TYPE II
FOREST LEVEL
SILVICULTURE STRATEGY

NORTH COAST TIMBER SUPPLY AREA

ANALYSIS REPORT

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EXECUTIVE SUMMARY

This Type II Silviculture Strategy for the North Coast Timber Supply Area (TSA) evaluates the impacts of various stand-level silviculture treatments on the total financial return from the TSA. Through the optimization of silviculture costs and harvest revenues, treatment regimes consider a balance between timber quality and quantity that result in the greatest financial return over the 200-year planning horizon.

The treatment scenarios in this analysis were determined at a stakeholder workshop attended by various government and industry representatives. Treatment scenarios were developed with the objective of examining opportunities to increase the quality and quantity of timber supply on the TSA.

This analysis is based on the data inputs and management assumptions developed for the Land and Resource Management Plan (LRMP) Base Case for the North Coast TSA. In order to model the impacts of silviculture treatments on the quality and quantity of timber supply on the TSA, some adjustments to this methodology have been made. Yield tables, developed using TASS, project the impacts of silviculture treatments on stand-level productivity and log quality. Woodstock, an optimization model, projects the impacts of these treatments over time while considering the current state of the land base, the maintenance of forest cover requirements for non-timber resource values, and the objective of maximizing financial return from the land base. Through benchmark analysis, in comparison with the LRMP Base Case, the impacts of these adjustments have been quantified and are shown to have minimal impact on timber supply.

The large component of hemlock natural ingress that occurs in many ecosystems in the North Coast TSA greatly reduces the forest-level impacts of planting as a silviculture management option. While operational planting does occur in the TSA, its impacts on timber supply at the forest-level are diluted due to the natural ingress. This condition reduces options for examining the impact of different planting regimes on the timber production and log quality. Historically, juvenile spacing of high and medium productivity cedar / hemlock stands has been the most significant form of incremental silviculture on the TSA.

The table below displays the results of each scenario as relative differences from the Base Case results. These percentages represent the change in the total for each value over the entire planning horizon. The scenarios in this table are sorted and ranked from the greatest positive change in NPV net revenue from the Base Case to the least (or greatest reduction).

Summary of Scenario Results.

Scenario / Variation	Total Harvest Volume (m^3)	Planning Horizon Totals ($ 1,000s)				NPV Net Revenue Rank
		Harvest Revenue	Total Costs	Net Revenue	NPV Net Revenue	
Base Case	102,910,901	8,582,634	5,661,296	2,921,338	614,655	n/a
% Difference from the Base Case						
Low Site Cedar Harvest ($300 / ha)	**31.200**	**27.961**	**34.153**	**15.963**	**10.948**	**1**
Low Site Cedar Harvest ($600 / ha)	31.100	27.814	34.571	14.719	10.727	n/a
Low Site Cedar Harvest ($1,200 / ha)	30.900	27.708	35.615	12.383	10.337	n/a
Low Site Cedar Harvest ($3,000 / ha)	30.700	27.503	38.887	5.440	9.250	n/a
Low Site Cedar Harvest ($6,000 / ha)	30.100	27.023	44.052	-5.979	7.522	n/a
Low Site Cedar Harvest ($300 / ha) - Max Vol.	39.000	34.553	41.964	20.190	-9.681	n/a
Red Alder (Evenflow)	**1.600**	**0.700**	**0.035**	**1.991**	**1.469**	**2**
Red Alder (Max)	1.600	0.748	0.151	1.906	1.569	n/a
Genetic	**0.800**	**-1.953**	**0.843**	**-7.370**	**0.407**	**3**
Genetic (Alt. Harvest)	0.300	-2.447	0.389	-7.941	0.123	n/a
Genetic (Max Vol)	1.400	-1.509	1.509	-7.358	-5.588	n/a
Juvenile Spacing - Logging Cost A[1]	**-0.120**	**0.025**	**-0.107**	**1.722**	**0.093**	**4**
Juvenile Spacing - Logging Cost B[1]	-0.076	0.579	-0.087	4.217	0.300	n/a
Juvenile Spacing - Logging Cost C[1]	0.709	2.039	1.246	7.358	1.349	n/a
Juvenile Spacing (Base Logging Costs)	**-**	**-**	**-**	**-**	**-**	**5**
Juvenile Spacing (Force)	-2.500	-0.940	-0.476	-1.841	-5.507	n/a
Juvenile Spacing (No Cost)	-	0.021	-0.005	0.072	0.082	n/a
JS-Prune	**-**	**-**	**-**	**-**	**-**	**6**
JS-Prune (No Cost)	-	0.340	-0.001	1.001	0.080	n/a
JS-Prune (Clear Value #2)	-	-	-	-	-	n/a
JS-Prune (Clear Value #3)	-	-	-	-	-	n/a
JS-Prune (Force)	-2.700	-0.639	1.427	-4.642	-9.409	n/a

[1] The percentages reported are in comparison with the Base Scenario with the same logging costs not the Base Case values in this table (See Section 5.3).

Shaded areas represent sensitivity analyses of already ranked scenarios and are not ranked individually.

These results demonstrate that of the scenarios tested, the largest return in terms of both volume and revenue occurs through the harvest and rehabilitation of low site, cedar-leading stands. The treatment with the next highest increase in financial return and overall harvest volume is the utilization of red alder. It is recognized that these scenarios reflect more of a shift in utilization within the TSA than a silviculture investment strategy.

Small financial and volume gains are realized through the use of genetically improved stock. Similarly, juvenile spacing produces a slight financial gain but only when higher logging costs in previously unharvested stands are considered. Juvenile spacing with pruning does not show measurable benefits at the TSA level even when clear wood values are increased. However, these results may also be sensitive to logging costs in a similar manner to juvenile spacing.

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1.0 INTRODUCTION

This Type II Silviculture Strategy provides strategic direction to silviculture planning and the allocation of scarce resources by determining the level, type and scheduling of discretionary silviculture expenditures that maximize the financial return on the North Coast Timber Supply Area (TSA). The purpose of this project is to identify how silviculture investments can improve the quality and quantity of timber supply on the TSA.

This Analysis Report is the second of three companion documents associated with the preparation of this *Type II Silviculture Strategy for North Coast Timber Supply Area*, namely:

- Data Package;
- Analysis Report; and
- Preferred Silviculture Strategy Report.

The Data Package describes the assumptions and information used in the Base Case and scenario analyses. This document describes and interprets the results of base case, benchmark and silviculture treatment analyses and will be used in consultation with stakeholders in the development of a preferred silviculture strategy.

The Land and Resource Management Plan (LRMP) process is currently underway in the North Coast Area and the *North Coast LRMP Resource Analysis Report – Timber Supply Analysis* (the LRMP Analysis Report) was released October 7, 2002. This Type II Silviculture Strategy analysis is based on data input decisions and management assumptions developed for the LRMP Base Case.

Silviculture treatments are applied to stands because it is believed that the treatment will assist in meeting management objectives for that stand. The stand-level effects of silviculture treatment are generally better understood than the impacts of a silviculture treatment regime at the forest-level. This project examines the impact of various silviculture treatment regimes on short, mid and long-term harvest forecast as well as their impacts on financial return and average product value in the North Coast TSA.

Opportunities for incremental silviculture treatments are limited within the North Coast TSA. This is primarily due to the high degree of natural ingress that generally occurs in many ecosystems that limits the forest-level impacts of planting as a silviculture treatment option. Historically, juvenile spacing has been the primary form of incremental silviculture undertaken on the TSA.

The *Type I Silviculture Strategy for the North Coast TSA (March 2000)* identifies tree and seedling damage from porcupine and deer as an issue for consideration and identified strategies to mitigate any potential timber supply impacts. The stakeholder group for this Type II Silviculture Strategy rejected these as potential scenarios as the timber supply impacts were thought to be negligible. Additionally, the recommendation for time-of-planting fertilization was rejected based on the fact that there was no information available regarding its effectiveness. The stakeholder group concluded that if any tree-level benefits did exist they would likely be short-lived and possibly overshadowed by hemlock natural ingress.

An incremental silviculture strategy should not be confused with the allowable annual cut (AAC) determination process. Allowable annual cut levels are based on actual practice and current information at the time of the determination. This strategy is concerned with planning for the future state of our forests over a 200-year planning horizon. The degree to which the strategy proves appropriate and is achieved may influence future, but not necessarily present AAC determinations.

2.0 INFORMATION PREPARATION

2.1 LAND BASE AND INVENTORY

Land base inventory information used in this analysis is provided by the Ministry of Sustainable Resource Management (MSRM) in the form of a non-spatial resultant database. This analysis uses the land base and inventory information as used for the LRMP analysis. Section 3.0 of the Data Package contains a complete listing of the information, source and vintage used in the development of this resultant.

The resultant database contains information for all land within the licence area, including areas where harvesting operations are not expected to take place. The timber harvesting land base (THLB) consists of all of the productive land expected to be available for harvest over the long-term. The THLB is determined by reclassifying the total land base according to specified management assumptions. Figure 1 provides a graphic representation of the land base reductions for the Base Case.

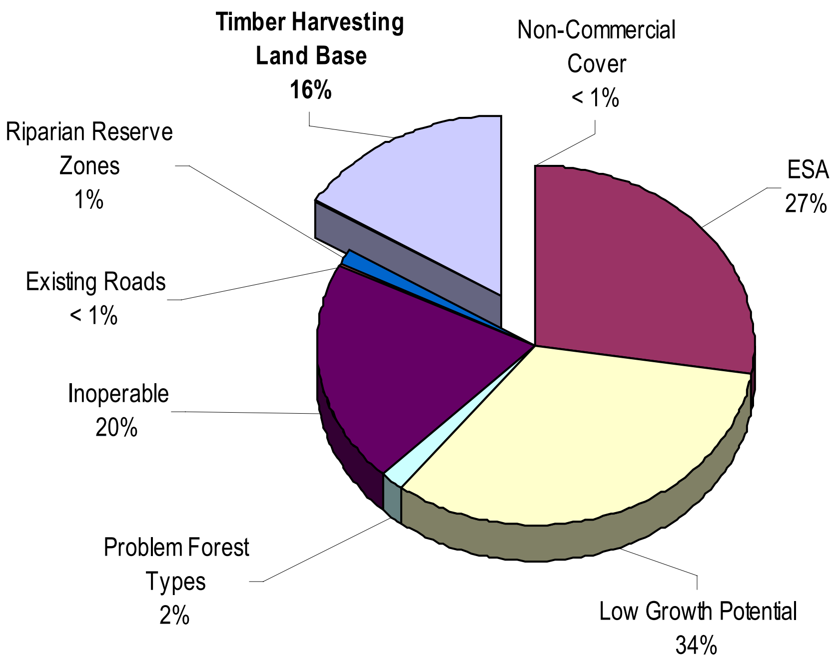

Figure 1: Land Base Classification.

Table 1 provides a summary of the areas removed for each land base reduction in determining the Base Case THLB.

Table 1: Timber Harvesting Land Base Determination – Base Case.

Land Base Classification	Land Base Reduction (ha)	Land Base Area (ha)
North Coast TSA		**1,875,334**
Not managed by MoF	191,104	
Non-forest	833,436	
Productive Forest Managed by the MoF		**850,794**
Non-commercial cover	335	
ESA	233,590	
Low growth potential	281,131	
Problem forest types	14,046	
Inoperable	171,554	
Existing roads	1,697	
Riparian reserve zones	11,118	
Timber Harvesting Land Base		**137,323**

2.2 GROWTH AND YIELD

Growth and yield traditionally refers to the prediction of age-volume relationships for a given stand over time. In order to capture the economic effects of silviculture treatments, yield information also includes a prediction of log yield by log grade and an estimation of associated log value. Value estimation allows for the incorporation of revenue-based objectives into the timber supply model and facilitates direct cost-benefit analysis.

Analysis units (AU) are the basic units to which growth and yield information is assigned to the land base. These are also the basic units to which silviculture treatments are applied. Figure 2 shows the distribution of analysis units across the THLB. The majority of the area is represented by hemlock / balsam leading analysis units.

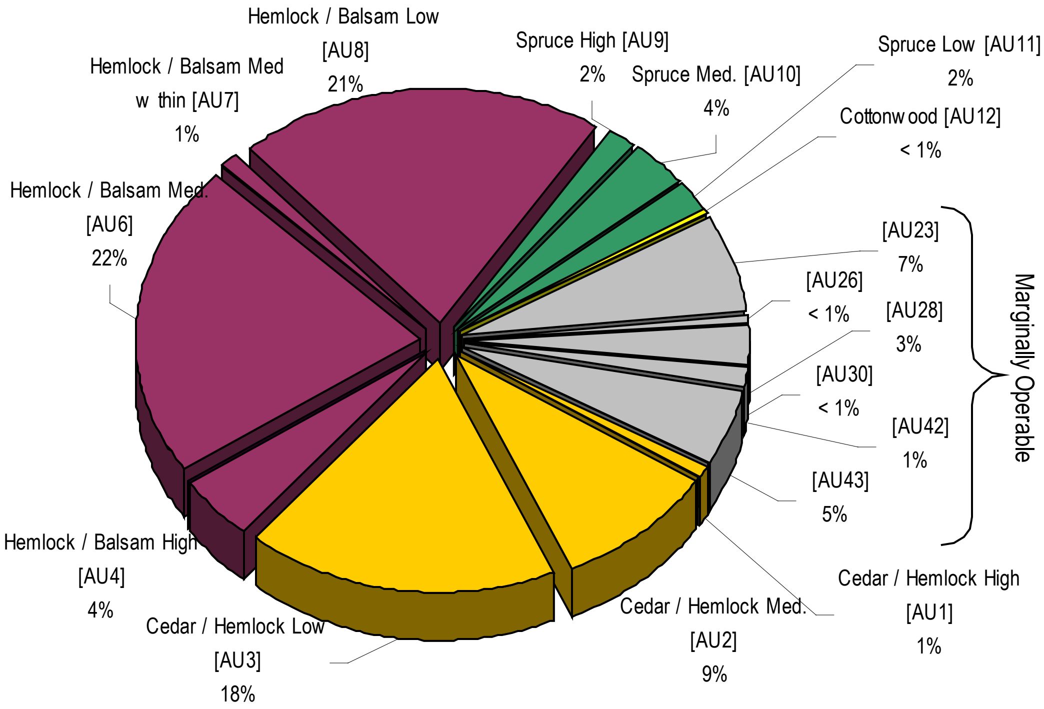

Figure 2: Analysis Unit Distribution by THLB.

Site index (SI), the height of a stand at age 50, is used to estimate site productivity and is a major determinant of how growth and yield models predict stand growth. For the purposes of this project, forest cover estimates of site productivity have been used for the Base Case and scenario analyses. This follows the decision of the LRMP not to include SIBEC site index values in the LRMP Base Case assumptions but rather to examine its impact through sensitivity analysis.

At the time of the LRMP analysis, five mapsheets had been classified using a predictive ecosystem mapping (PEM)-SIBEC approach. The primary reason for LRMP's decision to use forest cover site index values for the Base Case analysis, as stated in the *North Coast LRMP Description of Data Inputs and Assumptions for the Timber Supply Analysis Base Case for the North Coast TSA (May 16, 2002)* (the LRMP Data Package), is, "…there is some uncertainty regarding the application of predictive ecosystem mapping – site index – TSR analysis unit relationships from five mapsheets to the entire TSA …"

Yield tables for stands of natural origin (NSYT) are prepared using the Variable Density Yield Prediction batch application (VDYP batch version 6.6d). Managed stand yield tables (MSYT) are developed using the Tree and Stand Simulator (TASS). In addition to merchantable volume, TASS also produces merchantable volume by log grade to which log value information is applied, producing value curves (in dollars) for each managed stand analysis unit.

VDYP does cannot produce specific log grade information for natural stands. To overcome this limitation average value is calculated for each age, for each managed stand AU and these averages are applied *pro rata* to natural stand volumes, producing value tables for each natural stand analysis unit.

Minimum harvestable ages are determined using culmination ages, minimum diameter and minimum volume criteria as per the *Type II Forest Level Silviculture Strategy - North Coast Timber Supply Area – Data Package* (the Data Package). A detailed description of all growth and yield assumptions and methodology can be found in the Data Package.

2.3 MANAGEMENT PRACTICES

Timber supply is directly linked to current forest management activities. Current practices are modelled by matching model inputs to actual activity.

To model landscape level biodiversity objectives (old growth requirements) the land base is classified into units based on landscape unit (LU), biogeoclimatic ecosystem classification (BEC) to the variant level and natural disturbance type (NDT). Old forest requirements are assigned to each LU-BEC/NDT identified on the North Coast TSA.

Landscape level constraints are based on the draft biodiversity emphasis and associated Forest Practices Code (FPC) Biodiversity Guidebook old growth ages and minimum percentages for each LU-BEC/NDT.

Resource emphasis areas (REA) or management zones have been assigned to the land base for modelling purposes. Resource emphasis areas facilitate the application of management criteria. In this analysis, REA are defined on the basis of wildlife habitat, community watershed preservation and the maintenance of visual quality.

