Type 4 Silviculture Strategy

Silviculture Strategy – Prince George TSA

Version 1.7

Draft

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1 Introduction

1.1 Context

This document is the fourth of four documents that make up a Type 4 Silviculture Strategy, the documents are:

1. Situational Analysis – describes in general terms the situation for the unit – this could be in the form of a PowerPoint presentation with associated notes or a compendium document.
2. Data Package - describes the information that is material to the analysis including the model used, data inputs and assumptions.
3. Modeling and Analysis report –provides modeling outputs and rationale for choosing a preferred scenario.
4. **Silviculture Strategy –provides treatment options, associated targets, timeframes and benefits.**

1.2 Project Objectives

The Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) has initiated a Type 4 silviculture strategy for the Price George timber supply area (TSA). The strategy will help MFLNRO work towards the government's strategic objectives such as:

- Best return from investments and activities on the forest and range land base;
- Encourage investments to benefit forest and range resources;
- Manage the pest, disease and wildfire impacts;
- Mitigate mid-term timber supply shortage caused by the MPB;
- Maximize timber growth in the provincial forests.

This silviculture strategy is a result of collaboration and sharing of ideas involving MFLNRO Victoria staff, MFLNRO local staff, other government and industry stakeholders, and other professionals. The ultimate goal is a realistic strategy that will be owned and championed by district staff and licensees. In particular, this silviculture strategy will present:

- A fully rationalized plan to guide the expenditure of public silviculture funds to improve the future timber supply and habitat supply;
- A plan with a consistent format and content so that expanding it to regional and provincial levels is feasible and facilitates comparisons between management units;
- A plan containing the right information in the right format so that it can be utilized by government and industry for resource management related decision making;
- Silviculture regimes and associated standards that may potentially be adopted in forest stewardship plans as required standards for basic silviculture operations.
- An introduction of climate change into future management decision making.

1.3 Executive Summary of the Silviculture Strategy

Timber Supply	The growing stock losses to the MPB are predicted to reduce the mid-term timber supply in the Prince George TSA significantly. The estimates for this reduction vary; in this analysis the mid-term harvest level was predicted to decrease to approximately 6.3 million m^3 per year between years 6 and 50. The mid-term harvest forecast in the latest TSR by MFLNRO used different analysis assumptions and predicted a lower harvest level - between 4 and 6 million m^3 per year - depending on the scenario. There likely is an adequate supply of timber in the Prince George TSA to maintain the current level of industrial activity, however, a large part of this timber supply is not economically viable to harvest in the current market conditions. The mid-term timber supply is dependent on the assumption that substantial harvest must occur in the Fort St. James Resource District and a large part of this harvest must come from balsam leading stands. The timber supply in Vanderhoof is severely impacted due to the lack of local mature growing stock. In Prince George the harvest is also constrained by the MPB impacts, however, it is limited by the Prince George TSA Biodiversity Order as well. Many of the attacked and killed pine stands might not get salvaged. These stands pose a fire threat to the forest and surrounding communities for several decades; they also reduce the future timber supply .by not producing timber at their inherent capacity. The MPB outbreak has impacted young existing managed stands as well. The extent and the severity of the MPB impacts in young stands is not known; however, some of these younger stands may be so severely impacted that they have become or will become unproductive requiring rehabilitation.	
Objective	Mitigate the impact of the MPB, particularly on the mid-term timber supply.	
General Strategy	Maximize salvage and apply silviculture to improve quantity and quality of timber supply.	
Working Targets	Timber Volume Flow Over Time	**Short Term** (1-5 years): Maximize salvage of dead pine without compromising the mid-term by overcutting the green component. **Mid-term** (6 to 80 years): Increase the mid-term harvest by 15%. **Long Term** (>80 years): Maintain highest stable growing stock.
	Timber Quality	**Short Term** (1-5 years): Maximize the recovery of sawlog before the stands deteriorate. **Mid-term** (6 to 80 years): Regenerate harvested areas with silviculture practices that provide high quality timber. **Long Term** (>80 years): Regenerate harvested areas with silviculture practices that provide high quality timber.
	Habitat Supply	**Short Term** (1-5 years): Support key habitat modeling initiatives and incorporate the results into next iteration of strategies. Develop plans for age class imbalances and recruitment and management of AC 8 and 9. **Mid-term** (6 to 80 years): No specifics. **Long Term** (>80 years): No specifics..
Major Silviculture Strategies	Timber Volume Flow Over Time	**Years 2013 – 2017** Survey candidate stands for fertilization for health and overall condition. Fertilize stands closest to harvest first. Start multiple application fertilization regimes; priority order Sx, Pl. Survey existing managed stands for growth and yield, and pests and diseases. Rehabilitate younger dead pine stands with no merchantable volume.

<table>
<tr><td rowspan="3"></td><td></td><td>Monitor salvage operations in MPB attacked stands to determine when rehabilitation programs must be considered.

Investigate policy options to introduce higher planting densities and stocking standards.

Years 2018 - 2013
Continue Fertilization.

Survey existing managed stands for growth and yield, and pests and diseases.

Rehabilitate younger dead pine stands with no merchantable volume.

Monitor salvage operations in MPB attacked stands. If warranted, extend the rehabilitation to older stands that may remain unharvested.

Start using higher establishment densities in basic silviculture.</td></tr>
<tr><td>Timber Quality</td><td>Start using higher establishment densities in basic silviculture as soon as policy issues have been resolved.</td></tr>
<tr><td>Habitat Supply</td><td>Develop plans for age class imbalances and recruitment and management of AC 8 and 9.</td></tr>
<tr><td rowspan="2">Silviculture Program Scenarios</td><td rowspan="2">Program</td><td>Years 1-5
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<tr><th>Priority</th><th>Treatment</th><th>Target Area (ha/yr)</th><th>Unit Cost ($/ha)</th><th>Target Funding ($M/yr)</th></tr>
<tr><td>1</td><td>Surveys and Studies</td><td></td><td></td><td>$600,000</td></tr>
<tr><td>2</td><td>Fertilize</td><td>8,000</td><td>$500</td><td>$4,000,000</td></tr>
<tr><td>3</td><td>Rehab</td><td>200</td><td>$2,000</td><td>$400,000</td></tr>
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<tr><td>Years 6-10
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<tr><td rowspan="3">Outcomes</td><td>Timber Volume Flow Over Time</td><td>A 3.5% increase in harvest between years 6 and 45. Increase of 14.5% between years 46 and 50. Reduction of 15.8% between years 51 and 55 and a reduction of 3.3% between years 56 to 71.</td></tr>
<tr><td>Timber Quality</td><td>Fertilized stands are predicted to have larger mean diameters.</td></tr>
<tr><td>Habitat Supply</td><td>Not modeled.</td></tr>
<tr><td>Recommendations</td><td>Inventories and Monitoring</td><td>1. Existing managed stands: support the development of a protocol for, and implementation of, “mid-rotation” surveys from which the data can be used to accurately and efficiently develop growth and yield assumptions, include a timber quality assessment to help forecast future merchantability.

2. Promote the establishment of a YSM permanent sample plot network in the TSA as soon as possible.</td></tr>
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	Site Index	3. Conduct localized site index studies to increase confidence in site index estimates.
	Complete Additional Sensitivity Analysis	4. Complete additional sensitivity analyses using different minimum harvest criteria and harvesting rules to better assess possible future outcomes. Stand level modeling for quality is integral part of this. 5. Given the importance of managed stands to the mid-term timber supply, complete additional sensitivity analysis relative to the growth and yield inputs for modelling the growth and yield of existing managed stands. As part of this process, complete further assessments and analysis on damaged pine-leading existing stands.
	Implementation of Strategies	6. Establish a task force to investigate how an enhanced reforestation strategy can be implemented. 7. Establish a task force to investigate ways to implement large-scale rehabilitation programs.
	Quality Assessments	8. Support the development of projects to assess managed stand values resulting from different harvesting/treatment regimes. Projects could include valuations of standing timber using industrial and government log grades and prices and milling studies.
	Prioritization of the Landbase	9. Develop GIS-based prioritization of the TSA relative to expected investment returns from silviculture (e.g.: zonation based on site index, haul distance and terrain and harvest constraints).
	Access Management Planning	10. Develop and maintain an access management plan for the TSA.

1.4 Summary of the Current Situation

1.4.1 Land Base

The Prince George Timber Supply Area (TSA) covers 8.0 million hectares of the north-central interior of British Columbia. It is composed of the Prince George (3.4 million hectares), Vanderhoof (1.4 million hectares), and Fort St. James (3.2 million hectares) natural resource districts. Figure 1 illustrates the TSA location and the boundaries of three natural resource district districts within the Prince George TSA.

