Arrow
Timber Supply Area

Interim Silviculture Strategy

-- Version 1.3 --

British Columbia

Ministry of Forests

Funded By

Forest Renewal BC

January 31, 2000

Contents

1. EXECUTIVE SUMMARY

Purpose

This strategy is intended to help optimize the application of available funding for silviculture activities towards the goals of improving the future quantity and quality of both habitat and timber supply. The strategy will be considered as one of several inputs in decisions on funding allocations and treatment activities. The degree to which the overall strategy ultimately proves appropriate and is achieved will also be the degree to which the expressed targets will be achieved.

Objectives

1. The IFPA base case timber supply analysis forecasts the initial harvest level (IHL) of 615 000 m3/yr can be maintained for only one decade, after which it will drop over the next several decades to a mid term low of 451 200 m3/yr starting in the 4th decade (about 27% below the IHL). The first objective of this strategy, therefore, is to minimize the anticipated reductions in short and mid term harvest levels. Workshop analysis indicates there are limited silvicultural opportunities for achieving this objective. (There are, however, other non-silvicultural opportunities that are being explored under the IFPA Forestry Plan).

2. The IFPA base case analysis indicates that not only is the harvest forecast to drop, but also that this forecast may be optimistic because the available timber supply is only slightly above the forecast harvest level. A secondary short and mid term objective, therefore, is to increase the overall availability of timber for harvesting, particularly over the next 100 years. Workshop analysis indicates that silviculture activities can significantly contribute to this objective.

3. Because of the limited silvicultural opportunities to overcome the forecast base case mid term reduction in timber supply, improving the quality of the timber to be harvested during this time period is a viable alternative. A higher quality, high value timber supply could mitigate to some extent the reduction in income and profit associated with the expected reductions in harvest levels. A mid term objective, therefore, is to improve the quality of the timber to be harvested in this time period. Programs of spacing, pruning and fertilization can accomplish this. Pending the outcome of further investigation, emphasis could be placed on cultivating rust-resistant white pine trees wherever suitable. Western white pine grows very fast, is relatively rare due to blister rust infestation and a limited growing range, and produces high value wood.

4. In the long term, starting about 90 years from now, workshop analysis indicates improved estimates of the productivity of forest land as well as silvicultural activities can result in harvest levels of at least equal to if not greater than current levels. The long term objective therefore is to create a timber supply capable of supporting a steady harvest level of at least 620 000 m3/yr. Workshop analysis indicates that silvicultural activities can contribute significantly to this objective.

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

Product Objectives

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

Quality Class	Species	Characteristics
Premium Log:		
Peelers	All	35+ cm DBH, clear, 5 m log, min 20 cm top.
Building Log	Douglas-fir, larch, lodgepole pine, spruce	42.5+ cm DBH, straight, low taper, minimal twist, min 9 m log, min 27.5 cm top
Poles	western redcedar	27.5+ cm DBH, 13 m log, straight, min 10 cm top, no rot.
Large logs*	All	42.5+ cm DBH, 5 m log
White pine*	western white pine	22.5+ cm DBH, tight knots.
Sawlog:*	All except lodgepole pine	27.5+ cm DBH.
	lodgepole pine	22.5+ cm DBH.

***** Values are enhanced when “clear” of knots.

Major Silvicultural Strategies

The strategies listed below are those considered in the workshop and follow-up analysis to be appropriate towards achieving the working targets. Other strategies that were considered but deemed to have little opportunity at this time are documented in the report.

Some of the following are not within the traditional scope of 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.

No.	Strategy	Priority
Surveys	Conduct approximately 6 000 ha/yr of silviculture surveys in support of all strategies.	1
Surveys	Conduct approximately 1 600 ha/yr of retrospective OAF1 surveys over a 20 year period.	1

SHORT TERM

Objectives:

- Minimize the anticipated reductions in harvest levels.
- Increase the overall availability of timber for harvesting.

Working Targets:

- Maintain the current harvest level for at least 5 years.

Strategies:

ST2	Late rotation fertilize 400 ha/yr to produce approximately 3 000 m3/yr of additional harvest volume by the 2nd decade.	3
ST 4	Improve timber availability by achieving green-up 6-8 years earlier in existing stands aged 1-20 years in the VQO zone outside of watersheds by:	
(b)	spacing 150 ha/yr to prepare them for fertilization;	4
(e)	fertilizing 300 ha/yr to reduce time until 7 m green-up by 2 years; and	2
(d)	undertake a project to improve site index estimates with the expected result of reducing 7 m green-up ages by 5 years.	current IFPA project

MID TERM

Objectives:

- Minimize the anticipated reductions in harvest levels.
- Increase the overall availability of timber for harvesting.
- Improve the quality of the timber to be harvested.

Working Targets:

- Create a timber supply capable of supporting a minimum harvest level of at least 451 200 m3/yr.
- Generate at least 4% of total harvest volume in the later mid term in premium large logs.
- Generate at least 2¼ % of total harvest volume in the later mid term in clear premium logs (clear logs will generally also be large logs).

No.	Strategy	Priority
Strategies:		
MT1	Continue ST2: Late rotation fertilize 400 ha/yr to produce approximately 3 000 m3/yr of additional harvest volume.	6
MT3	Improve timber availability by reducing the minimum harvest ages of stands aged 1-20 years by undertaking the treatments specified in strategy ST4.	see ST4
MT5	Reduce green-up ages of about-to-be-regenerated stands by 8 years in the VQO (base case - 28 yrs to 7 m ht) zone and by 10 years in the watershed zones (base case - 34 yrs to 9 m ht) by:	
(b1)	increasing the use of improved seed with the expected result of reducing 7 m green-up ages by 2 years;	1
	forming a licensee and MoF small business program seed planning and use co-operative to lobby for more and better improved seed and to co-ordinate the use of the best available seed to greatest strategic advantage;	
(b2)	undertaking a project to improve site index estimates with the expected result of reducing 7 m green-up ages by 5 years; and	current IFPA project
(e)	fertilizing 300 ha/yr at time of planting with the expected result of reducing 7 m green-up ages by 1 year.	3
Q1	Space 400 ha/yr of existing stands aged 1 – 30 years so that at least 60% of harvested volumes in the latter half of the mid term are good quality sawlogs.	5
Q2	Prune 300 ha/yr of existing stands aged 1 – 30 years in two lifts (= 150 ha/yr X 2 lifts) to create knot-free timber in the bottom 5.0 m log.	4

LONG TERM

Objectives:

- Maximize long term timber production within a context of sound multiple resource stewardship.
- Improve the quality of the timber to be harvested.

Working Targets:

- Create a timber supply capable of supporting a steady harvest level of at least 620 000 m3/yr.
- Generate at least 8% of total harvest volume in premium large logs (no current silviculture strategy implications).
- Generate at least 2¼ % of total harvest volume in clear premium logs (clear logs will generally also be large logs).

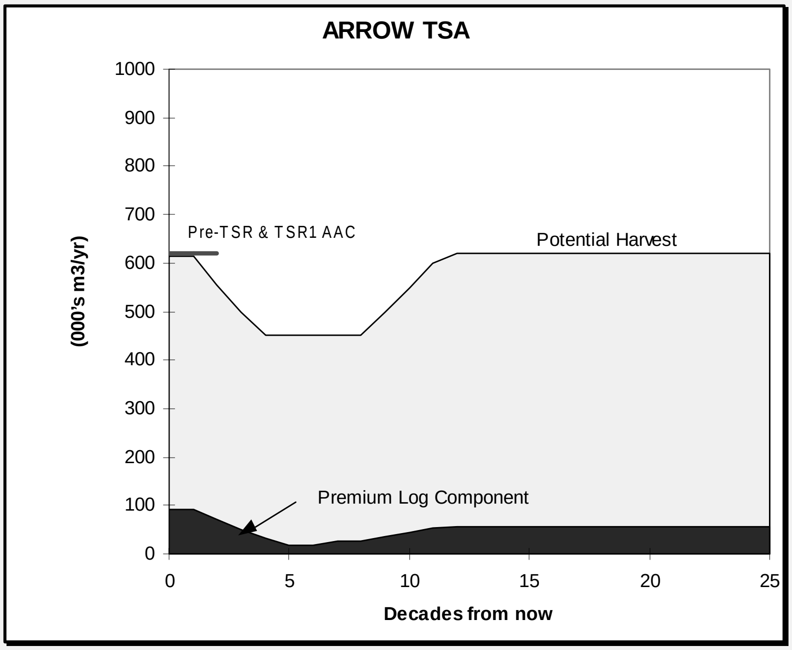
Strategies:

LT1	Maintain the timber harvesting land base by:	
(a)	Treating approximately 400 ha of backlog NSR.	1

No.	Strategy	Priority
(b)	Maintaining approximately 200 ha of previously reforested backlog plantations (Assumed to be required. No estimate of actual need available).	2
(c)	Survey 2 000 ha/yr of pre-1987 SR area to ensure they remain fully stocked.	1
LT2	Increase the timber harvesting land base by 4.25% by:	
(a)	Rehabilitating 2 000 ha of deciduous stands (= 1% of THLB) at the rate of 100 ha/yr. (Priority based on high cost and high risk of not achieving growth rates due to opposition to use of herbicides.)	6
(e)	Rehabilitating 500 ha of fume kill (= 0.25% of THLB) at the rate of 100 ha/yr. (Requires integrated planning and design.)	6
(f)	Rehabilitating 3 000 ha of permanent access structures (= 3% of THLB) at the rate of 150 ha/yr. (Priority based on high cost and low anticipated yield)	5
LT3	Increase the volume of regenerated stands by 40% by:	
(b1)	Increasing the use of improved seed with the expected near term result of a 6% gain in LTHL, with a strategic target of 20% yield gain over the long term.	1
(b2)	Undertaking a project to improve site index estimates with the expected result of a 34% gain in LTHL.	current IFPA project
(j)	Repeat fertilizing 300 ha/yr, rising gradually over about 60 years to 1 250 ha/yr as more stands come under management, for an expected result of a 2% gain in LTHL. (Note: The initial 300 ha/yr are the same stands as in ST 4.)	2
LT6	Rehabilitate 100 ha/yr of old IU logged areas for the purpose of managing these areas for multiple non-timber values in order to lessen timber harvesting constraints elsewhere.	7
Q1	Continue mid term Q1 strategy.	5
Q2	Continue mid term Q2 strategy.	4

Illustration of Working Targets

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



Silviculture Regimes & Investment Priorities

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

	Strategy	Opportunity	Opportunity	Timber Supply Effects				Habitat	Jobs	Cost	Wkshp
Activities		Area (Ha)	Area (Ha/Yr)	Short	Medium	Long	Quality		Days/ha	$/ha[1]	Rank
1 Surveys (general)	all	5355 /yr	5355						0.1	32	
Survey - restrospective OAF (last 20 years)	M5(f2)	1600/yr	1600						0.1	32	2
Survey - pre 1987 SR	L1	2000 /yr	2000						0.1	32	2
2 Backlog reforestation	L1(a)	300 /5yr	60		+	+		+/-	2	925	1
3 Conversion - fume kill	L2(e)	100 /5yr	20			+		+	6	3425	7
4 Conversion - decid	L2 (a)	100 /20yr	5					-	6	3425	7
5 rehab/reforest trails and landings	L2(f)	150 /yr	150	++	++	++			4	2725	6
6 Manage for OG structure; IU logging , riparian site prep, planting,brushing	L6	100/yr	100			+		+	3	1150	8
7 improved seed	M5(b1), L3			+	++	+++	++		0	80	2
8 space existing <21 yrs i VQO not Watershed	M3(b-c),M5(g..h), S4(b..c)	150/yr	150	+	+	+	+	+/-	3.5	1130	5
9 fertilization repeat	L2, L3	300 --> 1250/yr									
10 fertilze existing <21 yrs i VQO not Watershed	M3(b-c),M5(g..h), S4(b..c)	300 /yr	300	++	+	+	+	+/-	0.1	300	3
11 fertilization stands scheduled 2nd-4th dec	S2, M1	400 /yr	400	+	+			+/-	0.1	300	4
12 fertilize at planting; VQO & Watershed	M5(e)	300 /yr	300	++	+			+	0.5	150	4
13 Pruning	Q2	300 /yr	300				++		6	725	5

Notes
Activity 1: Area of general surveys is calculated as 3x are of the incrmental silviculture program.
Activity 9,10: Initially 300 ha/yr but rising to 1250 in the steady state; assume 300 ha/yr for 5 years (Activity 10).

Incremental Silviculture Program

The following annualized program will contribute to achieving the above goals and strategies. This program is considerably above historic levels and some activities may require phasing in.

Program Table - Ha, Arrow TSA August 17-18, 1999

Year	Surveys*	Backlog Establish	Conversion/ Rehab	Space	Prune	Fertilize	Total
1	8,955	60	275	150	300	1,000	10,740
2	8,955	60	275	150	300	1,000	10,740
3	8,955	60	275	150	300	1,000	10,740
4	8,955	60	275	150	300	1,000	10,740
5	8,955	60	275	150	300	1,000	10,740
Subtot Yr 1 - 5	44,775	300	1,375	750	1,500	5,000	53,700
6 - 10	44,775	-	1,275	750	1,500	5,000	53,300
Total Yr 1 - 10	89,550	300	2,650	1,500	3,000	10,000	107,000

* Includes prescription and layout

Unit cost ($/ha)	32	925	2,825	1,130	725	255	

Program Table - $ 000s, Arrow TSA August 17-18, 1999

Year	Surveys*	Backlog Establish	Conversion/ Rehab	Space -	Prune -	Fertilize -	Total
1	287	56	777	170	218	255	1,761
2	287	56	777	170	218	255	1,761
3	287	56	777	170	218	255	1,761
4	287	56	777	170	218	255	1,761
5	287	56	777	170	218	255	1,761
Subtot Yr 1 - 5	1,433	278	3,884	848	1,088	1,275	8,805
6 - 10	1,433	-	3,602	848	1,088	1,275	8,245
Total Yr 1 - 10	2,866	278	7,486	1,695	2,175	2,550	17,049

Job Creation

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

Program Job Outcomes, Arrow TSA August 17-18, 1999

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

Year	Surveys*	Backlog Establish	Conversion/ Rehab	Space -	Prune -	Fertilize -	Total
1	4.5	0.6	5.9	2.6	9.0	1.1	23.7
2	4.5	0.6	5.9	2.6	9.0	1.1	23.7
3	4.5	0.6	5.9	2.6	9.0	1.1	23.7
4	4.5	0.6	5.9	2.6	9.0	1.1	23.7
5	4.5	0.6	5.9	2.6	9.0	1.1	23.7
Subtot Yr 1 - 5	22.4	3.0	29.5	13.1	45.0	5.5	118.5
6 - 10	22.4	-	27.3	13.1	45.0	5.5	113.3
Total Yr 1 - 10	44.8	3.0	56.8	26.3	90.0	11.0	231.8

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

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

Decade	Harvest Increment ('000 m3)	Incremental Jobs per year Region[2]	per decade Region[2]
1	(158)	(621)	(6,209)
2	(158)	(621)	(6,209)
3	(158)	(621)	(6,209)
4	(158)	(621)	(6,209)
5	(158)	(621)	(6,209)
6	(158)	(621)	(6,209)
7	(204)	(802)	(8,017)
8	(204)	(802)	(8,017)
9	(116)	(456)	(4,559)
10	(116)	(456)	(4,559)
11	(40)	(157)	(1,572)
12	(40)	(157)	(1,572)
13	(40)	(157)	(1,572)
14	(40)	(157)	(1,572)
15	(40)	(157)	(1,572)
16	(128)	(503)	(5,030)
17	(167)	(656)	(6,563)
18	(167)	(656)	(6,563)
19	(167)	(656)	(6,563)
20	(167)	(656)	(6,563)
21	(167)	(656)	(6,563)
22	(167)	(656)	(6,563)
23	(167)	(656)	(6,563)
24	(167)	(656)	(6,563)
25	(167)	(656)	(6,563)
Total			(134,367)

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 strategy development.

2. Assumes 3.93 TSA level direct (harvesting, silviculture, processing), indirect and induced (PYs) per 1000 cubic metre. (Source: TFL 23 MP #9 Timber Supply Analysis Report, p.39)

Further Research and Information Needs

During the assessment process, the following needs for further information and research became apparent. The outcome of these have implications for 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 39).

1. Before considering excluded non-merch forest types for their rehabilitation potential, first determine their role/contribution in meeting OGMA objectives. (ST1(b))
2. Compare terrain hazard mapping vs inventory ESA's to refine THLB net-down impacts. (ST1 (x1))
3. Evaluate the regeneration implications of harvesting high elevation areas as an outcome of potentially moving the operability line higher. (ST1 (x2))
4. MoF to provide a map of ESA regen areas to AFLG to review for accuracy. (ST1 (x1))
5. Evaluate the late rotation fertilization potential of smaller live-crown trees. (ST2)
6. Model the changes in sensitivity to forest cover constraints attributed to the use of large patch sizes in meeting biodiversity objectives. (ST3)
7. Investigate the stocking levels of Fdi and spruce stands aged 21-30 years and other-species stands aged 11-20 years to determine if their yields are more accurately estimated using TIPSY. (MT4)
8. Evaluate the impact of the reduction in site preparation over the past 2 decades on site productivity and stand yield estimates. (MT5 (a))
9. AFLG to form a seed planning and use co-operative is proposed for the TSA licensees to lobby for more and better improved seed and to co-ordinate the use of the best available seed to greatest strategic advantage. (MT5 (b1))
10. Investigate access to white pine seed; investigate green-up potential; connect with TFL 23 to investigate success. (MT5 (d))
11. Evaluate efficacy of fertilization at planting and impact on reducing time to reach green-up. (MT5 (e))
12. Assess low end stocking levels of regenerated stands (e.g., 1 000 sph actual vs. 1 200 sph used in IFPA timber supply analysis) for yield implications. (MT5 (f1))
13. OAF 1 factor of 15% requires confirmation. Survey techniques are available. Requires statistical validity at the management unit level if to be used for AAC determination. (MT5 (f2))
14. Confer with Fish and Wildlife Branch re Arrow Lake fertilization and effects of fertilization on fish bearing streams. (MT5 (i))
15. MoF to provide the AFLG a map of excluded low sites to review for reclassification/rehabilitation opportunities. (LT2 (d))
16. Investigate Invermere's root rot OAF2 estimate methodology and research. Further study of root rot management techniques and resultant OAF2 impact is needed. (LT4)
17. Investigate effects of juvenile spacing on mountain pine beetle resistance. (LT 5 (a))
18. Provide Daryl & UBC people with the silv strategy to take it into account in their studies/projects. Note the need to analyze the cost/benefit of silviculture expenditures to consolidate OGMA's with old IU logged areas in riparian areas. (LT 6)

2. Introduction

2.1 About the Interim Strategy

This strategy is intended to help optimize the application of available funding for discretionary 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 that may be achievable as a result of increased silvicultural activities (other non-silvicultural strategies may also improve timber supply but are not within the scope of this strategy). 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 silviculture treatment activities are ranked. The end result hopefully points to the most effective and efficient means of at least partially achieving the working targets. The degree to which the overall strategy ultimately proves appropriate and is achieved will also be the degree to which the expressed targets will be achieved. This, of course, could also be affected by future unknowns, such as major changes in forest policy, land base available for timber production, or market demand.

Although this strategy focuses primarily on silviculture, it is recognized that silviculture is part of a suite of potential strategies which together may influence the future quality and quantity of habitat and timber supply. In particular, other strategies are being pursued under the *Forestry Plan* of the Arrow Forest Licence Group (AFLG).

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.

---

[1] See "Abbreviations," page 78 for a full listing of abbreviations used.

2.2 Methodology

This strategy was prepared through the following process:

1. Prior to the district workshop, in co-operation with district office personnel, Timberline Forest Inventory Consultants Ltd., and the Arrow Forest Licensee Group (AFLG), L. P. Atherton & Associates undertook preliminary research to identify issues and opportunities relevant to improving the future quantity and quality of timber supply.
2. A district workshop was held August 17-18, 1999 in Castlegar, attended by representatives of the organizations listed below. Larry Atherton of L. P. Atherton & Associates and Doug Williams of Cortex Consultants Inc. led the session. Participants reviewed the potential opportunities 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 the draft document and added forecasts of future harvest quantity and quality and of job outcomes.
4. After ministry review, the consultants submitted a completed strategy document to the Ministry of Forests (MoF) in electronic format as version 1.1. (The ministry will assign higher version numbers (e.g., 1.2, 1.3, etc.) as the strategy evolves and changes are made.)

2.3 Acknowledgements

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

Organization	*Participant's Name*	*Title*
Ministry of Forests, Arrow Forest District		
	Tom Johnston	Silviculture Officer
	Peter Lewis	Land Information Officer, Planning
Ministry of Forests, Nelson Forest Region		
	John Pollack	Mitigation Researcher
	Bernie Peschke	Forest Sectors Initiatives Officer
Slocan Forest Products Ltd.		
	Kathy Howard	Planning Forester
	Pat Cutts	Forest Renewal Coordinator
Kalesnikoff Lumber		
	Reiner Augustin	Forestry Manager
Atco Lumber		
	Ron Ozanne	Forestry Manager

Organization	*Participant's Name*	*Title*
	Mark MacAulay	Silviculture Supervisor
Riverside Forest Products		
	Peter Love	Operations Manager
Ministry of Environment, Lands and Parks		
	Norbert Kondla	Forest Ecosystem Specialist
Arrow Forest Licensee Group		
	Paul Jeakins	Kokanee Forest Consulting
Forest Renewal BC		
	Ian Johnston	Investment Officer

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, Nelson Forest Region, and Cortex Consultants, Inc.

3. Higher Level Goals and Objectives

3.1 Provincial Goals and Objectives

The *Incremental Silviculture Strategy For British Columbia (Interim)* states the Ministry of Forests' provincial level strategy. The strategy's executive summary is reprinted in Figure 1 on the following page. The provincial strategy was considered in the development of this TSA strategy.

It is recognized that not every management unit has the same capability to contribute to the provincial strategy's 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.

