Golden
Timber Supply Area

Interim Silviculture Strategy

-- Version 1.3 --

British Columbia
Ministry of Forests

Funded By

Forest Renewal BC

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Contents

Figures

STRATEGY AT A GLANCE

General Strategy

The primary focus of the silviculture strategy is to:

- increase regenerated stand volumes by 20%;
- accelerate the growth of stands currently aged 20-30 years to make them available for harvest at younger ages (i.e., at lower minimum harvest ages) in the period 60 to 80 years from now; and
- partially offset anticipated future lower log quality by spacing and pruning suitable young stands.

Accomplishing this strategy requires a program substantially above historic levels.

Working Targets

WT 1 (Quantity): Minimize the anticipated interim reduction in timber supply so that harvest levels of at least 0.46 million m3/yr can be achieved in this period.

WT 2 (Quantity): Manage long term timber supply to yield a steady harvest level of 0.54 million m3/yr.

WT 3 (Quality): Manage regenerated stands to yield at least 9% (by volume) premium large logs as well as 3% (by volume) clear logs, with the majority of the remainder being of sawlog quality. (The majority of clear logs will also be large logs.)

Product Objectives

The following are (unapproved) product objectives at the log level for the Golden TSA.

Quality Class	Species	Characteristics
Premium Log:		
Type III	All	15% of stands having 32.5+ cm minimum average stand diameter at breast height (DBH), having 60-100% of stems with a 1st log clear of knots, and achieved through faster growth at lower stocking levels (600 sph at rotation).
Type IV	All	15% of stands having 32.5+ cm minimum average stand diameter at breast height (DBH), having narrow ring width achieved through higher stand density (800 sph at rotation) and having 60-100% of stems with a 1st log clear of knots.
Sawlog:	All	27.5+ cm minimum average stand DBH.

Major Silvicultural Strategies	**Quantity and Quality of Timber Supply** (Some of the following are not within the traditional scope of incremental silviculture but are included here for completeness. Increase - increase over the second timber supply review (TSR2) base case. Maintain - maintain TSR2 base case)	*Priority Ranking*
General	Conduct silviculture surveys in support of all strategies.	1
LT1	Maintain the THLB by:	
	(a) Fill-planting 300 ha of remaining treatable backlog NSR (maintain); and	2
	(b) Maintaining approx. 400 ha of previously reforested backlog plantations. (maintain)	2
Q1	Two-lift prune 150 ha/yr (total 300 ha/yr) to 5.5 m to create knot-free timber in the lowest 5.0 m log.	3
Q2	Space 350 ha/yr (in addition to MT3 spacing) to obtain large dimension timber and prepare stands for fertilization, pruning and/or commercial thinning.	3
MT/LT 3	(a) Reduce minimum harvest ages 10 years over the period 6 to 8 decades from now; and	
	(b) increase the volume of regenerated stands by 20% over those used at the base case minimum harvest age (LT impact);	
	through the following:	
	i) Expand the area planted with improved seedlings by 700 ha/yr - priority East Kootenay, mid-elevation lodgepole pine. (increase)	2
	v) Brush 400 ha/yr for growth enhancement and increased survival. (increase)	4
	vi) Space 350 ha/yr of dense stands (in addition to Q2 spacing) primarily in the Sue fire and Beaverfoot Valley areas to make them harvestable during the period 7 to 8 decades from now, overcoming an age class gap. (increase)	3
	vii) Manage 30 000 ha on a 15 yr return fertilization cycle of 2 000 ha/yr.	6
ST/MT 2	Fertilize 450 ha/yr of suitable stands scheduled for harvest in the 2nd or later decades. (increase)	5
LT4	Reduce losses to root rot by: (maintain)	
	(a) planting alternate species;	Current Practice
	(b) pop-up spacing (20 ha/yr);	?
	(c) pushover logging / stumping; and	Current Practice
	(d) mixed species planting.	Current Practice

Major Silvicultural Strategies

Priority Ranking

Quantity and Quality of Habitat Supply

(Some of the following are not within the traditional scope of incremental silviculture but are included here for completeness.)

To be completed.

Incremental Silviculture Program

(ha)

Year	Surveys*	Fill Planting	Backlog Brushing	Brushing (for Growth)	Space	Prune	Fertilize
1	8,000	300	300	400	700	300	2,450
2	8,000	-	300	400	700	300	2,450
3	8,000	-	200	400	700	300	2,450
4	8,000	-	200	400	700	300	2,450
5	8,000	-	100	400	700	300	2,450
Subtot Yr 1 - 5	40,000	300	1,100	2,000	3,500	1,500	12,250
6 - 10	40,000	-	-	2,000	3,500	1,500	12,250
Total Yr 1 - 10	80,000	300	1,100	4,000	7,000	3,000	24,500

* Includes prescription and layout

Some activities under this program are substantially above current levels and may have to be phased in over time. Spacing and fertilization are shown at approximate maximum levels. The regime table (page 56) indicates investment priorities.

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 a silviculture strategy. Bracketed numbers refer to the strategy numbers under which the need is identified (see tables in "Workshop Review of Potential Strategies," page 24).

1. Analysis of how much area is presently below green-up and time until green-up is required by landscape unit/resource management zone. (ST1)

2. Fertilization trials are needed in spruce and cedar stands to determine efficacy. (ST2)

3. Analysis required of the potential of recent plantations for future commercial thinning in the VQ zone (MT1).

4. TIPSY OAF 1 factor of 15% requires confirmation with respect to non-productive openings that are not typed out of forest stands, and with respect to basic brushing and brushing for growth. Survey techniques are available. Requires statistical validity at the management unit level if to be used for AAC determination. (MT3 ii, v)

5. Assessment required of the 28 000 ha of stands aged 20-30 years as to what stocking levels will postpone the time to achieve the minimum piece size criteria (i.e., determine stocking threshold levels for spacing), and the occurrence of these stands (MT 3 vi).

6. FSSIM analysis is required to determine possible timber supply effect of lowering

ages for caribou habitat from 250 to 200. (MT4)

7. Silvicultural activities, particularly commercial thinning, can be used to create old-growth tree attributes at earlier ages, thereby relieving some constraints. However, some other biological requirements may not be met. Further study is required to determine if CT can achieve these attributes earlier. (MT4)

8. Further analysis of options and opportunities for dealing with non-merchantable hemlock is required before a course of action can be selected. (LT2)

9. An expert inventory of low-site stands similar to the Merritt small wood study is needed to determine their true productivity and silvicultural opportunities, if any. (LT2)

10. Further study of root rot management techniques and options is needed. (LT4)

11. Old growth site index estimation studies require completion. It is anticipated that site indexes may be underestimated.

12. Need to determine whether it is more cost effective to prune more hectares, but less stems per hectare than to prune all stems on fewer hectares. (Q1)

13. Greater certainty regarding the timber harvesting land base is critical - resolve is-sues such as operability and ESA1 occurrence - before large pruning investments can be made. (Q1)

Draft

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 prove appropriate and is achieved will ultimately be the degree to which the expressed targets will also 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. A silviculture strategy demonstration workshop was held November 26 & 27, 1998 in Revelstoke, using the Golden Timber Supply Area (TSA) as a case study. The workshop was attended by licensee representatives from both inside and outside the Golden TSA. Prior to the workshop, 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

[1] See "Abbreviations," page 60 for a full listing of abbreviations used.

future quantity and quality of timber supply. Larry Atherton of L. P. Atherton & Associates and Doug Williams of Cortex Consultants Inc. led the session. The preliminary strategy document was revised to reflect the outcome of the demonstration workshop.

2. Because few persons attending the demonstration workshop had first-hand knowledge of the TSA a second district workshop was held March 2 &3, 1999 in Golden, attended by representatives of the MoF, MoELP and forest licensees of the Golden Timber Supply Area (TSA). The workshop was led by the same team as the first demonstration workshop. Participants reviewed the potential opportunities identified in the revised draft document along with others that arose. The outcome of the session was a regime table, complete with priorities.
3. The consultants incorporated the results of the workshop into a revised draft document (version 1.2) and added forecasts of future harvest quantity and quality and of job outcomes.
4. Version 1.2 was submitted to the Ministry of Forests for review. Version 1.3 was prepared in response to client comment and resubmitted. (The ministry may assign higher version numbers (e.g., 1.4, 1.5, etc.) as the strategy evolves and changes are made.)

Structure of This Document

This document generally reflects the flow of the above methodology, that is, pre-workshop preparation (the earlier demonstration workshop is considered to be part of pre-workshop preparation), workshop findings and outcomes, and post-workshop analysis and review. A key objective of the process is to have a documented rationale to the strategy. Maintaining the thread of documentation throughout the process (i.e., from issue analysis through to final adopted strategy) is important to this objective, but is occasionally achieved at the cost of clarity and ease of reading. If needed, a table is included in the appendices which contains additional documentation on the process through which this document was developed.

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

Forest licensees of the Golden TSA:

- Evans Forest Products Ltd
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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.

Basic Data

Land Area

Description	Area (ha)	Area %
Total Area of TSA	893 400	100
Total Productive Crown Forest	295 800	33
Net Timber Harv. Land Base	166 600*	19

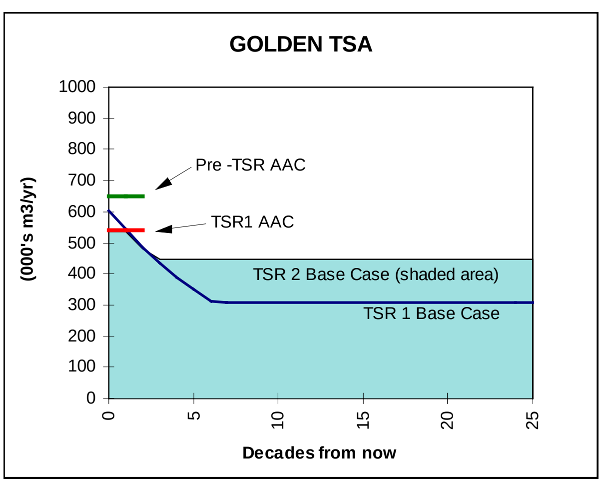
Source: TSR2 analysis report - rounded to nearest 100 ha.
*TSR1 net THLB - 174 600 ha.

AAC

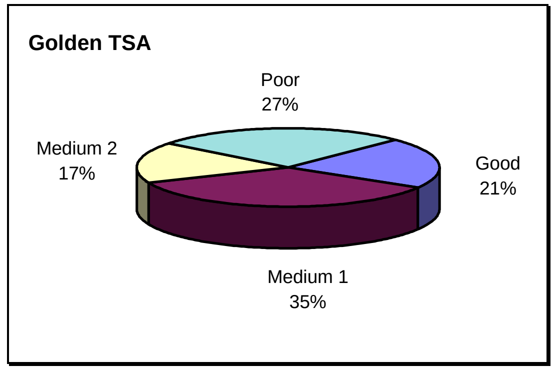
AAC Type	Pre-TSR	TSR1*	Change (%)
Conventional	650 000	540 000	-16.9
Deciduous	-	-	
Insect/Disease	-	-	
Marginal	-	-	
Total	650 000	540 000	-16.9
Woodlot AAC	Included in conventional AAC	5 000	

*effective January 1/95

Harvest Forecast

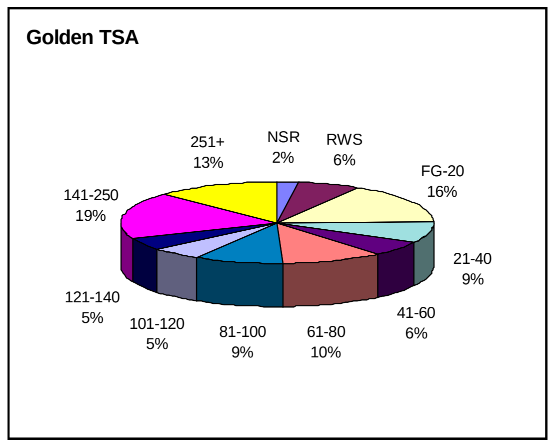


Site Class



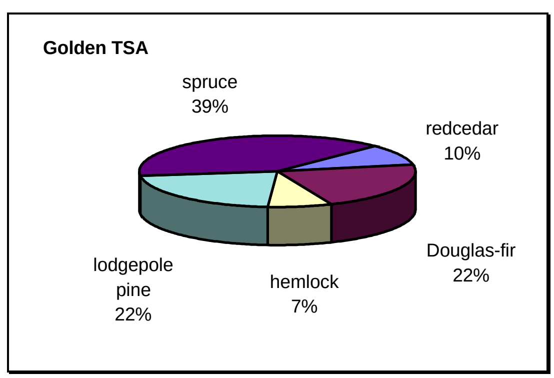
THLB only. Source:TSR2 analysis report - Fig 4.

Age Class



THLB only. Source:TSR2 analysis report - Fig 5 (scaled). #'s require confirmation.

Tree Species



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

Issue Analysis

Timber Quantity Issues

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 59. Only information which is relevant to a silviculture strategy is recorded. Key statements are bolded.

Issue	Description	Discussion	Silvicultural Opportunities	
			Increase Over Base Case	Maintain Base Case
♦ Harvest Forecast	The initial harvest level of 535 000 m3/yr (TSR1 AAC less 5 000 m3/yr for woodlots) can be maintained for 2 decades, followed by successive decadal declines of 10% and 7% over 2 decades to a long term harvest level of 446 000 m3/yr (17% below the TSR1 AAC) reached at the start of decade 4. (TSR2 report, 25) The first regenerated stands become available for harvest after 5 to 6 decades. In decade 7, almost no high volume older stands are available for harvesting and the harvest comes almost exclusively from lower volume regenerated stands on poor-quality sites that have just reached min harvest age. After decade 7 more regenerated stands on higher quality sites are available resulting in an increase in the average vol/ha harvested.	First regenerated stands being on poor site appears illogical. Usually the better sites were harvested first. May be a matter of access.	Can the first of the regenerated stands be made available sooner through spacing & fertilization? Is spacing assumed in the yield tables? Or would larger volumes at min ages be a greater benefit?	
♦ Age Class	Approximately 31% of stands in the timber harvesting land base (THLB) are 30 years or younger, 29% are between 31 and 100 years old, 6% between 101 and 140 years old, and 34% older than 140 years. Almost 56% of stands are at or above their min harvestable ages and a large portion of stands presently aged between 60 - 100 yrs will reach min harvestable age in the short term. (TSR2 report, 16) Inoperable and operable excluded forests 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 (TSR2 report, Fig 13, 32). After 4 decades the inoperable stands meet most wildlife habitat requirements for the analysis area (TSR2 report, 31). This will likely overestimate the long term timber supply (TSR2 report, 47). (see biodiversity)	Overall, stands in the TSA are relatively young. Few stands aged 101 to 140 results in fairly rapid transition to 2nd growth by 6th decade. Chief forester (CF) found age class distribution to be not a limiting factor in TSR1 AAC determination.		

