Ministry of Forests

Vancouver Forest Region

Queen Charlotte Islands Forest District

Type 2 Strategic Silviculture Analysis
Analysis Information Package
February 2001

A project submitted by: Forest Ecosystem Solutions Ltd.
#210 – 275 Fell Avenue
North Vancouver BC V7P 3R5

Contact: Antti Makitalo R.P.F
tel. 604-998-2222
fax. 604-986-0361
email: amakitalo@forestecosystem.com

forest ecosystem solutions ltd.

Type 2 Strategic Silviculture Analysis
Analysis Information Package

Table of Contents

List of Tables

List of Figures

1.0 INTRODUCTION

The Ministry of Forests (Queen Charlotte Islands Forest District and Vancouver Forest Region) has initiated the development of a Type 2 Forest Level Silviculture Strategy for the Queen Charlotte TSA. This information package documents the procedures, assumptions, data and model used in the analysis. Forest Ecosystem Solutions Ltd. (FESL) has been engaged to prepare the information package and conduct the Type 2 analysis on behalf of the MoF. While not as detailed as an information package for a timber supply analysis, this package will utilize where appropriate format and requirements within the *Provincial Guide for the Submission of Timber Supply Information Packages for Tree Farm Licences, Version 3*.

The purpose of this information package is to:

- Provide a mechanism for communication of technical analysis issues between the prior to undertaking the Type 2 analysis;
- Provide an opportunity for the MoF and participants to review those technical issues and assumptions that will be used in the preparation of the Type 2 analysis;
- Create a dynamic document which, over time, will ensure that all relevant information is accounted for appropriately in the Type 2 analysis; and
- Increase the efficiency of the Type 2 analysis process by reducing the risk of having analyses discarded due to inappropriate content.

Base data for the Type 2 analysis comes from the TSR II resultant dataset. This dataset includes the 1999 inventory audit and other resource data layers that were utilized in TSR II.

All data summarized in this package used spatial GIS data and forest inventory polygon (FIP) labels, allowing all Forest Simulation Optimization System (***FSOS***) analyses to be spatially and temporally referenced. ***FSOS*** will be used to assess silviculture strategies for the Queen Charlotte TSA over a 200 year planning horizon.

1.1 Management Unit Objectives

Much of the management unit objectives have changed since the Incremental Silviculture Strategy was completed for the QC TSA. During the workshop revised working targets, product objectives and strategies were developed. The revised working targets and product objectives are presented:

Quantity: Manage the short and long-term timber supplies to yield the maximum possible volume without sacrificing long-term sustainability.

Quality: Manage regenerated stands to yield 8% premium logs by volume, with the majority of the remainder being of good grade sawlog quality.

The following are the revised product objectives at the log level for the QC TSA:

Premium Log: Pine pole – 30+ cm min dia over 15 m, few knots (pole);
Cedar pole – 30+ cm min dia over 15 m, few knots (pole);

Cedar large timber – min. 55 cm & low taper for 10 m, mature wood;
Spruce/Hemlock clear – clear for 5m.

Sawlog: Minimum average 45 cm DBH and stand volume of 350 m^3/ha

It should be noted that both JS Jones and Husby identified that the premium log objectives do not represent an average premium description but were satisfied with the conservative assumption for the purpose of the analysis.

2.0 PROCESS

The development of the Type 2 forest level silviculture strategy for the Queen Charlotte TSA is directed through the project contract. The contract identifies the process for the development of a Type 2 forest level silviculture strategy.

This information package is one of the two reports for the Type 2 project. The second report will be the analysis report.

The background information that guided the assumptions and processes employed in this information package includes, but is not limited to, the following reports:

- *Queen Charlotte Timber Supply Area Timber Supply Review – Information Report, March 1999.*
- *Queen Charlotte Timber Supply Area Analysis Report (TSR II), October 2000*
- *Incorporating Biodiversity and Landscape Units in the Timber Supply Review*
- *Site Index Adjustments for Old-Growth Stands Based on Veteran Trees (Working Paper 36, 1998)*
- *Site Index Conversion Equations for Mixed Species Stands - MoF Research Branch, 1998*
- *Timber Supply Review Base Case Modeling Assumptions for Biodiversity and Landscape Units*
- *Tree Farm Licence Information Package Guidelines*
- *Request for Proposals – Development of Type 2 Forest Level Silviculture Strategies (July 27, 1999)*

2.1 Growth and Yield

The TSR 2 curve set will be utilized for the base case scenario. The variable density yield prediction (VDYP) model developed by the B.C. Ministry of Forests, Resources Inventory Branch, was used to estimate timber volumes for all existing 'naturally established' stands. The table interpolation program for stand yields (TIPSY) developed by the B.C. Ministry of Forests, Research Branch, was used to estimate timber volumes for managed stands.

The Research Branch, using The Tree and Stand Simulator (TASS), developed growth and yield information for the intensive silviculture regimes, which are used for all other scenarios.

2.2 Data Preparation and Missing Data

A large resultant spatial database was delivered to Forest Ecosystem Solutions Ltd. Also serving as the base data for TSR II, this master database is a complete resultant polygon list, each with unique identification numbers.

3.0 ANALYSIS AND SCENARIO PLANNING

3.1 Analysis Methods

The objective of the Type 2 forest level silviculture strategy is to meet forest-level objectives using incremental silviculture activities.

Through forest level modeling using FSOS, the variety of treatments can be considered in light of their ability to satisfy forest-level objectives. A single treatment at the stand level may result in a yield improvement. However, at the forest level, this treatment may be a poor investment when considered together with all other investments, budgets and objectives. Conversely, a treatment at the stand-level that does not represent a significant benefit may in fact be an important action and satisfy an objective at the forest-level.

Stand management options or treatment regimes describe a series of silviculture actions that are possible for a given stand type. Each treatment within the regime occurs in sequential order and has an associated set of costs, values, employment levels, and timber quality and quantity effects at a given point in time.

