Type 1
Incremental Silviculture Analysis
for TFL 8

Prepared for
Boundary Timber Division
Pope & Talbot Ltd.
Midway, BC

Project: PTM-051-010

Version 2
August 4, 2000

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Executive Summary

The Type 1 Incremental Silviculture Analysis was undertaken to provide background for the development of a silviculture strategy for TFL 8. A complete silviculture strategy will provide a rational framework for silviculture expenditures on the TFL.

The purpose of the Type 1 Incremental Silviculture Analysis was:

- to review the most recent timber supply analysis for TFL 8.
- to identify issues that might be addressed through silvicultural treatments.
- to estimate the potential impacts on timber supply of the application of incremental silviculture treatments.

The outcome of the Type 1 Analysis is summarized as an interim incremental silviculture strategy. The analysis shows that Pope and Talbot has recognized the main issues and no major changes in silviculture strategy are required. The key recommendations are:

1. Use genetically improved stock as much as possible.
2. Emphasize full site occupancy in silviculture regimes.
3. Encourage the establishment and development of mixed-species stands.
4. Evaluate the potential for fertilization.
5. Look for opportunities to prune legacy stands.

Acknowledgements

J.S. Thrower and Associates gratefully acknowledge the contributions of the staff of Pope and Talbot's Boundary Timber Division and the additional input from Ministry of Forests staff who participated in the workshop.

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1. INTRODUCTION

1.1 BACKGROUND

The Ministry of Forests and Forest Renewal BC are promoting and funding the development of incremental silviculture strategies for every Timber Supply Area and Tree Farm Licence in B.C. A strategy for incremental silviculture is a high-level planning initiative that emphasizes the broad implications of different options rather than the details of individual silviculture prescriptions. The purpose of an incremental silviculture strategy is to provide a rational framework for silviculture expenditures aimed at improving the future quantity and quality of both timber and wildlife habitat.

Three types of analysis will contribute to an incremental silvicultural strategy. A *Type 1 Analysis* uses information from the most recent timber supply analysis to identify issues that might be addressed through silvicultural treatments and then infer or speculate on the potential impacts. A *Type 2 Analysis* involves a new forest-level analysis that evaluates the timber supply consequences of alternative silviculture strategies. It identifies feasible strategies and the level of funding required to implement them. A *Type 3 Analysis* explores new approaches to the modelling of wildlife habitat and environmental (non-timber) values for eventual incorporation into a Type 2 Analysis. This report involves the Type 1 analysis for TFL 8.

1.2 DEFINITIONS

Silviculture is "the art of producing and tending a forest" (Smith *et al*., 1997) and involves the planned application of treatments that will influence the "establishment, growth, composition, and quality of forest vegetation" (Daniel *et al*., 1979). The complete program of activities planned through the life of the stand is a **silvicultural system** (Smith *et al*., 1997).

It is customary to categorize silvicultural treatments as either basic or intensive. **Basic silviculture** treatments are those that facilitate the establishment of a stand.[1] **Intensive silviculture** describes practices such as thinning, fertilization and genetic improvement that "increase the capability of the forest to produce fiber' (Franzese *et al*., 1978).

In British Columbia, the categorization of treatments is based on the regulatory context in which they are applied. **Basic silviculture** is therefore defined as "harvesting methods and silviculture operations … that are for the purpose of establishing a free growing crop of trees of a commercially valuable species and are required in a regulation, pre-harvest silviculture prescription or silviculture prescription."[2] **Incremental Silviculture** is a Ministry of Forests term

[1] The State of Canada's Forests. 1999. Natural Resources Canada, Canadian Forest Service, Ottawa.
[2] Glossary of Forest Terms. British Columbia Ministry of Forests (undated).

that refers the application of silvicultural treatments in addition to mandatory silviculture required by law. Under this definition, incremental silviculture extends beyond the traditional activities of spacing, pruning and fertilization. It also includes pre-free growing silviculture activities that are in excess of legal requirements, as well as commercial thinning and backlog reforestation. This means that a particular silvicultural treatment, such as pruning, could be regarded as either basic or incremental depending upon the regulatory situation under which it was applied.

2. OVERVIEW OF THE LAND BASE AND FOREST COVER

TFL 8 consists of two geographically distinct units that were originally separate TFLs. Block 1 (Boundary Block), originally awarded as TFL 8, is situated in the Boundary Creek area north of Greenwood. Block 2 (Carmi Block), covering the Trapping Creek and Carmi Creek drainages north of Beaverdell, was originally awarded as TFL 11. Pope and Talbot has been the license holder of the combined areas since 1969, when the two TFLs were amalgamated as TFL 8.

The total area of the TFL is 77,665 ha, of which approximately 82% is considered the net timber harvesting landbase (Table 1). The TFL is distributed across five biogeoclimatic zones, with slightly more than 50% of the Montane Spruce zone (Figure 1).

Table 1. Area of landbase.

Description	Area (ha)	%
Total Area of TFL	77,664	100
Total Productive Forest	74,239	96
Net Timber Harvesting Landbase	63,480	82

The main species on TFL 8 are Douglas-fir.(Fd), lodgepole pine (Pl) and western larch (Lw). Stands with Pl as the leading species occupy the most area (Figure 2a), but Fd stands have the highest proportion of the volume(Figure 2b). This observation reflects a difference in age distribution rather than a large gap in productivity. Approximately 70% of the Pl stands stands are in age classes 1-4 (0-80 years). In contrast, about 70% of the Fd stands are age classes 8 and 9 (140 years and older). Overall , the age class distribution shows that nearly 50% of the TFL is older than 140 years (age classes 7-9) (Figure 2c).

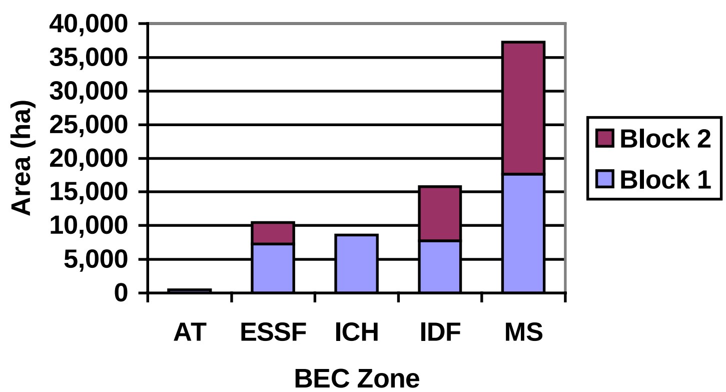

Figure 1. Area distribution by BEC zone.

Mixed-species stands are prominent on TFL 8 in all subzones (Figure 2d). More than one-half of the area qualifies as a mixed-species stands with less than 80% of the volume in any single species. In the MS and IDF zones, stands are generally some combination of Fd, Pl and Lw.