3.2 Regional Objectives

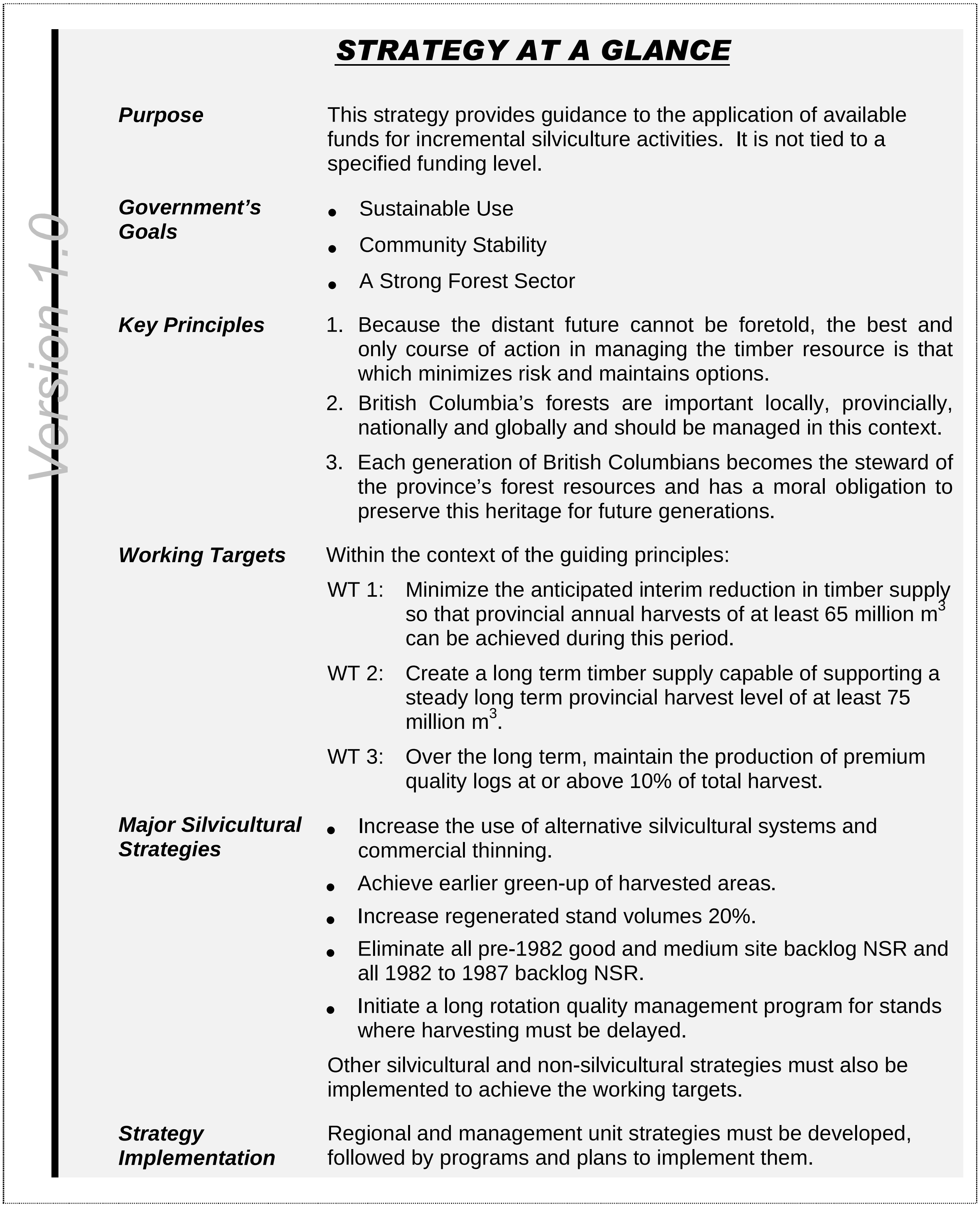
The region has not set out formal regional silviculture objectives. In the interim, the provincial objectives are accepted as being broadly applicable within the region.

3.3 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 Arrow 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.

Figure 1. Provincial Goals and Objectives



STRATEGY AT A GLANCE

Purpose	This strategy provides guidance to the application of available funds for incremental silviculture activities. It is not tied to a specified funding level.
Government's Goals	• Sustainable Use • Community Stability • A Strong Forest Sector
Key Principles	1. Because the distant future cannot be foretold, the best and only course of action in managing the timber resource is that which minimizes risk and maintains options. 2. British Columbia's forests are important locally, provincially, nationally and globally and should be managed in this context. 3. Each generation of British Columbians becomes the steward of the province's forest resources and has a moral obligation to preserve this heritage for future generations.
Working Targets	Within the context of the guiding principles: WT 1: Minimize the anticipated interim reduction in timber supply so that provincial annual harvests of at least 65 million m^3 can be achieved during this period. WT 2: Create a long term timber supply capable of supporting a steady long term provincial harvest level of at least 75 million m^3. WT 3: Over the long term, maintain the production of premium quality logs at or above 10% of total harvest.
Major Silvicultural Strategies	• Increase the use of alternative silvicultural systems and commercial thinning. • Achieve earlier green-up of harvested areas. • Increase regenerated stand volumes 20%. • Eliminate all pre-1982 good and medium site backlog NSR and all 1982 to 1987 backlog NSR. • Initiate a long rotation quality management program for stands where harvesting must be delayed. Other silvicultural and non-silvicultural strategies must also be implemented to achieve the working targets.
Strategy Implementation	Regional and management unit strategies must be developed, followed by programs and plans to implement them.

Source: MoF, 1999.

4. Basic Data

4.1 Land Area

Description	Area (ha)	Area %
Total Area of TSA	740 800	100
Total Productive Crown Forest	395 600	53
Net Timber Harv. Land Base	201 500	27

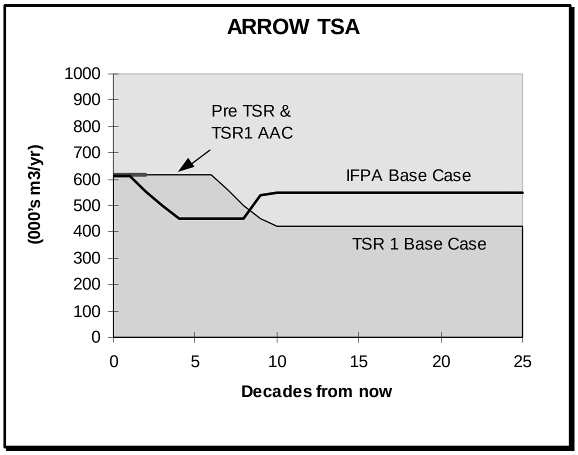
Source: Arrow IFPA analysis report - rounded to nearest 100 ha. The IFPA analysis THLB is 15 300 ha smaller than that used in TSR1.

4.2 AAC

AAC Type	Pre-TSR	TSR1*	Change (%)
Conventional	619 000	619 000	0.0
Deciduous	-	-	
Insect/Disease	-	-	
Marginal	-	-	
Total	619 000	619 000	0.0
Woodlot AAC			

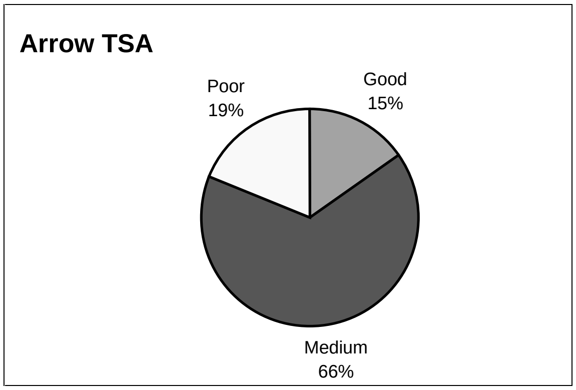
*effective October 1/95 Source: Pedersen, 1995

4.3 Harvest Forecast



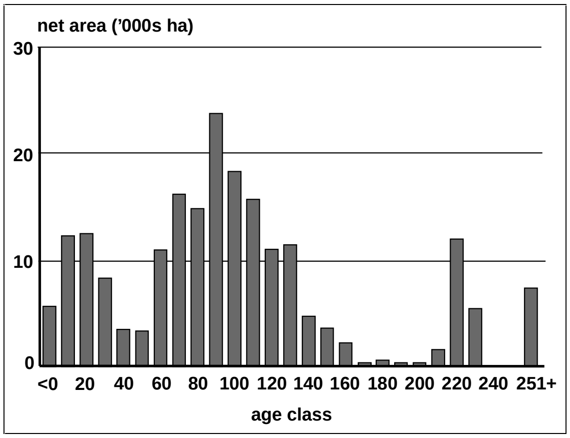
Sources: MoF, 1994. Pedersen, 1995. Timberline, 1999.

4.4 Site Class



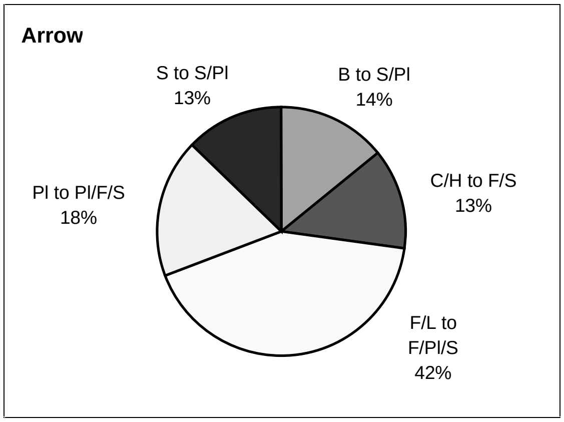
Source: Tline, 1999:10 + Wang, personal communication. Not including NSR.

4.5 Age Class



Source: Timberline, 1999

4.6 Tree Species



Data from Tline, 1999 + Wang. Not including NSR. Format: "current species" to "expected future species."

5. Incremental Silviculture History

Treatment	IFPA Status (1999)	Current Status (1999)
	Incorporated in Timber Supply Analysis	Source: AFD[2]
Backlog	70% of the 2 000 ha of backlog NSR were assumed in the base case to be restocked within the next 10 years, with the other 30% restocked in 20 years. Two stocking classes were used with the breakpoint being 400 sph.	As of June, 1999 there are 1 813 ha of backlog NSR in the ISIS database. Approximately 565 hectares of this is inaccessible or uneconomic to treat. Of the remainder, 1/3 is assumed untreatable, 1/3 is assumed stocked and 1/3, or about 400 ha, is assumed to be planted over the next 10 years. Recent backlog brushing has been about 90 ha/yr. Highest past brushing program was about 1 600 ha.
Conversion	None.	None.
Commercial Thin	None.	None at present.
Space	TIPSY used for F/L stands regenerated over the past 20 years and for all other stands regenerated over the last 10 years (Timberline, 1999:9). These stands and all future regenerated stands are modelled based on an initial density of 1 200 sph. This assumes stocking control on these stands.	Recent spacing has been about 150 ha/yr. Maximum past program level about 380 ha/yr. At the end of fiscal 98/99, there was a total of about ______ ha of spaced stands (about ___% of THLB).
Prune		Recent level of about 20 ha/yr. Max past program of 86 ha in 1996. Total accomplishment of ____ ha, none of which is 2nd lift pruned.
Fertilize		There has been no fertilization in this TSA.

---

[2] AFD - Arrow Forest District

6. Timber Harvesting Trends

The Timberline analysis (Timberline, 1999:spreadsheet) indicates a 1st decade harvest level of about 2 200 ha/yr declining to about 1 500 ha/yr in decades 4 through 8. Harvested area then rises to 1 800 ha/yr in decades 9 & 10, falling thereafter to about 1 600 ha/yr. All areas are assumed to be clearcut (Timberline, 1999:13).

Although recent harvesting records indicate a relatively high proportion of partial harvesting and alternative silviculture systems, workshop participants estimate about 90% of recent harvesting to be under an even-aged management regime.

For the purposes of this strategy, a mid to long term average harvest area of 1 600 ha/yr is assumed, that 90% or approximately 1 400 ha/yr is clearcut, and all clearcut areas are planted.

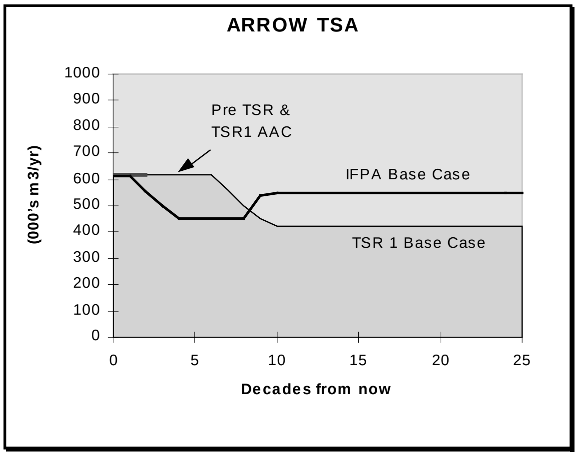
7. Issues and Silvicultural Opportunities

7.1 Discussion of Issues and Opportunities

TSA level modelling in support of silviculture planning has not yet been undertaken. At the TSA level, sensitivity analyses from the Arrow IFPA analysis report (Timberline, 1999) are the best available source of information as to the opportunities for incremental silviculture to increase future timber supply.

The following are selected sensitivity analsysis charts from this report. To the right of each chart is a brief discussion of the timber supply dynamics indicated by the chart, and associated silvicultural opportunities to influence these. In many cases, further modelling is required to confirm the indicated effects.

Figure 2. IFPA vs TSR1 Base Case Harvest Forecast



The TSR1 base case indicated the pre-TSR AAC could be maintained well into the future before a substantial drop to the long term harvest level would be required. (The provincial chief forester indicated in the TSR1 AAC determination that the TSR1 base case overstated the time that the initial harvest level could be maintained and that harvest levels may have to drop as early as the next determination.) The IFPA base case analysis indicates harvest levels must fall soon, but that long term harvest levels will be higher.

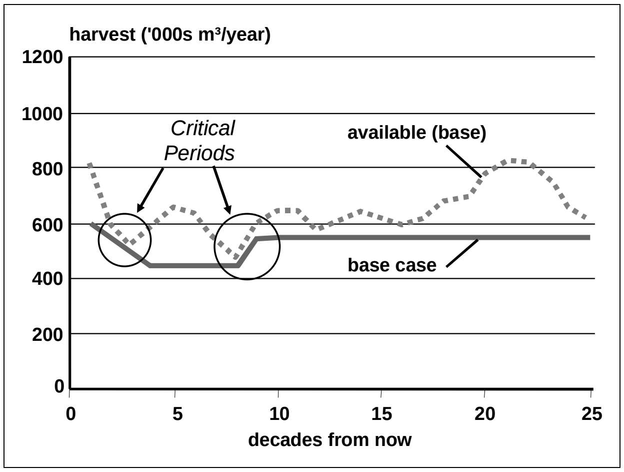
In the short term, there are 2 causes for the discrepancy between forecasts. One reason is that the IFPA net timber harvesting land base (THLB) is about 7% smaller than that of TSR1. A TSR1 sensitivity test of a 20% smaller land base indicated an immediate drop would be necessary, showing some similarity to the IFPA result.

The second reason for the discrepancy in short term forecasts is that the TSR1 analysis was pre forest practices code. It did not contain seral stage and watershed requirements that are part of the IFPA analysis.

In the long term, the TSR1 analysis used natural stand (VDYP) yields for regenerated stands, whereas the IFPA base case analysis used managed stand (TIPSY) yields. TIPSY yields are typically 20-30% above those of VDYP at the same age, which largely explains the discrepancy between the TSR1 and IFPA forecasts.

For the purposes of this interim silviculture strategy, it is assumed that the IFPA base case forecast is the most current and accurate information available.

Figure 3. Timber Availability vs. the IFPA Base Case



Timberline (1999) reports, "…it is highly unlikely that the base case harvest level is in fact operationally attainable." This is because the available volumes average only 25% more than the forecast harvest over the planning horizon. This indicates a very low "…degree of flexibility in actually locating the harvest operationally."

Increasing timber supply availability, as opposed to increasing the harvest forecast, is therefore an important objective for potential silviculture strategies. Timber supply is particularly critical in decades 3 and 8-9. Silvicultural options for decade 3 are limited, whereas there are significantly more management options for stands to be harvested in decades 8 & 9, these being among the first of the managed stands.

Figure 4. Current Age Class Structure

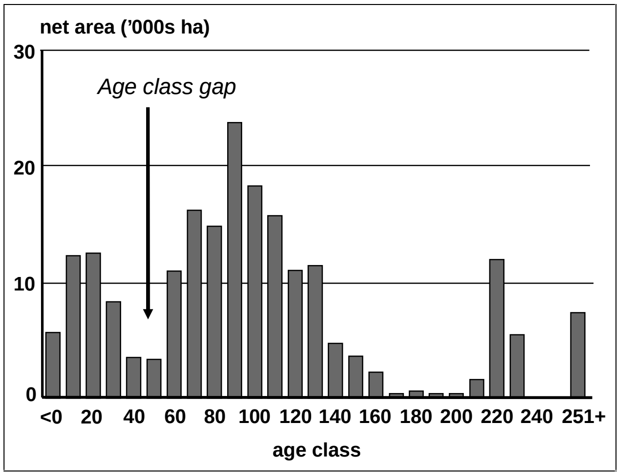
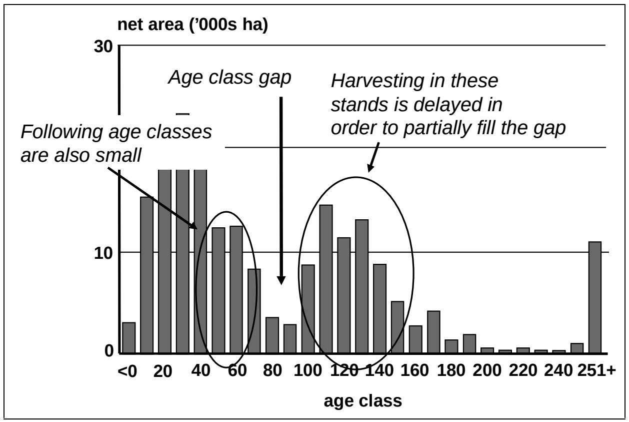


Figure 5. Age Class Structure 40 Years From Now



The current age class structure (Figure 4) shows a shortage of stands 31-50 years of age (age classes shown are the upper end of the age class).

Forty years from now (Figure 5), which is about the middle of the lowest level in the IFPA base case harvest forecast, the stands that are presently 31-50 years of age will then be 71-90 years old. The IFPA analysis report indicates a normal forest distribution would have about 16 000 ha's in each 10 year age class. Age classes 8-9 each have less than 1/4 this amount.

The next three age classes below age classes 8 & 9 are also not in plentiful supply. This makes them poor candidates for bringing forward to help fill the age class gap.

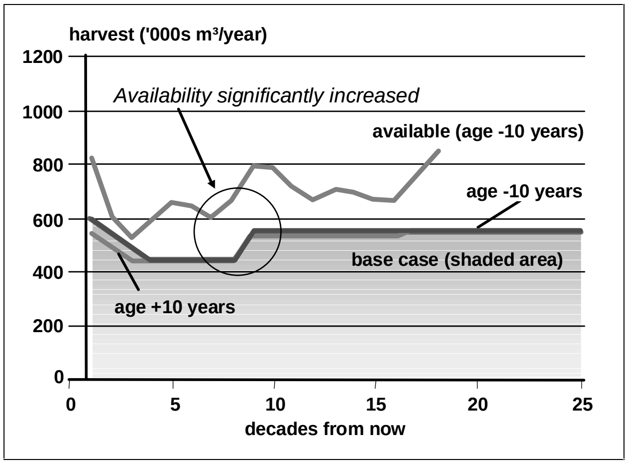
This age class gap drives the need to hold timber back from harvesting in the first 5 decades to avoid more serious mid term harvest shortfalls.

Potential mechanisms for filling in the mid term shortfall are:

- Increasing the volumes of the stands presently in age classes 3-6 through fertilization. (Most of these stands are too old for spacing. Some may be suitable for fertilization.)
- Advancing the productivity and merchantability of stands currently aged 1-20 years through a range of silviculture treatments.
- Partial harvesting or commercial thinning older stands that are otherwise unavailable for harvest at that time (i.e., stands that will be in age classes 10-14, 50 years from now). The volumes of some of these stands could be increased pre and/or post harvest by fertilization. ECA rules may limit this option.

(This likely has no implications for current silviculture activities.

Figure 6. Sensitivity to Changes in Minimum Harvestable Ages and Implications for Timber Quality Management



IFPA minimum harvestable ages are based on attaining a min avg. stand DBH of 25 cm and a min vol of 150 m3/ha.. (Tline, 1999:12) The DBH criterion is one of the most onerous in the region.

Species	Min Age by Site Class –managed. G	M	P
Exist Mangd (all sites)		90-110	
F/Pl	60	80-90	130-140
F/S	90	120-150	250-260
S/Pl	100-120	160-170	70-200
Pl/F	70	100-140	210-250

Minimum ages for G & M sites tend to be relatively close to culmination age. Min ages for poor sites (about 20% of the THLB), however, are well in excess of culmination age, sometimes by as much as 2X.

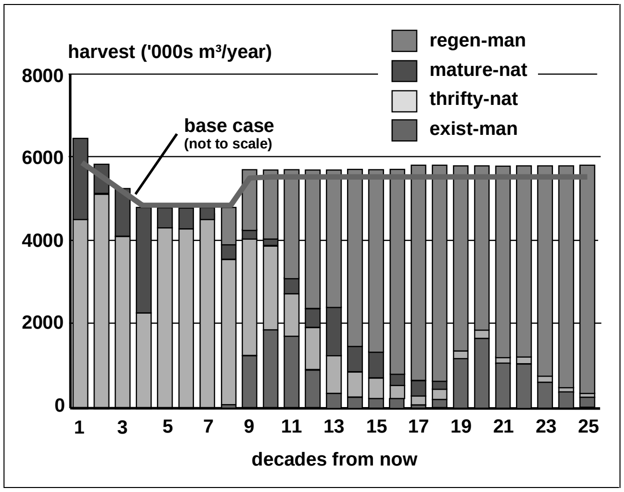
Lowering the minimum age by 10 years has no effect on the mid term shortfall (but significantly increases timber availability). The age class gap is 20 years wide and therefore lowering ages by 10 years is insufficient to span this gap.

Medium sites occupy about 2/3rd's of the THLB. Spacing these stands would significantly advance their minimum harvestable ages (see “Large Premium Log Analysis,” page 61). Initial densities for managed stands in the IFPA analysis are 1 200 sph. No mention is made of the need for stocking control. District indicates potential of 600 ha/yr of spacing from 3 000 to 1 200 sph. W/O spacing, this ingrowth will significantly increase the time for avg stand DBH to reach 25 cm and therefore increases min ages.

Growing forests to older ages generally improves their quality. However, this chart indicates that delaying harvests for this purpose would lower harvest levels in the first several decades. This is because a greater area must be reserved from harvesting to avoid worsening the mid-term shortfall.

The objective of growing forests longer for quality may be more compatible over the long term, where increasing harvestable ages does not appear to affect harvest levels.

Figure 7. The Transition From Existing to Managed Stands

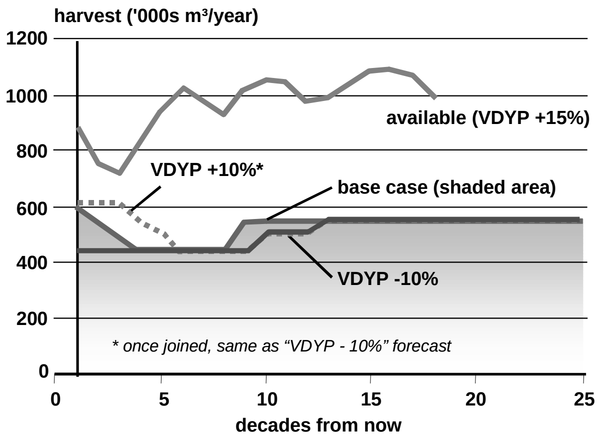


Because of forest cover constraints and long minimum harvest ages for medium and poor sites, the transition from existing to managed stands occurs gradually. Harvesting of regenerated stands actually occurs within the model in advance of existing managed stands (decade 8).

About 50% of the harvest is from managed stands in decade 9, rising to about 75% in decade 11. However, managed stand harvesting fall back temporarily to about 65% in decade 13. Harvesting is about 90% from managed stands by decade 16, and stays above this level thereafter.

By decade 9, the move into managed stands enables the harvest level to rise at this time. Other sensitivity tests (for example, see Figure 9) show the influence of the gradual transition to managed stands by increasing harvest levels later on in the planning horizon, usually at decade 13 (possibly because of the burst of harvesting in mature existing stands which will have higher volumes than the much younger managed stands).