In his *North Coast Timber Supply Area Rationale for Allowable Annual Cut Determination (January 1, 2001)* the Chief Forester identifies clearcutting as the predominant silviculture system used in the North Coast TSA[1]. In the TSR analysis it is assumed that juvenile spacing occurs on approximately 200 ha per year, based on district estimates of past practices. The Base Case analysis for this project assumes that all stands are harvested using a clearcut silviculture system. Two analysis units (105 and 107) are identified as having juvenile spacing treatment. Both these assumptions are consistent with the LRMP Base Case.

3.0 FOREST ESTATE MODELLING

Woodstock is the primary forest estate model used in this analysis. This model, developed by Remsoft, provides functionality in modelling and utilizes optimization technology to provide a wide range of modelling capabilities.

Woodstock's capabilities allow for the incorporation of product class, revenue and cost information into an optimized harvest schedule based on the maximization of financial return from the TSA.

Benchmarking to LRMP Base Case analysis is conducted using the Forest Service Simulator (FSSIM) version 4.1b. This version of FSSIM was used in the LRMP analysis and uses sequential simulation to project forest management activities over time.

In all scenarios maximum disturbance and minimum retention requirements are explicitly enforced.

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3.1 OPTIMIZATION OF THE NET PRESENT VALUE OF NET REVENUE

In order to evaluate the financial viability of various forms of silviculture investment, the model has been formulated to perform management activities (harvest timber and apply silviculture treatments) in a manner that maximizes the total net present value (NPV) of the net revenue returned from the TSA across the entire planning horizon.

By discounting (through NPV calculation) both silviculture investment costs and financial returns through harvesting, the model is able to incorporate the cost of delay between an investment and return on that investment in determining the optimum investment strategy. In all treatment scenarios, the model will apply a silviculture treatment (make a silviculture investment) only if it produces a positive change in the NPV net revenue produced. If the financial gains resulting from a silviculture investment (after being discounted) do not exceed the cost of that investment then the model will choose not to apply that treatment.

In some scenarios, the model treats a small portion (or in some cases none) of the treatable area, indicating that the financial gains of additional treatment are outweighed by the treatment cost and therefore do not produce a financial gain. A discount rate of 4% is used in the calculation of NPV. Increasing the discount rate would result in decreased silviculture investment, as the return from investment would have to be greater in order to produce a positive net gain. As the discount rate increases, silviculture investment becomes less favourable as a financial option due to the delay between investment and return.

In scenarios where little or no silviculture investment occurs the results are similar to the Base Case scenario. In these situations, additional scenarios are conducted where the model is forced to treat a minimum of 90% of the treatable area. These scenarios do not provide a treatment regime based on optimizing NPV net revenue but rather provide insight into why some treatments are financially viable and others are not by showing how the treatment affects the land base and resulting revenue and volume production.

Many type II silviculture strategies conducted to date use volume production as the primary indicator of the value of a silviculture treatment. While these strategies provide valuable information with respect to how silviculture treatments affect the productivity of the land base, they have little or no consideration of how treatment costs, product value and most importantly, the delay between an investment and the return on that investment influence silviculture investment decisions. By incorporating financial indicators into management objectives the model is able to evaluate trade-offs between timber quality and quantity in making silviculture investment decisions.

One of the limitations of using financial return as an indicator of silviculture treatment value is that results depend heavily on product value and treatment cost, which might change significantly over time. This project attempts to overcome these limitations using the following approaches:

1) Product values and treatment costs are based on historical averages thereby reducing some of the influence of periodic fluctuations.
2) Silviculture scenarios are compared to the Base Case results based on their relative influence on revenue as opposed to the absolute revenue produced. This reduces the importance of actual product values in making decisions by placing the focus on how treatments change the product profile harvested.

3) For some scenarios, sensitivity analysis is conducted testing volume maximization (as opposed to revenue). For other scenarios where limited treatment occurs in the optimized revenue scenario, sensitivity analysis examines the results when treatment is forced on 90% of the treatable area. These sensitivity analyses help to identify if conclusions would differ from a volume maximization approach and why those differences might occur.

3.2 COST ADJUSTMENTS BASED ON TASS OUTPUT

In the Data Package (Section 5.3) average harvesting costs are reported as \$115.01/m^3. This cost, when added to average stumpage and regeneration costs would have resulted in many stands never achieving economic merchantability (they would never generate a positive financial return) even though they are part of the THLB. It is assumed that the economic operability mapping work already conducted in the North Coast has eliminated all stands from the THLB that are not economically operable. Therefore, harvesting costs were reduced to only include the tree to truck cost found in Table 19 of the Data Package. Table 2 shows the final adjusted costs used in the analysis. Treatment costs for each treatment remain unchanged from those reported in the Data Package and are described in Section 5.0.

Table 2: Adjusted Basic Cost Information.

Harvesting Cost	\$31.47/m^3
Stumpage Cost	\$17.48/m^3
Basic Regeneration Cost	\$1,782 / ha

In the analysis of red alder utilization (Section 5.6, below), no costs are applied to the harvest of red alder stands to ensure that the utilization of these stands are not compromised by the application of average cost information that does not account for red alder utilization. It addition, it is assumed that no regeneration costs are incurred in the harvesting of these stands.

4.0 BENCHMARK ANALYSIS (BASE CASE)

The LRMP Base Case forms the foundation for this Type II analysis. However, specific requirements of this Type II analysis dictate that certain deviations from this set of procedures and assumptions occur. This phase of the project explains these differences and quantifies their impacts on timber supply.

Managed stand yield tables (MYST) for the LRMP analysis were developed using the Table Interpolation Program for Stand Yields (TIPSY). Because of its enhanced functionality to model silviculture treatments and changes in log profile, TASS was used to develop MSYT for this project. Small differences can occur in similar yield tables produced using these two methods of growth and yield modelling – this analysis quantifies these differences. A comparison of the individual yield tables produced using TASS (Type II Base Case) and TIPSY (LRMP Base Case) shows slight differences but the harvest forecast results shown in Figure 3 indicates that these differences do not significantly affect the harvest forecast. Similarly, the operable growing stock comparison in Figure 4 shows little difference between these two scenarios. Both of these scenarios were conducted using FSSIM over a planning horizon of 400 years.

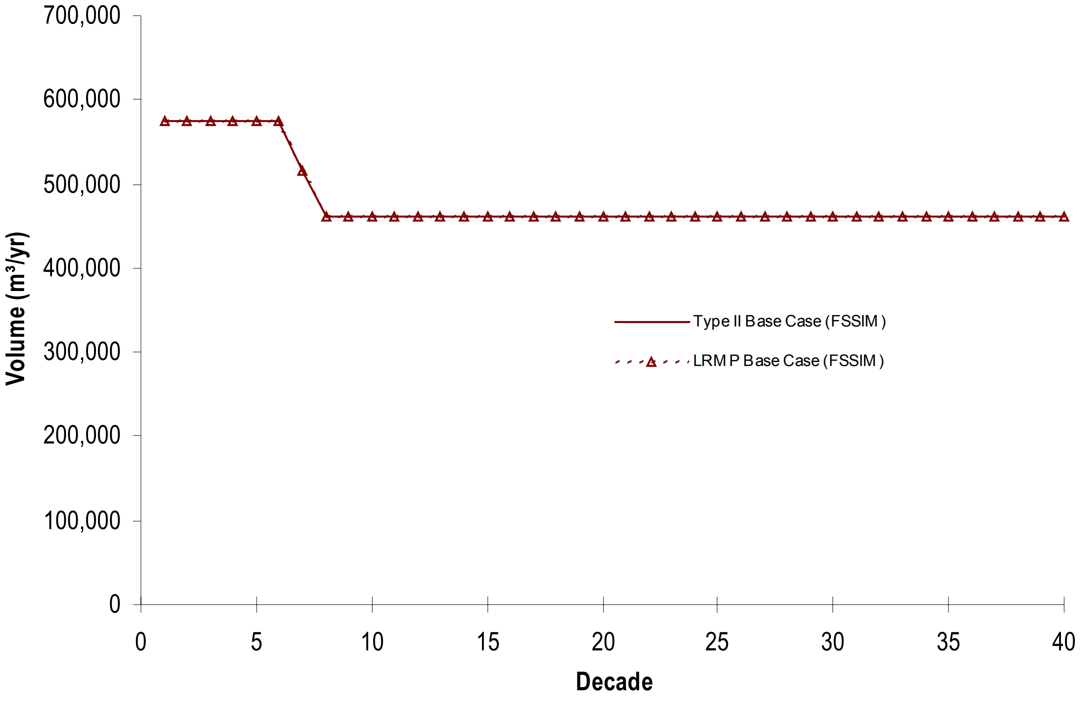

Figure 3: Harvest Forecast – Benchmark Analysis (Type II vs. LRMP).

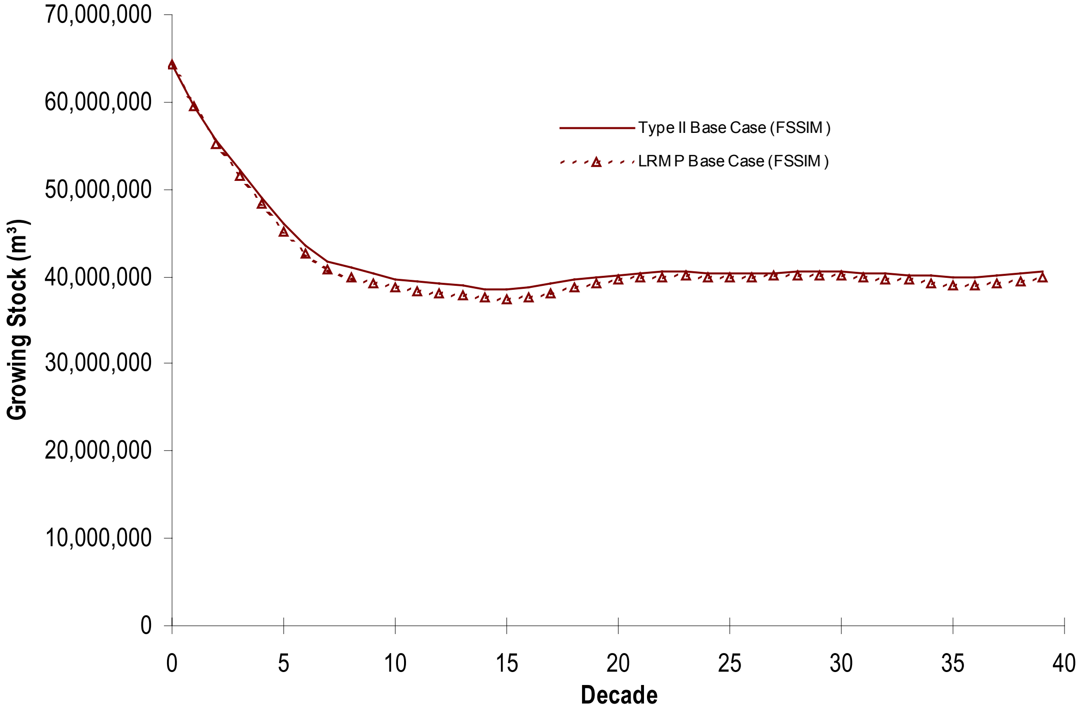

Figure 4: Operable Growing Stock – Benchmark Analysis (Type II vs. LRMP).

The other major deviation from the LRMP Base Case analysis is the use of Woodstock as opposed to FSSIM. Woodstock provides the capability to conduct economic analysis, increased reporting functionality and the ability to optimize harvest and treatment scheduling. Figure 5 compares harvest forecasts produced using FSSIM with the harvest forecasts produced using Woodstock. The slight increase in harvest forecast is attributable to Woodstock's ability to optimize scheduling. A Woodstock scenario using the TIPSY yield tables from the LRMP analysis is also shown in Figure 5. The dashed red line cannot be seen because the blue solid line obscures it.

Because of the complexity involved in the Woodstock optimization models the scenarios can only be run for a 200 year planning horizon as opposed to the 400 years in the FSSIM scenario. The time scale on the x-axis of Figure 5 is in decades. All subsequent harvest forecast graphs are measured in 5-year increments over a planning horizon of 200 years.

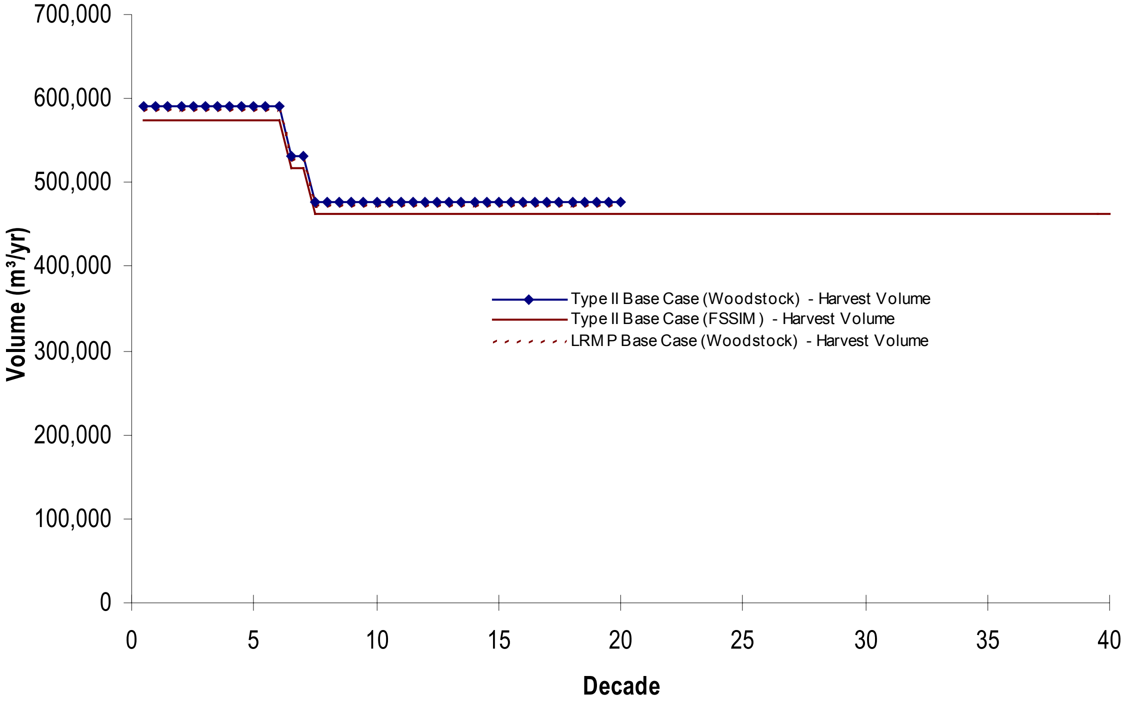

Figure 5: Harvest Forecast – Benchmark Analysis (FSSIM vs. Woodstock).

The harvest forecasts from all benchmarking scenarios are summarized in Table 3 and compared to the Type II FSSIM Base Case. The slight increases in harvest forecast for the two Woodstock scenarios can be attributed to the use of optimization versus sequential simulation in FSSIM.

Table 3: Harvest Forecast – Benchmark Analysis.

Decade	Harvest Levels (m^3/yr) and % Difference From Type II Base Case (FSSIM)						
	Type II Base Case (FSSIM)	LRMP Base Case (FSSIM)		Type II Base Case (Woodstock)		LRMP Base Case (Woodstock)	
1	573,624	573,624	-	591,911	3.2	585,377	2.0
2	573,624	573,624	-	591,911	3.2	585,377	2.0
3	573,624	573,624	-	591,911	3.2	585,377	2.0
4	573,624	573,624	-	591,911	3.2	585,377	2.0
5	573,624	573,624	-	591,911	3.2	585,377	2.0
6	573,624	573,624	-	591,911	3.2	585,377	2.0
7	516,262	516,262	-	531,711	3.0	525,831	1.8
8 – 20	462,000	462,000	-	477,532	3.4	472,240	2.2
21+	462,000	462,000	-	n/a	n/a	n/a	n/a

The operable growing stock graphs in Figure 6 shows slight differences between the FSSIM and Woodstock results, attributable to the differences in modelling methodology. Most importantly all scenarios begin at the same operable growing stock level and produce a stable growing stock indicating a sustainable long-term harvest level (LTHL).