Issue	Description	Discussion	Silvicultural Opportunities	
			Increase Over Base Case	Maintain Base Case
♦ Silvicul-tural Systems	Silvicultural systems not explicitly stated. A recent review of harvesting shows that 99% of the THLB is currently managed under a clearcut harvesting system. Table A-20 (TSR 2 analysis report[2], 116-117) indicates all areas are planted with a 2 yr regen delay.			
♦ Backlog NSR	Proportion of not satisfactorily restocked (NSR) area that is backlog is unspecified. All area was included in analysis. (TSR2 report, 118-119)	TSR1 reported 5 200 ha of operable backlog NSR. To be restocked in five years.		Failure to rehabili-tate would result in a lower base case forecast.
♦ Land Base	• 10 629 ha of deciduous stands (equiv to 6% of THLB) deducted from THLB (TSR2 report, 10). • 2 114 ha (equiv to 1% of THLB) of low productivity forest types deducted from THLB. Subsequent analysis indicates a further 7 583 ha of younger stands (equiv to 4.5% of THLB) do not meet the volume cut-off requirements when grown to maturity (i.e., SB mix or Cw not reaching 200 m3/ha by age 200, and other species and pure S not reaching 150 m3/ha by ages between 150 to 250). (TSR2 report, 102) • 2 090 ha (equiv to 1% of THLB) of brush deducted from THLB. (TSR2 report, 10) • 1 255 ha (equiv to 0.5% of THLB) of hemlock leading stands or balsam-hemlock stands greater than 140 years of age deducted from THLB as non-merchantable (TSR2 report, 102. Sensitivity test ± 10% of THLB. Area in all stand types and ages both increased and decreased. (TSR2 report, 57) Decrease: (-10%) Area removed considered inoperable, ∴ still contributes to meeting forest cover requirements. **Very sensitive.** Initial harvest level must start 2% below base case. Same rate of decline as base case to long term harvest level (**LTHL) 10% lower than base case**. Increase: (+10%) Additional area assumed to come from inoperable. Very sensi-	THLB in the base case ap-pears over-estimated by 4.5% due to under-estimation of low-site stand area. Impact on LTHL likely in the 2-3% range due to the very low volumes contributed by these stands. In TSR1 AAC rationale, CF concluded there was no op-portunity to consider estab-lishing a partitioned AAC for the purpose of harvesting in traditionally inoperable areas.	Rehabilitate/convert deciduous (often in ri-parian areas) and/or non-merch types? Fertilize low productiv-ity stands?	

[2] Hereafter referenced as TSR2 report.

Issue	Description	Discussion	Silvicultural Opportunities	
			Increase Over Base Case	Maintain Base Case
	tive - initial harvest level can be maintained 2 decades longer than base case (4 vs 2). **LTHL 9% above base case**.			
♦ Forest Cover	*Wildlife, Watershed & Integrated Resource Management (IRM) Zones*: 41%, 2%, and 50% of THLB and 51%, 4% and 48% of operable land base respectively (TSR2 report, 19-20). Base case requirement of at most 25% of the <u>operable land base</u> permitted to be < green-up ht (2 m in wildlife/IRM zones, 6m in watershed zone (TSR2 report, 110)). Currently about 20% of operable area is < 20 yrs old. Changing the allowable level to 20% (from 25%) causes some reduction but harvesting can occur in several zones and timber supply is not severely restricted. Increasing the constraint to 15% results in an immediate reduction in harvest levels as several management zones cannot be harvested in the short term. (TSR2 report, 38-39) **Area currently not greened up is likely underestimated.** Approx. 1 400 ha of NSR is older than 20 yrs but was effectively treated by the model as greened up due to age (TSR2 report, 118). Sensitivity tests of ± 5, ± 10% of area allowed to be not greened up. (TSR2 report, 38-39) <u>Relax Constraint</u>: (+5% to 30%) Short term insensitive. Transition to LTHL one decade longer than base case (4th decade same level as 3rd). LTHL 3% higher than base case. (+10% to 35%) **Same result as a 5% reduction.** <u>Increase Constraint</u>: (-5% to 20%) Moderately sensitive - initial harvest level (IHL) can only be maintained 1 decade, LTHL 4% below base case. (-10% to 15%) **Highly sensitive** - IHL deceased 19% below base case. LTHL 6% below base case.	The constraint threshold is somewhere between 25 - 30% of area not greened up. Relaxing the constraint beyond the threshold will not increase timber supply because other constraints then become limiting. TSR1 reports both the small business forest enterprise program (SBFEP) and the major licensee are having trouble finding suitable and available wood to meet planning requirements.	Role for commercial thinning (CT)? Harvesting timber using partial harvesting or CT methods has the effect of "relaxing" the constraint. (Mid Term (MT), Long Term (LT))	The short term harvest level is at serious risk should there be a substantial increase in forest cover constraints (FCC's) anytime over the next 30 yrs. Accelerating growth of young existing stands to achieve earlier green-up would serve to reduce this risk. (Short Term (ST))

Issue	Description	Discussion	Silvicultural Opportunities	
			Increase Over Base Case	Maintain Base Case
	Visual Quality Zones: Retention - 13% of THLB and of operable land base (OLB). Base case requirement of at most 15% (partial retention visual quality objective (VQO)) to be < 6 m tall (TSR2 report, 20). Only 20 ha considered to have retention VQO, so is lumped with partial retention (TSR2 report, 47). Sensitivity test of ± 10%. (TSR2 report, 47-48) Relax Constraint: (+10% to 25% - same as IRM) Slight sensitivity. Allows initial harvest level to be maintained 3 decades (vs base case 2). 4th decade harvest level is 7% higher than the base case. LTHL 1% higher. Increase Constraint: (-10% to 5%) Moderately sensitive - initial harvest level can be maintained only 1 decade. **LTHL 9% below base case**.	This is the only management zone in which harvesting is consistently limited by the forest cover requirements in the base case (TSR2 report, 48).	Increasing harvests from the VQ zones offers potential to have higher harvests in decade 3 onwards. Two avenues: CT to increase vol. or brush/fertilize regen stands to reach 6m green-up sooner. (MT, LT)	The short term harvest level is at risk only were there a severe increase in constraint. Such an increase is not likely.
	Green-up: green-up is a combination of green-up age and regen delay (TSR2 report, 39). Green-up ages range from 11-26 yrs for 2m ht and from 21-42 yrs for 6m ht (TSR2 report, 100). Regen delay is 2 yrs (TSR2 report, 116-117). Sensitivity test of ± 5 years. (TSR2 report, 39-40) Relaxation of constraint: (- 5 yrs) Insensitive over short and mid term. LTHL 2% higher than base case due to a small increase in the availability of timber, particularly in the VQ and watershed zones. Increase Constraint: (+ 5 yrs) Moderately sensitive - initial harvest level 1% below base case and can only be maintained for 1 decade. 2nd and 3rd decade harvests significantly below base case. LTHL 1% lower.		Targeting reduction in time until green-up in VQ and watershed zones (both have 6m ht reqmts) offers potential to increase LTHL 2%. (LT)	Ages used are not likely underestimated. Not a concern.
	Ungulate Winter Range: (27% of THLB) Base case modeled on basis that at all times and for every landscape unit, at least 40% must be in stands 100 yrs or older and no more than 25% in stands less than 2 m tall. However, actual guideline is to maintain at least 40% of mature forest cover in every 250 ha patch. Sensitivity test of applying the mature cover guideline in 250 ha patches and allowing a max of 15% or 35% (± 10% from base case) of the area within 250 ha patches to be disturbed (i.e., to be below green-up age). (TSR2 report, 40-42) 35% allowed to be disturbed: Insensitive over short and mid term. LTHL 1.5% lower than base case. The smaller winter range units require more of the THLB	Basically insensitive to modelling actual constraint.		

Issue	Description	Discussion	Silvicultural Opportunities	
			Increase Over Base Case	Maintain Base Case
	to meet cover requirements than the base case, and thus extends harvest age in each unit beyond that of the base case. 15% allowed to be disturbed: Moderately sensitive - initial harvest level can only be maintained for 1 decade because there is not enough timber available in other zones to compensate for the lowered limit. LTHL 1.5% lower.			
♦ Bio-diversity	*Landscape Level Old-Seral* Base case gradually applies low-emphasis portion of old-seral requirements over a 140 year period. Sensitivity test of application in full at the beginning of the planning horizon. Result is that IHL can be maintained for only 1 decade vs 2 in the base case. Requirements must be met in part from stands within the THLB. After 4 decades most of the requirement can be met by stands from outside the THLB, therefore LTHL does not change. Application of the old-seral requirement to the operable land base to ensure full representation of all biogeoclimatic variants yields the same sensitivity result, except the LTHL is slightly below the base case. (TSR2 report, 42-43)	See "Age Class" above, "Biodiversity contribution from areas outside the THLB" below.		Use CT to create old-seral stand structures at earlier ages? Not likely effective by 2nd decade.
	Biodiversity Emphasis Options Base case used average, area weighted proportions of old growth that would be retained to meet biodiversity emphasis targets and applied this average to each landscape unit. Sensitivity test of applying the old growth requirements to each landscape unit individually. Initial harvest level can be maintained only one decade, one less than the base case. LTHL is unchanged. (TSR2 report, 44-45)	Little difference between methodologies.		
	Combined Full Old-Seral and Biodiversity Emphasis Options Applying the above two constraints at the same time results in an **immediate 5% reduction in the IHL**. LTHL 2% below base case. (TSR2 report, 45)			
	Biodiversity contribution from areas outside the THLB When parks are excluded from the analysis area, the IHL can only be maintained for 1 decade (vs 2 in the base case) and LTHL is about 1% lower. More of the biodiversity requirements must be met from within the THLB which reduces the available timber supply.	Not regenerating stands in the OLB likely overestimates the timber supply.		Use CT to create old-seral stand structures at earlier ages. (MT, LT)

Issue	Description	Discussion	Silvicultural Opportunities	
			Increase Over Base Case	Maintain Base Case
	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**. (TSR2 report, 46-47)			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)
♦ Min. Harvest Ages	Base case uses ages based on: age at which stands reach a min vol/ha (150 m3/ha for F, S, Pl or 200 m3/ha for C, H); age to a min. 25cm dia.; age that is 90% of culmination age; and professional judgment. Selected min. ages range from 70 - 170 yrs for existing stands and from 60 - 170 yrs for regenerated stands. (TSR2 report, 106-108) Sensitivity analyses of ± 10 yrs and ±20 yrs. (TSR2 report, 49-51) **Very sensitive.** Decrease: (- 10 yrs) **IHL is extended 3 decades longer** than the base case (5 vs 2) followed by a decline of 10%/decade until LTHL reached at start of decade 10. **LTHL 7% below base case**, presumably due to stands being harvested before reaching culmination age. Decrease: (- 20 yrs) IHL is extended 4 decades longer than the base case (6 vs 2) followed by a decline of 10%/decade until LTHL reached at start of decade 8. **LTHL 16% below base case**, presumably due to stands being harvested before reaching culmination age. Increase: (+10 yrs - alternative 1) IHL can be maintained only 1 decade. Timber supply in the transition period is substantially reduced, necessitating a **5% shortfall below the LTHL** and the transition period is extended to the end of the 11th decade. (This shortfall may not exist if LTHL proves over-estimated.) Regenerating stands, which are critical to timber supply during the transition of harvesting	Base case min ages appear close to culmination age as LTHL shows sensitivity to changes. TSA shows more sensitivity than other TSA's - there may be some other factors at work as well. Increasing volumes at the same minimum age would be same as increasing regen stand vol's & will result in higher LTHL. Base case use of TIPSY assumes stocking control at approx 1 200 st/ha (density used is not stated). Legal requirements for basic spacing do no kick in until 10 000 st/ha. There must therefore be an incremental spacing	There is a potential for a trade-off between increasing volumes of regenerated stands and reducing min ages. Target sharing of these effects; e.g., lower min ages 5 yrs (allowing maintenance of IHL for 1 more decade) and increase regen volumes 10%? (MT, LT)	If trees in fact take 10 yrs longer to grow to min. sizes and volumes than at the ages used in the base case, the IHL can only be maintained 1 decade and there will be a 5% shortfall below the base case LTHL lasting until 110 years from now. Programs of spacing and fertilization would help ensure the sizes assumed in the forecast are attained. (ST, MT, LT)

Issue	Description	Discussion	Silvicultural Opportunities	
			Increase Over Base Case	Maintain Base Case
	ating stands, which are critical to timber supply during the transition of harvesting from old growth to second growth, must age an additional decade before they are considered merchantable. Some existing stands must be held longer to avoid even more serious timber supply disruptions. <u>Increase</u>: (+20 yrs) **Very sensitive**. IHL must be immediately reduced 5% below base case. A mid term shortfall 11% below the base case occurs, lasting until the end of the 11th decade. LTHL is 4% above base case Short term highly sensitive 21% below base case. Insensitive mid term.	program to control stocking or it is likely that stands will not reach the minimum diameter requirements at the base case minimum ages.		
♦ Timber Volume Estimates	Variable Density Yield Projection (VDYP) system used for existing stands older than 20 years. Table Interpolation Program for Stand Yields (TIPSY) used for all regenerated stands and existing stands aged 20 or less. (TSR2 report, 18) *Existing stand volumes*: Sensitivity test for ± 10% in volume. **Short term highly sensitive**. Long term insensitive to either increase or decrease. (TSR2 report, 51-52) <u>Increase</u>: (+10%) IHL can be maintained 5 decades, 3 longer than the base case. Harvest level then drops 10% and is held at this level for 3 decades (vs 1 in the base case). LTHL unchanged. <u>Decrease</u>: (-10% - alternative 1) **Highly sensitive**. IHL can only be maintained 1 decade before falling to a shortfall level 10% below the LTHL, rising to LTHL at the end of decade 10.	Very sensitive. A recently completed inventory audit indicates that the volume estimates used are reasonably accurate (TSR2 report, 52).	Increasing vol's of existing stands would enable extending current harvest levels. (ST, MT)	Increasing vol's of existing stands would prevent substantial short and mid term reductions if volumes prove overestimated. (ST, MT)
	Regenerated stand volumes: TIPSY operational adjustment factor 1 (OAF1) - 15%; OAF 2 - 5%, Concern OAF2 underestimates losses on some stands to root disease. (TSR2 report, 115-118). Sensitivity tests indicate TIPSY yields raise LTHL 35% over VDYP yields for regenerated stands. (TSR2 report, 54) Sensitivity tests for ± 10% in volume. Short term insensitive to either. **Highly sensitive to both in long term**. (TSR2 report, 52-53) <u>Increase</u>: (+10%) Short and mid term insensitive. LTHL 10% higher than base case, starting at the beginning of decade 8. Creates a mid term shortfall during decades 4-7	No indication of whether improved seed is used and factored into regen volume estimates. Assume not. Challenge is to move volumes forward to fill mid-term shortfall - see min harvest ages. (However, this shortfall may not exist if LTHL	Possibilities to increase regen vol's: • Improved seed. • Larger planting stock. • Reduce voids (OAF1).	Management for root rot to limit losses to 5%. (LT)

Issue	Description	Discussion	Silvicultural Opportunities: Increase Over Base Case	Silvicultural Opportunities: Maintain Base Case
	decades 4-7. Decrease: (-10%) LTHL 10% below base case. Extends IHL 1 decade because less volume must be held over the transition period due to lower LTHL.	proves over-estimated.) TSR1 reported armillaria root rot is assumed to be present in most stands. May reduce yields in some regenerated stands by 20%. This may prolong greenup or create gaps in free growing stands.	• Fertilization at planting. • Brushing for growth. (LT)	
♦ Site Productivity	Site indexes may be under or over-estimated. Site index change simulated by changing regen stand volumes based on ± 2.5 m site index (SI), and changing minimum harvest ages ± 10 yrs. Green-up ages unchanged. (TSR2 report, 55-56). SI underestimated: (increase SI 2.5 m) Extends IHL 1 decade longer than base case (3 vs 2). Drops 10% after 3rd decade to an LTHL 8% above base case. SI overestimated: (decrease SI 2.5 m) Short term insensitive. **LTHL 12% below base case**.			Consequences of SI being overestimated are severe in the long term. Need to determine accuracy of estimates & design silv. strategy accordingly.

