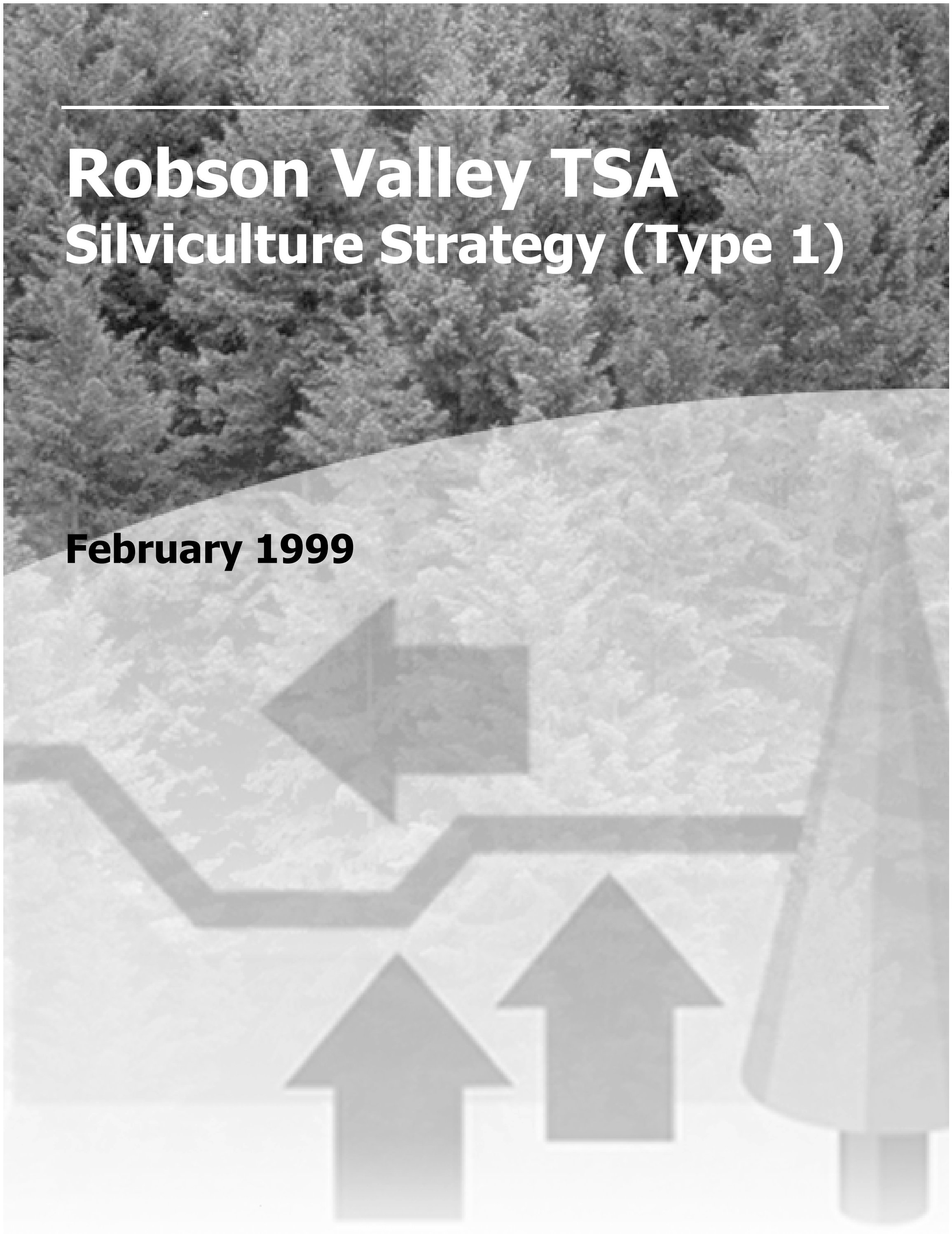
Robson Valley TSA
Silviculture Strategy (Type 1)

February 1999



funded by FOREST RENEWAL BC

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The consultants wish to express their gratitude to Les Herring of Prince George Forest Region who administered this project and for coordinating the six workshops to be undertaken in the Region. Victoria Stevens provided background information on habitat issues in the TSA. Norma Stromberg-Jones provided liason and support for the Robson Valley Forest District. The consultants are grateful to the Robson Valley Forest District for providing the presentation facility and other support.

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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7	Chris Ritchie	MELP
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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. A Type 2 analysis will be undertaken in the Robson Valley TSA in 2000.

Strategy Summary

Issues Addressed by the Strategy

While many issues were proposed and discussed in the workshop, the participants developed a silviculture strategy that addressed five issues: short, medium and long-term timber supply, timber quality (clear wood) and a forest health issue – white pine blister rust.

Elements of the Strategy

1. Maintain the dimension of timber harvesting land base that is assumed by the TSR by regenerating pre-87 backlog NSR and brushing impeded SR.

   Maintaining the timber harvesting land base will contribute to maintaining long-term timber supply.

2. Implement a regime of spacing Pl and Sx on appropriate sites, followed by fertilization of Pl and Fdi types on a 15 year cycle.

   Application of this regime to younger existing stands is expected to reduce the minimum harvestable ages of timber available for harvest and increase the supply of harvestable timber at a point of scarcity (pinch point) in the late mid-term. The timber supply benefits are expected to accrue to the short term.

   The fertilization component of this regime will accelerate green-up, also increasing timber supply in the short term. Applied to both current and future stands, fertilization will increase long-term timber supply by increasing stand yields.

3. Prune the Pw components of Fdi and Pl stands to reduce the risk of infection from white pine blister rust.

4. Prune appropriate Fdi and Pl stands to increase the volume of clear wood.

5. Undertake investigations and studies identified in the workshop as necessary for the further development of the TSA silviculture program.

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
	Surveys		
1	Surveys - general	1355	1
2	Survey - SR impeded backlog	4000	1
	Regeneration		
3	Site prep backlog NSR	50	3
4	Plant backlog NSR	50	3
5	Brush impeded SR	400	2
	Spacing		
6	Pl younger existing stands, ages 15-30, >3000 sph	100	5
7	Sx younger existing stands, ages 15-30, >3000 sph	100	6
	Fertilize, repeat 15 year cylce		
8	P, Fd, sites: (lower 1/4G, M, upper 1/4P), East Canoe, <2000 sph	400	7
9	P, Fd, sites: (lower 1/4G, M, upper 1/4P), <2000 sph	0	nr
	Prune		
10	Fdi, Pl, Pw stands (Pw priority; Fdi and Pl mixed in)	75	4
11	Fdi, Pl	200	8

nr: not ranked

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1. Introduction

The objective of this section is to identify the critical issues that guide silviculture planning on the TSA and to identify objectives with respect to those issues.

1.1 TSA Issues Impacted by Silviculture

Issues that can be addressed through silviculture were obtained from the District (District Enquiry), the most recent Resource Management Plan, and other documents identified by the District. These issues were reviewed and expanded by the workshop.

