Lillooet TSA
Type 1
Silviculture Strategy

Version 1.0

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Lillooet TSA Association

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FORSITE
Forest Management Specialists

Symmetree
Consulting Group

Mike Fenger and Associates Ltd.

Strategies at a Glance

General Strategy	The focus of the Lillooet TSA Silviculture Strategy over the next five years is the reforestation of sites without licensee obligations and the treatment of non lodgepole pine stands to improve midterm timber supply, while also mitigating impacts to non-timber values brought about by the mountain pine beetle epidemic and associated harvesting. The strategy aims to explore the potential of fertilization and its impacts on non timber values, regenerate previously burnt areas and current/future mountain pine beetle (MPB) impacted areas, explore the possibility of using fire (traditional burns and larger scale burns) to regenerate impacted MPB stands, improve yields and stand structures in complex drybelt Fd stands with thinning, and produce more Fd peeler volume through spacing/pruning treatments. From a habitat perspective the intent is to regenerate impacted non -THLB, improve NDT4 stand structures through spacing treatments, reintroduce fire into NDT4 ecosystems, and reduce the amount of roads and landings on the landbase. Other key issues were the need to address appraisal issues preventing the harvesting of pine stands (salvage of Pl stands currently unlikely), the need to support certification initiatives in order to maximize value from log products, and the need to complete access management planning.	
Working Targets	Timber Supply:	<u>Short term (0-20)</u> Minimize non-recoverable losses where practical. <u>Midterm (20-100 years)</u> Minimize the depth and duration of the midterm trough <u>Long term (100+years)</u> LTHL of 400,000 m³/yr (inherit capability +/-5%)(close to max productivity – midterm seen as more important)
	Timber Quality:	<u>Overall Objective</u> • Maintain diversity of stand types and ages across the land base – range of products (peelers, large sawlogs). • Maintain large Fd peelers into the future. • Maintain SFM certification to maximize value.
	Habitat Supply:	<u>Overall Objective</u> • Minimize negative impacts on water resources, ecosystems and species. • Enhance habitat supply wherever possible (Grizzly, Mule Deer, Spotted Owl, etc.). • Develop and implement access management plans.
Major Silvicultural Strategies	Timber Supply 1. Reforest THLB sites with no reforestation obligations - planting (TS5) 2. Reforestation of THLB sites with no reforestation obligations – mix of traditional cultural burning and large reforestation burns (Strategic Fire Planning -TS5) 3. Space clumped drybelt Fd stands (TS4) 4. Fertilization feasibility study (TS1 and TS2) 5. Address backlog impeded stands (TS7)	
	Timber Quality 1. Pruning combined with spacing of non-Pl stands (TQ1) 2. Support of certification initiatives (TQ3)	
	Habitat Supply 1. Plant impacted non-THLB areas with a riparian hydrology focus. (HS1) 2. Space/thin to accelerate old growth attributes (HS2) 3. Thin/underburn drybelt Fd (NDT4) stands to improve stand structure (HS3) 4. Re-introduce small scale traditional cultural burns (HS5) 5. Rehab of roads to manage access and increase use of habitat (HS6)	

Strategies at a Glance

Silviculture Program

Idealized funding level ($20.85 million over five years)

Activity	Year 1 (ha)	Year 2 (ha)	Year 3 (ha)	Year 4 (ha)	Year 5 (ha)	Totals (ha)
Studies/Surveys	-	-	-	-	-	-
Fertilize	-	1,000	1,000	1,000	1,000	4,000
Spacing/Thinning (timber)	500	500	500	500	500	2,500
Spacing/Thinning (habitat)	200	300	300	300	200	1,300
Reforestation (timber - MPB)	-	-	-	2,000	2,000	4,000
Reforestation (timber - fires)	-	1,500	1,500	1,500	1,500	6,000
Reforestation (timber - Backlog)	-	500	500	100	100	1,200
Planting (habitat)	200	200	200	200	200	1,000
Space & Prune (quality)	250	250	250	250	250	1,250
Cultural Burning (timber - MPB)	-	-	-	5,000	5,000	10,000
Cultural Burning (habitat)	400	400	400	400	400	2,000
Totals	**1,550**	**4,650**	**4,650**	**11,250**	**11,150**	**33,250**

Activity	Year 1 ($)	Year 2 ($)	Year 3 ($)	Year 4 ($)	Year 5 ($)	Totals ($)
Studies/Surveys	255,000	50,000	200,000	-	-	505,000
Fertilize		400,000	400,000	400,000	400,000	1,600,000
Spacing/Thinning (timber)	300,000	300,000	300,000	300,000	300,000	1,500,000
Spacing/Thinning (habitat)	120,000	180,000	180,000	180,000	120,000	780,000
Reforestation (timber - MPB)		-	-	2,000,000	2,000,000	4,000,000
Reforestation (timber - fires)	400,000	1,500,000	1,500,000	1,500,000	1,500,000	6,400,000
Reforestation (timber - Backlog)		600,000	600,000	120,000	120,000	1,440,000
Planting (habitat)	120,000	120,000	120,000	120,000	120,000	600,000
Space & Prune (quality)	350,000	350,000	350,000	350,000	350,000	1,750,000
Cultural Burning (timber - MPB)		-	-	1,000,000	1,000,000	2,000,000
Cultural Burning (habitat)	120,000	40,000	40,000	40,000	40,000	280,000
Totals	**1,665,000**	**3,540,000**	**3,690,000**	**6,010,000**	**5,950,000**	**20,855,000**

Estimated Timber Supply Outcomes

- 22,000 m^3 made available at the front end of the trough
  - Realized from late rotation fertilization (more not completed because of a perceived lack of candidate areas)
- 64,000 m^3 made available in the middle of the trough
  - Realized from young stand fertilization and spacing in drybelt Fd stands.
- 2,060,000 m^3 made available in the back end of the trough
  - Realized from regenerating THLB (through planting or burning) areas with no regeneration obligations.
- An unquantifiable benefit from the reforestation of up to 21,000 ha (includes cultural burning) of sites with a habitat focus, thereby avoiding further set-asides from within the THLB.

If similar benefits could be produced by continuously investing at this level for 20 years (total of $83.4 million), the front end of the trough would rise by 4,000 m^3/yr, the mid by 6,000 m^3/yr and the back end of the midterm trough could rise by 64,000 m^3/year. This forecast is highly speculative and there is no guarantee that enough suitable treatment areas could be found.

Timber Quality Outcomes

- ~125,000 m^3 of additional clear Fd log volume made available near the back of the trough from completing pruning and spacing on 1250 ha.

Strategies at a Glance

Habitat Supply Outcomes

- Enhanced forest structure on 300 ha of mid/mature seral stands and drybelt Fd stands (thinned/spaced) creating suitable mule deer and spotted owl habitat.
- Regeneration of 3,000 ha of impacted stands with a habitat focus (grizzly bear habitat maintenance), and regeneration of 20,000 ha of impacted stands with a timber focus to speed hydrologic recovery and mitigate stream temperatures by regeneration.
- Protection and planning for high value/high risk watersheds and riparian areas through the preparation of a watershed/riparian risk assessment.

Silviculture Program

Limited Funding ($5.45 million over five years)

Activity	Year 1 (ha)	Year 2 (ha)	Year 3 (ha)	Year 4 (ha)	Year 5 (ha)	Totals (ha)
Studies/Surveys	-	-	-	-	-	-
Fertilize	-	-	-	-	-	-
Spacing/Thinning (timber)	200	200	200	200	200	1,000
Spacing/Thinning (habitat)	100	200	100	100	100	600
Reforestation (timber - MPB)	-	-	-	300	300	600
Reforestation (timber - fires)	-	600	600	200	200	1,600
Reforestation (timber - Backlog)	-	-	-	-	-	-
Planting (habitat)	50	50	50	50	50	250
Space & Prune (quality)	100	100	100	100	100	500
Cultural Burning (timber - MPB)	-	-	-	1,000	1,000	2,000
Cultural Burning (habitat)	200	200	200	200	200	1,000
Totals	**650**	**1,350**	**1,250**	**2,150**	**2,150**	**7,550**

Activity	Year 1 ($)	Year 2 ($)	Year 3 ($)	Year 4 ($)	Year 5 ($)	Totals ($)
Studies/Surveys	255,000	50,000	200,000	-	-	505,000
Fertilize	-	-	-	-	-	-
Spacing/Thinning (timber)	120,000	120,000	120,000	120,000	120,000	600,000
Spacing/Thinning (habitat)	60,000	120,000	60,000	60,000	60,000	360,000
Reforestation (timber - MPB)	-	-	-	300,000	300,000	600,000
Reforestation (timber - fires)	400,000	600,000	600,000	200,000	200,000	2,000,000
Reforestation (timber - Backlog)	-	-	-	-	-	-
Planting (habitat)	30,000	30,000	30,000	30,000	30,000	150,000
Space & Prune (quality)	140,000	140,000	140,000	140,000	140,000	700,000
Cultural Burning (timber - MPB)	-	-	-	200,000	200,000	400,000
Cultural Burning (habitat)	60,000	20,000	20,000	20,000	20,000	140,000
Totals	**1,065,000**	**1,080,000**	**1,170,000**	**1,070,000**	**1,070,000**	**5,455,000**

Estimated Timber Supply Outcomes

- 0 m^3 made available at the front end of the trough
- 12,000 m^3 made available in the mid-back end of the trough
  - Realized from spacing in drybelt Fd stands.
- 420,000 m^3 made available at the back end of the trough
  - Realized from regenerating THLB (through planting or burning designed to promote natural regeneration) areas with no regeneration obligations.
- An unquantifiable benefit from regenerating of up to 3,250 ha (including the use of traditional cultural burning) for a habitat focus, thereby avoiding further set-asides from within the THLB.

If similar benefits could be produced by continuously investing at this level for 20 years (total of $21.8 million), front end of the trough would remain unchanged, the mid would rise by 1,000 m^3/yr and the back end of the midterm trough could rise by 14,000 m^3/year. This forecast is highly speculative and there is no guarantee that enough suitable treatment areas could be found.

Strategies at a Glance	
	Timber Quality Outcomes • ~50,000 m^3 of additional clear Fd log volume at the back of the trough from completing pruning and spacing on 500 ha. Habitat Supply Outcomes • Enhance forest structure on 500 ha of drybelt Fd stands (thinned/spaced/underburned) and 100 ha of mid-mature seral stands (accelerated old attributes). • Regeneration of 1,250 ha of impacted stands with a habitat focus, and regeneration of 4,200 ha of impacted stands with a timber focus to speed hydrologic recovery and mitigate stream temperatures by regeneration. • Protect and plan for high value/high risk watershed though the preparation of a watershed risk assessment. • Protect Grizzly bear habitat through access burning and access planning

Table of Contents

Strategies at a Glance ..... **i**

Table of Contents ..... **v**

List of Tables ..... **vi**

List of Figures ..... **vi**

1.0 Introduction **1**
1.1 About This Strategy 1
1.2 Methods 1
1.3 Acknowledgements 2
1.4 Limitations and Assumptions 3

2.0 Basic Data **3**
2.1 AAC History 3
2.2 Land Base Characteristics 4
2.2.1 Species Profile 5
2.2.2 Age Class Profile 6
2.2.3 Site Class Profile 6
2.2.4 Biogeoclimatic Profile 7
2.2.5 Integrated Resource Management 8
2.3 Incremental Silviculture History 8
2.4 Basic Silviculture Practices 10

3.0 Mountain Pine Beetle Situation **11**

4.0 Current TSA Situation **13**
4.1 Timber Supply Issues 13
4.1.1 TSR3 Base Case Harvest Forecast 13
4.1.2 Timber Supply Projection Including MPB Impacts 15
4.1.3 Midterm Dip in Harvest Levels 16
4.1.4 Unsalvaged MPB-killed timber with poor/No regeneration 16
4.1.5 Reliance on non-pine leading stands 17
4.1.6 Poor distribution of age classes over the long term with a potential dominance of pine. 17
4.2 Timber Quality Issues 17
4.3 Habitat Supply Issues 17

5.0 Summary of TSA Issues by Period **23**
5.1 Short term 23
5.2 Midterm 23
5.3 Long term 24

6.0 Opportunities to Address TSA Issues **25**
6.1 Potential Strategies to Improve Timber Supply 26
6.2 Potential Strategies to Improve Timber Quality 28
6.3 Potential Strategies to Improve Habitat Quality 28
6.4 Potential General Stewardship Strategies 29

7.0 Working Targets **30**
7.1 Timber Supply Targets – High Concern 30
7.2 Timber Quality Targets – Low Concern 30
7.3 Habitat Supply Targets – High Concern 30

8.0 Silviculture Strategy **31**
8.1 High Priority Strategies 31

8.2 Silviculture Strategy Program (Idealized Funding Level) 35
8.2.1 Expected Outcomes (Idealized Funding Level) 36
8.2.2 Expected Outcomes for 20 year Investment (Idealized Funding Level) 36
8.3 Silviculture Strategy Program (Limited Funding Level) 38
8.3.1 Expected Outcomes (Limited Funding Level) 39
8.3.2 Expected Outcomes for 20 year Investment (Timber-focus Limited Funding Level) 39

9.0 Summary of Information and Research Needs 41

10.0 References 42

Appendix A: Abbreviations 44

List of Tables

Table 1. Historical and current AAC (m3/year) 3
Table 2. Land base area statistics (TSR3 Analysis) 4
Table 3. Incremental Silviculture History on the Lillooet TSA 9
Table 4. Silviculture treatments recommended in Type 1 completed in 2000. 9
Table 5. Seedlings Requested By Species and Genetic Class for the Lillooet TSA (SPAR-2005 sowing yr) 10
Table 6. Forecasted gain in volume and availability for improved seed in the Lillooet TSA 10
Table 7. Summary of potential silviculture strategies to address TSA issues. 25
Table 8. Timber supply strategies. 26
Table 9. Strategies to improve timber quality. 28
Table 10. Strategies to improve habitat quality. 28
Table 11. General stewardship strategies. 29

List of Figures

Figure 1. Distribution and classification of productive landbase for the Lillooet TSA (TSR3 Analysis – Current Practice Land Base) 5
Figure 2. Tree species profile on the THLB (TSR3 Analysis) 5
Figure 3. Age Class Profile (TSR3 Analysis) 6
Figure 4. Site Class Profile (TSR3 Analysis) 7
Figure 5. Biogeoclimatic Profile (TSR3 Analysis) 7
Figure 6. Integrated Resource Management (TSR3 Analysis – Current Practice) 8
Figure 7. The extent of the mountain pine beetle infestation in the Southern Interior Region as mapped from overview flights in 2005. 11
Figure 8. MPB killed volume trend and predictions of future trend from 2004 and 2005 12
Figure 9. Data and projections of cumulative volume killed by the MPB. 12
Figure 10. TSR3 Base Case Harvest Forecast. 13
Figure 11. Harvest contribution from unmanaged and managed stands (TSR3) 14
Figure 12. Average volume harvested over time - Lillooet TSA (TSR3) 14
Figure 13. Average harvest age of stands over time - Lillooet TSA (TSR3) 15
Figure 14. Current timber supply projection vs. hypothetical timber supply projection considering MPB 16
Figure 15. 20 year continuous investment (idealized funding level). 37
Figure 16. 20 year continuous investment (Limited - funding level). 40

1.0 Introduction

1.1 About This Strategy

Type 1 Silviculture Strategies are currently being created or updated for most management units (TSAs and TFLs) in British Columbia's interior to provide a context for land base investment decisions. The strategies will help guide funding allocations between and within management units where that flexibility exists (i.e. Forests for Tomorrow and federal funds). One of the key motivating factors behind the completion of these strategies is the need to mitigate expected future impacts of the mountain pine beetle (MPB) epidemic and recent large scale fires in the interior of BC. More specifically, there is a need to mitigate impacts to midterm timber supply and short and mid term environmental values.

A Type 1 silviculture strategy compiles existing information to identify issues related to timber supply, timber quality, and habitat supply in the TSA, and then engages stakeholders in a workshop setting to identify silviculture strategies/investments that can be used to address the issues[1]. The strategy is based on readily available information and the knowledge of local forestry and environmental professionals. These potential strategies can later be quantified and/or refined in a more in-depth Type 2 analysis. The results of a Type 2 analysis would provide a better guide for on the ground implementation.

Investing in optional silviculture activities is a potential strategy that could influence the future quality and quantity of habitat and timber supply in a TSA. This strategy document broadly analyzes the potential range of silviculture activities in order to identify priority treatments for optional silviculture investments. This strategy should not be confused with the allowable annual cut (AAC) determination process. AAC's are based on current practices at the time of the determination. This strategy is forward looking and is about creating desired future conditions for our forests. The degree to which the strategy proves appropriate and is achieved may influence future AAC determinations.

