

Cranbrook Timber Supply Area

Silviculture Strategy

-- Version 1.3 --

British Columbia
Ministry of Forests

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Executive Summary

Refer to Section 12 for abbreviations used in this report.

Silviculture regimes outlined in this silviculture strategy provide opportunities to improve timber (quantity and quality) and wildlife habitat supply in the short (0-20 years), mid (20-100 years) and long (100-250 years) term.

The base case of TSR2 shows that an annual harvest level of 838 000 cubic metres can be maintained for the next 13 decades, without causing severe timber supply shortages in the future. For the next 5 decades, the harvest level would drop to 754 000 cubic metres and would rise in decade 20 to a long-term level of 883 000 cubic metres. However, for this silviculture strategy, a more realistic base case is being used (referred to as the hypothetical silviculture planning forecast) which was outlined on page 50 of the TSR2 Rationale for AAC Determination. This assumes that when various sensitivity factors are analyzed in combination, they may impact the timber supply after the second decade. (Refer to Figure 1 in this report). This hypothetical silviculture planning forecast indicates that the base case harvest level can be maintained for 20 years before starting a series of declines to a long-term harvest level of 776 000 cubic metres per year. Therefore, this silviculture strategy addresses shortages in mid and long-term timber supply.

Timber Quantity Objective: Increase the quantity of available timber in the mid-term and maximize timber production within a context of sound multiple resource stewardship in the long-term.

Timber Quality Objective: Improve the quality of timber to be harvested in the long-term.

Wildlife Habitat Objective: For the mid and long-term, improve the quality of wildlife habitat in designated areas.

The following summary is the preferred silviculture strategy to support timber quantity and quality and wildlife habitat objectives:

Timber Quantity

No.	Strategy	Priority
Database record-keeping	Carry out an annual program of maintaining a database (record keeping) to record all achieved strategies.	1
Surveys	Conduct approximately 18 000 ha/yr of silviculture surveys in support of all strategies.	2

SHORT TERM: FOR TIMBER QUALITY, THERE ARE NO OBJECTIVES, WORKING TARGETS OR STRATEGIES FOR THE SHORT-TERM

MID-TERM

Objectives:

- Increase the quantity of timber to be available for harvesting.

Working Targets:

- Generate an additional 1.13 million m³ to mid-term timber supply, which equates to:
 - An additional 14 085 cubic metres/year of AAC and increases the mid-term harvesting level from 700 000 to 714 000 cubic metres/year (2% increase)

Strategies:

MT1	Repeat fertilization cycle over an 80 year period of 80% of existing spaced stands (17 000 ha) at 1 700 ha/yr to produce approximately an additional 767 000 m³ to	6
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No.	Strategy	Priority
	mid-term timber supply.	
MT2	Spacing and repeat fertilization cycle of new stands over 80 yr period to: 1) Reduce minimum harvest ages of younger existing stands by 10 years in new stands, and 2) coincidentally, improve the timber quality.	
(b1)	Spacing 600 ha of stands harvested before 1987 having a stocking level > 6 000 sph at the rate of 200 ha/yr for 3 years.	5
(b2)	Spacing stands harvested after 1987 having a stocking level > 6 000 sph at the rate of 800 ha/ yr.	5
(c)	Fertilizing 533 ha/yr of newly spaced stands on a 15 year repeat cycle to produce approximately an additional 360 000 m³ to mid-term timber supply.	6

No.	Strategy	Priority
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LONG-TERM

Objectives:

- Maximize long-term timber production within a context of sound multiple resource stewardship.

Working Targets:

-
- Generate an additional 18.97 million m³ to long-term timber supply, which equates to:
 - An additional 126 488 cubic metres/year of AAC and increases the mid-term harvesting level from 776 000 to 902 500 cubic metres/year (16.3% increase)

Strategies:

LT1	Maintain the timber harvesting land base by:	
(a)	Treating approximately 1 250 ha of backlog NSR.	4
(b)	Maintaining approximately 1 300 ha of previously reforested backlog plantations.	4
(c)	Surveying 4 000 ha/yr of pre-1987 SR area to ensure they remain fully stocked.	9
LT2	Increase the timber harvesting land base by 2.9% by:	
(b1)	Rehabilitating 12 500 ha of non-merch PI stands at the rate of 500 ha/yr.	8
(b2)	Surveying 20 000 ha of problem forest type areas at the rate of 4 000 ha/yr for 5 years.	7
LT3	Increase the volume of regenerated stands by 13% by:	
(b)	Expanding the use of improved seed by 2007 to include PI, with the expected result of a 6.6% gain in LTHL.	3
(h)	Repeat fertilizing 1 700 ha/yr, rising gradually over about 60 years to 9 800 ha/yr as more stands come under management, for an expected result of a 6.8% gain in LTHL. (Note: The initial 1 700 ha/yr are the same stands as in MT1.)	6

Timber Quality (Long-Term)

Objectives:

- Improve the quality of the timber to be harvested.

Working Targets:

- Generate at least 5% of total harvest volume in premium large logs (no current silviculture strategy implications).
- Generate at least 1% of total harvest volume in clear premium logs (clear logs will generally also be large logs).

Strategies:

No.	Strategy	Priority
Q1	Adjust minimum harvest age so the majority of stands have an average diameter of 27.5 cm	10
Q2	Space stands as per MT2(b)	5
Q3	First-lift pruning 200 ha/yr	10

*Wildlife Habitat (Mid and Long-Term)***Objectives:**

- For the mid and long-term, improve the quality of wildlife habitat.

Working Targets:

- For the mid and long-term, provide a variety of habitat types by creating clumps and voids in low BEO NDT 4 areas, and NDT3 areas and drier sites of MSdk and ESSF second growth stands.

Strategies:

No.	Strategy	Priority
H1	Clumpy planting in Low BEO, NDT 4, second growth stands	10
H2	5% Increase in the proportion of stand voids in NDT3 and on drier sites of MSdk and ESSF in second growth stands	10

Sections 9.3.1, 9.4 and 9.5 analyze and summarize size, cost, employment, income and revenue associated with this silviculture strategy and section 10 summarizes information and research needs.

1. Introduction

1.1 About the Interim Strategy

This strategy, and the process on which it is founded, is intended to help optimize the application of available funding for silviculture activities towards the goals of improving the future quantity and quality of both habitat and timber supply. The strategy will be considered as one of several inputs in decisions on funding allocations and treatment activities.

The primary focus in this version of the strategy is to improve the quantity of future timber supply and the secondary focus is to improve timber quality in the long-term as well as enhancing habitat supply. It is expected that as the strategy development process evolves and as better and more information becomes available, the strategy will have more regard to the matters of future timber quality and the future quantity and quality of habitat supply.

To achieve silviculture objectives, the opportunity evaluation process is not limited by factors such as the availability of funding, funding source (e.g., public vs. private), or the ability to deliver a program. Because of this, the strategy generally illustrates the plausible high end of the potential of the timber resource. Within this context, as well as a broad context of cost-effectiveness, available treatment opportunities, operational realities and potential treatment activities are ranked (Refer to Table 15). The end result hopefully points to the most effective and efficient means to at least partially achieve the working targets. This strategy could also be affected by future unknowns, such as major changes in forest policy, land base available for timber production, or market demand.

Although this strategy focuses primarily on silviculture, it is recognized that silviculture is part of a suite of potential strategies, which together, may influence the future quality and quantity of habitat and timber supply.

This strategy should not be confused with the allowable annual cut (AAC) determination process. AAC's are based on actual practice and current information at the time of the determination. This strategy, on the other hand, is about creating a future state of our forests. Again, the degree to which the strategy proves appropriate and is achieved may influence future, but not necessarily present, AAC determinations.

This strategy is founded on readily available information and the knowledge of forestry professionals.

1.2 Methodology

This strategy was prepared using the following process:

1. An interim silviculture strategy was first prepared in 1999 based on input from a district-wide workshop attended by MoF district and industry participants, Timber Supply Review (TSR) 1 carried out in 1995, and the Regional Landscape Unit Planning System (RLUPS). Larry Atherton of L. P. Atherton & Associates and Doug Williams of Cortex Consultants Inc. facilitated the workshop in July 1999 in Cranbrook and participants reviewed potential silviculture opportunities. The outcome of the session was a regime table, complete with priorities.
2. Prior to the district workshop, in co-operation with district office personnel, L. P. Atherton & Associates undertook preliminary research to identify issues and opportunities relevant to improving the future quantity and quality of timber supply.
3. When the interim silviculture strategy was prepared in 1999, results of TSR2, carried out in 1999, were not available.

4. The consultants incorporated the results of the district workshop into the interim strategy and added forecasts of future harvest quantity, quality and job outcomes.
5. This silviculture strategy, completed by Industrial Forestry Service Ltd., updates the interim strategy based on TSR2, the accompanying data package and the Rationale for AAC Determination.
6. Other references used for this strategy, including the Kootenay Boundary Land Use Plan and the *Incremental Silviculture Strategy for British Columbia*, are listed in section 11.
7. A meeting was held Jan. 31/02 in Cranbrook to review a draft version of this strategy and rank activities. It was attended by: Jeff Allen and Jim Eunson of Tembec Industries, Cam Donaldson, of Galloway Lumber, Peter Davidson, of Ministry of Water, Land and Air Protection and Ivan Listar, Paul Chalifour, Lyn Konowalyk, and Denis Petryshen, with the Ministry of Forests.
8. This completed strategy was submitted to the Ministry of Forests (MoF) in electronic format as version 1.3. (The ministry will assign higher version numbers (e.g., 2.1, 2.2, etc.) as the strategy evolves and changes are made.)

1.3 Acknowledgements

Input to the interim strategy and to this strategy, from representatives of the following organizations is gratefully acknowledged (Table 1).

Table 1: Acknowledgements

Organization	Participant's Name	Title
Ministry of Forests, Cranbrook Forest District		
	Denis Petryshen	Silviculture Officer
	Lyn Konowalyk	Incremental Silviculture Forester
	Mike Black	Planning Forester
	Bill Olsen	Audit Forester
	Paul Chalifour	Forest Renewal Program Officer
	Tom Hedin	Operations Manager
Ministry of Forests, Nelson Forest Region		
	Ivan Listar	Stand Tending Forester
Ministry of Forests, Forest Practices Branch		
	Ralph Winter	Stand Management Officer
Ministry of Water, Land & Air Protection, Cranbrook		
	Peter Davidson	Ecosystem Biologist
Tembec Industries Ltd.		
	Marcie Belcher	FRBC Coordinator
	Jeff Allen	Contractor, (representing Tembec)
	Allison Wager	Prescription Forester
	Dave Basaraba	Silviculture Forester
	Jim Eunson	
Galloway Lumber Co.		
	Jeff Mycock	FRBC Coordinator, Interior Reforestation (representing Galloway)
	Cam Donaldson	
Forest Renewal BC		
	Rick Allen	Project Development Officer

Funds to undertake this strategy were provided by FRBC. Industrial Forestry Service Ltd. is updating this Type 1 strategy and developing the Type 2 analysis under contract with the Ministry of Forests.

2. Basic Data

Table 2: Land Area

Description	Area (ha)	Area %
Total Area of TSA	1 483 100	100
Total Productive Crown Forest	774 300	52
TSR2 Net Timber Harv. Land Base	439 200	30
Net Timber Harv. Land Base (AAC Rationale Base Case)	431 100	29

Table 3: AAC

AAC Type	TSR1	TSR2	Change (%)
Conventional	850 000	838 000	-1.4
Deciduous	-	-	
Insect/Disease	-	-	
Marginal	-	33 000	+3.9
Total	850 000	871 000	+2.5
Woodlot AAC		11 746	0

Figure 2: Site Class

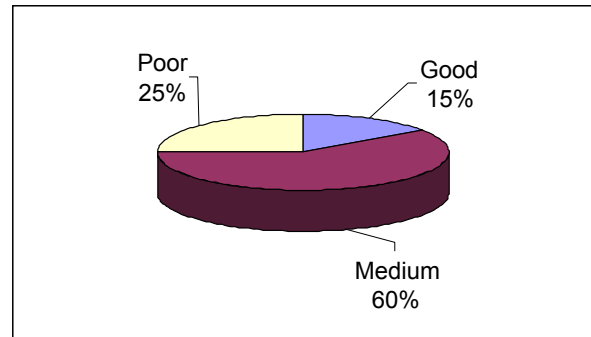


Figure 3: Age Class

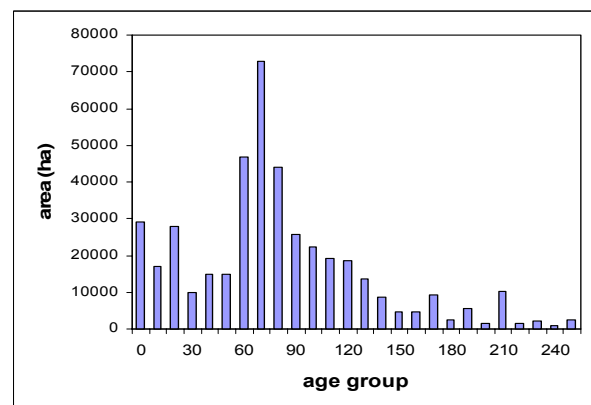


Figure 1: Harvest Forecast

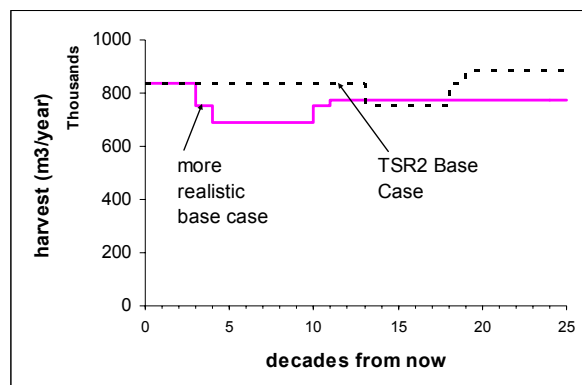
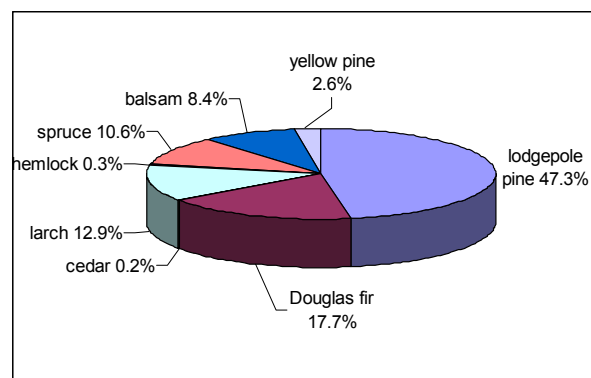


Figure 4: Tree Species



3. Key Issues Affecting Timber and Habitat Supply

TSA modelling in support of silviculture planning has not yet been undertaken. However, information from TSR2 is used for this strategy.

3.1 Quantity

To ensure the appropriateness of silvicultural strategies, it is necessary to hypothesize a “most likely” harvest forecast. This hypothetical silviculture-planning forecast is often different from the TSR base case harvest forecast because it incorporates some speculation about factors that may affect estimates of future timber supply. In the TSR process, such factors are addressed through sensitivity analyses. If the sensitivity does not affect short-term harvest levels, it is usually considered not relevant to an AAC determination and the base case is left unchanged. However, such factors may be highly relevant to silviculture planning which, unlike the AAC determination process, is more focused on the future than on the present. Subsequently:

The base case of TSR2 shows that an annual harvest level of 838 000 cubic metres can be maintained for the next 13 decades, without causing severe timber supply shortages in the future. For the next 5 decades, the harvest level would drop to 754 000 cubic metres and would rise in decade 20 to a long-term level of 883 000 cubic metres. (Refer to Figure 5, below). This base case presents a higher forecast of timber supply than the previous analysis (TSR1) completed in 1995. The more significant reasons for this change are:

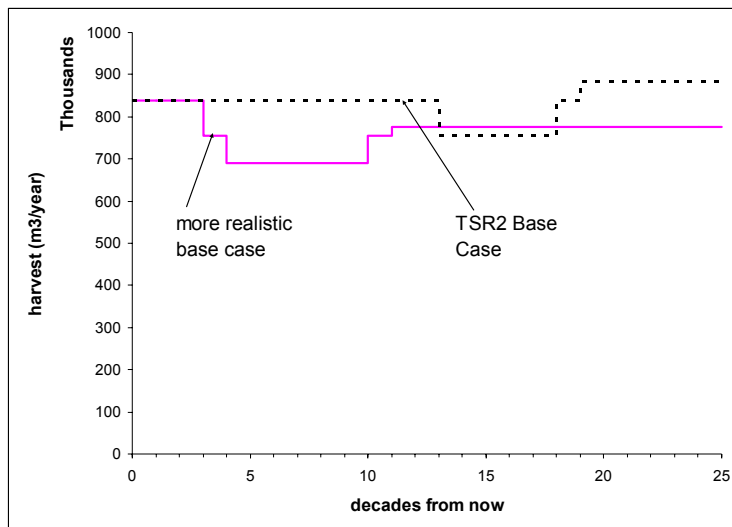
- An increase of 15 000 hectares in the timber harvesting land base, resulting from changes in operability information and approaches to environmentally sensitive areas and marginally merchantable forest types.
- A decrease in the unsalvaged losses estimate by approximately 60 000 cubic meters per year,
- Less stringent visual quality objectives,
- A decrease in old-growth requirements relative to the *Cranbrook Forest District Interim Old Growth Strategy* employed at the time of the 1995 analysis, combined with greater recognition of the role of forest outside the timber harvesting land base in achieving those requirements,
- Changes in riparian management requirements resulting from a decrease in the area over which they apply, as well as changes in the forest retention requirements, and
- Overall reductions in regeneration delays and green-up ages.

