

Revelstoke Timber Supply Area

Interim Silviculture Strategy

-- Version 1.2 --

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British Columbia
Ministry of Forests

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Forest Renewal BC

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STRATEGY AT A GLANCE

Purpose

This strategy 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.

Objectives

The primary objectives of the silviculture strategy are to:

- increase regenerated stand volumes by 7%;
- space 5 000 ha of stands in the harvest queue for decades 8 and 9 to ensure they will be of merchantable size at that time;
- research the desired stand characteristics for caribou lichen forage production in order to determine the need and opportunity, if any, for silvicultural management of stands for this purpose; and
- partially offset anticipated future lower log quality by pruning 50 ha/yr of suitable young stands (the requirements for significant areas to be in an older forest condition will also contribute to higher quality future stands).

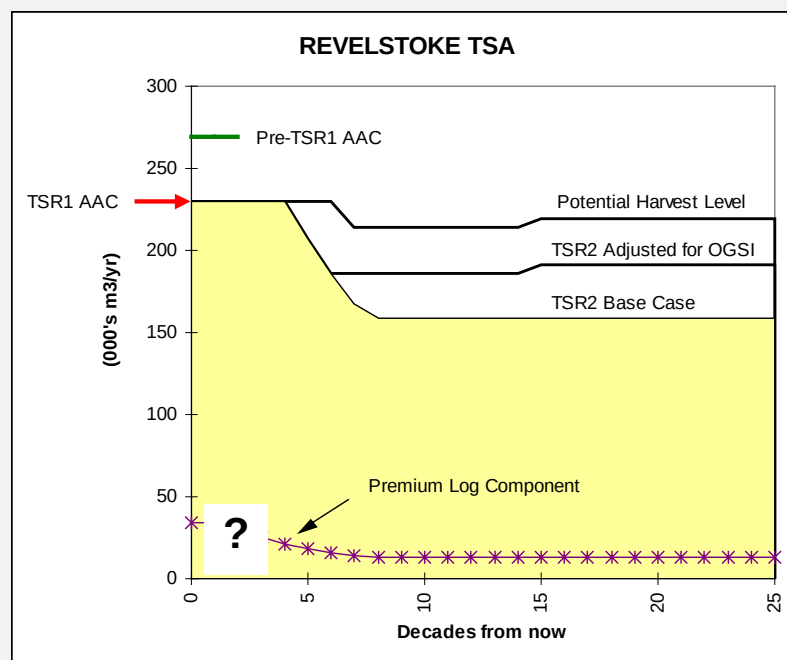
Accomplishing these objectives requires a program substantially above historic levels.

Working Targets

Quantity: Manage long term timber supply to yield a harvest of 0.22 million m³/yr.

Quality: Manage regenerated stands to yield at least 6% (by volume) premium large logs having a 2.5% clear log component, with the majority of the remainder being of sawlog quality.

The following chart illustrates the above working targets. They represent the plausible high end of the potential of the timber resource relative to the TSR2 base case. Changes to the base case would also effect changes to the potential forecast. These forecasts are interim and require confirmation through analysis and modeling.



Product Objectives

The following are product objectives at the log level for the Revelstoke TSA.

<u>Quality Class</u>	<u>Species</u>	<u>Characteristics</u>
Premium Log:	S	45+ cm minimum average stand diameter at breast height (DBH), some clear wood component.
	Hw, Cw	35+ cm minimum average stand DBH, some clear wood component.
Sawlog:	All	25+ cm minimum average stand DBH.

Major Silvicultural Strategies

The strategies listed below are those considered in the workshop and follow-up analysis to be appropriate towards achieving the working targets. Other strategies that were considered but found to have no opportunity area are documented in the report.

Timber Quantity

Some of the following are not within the traditional scope of incremental silviculture but are included here for completeness. Some practices are pre free-growing and are not likely to be undertaken by licensees without funding assistance if free growing obligations can be achieved without them. (Increase - increase over the second timber supply review (TSR2) base case. Maintain - maintain TSR2 base case)

<u>No.</u>	<u>Strategy</u>	<u>Priority</u>
General	Conduct silviculture surveys in support of all strategies.	1

Short Term

There are no strategies to increase the quantity of timber in the short term.

Mid Term

MT2	(See "Summary of Information and Research Needs.")	
MT4	Ensure stands at the beginning of the long term harvest queue (decades 8 & 9) are available by spacing 5 000 ha of dense hemlock/cedar stands over 10 years.	4

Long Term

LT1	Maintain the timber harvesting land base by:	
	(a) Treating approximately 200 ha of backlog NSR.	3
	(b) Maintaining approximately 400 ha of previously reforested backlog plantations.	2

- LT2 Survey 1 600 ha of deciduous stands to determine their potential and suitable silviculture treatments.
- LT3 Increase the volume of regenerated stands by 7% by:
- i) using improved seed as available (currently available for 80% of spruce stock); (increase) 2
 - iii) using larger planting stock on approximately 20% of areas; (increase) 7
 - iv) fertilizing approximately 80% of trees at the time of planting; (increase) 5
[does not match workshop writeup]
 - v) brushing 400 ha/yr for growth enhancement (i.e., not only for survival); (increase) and 6
 - vii) repeat fertilize 450 ha/yr on a 15 yr return cycle. 8
- LT4 Continue MT 2 as appropriate.

Timber Quality

<u>No.</u>	<u>Strategy</u>	<u>Priority</u>
Q1	Prune 25 ha/yr to 5.5 m in two lifts (requires a program of 50 ha/yr) to create knot-free timber in the bottom 5.0 m log.	4

*Silviculture
Regimes &
Investment
Priorities*

Incremental Silviculture Program

The following annualized program will contribute to achieving the above goals and strategies. This program is considerably above historic levels and some activities may require phasing in. However, it does not include activities that may be required for caribou habitat management (pending research results). Spacing and pruning goals represent an anticipated upper bound. Lesser program levels should be oriented to specific target stands as shown in the regime table.

Program Table - Ha, Revelstoke TSA, March 1999 (not including Pre-FTG activities)

Year	Surveys*	Backlog Site Prep	Backlog Planting	Backlog Brushing	Space	Prune	Fertilize
1	3,600	100	100	400	500	50	450
2	3,600	-	100	300	500	50	450
3	3,600	-	-	200	500	50	450
4	3,600	-	-	200	500	50	450
5	3,600	-	-	100	500	50	450
Subtot Yr 1 - 5	18,000		200	1,200	2,500	250	2,250
6 - 10	18,000	-	-	150	2,500	250	2,250
Total Yr 1 - 10	36,000		200	1,350	5,000	500	4,500
* Includes prescription and layout							
Unit cost (\$/ha)	25	800	400	500	800	800	250

Program Table - \$ 000s, Revelstoke TSA, March 1999 (not including Pre-FTG activities)

Year	Surveys*	Backlog Site Prep	Backlog Planting	Backlog Brushing	Space	Prune	Fertilize	Total
1	90	80	40	200	400	40	113	963
2	90	-	40	150	400	40	113	833
3	90	-	-	100	400	40	113	743
4	90	-	-	100	400	40	113	743
5	90	-	-	50	400	40	113	693
Subtot Yr 1 - 5	450	80	80	600	2,000	200	563	3,973
6 - 10	450	-	-	75	2,000	200	563	3,288
Total Yr 1 - 10	900	80	80	675	4,000	400	1,125	7,260

Job Creation The following are the anticipated job outcomes associated with the preceding program, assuming the program is maintained into the future as necessary to achieve the working targets. The long term jobs table includes the potential harvest increment associated with caribou habitat management on the basis that either the habitat requirements will prove (through research conducted under this strategy) to be either currently over-stated or if not, to be achievable at younger stand ages through silvicultural treatments.

Program Job Outcomes, Revelstoke TSA, March 1999 (not including Pre-FTG activities)

Short term employment associated with undertaking the silviculture activity, in person years

Year	Surveys [*]	Backlog Site Prep	Backlog Planting	Backlog Brushing	Space	Prune	Fertilize	Total
1	1.80	0.50	0.50	3.00	6.25	1.00	0.23	13.28
2	1.80	-	0.50	2.25	6.25	1.00	0.23	12.03
3	1.80	-	-	1.50	6.25	1.00	0.23	10.78
4	1.80	-	-	1.50	6.25	1.00	0.23	10.78
5	1.80	-	-	0.75	6.25	1.00	0.23	10.03
Subtot Yr 1 - 5	9.00	0.50	1.00	9.00	31.25	5.00	1.13	56.88
6 - 10	9.00	-	-	1.13	31.25	5.00	1.13	47.50
Total Yr 1 - 10	18.00	0.50	1.00	10.13	62.50	10.00	2.25	104.38

Note: Assumes 200 days of harvesting, silviculture work, and timber processing = 1 job (Source Revelstoke TSR2 SEA)

Long term employment associated with improved quality and quantity of the timber resource¹

Decade	Harvest Increment ('000 m3)	Incremental Jobs			
		per year by decade		Total by decade	
		TSA ²	Prov ³	TSA ²	Prov ³
1	-	-	-	-	-
2	-	-	-	-	-
3	-	-	-	-	-
4	-	-	-	-	-
5	23	32	65	320	646
6	44	61	124	612	1,236
7	28	39	79	389	787
8	28	39	79	389	787
9	28	39	79	389	787
10	28	39	79	389	787
11	28	39	79	389	787
12	28	39	79	389	787
13	28	39	79	389	787
14	28	39	79	389	787
15	28	39	79	389	787
16	28	39	79	389	787
17	28	39	79	389	787
18	28	39	79	389	787
19	28	39	79	389	787
20	28	39	79	389	787
21	28	39	79	389	787
22	28	39	79	389	787
23	28	39	79	389	787
24	28	39	79	389	787
25	28	39	79	389	787
Total				8,326	16,832

Notes:

1. Assumes continuation of on the incremental 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 the "Opportunities" section and is only partly attributable to spacing and fertilization practices. Some of the increase may be associated with pre-free growing silviculture that was not current practice at the time of TSR2.

2. Assumes 1.39 TSA level direct (harvesting, silviculture, processing), indirect and induced (PYs) per 1000 cubic metre (Source: Revelstoke TSR2 SEA Table 13, p

3. Assumes 2.81 Province level direct (harvesting, silviculture, processing), indirect and induced (PYs) per 1000 cubic metre (Source: Revelstoke TSR2 SEA Table 1

Further Research and Information Needs

During the assessment process, the following needs for further information and research became apparent. 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 “Workshop Review of Potential Strategies,” page 15).

Conduct the following research and assessments related to lichen forage production for caribou to determine if silvicultural actions can be beneficial: (MT2)

Research the desired stand characteristics for caribou lichen forage production and determine at what age they occur.

Conduct additional FSSIM modeling and analysis of the medium and high emphasis biodiversity constraints. It is unknown how the imposition of these biodiversity constraints might affect the results of the special caribou run and when the ages at which caribou constraints no longer become limiting.

If research indicates the desired stand characteristics do not occur unaided at desired younger ages (or if ages are older than currently modeled), design and apply silvicultural treatment regimes to create them. The extent of the benefit to the harvest forecast would depend upon the availability of treatable stands and the economics of silvicultural treatments. Conduct field analysis to locate these stands and determine the total opportunity.

TIPSY yields and diameters for older spruce stands require confirmation. (MT2)

Further analysis of suitability and effect of fertilizing young Fdi and Pl stands for the purpose of ensuring these stands are of merchantable size in 80-90 years is needed. (MT4)

A survey of deciduous stands is required to determine their potential and suitable silviculture treatments, if any. (LT2)

Fertilization trials are needed to determine if the fertilizable land base could be expanded to include spruce or hemlock. (LT3)

OAF 1 factor of 15% requires confirmation. Survey techniques are available. Requires statistical validity at the management unit level if to be used for AAC determination. (LT3)

Further study of root rot management techniques and options is needed. (LT5)

Old growth site index estimation studies require completion. It is anticipated that site indexes may be underestimated for Cw and Hw.

Introduction

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 limitations of time, budget and available information have tended to cause the focus in this first version of the strategy to be on the future quantity of the timber resource. 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 the optimization objective, the opportunity evaluation process recorded herein 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, and operational realities -- all of which were explored in general terms in the workshop -- potential treatment activities are ranked. The end result hopefully points to the most effective and efficient means of at least partially achieving the working targets. The degree to which the overall strategy ultimately proves appropriate and is achieved will also be the degree to which the expressed targets will be achieved. This, of course, 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)¹ 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. It is intended as an interim strategy until a more in-depth analysis-based review is completed.

Methodology

This strategy was prepared through the following process:

1. Prior to the district working session, L. P. Atherton & Associates prepared a preliminary draft of this document, summarizing all available information relevant to a strategy and identifying opportunities to improve the future quantity and quality of timber supply.
2. A district working session was held March 4 & 5, 1998 in Revelstoke, attended by representatives of the organizations and forest companies listed below. Larry Atherton of L. P. Atherton & Associates and Doug Williams of Cortex Consultants Inc. led the session. Participants reviewed the potential opportunities identified in the draft document along with others that arose. The outcome of the session was a regime table, complete with priorities.

¹ See "Abbreviations," page 43 for a full listing of abbreviations used.

3. The consultants incorporated the results of the working session into the draft document and added forecasts of future harvest quantity and quality and of job outcomes.
4. After ministry review, the consultants submitted a completed strategy document to the Ministry of Forests (MoF) in electronic format as version 1.2. (The ministry will assign higher version numbers (e.g., 1.3, 1.4, etc.) as the strategy evolves and changes are made.)

Acknowledgments

The participation of representatives of the following organizations at the district workshop is gratefully acknowledged.

Ministry of Forests:

- Columbia Forest District
- Nelson Forest Region

*Ministry of Environment,
Lands & Parks:*

- Habitat Protection Branch

Forest licensees of the Revelstoke TSA:

- Downie Street Sawmills
- Bell Pole Company

Representatives of Pope & Talbot Ltd. (TFL 23) also attended as observers and contributed to workshop discussions.

The project was directly managed by Ivan Listar of the Ministry of Forests, Nelson Forest Region. Funding was provided by Forest Renewal BC under a contract between the Ministry of Forests, Victoria (administered by Ralph Winter, Forest Practices Branch) and Cortex Consultants, Inc.

Higher Level Goals and Objectives

This section documents higher level goals and objectives relevant to a silviculture strategy for the TSA.

Provincial Goals

Fundamentally, government's goals can be characterized as:

- sustainable use;
- community stability; and
- a strong forest sector. (MoF, 1998a)

Provincial Objectives

Until provincial targets for timber quantity and quality are established, management unit strategies are to consider the following interim provincial strategic objectives (MoF, 1998a). Incremental silviculture strategies must also be in keeping with higher level plans under the Forest Practices Code.

- Objective 1:** Maintain current harvest levels as long as possible without creating disruptive short-falls in future timber supply.
- Objective 2:** Create a long term timber supply capable of supporting a steady long term provincial harvest level similar to current levels.
- Objective 3:** Minimize the interim shortfall in provincial harvest anticipated before a steady long term timber supply is achieved.
- Objective 4:** Create a long term timber supply which will enable the timber quality profile of future harvests to be the same or better than the current profile.

It is recognized that not every management unit has the same capability to contribute to these interim objectives. Further, it is recognized that these objectives may not be attainable at current funding levels. Their purpose is to provide general guidance to the application of available funds.

Regional Objectives

The region has not set out formal regional incremental silviculture objectives. In the interim, the provincial objectives are accepted as being broadly applicable within the region.

Higher Level Plans

Formal higher level plans are strategic plans defined by the Forest Practices Code, however, there are currently no approved higher level plans covering the Columbia Forest District. The Kootenay Boundary Land Use Plan has been approved but the decision whether to make it a higher level plan has not been finalized. Until that time it provides guidance for management practices.

There are other plans that exist at a higher level which are strategic (policies and guidelines), or operational that provide direction to any lower level of plans, prescriptions, or forest practices. These, however, are not higher level plans as defined under the Code.

Basic Data

Land Area

Description	Area (ha)	Area %
Total Area of TSA	501 500	100
Total Productive Crown Forest	221 500	44
Net Timber Harv. Land Base	67 700	13.5

Source: TSR2 analysis report - rounded to nearest 100 ha.

*TSR1 net THLB - 62 700 ha.