1.1.1 Timber supply issues (Source: Robson Valley Forest District)

The timber supply is declining. The most important factor is the abundance of old growth timber that has allowed harvesting above the long-term harvest level. The regenerating stands will be harvested at a younger age and smaller size than the old growth stands, and there will be less timber volume available to harvest. Forest cover requirements for other resources such as wildlife habitat and visual quality also limit timber harvesting.

Existing stand volumes - Sensitivity analyses performed for the 1994 timber supply review indicated that the short-term timber supply is very sensitive to changes in volumes of existing stands. Even moderate changes in assumptions resulted in initial harvests more than 40% lower than the base case or conversely, the initial harvest level being maintained for 3 decades. CH types and higher elevation SB were specifically identified in the workshop as having low volumes, and the SB may have less spruce than indicated by the type label.

Visually sensitive areas – Advance TSR2 results described by participants suggest that VQOs will have a substantial impact on the timber supply and methods to mitigate these effects are a high priority. Managing visual quality is an important issue in the district particularly in the Rocky Mountain Trench, and adjacent to Jasper National Park and the provincial parks that surround the district. Harvesting and silviculture operations must conform with the visual quality objectives. In the trench they are primarily retention and partial retention.

Unsalvaged losses – Unsalvaged losses in TSR1 were estimated at 70 500 m^3 but have increased to 98 600 m^3 in TSR2. Of the TSR2 unsalvaged losses, 53 056 m^3 (57%) is insect related, predominantly due to hemlock looper.

Biodiversity constraints – Forest cover constraints in TSR2 have increased substantially and can be expected to constrain timber supply from natural stands..

Other uncertainties – TSR1 indicates that uncertainties about minimum harvestable ages, green-up requirements, and visual quality objectives have moderate impacts on short-term harvest levels, while uncertainty about regenerated yields has a moderate impact on long term harvest level.

Timber Quality - No studies on timber quality have been completed for Robson Valley District and no information on timber quality is available from the 1994 timber supply review. However, it was noted at the workshop that low volume CH and high elevation SB were of low quality.

1.1.2 Habitat issues (Source: Victoria Stevens

Riparian values – There are areas in the TSA that have significant portions of streams logged to the bank. These are obvious areas for some silvicultural investments to stabilize banks, grow shade for the streams and restore the functioning of streamside vegetation as habitat and the energetics of stream foodchains. Accompanying maps highlight those areas that have the highest level of streamside logging. In the 7 years since the data was collected for this map, there has been additional logging, some of it prior to the implementation of FPC riparian standards. This activity may have put other watersheds at risk.

Cedar – Hemlock stands– The Robson Valley TSA represents some of the furthest extent of the ICH biogeoclimatic zone. Examples of this zone are often old cedar-hemlock stands that are not desireable for timber, but are good wildlife habitat. Old looper killed or damaged stands are ideal for cavity nesters. This damage represents a large stand initiating event. Shade tolerant species are coming up in these stands. Logging these areas means conversion to spruce stands. Because these stands are part of the timber harvesting land base, the chief forester has admonished the district to cut these areas in the proportion in which they are found (17%) or else they may be removed from the THLB in the next determination (i.e. a lower AAC). From a habitat point of view, removal of these stands from the THLB is the ideal solution.

Mountain Caribou – The Robson Valley is at the northern end of the range of mountain caribou in BC. These arboreal lichen foraging caribou are considered at risk in the province. There is a system of zonation for caribou habitat in the TSA including zones for high value habitat (deferral or no logging), medium value (small patch cutting or group selection) and corridors (no more than 10% not greened up). Further silvicultural investments may be suggested by some research currently underway (S. Stevenson, M. Jull, D. Coxson, H. Armleder and B. McClellan). Recommendations will be forthcoming from this group at the end of the current fiscal year. They will be published by MOE and/or MELP.

The bottom line is that the best strategy for mountain caribou is not to log at all. If you are determined to log, then partial cutting techniques that remove clumps of trees will maintain some of the habitat values. Specifics about ways to log will be in the recommendations. If high value habitat has already been logged, then possible techniques for restoring the habitat as quickly as possible include planting and thinning to create clumpiness and maintaining this clumpiness through partial cutting techniques.

Lichens require light. Thinning allows light to penetrate into the stand and allows lichens to grow on more surfaces than just the top of the canopy. Canopies that are partially defoliated also have a beneficial effect on lichen growth.

Grizzly Bear – In grizzly bear habitat stocking standards should be examined to make sure stands are not so dense as to exclude the growth of forage species (berry producing deciduous shrubs and trees and herbaceous plants). Herbicides should not be used in these stands.

1.1.3 Employment issues

Employment is also an important issue as the number of timber harvesting jobs has decreased significantly in recent years, and will likely continue to decrease as the timber supply declines. However, silviculture employment is dominated by non-local crews due to the short employment season. Residents dependent on the forest industry occupy higher paying harvesting jobs or leave the district.

1.2 Objectives of the Silviculture Program

1.2.1 Management Unit Objectives

The workshop did not define objectives specific to the issues listed in section 1.1 but instead adopted the facilitators more general objectives of increasing timber supply in each of the short, medium and long term (defined in section 2.4), and to increase timber quality with respect to premium and sawlog product definitions.

1.2.1 Provincial and Regional Objectives

The region has not set out formal regional incremental silviculture objectives. In the interim, the provincial objectives are accepted as being broadly applicable within the region. The *Incremental Silviculture Strategy For British Columbia (Interim)* states the Ministry of Forests' provincial level strategy. The strategy's executive summary is reprinted in Appendix 1. The provincial strategy was considered in the development of this TSA strategy.

2 The Timber Supply Context

Timber supply is often the dominating issue on British Columbia management units. 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 Robson Valley TSA Timber Supply Analysis (1994).

2.1 Synopsis of the Land-Base Inventory

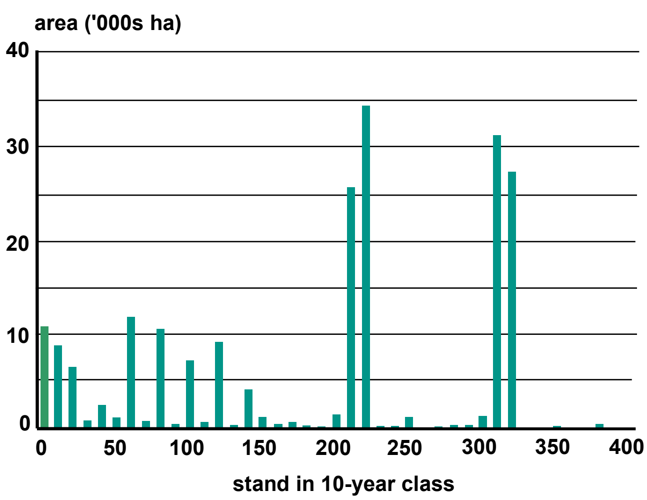
This section reviews aspects of the land base inventory that are relevant to determining a silviculture strategy.