However, for this silviculture strategy, a more realistic base case is being used (referred to as the hypothetical silviculture planning forecast) which was outlined on page 50 of the TSR2 Rationale for AAC Determination. In the TSR2 Rationale, concern was expressed that when various sensitivity factors are analyzed in combination, they may impact the timber supply after the second decade. With this in mind, a sensitivity analysis was prepared that included the following assumptions in Table 4.

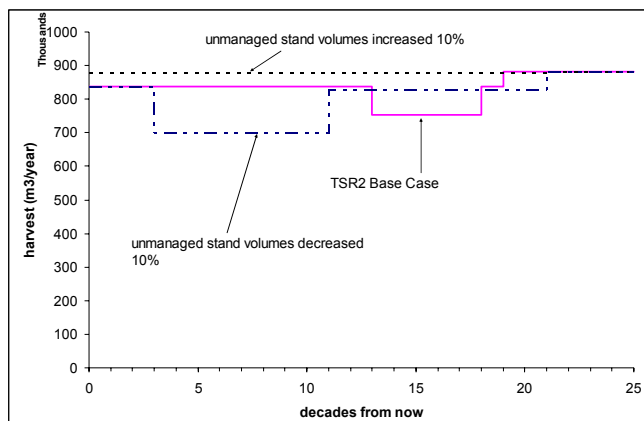
Table 4: Assumptions used for the hypothetical silviculture planning forecast base case for this silviculture strategy

Issue	Action/Comment
Landscape Units	Biodiversity emphasis options from the Regional L.U. Planning Strategy were applied
NSR	An additional 0.8 percent (720 ha) reduction to account for inoperable NSR differed from the Base Case in the <i>TSR2 Report</i> .
<i>Armillaria</i>	An additional 2.8% OAF 2 reduction was added to account for higher losses due to <i>Armillaria</i> .
Recreation	Forest cover constraints for the moderate recreation zone were replaced with the same constraints as applied in the IRM zone.
Ungulate Winter Range	Adjacency and green-up constraints were applied.
IWMS	<u>Identified Wildlife Management Strategy</u> . A one percent (1%) reduction to the Timber Harvesting Land Base was applied to address the establishment of future wildlife habitat areas
WTPs	A 0.8% volume reduction was added for unsalvaged seed trees and an additional 2.8% OAF 1 reduction was added to account for residual volumes left on partially harvested areas.
Harvest sequencing	A random-aged priority harvest rule was used to select stands eligible for harvest

The results of this sensitivity analysis (see Figure 5, below) indicate that the base case harvest level can be maintained for 20 years before starting a series of declines to a long-term harvest level of 776 000 cubic metres per year. The silviculture strategy should therefore address shortages in mid and long-term timber supply. Shortages are more acute during the mid-term because harvest levels normally rise out of a mid-term dip when harvesting is largely in managed stands.

Figure 5: TSR2 Base Case and the more realistic base case (hypothetical silviculture planning forecast) used in this silviculture strategy.

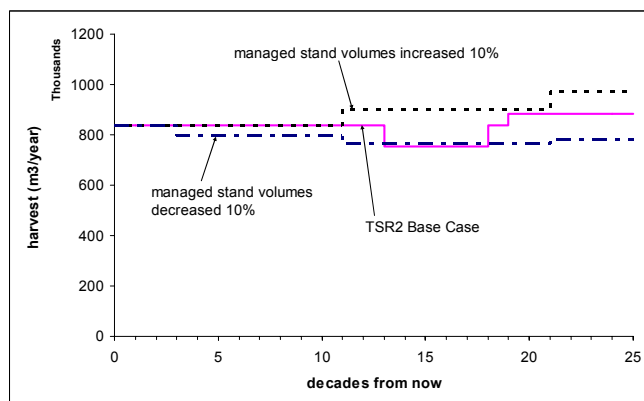
The following figures and text outline further issues, which affect the quantity of available timber in the mid and long-term. They are the results of sensitivity analyses determined for TSR2.

Figure 6: Changes in Existing Stand Volumes

In the previous AAC determination, district staff were concerned that the mature stand volumes were possibly overestimated. However, an inventory audit completed for the Cranbrook TSA reported that the volume estimates for the mature component of the inventory are statistically acceptable, even though the inventory audit information shows an overestimation of ground-measured volumes by 4.1%.

However, the Rationale for AAC Determination identifies an overestimation of about 2.8% of the total existing stand volumes. This is due to an adjustment not being applied to the reduced volumes on 24 900 hectares where partial harvesting has been carried out.

Typically, reducing existing stand volumes causes the transition from the initial harvest level to begin earlier than in a base case forecast. This is because there is less existing timber to span the period until managed second growth stands become available. Also, decreasing the volume/ha can magnify the impact of forest cover constraints. Lower volumes/ha require more area to be harvested to obtain the same volume. This increases the area not greened-up at a faster rate and the limits of forest cover constraints are reached sooner. Figure 6 to the left shows the results of a 10% change in the existing stand volume.

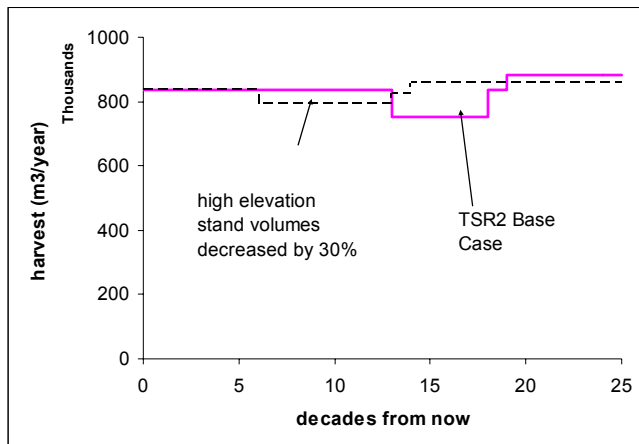
Figure 7: Sensitivity to an Increase in Regenerated Stand Volumes

For most TSA's increasing regenerated stand volumes by a certain percentage results in a corresponding increase in the long-term harvest level (LTHL) over the base case forecast. This was the case in the Cranbrook TSR2 analysis and therefore such a response is assumed to be the case for the purposes of this interim strategy.

The Rationale for AAC Determination identified that a higher Operational adjustment Factor (OAF) is required when projecting stand volumes for regenerated stands due to *Armillaria* root rot. As a result, an additional OAF of 2.8% was applied for the hypothetical silviculture-planning forecast.

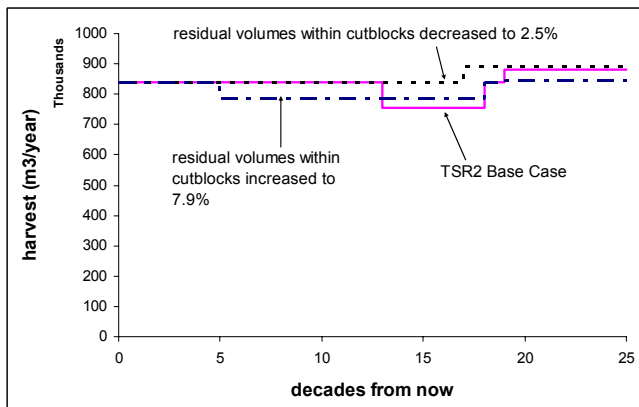
Many silvicultural practices can be used to achieve an increase in regenerated stand volumes, including practices to reduce losses to root disease and higher density planting. Figure 7 to the left shows the results of a 10% fluctuation in managed stand volumes.

Figure 8: Sensitivity to Volume Estimates for High Elevation Sites



High elevation sites occupy 8% of the timber harvesting land base in the ESSF where less is known about potential timber growth. Thus, much uncertainty surrounds the volume estimates for high elevation stands. Figure 8 to the left shows the average harvest levels for the TSR2 base case, if volume estimates for high elevation sites are 30% lower.

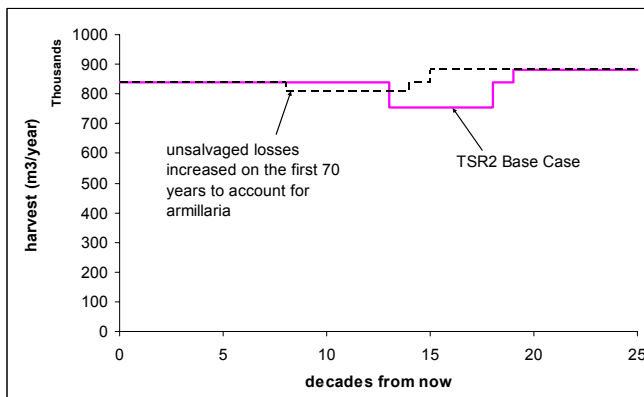
Figure 9: Sensitivity of Residual Volume Within Cutblocks (Stand Level Biodiversity)



The base case for TSR2 estimated that 3.9% of stand volume would be retained for stand-level biodiversity (wildlife tree patches and other management considerations). This estimate has some uncertainty because it is difficult to predict what portion of the *Biodiversity Guidebook* targets would be met by forest outside of the timber harvesting land base without knowing the exact future cutblock pattern and forest structure in a given area.

Figure 9 to the left shows that if residual volume for the TSR2 base case cutblocks was increased to 7.9% or decreased to 2.5%, harvest levels in the mid and long-term would be impacted.

Figure 10: Sensitivity to Armillaria Losses in the Estimate of Unsavaged Losses



The estimate for unsavaged losses in TSR2 did not include losses for disease. These losses were assumed to be accounted for in the estimates of stand volumes. District surveys indicate that 6000 hectares of mature stands have a high incidence of root rot. If the mortality rate was 2% per year, the total volume loss would be 19 800 cubic metres per year. Figure 10 to the left shows the effect of this on the TSR2 base case timber supply.

Future Timber Volumes in the Short-Term (1-20 Years)

The hypothetical silviculture-planning forecast indicates that harvest levels can be maintained at the current AAC throughout the short-term period. Short-term harvest levels are largely governed by the need to extend existing timber supply until managed stands become available. Thus, factors that affect the existing timber supply can affect the ability to maintain the initial harvest level for longer or shorter than in the base case. These are discussed under future volumes in the mid and long-term, below.

Since no short-term shortages in timber supply are forecast and TSR2 analysis allocates an extra 15 000 hectares to the timber harvesting land base, no silviculture strategies are planned for the short-term [see discussion at the beginning of this section (3.1)]. If a strategy was needed in the short-term, then late rotation fertilization within the next 20 years to give a boost in volume may be suitable.

Future Timber Volumes in the Mid-Term (20-100 Years)

The mid-term period continues until the transition from harvesting in existing natural stands to harvesting mainly in 2nd growth managed stands is complete. The hypothetical silviculture planning forecast shows that the end of this transition period will be approximately 100 years from now.

The mid-term is characterized by a shortfall below the long-term harvest level. However, this shortfall is more likely a product of a need to make existing stands last until the first of the managed stands become available for harvest than from an age class imbalance (gap).

Silvicultural actions to increase the availability of existing stands or improve the timing of the onset of the managed stands could potentially increase mid-term harvest levels, perhaps even to the extent of eliminating the anticipated mid-term harvest shortfall. Alternatively, silvicultural actions could be oriented to improve the quality of the late mid-term and long-term timber supply. Because the same actions, such as spacing and fertilizing appropriate stands, could potentially achieve either objective, the ultimate end-use does not have to be chosen now.

The most significant factor affecting both short and mid-term harvest levels is the estimate of existing stand volumes. Higher volumes will raise harvest levels and lower volumes will lower them (refer to Figure 6 above). As mentioned previously for the short-term, fertilizing suitable stands 10-15 years prior to harvest to give a volume boost will be a positive benefit to mid-term timber supplies.

Future Timber Volumes in the Long-Term (after 100 Years)

The long-term period is the time when harvesting is primarily in managed 2nd growth stands and is characterized by a steady state harvest level.

The long-term timber supply is sensitive to changes in managed stand volumes, the size of the timber harvesting land base, and the amount of various types of losses. Long-term supply can be increased by silviculture practices such as higher regenerated stand volumes, spacing and fertilization.

3.2 Timing

The following figures and text outline issues, which affect the timing of available timber in the mid and long-term. They are the results of sensitivity analyses determined for TSR2.

Figure 11: Present Age Class Structure Used for the Hypothetical Silviculture Planning Forecast

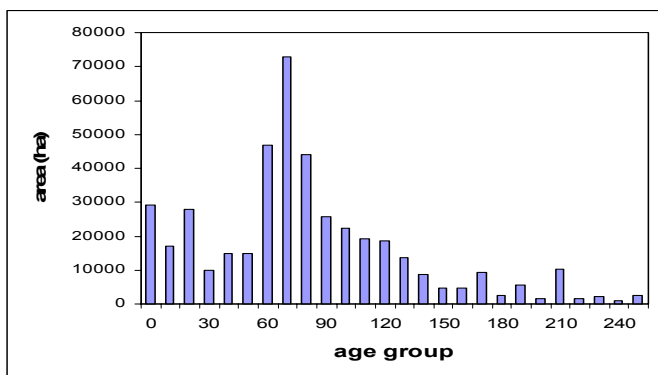


Figure 11 to the left shows the present age class structure used for the hypothetical silviculture-planning forecast. There appears to be an adequate supply of older age classes in the short-term (up to 20 years) but as available older age classes are used up, there may be mid-term shortages of available age classes (20 – 100 years from now). This can be seen in Figure 12, below, which shows the age class structure in 50 years.

Figure 12. Age Class Structure in 50 Years

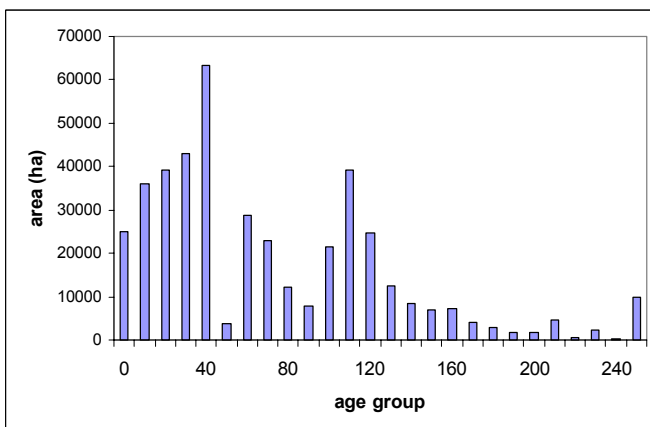


Figure 12 to the left shows the age class structure in 50 years (mid-term). This shows that there may be shortages in the age classes from 60-110 and older than 130. This mid-term shortfall could also be the product of not having enough available existing timber to span the time until managed stands become available rather than being the result of an age class gap.

