Williams Lake TSA – Type IV Silviculture Strategy

2012 Situational Analysis

Version 1.0

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Project 419-25

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List of Acronyms

AAC	Allowable Annual Cut
BEC	Biogeoclimatic Ecosystem Classification
CCLUP	Central Cariboo Land Use Plan
dbh	Diameter at Breast Height
FLNR	Ministry of Forests, Lands and Natural Resource Operations
MPB	Mountain Pine Beetle
RESULTS	Reporting Silviculture Updates and Land status Tracking System
TIPSY	Table Interpolation Program for Managed Stand Yields
TSA	Timber Supply Area
TSR	Timber Supply Review
VRIMS	Vegetation Resource Inventory Management System

1 Introduction

The British Columbia Ministry of Forests, Lands and Natural Resource Operations have initiated a Type IV Silviculture Strategy for the Williams Lake Timber Supply Area (TSA). The TSA is located in the Fraser Basin and Interior Plateau between the Coast Mountains on the west and the Cariboo Mountains on the east (Figure 1). The TSA includes the communities of Williams Lake, Alexis Creek and Horsefly. The Williams Lake TSA is administered by the Cariboo-Chilcotin District.

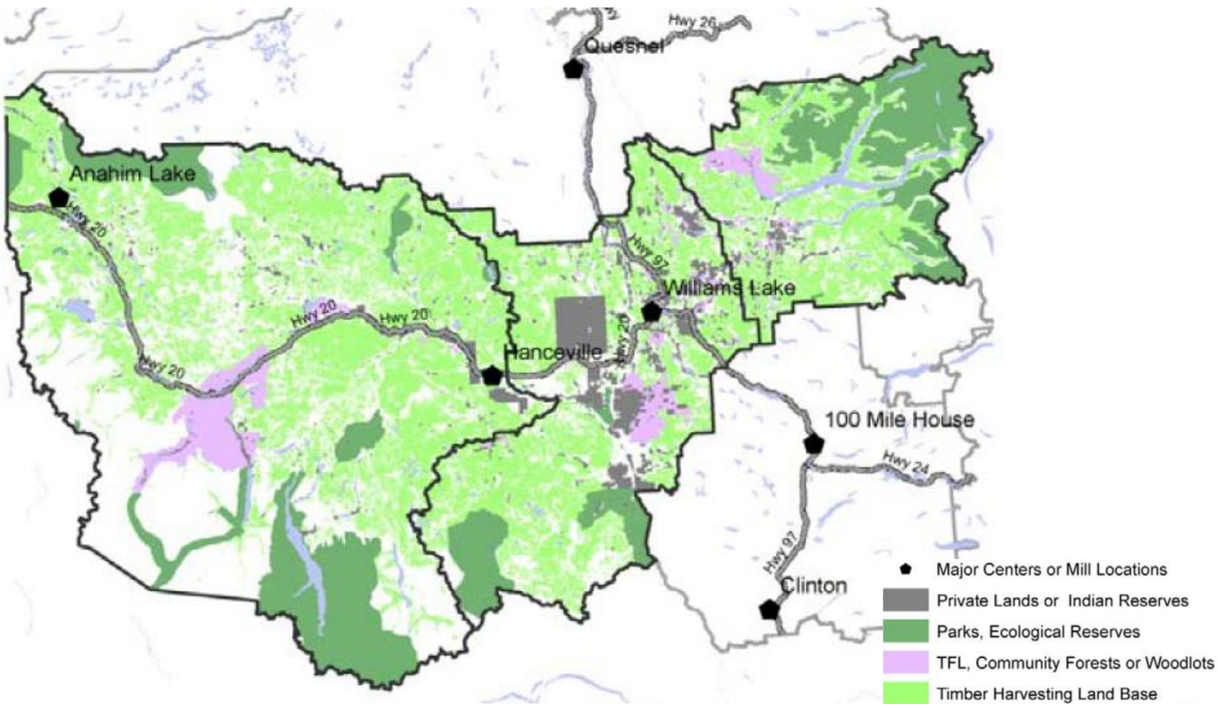


Figure 1: Map of the Williams Lake Timber Supply Area (TSA) in the Central Interior of B.C.

The TSA covers approximately 4.87 million hectares, of which about 58 percent is considered productive Crown forest (excludes First Nations reserves, private lands, non-forest, woodlots, and community forests). The productive Crown forest area consists of 69% working forest (~2 million ha of THLB) with the balance of that area set aside for parks, biodiversity, fish or wildlife or because the site is too poor to grow trees economically. Lodgepole pine comprises about 61 percent of the total mature volume on the Timber Harvesting Land Base in this TSA.

The Cariboo-Chilcotin Land Use Plan (CCLUP) is a legal higher level plan covering 100 Mile House, Quesnel and Williams Lake timber supply areas. The CCLUP was established by cabinet as a legal higher level plan under the Forest Practices Code in January 1996. Extensive planning was then done at the sub-regional level to further refine and map many of the land uses in consultation with industry, interest groups and some First Nations. Legal objectives were established for 13 values under the Land Use Objectives Regulation (June 2010) and nine species under the Government Actions Regulation (various dates). Many of the land use designations overlap to reduce impacts on timber availability (e.g. an old growth management area may also be a visual management area).

Previous silviculture strategies for the TSA (2006, 2009) indicate that the general silviculture strategy for the Williams Lake TSA is to reforest MPB impacted stands, fertilize thrifty Douglas-fir/spruce, and thin/fertilize repressed lodgepole pine stands to improve mid-term timber supply, while mitigating habitat supply impacts associated with the MPB epidemic and restoring the structure and health of dry-belt Douglas-fir ecosystems. Now that the MPB has effectively run its course in the TSA, **this Type 4 silviculture strategy aims to develop updated TSA objectives and strategic guidance on harvesting and basic / incremental silviculture - resulting in a tactical plan to support implementation. It will also be used to guide allocation of Land Base Investment Strategy (LBIS) resources.**

1.1 Context

This document is the first of four documents that make up a Type IV Silviculture Strategy. The complete package of the documents includes:

1. **Situational Analysis** – describes in general terms the situation for the unit.
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 recommended treatments, associated targets, timeframes and benefits.

2 AAC and Harvest Performance

During the period 2001 to 2010, the average harvest was 3.4 million cubic metres per year. Of that volume, about 74 percent was pine indicating excellent licensee and British Columbia Timber Sales response to harvesting beetle damaged pine stands on the land base unconstrained by non-timber values.

For the past 30 years, the AAC for the TSA has been dynamic. Table 1 shows how the AAC has reflected several MPB outbreaks, establishment of partition cuts, including MPB salvage, specific supply blocks, deciduous stands and problem forest types (PFT). The current AAC of 5,770,000 cubic metres per year remains in effect until a new AAC is determined (currently underway and expected by 2014). The 2007 AAC rationale states that this harvest level "is predicated on directing the entire AAC at stands with at least 70 percent pine that are located west of the Fraser River."

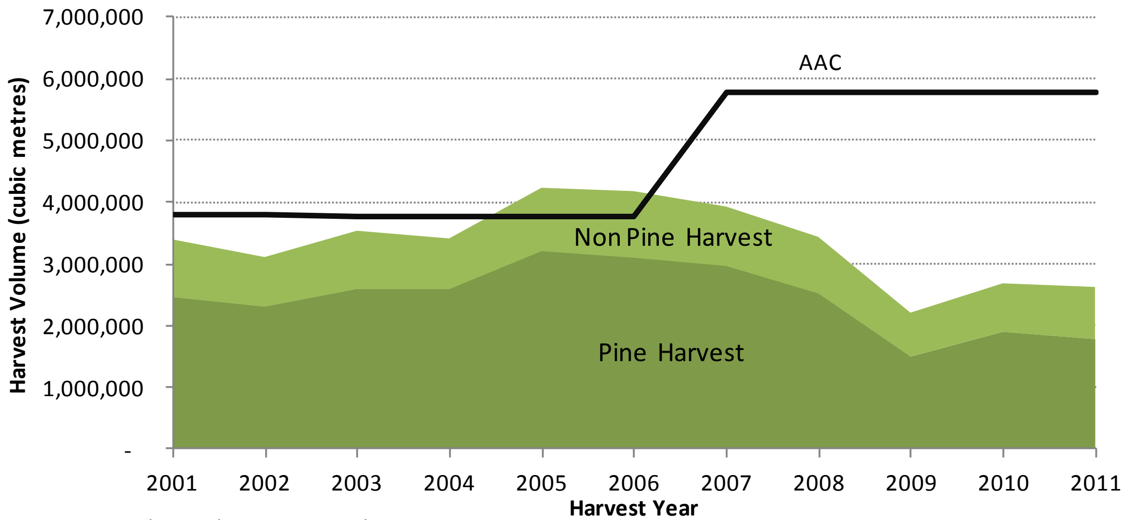
Table 1 Historical and current AAC

Determination	1981	1985	1989	1992	1996	2003	2007
AAC (000,000m^3)	2.500	3.750	4.093	3.975	3.807	3.768	5.77
Partitions	n/a	MPB	MPB, WSB	MPB, Dec	WSB, PFT	MPB; WSB; PFT	WSB, PFT

Figure 2 shows the volume of timber harvested over the past ten years (2001 to 2011) and indicates that recent harvest levels have fallen relative to historic levels, while the pine volume proportion has remained relatively consistent (~73%). A simple assessment conducted in this project suggests that between 2007 and 2011, approximately 56% [1] of the harvested area occurred west of the Fraser River

[1] Summarized by examining FTA Forest Tenure Cut Block polygons in June 2012.

(68% in 2011). In general, current harvest levels are well below the AAC and focused significantly, but not exclusively, in the west.



Source: Forest Analysis and Inventory Branch

Figure 2 Historic Harvest Volumes for the Williams Lake TSA

Table 2 shows the current AAC apportionment for the Williams Lake TSA, including partitions for problem forest types (PFTs) and western supply blocks. A significant portion of the AAC remains unallocated.

Table 2 Current AAC apportionment

Forest License Type	Conventional AAC (m^3/yr)	PFT Partition [(1)] AAC (m^3/yr)	W Partition [(2)] AAC (m^3/yr)	Total AAC (m^3/yr)	%
Forest Licensees – Replaceable	1,702,190			1,702,190	29.5
Forest Licensees – Non-Replaceable	2,197,681		420,000	2,617,681	45.4
BCTS Forest Licence Non-Replaceable	30,000			30,000	0.5
BCTS Timber Sale – Licence/Licence to Cut	1,018,129			1,018,129	17.7
Pulpwood Agreement TSL		107,000		107,000	1.9
Community Forest Agreement	20,000		25,000	45,000	0.8
Forest Service Reserve	60,000		5,000	65,000	1.1
FS Reserve – Small Scale Salvage Program	185,000			185,000	3.2
Total	**5,213,000**	**107,000**	**450,000**	**5,770,000**	**100%**

(1) Partition for problem forest types
(2) Partition for western supply blocks (unallocated)

Table 3 shows the current AAC allocations as approximately 2/3rds of the current AAC.

Table 3 Current AAC commitments

AAC Type	Licensee	Volume (m³)	Totals
Conventional	ALEXIS CREEK FIRST NATION	31,200	
	AMABILIS CONTRACTING LTD.	20,000	
	AMABILIS.; MAHECA ; CHICHELEAN	100,000	
	ESKETEMC FIRST NATION	25,000	
	JOHNSON, ALVIN	2,058	
	LINDE BROS. LUMBER LTD	8,702	
	PIONEER BIOMASS INC	50,000	
	TOLKO INDUSTRIES LTD.	1,042,968	
	TOOSEY FIRST NATION	14,200	
	WEST FRASER MILLS LTD.	659,222	
	WILLIAMS LAKE	45,000	
	XAT'SULL GENERAL PARTNER LTD.	33,026	
	BCTS	1,048,129	3,079,505
Western Supply Blocks	690361 B. C. LTD.	140,000	
	PIONEER BIOMASS INC	60,000	
	TSI DEL DEL ENTERPRISES LTD.	60,000	260,000
Problem Forest Types	AINSWORTH LUMBER CO. LTD.	107,000	107,000
Non-AAC Lump Sum	PIONEER BIOMASS INC	100,000	
	RENEW RESOURCES INC.	60,000	
	TOLKO INDUSTRIES LTD.	250,000	410,000
	Grand Totals	**3,856,505**	3,856,505

3 Timber Supply Situation

The current Land Based Investment Strategy (BC FLNR, 2009) lists the working targets for timber supply as:

- Short term (1-5 years) – maintain uplift required to salvage MPB impacted stands (5,770,000 m^3/yr)
- Mid-term (6-65) – minimize depth and duration of the mid-term trough
- Long-term (66-255 years) – harvest at or near the productive capacity of the land base

The major silviculture strategies suggested to address these working targets include:

1. Planting MPB impacted stands;
2. Late rotation fertilization of eligible stands; and
3. Spacing/fertilization of repressed pine stands.

3.1 Timber Supply Review (TSR)

A government led TSR process is underway in the TSA and a data package is currently being prepared.

The previous TSR (2006/2007) focused on the short-term timber supply and mid-term risk given the impacts of the beetle epidemic (i.e. 50 yr horizon). The analysis highlighted several key points:

- If the MPB epidemic continued unabated, it was projected to kill almost 100 million cubic metres on the timber harvesting land base and almost all of the pine damage is projected to be in stands with at least 70% pine content. (Reality has shown lower levels of impact)

- Most of the pine volume projected to be lost occurred west of the Fraser River and harvesting would be unable to salvage all of the pine volume that was projected to be lost.
- The recommended course to preserve the mid-term harvest level (assuming no other forest health issues) was to harvest in stands with at least 70% pine and preserve harvest opportunities in other stand types east of the Fraser River.
- Harvest levels were anticipated to decrease significantly after 20 yrs (by 2024).
- Harvest scheduling (timing / targeting of specific stand types) has a profound effect on the volume available in the midterm and the magnitude of area that goes unsalvaged.