Figure 8. Sensitivity to Changes in Existing Stand Volumes

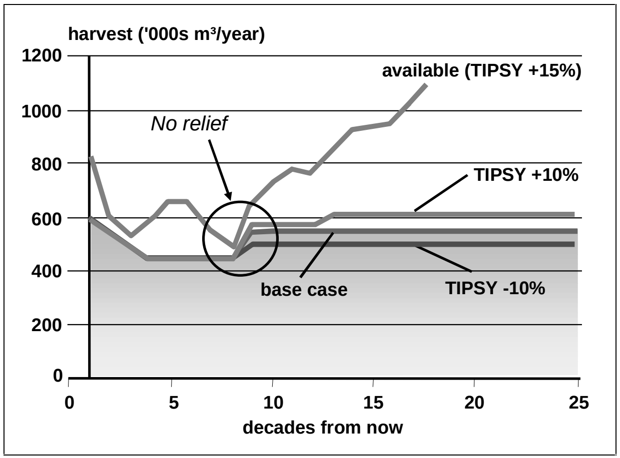


Lowering existing volumes 10% causes the starting harvest level to immediately drop to the mid term shortfall level. The significant lingering role of existing stands in decades 9-12 also causes harvest levels to drop in these decades.

Fortunately, a recent audit has indicated inventory stand volume estimates to be acceptable, so the base case is not at risk from lower estimates.

A 10% increase in existing stand volumes enables maintaining the initial harvest level a further 2 decades than in the base case. The TSA has a large fertilizable land base. Fertilization of suitable existing stands would increase their volumes and could contribute to increasing the timber supply in the short and mid terms.

Figure 9. Sensitivity to Changes in Managed Stand Volumes



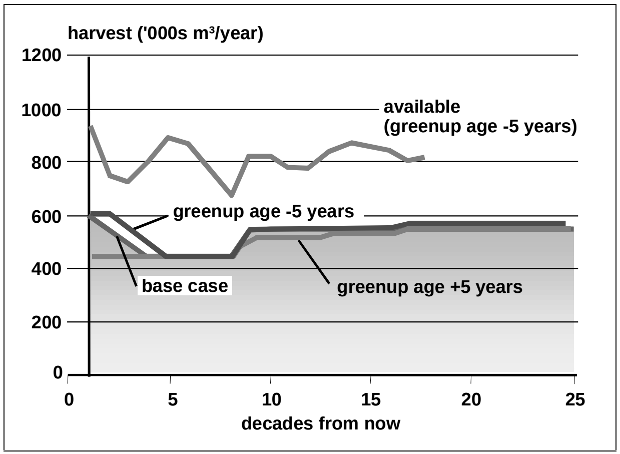
In the IFPA analysis, managed stands include existing Fdi stands less than 21 years old, all other existing stands less than 11 years old, and all future regenerated stands. (In the TSR2 analysis, spruce stands less than 21 years old, will also be defined as managed stands.) The volume of these stands is determined from TIPSY, using an OAF1 of 15% and an OAF2 of 5% (TLine, 1999:11). On average, managed stands have substantially more volume than existing natural stands of the same age. Managed stand volumes first become available for harvesting in decade 8, where about 20% of the harvest comes from these stands (see Figure 7).

Changing managed stand volumes by 10% results in corresponding changes in the long term harvest level (LTHL) from the base case, although because of the gradual transition from existing stands, the full effect of a 10% increase does not occur until decade 13.

A 10% increase in managed stand volumes does not relieve the extremely tight timber supply situation in decade 8. Managed stands comprise 20% of the harvest, so a 10% increase in managed stand volumes only increases timber supply by 2% in this decade.

Many silvicultural practices can be used to achieve an increase in managed stand volumes, including practices to reduce losses to root disease (which potentially are under-estimated in the IFPA base case but due to lack of time during the workshop individual root rot practices were not reviewed). An assessment of the stocking levels of stands in age classes immediately above the managed stand age cut-offs may show that more stands should be assigned the higher TIPSY yields than were done in the IFPA analysis.

Figure 10. Sensitivity to Green-up Ages



IFPA green-up heights and ages are as follows (Tline, 1999:8):

Zone	% THLB	Ht	Age	%allowed below age
IRM	85	2	14	25
Wildlife	19	2	14	25
VQO*	38	7/7/6	28/28/26	5/15/25
Water	46	9	34	15-25
Sig.Streams	31	9	34	25

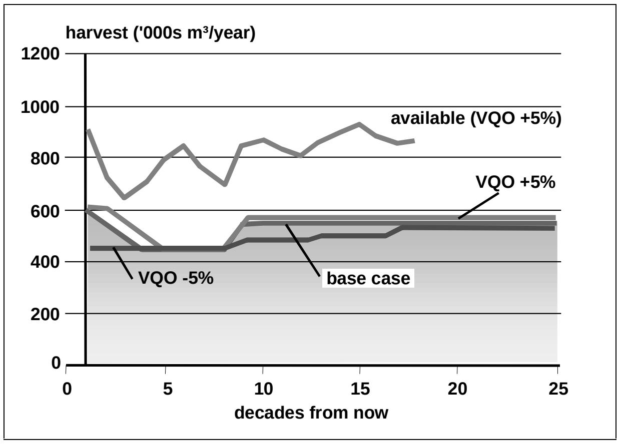
*retention/partial retention/modification

These ages represent current practice (Reichenback, 1996).

The IFPA sensitivity test indicates reducing time until green-up by 5 years results in extending the initial harvest level by 1 decade, but has little impact on harvest levels over the remainder of the planning horizon. Additionally, reducing green-up ages 5 years significantly improves timber supply availability over the entire planning horizon.

Reducing 2 m green-up ages by 5 yrs (from 14 to 9) would be very aggressive (although spruce and balsam are thought to achieve breast height much sooner than MoF estimates – see IFPA Forestry Plan, sec 3.3). Reducing 6, 7 & 9 m green up ages by 5 years is more achievable. Many silvicultural practices can be used to reduce the time until green-up. There is little risk to focusing on green-up issues in the short term, because these same practices will also serve to increase managed stand volumes. Figure 9 shows this would also be of considerable long term benefit.

Figure 11. Sensitivity to Changes in VQO Forest Cover Constraints



VQO Zone	% THLB	Ht	Age	%allowed below age	Rotation
Retention	5	7	28	5	560
Part Ret.	30	7	28	15	187
Mod'n*	3	6	26	25	104

* modification

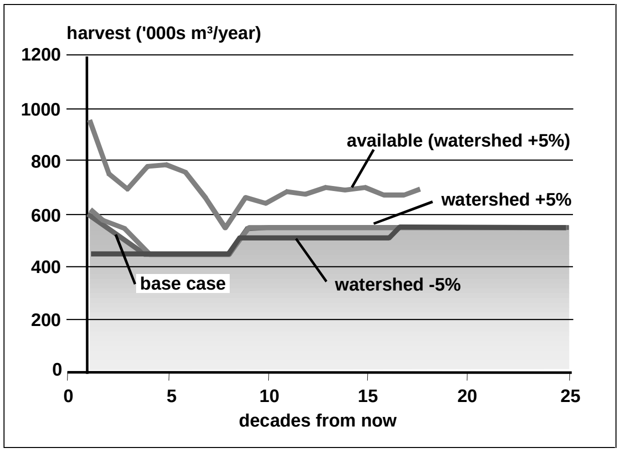
The retention VQO requirement is so high that about ½ the stands in this zone cannot be harvested within the planning horizon.

Lowering the area allowed to be not greened-up in VQO zones by 5% results in the immediate lowering of the initial harvest level to the shortfall level. This is because *the retention VQO zone (5% of the THLB) is eliminated from timber harvesting*, while timber availability in the partial retention zone, which covers 30% of the THLB, is cut by 1/3 (from 15% to 10%). The long term is also significantly affected from decade 9 to 17.

Relaxing VQO forest cover requirements by 5% is mathematically different from tightening by 5%, so would not show the same impact. As with all sensitivity tests, a relaxation only shows increased harvest levels up until another constraint becomes limiting. A 5% relaxation extends the time the initial harvest level can be maintained by 1 decade (from 1 to 2) and slightly increases LTHL. Alternatively, timber availability is significantly increased. This increase is likely caused mostly by relaxing constraints in the retention VQO and partial retention VQO zones.

A positive response to a relaxation of an area constraint generally shows an opportunity for partial harvesting or commercial thinning, whereas a positive response to reduced green-up ages points to silvicultural opportunities to achieve green-up sooner.

Figure 12. Sensitivity to Changes in Watershed Forest Cover Constraints



Note: Equivalent Clearcut Area (ECA) rules apply in watersheds. These rules acknowledge that hydrologic recovery occurs gradually, with 50% recovery occurring by 5 m stand height. Use of ECA rules in IFPA modelling would likely have made watershed requirements less restricting.

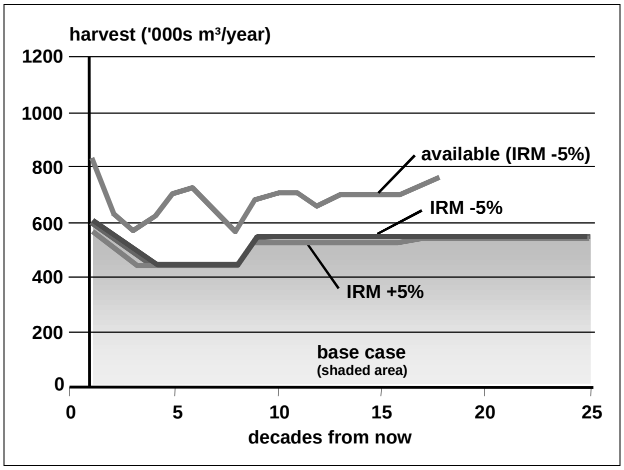
H2O Zone	% THLB	Ht	Age	%allowed below age	Rotation
Class 1	8	9	34	15	227
Class 2	4	9	34	20	170
Class 3	16	9	34	25	136
Comm*	18	9	34	20	170
Sig. Strm**	31	9	34	25	136

*community watershed ** regionally significant streams

Lowering the area allowed to be not greened-up in watershed zones by 5% results in the immediate lowering of the initial harvest level to the shortfall level. This is because timber availability in the various zones, which cover up to 30% of the TSA, is cut by 1/3rd to 1/5th, depending upon the zone. The long term is also significantly affected, until about decade 17.

Allowing 5% more area to be not greened-up has only minimal impact on the base case harvest forecast. Alternatively, a 5% relaxation significantly improves availability in decade 3 indicating a potential for partial harvesting or commercial thinning about this time.

Figure 13. Sensitivity to Changes in the IRM Zone Older Forest Constraint



Note: Older forest requirements can be partially met by forests that are outside the THLB. FSSIM, the model used in the IFPA analysis, ages but does not regenerate forests outside of the THLB. This overestimates the ability of these forests to meet the older forest cover requirements and consequently <u>likely underestimates the amount of older forest required to be maintained within the THLB</u>. While every TSA is different, a sensitivity test in the Golden TSA indicated a possible 10% reduction in LTHL when the ages of forests outside the THLB were not changed over time.

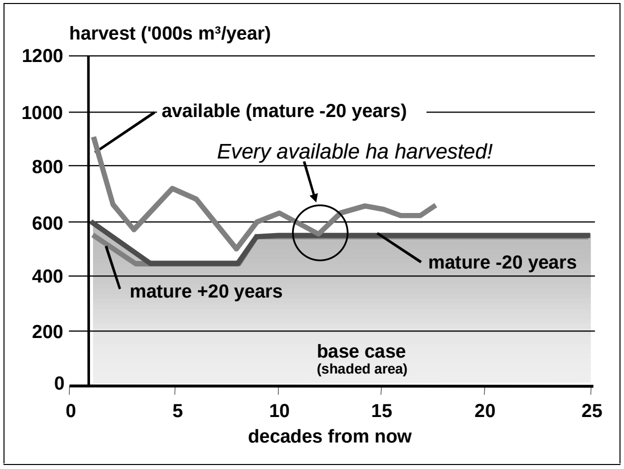
The IFPA base case older forest constraint requires 70% of the IRM area to be at least 40 years old at all times. The IRM zone covers 85% of the THLB and 90% of the productive forest area.

Increasing the requirement to 75% (IRM + 5% line) further restricts timber supply in the first 3 decades and in decades 9-17. Decreasing the requirement so that only 65% (IRM – 5% line) of the IRM zone must be above 40 years of age has no effect. Alternatively, decreasing the requirement marginally improves timber availability.

Silvicultural practices such as fertilization and commercial thinning may be used to accelerate stand structure so that the desired older forest attributes are achieved at an earlier age. However, this sensitivity test indicates there would be little benefit gained in terms of increased timber supply because the older forest constraint is not limiting.

±10% changes in the area required to be in older forests in the wildlife zones produces similar results to those shown in Figure 13, except that decades 9-17 are unaffected.

Figure 14. Sensitivity to Changes in the Mature Seral Age Definition



See note opposite Figure 13.

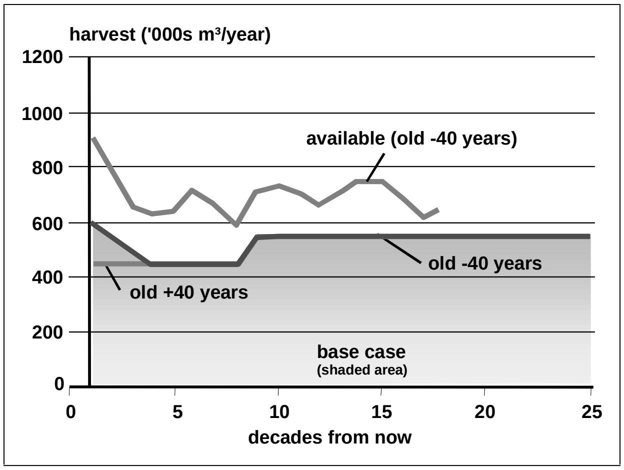
The proportion of area to be in each biodiversity emphasis is not stated in the Timberline report. The Landscape Unit Planning Guide and the Biodiversity Guidebook suggest 45-45-10% of a management unit should be in low-med-high biodiversity emphasis zones respectively.

The mature + old seral requirements used in the IFPA analysis are approximately 17% of low, 34% of medium and 50% of high biodiversity emphasis areas must be in stands aged 120+ yrs in the ESSF and in stands aged 100+ yrs in the ICH and IDF biogeoclimatic zones. This requirement can be met from the entire productive forest land base at the biogeoclimatic variant level within each landscape unit. Because this requirement can be partially satisfied from outside the THLB, the net requirement from within the THLB is often less than the percentages given.

Raising the mature seral age requirement by 20 years (to 140 yrs for ESSF or 120 years for other zones) reduces timber supply in the first 3 decades but otherwise does not affect the base case. Lowering these ages (to 100 or 80 yrs) *should* free up timber supply but instead appears to reduce availability. (Timberline does not provide an explanation as to why availability decreases.)
The base case mature seral stage requirements do not have a large impact on timber supply because the highly restricted green-up area requirements as well as the poor-site minimum harvest age requirements cause a significant area to be held in older forests.

Silvicultural practices such as fertilization and commercial thinning may be used to accelerate stand structure so that the desired older forest attributes are achieved at an earlier age. However, this sensitivity test indicates there would be little benefit gained in terms of increased timber supply from this factor alone. The composite scenario (Figure 20, page 29), on the other hand, indicates that considerable gain my occur when relieving this factor is combined with relieving other factors at the same time.

Figure 15. Sensitivity to Changes in the Old Seral Age Definition



See note opposite Figure 13.

See note opposite Figure 14.

The following are approximations of the biodiversity requirements applied in the IFPA analysis (Tline, 1996:8-9). The IFPA old seral requirements for the low biodiversity emphasis areas are phased in over 3 rotations, ultimately requiring about 13% of stands to be older than 250 yrs of age (140 yrs in NDT3 areas).

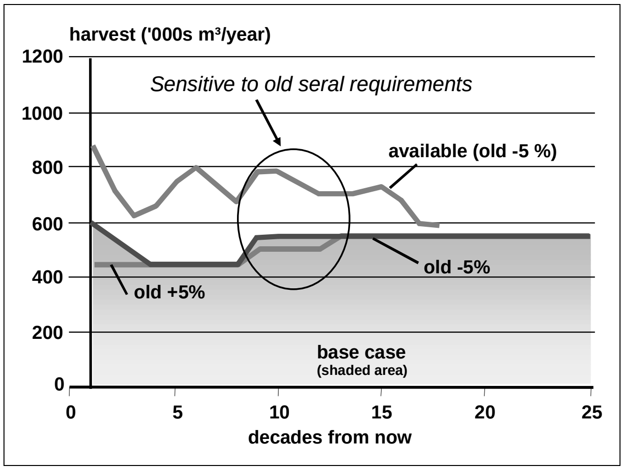
BDV emphasis	low	med	high
min % aged 250+	4⇒13	13	19

This requirement can be met from the entire productive forest land base at the biogeoclimatic variant level within each landscape unit. Therefore, the net requirement from within the THLB is often less than the percentages given.

Raising the old seral age definition by 40 years (to generally 290 yrs) reduces timber supply in the first 3 decades but otherwise does not affect the base case. Lowering these ages by 40 years (to generally 210 years) increases availability. Except in the short term, the base case seral stage requirements do not have a large impact on timber supply because the highly restricted green-up area requirements indirectly cause a significant area to be held in older forests.

Silvicultural practices such as fertilization and commercial thinning may be used to accelerate stand structure so that the desired older forest attributes are achieved at an earlier age. However, this sensitivity test indicates there would be little direct benefit gained in terms of increased timber supply but would indirectly increase overall availability. The composite scenario (Figure 20, page 29) indicates that considerable gain my occur when relieving this factor is combined with relieving other factors at the same time.

Figure 16. Sensitivity to Changes in the Old Seral Area Requirement



See note opposite Figure 13.

See note opposite Figure 14.

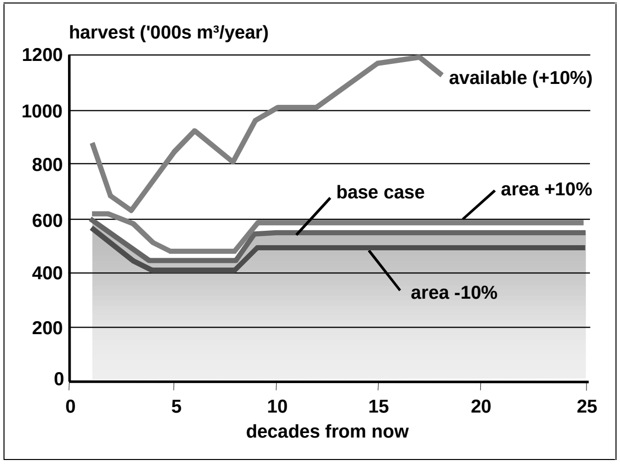
The following are approximations of the biodiversity requirements applied in the IFPA analysis (Tline, 1996:8-9). The IFPA old seral requirements are phased in over 3 rotations in the low biodiversity emphasis areas, ultimately requiring about 13% of stands to be older than 250 yrs of age (140 yrs in NDT3 areas).

BDV emphasis	low	med	high
min % aged 250+	4⇒13	13	19

This requirement can be met from the entire productive forest land base at the biogeoclimatic variant level within each landscape unit. Therefore, the net requirement from within the THLB is often less than the percentages given.

While increasing the old seral age requirement had no effect on decades 9-13 of the harvest forecast (see Figure 15), increasing the area requirement by 5% has a significant effect during this time. Decreasing the area requirement by 5% does not allow an increase in harvest levels, but does improve availability. Green-up area requirements as well as minimum harvest ages are likely limiting any possible rise in harvest level.

Figure 17. Sensitivity to Changes in the Size of the Timber Harvesting Land Base



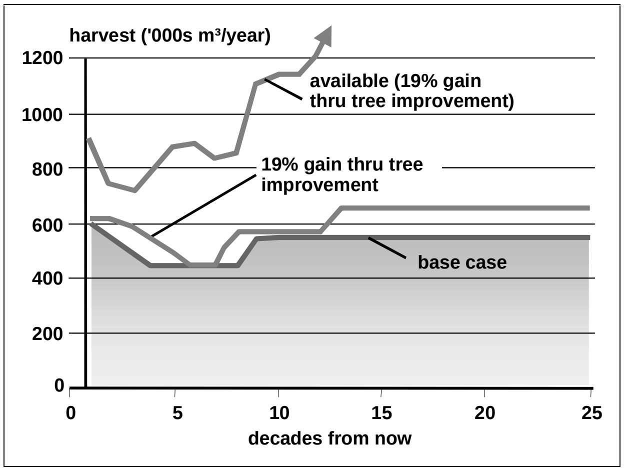
Increasing or decreasing the THLB by 10% correspondingly affects the harvest forecast over all periods. Silvicultural practices may be used to increase the size of the THLB through conversion of un-utilized stands to merchantable species and to increase the productivity of low sites.

Opportunity area consists of the areas deducted from the IFPA THLB. These include (Tline, 1996:3,5)

Type	Area	Equiv % THLB	Reference
Low site	1 800	1.7	Table 5, p5
Decid	8 300	4.1	Table 6, p5
Non Merch	3 100	1.5	Table 6, p5
Fume kill	500	0.2	workshop

70% of the 2 000 ha of backlog NSR were assumed in the IFPA base case to be restocked within the next 10 years, with the other 30% restocked in 20 years. Two stocking classes were used with the breakpoint being 400 sph. Recent district estimates indicate that about ½ of this is inaccessible or uneconomic to treat, indicating the IFPA base case may be slightly optimistic (see “Incremental Silviculture History,” page 16). Currently, there are about 400 treatable ha of backlog NSR.

Figure 18. Tree Improvement Program Potential



Greater yields resulting from tree improvement were modelled in the IFPA analysis by:

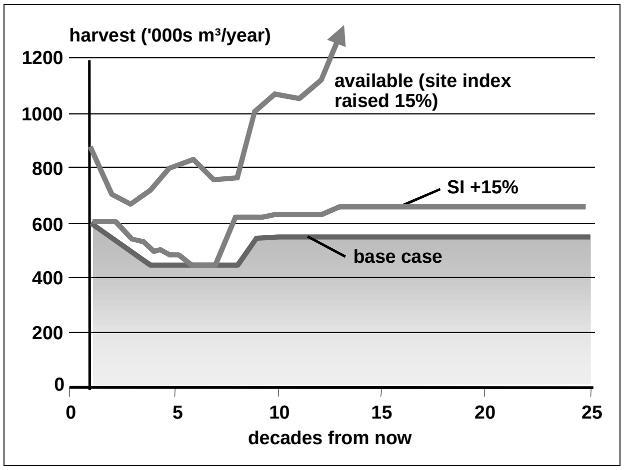
- increasing regenerated stand yields 19%;
- reducing green-up ages by 1, 3 and 5 years for 2, 7 and 9 m green-up hts respectively; and
- reducing minimum harvest ages by a range of 10 to 90 years.

(See discussions of: green-up ages - Figure 10; minimum ages - Figure 6; and increased regenerated stand yields - Figure 9.)

Note that neither this scenario nor the site productivity scenario (Figure 19) can entirely eliminate the mid term shortfall.

(Workshop analysis indicated tree improvement may yield a 7% LTHL gain (vs 19% used in the IFPA analysis) based on the current program. This lower estimate would not result in the lower green-up and minimum ages used in this sensitivity test.)