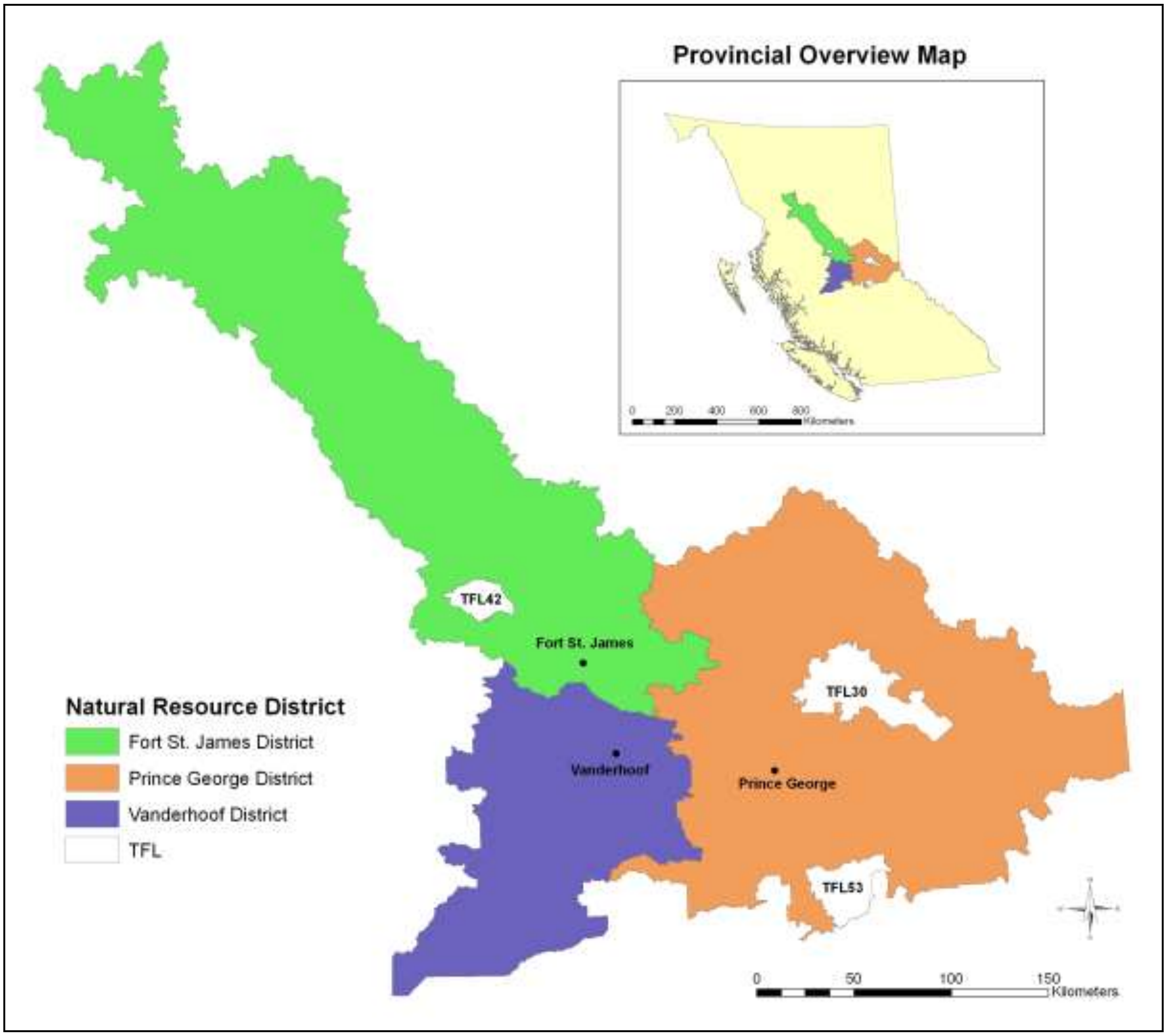

Figure 1: Location of Prince George TSA

Due to the large size of the TSA, variable landscapes exist from flat and gentle slopes in the middle and southwest to higher elevations along the Rocky Mountains. The forests in the flatter areas consist mostly of lodgepole pine and white spruce. The eastern parts of the TSA are spruce and subalpine fir dominated in higher elevations and western red cedar and western hemlock dominated in lower elevations. The Omineca and Skeena mountain ranges are located in the north west of the TSA where lodgepole pine mostly occupies the valley bottoms. Spruce and subalpine fir are the prevalent tree species in the lower and the upper slopes.

The Crown Forested Land Base (CFLB) in the Prince George TSA is 5,242,481 ha. The Timber Harvesting Land Base (THLB), area that is considered available for logging, is 3,096,125 ha. Table 1 shows the breakdown of CFLB and THLB in each natural resource district, as reported by MFLNRO (2011a). The Prince George Natural Resource District is the largest natural resource district with 1,377,451 ha of THLB followed by the Fort St James Natural Resource District with 978,917 ha of THLB. The Vanderhoof Natural Resource District is the smallest natural resource district and has a THLB of 739,757 ha.

Table 1: Prince George TSA netdown summary

District	CFLB	THLB
Fort St James Natural Resource District	2,012,989	978,917
Prince George Natural Resource District	2,192,863	1,377,451
Vanderhoof Natural Resource District	1,036,629	739,757
Entire TSA	5,242,481	3,096,125

Most of the Prince George TSA falls in the Sub-Boreal Spruce (SBS) biogeoclimatic (BEC) zone, as shown in Figure 2. There is also a significant amount of Englemann Spruce-Subalpine Fir (ESSF), and some minor areas of Interior Cedar-Hemlock (ICH), Sub-Boreal Pine and Spruce (SBPS), Boreal White and Black Spruce (BWBS), Spruce-Willow-Birch (SWB) and Montane Spruce (MS).

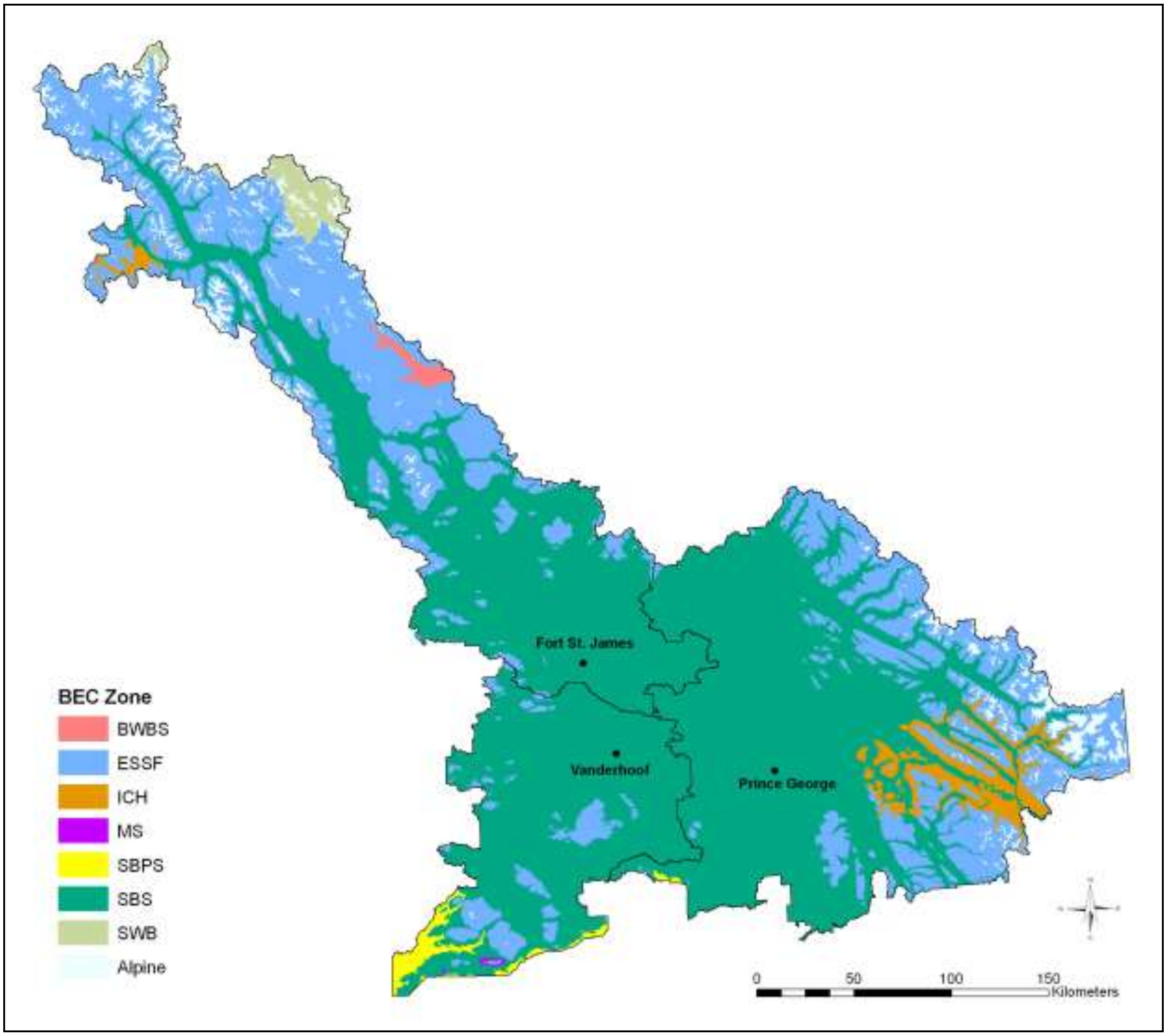

Figure 2: BEC Zones in the Prince George TSA

Biodiversity targets in the TSA are defined and reported by NDU-merged BEC units, which are shown in Figure 3. There are 25 units in the Prince George district, 17 in Fort St. James, and 7 in Vanderhoof.

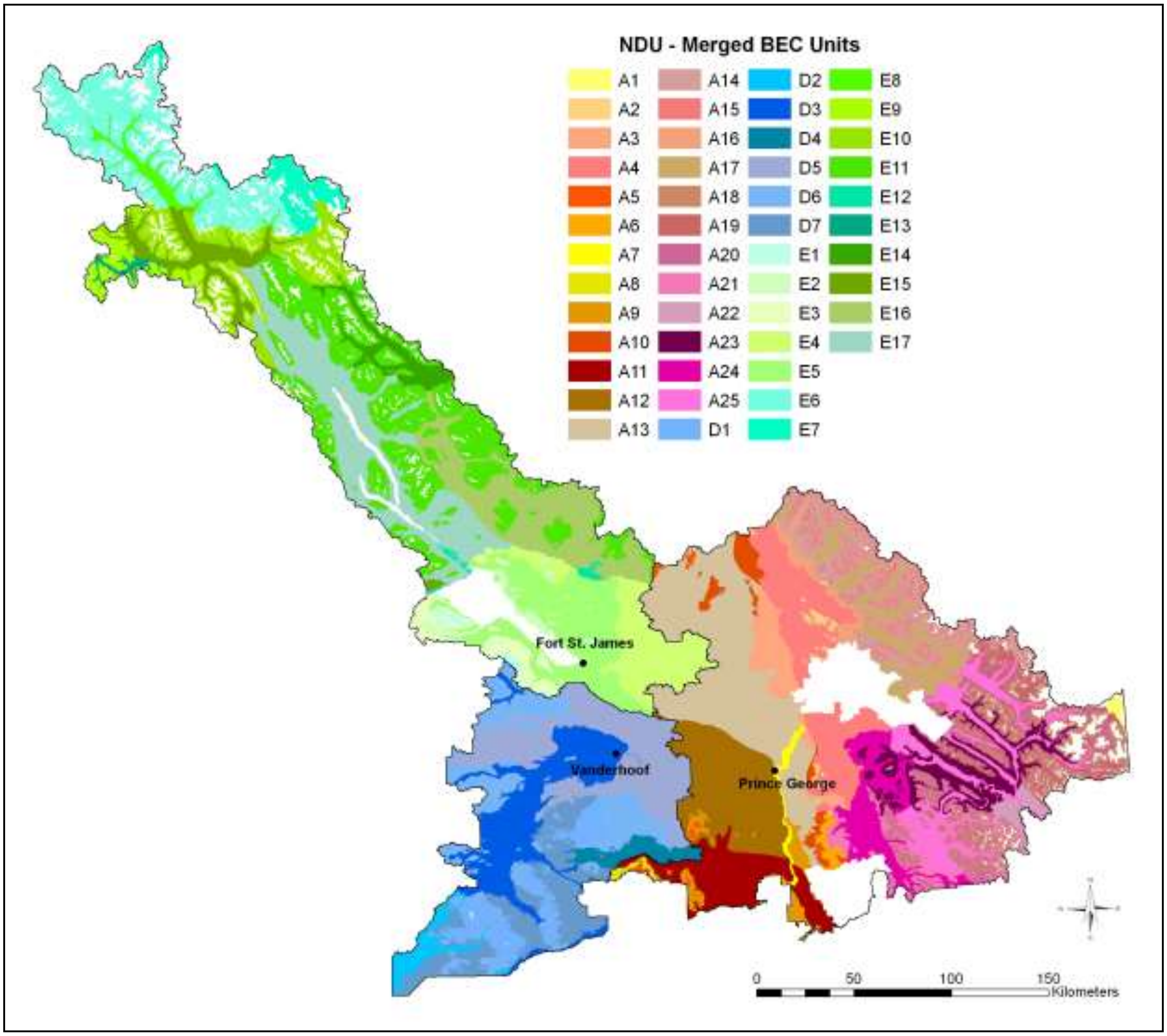

Figure 3: NDU-Merged BEC units in the Prince George TSA

Table 2 shows the average site indices for natural and managed stands for different species groups.