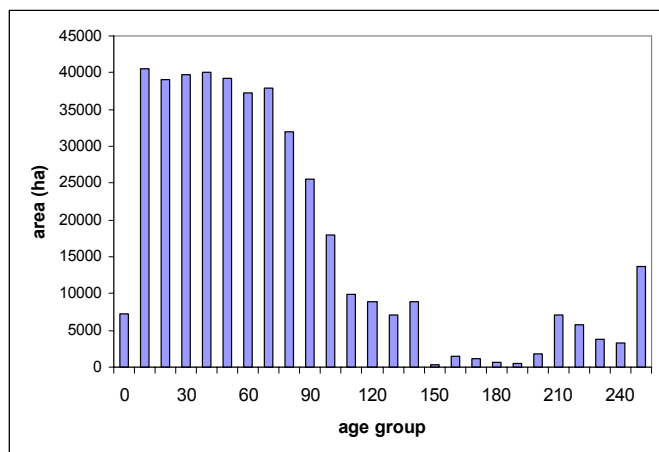
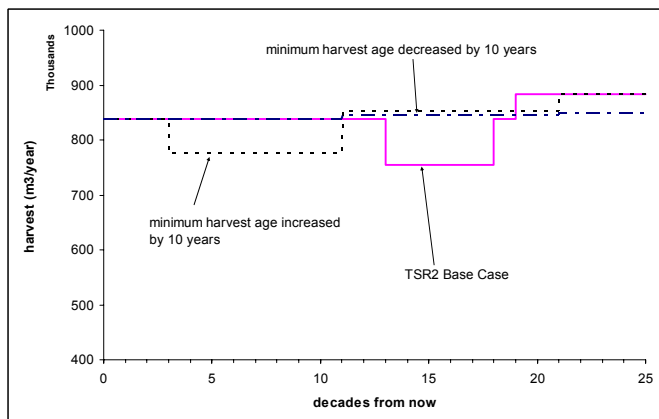
Figure 13: Age Class Structure in 150 Years.

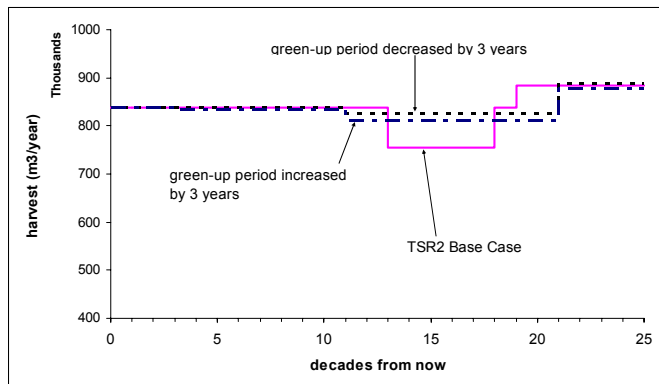
Figure 13 shows the age class structure in 150 years (long-term). There is almost an even distribution of young and middle age classes (except for a shortage of the 10 year age class) with a shortage of age classes 120 and older.

Spacing and repeat fertilizing suitable stands currently aged less than 30 years old and stands established in the future could help shorten the span of any mid and long-term shortfall harvest level.

Figure 14: Sensitivity to Changes in Minimum Harvestable Ages

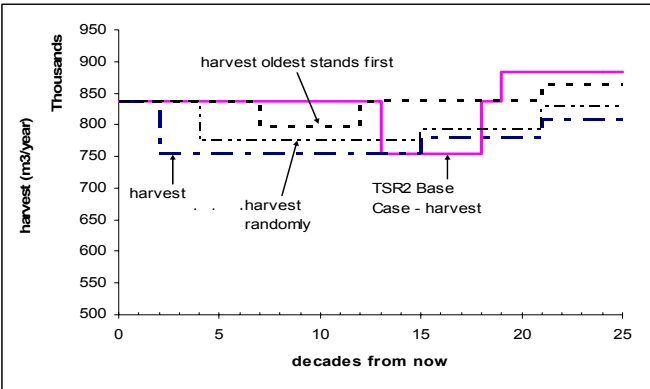
Minimum harvestable age is an estimate of the time needed for a stand to reach a merchantable condition. Minimum harvestable ages determine when second growth will be available for harvest. TSR2 outlines average harvest levels if minimum harvestable ages are changed. Figure 14 to the left shows that if minimum harvestable ages are reduced by 10 years, the projected long-term harvest level after the 21st decade would be 4% lower with no decreases in the harvest level in the short and mid-term. This shows that decreasing the minimum harvestable age may mitigate the effects of a mid-term fall-down but it would be at the expense of long-term supply.

If minimum harvestable ages were lowered, stands would reach the minimum merchantable conditions with spacing and fertilization treatments outlined in this strategy.

Figure 15: Sensitivity to Changes in Green-up Ages

Forest cover requirements for wildlife habitat, visual quality, recreation management, water quality and adjacency applied in the TSR2 analysis involves estimates of when stands will reach green-up conditions, expressed as the desired height of a stand. Figure 15 to the left shows that potential harvest levels over the short, mid and long-terms are not highly sensitive to uncertainty or changes in green-up ages or regeneration delay. With this in mind, silviculture practices do not have to be used to reduce the time until green-up.

Figure 16: Sensitivity to Alternative Harvest Queue Rules

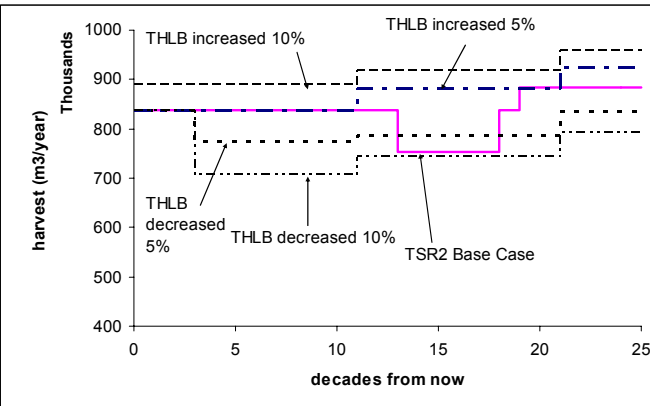


In TSR2, the highest priority for harvest is given to stands that are oldest relative to their minimum harvestable age. Figure 16 to the left shows that potential harvest levels would be negatively affected in the mid to long-terms by changing the way stands are prioritized for harvest.

3.3 Location

The following figures and text outline issues, which affect the location of available timber in the mid and long-term. They are the results of sensitivity analyses determined for TSR2.

Figure 17: Uncertainty in Land Base Available for Harvesting



Since approximations were used to define the land base and because the inventory itself contains uncertainty, there is some uncertainty about how much area actually falls within the timber harvesting land base under current management. Figure 17 to the left from TSR2 shows how changes of 5% and 10% in the timber harvesting land base would affect potential harvests. These changes have a proportional impact on mid and long-term timber supply and significantly change the timing of the transition to the long-term harvest level. Silviculture activities such as spacing, fertilization and commercial thinning would help to alleviate these impacts

Refer to the beginning of section 3.1 to see the change in the timber harvesting land base between TSR1 and TSR2.

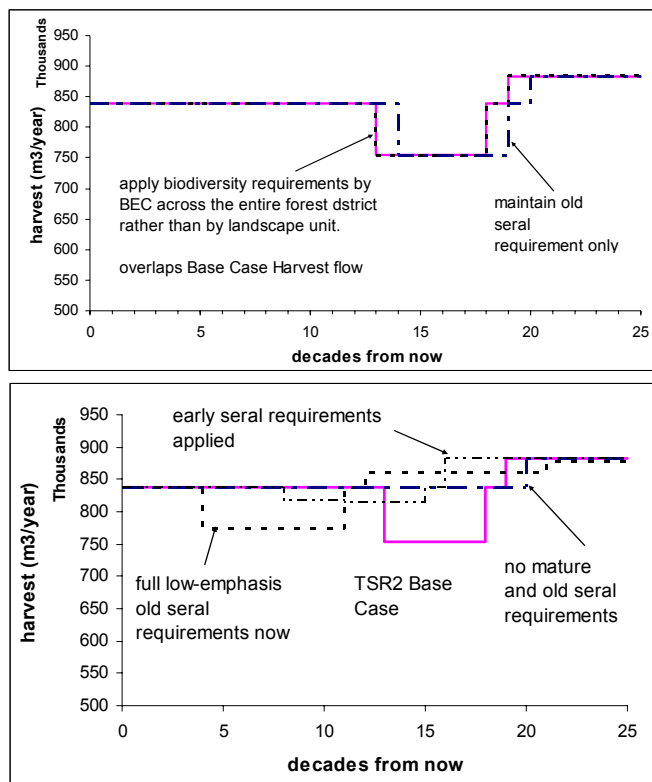
Silvicultural practices may be used to increase the size of the timber harvesting land base through conversion of unutilized stands to merchantable species and to increase the productivity of low sites.

Opportunity area consists of the areas deducted from the TSR2 THLB. These include:

Type	Area	Equiv % THLB
Low site	38 500	8.8
NCC	3 800	0.9
Non Merch (PFT's)	21 700	4.9
Excluded Types	27 000	6.1

There is little remaining treatable backlog NSR.

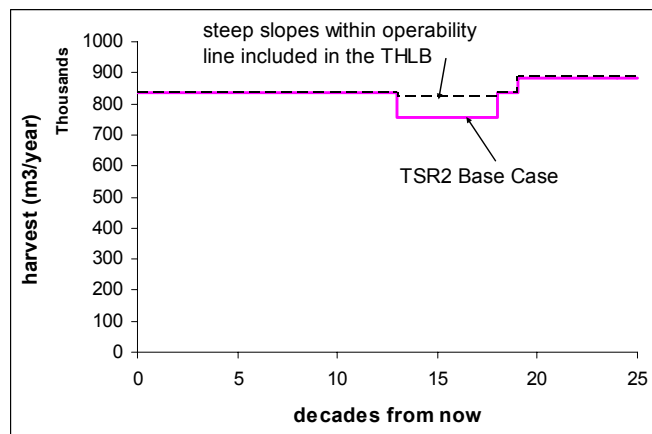
Figures 18 and 19: Uncertainty in Applying Landscape Level Biodiversity Requirements



In TSR2, landscape level biodiversity was represented in the analysis by forest cover requirements applied to natural disturbance types within landscape units. There is uncertainty about how the recommendations in the *Biodiversity Guidebook* should be interpreted and applied, as well as how the Cranbrook TSA should be delineated into landscape units. Figure 18 to the left shows that changes in the application of seral distribution targets would have a large impact on the timing of the transition to the long-term harvest level and little impact on the long-term level. Three separate scenarios are shown: all old seral requirements are applied in full from the beginning of the planning horizon, no mature or old seral forest cover requirements are applied; and early seral requirements are applied, an addition to the mature and old seral requirements applied in the hypothetical silviculture planning forecast base case.

Further to the above uncertainty, Figure 19 to the left shows that changing the way *Biodiversity Guidebook* seral stage distribution targets are applied would potentially have a moderate to large impact on the timing of the transition to the long-term harvest level and a small or no impact on the long-term level. These changes include: applying seral stage requirements by biogeoclimatic variant for the entire district (rather than by variant and landscape unit, as in the base case); applying only old seral requirements (excluding the old and mature seral requirements applied in the base case); and ensuring that seral stage forest cover requirements are applied both within the operable forested land base and the total Crown forest land base (proportional representation)

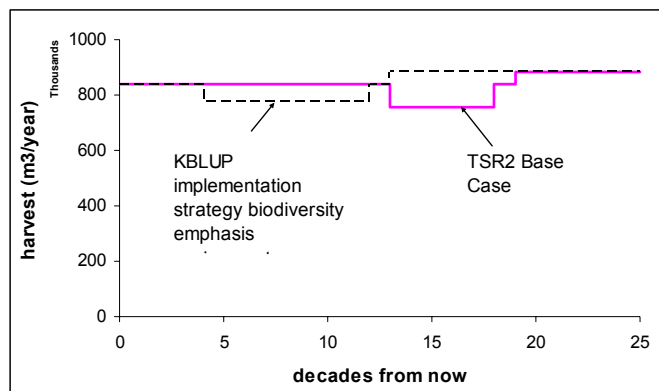
Figure 20: Including Steep Slope Sites Below the Operability Line in the Timber Harvesting Land Base



In the TSR2 base case, accessible areas below the operability line were excluded from the timber harvesting land base where the slope was greater than 65% and the leading species was lodgepole pine, or where the slope was greater than 70% and the leading species was not lodgepole pine. These steep slope sites could potentially be part of the timber harvesting land base in the future if improvements in harvesting methods and economic conditions occur. Figure 20 to the left illustrates that including these sites would result in a small increase in the projected long-term level.

Silviculture activities on these sites would probably not be feasible.

Figure 21: Biodiversity Emphasis Assignments Based on Kootenay-Boundary Land Use Plan Implementation Strategy



In the TSR2 base case, biodiversity emphasis option assignments were not specifically modelled because landscape units have not been designated for the Cranbrook Forest District. Landscape units and corresponding biodiversity emphasis options have been proposed in the *Kootenay-Boundary Land Use Plan Implementation Strategy (KBLUP-IS)*. Figure 21 to the left shows that applying the *KBLUP-IS* biodiversity emphasis assignment as indicated would significantly affect the Mid-term timber supply (7.5% reduction).

Silviculture activities, such as spacing, fertilization and thinning on working forests would mitigate these impacts.

3.4 Quality

Growing forests to older ages generally improves their quality. For most TSA's the objective of growing forests longer for quality is usually compatible over the very long-term. According to the TSR2, (page 73) there would be a 6.5% to 7.5% drop in timber supply from decade 3 to decade 20 if the minimum harvestable age were increased by 10 years.

The focus of the timber supply review on AAC determination has resulted in the planning emphasis being solely on timber volumes. Until recently, there has been little higher-level policy guidance with respect to managing for future timber quality.

Using age as a surrogate measure of timber quality, the expected decline in harvest ages towards minimum harvestable ages indicates future timber quality will be generally lower than today's. The future timber supply will be much smaller in average diameter and, without pruning, there will be little, if any, clear wood. On the positive side, other than areas affected by root rot, most harvested second growth timber will be sound wood with little or no decay.

Lower quality stands present some future market risk. In low market periods it is often only the readily accessible, higher-quality timber that is profitable to harvest. Also, a narrow portfolio of small diameter timber offers less opportunity for creating a range of value-added forest products.

Stand density also affects wood quality. Stands with higher density generally have higher wood quality. Juvenile spacing, which decreases stand density can have a negative impact on wood quality. Spacing affects wood quality in two ways:

1. In a spaced stand, the live crown will not lift as quickly as in an unspaced stand. This will cause juvenile wood (wood formed in association with the live crown) to be produced on the lower bole of the tree for a longer period than in an unspaced stand.
2. In a spaced stand, live branches on the lower bole will continue to grow, causing larger knots.

However, there are a number of reasons to believe that the effects of juvenile spacing on wood quality may not be as important as once thought:

1. Growth rate in Douglas-fir and lodgepole pine does not significantly affect wood density or strength.
2. Wide spacings increase juvenile wood only on the lower bole.

3. The market place is not currently attaching much significance to wood density.
4. Juvenile wood may provide a more balanced chemical pulp and is sometimes preferred for mechanical pulps because it is easier to de-fibre and forms better paper sheets. Paper strength produced from juvenile wood also has increased burst and tensile strength.
5. Spacing may increase knot size, but it does not result in an increase in number of knots (i.e. a decrease in clear wood production. In unspaced stands, dead branches on the lower bole persist through much of the rotation causing smaller loose knots.
6. Changes resulting from juvenile spacing with respect to knot size and juvenile wood are unlikely to cause a significant increase in lumber degrade.

Therefore, the juvenile spacing activities in this silviculture strategy may not have a negative impact on future timber quality.

3.5 Limitations of Available Information

Timber supply forecasts must be used cautiously in silviculture planning. Stand level models are used to predict yields, which are then used in the TSA level model; in other words, models are used to feed models. The probability of the exact sequence of harvested ages and stands that the TSA model selects to form a harvest forecast actually occurring, is virtually nil. Certain features of the TSA can be expected to hold consistent across both present and future analyses. Such features should be the primary focus of a silviculture strategy. These features in the Cranbrook TSA are:

1. According to TSR2, harvest levels are limited mainly by the amount of timber of a harvestable age, and by the maximum allowable amount of recent disturbance, particularly in community and domestic watersheds and to a lesser degree, in caribou habitat, visual management, recreation management and integrated resource management zones.
2. For the base case used in this strategy (hypothetical silviculture planning forecast), a mid-term harvest level shortfall below the long-term harvest level, occurs in 20 years, with a series of declines to a long-term harvest level of 776 000 cubic metres per year, due to various constraints listed in section 3.1.
3. Increases in yields of managed stands will directly translate into increases in long-term harvest levels. TSR2 projects the average growth rate for managed stands to be about 2.6 cubic metres per hectare per year, about 30% more than the 2.0 cubic metres per hectare per year for naturally regenerated stands with no density control.

While all factors can be influenced by silvicultural actions, the first factor can also be influenced by policy changes.