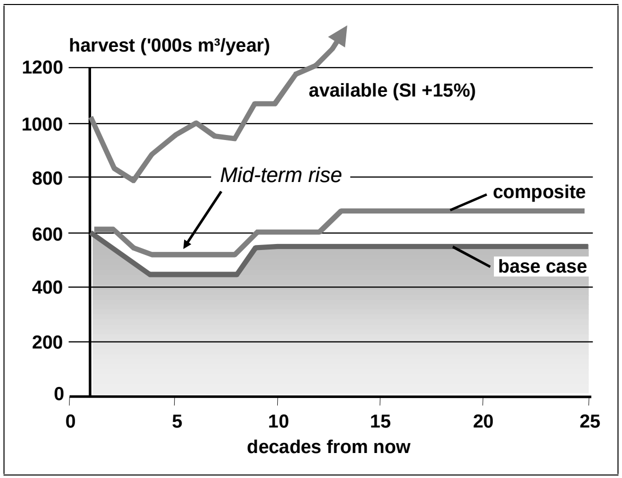
Figure 19. Potential of Improved Estimates of Site Productivity



Increased site productivity estimates were approximated by increasing all managed stand yields by 15%. A higher response is seen in decades 8-12 because the increased yields were also applied to existing managed stands (these stands do not have increased yields in the improved tree scenario in Figure 18 because they did not originate from improved seed.). Similar changes to green-up ages and minimum harvest ages were applied as in Figure 18.

(Workshop analysis indicated a higher site productivity gain than was used in the IFPA analysis may be likely. This may offset the workshop's lower expected result from the tree improvement program compared to the IFPA analysis.)

Figure 20. Composite scenario



The composite scenario incorporates a small land base increase, a 15% site index improvement and a 5% relaxation of mature + old and old growth seral stage requirements.

This is the only sensitivity test that indicates a potential rise in harvest levels across the entire mid term shortfall period. The underlying fundamentals of the changes that drive this composite scenario forecast indicate that all three constraining factors must be moved at the same time; i.e., green-up must be achieved sooner, merchantable timber sizes must be achieved at younger ages, and older forest requirements must either be relaxed or achieved in some other way.

7.2 Summary of Issues and Silvicultural Opportunities

7.2.1 Modelling/Data Factors

The following modelling methodologies or data estimates will likely have an effect on the forecasts:

- Ageing but not regenerating stands outside of the THLB likely underestimates the amount of older forest that must be maintained within the THLB and therefore likely overestimates LTHL.
- Improved site productivity estimates are likely to result in greater yield increases than used in the analysis.
- Given present tree improvement program plans, yields from improved trees will be lower than those used in the analysis (about 7% vs 19% used).
- The use of ECA rules in watersheds would likely ease the overall green-up requirements associated with watersheds. Sensitivity tests indicate the effects may be minimal.
- Minimum harvest ages are based on the demanding criteria of an average 25 cm DBH. This results in very high minimum ages for poor site stands. Lower minimum harvest ages may result in the older forest requirements becoming more limiting.
- In the retention VQO zone (5% of the THLB) a 5% green-up area limit coupled with a 28 year green-up age results in over half of the area never being harvested during the planning horizon (560 years to harvest all stands vs a 250 yr planning horizon). This is effectively a 2½% reduction to the THLB.

7.2.2 General Synopsis

As pointed out by Timberline in its IFPA analysis, the base case harvest forecast is not likely to be operationally attainable, *unless either or both of the tree improvement or site productivity scenarios become a reality*. Even then, achieving the indicated harvest levels over the next 5 to 6 decades will likely be difficult. Consequently the goals of a silvicultural strategy should be to: first, minimize the anticipated harvest level reductions; and second, to increase the overall availability of timber supply in this time period.

At least three different base case constraints force the model to harvest stands at older ages, or conversely force the model to harvest younger stands when older forests are unavailable. Minimum harvest ages for some medium-site stands are as high as 170 years and for some poor-site stands are as high as 250 years. Green-up constraints in the retention VQO zone *may cause some stands to never be harvested within the planning horizon*, and in the partial retention zone (30% of the THLB) delays harvesting of some stands until they are over 180 years of age. Green-up constraints in the watershed zones can cause delays until 170 years (Class 2 and Community watersheds). Lastly, old seral state requirements also require significant areas to be held in older forest.

All of these constraints are very tightly bound. The most binding are the VQO and watershed zone green-up forest cover requirements, followed closely by older forest and biodiversity requirements. When one requirement category is relieved in a sensitivity test, changes in the harvest forecast are almost immediately (if not already) limited by the other. Conversely, when a requirement is increased, the harvest forecast invariably drops, usually immediately. It seems apparent that measurably increasing timber supply or at a minimum increasing the general availability of timber supply at the base case forecast level, requires relieving both green-up and older forest requirements as well as lowering minimum harvest ages. This is demonstrated by the composite scenario in Figure 20.

Silvicultural practices can be used to reduce the time until green-up heights are achieved. While silvicultural practices cannot reduce the time at which older forest ages are achieved, they can be used to develop the stand structure of older forests at younger ages. Not all desired characteristics of older forests may be achieved in this fashion, however.

Another defining characteristic of the timber supply is the shortage of stands currently 21 to 60 years of age (acutely 31-50). This “age class gap” contributes to a mid term harvest shortfall below the long term harvest level. While some sensitivity tests showed results that narrowed the length of time of the shortfall period, no sensitivity test was able to overcome the shortfall across the entire shortfall period. Only the composite scenario resulted in raising the harvest level across the entire shortfall period, but it was not able to completely eliminate the shortfall.

Compared to most other TSA’s, the Arrow TSA does not have an abundance of older forests. This factor contributes to the sensitivity in the first 3 decades and in decades 9 – 17 to increases in constraints that reduce the availability of older forests.

Many of the constraints imposed are crude surrogate measures used in the absence of better information. Before spending huge sums in silvicultural programs to mitigate the impacts of the constraints, it may prove wiser to first improve the research and assumptions behind the constraints to determine their appropriateness. Habitat supply modelling could be useful in this regard.

In a similar vein, much of the Arrow TSA lies within the Interior wet belt and contains highly productive forests. This productivity does not seem appropriately represented in the IFPA analysis. Again, improving the information base might be an appropriate first step before spending large sums on silvicultural programs.

7.2.3 Limitations of Available Information

The disparities between the TSR1 and the IFPA analyses and the data/modelling limitations discussed on page 29 are evidence that timber supply forecasts must be used cautiously in silviculture planning. Stand level models are used to predict yields that are then used in the TSA level model. The probability of the exact sequence of harvested ages and stands that the TSA model selects to form a harvest forecast actually occurring is virtually nil. Yet certain features of the TSA can be expected to hold consistent across both present and future analyses. Such features should be the primary focus of a silviculture strategy. These features in the Arrow TSA are:

1. A physical scarcity of timber in the short term, somewhat related to a lack of stands currently 21 to 50 years of age.
2. Increases in yields of managed stands will directly translate into increases in long term harvest levels.
3. Time until green-up heights are reached will continue to be a limiting factor, particularly in VQO zones (watershed zones require re-analysis under ECA rules to confirm the role of green-up ages in those zones).
4. Older forest requirements will be very tight, if not outright limiting.

While all factors can be influenced by silvicultural actions, the third and fourth factors can also can be influenced by policy changes.

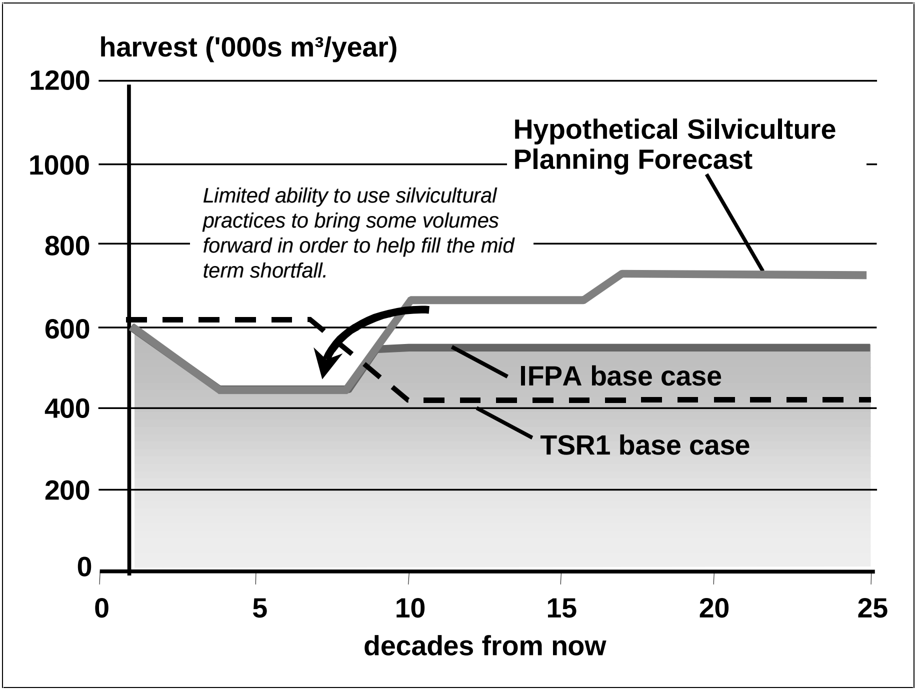
7.2.4 The Silviculture Planning Harvest Forecast

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

Figure 21 below illustrates the silviculture planning harvest forecast for the Arrow TSA. This forecast takes into account the items noted under “Modelling/Data Factors,” page 29 and was confirmed in the district workshop. For the purposes of this interim silviculture strategy, it is assumed that future timber supply forecasts will likely show declining harvest levels over the next several decades, similar to the IFPA base case forecast. This reflects the physical short term scarcity of timber in the TSA which is an adjunct to a transition from a natural forest to a managed, but diverse, forest. The shortage of stands presently aged 21-60 years will continue to be a significant factor, contributing to the mid term shortfall period of the forecast. Future long term harvest levels (LTHL) are expected to be significantly above the TSR1 and IFPA base case forecasts. Higher managed stand yields, improved estimates of site productivity and the volume gains resulting from tree improvement programs, will more than offset any potential reductions that may be needed in order to maintain more area in an older forest condition.

The significant feature of the silviculture planning harvest forecast is the higher long term harvest level. Unfortunately, there is limited opportunity to move some harvest volume forward in time to help fill the mid term shortfall because stands currently aged 1 – 20 years are themselves not overly abundant.

Figure 21. Silviculture Planning Harvest Forecast



Factors that are likely to influence the harvest forecast, but are not certain and are subject to changes in rules are:

- old growth constraints, which may particularly impact decades 8-17; and
- green-up constraints.

While these two factors can be planned for in this strategy, confirmation of their importance to the harvest forecasts must await further analysis.

7.2.5 Future Timber Volumes (Quantity)

Short Term (1 - 20 years)

The short term period is somewhat arbitrarily defined as the next 20 years.

The TSR2 base case is likely to indicate that harvest levels cannot be maintained at the current AAC throughout the short term period (see Figure 21).

In the IFPA analysis, short term harvest levels are largely governed by the need to have a relatively smooth transition down to an unavoidable low point in the harvest forecast.

Short term timber supply therefore may benefit from:

1. activities that will reduce the critical shortages in decades 4 to 8;
2. activities that will overcome currently experienced adjacency constraints, such as large patch cuts, partial harvesting and commercial thinning, provided they do not further lower harvests in the mid term; and
3. activities that will increase the volume to be harvested in this time period, such as:
   - (a) harvesting and recovering merchantable volumes from stands currently classified as non-merchantable, such as deciduous stands or decadent coniferous stands;
   - (b) late rotation fertilization of suitable stands in advance of clear-cut harvest or following partial harvesting);
   - (c) harvest from other areas, such as environmentally sensitive areas (ESA's), in a manner that meets the objectives for which the areas were originally set aside (replace ESA soils mapping with terrain stability mapping?); and
   - (d) harvest from areas currently considered inoperable.

The allocation of the potential benefit from the above activities is a matter of allowable annual cut policies and determinations. Under current policy, an increase in short term harvest level above the current level is highly improbable. Rather, it is likely that any benefits will be allocated:

- first, to maintaining the current harvest level for another 5-10 years, provided this does not further worsen forecast future harvest level reductions;
- second, to eliminating the mid term shortfall (below LTHL); and
- last, to extending the current harvest level beyond 10 years.

For this reason, all of the above, except item 3 are considered potential mid-term strategies. Of those listed under item 3, only (a) and (b) are silviculture related.

Mid Term (21 - 80 years)

The mid term period begins at the end of the short term period (i.e., 21 years from now) and continues until the transition from harvesting in existing natural stands to harvesting mainly in 2nd growth managed stands is complete. In the Arrow TSA IFPA forecast, about half of the harvest volume in decade 9 is from managed stands (decade 9 is the period 81 to 90 years from now). However, even though a steady long term harvest level is reached in decade 9, it is not until about the 13th decade that harvesting is about 90% in managed stands. For the purposes of this strategy, the end of the transition period is assumed to be 80 years; i.e., at the end of decade 8.

The mid term is governed by the need to extend existing timber supply to cover what appears to be critical shortages in decades 4 to 8. Mid term timber supply will benefit indirectly from the movement of any additional timber supply that may be created under the short term strategies into the mid term.

Mid term timber supply may directly benefit from:

1. setting up stands for activities that will overcome adjacency constraints that may exist in the mid term, such as partial harvesting and commercial thinning;

2. activities that will achieve-green-up earlier in the VQO and watershed zones, so that green-up is not limiting on the ground;
3. setting up stands now to meet older forest requirements in that period; and
4. activities that will increase the volume of stands to be harvested in this time period, particularly in decades 4 to 8, such as:
    (a) fertilization of suitable stands;
    (b) commercial thinning volumes from stands that otherwise will be harvested later during the long term (i.e., bring volumes forward from the long term); and
    (c) spacing and fertilizing younger existing stands and newly regenerated stands to lower make them merchantable sooner (i.e., effectively lower their minimum harvestable ages).

Long Term (81 + years)

The long term period is the time when harvesting is primarily in managed 2^{nd} growth stands and is characterized by a steady state harvest level. In the Arrow TSA, this point is reached in decade 9 of the IFPA analysis which begins 81 years from now.

The long term is assumed to be sensitive only to changes in managed stand volumes, the size of the timber harvesting land base, and the amount of losses to root rot diseases. It is assumed that stands will be harvested at ages that are near biological rotation ages and that harvesting stands below these ages will not be occurring.

7.2.6 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 volumes. Until recently, there has been little higher-level policy guidance with respect to managing for future timber quality.

Using age as a surrogate measure of timber quality, the expected decline in harvest ages towards lower harvestable ages during the mid term indicates future timber quality will be substantially lower than today's. Quality levels will recover somewhat in the long term with the trend towards older forests. Other than areas affected by root rot, most harvested second growth timber will be sound wood with little or no decay.

Smaller diameter material is not necessarily all negative in terms of timber quality. There is some evidence that slower grown, smaller diameter lodgepole pine produces a better proportion of machine stress rated (MSR) lumber, which currently commands a higher price than standard grade lumber.

If a 'clear' log is defined as one having at least 25% clear lumber content (based on coastal log grading rules), then 2^{nd} growth forests will have few if any such logs. Pruning will be necessary if future standing inventories are to contain any clear log content.

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.

Timber quality can be improved through silviculture practices such as spacing, fertilization and pruning. Portions of the TSA are suited to growing white pine trees, a singularly valuable species that currently commands premium prices.

8. Opportunities to Increase Timber Supply

8.1 Potential Silviculture Strategies

Prior to the district workshop, information in the previous sections was used to identify the following potential silvicultural strategies for either maintaining or increasing future timber supply at the TSA level. Each of these was discussed in detail in the district workshop, the results of which are recorded in "Workshop Review of Potential Strategies," page 39, along with additional strategies that arose during the meeting. Strategies that are ultimately adopted are noted in "Silviculture Strategies," page 67.

8.1.1 Short Term (1 - 20 yrs)

ST 1: Harvesting and recovering merchantable volumes from (increase)[3]:

(a) _______ ha's deciduous stands;

(b) _______ ha's of coniferous stands currently classified as non-merchantable; and

(x) _______ ha's of ESA's (not a silviculture strategy);

(x) _______ ha's of forests currently classified as inoperable (not a silviculture strategy).

ST 2: Late rotation fertilize ____ ha/yr of suitable stands scheduled for harvest in the 2nd decade to increase their volumes. (increase)

ST3: Utilize large patch cuts to emulate stand replacing fires (also overcomes adjacency?) (increase)

ST 4: Achieve green-up earlier in existing managed stands currently aged 1-20 years in the watershed (9m green-up) and VQO zones (6-7 m green-up) by (increase – this is a subset of MT5):

(a) brushing ____ ha/yr for growth enhancement (in addition to ___ ha/yr to ensure free growing; and

(b) spacing ____ ha/yr of pine stands (priority - those subject to repression);

(c) spacing ____ ha/yr of Douglas-fir stands (prioity – those subject to seasonal moisture deficits); and

ST5:

---

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

8.1.2 Mid Term (21 - 80 yrs)

MT 1: Late rotation fertilize ____ ha/yr of suitable 71 to 100 year old stands scheduled for harvest 20 to 80 years from now to increase their volumes (continuation of ST 2). (increase)

MT 2: Repeat fertilize stands presently 21 – 60 years old to increase their volumes at harvest. (increase)

MT 3: Reduce the minimum harvest ages of stands presently 1 – 20 years old by: (increase)

(a) brushing ____ ha/yr for growth enhancement (in addition to ___ ha/yr to ensure free growing;

(b) spacing ____ ha/yr of pine stands (priority - those subject to repression);

(c) spacing ____ ha/yr of Douglas-fir stands (prioity – those subject to seasonal moisture deficits); and

(d) repeat fertilizing ____ ha/yr.

MT 4: Investigate stocking levels of stands of Fdi, 21-30 yrs of age and of all other species 11-30 yrs of age.

MT 5: Reduce green-up ages of about-to-be-regenerated stands by 8 years in the VQO (base case - 28 yrs to 7 m ht) zone and by 10 years in the watershed zones (base case - 34 yrs to 9 m ht) by: (increase)

(a) site preparing ___ additional hectares;

(b) using improved seed;

(c) using larger planting stock;

(d) planting white pine wherever suitable;

(e) fertilizing at time of planting;

(f) brushing ____ ha/yr for growth enhancement (in addition to ___ ha/yr to ensure free growing; and

(g) spacing ____ ha/yr of pine stands (priority - those subject to repression);

(h) spacing ____ ha/yr of Douglas-fir stands (prioity – those subject to seasonal moisture deficits); and

(i) repeat fertilizing ____ ha/yr.

MT 6: Set up stands presently 60 – 100 years old for future partial harvesting/ commercial thinning in the VQO and watershed zones by:

(a) commercial thinning to recover small diameter products; and

(b) repeat fertilizing ____ ha/yr.

MT 7: Increase the area satisfying mature forest biodiversity requirements in decades 8-13 by achieving the desired stand characteristics by 100 years of age by:

(a) spacing ____ ha/yr; and

(b) repeat fertilizing ____ ha/yr.

8.1.3 Long Term (81+ yrs)

LT 1: Maintain the THLB by:

(a) Planting ____ ha of backlog NSR; and

(b) Maintaining ____ ha of existing backlog plantations.

LT 2: Increase the THLB by:

(a) converting/rehabilitating ____ ha/yr of deciduous stands; (increase)

(b) converting/rehabilitating ____ ha/y of non-merchantable ____?____ stands; (increase)

(c) assessing _______ ha of low-site stands for proper classification; or

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

LT 3: Increase regenerated stand volumes by, in addition to those practices in MT 5:

(a) managing stocking so voids do not account for more than 10% of the area (increase); and

(b) repeat fertilize _____ ha/yr on a 15 yr return cycle (increase).

LT 4: Reduce losses to root rot by: (increase)

(a) pushover logging/stumping _____ ha/yr;

(b) planting alternate/mixed species on ______ ha/yr;

(c) pop-up spacing on _____ ha/yr; or

(d) small diameter spacing.

LT 5:

LT 6:

LT 7:

8.2 Workshop Review of Potential Strategies

8.2.1 Introduction

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

Workshop discussions are documented in the following tables. The contents of each column are further described below.

Column Number	Note
1	Strategy numbers correspond with the numbers recorded earlier in "Potential Silviculture Strategies," page 36. Items followed by an asterisk (*) were added during the district workshop.
2	Information is largely from the district workshop, combined with information presented earlier in this document.
3	Anticipated results are calculated using a variety of methods.

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

8.2.2 Short Term (1 - 20 years)

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
ST 1	1. Harvesting and recovering merchantable volumes from (increase)[4]	1. The listed items have potential to immediately increase timber supply through the harvesting of standing timber. They also have implications, where there is no merchantable timber, for the development of silviculture rehabilitation plans and, in all cases, for expanding the timber harvesting land base.	
ST 1	(a)_______ ha's deciduous stands;	(a) About 8 300 ha's of deciduous stands were deducted during the TSR2 THLB netdown process. Mostly birch, but some aspen. Because Kalesnikoff Lumber has birch lumber sitting in its yard that it cannot sell, the market potential for harvested deciduous appears bleak. See LT 2 regarding rehabilitation potential for deciduous stands.	(a) No opportunity.
ST 1	(b)_______ ha's of coniferous stands currently classified as non-merchantable;	(b) About 3 100 ha's of the following forest types were deducted during the IFPA THLB netdown process. Percentage deductions are shown in brackets. • CH > 140 yrs (50%) • H > 140 yrs (40%) • B, BH > 140 (10%) • BH > 250 (100%) • Pl 220 > 100 (100%). The potential for these areas to contribute to meeting old growth management area objectives needs to be determined before they should be considered for harvesting or rehabilitation. Noted under "Summary of Information and Research Needs," page 75. See also LT2.	(b) Further info required.
ST 1	(x1) _______ ha's of ESA's (not a silviculture strategy);	(x) About 32 200 ha (outside watersheds) and 11 500 ha (inside watersheds) of environmentally sensitive areas (ESA's) were deducted during the netdown process. Of this, about 26 000 ha is attributable to sensitive soils and 3 000 ha to regeneration difficulty. Some of these areas can hold significant timber volumes. Terrain stability mapping can be used to fine tune areas classified into ESA. The need to compare TSM vs ESA mapping and for MoF to provide maps showing ESA-regen areas noted under "Summary of Information and Research Needs," page 75. Otherwise, no immediate opportunity is apparent.	(c) No opportunity.
ST 1	(x2) _______ ha's of forests currently classified as inoperable (not a silviculture strategy).	(x) The Arrow IFPA is assessing the potential for harvesting outside of the area currently defined as operable. See the IFPA *Forestry Plan*. An outcome of moving the operability line higher might be greater difficulty achieving regeneration success. The need to investigate these regeneration implications is noted under "Summary of Information and Research Needs," page 75.	(x) See IFPA forestry plan.

