Mackenzie-Cariboo Tree Farm

TYPE I INCREMENTAL SILVICULTURE STRATEGY FOR TFL 5

Version 1.0

Funded by
Forest Renewal BC

Acknowledgments

The participation of representatives from the following organizations at the Weldwood silviculture strategy working session is gratefully acknowledged.

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Weldwood of Canada Ltd.
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Preface

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

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

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

This strategy is founded upon 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.

Strategy Summary

General Strategy

The focus of the silviculture strategy for Weldwood's TFL #5 is to aid in the improvement of premium quality sawlogs, although not at the expense of a reduction in current AAC.

Working Targets

Quantity: Manage short-, mid- and long-term timber supplies to yield a harvest of 122,800 m3/year or more.

Quality: Manage existing and future plantations to yield at least 50% premium sawlogs by volume, with the majority of the remainder being of sawlog quality. Preferred species being Douglas-fir, then white spruce and then lodgepole pine

Product Objectives

Following are the product objectives at the log level for TFL 5

Quality Class	**Characteristics**
Premium Log:	- Douglas-fir preferred to spruce, preferred to pine
	- 50% Douglas-fir by species.
	- log diameter 35 - 55 cm with little taper and no rot.
	- small tight knots (max. size 4.8 cm).
	- min. 17cm top DIB, 8.6 cm core.
Sawlog	- minimum stand diameter 22 cm and volume 200 m3/ha.

Major Silviculture Strategies

Quantity

1. Minimize stand voids in plantations.
2. Maximize the use of Class A seed.
3. Maximize the productive area of the TFL through the rehabilitation of old pastures, roads, landings and other suitable stand voids.
4. Use conifer release treatments in immature mixedwood stands.

Quality

1. Increase proportion of Douglas-fir to 50% of the TFL by volume.
2. Utilize spacing to: a) reduce plantation densities to optimize site occupancy and growth; b) set densities suitable for pruning; c) select crop trees.
3. Prune to: a) minimize knots in bottom 5.5 m of stem and to maintain juvenile wood core to 9 cm diameter or less.
4. Utilize late rotation fertilization to increase the production of mature wood approx, 10 years before harvest.
5. Experiment with commercial thinning in appropriate mature or near mature stands to increase the average diameter of the remaining crop trees.

Habitat

1. Maintain existing MDWR and OG constraints while continuing to salvage diseased or infected stems
2. Increase the proportion of Douglas-fir on the TFL

Information Requirements

The following missing information is vital to confirming or initiating the above strategies:

1. Stand density data in conjunction with an inventory update is required to aid in the selection of appropriate stands for the proposed incremental strategies.
2. Verification of Operational Adjustment Factors.
3. The area in roads, landings or other voids and to what extent they can be rehabilitated.
4. Verification of managed stand growth and yield estimates.
5. Verification of genetic gains in the field.
6. A review of the Wildlife Plan and CCLUP to ensure habitat needs are compatible with proposed silviculture strategies.
7. Implement silviculture monitoring/growth and yield programs to track the development of managed and natural stands (i.e., paired plot sampling, PSPs).

TYPE I
INCREMENTAL SILVICULTURE
STRATEGY FOR TFL 5

Table of Contents

List of Tables

List of Figures

TYPE I
INCREMENTAL SILVICULTURE
STRATEGY FOR TFL 5

1. Introduction

The Mackenzie-Cariboo Tree Farm, or TFL 5, is located within the Quesnel Forest District. Weldwood of Canada Ltd carries out forestry operations and general management of TFL 5. This Tree Farm was first awarded in 1951 to Western Plywood Ltd., the predecessor of Weldwood of Canada Ltd. The purpose of the award was to serve as a secure fibre source for an innovative venture into plywood manufacture in the interior of BC.

Since 1951, nine Management and Working Plans have guided resource development activities on TFL 5. Recent programs (post 1985) that have influenced resource management activities include:

- X Forest cover inventory
- X Fish, Forest and Wildlife Plan
- X Biogeoclimatic Ecosystem Mapping
- X Creation of Managed Stand Yield Tables specific for TFL 5
- X A 10-Year incremental silviculture program (completed in 1995)
- X Analysis into the effects of White Pine Weevil (ongoing)

The most current Management Plan for TFL 5 (MP # 9) was completed and accepted by the MOF in 1997. One of the goals committed to occur during the term of MP #9 is the creation of a new Enhanced Silviculture Strategy. This document fulfills that commitment.

This silviculture strategy is founded upon 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. An in-depth analysis-based review is referred to as a Type II Silviculture Strategy.

This strategy was prepared through the following process:

1. Industrial Forestry Service Ltd. (IFS) prepared a preliminary draft of this document, summarizing much of the available information relevant to the timber supply situation within TFL 5. Potential opportunities to improve timber quantity and quality were identified.
2. A working session was held on February 9, 2000 in Quesnel, attended by representatives from the MOF, Weldwood, MOELP, FRBC and IFS. The working session participants reviewed the potential opportunities proposed in a pre-workshop document, discussed the merits of each opportunity as it would apply to the TFL, and identified those opportunities which best suited the timber management goals of Weldwood. The outcome of the session was a regime table with identified priorities.
3. IFS incorporated the results of the working session into this document and added forecasts of future harvest quantity, quality and job outcomes.
4. After Weldwood's review of the document, a final version was completed and

provided to Weldwood in electronic format as version 1.0

1.1 TFL Issues Impacted by Silviculture

1.1.1 Timber Issues

The timber supply analysis report for TFL 5's MP # 9 and information gained from the TFL Workshop revealed that silviculture activities will play an important role in the future timber supply of the TFL. Perhaps just as importantly, these activities will have a significant effect on timber quality.

Weldwood's AAC apportionments within the Quesnel TSA are currently secured through long-term tenure with TFL 5 and replaceable Forest Licenses in the Quesnel and Prince George Forest Districts. These tenures comprise a total annual volume of approximately 611,000 m3/year. This is only 67 percent of the total volume that the plywood mill and the sawmill can utilize under full operating capacity. The shortfall must therefore be addressed through private wood purchases.

Premium sawlogs are of very high demand in Weldwood's manufacturing facilities. These facilities have a throughput requirement that demands that approximately 50-55% of the logs processed be of premium sawlog/peeler grades. To offset the shortfall in quality that currently exists, aggressive log trades are made with other Quesnel and Prince George Licensees. Also, as the combined AACs are unable to meet the operating capacity of the two plants, private purchases of as much as 400,000 cubic metres are made annually. Weldwood recognizes that current basic silviculture practices and reduced rotation ages will have a negative affect on premium sawlog supplies. Weldwood also recognizes that the high quality growing sites occurring within TFL 5 would be well suited to silviculture regimes geared to produce premium grade sawlogs.

As a result of these quality and quantity issues, silviculture activities are very important in overall strategic management considerations. Within the next 30-50 years an increasing percentage of previously harvested area will be providing second growth forests to support the Allowable Annual Cut. It is forecast that by the year 2050, 60 percent of the harvest will come from second growth managed stands. The condition of these stands both on a volume level and on a quality basis will play a critical role in the future opportunities that are available to Weldwood.

1.1.2 Habitat Issues

Approximately 70 percent of TFL 5 is found within the Lower Blackwater Special Resource Development Zone (SRDZ) (as identified in the Cariboo-Chilcotin Land Use Plan (CCLUP)). The CCLUP has identified this area as having high wildlife values, for mule deer winter range in particular. The mule deer winter range issues

were largely resolved in 1995 with a Fish, Forest and Wildlife Management Plan completed for TFL 5 by Keystone Wildlife Research. Management constraints designed to regulate mule deer habitat were incorporated into the 1997 Timber Supply Analysis for TFL 5.