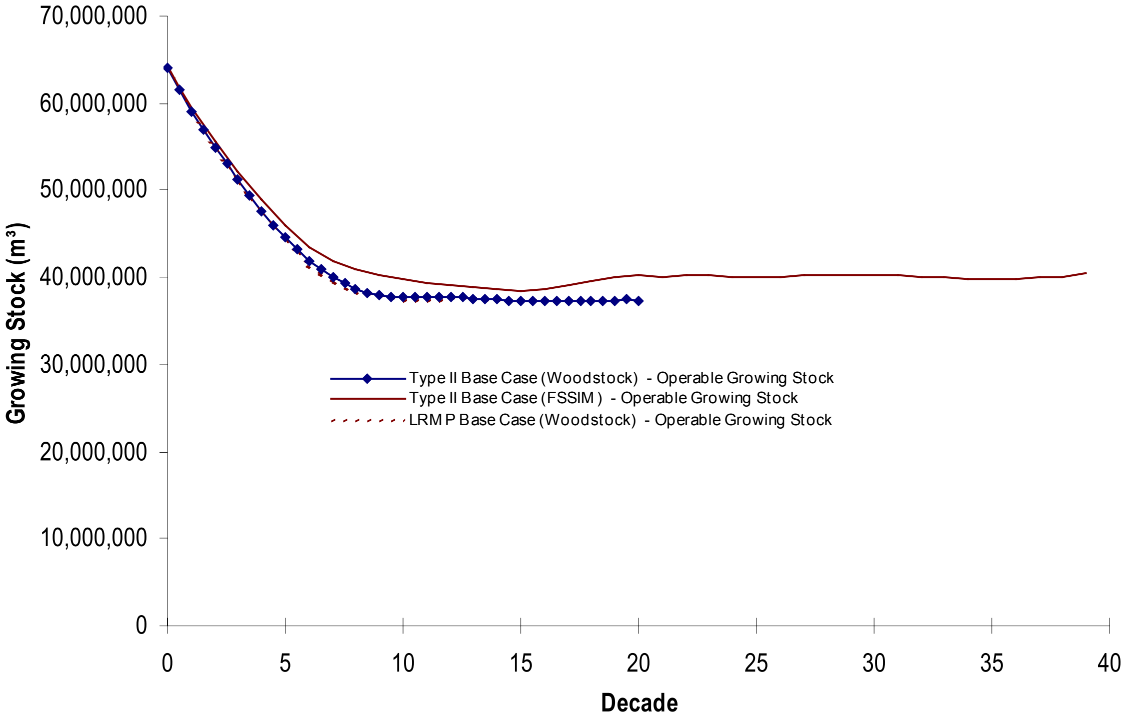

Figure 6: Operable Growing Stock – Benchmark Analysis (Type II vs. LRMP).

As shown in Figure 7 there is a shortage of stands in the THLB that are currently between the ages of 80 of 250 years. Therefore, the short-term timber supply in the TSA is predominantly determined by the amount of THLB currently 250+ years old. As this older, higher volume area is harvested a transition in harvest to younger, lower volume managed stands must occur. As this transition occurs, the harvest level must step down from the current AAC in order to maintain sustainability. The rate at which existing, natural stands are harvested (the AAC), in combination with the minimum harvest ages and productivity of future managed stands, will determine the timing and size of this falldown. Silviculture treatments are primarily aimed at delaying and decreasing the falldown.

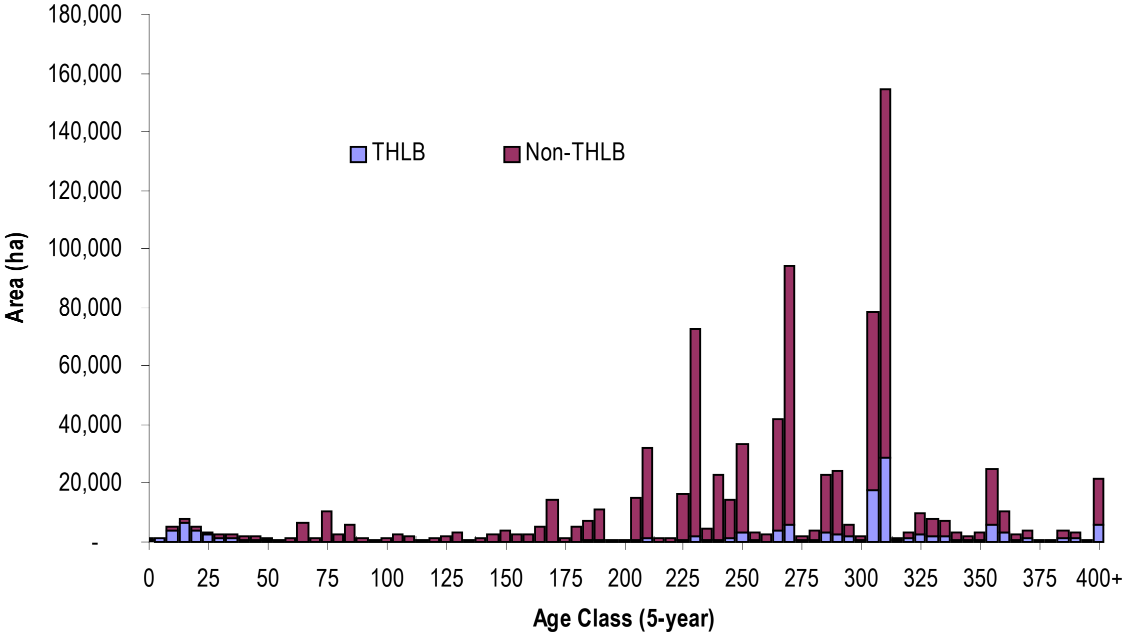

Figure 7: Current Age Class Distribution.

5.0 SILVICULTURE SCENARIOS

All scenarios are tested and compared against the Type II Base Case (the Base Case) and reflect incremental changes from Base Case assumptions. The assumptions used in the Base Case and scenario analyses are described in detail in the Data Package.

All analysis scenarios are optimized based on maximizing the financial return (the total NPV net revenue for the entire planning horizon) from the TSA. Through optimization, the model will alter the timing and location of silviculture treatments and harvest activities to produce the maximum possible NPV net revenue given the various harvest flow and forest cover requirements. In some scenarios variations are produced where volume production is maximized (*Max Vol.*).

None of these scenarios contain limitations on the maximum amount of silviculture investment. The model can prescribe silviculture treatments as long as treatable area is available as defined by individual treatment operability (see the Data Package). Sensitivity to budgetary limitations will be explored in the Preferred Silviculture Scenario (PSS).

5.1 SCENARIO #1: GENETICALLY IMPROVED STOCK

The ability to use genetically improved stock in the North Coast TSA is hampered by the current availability of class-A seed in the region as well as the large amount of hemlock ingress on many stands. In the Base Case, many analysis units are modelled as natural stands with an initial density of 10,000 stems per hectare (sph) to simulate this natural ingress, even though some planting does occur in the TSA. This scenario examines how the use of genetically improved seed under the current planting program might affect timber supply and quality on the TSA.

The growth and yield of stands is modelled using TASS. It is assumed that genetically improved seedlings are planted, followed by 10,000 sph of hemlock natural ingress. It is thought that some mortality of planted seedlings will occur but that the majority will survive to be harvested due to their competitive advantage over naturally regenerated hemlock seedlings.

The harvest forecasts resulting from the use of genetically improved seed are shown in Figure 8 and Table 4. The main scenario (*Genetic*) maximizes revenue, allowing additional volume to be harvested anywhere in the planning horizon. This results in a slight (0.8%) increase in harvest volume in the short, mid and long-term.

The first variation of this scenario (*Genetic (Alt. Harvest)*) attempts to direct any additional harvest volume towards extending the current AAC or reducing the falldown. In this variation, there is no increase in the short or long-term harvest level but the mid-term increases by 2.9%.

The second variation (*Genetic (Max Vol.)*) attempts to maximize volume production (as opposed to revenue), producing a slightly higher harvest volume than the other variations.

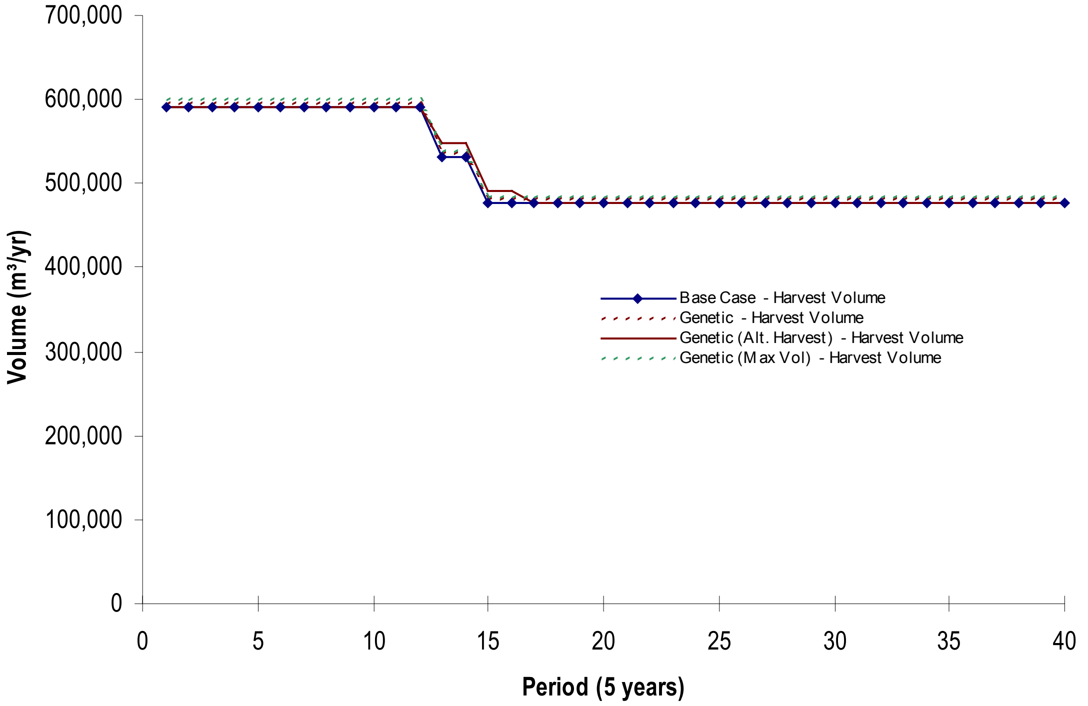

Figure 8: Harvest Forecast – Genetically Improved Stock Scenarios.

Table 4: Harvest Forecast – Genetically Improved Stock Scenarios.

Period (5-year)	Base Case (m³/yr)	Genetic (m³/yr)	% Difference	Genetic (Alt. Harvest) (m³/yr)	% Difference	Genetic (Max Vol) (m³/yr)	% Difference
1	591,911	596,393	0.8	591,911	-	600,248	1.4
2	591,911	596,393	0.8	591,911	-	600,248	1.4
3	591,911	596,393	0.8	591,911	-	600,248	1.4
4	591,911	596,393	0.8	591,911	-	600,248	1.4
5	591,911	596,393	0.8	591,911	-	600,248	1.4
6	591,911	596,393	0.8	591,911	-	600,248	1.4
7	591,911	596,393	0.8	591,911	-	600,248	1.4
8	591,911	596,393	0.8	591,911	-	600,248	1.4
9	591,911	596,393	0.8	591,911	-	600,248	1.4
10	591,911	596,393	0.8	591,911	-	600,248	1.4
11	591,911	596,393	0.8	591,911	-	600,248	1.4
12	591,911	596,393	0.8	591,911	-	600,248	1.4
13	531,711	535,745	0.8	547,493	3.0	539,215	1.4
14	531,711	535,745	0.8	547,493	3.0	539,215	1.4
15	477,532	481,163	0.8	491,735	3.0	484,285	1.4
16	477,532	481,163	0.8	491,735	3.0	484,285	1.4
17+	477,532	481,163	0.8	477,532	-	484,285	1.4
TOTAL	**102,910,901**	**103,692,169**	**0.8**	**103,210,747**	**0.3**	**104,364,148**	**1.4**

Table 5 shows total cost and revenue information for each variation of the genetically improved stock scenario. The harvest revenue, total cost and net revenue figures provide information on how each scenario variation affects financial aspects of the analysis. Scenario variations are evaluated based how NPV net revenue and average product value are affected in comparison with the Base Case figures. As shown below the two revenue maximization scenario's produce a slight positive financial return (higher NPV net revenue than the Base Case) while the volume maximization is lower than the Base Case. All three of these scenario variations produce lower average product values, a result of higher proportions of hemlock through ingress modelling.

It was decided that the natural ingress of hemlock should be modelled in the Genetically Improved Stock scenario. However, the Base Case yield tables (as with the LRMP Base Case) assume that ingress occurs in a variety of species. Because of this difference in growth and yield modelling assumptions the negative change in average product value may be overestimated for the genetic scenario variations due to the lower value of hemlock compared to other species. This factor likely contributes to the lower harvest revenue and net revenues (since harvest volumes are higher). In consideration of this factor, it is likely that the financial return of using genetically improved stock is higher than the 0.407% increase reported.

Table 5: Total Revenue / Cost Information – Genetically Improved Stock Scenarios.

Scenario / Variation	Planning Horizon Totals ($ 1,000s)				Average Product Value ($ / m³)[a]
	Harvest Revenue	Total Costs	Net Revenue	NPV Net Revenue	
Base Case	8,582,634	5,661,296	2,921,338	614,655	83.40
Genetic	8,415,036	5,708,995	2,706,041	617,154	81.15
% Difference	**-1.953**	**0.843**	**-7.370**	**0.407**	**-2.691**
Genetic (Alt. Harvest)	8,372,647	5,683,306	2,689,341	615,411	81.12
% Difference	**-2.447**	**0.389**	**-7.941**	**0.123**	**-2.730**
Genetic (Max Vol)	8,453,134	5,746,744	2,706,390	580,310	81.00
% Difference	**-1.509**	**1.509**	**-7.358**	**-5.588**	**-2.880**

[a] Percent difference is based on unrounded average product value and percentage may not equal the rounded percent difference.

The most important aspect of using NPV net revenue as the primary indicator of the success of silviculture treatments is that it accounts for the delay between investments and return on investment by discounting future costs and revenues. By evaluating scenarios in this manner, the timing of investments and revenues becomes an important factor. The *Genetic* scenario demonstrates this as the harvest and net revenues are both lower than the Base Case and the total costs are higher than the Base Case. Because of the timing of these costs and revenues the NPV net revenue is slightly higher. In this situation, mainly because of the slightly higher initial harvest level, the net revenue is higher than the Base Case at the beginning of the planning horizon (when NPV is high). This higher initial level is enough to overcome the fact that net revenue later in the planning horizon (when NPV is low) is lower than the Base Case, resulting in the total NPV net revenue being higher than the Base Case.

Figure 9 shows the average product value (harvest revenue per m^3 harvested) over time for each of the Genetically Improved Stock scenarios. The genetically improved stock scenario variations are generally lower than the Base Case likely due to the factors described above.

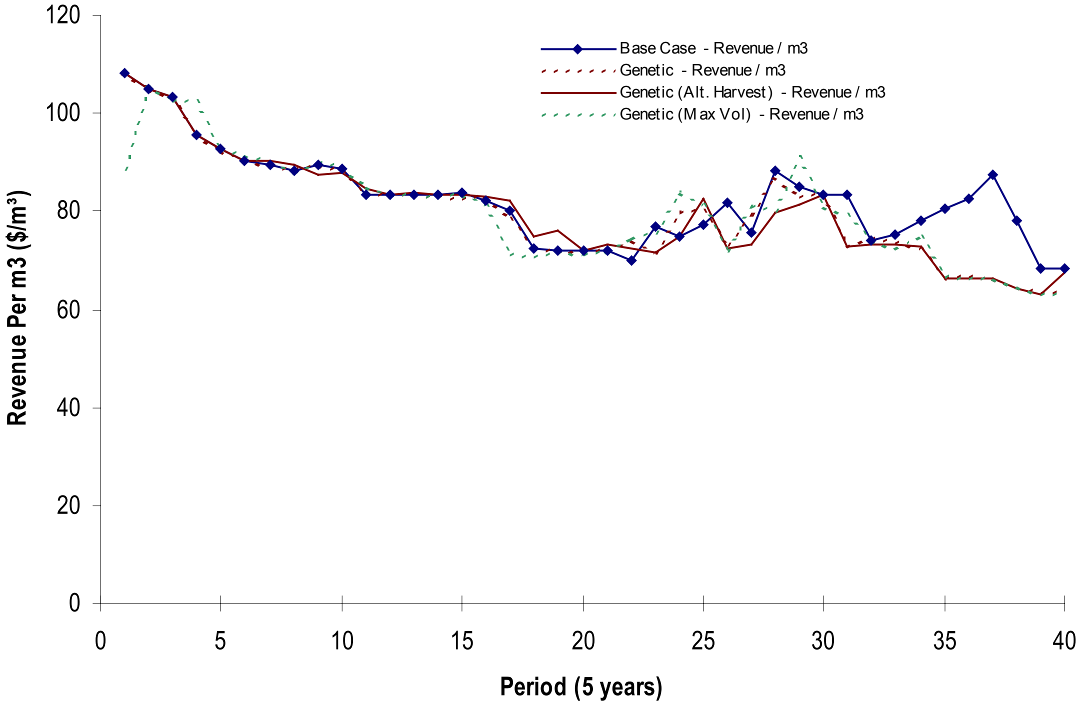

Figure 9: Product Value – Genetically Improved Stock Scenarios.

5.2 SCENARIO #2A: JUVENILE SPACING A (BASE CASE LOGGING COSTS)

The Base Case analysis assumes that juvenile spacing occurs on approximately 1,600 ha of hemlock / balsam-leading high and medium productivity sites. This scenario examines the impacts of expanding this treatment to all high and medium productivity hemlock, balsam and cedar-leading stands. These stands are treated at age 20 and are thinned to a density of 700 sph. The cost of this treatment is $1,900 / ha and is incurred at the time of treatment.