FSOS will determine the appropriate treatment regime for each stand following harvest, or for those stands that were previously harvested and are still treatable. Each regime provides a timeframe of treatments, including harvesting, and stand development. Following harvest, the stand may follow the same treatment regime or transform to another regime or receive no treatment at all, based on decisions of costs, values, and overall satisfaction of objectives.

A number of forest-level scenarios will be developed and analyzed. These scenarios will eventually lead to the development of a preferred option. This approach presents a sequential and iterative process of analysis - each step providing insight, understanding and direction for the next.

3.2 Scenarios

The development of a forest level silviculture strategy is not an easy process. Considering that there is a variety of stand- and forest-level objectives or desired future outcomes, elaborate stand treatment regimes, and long time horizons create complexity in forest dynamics, making understanding difficult and complicating the development of an incremental silviculture plan.

Scenario planning helps to understand those significant issues that control future outcomes related to the stated objectives by simplifying the complex interactions. Scenarios are developed to test options through either sensitivity analysis, or they can be based on individual management interests and questions. Knowledge of these issues and outcomes allow the forest managers to develop management decisions based on improved information and understanding of the consequences and interactions.

Each scenario result describes the silvicultural and forest-level outcome given the management approach defined in that scenario. The scenarios are assessed individually for the development of the preferred option. The actual final silvicultural strategy may be composed of constituents of some or all of the other scenarios. The scenarios provide an incremental process of understanding of the minimum and maximum values of future forest conditions and possibilities.

Key items that are assessed within each scenario are the response of important indicators (i.e. timber supply), similar trends across scenarios, tradeoffs between scenarios, and short- and long-term variations.

Both simulation and heuristic analysis techniques will be used in this Queen Charlotte TSA analysis. Table 1 provides a summary of different analysis scenarios.

Table 1 - Summary of Scenarios

Scenario	Title	Scenario Description
1	Benchmark	Re-creation of the TSR 2 Base Case to calibrate model and to test reliability of results.
2	Revised Base Case	Includes ingress and OGSI. No incremental silviculture treatments.
3	Silviculture Strategy Base Case	Includes ingress and OGSI plus tree improvement. No incremental silviculture treatments.
4	Timber Volume Scenarios	A set of scenarios varying annual investment budgets. Intent is to determine impact on volume.
5	Timber Value Scenarios	A set of scenarios attempting to increase value through larger piece size and clear wood.
6	Preferred Scenario	Scenario of the full combination of silviculture activities required to achieve the desired forest level objectives for timber and habitat.

The levels of incremental silviculture investment to be tested are:

1. $200k
2. $500k
3. $1000k
4. $1500k
5. $2000k

3.2.1 Benchmark (Scenario 1)

Re-creating the TSR 2 base case makes it possible to evaluate the model's performance as well as monitor differences between this analysis and TSR 2. The base case assumes some incremental silviculture; most stands are assumed to receive a spacing treatment. Only cedar growing on poor sites will not receive a spacing treatment.

The base case does not include genetic improvement.

3.2.2 Revised Base Case (Scenario 2)

The revised base case uses old growth site index (OGSI) adjustments for all stands older than 140 years. It also includes ingress. Starting out with higher establishment densities than in the base case incorporated an estimate for ingress. All past treatments indicated in ISS and FIP files are included however no incremental silviculture treatments beyond this are included in this scenario.

3.2.3 Silviculture Strategy Base Case (Scenario 3)

This scenario is identical to previous scenario with the inclusion of the next generation improved seed and corresponding estimated genetic worth.

The silviculture strategy base case is the basis for all the upcoming scenarios, and will be compared to all future volume and value scenarios.

3.2.4 Timber Volume Scenarios (Scenario 4)

This is a set of scenarios, which vary the annual investment budget and incorporate multiple incremental silviculture transition options. The intent is to determine the increases in timber quantity.

- No timber value incorporated in the objectives.
- Investment levels are $200,000, $500,000, $1,000,000, $1,500,000, and $2,000,000.
- Helicopter logging treatments were fixed on the do-nothing option.

3.2.5 Timber Value Scenarios (Scenario 5)

This is a scenario(s) incorporating value in the model. It is assumed that including value in the optimization function will allocate the silviculture budget favouring those treatments that increase the value of the harvest across the forest estate, such as spacing and pruning.

3.2.6 Preferred Scenario (Scenario 6)

This scenario may be one of the previous scenarios, or it may be a new scenario based on the results of all previous scenarios. It is the ‘best’ option that includes all preferred management and serves as a basis for the incremental silviculture strategy. Map output will be limited to the presentation of a 20-year ‘optimized’ silviculture treatment schedule.

3.3 Analysis Assumptions

Agreement was made during the workshop that timber and non-timber resources will be managed as per TSR 2 analysis report unless otherwise specified. There was significant discussion that assumptions and procedures of TSR 2 did not reflect “reality” in the TSA and that there are on-going reviews of the analysis report. Husby has undertaken a revised Type 2 shadow analysis to reflect the perceived differences and believes that there are significant changes required for the Type 2 analysis assumptions. To date these assumptions have not been provided.

The following assumptions will be changed for the revised base scenario:

1. “Normal” market conditions will prevail for demand and prices for timber and fibre.

2. Current Forest Practises Code requirements are maintained throughout the planning horizon.

3. MoF timber supply concepts and harvest flow rules are followed (maintain current harvest as long as possible with reasonable declines in the future - 10%/decade).

4. Specific levels of precision are used in the optimization analysis are as follows:
    - +/- 10% change in timber flow between decades.
    - Silviculture investment not to exceed maximum budget level by more than 10%.
    - Maximum 5% tolerance around age-class targets specified in TSR 2 for optimization to allow for smooth transition strategies to be achieved without impacting timber flows.

5. The opportunity evaluation process is not limited by factors such as the availability of funding, funding source, or the ability to deliver a program. However, a final strategy must be plausible.

6. A status quo timber harvesting land base, excepting substantial actual alienations since the last TSR may be taken into account in a “revised base case”.

7. Regeneration delay will be 3 years for all analysis units.

8. Site index adjustment will be applied to the appropriate analysis units as per the inventory audit figures and the OGSI veteran study as defined on page 69 of the analysis report.