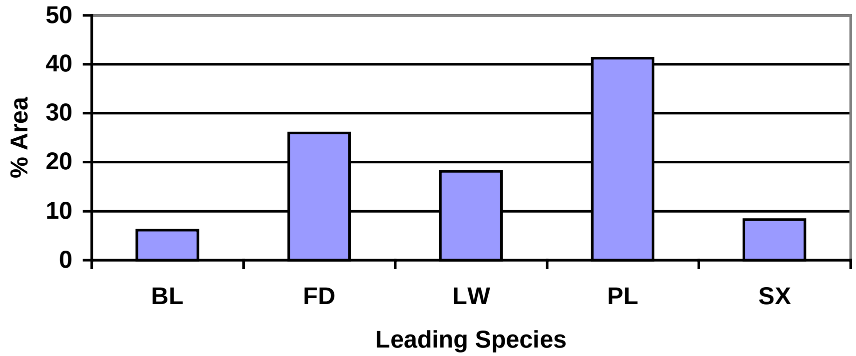

Figure 2a. Species distribution by area.

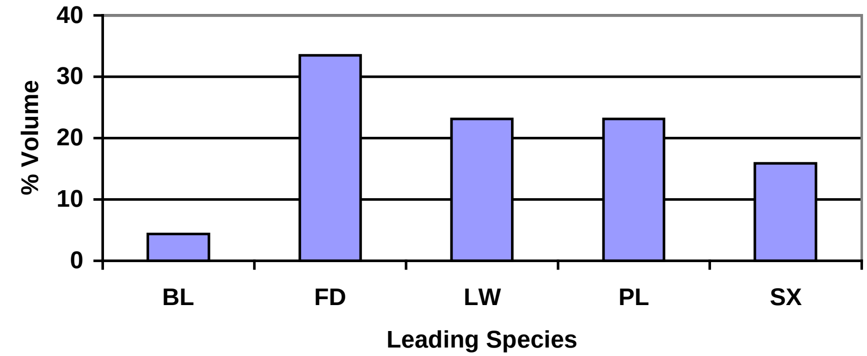

Figure 2b. Species distribution by volume.

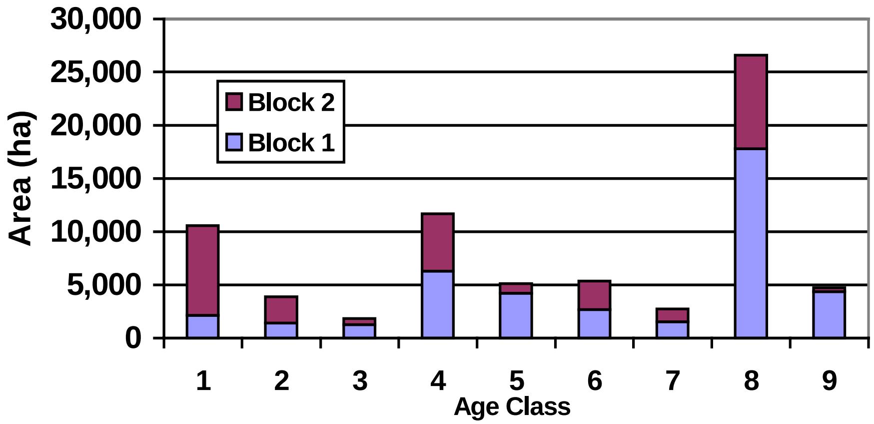

Figure 2c. Age distribution by TFL block.

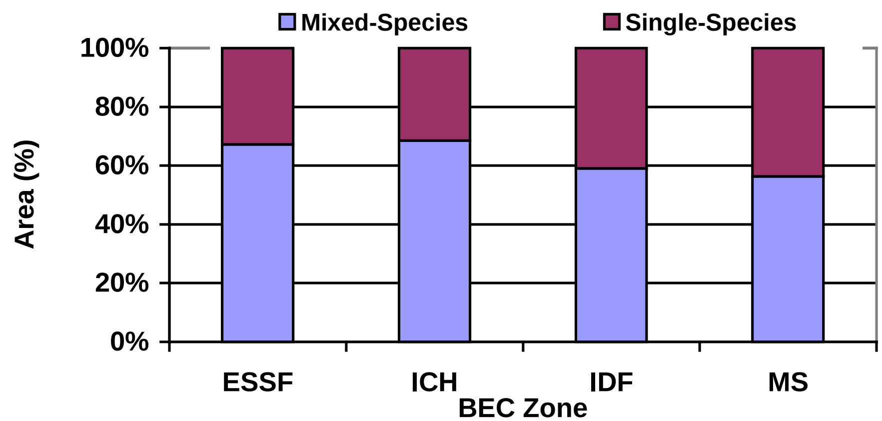

Figure 2d. Distribution of mixed-and single-species stands by BEC zone

3. REVIEW OF THE TIMBER SUPPLY ANALYSIS

The most recent timber supply analysis for TFL 8 is the analysis completed in 1997 by Sterling Wood Group Inc. in support of Management Plan 9 (MP 9). Preparations for the next analysis, due in 2001, are already underway. There will be new information and some different assumptions used for the next analysis which may bring a different perspective to many of the issues discussed in this report.

3.1 BASE CASE HARVEST FORECAST

The current Allowable Annual Cut (AAC) for TFL 8 is 145,000 m^3, which remains unchanged from the previous AAC. Under the assumptions of MP 9, the timber supply analysis forecasts that the harvest will be maintained at 145,000m^3 for four decades, step down to 132,000m^3 at the beginning of the fifth decade and level out at 128,000m^3 from the beginning of the sixth decade and onward (Figure 3).

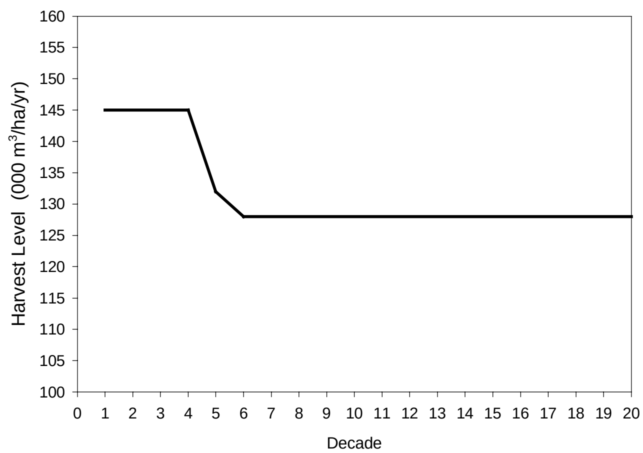

Figure 3. Base case harvest flow from MP 9 Timber Supply Analysis.

3.2 SENSITIVITY ANALYSIS

A sensitivity analysis shows how changes in the input assumptions affect the harvest flow. The timber supply analysis for MP 9 was conducted within an “even-flow” framework rather than the “step-down” approach used by the Ministry of Forests. This means that it can be difficult to determine which factors most restrict the harvest flow at different points in time. Furthermore, we cannot be certain that level of sensitivity observed in the even-flow sensitivity analysis would be equivalent under the step-down method. The few scenarios run under both approaches, however, show approximately the same level of sensitivity.