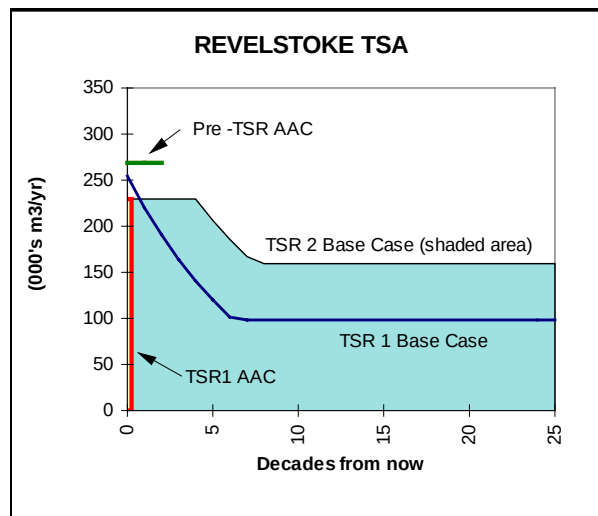
AAC

AAC Type	Pre-TSR	TSR1*	Change (%)
Conventional	269 000	230 000	-14.5
Deciduous	-	-	-
Insect/Disease	-	-	-
Marginal	-	-	-
Total	269 000	230 000	-14.5

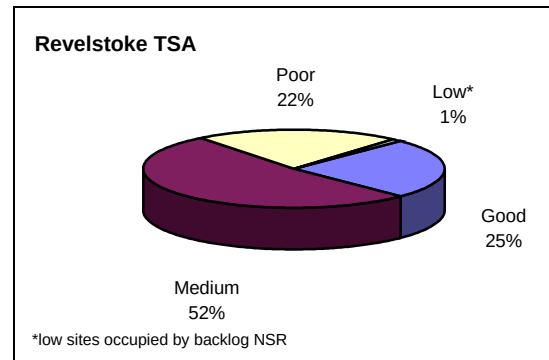
Woodlot AAC

*effective January 1/95

Harvest Forecast

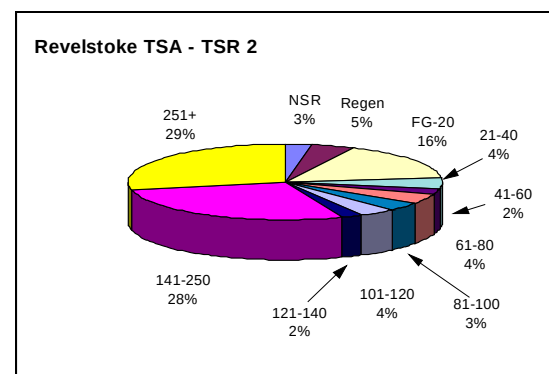


Site Class



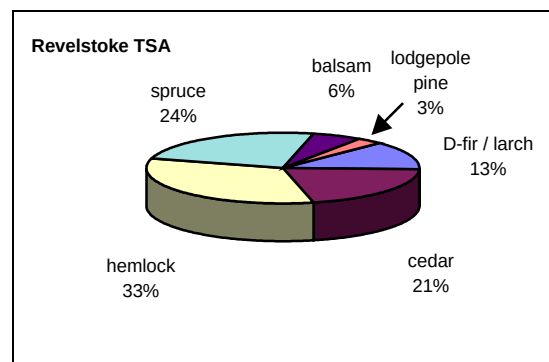
THLB only. Source: TSR2 analysis report - Fig 4.

Age Class



THLB only. Source: TSR2 analysis report - Fig 5, Table A-19

Tree Species



THLB only. Source: TSR2 analysis report Fig. 3.

Incremental Silviculture History

Approximately 480 ha are harvested annually (TSR2 analysis report, p. 24).

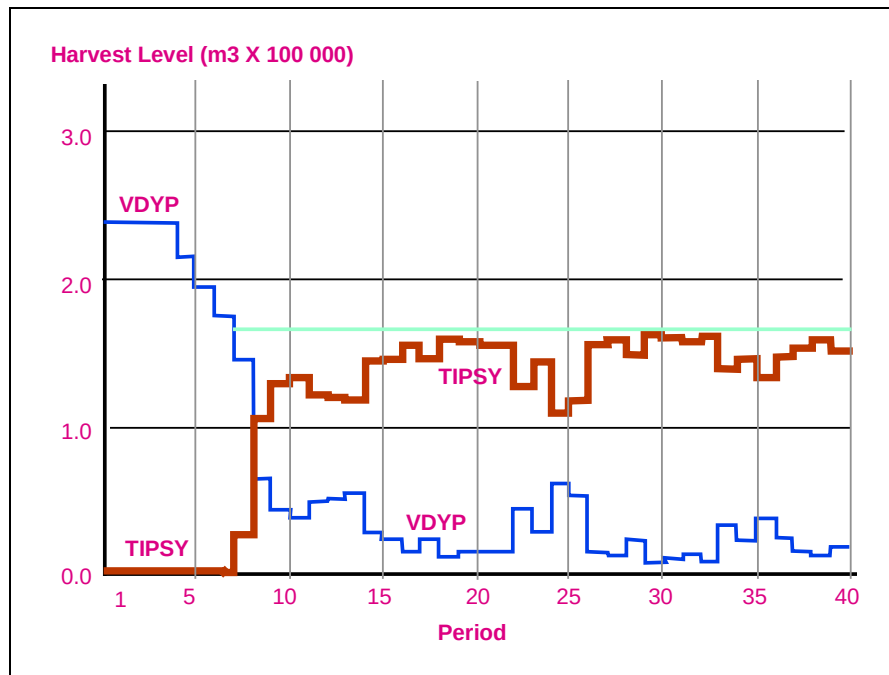
Treatment	TSR2 Status (1998)		Current Status (1999)
	Incorporated in Timber Supply Analysis	Not Incorporated in Timber Supply Analysis	Source: CFD ²
◆ Backlog	All backlog areas (1 800 ha) are considered part of the THLB. Yields are projected for various natural stocking levels.		Approximately 200 ha are planned for treatment. An additional 400 ha require brushing to ensure free growing is achieved. The remaining backlog areas are not planned for treatment and are expected to regenerate naturally over time.
◆ Conversion	None.		None
◆ Commercial Thin	None.		None
◆ Space	TIPSY used for stands regenerated over the past 20 years. Assumes incremental spacing for stocking control on stands harvested prior to 1987 and either basic or incremental spacing thereafter.		Max recent program of 100 ha/yr. Spacing is not usually required to deal with over stocking. Rather, the problem is the opposite - brushing is needed on most stands to keep stocking levels up.
◆ Prune			Max recent program of 50 ha/yr.
◆ Fertilize			None

² CFD - Columbia Forest District

Issues and Silvicultural Opportunities

TSA modelling in support of silviculture planning has not yet been undertaken. In its absence, sensitivity analyses from the TSR2 analysis report are the best source of information as to the opportunities for incremental silviculture to increase future timber supply. A detailed issues and opportunities analysis is contained in Appendix B, page 46.

The following are selected sensitivity analysis charts from the TSR2 analysis report, to which opportunity information is added to illustrate the opportunities. (Figure 1 was not included in the analysis report.) Further modeling is required to confirm the indicated effects.



Decade eight is the earliest the model can draw from managed stands due to minimum harvest age limitations. The major transition from existing to managed stands occurs in decade 9. The harvest forecast is highly sensitive to the availability of these stands as Figure 2 shows.

Unlike most other TSA's, existing stands are utilized throughout the planning horizon, probably because of caribou constraints on harvesting.

Figure 1. Harvest Queue of Existing Stands (VDYP) and Managed Stands (TIPSY)

Draft

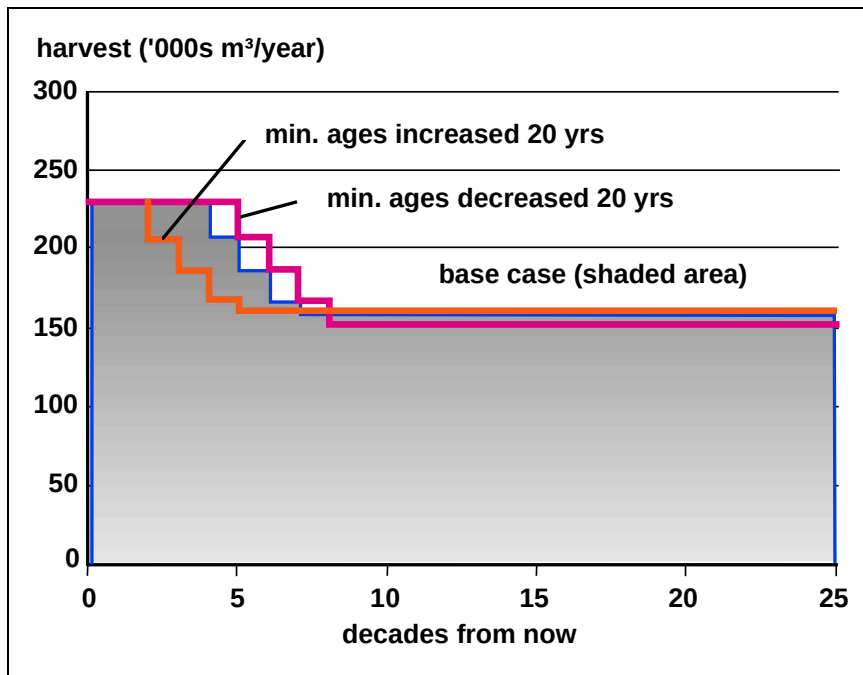


Figure 2. Sensitivity to Changes in Minimum Harvestable Ages and Implications for Timber Quality Management

The sensitivity to a 20 year increase in minimum harvest ages points to the need to ensure that stands in the harvest queue at the point of transition between existing stands and managed stands (80 -90 years from now) have achieved minimum harvestable size and are available. Silvicultural activities such as spacing and fertilization can assist this.

The chart illustrates that growing forests 20 years longer for quality purposes would substantially reduces mid term harvest levels. In the long term, quality and quantity goals are more compatible. Raising minimum ages 20 years for the purpose of improving timber quality has no effect on the LTHL.

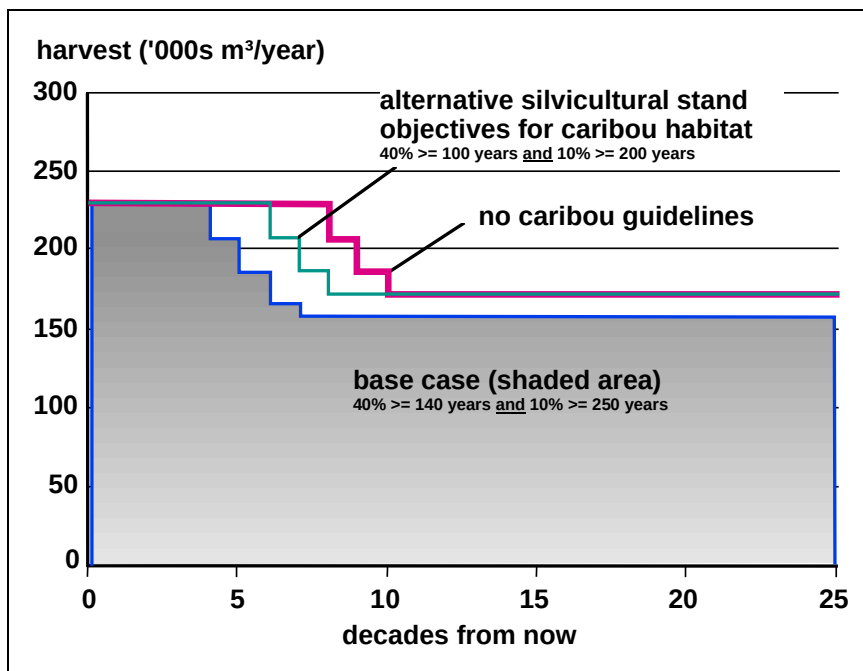


Figure 3. The Effect of Varying Caribou Constraints on the Harvest Forecast

Caribou guidelines significantly constrain the base case harvest forecast. Silvicultural treatments may achieve the desired stand characteristics for the production of lichen feed at younger stand ages than were modeled in the base case. A special FSSIM analysis of alternative stand objectives for caribou illustrates this potential.³ However, because of the heavy caribou constraints, the mid and old seral biodiversity constraints were not modeled in the normal fashion in the base case. It is unknown how the imposition of normal constraints might affect the results of the special FSSIM caribou run. A better understanding of the desired stand characteristics is needed before silvicultural prescriptions can be prepared.

³ Thanks to Hal MacLean, Regional Timber Supply Analyst.

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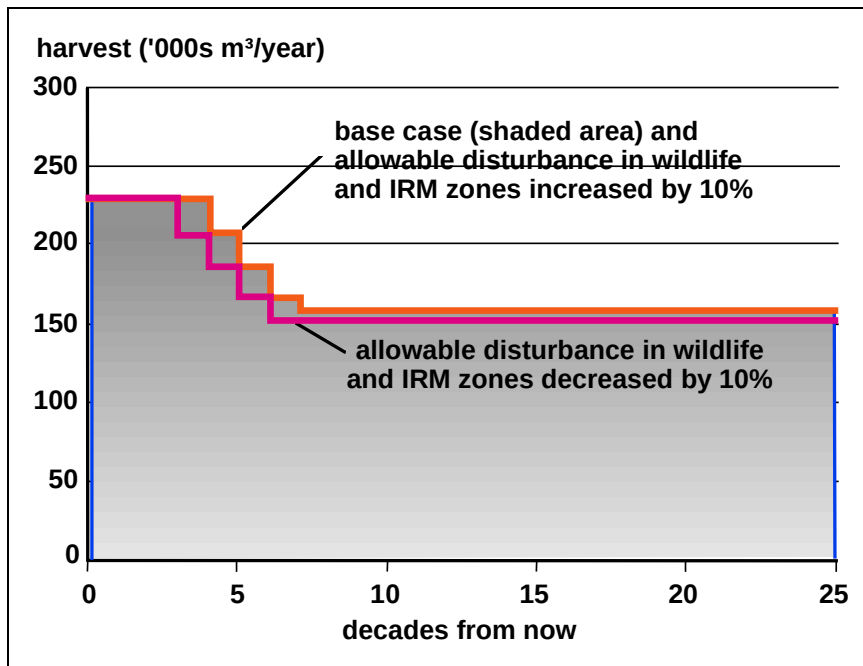


Figure 4. Sensitivity to Changes in Allowable Disturbance Levels in the Wildlife and IRM Zones

The base case is not constrained by forest cover constraints in the wildlife and IRM zones. Increasing the area allowed to be not greened up has no effect. This indicates that silvicultural efforts are better directed at accomplishing caribou habitat requirements at an earlier age (see Figure 3).

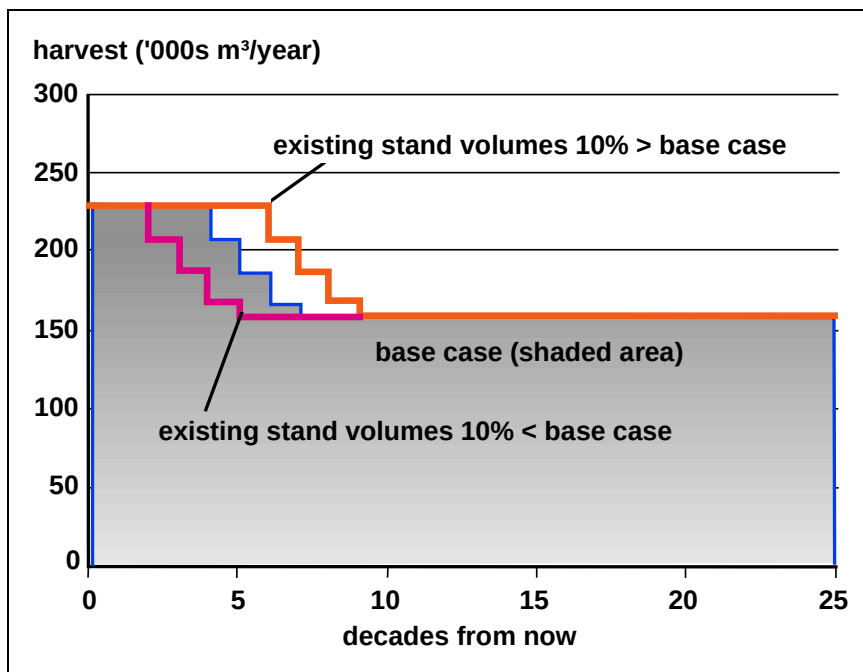


Figure 5. Sensitivity to Changes in Existing Stand Volumes

A recent inventory audit indicates inventory stand volume estimates to be acceptable. Nevertheless there is local concern that cedar/hemlock stand volumes may be overestimated. Should this be the case, the harvest forecast may be lowered as illustrated by the 10% < base case forecast line.

