North Coast
Timber Supply Area
and
Nootum / Draney Parcel, Pacific TSA

Economic Operability Assessment

Version 2.1 - August 11, 2010

Prepared for:

Ministry of Forests and Range

Prepared By:

Forsite
Box 2079, 330-42nd Street SW
Salmon Arm, B.C. V1E 4R1
(250) 832-3366

ACKNOWLEDGEMENTS

The support and contributions from the following people and organizations was instrumental in the completion of this project:

Agency	Name
MoFR – Coast Forest Region	Andrew Hall Hal Maclean Lew Greentree Jim Brown
International Forest Products Ltd.	Mike Landers
B.C. Timber Sales	Bob Brand Lisa Gibbons Dave Nicolson Mike Grainger Andrew Reviakin
Sonora Tenures	Rick Brower
Gitga'at Forest Product	Dan Cardinall
Coast Tsimpsean Resources	Brendan Wilson
Gitxaala Forest Products	Mark Ignas
Metlakatla Forest Products	Ron Smith
Triumph Timber	Ryan Monsen
MoFR - Revenue Systems	Stephen Davis Brian Corregan
Forsite	Reg Davis Alina Turner Cam Brown Simon Moreira-Munoz

EXECUTIVE SUMMARY

This analysis examined the area within the North Coast TSA and the Nootum/Draney Parcel of the Pacific Timber Supply Area (formerly Block 7 of TFL 39). The project excluded areas like conservancies, BMTAs, parks, TFLs, Woodlots and Community Forests, but included all the remaining productive forest land that could potentially contribute to long-term timber supply.

The goal of this operability project was to provide a defensible, transparent process for defining an economically operable landbase that can be used in TSR and other projects. For example, the Ministry will use the mapping products to support EBM implementation, including the strategic landscape reserve design project. It will also be used in the next Timber Supply Review (TSR), and to assist with tenure charting decisions.

The method used defines a landbase that is likely to be economically viable for harvest under a reasonable range of future market conditions (a full market cycle). It is based on a dynamic solution, in contrast to other "snapshot" type methods. It offers these advantages:

- This method grows stands to gain volume and value over time.
- Road related costs are assigned to the specific area when it is logged, when the required roads are constructed and used. Road construction costs are carried by these initial stands. Once constructed, other stands appear more economic.
- Cutblock blending is explicitly addressed in the model, and a net revenue target ($/m3) is maintained in each 5 year period, i.e. enough revenue is generated in that period to cover the target stumpage payments.

The economic objective used during modeling was based on the premise that future logging is expected to produce enough revenue to pay stumpage to the crown consistent with the historical TSA average. The average stumpage paid by major licensees (not BCTS) from 1998-2007 was $1.74/m^3$.

From a potentially operable land base of 282,329 ha, an economically operable land base of 87,162 ha was achieved in Patchworks using the $1.74/m^3$ net return objective in each period. This operable land base includes a range of net stand values because positive stands were able to offset negative value stands as long as the net return objective was met in each period.

Cedar (Cw, Yc) leading stands make up a significant portion (62%) of the new operable land base, while hemlock (Hw) leading stands followed at 31%. Higher proportions of the more valuable species (e.g. Cw) are represented in the operable land base, compared to the inoperable landbase, while lower value species such as Hw and Ba have a lower representation in the operable, and higher in the inoperable. For example, the hemlock-leading stands comprise 31% of the operable landbase, and 63% of remaining inoperable landbase.

The new operable land base in the North Coast TSA consists of 58% conventional logging and 42% helicopter logging.

In order to assess the sensitivity of the operable area to different financial objectives, two sensitivity analyses were completed. Results showed that assuming -1 standard deviation, or +1 standard deviation change in stand value resulted in a landbase change of +216 % and – 99%, respectively, in the North Coast TSA. This change is directly related to how much the higher value stands on the land base are able to subsidize the lower value stands. When higher value stands are assumed, the remaining, few negative value stands are able to be included in the operable land base, while the reverse is true for lower stand values.

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1.0 Introduction

The goal of this operability project is to provide a defensible, transparent process for defining an economically operable landbase that can be used in TSR and other projects. For example, the Ministry needs this mapping to support tasks related to EBM implementation, including a strategic landscape reserve design, for use in the Timber Supply Review (TSR) and to assist with tenure charting decisions. In the North Coast TSA, this mapping is needed to fulfill the Chief Forester's TSR3 implementation instructions requesting Forest District staff and Licensees to conduct a review of the timber operability for the TSA.

This project was conceived to produce an updated operable landbase. It was determined that the new operable landbase would be based on stand level economic assessments because any tree in the TSA is physically harvestable with enough resources, but it is only those that are economic under historical market conditions that should be considered operable.

This analysis will examine all productive areas of the entire North Coast TSA and the Nootum/Draney Parcel of the Pacific Timber Supply Area (formerly Block 7 of TFL 39) that could potentially contribute to long-term timber supply. This excludes areas like conservancies, BMTAs, parks, TFLs, Woodlots and Community Forests, but would include all remaining productive forest land.

2.0 Description of the Land Base

The North Coast TSA is located in northwest British Columbia, within the Coast Forest Region. The North Coast TSA covers approximately 1.8 million hectares, of which, approximately 8% or 146 000 hectares is currently classified as the timber harvesting land base.

The North Coast TSA is administered from the Ministry of Forests and Range (MFR), North Coast Forest District office located in the City of Prince Rupert. Other communities within the TSA include the District of Port Edward, Dodge Cove, Port Simpson, and the villages of Gingolix, Lakalzap, Metlakatla, Oona River, Kitkatla, Hartley Bay and Kitsault. (Min. of For. Range: http://www.for.gov.bc.ca/hts/tsa/tsa21/)

This area included all the productive areas of the entire North Coast TSA and the Nootum/Draney Parcel of the Pacific Timber Supply Area (formerly Block 7 of TFL 39) that could potentially contribute to long-term timber supply. It excludes areas like conservancies, BMTAs, parks, TFLs, Woodlots and Community Forests, but would include all remaining productive forest land. (MoFR, 2009)

Figure 1 Map of the North Coast TSA

Figure 2 Map of the Nootum Parcel area

3.0 Data Sources

This project utilized the data sources listed in the following tables.

Table 1 Data sources and databases used in the project.

Spatial Data Theme	Vintage
Archaeological sites	2010 - MoFR, Nanaimo
Biogeoclimatic subzones	2010 – LRDW
Licensee cutblocks	2010 – Forest licensees
BMT	2010 - MoFR, Nanaimo
Harvest and barging zones	Derived 2010 (Forsite)
Goat habitat	2010 - MoFR, Nanaimo
Class 1 grizzly habitat	2010 - MoFR, Nanaimo
Mountain Goat UWR	2010 - MoFR, Nanaimo
Harvest system buffers	
Nisgaa Treaty Areas	2010 - MoFR, Nanaimo
TSR 3 ownership	2006 - MoFR, Nanaimo
Parks and Protected Areas	2010 - MoFR, Nanaimo
PSYU	2010 – LRDW
TSA	2010 – LRDW
Wildlife Habitat Areas	2010 - MoFR, Nanaimo
Env. Sensitive Areas (ESA)	???? - MoFR, Nanaimo
Forest cover – N. Coast	2010 – LRDW
Forest cover – Nootum Parcel	???? - MoFR, Nanaimo
Operating areas	2010 - MoFR, Nanaimo
Operability – N. Coast, TSR3	???? - MoFR, Nanaimo
Operability – Nootum Parcel	???? - BCTS, Pt. McNeil

Databases	Vintage	Comments
Scaled Volumes and Values / Stumpage (Mid Coast TSA)	1982-2009 (MFR Revenue Branch)	Tracked by timbermark. Includes waste and reject volumes.
Master Average Market Value (AMV) spreadsheet (Coast)	1994-2009 (MFR Revenue Branch)	Based on Vancouver Log Market sales.

4.0 Methodology Overview

Objective: Define a land base that is likely to be economically viable for harvest under a reasonable range of future market conditions (a market cycle). This was done using the following steps:

1. Develop a road network (existing and proposed roads)
2. Assign harvest systems based on distances from roads.
3. Identify candidate stands for assessment.
4. Determine net stand values ($\$/m^3$) that did not include road related costs.
5. Patchworks modeling:
    a. Build a model that allows cutblock blending to occur and allows road costs to be amortized over the volume logged in each period.
    b. Limit road building costs to reasonable levels each period.
    c. Ask the model to find the largest land base possible while still generating a reasonable economic return ($\$/m^3$) to the crown over time.
6. Define the operable land base (all stands harvested by the model).

4.1 Develop Road Network

A road network was developed with the goal of identifying the full extent of potential access throughout the TSA. This started with compiling all existing road data sources into a single dataset and classifying them as mainline or spur roads. Some of the roads were planned or potential roads that were developed as part of previous projects. These were adjusted manually to eliminate those that had since been built and were now present as existing roads. Additional future roads were mapped by the licensees and MoF staff, and these were added to the network. As with existing roads, all proposed roads were classified as either mainlines or spurs. This step was followed by a review of the compiled road dataset by the licensees, and further edits by the MoF staff. Finally, Forsite staff completed the road network to a GIS network standard (i.e. all segments connected, no breaks or loops or isolated segments, all database fields populated, all the network attributes rationalized, etc)

Construction costs were assigned to proposed roads based on terrain slope classes and road types (mainline vs. spur). Major bridges were identified as short segments in the road network and assigned costs (generally only for $250,000 and up). Bridge reestablishment costs were also assigned to existing road segments where licensees/MFR knew major bridges would require reconstruction. Identifying all proposed crossings and associated costs in the TSA was not practical – the intent was to capture all but the very major infrastructures within the general road building costs.

Proposed log dumps and dewatering sites (for those areas that used lake transport) were identified in the road network as short segments leading into the ocean (or lake), and back onto land, respectively. This allowed construction costs to be attributed to the dump sites if and when they were utilized. A barge network was established so that wood from every point in the TSA could flow down to the Vancouver Log Market. Barging and lake towing costs were assigned according to “cost zones” that were identified by the licensees. Six “zones” were used in this project. First, the North end of the North Coast TSA, south end of the North Coast TSA, and the Nootum Parcel were each assigned different barge costs. Then, within each of those zones, two “sub-zones” were identified: (1) any area that included lake towing costs, and (2) all other areas. As all wood flowed to the same destination, the barge and lake tow costs were assigned at the time of logging, and hence were treated as a portion of the logging cost, rather than a transportation network cost. This simplified the modeling setup a bit.

4.2 Assign Harvest Systems

The road dataset was then used to assign harvest systems. Areas within 250 m of roads were considered for conventional harvest, while areas >250 m and <2 km from roads. Helicopter harvest was also designated for stands that were up to 2 km from any potential water drop locations (ocean, or lakes that had water tow). Where stands could qualify for more than one system, the following hierarchy was used: conventional, heli-to-ocean, heli-to-lake, then heli-to-road.

4.3 Identify Candidate Stands

In order to be considered a candidate for economic assessment, stands needed to meet the following general criteria

- Only forested polygons were included in the model
- Only polygons in TSA ownership were included.
- Non-merchantable stands were excluded.
- Only polygons with a valid harvest system (conventional or helicopter) were included.

More detailed descriptions of the netdown criteria are found in section 7.5.

4.4 Determine Net Stand Values

Prior to modeling, a logging cost and stand value table were constructed for each stand on the land base. These tables were derived from the value and cost assumptions which are described below, and applied to each stand based on its age, site index and species composition (for the stand value) and the stand location (for the logging cost). Eventually, similar stands were grouped into blocks, based on the two leading species, age class (10-year classes), site index class (5-m classes) and harvest system. Then, a cost and value table (or curve) was developed for each block based on the stands in the block, and the block-level curves were used in the modeling.

During modeling, the various costs, values, and net values (grand totals, and $/m^3) were tracked. This methodology differs from the previous Mid Coast EOP project where a fixed value per m^3 and fixed cost per m^3 were calculated, and then multiplied by the stand volume to assign the final stand value and cost.

The logging costs, at the block level, do not include the road-related costs (construction, hauling, and maintenance) although they do include the barging and lake tow costs (since these costs are determined by the block location). Construction, hauling and maintenance costs were addressed separately in the road network to avoid assigning broad averages to each block. This better reflects operational realities. As an example, a specific subset of stands can be used to pay for initial road construction costs, while allowing the remaining stands to benefit from the existing roads, later in the modeling.

Ultimately, to determine the net stand value, numerous assumptions are required to assign costs and values to each stand (see diagram below).

5.0 Stand Valuation Assumptions

Each stand in the North Coast TSA was assigned a value ($/m^3) based on its volume by species, estimated grade distribution by species, and log market values by species and grade. In order to complete this task, it was necessary to stratify the TSA into two groups (old growth and second growth). See Table 2**Error! Reference source not found.** for the general approach taken for each group. Additional detail is provided in the text below.

Table 2. Stratums used to develop stand value assumptions.

Stand Type	Source of Stand Attributes	Source of Grade Distributions	Log Values
Old Growth (Existing stands >120 yrs)	Age / volume from Inventory and then projected forward by Patchworks	Scale Data Stratified by Geographic Zones	Revenue Branch 1 Month Average Market Values Tables: 10 yr Mean, Apr/06 (low), Mar/03 (high)
Second Growth (Stands <120 years and all regen stands)	Inventory attributes for existing stands, regen assumptions for regenerating stands.	TIPSY Log Grades (100 yr old stand for each species for 4 site classes)	Second Growth Value Conversion Factors (Coast Appraisal Advisory Committee) applied to old growth values.

5.1 Old Growth Grade Distributions and Values

The following steps were used to develop old growth value projections for each species:

1. 10 yr average old growth values were determined for each species and grade combination. This was done using the MoFR Revenue Branch 1 Month Average Coastal Log Market Values between May 2000 and May 2009 and calculating a volume weighted average value for each species/grade. A 10 year period was used because it was felt to reasonably reflect a full market cycle.

2. Old growth grade distributions specific to the North Coast TSA were determined for each species. This was done using MFR Harvest Billing System data for the North Coast TSA (all species, all grades, all licensees, and timber-marks) – 1995-2009. The scaled volume for each species was summed across the time period and a percentage by grade was determined. Using this and the values from step 1, average values for each species were determined.

A summary of the findings for old growth stands is provided below. **Error! Reference source not found.**Figure 3 and Figure 4 detail the average old growth grade distributions for each species in the TSA.

Table 3. Historical Harvest Old Growth Grade Distribution in the North Coast TSA

Grade	Species				
	Balsam	Cedar	Cypress	Hemlock	Spruce
3	0	0	0	0	0
4	1	2	3	2	1
5	0	0	0	0	0
6	0	0	0	0	0
D	3	1	1	1	2
E	0	0	0	0	2
F	6	1	2	2	2
G	0	0	0	0	5
H	32	31	24	18	35
I	12	14	10	16	22
J	27	22	32	24	12
K	0	3	0	0	0
L	0	5	0	0	0
M	0	4	0	0	0
U	7	8	13	14	9
X	7	4	7	11	5
Y	5	3	8	10	6
Z	0	0	0	0	0
Total	**100**	**100**	**100**	**100**	**100**

Note: Figures are the percentage of the total.