3.2 Other Available Harvest Forecasts

A Type 2 Silviculture Analysis (Timberline, 2008) forecast a TSA base case (see Figure 3) with an initial salvage harvest (5.7 million m^3/yr) that then needed to drop in 10 years to a midterm low of 1.2 million m^3/yr and then rise to a long term flow of 4.5 million m^3/yr. The final strategy, spending $10 million/yr over a 10 yr period, involved the planting of 4,209 ha of MPB impacted stands (67% of cost), spacing/fertilizing 1,973 ha of repressed Pl stands (24% of cost), and fertilizing 1,997 ha of Sx and Fd stands (9% of cost). This scenario had a lower initial harvest than the base case (4 million m^3/yr) and improved the midterm significantly to 2-2.5 million m^3/yr. This midterm gain is likely attributed to both the reduced initial harvest level and the silviculture treatments.

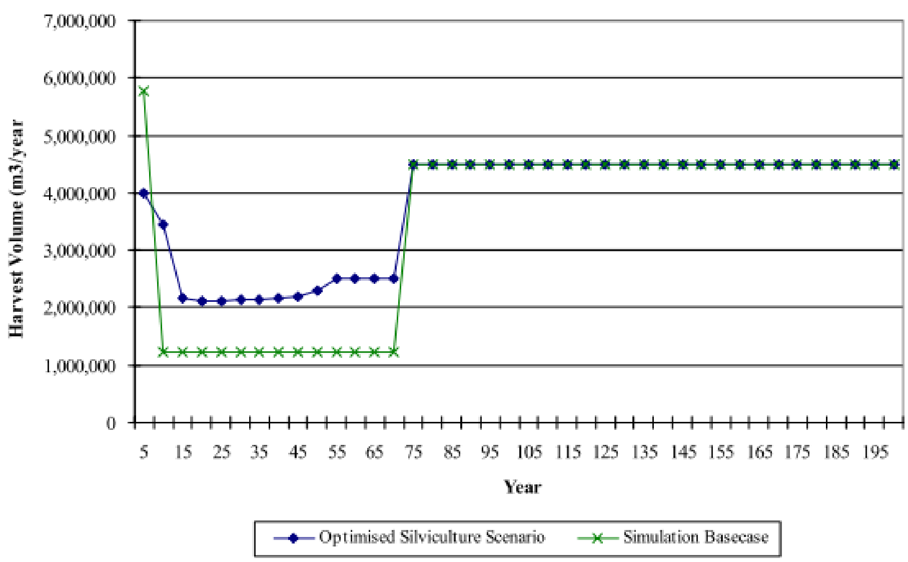
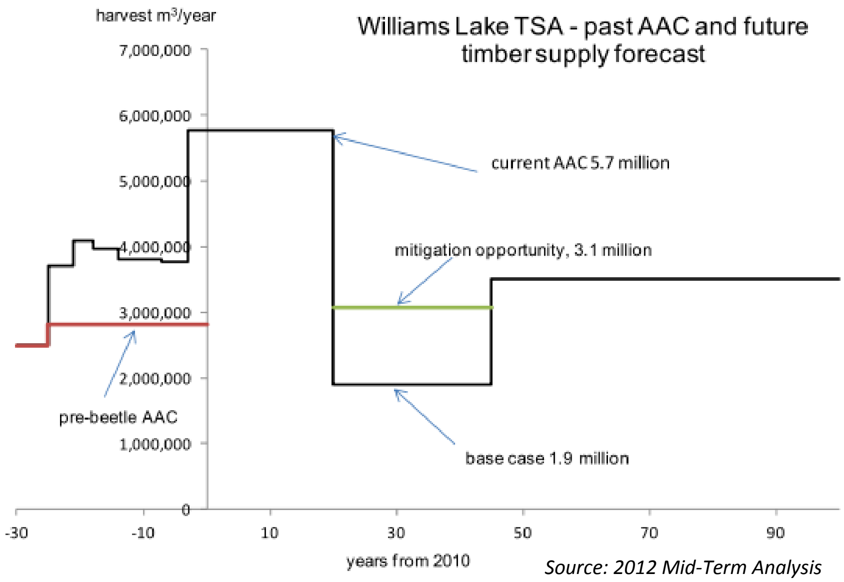


Figure 3 2008 Type 2 Silviculture Analysis - Base Case and Optimized Silviculture Harvest Level ($10 million/yr)

In November 2011, the BC government completed a Midterm Timber Supply analysis that showed a baseline forecast starting at 5.7 million m^3/yr for 20 years, followed by a midterm trough at 1.9 million m^3/yr for 25 years and a long term harvest level of 3.5 million m^3/yr (Figure 4). Relative to the 2008 Type 2, this forecast shows a stronger short and midterm but a lower long term level[2]. This midterm forecast is approximately 900,000 m^3/yr lower than the pre-beetle AAC (Figure 4), but the report also

[2] Likely linked to different estimates of managed stand yields (site index adjustment).

indicated that the midterm harvest level could be very similar to the pre-beetle AAC if modeling did not include a somewhat arbitrary control on growing stock[3].



Source: 2012 Mid-Term Analysis

Figure 4 Baseline or Reference Harvest Forecast from the 2011 Mid-Term Timber Supply Project

Thus, the analysis suggests:

1. There is little to no midterm trough to fill relative to the pre-beetle AAC, however:
    a. Achieving the forecasted 20 yrs of salvage in the short term is unlikely unless lumber markets improve to offset falling wood quality and higher access costs. Limited consideration was given to current economic conditions (no limits on haul distances, marginal stand conditions/volumes, etc). When some of these issues were explored, the short term harvest levels fell substantially to levels not unlike current harvest levels, but midterm levels remained relatively consistent.
    b. The TSA will enter the midterm trough when it is no longer able to focus salvage efforts into impacted pine stands.
    c. Harvest of any non-pine stands in the short term will result in lower midterm harvest levels.
2. The mitigation opportunity (Figure 4) scenario suggests it is possible to increase mid-term timber supply from 1.9 to 3.1 million m^3/yr by harvesting:
    i. Stands earlier when they have lower volumes (65 m^3/ha for pine-leading stands and 120 m^3/ha for other stands) – (leading to a lower long term growing stock.
    ii. OGMA's that do not overlap with other non timber values.
    iii. Half of the area on slopes > 40%. (e.g. cable logging ground)

In general, the speed at which managed stands can be brought online has a significant impact on the size and depth of the mid-term trough. Ultimately, the mid-term harvest level depends on the economic availability of timber supply and on the extent of young pine mortality. Accessing second growth stands earlier is likely to have the largest single benefit to timber supply if it proves to be economically realistic.

[3] Once a somewhat arbitrary long term growing constraint was removed from the modeling. (pg 10, Williams Lake Technical Working Group Final Report, November 28, 2011). The scenario where this constraint was dropped was thought to "more accurately reflect operational practice".

There are numerous other opportunities to mitigate midterm timber supply that require further exploration in this Type 4 analysis (e.g. incremental silviculture treatments).

3.3 Timber Supply Issues

There are many complex issues affecting timber supply in the Williams Lake TSA. The following sections identify, in no particular order, key issues that should be considered for this silviculture analysis.

3.3.1 Mountain Pine Beetle Impacts

3.3.1.1 MPB projections

The unprecedented MPB infestation is the dominant factor affecting forest management in the Williams Lake TSA. Since the start of the epidemic, over 86,000,000 m³ or 60% of pine volume has been killed by the MPB (see Figure 5). Projections suggest up to 61% will ultimately be killed by 2024.

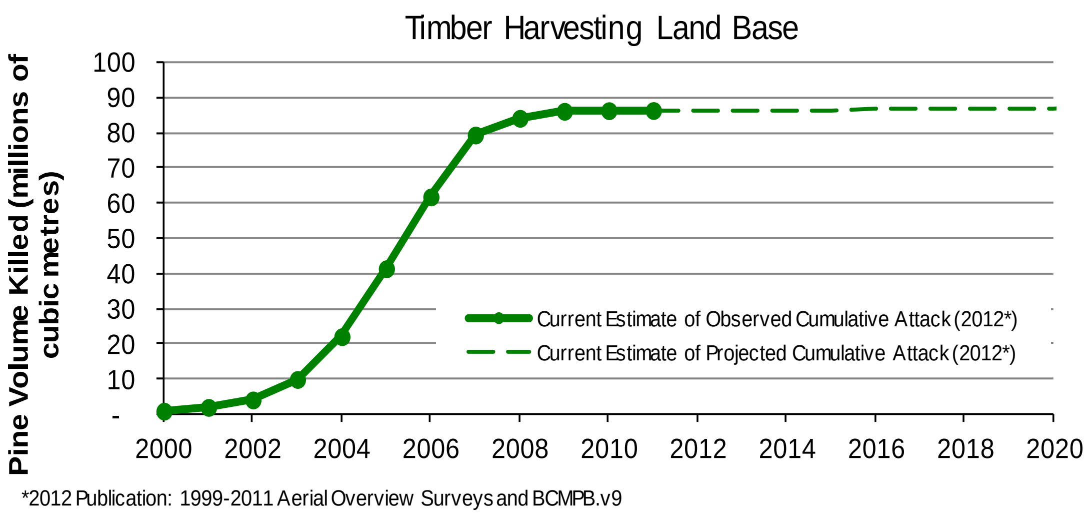


Figure 5 Cumulative volume killed – observed and projected

Figure 6 shows that starting in 1999 the MPB epidemic reached its peak in 2006, rapidly declined to zero in 2011 and is projected to remain very low in the foreseeable future.

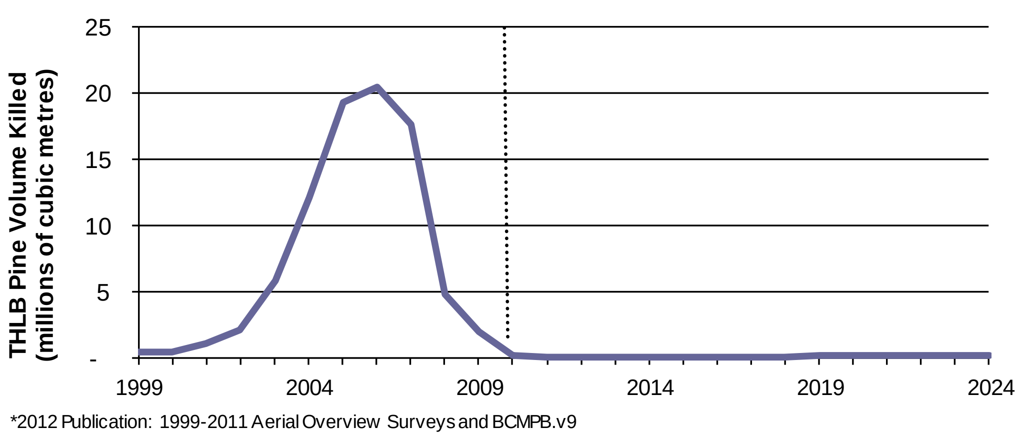


Figure 6 Volume of Pine volume killed

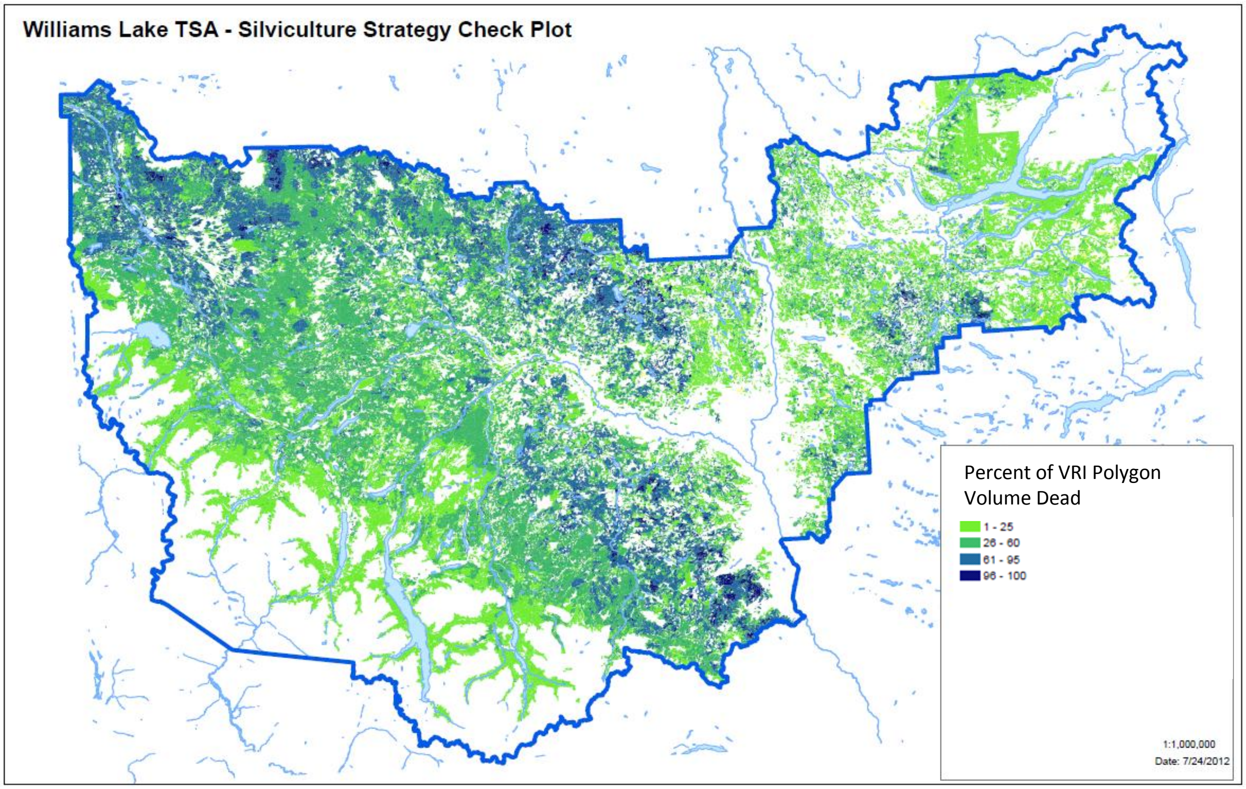


Figure 7 Percentage dead by stand as indicated in the 2012 VRI file

3.3.1.2 Criteria for shelf life

Shelf life is the time a tree/stand will remain economically viable to harvest. Typically, this begins the year that a stand is greater than 50% affected by MPB.

