flow_options.pdf

below were critical to the Revelstoke TSA and it will be critical to explore them in this analysis to provide perspective to the Chief Forester for the AAC determination. Additional sensitivities have been added to reflect pending changes in practices or data uncertainties specific to this analysis.

Table 50. Planned sensitivity analyses

Sensitivity analysis	Zone/ group / analysis unit subject to uncertainty	Magnitude of change	# of Runs
Size of Timber Harvesting Land base	Timber Harvesting Land Base (THLB)	The timber harvesting land base will be increased and decreased by +/– 10%.	2
Managed Stand Yields	Managed Stands	The volume associated with managed stands will be increased and decreased by +/- 10%	2
PEM site Indices in ESSF	Managed Stands in ESSF	Apply SIBEC correlations to ESSF based on current PEM site series classifications	1
Natural Stand Yields	Natural Stands	The volume associated with natural stands will be increased and decreased by +/- 10%	2
VDYP6	Natural Stands	Compare initial growing stock (on THLB) between VDYP 6 and VDYP 7 projected inventory.	1
Minimum Harvest Ages	All Stands	Minimum Harvest ages will be increased and decreased by +/- 10 years.	2
Armillaria Root rot	Managed Stands	TIPSY low severity *Armillaria* OAF 2 applied to Douglas-fir in the ICH	1
2019 Genetic Gains	Future Managed Stands	The genetic gains projected for 2019 (10 years out) will be applied to all future managed stands.	1
VQO's	Visuals	Shift disturbance allowance up by one class	1
Exclude Hw stands(>79% volume)	All stands	Remove all Hw stands (>79% volume) from the THLB	1
Total			14

10.0 References

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11.0 Glossary

Allowable annual cut (AAC)	The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic meters of wood per year.
Analysis unit	A grouping of types of forest — for example, by species, site productivity, silvicultural treatment, age, and or location — done to simplify analysis and generation of timber yield tables.
Base case harvest forecast	The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.
Biodiversity (biological diversity)	The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.
Biogeoclimatic (BEC) variant	A subdivision of a biogeoclimatic subzone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.
Biogeoclimatic zones	A large geographic area with broadly homogeneous climate and similar dominant tree species.
Coniferous	Coniferous trees have needles or scale-like leaves and are usually 'evergreen'.
Cutblock	A specific area, with defined boundaries, authorized for harvest.
Cutblock adjacency	The spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.
Deciduous	Deciduous trees shed their leaves annually and commonly have broad-leaves.
Environmentally sensitive areas (ESA)	Areas with significant non-timber values, fragile or unstable soils, impediments to establishing a new tree crop, or high risk of avalanches.
Forest cover objectives	Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see **Cutblock adjacency and Green–up**).
Forest inventory	An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.
Forest and Range Practices Act (FRPA)	Legislation that govern forest practices and planning, with a focus on ensuring management for all forest values.
Forest type	The classification or label given to a forest stand, usually based on its tree species composition. Pure spruce stands and spruce-balsam mixed stands are two examples.
Free-growing	An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.
Green-up	The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.
Growing stock	The volume estimate for all standing timber at a particular time.
Harvest forecast	The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.
Higher level plans	Higher level plans establish the broader, strategic context for operational plans, providing objectives that determine the mix of forest resources to be managed in a given area.

Inoperable areas	Areas defined as unavailable for harvest for terrain-related or economic reasons. Operability can change over time as a function of changing harvesting technology and economics.
Integrated resource management (IRM)	The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.
Landscape-level biodiversity	The *Landscape Unit Planning Guide* provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.
Landscape unit	A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.
Long-term harvest level	A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.
Mature seral	Forest stands with trees between 80 and 120 years old, depending on species, site conditions and biogeoclimatic zone.
Management assumptions	Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.
Mean annual increment (MAI)	Stand volume divided by stand age. The age at which average stand growth, or MAI, reaches its maximum is called the culmination age (CMAI). Harvesting all stands at this age results in a maximum average harvest over the long term.
Minimum harvestable age (MHA)	The age at which a stand of trees is expected to achieve a merchantable condition. The minimum harvestable age could be defined based on maximize average productivity (culmination of mean annual increment), minimum stand volume, or product objectives (usually related to average tree diameter).
Model	An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.
Natural disturbance type (NDT)	An area that is characterized by a natural disturbance regime, such as wildfires, which affects the natural distribution of seral stages. For example areas subject to less frequent stand-initiating disturbances usually have more older forests.
Not satisfactorily restocked (NSR)	An area not covered by a sufficient number of well-spaced trees of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.
Operational Adjustment Factor (OAF)	OAF1 and OAF2 are TIPSY input parameters that reduce predicted yield to account for factors such as non-productive areas within stands, disease and insects, non-commercial cover, stocking gaps, decay, waste, and breakage.
Operability	Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.
Crown forest land base (CFLB)	All forested crown land in a management unit. Used to support the management of non timber resources. The THLB is a subset of this land base.
Protected area	A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).
Riparian area	Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.
Scenic area	Any visually sensitive area or scenic landscape identified through a visual landscape inventory or planning process carried out or approved by a district manager.