Figure 10 and Table 6 shows the harvest forecast resulting from this treatment regime. Variations of this scenario test the results when treatment is forced into 90% of the treatable area (*Juvenile Spacing (Force)*) as well as the sensitivity of results when no treatment costs are applied (*Juvenile Spacing (No Cost)*). Under the maximization of financial return scenario (*Juvenile Spacing*), no treatment is applied to the land base (Figure 11) and as a result the harvest forecast and financial outcome is identical to the Base Case. When treatment is forced the harvest forecast declines slightly. Eliminating the treatment cost results in an additional 1,400 ha being treated but does not significantly affect the harvest forecast for the TSA.

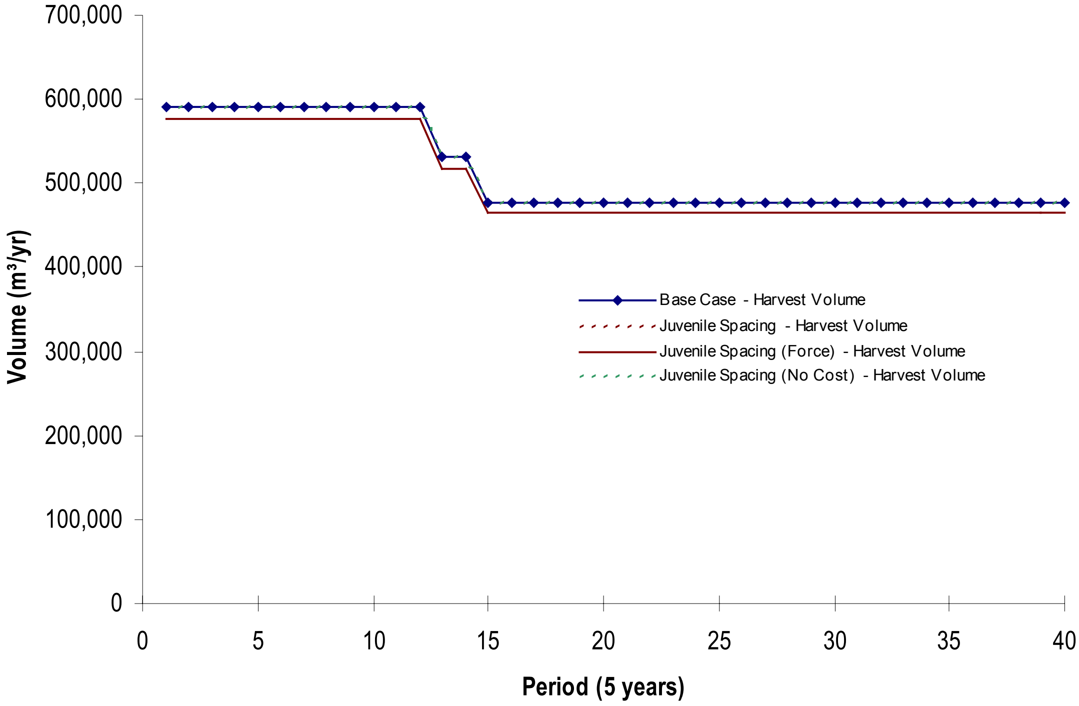

Figure 10: Harvest Forecast – Juvenile Spacing Scenarios.

Table 6: Harvest Forecast – Juvenile Spacing Scenarios.

Period (5-year)	Base Case (m³/yr)	Juvenile Spacing (m³/yr)	% Difference	Juvenile Spacing (Force) (m³/yr)	% Difference	Juvenile Spacing (No Cost) (m³/yr)	% Difference
1	591,911	591,956	-	577,203	-2.5	591,911	-
2	591,911	591,956	-	577,203	-2.5	591,911	-
3	591,911	591,956	-	577,203	-2.5	591,911	-
4	591,911	591,956	-	577,203	-2.5	591,911	-
5	591,911	591,956	-	577,203	-2.5	591,911	-
6	591,911	591,956	-	577,203	-2.5	591,911	-
7	591,911	591,956	-	577,203	-2.5	591,911	-
8	591,911	591,956	-	577,203	-2.5	591,911	-
9	591,911	591,956	-	577,203	-2.5	591,911	-
10	591,911	591,956	-	577,203	-2.5	591,911	-
11	591,911	591,956	-	577,203	-2.5	591,911	-
12	591,911	591,956	-	577,203	-2.5	591,911	-
13	531,711	531,752	-	518,474	-2.5	531,711	-
14	531,711	531,752	-	518,474	-2.5	531,711	-
15+	477,532	477,568	-	465,618	-2.5	477,532	-
TOTAL	**102,910,901**	**102,910,901**	**-**	**100,347,280**	**-2.5**	**102,910,901**	**-**

Because no treatment is scheduled in the revenue maximization scenario (*Optimized Treatment*), only the area available for treatment is shown in the treatment schedule below (Figure 11). Also shown below are the treatment schedules for the *No Treatment Cost* and the *Forced Treatment* scenarios.

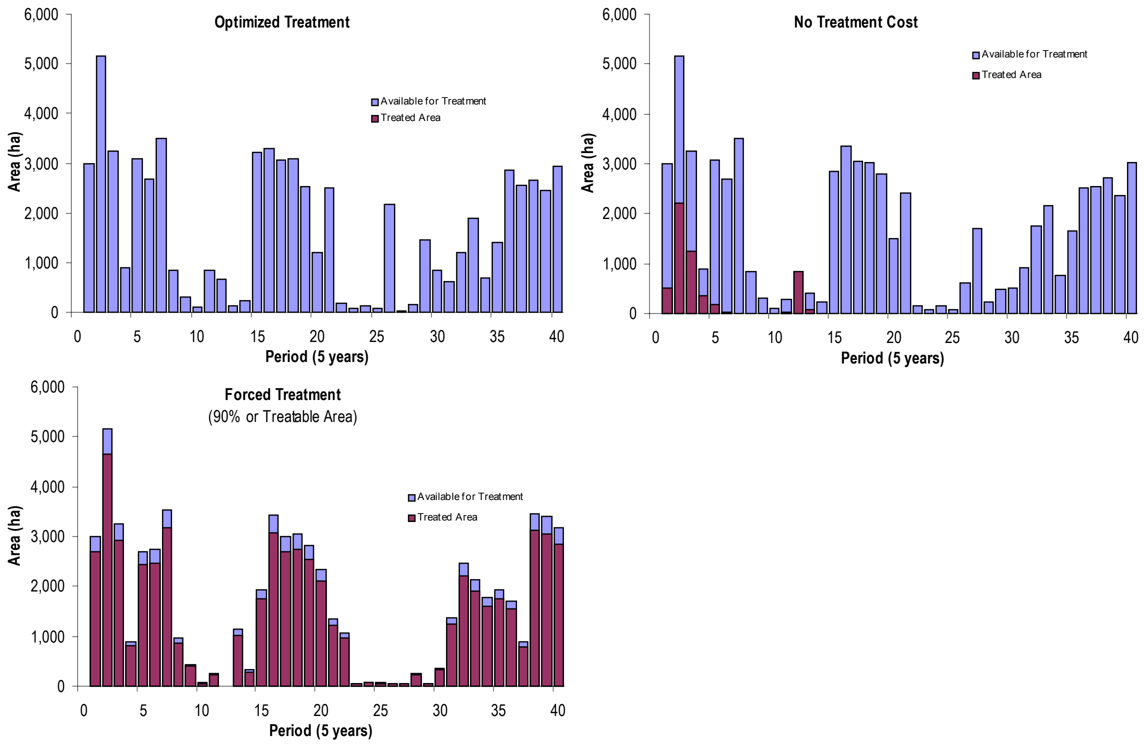

Figure 11: Treatment Schedule – Juvenile Spacing Scenarios.

The financial information in Table 7 shows that as expected, financial results do not change when no area is scheduled for treatment. As a result of forcing treatment, average product values increase but this is offset by the additional treatment costs, resulting in a reduced financial return over that of the Base Case. Setting the treatment cost to zero tests the sensitivity of the results to treatment cost. In this scenario variation some treatment is scheduled (Figure 11, above) and the average product value and NPV net revenue increase slightly over that of the Base Case.

Table 7: Total Revenue / Cost Information – Juvenile Spacing Scenarios.

Scenario / Variation	Planning Horizon Totals ($ 1,000s)				Average Product Value ($ / m³)[a]
	Harvest Revenue	Total Costs	Net Revenue	NPV Net Revenue	
Base Case	8,582,634	5,661,296	2,921,338	614,655	83.40
Juvenile Spacing	8,582,634	5,661,296	2,921,338	614,655	83.40
% Difference	-	-	-	-	-
Juvenile Spacing (Force)	8,501,927	5,634,362	2,867,565	580,805	84.73
% Difference	**-0.940**	**-0.476**	**-1.841**	**-5.507**	**1.590**
Juvenile Spacing (No Cost)	8,584,473	5,661,018	2,923,454	615,162	83.42
% Difference	**0.021**	**-0.005**	**0.072**	**0.082**	**0.021**

[a] Percent difference is based on unrounded average product value and percentage may not equal the rounded percent difference.

5.3 SCENARIO #2B: JUVENILE SPACING B (ALTERNATE LOGGING COSTS)

In this set of juvenile spacing scenarios the impacts of logging cost and post-spacing species composition are examined. In the previous juvenile spacing scenario one average logging cost was calculated across the TSA and was applied to each stand. During a review of the results it was determined that a significant difference in the cost of harvesting 2nd growth versus previously unharvested stands could potentially impact the economic value of juvenile spacing and pruning.

The primary stand-level benefit of juvenile spacing is a reduction in the minimum harvestable age through increased diameter growth. Slight increases in average stand value may also result from juvenile spacing. At the TSA level, juvenile spacing could potentially increase a constrained timber supply by decreasing the rotation ages, thereby increasing the amount of available timber. However the stand level benefits of decreased rotation ages will only translate into forest level gains if it can positively impact timber supply by making volume available at a time in the planning horizon when timber supply is limited (low available volume).

Within the North Coast TSA there is an abundance of timber harvesting land base that is currently 250+ years of age. The majority of this area is available for harvest and because of this timber supply is not highly constrained. Therefore, any increase in available volume generated through juvenile spacing does not significantly impact timber supply.

However, this does not take into account the difference in logging costs between 2nd growth stands, 2nd growth stands that have been spaced and, previously unharvested stands. Based on consultation with the stakeholder group it was decided that the profitability of harvesting previously unharvested stands was over estimated due to the application of average TSA logging costs. Further analysis was conducted to examine the TSA level impacts of these economic factors and the role of juvenile spacing in this context.

It is important to note that increasing logging costs in an economically driven timber supply model has the potential to limit that amount of area available for harvest at any particular time as the model will not usually harvest volume at a financial loss. The base case logging costs used in all other scenarios were developed under the assumption that economic operability mapping has already excluded any uneconomical areas from the timber harvesting land base. However, the logging costs used in these scenarios result in areas never achieving a positive financial return and as a result, never be harvested.

5.3.1 ADJUSTED LOGGING COSTS

Four different logging costs scenarios were conducted for each of the original base case and juvenile spacing scenarios (eight additional scenarios). Table 8 shows the logging costs applied to previously unharvested, 2nd growth and 2nd growth juvenile spaced stands for each of the scenarios. In addition to logging costs, all stands accrue a stumpage cost of $17.68/m^3 and a regeneration cost of $1,768/ha. The purpose of this sensitivity analysis is to determine the impacts that a juvenile spacing program might have using various logging cost assumptions. Therefore each juvenile spacing scenario in this section is compared with the base scenario (no juvenile spacing) with the same logging cost assumptions (JS – Logging Cost A compared with Base Logging Cost A, etc.)

Logging costs for 2nd growth untreated stands remains at $31.47/m^3 for all scenarios. This is based on the tree to truck costs reported in Table 19 of the Data Package. The *Logging Cost A* values shown in Table 8 have been adjusted from \$31.47/m^3 based on estimates of harvesting cost differences between previously unharvested, 2nd growth untreated and, 2nd growth spaced stands. It is anticipated that helicopter logging will be required for a higher proportion of future harvest in previously unharvested stands, an estimated increase of \$14/m^3. Additionally, road-building costs are anticipated to be higher in unharvested stands by approximately \$15/m^3. Also, bridge costs and haul costs are increased by one and two dollars per cubic metre respectively. This results in an increase of \$34/m^3 for the harvest of previously unharvested stands in comparison with 2nd growth untreated stands. It is anticipated, based on stakeholder experience, that harvesting costs in stands that have been spaced are approximately \$7/m^3 less than un-spaced stands due to increased piece size. Therefore, logging costs in 2nd growth spaced stands are reduced to \$21.47/m^3.

Table 8: Additional Logging Costs Tested.

Scenario Name	Logging Cost ($/m3)		
	Previously Unharvested	2nd Growth (Untreated)	2nd Growth (Juvenile Spaced)
Base Case	31.47	31.47	
Base – Logging Cost A	65.47	31.47	
Base – Logging Cost B	75.47	31.47	
Base – Logging Cost C	85.47	31.47	
JS	31.47	31.47	31.47
JS – Logging Cost A	65.47	31.47	24.47
JS – Logging Cost B	75.47	31.47	24.47
JS – Logging Cost C	85.47	31.47	24.47

For *Logging Costs B* and *C* the costs are increased for previously unharvested stands by \$10/m^3 and \$20/m^3 respectively in order to determine the impacts of higher logging costs on the base case timber supply as well as the ability of juvenile spacing to increase the amount of profitable volume harvested.

It is important to note that the purpose of these logging cost scenarios is not necessarily to determine the exact cost of harvesting these stands but rather to gain an understanding of how different logging costs might affect base case timber supply as well as to determine how successful juvenile spacing might be at increasing timber supply in these situation.

5.3.2 ADJUSTED SPECIES COMPOSITION

It is assumed that Juvenile Spacing treatments will target hemlock ingress thereby shifting the species composition. Table 9 below, shows that species composition and minimum harvestable age (MHA) with and without treatment.

Table 9: Species Composition and Minimum Harvest Ages for Treated Stands .

Analysis Units Available for JS	THLB Area (ha)	Description	Untreated		After Juvenile Spacing	
			Species Composition (%)	MHA (years)	Species Composition (%)	MHA (years)
101	1,300	Cedar, Hemlock / Cedar - High	Cw(40)Hw(40)Ss(10)Ba(10)	70	Cw(60)Hw(20)Ss(10)Ba(10)	60
102	12,404	Cedar, Hemlock / Cedar – High	Cw(40)Hw(40)Ss(10)Ba(10)	120	Cw(60)Hw(20)Ss(10)Ba(10)	100
104	6,160	Hemlock, Balsam – High	Hw(65)Ba(20)Ss(15)	70	Ba(40)Ss(40)Hw(20)	55
106	29,763	Hemlock, Balsam – Medium	Hw(60)Ba(15)Ss(15)	115	Ba(30)Ss(30)Cw(20)Hw(20)	90

5.3.3 RESULTS

The majority of stands harvested in the first 50-60 years of the base case are previously unharvested stands. As the cost of harvesting previously unharvested stands increases, these stands become uneconomical to harvest. As a result, the initial harvest level decreases as is shown in Figure 12 and Table 18. Juvenile spacing has very little impact on timber supply at any of logging cost levels.

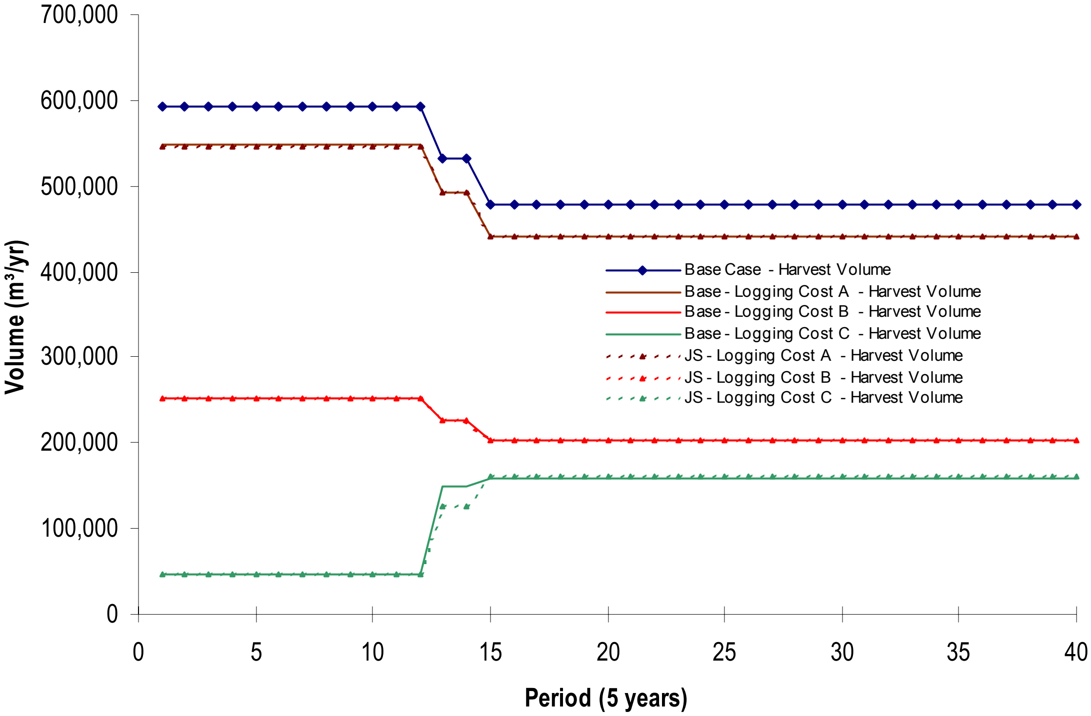

Figure 12: Harvest Forecast – Juvenile Spacing Scenarios at Various Logging Costs.