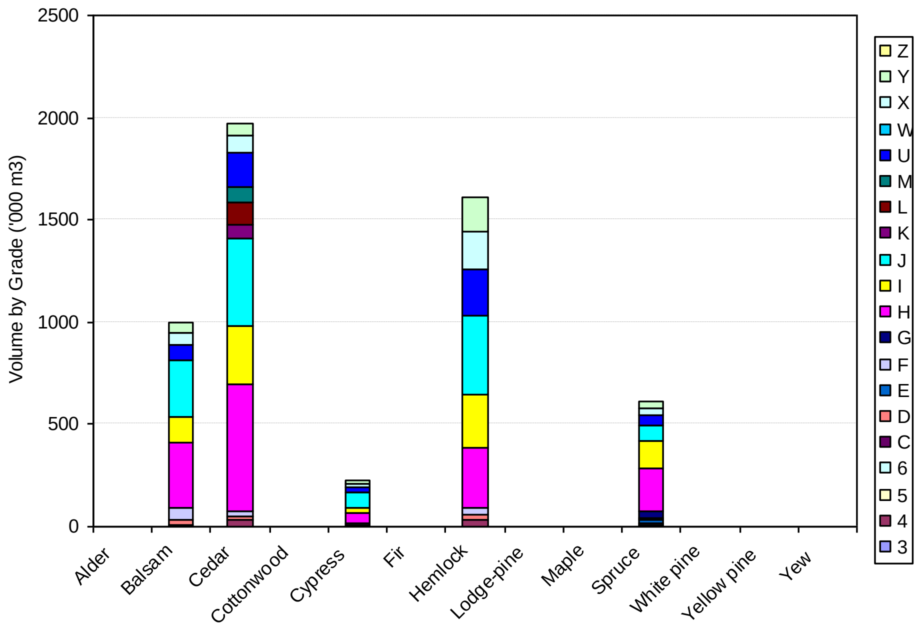


Figure 3. North Coast TSA 1995-2009 Old Growth Grade Distribution (Scale Data by Volume)

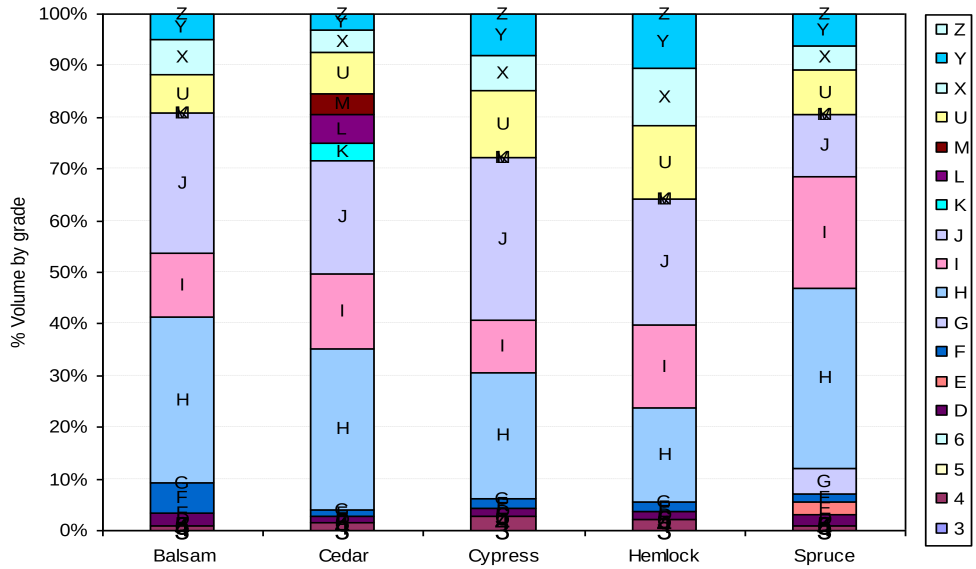


Figure 4. North Coast TSA - Old Growth Grade Distribution (Scale Data by %)

5.2 Old Growth Log Values

Old growth log values were obtained from the Vancouver Log Market as tracked by the MoFR Revenue Branch in their '1 and 3 Month Average Market Value' database. The log market conditions between and including 2000 and 2009 were evaluated to define the average market conditions for each species and grade. The previous 10 year average selling price for old growth logs (all non deciduous species/all grades) on the coast was $**93.32**/m^3.

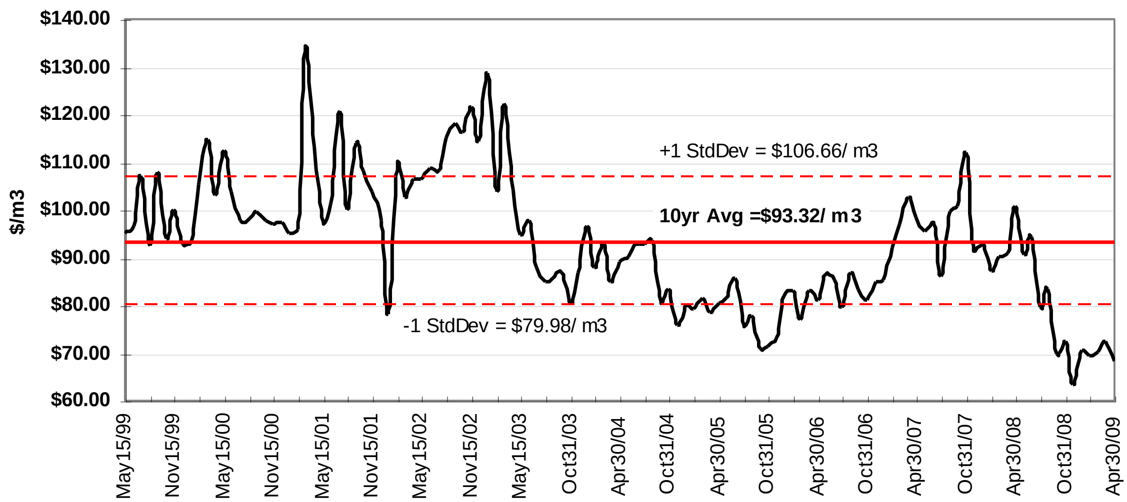


Figure 5. 10 Years of 1 Month Average Selling Prices for Coastal Logs (Vancouver Log Market Sales)

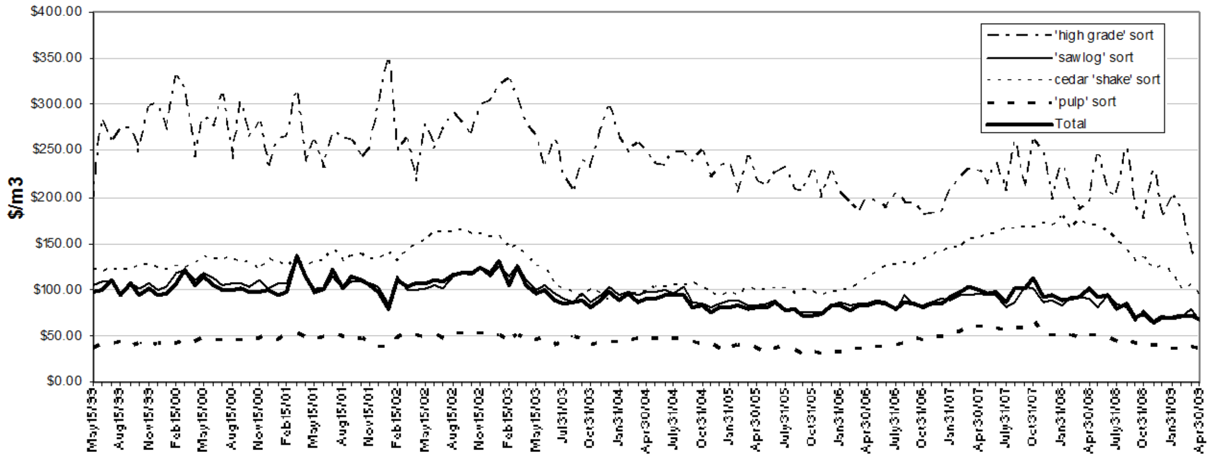


Figure 6. 10 Years of 1 Month Average Selling Prices by Product Type (Vancouver Log Market Sales)

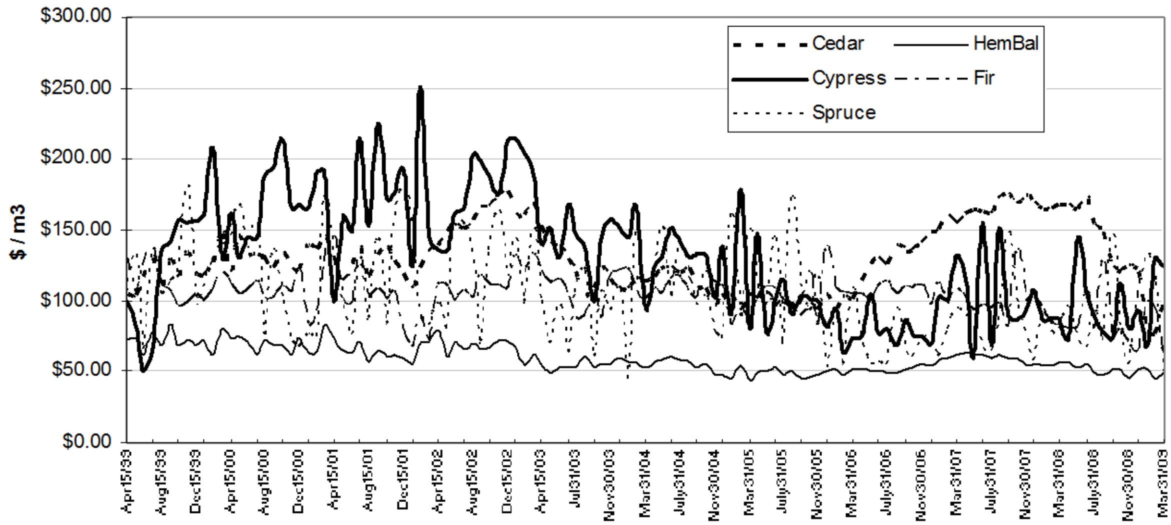


Figure 7. 10 Years of 1 Month Average Selling Prices by Species (Vancouver Log Market Sales)

10 Year Average Market: The 10 year (2000 - 2009) average of monthly selling prices (values)[1] for each species/grade combination was calculated (see table below). Monthly values were weighted based on volumes sold so months with no volume did not impact the average, and anomalies associated with small volumes had little impact.

1 Provided by MoF Revenue Branch in their '1 and 3 Month Average Market Value' database (Brian Corregan) reflecting Vancouver Log Market sales.

Table 4 Old growth product values by species and grade (10 yr average, 2000-2009)

			10 Year (2000 - 2009) Values				
Species	**Grade**	**Description**	**Avg. ($/m³)**	**x̄ +Std Dev ($/m³)**	**x̄ -Std Dev ($/m³)**	**Max ($/m³)**	**Min ($/m³)**
Hembal	D	Lumber	**$ 185.07**	$ 221.81	$ 148.34	$ 283.42	$ 82.20
	F	Lumber	**$ 125.21**	$ 147.46	$ 102.96	$ 190.99	$ 73.38
	H	Sawlog	**$ 83.13**	$ 94.08	$ 72.18	$ 101.61	$ 60.26
	I	Sawlog	**$ 62.36**	$ 71.82	$ 52.90	$ 81.72	$ 44.55
	J	Sawlog	**$ 55.55**	$ 60.70	$ 50.40	$ 65.65	$ 40.96
	U	Utility	**$ 42.26**	$ 47.43	$ 37.09	$ 54.49	$ 32.88
	X	Utility	**$ 40.69**	$ 46.34	$ 35.05	$ 52.57	$ 29.70
	Y	Chipper	**$ 39.01**	$ 44.96	$ 33.07	$ 50.41	$ 27.25
Cedar	D	Lumber	**$ 306.75**	$ 369.82	$ 243.67	$ 450.95	$ 197.20
	F	Lumber	**$ 267.71**	$ 323.39	$ 212.03	$ 384.89	$ 159.27
	H	Sawlog	**$ 181.93**	$ 210.97	$ 152.89	$ 246.84	$ 118.73
	I	Sawlog	**$ 129.68**	$ 156.60	$ 102.76	$ 185.64	$ 47.58
	J	Sawlog	**$ 133.08**	$ 158.01	$ 108.14	$ 200.12	$ 73.46
	K	Shingle	**$ 158.49**	$ 188.76	$ 128.22	$ 242.06	$ 112.98
	L	Shingle	**$ 135.22**	$ 159.99	$ 110.45	$ 188.27	$ 99.38
	M	Shingle	**$ 94.82**	$ 113.42	$ 76.22	$ 134.43	$ 63.66
	U	Utility	**$ 66.79**	$ 87.18	$ 46.40	$ 110.97	$ 31.55
	X	Utility	**$ 44.73**	$ 57.68	$ 31.78	$ 92.22	$ 24.91
	Y	Chipper	**$ 15.03**	$ 20.58	$ 9.48	$ 27.57	$ -
Cypress	D	Lumber	**$ 580.74**	$ 698.45	$ 463.03	$ 810.76	$ 117.73
	F	Lumber	**$ 383.08**	$ 479.73	$ 286.43	$ 573.88	$ 154.20
	H	Sawlog	**$ 204.75**	$ 268.28	$ 141.22	$ 335.20	$ 98.93
	I	Sawlog	**$ 132.50**	$ 174.15	$ 90.85	$ 214.99	$ 61.09
	J	Sawlog	**$ 91.49**	$ 113.92	$ 69.05	$ 138.27	$ -
	U	Utility	**$ 62.32**	$ 80.25	$ 44.39	$ 106.66	$ 29.99
	X	Utility	**$ 34.31**	$ 46.05	$ 22.57	$ 97.01	$ 12.64
	Y	Chipper	**$ 18.56**	$ 26.90	$ 10.22	$ 44.72	$ -
Douglas Fir	B	Peeler	**$ 227.54**	$ 258.42	$ 196.65	$ 320.10	$ -
	C	Peeler	**$ 156.32**	$ 171.16	$ 141.49	$ 226.57	$ 105.58
	D	Lumber	**$ 451.82**	$ 526.51	$ 377.12	$ 617.64	$ 150.49
	F	Lumber	**$ 290.36**	$ 324.03	$ 256.68	$ 371.46	$ 162.56
	H	Sawlog	**$ 142.53**	$ 161.17	$ 123.89	$ 193.83	$ 78.78
	I	Sawlog	**$ 104.01**	$ 116.96	$ 91.06	$ 137.44	$ 57.59
	J	Sawlog	**$ 82.71**	$ 91.21	$ 74.21	$ 97.65	$ 45.54
	U	Utility	**$ 48.65**	$ 54.68	$ 42.62	$ 66.29	$ 27.81
	X	Utility	**$ 29.82**	$ 35.91	$ 23.74	$ 57.44	$ 17.15
	Y	Chipper	**$ 27.55**	$ 34.62	$ 20.48	$ 46.58	$ 6.13
Spruce	D	Lumber	**$ 379.25**	$ 471.30	$ 287.20	$ 800.00	$ -
	E	Premium S	**$ 318.45**	$ 392.12	$ 244.77	$ 530.45	$ -
	F	Lumber	**$ 285.96**	$ 363.15	$ 208.77	$ 579.56	$ -
	G	Lumber	**$ 217.82**	$ 260.79	$ 174.84	$ 486.40	$ -
	H	Sawlog	**$ 118.52**	$ 149.07	$ 87.97	$ 196.86	$ 47.92
	I	Sawlog	**$ 72.48**	$ 87.71	$ 57.26	$ 131.74	$ 36.49
	J	Sawlog	**$ 66.81**	$ 72.37	$ 61.25	$ 81.45	$ 39.95
	U	Utility	**$ 42.81**	$ 48.80	$ 36.82	$ 58.52	$ 27.88
	X	Utility	**$ 40.10**	$ 46.54	$ 33.67	$ 53.63	$ 21.58
	Y	Chipper	**$ 39.22**	$ 46.23	$ 32.21	$ 52.11	$ -
Pine	D	Lumber	**$ 81.53**	$ 132.66	$ 30.39	$ 333.91	$ -
	F	Lumber	**$ 70.14**	$ 93.51	$ 46.76	$ 137.18	$ -
	H	Sawlog	**$ 57.88**	$ 71.73	$ 44.03	$ 85.29	$ 5.33
	I	Sawlog	**$ 44.69**	$ 56.29	$ 33.10	$ 72.85	$ 5.19
	J	Sawlog	**$ 63.61**	$ 72.56	$ 54.65	$ 74.07	$ 15.79
	U	Utility	**$ 33.27**	$ 44.22	$ 22.32	$ 56.47	$ 8.71
	X	Utility	**$ 25.48**	$ 33.45	$ 17.51	$ 47.12	$ 5.29
	Y	Chipper	**$ 24.72**	$ 33.40	$ 16.04	$ 47.83	$ 3.30

Alder	X	Utility	**$ 71.73**	$ 79.82	$ 63.64	$ 150.00	$ -
Alder	Y	Chipper	**$ 53.86**	$ 74.59	$ 33.13	$ 75.83	$ -
Cottonwood	X	Utility	**$ 36.20**	$ 41.12	$ 31.28	$ 47.02	$ -
Cottonwood	Y	Chipper	**$ 35.69**	$ 38.43	$ 32.95	$ 45.70	$ -

When these old growth values are combined with the grade distributions determined for each species in the North Coast TSA, the average values per species shown in **Error! Reference source not found.** (and Figure 8) are determined. This average old growth value for each species is applied to the inventory volume for that species in a given stand.

Table 5. Old growth values by species (all grades), for the North Coast TSA, for the last 10 years.

Species	Note	Volume ('000 m3)	10yr minus 1 std	Weighted 10 yr Average Value ($/m3)	10yr plus 1 std
Cedar		27,601	$79.85	$136.05	$195.60
Cypress		2,299	$39.78	$119.98	$194.05
Spruce		8,610	$32.75	$103.85	$180.40
Fir	(1)	0	--	$108.32	--
Balsam		12,022	$48.17	$69.37	$89.06
Hemlock		19,324	$41.54	$58.38	$74.26
Pine	(1)	0	--	$54.59	--
Weighted		**69,856**	**$56.67**	**$98.59**	**$141.78**

Notes: (1) Only trace amounts of fir and pine were scaled in the N. Coast TSA.
This necessitated using the Mid Coast average values, and no standard deviations were calculated.