At the silviculture workshop, the Quesnel District MOELP representative suggested that with the arrival of landscape unit planning, a review of this Wildlife Plan will be necessary.

Discussions relating to various incremental silviculture activities that may be pursued on TFL 5 in the future, were not a concern as a habitat issue. The indication was made that most of these activities would lend themselves to an increased diversity of habitat throughout TFL 5.

1.1.3 Employment Issues

Within the Quesnel Forest District, TFL 5 contributes only a very small part of the total harvest (i.e., ~ 5%). TFL 5's current AAC supports approximately 15 percent of the workers employed in the Weldwood sawmill and plywood mill in Quesnel. There are no major issues regarding employment other than the general goal of not reducing the current AAC. The timber supply analysis showed that a reduction in the future AAC is unlikely given current management assumptions.

1.2 Objectives of the Silviculture Program

1.2.1 TFL Objectives

Weldwood's objective for having a silviculture program implemented on TFL 5 is to improve the quality of future managed stand timber harvested on the TFL, while maintaining a harvest level that is similar to or greater than the existing AAC.

1.2.2 Provincial and Regional Objectives

Provincial objectives regarding a silviculture strategy for BC were identified in the *Incremental Silviculture Strategy Document (Interim).* Fundamentally, government's goals can be characterized as:

- X Sustainable use,
- X Community stability, and
- X A strong forest sector.

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

interim provincial strategic objectives.

Objective 1: Maintain current harvest levels as long as possible, without creating disruptive shortfalls in future timber supply.

Objective 2: Create long-term timber supply capable of supporting a steady long-term provincial harvest level similar to current levels.

Objective 3: Minimize the interim shortfall in provincial harvest anticipated before a steady long-term timber supply is achieved.

Objective 4: Create a long-term timber supply that will enable the timber quality profile of future harvests to be the same or better than the current profile.

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

Regional goals have yet to be formulated.

2. Resource Dynamics

2.1 Synopsis of the Land Based Inventory

The following tables and figures were created from data extracted from Weldwood's Management Plan #9 (July-9-1997), the Timber Supply Analysis Report, Data Package, AAC Rationale and other associated documents. They provide a qualitative and quantitative picture of the timber supply, land mass, species profile, age class distribution and forecasted growing stock.

Table 1 TFL 5 Land Area

Description	Area (ha)	Area (%)
Total Area of TFL 5	34,447	100
Total Productive Crown Forest	32,907	95.5
Net Timber Harv. Land Base	30,099	87.4

Table 2 AAC Allocation and History

AAC Type	MP 8	MP 9 [1]	Change (%)
Conventional	104,546	115,846	+10.81
Deciduous	0	1,500	∞
SBFEP	5,454	5,454	0
Total	110,000	122,800	+11.64
NRLs	2,250	1,650	-26.67

