Integrated Silviculture Strategy

Fraser Timber Supply Area

Modelling and Analysis Report

V 2.0

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1 Introduction

The Resource Practices Branch (RPB) of the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) aims to develop a new management unit planning framework; the Integrated Silviculture Strategy (ISS). The ISS is a sustainable forest management planning framework with the objective to integrate all aspects of landscape-level and operational planning for each Timber Supply Area (TSA).

The ISS will integrate Type 4 Silviculture Strategies with timber supply review (TSR) to reduce duplication and redundancies where possible by sharing inventories, management zones, analysis units, Timber Harvesting Land Base (THLB) definitions and management assumptions. It is expected that the ISS process will improve the linkages to landscape level fire management, the Cumulative Effects Framework, the Forest and Range Evaluation Program's (FREP) multiple resource values assessments (MRVA) and other regional, management unit level or landscape level plans and strategies.

2 Context

This document is the third of four documents that make up an ISS. The documents are:

1 Situational Analysis – describes in general terms the current situation for the unit. The Situational Analysis forms the starting point for the initial planning group meeting to identify opportunities.

2 Data Package - describes the information that is material to the analysis including data inputs and assumptions.

3 Modeling and Analysis report –provides modeling outputs and rationale for choosing the selected scenario.

4 Integrated Silviculture Strategy – represents the preferred management scenario which is the basis for the first iteration of the ISS. It includes an investment strategy and provides treatment options, associated targets, timeframes and expected benefits.

When the ISS is complete, a spatial operations schedule will provide direction for harvesting and a land base investment schedule will guide Forest for Tomorrow Annual Operating Plans.

3 Analysis Assumptions

This analysis relied on many of the same analysis assumptions that were used in the latest TSR; however, the analysis assumptions were revised through stakeholder meetings to reflect current management in the Fraser TSA. The Analysis assumptions are detailed in the Fraser TSA ISS Data Package (FESL 2020).

3.1 Forest Level Analysis

This report describes the forest level analysis results for the Fraser TSA. This analysis is essentially an expanded timber supply analysis, which examines the availability of timber volume and other indicators over time. It involves testing and reporting on a variety of assumptions and management strategies. The analysis provides stakeholders with information about the relationship between a variety of possible management strategies and the supply of timber, habitat and other values.

Timber supply analysis is intended to ensure that current harvest levels are sustainable and do not threaten the availability of future timber volume. Sustainability is therefore the key concept in timber supply analyses in general. While this analysis does use this timber based definition as a guideline to complete various scenarios, it also attempts to evaluate sustainability in terms of the wider range of biological, social, or economic values that are affected by timber harvesting.

3.2 Indicator Forecasts

A single forecast is not enough to depict the supply of various values in the Fraser TSA due to the complexity of factors affecting the supply of timber and other values. There are uncertainties about how well the analysis assumptions reflect the realities of timber supply and other factors in the TSA and there are many options for managing harvest levels. Several forecasts are developed in this analysis to account for these uncertainties and options. The purpose of presenting different forecasts is to construct a complete understanding of the timber supply dynamics and the dynamics of other values in the Fraser TSA, under a variety of different assumptions and management options. The following forecasts are presented in this report:

ISS Base Case: The ISS Base Case is the standard against which other forecasts are compared when assessing the effects of uncertainty or different management emphases on indicators values. In most analyses, the Base Case reflects the best available knowledge about current management and immediate future activities and forest development.

Sensitivity Analyses: Sensitivity analyses are used to determine the risk associated with uncertainties in the assumptions of the analysis. These forecasts isolate an area of uncertainty and test the implications of using a variety of assumptions.

Learning Scenarios: Management objectives were developed for the Fraser TSA through several stakeholder meetings. The objectives were developed for a broad set of values that were considered important to the stakeholder group: economic values, environmental values and social values. Strategies to achieve stated objectives were collated into logical scenarios for comparison against the ISS Base Case.

Selected Scenario: Scenario that optimizes management, in the opinion of the stakeholder group; the basis of the ISS. It may combine components from different learning scenarios.

3.3 Model

All analyses presented in this report were conducted using Forest Simulation and Optimization System (FSOS), a proprietary forest estate model developed by FESL. FSOS has both simulation and heuristic (pseudo-optimization) capabilities. The time-step simulation mode was primarily used in this analysis. Time-step simulation grows the forest based on growth and yield inputs and harvests units of land area based on user-specified harvest rules and constraints that cannot be exceeded.

3.4 Sustainable Harvest

A reliable and objective indicator of sustainability is required to differentiate sustainable harvest levels from unsustainable harvest levels. Crashes in timber supply occur at pinch points when there is insufficient merchantable volume to satisfy the target harvest level. Timber supply analysts commonly use these crashes as an indicator of non-sustainable harvest levels. However, pinch points are directly related to how minimum harvest criteria are defined and may not reflect true constraints on timber supply.

Pinch points are useful as indicators of sustainability only if minimum harvest ages are equal or close to the culmination ages of mean annual increment (MAI). When minimum harvest ages are set close to culmination age, pinch points indicate that the model is attempting to harvest stands below culmination age. Pinch points are less effective indicators of sustainability when minimum harvest ages are set using other criteria, such as volume per ha as in most scenarios this analysis. The stable long-term growing stock is the sole indicator of timber sustainability in this analysis. Short- and medium-term harvest levels are considered sustainable if they do not compromise growing stock in the long term.

3.5 Determining the Harvest Level

Growing stock becomes stable when the rate of harvest equals the rate of growth of the forest. At low harvest levels stands are harvested after their MAI culmination age – provided that they have achieved their minimum harvestable volume – and the growing stock accumulates until an equilibrium is reached, often far into the future. If the harvest level is too high, the stands are harvested below their culmination age. This often causes a rapid decline of the growing stock until it can no longer support the desired harvest level.

Maximum sustainable even flow is the highest harvest level that can sustain a stable growing stock. In the absence of constraints, this harvest rate would equal the long-range sustained yield harvest rate, where all stands would be harvested at their MAI culmination age. However, the presence of forest cover constraints such as VQOs can limit the ability of the model to harvest stands at culmination age. As a result, long-term harvest levels are typically somewhat lower than the maximum possible growth rate of the forest.

In this analysis the maximum sustainable even flow was established first. After this, the short-term harvest was elevated as high as possible without compromising the long-term sustainability of the harvest forecast. As a final step, higher long-term harvest levels were tested last (subject to already established short-term harvest level and maximum sustainable even flow depicting the medium-term harvest level).

4 Analysis Results

4.1 ISS Base Case

The TSR analysis assumptions were revised through stakeholder meetings to reflect current management in the Fraser TSA. Table 1 shows the core ISS Base Case assumptions in a nutshell.

Table 1: ISS Base Case assumptions

Objectives and overall assumptions	**Characterize current management to the extent practicable**
Land base assumptions	• Follow the latest TSR with updates to ownership etc. • Remove prospective FNWL outside of BCTS operating area from the TLHB; • Remove known NOGO nests and nest buffers from the THLB; • Incorporate the Stó:lō Plan in the analysis (netdowns); • Incorporate proposed Northern Goshawk (NOGO) WHAs and nests currently outside of WHAs in the analysis; • Use most TSR assumptions as they are; • Remove areas considered uneconomic from the THLB (in addition to TSR definition of uneconomic); • THLB 219,490 ha.
Harvest assumptions	• Incorporate available proposed harvest into the harvest forecast; • Use highest volume first harvest rule; • Incorporate the Stó:lōPlan in the analysis (harvest constraints); • Set harvest priority based on distance from road and timber supply block; • Limit the harvest of stands older than 115 years to around 460,000 m^3 per year; • Maintain the harvest of HemBal around 50% of total harvest until natural HemBal stands are mostly harvested; • Limit alder harvest to 10,000 m^3 per year; • Include other deciduous in conifer leading stands in harvest and modelling (biodiversity values and silviculture implications).
Silviculture assumptions	• BEC based analysis units for managed stands; • Use the provincial site index layer as the site index source for managed stands; • Use TASS for modelling the growth and yield of managed stands; • Incorporate past treatments (fertilization); • Separate existing managed stands into eras to reflect different management.
Habitat assumptions	• Spotted Owl legal requirements as per TSR; • Report on nesting and foraging habitat in each LU as per the Spotted Owl model; • Report on Marbled Murrelet habitat; • Report on potential NOGO forage habitat.

4.1.1 Harvest Forecast

Figure 1 illustrates the ISS Base Case harvest forecast; a harvest level of 1,212,000 m^3 per year can be maintained throughout the planning horizon.

Figure 2 illustrates the predicted development of the growing stock for the ISS Base Case. The stable long-term growing stock indicates a sustainable timber supply.

During the first 50 years of the planning horizon, the majority of harvest is predicted to come from natural stands, i.e. Douglas-fir stands established prior to 1968 or all other stands established prior to 1978 (Figure 3). A small volume of managed stands is harvested immediately at the beginning of the planning horizon. In 60 years, half of the harvest is forecasted to come from managed stands.

Figure 4 shows the harvest forecast by species. The harvest of HemBal species was limited to approximately 50% to reflect their current share of the merchantable volume in the land base. As illustrated in Figure 4 and Table 2, this objective is met in the ISS Base Case. In the course of time the projected harvest of HemBal decreases, while the harvest of Douglas-fir is projected to increase.

Despite the significant planting of Cw within the last 40 years on many ecological units in the Fraser TSA, Figure 4 predicts only a modest amount of Cw harvest from managed stands in the future. The Cw harvest is smaller than expected, because much of the Cw has been planted in small patches or in mixes. It is competing with other conifers with significantly higher site productivities. As a result, the TASS model predicts that much of the Cw will be overtopped by other species and will not achieve merchantability by the time the rest of the stand is harvested.

This analysis attempted to limit the harvest of alder to 10,000 m^3 per year. This was not possible (Table 3), because alder is a minor component of many natural conifer stands and it is also assumed to be a minor component of many future Douglas-fir stands. As a result, harvest of alder consistently exceeded the limit.

