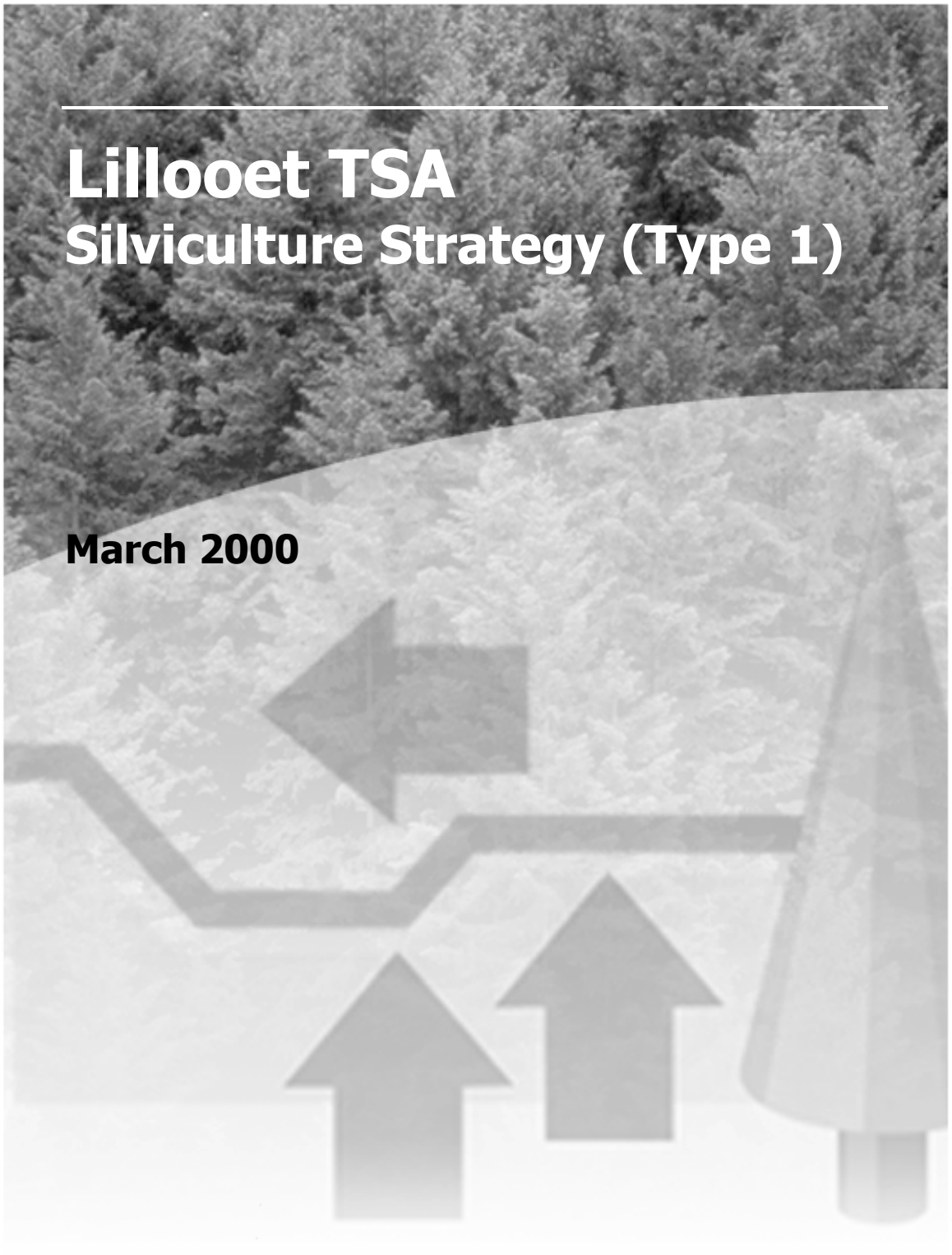
Lillooet TSA
Silviculture Strategy (Type 1)

March 2000



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The consultants also wish to thank the participants in the workshop whose contributions are the basis of this strategy, and are listed below.

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Preface

The development of silviculture strategies for TSAs and TFLs is motivated by the desire to clarify the relationship between investments in silviculture and the critical forest-level issues specific to the management unit.

The Type 1 analysis is workshop-based. It draws on the expert knowledge of the participants to identify the critical issues, derive objectives with respect to those issues, specify regimes to meet those issues, and identify the regime activities that can be implemented in the next five years. After consideration of the benefits and costs of each of the activities on each of the forest-level objectives, the participants rank the silviculture activities by priority. The result is a prioritized list of silviculture activities that are explicitly linked to the critical issues of the management unit.

Type 2 analyses are model-based, but the analysis process is fundamentally identical to the Type 1 analysis. A forest-level model is used to evaluate the impacts of regimes on the forest-level objectives, to identify the silviculture activities constituting the "preferred management scenario", and to rank those activities.

The Type 2 (model-based) analysis will result in a silviculture strategy that is considerably more appropriate and robust than the Type 1 approach, but it is more expensive and demanding of scarce modeling expertise. Hence the Type 1 (workshop-based) approach has been designed to produce an interim silviculture strategy that will serve until a Type 2 analysis can be completed.

In the absence of a silviculture strategy for a management unit, the Ministry of Forests' provincial level strategy *Incremental Silviculture Strategy For British Columbia (Interim)* has provided interim guidance. A summary of this document is included as an appendix to this report.

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Strategy Summary

While many issues were proposed and discussed in the workshop, the participants focused on 13 issues, and subsequently developed 11 strategies to address them.

Elements of the Strategy

Alleviate the timing and magnitude of the 40% falldown in timber supply that is projected to begin in three decades by harvesting low-volume, fire-origin stands and bringing them into management; using patch cut and strip cut silvicultural systems in older, high-graded Douglas-fir stands; protecting established plantations; and planting mixed deciduous-coniferous species on backlog NSR or borderline stocked river valley sites.

Initiating these practices in the next 5-year management period will help to offset the forecast reduction in long-term harvest level as well as any additional constraints from protected areas that may arise.

Large-diameter Douglas-fir in areas with VQOs are under increasing harvesting pressure, and their mid- and long-term supply may not be sustainable under current silviculture practices. There is a need to increase emphasis on modelling and design in VSAs and achieve green-up more quickly through reducing regeneration delay from the TSR2 assumption of 3-4 years.

Mule deer winter range (MDWR) requirements are not defined for the TSA and MDWR is a common source of large-diameter Douglas-fir. South-facing blocks scheduled for harvest in the next ten years (i.e., potential MDWR) require criteria and targets. Consider combining MDWR and VSAs where they overlap to minimize downward pressure on the AAC.

Visual Quality Objectives can be met with partial cutting in some situations, but VQOs require better clarification in the Lillooet TSA. Determine the long-term impacts of VQOs on forest productivity, regeneration success and extent of root disease.

Reduce the time to achieving visual, hydrological and regeneration green-up through appropriate silviculture practices (prompt regeneration, use of improved seed and large stock, brushing for height growth) to minimize constraints on timber supply from adjacent stands.

Investigate and mitigate, where required, the impacts of past streamside logging through streamside classification and appropriate silviculture treatments.

Train and employ a local workforce that can anticipate long-term, all-season forestry work that improves stand condition and long-term timber supply at the TSA level.

Inventory root disease (Armillaria root rot) in the ICH to determine the extent and impact. Conduct management practices that extract timber where possible, combine severely infected sites with other management constraints to optimize overlap for planning purposes, and treat root disease as required through various harvesting and silviculture practices.

Investigate the condition of the TSA's 50 000 ha of dry belt Douglas-fir to identify needed silviculture goals for low elevation, low volume stands and areas with low stocking or site occupancy.

Maximize Douglas-fir stocking on drier sites in the IDF/MS transition to avoid short-term conversion to lodgepole pine.

Survey roads and landings to identify opportunities for rehabilitation and the necessary treatments to restore site productivity.

Tactical Priorities

The tactical priorities set by the participants represent a balance between the participant's strategic objectives for the management unit and the silvicultural opportunities available on the TSA in the next 5 years. Table S-1 lists activities identified by the participants and the rank (priority) assigned to each activity.

Table S-1. Silviculture treatments and areas selected by the workshop participants.