1 The current AAC was set effective December 1, 1997

Figure 1 Harvest Forecast

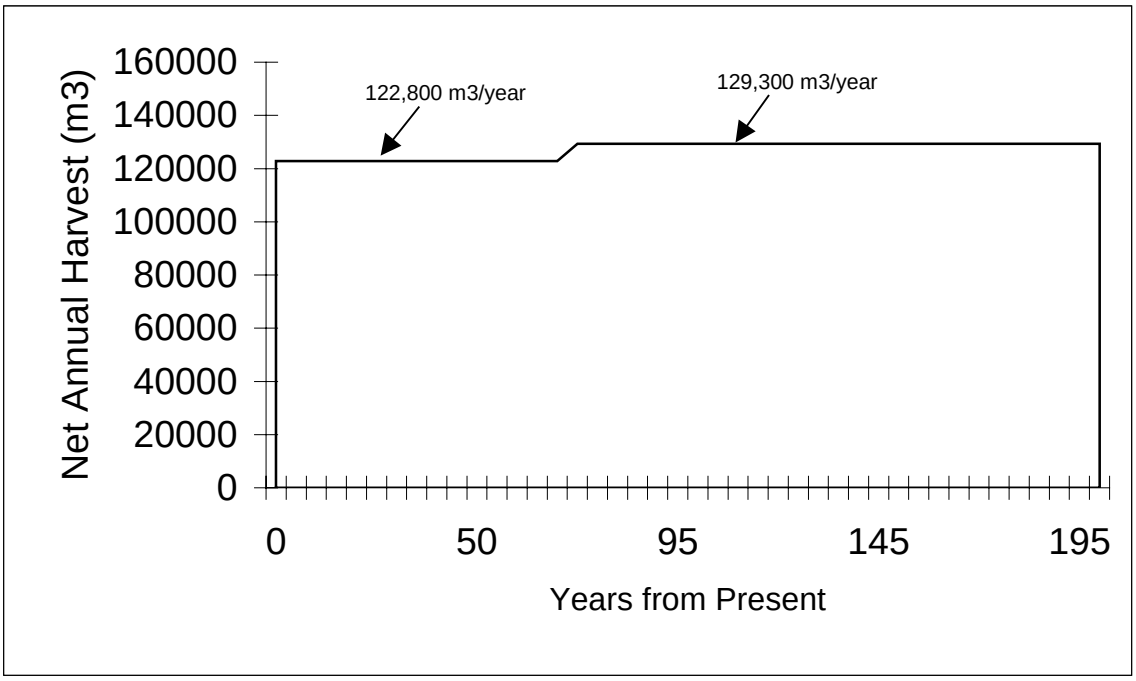


Figure 2 Change in Growing Stock Resulting from the Base Case Harvest Forecast

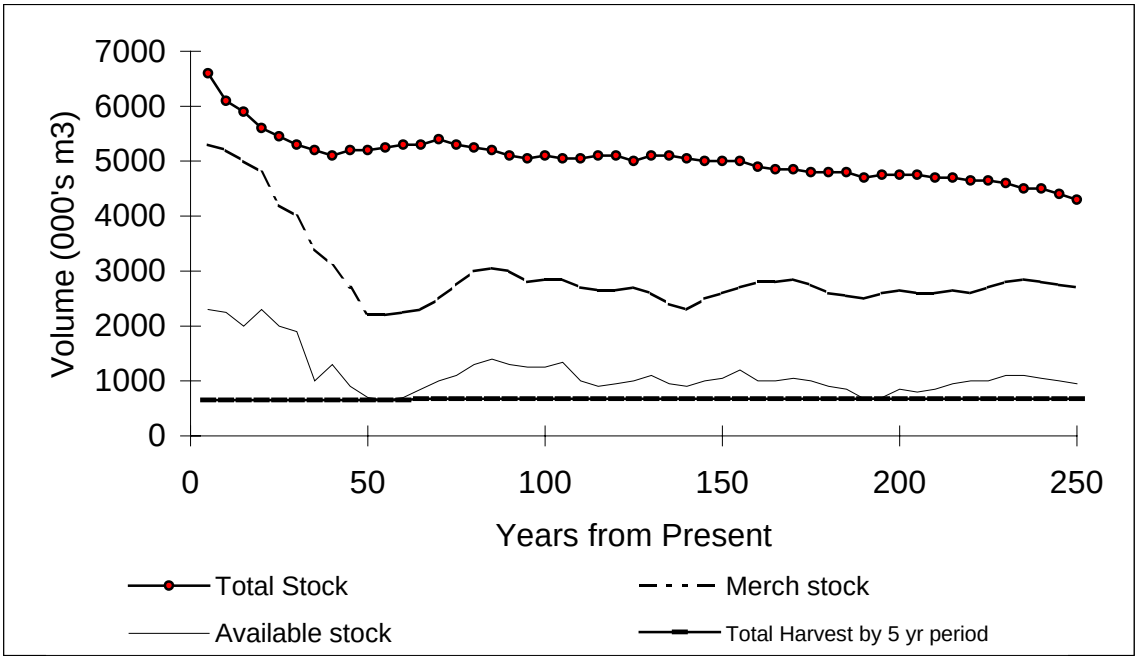


Figure 3 Current Age Class Distribution of THLB

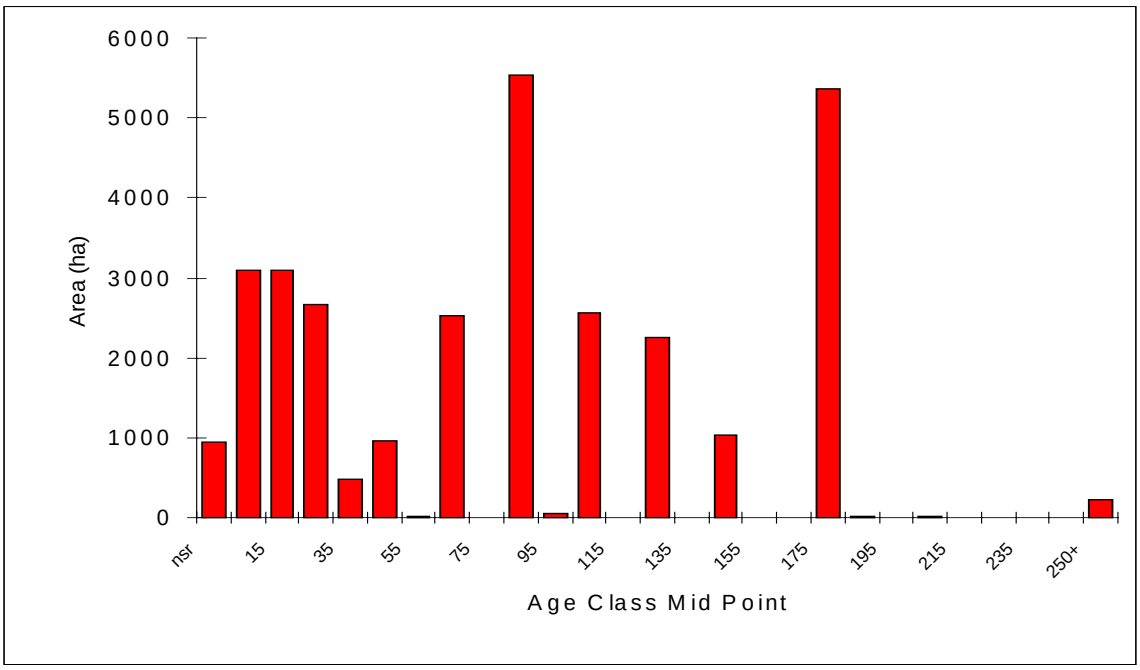


Figure 4 Age Class Distribution Forecast in 50 Years

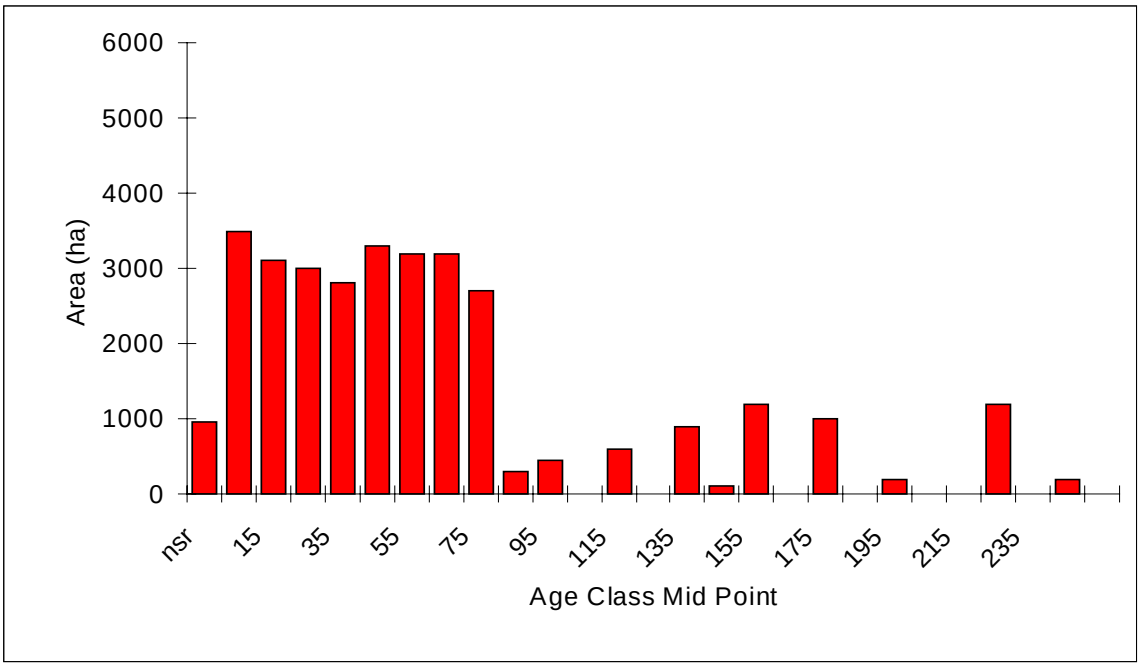


Figure 5 Current Leading Species Distribution

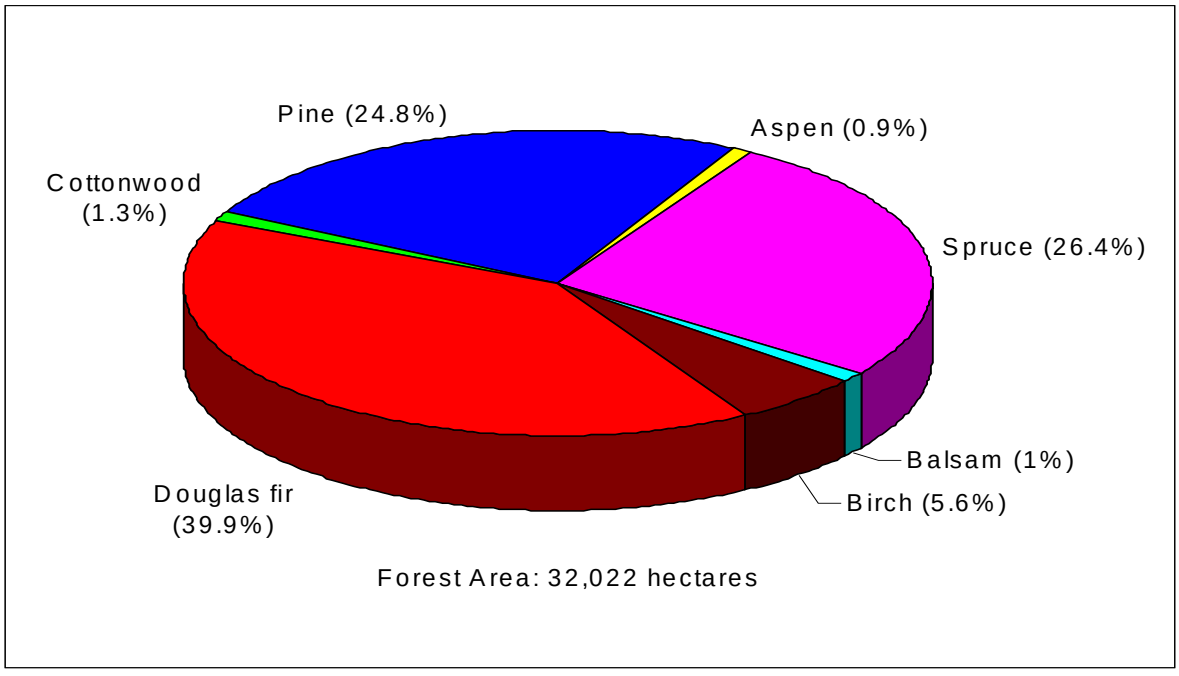


Figure 6 Mature Timber Site Class Distribution

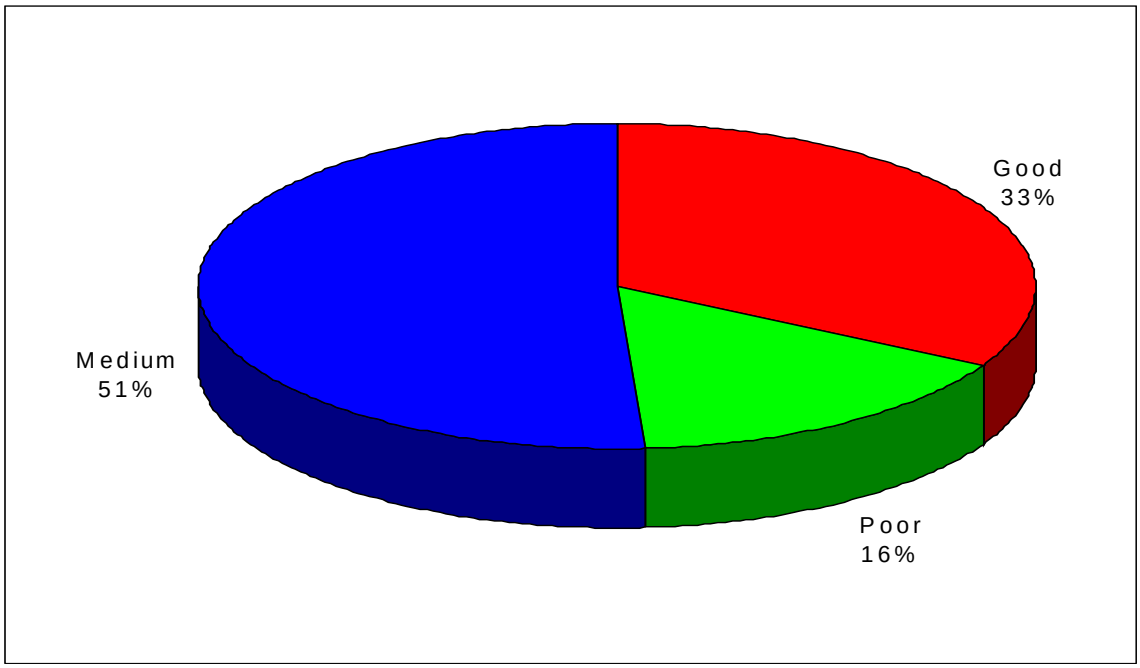


Table 3 Site Index of Existing Managed Stands by Species

Site Series	SBS mw (82% of THLB)			SBS mh (18% of THLB)		
	Fd	Pl	Sx [1]	Fd	Pl	Sx
01	21	21	21	21	21	21
02	21	21	17	21	21	17
03	21	21	17	21	21	17
04	21	21	17	21	21	17
05	21	21	17	21	21	21
06	24	22	22	24	22	22
07	24	22	22	24	22	22
08	24	22	22	24	22	22
09	24	22	22	24	22	22
10	21	21	17	21	21	17

[1] *There were insufficient opportunities for sampling Sx in site series 02,03, 04, 10 and 05 (SBS mw), thus these estimates of site index were developed as a weighted average using forest inventory data and MOF site class mid points.*

The preceding tables and figures should provide a general overview of TFL 5. Compared with the BC Central Interior, the TFL is small and consists of good and above average quality growing sites. Timber species growing here are highly suited to BC Interior processing facilities. The TFL is currently operating on a sustainable, non-declining harvest level. The limiting factor for timber supply is a shortfall in available mature timber predicted to occur in the years 2050-2060.

2.2 Timber Supply Dynamics

2.2.1 "Deconstruct" the Timber Supply Analysis Report

The following section is a review of the Timber Supply Analysis Report produced by Timberline Forest Inventory Consultants for TFL 5 in 1997. This review identifies the 'pinch points' and constraining mechanisms that shaped the timber supply forecast for the TFL. Most of the information is based upon the information provided in the Base Case "status quo" scenario. Three additional scenarios that changed land base and modeling assumptions are reported. However, the impact on the future timber supply and consideration given in the past AAC Rationale was negligible.

Harvest Forecast

