

**TYPE II
FOREST LEVEL
SILVICULTURE STRATEGY**

NORTH COAST TIMBER SUPPLY AREA

**PREFERRED SILVICULTURE
STRATEGY REPORT**

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EXECUTIVE SUMMARY

The objective of this Preferred Silviculture Strategy (PSS) is to provide strategic direction to silviculture planning by determining the level, type and scheduling of discretionary silviculture expenditures that maximize the financial return in the North Coast Timber Supply Area (TSA). A list of potential silviculture treatments was developed in consultation with a number of stakeholders within the North Coast TSA. The financial viability of each of these treatments was first tested individually through an economically based timber supply model. Within the model treatments are defined based on treatment costs, stand-level response to treatment, and operability ranges (treatable areas and ages) of the treatment. The actual application of the treatment is determined by the model (with these operability ranges) based on the objective of maximizing the financial return from the land base. If there is no financial benefit, the model will not apply a treatment.

The substantial component of hemlock natural ingress in many ecosystems influences much of the silviculture activity within the North Coast TSA and limits the effectiveness of many traditional incremental silviculture treatments. While operational planting does occur in the TSA, many stands are modelled as natural stands due to this ingress. Historically, juvenile spacing of high and medium site cedar/hemlock stands has been the most significant form of incremental silviculture on the TSA, but (for the most part) has been very expensive and supported more as a socially driven employment generator than a biological necessity.

The results of each individual silviculture treatment scenario are described in the *Type II Forest Level Silviculture Strategy - North Coast Timber Supply Area – Analysis Report* (the *Analysis Report*). Each of these scenarios is evaluated for inclusion in the PSS based on the following criteria:

- The total financial return for the scenario, in comparison with the Base Case, as indicated by the net present value of the net revenue produced;
- The impact of the scenario on product value and timber quality;
- The short and long-term harvest forecast;
- The total silviculture cost; and
- An assessment of the risk associated with each scenario.

Based on this evaluation, a composite scenario (the PSS) was developed and modelled using the following incremental silviculture treatments:

- Use of genetically improved stock;
- Juvenile spacing; and
- Juvenile spacing followed by pruning.

Other treatments were considered but were rejected. These treatments include commercial thinning, dropped at the workshop stage because of a lack of forest-level profile to treat and, fertilization due to the lack of operable stands to treat. The harvest of low site cedar stands and the utilization of red alder were both analyzed individually, producing positive financial results but were not included in the PSS because they were deemed to be outside the scope of incremental silviculture.

The results of this analysis do not support an increased level of investment in incremental silviculture in the North Coast TSA. While small financial gains have been shown for certain treatments and combinations of treatments, the scale of these impacts is not significant enough to justify a recommendation for increased incremental silviculture investment.

In addition, the results have been shown to be sensitive to slight changes in assumptions. The scenarios examined in this analysis (both of individual treatments and combinations of treatments) produce results that are only slightly better or worse than the base case. In addition, these results have been shown to change from slightly negative to slightly positive with small changes in assumptions. These two factors suggest that there is insufficient evidence to support an increased level of incremental silviculture investment, even for treatments demonstrating slight financial gains.

Concurrent with the insignificant impacts of incremental silviculture and the small annual treatment area, employment opportunities are virtually non-existent. Future investments on the land base should remain focused on resolving uncertainties with the current land base, particularly with respect to site productivity. Resolving uncertainty around site productivity will have a more immediate impact on timber supply and the value of incremental silviculture.

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1.0 INTRODUCTION

The following Preferred Silviculture Strategy (PSS) Report provides strategic direction to silviculture planning by determining the level, type, and scheduling of discretionary silviculture expenditures that maximize the financial return in the North Coast TSA. Specifically, the purpose of this project is to identify how to allocate discretionary silviculture expenditures to improve the quality and quantity of timber supply in the TSA.

This Preferred Silviculture Strategy Report is the last of three companion documents associated with the preparation of a silviculture strategy for the North Coast TSA, namely:

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

This document describes a silviculture investment strategy based on forest-level financial analysis of stand-level silviculture treatments that improve the quantity and quality of timber supply in the TSA.

The assumptions used for this PSS Report are 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.

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 implemented may influence future, but not necessarily present AAC determinations.

1.1 INFORMATION SOURCES

A variety of sources were used in developing a Type II Forest Level Silviculture Strategy for the North Coast TSA. The main sources of information are listed below:

- *North Coast Timber Supply Area Rationale for Allowable Annual Cut Determination, January 2001.* British Columbia Ministry of Forests, Victoria, B.C.
- North Coast Timber Supply Area – Timber Supply Review Data Package, February 1998. British Columbia Ministry of Forests, Victoria, B.C.

- *Clear Wood Price Premiums & Stand Value Gain from Pruning* – July 2002 (Draft 1.2). British Columbia Ministry of Forests, Victoria, B.C.
- *North Coast LRMP Resource Analysis Report – Timber Supply Analysis* - 2002. North Coast Government Technical Team. British Columbia Ministry of Forests, Victoria, B.C.
- *North Coast Timber Supply Area – Type 1 Silviculture Strategy* - 2000 Tanz, Jordan and Craig Farnden. British Columbia Ministry of Forests, Victoria, B.C.
- *Incremental Silviculture Strategy for British Columbia*, B.C. Ministry of Forests (1999).
- North Coast TSA – Type II Silviculture Strategy Workshop held at Prince Rupert, B.C. (December, 2001).
- North Coast TSA – Type II Silviculture Strategy Conference Call held from Prince George, BC (December 2002).
- Numerous emails and communications during the formulation period of December 2001- March 2003.

1.2 ACKNOWLEDGEMENTS

Integrated Silviculture Services Ltd., the lead proponent and Timberline Forest Inventory Consultants Ltd. were selected by the Ministry of Forests to undertake this project. This project was administered by Lou Tromp, RPF of the Ministry of Forests, Regional Office in Smithers and was funded by Forest Renewal BC (FRBC). Representatives from the Ministry of Forests (MoF), Interpac Resources Ltd., Triumph Timber Ltd., and International Forest Products Ltd. provided the majority of input. Initial contact and opportunities for input were also provided to the Ministry of Sustainable Resource Management (MSRM) and the Ministry of Water, Lands and Air Protection (MWLAP).