9. Minimum harvest requirements and utilization levels will be applied as per TSR II.

4.0 MODELS

The following models were used in the preparation of the strategic silviculture analysis and data package for the Sunshine Coast TSA:

- ***FSOS*** time-step simulation model and ***FSOS*** forest estate optimization model;
- MoF Variable Density Yield Program (VDYP);
- MoF Table Interpolation Program for Stand Yields for Microsoft Windows (WinTIPSY).
- MoF Tree and Stand Simulator (TASS)

Landscape Design Model - *FSOS*

Model Name:	***FSOS***
Model Developer:	Guoliang Liu
Model Development:	Forest Ecosystem Solutions (Hugh Hamilton Limited) and UBC
Model Type:	Landscape Design Model

Description

Forest Ecosystem Solutions Ltd. combines the power of advanced computer modeling techniques and GIS tools with expert professional experience. At the centre is a landscape optimization model called ***FSOS*** (Forest Simulation Optimization System). The model uses C++ programming language and can be run with both Windows '98 and Windows NT operating systems. The model interfaces directly with Microsoft Access for data management. The Timber Supply Branch of the MoF accepted the use of FSOS for timber supply analysis in August 1998. ***FSOS*** uses dynamic heuristic and simulation techniques to schedule harvest units based on 1) patch and seral objectives defined by non-timber (e.g. old-growth, biodiversity, visuals, habitat, watershed, etc.) resource values and 2) timber management objectives (e.g. even flow, volume levels, opening size distribution, species quotas). Harvest and approximate cut block shape and size over the planning horizon are an output of the model. Modeling of strict adjacency and seral constraints is accomplished using simulation modeling. The data structure is identical for both heuristic and simulation models, which prevents extensive data loading procedures when switching between techniques.

FSOS uses the multiple resultant polygons created by GIS overlay as the basic model unit, allowing great flexibility in creating a variety of potential harvest unit configurations by amalgamating these resultant polygons. Amalgamations of the harvest units through time create early seral openings and mature and old growth patches consistent with planned patch management strategies defined by higher level plans. Managing for specific patch size distributions within each seral class is also inherent within the model framework and is an extremely effective way to meet long-term biodiversity objectives. High weightings can be applied to relatively important resource objectives or objectives which are difficult to achieve. The objective function (evaluation equation) provides the means to evaluate the relative "success" between differing solutions. For each iteration, the model calculates a "penalty" based on the deviation of a given solution from the target values. Optimal solutions achieve targets quickly for highly weighted parameters in order to minimize the total "penalty" over the planning horizon. With optimization, "constraints" can be violated. As all resource values are tracked throughout the planning horizon, where and when this occurs is part of the model output.

The initial inventory data represents the gross land base, which includes both operable and inoperable areas and the contributing and non-contributing timber harvesting land base. This is required, as inoperable and other reserve areas contribute to the achievement of non-timber objectives. From GIS overlay, the land base is divided into resultant polygons, each with a unique set of attributes. Treatments are applied to each polygon based on these attributes. Analysis unit, forest type, forest age, silvicultural treatment, user allocation, site index, non-timber resource objectives or any other parameter can define treatment type and regime.

FSOS uses individual stand ages to project the current age structure of stands in the analysis area. As stands age, they move into and out of age classes established as a basis for meeting target objectives. For example, age classes may be established as ≤40 yrs, 41-120 yrs, 121-250 yrs, and >250 yrs.

The planning horizon length can vary as required. ***FSOS*** can produce spatially and temporally explicit plans over 20 years or for multiple rotations. A unique feature of ***FSOS*** is its ability to integrate strategic, tactical and operational planning phases into one process. Analysis runs include harvest timing and location for each period, as well as long-term, sustainable harvest levels.

Harvest rules that are used in ***FSOS*** are:

- Minimum stand age before a stand can be harvested;
- Maximum stand age, at which the stand is scheduled for cutting within a certain number of years (i.e. 10);
- Green-up period required before adjacent patches can be harvested (this is not between openings but between patches. Patch size in early seral can reflect desired cut block size distributions).

A range of priorities can also be applied to include the following:

- Stands at risk from fire, disease or insects;
- Species preferences to meet mill requirements;
- Opening size distribution;
- Piece size requirements;
- Silviculture investment;
- Even volume flow; and
- Minimize transportation costs.

All possible regeneration alternatives and treatment regimes can be incorporated into the model. Adjusting growth curves or harvesting percentages of the block at specified intervals incorporates complex harvest systems (i.e. partial cutting) and silvicultural treatments. ***FSOS*** can also account for re-entry delays. ***FSOS*** can apply multiple regeneration assumptions.

The reporting functions of ***FSOS*** are extensive. The data for each period is easily accessible for any analysis unit, zone, polygon, landscape unit, etc. and gives an overview of the forest state at any point in time. Species compositions, age structure, patch distribution, harvest scheduling, treatment cost, product values and many other variables are tracked and reported by period. Reporting functions are highly effective for the direct comparison of sensitivity analysis and scenario options. ***FSOS*** is linked directly to the powerful ArcView environment for the easy production of high-quality map production.

Updates to the land base can be applied by two methods. Changes to applied net downs occur in the database framework by reapplying net down percentages. Changes to layer boundaries or additions or subtractions from the land base require the data be altered in the G.I.S. environment.

Cover targets are usually applied by age as a surrogate for height. Using patch and age class distribution indicators can achieve all cover targets. Age class distribution targets can be set as minimums, maximums, or desired levels. For example, wildlife habitat cover requirements may be achieved by having 70% of the management zone greater than 100 years of age.

Some other capabilities of ***FSOS*** include:

- Negative ages;
- Multiple constraints (guidelines) by unit, zone or group;
- Yearly age distribution;
- Volume Operational Adjustment Factors (OAFs) and land OAFs;
- Spatial and temporal referencing of neighbouring polygons;
- Multi-species stands;
- No maximum planning horizon;
- Opening size distribution;
- Timber flow management;
- Landscape metrics options; and
- Economic indicators.