Table 10: Harvest Forecast – Juvenile Spacing Scenarios at Various Logging Costs.

Period (5-year)	Base - Logging Cost A (m^3/yr)	JS - Logging Cost A (m^3/yr)	% Difference	Base - Logging Cost B (m^3/yr)	JS - Logging Cost B (m^3/yr)	% Difference	Base - Logging Cost C (m^3/yr)	JS - Logging Cost C (m^3/yr)	% Difference
1	547,583	546,926	-0.1	251,881	251,691	-0.1	47,055	47,383	0.7
2	547,583	546,926	-0.1	251,881	251,691	-0.1	47,055	47,383	0.7
3	547,583	546,926	-0.1	251,881	251,691	-0.1	47,055	47,383	0.7
4	547,583	546,926	-0.1	251,881	251,691	-0.1	47,055	47,383	0.7
5	547,583	546,926	-0.1	251,881	251,691	-0.1	47,055	47,383	0.7
6	547,583	546,926	-0.1	251,881	251,691	-0.1	47,055	47,383	0.7
7	547,583	546,926	-0.1	251,881	251,691	-0.1	47,055	47,383	0.7
8	547,583	546,926	-0.1	251,881	251,691	-0.1	47,055	47,383	0.7
9	547,583	546,926	-0.1	251,881	251,691	-0.1	47,055	47,383	0.7
10	547,583	546,926	-0.1	251,881	251,691	-0.1	47,055	47,383	0.7
11	547,583	546,926	-0.1	251,881	251,691	-0.1	47,055	47,383	0.7
12	547,583	546,926	-0.1	251,881	251,691	-0.1	47,055	47,383	0.7
13	491,817	491,225	-0.1	225,684	225,513	-0.1	150,017	126,069	-16.0
14	491,817	491,225	-0.1	225,684	225,513	-0.1	150,017	126,069	-16.0
15	441,627	441,094	-0.1	202,107	201,954	-0.1	158,807	161,859	1.9
16	441,627	441,094	-0.1	202,107	201,954	-0.1	158,807	161,859	1.9
17	441,627	441,094	-0.1	202,107	201,954	-0.1	158,807	161,859	1.9
18	441,627	441,094	-0.1	202,107	201,954	-0.1	158,807	161,859	1.9
19	441,627	441,094	-0.1	202,107	201,954	-0.1	158,807	161,859	1.9
20	441,627	441,094	-0.1	202,107	201,954	-0.1	158,807	161,859	1.9
21+	441,627	441,094	-0.1	202,107	201,954	-0.1	158,807	161,859	1.9
TOTAL	**95,184,616**	**95,070,002**	**-0.1**	**43,643,650**	**43,610,558**	**-0.1**	**24,968,370**	**25,145,351**	**0.7**

Table 11 shows the financial information for Base (untreated) scenarios at the various logging cost levels. Expectedly, with higher logging costs in previously unharvested stands the financial return from these stands is lower than the base case. As the harvest levels decline in response to higher logging costs the total revenue, net revenue and NPV net revenue also decline. Total costs for Scenario B and C are lower even though per cubic metre logging costs are higher because the harvest levels are significantly lower.

Table 11: Total Revenue / Cost Information – Base Case Scenarios (no treatment) at Various Logging Costs.

Scenario	Planning Horizon Totals ($ 1,000s)			
	Total Revenue	Total Costs	Net Revenue	NPV Net Revenue
Base Case	8,582,634	5,661,296	2,921,338	614,655
Base - Logging Cost A	7,747,069	7,189,260	557,809	147,767
% Difference	**-9.736**	**26.990**	**-80.906**	**-75.959**
Base - Logging Cost B	3,776,545	3,192,234	584,311	50,560
% Difference	**-55.998**	**-43.613**	**-79.999**	**-91.774**
Base - Logging Cost C	2,195,629	1,910,771	284,858	12,467
% Difference	**-74.418**	**-66.249**	**-90.249**	**-97.972**

A total of 1,093 ha are treated in the *JS - Logging Cost A* scenario producing a slight increase in NPV net revenue (Table 12).

Table 12: Total Revenue / Cost Information – Juvenile Spacing Scenario (Logging Cost A).

Scenario	Planning Horizon Totals ($ 1,000s)			
	Total Revenue	Total Costs	Net Revenue	NPV Net Revenue
Base - Logging Cost A	7,747,069	7,189,260	557,809	147,767
JS - Logging Cost A	7,748,986	7,181,572	567,414	147,904
% Difference	**0.025**	**-0.107**	**1.722**	**0.093**

A further increase in the cost of harvesting previously unharvested stands from $65.14/m^3 to $75.14/m^3 results in a significant decrease in harvest level, indicating that this the point at which most of the previously unharvested stands become uneconomical to harvest. Applying juvenile spacing in this scenario produces a slightly larger increase in NPV net revenue (Table 13). A total of 2,621 ha are treated.

Table 13: Total Revenue / Cost Information – Juvenile Spacing Scenario (Logging Cost B).

Scenario	Planning Horizon Totals ($ 1,000s)			
	Total Revenue	Total Costs	Net Revenue	NPV Net Revenue
Base - Logging Cost B	3,776,545	3,192,234	584,311	50,560
JS - Logging Cost B	3,798,401	3,189,449	608,952	50,712
% Difference	**0.579**	**-0.087**	**4.217**	**0.300**

A further increase in logging costs for previously unharvested stands to $85.47/m^3 results in a further decrease in the initial harvest level. In this situation juvenile spacing provides a 1.35% increase in the overall financial return over the untreated scenario (Table 14).

Table 14: Total Revenue / Cost Information – Juvenile Spacing Scenario (Logging Cost C).

Scenario	Planning Horizon Totals ($ 1,000s)			
	Total Revenue	Total Costs	Net Revenue	NPV Net Revenue
Base - Logging Cost C	2,195,629	1,910,771	284,858	12,467
JS - Logging Cost C	2,240,401	1,934,582	305,819	12,636
% Difference	**2.039**	**1.246**	**7.358**	**1.349**

Table 15 and Figure 13 below show the total area treated with juvenile spacing and the timings of those treatments under the various logging cost assumptions. The area available for treatment varies depending on the harvest schedule (harvesting increases the area available for treatment). It each scenario less than 10% of the area available for treatment is treated indicating that financial gains from juvenile spacing are dependant on specific location and timing of its application.

Table 15: Total Area Treated – Juvenile Spacing Scenarios at Various Logging Costs.

Scenario	Total Area Treated (ha)	Total Area Available for Treatment (over 200 years) (ha)	% of Area Treated
JS - Logging Cost A	1,093	79,989	1.4%
JS - Logging Cost B	2,621	53,533	4.9%
JS - Logging Cost C	3,261	39,797	8.2%

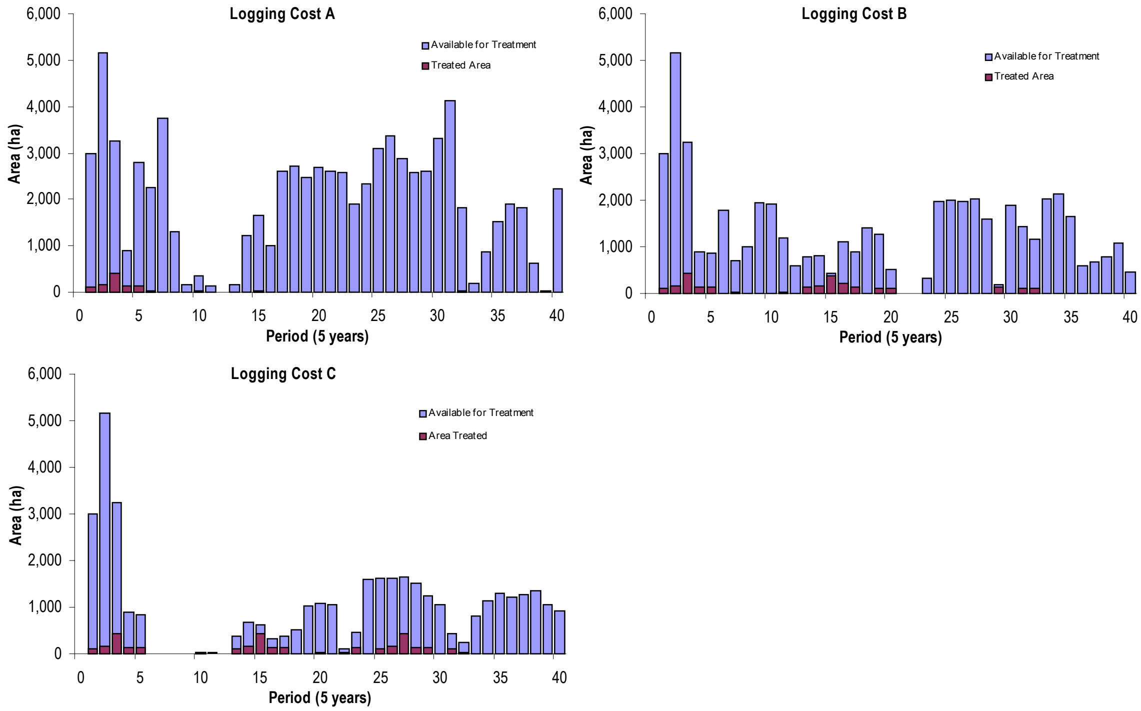

Figure 13: Treatment Schedule – Juvenile Spacing Scenarios at Various Logging Costs.

5.4 SCENARIO #3: JUVENILE SPACING – PRUNING

The report, *Clear Wood Price Premiums & Stand Value Gain from Pruning (July, 2002 - Draft1.2)* (Ministry of Forests, 2002) identifies that lumber "clear" of knots and defects has historically commanded higher prices over "not-clear" lumber. This scenario examines the impacts of juvenile spacing in combination with pruning on the financial return from the TSA. The sensitivity of the results to changes in treatment cost and clear wood value are also examined. According to the parameters used in grading logs from TASS output[2], grades B through F all have a requirement for a proportion of clear wood. Grades B and C do not apply to the cedar, hemlock or balsam and TASS produced no E-grade volume. Clear wood values applied to grade D and F logs are shown in Table 16. Clear wood values reported in Table 16 are based on *Average Domestic Coastal Log Selling Prices* as reported by the Ministry of Forests, Economic and Trade Branch (data package – Section 5.1).

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[2] Log grading parameters applied to TASS outputs provided by Ministry of Forest, Research Branch - September 19, 2002.

The treatment costs for this scenario includes $1,900 / ha for juvenile spacing plus $2,000 / ha for pruning for a total cost of $3,900 / ha.

Table 16: Clear Wood Value #1 – Juvenile Spacing – Pruning Scenarios.

Species	Log Value by Grade ($/m³)	
	D	F
Cedar	360.10	315.16
Hemlock / Balsam	203.02	137.32

The harvest forecasts in Figure 14 and Table 17 demonstrate that juvenile spacing with pruning treatments do not positively affect timber supply in the TSA. These results are similar to the juvenile spacing scenario:

- Under the revenue optimization scenario no treatment is applied;
- When treatment is forced the harvest forecast is reduced; and
- When no treatment cost is applied a small amount of treatment occurs.

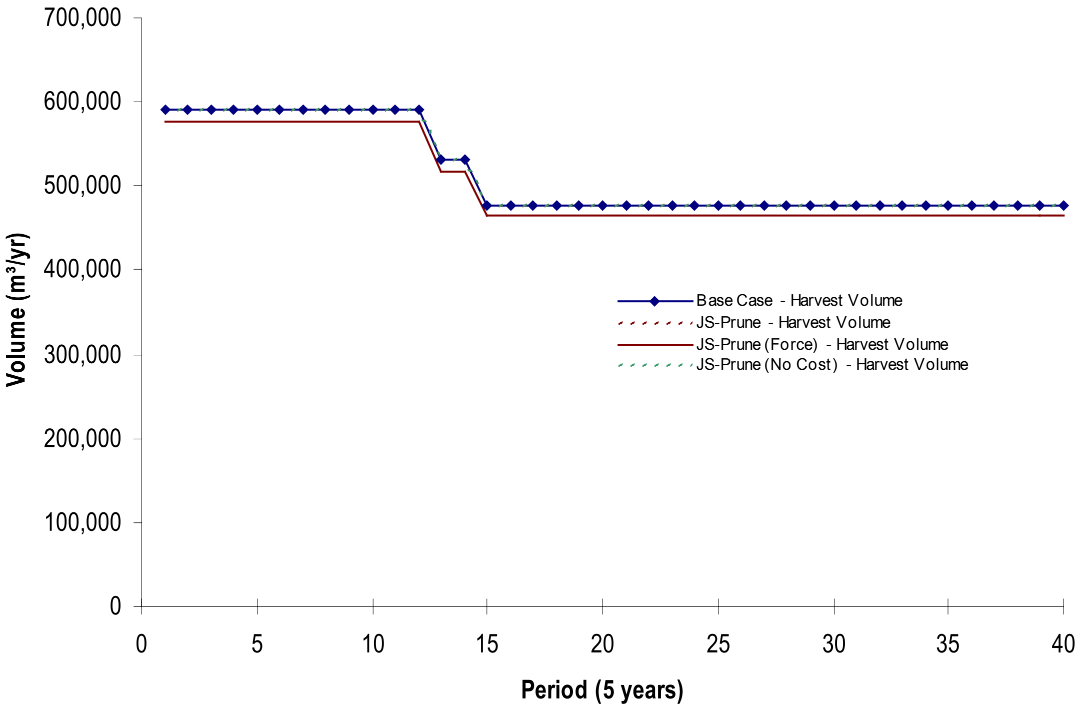

Figure 14: Harvest Forecast – Juvenile Spacing-Pruning Scenarios.

Table 17: Harvest Forecast – Juvenile Spacing-Pruning Scenarios.

Period (5-year)	Base Case (m^3/yr)	JS-Prune (m^3/yr)	% Difference	JS-Prune (Force) (m^3/yr)	% Difference	JS-Prune (No Cost) (m^3/yr)	% Difference
1	591,911	591,956	-	576,009	-2.7	591,911	-
2	591,911	591,956	-	576,009	-2.7	591,911	-
3	591,911	591,956	-	576,009	-2.7	591,911	-
4	591,911	591,956	-	576,009	-2.7	591,911	-
5	591,911	591,956	-	576,009	-2.7	591,911	-
6	591,911	591,956	-	576,009	-2.7	591,911	-
7	591,911	591,956	-	576,009	-2.7	591,911	-
8	591,911	591,956	-	576,009	-2.7	591,911	-
9	591,911	591,956	-	576,009	-2.7	591,911	-
10	591,911	591,956	-	576,009	-2.7	591,911	-
11	591,911	591,956	-	576,009	-2.7	591,911	-
12	591,911	591,956	-	576,009	-2.7	591,911	-
13	531,711	531,752	-	517,400	-2.7	531,711	-
14	531,711	531,752	-	517,400	-2.7	531,711	-
15+	477,532	477,568	-	464,652	-2.7	477,532	-
TOTAL	**102,910,901**	**102,910,901**	**-**	**100,139,295**	**-2.7**	**102,910,901**	**-**

Figure 15 shows the treatment schedule of these three scenario variations.