The sensitivity of the base case to the changes in selected inputs are summarize in Table 2. The base case is highly sensitive to changes in the yield predictions for regenerated stands, and changes in the timber harvesting landbase. Moreover, the effect of positive change is approximately the same as a negative change. Other input variables have more complicated effects on the harvest volume. Increasing the minimum harvest age by 10 years, for example, will lower the harvest rate by 3.9%, but a 10-year decrease has no effect.

3.3 REVISED BASE CASE

A Type 1 Incremental Silviculture Analysis involves close scrutiny of the base case and the sensitivity analysis. One of the most sensitive inputs to the base case – site productivity – is a primary concern on TFL 8. In the rationale statement[3] for the last timber supply analysis, the Chief Forester suggested that site index was probably underestimated in older stands, and that opinion was echoed in the growth and yield strategy (J.S. Thrower and Associates, 1999a). In a timber supply analysis, the site index estimates from the older stands would be used to predict the growth of the young stands established after logging. The effect is potentially so powerful that we have chosen to estimate it's effect on the base case harvest flow and produce a revised base case before we proceed with any discussion of silviculture options.

Table 2. Sensitivity analysis of base case harvest flow.

Input	Input Change		Harvest Change
Existing Stand Yields	-10 %		0.8 %
	+10 %	↑	1.6 %
Regenerated Stand Yields	-10 %		10.2 %
	+10 %	↑	9.4 %
Minimum Harvest Age	-10 years	–	0.0 %
	+10 years		3.9 %
Minimum Harvest Volume	-25 m^3/ha		1.6 %
	+25 m^3/ha		3.1 %
Green Up	-2 m	↑	3.1 %
	+2 m		7.0 %
Timber Harvest Land Base	-10 %		10.9 %
	+10 %	↑	11.7 %

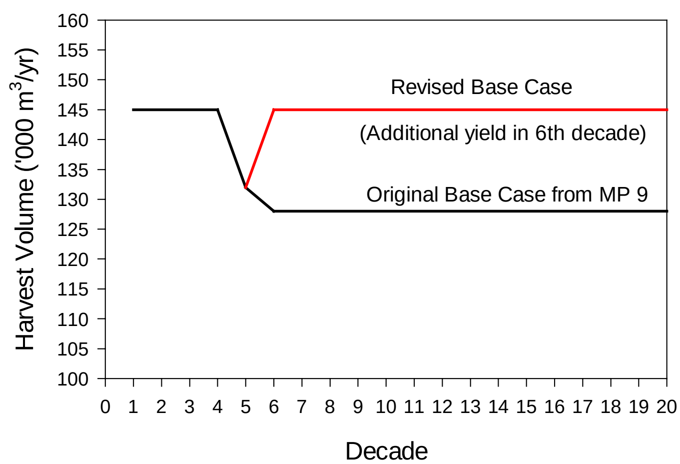

Figure 4. Revised base case with predicted impact of potential site index.

A comparison of the inventory estimates of site index with new estimates of the potential site index (J.S. Thrower and Associates, 2000a) suggested that the area-weighted average site index is underestimated by more than 1 metre. Using TIPSY estimates of yield for lodgepole pine as a benchmark, a 1-metre increase in site index translates into a 14% increase in yield. According to the sensitivity analysis in MP 9, a 14% increase in the yield curves for regenerated stands is likely to produce a 13% increase in the harvest level.

[3] Ministry of Forests. 1997. Tree Farm Licence 8: Rationale for allowable annual cut (AAC) determination. L. Pedersen, Chief Forester

The key point is predicting when the increase in the harvest flow will occur. It seems safe to assume the stands established over the past 25 years are growing at the potential site index and could possibly be harvested at the beginning of the 6th decade. In this case the harvest flow would show only a slight dip to 132,000 m^3/yr in the 5th decade, followed by a return to 145,000 m^3/yr thereafter (Figure 4). Alternatively, if enough of the managed stands are available a decade earlier (i.e, beginning of the 5th decade), then there would be no decrease in the harvest level. In the first case, a silviculture strategy might then focus on silviculture treatments that might ameliorate the drop in harvest in the 5th decade. In the second case, the silviculture strategy would aim for a general increase in harvest flow. The next timber supply analysis – to be conducted with new information, new assumptions and a spatial timber supply model – will offer a better assessment of this situation.

4. POTENTIAL EFFECTS OF INCREMENTAL SILVICULTURE

4.1 TIMBER SUPPLY

The projected harvest flow, as modelled in a timber supply analysis, could be increased beyond the levels observed in the base case through any of the following steps:

1. Increasing the landbase available for growing timber.
2. Identifying and correcting any underestimation of the standing inventory.
3. Identifying and correcting any underestimation of site productivity.
4. Increasing the level of utilization.
5. Enhancing the yield of regenerated stands.
6. Meeting regulatory requirements sooner (e.g., adjacency constraints).
7. Redefining critical timber supply assumptions (e.g., minimum harvest age).

Incremental silviculture treatments can play a role in items 5, 6 and 7, as discussed in the following sections.

4.1.1 Regenerated Stand Yields

The key to enhancing the yield of regenerated stands is to capture as much as possible of the potential productivity of each site. Basic silviculture practices deserve most of the credit for impressive gains already achieved through reduced regeneration delay and enhanced site occupancy. The opportunities for further increases are somewhat limited because site resources are essentially fixed (Ministry of Forests, 1999). We can add to the pool of site resources with fertilization or enhance the efficiency of use by planting improved stock. We can also effectively increase yields by reducing losses to pests and by avoiding treatments that can impair site occupancy.

4.1.1.1 Fertilization

Fertilization is one of the few treatments that will increase the biological yield of forest stands. The fertilization routine in TIPSY Version 2.5 suggests that for a typical Pl plantation on the mesic site series in TFL 8's IDF or MS subzones (initial density=1600, site index=21m), a single application will add 12m^3/ha over a ten-year response period. That amount translates to a 9.5% increase in growth rate in the response period, and an overall 3% increase in stand yield at rotation.

At the forest level, the impact of fertilization on the harvest flow would depend on the proportion of stands that were fertilized. A general 3% increase in the harvest flow would result only if every regenerated stand were fertilized and only if each attained the predicted response.

Fertilization could be used to target the potential drop of 13,000 m^3/yr in the 5th decade, as shown earlier in one of the revised base case alternatives. This would require fertilization of approximately 11,000 ha before the 4th decade. There are too few stands currently in age classes 2 and 3 (ages 20 to 60years) to support this level of fertilization without multiple applications to each stand. As noted earlier, this context may change in the new timber supply analysis; the merits of fertilization should be revisited after the analysis is completed.