Sensitivity analysis	A process used to examine how uncertainties about data and management practices could affect timber supply. Inputs to an analysis are changed, and the results are compared to a baseline or base case.
Seral stages	Sequential stages in the development of plant communities that successively occupy a site and replace each other over time.
Site index	A measure of site productivity. The indices are reported as the average height, in meters, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 meters above the ground). Site index curves have been developed for British Columbia's major commercial tree species.
Stand-level biodiversity	A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.
Stocking	The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.
Table Interpolation Program for Stand Yields (TIPSY)	A B.C. Forest Service computer program used to generate yield projections for managed stands based on interpolating from yield tables of a model (TASS) that simulates the growth of individual trees based on internal growth processes, crown competition, environmental factors and silvicultural practices.
Timber harvesting land base (THLB)	Crown forest land within the timber supply area where timber harvesting is considered both acceptable and economically feasible, given objectives for all relevant forest values, existing timber quality, market values and applicable technology.
Timber supply	The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)	An integrated resource management unit established in accordance with *Section 7* of the *Forest Act*.
Tree farm license (TFL)	Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.
Ungulate	A hoofed herbivore, such as deer.
Unsalvaged losses	The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) that is not harvested.
Variable Density Yield Prediction (VDYP)	An empirical yield prediction system, supported by the Ministry of Forests and Range, designed to predict average yields and provide forest inventory updates over large areas (i.e., Timber Supply Areas). It is intended for use in unmanaged natural stands of pure or mixed species composition.
Vegetation Resources Inventory (VRI)	An assessment of British Columbia's vegetation resources. It includes computerized maps, a database describing the location and nature of forest information, including timber size, stand age, timber volume, tree species composition, and shrub, herb, and bryoid information. It replaces the older forest inventory.
Visual quality objective (VQO)	Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.
Volume estimates	Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.
Yield projections	See volume estimates
Watershed	An area drained by a stream or river. A large watershed may contain several smaller watersheds.
Wildlife tree	A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.
Woodlot licence	An agreement entered into under the *Forest Act*. It allows for small-scale forestry to be practised in a described area (Crown and private) on a sustained yield basis.

12.0 Acronyms

AAC	Allowable Annual Cut
Analysis	Timber Supply Analysis
AU	Analysis Unit
BCTS	British Columbia Timber Sales
BEC	Biogeoclimatic Ecosystem Classification
BEO	Biodiversity Emphasis Option
CF	Chief Forester
CPR	Canadian Pacific Railway
DFO	Department of Fisheries and Oceans
DM	District Manager
DP	Data Package
ESA	Environmentally Sensitive Area
FAIB	Forest Analysis and Inventory Branch
FIZ	Forest Inventory Zone
FPC	Forest Practices Code
FPPR	Forest Planning and Practices Regulation
FSP	Forest Stewardship Plan
GAR	Government Action Regulation
GIS	Geographic Information System
HLP	Higher Level Plan
ILMB	Integrated Land Management Bureau (Ministry of Agriculture and Lands)
IRM	Integrated Resource Management
LRMP	Land and Resource Management Plan
LU	Landscape Unit
MHA	Minimum Harvestable Age
MOE	Ministry of Environment
MOGMA	Mature + Old Growth Management Area
MFR	Ministry of Forests and Range
MO	Ministerial Order
NCC	Non-Commercial Cover
NDT	Natural Disturbance Type
NRL	Non-Recoverable Losses
NSR	Not Satisfactorily Restocked
OAF	Operational Adjustment Factor
OGMA	Old Growth Management Area
PSP	Permanent Sample Plot
CFLB	Crown Forest Land Base
PSYU	Public Sustained Yield Unit
RMR	Revelstoke Mountain Resort
RMZ	Riparian Management Zone
RRZ	Riparian Reserve Zone
RVQC	Recommended Visual Quality Class
SI	Site Index
TFL	Tree Farm License
THLB	Timber harvesting land base
VAC	Visual Absorption Capability
VQO	Visual Quality Objective
WHA	Wildlife habitat area
UWR	Ungulate winter range