Activities/Treatments	Opportunity (ha/year)	Workshop Rank
Survey		
1 Backlog	1397	3
2 Green up surveys	5000	3
3 Survey - opportunity road and landing rehab	20	5
Regen to FG		
4 Protection of existing plantations: Brush blanket, vexar, shade card maintenance, brushing - Backlog	211	1
5 Planting - Backlog	170	2
6 Seed - Backlog	81	2
7 General surveys	318	3
Spacing		
8 Incremental	78	4
Pruning		
9 Incremental	23	4
10 Forest health	21	3

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1 Introduction

The Silviculture Strategy (Type 1) workshop draws on the expert knowledge of the participants to identify the key issues that should guide silvicultural planning on the TSA, derive objectives with respect to those issues, specify regimes to meet those issues, and identify the regime activities that can be implemented in the next five years. The key idea is that this line of logic from issues to silvicultural activities can be retraced when evaluating funding levels, ensuring that activities are funded that address critical TSA issues.

The first step in developing this line of logic is to identify the key issues that should guide silvicultural planning on the TSA. Next, the participants' objectives with respect to these issues are clearly stated. Strategies for meeting these objectives are identified, together with the silvicultural target (stand types) to which these strategies are to be applied. A plan of action, most often a silvicultural regime, is then developed to implement each strategy. This sequence constitutes the "strategic analysis"part of the workshop and the resulting compilation of issues, objectives, strategies and regimes is the silviculture strategy.

After developing the strategy, the workshop identifies opportunities to implement the regimes in the next five years and develops a program of silvicultural activities that is consistent with the strategy and is feasible with respect to the operational realities of the TSA. The impacts of these silvicultural activities on selected objectives are estimated by the workshop participants, and in a final step, the activities are ranked as to their importance with respect to the TSA issues. Development of the 5-year plan of silvicultural activity and estimating impacts and evaluating ranks of the activities constitutes the "tactical analysis"part of the workshop.

This report documents the results of a workshop to develop a strategy and a 5-year plan for the Lillooet TSA. Following this introduction, section 2 summarizes the results of the strategic analysis and section 3 presents the analysis of the 5-year plan. Appendix 1 contains a detailed examination of the timber supply situation on the TSA, prepared prior to the workshop, as some aspect of timber supply is often a guiding issue for silviculture planning. During the workshop's consideration of TSA issues, strategies and silvicultural regimes, a number of additional issues were identified that require investigation prior to silvicultural action and are compiled in Appendix 2.

2 Analysis of Issues and Strategies

2.1 Identification of Issues and Strategies

This section identifies the critical issues that guide silviculture planning in the Lillooet TSA and the strategies developed in the workshop for addressing them. Related "to do" tasks are included with the relevant issue.

Issue 1: Timber Supply Falldown (H)

The timber harvest is forecast to fall by about 40% from current harvest levels to the LTHL, beginning in three decades. The timing of the falldown is highly sensitive to existing stand yields, forest cover constraints and exclusion of mature timber, and the falldown could begin almost immediately if the landbase is reduced or SI/Inventory audits are unfavourable. The timing and magnitude of the falldown need alleviation in the early mid-term.

Strategies:

1. Harvest for OSB sales and regenerate, targeting low-volume, fire-origin pine stands greater than 60-years-old in the West Pavilion and Yalakom.
2. Harvest using patch cut and strip cut silvicultural systems in older, high-graded Douglas-fir. Microsite plant to maximize survival and growth.
3. Plant mixed deciduous-conifer stands on older river valley sites that are backlog NSR or borderline stocked.
4. Protection of existing plantations (backlog) through brush blankets, vexar, shade card maintenance and brushing.

To Do:

1. Investigate opportunities for juvenile spacing within the TSA with regard to accelerating minimum harvest age and offsetting falldown.
2. Determine extent of protected areas (not yet known), as they could have a substantial effect on timber supply.

Issue 2: Harvest Profile for Visually Sensitive Areas (H)

Harvesting pressure is increasing on large-diameter Douglas-fir in areas with VQOs. Some of the workshop participants expressed concern over the sustainability of this resource, including the ability for future needs for large-diameter Douglas-fir to be met through current silviculture practices.

Strategies:

1. Increase emphasis on modelling and design in visually sensitive areas (VSAs). Mimic natural disturbances with harvesting practices.

2. Achieve green-up more quickly in VSAs by minimizing regeneration delay from the 3-4 years assumed in TSR2.

Issue 3: Mule Deer Winter Range (H)

Mule deer winter range (MDWR) often includes large-diameter Douglas-fir that are experiencing increased harvest pressure with resultant concerns over the future supply of this valuable forest product. Additionally, MDWRs are currently not defined, but those areas that overlap with VSAs could be combined to reduce downward pressure on the AAC.

Strategies:

1. Set criteria and targets for MDWR on south-facing blocks scheduled for harvest in the next ten years, and undertake management practices to retain or create attributes as required.

To Do:

1. Develop criteria for critical mule deer winter range, map and field check.
2. Undertake yield studies on the different silvicultural systems that will maximize yields while meeting VQOs. Monitor effect on LRMP.

Issue 4: Visual Quality Objectives (H)

Partial cutting mitigates timber supply reductions resulting from VQO requirements, but VQOs require better clarification in the TSA. Furthermore, the long-term effects of the impacts of VQOS are unknown. There is a need to determine VQO impacts on forest productivity, regeneration success and extent of root disease, and develop more reliable yield information for overstory and understory species under partial cutting silvicultural systems.

Strategies:

1. Use lay-out and design to mimic natural disturbance for openings in Visually Sensitive Areas and use silvicultural systems that maintain VQO while creating openings.

To Do:

1. Undertake yield studies on the different silvicultural systems that will maximize yields while meeting VQOs. Monitor effect on LRMP.
2. Complete visual quality inventory.

Issue 5: Green-up (H)

Achievement of green-up requirements (visual, hydrological, regeneration) constrains timber supply, particularly in Pulpwood Agreement #16 where harvesting a low volume pulp stand may make an adjacent high volume stand inoperable until green-up requirements are met.

1. Reduce the time to achieving green-up (visual, hydrological and regeneration) throughout the TSA through various silviculture options.

2. Investigate deviations from the standard (top height, density, adjacency requirement) through surveys and other data to present to the MOF district manager for consideration.

Issue 6: Riparian (H)

Significant lengths of streams in the TSA were logged to their banks, which may increase stream temperature from reduced shade. Streamside classification is required to determine the impact of prior logging and the resultant need for silviculture activities to stabilize banks, grow shade and restore the functioning of streamside vegetation as habitat and foodchain input.

Strategies:

1. Mitigate the impacts of past streamside logging by defining the significant parameters, identifying practices, and conducting appropriate silviculture activities on critical sites in Riparian Management Zones.

To Do:

1. Complete streamside classification. Define significant parameters and identify practices to mitigate the impact of streamside harvesting.

Issue 7: Employment (H)

Long-term employment opportunities are required for the local workforce through desirable, site-specific silviculture activities that improve stand condition and long-term timber supply.

Strategies:

1. Train and employ a local workforce that can anticipate long-term, all-season forestry work.

To Do:

1. Develop continuity of employment opportunities for the local labour force. Identify target workforce and appropriate forestry and silviculture opportunities and training needs. Address how to fund training (agencies, programs) and the hiring of local crews through direct award or local bid, which may admittedly be more expensive.

Issue 8: Root Disease (M)

Root disease (Armillaria root rot) in even-aged and uneven-aged Douglas-fir stands, most notably in the IDF, poses an unknown threat that requires inventory of its extent and impact. Strategies are required to deal with root disease.

Strategies:

1. Extract timber values where they exist for sites that exceed a given threshold of root disease incidence.

2. Combine, through planning, root disease areas that are untreatable or very costly to treat with other constrained areas to meet multiple objectives.

3. Treat root disease as required within development areas by identifying root rot centres and reducing inoculum through various harvesting and silviculture methods.

To Do:

1. Identify the extent and impact of root disease in the TSA and develop strategies to minimize.

2. Monitor efficacy of root rot inventory and treatment. Assess validity of inventory and use adaptive management to find solutions.

Issue 9: Dry Belt Douglas-fir (M)

Various silvicultural approaches exist for managing the 50 000 ha of dry belt Douglas-fir in the Lillooet TSA. However, the condition of these forests is largely unknown due to the failure of forest cover labels to adequately describe these stands. A major mapping project is required that includes an interpretive component that stratifies the polygons into known/unknown, with a field check to check the unknowns. Silvicultural goals can then be set for limiting Fdi encroachment onto grasslands, reducing the encroachment of fir thickets into old growth Fdi forests and maintaining mule deer winter range.