The definition of shelf-life has changed. In 2006 it was considered to be 5, 8 or 14 year depending on Biogeoclimatic subzone. The most recent analysis (2011), however, assumed a 20 year shelf-life. The Enhanced Type 2 Silviculture Analysis (Timberline, 2008) assumed pulpwood would continue to be available out to 38 years.

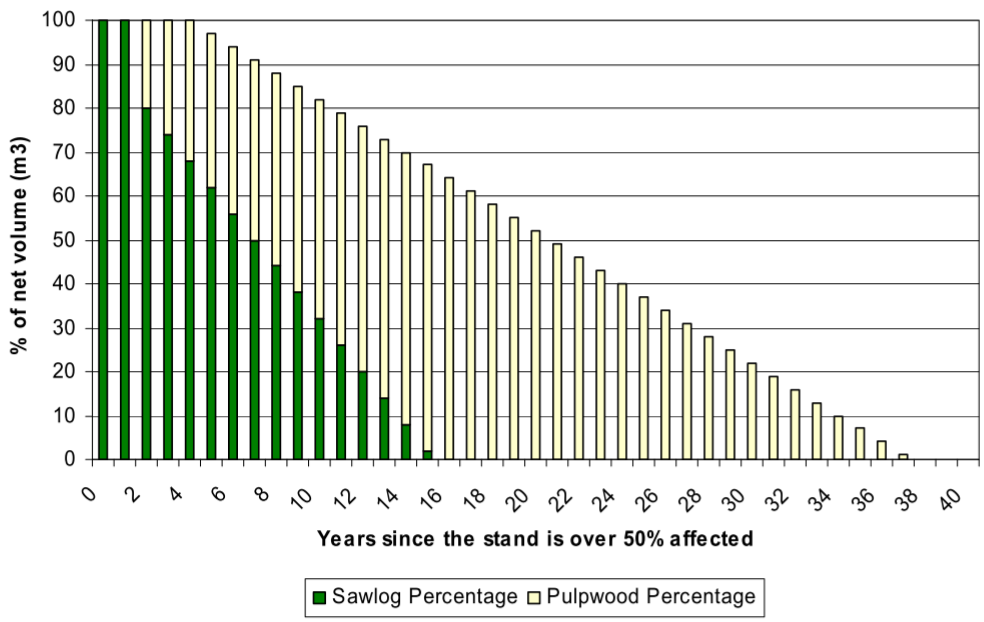


Figure 8. Shelf life criteria used in 2008 Type 2 Analysis for sawlogs and pulpwood/biomass

3.3.1.3 MPB attack on young stands

As optimal habitat decreased, the MPB and their associated secondary beetles (particularly *Ips spp*) have attacked stands as young as 20 to 35 years. These stands are obviously important to the mid-term timber supply and their mortality creates a downward pressure on timber supply where mortality occurs (BC FLNR, 2007). Stands with little or no natural regeneration will require some form of intervention to remove existing stems and promote regeneration by other means, if we expect those stands to contribute to the timber supply. A study published in 2009 by Lorraine Maclauchlan (MFLNRO) shows the impact on young pine stands (Table 4).

Table 4: Mortality of pine in young stands, from MacLauchlan (2009).

	Percent stands w MPB attack		Ave. % attack in attacked stands	
Age	2007	2008	2007	2008
Central Cariboo				
20-25	80.0%	87.9%	20.5	24.7
26-30	91.1%	95.7%	32.2	38.2
31-40	95.7%	100.0%	38.4	40.0
41-50	100.0%	100.0%	34.9	42.1
51-55	100.0%	100.0%	47	38.0

Assuming little has changed since 2008, the trends indicate that 95-100% of stands>25 yrs were ~40% impacted (39% net), while 88% of stands 20-35 yrs were 25% impacted (22% net). Will this result in yield reductions from typical managed stand trajectories?

3.3.1.4 Regeneration in unsalvaged MPB stands

Salvage operations will recover as much MPB impacted wood as possible before it becomes economically unavailable, but 25-40% of MPB-attacked stands may remain unsalvaged (Reference?a0. According to Coates et al. (2006), 20-30% of these stands may have sufficient secondary stand structure to contribute to the mid-term timber supply even if the dead pine is not removed. Plus, some additional percentage of these stands can provide future timber without any further management intervention because of successful natural regeneration.

It will be important to understand the secondary structure present within different ecosystems and the probability of natural regeneration occurring post MPB attack. These stands will be quite different from managed forests or those originating from other types of disturbance (fire).

3.3.1.5 Pressures on non-pine leading stands

Because of the losses expected in MPB-attacked stands and the current concentration of harvest in pine stands, the mid-term period will focus harvesting onto stands with other species. Significant pressure will be placed on these green stands from both a timber supply and non-timber values perspective.

3.3.1.6 Age class distribution

Considering the magnitude of area affected by the MPB across the spectrum of age classes, we can expect a large shift of future stands into a narrow age class range. Once mature, these stands will become available for harvest again in a common period. It will be necessary to find ways to break up this age class cohort and find ways to minimize the risk of future MPB outbreaks as we try to hold a portion of these stands on the landbase for extended rotations.

Figure 9. Age Class Distribution from 2008 Type 2 Analysis (reflects MPB kill)

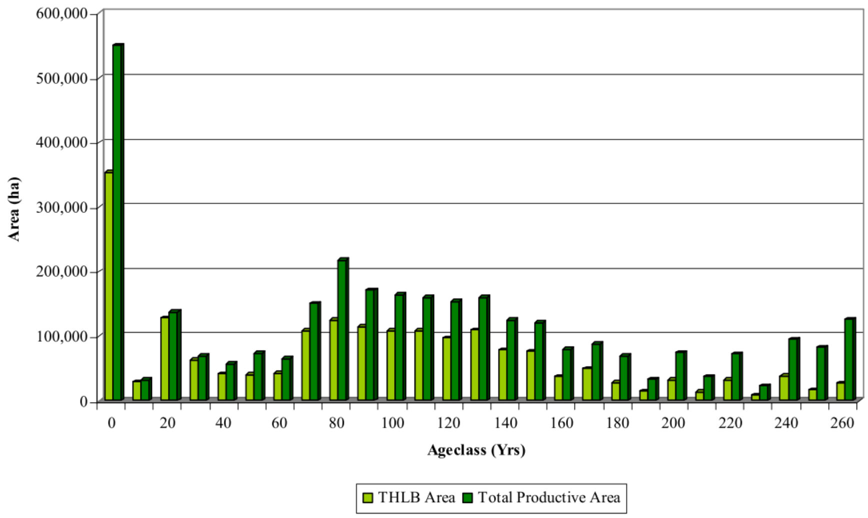


Figure 10. Age class distribution from the 2008 Type 2 Silviculture Analysis (reflects MPB mortality)

3.3.2 Changes to the forest inventory

The current forest inventory data of the Williams Lake TSA is comprised of a series of projects (Figure 11) spanning the last fifty years. Most of the TSA east of the Fraser River has been updated to the current Vegetation Resources Inventory (VRI) standard. Conversely, west of the Fraser River, the vast majority of the TSA is based on older inventories rolled-over from the previous Forest Inventory Planning (FIP/FC1) standard – with the notable exception of a large area near Alexis Creek that was part of the Lignum VRI project.

3.3.2.1 Inventory audits

Prior to any new VRI projects, an inventory audit was completed in 1998, which installed 124 samples in mature stands. The objective was to assess the overall accuracy of the inventory in place at that time. The results of the audit showed that ground sample volume was 13% less than the inventory file volume. The final report suggested that the mature forested component of the inventory was statistically acceptable. Portions of the sampled area now have new VRI mapping.

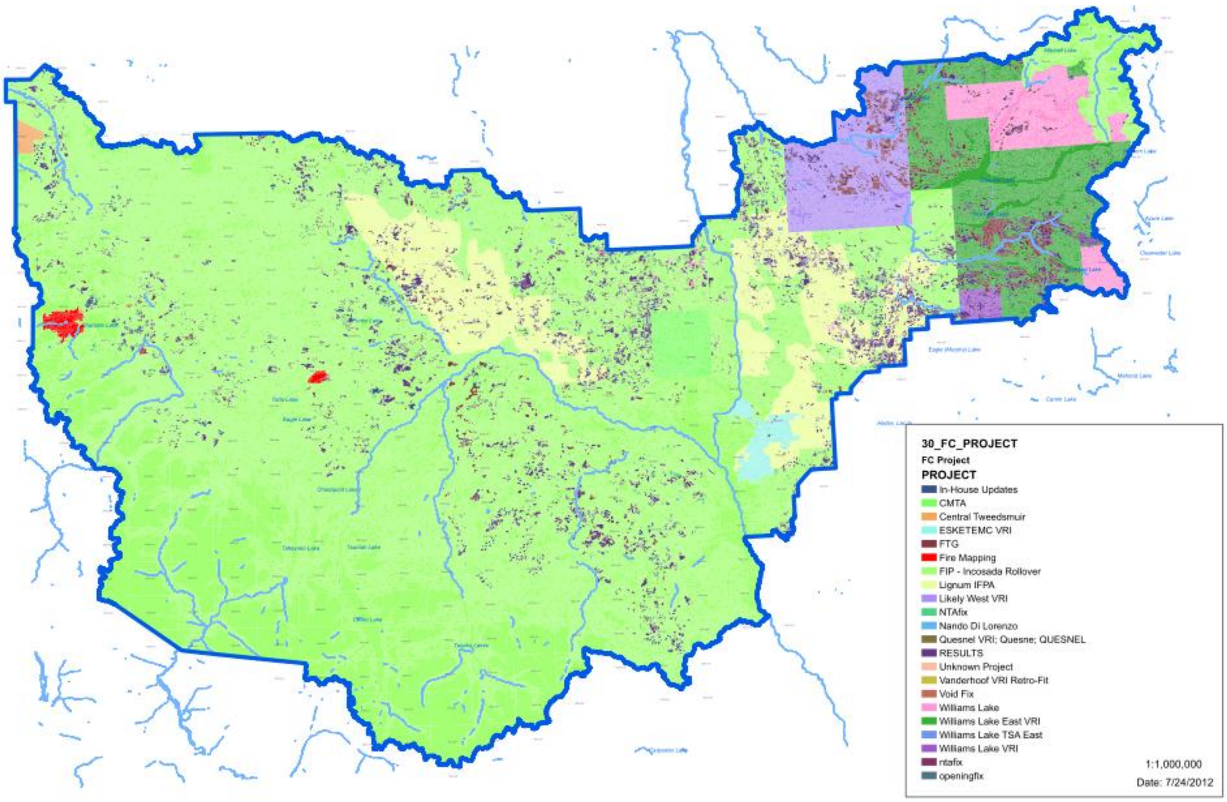


Figure 11: Inventory projects of the Williams Lake Timber Supply Area.

3.3.2.2 Volume adjustments

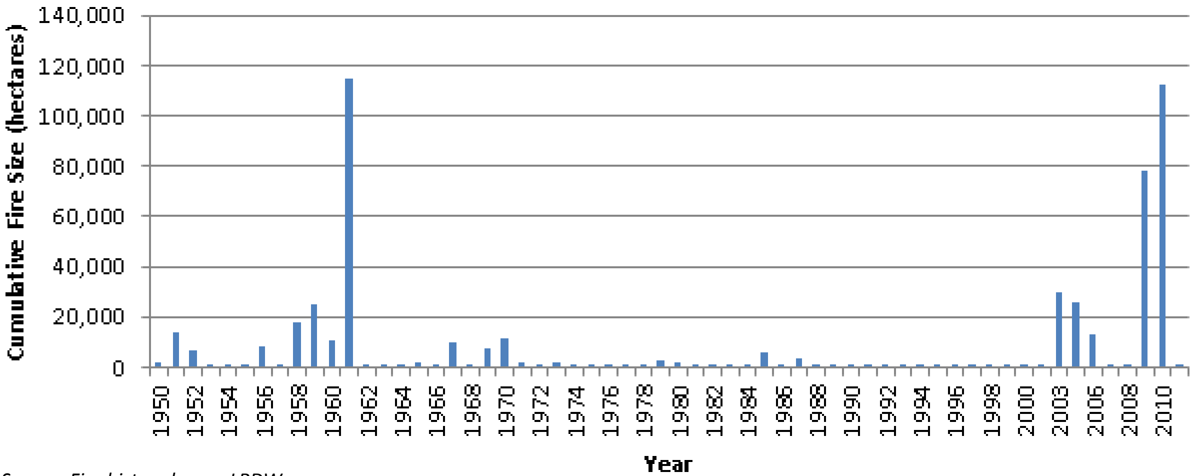
Two VRI ground sampling and adjustment projects were undertaken in the Williams Lake TSA. The Williams Lake VRI program (excluding Lignum VRI) established 333 sample plots that were grouped into 8 primary strata. Subsequent analysis applied the Fraser Protocol for adjustments. This showed that for the population defined as vegetated-treed, non-Lignum, and greater than 30 years of age, inventory volumes were underestimated by 14% overall. Through their Innovative Forest Practices Agreement, Lignum (now Tolko) established 372 VRI ground samples in both the Williams Lake and 100 Mile TSAs. The Boston Bar protocol for undertaking volume adjustments (now non-standard) was applied and showed that for all stands in their IFPA, the inventory was overestimated by 6.6% at a 4 cm utilization level. The adjustment report could not provide results at the typical 12.5 cm utilization level.

