

Tembec Industries Incorporated
Tree Farm Licence No. 14

Management Plan No. 8
Silviculture Strategy

Prepared With the Assistance of
Timberline Forest Inventory Consultants Limited
And
L.P. Atherton & Associates

Funded By
Forest Renewal BC

March 25, 2001

Executive Summary

This document presents a silviculture strategy for Tree Farm Licence (TFL) No. 14, held by Tembec Industries Incorporated. TFL 14 is situated in the East Kootenay region of British Columbia and is within the Invermere Forest District of the BC Ministry of Forests.

The strategy is valid for the duration of the TFL's Management Plan No. 8 and will be re-visited when MP No. 9 is prepared in 2005. It is the result of two workshops and forest estate modelling analysis. Full documentation of the process, including potential strategies considered but rejected, is contained in separate reports.

Issues

The key TFL 14 forest management issues that silviculture can influence are:

1. Maintaining a sustainable harvest level.
2. Critically low timber availability approximately 60 to 80 years from now.
3. Low timber quality in stands to be harvested approximately 60 to 80 years from now.
4. Finding the optimum mix between ungulate winter range, old seral stage requirements, and timber supply.
5. Ensuring healthy managed stands so that expected timber yields and quality are achieved.

Management Objectives

As the holder of Tree Farm Licence No. 14, Tembec's management objectives are:

1. Practice and demonstrate responsible stewardship of the forest, fish and aquatic habitat, wildlife, air, land and water resources of the TFL.
2. Maintain the biodiversity, habitat resources and ecosystems of the TFL.
3. Produce a higher future log quality profile than will be available from the adjacent timber supply areas.
4. Maintain a sustainable harvest from this point forward, rising only when there is reasonable certainty that a higher level is also sustainable (major salvage requirements excepted).
5. Maintain a steady employment base for its silviculture, logging and manufacturing employees and contractors.

Strategic Objectives and Targets

The silviculture analysis indicates the following strategic objectives and targets are attainable through the strategies further below. The objectives are listed in general but not strict order of priority.

1. Maintain a distribution of seral stages across each landscape unit.

2. Maintain, within their respective resource emphasis areas, 350, 1500, and 3300 ha of deer, elk, and moose winter range at all times.
3. Maintain a sustainable harvest level of 160 000 m³/yr, rising to a sustainable level of 170 000 m³/yr or higher approximately 100 years from now.
4. Improve available timber supply in decades 7-11 and 20.
5. Use silvicultural practices to manage stand structure and density through each seral stage to keep forest pest incidence to endemic levels, managed stand yields to within 10% of their biological potential, and unsalvaged losses less than 5% of the harvest level.
6. Achieve a minimum average harvested stand dbh of 25 cm in the long term.

Strategies

The following strategies support the achievement of the objectives and targets.

<u>Strategy</u>	<u>Priority</u>
1. Monitor the progress of the Ministry of Forests' tree improvement program to ensure: <ul style="list-style-type: none"> (a) yield gains of at least 25% for spruce, and 10% for lodgepole pine, western larch and Douglas-fir species are achieved, and (b) sufficient improved seed is available to meet TFL 14 planting program needs by the year 2010. 	Highest
2. Maintain the timber harvesting land base by surveying 200 ha/yr and brushing 20 ha/yr of existing backlog plantations to ensure they reach free growing status.	High
3. Maintain the timber harvesting land base by restoring areas destroyed by fire or pests.	High, as needed
4. Survey 400 ha/yr of post free growing juvenile stands to monitor their productivity and health to ensure their expected yields and quality will ultimately be attained.	High
5. Maintain the incremental silviculture analysis base case harvest and timber quality forecasts by juvenile spacing 250 ha/yr over the next 10 years, 150 ha/yr thereafter.	High
6. Increase the mid term harvest level by 4000 m ³ /yr through 200 ha/yr of late rotation fertilization and 150 ha/yr of mid rotation fertilization of suitable Douglas-fir and lodgepole pine stands.	High
7. First and second lift prune 25 ha/yr (total program 50 ha/yr) to increase premium log content by 1%.	Low

Further Information and Research Needs

Further information and research needs are identified in the strategy. Three of these are related to habitat supply and can possibly be accomplished through a Type III silviculture analysis. The majority of the remainder are related to growth and yield of managed stands.

Strategy Monitoring

Formal strategy monitoring shall occur in January (starting January 2002) with reports submitted to Tembec's chief forester by February 15th. Monitoring in year 2002 and 03 shall focus on implementation. Monitoring in 2004 and 06 shall address both implementation and effectiveness. No monitoring is planned for 2005.

Program

The following table outlines the incremental silviculture activities and budgets required annually over the five year period, 2001/02 to 05/06, together with identified studies. Many of the silviculture activities will need to be continued beyond the five year program period in order to fully realize the objectives and targets of this strategy. Operational factors (for example, access, efficient treatment unit groupings, *etc.*) and funding variability may result in year-to-year program variation.

Forest Renewal BC funding of all of the indicated backlog reforestation and stand tending activity cost is considered attainable. Attaining FRBC funding for all of the identified studies is less certain, particularly for the pulp thinning trial which has funding policy implications due to the recovery of useable wood.

Activity		Priority		Treatment Area & Cost		Outcome by Time Period (yrs)									
				Ha	\$	Labour (yrs)	Maintain/ Increase	Stand Level (m3) ¹				Forest Level (m3/yr) ²			
								1 - 20	21 - 50	51 - 100	101+	1 - 20	21 - 50	51 - 100	101+
BACKLOG REFORESTATION / RESTORATION															
Surveys	High	200	4,600	0.1	Maintain										
Brushing	High	20	14,000	0.0	Maintain			1500				150	150		
Program Total		220	18,600	0.1		0	0	1500	0	0	0	150	150		
STAND TENDING															
Juvenile Stand Monitoring	High	400	9,200	0.1	Maintain										
Surveys/Presc/Layout	High	1,300	29,900	0.3	N/A										
Spacing	High	250	193,750	3.5	Maintain			875		2375	2000	2000			
Fertilization	High	350	87,500	0.1	Increase	7700					4000	4000			
Pruning	Low	50	40,000	0.5	Increase			25ha prem				1% prem.	1% prem.		
Program Total		1,950	321,250	4.1		7700	0	875	0	2375	6000	6000	0		
FOREST HEALTH															
Program Total		-	-	0.0		0	0	0	0	0	0	0	0		
STUDIES															
Strategy Monitoring	1		2,500												
Fertilization Trials	2		7,500												
Managed Stand Yields	3		40,000												
Type III Silv. Analysis	3*		75,000												
IU Logging Analysis/Trials	4		10,000												
Early Ht Growth Measure	5		8,000												
Stock Type / Green-up	5		7,500												
Pulp Thin Trial	6		253,000												
Comm'l Thin Field Check	7		6,800												
Balsam Yield Tables	8		50,000												
Program Total		-	450,300	0.0		0	0	0	0	0	0	0	0		
GRAND TOTAL		2,170	790,150	4.2		7700	0	2375	0	2375	6000	6150	150		

1-Outcome of a single year's treatment; m3 unless otherwise stated.

2-Forest level outcome of a continued program of treatments; m3/yr unless otherwise stated.

* Priority to be re-evaluated after completion of the Nelson Forest Region spatial analysis trial.