---

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

* *Indicates a potential strategy that was added during the workshop.*

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
ST 2	2. Late rotation fertilize ____ ha/yr of suitable stands scheduled for harvest in the 2^{nd} decade to increase their volumes. (increase)	2. A few years ago the district field-assessed about 45 000 ha for potential commercial thinning. The large majority of these areas were found to have small crowns and high densities. Consequently, CT was not recommended because of the concerns about the long delay in the crown recovery of the residual trees. The same findings would apply to late rotation fertilization potential – the majority of stands would not be suitable because of high densities and small crowns. The need to evaluate the late rotation fertilization potential of smaller live crown trees noted under “Summary of Information and Research Needs,” page 75. If 2 000 ha planned for 2^{nd} decade harvest could be identified that was also suitable for late rotation fertilization, this would indicate a potential fertilization program of 200 ha/yr. Increasing this to **400 ha/yr** would support the strategic objective of increasing overall timber supply availability/flexibility because: • identifying stands that will be harvested for certain 10-20 years from now is difficult, • areas that are not harvested on queue, could be given a second fertilization treatment to further enhance growth; • this strategy is linked to MT1 (continuation of late rotation fert into the mid term), and fertilizing a greater area now also increases mid term timber supply. Fertilizing 200 ha/yr would increase stand yields 15 m3/ha = 3 000 m3/yr starting in the 2^{nd} decade, approx = 0.5% of current AAC. If 400 ha/yr were fertilized, the benefit from the additional 200 ha/yr could either be harvested or accumulated in the timber supply to increase flexibility.	2. Possible 3 000 m3/yr, beginning in 2^{nd} decade.
ST 3	3. Utilize large patch ~~cuts~~ sizes to emulate stand replacing fires (also overcomes adjacency?) (increase)	3. Large patch sizes are becoming more common practice in order to emulate stand replacing fire events. This has no associated silviculture activity potential. It is noted here more for its potential to have a positive effect in overcoming adjacency constraints. This may reduce the need to use silviculture for the same purpose. Additional modelling required. Noted under “Summary of Information and Research Needs,” page 75.	3. Not a silviculture strategy but may affect silv strategy choices. Further info required.
ST 4	4. Achieve green-up earlier in existing managed stands currently aged 1-20 years in the watershed (9m green-up) and VQO zones (6-7 m green-up) by (increase – this is a subset of MT5):		
ST 4	(a) brushing ____ ha/yr for growth enhancement (in addition to ___ ha/yr to ensure free growing; and	(a) No opportunity. See MT 5(f1).	(a) No opportunity. See MT 5(f1).

* *Indicates a potential strategy that was added during the workshop.*

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
ST 4	(b) spacing ____ ha/yr of pine stands (priority - those subject to repression); (c) spacing ____ ha/yr of Douglas-fir stands (priority – those subject to seasonal moisture deficits); and	(b) (c). Current spacing program is about 150 ha/yr. Spacing may have a height effect on stands having seasonal moisture deficits but otherwise has no effect on green-up heights. It may have a temporary slight negative effect on VQO and H2O green-up by reducing crown closure. Assume ½ of fertilizable area (see ST4 (d) below) will require early spacing to set up for fert program = **program of 150 ha/yr**.	(b) (c) No direct opportunity. Required for fertilization treatments.
	(d) improving site index estimates*	(d) This item added during the workshop. See MT 5 (b2) for S.I. analysis. Higher site indices are estimated to reduce time to green up as follows: 2m 7m 9m 18mS/22mPl S 1.5 4 5 9 Pl 2 6 9 46	(d) 4-6 yr reduction in time to 7 m green-up.
ST 4	(e) fertilizing suitable stands*	(e) This item added during the workshop. Target stands are in VQO areas outside of watersheds, 1-20 yrs old. Estimate between 3 000 to 5 000 ha of target stands. **Potential fertilization program of 300 ha/yr** (equal to about 20% of annual area harvested. These are the main areas to be harvested and therefore should be the focus of intensive management efforts (i.e., from improved seed on up). To be of greatest value, this fert would be applied at an earlier age than would be normal under a multiple fert regime. No info available in the workshop on reduction in time until green-up. Post-workshop review indicates about a 20% height response 3 years following Pl fertilization (Brockley, 1989). Therefore, a rough estimate of green-up gain of 1 yr every five years. If fertilization takes place at around age 15, should be about a 2 yr reduction in time to 7 m green-up.	(e) 2 yr reduction in green-up age.
ST 4	Summary	4. Summary. Workshop estimate was the above could in theory drop VQO green-up by as much as 10 years, from 28 yrs (7 m) to 18 yrs. Post-workshop analysis indicates a 6-8 year reduction to about the 20 year range is more likely. The largest component of this would be from revised site productivity estimates which would be applicable across the entire THLB. The IFPA analysis indicates a 5 yr across-the-board reduction in green-up ages extends the initial harvest level from 1 decade to 2. Alternatively, a 5 yr reduction in green-up ages substantially improves availability in the critical 3rd and 9th decades. The effects of a targeted fertilization program requires modelling to determine.	4. Summary. Substantially improved timber availability in the 3rd and 9th decades.

* *Indicates a potential strategy that was added during the workshop.*

<table>
<tr><th>Number</th><th>Potential Strategy/Action</th><th>Discussion / Current Status</th><th>Anticipated Result</th></tr>
<tr><td></td><td>Short Term Harvest Forecast Summary</td><td>
<table>
<tr><th>Potential Strategy #</th><th>Effect</th></tr>
<tr><td>ST1 Recover merch volumes from:</td><td></td></tr>
<tr><td>(a) deciduous stands</td><td>No opportunity</td></tr>
<tr><td>(b) non-merch conifer stands</td><td>Further info required</td></tr>
<tr><td>(x) ESA’s</td><td>No opportunity</td></tr>
<tr><td>(x) inoperable areas</td><td>Pursued under IFPA</td></tr>
<tr><td>ST2 Late rotation fertilization 400 ha/yr</td><td>3 000 m3/ha starting in 2nd decade</td></tr>
<tr><td>ST3 Utilize large patch sizes</td><td>Not a silv. strategy. Further info req’d</td></tr>
<tr><td>ST4 Earlier green-up</td><td></td></tr>
<tr><td>(a) brushing for growth</td><td>No opportunity</td></tr>
<tr><td>(b-c) space 150 ha/yr</td><td>No direct opportunity, 150 ha/yr req’d to set up stands for fertilization</td></tr>
<tr><td>(d) improved SI estimates</td><td>4-6 yr reduction in 7 m green-up across entire THLB</td></tr>
<tr><td>(e) fert 1-20 yr old stands in VQO o/s W/S</td><td>(300 ha/yr) 2 yr reduction in 7 m g-up in treated stands. Requires modelling.</td></tr>
<tr><td>ST 4 Summary</td><td>6-8 yr reduction in green-up ages in some stands - improves timber availability.</td></tr>
</table>
</td><td></td></tr>
<tr><td></td><td>Conclusion</td><td>Opportunities were identified that will improve overall timber availability. The short term harvest forecast can be expected to be similar to the IFPA forecast. Increased availability improves the likelihood that this forecast is attainable.</td><td></td></tr>
</table>

8.2.3 Mid Term (21 - 80 years)

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
MT 1	1. Late rotation fertilize ____ ha/yr of existing stands scheduled for harvest 20	1. This strategy is a continuation of ST 2. See ST2	1. Possible 3 000 m3/yr.

* *Indicates a potential strategy that was added during the workshop.*

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
	to 90 years from now to increase their volumes (continuation of ST 2). (increase)		
MT 2	2. Repeat fertilize stands presently 21 – 60 years old to increase their volumes at harvest. (increase)	2. This strategy is focused on those stands that will be harvested during the shortfall period. Few of these stands are suitable for fertilization. The origin of 40-60 year old stands is intermediate utilization logging in the 1940's through 1960's or fire. These stands have poor structure. Stands aged 21-40 have not had stocking control and are generally too dense for fertilization.	2. No opportunity.
MT 3	3. Reduce the minimum harvest ages of stands presently 1 – 20 years old by: (increase)	3. The difference between this potential strategy and ST4 is that ST4 focuses on green-up ages in VQO and H2O while this strategy focuses on minimum harvestable ages across all zones. Much of the analysis undertaken under MT 5 is applicable to this potential strategy. Fdi and spruce stands aged 1-20 yrs will be considered managed stands in TSR2. All other species < 11 yrs in age will be considered managed.	3.
MT 3	(a) brushing ____ ha/yr for growth enhancement (in addition to ___ ha/yr to ensure free growing;	(a) The TSA does not have a major brush problem.	(a) No opportunity.
MT 3	(b) spacing ____ ha/yr of pine stands (priority - those subject to repression);	(b) See MT 5 (g-h)	(b) Improves availability. See MT5 (g-h)
MT 3	(c) spacing ____ ha/yr of Douglas-fir stands (prioity – those subject to seasonal moisture deficits); and	(c) See above.	(c) See above.
MT 3	(d) repeat fertilizing ____ ha/yr.	(d) See MT5 (i)	(d) See MT5 (i). Improves availability.
MT 4	4. Investigate stocking levels of stands of Fdi and spruce*, 21-30 yrs of age and of all other species 11-30 yrs of age.	4. Potential strategy reworded to include spruce with Fdi. This is how it will be treated in TSR2. The cut-off ages for managed stands are lower than in most other management units. The designation of "other" species under 11 yrs of age as managed stands is particularly low. Stands that are in the age classes immediately above these are assigned VDYP yields which are much lower than TIPSY yields. Because the primary difference between the two model yields is well-spaced stocking, stocking surveys of the stands in the ages immediately above those considered to be managed may indicate that they are better estimated as TIPSY yields, perhaps with a higher OAF1 factor. The need for surveys is noted under "Summary of Information and Research Needs," page 75.	4. Surveys required. Has potential to increase the yield estimates of the target stands by 20% to 30%.

* *Indicates a potential strategy that was added during the workshop.*

<table>
<tr><th>Number</th><th>Potential Strategy/Action</th><th>Discussion / Current Status</th><th>Anticipated Result</th></tr>
<tr><td>MT 5</td><td>5. Reduce green-up ages of about-to-be-regenerated stands by 8 years in the VQO (base case - 28 yrs to 7 m ht) zone and by 10 years in the watershed zones (base case - 34 yrs to 9 m ht) by: (increase)</td><td>5. See MT5 “Summary” below.</td><td>5. See MT5 “Summary” below.</td></tr>
<tr><td>MT 5</td><td>(a) site preparing ___ additional hectares;</td><td>(a) About 400 ha of 1400 ha planted annually is currently site prepped. 100 ha is mech site prep and 300 is prescribed burned. Requirements for coarse woody debris, smoke control and site/soils sensitivities prevent increasing the area of site prep. No additional opportunity. Concern expressed that the large reduction in site prep over the last two decades may be reducing site/stand productivity. The need to evaluate this is noted under “Summary of Information and Research Needs,” page 75.</td><td>(a) No opportunity.</td></tr>
<tr><td>MT 5</td><td>(b1) using improved seed;</td><td>(b1) All even-aged managed areas are planted (1 400 ha/yr). In 1998 about 23% of all planted area was improved S but the volume gain is low, estimated between 2 – 3%. Some participants felt the actual gain will be greater, given the visibly better growth seen in the field. Future tree improvement gains by 2007 are estimated to be:
<table>
<tr><th>%</th><th></th><th>% vol gain (stand level)</th><th></th><th>% gain</th><th>seed (million/yr)</th><th></th></tr>
<tr><th>THLB</th><th>Species</th><th>Now</th><th>2007</th><th>(TSA level)</th><th>need</th><th>production</th></tr>
<tr><td>30</td><td>Sx</td><td>2 - 3</td><td>14</td><td>4</td><td>0.6</td><td>7.0</td></tr>
<tr><td>20</td><td>Pl</td><td>2 - 3</td><td>12</td><td>2</td><td>0.4</td><td>5.6</td></tr>
<tr><td>30</td><td>Fdi</td><td>-</td><td>0.3</td><td>0</td><td>0.6</td><td>0.5</td></tr>
<tr><td>20</td><td>Lw</td><td>-</td><td>7</td><td>1</td><td>0.4</td><td>0.9</td></tr>
<tr><td>5</td><td>Pw</td><td>-</td><td>0</td><td>0</td><td>-</td><td>-</td></tr>
<tr><td></td><td></td><td></td><td></td><td>7</td><td></td><td></td></tr>
</table>
Fdi and Lw are forecast to offer relatively little volume gain. Other than for Fdi, there should be adequate improved seed available to meet the needs for the TSA.
About 90% of harvested areas are planted, so the LTHL gain across the entire TSA = .9 X .07 ≅ 6%.
There is substantial variation over the above estimates. For example, some spruce orchards are exhibiting 25% gains. The best of the improved seed for each species should be targeted to areas needing quick green-up. Unfortunately VQO areas are Fd/Pl/Lw/Pw sites for which there isn’t large-gain improved seed available. A seed planning and use co-operative is proposed for the TSA licensees to lobby for more and better improved seed and to co-ordinate the use of the best available seed to greatest strategic advantage. Noted under “Summary of Information and Research Needs,” page 75. A strategic target of 20% yield gain at the TSA level was adopted.
Tree improvement could reduce green-up (estimate by 3 yrs on 7 m green-up ht) & minimum harvest ages (estimate by 10 yrs) on 50% of the THLB. Green-up is not an is-</td><td>(b1)
stand level
Vol gain – up to 25%
GU red’n (7m)– 1 yrs
min age red’n - 10 yrs
TSA level
Vol gain – 6%
GU red’n (7m)– 0.5 yr
min age red’n - 5 yrs
See “Summary” below.</td></tr>
</table>

* *Indicates a potential strategy that was added during the workshop.*

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result

sue in partial-harvesting areas.

Time to green-up reduction was calculated in the workshop as follows. An SI of 18 (avg for S from Martin, 1999) means a spruce stand would hit 18 m at breast height age 50. If the 14% volume gain associated with improved S seed is considered to largely equate to faster ht growth, it takes 14% less time, or (.14 X 50 =) 7 yrs, to get to 18 m. On a strictly pro-rata basis, which is not technically correct because total age at ht 18 is > 50 (adding in regen delay and time to reach breast ht), reduced time until green-up is as shown in the table below. (top line is workshop analysis, lower lines are post-workshop TIPSY analysis for Spruce, SI 18 and Pl, SI 22).

<u>Post workshop analysis indicates workshop green-up age reduction assumptions were erroneous</u>. Post-workshop results are used in “expected results”. (min age reduction assumptions not checked.)

green-up ht (m)	2	7	9	18S/22Pl
Age reductions				
Workshop calc’n	-1	-3	-4	-7
TIPSY analysis - spruce				
(time SI 18)	13.5	28	33	59
(time SI 18.8)	13	27	32	56
(difference)	-.5	-1	-1	-3
TIPSY analysis – Pl				
(time SI 22)	10	20	23	58
(time SI 23)	10	19	22	54
(difference)	0	-1	-1	-4

TIPSY based on following logic:

Spruce, SI 18 hits 18 m at age 59. Vol at this age is 156 m3/ha (17.5 cm util., 1400 sph). A 14% volume gain (TI volume gain is measured at age 12 and forecast to age 60, so ages are comparable) on this vol gives a total vol of 178 m3/ha. To get 178 m3 at age 59 requires an SI of approx 18.8. Ages at the various green-up hts are then looked up in TIPSY at this SI and compared to ages for those heights at SI 18.

Pl, SI 22 hits 22 m at age 59. Vol at this age is 288 m3/ha (12.5 cm util. 1400 sph). A 12% volume gain on this vol gives a total vol of 323 m3/ha. To get 323 m3 at age 59 requires an SI of approx 23. Ages at the various green-up hts are then looked up in TIPSY at this SI and compared to ages for those heights at SI 22.

---

* *Indicates a potential strategy that was added during the workshop.*

<table>
<tr><th>Number</th><th>Potential Strategy/Action</th><th>Discussion / Current Status</th><th>Anticipated Result</th></tr>
<tr><td></td><td>(b2) site index shift;*</td><td>(b2) This potential strategy was added during the workshop. The volume implications of a possible site index shift were calculated in the workshop as follows:
<table>
<tr><th>%</th><th></th><th></th><th></th><th></th><th colspan="2">vol % gain</th></tr>
<tr><th>THLB</th><th>Species</th><th>Current SI</th><th>Martin SI</th><th>(SI % gain)</th><th>stand</th><th>TSA</th></tr>
<tr><td>30</td><td>Sx</td><td>16</td><td>18</td><td>15</td><td>20</td><td>6</td></tr>
<tr><td>20</td><td>Pl</td><td>16</td><td>22</td><td>40</td><td>50</td><td>10</td></tr>
<tr><td>30</td><td>Fdi</td><td>20</td><td>24</td><td>20</td><td>35</td><td>11</td></tr>
<tr><td>20</td><td>Lw</td><td>20</td><td>24</td><td>20</td><td>35</td><td>7</td></tr>
<tr><td>5</td><td>Pw</td><td>-</td><td>24</td><td>-</td><td>-</td><td>34</td></tr>
</table>
The Martin (1999) SI gains are in the range of the possible 10-30% gains suggested by an IFPA estimate prepared by J.S. Thrower. A rough guide used in the workshop was every 1m SI increase results in a 10% yield increase. This shift is expected to apply to the entire THLB. The Arrow IFPA has funded a $300,000 project over the next 2 yrs to improve SI estimates.

The table below shows the results of a post-workshop TIPSY analysis of the possible effects of a site index shift on green-up ages. For spruce, an anticipated 2m SI shift results in a potential 4 yr reduction for 7m green-up while for Pl an anticipated 6 m shift yields a 6 yr reduction.
<table>
<tr><th>green-up ht (m)</th><th>2</th><th>7</th><th>9</th><th>18S/22Pl</th></tr>
<tr><td>Age reductions</td><td></td><td></td><td></td><td></td></tr>
<tr><td>TIPSY analysis - spruce</td><td></td><td></td><td></td><td></td></tr>
<tr><td>(age SI 16)</td><td>15</td><td>32</td><td>38</td><td>68</td></tr>
<tr><td>(age SI 18)</td><td>13.5</td><td>28</td><td>33</td><td>59</td></tr>
<tr><td>(difference)</td><td>-1.5</td><td>-4</td><td>-5</td><td>-9</td></tr>
<tr><td>TIPSY analysis – Pl</td><td></td><td></td><td></td><td></td></tr>
<tr><td>(age SI 16)</td><td>12</td><td>26</td><td>32</td><td>104</td></tr>
<tr><td>(age SI 22)</td><td>10</td><td>20</td><td>23</td><td>58</td></tr>
<tr><td>(difference)</td><td>-2</td><td>-6</td><td>-9</td><td>-46</td></tr>
</table></td><td>(b2)
<u>stand level</u>
Vol gain – up to 50%
GU red'n (7m)– 6 yrs
min age red'n - yrs
<u>TSA level</u>
Vol gain – 34%
GU red'n (7m)– 5 yr
min age red'n - yrs
See "Summary" below.</td></tr>
<tr><td>MT 5</td><td>(b3) reduce regeneration delay;*</td><td>(b3) This potential strategy was added during the workshop. The IFPA analysis used a 2 year regen delay for all species. MLSIS indicates all areas are currently planted within an average of 1.7 years of harvest commencement. Allowing for some failures, this performance would be difficult to improve upon.</td><td>(b3) Current practice 1.7 yrs. No add'l opportunity.</td></tr>
<tr><td>MT 5</td><td>(c) using larger planting stock</td><td>(c) Current practice is to plant 410 and 415 stock types, which cost about $0.25/seedling. Fd/Lw stock is 25-40 cm tall, Pl 15 cm, and improved Sw 35 cm. Larger stock would be much more costly and is not considered practical.</td><td>(c) Current practice. No add'l opportunity.</td></tr>
</table>

* *Indicates a potential strategy that was added during the workshop.*

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
MT 5	(d) planting white pine wherever suitable;	(d) Pw would achieve 7 m green-up ht faster than Fdi or Lw. Estimate Fd/Lw 7 m green-up to be 20 yrs at SI 24 (post-workshop TIPSY indicates 18 yrs). Only want to plant rust resistant stock. The need to investigate access to improved Pw seed and green-up potential (contact Pope and Talbot re TFL 23 Pw experience) noted under "Summary of Information and Research Needs," page 75.	(d) Further info required.
MT 5	(e) fertilizing at time of planting	(e) Results are inconclusive. Need for further research noted under "Summary of Information and Research Needs," page 75. A 1 yr reduction in 7 m green-up was felt possible. It's also possible that if the fertilizer gives an initial ht growth increase there would have to be a later period of lower ht increases while the tree concentrates on root growth to balance root/stem mass. Tea bag cost is about 9¢ + 2¢ for placement = 11¢ X 1 400 sph = $154/ha. **Opportunity area of 300 ha/yr**, the area expected to be harvested in VQO and watershed zones.	(e) Limited opportunity. 1yr reduction for 7 m green-up assumed in VQO and H2O zones. Further info required.
MT 5	(f1) brushing ____ ha/yr for growth enhancement (in addition to ___ ha/yr to ensure free growing)	(f1) Brushing for growth can reduce brush impedance as well as increase survival/site occupancy. About 250 ha/yr out of 1 400 ha/yr of plantations require brushing for survival. About 40% of these sites require a 2nd brushing (100 ha/yr). Total annual brushing program is therefore 350 ha/yr. Beyond these sites, there are few other areas that would benefit from brushing treatments. Experimental trials indicate brushing may serve to reduce ht growth in favour of heavier stem growth. This is because the presence of brush forces the tree into ht growth to get above the brush. Local FG standards are 1 200 sph target and 700 sph minimum. Actual stocking at FG on these sites is about 1 000 sph. More information/assessment of the yield implications of low end stocking is needed. Noted under "Summary of Information and Research Needs," page 75.	(f1) No opportunity. Further information required.
MT 5	(f2) reduce stand voids	(f2) TIPSY OAF1 of 15% used in the IFPA analysis. The fact that only 27% of the TSA falls within the THLB indicates more rugged terrain and would suggest that 15% is appropriate. An OAF survey technique which can be done in conjunction with regen surveys is now available to help improve OAF estimates. Would have to be a statistically valid sample in order for info to be accepted for TSR process. Data could build up over time in conjunction with regen surveys and at some point remaining data gaps could be filled in with a focussed survey program. **A retrospective OAF1 survey program of areas harvested over the past 20 years is proposed**. Need to investigate use of OAF surveys noted under "Summary of Information and Research Needs," page 75.	(f2) No opportunity. Surveys required.