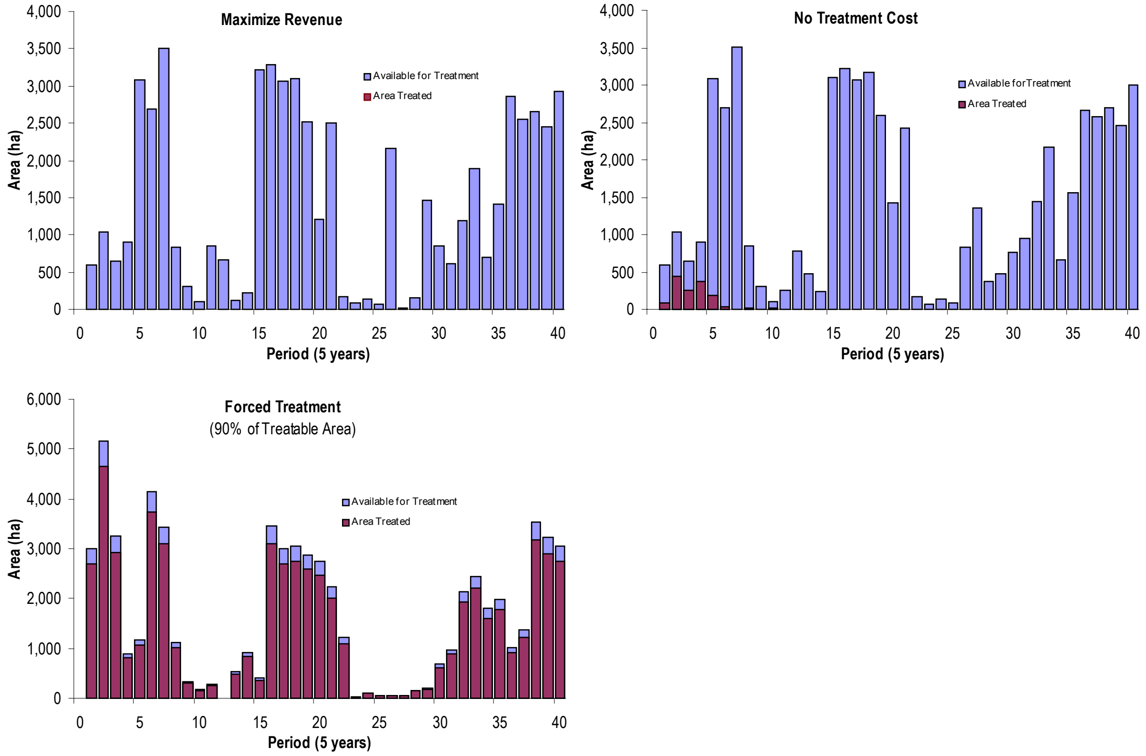

Figure 15: Treatment Schedule – Juvenile Spacing-Pruning Scenarios.

The financial information from juvenile spacing with pruning scenario variations is also quite similar to the juvenile spacing scenario variations. When treatment in this scenario is forced there is a larger decrease in NPV net revenue over that of the Base Case due to the higher treatment cost (compared to juvenile spacing alone). The average product value increase is higher than juvenile spacing alone due to an increased component of clear wood produced. However, the negative change in NPV net revenue indicates that this increase in product value is overshadowed primarily by the treatment cost and to a lesser extent by a decrease in overall productivity. Removing the treatment cost shows a very slight increase in average product value and NPV net revenue, corroborating this point.

Table 18: Total Revenue / Cost Information – Juvenile Spacing-Pruning Scenarios.

Scenario / Variation	Planning Horizon Totals ($ 1,000s) Harvest Revenue	Total Costs	Net Revenue	NPV Net Revenue	Average Product Value ($ / m³)[a]
Base Case	8,582,634	5,661,296	2,921,338	614,655	83.40
JS-Prune	8,582,633	5,661,295	2,921,337	614,655	83.40
% Difference	-	-	-	-	-
JS-Prune (Force)	8,527,791	5,742,061	2,785,730	556,823	85.16
% Difference	**-0.639**	**1.427**	**-4.642**	**-9.409**	**2.111**
JS-Prune (No Cost)	8,611,845	5,661,259	2,950,586	615,148	83.68
% Difference	**0.340**	**-0.001**	**1.001**	**0.080**	**0.340**

[a] Percent difference is based on unrounded average product value and percentage may not equal the rounded percent difference.

5.4.1 SENSITIVITY TO CLEAR WOOD VALUE

These scenario variations examine the sensitivity of these results to changes in the value of clear wood. The purpose of these variations is to see if higher clear wood values can result in juvenile spacing with pruning producing a positive financial return. To test this, two alternate clear wood value approximations were used and are shown in Table 19 and Table 20. The clear wood values in Table 19 (clear wood value #2) are based on the 20-year average prices for small clear lumber reported in *Clear Wood Price Premiums & Stand Value Gain from Pruning (Draft 2.1)* (MoF, 2002). In an effort to test even higher clear wood values the D-grade values from Table 16 are doubled to form clear wood value #3 (Table 20) and are applied to both D and F-grade volumes.

Table 19: Clear Wood Value #2 – Juvenile Spacing-Pruning Scenarios.

Species	Log Value by Grade ($/m³)	
	D	F
Cedar	467.13	467.13
Hemlock / Balsam	396.60	396.60

Table 20: Clear Wood Value #3 – Juvenile Spacing-Pruning Scenarios.

Species	Log Value by Grade ($/m³)	
	D	F
Cedar	720.20	720.20
Hemlock / Balsam	406.00	406.00

As shown in Figure 16 and Table 21, these increases in clear wood value have no impact on the harvest forecast because under the maximization of NPV net revenue no treatment is applied as the financial return from treatment is still negative. These results indicate that based on the cost of treatment and a wide range of clear wood values, juvenile spacing in combination with pruning is not a financially viable silviculture treatment option.

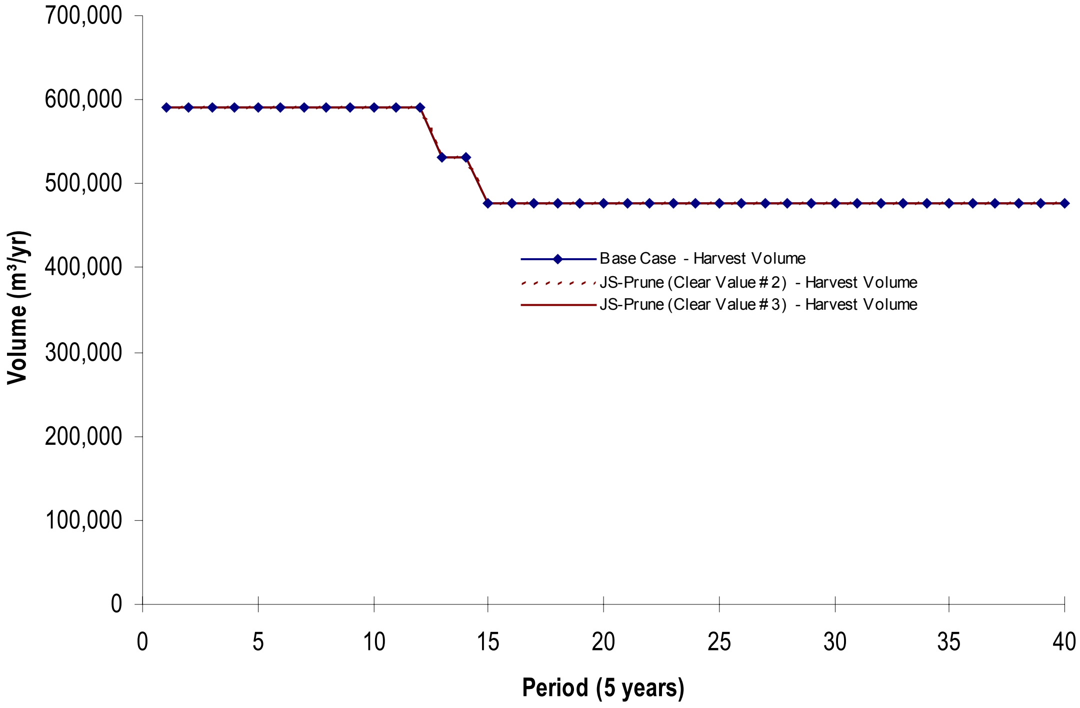

Figure 16: Harvest Forecast – Juvenile Spacing-Pruning Clear Value Scenarios.

Table 21: Harvest Forecast – Juvenile Spacing-Pruning Clear Value Scenarios.

Period (5-year)	Base Case (m^3/yr)	JS-Prune (Clear Value #2) (m^3/yr)	% Difference	JS-Prune (Clear Value #3) (m^3/yr)	% Difference
1	591,911	591,911	-	591,911	-
2	591,911	591,911	-	591,911	-
3	591,911	591,911	-	591,911	-
4	591,911	591,911	-	591,911	-
5	591,911	591,911	-	591,911	-
6	591,911	591,911	-	591,911	-
7	591,911	591,911	-	591,911	-
8	591,911	591,911	-	591,911	-
9	591,911	591,911	-	591,911	-
10	591,911	591,911	-	591,911	-
11	591,911	591,911	-	591,911	-
12	591,911	591,911	-	591,911	-
13	531,711	531,711	-	531,711	-
14	531,711	531,711	-	531,711	-
15+	477,532	477,532	-	477,532	-
TOTAL	**102,910,901**	**102,910,901**	**-**	**102,910,901**	**-**

Financial results of these scenario variations are not shown because they are identical to the Base Case as no treatments are applied.

5.5 SCENARIO #4: LOW SITES PRODUCTIVITY CEDAR HARVEST

This scenario examines opportunities to harvest cedar-leading sites that are excluded from the Base Case THLB because they have low site productivity (primarily SI <10). In the model it is assumed that some rehabilitation of these stands occurs following normal harvesting operations. Because these stands have low volume and wood value it is likely that harvesting will occur at a financial loss. A treatment cost of $300 / ha is applied to account for site preparation of some stands. This scenario tests whether these initial costs can result in long-term financial gains from the TSA by increasing the timber harvesting land base.

Two scenario variations are tested in Figure 17 and Table 22. The first scenario, *Low Site Cedar Harvest ($300 / ha)*, shows the harvest forecast based on maximizing financial return (total NPV net revenue) and the second scenario, *Low Site Cedar Harvest ($300 / ha) – Max Vol.*, shows the harvest forecast resulting from maximizing total harvest volume. In order to maximize volume production the model increases the long-term harvest level as every available stand is harvested. The maximize revenue scenario only treats and harvests stands that will produce a financial return, electing to leave some stands untreated and unharvested based on stand value and their contributions to other values on the land base (VQO, biodiversity, etc). Both of these scenarios produce sustainable growing stock levels although the growing stock of the maximize revenue scenario increases over time as unprofitable stands are left unharvested. Both scenarios show significant increases to short, mid and long-term harvest levels.

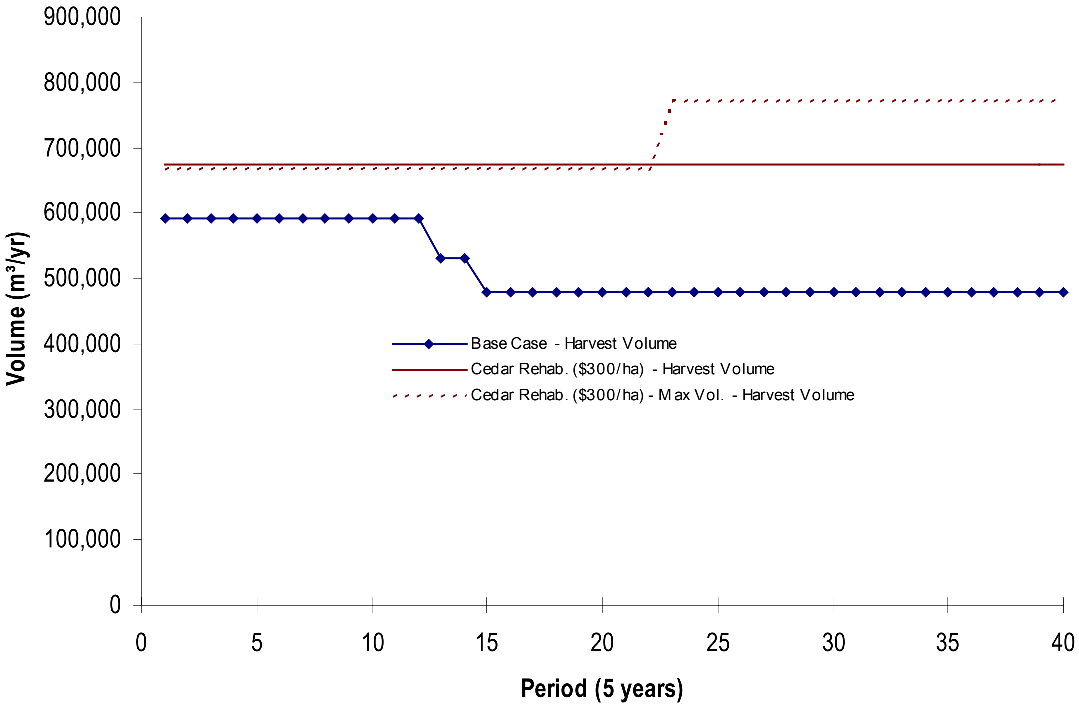

Figure 17: Harvest Forecast – Low Site Cedar Harvest Scenarios ($300 / ha).

Table 22: Harvest Forecast – Low Site Cedar Harvest Scenarios ($300 / ha).

Period (5-year)	Base Case (m³/yr)	Low Site Cedar Harvest ($300 / ha) (m³/yr)	% Difference	Low Site Cedar Harvest ($300 / ha) - Max Vol. (m³/yr)	% Difference
1	591,911	675,306	14.1	668,604	13.0
2	591,911	675,306	14.1	668,604	13.0
3	591,911	675,306	14.1	668,604	13.0
4	591,911	675,306	14.1	668,604	13.0
5	591,911	675,306	14.1	668,604	13.0
6	591,911	675,306	14.1	668,604	13.0
7	591,911	675,306	14.1	668,604	13.0
8	591,911	675,306	14.1	668,604	13.0
9	591,911	675,306	14.1	668,604	13.0
10	591,911	675,306	14.1	668,604	13.0
11	591,911	675,306	14.1	668,604	13.0
12	591,911	675,306	14.1	668,604	13.0
13	531,711	675,306	27.0	668,604	25.7
14	531,711	675,306	27.0	668,604	25.7
15-22	477,532	675,306	41.4	668,604	40.0
23+	477,532	675,306	41.4	772,323	61.7
TOTAL	**102,910,901**	**135,061,257**	**31.2**	**143,055,552**	**39.0**

Figure 18 shows the treatment schedules for the maximize revenue and maximize volume scenario variations. Once area available for cedar rehabilitation has been treated it becomes part of the THLB and will not be treated again; as area is treated the area available for treatment declines.

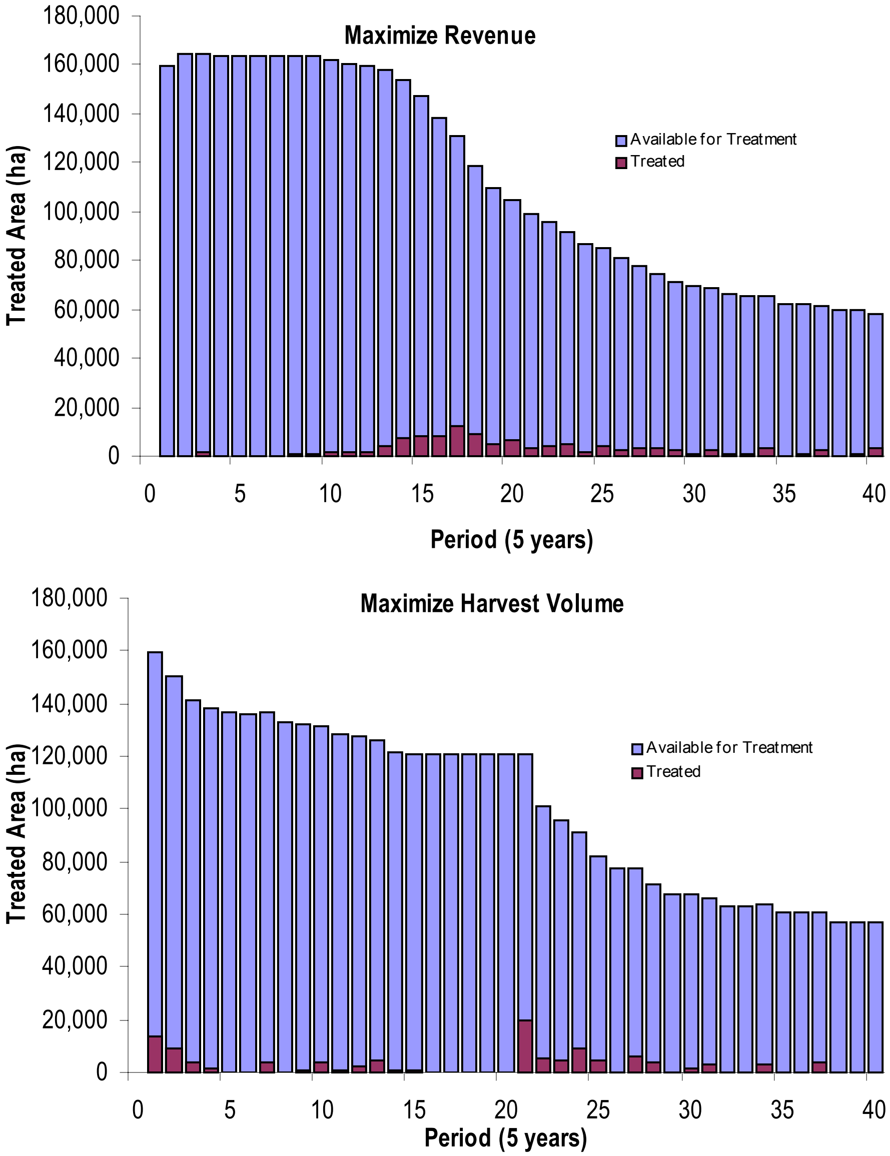

Figure 18: Treatment Schedule – Low Site Cedar Harvest Scenarios ($300 / ha).