Table 2: Average site productivity in the Fort St. James Natural Resource District

DJA Site Index Source	Balsam	Deciduous	Douglas Fir	Pine	Spruce
VRI Site Index (used for natural stands)	10.1	16.7	15.6	16.8	14.5
SIBEC Site Index (used for managed stands)	14.5		19.1	19.7	17.8

Table 3: Average site productivity in the Prince George Natural Resource District

DPG Site Index Source	Balsam	Cedar	Deciduous	Douglas Fir	Hemlock	Pine	Spruce
VRI Site Index (used for natural stands)	13.1	9.7	18.6	17.9	13.3	18.4	15.2
SIBEC Site Index (used for managed stands)	19.4	16.8		21.0	19.9	20.6	19.7

Table 4: Average site productivity in the Vanderhoof Natural Resource District

DVA Site Index Source	Balsam	Deciduous	Douglas Fir	Pine	Spruce
VRI Site Index (used for natural stands)	9.5	17.5	16.0	15.1	12.6
SIBEC Site Index (used for managed stands)	13.3		18.8	18.2	17.7

1.4.2 Historical and Current AAC

The Prince George TSA was established 1978. Since its creation the AAC has been determined many times (Table 5). The last three determinations (2002, 2004 and 2011) set the AAC significantly higher to facilitate timely harvest of stands affected by mountain pine beetle.

Table 5: Historical and current AAC

Year	AAC m^3	Notes
1986	8,605,000	
1987	8,855,000	Facilitate use of small pine in Vanderhoof
1988	9,255,000	Encourage harvest in the Takla Sustut supply blocks
1989	9,501,093	Facilitate harvest in balsam leading stands, spruce beetle salvage
1989	9,313,463	Creation of TFL 53
1991	9,280,499	Creation of TFL 52
1991	9,180,499	TSL expiry
1996	9,363,661	Facilitate hemlock looper salvage
2002	12,244,000	Facilitate MPB salvage
2004	14,944,000	Facilitate MPB salvage
2011	12,500,000	Facilitate MPB salvage

The 2011 determination also created a partition of 3.5 million m^3 annually for non-pine species with the goal to focus harvesting on dead and dying pine stands while retaining non-pine stands for the mid-term.

1.4.3 Age Class Distribution

The current age class distribution for the Prince George TSA is presented in Figure 4. The increased harvest due to the MPB salvage is reflected in the age class distribution. Twenty one percent of the THLB is between 0 and 20 years old and 32% of the THLB is younger than 41 years of age.

Age class 3 is under-represented, which characterizes the timber supply problem in the TSA; these age classes are the potential sources of timber for the mid-term timber supply.

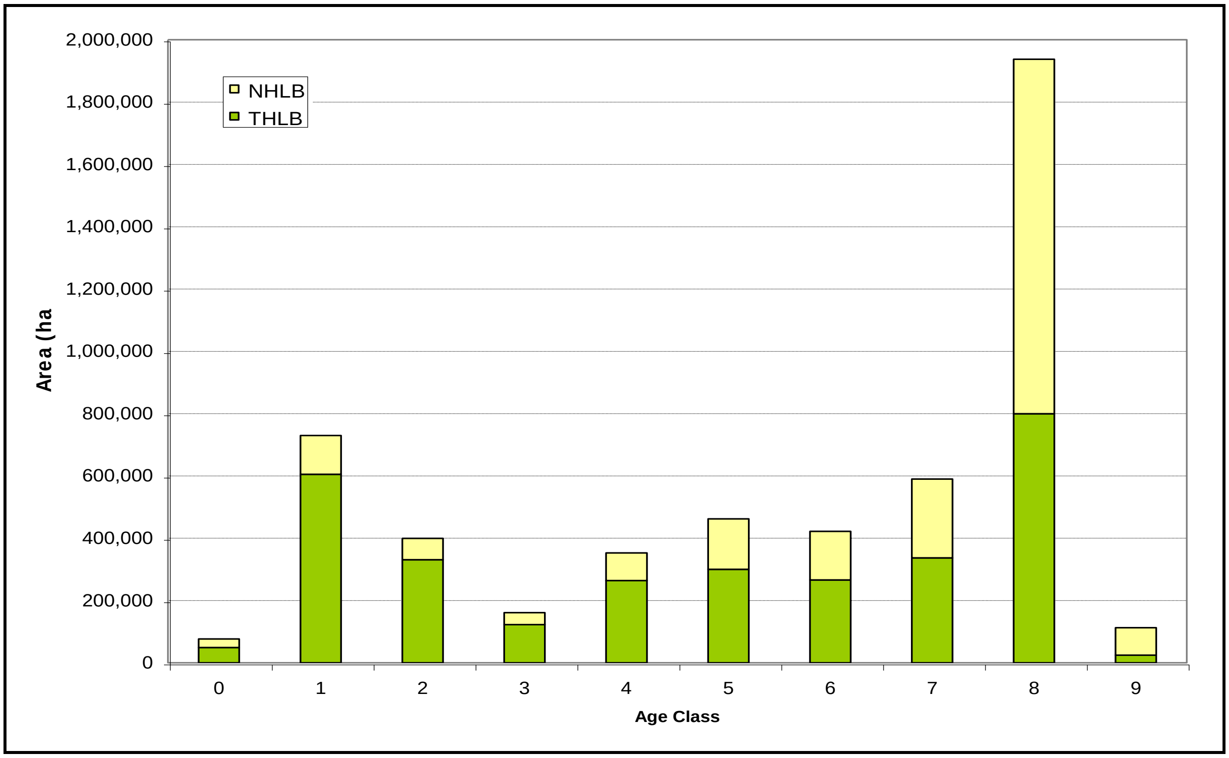

Figure 4: Current age class distribution in the Prince George TSA

1.4.4 MPB in the Prince George TSA

The latest version of the British Columbia Mountain Pine Beetle Model (BCMPB v9) predicts a total mature pine kill of 163 million cubic metres for the Prince George TSA by 2021. This is approximately 79% of the mature pine that was on the timber harvesting land base in 1999. Figure 5 illustrates the killed pine volume since 1999 by year and cumulative to 2012 as per the BCMPB 9. The estimated volume of dead pine in the TSA in 2012 was 157,000,000 m^3.

The MPB outbreak has impacted young existing managed stands as well. This analysis accounted for these impacts by using the data collected for use in the TSR 4 analysis (MOFR, 2008a). Some of these younger stands may be so severely impacted that they will not reach merchantability within a reasonable timeframe and therefore require rehabilitation.

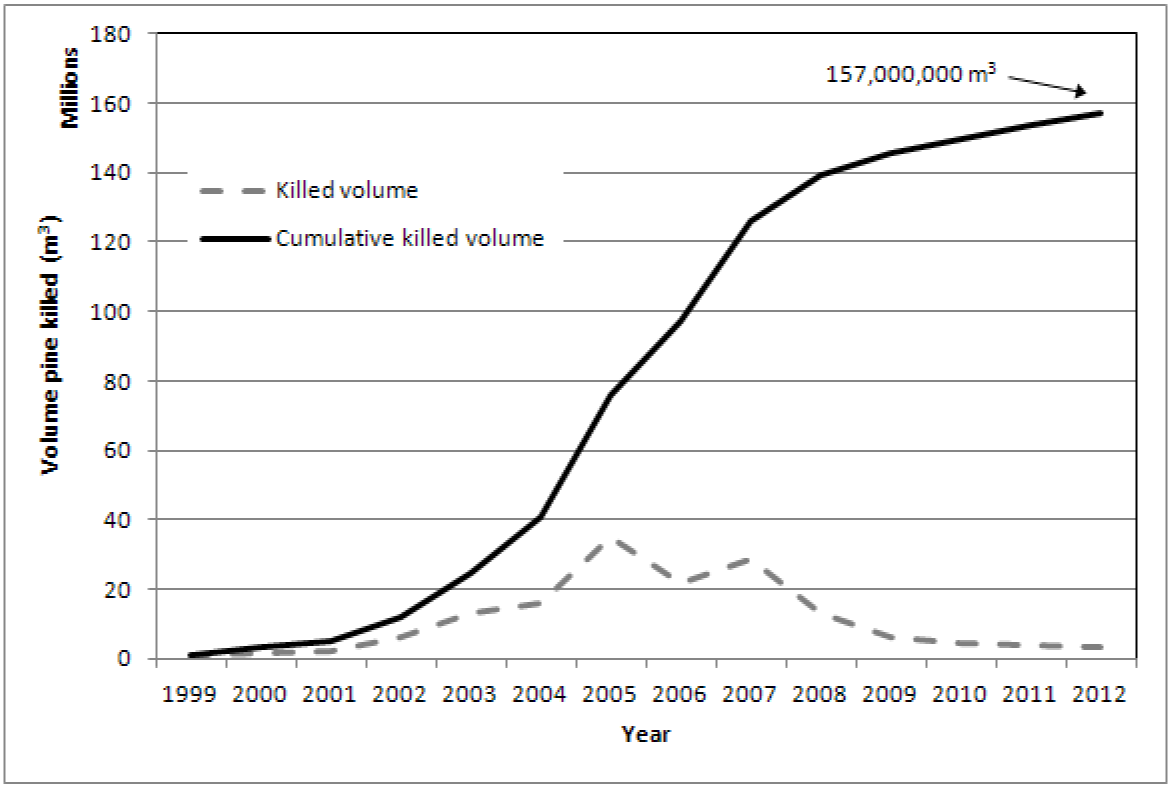

Figure 5: Killed pine volume in the Prince George TSA since 1999 (source BCMPB v9)

1.4.4.1 Shelf Life

The merchantability of beetle-killed wood remains an important uncertainty in timber supply analyses. In this analysis shelf life is defined as the time a stand remains economically viable for sawlog harvesting. The shelf life starts at the year of death; which is when cumulative kill reaches 50%. This analysis assumed that a time period of 16 years is required from the average time of death until the stand becomes entirely unmerchantable. The merchantability is assumed to be 100% at the year of death and for the next year, and then to decline in a linear fashion to 0 at year 16.

The shelf life assumptions in the analysis reduced the volume of dead pine by approximately 65 million m^3 as shown in Figure 6; instead of 157 million m^3, the potentially harvestable pine volume is reduced to approximately 92 million m^3 by 2012. The harvestable volume is further reduced to 83 million m^3 in 2013 and 65 million m^3 by 2015.