4.1.1.2 Genetic Gain

Genetic gain can now be incorporated into timber supply analysis. Yield gains from improved stock are derived from more efficient use of site resources. TIPSY 2.5. predicts the yield gains from tree improvement based on values of genetic worth. Application of the default values for lodgepole pine produces the gains observed in Figure 5. The predicted gain in merchantable volume at 60 years is approximately 8.5%, diminishing to less than 3% by 120 years.

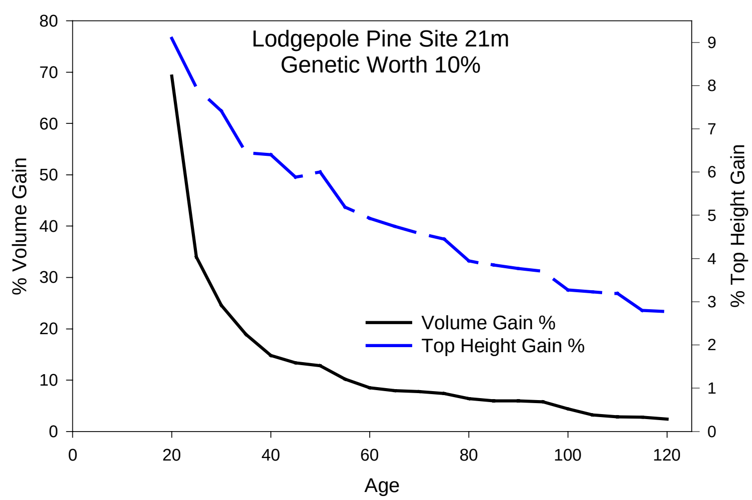

Figure 5. Genetic gain in volume and height.

The effect of tree improvement on harvest flow depends on the proportion of improved seed used in annual plantings. Currently, Class A seed makes up 100% of Pope and Talbot's spruce planting stock, 30% of the lodgepole pine stock and 10% of the larch stock. Based on the number of seedlings planted in the last three years (Table 3), proportion of improved seed being used is about 45% overall. Although demand for improved stock will continue to outstrip supply for several years, Pope and Talbot expects to increase the proportion of their planting stock derived from improved seed. Tree improvement appears to be one of the best options for obtaining meaningful and feasible increases in yield at the stand and forest level

Table 3. Seedlings planted 1997-99.

Species	Number	Percent
Bl	7,650	0.5
Fd	8,520	0.5
Lw	258,020	16.5
Pl	855,090	54.5
Pw	500	0.0
Py	20,155	1.3
Sx	417,770	26.6
Totals	1,567,705	100.0

4.1.1.3 Juvenile Spacing

Juvenile spacing is a pre-commercial thinning that removes selected trees to provide additional growing space for the residual trees. Juvenile spacing reduces the occupancy of growing space by an amount that depends on the number of trees removed. Over time the residual stand will re-occupy some or all of the additional growing space created by the thinning (Ministry of Forests, 1999). The loss of occupancy, albeit temporary for light thinnings, translates into a loss in biomass production that will not be recovered (Figure 6a). If we apply utilization standards (10cm top, 30cm stump) and merchantability limits (minimum DBH), then some of the regimes with higher residual densities (1600 per ha and higher) will show modest gains in merchantable volume (4% to 6%) over what is predicted for unthinned natural stands established at about 10,000 stems per ha (Figure 6b).

A notable exception is in the repression of height growth observed in fire-origin stands of lodgepole pine that germinate at densities in excess of 15,000 stems per ha. Early thinning of these dense stands will allow them to reach their productive potential and avoid losses of 10-30% as densities increase from 50,000 per ha to 250,000 per ha. These high density stands are spaced as part of the basic silviculture obligations.

In the timber supply context, merchantable volume is the most relevant yield statistic. Harvest flows and the allowable annual cut are both expressed as merchantable volume without respect to species or product value. Those considerations are addressed in other forms of management planning.

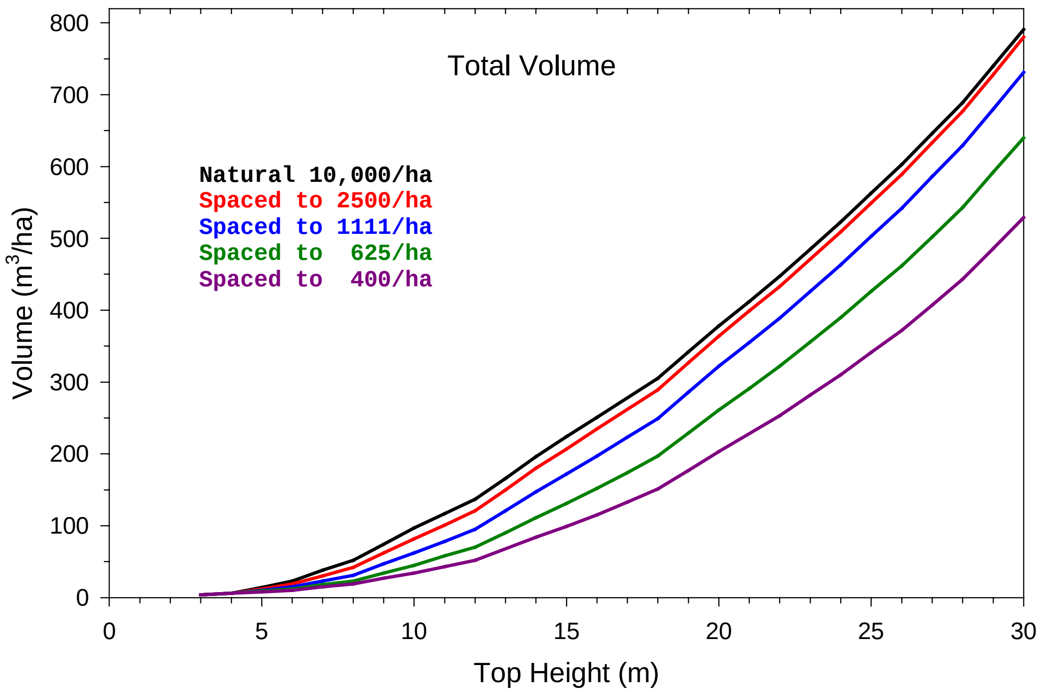

Figure 6a. Impact of juvenile spacing on total volume.