5.0 FOREST INVENTORY

All spatial information was received in ARC/INFO format. All data is controlled to the North American Datum (NAD) 83 base. The forest cover inventory has been updated for depletions to 1997. Stand characteristics such as average tee height, tree age and stocking have been projected to 1999. In 1998, two additional forest inventory projects were carried out. The first was the QCI Volume and Decay Study and the second was the Inventory Audit for the Queen Charlotte TSA. Both provided new stand volume, decay and waste estimates for the Queen Charlotte Islands.

The spatial and attribute data are stored in both the FC1 and FIP file formats, as per the provincial inventory standard database. The spatial inventory data is currently managed through ARC/INFO, which maintains the spatial relationships within the forest inventory as well as the other resource inventory information.

The adjacency file was set for a tolerance of 15 m. This means that the maximum distance between two polygons must be 15 m or less if the two polygons are to be considered adjacent. This distance affects polygon aggregation into harvest units and patches. Generating polygon adjacency at 15 m will prevent small sliver polygons, which may be present in the database, from being a barrier for adjacency.

6.0 DESCRIPTION OF LANDBASE

Determination of the timber harvesting land base (THLB) results from a sequential procedure where stands ineligible for harvest due to poor stand quality, non-merchantable species, specific geographical or management reductions or site sensitivity are systematically removed from the land base. Although portions of the land base are reserved from harvesting, their attributes within forested crown land still contribute to forest cover objectives.

6.1 Timber Harvesting Land Base

The net down procedure is an exclusionary process. Once an area has been removed, it cannot be deducted further along in the process. For this reason, the gross area removed is often greater than the net area removed, a result of overlapping resource issues. Table 2 illustrates the netdown for TSR 2. There are some slight differences (approximately 1% in the current and long-term) in the timber harvesting land base between the TSR 2 and Type 2 due to data processing.

Table 2 - Timber Harvesting Land Base – Base Case

	TSR 2 Netdown
Classification	**Area Reductions (ha)**
Total Land base:	**460,091**
Federal Lands and reserves	6,589
Not directly managed by B.C. Forest Service	9,212
Non-forest	78,632
Non-productive forest	11,305
Total Productive Forest	**354,353**
Reductions to Total Productive Forest:	
Ecological reserve areas	1,621
Unmerchantable forest types	8,346
Inaccessible and inoperable areas	54,999
Uneconomic and low site stands	165,331
Environmentally sensitive areas	8,333
Areas with high recreation values	2,412
Areas with unstable soils	13,574
Riparian management areas	9,774
Areas with cultural/heritage values	5,757
Wildlife tree reserve areas	593
Unmapped roads	1,240
Total Reductions to Land base	**271,980**
Current THLB Includes net NSR and net ha of Timber Licences	**82,373**
Future Reductions:	
Future Roads	4,842
Long-Term THLB	**77,531**

7.0 INVENTORY AGGREGATION

Inventory aggregation is a process of simplifying the landscape into similar units. It identifies management zones or resource emphasis areas for the application of unique forest cover and spatial structure requirements, as well as for the application of growth and yield information. The aggregation must recognize both the similarities and differences in forest stand productivity as well as management objectives and prescriptions. This section describes the criteria and rationale behind the aggregation.

7.1 Management Zones

Management zones are geographically referenced areas that require unique management considerations. Resource emphasis areas requiring the same management regime or the same forest cover requirements are grouped into management zones. Table 3 lists the management zones in the TSA and the rationale used to define these zones.

Multiple resource issues may be present on the same forest area. For example, the watershed management zone may also have areas, which are visually sensitive and require an old growth objective. ***FSOS*** can accommodate multiple overlapping resource layers. Establishing target levels for each layer does this. The model then schedules harvest units which best meet the target levels for all resource layers as a whole.

Table 3 - Management Zones

Management Zone	Net Area (Productive) (ha)	Criteria used to Delineate Zone	Rationale/Comment
IRM Zone	39,018	All areas on which standard integrated resource management practices occur.	The timber harvesting land base which is considered to be outside of other management zones
Visually Sensitivity Retention Partial Retention	 9,278 12,951	 High sensitivity to alteration. Moderate sensitivity to alteration	Scenic areas have been identified by the District Manager throughout the TSA. While not formally established, they have all been assigned to a VQC.
BEC Variants: CWH vh 2 CWH wh 1 CWH wh 2 MH wh 1 MH wh 2 AT p	 18,367 53,430 7,769 902 1,074 3	Defined in the Biodiversity Guidebook. They determine the natural disturbance regime, and old growth objectives within these zones. A 10/45/45 rule for biodiversity emphasis with 1/3 drawdown for low will be applied to each landscape unit.	Old growth objectives will be applied by landscape unit and by BEC variant to ensure representation within each unit.
Community Watersheds	1,931	Areas defined by MELP based on height of land analysis.	Forest Practices Code Community Watershed Guidebook provides guidelines for managing community watersheds.
Haida declared areas	27,299	Areas defined by the Council of the Haida Nation as important for cultural reasons.	Comprising approximately 41% of the THLB, these areas will be allowed to have a maximum of 20% under 3 metres height for the first 30 years, after which a maximum of 25% will be permitted.

Management Zone	Net Area (Productive) (ha)	Criteria used to Delineate Zone	Rationale/Comment
Protected Areas Strategy	635	Thirteen Cabinet approved study areas were identified under the Protected Areas Strategy.	Representing PAS goal 1 and 2 areas, they were not excluded from the THLB in the base case.
Tlell Watershed Local Resource Use Plan area	6,979	The Tlell River watershed has been delineated through the LRUP process and will be included in this analysis.	As the subject of much discussion, the Tlell River watershed is currently being negotiated as a community forest licence.
Goshawk nest site		One goshawk nest is known to exist in the QC TSA.	MELP has designated the Northern Goshawk as a red-listed species. No established management practices have been set but current practice is to avoid timber harvest around Goshawk nesting areas.
AAC partition		From the 1996 determination, the Chief Forester specified that 75,000 m^3 of low volume cedar stands be tracked and reported.	Future performance of low volume cedar stands is uncertain and must be monitored.