1.2 Methods

This strategy was prepared through the following process:

- Prior to the district workshop, Forsite and Symmetree prepared a background document, summarizing all available information relevant to a strategy and identified opportunities to improve the future quantity and quality of timber and habitat supply. Mike Fenger and Associates Ltd. provided input on habitat related issues on behalf of the Ministry of Environment. This document was provided to local major licensees and First Nations along with an invitation to the workshop.
- A district workshop was held November 8th & 9th, 2006 in Lillooet, attended by representatives of the MoFR, MoE and forest licensees within the Lillooet TSA. Bryce Bancroft of Symmetree Consulting Group Ltd and Cam Brown of Forsite

[1] This Type 1 silviculture strategy builds upon the one completed in March 2000 funded by Forest Renewal BC. See http://www.for.gov.bc.ca/hfp/silstrat/ for links to previous strategies.

Consultants Ltd. led the session. Mike Fenger of Mike Fenger and Associates Ltd. represented MoE's interests in the workshop.

- Participants reviewed the potential opportunities identified in the draft document and provided others as they were discussed. The outcome of the session was a regime table, complete with priorities.
- Two five-year budget scenarios were developed; an idealized 'desired' budget, and a limited 'Historical' budget. The limited budget forced participants to make choices between the identified strategies/opportunities.
- The consultants incorporated the results of the working session into this draft document and added forecasts of future harvest quantity and quality and of job outcomes.

1.3 Acknowledgements

We would like to thank all those who participated in the workshop, without their input this strategy would not have been possible. They are as follows:

Attendee	Affiliation
Christine Galliazzo	Ministry of Forests and Range – Cascades Forest District
Alfred Jack	Chilcotin Plateau
Jason Garland	Chilcotin Plateau
Ida Mary Peter	Tsalalh (Seton Lake Indian Band)
Kevin Whitney	Lillooet Tribal Council
William Alexander	Tsalalh (Seton Lake Indian Band)
Karin Ely	Interwest Forest Manangement
Chris Ortner	Cirque Resource Associates
Don Brown	Ainsworth Engineered Canada
Sharon Parsons	Nicola Tribal Association Tmixw Research
Howard Bob	Ts'kw'aylaxw First Nation /Xaxlip First Nation
Michelle Edwards	Cayoose Creek Indian Band
Mike Campbell	Boothroyd Indian Band
Larry Casper	Lillooet Tribal Council
Rocky Chan	Ministry of Forests and Range – SIR (FFT)
Al Randall	Ministry of Forests and Range – SIR (FFT)
Oliver Thomae	Arbourtech – (Consultant for MoFR – SIR - FFT)
Mike Fenger	Mike Fenger and Associates Ltd. (MoE Rep)
Bryce Bancroft	Symmetree Consulting Group Ltd.
Cam Brown	Forsite Consulting Ltd.

Mike Fenger and Associates Ltd. provided summary information on habitat related issues prior to the workshop, participated in the workshop, and helped to craft this document.

1.4 Limitations and Assumptions

This strategy is focused on silviculture investments not covered by legislative obligations, which can be completed over the next five years (2007-2012). Because of risks associated with the current MPB infestation, investments in Pl stands were avoided. After the MPB epidemic subsides, investment in Pl stands may represent a significant opportunity to address TSA's timber supply issues.

Timber supply modeling was not completed in this project and all timber supply projections are from existing published sources or have been estimated based on professional judgment. Sources are indicated with each graph.

This strategy was developed to reflect TSA needs, and proposed strategies were not excluded because they did not fit within existing funding sources. The intent is for the TSA to use whatever funding sources are available to address those issues important to the TSA. The strategy itself is assumed to be funding independent.

2.0 Basic Data

This section provides a summary of basic TSA data that describes the land base and related issues. This information is included to provide context for the resulting strategies that are presented later in the document.

2.1 AAC History

Table 1 provides an overview of the AAC since 1996. The current AAC remains consistent with the 2002 determination and is virtually unchanged from the previous 1996 determination. A TSR3 timber supply analysis has been completed (2005) and it indicates that the current cut can remain unchanged in the short term, however, a determination has not yet been announced.

Table 1. Historical and current AAC (m3/year)

AAC Type	1996 (TSR1)	2002 (TSR2 - Current)
Forest Licences - Replaceable (3)	469,456	469,456
Forest Licences - non-Replaceable	15,000	15,000
Timber Sale Licence< or = 10,000m³, replaceable	7,278	7,278
SBFEP Category 1	63,030	-
SBFEP	75,336	-
BCTS Timber Sale Liecence	-	138,366
Forest Service Reserve	6,500	3,700
Woodlot licences	6,900	2,100
Total	643,500	635,900

There is currently a significant undercut relative to the AAC. Only Lytton Lumber is expected to meet 5 year cut control requirements – all other licensees are cutting at levels well below their allocations. The undercut can be attributed to poor economics (stumpage related issues), and challenges addressing First Nation's issues. Pine (Pl) stands outside of Lytton Lumber's operating area are typically not being harvested, even with ongoing mountain pine beetle mortality.

2.2 Land Base Characteristics

The Crown Forested Land Base (CFLB) is the area of productive forest under provincial crown ownership. This portion of the land base contributes to forest management objectives, such as landscape-level biodiversity, wildlife habitat and visual quality. The timber harvesting land base (THLB) is the portion of the management unit where forest licensees are expected to be able to harvest timber. The THLB is a subset of the crown forested land base and excludes areas that are inoperable or uneconomic for timber harvesting, or are otherwise off-limits to timber harvesting. Table 2 summarizes the landbase for the Lillooet TSA.

Table 2. Land base area statistics (TSR3 Analysis).

	Current Practice Base Case			LRMP Base Case		
Land Base Element	**Effective* Area (ha)**	**% Total**	**% CFLB**	**Effective* Area (ha)**	**% Total**	**% CFLB**
Total area (Lillooet Forest District)	1,124,999	100%		1,124,999	100%	
Less:						
Private Land, First Nation reserves	46,539	4%		46,539	4%	
Woodlots, Misc Leases	9,800	1%		9,800	1%	
Total TSA Area	1,068,659	95%		1,068,659	95%	
Non forest / Non-productive forest	530,792	47%		530,792	47%	
Non-Commercial Brush	531	0%		531	0%	
Unclassified existing roads, trails and landings	9,240	1%		9,195	1%	
Total Crown Forested Land Base ** **(CFLB)**	528,096	47%	100%	528,141	47%	100%
Less:						
Parks and Ecological Reserves	60,945	5%	12%	76,963	7%	15%
Inoperable/Inaccessible	96,045	9%	18%	94,414	8%	18%
Unstable / Sensitive Terrain	34,899	3%	7%	33,084	3%	6%
ESA - Avalanche	735	0%	0%	710	0%	0%
Non-Merchantable or Problem Types	31,281	3%	6%	29,111	3%	6%
Low Sites	45,387	4%	9%	42,465	4%	8%
Riparian Management	7,557	1%	1%	7,414	1%	1%
Cultural Heritage	818	0%	0%	818	0%	0%
Community Watershed Intakes	3	0%	0%	3	0%	0%
Timber Harvesting Land Base –THLB (ha)	**250,426**	**22%**	**47%**	**243,160**	**22%**	**46%**
Volume Reductions:						
Future Wildlife Tree Patches (%)	14,525	1%	3%	14,103	1%	3%
Future roads, trails and landings	10,231	1%	2%	9,757	1%	2%
Long Term Timber Harvesting Land Base (ha)	225,670	20%	43%	219,301	19%	42%

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

Approximately 47% of the total area of the Lillooet TSA is considered CFLB (Figure 1). The remaining 53% is considered non-productive (i.e. rock, ice, alpine, etc), or is not managed by the B.C. Forest Service (i.e. private, First Nations, woodlots, etc). Within the CFLB, only about 47% is considered available for timber harvesting (22% of the total TSA).

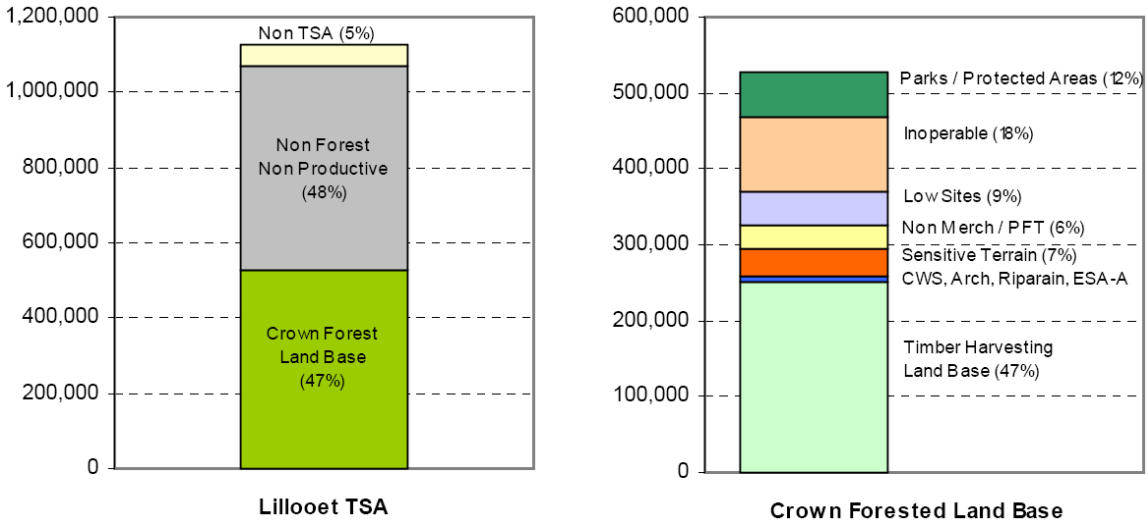

Figure 1. Distribution and classification of productive landbase for the Lillooet TSA (TSR3 Analysis – Current Practice Land Base)

2.2.1 Species Profile

The forests of the Lillooet TSA are dominated by Douglas-fir (41%), lodgepole pine (39%), and spruce/balsam (19%) stands (Figure 2). Other tree species that occur less commonly in the TSA include ponderosa pine, western hemlock, whitebark pine, and several broadleaf species. Figure 2 indicates that approximately 70% of the THLB is currently older than the minimum harvest ages as defined in the TSR3 Analysis.

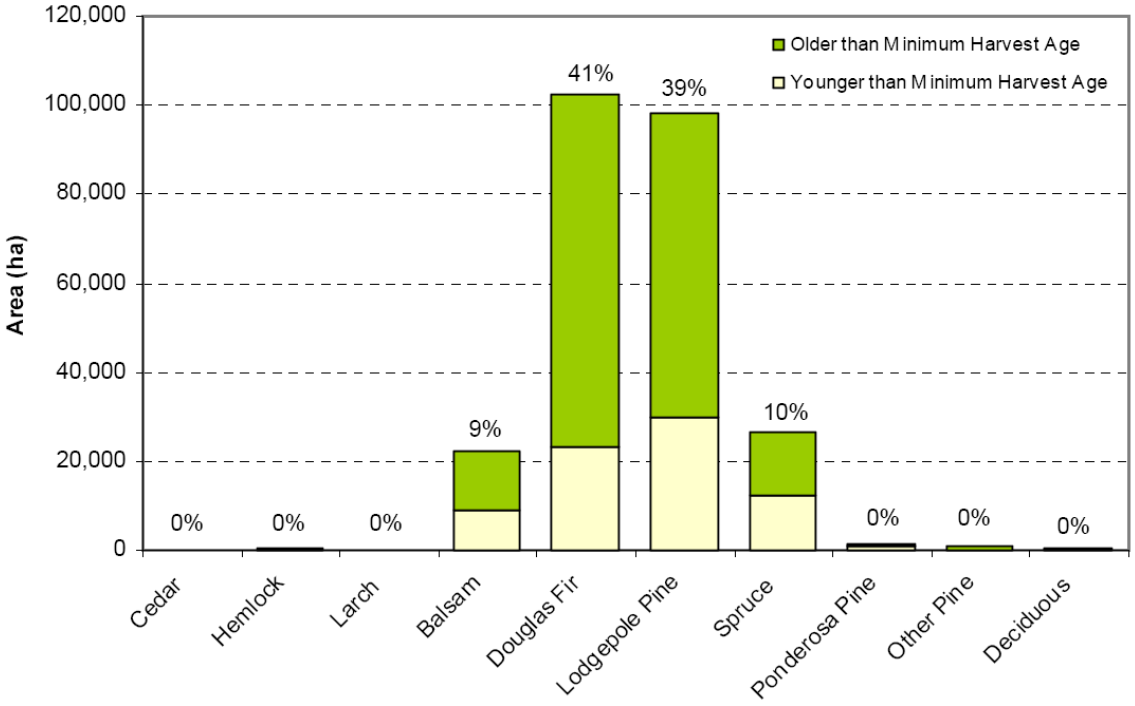

Figure 2. Tree species profile on the THLB (TSR3 Analysis)

Pl volume is a present in stands covering 65% of the THLB. Approximately 39% of the THLB has Pl volume leading in the stand. Currently there are 17.5 million m³ of Pl volume on the THLB; just under half of the total current mature growing stock.

2.2.2 Age Class Profile

The age class structure over the entire CFLB is shown in Figure 3. Area is well distributed over a wide range of age classes, with most area (70%) falling within the 60-160 year age classes. The younger age classes (<30 yrs) have a high % of THLB within them because the predominant method of creating young stands in recent years has been forest harvesting.

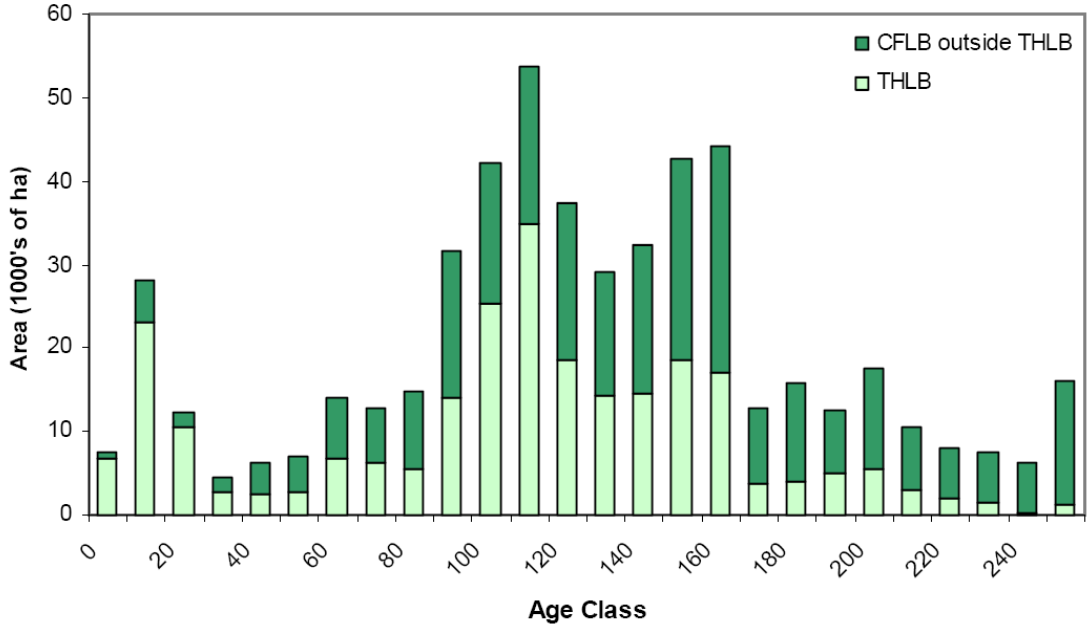

Figure 3. Age Class Profile (TSR3 Analysis)

2.2.3 Site Class Profile

The site index profile (Figure 4) reveals that the THLB area is skewed toward the portion of the land base with higher site indexes. The average site $index_{50}$[2] in the THLB is 13.1 meters.

[2] Site Index at Breast Height age of 50 years.