Appendix 1 – THLB / CFLB Operable Areas by BEO/BEC

Landscape Unit	Biodiversity Emphasis	Biogeoclimatic Variant	Operable CFLB Area (ha)	THLB Area (ha)	Percent Mature + Old Requirement	Percent Old Requirement	Percent Reserved as MOGMA	Percent Reserved as OGMA
Akolkolex	Intermediate	ESSFwc 1	2	2	36%	19%	0.0%	0.0%
		ICH mw 2	1,871	1,579	31%	9%	31.6%	9.0%
		ICH mw 3	1,244	760	31%	9%	23.2%	14.0%
		ICH wk 1	13	12	34%	13%	35.2%	21.5%
	Low	ESSFwc 1	1,752	1,304	19%	19%	14.2%	14.2%
		ESSFwc 4	965	579	19%	19%	18.8%	18.8%
		ICH mw 2	2,262	2,124	15%	9%	15.0%	9.0%
		ICH mw 3	2,060	887	15%	9%	14.1%	14.1%
		ICH vk 1	2,351	1,946	17%	13%	16.1%	12.2%
		ICH wk 1	2,804	2,156	17%	13%	16.5%	12.8%
Big Eddy	High	ESSFvc	44	26	54%	28%	55.8%	29.1%
		ICH vk 1	99	76	51%	19%	52.4%	19.8%
		ICH wk 1	1,350	923	51%	19%	51.4%	19.0%
	Low	ESSFvc	511	321	19%	19%	19.3%	19.3%
		ICH vk 1	1,147	848	17%	13%	18.4%	12.7%
		ICH wk 1	697	503	17%	13%	17.3%	13.2%
Bigmouth	Low	ESSFvc	847	120	19%	19%	17.7%	17.7%
		ICH vk 1	3,418	2,531	17%	13%	16.6%	12.5%
Cranberry	Intermediate	ICH mw 3	358	270	31%	9%	0.0%	0.0%
	Low	ESSFwc 1	3	3	19%	19%	0.0%	0.0%
		ESSFwc 4	3	3	19%	19%	0.0%	0.0%
		ICH mw 3	89	78	15%	9%	0.0%	0.0%
		ICH wk 1	399	323	17%	13%	0.0%	0.0%
Downie	Intermediate	ICH mw 3	166	137	31%	9%	0.0%	14.5%
		ICH wk 1	10	10	34%	13%	0.0%	0.0%
	Low	ICH mw 3	1	1	15%	9%	0.0%	51.4%
		ICH wk 1	53	53	17%	13%	0.0%	0.0%
Frisby Ridge	High	ICH mw 3	73	49	46%	13%	36.7%	26.6%
		ICH wk 1	1,445	889	51%	19%	51.3%	19.2%