The Robson Valley TSA covers 1,235, 821 hectares, of which 209,365 (17%) is considered to be in the timber harvesting land base.

The site class profile of the timber harvesting land base is: 54% poor, 30% medium and 16% good site.

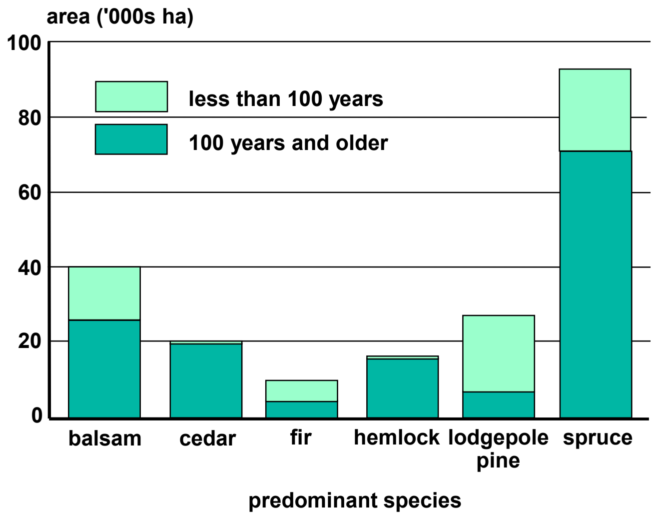
The current age class profile (Figure 2.1) of the timber harvesting land base is skewed toward older age classes. Over 70% of the stands are 100 years of age or older, and 60% of the stands are 200 years of age or older.

Figure 2-1. Current age class distribution—timber harvesting land base, Robson Valley TSA 1994.



The tree species profile (Figure 2.2) on the timber harvesting land base is approximately 45% spruce, 19% sub-alpine fir, 13% lodgepole pine, 10% western red cedar, 8% western hemlock, and 5% Douglas-fir. Spruce stands over 100 years of age account for more than 33% of the timber harvesting land base.

Figure 2-2. Current species composition – timber harvesting land base, Robson Valley TSA 1994.



The Watersheds BC database classifies forests stands by age and disturbance, and is useful for identifying habitat issues. On Figure 2-3, old forests are defined as age >140 years, young forests are age <140 years, recently logged forests are age ≤ 20 years, selectively logged forests are forests selectively logged during the last 20 years, and burned forests are forests burned during the last 20 years. The maps used to create this database were based on data from 1992-1993. Therefore any areas burned or logged in the last 6 or 7 years are not reflected by this data. Figure 2-4 illustrates the concentration [of harvesting?] on low gradient forests in the last 20 (27) years.

Figure 2-3. Forest classification—timber harvesting land base, Robson Valley TSA 1994.

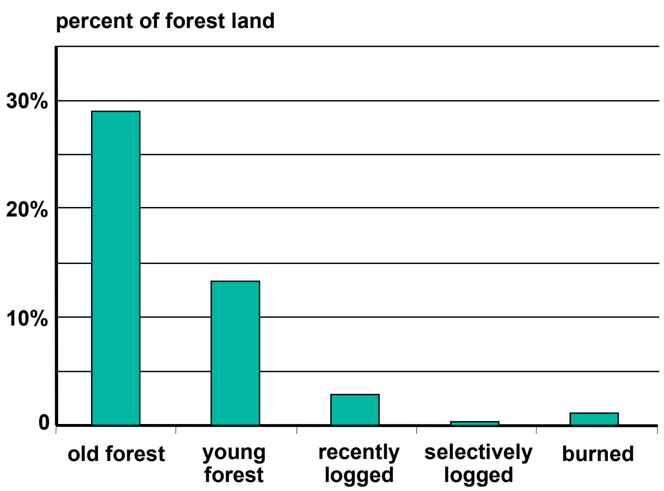


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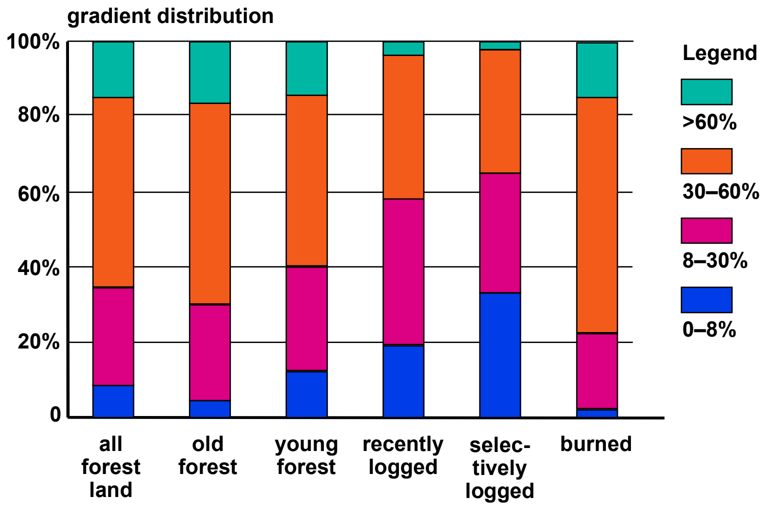
Figure 2-4. Gradient of forest classification —timber harvesting land base, Robson Valley TSA 1994.



2.2 Silviculture Program

2.2.1 Silviculture History

Table 2-4 records both backlog (pre-1987 openings) and incremental silviculture for the TSA. From 1990 to 1999, a total of 14.4 hectares were pruned (first lift) in 1998. Potential for incremental pruning is unknown. The pruning that was proposed in the FRBC resource management plan is to treat for blister rust in young white pine stands.

Table 2-4. Backlog and incremental silviculture history 1990-99 , Robson Valley TSA.

Year	Backlog Planting (ha)	Backlog Brushing (ha)	Juvenile Spacing (ha)
1990	2763	323	53
1991	548	544	76
1992	178	472	228
1993	100	134	25
1994	440	329	0
1995	39	199	0
1996	267	438	0
1997	0	198	0
1998	32	28	14
1999	4	10	0
Total	**4,371**	**2,674**	**396**

2.2.2 Backlog

Backlog treatments have consisted of primarily planting and brushing. See Table 2-4 for yearly details. The area of backlog not satisfactorily restocked land is 1515 ha according to the TSR2 data package.

2.2.3 Spacing Regimes

There is no "typical" spacing regime in the district. There is no incremental plan where stands are targeted for treatment. About three years ago the district began to identify stands, but the enthusiasm for the project waned when the District's forest renewal funding was discontinued. The licensees would like to do some incremental work, but the priority has been to brush impeded stands and conduct surveys. If funding were not a concern about 300 hectares could be spaced per year.

2.2.4 Tree Improvement

Genetic gain will be incorporated in TSR2 as a gain of 18% for all spruce planted from this year onward. The projected gain from improved seed for the Robson Valley TSA is listed in Table 2-5.

Table 2-5. Forecast gain in volume from improved seed for the Robson Valley TSA.