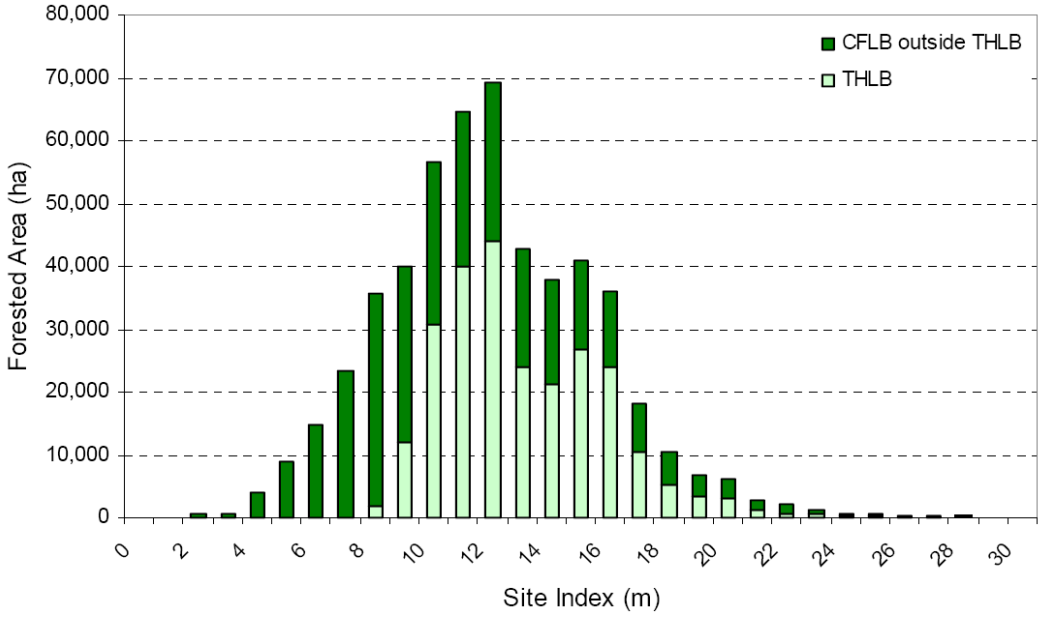

Figure 4. Site Class Profile (TSR3 Analysis)

2.2.4 Biogeoclimatic Profile

The majority of the THLB falls within the IDF (~44%), MS (~28%), and ESSF (~26%) biogeoclimatic zones. Drybelt stands were considered to be in the BG, PP, and dry IDF variants (44% of the THLB) (Figure 5).

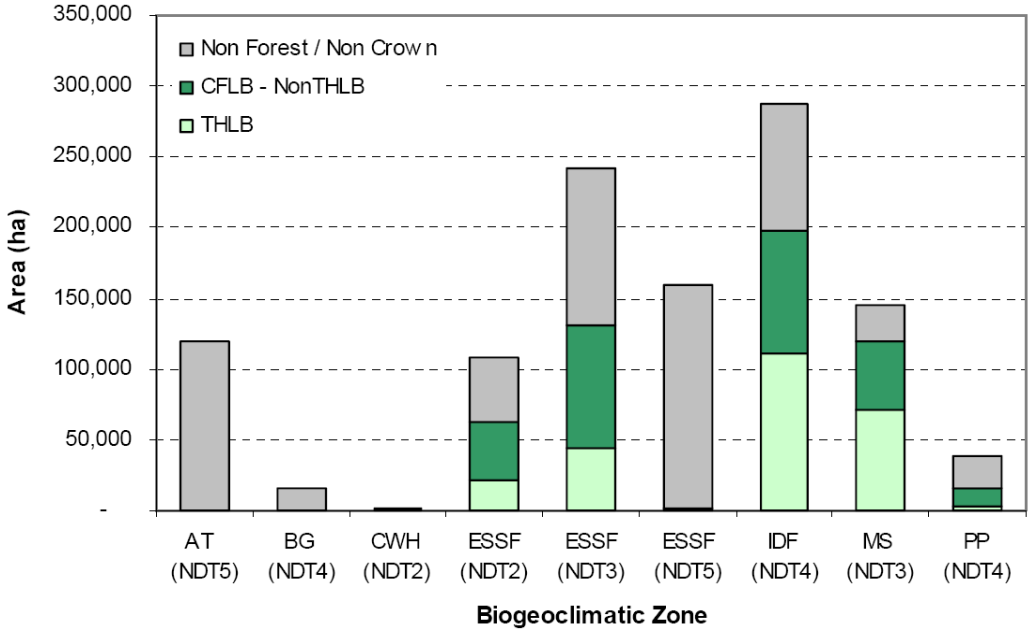

Figure 5. Biogeoclimatic Profile (TSR3 Analysis)

2.2.5 Integrated Resource Management

In order to accommodate the range of timber and non-timber resource objectives that occur within the TSA, forest cover requirements are applied to the landbase (Figure 6). These requirements limit disturbance or maintain appropriate levels of specific forest types that are needed to satisfy objectives for wildlife habitat, visual quality, biological diversity, etc.

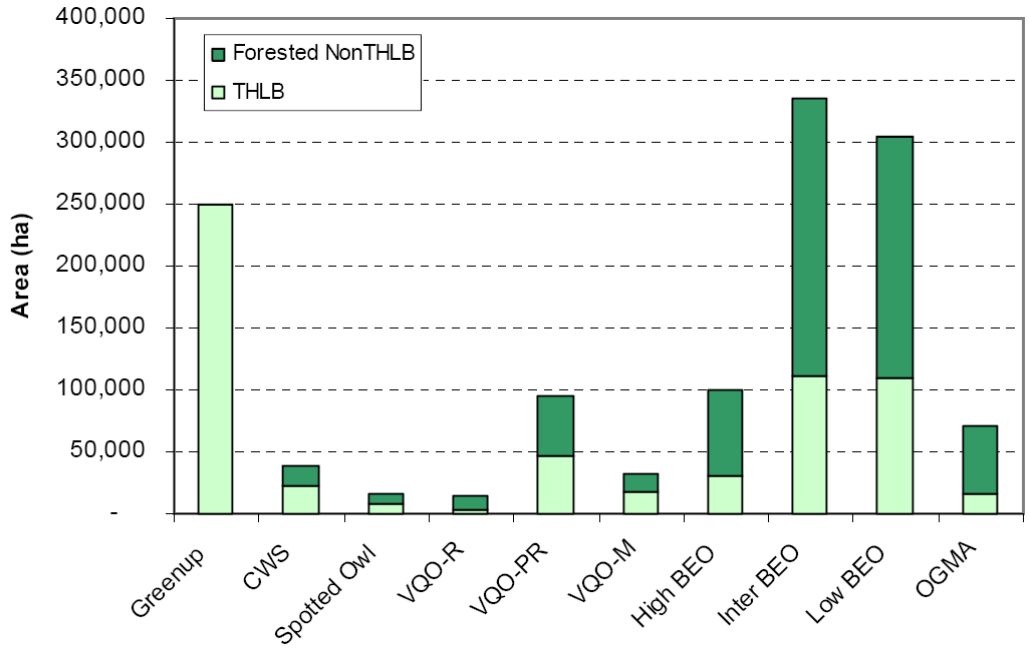

Figure 6. Integrated Resource Management (TSR3 Analysis – Current Practice)

2.3 Incremental Silviculture History

Table 3 details the incremental silviculture conducted on the Lillooet TSA for as far back as 1980. Between 1990 and 1995, the MoF and FRDA funded ~225 ha/year of juvenile spacing, ~6,219 ha/year of surveys and ~380 ha/year of planting. Much of the activities funded by the MoF were to address pre-1987 backlog issues. From 1996 to 2002, FRBC funded ~175 ha/year of juvenile spacing, ~140 ha/yr of planting, and ~6,800 ha/yr of surveys. Pest control has occurred intermittently over the past 15 years with a large program occurring in 1994. Very little or no incremental silviculture has occurred on the TSA since 2002.

Table 3. Incremental Silviculture History on the Lillooet TSA

Funding Source	Base Activity	Pre-1990	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Totals
Forest Renewal B.C. - licensee administered	Brushing	-								59	23	8				90
	Juvenile Spacing	-							50	9	78	134	118	218		608
	Pest Control	-								127	389	330	575	560		1,979
	Planting	-							12	152	50	293	258	96		859
	Pruning	-									22				8	30
	Site Preparation	-								1	14	194	20			229
	Surveys	-						738	45	28,412	3,347	1,315	4,135	3,924	726	42,643
Forest Stand Management Fund	Brushing	28														28
	Juvenile Spacing	124														124
	Planting	2														2
	Site Preparation	16														16
	Surveys	3														3
Forest Worker Development Program (non-MOF funded)	Brushing	-		11												11
	Juvenile Spacing	-		23		62			71							156
	Pruning	-							71							71
FRDA	Brushing	825	8	105												938
	Juvenile Spacing	869	162	150	71	46	5	240								1,544
	Pest Control	80														80
	Planting	1,895	475													2,370
	Pruning	-			4		35	60								99
	Site Preparation	623	27													650
	Surveys	17,429	3,462	2,255	256	580	51	43			49					24,125
Ministry Outstanding	Brushing	154	81	143	374	541	375	398	107							2,173
	Direct Seeding	2														2
	Juvenile Spacing	517			227	502	415	142	648							2,451
	Pest Control	56			25	55	3,709									3,845
	Planting	5,070	230	29	98	296	562	479	479							7,241
	Pruning	-						22	8							30
	Site Preparation	1,939	106	8	233	408	279	247	76							3,296
	Surveys	23,112	505	1,109	4,375	8,152	5,969	10,558	5,457	521	1,140	28				60,925
Provicial Incremental	Juvenile Spacing	-							21							21
	Planting	50														50
	Surveys	-							24	276						300
	Totals	52,794	5,056	3,833	5,662	10,642	11,401	12,926	7,068	29,558	5,111	2,301	5,105	4,797	734	156,986

Table 4 shows the incremental silviculture suggested by the 2000 Type 1 silviculture strategy to address the issues and strategies identified at that time. It recommended/projected a total of 5,340ha/yr to be surveyed, 170 ha/yr to be backlog planted, 80 ha/yr to be spaced, and 40 ha/yr to be pruned. Additional treatments were also recommended to regenerate or improve backlog sites.

Table 4. Silviculture treatments recommended in Type 1 completed in 2000.

Year	Surveys* General	Backlog Plant	Backlog Establish	Backlog Brush	Space	Prune Health	Prune Quality	Total
1	5,340	170	190	25	80	20	20	9,890
2	5,340	170	190	25	80	20	20	9,890
3	5,340	170	190	25	80	20	20	9,890
4	5,340	170	190	25	80	20	20	9,890
5	5,340	170	190	25	80	20	20	9,890
Subtot Yr 1 - 5	26,700	850	950	125	400	100	100	49,450
6 - 10	26,700	850	950	125	400	100	100	49,475
Total Yr 1 - 10	53,400	1,700	1,900	250	800	200	200	100,950

* Includes prescription and layout

2.4 Basic Silviculture Practices

The TSR3 analysis assigned silviculture regimes based on originating stand type. Clear cutting followed by planting is the dominant silviculture regime occurring on the landbase. The only exception is the usage of single tree selection silvicultural systems within Douglas-fir dry belt stands (~29,000 ha or 11.8% of the THLB). An average regeneration delay of 2 years was assumed. The analysis assumed no backlog NSR existed.

The TSR3 base case scenario assumed net gains of 0.7% for Pl stands and 8.0% for Sx stands associated with the use of Class A seed in new plantations. The estimated gains used in the timber supply analysis were recognized as being somewhat conservative relative to slightly higher gains projected for the future by BCFS Tree Improvement Branch (see Table 6). Actual 2005 seedling requests (Table 5) indicate that almost all Sx seed used is improved (8% gain) and that a large majority of the Pl seed used is Class B, which does not have a significant gain associated with it.

Table 5. Seedlings Requested By Species and Genetic Class for the Lillooet TSA (SPAR-2005 sowing yr)

Species	Class A Seedlings Requested (000)s)	Class B+ Seedlings Requested (000s)	Class B Seedlings Requested (000s)	Total Seedlings Requested (000s)	Percent Class A Seedlings Requested (%)	Percent Improved Seed
Bl	-	-	20.4	20.4	0.0%	0.0%
Fdi	-	-	677.3	677.3	0.0%	0.0%
Plc	-	-	3.0	3.0	0.0%	0.0%
Pli	-	15.0	867.8	882.8	0.0%	1.7%
Py	-	-	29.8	29.8	0.0%	0.0%
Sx	512.0	-	45.8	557.8	91.8%	91.8%
	512.0	15.0	1,644.1	2,171.1	24%	24%

Table 6. Forecasted gain in volume and availability for improved seed in the Lillooet TSA

			Gain From Improved Seed/Availability								
			2005				2010		2015		
SPU	Elevation (M)	SPU Seedling Need (million)	Actual Gain	Actual Percent Class A used (%)	Projected Gain	Est. % Avail.	Projected Gain	Est. % Avail.	Projected Gain	Est. % Avail.	THLB Area
FDC SM LOW	200-1000	1	-	-	2%	50%	8%	80%	8%	150%	3,305
PLI TO HIGH	1400-1600	5.3	3%	2%	11%	21%	14%	42%	16%	85%	40,412
PLI TO LOW	700-1400	13.6			9%	18%	12%	38%	13%	64%	53,617
SX TO HIGH	1300-1900	3.3	9%	92%	8%	73%	12%	118%	17%	124%	221,797
SX TO LOW	700-1300	1.2			9%	200%	12%	250%	22%	150%	7

3.0 Mountain Pine Beetle Situation

Figure 7 graphically illustrates the extent of the mountain pine beetle infestation in the southern interior as mapped from overview flights in 2005. Although not yet as seriously infested as some of the more northerly TSA's, it is anticipated that the Lillooet TSA will experience significant impacts over the next few years.

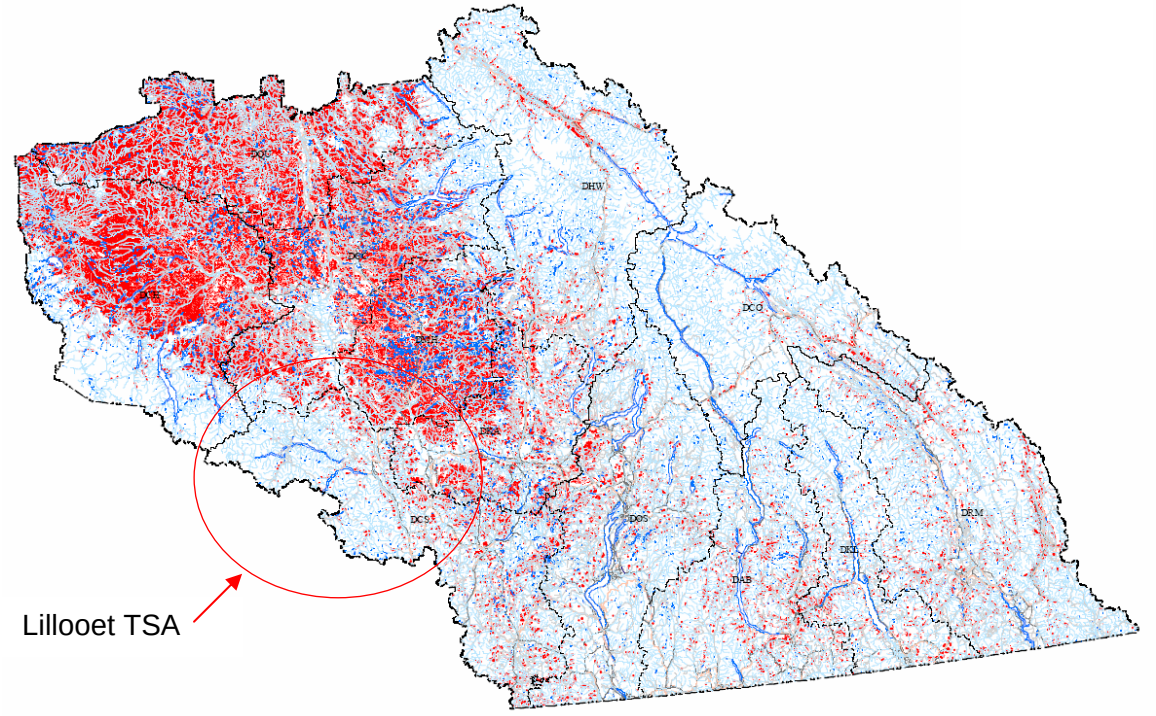

Figure 7. The extent of the mountain pine beetle infestation in the Southern Interior Region as mapped from overview flights in 2005.

Due to the prevalence of pine-leading stands on the Lillooet TSA, there are potentially severe implications on timber supply. It is important to note that current mill profiles, market conditions, and appraisal issues in Lillooet prevent pine volume from being harvested in a significant way. Figure 8 shows the trend predicted by Marvin Eng for yearly volume killed peeking in 2009 for this TSA at 2.9 million m^3 killed/yr.

Figure 9 shows projections of the cumulative pine volume killed by the MPB to 2025 (Marvin Eng 2006)[3] assuming no management intervention. By 2015, the vast majority of the expected mortality is predicted to have occurred (85% of the mature Pl volume dead). Because Pl volume is currently typically only harvested as an incidental species, there is the potential that the majority of the impacted Pl volume (~16 million m^3) will not be salvaged given the current policy structure. This exacerbates the timber supply situation because non pine healthy stands needed in the mid term would be harvested

[3] Provincial-Level Projection of the Current Mountain Pine Beetle Outbreak: An Overview of the Model (BCMPB v3) and Results of Year 3 of the *Project*.

while Pl stands die, and regeneration on these impacted Pl stands would likely be slow or spotty without the occurrence of fires or human intervention.