Fertilization has the potential to improve the volumes of some younger existing stands. This may help offset possible lower harvest levels should cedar/hemlock stands prove overestimated. Otherwise, fertilization may help improve the harvest forecast above the base case.

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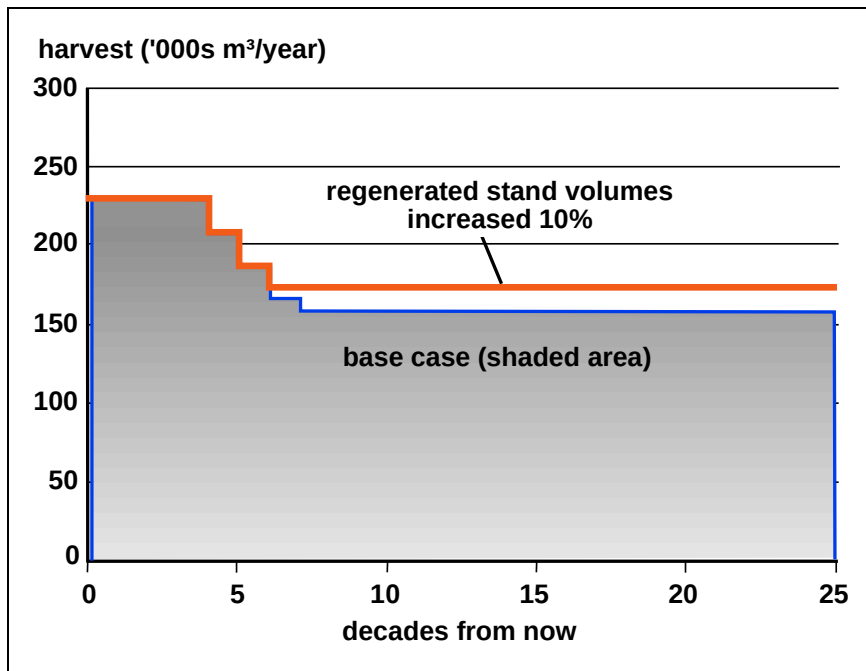


Figure 6. Sensitivity to an Increase in Regenerated Stand Volumes

Increasing regenerated stand volumes by 10% results in a 9% increase in the long term harvest level (LTHL) over the base case. LTHL is also reached one decade sooner. Many silvicultural practices can be used to achieve an increase in regenerated stand volumes.

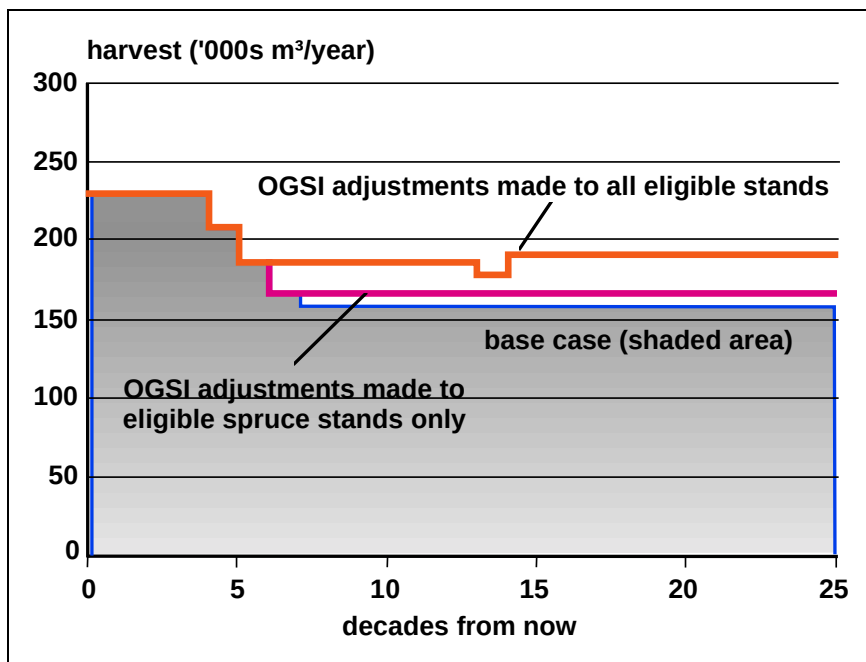
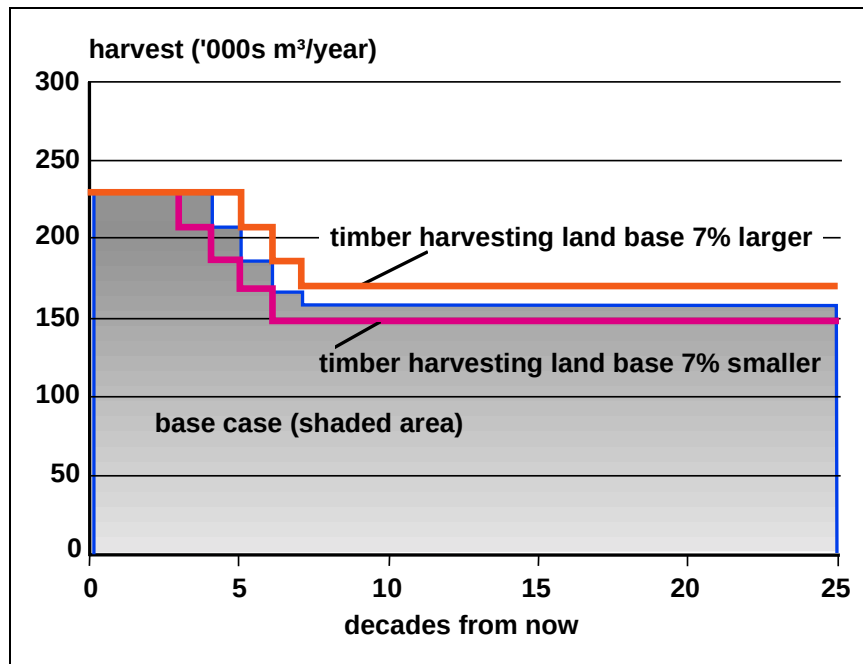


Figure 7. Effects of OGSi Adjustments on the Harvest Forecast

Old Growth Site Index (OGSi) studies have been completed to a statistically valid level for spruce stands (middle line).

When provincial estimates are applied to all eligible stands, a substantial increase in the forecast LTHL results (upper line). LTHL is also reached 2 decades sooner than in the base case. A slight increase in LTHL occurs at the beginning of decade 15, but otherwise the shape of the LTHL does not change. The rise in decade 15 occurs in conjunction with an increasing proportion of managed stands being harvested by the model at this time (see Figure 1).



Changing the size of the timber harvesting land base affects the timing of the onset of the transition to the LTHL. The LTHL also increases or decreases correspondingly.

Silvicultural practices may be used to enlarge the THLB through activities such as, for example, conversion of non-utilized stands to merchantable species and increasing the productivity of low sites.

Figure 8. Sensitivity to Changes in the Size of the Timber Harvesting Land Base

Summary of Issues

General

The timber supply of the Revelstoke TSA now appears relatively stable. The harvest forecasts and available information paint the picture of a classic “falldown” situation, where harvest levels are systematically reduced over time to reflect the transition from mainly primary to mainly secondary forests. The TSR 2 timber supply is less sensitive to changes in many factors than observed in the TSR1 analysis because there is less pressure on the harvest forecast. The AAC ‘ceiling’ was lowered from 269 000 (pre-TSR) to 230 000 m³/yr (TSR1) and the LTHL ‘floor’ was raised from 98 000 (TSR1) to 159 000 m³/yr (TSR2). Also, the TSR2 forecast has better resource information in the base case - for example, VDYP yields for regenerated stands have been replaced with TIPS Y yields, an inventory audit has increased confidence in the volume estimates for existing stands, and older forest and other forest practices code requirements are now incorporated.

Due to the abundance of older forests and the relatively small area with very restrictive forest cover constraints (watershed and VQO areas are minor), there are few factors heavily constraining the forecast outside of the forest age profile. The notable exception to this are the caribou habitat requirements for older forest cover which affect 49% of the THLB.

Following from the above, the silvicultural opportunities in the Revelstoke TSA appear to primarily be associated with:

1. increasing the THLB through rehabilitation of problem forest types;
2. maintaining the stocking levels assumed in the base case harvest forecast;

3. spacing and commercially thinning stands to create ungulate winter range and caribou habitat conditions at younger stand ages, thereby freeing up some timber for earlier harvest; and
4. increasing the volumes of regenerated stands.

Potential for Change in the Shape of the Harvest Forecast

Confirming the shape of the TSR2 harvest forecast is necessary because different silviculture opportunities arise in association with different shapes. There is a degree of uncertainty of the base case, resulting in the need for flexibility regarding implementation of the workshop results as ongoing reviews of issues occur. In choosing and ranking silvicultural strategies, those that will prove valid across the range of possible scenarios, should generally be given a higher priority than those tied into a specific scenario having a degree of uncertainty about it. It should also be recognized that the shape of a harvest forecast can be highly controlled by modeling rules, such that different rules could generate different shapes.

With only one exception, none of the timber supply review sensitivity analysis change shape as a result of varying constraints or information/data. The sole exception is a very mild increase in LTHL above the mid term level that results from a 20% adjustment in productivity to reflect the higher rates indicated by the OGSI project. This higher LTHL could be further enhanced by a possible further 10-15% increase if a goal of increasing regenerated stand volumes by this amount is realized. However, offsetting these future possible increases might be a 6-10% reduction due to modelling the stands outside the THLB without regeneration. When these possible increases and decrease are combined, a mid term harvest shortfall may occur. This is not a result of reductions to the base case, but rather is a result of holding the harvest level constant in this period and raising the harvest level in later decades. Analysis-based work is required to confirm if such a shortfall would be significant. For the purposes of this interim strategy, it is assumed that even if the harvest forecast were to change shape, it will not significantly do so. The underlying age class profile, together with modeling rules would tend to consistently yield a harvest forecast that declines to a steady state level, without a mid term shortfall.

In the district workshop, factors such as operability, spatial distribution of harvest, extent of ESA1 areas and higher TIPSYS OAF's were also raised as possible downward influences on the base case, but were not quantified. With the exception of higher TIPSYS OAF's these factors, if proven, would likely have a downward influence on the forecast across all time periods. This would tend to move the entire forecast lower, but otherwise not change its shape from that of the base case. Higher TIPSYS OAF's would reduce regenerated stand volumes, which if taken from the anticipated increase in these volumes mentioned above, would lessen but not likely eliminate the consequent rise in LTHL.

The age class profile of the TSA suggests any planned silviculture activities will be robust against future change in the TSA land base because there are basically only two age groupings - very young or very old. Future land base reductions are not likely to change the profile because it will either remove old growth, in which case the transition period will commence sooner and the LTHL will be lower because of the smaller future land base; or it will remove second-growth, in which case the LTHL will be lower.

In the absence of better information, the base case harvest forecast is accepted as the benchmark against which the potential outcomes of silvicultural strategies are estimated. (However, the potential harvest forecast contains an adjustment to the base case LTHL to reflect an anticipated site productivity increase.)

Short Term (1 - 20 years)

The TSR2 base case forecasts 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 regenerated stands become available. Thus factors that affect the existing timber supply greatly affect the ability

to maintain the initial harvest level for longer or shorter than in the base case. These are discussed under the Mid Term, below.

There appears to be little opportunity to use silviculture to effect change in the harvests during this transition period, other than perhaps to fertilize suitable stands (if there are any) 10-15 years prior to harvest to give a volume boost.

Mid Term (21 - 70 years)

The mid term is characterized by a 10%/decade transition from the IHL to the LTHL. In the base case the transition begins at 40 years and ends at 70 years.

Like the short term, the mid term is also largely governed by the need to extend existing timber supply until regenerated stands become available. Factors that affect the existing timber supply greatly affect the ability to maintain the initial harvest level for longer or shorter than in the base case.

Various factors either accelerate or delay the onset of the transition; none change its shape. This indicates that the forest profile holds a greater degree of control over the mid term than do any of the constraints. The sharp transition is probably related to the fact that only 19% of the THLB is currently aged 21-140 years. The model holds the harvest level at the IHL for as long as it can, and then quickly moves through this limited age group (after allowing for the need to hold some stands to satisfy caribou constraints at perhaps much later decades) on to the first available regenerated stands at a steady LTHL. As in the short term, there appears to be little opportunity to use silviculture to effect change in the harvests during this transition period, other than perhaps to fertilize suitable stands (if there are any) 10-15 years prior to harvest to give a volume boost.

The most significant factor affecting the length of time the IHL can be held is the estimate of existing stand volumes. Higher volumes extend IHL, lower volumes shorten it. However, an inventory audit confirms the current estimates as being accurate.

The next most significant factor is the older forest cover requirements for caribou. Sensitivity analysis indicates changes to these can extend IHL up to 4 decades beyond that of the base case. Creating old stand attributes earlier through silviculture may have some potential for increasing mid term harvest. (An additional FSSIM sensitivity analysis conducted while the workshop was in session confirms this - see Figure 3, page 7.) The sensitivity analysis was area-based, while the silvicultural treatments would be age-related.

The transition period begins 2 decades earlier than in the base case if minimum harvest ages are increased 20 years. This is because the base case harvest queue is dependent upon the transition from primary to secondary forests occurring in decades 8 & 9. If these forests are not available until 2 decades later, the existing older forests must be rationed out for 2 more decades to offset this. This is accomplished by commencing the transition period 2 decades sooner.

Long Term (71 + years)

Modeling methodology may have some implications to formulating a long term strategy. The long term is indicated as sensitive to changes in existing stand volumes, particularly in the test for sensitivity to cedar/hemlock volume estimates. The sensitivity test reflects concerns about the possible effects of decay in these stands.

Continuing on with modeling methodology, the model does not regenerate existing stands outside the THLB. Consequently they are always available to satisfy old forest biodiversity requirements. Increasing ungulate cover requirements 10% lowered LTHL 6%, which may be an indication of the effect to be expected were the TSA required to meet more older forest requirements from within the THLB. In the Golden TSA analysis, the modeling methodology was reported to result in a 10% overestimate in LTHL.

Beyond the above methodological factors, the most significant long term factors are site productivity, regenerated stand volumes and older forest cover constraints.

It is likely that the site productivity of older stands may be underestimated. Sensitivity analysis indicates LTHL could rise 21% above the base case if site indices are underestimated.

As is the case in virtually all management units, the long term is sensitive to changes in regenerated stand volumes. A 10% increase or decrease in volume results in a corresponding approximate 9% increase or decrease to LTHL.

Older forest cover constraints were discussed above under the Mid Term.

Future

The only significant unknowns indicated by the TSR2 analysis report appear to be site productivity estimates and the level of decay in cedar-hemlock stands. Other significant unknowns (or uncertainties) raised in the workshop and post-workshop are the size of the timber harvesting land base, the effects of explicitly spatial (real) harvest and biological attribute planning and implementation in the TSA, whether certain guidelines for non-timber resources are appropriate to fulfill the objectives behind the guidelines, and problems relating to inventory volumes versus scaled volumes.

◆ Future Timber Quality

To date there has been little attention to the matter of future timber quality. The focus of the Timber Supply Review on AAC determination has resulted in the planning emphasis being solely on timber quantity. 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 projected decline in harvest ages towards minimum ages indicates future timber quality will be generally be 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, most harvested second growth timber will be sound wood with little or no decay.

The very high old forest constraints for caribou habitat result in a significant area being held in older stands. A side benefit of this is increased timber quality in these older stands, provided they can be harvested prior to high levels of decay setting in.

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.

Opportunities to Increase Timber Supply

Potential Silviculture Strategies

Prior to the district workshop, 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 was discussed in detail in the district workshop, the results of which are recorded in “Workshop Review of Potential Strategies,” page 15, along with additional strategies that arose during the meeting. Strategies that are ultimately adopted are noted in “Silviculture Strategies,” page 35.