The current AAC of 122,800 m3/year can be maintained for 65 years before an increase to 129,300 m3/year is sustainable as a long term non-declining harvest forecast. The current AAC reflects the Base Case Harvest Forecast presented by Weldwood in the Timber Supply Analysis Report.

As indicated in Figure 2, the critical period for mature timber availability occurs 50-60 years from the present.

Age Classes

Harvesting has occurred on the TFL since the early 1950's. Because of this harvesting, approximately 33 percent of the stands are younger than 45 years (mainly regeneration after earlier harvesting). Forty-two percent of the THLB is immature. A definite lack of stands aged 30 to 60 years is a concern from a timber supply perspective. Twenty-two percent of the area is aged 140 years and older. Much of this area is constrained in the short term for biodiversity seral stage distribution targets. Timber aged 141+ is distributed throughout the TFL, but is also heavily concentrated along the Fraser River corridor. The corridor contains much of the mule deer winter range habitat.

Forest Cover

The IRM "working forest" zone encompasses 71 percent of the THLB. Similarly

riparian management zones (RMZ) and forest corridors together contribute 9%; General mule deer winter range (GMDWR), 15% and Core MDWR, 5% of the THLB.

Within the TFL forest cover requirements were applied to the management zones in the base case as follows:

Table 4 Forest Cover Constraints

Management Zone	Constraint		
	Green up	**Mature**	**Old growth**
IRM	max. 33% < 3m	n/a	min. 10%> 120 yrs
Corridor/RMZ	max. 25% < 3m	n/a	min. 10% > 120 yrs
GMDWR	max. 25% < 3m	min. 50% > 60 yrs	min. 25% > 120 yrs
Core MDWR	Max 10 ha annual salvage harvest (160 year rotation)		

Several sensitivity tests were carried out to determine the level at which forest cover constraints influenced the harvest forecast. The tests and their results follow:

X Sensitivity test of an *additional pass* (4 pass) in the IRM zone:
Insensitive to additional pass in the short- and long-term. This was not a limiting factor in the base case.

X Sensitivity of varying *green up height* from 3 metres.
Relaxation: 2 metre green up. No impact in the short-term. Long-term harvest increase was insignificant (+0.07%).
Increase: 4 metre green up. Short-term harvest rate change was insignificant (-0.08%). Long-term rate was unaffected.