1.3 HOW THE STRATEGY WAS DEVELOPED

The development of this Preferred Silviculture Strategy represents the culmination of a series of steps including research and the collaboration with stakeholder and other experts. Following is a brief synopsis of the process:

- 1) Preparation of the *Preliminary Information Report – Stakeholder Workshop (December 2001)*. This document contains a description of the project objectives, land base summaries as per North Coast TSA TSR II, and a list of potential scenarios for analysis.
- 2) Workshop #1 was held at Ministry of Forests office in Prince Rupert on December 12, 2001. Input was solicited from the attendees representing Interpac Resources Ltd., Triumph Timber Ltd., International Forest Products Ltd., Ministry of Forests and, Ministry of Water, Lands and Air Protection (MWLAP).
- 3) Input from the workshop and the results of further collaboration was summarized in the *North Coast TSA – Type II Forest Level Silviculture Strategy – Consensus Document – Draft January 2002*. The document was sent to workshop stakeholders for further review and comment.

- 4) Input from stakeholders was incorporated with the *Consensus Document* to produce the *Type II Forest Level Silviculture Strategy – North Coast Timber Supply Area – Data Package* (the *Data Package*), submitted to the Ministry of Forests for approval¹.
- 5) Base case and silviculture scenario analysis were conducted as per the assumptions contained in the *Information Package*.
- 6) The results and interpretations of the analysis were presented to the stakeholders in the *Type II Forest Level Silviculture Strategy – North Coast Timber Supply Area – Analysis Report* (the *Analysis Report*).
- 7) Further input was garnered in a Conference Call with the stakeholders in December 12, 2003. Modification to the analysis was requested to include additional runs for juvenile spacing with alternate harvesting costs and minimum harvestable ages to reflect more realistic assumptions. An adjustment was made to the *Analysis Report* to reflect these additional changes.
- 8) From these results, specific treatments were selected and combined into one composite scenario – the Preferred Silviculture Strategy. The results of this scenario and various sensitivity analyses are described in this report.

1.4 PROVINCIAL STRATEGY AND OBJECTIVES

In the document “*Incremental Silviculture Strategy for British Columbia (1999)*”, the Ministry of Forests’ broad goals are to provide for a sustainable use of the forest resources, create and maintain community stability, and encourage a strong, thriving forest sector. Incremental silviculture strategies must also be in keeping with higher-level plans under the Forest Practices Code. Until provincial targets for timber quantity and quality are established, management unit strategies are to consider the following interim provincial strategic objectives:

- 1) Maintain current harvest levels as long as possible, without creating disruptive shortfalls in future timber supply.
- 2) Create long-term timber supply capable of supporting a steady long-term provincial harvest level similar to current levels.
- 3) Minimize the interim shortfall in provincial harvest anticipated before a steady long-term timber supply is achieved.
- 4) Create a long-term timber supply that will enable the timber quality profile of future harvests to be the same or better than the current profile.

It is recognized that not every management unit has the same capacity to achieve these objectives and that the ability to do so is highly dependant on the availability of silviculture funding. The purpose of these objectives is to provide guidance to the silviculture investment planning and to the allocation of available funds.

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 in the North Coast TSA. The

¹ Based on stakeholder input, the decision was made to delay the remainder of the Type II Silviculture Strategy until the LRMP base case was finalized. This resulted in a significant delay to the time lines identified in the original technical plan.

purpose of this project is to identify how silviculture investments can improve the quality and quantity of timber supply in the North Coast TSA.

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 the data input decisions and management assumptions developed for the LRMP Base Case.

1.5 BASIC SILVICULTURE AND MANAGEMENT OBJECTIVES

The application of silviculture can be described from the broadest system to the smallest detail of the individual stem and its growing environment. A plethora of variables can be incorporated into an analysis, each added trait providing the opportunity to generate a cumulative positive effect on a preferred outcome, generally more high quality fibre, or at the very least, maintenance of current harvest levels.

This is an important aspect for the North Coast TSA where a fall-down in timber supply is forecasted, leading to a reduced level of forestry activities and eventual loss of employment opportunities. There is a supposition, if supported by sound evidence, that incremental silviculture may mitigate forecast timber supply reductions. This Type II Silviculture Strategy evaluates these opportunities.

Clearcutting continues to be the predominant silvicultural system used in the North Coast TSA. Clearcutting is generally found on the lower slopes, valley bottoms and floodplains of the major watersheds. According to the Chief Forester's determination, 100% of the harvest is being removed from 70% of the timber supply base. Maintenance of non-timber values, along with operability in rugged terrain, and economics has lead to the historical avoidance of partial retention harvesting. Past data indicates that slightly less than 1% of the harvest was accomplished using partial cutting systems in this TSA (Table 1).

Table 1: Distribution of the AAC by Logging Methods.²

Licensee	Non-aerial (%)	Helicopter (%)	Partial Cutting (%)	Licence AAC (cubic metres per year)
Interfor	77	23	0	226,617
West Fraser Mills	79	21	0	161,449
SBFEP and Forest Service Reserve	87	9	4	155,082
Thompson Ind.	100	0	0	30,696
Boyle and Dean	100	0	0	20,156
Woodlot Licences	100	0	0	6,000
Total weighted average	83	17	< 1	

Recently, operability adjustments are permitting an increased level of variable retention harvesting. More experience in the harvesting techniques is occurring in similar jurisdictions tending to increase the use of partial cutting over time. However, as increased reliance on

² North Coast TSA – Timber Supply Review Data Package (February (1998)).

partial cutting occurs, timber supply may become more constrained and the implications may be reflected in future timber supply reviews.

While there is some planting in the TSA, there is usually considerable ingress of existing species to cause the regenerated stand to develop more like a natural stand. Western hemlock is the main species that consistently seeds well into openings. To ensure a good species mix and reduce stocking gaps in a regenerating stand, the majority of currently harvested areas are planted with a mix of species which may include western red cedar, sitka spruce, balsam and yellow cedar. The planting combined with the ingress of naturals leads to high initial densities in most stands in the TSA.

Minor regeneration impediments were identified in the Type I Silviculture Strategy and have been noted in isolated areas of the TSA. The impacts of these impediments on timber supply are somewhat uncertain, as the extensiveness over the entire TSA is considered minimal. Management techniques, research findings, data review and population dynamics of the damaging agents such as deer, voles and porcupine suggest that the problem is not as serious as normally feared. This does not suggest that complacency in management can be entertained. Diligent monitoring and application of management strategies must remain in place.