Strategies:

1. In the IDF, catalogue site productivity for low elevation, low volume (100-150 m3/ha) areas, and areas with low stocking or site occupancy. Harvest higher sites, priorize and retain for other objectives.

To Do:

1. Reduce the uncertainty by calibrating inventory of dry belt Douglas-fir and identify appropriate practices.

Issue 10: IDF/MS Zones (M)

Douglas-fir stands are being converted to leading lodgepole pine to meet free-growing standards. Fir then restocks back naturally over time.

Strategies:

1. Maximize Douglas-fir stocking levels on sites where fir is appropriate, particularly on drier sites in the IDF/MS transition.

Issue 11: NDT4 (M)

Management of NDT4 for habitat and forest health requires lower stocking and less planting of Douglas-fir.

To Do:

1. Clarify transitional NDT4 (grassland/forested) management practices.

Issue 12: Roads and Landings (L)

Restore site productivity of roads and landings to bring back into the THLB.

Strategies:

1. Survey roads and landings to identify opportunities and rehabilitation (site preparation and planting) as appropriate.

Issue 13: Landscape Unit Planning/Dry Belt Douglas-fir (L)

Interaction of old growth targets at the landscape level cannot be met in the IDF. Old growth is mapped but not ground truthed. Need to determine impact of OGMAs on timber supply in the IDF.

To Do:

1. Determine the impact of current and proposed OGMAs on timber availability and supply in the IDF.

2.2 Identification of Targets, Regimes and Activities

Table 2-1 documents the workshop's analysis of the issues and strategies identified in section 2.1. In some situations the workshop participants rejected some strategies after identifying their silvicultural target and the activities required to implement the strategy.

Table 2-1. Silviculture strategies developed by the workshop to mitigate critical TSA issues.

#	P	Issue Name	Issue Description	Objective	Strategy	Target	R	Regime Description	A	Activities
1	H	Timber supply falldown	A 40% reduction in timber supply is projected beginning in decade 3	Alleviate timing and/or magnitude of falldown in early mid term	Harvest for OSB sales; regen	Low volume pine, fire origin 60+ year old; West Pavillion and Yalakom; some is protected area.		Site prep, plant.		
					Patch cuts; strip cuts; regen	older IDF high graded		Site prep, microsite plant.		
					Plant mixed deciduous - conifer	older river valley sites; backlog NSR and SR at minimums		Deciduous reforestation		plant cottonwood; microsite plant on natural mounds to lower stocking
2	H	Visually Sensitive Areas harvest profile	Increasing harvest pressure on large diameter Fdi in VSA - concern with long-term availability.	Increase or maintain timber supply from VSAs	Increase emphasis on modelling and design; mimic natural disturbances	VSA				
					Achieve green-up more quickly	VSA		Mimimize regen delay (TSR2 assumes 3-4 years)		aggressive planting (<1 year after harvest) using large stock (>415D)
3	H	Mule deer winter range	Increasing harvest pressure on large diameter Fdi in MDWR. Concern with availability.	Define MDWR; Increase or maintain supply from VSAs; minimize the effect on AAC by aggregating	Set targets and criteria indicative of MDWR	Blocks scheduled over next 10 years with south-facing aspects. Confirm by field check.		Manage to retain or create attributes		harvesting system appropriate for MDWR; recruitment by species selection and density control
4	H	VQO	Partial cutting mitigated VQO timber supply reductions, but long-term effects unknown. Determine impact on productivity, regeneration problems, and extent of root rot.	Clarify VQOs in the TSA.; better yield info for partial cuts; regenerating under partial cuts;	Use layout and design to mimic natural disturbance for openings	VSAs; priorize by zones, major travel corridors		Harvesting system that maintains VQO while creating openings		plant higher densities with root rot-resistant species
5	H	Green-up	Constrains timber supply. Relates to PA16 - harvesting a low volume stand may make an adjacent high volume stand inoperable.	Reduce time to green-up (visual, hydrological, reforestation).	Reduce time to green-up	SP to green-up, TSA wide	1	Silviculture options		minimize regen delay; mechanical site prep (site-specific due to terrain); brushing (chemical and manual); plant higher densities, microsite selection; fertilize prior to green-up; at harvest protect advance regen
							2	Investigate deviations from standard: top height, density, adjacency requirement		as required; surveys and data to make case to DM
6	H	Riparian	Significant lengths of streams were logged to the bank, which may increase stream temperature. Complete streamside classification.	Define significant prarmeters; identify practices; mitigate impact of streamside harvesting	Mitigate impacts of harvesting	RMZs; critical sites		SIlviculture practices to address impacts on streamside vegetation		determine critical factor at FDP stage; vary stocking standards; allow for mixed stocking; allow herbaceous species; concentrate on microsite planting; consider best management practices as appropriate
7	H	Employment	Provide local employment opportunities by sound forest management activities. Spacing and pruning support local employment needs, but are these treatments site-specifically appropriate?	Promote employment opportunities; develop practices that are good forestry and provide employment	Train and utilize local workforce to implement sound, site-specific forest practices.	—-> to do list				
8	M	Root disease	Occurs in uneven-aged stands and even-aged Fdi. Determine extent of the issue through an inventory.	Identify extent and impact. Identify strategies to deal with root rot.	Extract timber value where it exists	Sites with root rot > x%		Harvest		
					Combine root rot areas with other constrained areas	Sites with root rot > x%		Planning to meet multiple objective (biodiversity, wildlife tree patches, coasrse woody debris)		
					Within areas of development treat to minimize long term impact	Post-disturbance root rot sites		Identification of centres; prepare to reduce innoculum.		stumping; push over logging where practical; plant resistant species (conifers and non-con); avoidance planting; biological controls

#	P	Issue Name	Issue Description	Objective	Strategy	Target	R	Regime Description	A	Activities
9	M	Dry belt fir	Mapping, confirm/correct inventory labels define silvicultural zones. Define treatment regimes and silviculture system issues; budworm, root rot, DWR. Poor regen in older logged stands. Poor quality old growth left. In THLB but economically unattractive.	Reduce uncertainty by recalibrating inventory of dry belt fir; Identify appropriate practices	Catalogue areas by productivity. Log higher sites, priorize, retain for other objectives.	Low elevation IDF with lower volumes (100-150 m3 /ha). Low stocking IDF, SR low site occupancy; better sites.		Inventory to determine economic viability; select harvestable stands; treat Identify candidate stands, treat.		re-inventory area; if previously harvested then site prep to reduce grass, plant higher densities and larger stock, fertilize, stump, alternative species. survey; site prep and fill plant; grass control; protection
10	M	IDF/MS zones	Conversion of fir stands to pine to meet FG, then fir establishes naturally.	Regenerate fir to as high a stocking level as appropriate where stocking standards and/or other values indicate that fir is suitable.	Maximize fir regeneration	Drier sites in IDF/lower MS.		Regen regimes that maximize fir survival.		microsite planting with larger stock; protect fir when spacing
11	M	NDT4	Manage for habitat and health issues. Lower stocking and less planting of Fdi.	Clarify transitional NDT4 (grassland/forested) management practices —> to do list						
12	L	Roads and Landings	Restore productivity.	Bring back into THLB	Survey to identify opportunities; rehab.	Areas not already under licensee responsibility to restore.		Assess and develop strategy		
13	L	LU planning/ Dry belt Fdi	Interaction of old growth targets at landscape level can't be met in IDF. OG is mapped but not ground truthed.	Determine impact of OGMA on timber supply in IDF —> to do list.						

3 Silviculture Impacts and Priorities

The silviculture activities required to implement the strategies identified in Table 2.1 are summarized below in Table 3.1, together with their impacts on selected TSA objectives. The workshop determined the opportunity area (i.e., the area available for treatment for the next 5 years), the impacts on timber supply quantity and quality, and habitat effects for each treatment. The employment effects and costs are based on district and licensee records. The rank (priority) of each treatment was determined through consideration of the impacts of each activity on each objective, and represents a consensus of the participants.