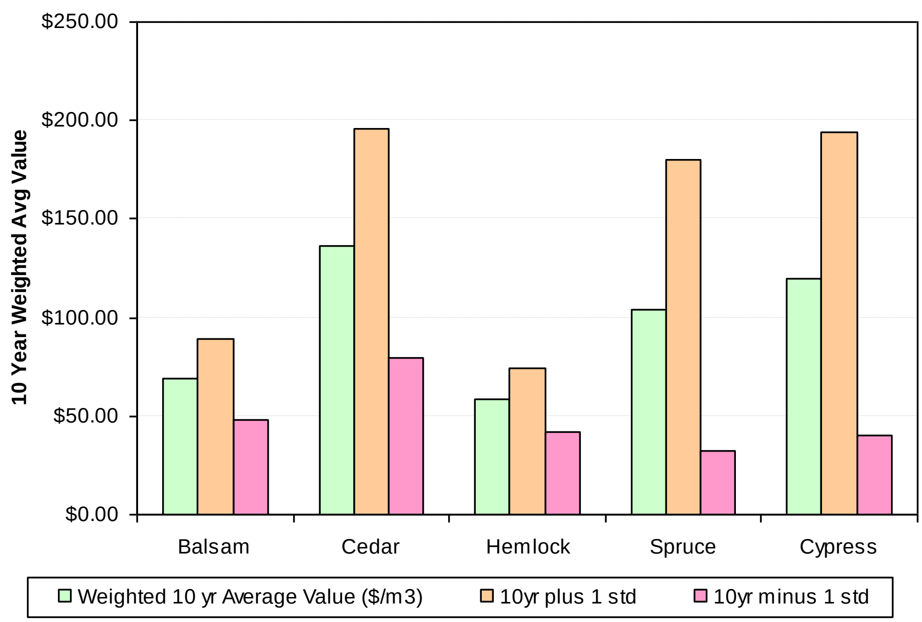


Figure 8. Comparison of North Coast 10 yr average prices by species (all grades).

5.3 Second Growth Grade Distributions

TIPSY was used to generate log grade distributions for second growth stands. Each species was modeled independently using four site index values (15, 20, 25, 30), standard OAF's, 1400 sph initial stocking, and no genetic gains from class A seed. Various initial densities and regeneration methods (planted vs. natural) were explored in the past (Forsite 2009, 2010) and these factors made little difference to the grade distributions. Site index and stand age were the primary drivers of change in grades over time so site index classes were created and linked with site index in the inventory to assign species a grade profile, and a weighted species-specific value.

Grades/values are dependant on stand age. Grades that required a % of clear lumber are not supported by TIPSY under the assumption that second growth stands are unlikely to develop these characteristics without pruning. That assumption is carried into this analysis.

The graphs below show the second growth grade distributions to be used for each species and site class for two example ages (80 yrs and 140yrs).

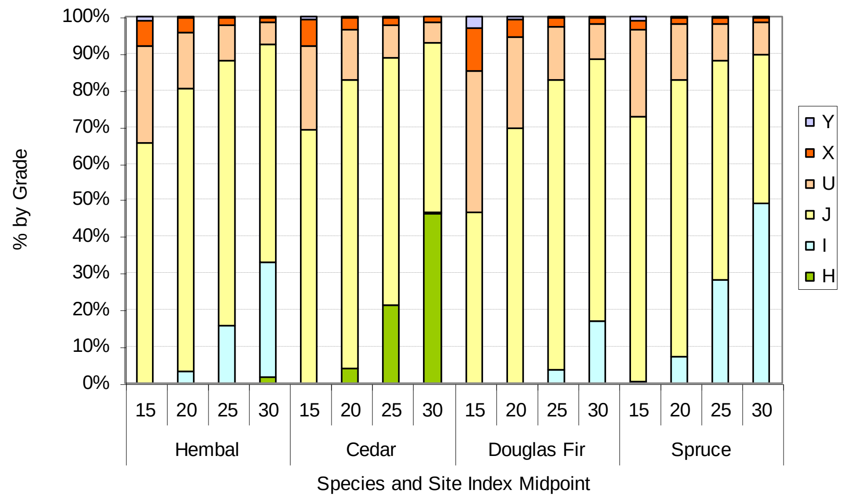


Figure 9. 2nd Growth Grade Distributions for 80 yrs old stands.

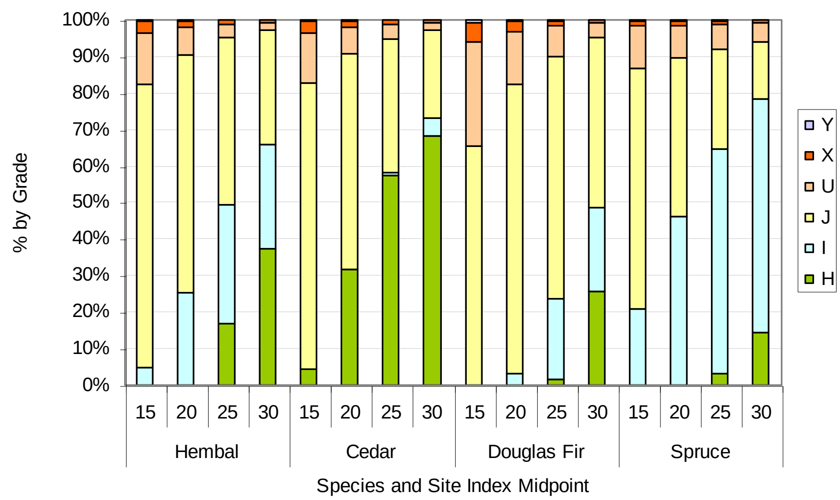


Figure 10. 2nd Growth Grade Distributions for 140 yrs old stands.

Table 6. Example Second Growth Grade Distributions for use in North Coast TSA (100 yr old stands)

SI	Grade	Species					
		Balsam	**Cedar**	**Cypress**	**Douglas Fir**	**Hemlock**	**Spruce**
15	H	0.0%	1.0%	1.0%	0.0%	0.0%	0.0%
	I	0.9%	0.0%	0.0%	0.0%	0.9%	3.5%
	J	72.7%	74.9%	74.9%	55.4%	72.7%	76.0%
	U	20.3%	18.7%	18.7%	35.5%	20.3%	17.9%
	X	5.2%	4.8%	4.8%	7.2%	5.2%	2.0%
	Y	0.9%	0.6%	0.6%	1.8%	0.9%	0.6%
20	H	0.0%	12.0%	12.0%	0.0%	0.0%	0.0%
	I	9.2%	0.0%	0.0%	0.6%	9.2%	23.4%
	J	76.0%	74.8%	74.8%	75.4%	76.0%	63.5%
	U	11.7%	10.4%	10.4%	20.3%	11.7%	11.1%
	X	2.8%	2.5%	2.5%	3.2%	2.8%	1.4%
	Y	0.3%	0.3%	0.3%	0.6%	0.3%	0.5%
25	H	0.7%	40.0%	40.0%	0.0%	0.7%	0.0%
	I	27.9%	0.0%	0.0%	10.1%	27.9%	45.8%
	J	62.8%	51.9%	51.9%	76.3%	62.8%	43.5%
	U	6.9%	6.4%	6.4%	11.4%	6.9%	9.2%
	X	1.5%	1.5%	1.5%	1.9%	1.5%	1.1%
	Y	0.2%	0.2%	0.2%	0.3%	0.2%	0.4%
30	H	16.3%	59.1%	59.1%	4.8%	16.3%	2.9%
	I	32.8%	1.1%	1.1%	25.0%	32.8%	60.3%
	J	46.0%	34.7%	34.7%	61.8%	46.0%	28.5%
	U	3.8%	4.0%	4.0%	6.8%	3.8%	7.0%
	X	0.9%	0.9%	0.9%	1.3%	0.9%	1.0%
	Y	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%

5.4 Second Growth Stand Values

Values by species and grade for second growth stands were obtained from MFR Revenue Branch Coast Selling Price database. Individual sale values/volumes were used to derive 10 year average market prices (2000-2009) for each species grade combination and are shown in Table 7.

Table 7 Ten Year Average Second Growth Values by Species and Grade

	10 yr Avg Second Growth Values						
Grade	**Hembal**	**Cedar**	**Cypress**	**Douglas Fir**	**Spruce**	**Alder**	**Cotton wood**
H	$73.16	$184.66	$228.00	$105.95	$73.89		
I	$62.19	$151.18	$157.38	$104.00	$61.66		
J	$52.08	$145.04	$100.58	$88.20	$58.94		
U	$40.64	$81.34	$81.89	$55.37	$43.23		
X	$39.55	$51.10	$29.80	$36.27	$40.50	$72.37	
Y	$36.52	$36.43	$22.48	$28.88	$38.55	$72.64	$45.91

These values are then weighted by the grade distributions for each age and site index combination to derive a weighted average value curve for each species for each of the site index classes (Table 7).

Ultimately, the species volume in each second growth forest cover polygon was multiplied by a single value from Table 7. For example, in the 10 year average price scenario, a second growth forest cover polygon (100 years old) with a site index of 20 would have its Hembal volume valued at $51.68/m3 and its Cedar volume valued at $140.85/m3. A similar approach to the old growth values was used: plus and minus one standard deviation prices were calculated for every species, age, and site index combination to do sensitivities on the price impact. Table 7 summarizes the weighted averages and standard deviations for the second growth price values.

Table 8 Ten Year Weighted Average Second Growth Values by Species and Site Index Class

		10 yr Avg Values				10 yr Standard Deviation Values			
		Site Index Midpoint				Site Index Midpoint			
Species	**Age**	**SI 15**	**SI 20**	**SI 25**	**SI 30**	**SI 15**	**SI 20**	**SI 25**	**SI 30**
Cedar	60	$ 111.46	$ 127.00	$ 135.74	$ 145.57	$ 21.54	$ 22.65	$ 23.26	$ 23.94
Cedar	80	$ 122.96	$ 134.87	$ 146.11	$ 158.73	$ 22.35	$ 23.20	$ 23.99	$ 24.86
Cedar	100	$ 128.70	$ 140.85	$ 155.53	$ 165.24	$ 22.77	$ 23.61	$ 24.64	$ 25.31
Cedar	120	$ 131.88	$ 146.25	$ 160.94	$ 168.87	$ 22.99	$ 23.99	$ 25.03	$ 25.54
Cedar	140	$ 135.09	$ 151.27	$ 164.37	$ 170.75	$ 23.21	$ 24.33	$ 25.25	$ 25.65
Cedar	160	$ 136.92	$ 155.22	$ 166.76	$ 171.57	$ 23.34	$ 24.61	$ 25.41	$ 25.69
Cedar	180	$ 139.24	$ 157.87	$ 168.48	$ 171.98	$ 23.48	$ 24.80	$ 25.53	$ 25.70
Cedar	200	$ 141.15	$ 159.64	$ 169.38	$ 172.22	$ 23.62	$ 24.93	$ 25.57	$ 25.69
Cypress	60	$ 84.95	$ 93.01	$ 101.64	$ 123.21	$ 7.45	$ 7.03	$ 7.36	$ 9.33
Cypress	80	$ 90.48	$ 100.61	$ 124.58	$ 157.55	$ 7.05	$ 7.30	$ 9.47	$ 12.72
Cypress	100	$ 94.49	$ 111.92	$ 149.13	$ 174.97	$ 7.07	$ 8.26	$ 11.88	$ 14.47
Cypress	120	$ 97.10	$ 125.03	$ 163.46	$ 184.51	$ 7.10	$ 9.51	$ 13.32	$ 15.45
Cypress	140	$ 100.97	$ 138.13	$ 172.71	$ 189.73	$ 7.32	$ 10.80	$ 14.24	$ 16.03
Cypress	160	$ 103.41	$ 148.52	$ 178.79	$ 192.16	$ 7.49	$ 11.82	$ 14.85	$ 16.32
Cypress	180	$ 108.52	$ 155.34	$ 183.13	$ 193.69	$ 7.95	$ 12.51	$ 15.30	$ 16.52
Cypress	200	$ 112.46	$ 160.13	$ 185.87	$ 194.75	$ 8.30	$ 12.98	$ 15.59	$ 16.67
Douglas Fir	60	$ 61.57	$ 72.79	$ 79.12	$ 83.22	$ 8.08	$ 9.51	$ 10.29	$ 10.62
Douglas Fir	80	$ 67.87	$ 77.41	$ 82.90	$ 87.16	$ 8.94	$ 10.09	$ 10.60	$ 10.53
Douglas Fir	100	$ 71.98	$ 80.10	$ 85.32	$ 90.34	$ 9.41	$ 10.40	$ 10.61	$ 10.86
Douglas Fir	120	$ 74.34	$ 81.65	$ 87.12	$ 92.98	$ 9.70	$ 10.53	$ 10.51	$ 12.07
Douglas Fir	140	$ 75.99	$ 82.68	$ 88.98	$ 95.07	$ 9.91	$ 10.60	$ 10.59	$ 12.96
Douglas Fir	160	$ 76.96	$ 83.46	$ 90.34	$ 96.57	$ 10.04	$ 10.62	$ 10.87	$ 13.57
Douglas Fir	180	$ 78.08	$ 84.08	$ 91.44	$ 97.64	$ 10.16	$ 10.63	$ 11.35	$ 14.01
Douglas Fir	200	$ 78.91	$ 84.84	$ 92.41	$ 98.57	$ 10.26	$ 10.61	$ 11.84	$ 14.35
Hembal	60	$ 46.27	$ 48.90	$ 50.55	$ 52.43	$ 4.35	$ 4.15	$ 4.08	$ 4.11
Hembal	80	$ 48.39	$ 50.49	$ 52.63	$ 54.98	$ 4.18	$ 4.08	$ 4.12	$ 4.22
Hembal	100	$ 49.46	$ 51.68	$ 54.38	$ 58.51	$ 4.12	$ 4.09	$ 4.19	$ 4.43
Hembal	120	$ 50.31	$ 52.90	$ 56.33	$ 61.04	$ 4.09	$ 4.13	$ 4.30	$ 4.59
Hembal	140	$ 50.94	$ 53.87	$ 58.58	$ 62.60	$ 4.08	$ 4.17	$ 4.44	$ 4.69
Hembal	160	$ 51.47	$ 54.80	$ 60.27	$ 63.75	$ 4.09	$ 4.21	$ 4.55	$ 4.77
Hembal	180	$ 52.10	$ 55.95	$ 61.40	$ 64.43	$ 4.10	$ 4.28	$ 4.62	$ 4.81
Hembal	200	$ 52.61	$ 57.02	$ 62.34	$ 64.96	$ 4.12	$ 4.34	$ 4.68	$ 4.85
Spruce	60	$ 51.81	$ 55.90	$ 57.48	$ 58.49	$ 7.34	$ 8.58	$ 8.92	$ 8.72
Spruce	80	$ 55.66	$ 57.56	$ 58.74	$ 59.33	$ 8.53	$ 8.92	$ 8.68	$ 8.26
Spruce	100	$ 56.99	$ 58.47	$ 59.18	$ 60.11	$ 8.84	$ 8.74	$ 8.32	$ 8.28
Spruce	120	$ 57.92	$ 58.88	$ 59.67	$ 61.37	$ 8.89	$ 8.50	$ 8.18	$ 8.78
Spruce	140	$ 58.48	$ 59.19	$ 60.33	$ 62.19	$ 8.79	$ 8.30	$ 8.32	$ 9.13
Spruce	160	$ 58.79	$ 59.55	$ 60.97	$ 62.51	$ 8.66	$ 8.22	$ 8.62	$ 9.23
Spruce	180	$ 58.87	$ 59.73	$ 61.65	$ 62.58	$ 8.50	$ 8.18	$ 8.90	$ 9.25
Spruce	200	$ 59.03	$ 60.13	$ 62.06	$ 62.58	$ 8.38	$ 8.28	$ 9.07	$ 9.25

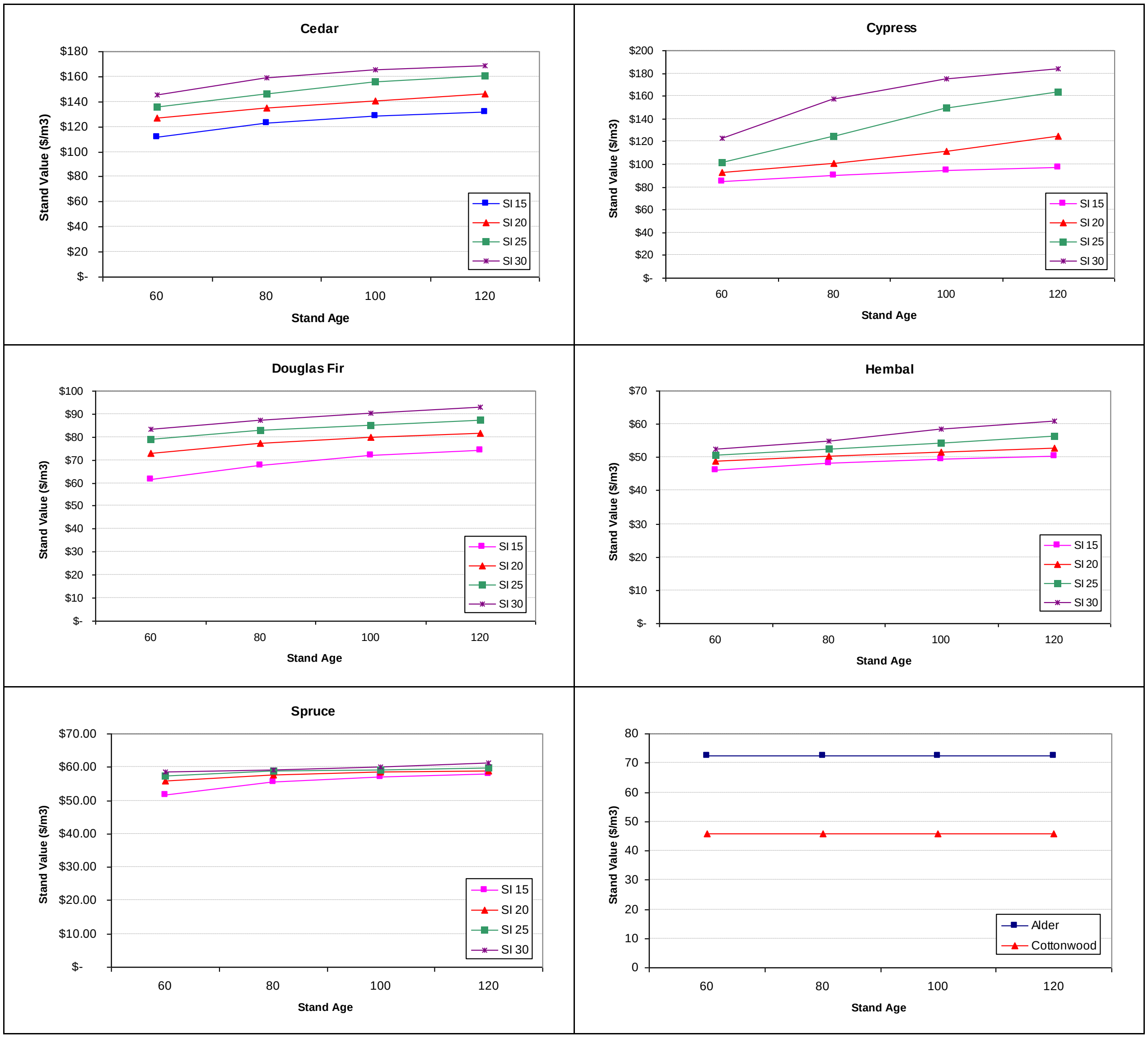


Figure 11 Second growth value curves by species and site index class (10 yr average values).