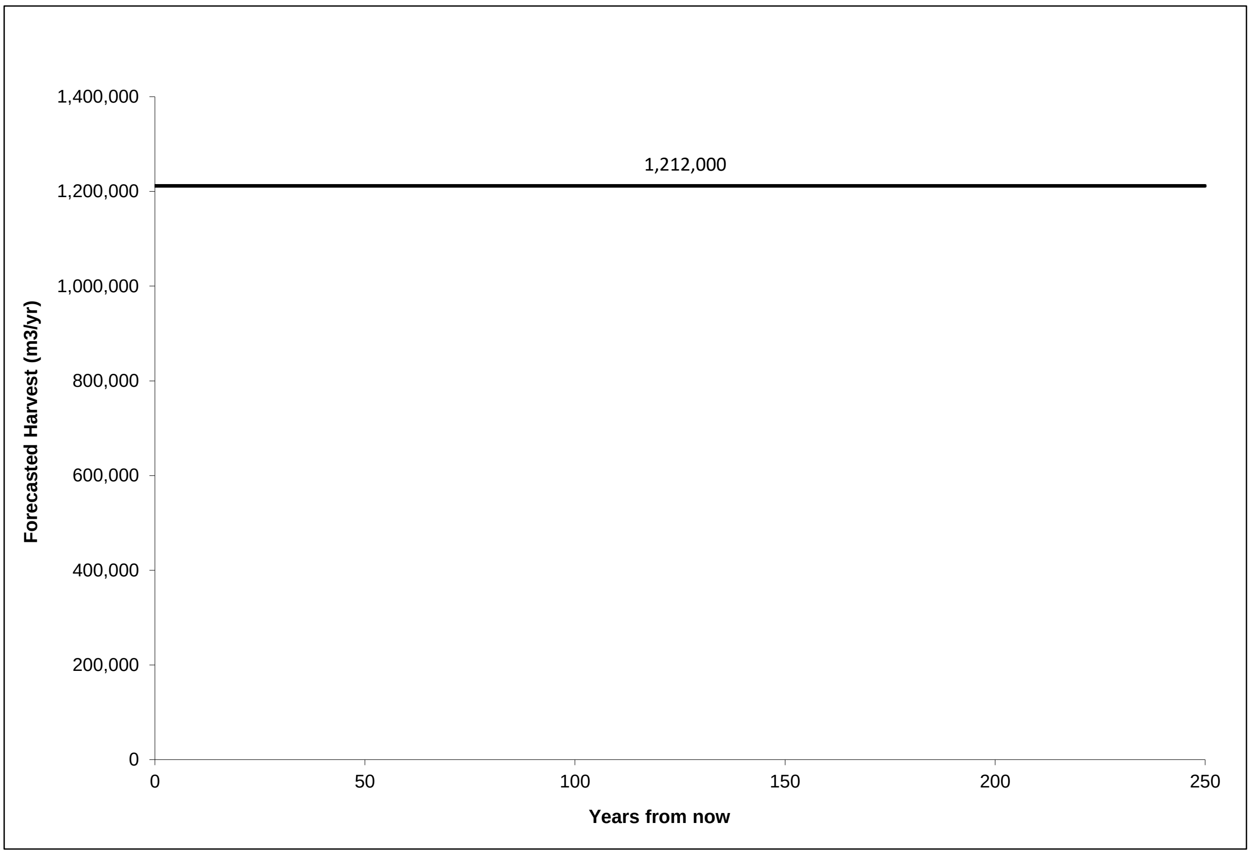

Figure 1: ISS Base Case harvest forecast

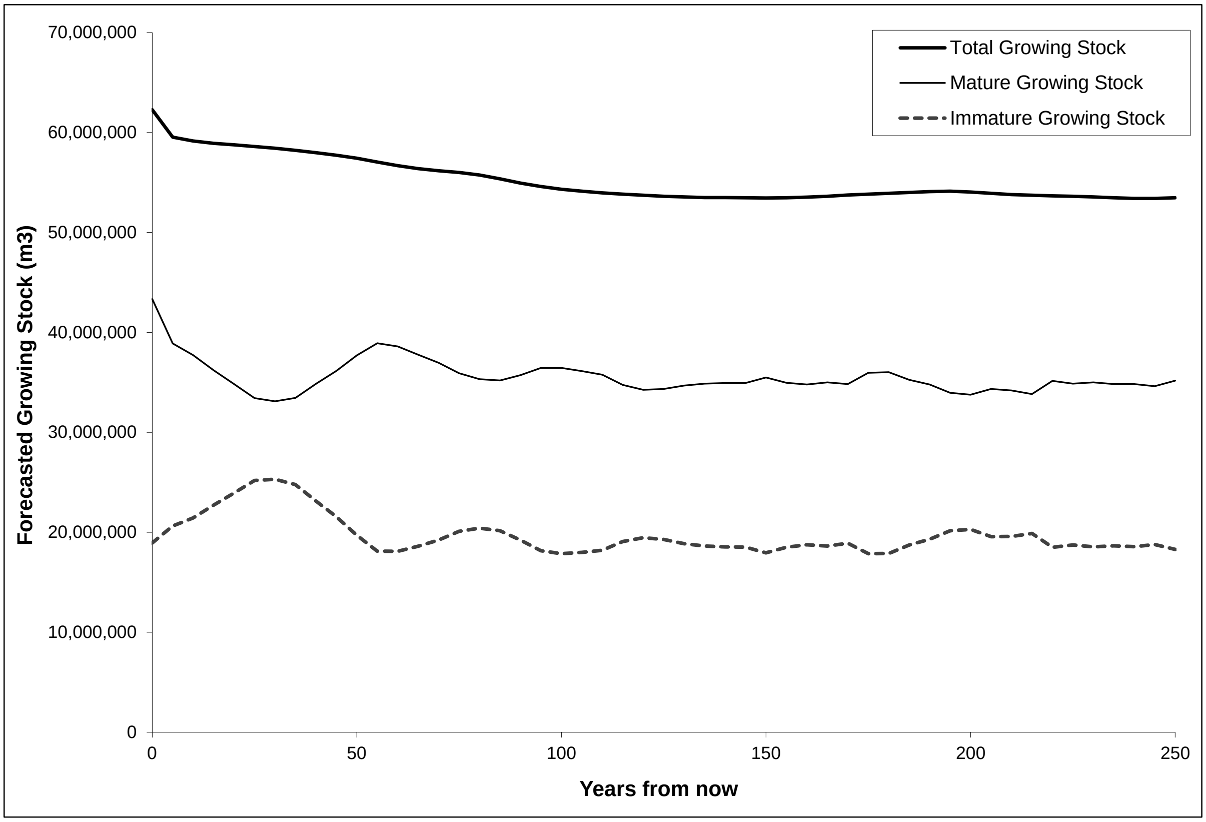

Figure 2: Predicted growing stock development, ISS Base Case

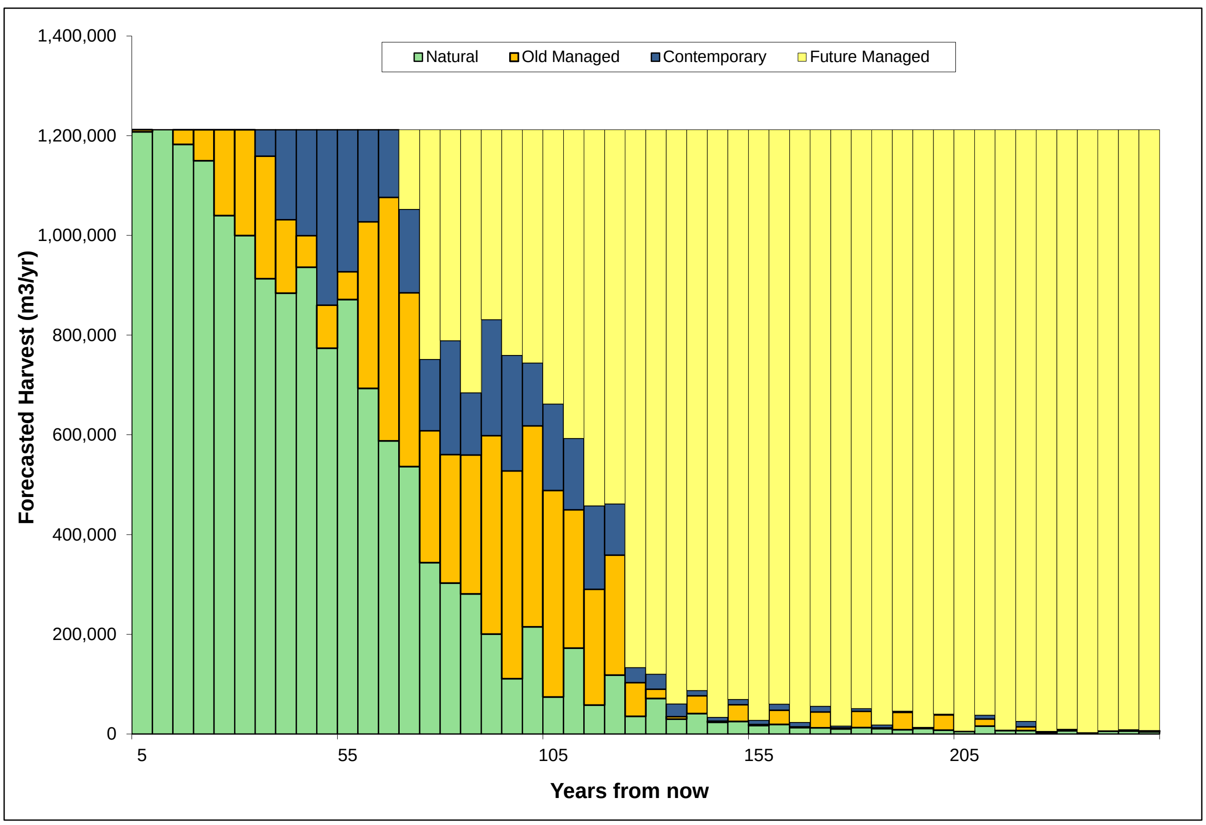

Figure 3: ISS Base Case harvest forecast by stand type

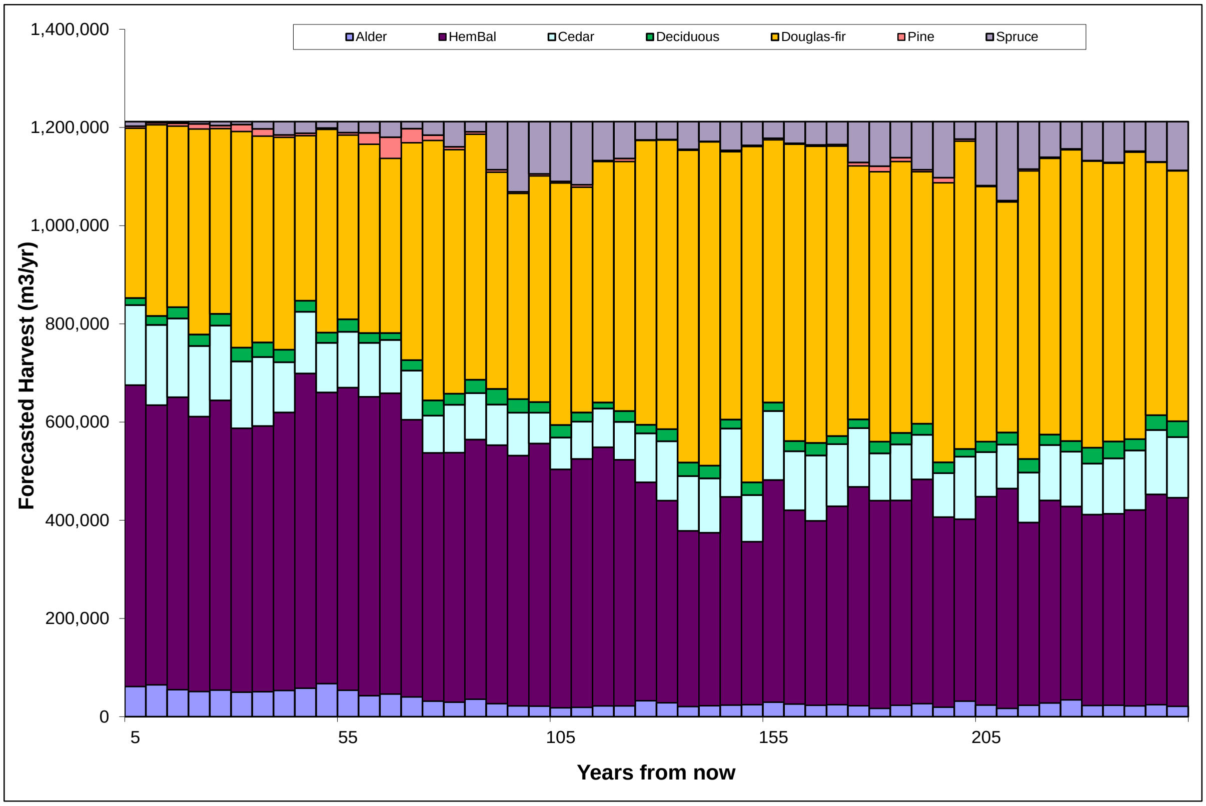

Figure 4: Harvest forecast by species, ISS Base Case

Table 2: ISS Base Case; predicted annual HemBal Harvest

Year	Total Harvest (m^3)	Projected HemBal Harvest (m^3)	HemBal Harvest %
1 – 5	1,212,000	613,711	51%
6 – 10	1,212,000	569,453	47%
11 – 15	1,212,000	595,494	49%
16 – 20	1,212,000	559,751	46%
21 – 25	1,212,000	589,966	49%
26 – 30	1,212,000	537,160	44%
31 – 35	1,212,000	541,137	45%
36 – 40	1,212,000	566,215	47%
41 – 45	1,212,000	640,684	53%
46 – 50	1,212,000	593,092	49%
51 – 55	1,212,000	616,069	51%
56 – 60	1,212,000	608,787	50%
61 – 65	1,212,000	612,584	51%
66 – 70	1,212,000	564,212	47%
71 – 75	1,212,000	505,496	42%
76 – 80	1,212,000	508,228	42%
81 – 85	1,212,000	528,537	44%

Year	Total Harvest (m^3)	Projected HemBal Harvest (m^3)	HemBal Harvest %
86 – 90	1,212,000	526,265	43%
91 – 95	1,212,000	509,569	42%
96 – 100	1,212,000	534,353	44%

Table 3: ISS Base Case; predicted annual Alder harvest

Year	Total Harvest (m^3)	Projected Alder Harvest (m^3)	Alder Harvest %
1 – 5	1,212,000	61,721	5%
6 – 10	1,212,000	65,063	5%
11 – 15	1,212,000	55,313	5%
16 – 20	1,212,000	51,520	4%
21 – 25	1,212,000	54,221	4%
26 – 30	1,212,000	49,968	4%
31 – 35	1,212,000	51,027	4%
36 – 40	1,212,000	53,381	4%
41 – 45	1,212,000	58,116	5%
46 – 50	1,212,000	67,369	6%
51 – 55	1,212,000	54,044	4%
56 – 60	1,212,000	42,673	4%
61 – 65	1,212,000	46,251	4%
66 – 70	1,212,000	40,378	3%
71 – 75	1,212,000	31,719	3%
76 – 80	1,212,000	29,575	2%
81 – 85	1,212,000	35,786	3%
86 – 90	1,212,000	26,672	2%