4 Silviculture Program

4.1 Tactical Priorities

The rankings of Table 3.1 represent a balance between the participant's strategic concerns and the silvicultural opportunities available on the TSA in the next 5 years.

The highest ranked activities are the protection of existing plantations and restocking of backlog NSR, both necessary to the maintenance of the timber harvesting land base as represented in the TSR.

The next priority identified by the participants was surveys and pruning for forest health. Pruning for quality and juvenile spacing, undertaken mainly for employment benefits, were ranked last.

4.2 Program Costs and Benefits

Table 4-1 contains the opportunity (area) for treatment by activity and year.

Table 4-2 contains the expenditure by activity and year, based on the unit costs recorded in the treatment table (Table 4.1).

Table 4-3 contains the silviculture employment benefits associated with the program..

Table 3-1. Silviculture activities, the strategies they implement, their impacts on TSA objectives, and their priorities as determined by the workshop.

Activities/Treatments	Issues Addressed	Opportunity Area	Timber Supply Effects			Quality	Habitat	Jobs Days/ha	Cost $/ha[1]	Wkshp Rank
			Short 0-20	Medium 21-120	Long 121+					
Survey										
1 Backlog	1,7,11	1400						0.04	15	3
2 Green up surveys	1,4,11	5000	+	+				0.04	15	3
3 Survey - opportunity road and landing rehab		20			+		+	0.04	15	5
Regen to FG										
4 Protection of existing plantations: Brush blanket, vexar, shade card maintenance, brushing - Backlog	1,7,11	190			+			2.0	630	1
Brushing - Backlog		25			+		+/-	2.0	400	1
5 Planting - Backlog	1,7,11	170			+		+	2.0	660	2
6 Seed - Backlog	1,7	80			+					2
7 General surveys	1,7,11	320			+			0.04	15	3
Spacing										
8 Incremental	1,7.5,11	80		+		+	+/-	3.0	550	4
Pruning										
9 Incremental	1,7.5	20				+		8.0	1200	4
10 Forest health		20		+	+			8.0	300	3

Notes:

+, - indicates, respectively, a positive or negative impact on the indicated objective.

+/- indicates that the activity could have a positive or negative effect, depending on its circumstances of application

Costs and employment effects were obtained from the Merritt TSA or Regional averages.

The Opportunity Area for green-up surveys (activity 2; 5000 ha/year) was to be reconsidered by District staff subsequent to the workshop.

Pruning for forest health (activity 11) would be undertaken for forest sanitation (white pine).

Table 4-1. Area (ha) treated by activity and year.

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

Table 4-2. Expenditure ('000 $) by activity and year.

Year	Surveys* General	Backlog Plant	Backlog Establish	Backlog Brush	Space	Prune Health	Prune Quality	Total
1	123	112	120	10	44	6	24	664
2	123	112	120	10	44	6	24	664
3	123	112	120	10	44	6	24	664
4	123	112	120	10	44	6	24	664
5	123	112	120	10	44	6	24	664
Subtot Yr 1 - 5	614	561	599	50	220	30	120	3,319
6 - 10	614	561	599	50	220	30	120	2,819
Total Yr 1 - 10	1,228	1,122	1,197	100	440	60	240	6,137

Table 4-3. Short term employment benefits (person-years) of the silviculture program, by year and activity.

Year	Surveys*	Backlog Plant	Backlog Establish	Backlog Brush	Space -	Prune Health	Prune Quality	Total
1	2.7	1.7	1.9	0.3	1.2	0.1	0.4	11
2	2.7	1.7	1.9	0.3	1.2	0.1	0.4	11
3	2.7	1.7	1.9	0.3	1.2	0.1	0.4	11
4	2.7	1.7	1.9	0.3	1.2	0.1	0.4	11
5	2.7	1.7	1.9	0.3	1.2	0.1	0.4	11
Subtot Yr 1 - 5	13.4	8.5	9.5	1.3	6.0	0.5	2.0	53
6 - 10	13.4	8.5	9.5	1.3	6.0	0.5	2.0	52
Total Yr 1 - 10	26.7	17.0	19.0	2.5	12.0	1.0	4.0	106

Note: Assumes 200 days of harvesting, silviculture work, and timber processing = 1 job

Appendix 1
The Timber Supply Context of Silviculture in the Lillooet TSA

The objective of this section is to identify aspects of the timber harvesting land base and its management that govern the supply of timber from the TSA. This information provides the basis for identifying the constraining mechanisms that shape the timber supply forecast for the unit and for specifying possible silvicultural remedies. Unless otherwise indicated, the data in section is drawn from the Lillooet TSA Timber Supply Analysis (1993) and Addendum (1995).

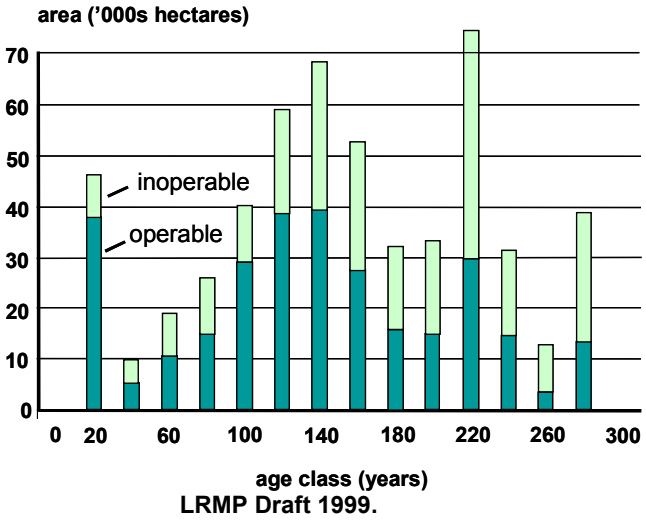
A1.1 Synopsis of the Land Base Inventory

This section reviews aspects of the land base inventory that are relevant to determining a silviculture strategy.

The Lillooet TSA covers 1 125 186 hectares, of which 251 959 (22%) is considered to be in the timber harvesting land base (LRMP Netdown Draft, 1999). The site class profile of the timber harvesting land base is: 60% poor, 31% medium and 9% good site.

The current age class profile of the (Figure A1.1) of the timber harvesting land base is skewed towards older age classes. Over 80% of the land base is classified as mature – over 80 years old for lodgepole pine and 120 years for other species. This large mature portion of the forest is considered to be over cutting age and only a small part is below green-up criteria.

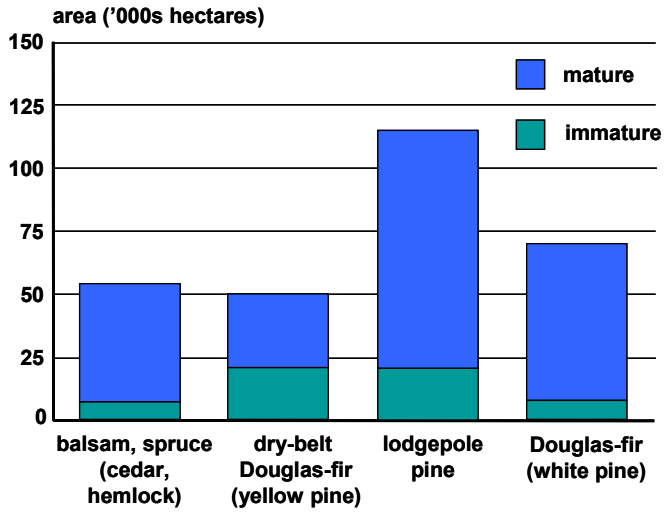
Figure A1.1 Current age class distribution—timber harvesting land base, Lillooet TSA,



LRMP Draft 1999.

Figure A1-2 shows the area by species and maturity for the timber harvesting land base. Mixtures of Douglas-fir, lodgepole pine and spruce are most prevalent. Less common species include balsam, redcedar and hemlock.

Figure A1-2. Area of dominant tree species, quality of site, and maturity of stand in the timber harvesting land base, Lillooet TSA 1993.



A1.2 Silviculture Program

A1.2.1 Silviculture History

Table 2-1 records backlog (pre-1988 openings) silviculture for the TSA, while Table 2-2 records current (post-1987 openings) silviculture. Only silvicultural activities which took place after 1985 are shown for both tables.

Table A1-1 Silviculture Accomplishments on Areas Disturbed pre-1988, by Activity Completion Year, Lillooet TSA.