Beyond 120 years of age, stands were valued using the old growth valuation approach.

6.0 Delivered Wood Cost

Delivered Wood Cost = *Overhead + Tree to Truck + Silviculture + Road Building +Dump/Bridge Building + Road Management + Crew Transport + Truck Haul + Barging + Scaling*

Note:
In the North Coast the block-level EBM costs (layout/planning/yarding) are an extra cost added to normal admin costs. Landscape level costs (i.e. the road costs that are amortized over less volume) will be inherently calculated in the Patchworks modeling. These costs are structured so that the cost/m^3 is calculated dynamically instead of being a fixed input.

1. **Planning/Layout /Admin/Overhead** – N. Coast TSA only (costs born by long term licensee)
   a. Includes camp costs.
   b. Fixed cost of: **$10.63/m^3** (July 1, 2009 Coast Appraisal Manual)
   c. An additional $**2.75** is related to EBM. This will be a simple way of recognizing all of the extra costs associated with EBM without having to discern how it impacts each of the costs below.
   d. Nootum Parcel's Planning/Layout/Admin costs are included in the Logging category.

2. **Logging** (Tree to Truck – includes falling, yarding, processing, sorting on landings, loading, mob/demob of equipment, etc).

North Coast

Harvest System	**Definition**	**Costs/m^3 <450 m3/ha**	**Costs/m^3 450-850 m3/ha**	**Costs/m^3 >850 m3/ha**
Conventional	<250m from road	**$40.00**	**$32.00**	**$28.00**
Heli to Water	>=250m from road, < 1km from the ocean or barge lakes.	**$76.00**	**$71.00**	**$69.00**
	1-2km from ocean or barge lakes.	**$91.00**	**$86.00**	**$84.00**
Heli to Road	>=250 from a road and <1km from a road, not eligible for heli to water.	**$84.00**	**$79.00**	**$77.00**
	1-2 km from a road, not eligible for heli to water.	**$94.00**	**$89.00**	**$87.00**

Note: Price Waterhouse Coopers 2006 Survey of Selected BC Logging and Forest Management Costs (2005 data) on the BC coast indicates that heli logging averaged $78.71/m3. Values presented here considered this estimate and used local experience to refine costs based on distance and drop types. FERIC data suggested that for each additional 500m in flight distance, costs increased by $7.51/m3.

Nootum Parcel

Harvest System	Definition	Costs/m³	Retention Costs/m³	Total Costs/m³
Conventional	<250m from road	**$50.00**	**$3.80**	**$53.80**
Heli to Ocean	<2 km from ocean	**$100.71**	**$3.80**	**$104.51**
Heli to Road	<2 km from road	**$112.71**	**$3.80**	**$116.51**
Heli to Lake	<2 km from lake	**$106.71**	**$3.80**	**$110.51**

Note: Retention costs were associated with partially retained stands in order to capture additional costs. Retention cost was $38.00 x percentage retained. Retention percentage was assumed to be 10% of the stand.

3. **Silviculture** (from regeneration to free growing)
These costs include planning, surveys, ordering stock, planting costs, stand tending, camp costs, crew transport, and deer protection where needed). Interfor and BCTS staff provided the values in the table below.

Location	Conventional System	Heli System
Nootum Parcel	**$2,500/ha**	**$2,900/ha**
North Coast	**$1,900/ha**	**$2,985/ha**

Access

4. **Road Building** (Cost by planning area, road and slope class)

Slope Class	North Coast TSA			Nootum Parcel
	Mainline	*Spur*		*Any Road*
0-30%	**$100,000/km**	**$75,000/km**		**$175,000/km**
30-60%	**$150,000/km**	**$125,000/km**		**$175,000/km**
60+	**$250,000/km**	**$200,000/km**		**$175,000/km**

5. **Road Management** (Maintenance & Deactivation)
    a. This includes any deactivation/reactivation, snowplowing, grading, brush control, minor repairs, ditch maintenance, rebuilding of crossings for existing roads, etc. This fixed cost per km of active road will recognize higher amortization costs that can arise when available volumes are reduced and road use requirements are unchanged.
    b. North Coast TSA: **$15,000/km/yr**.
    c. Nootum Parcel: **$13,000/km/yr**.

6. **Log Dump - Construction and Reactivation of Existing Dumps**
    a. Reactivation of Existing Dumps: $**50,000/dump**
    b. New Dump Construction/Permitting: **$100,000 / dump**

7. **Major Bridge Construction** (>8m span)
    a. Large crossings (proposed and rebuilds) were geographically identified and costs were incorporated into the road dataset. These costs were based on local knowledge of project participants.
    b. Other existing crossings that required bridge reconstruction/replacement were assumed to be included in the Road Management costs discussed above.
    c. New proposed bridges and culverts are assumed to be included in the road construction costs.

8. **Scaling** These costs are for the North Coast TSA only. The Nootum Parcel scaling costs are included in the "Logging" category.
    a. Scaling: **$0.75/m3**

Transportation

9. **Crew Transportation** (North Coast TSA only, Nootum Parcel costs are included in "Logging")

a. Transport costs = 2.244 + 0.02611* Distance (Aug 1/2003 Appraisal Manual) Assume a average of 30 km distance from camp = $3.03/m3 or ~**$0.10/m3/km** added to hauling cost.

10. **Truck Haul / Dump / Sort / Rehaul**
    a. North Coat TSA - Haul costs = 3.69 + 0.08129 * Distance (Aug 1/2003 Appraisal Manual). Assume an average of a 10 km haul = $4.90935/m3 or **$0.490935/m3/km**.
    b. Nootum Parcel – As per Timberline (2008) = **$0.16780/m3/km**.

11. **Barge/Tow**
    a. Barge costs were assigned based on the location of the stand in the TSA.
    b. Costs to the Vancouver log market escalated as one moved further north.

Location (see map)	**Barge Cost to Vancouver Log Market (per/ m3)**
Nootum Parcel Zone	$9.50
North Coast – South Zone	$17.00
North Coast – North Zone	$18.40

The possibility of exporting a portion of the N. Coast TSA harvest to the United States, or to off-shore markets was examined, rather than barging the logs to the Vancouver log market. In the end, the costs of exporting logs were found to closely approximate the barging costs. It was decided not to complicate the analysis for what seemed to be equivalent costs. One destination was modeled – the Vancouver Log Market.

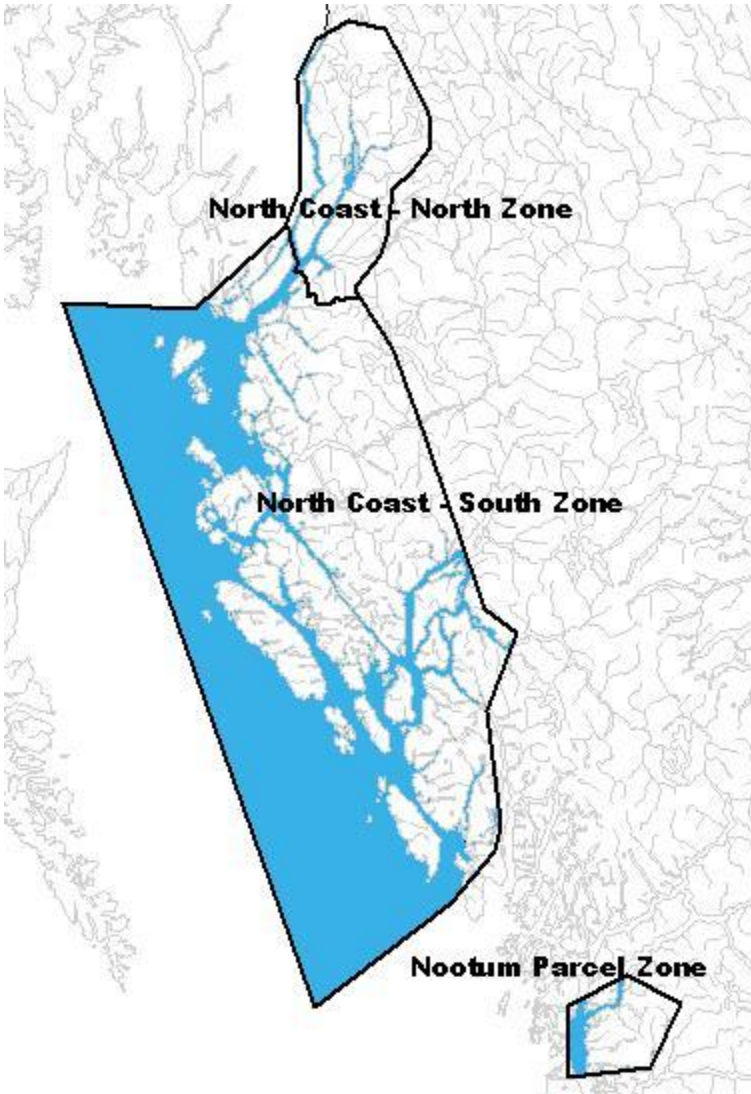


Figure 12. Geographic zones used in North Coast Econ. Operability Project to apply barging costs.

Note: The large cost, or barging zones, were further separated into

(a) areas that required lake towing (an additional cost), and

(b) non-lake towing areas.

An extra lake towing cost was applied to any wood harvested within the lake towing sub-zone

6.1 Forest Level Stumpage Objectives

Stumpage is a cost born by licensees, but is **not applicable at the stand level – only the forest level**. Higher value blocks bear more of the development cost which in turn makes lower value blocks look more attractive. In order to recognize this issue when assessing stand level economic viability, stumpage costs are only recognized at the forest level when modeling. This is achieved by forcing all harvesting in a given period to generate enough revenue to pay historical average stumpage rates for the TSA / supply block.

The average stumpage rate was calculated on data from the last 15-year period (1995 – 2009) using the Ministry of Forests and Range Harvest Billing System data[2] for the North Coast TSA (all species, all grades, billed to Major Licensees excluding waste). The 15 year weighted average is $5.47/m^3. The last 10 and last 5 year weighted averages are $1.74/m^3 and $2.72/m^3, respectively. The 10 year, $1.74 value is the stumpage revenue target (net revenue per m3) that was applied in this project.

Table 9 North Coast TSA (1995-2009) stumpage volume and stumpage value billed.

Year	Volume (m3)	Value	Avg. Value
1995	322,077	$8,819,688.55	$27.38
1996	408,883	$7,314,644.08	$17.89
1997	471,943	$1,896,371.40	$4.02
1998	309,538	$651,403.37	$2.10
1999	343,360	$678,262.55	$1.98
2000	251,623	$1,267,353.04	$5.04
2001	379,103	$439,890.79	$1.16
2002	381,896	$464,187.12	$1.22
2003	235,591	$133,419.21	$0.57
2004	572,459	$223,755.12	$0.39
2005	152,666	$37,944.73	$0.25
2006	87,739	$20,647.13	$0.24
2007	276,556	$1,305,563.31	$4.72
2008	135,938	$413,684.47	$3.04
2009	112	$1,336.36	$11.90

[2] MoFR Revenue Branch (Stephen Davis) provided a database of scaled volumes and values by species and timbermarks going back to 1982. Volumes included waste and reject. No special forest products were included.

7.0 Patchworks Modeling

Methodology

Once cost and value relationships were determined for each polygon in the dataset, as per the above, the data was loaded in the Patchworks forest estate model.

- Resultant polygons that were >40 ha in size were split to allow reasonable block sizes.
- Resultant polygons were grouped into blocks wherever possible (with a target of 20 ha) but no blocks spanned harvest systems or forest cover types (based on Species 1, Species 2, site index). The age range within a block was limited to 10 yrs. Many of the final "blocks" are smaller than 20 ha, due either to being isolated from other forest stands by intervening non-forest area, or because the adjacent stands are a significantly different stand type. Blocks will still combine, during the modeling, to form larger, logged areas. These could be considered to be "larger blocks" or "patches".
- Only forested polygons within the TSA were included in the model, i.e. non-productive types were removed. Non productive types included:
    - All NP_CODE values greater than 0 (Alpine, Rock, Alpine forest, swamp, rivers, etc)
    - Polygons with no typing (NTA) or comprised of non-commercial brush (NCBR)
    - Ocean (mostly denoted in the database as [bclcs_lv_5 = "OC"])
    - No history of logging with NP-type BC land cover class (blcs_lv_4 = "SL" (Shrub Low) or "EL" (exposed land)]
- Only polygons with potential harvest systems in TSA ownership were eligible for harvest in the model. Ownership classes excluded will be non-Crown lands (the data source is within brackets)
    - Private (40-N) and Woodlots (77) (TSR3 ownership map)
    - Woodlots (TSR3 ownership)
    - Federal Parks (LRDW federal parks map)
    - Provincial parks and conservancies (LRDW parks and protected)
    - BMTA polygons (L. Greentree, MoFR, Nanaimo)
    - Nisga'a Treaty Lands (L. Greentree, MoFR, Nanaimo)
- The following non-merchantable stands are excluded. They are based on TSR3 standards/
    - All stands with site index value less than 10 m. at 50 years of age
    - All age class 5 stands (81-100 years) that have not attained a height greater than height class 2 (10.5 - 19.4 m.)
    - Red alder-leading stands over 60 years old
    - Pine or other deciduous species leading stands
    - High sensitivity ESA's, i.e. class 1 soils, regeneration, avalanche, watershed (TSR3)
    - Class 1 grizzly bear habitat.
- The landbase was netted down for spatially discreet areas where non timber values prevent harvest from occurring:
    - Mountain Goat Habitat (i.e. the impending UWR order, obtained from H. Maclean, MoFR, Nanaimo)
    - WHA's (from L. Greentree, MoFR, Nanaimo)
    - Archaeological sites (from L. Greentree, MoFR, Nanaimo)
- The immediately above netdowns were added back into the gross operable landbase at the end of modeling so that the final operability map is less fragmented. The next TSR process may net these areas out again, as per the appropriate policy at that time.

7.1 Yield Curves

- Each forest cover polygon with an SI of at least 10 was assigned a yield curve (m^3/ha). Stands <28 yrs old with a history of logging had yields assigned using TIPSY, while other stands, and any older stand yields were assigned using VDYP. Once logged, the regenerated stand yields were calculated using TIPSY. TIPSY yields were based on the forest inventory data for species and site index, and planting or natural regeneration densities based on TSR 3. Standard OAF values and zero genetic gains were applied. No site index adjustments were applied to site index for managed stands.
- Yield tables are derived by area-weighting the yield table for each polygon into an aggregate value, by age, combined into one yield table for each block. Yield tables are based on unique combinations of:
  - natural or managed stand designation
  - species 1
  - species 2
  - site index class (e.g. class 15 = site index. values from 12.49 to 17.5 inclusive)
  - proportion of cedar (red cedar or cypress) which represented the highest value species.