91 – 95	1,212,000	22,241	2%
96 – 100	1,212,000	21,778	2%

In the ISS Base Case, the harvest from stands 115 years and older was limited to 460,000 m^3 per year (around 40%) for 50 years to reflect current operations in the TSA. The share of these stands was approximately 37% of the total harvest for 45 years before it declined (Figure 5).

Limiting the harvest of old stands is reflected in Figure 6, which depicts the harvest forecast by age class. While older stands, particularly age class 8 and 9 stands (older than 140 years), are harvested in the first 50 years, the harvest share of younger stands of the total volume is significant. Approximately 50% of the harvest in this time period is predicted to come from stands between 41 and 100 years old with age class 4 (61 to 80 years) predicted to be prevalent. In the long term, the harvest is predicted to come mostly from age classes 4, 5 and 6 (61 to 80 years, 81 to 100 years and 101 to 120 years).

This is also reflected in Figure 7 illustrating the predicted average harvest age. The average harvest age is high at first due to the harvest of older stands; however, it stabilizes and settles at around 100 years in the long term.

Figure 8 illustrates the harvest forecast by vol/ha classes, while Figure 9 shows the predicted average harvest volume over time. In the long run, the harvest forecast is dependent on the 500 to 600 m^3 per ha class with the average harvest volume trending close to 600 m^3 per ha. Limiting the harvest of older stands (50 years) and HemBal stands (100 years) necessitate the harvest of lower volume stands during the first 100 years, which shows in Figure 8; more stands with volumes between 400 and 500 m^3 per ha are harvested in this time period.

The predicted average annual harvest area is illustrated in Figure 10.