4. Incremental Silviculture History

Table 5, below, outlines the incremental silviculture history for the Cranbrook TSA

Table 5: Cranbrook TSA Incremental Silviculture History

Treatment	TSR2 Status (Source 1999 Data Package)	Current Status (2002) Source: CFD
Backlog	Of 6 010 ha in ISIS, half (3 005 ha) is considered operable. This is assumed to be restocked over 9 yrs at the rate of 300 ha/yr. Yields are projected for 2 stocking levels (breakpoint 420 sph).	Total treated area = 13 138 ha. Approximately 900 ha have been identified for treatment. About 1 250 ha require assessment, of which about an estimated 350 ha will require treatment. Total remaining for treatment = (900 + 350=) 1 250 ha. An additional 1 300 ha require brushing to ensure free growing is achieved.
Conversion	None.	None
Commercial Thin	None.	None
Space	TIPSY will be used for all existing stands < 30 yrs old. 30% of pure PI and 50% of PI leading stands will be assigned yield tables that reflect past stocking control. Remaining stands will be assigned yield tables that have 45-4800 sph densities. Initial and target densities specified for stands > 30 yrs old, but no info on assignment to yield tables based on stocking levels.	Total treated area = 20 500 ha (5% of TSR2 THLB). Max past program 2 800 ha/yr in 1995. Recent level 400 ha/yr.
Prune		Total treated area = 1 216 ha 1 st lift pruned. Max past program 200 ha/yr. Recent level 0.
Fertilize		Total treated area = 5 931 ha, including 1 100 ha fertilized 2X. Max past program: 1 100 ha/yr. Recent level: 0.

5. *Timber Harvesting Trends*

The TSR1 base case analysis forecasted approximately 3 200 ha/yr to be harvested over time (MoF, 1995:22). This level was associated with a forecast decline in timber harvesting. The TSR2 data package indicates that about 80% of recent harvesting has been even aged silvicultural systems (MoF, 1999: 34). The TSR 2 forecast total harvest area to be increased at 3 600 ha/yr in decade one, so approximately 2 900 ha/yr would be harvested under even-aged silvicultural systems in the future. The area forecasted to be harvested fluctuates from a minimum of 3 600 ha (short-term) to 4 400 ha (in 60 years) over the next 250 years.

For the purposes of this strategy, the average future harvest level is assumed to be **4 000 ha/yr**. The area of partial harvesting is declining, mostly in response to using timber harvesting to emulate the role of fire in maintaining certain ecosystems. For simplicity, for the purposes of this strategy, all harvesting is assumed to be even-aged. It is estimated that about **60%** of the annual area harvested, or **2 400 ha/yr**, is planted.

6. Opportunities to Increase Timber Supply

6.1 Potential Silviculture Strategies

Information in the previous sections was used to identify the following silvicultural strategies as having potential to either maintain or increase future timber supply at the TSA level. Each of these is discussed in detail in the next section (Review of Potential Silviculture Strategies). Strategies, which are ultimately adopted, are noted in Section 9. Strategies are labelled as ST (short-term), MT (mid-term) or LT (long-term). These term labels do **not** refer to when the strategies are applied. They refer to when the benefits (timber quantity) are realized as a result of a silviculture strategy.

At present, approximately 18 000 ha of silviculture surveys are needed to be carried out each year in order to provide data to support all strategies. Also, an annual program of maintaining a database (record-keeping) to record all achieved strategies needs to be carried out.

6.1.1 Short-Term (1 - 20 yrs)

The interim silviculture strategy has the following short-term strategy:

Fertilize ____ ha/yr of existing stands scheduled for harvest in the 2nd decade to increase their volumes. (increase)¹. This was meant to provide a short-term, late rotation volume boost to increase the short-term supply by 12 000 cubic metres per year commencing in the second decade. This was deleted for this strategy because the TSR2 found an increase of 15 000 hectares in the timber harvesting land base, and the hypothetical silviculture planning forecast used for this strategy, based on TSR2, does not show a decline in timber supply for the first 20 years, contrary to the forecast used for the interim silviculture strategy.

6.1.2 Mid-Term (21 - 100 yrs)

MT 1: Fertilize ____ ha/yr of existing stands scheduled for harvest 20 to 70 years from now to increase their volumes. (increase)

MT 2: Reduce minimum harvest ages of younger existing stands by 10 years, or alternatively improve the quality of the timber supply, by:

- (a) spacing ____ ha/yr of pine stands subject to repression
- (b) spacing ____ ha/yr of ____ stands; or
- (c) repeat fertilizing ____ ha/yr on a 15-year return cycle.

MT 3: Strategies to reduce the impact of wildlife habitat constraints.

¹ (Increase) means oriented to increasing harvest levels above those indicated by the TSR2 base case. (Maintain) means oriented to maintaining the harvest level indicated by the TSR 2 base case.

MT 4: Strategies related to commercial thinning.

6.1.3 Long-Term (101+ yrs)

LT 1: Increase/Maintain the THLB by

- (a) Planting ____ ha of backlog NSR;
- (b) Maintaining ____ ha of existing backlog plantations and
- (c) Surveying ____ ha/yr of ____ areas to ensure they remain fully stocked.

LT 2: Increase the THLB by:

- (a) converting/rehabilitating ____ ha/yr of deciduous stands; (increase)
- (b) converting/rehabilitating ____ ha/y of non-merchantable ____ stands; (increase)
- (c) assessing _____ ha of low-site stands for proper classification
- (d) improve the site productivity of low-site stands by ____ (fertilization). (increase/maintain)
- (e) bring excluded areas into the timber harvesting land base (THLB).
- (f) rehabilitate areas classified as non-commercial cover (NCC). (increase/maintain).

LT 3: Increase regenerated stand volumes 20% by:

- (a) site preparing ____ ha/yr.
- (b) using improved seed; (increase)
- (c) managing stocking so voids do not account for more than 10% of the area; (increase)
- (d) using larger planting stock; (increase)
- (e) fertilizing at the time of planting; (increase)
- (f) brushing ____ ha/yr for growth enhancement (i.e., not only for survival); (increase)
- (g) juvenile spacing ____ ha/yr; (maintain) or
- (h) repeat fertilize ____ ha/yr on a 15 yr return cycle.

LT 4: Reduce losses to root rot by: (maintain?)

- (a) pushover logging/stumping ____ ha/yr;
- (b) planting alternate/mixed species on ____ ha/yr; or
- (c) pop-up spacing on ____ ha/yr.

6.2 Review of Potential Silviculture Strategies

Potential strategies were reviewed according to the response time frames of short, mid and long-term time periods. Each response time frame is the period in which the anticipated result of a potential strategy is expected, not the period in which actions must necessarily commence.

The potential strategies are discussed Table 7. Table 6, below, describes the contents of each column for Table 7.

Table 6: Contents of Each Column in Table 7

Column Number	Note
1	<u>Number</u> : Strategy numbers correspond with the numbers recorded earlier in Section 6.1: "Potential Silviculture Strategies".
2	<u>Potential Strategy/Action</u> : Corresponds to the previous section (6.1).
3	<u>Discussion/Current Status</u> : This information is largely from the interim silviculture strategy, combined with information presented earlier in this document.
4	<u>Anticipated results</u> are calculated using a variety of methods.

At the end of each time period is a summary of the anticipated responses for all strategies proposed for the period. A potential harvest forecast is prepared under this summary. This forecast is highly speculative and requires confirmation through computerized management unit level analysis.

Each year, approximately 18 000 ha of silviculture surveys are continually needed in order to provide data to support all strategies. Also, an annual program of maintaining a database (record-keeping) to record all achieved strategies needs to be carried out.

Table 7, below, describes the details of silviculture strategies to improve timber supply.

Table 7: Silviculture Strategies to Improve Timber Supply

6.2.1 Short-Term (1 - 20 years)

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
ST-1 N/A	1. Late rotation fertilize all suitable stands scheduled for harvest in the 2nd decade to increase their volumes. (increase)	1. The interim silviculture strategy meant to provide a short-term, late rotation volume boost to increase the short-term supply by 12 000 cubic metres per year commencing in the second decade. This was deleted for this strategy because the TSR2 found an increase of 15 000 hectares in the timber harvesting land base, and the hypothetical silviculture planning forecast used for this strategy, based on TSR2, does not show a decline in timber supply for the first 20 years, contrary to the forecast used for the interim silviculture strategy.	1. Not applicable

6.2.2 Mid-Term (21 - 100 years)

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
MT 1	1. Fertilize ____ ha/yr of existing stands scheduled for harvest 20 to 70 years from now to increase their volumes (increase).	<p>At some point, harvesting will transition into younger existing stands, of which there are about 21 300 ha of spaced stands that are presently 20-50 years old. It is estimated that about 80% of these stands (17 000 ha) are suitable for multiple fertilization on a 10 year cycle = an annual program of 17 000ha/10yr = 1 700 ha/yr.</p> <p>This program could commence immediately.</p> <p>The oldest of these stands (i.e., current age 50) are likely to receive only 2 fertilization treatments. The youngest (i.e., age 20) would receive 3 or more fertilization treatments.</p> <p>3 fertilizations X 15 m3/fert X 17 000 ha = 765 000 m3 additional harvest volume. Over the 80 yr span of the mid-term = (765 000/80 =) 9 600 m3/yr.</p> <p>Over the mid-term time period, as more stands are harvested and regenerated to managed stands, the area under repeat fertilization would expand, first to the level determined under MT2(c), and ultimately to the level determined under LT 3(h).</p>	1. 9 600 m3/yr during years 21 – 100.

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
MT 2	2. Reduce minimum harvest ages of younger existing stands 10 years, or alternatively improve the quality of the timber supply, by:	<p>2. TSR2 assumptions for altering minimum ages are noted in Section 3.2. The district has already spaced about 21 300 ha.</p> <p>The TSR2 shows that if minimum harvestable ages are reduced by 10 years, compared to the base case, the projected long-term harvest level after the 21st decade would be 4% lower with no decreases in the harvest level in the short and mid-term. This shows that decreasing the minimum harvestable age may mitigate the effects of a mid-term fall-down but it would be at the expense of long-term supply.</p>	
MT 2	(a) spacing ____ ha/yr of pine stands subject to repression;	<p>(a) Most of the repressed stands from recent fires have been treated. Few stands harvested since 1987 have repression levels of stocking. Post '87 harvested areas that have over 10 000 sph are required by law to be spaced.</p> <p>Older repressed PI stands are considered problem forest types and are not suitable for spacing.</p>	(a) Most repressed PI areas have been treated. Benefits likely already factored into timber supply forecasts.
MT 2	(b) spacing ____ ha/yr of ____ stands	<p>Suitable stands are 15-20 yrs old. Stands with 2 200 – 5 000 sph are lower priority; those over 6 000 are high priority. Post-spacing densities are typically 1 800-2 000 sph for PI and 1 200 sph for Fdi/Lw. PI post-spacing densities are high to allow for the high risk associated with these stands in the SE corner of the province. PI stands are at substantial risk to fire, insect and animal losses.</p> <p>(b1) <u>Pre-87</u>: The Cranbrook Silviculture subcommittee estimates that 200 ha/yr are currently suitable for juvenile spacing over the next 3 years. A 3 yr program = 200 ha/yr.</p> <p>(b2) <u>Post-87</u>: About 20% of harvested areas would be suitable for spacing = $0.20 \times 4\,000$ ha harvested/yr = 800 ha/yr.</p> <p>Pre and post 87 spacing programs would overlap. A spacing program would be maintained at 1 000 ha/yr by increasing the post-87 stands to be spaced by 200 ha/yr after 3 years.</p> <p>Total area currently spaced + spaced under this potential strategy over the next 10 years = $21\,300 \text{ ha} + (10\text{yrs} \times 1000 \text{ ha/yr}) = 31\,300 \text{ ha}.$</p> <p>Assume these stands are in the 10-30 year age class. TSR2 data indicates the total current area in these age classes in the THLB to be approx. 55 000 ha. Therefore, about $31.3/55 \approx 57\%$ of stands will have had stocking control.</p> <p><u>The regeneration assumptions in the yield tables used for the TSR2 base case and the hypothetical silviculture planning forecast assumed an annual juvenile spacing program of 1300 ha. Therefore, it is advisable, if possible, to immediately increase the spacing program to 1000 ha/yr.</u> Because there may not be sufficient funds to do all of the identified spacing, there is a need to further examine the impacts/potential of spacing to determine which are the most cost-effective treatments (what landscape units, sites, species). This need is noted under "Summary of Information and Research Needs," Section 10. For this silviculture strategy, incremental silviculture activities are recommended on lands zoned for Integrated Resource Management (IRM) and areas of low biodiversity emphasis.</p> <p>Table 12 indicates that spacing:</p>	(b) Estimate the 21 300 ha of existing spacing + 10 000 ha of future spacing will lower the minimum ages of all stands currently aged 10 – 30 yrs by 20 to 45 years at the stand level and 17 years overall at the TSA level.

		<p>PI from 5 000 sph down to 1 300 sph, or from 9 000 sph down to 1 600 sph reduces the 27.5 cm DBH technical rotation age by 51 and 45 years respectively. At the technical rotation ages, MAI of the spaced stands is significantly greater than that of the unspaced stands (3.01 for 9000/spaced to 1600 vs. 2.33 for 9000/unspaced), but is well below the MAI of biological culmination (3.58 for 9000/unspaced). The MAI of biological culmination occurs at about 80 years regardless of whether the stands are spaced or not. Because the technical target of 27.5 is higher than the min merch DBH standards for PI (20 cm for slopes < 40% and 25 cm for slopes 40%+), the effect of spacing on lowering the min ages to meet these targets is about half that noted previously, or about 20-25 years.</p> <p>Fdi and spruce from 3 000 sph down to 1 200 sph lowers the age to achieving 27.5 cm DBH by 38 years and 42 years respectively. Because the technical target of 27.5 is higher than the min merch DBH standards for Fdi and spruce, the effect of spacing on lowering the min ages to meet these targets is in the range of the min age cut-offs.</p> <p>The TSA-level effect on lowering minimum harvestable ages by spacing 57% of stands in the currently in the 10-30 year age class can be calculated as follows:</p> <p>57% spaced X (60% PI by species X 20 yrs + 40% other species X 45 years) = 17 yr lower minimum harvest age overall.</p>	
MT 2	(c) repeat fertilizing _____ ha/yr on a 15-year return cycle.	<p>(c) MT1 defines the fertilization program level based on 21 300 ha of <u>existing</u> spaced stands. This potential strategy extends the fertilization program to include <u>both existing spaced stands as well as newly spaced stands</u> under MT2 (b) above (assumed to be 1000 ha/yr pending funding review.)</p> <p>Using the same rationale as in MT1, i.e., that 80% of spaced stands would be suitable for fertilization on a 10-year cycle, and 3 fertilizations adds 45 m³/ha to harvest volumes on these stands:</p> <p>3 fertilizations X 15 m³/fert X 0.8 X 10 000 ha = 360 000 m³ additional harvest volume. Over the 80 yr span of the mid-term = (360 000/80 =) 4 500 m³/yr.</p> <p>The increased associated fertilization program level would be (.8 X 10 000ha/10 yr cycle =) 800 ha/yr. On a 15 yr cycle the program level would be (.8 X 10 000ha/15 yr cycle =) 533 ha/yr.</p> <p>This program and increased yield incorporates that of MT1 (i.e., is not in addition to MT1).</p> <p>The associated fertilization program level would be (.8 X 31 300ha/10 yr cycle =) 2 500 ha/yr. On a 15 yr cycle the program level would be (.8 X 31 300ha/15 yr cycle =) 1 670 ha/yr.</p> <p>The potential fertilization program could rise to (.8 X 31 300 X 45 =) 1.13 million m³. Rationing this over the 80 yr span of the mid-term = 1.13 m³/80yrs = 14 085 m³/yr.</p> <p>This program would not reach this level until after all stands have been spaced, so MT1 level is the starting level.</p>	(c) Increasing the spaced and fertilized area potentially adds 14 085 m ³ /yr to mid-term harvests.