* *Indicates a potential strategy that was added during the workshop.*

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
MT 5	(g) spacing ____ ha/yr of pine stands (priority - those subject to repression); (h) spacing ____ ha/yr of Douglas-fir stands (priority – those subject to seasonal moisture deficits); and	(g-h) No Pl repression problem in the TSA. Season moisture deficits were not discussed. The min age criteria used in the IFPA analysis was 25cm avg. DBH or 150 m3/ha stand vol. The DBH criterion is high compared to the other TSA's in the region and resulted in very high min ages for poor sites (see Figure 6, page 20). Because it is likely that the model selected poor sites to satisfy older forest requirements, this may result in an over-estimate of LTHL if older forests over a range of site productivity are in fact desired. Spacing can be used to achieve min harvestable stem sizes earlier. TIPSY indicates spacing Pl stands from 3 000 sph down to 1 600 sph can reduce time to 22.5 cm stand avg DBH by 14 yrs and by 25 yrs if spaced to 1 200 sph (see Table 1, page 62). TIPSY indicates the MAI of the spaced stand to be slightly higher than that of the unspaced stand when spaced to 1 600 sph and about 9% lower when spaced to 1 200. Greater min age reductions are obtained for Fdi and spruce when spaced from 3 000 sph to 1 200 sph (24 yrs and 41 yrs respectively at 17.5 cm DBH util.), again with no loss in MAI. Spacing can have a role in filling the age class gap, however the stands in the age classes immediately following the gap are not themselves in great abundance and therefore limit the opportunity to lower their minimum ages to bring volumes forward to help fill the mid term shortfall. (see Figure 5, on page 19). The IFPA analysis (see Figure 6, page 20) indicates a 10 yr reduction in all minimum harvest ages has no effect on the harvest forecast. Spacing, therefore, is best looked upon as a means to improve overall timber availability and to improve stand quality (see also strategy Q1 – page 59).	(g-h) stand level Vol gain – 0% GU red'n – 0 yrs min age red'n - 14-41 yrs TSA level Vol gain – 0% GU red'n – 0 yr min age red'n - ___yrs See "Summary" below.
MT 5	(i) repeat fertilize _____ ha/yr on a 15 yr return cycle (increase).	(i) On a long term steady state basis, 50% of the species (Fdi & Pl) on 65% of the site classes could be suitable for a multiple fertilization regime (¼ G, all M & ¼ P site calculated on an adjusted SI basis of 30% of THLB being good, 55% M and 15% P). About 40% of this is considered available for treatment, the primary reason for unavailability being the large area in watersheds. More difficult access areas are already netted out on a species basis, with most inaccessible areas being spruce. This equates to (.50 X .65 X .4=) 13% of the THLB. This could be reduced further to 10% to allow for possible fisheries concerns. (Fertilizer is added directly to the Arrow Lakes to improve nutrient levels for fisheries management purposes under the Fish and Wildlife Branch's Compensation Program. The need to check with F&W re fertilizer effects noted under "Summary of Information and Research Needs," page 75.) 10% of THLB ≅ 20 000 ha. On a 15 yr return cycle, **this requires a program of (20 000/15 =) 1 250 ha/yr**. Estimated cost at $200/ha = $0.25 million/yr. Probably 3 applications would be required, with the first occurring after juvenile spacing. Each application is estimated to add 15 m3/ha of growth, so 3 applications yields an additional 45 m3/ha. This is a 20% volume gain on a base stand yield of 250 m3/ha. A 20% volume gain across 10% of the THLB would increase long term harvest levels (0.2 X 0.1 =) 2%. Guesstimate in the workshop that a repeat fert program giving a 20% stand level volume gain would alternatively enable at least a 15 yr stand level reduction in min ages. Post workshop TIPSY review indicates about a 10 yr gain for Pl SI 22, 1600 sph. If this were applicable across 10% of the THLB, would be a 1 yr min age reduction. See MT5 (g-h)	(i) stand level Vol gain – up to 20% GU red'n – 0 yrs min age red'n - 10 yrs TSA level Vol gain – 2% GU red'n – 0 yr min age red'n - 1 yr See "Summary" below.

* *Indicates a potential strategy that was added during the workshop.*

<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>for harvest forecast implications.</td><td></td></tr>
<tr><td>MT 5</td><td>SUMMARY</td><td>The following summarizes the estimated effects of strategy MT5. Effects at the TSA level are prorated based on the opportunity area as a percentage of the TSA's THLB. Totals are estimated using best judgement with respect to potential overlapping effects. The volume gain in the form of larger logs and the min age reductions cannot both be captured at the same time. (However, a volume gain in the form of a higher MAI and therefore a higher LTHL can occur at the same time as a min. age reduction.) Benefits must be allocated to one or the other based on TSA need.
<table>
<tr><th>Strategy</th><th colspan="2">Volume Gain (%)</th><th colspan="2">Green-up age red'n(yrs)</th><th colspan="2">Min Harv. Age red'n(yrs)</th></tr>
<tr><th></th><th>Stand</th><th>TSA</th><th>Stand</th><th>TSA</th><th>Stand</th><th>TSA</th></tr>
<tr><td>(a) incr. site prep</td><td></td><td></td><td colspan="2">no opportunity</td><td></td><td></td></tr>
<tr><td>(b1) improved seed</td><td>25</td><td>6</td><td>1</td><td>0.5</td><td>10</td><td>5</td></tr>
<tr><td>(b2) site index</td><td>up to 50</td><td>34</td><td>6</td><td>5</td><td colspan="2">not assessed</td></tr>
<tr><td>(b3) regen delay</td><td></td><td colspan="3">current practice – no add'l opportunity</td><td></td><td></td></tr>
<tr><td>(c) large stock</td><td></td><td colspan="3">current practice – no add'l opportunity</td><td></td><td></td></tr>
<tr><td>(d) plant Pw</td><td></td><td colspan="3">potential opportunity - further info required</td><td></td><td></td></tr>
<tr><td>(e) fert at planting</td><td>-</td><td>-</td><td>1</td><td>1</td><td>-</td><td>-</td></tr>
<tr><td>(f1) brush for growth</td><td></td><td></td><td colspan="2">no opportunity</td><td></td><td></td></tr>
<tr><td>(f2) reduce voids</td><td></td><td colspan="3">no opportunity – further info required</td><td></td><td></td></tr>
<tr><td>(g) (h) spacing</td><td>0</td><td>0</td><td>0</td><td>0</td><td>14-41</td><td>no calc</td></tr>
<tr><td>(i) repeat fert</td><td>20</td><td>2</td><td>0</td><td>0</td><td>10</td><td>1</td></tr>
<tr><td>Total</td><td>60?</td><td>40?</td><td>8</td><td>6.5</td><td>35+?</td><td>20?</td></tr>
</table>
Conclusion: the objective of reducing green-up ages by 8 yrs (VQO) and 10 yrs (watershed) is marginally attainable, depending largely on the outcome of site index estimation studies.</td><td>5. Summary
Significant improvement in timber availability (see Figure 10, page 22).</td></tr>
<tr><td>MT 6</td><td>6. Set up stands presently 60 – 100 years old for future partial harvesting/ commercial thinning in the VQO and watershed zones by:
(a) commercial thinning to recover small diameter products; and
(b) repeat fertilizing ____ ha/yr.</td><td>6. Stands presently 60 – 100 years old will be 110 – 150 years old 50 years from now. Figure 5, page 19, illustrates that there will be many stands in this age group at that time. Those that are unavailable for harvest will be candidates for commercial thinning or partial harvesting. This potential strategy is about using silviculture now to prepare such stands for either treatment. Workshop participants felt very few stands presently 60 – 100 years old present such opportunities. While some stands will be amenable to partial harvesting, very few are suitable for fertilization to prepare them for either partial harvesting or commercial thinning. The fertilization problem is again a matter of stand density and small live crowns which is discussed under ST2.</td><td>6. No opportunity.</td></tr>
<tr><td>MT 7</td><td>7. Increase the area satisfying older forest biodiversity requirements in decades 8-13 by achiev-</td><td>7. At this time, it is probable but not certain that old growth requirements will be constraining mid term harvest levels. Spacing and fertilizing younger existing stands will aid in the recruitment of stands having older forest attributes at earlier ages. No additional opportunities were identified beyond those under MT3/MT5. Some MT3 stands may have to be</td><td>7. Await results of IFPA studies.</td></tr>
</table>

* *Indicates a potential strategy that was added during the workshop.*

<table>
<tr><th>Number</th><th>Potential Strategy/Action</th><th>Discussion / Current Status</th><th>Anticipated Result</th></tr>
<tr><td></td><td>ing the desired stand characteristics by 100 years of age by:
(a) spacing ____ ha/yr; and
(b) repeat fertilizing ____ ha/yr.</td><td>reserved for older forest purposes. Presume that if these stands are not available for this purpose, harvest levels would be at risk of further reduction to accommodate older forest biodiversity needs.
The IFPA is funding studies to help determine the desired structural characteristics of older forests. Once these studies are complete, silviculture can potentially then be used to help achieve the desired characteristics.</td><td></td></tr>
<tr><td></td><td>Mid Term Harvest Forecast Summary</td><td>
<table>
<tr><th>Potential Strategy #</th><th>Effect</th></tr>
<tr><td>MT1 Late rotation fert.</td><td>3 000 m3/ha. Improves availability</td></tr>
<tr><td>MT2 Repeat fert stands 21-60 yrs old</td><td>No opportunity</td></tr>
<tr><td>MT3 Reduce min ages of stands 1-20 yrs old by:</td><td></td></tr>
<tr><td>(a) brushing for growth</td><td>No opportunity</td></tr>
<tr><td>(b)(c) spacing</td><td>Improves availability. Sets up stands for fertilization.</td></tr>
<tr><td>(d) repeat fertilizing</td><td>Improves availability.</td></tr>
<tr><td>MT4 Investigate stocking levels</td><td>Surveys required. 20-30% potential gain in age classes 2 & 3</td></tr>
<tr><td>MT5 Achieve 8-10 yr earlier green-up</td><td>Significant improvement in availability. Potential for 30-40% volume gain. See MT5 summary.</td></tr>
<tr><td>MT6 Prep 60-100 yr old stands for PH/CT</td><td>No opportunity.</td></tr>
<tr><td>MT7 Increase area in older forests</td><td>Await results of IFPA studies.</td></tr>
</table>
</td><td></td></tr>
<tr><td></td><td>Conclusion</td><td>The mid-term shortfall is likely to remain at about the IFPA forecast level. There are, however, significant opportunities to increase timber supply availability.</td><td></td></tr>
</table>

---

* *Indicates a potential strategy that was added during the workshop.*

8.2.4 *Long Term (81+ 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. Maintain the THLB by
(a) Planting ____ ha of backlog NSR; and
(b) Maintaining ____ ha of existing backlog plantations.</td><td>1. As of June, 1999 there are 1 813 ha of backlog NSR in the ISIS database. Approximately 565 hectares of this is inaccessible or uneconomic to treat. Of the remainder, 1/3 is assumed untreatable, 1/3 is assumed stocked and 1/3, or about 400 ha, is assumed to be treatable. It appears there is about 1 000 ha that are included in the IFPA base case that have since been determined or assumed to be untreatable. Base case LTHL may therefore be overstated by about 0.5%.
(a) Most of the backlog NSR has been treated or reclassified. The 400 remaining treatable ha requires **a program of fill-planting 100 ha/yr for the next 4 years** to achieve free growing.
There is the possibility that areas currently classed as SR may fall back into NSR. **A survey program of 2 000 ha/yr is needed** to monitor regeneration on areas harvested pre-1987.
(b) About 50% of recently planted backlog area will require brushing (total 200 ha, but firm estimate not available).
<table>
<tr><th></th><th colspan="4">Area (ha)</th></tr>
<tr><th></th><th></th><th colspan="3">Brush</th></tr>
<tr><th>Year</th><th>Plant NSR</th><th>New Plnt'n</th><th>Existing</th><th>Total</th></tr>
<tr><td>1</td><td>100</td><td></td><td>50</td><td>50</td></tr>
<tr><td>2</td><td>100</td><td></td><td>50</td><td>50</td></tr>
<tr><td>3</td><td>100</td><td></td><td>50</td><td>50</td></tr>
<tr><td>4</td><td>100</td><td></td><td>50</td><td>50</td></tr>
<tr><td>5</td><td></td><td></td><td></td><td>0</td></tr>
<tr><td>6-10</td><td></td><td></td><td></td><td>0</td></tr>
</table></td><td>1. (a) (b) Base case potentially overstated by 0.5%.</td></tr>
<tr><td>LT 2</td><td>2. Increase the THLB by:</td><td>2. Following are IFPA/TSR2 netdown figures. Net THLB ≅ 201 500 ha
<table>
<tr><th></th><th>Area (ha)</th><th>%THLB</th></tr>
<tr><td>(a) Decid</td><td>8 300</td><td>4.0</td></tr>
<tr><td>(b) Non-merch</td><td>3 100</td><td>2.1</td></tr>
<tr><td>(c) Low site</td><td>1 800</td><td>1.7</td></tr>
</table></td><td></td></tr>
</table>

* *Indicates a potential strategy that was added during the workshop.*

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
LT 2	(a) converting /rehabilitating 100 ha/yr of deciduous stands; (increase)	(a) MoELP considers these areas as valuable towards meeting biodiversity objectives and would object to them being changed to coniferous species. General consensus (MoELP rep absent at the time) was to consider ¼ of these sites (about 2 000 ha) as eligible for conversion to coniferous species. This equals about 1% of the THLB. **A program of 100 ha/yr over 20 years is required**. See also ST1.	(a) 1% LTHL gain.
LT 2	(b) converting/rehabilitating non-merchantable stands; (increase)	(b) See ST1.	(b) Possible opportunity. Further info required.
LT 2	(c) assessing _______ ha of low-site stands for proper classification; or	(c) Workshop participants were unfamiliar with the location and actual condition of these sites. MoF will produce a thematic map highlighting these areas for review by participants. Noted under “Summary of Information and Research Needs,” page 75.	(c) Further info required.
LT 2	(d) improve the site productivity of low-site stands by (fertilization?). (increase/maintain)	(d) Needs to await results of LT 2 (c).	(d) Not applicable.
LT 2	(e) rehabilitating 500 ha fume kill area.	(e) There are substantial areas of fume kill around the trail smelter. Much of this is private land. Crown areas are mostly classed as NC Brush. The Arrow IFPA has already identified the potential for rehabilitation and proposes a 2 year **test of 100 ha/yr** of rehabilitation to be evaluated for further potential once completed. Assume will continue at the rate of 100 ha/yr for 5 yrs.	(e) 0.25% LTHL gain.
LT 2	(f) recovering area in permanent access structures.	(f) The IFPA netdown process removed 3 900 ha and 11 900 ha of existing and future roads respectively. General factors were 3% reduction of THLB for roads, 3% for trails and 2.4% for landings. This occurs over a 40 year period. A rehabilitation program of 150 ha/yr would recover half of the area deducted for future roads, or 6 000 ha in total. This would increase the THLB by 3%.	(f) 3% LTHL increase.
LT3	3. Increase regenerated stand volumes by, in addition to those practices in MT 5: (a) managing stocking so voids do not account for more than 10% of the area (increase); and (b) repeat fertilize _____ ha/yr on a 15 yr return cycle (increase).	3. These subjects were covered together with the related activities under MT 5. See MT 5.	3. See MT 5. Potential total volume gains of about 40%, largely due to improved site index estimates and tree improvement.

* *Indicates a potential strategy that was added during the workshop.*

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
LT 4	4. Reduce losses to root rot by: (increase) (a) pushover logging / stumping _____ ha/yr; (b) planting alternate species on ______ ha/yr; (c) pop-up spacing on _____ ha/yr; or (d) small diameter spacing.	4. IFPA analysis used standard TIPSY OAF2 factor of 5%. OAF2 can be broken down to 3% decay and 2% waste/breakage. Workshop estimate of losses to root rot made as follows. Root rot affects 60% of the THLB. Of this, 20% is serious infection so (.6 X .2 =) 12% of THLB is seriously infected. If the volume loss of the seriously infected stands is 20% then total volume loss at the TSA level associated with serious infection is (.12 X .2 =) 2.4%. This 2.4% is within the 3% decay allowance of a 5% TIPSY OAF2. If the TIPSY OAF2 decay allowance was considered to cover endemic/less serious losses, then an OAF2 of (5 + 2.4 =) 7.4% would be appropriate. Given the significant presence of root rot in the wet belt, a higher OAF2 would appear warranted. However, root rot also contributes to stand voids which are estimated through TIPSY OAF1, and it was unclear in the workshop as to how the two OAF factors interact. Due to a lack of time in the workshop, the potential activities (a) to (d) were not individually reviewed. Participants noted basic silviculture prescriptions are oriented to minimizing root rot impacts but that treatment options are limited by steep terrain, rockiness, etc. The need for further study of root rot management techniques and improved OAF2 estimates (investigate Invermere methodology) is noted under “Summary of Information and Research Needs,” page 75.	4. Basic silviculture obligation. Being actively pursued. OAF2 estimate requires verification.
LT 5	Maintain healthy forests and reduce timber losses by reducing risk of:		
	(a) mountain pine beetle attack;	(a) Workshop discussions did not identify a silvicultural opportunity related to mountain pine beetle management. The need to investigate effects of juvenile spacing on mountain pine beetle resistance noted under “Summary of Information and Research Needs,” page 75.	(a) No opportunity.
	(b) spruce leader weevil attack; and	(b) Some spruce leader weevil damage is presently occurring. Has the potential of being a major problem in the future. Current preventative strategy is to plant mixed species. No other strategies proposed.	(b) No opportunity.
	(c) white pine blister rust.	(c) No silvicultural activities proposed. White pine is generally < 30% of stand composition. Some Pw pruning has been done in association with spacing. Natural white pine may also be pruned as part of a basic silviculture obligation when it is needed to meet free-growing obligations. See also “Opportunities to Improve Timber Quality,” page 58.	(c) No opportunity.

** Indicates a potential strategy that was added during the workshop.*

Number	Potential Strategy/Action	Discussion / Current Status	Anticipated Result
LT 6	6. Manage some old IU logged areas for multiple non-timber values.	6. 20 –30 years ago, timber was harvested to intermediate utilization (IU) standards. Harvested areas were generally left for natural regeneration and consequently have poor residual stocking in brushy areas. About 3 000 ha of such areas are within riparian reserve and management zones. If these areas were rehabilitated, they could be managed for old-growth as well as riparian values. Moving old growth management areas into the riparian zone and managing for both values on the same area could be less restricting on timber harvests than if both values were managed for on separate areas. Evaluating this potential requires the following process: 1. Map environmental net-down areas; 2. Overlay past harvesting; 3. Identify those areas of past harvesting that are no longer available for future harvesting (e.g., in riparian reserve zones) and that would be suited to managing for multiple values; 4. Identify those existing environmental net-down areas that could subsequently be released for timber harvesting under IRM management. 5. Through modelling analysis, determine the cost-benefit of rehabilitating past harvested areas and managing for multiple non-timber values (cost) vs increased timber availability gained elsewhere (benefit). Some sites may meet the stand structural requirements as they are now. Others would likely require rehabilitation. Rehabilitation costs are estimated to be: - site prep - $800/ha - planting - $800/ha - brushing - $800/ha. Up to 3 brushings may be required. Overall cost may be between $2 400 (1 brushing)and $4 000 (3 brushings) per ha. **Initially a small trial of 100 ha/yr could be undertaken.** The need for further evaluation of this potential strategy is noted under “Summary of Information and Research Needs,” page 75. This can be done under an IFPA-funded UBC project looking at habitat and silviculture strategy linkages.	

---

* *Indicates a potential strategy that was added during the workshop.*

Number	Potential Strategy/Action	Discussion / Current Status		Anticipated Result
	Long Term Harvest Forecast Summary	Potential Strategy #	Effect	
		LT1 Backlog NSR	Base case potentially overstated by 0.5%.	
		LT2 Increase the THLB		
		(a) convert 2 000 ha decid	1% LTHL gain	
		(b) rehab non-merch	further info required	
		(c) assess L site classifications	further info required	
		(d) fert L site stands	not applicable	
		(e) rehab 500 ha fume kill	0.25% LTHL gain	
		(f) recover perm. access structures	3% LTHL gain	
		LT3 Incr. regenerated stand vol's	Potential 40% LTHL increase from better site index estimates & tree improvement.	
		LT4 Root rot	OAF2 estimate requires verification. Base case potentially overstated by 2 –3%.	
		LT5 Reduce timber losses to:		
		(a) mountain pine beetle	no opportunity	
		(b) spruce leader weevil	no opportunity	
		(c) white pine blister rust	no opportunity	
		LT6 Manage old IU areas	Modelling analysis required.	
	Conclusion	Small gains may offset small reductions. Largest variable is the potential 40% increase associated with site index and tree improvement. Because such gains are probable but the estimates are highly uncertain, an interim target of recovering LTHL to today's level is reasonable until such time as better information is available.		

* *Indicates a potential strategy that was added during the workshop.*

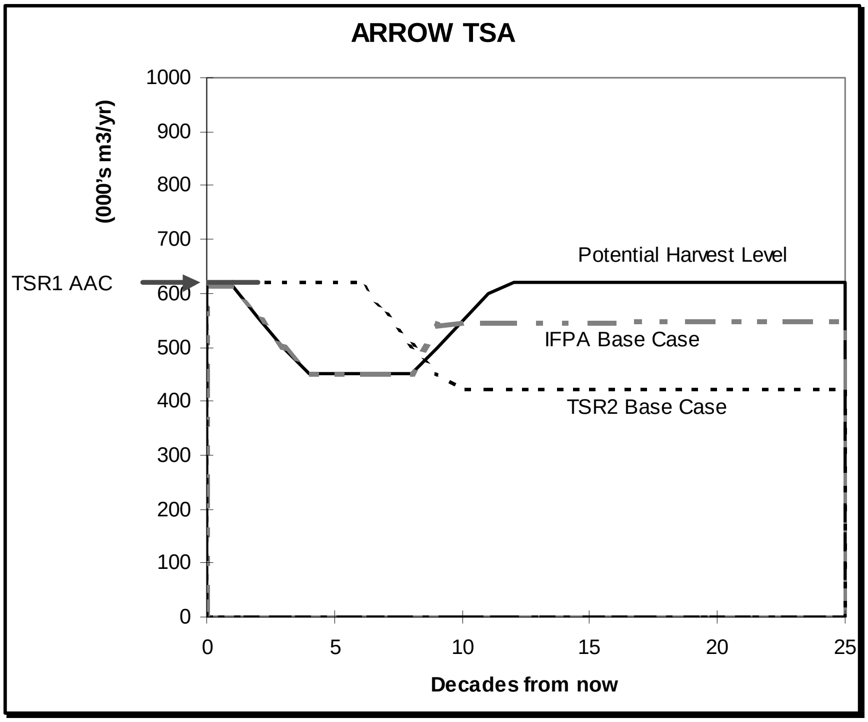
8.3 Potential Harvest Forecast

Workshop and post-workshop analyses indicate the following potential harvest forecast for each time period.

Short Term	Opportunities were identified that will improve overall timber availability. The short term harvest forecast can be expected to be similar to the IFPA forecast. Increased availability improves the likelihood that this forecast is attainable.
Mid Term	The mid-term shortfall is likely to remain at about the IFPA forecast level. There are, however, significant opportunities to increase timber supply availability.
Long Term	Small gains may offset small reductions. Largest variable is the potential 40% increase associated with site index and tree improvement. Because such gains are probable but the estimates are highly uncertain, an interim target of recovering LTHL to today's level is reasonable until such time as better information is available.

Figure 22 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 modelling and analysis. It also includes silvicultural activities that are not within the traditional scope of incremental silviculture. Modelling may indicate more precise timing, targeting and program levels associated with incremental silviculture activities than could be developed in this interim strategy.

Figure 22. Potential harvest forecast, Arrow TSA



9. Opportunities to Improve Timber Quality

The effects of incremental silviculture on the future quality of the timber resource are not analyzed in the timber supply review or the IFPA analysis. Information in this section was gathered during the district workshop.

9.1 Product Objectives

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

Quality Class	Species	Characteristics
Premium Log:		
Peelers	All	35+ cm DBH, clear, 5 m log, min 20 cm top.
Building Log	Douglas-fir, larch, lodgepole pine, spruce	42.5+ cm DBH, straight, low taper, minimal twist, min 9 m log, min 27.5 cm top
Poles	western redcedar	27.5+ cm DBH, 13 m log, straight, min 10 cm top, no rot.
Large logs*	All	42.5+ cm DBH, 5 m log
White pine*	western white pine	22.5+ cm DBH, tight knots.
Sawlog:*	All except lodgepole pine	27.5+ cm DBH.
	lodgepole pine	22.5+ cm DBH.

***** Values are enhanced when “clear” of knots.

9.2 Potential Strategies by Response Time Frame

The following strategies have potential to increase timber quality. These were reviewed in the district workshop. The response time frame is the period in which the anticipated result is expected, <u>not</u> the period in which actions must necessarily commence.