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Contents

EXECUTIVE SUMMARY	I	4.3 Composite Scenario	10
CONTENTS	VI	5. STRATEGIC OBJECTIVES AND TARGETS	10
LIST OF TABLES	VII	6. SILVICULTURE STRATEGIES AND PRIORITIES .	11
LIST OF FIGURES	VII	6.1 Basic Silviculture.....	11
1. INTRODUCTION	1	6.1.1 Achievement of Modelling Assumptions.....	11
1.1 About This Strategy	1	6.1.2 Reforestation Regimes	11
1.2 How The Strategy Was Developed	2	6.2 Incremental Silviculture.....	13
1.3 Terminology, Definitions and Acronyms....	2	6.2.1 Tree Improvement.....	13
2. ISSUES	2	6.2.2 Backlog Reforestation / Restoration.....	14
2.1 Timber Quantity	3	6.2.3 Juvenile Stand Monitoring	15
2.2 Timber Quality.....	4	6.2.4 Juvenile Spacing.....	15
2.3 Habitat Supply.....	5	6.2.5 Fertilization.....	17
2.4 Forest Health	7	6.2.6 Pruning.....	18
2.5 Summary of Issues	7	6.2.7 Forest Health.....	18
3. GOALS, OBJECTIVES AND GUIDING PRINCIPLES	7	7. FURTHER INFORMATION AND RESEARCH NEEDS.....	19
3.1 Government's Goals	7	8. MONITORING AND EVALUATION	21
3.2 Tembec's Management Objectives	7	8.1 Monitoring Responsibility and Team	21
3.3 Guiding Principles.....	8	8.2 Monitoring Schedule	21
4. SILVICULTURE ANALYSIS	8	8.3 Procedure	21
4.1 Incremental Silviculture Base Case.....	8	8.4 Monitoring Reports	22
4.2 Initial Scenarios.....	9	9. INCREMENTAL SILVICULTURE PROGRAM	23
		APPENDIX A: TERMINOLOGY & ACRONYMS	24

List of Tables

Table 1. Reforestation regimes on Planted Areas	12
Table 2. Reforestation regimes on Areas Managed for Natural Regeneration	13
Table 3. Juvenile Spacing Regimes	16
Table 4. Target Stands for Fertilization	18

List of Figures

Figure 1. Base Case Harvest and Timber Availability Forecasts.....	3
Figure 2. Sensitivity to a 10 Year Increase in Minimum Harvest Age.....	3
Figure 3. Harvested Stand Diameter by Species, ISBC	4
Figure 4. Premium Log Content, ISBC	4
Figure 5. Average Volume/ha, ISBC	5
Figure 6. Seral Stage Distribution, ISBC	5
Figure 7. Harvest Forecast, Reduced Old Seral/ UWR Requirements vs ISBC.	6
Figure 8. Satisfaction of UWR Requirement, Reduced Old Seral/UWR Requirements vs ISBC.....	6

Management Plan No. 8 Silviculture Strategy

1. INTRODUCTION

1.1 About This Strategy

This document presents a silviculture strategy for Tree Farm Licence (TFL) No. 14, held by Tembec Industries Incorporated. TFL 14 is situated in the East Kootenay region of British Columbia and is within the Invermere Forest District of the BC Ministry of Forests.

The purpose of the strategy is to guide the application of available incremental silviculture funds so that they are put to the most efficient and effective use possible. It focuses mainly on incremental silviculture activities but also addresses companion basic silviculture activities where appropriate.

This document is the final of three reports in the process to develop and document a silviculture strategy. The others are,

Report 1: *TFL 14 Management Plan No. 8 Silviculture Strategy Background Information and Initial Analysis – Version 2.3* (Atherton & Timberline), and

Report 2: *Incremental Silviculture Analysis - TFL 14 Spillimacheen* (Timberline).

These reports contain additional information on potential strategies considered but found as unsuitable, typically due to either a lack of treatable area or because analysis indicated little positive or even a negative effect on future timber supply.

The strategy is not tied to a specified funding level, nor has a socio-economic analysis been undertaken although such factors were taken into account in the selection and ranking of individual strategies. The degree to which the overall strategy ultimately proves appropriate and is achieved will also be the degree to which the expressed targets will be achieved. This, of course, may be affected by future unknowns such as catastrophic natural events, major shifts in forest policy, land base available for timber harvesting, or market demand – all of which are assumed to remain within the current status quo.

The strategy is guided by the principles contained herein and by those of the *Incremental Silviculture Strategy for British Columbia*. These principles dictate responsible stewardship of all forest-dependent resources within the TFL.

This strategy should not be confused with the allowable annual cut (AAC). AAC's are based on actual practice and current information at the time of the determination. This strategy, on the other hand, is about improving the future state of the forests within TFL 14 and may influence future, but not necessarily present, AAC determinations.

1.2 How The Strategy Was Developed

This strategy is the product of a team effort – the main team consisting of Woodlands forestry personnel from Tembec and the consulting firms of Timberline Forest Inventory Consultants Limited and L. P. Atherton and Associates. Timberline undertook the modelling of potential silviculture strategies and Atherton and Associates contributed silviculture planning expertise. Tembec Woodlands staff provided operational silviculture expertise and guidance to the overall planning process. Ministry of Environment, Lands and Parks contributed habitat information and expertise. Ministry of Forests, Invermere Forest District staff participated in both workshops.

Project funding was by Forest Renewal BC, with project administration by Marcie Belcher of Tembec.

The strategy was developed through the following process:

1. With Tembec staff participation, the consultants prepared a draft background information document for discussion at the initial planning workshop.
2. An initial workshop was held in Cranbrook, January 19-20, 2000, followed by a conference call to complete unfinished items. Report #1 was submitted to Tembec for approval. This report proposed silviculture scenarios for further analysis.
3. Timberline completed a silviculture analysis using its model, CASH6, the results of which are in Report #2.
4. The silviculture analysis and a draft strategy were presented by the consultants to Tembec Woodlands staff in a second workshop, November 8, 2000. Representatives of the Ministry of Forests participated in the workshop.
5. A final strategy review and priority setting session was held February 7, 2001 by Tembec Woodlands staff, assisted by L.P. Atherton and Associates.
6. The strategy was finalized in this document and approved by Tembec February 15, 2001.

1.3 Terminology, Definitions and Acronyms

Technical terms used in this document are defined in Appendix A.

2. ISSUES

The following issues were identified during the planning process as having the potential to be addressed through incremental silviculture activities.

2.1 Timber Quantity

1. The incremental silviculture base case (ISBC) presents a more optimistic view of the future than does the timber supply base case (TSBC). The ISBC indicates the current harvest level of 164 000 m³/yr can potentially be maintained for 20 years.¹ (Figure 1) After this, it is projected to fall by 5% to 156 000 m³/yr. It is forecast to remain at this lower level until about 100 years from now when it rises by 9% to 170 000 m³/yr, about 4% above the current harvest level.
2. Timber availability is projected to be critically low 61 to 70 years from now (decade 7) indicating that the forecast harvest level during this time may not be operationally attainable. The ISBC shows improved timber availability in decades 11 and 12 over the TSBC, relieving a possible second critical period of low timber availability.
3. The TSBC (and presumably the ISBC) harvest forecast is dependent upon minimum harvest ages which in turn are dependent upon stand density assumptions. About ¼ of annually harvested areas (150 of 600 ha) currently regenerate to densities in excess of 5000 sph, which are significantly above the managed stand densities assumed for the TSBC (2400 sph for Douglas-fir and lodgepole pine and 1600 sph for all other species). Failure to space these areas could result in raising their minimum harvestable ages. The timber supply analysis minimum harvest age sensitivity test indicates this could lower the mid term harvest level (Figure 2). Because about ¼ of the area has significantly higher than assumed densities, the effect is likely ¼ of that indicated by the sensitivity test.