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 280 years to 102 years. From decade 6 onwards most of the harvested stands are regenerated stands that have only recently reached minimum harvest ages. Their average harvested age is about 107 years. (TSR2 report, 30)

Changes to minimum harvest ages have a substantial impact on the harvest forecast (see Timber Quantity Issues - Min. Harvest Ages above, Figure 2 and Figure 3 below).

The TSR2 base case harvest forecast relied substantially on areas outside the THLB to meet old-seral biodiversity requirements. There is some uncertainty about this being the case. A sensitivity analysis demonstrated that requiring more old-seral stands to be within the THLB would substantially reduce the harvest forecast. (TSR2 report, 46) This has implications for improved timber quality which are discussed below.

♦ 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.

Because lowering minimum ages 10 years enables extending the current harvest level a further 3 decades, timber quantity strategies will focus on lowering minimum ages, with the potential to further lower the overall quality of the timber resource (unless lower ages are compensated by strategies to ensure average tree sizes are maintained).

Requiring more of the old-seral biodiversity requirement to be met from within the THLB would lengthen the harvest ages of some stands considerably. This would increase the average quality content of future harvests when some of these areas are harvested. However, these stands may tend to occupy poorer quality growing sites, and once set aside for the purpose of providing old-seral biodiversity, may be held for great lengths of time. Tracking these stands through modeling would help improve understanding of the implications of different management scenarios on the future harvest quality profile.

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 (this would also be a strategy, however, for enabling harvesting at younger ages).

Illustration of Issues and Silvicultural Opportunities

TSA modelling in support of planning for silviculture 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 silviculture to increase future timber supply. These opportunities are identified in the "Issue Analysis" section, which starts on page 4. The following are selected sensitivity analsysis charts from the TSR2 analysis report. Detailed analyses are required to confirm the indicated effects.

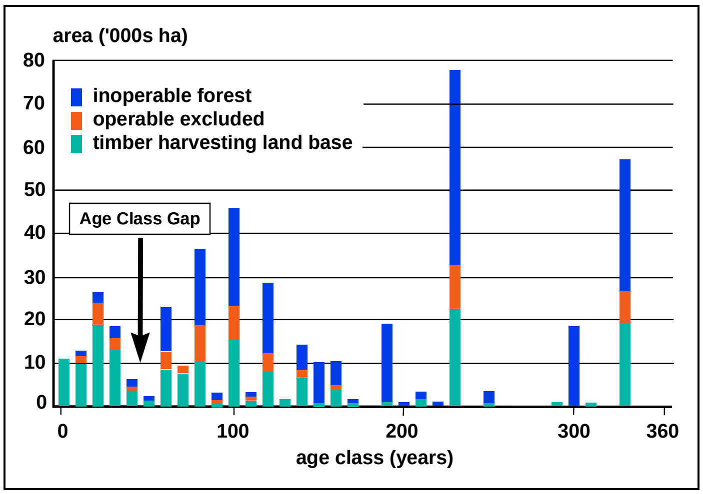


Figure 1. Current age class structure

There is a shortage of stands currently in age classes 40 and 50 years. In 30 years from now, these stands will be 70 - 80 years of age, which is still below the base case minimum harvest age. Lowering minimum ages makes these stands immediately available, enabling the initial harvest level to be extended at least 2 more decades than in the base case. See Figure 2 below.

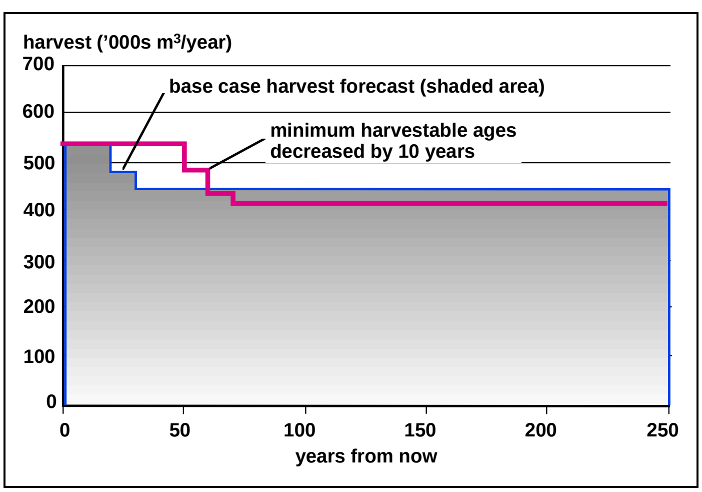


Figure 2. Sensitivity to a decrease in minimum ages

Decreasing minimum ages 10 years extends the current harvest level by 3 decades. However, the long term harvest level goes down, because minimum ages become well below culmination ages; not allowing the growing potential of the land to be realized. During the district workshop, this sensitivity was found to be related to an age class gap (see Figure 1, above). Silvicultural strategies may be employed to overcome this gap. Lower minimum ages many not be required over all time periods, thus avoiding a reduced LTHL.

thus avoiding a reduced LTHL.

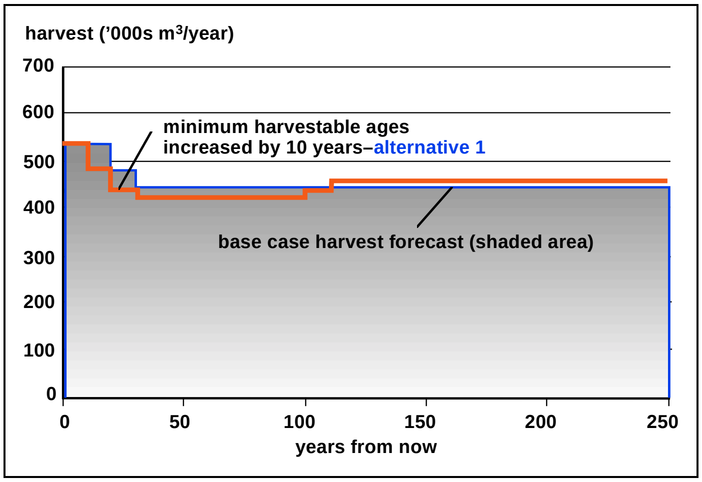


Figure 3. Sensitivity to an increase in minimum ages and implications for timber quality management

Growing forests longer for quality purposes has harvest forecast implications over all terms. A 10 year increase in minimum harvestable ages lowers short and mid term harvest levels because this exacerbates the age class gap discussed above.

In the long term, quality and quantity goals are more compatible. Raising minimum ages results in stands being harvested closer to culmination and therefore at higher rates of productivity. Timber quality will also improve at these older harvest ages.

A 20 year increase in minimum ages (not shown) lowers short and mid term harvest levels further still, but does not significantly change the long term forecast from that of a 10 year increase in ages.

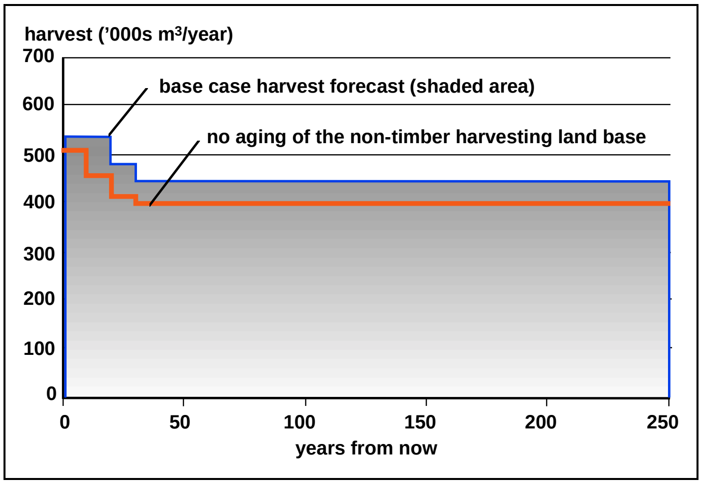


Figure 4. Satisfying older forest biodiversity requirements

Much of the biodiversity requirement for older forests can be met from outside the timber harvesting land base. However, the modeling did not age and replace these forests. At the end of the planning period all stands outside the THLB are aged 400+ years. When stands outside the THLB are not aged, more of the older forest requirement must be met from within the THLB. This results in lower harvest levels across all periods. Silviculture practices can be used to create older forest attributes sooner, satisfying some of the requirements and allowing a higher harvest level than otherwise possible under this scenario.

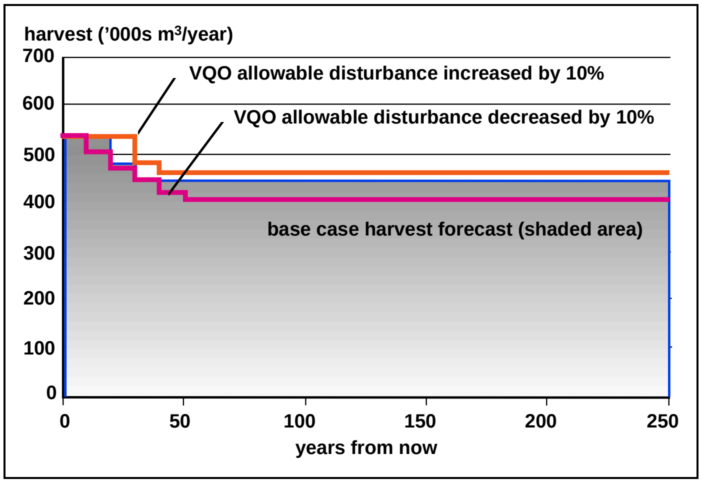


Figure 5. Changes in allowable disturbance in VQO zones

Although the VQO zone is only 13% of the THLB, the high VQO constraints heavily restrict harvest levels in the base case. Commercial thinning or partial harvesting may allow some harvesting in otherwise restricted areas. Silvicultural practices can be employed to accelerate green-up of harvested areas.

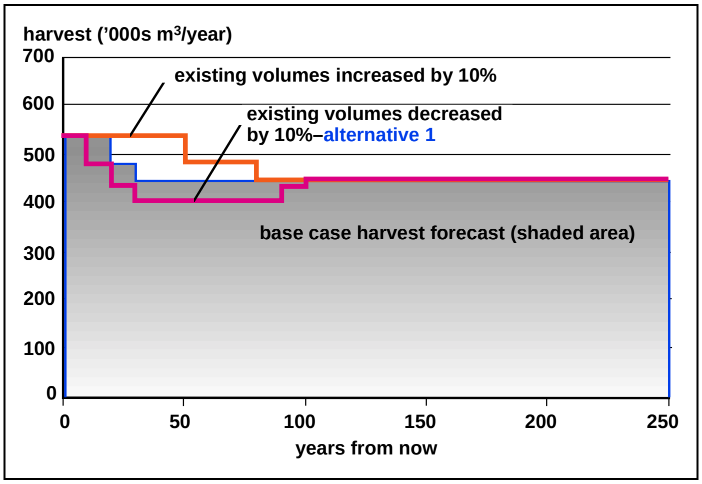


Figure 6. Changes in existing stand volumes

An inventory audit confirms inventory volumes are statistically accurate. Otherwise, harvest levels would drop dramatically if existing stand volumes were overestimated. Fertilization of existing suitable stands could increase their volumes. If sufficient area could be treated, the initial harvest level could be maintained further into the future.

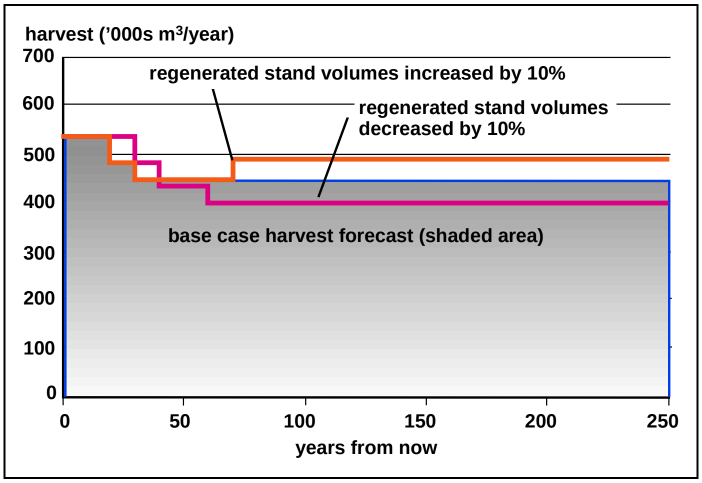


Figure 7. Changes in regenerated stand yields

Increasing regenerated stand yields 10% increases LTHL by 10%. Yields can be increased though a variety of silvicultural actions.

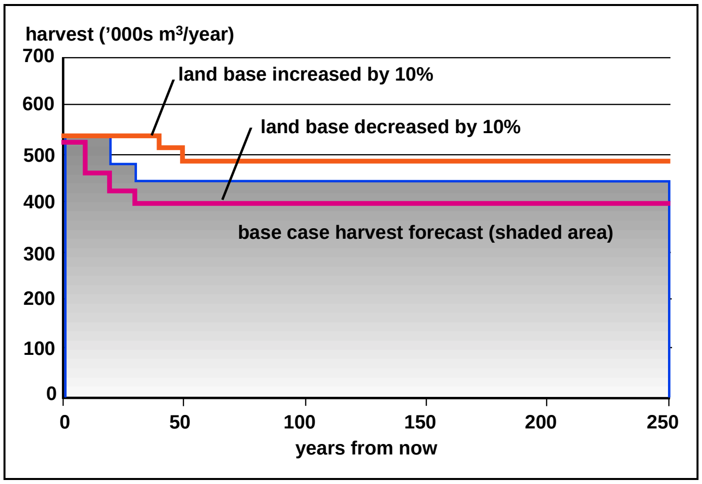


Figure 8. Changes in timber harvesting land base

Increasing the THLB increases the harvest forecast in the mid and long term. Silvicultural practices can be used to rehabilitate or convert areas that have been excluded from the THLB due to poor productivity, low volumes or non-commercial cover.

Summary of Issues

♦ 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.

Decreasing the timber harvesting land base 10%, increasing minimum harvest ages by 20 years, fully applying old-seral biodiversity requirements, or allowing for some stands outside the THLB to turnover into younger stands (reducing their ability to contribute to FCC's and biodiversity) each can result in a need to lower the initial harvest level below that of the base case (the current AAC).

The short term is also sensitive to green-up age and to a decrease in the area allowed to be not greened-up. This is because recent harvesting has resulted in the area currently not greened up being close to the limits used in the base case. The area not greened-up may be under-estimated (by approx. 1 400 ha ≅ 0.5% of THLB) due to the way the model treated NSR > 20 years old.

Standard timber supply analysis modeling rules do not allow a short term increase above the initial harvest level in response to sensitivity tests. Rather, positive impacts are expressed by extending the IHL further into the mid term period. Thus no sensitivity tests show an increase to the short term harvest level.

♦ Mid Term (21 - 70 years)

In the TSR2 base case, LTHL is reached at the end of the 3^{rd} decade. In this case, the transition period is only one decade. In the sensitivity analyses, the transition period can be extended until the 11^{th} decade. However, it is more common for the transition period to end at or near the 7^{th} decade, which is when the harvest moves to primarily 2^{nd} growth. For the purposes of this strategy, the end of the mid-term period is therefore defined as 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. Again, 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. Unlike the short term, however, the mid term can also be affected by factors that make regenerated stands available for harvesting sooner or later than that modeled in the base case.