◆ Short Term (1 - 20 yrs)

ST 1: Fertilize all suitable stands scheduled for harvest in the 2nd decade to increase their volumes. (increase)⁴

ST 2:

◆ Mid Term (21 - 70 yrs)

MT 1: Repeat fertilize all suitable existing stands scheduled for harvest 20 to 70 years from now to increase their volumes. (increase)

MT 2: Commercially thin stands to create old-seral attributes earlier. (increase)

MT 3:

MT 4:

◆ Long Term (71+ yrs)

LT 1: Maintain the THLB by maintaining ____ ha of existing backlog plantations;

LT 2: Increase the THLB by:

- a) converting/rehabilitating deciduous stands; (increase)
- b) converting/rehabilitating non-merchantable hemlock and cedar stands; (increase)
- c) improve the site productivity of low-site stands by (fertilization?). (increase/maintain)

LT 3: Increase regenerated stand volumes by:

- i) using improved seed; (increase)
- ii) managing stocking so voids do not account for more than 10% of the area; (increase)
- iii) using larger planting stock; (increase)
- iv) fertilizing at the time of planting; (increase)
- v) brushing for growth enhancement (i.e., not only for survival); (increase)

⁴ (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.

- vi) spacing stands; (maintain) and
- vii) repeat fertilize suitable stands on a 15 yr return cycle.
- LT 4: Continue MT 2. (maintain/increase)
- LT 5: Reduce losses to root rot? (maintain)
- LT 6: Plant areas outside of the THLB to increase the area in an old-seral state in 100 to 200 years. (maintain)
- LT 7:

Workshop Review of Potential Strategies

Explanatory notes with respect to the following tables.

<u>Column Number</u>	<u>Note</u>
1	The response time frame is the period in which the anticipated result is expected, <u>not</u> the period in which actions must necessarily commence.
2	Strategy numbers correspond with the numbers recorded earlier in “Potential Silviculture Strategies,” page 14. Items followed by an asterisk (*) were added during the district working session.
3	Information is largely from a meeting of MoF and MoELP personnel and forest licensees held March 4 & 5, 1999 in Revelstoke (the “district workshop”) combined with information presented earlier in this document.
4	Anticipated results are typically calculated using the timber supply response indicated by TSR2 sensitivity analyses.
5	The harvest forecast for each period uses the TSR2 base case as the starting level. The harvest forecast column was not thoroughly reviewed during the district meeting. <i>Results are largely conjecture and are meant to illustrate the potential of the strategies.</i>

♦ **Short Term (1 - 20 years)**

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
♦ ST 1	1. Fertilize all suitable stands scheduled for harvest in the 2nd decade. (increase)	1. Stands scheduled for harvest in this time period are not fertilizable due to their old age.	2. N/A
♦	<u>Short Term Harvest Forecast Summary</u> <div style="text-align: right;">(000s m3/yr)</div> <div style="text-align: right;">230 1st decade</div> <div style="text-align: right;">230 2nd decade</div> <div style="text-align: right;">0 fertilization</div> <div style="text-align: right;">230 total</div>		

♦ **Mid Term (21 - 70 years)**

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
♦ MT 1	1. Repeat fertilize all suitable existing stands scheduled for harvest 20 to 70 years from now.	<p>1. Effectively, this strategy is a continuation of ST 1. Stands in the early part of this time period, like in the short term, are generally too old to fertilize. Stands that are not too old probably have too high a crown closure to be suitable for fertilization.</p> <p>Stands scheduled for harvest in 50 to 70 years are likely those currently aged 21 - 140 yrs, but this is difficult to tell without better information. Some of these stands may be needed for later harvest in order to meet caribou older forest constraints. There are few stands currently aged 21 - 140 yrs (19% of THLB) because until recently most logging in the general area was in the TFL's and most older TSA logging is now under hydro reservoir.</p> <p>Stands to be harvested 50 years from now would be fertilizable approx. 35 years from now. Those in the ICH zone may need spacing to prepare the density for fertilization. This would mean carrying the spacing cost for much of the rotation. For the purpose of fertilization alone, this carrying cost would be too great. Would require some other benefit to spacing to make it viable.</p>	1. There is limited potential to raise harvests in this time period. Consider for stand level effects. See LT 3 vii for discussion of fert potential in the long term.
♦ MT 2	2. Commercially thin stands to create old seral attrib-	2. Old seral stage is critical. Due to modeling methodology, the contribution of areas outside the THLB to meeting requirements was possibly overstated. However, workshop	2. Extend IHL through decades 4-6.

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Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
	<p>utes in:</p> <p>(a) caribou winter range (maintain/increase); and</p>	<p>participants felt that, unlike the Golden TSA, both caribou and biodiversity requirements could be met from within the THLB without further impact to the LTHL.</p> <p>(a) The caribou requirements are particularly constraining. The caribou winter range zone occupies 21 900 ha of the ICH and 11 100 ha of the engelmann spruce-subalpine fir (ESSF) zones (49% of THLB). The current requirement is 40% of these areas must be in stands ≥ 140 years old and 10% ≥ 250 years.</p> <p>Research is required to determine the ages and stand structures necessary for the growth of lichen feed for caribou (noted under “Summary of Information and Research Needs,” page 41). It is possible that the requirements are overstated in the base case due to a lack of better information, and that better information can lead to simply changing the constraints without having to undertake silvicultural treatments.</p> <p>A special FSSIM run was done to analyze the sensitivity of the harvest forecast to lower ages for caribou requirements (Figure 3, page 7). The lower constraints were 10% > 200 yrs of age (vs 250 yrs) and 40% > 100 yrs of age (vs 140 yrs). The results indicated the current IHL could be maintained 2 decades longer than the base case (6 vs 4). At lower ages, caribou constraints were no longer limiting in the long term, with LTHL rising above the base case to essentially the same level as the sensitivity test where caribou constraints were removed entirely. However, because of the heavy caribou constraints in the base case, the medium and high emphasis biodiversity constraints were not modeled in the normal fashion in the base case. It is unknown how the imposition of these biodiversity constraints might affect the results of the special FSSIM caribou run. Additional modeling and analysis is required (noted under “Summary of Information and Research Needs,” page 41).</p> <p>Meeting the lower age requirements means that the caribou zone must at all times have 3 300 ha (10% of the 33 000 ha in the zone) and 13 200 ha (40% of the 33 000 ha) in stands aged ≥ 150 and 100 years respectively. Allocating this on the basis of zone %’s means the ESSF zone must have roughly 1/3 of this, or 1 100 and 4 400 ha in stands aged ≥ 150 and 100 years respectively (total 5 500). The ICH must have the remainder, or 2 200 and 8 800 respectively (total 11 000). Because these are the minimum requirements, the entire zone would have to be under silvicultural management in order to have sufficient stands under recruitment to replace those stands older than the age requirements as they are harvested. Because this cannot occur, some older stands must be held for a considerable time in this state, substantially reducing their MAI.</p> <p>Of the 33 000 ha in the zone possibly just under half, or 15 000 ha, is estimated to be available for silvicultural management. Splitting this evenly between the ESSF and ICH zones allots 7500 ha for management in each. Because commercial thinning in the ESSF may be a difficult proposition, the ESSF allotment is further reduced to a management area of 4 000 ha. These areas (4 000 in the ESSF and 7 500 in the ICH) are less than the</p>	

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Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
		<p>required areas noted above (6 600 and 11 000 ha). Were the option of silvicultural management of stands for caribou habitat to be pursued, field assessments would be required to determine the extent and location of candidate stands. Again, additional modeling and analysis is required.</p> <p>The workshop explored how a regime of silvicultural treatments in the ESSF zone might be used to create old-growth tree attributes at earlier ages, thereby relieving some constraints. Target objectives were to lower the base case constraint ages from 250 and 140 years to 150 and 100 years respectively. Commercial thinning at ages 100 and 80 respectively was assumed to be appropriate to creating stand conditions of the desired vertical structure plus open enough so lichen can become established. This would allow 50 years for lichen development in the target 150 year old stands and 20 years for development in the 100 year old stands.</p> <p>A crown closure of 80% post CT was determined suitable for achieving the desired stand structure. For simplicity, for both the 150 and 100 year old stand age groups a post CT stocking density of 500 stems/ha was established as the target. Using TIPSYS, a pre CT density of 800 stems/ha was determined to get this residual density, as well as have a 150 m³/ha minimum volume removal in order to create a profitable CT operation. A minimum pre-CT volume of 300 m³/ha and avg dbh of 30 cm was felt necessary to create a profitable or break-even harvest opportunity. TIPSYS indicated that for SI 18, standard OAFs, S stands planted to 1 500 st/ha would have an avg dbh of 26 cm, 933 sph and 411 m³/ha at age 100, and an avg dbh of 24 cm, 1065 sph and 315 m³/ha at age 80. (SI 18 may be high but somewhat reflects the fact that CT is more likely on the higher productivity sites. Higher sites is also reflected to some extent in the netdown of area from 7500 to 4400 ha.) Stand volume and stocking would therefore be adequate, but average diameters would be lower than desired. Achieving the desired pre-CT stocking levels would require managing stands to meet target stocking standards at free growing. Minimum stocking standards would be too low. Spacing would not likely be necessary because under-stocking rather than over-stocking is the usual problem in the ESSF. However, stands should be monitored for ingrowth to be certain they do not become overstocked and consequently of too low average diameter to be commercially thinned.</p> <p>A TIPSYS analysis also showed no increase in spruce stand volumes between ages 150 and 250. Also, although average diameters were greater in 250 year old stands, there were few stems over 60 cm dbh. This did not match local field experience and could be a result of TIPSYS data limitations. This should be checked (noted under “Summary of Information and Research Needs,” page 41). It may partially explain why the Revelstoke TSA LTHL is 28% below the long run sustained yield (LRSY). Normally LTHL is only about 10% lower.</p>	

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Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
		<p>To summarize:</p> <ul style="list-style-type: none"> Research is required to determine the desired stand characteristics for caribou lichen forage production and if they occur at younger ages than currently modeled. Further FSSIM modeling is required to determine the effect of landscape level biodiversity requirements and the ages at which caribou constraints no longer become limiting. If research indicates the desired stand characteristics do not occur unaided at the desired younger ages, silvicultural treatments can be applied to create them. The extent of the benefit to the harvest forecast would depend upon the availability of treatable stands and the efficacy and economics of silvicultural treatments. Field analysis would be needed to locate these stands and determine the total opportunity. In the ESSF, if it is assumed that CT will be necessary to creating the desired stand characteristics (this may not be the case - brush competition may result in lower stocking and create more open stand characteristics), preliminary analysis indicates a regime of planting 1 500 sph, managing for target densities (1 200 sph) at free growing, and spacing only if there is significant ingrowth would yield the necessary stand characteristics for CT at target ages 80 and 100 years. 	
♦ MT 2	(b) ungulate winter range. (maintain/increase)	(b) Sensitivity tests indicate much lower sensitivity to changes in ungulate winter range requirements than to caribou requirements. Consequently, the workshop focused on managing caribou habitat requirements.	(b) N/A.
♦ MT 3	3. Bring forward volumes from the long term. ^{*5}	3. At the start of the workshop there was some indication of a possible rise in LTHL creating a mid term shortfall. This potential strategy was therefore added to the list for later consideration. By the completion of the workshop, however, a mid term shortfall, if any, appeared to be minimal.	3. N/A

⁵ * - indicates added during the district working session.

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Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
♦ MT 4	4. Ensure stands at the beginning of the long term harvest queue (decades 8 & 9) are available.*	<p>4. Decades 8 & 9 are part of the long term according to the time period definitions adopted for this strategy. However, if the first stands in the long term harvest queue are not merchantable, mid term harvest levels are affected. This is indicated by the sensitivity to an increase in minimum harvest ages. Thus it is important to ensure that the first of the managed stands in the harvest queue are of sufficient size and volume to be merchantable.</p> <p>The first of the managed stands are now 10-20 years old. In 80 years these will be 100 years old. TIPSy analysis conducted in the workshop indicates that these stands can be expected to be merchantable by the time they are needed and that silvicultural treatments are therefore not generally required. However, there are approximately 8-10 000 ha of dense hemlock/cedar stands in this age group. If half of these stands were spaced over a 10 year period, a spacing program of 500 ha/yr would ensure these stands reach merchantable size in time.</p> <p>Young Fdi and Pl stands could also be fertilized for the purposes of this objective if necessary. Further analysis of this is required (noted under "Summary of Information and Research Needs," page 41).</p>	
♦	<u>Mid Term Harvest Forecast Summary</u>	Decades 3-4 maintained at IHL of 230 000 m ³ /yr (base case). Decades 5-6 increased to IHL though either reduced caribou requirements due to better info or management of caribou habitat.	

♦ Long Term (71+ years)

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result																																																															
◆ LT 1	1. Maintain the THLB by (a) Treating approx. 200 ha of backlog NSR; (main- tain) and (b) maintaining approx. 400 ha of previously refor- ested backlog planta- tions.* (maintain)	1. (a) Most of the remaining backlog NSR is uneconomic to treat. The 200 treatable ha requires the program shown below to achieve free growing. (b) About 400 ha of previously reforested area requires brushing to ensure free growing is achieved. The program shown below is required. <table><tr><td></td><td colspan="6">Area (ha)</td></tr><tr><td></td><td></td><td></td><td></td><td colspan="3">Brush</td></tr><tr><td></td><td><u>Year</u></td><td><u>Site Prep</u></td><td><u>Plant</u></td><td><u>New</u></td><td><u>Existing</u></td><td><u>Total</u></td></tr><tr><td></td><td>1</td><td>100</td><td>100</td><td>0</td><td>400</td><td>400</td></tr><tr><td></td><td>2</td><td></td><td>100</td><td>0</td><td>300</td><td>300</td></tr><tr><td></td><td>3</td><td></td><td></td><td>100</td><td>100</td><td>200</td></tr><tr><td></td><td>4</td><td></td><td></td><td>100</td><td>100</td><td>200</td></tr><tr><td></td><td>5</td><td></td><td></td><td>100</td><td>0</td><td>100</td></tr><tr><td></td><td>6-10</td><td></td><td></td><td>150</td><td></td><td>150</td></tr></table>		Area (ha)										Brush				<u>Year</u>	<u>Site Prep</u>	<u>Plant</u>	<u>New</u>	<u>Existing</u>	<u>Total</u>		1	100	100	0	400	400		2		100	0	300	300		3			100	100	200		4			100	100	200		5			100	0	100		6-10			150		150	1. (a) (b) Maintain base case LTHL. Area re- quiring treatment totals 600 ha ≅ 1% of THLB. Failure to treat would result in a 1% drop in LTHL.
	Area (ha)																																																																	
				Brush																																																														
	<u>Year</u>	<u>Site Prep</u>	<u>Plant</u>	<u>New</u>	<u>Existing</u>	<u>Total</u>																																																												
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	6-10			150		150																																																												
◆ LT 2	2. Increase the THLB by: (a) converting /rehabilitating deciduous stands; (in- crease)	2. <table><tr><td></td><td><u>Area (ha)</u></td><td><u>%tot area</u></td><td><u>%prod area</u></td><td><u>%THLB</u></td></tr><tr><td>(a) Decid</td><td>1 600</td><td></td><td></td><td>2</td></tr><tr><td>(b) Non-merch</td><td>4 900</td><td></td><td></td><td>7</td></tr><tr><td>(c) Low site</td><td>1 200</td><td></td><td></td><td>2</td></tr></table> (a) <u>Decid.</u> Most decid is birch. The condition of these stands is not known. Some stands may be harvestable, some may be suitable for conifer release, some may be best allocated to meeting wildlife habitat objectives, while others may be suited to continuous decidu- ous management. A survey of these stands is required to determine their potential and suitable silviculture treatments.		<u>Area (ha)</u>	<u>%tot area</u>	<u>%prod area</u>	<u>%THLB</u>	(a) Decid	1 600			2	(b) Non-merch	4 900			7	(c) Low site	1 200			2	2. Summary. Little poten- tial identified. Survey of decid stands required.																																											
	<u>Area (ha)</u>	<u>%tot area</u>	<u>%prod area</u>	<u>%THLB</u>																																																														
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(c) Low site	1 200			2																																																														
◆ LT 2	(b) converting/rehabilitating non-merchantable hem- lock and cedar stands; (in- crease)	(b) <u>Non-merch.</u> These stands are mostly highly decadent age class 8/9 hemlock with 50%+ decay and are spread out throughout the TSA. Although they equal 7% of the THLB there are two reasons for not treating them immediately: (1) some may prove merchant- able in periods of high pulp prices, and (2) if caribou old-growth constraints are at their limits, other stands of better species and productivity would have to be immediately set																																																																