- Netdowns are applied for the following factors. The final values were confirmed by, or decided by by the MoFR staff in Nanaimo.
  - A 7.49% is applied for riparian reserve zones, and another 4.2% applied for riparian management zones to the operable landbase. These values are based on the North Coast TSR3 process.
  - An additional 5% reduction was applied to the landbase to account for the overall impact associated with the EBM management for HVFH, Non-HVFH, and floodplains, and stand level retention (i.e. a minimum of 15% EBM requirement inside and outside blocks), archaeological sites, culturally modified trees (CMT), forested swamps, monumental cedar, and the class 2 grizzly bear habitat.
  - No reduction for wildlife tree retention was made as wildlife tree retention areas could be made within the immediately adjacent riparian reserve zone.
  - A reduction of 1% was applied to the landbase to reflect cultural and heritage values.
  - An 8.4% reduction for future roads, trails and landings was applied to the managed stand yield tables only to account for future roads trails and landings (same as the North Coast TSR3).
  - The deciduous component of all stands was removed from the yield tables.
  - The total landbase percentage reduction associated with the above is 17.69 (i.e. 7.49 + 4.2 + 5 + 1). In essence, all gross THLB polygon areas are multiplied by the factor 0.8231 to arrive at a net area that was used in the model.
  - The total managed stand yield curve reduction (for future RTLs) is 8.4%

- Each forest cover polygon was assigned a minimum harvest age that ensured there was at least 350m^3/ha in the stand before harvest was allowed (or 300m^3/ha for Cw-leading stands).

7.2 Blocking

- Resultant polygons in the GIS file that were >40 ha in size were split to keep the final block sizes reasonable.
- The resultant polygons were then grouped into blocks wherever possible, with a target size of 20ha. No blocks spanned harvest systems or forest cover types (species1, species2, and SI). The age range within a block was limited to 10 yrs.

7.3 Transportation Network

- Roads, bridges, dumps, and barge routes where networked into a double destination GIS dataset. Destinations were:
  - Howe Sound (which represents the Vancouver Log Market). Barging costs were built into the stand costs on a per m3 basis
  - The concept of shipping some volume to offshore destinations out of Prince Rupert harbour was initially considered, but eventually dropped.
- The transportation network was only used to estimate road costs – all barge segments had no cost, and dump segments only had building costs applied. This was done to simply the patchworks model to a single transportation destination. Hauling and maintenance distances reported in the model only refer to the areas with roads, as the barge and dump segment lengths were effectively treated as zero.

7.4 Modeling Methodology

- Modeling spanned a 200 yr horizon using 5 yr periods.
- A volume target of **504,084 m^3/yr** was used as the starting harvest request. Note that 504,084 is the total of (a) un-salvaged volume losses due to epidemics of fire and wind damage of 10,084 m3/yr, and (b) current AAC of 494 000 m^3/yr). This value translates to 2,520,420 m^3/period, for each 5-year period.
- Each of the Nootkum Draney parcel and North Coast TSA was modeled as an independent Patchworks model. In each project, all volumes flowed to the Vancouver log market.
- Accounts were established in the Patchworks model to track various statistics, and to set targets for the model. An example is the net value (total dollars) for each block that was harvested (not including road related costs). This was done by subtracting the costs ($/ha) from the value ($/ha) and then multiplying by the block net area. This account provided a means to tally total block level net revenue generated in each period.
- Road related costs (building, hauling, maintaining) associated with the blocks harvested in each period were tracked by Patchworks and then accumulated into an overall road cost per period ($).
- The final net revenue generated in each period was then calculated as:
  - Total Net Revenue ($'s)=Total Block Level Net Revenue ($'s) – Total Road Costs ($'s)
  - Average Net Revenue/m^3 ($/$m^3$)= Total Net Revenue ($) / Total Volume Logged (m^3)
- Net revenue target of $**1.74/**$m^3$ was used to ensure a reasonable profile of blocks was harvested in each period. The $1.74 value is the average stumpage value for the last 10 years. These values were derived using the past 10 years of stumpage payments and volume logged in the TSA, i.e. the statistics from 2000-2009, for the major licensees only (not BCTS).
- The assumption is that harvesting in the future must produce at least enough revenue to pay future stumpage costs. In combination, the volume and net revenue targets work to maximize the volume harvested while ensuring that the harvest is economic.
- Figure 13**Error! Reference source not found.** provides a summary of the historical stumpage payments for all licensees other than BCTS, for the North Coast TSA, for the last <u>15</u> years.

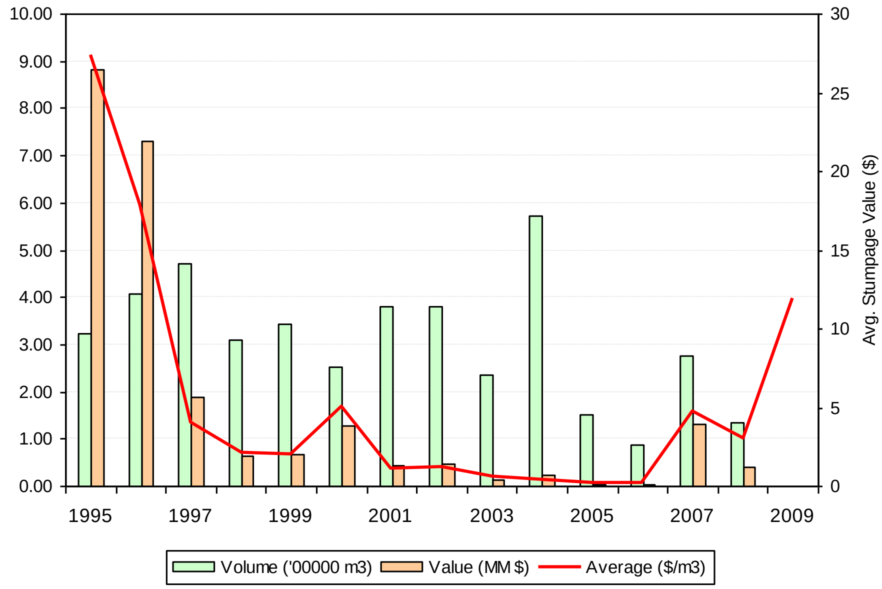


Figure 13. Last fifteen years of historical stumpage payments for the North Coast TSA.

7.5 Determination of Operable Landbase

The operable landbase will be assumed to be comprised of all the blocks that were harvested by Patchworks in any of the modeled periods. Blocks harvested prior to 2009 will be included in the operable landbase regardless of whether Patchworks indicates that they would be economic to harvest at some time in the future using the second growth log value assumptions.

8.0 Results

The subset of TSA that was evaluated for economic operability was the timber harvesting landbase (THLB) which was the area after all netdowns. This was 282,329 ha in the North Coast TSA, and 14,540 ha in the Nootum Parcel (Table 10).

That the statistics in this section are based on the stands that were determined to be operable by the Patchworks model. After the modeling, additional stands were added back into the final operability map according to the assumptions in section 7.5. Examples of additions are the previously logged stands (if not already logged by the Patchworks model), class 1 grizzly bear habitat, goat habitat, and Wildlife Habitat Areas.

Table 10 North Coast TSA Landbase – Gross, CFLB, THLB and Operable Area

Project Area	Gross GIS Area (ha)	CFLB (ha)	THLB (ha)
North Coast TSA	3,773,962	319,443	282,329
Nootum Parcel	55,626	15,318	14,540

The North Coast and the the Nootum Parcel project areas exhibit the same general trends. For the rest of this section, the North Coast TSA – Average Stand Value scenario is presented, unless otherwise stated. Additional statistics and charts for the Nootum Parcel project area can be found in Appendix A.

North Coast TSA – Average Stand Value Scenario

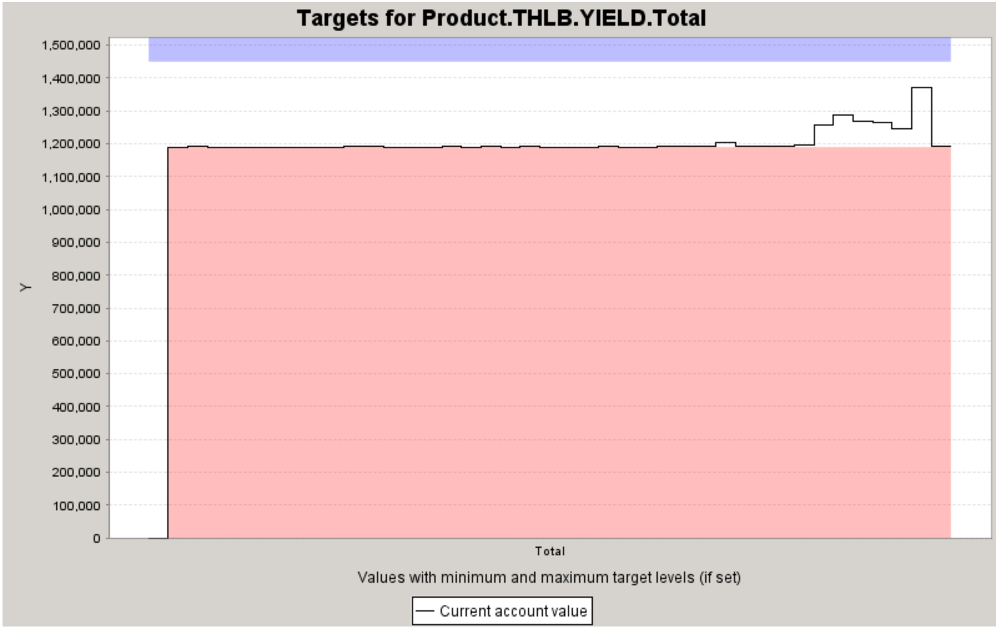
From the potentially operable land base of 232,329 ha, an economically operable forested land base of 87,162 ha (30.9 % of the THLB) was achieved in Patchworks based on average stand values, and a $1.74/m^3 net return per period objective.

Detailed Patchworks output illustrating the targets and the achieved values over the 200 year planning horizon is shown below. Values are shown for 5 year periods so y-axis values should be divided by 5 to get annual numbers unless they are average values. For example, a value of 100,000 m^3 annually is 500,000 m^3 periodically.

During modeling, the volume and net revenue per m3 are adjusted until an equilibrium is established. Higher and lower values were tested to see how well the model stabilized, in terms of meeting the targets in a more-or-less consistent manner. The final equilibrium volume that was requested (upper chart) is 1,190,000 m3/period. This equates to 238,000 m3/year, which is only 47% of the current AAC of 504,084 m3/yr (with accounting for NRLs as part of the harvest, as per the assumptions). The operable landbase supporting this harvest is 87,162 ha, and is 62% of the operable landbase of 140,000 ha that was used in the last TSR. Comparisons to the last TSR should be made cautiously, however, as we have modeled in a significantly different fashion, with new assumptions and new landbase netdowns.

The equilibrium net revenue per m3 requested was $1.75/m3. This is a slightly (perhaps insignificantly) higher value than our $1.74/m3 target, but since the model showed some variation around the target value, a bit higher or lower during some periods, it was decided to apply a higher target to ensure that the $1.74 target was better met over the whole timeframe.

At the final equilibrium, the amount of harvest (and size of the land base) is being actively limited by the amount of negative value stands that can be blended into the harvest schedule over time. Inclusion of more stands will, on average, be from the negative value stands, and these would drive down the net revenue value below $1.74/m3.



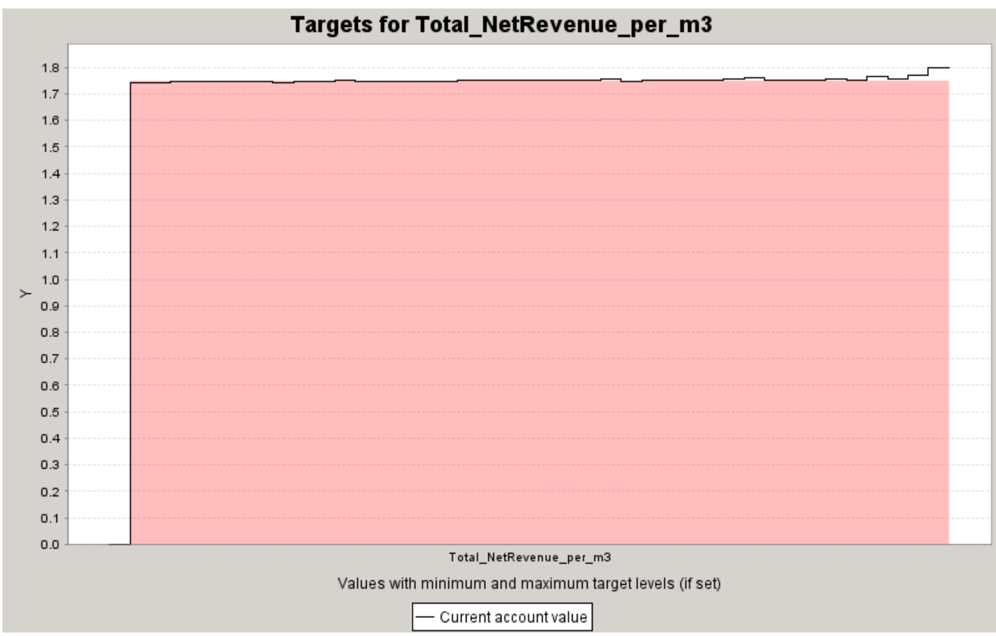


Figure 14. Patchwork model output for the N. Coast, Average Stand Value scenario.

8.1 Breakdown of New Operable Area by Attributes

Figure 15**Error! Reference source not found.** shows that the operable land base is predominately conventional (58%), followed by helicopter using ocean drops (37%). Within the helicopter harvest type, most of this has flight distances of less than 1 km.

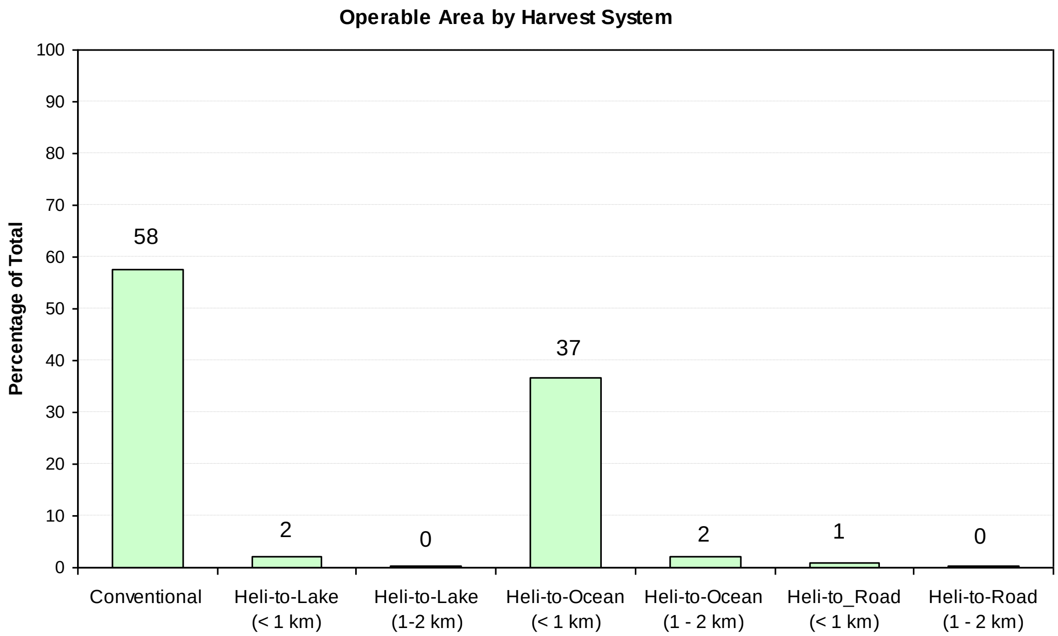


Figure 15. Operable land base by harvest system

Figure 16**Error! Reference source not found.** provides a breakdown of the operable land base by leading species. It indicates that cedar (red and yellow cedar, combined) leading stands make up a significant portion (62%) of the land base, while hemlock-leading stands follow at 31%. The Hw-leading stands that were included in the harvest also tended to include Cw or Yc as additional species.

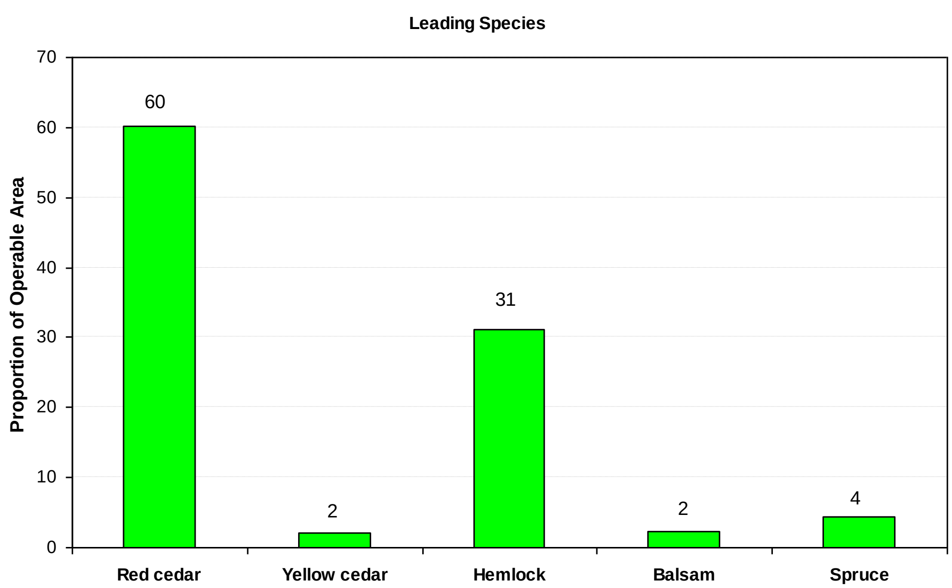


Figure 16. Operable land base by leading species.