1.5.1 NOT SATISFACTORILY RESTOCKED (NSR) AREAS

Land classified in the TSA inventory file as type identity 4 or 9, is included in the current timber harvesting land base. These type identities, 4 and 9, correspond to non-satisfactorily restocked areas. This section describes the total area of NSR currently existing in the timber harvesting land base, and the estimated rate at which the NSR area will be restocked.

The Integrated Silvicultural Information System (ISIS) records 4,724 hectares of backlog NSR (NSR area depleted prior to 1987). The district silvicultural specialist estimates 1,125 hectares of this area is already satisfactorily restocked (SR) and another 1,563 hectares will be restocked with 10 years. The remaining 2,036 hectares of backlog NSR is unlikely to attain SR status. This residual area will be retained in the timber harvesting land base however, based on the low stocking rates the volume estimates for these areas will be reduced by 60%.

Together the Major License Silvicultural Information System (MLSIS) and the ISIS record a total of 2,101 hectares of current NSR. This area is expected to regenerate within the regeneration delays specified in the regeneration assumptions table (the *Data Package* - Table 13).

1.6 INCREMENTAL SILVICULTURE IN THE NORTH COAST TSA

The North Coast TSA is rich in natural resources including timber, significant fish and wildlife habitat, and recreation and tourism amenities. Along with other areas of the central coast, the North Coast TSA has attracted international attention by virtue of its outstanding scenery, globally recognized ecological values, and the potential loss of undeveloped temperate rainforests. A great deal of uncertainty and risk persists in the attempt to balance all the values with development of harvesting strategies and the application of incremental silviculture. The North Coast TSA has been declared as one of the most difficult areas to define a physical and economically accessible land base.

The Chief Forester, in his determination of the AAC effective January 1, 2001, noted the requirement for sound evidence before accounting for the effects of intensive silviculture on harvest levels. The Chief Forester encouraged North Coast Forest District staff to undertake the tasks and studies necessary to help reduce the uncertainty and risk associated with key factors that affect the timber supply in the TSA. District staff is looking to this analysis to guide their efforts in the most effective manner.

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 the 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 little information available regarding its effectiveness in the North Coast area. 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.

1.6.1 IMMATURE MANAGED STAND HISTORY

A juvenile spacing program, which treats approximately 200 hectares per year, has been conducted in the TSA for the past 12 years³. Table 2 shows the ages of managed stands based on information from the Integrated Silviculture Information System.

This program focuses on stands of high to medium site potential that are in the hemlock-balsam and spruce types. The level of spacing in the North Coast TSA has dropped in the past two years as result of reduced funding for incremental silviculture.

³ North Coast TSA – Timber Supply Review Data Package (February (1998)).

Table 2: Immature Managed Stand History.³

Analysis Unit	Area Managed (ha)			
	Age 1–10	Age 11–20	Age 21–30	Age 31–40
HemBal:H, HemBal:M, Spruce:H, Spruce:M	2,000	2,000	2,000	314

This analysis examines opportunities to expand the juvenile spacing program in the North Coast TSA.

1.6.2 GENETICALLY IMPROVED STOCK

Requirements under the Forest Practices Code include the direction to use genetically improved stock orchard seed (class A) for regeneration where possible.

A limited amount of genetically improved stock is available for the North Coast TSA, and is used where possible. The base case for the timber supply analysis assumes no use of genetically improved stock. Because current use of genetically improved stock is limited due to scale of planting activities, there is a negligible positive impact on timber supply. However, in other jurisdictions where class A seed is used more extensively, there is a marked improvement in the mid to long-term timber supply.

This analysis examines opportunities to increase the quantity of genetically improved stock planted in the North Coast TSA.

1.6.3 FERTILIZATION

Fertilization is the application of nutrients in a stand to enhance the growth of individual trees. No operational fertilization has occurred to date in the North Coast TSA, and none is assumed in this analysis.

Interest was expressed in the Type I Silviculture Strategy to consider the use of “at time of planting fertilizers” to speed early growth rates of planted trees. The intended effects include earlier green-up, shorter rotations, and reduced brushing costs. Currently, there is insufficient information on the growth response under different conditions for reliable application of this treatment. The low percentage of areas planted negates the expectation of a positive impact on timber supply. District staff states that the use of fertilization is not expected to increase in the future, and that in any event data has shown inconsistent results for the type of stands occurring in the TSA. As a result, this analysis does not consider opportunities for fertilization.

1.6.4 COMMERCIAL THINNING

Commercial thinning is a partial cutting silvicultural intervention to remove some volume from an immature stand after components of the stand have reached a merchantable size. The volume removed is sold and therefore contributes to timber supply. Commercial thinning activity may not significantly affect overall timber supply but does offer increased flexibility with respect to timing and location of harvest.

Very little commercial thinning occurs in current practice in the North Coast TSA, as it is most appropriately conducted in 40-60 year old stands and less than 10% of the timber harvesting

land base (THLB) is occupied by stands in this age class. In addition, District staff indicates that the steep, rugged, and inaccessible terrain prevalent in the TSA precludes any appreciable amount of commercial thinning opportunities. This analysis does not consider opportunities for commercial thinning.

1.6.5 LOW PRODUCTIVITY SITES

Sites with low productivity as a result of inherent site factors such as nutrient availability, exposure, excessive moisture, or are not fully occupied by commercial tree species are excluded from the forested land base. Low productivity sites in the North Coast TSA tend to be wet, boggy sites where the growth of existing natural stands has been limited by moisture and climate. Approximately 49% of the productive forest land base in the TSA is occupied by mature stands less than 25.4 m in height. This amounts to a reported 276,449 hectares.

It is understood there has been some attempt to resolve the uncertainty with respect to the location and extent of the volume potentially accessible in low site stands and the operational requirements necessary to harvest and reforest those areas. Some research results thus far indicate that yields possible from regenerated managed stands on low sites could be greater than those of existing stands. Opportunities to reclassify/rehabilitate low site, cedar-leading stands were examined in the analysis and are reported in Section 5.5 of the *Analysis Report*. However, after careful consideration, in consultation with the stakeholders, it was determined that the definition of rehabilitation applied more to the traditional “backlog” rehabilitation of brush fields and that utilization of low site cedar was a greater function of a harvest strategy than a silviculture strategy.

1.6.6 DECIDUOUS FOREST TYPES

Some new attention is given to red alder as a potentially viable commercial species. Data from the inventory file indicates that 2,100 hectares could be potentially added to the timber harvesting land base if red alder stands were not excluded.