Landscape Unit	Biodiversity Emphasis	Biogeoclimatic Variant	Operable CFLB Area (ha)	THLB Area (ha)	Percent Mature + Old Requirement	Percent Old Requirement	Percent Reserved as MOGMA	Percent Reserved as OGMA
	Low	ESSFvc	898	628	19%	19%	17.6%	17.6%
		ICH vk 1	540	139	17%	13%	17.3%	13.3%
		ICH wk 1	3,522	1,968	17%	13%	17.1%	13.1%
Goldstream	Intermediate	ICH mw 3	51	19	31%	9%	0.0%	34.2%
		ICH wk 1	29	25	34%	13%	0.0%	11.4%
	Low	ICH wk 1	17	17	17%	13%	0.0%	0.0%
Horne	High	ESSFvc	144	68	54%	28%	54.8%	28.1%
		ICH vk 1	2,027	829	51%	19%	51.3%	19.2%
		ICH wk 1	182	87	51%	19%	62.6%	19.7%
	Intermediate	ESSFvc	601	221	36%	19%	33.3%	18.6%
		ICH vk 1	711	323	34%	13%	32.8%	13.0%
		ICH wk 1	295	188	34%	13%	38.1%	13.3%
	Low	ESSFvc	81	32	19%	19%	20.4%	20.4%
		ICH vk 1	1,377	873	17%	13%	16.9%	13.2%
		ICH wk 1	367	321	17%	13%	18.4%	13.3%
Illecillewaet	Intermediate	ICH mw 3	353	119	31%	9%	27.3%	17.2%
		ICH vk 1	599	229	34%	13%	35.0%	13.3%
		ICH wk 1	104	22	34%	13%	35.7%	14.7%
	Low	ESSFvc	419	240	19%	19%	21.4%	21.4%
		ESSFwc 1	676	503	19%	19%	19.8%	19.8%
		ESSFwc 4	502	221	19%	19%	27.8%	27.8%
		ICH mw 3	257	63	15%	9%	14.1%	13.8%
		ICH vk 1	1,746	1,124	17%	13%	17.0%	12.9%
		ICH wk 1	4,383	3,265	17%	13%	17.0%	13.0%
Jordan	High	ICH mw 3	92	70	46%	13%	34.2%	20.5%
		ICH wk 1	0	0	51%	19%	0.0%	0.0%
	Intermediate	ICH mw 3	1,007	831	31%	9%	23.3%	11.9%
		ICH wk 1	130	113	34%	13%	25.2%	16.9%
	Low	ESSFvc	747	533	19%	19%	19.1%	19.1%
		ESSFwc 1	8	3	19%	19%	20.4%	20.4%
		ICH mw 3	534	382	15%	9%	15.4%	15.4%
		ICH vk 1	1,245	854	17%	13%	17.0%	13.0%
		ICH wk 1	2,704	2,281	17%	13%	17.4%	13.3%

Landscape Unit	Biodiversity Emphasis	Biogeoclimatic Variant	Operable CFLB Area (ha)	THLB Area (ha)	Percent Mature + Old Requirement	Percent Old Requirement	Percent Reserved as MOGMA	Percent Reserved as OGMA
LaForme	Intermediate	ESSFvc	1	0	36%	19%	0.0%	0.0%
		ICH mw 3	1,668	884	31%	9%	23.1%	14.0%
		ICH vk 1	3	1	34%	13%	59.8%	59.8%
		ICH wk 1	1,033	464	34%	13%	34.1%	13.0%
	Low	ESSFvc	1,788	878	19%	19%	17.2%	17.2%
		ICH mw 3	49	9	15%	9%	85.2%	85.2%
		ICH vk 1	1,837	871	17%	13%	17.7%	13.4%
		ICH wk 1	803	409	17%	13%	16.8%	13.3%
Liberty	High	ESSFvc	804	233	54%	28%	54.4%	28.0%
		ICH mw 3	2	2	46%	13%	0.0%	0.0%
		ICH vk 1	1,485	733	51%	19%	48.3%	18.1%
		ICH wk 1	2,876	1,526	51%	19%	48.4%	18.2%
	Intermediate	ESSFvc	1,746	1,042	36%	19%	35.4%	18.5%
		ICH vk 1	2,237	1,134	34%	13%	30.1%	11.5%
		ICH wk 1	1,284	577	34%	13%	28.4%	11.3%
	Low	ESSFvc	754	437	19%	19%	21.9%	21.9%
		ICH vk 1	1,454	834	17%	13%	15.3%	11.5%
		ICH wk 1	306	236	17%	13%	15.6%	13.5%
Mica	Intermediate	ICH vk 1	318	287	34%	13%	0.0%	3.2%
	Low	ICH vk 1	4	2	17%	13%	0.0%	28.8%
Mulvehill	Intermediate	ICH mw 3	184	30	31%	9%	0.0%	0.0%
		ICH wk 1	0	0	34%	13%	0.0%	0.0%
Pingston	Low	ESSFwc 1	358	267	19%	19%	0.0%	0.0%
		ESSFwc 4	366	359	19%	19%	0.0%	0.0%
		ICH wk 1	1,566	1,260	17%	13%	0.0%	0.0%
Redrock	Intermediate	ICH vk 1	1,671	1,347	34%	13%	34.2%	13.1%
		ICH wk 1	173	111	34%	13%	38.3%	11.8%
	Low	ESSFwc 2	1,130	725	19%	19%	21.3%	21.3%
		ESSFwcw	123	61	19%	19%	2.5%	22.8%
		ICH vk 1	2,283	1,887	17%	13%	13.3%	11.7%
Soards	High	ESSFvc	2	0	54%	28%	84.0%	84.0%
		ICH vk 1	1,198	594	51%	19%	50.9%	18.9%
		ICH wk 1	77	45	51%	19%	51.3%	20.7%