Figure 1. Base Case Harvest and Timber Availability Forecasts

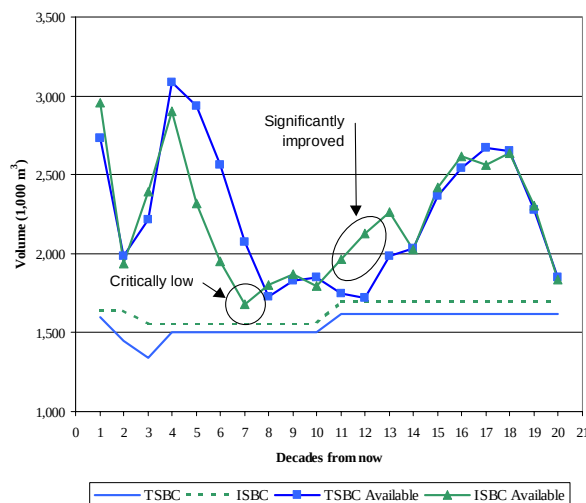
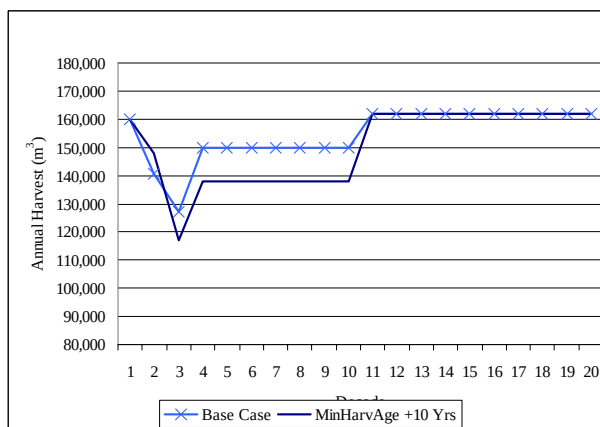


Figure 2. Sensitivity to a 10 Year Increase in Minimum Harvest Age

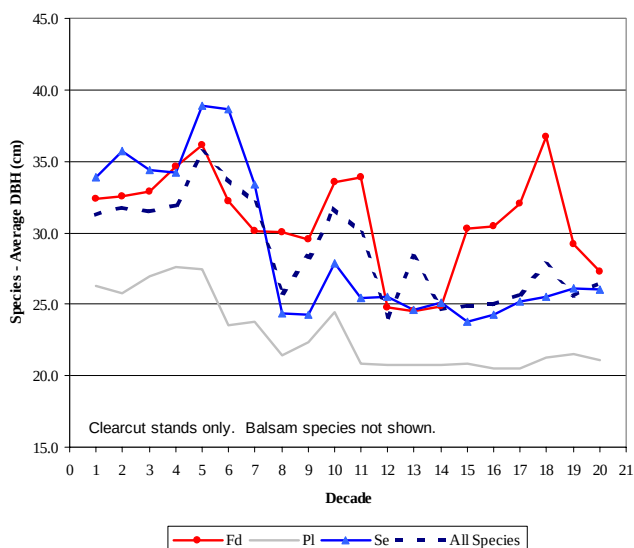


¹ The silviculture analysis and this strategy were completed before the deputy chief forester's determination of the MP #8 AAC. The "current harvest level" is the approved MP#7 AAC.

2.2 Timber Quality

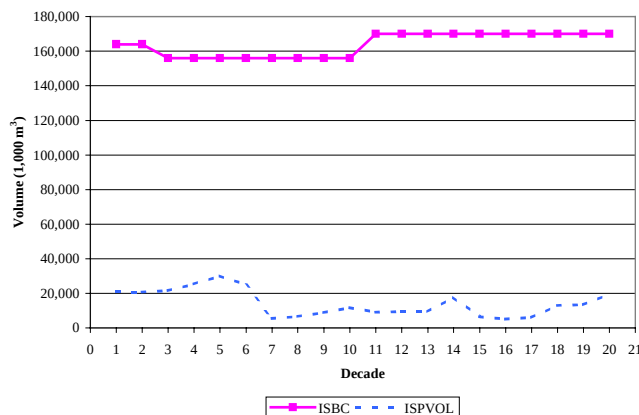
4. The average diameter of harvested stands, a surrogate for timber quality, is projected to gradually rise over the next 50 to 60 years as the remaining existing natural stands are harvested. (Figure 3) Immediately after this, the average stand diameter falls steeply from about 36 cm in decade 5 to about 26 cm in decade 8. This fall in timber quality is at about the same time as timber availability becomes critically low. On average, lodgepole pine and Douglas-fir represent about 80% of total harvest.

Figure 3. Harvested Stand Diameter by Species, ISBC



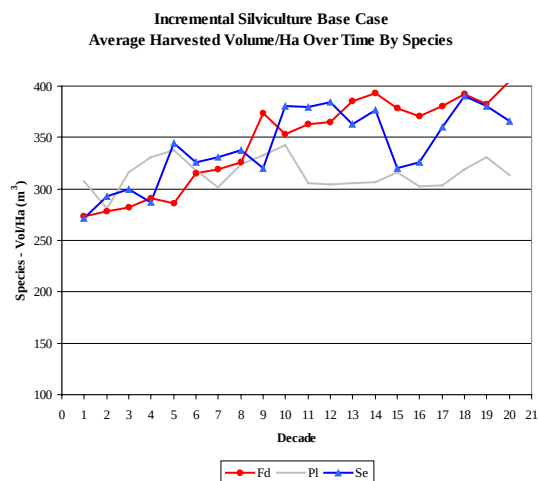
5. Following a similar trend as average stand diameters, Figure 4 (lower line) shows premium log content is forecast to remain level over the short term, rising during the early mid term, from a present level of about 20 000 m³/yr (about 12% of total harvest) to about 30 000 m³/yr (19% of total harvest). At about 60 to 70 years from now it is projected to fall to less than 5000 m³ yr (3% of total harvest). After this, it is not expected to recover again to current levels.

Figure 4. Premium Log Content, ISBC



6. Average harvested vol/ha is forecast to rise over time from about 275 m³/ha to about 325-350 m³/ha (Figure 5). A rising vol/ha, falling harvest ages, and a falling average DBH means future harvested stands will have more, smaller, and younger stems than at present. Harvesting costs are likely to rise and juvenile wood content can be expected to increase with a consequent decrease in machine stress rated (MSR) lumber.

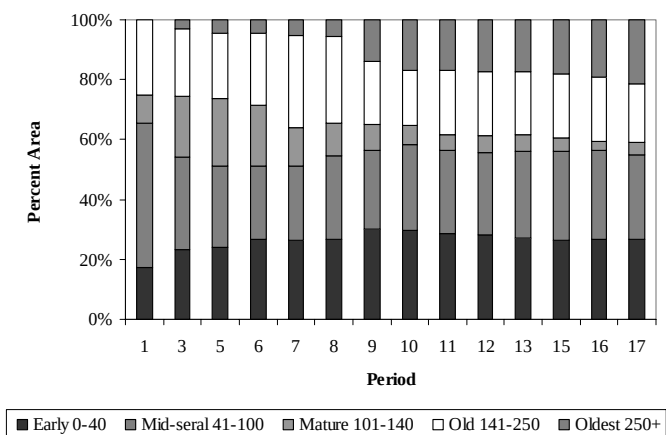
Figure 5. Average Volume/ha, ISBC



2.3 Habitat Supply

7. Figure 6 shows very old stands are forecast to increase significantly over time. However, this is likely overstated because the timber supply analysis model does not emulate natural succession in areas outside the THLB. Instead it ages these stands over time and accumulates them in the very old seral stage. Given that there is presently only about 1000 ha in the oldest category, it is unlikely that future biodiversity will be less than recent levels.
8. Mature stands are forecast to diminish substantially but the combination of mature plus old is within acceptable limits and is not an issue within current guidelines.