Table 23 summarizes the financial information from each scenario variation. Both of the scenario variations below increase harvest revenue, costs and net revenues and lower average product value. Because it considers the timing of investment and harvest decisions, the revenue maximization scenario produces a much higher financial return than the volume maximization scenario. This example demonstrates that the timing of treatments can make the difference between a positive financial return and a negative one, underscoring the importance of accounting for treatment cost and timing in silviculture investment planning. The average product value for each of these scenario variations is lower than the Base Case as a higher proportion of the harvest comes from lower value rehabilitated stands.

Table 23: Total Revenue / Cost Information – Low Site Cedar Harvest Scenarios ($300 / ha).

Scenario / Variation	Planning Horizon Totals ($ 1,000s)				Average Product Value ($ / m^3)[a]
	Harvest Revenue	Total Costs	Net Revenue	NPV Net Revenue	
Base Case	8,582,634	5,661,296	2,921,338	614,655	83.40
Low Site Cedar Harvest ($300 / ha)	10,982,466	7,594,789	3,387,678	681,948	81.31
% Difference	**27.961**	**34.153**	**15.963**	**10.948**	**-2.499**
Low Site Cedar Harvest ($300 / ha) - Max Vol.	11,548,158	8,037,007	3,511,151	555,153	80.72
% Difference	**34.553**	**41.964**	**20.190**	**-9.681**	**-3.207**

[a] Percent difference is based on unrounded average product value and percentage may not equal the rounded percent difference.

5.5.1 SENSITIVITY TO TREATMENT COST

The sensitivity of the results above to changes in treatment cost is tested in the scenario variations below. Each scenario tests a different rehabilitation cost ranging from $600 / ha to $6,000 / ha while maximizing financial return. Figure 19 and Table 24 below shows the harvest forecasts resulting from these assumptions demonstrating that the optimum harvest forecast does not change significantly as treatment costs increase.

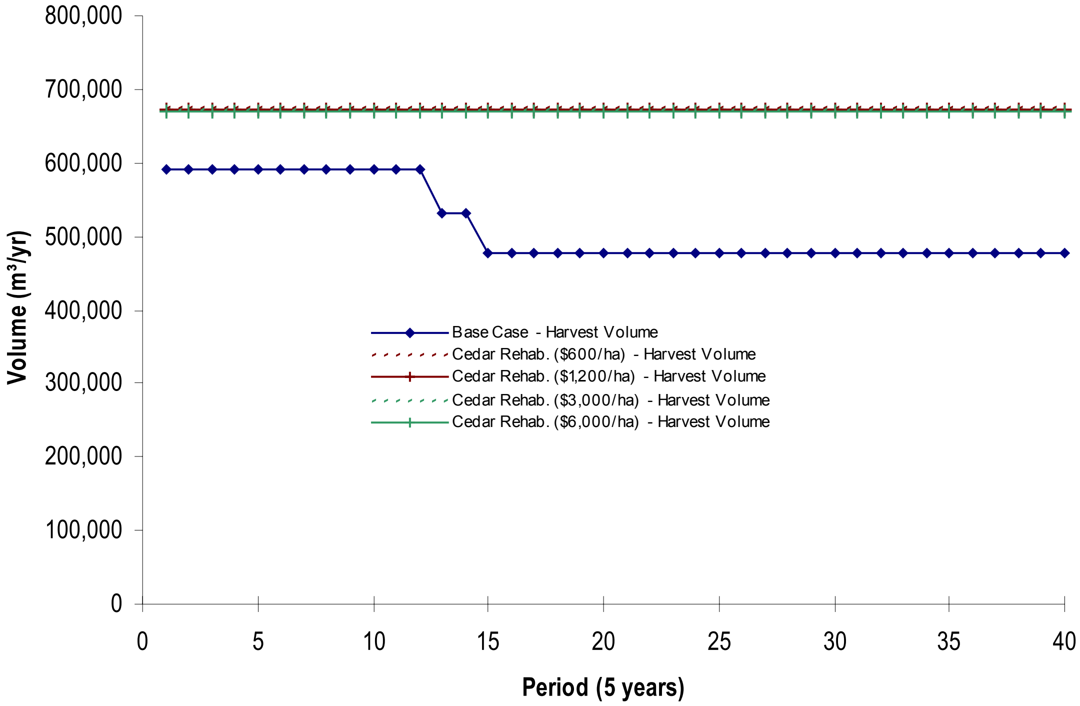

Figure 19: Harvest Forecast – Low Site Cedar Harvest Scenarios.

Table 24: Harvest Forecast – Low Site Cedar Harvest Scenarios.

Period (5-year)	Base Case (m^3/yr)	Low Site Cedar Harvest Treatment Cost Scenarios							
		$600 / ha ($m^3$/yr)	% Difference	$1,200 / ha ($m^3$/yr)	% Difference	$3,000 / ha ($m^3$/yr)	% Difference	$6,000 / ha ($m^3$/yr)	% Difference
1	591,911	674,420	13.9	673,739	13.8	672,517	13.6	669,610	13.1
2	591,911	674,420	13.9	673,739	13.8	672,517	13.6	669,610	13.1
3	591,911	674,420	13.9	673,739	13.8	672,517	13.6	669,610	13.1
4	591,911	674,420	13.9	673,739	13.8	672,517	13.6	669,610	13.1
5	591,911	674,420	13.9	673,739	13.8	672,517	13.6	669,610	13.1
6	591,911	674,420	13.9	673,739	13.8	672,517	13.6	669,610	13.1
7	591,911	674,420	13.9	673,739	13.8	672,517	13.6	669,610	13.1
8	591,911	674,420	13.9	673,739	13.8	672,517	13.6	669,610	13.1
9	591,911	674,420	13.9	673,739	13.8	672,517	13.6	669,610	13.1
10	591,911	674,420	13.9	673,739	13.8	672,517	13.6	669,610	13.1
11	591,911	674,420	13.9	673,739	13.8	672,517	13.6	669,610	13.1
12	591,911	674,420	13.9	673,739	13.8	672,517	13.6	669,610	13.1
13	531,711	674,420	26.8	673,739	26.7	672,517	26.5	669,610	25.9
14	531,711	674,420	26.8	673,739	26.7	672,517	26.5	669,610	25.9
15+	477,532	674,420	41.2	673,739	41.1	672,517	40.8	669,610	40.2
TOTAL	**102,910,901**	**134,883,916**	**31.1**	**134,747,725**	**30.9**	**134,503,307**	**30.7**	**133,922,081**	**30.1**

Figure 20 below shows that the treatment schedule does not vary significantly with changes in treatment cost. These treatments are focused near the middle of the planning horizon, during a transition from harvesting existing stands to harvesting managed stands. The ability of these treatments to provide harvest volume at a time when available volume is limited greatly contributes to the financial return of this scenario. The total area treated in each of these scenario variations is roughly the same.

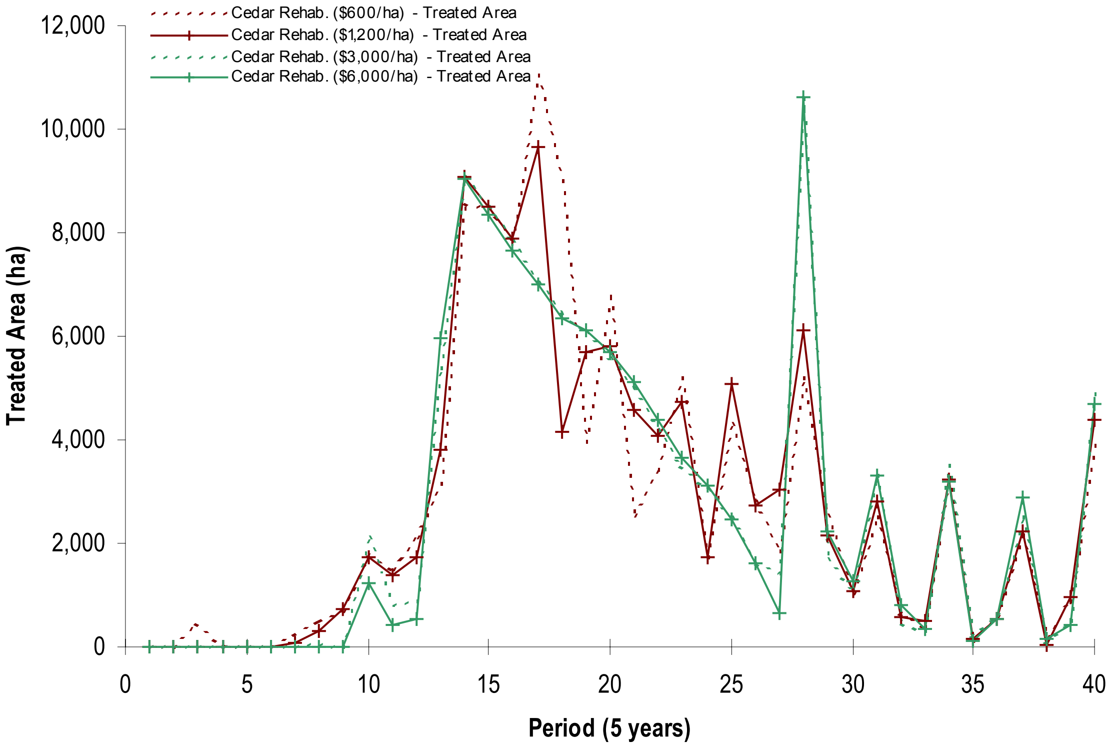

Figure 20: Treatment Schedule – Low Site Cedar Harvest Scenarios.

With similar volume harvested in each scenario variation the harvest revenues are consistent as well. As treatment cost increases total cost increases and net revenue decreases. The financial information for each of these scenario variations is shown in Table 25. Most importantly, these scenarios demonstrate (through a positive change in NPV net revenue) that the rehabilitation of these low site, cedar-leading stands is economically viable even at a treatment cost of $6,000 / ha. By providing additional merchantable volume in the mid-term (periods 10 to 20) the model is able to harvest higher value stands earlier in the planning horizon. This allowable cut effect[3], coupled with the increase in the THLB is the primary reason why this treatment produces such an economic gain.

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[3] Allowable cut effect - Allocation of anticipated future forest timber yields to the present allowable cut; this is employed to increase current harvest levels (especially when constrained by evenflow) by spreading anticipated future growth over all the years in the rotation. (http://forestry.about.com)

Table 25: Total Revenue / Cost Information – Low Site Cedar Harvest Scenarios.

Scenario / Variation	Planning Horizon Totals ($ 1,000s) Harvest Revenue	Total Costs	Net Revenue	NPV Net Revenue	Average Product Value ($ / m³)[a]
Base Case	8,582,634	5,661,296	2,921,338	614,655	83.40
Low Site Cedar Harvest ($600 / ha)	10,969,803	7,618,478	3,351,325	680,591	81.33
% Difference	**27.814**	**34.571**	**14.719**	**10.727**	**-2.483**
Low Site Cedar Harvest ($1,200 / ha)	10,960,669	7,677,581	3,283,088	678,193	81.34
% Difference	**27.708**	**35.615**	**12.383**	**10.337**	**-2.466**
Low Site Cedar Harvest ($3,000 / ha)	10,943,075	7,862,827	3,080,247	671,510	81.36
% Difference	**27.503**	**38.887**	**5.440**	**9.250**	**-2.446**
Low Site Cedar Harvest ($6,000 / ha)	10,901,881	8,155,217	2,746,665	660,891	81.40
% Difference	**27.023**	**44.052**	**-5.979**	**7.522**	**-2.391**

[a] Percent difference is based on unrounded average product value and percentage may not equal the rounded percent difference.

However, it should be noted that all sites classified as low site, cedar-leading are eligible for treatment with no consideration of access. It is also assumed that all stands, following rehabilitation, are capable of producing economically merchantable stands. These assumptions should be confirmed prior to treatment.

As described in the Data Package, a project is currently underway to provide better estimates of site productivity for the North Coast TSA. Preliminary results indicate that revised site index estimates are considerably higher than the forest cover site indices used in this analysis. Increasing the site index of these stands will result in much less of the land base being excluded as low site, likely producing results similar to those experienced in this scenario.

5.6 SCENARIO #5: RED ALDER UTILIZATION

The objective of this scenario is to determine what levels of red alder harvest can be sustained in the North Coast TSA. In the LRMP and TSR analyses, red alder is not considered an economically viable species and therefore red alder-leading stands are excluded from the THLB. This scenario includes 1,941 ha of red alder-leading stands into the THLB and examines different rates of red alder harvest.

Figure 21 and Table 26 shows the harvest forecast with red alder included, resulting in a 1.6% increase in the overall harvest levels.

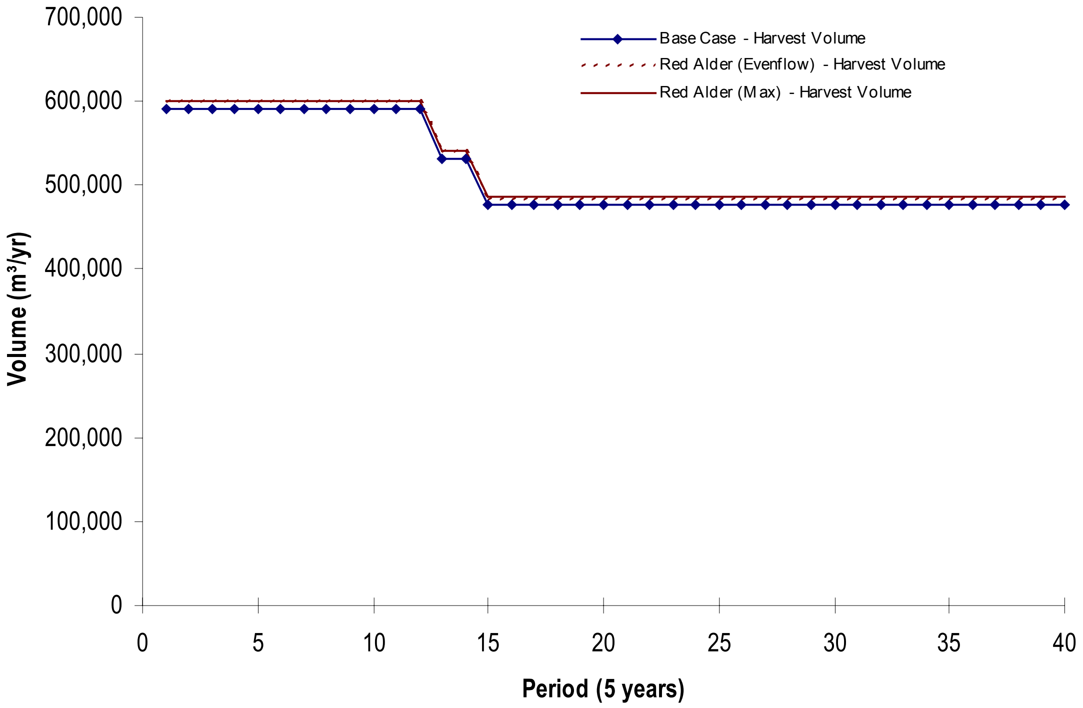

Figure 21: Harvest Forecast – Red Alder Utilization Scenarios.

Table 26: Harvest Forecast – Red Alder Utilization Scenarios.

Period (5-year)	Base Case (m^3/yr)	Red Alder (Max Even) (m^3/yr)	% Difference	Red Alder (Max) (m^3/yr)	% Difference
1	591,911	601,271	1.6	601,467	1.6
2	591,911	601,271	1.6	601,467	1.6
3	591,911	601,271	1.6	601,467	1.6
4	591,911	601,271	1.6	601,467	1.6
5	591,911	601,271	1.6	601,467	1.6
6	591,911	601,271	1.6	601,467	1.6
7	591,911	601,271	1.6	601,467	1.6
8	591,911	601,271	1.6	601,467	1.6
9	591,911	601,271	1.6	601,467	1.6
10	591,911	601,271	1.6	601,467	1.6
11	591,911	601,271	1.6	601,467	1.6
12	591,911	601,271	1.6	601,467	1.6
13	531,711	540,135	1.6	540,312	1.6
14	531,711	540,135	1.6	540,312	1.6
15+	477,532	485,113	1.6	485,273	1.6
TOTAL	**102,910,901**	**104,542,339**	**1.6**	**104,576,587**	**1.6**

Figure 22 shows the annual red alder harvest under two different harvest flow policies. The first scenario variation produces an evenflow red alder harvest while the second maximizes the harvest of red alder. Based on this analysis, the North Cost TSA can support the harvest of approximately 7,368 m^3/yr of red alder.