Decreasing minimum harvest ages extends the initial harvest level by 1 to 3 decades (depending upon the amount of decrease), but also lowers LTHL. At least some of this is modelling effect, however. Because of the lower LTHL, some timber that was previously being held to fill in timber supply in the early decades of the long term is no longer required. Under standard modeling rules, this timber supply is reassigned to extending the IHL. At least one decade of the up to 3 decade extension of the IHL in the minimum age sensitivity test can be attributed to this. This same effect is observed when regenerated stand volumes are reduced by 10%.

Increasing minimum harvest ages 10 years or decreasing existing stand volumes creates a mid term shortfall below the LTHL and extends the time until the LTHL is reached to the end of the 11^{th} decade.

Increasing regenerated stand volumes 10% generates a mid term shortfall by raising LTHL above the base case level (but does not lower the mid term below the base case which happens in the case of increased min ages or decreased existing stand volumes).

♦ Long Term (71 + years)

The long term harvest level as indicated in the TSR 2 base case may be overestimated due to:

- ages of stands outside the THLB that contribute to FCC's are advanced over time but do not turn over into regenerated stands (sensitivity analysis indicates that if current ages are frozen LTHL drops 10%);

- the base case harvest queue is relative oldest first, which does not reflect the current harvest profile (see TSR2 report, 37, 109 - sensitivity analysis indicates a 9% lower LTHL if the harvest queuing is random);
- low site stand area is underestimated by an area equivalent to 4.5% of the THLB (likely a 2-3% impact); and
- armillaria root rot is not factored into regenerated stand volumes (can reduce some stand volumes by 20%).

Offsetting these to some degree, but likely not entirely, is the possibility that the site productivity of older stands may be underestimated. Sensitivity analysis indicates LTHL would rise 8% above the base case if site indices are underestimated by 2.5 m.

Because of the reliance on forests outside of the THLB to assist in meeting adjacency and older forest requirements, the long term is sensitive to changes in these. Increases in requirements can only be met by stands from within the THLB.

Because harvesting is consistently limited by forest cover constraints in the VQ zone, either relaxing or restricting these requirements directly impacts long term timber supply, more so when requirements are increased to allow less area in this zone to be disturbed at any given time.

Decreasing minimum harvest ages by 10 or 20 years significantly reduces the LTHL, presumably because stands are consistently harvested before reaching maximum growth potential.

As is the case in virtually all management units, the long term is sensitive to changes in regenerated stand volumes. A 1% increase or decrease in volume results in a corresponding approximately 1% increase or decrease to LTHL.

♦ 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.

The Golden timber supply analysis explored a number of possible factors unique to the TSA that have the potential to reduce the harvest forecast. These included potential reductions due to modelling the stands outside the THLB without regeneration, the underestimation of areas of low site productivity, and differences in harvest queue rules. The sensitivity tests for these all show similar shapes to the base case.

Sensitivity tests for changes in forest cover constraints (i.e., for biodiversity requirements, allowable disturbance levels in different management zones and green-up requirements) all show the same shape as in the base case, regardless of whether constraints are relaxed or tightened.

The sensitivity tests for minimum harvest ages show potential for change in the shape of the harvest forecast. Of particular interest are the tests for increases in minimum ages. These tests show a higher long term harvest level than the base case, and create a lengthy mid term shortfall period. Decreasing ages, on the other hand, extends the initial harvest level significantly, but otherwise does not change the shape of the forecast from that of the base case.

There are two likely upward influences on the base case forecast that are quantified by sensitivity analysis. One of these, increased regenerated stand volumes, shows a rise in the long term harvest level at the start of decade 8, creating a mid term shortfall. This is significant in that, as will be seen, silvicultural strategies have the potential to substantially increase regenerated stand volumes. The other test, for an underestimate of site productivity, shows a similar shape to that of the base case. However, in this test both reduced minimum ages and increased site indices were applied. Were a productivity increase alone applied, the effect would likely have been similar to that of increasing regenerated stand volumes, that is, it likely would have raised the long term harvest level and created a mid term shortfall. Combining the two factors into one test shows the potential of reducing minimum harvest ages to fill in the mid term shortfall generated by an increase in regenerated stand volumes.

In the district workshop, factors such as operability, spatial distribution of harvest, extent of ESA1 areas and higher TIPSY OAF's were also raised as possible downward influences on the base case, but were not quantified. With the exception of higher TIPSY 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 TIPSY 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.

Future land base reductions could change the profile of the harvest forecast if a substantial area of younger or middle aged forests are removed. This suggests silviculture strategies appropriate to the existing land base and forest profile may not be robust against future change in the TSA land base. However, this is true of most TSA's and should not be cause for inaction; rather, when choices between strategies or actions are to be made, this factor should be kept in mind.

In conclusion, for the purposes of this interim strategy, it is assumed that:

- the shape of the harvest forecast is not likely to change in response to most uncertainties;
- an increase in regenerated stand volumes will generate a mid term shortfall; and
- a reduction in minimum harvest ages has the potential to alleviate this shortfall to some degree.

Further, 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. When the TSR2 AAC rationale is released, adjustments to the base case could be made in accordance with the chief forester's findings with respect to these factors.

♦ 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.

Were more old-seral biodiversity requirements to be met from within the timber harvesting land base the harvest ages of some stands would lengthen considerably, giving a commensurate increase in the average quality content of future harvests when some of these areas are harvested. However, these stands may tend to occupy poorer quality growing sites, and once set aside for the purpose of providing old-seral biodiversity, may be held for great lengths of time. Tracking these stands through modeling would help improve understanding of the implications of different management scenarios on the future harvest quality profile.

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.

Incremental Silviculture History

Approximately 1 400 ha are harvested annually (TSR2 report, 28).

Treatment	TSR2 Status (1998)		Current Status (1998)
	Incorporated in Timber Supply Analysis	Not Incorporated in Timber Supply Analysis	Source: CFD[3]
♦ Backlog	All backlog areas (1 400 ha - analysis report p 119, au's 11 to 53) are considered part of the THLB.		2 100 ha total, about 300 of which is treatable.
♦ Conversion			
♦ Commercial Thin			Nil
♦ Space			Current level about 40 ha/yr. Max. past program level of 400 ha/yr.
♦ Prune			No pruning program at present. Max past program level of 100 ha/yr.
♦ Fertilize			Nil

[3] CFD - Columbia Forest District

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). 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 shortfalls 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 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.

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Opportunities to Increase Timber Supply

Potential Silviculture Strategies

Prior to the initial demonstration 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 were discussed in detail in both the demonstration and follow-up district workshops, the results of which are recorded in "Workshop Review of Potential Strategies," page 24, along with additional strategies that arose during the meetings. Strategies that are ultimately adopted are noted in "Silviculture Strategies," page 53.

- **Short Term (1 - 20 yrs)**

ST 1: Reduce the area not greened-up by 25% by accelerating the growth of existing young stands by: (maintain)[4]

a) brushing for growth enhancement;

b) spacing and fertilizing free growing (FG) stands in watershed & VQ zones where green-up is 6m.

ST 2: Fertilize all suitable stands scheduled for harvest in the 2nd decade. (increase)[5]

- **Mid Term (21 - 70 yrs)**

MT 1: Implement partial harvesting (CT?) regimes in all zones (particularly the VQO zone) to overcome adjacency limitations. (increase)

MT 2: Repeat fertilize all suitable existing stands scheduled for harvest 20 to 80 years from now to achieve the same harvested volumes as modeled in the base case but at lower min harvest ages. (increase)

MT 3: (a) Reduce minimum harvest ages 10 years while at the same time, (b) increase the volume of regenerated stands by 10% over those used at the base case minimum harvest age (LT impact), and (c) achieve green-up 3-5 years earlier (LT impact) 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)

vi) spacing stands; (maintain) and

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[4] (maintain) means oriented to maintaining the harvest level indicated by the TSR 2 base case.
[5] (increase) means oriented to increasing harvest levels above those indicated by the TSR2 base case.

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vii) repeat fertilize suitable stands on a 15 yr return cycle.

MT 4: Commercially thin stands to create old-seral attributes earlier. (maintain)

- **Long Term (71+ yrs)**

LT 1: (a) Rehabilitate all remaining treatable backlog NSR and (b) brush ___ ha of existing backlog plantations. (maintain)

LT 2: Increase the THLB by:

a) rehabilitating non-commercial brush (NCBr); (increase)

b) converting/rehabilitating deciduous stands; (increase)

c) converting/rehabilitating non-merchantable hemlock stands; (increase)

d) improve the site productivity of low-site stands by (fertilization?). (increase/maintain)

LT 3: Continue MT 3. (increase)

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

LT 5: Plant areas outside of the THLB to increase the area in an old-seral state in 100 to 200 years. (maintain)

LT 6: Continue MT 4.

Workshop Review of Potential Strategies

Explanatory notes with respect to the following tables.

The response time frame (i.e., the short, mid or long term) is the period in which the anticipated result is expected, not the period in which actions must necessarily commence. 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. *Results are largely conjecture and are meant to illustrate the potential of the strategies.*

Column Number	Note
1	Strategy numbers correspond with the numbers recorded earlier in "Potential Silviculture Strategies," page 23. Items followed by an asterisk (*) were added during the district workshop.
2	Information is largely from a meeting of Ministry of Forests and Ministry of Environment, Lands and Parks personnel and forest licensees held March 2 & 3, 1999 in Golden (the "district workshop") combined with information presented earlier in this document.
3	Anticipated results are typically calculated using the timber supply response indicated by TSR2 sensitivity analyses.

- **Short Term (1 - 20 years)**

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
♦ **ST 1**	1. Reduce the area not greened-up by 25% by accelerating the growth of existing young stands by: (maintain)	1. This is a defensive strategy. Sensitivity analysis indicates short term harvest levels would drop dramatically were more restrictive forest cover constraints were introduced. TSR2 base case used a 2 metre inventory height, so the recent policy change on green-up hts has partially been incorporated. Post workshop follow-up indicates the base case time to green-up may be optimistic - the 2 metre green-up may not apply in all cases due to site specific reasons. There is also the issue that KBLUP uses 2 metre silviculture height and that if we want to keep using 2 metres, we have to start using silv. height for management and TSR. Analysis of how much area below green-up and time until green-up is required (noted under "Summary of Information and Research Needs," page 55.). Efforts would focus on younger stands because treating stands that are within a few years of green-up would not be cost-effective. Options primarily consist of (a) brushing for growth enhancement and/or (b) spacing and fertilizing in areas having 6m green-up requirements.	1. N/A. Strategy orientation is to reduce risks posed by the possibility of a future increase in forest cover constraints or by the possibility that the base case time until green-up is optimistic. Brushing strategy overlaps with MT 3 (v). No spacing/fertilization opportunities identified.
♦ **ST 1**	(a) brushing for growth enhancement;	(a) Brushing for growth. See MT 3 (v). No additional brushing proposed here.	
♦ **ST 1**	(b) spacing and fertilizing FG stands in watershed & VQ zones where green-up is 6m.	(b) Spacing would have little effect on 2m green up as trees are usually not in serious competition during this time. VQO & watershed areas have 6m green-up requirement. Spacing/fertilizing of post FG / pre 6 m green-up stands is an option and can be funded by Forest Renewal BC (FRBC). Zone — %THLB — Years to 6m green-up VQO — 13 — 21 - 41 Watershed — 2 — 21 - 30 Post workshop follow-up indicates stands in these zones will not likely have the densities requiring spacing. Also, we may not want to space due to a resulting reduction in effective green-up due to a loss of crown closure (spacing will reduce crown closure, resulting in a potential increase to green-up - it is not just height which is important, but the assumed crown closure that comes with the height). Need to identify opportunity area for fertilization. Depends on species, site class, location. May not be many candidate areas. **Assume no spacing or fertilization candidate areas to support this strategy**. There is potential for overlap with other strategies (see MT3 vii). This strategy may be of lesser importance due to the small potential area for its application and its defensive na-	

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
		ture.	
♦ ST 2	2. Fertilize all suitable stands scheduled for harvest in the 2nd decade. (increase)	2. Inventory audit indicates volume estimates for existing stands are accurate. Any gain in existing volumes would therefore serve to increase harvest levels above the base case. There is a substantial area of suitable species and site productivity for fertilizing, but stand structure may not be suitable. Current planning and approval processes are inadequate to identify stands that will be harvested that far in the future. Assuming these factors could be overcome, a fertilization program of 450 ha/yr could be derived as follows. Assume Pl and Fdi species respond to fertilization (40% of area) and 70% of site classes are suitable for treatment = (.4 X .7 =) 28% of THLB suitable. (Spruce and cedar may be treatable but there is no local experience with fertilizing these species - need for trials noted under "Summary of Information and Research Needs," page 55.) Stands currently aged 60-80 years occupy approx. 25 000 ha of the THLB. Assuming these stands have the average species and site class distributions of the TSA, then .28 X 25 000 = 7 000 ha of treatable area. (Potential stands for fertilization were identified under contract a couple of years ago and this information could be used to refine these calculations.) Spreading treatment over a 15 yr period would result in an **annual program of roughly 450 ha/yr**. Benefits would accrue to last 5 yrs of short term and 1st decade of mid term. Based on a 5% vol. gain in fertilized stands, annual harvest gain would be 13 m3/ha over stands averaging 250 m3/ha at harvest. This would yield (13 X 450 ha/yr =) 5 850 m3/yr or 1% additional harvest volume over the 15 yr period.	2. 1% increase over last 5 years of the short term. Benefit passed on to increasing mid term harvest levels.
		<u>Short Term Harvest Forecast Summary</u> Other than for late rotation fertilization, the workshop review of the above potential strategies indicated no opportunities for increasing the short term harvest level above the base TSR2 base case. The indicated late rotation fertilization benefit was postponed into the mid-term period. The following summarizes the short term findings in terms of a potential harvest forecast for the period. **(000s m3/yr)** 535 1st dec. 535 2nd dec. - grn-up - fert 535 total	

♦ **Mid Term (21 - 70 years)**

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
♦ **MT 1**	1. Implement partial harvesting and/or commercial thinning regimes in all zones (particularly the VQO zone) to overcome adjacency limitations. (increase)	1. VQO zone is 13% of THLB. Harvesting from this zone is nearly always at its forest cover limits in the model. Partial harvesting will likely increase out of necessary to access timber and was not discussed further in the workshop. A study of partial cutting in 3 TSA's (Wang and Pollack, 1998) indicates that a global program of partial harvesting throughout a TSA can actually reduce harvest levels in early time periods (although in Golden this was found to be neutral), whereas a directed effort in a small portion of the TSA, particularly in VQO zones, can increase the overall harvest level (a 3% rise in Golden). This is due to a harvest scheduling effect; total stand volume from both partial harvesting and final harvest was by and large unchanged. (CT may offer up to 10% additional volume through recovery of timber that would otherwise be lost through mortality.) Currently there is no commercial thinning program. Log products from thinnings are very sensitive to market prices. Because of a lack of candidate stands and markets, CT is not a short term option. Stands must be set up for CT through stocking control. If CT is to be an option in the mid term appropriate stocking must be ensured - some stands will require brushing in order to keep stocking levels up, while others will require spacing to keep stands from being overstocked. There has been little spacing to date and there is not much spacing potential within the VQ zone. Some recent plantations may be candidates for future commercial thinning. **Needs to be analyzed further** (noted under "Summary of Information and Research Needs," page 55).	1. Sensitivity test indicates a 10% increase in allowable disturbance limits in VQO zone extends the IHL to 3 decades and raises decade 4 harvests by 7%. LTHL increases 1%. A 5% increase in limits in other zones lifts the 4th decade harvest level but not the 3rd. LTHL increases 3%. No opportunities identified.
♦ **MT 2**	2. Repeat fertilize all suitable existing stands scheduled for harvest 20 to 80 years from now to achieve the same harvested volumes as modeled in the base case but at lower min harvest ages.	2. Effectively, this strategy is a continuation of ST 2. See ST2.	2. Possible 1% increase in harvest level in decades 3 and 4. Regardless of effect at the management unit level. should consider fertilization for stand level effects.