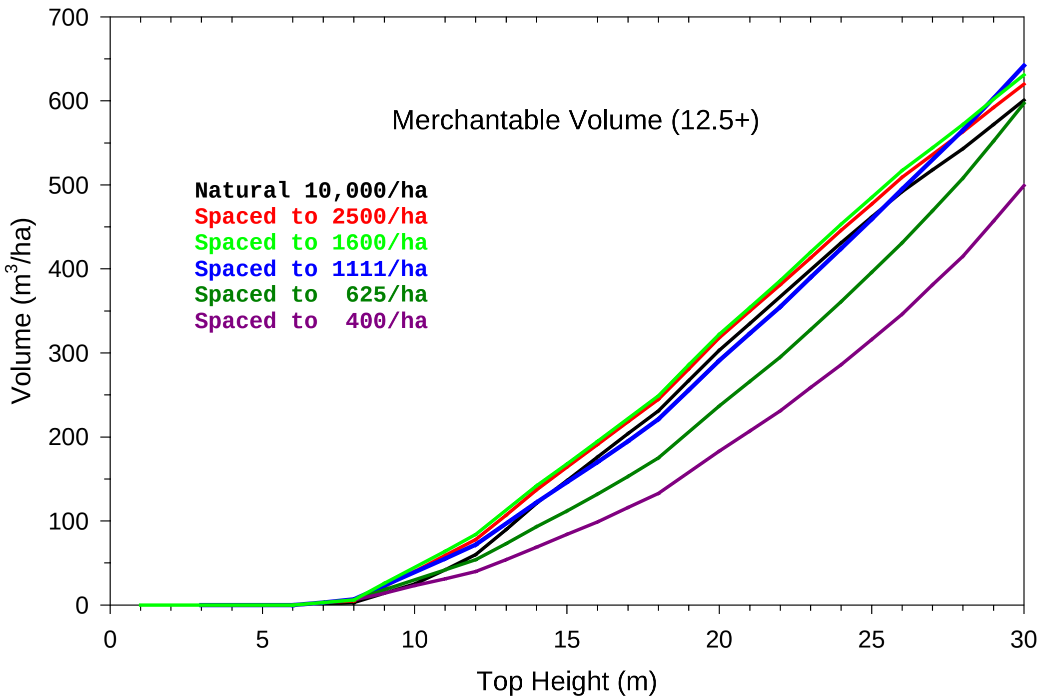

Figure 6b. Impact of juvenile spacing on merchantable volume (12.5cm+).

Pope and Talbot recognizes the importance of maintaining full site occupancy and normally prescribes 200-400 stems per ha more that the MOF target standards for planting density and 600 stems per ha more than the targets for residual spacing density. This strategy could be further enhanced by minimizing all unnecessary or discretionary juvenile spacing when there are no other compelling reasons for spacing.

4.1.2 Minimum Harvest Age

The minimum harvest age specified for each analysis unit in the timber supply analysis indicates the earliest age at which stands can be harvested. In many TFLs and TSAs, the projections of the harvest flow can be very sensitive to the minimum harvest age, especially at the point where the emphasis in harvesting must switch from the mature natural forest to second growth. Lowering the minimum harvest age – even just temporarily – can sometimes help bridge the gap until the bulk of the managed stands reach merchantability. However, an ongoing policy of harvesting at the minimum possible age would severely impair long term harvest levels if the minimum harvest age is substantially earlier than the culmination of mean annual increment.

There are no firm guidelines for assigning minimum harvest age. It was once customary to use the culmination age of mean annual increment. In the previous timber supply analysis for TFL 8, the minimum harvest age was set to the age when stands reached a volume of 175 m^3 per ha.

Silvicultural treatments that enhance yield , such as planting genetically improved stock or applying fertilizer, will also tend to reduce the minimum harvest age. The magnitude of the effect, however, is often small. For lodgepole pine on site 21m, a single application of fertilizer will reduce the harvest age by about 2 years, while a 10% increase in genetic worth will reduce the harvest age approximately 5 years. Whether those reductions are sufficient to relieve some timber supply constraints will depend on the particulars of the management unit and the analysis.

Recently there have been suggestions that juvenile spacing should be prescribed explicitly to reduce minimum harvest age in timber supply analysis. Yield predictions from TIPSY 2.1 (Table 4) show that this approach would not reduce the minimum harvest age if it was defined by culmination of mean annual increment or a minimum volume. Under those assumptions, juvenile spacing would actually increase the minimum harvest age. Reductions in harvest age would only occur if they were based on some measure of stand diameter, such as mean stand DBH or the mean DBH of prime trees (largest 250 per ha). The example below, however, demonstrates that thinning introduces an artificial increase to the mean DBH statistic that does not reflect the real changes in tree size. This point is expanded in more detail in the Guidelines for Developing Stand Density Management Regimes (Ministry of Forests, 1999).

Table 4. Effects of juvenile spacing on various definitions of minimum harvest age.

	Residual Juvenile Spacing Density								
PCT Density	No PCT	4444	2500	1600	1111	816	625	493	400
Square Spacing	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Mean Annual Incr.	5.7	5.8	5.9	6.0	5.6	5.4	4.8	4.4	3.9
Culmination Age	70	66	59	70	75	80	83	85	94
Age at 175m^3/ha	42	41	40	40	42	44	48	50	54
Age at 25cm DBH	100	98	85	79	60	49	43	40	39
Age at 25cm Prime	52	52	47	44	39	37	36	35	35

If stands are spaced, they will attain a specified DBH sooner than if they had not been spaced. As shown in Figure 7, the unspaced natural stand reaches 25cm DBH near age 100 (A) while the stand spaced to 1111 per ha reaches the same mean DBH at 60 years (B). A reduction in minimum harvest age of this magnitude could have a dramatic positive impact on harvest flow in a timber supply analysis.

An alternative approach would be to forgo the juvenile spacing and simply reset the minimum harvest age at 60. Although the mean DBH is only 18cm, the unthinned stand carries slightly more merchantable volume (4%) than the thinned stand would at the same age (Table 5). The harvest revenue predicted for the unthinned stand is about 3% lower, but the cost of the spacing has been avoided altogether.

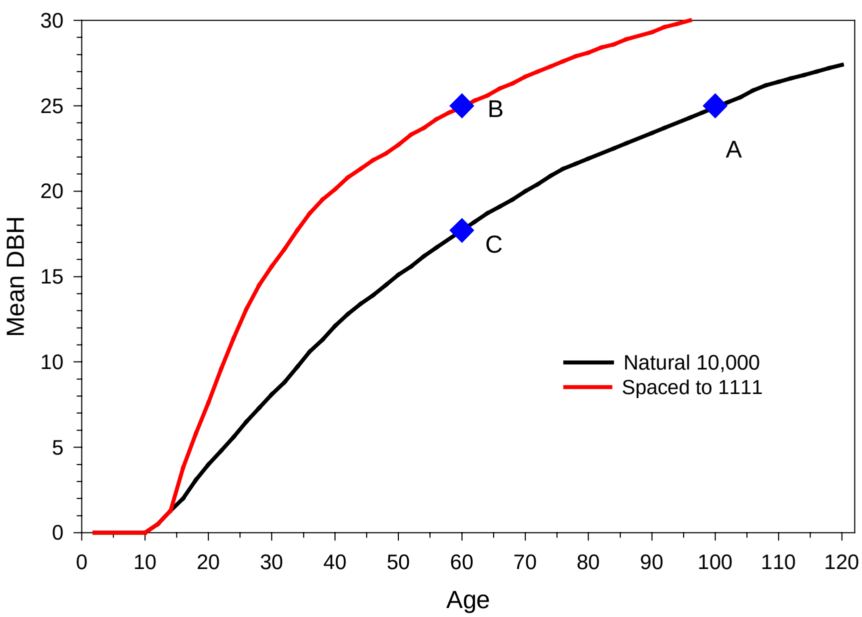

Figure 7. Harvest ages based on mean DBH.