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
MT 3	3. Strategies to reduce the impact of wildlife habitat constraints	3. TheTSR2 base case does not identify any significant impacts on timber supply for ungulate winter range or caribou habitat. The impacts of grizzly bear habitat were not analyzed in TSR2. For the hypothetical silviculture planning forecast, a 1% reduction in the timber harvesting land base (THLB) was assumed. In the TSR2 a 5% reduction in the THLB produced a 7.5% AAC reduction in the mid-term and a 6% reduction in the long-term AAC. Proportionately, a 1% reduction in the THLB would reduce the mid-term AAC by 1.5% or 12 600 cubic metres per year in the mid-term and by 1.2% or 10 000 cubic metres per year in the long-term. The MT and LT strategies should mitigate this impact.	3. All mid-term and long-term strategies will mitigate this impact.
MT 4	4. Strategies related to commercial thinning	<p>4. There are no stands suitable for commercial thinning. Much of the older PI is too dense, having small diameters and small live crowns. Markets for small diameter material are poor. Root rot can also be an issue. CT is only likely to occur if there are no other alternatives, which is not currently the case. Stands are more likely to be partial harvested than commercially thinned, due both to stand structure and to lower harvesting costs.</p> <p>As managed stands become older, there will be more opportunities for commercial thinning. However, there is little, if any, growth and yield information on CT'd or partially harvested stands. Operational trials should be undertaken now, so that the necessary G&Y information will be available when the managed stands become suitable. This information need is noted under "Summary of Information and Research Needs," Section 10.</p>	4. No opportunity.
Mid-Term Harvest Forecast Summary		Potential Strategy #	Effect
		MT1 Late rotation/ fert. existing spaced.	9 600 m3/yr. Improves availability.
		MT2 Reduce min ages of young existing stands by:	
		(a) spacing repressed PI	Treatments already completed and embedded in harvest forecasts.
		(b) Spacing stands	Total existing and planned spacing = 31 300 ha, which improves availability and sets up stands for fertilization. Reduces min ages 20-45 yrs at stand level and 17 yrs at TSA level.
		(d) Repeat fertilizing	Including MT1, adds 14 085 m3/yr total to mid-term.
		MT3 Reduce impact of wildlife constraints	All mid-term and long-term strategies will mitigate this impact.
		MT4 Commercial thinning	No opportunity.
Conclusion		The potential exists to add 14 085 m3/yr (1.13 million m3 total) to mid-term harvest levels through programs of spacing and fertilization. This increases the mid-term harvesting	

level from 700 000 to 714 000 cubic metres/year (2% increase). Significant opportunities exist to increase timber supply availability, particularly in the latter part of the mid-term period.

6.2.3 Long-Term (101+ years)

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result																																																											
LT 1	1. Maintain the THLB by (a) Treating approx. 1 250 ha of backlog NSR; (main- tain) and (b) Maintaining approx. 1 300 ha of previously reforested backlog plantations. (maintain)	1. (a) About 1 250 ha of backlog NSR require assessment and it is estimated that about 350 ha of this will require treatment. About 900 ha have already been identified for treatment for a total treatable of 1 250 ha. See table below for treatment program. (b) About 1 300 ha of previously reforested area requires brushing to ensure free growing is achieved. The program shown below is required. <table><tr><th colspan="7">Area (ha)</th></tr><tr><th rowspan="2">Year</th><th rowspan="2">Site Prep</th><th rowspan="2">Plant</th><th colspan="3">Brush</th><th rowspan="2">Total</th></tr><tr><th>New</th><th>Existing</th><th></th></tr><tr><td>1</td><td>100</td><td>400</td><td>0</td><td>250</td><td></td><td>250</td></tr><tr><td>2</td><td>100</td><td>400</td><td>0</td><td>250</td><td></td><td>250</td></tr><tr><td>3</td><td>100</td><td>400</td><td>0</td><td>250</td><td></td><td>250</td></tr><tr><td>4</td><td></td><td></td><td>0</td><td>250</td><td></td><td>250</td></tr><tr><td>5</td><td></td><td></td><td>0</td><td>250</td><td></td><td>250</td></tr><tr><td>6-10</td><td></td><td></td><td>0</td><td>0</td><td></td><td>0</td></tr></table> Issues are reliability of survey data and what to do with marginal stands.	Area (ha)							Year	Site Prep	Plant	Brush			Total	New	Existing		1	100	400	0	250		250	2	100	400	0	250		250	3	100	400	0	250		250	4			0	250		250	5			0	250		250	6-10			0	0		0	1. (a) (b) (c) Maintain base case LTHL. Area requiring treatment totals 2 550 ha or 0.6% of the THLB. Failure to treat would result in a 0.6% drop in LTHL.
Area (ha)																																																														
Year	Site Prep	Plant	Brush			Total																																																								
			New	Existing																																																										
1	100	400	0	250		250																																																								
2	100	400	0	250		250																																																								
3	100	400	0	250		250																																																								
4			0	250		250																																																								
5			0	250		250																																																								
6-10			0	0		0																																																								
	(c) Surveying 4000 ha/yr of pre-1987 SR area to ensure they remain fully stocked.	(c) Plantations previously found to be stocked may subsequently fall back into an NSR status due to tree mortality. A survey program of 4 000 ha/yr is necessary to monitor these areas.	See above.																																																											

Number	Potential Strat- egy/Action	Discussion / Current Status				Anticipated Result
LT 2	2. Increase the THLB by including:	2.	Area (ha)	%prod area	%THLB	2. Summary. A possible 2.9% LTHL gain fromrehabilitating as per (b).
		(a)Decid	Included in non-merch			
		(b)Non-merch/PFT	21 700	2.8	5.0	
		(c, d) Low site	38 500	5.0	8.9	
		(e) NCC	3 800	0.5	0.9	
		(f) Excluded	28 600	3.7	6.6	
LT 2	(a) converting /rehabilitating _____ ha/yr of deciduous stands; (increase)	(a) <u>Decid.</u> Part of the excluded category. Important for wildlife and for contributing to biodiversity (MoF, 1999a:26). No opportunity.				(a) No opportunity.
LT 2	(b) converting/rehabilitating non-merchantable hemlock, lodgepole pine and cedar stands; (increase)	(b) <u>Non-merch.</u> These stands are mostly short, small diameter PI, Hw and Cw (MoF, 1999a:28). Although they equal 5% of the THLB (21 550 ha), some stands may prove merchantable in periods of high pulp prices. The consensus is to rehab about 58% of the most non-merch of the stands, or 12 500 ha. The rehab program would be 500 ha/yr for 25 yrs. A survey program of 4 000 ha/yr over the next 5 years is needed to assess all stands and select the ones for treatment.				(b) Rehab 12 500 ha (2.9% of THLB, or 2.9% increase in LTHL).
LT 2	(c) assessing _____ ha of low-site stands for proper classification; or (d) improve the site productivity of low-site stands by _____ (fertilization). (increase/maintain)	(c) <u>Low site.</u> Many low site areas have been reclassified and/or included in the THLB. Those that are still excluded are the “worst of the worst.” There is no potential for silvicultural treatments to increase the productivity of these stands.				(c, d) No opportunity.
LT 2	(e) rehabilitating areas classified as non-commercial cover (NCC).	(e) No opportunity				(e) No opportunity.
LT 2	(f) Bringing excluded areas into the THLB.	(f) Excluded areas (low merchantability or difficult to reforest) consist of old, non-merchantable cedar, hemlock, spruce and balsam stands, deciduous stands (see (a) above), or high elevation parkland stands. The old forests can contribute to old growth management areas and biodiversity requirements. No immediate opportunity was identified, however, there is a need to further examine excluded areas for opportunities to bring them into the THLB through rehabilitation, reclassification, or even harvesting, as noted in the TSR2 Rationale for AAC Determination. This need is noted under “Summary of Information and Research Needs,” Section 10.				(f) No opportunity.
LT 3	3. Increase the volume of	3.				3. See “Summary” below.

Number	Potential Strat- egy/Action	Discussion / Current Status	Anticipated Result																																																	
	regenerated stands by 20% over the base case by:																																																			
LT 3	(a) site preparing ____ ha/yr.	(a) Current site prep is: <table><tr><td><u>Company</u></td><td><u>ha/yr</u></td></tr><tr><td>Galloway</td><td>250</td></tr><tr><td>SBFEP</td><td>200</td></tr><tr><td>Tembec</td><td><u>1000</u></td></tr><tr><td>Total</td><td>1450</td></tr></table> Total is about 1450/2400 planted = 60% of area planted. No additional opportunity.	<u>Company</u>	<u>ha/yr</u>	Galloway	250	SBFEP	200	Tembec	<u>1000</u>	Total	1450	(a) No opportunity.																																							
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SBFEP	200																																																			
Tembec	<u>1000</u>																																																			
Total	1450																																																			
LT 3	(b) using improved seed;	(b) All even-aged managed areas are planted (2 400 ha/yr). In 1998, some planted area was improved S but the volume gain is low, estimated between 2 – 12% (average 5%). However, some S orchards are showing as much as a 22% gain. In 2000-01, 20% of all planted areas used improved seed. Future tree improvement gains by 2007 are estimated to be: <table><tr><th>Future%</th><th></th><th colspan="2"><u>% vol gain (stand level)</u></th><th><u>% gain</u></th><th colspan="2"><u>seed (million/yr)</u></th></tr><tr><th>THLB</th><th>Species</th><th><u>Now</u></th><th><u>2007</u></th><th><u>(TSA level)</u></th><th><u>need</u></th><th><u>production</u></th></tr><tr><td>15</td><td>Sx</td><td>5</td><td>14-25</td><td>3</td><td></td><td></td></tr><tr><td>10</td><td>Lw</td><td>0</td><td>4</td><td>1</td><td></td><td></td></tr><tr><td>60</td><td>PI</td><td>0</td><td>12*</td><td>7</td><td></td><td>2.0</td></tr><tr><td>10</td><td>Fdi</td><td>-</td><td>-</td><td>0</td><td></td><td></td></tr><tr><td colspan="4">Total</td><td><u>11</u></td><td></td><td></td></tr></table> *There are no plans for Pli improved seed for the East Kootenay, but there should be seed available by 2007. No info available on potential volume gain, so the W. Kootenay estimate of 12% gain is used. About 60% of harvested areas are planted, so the LTHL gain across the entire TSA = .6 X .11 $\cong$ 6.6%. There is substantial variation over the above estimates. For example, some spruce orchards are exhibiting 25% gains. <u>The best of the improved seed for each species should be targeted to areas needing quick green-up.</u> A need to lobby for more and better improved seed is noted under “Summary of Information and Research Needs,” Section 10, along with the need to examine seed planning zone guidelines to expand improved seed into the East Kootenays.	Future%		<u>% vol gain (stand level)</u>		<u>% gain</u>	<u>seed (million/yr)</u>		THLB	Species	<u>Now</u>	<u>2007</u>	<u>(TSA level)</u>	<u>need</u>	<u>production</u>	15	Sx	5	14-25	3			10	Lw	0	4	1			60	PI	0	12*	7		2.0	10	Fdi	-	-	0			Total				<u>11</u>			(b) <u>stand level</u> Vol gain – up to 25% GU red’n (7m)– 2 yrs min age red’n - 10 yrs <u>TSA level</u> Vol gain – 6.6% GU red’n (7m)– - yr Min. age red’n - - yrs See “Summary” below.
Future%		<u>% vol gain (stand level)</u>		<u>% gain</u>	<u>seed (million/yr)</u>																																															
THLB	Species	<u>Now</u>	<u>2007</u>	<u>(TSA level)</u>	<u>need</u>	<u>production</u>																																														
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10	Fdi	-	-	0																																																
Total				<u>11</u>																																																

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
LT 3	(c) managing stocking so voids do not account for more than 10% of the area; (increase)	<p>(c) The TIPSy standard OAF1 factor for voids is 15%. The objective is to reduce this to 10%. Current free growing requirements will result in < 15% in voids, however the actual amount is unknown. About 29% of the total land area of the TSA is within the THLB. This implies a reasonable amount of favourable terrain, so an OAF1 of 15% may be high. There is a need for completion of surveys for voids to get a measure of the actual area in voids (noted under "Summary of Information and Research Needs," Section 10).</p> <p>Galloway is spacing dense clumps and fill planting voids in between. The need to survey backlog sites to get better information on voids/clumpiness in these stands, together with their potential for fill planting is noted under "Summary of Information and Research Needs," Section 10). Voids can be desirable for wildlife habitat, so intensive void management may not be practicable on all areas. Refer to habitat strategies in Section 8.3.</p> <p>The hypothetical silviculture planning forecast used for this strategy, planned for an additional 2.8% OAF1 reduction from the TSR2 base case to account for residual volumes left on partially harvested sites.</p>	(c) Surveys required. See "Summary" below.
LT 3	(d) using larger planting stock; (increase)	<p>(d) This is a pre free-growing item, although as considered here, it could be incremental to achieving free growing.</p> <p>The current practice is to plant 410 or 412 stock. Larger stock is not possible due to shallow/ rocky/cold soils.</p> <p>Concern was expressed about the lack of information on the # of years for trees to reach breast height. This time estimate affects site index equations and estimates of years until green-up hts are reached. The need to examine opportunities to improve this information is noted under "Summary of Information and Research Needs," Section 10.</p>	(d) Current practice. No additional opportunity.
LT 3	(e) fertilizing at the time of planting; (increase)	<p>(e) This is a pre free-growing item, although as considered here, it could be incremental to achieving free growing. Funding opportunities are limited and not likely to be voluntarily undertaken, unless necessary to achieve FG.</p> <p>This is being done on a trial basis on rehab of roads, landings and skid trails. No other opportunities identified.</p> <p>Note: Results elsewhere are inconclusive. One trial found a general favourable response, but also, certain formulations and certain species had a negative response. Fertilization did not prevent the need for brushing.</p>	(e) No opportunity.
LT 3	(f) brushing ____ ha/y for growth enhancement (i.e., not only for survival); (increase)	<p>(v) This is a pre free-growing item, although as considered here, it could be incremental to achieving free growing. Funding opportunities are limited and not likely to be voluntarily undertaken, unless necessary to achieve FG.</p> <p>Brush is not a major factor in the TSA. No opportunities identified.</p>	(f) No opportunity.

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
LT 3	(g)juvenile spacing _____ ha/yr; (maintain) or	<p>(g) Virtually no basic spacing is necessary. See MT2 (b).</p> <p>With high minimum harvest ages to obtain merchantable stands, spaced stands can generate considerable MAI gains over unspaced stands. For example, for spruce stands on slopes > 40%, the min avg DBH must be 28 cm before they are considered merchantable. TIPSYS results in Table 12 shows that for SI 15 spruce stands, spacing from 3000 sph down to 1200 sph not only achieves a 27.5 cm avg stand DBH 42 years earlier, <u>but also considerably increases MAI (from 2.76 unspaced to 3.29 spaced – an almost 20% increase)</u>. This potential for spacing to increase long-term harvest levels should be evaluated under a Type II silviculture analysis. This is noted under “Summary of Information and Research Needs,” Section 10.</p>	<p>(g)</p> <p>_____ stand level</p> <p>Vol gain – 0%</p> <p>GU red'n – 0yrs</p> <p>min age red'n - 20-45 yrs</p> <p>_____ TSA level</p> <p>Vol gain – ???%</p> <p>GU red'n – 0 yr</p> <p>min age red'n - 27 yrs</p> <p>See “Summary” below.</p>
LT 3	(h)repeat fertilize _____ ha/yr on a 15 yr return cycle.	<p>(h) It is estimated that 89% of the TSA could be fertilized on a species basis (all species, including PI (47% of THLB), Fdi (18%), Lw (13%) & S (11%) except those classified as “other”) and about 64% on a site classification basis [all medium site (60%) and the lower ¼ of good site (15%)]. Availability is estimated at 60%. Fertilizable land base = (.89 X .6 X .64 =) 34% of THLB = (.34 X 431 100 =) 146 600. On a 15 year return cycle, this requires a program of (146 600/15 =) 9 800 ha/yr. Cost at \$300/ha would be \$2.94 million/yr.</p> <p>Probably 3 applications would be required, with the first occurring after juvenile spacing. Each application is estimated to add 15 m3/ha of growth, so 3 applications yields an additional 45 m3/ha. This is a 20% volume gain on a base stand yield of 225 m3/ha. A 20% volume gain across 34% of the THLB would increase long-term harvest levels (0.2 X 0.34 =) 6.8%.</p> <p>Estimate that a repeat fertilization program giving a 20% stand level volume gain would alternatively enable at least a 10 yr stand level reduction in minimum ages. If this were applicable across 34% of the THLB, it would be a 3-yr minimum age reduction.</p> <p>There is little experience in fertilizing spruce or larch. Given that these are major species components of the THLB, fertilization trials are needed to determine if the fertilizable land base should include these species (noted under “Summary of Information and Research Needs,” Section 10).</p>	<p>(h)</p> <p>_____ stand level</p> <p>Vol gain – 20%</p> <p>GU red'n – 0 yrs</p> <p>min age red'n - 10 yrs</p> <p>_____ TSA level</p> <p>Vol gain – 6.8%</p> <p>GU red'n – 0 yr</p> <p>min age red'n - 3 yr</p> <p>See “Summary” below.</p>