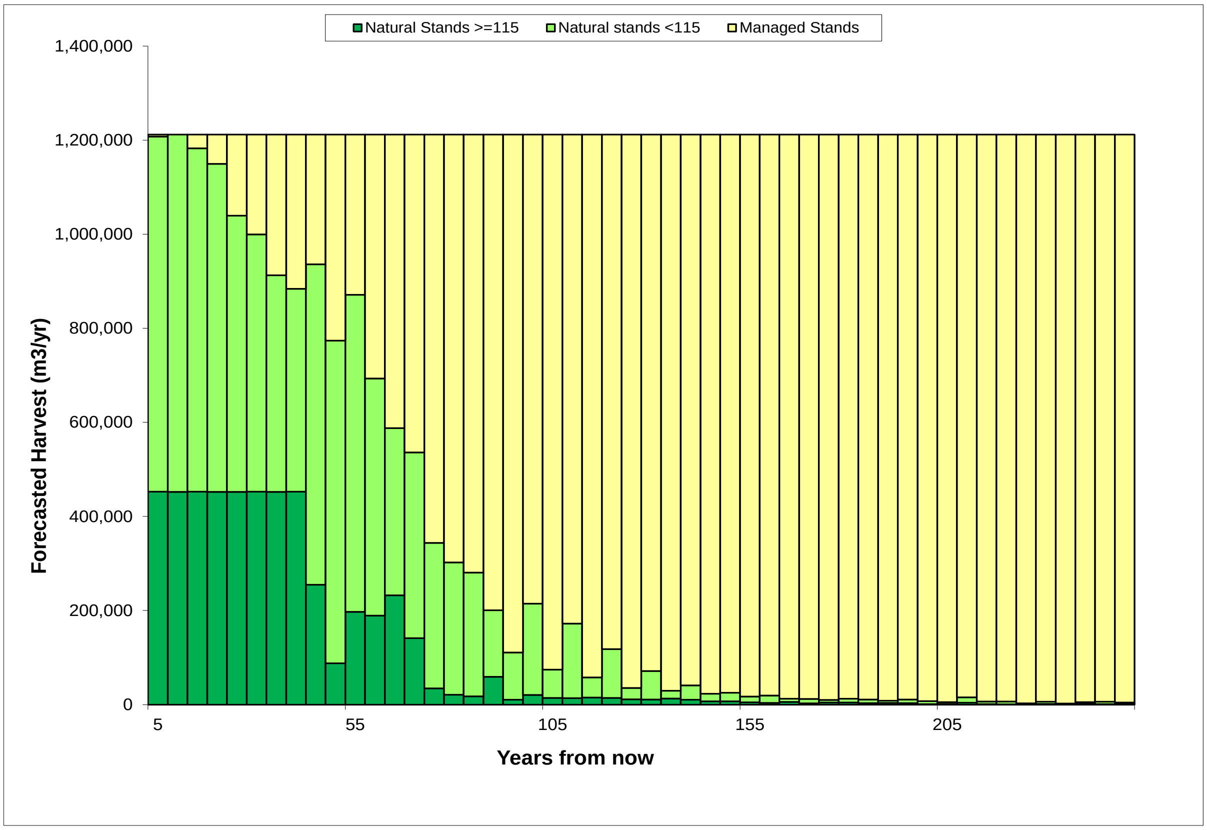

Figure 5: Harvest forecast by stand age, ISS Base Case

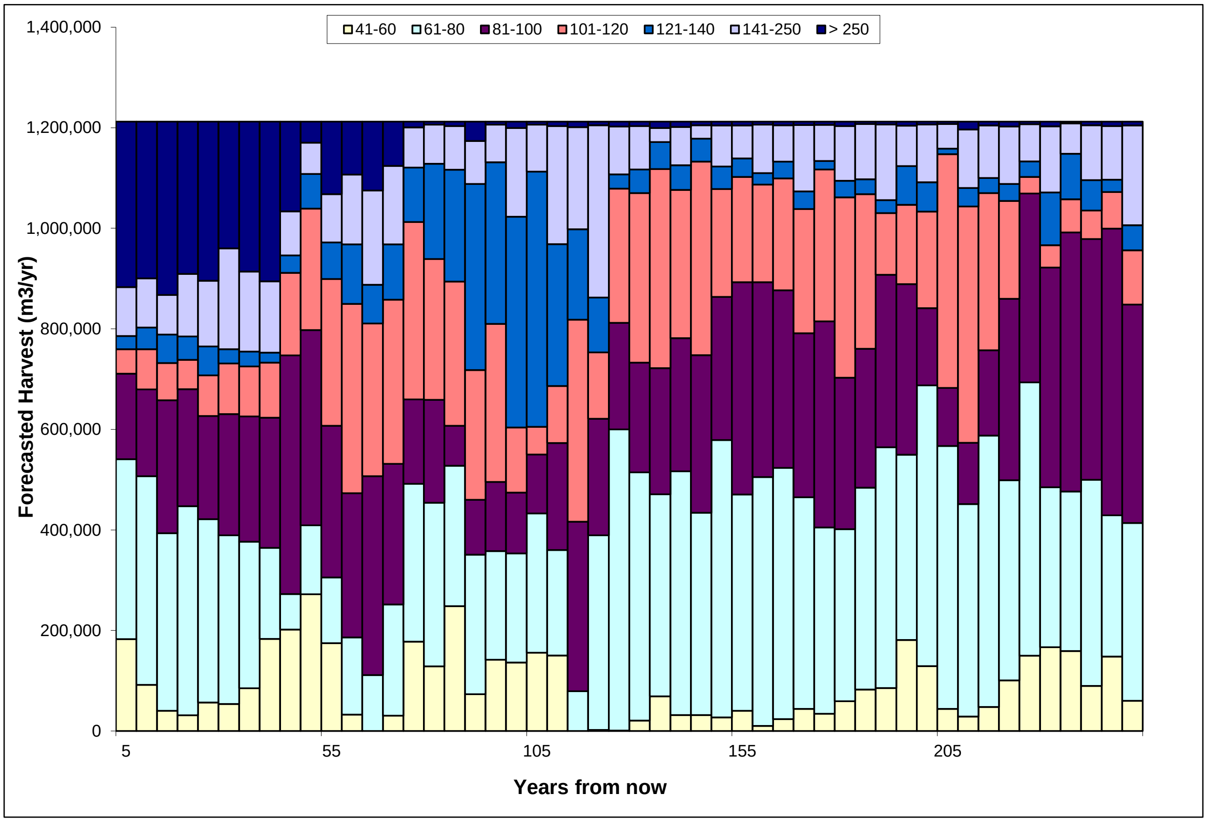

Figure 6: Harvest forecast by age class, ISS Base Case

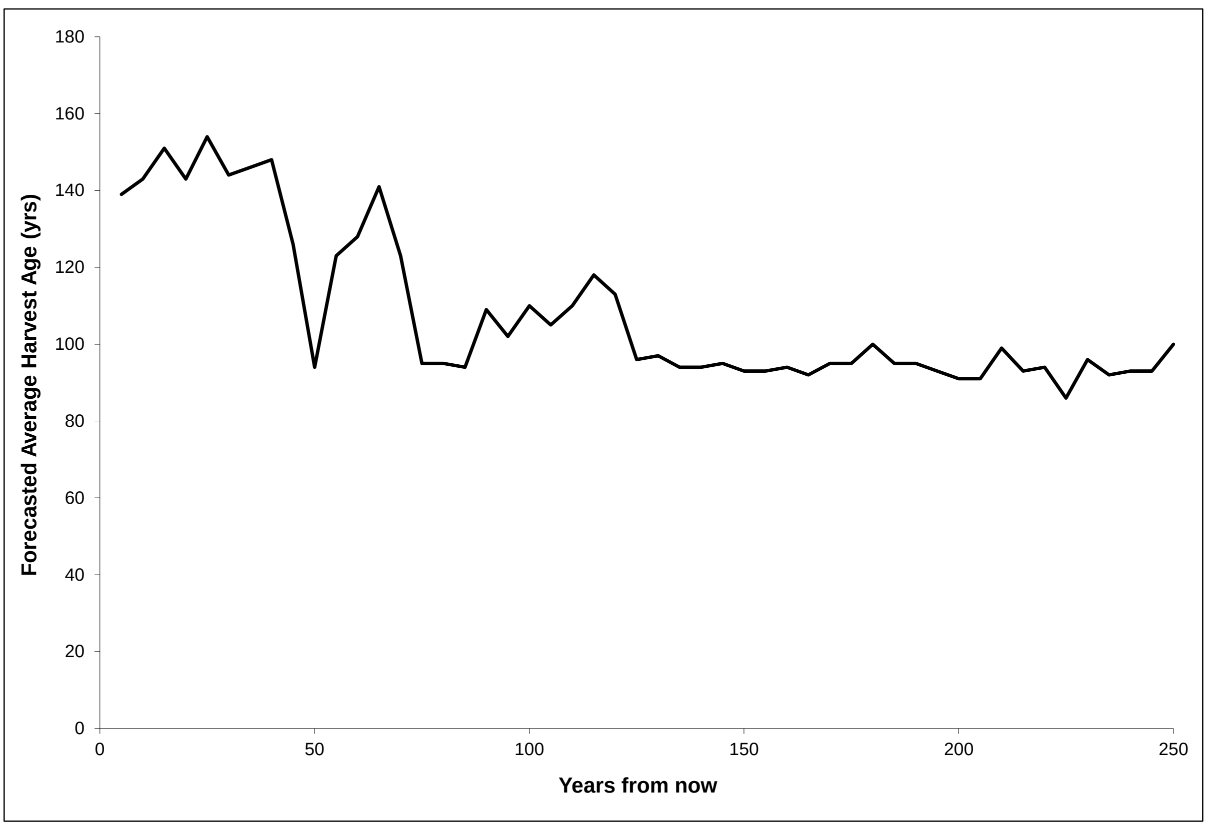

Figure 7: Average harvest age, ISS Base Case

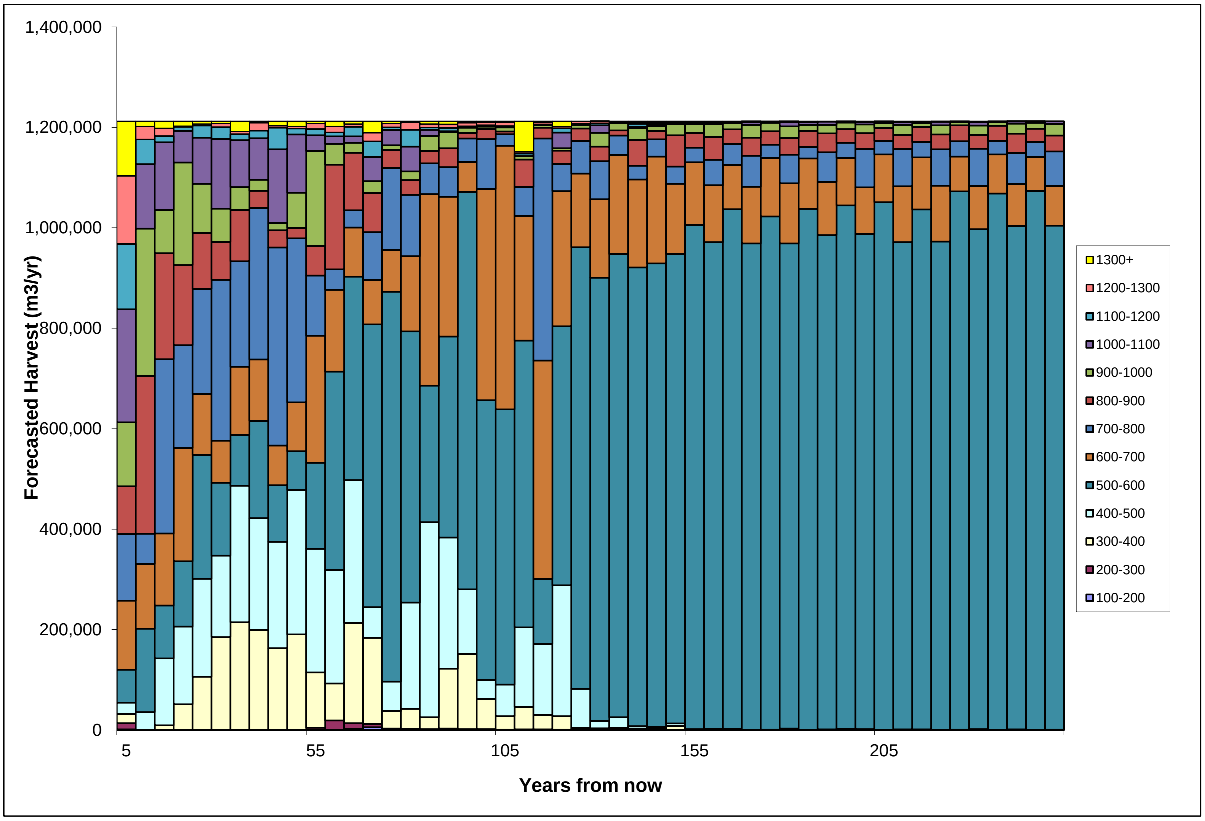

Figure 8: Harvest forecast by volume per ha class, ISS Base Case

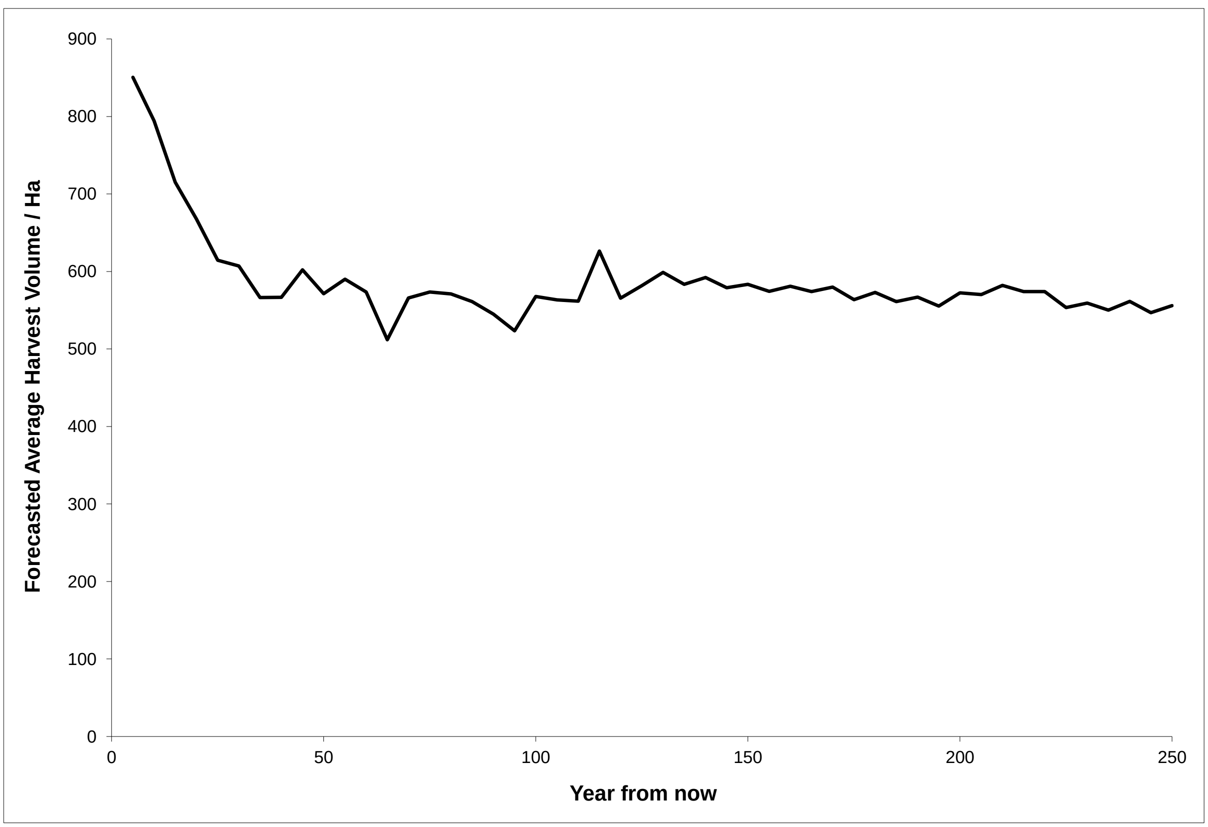

Figure 9: Predicted average harvest volume per ha, ISS Base Case

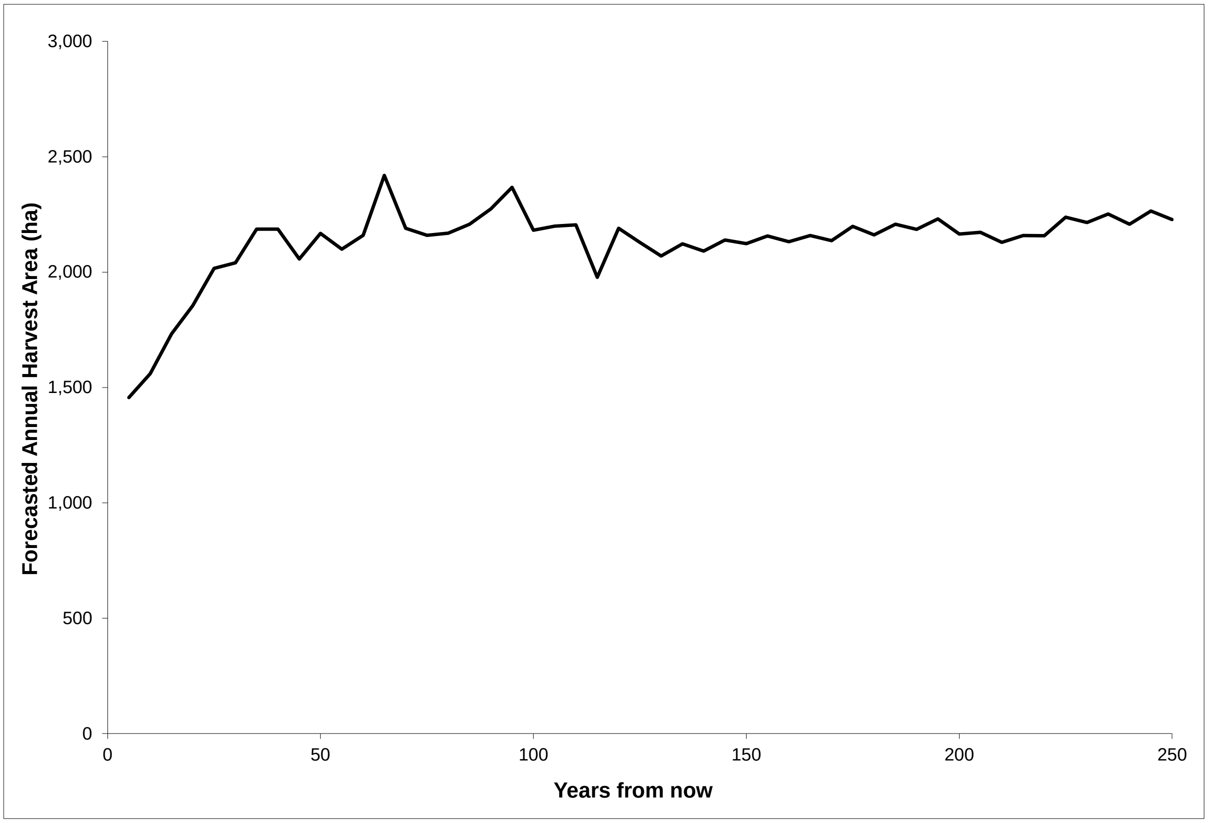

Figure 10: Predicted average harvest area, ISS Base Case

Almost the entire harvest is predicted to come from areas where conventional harvest systems are prevalent; however, some helicopter harvesting is also predicted (Figure 11).

The harvest priority in the ISS Base Case was governed by distance from road and the timber supply block (TSB) as follows:

- Harrison, Stave Chilliwack, high harvest priority;
- Pitt, Yale, medium harvest priority;
- Maple Ridge, Nahatlatch low harvest priority.

Figure 12 illustrates the ISS Base Case harvest forecast by TSB. Note that eventually harvest will have to move to lower harvest priority areas to meet the harvest request.

Figure 13 and Figure 14 depict the predicted age class distribution over time in the THLB and the Crown Forested Land Base (CFLB) correspondingly. Over time age classes 1 to 4 are forecasted to cover almost 80% of the THLB (Figure 13). Older age classes, especially age classes 9, are well represented in the Non-Harvestable Land Base (NHLB) and contribute significantly to the mature and old seral stages of the CFLB (Figure 14).