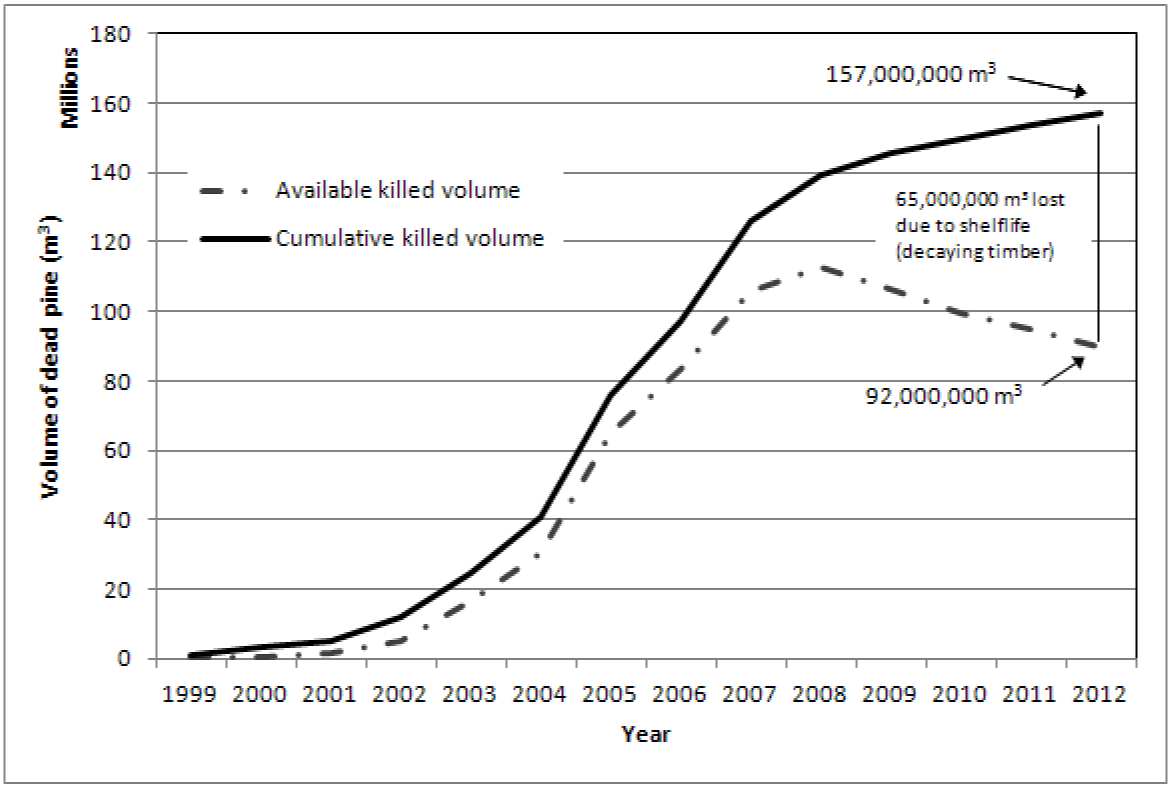

Figure 6: Impact of shelf life on the available dead pine volume in the Prince George TSA

1.4.5 Growing Stock

The total growing stock in the modelling THLB is estimated at approximately 483 million m^3. This estimate excludes the dead volume lost due to decay as described above. Spruce accounts for 40% of this volume, with balsam at 14%. 13% of the growing stock is in deciduous, Douglas fir, cedar, and hemlock combined. . The remainder of the volume (33%) consists of pine; however, more than half of it is dead (19% of total growing stock) (Table 6, Figure 7).

Table 6: Growing stock by species in the Prince George TSA

Species	Volume (m^3)		
	Live	Dead	Total
Balsam	67,604,965		67,604,965
Cedar/Hemlock	7,081,821		7,081,821
Deciduous	41,197,781		41,197,781
Douglas fir	12,732,366		12,732,366
Pine	69,614,011	91,733,081	161,347,092
Spruce	193,446,684		193,446,684
Total	**391,677,628**	**91,733,081**	**483,410,709**

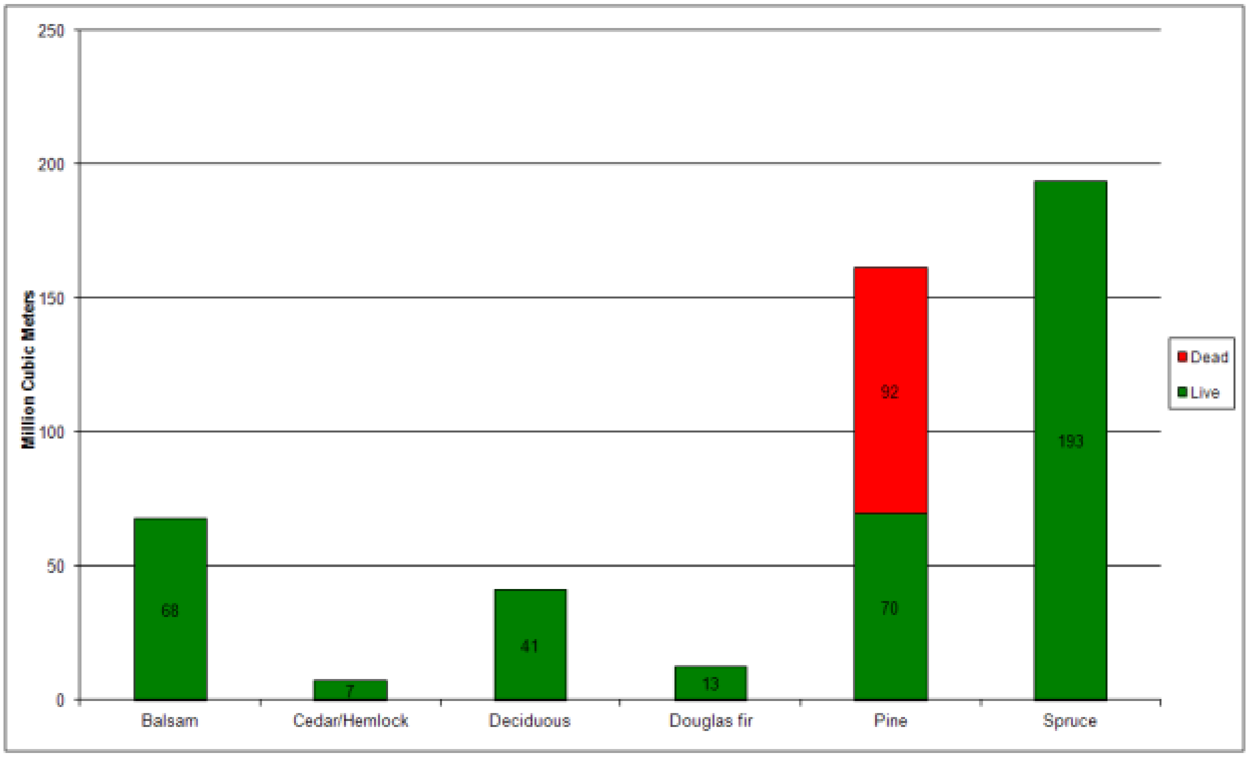

Figure 7: Growing stock by species in the 100 Mile TSA

1.4.6 Timber Supply

The impacts of the MPB infestation on the timber supply in the Prince George TSA are multiple and severe. The growing stock losses to the MPB will reduce the mid-term timber supply. The estimates for this reduction vary; in this analysis the mid-term harvest level was predicted to decrease to approximately 6.3 million m^3 per year between years 6 and 50, a considerable drop from the current AAC of 12.5 million m^3 per year, or the pre MPB AAC levels of approximately 9 million m^3 per year. The mid-term harvest forecast in the latest TSR by MFLNRO was lower, between 4 and 6 million m^3 per year depending on the scenario. The differences in the two analyses are likely caused by different analysis assumptions. Most notable are the mountain pine beetle related assumptions dealing with the merchantability of beetle killed timber, i.e. shelf life. The TSR assumed 100% retention of merchantability for 15 years, after which the dead pine volume is no longer usable. The shelf life assumptions of this analysis are discussed earlier in this document.

The latest TSR included spatial elements in the modelling of timber supply; minimum block sizes were incorporated in the Base Case. This analysis did not attempt to form blocks, nor did it enforce block size minimums or maximums.

1.4.6.1 Unsalvaged Timber

Harvesting all MPB attacked pine stands and immediately reforesting them would benefit future timber supply and reduce fire risk. For this reason the MFLNRO has promoted pine salvage in recent years. The harvest focus on pine has generally been successful. While the harvest has not usually reached the AAC, approximately 75% of the total harvest in the Prince George TSA consists of pine.

Many of the attacked and killed pine stands will not get salvaged. The haul distance for some of the dead pine stands may not warrant their harvest given the lower grade timber and reduced recovery. Silviculture cost may limit salvage of dead pine stands on poorer sites, not logging costs; regeneration standards on some poor sites may require significant silviculture investment, which must be weighed against small volumes, often reduced further by decreasing recovery of decaying timber.

This analysis estimated that up to 436,000 ha of dead stands might remain in the landscape; these stands pose a fire threat to the forest and surrounding communities for several decades. They reduce future timber supply as it is expected that it may take several decades until these stands will become productive again.

1.4.6.2 Advanced Regeneration

Studies have shown that some of the dead pine stands may contain adequate advanced regeneration and non-pine species of residual trees, i.e. secondary structure, to contribute to the mid-term and long-term timber supply. The extent of these stands in the TSA is unknown, as is the growth and yield of them.

1.4.6.3 Economically Available Harvest

The last TSR and this analysis used the combination of minimum harvest volume per hectare and cycle time for log haul as the criteria for defining economically available harvest. As a result, 939,390 ha of otherwise productive forest were removed from the timber harvesting land base as uneconomical. In 2011, the MFLNRO investigated timber supply mitigation options in the TSA and discovered that if no cycle time limitations were used, and if the minimum harvest volume per ha were reduced to 140 m^3 per ha, most of the predicted mid-term timber supply deficit would disappear (MFLNRO 2011b). There likely is an adequate supply of timber in the TSA to maintain the current level of industrial activity, however, a large part of this timber supply is not economically viable to harvest in the current market conditions. Improved commodity prices may reduce the areas that are currently considered uneconomic to harvest.

1.4.6.4 Harvest Species and Harvest Locations

The mid-term timber supply is dependent on the assumption that substantial harvest must occur in the Fort St. James Resource District (from 50% to 70% at times) and a large part of this harvest must come from balsam leading stands. Balsam bark beetles have periodically attacked portions of the Fort St. James Resource District. The health of mature non-pine species in the Fort St James district and the Prince George TSA as a whole is a concern for the mid-term timber supply.