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result																																																																													
LT 3	SUMMARY	<p>The following summarizes the estimated effects of strategy LT3. Effects at the TSA level are prorated based on the opportunity area as a percentage of the TSA's THLB. Totals are estimated using best judgement with respect to potential overlapping effects. The volume gain in the form of larger logs and the minimum age reductions cannot both be captured at the same time. (However, a volume gain in the form of a higher MAI and therefore a higher LTHL can occur at the same time as a minimum age reduction.) Benefits must be allocated based on TSA need.</p> <table><tr><th>Strategy</th><th colspan="2">Volume Gain (%)</th><th colspan="2">Green-up age red'n(yrs)</th><th colspan="2">Min Harv. Age red'n(yrs)</th></tr><tr><th></th><th>Stand</th><th>TSA</th><th>Stand</th><th>TSA</th><th>Stand</th><th>TSA</th></tr><tr><td>(a) incr. site prep</td><td></td><td></td><td colspan="4">no opportunity</td></tr><tr><td>(b) improved seed</td><td>14-25</td><td>6.6</td><td>2</td><td>-</td><td>10</td><td>-</td></tr><tr><td>(c) reduce voids</td><td>5</td><td>-</td><td colspan="4">Surveys required</td></tr><tr><td>(d) large stock</td><td></td><td></td><td colspan="4">current practice – no add'l opportunity</td></tr><tr><td>(e) fert at planting</td><td></td><td></td><td colspan="4">no opportunity</td></tr><tr><td>(f) brush for growth</td><td></td><td></td><td colspan="4">no opportunity</td></tr><tr><td>(g) spacing</td><td>0</td><td>???</td><td>0</td><td>0</td><td>20-45</td><td>27</td></tr><tr><td>(i) repeat fert</td><td>20</td><td>6.8</td><td>0</td><td>0</td><td>10</td><td>3</td></tr><tr><td>Total</td><td>50?</td><td>13?</td><td>2</td><td>0</td><td>30+?</td><td>18+?</td></tr></table>	Strategy	Volume Gain (%)		Green-up age red'n(yrs)		Min Harv. Age red'n(yrs)			Stand	TSA	Stand	TSA	Stand	TSA	(a) incr. site prep			no opportunity				(b) improved seed	14-25	6.6	2	-	10	-	(c) reduce voids	5	-	Surveys required				(d) large stock			current practice – no add'l opportunity				(e) fert at planting			no opportunity				(f) brush for growth			no opportunity				(g) spacing	0	???	0	0	20-45	27	(i) repeat fert	20	6.8	0	0	10	3	Total	50?	13?	2	0	30+?	18+?	<p>5. Summary</p> <p>Significant improvement in timber availability.</p> <p>The objective of increasing the volume of regenerated stands by 20% cannot be fully attained at the above level of program. However, further yield gains may develop depending on the outcome of site index estimation studies and upon the outcome of an expanded tree improvement program or from higher tree improvement program yield gains.</p>
Strategy	Volume Gain (%)		Green-up age red'n(yrs)		Min Harv. Age red'n(yrs)																																																																											
	Stand	TSA	Stand	TSA	Stand	TSA																																																																										
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(i) repeat fert	20	6.8	0	0	10	3																																																																										
Total	50?	13?	2	0	30+?	18+?																																																																										
LT 4	<p>4. Reduce losses to root rot by: (maintain)</p> <p>(a) pushover logging / stumping_____ ha/yr;</p> <p>(b)planting alternate species on _____ ha/yr; or</p> <p>(c) pop-up spacing on _____ ha/yr.</p>	<p>4. For the hypothetical silviculture planning forecast, an additional 2.8% was added to OAF2 over the TSR2 base case to account for <i>Armillaria</i> root rot (OAF2 will be 7%).</p> <p>Activities (a) and (b) will occur through basic silviculture where necessary. Shallow or calcareous soils often limit the use of stumping.</p> <p>There is a need for further study of root rot management and to confirm the OAF2 factor. This is noted under “Summary of Information and Research Needs,” Section 10.</p>	<p>4. Not applicable</p>																																																																													

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
	Long-Term Harvest Forecast Summary	<u>Potential Strategy #</u>	<u>Effect</u>
		LT1 Backlog NSR	Maintain base case LTHL
		LT2 Increase the THLB	
		(a) convert decid	No opportunity
		(b) rehab non-merch	Rehab 12 500 ha for 2.9% increase in LTHL
		(c) assess L site classifications	No opportunity
		(d) fert L site stands	No opportunity
		(e) rehab NCC	No opportunity
		(f) use excluded areas	No opportunity
		LT3 Incr. regenerated stand vol's	Potential 13% LTHL increase. Better site index estimates & tree improvement may increase this further.
		LT4 Root rot	N/A.
	Conclusion	<p>A 16% LTHL gain can be expected with current tree improvement and rehabilitation program plans, plus a very large repeat fertilization program that would commence at a low level and increase gradually as more area becomes occupied by managed stands. Additional tree improvement and possible site index adjustments may increase this further. This increases the long-term harvesting level from 776 000 to 902 500 cubic metres/year, which is an additional 126 488 cubic metres/year. The total increase over the long-term would be 18.97 million cubic metres.</p>	

6.3 Potential Harvest Forecast

This silviculture strategy indicates the following potential relative harvest forecast for each time period. This forecast is highly speculative and requires confirmation through computer-based modelling and analysis. It also includes silvicultural activities that are not within the traditional scope of incremental silviculture. Modelling may indicate more precise timing, targeting and program levels associated with incremental silviculture activities than could be developed in this interim strategy. Table 8, below, summarizes the potential harvest gains as a result of the silviculture strategy.

Table 8: Summary of Potential Harvest Gains

Short-term	Not applicable
Mid-Term	The potential exists to add 14 085 m ³ /yr (1.13 million m ³ total) to mid-term harvest levels through programs of spacing and fertilization. This increases the mid-term harvesting level from 700 000 to 714 000 cubic metres/year (2% increase). Significant opportunities exist to increase timber supply availability, particularly in the latter part of the mid-term period.
Long-Term	A 16% LTHL gain can be expected with current tree improvement and rehabilitation program plans, plus a very large repeat fertilization program that would commence at a low level and increase gradually as more area becomes occupied by managed stands. Additional tree improvement and possible site index adjustments may increase this further.

7. Opportunities to Improve Timber Quality

TSR2 does not analyze the effects of incremental silviculture practices on the future quality of the timber resource. Information in this section was gathered during the district working session in 1999 and during the preparation of this report in 2002.

7.1 Product Objectives

Table 9: Product Objectives at the Log Level for the Cranbrook TSA

Quality Class	Species	Characteristics
Premium Log:	All	32.5+ cm minimum average stand diameter at breast height (DBH).
Sawlog:	All	27.5+ cm minimum average stand DBH.

7.2 Potential Strategies to Achieve Product Objectives

The following strategies in table 10 have potential to improve timber quality. These were identified in the district working session in 1999, except the large log calculation was performed later. The response time frame is the period in which the anticipated result is expected, not the period in which actions must necessarily commence. Refer to section 3.4 for an earlier discussion on timber quality.

Table 10: Strategies to Improve Timber Quality

Response Time Frame	Potential Strategy/Action	Discussion/Current Status	Anticipated Result
Short-term (1-20 yrs)	None	Short-term harvests will come from existing older stands, which are not treatable to improve quality.	Quality profile of existing old growth will prevail. Assume this is equal to a coast-wide estimate of 15%.
Mid-term (21-100 yrs)	None	See above	See above
Long-term (101 + yrs)	Q1. Adjust minimum harvest age so the majority of stands have an average diameter of 27.5 cm (scenario 9 of the data package)	Increase minimum harvest age for select analysis units. Each analysis unit's yield table and diameter table is assessed to identify the point in time when the top 250 prime trees have an average diameter of 27.5 cm. This is used as the minimum harvest age for future managed stands.	Logs with higher average diameters will improve quality. The majority of volume harvested from future managed stands will be of sawlog size and quality.
Long-term	Q2. Space to increase average stand DBH	Q2. Spacing for quality strategies are intertwined with spacing for volume.	See MT2(b)
Long-term	Q3. 1 st lift prune 200 ha/yr to 3.5 m.	Q3. The maximum historic program has been 200 ha/hr. Currently 1,216 ha have been 1 st lift pruned.	An annual program of 200 ha/yr would equal (200/4000 ha/yr harvested =) 5% of THLB. If 3.5 m = 15% of tree vol, (.05 X .15 =) 1%/yr of future harvest volume will be clear logs resulting from pruning. There is a concern about being able to track pruned stands so that

		their value can be captured at harvest.
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7.3 Large Premium Log Analysis

Two large log analyses are reported below in Tables 11 and 12. Both tables are based on an annual spacing program of 1 200 ha/yr. This is equal to spacing one-half of the 2 400 hectares harvested and planted annually under an even-aged management system. The tables do not include an estimate for the premium log content from harvests in the uneven-aged management zone.

All tables were generated using TIPSYS version 2.1e with standard OAF's, to a 12.5 cm utilization standard for all species. Because TIPSYS has no mechanism for in-growth following planting, unspaced stands having a stocking level of 5 000+ sph were assumed to be naturally regenerated. Stands with a stocking level of $\leq 3\ 000$ sph were assumed to be planted. The difference between the # sph actually planted and the # used in the table is assumed ingrowth (e.g.; 3 000 sph planted = 1 400 sph planted + 1 600 sph ingrowth).

The tables are based on the expected future species mix derived from Petryshen (1999). The site indices used are weighted averages from Martin (1999) and can be considered inclusive of an OGSi adjustment. They do not, incorporate gains from silviculture strategies to improve the quantity of future timber supply.

Table 11 illustrates the effects of spacing on achieving a technical rotation (sawlog target of 27.5 cm DBH). For example, rows 3 & 4 show that by spacing a PI stand from 5 000 sph to 1 300 sph, a 27.5 cm DBH average diameter target can be reached 51 years earlier, at 115 years versus at 166 years for the unspaced stand. The MAI of the spaced PI stand is 26% higher than that of the unspaced stand, indicating that spacing would also substantially increase the harvest level over time at this technical rotation. Under the assumptions employed, even with spacing, only **5.1%** (row 20) of annual harvested volumes in the long-term will be large premium logs (32.5+ cm DBH). This number is probably higher than can be expected, given that it is based on harvest ages that are in excess of TSR2 mid and long-term average harvest ages.

Table 12 shows the effects of managing stands to younger harvest ages (PI – 65, other species – 90). This would be representative of the harvest profile at about the time of transition from existing stands to managed stands, about 90-100 years from now, with minimum harvest ages reduced about 15 years below culmination for PI and about 30 years for other species. Under this scenario the large premium log content falls to **0.9%**. However, at younger harvest ages, spacing significantly reduces the number of smaller trees in the stand and increases those in the middle size range, while still maintaining similar stand volume. For example, spacing PI from 9 000 sph to 1 600 sph (row 2 vs. row 1) reduces the # stems/ha in the 15-20 cm class by over 300 and almost doubles the # stems/ha in the 25-30 cm DBH class from 195 to 356 sph. Total stand volume at 1 600 sph is 12 m³ greater than at 9 000 sph. Average stand DBH increases by almost 5 cm, creating a merchantable stand, whereas the unspaced stand would not be merchantable. Also significant, the MAI of the spaced stand at the target harvest age of 65 years is the same as that of the unspaced stand at 80 years.

With regard to Fdi, Table 12 TIPSYS results indicate that MAI changes very little across the range of stocking levels shown in the table at age 90. Diameter distributions, however, are significantly affected by stocking. An unspaced stand with 3 000 sph at establishment has 44% of its stems below the 12.5 cm merchantability limit. At the current limit of 17.5 cm, > 50% of total stems wouldn't be merchantable. This has some implications for various costs and treatment decisions. Also, there is a shift in the number of stems from the 15-20 cm group into the 25-30 cm group. Spacing from 3 000 sph down to 900 sph reduces the number of stems and the % total volume in the smallest merchantable size grouping by about half. Unspaced, fully 60% of the stand's volume is in the 15-20 cm group, while, with spacing, this falls to about 30% of total volume. At the same time, the volume in the 25-30 cm group increases by more than two thirds.

For spruce, Table 12 indicates a significant volume shift into the 25-30 cm group (from 5% of total volume of unspaced stands to 20% spaced). The spaced stand, however, has 17m³/ha (6%) less total volume than the unspaced stand.

Table 11. Large log analysis – 27.5 cm DBH target harvest diameter

Target - 27.5 cm DBHg																																																							
Row #	Species	%inv	SI ²	Regime	Area no space	Space frm/to:	Reference			Target DBHg -all	Harv Age	MAI	LRF b1/m3	Total		Largest 250		DBH class ¹																5m large log ³																					
							Cul Age	Cul Vol	Cul MAI					Vol (12.5cm util)	Trees	Vol	DBHg	0 - 10 cm		15 - 20 cm			25 - 30 cm			35+ cm				% tot hrst vol																									
				spaced														# trees	% tot trees	# trees	% tot trees	vol	% tot vol	# trees	% tot trees	vol	% tot vol	# trees	% tot trees	vol	% tot vol																								
1	PI	60	18	360		nat9000/1600	78	292	3.74	27.5	142	3.01	252	490	784	231	34.5	2	0	186	24	44	9	467	60	251	51	128	16	130	27	1.0																							
2	comparison					nat9000/unspaced	80	286	3.58	27.5	187	2.33	257	435	693	261	34.6	0	0	177	26	50	11	397	57	243	56	119	17	143	33	N/A																							
3				220		nat5000/1300	82	285	3.48	27.5	115	3.26	243	375	761	206	34.6	2	0	204	27	43	11	413	54	204	54	142	19	127	34	0.8																							
4	comparison					nat5000/unspaced	79	286	3.62	27.5	166	2.58	258	429	724	245	34.5	1	0	189	26	52	12	405	56	239	56	128	18	139	32	N/A																							
5	comparison					nat5000/900	89	289	3.25	27.5	84	3.24	231	272	650	161	33.5	5	1	144	22	27	10	381	59	161	59	119	18	86	32	N/A																							
6				140		plt3000/900	81	270	3.34	27.5	85	3.33	229	283	667	162	33.3	6	1	146	22	27	10	405	61	174	61	101	15	82	29	0.4																							
7				360		plt3000/unspaced	74	269	3.64	27.5	187	2.21	248	414	689	247	34.3	0	0	166	24	46	11	407	59	237	57	116	17	130	31	1.2																							
8				360		plt2000/unspaced	75	272	3.63	27.5	167	2.48	244	414	748	233	34.4	0	0	176	24	45	11	448	60	242	58	123	16	127	31	1.2																							
9	Subtot.			720	720																											4.5																							
10	Fd/L	20	16	240		plt3000/1200	129	298	2.31	27.5	183	2.18	245	400	726	299	38.6	38	5	275	38	44	11	208	29	113	28	205	28	242	61	1.5																							
11	comparison					plt3000/unspaced	126	295	2.34	27.5	exceeds TIPSy data: max's out at DBHg =25.3 at age 229							#####		#####		#####		#####		#####		#####		#####		N/A																							
12	alternative					plt3000/900	132	298	2.26	27.5	145	2.25	238	326	633	234	35.8	25	4	186	29	31	10	263	42	139	43	161	25	158	48	N/A																							
13				240		plt1600/unspaced	130	296	2.28	26.9 ⁵	219	2.00	251	438	816	339	40.2	48	6	365	45	57	13	193	24	106	24	211	26	275	63	1.6																							
14	Subtot.			240	240																																																		
15	Sw,BI ⁴	20	15	240		plt3000/1200	118	388	3.29	27.5	118	3.29	239	388	798	228	36.4	12	2	249	31	49	13	366	46	176	45	171	21	162	42	1.0																							
16	comparison					plt3000/unspaced	106	356	3.36	27.5	160	2.76	246	441	767	269	36.4	2	0	240	31	57	13	374	49	208	47	151	20	176	40	N/A																							
17				240		plt1600/unspaced	114	384	3.37	27.5	146	3.06	243	447	848	255	36.8	4	0	260	31	56	13	416	49	210	47	169	20	180	40	1.0																							
18	Subtot.			240	240																																																		
19																																																							
20	Total			1200	1200																											5.1																							
¹ Actual ranges are 0 - 12.5 cm, 12.6 - 22.5 cm, 22.6 - 32.5, and 32.6 + cm																																																							
² From Martin, 1999. <i>ISIS Polygon Area by Site Index Class</i>																																																							
³ 1st 5 m log assumed to be 25% of tree volume. Volume calculated is a % of total harvest volume based on proportion of annual harvested area under a particular regime, not a % of stand volume.																																																							
⁴ Modeled as all planted Sw due to TIPSy limitations.																																																							
⁵ Exceeds TIPSy data: max's out at DBHg =26.9 at age 219																																																							