Table 5. Comparison of points C and B from Figure 7.

	C	B	C/B
Treatment	unspaced	spaced	ratio
DBH (cm)	17.7	25	0.71
Merch. Volume (m^3/ha)	338	326	1.04
Harvest Revenue ($/ha)	34,090	35,053	0.97

The large difference in mean DBH between the thinned and unthinned stand conceals the fact that the largest trees in the unthinned stand are nearly as large as the largest trees in the thinned stand. Much of the difference in mean DBH is due to the artificial *chainsaw effect* (Ministry of Forests, 1999) caused by the removal of the small trees in the thinned stand.

4.2 WOOD QUALITY

4.2.1 Current Products and Markets

The Pope and Talbot sawmills that process timber from TFL 8 produce kiln dried, random length dimensional lumber for North American market. Approximately 90% of the lumber is sold in the USA and 10% in Canada. Byproducts such as chips, sawdust, chipfines, planer shavings and hog fuel are sold to other manufacturing facilities in the region. Input capacity

Pope & Talbot currently manufactures a range of high quality, solid-wood products from trees cut on the TFL. These include long length (22' & 24') dimension lumber; MSR and appearance grade lumber; 1" appearance grade boards; cedar decking; timbers; and railroad ties. Fdi, Lw, and Pl provide high MSR recovery and also have proved valuable for structural and appearance lumber.

Input capacity is approximately 800,000 m^3/yr with Midway running two shifts and Grand Forks one shift. Both mills rely on high lumber recovery for profitability.

4.2.2 Product Vision to 2020

Pope and Talbot's expectation of the solid wood markets to the year 2020 area summarized below.

Product Component	Medium Term Perspective (5-10 years)	Long Term Perspective (20+ years)
MSR lumber	Continued market premium and expanded use in engineered wood products.	Continued market premium and expanded use in engineered wood products.
Appearance grade boards	Continued market premium.	unknown
Long lengths	Continued market premium	Probable replacement by engineered products
Wider dimensions (2x10, 2x12):	Will not remain competitive with engineered products	Complete replacement by engineered wood products
Fdi, Lw, and Pl	Continued value for properties such as high specific gravity	Continued value for properties such as high specific gravity
Log Quality	Higher value for low taper, low wane, and small knots	Higher value for low taper, low wane, and small knots

4.2.3 Silviculture and Wood Quality

The basic wood quality attributes that can be affected by silviculture are the proportion of juvenile wood, specific gravity (relative density), knot size and frequency, and the relative proportions of earlywood and latewood. Log quality is affected by diameter, length, uniformity, taper, knots, sweep, shake and pathological indicators.

Wood quality must be defined with reference to some specified product (Zobel and van Buijtenen, 1989). In Pope and Talbot's long-term view of the future, there will be less emphasis on large dimension lumber and more emphasis on smaller dimension lumber and engineered wood products. Wood quality, in this context, is defined by the basic fibre properties as influenced by specific gravity, juvenile wood and knot size. Lumber recovery is important in any context.

Higher wood quality, under this definition, is generally associated with higher stand densities ((Zobel and van Buijtenen, 1989). Rapid crown recession tends to produce smaller knots, less taper and an earlier transition from juvenile to mature wood. If the specific gravity of a species is negatively affected by growth rate, then the higher density stands will produce the densest wood.

Stands managed to the current MOF target densities for planting and juvenile spacing will likely not produce the wood quality desired by Pope and Talbot. Studies of branch size in 20-year-old Pl stands in the Merritt and Kamloops areas (J.S. Thrower and Associates, 1999b) show that most branches already exceed 2.5cm in diameter when current density is less than 2000 stems/ha. Furthermore, the increased taper in more widely spaced stands will decrease lumber recovery. A study of taper in Pl stands (J.S. Thrower and Associates, 2000c) suggested that the taper in stands at target densities will have twice the taper, which could mean losses of 10% or more in lumber recovery.

Pruning treatments are a solution to the branch size problem and, in addition, promote the transition from juvenile wood to mature wood. At Pl densities of 1200ha to 1600/ha, however, the will be little clear wood recovered (J. S. Thrower and Associates, 2000c). Nevertheless, it may be worthwhile to consider pruning these stands simply to keep the branches from getting any larger.

There is little doubt that the highest growth rates per tree result from the ample growing space afforded in low density stands. Historically, log and tree sizes have been good indicators of product value. Studies of wood quality in second growth stands, however, suggest that larger size of trees and higher growth rates frequently will not compensate for "the detrimental effects of increased tree taper, larger branches and higher proportions of juvenile wood" (Josza and Middleton, 1994).

4.3 WILDLIFE HABITAT

The major wildlife habitat issue on TFL 8 is mule deer winter range (MDWR) and the Ministry of Environment, Lands and Parks (MOELP) has specified that the most critical habitat attribute is cover. Consequently, the main objective of silviculture in the MDWR areas has been to create all-aged, multi-layered stands for maintenance of cover. A wide array of silvicultural systems is employed on TFL 8, but single-tree selection is the system of choice in MDWR areas.

A wildlife management plan for the TFL is currently being developed for Pope and Talbot by Dr. Darryl Hebert and Interior Reforestation Ltd. Based on a review of recent research, Dr. Hebert has suggested that the quantity and quality of browse and forage should receive more emphasis in MDWR. If a review of stand conditions in MDWR indicates that these results apply to TFL 8, then there will probably be a shift in emphasis in silviculture prescriptions. If, for example, it is necessary promote additional growth of shade intolerant browse species, then there needs to be a reduction in crown cover in some stands within MDWR to allow those species to flourish. If this viewpoint is accepted by MOELP there will be fewer prescriptions for single-tree selection in the future, with more emphasis on patch cutting, shelterwood and seed-tree systems.

4.4 INSECT AND DISEASE PESTS

4.4.1 Insect and Disease Issues

Forest insects and disease play a significant role in stand development on TFL 8. Furthermore, forest management on the TFL has long recognized the importance of ameliorating and accommodating the effects of forest pests. The main pests issues on the TFL are summarized below.

4.4.1.1 Bark beetles

Periodic catastrophic infestations of bark beetles – particularly mountain pine beetle – figure prominently in the history of TFL 8. The most recent outbreak of mountain pine beetle started in the 1980s. A temporary uplift in the AAC was granted to Pope and Talbot to combat the infestation on the TFL. The result of the accelerated harvesting of Pl is that there now relatively few mature stands with Pl as the leading species within the TFL. The major concern, therefore, is for the current immature stands that will become more susceptible over the next three decades.