TSA	Species & Seed Zone	Elevation (m)	Gain from Improved Seed (%) 98-99	99-00	2007-08
	Pli PG low	<1100	6	6	7
	Sx PG low	<1200	14	15	17
	Sx PG high	<1200	17	17	16
	Sx NE low	<1300	2	4	12
	Sx NE high	1300 - 1700	2	5	13
	Fdi QL all	all	9	9	9

Source: FGC

2.3 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.

2.3.1 Inventory Profile

The inventory profile (species composition) of the timber harvesting land base will change over time with harvesting and replanting. Table 2-1 records the trend in species profile resulting from the harvesting schedule of the TSR base case.

Table 2-6. Current inventory profile and conversion trends, Robson Valley TSA 1994.

Species	Percent of Inventory Present	Future	Conversion	Future Rounded
S	44	83		80
Bl	19	4	(15% to S)	5
Pl	13	7	(6% to S)	5
Cw	10	0	(2% to Fd, 8% to S)	3
Hw	9	0	(9% to S)	2
Fdi	5	6	(2% from Cw, 1% to S)	5
Total	100	100		100

Source: TSR Robson Valley TSA Timber Supply Analysis 1994

2.3.2 Management Zones and Forest Cover Requirements

The TSR management zones and their associated forest cover requirements are listed in Table 2-2 and the minimum harvest ages are summarized in Table 2-3.

Table 2-7. Management zones and forest cover requirements, Robson Valley TSA 1994

Management Zone	% THLB Area	Height 1 (meters)	Age 1 (years)	Maximum per cent area younger than Age 1	Height 2 (meters)	Age 2 (years)	Minimum per cent area older than Age 2
1 partial retention	12.0	5	26	10			
2 retention	1.4	5	26	3			
3 caribou - high	0.0		100%	Excluded			
4 caribou- moderate	7.5	3	27	33		80	67
5	2.0		Partial	Cut zone			
6 reserve	0.0		100%	Excluded			
7 moderate	7.1	5	26	25			
8 IRM	65.2	3	23	33			
9 old-growth	4.8	3	22	25		200	5

Source: TSR Robson Valley TSA Timber Supply Analysis 1994, p60.

2.3.3 Harvesting Practices

The average area harvested is 1858 ha/ year. This was calculated using the total volume logged by all licensees in the last five years (2,443,898 m3) divided by an estimate of the average volume (263 m3/ha) which equals the total area harvested over 5 years (9292 hectares). This was divided by five years to equal 1858 ha/year. One hundred percent of the volume is even-aged management.

The total annual harvested area is likely to decrease slightly as the timber supply is projected to decline 10 percent per decade. . See *Robson Valley TSA Timber Supply Analysis September 1994* Figure 11 which show the average annual area harvested over time. The percentage of even-aged management may also decrease as uneven-aged management is used to address non-timber resource values such as visual quality.

Table 2-8. Minimum harvestable ages by leading species and site class, Robson Valley TSA 1994

Species	Site: G	M	P
Fdi	90	120	140
pl	80	90	100
S	100	110	120

Source: Derived from TSR Robson Valley TSA Timber Supply Analysis 1994, p56.

2.4 Timber Supply Dynamics

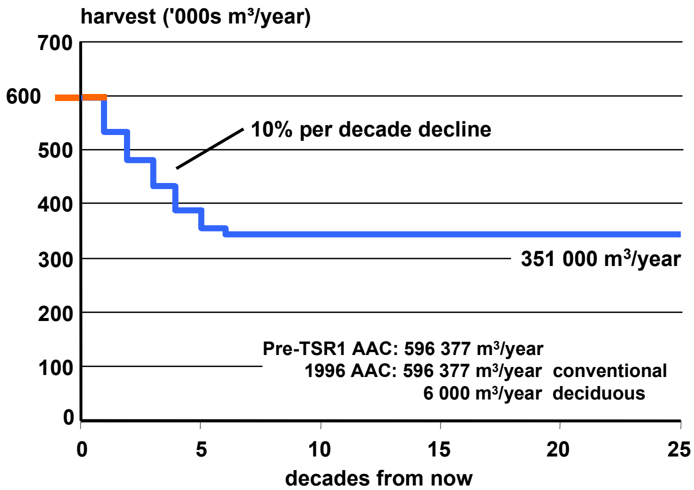
Timber supply is the rate at which timber is made available for harvesting, and it is "made available" through natural, administrative, and economic processes. The forest economy draws timber from the land base in response to consumer demand, and this flow of timber is limited by the rate at which the 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.

2.4.1 Timber Supply and the AAC

The 1994 TSR, upon which the current AAC determination was based, shows the allowable annual cut can be maintained for 10 years without causing a reduction in future harvest levels below the long-term level. After 10 years the harvest declines at 10% each decade until the long term is reached in the sixth decade. The long-term harvest level, the potential maximum that can be harvested in perpetuity, is about 351,000 cubic metres per year, a 41% decline from the initial harvest level.

Figure 2-5. Base harvest forecast, Robson Valley TSA.

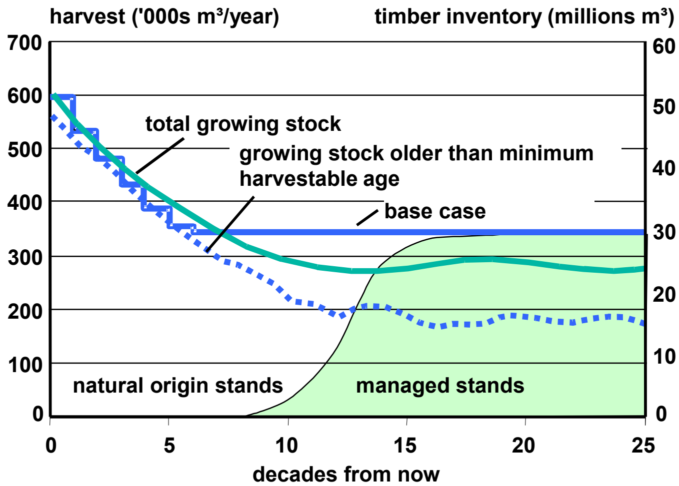


The steep decline from current harvesting levels to a much lower long term harvest level is characteristic of management units where the remaining mature timber is being rapidly depleted. Figure 2-6 overlays the forecast levels of total and harvestable growing stock on the base case, demonstrating that the timing of the reduction of the stock coincides with the fall down in harvest.

2.4.2 Transition from Natural to Managed Stands

The transition of the harvest from old growth to predominantly second growth is also plotted on Figure 2-6. Note that this transition line is an estimate – this information was not reported from the TSR1 analysis. The transition curve helps identify the response frameworks 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 130 years as the end of the mid-term for Robson Valley TSA. The short term is arbitrarily defined as the first 20 years.

Figure 2-6. Total and harvestable growing stock and harvest composition, Robson Valley TSA.



2.4.3 Scarcity of Harvestable Timber in Late Mid-Term

Figure 2.7 displays the age distribution of the timber harvesting land base currently, and in 50 and 100 years. 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.