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
♦ **MT 3**	3. (a) Reduce minimum harvest ages 10 years while at the same time, (b) increase the volume of regenerated stands by 10% over those used at the base case minimum harvest age (LT impact), and (c) achieve green-up 3-5 years earlier (LT impact) by:	The actions listed below (items i to vii) can influence both the mid and long term harvest levels depending upon the degree to which the objectives listed to the left (a - c) are attained. To avoid duplication, they are all evaluated together in this section.	

<table>
<tr><th>Number</th><th>Potential Strategy/Action</th><th>Discussion / Current Status</th><th>Anticipated Result</th></tr>
<tr><td>♦ MT 3</td><td>i) using improved seed; (increase)</td><td>3. (i) 100% of areas are planted. Of this, about 60% is genetically improved stock. All S (which is 60% of planting) is improved. No improved Cw or Hw. Latest estimates of yield gains are (%):[6]
<table>
<tr><th>Species</th><th>Cur Species %</th><th>Future Species %</th><th>1st gen % gain</th><th>2nd gen % gain</th></tr>
<tr><td>S</td><td>40</td><td>55</td><td>22</td><td></td></tr>
<tr><td>Pl</td><td>20</td><td>20</td><td></td><td></td></tr>
<tr><td>Fdi</td><td>20</td><td>15</td><td></td><td></td></tr>
<tr><td>Cw</td><td>10</td><td>5</td><td></td><td></td></tr>
<tr><td>Hw</td><td>10</td><td>-</td><td></td><td></td></tr>
<tr><td>Other</td><td>-</td><td>5</td><td></td><td></td></tr>
<tr><td></td><td>100</td><td>100</td><td></td><td></td></tr>
</table>
Based on S alone, LTHL can be expected to rise 12% (55% of area X 22% gain). If Pl and Fd added to S, an 18% rise could occur (90% of area X 20% gain). Yield gains were not included in TSR 2.

Tree improvement could significantly reduce green-up & minimum harvest ages. Sw SI 17-21 is expected (based on analysis unit 132, p 125, TSR2 analysis report) to yield 193 and 249 m3/ha at ages 70 and 80 respectively. Increasing these by 20% gives yields of 230 and 300 m3/ha respectively.

There are no tree improvement plans for other species within the Golden TSA at this time. Expanding the tree improvement program to include Fdi & Pl would likely offer similar gains to that of S and should be a high priority. Opportunity area = approx ½ of ann area harvested not currently planted with improved seedlings = 700 ha/yr. Priority is East Kootenay mid-elevation Pl.</td><td>3. (i) 12-18% LTHL gain. Lower green-up ages starting in 1-2 decades. Could lower minimum ages 10-20 yrs depending on species and site productivity.

See “Summary” below.</td></tr>
<tr><td>♦ MT 3</td><td>ii) managing stocking so voids do not account for more than 10% of the area; (increase)</td><td>(ii) TIPSY 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 approximately 19% of the total land area of the Golden 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 55). Voids can be desirable for wildlife habitat, so intensive void management may not be practicable on all areas.</td><td>3. (ii) No opportunity.

See “Summary” below.</td></tr>
<tr><td>♦ MT 3</td><td>iii) using larger planting</td><td>(iii) Pre free-growing item.</td><td>3. (iii) No opportunity.</td></tr>
</table>

[6] Source: Ivan Listar.

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Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
	stock; (increase)	Mostly plant 1+0 415d stock. Increased cost for larger stock may be (1400 ha/yr X 1200 trees/ha X $.30/tree =) $500,000/yr. Upper bound of opportunity area is the annual area planted = 1 400 ha/yr. Depending on size of stock, could reduce green-up ages and minimum ages 2-3 yrs. Workshop participants did not view this as a viable option. For now, **no opportunity is assumed.**	See "Summary" below.
♦ **MT 3**	iv) fertilizing at the time of planting; (increase)	(iv) Pre free-growing item. Not presently eligible for FRBC funding and not likely to be voluntarily undertaken unless necessary to achieve FG. Only a little amount of fert at time of planting has been done within the TSA with the objective of overcoming brush competition. Results are inconclusive. Could be a matter of fertilizer formulation. Experience elsewhere shows fertilizing at time of planting can give similar early results as using larger planting stock. For now, **no opportunity is assumed.**	3. (iv) No opportunity. See "Summary" below.
♦ **MT 3**	v) brushing for growth enhancement (i.e., not only for survival); (increase)	(v) Of the 1 400 ha logged/yr at least 600 ha (up to 1 000 ha) require brushing for survival. Approx 1/3 to ½ of these (400 ha) require a 2nd brushing for survival (equals annual basic brushing program of 1 100 - 1 500 ha), leaving 200 ha that could receive a 2nd brushing for growth. Another 200 ha of otherwise unbrushed logged area could receive a brushing for growth treatment, for a total **possible program of 400 ha/yr**. Habitat Protection Branch is more concerned about the brushing method used than the area brushed. The additional brushing will reduce voids in the stand and will bring it closer to meeting target stocking standards rather than minimums. If 50 additional trees/ha survive = (50/1 200=) 4% greater survival. If this occurred on (400/1400=) 0.3 of the area = (0.3 X 4%=) 1.2% LTHL gain. Cost would be 400 ha/yr X $450/ha = $180,000/yr. Typically, trees are brush for survival up to 1m in ht. Between 1 m and 2 m ht, tree growth is slowed by brush and some additional mortality occurs. However, because free growing obligations will be met, no brushing occurs after the 1 m ht is reached. Brush impedence is estimated to add 1 yr to reaching free growing and therefore 1 yr to culmination. This is equated to a 1% volume loss. Brushing for growth should be reviewed more closely when silviculture modeling is done for the TSA. There is also a need to determine the correct OAF1 factors on these sites both with and without brushing for growth (noted under "Summary of Information and Research Needs," page 55). For the purpose of this exercise it is assumed the TSR OAF1 factor of 15% is correct and reflects brushing for survival only. (For a 15% OAF1 to be correct, a stand planted to 1 200 sph must have about 1 000 sph at free growing to match the forecast used in TSR2.)	3. (v) 1% gain from reduced brush impedence + 4% gain from increased survival = 5% gain. Applicable to 400/1400 ha = net LTHL gain of 1.4%. Conservatively rounded down to 1%. See "Summary" below.
♦ **MT 3**	vi) spacing stands; (maintain) and	(vi) Virtually no basic spacing is necessary. TSR assumptions for establishing min. harvest ages for regenerated stands include a min 25 cm DBH criterion. TSR use of TIPSY	3. (vi) Reduce min harvest ages on 3 500 ha to al-

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
		yields based on establishment at 1200 st/ha assumes stocking control - either brushing to prevent under-stocking or spacing to keep from over-stocking. Not all stands will require spacing, but failure to maintain the assumed stocking levels may postpone time until stands reach 25 cm and therefore lengthen minimum harvest ages. (Usually a lower OAF1 should be used for spaced stands than for brushed stands.) During the workshop, it was discovered that the sensitivity to minimum ages is likely attributable to a shortage of stands currently aged 40 to 50 years old (see Figure 1, page 13). Accelerating the growth of stands currently aged 20-30 years old to make them harvestable (i.e., min 25 cm avg dbh and 175 m3/ha) at earlier ages, without unduly lessening site occupancy, would achieve a similar effect on the harvest forecast as demonstrated by a reduction in minimum harvest ages. There are about 35 000 ha of stands aged 20 - 30 years. Most of these are in the Sue Fire / Beaverfoot valley areas. They are estimated to consist of 50% Pl, 25% Fdi and 25% S. Because the stands are contiguous, forest cover constraints may affect their availability at harvest, so full effect on the harvest forecast may not be achieved. 80% of this area already has reasonable spacing so 0.2 X 35 000 ha = 7 000 ha spaceable. (Important to check out on the other 28 000 ha what stocking levels will postpone the time to achieve the minimum piece size criteria, and the occurrence of these stands - noted under "Summary of Information and Research Needs," page 55.) Reducing this by half (to allow for operational reasons such as slope which may prevent treatment, as well as allowing for some of these areas to be managed for longer rotations to allow for quality) and spreading over a 10 year period = **350 ha/yr spacing program**. These stands are targeted for early harvest at lower minimum ages and therefore should not be included as target stands for quality types III and IV. **No additional stands identified for spacing beyond those for wood flow (see above) and quality (see Q1 below)**. Spacing could reduce minimum harvest ages 10 years. Further analysis required.	low earlier harvest in decades 6-8. 1 decade total harvest = 14 000 ha. 3 500 ha = (3500/14000) 25% of a decade harvest. If spacing reduces ages 10 years, then a 10 yr reduction on 25% of the area is the equivalent of a 2.5 yr reduction on the whole area. TSR sensitivity test indicates a 10 yr reduction in min ages extends IHL 3 decades over the base case. A 2.5 yr age reduction therefore roughly equates to a 1 decade extension of IHL. See "Summary" below.
♦ MT 3	vii)repeat fertilize suitable stands on a 15 yr return cycle.	(vii) On a steady state basis, 40% of the species on 70% of the site classes, or 28% (46 600 ha) of the total THLB (166 600 ha) could be suitable for repeat fertilization. If 80% of these have suitable stand conditions, this area is reduced to (46 600 X .8 = 37 300 ha). However, not all areas would be available to be fertilized. Assuming 80% of areas are available (.8 X 37 300 = 30 000 ha), on a 15 yr return cycle, a maximum fertilization **program would then be (30 000/15=) 2 000 ha/yr**. **Stands spaced for the purpose of reducing minimum ages should be priority for fertilization. This could lower their min ages a further 5-10 years.**	3. (vii) A 10% volume gain would increase harvest levels (30000/166 600 X .1 =) 2%. 5-10 year lower min ages on fertilized stands. See "Summary" below.
♦ MT 3	3. (a)-(c) Summary	3. (a)-(c) Summary Treatment % Increase Lower Min Ages (yrs)	3. (a)-(c) Summary (a) Sensitivity analysis in-

<table>
<tr><th>Number</th><th>Potential Strategy/Action</th><th>Discussion / Current Status</th><th>Anticipated Result</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><th></th><th>in Vol (net)</th><th>(LT potential)</th><th>(oppt'y factor)</th><th>(net oppt'y) LT</th><th>(net oppt'y) Decade7</th></tr>
<tr><td>improved seed</td><td>12-18</td><td>10-20</td><td>90% of area</td><td>14</td><td>-</td></tr>
<tr><td>red. in voids</td><td>-</td><td>-</td><td>(no oppt'y)</td><td>-</td><td>-</td></tr>
<tr><td>larger stock</td><td>-</td><td>2-3</td><td>(no oppt'y)</td><td>-</td><td>-</td></tr>
<tr><td>fert. at planting</td><td>-</td><td>1-2</td><td>(no oppt'y)</td><td>-</td><td>-</td></tr>
<tr><td>brush for growth</td><td>1</td><td>1-2</td><td>(on 4/14th of area)</td><td>1</td><td>-</td></tr>
<tr><td>spacing</td><td>-</td><td>10</td><td>(3 500 - 7 000 ha: decades 3-5)</td><td>-</td><td>2.5-5</td></tr>
<tr><td>repeat fert.</td><td>2</td><td>10</td><td>(18% of THLB)</td><td>2</td><td>-</td></tr>
<tr><td>TOTAL</td><td>15-21</td><td>?*</td><td></td><td>17*</td><td>2.5-5</td></tr>
</table>
*Some effects may not be additive, but others may compound. Can usually take the benefit either in the form of increased volume or reduced harvest age, but not both.
(a) A 10 year reduction in min harvest ages is readily achievable over the long term. However, fewer options are available in decade 6 or 7. Depending on the ultimate allocation of spacing efforts between volume and quality objectives, minimum ages in this period could be lowered between 2.5-5 years when the spaced area is prorated across the 14 000 ha to be harvested in a decade.
(b) A 15-21% gain in regenerated stand volumes appears achievable, depending largely on the extent of the tree improvement program. If benefits are taken in the form of earlier harvest ages, the volume gains would be proportionately less.
(c) Although a 5 yr earlier green-up is likely possible given the potential for improved silvicultural practices and the recent change in standards for measuring green-up, there is some reason to believe the base case green-up ages are optimistic - see ST1. Assume no change.
Aggressive site preparation and reforestation is necessary to meet the objectives. These will improve initial seedling survival and growth. Planting and/or brushing alone is not sufficient to produce the desired volumes.
</td><td>
dicates a 10 yr reduction in min harvest ages will extend the initial harvest level to decade 5. This reduction in ages is only needed in this time period due to an age class imbalance.
(b) Sensitivity analysis indicates a 10% increase in regen vol's results in a 10% increase in long term harvest levels. A 19% increase in regen vol's therefore yields a 19% increase in <u>LTHL</u>. This rise might be delayed 2-3 decades due to lower minimum ages in decades 7-8.
(c) N/A
Increased site productivity may further compound these effects.
</td></tr>
<tr><td>♦ MT 4</td><td>4. Commercially thin stands to:</td><td>4. Old seral stage is critical. Due to modeling methodology, the contribution of areas outside the THLB to meeting requirements was possibly overstated. Sensitivity analysis indicates the base case may be overstated in the long term by 10%. On the other hand, current fire suppression fire suppression activities outside the THLB are capable of maintaining most areas as older forests.</td><td>4. Subset of MT1.</td></tr>
</table>

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Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
		The caribou and ungulate winter range zones are particularly constraining. Silvicultural activities, particularly commercial thinning, can be used to create old-growth tree attributes at earlier ages, thereby relieving some constraints. However, some other biological requirements may not be met. Analysis is required to determine if CT can achieve these attributes earlier. FSSIM analysis also required to determine possible timber supply effect of lowering ages for caribou habitat from 250 to 200. (Noted under "Summary of Information and Research Needs," page 55).	
♦ **MT 4**	(a) create old seral attributes generally across all zones;	(a) Not discussed in the workshop.	(a) N/A
♦ **MT 4**	(b) create old-seral attributes earlier in caribou winter range (maintain);*[7] and	(b) The caribou winter range zone occupies 11.9% of the ICH and 2.6% of the engelmann spruce-subalpine fir (ESSF) zones (14.5% of THLB). About 40% of this area (6% of THLB) has specific caribou prescriptions. The current requirement is 40% of these areas must be in stands ≥ 140 years old and 10% ≥ 250 years. As a first step, further research is required to determine lichen production rates under different stand conditions and ages. Once this is known silvicultural strategies can be devised to achieve these conditions at an earlier age, if further analysis indicates the required ages for caribou habitat are still limiting timber supply. In the absence of better information, it is expected that the objective of a management strategy would be to create more open stand conditions to encourage lichen growth on trees. Commercially thinning 60 -70 year-old stands accelerates the development of the desired stand structure and lichen growth. This may enable reducing the age limitations to 100 and 200 years respectively. Meeting the objective may require spacing stands now to set them up for commercial thinning in 30 - 50 years from now. The current age class structure indicates candidate stands may be available. **Modeling/further analysis is needed to determine extent of candidates & potential impact.**	(b) Further modeling required.
♦ **MT 4**	(c) create old-seral attributes earlier in ungulate winter range. (maintain)*	(c) For deer winter range, the stand structural objective is deep, wide crowns for snow interception. A fertilization treatment after CT would help promote crown development.	(c) Not discussed.
♦ **MT 4**	(a) - (c) Summary	4. Summary: Both (a) and (b) would likely be a subset of the strategy to CT for harvest flow purposes. See MT 1. Further modeling required. **No specific strategies proposed.**	(a)-(c) Modeling required.