Figure 6. Seral Stage Distribution, ISBC



9. The combination of removal of old-seral biodiversity requirements and reduction of ungulate winter range age requirements by 20 years enables maintaining the current harvest level for 4 decades vs. 2 in the ISBC (Figure 7). Timber availability also increases during the early and later periods but does not change in the critical period of decades 7-10 (not shown).

Except for decade 1, ungulate winter range requirements are always met in the ISBC (Figure 8). After the 3rd decade, deer winter range is in abundant supply, while moose and elk winter range is maintained at or slightly above the target level.

Under the less stringent requirements of the sensitivity test, all UWR requirements are highly satisfied in the short term. Moose habitat supply is increased in the short term, but remains relatively unchanged from the ISBC thereafter. It appears that the requirement to maintain 40% (approx. 3 300 ha) of the moose winter range zone above either 61 or 81 years of age is limiting timber supply in the early mid term. However, because availability in the later mid term is unchanged, the moose winter range requirement is not the limiting factor in the critical 7th decade.

While timber supply is not sensitive to independent relaxation of either old seral or UWR requirements, it is very sensitive to relaxation of both together. Not only is there an effect on timber supply but biodiversity requirements appear to conflict with UWR requirements. Research on the true old seral and UWR requirements, the optimum mix between these and timber supply, and on silvicultural means to meet the requirements in other ways may all be appropriate.

Figure 7. Harvest Forecast, Reduced Old Seral/ UWR Requirements vs ISBC.

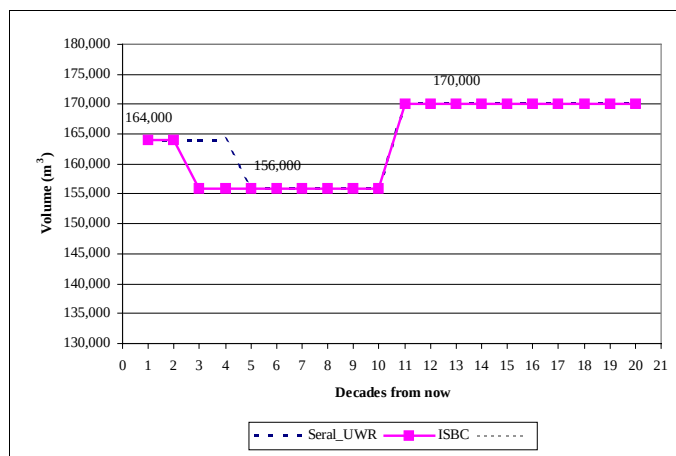
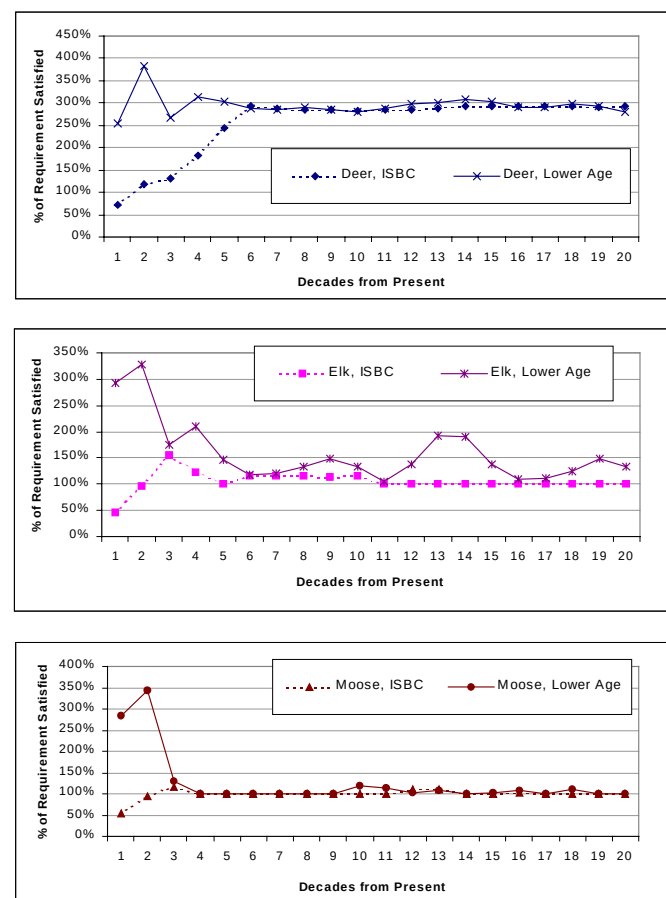


Figure 8. Satisfaction of UWR Requirement, Reduced Old Seral/UWR Requirements vs ISBC



2.4 Forest Health

10. TFL 14 has a moderate to high risk of catastrophic forest fire, insect attack or disease. At present the TFL is relatively free from all of these, although recent increases in lodgepole pine rust and gall infection levels in juvenile stands are resulting in decreasing the amount of lodgepole pine planted in favour of other species.

(No chart)

Good management practices through all stages of a stand's development are necessary to minimize risks.

2.5 Summary of Issues

The key TFL 14 forest management issues that silviculture can influence are:

1. Maintaining a sustainable harvest level.
2. Critically low timber availability approximately 60 to 80 years from now.
3. Low timber quality in stands to be harvested approximately 60 to 80 years from now.
4. Finding the optimum mix between ungulate winter range, old seral stage requirements, and timber supply.
5. Ensuring healthy managed stands so that expected timber yields and quality are achieved.

3. GOALS, OBJECTIVES AND GUIDING PRINCIPLES

3.1 Government's Goals

As expressed in the *Incremental Silviculture Strategy for British Columbia*, government's goals are:

- ♦ Sustainable use.
- ♦ Community stability.
- ♦ A strong forest sector.

3.2 Tembec's Management Objectives

As the holder of Tree Farm Licence No. 14, Tembec's management objectives are:

1. Practice and demonstrate responsible stewardship of the forest, fish and aquatic habitat, wildlife, air, land and water resources of the TFL.
2. Maintain the biodiversity, habitat resources and ecosystems of the TFL.
3. Produce a higher future log quality profile than will be available from the adjacent timber supply areas.
4. Maintain a sustainable harvest from this point forward, rising only when there is reasonable certainty that a higher level is also sustainable (major salvage requirements excepted).²
5. Maintain a steady employment base for its silviculture, logging and manufacturing employees and contractors.

3.3 Guiding Principles

In addition to the guiding principles of the provincial incremental silviculture strategy, the following principles were used to guide the development of this strategy.

- Focus on consistent trends as opposed to small or one-time variations in forecasts.
- Give precedence to strategies that create future options and that are likely stand up under a variety of future conditions or scenarios.

4. SILVICULTURE ANALYSIS

The silviculture analysis consisted of preparing and modelling an incremental silviculture base case (ISBC) and six initial scenarios.³ Following assessment of the initial scenarios, a composite scenario was formulated and modelled.

4.1 Incremental Silviculture Base Case

The ISBC used the same data set and assumptions used in the MP No. 8 timber supply analysis base case (TSBC), except:

1. Expected tree-improvement yield gains of spruce = 25%, interior lodgepole pine = 10%, and interior Douglas-fir = 6%. (The TSBC used 10% for spruce only.)
2. Two-year regeneration delay. (The TSBC used three.)
3. Old seral age requirement for IDF/NDT 4 area of 177+ years of age. (Reduced from 250 by using a weighted age between lodgepole pine at 120 and all other species at 250).

The TSBC incorporates assumptions that about 150 ha/yr of juvenile spacing will occur (necessary to attain the stand densities assumed) and that sufficient survey, fill-planting, and

² The actual determination of AAC, however, is the sole authority of the provincial chief forester.

³ For further information see *Incremental Silviculture Analysis TFL 14 – Spillimacheen*.

brushing activities will occur on existing established backlog (pre-1987) stands so that they are maintained to free-growing status. These assumptions were also included in the silviculture analysis base case, and delivering on them is a high priority in this strategy.