Little is known about the typical characteristics of the red alder stems available in the North Coast TSA, or whether their characteristics point to economic merchantability for the species. Intensive management may be required to develop high quality red alder stems with associated high costs. There is a need to garner localized data which could indicate whether utilization and future management of red alder is a one time opportunity or whether strategies would evolve to dedicate some sites exclusively for red alder production. The capability of the North Coast TSA to support a sustainable supply of red alder was examined; the results are reported in Section 5.6 of the *Analysis Report*.

2.0 PREFERRED SILVICULTURE STRATEGY

In the document jointly prepared by the Ministry of Forests (MoF) and Forest Renewal BC (FRBC), entitled “*Forest Level Analysis for Silvicultural Investments (Draft July 1999)*”, the agencies embarked upon an initiative to implement strategic silviculture planning for crown forest land in British Columbia. The ultimate goal of the initiative is to improve the future quantity and quality of both timber and habitat supply by ensuring that silviculture investments are effective and strategically placed.

This project utilizes Type II Silviculture Strategy analysis methods and stakeholder input to identify issues and opportunities for silviculture investment. Table 3 shows the results of each individual scenario as reported in the *Analysis Report*. These results were used in the selection of treatments included in the PSS.

Table 3: 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 A¹	-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.

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 largest 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 higher values for clear wood are considered. 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/utilization 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.

Table 4 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 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 4: 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	↑	

2.1 TREATMENTS NOT INCLUDED IN THE PSS

Based on the decision matrix above some treatments / scenarios are not been included in the PSS. Following is a list of these treatments/scenarios and reasons for their exclusion.

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.

One purpose of the PSS is to provide direction towards the allocation of incremental silviculture dollars. It is unlikely that the reclassification or rehabilitation of these sites would be undertaken using incremental silviculture dollars.

RED ALDER UTILIZATION

Similar to the low site cedar harvest scenario, red alder utilization represents more of a shift in operability classification rather than an incremental silviculture investment. While providing valuable information on the ability of the North Coast TSA to support this niche, this scenario has not been included in the PSS.

2.2 TREATMENTS INCLUDED IN THE PSS

The primary role of the PSS is to examine the cumulative impact of incremental silviculture investment. Juvenile spacing, pruning, and the use of genetically improved stock are combined to determine the optimum combination of these treatments.

GENETICALLY IMPROVED STOCK

Slight gains were demonstrated when genetically improved stock was examined individually (Table 3). The high degree of natural ingress (primarily hemlock) dilutes much of the benefits from using genetically improved stock. By combining the use of genetically improved stock with juvenile spacing it may be possible to recover some of the genetic gains by removing much of the competing hemlock naturals.

The slight gains from using genetically improved stock reported in Table 3 above are based on the initial base case logging costs. Variations of the PSS scenario will test whether these gains still hold true when higher logging costs for previously unharvested stands are considered. In addition, genetically improved stock will only be applied to those stands available for juvenile spacing (Table 5, below). Aside from this, the assumptions used for genetically improved stock are as described in Section 6.1 of the *Data Package*.

JUVENILE SPACING

As reported in the *Analysis Report* and Table 3 above, juvenile spacing treatments produce a small increase in the net present value (NPV) of net revenue when higher logging costs for previously unharvested stands are considered. The PSS will include juvenile spacing to determine if the use of genetically improved stock can increase these gains. Table 5 shows the areas, minimum harvestable ages, and species composition of stands eligible for juvenile spacing.

Table 5: Species Composition and Minimum Harvest Ages for Treated Stands.

Analysis Units Available for JS	THLB Area (ha)	Description	Untreated	MHA (years)	After Juvenile Spacing	MHA (years)
			Species Composition (%)		Species Composition (%)	
101 ¹	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
105	174	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
107	1,438	Hemlock, Balsam - Medium	Hw(60)Ba(15)Ss(15)	115	Ba(30)Ss(30)Cw(20)Hw(20)	70

¹available for pruning following juvenile spacing

JUVENILE SPACING WITH PRUNING

Juvenile spacing with pruning did not produce positive financial gains when examined individually (Table 3). By including pruning following juvenile spacing as an optional treatment for high site cedar leading stands (analysis unit 101), we can determine if logging costs and the use of genetically improved stock will impact the financial viability of pruning.

2.3 ANALYSIS RESULTS

As described above, the Preferred Silviculture Strategy Scenario includes the use of genetically improved stock, juvenile spacing, and pruning. As with the individual scenarios, juvenile spacing and pruning are optional treatments that are only applied by the model if and when they generate a positive return on investment. The use of genetically improved stock is not an optional treatment. Genetically improved stock and higher regeneration costs are applied to all stands available for juvenile spacing (Table 5, above).

All of the following scenarios use the *PSS (Logging Cost A)* logging costs shown in Table 6. These costs are the same as the *Logging Costs A* used in the *JS – Logging Cost A* scenario (Analysis Report Section 5.3).

Table 6: Logging Costs for the Preferred Silviculture Strategy.

Scenario Name	Logging Cost (\$/m3)		
	Previously Unharvested	2 nd Growth (Untreated)	2 nd Growth (Juvenile Spaced)
Base Case	31.47	31.47	
PSS (Logging Cost A)	65.47	31.47	24.47

2.3.1 PREFERRED SILVICULTURE STRATEGY SCENARIOS

Table 7 describes the possible treatments and associated regeneration costs tested in each variation of the PSS. The results of each PSS scenario variation are discussed below. The *Base Case - Cost A* scenario does not include any incremental silviculture investment. “Cost A” refers to the logging costs used in this (and all PSS) scenarios (Table 6).

Table 7: Preferred Silviculture Strategy Scenario Variation Description.

PSS Scenario Name	Possible Treatments			Regeneration Costs
	Juvenile Spacing	Juvenile Spacing + Pruning (AU 101)	Use of Genetically Improved Stock	
Base Case - Cost A	N	N	N	\$1,782 /ha
PSS – Genetic Only	N	N	Y	\$1,782 /ha (normal) \$1,810/ha (genetic)
PSS – Genetic +JS	Y	Y	Y	\$1,782 /ha (normal) \$1,810/ha (genetic)
PSS – Genetic Regen. Cost	Y	Y	Y	\$1,782 /ha (normal) \$1,782 /ha (genetic)
PSS – JS Only	Y	Y	N	\$1,782 /ha (normal)

Figure 1 and Table 8 shows that none of the PSS scenario variations have any significant impact on short, mid and long-term timber supply in the North Coast TSA.