ATU Yr	Site Prep	Planting	Brushing	Spacing	Pruning	Fertilizating
1986	1263	1850	244	799	0	0
1987	1288	2645	313	310	0	0
1988	3601	2439	340	412	0	0
1989	487	2408	512	111	0	0
1990	487	2947	93	140	0	0
1991	133	831	320	368	0	0
1992	533	498	587	1060	8	0
1993	921	771	695	652	0	0
1994	345	413	724	498	35	0
1995	427	336	745	633	102	0
1996	144	270	249	514	87	0
1997	157	6	224	416	42	0
1998	0	5	0	61	0	0

1999						
Total	9786	15418	5046	5974	275	0

Data Source: ISIS Onetime November 23, 1999, IEA Section, Forest Practices Branch

Table A1-2 Silviculture Accomplishments on Areas Disturbed post-1987, by Activity Completion Year, Lillooet TSA.

ATU Yr	Site Prep	Planting	Brushing	Spacing	Pruning	Fertilizating
1987	10	-	-	-	-	-
1988	481	-	-	68	-	-
1989	647	179	-	-	-	-
1990	221	1,001	81	22	-	-
1991	333	560	-	191	-	-
1992	847	1,009	37	33	-	-
1993	787	1,448	-	-	-	-
1994	1,083	1,221	-	-	-	-
1995	1,064	1,858	73	-	-	-
1996	433	2,076	45	28	-	-
1997	387	1,645	31	-	-	-
1998	44	640	26	-	-	-
1999	156	98	-	-	-	-
Total	6,491	11,735	292	343	-	-

Data Source: ISIS Onetime November 23, 1999, IEA Section, Forest Practices Branch

A1.2.2 Backlog

Backlog NSR is about 527 ha; all will be replanted by year 2001.

A1.2.3 Spacing Regimes

(no information at printing)

A1.2.4 Tree Improvement

The projected gain from improved seed for the Lillooet TSA is tabulated in Table A1-3.

Table A1-3. Projected gain from improved seed per species, Lillooet TSA.

		Gain from Improved Seed (%)		
Species & Seed Zone	Elevation (m)	98-99	99-00	2007-08
Pli TO low	<1400	7	7	10
Pli TO high	>1400	11	11	11
Sx TO low	<1300	8	8	12
Sx TO high	>1300	8	8	12

A1.3 TSR1 Management Assumptions

In addition to the inventory, or current state of the forest, assumptions about how it will be managed as essential for determining a silviculture strategy.

A1.3.1 Inventory Profile

The current inventory profile for the Lillooet TSA is given in Table A1-4.

Table A1-4. Current species profile for the Lillooet TSA.

Species	% of Volume Harvested
Fdi	37
Pli	27
Bl	15
Sx	11
Pa	5
Py	4

A1.3.2 Management Zones and Forest Cover Requirements

The TSR1 management zones and their associated forest cover requirements are listed in Table A1-5. In addition to the requirements shown 20% of each zone is to maintained in ages older than 80 years (TSR1 p.48).

Table A1-5. Management zones and forest cover requirements, Lillooet TSA 1993

Management Zone		Age 1 (years)	Maximum per cent area younger than Age 1
1	Spruce Lake	22	33
2	Mid-Stein	35	24
3	Community Watersheds	29	24
4	Selection Management	N/A	N/A
5	VQO	30	14
6	Timber	20	33

Minimum harvest ages for clear-cut harvested stands are 80 years for lodgepole time and 120 years for other species. For selection management, the first entry harvest is assumed to occur at a stand age of 140 years or older. After the first entry, the ages of stands under selection management are not defined (TSR1 p.46).

A1.3.3 Harvesting Practices

The District is currently (last five years) harvesting 1850 ha per year; this area would rise to 2500 ha per year is the entire AAC was harvested.

For the timber harvesting land base under clearcut management (92% by volume, 86% by area) minimum harvest ages are 80 years for lodgepole pine and 120 years for other species.

The remainder of the timber harvesting land base (8% by volume, 14% by area) is under selection management and first entry is assumed to occur at a stand age of ≥ 140 years.

The current harvest profile for the Lillooet TSA is given in Table A1-6.

Table A1-6. Harvest profile (circa 1993) for the Lillooet TSA.

Species	% of Volume Harvested
Fdi dry belt	8
Fdi wet belt	15
C,H,B,S	52
Pl	25

Regeneration delay is assumed to be 4 years and initial planting densities range from 1000-1400 stems per hectare.

A1.4 Timber Supply Dynamics

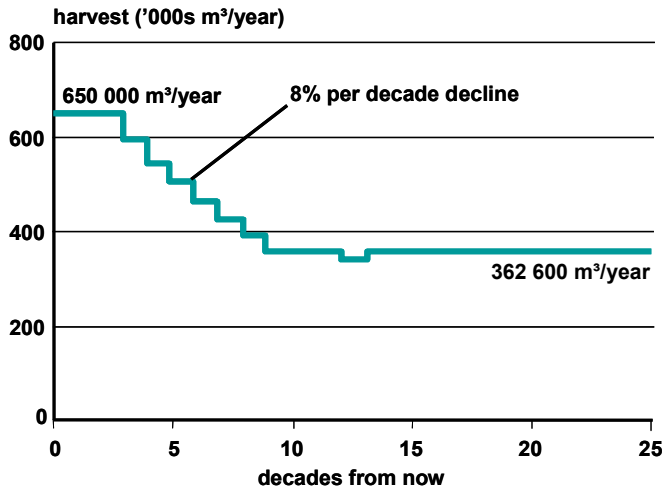
Timber supply is the rate at which timber is made available for harvesting, and it is "made available" through natural, administrative, and economic processes. The forest economy draws timber from the land base in response to consumer demand, and this flow of timber is limited by the rate at which the forest can physically grow trees, and by a variety of administrative constraints. The combined effect of these administrative constraints is incorporated in the Annual Allowable Cut (AAC). Silviculture can modify directly or adjust the effect of each of the three underlying processes.

The base case of the timber supply review (TSR) forecasts future timber supply subject to current administrative constraints and present market conditions. The purpose of this section is to identify the "pinch points" and constraining mechanisms that shape the timber supply forecast for the unit. Observations drawn from the TSR base case and selected sensitivity analyses are used to describe the timber supply dynamics of the management unit and to suggest how silviculture treatments might enhance timber supply.

A1.4.1 Timber Supply and the AAC

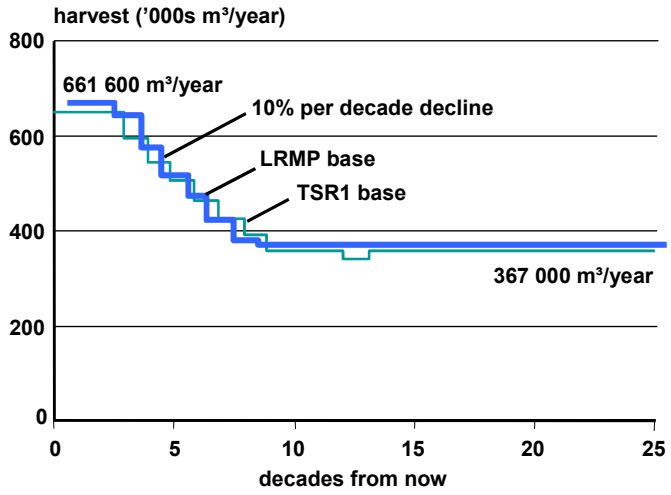
The 1995 Addendum to the 1993 Timber Supply Analysis of the Lillooet TSA, upon which the current AAC determination was based, forecast that the allowable annual cut would be maintained for 30 years without causing a reduction in future harvest levels below the long-term level (Figure A1-3). After 30 years the harvest declines at 8% each decade until the long term is reached in the eighth decade. The long-term harvest level, the potential maximum that can be harvested in perpetuity, is about 362,000 cubic metres per year, a 44% decline from the initial harvest level.

Figure A1-3. TSR1 Base harvest forecast, Lillooet TSA, 1995.



At the time of preparation of this report, a draft of the Lillooet LRMP was in preparation and a revised timber supply analysis underway. Figure A1-4 compares the base harvest forecast of the LRMP to TSR1. For the purposes of this Type 1 analysis, there is little difference between the base harvest forecasts of the LRMP and TSR1. Consequently, this report will assume that the basic structure and dynamics of the timber supply as determined in TSR1 and explained in the TSR1 documents remain valid.