The initial timber supply objectives set for the silviculture analysis scenarios were based on results of the timber supply analysis and were to: (1) eliminate the 3rd decade harvest shortfall; (2) eliminate the mid term harvest shortfall; (3) raise the long term harvest level 10%; and (4) improve timber supply availability to a minimum of 1.25 times the harvest level. The ISBC fully met target 1, partially met targets 2 and 3, and met target 4 in decades 11 and 12 but not in decades 7-10 and 20.

4.2 Initial Scenarios

The six initial scenarios were:

1. Late Rotation Fertilization
2. Pulp Thinning/Commercial Thinning and Fertilization
3. Rehabilitation of Intermediate Utilization Stands
4. Early Harvest of Over-Stocked Lodgepole Pine Stands
5. Reduced Old Forest Retention Requirements (old seral and UWR older forest)
6. Reduced Time to Green-up

Of these, two scenarios, late rotation fertilization and reduced old forest retention requirements, showed reasonable potential to improve future timber supply. Late rotation fertilizing approximately 350 ha/yr of existing thrifty Douglas-fir and lodgepole pine stands can extend the initial harvest level one decade further than in the ISBC (to 3 decades). At the higher fertilizer response assumption, fertilization also raises the mid term harvest level by 4,000 m³/yr and increases timber availability in the critical late mid term period.

The reduced old forest retention requirements scenario enabled maintaining the initial harvest level 2 more decades (4 vs 2 in the ISBC) while at the same time significantly improving deer, elk and moose winter range availability.⁴ This indicates a potential for using silvicultural regimes to achieve the same timber and habitat supply effects by creating old forest stand structures at younger ages. However, the current old seral and ungulate winter range age requirements may be higher than necessary and a review of these appears appropriate before attempting any silvicultural treatments.

Three scenarios, although having benefits, also had costs which make them either a low priority or unacceptable. The PT/CT/Fert scenario extended the initial harvest level 2 decades but caused significant reductions in average volumes/ha over several time periods. Early harvest of the IU stands raised long term timber availability but reduced the mid term harvest level. Advancing the harvest of overstocked pine stands enabled the maintenance of the initial harvest level for three decades (vs 2 in the ISBC) but at the cost of lowering timber supply availability in decade 7.

⁴ This scenario involved completely removing the old seral biodiversity requirements plus lowering older forest retention requirements for ungulate winter range by 20 years. Timber supply forecasts showed little sensitivity to changes in either of these requirements when they were separately examined in the MP #8 timber supply analysis.

Lastly, the green-up scenario indicated little change from the base case.

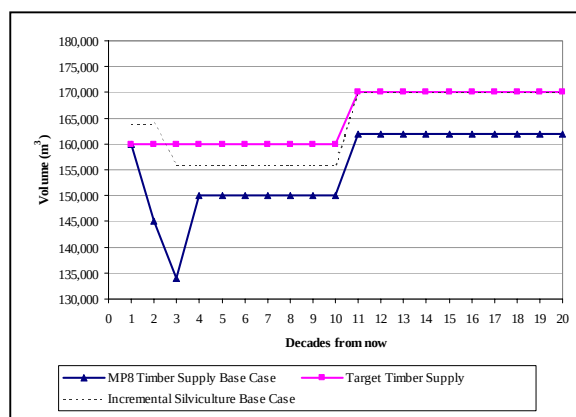
4.3 Composite Scenario

Based on the results of the ISBC and the six initial scenarios, a composite scenario was undertaken that included the high-response late rotation fertilization scenario, the basic assumptions of the ISBC, and corrections to a block composition modelling issue. The resultant harvest forecast was the same as for the late rotation fertilization scenario, but the period of critical timber availability is pushed back from decade 7 to 10.

5. STRATEGIC OBJECTIVES AND TARGETS

The silviculture analysis indicates the following strategic objectives and targets are attainable through the strategies further below. The objectives are listed in general but not strict order of priority.

1. Maintain a distribution of seral stages across each landscape unit.
2. Maintain, within their respective resource emphasis areas, 350, 1500, and 3300 ha of deer, elk, and moose winter range at all times.
3. Maintain a sustainable harvest level of 160 000 m³/yr, rising to a sustainable level of 170 000 m³/yr or higher approximately 100 years from now.
4. Improve available timber supply in decades 7-11 and 20.
5. Use silvicultural practices to manage stand structure and density through each seral stage to keep forest pest incidence to endemic levels, managed stand yields to within 10% of their biological potential, and unsalvaged losses less than 5% of the harvest level.
6. Achieve a minimum average harvested stand dbh of 25 cm in the long term.



6. SILVICULTURE STRATEGIES AND PRIORITIES

6.1 Basic Silviculture

6.1.1 Achievement of Modelling Assumptions

The incremental silviculture base case employed the following assumptions about future basic silviculture practices. These assumptions, listed in order of priority, **must become reality** in order for the objectives and targets to be achieved.

1. Expected tree-improvement yield gains of spruce = 25%, interior lodgepole pine = 10%, and interior Douglas-fir = 6%. (The TSBC used 10% for spruce only.)
2. Two-year regeneration delay. (The TSBC used three.)

A strategy for monitoring the tree improvement program is presented on page 13. A two-year regeneration delay is virtually current practice and therefore does not require a specific strategy.

Additionally, western larch comprises about 20-25% of trees currently planted on the TFL. Because larch managed stand yield tables are not available, Douglas-fir was used as a surrogate species in modelling. Western larch offers superior growth and wood quality characteristics beyond that captured in modelling.

6.1.2 Reforestation Regimes

The species and densities achieved during reforestation set the stage for later incremental silviculture stand management requirements and harvesting options. The reforestation density objective is to achieve a target of 1200 well-spaced stems/hectare (minimum 700) by the earliest free growing date on 100% of each harvested cutblock. Except in the ESSF, total stems at free-growing are expected to be a minimum of 1600 sph and a target of 2500 sph. Total stocking will be purposely maintained at a high level to offset potential forest health losses.

About 90% of harvested area will be planted with one-year old seedlings. Table 1 shows the common species mixes and planting densities. Planting densities will vary primarily according to the amount of anticipated ingrowth of natural regeneration.

Table 2 shows the common silvicultural regimes on the about 10% of harvested areas that are managed for natural regeneration. Most of these areas are partially harvested and there can be substantial variation in regeneration patterns corresponding with the variation in the amount and distribution of overstory removal. Any area on which acceptable natural regeneration does not occur within three years will be planted in accordance with the planting regimes presented above.

Table 1. Reforestation regimes on Planted Areas

BEC Zone ¹	% ²	Typical Planting Proportion ³	Typical Planting Density (sph)	Comment
ESSF	29	55% Sx, 45% PI	90% - 1600 10% - 1400	Minimal expected natural ingrowth, therefore ESSF planting densities are the highest of all zones. Both PI and Sx will typically be mixed on every block, but will vary within blocks to exclusively one species or the other depending upon site-specific conditions.
MS	31	45% PI, 25% Lw, 20% Fdi, 10% Sx	70% - 1400 30% - 1200	Planting density will vary according to expected natural ingrowth. At least 2 species will be planted on every site, sometimes 3. Larch will usually be mixed with PI for early height growth and for mitigating forest health risks associated with PI.
ICH	27	40% PI, 30% Fdi, 15% Lw, 15% Sx	30% - 1400 70% - 1200	As above.
IDF	12	40% Fdi, 35% PI, 15% Lw, 10% Sx	20% - 1400 50% - 1200 30% - 1000	Partial harvest zone. Planting will ensure an understory layer and full site occupancy. Expect PI and Fdi natural ingrowth.