Landscape Unit	Biodiversity Emphasis	Biogeoclimatic Variant	Operable CFLB Area (ha)	THLB Area (ha)	Percent Mature + Old Requirement	Percent Old Requirement	Percent Reserved as MOGMA	Percent Reserved as OGMA
	Intermediate	ESSFvc	76	25	36%	19%	39.1%	19.4%
		ICH vk 1	238	108	34%	13%	35.0%	13.2%
		ICH wk 1	109	42	34%	13%	33.8%	13.8%
	Low	ESSFvc	3,308	1,579	19%	19%	19.2%	19.2%
		ICH vk 1	4,439	2,887	17%	13%	16.6%	12.8%
		ICH wk 1	207	148	17%	13%	17.6%	13.2%

Notes: OGMA's and MOGMA's were developed with the premise that the ICHmw3 variant belonged to NDT3. However, since then ICHmw3 has been re-classified to belong to NDT2, which has a different old seral age definition, lower old seral retention requirements, and higher mature + old requirements.

Appendix 2 – Analysis Unit Volumes

	Existing Natural Yields (VDYP7)														
Age	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**	**112**	**113**	**114**	**115**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	17	16	3	1	0	0	11	13	0	0	0	0	14	12	0
40	54	52	19	16	3	3	40	60	17	17	3	0	46	46	10
50	108	106	43	37	15	9	82	134	46	54	14	13	89	101	29
60	171	168	75	68	32	19	133	225	86	106	31	40	139	170	55
70	233	231	110	104	52	46	184	316	133	171	53	80	187	243	85
80	290	289	145	142	76	74	232	396	180	239	76	131	232	311	117
90	343	342	178	179	99	104	276	466	226	302	100	188	272	371	147
100	393	388	209	214	121	136	315	526	267	359	124	244	308	420	176
110	439	430	237	246	141	168	350	577	305	409	147	298	340	461	204
120	479	467	263	275	160	198	381	621	339	454	167	348	369	493	229
130	515	499	286	301	177	221	408	657	369	492	187	393	394	519	254
140	544	526	306	323	192	241	430	686	396	525	205	434	416	539	275
150	567	546	321	340	205	257	447	705	417	550	220	466	433	552	293
160	580	557	332	350	214	266	457	714	431	565	231	486	444	559	306
170	588	565	338	357	220	271	464	717	440	573	239	499	451	561	315
180	593	568	342	361	224	274	467	715	445	576	243	507	455	560	321
190	594	568	345	362	226	275	468	713	448	576	246	510	456	557	324
200	594	567	346	363	228	276	468	709	450	575	248	510	456	552	326
210	591	563	344	362	228	275	465	703	447	571	247	507	452	544	324
220	587	559	342	360	227	274	462	698	444	566	246	504	447	537	322
230	583	555	340	359	226	273	459	692	442	562	244	500	443	529	319
240	580	552	338	358	226	271	456	687	439	558	243	497	439	522	317
250	577	548	336	356	225	270	452	681	436	554	242	493	434	515	315
260	573	545	334	355	224	269	449	675	433	549	240	490	430	507	312
270	570	542	332	353	223	268	446	669	430	545	239	486	426	500	310
280	567	538	330	352	222	267	442	662	427	541	237	483	421	492	307
290	564	535	328	350	221	266	439	656	424	537	235	479	417	485	305
300	561	532	326	349	220	264	435	649	421	533	234	476	412	478	302