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

2.4.4 Rationing of Current Mature Timber

Figure 2-8 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 almost to zero 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 which is currently age 210+ years. 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

Figure 2-7. Stand age distribution over time – Robson Valley TSA.

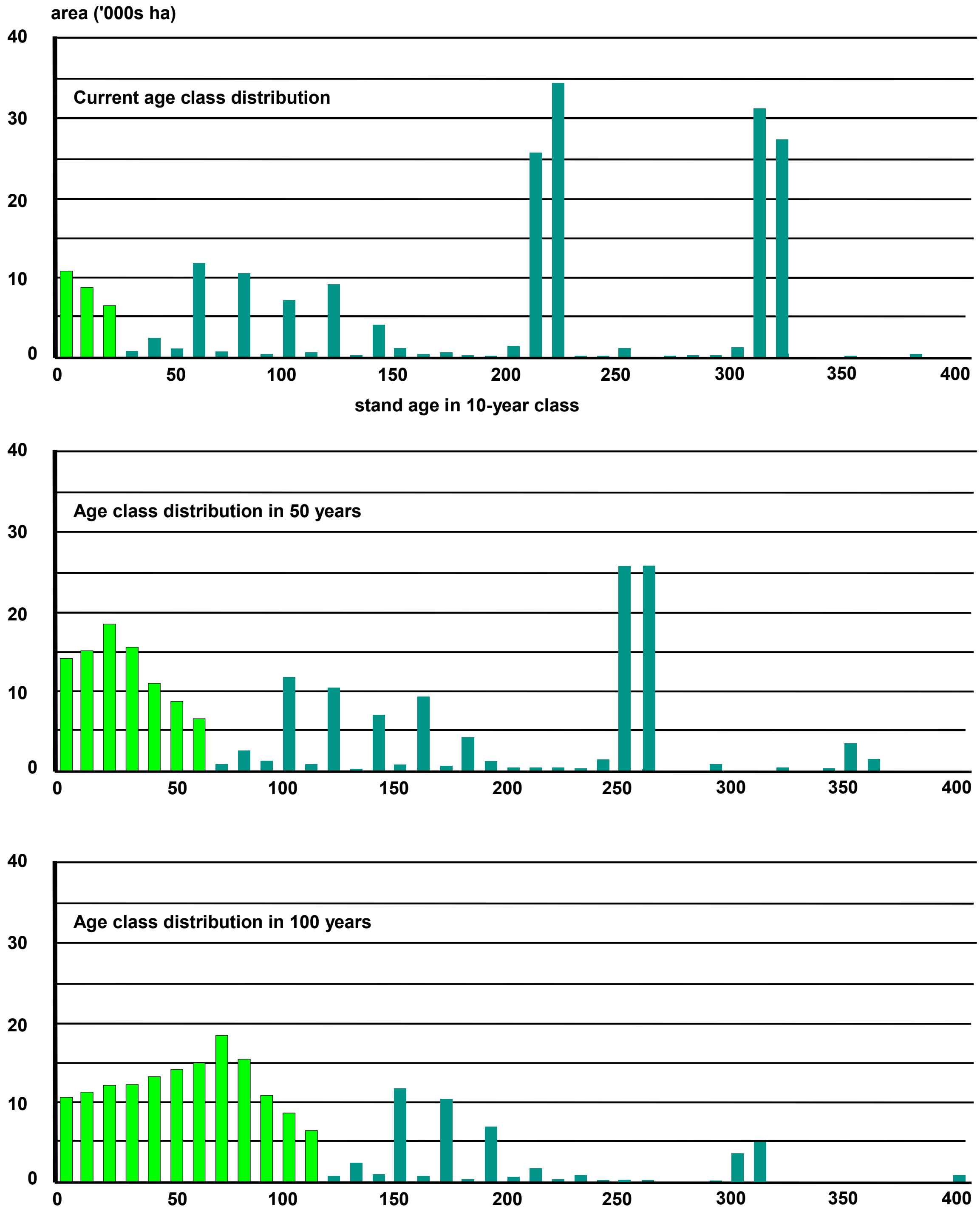
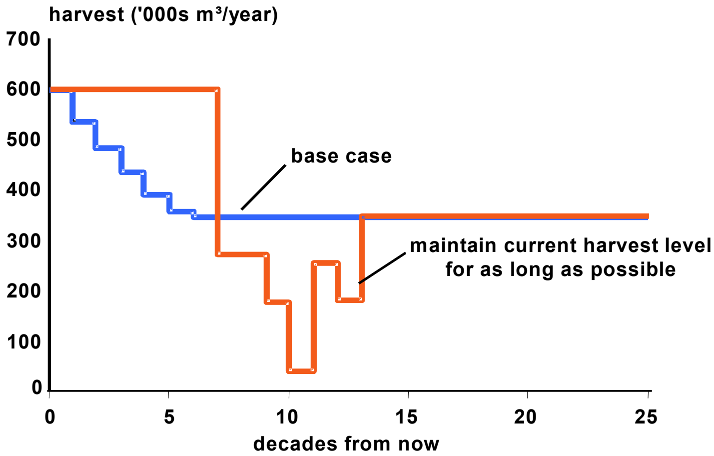


Figure 2-8. Harvest forecast with current harvest maintained as long as possible, Robson Valley TSA.



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.

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.

2.4.5 Minimum Harvest Ages

Minimum harvest ages were set by District staff after review of volume per hectare requirements, culmination ages and field experience. Most minimum harvest ages are set at least 10 years before culmination. Minimum harvest ages might be reduced further through silviculture and the TSR sensitivity analysis Figure 2-9 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 our earlier examination of the forecasted age class distributions indicated that the harvest was support mainly by stands age >200 years. However, its 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 minimum harvest age. The increase in available stands at this critical point, that result from reducing minimum harvest age by 20 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 short term (second decade), reducing the minimum harvest age by 20 years produces a benefit of 60,000 m^3. This is based on a harvest rate of 1400 ha per year. So, a silvicultural treatment that reduces mha by 20 years produces a benefit of (60,000/1400=) 43 m^3/ha, and a treatment that reduces mha by 1 year produces a benefit of

(43/20=) 2.1 m³/ha in decade 2. Using similar logic, in the early mid term (decades 3-6), any treatment that reduces mha by 1 year produces a benefit of ((40,000/1400)/20 =) 1.4 m³/ha treated.

Figure 2-9. Harvest forecast with minimum harvest ages changed by 20 years – Robson Valley TSA.