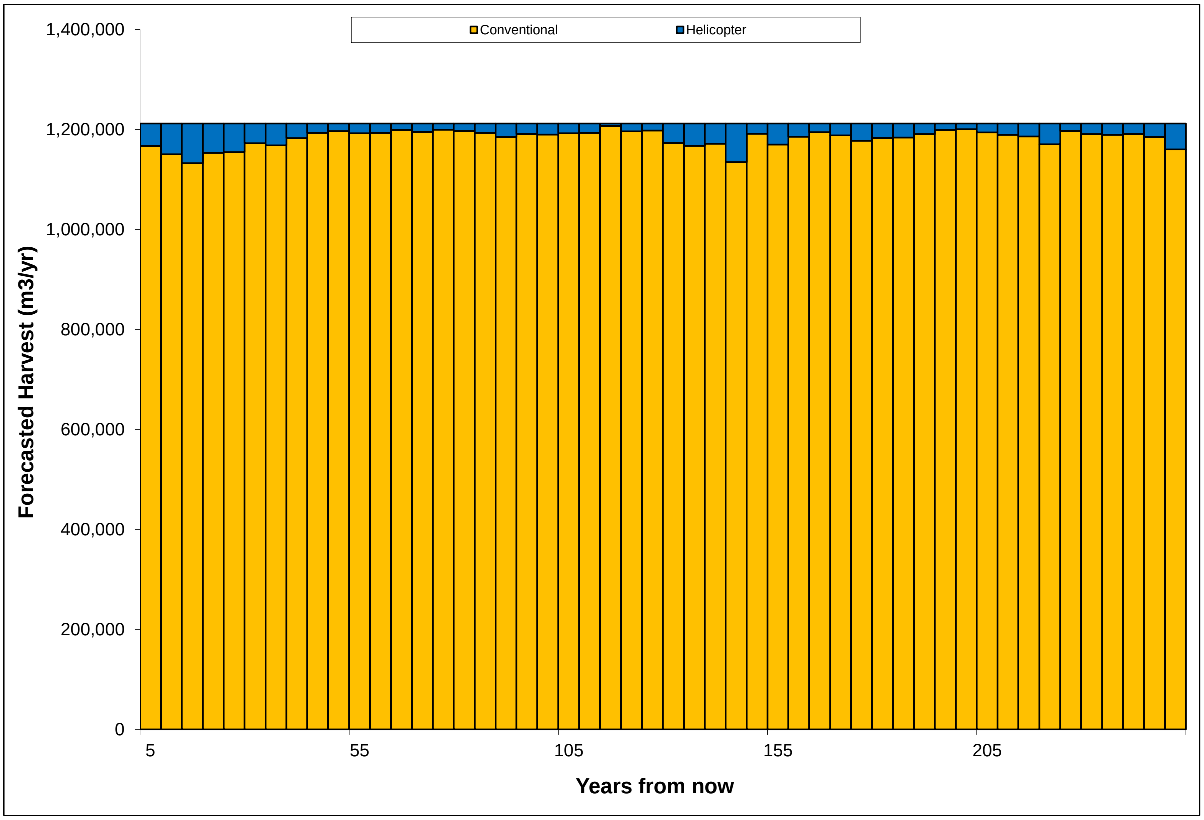

Figure 11: Harvest forecast by harvest method, ISS Base Case

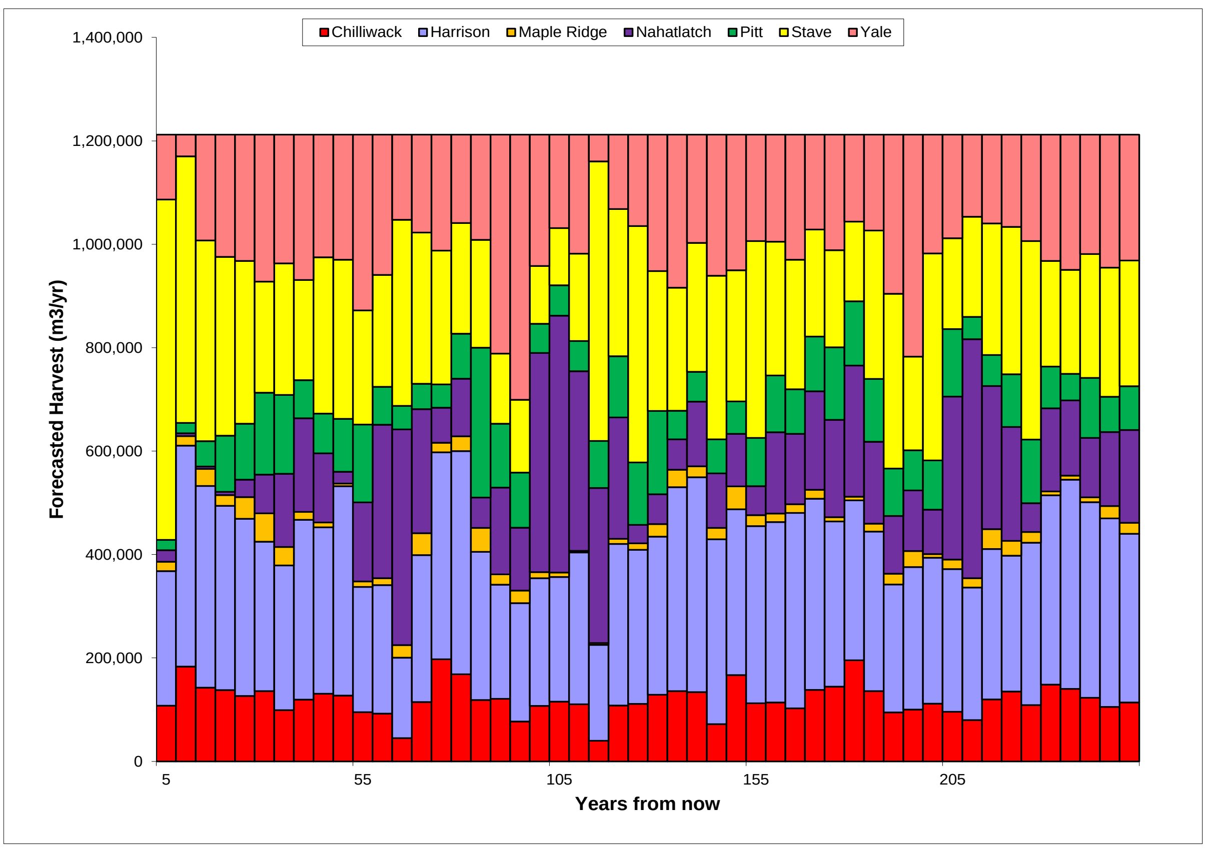

Figure 12: Harvest forecast by timber supply block, ISS Base Case

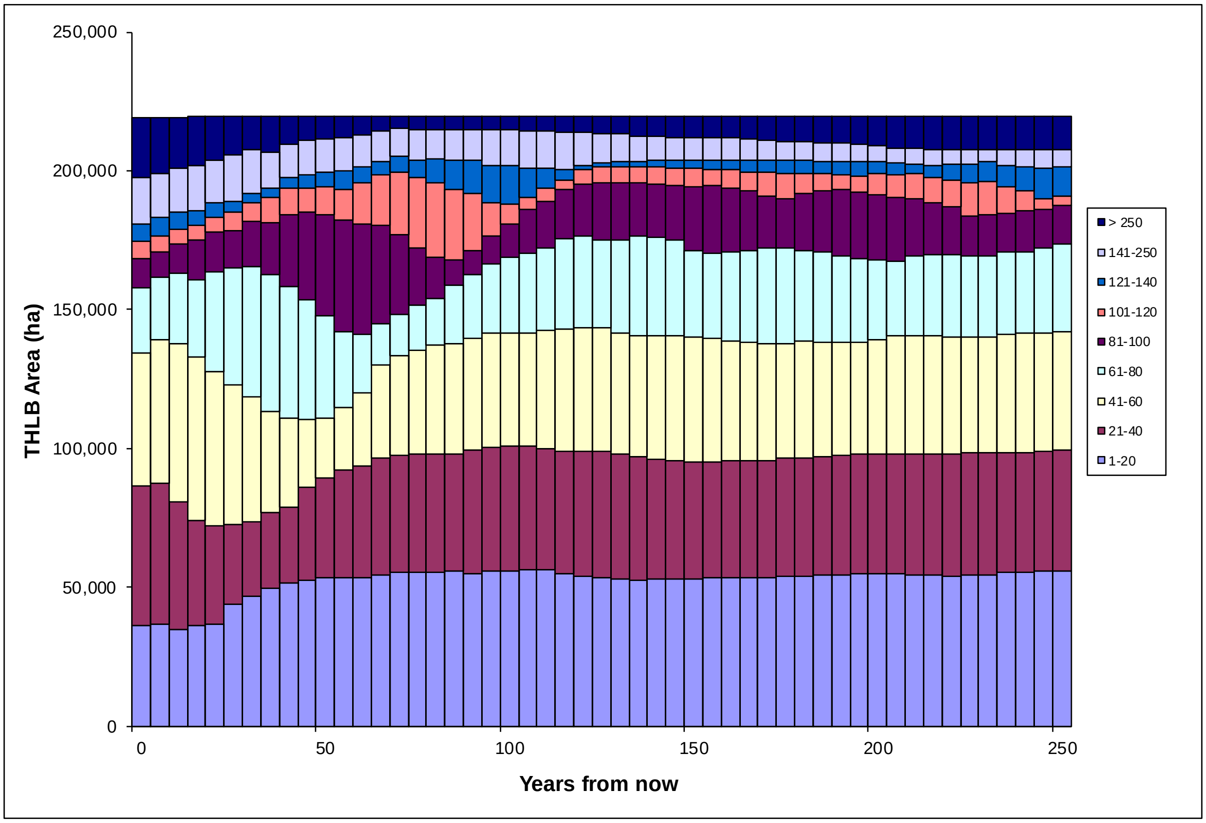

Figure 13: Predicted age class distribution over time on the THLB, ISS Base Case

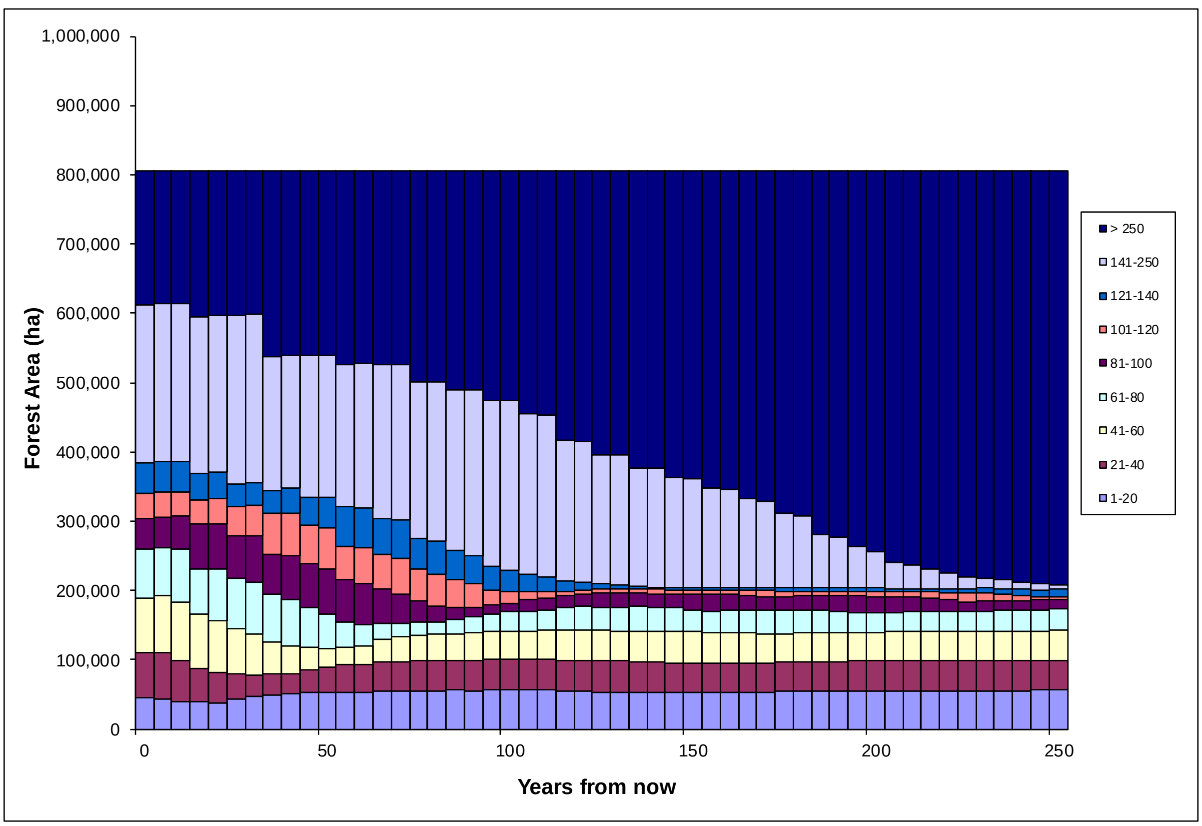

Figure 14: Predicted age class distribution over time on the CFLB, ISS Base Case

4.1.2 Northern Goshawk (NOGO)

The ISS Base Case was set up to report on NOGO forage habitat; 2,500 m buffers (1962.5 ha) were placed around known NOGO nests. The amount of forage habitat is reported for each forage area.