Response Time Frame	Potential Strategy/Action	Discussion / Current Status	Anticipated Result / Premium Log Forecast
Short Term (1 - 20 yrs)	None	Short term harvests will come from existing older stands which are not treatable to improve quality.	Quality profile of existing old growth will prevail. Assume this is equal to a recent coast-wide estimate of 15%.
Mid Term (21 - 80 yrs)	Q1. space ____ ha/yr to increase average stand $DBHg_{all}$ from ___ cm to ___ cm.	Current spacing program is 150 ha/yr, but this includes catch-up spacing on older stands and in fire areas. Normal regimes for naturally established stands are to space when density exceeds 3 000 sph and to leave unspaced where densities are below 3 000 sph. In the IFPA analysis, planted stands are established at 1 200 sph (workshop participants say they plant 1 400 sph) and assumed to not require spacing. An analysis of large logs was prepared based on a district indication of a possible spacing program of 600 ha/yr. See “Large Premium Log Analysis,” page 61, and Table 1 through Table 3 below. Spacing overstocked stands is a pre-requisite to other stand management practices such as fertilization, pruning and commercial thinning. There was inadequate time in the workshop to fully explore the implications of a spacing program on timber quality. No specific strategies for spacing for quality were proposed. Post-workshop, district staff indicated a strategy of spacing 400 ha/yr with a priority 4 ranking would be appropriate.[	To be approximated from large log analysis.
	Q2. 1st lift prune ____ ha/yr to 3.5 m, and 2nd lift prune ___ ha to 5.5 m.	A clear log is defined as one capable of producing 25% clear lumber by volume. Based on this definition, other than from those forests managed to very old ages, harvests from 2nd growth stands in the later mid term and long term will produce no clear logs. Max historic program has been 90 ha/yr. Currently ___ ha have been 1st lift pruned and only ____ ha’s have been 2-lift pruned. Goal is a 10 cm radius of clear wood. This requires a minimum DBH of 30 cm, preferably 35 cm. Target species are Pl, Fdi and Pw (future). An annual pruning program of 200 ha/yr each lift (= 100 ha under 2-lift regime) would equal (100/1600 ha/yr harvested =) 6.25% of THLB. If 5 m = 25% of tree vol, (.0625 X .25 =) 1.5%/yr of future harvest volume will be clear logs resulting from pruning. To get 4.5% clear by volume would need to 2-lift prune roughly 300 ha/yr (600 ha/yr total).	2¼ % clear log content across total annual harvest volume.

Response Time Frame	Potential Strategy/Action	Discussion / Current Status	Anticipated Result / Premium Log Forecast
	Q3. Plant white pine species	White pine lumber commands a premium market price. Pending the outcome of further investigation of TFL 23 experience, increasing the planting of Pw stock could be considered as part of a quality objective. See MT5 (d)	See MT5 (d)
Long Term (81 + yrs)	As above.	As above.	As above.

9.3 Large Premium Log Analysis

Three large log analyses are reported below. Each table shows at the right hand side a comparison of the effect of spacing 600 ha/yr vs not spacing any stands on the percentage by volume of the total future harvest that will be in large premium logs. This is equal to spacing just under 40% of the annual area harvested under an even-aged management system (1 400 ha/yr).

All tables were generated using TIPSY version 2.1e with standard OAF's, to a 12.5 cm utilization with Pl leading and to a 17.5 cm utilization with other species leading. Because TIPSY has no mechanism for in-growth following planting, unspaced stands were assumed to have 1 600 sph of ingrowth, and were modelled as 3 000 sph planted (1 400 sph planted + 1 600 sph ingrowth).

The tables are based on the expected future species mix derived from Table 19 of Timberline (1999). The site indices used are weighted averages from Martin (1999) and can be considered inclusive of an OGSI site index adjustment. They do not, however, incorporate gains from stand management activities proposed under the strategies to improve the quantity of future timber supply.

Table 1 illustrates the effects of spacing on achieving a technical rotation (sawlog targets of 22.5 (Pl) or 27.5 cm DBH, depending upon species) at younger ages. For example, rows 1 & 2 show that by spacing a Pl stand from 3 000 sph to 1 600 sph, a 22.5 cm DBH avg diameter target can be reached at 67 years vs at 81 years for the unspaced stand. The MAI of the spaced stand is also higher than that of the unspaced stand, indicating that spacing would also marginally increase the harvest level over time. Under the assumptions employed, even with spacing, only 1.7% (row 21) of annual harvested volumes in the long term will be large premium logs (42.5+ cm DBH).

Table 2 shows that for stands managed to younger harvest ages (Pl – 60, other species – 80), spacing increases the relative large log content by about 50%. However on an absolute basis, spacing only increases the large log content from 1.2% of future harvested volumes to 1.7%. Perhaps more significantly, in the Arrow TSA where improving availability is important, Table 2 shows spacing significantly reduces the number of smaller trees in the stand and increases those in the middle size range, while still maintaining about the same overall stand volume. For example, spacing Pl from 3 000 sph to 1 200 sph (row 1 vs row 3 reduces the # stems/ha in the 15-25 cm class by over 400 and more than doubles the # stems/ha in the 30-40 cm DBH class from 85 to 191 sph. Total stand volume at 1 200 sph is only 9 m3 less than at 3 000 sph. Similar shifts are shown for spruce stands. Similar but lesser trends are shown for Fdi stands, which appear to have a very high natural mortality rate in TIPSY. This would indicate that spacing priority should be given to over-stocked Pl and spruce leading stands over Fdi leading stands.

Table 2 shows spacing stands to low densities (i.e. to 900 sph for Pl and 1 000 sph for Fdi & S) results in noticeably lower stand volumes and MAI than in either unspaced or mid-range spaced stands. These lower density impacts disappear when stands are managed to older ages however, as shown by comparisons with Table 3. At older ages, densities would have to be lower than those shown in the tables to cause significant reductions in total stand volume.

Table 3 shows that even without spacing, managing stands to older ages substantially increases the large log content, to an estimated 7.0% of total harvested volume. Spacing 600 ha/yr raises this figure to 8.2%. This table shows MAI gains of 6-8% across all species when stands are spaced down from 3 000 sph. Table 3 also shows that, as in Table 2, spacing substantially lowers the number of trees in the smallest diameter groups and raises the number in the mid-range sawlog sizes.

Table 1. Large log (45+cm) analysis - Target harvest diameters

Spacing reduces the harvest age at the target DBH by 14 to 34 years.

Spacing can increase MAI (e.g. 4.77 when spaced to 1600 vs 4.61 unspaced). However, spacing to lower densities (i.e., to 1200 or 900 sph) decreases MAI when stands are harvested at early ages. Table 3 shows virtually no difference in MAI at these lower densities when stands are all harvested at age 90.

Target - 27.5 cm DBHg (22.5 for Pl)

Row #	Species	%inv	SI[2]	Space frm/to:	Reference			Target DBHg -all	Harv Age	Harv Ht. (m)	MAI	Total		Largest 250		DBH class[1]														Space 600 ha			No Spacing	
																0 - 10 cm		15 - 25 cm				30 - 40 cm				45+ cm				Regime	Area	5m large		5m large
					Cul Age	Cul Vol	Cul MAI					Vol	Trees	Vol	DBHg	# trees	% tot trees	# trees	% tot trees	vol	% tot vol	# trees	% tot trees	vol	% tot vol	# trees	% tot trees	vol	% tot vol	spaced	not spaced	log 3- % tot hrvst vol	Regime Area	log 3- % tot hrvst vol
1	**$Pl_5F_3S_2$**	**18**	**22**	plt3000/unspaced	73	341	4.67	22.5	81	26.5	4.61	373	1105	196	32.2	148	13	731	66	200	54	226	20	171	46	2	0	3	1			N/A	100	**0.0**
2				**plt3000/1600**	**73**	**350**	**4.80**	**22.5**	**67**	**23.7**	**4.77**	**320**	**1064**	**154**	**30.4**	**82**	**8**	**799**	**75**	**201**	**63**	**183**	**17**	**117**	**37**	**1**	**0**	**1**	**0**	**100**		**0.0**		**N/A**
3	comparison			plt3000/1200	76	354	4.66	22.5	56	20.8	4.24	237	895	122	29.2	70	8	669	75	152	64	156	17	86	36	0	0	0	0			N/A		N/A
4	comparison			plt3000/900	83	379	4.57	22.5	47	18	3.43	161	702	91	27.3	33	5	553	79	108	67	116	17	53	33	0	0	0	0			N/A		N/A
5	comparison			plt2000/unspaced	74	349	4.71	22.5	73	25	4.71	344	1104	172	31.4	110	10	786	71	199	58	207	19	141	41	2	0	3	1			N/A		N/A
6				**plt1200/unspaced**	**78**	**355**	**4.56**	**22.5**	**55**	**20.5**	**4.02**	**221**	**883**	**111**	**28.5**	**41**	**5**	**704**	**80**	**151**	**68**	**138**	**16**	**70**	**32**	**0**	**0**	**0**	**0**		**188**	**0.0**	**188**	**0.0**
7	Subtot.																													100	188		288	
8	**Fd_6S_4**	**55**	**23**	plt3000/unspaced	85	419	4.93	27.5	100	33.8	4.79	479	811	353	39.9	83	10	383	47	100	21	295	36	302	63	50	6	95	20			N/A	350	**1.1**
9				**plt3000/1200**	**85**	**443**	**5.21**	**27.5**	**76**	**28.9**	**5.15**	**392**	**760**	**261**	**37.1**	**40**	**5**	**382**	**50**	**102**	**26**	**314**	**41**	**262**	**67**	**24**	**3**	**38**	**10**	**350**		**0.5**		**N/A**
10	comparison			plt3000/1000	85	446	5.25	27.5	69	27.1	5.08	350	705	231	35.9	31	4	353	50	97	28	301	43	233	67	19	3	29	8			N/A		N/A
11	comparison			plt2000/unspaced	84	423	5.03	27.5	92	32.4	4.99	459	828	324	39.2	58	7	419	51	106	23	313	38	299	65	38	5	72	16			N/A		N/A
12				**plt1200/unspaced**	**85**	**437**	**5.15**	**27.5**	**78**	**29.4**	**5.11**	**398**	**782**	**261**	**37.2**	**28**	**4**	**414**	**53**	**111**	**28**	**313**	**40**	**255**	**64**	**25**	**3**	**41**	**10**		**530**	**0.9**	**530**	**0.9**
13	Subtot.																													350	530		880	
14	**S_6Pl_4**	**27**	**18**	plt3000/unspaced	93	343	3.69	27.5	137	30.1	3.16	432	750	263	35.6	3	0	440	59	156	36	295	39	258	60	13	2	23	5			N/A	150	**0.1**
15				**plt3000/1200**	**93**	**363**	**3.91**	**27.5**	**96**	**25.6**	**3.89**	**373**	**786**	**217**	**35.5**	**7**	**1**	**441**	**56**	**127**	**34**	**325**	**41**	**234**	**63**	**13**	**2**	**19**	**5**	**150**		**0.1**		**N/A**
16	comparison			plt3000/1000	96	371	3.86	27.5	85	23.9	3.83	326	727	195	35.0	10	1	383	53	105	32	326	45	215	66	8	1	12	4			N/A		N/A
17	comparison			plt2000/unspaced	93	357	3.83	27.5	127	29.2	3.40	432	804	252	35.8	2	0	472	59	156	36	315	39	256	59	15	2	26	6			N/A		N/A
18				**plt1200/unspaced**	**93**	**355**	**3.82**	**27.5**	**102**	**26.4**	**3.77**	**384**	**819**	**215**	**35.5**	**3**	**0**	**471**	**58**	**137**	**36**	**334**	**41**	**234**	**61**	**11**	**1**	**17**	**4**		**282**	**0.2**	**282**	**0.0**
19	Subtot.																													150	282		432	
20																																		
21	**Total**																													**600**	**1000**	**1.7**	**1600**	**2.1**

[1] Actual ranges are 0 - 12.5 cm, 12.6 - 27.5 cm, 27.6 - 42.5, and 42.6 + cm

[2] From Martin, 1999. *ISIS Polygon Area by Site Index Class*

[3] 1st 5 m log assumed to be 25% of tree volume. Volume calculated is a % of total harvest volume based on proportion of annual harvested area under a particular regime, **not** a % of stand volume.

Not a valid comparison. Unspaced stands take longer to readh target DBH and so have more large logs at these older ages.

Table 2. Large log (45+cm) analysis - Target harvest ages Pl 60 / Other species 80

Total volume falls 9 m3, about 3% below that of the unspaced stand.

# of non-merch trees is 1/6th that of the unspaced stand. Has implications for planting, visual quality, and fire hazard.

More that twice the number of mid-diameter trees having twice the percentage of total volume.

Average diameter increases 5 cm.

Over 400 fewer small diameter trees.

Target - Harvest at age 80 (Pl - 60)

					Reference				Target			Total		Largest 250		DBH class[1]														Space 600 ha			No Spacing	
																0 - 10 cm		15 - 25 cm				30 - 40 cm				45+ cm				Regime	Area	5m large		5m large
Row #	Species	%inv	SI[2]	Space frm/to:	Cul Age	Cul Vol	Cul MAI	DBHg -all	Harv Age	Harv Ht. (m)	MAI	Vol	Trees	Vol	DBHg	# trees	% tot trees	# trees	% tot trees	vol	% tot vol	# trees	% tot trees	vol	% tot vol	# trees	% tot trees	vol	% tot vol	spaced	not spaced	log 3- % tot hrvst vol	Regime Area	log 3- % tot hrvst vol
1	$Pl_5F_3S_2$	18	22	plt3000/unspaced	73	341	4.67	18.4	60	21.9	4.54	272	1517	120	27.4	367	24	1065	70	221	81	85	6	51	19	0	0	0	0			N/A	100	0.0
2				plt3000/1600	73	350	4.80	21.1	60	21.9	4.63	278	1131	127	28.6	110	10	894	79	203	73	127	11	74	27	0	0	0	0	100		0.0		N/A
3	comparison			plt3000/1200	76	354	4.66	23.3	60	21.9	4.38	263	876	138	30.3	59	7	626	71	151	57	191	22	111	42	1	0	1	0			N/A		N/A
4	comparison			plt3000/900	83	379	4.57	25.7	60	21.9	4.19	252	685	147	31.6	19	3	424	62	111	44	239	35	140	56	1	0	2	1			N/A		N/A
5	comparison			plt2000/unspaced	74	349	4.71	20.1	60	21.9	4.53	272	1267	123	28.3	187	15	967	76	207	76	112	9	65	24	0	0	0	0			N/A		N/A
6				plt1200/unspaced	78	355	4.56	23.4	60	21.9	4.23	254	875	130	29.9	35	4	660	75	154	61	178	20	98	39	0	0	0	0		188	0.0	188	0.0
7	Subtot.																													100	188		288	
8	Fd_6S_4	55	23	plt3000/unspaced	85	419	4.93	23.7	80	29.9	4.91	393	1039	259	35.8	171	16	557	54	142	36	290	28	255	65	11	1	19	5			N/A	350	0.3
9				plt3000/1200	85	443	5.21	28.4	80	29.9	5.19	415	738	283	38.1	33	4	353	48	95	23	320	43	279	67	31	4	52	13	350		0.7		N/A
10	comparison			plt3000/1000	85	446	5.25	29.9	80	29.9	5.23	418	663	290	38.8	18	3	280	42	79	19	326	49	284	68	38	6	63	15			N/A		N/A
11	comparison			plt2000/unspaced	84	423	5.03	25.1	80	29.9	5.02	402	946	263	36.5	102	11	526	56	133	33	302	32	260	65	16	2	29	7			N/A		N/A
12				plt1200/unspaced	85	437	5.15	27.9	80	29.9	5.12	410	772	272	37.7	26	3	400	52	108	26	317	41	265	65	28	4	47	11		530	0.9	530	0.9
13	Subtot.																													350	530		880	
14	S_6Pl_4	27	18	plt3000/unspaced	93	343	3.69	20.4	80	23	3.54	283	1382	146	29.7	163	12	1079	78	235	83	141	10	90	32	1	0	1	0			N/A	150	0.0
15				plt3000/1200	93	363	3.91	25.2	80	23	3.79	303	857	170	33.1	24	3	561	65	142	47	268	31	168	55	4	0	5	2	150		0.0		N/A
16	comparison			plt3000/1000	96	371	3.86	26.8	80	23	3.74	300	740	178	34.1	14	2	418	56	111	37	303	41	190	63	5	1	6	2			N/A		N/A
17	comparison			plt2000/unspaced	93	357	3.83	21.9	80	23	3.70	296	1215	149	30.6	78	6	961	79	217	73	173	14	106	36	1	0	2	1			N/A		N/A
18				plt1200/unspaced	93	355	3.82	25.0	80	23	3.69	295	880	158	32.5	14	2	610	69	151	51	254	29	150	51	2	0	3	1		282	0.0	282	0.0
19	Subtot.																													150	282		432	
20																																		
21	Total																													600	1000	1.7	1600	1.2

[1] Actual ranges are 0 - 12.5 cm, 12.6 - 27.5 cm, 27.6 - 42.5, and 42.6 + cm

[2] From Martin, 1999. *ISIS Polygon Area by Site Index Class*

[3] 1st 5 m log assumed to be 25% of tree volume. Volume calculated is a % of total harvest volume based on proportion of annual harvested area under a particular regime, **not** a % of stand volume.

Table 3. Large log (45+cm) analysis - Target harvest ages Pl 90 / Other species 140

When planned for later harvest (age 90), stands can be spaced to lower densities. In this scenario, avg DBH is increase by over 6.5 cm.

Total volume increases slightly.

Over 375 fewer small diameter trees.

Almost 3/4's of the volume is in good-sized sawlogs.

Target - Harvest at age 140 (Pl - 90)

					Reference				Target			Total		Largest 250		DBH class[1]														Space 600 ha			No Spacing	
Row #	Species	%inv	SI[2]	Space frm/to:	Cul Age	Cul Vol	Cul MAI	DBHg -all	Harv Age	Harv Ht. (m)	MAI	Vol	Trees	Vol	DBHg	0 - 10 cm		15 - 25 cm				30 - 40 cm				45+ cm				Regime	Area	5m large		5m large
																# trees	% tot trees	# trees	% tot trees	vol	% tot vol	# trees	% tot trees	vol	% tot vol	# trees	% tot trees	vol	% tot vol	spaced	not spaced	log 3- % tot hrvst vol	Regime Area	log 3- % tot hrvst vol
1	**$Pl_5F_3S_2$**	**18**	**22**	plt3000/unspaced	73	341	4.67	24.1	90	28.1	4.46	402	974	226	33.8	105	11	597	61	174	43	267	27	219	54	5	1	8	2			N/A	100	**0.0**
2				**plt3000/1600**	**73**	**350**	**4.80**	**26.1**	**90**	**28.1**	**4.62**	**416**	**863**	**235**	**34.9**	**35**	**4**	**512**	**59**	**155**	**37**	**308**	**36**	**248**	**60**	**7**	**1**	**12**	**3**	**100**		**0.0**		**N/A**
3	comparison			plt3000/1200	76	354	4.66	28.5	90	28.1	4.58	412	726	251	36.6	19	3	345	48	105	25	346	48	280	68	16	2	26	6			N/A		N/A
4	comparison			plt3000/900	83	379	4.57	30.8	90	28.1	4.55	410	623	263	37.9	7	1	219	35	69	17	373	60	303	74	25	4	37	9			N/A		N/A
5	comparison			plt2000/unspaced	74	349	4.71	25.3	90	28.1	4.53	408	918	230	34.6	59	6	557	61	161	39	295	32	233	57	8	1	13	3			N/A		N/A
6				**plt1200/unspaced**	**78**	**355**	**4.56**	**27.9**	**90**	**28.1**	**4.50**	**405**	**776**	**238**	**36.1**	**15**	**2**	**406**	**52**	**122**	**30**	**370**	**48**	**260**	**64**	**14**	**2**	**23**	**6**		**188**	**0.2**	**188**	**0.2**
7	Subtot.																													100	188		288	
8	**Fd_6S_4**	**55**	**23**	plt3000/unspaced	85	419	4.93	32.8	140	39.2	4.09	572	592	487	44.7	30	5	225	38	61	11	226	38	260	45	112	19	256	45			N/A	350	**2.4**
9				**plt3000/1200**	**85**	**443**	**5.21**	**36.7**	**140**	**39.2**	**4.27**	**598**	**504**	**518**	**46.9**	**3**	**1**	**151**	**30**	**44**	**7**	**209**	**41**	**234**	**39**	**141**	**28**	**323**	**54**	**350**		**3.0**		**N/A**
10	comparison			plt3000/1000	85	446	5.25	37.9	140	39.2	4.33	606	479	527	47.5	2	0	122	25	37	6	205	43	228	38	150	31	343	57			N/A		N/A
11	comparison			plt2000/unspaced	84	423	5.03	33.8	140	39.2	4.13	578	573	495	45.4	14	2	218	38	60	10	222	39	251	43	118	21	275	48			N/A		N/A
12				**plt1200/unspaced**	**85**	**437**	**5.15**	**35.7**	**140**	**39.2**	**4.20**	**588**	**534**	**505**	**46.6**	**3**	**1**	**180**	**34**	**51**	**9**	**221**	**41**	**237**	**40**	**129**	**24**	**298**	**51**		**530**	**4.2**	**530**	**4.2**
13	Subtot.																													350	530		880	
14	**S_6Pl_4**	**27**	**18**	plt3000/unspaced	93	343	3.69	27.8	140	30.3	3.11	436	734	268	35.8	2	0	419	57	151	35	297	40	263	60	15	2	26	6			N/A	150	**0.1**
15				**plt3000/1200**	**93**	**363**	**3.91**	**31.7**	**140**	**30.3**	**3.34**	**467**	**625**	**302**	**39.2**	**0**	**0**	**224**	**36**	**84**	**18**	**358**	**57**	**310**	**66**	**42**	**7**	**75**	**16**	**150**		**0.4**		**N/A**
16	comparison			plt3000/1000	96	371	3.86	33.0	140	30.3	3.37	471	587	313	40.2	0	0	168	29	63	13	368	63	319	68	52	9	90	19			N/A		N/A
17	comparison			plt2000/unspaced	93	357	3.83	28.6	140	30.3	3.21	449	738	273	36.7	1	0	388	53	137	31	330	45	281	63	19	3	35	8			N/A		N/A
18				**plt1200/unspaced**	**93**	**355**	**3.82**	**30.4**	**140**	**30.3**	**3.29**	**461**	**698**	**282**	**38.4**	**0**	**0**	**296**	**42**	**105**	**23**	**373**	**53**	**304**	**66**	**29**	**4**	**52**	**11**		**282**	**0.5**	**282**	**0.0**
19	Subtot.																													150	282		432	
20																																		
21	**Total**																													**600**	**1000**	**8.2**	**1600**	**7.0**

[1] Actual ranges are 0 - 12.5 cm, 12.6 - 27.5 cm, 27.6 - 42.5, and 42.6 + cm

[2] From Martin, 1999. *ISIS Polygon Area by Site Index Class*

[3] 1st 5 m log assumed to be 25% of tree volume. Volume calculated is a % of total harvest volume based on proportion of annual harvested area under a particular regime, **not** a % of stand volume.