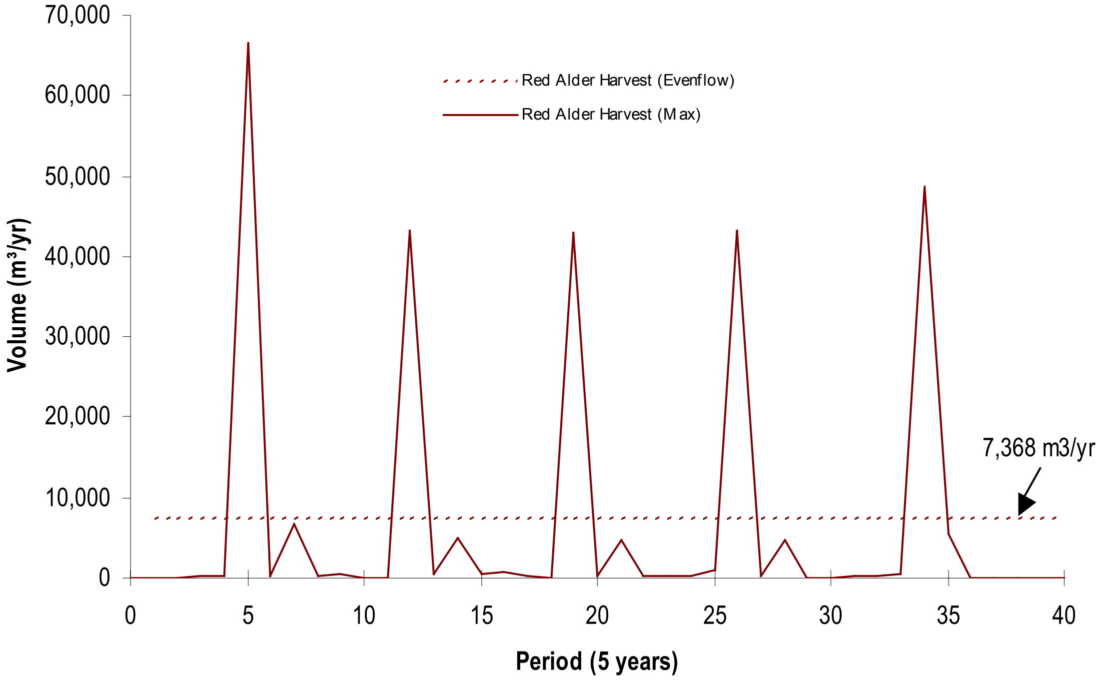

Figure 22: Red Alder Harvest Forecast – Red Alder Utilization Scenarios.

As described in Section 3.2 there are no logging, basic silviculture or stumpage costs applied to the harvest of red alder stands. It is likely that TSA averages of these costs do not accurately reflect these stands and would result them becoming economically unviable. This should be considered when interpreting the financial information shown in Table 27.

As a result of the additional red alder volume being harvested the financial return for these scenario variations is higher than the Base Case. Because the value of red alder is lower that the Base Case average, the average product value decreases for this scenario.

Table 27: Total Revenue / Cost Information – Red Alder Utilization Scenarios.

Scenario / Variation	Planning Horizon Totals ($ 1,000s)				Average Product Value ($ / m³)[a]
	Harvest Revenue	Total Costs	Net Revenue	NPV Net Revenue	
Base Case	8,582,634	5,661,296	2,921,338	614,655	83.40
Red Alder (Max)	8,646,854	5,669,840	2,977,014	624,299	82.68
% Difference	**0.748**	**0.151**	**1.906**	**1.569**	**-0.856**
Red Alder (Evenflow)	8,642,750	28,316,250	2,979,500	623,681	82.67
% Difference	**0.700**	**0.035**	**1.991**	**1.469**	**-0.871**

[a] Percent difference is based on unrounded average product value and percentage may not equal the rounded percent difference.

6.0 DISCUSSION AND RECOMMENDATIONS

The purpose of this document is to report the results of individual scenario analysis and to aid in the development of a preferred silviculture strategy for subsequent analysis and interpretation. Table 28 displays the results of each scenario as relative differences from the Base Case results. These percentages represent the change in the total for each value over the entire planning horizon. The scenarios in this table are sorted and ranked from the greatest positive change in NPV net revenue from the Base Case to the least (or greatest reduction).

Table 28: Summary of Scenario Results.

Scenario / Variation	Total Harvest Volume (m^3)	Planning Horizon Totals ($ 1,000s)				NPV Net Revenue Rank
		Harvest Revenue	Total Costs	Net Revenue	NPV Net Revenue	
Base Case	102,910,901	8,582,634	5,661,296	2,921,338	614,655	n/a
			% Difference from the Base Case			
Low Site Cedar Harvest ($300 / ha)	**31.200**	**27.961**	**34.153**	**15.963**	**10.948**	**1**
Low Site Cedar Harvest ($600 / ha)	31.100	27.814	34.571	14.719	10.727	n/a
Low Site Cedar Harvest ($1,200 / ha)	30.900	27.708	35.615	12.383	10.337	n/a
Low Site Cedar Harvest ($3,000 / ha)	30.700	27.503	38.887	5.440	9.250	n/a
Low Site Cedar Harvest ($6,000 / ha)	30.100	27.023	44.052	-5.979	7.522	n/a
Low Site Cedar Harvest ($300 / ha) - Max Vol.	39.000	34.553	41.964	20.190	-9.681	n/a
Red Alder (Evenflow)	**1.600**	**0.700**	**0.035**	**1.991**	**1.469**	**2**
Red Alder (Max)	1.600	0.748	0.151	1.906	1.569	n/a
Genetic	**0.800**	**-1.953**	**0.843**	**-7.370**	**0.407**	**3**
Genetic (Alt. Harvest)	0.300	-2.447	0.389	-7.941	0.123	n/a
Genetic (Max Vol)	1.400	-1.509	1.509	-7.358	-5.588	n/a
Juvenile Spacing - Logging Cost A[1]	**-0.120**	**0.025**	**-0.107**	**1.722**	**0.093**	**4**
Juvenile Spacing - Logging Cost B[1]	-0.076	0.579	-0.087	4.217	0.300	n/a
Juvenile Spacing - Logging Cost C[1]	0.709	2.039	1.246	7.358	1.349	n/a
Juvenile Spacing (Base Logging Costs)	**-**	**-**	**-**	**-**	**-**	**5**
Juvenile Spacing (Force)	-2.500	-0.940	-0.476	-1.841	-5.507	n/a
Juvenile Spacing (No Cost)	-	0.021	-0.005	0.072	0.082	n/a
JS-Prune	**-**	**-**	**-**	**-**	**-**	**6**
JS-Prune (No Cost)	-	0.340	-0.001	1.001	0.080	n/a
JS-Prune (Clear Value #2)	-	-	-	-	-	n/a
JS-Prune (Clear Value #3)	-	-	-	-	-	n/a
JS-Prune (Force)	-2.700	-0.639	1.427	-4.642	-9.409	n/a

[1] The percentages reported are in comparison with the Base Scenario with the same logging costs not the Base Case values in this table (See Section 5.3).

Shaded areas represent sensitivity analyses of already ranked scenarios and are not ranked individually.

These results demonstrate that of the scenarios tested, the largest return in terms of both volume and revenue occurs through the harvest and rehabilitation of low site, cedar-leading stands. The treatment with the next highest increase in financial return and overall harvest volume is the utilization of red alder. It is recognized that these scenarios reflect more of a shift in utilization within the TSA than a silviculture investment strategy.

Small financial and volume gains are realized through the use of genetically improved stock. Similarly, juvenile spacing produces a slight financial gain but only when higher logging costs in previously unharvested stands are considered. Juvenile spacing with pruning does not show measurable benefits at the TSA level even when clear wood values are increased. However, these results may also be sensitive to logging costs in a similar manner to juvenile spacing.

Of note is the fact that the most significant gains occur through increases to the THLB (rehabilitation of currently excluded area and the utilization of red alder stands) as opposed to investment in the current THLB. Further examination of opportunities to reclassify or rehabilitate areas currently outside the THLB may provide further gains.

6.1 OPPORTUNITIES TO IMPROVE TIMBER SUPPLY

The rehabilitation of low site, cedar-leading stands is the only treatment with significant impacts on timber supply in the North Coast TSA. The utilization of red alder and the use of genetically improved stock produce small gains in short and long-term timber supply.

6.2 OPPORTUNITIES TO IMPROVE TIMBER QUALITY

Changes in product value are inherently captured in the NPV net revenue figures used to rank the scenarios in Table 28 above. The optimization of financial return provides solutions that balance changes in timber quality with changes in timber quantity to produce an optimum investment and harvest regime for each scenario. As shown in Table 28 above and Table 29 below, the scenario that produces the largest increase in average product value is not always the scenario that generates the best financial return. These figures allow for a comparison of scenarios based strictly on changes to average product value and indicate how scenario results might change given a dramatic shift in the value of larger diameter or clear logs.

Treatments of juvenile spacing and juvenile spacing in combination with pruning increase the average product value at the stand-level as shown when these treatments are forced. However, the results of these scenarios demonstrate that this increase in average product value over the entire TSA is not enough to compensate for slight decreases in stand productivity and the additional costs of treatment.

Table 29: Treatment Impacts on Average Product Value.

Scenario / Variation	Average Product Value ($ / m^3)	Average Product Value Rank
Base Case	83.4	n/a
% Difference from the Base Case		
Juvenile Spacing - Logging Cost A[1]	**0.145**	**1**
Juvenile Spacing - Logging Cost B[1]	0.655	n/a
Juvenile Spacing - Logging Cost C[1]	1.321	n/a
JS-Prune	**-**	**2**
JS-Prune (Force)	2.111	n/a
JS-Prune (No Cost)	0.340	n/a
JS-Prune (Clear Value #2)	-	n/a
JS-Prune (Clear Value #3)	-	n/a
Juvenile Spacing (Base Logging Costs)	**-**	**3**
Juvenile Spacing (Force)	1.590	n/a
Juvenile Spacing (No Cost)	0.021	n/a
Red Alder (Evenflow)	**- 0.871**	**4**
Red Alder (Max)	- 0.856	3
Low Site Cedar Harvest ($300 / ha)	**- 2.499**	**5**
Low Site Cedar Harvest ($600 / ha)	- 2.483	n/a
Low Site Cedar Harvest ($1,200 / ha)	- 2.466	n/a
Low Site Cedar Harvest ($3,000 / ha)	- 2.446	n/a
Low Site Cedar Harvest ($6,000 / ha)	- 2.391	n/a
Low Site Cedar Harvest ($300 / ha) - Max Vol.	- 3.207	n/a
Genetic	**- 2.691**	**6**
Genetic (Alt. Harvest)	- 2.730	n/a
Genetic (Max Vol)	- 2.880	n/a

[1] The percentages reported are in comparison with the Base Scenario with the same logging costs not the Base Case values in this table (See Section 5.3).

Shaded areas represent sensitivity analyses of already ranked scenarios and are not ranked individually.

6.3 THE PREFERRED SILVICULTURE STRATEGY

The maximization of NPV net revenue considers a number of different factors in developing a financially optimal investment and harvest regime for the TSA:

- An analysis of trade-offs between timber quality and timber quantity;
- An assessment of the delay in time between silviculture investment and return on that investment as a determination of financial viability;
- Limiting factors on the current land base (e.g. age class gaps) and the best allocation of resources to mitigate their impacts;
- Timing, location and intensity of silviculture investment;

- Timing, location and intensity of harvesting activities; and
- Placing a greater importance of events occurring in the near future when certainty is highest (and NPV is the highest) as opposed to events occurring in the distant future when certainty is lowest (as is NPV).

In considering these factors, the total NPV net revenue and its relative difference from the Base Case provides an excellent indication of the impacts of silviculture treatment on the financial return from the land base given the assumptions used in the analysis.

Table 30 shows a decision matrix for the silviculture treatments examined. While financial return is the key indicator of the success of each scenario, other indicators also provide assistance in developing a preferred silviculture strategy (PSS) for the North Coast TSA. In addition to indicators already described in this report, this table also provides a qualitative assessment of risk ([H]igh, [M]oderate, and [L]ow) associated with each scenario. This risk assessment is based on a combination of the results of sensitivity analysis and an understanding of the assumption inherent in each scenario and possible limitations of these.

Table 30: Decision Matrix for PSS Treatment Selection.

Scenario Number / Name		Harvest Volume Short / Long-Term	Product Value	Costs	Risk	Financial Return	Recommended for the PSS?
1	Genetic	— / —	↓	—	M	—	YES
2	Juvenile Spacing	— / —	↑	—	M	—	YES
3	JS-Prune	— / —	↑	—	M	—	YES
4	Low Site Cedar Harvest	↑ / ↑	↑	↑	M	↑	
5	Red Alder (Evenflow)	↑ / ↑	↓	—	M	↑	

GENETICALLY IMPROVED STOCK

Due to the large proportion of hemlock natural ingress, the use of genetically improved stock does not provide any significant changes over the Base Case scenario. An assessment of moderate risk is based on this factor in combination with an underassessment of the impacts of this scenario on average product value due to hemlock natural ingress (described in Section 5.1). Combining this treatment with juvenile spacing will decrease the influence of natural ingress and may improve the profitability of this silviculture investment.

JUVENILE SPACING

Sensitivity analysis to treatment cost provides confidence that it is not the determining factor in making this treatment financially unattractive. The treatment result in higher average product value but this is largely offset by a decrease in productivity. This decrease in productivity may be sensitive to uncertainties in site productivity estimates and therefore receives a moderate risk assessment. Verification of these results once reliable productivity estimates have been collected will reduce the risk associated with these assumptions.

Additional scenario analysis around the sensitivity to the logging costs of previously unharvested stands shows that higher logging cost in these stands results in a slightly higher return on investment from juvenile spacing. If the stakeholder group determines that higher logging costs more accurately reflect the situation in the North Coast TSA then it is recommended that juvenile spacing be included in the PSS.

JUVENILE SPACING WITH PRUNING

Sensitivity analysis around clear wood value all but eliminates this as a major factor limiting the financial viability of this treatment. Because this treatment regime is built on the juvenile spacing treatment regime, it receives a moderate risk assessment as well. If higher logging costs are used in the PSS, then it is recommended that juvenile spacing with pruning also be included.

LOW SITE CEDAR HARVEST

The rehabilitation of low site, cedar-leading stands produces the best overall results in terms of both increased harvest level and financial return. However, this scenario makes assumptions regarding the ability of these areas to support higher productivity stands. While these assumptions are based on un-validated expert opinion, it is likely that higher site productivity estimates as a result of ecological mapping currently underway will reclassify these stands into the THLB without the need for treatment. This uncertainty is somewhat balanced by a very low sensitivity to treatment cost and consequently the risk assessment for this scenario is moderate.

One purpose of the PSS is to examine how different treatments might interact on the land base to produce cumulative gains (i.e. the combination of genetically improved stock and juvenile spacing to reduce natural ingress). It is unlikely that any of the previous treatments will affect the gains shown in the *Low Site Cedar Harvest* scenario. Therefore it is recommended that this treatment not be included in the PSS in order to better isolate the impacts of the other treatments in the PSS results.

RED ALDER UTILIZATION

Interest in the utilization of red alder and the ability of the North Coast TSA to support this niche led to the development of this scenario. Uncertainty regarding harvesting and stumpage costs results in a risk rating of moderate. It is recommended that this treatment not be included in the PSS in order to isolate the impacts of the other treatments more focused on specific silviculture investment.

6.4 ADDITIONAL RECOMMENDATIONS

Current estimates of site productivity remain a source of uncertainty in the North Coast TSA. Significant increases in site productivity estimates such as those used in LRMP sensitivity analysis will dramatically increase Base Case and scenario harvest levels and financial return. However, because this factor affects both the Base Case and the scenarios and because the scenario success is measured in comparison with the Base Case and, because of the nature of the scenarios tested, it is possible that similar conclusions might be reached using higher site index values.

As described above, site productivity estimates may increase the economic viability of juvenile spacing and juvenile spacing with pruning treatments as reductions in productivity as a result of spacing may not occur. Higher productivity stands may respond more favourably to juvenile spacing and pruning through increased productivity and decreased minimum harvest ages.

Therefore, it is recommended that once site productivity estimates have been completed and are accepted for use in Base Case timber supply analysis, these treatment scenarios be re-evaluated based on more accurate estimates of site productivity. A cursory evaluation of yield and value curves pre and post treatment would provide an indication of the scale of any differences. Based on the work already conducted for this project this preliminary evaluation would be a relatively small-scale project. If preliminary results demonstrate significant stand-level (yield curve) differences, this project could be updated using revised site productivity estimates at a greatly reduced cost due to work already conducted under this project.

Additionally, uncertainty exists around the amount of natural ingress and the survival of planted trees for each analysis unit. Because there are relatively few analysis units, broad assumptions regarding natural and planted trees are applied across most analysis units. If future inventory and growth and yield information is able to support more detailed analysis units it may be possible to examine more site-specific treatments, such as the use of genetically improved stock, with greater success and possibly greater financial return.

7.0 REFERENCES

In addition to the references cited below, Section 7.0 of the data package contains a list of references used in the development of the scenarios below.

British Columbia Ministry of Forests. 2002. Clear Wood Price Premiums & Stand Value Gain from Pruning – July 2002 (Draft 1.2). Province of British Columbia, Victoria, B.C.

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