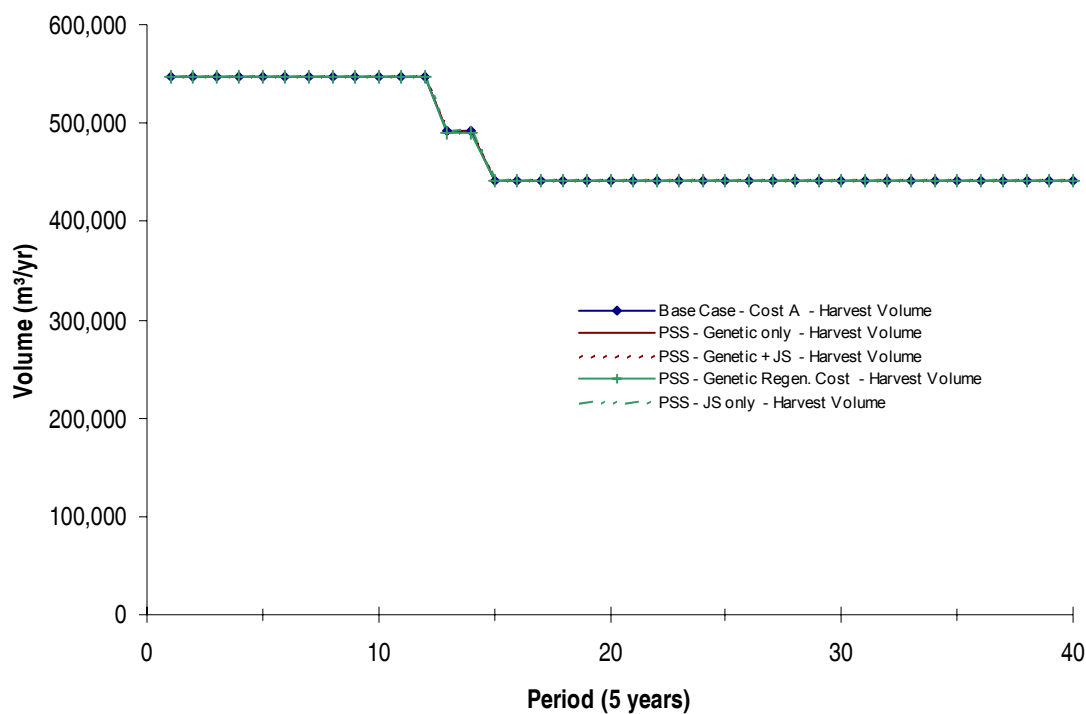
**Figure 1: Harvest Forecast – PSS Scenarios.**

Table 8: Harvest Forecast – PSS Scenarios.

Scenario	Harvest Volume (m³/yr) (Periods)			Total
	Short-Term (1 – 12)	Mid-Term (13-14)	Long-Term (15-40)	
Base Case - Cost A	547,583	491,817	441,627	95,184,615
PSS - Genetic only	547,648	491,875	441,679	95,195,834
% Difference	<0.1	<0.1	<0.1	<0.1
PSS - Genetic + JS	546,586	490,919	440,819	95,010,851
% Difference	-0.2	-0.2	-0.2	-0.2
PSS - Genetic Regen. Cost	546,744	491,061	440,947	95,038,343
% Difference	-0.2	-0.2	-0.2	-0.2
PSS - JS only	546,926	491,225	441,094	95,070,003
% Difference	-0.1	-0.1	-0.1	-0.1

Table 9 shows the financial results of each scenario in comparison with the base case. Scenarios that produce a positive percent difference in NPV net revenue from the base case generate a positive return from incremental silviculture investment. The size of the percent difference indicates the size of the return on investment (or loss) as well as the degree of confidence as to whether the treatment regime is in fact positive (or negative). Scenarios with percent differences that are close to zero indicate that the investments do not produce a large gain (or loss) and that slight changes in data or assumptions could change positive results to negative and visa versa.

Table 9: Total Revenue / Cost Information – PSS Scenarios.

Scenario	Planning Horizon Totals (\$ 1,000s)				Average Product Value (\$/m³)
	Harvest Revenue	Total Costs	Net Revenue	NPV Net Revenue	
Base Case - Cost A	7,747,069	7,189,260	557,809	147,767	81.39
PSS - Genetic only	7,757,975	7,220,557	537,418	147,290	81.49
% Difference	0.141	0.435	-3.656	-0.322	0.129
PSS - Genetic + JS	7,762,257	7,202,623	559,634	147,669	81.70
% Difference	0.196	0.186	0.327	-0.066	0.379
PSS - Genetic Regen. Cost	7,765,537	7,203,434	562,103	147,922	81.71
% Difference	0.238	0.197	0.770	0.105	0.393
PSS - JS only	7,748,986	7,181,572	567,414	147,904	81.51
% Difference	0.025	-0.107	1.722	0.093	0.145

The *PSS – Genetic Only* scenario examines the impacts of planting genetically improved stock on high and medium cedar and hemlock leading stands (as described in Table 5). Juvenile spacing and pruning are not applied in this scenario. In the original genetic scenario (*Analysis Report* Section 5.1), genetically improved stock was planted on all stands and the scenario used the same logging cost for all stands. The purpose of this scenario is to isolate the impacts of planting genetically improved stock (with higher regeneration costs) only on stands available for juvenile spacing, using the revised logging costs. The results in Table 9 show that harvest revenue, and average product value increase slightly as a result of using genetically improved

stock without any juvenile spacing. However, the higher regeneration costs results in higher total costs and a slight reduction in both net revenue and NPV net revenue, in comparison with the base case, indicating that the increased productivity does not compensate for the higher regeneration costs. This is due, in large part, to the higher degree of hemlock natural ingress that occurs on the higher productivity sites.

Building on the *Genetic Only* scenario, juvenile spacing and pruning is allowed to occur in the *PSS – Genetic + JS* scenario. In this scenario, the juvenile spacing and pruning treatments are applied only when and where they result in a positive return on investment. The treatment schedules and total area treated in this scenario is shown in Figure 2 and Table 10. For this scenario, only 2.4% of the area available for treatment is scheduled for juvenile spacing. The timing and area of these treatments are shown as the dark purple bars in Figure 2. The light blue bars in this figure represent area that could have been treated in each of the planning periods. For high site cedar-leading stands the model must choose between juvenile spacing, juvenile spacing followed by pruning, or no treatment. In all of these scenarios no area is scheduled for juvenile spacing followed by pruning indicating that the increased product values associated with pruning is not enough to overcome the initial cost of the treatment.