Biodiversity, IRM, and VQO objectives were applied by landscape unit.

7.2 Analysis Units

Table 4 lists the principal criteria used in the aggregation of stands with similar biological characteristics into larger homogeneous units called analysis units (AUs). This aggregation provides the mechanism for application of stand-level modeling and reporting. Each forest cover polygon will be assigned an AU, based on the criteria in the Table. The intensive silviculture regimes will also be developed based on the same analysis unit criteria.

Table 4 - Analysis Units

AU	Species & Site Class	Inventory Type Group	SI Range	Stand Type
1	Cedar – good / medium	9 – 11	≥ 15	
2	Cedar – poor	9 – 11	12.5 – 14.9	
3	Cedar low	9 – 11	< 12.5	
4	Hemlock – good	12 – 20	≥ 18	
5	Cedar – poor	9-11	< 17	
6	Hemlock – medium	12 – 20	15 – 17.9	
7	Hemlock – poor	12 – 20	< 15	
8	Spruce – good, age class 1 – 6	21 – 26	≥ 16	
	Spruce – good, age class 7 – 9	21 – 26		751, 861, 961, 962, 971
9	Spruce – medium / poor, age class 1 – 6	21 – 26	< 16	
	Spruce – medium / poor, age class 7 – 9	21 – 26		741, 841, 851, 852, 951, 952, 731, 831, 941

8.0 REGENERATION ASSUMPTIONS

Within the strategic silviculture analysis, there are two components of regeneration assumptions. The first is maintaining regeneration trends consistent with the TSR 2 analysis. These assumptions deal with age of regenerating trees, NSR regeneration assumptions, regeneration distributions, site index adjustments, etc. The second is the strategic silviculture level, addresses trajectory options for regenerating stands. Each analysis unit is eligible to follow any of the different trajectory options.

8.1 Yields for Base Case Managed Stands

This section describes the current regeneration regimes for the TSR 2 base case, identifying managed stand conditions for each analysis unit. The operational adjustment factors for all regenerated AUs are 15% for OAF 1 and 5% for OAF 2. Table 5 identifies the existing and future managed regeneration information for the QC TSA.

Table 5 - Existing and Future Managed TIPSY Curves - Planted and Spaced

AU	Regen Delay	OAF1 %	OAF2 %	Plant/Natural	Initial Density	Space
101 Cedar – low	5	15	5	Plant	2000	N/A
102 Cedar – poor	5	15	5	Plant	3000 (50%) 7000 (50%)	1600 1600
103 Cedar – good/medium	3	15	5	Plant	15000	1600
104 Hemlock – poor	5	15	5	Nat/Plant	30000	1600
105 Hemlock – medium	3	15	5	Nat/Plant	20000	1600
106 Hemlock – good	3	15	5	Nat/Plant	20000	1600
107 Spruce – medium/poor	3	15	5	Nat/Plant	15000	1600
108 Spruce – Good	3	15	5	Plant	3000	700

8.2 Genetic Gain Allowances

The TSR 2 base case assumed no genetic gain. Future genetic gain is described later in this document.

8.3 Existing Managed Immature

Table 6 illustrates the percentage of each age group between 1 and 40 years old that are classified as managed immature.

Table 6 - Existing Managed Immature by Age Class

Analysis Unit	Area Managed (%)			
	Age 1-10	Age 11-20	Age 21-30	Age 31-40
All Units	60	70	60	30

All scenarios will use the above definition for existing managed stands, however, from the silviculture strategy onward also older stands with a history of management were considered managed stands.

8.4 Not Satisfactorily Restocked

In ***FSOS***, NSR is modeled using negative ages, which are applied to reflect the NSR restocking schedule. All NSR is considered current and is assumed to regenerate within 5 years.

8.5 TASS Curves

The strategic silviculture analysis focuses on determining the optimal timing and treatments given certain forest cover objectives, employment objectives, budgeting, timber flow criteria, timber volumes and costs of treatment. For each AU, the stakeholder group in Workshop #1 identified a series of treatment regimes. The TASS curves were generated for each regime for forest-level analysis.

The TASS curves provide a range of treatment regimes for regenerating stands. The treatment regimes are shown in Table 7.

Table 7 - Treatment Regimes

AU	SP	Regen Delay	OAF1	OAF2	Plant/ Natural %	SI	Initial Density	Space	Space Fert	Fert	Space Prune 1 lift	Space Prune 2 lifts	Space Prune Fert	Do Not Treat
101 Cedar – low	Cw	3	15	5	100/0	11.4	2000							✔
102 Cedar – poor	Cw	3	15	5	50/50	13.8	3000			✔				✔
103 Cedar – good	Cw	3	15	5	10/90	16.8	15000	✔						✔
104 Hemlock – poor	Hw	3	15	5	5/95	13.6	30000	✔						✔
105 Hemlock – med	Hw	3	15	5	5/95	15.9	20000	✔						✔
106 Hemlock – good	Hw	3	15	5	5/95	22.7	20000	✔			✔	✔		✔
107 Spruce – med/poor	Ss	3	15	5	10/90	12.3	15000	✔	✔					✔
108 Spruce – good	Ss	3	15	5	50/50	23.6	3000	✔			✔	✔		✔
111 Cedar – low OGSI	Cw	3	15	5	100/0	15.1	2000							✔
112 Cedar – poor OGSI	Cw	3	15	5	50/50	18.1	3000			✔				✔
113 Cedar – good OGSI	Cw	3	15	5	10/90	20.7	15000	✔			✔	✔		✔
114 Hemlock – poor OGSI	Hw	3	15	5	5/95	23.8	30000	✔			✔	✔		✔
115 Hemlock – med OGSI	Hw	3	15	5	5/95	26.6	20000	✔			✔	✔		✔
116 Hemlock – good OGSI	Hw	3	15	5	5/95	23.6	20000	✔			✔	✔		✔
228 Spruce – good OGSI	Ss	3	15	5	50/50	28.3	3000	✔			✔	✔		✔

[1] Parameters for Treatments:

Space – 1,000 stems/ha at 12 years
Prune (1 lift) – 1st lift to 3 m at 6 m stand height
Prune (2 lifts) – 2nd lift to 5.5 m at 10 m stand height
Fert (manual) – at 15 years and 10 years before rotation

Stands in the heli-logging zone do not receive any treatment and will be regenerated on the 'do nothing' curve set.