¹ BEC – Biogeoclimatic Ecosystem Classification. ESSF – engelmann spruce subalpine fir; MS – montane spruce; ICH – interior cedar hemlock; IDF – interior Douglas-fir.

² % - percentage of total planting that occurs on average within a BEC zone.

³ PI – lodgepole pine; Lw – western larch; Fdi – interior Douglas-fir; Sx – spruce.

Table 2. Reforestation regimes on Areas Managed for Natural Regeneration

BEC Zone ¹	% ²	Typical Regenerated Species Proportion ³	Target Establishment Density (sph)	Comment
IDF	40	50% Fdi 40% PI 10% Sx	20% - 1400 50% - 1200 30% - 1000	Establishment density is proportional to amount of overstory removal. The greater the removal the higher the establishment density. Areas not achieving satisfactory regeneration within 3 years will be planted (see Table 1 for planting regime in such cases).
MS	30	50% PI 30% Fdi 20% Sx	As above	As above
ICH	30	40% Fdi 30% PI 20% Sx 10% Cw	As above	As above

¹ See Table 1 footnote.

² % - percentage of total area managed for natural regeneration that occurs on average within a BEC zone.

³ PI – lodgepole pine; Lw – western larch; Fdi – interior Douglas-fir; Sx – spruce.

6.2 Incremental Silviculture

6.2.1 Tree Improvement

Strategy

Monitor the progress of the Ministry of Forests' tree improvement program to ensure:

- (a) *yield gains of at least 25% for spruce, and 10% for lodgepole pine, western larch and Douglas-fir species are achieved, and*
- (b) *sufficient improved seed is available to meet TFL 14 planting program needs by the year 2010.*

Priority: Highest

Rationale

The incremental silviculture base case incorporated yield gains close to those stated in the strategy. These are based on current estimates from the Tree Improvement Branch of the Ministry of Forests, which is responsible for the tree improvement program and receives FRBC funding support for it. The production of improved seed is not within the FRBC funding envelopes that are directly available to Tembec. However, because such yield gains

have been assumed and have by far the greatest effect on the harvest forecast of any alternative, it is imperative that the program be monitored to ensure that they actually come about.

6.2.2 Backlog Reforestation / Restoration

Backlog Strategy

Maintain the timber harvesting land base by surveying 200 ha/yr and brushing 20 ha/yr of existing backlog plantations to ensure they reach free growing status.

Priority: High

Rationale

TFL 14 has virtually no un-regenerated backlog NSR area. However, there are about 1 100 ha's of backlog area that have not yet reached free growing status.⁵ Both the timber supply and incremental silviculture analysis base cases assume existing backlog plantations to become free growing. Failure to achieve this would result in having to lower future harvest forecasts. There is a legal obligation to achieve free growing on these areas since reforestation activities have been commenced.

Restoration Strategy

Maintain the timber harvesting land base by restoring areas destroyed by fire or pests.

Priority: High, as needed

Rationale

The MP No. 8 timber supply analysis estimated non-recoverable losses to fire and pests at approximately 8600 m³/yr. At a current harvested average vol/ha of about 280 m³, this translates to about 30 ha/yr. These areas are uneconomic to salvage and restore because they are too small and isolated or else are only partially damaged. Larger, accessible damaged areas within the timber harvesting land base that are not harvestable will be reforested where feasible and government/FRBC funding is available.

There are no areas requiring restoration at present. Requirements will be added to the strategy and program on an as-needed basis.

⁵ Free growing status is not legally recognized until an entire block achieves it. A significant percentage of the 1100 ha's is currently free-growing, but cannot yet be legally declared as such.

6.2.3 Juvenile Stand Monitoring

Strategy

Survey 400 ha/yr of post free growing juvenile stands to monitor their productivity and health to ensure their expected yields and quality will ultimately be attained.

Priority: High

Rationale

Both the timber supply and incremental silviculture analysis base cases assume all regenerated stands reach their projected managed stand yields at harvest. To ensure this, objective #5 of this strategy (page 10) sets the objective of keeping managed stand yields to within 10% of their biological potential. Failure to achieve this objective on a significant number of stands would result in having to lower future harvest forecasts. On-going monitoring of free growing juvenile stands is therefore important as the first step in ensuring they remain healthy and fully stocked. Monitoring techniques may range from aerial inspection to on-ground statistically-valid surveys. Should monitoring detect significant problems, this strategy may be amended to include appropriate remedial actions.

6.2.4 Juvenile Spacing

Strategy

Maintain the incremental silviculture analysis base case harvest and timber quality forecasts by juvenile spacing 250 ha/yr over the next 10 years, 150 ha/yr thereafter.

Priority: High

Rationale

Both the TSBC and ISBC harvest forecasts assume managed stand densities of 2400 sph for Douglas-fir and pine stands and 1600 sph for all other species. However, about 150 ha's/yr regenerate to densities substantially more than the modelled densities. Failure to space these stands to the assumed densities would result in longer minimum harvest ages and will delay their availability in the critical late mid term period. In addition, there are about 1000 ha of outstanding spacing required, which can be accomplished at a rate of 100 ha/yr (total 250 ha/yr required for 10 years, 150 ha/yr thereafter). Juvenile spacing will also create stand densities that are suitable for later fertilization and/or commercial thinning.

Juvenile Spacing Density Management Regimes

Planned density management regimes for juvenile spacing are shown in Table 1. Relatively high post-spacing densities are maintained in order to manage pest risks and to allow for possible future pulp or commercial thinning.

Table 3. Juvenile Spacing Regimes

Leading Species	% that Reaches Pre-spacing Density	Pre-spacing Density	Post-spacing Density	Spacing Priority	Comments / Objective
Lodgepole pine					
	10	< 1600	N/A	N/A	Pruning densities approx. 800-900 tph
	30	1600 to < 3000	N/A	N/A	
	30	3000 to < 5000	2000-2200	Low	Possibly treat with two pass entry
	30	5000+	2000-2200	Mod - High	Possibly treat with two pass entry
Total	100%				
Douglas-fir					
	20	< 1600	N/A	N/A	
	20	1600 to < 3000	1800	Very Low	Post spacing densities may increase due to % PI content
	40	3000 to < 5000	1800	Low	
	20	5000+	1800	Mod - High	Depends on density
Total	100%				
Spruce					
	20	< 1600	N/A	N/A	
	30	1600 to < 3000	1800	Very Low	Post spacing densities may increase due to % PI content
	30	3000 to < 5000	1800	Low	
	20	5000+	1800	Mod - High	Depends on density
Total	100%				
Balsam					
	15	< 1600	N/A	N/A	
	20	1600 to < 3000	1800	Very Low	Priority may depend on species conversion and balsam viability
	30	3000 to < 5000	1800	Low	
	25	5000+	1800	Mod - High	Depends on density.
Total	100%				

6.2.5 Fertilization

Strategy

Increase the mid term harvest level by 4000 m³/yr through 200 ha/yr of late rotation fertilization and 150 ha/yr of mid rotation fertilization of suitable Douglas-fir and lodgepole pine stands.

Priority: Medium

Rationale

The late rotation fertilization scenario consisted of fertilizing existing natural Douglas-fir and lodgepole pine stands 15 years in advance of their harvest. Treatment was limited to stands currently 25 to 140 years old. Eligible stands were fertilized once as they moved up in the harvest queue over the decades. The model selected approximately 350 ha/yr for treatment during the first four decades. The treated area fell thereafter as the existing natural stand inventory becomes depleted. The scenario resulted in a 4000 m³/yr increase in the mid-term harvest level at the higher yield response assumption.

The modelling used an optimistic estimate of fertilizable stands due to the inclusion of existing stands 100 to 140 years old. Such stands, particularly lodgepole pine, are too old to respond well to fertilization. Also, operational realities are such that not all stands suitable for late rotation fertilization will be available for treatment.