The timber supply in Vanderhoof is severely impacted for decades to come due to the lack of local mature growing stock as a result of the MPB epidemic. In Prince George the harvest is constrained by the MPB impacts, however, it is also limited by the Prince George TSA Biodiversity Order, as discussed below. Planning for this large shift in species and locations harvested will be a major challenge in the mid-term.

1.4.6.5 Biodiversity Management

In the Prince George TSA, biodiversity is managed through the Prince George TSA Biodiversity Order (MSRM, 2004). The order establishes landscape biodiversity objectives throughout the Prince George Timber Supply Area for old forest retention; old interior forest and young forest patch size distribution. The targets are set for natural disturbance unit (NDU) and merged biogeoclimatic (BEC) unit combinations, rather than combinations of landscape units and BEC variants. The NDUs are large geographic areas that are based on natural disturbance regimes.

In most other TSAs throughout British Columbia, biodiversity is managed either via old growth management areas (OGMA), which are spatially explicit areas of old growth forest, or via the Provincial Order Establishing Provincial Non-Spatial Old Growth Objectives often referred to as the "Provincial Old Growth Order". Past analyses have shown that in the Prince George TSA the adoption of the TSA based biodiversity order has little impact on the timber supply at the TSA level. However, there are localized impacts, particularly in the Prince George Resource District where the mid-term timber supply is dependent on the harvest of older non-pine leading conifer stands, which are heavily constrained due to the TSA biodiversity order. When the timber supply in the Prince George Resource District is limited by the biodiversity order, most of the TSA harvest must take place in Fort St. James.

The current approach to biodiversity management classifies all pine stands that meet the old age requirement as old, regardless of their condition. This includes dead, unsalvaged pine stands. At some point in the future these dead stands will cease to represent the late seral stage, which will undoubtedly constrain the timber supply.

1.4.7 Timber Quality

The ongoing salvage operations are facing a declining timber quality due to decaying dead timber and smaller piece sizes. After the salvage period ends – within the next 5 years – the harvest will move on to green timber.

The early mid-term harvest volume is predicted to come mostly from green age class 8 spruce and balsam stands. The harvest of managed stands starts between years 36 and 40 and by year 60 makes up about 70% of the total harvest. During the rest of the mid-term, managed stands make up approximately 80% of the harvest. The health, quality and performance of the managed stands is crucial to the mid-term timber supply. Many of the young pine stands have been impacted by the MPB. Incidents of stem rusts in immature pine also occur; these have negative effects on both stand productivity and wood quality.

1.4.8 Biodiversity and Habitat Supply

The loss of mature and old forest due to the MPB infestation and associated salvage has a significant impact on aquatic and terrestrial habitat and other values. Overall biodiversity is likely reduced while connectivity and patch size objectives are affected. Seral stage objectives are compromised in the short term with large areas of the forest dying and eventually falling down.

The visual quality is impacted; salvage operations change the visual quality in the harvested areas. In areas where dead trees are not salvaged, the visual quality is obviously affected as well.

In watersheds water quality and peak flows are likely affected by increased harvesting and the prevalence of dead trees. Ecologic functions of lakeshore areas and riparian areas are impacted; these impacts will extend to fisheries as well.

As discussed above, in the Prince George TSA, biodiversity is managed through the Prince George TSA Biodiversity Order (MSRM, 2004). Complementing the biodiversity order are three Land and Resource Management Plans (LRMP) that cover the TSA. The Vanderhoof LRMP was approved by Government in 1997 while the Prince George and Fort St. James LRMPs were approved in 1999. The plans contain direction for the sustainable management of Crown land and resources in the corresponding plan areas.

The Prince George TSA LRMPs have been accounted for in this analysis either by removing appropriate areas from the THLB or setting up harvest constraints that follow the management direction outlined in the plans.

2 Silviculture Strategies

2.1 Working Targets

Provincial timber management goals and objectives that include working targets for the provincial timber supply are currently under development. The provincial goals and objectives will in turn provide direction to all the TSAs. The stakeholder group agreed to set a target for increasing the mid-term harvest volume by 15%. Other targets listed Table 7 were discussed at several meetings; however, they were not specifically set by the stakeholder group.

Table 7: Targets for timber quantity and quality

Indicator	Target
Harvest Volume over Time	**Short Term (1-5 years):** Maximize salvage of dead pine without compromising the mid-term by overcutting the green component. **Mid-term (6 to 80 years):** Increase the mid-term harvest by 15%. **Long Term (>80 years):** Maintain highest stable growing stock.
Timber Quality	**Short Term (1-5 years):** Maximize the recovery of sawlog before the stands deteriorate. **Mid-term (6 to 80 years):** Regenerate harvested areas with silviculture practices that provide high quality timber. **Long Term (>80 years):** Regenerate harvested areas with silviculture practices that provide high quality timber.

2.2 Scenario Overview

In addition to the base case 11 scenarios were constructed and compared to the base case. Two were sensitivity analyses testing the impact of harvest scheduling on the mid-term timber supply. Eight were silviculture strategy scenarios testing the impact of various silviculture treatments on timber supply, particularly the mid-term timber supply. One scenario tested the impact of expanding the economically operable land base by providing access to currently inaccessible areas. These learning scenarios directed the final two composite scenarios. In the composite scenarios different silviculture treatments were combined into two scenarios; one with an annual budget of $ 4.4 million, the other with an annual budget of $6.8 million. The funding was assumed to continue at this level for 20 years. Enhanced reforestation was not included in the composite scenarios as the funding mechanism for this treatment was still pending at the time of this analysis. All scenarios are summarized in Table 8.

Table 8: Scenario summary

Type	Scenario	Description
Base Case		Current practice, best available information
Base Case Sensitivities	Lower Initial Harvest Level	Test the impact of lowering the initial harvest level to 9.364 million m3 per year. This initial harvest level is the pre-MPB AAC prior to 2006.
	Minimum Harvest Criteria	Test the impact of lowering the minimum harvest criteria on the mid-term harvest.
	Expand Economically Accessible Land Base	Test the impact of expanding the economically accessible land base on the mid-term timber supply.
Silviculture Strategies	Rehabilitation of Dead Pine Stands	Test the impact of rehabilitating dead pine stands. Incidental recovered volumes are not assumed to contribute to timber supply.
	Rehabilitation of Dead Pine Stands and Fertilization	Test the impact of rehabilitating dead pine stands and fertilizing the rehabilitated stands up to 4 times at ages 25, 35, 45 and 55.
	Fertilize Young Natural Stands	Test the impact of fertilizing young natural stands (26 to 60 years old in 2012). The candidate stands are natural good and medium mostly spruce and some Douglas fir leading stands. Depending on the age the stands were fertilized 1 to 3 times.
	Fertilize Existing Managed Stands	Test the impact of fertilizing existing managed stands. The candidate stands are currently between 16 and 25 years of age. They were fertilized up to 4 times at the age of 25, 35, 45 and 55.
	Fertilize Existing Managed Stands and Current Future Managed Stands	Test the impact of fertilizing existing managed stands and current future managed stands. The candidate stands are currently between 0 and 25 years of age. They were fertilized up to 4 times at the age of 25, 35, 45 and 55.
	Fertilize Young Natural Stands, Existing Managed Stands and Current Future Managed Stands	Test the impact of fertilizing young natural stands (26 to 60 years old in 2012), existing managed stands and current future managed stands.
	Enhanced Reforestation	Test the impact of increasing planting densities to 1,700.
	Enhanced Reforestation and Fertilization	This scenario added up to four fertilization treatments to a subset of the enhanced silviculture population from the previous scenario. Fertilization occurred at ages 25, 35, 45, and 55.
	Combination of Strategies ($4.4 M/year)	This scenario included rehabilitation of dead pine stands and fertilization of existing stands. Maximum budget was set at $4.4 M/year.
	Combination of Strategies ($6.8 M/year)	This scenario included rehabilitation of dead pine stands and fertilization of existing stands. Maximum budget was set at $6.8 M/year.

Table 9 summarizes the relative impacts of the various silviculture scenarios on timber supply relative to the predicted harvest in the base case. The short term is defined as the next 5 years. The mid-term is divided into two components: near mid-term and far mid-term. This was necessary as many of the tested scenarios had significant mid-term impacts; however, these impacts are predicted to take place later in the mid-term. The focus of this analysis and strategy – while on the mid-term timber supply in general – emphasizes the mitigation of timber supply as close to today as possible.

The near mid-term in this analysis is defined as the time between years 6 and 50, while the far mid-term extends from year 51 to year 125. The remainder of the planning horizon (150 years) is called "long term".

Table 9: Scenario timber supply impacts

Scenario	Timber Supply			
	Short Term	Near Mid-term	Far Mid-term	Long Term
Lower Initial Harvest Level	- - -	+	-	0
Minimum Harvest Criteria	0	+++	- - -	- - -
Expand Economically Accessible Land Base	0	+	0	0
Rehabilitation of Dead Pine Stands	0	0	+++	0
Rehabilitation of Dead Pine Stands and Fertilization	0	0	+++	0
Fertilize Young Natural Stands	0	0	0	0
Fertilize Existing Managed Stands	0	++	0	0
Fertilize Existing Managed Stands and Current Future Managed Stands	0	+++	-	0
Fertilize Young Natural Stands, Existing Managed Stands and Current Future Managed Stands	0	++++	-	-
Enhanced Reforestation	0	0	0	+
Enhanced Reforestation and Fertilization	0	0	++++	++++
Combination of Strategies ($4.4 M/year)	0	+	-	0
Combination of Strategies ($6.8 M/year)	0	+	-	0

Notes:

- The timber supply in the Prince George TSA will be reduced significantly in 5 years. The shortage of available volume is expected to last at least until year 50.
- Shelf life assumptions used in the analysis are subject to uncertainty. The timber supply is sensitive to these assumptions.
- Decreasing the harvest immediately increases the early mid-term harvest compared to the base case. This increase comes at the cost: the total loss of harvest in the short term is greater than the total gain the mid-term.
- Reducing the minimum harvest criteria has a significant positive impact on the near mid-term timber supply. The timber supply in the late mid-term and long term is reduced considerably. It is also

likely that timber quality is reduced due to the smaller piece size that is associated with lower minimum harvest criteria.