It is assumed that the densities depicted in Table 7 model natural ingress adequately.

forest ecosystem solutions ltd.

Existing managed stands were determined as per TSR2 (Table 6). Where treatments could be confirmed in the ISIS database or in the FIP database, existing managed stands were placed on the appropriate point on the yield curve based on age and previously applied treatments.

Where information could not be directly linked to ISIS, the forest cover information was used.

8.5.1 Fertilization Adjustment

There is currently a lack of growth and yield response for fertilization in TASS. For this analysis we have assumed a 2m site index adjustment for SS and CW based on a 20-25% response to treatment.

8.5.2 Genetic Gain Allowances for TASS Curves

The genetic worth was adjusted for the silviculture strategy base case and the ensuing analyses to reflect the quality of future seed lots. The second-generation improved seed is not anticipated to be available until 2010. However, this analysis assumed the use of the second-generation seed throughout the planning horizon. The projected genetic gains for Cw and Hw were received from the Tree Improvement Branch of the Ministry of Forests. The projected genetic gains for planted Hw and Cw are 15% and 11% respectively.

8.5.3 Minimum Harvest Age Criteria

The same criteria as in the TSR 2 base case were used to determine the minimum harvest age (MHA) for TASS yield curves. The lowest minimum age at which all the criteria were achieved defined the MHA. The actual harvest will be determined during the analysis based on the rate at which the forest can actually grow trees and the combined effect of administrative constraints. Table 8 illustrates the minimum harvest criteria for each analysis unit.

Table 8 – Minimum Harvest Criteria

Analysis Units		Minimum Volume/ha	Harvest Age
1	Cedar low – natural	400 m^3/ha	95% of max MAI
2	Cedar poor – natural	400 m^3/ha	95% of max MAI
3	Cedar good – natural	400 m^3/ha	95% of max MAI
4	Hemlock poor – natural	400 m^3/ha	95% of max MAI
5	Hemlock medium – natural	400 m^3/ha	95% of max MAI
6	Hemlock good – natural	400 m^3/ha	95% of max MAI
7	Spruce poor – natural	400 m^3/ha	95% of max MAI
8	Spruce good – natural	400 m^3/ha	95% of max MAI
101	Cedar low – managed	400 m^3/ha	95% of max MAI
102	Cedar poor – managed	400 m^3/ha	95% of max MAI
103	Cedar good – managed	400 m^3/ha	95% of max MAI
104	Hemlock poor – managed	400 m^3/ha	95% of max MAI
105	Hemlock medium – managed	400 m^3/ha	95% of max MAI
106	Hemlock good – managed	400 m^3/ha	95% of max MAI
107	Spruce poor – managed	400 m^3/ha	95% of max MAI
108	Spruce good – managed	400 m^3/ha	95% of max MAI

8.5.4 Site Index Adjustments

Prior to reassignment of a yield curve, existing mature stands (>140 years) had OGSI adjustments applied, after harvest, according to the *Site Index Adjustments for Old-Growth Stands Based on Veteran Trees* (1998) study. No SIBEC adjustments were applied, as it was assumed that the recently completed inventory audit and the resulting site index adjustments represented the best available information.

8.5.5 ISIS Integration

The linkage from ISIS to the forest cover is not a 1-to-1 relationship. Currently, an opening number is used to link the two databases; however, within each opening, the forest cover data may have several forest cover polygons, and ISIS several treatment units. The number of sub-components in the opening may or may not be equal between ISIS and the forest cover information.

Where a 1-to-1 relationship existed, the FIP database was updated with ISIS data based on the leading species within each opening. Where a direct linkage was not achieved, the data was linked based on leading species and a tolerance around reported areas and a "best-fit" was achieved. With this method, a high usability of the ISIS data was achieved.

8.5.6 TASS – Regeneration Delay

The assumption for regeneration delay differed from the Timber Supply Review in that planting would utilize 1-year-old seedlings after 3 years, resulting in the effective regeneration delay of 2 years.

9.0 PROTECTION

9.1 Unsalvaged Losses

Unsalvaged losses are those that result from natural events, are non-recoverable, and result in a decrease in the productivity of the TSA. These losses focus on the epidemic losses, such as losses due to fire, insects and diseases that are not salvaged, whereby the endemic losses are accounted for through operational adjustments and net down reductions. This analysis will use the values and rationale from the TSR 2 data package. The losses for wind, fire, mammals and insects total 7,100 m^3/year.

Volumes are removed from the modeled harvest levels to represent net available volume.

10.0 INTEGRATED RESOURCE MANAGEMENT

The intent of this section is to provide details on how modeling methodology will integrate non-timber resource values with timber objectives.

10.1 Forest Cover Requirements

Table 9 outlines the forest cover objectives for the Queen Charlotte TSA, by management zone, for maintaining non-timber values. Forest cover objectives are applied to model biodiversity values, hydrological recovery, and visual quality objectives by placing maximum and/or minimum boundaries on specific age distributions, focusing largely on young age and old age forests.

By applying Forest Ecosystem Solutions Ltd.'s analysis approach, forest cover objectives can be viewed as either targets or constraints. In simulation mode, forest cover constraints can be applied that must coincide with harvesting actions. In the optimization approach, targets will be set in an attempt to develop and schedule harvest units to best achieve age class and timber flow objectives. Some trade-offs between objectives may occur.