Conversely, the modelling under-estimated the treatable area in future decades by excluding existing managed stands under 25 yrs old and future regenerated stands from treatment eligibility. As these stands age, they will become prime candidates for mid rotation fertilization in future decades.⁶

Workshop 2 participants therefore felt a fertilization program similar to the level determined in modelling but consisting of about 200 ha/yr of late- and 150 ha/yr of mid-rotation fertilization would be appropriate and attainable. Because this equates to the same treatment area used in modelling, more or less the same result of an increased mid term harvest level of 4 000 m³/yr is expected.

Although additional species may prove suited to fertilization, it is likely that a program much higher than 350 ha/yr would be socially or environmentally unacceptable.

Target Stands for Treatment

Table 4 shows the target stands for fertilization treatment. Spruce fertilization would be experimental to determine treatment regimes and efficacy. Pruned stands are highest priority.

⁶ Early rotation fertilization (i.e., below 25 years of age) is not recommended as this will increase the production of juvenile wood. Stands currently 25 years old or less should ideally grow to 30 to 35 years of age before fertilization.

Table 4. Target Stands for Fertilization

Species	Site Index	BEC Zone	Site Series	Mid Rot'n Fert		Late Rot'n Fert		Vol Gain Single Application ³ (m3/ha)
				Age	Stk	Age	Stk	
Douglas-fir	17 – 28 ¹	IDF		36-50		51-80	≤ 1400	10-20
		ICH		35-50		51-100	≤ 1400	10-20
Lodgepole pine	17-25 ²	All		35-50	≤ 2000	51-70	≤ 2000	12-24
Spruce		All		35-50	≤ 2000	51-70	≤ 2000	12-24

¹About 70% of range³Volume gain 10-15 years after fertilization.²About 55% of range

6.2.6 Pruning

Strategy

First and second lift prune 25 ha/yr (total program 50 ha/yr) to increase premium log content by 1%.

Priority: Low

Rationale

The incremental silviculture analysis indicates that premium log content will diminish greatly in the future. Since managed stands will be harvested at younger ages than existing natural stands, clear logs will virtually disappear from future timber supply without pruning. The production of clear logs through pruning can raise the forecast long term premium log content by an estimated 1% (to 6%). Although the activity has a high jobs content, pruning is considered a low priority activity from a forest management perspective. Historically, the TFL has not produced significant volumes of clear wood.

Target Stands

Target stands for pruning are lodgepole pine, 800-900 sph, site index > 22.

6.2.7 Forest Health

No immediate forest health strategies were identified. Stand management practices suited to maintaining endemic pest levels and continuous pest incidence monitoring will be employed.

7. FURTHER INFORMATION AND RESEARCH NEEDS

The following items arose as longer term information and research needs during the process of strategy development. These would hopefully be resolved before the next silviculture analysis, approximately five years from now.

Study Name	Priority ⁷	Description/ Background ⁸	Estimated Cost (\$)	Basis for Costing
Fertilization Trials	2	Conduct fertilization trials for: <ul style="list-style-type: none"> early height growth (at planting and pre-free growing); and spruce response to late rotation fertilization (Workshop 1). 	7,500	Includes trial establishment and 1 st year monitoring.
Confirming Managed Stand Yield Estimates	3	Compare actual managed stand yields at mid to late ages with stand-level model yields (Workshop 1).	40,000	Establish permanent sample plots - 20/year at \$600/plot over 3 years. Establishment approx. \$40,000. Monitoring extra cost and long term.
Type III Silviculture Analysis ⁹	3* (* Subject to spatial analysis project results)	<p>The following arose at various stages of the strategy development process. They are combined here as having potential to be part of a Type III silviculture analysis.</p> <ol style="list-style-type: none"> 1. Model moose habitat requirements and forest cover constraint impacts and interactions (<i>Background Info Report</i>, section 8.2). 2. For specific target wildlife species, redefine seral stage distributions based on identified relationships between stand types/ages and habitat. Track habitat status by the redefined seral stage distribution by terrestrial ecosystem mapping (TEM) site series during modelling (<i>Background Info Report</i>, section 8.2): 3. Research the true old seral and UWR requirements, the optimum mix between these and timber supply, and investigate silvicultural means to meet the requirements in other ways (section 2.3 of this strategy). <p>Noted as a Type III analysis process item – Discuss with Matrix Resources (Bob Ferguson) which parameters should be included/tracked in analysis units and data sets to make the Type III easier or could be fed into the Type III (<i>Background Info Report</i>, section 8.3.2).</p>	75,000	Would use the Nelson Forest Region's spatial analysis study data set. Spatial analysis study may already accomplish much of what is desired. Type III earliest commencement would be 2002, pending results of spatial analysis study.
IU logging analysis/trials	4	Stratify the IU rehab areas into several treatment regimes and re-analyze the IU rehab modelling scenario with an assumption of advanced understory regeneration and regeneration to a species mix having a shorter minimum harvest age (<i>Background Info Report</i> , sections 4.6.3, 14.2.3; <i>Silv. Analysis Report</i> , section 4.0;	10,000	Commencing initial IU walkthroughs for data collection. Rec-ces=\$8,000, planning = \$2,000

⁷ First priority ranking is given to Strategy Monitoring. See page 21.

⁸ Reference source is indicated in brackets ().

⁹ A Type III silviculture analysis is an experimental analysis focussing on incremental silviculture and habitat supply.

Study Name	Priority ⁷	Description/ Background ⁸	Estimated Cost (\$)	Basis for Costing
		Workshop 2). If this improves the harvest level forecast, then undertake rehab trials.		
Measure Early Plantation Height Growth	5	Develop an early height growth measurement research project in improved larch and spruce plantations, and in PI plantations using B+ seed, to produce statistically valid data for early height growth curves. (<i>Background Info Report</i> , section 4.4.4) May be combined with next study project.	8,000	Some initial work already completed for experimental trials. Field portion will be timely.
Effect of Stock Type on Green-up	5	Review records to determine if there is any correlation between stock type/size and time until green-up. Some field measurements may be required. Some trials may be planned. (A microsite analysis, looking at refining microsite selection by reviewing individual tree performance in plantations, is also planned.) May be combined with study project immediately above.	7,500	All found. Includes 2 days office review, trial establishment and monitoring.
Pulp Thinning Trial	6	Many areas are now too old for juvenile spacing. Densities are too high for fertilization and/or future commercial thinning. Possibility exists to bring these areas back to managed stand densities through thinning for pulp. Set up trial areas to assess post-harvested stand response. Is this feasible and will it work? 1 year of field identification/ground truthing of proposed trial sites after a forest cover query by Timberline. Layout and prescriptions in year 1 as well. Four locations of 5 ha's each. Monitor results for a few years and if all is looking good, proceed with operational work on a larger scale. (<i>Background Info Report</i> , sections 4.5.2, 14.2.2; <i>Silv. Analysis Report</i> , section 3.0)	253,000	\$50/m3 harvesting costs. Estimate 250 m3/ha of fibre (mainly all small p-size) over 20 ha's. Total cost = \$253,000.
Field Check Areas for Potential for Commercial Thinning.	7	Field check stands currently 21-30 years old for potential commercial thinning 21-30 years from now. (<i>Background Info Report</i> , section 4.5.3, Workshop 1)	6,800	2 days office check with 15 field days.
Balsam Yield Tables	8	Develop managed stand yield tables for balsam-leading stands, presently about 3% of the TFL THLB. (<i>Background Info Report</i> , section 4.4.4)	50,000	Procedure: Sample stands. Build age/vol curves. Look at prov data from PSP's. \$50,000 for 1st approximation and a plan to do better.
Future Modelling	Not ranked	Possible future silviculture analysis work is noted in section 18.3 of the <i>Background Info Report</i> . To these may be added: <ul style="list-style-type: none"> • early and repeated fertilization – extension of fertilization beyond the late rotation fertilization scenario to managed stands to assess long term benefits (Workshop 2); • new composite analysis with different harvest flow assumptions (flat line at 155,000 or 160,000 for example) to analyze effects on availability and timber quality. 		