X Sensitivity of imposing *IRM constraints* over all management zones except the Core MDWR
Short-term increase of 2%. Long-term increase of 1.7%

X Sensitivity of *old growth constraints*:
Relaxation: Old Growth (OG) constraint removed in the IRM and RMZ. Short-term increase +1.3%, long-term increase +1% (Note: TSR 2 does not typically apply an OG constraint to the IRM zone)
Increase: 1) OG increased to 20% in IRM, riparian and corridor zones - 12.7% short-term decrease; 7.6% long-term decrease
2) OG increases to 30% in IRM, riparian and corridor zones. 32% short-term decrease; 16% long-term decrease.

In the AAC Rationale for TFL 5 the MOF and MOELP indicated that they believed that the allowable maximum disturbance in the Forest Corridor was too high. They

also believed that forest cover constraints in the RMZ were not restrictive enough.

Backlog NSR

Although an intensive backlog NSR reforestation program was carried out on TFL 5, 447 hectares of backlog NSR still exist on the inventory file. There is uncertainty over how much is treatable and how much has converted to a new timber type. The MOF believed that the 447 ha amount was over-estimated. During the workshop a discussion regarding this topic revealed that most of the remaining NSR exists as small slivers of land (i.e., less than 1 hectare). It was suggested that most of the NSR is only in need of a new timber type label. This might be addressed through a re-inventory of the TFL land base.

Land Base Quality

There were no coniferous problem forest types excluded from the THLB for merchantability reasons or low site quality.

Deciduous stands totaling 572 hectares were excluded from the THLB in the base case. Sensitivity analysis indicated that most of the deciduous exist within constrained management zones. The addition of previously excluded deciduous stands into the THLB resulted in a relatively insignificant increase in the harvest forecast.

Non-commercial cover (NCBr) totaling 341 ha was removed from the THLB.

Older Forests

Seral stage distribution targets were applied in the base case. As per direction from the Wildlife Plan for TFL 5, high biodiversity emphasis was applied to the SBS mh (18% of THLB) and low biodiversity emphasis was applied to the SBS mw (82% of THLB). Seral stage biodiversity targets were applied as follows:

Biogeo. Zone/subzone	Early	Mature+Old	Old
SBSmh	40%<40yr	34%>98yrs	16%>138 yrs
SBSmw	n/a	n/a	11%>133 yrs

Sensitivity tests on the impact of seral stage targets included 5 scenarios:

Relaxation:
1. Apply low biodiversity to the SBS mh. Not sensitive (+1%)
2. Remove mature seral targets. Not sensitive (+0.7 short- & long-term)
3. Remove watershed level seral stage targets. Sensitive in the short-term (+2.4% short-; +1.2% long-term)
4. Remove all forest cover constraints. Very sensitive (+15% short-term, + 11% long-term)

Increase:
5. Remove excluded forest from contributing to biodiversity. Sensitive in the short-term (- 4% short-term, -1% long-term).

In the Base Case, seral stage targets were applied to six 'watersheds', which were used as a proxy for landscape units that had yet to be defined. The workshop participants revealed that landscape unit planning in the Quesnel Forest District has designated TFL 5 as one landscape unit. This designation will provide significant upward pressure on the available timber supply.

Minimum Harvest Ages

Minimum harvest ages were defined as the culmination age for each analysis unit. Ages ranged from a low of 60 years (for Pl on "good" sites) to a high of 120 years (for Spruce on "poor" sites). Sensitivity analysis of + 10 years and minimum harvest age @ 180 m3/ha were analyzed.

Relaxation: Min. harvest @ 180 m3/ha results in a decrease in the average harvest age. Results in a +5% increase in short term, - 7% decrease in long term. Second growth stands are available for harvest earlier, however the inventory then declines as a result of harvesting before the full productive capacity of the land base is realized.

Increase: (+ 10 years) Causes a 10% drop in the short term. Insensitive in the long-term.

Silviculture Systems

The THLB is currently managed under a clear cut with reserves harvesting system. In response to concerns from previous Management Plans, a comprehensive silviculture program was implemented in 1985. The Program resulted in 2827 ha of site preparation, treatment of 1456 ha of backlog NSR, 1747 ha of brushing & weeding, 1340 ha of conifer release and 242 ha of juvenile spacing.

An intensive silviculture scenario was examined. The scenario assumed that an additional 546 ha of deciduous stands (previously excluded) would be harvested and would then regenerate to conifer. It was also assumed that Pl and Fd managed stands on good and medium site would be spaced and fertilized.

The result was a +0.4% short-term gain and a +8% long-term gain.

Estimates of Timber Volumes

VDYP was used for existing unmanaged stands. TIPSY was used for all stands harvested from 1950 until 1987 (as one set of analysis units) and for all stands harvested from 1987 to present (as a second set).

Existing Stand Volumes: An inventory audit of TFL 5 indicated that existing stand volumes are acceptable, although considerable variation occurs between individual samples. A sensitivity test on the impact of ±10% changes in yield for natural stands was not analyzed.

Regenerated Stand Volumes: Provincial estimates of 15% and 5% were applied as Operational Adjustment Factors (OAF) 1 and 2 respectively. A genetic gain of 4.3% was also applied to post 1987 yield curves. Changes to regenerated stand volume estimates are sensitive in both the long- and short-term.

Increase: (12.5 cm utilization for all species) short-term increase +1.1%; long-term increase + 2.6%.

Decrease: (regenerate to VDYP Natural Stand Yield Tables): Short-term decrease -9%; long-term decrease - 35%.

Regeneration Delay

The actual average regeneration delay on the TFL is less than 2 years. Two years was used in the base case. Changes to this delay are insensitive in the short-term and sensitive in the long-term.

Increase: (0 years regen delay): Short-term no change; long-term +2.7%

Decrease: (7 years regen delay): Short-term no impact; Mid-term and long-term - 7%

Wildlife Plan Fish, Forest & Wildlife Management Plan

This Plan was completed for TFL 5 in 1995. Analysis options resulted in the following changes to the Base Case assumptions:

1) Land base increase of 110 ha (no reduction for ESA's in Core MDWR-salvage harvesting).

2) Unmanaged deciduous regenerate to deciduous.

3) Volume pass approach to harvesting used in RMZs and corridors (old growth percent increased to 12% from 10%). Seral stage targets not modified from base case.

Result: Insensitive: -1% short-and long-term decrease in flow

3 Additional Sensitivity scenarios:

1. *Apply intermediate biodiversity emphasis on the SBS mw.* Highly sensitive, 23% decrease in the short term, 14% decrease in the long-term.
2. *Increase green up height to 10 m in Corridors*: Short-term decrease of 1%, long-term decrease of 13%.
3. *Reduce land base by 3%*. Result is a 3% reduction in harvest.

Cariboo Chilcotin Land Use Plan (CCLUP)

An analysis option considered the CCLUP since 70% of the TFL is in the Lower Blackwater SRDZ and 30% of the TFL is in the Quesnel ERDZ. The THLB decreased by 62 ha for aspen stands having high wildlife values. Forest cover requirements were applied according to the Wildlife Plan. High biodiversity emphasis was applied to the SRDZ. Low emphasis was applied to the ERDZ.

Result: Highly Sensitive. 27% short-term decrease, 20% long-term decrease.

Important note: The Cariboo-Chilcotin Regional Resource Board has recommended TFL 5 develop forest resources according to the process for an ERDZ.