3.3.2.3 Inventory updates

The Vegetation Resource Inventory Management System (VRIMS) is used to update the Provincial Forest Inventory. In this process, new harvest and free-growing data are extracted from the Reporting Silviculture Updates and Land status Tracking System (RESULTS), verified and integrated into the VRI. Based on a cursory examination of air photo images available for the Williams Lake TSA, it appears that many harvested blocks and/or free-growing information are not yet reflected in the inventory.

The 2011 update to the Provincial Forest Cover incorporates changes to account for MPB losses. For inventories captured before MPB, stand density and volume estimates were prorated based on the BCMPB Model (cumkill2010) and a Year of Death data layer. Volumes for inventories captured after MPB, were reduced based on the live and dead stem densities captured.

Earlier wildfires are typically incorporated in the forest inventory through past update processes, however recent fires, such as Chilko (~65,000 hectares) and Lava Canyon (~70,000 hectares), have yet to be reflected in the inventory projected to 2011 (planned for incorporation in this project). Figure 12 shows the wildfire history within the Williams Lake TSA.



Source: Fire history layer - LRDW

Figure 12 Wildfire history in the Williams Lake TSA

3.3.2.4 Plans for inventory projects

Two inventory projects will be undertaken in 2012: 1) VRI Phase 1 (photo-estimation) inventory will be completed for the eastern portion of the TSA, and 2) Landscape Vegetation Inventory (LVI) will commence for the western part. Plans for future inventory projects include additional ground sampling in 2012 and an inventory audit analysis in 2014-15.

3.3.3 Considering the CCLUP

The Mid-Term Analysis (BC FLNR 2011) described issues associated with the Cariboo-Chilcotin Land Use Plan (CCLUP). Apart from Forest and Range Practices Act requirements, land use values in the Williams Lake TSA are derived from the CCLUP. The CCLUP was established as a higher level plan through a legal order under the Forest Practices Code in January 1996, making the CCLUP zones, objectives, targets and strategies legal requirements applicable to operational forestry planning. Since then, extensive planning was done at the sub-regional level to produce Sustainable Resource Management Plans that further refined and mapped the various land use values in consultation with interest groups and First Nations. The CCLUP remains in force under the Forest and Range Practices Act and has been supplemented by numerous legal objectives for tourism, recreation, and conservation (fish, wildlife and biodiversity) under the Land Use Objectives Regulation and the Government Actions Regulation.

The land use plan resulted in a compromise between timber and non-timber values. Biodiversity targets for retention of old and mature forest worked to reduce the AAC but were also only a portion of the estimated old and mature forest that would exist naturally on the land prior to industrial development. MPB has affected the forest condition in pine stands for both the constrained and unconstrained land base. Impacts to non-timber values from MPB vary by stand type, understory condition and mortality level. Nevertheless, ecological values still exist, including residual green trees, intact understory soils and shrubs, snags and coarse woody debris. For conservation values like biodiversity and some wildlife species, retention of original stands, including dead trees can be especially important in a landscape that is increasingly moving towards greater fibre utilization and a more managed forest estate.

3.3.4 Establishing a minimum harvestable volume

In the last TSR (BCMFR, 2007), all scenarios assumed a stand could be harvested if it achieved at least 65 cubic metres per hectare (100% ground based logging in THLB).

In preparation for the upcoming TSR (BC FLNR, Draft 2012b), Barry Snowdon mined the Electronic Commerce Appraisal System for harvest volumes for the years from 1997 to 2009. The results are shown in Table 5 and demonstrate that in the years 1997 to 2009, only 10% of the pine leading stands harvested were <= 87 cubic metres per hectare (90% were had greater m^3/ha), while all Douglas-fir leading stands had at least 102 m^3/ha (90% were > 200m^3/ha).

Table 5 Harvest volume (m^3)/ha in Williams Lake TSA

Timber mark	Harvest volume (m^3/ha) by percentile										
	0%	1%	5%	10%	25%	50%	75%	90%	95%	99%	100%
Pine leading	46	49	73	87	115	168	223	295	342	409	536
Doug Fir leading	102	102	130	200	266	325	353	399	445	465	465
Other leading	60	123	228	248	302	334	375	448	474	538	558
Overall	46	52	79	88	119	177	247	332	360	447	558

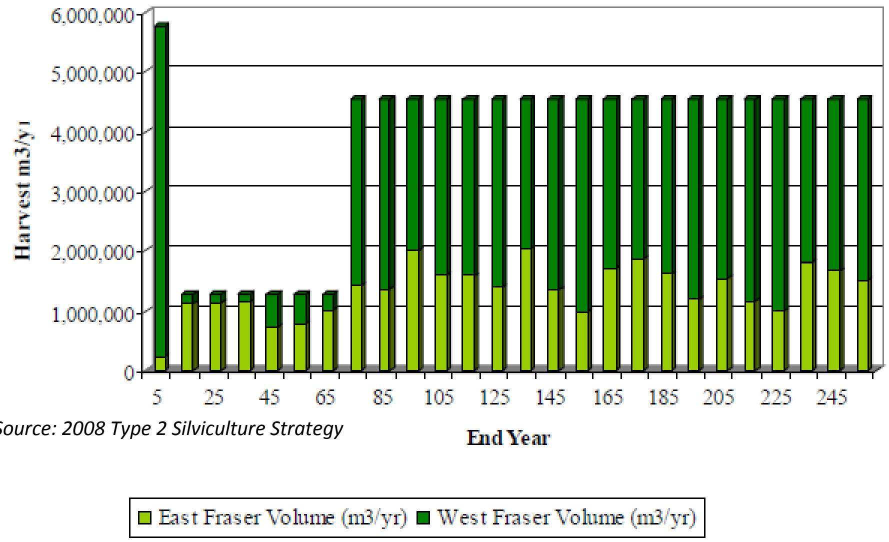
In the ongoing TSR process, the minimum harvest volume will likely be set at 80 cubic metres per hectare for pine leading stands and 120 cubic metres per hectare for non-pine leading stands.

3.3.5 Capacity to harvest the AAC in the short term

Table 3 in section 2 shows the current AAC commitment is approximately 2/3rd of the current AAC for the Williams Lake TSA. This is not surprising since Kreise (2012) showed the current 2-shift mill capacity for the Williams Lake TSA is 3.5 million cubic metres, or 60% of the current AAC (although imports from other TSA's also occur). Under ideal market conditions, the 3-shift mill capacity is 5.2 million cubic metres, or 90% of the current AAC. It is unlikely that mill capacity will limit the MPB-attacked stands that be salvaged. This issue will be driven by economics / market conditions.

3.3.6 Harvest by East and West of the Fraser River

The 2008 Enhanced Type 2 Silviculture Analysis showed that 96% of the harvest in the first 5 years would come from west of the Fraser River, then an average of 77% of the harvest through the mid-term would come from east of the Fraser River. In the long term, this split would fluctuate around 33% east and 66% west. A key element of the last AAC rationale was that harvesting would be almost exclusively located in the west until the falldown to the midterm harvest level.



Source: 2008 Type 2 Silviculture Strategy

Figure 13 Harvest Flow from East and West of the Fraser River

3.3.7 Distance to extended land base (time cycles)

The Mid-Term Timber Supply Project (BC FLNR, 2011) divided the TSA into haul distance zones based on cycle times from the main processing facilities in the region. One scenario focused on the timber supply closest to Williams Lake and removed the land base with cycle times greater than 9 hours. This scenario reduced the base case harvest forecast by 45%, 11% and 31% in the short-, mid- and long-terms, respectively. The model run highlighted that: 1) a large component of the growing stock exists beyond 9 hours from Williams Lake, and 2) non-pine contributions to the mid-term were not affected much by the removed land base. Mills in the western portion of the TSA can help to address these concerns but are limited in the volume they can process.

3.3.8 Criteria for steep slopes

The Mid-Term Timber Supply Project (BC FLNR, 2011) identified that 24,044 hectares, or 4,265,082 m^3 has been taken out of the timber harvesting land base in the last TSR to account for areas of steep slope (>40%). Licensees argue that half of this volume should actually be made available for mid-term harvest opportunities, which would contribute up to 2.1 million cubic metres to the mid-term harvest level. Table 6 describes the slope criteria used to define operable stands in the 2008 Silviculture Strategy analysis.

Table 6 Slope Criteria for Defining Operability

Location	Slopes Excluded
East of the Fraser river	greater than 70%
East of the Fraser river and not achieving 200 m3/ha by 160 years	between 40% and 70%
West of the Fraser river	greater than 40%

3.3.9 Past partitions: MPB; Western Supply Block; and problem forest types

Table 2 in section 2 shows the current AAC apportionment for the Williams Lake TSA, including partitions for problem forest types (Pulpwood License) and the western supply blocks (450,000 m^3/yr).

The problem forest type partition was first set in 1996 and targeted certain stand types, including deciduous, in the Pulpwood Agreement 16 area located in the eastern portion of the TSA and the Moffat

(29K) and Upper Horsefly (29M) Timber Supply Blocks. Specific stand types are described in the TSR 2 analysis report (BC MoF, 2001).

An AAC partition in the three western supply blocks (Anahim -29A, Tatla- 29C, and Chilcotin - 29D) was also maintained in the last determination (BC MFL, 2007).

3.3.10 Uneven-Aged Management in Dry-Belt Fir

For decades, Douglas-fir stands in the dry-belt of the TSA have been logged by some form of partial cutting and restocked by natural regeneration, but there is still little reliable information on regeneration rates and the effects of different amounts of residual stocking. These dry-belt stands have good timber values, are typically close to mills, and have good access. If managed well, these stands can provide opportunities for regular harvest entries approximately every 20 to 50 years. At the same time, many stands are important winter habitat for mule deer providing forage, thermal cover, security cover, and snow interception cover, and particular direction on mule deer winter range management has been provided under the Government Actions Regulation.

There are approximately 400,000 hectares of Douglas-fir leading stands greater than 50 years in age within the dry-belt (IDF) region of the Williams Lake TSA. The weighted average inventory site index for these stands is 12 metres growing at an estimated 1.02 m^3/ha/yr (as per last TSR). There is opportunity to improve site quality estimation, since site index (height at age 50) is a poor estimator of growth. The modeling of these stands could be improved through the use of Prognosis in combination with stand structure classification. Thinning treatments aimed at reducing dense thickets of layer 2 and 3 have been shown to improve the productivity of these stands.

Given the significant area of Dry-belt fir in this TSA and its traditionally low contribution to the AAC, it is worthwhile to develop a strategy specific to this area.

3.3.11 Protecting Secondary Structure

Section 43.1 of the Forest and Range Practices Act Forest Planning and Practices Regulation requires forest licensees to protect secondary structure (understory advanced regeneration and non-pine canopy trees) in MPB affected areas.

Considerable variation in secondary stand structure exists among different lodgepole pine stands. In their recent study to determine the proportion of Biogeoclimatic Ecosystem Classification (BEC) units considered to be in poor condition and hence likely to recover slowly from a timber supply perspective, Coates and Sachs (2012) reached the following conclusions for pine leading stands:

- Generalizations about secondary structure abundance based solely on pre-beetle dominance are too crude since understory, sub-canopy and canopy secondary structure post-beetle can vary widely at any level of pine dominance.
- ESSF and ICH zones pose few problems for recovery while MPB-impacted stands in the SBS zone pose the greatest risk.

Based on 3,823 plots examined, Coates and Sachs (2012) further predicted the natural recovery of pine leading stands, as shown in Table 7.

Table 7 Predicted Natural Recovery of Pine-Leading Stands by BEC

BEC Unit	Suggested % range of predicted natural recovery (1)
SBS	58-68
MS	76-86
SBPS	78-88

IDF	75-85
ESSF	92-100
ICH	90-100
BWBS	80-100
Total	70-80

+/- 5% tolerance used around calculated means except for ICH and BWBS where +/-10% used given low # of plots

To our knowledge, a process for identifying, protecting and tracking potential or actual stands retained for secondary structure retention does not currently exist within the Williams Lake TSA.

- *District Action: Is secondary structure being identified, protected and tracked? How? Status?*
- *How long do would have to wait to see recovery where secondary structure is present?*
- *How do we reflect this in the base case – and identify opportunities for rehab treatments?*

Distinctions must be made between "timber supply" and "the quality of the timber supply" and should consider additional factors. Factors such as:

- *What constitutes secondary structure. Understory? Mature green pine or non-pine scattered in dead pine?*
- *Regeneration delay. Natural regeneration in the ESSF takes a long time and growth rates are slow*
- *Species, regeneration and growth rates (natural balsam vs. planted pine)*
- *Market preferences and price differentials for lumber products (msr vs economy)*
- *Harvesting costs and minimum thresholds (4 to 6 m2 BA & 800 to 1600 sph)*

As a tool for defining which areas to treat/not treat the Coates report is likely ok. But in the absence of inventory information about where the understory is, what age it is, species composition, site index etc, we should be very cautious about including this work in timber supply. I believe it will underestimate the problem.