The *PSS – Genetic + JS* scenario produces financial results that are slightly better than the *Genetic Only* scenario, indicating that juvenile spacing has some limited benefit on the TSA. However, this scenario still results in total NPV net revenue slightly less than the base case, indicating that this combination of treatments is not financially viable, given the modelling assumptions.

The *PSS – Genetic Regen. Cost* scenario is designed to examine the role of higher regeneration costs of genetic stock in the *PSS – Genetic + JS* scenario. This scenario is the same as the *PSS – Genetic + JS* scenario except that the regeneration costs for genetically improved stock have been reduced to the same levels as stands planted with regular planting stock (from \$1,810/ha to \$1,782/ha (Table 7)). By reducing the regeneration cost for these stands by \$28/ha the results go from being slightly worse than the base case to being slightly better than the base case, indicating how small the impact of these treatments is across the TSA and how slight changes might affect the results. The fact that this scenario produces positive results demonstrates that there are small benefits from using genetically improved stock but these benefits are overshadowed by the higher regeneration costs. The treatment schedule and area treated (Figure 2 and Table 10) are both similar to that of the *PSS – Genetic + JS* scenario. The slight change in the area available for treatment is as a result of changes in the harvest schedule, caused by the change in regeneration costs.

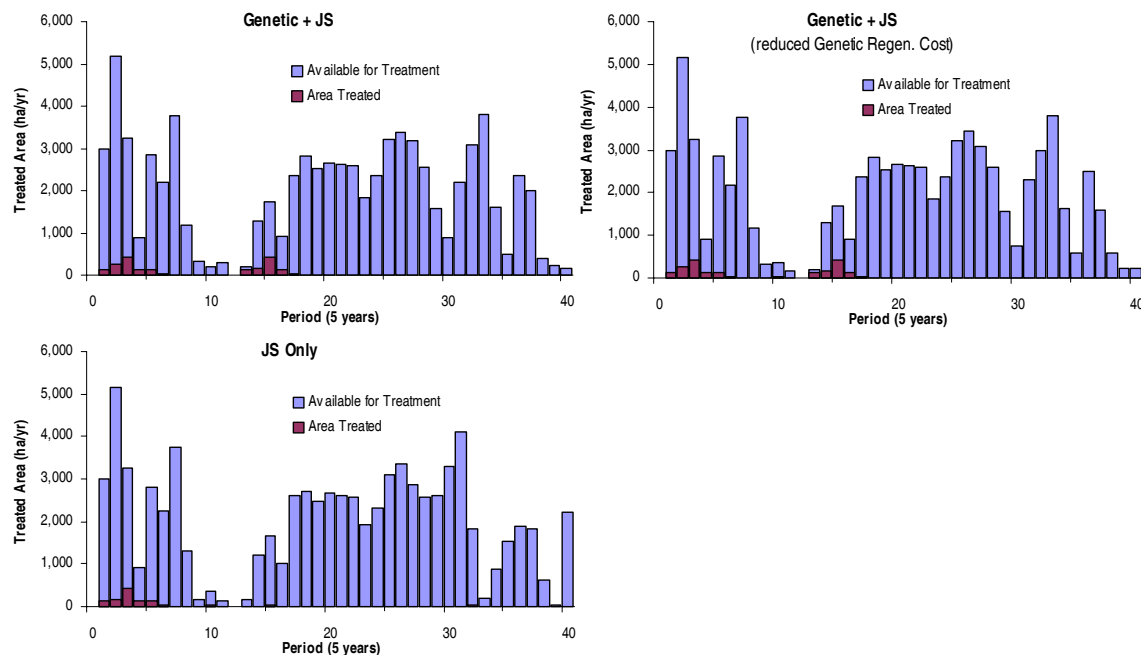


Figure 2: Juvenile Spacing Treatment Schedule – PSS Scenarios.

Table 10: Total Area Juvenile Spaced – PSS Scenarios.

Scenario	Juvenile Spaced Area (ha)		
	Treated	Available for Treatment	Percent Treated
Base Case - Cost A	-	-	-
PSS - Genetic only	-	-	-
PSS - Genetic + JS	2,011	81,800	2.4
PSS - Genetic Regen. Cost	2,011	81,743	2.5
PSS - JS only	1,093	83,549	1.3

The final PSS scenario variation is *PSS – JS Only*. This scenario uses regular planting stock and juvenile spacing may be applied when and where it is financially beneficial to do so. This scenario is identical to the *JS – Logging Cost A* scenario reported in Section 5.3 of the *Analysis Report*. This scenario has little impact on timber supply but produces a financial return higher than that of the base case. Average product values also increase slightly. There is less area treated in this scenario than in the scenarios with genetically improved planting stock.

2.3.2 SENSITIVITY TO TREATMENT COSTS (JS AND PRUNING)

The following scenarios are designed to test the impact of various treatments costs on the financial return from the *PSS – Genetic + JS* scenario. In these scenarios genetically improved stock is used on the same stands as the *PSS – Genetic + JS* scenario (analysis units 101, 102, 104, 105, 106, and 107 (Table 5)). Juvenile spacing and juvenile spacing followed by pruning are applied when and where a financial benefit can be realized. In each scenario, the juvenile spacing costs (\$1,900/ha) and juvenile spacing + pruning costs (\$3,900/ha) are multiplied by factors from 75% (reduced by 25%) to zero percent (no cost).

As treatment costs decrease the amount of area treated increases (Figure 4 and Table 13). As the amount of area treated increases, harvest levels decrease (Figure 3 and Table 11).