	Existing Natural Yields (VDYP7) continued														
Age	**116**	**117**	**118**	**119**	**120**	**121**	**122**	**123**	**124**	**125**	**126**	**127**	**128**	**129**	**130**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0
40	8	0	0	20	17	2	1	0	0	20	29	1	3	0	0
50	31	2	0	58	60	17	16	0	0	63	100	12	21	2	1
60	64	11	13	107	120	44	45	11	6	121	193	34	61	12	12
70	107	25	34	157	183	79	86	30	20	181	279	64	119	29	34
80	156	40	63	203	238	116	130	53	42	234	350	97	179	52	68
90	206	57	99	243	284	152	173	80	68	280	406	128	233	76	109
100	253	75	138	275	320	184	212	108	98	319	449	157	279	102	152
110	296	94	179	302	350	213	245	134	128	350	483	184	318	126	192
120	334	112	219	324	373	239	274	159	156	377	508	207	350	148	228
130	366	131	256	343	393	260	297	180	183	399	528	229	376	168	261
140	393	150	290	358	409	277	317	199	206	416	543	248	397	187	289
150	413	167	316	368	421	291	332	214	225	429	552	263	412	203	310
160	425	181	334	376	427	300	342	225	238	437	555	274	421	215	323
170	432	192	346	381	429	305	347	232	245	441	553	281	425	224	331
180	436	199	353	385	429	309	349	238	250	443	550	286	426	229	336
190	437	204	357	387	429	311	349	241	252	443	544	288	424	233	338
200	436	208	359	389	428	313	349	244	253	443	538	290	422	235	339
210	431	208	357	389	426	313	347	244	251	440	531	289	417	235	337
220	427	207	354	389	424	312	346	243	250	437	524	287	413	234	334
230	423	207	353	389	422	312	344	243	249	435	518	286	409	233	332
240	419	206	350	389	421	311	343	243	248	432	513	284	406	232	330
250	415	205	347	388	420	311	341	243	247	430	507	283	403	231	329
260	411	205	345	388	418	310	340	243	246	427	503	282	400	230	327
270	406	204	342	388	416	310	339	243	245	425	498	281	397	229	325
280	402	203	339	388	415	310	337	243	244	423	494	279	394	228	324
290	398	202	336	388	413	309	336	242	243	421	489	278	391	227	322
300	394	201	334	388	412	309	335	242	243	419	485	277	389	227	321

	Future Managed Yields (BatchTIPSY 4.1)														
Age	**201**	**202**	**203**	**204**	**205**	**206**	**207**	**208**	**209**	**210**	**211**	**212**	**213**	**214**	**215**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	31	29	6	2	1	1	1	4	0	1	0	0	1	2	0
40	126	120	54	24	26	31	39	68	23	37	24	21	38	48	22
50	235	229	134	82	93	105	131	176	103	126	106	100	124	138	94
60	324	317	215	150	178	193	228	281	195	223	198	191	213	230	178
70	401	393	284	215	246	262	312	365	279	306	283	276	293	309	256
80	468	460	345	271	317	335	385	443	348	379	352	344	360	376	321
90	518	510	396	321	380	400	451	511	415	445	419	411	417	434	379
100	563	555	439	363	438	458	509	566	472	503	476	468	465	481	428
110	599	592	475	399	486	507	556	612	522	551	526	518	505	521	470
120	599	620	504	430	531	554	596	662	562	590	566	559	539	555	487
130	599	618	528	456	573	597	640	704	597	632	603	594	573	590	502
140	599	617	550	479	610	632	678	738	638	671	644	634	601	617	517
150	599	615	567	496	640	662	709	766	673	703	678	668	624	638	530
160	599	613	580	510	667	688	734	791	701	728	704	697	643	657	540
170	599	612	591	523	689	711	758	814	723	751	727	720	660	675	549
180	599	610	600	535	710	731	778	835	744	761	748	740	676	691	556
190	599	610	600	545	727	748	796	853	762	771	766	758	690	703	563
200	599	610	600	552	744	763	813	868	771	779	784	776	701	715	569
210	599	610	600	559	757	777	828	868	779	787	799	791	711	725	575
220	599	610	600	564	769	789	840	868	785	793	812	805	721	734	580
230	599	610	600	569	780	799	851	868	791	799	824	816	728	738	584
240	599	610	600	574	790	809	861	868	796	803	834	826	735	738	588
250	599	610	600	577	799	818	869	868	800	808	843	835	740	738	591
260	599	610	600	581	807	826	869	868	804	812	851	844	740	738	593
270	599	610	600	584	814	834	869	868	808	812	857	850	740	738	596
280	599	610	600	584	820	841	869	868	811	812	863	857	740	738	598
290	599	610	600	584	826	847	869	868	814	812	869	862	740	738	599
300	599	610	600	584	826	847	869	868	814	812	869	862	740	738	599
310	599	610	600	584	826	847	869	868	814	812	869	862	740	738	599
320	599	610	600	584	826	847	869	868	814	812	869	862	740	738	599
330	599	610	600	584	826	847	869	868	814	812	869	862	740	738	599
340	599	610	600	584	826	847	869	868	814	812	869	862	740	738	599
350	599	610	600	584	826	847	869	868	814	812	869	862	740	738	599