3.3.12 Adequate seed supply

It is predicted that at current harvest levels, the existing Pl seed supply of 240 million seedlings will be exhausted in less than 5 years. This may well delay the regeneration for some stands and affect the long term harvest level. There is a need to improve Pl seed supply from orchards.

What is the status of seed supply for fir and spruce?   Genetic gains?

3.3.13 Fire management strategies

It is likely that a large portion of the MPB-impacted land base will remain unsalvaged and contain increased feul loads. This can result in very aggressive fire behaviour and high fire intensity due to the increased amount of standing and surface fuels.

Fire Management Plans (BC FLNR, 2012b, c) are tools used by land managers and response staff to identify values at risk in developing a fire analysis that describes general control objectives and strategies. Priority is given to protecting values ranked as follows: human life and safety, property, high environmental values and resource values.

The Williams Lake and Area Interface Fire Committee produced a plan (WLAIFC, 2005) that listed 22 interface recommendations with 9 high priority items for the interface boundaries. The Cariboo Regional District produced an interface fire plan for seven unincorporated communities in the Williams Lake TSA, with 17 recommendations common to all those communities.

3.3.14 Impacts of fire on site productivity

Major wildfires in the last decade, most significantly in 2009 and 2010, damaged stands on more than 100,000 hectares of the timber harvesting land base, including 24,490 hectares of areas harvested and not yet declared free-growing (BC FLNR, 2012). These intense fires have likely impacted site productivity but the magnitude is still unknown. Dead pine stands after fire are proving to be very significant regeneration challenges (e.g. Lava Canyon Fire). Severely burned drybelt fir stands are also proving to be a significant regeneration challenge.

3.3.15 Strategies for climate change

The rate of change in climate over the last 100 years is equivalent to the rate of change of the preceding 1000 years. Rapid change in climate is an overarching pressure on the forests affecting both timber and environmental values (see table below for predicted change by 2050). Collaborative work with UBC, and the ability to use previous climate change work (Kamloops Future Forest Strategy, 2012) can help identify pending vulnerabilities and potential management strategies.

Summary of Climate Change for Cariboo in the 2050s (Pacific Climate Impacts Consortium – Plan2Adapt)

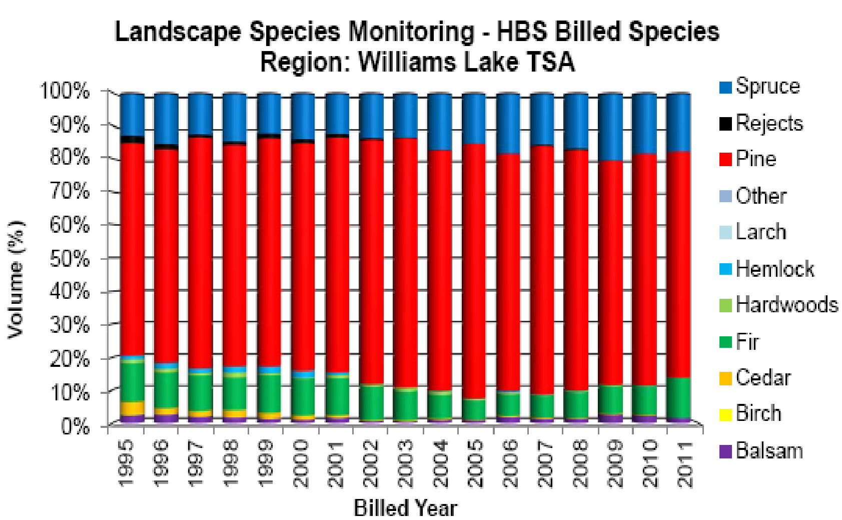
Climate Variable	Season	Projected Change from 1961-1990 Baseline	
		Ensemble Median	**Range (10th to 90th percentile)**
Mean Temperature (°C)	Annual	+1.8 °C	+1.1 °C to +2.6 °C
Precipitation (%)	Annual Summer Winter	+6% -7% +7%	-1% to +13% -15% to +4% -4% to +14%
Snowfall (%)	Winter Spring	-9% -55%	-15% to +3% -74% to -10%
Growing Degree Days (degree days)	Annual	+280 degree days	+159 to +440 degree days
Heating Degree Days (degree days)	Annual	-630 degree days	-936 to -393 degree days
Frost-Free Days (days)	Annual	+23 days	+14 to +35 days

The table above shows projected changes in average (mean) temperature, precipitation and several derived climate variables from the baseline historical period (1961-1990) to the **2050s** for the **Cariboo** region. The ensemble median is a mid-point value, chosen from a PCIC standard set of Global Climate Model (GCM) projections (see the 'Notes' tab for more information). The range values represent the lowest and highest results within the set. Please note that this summary table does not reflect the 'Season' choice made under the 'Region & Time' tab. However, this setting does affect results obtained under each variable tab.

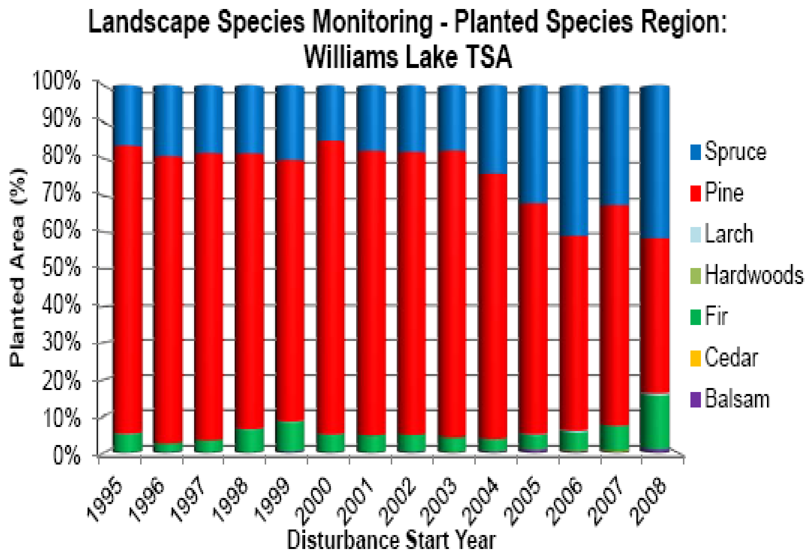
3.3.16 Tree species diversity

Provincially, concerns have been expressed about what may be occurring to the diversity of tree species over time. Resource Practices Branch recently reported (BC FLNR, 2012) on the species harvested and regenerated from a variety of data sources and points in time.

Species at Harvest



Species at Planting



The results for the Williams Lake TSA suggest that harvest has consistently been around 70% Pl and the proportion of Pl planted has been decreasing since 2003/2004 (more left for naturals?). An increase in the planting of Sx has occurred (significant genetic gains).

Species composition has a significant potential link to timber supply volume and quality. Species distribution by leading species and by overall species will be tracked in the model to compare against the recent data to identify desired species distribution targets by BEC variant.

3.3.17 Ecosystem restoration

The vision of the Provincial ecosystem restoration program is to restore identified ecosystems to an ecologically appropriate condition creating a resilient landscape that supports the economic, social, and cultural interests of British Columbia (Neil & Anderson, 2009). Ecosystem Restoration 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 processes.

The key types of ecosystems potentially in need of restoration in the Williams Lake TSA include grasslands, dry forests and riparian communities. Primarily in NDT4 fire-maintained ecosystems, these activities are focussed in the IDF (dk3, dk4, dw, xm). Together these ecosystems comprise approximately 533,000 hectares of timber harvesting land base and 294,000 hectares of non-timber harvesting land base.

The CCLUP established grassland benchmark areas within which all upland sites would be managed for grassland vegetation regardless of the vegetation community currently present on the site. The area of Cariboo-Chilcotin grassland has been decreasing over the past several decades due to ingrowth and encroachment of conifer species (Blackwell 2007). Historically, these grasslands were renewed through frequent, low-intensity surface fires. Such fires reduced tree encroachment and ingrowth, rejuvenated understory plants and maintained more open grasslands and forests with large trees. The reintroduction of managed, low-intensity surface fires to these grasslands, like the Riske Creek/Becher's Prairie area west of Williams Lake, is intended to restore and maintain the traditional grassland plant communities that naturally occurred in these areas. Thinning treatments have an objective of reducing ingrowth.

Blackwell (2007) also points out that more red- and blue-listed species are found in grasslands than on all other ecosystems in the Cariboo-Chilcotin. Up to 90% of species at risk are grassland species in some forests districts in the Cariboo. Forest encroachment and ingrowth has further restricted the distribution of habitats for these species and their distribution will continue to shrink if grassland habitats continue to convert to forest. Restoring the currently encroached grasslands and ingrown forests will increase the available habitat for these species and may help stabilize or increase populations.

3.3.18 Impacts of drought and frost

Developing strategies to minimize the impacts of drought and frost on regeneration is important to forest managers. Delong (2011) prepared drought risk and frost hazard maps for the Williams Lake TSA. These maps assist forest planners to identify areas where climate change impacts are likely to decrease available moisture (e.g. large portions of the SBPS (xc, dc), MSxv, IDF (dk4, dw, xm). Planners might then implement regeneration strategies to mitigate these impacts (e.g., use of more Douglas-fir, western larch, and possibly ponderosa pine in areas predicted to be impacted by drought with relatively low frost hazard).

4 Timber Quality Situation

The current Land Based Investment Strategy – Strategy at a Glance (BC FLNR) lists the working targets for timber quality to yield a minimum of 10% premium logs composed of peeler quality logs (peelers, poles, house logs and high-grade sawlogs) at least 32.5 cm dbh and standard sawlogs at least 27.5 cm dbh.

The major silviculture strategies assigned to address these working targets include:

1. Manage for larger logs (house logs/peelers) through long rotations in stands constrained by non-timber objectives (visual quality objectives, ungulate winter ranges, etc.);
2. Manage for MSR lumber through acceptance of higher stand densities on a portion of the land base; and
3. Optimize assumptions, methodologies and harvest schedules.

Using TSR assumptions, the Enhanced Type 2 Silviculture Strategy (Timberline, 2008) prepared charts showing harvest flow characteristics for the base case scenario (see Figure 14). Notable changes throughout the planning period occur with:

- Average harvest age – decreases from 180 years in the short-term to approximately 80 years in the long-term, except for occasional fluctuations;
- Average harvest volume – increases from 150 to 275 cubic metres per hectare from the short- to mid-term;
- Average harvest area – drops significantly from 38,000 hectares in the short-term (at 5.77 million cubic metres) to approximately 8,000 hectares (at 1.9 million cubic metres) through the mid-term.

Log quality will improve as the overall harvest of non-pine stands increases, however as greater proportions of regenerated stands are harvested the impact on log-quality is less certain. Results from other areas indicate that the stands we are growing and expect to harvest within the next 20 to 40 years will consist of smaller average log sizes, larger branches and heavier taper relative to current stands (Thrower, 2003). This is linked to generally lower stocking densities than natural disturbance conditions.

While averages can be misleading, there is an opportunity to identify incremental silviculture activities that could mitigate negative impacts to timber quality. These activities could include a range of incremental silviculture activities aimed at increasing average piece size at harvest (but not necessarily increasing taper), creating clear logs (lower knot density, smaller knots), managing for long rotation of some forest types (e.g. Douglas-fir), or increasing the heartwood to sapwood ratio (lumber density).

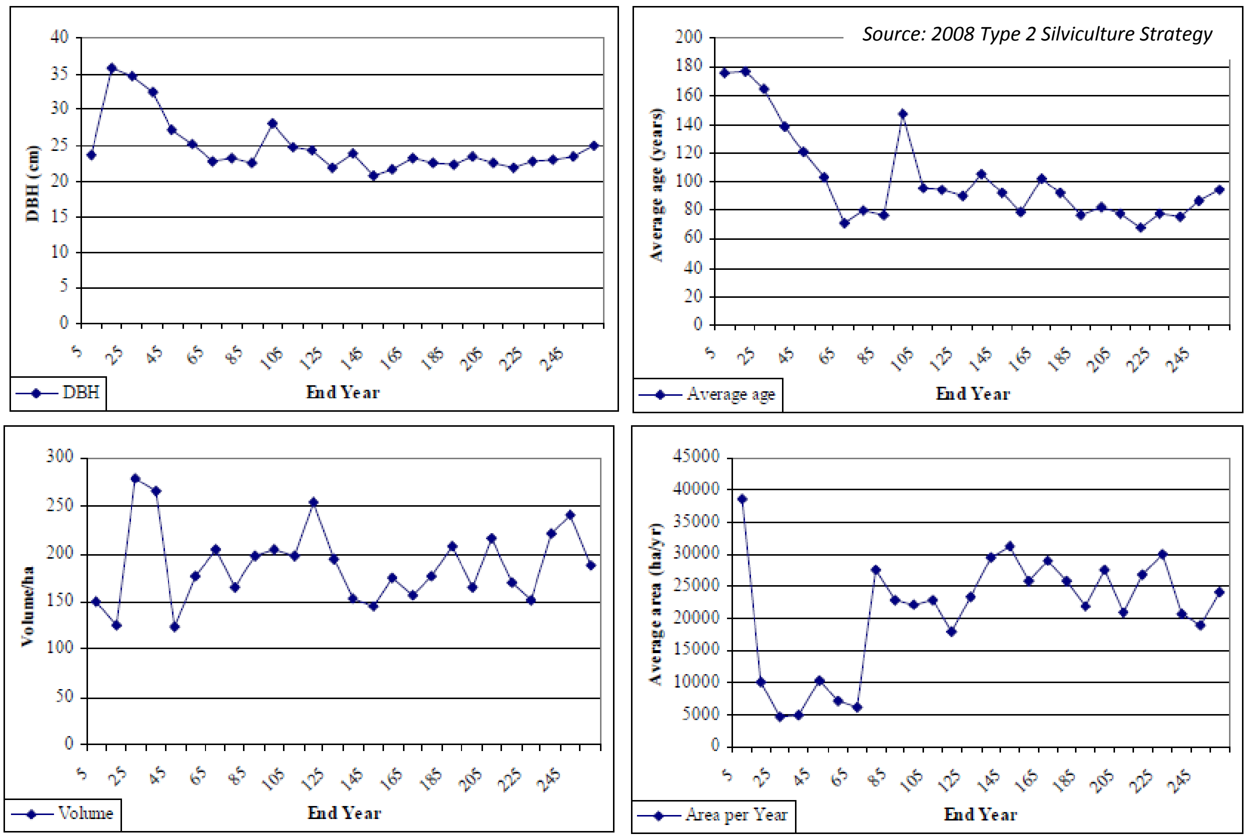


Figure 14 Average Diameters, Ages, Volumes and Area for the Base Case Harvest Scenario

4.1 Timber Quality Issues

4.1.1 Criteria for product objectives

The Enhanced Type 2 Silviculture Strategy (Timberline, 2008) defined criteria for three log quality classes according to Table 8.