4.4.1.2 Spruce Budworm

Spruce budworm is a concern only in the IDF stands less than 1100m in elevation.

4.4.1.3 Root Diseases

The root diseases *Armillaria* and *Phellinus* are natural floristic elements of many of the ecosystems on TFL 8. There are few identifiable areas of heavy concentrations of root disease, but there are various concentrations of root disease throughout the IDF, ICH and MS subzones. Root disease is acknowledged in prescriptions for basic silviculture prescriptions by the frequent use of stumping.

4.4.2 Forest Pests and Silviculture

4.4.2.1 Bark Beetles

The risk and associated impact of mountain pine beetle is less in mixed-species stands than it is in pure pine stands. Encouraging the establishment and development of mixtures is one way to reduce beetle impacts in the long term.

For existing pine stands, research has demonstrated that the susceptibility to mountain pine beetle can be lessened by reducing stand density (Cochrane *et al*., 1994; Mitchell *et al*., 1983). It is not clear that density management alone will preserve pure pine stands in a major outbreak. Commercial thinning of older stands is currently viewed as short-term tactic that may help delay rather than prevent beetle attack.

4.4.2.2 Spruce Budworm

The stand structures that will be most affected by spruce budworm are those that have susceptible species in both the upper and lower strata. For example, in stands where Douglas-fir dominates both strata, prolonged infestations will decimate the lower stratum. The potential impact of spruce budworm can be lessened by silvicultural practices in two ways. The first is promoting the establishment of mixed-species stands. The second is to prescribe fewer applications of the silvicultural systems that lead to relatively pure and vertically stratified stands of Douglas-fir – i.e., single-tree selection and the uniform shelterwoods with substantial overstory.

4.4.2.3 Root Diseases

The potential impacts of *Armillaria* and *Phellinus* can also be reduced by promoting the establishment and development of mixed-species stands. Some silvicultural treatments, such brushing, juvenile spacing and commercial thinning, can unintentionally stimulate the activity of root diseases. Current silviculture guidelines discourage treatments in stands with obvious symptoms of root disease, but many low-level infections are difficult to diagnose. A prudent approach is to minimize post-establishment interventions in ecosystems in which *Phellinus* and *Armillaria* are prominent.

5. INTERIM INCREMENTAL SILVICULTURE STRATEGY

The preceding evaluation of the existing timber supply analysis and available information on response to silvicultural treatments leads to the following recommendation for an interim strategy for incremental silviculture investments. This should be regarded as an interim strategy until the next timber supply analysis is completed and there is an opportunity to incorporate the most recent harvest flow schedules into the strategy.

1. **Use genetically improved stock as much as possible.**
   Planting stock grown from Class A seed is the most cost-effective way to improve the yield of regenerated stands.

2. **Emphasize full site occupancy in silviculture regimes.**
   Pope and Talbot have already recognized that maintaining full site occupancy will enhance merchantable volume, and adjusted upward their density management targets for planting and juvenile spacing. This approach is consistent with their view of future in which there will be premiums for high quality but with more emphasis on engineered wood products than wide dimension lumber. This density management strategy should be expanded by pursuing the following recommendations:
   a) Encourage natural regeneration to complement planted stock and achieve higher initial densities.
   b) Aim for establishment densities (planted + natural) greater than 2500 stems/ha.
   c) Aim for higher post-spacing densities (2500-4000 stems/ha) to promote higher wood quality, lower costs of spacing and reduce losses to forest pests. Minimum inter-tree distance requirements should be set below 50cm and preferably at 25cm.
   d) Minimize unnecessary juvenile spacing and brushing activities to retain higher densities and reduce losses to forest pests.
   e) Evaluate the effectiveness of fill-in planting to ensure full site occupancy in young stands that currently meet minimal free growing requirements.

3. **Encourage the establishment and development of mixed-species stands.**
   The impact of forest pests tends to be less severe in mixed-species stands. For the types of mixtures that occur naturally on TFL 8, the mixed-species stands will usually have higher yields than single-species stands. Mixtures should be encouraged by pursuing the following recommendations:
   a) Ensure the development of mixtures by planting minor components of complementary species. For example, the planting of larch should be expanded to introduce more larch into regenerated stands that might otherwise be nearly pure Pl. Larch offers fast growth rates, resistance to disease and high-quality fibre (Sauter *et al*., 1999).

b) Ensure that mixed-species stands remain mixed after juvenile spacing. Spacing guidelines sometimes have unintended pernicious effects, such as removing small, shade tolerant spruce. To encourage the development of stratified mixtures, it may be necessary to explicitly allow for the retention of such trees by adjusting the countable height limit to 50% or higher.

4. **Evaluate the potential for fertilization.**
The next timber supply analysis will help clarify the potential value of a fertilization program on TFL 8. In particular, if a short-term drop in harvest flow appears in the 5th or 6th decade, then fertilization may be a good investment.

5. **Look for opportunities to prune legacy stands.**
TFL 8 has a substantial legacy of Pl stands that have been either planted or spaced to densities that are too low for the future product requirement of Pope and Talbot. These stands already have large branches which are still growing. Although pruning these stands will not lead to optimal financial returns, the resulting stand will likely be more valuable than if these already large branches are allowed to grow larger. Funding intended for job creation in forestry might be better spent on pruning of legacy stands rather than on spacing activities that will produce stands that are inconsistent with Pope and Talbot's product goals.

It can be expected that both the next timber supply analysis and the Type 2 Incremental Silviculture analysis will revise some of the assumptions and estimates used to generate these projections. New estimates may reflect improved information about the landbase or the effects of silvicultural treatments. In some cases, an investment in improved information may have a greater effect on either the magnitude or the credibility of the predicted harvest flow than the silvicultural treatment itself.

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7. APPENDIX I INCREMENTAL SILVICULTURE ACTIVITIES

7.1 PRE 1987 OVERVIEW

Table 6. Overview of stands logged prior to 1987.

Status	Notes	Area (ha)
FG	Free-Growing. Generally no further treatment required except the pruning areas fall within this category and there could be some enhanced spacing done (probably not more than 200-300 ha).	9,837
SR	Not yet Free-Growing due to Height or Brush. Probably 25% of this will require some brush treatment, either chemical or manual (the latter done in conjunction with spacing). These areas have been proposed or scheduled either for treatment or free-growing surveys over the next 5 years.	2,369
NSR	see separate table	490
Unknown	Mostly remnants of blocks spaced - mixed SR/FG, mature, NP, possibly some NSR, etc. (00/01 walkthroughs to be done)	135
NP	Generally small NP strata within blocks (16 ha total of swamp, 13 ha Open Rock, 32 ha NCBr)	61
Mature	Small mature patches within blocks.	31
NP-Road	Only on some blocks have roads been netted out. This is really much higher (i.e could use the standard 7%) and is a mapping project that will be done in the next year or two.	57
Total		12,980

7.2 SUMMARY OF PAST INCREMENTAL SILVICULTURE ACTIVITIES

Table 7. Incremental silviculture treatment area by year.

