Arrowsmith Timber Supply Area

Incremental Silviculture Strategy (Interim)

-- Version 1.0 --

Contents

British Columbia

Ministry of Forests

Funded By

Forest Renewal BC

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STRATEGY AT A GLANCE

Working Targets

Quantity: Maintain the current harvest level of 400 000 m3 in the short and mid terms, rising in 15 decades to a long term harvest level of 435 000 m3.

Quality: Maintain the proportion of premium logs at or above 8% of future harvest volumes.

Product Objectives

The following are definitions of premium logs and sawlogs in the Arrowsmith TSA.

Premium Log: 45 + cm DBH, pruned Douglas-fir. 200 + years, unpruned Douglas-fir.

Sawlog: (Former) Duncan district: age at which stand reaches 30 m height. (Former) Pt. Alberni district: E zone - min DBH of 25 cm and min vol/ha of 300 m3; W zone - 400 m3/ha; cable/heli zone - 600 m3/ha. Ages range from 45 yrs on good sites to 165 years on poor sites.

Major Silvicultural Strategies

Quantity

1. Implement more alternative silvicultural systems to overcome adjacency constraints.
2. Reduce green-up ages by 5 years by:
   - reducing time to regeneration;
   - using A class seed or better;
   - using large planting stock;
   - fertilizing regenerated stands where efficacy is proven.
3. Increase regenerated stand yields 25% by, in addition to the above program for reducing green-up ages:
   - practicing root rot management in Fdc to reduce the volume reduction from 16% to 5%; and
   - manage stocking to reduce voids to no more than 10% of regenerated stand area.
4. Commercial thin and fertilize older existing immature stands in VQ zones to increase yields of existing stands.

Quality

1. Prune all spaced stands. East zone: Douglas-fir 2 lifts; hemlock/cedar one lift. West zone: hemlock/cedar one lift.
2. Fertilize after 2nd lift prune.

Incremental Silviculture Program

Year	Surveys*	Backlog Brushing	Space	Prune	Fertilize
1	2,900	100	325	500	500
2	2,900	100	325	500	500
3	2,900	100	325	500	500
4	2,900	100	325	500	500
5	2,900	100	325	500	500
Subtot Yr 1 - 5	14,500	500	1,625	2,500	2,500
6 - 10	14,500	500	1,625	2,500	2,500
Total Yr 1 - 10	29,000	1,000	3,250	5,000	5,000

* Includes prescription and layout

Introduction

About the Interim Strategy

The terms of a service agreement between Forest Renewal BC (FRBC) and the BC Ministry of Forests (MoF) require the MoF to develop, and FRBC to fund, what is essentially an incremental silviculture strategy. This document is in fulfillment of this contractual requirement.

Incremental silviculture is part of a suite of strategies which together may influence the future quality and quantity of habitat and timber supply. This strategy document broadly analyzes the full potential range of silviculture activities in order to create a context for an incremental silviculture strategy.

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

This strategy is founded on readily available information and the knowledge of forestry professionals. It is intended as an interim strategy until a more in-depth analysis-based review is completed.

Methodology

This strategy was prepared through the following process:

1. Prior to the district working session, L. P. Atherton & Associates prepared a preliminary draft of this document, summarizing all available information relevant to a strategy and identifying opportunities to improve the future quantity and quality of timber supply.
2. A district working session was held June 18 & 19, 1998 in Port Alberni, attended by representatives of the MoF from Victoria headquarters, Vancouver Forest Region and South Island Forest District. Because this was a pilot project, no forest licensees were invited. Larry Atherton of L. P. Atherton & Associates and Doug Williams of Cortex Consultants Inc. led the session. Participants reviewed the potential opportunities identified in the draft document along with others that arose. The outcome of the session was a regime table, complete with priorities.
3. The consultants incorporated the results of the working session into the draft document and added forecasts of future harvest quantity and quality and of job outcomes.
4. After ministry review, the consultants submitted a completed strategy document to the MoF in electronic format as version 1.0. (The ministry will assign higher version numbers (e.g., 1.1, 1.2, etc.) as the strategy evolves and changes are made.)

Acknowledgments

The participation of representatives of the South Island Forest District at the district working session is gratefully acknowledged.

The project was managed by Mr. Larry Sigurdson of the Ministry of Forests, Vancouver Forest Region. Funding was provided by Forest Renewal BC.

Basic Data

After publication of the Analysis Report, the BCFS corrected errors and updated certain information. Few of the corrected data are available in published documents. Consequently, information below is noted as corrected or uncorrected, as available.

Land Area

Description	Area (ha)	Area %
Total Area of TSA	168 800	100
Total Productive Crown Forest	124 600	74
Net Timber Harv. Land Base	75 200	45

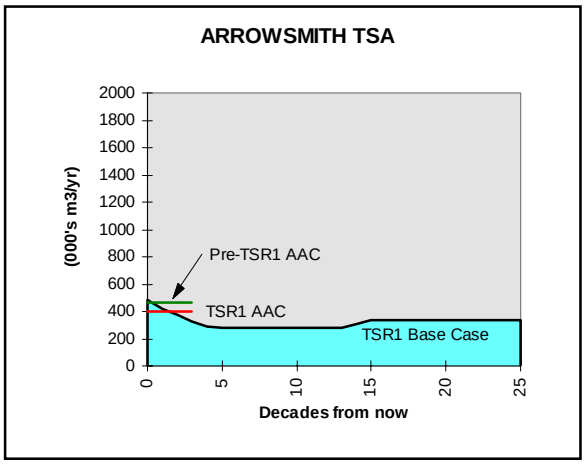
Uncorrected THLB - rounded to nearest 100 ha.