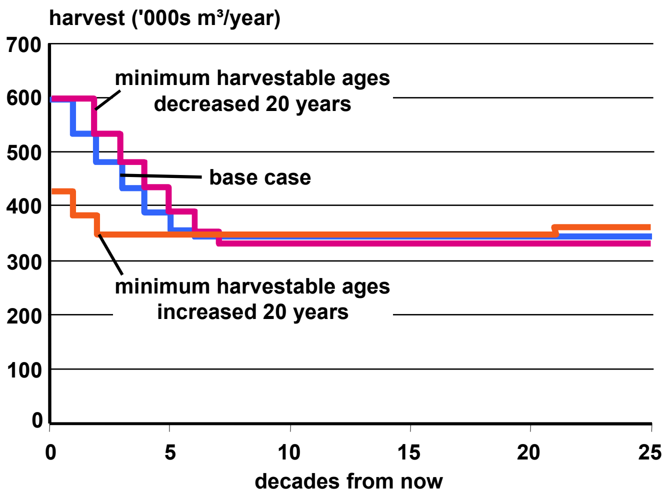


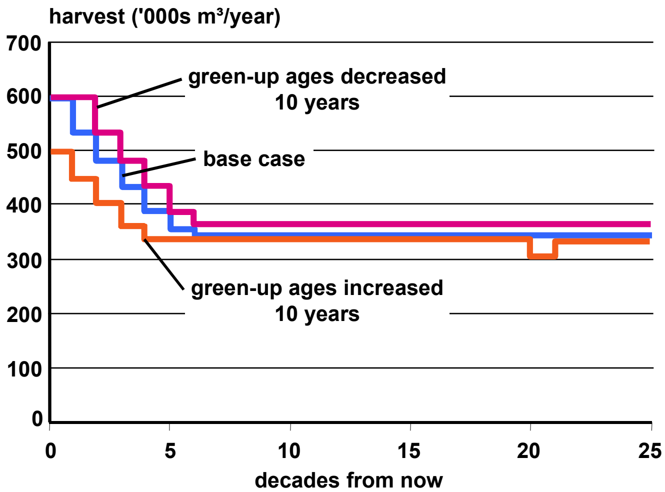
Figure 2-9 also demonstrates that the harvest flow constraint mechanism for bring benefits forward also works in reverse if there is a increase in scarcity at the critical period (pinch point) in supply. If minimum harvestable ages increase by 20 years, the period of scarcity is deepened and lengthened, and much more of the remaining mature timber must be held in order to sustain the cut at the long term harvest level. In this case , the short-term and early mid-term reduction in supply resulting from increased minimum harvest age is much larger in magnitude than the short-term and early mid-term increases that would occur if the minimum harvest ages were decreased.

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

2.4.6 Green-up

The TSR sensitivity analysis for green-up (Figure 2-10) provides us with similar results. A 10 year decrease in green-up results in benefits across the entire planing horizon, but the short-term and early mid-term benefits are much larger than the long term benefits. The same mechanism that were described for minimum harvest ages also applies here – at the time of real physical shortage (decades 7-15), reduction of the green-up ages by 10 years frees up harvestable stands, and the benefits forward substitute back up the fall down staircase. The sensitivity coefficients can be calculated using the same logic as for minimum harvest ages. In the short term, reducing green-up age by 1 year produces 4.3 m3 per hectare treated; in the early mid term, the benefit is 2.9 m3 per hectare treated, and in the later mid term and long term, the benefit is 0.7 m3 per hectare treated. The assumptions for this and subsequent calculations can be found in the summary table at the end of this section.

Figure 2-10. Harvest forecast with green-up ages changed by 10 years – Robson Valley TSA.

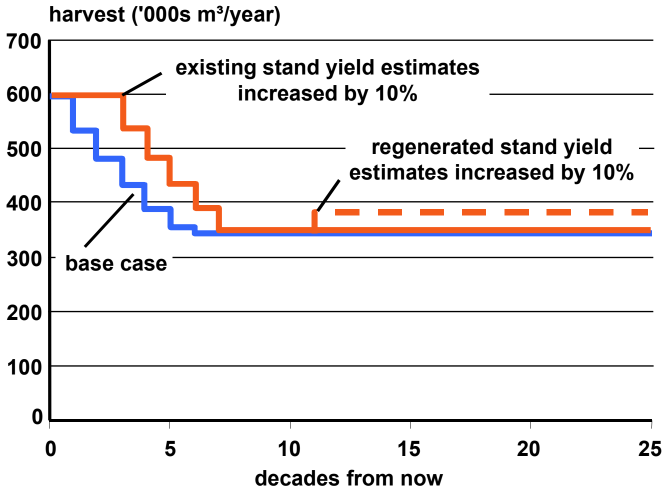


An increase in green-up age results a large reduction in short and early mid-term timber supply for the same reason described for minimum harvest ages: the increased green-up age causes the period of real physical scarcity to broaden and deepen, and more of the existing stock of mature timber must be rationed to maintain the harvest at the long term harvest level.

2.4.7 Increasing Stand Yields

Increasing existing stand yields has a substantial effect on short- and mid-term timber supply (Figure 2-11). Again, the late mid term scarcity and forward substitution effect allows a disproportionate benefit to be realized in the earlier decades. 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.

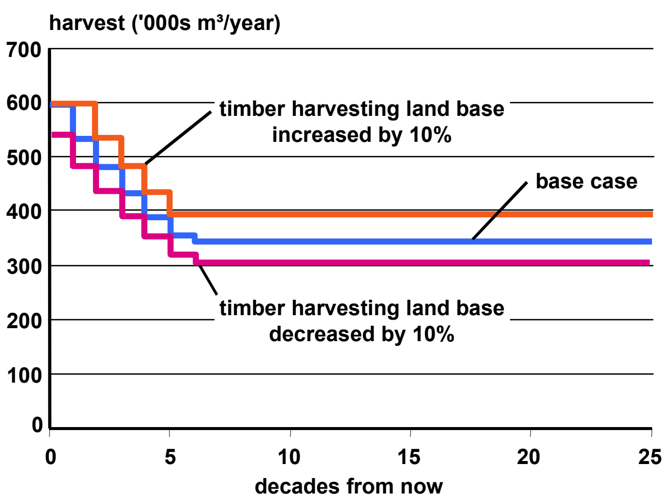
Figure 2-11. Harvest forecasts with existing and regenerated stand yield estimates increased by 10%



2.4.8 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 increased and decreased by 10%.



2.4.9 Timber Supply Dynamics - Summary

The main constraint on timber supply in the Robson Valley TSA is the physical scarcity of timber 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 adjust green-up ages, minimum harvest ages, stand yields, and the extent of timber harvesting land base will have significant effect 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.

Table 2-4. Sensitivity coefficients relating forest-level factors to timber supply.

	Term	Gross Benefit (m^3/yr)	Area Harvested (ha)	Change	Sensitivity Coefficient[1]
Greenup Age (years)	Short	60,000	1400	-10	4.3
	Mid	40,000	1400	-10	2.9
	Long	10,000	1400	-10	0.7
Minimum Harvest Age (years)	Short	60,000	1400	-20	2.1
	Mid	40,000	1400	-20	1.4
THLB age< greenup (%)	Short	60,000	1400	-5	8.6
	Mid	40,000	1400	-5	5.7
	Long	10,000	1400	-5	1.4
existing stand yields (%)	Short	70,000	1400	10	5.0
	Mid	82,000	1400	10	5.9
regenerated stand yields (%)	Long	42,000	1400	10	3.0
timber harvesting land base (%)	Short	60,000	1400	10	4.3
	Mid	47,000	1400	10	3.4
	Long	50,000	1400	10	3.6

[1] m^3/ha treated per unit reduction

3. Silviculture Strategies

Prior to the district workshop, information in the previous sections was used to identify silvicultural strategies as having potential to either maintain or increase future timber supply at the TSA level. These strategies and others introduced by participants at the workshop were analyzed by the participants as to their appropriateness and efficacy. Some of these strategies were selected by the participants as feasible and desirable for the TSA and are listed in Table 3-1. This set of strategies constitutes the silviculture strategy for the Robson Valley TSA, as determined by the workshop participants.