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Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result																												
		aside to replace them upon rehabilitation. The consensus of workshop participants was to keep these stands on the shelf for future rehab potential, at which time rehab would start in those landscape units having an old growth surplus.																													
♦ LT 2	(c) improve the site productivity of low-site stands by (fertilization?). (increase/maintain)	(c) Low site. There is no potential for silvicultural treatments to increase the productivity of these stands.																													
♦ LT 3	3. Increase the volume of regenerated stands by 20% over those used at the base case by: i) using improved seed; (increase)	3. (i) 100% of areas are planted. About 80% of S is genetically improved stock. No improved stock is planned for the other major species. Latest estimates of yield gains are (%): ⁶ <table> <tr> <th>Species</th><th>Cur %</th><th>Future %</th><th>% gain</th></tr> <tr> <td>Hw</td><td>35</td><td>25</td><td></td></tr> <tr> <td>S</td><td>25</td><td>35</td><td>22</td></tr> <tr> <td>Cw</td><td>20</td><td>20</td><td></td></tr> <tr> <td>Fdi(L)</td><td>10</td><td>10</td><td></td></tr> <tr> <td>Ba</td><td>5</td><td>5</td><td></td></tr> <tr> <td>Pl</td><td>5</td><td>5</td><td></td></tr> </table> <p>Based on S alone, LTHL can be expected to rise 6-7% (80%-100% of S X 35% of area X 20% gain). If Hw and Cw added to S, a 16% rise could occur (80% of area X 20% gain). Yield gains were not included in TSR 2.</p> <p>Tree improvement could significantly reduce green-up & minimum harvest ages. Expanding the tree improvement program to include Hw & Cw would likely offer similar gains to that of S and should be a high priority. Opportunity area (including S, Hw & Cw) = .8 X 480 = 380 ha/yr.</p>	Species	Cur %	Future %	% gain	Hw	35	25		S	25	35	22	Cw	20	20		Fdi(L)	10	10		Ba	5	5		Pl	5	5		3. (i) 7% - 21% gain possible. See "Summary" below.
Species	Cur %	Future %	% gain																												
Hw	35	25																													
S	25	35	22																												
Cw	20	20																													
Fdi(L)	10	10																													
Ba	5	5																													
Pl	5	5																													
♦ LT 3	ii) managing stocking so voids do not account for more than 10% of the area; (increase)	(ii) TIPSYS standard OAF1 factor for voids is 15%. Objective is to reduce this to 10%. Current free growing requirements will result in < 15% in voids, however the actual amount is unknown. Only 13.5% of the total land area of the Revelstoke TSA is within the THLB. This implies more rugged terrain, so an OAF1 of 15% may be reasonable. 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," page 41). Voids can be desirable for wildlife habitat, so intensive void management may not be practicable on all areas.	3. (ii) No gain likely. See "Summary" below.																												

⁶ Source: Ivan Listar.

Draft

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
◆ LT 3	iii) using larger planting stock; (increase)	<p>(iii) Pre free-growing item, although as considered here could be incremental to achieving free growing. Larger stock could be used but not likely in current economic conditions. Upper bound of opportunity area is the annual area planted = 480 ha/yr.</p> <p>Mostly now plant 1+0 415b stock which is about 25cm tall. Larger stock would be 1+0 415d which is about 30 cm tall and has a larger caliper. Increased cost for larger stock may be (1500 trees/ha X \$.20/tree =) \$300/ha. If larger stock used on all sites increased cost would be 480 ha/yr X \$300/ha = \$144,000/yr.</p> <p>The free growing period is 10-12 years. Pure speculation, but if larger stock reduces age to FG by 2 yrs, could also reduce time to a specified technical rotation size by 2 yrs. Assuming technical rotation size is equal to size at culmination and this age is 100, MAI is increased by 2% when the same size is reached at age 98. A 2% MAI increase translates to a 2% LTHL increase.</p>	3. (iii) Possible 2% gain in LTHL. See "Summary" below.
◆ LT 3	iv) fertilizing at the time of planting; (increase)	<p>(iv) Pre free-growing item, although as considered here could be incremental to achieving free growing. Not presently eligible for FRBC funding and not likely to be voluntarily undertaken unless necessary to achieve FG.</p> <p>Bell Pole has been fertilizing at time of planting in the Mica area. Early results look promising. Goal is to eliminate one brushing treatment as well as reach free growing one year earlier. Cost is currently in the \$150/ha range (vs. \$450/ha for brushing) but may come down with more experience. Also, some nurseries are looking at adding formulations to the rooting medium.</p> <p>Bell Pole estimates free growing may be achieved 1 year earlier in the ESSF zone in response to fertilizing at planting (12 yrs vs 13 for 2m ht). Estimates are not available for the ICH zone. Estimated gain in LTHL is therefore < 1% (see LT 3 iii for logic in determining LTHL gain).</p> <p>Opportunity area assumed to be 100% of areas planted. Opportunity cost = (\$150 X 480 =) \$72,000/yr.</p> <p><u>Note:</u> Post workshop follow-up by Ivan Listar of the MoF indicates that results elsewhere are inconclusive. One trial found a general favourable response, but also that certain formulations and certain species had a negative response. Fertilization did not prevent a brushing on brush sites.</p>	3. (iv) Less than 1%. See "Summary" below.

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
♦ LT 3	v) brushing for growth enhancement (i.e., not only for survival); (increase)	<p>(v) Pre free-growing item, although as considered here could be incremental to achieving free growing. Not presently eligible for FRBC funding and not likely to be voluntarily undertaken unless necessary to achieve FG.</p> <p>About 80% of harvested areas or (.8 X 480 =) 400 ha currently being brushed for survival. Because every ha needs approx. 2.5 brushing treatments this equals an annual program of 1 000 ha/yr.</p> <p>Brushing treatments typically are done until trees reach 1 m in ht. After this they are expected to survive to free growing at 2m, but growth is impeded. If 1m ht reached in 6 yrs, it then takes 4-5 yrs to reach 2m. An additional brushing may shorten this by 1 year.</p> <p>Potential for 400 add'l ha of brushing for growth at a total cost of \$140,000/yr (@\$350/ha). Resultant gain in LTHL would be < 1%.</p>	3. (v) Less than 1%. See "Summary" below.
♦ LT 3	vi) spacing stands; (maintain) and	(vi) Virtually no basic and little incremental spacing is necessary. In fact, due to heavy brush competition, the opposite problem - that of too few stems - tends to be the problem.	3. (vi) N/A. See "Summary" below.
♦ LT 3	vii) repeat fertilize suitable stands on a 15 yr return cycle.	<p>(vii) See LT 3 (i) for future species profile.</p> <p>On a long term steady state basis, 15% of the species (Fdi & Pl) on 60% of the site classes could be suitable for a multiple fertilization regime. This equates to (.15 X .6 =) 10% of the THLB or 6 700 ha. On a 15 yr return cycle, this requires a program of (6 700/15 =) 450 ha/yr. A 10% volume gain would increase long term harvest levels (0.1 X 0.1 =) 1%.</p> <p>Much of the above fertilizable land base is in valley bottoms where most of the harvest constraints are. Workshop participants felt there was some risk to fertilizing these stands and then not being able to harvest them either at the optimum time or at all.</p> <p>There is little experience in fertilizing spruce or hemlock. Given that these are major species components of the THLB, fertilization trials are needed to determine if the fertilizable land base could be expanded to include these species (noted under "Summary of Information and Research Needs," page 41).</p>	3. (vii) Possible 1% gain to LTHL. See "Summary" below.

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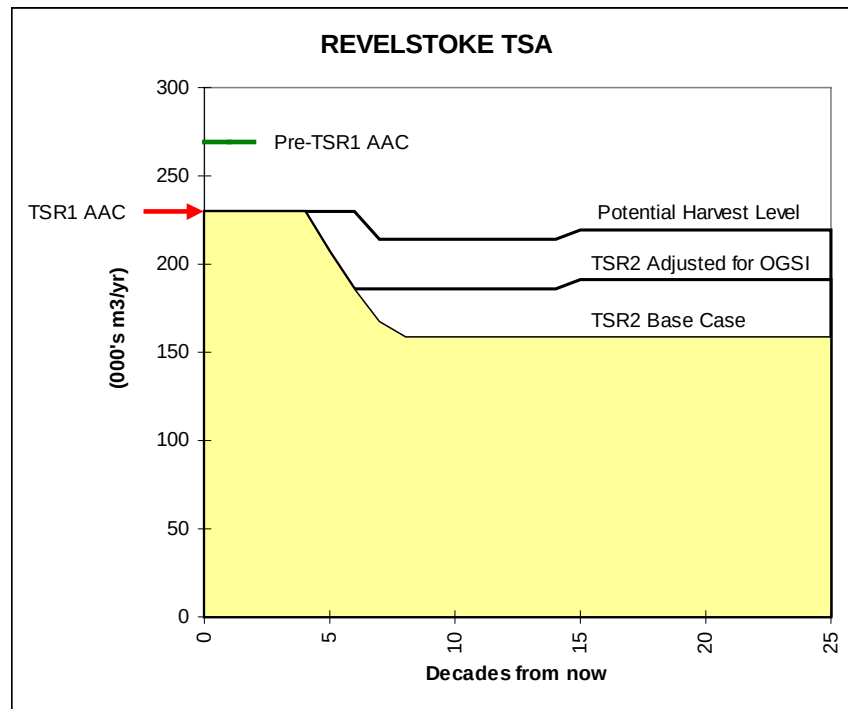
Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result																											
♦ LT 3	3. Summary	<div>3. Summary</div> <table><thead><tr><th>Item</th><th>% Gain (low end)</th><th>% Gain (high end)</th></tr></thead><tbody><tr><td>Seed</td><td>6</td><td>16</td></tr><tr><td>Voids</td><td>0</td><td>0</td></tr><tr><td>Lg stock</td><td>1</td><td>2</td></tr><tr><td>Fert at plant</td><td>0</td><td>1</td></tr><tr><td>Brush</td><td>0</td><td>1</td></tr><tr><td>Spacing</td><td>0</td><td>0</td></tr><tr><td>Repeat fert.</td><td><u>0</u></td><td><u>1</u></td></tr><tr><td>Total</td><td>7</td><td>21</td></tr></tbody></table>	Item	% Gain (low end)	% Gain (high end)	Seed	6	16	Voids	0	0	Lg stock	1	2	Fert at plant	0	1	Brush	0	1	Spacing	0	0	Repeat fert.	<u>0</u>	<u>1</u>	Total	7	21	<div>3. Summary</div> <div>Sensitivity analysis indicates a 10% increase in regen vol's results in a 9% increase in long term harvest levels. A 7-21% gain would therefore yield a 6-19% increase in <u>LTHL</u>. Assume 6% potential for now.</div> <div>Increased site productivity may compound these effects.</div>
Item	% Gain (low end)	% Gain (high end)																												
Seed	6	16																												
Voids	0	0																												
Lg stock	1	2																												
Fert at plant	0	1																												
Brush	0	1																												
Spacing	0	0																												
Repeat fert.	<u>0</u>	<u>1</u>																												
Total	7	21																												
♦ LT 4	4. Continue MT 2.	4. See MT 2 above.	4. See MT 2 above.																											
♦ LT 5	<div>5. Reduce losses to root rot by: (maintain)</div> <div>(a) planting alternate species;</div> <div>(b)pop-up spacing;</div> <div>(c) pushover logging / stumping; and</div> <div>(d)mixed species planting.</div>	<div>5. The smaller THLB makes the consequences of a severe pest attack more serious in this TSA.</div> <div>Due to limited time availability in the workshop, root rot management activities were not individually reviewed. Activities (a), (c) and (d) will occur through basic silviculture where necessary.</div> <div>Root rot is endemic mostly in Fdi and Ba stands (15% of THLB). If 20% of these stands are severely infected and infection results in a 20% growth reduction, net effect is (.15 X .2 X .2 =) <1%. This is likely already allowed for by the 5% OAF 2 reduction applied to TIPSYS yields.</div> <div>The need for further study of root rot management noted under “Summary of Information and Research Needs,” page 41.</div>	5. N/A																											
♦ LT 6	6. Plant areas outside of the THLB to increase the area in an old-seral state in 100 to 200 years. (maintain)	6. This opportunity was not discussed during the district workshop. Not likely to be practiced in the foreseeable future.	6. N/A.																											

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
	<u>Long Term Harvest Forecast Summary</u>	(000s m3/yr)	
		159 base case	
		<u>32</u> site productivity (20%)	
		191 adjusted base	
		0 increase THLB	
		13 increase regenerated stand volumes (7%)	
		15 ungulate (8%)	
		0 root rot	
		<u>0</u> plant outside THLB	
		219 total	

Draft

Potential Harvest Forecast

Figure 9 graphs the potential harvest level that may be attained through implementation of the silvicultural strategies in the preceding tables. This forecast is highly speculative and requires confirmation through computer-based modeling and analysis. It also includes silvicultural activities that are not within the traditional scope of incremental silviculture. Modeling may indicate more precise timing, targeting and program levels associated with incremental silviculture activities than could be developed in this interim strategy.



In the strategy workshop, some uncertainties regarding the base case were mentioned. At the time this strategy was prepared, the chief forester had not yet made the TSR2 AAC determination, so it was not known how he will view the base case forecast. Figure 9 contains only an adjustment for increased site productivity which appears fairly certain (OGSI line). Other, potentially negative influences may exist but are not accounted for here. The difference between the two higher forecasts illustrates the potential outcome of the strategy. This difference would likely remain the same regardless of any base case amendment. The potential harvest level primarily results from improved caribou habitat management and increased regenerated stand volumes.

Figure 9. Potential harvest forecast, Revelstoke TSA

Opportunities to Improve Timber Quality

The effects of incremental silviculture on the future quality of the timber resource is not analyzed in the timber supply review. Information in this section was gathered during the district working session.

Product Objectives

The following are product objectives at the log level for the Revelstoke TSA.

<u>Quality Class</u>	<u>Species</u>	<u>Characteristics</u>
Premium Log:	S	45+ cm minimum average stand diameter at breast height (DBH), some clear wood component.
	Hw, Cw	35+ cm minimum average stand DBH, some clear wood component.
Sawlog:	All	25+ cm minimum average stand DBH.

Potential Strategies by Response Time Frame

The following strategies have potential to increase timber quality. These were identified in the district working session, 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.

Response Time Frame	Potential Strategy/Action	Discussion / Current Status	Anticipated Result	Premium Log Forecast																				
◆ 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 recent coast-wide estimate of 15%.	15%?																				
◆ Mid Term (21 - 70 yrs)	As above.	As above.	As above.	Steady decline to long term level.																				
◆ Long Term (71 + yrs)	Q1. Two lift prune 25 ha/yr to 5.5 m.	<p>1. Max historic program has been 50 ha/yr. This equates to 25 ha under 2-lift management. If this were an annual program, would equal (25/480 ha/yr harvested =) 5% of THLB. If 5 m = 25% of tree vol, (.05 X .25 =) 1.25%/yr of future harvest volume will be clear logs resulting from pruning.</p> <p>Because of epicormic branching problems with spruce, this species is best pruned once the prunable branches have died.</p> <p>Pruning only the dominant trees in a stand will yield a greater clear volume at lower cost. Estimate this could increase clear log component to 2.5% with a 50 ha/yr pruning program.</p> <p>The following guesses were made at the % clear volume which could result from extended rotations due to caribou habitat requirements.</p> <table><tr><th><u>Age</u></th><th colspan="3"><u>% clear by species</u></th></tr><tr><th></th><th><u>S</u></th><th><u>C</u></th><th><u>H</u></th></tr><tr><td>250</td><td>1</td><td>12</td><td>5</td></tr><tr><td>140/150</td><td>0</td><td>3</td><td>3</td></tr><tr><td>100</td><td>0</td><td>0</td><td>0</td></tr></table> <p>If Cw is 20% of future species, the caribou zone is 50% of the total land base and extended rotations are on 10% and 40% of the caribou zone, the future % of clear Cw on an unmanaged, extended rotation basis would be as follows:</p> <p>On areas managed to age 250: = .2 X .5 X .1 X .12 = 0.1%</p>	<u>Age</u>	<u>% clear by species</u>				<u>S</u>	<u>C</u>	<u>H</u>	250	1	12	5	140/150	0	3	3	100	0	0	0	1.	2.5% clear log content. See also the large log analysis below.
<u>Age</u>	<u>% clear by species</u>																							
	<u>S</u>	<u>C</u>	<u>H</u>																					
250	1	12	5																					
140/150	0	3	3																					
100	0	0	0																					

Response Time Frame	Potential Strategy/Action	Discussion / Current Status	Anticipated Result	Premium Log Forecast
		On areas managed to age 140: = .2 X .5 X .4 X .03 = <u>0.1%</u>		
		Total 0.2%		
		However, meeting the objective of managing for caribou stand conditions at younger ages would virtually eliminate this clear log component.		