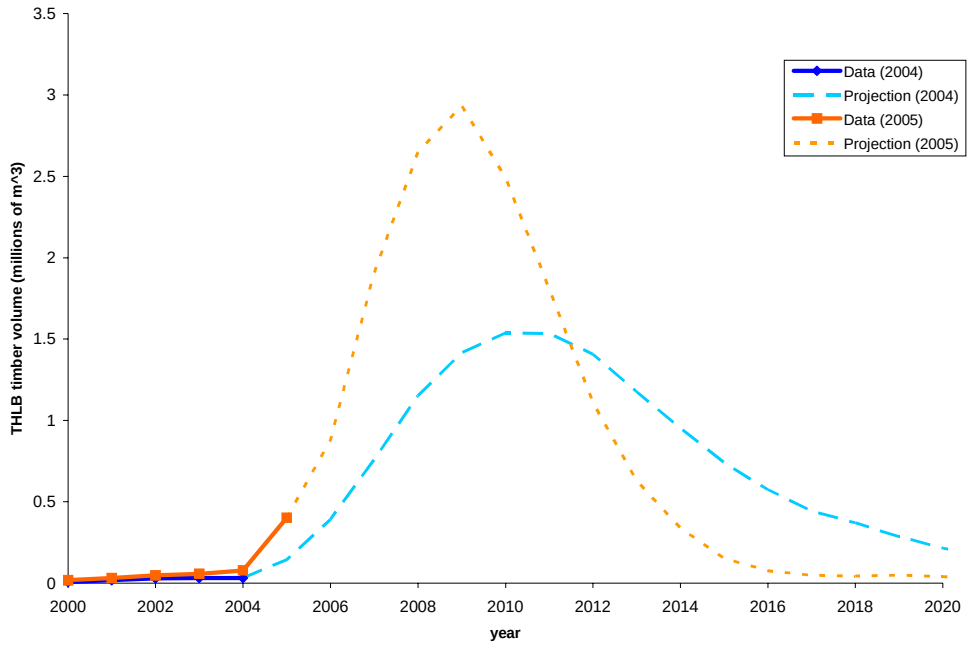

Figure 8. MPB killed volume trend and predictions of future trend from 2004 and 2005

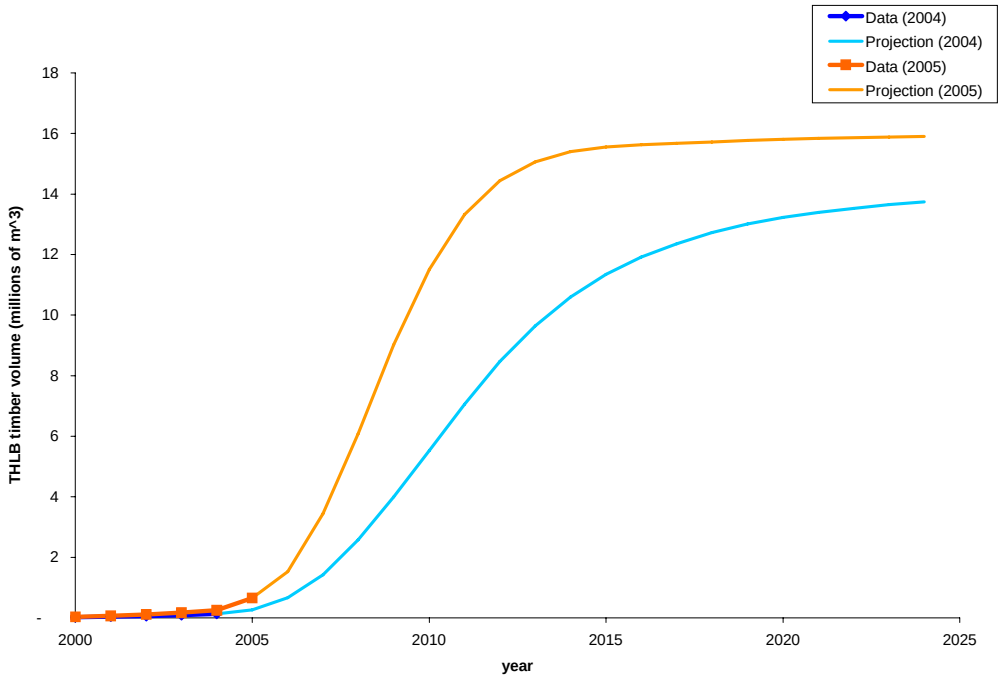

Figure 9. Data and projections of cumulative volume killed by the MPB.

4.0 Current TSA Situation

4.1 Timber Supply Issues

4.1.1 TSR3 Base Case Harvest Forecast

Figure 10 shows the TSR3 base case harvest forecast (Current Practice). A major timber supply "fall down" is expected in the future because future managed stands are not expected to provide the same volume as the older natural stands currently on the landbase. However, it is important to note that no site index adjustments were considered in this scenario and thus future yields are underestimated. The TSR3 analysis included a sensitivity analysis where ecologically based site index adjustments (SIBEC) were applied. This resulted in an increase in average Site $Index_{50}$ from 13.1m to 14.8m which in turn resulted in a 6.9% increase in the LTHL. The SIBEC adjustment was not included in the base case because the accuracy of the ecosystem map has not been verified.

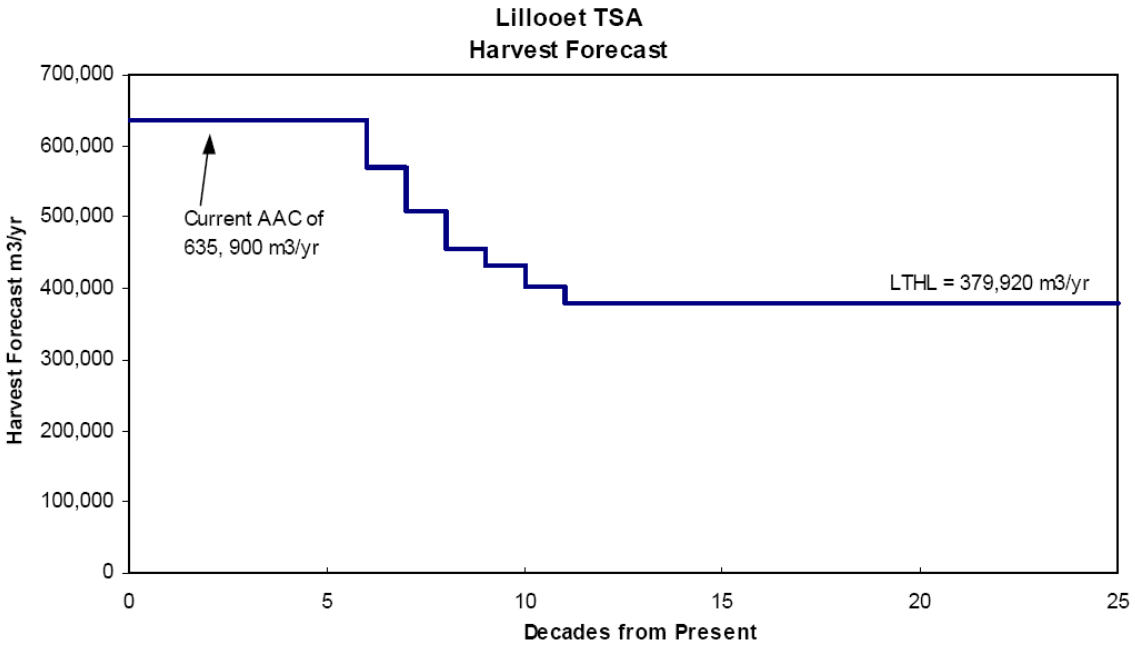

Figure 10. TSR3 Base Case Harvest Forecast.

Total growing stock on the THLB is ~47million m³ and about 93% of this volume is currently merchantable (older than min harvest age). Almost 40% of this growing stock is mature Pl stands that are at risk to mountain pine beetle.

Figure 11 illustrates the transition from natural to managed stands in the TSR3 base case scenario. Timber supply pinch points exists around period 8 when harvest begins to rely more heavily on managed stands. Natural stand volumes must be metered out for 60 yrs while managed stands come online. Depending on the volume killed by MPB, managed stand volumes will be required within 40-60 years from now.

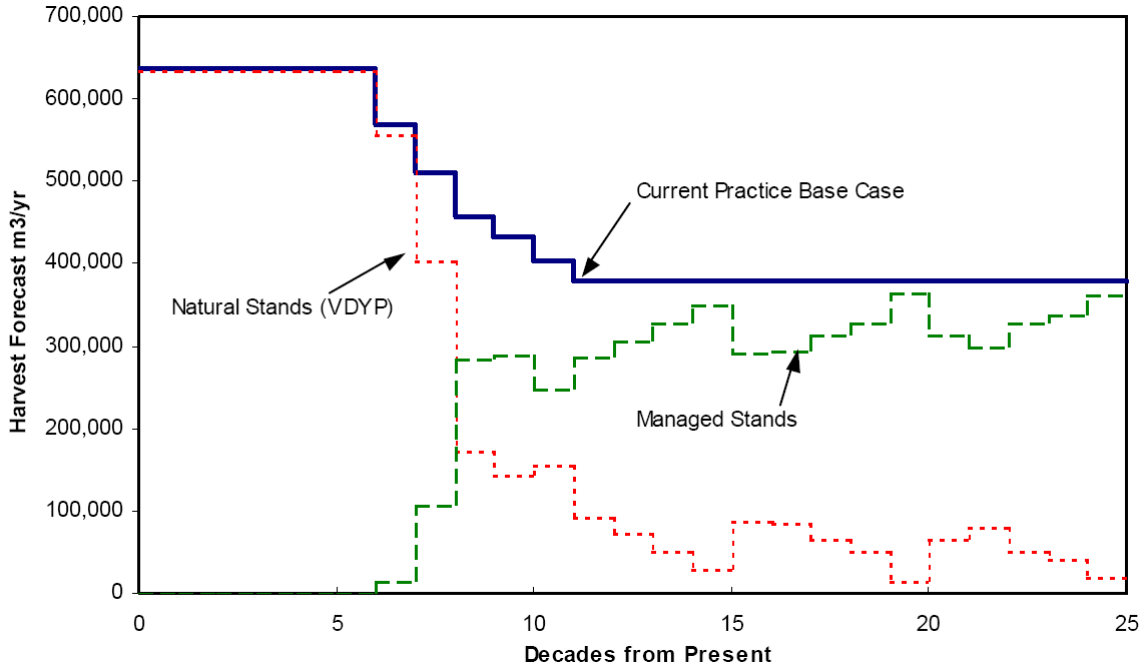

Figure 11. Harvest contribution from unmanaged and managed stands (TSR3)

Figure 12 illustrates the average harvest volume per hectare while Figure 13 shows the average harvest age of harvested stands for the TSR3 base case scenario. Short term volumes are 295 m^3/ha from ~170 year old stands on average, while long term volumes are 200 m^3/ha from ~120 year old stands on average.

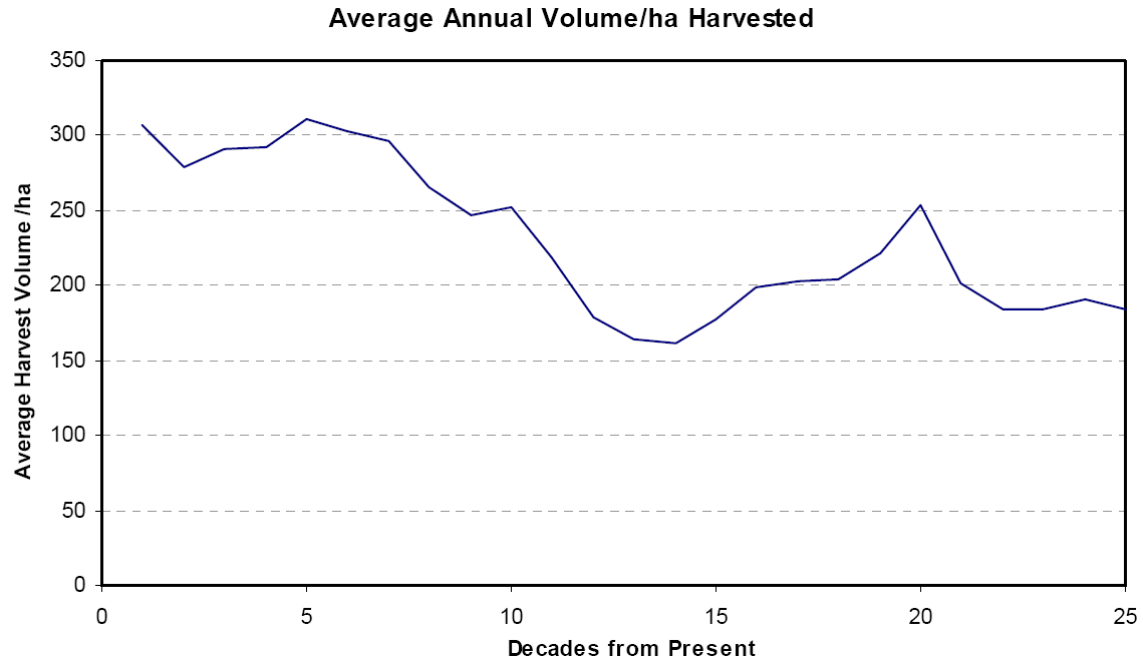

Figure 12. Average volume harvested over time - Lillooet TSA (TSR3)

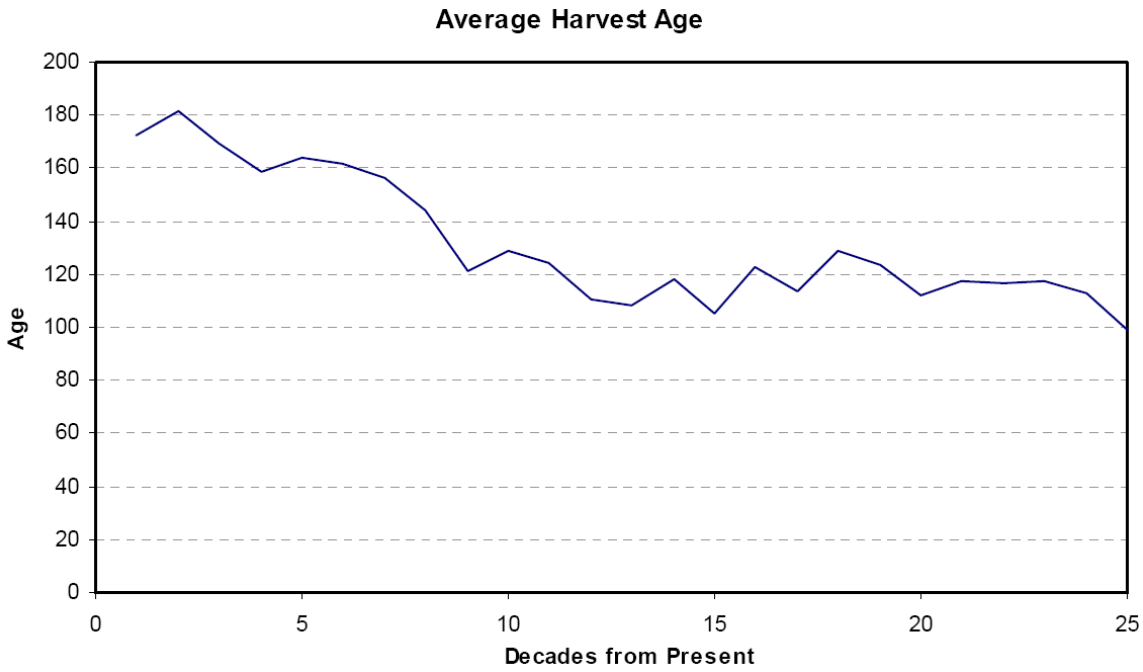

Figure 13. Average harvest age of stands over time - Lillooet TSA (TSR3)

4.1.2 Timber Supply Projection Including MPB Impacts

In an attempt to shed some light on the possible implications of the MPB on timber supply, Figure 14 shows the current timber supply projection (TSR3) along with a ***hypothetical*** timber supply projection where MPB impacts are considered. It is important to note that this hypothetical scenario uses broad and simplified assumptions and is not a result of a forest estate modeling exercise. It is likely that this gives an optimistic outlook of the situation. In reality, slower regeneration and the increased pressures on other resource values - created by the MPB - such as visual management, wildlife habitat, and hydrological recovery could make the situation worse.