	Future Managed Yields (BatchTIPSY 4.1) continued														
Age	**216**	**217**	**218**	**219**	**220**	**221**	**222**	**223**	**224**	**225**	**226**	**227**	**228**	**229**	**230**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	1	1	0	0	0	0	7	16	7	1	0	0
40	11	5	1	45	43	7	3	0	0	91	129	78	44	2	1
50	68	42	22	136	132	50	39	7	1	209	255	187	137	31	21
60	145	105	71	221	216	120	100	35	13	316	362	287	230	94	80
70	219	170	131	306	299	187	167	81	45	403	449	371	314	166	150
80	285	229	188	368	364	247	225	136	86	472	517	435	382	235	216
90	340	283	239	408	404	309	283	184	135	528	568	488	436	297	277
100	391	328	284	437	434	354	331	228	176	571	613	528	481	348	331
110	432	367	324	458	455	386	368	273	215	611	650	562	517	397	379
120	468	400	358	473	471	409	394	313	252	643	679	594	545	438	421
130	498	429	388	484	482	428	414	344	290	669	704	617	577	474	457
140	525	453	414	487	486	442	429	368	321	691	724	635	598	506	489
150	551	475	435	488	487	453	442	386	347	709	742	652	615	530	515
160	576	495	454	489	487	461	451	400	365	726	758	666	630	553	538
170	595	514	471	489	488	468	459	413	380	739	758	679	643	574	558
180	611	531	488	489	489	473	465	422	392	752	758	689	655	597	580
190	624	544	504	489	489	473	469	430	403	762	758	697	664	617	601
200	635	554	518	489	489	473	470	437	411	762	758	697	673	634	619
210	647	563	529	489	489	473	470	442	418	762	758	697	680	646	634
220	657	571	538	489	489	473	470	446	424	762	758	697	686	656	645
230	666	579	545	489	489	473	470	449	429	762	758	697	691	666	654
240	675	586	551	489	489	473	470	451	433	762	758	697	696	675	663
250	682	592	558	489	489	473	470	453	437	762	758	697	696	682	671
260	687	598	562	489	489	473	470	454	438	762	758	697	696	689	678
270	692	602	568	489	489	473	470	454	440	762	758	697	696	696	685
280	697	607	572	489	489	473	470	454	442	762	758	697	696	702	691
290	700	611	576	489	489	473	470	454	443	762	758	697	696	707	696
300	700	611	576	489	489	473	470	454	443	762	758	697	696	707	696
310	700	611	576	489	489	473	470	454	443	762	758	697	696	707	696
320	700	611	576	489	489	473	470	454	443	762	758	697	696	707	696
330	700	611	576	489	489	473	470	454	443	762	758	697	696	707	696
340	700	611	576	489	489	473	470	454	443	762	758	697	696	707	696
350	700	611	576	489	489	473	470	454	443	762	758	697	696	707	696