Draft Large Premium Log Analysis

Spacing for the purpose of improving future timber quality was not assessed during the workshop. A post-workshop large log analysis (below) indicates that with a 120 ha/yr spacing program approx. 5.9% of future volumes harvested would consist of large premium logs assuming all stands are harvested at culmination. If regenerated stand volumes were increased by 20% (high by current best estimate) and allowing for delayed harvesting due to caribou constraints, this could rise to approx 8.8%. A projection of large premium log content without spacing was not conducted, but would likely be somewhere in the 4% range, based on analyses done for other TSA's.

It should be noted that the large log specifications for the Revelstoke TSA are likely high compared to other interior locations. In particular, based on TIPSy, the spruce specifications are largely unmet. (The need for further investigation of TIPSy modeling of spruce has been noted elsewhere.) Given spruce is the most common species, this is a significant shortfall in meeting the large log requirements.

Another observation from the large log analysis is that from scenario 2, all else being equal, cedar stands would be the best candidates for managing for longer time frames for caribou habitat. Periodic annual increment (PAI) for cedar over the 50 years from culmination at age 110 to age 160 is 5.0 m³/ha/yr, more than 2 time the PAI of spruce between culmination age 100 and age 160. Again, the poor spruce showing may be related to TIPSy limitations.

Assumptions

Avg. annual area harvested = 480 ha Utilization std = 12.5 cm dbh for all species

TIPSY ver 2.1d OAF1 = 15% OAF2 = 5% Ages in 10 yr steps All areas planted to 1500 sph.

all species to 35 cm large log, except Sw which is 45 cm. Because TIPSY table dbh classes are mid points, this translates in TIPSY yield tables to 40 and 50 cm respectively

% ≥ 40/50 cm is from TIPSY stock table, rounded to nearest 5%.

Bottom 5m log = 25% of tree vol.

% large of total ann. harv. volume = (Area/480) X (% ≥ 40/50 cm) X (25% of tree vol.)

Assume ¼ of areas are spaced (120 ha/yr total), of this 60 ha is in Hw, 30 ha in Cw, 15 ha in each of Fd and Pl, none in Spruce or Ba.

SCENARIO 1

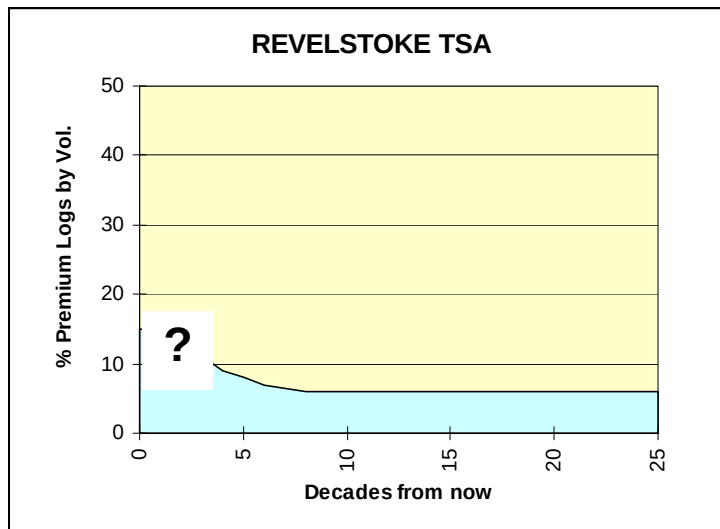
SI from SIBEC/ISIS project.	Species	%inv	SI	Space frm/to:	Area	Cul Age	Yield	% ≥ 40/50cm	% large	5.9% premium log content, 3.0% from spaced stands and 2.9% from unspaced stands. Without pruning none of this will be clear.
	Sw	35	15	1500/unspaced	170	110	366	1 ¹	0.0	
Expected <u>future</u> species profile.	Hwi	25	18	4000/900	60	110 ²	477 ³	45	1.4	¹ only Sw has req'mt of >50 cm. ² spacing raises culmination age ³ 431 at age 100 ⁴ 574 at age 120 ⁵ % likely higher - some 2 nd logs will be ≥ 40cm ⁶ 291 at age 60
				1500/unspaced	60	100	464	25	0.8	
	Cw	20	18	3000/900	30	130 ²	622 ⁴	70 ⁵	1.1	
				1500/unspaced	65	120	587	45	1.4	
	Fdi	10	23	3000/900	15	100	475	55	0.4	
				1500/unspaced	30	100	480	45	0.7	
	Pl	5	22	4000/900	15	70 ²	343 ⁶	15	0.1	
				1500/unspaced	10	60	305	5	0.0	
	Ba	5	-	1500/unspaced	25				0.0	
	Total				480				5.9	

SCENARIO 2										
Expected <u>future</u> species profile.	Species	%inv	SI	Space frm/to:	Area	Cul/Rot Age	Yield	% ≥ 40/50cm	% large	8.8% large premium log content, 3.6% from spaced stands and 5.2% from unspaced stands. Some of this will be clear.
20% yield gain modeled by choosing SI yielding nearest to a 20% MAI gain over SIBEC/ISIS project SI's for spaced stands. ½ of unspaced stands held until age 160 to reflect caribou re-quirements.	Sw	35	17	1500/unspaced	85	100	390	1 ¹	0.0	
					85	160	493	5	0.2	
	Hwi	25	20	4000/900	60	110 ²	570 ⁴	60	1.9	
				1500/unspaced	30	90	493	25	0.4	
					30	160	770	70 ⁵	1.2	¹ only Sw has req'mt of >50 cm.
	Cw	20	20	3000/900	30	110	654	70 ⁵	1.1	² spacing raises culmination age
				1500/unspaced	30	110	665	55	0.9	
					35	160	915	75 ⁵	1.4	⁵ % likely higher - some 2 nd logs will be ≥ 40cm
	Fdi	10	25	3000/900	15	100	562	70 ⁵	0.5	⁴ 462 at age 90
				1500/unspaced	15	100	560	60	0.5	
					15	160	745	85 ⁵	0.6	⁵ TIPSYS data only goes to age 90
	Pl	5	24	4000/900	15	60	347	15	0.1	
				1500/unspaced	5	60	357	5	0.0	
					5	90 ⁵	463	15	0.0	
	Ba	5	-	1500/unspaced	25				0.0	
	Total				480				8.8	

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 (4-6% forecast vs. assumed current estimate of 15%).

Postponing harvest to ages that are past culmination age would increase the large dimension component of premium logs. This is a significant factor in this TSA, given the requirements in the caribou zone (49% of THLB) to maintain 40% of stands ≥ 140 yrs of age and 10% ≥ 250 yrs. However, it is unknown how much of this requirement is met within the THLB.



This quality forecast is for a combination of clear logs and large-dimension logs. Large logs could form 6% of future harvests (based on spacing 120 ha/yr) and clear logs 2.5% (based on pruning 50 ha/yr). Some large logs will also be clear logs.

Figure 10. Potential Quality Forecast, Revelstoke TSA

Incremental Silviculture Strategy

This section synthesizes the preceding background information, workshop discussion and subsequent analysis into an incremental silviculture strategy for the TSA.

General Strategy

The primary objectives of the silviculture strategy are to:

- increase regenerated stand volumes by 7%;
- space 5 000 ha of stands in the harvest queue for decades 8 and 9 to ensure they will be of merchantable size at that time;
- research the desired stand characteristics for caribou lichen forage production in order to determine the need and opportunity, if any, for silvicultural management of stands for this purpose; and
- partially offset anticipated future lower log quality by pruning 50 ha/yr of suitable young stands (the requirements for significant areas to be in an older forest condition will also contribute to higher quality future stands).

Accomplishing these objectives requires a program substantially above historic levels.

Working Targets

The preceding analysis indicates the following working targets are attainable. Figure 11 illustrates these. Achieving these targets requires a substantially higher incremental silviculture program level than in the past.

WT 1 (Quantity): Manage long term timber supply to yield a harvest of 0.22 million m³/yr.

WT 2 (Quality): Manage regenerated stands to yield at least 6% (by volume) premium large logs having a 2.5% clear log component, with the majority of the remainder being of sawlog quality.

The preceding working target for timber quantity and Figure 11 below incorporate an upwards adjustment for increased site productivity. Other, potentially negative influences may exist but are not accounted for. The targets may require adjustment following the chief forester's TSR2 AAC determination which was not yet released at the time these targets were developed.

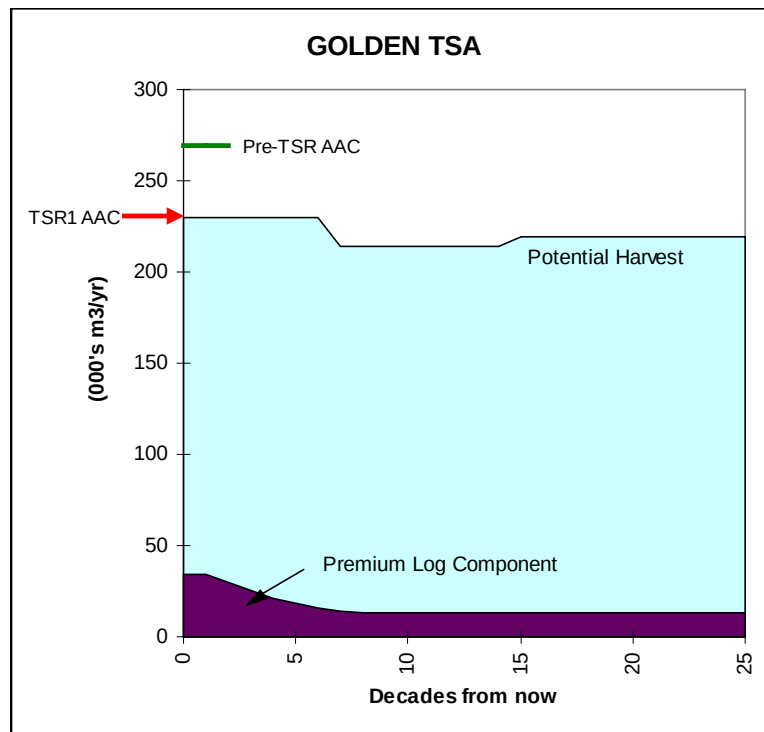


Figure 11. Combined Potential Quantity and Quality Harvest Forecasts, Revelstoke TSA

Log Product Objectives

The following are product objectives at the log level for the Revelstoke TSA.

<u>Quality Class</u>	<u>Species</u>	<u>Characteristics</u>
Premium Log:	S	45+ cm minimum average stand diameter at breast height (DBH), some clear wood component.
	Hw, Cw	35+ cm minimum average stand DBH, some clear wood component.
Sawlog:	All	25+ cm minimum average stand DBH.

Silviculture Strategies

The following strategies have identified potential to maintain and/or increase the quantity and quality of the timber supply of the Revelstoke TSA. Strategy numbers correspond with those recorded earlier.

◆ Strategies to Increase the Quantity of Future Timber Supply

Some of the following are not within the traditional scope of incremental silviculture but are included here for completeness. Some practices are pre free-growing and are not likely to be undertaken by licensees without funding assistance if free growing obligations can be achieved without them.

These strategies are supported by specific silvicultural regimes listed on page 38 along with investment priorities.

<u>No.</u>	<u>Strategy</u>	<u>Priority</u>
General	Conduct silviculture surveys in support of all strategies.	1

Short Term

There are no strategies to increase the quantity of timber in the short term.

Mid Term

MT2	(See "Summary of Information and Research Needs.")	
MT4	Ensure stands at the beginning of the long term harvest queue (decades 8 & 9) are available by spacing 5 000 ha of dense hemlock/cedar stands over 10 years.	4

Long Term

LT1	Maintain the timber harvesting land base by:	
	(a) Treating approximately 200 ha of backlog NSR.	3
	(b) Maintaining approximately 400 ha of previously reforested backlog plantations.	2
LT2	Survey 1 600 ha of deciduous stands to determine their potential and suitable silviculture treatments.	
LT3	Increase the volume of regenerated stands by 7% by:	
	i) using improved seed as available (currently available for 80% of spruce stock); (increase)	2
	iii) using larger planting stock on approximately 20% of areas; (increase)	7
	iv) fertilizing approximately 80% of trees at the time of planting; (increase) [does not match workshop writeup]	5
	v) brushing 400 ha/yr for growth enhancement (i.e., not only for survival); (increase) and	6
	vii) repeat fertilize 450 ha/yr on a 15 yr return cycle.	8
LT4	Continue MT 2 as appropriate.	

◆ **Strategies to Increase the *Quality* of Future Timber Supply**

<u>No.</u>	<u>Strategy</u>	<u>Priority</u>
Q1	Prune 25 ha/yr to 5.5 m in two lifts (requires a program of 50 ha/yr) to create knot-free timber in the bottom 5.0 m log.	4

◆ **Strategies to Increase the *Quantity* or *Quality* of Future Habitat Supply**

The following strategy has identified potential to increase the quality or quantity of the habitat supply of the Revelstoke TSA.

<u>No.</u>	<u>Strategy</u>
	No specific strategies proposed at this time. See “Summary of Information and Research Needs for caribou habitat.”

Draft

Silviculture Regimes and Investment Priorities

The following table indicates incremental silviculture regimes which are suitable to attaining the above working targets and strategies.

Regimes	Strategy	Opportunity Area (Ha/Yr)	Timber Supply Effects			Quality	Habitat	Jobs Days/ha	Direct Cost \$/ha ¹	Wkshp Rank
			Short	Medium	Long					
Surveys		3600							25	1
Backlog										
1 rehab site prep	LT1a	100	0	0	++	++	+	1	800	3
2 rehab planting	LT1a	100	0	0	++	++	+	1	400	3
3 brushing (plant + maintenance)	LT1a,b	400	0	+	++	++	+	1.5	500	2
Pre FTG¹										
4 improved seed	LT1	250	0	0	+++	+	0			2
5 large stock	LT3	100	0	0	+	+	0	0.5	400	6
6 fertilize at planting	LT3	480	0	0	+	+	0	0.1	150	5
7 brushing for growth	LT3	400	0	0	+	+	0	1.5	500	6
Post FTG										
8 space	MT4	500	0	++	0	0	+/-	2.5	800	4
9 fertilize (multi fert)	LT3	450	0	+	+	0	+/-	0.1	250	8
10 Prune (spaced) 1st lift	Q3	25	0	0	0	+++	+/-	4	800	4
11 Prune (spaced) 2nd lift	Q3	25	0	0	0	+++	+/-	4	800	4

¹FTG - Free to Grow. Pre-FTG activities are not included in the program or jobs table.

Incremental Silviculture Program

The following annualized program will contribute to achieving the above goals and strategies. This program is considerably above historic levels and some activities may require phasing in. However, it does not include activities that may be required for caribou habitat management (pending research results). Spacing and pruning goals represent an anticipated upper bound. Lesser program levels should be oriented to specific target stands as shown in the regime table.

Program Table - Ha, Revelstoke TSA, March 1999 (not including Pre-FTG activities)

Year	Surveys *	Backlog Site Prep	Backlog Planting	Backlog Brushing	Space	Prune	Fertilize
1	3,600	100	100	400	500	50	450
2	3,600	-	100	300	500	50	450
3	3,600	-	-	200	500	50	450
4	3,600	-	-	200	500	50	450
5	3,600	-	-	100	500	50	450
Subtot Yr 1 - 5	18,000		200	1,200	2,500	250	2,250
6 - 10	18,000	-	-	150	2,500	250	2,250
Total Yr 1 - 10	36,000		200	1,350	5,000	500	4,500

* Includes prescription and layout

Unit cost (\$/ha)	25	800	400	500	800	800	250
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Program Table - \$ 000s, Revelstoke TSA, March 1999 (not including Pre-FTG activities)

Year	Surveys *	Backlog Site Prep	Backlog Planting	Backlog Brushing	Space	Prune	Fertilize	Total
1	90	80	40	200	400	40	113	963
2	90	-	40	150	400	40	113	833
3	90	-	-	100	400	40	113	743
4	90	-	-	100	400	40	113	743
5	90	-	-	50	400	40	113	693
Subtot Yr 1 - 5	450	80	80	600	2,000	200	563	3,973
6 - 10	450	-	-	75	2,000	200	563	3,288
Total Yr 1 - 10	900	80	80	675	4,000	400	1,125	7,260

Job Outcomes

The following are the anticipated job outcomes associated with the preceding program, assuming the program is maintained into the future as necessary to achieve the working targets. The long term jobs table includes the potential harvest increment associated with caribou habitat management on the basis that either the habitat requirements will prove (through research conducted under this strategy) to be either currently over-stated or if not, to be achievable at younger stand ages through silvicultural treatments.