Figure A1-4. LRMP Base harvest forecast, Lillooet TSA, 1999.

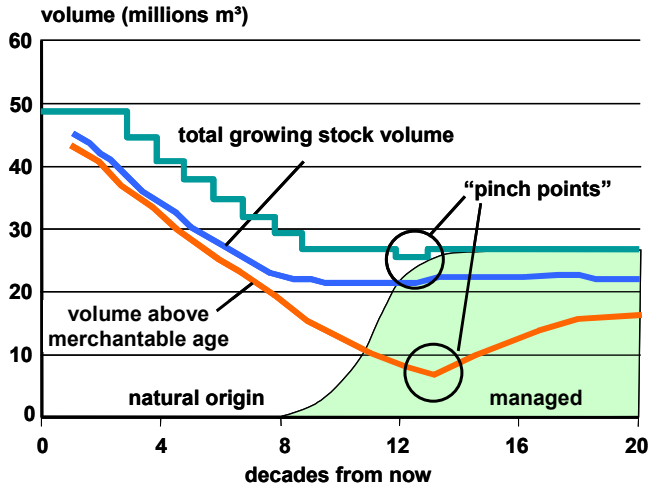


The steep decline from current harvest levels to a much lower long-term harvest level is characteristic of a management unit that is in transition from a timber surplus condition to condition of timber scarcity. FigureA1-5 overlays the forecast levels of total and harvestable growing stock on the base case, demonstrating that the timing of the reduction of the stock coincides with the fall down in harvest. Note the increasing scarcity of merchantable timber. The pinch point in supply corresponds to the point of maximum scarcity of merchantable stock.

A1.4.2 Transition from Natural to Managed Stands

The transition of the harvest from old growth to predominantly second growth is also plotted on Figure A1-5. Note that this transition line is an estimate – this information was not reported from the TSR1 analysis. The transition curve helps identify the response framework for Type 1 and Type 2 Silviculture Analyses– the end of the mid term and beginning of the long term is the point at which the harvest is predominantly dependent on managed stands. We have identified 120 years as the end of the mid-term for Lillooet TSA. The short term is arbitrarily defined as the first 20 years.

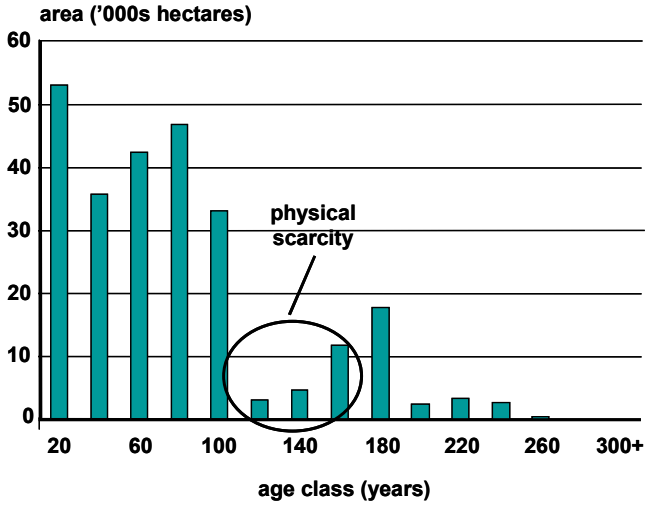
Figure A1-5. Total and harvestable growing stock and harvest composition, Lillooet TSA, 1999.



A1.4.3 Scarcity of Harvestable Timber in Late Mid-Term

The scarcity in merchantable revealed Figure A1.5 can be described as an "economic scarcity" in that there appears to be sufficient physical stock but only a small portion of it exceeds the minimum harvest age, where age is surrogate for profitability. This point is emphasized by Figure A1-6 which displays the age distribution of the timber harvesting land base in 100 years time. Harvesting is concentrated in the age 310-320 (currently) for the first 50 years, and then in the 210-220 ages (currently) until 100 years. After 100 years (not shown) the harvest shifts to stands age 120+ years and is down to stands age 80+ years after 200 years.

Figure A1-6. Forecast stand age distribution over time 100 years from now, Lillooet TSA, 1999.



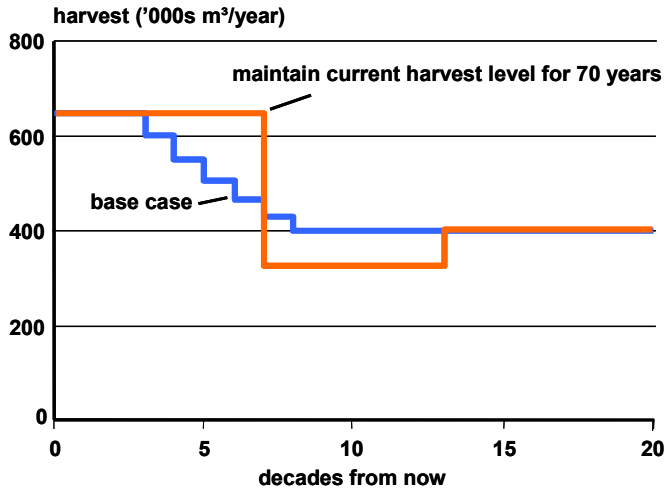
So far, our examination of the TSR graphics indicates that the timber supply curve for the Lillooet TSA is shaped in the main by future scarcity of mature timber -- the main constraining mechanism is simply the age class distribution and growth rates.

A1.4.4 Rationing of Current Mature Timber

Figure A1-7 demonstrates another major factor shaping timber supply – constraints on the rate of change of the harvest level. If the constraint of a maximum of 10% per decade decline is removed, the harvest level could be maintained for 7 decades before collapsing by almost 50% in decade 10, and then recovering to the base case long-term harvest level by decade 13.

Clearly, the lack of harvestable timber in decades 8-13 has been "filled in" by rationing the current available mature. Timber rationing is the main objective of constraints on the rate of change of harvest levels. Note that under the base case constraints, any silvicultural activity that produces incremental volume in decades 8-13 releases some of this rationed timber, which in turn releases rationed timber earlier in the harvest queue. This process is a chain reaction allowing timber to substitute back up the falldown steps. Because TSR harvest flow rules will not allow the first decade cut to be increased above TSR if it must subsequently fall, the increment will probably accrue to the second decade. This is the Allowable Cut Effect, in the context of TSR rules.

Figure A1-7. Harvest forecast with current harvest maintained as long as possible, Lillooet TSA, 1993.

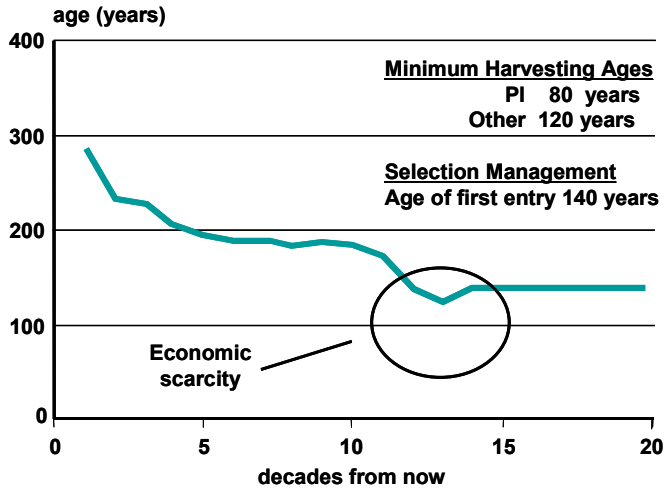


So this second mechanism shaping timber supply – constraints on the rate of change of the harvest level – also provides a means of capturing silvicultural benefits in the short term. Note that the efficacy of this effect is determined by the shape of the timber supply curve and hence is specific to a management unit.

A1.4.5 Minimum Harvest Ages

For TSR1, minimum harvest ages (mha) were set at 80 years for lodgepole pine and 120 years for other species. Figure A1-8 shows that the average mha is initially 280 years, but is forecast to drop to a minimum of 120 years 13 decades from now. To the extent that mha represents an economic margin below which harvesting is not profitable, we can identify this minimum as a point of economic scarcity. Note that the point of physical scarcity of timber identified earlier is coincident with this point of economic scarcity – as mature timber becomes scarce the model harvests younger stands.