- The near mid-term timber supply is dependent on age class 8 spruce and balsam stands. After year 50, managed stands are predicted to form the majority of harvest. The health and condition of these stands is unknown.
- The near mid-term timber supply is dependent on harvesting 50% and more of the TSA volume in Fort St James.
- Rehabilitation of unharvested dead pine stands has no timber supply impact until year 61. Note that this analysis assumed no timber recovery from these stands at the time of rehabilitation. Rehabilitation will reduce overall fire hazard significantly. This impact was not modeled and is not shown in the analysis outcomes.
- Fertilization had a significant impact on the near mid-term timber supply. The fertilization impacts are negligible or slightly negative in the far mid-term and in the long term.
- The candidate area for fertilization is large. The health and condition of these stands is unknown; the candidate population as modeled may be overstated.
- The best return in fertilization is achieved by fertilizing stands once approximately 10 years before harvest.
- Fertilization of young stands is risky due to the long return period; investments can be lost due to fires, pests and diseases.
- Enhanced reforestation (higher densities) has a small impact on timber supply in the long term. The small difference in yield between the higher density stands and base case modeled stands contributed to this of impact. Note that the modelling did not account for the increased resiliency and buffer against pests and diseases of these stands. This point was considered in preparing this silviculture strategy.
- Composite scenarios yielded modest increases in harvest in the near mid-term (3.5% and 5.9% between years 31and 35). The harvest increases in the near mid-term come at a cost: the step up to higher harvest levels is delayed compared to the base case. Between years 51 and 55 the harvest level is predicted to be 15.8% and 19.6% less than that of the base case, and from year 56 to 71, 3.3% and 4.3%.

3 Preferred Silviculture Strategy

The preferred silviculture strategy was designed by the Prince George TSA stakeholder group. It sets an incremental silviculture target of 8,000 ha of fertilization per year for the next 5 years at the cost $4 million per year. The annual fertilization program is to remain at this level in the post salvage period starting 6 years from today.

The rehabilitation of dead pine stands will start immediately; 200 ha per year are planned for the next 10 years at the annual cost of $400,000. The stakeholders in the Prince George TSA suggest that opportunities still exist for the biofuel industry to utilize the timber in the dead pine stands. For this reason, their recommendation is to focus any rehabilitation efforts on younger stands with little or no merchantable volume, so as to not compromise the future biofuel opportunities.

No targets were set for enhanced reforestation; the stakeholder group felt that while important and worth pursuing, increased planting densities should be pursued through policy direction.

An additional $600,000 per year is allocated for surveys and studies.

The annual budget for the first 5-year period is $5 million. This funding level is expected to continue in years 6 to 10.

Using a $4.4 million annual incremental silviculture budget (surveys and studies were not modeled) resulted in a 3.5% increase in harvest between years 6 and 45. The increase was more pronounced between years 46 and 50 at approximately 14.5%. The harvest increases in the near mid-term come at a cost: the step up to higher harvest levels is delayed compared to the base case. Between years 51 and 55 the harvest level is predicted to be 15.8% less than that of the base case, and from year 56 to 71, 3.3% less harvest is projected compared to the base case.

Table 10 shows the projected expenditures by treatment for the preferred strategy.

Table 10: Projected expenditures by treatment

Treatment/Activity	Years 1 to 5	Years 6 to 10
Surveys and Studies	$600,000	$600,000
Fertilization	$4,000,000	$4,000,000
Rehabilitation	$400,000	$400,000
Total	$5,550,000	$5,550,000

3.1.1 Surveys and Studies

$600,000 annually is allocated for surveys and studies over the next 10 years. These studies will help to gain a better understanding of the condition of existing managed stands. The studies and surveys will also help in determining which stands in the Prince George TSA are best candidates for rehabilitation. The budget allocation for studies and surveys was not included in the modelling scenarios.

3.1.2 Increased Planting Densities

Increased planting densities are a priority in the Prince George TSA. There is no current funding mechanism for increased planting densities; this strategy component is not funded under the Land Base

Investment Program. For this reason, this treatment will not be adopted as part of the silviculture strategy until the funding mechanism for it has been determined through industry government consultation.

3.1.3 Fertilization

The candidate area for fertilization in the Prince George TSA is large. The condition of the candidate stands needs to be evaluated before operational fertilization takes place. No fertilization is scheduled in the Fort St. James Natural Resource District within the next 5 years due to First Nations' concerns. Some fertilization treatments are scheduled in the district for year 6 and 10; however, further consultation with First Nations is required.

The best financial return in fertilization is achieved by fertilizing stands younger than 80 years of age once approximately 10 years before harvest; however this population is limited. The modelling results are based on multiple fertilization treatments of younger stands; the multiple fertilization regimes should be followed operationally as well. The Land Base Investment Program is expected to fund fertilization.

3.1.4 Rehabilitation of Dead Pine Stands

Rehabilitation of MPB killed pine stands is a potential opportunity to mitigate the late mid-term timber supply and reduce fire risk at the landscape and local levels. However, the TSA licensees and government staff believe that much of the forest killed by the MPB will be salvaged by major licensees and fuel wood operators, and subsequently reforested. For this reason, the rehabilitation of unsalvaged dead stands will concentrate on unmerchantable younger stands.

Based on stand-level financial analysis, rehabilitation may be financially favourable, if the total costs can be kept at around $1500 per hectare or below. A simplified forest level economic analysis showed that rehabilitation of dead pine stands did not produce a positive net present value at the forest level.

Rehabilitation treatments can be funded through the Land Base Investment Program; however other funding sources such as Innovative Timber Sale Licenses (ITSL) should be considered.

4 Related Plans and Strategies

The presented silviculture strategy needs to be integrated with other plans and strategies that exist in the Prince George TSA. These are briefly described below with operational notes where necessary.

4.1 Climate Change

As climate change is projected to impact both timber supply and environmental values, it must be accounted for in longer term plans and strategies. The speed and the scope of this predicted change is not known; however, it is expected that ecological niches of tree species will be altered. The occurrence of various diseases is also expected to rise as a result of the stress brought on by climate change. Table 11 provides links and references to some climate change information sources.

Table 11: Climate change information sources

Source or Publication	Link
Climate Change in BC	
Plan2Adapt - Regional projections of future climate scenarios	pacificclimate.org/tools-and-data/plan2adapt
Climate Overview 2007 – Hydro-climatology and Future Climate Impacts in BC. 2009.	http://pacificclimate.org/docs/publications/PCIC.ClimateOverview.Revised.March2009.pdf
Regional Analysis for Columbia Basin	http://pacificclimate.org/sites/default/files/publications/Murdock.CBT2007-2010Update.Jul2011.pdf
Regional Analysis for Cariboo-Chilcotin	http://pacificclimate.org/sites/default/files/publications/Werner.ClimateChangeCaribooChilcotin.Sep2008.pdf
Regional Analysis for Prince George	http://pacificclimate.org/sites/default/files/publications/Werner.ClimateChangePrinceGeorge.Aug2009.pdf
Regional Analysis for Vanderhoof to Fraser Lake	http://www.pacificclimate.org/project/infrastructure-and-climate-riskyellowhead-highway
Climate WNA (Western North America) for historical and future climate information	pacificclimate.org/tools-anddata/climatewna
Environment Canada Climate Data and Information Archive – Historical Normals and Averages	http://www.climate.weatheroffice.gc.ca/climate_normals/index_e.html
Selecting and Using Climate Change Scenarios for British Columbia. Murdock & Spittlehouse, 2011	http://pacificclimate.org/news/2012/new-publication-selecting-and-using-climate-change-scenarios-britishcolumbia
Regional Forestry Related Climate Change Assessments	
West Kootenays - *Resilience and climate change: Adaption potential for ecological systems and forest management*	http://www.westkootenayresilience.org/
Kamloops TSA – *Kamloops future forest strategy*	http://k2kamloopstsa.com/
Morice & Lakes TSAs – *Multi-scale trans-disciplinary vulnerability assessmen*	http://bvcentre.ca/research/project/a_multi-scale_trans-disciplinary_vulnerability_assessment/
Clayquot – *Building on traditional and scientific knowledge to build resilience in the face of climate change*.	http://ecotrust.ca/clayoquot/building-traditional-and-scientific-knowledge-develop-resiliency-face-climate-change
Vanderhoof – *Assessing potential biophysical and socio-economic impacts of climate change on forest-based communities – a methodological case study.*	http://publications.gc.ca/collections/collection_2009/nrcan/Fo133-1-415E.pdf
Northwest Skeena – *Climate change adaptation planning for Northwest Skeena communities*.	http://brinkmanforest.com/ffesc/
Quesnel TSA – *Integrating Climate Change Adaptation Strategies with Sustainability and Socioeconomic Objectives.*	http://biod.forestry.ubc.ca/FFESC/ (PPT only)

Source or Publication	Link
Climate Change Impacts for BC Forests	
BC Journal of Ecosystem and Management on Climate Change Volume 13 No. 1 **(**2012) Published by FORREX Forum for Research and Extension in Natural Resources	http://jem.forrex.org/index.php/jem
Climate Impacts on BC Watershed Hydrology. 2008. Pike et. al. (4 pgs)	http://cbtadaptation.squarespace.com/storage/ClimateImpactsonBCWatershedHydrology.pdf
Climate Change Effects on Watershed Processes in British Columbia, Chapter 19. 2010. Pike, R.G. et al. in: R.G Pike, T.E. Redding, R.D. Moore, R.D. Winkler, K.D. Bladon (Eds.), Compendium of Forest Hydrology and Geomorphology in British Columbia. BC Ministry of Forests and Range, Forest Sciences Program, Victoria, B.C. and FORREX Forest Research Extension in Natural Resources, Kamloops, BC Land Management Handbook 66 (48 pgs).	http://pacificclimate.org/sites/default/files/publications/Pike.Ch19ForestHydrology.Dec2010.pdf
Climate Change Adaptation and Biodiversity – Background & summary reports. 2009. SFU - ACT. (72 pgs).	http://act-adapt.org/biodiversity/
Ecological resilience and complexity: A theoretical framework for understanding and managing BC's forest ecosystems in a changing climate. 2009. Campbell et. al. MOF Technical Report 055. (36 pgs).	http://www.for.gov.bc.ca/hfd/pubs/Docs/Tr/Tr055.pdf
PCIC Forest pest and tree species suitability project	http://pacificclimate.org/project/forest-pests-and-treespecies-suitability-future-climates
Adapting Forest Management to Climate Change	
Reducing Uncertainty and Risk through Forest Management Planning, 2012. Kenneth Day and David Manuel Pérez.(Submitted - will be posted on BCCFA website)	
Climate Change and Forest Management in Canada:Impacts, Adaptive Capacity and Adaptation Options, 2011. Johnston, et. al.	http://www.sfmn.ales.ualberta.ca/en/Publications/~/media/sfmn/Publications/StateofKnowledgeReports/Documents/SOK2010ClimateChangeJohnstonetalEn.ashx
*Vulnerability of Canada's Tree Species to Climate Change and Management Options for Adaptation, 2011.*Johnston, et. al.	http://www.ccfm.org/pdf/TreeSpecies_web_e.pdf
Climate Change Adaptation and Extreme Weather – SFU ACT Background & Summary reports.	http://actadapt.org/extreme-weather/
Impacts to Adaptation: Canada in a Changing Climate. 2007. Natural Resources Canada. (See Synthesis - 20 pg and the BC chapter – 56 pg)	http://adaptation.nrcan.gc.ca/assess/2007/index_e.php
Analyzing and Deciding How to Adapt Forest Management Systems	
A structured decision-making approach to climate change adaptation in the forest sector. 2005. Ohlsen, D. W.,McKinnon G. A. and Hirsch, K.G. The Forestry Chronicle. VOL. 81, No. 1. *Alberta Sustainable Resource Development Climate Change Adaptation Framework*	http://www.srd.alberta.ca/MapsPhotosPublications/Publications/ClimateChangeAdaptationFramework.aspx
A framework for assessing vulnerability of forest-based communities to climate change. 2007. Williamson, T.B.; Price, D.T.; Beverly, J.L.; Bothwell, P.M.; Parkins, J.R.; Patriquin, M.N.; Pearce, C.V.; Stedman, R.C. and Volney, W.J.A. Nat. Resour. Can., Can. For. Serv., North. For. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-414.	