AAC

AAC Type	Pre-TSR	TSR1*	Change (%)
Conventional			
- Main TSA		380 000	
-Clayoquot Snd		13 700	
Sub-total	464 630	393 700	-15.3
Deciduous	3 870	6 300	+62.8
Insect/Disease	-	-	
Marginal	-	-	
Total	468 500	400 000	-14.6
Woodlot AAC		13 750	

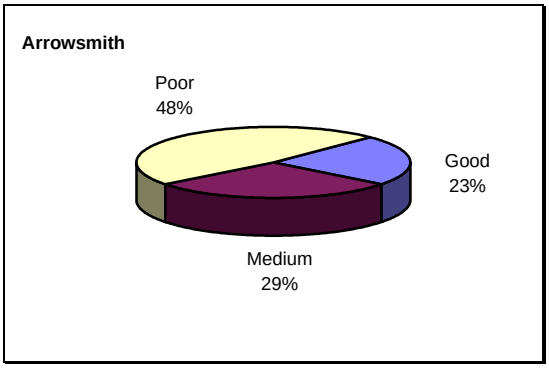
*effective Dec 30/96

Harvest Forecast



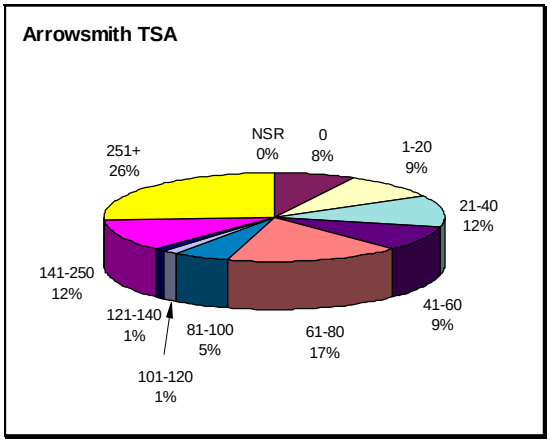
Corrected Base Case

Site Class



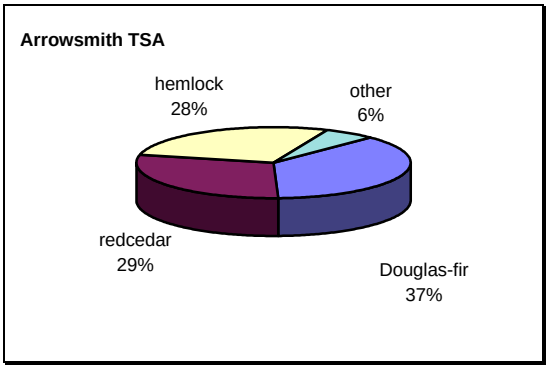
Uncorrected THLB

Age Class



Uncorrected THLB. Data scaled from chart in TS analysis report.

Tree Species



Uncorrected THLB

Issues

Individual Issue Analysis

The following information is primarily from documentation produced under the first timber supply review, or TSR1. Sources are noted, with full references given on page 23. Only information which is relevant to an incremental silviculture strategy is recorded. Key statements are bolded. *Since the timber supply analysis report, the chief forester used a corrected base case in determining the AAC and created a partitioned AAC for the Clayoquot Sound portion of the TSA. These factors are not represented in the information below.*

Issue	Comment / Sensitivity Analysis
♦ Harvest Forecast	Initial harvest level (IHL) of 479 150 m3[1] maintained for only one decade, followed by declines of about 12%/decade, reaching a mid term level of 277 000 m3 (**42% below IHL, 30% below TSR1 AAC**) 50 years from now. This shortfall level is maintained until 140 yrs from now, when harvests increase at the rate of 10%/decade to reach a long term harvest level (LTHL) of 337 000 m3 (30% below IHL, 14% below TSR1 AAC). (rationale, 12)
♦ Age Class	Younger stands dominated by predominantly good and medium site Douglas-fir are more common in the eastern portions of the TSA, while older stands dominated by predominantly poor-site western red cedar and western hemlock are more common on the west side. This **east/west split of age groups has implications** for distribution of harvest, commercial thinning potential and landscape level biodiversity. Commercial thinning in the eastern portion allows the shifting of part of the harvest that would otherwise all be concentrated in the older stands of the western portion.
♦ Forest Cover	The Arrowsmith is more sensitive to green-up ages than adjacency. *IRM Zone*: 52% of THLB (rationale, 28). Max 25% to be below green-up ht of 3 m (4 pass). Sensitivity test ± 1 pass. CF satisfied with base case assumptions (rationale, 29). Source of sensitivity results: AAC Rationale. Relaxation: (3 pass) Short term insensitive. Increase: (5 pass) Short term sensitive, dropping 9% below base case in 1st decade. *VQO Zone*: 45% of THLB (rationale, 28). Max 25% to be below green-up ht of 5 m (4 pass). Sensitivity test maximum (5% retention, 15% partial retention, and 25% modification) and minimum (1% retention, 6% partial retention, and 16% modification) allowable disturbance limits (base case based on mid-point of allowable limits). Source of sensitivity results: TSR report. Maximum limits (least stringent requirements): Short term slightly sensitive, rising 2% above base case. **Mid term very sensitive**, rising 10% above base case. LTHL 4% higher. Minimum limits (most stringent requirements): **All periods moderately sensitive**, dropping 9% below base case in 1st decade, 8% mid term, and 9% long term. *Green-up* - 3m in IRM zone (ages 12 - 15 yrs); 5m in visual quality zones (ages 15 - 20 yrs). Sensitivity test ± 5, 10 years (10 yr sensitivity test not reported below as this would require 2 year old trees to be greened up). Source of sensitivity results: AAC Rationale. Decrease: (-5 yrs) Short term insensitive; **increases supply in medium and long term by**

[1] 479 150 m3 is considered in the AAC rationale to be the pre-TSR AAC. This figure does not match the pre-TSR AAC of 468 500 m3 given in CF summary dated Jan 29/97.