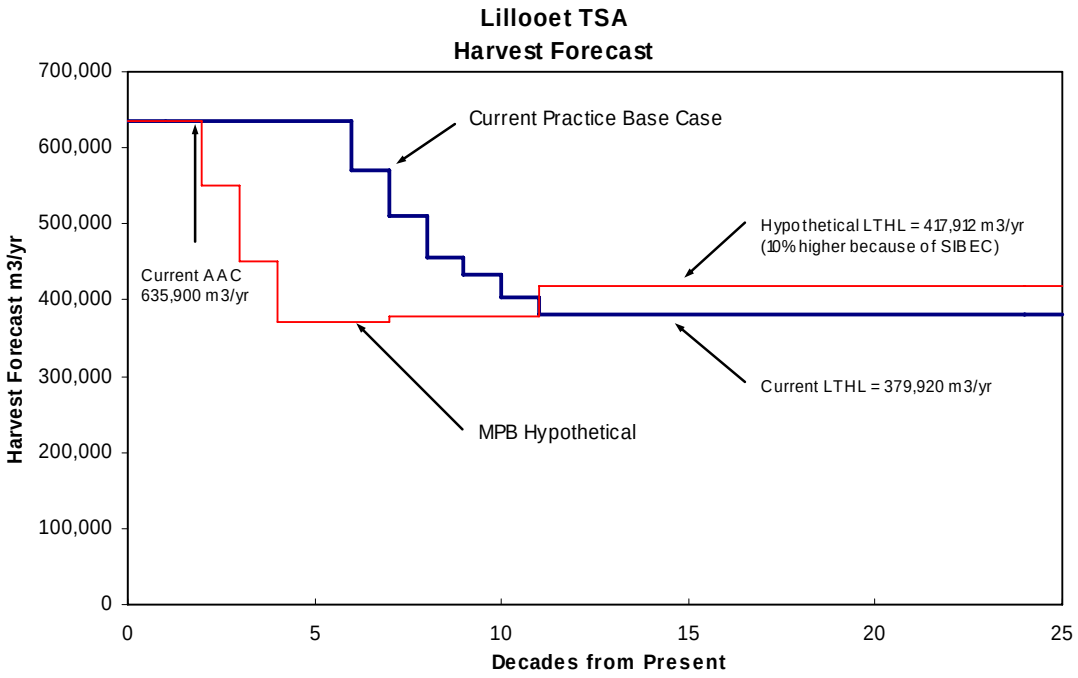

Figure 14. Current timber supply projection vs. hypothetical timber supply projection considering MPB

Timber supply issues to be addressed:

1. Midterm Dip in Harvest Levels.
2. Unsalvaged MPB-killed timber with poor or no regeneration.
3. Reliance on non-pine leading stands.
4. Poor distribution of age classes over the long term with a potential dominance of pine.

4.1.3 Midterm Dip in Harvest Levels

As a result of the reduction in growing stock over the next 10-20 years from MPB, harvest flow will likely exhibit a midterm trough for 50-60 yrs. The speed at which managed stands can be brought online will have a large impact on the size and depth of this trough.

4.1.4 Unsalvaged MPB-killed timber with poor/No regeneration

Pine is currently not harvested in any significant way in the Lillooet TSA although it makes up a large portion of the landbase. Given that pine is not targeted even when it green, it is highly possible that a large portion of the land base will die with no salvage harvesting. This could potentially result in a period of high fire hazard due to the high incidence of standing dead timber and/or impaired regeneration if fires are avoided.

Additionally, it is highly probably that many immature Pl stands could be impacted by the mountain pine beetle. This area could also have little or no natural regeneration and require intervention to remove existing stems and get new trees growing.

It will be key to ensure that all impacted THLB sites with no reforestation obligations are regenerated to maximum potential. If not regenerated, it will be critical to understand the extent of the impacts as they are represented in non-recoverable losses or stand volume reductions.

4.1.5 Reliance on non-pine leading stands

Pine leading stands currently do not contribute significantly to the harvesting profile in the Lillooet TSA. Rather, harvesting is concentrated in Douglas fir (Fd) stands. Because of the losses expected in Pl stands and the current concentration on Fd stands, it is likely that harvesting will be forced into other species in the mid term period where timber availability is at its lowest.

4.1.6 Poor distribution of age classes over the long term with a potential dominance of pine.

Given the magnitude of area affected by the mountain pine beetle across many age classes (as low as 30 years to 200+ years old) there will be a large shift of area into a narrow range of age classes. This area will in turn become available for harvest again at the same period in the future. If this area is once again dominated with pine, it will once again become susceptible to a major MPB infestation.

4.2 Timber Quality Issues

The current provincial target for premium sawlogs produced is 10% of a TSA's AAC. No targets for timber quality were defined in the previous Type 1 project.

In general, the average age of harvested stands is declining over time as we move into the harvest of second growth managed stands. The forecasted "fall down" in timber supply coupled with timber supply shortages caused by the MPB will expedite this trend because very young managed stands will be the primary source of harvest during the midterm period. As a result, timber quality will decrease during the deficit period along with average piece size. There is an opportunity to identify silviculture activities that could increase timber quality during this deficit period. These activities could include a range of activities aimed at increasing average piece size at harvest, creating clear logs (lower knot density), or increasing the heartwood to sapwood ratio (lumber density).

4.3 Habitat Supply Issues

Pressures on the environment will come as direct impacts of the MPB epidemic and indirect impacts due to salvage logging and efforts to minimize reductions in AAC during the "fall down" period. The loss of mature and old forest (pine and pine mixed with other species) over the next 5 – 10 years will have significant impacts on associated aquatic and terrestrial values. Habitat supply in NDT 4 (Forest which has under natural conditions had structures maintained by frequent stand-maintaining fires) is also being impacted by high stocking density in Douglas-fir and ponderosa pine forests and encroachment of conifers into grasslands associated with absence of frequent stand maintaining fires. Although this is separate from MPB there are impacts in much of the TSA due to fire suppression and fire exclusion enabling high survival and unnaturally dense understories which reduces

understory productivity for many species such a mule deer and reduced growth of dominant trees which have to compete for moisture and nutrients.

The draft Lillooet LRMP was released as in July 2004 and is now the focus of ongoing government discussions with First Nations. Almost all other TSAs in the province have over-arching land use plans (LUP) including established protected areas to provide landscape level protection for environmental values. The spirit and intent of the draft LRMP is being followed to the extent possible by many of the LRMP participants. Habitat supply comments are based on this guidance.

Mountain Pine beetle impacts will not be limited to areas available for timber harvest. Forest areas identified to provide protection for sensitive species, riparian, wildlife tree recruitment, and old growth will also be affected directly by increased mortality of pine and indirectly by impacts of roads, water quality/quantity/ECA changes, and associated habitat impacts. Landscape units with low biodiversity emphasis relying on pine retention will be at higher risk of loss of older forest dependent species diversity because of reduced older forest reserve areas. The degree to which pine has been used to meet the older forest component will determine the level of risk. Assessment of the amount of pine contributing to meeting old forest biodiversity objectives (targets) is considered prudent. Species sensitive to changes in pine forest, or indirect forestry related impacts will also be at higher risk, particularly if spreading mountain pine beetle and salvage occurs within reserves designed to protect them, for example pine marten and the condition of riparian reserves and management zones.

Grizzly bear and Spotted Owl are landscape-level species specifically mentioned as part of the LRMP direction and press releases.

Grizzly bear recovery is dependent on access management as grizzly bear require large areas that are relatively undisturbed, with low risk of mortality or displacement. Increases in road access and reduction in roadless areas is a concern that will need to be integrated with salvage harvest and incremental silviculture investment. Reduced stocking linked to specific site series is included in TSR3 as a “best practice” to provide within stand understory bear forage/berry production through time. There is an allowance for up to 8,000 ha in TSR3 for Grizzly bear recovery measures. Most of this habitat management budget is expected to go to Wildlife Habitat Areas but some can be applied to reduced stocking post harvest and some can be used to reduce stocking density in established stands. The stocking densities and site series suitable for bear habitat management are provided in Table 3 of the draft Lillooet LRMP, 2004. Proposed stocking is approximately 30% to 50% below the stocking targets set for optimum timber and full site occupancy by conifers. Summarizing the selected site series and the currently over- stocked and potentially treatable site series can be undertaken in a type 2 silviculture strategy. Many of the critical habitat areas for bears are small 1 to 5 ha. Some trials using prescribed fire as a site rehabilitation practice for incremental silviculture projects also is beneficial to many species including grizzly bear.

Spotted Owl is endangered in BC and the Lillooet area represents the most northern known distribution. The provincial goal and also the draft LRMP goal for spotted owl is to maintain a stable well distributed owl population. A memorandum of understanding between major licensees and government, signed by in 2003, guides spotted owl management. Suitable habitat is defined and forest management is to maintain 67% of the habitat in a suitable condition. It is likely that there are forest stands within the areas

identified for owl management that can be improved through incremental silviculture such as pre-commercial thinning to increase stand complexity and more quickly develop older forest stand characteristics. A type 2 silviculture assessment can identify forest stands within owl management areas and assess how much is potentially treatable to improve habitat suitability.

Mule deer winter ranges provide for snow interception, cover and forage supply. Both forest harvesting and fire exclusion have changed these habitat factors. Management for winter ranges is consistent with management of older forest biodiversity see NDT4 below. Thinning/spacing/understory burning in these types of stands improve habitat for wildlife and timber and reduce forest health risks

This strategy seeks to identify the best silviculture opportunities to maintain and enhance habitat supply. Reducing impacts will also require planning to design salvage harvest approaches that either avoid or sensitively address watersheds with high value to fish and water users, biodiversity, key habitat values and species at risk and species of management concern. If too many habitat elements are removed, or damaged under the pressure to manage mountain pine beetle, even the best silviculture strategies will not be able to create, in the short/medium term, what has been removed. A supply of habitat will be better sustained by avoiding salvage in sensitive watersheds, riparian areas, OGMAs, WTPs, and other retained areas designed for mitigating impact to environmental values. Key habitat elements can be maintained by retaining non susceptible tree species. Trees left today will support both habitat and timber supply in the future.

Two NDTs characterize the area where pine and fir forests dominate in the Lillooet TSA (Biodiversity Guide Book 1995).

1) NDT 3 (frequent stand initiating events)

   Fire suppression has increased the mature and old pine component providing enhanced supply of host trees for MPB. The current MPB infestation is considered unprecedented and attributed to many factors, including fire suppression and climate change. Salvage logging in highly infested areas is expected to result in larger than normal openings. To achieve resemblance of a natural disturbance requires increased stand structure in the form of tree retention, understory vegetation and coarse woody debris. In this NDT, added retention, strategically located will reduce risk to environmental values.

2) NDT 4 (frequent stand-maintaining fires).

   Suppression of frequent understory fires has created extensive in-growth, and fuel levels considered to be beyond the range of natural variability in Douglas-fir and ponderosa pine stands. This has increased the risk of widespread crown fires in areas where these did not naturally occur. Removing some of this ingrowth mechanically, and with managed understory fire will decrease wildfire risk near settlement areas as well as enhance/protect timber and environmental values.

   Marvin Eng's work suggests that most of the susceptible pine will be killed by 2015. In the current harvesting regime pine volume is generally harvested as incidental species, even though pine exists in 39% of the stands in the THLB. It is anticipated that a high percentage of area currently in mature pine forests will

be converted to early seral condition by MPB, road density will increase and salvage will be extensive.

Rapid change in climate is an overarching pressure on the forests affecting both timber and environmental values. The impacts of climate change on forest health and environmental values are currently poorly understood.

Landscape/Watershed Values Placed at Increased Risk

- **Aquatic ecosystems, species and supply of domestic water use**
  Changes in hydrology can be estimated by equivalent clear cut area (ECA) and road density. Higher ECA's, higher road density, kilometres of road ditches, and increased numbers of stream crossings will result from salvage harvest. These changes, increase runoff and place infrastructure for water users and stream crossing structures at greater risk. This also increases risk to stream integrity, and possible changes in channel morphology, increased bedload transport and stream bank instability. There is concern over some watersheds as a result of recent wildfires and the impacts on water An operation trial reported on by C. Laursen and I. Davis, (2005) titled the Town Creek Watershed Native Plants report (prepared for Ministry of Environment) details the use of broadleaf species to recover ecosystems in a post fire disturbed watershed near the town of Lillooet.

  Hydrologic risk can be reduced through speeding-up hydrological green-up in the most sensitive watersheds and through increased emphasis on maintaining vegetation within riparian ecosystems. This is especially important in the following areas.
  1. All fish-bearing streams and streams containing Coastal Tailed Frog.
  2. Wetlands
  3. Temperature sensitive streams
  4. Community and domestic watersheds

Bull trout, Chisel mouth, Mountain Sucker, Columbia Mottled Sculpin and white sturgeon (lower Fraser population) are red or blue listed fish species within the TSA (CDC species explorer. http://srmapps.gov.bc.ca/apps/eswp/). All provincially threatened and endangered species are listed in Table 13 Appendix 2.

- **Loss of mature and old pine:** The loss of mature and old forest (pine and pine mixed with other species) over the next 5 – 10 years will have significant impacts on associated aquatic, terrestrial and water values. Draft Old growth areas are available for the LRMP at ftp://kamftp.env.gov.bc.ca/pub/outgoing/dist/OGMA_Lillooet_2005/ These areas are being avoided for harvest, but resources are lacking to field check, monitor or respond to forest health considerations in OGMAs. Where possible, OGMAs can be designed to minimize MPB risks by selecting mixed species stands, where these are available. Elsewhere, uniform stands of pure pine (e.g. some Montane Spruce subzones) limit opportunities for mixed species retention. In sites like these, replacing OGMAs infested by MPB may not be possible. Silviculture strategies may provide an opportunity to improve future

condition of OGMAs. The degree to which lodgepole pine and ponderosa pine contribute to the draft OGMAs is not clear.

- **Reduced Landscape Connectivity:** Clearcut harvesting to remove infested pine from mixed stands, extensive clearcuts in pine-dominated watersheds, and intensive large scale fires limit stand structures than serve to connect suitable habitats across a landscape. Loss of stand structures impact habitat and can cause disproportionate impacts to species at risk or those confined to isolated pockets of suitable habitat. There are tools that can be used by the prescribing forester to maintain connectivity in much of the landscape. Increasing retention levels in large cutblocks and focusing silviculture strategies in riparian areas, gullies, areas around avalanche tracks and meadows, and other reserve areas will help. Risk to biodiversity already higher in low biodiversity landscape units, is likely to increase as a result of losses of mature pine forests to pine beetle. Where a number of low emphasis landscape units are clustered consideration may be required to maintain connectivity between isolated populations of species at risk. Depending on species composition and clear cut levels, areas managed for moderate or high biodiversity may also require additional management for connectivity Mapping pine stands, OGMAs, retained riparian areas, retained WTPs and other reserves by watershed will help identify deficiencies and focus priorities for both retention and silviculture.

- **Loss of Large Older and Mature sized Forest Patches:** There are no objectives for managing patch size in the Lillooet TSA. The large cutblock strategy considers and incorporates patch size considerations, but the strategy was not designed to be implemented at the scale or for the purpose of addressing mountain pine beetle infestations. MPB has the advantage of promoting larger patch sizes in landscapes that traditionally experienced large scale disturbances. However, salvage harvesting is in many ways different from what would occur in nature, and the extent and intensity of current infestations may be exceeding historical scales of disturbance. Managing to maintain a continuous supply of the various patch sizes over space and time poses a daunting task when overlaid by MPB patterns of infestation. Nevertheless, this deserves to be considered as part of silviculture planning.

- **Wildlife trees and coarse woody debris:** Wildlife trees are managed in the TSA through provisions in the Forest and Range Practices Act. Direct impacts of MPB infestation can enhance supplies of wildlife trees and CWD, at least in the short to medium term but, actions such as salvage, road building, and safety issues associated with roads, replanting and stand tending may result in the loss of higher value large diameter fir, larch, ponderosa pine and deciduous wildlife trees and CWD. Wildlife trees and CWD are also vulnerable to intensive fires promoted by climate change and large supplies of MPB killed pine. Strategies to retain coarse woody debris, wildlife trees and wildlife tree supply through time are a critical part of silviculture planning.

Increase in Roads and access:

Many species at risk or of management concern are negatively affected by roads and roads will increase significantly to manage the forest and salvage MPB. The

potential for impact to many species including grizzly bear, tailed frog, bull trout, moose, Mountain Goat, and Bighorn Sheep is of serious concern. Given the concentration of species at risk in this TSA and the vulnerability of key forest-dependent species like grizzly bear, increased emphasis on managing road impacts is warranted.

- **Cattle use:** Cattle use in association particularly with riparian areas and newly planted areas will continue to be a concern for managing both habitat and timber supply. When designing silviculture treatments, consider, retain and enhance existing barriers to cattle access associated with riparian areas.