Source or Publication	Link
Climate Change Barriers and Adaptive Capacity in BC Forest Management	
Removing multi-scale barriers to climate-change adaptation in managed forests of BC. 2012. D. Daust and D. Morgan.	http://bvcentre.ca/files/research_reports/09-12RemovingBarriers.pdf
Achieving climate change adaptation in West Kootenay forest management – Barriers & opportunities. 2012, Pearce. Unpublished Report #8 from the West Kootenay Climate Vulnerability and Resilience Project.	http://www.westkootenayresilience.org/Report8_BarriersOpportunities-Draft.pdf
Adaptive capacity of community forests to climate change – An assessment of the potential role of community forests as governance mechanisms for promoting local adaptation. 2012. E. Furness. Will be posted on BCCFA website.	
Rural Community Climate Change Adaptation	
Pathways to climate resilience: A guidebook for Canadian forest-based communities. 2011. C. Pearce and C. Callihoo. Canadian Model Forest Network.	http://www.modelforest.net/pubs/Pathways_to_Climate_Change_Resilience_Community_Resource_Collection_Final_Feb_2011.pdf
Columbia Basin Trust Communities Adapting to Climate Change Initiative Adaptation Resource Kit	http://adaptationresourcekit.squarespace.com/introduction-to-adaptation-act/
Increasing the resilience of British Columbia's rural communities to natural disturbances and climate change. 2012. Krishnaswamy, A., Simmons, E., & Joseph, L.BC Journal of Ecosystems and Management 13(1):1–15. Published by FORREX Forum for Research and Extension in Natural Resources.	http://jem.forrex.org/index.php/jem/article/viewFile/164/115
General	
Climate change, impacts, and adaptation scenarios: climate change and forest and range management in British Columbia. 2008. D. Spittlehouse. MOF Technical Report 045	http://www.for.gov.bc.ca/hfd/pubs/Docs/Tr/Tr045.pdf
Climate change and Canada's forests: From Impacts to Adaptation. 2009. Williamson et. al.	http://nofc.cfs.nrcan.gc.ca/bookstore_pdfs/29616.pdf
Ministry of Forest, Lands and Natural Resource Operations Climate Change	https://www.for.gov.bc.ca/het/climate/index.htm
BC Government Climate Action Team – Adaptation	http://www.env.gov.bc.ca/cas/adaptation/index.html
Adaptation to Climate Change Team (Simon Fraser University) (ACT)	http://www.sfu.ca/act/
Resources North Climate Change Network	http://www.resourcesnorth.org/rna/380/nccn
Natural Resources Canada forestry adaptation	http://cfs.nrcan.gc.ca/pages/35
Canadian Council of Forest Ministers – Climate Change	http://www.ccfm.org/english/coreproducts-cc.asp
Climate Change Resource Centre, US Forest Service	http://www.fs.fed.us/ccrc/
North Cascadia Adaptation Partnership	http://northcascadia.org/events.php

Source: 2012 BCCFA Conference and AGM Conference Presentations: http://www.bccfa.ca/index.php/what-we-do/conferences/item/download/112_14e91a620a9e05dda0d75777e84af0b0

4.2 Species Deployment

Concerns have been expressed about the diversity of tree species over time and the lack of clear objectives (e.g., Auditor General's report, 2012) in this regard. A recent report from MFLRNO focuses on the harvested land base and provides an assessment of the species distribution from a variety of data sources and points in time (MFLRNO, 2012).

Building on the methodology developed as part of pilot project (Mah et al, 2012), inventory data were used to produce summaries of species composition by age class. Information was also gathered for the Prince George TSA on the projected shifts to BEC subzone from climate change. Using the existing inventory, ecologically-based species benchmarks were developed for each BEC variant based on professional opinion and field experience. These benchmarks were expected to be feasible from both ecological and silvicultural perspectives and desirable at the landscape level regardless of the management objectives.

Additionally BEC related climate change information was used to identify units where species will either be more or less suited over time. This information along with the ecological benchmarks, the present harvesting profile and an understanding of the feasibility for establishment were used in a workshop of local practitioners to create the desired direction for species at the landscape level for the TSA.

This approach is a first step in managing species at the landscape scale. Future iterations may recommend finer scales and promote not only species direction but provenances as well. The expectation is that species direction will be further refined at appropriate scales incorporating direction that links area specific objectives to the species/provenances used, appropriate densities, and suitable species mixes within and between blocks.

Sowing requests will be used to track direction in the short term. These trends and targets will be used to assess success on meeting the described targets/trends. A narrative to describe the situation moving forward will be part of the next iteration of the Silviculture Strategy. Note that the direction may be revised once the harvest moves from pine-dominated stands.

The tables below summarize the direction towards a desired percentage by species by Biogeoclimatic subzone. This information is for planted stock and may not fully reflect the species diversity that will emerge through additional natural regeneration over time. At times, the nature of the stands being logged (i.e., pine stands that are suited to pine), suggests the trend should remain the same.

4.2.1 Species Direction, Prince George TSA

Species direction at the landscape – the following information is for planted stock and may not fully reflect the species diversity that will emerge through additional natural regeneration over time.

The categories used are:

- Current –proportions planted / logged
- Trend – whether it is desirable to
    - Increase
    - decrease or
    - maintain the proportion planted / logged
- Target – a biological target for the unit to trend towards where feasible

Note at times the trend is suggested to remain as is due to the nature of the stands being logged, i.e., pine stands that are suited to pine. These trends and targets should be revisited yearly comparing sowing requests to the trend/target, particularly once the harvest moves from pine-dominated stands. Table 12 indicates the recommended species direction trends in the Prince George TSA for selected BEC variants.

Table 12: Species direction for BEC variants

BEC	Category	Pl	Sx	Fd	Comments
ESSFmv	Current	50 / 62	50 / 20	0 / 0	Mix species where possible, maintain the trend downwards for Pl and upwards for Sx. Increase the use of Fd (and Lw) on suitable sites – e.g., low elevation south facing. Manage Bl using naturals (target 15-40%).
	Target	20 - 40	20 - 40	1 - 2	
	Trend	--- / ↓	--- / ↑	↑	
ESSFwk	Current	2 / 10	98 / 60	1 / 25	Maintain limited use of Pl, maintain trend for Sx, and manage Bl with naturals. No or very limited options for Fd in this unit at this time.
	Target	5 - 20	35 - 70	25 - 50	
	Trend	---	---	---	
SBSdk	Current	75 / 85	25 / 10	3 / 0	Maintain the trend for Pl as mostly harvesting Pl. Maintain the trend for Sx, increase the use of Fd.
	Target	20 - 45	15 - 25	5 - 10	
	Trend	---	---	↑	
SBSdw	Current	70 / 80	25 / 15	8 / 3	Maintain the trend for Pl as mostly harvesting Pl. Reduce reliance on Sx, increase use of Fd where feasible. Consider introducing Pw, Py and Cw on a limited basis – need a seed source.
	Target	20 - 55	10 - 15	15 - 40	
	Trend	↑	↓	↑	
BEC	**Category**	**Pl**	**Sx**	**Fd/Lw**	**Comments**
SBSmc	Current	75 / 75	23 / 18	0 / 0	Maintain the trends for Pl and Sx. Consider introducing Fd and Lw on a limited basis.
	Target	40 - 85	5 - 30		
	Trend	---	---	↑	
BEC	**Category**	**Pl**	**Sx**	**Fd**	**Comments**
SBSmk	Current	55 / 70	45 / 25	3 / 0	Maintain the trend for Pl. Decrease the use of Sx where possible (towards the lower part of the target range) and promote Fd.
	Target	25 - 50	25 - 40	5 - 10	
	Trend	---	↓	↑	
SBSwk	Current	52 / 55	46 / 30	2 / 1	Maintain trends for Pl and Sx, increase Fd where feasible.
	Target	10 - 50	25 - 60	2 - 20	
	Trend	---	---	↑	

4.3 Land Use Plans and Biodiversity

As discussed earlier in this document, in the Prince George TSA, biodiversity is managed through the Prince George TSA Biodiversity Order (MSRM, 2004). Three Land and Resource Management Plans (LRMP) complement the biodiversity; the Vanderhoof LRMP was approved by Government in 1997 while the Prince George and Fort St. James LRMPs were approved in 1999. The plans contain direction for the sustainable management of Crown land and resources in the TSA. The LRMPs and the biodiversity order were accounted for in this analysis.

While analyses have shown that the timber supply impacts of the Prince George TSA Biodiversity Order are localized, rather than TSA wide, the order limits the opportunities to use silviculture as a tool to mitigate the mid-term timber supply shortage. As and example, late seral stage requirements may prevent aggressive rehabilitation of dead pine stands in the Vanderhoof Resource District.

4.4 Forest Health

The 2013 Omenica Region Forest Health Strategy (MFLNRO, 2013) identifies the significant health issues in the Prince George TSA and provides recommendations for management (see Table 13 for rankings for the Fort St. James Resource District; Table 14 for rankings for the Prince George Resource District and Table 15 for rankings for the Vanderhoof Resource District).