Issue	Comment / Sensitivity Analysis
	11% and 5% respectively. CF acknowledges that higher site indexes may reduce time to green-up and may increase mid and long term harvest levels. Increase: (+5 yrs) **Short term highly sensitive**, dropping 20% below base case in 1st decade.
♦ Backlog NSR	197 ha backlog NSR considered uneconomical to plant. Assumed to fully restock naturally over 30 years.
♦ Quality	• 3 832 ha deciduous completely deducted from harvesting land base. Deciduous volumes in mixed stands excluded from yield tables. CF creates partitioned AAC based on 289 ha likely to be harvested over 15 years. (rationale, 17) • 4 372 ha non-merchantable stands completely deducted from harvesting land base (low site or too low volume stands). • OAF2 for Fdc set at 16.9% to account for losses to root rot (70% of stands estimated to have moderate to severe infection).
♦ Older Forests	Objectives not yet established. No base case requirement. No sensitivity tests. CF to incorporate in next determination. Relaxation: N/A Increase: Not a problem in west. **Likely a considerable problem in east** where very little old growth exists.
♦ Min. Harvest Ages	Duncan district: age at which stand reaches 30m height. Pt. Alberni district: E zone - min DBH of 25cm and min vol/ha of 300 m3; W zone - 400 m3/ha; cable/heli zone - 600 m3/ha. Ages range from 45 yrs on good sites to 165 years on poor sites. Sensitivity analysis indicates short term insensitive to changes.
♦ Silvicultural Systems	Clearcutting assumed in base case. Partial cutting common in east zone and clearcutting with reserves frequently found in west, but neither taken into account in analysis. CF estimates reserves represent approx. 1% of available timber supply.
♦ Estimates of Timber Volumes	VDYP used for existing stands 30 years and older. TIPSY used for regenerated stands and existing stands < 30 years. *Existing stand volumes*: CF considers volume estimates reasonable. Source of sensitivity analysis: TSR analysis report. Long term insensitive Increase: Short term slightly sensitive, with harvest levels over 1st 3 decades 2% above base case. **Medium term harvest level 7% above base case**. Decrease: **Short term very sensitive**, with harvest levels over 1st 3 decades 9% below base case. Medium term harvest level 6% below base case. *Regenerated stand volumes*: sensitivity tests for ± 10% in volume. Source of sensitivity analysis: AAC rationale. Short term insensitive. Increase: **Medium and long term harvest levels 6% and 10% above base** respectively. Decrease: Medium and long term harvest levels 6% and 10% below base respectively.
♦ TSA fragments	71 land fragments in eastern portion of TSA. These require more restrictive management regimes.

Summary of Issues by Period

Short Term: 1-20 years

A lack of available older stands makes the short term harvest level highly sensitive to green-up ages and/or forest cover constraints. The fact that short term volumes must also come from poorer sites exacerbates the problem. This is because harvesting a given volume of timber from them requires a greater area than from better sites having higher volumes per hectare.

The 2nd decade harvest is limited by reversion of timber licences into the TSA. These constitute 5% of the long term THLB. These areas do not contribute volume under the AAC when harvested, but, when reverted, add to the area not greened up, thereby affecting adjacency.

Mid Term: 21 - 150 years

Although there is a good distribution of younger age classes, there is a mid term shortfall in harvest levels before rising to the long term harvest level. A number of factors cause this. There is a shortage of stands currently aged 81 to 140 years. Existing immature stands aged 21+ are considered unmanaged, therefore having lower yields per hectare. This is reflected by applying VDYP yields. In contrast, regenerated stands are considered to be fully managed, thus having higher yields as reflected through the application of TIPSY yields.

The timber supply shortage in decades 10 to 15 is also affected by:

- forest cover constraints in the visual quality zones;
- there being insufficient 2nd growth timber in the IRM and modification visual quality zones; and
- the fact that at this time approximately one-half of the THLB is of poor site quality where stands have relatively old minimum harvest ages and low volumes/ha.

Long Term: 151+ years

The long term is sensitive to changes in green-up ages and in long term yields. The sensitivity to changes in regenerated volumes is virtually on a 1:1 ratio; for every 1% increase or decrease in regenerated volumes there is a corresponding 1% increase or decrease in the LTHL.

Long term yields in Douglas-fir are affected by root rot. Approximately 37% of the TSA is comprised of stands having this as the primary species and for which yields have been reduced an additional 12% to account for losses to root rot. (This reduction has been implemented by increasing the TIPSY OAF2 factor from the normal 5% to 16.9%.)

Future

Future factors to be considered in determining an incremental silviculture program include:

- further reductions in land base resulting from implementation of the Vancouver Island Land Use Plan;
- the implementation of biodiversity and old growth plans, particularly affecting the eastern portion of the TSA which has very little current old growth.

Incremental Silviculture History

Approximately 550 ha are harvested annually. This amount varies over time depending upon how much logging is on poorer sites. (analysis, 21)

Treatment	Incorporated in Timber Supply Analysis	Not Incorporated in Timber Supply Analysis
♦ Backlog	Naturally restock 197 ha in 30 years. Assumes the maintenance of previously stocked backlog NSR areas that are not yet free growing (mostly brushing - XXX ha's outstanding as of June/98).	
♦ Conversion		Nil.
♦ Commercial Thin		350 ha/yr at the time of TS analysis (rationale, 26). Recent level (avg 96/97 to 98/99) is approx. 300 ha/yr.
♦ Space	Approximately 375 ha spaced annually (rationale, 26). To reflect this, TIPSY was used on stands regenerated over the past 20 years. Assumes basic spacing for stocking control on those stands harvested after 1987 (stands approximately 1 - 8 yrs of age) and incremental spacing on those harvested before this date (stands approximately 9 - 20 yrs of age). Recent level of incremental spacing (avg 96/97 to 98/99) is XXX ha/yr.	
♦ Prune		550 ha/yr at the time of TS analysis (rationale, 26). Recent level (avg 96/97 to 98/99) is approx. 500 ha/yr.
♦ Fertilize		550 ha/yr at the time of TS analysis (rationale, 26). There is no fertilization program planned for 98/99.
♦ Space/ Prune		All spaced stands are pruned 1 or 2 lifts (see regime table).