Table 9 - Management Zones and Forest Cover Objectives – Base Case Scenario

Resource	Zone	THLB Area (ha)	Prod Area (ha)	Cover Requirement			
				Age 1	Max % < age 1	Age 2 (years)	Min % > Age 2 (1,70,140)
IRM				15	25		
Visual Quality[a]	Retention Partial Retention			25 25	5 15		
BEC Variants[a]	CWH MH AT					250 250	9.7 /11.6 /13.6 14.2 /17.0 /19.9
Community Watersheds				10	10		
Haida declared areas				15	20 (25)[b]		
Goshawk nest site				40	20	250 80	20 40

[a] Applied by individual landscape unit
[b] Maximum of 20% for first 30 years, after which a maximum of 25% is permitted.

11.0 TIMBER OBJECTIVES

11.1 Timber Values

Timber values used within the analysis are based on a series of piece size groupings - similar to industrial grading - for each species. The analysis is based on average log diameter, taper, and knot size and rings per inch. Logs will be bucked to provide optimal lengths for value.

The product selling prices for the analysis were derived using MoF second growth coastal log survey data with all incidental volumes removed from the database. The data is based on indexed monthly averages for the seven years ending December 15. 1999. The indexing is by the British Columbia consumer price index. The second growth selling prices are summarized in Table 10. Figure 1 depicts per cubic meter pricing for different grades by incremental top diameter.

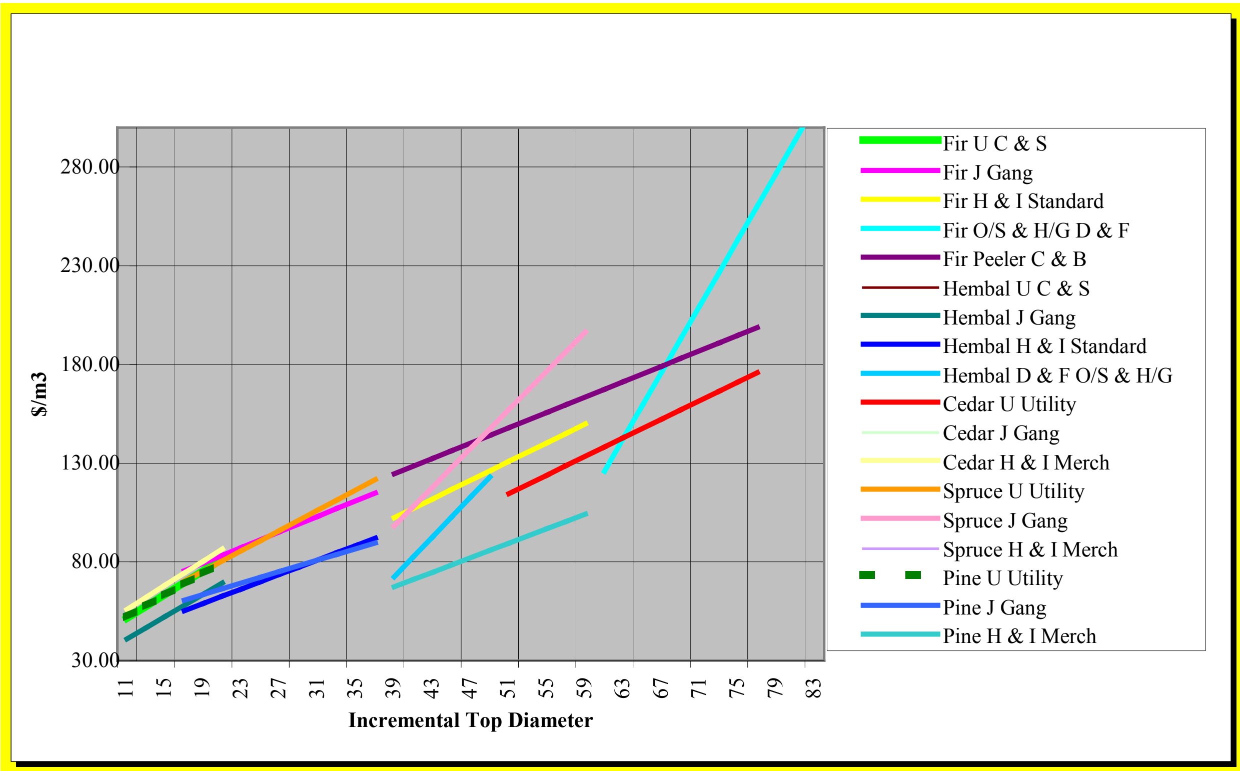

Figure 1 - Second Growth Timber Value by Species Grade; Sort at Howe Sound

Table 10 - Summary of Second Growth Selling Prices by Diameter Class

Species	Statutory Grades	Assumed Industrial Sorts	Average Selling Price ($/m3)	Max. Selling Price ($/m3)	Min. Selling Price ($/m3)	Upper Quartile ($/m3)	Lower Quartile ($/m3)	Incremental Top Diameters In 2 cm Classes (i.b.) 11	13	15	17	19	21	23	25	27	29	31	33	35	37
Fir	U	C & S	61.85	101.31	41.19	81.58	51.52	51.52	57.53	63.54	69.55	75.57	81.58								
Fir	J	Gang	100.55	129.43	50.40	114.99	75.47				75.47	79.43	83.38	87.33	91.28	95.23	99.18	103.13	107.09	111.04	114.99
Fir	H & I	Standard	130.21	169.55	74.59	149.88	102.40														
Fir	O/S & H/G	D & F	169.14	451.90	82.77	310.52	125.95														
Fir	Peeler	C & B	158.33	238.99	90.90	198.66	124.62														
Hembal	U	C & S	52.29	86.55	29.85	69.42	41.07	41.07	46.74	52.41	58.08	63.75	69.42								
Hembal	J	Gang	69.65	114.43	41.06	92.04	55.36				55.36	59.02	62.69	66.36	70.03	73.70	77.37	81.04	84.70	88.37	92.04
Hembal	H & I	Standard	92.71	153.35	52.30	123.03	72.51														
Hembal	D & F	O/S & H/G	133.79	217.99	95.51	175.89	114.65														
Cedar	U	Utility	67.53	105.65	44.46	86.59	55.99	55.99	62.11	68.23	74.35	80.47	86.59								
Cedar	J	Gang	93.22	150.21	47.33	121.72	70.28				70.28	75.42	80.56	85.71	90.85	96.00	101.14	106.28	111.43	116.57	121.72
Cedar	H & I	Merch	136.61	256.25	59.95	196.43	98.28														
Spruce	U	Utility	64.87	94.44	39.17	79.66	52.02	52.02	57.55	63.07	68.60	74.13	79.66								
Spruce	J	Gang	69.03	110.30	52.38	89.67	60.70				60.70	63.60	66.50	69.39	72.29	75.18	78.08	80.98	83.87	86.77	89.67
Spruce	H & I	Merch	83.61	124.87	51.30	104.24	67.45														
Pine	U	Utility	52.30	79.97	29.25	66.14	40.77	40.77	45.85	50.92	55.99	61.07	66.14								
Pine	J	Gang	61.23	95.97	35.40	78.60	48.32				48.32	51.35	54.38	57.40	60.43	63.46	66.49	69.52	72.55	75.58	78.60
Pine	H & I	Merch	All incidental volumes & pricing.																		