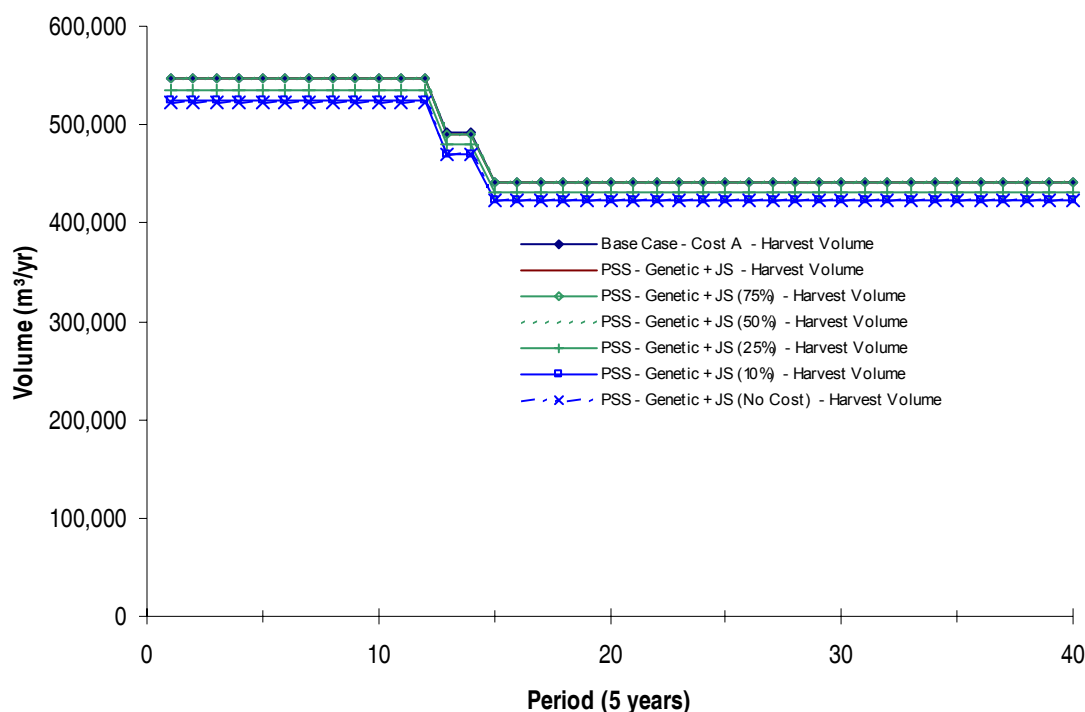


Figure 3: Harvest Forecast – PSS-JS Cost Scenarios.

Table 11: Harvest Forecast – PSS-JS Cost Scenarios.

Scenario	Harvest Volume (m³/yr) (Periods)			Total
	Short-Term (1-12)	Mid-Term (13-14)	Long-Term (15-40)	
PSS - Genetic + JS	546,586	490,919	440,819	95,010,851
PSS - Genetic + JS (75%)	546,370	490,725	440,644	94,973,191
% Difference	<0.01	<0.01	<0.01	<0.01
PSS - Genetic + JS (50%)	546,352	490,709	440,629	94,970,034
% Difference	<0.01	<0.01	<0.01	<0.01
PSS - Genetic + JS (25%)	535,179	480,653	431,579	93,022,555
% Difference	-2.10	-2.10	-2.10	-2.10
PSS - Genetic + JS (10%)	523,797	470,409	422,360	91,038,693
% Difference	-4.20	-4.20	-4.20	-4.20
PSS - Genetic + JS (No Cost)	523,488	470,131	422,109	90,984,792
% Difference	-4.20	-4.20	-4.20	-4.20

Financially, as treatment costs decline and the area treated increases, the financial returns and average product values both increase (Table 12). Each of the treatment cost scenarios in Table 12 is compared to the full treatment cost scenario (*PSS – Genetic + JS*). The benefits of juvenile spacing include reduced logging costs, reduced minimum harvestable ages, and increased

product value. These results suggest that these benefits are, for the most part, outweighed by the initial cost of the treatment. As these costs are gradually removed we begin to see the financial benefits of the treatment. Even as harvest levels and revenues decrease, the overall financial returns increase though lower total costs and higher returns per cubic metre harvested.

Table 12: Total Revenue / Cost Information – PSS-JS Cost Scenarios.

Scenario	Planning Horizon Totals (\$ 1,000s)				Average Product Value (\$/m ³)
	Harvest Revenue	Total Costs	Net Revenue	NPV Net Revenue	
PSS - Genetic + JS	7,762,257	7,202,623	559,634	147,669	81.70
PSS - Genetic + JS (75%)	7,766,700	7,200,919	565,781	147,770	81.78
% Difference	0.057	-0.024	1.098	0.069	0.097
PSS - Genetic + JS (50%)	7,766,455	7,199,386	567,069	148,144	81.78
% Difference	0.054	-0.045	1.329	0.322	0.097
PSS - Genetic + JS (25%)	7,679,261	7,035,512	643,750	149,340	82.55
% Difference	-1.069	-2.320	15.031	1.131	1.045
PSS - Genetic + JS (10%)	7,609,234	6,846,597	762,637	154,625	83.58
% Difference	-1.971	-4.943	36.274	4.711	2.306
PSS - Genetic + JS (No Cost)	7,612,779	6,826,173	786,606	157,061	83.67
% Difference	-1.926	-5.227	40.557	6.360	2.414

The treatment schedules and total treated area shown in Figure 4 and Table 13 represents the area scheduled for juvenile spacing. There is no pruning scheduled in any of the scenarios, except for the *PSS – Genetic + JS (No Cost)* scenario, in which 13 ha are scheduled for pruning.