Table 12. Large log analysis - Target harvest ages

Target - Harvest at age 90 (PI - 65)																																
						Reference (12.5cm)				Target			Total		Largest 250		DBH class ¹															
Row #	Species	%inv	SI ²	Regime	Area	Space firm/to:	Cul Age	Cul Vol	Cul MAI	DBHg -all (0.0+)	Harv Age (12.5cm util)	MAI (12.5cm util)	LRF b7/m3	Vol (12.5cm util)	Trees -all (0.0+)	Vol (12.5cm util)	DBHg (12.5cm util)	0 - 10 cm		15 - 20 cm			25 - 30 cm				35+ cm				5m large log ³ .	
				spaced	no space													# trees	% tot trees	# trees	% tot trees	vol	% tot vol	# trees	% tot trees	vol	% tot vol	# trees	% tot trees	vol	% tot vol	
1	PI	60	18	360		nat9000/1600	78	292	3.74	20.5	65	3.58	203	233	1145	99	27.2	99	9	683	60	106	45	356	31	123	53	6	1	4	2	0.1
2	comparison					nat9000/unspaced	80	286	3.58	15.8	65	3.39	195	221	1959	91	25.1	769	39	992	51	147	67	195	10	73	33	2	0	2	1	N/A
3				220		nat5000/1300	82	285	3.48	22.0	65	3.26	207	212	928	104	28.8	71	8	462	50	71	33	373	40	128	60	22	2	14	7	0.2
4	comparison					nat5000/unspaced	79	286	3.62	17.2	65	3.45	195	224	1648	93	26.0	464	28	925	56	133	59	247	15	87	39	5	0	4	2	N/A
5	comparison					nat5000/900	89	289	3.25	24.8	65	2.99	215	194	675	112	30.4	18	3	229	34	37	19	387	57	133	69	40	6	24	12	N/A
6				140		plt3000/900	81	270	3.34	25.0	65	3.16	213	205	688	115	30.3	14	2	222	32	36	18	412	60	145	71	41	6	25	12	0.2
7				360		plt3000/unspaced	74	269	3.64	17.4	65	3.53	185	226	1673	92	25.7	421	25	1014	61	144	64	235	14	84	37	3	0	2	1	0.0
8				360		plt2000/unspaced	75	272	3.63	19.3	65	3.51	190	228	1339	94	26.6	177	13	853	64	122	54	302	23	102	45	6	0	3	1	0.0
9	Subtot.			720	720																											0.5
10	Fd/L	20	16	240		plt3000/1200	129	298	2.31	20.1	90	2.12	195	190	878	109	26.9	130	15	478	54	81	43	264	30	105	55	6	1	5	3	0.1
11	comparison					plt3000/unspaced	126	295	2.34	15.6	90	2.17	181	195	1669	98	25.1	735	44	747	45	120	62	185	11	75	38	2	0	1	1	N/A
12	comparison					plt3000/900	132	298	2.26	22.2	90	2.03	203	183	673	114	27.7	44	7	322	48	57	31	297	44	118	64	9	1	6	3	N/A
13				240		plt1600/unspaced	130	296	2.28	18.2	90	2.09	190	188	1117	99	25.7	238	21	674	60	107	57	198	18	76	40	8	1	6	3	0.1
14	Subtot.			240	240																											
15	Sw,BI ⁴	20	15	240		plt3000/1200	118	388	3.29	23.6	90	2.94	217	265	898	143	31.7	48	5	413	46	68	26	367	41	144	54	71	8	52	20	0.5
16	comparison					plt3000/unspaced	106	356	3.36	18.6	90	3.13	193	282	1623	120	28.3	332	20	960	59	143	51	312	19	169	60	20	1	15	5	N/A
17				240		plt1600/unspaced	114	384	3.37	21.5	90	3.04	207	274	1168	127	29.9	85	7	659	56	102	37	391	33	147	54	33	3	26	9	0.2
18	Subtot.			240	240																											
19																																
20	Total			1200	1200																											0.9
¹ Actual ranges are 0 - 12.5 cm, 12.6 - 22.5 cm, 22.6 - 32.5, and 32.6 + cm																																
² From Martin, 1999. <i>ISIS Polygon Area by Site Index Class</i>																																
³ 1st 5 m log assumed to be 25% of tree volume. Volume calculated is a % of total harvest volume based on proportion of annual harvested area under a particular regime, not a % of stand volume.																																
⁴ Modeled as all planted Sw due to TIPSy limitations.																																

7.4 Timber Quality Forecast

The foregoing analysis indicates the premium log content of harvests in the mid and long-term will be lower than today's levels. In the absence of a more precise analysis, it is assumed that premium log content will fall to about 1% in the later mid-term and recover to about 5% in the long-term. Contributions from partially harvested areas may increase these estimates slightly. Data for the current local percentage of harvest that is in premium logs is not available, but could readily be obtained from local sawmills. In the interim it is assumed to be about 15%, the figure used in the provincial interim strategy document (MoF, 1999).

Postponing harvest to ages that are past culmination age would increase the large dimension component of premium logs.

Clear logs produced from a first lift pruning program of 200 ha/yr could form about 1% of future harvest volumes. Most clear logs will also be large logs.

8. Opportunities to Improve Habitat Supply

8.1 Issues Regarding Habitat Supply and Biodiversity

Since forest habitat is also wildlife habitat, all silviculture strategies and forest practices outlined in this report have significant impacts on wildlife habitat supply. Present silviculture practices determine the density and diversity of many wildlife species in the future.

The following are silviculture strategy issues regarding wildlife habitat supply and biodiversity:

1. Maintenance of diverse structures and functions (natural conditions) is critical for survival of endemic wildlife species.
2. Changing tree species, seral stages, patch sizes and disturbance patterns also changes the density, distribution and connectivity of forest dependent wildlife species. These biodiversity characteristics can be partially achieved by silviculture practices listed in the next section. Silviculture practices can be planned at the landscape level to enhance wildlife habitat.
3. Lodgepole pine stands are not biologically diverse. If silviculture strategies can change the species mixture, structure, density and distribution, biodiversity will be enhanced. It may be beneficial to harvest younger seral stage lodgepole pine stands to avoid mountain pine beetle outbreaks, as long as these stands are reforested in clumps and mixtures.
4. Planting tree species in clumps, as well as in mixtures and increasing voids, imitates natural biodiversity. Planting climatic climax tree species instead of lodgepole pine provides for more suitable old growth stands in the future. Planting blister rust resistant white pine, whitebark pine and ponderosa pine, where suitable, also increases biodiversity.
5. In class 1 and 2 grizzly bear habitat, lower silviculture stocking standards, which promote soapberries and huckleberries, improves grizzly bear habitat.

8.2 Opportunities for Utilizing Silviculture Activities to Mitigate Habitat Supply Problems and Enhance Habitat Quality

Silviculture activities, which are properly planned to achieve biodiversity and old growth objectives, can enhance wildlife habitat supply. Each silviculture activity affects stand-level biodiversity attributes but activities properly planned over time and large areas also improves wildlife habitat at the landscape level.

For landscapes with greater diversity over many stands (variety of ages, species, density and coarse woody debris attributes), there is a greater amount of flexibility for future resource management. Silviculture activities for this strategy could be planned to provide a variety of ages, stand and coarse woody debris densities and species within biodiversity objectives to provide this resource management flexibility.

Silviculture activities can enhance both habitat and timber supply. This strategy primarily outlines future silviculture activities to enhance timber supply, but strategies can also be developed to enhance wildlife habitat (refer to section 8.3).

In areas where producing non-timber resources are the primary objective (high biodiversity emphasis option areas, riparian management areas, wildlife habitat areas, sensitive areas, reserves) silviculture treatment regimes can be designed to enhance habitat. For example:

- For future wildlife corridors and wildlife tree patches planned for the mid and long-term, spacing fertilization and thinning treatments will decrease the amount of time to achieve stand maturity and old growth objectives, provided spacing slash does not cause impediments to wildlife travel.
- Clumpy initial densities or clumpy spacing (voids) can enhance stand diversity and ungulate or grizzly habitat (increased forage, thermal cover, protection).
- Late successional tree species (planting, spacing or thinning) more suitable to wildlife habitat can be favoured.
- Fertilized ecosystems can increase amount and quality of browse and forage.

In areas zoned for Integrated Resource Management, high biodiversity emphasis options, the following silviculture treatment regimes can be planned to enhance stand level biodiversity:

- Clumpy spacing, larger voids
- Retain large live conifers and snags, if available
- Fall some snags for coarse woody debris during spacing,
- Use silvicultural systems to promote multi-layers (selection systems, irregular shelterwood)
- Promote openings for berries, willow and red-osier dogwood (increased browse and forage)
- Regeneration and spacing should promote a mixture of species, especially the inclusion of deciduous species.
- Vary stand density over the landscape.

The above are general strategies to enhance wildlife habitat and can be incorporated into the planned treatment regimes for this silviculture strategy. Refer to the next section for specific silviculture strategies to enhance habitat supply/biodiversity.

8.3 Silviculture Strategies to Enhance Habitat Supply/Biodiversity

The following regimes (Table 13) have been identified for this silviculture strategy to enhance wildlife habitat.

Table 13: Silviculture Strategies to Enhance Wildlife Habitat

Strategy Number	Potential Strategy/Action	Discussion/Current Status	Anticipated Result
H1. (Mid and long-term)	Clumpy planting in Low BEO, NDT 4, second growth stands (scenario 7 in the data package)	This produces a more variable habitat for the benefit of wildlife where dense canopies are available for thermal cover and protection and openings are provided for forage and feeding.	Future timber yields are reduced as a result of this regime
H2. (Mid and long-term)	Increase in the proportion of stand voids in NDT3 and on drier sites of MSdk and ESSF in second growth stands (scenario 8 in the data package).	Operational Adjustment Factors were increased from 15% to 20% to promote the occurrence of berry patches and shrub areas. This produces a more variable habitat for the benefit of wildlife where dense canopies are available for thermal cover and protection and openings are provided for forage and feeding.	Future timber yields are reduced as a result of this regime.

9. Preferred Silviculture Program

This section synthesizes the preceding background information into an incremental silviculture strategy for the Cranbrook TSA.

9.1 Working Target for Timber Quantity

The base case of TSR2 shows that an annual harvest level of 838 000 cubic metres can be maintained for the next 13 decades, without causing severe timber supply shortages in the future. After 130 years, for the next 5 decades, the harvest level would drop to 754 000 cubic metres and would rise in decade 20 to a long-term level of 883 000 cubic metres. This base case presents a higher forecast of timber supply than the previous analysis (TSR1) completed in 1995.

However, for this silviculture strategy, a more realistic base case is being used (referred to as the hypothetical silviculture planning forecast) which was described on page 50 of the TSR2 Rationale for AAC Determination. In the TSR2 Rationale, concern was expressed that when various sensitivity factors are analyzed in combination, they may impact the timber supply after the second decade. The results of this sensitivity analysis (refer to section 3.1) indicate that the base case harvest level can be maintained for 20 years before starting a series of declines to a long-term harvest level of 776 000 cubic metres per year. The silviculture strategy should therefore address shortages in mid and long-term timber supply. Shortages are more acute during the mid-term because harvest levels normally rise out of a mid-term dip when harvesting is largely in managed stands. Since harvest levels for the short-term (20 years) can be maintained, short-term treatment regimes are not required to maintain harvest levels for the next 20 years.

The hypothetical silviculture planning forecast shows that a mid-term harvest shortfall will occur between 20 and 100 years and there is not sufficient older forest to span the time until managed 2nd growth stands become available for harvest. Also, the regeneration assumptions in the yield tables used for the TSR2 base case and the hypothetical silviculture planning forecast assumed an annual juvenile spacing program of 1 300 ha. Therefore, to at least maintain the silviculture planning forecast used for this silviculture strategy and to mitigate mid-term harvest shortfalls, a silviculture strategy of annually spacing 1 300 ha should be started immediately. Approximately 400 ha are currently being spaced each year.

A mid-term objective, therefore, is to increase the quantity of the timber to be available for harvesting in this time period. Programs of spacing, and fertilization can accomplish this. The working target is to generate an additional 1.13 million m³ to mid-term timber supply.

In the long-term, starting about 100 years from now, various analyses indicate improved estimates of the productivity of forestland as well as silvicultural activities can result in harvest levels of at least equal to if not greater than current levels. A long-term objective is to maximize timber production within a context of sound multiple resource stewardship. Analysis indicates that silvicultural activities can contribute significantly to this objective. The working target is to increase the long-term timber supply by at least 16%.

Accomplishing these objectives requires an incremental silviculture program substantially above historic levels. Some changes in basic silviculture activities also present opportunities to contribute to the objectives.

9.2 Working Target for Timber Quality

Table 14: Product Objectives at the Log Level for the Cranbrook TSA

Quality Class	Species	Characteristics
Premium Log:	All	32.5+ cm minimum average stand diameter at breast height (DBH).
Sawlog:	All	27.5+ cm minimum average stand DBH.

9.3 Silviculture Strategies to Support Timber Quantity and Quality and Wildlife Habitat Objectives

The following strategies in Table 15 have identified potential to maintain and/or increase the quantity and quality of the timber and habitat supply of the Cranbrook TSA. Strategy numbers correspond with those recorded earlier. Some of the following are not within the traditional scope of incremental silviculture but are included here for completeness.

Table 15: Strategies to Maintain/Increase Timber and Habitat Supply

Timber Quantity

No.	Strategy	Priority
Database record-keeping	Carry out an annual program of maintaining a database (record keeping) to record all achieved strategies.	1
Surveys	Conduct approximately 18 000 ha/yr of silviculture surveys in support of all strategies.	2

SHORT TERM: FOR TIMBER QUALITY, THERE ARE NO OBJECTIVES, WORKING TARGETS OR STRATEGIES FOR THE SHORT-TERM

MID-TERM

Objectives:

- Increase the quantity of timber to be available for harvesting.

Working Targets:

- Generate an additional 1.13 million m³ to mid-term timber supply, which equates to:
 - An additional 14 085 cubic metres/year of AAC and increases the mid-term harvesting level from 700 000 to 714 000 cubic metres/year (2% increase).

Strategies:

MT1	Late rotation repeat fertilization cycle over an 80yr period of 80% of existing spaced stands (17 000 ha) at 1 700 ha/yr to produce approximately an additional 767 000 m³ to mid-term timber supply.	6
MT2	Spacing and repeat fertilization cycle of new stands over 80 yr period to: <ol style="list-style-type: none"> 1) Reduce minimum harvest ages of younger existing stands by 10 years in new stands, and coincidentally improve the timber quality 	
(b1)	Spacing 600 ha of stands harvested before 1987 having a stocking level > 6 000 sph at the rate of 200 ha/yr for 3 years.	5
(b2)	Spacing stands harvested after 1987 having a stocking level > 6 000 sph at the rate of 1 000 ha/ yr.	5
(c)	Fertilizing 533 ha/yr of newly spaced stands on a 15 year repeat cycle to produce approximately an additional 360 000 m³ to mid-term timber supply.	6

LONG-TERM**Objectives:**

- Maximize long-term timber production within a context of sound multiple resource stewardship.

Working Targets:

-
- Generate an additional 18.97 million m³ to long-term timber supply, which equates to:
 - An additional 126 488 cubic metres/year of AAC and increases the MT harvesting level from 776 000 to 902 500 cubic metres/year (16.3% increase)

Strategies:

LT1	Maintain the timber harvesting land base by:	
(a)	Treating approximately 1 250 ha of backlog NSR.	4
(b)	Maintaining approximately 1 300 ha of previously reforested backlog plantations.	4
(c)	Surveying 4 000 ha/yr of pre-1987 SR area to ensure they remain fully stocked.	9
LT2	Increase the timber harvesting land base by 2.9% by:	
(b1)	Rehabilitating 12 500 ha of non-merch PI stands at the rate of 500 ha/yr.	8
(b2)	Surveying 20 000 ha of problem forest type areas at the rate of 4 000 ha/yr for 5 years.	7
LT3	Increase the volume of regenerated stands by 13% by:	
(b)	Expanding the use of improved seed by 2007 to include PI, with the expected result of a 6.6% gain in LTHL.	3
(h)	Repeat fertilizing 1 700 ha/yr, rising gradually over about 60 years to 9 800 ha/yr as more stands come under management, for an expected result of a 6.8% gain in LTHL. (Note: The initial 1 700 ha/yr are the same stands as in M1. This rises to an additional 1 670 ha/yr under MT2 (c).)	6

Timber Quality (Long-Term)**Objectives:**

- Improve the quality of the timber to be harvested.

Working Targets:

- Generate at least 5% of total harvest volume in premium large logs (no current silviculture strategy implications).
- Generate at least 1% of total harvest volume in clear premium logs (clear logs will generally also be large logs).

Strategies:

No.	Strategy	Priority
Q1	Adjust minimum harvest age so the majority of stands have an average diameter of 27.5 cm	10
Q2	Space stands as per MT2(b)	5
Q3	First-lift pruning 200 ha/yr	10

Wildlife Habitat (Mid and Long-Term)**Objectives:**

- For the mid and long-term, improve the quality of wildlife habitat.