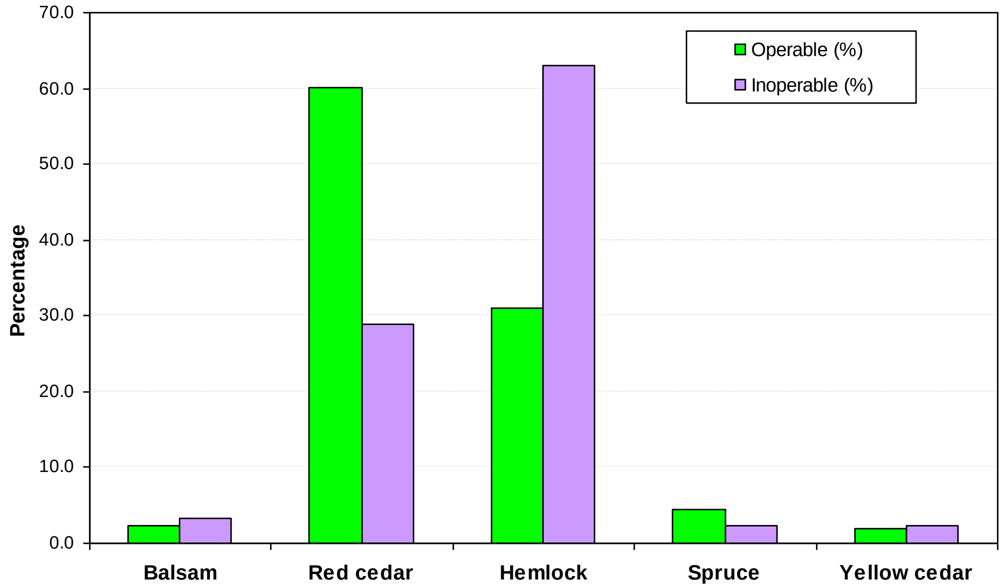


Figure 17 Operable and inoperable landbase by leading species.

Table 11 compares the amount of each species in the operable relative to the proportion in the remaining inoperable. Where the operable proportion is higher the model is selecting for those stands. Conversely, where the operable proportion is lower then the model is avoiding those stands. The more valuable species like Cw tend to be represented in higher proportions in the operable land base, while lower value species such as Hw/Ba have lower representation. For example, only 31% of the operable is in Hw leading stands, versus 63% in the remaining inoperable.

Table 11 Proportion of stands of each leading species in the operable versus inoperable

Leading Species	Operable (ha)	Inoperable (ha)	Operable (total ha)	Inoperable (total ha)	Operable (% of total operable)"	Inoperable (% of total inoperable
Balsam	1,947	7,881	87,162	232,281	2.2	3.4
Red cedar	52,476	66,998	87,162	232,281	60.2	28.8
Hemlock	27,102	146,588	87,162	232,281	31.1	63.1
Spruce	3,877	5,261	87,162	232,281	4.4	2.3
Yellow cedar	1,760	5,553	87,162	232,281	2.0	2.4

From a site index perspective, the operable land base is skewed toward the higher site indexes but still includes areas with site index value as low as 10 (the minimum intended to be allowed into analysis). Selection of these stands occurs when lower site index sites have a relatively high value species mixture combined with a low cost of extraction.

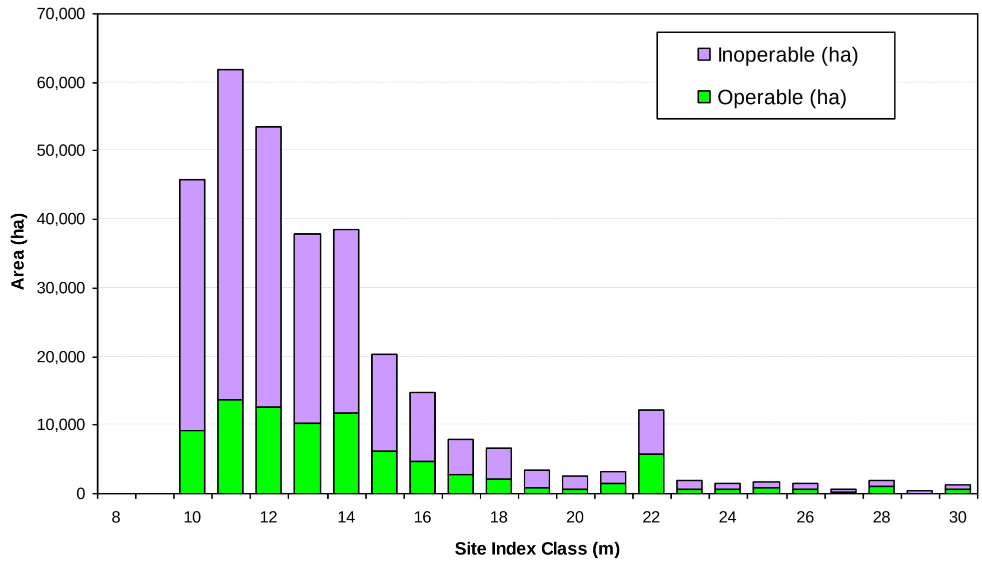


Figure 18 (a) Area of operable and inoperable by site index class

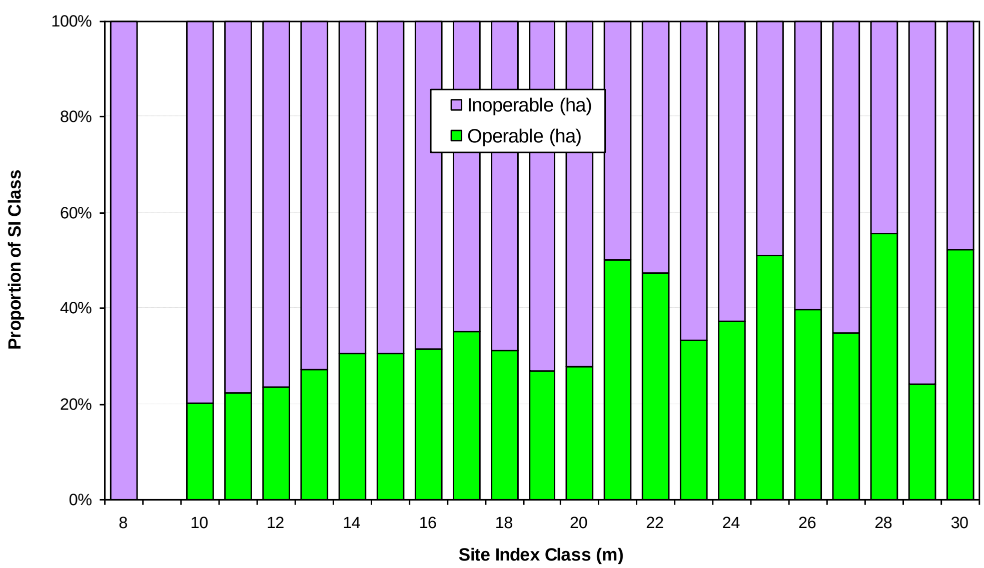


Figure 19. (b) Proportion (based on area) of operable and inoperable by site index class

A mix of positive and negative net stand values are found in the operable landbase. As expected, all or most of the very highly negative stand values are excluded from the operable landbase. Conversely, those that were included are more likely to be the more highly positive net valued ones.

Negative stands will be included in the operable landbase, by the model, in order to maximize the harvest volume, although the model is always constrained to meeting the $1.74/m3 net return each period (i.e. through "cutblock blending"). Road costs are not block-level costs as these costs are distributed across a number of blocks. Therefore the figures depict the "net stand value before road costs".

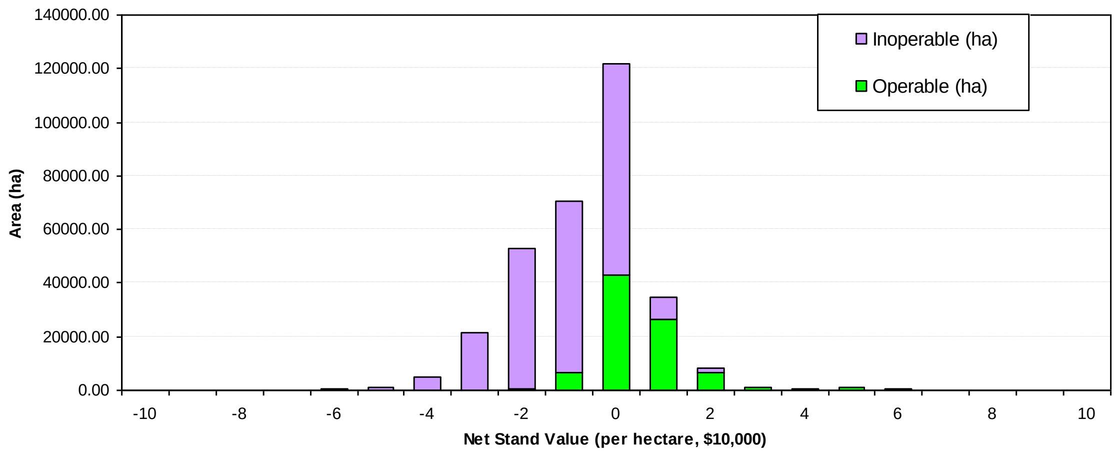


Figure 20 Net stand values in the North Coast operable landbase, based on average stand values

Note: The stand level net revenue charts do not include the road costs.

Detailed road related costs can be found in Table 12, and a summary of the road costs is provided in Figure 21.

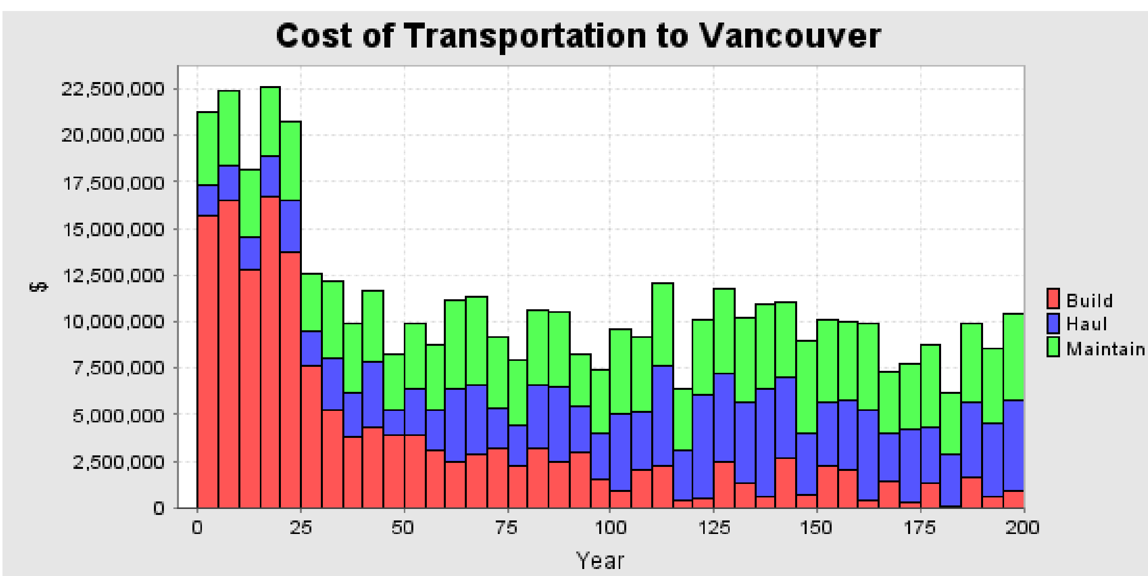


Figure 21 Summary of road costs from the Patchworks model

Table 12 Detailed Road Costs from the Patchworks model.

Period	Year	Length of road (m)		Costs ($)				Volume (m3)	Average haul	Average costs ($/m3)		
		Active	Built	Build	Haul	Maintain	Total	Total	distance (km)	Build	Haul	Maintain
0	0	0	0	0	0	0	0	0				
1	5	1,887,935	109,287	15,628,475	1,692,560	3,986,044	21,307,079	1,190,100	266.58	13.13	1.42	3.35
2	10	1,836,178	123,812	16,476,651	1,877,951	4,070,089	22,424,691	1,192,110	269.26	13.82	1.58	3.41
3	15	1,903,869	92,056	12,814,427	1,701,425	3,692,326	18,208,178	1,190,066	282.55	10.77	1.43	3.1
4	20	1,780,126	116,973	16,749,332	2,131,598	3,709,375	22,590,305	1,190,011	258.37	14.07	1.79	3.12
5	25	1,765,580	86,058	13,753,387	2,705,628	4,315,301	20,774,316	1,190,099	278.72	11.56	2.27	3.63
6	30	1,575,173	52,771	7,664,963	1,841,936	3,091,020	12,597,919	1,190,299	259.92	6.44	1.55	2.6
7	35	1,702,614	40,116	5,259,863	2,819,407	4,120,102	12,199,372	1,190,093	269.11	4.42	2.37	3.46
8	40	1,889,155	25,203	3,779,086	2,423,219	3,676,923	9,879,228	1,190,114	294.68	3.18	2.04	3.09
9	45	1,746,777	32,005	4,362,419	3,426,718	3,816,133	11,605,270	1,190,004	295.26	3.67	2.88	3.21
10	50	1,901,201	29,639	3,901,346	1,369,097	3,006,886	8,277,329	1,190,572	292.01	3.28	1.15	2.53
11	55	1,703,859	28,253	3,942,947	2,487,445	3,496,614	9,927,006	1,191,685	275.71	3.31	2.09	2.93
12	60	1,888,293	21,291	3,082,067	2,151,050	3,496,148	8,729,265	1,190,258	290.31	2.59	1.81	2.94
13	65	1,785,066	16,555	2,429,893	3,974,763	4,682,566	11,087,222	1,190,004	309.06	2.04	3.34	3.93
14	70	1,865,214	21,076	2,838,752	3,768,045	4,718,276	11,325,073	1,189,998	308.35	2.39	3.17	3.96
15	75	1,910,378	19,899	3,146,211	2,239,367	3,782,855	9,168,433	1,191,375	282.75	2.64	1.88	3.18
16	80	1,676,109	17,061	2,262,015	2,145,883	3,572,685	7,980,583	1,190,026	260.35	1.9	1.8	3
17	85	1,746,733	23,770	3,224,865	3,390,182	4,027,145	10,642,192	1,190,792	268.56	2.71	2.85	3.38
18	90	1,760,645	18,447	2,409,863	4,076,278	3,998,525	10,484,666	1,190,054	275.58	2.03	3.43	3.36
19	95	1,560,230	20,390	3,012,009	2,407,585	2,839,687	8,259,281	1,190,506	282.12	2.53	2.02	2.39
20	100	1,791,841	10,320	1,562,316	2,491,441	3,408,772	7,462,529	1,190,164	293.04	1.31	2.09	2.86
21	105	1,920,155	7,715	871,442	4,209,027	4,459,450	9,539,919	1,190,385	316.09	0.73	3.54	3.75
22	110	1,575,114	15,494	2,091,236	3,037,629	4,039,457	9,168,322	1,190,240	308	1.76	2.55	3.39
23	115	1,650,406	17,830	2,304,982	5,268,731	4,526,014	12,099,727	1,192,355	315.8	1.93	4.42	3.8
24	120	1,707,267	2,295	358,461	2,721,366	3,349,648	6,429,475	1,190,363	271.66	0.3	2.29	2.81
25	125	1,689,675	3,643	499,875	5,614,010	3,963,180	10,077,065	1,190,024	327.15	0.42	4.72	3.33
26	130	1,697,526	17,025	2,469,618	4,780,735	4,534,772	11,785,125	1,191,759	320.09	2.07	4.01	3.81
27	135	1,744,505	9,978	1,332,116	4,303,777	4,564,534	10,200,427	1,190,730	310.78	1.12	3.61	3.83
28	140	1,726,346	4,445	568,735	5,767,670	4,643,109	10,979,514	1,190,774	320.41	0.48	4.84	3.9
29	145	1,611,933	18,995	2,712,204	4,252,599	4,025,242	10,990,045	1,204,010	272.3	2.25	3.53	3.34
30	150	1,796,842	4,274	710,250	3,319,919	4,908,290	8,938,459	1,192,395	300.55	0.6	2.78	4.12
31	155	1,708,616	14,231	2,239,952	3,375,082	4,533,717	10,148,751	1,191,414	304.07	1.88	2.83	3.81
32	160	1,783,495	15,328	2,087,638	3,718,223	4,161,215	9,967,076	1,192,779	303.01	1.75	3.12	3.49
33	165	1,868,259	3,204	422,000	4,795,138	4,637,262	9,854,400	1,197,066	306.13	0.35	4.01	3.87
34	170	1,643,457	9,784	1,402,134	2,565,716	3,392,509	7,360,359	1,256,577	303.06	1.12	2.04	2.7
35	175	1,804,801	2,029	269,884	3,954,102	3,468,111	7,692,097	1,286,251	294.84	0.21	3.07	2.7
36	180	1,840,316	7,001	1,283,176	2,992,117	4,453,343	8,728,636	1,267,622	279.75	1.01	2.36	3.51
37	185	1,736,225	1,245	121,168	2,775,682	3,236,165	6,133,015	1,265,998	283.3	0.1	2.19	2.56
38	190	1,810,334	11,529	1,646,031	4,009,906	4,244,762	9,900,699	1,244,845	315.95	1.32	3.22	3.41
39	195	1,896,398	5,790	646,718	3,881,556	4,041,581	8,569,855	1,370,007	283.17	0.47	2.83	2.95
40	200	1,718,222	7,199	962,340	4,817,958	4,623,036	10,403,334	1,193,142	309.27	0.81	4.04	3.87

Observations

- Construction costs are highest in the first 5 periods, then drop during and after period 6.
- Average haul costs range from 4.84/m^3 to \$1.15/m^3.
- Maintenance costs always range from ~\$2.5/m^3 to ~\$4/m^3 and never settle into a tighter range.
- Total road costs range from ~\$19/m^3 in period four, settles into the 6-10 \$/m3 range from periods 6 onwards. The minimum cost of 4.84/m^3 appears in period 37.
- The haul distances are not meaningful as they include the barge and lake tow distances, which have no cost applied in the transportation network. As well, the barge routes are conceptual.
- Barge and lake tow costs were applied at the block level, not within the transportation network.