Figure A1-8. Harvest forecast with current harvest maintained as long as possible, Lillooet TSA, 1993.



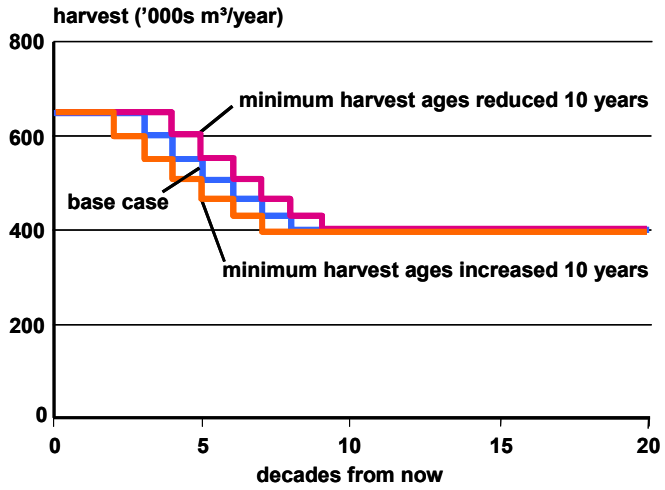
Minimum harvest ages might be reduced through silviculture and the TSR sensitivity analysis Figure A1-9 gives us some idea of how much of a timber supply benefit is possible and when it might occur. In the short and early mid term, reducing minimum harvest ages has significant improvement is timber supply. This seems odd as Figure A1-8 indicates that the harvest in the short and mid term was supported mainly by stands age >200 years. However, it is likely that sometime after decade 10, during the period of maximum scarcity before sufficient managed stands were available to support the cut, the model is harvesting stands at their mha. The increase in available stands at this critical point, that results from reducing mha by 10 years, is substituted forward in harvest queue, up the fall-down staircase, drawn by the modelers desire to maintain the initial harvest level for as long as possible and yet still decline at a maximum rate of 10% per decade.

We can quantify these effects. In the early mid term (decades 4-9), reducing the mha by 10 years produces an approximate annual benefit of 43,000 m3. This is based on an (approximate) harvest rate of 2000 ha per year. So, a silvicultural treatment that reduces mha by 10 years produces a benefit of (43,000/2000=) 21.5 m3/ha, and a treatment that reduces mha by 1 year produces a benefit of (21.5/10=) 2.15 m3/ha .

Note that in the TSR sensitivity analysis, the change in harvest ages is applied to all stands across the 250 year modelling horizon, while silviculture treatments would be applied to specific inventory targets and should result in larger benefits.

Figure 2-9 also demonstrates that the harvest flow constraint mechanism for bringing benefits forward also works in reverse if there is a increase in scarcity at the critical period (pinch point) in supply. If minimum harvestable ages increase by 10 years, the period of scarcity is deepened and lengthened, and much more of the remaining mature timber must be held in order to sustain the cut at the long-term harvest level

Figure A1-9. Harvest forecast with minimum harvest ages changed by 10 years, Lillooet TSA, 1993.



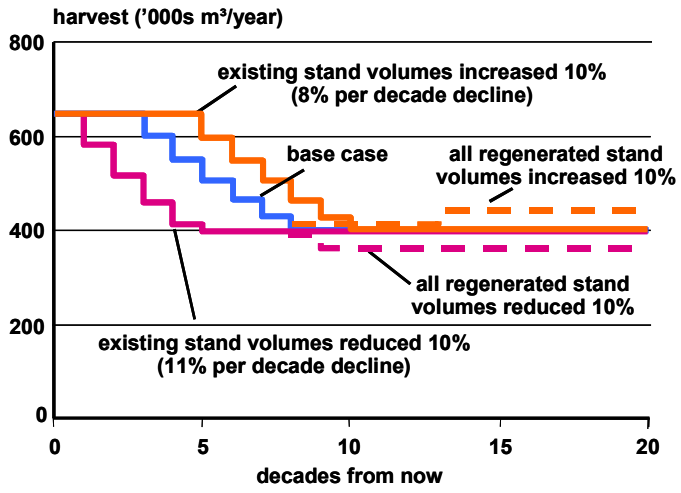
A1.4.6 Increasing Stand Yields

Increasing existing stand yields has a substantial effect mid-term timber supply (Figure A1-10). Note that he late mid term scarcity and forward substitution effect allows a disproportionate benefit to be realized in the earlier decades. Note that the short-term and early mid-term reduction in supply resulting from increased existing stand yields is much larger in magnitude than the mid-term increases that would occur if the minimum harvest ages were decreased.

The recent inventory audit, after correction of some stocking class errors, estimates that the existing inventory is underestimated by 10-11%.

Increasing regenerated volumes has no effect in the short or mid-term. The sensitivity coefficients for these two effects are included in the summary table at the end of this section.

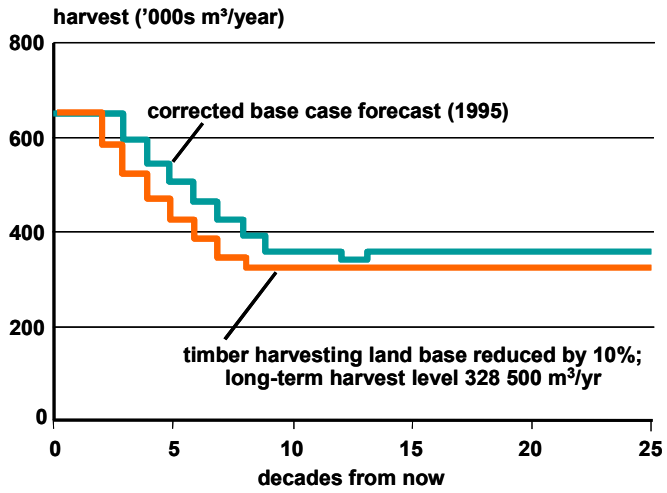
Figure A1-10. Harvest forecasts with existing and regenerated stand yield estimates increased by 10%, Lillooet TSA, 1993.



A1.4.7 Increasing the Timber Harvesting Land Base

Various silvicultural activities can be interpreted as bringing land into the timber harvesting land base and so the TSR sensitivity analyses of the effect of increasing the timber harvesting land base (Figure 2-12) will provide information on the magnitude and timing of the benefits. Increasing the timber harvesting land base increases timber supply across the whole planning horizon and the sensitivity coefficients for this effect is included in the summary table at the end of this section.

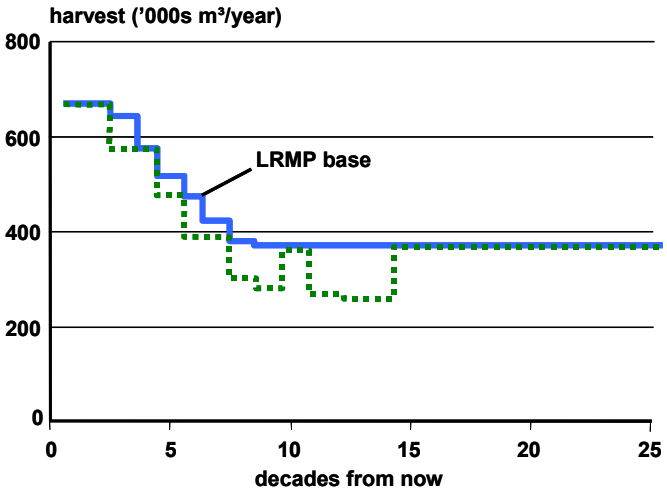
Figure 2-12. Harvest forecasts with the area of the timber harvesting land base decreased by 10%, Lillooet TSA, 1993.



A1.4.8 Sensitivity to Grizzly Bear Management

The TSA encompasses parts of three different Grizzly Bear ranges and the impact on timber supply of managing that habitat is shown in Figure 2-13.

Figure 2-13. Impact of management of Grizzly Bear habitat— mid seral management for NDT2 (CWH, E*SSF) and NDT3(MS, ESSF) with no stocking adjustments applied.