Strategies that were rejected by the workshop are listed in Appendix 3, together with the reasons for their rejection.

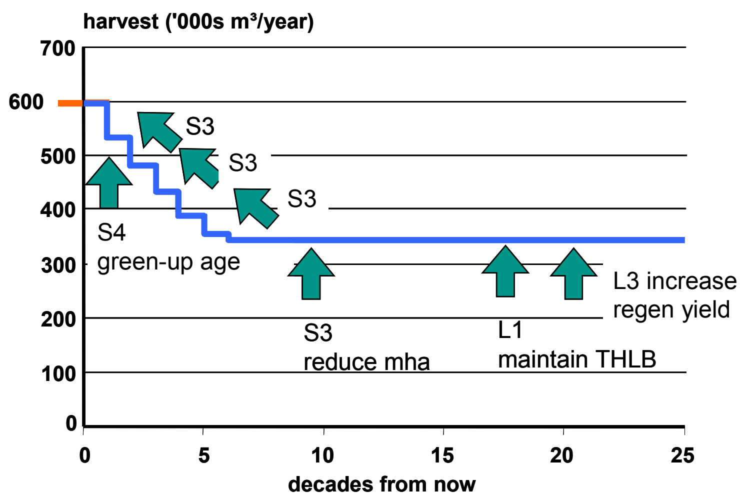
Table 3-1. Silviculture strategies, targets and activities identified in the workshop as feasible and desireable for the Robson Valley TSA.

ID	Strategy	Target	Activities
S3	Reduce minimum harvestable ages by 10 years	1 younger existing stands, ages 15-30, >3000 sph	
		Pl	spacing
		Sx	spacing
		2 P, Fd, sites: (lower 1/4G, M, upper 1/4P), East Canoe, <2000 sph	repeat fertilization, 15year cycle
S4	Reduce green-up ages by 10 years	2 P, Fd, sites: (lower 1/4G, M, upper 1/4P), East Canoe, <2000 sph	repeat fertilization, 15 year cycle
L1	Maintain the timber harvesting land base	pre-87 backlog	
		SR impeded	1 survey 2 brush
		NSR	1 site prep 2 plant
L3	Increase the volume of regenerated stands by 20%	regen, all; Pl, Fd, sites: (lower 1/4G, M, upper 1/4P)	repeat fertilization, 15 year cycle
FH1	Prune to reduce risk of infection	Fdi, Pl, Pw stands (Pw priority; Fdi and Pl mixed in)	prune
Q1	Prune for quality	Fdi, Pl	prune

The ID of each strategy in Table 3-1 conveys the expected time of timber supply response (S-short term, M-medium term, and L-long term, or whether the strategy is timber quality oriented (Q), designed to address forest health (FH) or habitat (H) issues.

Figure 3-1 illustrates the timber supply responses of strategies selected in Table 3-1. Strategy S3, reducing the minimum harvestable age by spacing younger existing stands, targets the pinch point in timber supply identified in section 2.4.3. Short term timber supply is sensitive to reductions in minimum harvestable age due to the forward substitution mechanism described in section 2.4.5. Attaining green-up at an earlier age (S4) releases adjacent timber for harvesting in the short term. Maintaining the timber harvesting land base by meeting the backlog reforestation assumptions of the TSR (L1) benefits timber supply in the long term, as does increasing the yield of regenerated stands.

Figure 3-1. Location of timber supply effects of the selected strategies.



4. Silviculture Impacts and Priorities

The silviculture activities required to implement the strategies identified in Table 3.1 are listed below in Table 4.1, together with their impacts on the TSA objectives adopted in section 1.2. 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.

5. Silviculture Program

5.1 Tactical Priorities

The rankings of Table 4.1 represent a balance between the participant's strategic concerns and the silvicultural opportunities available on the TSA in the next 5 years.

After surveys, which are necessary precursors to the remainder of the program, the highest ranked activities are the treatment of backlog NSR, which implement strategy L1, the maintenance of the timber harvesting land base as represented in the TSR.

The next priority was the pruning of the Pw components of mixed Fdi, Pl, Pw stands, which implements the forest health strategy FH1, pruning to reduce risk of infection, and L3, increasing regenerated stand yields.

The next treatments selected were spacing younger existing Pl and Sx stands, to implement S3, the strategy of reducing minimum harvestable age.

Finally, the fertilization of suitable Pl and Fdi sites on a 15 year cycle implements S3 (reducing minimum harvest ages), S4 (reducing green-up ages), and L3 (increasing the yield of regenerated stands).

5.2 Program Costs and Benefits

Table 5-1 contains the area treated by activity and year. Variations in activity levels by year were supplied by the workshop and most often represent the completion of an obligation or specific opportunity (e.g., backlog) or the ramping up of treatment to a higher level of effort (e.g., fertilization).

Table 5-2 contains the expenditure by activity and year, based on the unit costs recorded in the treatment table (Table 4.1).

Table 5-3 contains the silviculture employment benefits associated with the program. These benefits were calculated using employment multipliers tabulated for the most recent TSR.

Table 4-1. Silviculture activities, the strategies they implement, their impacts on TSA objectives, and their priorities as determined by the workshop.

	Activities/Treatments	Strategy	Opportunity Area (Ha/Yr)	Timber Supply Effects Short	Medium	Long	Quality	Habitat	Jobs Days/ha	Cost $/ha[1]	Wkshp Rank
1	Surveys - general		1355						0.1	23	1
2	Survey - SR impeded backlog		4000						0.1	20	1
3	Site prep backlog NSR	L1	50		M	M		-	1.0	900	3
4	Plant backlog NSR	L1	50		M	M		-	1.3	800	3
5	Brush impeded SR	L1	400		M	M		-	2.0	900	2
	Spacing										
6	Pl younger existing stands, ages 15-30, >3000 sph	S3	100	+ +	+	-		+ +	3.0	1200	5
7	Sx younger existing stands, ages 15-30, >3000 sph	S3	100	+ +	+	-		+	3.0	1200	6
	Fertilize, repeat 15 year cylce										
8	P, Fd, sites: (lower 1/4G, M, upper 1/4P), East Canoe, <2000 sph	S3, S4, L3	400	+ +	+			+/-	0.1	250	7
9	P, Fd, sites: (lower 1/4G, M, upper 1/4P), <2000 sph	S3, S4, L3	0		+	+		+/-	0.1	250	nr
	Prune										
10	Fdi, Pl, Pw stands (Pw priority; Fdi and Pl mixed in)	FH1, L3	75	+ +	+		+		1.0	300	4
11	Fdi, Pl	Q1	200				+		4.0	1200	8

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

M necessary to maintain the TSR; TSR assumption

nr not ranked

Activity 1, general surveys, is estimated to be three times the annual total program level.