Higher Level Goals and Objectives

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

Provincial Goals

Fundamentally, government's goals can be characterized as:

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

Provincial Objectives

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

Objective 1: Maintain current harvest levels as long as possible without creating disruptive 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 objectives of the regional incremental silviculture strategy are to:

- Ensure a long term sustainable harvest which approximates the current harvest value and volume levels and that produces a diversified mix of products necessary to create and maintain sustainable forest employment.
- Balance treatments that enhance growth and yield such as fertilizing, spacing and forest health activities with those that increase the value of the wood such as pruning.
- Utilize incremental silviculture treatments to contribute to sustainable management of non-timber values at the landscape level. (MoF, 1998b)

Opportunities to Increase Timber Supply

Opportunities Indicated Through TSR Sensitivity Analyses

TSA modelling in support of planning incremental silviculture has not yet been undertaken. In its absence, sensitivity analyses from the TSR1 analysis report are the best source of information as to the opportunities for incremental silviculture to increase future timber supply. The following are selected sensitivity analsysis charts from the TSR1 analysis report, to which opportunity information is added.

Since the TSR1 analysis report, an amended base case was prepared. Further to this, the chief forester considered in his AAC determination a harvest forecast which excluded the area in Clayoquot Sound, and partitioned the AAC on that basis. Thus, while the sensitivity analyses shown below may indicate

certain potential results from silvicultural actions, they are not directly comparable with the TSR1 AAC. Further analyses are required to confirm the indicated effects.

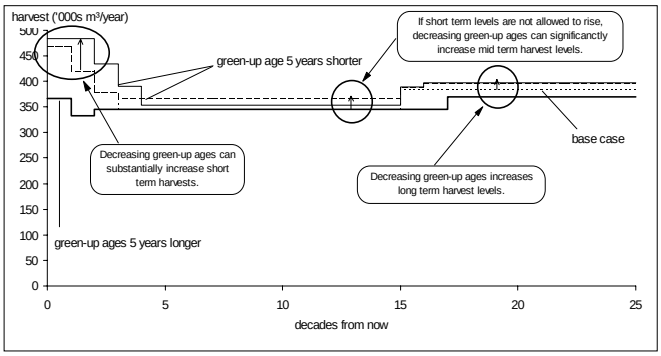


Figure 1. Opportunities to Raise Harvest Levels By Reducing Green-up Ages, Arrowsmith TSA

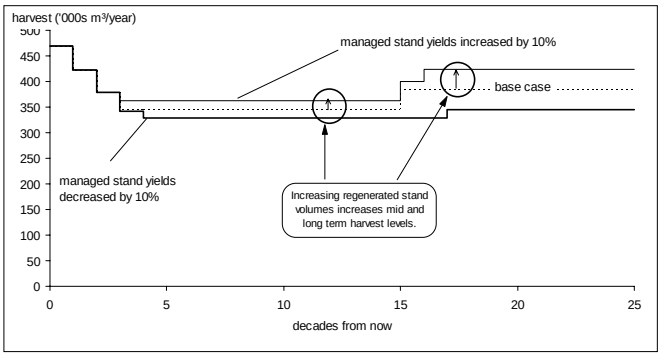


Figure 3. Impact of Increasing Regenerated Stand Yields 10%, Arrowsmith TSA

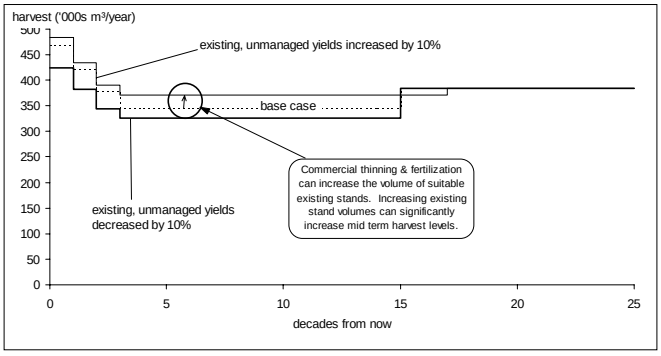


Figure 2. Opportunity to Raise Mid Term Harvests Through Commercial Thinning & Fertilization, Arrowsmith TSA

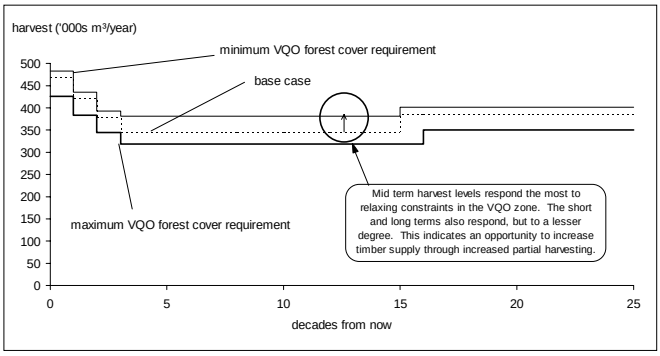


Figure 4. Potential Effects of Increasing Partial Harvesting Methods in the VQO Zone, Arrowsmith TSA

Preliminary Identification of Silviculture Opportunities

Information in the previous sections indicates the following silvicultural strategies may have potential to increase future timber supply. Each of these was discussed in detail in the district working session, the results of which are recorded in "Potential Strategies by Response Time Frame," page 10, along with additional strategies that arose during the meeting. Strategies that are ultimately adopted are noted in "Silviculture Strategies," page 19.

♦ Short Term (1 - 20 yrs)

ST 1: implement more alternative silviculture systems to overcome adjacency limitations; and

ST 2: reduce green-up ages 5 years.

♦ Mid Term (21 - 70 yrs)

MT 1: implement a range of practices and incremental silviculture treatments that will increase regenerated stand yields 25% as well as decrease green-up ages 5 years; and

MT 2: commercial thin and fertilize older existing stands in the VQ zones to increase yields.