Result of low emphasis in the SRDZ, 2% reduction from Base Case

Planned Management

This scenario was formulated to provide an impact assessment of the activities and constraints that most closely represented Weldwood's management strategies and objectives, scheduled to occur during the term of MP #9. The 20-Year Strategic Harvest Plan supported this scenario. Assumptions were as follows:

1) Wildlife option land base 30,448 ha.
2) All harvesting regenerates to conifer;
3) Old growth constraints in the IRM and RMZs removed;
4) Old growth in Corridors increased to 16% > 140 yrs from 10% >120 yrs;
5) RMZ disturbance increased to 20% < 3 m;
6) Landscape biodiversity grouped into 4 units from the 6 used in the base case (i.e. ignore CCLUP boundaries and divide according to NE and NW portions of the TFL, and by the SBS mh and SBS mw).

Result: 1.9% increase in short-term; 2% increase in long-term
The results would enable the initial harvest forecast to increase to 125,100 and 132,000 m3/year in the short term and long term respectively

Roads, Trails and Landings

The AAC Rationale indicated that the MOF was concerned that although the reductions made for existing roads were reasonable, existing road widths were used to predict future road widths. Since the FPC Act will result in future road widths that are wider then the historic average, the reduction for future roads may be underestimated. Current actions such as the deactivation of an increasing number of forest roads and the move to a forwarder/stumpside system should alleviate the downward pressure on timber supply as a result of this concern.

Wildlife Tree Patches

Area removed for Wildlife Tree Patches (WTPs) in the Base Case equated to 2.3 percent of the timber harvesting land base. The MOELP felt this number was low. Weldwood contended that the WTP requirements overlapped with riparian management zones, forest corridors, mule deer habitat, and ESAs.

2.2.2 Summary of Issues by Period

Short Term (1-20 years)

The short term timber supply situation on TFL 5 is largely unaffected by changes to most management assumptions. The harvest flow appears to have reached its upper limit, wherein any change to silviculture management strategies results in only minor changes in short-term yield.

Changes in habitat/old growth management strategies can have a significant impact on the harvest. At the extremes, removing forest cover constraints entirely would increase the short term forecast by 15%, whereas increasing old growth to 30% results in a 32% decrease in harvest. Higher level directions regarding landscape unit planning guidelines and the CCLUP may influence both extremes.

Changing the minimum harvest age can have a significant positive short-term impact that is then offset by large harvest declines. Harvesting at any point above or below the maximum MAI of a stand will always result in a less than optimal harvest forecast.

The 20-Year Strategic Harvest Plan (1995-2015) completed by Weldwood verifies that the short-term harvest level is attainable. The Plan showed that an average annual harvest of 124,831 m3/year is possible, in light of forest cover constraints and other resource considerations.

Sensitivity analysis show that the short-term Base Case harvest forecast can withstand many uncertainties in stand level assumptions. Changes to landscape level management assumptions have occurred since the Timber Supply Analysis

Report was completed in 1997. These changes indicate that the Base Case assumptions were conservative and an increase in the order of 2 percent (Planned Management Scenario) is supportable.

Mid Term (21-70 years)

The harvest forecast does not predict a fall down in harvest at any point in the simulation period. Therefore, the initial harvest level does not affect future timber supply. The available mature growing stock is the principle constraining factor limiting an increase in timber supply in the short- and mid-terms. As was shown in Figure 2, 50-60 years from now is when timber supply is most constrained, if the Base Case harvest flow is followed and management strategies are not changed.

A very significant portion of the TFL is currently classified as managed stands and assumed to be growing along managed stand yield tables. Although all harvesting is currently from natural stands, within 50 years, 60% of the harvest will come from managed second growth. Beyond year 65, at least 90% of the harvest will come from managed second growth. When fertilization and spacing were preformed on all managed stands, sensitivity analysis indicated only a 0.4% short- and mid-term gain in harvest.

Long Term (71+ years)

The long term is highly sensitive to several management strategies. Intensive silviculture activities (fertilization/spacing) performed on managed stands can result in an 8% long-term gain in harvest. A change in the regeneration delay to 7 years will drop the harvest by 7%. No regeneration delay results in a 2.7 percent increase. Increasing stand utilization to 12.5 cm D.B.H. for all managed stands would increase the long-term results by 2.6%.

As with the short-term effects, changes in forest cover requirements as a result of habitat and/or higher level planning initiatives can have a large impact on the long-term harvest. Forest cover constraints are currently impacting the Base Case by an 11 percent reduction in possible yield. The implementation of high biodiversity emphasis on the SRDZ portion of the TFL could result in a further 20% decrease in harvest.

2.2.3 Stand Level Tradeoffs of Quality, Quantity and Harvest Timing

In the workshop, Weldwood indicated that they would like to see an improvement in the forecasted quality of wood, but not at the expense of a reduction in the current AAC. Changes in both managed stand regeneration assumptions (genetics), and in policy-level planning initiatives (Landscape Unit Planning) would suggest that small increases to the current AAC are possible. On the assumption that Weldwood would forgo some of the future increase in AAC, in return for a better log quality profile, trade-offs between timber quality and timber quantity will occur. Using the managed stand yield prediction model TIPSY, an estimate of the tradeoffs can be made.

In the workshop, Weldwood also indicated that they would like to see from 50 to 60 percent of the future logs harvested on TFL 5 be of premium quality. Premium quality was defined as having the following attributes:

- No Rot
- Low Taper
- Maximum knot size 2 inches
- 35-50 cm diameter
- Preferred species: Fir > Spruce > Pine
- ± 50% Douglas-fir by volume

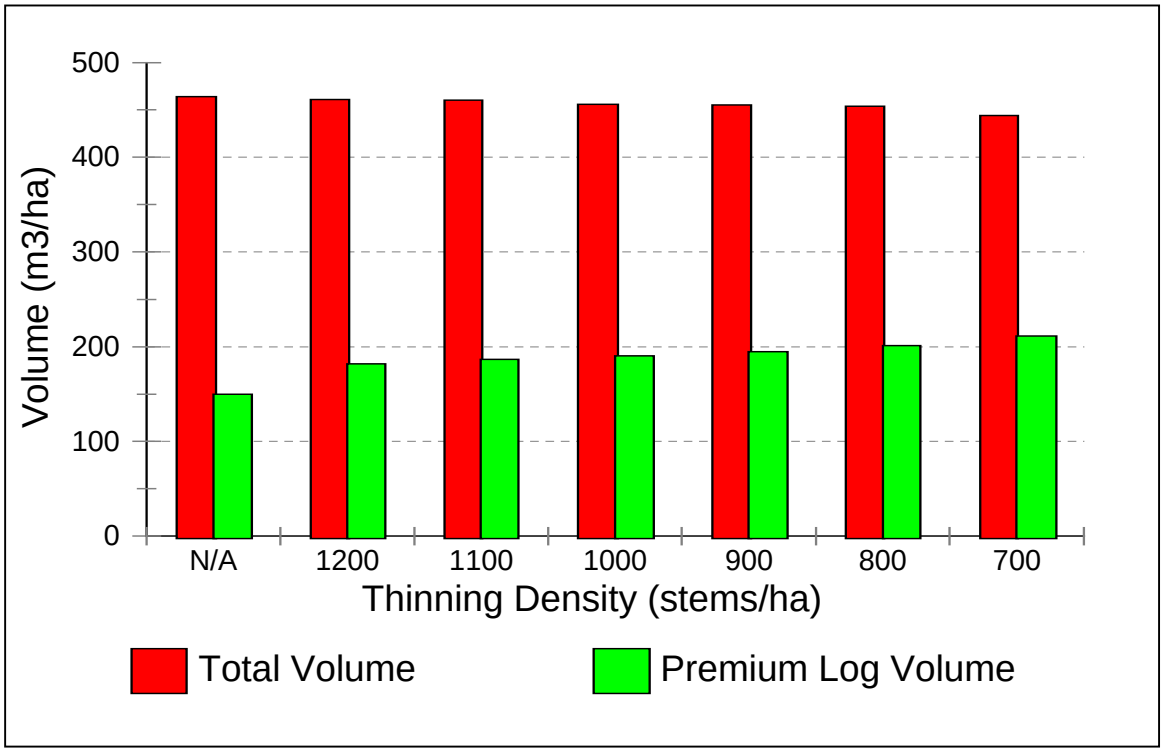
Several 'generic' TIPSY runs were completed to evaluate the trade off in volume as a result of improved timber quality. Improved quality was obtained by thinning treatments to a target stand density. Table 5 and Figure 7 show the results of this test for Interior Douglas-fir.