Activity 3, site preparation of backlog NSR, will not begin until 2001.

Activity 8, fertilization of East Canoe sites: the opportunity area of 400 ha/year will be exhausted in 5 years.

Activity 8, East Canoe sites consist of old beetle salvage

Activity 9, fertilization: there is no oppoertunity in the next five yearsto implement this regime but the workshop determined that the program could reach a level of 1100 ha per year in the long run.

Table 5-1. Area (ha) treated by activity and year.

Year	Surveys* General	Surveys SR Impeded	Backlog Site Prep	Backlog Plant	Backlog Brush	Space	Prune Health	Prune Quality	Fertilize -	Total
1	1,355	4,000	50			200	50	50	400	6,055
2	1,355	4,000	50	50		200	50	50	400	6,055
3	1,355	4,000	50	50	50	200	50	50	400	6,055
4	1,355	4,000	50	50	50	200	50	50	400	6,055
5	1,355	4,000	50	50	50	200	50	50	400	6,055
Subtot Yr 1 - 5	6,775	20,000	250	200	150	1,000	250	250	2,000	30,275
6 - 10	6,775	20,000	250	250	250	1,000	250	250		29,025
Total Yr 1 - 10	13,550	40,000	500	450	400	2,000	500	500	2,000	59,900

* Includes prescription and layout

Table 5-2. Expenditure ('000 $) by activity and year.

Year	Surveys* General	Surveys SR Impeded	Backlog Site Prep	Backlog Plant	Backlog Brush	Space	Prune Health	Prune Quality	Fertilize -	Total
1	31	80	45	-	-	240	15	60	100	571
2	31	80	45	40	-	240	15	60	100	611
3	31	80	45	40	45	240	15	60	100	656
4	31	80	45	40	45	240	15	60	100	656
5	31	80	45	40	45	240	15	60	100	656
Subtot Yr 1 - 5	156	400	225	160	135	1,200	75	300	500	3,151
6 - 10	156	400	225	200	225	1,200	75	300	-	2,781
Total Yr 1 - 10	312	800	450	360	360	2,400	150	600	500	5,932

Table 5-3. Short term employment benefits (person-years) of the silviculture program, by year and activity.

Year	Surveys*	Surveys SR Impeded	Backlog Site Prep	Backlog Plant	Backlog Brush	Space -	Prune Health	Prune Quality	Fertilize -	Total
1	0.7	2.0	0.3	-	-	3.0	0.3	1.0	0.2	7
2	0.7	2.0	0.3	0.3	-	3.0	0.3	1.0	0.2	8
3	0.7	2.0	0.3	0.3	0.5	3.0	0.3	1.0	0.2	8
4	0.7	2.0	0.3	0.3	0.5	3.0	0.3	1.0	0.2	8
5	0.7	2.0	0.3	0.3	0.5	3.0	0.3	1.0	0.2	8
Subtot Yr 1 - 5	3.4	10.0	1.3	1.3	1.5	15.0	1.3	5.0	1.0	40
6 - 10	3.4	10.0	1.3	1.6	2.5	15.0	1.3	5.0	-	40
Total Yr 1 - 10	6.8	20.0	2.5	2.9	4.0	30.0	2.5	10.0	1.0	80

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

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Appendix 1
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.

Appendix 2
Summary of Issues Requiring Investigation

During the workshop's consideration of TSA issues, strategies and silvicultural regimes, an number of additional issues were identified that require investigation. These issues are listed in Table A2-1 in the order of priority established by the participants.

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

Priority	Issue
1	Investigate plans for improved Pl seed for the district.
2	Confirm or refine site productivity estimates for the TSA.
3	Develop a growth and yield monitoring strategy (including the effects of leader weevil and root collar weevil).
4	Review the green-up ages used in the TSR and clarify how they were derived. Confirmation of these green-up ages may require a sampling project.
5	Confirm or refine the OAF1 estimates of the TSR with OAF1 surveys
6	Establish spruce fertilization trials, emphasizing both late rotation and early fertilization regimes.
7	Support and participate in the caribou high trials.
8	Post TSR2, investigate opportunities on non-merch and low sites.
9	Evaluate the need and opportunity for Pw pruning.
10	Establish fertilization trials in Pl age 30-50
11	Establish spruce pruning trials and determine if timing is a factor in success or failure.

Appendix 3
Rejected Strategies

The workshop participants rejected some strategies after identifying their silvicultural target and the activities required to implement the strategy. These rejected strategies and the reasons why they were rejected are listed in Table A3-1.

Table A3-1. Strategies considered and rejected strategies for Robson Valley TSA silviculture strategy.

Strategy #	Strategy Description	Target	Activities	Reason for Rejection
S1	Increase standing volume by 20 m3/ha	thrifty existing Pl, Fi 80-100 yrs, open canopies, 700-800 sph	late rotation fertilization	no opportunity - most of the stands age 60-80n have inappropriate structure for fertilization
S2	Reduce green-up ages	younger existing in VQO	a. brushing	no opportunity, no problem - VQO emphasis is not justified as most stands exceed 5m.
		P, Fd, 1/4G,M,1/4P <2000 sph	b. fertilize	no opportunity as already at green up and wil move into the repeat fertilization regime when 30 years old
S4	Reduce green-up ages by 10 years	future, stands,all zones, priority community watersheds	a. plant improved stock	No opportunity - not considered in Robson Valley TSA
			b. brushing for survival and growth	No opportunity - not considered in Robson Valley TSA
S5	Reduce minimum harvest age by 20 years	future stands	a. spacing	not evaluated
			b. repeat fert, 15 yr	not evaluated
M1	Reduce cover constraints associated with caribou habitat	caribou habitat	not identified	not evaluated - will wait for the results of the caribou study
M2	Setup for partial harvesting and commercial thinning	future stands, VQO priority	not identified	not evaluated
L2	Increase the timber harvesting land base	TSR net downs		
		NC Br	a. afforestation	no opportunity recognized by the participants
		decids	b. convert/rehab	no opportunity recognized by the participants
		non-merch	c. convert/rehab	no opportunity - some otherwise non-merch stands are contributing as an AAC partition
		low sites	d. assess	wait for tsr2; --> "to do" list, Appendix 2
		low sites, Pl, FD	e. fertilize	???
L3	Increase regenerated volumes by 20%	regenerating stands, all		
		all	a. improved seed	--> "to do " list, Appendix 2
			b. reduce loss spruce weevil	--> "to do " list, Appendix 2
		voids	c. incr brush	--> "to do " list, Appendix 2
		voids	d. OAF survey	--> "to do " list, Appendix 2
L4	reduce losses to root rot	root rot	a. pop-up spacing	not evaluated

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