♦ Long Term (71+ yrs)

LT 1: increase regenerated stand volumes 25%.

Available Information Regarding Potential Treatments and Treatable Area

This section summarizes available information directly relevant to the potential treatments for the TSA.

Treatment	Comment/ Potential Treatment Regimes	Treatable Area/
♦ General	The CF states in the AAC rationale, "Clear plans and further modeling of incremental silviculture practices is needed before the next determination in order to project the timber supply implications with higher confidence."	
♦ Conifer Release/ Brushing	No opportunities noted in TS analysis.	26 ha of NCBr excluded from analysis.
♦ Spacing	375 ha/yr at time of TS analysis. Effects not analyzed, but spacing assumed through application of TIPSY yields to age class 1 stands. May be used to improve upon 15% OAF1 TIPSY reductions.	
♦ Fertilization	550 ha/yr at time of TS analysis. An analysis by Timberline, *Forest Level Benefits to Commercial Thinning and Fertilization*, indicates that increases in harvest due to fertilization for accelerated green-up start to appear in the second decade and peak in the 5th decade when increases over base levels are from 7% (with a 2 yr reduction in green-up ages) to 22% (with a 50% reduction in ages). A 2 yr decrease in ages yields no benefits over decades 6 to 14, whereas a 10%increase is realized during this period from a 50% reduction in ages. Long term effects are measurable but relatively minor (1-4%).	37% of forests in the THLB has Fdc as the leading species and may be candidates for fertilization. There is little data on response of juvenile stands to fertilization. Fdc is expected to respond well, but the Timberline study was based on all E zone stands having a response.
♦ Commercial Thinning	350 ha/yr at time of TS analysis. MoF conducted a post-TSR sensitivity test of combined CT and fertilization on Fdc (at higher levels than currently practiced). The results showed no effect in short term, 2 000 m3 increase mid term and 4 000 m3 increase long term. Shifts part of harvest from older stands in W to younger stands in E zone. Sensitivity test of combined CT and changes to VQ zone guidelines indicates no short term sensitivity but significant 10% gain in mid term and 3% gain in long term. May be used to mitigate short-term wood supply pressure should more stringent green-up/adjacency requirements be imposed.	Approx 26% of the THLB is currently aged 41-80 which may be candidates for CT. The actual area may be somewhat less if CT only practiced in conjunction with a fertilization program. See above.

Treatment	Comment/ Potential Treatment Regimes	Treatable Area/
	CF notes some opportunity to offset projected losses to root rot. An analysis conducted by Timberline (see above reference) in contrast noted that a combined CT/fertilization program has substantial potential to increase future harvest levels by as much as 22% in the short term and 14% in the long term depending upon the chosen treatment regime. This analysis is based on limiting CT to 300 ha/yr (below current levels) in east zone Fdc and multiple fertilization of Fdc managed stands in the east zone.	
♦ Backlog NSR	No additional opportunity. Minor existing amount to be naturally restocked in 30 years.	197 ha
♦ Conversion	No additional opportunity to harvest/rehabilitate deciduous. Partitioned AAC based on calculation of max amount available after all constraints considered. No plans to convert NCBr.	26 ha NCBr

Potential Strategies by Response Time Frame

This section documents the discussions and outcomes of the district working session.

In the AAC rationale, the chief forester identified a number of potential downward influences on timber supply. For the purposes of this strategy, however, a status quo is assumed with respect to these. Should any arise, the indicated strategies would serve to mitigate their effects rather than increase timber supply.

Explanatory notes with respect to the following tables:

Column Number	Note
1	The response time frame is the period in which the anticipated result is expected, not the period in which actions must necessarily commence.
2	Strategy numbers correspond with the numbers recorded earlier in "Preliminary Identification of Silviculture Opportunities," page 8. Items followed by an * were added during the district working session.
3	Information in this column is largely from the district working session, combined with information presented earlier in this document. Potential treatment regimes are highlighted in bold print.
4	Anticipated results are calculated using the timber supply response indicated by TSR1 sensitivity analyses.
5	The harvest forecast for the short term uses the TSR1 AAC as the starting level in the first decade. Mid and long term harvest forecasts take the base case levels from TSR1 as the starting levels. The harvest forecast column was not thoroughly reviewed during the district meeting. *Results are largely conjecture and are meant to illustrate the potential strategies.*

Response Time Frame	Potential Strategy/Action	Discussion / Current Status	Anticipated Result	Potential Harvest Forecast (000s m3/yr)
♦ Short Term (1 - 20 yrs)	1. Implement more alternative silvicultural systems to overcome adjacency constraints. 2. Reduce green-up ages by 5 years by: reducing time to regeneration; using A class seed or better; using large planting stock; fertilizing regenerated stands where efficacy is proven.	1. In effect. E. coast now all small seed tree retention blocks. W. coast primarily clearcut with reserves. Approx. 300 ha/yr of CT, mostly on the E side of the TSA. 2. Almost all are currently being managed as per strategy items. (b) All Fdc seed is 1st generation "A" class. Latest estimates of yield gains are (%):[2] Species — 1st gen — 2nd gen Doug-fir — 3-5 — 15 Hemlock — 3 — 20 Cedar — 3 — 10	Maintain post TSR AAC into 2nd decade.	400

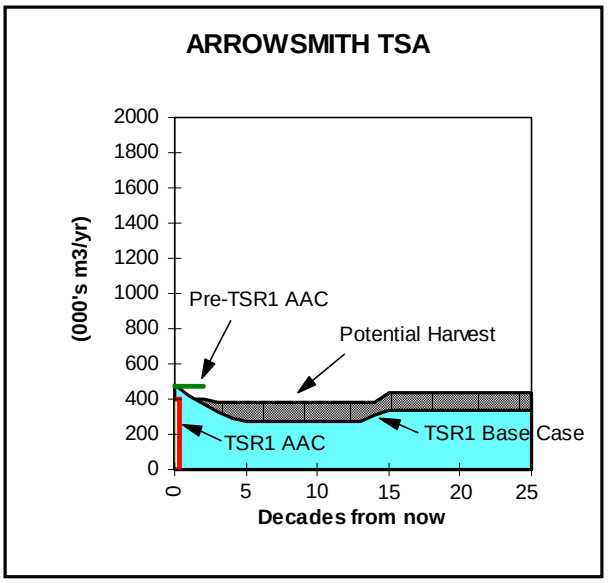
[2] Source: participants at Chilliwack district meeting.