Year	Juvenile Spacing	Manual Brushing	Chemical Brushing	Pruning
1982	7.8			
1985	71.5			
1986	21.7			
1987	80.6			
1988	81.1			
1989	391.1	80.9		
1990	193.8			
1991	221.8			
1992	566.6		5.5	
1993	657.1		29.2	
1994	544.5			
1995	619.4			44.0
1996	747.8			95.7
1997	719.5			
1998	624.9			
1999	207.6	166.9		
Total	**5,757**	**248**	**34.7**	**139.7**

7.3 CURRENT INCREMENTAL SILVICULTURE PROGRAM PLAN

Table 8. Current 5-year incremental silviculture program plan (area).

Year	Spacing	Manual Brush	Prune	Plant (NSR)	BSP	SMP/TP	Survey (ST/FG)	Survey (Walkthru)
2000	13	4		196	58			800
2001		187		37	*50*	*300*	1162	482
2002	*150*	93		*50*		*200*	520	
2003	*150*	*30*	*44*			*300*	365	
2004	*150*	*30*	*6*				*150*	
2005	*150*	*49*					*150*	
2006							*150*	
2007							*150*	
2008							*150*	
2009							*150*	
2010							*150*	
Total	613	393	50	283	108	800	3097	1282

7.4 PRE 1987 NSR PLANS

Table 9. Plans for treatment of pre-1987 NSR areas.

Status	Area (ha)
Plant 2000	195
Plant 2001	37
Plant 2002	11
Probable fill-plant (Requires BSP's)	115
Probably Stocked (Requires re-survey)	102
Probable NCBr	28
Total March 2000 NSR	490

7.5 POTENTIAL INCREMENTAL SILVICULTURE TREATMENTS

Table 10. Summary of potential incremental silviculture treatment.

Activity	Area (ha)
Backlog	489
Spacing	667
Manual brushing	257
Chemical brushing	82
Pruning	140
Fertilization (spaced)	7011
Total	8646

8. APPENDIX II WORKSHOP SUMMARY

8.1 WORKSHOP OVERVIEW

A silviculture strategy workshop was facilitated by J.S. Thrower and Associates at the Grand Forks office of Pope and Talbot on January 25, 2000. The attendees are listed in Table 11 below. The objectives of the workshop were:

- to seek input from knowledgeable individuals with local experience in the application and evaluation of silvicultural treatments.
- to summarize management issues that might be addressed through silviculture.
- to discuss the current information about the responses to silvicultural treatments and it's relevance to TFL 8.

Table 11. List of workshop attendees.

Name	Affiliation
Steve Baumber, R.P.F	J.S. Thrower
Geoff Bekker, R.P.F.	Pope & Talbot
Ian Cameron, R.P.F.	J.S. Thrower
George Delisle	Pope & Talbot
Lyle LeClair, R.P.F.	Pope & Talbot
Gordon LeSergent, R.P.F	Ministry of Forests, Boundary District
Ivan Listar, R.P.F.	Ministry of Forests, Nelson Region
Mark Messmer, R.P.F.	J.S. Thrower
Randy Waterous	Pope & Talbot

The framework for the workshop was a series of presentations by J.S. Thrower staff on the principles of timber supply analysis, stand-level and forest-level effects of silvicultural treatments and management issues that affect timber supply analysis.

8.2 ISSUES IDENTIFIED

Discussions at the workshop brought to light some new issues and provided additional insight into other issues previously identified in the growth and yield strategy. The following section is an abridged summary of the issues identified and discussed at the workshop.

Issue	Background
Establishment to Free-Growing	• The time to reach green-up, as modelled in Timber Supply Analysis, may be too long. Local experience and ISIS summaries suggest that the time period may be shorter. • Early fertilization to hasten free growing has had mixed results locally. Some local trials do exist and should be examined. Fertilization may not help on brushy sites because nutrient deficiency is not the issue. • Local experience suggests that the issue of regeneration delay is best addressed by minimizing time lags between the harvesting, site preparation and planting phases. • Currently the proportion of planting stock derived from improved seed is 100% for Sx, 10% for Lw and 30% for Pl.
Forest Health	• An increase in mountain pine beetle activity may have little impact in the short term. Accelerated harvesting in the 1980s and early 1990s has left few susceptible stands. MPB may be more of an issue in the medium and long terms as regenerated stands approach the size and age of susceptibility. • For spruce budworm, the main areas of concern are IDF stands lower than 1100m elevation. • Stumping is a common practice on TFL 8, but is considered a basic obligation rather than incremental silviculture. • Stem rusts are not an extensive problem, but a small number of stands have suffered severe losses. • Trap tree programs for Douglas-fir beetle and spruce beetle have been effective. The practice may be less effective in the future if biodiversity or stand structure requirements prohibit the removal of large trees.
Mule Deer Winter Range (MDWR)	• Under current definitions, over 40% of TFL 8 has some designation for MDWR. By subzone, the MDWR covers 40% of MS, 90% of the IDF and 10% of the ICH. • The current focus of management in MDWR is partial cutting to meet cover requirements. A wildlife planning initiative is currently underway, and will address this issue in more detail.

Issue	Background
Product Objectives	• Pope & Talbot currently obtains premium prices for long length (24') dimension lumber, but they don't expect those premiums to be maintained in the medium and long term. High quality MSR lumber in 2X4 and 2X6 dimensions are viewed as the product likely to be in demand in the future.
Grazing	• Grazing takes place in all areas of the TFL. • The potential impacts of compaction and tree damage have not been assessed, but are a concern. • Potential silvicultural treatments to enhance grazing include wide spacing of trees and planting or seeding of forage species.
Biodiversity	• A re-evaluation of the definition of Natural Disturbance Type 4 (NDT4) is currently underway by the MOF and MOELP. Draft maps are available. A broader definition might impose partial cutting requirements over more area. The biggest concern is reallocating areas from "managed forest" to "open forest". Local experience suggests that large areas of the IDF and MS may actually have disturbance histories that don't fit the NDT4 definition. • Old Growth Management Areas (OGMAs) will place constraints on management, particularly in watersheds. There is a perception that old growth is in short supply even though Age Class 8 covers the most area on the TFL. Partial cutting may be able to accelerate the attainment of some old-growth characteristics in mature stands. There is general recognition that some attributes can only develop over long periods of time. • If seral stage distribution receives more attention in the future, there may be some additional stand structure requirements for TFL 8. Some of those may be met through silvicultural treatments. • For calculation of Equivalent Clearcut Area (ECA), stands approach 90% of recovery at a height of 9m. Fertilization may help attain 9m sooner in some areas. Use of improved stock may also hasten recovery.
Visual Quality Objectives	• The corridors for highways 3 and 33, and the Jewel Lake area have high scenic values. • The Kettle Valley Railway right-of-way does not currently have VQOs, but Pope & Talbot is aware of the high recreational use and is being proactive in their management.