[7] * - indicates added during the district working session.

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
		Mid Term Harvest Forecast Summary Multiple alternatives are possible depending upon the allocation of the spacing benefit between reducing minimum harvest ages (resulting in a volume effect) or improving stand quality. The preferred district alternative is to split the benefit between the two. On this basis, the allowable cut effect could be either used to maintain the IHL for an additional decade, or to spread the equivalent volume across the entire mid term, raising the bottom of the mid term trough. See Figure 10, page 40 for these and other alternative. (Base case not adjusted for possible over-estimates acknowledged in TSR2 analysis report. When released, adjustments should in accordance with CF TSR2 AAC determination.)	

♦ Long Term (71+ years)

<table>
<tr><th>Number</th><th>Potential Strategy/Action</th><th>Discussion / Current Status</th><th>Anticipated Result</th></tr>
<tr>
<td>♦ LT 1</td>
<td>1. (a)Rehabilitate 300 ha of remaining treatable backlog NSR (maintain); and

(b) Maintain approx. 400 ha of previously reforested backlog plantations. (maintain)</td>
<td>1. (a) About 2 100 ha of backlog remains, about 300 ha of which is treatable. A program of 300 ha/yr of fill planting over the next 1 year is needed. Cost is $200/ha. Each ha will require 2-3 brushings. See schedule below.

(b) About 400 ha of previously reforested area requires maintenance to ensure free growing is achieved. Brushing is needed on some plantations to ensure they attain free-growing. An initial program of 300 ha/yr, declining to 100 ha/yr over the next 5 years is needed to maintain this area as well as newly reforested area under (a) above.

The following program is required.
<table>
<tr><th></th><th colspan="5">Area (ha)</th></tr>
<tr><th></th><th></th><th></th><th colspan="3">Brush</th></tr>
<tr><th>Year</th><th>Site Prep</th><th>Plant</th><th>New Plantation</th><th>Existing Plantation</th><th>Total</th></tr>
<tr><td>1</td><td>-</td><td>300</td><td>200</td><td>100</td><td>300</td></tr>
<tr><td>2</td><td></td><td>-</td><td>100</td><td>200</td><td>300</td></tr>
<tr><td>3</td><td></td><td></td><td>100</td><td>100</td><td>200</td></tr>
<tr><td>4</td><td></td><td></td><td>100</td><td>100</td><td>200</td></tr>
<tr><td>5</td><td></td><td></td><td>-</td><td>100</td><td>100</td></tr>
<tr><td>6-10</td><td></td><td></td><td>-</td><td></td><td>-</td></tr>
</table>
</td>
<td>1. (a) (b) Maintain base case LTHL. Failure to treat would result in a drop in LTHL.</td>
</tr>
<tr>
<td>♦ LT 2</td>
<td>2. Increase the THLB by:</td>
<td>2.
<table>
<tr><th></th><th>Area (ha)</th><th>%tot area</th><th>%prod area</th><th>%THLB</th></tr>
<tr><td>(a) NCBr</td><td>2 100</td><td>.2</td><td>.7</td><td>1.3</td></tr>
<tr><td>(b) Decid</td><td>10 600</td><td>.9</td><td>3.6</td><td>6.3</td></tr>
<tr><td>(c) Non-merch</td><td>1 300</td><td>.1</td><td>.4</td><td>0.8</td></tr>
<tr><td>(d) Low site</td><td>9 700</td><td>.8</td><td>3.4</td><td>5.8</td></tr>
</table>
</td>
<td></td>
</tr>
<tr>
<td>• LT 2</td>
<td>(a) rehabilitating NCBr; (increase)</td>
<td>(a) NCBr areas may are likely associated with avalanche tracks and do not offer potential for rehab.</td>
<td>(a) No opportunity.</td>
</tr>
</table>

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
• **LT 2**	(b)converting /rehabilitating deciduous stands; (increase)	(b) Decid. Most decid is aspen. Of the 10 600 ha total, about 1 600 is in ESA or other constrained areas and 2 000 ha is probably merchantable. Of the 7 000 remaining ha, about ½ is suited to ultimate conifer management with the other ½ suited to hardwood management. Aspen is very important for wildlife because there is not much of it in the TSA. Consensus is to basically leave the deciduous alone. Also see H8.	(b) No opportunity.
• **LT 2**	(c)converting/rehabilitating non-merchantable hemlock stands; (increase)	(c) Non-merch is mostly Hw. By definition, this is operable and productive but of low quality. Options for management include: • wait for good markets to harvest; • subsidize salvage/rehab; • inventory reclassification; • lump in a cutting permit having mostly good wood; • leave to satisfy old-seral requirements. Workshop consensus that further analysis of these opportunities was required before a course of action could be selected. Noted under "Summary of Information and Research Needs," page 55.	(c) Further analysis required.
• **LT 2**	(d) improve the site productivity of low-site stands by (fertilization?). (increase/maintain)	(d) Chief forester is unsure of the potential for improving the productivity of low site lands in this TSA. May be useful to re-assess the status of these lands through an expert inventory similar to the Merritt small wood study. Noted under "Summary of Information and Research Needs," page 55. Gain to LRSY would be lower than for average site productivity.	(c) Expert inventory required.
♦ **LT 3**	3. Continue MT 3. (increase)	3. See MT 3 above. Assume: (a) A 10 yr reduction in min harvest ages could be achieved. This reduction in ages may be relevant in the first few decades of the long term, following through on reduced ages in decades 6-7. After this, however, there is likely to be a gradual transition in harvest ages back towards culmination age in order to improve stand quality and volume. (b) a 21% gain on regen stand volumes, based primarily on an expanded tree improvement program; and (c) no change in green-up ages.	3. (a) Sensitivity analysis indicates a 10 yr reduction in min ages will reduce LTHL by 7%. Assume min. harv. ages will not be reduced once age class imbalance passes and therefore this reduction will not occur. (b) Sensitivity analysis indicates a 10% increase in regen stand vol's will

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Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
			result in a 10% increase in long term harvest levels. A 21% gain in vol's therefore = a 21% LTHL increase. (c) Sensitivity analysis indicates a 5yr reduction in green-up ages will result in a 2% increase in LTHL. However, no change in ages assumed.
♦ **LT 4**	4. Reduce losses to root rot by: (maintain)	4. A possible 2% reduction in LTHL can be estimated as follows. Significant root rot occurs primarily in Fd (20% of THLB) in ICH zone (60% of THLB). This nets to (.2 X .6 =) 12% of THLB. If these stands suffer a 15% volume loss, TSA level loss amounts to (.12 X .15 =) 2%. This may be accounted for within the global TIPSY OAF2 of 5% which is applied to all stands. Nevertheless, a goal could be to reduce root rot losses by half, to a 1% loss. The need for further study of root rot management noted under "Summary of Information and Research Needs," page 55.	4. Uncertain as to effect on base case. Assume neutral.
LT 4	(a) planting alternate species;*[8]	(a) This is current practice, see MT 3 (i) for projected species changes.	(a) Current practice.
LT 4	(b) pop-up spacing;*	(b) This is expensive and only suitable for heavily infected areas. **A program of 20 ha/yr is required**.	(b) Minimal effect on LTHL.
LT 4	(c) pushover logging / stumping;* and	(c) This is done on a limited area where practical as part of a basic silviculture obligation.	(c) Current practice.
LT 4	(d) mixed species planting.*	(d) Mixed species planting. This is current practice in most areas.	(d) Current practice.
		Note: A further technique of judicious planning use of partial cutting techniques was suggested by the region after the demonstration workshop.	
♦ **LT 5**	5. Plant areas outside of the THLB to increase the area in an old-seral state in 100 to 200 years. (maintain)	This opportunity was not discussed during the district workshop. Not likely to be practiced in the foreseeable future. More information required.	5. N/A.

[8] *- indicates added during the demonstration workshop.

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
♦ **LT 6**	6. Continue MT 4.	See MT 4.	6. See MT4. Requires additional research and modeling.
		Long Term Harvest Forecast Summary **(000s m3/yr)** 446 base case - backlog - incr. THLB 0 min ages 94 rgn vols (21%) 0 grn-up - root rot - plant outside the THLB - prt harv. 540 total	

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Potential Harvest Forecast

Figure 9 graphs the potential harvest level that may be attained through implementation of the silvicultural strategies in the preceding tables. It is based on the "Harvest Forecast" summaries of the short mid and long term tables in "Workshop Review of Potential Strategies." 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 silviculture activities than could be developed in this interim strategy. See the expanded view in Figure 10 regarding mid-term alternatives.

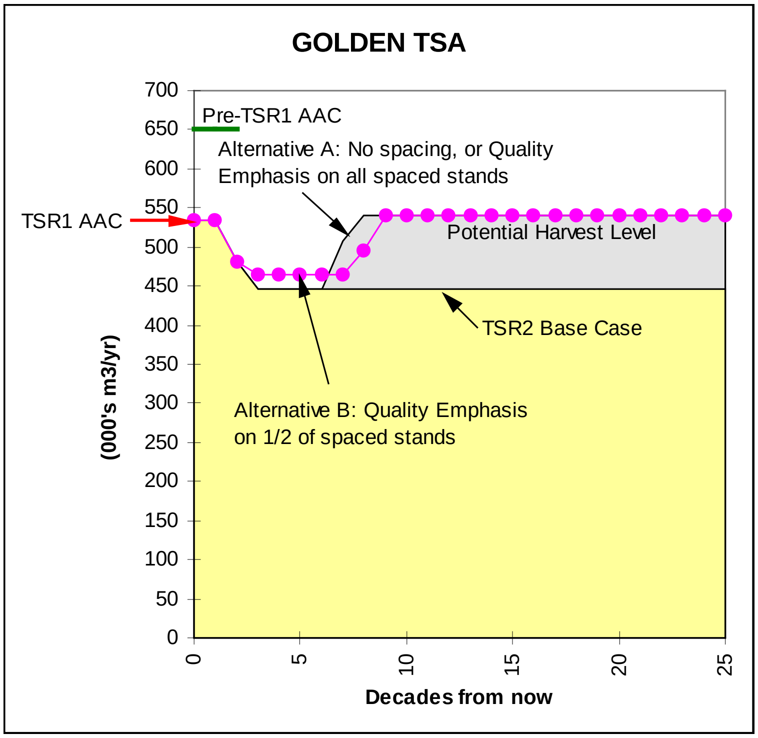

Figure 9. Potential harvest forecast, Golden TSA

NB: The TSR2 analysis report acknowledges several areas where the base case forecast may be overestimated (see "Long Term," under "Summary of Issues," page 16). In the strategy workshop, other uncertainties regarding the base case were also 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 these. Consequently, Figure 9 contains no adjustments to the base case. In any event, the difference between the two forecasts illustrates the potential outcome of the strategy. This difference would likely remain the same in the event the base case is amended. Were the base case to substantially change shape, however, the strategies should be re-evaluated to confirm their validity.

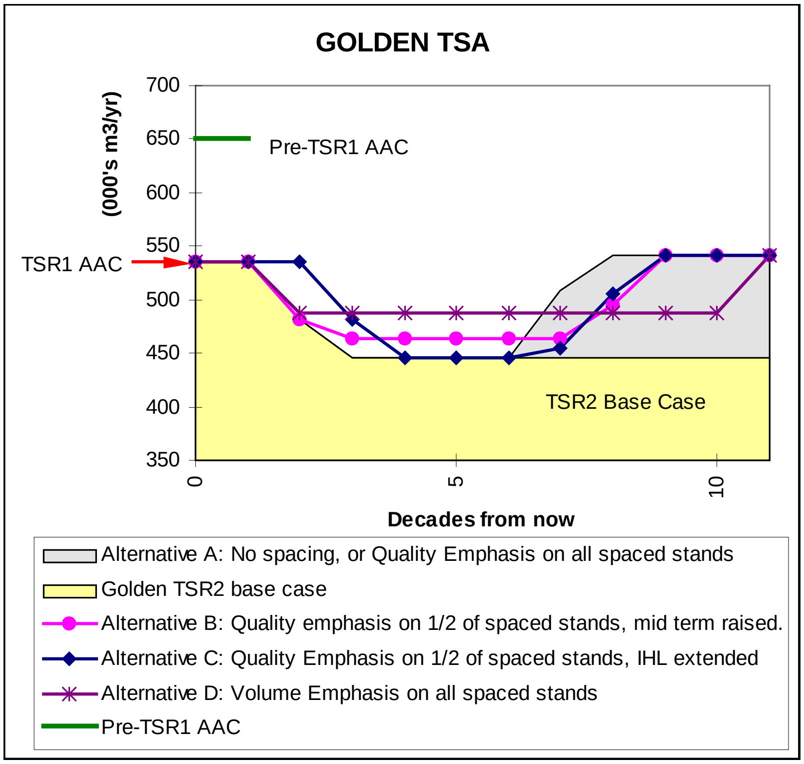

Figure 10. Expanded view of potential harvest forecast alternatives, Golden TSA

The TSR2 analysis report indicates the TSA is highly sensitive to a 10 year reduction in minimum ages. This was found in the workshop to likely be due to a shortage of stands currently aged 40-50 years. The minimum harvest ages of stands currently aged 10-30 years (of which there is a relatively large area) can potentially be reduced through spacing. Bringing forward the harvest of the spaced stands 10 years in time generates an allowable cut effect[9] because some older existing stands no longer have to be reserved for harvest in the latter part of the mid term time period.

Spacing can also be used to improve stand quality by increasing average stand diameter and merchantable volume at specified ages. Many such 'quality' stands would likely also be candidates for pruning. When spacing is done for this purpose, minimum harvest ages are not reduced. If ages were reduced, the stands would be harvested before reaching their target sizes.

Alternative A shows the effect of either not spacing any stands, or of allocating all spacing to quality purposes (in which case minimum ages are not reduced). The increased long term harvest level over the base case is due to increased regenerated stand volumes resulting from the strategies identified as having potential.

[9] The term allowable cut effect (ACE) is used in forestry literature to describe situations where undertaking an action which affects stands scheduled for harvest later in the planning horizon allows higher harvest levels earlier in the horizon. This term should not be confused with the allowable annual cut determination by the chief forester. For the indicated ACE to be considered in an AAC determination, the chief forester would consider whether the spacing has taken place, whether the effects on minimum ages and harvest levels are as described, and when to incorporate them in an AAC determination. Given that none of the indicated alternatives changes the harvest forecast for the next 20 years, the ACE from spacing stands is not likely an issue in AAC determination for over this time. However, if the identified stands are not spaced soon, the window of opportunity will be lost and 20 years from now the matter of an allowable cut effect will be a non-issue.

There are about 7 000 ha of potentially spaceable stands (however, many stands have clumpy distribution and this spacing potential may not fully exist). The district plans to allocate ½ of the potential spacing (3 500 ha) to improving stand quality, in which case the minimum ages of these stands would not be planned to be reduced. Alternatives B and C illustrate harvest forecasts based on allocating ½ of the spaced stands (3 500 ha) to improving stand quality and the other ½ (3 500 ha) to reducing minimum ages. Alternative B allocates the allowable cut effect resulting from the reduced ages on ½ the stands across the mid term trough. Alternative C allocates the effect to extending the initial harvest level by one decade.