Table 8 Definition of Log Quality Classes

Quality Class	Products	Species	Min Avg Stand DBH	Avg. Height For Min DBH
Peeler	Peelers, poles, house-logs and high-grade sawlogs	All except deciduous	>=32.5 cm	28 m
Standard	Standard sawlogs		>=27.5 cm	24 m
Merchantable	Merchantable sawlogs		>=12.5 cm	11 m

These criteria were used to categorized yield tables based on TIPSY-generated log grades and modelled in the base case harvest flow according to Figure 15. Following the MPB uplift, most of the harvest in beginning of the mid-term is from peeler and standard material. Towards the end of the mid-term and throughout the long term harvest, the harvest is comprised primarily of merchantable sawlog material.

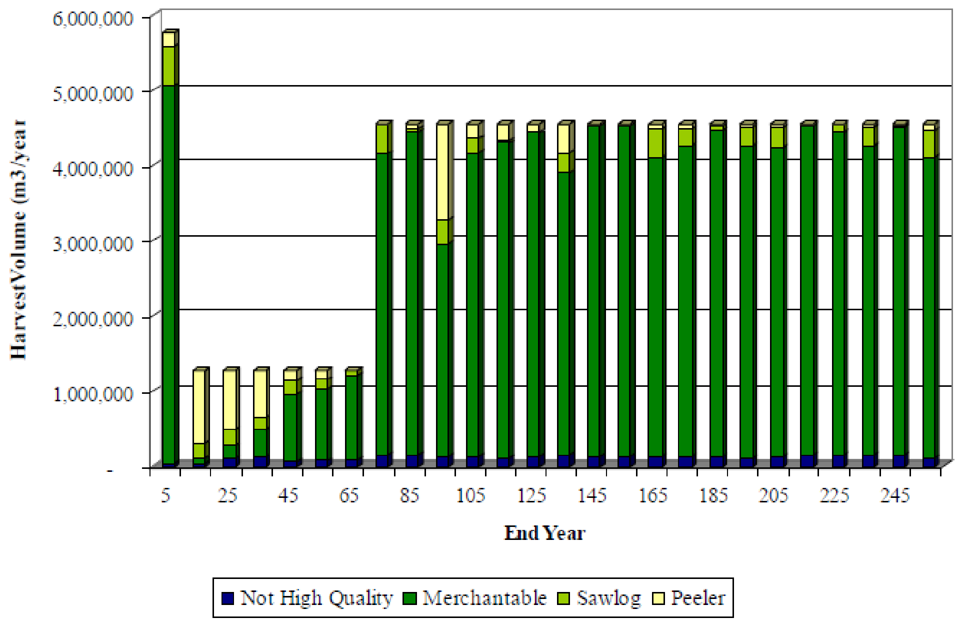


Figure 15 Base Case Harvest by Log Quality Class

5 Biodiversity and Habitat Situation

The magnitude of the MPB epidemic poses significant impacts to timber supply, with corresponding impacts to biodiversity and habitat supply. The current Land Based Investment Strategy (BC FLNR, 2009) lists the working targets for biodiversity and habitat supply as:

- Short- term
  - Develop retention strategy to minimize impacts on watersheds, ecosystems, and species (20% of timber harvesting land base) for short term retention to improve or maintain environmental values where opportunities exist;
  - Increase levels of broadleaved trees and other appropriate species on the land base;
  - Reforest 50% of impacted wildlife tree patches, old growth management areas, riparian management areas or other landscape-level retention areas to reduced stocking levels where ecologically appropriate; and
  - Minimize loss of habitat for species and ecosystems of conservation and management concern.
- Mid- and Long-term
  - Maintain or improve the conservation status of all species.

The major silviculture strategies assigned to address these working targets include:

1. Planting of impacted non-timber harvesting land base areas with a habitat focus.

2. Spacing/thinning in dry-belt Douglas-fir stands.
3. Under-burning in dry-belt Douglas-fir stands.
4. Treating invasive plants.
5. Rehabilitating roads and landings to control access.
6. Completing a retention strategy and access management plan.
7. Incorporating management of species and ecosystems of conservation and management concern into all silviculture planning.
8. Optimizing assumptions, methodologies and harvesting schedules.

In considering habitat supply, it is important to identify the environmental values potentially at risk from MPB, wildfires and/or harvesting. Table 9 shows the *species at risk* (BCMoE, 2012) for the Williams Lake and Chilcotin Forest Districts.

Table 9 Species at risk for the Williams Lake and Central Cariboo Forest Districts

Red-Listed	**Species**
Non-Vascular Plant	alkaline wing-nerved moss
Vascular Plant	Carolina draba, low hawksbeard, mutton grass, northern gooseberry, porcupine grass, silvery orache, slender hawksbeard, Sprengel's sedge, stretching suncress
Invertebrate Animal	
Vertebrate Animal	American Avocet, American Badger, American White Pelican, Brewer's Sparrow, breweri subspecies, Caribou (southern mountain population), Lark Sparrow, Lewis's Woodpecker, Peregrine Falcon, *anatum* subspecies, Prairie Falcon, Swainson's Hawk, Upland Sandpiper, White Sturgeon (Middle Fraser River population), Yellow-breasted Chat
Blue-Listed	
Vascular Plant	American chamaerhodos, autumn willow, Back's sedge, birdfoot buttercup, Booth's willow, Drummond's campion, five-leaved cinquefoil, fragile sedge, Gastony's cliff-brake, Geyer's onion, Hall's willowherb, Hudson Bay sedge, Kellogg's knotweed, meadow arnica, perfoliate pondweed, porcupine sedge, sheathing pondweed, short-beaked fen sedge, slender mannagrass, small-fruited willowherb, tender sedge, water marigold, wedgescale orache, white wintergreen, whitebark pine
Invertebrate Animal	Hagen's Bluet, Jutta Arctic, chermocki subspecies, Magnum Mantleslug
Vertebrate Animal	American Bittern, Barn Swallow, Bighorn Sheep, Bobolink, Bull Trout, California Gull, Chiselmouth, Fisher, Flammulated Owl, Fringed Myotis, Gopher Snake *deserticola* subspecies, Great Basin Spadefoot, Great Blue Heron *herodias* subspecies, Grizzly Bear, Horned Lark *merrilli* subspecies, Long-billed Curlew, North American Racer, Northern Myotis, Olive-sided Flycatcher, Painted Turtle - Intermountain - Rocky Mountain Population, Rusty Blackbird, Sharp-tailed Grouse *columbianus* subspecies, Short-eared Owl, Spotted Bat, Townsend's Big-eared Bat, Western Small-footed Myotis, Western Toad, Wolverine *luscus* subspecies
Yellow-Listed	
Vertebrate Animal	Bald Eagle, Black Swift, Black Tern, Boreal Owl, Coho Salmon, Columbia Spotted Frog, Common Nighthawk, Grey Wolf, Long-toed Salamander, Northern Harrier, Northern Rubber Boa, Sandhill Crane

Specific strategies, including silviculture practices, can be employed to reduce the risks to biodiversity, water, fish, wildlife and habitat (Manning et. al., 2006). These strategies focus on enhancing special habitat like riparian areas and maintaining landscape level biodiversity elements and ecological values. Managing forest health and salvaging MPB will undoubtedly increase road densities across the landscape, which can cause disproportionate impacts to species at risk. Given the vulnerability of forest-dependent species and large areas of MPB impacted timber, increased emphasis on managing these road impacts is warranted.

5.1 Landscape Level Retention Strategy

MPB impacts are not limited to areas available for timber harvest. Lands reserved to protect sensitive species, riparian areas, wildlife tree patches, and old growth management areas are also affected. Direct effects (increased mortality of pine, roads) and indirect effects (water quality/quantity and equivalent clear cut area), produce habitat impacts. Landscape units with low biodiversity emphasis pose higher risks of loss for species diversity because of the reduced reserve areas. Species sensitive to changes in pine forest, or indirect impacts will also be at higher risk, particularly because the MPB attack and salvage occurs within reserves designed to protect those species.

In the latest AAC rationale (BC MoF, 2007), the Chief Forester encouraged district staff and licensees to monitor green up and the level of retention across the landscape. He further encouraged development of a landscape-level retention strategy based on his guidance on retaining forest structure in large-scale salvage operations (Chief Forester, 2005). Table 10 shows the chief forester's recommended retention proportions.

Table 10 Recommended proportion of stand-level retention based on opening size

Opening Size (ha)	Percent of Opening Retained
<50	10%
50-250	10-15%
250-1000	15-25%
>1000	>25%

A landscape level retention strategy is not currently available in the Williams Lake TSA.

- *District: Was a landscape retention strategy developed? If so, how is this monitored and what is the status?*

5.2 Biodiversity and Habitat Issues

5.2.1 Considering sustainable resource management plans

A key component of the CCLUP implementation is the completion of Sustainable Resource Management Plans within the Williams Lake TSA: Anahim (2002), South Chilcotin (2002), Horsefly (2005), Williams Lake (2005),and Chilcotin (2007). These plans were developed in accordance with the CCLUP and subsequent direction from the Inter-Agency Management Committee. Their purpose is to provide a mechanism by which CCLUP targets can be achieved and to provide statutory decision makers and operational planners with information and guidance for future resource decision making. While they are endorsed by the Inter-Agency Management Committee, these plans do not impose legal objectives, per se, although the CCLUP does.

5.2.2 Reduced landscape connectivity

In some areas, stand structures that serve to connect habitats across a landscape have been adversely affected by salvaging infested pine from mixed stands, extensive clearcuts in pine-dominated watersheds, limited retention and large scale fires. The loss of this aspect of biodiversity can cause disproportionate impacts to species at risk confined to isolated pockets of suitable habitat. Connectivity is provided in the Williams Lake TSA through various mechanisms including strategies that prescribe retention for specific resource management zones, conservation legacy areas, old growth management areas, and provisions for riparian management.

Monitoring the impact to stand structure in these areas may be needed to ensure they provide required stand structure over time. Prescribing foresters can help enhance connectivity by increasing retention levels in large cutblocks and focusing some retention strategies in riparian areas, gullies, and other connectivity corridors for wildlife habitat features.

5.2.3 Loss of large older and mature forest patches

Objectives to manage patch size were not included in the CCLUP. MPB and salvage harvesting is working to create larger patch sizes on the landscape and reducing the amount if large older seral patches.

Managing to maintain a continuous supply of the various patch sizes over space and time poses a daunting task when faced with MPB patterns of infestation. Nevertheless, maintaining diverse forests must be considered in developing harvest plans and silviculture strategies.

5.2.4 Loss of mature and old pine

The loss of mature and old forest (including pine mixed with other species) can have significant impacts on associated aquatic and terrestrial values. Adjusting boundaries and implementing silviculture strategies may provide opportunities to improve the current and/or future condition of old growth management areas, while allowing timber extraction.

5.2.5 Wildlife trees and coarse woody debris

At a stand level, wildlife trees and coarse woody debris are managed through provisions in the forest stewardship plans, the Chief Forester's guidance, licensee discretion and stewardship principles. While the beetle infestation will certainly enhance the supply of wildlife trees and coarse woody debris in the short- and medium-terms, activities such as salvage, road building, and safety-hazard abatement for roads, replanting and stand tending, can significantly reduce the supply of non-pine wildlife trees and coarse woody debris. Wildlife trees and coarse woody debris are also vulnerable to intensive fires promoted by large supplies of MPB killed pine. Strategies to retain coarse woody debris, wildlife trees and wildlife tree supply through time are an essential component for developing silviculture strategies.

5.2.6 Considering existing habitat plans

The CCLUP order (2011) identifies Mule Deer Winter Range and Caribou habitat and specifies that both are to be managed with uneven-aged silvicultural systems. Multiple entries are assumed for both areas, with the return periods ranging from 30 to 70 years.

- *Mule deer habitat (dry-belt fir? Research fores?).*
- *District: Are there targets for this existing habitat plans? Treat how many hectares to support this*

5.2.7 Increased risk on watershed values

Large scale MPB infestations will affect watershed hydrological process such as canopy interception, transpiration, soil moisture storage, groundwater levels and recharge, snowfall, snow melt, runoff and peak flow timing and duration, flood events, stream and stream bank stability, erosion and sedimentation. Changes in these hydrologic effects can increase the risk on a number of watershed values including aquatic ecosystems, species and supply of domestic water use.