Species	Statutory Grades	Assumed Industrial Sorts	39	41	43	45	47	49	51	53	55	57	59	61	63	65	67	69	71	73	75	77	79	81	83
Fir	U	C & S																							
Fir	J	Gang																							
Fir	H & I	Standard	102.40	107.15	111.89	116.64	121.39	126.14	130.89	135.64	140.38	145.13	149.88												
Fir	O/S & H/G	D & F												125.95	142.73	159.51	176.29	193.07	209.85	226.63	243.40	260.18	276.96	293.74	310.52
Fir	Peeler	C & B	124.62	128.51	132.41	136.31	140.20	144.10	148.00	151.90	155.79	159.69	163.59	167.48	171.38	175.28	179.17	183.07	186.97	190.87	194.76	198.66			
Hembal	U	C & S																							
Hembal	J	Gang																							
Hembal	H & I	Standard	72.51	82.61	92.72	102.82	112.92	123.03																	
Hembal	D & F	O/S & H/G							114.65	119.36	124.07	128.78	133.49	138.20	142.91	147.62	152.33	157.05	161.76	166.47	171.18	175.89			
Cedar	U	Utility																							
Cedar	J	Gang																							
Cedar	H & I	Merch	98.28	108.10	117.91	127.73	137.54	147.36	157.17	166.99	176.80	186.62	196.43												
Spruce	U	Utility																							
Spruce	J	Gang																							
Spruce	H & I	Merch	67.45	71.13	74.81	78.49	82.17	85.85	89.53	93.20	96.88	100.56	104.24												
Pine	U	Utility																							
Pine	J	Gang																							
Pine	H & I	Merch																							

All timber values are based on domestic pricing, regardless of whether export opportunities for the wood exist.

11.2 Pruning Value

It has been identified that the log grades and their valuation do not often reflect the increase in log value due to pruning adequately. For this reason the stand values of pruned stands were increased as per Table 11. The value multipliers in the table are applied based on the report *Clear Wood Values From Pruning* by Silviculture Practices Section in the Forest Practices Branch (December, 2000).

Table 11 - Percent Clear Volume per ha and Corresponding Value Increase

Leading Species	% Clear (m^3/ha)	Value Multiplier (20 year Avg.)	Stand Value Multiplier
Hemlock	20.5 – 36.5	3.6	1.53 – 1.87
Cedar	27.1 – 40.4	3.0	1.54 – 1.81
Spruce	26.4 – 42.5	3.5*	1.66 – 2.06

* As no multiplier was available for spruce, the multiplier for pine was used.

11.3 Treatment Costs and Employment

Treatment costs for the analysis are based on industry information obtained after the first workshop. Table 13 shows the treatment costs used in the analysis.

Table 12 - Treatment Costs and Employment Factors

Treatment	Cost	Person Days
Spacing (per ha)	$2100	4.0
Pruning 1st lift (per ha)	$2500	6.0
Pruning 2nd lift (per ha)	$2700	6.0
Fertilization (per ha)	$750	0.1

11.4 Value Analysis

In the analysis, all treatments costs and revenues are aggregated at the forest level and brought back to today's dollars using a 4% discount rate. The model is then used to find a solution that would maximize the forest-level difference between costs and revenues over the planning horizon.

12. REFERENCES

B.C. Ministry of Forests. 2000. Clear Wood Values from Pruning, Madison's Canadian Lumber Reporter, and The Tree and Stand Simulator (TASS). December 2000. Victoria. B.C.

B.C. Ministry of Forests. 2000. Queen Charlotte Timber Supply Area, Timber Supply Review, Analysis Report October 2000. Victoria. B.C.

Atherton, L.P. 1999. Incremental Silviculture Strategy for B.C. - Working paper #2: Concepts and Strategy of Planning - Proposed Planning Framework. February 19, 1999. Victoria, B.C.

B.C. Ministry of Forests. 2000. Queen Charlotte Timber Supply Area, Timber Supply Review, Data Package March 1999. Victoria. B.C.

Nussbaum, A.F. 1998. Site Index Adjustments for Old –growth Stands Based on Paired Plots. Research Branch, B.C. Ministry of Forests 1998. Victoria B.C.

B.C. Ministry of Forests. 1998. Queen Charlotte Timber Supply Area, Incremental Silviculture Strategy (Interim) Version 1.1. September 1998. Victoria B.C.

B.C. Ministry of Forests. 1996. Sunshine Coast Timber Supply Area - Rationale for Allowable Annual Cut (AAC) Determination. March 1996. Victoria, B.C.

B.C. Ministry of Forests and Ministry of Environment, Lands, and Parks. 1999. Resource Planning Framework - Guidelines for the Development of Resource Management Plans for 2000/01 (working draft). June 30, 1999. Victoria, B.C.

DeBell, D.S., Curtis, R.O., Harrington, C.A., and Tappeiner, J.C. 1997. Shaping stand development through silviculture practices *In* Creating a Forestry for the 21st Century. *Editors* Kohm, K.A. and Franklin, J.F. pp. 141-149.