Alternative D shows how the forecast might appear if all of the spaced stands (i.e., all 7 000 ha) were allocated to increasing harvest levels through reduced minimum ages.

Relative to Alternative A, the onset of the rise to LTHL is delayed in all other alternatives. This is because the reduction in minimum ages has moved some harvest forward in time, creating something of a domino effect. The total volume harvested over time more or less does not change, only the timing of the harvest changes.

The working targets expressed in this strategy are based upon Alternative B. Follow-up analysis and modeling is required to confirm the potential benefits. They are likely over-stated in this analysis.

Opportunities to Improve Timber Quality

The effects of 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 workshop.

Product Objectives

The following are (unapproved) product objectives at the log level for the Golden TSA.

Quality Class	Species	Characteristics
Premium Log:		
Type III	All	15% of stands having 32.5+ cm minimum average stand diameter at breast height (DBH), having 60-100% of stems with a 1st log clear of knots, and achieved through faster growth at lower stocking levels (600 sph at rotation).
Type IV	All	15% of stands having 32.5+ cm minimum average stand diameter at breast height (DBH), having narrow ring width achieved through higher stand density (800 sph at rotation) and having 60-100% of stems with a 1st log clear of knots.
Sawlog:	All	27.5+ cm minimum average stand DBH.

Workshop Review of Potential Strategies

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

<table>
<tr><th>Response Time Frame</th><th>Potential Strategy/Action</th><th>Discussion / Current Status</th><th>Anticipated Result</th><th>Premium Log Forecast</th></tr>
<tr><td>♦ Short Term (1 - 20 yrs)</td><td>None</td><td>Short term harvests will come from existing older stands which are not treatable to improve quality.</td><td>Quality profile of existing old growth will prevail. Assume this is equal to a recent coast-wide estimate of 15%.</td><td>15%?</td></tr>
<tr><td>♦ Mid Term (21 - 70 yrs)</td><td>As above.</td><td>As above.</td><td>As above.</td><td>Steady decline to long term level.</td></tr>
<tr><td>♦ Long Term (71 + yrs)</td><td>Q1. ~~First lift prune 150 ha/yr to 3.1 m.~~

Revised in workshop to: Two-lift prune 150 ha/yr to 5.5 m. (total program of 300 ha/yr required)*</td><td>1. Maximum past pruning program has been 100 ha/yr. On a 2-lift basis this would equal 50 ha/yr under pruning management.

A number of program options were analyzed. Assume 1st 5 m log = 25% of tree vol., annual harvest area = 1 400 ha/yr.
<table>
<tr><th>Ann prog - ha</th><th>two lift equiv - ha</th><th>% of ann hrvst area</th><th>%tree vol pruned</th><th>% tot hrvst vol pruned</th></tr>
<tr><td>100</td><td>50</td><td>3.6</td><td>25</td><td>1</td></tr>
<tr><td>200</td><td>100</td><td>7.1</td><td>25</td><td>2</td></tr>
<tr><td>300</td><td>150</td><td>10.7</td><td>25</td><td>3</td></tr>
<tr><td>600</td><td>300</td><td>21.4</td><td>25</td><td>6</td></tr>
</table>

District objectives are to have 60-100 % of stems with 1st log with clear wood on 30% of area. If an average of 80% of stems were used, this equates on an area basis to .8 X 30% = 21%. From the above table, without any natural pruning, an annual pruning program of 600 ha would be necessary to achieve this objective. Because this is far above past maximum program levels, **a program level of 300 ha/yr** was adopted (during discussion of the regime table). This also recognizes the tradeoffs with having to space areas to harvest at younger minimum ages for wood flow purposes (see potential strategy MT 3).</td><td>1. A pruning program of 600 ha/yr would achieve the product objective for clear logs. However, in view of past program levels, ½ of this seems more realistic and attainable.</td><td>3% of total annual harvest volume to be in clear logs.</td></tr>
</table>

Response Time Frame	Potential Strategy/Action	Discussion / Current Status	Anticipated Result	Premium Log Forecast
	Q2. Space 700 ha/yr to obtain large dimension timber and prepare stands for fertilization, pruning and/or commercial thinning.	2. See large log analysis below.	2. See large log analysis below.	2. See large log analysis below.

Large Premium Log Analysis

The following analysis is primarily for demonstration purposes. It has several weaknesses, such as: in the long term, a steady-state program of 700 ha/yr of spacing is high; stocking levels used for unspaced stands are high; and there are only about 7 000 ha of candidate stands for spacing that would be harvested in late mid-term period. Consequently the results should be used with caution until replaced with analysis-based results.

The large log analysis below indicates that, based on the assumptions used, on a long term steady-state basis, a 700 ha/yr spacing program (i.e., approx. one-half of the annual area harvested being spaced) would result in approx. 9% of future harvested volumes being large premium logs, assuming all stands are harvested at culmination of MAI (scenario 1), (Note: culmination ages are generally higher than the minimum ages used in the TSR2 analysis but are in the range of the forecast average harvest age of the base case). Scenario 1 also indicates that without any spacing there would still be a 6% large log yield (the spaced stands, if left unspaced, would still yield the same large log component as the unspaced stands shown in the analysis).

Increasing regenerated stand volumes 20% and changing the species profile to the anticipated future profile results in a lower large log component of 8%, due to both lower culmination ages and the increased proportion of spruce stands (Scenario 2). At this point, however, only Sw is from improved seed, so effects are overestimated. Analysis of spacing effects may show more positive results using other models.

Towards the end of the mid term period, that is, from decades 6-10 depending upon the chosen alternative (see Figure 10, page 40), there is a need to allocate some of the spacing benefit to lowering minimum harvest ages. Alternative B is the preferred district alternative where, out of a 700 ha/yr total program, approximately ½, or 350 ha/yr would be dedicated to lowering minimum ages and the other ½ dedicated to creating large premium logs. Assuming stands harvested at lower minimum ages have a minimal large log component, spacing 350 ha/yr for stand quality would likely result in somewhat less than one-half of the additional 3% increase shown in scenario 1 as attributable to spacing; i.e., a total of less than 7.5% large logs by volume during this period. It is assumed to be less than half because the overall average age of harvest during this time would likely drop below the culmination ages on which the scenario 1 calculations are based.

Assumptions

Avg. annual area harvested = 1 400 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 1200 sph.

all species to 32.5 cm large log. Because TIPSY table dbh classes are mid points, this translates in TIPSY yield tables to the bottom end of the 35 cm class.

Diameters and yields are at culmination age. Culmination ages are generally higher than the minimum ages used in the TSR2 analysis, but are in the range of the average harvest age of the TSR2 base case (107 yrs from decades 6-25).

% ≥ 35 cm is from TIPSY stock table, rounded to nearest 5%.

Bottom 5m log = 20% of tree vol.

% large of total ann. harv. volume = (Area/1400) X (%≥ 35 cm) X (20% of tree vol.)

Assume ½ of areas are spaced (700 ha/yr total).

SCENARIO 1

SI from SIBEC/ISIS project.

TSR2 existing species profile.

Species	%inv	SI	Space frm/to:	Area	Cul Age	Yield	% tot vol ≥ 35cm DBH class, -this tmt	% of tot harv vol (all areas) in 5m prem. logs
Sw	40	15	3000/900	280	120[1]	386[2]	55	2.2
			3000/unspaced	280	110	369	20	0.8
Pl	20	22	4000/900	140	70[1]	344[3]	40	0.8
			4000/unspaced	140	60	306	5	0.1
Fdi	20	23	3000/900	140	100	475	75	1.5
			3000/unspaced	140	100	477	60	1.2
Cw	10	18	3000/900	70	130[1]	622[4]	80[5]	0.8
			3000/unspaced	70	120	601	60	0.5
Hwi	10	18	4000/900	70	110[1]	477[6]	70	0.7
			4000/unspaced	70	100	469	35	0.4
Total				1400				9.0

9% premium log content,6.0% from spaced stands and 3.0% from unspaced stands. Some of this will be clear.

[1] spacing raises culmination age

[2] 350 at age 110

[3] 291 at age 60

[4] 574 at age 120

[5] % likely higher - some 2nd logs will be ≥ 35cm

[6] 431 at age 100

SCENARIO 2

Expected future species profile.

20% yield gain modeled by choosing SI yielding nearest to a 20% MAI gain over SIBEC/ISIS project SI's for spaced stands.

Species	%inv	SI	Space frm/to:	Area	Cul Age	Yield	% tot vol ≥ 35cm DBH class, -this tmt	% of tot harv vol (all areas) in 5m prem. logs
Sw	60	17	3000/900	420	100	376	50	3.0
			3000/unspaced	420	100	390	20	1.2
Pl	20	24	4000/900	140	60[1]	347[2]	40	0.8
			4000/unspaced	140	50	294	2	0.0
Fdi	10	25	3000/900	70	100	559	80	0.8
			3000/unspaced	70	100	555	70	0.7
Cw	5	20	3000/900	35	110	654	80	0.4
			3000/unspaced	35	110	678	65	0.4
Hwi	5	20	4000/900	35	110[1]	570[3]	80	0.4
			4000/unspaced	35	90	497	40	0.2
Total				1400				7.9

7.9% premium log content, 5.4% from spaced stands and 2.5% from unspaced stands. Some of this will be clear.

[1] spacing raises culmination age.

[2] 277 at age 50

[3] 500 at age 100

Potential 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 (9% forecast vs. assumed current estimate of 15%). This forecast is based on harvesting future stands at culmination ages, which are higher then the minimum ages used in the timber supply analysis, but close to the modeled average harvested age in the analysis.

Postponing harvest to ages that are past culmination age would increase the large dimension component of premium logs. Depending upon future timber market demands and values, rotations may be extended past culmination age to increase the large dimension component of premium logs.

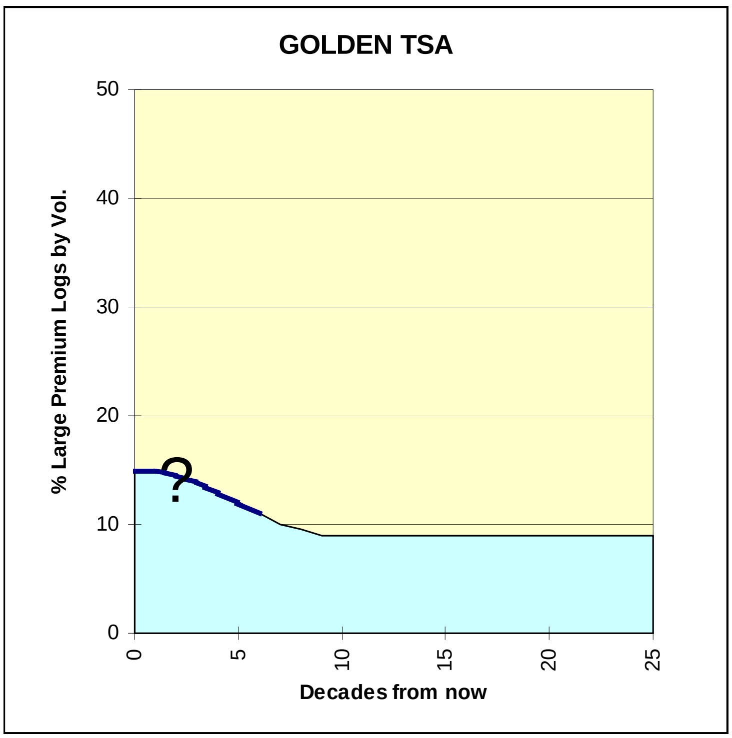

Figure 11. Potential quality forecast, Golden TSA

This potential quality forecast is based on large-premium logs. The current timber quality profile is unknown. Rough analysis indicates large logs could form 9% of future harvests (based on spacing 700 ha/yr) and clear logs 3% (based on pruning 300 ha/yr which is the equivalent of 150ha/yr under 2-lift management). Most of the clear logs will also be large logs. Further analysis is required to improve upon these forecasts.

Opportunities to Improve Habitat Supply

Workshop Review of Potential Strategies

The following strategies have potential to increase habitat supply or improve habitat quality. These were identified in the district workshop. No response time frames were identified. [This can be improved over time - What are the supply objectives in terms of ha's of thermal cover, ha's of winter range, when might there be shortages of these and how can silv be used specifically to help fill the gap.]

Response Time Frame	Potential Strategy/Action	Discussion / Current Status	Anticipated Result	Habitat Supply Forecast
	H1. Increase thermal cover in winter ranges by (a) preferred species selection; and (b) diversifying habitat through harvest scheduling.	[Goal for ha to be continuously maintained in thermal cover? Spatial requirements?] (a) Obtaining crown closure as soon as possible after harvesting restores thermal cover. Desired species are Fdi, Sw and Cw. Pl is not favoured due to its narrower, sparser crown. The preferred species should be selected during both planting and spacing treatments. (b) Harvest scheduling can be used to increase the diversity of habitat types. In large contiguous areas of similar timber types, planning harvests to cut some areas sooner and holding others longer will accomplish this.		?
	H2. Increase forage for ungulates by (a) commercial thinning, with Fdi as the preferred leave species; and (b) spacing/fertilizing Fdi stands.	[Goal for ha to be continuously maintained in forage production? Spatial requirements?] (a) Stands in ungulate winter ranges with a high component of Fdi are preferred, this being one of the better species for snow interception. Commercial thinning, bringing crown closure down to 70/75 percent, will open up the stands to allow more light to reach the forest floor to increase forage supply while maintaining snow interception. This will promote forage production. [Goal - ha's of CT] [When?] (b) Program?		?

Response Time Frame	Potential Strategy/Action	Discussion / Current Status	Anticipated Result	Habitat Supply Forecast
	H3. Manage riparian zones for a natural diversity of species by planting a natural vegetation mix on all areas within the zone.	3. Manage the actual riparian area for a natural diversity of species. Do not force a conifer monoculture. The actual riparian area does not fully equate to the code's Riparian Management areas.		
	H4. Manage NDT 4 for ______ through regimes of spacing, CT and partial harvesting.	4. Natural disturbance type 4 includes ecosystems with frequent stand-maintaining fires. In the Golden TSA this occurs on the drier IDF biogeoclimatic zone. Fire suppression has altered fire regimes, resulting in species changes and denser stocking. The objective of this strategy is to maintain newly established stands in -or return older existing stands to- a more open stand condition. Harvest planning should consider partial cutting in this zone. Silvicultural techniques of spacing and commercial thinning can be used in younger stands. [How many ha's of NDT4 are there? What is it's current status? Is there a quality scale? How might this affect harvest levels? Is there a win-win here; eg. pruning to improve the stem value? Could mechanical pruning work on wider spaced stands to lower the costs. How many ha's of spacing and CT are needed here? What about burning? What time frames - short, mid, long term?] There is also a small opportunity to convert/maintain some transitional NT3 areas in the Beaverfoot Valley open forest conditions, maybe 2-300 hectares.		