There are only two nests and forage areas within the Fraser TSA shown in Table 4. Only forested area within the TSA boundaries was considered.

Table 4: The portions of NOGO forage areas around known nests that are located within the Fraser TSA

Area Name	Forest Area (ha)
Bear Creek	1,700
Harrison Lake	485

4.1.2.1 Foraging Model

For this analysis it is assumed that all forested areas within the TSA are capable of becoming suitable NOGO foraging habitat. The NOGO foraging model allows for capable stands to become suitable as a function of age, height, BEC and leading species as per the following formula:

HSIf = mean (Ager, Heightr) * ITGr * BECvar

HSIf values greater than 0.5 indicate suitable goshawk habitat. The habitat index (HSIf) value was assigned to each yield curve in 5-year intervals in the analysis data set. Rather than using the ITG, a simpler rating scheme employing leading species was used with some exceptions. In using the leading species the following adjustments were made:

- ITG group value was used for hemlock and balsam stands only (0.95).
- Some of the analysis units are 50/50 cedar and hemlock. In these cases it was assumed that the predominant management of these stands would favor cedar and the forage rating was set accordingly at 0.7.

Figure 15 and Figure 16 illustrate the forecasted NOGO foraging habitat for the Bear Creek and Harrison Lake NOGO forage habitat areas. In both cases, the NHLB provides over 40% of the forage habitat in these units in the medium and long terms.

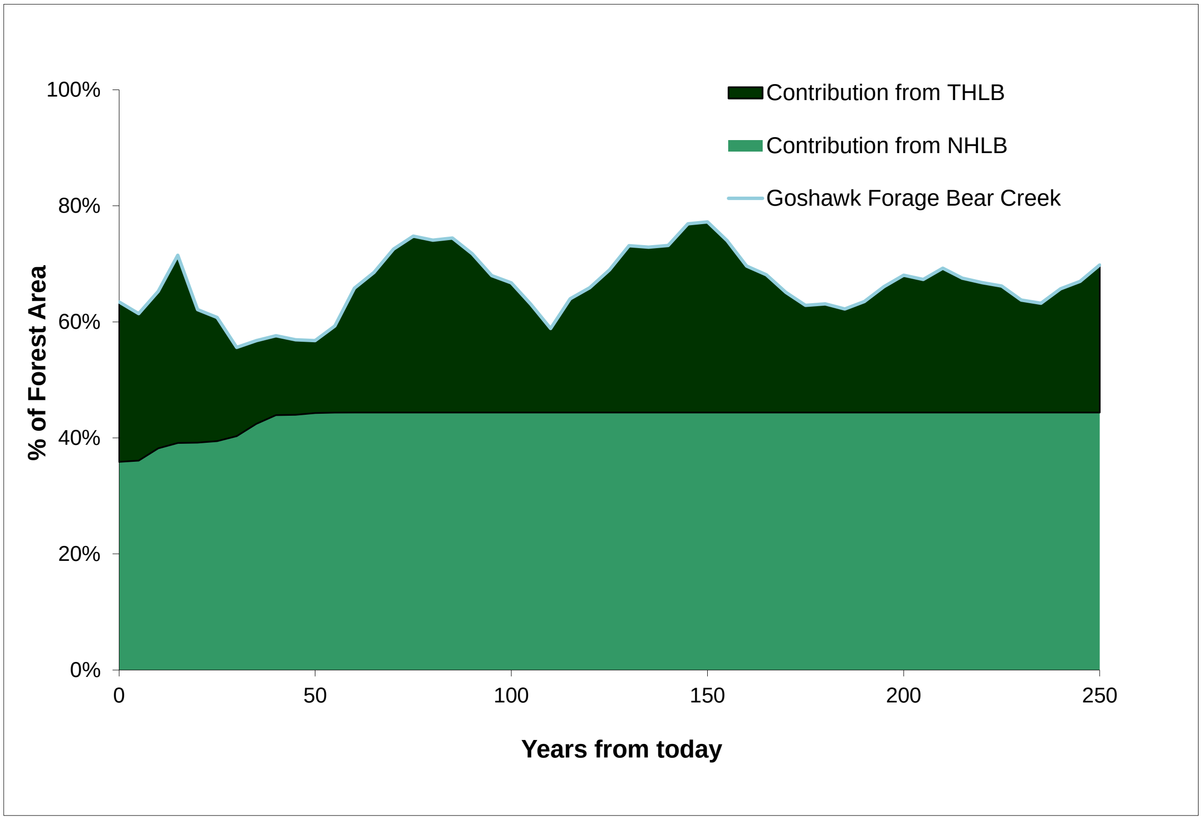

Figure 15: ISS Base Case; NOGO % suitable foraging habitat within the Bear Creek foraging area

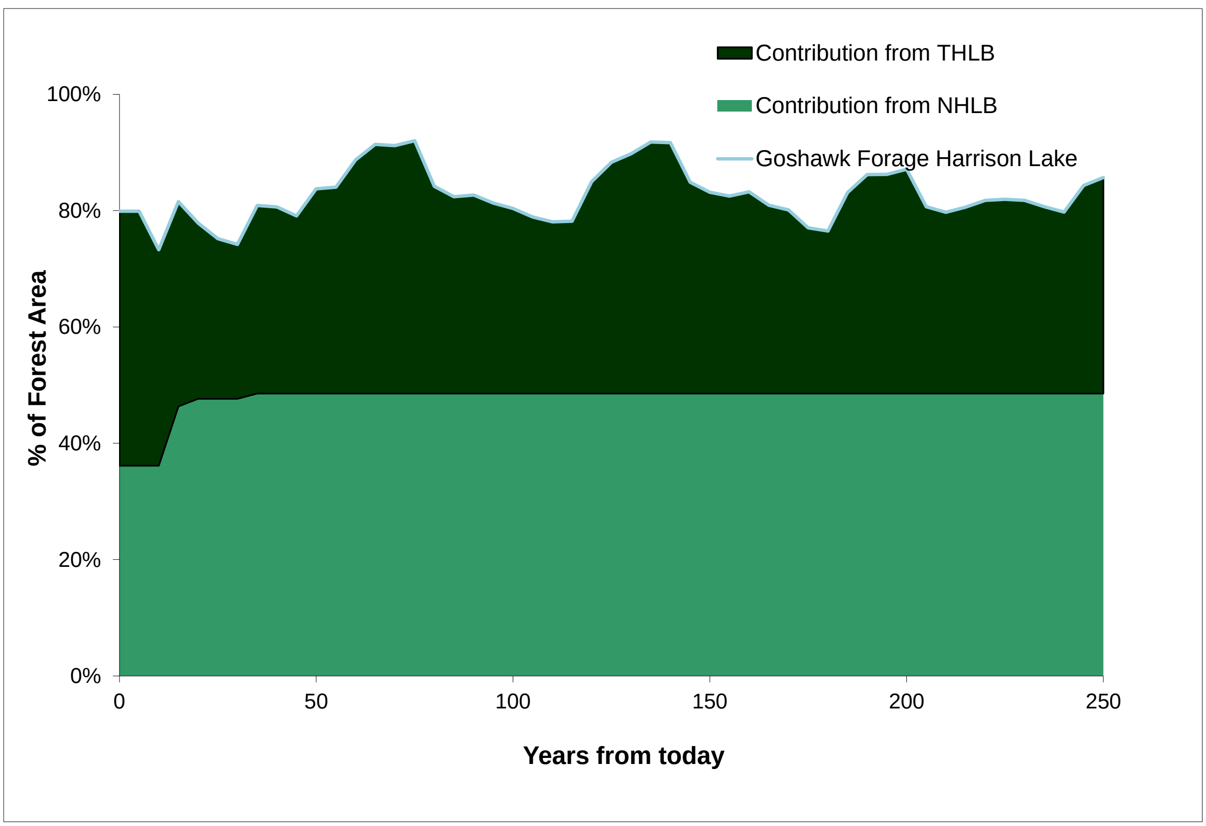

Figure 16: ISS Base Case; NOGO % suitable foraging habitat within the Harrison Lake foraging area

4.1.3 Spotted Owl

The ISS Base Case accounted for the legal spotted owl management requirements; the long-term owl habitat areas (LTOHA) were removed from the THLB and the harvest in managed forest habitat areas (MFHA) was constrained. Nesting and foraging habitat was tracked in each LTOHA and MFHA. Nesting and foraging habitat was also tracked in each landscape unit (LU).

Table 5 shows the predicted spotted owl forage and nesting habitat in each LTOHA within the Fraser TSA. No harvesting can occur in these areas and the area of both forage and nesting habitat is increasing over time. Figure 17 and Figure 18 illustrate the predicted development of habitat for one LTOHA (Spotted Owl LTOH 2-503).

Within the spotted owl MFHA, a minimum of 10% of the area must be retained as wildlife tree retention, with a minimum of 40 large-diameter trees retained per hectare in drier ecosystems, and a minimum of 15 large-diameter trees per hectare in wetter ecosystems. No more than 40% of these retained trees can be in established WTP and other reserves.

In this analysis, the retention in MFHA was simulated by reducing the THLB; however, it was not possible to model the above described partial harvesting adequately. Rather, all harvesting is MFHA areas was assumed to be clearcutting. For this reason, the predicted percent of spotted owl forage and nesting habitat in each MFHA as shown in Table 6 is likely underestimated.

Figure 19 and Figure 20 illustrate the predicted development of habitat for one MFHA (Spotted Owl MFHA 2-504).