Hydrologic changes can be estimated by equivalent clear cut and road density. Significant increases in equivalent clear cut, road density and numbers of stream crossings can increase peak flows, sedimentation and changes in channel morphology. This can be reduced by accelerating hydrological green-up with an emphasis on maintaining vegetation within riparian ecosystems. This is especially important along fish-bearing streams and wetlands and within fishery-sensitive watersheds and community watersheds.

- Should we model? Hlines?

5.2.8 Effects of cattle

Damage resulting from cattle use, particularly within riparian areas and newly planted areas, will continue to be a concern for managing both habitat and timber supply. When designing silviculture treatments, prescribing foresters must consider retaining or enhancing barriers to cattle. On the other hand, if stocking levels remain the same (question) then there is more range available and therefore lower concentrations of cattle (perhaps?).

6 Potential Objectives and Strategies

The information below is a compendium of the current objectives and various strategies considered in past analyses. These are presented here as discussion points and grouped according to their potential to affect timber supply, timber quality or biodiversity and habitat issues. We recognize, however, that some strategies can influence one or more of these issues.

6.1 Addressing timber supply issues

Harvest levels are controlled by the biological capacity of the land base to grow timber and the management goals that translate into forest objectives. However, these harvest levels throughout the planning period (i.e., harvest flow) can be altered to help achieve various management objectives. In this analysis, the main objectives to address timber supply issues are:

- Short term (1-10 years) – maintain uplift required to salvage MPB impacted stands (5,770,000 cubic metres per year)
- Mid-term (11-65) – minimize depth and duration of the mid-term trough
- Long-term (66-255 years) – harvest at or near the productive capacity of the land base (4,495,000 cubic metres per year)

Table 11 Potential strategies to address timber supply issues

Strategy	Discussion	Anticipated Benefits	Timing of Benefit
TS1) Repeated fertilization of late rotation, near mature stands (40-80years) where moisture is not limiting	These stands will be candidates for harvesting near the front end of the trough. The intent is to add volume to these stands to reduce the depth of the front end of the trough. Focus is on Fd and Lw stands with greater response than Sx. Avoid moisture limited sites (dry-belt). Priority = **HIGH** One of the few opportunities to influence the front end of the trough.	On a 10-year treatment interval: • Fd SI 15 to 24: 15m^3/ha response per application. • Sx SI 15 to 24: 15 m^3/ha response per application. • Pl SI 19 to25: 12 m^3/ha response per application.	Short- to mid-term
TS2) Late rotation fertilization of older Fd and Sx stands (81-140 years old stands where moisture is not limiting)	These stands will be candidates for harvesting near the front end of the trough. The intent is to add volume to these stands to reduce the depth of the front end of the trough. Avoid moisture limited sites (dry-belt). Lots of opportunity (ha) but responses are unproven. Priority = **HIGH (as trial)**	No North American data but is expected to be similar to the younger stand benefits described above.	Short- to mid-term

Strategy	Discussion	Anticipated Benefits	Timing of Benefit
TS3) Repeated fertilization of young stands (20 – 40 years) where moisture is not limiting	These stands will be candidates for harvesting in the mid to back end of the trough. The intent is to add volume to these stands more quickly with 3-4 applications at 10 yr intervals. This will make these stands available sooner or have more volume at time of harvest. Avoid moisture limited sites (dry-belt). Priority = **HIGH** – the intent is to focus on Fd first over Sx because of better response and concerns around terminal weevil. Pl a priotity once *MPB risks are reduced.*	On a 10-year treatment interval: • Fd SI 15 to 24: 15m^3/ha response per application. • Sx SI 15 to 24: 15 m^3/ha response per application. • Pl SI 19 to25: 12 m^3/ha response per application.	Back end of Mid-term
TS4) Space non-Pl stands <= 20 years old, 5000 – 10000 sph	Improve merchantability of remaining stems; reduce time to 1st entry (technical rotation). Priority = **LOW (reduced timber supply)**	Larger diameter trees with increased taper but reduced overall merch volume.	Mid- to long-term
TS5) Space even aged Fd and Sx stands 21-40 years old, > 5000 sph	Improve merchantability of remaining stems; reduce time to 1st entry (technical rotation), not many stands available. Priority = **LOW** – due to limited stand availability and potential for leader weevil damage.	Opportunity to improve piece size/wood quality and provide a stand entry in the mid-term.	Mid- to long-term
TS6) Space dry-belt Fd	Spacing in layer 2 and 3 to thin out stagnant thickets will help to realize more merchantable volume in subsequent entries. Dealing with budworm through spraying of BTK will be required in many of these stands prior to any spacing treatments. There was interest expressed in implementing a trial that looked at fertilizing these stands as well (BTK + space + fertilization). Priority = **HIGH** – lots of potential area and both timber and non-timber benefits will be achieved (habitat, urban interface fuels reductions, etc). MOE had concerns over large scale BTK spray programs because of impacts to non target lepodoptera species.	Based on Ken Day's research on thinning these stands, it was felt that 30m3/ha in x? years was a conservative potential gain.	Mid- to long-term
TS7) Space and/or fertilize repressed Pl or space fire origin Pl / Fd / Lw stands	Several recent small-scale studies have shown spacing and fertilization of repressed Pl stands has the potential to break them out of their stagnant condition and promote height differentiation. Priority = **HIGH** for fertilization on areas that have already been spaced, **LOW** on other areas that require spacing and fertilization due to uncertainty of success.	Bring stands back into the THLB (~150m^3/ha) or improve their merchantable volume (~100 m^3/ha).	Mid- to long-term

Strategy	Discussion	Anticipated Benefits	Timing of Benefit
TS8) Backlog rehab and maintenance	There are still a few hectares of backlog NSR that require site preparation and planting or brushing and fill planting. In addition, there are sites that require brushing treatments to protect the investments that have already been made (i.e., backlog impeded stands). Priority = Low – **Does not improve mid-term timber supply and costly**. Otherwise high because THLB land is not producing an appropriate crop or there is a significant potential to lose previous investments.	Maintain productivity of the THLB.	Long-term
TS9) Rehab non-merchantable problem forest types	Many of these areas are not included in the cut. However, they are often difficult to identify on the ground and make a commitment to the aggressive treatments that would be required to prepare them for planting. Priority = **LOW – Does not improve mid-term timber supply** plus high costs along with the difficulty in locating and prescribing these sites.	Increase the size of the THLB.	Long-term
TS10) Under-plant unsalvaged areas in THLB	Ensure all THLB is regenerated. Candidate areas are unsalvaged stands or those with no reforestation obligations (i.e., small scale salvage). Often requires site prep to deal with overstory. Priority = **LOW – Does not improve mid-term timber supply.** Otherwise high where natural regeneration is poor/slow. Cost-effective. Habitat supply also benefits particularly within highly impacted/risk watersheds.	Maintain productivity of the THLB.	Long-term
TS11) Fill-plant FG areas dropped below minimum stocking	Some areas have been declared FG and have since been affected by insect/disease damage to the point where they are not producing volume at levels assumed in TSR2. Priority = **LOW – Does not improve mid-term timber supply**. Also limited stand availability.	Maintain productivity of the THLB.	Long-term

6.2 Addressing timber quality issues

Timber quality is typically defined as attributes that make logs valuable for a given end use. While preferred characteristics can be inherent to particular species and genetic composition, they are also influenced by tree growing conditions such as stand density and rotation length. This connection to tree growth gives forest managers an opportunity to influence future timber quality. In this analysis, the main objective for timber quality is:

- To yield a minimum of 10% premium quality logs (peelers, poles, house logs, and high-grade sawlogs) at least 32.5 cm dbh and standard sawlogs at least 27.5 cm dbh

- *Introduce strategies*

Table 12 Potential strategies to address timber supply issues

Strategy	Discussion	Anticipated Benefits	Timing of Benefit
TQ1) Pruning	Produces greater proportion of clear logs. Priority = **LOW** – Future supply of clear logs is not a priority. Cost/benefit is difficult to show.	Increase in clear log volume.	long-term
TQ2) Manage for Higher Densities on a portion of the land base	Produce greater proportion of machine stress rated (MSR) lumber. Priority = **Mod – improves value**	Create more MSR grade timber	Long-term
TQ3) Manage for long rotations	Increases minimum harvest age/volume on selected sites. May be best suited where harvest is constrained by non-timber objectives that force longer rotations (VQO's MDWR, etc), to release adjacent areas. Priority = **Mod** – improves diversity of products but likely worsens mid-term timber supply.	Larger piece sizes, diversity in log products.	Long-term

6.3 Addressing biodiversity and habitat issues

Biodiversity and habitat elements are typically considered at a coarse level through landscape level conservation of key areas and stand level retention, which both affect timber supply. Moreover, public expectations and professional accountability suggest that maintaining biodiversity and habitat supply, particularly in the aftermath of the MPB epidemic, is a paramount consideration management going forward. Fenger et.al. (2008) explained that scenarios of alternative management regimes and practices should be designed and assessed to address habitat supply shortfalls.

In this analysis, the main objectives to address biodiversity and habitat issues are:

- Short-term: minimize loss of habitat for species and ecosystems of conservation and management concern, improve or maintain environmental values where opportunities exist, and achieve an appropriate tree species distribution
- Mid- and long-term: maintain or improve the conservation status of all species

Table 13 Potential strategies to address biodiversity and habitat issues

Strategy	Discussion	Anticipated Benefits	Timing of Benefit

Strategy	Discussion	Anticipated Benefits	Timing of Benefit
HS1) Plant trees and shrubs on Non-THLB sites with no reforestation obligations (habitat focus)	Reforestation of non-THLB areas impacted by MPB or other natural disturbances can improve habitat quality – riparian areas, high risk watersheds, WTRs, critical habitat. The intention is to plant trees and/or shrubs with a habitat focus (use of broadleaves, diverse spacing, etc.). Potential candidate areas include heavily impacted parks, riparian reserves/management zones[4], WTPs, and potentially habitats associated with species at risk. . Priority = **HIGH**	Improve habitat quality, hydrologic recovery, and recovery of pine dominated riparian areas for shade to reduce in-stream temperatures.	Continuous
HS2) Thinning old and mature stands	On high stocking density Fd-leading sites, thin from below to remove smaller diameters/subdominants to create or retain existing old forest stand structures, and reduce the threat from spruce budworm and Douglas-fir bark beetle, consistent broader species objectives, WTP and OGMA objectives where applicable. In general, managing for fewer, high quality larger trees in at least some Fir forests has the potential for benefits to the environment Priority = **?**	Reduce forest fire behaviour in interface areas, help create habitat diversity, support forest health and promote forest conditions closer to those found prior to fire suppression.	Continuous
HS3) Treat for invasive species	Invasive species can severely reduce native species abundance and diversity. Large areas are presently affected, reducing browse and diversity, and potentially making conifer regen more difficult. Priority = **HIGH**	Maintain native species mix and distribution. Maintain grazing and browse species abundance.	Continuous
HS4) Thinning / Spacing – to accelerate old growth attributes – in constrained stands	To be applied to mid seral to mature stands where old growth attributes need to be accelerated (deficit LU-BEC units). Thinning will help to accelerate the presence of old growth attributes in these stands; Areas that contribute to caribou habitat may be a priority. Priority = **HIGH**	Increased areas with old growth attributes.	Short- to mid-term

[4] Restoration of riparian ecosystems associated with the following areas will be key: fish bearing streams, wetlands, temperature sensitive streams, and community watersheds.

Strategy	Discussion	Anticipated Benefits	Timing of Benefit
HS5) Spacing/thinning in dry-belt Fd stands (NDT4)	Reduces ingress / encroachment / overstocking. An integrated strategy incorporating timber and habitat objectives is needed. Focus on cover objectives (e.g., MDWR) and/or removal of ladder fuels from a habitat perspective. Habitat specific treatments would aim to reduce ingress / encroachment in historically open stands. There is also a desire to treat select mid to mature seral stands where old growth attributes need to be accelerated (deficit LU – BEC Units Priority = **VERY HIGH** (dry-belt); **HIGH** (others)	Improves stand structure in dry-belt Fd types, reduces crown fire risk, shifts towards the range of natural variation (less stems and more understory)	Short- to mid-term
HS6) Under-burn to Improve Habitat Quality	Focus on spaced and/or currently open stands in dry-belt (NDT4) to develop 'natural' stand conditions. Priority = **HIGH**	More natural stand structures in dry-belt Fd types.	Short- to mid-term

6.4 General stewardship strategies

While some general stewardship strategies will address the timber supply, quality or habitat issues described above, they are not considered incremental silviculture activities because they are considered to be outside the scope of a silviculture strategy:

- basic silviculture obligation
- harvest or other planning activity
- information gathering requirement.

Table 14 provides a list of these general stewardship strategies.