Response Time Frame	Potential Strategy/Action	Discussion / Current Status	Anticipated Result	Potential Harvest Forecast (000s m3/yr)
♦ Mid Term (21 - 150 yrs)	1. Increase regenerated stand yields 25% and reduce green-up ages 5 yrs by: continuing above short term program for reducing green-up ages; practicing root rot management in Fdc; and manage stocking so as to reduce voids. CT and fertilize older existing immature stands in VQ zones to increase yields of existing stands. Implement more alternative silvicultural systems to overcome adjacency constraints.	1. All strategies currently in effect except fertilization. Repeat fertilization of regenerated stands as well as fertilization of existing commercially-thinned stands required. 2. Approx. 300 ha/yr are commercially thinned. 3. See ST1 above.	Based on TSR1 sensitivity analysis results, actions will increase harvest: 1. 15% (pro-rated mid term response) from increased yields of regenerated stands (including effect of 5% TIPSY OAF1 reduction for all stands and 5% OAF2 reduction in Fdc); 10% from reduced green-up ages; 2. 4% from fertilization and CT; 3. 10% from partial cutting in VQO areas. <u>Total: 39%</u> Unknown if effects are additive. Increased site productivity may compound some effects.	277 - base case <u>108</u> - 39% 385

Response Time Frame	Potential Strategy/Action	Discussion / Current Status	Anticipated Result	Potential Harvest Forecast (000s m3/yr)
♦ Long Term (151+ yrs)	1. Increase regenerated stand yields 25% as above. 2. Reduce green-up ages as above. 3. Implement more alternative silvicultural systems to overcome adjacency constraints.	All strategies currently in effect except fertilization. Repeat fertilization of regenerated stands required.	Increase harvest: 1. 25% from increased yields of regenerated stands, including: • 10% tree improvement; • 5% fertilization; • 5% TIPSY OAF1 reduction for all stands, and; • 5% OAF2 reduction in Fdc). 2. 5% from reduced green-up ages. 3. 4% from partial cutting in VQO areas. Total: 34% Unknown if effects are additive. Increased site productivity may compound some effects.	325 - base case 110 - 34% 435

Potential Harvest Forecast

Figure 5 graphs the potential harvest level that may be attained through implementation of the silvicultural strategies in the preceding tables. This forecast is highly speculative and requires confirmation through computer-based modeling and analysis. Modeling may also indicate more precise timing, targeting and program levels associated with incremental silviculture activities than could be developed in this interim strategy.



This chart is based on the timber harvesting land base and forest practices at the time of the TSR1 analysis. Land base reductions through the Vancouver Island Land Use Plan and additional forest practice requirements under the Forest Practices Code may result in lower forecast harvest levels than shown.

Figure 5. Potential Harvest Forecast, Arrowsmith TSA

Summary of Information and Research Needs

During the assessment process, the following needs for further information and research became apparent. The outcome of these have implications for an incremental silviculture strategy.

1. Achievement of an OAF 1 factor of 10% requires confirmation. Survey techniques are available. Requires statistical validity at the management unit level if to be used for AAC determination.
2. Old growth site index and existing stand volume estimation studies require completion.
3. Hemlock response to fertilization is variable. Were the causes for this determined there may be considerable potential for hemlock fertilization to improve the harvest forecast. A program of screening trials to determine the extent of treatment opportunities is required.

Opportunities to Improve Timber Quality

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

Log Product Objectives

The following product objectives at the log level for the Arrowsmith TSA were defined by the participants at the district working session.

Premium Log: 45 + cm DBH, pruned Douglas-fir. 200 + years, unpruned Douglas-fir.

Sawlog: Duncan district: age at which stand reaches 30 m height. Pt. Alberni district: E zone - min DBH of 25 cm and min vol/ha of 300 m3; W zone - 400 m3/ha; cable/heli zone - 600 m3/ha. Ages range from 45 yrs on good sites to 165 years on poor sites.

Available Information Regarding Potential Treatments and Treatable Area

Treatment	Comment/ Potential Treatment Regimes	Treatable Area
♦ Spacing		
♦ Commercial Thinning		
♦ Pruning	550 ha/yr at time of TS analysis. CF acknowledges this may improve value, however clear plans and further modeling is needed in order to project timber supply implications.	Consider riparian management zones and old growth areas for long rotation quality management program.
♦ Space/ Prune	All spaced stands are pruned.	

Potential Strategies by Response Time Frame

The following strategies have potential to increase timber quality. These were identified in the district working session. The response time frame is the period in which the anticipated result is expected, not the period in which actions must necessarily commence.