8.2 Sensitivity Run Results

In order to understand how sensitive the size of the operable land base is to the economic objective, two different scenarios were explored. The stand values were changed in these scenarios, the net revenue target remained constant. In one scenario the stand values were increased by one standard deviation (**up 1 SD**), in the other scenario the values were decreased by one standard deviation (**down 1 SD**). The changes were applied to both the old growth species values (Table 5) and to the regenerated young stand values (Table 7). For example, the old growth values for red cedar (Cw) were

$**79.85**/m^3 in the **down 1 SD scenario**,
$**136.05**/m^3 in the **average value scenario**, and
$**195.60**/m^3 in the **up 1 SD scenario**.

The minimum net return required in each period remained the same at \$1.74/m^3. The results are summarized in Table 13 and Table 14.

8.2.1 Operable Landbase

Table 13 North Coast TSA scenario landbases - gross, CFLB, THLB and operable area

Modeling Scenario	Gross GIS Area (ha)	CFLB (ha)	THLB (ha)	Operable (ha)	Operable (% of THLB)
Average Value plus 1 SD	3,773,962	319,443	282,329	276,094	97.8
Average Stand Value	3,773,962	319,443	282,329	87,162	30.9
Average Value minus 1 SD	3,773,962	319,443	282,329	698	0.2

Table 14 Nootum Parcel scenario landbases – gross, CFLB, THLB and operable area

Modeling Scenario	Gross GIS Area (ha)	CFLB (ha)	THLB (ha)	Operable (ha)	Operable (% of THLB)
Average Value plus 1 SD	55,626	15,318	14,540	14,487	99.6
Average Stand Value	55,626	15,318	14,540	6,447	44.3
Average Value minus 1 SD	55,626	15,318	14,540	655	4.5

These results show that a ± 1 standard deviation change in the stand values results in a huge change in the land base, in both the North Coast and the Nootum Parcel study areas. The average stand value land base is 31% of the potential THLB in the North Coast, and 44% in the Nootum Parcel. With stand values increased by 1 SD almost all (97.8 to 99.6%) of the THLB becomes operable, and if stand values are decreased by 1 SD almost all the land base is inoperable (0.2 to 4.5%).

8.2.2 Distribution of Net Stand Value

The net stand values for the three North Coast scenarios are shown in Figure 21, Figure 23, and Figure 24. As expected, the net stand values increase as the stand values increase, and the proportion of operable area in any net stand value class increases as the stand values increase. The increased operable landbase (green shading) can also be seen when the stand values increase.

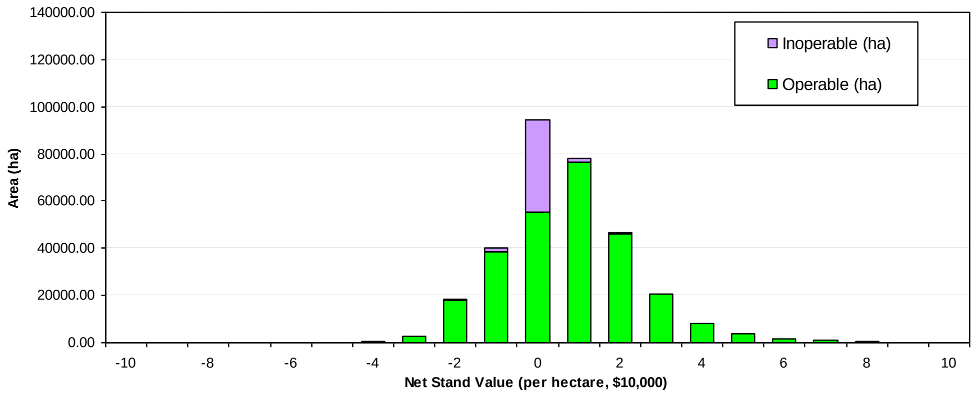


Figure 22 Net stand values for the North Coast - up 1 SD stand value

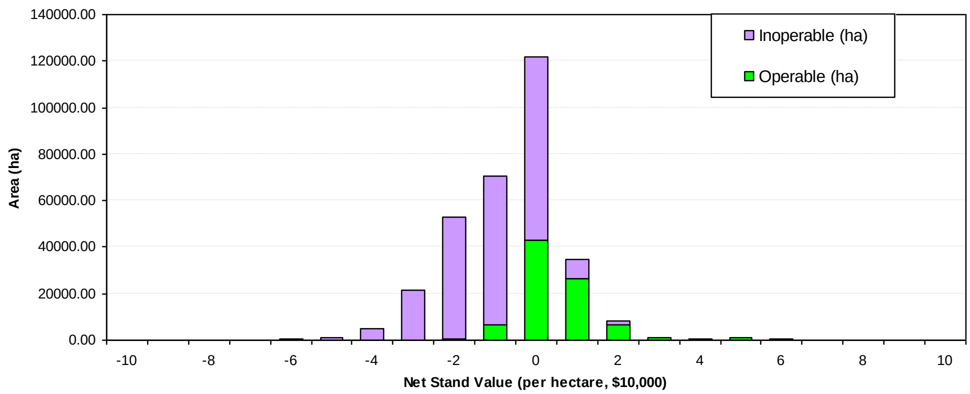


Figure 23 Net stand values for the North Coast – average stand values

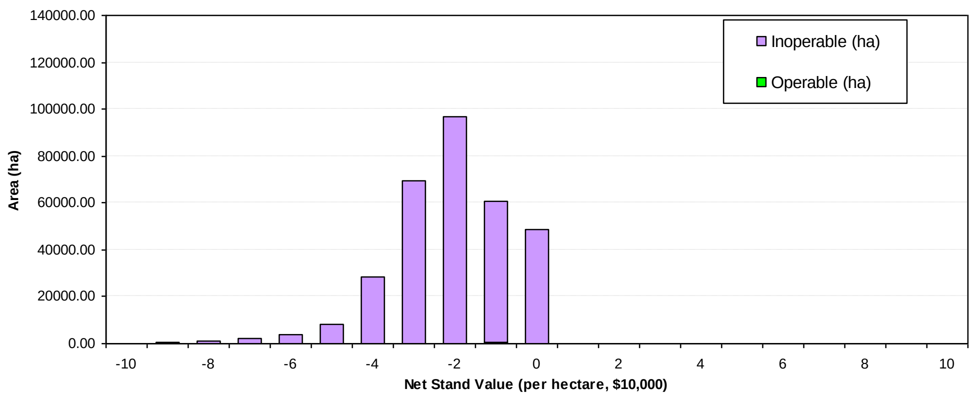


Figure 24 Net stand values for the North Coast – down 1 SD stand values

9.0 Discussion

A simple interpretation of the results is:

If stand values change (or more specifically, species values change), and if all species change in the same direction at the same time (i.e. all species rise or fall together), and if costs remain relatively constant (this includes stumpage costs remaining constant), as we have modeled in our scenarios, then the forest industry's financial situation will vary between two extremes:

- *Almost all of the working forest is operable and the industry can operate anywhere in the TSA, or*
- *Almost none of the working forest is operable, and the industry will virtually shut down".*

The situation will depend on the balance between multiple factors. For example, if stumpage costs, which we modeled as a fixed target of $1.74 total net revenue per m3 in all scenarios, were to increase as much as the stand values increased, then the operable area would not change. In other words, if all the species values were increased by $40.00 m3, and at the same time the net revenue target increased by $40.00/m3, then the operable area will not change, although the revenue collected by the Province would increase.

The results from our scenarios are driven three main factors - stand value, logging costs, and transportation costs. These influenced the results, in the following, decreasing order of impact:

(1) The changes in stand values that we have modeled are very large. For example, red cedar (Cw) value varies by $115.75/m3 between the up 1 SD and down 1 SD scenarios. In comparison, the adjacent, Mid Coast Economic Operability Project did not vary the stand values. Instead, the net return values were varied by +/- $5.00/m3, which is the equivalent of keeping the net revenue target constant and changing the species values by only +/-$5.00/m3. Hence, our results are more extreme than theirs.

(2) Logging costs are the largest proportion of the total costs and therefore have the largest influence on net stand value. Logging costs (after excluding the barge and lake tow costs) ranged from 64% to 75% of the total costs. Thus it is not surprising to see the sensitivity runs show that as fewer negative value stands are included in the land base, the proportion of the land base using helicopter harvest systems (with relatively high logging costs) declines and the proportion of conventional (with lower logging cost) increases.

(3) The transportation-related costs (building, hauling, maintenance, and barging and lake tow costs) range from 25% to 34% of the total costs. While this is a smaller portion than the logging costs, it is likely a higher proportion of the total costs compared to the coastal average, because the stands in the North Coast TSA are remote, requiring longer, more costly ocean transport, and they are distributed in a very patchy, dispersed manner, therefore they require more road to access the same area or same volume, on average, compared to the more extensive, compact distribution of stands found in the southern coastal management units.

As expected, the species distributions for Cw and Hw in the operable land base varied significantly between the operable and inoperable, since it is assumed that higher return land bases will favour the higher values species – similar to how it favours the lower cost harvest systems.

This is different from the Mid-Coast TSA economic operability project, in which no difference in Cw and Hw distributions was found. That was an unexpected result, and was attributed to using a broader grouping of stand types in that project. In this project, cost and value curves were derived at the stand-level, which were then compiled into block-level cost and value curves. The result is that in this project the differences in species percentages within stands, e.g. Cw_6Hw_4 vs Hw_6Cw_4, that shift the reporting bin from Cw leading to Hw leading, do show up in the harvest statistics. And, as expected, the Patchworks-defined operable land base does favor the higher value stands.

10.0 Summary of the Results

We used a particular computer model (Patchworks), and a particular set of assumptions in this project. Each of our choices had an impact on the results. A quick recap of the major factors and assumptions are:

Patchworks
The Patchworks model works by using a huge number of random choices (picking a particular block for harvest, or dropping that particular block, in a particular period) to try to find a good solution.
Each choice is assessed against a set of targets, either minimum(s) and/or maximum(s)
The targets (or more precisely the deviation from the targets) are weighted, and the weights are balanced against one another, such as balancing the total amount harvested (more harvest is better) against the net revenue target (harvesting less stands, each with a high net value, is better).

Methodology
We ran the model once for each geographic area, for each of three scenarios (average stand values, plus 1 SD value and minus 1 SD value.) The result is six “answers”, i.e. one iteration, for each of three scenarios, for each of two geographic areas). The point is that we ran the model once, for each of those scenarios, rather than several times for each scenario and then combine the iterations into a combined answer.

The geographic scale we used was "strategic", in the case of the N.Coast TSA, and likely "tactical" in the case of the Nootum Parcel. The important point is that neither was at the "operational" scale.

The harvest request was relatively constant, for each of the 40 five-year periods. Conversely, we did not allow the model to vary the harvest rate significantly between periods.

We did not model IRM constraints.

The stand value was related to (a) old growth (120+ yrs) versus young or second growth (<120 years) log values, and (b) stand volume, and (c) stand species composition.

The stand logging costs (which exclude the transportation costs) varied according to the (d) stand volume (e.g. $/m3 costs) and (e) the stand area (e.g. silviculture per ha costs) and (f) logging system.

The net stand value, i.e. all values and costs ("a" to "f") combined, resulted in net stand values that might be negative, or positive, or sometimes negative for a portion of the range of stand ages, (usually the younger stand ages) and sometimes positive for other stand ages (generally the older ages where stands had higher volumes/ha, and higher log values).

The stand values for second growth were generally lower than for the previous old growth stand (on a per ha basis).

Finally, the results were: ***Under average log value conditions a portion of the landbase is operable, under very low log value conditions virtually nothing is operable, and under very high log value conditions almost all the landbase is operable.***

The above is relevant to some questions that typically arise.

Question: Why wasn't this particular block harvested by the model, and therefore considered 'operable'?

Answer:

First, the model works by making random choices. While it did run millions of attempts in each of the scenario, it just might be the case that the model never actually picked that particular block, and maybe that block should be 'operable'. Cases may exist where, by chance, all the adjacent blocks were chosen, or even all the surrounding blocks were chosen, and that particular block wasn't.

However, the model could also have chosen that block, and then later traded it for another one, perhaps a far distant block that better met the overall targets that it was trying to balance, such as trading for another block in another watershed to pay off the road building in the other location.

The ultimate answer is that our operability answer is strategic – the set of blocks in total, across all the 40 periods is our estimate of the operable area, not examining each block on its own.

Note that we made the choice to run one iteration to reach one answer. If we had run the model several times for each of our scenarios, and if we decided that if any block harvested in any of the iterations was operable, then the block you are looking at would have had a higher chance of being considered “operable”. However, that methodology is a slippery slope, as it is conceivable that if we ran many iterations, then most, or even all of the blocks would appear in at least one of those, and most or all of the landbase would be “operable”.

Question: Should all the previously harvested blocks be considered to be 'operable', since they obviously once were?

Answer: We decided to include past harvesting in the final operable map. All blocks with any history of logging in any of the datasets we used should, barring a mistake, be part of the operable landbase. The “logged blocks” will appear as operable in all of our scenarios.

Whether this is a valid decision is a matter of opinion. For example, previously logged blocks likely differed, at the time of harvest, from the scenario conditions - they were likely old growth stands (the existing block is second growth with a lower net stand value), they may have been a different species composition (perhaps a cedar stand at the time of logging which later regenerated to a hemlock stand), they may have been logged with greatly reduced environmental oversight, or they may have been logged in a year with extremely good economic conditions.

At one extreme, adding the previously logged stands into the "stand-value-minus-1-SD" scenario seems very generous, as the modeling results indicated that almost none of the landbase is operable under these low stand values. At the other extreme, our "stand-value-plus-1-SD" scenario indicates that almost all the landbase is operable under high value conditions, so if we took a cumulative, long-term view and assumed that eventually enough years with good economic conditions would eventually occur over a long time period, then eventually all stands would (or could) be harvested, and so all of the landbase is operable (and the other scenarios are irrelevant).

Regardless of one’s opinion, we have included previously logged stands in our final operability maps.

Question: Should each drainage or access unit stand on its own, rather than costs and values being shared across the whole TSA? If so, shouldn't the analysis be performed on a drainage-by-drainage approach to determine which drainages are operable, and which are not?

Note: This question could also include a reference to each operating area, or to each drainage within an operating area, since in real life it is unlikely that the stand values in one operating area would be used to offset another operator's road building costs.

Answer: There is one obvious reason to model as we have, rather than attempting to model at this level of detail - pragmatism.

One can imagine that with enough time and effort the model could be coaxed into developing and harvesting individual watersheds in a more operational and realistic manner. And, if we were to model our geographic units in detail, then we should also model the costs, values and net revenue targets in a more operable manner as well. We could, with enough effort, model the individual costs and values in each drainage and road system in a manner similar to how appraisal costs are determined. Then, the overall TSA-level net revenue target might be a rollup of all the individual watershed units, perhaps each having its own net revenue target.