Table 14 Potential general stewardship strategies

Strategy	Discussion	Anticipated Benefits	Timing of Benefit
HS7) Enhance habitat for specific species	There will be opportunities to improve specific habitats (e.g., riparian) while focusing on larger scale MPB treatments. Potential sites will be identified (found) during layout of larger scale treatment areas to minimize impacts on species and ecosystems of conservation and management concern. Priority = **?????**	Enhance the expected benefits from larger scale treatments proposed in this strategy while ensuring that other (often small) important habitats are protected or enhanced.	Continuous

Strategy	Discussion	Anticipated Benefits	Timing of Benefit
HS8) Prioritize reforestation of salvaged areas	• All riparian areas (especially steams containing salmon): to promote shade to increase rate of recovery of these high value areas • High ECA Community watersheds: to address water quality risks and improve hydrological green-up • Connectivity Corridors: to maintain connectedness/cover • Disturbed areas associated with roads: to reduce risk of sediment transfer and enhance roadside cover for wildlife • Priority = **?????**	Improve habitat and water quality, hydrologic recovery and connectedness/cover.	Continuous
HS9) Minimize regeneration delay	Where appropriate in some ecosystems, plant rather than rely on naturals to establish stands and supress brush competition. Priority = **?????**	Promote healthy, functioning forests sooner.	Continuous
HS10) Rehab roads and landings	Restrict access to areas by rehabilitating dead-end spurs in blocks and landings – especially large landings – and replanting. Other roads should be looked at within a coordinated access plan. Priority = **HIGH**	Reduce road density - less access for predators and human disturbance and increase land base.	Continuous
TS12) Create an access management plan	Manage access within forested land base when so much of it will be opened up all at one for salvage purposes. Priority = **?????**	Reduce risk from fire and habitat	Short- to mid-term
TS13) Protect non-pine species in mature stands and/or advanced regeneration	Avoid harvest of non Pl during salvage period as this directly affects the midterm trough in wood and habitat supply. Identify and retain areas with advanced regeneration as this affect the long term habitat and wood supply. Priority = **?????**	Reserves volume for the mid-term.	Mid-term
TS14) Protect growing volume from forest health risks	Need to keep green timber growing and available for deficit period (midterm). Risks include secondary insects, disease and fire (e.g., spray BtK for spruce budworm to protect Fd) Priority = **?????**	Ensures volume and maintains timber quality for the mid-term.	Mid-term
TS15) Partial cutting during deficit period	Implement a shelterwood system within constrained areas (VQOs, UWR, etc.) that supports some harvest during a deficit period. Priority = **?????** Complex systems require careful planning.	Encourage natural regeneration of different species and fill a timber supply gap. Also realize volume of premium logs (older stands).	Mid-term
TS16) Improve growth and yield predictions for complex stands (dry-belt Fd).	Yields for sites under selection management may be underestimated. Priority = **?????**	Realize volume of premium logs (older stands).	Mid-term

Strategy	Discussion	Anticipated Benefits	Timing of Benefit
HS11) Manage for long rotations or partial cutting of dry-belt Fd stands	Partial cutting, particularly where the Pl component can be removed effectively, provides an opportunity to extend rotations and create stand structures that will become less common over time (e.g., large dbh). Priority = **HIGH**	Larger diameter stems will be available for species with that habitat preference; promote premium logs.	Mid- to long-term
TS17) Utilize improved planting stock (best available) whenever possible.	Get stands online sooner or with more volume. Genetic gains will increase volume and/or forest health tolerance. Create a localized seed source for class A seed. Priority = **LOW – Does not improve mid-term timber supply**	Stands reach merchantable size sooner and ensures adequate seed supply.	Long-term
TS18) Site prep and plant	Some old MPB (1980s), Hw Looper, and current MPB sites will require snag knockdown before they will be safe to plant, others will also require additional site preparation (piling). Also applies to reduce fuels or regenerating areas recently burned. Priority = **LOW – Does not improve mid-term timber supply**. Otherwise high where economics are reasonable).	Maintain productivity of the THLB.	Long-term
TS19) Enhance tree species diversity	Retain or establish non Pl species, including broadleaves during planting, spacing or thinning treatments. This should help moderate impacts of future MPB outbreaks to habitat and timber supply. Priority = **?????**	Promote a more stable timber supply and reduce issues associated with forest health and climate change.	Long-term
TS20) Vary regenerated stand spacing	Space to leave clumps of low and high stand densities to encourage a diversity of products and habitats. Priority = **LOW – Does not improve mid-term timber supply**	Promote a more stable timber supply and reduce issues associated with forest health and climate change.	Long-term
TS21) Shelterwood harvest in constrained areas	Shelterwood systems can provide access to constrained stands in the front end of the trough, remove regen delay, and add full increment to residual stems through the 10-20 year period after harvest.	Provide access in constrained stands (visuals, green-up constraints. Holds high-grade volume to later in the mid term trough.	Short term
TS22) Increase skidding distance to reduce access losses to the landbase	Removals from the landbase for access improve logging efficiency at the expense of timber production in the next rotation. In partial cutting (eg IDF) volume removed now for access is not available in the next entry (mid-point of the trough)	Maintain productivity of the THLB.	Long term in clearcut systems, mid term in partial cut systems
TS23) Promote a market for pulp logs and biomass logs	More complete utilization will improve harvest economics and provide access to more dead pine stands at the front end of the trough. Later in the trough this market could support access to problem forest types (e.g. Hw, Cw, small pine)	Improve production across the whole species profile, reduce waste.	Short term through mid term

Strategy	Discussion	Anticipated Benefits	Timing of Benefit
TS24) Promote markets for aspen, cottonwood and birch	Under-utilized species are currently left standing or left at roadside as waste.	Improve production across the whole species profile, reduce waste.	Short term through mid term

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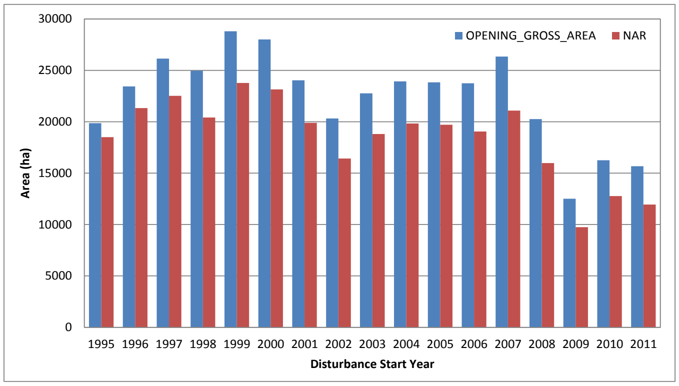
Appendix 1 Summary of RESULTS data for Williams Lake TSA

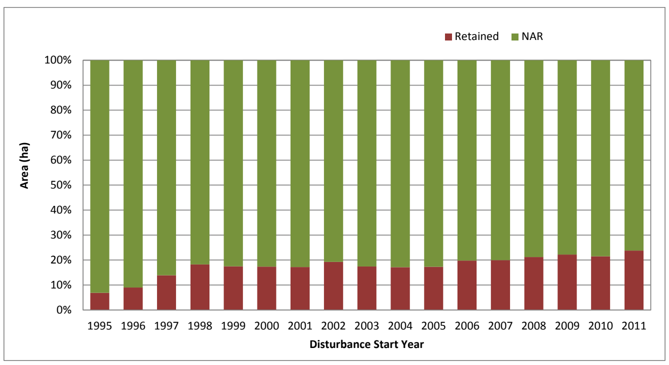
This summary includes all TSA Licensees.

Data source: RESULTS as of July 13, 2012, Prepared by Mei-Ching Tsoi and Patrick Bryant
These results are averaged or summed for all openings throughout the TSA.
These results reflect the stands/sites disturbed – not the entire landbase



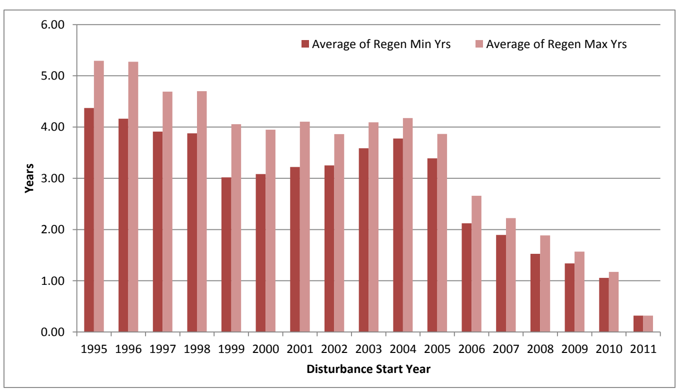
Harvest Area

- NAR over last 5 years is 2/3 of that between 1995-99
- Nearly 86% of the harvest by Tolko, West Fraser and BCTS



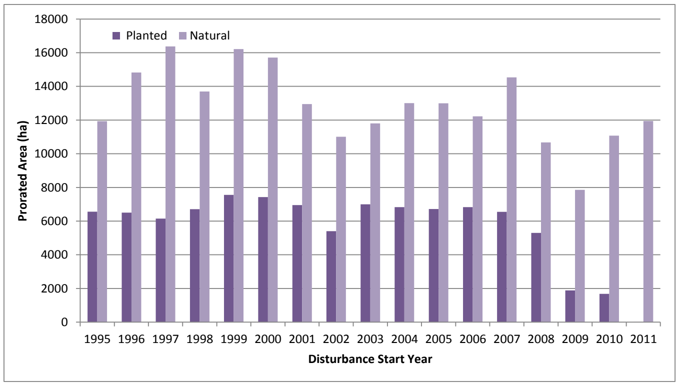
Proportion Retained

- Higher percentage of stand retained compared to pre-1999



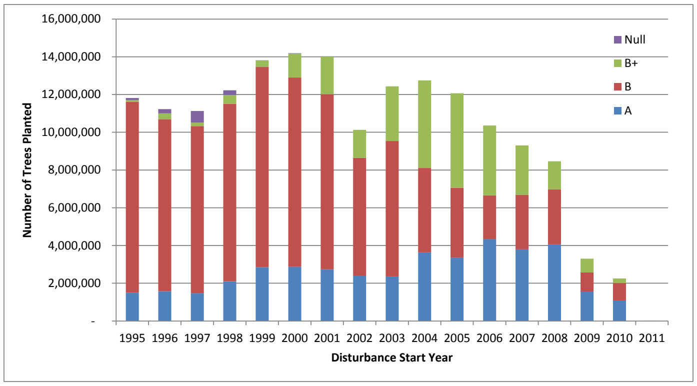
Regeneration Delay

- NOTE: Numbers drop after 2005 because there's a time lag for treating and reporting
- Regeneration delay occurs at the mid-point between min and max years
- Averages 3.99 years between 1999-2005
- Averages 3.73 years between 2000-2005
- BCTS has longer delays than West Fraser or Tolko



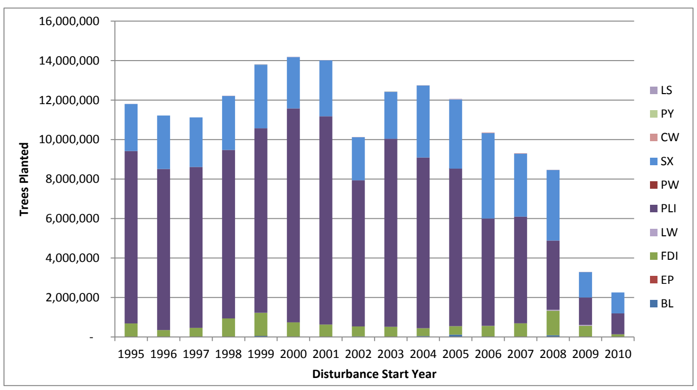
Regeneration Method

- NOTE: Numbers drop after 2005 because there's a time lag for treating and reporting
- These areas are prorated based on SUs reported with planting and otherwise considered natural.
- Fairly stable at 33% planted



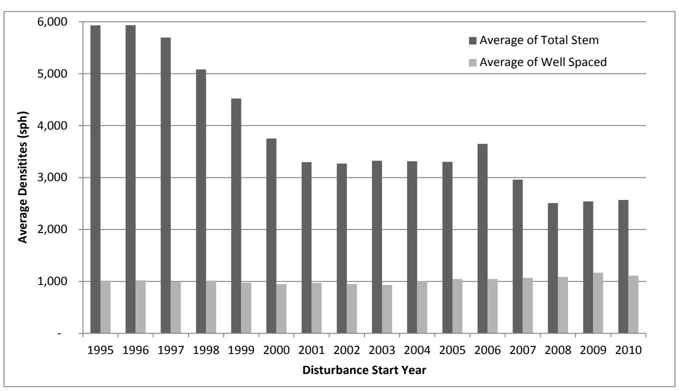
Trees Planted by Seed Class

- NOTE: Numbers drop after 2005 because there's a time lag for treating and reporting
- Increasing proportion of A Class seed



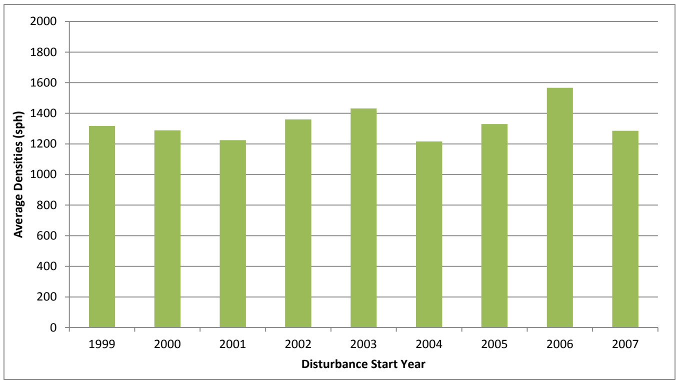
Trees Planted by Species

- NOTE: Numbers drop after 2005 because there's a time lag for treating and reporting
- Proportions of Sx and Fd are increasing slightly



Total and Well Spaced Stems

- Based on RESULTS survey data in the "Forest Cover" spatial layer
- Pattern illustrates ingress (as total number of stems) increases with time
- Well-spaced stems increasing very slightly



Average Planting Densities

- NOTE: Numbers drop after 2005 because there's a time lag for treating and reporting
- Planting densities relatively stable