Response Time Frame	Potential Strategy/Action	Discussion / Current Status	Anticipated Result	Premium Log Forecast
♦ Short Term (1 - 20 yrs)	None	Short term harvests will largely come from existing very old stands in the W zone which are not treatable to improve quality.	Quality profile of existing old growth will prevail. Assume this is equal to recent coast-wide estimate of 15%.	15%?
♦ Mid Term (21 - 150 yrs)	1. Prune all spaced stands. 2. Fertilize after 2nd lift prune.	1. **Annual program 500 ha/yr**. Current pruning regimes are: East zone: Douglas-fir 2 lifts - all stems pruned 1st lift, 300 st/ha pruned 2nd lift; hemlock/cedar one lift. 1 lift pruned Fdc expected to be removed through commercial thinning. West zone: hemlock/cedar one lift. 2. Fertilizing after 2nd lift gives a volume boost, as well as can accelerates occlusion of pruned limb stubs. If Douglas-fir is approx. 40% of annual harvest, this requires **a fertilizing program of 220 ha/yr**. (0.4 X 550 ha).	1. Fdc about 35% of THLB. Assume this ratio applies to avg area harvested = .35X550 ≅ 200 ha. If 2 lift prune means 2X200=400 ha/yr is in Fdc. Remaining 100 ha is HC. If 25% of tree vol is pruned 1st 5m log, and ½ of stems are 2 lift pruned, future vol premium Fdc= .25 X .35 X .5 ⇒ 4%. If other ½ of stems are 1 lift pruned, premium = ½ of above ⇒ 2% 100ha of 1 lift prune/yr = 100/550 X (.5 X .25) ⇒ 2%. 2. Improves volume, thereby improves % premium component.	8%
♦ Long Term (151 + yrs)	As above.	If 5% of Fdc is required to be reserved to older age such that it achieves an age of 200+ yrs, this will yield an additional 1% premium log volume (25% vol/tree X 5%).	As above. (8% + 1% = 9%)	9%

Timber Quality Forecast

The foregoing analysis indicates premium log content in the Arrowsmith TSA will decline to a little better than one-half of today's levels.

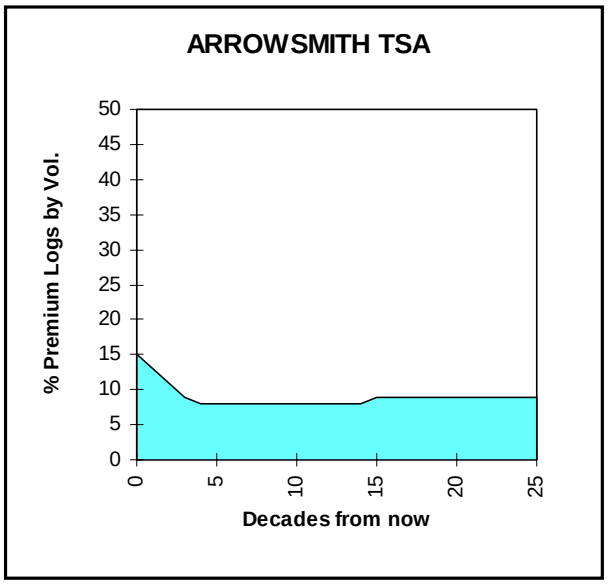


Figure 6. Potential Quality Forecast, Arrowsmith TSA

Incremental Silviculture Strategy

General Strategy

The existing age class structure of the Arrowsmith TSA, coupled with an east/west split in age groups, make it particularly sensitive to changes in forest cover requirements and in volume estimates for existing and regenerated stands. The general strategy, therefore, is to undertake those silvicultural treatments that will overcome these constraining factors, in particular to increase stand volumes, reduce green-up ages, and implement alternative silvicultural systems to gain access to stands otherwise unavailable due to adjacency constraints. Much of this is now occurring in the TSA.

The ability to maintain future harvest levels at near current levels enables a focus on timber quality. The high accessibility of stands, coupled with a large proportion of Douglas-fir make this TSA well-suited to an extensive pruning program.

Working Targets

The preceding analysis indicates the following working targets may be attainable. Figure 7 illustrates these.

WT 1 (Quantity): Maintain the current harvest level of 400 000 m3 in the short and mid terms, rising in 15 decades to a long term harvest level of 435 000 m3.

WT 2 (Quality): Maintain the proportion of premium logs at or above 8% of future harvest volumes.

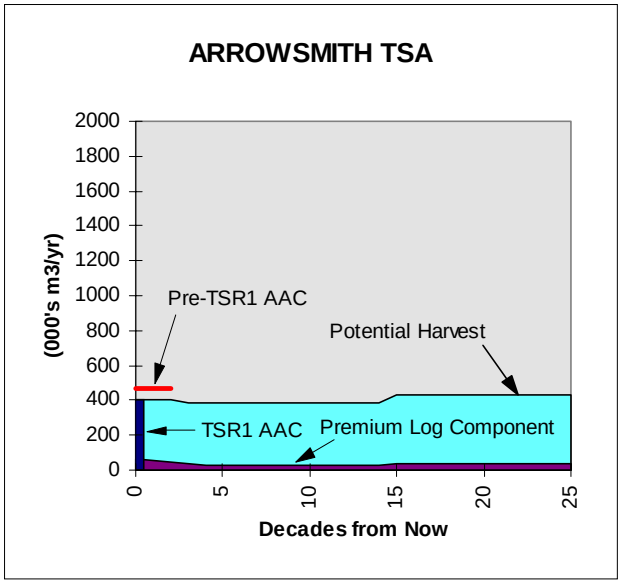


Figure 7. Combined Potential Quantity and Quality Harvest Forecasts, Arrowsmith TSA

Log Product Objectives

The following are definitions of premium logs and sawlogs in the Arrowsmith TSA.

Premium Log: 45 + cm DBH, pruned Douglas-fir. 200 + years, unpruned Douglas-fir.

Sawlog: Duncan district: age at which stand reaches 30 m height. Pt. Alberni district: E zone - min DBH of 25 cm and min vol/ha of 300 m3; W zone - 400 m3/ha; cable/heli zone - 600 m3/ha. Ages range from 45 yrs on good sites to 165 years on poor sites.

Silviculture Strategies

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

♦ Strategies to Increase the *Quantity* of Future Timber Supply

No.	Strategy
ST1	Implement alternative silvicultural systems to over come adjacency constraints.
ST2	Reduce green-up ages by 5 years by: reducing time to regeneration; using A class seed or better; using large planting stock; and fertilizing regenerated stands where efficacy is proven.
MT1	Increase regenerated stand yields 25% and reduce green-up ages 5 yrs by: continuing above short term program for reducing green-up ages; practicing root rot management in Fdc; and manage stocking so as to reduce voids.
MT2	CT and fertilize older existing immature stands in VQ zones to increase yields of existing stands.
LT1	Increase regenerated stand yields 25% as above.
LT2	Reduce green-up ages as above.
LT3	Implement more alternative silvicultural systems to overcome adjacency constraints.