	Existing Managed Yields (BatchTIPSY 4.1)														
Age	**501**	**502**	**503**	**504**	**505**	**506**	**507**	**508**	**509**	**510**	**511**	**512**	**513**	**514**	**515**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	18	6	1	2	0	0	1	0	0	1	0	0	10	2	0
40	108	72	35	48	16	12	42	8	1	30	2	0	103	47	8
50	217	172	110	144	89	83	129	64	17	108	29	0	221	140	59
60	309	259	194	244	178	169	223	142	71	195	87	5	323	237	135
70	391	337	263	326	260	251	302	219	135	271	156	25	414	318	211
80	463	405	328	405	329	319	376	285	198	343	215	60	484	393	277
90	523	464	384	470	396	386	441	345	255	392	273	101	538	453	339
100	576	515	433	523	453	442	495	401	303	425	331	148	588	500	393
110	623	560	474	566	500	490	538	448	350	449	375	187	633	540	438
120	659	599	514	609	538	528	578	489	393	467	408	224	664	577	475
130	689	632	549	650	572	561	618	522	430	480	436	258	690	612	506
140	689	658	576	682	608	596	653	552	463	491	457	295	714	639	532
150	689	681	601	707	640	628	680	583	490	495	476	328	735	659	559
160	689	700	623	728	667	657	703	611	514	495	491	354	753	676	583
170	689	700	641	748	686	677	723	636	534	495	504	377	768	693	605
180	689	700	657	767	703	695	743	656	558	495	514	394	768	707	622
190	689	700	670	782	719	710	761	671	579	496	522	409	768	719	635
200	689	700	682	796	734	724	776	686	598	496	530	422	768	731	646
210	689	700	692	808	747	737	789	699	614	496	533	433	768	740	655
220	689	700	700	818	759	750	801	712	628	496	536	443	768	748	665
230	689	700	700	828	769	755	811	723	640	496	537	451	768	755	674
240	689	700	700	835	778	759	821	733	650	496	539	459	768	761	681
250	689	700	700	842	785	763	829	742	658	496	539	464	768	766	688
260	689	700	700	842	792	767	836	750	666	496	540	471	768	766	694
270	689	700	700	842	797	770	842	756	674	496	540	475	768	766	699
280	689	700	700	842	802	772	842	762	681	496	540	478	768	766	703
290	689	700	700	842	807	774	842	767	686	496	540	480	768	766	706
300	689	700	700	842	807	774	842	767	686	496	540	480	768	766	706
310	689	700	700	842	807	774	842	767	686	496	540	480	768	766	706
320	689	700	700	842	807	774	842	767	686	496	540	480	768	766	706
330	689	700	700	842	807	774	842	767	686	496	540	480	768	766	706
340	689	700	700	842	807	774	842	767	686	496	540	480	768	766	706
350	689	700	700	842	807	774	842	767	686	496	540	480	768	766	706

	Future Managed Yields (BatchTIPSY 4.1) - Previously Existing Managed														
Age	**601**	**602**	**603**	**604**	**605**	**606**	**607**	**608**	**609**	**610**	**611**	**612**	**613**	**614**	**615**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	29	13	3	3	0	0	2	0	0	1	0	0	15	3	0
40	133	95	50	58	22	18	47	11	1	46	5	0	122	59	11
50	248	200	133	159	102	94	140	73	22	139	41	1	244	159	71
60	341	287	220	261	192	183	235	153	78	226	108	9	347	257	152
70	422	366	289	345	277	267	318	230	145	311	178	35	433	341	229
80	494	434	354	419	346	336	388	299	208	375	241	74	501	410	299
90	548	492	408	482	410	399	451	357	266	416	303	120	554	467	357
100	602	538	457	535	464	454	503	411	315	446	356	165	600	515	408
110	644	582	497	577	510	500	547	457	361	468	396	204	638	553	450
120	678	620	534	618	548	538	586	497	401	483	426	242	669	588	487
130	678	649	565	655	580	571	625	530	438	495	451	280	696	618	517
140	678	674	593	686	615	604	657	558	469	498	472	317	719	642	542
150	678	674	616	710	645	635	683	589	496	498	489	345	738	662	567
160	678	674	636	732	670	660	706	616	520	499	504	371	755	680	591
170	678	674	652	752	689	679	727	639	540	500	514	390	755	696	610
180	678	674	666	770	706	697	746	657	562	500	522	406	755	710	625
190	678	674	678	785	722	713	763	673	583	500	530	420	755	722	637
200	678	674	689	798	736	720	777	688	602	500	533	431	755	732	648
210	678	674	689	810	749	726	790	701	618	500	535	442	755	742	658
220	678	674	689	820	761	732	802	714	630	500	537	451	755	750	668
230	678	674	689	820	770	737	812	724	641	500	539	459	755	750	676
240	678	674	689	820	779	741	822	735	650	500	540	465	755	750	683
250	678	674	689	820	786	745	819	743	659	500	541	471	755	750	690
260	678	674	689	820	792	748	817	751	667	500	541	476	755	750	695
270	678	674	689	820	798	751	815	757	674	500	542	479	755	750	700
280	678	674	689	820	803	754	812	763	681	500	542	481	755	750	703
290	678	674	689	820	807	756	810	768	687	500	542	484	755	750	706
300	678	674	689	820	807	756	810	768	687	500	542	484	755	750	706
310	678	674	689	820	807	756	810	768	687	500	542	484	755	750	706
320	678	674	689	820	807	756	810	768	687	500	542	484	755	750	706
330	678	674	689	820	807	756	810	768	687	500	542	484	755	750	706
340	678	674	689	820	807	756	810	768	687	500	542	484	755	750	706
350	678	674	689	820	807	756	810	768	687	500	542	484	755	750	706