Program Job Outcomes, Revelstoke TSA, March 1999 (not including Pre-FTG activities)

Short term employment associated with undertaking the silviculture activity, in person years

Year	Surveys*	Backlog Site Prep	Backlog Planting	Backlog Brushing	Space	Prune	Fertilize	Total
1	1.80	0.50	0.50	3.00	6.25	1.00	0.23	13.28
2	1.80	-	0.50	2.25	6.25	1.00	0.23	12.03
3	1.80	-	-	1.50	6.25	1.00	0.23	10.78
4	1.80	-	-	1.50	6.25	1.00	0.23	10.78
5	1.80	-	-	0.75	6.25	1.00	0.23	10.03
Subtot Yr 1 - 5	9.00	0.50	1.00	9.00	31.25	5.00	1.13	56.88
6 - 10	9.00	-	-	1.13	31.25	5.00	1.13	47.50
Total Yr 1 - 10	18.00	0.50	1.00	10.13	62.50	10.00	2.25	104.38

Note: Assumes 200 days of harvesting, silviculture work, and timber processing = 1 job (Source Revelstoke TSR2 SEA)

Long term employment associated with improved quality and quantity of the timber resource¹

Decade	Harvest Increment ('000 m3)	Incremental Jobs			
		per year by decade		Total by decade	
		TSA ²	Prov ³	TSA ²	Prov ³
1	-	-	-	-	-
2	-	-	-	-	-
3	-	-	-	-	-
4	-	-	-	-	-
5	23	32	65	320	646
6	44	61	124	612	1,236
7	28	39	79	389	787
8	28	39	79	389	787
9	28	39	79	389	787
10	28	39	79	389	787
11	28	39	79	389	787
12	28	39	79	389	787
13	28	39	79	389	787
14	28	39	79	389	787
15	28	39	79	389	787
16	28	39	79	389	787
17	28	39	79	389	787
18	28	39	79	389	787
19	28	39	79	389	787
20	28	39	79	389	787
21	28	39	79	389	787
22	28	39	79	389	787
23	28	39	79	389	787
24	28	39	79	389	787
25	28	39	79	389	787
Total				8,326	16,832

Notes:

1. Assumes continuation of on the incremental 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 the "Opportunities" section and is only partly attributable to spacing and fertilization practices. Some of the increase may be associated with pre-free growing silviculture that was not current practice at the time of TSR2.

2. Assumes 1.39 TSA level direct (harvesting, silviculture, processing), indirect and induced (PYs) per 1000 cubic metre (Source: Revelstoke TSR2 SEA Table 13, p.

3. Assumes 2.81 Province level direct (harvesting, silviculture, processing), indirect and induced (PYs) per 1000 cubic metre (Source: Revelstoke TSR2 SEA Table 1

Summary of Information and Research Needs

During the assessment process, the following needs for further information and research became apparent. 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 “Workshop Review of Potential Strategies,” page 15).

1. Conduct the following research and assessments related to lichen forage production for caribou to determine if silvicultural actions can be beneficial: (MT2)
 - a) Research the desired stand characteristics for caribou lichen forage production and determine at what age they occur.
 - b) Conduct additional FSSIM modeling and analysis of the medium and high emphasis biodiversity constraints. It is unknown how the imposition of these biodiversity constraints might affect the results of the special caribou run and when the ages at which caribou constraints no longer become limiting.
 - c) If research indicates the desired stand characteristics do not occur unaided at desired younger ages (or if ages are older than currently modeled), design and apply silvicultural treatment regimes to create them. The extent of the benefit to the harvest forecast would depend upon the availability of treatable stands and the economics of silvicultural treatments. Conduct field analysis to locate these stands and determine the total opportunity.
2. TIPSy yields and diameters for older spruce stands require confirmation. (MT2)
3. Further analysis of suitability and effect of fertilizing young Fdi and Pl stands for the purpose of ensuring these stands are of merchantable size in 80-90 years is needed. (MT4)
4. A survey of deciduous stands is required to determine their potential and suitable silviculture treatments, if any. (LT2)
5. Fertilization trials are needed to determine if the fertilizable land base could be expanded to include spruce or hemlock. (LT3)
6. OAF 1 factor of 15% requires confirmation. Survey techniques are available. Requires statistical validity at the management unit level if to be used for AAC determination. (LT3)
7. Further study of root rot management techniques and options is needed. (LT5)
8. Old growth site index estimation studies require completion. It is anticipated that site indexes may be underestimated for Cw and Hw.

References

- B.C. Ministry of Forests. 1998a. *Guidance towards Participation in the Forest Renewal BC Planning Process and the Development of Resource Management Plans*. Victoria, British Columbia. 20p.
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- Hawe, Angela. 1996. *Review of Past Partial-Cutting Activities in the Nelson Forest Region (1988 - Present)*. Technical Report MIT-001, prepared for the B.C. Ministry of Forests, Nelson Forest Region, Nelson, B.C. 67p.
- Timberline Forest Inventory Consultants Ltd. 1997. *Forest Level Benefits to Commercial Thinning and Fertilization*. Prepared for the B.C. Ministry of Forests, Forest Practices Branch, Victoria, British Columbia. 64p.
- Wang, Eric and John Pollack. 1998. *The Effects of Partial Cutting On the Wood Supply of the Arrow, Cranbrook and Golden TSAs*. MoF internal technical report prepared for the Kootenay-Boundary Forest Resource Task Force. Ministry of Forests, Nelson, BC. 37p.

Abbreviations

The following abbreviations may be used.

AAC	allowable annual cut	NCBr	non-commercial brush
CF	chief forester	NSR	not satisfactorily restocked
CT	commercial thinning	OAF	operational adjustment factor
DBH	diameter at breast height	OLB	operable land base
ESSF	engelmann spruce - subalpine fir (ecological zone)	SBFEP	small business forest enterprise program
FCC	forest cover constraints	SI	site index
FG	free growing	ST	short term
FRBC	Forest Renewal BC	TFL	tree farm licence
ICH	interior cedar-hemlock (ecological zone)	THLB	timber harvesting land base
IHL	initial harvest level	TIPSY	table interpolation program for stand yields
IRM	integrated resource management	TSA	timber supply area
KBLUP	Kootenay-Boundary Land Use Plan	TSR	timber supply review
LT	long term	VDYP	variable density yield projection
LTHL	long term harvest level	VQO	visual quality objective
LRSY	long run sustained yield	WT	working target
MoELP	Ministry of Environment, Lands and Parks		
MoF	Ministry of Forests		
MS	montane spruce (ecological zone)		
MT	mid term		

Species abbreviations: B or Ba - balsam fir; Cw - western redcedar; Fd - Douglas-fir; Fdi - interior Douglas-fir; Hw - western hemlock; Pl - lodgepole pine; S - spruce species.

Site class abbreviations: G - good; M - medium; P - poor; L - low.

Appendix A: Additional Document Detail

<u>Section</u>	<u>Source</u>	<u>Prepared</u>
Strategy at a Glance	Executive Summary - captures the essence of the final silviculture strategy.	Post - workshop.
Basic Data	Timber Supply Review reports.	Pre-workshop.
Issues		
- Individual Issue Analysis	Consultant's review and analysis of available documentation, mostly Timber Supply Review reports, in advance of preparing potential strategies for workshop discussion.	Pre-workshop.
- Illustration of Issues and Silvicultural Opportunities	Charts - timber supply review, prepared pre-workshop as a Powerpoint presentation to facilitate workshop discussion of issues and opportunities. Commentary - added post workshop but largely illustrates the findings of the individual issue analysis. May incorporate some workshop findings.	Pre-workshop, workshop, post-workshop.
- Summary of Issues by Period	Prepared in advance of the workshop as a summary of the timber supply dynamics of the management unit, to facilitate development of potential strategies for workshop discussion. May be amended post-workshop to incorporate new insights, findings resulting from the workshop review.	Mostly pre-workshop. Some post-workshop.
Incremental Silviculture History	Past history - Timber Supply Review. Current history - workshop participants.	Pre-workshop, workshop.
Higher Level Goals and Objectives	Ministry of Forests documents - see references	Pre-workshop.
Opportunities to Increase Timber Supply		
- Potential Strategies	Consultant's proposals, based on the issue analysis, to facilitate workshop discussion. Strategy numbers are carried throughout the documentation for tracking purposes. Potential strategies can be related back to the Silvicultural Opportunities columns of the issue analysis.	Pre-workshop.
- Workshop Review of Potential Strategies	Documentation of the workshop session.	Workshop

<u>Section</u>	<u>Source</u>	<u>Prepared</u>
Potential Strategies		
- Potential Harvest Forecast	Consultant's illustration of strategy potential based on workshop results.	Post workshop.
Opportunity to Improve Timber Quality	Note: The lack of available information on timber quality and habitat supply limited pre-workshop development of these aspects of the strategy.	
Product Objectives	District's statement of objectives and workshop discussion.	Pre-workshop, workshop.
Potential Strategies	Partially consultant's proposals to facilitate workshop discussion. Mostly developed in the workshop. Strategy numbers are carried throughout the documentation for tracking purposes.	Some pre-workshop, mostly workshop.
Large Premium Log Analysis	Prepared by consultant in advance of workshop to facilitate workshop discussion. Modified afterwards to reflect workshop strategies.	Pre-workshop, workshop, post-workshop.
Potential Quality Forecast	Consultant's illustration of strategy potential based on workshop results.	Post workshop.
Opportunities to Improve Habitat Supply	Proposed by workshop participants. Incorporates post workshop commentary by MoELP.	Workshop, post-workshop.
Silviculture Strategy	Summation of the findings of the workshop, translated into a strategy. Only those potential strategies deemed feasible by workshop participants are kept. Strategy numbers correspond with those initially proposed for tracking purposes (which are founded in the issue analysis). Strategies are ranked in keeping with the treatment rankings of the regime table.	Post workshop.
Silviculture Regimes and Investment Priorities	Prepared during the workshop. Recorded here as part of the final strategy (rather than under the workshop) to avoid unnecessary duplication.	Workshop.
Silviculture Program	Basic program elements prepared during the workshop. Program developed later by consultants.	Workshop, post-workshop.
Job Outcomes	Basic factors from workshop participants. Calculations performed later by consultants.	Workshop, post-workshop.

Appendix B: Detailed Issues and Silvicultural Opportunities Analysis

Timber Quantity Issue Analysis

The following information is primarily from documentation produced under the second timber supply review, or TSR2. Sources are noted, with full references given on page 41. Only information which is relevant to a silviculture strategy is recorded. Unless otherwise specified, page references are to the TSR 2 timber supply analysis report for the Revelstoke TSA. Key statements are bolded.

Issue	Description	Discussion	Silvicultural Opportunities	
			Increase Over Base Case	Maintain Base Case
♦ Harvest Forecast	<p>The initial harvest level of 230 000 m³/yr (TSR1 AAC) can be maintained for 4 decades, followed by successive declines of 10%/decade over 3 decades to a long term harvest level of 159 000 m³/yr (31% below the TSR1 AAC) reached 70 years from now. (p. 20-21)</p> <p>Harvest levels must decrease to the LTHL because over time less harvesting occurs in high-volume, older stands and more in second-growth stands which are harvested at younger ages and therefore generally have lower volumes. (p. 22)</p> <p>The first regenerated stands become available for harvest in 60 years (p. 23). After 100 years, the majority of the harvest is from regenerated stands (p. 26). A small number of existing stands continue to be harvested past this point (p. 36).</p> <p>If all stands were harvested at the age of maximum productivity, LTHL would be 28% higher than the base case.</p>	<p>Most TSA's have a LRSY 5-10% above LTHL. The 28% gap indicates significant constraints on LT. This appears to be largely associated with caribou habitat requirements.</p>		
♦ Age Class	<p>Approximately 24% of stands in the timber harvesting land base (THLB) are 20 years or younger, including stands in the not satisfactorily restocked (NSR) and regeneration (Regen) categories. Only 19% of stands are between 21 and 140 years old, and 57% are older than 140 years. (see pie chart)</p>	<p>Overall, there is an abundance of older forests and a high proportion of stands younger than 20 years old. There are relatively few stands in between which results in fairly rapid transition to LTHL by 7th decade.</p>		

Issue	Description	Discussion	Silvicultural Opportunities	
			Increase Over Base Case	Maintain Base Case
♦ Silvicultural Systems	Silvicultural systems not explicitly stated. 97% of the THLB is currently managed under a clearcut harvesting system (Hawe, 1996:37). Analysis report Table A-17 indicates all areas are planted with a 2 yr regen delay, except for backlog NSR areas which are expected to regenerate naturally over a 3 year period (p.108-9). Planting is to similar species to those harvested. (p 11)			
♦ NSR	Total NSR = 4 918 ha, of which 3 128 is current (referred to in this document as RWS for ‘regenerating within standards’) and 1 800 ha is backlog NSR (referred to as NSR). (p.111) All NSR was included in the analysis, to be regenerated under different analysis units, depending upon existing stocking levels. (p. 110) RWS area assumed for normal stocking of 1 500 st/ha.			Failure to restock NSR would result in a slightly lower LTHL than in the base case.
♦ Land Base	<p>New inventory classified 19 000 more ha of productive forest, of which 4 942 ha (7%) is in THLB. (p. 52)</p> <ul style="list-style-type: none">• 1 597 ha of deciduous stands (equiv to 2% of THLB) deducted from THLB (p. 9).• 1 176 ha (equiv to 2% of THLB) of low productivity forest types deducted from THLB. Stands with an SI below 8 are excluded on the basis they would not likely attain a 25 cm dbh before 120 years of age. (p.97)• 4 868 ha (equiv to 7% of THLB) of hemlock pure stands (3 473 ha) or balsam-leading stands (1 395 ha) greater than 140 years of age deducted from THLB as non-merchantable based on current forest management practices and recent harvesting performance. (p. 97) These stands are physically operable and have adequate productivity but are not currently utilized due to low quality timber. (p. 8) <p>Sensitivity test ± 7% of THLB. Area in all stand types and ages both increased and decreased. (p. 52)</p> <p><u>Decrease:</u> (-7%) Moderately sensitive. Initial harvest level (IHL) can be maintained for 3 decades, 1 less than the base case. Same rate of decline as base case to long term harvest level (LTHL) 7% lower than base case.</p> <p><u>Increase:</u> (+7%) Moderately sensitive - initial harvest level can be maintained 1 decade longer than base case (5 vs 4). LTHL 7% above base case.</p>	With the relatively small THLB this TSA is at risk to catastrophic fires and insect outbreaks. Risk of these occurring is relatively low, however.	Rehabilitate/convert deciduous (often in riparian areas) and/or non-merch types? Fertilize low productivity stands?	