- **Forest infill and encroachment**
  In many NDT 4 forests, Douglas-fir and ponderosa pine regeneration forms dense thickets. These thickets tend to stagnate due to competition for light and moisture. Many of these stands historically grew under open forest conditions and provided habitat for a variety of wildlife. Thinning/spacing/understory burning in these types of stands improve habitat supply for wildlife and timber piece size and reduce forest health risks.
  There are some grasslands, in particular those along the Fraser River where conifer encroachment is impacting forage values for California bighorn sheep and other grassland species. This has been well document in the area north of the Lillooet TSA.

- All provincially Red and Blue listed species appear in Table 13 (CDC species explore, http://srmapps.gov.bc.ca/apps/eswp/) In addition to spotted owl and grizzly bear which are mentioned specifically in the draft LRMP other wildlife species have the greatest links to pine forest are the woodpeckers, bats, owls and the furbearers.

- All Red and Blue listed plant communities are listed in Table 14 and the five lodgepole pine communities are considered to be most impacted.

Additional issues identified beyond the scope of a Silviculture Strategy

- **Data gaps:** A spatial framework is required to plan a coordinated response to MPB at the landscape level. This framework can help planners decide priorities for reserving trees; it can help set priorities for silviculture strategies, and identify timber and habitat supply challenges. Field review of draft OGMAs should be a high priority because in the absence of protected areas, the best option to protect high value habitats is to ensure that OGMAs protect the best old growth. To support current efforts to limit impact of MPB on habitat supply, increased inventory of species and habitats is required to avoid unintended impacts during salvage and to better direct silviculture treatments to achieve habitat objectives. This could be linked to inventory efforts required to refine and update timber supply. Inventory needs include: identifying creek resident trout populations, further work to inventory for species at risk and identify WHA candidates for Identified Wildlife.

- **Complete land use planning and update policy provisions as new information becomes available:** There are a number of opportunities remaining to identify, and conserve habitat supply. These include completing protected areas, WHAs, Wildlife Habitat Features, and OGMAs. Regular reviews of salvage guidelines to incorporate new information and ideas would also help manage risk to environmental values. For example, Ministry of Environment in Prince George is currently working on best management practices for MPB salvage harvesting, and Kamloops TSA has begun to discuss an approach to address roads.

- **Consider changes to acceptable species:** Given climate change and environment threats from MPB, it may be worthwhile to reconsider what should be considered an acceptable species for planting. For example, planting western larch, cottonwood, and aspen may provide an option to enhance diversity without MPB risks. Including broadleaf species in stocking standards will enable acceptance post salvage and improve species diversity.

- **Partnerships:** With MPB, increased roads, and more intensive second growth forestry, forest managers can also anticipate a rapidly expanding problem with noxious weeds. There may be partnership opportunities between silviculture and weed control initiatives to jointly and more efficiently complete what needs to be done.

5.0 Summary of TSA Issues by Period

5.1 Short term

Harvesting on the TSA is currently significantly below the allotted AAC. Additionally, current mill profiles, market conditions, and appraisal system (stumpage) in the TSA prevent pine volume from being harvested in a significant way even when green. Due to the prevalence of pine susceptible to MPB on the TSA, large areas of the TSA are at risk of being attacked with little or no salvage harvesting. Unless burned or salvaged, these areas will have poor and delayed regeneration that will have impacts on the mid and long term.

Habitat supply issues exist in the short term as a result of salvage and/or MPB mortality. Pressure will be put on habitat values and watersheds by elevated harvest levels, loss of older Pl stand types, and increases in the amount of active road.

5.2 Midterm

Even without the MPB, there has been a forecasted falldown in timber supply for some time. With MPB impacts considered, this falldown will likely occur much sooner than previously thought. Salvage harvesting – if it occurs – will have ended and harvest will be focused on remaining mature non-Pl stands. Harvesting of these currently existing natural stands will occur in the front and middle portions of the midterm trough, while the

back end will be made up of the first managed stands coming online. These stands will be very young and have small piece size, and thus will put intense pressure on the log quality profile.

The supply of habitat needed to maintain current fish and wildlife populations and maintain biodiversity complexity will be at high risk because the remaining mature and old forests will be diminished in extent and fragmented in distribution. In addition, it is expected that remaining mature and older forests will be under pressure to provide timber harvesting opportunities. At the start of the midterm, many watersheds will have high ECA's from the impacts experienced in the short term and further harvesting will create significant hydrological risks. In addition, some of the tools originally designed to help maintain biodiversity will have been severely impacted by MPB (OGMA's, WTP's, Riparian Areas, Parks, etc). Even areas left unharvested and untreated will go through a period where there is little remaining CWD. Species such as pine marten will find little suitable habitat. Only the live tree species left today will be available to bridge the midterm habitat supply gap.

5.3 Long term

Long term harvest levels are projected to be above midterm levels but could fall below the potential shown in TSR3 because of poor or no regeneration on MPB impacted sites that have no reforestation obligations. Long term harvest levels are most sensitive to the size of the THLB and estimates of the productive capacity of the land base.

The current TSR3 base case did not reflect an adjustment of site index for second growth stands based on unique ecosystem combinations (using predictive ecosystem mapping polygons, soil, drainage and elevation class) because the accuracy of the underlying ecosystem mapping was unknown.

Timber quality may improve over that experienced at the back end of the midterm trough but it will remain depressed relative to current levels because of short rotations and focus on volume production.

Environmental values, including habitat quality and quantity, will likely have recovered somewhat from the worst period near the front of the midterm trough, but will remain under pressure indefinitely due to an extensively roaded land base growing timber on short rotations (50-100 years). In addition, climate change has the potential to change ecosystems and species habitats in dramatic ways in the long term.

6.0 Opportunities to Address TSA Issues

Prior to the workshop, background information was used to identify silviculture strategies with the potential to address timber and habitat issues at the TSA level. Each of these potential strategies was discussed during the workshop to clarify or refine them and/or add new strategies. Each strategy was assigned an effective opportunity area based on data and local knowledge. The impact on Timber Supply, Quality and Habitat were estimated and each strategy was given a ranking of High, Medium or Low as shown in Table 7.

Table 7. Summary of potential silviculture strategies to address TSA issues.

Strategy	Opportunity in next five years (ha)	Timber Supply Effects			Quality	Habitat	Cost/ha ($)	Rank
		Short	Mid	Long				
TS1a-b. Late rotation fertilization (40-80 yrs old) Sx/Fd	1,719	++	++		+	+/-	400	H*
TS1c-d. Late rotation fertilization (81+ yrs old) Sx/Fd	12,677	+	+		+	+/-	400	H*
TS2 a-b. Young stand fertilization (Sx/Fd)	5,957		+++		+	++	400	H*
TS3. Fertilize repressed Pl stands	Limited		+	+++	+	++	400	L
TS4a. Spacing drybelt Fd thickets [4]	5,600		+	++	++	++	600	H
TS4b. Spacing young dense Fd or Sx leading stands (non-drybelt)	1050		+	+	++	+	600	L
TS4c. Spacing repressed Pl stands	Limited		++	+++	++	+	600	L
TS5a. Reforest dead Pl (MPB killed) sites with no reforestation obligations (timber focus)	10,000		++	++		+++	1000	H
TS5b. Initiate controlled traditional burns to get natural regeneration in MPB killed stands	5,000		++	++		+++	300	H
TS5c. Fire strategy planning – look at opportunity to do large scale (valley to ridge) reforestation burns to get natural regeneration in MPB killed stands	20,000		++	++		+++	50	H
TS5d. Reforest 2003/2004 wildfire areas without reforestation obligations	8,000		++	++		+++	1000	H
TS7a. Address backlog NSR	Limited		+	+		-	1200	L
TS7b. Address backlog impeded stands (survey / brush)	3729		+	+		-	700	H
TQ1. Space, prune, and fertilize 15-25 yr old Sx and Fd with >600 sph	1250				++	++	1800	H
TQ2. Encourage certification of TSA forest mgmt	-				+		-	H
HS1. Planting trees and shrubs in non-THLB sites with no reforestation obligations (habitat focus)	1,000					++	600	H
HS2. Thinning/spacing to accelerate old growth attributes (Grizzly and Spotted Owl habitat)	100				++	++	600	H**
HS3. Thinning from below in NDT4 Fd stands	1000		+	+		++	600	H
HS5. Introduce traditional cultural burning in un-logged areas.	5000		+	+		++	300	H
HS6. Rehab of roads and landings (habitat focus)	100		+	+		++	5000	H^

Note: +/- rankings shown above are subjective rankings assigned by the authors after the workshop.
* High as a trial or after further exploration of options/impacts to address First Nation concerns. Focus is on 40-80 yr stands for first operational trials.
** Need to understand the potential for this strategy
^ An access management plan is necessary to complete this strategy. It is ranked high to encourage the completion of AMP's.

[4] All spacing and planting prescriptions would incorporate habitat direction where applicable.

6.1 Potential Strategies to Improve Timber Supply

The following table (Table 8) provides detail regarding potential timber supply strategies. It reflects discussions within the workshop and is meant to add clarity around the strategy and how it was ranked.

Table 8. Timber supply strategies.

Strategy	Workshop Comments / Discussion	Anticipated Benefits	Timing of Benefit
TS1a-b Late rotation fertilization of near mature Fd and Sx stands (40-80years 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. Focus is on Fd stands first as it has a greater response than Sx. Moisture limited sites (drybelt) should be avoided. Priority = High as a trial. Workshop participants want to better understand non-timber implications. Also, there is a need to better define the ecosystems where moisture is truly limiting for this area. There is very little potential area in what is currently considered non-drybelt.	Fd -17m^3/ha per application.[5] Sx -11 m^3/ha per application. Benefit realized over 10 year period.	Short to Midterm
TS1c-d Late rotation fertilization of older Fd and Sx stands (81-140years 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. Moisture limited sites (drybelt) should be avoided. Priority = High as a trial for similar reasons as mentioned above, plus the unknowns around responses from older stands.	No North American data but response could be similar to younger stand benefits described above.	Short to Midterm
TS2a-b Young stand fertilization (Fd and Sx - where moisture is not limiting)	These stands will be candidates for harvesting in the mid-back end of the trough. The intent is to add volume to these stands through repeated fertilizations at 10 year intervals. This will make these stands available sooner or have more volume at time of harvest. Moisture limited sites (drybelt) should be avoided. Priority = High as a trial. Workshop participants want to better understand non-timber implications. The intent would be to focus on Fd first and then Sx because of concerns around terminal weevil exist. *Once the risks associated with MPB are reduced, treatment of younger Pl stands will become a high priority with very large potential benefits.*	Fd - 17m^3/ha per application. Sx - 11 m^3/ha per application. Benefit realized over 10 year period.	Back end of Midterm
TS3 a. Fertilize repressed Pl	Several recent small scale studies have shown spacing and fertilization of these stands has the potential to break them out of their stagnant condition and promote height differentiation. Fertilization alone may have some limited success. Priority = High to study extent of problem (uncertain on the number of ha's of repressed Pl). Low to treat due to uncertainty of success.	Bring stands back into the THLB (~150m3/ha) or improve their merchantable volume (~100 m^3/ha).	Mid to Long Term
TS4 a Spacing (drybelt Fd)	Spacing in layer 3 to thin out stagnant thickets will help to realize more merchantable volume in subsequent entries. Some stands will also require treatment of layer 2 into order to achieve the objective. Priority = High – lots of potential area and both timber and non-timber benefits achieved (habitat, urban interface fuels reductions, etc)	It was assumed that an additional entry into the stand would be possible if treatment occurs (15-30m^3/ha).	Mid to Long Term

[5] Rob Brockley, pers comm., August 2005. More detailed provided in Fertilization Backgrounder, Forsite et al. 2005. BC interior data on Fd and Sx data is unpublished. Published Pl data for the BC interior is showing average response of 12m^3/ha per application (Brockley 2001).

Strategy	Workshop Comments / Discussion	Anticipated Benefits	Timing of Benefit
TS4 b. Spacing young dense Fd or Sx leading stands (non-drybelt)	Spacing of younger even aged stands to realize merchantable volume more quickly, particularly if combined with subsequent fertilization, perhaps several times, further reducing the time to merchantability. Priority = Low. Timber supply benefit is negligible and the extent/location of these stands in the TSA is felt to be questionable.	Benefit here is mostly the promotion of a suitable stand for a subsequent fertilization adding 11-17 m3/ha.	Back end of Midterm
TS4 c. Space repressed Pl stands	Spacing to break stand out of repression by encouraging stand differentiation. Priority = Low due to limited stand availability. See TS3a	Opportunity to improve piece size/wood quality and provide a stand entry in the midterm	Mid to Long Term
TS5. Reforestation of sites with no reforestation obligations (timber focus)	Large areas of Pl are expected to be killed and not salvaged because it is currently not economic even when green. Ensuring that all of the THLB is promptly regenerated will have significant timber supply and habitat supply benefits. Candidate areas are stands killed by MPB and/or other natural mechanisms and not salvaged and therefore have no reforestation obligations. Planting under dead stems may be an option if done quickly - need to work with WCB to determine options. Note there is concern over future access for other treatments (spacing, brushing, etc). Planning will be needed to identify suitable areas and approaches. Possibility of initiating fires (small scale controlled traditional burns and/or large scale regeneration burns) in dead Pl areas was put forward by workshop participants and the creation of a fire strategy plan was encouraged. Some areas in the TSA have non-serotinous Pl cones and may not require fire but fire could be a very cost effective way to regenerate stands and can have positive effects to habitat values. Priority = High for planting, traditional burning, and development of a Fire Strategy Plan. Improves both timber supply and habitat supply. Habitat supply would benefit most from regeneration in highly impacted/ high risk watersheds.	Maintain productivity of the THLB	Mid to Long Term
TS7a. Address backlog NSR	Little to no backlog NSR sites exist and none are expected to be economically worthwhile to treat. Priority = Low	Maintain productivity of the THLB.	Mid to Long Term
TS7b. Address backlog impeded stands	Impeded stand project (2005) indicated some impeded stand exist in the TSA and should be evaluated in the field for potential treatment prescriptions. Priority = High. Reasonable efforts should be made to keep these stands on track to contribute in the midterm.	Maintain productivity of the THLB.	Mid to Long Term

6.2 Potential Strategies to Improve Timber Quality

The following table provides detail regarding potential timber quality strategies discussed in the workshop.

Table 9. Strategies to improve timber quality.

Strategy	Workshop Comments / Discussion	Anticipated Benefits	Timing of Benefit
TQ1. Spacing & Pruning	Spacing combined with pruning can improve log quality through the production of clear wood. Additionally, it can reduce fire hazard and increase species diversity in the understorey. Priority = High. Peeler Fd logs are a key focus in the TSA.	Some high value clear Douglas-fir on a small area.	Mid to long term.
TQ2. Spacing & Pruning + Fertilization	Fertilizing may allow earlier access to premium logs in deficit periods. Priority = Moderate	Some high value clear Douglas-fir on a small area	Mid to long term.
TQ3. Encourage Certification of TSA Forest Management	Continue to support the current TSA certification direction (CSA Standard CAN/CSA-Z809). Priority = High	Provides added value to all log products produced in the TSA.	Continuous

6.3 Potential Strategies to Improve Habitat Quality

The following table provides detail regarding the potential habitat supply strategies discussed in the workshop.

Table 10. Strategies to improve habitat quality.

Strategy	Workshop Comments / Discussion	Anticipated Benefits	Timing of Benefit
HS1. Planting trees and shrubs (priority habitat/species focus)	Reforestation of non-THLB areas impacted by MPB or other natural disturbances can improve hydrologic conditions in a watershed and in riparian areas.. The intention is to plant trees and/or shrubs with a habitat focus (use of broadleaves, diverse spacing, etc). Intent is to treat without removal of dead stems so there is a need to address this quickly by working with WCB to allow access. Some danger tree removal may be necessary. Potential candidate areas include watersheds with high fisheries or water use values, riparian reserves/management zones[6],.. The pine dominated areas with the highest potentially impacted fish values were in the more northerly portion of the TSA ie the Yalakom River. Priority = High	Improved habitat quality and timing of peak and low flows, hydrologic stability, faster recovery of pine dominated riparian areas and watersheds with high fisheries values. Focus on temperature sensitive streams, small lake spawning streams and streams supporting salmon, bull trout, and community watersheds.	Continuous
HS2. Thinning/spacing to accelerate old growth attributes	To be applied to mid seral to mature stands where old growth attributes need to be accelerated. (Critical habitats within Grizzly habitat and long term activity centers for spotted owls) Priority = High as a trial to understand potential	Increased areas with old growth attributes	Short to Midterm

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

Strategy	Workshop Comments / Discussion	Anticipated Benefits	Timing of Benefit
HS3. Thinning from Below in NDT4 Fd stands	Drybelt Fd stands with dense, clumped non-merch diameter classes. (Thin from below/pile and burn/underburn) Habitat specific treatments would aim to reduce ingress and encroachment in stands that historically were more open with lower stocking densities. Priority = High. Priority is for ungulate winter ranges	Helps to produce cover, forage and fire proof stands by reducing ladder fuels. Retain older structure where it exists. Priorities within ungulate winter ranges	Continuous
HS5. Introduce traditional cultural burning - regen	Regen stands - reintroduce fire to ecosystems. Broadcast burning of un-logged sites. Improves forage and berry production Priority = High (Part of fire strategy plan in TS5)	Seen as a cost effective mechanism for regeneration and habitat production.	Continuous
HS6. Road Rehab	Rehabilitating landings and roads and replanting roads important to control access, especially in areas where road density will increase due to salvage harvesting. Priority = High once access management planning is complete.	Minimize road density and access into sensitive habitat areas. Grizzly bear and mule benefit.	Continuous

6.4 Potential General Stewardship Strategies

The following table provides a list of general strategies that will assist in meeting the TSA's issues (timber supply / timber quality, habitat supply) but are not considered optional silviculture strategies because they:

- fall under basic licensee silviculture obligations, or
- are considered outside the scope of a silviculture strategy (i.e. harvesting practices), or
- are information gathering requirements.