Table 5 TIPSY Yield Estimates for Premium Logs

Interior Douglas-fir - Site Index 21								
Original Density (stems/ha)	**Thinning Density (Stems/ha)**	**Harvest Age[1] (Yrs)**	**Stems Per Ha. @ Harvest**		**Max. Vol/ha @ Harvest**		**Premium Vol/ha @ Harvest (35-55 cm)**	
			# stems	**% change from Base Case**	**m3/ha**	**% change from Base Case**	**m3/ha**	**% of total volume**
1600	n/a	115	866	0.0	464	0.0	149.8	32.3
1600	1200	115	734	-15.2	461	-0.6	181.8	39.4
1600	1100	115	691	-20.2	460	-0.9	186.5	40.5
1600	1000	115	651	-24.8	456	-1.7	190.4	41.8
1600	900	115	609	-29.7	455	-1.9	194.9	42.8
1600	800	115	566	-34.6	454	-2.2	201.1	44.3
1600	700	115	500	-42.3	444	-4.3	211.3	47.6

[1] The harvest age indicated is the culmination age of a stand with the characteristics indicated by this table.

Figure 7 Comparison of Volume per Hectare, Premium log vs. Total Volume



This brief analysis revealed a number of things.

1. Thinning reduces total stand volume, but increases the average diameter of a stand as well as the proportion of large logs.
2. Thinning treatments alone can result in 32% of the stand meeting the size requirement for premium sawlogs.
3. Thinning to 700 stems per hectare will reduce the stand volume by 4.3 percent. This will increase the proportion of premium-sized logs to 47.6 percent of the stand, or 15 % more than was available if no thinning was performed.
4. Density control is close to achieving the lower end of Weldwood's target percent at Site Index 21 (at least within model limits). Therefore it is likely a reasonable strategy when combined with pruning and/or fertilization at site indices greater than 21. However, when pine and spruce were tested the results were much less favorable. Other strategies such as fertilization and delaying harvesting beyond culmination age would need to be adopted to provide an optimal result for these species.

Further analysis of a Type II nature would be better suited to quantify the tradeoffs in quality versus quantity that would occur specifically for TFL 5.

2.3 Incremental Silviculture History

As a result of concerns expressed by the MOF in the AAC Rationale for Management and Working Plan # 7, Weldwood began a 10-year incremental silviculture program in 1985. The following table describes the goals set out in the program and Weldwood's success in meeting these goals. Detailed incremental silviculture history information is not something that can be easily extracted from ISIS/MLSIS reports for TFL 5. A change in reporting protocols within TFL 5's GIS is a goal that should be addressed in the future. This tracking is essential to ensure that the costs incurred by incremental silviculture are tracked geographically in order to realize future gains in timber quality.

Table 6 Incremental Silviculture History Targets and Performance

Treatment	1985 Target	Performance to 1995	Current Status (2000)
Backlog	1950 ha	1456 ha	447 remaining [1]
Conifer Release	1618 ha	1340 ha	0 remaining
Reduce NSR to 2 yr Regen. Delay	2 yrs	2.4 yrs	1.5 yrs
Space (juvenile)	160 ha	242 ha	37 ha additional
Brushing and Weeding	125 ha/yr	1747	642 ha additional
Other Activities not included in the 10-Year Silviculture Program			
Fertilize	N/A	several small trials	
Genetic Improvement	N/A	Used where Class A seed was available	Use of Class A seed the norm for Sw
Pruning	N/A	66 ha	
Commercial Thinning	80 ha	5 ha	75 outstanding

Note: 1 Most of the areas exist as sliver polygons that need to be reclassified as a new timber type or part of an adjacent stand.

3. Opportunities to Increase Timber Supply

Before the TFL working session, silviculture strategies having the potential to increase the TFL timber supply were identified. The workshop participants reviewed these strategies and took those strategies with silviculture implications into consideration as a possible action item. The following table describes these potential opportunities. Detailed analysis would be required to confirm the indicated effects

Table 7. Potential Strategies by Time Frame

Response Time Frame	Objective/Action	Anticipated Result
Short Term	1. OAF survey 2. Ensure future managed stand voids are at a maximum of 10% (ie OAF1)	1. If the survey identifies that the OAF 1 of 15% for the TFL overestimates the forecast losses to openings in managed stands, the managed stands which will be harvested in 50-60 years will experience in increase in yield of as much as 5-10% 2 ±1 % on managed stand curves
Mid Term	1. OAF survey 2 Utilize better genetic gain information 3. reduce harvest age 4. remove OG constraint in IRM zone 5. Commercial Thinning 6. Purchase of Private land to fill hole in age class profile in 50 years	1 ±5 % on managed stand curves 2. ±5% on managed stand curves 3. +5% short/mid term impact (negative effect (-7%) in the long term due to harvesting at below culmination age) 4. estimated + 1% increase 5. estimated +2% as a result of a shift in the scheduling of available volume 6. Area multiplied by an MAI of 4 would provide a thumb-nail impact. Weldwood began this strategy in mid 1990s.
Long Term	1. reduce regeneration delay to 0 years 2. Space/fertilize future managed stands 3. remove OG constraint in IRM zone	1. + 2.7% increase 2. + 4% 3. + 1%

4. TFL Issues Considered in the Selection of Incremental Silviculture Strategies

At the working session it was agreed that given the pro-active accumulation of forest and wildlife inventory information that has occurred on TFL 5, there are only a few remaining opportunities to increase the AAC significantly. Large capital investments would likely return only a small amount of yield. Changes to forest policy and information regarding future gains from Class A stock would provide a better opportunity to increase the AAC, than would a large investment into silviculture practices.

The forgoing information, when considered in light of the manufacturing facility requirements of Weldwood, makes it clear that the greatest opportunity for modifying silviculture practices on TFL 5 is to adopt practices that will influence timber quality.

Considering this information, workshop participants identified 6 issues that needed to be addressed in the development of the silviculture strategy:

a) While quality objectives are of primary concern, any strategies targeting log quality should not impact the current AAC or wildlife habitat negatively.

b) Deciduous production would not be enhanced because coniferous products are the main emphasis. Any future deciduous management opportunities must not reduce coniferous volumes on the TFL.

c) Ongoing forest health strategies have the potential to increase yields, but will be considered as basic management rather than incremental. The strategies considered are:
   - X Using weevil resistant spruce stock
   - X Maintaining beetle salvage programs
   - X Continuing to develop and maintain mixed species stands
   - X Minimizing cattle damage to plantations

d) Strategies that were reviewed but considered to be "taken care of" and have a low potential to increase the harvest forecast are:
   - Adjusted green-up constraints
   - Backlog reforestation (should still be pursued where it exists)
   - Reduction in harvest age (accelerated harvest)
   - Reducing regeneration delay below 2 years

e) Current policy regarding the management of other resource values (i.e., wildlife) results in many areas within the TFL having rotation ages well beyond culmination age. The indirect benefit of these policy decisions is that the affected stands will naturally produce many premium sawlogs. Weldwood should continue to harvest small portions of these old growth reserves, while maintaining the forest cover constraints by replacing the removed timber with younger, thrifty stands in the same geographic area.

f) If an incremental silviculture strategy is not incorporated, timber quality will decrease as second growth stands come on line. In absence of long rotations, silviculture treatments are the only way to ensure the second growth stands approach the quality levels we currently obtain from our existing unmanaged stands.