Timber Supply Dynamics - Summary

The main constraint on timber supply in the Lillooet TSA is the physical scarcity of harvestable timber in the late mid-term. This scarcity requires that the substantial volumes of existing mature timber from unmanaged stands be rationed until managed stands are ready for harvest. The rationing mechanism (TSR harvest flow constraints) can also be used to convey back to the short- and early mid-term the future timber supply benefits resulting from manipulating forest-level parameters. Silvicultural practices that modify minimum harvest ages, stand yields, and the extent of timber harvesting land base will have significant effects on timber supply and those effects are quantified as sensitivity coefficients in Table 2-1.

However, the same mechanism works in reverse if timber supply is reduced at the period of physical scarcity. Currently mature and available timber must be pulled backward in the harvest queue (rationed) to offset the reduction in available supply in the critical period. Short- and mid-term reductions due to increases in minimum harvest ages and green-up ages are disproportionately large relative to the timber supply benefits accruing to those time periods from reducing minimum harvest ages and green-up ages. Managing for Grizzly bear habitat also shows significant negative impacts on timber supply in the medium term.

The objective of this section is to identify aspects of the timber harvesting land base and its management that govern the supply of timber from the TSA. This information provides the basis for identifying the constraining mechanisms that shape the timber supply forecast for the unit and for specifying possible silvicultural remedies. Unless otherwise indicated, the data in section is drawn from the Lillooet TSA Timber Supply Analysis (1993) and Addendum (1995).

Appendix 2
Summary of Issues Requiring Investigation

During the workshop's consideration of TSA issues, strategies and silvicultural regimes, a number of additional issues were identified that require investigation. These issues are listed in Table A3-1 in the order of priority established by the participants.

Table A-2.1 Issues identified in the workshop that require investigation.

Priority	Issue
1	**Juvenile spacing opportunities.** Investigate opportunities for spacing within the TSA with regard to accelerating minimum harvest age and offsetting falldown.
2	**Local employment opportunities**. Develop continuity of employment opportunities for local labour force. Identify workforce and appropriate forestry and silviculture opportunities and training needs. Address how to fund training (agencies, programs). Address hiring of local crews through direct award or local bid which may be more expensive.
3	**Mule deer winter range.** Develop criteria for critical MDWR, map and field check.
4	**Spotted owl habitat.** Preserve/recruit spotted owl habitat at SW end of TSA. Presence/absence not proved. Need to understand structural requirements for habitat. Constraints on pockets of mature timber may render an entire valley economically inoperable.
5	**Red/blue species.** Complexity of managing red/blue species without species count and habitat inventory.
6	**Steep slopes and operability.** Economic operability of harvesting and regenerating steep slopes is not reflected in the TSR.
7	**Protected areas.** Determine extent of PAs (not yet known), as they could have a substantial effect on timber supply.
8	**Crown land access.** First Nations reserves often prohibit access to Crown land.
M	**Root disease.** Identify extent and impact, and develop strategies to deal with Armillaria root rot.
M	**Silvicultural systems G&Y.** Yield studies on different silvicultural systems are required that will maximize yields while meeting VQO. Monitor LRMP.
M	**White pine blister rust.** Investigate site-specific rust-resistant Pw suitable for Lillooet TSA. (Address root rot issue). Investigate planting Larch to offset root rot in MDWR; remove doubt or confirm. (root rot). Survey literature and current practices.
M	**Extent of root disease in TSA.** Monitor efficacy of root rot inventory and treatment. Assess validity of inventory. Use adaptive management to find solutions.
M	**Availability of improved seed.** Investigate efficacy of improved seed available for Lillooet TSA.
M	**Visual quality.** Complete visual quality inventory.
L	**Stocking standards in grizzly bear habitat.** Review stocking standards in grizzly bear habitat. LRMP proposes lower stocking; need to know the proposed extent (ha) and resultant reduction in yields.
L	**Streamside classification.** Complete streamside classification. Define significant parameters and identify practices to mitigate the impact of streamside harvesting.
L	**Dry belt Douglas-fir.** Reduce uncertainty of stand characteristics and projected yield by recalibrating inventory of dry belt fir. Identify appropriate practices
L	**NDT4 .** Clarify transitional NDT4 (grassland/forested) management practices.
L	**Old Growth Management Areas .** Determine the impact of current and proposed OGMAs on timber availability and supply in IDF.

Appendix 3
Workshop Feedback

Please circle the number that best represents your view.

1 Length of session	5 too long (1)	4 (3)	3 just right (5)	2	1 too short (1)
2 Level of detail of content	5 too much (2)	4 (2)	3 just right (5)	2	1 not enough (1)
3 Instructional method (style, interaction, clarity)	5 excellent	4 (4)	3 adequate (6)	2	1 poor
4 Relevance to your interests/needs	5 extremely	4 (6)	3 average (2)	2 (2)	1 not at all
5 Extent to which your needs were met	5 entirely	4 (1)	3 average (8)	2	1 not at all
6 Usefulness of the handout graphics and texts	5 very (1)	4 (6)	3 adequate (3)	2	1 useless

What were the strengths of this workshop?

- Patience. Bringing together licensees with issues.
- Good discussion on issues relevant to the Lillooet TSA.
- Combined interests from MoF, MoE, licensees, etc.
- Use of spreadsheets, group discussions.
- Group discussion.
- Good discussion was initiated.
- Getting interested bodies together.
- Gives some direction to FRBC managers.
- Openess – somewhat free to express opinions.
- Identification of needs outside of the FRBC envelope.

What were the weaknesses of this workshop?

- Product use not entirely bought into.
- Some overlap of issues. Most are being dealt with at the LRMP table. Until these are resolved, one can only speculate.
- Licensees could have had the MoF/FRBC 5-year plan to view ahead of time.
- Focus taken off silviculture activities, specifically - drawn more on the issues which cannot be dealt with at this level.
- Need to told beforehand what the outcomes are for. Important issues skipped over.
- Some of the issues, while extremely important to Timber Supply, were not silviculturally manageable.
- Procedure to the end result was not useful.
- A lot of detail missed. I don't see this as a problem with this workshop. The site-specific details can only be dealt with operationally.

- Results somewhat predetermined – an attempt to make participants feel "empowered".
- An analysis of Timber Supply could have been stronger – e.g. can spacing fill in the potential hole in mid term supply.

How could this workshop be improved?

- Relate to R.M.S - strategy and logic previously.
- Donuts.
- Having a greater number of other stake holders at the table (i.e., not being overpowered by Ministry officials or industry).
- Do not split up into small groups, keep the subjects open.
- Number juggling at end was too tedious for the level of confidence of information being provided.
- Move right to the silviculture activity table.
- Some people were not included who should have been. Some people should not (or need to have been included), i.e. licensees not directly involved with backlog. A more specific agenda with some prep by participants may have helped.
- Review RMP first to see how it was developed, rather than try and take it apart at the end.

Other comments? (use back if necessary)

- Very thorough. Good detail.
- I found the initital part of the workshop of low usefulness. More time spent on the actual silviculture treatments would have been better.

Appendix 4
Executive Summary of *The Incremental Silviculture Strategy For British Columbia (Interim)*

STRATEGY AT A GLANCE

Purpose	This strategy provides guidance to the application of available funds for incremental silviculture activities. It is not tied to a specified funding level.
Government's Goals	• Sustainable Use • Community Stability • A Strong Forest Sector
Key Principles	1. Because the distant future cannot be foretold, the best and only course of action in managing the timber resource is that which minimizes risk and maintains options. 2. British Columbia's forests are important locally, provincially, nationally and glo bally and should be managed in this context. 3. Each generation of British Columbians becomes the steward of the province's forest resources and has a moral obligation to preserve this heritage for future generations.
Working Targets	Within the context of the guiding principles: WT 1: Minimize the anticipated interim reduction in timber supply so that provincial annual harvests of at least 65 million m^3 can be achieved during this period. WT 2: Create a long term timber supply capable of supporting a steady long term provincial harvest level of at least 75 million m^3. WT 3: Over the long term, maintain the production of premium quality logs at or above 10% of total harvest.
Major Silvicultural Strategies	• Increase the use of alternative silvicultural systems and commercial thinning. • Achieve earlier green-up of harvested areas. • Increase regenerated stand volumes 20%. • Eliminate all pre-1982 good and medium site backlog NSR and all 1982 to 1987 backlog NSR. • Initiate a long rotation quality management program for stands where harvesting must be delayed. Other silvicultural and non-silvicultural strategies must also be implemented to achieve the working targets.
Strategy Implementation	Regional and management unit strategies must be developed, followed by programs and plans to implement them.