Table 11. General stewardship strategies.

Strategy	Workshop Comments / Discussion
GS1. Where planting occurs, plant with minimal delay	Decrease regeneration delay and get stands online sooner. Planting instead of relying on naturals may be considered in some ecosystems in the TSA. Considerations - Some licensees are encouraging more natural regeneration. MoE identified that a widespread aggressive planting program reduces biological complexity. MoE supports aggressive regeneration to improve hydrologic recovery in watershed with high fisheries and human use water values.
GS2. Utilize improved planting stock (best available) whenever possible.	Get stands online sooner or with more volume.
GS4. Revise minimum harvest age criteria.	Allowing short term flexibility to harvest younger stands could dramatically help in the midterm with limited long term consequences.
GS7. Protect growing volume from forest health threats	Protect Fd from budworm and Sx from weevil – to ensure stands are available to contribute to the midterm deficit period. MoE had some concerns about the use of Btk (non-target Lepidoptera etc.).
GS8. Manage Tree Species for Diversity	Retain or establish non Pl species, including broadleafs during spacing, thinning or planting. Look to use alternatives to Pl where appropriate.
GS9. Vary regenerated stand spacing	Leave clumps, low and high densities to also encourage a diversity of products and habitats.

Strategy	Workshop Comments / Discussion
GS10. Complete an Access Management Plan	Watersheds with high wildlife values or extensive road systems. Need to limit access within forested land base when so much of it will be opened up all at one for salvage purposes.
GS11. Complete Retention Planning associated with salvage	TSA needs to complete BMP's for salvage of timber and spatially identify areas where salvage is a lower priority than non-timber values.
GS12. Work to achieve changes in pricing policy (Stumpage) that will make harvesting Pl economically feasible.	Stumpage is currently a major impediment to dealing with MPB salvage – which is key to minimizing timber supply impacts. Logging green volume when Pl stands die is worst case scenario for timber supply.

7.0 Working Targets

The following working targets were created using the current TSA situation as outlined in this document. The targets reflect what the TSA would like to achieve through the implementation of this silviculture strategy. It is recognized that it may not be possible to achieve all of the targets because of limited budgets or conflicts between targets, but they are presented to help frame high level objectives of the TSA.

7.1 Timber Supply Targets – High Concern

Short Term (0-20)

- Minimize non-recoverable losses where practical

Midterm (20-100 years)

- Minimize the depth and duration of the midterm trough.

Long Term (100years+)

- LTHL of 400,000 m³/yr (inherit capability +/- 5%) (close to max productivity – midterm seen as more important)

7.2 Timber Quality Targets – Low Concern

- Maintain diversity of stand types and ages across the land base – range of products (peelers, large sawlogs).
- Maintain large Fd peelers (min 10" top, max 25" butt) into the future.
- Maintain SFM certification to maximize value.

7.3 Habitat Supply Targets – High Concern

- Minimize negative impacts on water resources, ecosystems and species.
- Enhance/rehabilitate habitat supply sufficiently to recover Grizzly and spotted owl).
- Reduce impacts to fisheries values by addressing riparian and hydrologic recovery
- Rehabilitate NDT 4 to more natural stand structures for biodiversity and mule deer
- Develop and implement access management plans.

8.0 Silviculture Strategy

This section summarizes the preferred silviculture strategy developed at the Lillooet TSA workshop. First, the high priority strategies are outlined and then two different 5-year implementation plans/budgets are presented. The *idealized plan/budget* reflects TSA needs over the next five years and was not constrained by anything other than the availability of stands for treatment, desire to complete the treatments, and logical timelines for treatments. The *limited funding plan/budget* reflects a five year flat-line budget consistent with twice the historical funding levels for incremental silviculture[7]. This plan/budget was designed to illustrate where resources would be allocated if resources were limited.

8.1 High Priority Strategies

The workshop group in the Lillooet TSA considered the following strategies to be high priority for implementation in the next five years. The treatment of Pl stands was avoided during this time period because of the risk associated with MPB. The strategies are presented in the order they were considered, not listed in order of importance.

Late Rotation Fertilization (40-80 year old Fd and Sx stands where moisture not limiting)

Late rotation fertilization was identified as one of the only means of making more volume available at the front end of the midterm timber supply trough and is seen as the most cost effective method of fertilization[8]. Fertilization is to be restricted to sites that are not moisture limiting – the specific ecosystems in the TSA fitting this definition require evaluation. The desire of workshop participants was to implement a feasibility study for fertilization of Fd stands in Lillooet since most of the Fd leading types are considered drybelt (i.e. moisture is likely limiting). Less than 2,000 ha of prime candidate area (non Pl, non-drybelt, 40-80 years old) exists so this strategy is limited in its potential impact. There is significantly more opportunity in stands older than 80 years (~13,000 ha). A trial is recommended in these stands as well. The workshop group also expressed a need to understand/evaluate fertilizer implications on non-timber values before proceeding to operational level projects.

Young Stand Fertilization (15-40 year old Fd and Sx stands where moisture not limiting)

Fertilization of younger stands was identified as a good opportunity to add volume to the middle and back end of the midterm timber supply trough. Fd was considered the more desirable species to treat due to higher volume gains and the concern of leader weevil attacks in young Sx stands[9]. The issues around moisture limiting ecosystems and impacts to non timber values also exist with this strategy and should be addressed along with the late rotation fertilization strategy. The risks associated with this treatment are the long timeframes over which the investment must be held and protected from loss (i.e. pests or other natural disturbances). There is some question regarding the availability of applicable stand types (appears to be less than 6,000 ha currently).

[7] The 2002 FRBC RMP spreadsheets were used to define this historical expenditure level.

[8] Return on investment analysis often shows positive values for late rotation fertilization because of the short period over which the investment must be held before realizing the gain (~10 years). This short period also means less risk of losing the investment to pests or natural disturbances when compared with fertilization of younger stands.

[9] Studies where young Sx stands are fertilized have shown increased weevil damage but the net gains are still positive. This is likely part of the reason why mean Sx fertilization response is lower than that of mean Fd response.

Spacing / Thinning in Drybelt Fd stands with dense, clumped understory

Large areas of IDF have regenerated naturally with dense thickets under mature overstories. These ecosystems were adapted to some level of fire, which had the ability to thin the understory, reduce ladder fuels, and create more open conditions for surviving trees. With the exclusion of fire, high understory densities limit individual tree growth, increase ladder fuels, potentially increase susceptibility to forest health factors, and generally slow recruitment of trees into larger classes over time.

Both timber supply and habitat supply benefits were recognized with the treatment of these stands. It was determined that an integrated strategy is required in the IDF to determine different approaches to varying densities in the understory layers. Also, the strategy must be part of a long-term plan for uneven-aged management that considers forest health agents (e.g., spruce budworm), ungulate winter range objectives, and long term sustainable timber flows as each layer recruits into successive layers. This strategy is a high priority as it will yield habitat and timber supply benefits. The extent of this stand type is not clear in this TSA, so a focus in the first year should be data collection (as was also suggested in previous Type 1 strategy).

Reforestation for Timber Values - Planting

Benefits were identified for planting impacted areas of the THLB that have no reforestation obligations and a low probability of prompt natural regeneration. Planting these sites will provide future volume and ensure timely access to the remaining mature timber in heavily impacted watersheds or landscape units. Depending upon the site, natural regeneration may be slow or unable to reforest the site. This includes burnt areas and Pl stands and plantations impacted by MPB. Large areas of MPB impacted stands are not anticipated to be salvaged for economic reasons so there is expected to be significant opportunity for this strategy as the infestation progresses.

There are numerous logistical challenges for this strategy. First, areas have to be identified that will not (likely) be salvage harvested. Second, areas need to be prioritized to identify those that would benefit from artificial regeneration (i.e. not regenerate naturally for a long period) and would best help non-timber values. Third, work must be coordinated with WCB to ensure safe working conditions for planters and those who follow. Fourth, seedlings need to be ordered and paid for. These concerns need to be addressed as soon as possible to allow for timely implementation of this strategy. A staggered approach will be required to deliver this strategy: year one and two funding is identified for planning and seedling orders while planting does not begin until year three.

Reforestation for Timber Values – Fires (Strategy Development)

Workshop participants expressed a desire to reintroduce fire into the landscape through small, controlled traditional burns, and possibility large regeneration fires in areas significantly impacted by MPB. The intent is to develop a fire strategy plan designed to explore possible candidate areas and their costs/benefits/risks. Some areas in the TSA have non-serotinous Pl cones and may not require fire. Fire was seen as a potentially cost effective method of regenerating the large areas impacted by MPB because widespread salvage operations are unlikely.

The reintroduction of smaller scale traditional burns were important to First Nations and also represent a viable method for regenerating impacted Pl stands.

Address Backlog Impeded Stands

Impeded stands were identified as potentially existing in the TSA and the survey and treatment of these stands was seen as a high priority by the workshop group. Initial efforts should be put into evaluating the extent of the issue and developing prescriptions for identified stands. In some instances the no treatment option will be preferred for economic and structural diversity reasons.

Space and Prune Fd Stands for Timber Values

Pruning is noted for increasing the amount of clear wood while reducing the proportion of the knotty core. As well, pruning helps to manage the influence of the crown to produce juvenile wood with its associated poor wood properties. Ainsworth is heavily dependant on Fd peelers for their mill in the Lillooet TSA and these higher value trees tend to make harvesting economically viable in the TSA.

Support Forest Certification Initiatives

Licensees see certification of forest management in the TSA as critical to maximizing product values. Efforts to support the certification process (Public advisory process, annual reporting, etc) was a high priority.

Planting for Habitat Values

Benefits were identified for planting heavily impacted areas of the Non-THLB where natural regeneration is not expected to occur in a reasonable amount of time (i.e. specific watersheds where hydrologic green will speed recovery and reduce risk to fish). Planting these sites with conifers, broadleaves, and/or shrubs will provide improved habitat values in high risk/high values areas.

There is a time limit on making decisions for these areas as it is not considered practical if snag falling is required, so a timely under-planting program coordinated with WCB will need to be pursued.

Assess Practicality of Thinning to Promote Old Growth Attributes

Where spotted owl and mule winter range habitat areas are deficient of old growth stands, look at the possibility of thinning mid to mature seral stands to accelerate the attributes associated with old growth stands.

Where forest stand density is high in selected site series important for Grizzly bear forage, look at the possibility of thinning young and mid seral stands to accelerate the attributes associated with forage and berry production.

Use of Improved Seed

Continuing to maximize use of improved seed will improve timber supply forecasts in subsequent timber supply analyses.

Protect growing volume from forest health threats

There is a need to keep green timber growing and available for deficit period (midterm). The MPB is not the only forest damaging insect. Significant Douglas-fir beetle (*Dendroctonus pseudotsugae)* has been noted in the Fountain Valley and West Pavilion. White pine weevil (*Pissodes strobi*) is also a concern in the TSA.

Work to change current appraisal system to make Pl harvesting more economical

Current mill profiles, market conditions, and appraisal system (stumpage) in the TSA prevent pine volume from being harvested in a significant way even when green. Due to the prevalence of pine susceptible to MPB on the TSA, large areas of the TSA are at risk of being attacked with little or no salvage harvesting. Unless burned or salvaged, these areas will have poor and delayed regeneration which will have impacts on the mid and long term.

Watershed Risk Assessment

There is a need to complete an analysis to identify watersheds that are inherently at high risk from forest disturbances and those that are likely to be put in high risk situations because of MPB. Risk can be assessed using a forecast of equivalent clear cut areas. This information can be used to support decisions on whether to pursue an aggressive incremental planting program.

Riparian, Spotted owl, Grizzly bear, and Mule Deer Habitat assessments

To mitigate impacts on these values assessments are needed to identify condition and area in potentially treatable condition. Field visits would be needed after treatable stands and their locations are known. The condition of riparian reserve and management areas is needed in drainages with higher fisheries values. The purpose of riparian assessment is to find treatable stands where broadleaf species or other appropriate riparian species could be planted. Assessment of suitable habitat associated with long term activity centers for spotted owls will also determine which areas do not meet the 67% suitable habitat condition and how much treatable area is present practices such as pre-commercial thinning to improve older forest stand structure. Similarly an assessment of the amount and condition of selected site series identified as grizzly bear forage and berry producing areas will inform how much treatable area is potentially available for bear recovery.

Assessment of area and condition of mule deer winter range and Old Growth Management area will are determine condition and treatable area potentially available. These assessments are seen as logical habitat outcomes of a Type 2 silviculture strategy to guide silviculture investments.

8.2 Silviculture Strategy Program (Idealized Funding Level)

This section describes an idealized or desired (no constraints on $ or manpower) silviculture program in terms of ha treated, budget requirements, and job outcomes. It assumes 20.9 million dollars are needed and available over the next five years.

Proposed Area Treated (ha)

Activity	Year 1 (ha)	Year 2 (ha)	Year 3 (ha)	Year 4 (ha)	Year 5 (ha)	Totals (ha)
Studies/Surveys	-	-	-	-	-	-
Fertilize	-	1,000	1,000	1,000	1,000	4,000
Spacing/Thinning (timber)	500	500	500	500	500	2,500
Spacing/Thinning (habitat)	200	300	300	300	200	1,300
Reforestation (timber - MPB)	-	-	-	2,000	2,000	4,000
Reforestation (timber - fires)	-	1,500	1,500	1,500	1,500	6,000
Reforestation (timber - Backlog)	-	500	500	100	100	1,200
Planting (habitat)	200	200	200	200	200	1,000
Space & Prune (quality)	250	250	250	250	250	1,250
Cultural Burning (timber - MPB)	-	-	-	5,000	5,000	10,000
Cultural Burning (habitat)	400	400	400	400	400	2,000
Totals	**1,550**	**4,650**	**4,650**	**11,250**	**11,150**	**33,250**

Proposed Budget ($)

Activity	Year 1 ($)	Year 2 ($)	Year 3 ($)	Year 4 ($)	Year 5 ($)	Totals ($)
Studies/Surveys	255,000	50,000	200,000	-	-	505,000
Fertilize		400,000	400,000	400,000	400,000	1,600,000
Spacing/Thinning (timber)	300,000	300,000	300,000	300,000	300,000	1,500,000
Spacing/Thinning (habitat)	120,000	180,000	180,000	180,000	120,000	780,000
Reforestation (timber - MPB)		-	-	2,000,000	2,000,000	4,000,000
Reforestation (timber - fires)	400,000	1,500,000	1,500,000	1,500,000	1,500,000	6,400,000
Reforestation (timber - Backlog)		600,000	600,000	120,000	120,000	1,440,000
Planting (habitat)	120,000	120,000	120,000	120,000	120,000	600,000
Space & Prune (quality)	350,000	350,000	350,000	350,000	350,000	1,750,000
Cultural Burning (timber - MPB)		-	-	1,000,000	1,000,000	2,000,000
Cultural Burning (habitat)	120,000	40,000	40,000	40,000	40,000	280,000
Totals	**1,665,000**	**3,540,000**	**3,690,000**	**6,010,000**	**5,950,000**	**20,855,000**

Job Outcomes

Activity	Year 1 Person Days	Year 2 Person Days	Year 3 Person Days	Year 4 Person Days	Year 5 Person Days	Totals Person Days
Studies/Surveys	850	167	667	-	-	1,683
Fertilize	-	100	100	100	100	400
Spacing/Thinning (timber)	1,695	1,695	1,695	1,695	1,695	8,475
Spacing/Thinning (habitat)	680	1,020	1,020	1,020	680	4,420
Reforestation (timber - MPB)	-	-	-	9,000	9,000	18,000
Reforestation (timber - fires)	-	6,750	6,750	6,750	6,750	27,000
Reforestation (timber -Backlog)	920	920	920	920	920	4,600
Planting (habitat)	500	500	500	500	500	2,500
Space & Prune (quality)	2,910	2,910	2,910	2,910	2,910	-
Cultural Burning (timber- MPB)	-	-	-	10,000	10,000	
Cultural Burning (habitat)	800	800	800	800	800	4,000
Totals	**8,355**	**14,862**	**15,362**	**33,695**	**33,355**	**71,078**

The studies/surveys listed in the tables above reflect the initial setup of specific programs (e.g. identify and prioritize fertilization candidates, fire strategy planning, identification of repressed PI, watershed risk assessments, impeded stands), and the confirmation of areas suitable for habitat or timber strategies. Ongoing survey and layout costs associated with specific strategies are included in the strategy costs.