5. Silviculture Strategies Identified in Working Session

5.1 Timber Quantity Strategies

Following are the strategies the workshop participants identified as most appropriate for implementation on TFL 5 to improve timber quantity and/or availability. The descriptor itemizing each strategy is consistent with the description used in Table 8.

Quan.1 Minimize managed stand voids in all future plantations, so OAF's can be reduced appropriately to match managed stand attributes.

Quan. 2 Maximize the use of Class A seed and genetically improved stock on all future plantations.

Quan. 3 Maximize the productive area of the TFL through the rehabilitation and planting of:

- X Old pasture
- X Old roads and landings
- X Other suitable stand voids

Quan. 4 Use conifer release treatments in immature mixedwood stands to capture more growth on the coniferous crop trees.

5.2 Timber Quality Strategies

Following are the strategies the workshop participants identified as most appropriate for implementation on TFL 5 to improve timber quality. Timber quality attributes were discussed in Section 2.2. Generally, premium sawlogs of peeler quality being large-diameter Douglas-fir, having little rot and few tight knots defines Weldwood's goal for improved timber quality. The descriptor itemizing each strategy to achieve improved timber quality is consistent with the description used in Table 8.

Qual. 1 Increase the proportion of Douglas-fir on the TFL to 50% by volume. This will be done using planting and preference to Douglas-fir in any spacing or conifer release treatments.

Qual. 2 Utilize spacing to:

- X Reduce immature stand densities to optimize both site occupancy and growth per tree to achieve a target D.B.H. at culmination of >35 cm for approximately 50-60% of the stand volume.
- X Set immature stand and plantation densities at levels suitable for pruning so that pruning costs are not prohibitive and to allow crop tree selection for

pruning.

- X Reduce conifer densities and select crop trees accordingly during conifer release treatments such that target diameters can be achieved at rotation and or “set up” for pruning if required.

Qual. 3 Utilize pruning to:

- X Minimize the frequency of knots in, at least, the bottom two logs of each stem (>5.5 m), in spaced stands.
- X Maintain the juvenile wood core in the bottom two logs to 9 cm or less in spaced stands

Qual. 4 Use late rotation fertilization to increase the production of mature wood approximately 10 years before harvest (clear or near clear wood). This should be used in combination with a commercial thin (Qual. 5) or in other mature or near mature stands with appropriate densities.

Qual. 5 Commercial thin appropriate mature or near mature stands to increase the average diameter of the remaining crop trees and the proportion of premium sawlogs in the residual stand. This should be done on an experimental basis to identify economic factors and stand attributes that will make this treatment successful.

5.3 Habitat Strategies

Following are the strategies the workshop participant identified as most appropriate for implementation on TFL 5 to improve habitat quality and quantity.

Hab. 1 Maintain existing mule deer winter range and old growth constraints, while continuing to harvest small patches of Douglas-fir beetle attacked trees.

Hab. 2 Increase the proportion of Douglas fir stands on the TFL.

Hab. 3 Stand structures created by incremental silviculture strategies may coincidentally increase habitat quality and quantity.

6. Further Information Required to Initiate or Confirm the Selected Strategies

Several items of information are currently missing that are vital to initiating or confirming the strategies selected in this report. Additional information must be accumulated in the following areas:

a) Operational Adjustment Factors (OAFs) need to be confirmed with surveys before they can be reduced.

b) The total area in roads, landings or other voids and to what extent they can be rehabilitated, must be confirmed before the strategy for increasing the productive area on the TFL can be initiated.

c) Yield curves must be localized with better or more current inventory data.

d) The Wildlife Plan and the CCLUP must be reviewed to ensure habitat needs are compatible with the proposed incremental silviculture strategies and to ensure the proper constraints are applied for timber supply analysis.

e) *Stand density data in conjunction with an inventory update is required to aide in the selection of appropriate stands for the proposed incremental silviculture strategies.*

f) Verify genetic gains in the field.

g) Implement silviculture monitoring/growth and yield programs to track the development of managed and natural stands.

7. Silviculture Program

Table 8 provides a detailed summary of the silviculture treatment regimes that best suit the short- and long-term incremental silviculture objectives for TFL 5. The table gives an indication of the areas to be targeted under each treatment regime, as well as the associated time frame results can be expected, the labor required and the costs that would be incurred. The priority or ranking of each regime is provided near the far right of the table.

Table 8 Incremental Silviculture Program

Regimes	Strategy	Opportunity Area (ha)	Time Frame for Expected response			Candidate Site and Stand Attributes				Habitat Impact			Direct Silv. Jobs (Person-days per ha)	Direct Cost ($/ha)	Ranking	impact on premium sawlog prod.	Impact on AAC
			Short (1-20 yrs)	Medium (21-70 yrs)	Long (71-200 years)	Sites (site index)	Stand Types	Species	Ages (Yrs)	Old Growth	Riparian	Wildlife					
Conifer release	Quan.4	± 3000		x	x	17+	late immature 700-1600 stems/ha	Pl, Sw, Bl	30-50	0	0	+	5	1200	2	0	+
Space to 1600-1800 sph	Qual.1, Qual.2	?		x	xx	17+	Late immature ± 2500 sph	Pl or PlFd	15-30	0	0	0	5	950	6	+	0
Conifer release	Quan.4	±2500			x	17+	immature 700 - ± 2500 sph	Fd, Pl, Sw	15-29	0	0	+	5	1200	1	0	+
Conifer release & prune	Quan.4, Qual.3				x	21-25	immature 400-900 sph	Fd, Fd leading	15-25	0	0	+	5+7	1200+1600	1	++	+
conifer release, space to 700-900 sph, prune	Quan.4, Qual. 1,2,3				x	21-25	900- ± 2500 sph	Fd, Fd leading	15-25	0	0	+	5+5+7	1200+950+1600	1	+++	0
Space, prune, late fertilization [1]	Qual. 1,2,3,4	± 4000			x	21-25	current plantations post 1987 ±1600 sph	Fd, Fd leading	1-13	0	0	+	5+5+1	950+1600+300	3	+++	?
Commercial thin, late fertilization trials (to 700-900 sph)	Qual. 4 & 5	?	x	x		21-25	mature 1600-2500 sph	Fd, Pl, Sw	80-120	0	0	+	? + 1	? + 300	5	++	0
Late fertilization trials	Qual. 5	?	x	x		21-25	mature naturally pruned 700-1600 sph	Fd, Fd leading	90-100	0	0	0	1	300	5	+	+
Plant good sites, space @ 15yrs, prune @ 25 yrs, minimize voids	Quan 1, 2 Qual 1, 2, 3			x		17+	future plantations ± 1600 sph	Fd > Pl > Sw	0	0	0	-	2+5+7	450+950+1600	4	++	+
Rehab, plant good sites	Quan.3				x	all	NSR	all	0	0	0	-			7	0	+

1 Space at 15 years to 700 - 900 sph, prune at 25 years 5.5 meter lift, late fertilization at harvest age minus 10 years

8.0 References

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