The author, as a matter of interest beyond and outside this project, worked with the Nootum Parcel model and coaxed it into developing a more efficient road development pattern by manually adjusting the harvest sequence and the harvest level between periods. The result was a more efficient harvest, i.e. a higher harvest volume for the same net revenue target. Extrapolating those results back to this project, in the authors opinion:

> (a) the results that we report are perhaps slightly pessimistic, as the model does seem to be harvesting in a rather dispersed harvest pattern. It appeared from the test case that this pattern could be better concentrated into fewer harvesting periods, with a possible increase in efficiency, by manually adjusting the harvest schedule.
>
> (b) However, the effort to model at the whole TSA at the drainage level of detail would be overwhelming. Assuming the analyst worked drainage by drainage, with the each licensee on their own operating area, it could easily require another year of modeling effort.

11.0 Application in Timber Supply Review

Simple spatial files have been created from the results of the Patchworks modeling. This process involved dissolving out GIS files that only contained the operable/inoperable designations (A=operable, I=inoperable). Part of this included adding back into the operable landbase those polygons that had any history of logging, and polygons that were netted out of the THLB due to special, spatial netdowns for WHA, goat habitat, class 1 grizzly bear habitat, and archaeological sites. The operable land base continues to exclude all non TSA lands (private, CFA, TFL, parks, etc) and non forested areas. Final operable areas after simplification and inclusion of the previous netdowns are depicted in the following table.

Scenario	Patchworks operable area (ha)	Final operable map area (ha)
North Coast – up 1 SD	276,094	303,510
North Coast - Average stand value	87,162	131,562
North Coast – down 1 SD	698	58,938
Nootum Parcel – up 1 SD	14,487	15,129
Nootum Parcel – average stand value	6,447	7,402
Nootum Parcel – down 1 SD	655	1,989

It is recommended that the average stand value scenario be used in the base case timber supply analysis for TSR3. The high stand value and low stand value return land bases could be used in sensitivity analyses, although they appear to be rather more extreme cases that would normally be used in TSR.

Appendix A – Nootum Parcel Statistics

Nootum Parcel Statistics based on the average stand values

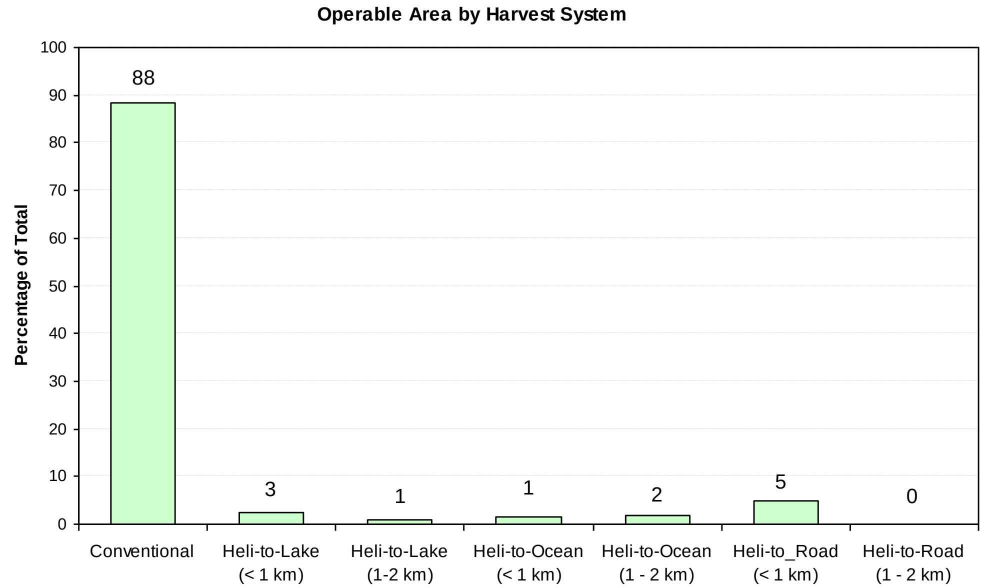


Figure 25 Nootum Parcel operable area by harvest system

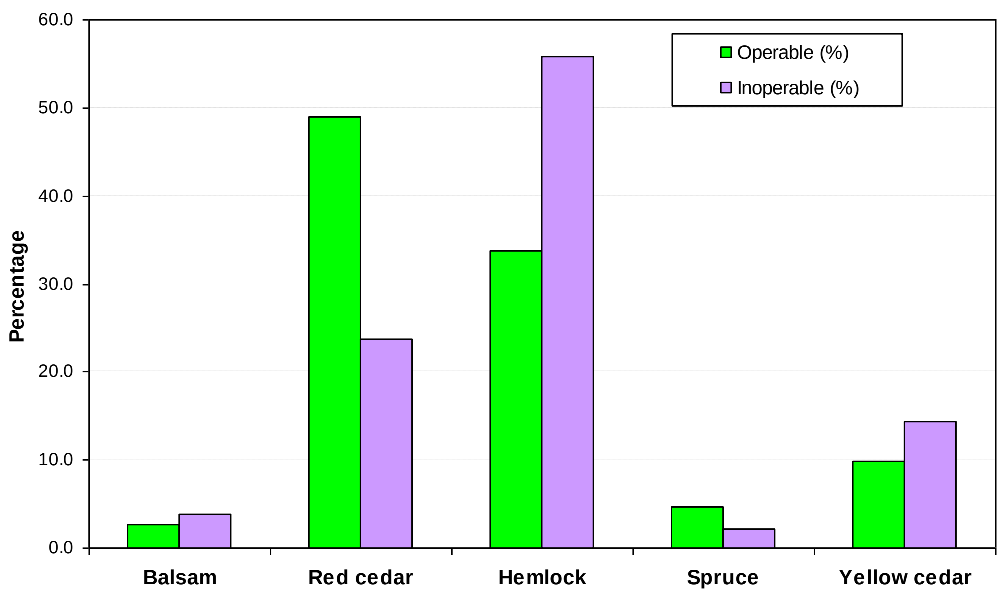


Figure 26 Nootum Parcel operable and inoperable leading species (%)

Table 15 Proportion of stands of each leading species in the operable versus inoperable

Leading Species	Operable (ha)	Inoperable (ha)	Operable (total ha)	Inoperable (total ha)	Operable (% of total operable)"	Inoperable (% of total inoperable
Balsam	176	345	6,447	8,871	2.7	3.9
Red cedar	3,161	2,112	6,447	8,871	49.0	23.8
Hemlock	2,176	4,955	6,447	8,871	33.8	55.9
Spruce	301	189	6,447	8,871	4.7	2.1
Yellow cedar	634	1,271	6,447	8,871	9.8	14.3

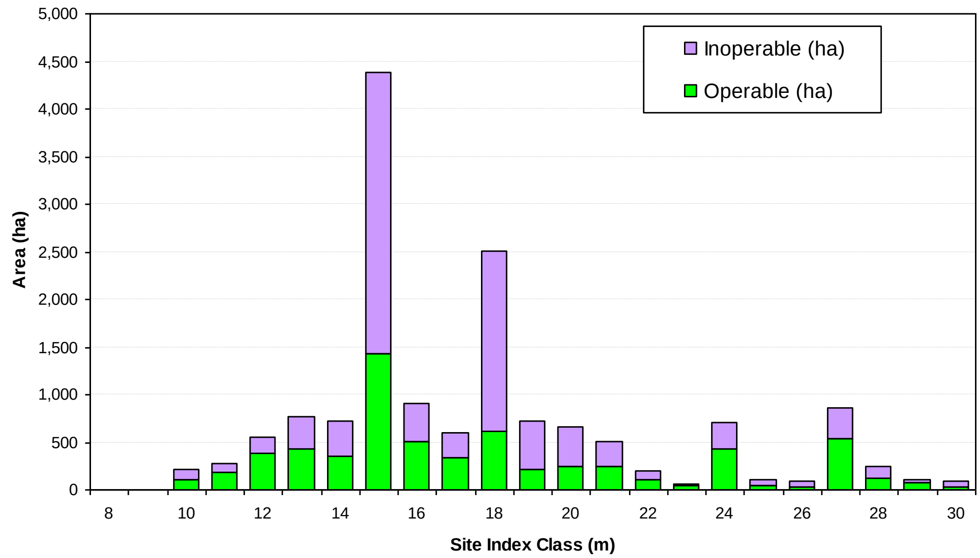


Figure 27 Nootum Parcel operable and inoperable area by site class

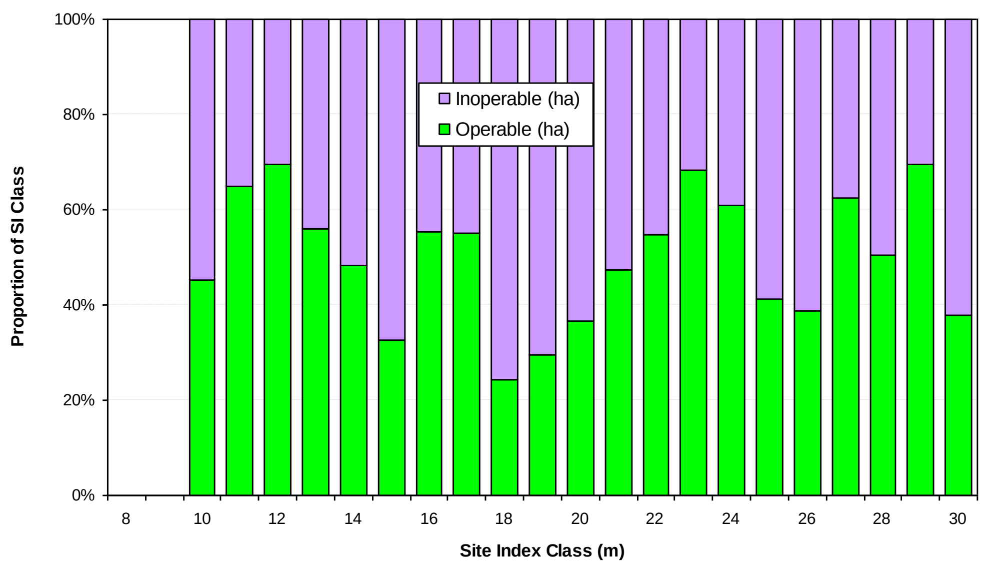


Figure 28 Nootum Parcel operable and inoperable proportion by site class

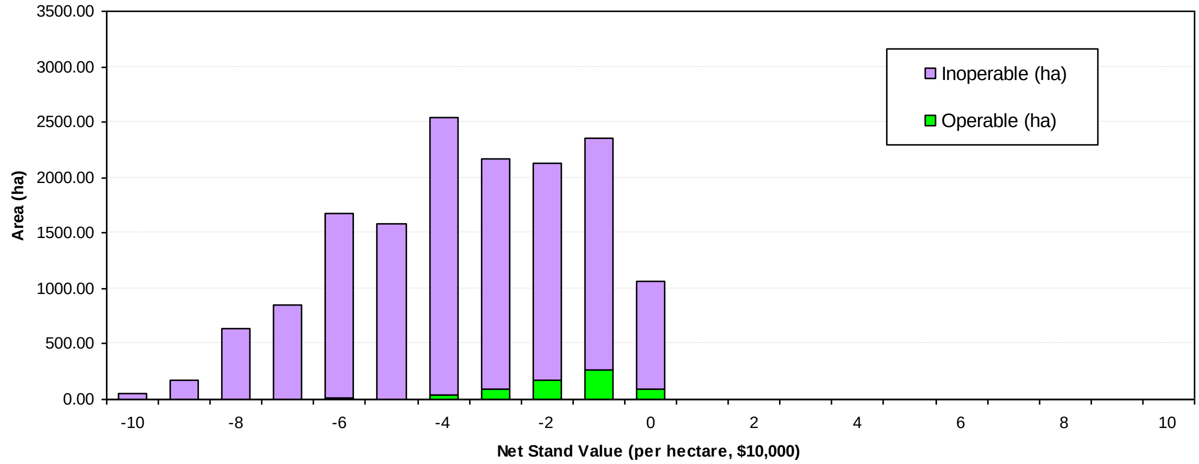


Figure 29 Nootum Parcel net stand value classes- stand values minus one SD

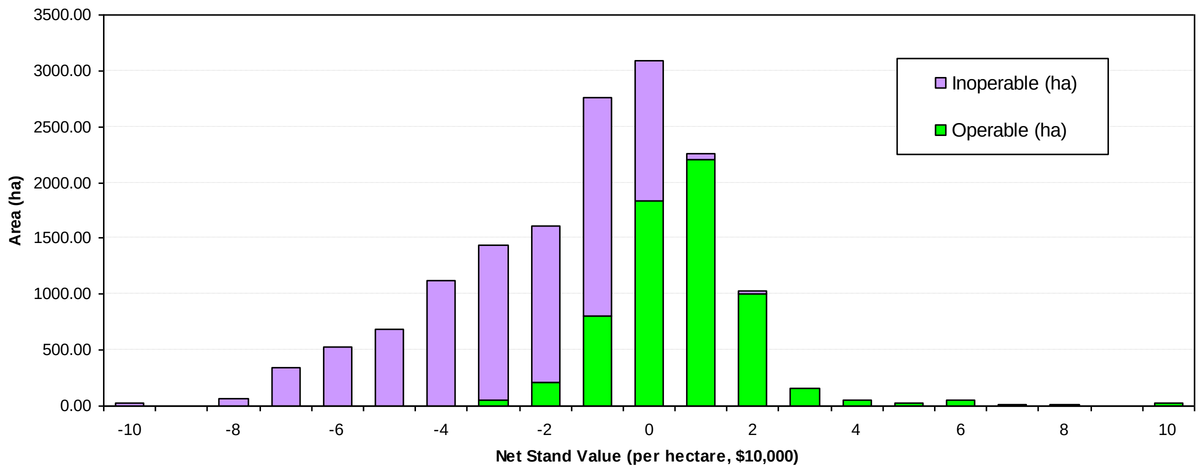


Figure 30 Nootum Parcel net stand value classes - average stand values

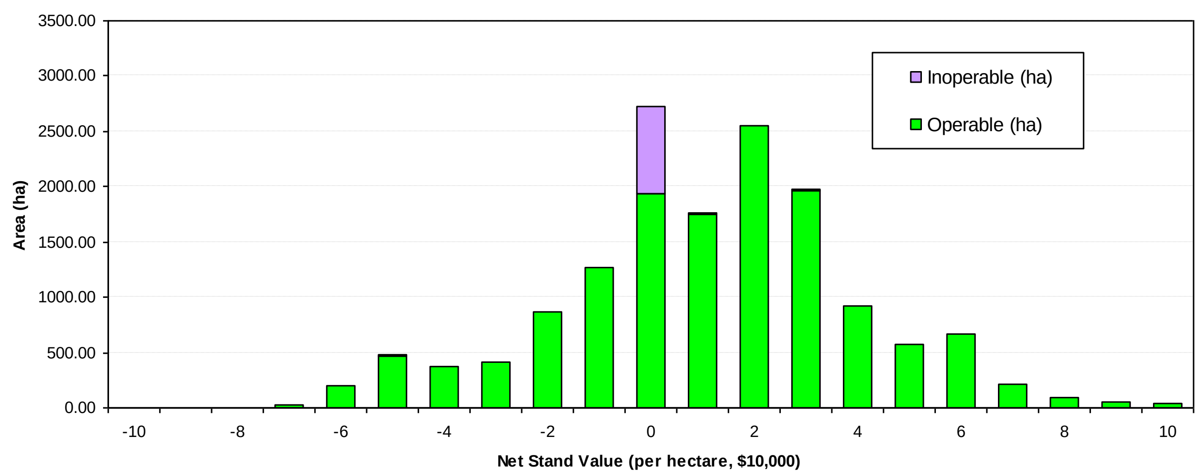


Figure 31 Nootum Parcel net stand value classes – stand value plus one SD

Appendix B - Maps

The three scenarios, stand values up 1 standard deviation (SD), average stand values, and stand values down 1 SD,) are each provided as a separate Arc Info cover (map), for both of the project areas - North Coast TSA, and the Nootum Parcel.

The six zip files will each expand to arc-Info workspaces with an Arc Info maps within their own directory (with name such as: DND, DNC, DNU, NPA, NPU, and NPD).

The mnemonics used in the maps, and as well for many of the data summaries or data tables (not provided) are:

DNC = North Coast TSA (DNC), Average conditions
DNU = North Coast TSA; stand values up (U) one standard deviation
DND = North Coast TSA; stand values down (D) one standard deviation

NPA = Nootum Parcel (NPA), Average conditions
NPU = Nootum Parcel, stand values up (U) one standard deviation
NPD = Nootum Parcel, stand values down (D) one standard deviation

The data field in each of the maps is **OPER_PW_LOG**, which is the operability based on

(a) blocks logged by Patchworks (hence "OPER"), plus
(b) any blocks with any history of logging ("LOG"). As well, the spatially-mapped, IRM landbase netdowns are also added back into the map as "operable". These IRM netdowns include class 1 grizzly bear habitat, goat habitat, etc (see the project report for details).

Values in the field:OPER_PW_LOG are the standard Ministry of Forests operability values:

A = operable
I = inoperable