Working Targets:

- For the mid and long-term, provide a variety of habitat types by creating clumps and voids in low BEO NDT 4 areas, and NDT3 areas and drier sites of MSdk and ESSF second growth stands.

Strategies:

No.	Strategy	Priority
H1	Clumpy planting in Low BEO, NDT 4, second growth stands	10
H2	5% Increase in the proportion of stand voids in NDT3 and on drier sites of MSdk and ESSF in second growth stands	10

9.3.1 Silviculture Regimes and Investment Priorities

The following 3 tables provide an analysis of incremental silviculture regimes, which are suitable to achieve the above working targets and strategies.

Table 16: Incremental Silviculture Regimes, Which Achieve Working Targets and Strategies

Regimes	Strategy	Opportunity Area (Ha)	Opportunity Area (Ha/Yr)
1. Database record-keeping		Yearly Program	
2. Surveys (general)		Yearly Program	18 000
Surveys – PFT	LT2b	20 000	4 000/5 yr
Surveys – Pre 1987 SR	LT1c	Yearly Program	4 000
3. Backlog Reforestation	LT1a	1 250	400/3 yr
4. Backlog Brushing	LT1b	1 300	250/5 yr
5. Rehab PFT	LT2b	12 500	500/25 yr
6. Improved Seed	LT3b	Yearly Program	1 440
7. Space > 6000 existing SPH	MT2b	Yearly Program	1 000 (1 300)
8. Repeat Fertilization	LT3h, MT1, MT2c	Yearly Program	1 700-9 800
9. Pruning 1 st Lift	Q3	Yearly Program	200
10. Clumpy Planting/Increase Voids	H1, H2	Yearly Program	400

Table 17: Incremental Silviculture Strategy Effects on Timber and Habitat Supply and Timber Quality

Regimes	Short-Term Timber Supply	Mid-Term Timber Supply	Long-Term Timber Supply	Timber Quality	Habitat Supply
1. Database Record-keeping					
2. Surveys (general)					
Surveys – PFT					
Surveys – Pre 1987 SR					
3. Backlog Reforestation		++	+++		+/-
4. Backlog Brushing		++	+++		+/-
5. Rehab PFT	-	++	+++		+/-
6. Improved Seed		+	++		
7. Space > 6000 existing SPH		+++		+	+
8. Repeat Fertilization		+++	++		+
9. Pruning 1 st Lift				+++	
10. Clumpy Planting/Increase Voids		-	--	+/-	++

Table 18: Incremental Silviculture Strategy Investment Priorities

Regimes	Jobs Days/Ha	Cost \$/Ha	Priority Ranking
1. Database record-keeping			1
2. Surveys (general)	0.1	20	2
Surveys – PFT	0.3	60	7
Surveys – Pre 1987 SR	0.1	20	9
3. Backlog Reforestation	3	1 500	4
4. Backlog Brushing	2.5	600	4

Regimes	Jobs Days/Ha	Cost \$/Ha	Priority Ranking
5. Rehab PFT	3	2 000	8
6. Improved Seed	0	70	3
7. Space > 6000 existing SPH	2	500	5
8. Repeat Fertilization	0.02	200	6
9. Pruning 1 st Lift	4	800	10
10. Clumpy Planting/Increase Voids	2	1 200	10

9.4 Five-Year Incremental Silviculture Program

The following annual program, in Tables 19 and 20, will contribute to achieving the above goals and strategies. This program is considerably above historic levels and some activities may require phasing-in.

Table 19: Annual Program – Ha, Cranbrook TSA

Year	Surveys ²	Backlog		Rehab PFT	Improved Seed	Space	Fertilize	Prune	Clumpy Planting	Total
		Reforest	Brushing							
1	18 000	450	500	500	1 440	1 500	3 370	200	400	26 360
2	14 870	400	400	500	1 440	1 500	3 540	200	400	23 250
3	15 040	400	400	500	1 440	1 500	3 710	200	400	23 590
4	17 560	-	-	500	1 440	1 300	3 880	200	400	25 280
5	17 730	-	-	500	1 440	1 300	4 050	200	400	25 620
Subtot, Yr 1-5	83 200	1 250	1300	2 500	7 200	7 100	18 550	1 000	2 000	124 100
6-10	76 300	-	-	2 500	7 200	6 500	22 800	1 000	2 000	118 300
Total Yr 1-10	159 500	1 250	1300	5 000	14 400	13 600	41 350	2 000	4 000	242 400

Table 20: Annual Program - \$ 000s, Cranbrook TSA

Year	Surveys	Backlog		Rehab PFT	Improved Seed	Space	Fertilize	Prune	Clumpy Planting	Total
		Reforest	Brushing							
1	465	675	300	1 000	101	750	1 781	160	120	5 352
2	384	600	240	1 000	101	750	1 871	160	120	5 226
3	389	600	240	1 000	101	750	1 961	160	120	5 321
4	454	-	-	1 000	101	650	2 051	160	120	4 535
5	458	-	-	1 000	101	650	2 141	160	120	4 630
Subtot, Yr 1-5	2 150	1 875	780	5 000	504	3 550	9 805	800	600	25 064
6-10	1 972	-	-	5 000	504	3 250	12 051	800	600	24 177
Total Yr 1-10	4 122	1 875	780	10 000	1 008	6 800	21 856	1 600	1 200	49 241

9.5 Job Outcomes, Income and Revenue

Tables 21 to 24 outline the anticipated job outcomes, income and revenue associated with the preceding program, assuming the program is maintained into the future as necessary to achieve the working targets.

Table 21: Short Term Employment Associated with Undertaking the Silviculture Activity, in Person Years, Cranbrook TSA

Year	Surveys	Backlog		Rehab PFT	Improved Seed	Space	Fertilize	Prune	Clumpy Planting	Total
		Reforest	Brushing							
1	11.7	6.8	6.2	7.5	-	12.9	0.4	4.0	2.9	52.4
2	9.6	6.0	5.0	7.5	-	12.9	0.4	4.0	2.9	48.3

² Includes all types of silviculture surveys to support this strategy. Assumes surveying backlog and plantation maintenance areas every 3 years.

Year	Surveys	Backlog		Rehab PFT	Improved Seed	Space	Fertilize	Prune	Clumpy Planting	Total
		Reforest	Brushing							
3	9.7	6.0	5.0	7.5	-	12.9	0.4	4.0	2.9	48.4
4	11.4	-	-	7.5	-	11.2	0.4	4.0	2.9	37.4
5	11.5	-	-	7.5	-	11.2	0.4	4.0	2.9	37.5
Subtot, Yr 1-5	53.9	18.8	16.2	37.5	-	61.1	2.0	20.0	14.5	224.0
6-10	49.4	-	-	37.5	-	56.0	2.4	20.0	14.5	179.8
Total Yr 1-10	103.3	18.8	16.2	75.0	-	117.1	4.4	40.0	29.0	403.8

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

Table 22: Yearly Income Associated with Undertaking the Silviculture Activity - \$ 000s, Cranbrook TSA³

Year	Surveys	Backlog		Rehab PFT	Improved Seed	Space	Fertilize	Prune	Clumpy Planting	Total
		Reforest	Brushing							
1	293	170	155	188	-	323	10	100	73	1 312
2	240	150	125	188	-	323	10	100	73	1 209
3	243	150	125	188	-	323	10	100	73	1 212
4	285	-	-	188	-	280	10	100	73	936
5	288	-	-	188	-	280	10	100	73	939
Subtot, Yr 1-5	1 349	470	405	940	-	1 529	50	500	365	5 608
6-10	1 235	-	-	940	-	1 400	60	500	365	4 500
Total Yr 1-10	2 584	470	405	1 880	-	2 929	110	1 000	730	10 108

Table 23: Long Term Employment Associated with Improved Quality and Quantity of the Timber Resource⁴

Decade	Decade Harvest Increment ('000 m ³)	Incremental Jobs/Yr Region ⁵	Incremental Jobs/Decade Region	Total employment Revenue/yr (\$'000)	Total employment Revenue/Decade (\$'000)
1	0	0	0	\$ -	\$ -
2	0	0	0	\$ -	\$ -
3	141	55.4	554	1 385	13 850
4	141	55.4	554	1 385	13 850
5	141	55.4	554	1 385	13 850
6	141	55.4	554	1 385	13 850
7	141	55.4	554	1 385	13 850
8	141	55.4	554	1 385	13 850
9	141	55.4	554	1 385	13 850
10	141	55.4	554	1 385	13 850
11	1 265	497	4 971	12 425	124 275
12	1 265	497	4 971	12 425	124 275
13	1 265	497	4 971	12 425	124 275
14	1 265	497	4 971	12 425	124 275
15	1 265	497	4 971	12 425	124 275
16	1 265	497	4 971	12 425	124 275
17	1 265	497	4 971	12 425	124 275

³ Assumes 200 days = 1 person year = \$25 000

⁴ Assumes continuation of the silviculture program beyond the first 10 years, in accordance with the strategy. The total harvest increment is associated with all the silvicultural practices documented in Section 9.3.

⁵ Assumes 3.93 TSA level direct, indirect and induced (Pys) jobs (harvesting, silviculture, processing) per 1000 m³. (Source: TFL 23 MP #9 Timber Supply Analysis Report, p. 39)

Decade	Decade Harvest Increment ('000 m ³)	Incremental Jobs/Yr Region ⁵	Incremental Jobs/Decade Region	Total employment Revenue/yr (\$'000)	Total employment Revenue/Decade (\$'000)
18	1 265	497	4 971	12 425	124 275
19	1 265	497	4 971	12 425	124 275
20	1 265	497	4 971	12 425	124 275
21	1 265	497	4 971	12 425	124 275
22	1 265	497	4 971	12 425	124 275
23	1 265	497	4 971	12 425	124 275
24	1 265	497	4 971	12 425	124 275
25	1 265	497	4 971	12 425	124 275
Total			78 997	197 455	1 974 925

Note: Includes direct, indirect and induced jobs.

Table 24: Future Additional Provincial Revenue Associated with Undertaking the Silviculture Strategy - \$000s, Cranbrook TSA

Decade	Stumpage Revenue/yr Region ⁶	Stumpage Revenue/Decade Region	Income Tax Revenue/Yr Region ⁷	Income Tax Revenue/Decade Region	Total Revenue/Decade Region
1	0	0	0	-	-
2	0	0	0	-	-
3	4 93	4 930	173	1 730	6 660
4	4 93	4 930	173	1 730	6 660
5	4 93	4 930	173	1 730	6 660
6	4 93	4 930	173	1 730	6 660
7	4 93	4 930	173	1 730	6 660
8	4 93	4 930	173	1 730	6 660
9	4 93	4 930	173	1 730	6 660
10	4 93	4 930	173	1 730	6 660
11	4 428	44 271	1 553	15 530	59 801
12	4 428	44 271	1 553	15 530	59 801
13	4 428	44 271	1 553	15 530	59 801
14	4 428	44 271	1 553	15 530	59 801
15	4 428	44 271	1 553	15 530	59 801
16	4 428	44 271	1 553	15 530	59 801
17	4 428	44 271	1 553	15 530	59 801
18	4 428	44 271	1 553	15 530	59 801
19	4 428	44 271	1 553	15 530	59 801
20	4 428	44 271	1 553	15 530	59 801
21	4 428	44 271	1 553	15 530	59 801
22	4 428	44 271	1 553	15 530	59 801
23	4 428	44 271	1 553	15 530	59 801
24	4 428	44 271	1 553	15 530	59 801
25	4 428	44 271	1 553	15 530	59 801
Total		703 505		246 790	950 295

⁶ Based on a stumpage rate of \$35/m³ times the harvest increment.

⁷ Based on a 12.5% tax rate.

Table 25: Future Additional Federal Revenue Associated with Undertaking the Silviculture Strategy - \$ 000s, Cranbrook TSA

Decade	Income Tax Revenue/Yr Region ⁸	Income Tax Revenue/Decade Region
1	0	0
2	0	0
3	346	3 460
4	346	3 460
5	346	3 460
6	346	3 460
7	346	3 460
8	346	3 460
9	346	3 460
10	346	3 460
11	3 106	31 060
12	3 106	31 060
13	3 106	31 060
14	3 106	31 060
15	3 106	31 060
16	3 106	31 060
17	3 106	31 060
18	3 106	31 060
19	3 106	31 060
20	3 106	31 060
21	3 106	31 060
22	3 106	31 060
23	3 106	31 060
24	3 106	31 060
25	3 106	31 060
Total		493 580

⁸ Based on a 25% tax rate.

10. Summary of Information and Research Needs

The following needs for further information and research became apparent during preparation of this silviculture strategy. The outcome of these have implications for an incremental silviculture strategy. Bracketed numbers refer to the strategy numbers under which the need is identified (see tables in Section 6.2, “Review of Potential Silviculture Strategies”).

1. Further examine the impacts/potential of spacing to determine which are the most cost-effective treatments (what landscape units, sites, species). (MT2(b))
2. Examine grizzly bear and ungulate winter range impacts and opportunities. (MT3, H1, H2)
3. Undertake operational partial harvesting and commercial thinning trials, so that the necessary growth and yield information will be available when the managed stands become suitable. (MT4)
4. Examine excluded areas for opportunities to bring into the THLB through rehabilitation or reclassification. (LT2)
5. Lobby for more and better-improved seed. (LT3(b))
6. Examine seed planning zone guidelines for opportunities for modification to expand improved seed into the East Kootenays. (LT3(b))
7. Complete surveys for voids to get a measure of the actual area in voids. (LT3(c), H1, H2)
8. Survey and assess backlog sites to get better information on stocking distribution into voids and clumps, together with their potential for fill planting the void areas and spacing the clumpy areas. (LT3(c), H1, H2)
9. Improve information on the # of years for trees to reach breast height. (LT3(d))
10. Evaluate the potential for spacing to increase long-term harvest levels under Type II silviculture analysis. (LT3(g))
11. Fertilization trials are needed to determine if the fertilizable land base should include spruce and larch species. (LT3(h))
12. Further study of root rot management and to confirm the OAF2 factor. (LT4)

In addition, the Rationale for AAC Determination for TSR2 provides the following recommendations:

- Evaluate and implement strategies for harvesting of difficult terrain, if the areas are to continue to contribute to the timber supply;
- Continue landscape unit planning to ensure that future timber supply reviews can reflect more accurate timber supply impacts;
- Include considerations for whitebark pine when determining retention areas for biodiversity;
- Work with Headquarters staff to determine harvest sequence rules that more closely approximate current practice;
- Confirm that appropriate areas of backlog NSR are being excluded from the timber harvesting land base;
- Refine information regarding management of the recreation resource for future timber supply reviews; and
- Monitor the level of harvesting within the partitions.

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12. Abbreviations

The following abbreviations are used in this report.

AAC	allowable annual cut	MAI	mean annual increment
BEO	biodiversity emphasis option	Merch	merchantable
CFD	Cranbrook Forest District	MoF	Ministry of Forests
Cm	centimetres	MP	management plan
CMAI	culmination of mean annual increment	MSdk	montane spruce dry cool [biogeoclimatic (ecological) subzone]
CT	commercial thinning	MT	mid-term
DBH	diameter at breast height	Mu	management unit
ESSF	Engelmann spruce - subalpine fir [biogeoclimatic (ecological) zone]	Nat	natural
Fert	fertilization	NCC	non-commercial cover
FG	free growing	NDT	natural disturbance type
FMER	fire maintained ecosystem restoration	NSR	not satisfactorily restocked
FRBC	Forest Renewal BC	OAF	operational adjustment factor
GU	greenup	OGSI	old growth site index
Ha	hectares	PFT	problem forest type
Hts	heights	pl	planted
IRM	integrated resource management	Pys	person years
ISIS	integrated silviculture information system	RLUPS	regional landscape unit planning system
KBLUP	Kootenay-Boundary Land Use Plan	SBFEP	small business forest enterprise program
KBLUP-IS	Kootenay-Boundary Land Use Plan Implementation Strategy	SI	site index
LT	long-term	SPH	stems per hectare
LTHL	long-term harvest level	SR	satisfactorily restocked
LU	landscape unit	ST	short-term
M ³	cubic metres	TFL	tree farm licence
M	metres	THLB	timber harvesting land base

TIPSY	table interpolation program for stand yields	Vol	volume
		W	west
TSA	timber supply area	WTP	wildlife tree patch
TSR	timber supply review	Yr	year
VDYP	variable density yield projection		

Species abbreviations: Bl - subalpine fir; Cw - western redcedar; Fd - Douglas-fir; Fdi - interior Douglas-fir; Hw - western hemlock; Lw – western larch; L – larch; Pl - lodgepole pine; Se – Engelmann spruce; S - spruce species; Sx – hybrid spruce; Sw – white spruce