Table 13: Ranking of Forest Health Factors in the Fort St. James Resource District

Very High	High	Medium	Low	Very Low
	Two- Year Budworm	Spruce Beetle	Tomentosus Root Disease	Large Aspen Tortrix
	Western Balsam Bark Beetle	Mountain Pine Beetle	Lodgepole Pine Dwarf Mistletoe	Serpentine Leaf Miner - aspen
	Douglas-Fir Beetle	Engraver Beetles (*Ips Pini)*	White Pine Weevil	Birch Leaf Miner
	Stalactiform Blister Rust	Warren's Root Collar Weevil	*Venturia*	Forest Tent Caterpillar
	Western Gall Rust		Red Band Needle Blight – *Dothistroma*	Black Army Cutworm
	Comandra Blister Rust			

Table 14: Ranking of Forest Health Factors in the Prince George Resource District

Very High	High	Medium	Low	Very Low
Spruce Beetle	Western Gall Rust	Mountain Pine Beetle	Red Band Needle Blight – *Dothistroma*	Large Aspen Tortrix
Douglas-Fir Beetle	Comandra Blister Rust	Two-Year Budworm	Lodgepole Pine Dwarf Mistletoe	Serpentine Leaf Miner on Aspen
	Stalactiform Blister Rust		Engraver Beetles (*Ips pini)*	Forest Tent Caterpillar
			Tomentosus Root Disease	Birch Leaf Miner
			Western Balsam Bark Beetle	Satin Moth
			Spruce Weevil	Black Army Cutworm

Table 15: Ranking of Forest Health Factors in the Vanderhoof Resource District

Very High	High	Medium	Low	Very Low
Douglas-Fir Beetle	Western Gall Rust	Spruce Beetle	Mountain Pine Beetle	Large Aspen Tortrix
	Comandra Blister Rust	Black Army Cutworm	Lodgepole Pine Dwarf Mistletoe	Serpentine Leaf Miner on Aspen
	Stalactiform Blister Rust		Engraver Beetles (*Ips pini)*	Forest Tent Caterpillar
			Tomentosus Root Disease	Western Balsam Bark Beetle
			Venturia	Red Band Needle Blight – *Dothistroma*

Collectively the pine stem rusts (Western Gall Rust, Comandra Blister Rust and Stalactiform Blister Rust) cause more losses than any other pests in young stands in the TSA (MFLNRO, 2013). This analysis did not include extra allowances for non-MPB forest health damage agents in managed stands, beyond naturally occurring, endemic levels. There is some concern among local foresters that actual non-MPB forest health impacts in managed pine-leading stands may be worse than assumed. These concerns are heightened by the prevalence of pine in managed stands and the potential additive impact of climate change.

4.5 Wildfire Management

The BC Wildland Fire Management Strategy (BCFS, 2010) has five main components, two of which directly pertain to this silviculture strategy;

- Reduce fire hazards and risks (particularly in and around communities and other high-value areas) and;
- Implement land, natural resource and community planning that incorporates management of wildland fire at all appropriate scales.

Under the Strategic Wildfire Prevention Initiative, the City of Prince George completed a Community Wildfire Protection Plan (CWPP) in 2005 (DHCL et al, 2005). The communities of Vanderhoof and Fort St. James are also in the process of developing CWPPs. Integrating detailed plans and strategies from CWPP's with silviculture strategies in the future would be desirable.

In general, silviculture treatments should be planned to reduce wildfire risk and consequences to safety, infrastructure, property and other values. For the Prince George TSA the primary treatment which can be used to achieve timber supply objectives and mitigate wildfire risk is the rehabilitation of MPB impacted stands which are not expected to be conventionally harvested. Other silviculture treatments (primarily fertilization) should be strategically located to minimize the longer term risk of loss from wildfire.

At this point wildfire planning is done separately from this silviculture strategy. The first step – burn probability mapping (Burn-P3) – is in the process of being completed for the Prince George TSA. The second step will be to develop a fire management plan which will utilize the Burn-P3 results and local input on values at risk. Subsequently, the Fire Management Plan should be integrated if possible with the silviculture strategy to prioritize treatments and candidate treatment areas.

4.6 Ecosystem Restoration

Ecosystem Restoration (ER) is defined as the process of assisting with the recovery of an ecosystem that has been degraded, damaged or destroyed by re-establishing its structural characteristics, species composition and ecological process (MFLNRO, March 2014a). The Vanderhoof Resource District has an ER program and a strategic plan which focuses on Douglas fir stands, grassland, wetland and berry producing shrub ecosystems (LM FRS, 2011).

ER does not directly impact mid-term timber supply and is therefore not a component of this silviculture strategy.

4.7 Enhanced Retention and Secondary Structure

There is no formal enhanced retention strategy in the Prince George TSA. In addition to direction provided in the LRMPs, additional recommendations for retention come from the 2005 Chief Forester's guidance and the Forest Planning and Practices Regulation Amendments to Protect Secondary Structure (Chief Forester, 2005).

Where suitable secondary structure exists in MPB-impacted stands, it may improve future timber supply (MOFR, 2008b). Currently legislation requires the protection of suitable secondary structure in pine-leading stands in the Prince George TSA either by not harvesting or by harvesting with protection of the secondary structure.

4.8 Inventories and Monitoring

The government forest inventory and stand growth modelling programs are used to analyze current and forecast future forest conditions. Accurate mid-term timber supply forecasts and development of strategic mitigation measures depend on good inventories and modelling. This is especially true for managed stands.

A network of permanent sample plots (PSPs) has not yet been established in the Prince George TSA under the Young Stand Monitoring (YSM) program. Local stakeholders would like to see this program deployed in the TSA as soon as possible.

4.9 Habitat

The three LRMPs, legal objectives under FRPA and the Identified Wildlife Management Strategy (IWMS) provide legal and policy management direction relative to species at risk, regionally important wildlife and critical habitat. In the Prince George TSA draft or legal objectives exist for Ungulate Winter Range. There is also one small WHA in the Prince George Resource District. This analysis incorporated landbase netdowns and forest cover constraints to address these identified wildlife habitat areas. However no additional considerations were assumed for other habitat issues.

As the current MPB infestation and the resulting extensive salvage logging and climate change are expected to have significant impacts on wildlife and habitat, it is expected that habitat modelling will be completed over the next few years and the results of this planning can then be integrated into updated silviculture strategies.

4.10 Invasive Plants

Invasive plants pose a threat to our native environment and are a threat to biodiversity (MFLNRO, March 2014b). MFLNRO is primarily responsible for minimizing the impacts of invasive plants on crown forest land in BC. The 2013 Omenica Region Forest Health Strategy contains summaries of recent inventory and treatment efforts by resource district. Legislation requires licensees to report invasive plants when they are found in forestry operating areas and take actions to prevent their spread. There is no direct consideration of invasive plants in this silviculture strategy.

4.11 Tree Improvement and Seed Transfer

Use of improved seed and climate-based seed transfer procedures are two key ways the Forest Genetics Council of BC guides forest genetic resource management activities. All mitigation scenarios in this silviculture strategy involving planting assume the use of the best select seed available. In addition climate change tree species adaption strategies are being developed in conjunction with evolving climate based seed transfer rules.

4.12 Recreation

Many areas within the Prince George TSA are important for recreation. Several designated heritage trails are within the TSA which require protection (with buffers). In addition there are related objectives for visual quality in scenic areas. This analysis was consistent with the objectives for scenic areas and corridors along designated trials. Silviculture treatment scenarios were not applied to areas with a Visual Quality Objective of Retention and designated trail corridors. Otherwise there is no direct linkage between recreation values and this silviculture strategy.

5 Recommendations

This section provides a summary of recommendations for improved data, analysis approach and additional analysis. In addition, recommendations are made for strategic projects that are traditionally not funded through silviculture treatment programs.

5.1 Inventories and Monitoring

The data used to set the initial establishment conditions for existing managed stands for the base case come from RESULTS data through silviculture surveys which are commonly more than 10 years old. As conditions in young stands often change rapidly before crown closure in terms of crop tree species composition, ages and heights, the older RESULTS data may no longer accurately reflect existing conditions. In addition, some of the older RESULTS data is not spatially linked and, therefore cannot be used to develop appropriate growth and yield assumptions.

Recommendation 1: Due to the importance of these stands for the late mid-term timber supply and the uncertainty associated with their current condition and development, support the development of a protocol for, and implementation of, "mid-rotation" surveys from which the data can be used to accurately and efficiently develop growth and yield assumptions. If possible, these surveys could include a timber quality assessment to help forecast future merchantability.

Recommendation 2: Promote the establishment of a permanent sample plot network (YSM) in the TSA as soon as possible.

Note that a network of YSM plots will be established in the Prince George TSA starting in the summer of 2014. An inventory audit will also be completed in the TSA in 2014.

5.2 Site Index

Site indices in the Prince George TSA are based on the BEC classification. The site index data is available from the MFLNRO as a provincial layer, which provides a site index estimate by species for a 100 m by 100 m grid throughout the TSA. Practicing foresters generally agree that the provincial site index data appear to represent broad site index averages in a reasonable manner. However, the distribution of the site index data is often disputed, as it contains generally little or no poor or very good sites. Localized site index studies are required to increase the reliability of site index estimates.

Recommendation 3: Conduct localized site index studies to increase confidence in site index estimates and make adjustments to the provincial site index layer where warranted.

5.3 Complete Additional Sensitivity Analysis

As there is expected to be pressure during the mid-term to harvest a significant component of managed stands below biological culmination age, it would be desirable to assess how this may impact timber supply and its quality. This investigation could facilitate new or modified mitigation responses.

Recommendation 4: Complete additional sensitivity analyses using different minimum harvest criteria and harvesting rules to better assess possible future outcomes. Stand level modeling for quality is integral part of this.

Recommendation 5: Given the importance of managed stands to the mid-term timber supply, complete additional sensitivity analysis relative to the growth and yield inputs for modelling the growth and yield *of existing managed stands. As part of this process, complete further assessments and analysis on damaged pine-leading existing stands.*

5.4 Implementation of Strategies

Despite the importance of enhanced reforestation strategies, which broadly include increased densities and species diversification to reduce the reliance on pine and to meet climate change mitigation challenges, it is unlikely that these types of treatments can be implemented without changes to policy. The provincial stocking standards will need to be revised and a new or revised funding mechanism developed.

Recommendation 6: Establish a task force to investigate how an enhanced reforestation strategy can be implemented. The task force should consist of like-minded adjacent management units.

Due to the potential importance of rehabilitation strategies to MPB mitigation and the potential magnitude of the areas available for treatment, there is a need to find efficient, cost effective solutions for program delivery.

Recommendation 7: Together with like-minded adjacent management units, establish a task force to investigate ways to implement large-scale rehabilitation programs (more ITSLs, variations of FLTCs; ways for major licensees to participate).

5.5 Quality Assessment of Different Managed Stand Regimes

Given the importance of minimum harvest criteria, including impacts on timber quality, mid-term timber supply and value recovery, it is important to increase our understanding of the linkage between yields, values and costs associated with different silviculture regimes (species mixes and densities).

Recommendation 8: Support the development of projects to assess managed stand values resulting from different harvesting/treatment regimes. Projects could include valuations of standing timber using industrial and government log grades and prices, and milling studies.

5.6 Prioritization of the Landbase as a Framework for Silviculture Investments

Given that funding for silviculture is expected to be limited, it is important to prioritize investments. Good to medium sites within reasonable distances from infrastructure will likely make up the core, managed timber harvesting landbase into the future.

Recommendation 9: Develop GIS-based prioritization of the three resource districts in the TSA relative to expected investment returns from silviculture (e.g.: zonation based on site index, haul distance and terrain and harvest constraints).

5.7 Access Management Planning

Maintenance of adequate access throughout the TSA is important for many reasons such as ensuring cost-effective fire fighting and silviculture treatments. Access management is also important for wildlife management and protection of other environment values.

Recommendation 10: Develop and maintain an access management plan for the TSA.

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