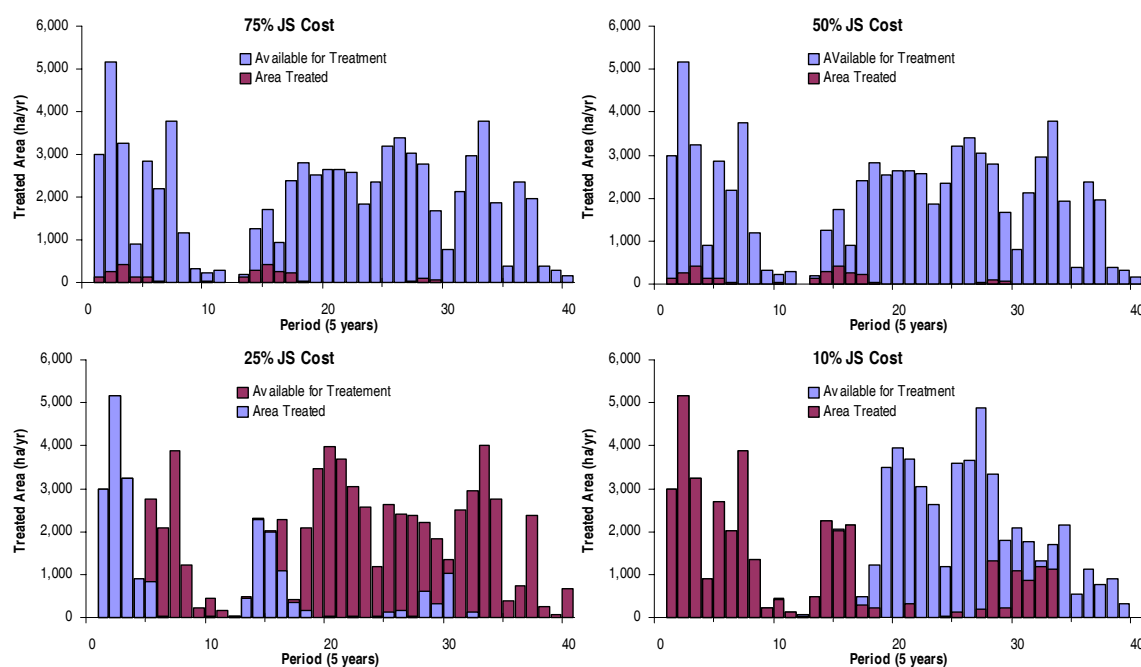


Figure 4: Juvenile Spacing Treatment Schedule – PSS-JS Cost Scenarios.

Table 13: Total Area Juvenile Spaced – PSS-JS Cost Scenarios.

Scenario	Total Area (ha)		
	Treated	Available for Treatment	Percent Treated
PSS - Genetic + JS	2,011	81,800	2.459
PSS - Genetic + JS (75%)	2,695	81,868	3.291
PSS - Genetic + JS (50%)	2,723	81,870	3.326
PSS - Genetic + JS (25%)	22,011	84,543	26.035
PSS - Genetic + JS (10%)	36,903	83,540	44.174
PSS - Genetic + JS (No Cost)	43,611	84,227	51.778

3.0 CONCLUSIONS AND RECOMMENDATIONS

The results of this analysis do not support an increased level of investment in incremental silviculture in the North Coast TSA. While small financial gains have been shown for certain treatments and combinations of treatments, the scale of these impacts is not significant enough to justify a recommendation for increased incremental silviculture investment.

In addition, the results have been shown to be sensitive to slight changes in assumptions. The fact that financial results are only slightly better or worse than the base case and, that the results may go from slightly negative to slightly positive with changes in assumptions, also suggests an increased level of incremental silviculture investment is not justified.

The goal of this silviculture strategy is to identify if there are opportunities to increase the quality and quantity of timber supply through silviculture investment and to identify which treatments have the potential to impact the timber supply and financial returns on the entire TSA.

The treatments examined in this analysis do not produce significant gains for the TSA. This does not mean that there are not stand level conditions on the TSA where treatments such as the use of genetically improved stock and juvenile spacing may provide benefit. However, these results do provide information indicating that great care should be taken in prescribing these treatments based on economic objectives. The risk of not recovering one's incremental silviculture investment at the TSA-level is quite high. Therefore, stand level prescriptions for incremental silviculture should account for long-term harvest scheduling and ensure that treatment costs can be recovered by harvesting the stand close to its economic rotation. In order to minimize this risk, prescriptions for incremental silviculture should consider factors such as forest-level biodiversity and visual quality requirements that will affect the timing of harvest as well as anticipated harvesting costs and expected revenues.

This analysis demonstrates that juvenile spacing alone, without the use of genetically improved stock, provides a limited financial benefit to the TSA. This is based on the treatment of approximately 1,100 ha in the first 60 years. The cost of this treatment is approximately \$2.09 million or \$34,800 / year for the first 60 years. This treatment results in a slight reduction in timber supply but the reduced logging costs and higher product values result in a positive financial return from the silviculture investment. The results, through these scenarios as well as those reported in the Analysis Report, have been shown to be sensitive to changes in treatment cost, logging costs, and minimum harvestable ages, all of which have a certain degree of

uncertainty associated with them. This juvenile spacing program would generate an average of 73 person days⁴ of juvenile spacing work per year for 60 years.

The use of genetically improved stock, while producing slightly positive gains when applied to the entire land base, using one logging cost for all stands, was shown to have lower financial returns when applied only to higher productivity sites and using revised logging cost estimates. This is likely due to the higher degree of hemlock natural ingress modelled on high productivity sites.

The combination of planting genetically improved stock and juvenile spacing does produce a higher financial return than juvenile spacing alone. Sensitivity analysis around regeneration costs indicate that the higher cost of planting genetically improved stock is the primary reason for this.

There are a few key sources of uncertainty within the North Coast TSA that have the potential to significantly impact results. The most pressing of these issues is the need to improve site productivity estimates. Currently, in the North Coast TSA, a fall down in timber supply is projected to occur over the next 60 to 80 years. Sensitivity analysis, conducted as part of the LRMP analysis suggests that better estimates of site productivity may result in a substantial increase in the mid and long-term harvest levels. This factor alone can significantly impact the role of incremental silviculture in the TSA.

Another source of uncertainty that has the potential to impact returns from incremental silviculture in the TSA is delivered wood costs and in particular, logging costs. As demonstrated in the Analysis Report, the net revenue generated from stand-to-stand (influenced particularly by logging costs) can influence the ability of incremental silviculture investment to generate a positive return.

Another aspect with the potential to impact the application of incremental silviculture is direction from the Chief Forester to increase utilization of retention silviculture systems in order to mitigate harvesting constraints. In the Chief Forester's rationale for AAC determination, he noted maintenance of current ACC levels will be predicated on greater utilization of the THLB compared to the 70% presently experienced. As the amount of retention area increases, rumoured to approach a 50/50 mix of conventional and helicopter logging, the typical incremental silviculture treatments associated with clear cutting systems will decline.

The next allowable annual cut determination for the North Coast TSA (Timber Supply Review III) is scheduled for completion by December 2004. Many of the issues discussed above will have ramifications in the next TSR. These issues should be addressed prior to the next Timber Supply Review.

4.0 REFERENCES

Section 7.0 of the *Data Package* and Section 7.0 of the *Analysis Report* contains a list of references used in the development of this preferred silviculture strategy for the North Coast TSA.

⁴ Based on an average juvenile spacing productivity of 0.25 ha per day.