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

No.	Strategy
Q1	Prune all spaced stands (approximately 500 ha/yr on several pruning regimes).
Q2	Fertilize after 2nd lift prune.

Silviculture Treatments and Investment Priorities

The following table indicates incremental silviculture treatments determined during the district working session to be suitable to attaining the above working targets and strategies. Several treatments may be applied to the same stand in a regime of treatments (however, these regimes are not specifically identified in the table).

Regime Table, Arrowsmith TSA, June 1998

Regimes	Opportunity Area (Ha/Yr)	Timber Supply Effects Short	Medium	Long	Quality	Direct Jobs Silv. Days/ha	Harv. Days/m3	Direct Cost $/ha	Habi-tat	Rank
1 **Backlog Brushing**	100	0	A++	A++	0	3		800		1
Spacing										
2 East G&M, Fdc@4.5m, 600-700 sph Poor, Fdc@4.5m, 800-900 sph	175	0	A+	A+	+	2		800		3
3 West G&M, Hem/c@5-6m, 800-1000 sph Poor, Hem/c@5-6m, not spaced	150	0	A+	A+	+	4		1700		4
4 Habitat	5% of above								+++	
Pruning										
5 East all stems, Fdc @4.5m, 1st lift 2.5 m 300 sph, Fdc @9m, 2nd lift 2.5 m remainder, @3.0 m	350	0	0	0	+++	6		1100		2
6 West all stems, Hem/c @5-6 m 1st lift 3 m no second lift	150	0	0	0	++	8		2200		5
Fertilization										
7 East P&M only, Fdc after CT	300	B+	B++	B++	0	0.1		200		3
after 2nd lift prune	200	0	0	0	+	0.1		200		6

Notes

A-type timber supply effects are incorporated in the TSR base case

B-type timber supply effects are incremental to the TSR base case

Incremental Silviculture Program

The following annualized program will achieve the above goals and strategies.

Program Table - Ha, Arrowsmith TSA, June 1998

Year	Surveys*	Backlog Brushing	Space	Prune	Fertilize
1	2,900	100	325	500	500
2	2,900	100	325	500	500
3	2,900	100	325	500	500
4	2,900	100	325	500	500
5	2,900	100	325	500	500
Subtot Yr 1 - 5	14,500	500	1,625	2,500	2,500
6 - 10	14,500	500	1,625	2,500	2,500
Total Yr 1 - 10	29,000	1,000	3,250	5,000	5,000

* Includes prescription and layout

Unit Cost			800 East	1 100 East	
($/ha)	50	800	1700 West	2 200 West	200

Program Table - $ 000s, Arrowsmith TSA, June 1998

Year	Surveys	Backlog Brushing	Space	Prune	Fertilize	Total
1	145	80	395	715	100	1,290
2	145	80	395	715	100	1,290
3	145	80	395	715	100	1,290
4	145	80	395	715	100	1,290
5	145	80	395	715	100	1,290
Subtot Yr 1 - 5	725	400	1,975	3,575	500	6,450
6 - 10	725	400	1,975	3,575	500	6,450
Total Yr 1 - 10	1,450	800	3,950	7,150	1,000	12,900

Job Outcomes

The following are the anticipated job outcomes of the preceding program, assuming the program is maintained into the future as necessary to achieve the working targets.

Program Job Outcomes, Arrowsmith TSA, June 1998

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

Year	Surveys	Backlog Brushing	Space	Prune	Fertilize	Total PDs	Silviculture Jobs
1		300	950	3,300	50	4,600	25.6
2		300	950	3,300	50	4,600	25.6
3		300	950	3,300	50	4,600	25.6
4		300	950	3,300	50	4,600	25.6
5		300	950	3,300	50	4,600	25.6
Subtot Yr 1 - 5	-	1,500	4,750	16,500	250	23,000	127.8
6 - 10	-	1,500	4,750	16,500	250	23,000	127.8
Total Yr 1 - 10	-	3,000	9,500	33,000	500	46,000	255.6

Note: Assumes 180 days of silviculture work = 1 job (Source: Jobs and Timber Accord)

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

Decade	Harvest Increment ('000 m3)	Incremental Jobs per year by decade TSA[2]	Prov[3]	Total by decade TSA[2]	Prov[3]
1	0	-	-	-	-
2	29	25	39	252	389
3	59	51	79	513	791
4	98	85	131	853	1,313
5	108	94	145	940	1,447
6	108	94	145	940	1,447
7	108	94	145	940	1,447
8	108	94	145	940	1,447
9	108	94	145	940	1,447
10	108	94	145	940	1,447
11	108	94	145	940	1,447
12	108	94	145	940	1,447
13	108	94	145	940	1,447
14	80	70	108	699	1,076
15	98	85	131	853	1,313
16	98	85	131	853	1,313
17	98	85	131	853	1,313
18	98	85	131	853	1,313
19	98	85	131	853	1,313
20	98	85	131	853	1,313
21	98	85	131	853	1,313
22	98	85	131	853	1,313
23	98	85	131	853	1,313
24	98	85	131	853	1,313
25	98	85	131	853	1,313
Total				20,152	31,038

1 - Assumes continuation of the incremental silviculture program beyond the first 10 years, in accordance with the strategy.
The total harvest increment is associated with all 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 TSR1.

2 - Assumes 0.87 TSA level harvesting and prcessing jobs (PYs) per 1000 cubic metre (Source: Arrowsmith SEA)

3 - Assumes 1.34 Provincial level harvesting and prcessing jobs (PYs) per 1000 cubic metre (Source: Arrowsmith SEA)

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