Issue	Description	Discussion	Silvicultural Opportunities	
			Increase Over Base Case	Maintain Base Case
♦ Forest Cover	<p><i>Ungulate Winter Range, Caribou & Integrated Resource Management (IRM) Zones: 15%, 49%, and 39% of THLB (p. 18).</i></p> <p>Base case requirement of at most 25% of the THLB of the IRM zone and 25% of the <u>operable land base</u> of the wildlife zones permitted to be < green-up ht (2 m (p 102)).</p> <p>Sensitivity test of ± 10% of area allowed to be not greened up. (p. 42-43)</p> <p><u>Relax Constraint:</u> (+10% to 35%) Insensitive. Base case is not significantly affected by maximum disturbance levels in the wildlife & IRM zones.</p> <p><u>Increase Constraint:</u> (-10% to 15%) Moderately sensitive - initial harvest level (IHL) can be maintained 3 decades, 1 less than the base case. LTHL 5% below base case.</p> <p><i>Visual Quality Zones:</i></p> <p>Retention - 2% of THLB; partial retention - 4% of THLB (p. 16). Base case requirement of at most 5% of retention and 15% of partial retention visual quality objective (VQO)) to be < 6 m tall (p 16).</p> <p>Sensitivity test of either removing requirements entirely, or shifting the requirements to the next most restrictive category had no effect. (p.41)</p> <p><i>Green-up:</i></p> <p>Green-up period is a combination of green-up age and regen delay (p 40). Green-up ages are 15 yrs for 2m ht, 29 yrs for 6m ht (VQO + domestic watersheds) and 38 yrs for 9 m ht (community watersheds) (p. 102). Regen delay is 2 yrs (p 108-9).</p> <p>Sensitivity test of ± 10 years in green-up period. (p. 40-41)</p> <p><u>Relaxation of constraint:</u> (- 10 yrs) Insensitive over short and mid term. LTHL slightly above base case (1%?).</p> <p><u>Increase Constraint:</u> (+ 10 yrs) Slightly sensitive - initial harvest maintained for 1 decade less than base case (3 vs. 4). LTHL 1% lower. An increase in ages restricts supply because at any time more area is likely to be below green-up age, meaning max disturbance limits are reached sooner.</p>	<p>The constraint threshold is somewhere between 15 - 20% of area not greened up. Relaxing the constraint beyond the threshold will not increase timber supply because other constraints then become limiting.</p> <p>The low response to reducing green-up age can be questioned. About 90% of the TSA is managed for 2m ht. with a 17 yr green-up period. Reducing this by 10 yrs means a green up period of 7 yrs. There should be a considerable productivity increase shown with this. LTHL avg. harvest age should drop from 105 yrs (p 26) to 95 yrs. A 10% productivity increase could therefore be expected.</p>	<p>Targeting reduction in time until green-up may offer more potential than indicated by the sensitivity test. (LT)</p>	

Issue	Description	Discussion	Silvicultural Opportunities	
			Increase Over Base Case	Maintain Base Case
Draft	<p><i>Caribou & Ungulate Winter Ranges - thermal cover requirements:</i></p> <p>(64% of THLB - 49% caribou, 15% ungulate) Base case modeled on basis that at all times at least 40% must be in stands 100 yrs or older in the ungulate winter range zone and in stands 140 or older in the caribou zone) and no more than 25% in stands less than 2 m tall. Unclear as to treatment of caribou requirement of 10% ≥ 250 yrs of age.</p> <p>Sensitivity test of ± 5%, ± 10% of area from base case. (p.49)</p> <p><u>Increase Constraint (+5, 10% to 45, 50%):</u> IHL can be maintained 1 or 2 decades less than base case, respectively. LTHL basically insensitive to a 5% increase, but falls 6% below base case with a 10% increase.</p> <p><u>Relax Constraint (-5, 10% to 35, 30%):</u> A 5% relaxation gives similar but inverse response as a 5% increase (otherwise not discussed). A 10% relaxation allows the IHL to be maintained 2 decades longer (6 vs. 4) and increases LTHL by 6%.</p> <p>Additional info is provided in the analysis report re winter range only and caribou zone only sensitivities. A 5% increase in caribou habitat area lowers LTHL 5%, which appears to be greater than when all areas have increased requirements. A 10% increase does not change this much. (p 49).</p>	<p>See “<i>Uncertainty in the size of caribou zone</i>” below.</p>	<p>Opportunity to extend IHL (MT) and increase LTHL (LT) by emulating older forests sooner? Would need to know impact of reduced ages which was not modeled here (reduced area was modeled).</p>	<p>If the range requirements are underestimated by 10% the IHL can only be maintained for 2 decades and LTHL would Fall 6%. This presents some risk to the base case due to the uncertainty of requirements.</p>
	<p><i>Uncertainty in the size of caribou zone:</i> (49% of THLB)</p> <p>Base case includes requirements that at least 10% of the physically operable forest (an area larger than the THLB) must be in stands 250 years old or older and at least 40% of the operable forest be in stands 140 years or older. These requirements must be met within each landscape unit and in both the ESSF (11 084 ha) and ICH (21 896 ha) biogeoclimatic zone areas within each landscape unit (p. 15). These requirements are much more stringent than old-forest requirements for other values.</p> <p>Sensitivity test of completely removing the caribou guidelines and of increasing the zone by 2 600 ha (4% of THLB). (p. 47-8)</p> <p><u>Caribou guidelines removed:</u> Very Sensitive. IHL extended 4 decades longer than the base case (8 vs. 4). LTHL 8% above base case. Over the 250 year analysis horizon cumulative harvests are 10.3% more than the base case.</p> <p><u>Caribou zone expanded 2 600 ha:</u> Short term insensitive. LTHL slightly below base case.</p>	<p>Other older forest cover requirements for the same area are less restrictive and have little or no impact on timber supply. (p. 48)</p> <p>A 10% relaxation in the preceding sensitivity test (above) lengthened IHL 2 decades and increased LTHL 6%.</p> <p>This indicates relaxing the requirement by ¼ reduces the total impact by ¾.</p> <p>Need to know impact of reduced ages (reduced area modeled).</p>	<p>Caribou guidelines are very restrictive on timber supply. Potential exists for incremental silviculture activities to help create stand conditions that meet the caribou requirements sooner (i.e., creating a forest structure that meets the needs at age 200 vs age 250 or age 100 vs 140).</p>	<p>The modeling methodology will likely overestimate the long term timber supply (see Golden TSR2 report, p 47). Opportunity to create old seral state within the THLB through spacing & CT regimes?</p>

Issue	Description	Discussion	Silvicultural Opportunities	
			Increase Over Base Case	Maintain Base Case
♦ Bio-diversity	<p><i>Landscape Level Old-Seral</i></p> <p>Biodiversity emphasis options were not modeled in the base case as landscape units had not been designated for the Revelstoke area. (p. 50) Sensitivity test of application of the MAC recommendations. The harvest forecast was insensitive to this change as well as to applying the low-emphasis biodiversity portion of the old-seral requirement at the beginning of the analysis horizon vs being phased in over 140 years as recommended by MAC. (p. 51) Timber supply is not highly sensitive to changes because mature and old forest stands outside the THLB on both the operable and inoperable forest are sufficient to meet most mature and old-seral requirements.</p>	<p>Base case LTHL is likely over-estimated. See “Age Class” above, “Biodiversity contribution from areas outside the THLB” below.</p>		<p>Use CT to create old-seral stand structures at earlier ages?</p>
	<p><i>Biodiversity contribution from areas outside the THLB</i></p> <p>Forested stands outside the THLB (“inoperable” stands) are aged but not regenerated. In 200 years the bulk of them are aged over 400 yrs with virtually none below 200 years of age (p. 30). Initially, very little of the THLB must be retained to meet older forest or wildlife habitat requirements. After 100 years, little older forest remains in the THLB. (p27).</p> <p><u>The following is from the Golden TSA.</u> It is relevant to the Revelstoke TSA because the same modeling methodology of not regenerating stands outside the THLB was used.</p> <p>[When the current age class distribution of forests outside the THLB is held constant the IHL must drop 5% below the base case and LTHL is about 10% lower, due to the increased need to use stands within the THLB to meet seral stage requirements. The base case assumption that there will be no creation of young stands in forests outside the THLB does not likely represent the future distribution of the land base and will likely overestimate the long term timber supply. (Golden TSR2 analysis report, 46-47)]</p>	<p>Not regenerating stands in the OLB likely overestimates the timber supply. The effect is likely to be similar to that of increasing ungulate cover requirements 10%. This lowered LTHL 6%.</p>		<p>Use CT to create old-seral stand structures at earlier ages. (MT, LT)</p> <p>As forested areas outside of the THLB are damaged they may revert to NSR for long time periods. For those areas outside of parks, would it be of long term benefit to consider stocking establishment? (LT)</p>
♦ Min. Harvest Ages	<p>Base case uses ages based on: age at which stands reach a min vol/ha (150 m3/ha); age to a min. 25 cm dia.; culmination age; and professional judgment. Selected min. ages range from 70 - 140 yrs for natural stands and from 60 - 140 yrs for managed stands (160 -200 yrs for backlog stands). (p 100)</p> <p>Sensitivity analyses of ±20 yrs. (p 35-36) Changes affect the timing of the transition to the LTHL (p. v)</p>	<p>Base case min ages appear close to culmination age as LTHL shows little sensitivity to changes.</p> <p>Increasing volumes at the same minimum age would be</p>		

Issue	Description	Discussion	Silvicultural Opportunities	
			Increase Over Base Case	Maintain Base Case
♦ Timber Volume Estimates	<p><u>Decrease:</u> (- 20 yrs) IHL is extended 1 decades longer than the base case (5 vs 4) followed by a decline of 10%/decade until LTHL reached at start of decade 9. LTHL 3% below base case, presumably due to stands being harvested before reaching culmination age.</p> <p><u>Increase:</u> (+20 yrs) IHL can be maintained only 2 decades, 2 less than in the base case. Timber supply in the transition period is substantially reduced. Regenerating stands must age an additional 20 years before they are considered merchantable. As a result, existing older stands must be harvested at a slower rate to allow regenerating stands to reach their harvestable age. Rate of decline same as in base case, so LTHL reached after 5 decades vs. base case 7. LTHL is 1% above base case since some stands are harvested closer to culmination age.</p>	<p>same as increasing regen stand vol's & will result in higher LTHL.</p> <p>Base case use of TIPSYS assumes stocking control at approx 1 500 st/ha. This is probably accurate, since in the Revelstoke TSA overstocking is not normally an issue.</p>		
	<p>Variable Density Yield Projection (VDYP) system used for existing stands older than 20 years. Table Interpolation Program for Stand Yields (TIPSYS) used for all regenerated stands and existing stands aged 20 or less. (p. 14)</p> <p><i>Existing stand volumes:</i></p> <p>Sensitivity test for $\pm 10\%$ in volume. Short term very sensitive. Long term slightly sensitive to either increase or decrease. (p. 36-37)</p> <p><u>Increase:</u> (+10%) IHL can be maintained 6 decades, 2 longer than the base case. Harvest level then drops 10%/decade to an LTHL slightly higher than the base case.</p> <p><u>Decrease:</u> (-10%) Very sensitive. IHL can only be maintained 2 decades (2 less than base case) before falling to a LTHL slightly below the base case LTHL.</p>	<p>TSA shows long term sensitivity to existing stand yields, because a small number of existing stands are still harvested in this time period. (p. 36)</p>	<p>Increasing vol's of existing stands would enable extending the current harvest level as well as raise mid and long term harvests. (MT, LT)</p>	<p>Inventory audit indicates volume estimates to be accurate. (p. 37) TSA not at significant risk.</p>

Issue	Description	Discussion	Silvicultural Opportunities	
			Increase Over Base Case	Maintain Base Case
♦ Site Productivity	<p><i>Existing cedar or hemlock stand volumes:</i></p> <p>Estimates can vary because of difficulty of estimating volume loss to decay. (p. 38) Hemlock and cedar stands occupy 53% of the area of the THLB (p. 11) Stand volumes are similar to those of spruce and D-fir, the next most common species, so do not have a disproportionate effect. (p 112-3)</p> <p>Sensitivity test for $\pm 25\%$ in volume. Short term very sensitive. Long term slightly sensitive to either increase or decrease. (p. 38)</p> <p><u>Increase:</u> (+25%) IHL can be maintained 8 decades, 4 longer than the base case. Harvest level then drops 10%/decade to an LTHL slightly higher than the base case.</p> <p><u>Decrease:</u> (-25%) Very sensitive. IHL can only be maintained 1 decade (3 less than base case) before falling to a LTHL 3.7% below the base case LTHL.</p> <p><i>Regenerated stand volumes:</i></p> <p>TIPSY operational adjustment factor 1 (OAF1) - 15%; OAF 2 - 5% (p. 108-9).</p> <p>Sensitivity tests for $\pm 10\%$ in volume. Short term insensitive to either. Highly sensitive to both in long term. (p. 39)</p> <p><u>Increase:</u> (+10%) Short and mid term insensitive. LTHL 9% higher than base case, starting at the beginning of decade 7, one decade earlier than in the base case.</p> <p><u>Decrease:</u> (-10%) LTHL 9% below base case.</p> <p>Effects are not fully proportional to the change in regenerated stand volumes because some existing stands continue to contribute over the long term.</p>	<p>The sensitivity results would indicate existing stands contribute about (4 X 3.7%=) 15% of long term harvests. Because average harvest age in LT is about 120 yrs these probably consist of the 19% of existing stands that are currently between 21 and 140 years old.</p> <p>No indication of whether improved seed is used and factored into regen volume estimates. Assume not.</p> <p>Average growth rate for managed stands is 25.5% more than for existing natural stands <u>with no density control.</u> (p. 23) (35% in Golden TSA - see Golden TSR2 analysis report p 54)</p> <p>See comment under “min harv ages” re spacing for density control.</p> <p>No mention of armillaria root rot.</p>	<p>As above.</p> <p>Possibilities to increase regen vol's:</p> <ul style="list-style-type: none"> • Improved seed. • Larger planting stock. • Reduce voids (OAF1). • Fertilization at planting. • Brushing for growth. <p>(LT)</p>	<p>Not sure how this relates to the inventory audit that indicates the volume estimates used are reasonably accurate (p. 37). Is there a significant risk here? Not likely a silviculture opportunity to mitigate it if there is.</p>
	<p>Over 80% of the THLB is in ages that are difficult to accurately predict site productivity. (p 43) Higher productivity will affect regenerated stand volumes, green-up ages and minimum harvest ages. The largest volume increases occur for spruce, cedar and hemlock-leading stands on M or P sites. However, statistically sound</p>	<p>Associated with the OGSi adjustment, min harvest ages may be 10-15 years lower and green-up ages 2-3 years</p>		

Issue	Description	Discussion	Silvicultural Opportunities	
			Increase Over Base Case	Maintain Base Case
	<p>data exists only for spruce.</p> <p>Sensitivity test conducted by adjusting SI's according to OGSi results for spruce only (9% of THLB) and for all eligible stands (58% of THLB). Short term insensitive to either. (p. 44-5)</p> <p><u>SI adjusted for spruce only:</u> LTHL 3% above base case.</p> <p><u>SI adjusted for all eligible stands:</u> LTHL 20% above base case. Creates a minor shortfall below LTHL in decades 5 through 14.</p>	<p>lower for affected stands. See "green-up ages" above.</p> <p>Sensitivity test hints at a change in forecast shape. Would an add'l 20% increase in regen vol's exacerbate the indicated mid term shortfall?</p>		

Timber Quality Issues

The timber supply review does not address the future quality of the timber resource. However, the review presents some information on harvested stand ages, which can be used as a broad surrogate for timber quality. Within limits, the older the stand the higher the timber quality.

◆ Available Information

The average harvested age over time is projected to decline in the next 60 years from an initial average of 320 years to 105 years. From decade 11 onwards most of the harvested stands are regenerated stands that have only recently reached minimum harvest ages, which range from 60 - 140 years. Starting in decade 14, average harvested age is about 120 years. (TSR2 report, 26)

Increasing minimum harvest ages has a substantial impact on the harvest forecast.

The caribou zone (49% of the THLB) has very high older forest requirements. At least 10% of the physically operable forest must be in stands 250 years old or older and at least 40% must be in stands 140 years or older.

◆ Discussion

Harvesting future stands at or near minimum ages indicates future timber quality will be much lower than today's. Timber will be of much smaller diameter, stem taper will tend to be greater, ring widths will be wider, there will be more juvenile wood content and there will be little clear wood.

There is some riskiness to maintaining a strictly volume-oriented focus at the expense of overall quality. Future markets must be such that a full diet of small diameter wood can be profitable. Secondary manufacturing opportunities, as well as manufacturing of very high quality products will become more limited.

The dilemma presented is choosing between volume and value. **However, some choices do not necessarily have to be made today.** Stand spacing can be performed now for the benefit of reducing minimum ages or for increasing stand value. Future markets and forest management policies will decide the ultimate allocation between quantity and quality. More attention likely is required for pruning decisions. Here, there will be trade-offs between potential log value, which could potentially increase with more time to add a larger clear-wood jacket, and earliest harvest to recover the pruning investment, which is more commensurate with timber quantity goals.

Modeling is required to have a better grasp of future timber quality scenarios.

◆ Silvicultural Opportunities

Pruning stands can develop a clear wood component to future harvests. Spacing can be used to increase the average diameters of some stands.