8.2.1 Expected Outcomes (Idealized Funding Level)

If 20.9 million was invested over a 5-year period, the following outcomes could be expected:

Estimated Timber Supply Outcomes

- 22,000 m^3 made available at the front end of the trough
    - Realized from late rotation fertilization (more not completed because of a perceived lack of candidate areas)
- 64,000 m^3 made available in the middle of the trough
    - Realized from young stand fertilization and spacing in drybelt Fd stands.
- 2,060,000 m^3 made available in the back end of the trough
    - Realized from regenerating THLB (through planting or burning) areas with no regeneration obligations.
- An unquantifiable benefit from the reforestation of up to 21,000 ha (includes cultural burning) of sites with a habitat focus, thereby avoiding further set-asides from within the THLB.

Timber Quality Outcomes

- ~125,000 m^3 of additional clear Fd log volume made available near the back of the trough from completing pruning and spacing on 1250 ha.

Habitat Supply Outcomes

- Enhanced forest structure on 300 ha of mid/mature seral stands and drybelt Fd stands (thinned/spaced).
- Regeneration of 3,000 ha of impacted stands with a habitat focus, and regeneration of 20,000 ha of impacted stands with a timber focus to speed hydrologic recovery and mitigate stream temperatures by regeneration.
- Protection and planning for high value/high risk watersheds though the preparation of a watershed risk assessment.

8.2.2 Expected Outcomes for 20 year Investment (Idealized Funding Level)

If similar benefits could be produced by continuously investing at this level for 20 years (total of $83.4 million), the front end of the trough would rise by 4,000 m^3/yr, the mid by 6,000 m^3/yr and the back end of the midterm trough could rise by 64,000 m^3/year (Figure 15). This forecast is highly speculative and there is no guarantee that enough suitable treatment areas could be found.

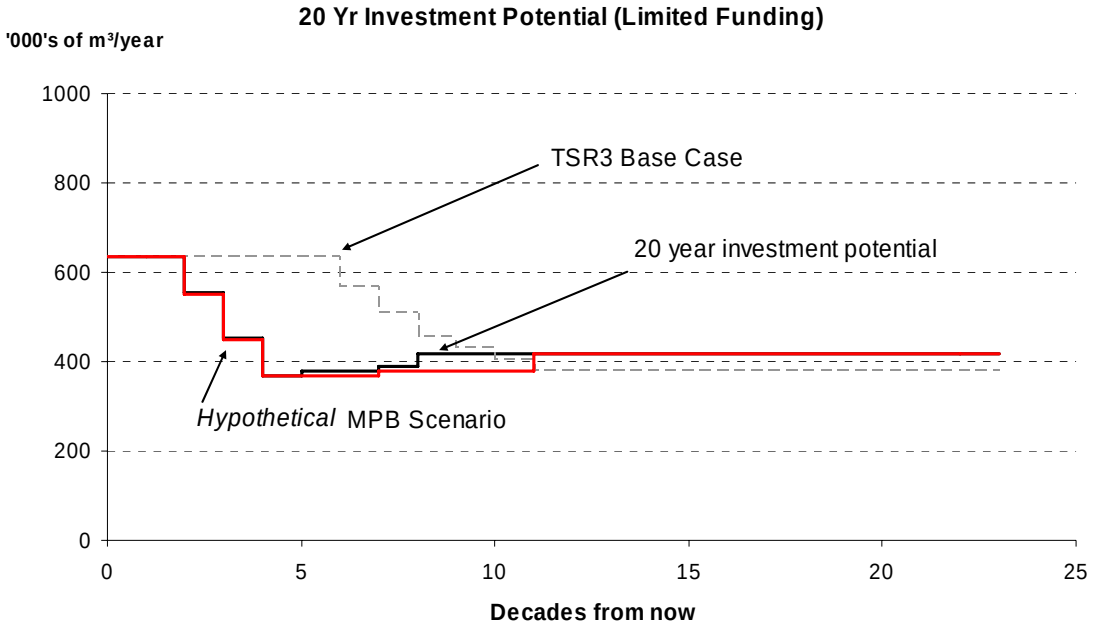

Figure 15. 20 year continuous investment (idealized funding level).

8.3 Silviculture Strategy Program (Limited Funding Level)

This section describes a silviculture program constrained to approximately 5.5 million dollars over five years in terms of ha treated, budget requirements, and job outcomes to achieve objectives focused on timber supply.

Proposed Area Treated (ha)

Activity	Year 1 (ha)	Year 2 (ha)	Year 3 (ha)	Year 4 (ha)	Year 5 (ha)	Totals (ha)
Studies/Surveys	-	-	-	-	-	-
Fertilize	-	-	-	-	-	-
Spacing/Thinning (timber)	200	200	200	200	200	1,000
Spacing/Thinning (habitat)	100	200	100	100	100	600
Reforestation (timber - MPB)	-	-	-	300	300	600
Reforestation (timber - fires)	-	600	600	200	200	1,600
Reforestation (timber - Backlog)	-	-	-	-	-	-
Planting (habitat)	50	50	50	50	50	250
Space & Prune (quality)	100	100	100	100	100	500
Cultural Burning (timber - MPB)	-	-	-	1,000	1,000	2,000
Cultural Burning (habitat)	200	200	200	200	200	1,000
Totals	**650**	**1,350**	**1,250**	**2,150**	**2,150**	**7,550**

Proposed Budget ($)

Activity	Year 1 ($)	Year 2 ($)	Year 3 ($)	Year 4 ($)	Year 5 ($)	Totals ($)
Studies/Surveys	255,000	50,000	200,000	-	-	505,000
Fertilize	-	-	-	-	-	-
Spacing/Thinning (timber)	120,000	120,000	120,000	120,000	120,000	600,000
Spacing/Thinning (habitat)	60,000	120,000	60,000	60,000	60,000	360,000
Reforestation (timber - MPB)	-	-	-	300,000	300,000	600,000
Reforestation (timber - fires)	400,000	600,000	600,000	200,000	200,000	2,000,000
Reforestation (timber - Backlog)	-	-	-	-	-	-
Planting (habitat)	30,000	30,000	30,000	30,000	30,000	150,000
Space & Prune (quality)	140,000	140,000	140,000	140,000	140,000	700,000
Cultural Burning (timber - MPB)	-	-	-	200,000	200,000	400,000
Cultural Burning (habitat)	60,000	20,000	20,000	20,000	20,000	140,000
Totals	**1,065,000**	**1,080,000**	**1,170,000**	**1,070,000**	**1,070,000**	**5,455,000**

Job Outcomes

Activity	Year 1 Person Days	Year 2 Person Days	Year 3 Person Days	Year 4 Person Days	Year 5 Person Days	Totals Person Days
Studies/Surveys	850	167	667	-	-	1,683
Fertilize	-	-	-	-	-	-
Spacing/Thinning (timber)	678	678	678	678	678	3,390
Spacing/Thinning (habitat)	340	680	340	340	340	2,040
Reforestation (timber - MPB)	-	-	-	1,350	1,350	2,700
Reforestation (timber - fires)	-	2,700	2,700	900	900	7,200
Reforestation (timber -Backlog)	230	230	230	230	230	1,150
Planting (habitat)	200	200	200	200	200	1,000
Space & Prune (quality)	1,164	1,164	1,164	1,164	1,164	-
Cultural Burning (timber- MPB)	-	-	-	2,000	2,000	
Cultural Burning (habitat)	400	400	400	400	400	2,000
Totals	**3,862**	**6,219**	**6,379**	**7,262**	**7,262**	**21,163**

The studies/surveys listed in the tables above reflect the initial setup of specific programs (e.g. fertilization feasibility study, repressed Pl identification, fire strategy planning, drybelt Fd thinning candidates), and the confirmation for the amount of area suitable for habitat or timber strategies. Ongoing survey and layout costs associated with specific strategies are included in the strategy costs.

8.3.1 Expected Outcomes (Limited Funding Level)

If approximately 8 million was invested in timber focused projects over a 5-year period, the following outcomes could be expected:

Estimated Timber Supply Outcomes

- 0 m^3 made available at the front end of the trough
- 12,000 m^3 made available in the mid-back end of the trough
    - Realized from spacing in drybelt Fd stands.
- 420,000 m^3 made available at the back end of the trough
    - Realized from regenerating THLB (through planting or burning designed to promote natural regeneration) areas with no regeneration obligations.
- An unquantifiable benefit from regenerating of up to 3,250 ha (including the use of traditional cultural burning) for a habitat focus, thereby avoiding further set-asides from within the THLB.

Timber Quality Outcomes

- ~50,000 m^3 of additional clear Fd log volume at the back of the trough from completing pruning and spacing on 500 ha.

Habitat Supply Outcomes

- Enhance forest structure on 500 ha of drybelt Fd stands (thinned/spaced) and 100 ha of mid-mature seral stands (accelerated old attributes).
- Regeneration of 1,250 ha of impacted stands with a habitat focus, and regeneration of 4,200 ha of impacted stands with a timber focus to speed hydrologic recovery and mitigate stream temperatures by regeneration.
- Protect and plan for high value/high risk watershed though the preparation of a watershed risk assessment.

8.3.2 Expected Outcomes for 20 year Investment (Timber-focus Limited Funding Level)

If similar benefits could be produced by continuously investing at this level for 20 years (total of $21.8 million), front end of the trough would remain unchanged, the mid would rise by 1,000 m^3/yr and the back end of the midterm trough could rise by 14,000 m^3/year (Figure 16). This forecast is highly speculative and there is no guarantee that enough suitable treatment areas could be found.

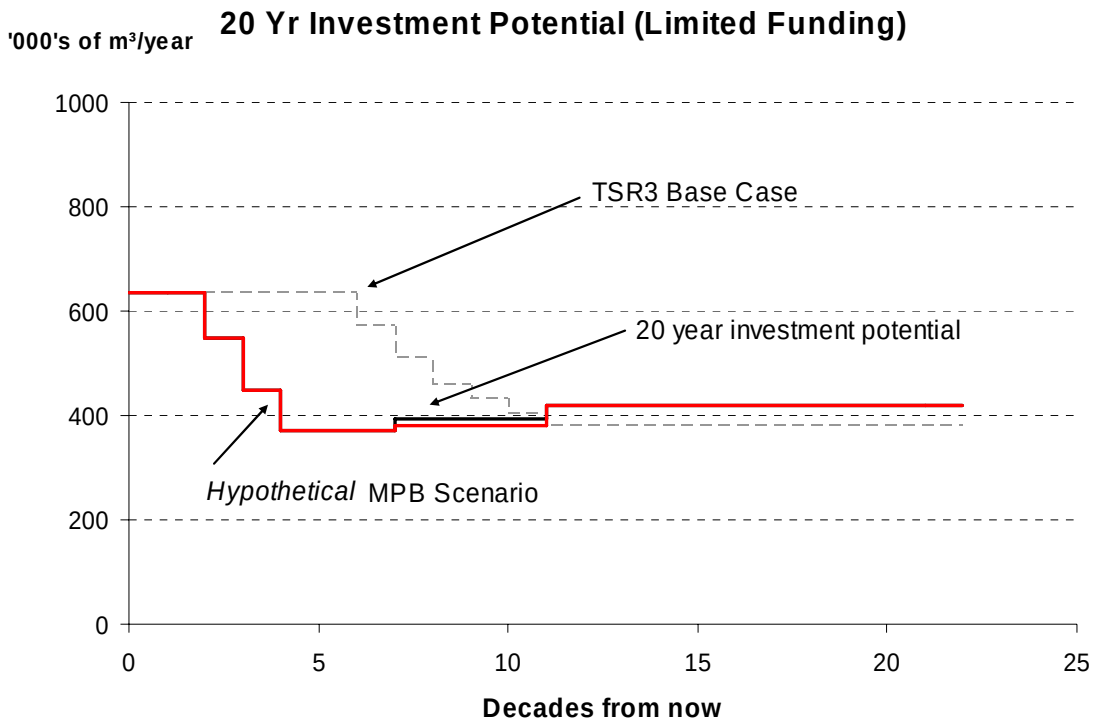

Figure 16. 20 year continuous investment (Limited - funding level).

9.0 Summary of Information and Research Needs

During the preparation of this document, the following needs for further information and/or research were identified in support of meeting TSA objectives for timber supply, timber quality, and habitat supply.

1. Extension of fertilization research results is required to satisfy concerns around impacts to non-timber issues.
2. A feasibility study for the fertilization of Fd in drybelt ecosystems since almost all Fd in the Lillooet TSA are in drybelt zones (determine which ecosystems in the drybelt are truly moisture limiting).
3. An inventory of repressed Pl stands is needed to understand the significance of this issue.
4. Development of a strategic fire plan that would guide the use of fire designed to promote regeneration of impacted Pl stands and address traditional management concerns (encroachment, ingress).
5. Inventory for locations of species of conservation concern and the amount and condition of habitat that is potentially treatable so that management, including incremental silviculture activities, can better address these species.
6. Develop a forest health strategy that looks beyond MPB in order to protect growing volume that will be critical in the midterm trough.
7. Develop an access management plan to limit the amount of open road within the TSA.
8. Develop a seed strategy that identifies seed inventories (natural stand and orchard), seed gaps and seed mitigation strategies over the short and long term.
9. There is a desire to look at changing stocking standards / free growing standards to include more broadleaves.
10. Develop a watershed risk assessment to identify and plan for highly sensitive watersheds and minimize risk to water resources.
11. A Type 2 Silviculture Strategy is needed to clarify the outcomes for opportunities presented here and to identify sensitive watersheds and riparian areas for treatment as well as the stands to treat for enhancement to stand structure. All of the potential opportunities presented here require refinement in terms of areas, timing and impacts.

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Appendix A: Abbreviations

AAC	Allowable Annual Cut
Analysis	Timber Supply Analysis
AU	Analysis Unit
BCTS	BC Timber Sales (Formerly Small Business Forest Enterprise Program)
BEC	Biogeoclimatic Ecosystem Classification
BEO	Biodiversity Emphasis Options
BGB	Biodiversity Guidebook
Bl	Subalpine fir
BMP	Best Management Practices
CF	Chief Forester
CFLB	Crown Forested Land base
CT	Commercial Thinning
CW	Western Red Cedar
DBH	Diameter at breast height (1.3m)
DEO	Designated Environment Official
DFO	Department of Fisheries and Oceans
DM	District Manager
ECA	Equivalent Clearcut Area
ESA	Environmentally Sensitive Area
Fd	Douglas Fir
FES	Forest Ecosystem Specialist
FIP/FC1	Old Forest Cover Digital Files
FMER	Fire Maintained Ecosystem Restoration
FIZ	Forest Inventory Zone
FPC	Forest Practices Code
FRBC	Forest Renewal British Columbia
FSSIM	Forest Service Simulation Model
GIS	Geographic Information System
HLPO	Higher Level Plan Order
Hw	Western Hemlock
ICH	Interior Cedar Hemlock
IWAPS	Interior Watershed Assessment Procedure System
La	Alpine Larch
LRMP	Local Resource Management Plan
LTHL	Long Term Harvest Level
LU	Landscape Unit
Lw	Western Larch
MoFR	Ministry of Forests and Range
MoE	Ministry of Environment
MPB	Mountain Pine Beetle
MSR	Machine Stress Rated
MSY	Maximum Sustained Yield
MSYT	Managed Stand Yield Tables
NCC	Non-Commercial Cover
NDT	Natural Disturbance Type
NP	Non Productive
Pl	Lodgepole Pine
PSP	Permanent Sample Plot
PSYU	Public Sustained Yield Unit
Pw	White Pine
Py	Ponderosa Pine (tree species) or person years (economics)
RM	Regional Manager
RMZ	Riparian Management Zone
ROS	Recreation Opportunity Spectrum
THLB	Timber Harvesting Land base
TIPSY	Table Interpolation Program for Stand Yields (growth and yield model)
TSA	Timber Supply Area
TSR	Timber Supply Review
UREP	Use, Recreation, and Enjoyment of Public
VDYP	Variable Density Yield Predictor (growth and yield model)
VEG Ht	Visually Effective Greenup Height
VQO	Visual Quality Objective
WTP	Wildlife Tree Patch