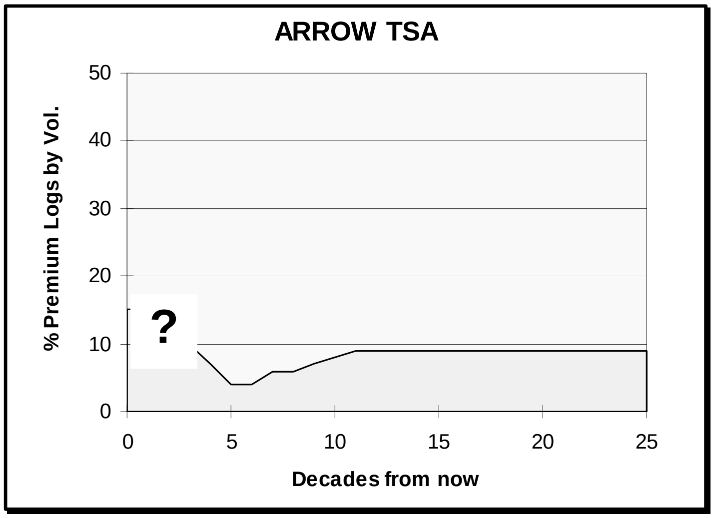
9.4 Timber Quality Forecast

The foregoing large log analysis indicates the premium log content of harvests in the mid and long term will be lower than today's levels. Premium logs will likely form 3-5% of total future harvest volume, given that the average age of harvested stands is likely to be somewhere between those used in Table 2 and Table 3. Data for the current local percentage of harvest that is in premium logs is not available, but could readily be obtained from local sawmills. In the interim it is assumed to be about 15%, the figure used in the provincial interim strategy document (MoF, 1999).

Postponing harvest to ages that are past culmination age would increase the large dimension component of premium logs, probably to between 7-10% of harvest (Table 3, page 64). Managing for older forests is a significant factor in this TSA, given the substantial forest cover requirements.

Spacing stands will increase the large premium log component of future harvests, but not to a great degree. More importantly, perhaps, spacing will make stands available for harvest earlier, increasing overall timber supply availability. Spacing Pl and spruce leading stands will also significantly shift the harvest from being mostly in a large number of small-diameter sawlogs to being mostly in mid-sized sawlogs. For Douglas-fir leading stands, the shifts are similar but much less dramatic. High natural mortality rates in the smaller diameter Fdi trees effect a natural spacing function.

Figure 23. Potential Quality Forecast, Arrow TSA



This quality forecast is for a combination of clear logs and large-premium logs. Best estimate is that large premium logs will likely form 3-5% of future harvests. With a substantial spacing program combined with harvesting at older ages, large premium logs could form 8-10% of long term harvest volumes.

Clear logs could form about 2.25% of future harvest volumes (based on pruning 300 ha/yr). Most clear logs will also be large logs. Without pruning there will be no clear logs from the majority of the 2nd growth forests.

10. Incremental Silviculture Strategy

This section synthesizes the preceding background information, workshop discussion and post-workshop analysis into a silviculture strategy for the TSA. Basic silviculture as required by the *Forest Practices Code of British Columbia Act* is assumed.

10.1 General Strategy

The IFPA base case timber supply analysis forecasts the initial harvest level (IHL) of 615 000 m3/yr can be maintained for only one decade, after which it will drop over the next several decades to a mid term low of 451 200 m3/yr starting in the 4th decade (about 27% below the IHL). The first objective of this strategy, therefore, is to minimize the anticipated reductions in short and mid term harvest levels. Workshop analysis indicates there are limited silvicultural opportunities for achieving this objective. (There are, however, other non-silvicultural opportunities that are being explored under the IFPA Forestry Plan).

The IFPA base case analysis indicates that not only is the harvest forecast to drop, but also that this forecast may be optimistic because the available timber supply is only slightly above the forecast harvest level. A secondary short and mid term objective, therefore, is to increase the overall availability of timber for harvesting, particularly over the next 100 years. Workshop analysis indicates that silviculture activities can significantly contribute to this objective.

Because of the limited silvicultural opportunities to overcome the forecast base case mid term reduction in timber supply, improving the quality of the timber to be harvested during this time period is a viable alternative. A higher quality, high value timber supply could mitigate to some extent the reduction in income and profit associated with the expected reductions in harvest levels. A mid term objective, therefore, is to improve the quality of the timber to be harvested in this time period. Programs of spacing, pruning and fertilization can accomplish this. Pending the outcome of further investigation, emphasis could be placed on cultivating rust-resistant white pine trees wherever suitable. Western white pine grows very fast, is relatively rare due to blister rust infestation and a limited growing range, and produces high value wood.

In the long term, starting about 90 years from now, workshop analysis indicates improved estimates of the productivity of forest land as well as silvicultural activities can result in harvest levels of at least equal to if not greater than current levels. The long term objective therefore is to create a timber supply capable of supporting a steady harvest level of at least 620 000 m3/yr. Workshop analysis indicates that silvicultural activities can contribute significantly to this objective.

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

10.2 Log Product Objectives

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

Quality Class	Species	Characteristics
Premium Log:		
Peelers	All	35+ cm DBH, clear, 5 m log, min 20 cm top.
Building Log	Douglas-fir, larch, lodgepole pine, spruce	42.5+ cm DBH, straight, low taper, minimal twist, min 9 m log, min 27.5 cm top
Poles	western redcedar	27.5+ cm DBH, 13 m log, straight, min 10 cm top, no rot.
Large logs*	All	42.5+ cm DBH, 5 m log
White pine*	western white pine	22.5+ cm DBH, tight knots.
Sawlog:*	All except lodgepole pine	27.5+ cm DBH.
	lodgepole pine	22.5+ cm DBH.

***** Values are enhanced when "clear" of knots.

10.3 Silviculture Strategies

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

10.3.1 Strategies to Increase the Quantity and Quality 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 72 along with investment priorities.

No.	Strategy	Priority
Surveys	Conduct approximately 6 000 ha/yr of silviculture surveys in support of all strategies.	1
Surveys	Conduct approximately 1 600 ha/yr of retrospective OAF1 surveys over a 20 year period.	1

Short Term

Objectives:

- Minimize the anticipated reductions in harvest levels.
- Increase the overall availability of timber for harvesting.

Working Targets:

- Maintain the current harvest level for at least 5 years.

Strategies:

ST2	Late rotation fertilize 400 ha/yr to produce approximately 3 000 m3/yr of additional harvest volume by the 2nd decade.	3
ST 4	Improve timber availability by achieving green-up 6-8 years earlier in existing stands aged 1-20 years in the VQO zone outside of watersheds by:	
(b)	spacing 150 ha/yr to prepare them for fertilization;	4
(e)	fertilizing 300 ha/yr to reduce time until 7 m green-up by 2 years; and	2
(d)	undertake a project to improve site index estimates with the expected result of reducing 7 m green-up ages by 5 years.	current IFPA project

Mid Term

Objectives:

- Minimize the anticipated reductions in harvest levels.
- Increase the overall availability of timber for harvesting.
- Improve the quality of the timber to be harvested.

Working Targets:

- Create a timber supply capable of supporting a minimum harvest level of at least 451 200 m3/yr.
- Generate at least 4% of total harvest volume in the later mid term in premium large logs.
- Generate at least 2¼ % of total harvest volume in the later mid term in clear premium logs (clear logs will generally also be large logs).

No.	Strategy	Priority
Strategies:		
MT1	Continue ST2: Late rotation fertilize 400 ha/yr to produce approximately 3 000 m3/yr of additional harvest volume.	6
MT3	Improve timber availability by reducing the minimum harvest ages of stands aged 1-20 years by undertaking the treatments specified in strategy ST4.	see ST4
MT5	Reduce green-up ages of about-to-be-regenerated stands by 8 years in the VQO (base case - 28 yrs to 7 m ht) zone and by 10 years in the watershed zones (base case - 34 yrs to 9 m ht) by:	
(b1)	increasing the use of improved seed with the expected result of reducing 7 m green-up ages by 2 years;	1
	forming a licensee and MoF small business program seed planning and use co-operative to lobby for more and better improved seed and to co-ordinate the use of the best available seed to greatest strategic advantage;	
(b2)	undertaking a project to improve site index estimates with the expected result of reducing 7 m green-up ages by 5 years; and	current IFPA project
(e)	fertilizing 300 ha/yr at time of planting with the expected result of reducing 7 m green-up ages by 1 year.	3
Q1	Space 400 ha/yr of existing stands aged 1 – 30 years so that at least 60% of harvested volumes in the latter half of the mid term are good quality sawlogs.	5
Q2	Prune 300 ha/yr of existing stands aged 1 – 30 years in two lifts (= 150 ha/yr X 2 lifts) to create knot-free timber in the bottom 5.0 m log.	4

LONG TERM

Objectives:

- Maximize long term timber production within a context of sound multiple resource stewardship.
- Improve the quality of the timber to be harvested.

Working Targets:

- Create a timber supply capable of supporting a steady harvest level of at least 620 000 m3/yr.
- Generate at least 8% of total harvest volume in premium large logs (no current silviculture strategy implications).
- Generate at least 2¼ % of total harvest volume in clear premium logs (clear logs will generally also be large logs).

Strategies:

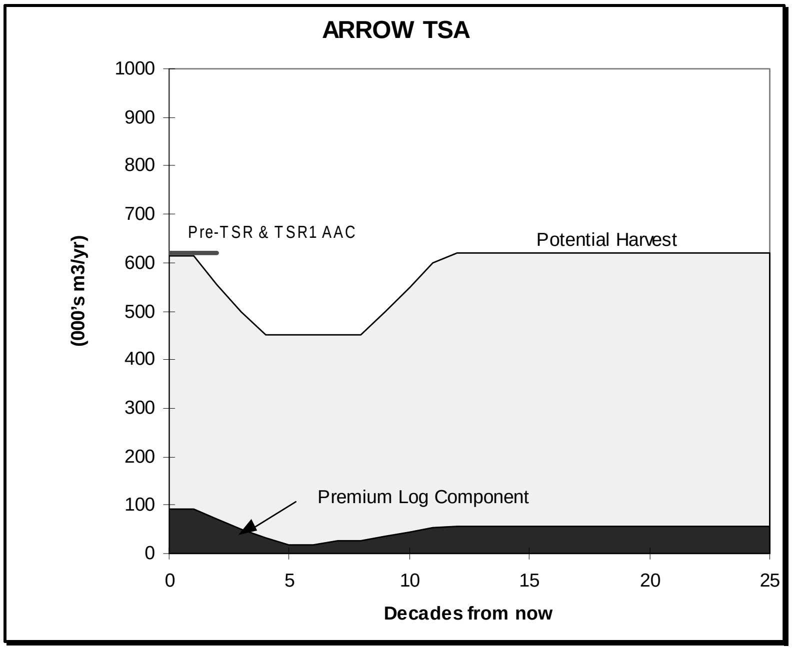
LT1 Maintain the timber harvesting land base by:

No.		Strategy	Priority
	(a)	Treating approximately 400 ha of backlog NSR.	1
	(b)	Maintaining approximately 200 ha of previously reforested backlog plantations (Assumed to be required. No estimate of actual need available).	2
	(c)	Survey 2 000 ha/yr of pre-1987 SR area to ensure they remain fully stocked.	1
LT2		Increase the timber harvesting land base by 4.25% by:	
	(a)	Rehabilitating 2 000 ha of deciduous stands (= 1% of THLB) at the rate of 100 ha/yr. (Priority based on high cost and high risk of not achieving growth rates due to opposition to use of herbicides.)	6
	(e)	Rehabilitating 500 ha of fume kill (= 0.25% of THLB) at the rate of 100 ha/yr. (Requires integrated planning and design.)	6
	(f)	Rehabilitating 3 000 ha of permanent access structures (= 3% of THLB) at the rate of 150 ha/yr. (Priority based on high cost and low anticipated yield)	5
LT3		Increase the volume of regenerated stands by 40% by:	
	(b1)	Increasing the use of improved seed with the expected near term result of a 6% gain in LTHL, with a strategic target of 20% yield gain over the long term.	1
	(b2)	Undertaking a project to improve site index estimates with the expected result of a 34% gain in LTHL.	current IFPA project
	(j)	Repeat fertilizing 300 ha/yr, rising gradually over about 60 years to 1 250 ha/yr as more stands come under management, for an expected result of a 2% gain in LTHL. (Note: The initial 300 ha/yr are the same stands as in ST 4.)	2
LT6		Rehabilitate 100 ha/yr of old IU logged areas for the purpose of managing these areas for multiple non-timber values in order to lessen timber harvesting constraints elsewhere.	7
Q1		Continue mid term Q1 strategy.	5
Q2		Continue mid term Q2 strategy.	4

10.3.2 Working Target Illustration

The preceding working targets for timber quantity and Figure 24 below incorporate an upwards adjustment for increased site productivity. Other, potentially negative influences may exist but are not specifically accounted for. The targets may require adjustment following the chief forester's TSR2 AAC determination.

Figure 24. Combined Potential Quantity and Quality Harvest Forecasts, Arrow TSA



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

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

No.	Strategy	Priority
	No specific strategies proposed at this time. See “Silviculture Regimes and Investment Priorities,” page 72 for implications of specific silvicultural activities for habitat.	

11. Silviculture Regimes and Investment Priorities

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

Activities	Strategy	Opportunity Area (Ha)	Opportunity Area (Ha/Yr)	Timber Supply Effects			Quality	Habitat	Jobs Days/ha	Cost $/ha^1	Wkshp Rank
				Short	Medium	Long					
1 Surveys (general)	all	5355 /yr	5355						0.1	32	
Survey - restrospective OAF (last 20 years)	M5(f2)	1600/yr	1600						0.1	32	2
Survey - pre 1987 SR	L1	2000 /yr	2000						0.1	32	2
2 Backlog reforestation	L1(a)	300 /5yr	60		+	+		+/-	2	925	1
3 Conversion - fume kill	L2(e)	100 /5yr	20			+		+	6	3425	7
4 Conversion - decid	L2 (a)	100 /20yr	5					-	6	3425	7
5 rehab/reforest trails and landings	L2(f)	150 /yr	150	++	++	++			4	2725	6
6 Manage for OG structure; IU logging , riparian site prep, planting,brushing	L6	100/yr	100			+		+	3	1150	8
7 improved seed	M5(b1), L3			+	++	+++	++		0	80	2
8 space existing <21 yrs i VQO not Watershed	M3(b-c),M5(g..h), S4(b..c)	150/yr	150	+	+	+	+	+/-	3.5	1130	5
9 fertilization repeat	L2, L3	300 --> 1250/yr									
10 fertilze existing <21 yrs i VQO not Watershed	M3(b-c),M5(g..h), S4(b..c)	300 /yr	300	++	+	+	+	+/-	0.1	300	3
11 fertilization stands scheduled 2nd-4th dec	S2, M1	400 /yr	400	+	+			+/-	0.1	300	4
12 fertilize at planting; VQO & Watershed	M5(e)	300 /yr	300	++	+			+	0.5	150	4
13 Pruning	Q2	300 /yr	300				++		6	725	5

Notes
Activity 1: Area of general surveys is calculated as 3x are of the incrmental silviculture program.
Activity 9,10: Initially 300 ha/yr but rising to 1250 in the steady state; assume 300 ha/yr for 5 years (Activity 10).

12. Incremental Silviculture Program

The following annualized program will contribute to achieving the above goals and strategies. This program is considerably above historic levels and some activities may require phasing in.

Program Table - Ha, Arrow TSA August 17-18, 1999

Year	Surveys*	Backlog Establish	Conversion/ Rehab	Space	Prune	Fertilize	Total
1	8,955	60	275	150	300	1,000	10,740
2	8,955	60	275	150	300	1,000	10,740
3	8,955	60	275	150	300	1,000	10,740
4	8,955	60	275	150	300	1,000	10,740
5	8,955	60	275	150	300	1,000	10,740
Subtot Yr 1 - 5	44,775	300	1,375	750	1,500	5,000	53,700
6 - 10	44,775	-	1,275	750	1,500	5,000	53,300
Total Yr 1 - 10	89,550	300	2,650	1,500	3,000	10,000	107,000

* Includes prescription and layout

Unit cost ($/ha)	32	925	2,825	1,130	725	255	

Program Table - $ 000s, Arrow TSA August 17-18, 1999

Year	Surveys*	Backlog Establish	Conversion/ Rehab	Space -	Prune -	Fertilize -	Total
1	287	56	777	170	218	255	1,761
2	287	56	777	170	218	255	1,761
3	287	56	777	170	218	255	1,761
4	287	56	777	170	218	255	1,761
5	287	56	777	170	218	255	1,761
Subtot Yr 1 - 5	1,433	278	3,884	848	1,088	1,275	8,805
6 - 10	1,433	-	3,602	848	1,088	1,275	8,245
Total Yr 1 - 10	2,866	278	7,486	1,695	2,175	2,550	17,049

13. 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, Arrow TSA August 17-18, 1999

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

Year	Surveys*	Backlog Establish	Conversion/ Rehab	Space -	Prune -	Fertilize -	Total
1	4.5	0.6	5.9	2.6	9.0	1.1	23.7
2	4.5	0.6	5.9	2.6	9.0	1.1	23.7
3	4.5	0.6	5.9	2.6	9.0	1.1	23.7
4	4.5	0.6	5.9	2.6	9.0	1.1	23.7
5	4.5	0.6	5.9	2.6	9.0	1.1	23.7
Subtot Yr 1 - 5	22.4	3.0	29.5	13.1	45.0	5.5	118.5
6 - 10	22.4	-	27.3	13.1	45.0	5.5	113.3
Total Yr 1 - 10	44.8	3.0	56.8	26.3	90.0	11.0	231.8

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

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

	Harvest Increment	Incremental Jobs	
Decade	('000 m3)	per year Region[2]	per decade Region[2]
1	(158)	(621)	(6,209)
2	(158)	(621)	(6,209)
3	(158)	(621)	(6,209)
4	(158)	(621)	(6,209)
5	(158)	(621)	(6,209)
6	(158)	(621)	(6,209)
7	(204)	(802)	(8,017)
8	(204)	(802)	(8,017)
9	(116)	(456)	(4,559)
10	(116)	(456)	(4,559)
11	(40)	(157)	(1,572)
12	(40)	(157)	(1,572)
13	(40)	(157)	(1,572)
14	(40)	(157)	(1,572)
15	(40)	(157)	(1,572)
16	(128)	(503)	(5,030)
17	(167)	(656)	(6,563)
18	(167)	(656)	(6,563)
19	(167)	(656)	(6,563)
20	(167)	(656)	(6,563)
21	(167)	(656)	(6,563)
22	(167)	(656)	(6,563)
23	(167)	(656)	(6,563)
24	(167)	(656)	(6,563)
25	(167)	(656)	(6,563)
Total			(134,367)

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 strategy development.

2. Assumes 3.93 TSA level direct (harvesting, silviculture, processing), indirect and induced (PYs) per 1000 cubic metre. (Source: TFL 23 MP #9 Timber Supply Analysis Report, p.39)

14. 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 39).

1. Before considering excluded non-merch forest types for their rehabilitation potential, first determine their role/contribution in meeting OGMA objectives. (ST1(b))
2. Compare terrain hazard mapping vs inventory ESA's to refine THLB net-down impacts. (ST1 (x1))
3. Evaluate the regeneration implications of harvesting high elevation areas as an outcome of potentially moving the operability line higher. (ST1 (x2))
4. MoF to provide a map of ESA regen areas to AFLG to review for accuracy. (ST1 (x1))
5. Evaluate the late rotation fertilization potential of smaller live-crown trees. (ST2)
6. Model the changes in sensitivity to forest cover constraints attributed to the use of large patch sizes in meeting biodiversity objectives. (ST3)
7. Investigate the stocking levels of Fdi and spruce stands aged 21-30 years and other-species stands aged 11-20 years to determine if their yields are more accurately estimated using TIPSY. (MT4)
8. Evaluate the impact of the reduction in site preparation over the past 2 decades on site productivity and stand yield estimates. (MT5 (a))
9. AFLG to form a seed planning and use co-operative is proposed for the TSA licensees to lobby for more and better improved seed and to co-ordinate the use of the best available seed to greatest strategic advantage. (MT5 (b1))
10. Investigate access to white pine seed; investigate green-up potential; connect with TFL 23 to investigate success. (MT5 (d))
11. Evaluate efficacy of fertilization at planting and impact on reducing time to reach green-up. (MT5 (e))
12. Assess low end stocking levels of regenerated stands (e.g., 1 000 sph actual vs. 1 200 sph used in IFPA timber supply analysis) for yield implications. (MT5 (f1))
13. OAF 1 factor of 15% requires confirmation. Survey techniques are available. Requires statistical validity at the management unit level if to be used for AAC determination. (MT5 (f2))
14. Confer with Fish and Wildlife Branch re Arrow Lake fertilization and effects of fertilization on fish bearing streams. (MT5 (i))
15. MoF to provide the AFLG a map of excluded low sites to review for reclassification/rehabilitation opportunities. (LT2 (d))
16. Investigate Invermere's root rot OAF2 estimate methodology and research. Further study of root rot management techniques and resultant OAF2 impact is needed. (LT4)

17. Investigate effects of juvenile spacing on mountain pine beetle resistance. (LT 5 (a))
18. Provide Daryl & UBC people with the silv strategy to take it into account in their studies/projects. Note the need to analyze the cost/benefit of silviculture expenditures to consolidate OGMA’s with old IU logged areas in riparian areas. (LT 6)

15. References

Arrow Forest Licence Group. 1999. *Forestry Plan*. Internet website http://www.arrow-ifpa.com/forestry%20plan/

B.C. Ministry of Forests. 1994. *Arrow TSA Timber Supply Analysis*. Timber Supply Branch, Victoria, British Columbia. 69p.

________. 1999. *Incremental Silviculture Strategy For British Columbia (Interim)*. Forest Practices Branch, Victoria, British Columbia. 23p.

Brockley, R.P. 1989. *Response of Thinned, Immature Lodgepole Pine to Nitrogen Fertilization: 3-year Growth Response*. FRDA Report 036. B.C. Ministry of Forests, Kalamalka Research Station and Seed Orchard, Vernon, B.C.

Hawe, Angela. 1996. *Review of Past Partial-Cutting Activities in the Nelson Forest Region (1988 - Present)*. Technical Report MIT-001, prepared for the B.C. Ministry of Forests, Nelson Forest Region, Nelson, B.C. 67p.

Martin, Patrick. 1999. *ISIS Polygon Area by Site Index Class*. B.C. Ministry of Forests, Forest Practices Branch, Victoria, B.C.

Pedersen, Larry. 1995. *Arrow Timber Supply Area Rationale for allowable annual cut (AAC) determination*. Victoria, British Columbia. 41p + Attachments.

Reichenback, Gerald. 1996. *Effect of Silviculture Practices on Greenup Delay in the Nelson Forest Region*. Technical Report MIT-003, prepared for the B.C. Ministry of Forests, Nelson Forest Region, Nelson, B.C. 39p.

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.

________. 1999. *Technical Report, Arrow IFPA Base Case Analysis Final Report*. Prepared for the Arrow Forest Licensee Group, Victoria, British Columbia. 64p.

Wang, Eric. 1999. *Personal Communication*. Timberline Forest Inventory Consultants, Victoria, BC.

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.

16. Abbreviations

The following abbreviations may be used.

AAC	allowable annual cut
AFLG	Arrow Forest Licensee Group
CF	chief forester
CT	commercial thinning
DBH	diameter at breast height
EFMPP	enhanced forest management pilot project
ESA	environmentally sensitive area
ESSF	engelmann spruce - subalpine fir (ecological zone)
FCC	forest cover constraints
FG	free growing
FRBC	Forest Renewal BC
ICH	interior cedar-hemlock (ecological zone)
IFPA	innovative forest practices agreement
IHL	initial harvest level
IRM	integrated resource management
KBLUP	Kootenay-Boundary Land Use Plan
LT	long term
LTHL	long term harvest level
LRSY	long run sustained yield
MAI	mean annual increment
MoELP	Ministry of Environment, Lands and Parks
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
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; Pw – western white pine; S - spruce species.

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