8. MONITORING AND EVALUATION

This document sets out goals, objectives and targets together with specific strategies to achieve these. A process of monitoring and evaluation is required to ensure the actions are in fact being taken and are effective towards achieving the goals and objectives.

8.1 Monitoring Responsibility and Team

Monitoring shall be the responsibility of Tembec's Assistant Chief Forester who shall also be the monitoring team leader. Other monitoring team members shall be (TFL forester, MoF rep (invited), MoELP rep (invited)). A consultant could undertake the monitoring activities themselves.

8.2 Monitoring Schedule

Monitoring shall occur in January (starting January 2002) and shall cover the actual and remaining planned activities for that fiscal year. Year 1 and year 2 monitoring shall focus on implementation. Year 3 and 5 monitoring shall address both implementation and effectiveness. No monitoring is planned for year 4.

8.3 Procedure

Tembec staff will develop a monitoring procedure for approval of Tembec's chief forester. The procedure will be compatible with any Ministry of Forests monitoring protocols. Monitoring will address the following questions.

Implementation:

- ♦ Do local managers consider the strategies relevant and appropriate?
- ♦ To what extent has each strategy been implemented?
- ♦ If funding has been limited, has it been directed to priority activities?
- ♦ Did the treated stands meet the criteria specified in the strategy (e.g., age, species, density, location, etc.)?
- ♦ Are the additional information needs identified in the strategy being addressed?

Effectiveness:

In addition to the implementation questions -

- ♦ Is each strategy functioning as intended?
- ♦ Were there any unanticipated outcomes or effects that warrant changing a strategy?

- ♦ Is the progress towards the objectives and targets proportionate with the level of effort?
- ♦ Can progress be attributed to some other outside factor rather than activities under the strategies?
- ♦ Have actual costs been in keeping with estimated costs?

Tembec will investigate the benefits to establishing a system of criteria and indicators to aid effectiveness monitoring over the long term as well as for reporting on the state of the TFL's forest resources.

8.4 Monitoring Reports

Monitoring reports shall be submitted by February 15th to Tembec's chief forester, with a copy to team members. Reports shall compare intended actions to actual progress, comment on the effectiveness of strategies towards the goals and objectives (years 3 and 5 only), and make recommendations for changes to the incremental silviculture strategy and the monitoring procedures as appropriate.

9. INCREMENTAL SILVICULTURE PROGRAM

The following table outlines the incremental silviculture activities and budgets required annually over the five year period, 2001/02 to 05/06, together with identified studies. Many of the silviculture activities will need to be continued beyond the five year program period in order to fully realize the objectives and targets of this strategy. Operational factors (for example, access, efficient treatment unit groupings, etc.) and funding variability may result in year-to-year program variation.

Forest Renewal BC funding of all of the indicated backlog reforestation and stand tending activity cost is considered attainable. Attaining FRBC funding for all of the identified studies is less certain, particularly for the pulp thinning trial which has funding policy implications due to the recovery of useable wood.

Activity		Priority	Treatment Area & Cost			Outcome by Time Period (yrs)								
			Ha	\$	Labour (yrs)	Maintain/ Increase	Stand Level (m3)				Forest Level (m3/yr) ²			
							1 - 20	21 - 50	51 - 100	101+	1 - 20	21 - 50	51 - 100	101+
BACKLOG REFORESTATION / RESTORATION														
Surveys	High	200	4,600	0.1	Maintain									
Brushing	High	20	14,000	0.0	Maintain			1500				150	150	
Program Total		220	18,600	0.1		0	0	1500	0	0	0	150	150	
STAND TENDING														
Juvenile Stand Monitoring	High	400	9,200	0.1	Maintain									
Surveys/Presc/Layout	High	1,300	29,900	0.3	N/A									
Spacing	High	250	193,750	3.5	Maintain			875		2375	2000	2000		
Fertilization	High	350	87,500	0.1	Increase	7700					4000	4000		
Pruning	Low	50	40,000	0.5	Increase			25ha prem				1% prem.	1% prem.	
Program Total		1,950	321,250	4.1		7700	0	875	0	2375	6000	6000	0	
FOREST HEALTH														
Program Total		-	-	0.0		0	0	0	0	0	0	0	0	
STUDIES														
Strategy Monitoring	1		2,500											
Fertilization Trials	2		7,500											
Managed Stand Yields	3		40,000											
Type III Silv. Analysis	3*		75,000											
IU Logging Analysis/Trials	4		10,000											
Early Ht Growth Measure	5		8,000											
Stock Type / Green-up	5		7,500											
Pulp Thin Trial	6		253,000											
Comm'l Thin Field Check	7		6,800											
Balsam Yield Tables	8		50,000											
Program Total		-	450,300	0.0		0	0	0	0	0	0	0	0	
GRAND TOTAL		2,170	790,150	4.2		7700	0	2375	0	2375	6000	6150	150	

1-Outcome of a single year's treatment; m3 unless otherwise stated.

2-Forest level outcome of a continued program of treatments; m3/yr unless otherwise stated.

* Priority to be re-evaluated after completion of the Nelson Forest Region spatial analysis trial.

Appendix A: Terminology & Acronyms

The following terms are used in this document.

Backlog NSR refers to areas from which timber was harvested, damaged or destroyed before September 1, 1987 and that in the district manager's opinion is insufficiently stocked with healthy well-spaced trees of a commercially acceptable species.

Basic Silviculture consists of reforestation obligations following timber harvesting or natural disturbance that are required by law. *Incremental silviculture* consists of all backlog reforestation activities and any other silviculture activity (typically spacing, fertilization and pruning) that is not required by law.

Free growing stand means a stand of healthy trees of a commercially valuable species, the growth of which is not impeded by competition from plants, shrubs or other trees.

A 200-year planning horizon is broken into three periods. The *short term* is defined as years 1-30, *mid term* as 31-100 and *long term* as 101+.

Mid term shortfall refers to the situation where a forecast mid term harvest level is lower than both the current and forecast long term levels.

A *premium log* is 5 m long and has a minimum 30 cm top diameter inside bark (dib) or a minimum 20 cm top dib if it is capable of producing 25% clear lumber by volume. Thirty and twenty cm top dib's are the minimum required to produce reasonable proportions of 2X10 and 2X6 lumber respectively. A standing tree would require about a 45 cm DBH to produce a premium log with a 30 cm top dib. A tree over about 60 cm DBH would likely produce more than one premium log.

Wherever a stand is described as a being of a particular species, that species is the *leading*, or most predominant species in the stand. Other species are usually also present in lesser proportions.

A *seral stage* is a distinct growth phase of a forest stand each having its own stand structural characteristics and associated flora and fauna; often categorized into early, mid, and late seral stages but also into *early* (1-40 yrs), *mid* (41-100), *mature* (101-140), *old* (141-250) and *oldest* (251+) seral stage.

The following acronyms are used in this document:

AAC	allowable annual cut	NSR	not satisfactorily restocked
DBH	diameter, breast height	sph	stems per hectare
ISBC	incremental silviculture base case	TFL	tree farm licence
IU	intermediate utilization	THLB	timber harvesting land base
MP	management plan	TSBC	timber supply base case
MSR	machine stress rated	UWR	ungulate winter range

(See also the footnotes to Table 1, page 12.)