Response Time Frame	Potential Strategy/Action	Discussion / Current Status	Anticipated Result	Habitat Supply Forecast
	H5. Manage regenerated stands in the vicinity of hydro reservoirs to create perching and nesting trees for both eagles and ospreys trees by a) variable density thinning and b) varied planting stock.	5. [How many of these sites or total area needed?] We can't rely on wildlife tree patches to maintain nest and perch opportunty through time as gaps in supply will occur when managing even aged one structured stands on 120/140 year rotations. Silviculturally, there is opportunity to manipulate stands possibly by variable density thinning and varied planting stock to create multi-structured stands that will include large dominants above the canopy of surrounding forests with the suitable habitat characteristic such as larger branching.		
	H6. Maintain a mosaic of stand densities through variable density spacing of all stands.	6. This strategy should be a goal district wide. A strategy such as multiple entry variable spacing should increase stand diversity by better resembling natural conditions and processes. This could also be a step closer to gaining old growth conditions at an earlier age.		
	H7. Create lichen forage in younger stands.	7. [Need more info? How much area in young stand lichen production is needed? What age stands are we targeting? How does this relate to H2?]		
	H8. Rehabilitate 30 ha/yr of aspen stands to maintain deciduous cover.	8. **About 30 ha/yr of aspen stand maintenance is occurring under the Columbia Basin Trust.** Treatment is felling/girdling @ $600/ha = $18,000/yr.		

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 focus of the silviculture strategy is to:

- increase regenerated stand volumes by 20%;
- accelerate the growth of stands currently aged 20-30 years to make them available for harvest at younger ages (i.e., at lower minimum harvest ages) in the period 60 to 80 years from now; and
- partially offset anticipated future lower log quality by spacing and pruning suitable young stands.

Accomplishing this strategy requires a program substantially above historic levels.

Working Targets

The preceding analysis indicates the following working targets are attainable. Figure 12 illustrates these. Achieving these targets requires a substantially higher silviculture program level than in the past. The targets assume a status quo with respect to the TSR2 base case and the size of the timber harvesting land base. As these change, so will the targets.

WT 1 (Quantity): Minimize the anticipated interim reduction in timber supply so that harvest levels of at least 0.46 million m3/yr can be achieved in this period.

WT 2 (Quantity): Manage long term timber supply to yield a steady harvest level of 0.54 million m3/yr.

WT 3 (Quality): Manage regenerated stands to yield at least 9% (by volume) premium large logs as well as 3% (by volume) clear logs, with the majority of the remainder being of sawlog quality. (The majority of clear logs will also be large logs.)

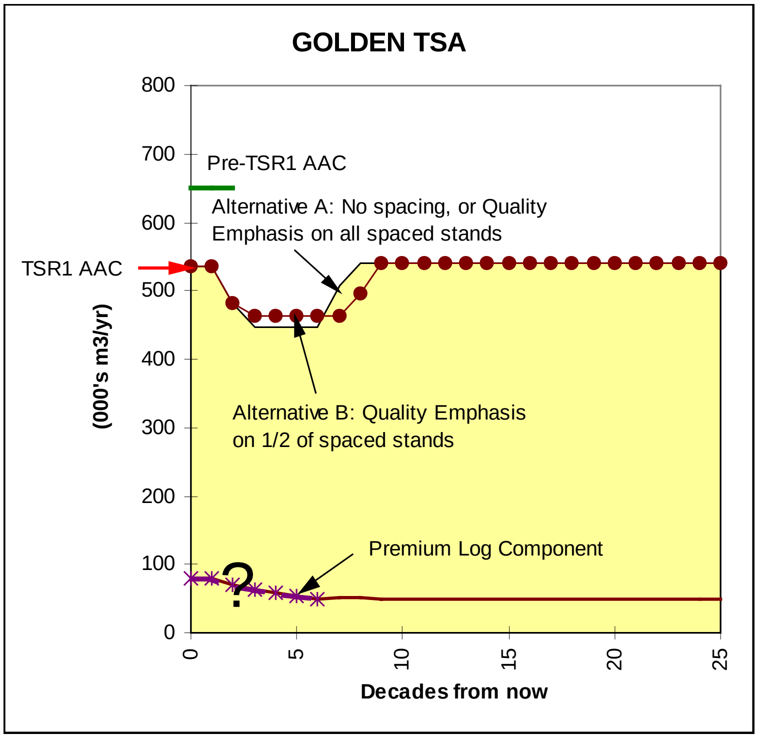

Figure 12. Combined potential quantity and quality harvest forecasts, Golden TSA

Log Product Objectives

The following are (unapproved) product objectives at the log level for the Golden TSA.

Quality Class	Species	Characteristics
Premium Log:		
Type III	All..................	15% of stands having 32.5+ cm minimum average stand diameter at breast height (DBH), having 60-100% of stems with a 1st log clear of knots, and achieved through faster growth at lower stocking levels (600 sph at rotation).
Type IV	All..................	15% of stands having 32.5+ cm minimum average stand diameter at breast height (DBH), having narrow ring width achieved through higher stand density (800 sph at rotation) and having 60-100% of stems with a 1st log clear of knots.
Sawlog:	All..................	27.5+ 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 Golden 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 56 along with investment priorities.

No.	Strategy	Priority Ranking
General	Conduct silviculture surveys in support of all strategies.	1
Short Term		
ST2	Fertilize 450 ha/yr of suitable stands scheduled for harvest in the 2nd or later decades. (increase)	5
Mid Term		
MT2	Continue ST 2.	5
MT3	(a) Reduce minimum harvest ages 10 years over the period 6 to 8 decades from now; and	
	(b) increase the volume of regenerated stands by 20% over those used at the base case minimum harvest age (LT impact);	
	through the following:	
	i) Expand the area planted with improved seedlings by 700 ha/yr - priority East Kootenay, mid-elevation lodgepole pine. (increase)	2
	v) Brush 400 ha/yr for growth enhancement and increased survival. (increase)	4
	vi) Space 350 ha/yr of dense stands (in addition to Q2 spacing) primarily in the Sue fire and Beaverfoot Valley areas to make them harvestable during the period 7 to 8 decades from now, overcoming an age class gap. (increase)	3
	vii) Manage 30 000 ha on a 15 yr return fertilization cycle of 2 000 ha/yr.	6

No.	Strategy	Priority Ranking
Long Term		
LT1	Maintain the THLB by:	
	(a) Fill-planting 300 ha of remaining treatable backlog NSR (maintain); and	2
	(b) Maintaining approx. 400 ha of previously reforested backlog plantations. (maintain)	2
LT3	Continue MT 3. (increase)	See MT3
LT4	Reduce losses to root rot by: (maintain)	
	(a) planting alternate species;	Current Practice
	(b) pop-up spacing (20 ha/yr);	?
	(c) pushover logging / stumping; and	Current Practice
	(d) mixed species planting.	Current Practice
LT6	Continue MT 4.	Not Ranked

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

No.	Strategy	Priority Ranking
Q1	Two-lift prune 150 ha/yr (total 300 ha/yr) to 5.5 m to create knot-free timber in the lowest 5.0 m log.	3
Q2	Space 300 ha/yr (in addition to MT3(to obtain large dimension timber and prepare stands for fertilization, pruning and/or commercial thinning.	3

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

The following strategies have identified potential to increase the quality or quantity of the habitat supply of the Golden TSA. These were identified in the district workshop. Also see MT4 for CT strategies for caribou and ungulate habitat.

No.	Strategy	Priority Ranking
H1	To be completed.	

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 a silviculture strategy. Bracketed numbers refer to the strategy numbers under which the need is identified (see tables in “Workshop Review of Potential Strategies,” page 24).

1. Analysis of how much area is presently below green-up and time until green-up is required by landscape unit/resource management zone. (ST1)
2. Fertilization trials are needed in spruce and cedar stands to determine efficacy. (ST2)
3. Analysis required of the potential of recent plantations for future commercial thinning in the VQ zone (MT1).
4. TIPSY OAF 1 factor of 15% requires confirmation with respect to non-productive openings that are not typed out of forest stands, and with respect to basic brushing and brushing for growth. Survey techniques are available. Requires statistical validity at the management unit level if to be used for AAC determination. (MT3 ii, v)
5. Assessment required of the 28 000 ha of stands aged 20-30 years as to what stocking levels will postpone the time to achieve the minimum piece size criteria (i.e., determine stocking threshold levels for spacing), and the occurrence of these stands (MT 3 vi).
6. FSSIM analysis is required to determine possible timber supply effect of lowering ages for caribou habitat from 250 to 200. (MT4)
7. Silvicultural activities, particularly commercial thinning, can be used to create old-growth tree attributes at earlier ages, thereby relieving some constraints. However, some other biological requirements may not be met. Further study is required to determine if CT can achieve these attributes earlier. (MT4)
8. Further analysis of options and opportunities for dealing with non-merchantable hemlock is required before a course of action can be selected. (LT2)
9. An expert inventory of low-site stands similar to the Merritt small wood study is needed to determine their true productivity and silvicultural opportunities, if any. (LT2)
10. Further study of root rot management techniques and options is needed. (LT4)
11. Old growth site index estimation studies require completion. It is anticipated that site indexes may be underestimated.
12. Need to determine whether it is more cost effective to prune more hectares, but less stems per hectare than to prune all stems on fewer hectares. (Q1)
13. Greater certainty regarding the timber harvesting land base is critical - resolve issues such as operability and ESA1 occurrence - before large pruning investments can be made. (Q1)

Silviculture Regimes and Investment Priorities

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

			Timber Supply Effects					--------- Habitat ---------			Direct		
	Strategy	Opportunity				Quality				Jobs	Cost	Revsd	Wkshp
Regimes		Area (Ha/Yr)	Short	Medium	Long	Clears	Density	Thermal	Forage	Days/ha	$/ha[1]	Rank	Rank
Survey													
1 Backlog and incremental		} 8,000								0.1	30		1
2 Habitat opportunities													
Backlog													
3 rehab (fill planting)	L1a	300	0	0	++	0	0	0	++	1	600		2
4 brushing	L1b,L1a	300	+	0	++	0	0	0	+/-	1.5	550		2
Pre FTG													
8 brushing for growth	M3e, L3	400	+	++	+	0	0	0/+	0/+	1	400		4
Post FTG													
10 space (wood flow- quantity)	M3vi, L3	350	+	+	0/+	+	+	0/+	+	2.5	800		3
11 space (quality)	Q1	350	0	0/-	0/-	+++	+++	+	+	2.5	800		3
12 space (Ungulate habitat - prefer Fdi, Sw, Cw)	H1,H2	?	0	+	0	+	+	+/-	+/-	2.5	800		3
13													
space (root rot)?	LT4	20											
15 fertilize (space/repeat fert)	M3g,L3	2000	0	+	+	+	+	0	0	0.1	250		6
16 fertilize older, 2nd decade harvest	S2, M2	450	+	+	+	+	+	0	0	0.1	250		5
17 fertilize (Ungulate habitat)	H1,H2	?	0	0	0	+	+	+	+	0.1	250		7
19 Prune (spaced)	Q1,Q2	300	0/-	0/-	0/-	+++	+++	0	0	4	1000		3

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. 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, Golden TSA, March 1999

Year	Surveys*	Fill Planting	Backlog Brushing	Brushing (for Growth)	Space	Prune	Fertilize
1	8,000	300	300	400	700	300	2,450
2	8,000	-	300	400	700	300	2,450
3	8,000	-	200	400	700	300	2,450
4	8,000	-	200	400	700	300	2,450
5	8,000	-	100	400	700	300	2,450
Subtot Yr 1 - 5	40,000	300	1,100	2,000	3,500	1,500	12,250
6 - 10	40,000	-	-	2,000	3,500	1,500	12,250
Total Yr 1 - 10	80,000	300	1,100	4,000	7,000	3,000	24,500

* Includes prescription and layout

Unit cost ($/ha)	30	600	550	400	800	1,000	250

Program Table - $ 000s, Golden TSA, March 1999

Year	Surveys*	Fill Planting	Backlog Brushing	Brushing (for Growth)	Space	Prune	Fertilize	Total
1	240	180	165	160	560	300	613	2,218
2	240	-	165	160	560	300	613	2,038
3	240	-	110	160	560	300	613	1,983
4	240	-	110	160	560	300	613	1,983
5	240	-	55	160	560	300	613	1,928
Subtot Yr 1 - 5	1,200	180	605	800	2,800	1,500	3,063	10,148
6 - 10	1,200	-	-	800	2,800	1,500	3,063	9,363
Total Yr 1 - 10	2,400	180	605	1,600	5,600	3,000	6,125	19,510

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.

Program Job Outcomes, Golden TSA, March 1999

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

Year	Surveys*	Fill Planting	Backlog Brushing	Brushing (for Growth)	Space	Prune	Fertilize	Total
1	4.0	1.5	2.3	2.0	8.8	6.0	1.2	25.7
2	4.0	-	2.3	2.0	8.8	6.0	1.2	24.2
3	4.0	-	1.5	2.0	8.8	6.0	1.2	23.5
4	4.0	-	1.5	2.0	8.8	6.0	1.2	23.5
5	4.0	-	0.8	2.0	8.8	6.0	1.2	22.7
Subtot Yr 1 - 5	20.0	1.5	8.3	10.0	43.8	30.0	6.1	119.6
6 - 10	20.0	-	-	10.0	43.8	30.0	6.1	109.9
Total Yr 1 - 10	40.0	1.5	8.3	20.0	87.5	60.0	12.3	229.5

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

Long term *employment associated with improved quality and quantity of the timber resource* [1]

Decade	Harvest Increment ('000 m3)	Incremental Jobs per year by decade TSA[2]	Incremental Jobs per year by decade Prov[3]	Incremental Jobs Total by decade TSA[2]	Incremental Jobs Total by decade Prov[3]
1	-	-	-	-	-
2	54	84	152	840	1,519
3	89	140	253	1,397	2,528
4	89	140	253	1,397	2,528
5	89	140	253	1,397	2,528
6	62	98	177	977	1,768
7	62	98	177	977	1,768
8	95	149	270	1,492	2,698
9	95	149	270	1,492	2,698
10	95	149	270	1,492	2,698
11	95	149	270	1,492	2,698
12	95	149	270	1,492	2,698
13	95	149	270	1,492	2,698
14	95	149	270	1,492	2,698
15	95	149	270	1,492	2,698
16	95	149	270	1,492	2,698
17	95	149	270	1,492	2,698
18	95	149	270	1,492	2,698
19	95	149	270	1,492	2,698
20	95	149	270	1,492	2,698
21	95	149	270	1,492	2,698
22	95	149	270	1,492	2,698
23	95	149	270	1,492	2,698
24	95	149	270	1,492	2,698
25	95	149	270	1,492	2,698
Total				33,834	61,202

Notes:

1. Assumes continuation of the silviculture program beyond the first 10 years, in accordance with the strategy. The total harvest increment is associated with all the silvicultural practices documented in 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 1.57 TSA level direct (harvesting, silviculture, processing), indirect and induced (PYs) per 1000 cubic metre (Source: TSR2 SEA Table 12, p.69)

3. Assumes 2.84 Province level direct (harvesting, silviculture, processing), indirect and induced (PYs) per 1000 cubic metre (Source: TSR2 SEA Table 12, p.69)

Draft

References

B.C. Ministry of Forests. 1996. *A Framework for Determining Timber Product Objectives, Associated Management Regimes and Efficient Expenditure of Enhanced Silviculture Resources Within the Golden Forest District.* Draft report. LIM Section, Columbia District, Revelstoke, BC. 12p.

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Cuthbert, John. 1994. *Golden Timber Supply Area Rationale for AAC Determination*. Victoria, British Columbia. 27p + Attachments.

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 are used.

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

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.

Appendix A: Additional Document Detail

Section	**Source**	**Prepared**
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.	Pre-workshop, workshop, post-workshop.
	Commentary - added post workshop but largely illustrates the findings of the individual issue analysis. May incorporate some workshop findings.	
- 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

Section	Source	Prepared
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.