Table 5: Forecasted spotted owl habitat in LTOHAs

LTOH ID	Forest Area (ha)	THLB Area (ha)	Habitat Type	Habitat (ha)					
				Now	Year 50	Year 100	Year 150	Year 200	Year 250
Spotted Owl LTOH 2-494	4,158	0	Forage	3,335	3,584	3,764	3,764	3,764	3,764
			Nesting	640	1,661	2,837	3,031	3,053	3,053
Spotted Owl LTOH 2-495	2,819	0	Forage	1,293	2,042	2,482	2,490	2,490	2,490
			Nesting	22	927	1,168	1,896	2,311	2,311
Spotted Owl LTOH 2-496	6,569	0	Forage	4,221	4,916	5,817	5,817	5,817	5,817
			Nesting	1,635	2,634	3,786	4,457	5,003	5,003
Spotted Owl LTOH 2-497	9,53	0	Forage	534	766	921	921	921	921
			Nesting	226	226	670	792	844	844
Spotted Owl LTOH 2-498	6,937	0	Forage	4,970	5,896	6,627	6,627	6,627	6,627
			Nesting	2,492	3,668	4,373	5,166	5,885	5,885
Spotted Owl LTOH 2-501	2,417	0	Forage	1,606	1,723	1,753	1,965	1,965	1,965
			Nesting	508	715	1,432	1,482	1,702	1,702
Spotted Owl LTOH 2-502	19,070	0	Forage	12,979	14,567	17,037	17,037	17,037	17,037
			Nesting	6,221	9,445	12,394	13,849	15,095	15,095
Spotted Owl LTOH 2-503	3,061	0	Forage	1,695	2,329	2,935	2,935	2,935	2,935
			Nesting	768	1,226	1,575	2,199	2,789	2,789
Spotted Owl LTOH 2-505	3,081	0	Forage	2,078	2,496	2,974	2,974	2,974	2,974
			Nesting	1,133	1,677	1,996	2,399	2,873	2,873
Spotted Owl LTOH 2-506	3,343	0	Forage	2,407	2,599	3,042	3,042	3,042	3,042
			Nesting	1,302	1,674	2,120	2,287	2,678	2,678

LTOH ID	Forest Area (ha)	THLB Area (ha)	Habitat Type	Habitat (ha)					
				Now	Year 50	Year 100	Year 150	Year 200	Year 250
Spotted Owl LTOH 2-507	3,022	0	Forage	2,057	2,307	2,833	2,833	2,833	2,833
			Nesting	497	1,154	1,943	2,156	2,593	2,593
Spotted Owl LTOH 2-508	1,656	0	Forage	1,320	1,619	1,619	1,619	1,619	1,619
			Nesting	690	1,083	1,302	1,455	1,455	1,455
Total	**67,912**	**0**	**Forage**	**46,733**	**53,847**	**61,528**	**61,748**	**61,748**	**61,748**
			Nesting	**20,776**	**32,348**	**43,477**	**49,728**	**55,411**	**55,411**

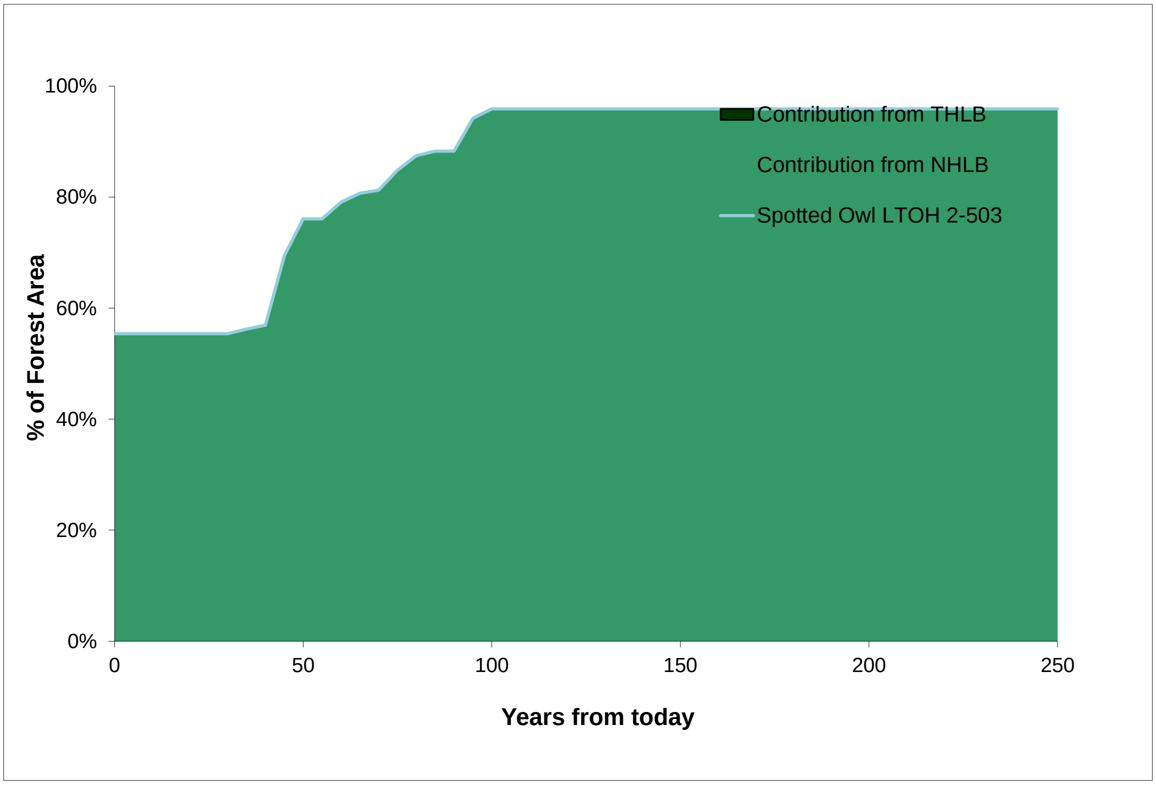

Figure 17: Predicted spotted owl forage habitat in Spotted Owl LTOH 2-503

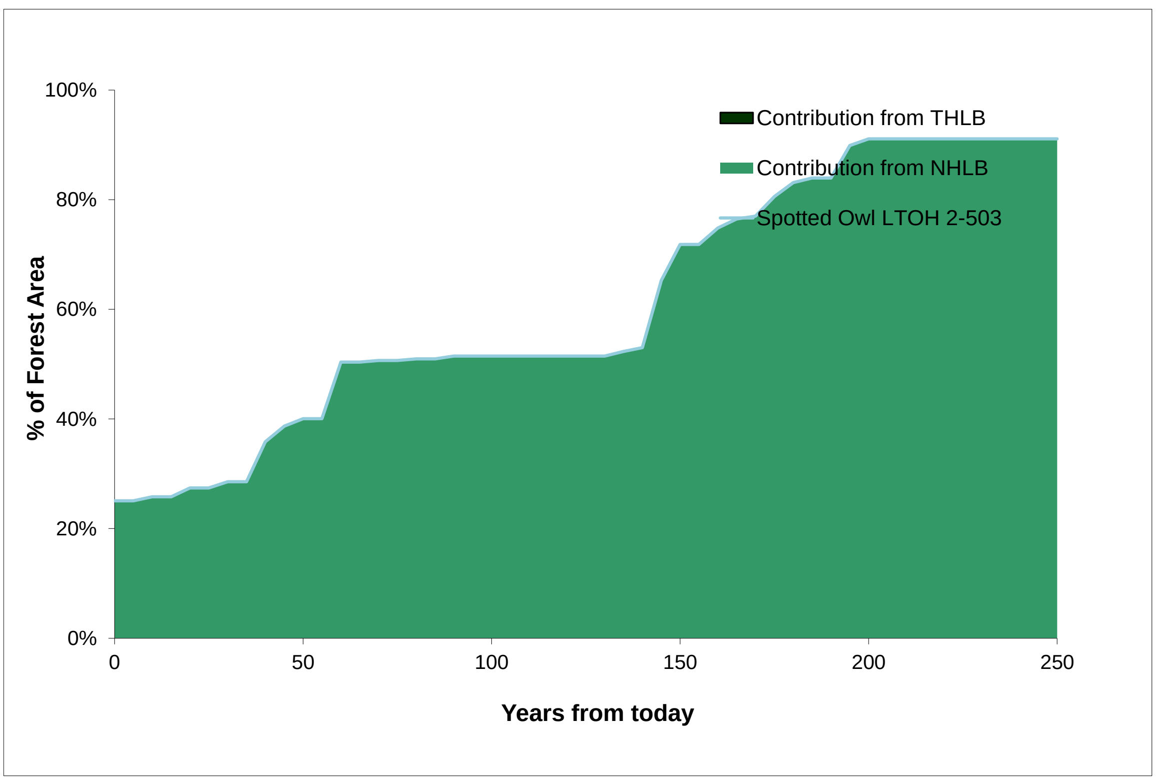

Figure 18: Predicted spotted owl nesting habitat in Spotted Owl LTOH 2-503

Table 6: Forecasted spotted owl habitat in MFHAs

MFHA ID	Forest Area (ha)	THLB Area (ha)	Habitat Type	Habitat (ha)					
				Now	Year 50	Year 100	Year 150	Year 200	Year 250
Spotted Owl MFHA 2-497	502	372	Forage	0	78	54	68	68	68
			Nesting	0	0	0	41	56	56
Spotted Owl MFHA 2-499	2,295	1,063	Forage	224	325	513	523	512	519
			Nesting	186	128	159	445	449	449
Spotted Owl MFHA 2-500	10,031	5,571	Forage	4,258	3,629	4,358	4,504	4,242	4,469
			Nesting	2,728	2,457	2,500	3,064	3,292	3,292
Spotted Owl MFHA 2-503	3,067	1,412	Forage	1,446	1,233	1,577	1,579	1,581	1,603
			Nesting	261	672	1,081	1,175	1,519	1,519
Spotted Owl MFHA 2-504	9,826	3,439	Forage	6,117	6,194	6,179	6,268	6,188	6,222
			Nesting	4,101	3,632	3,767	4,370	4,505	4,505
Total	**25,721**	**11,857**	**Forage**	**12,044**	**11,460**	**12,681**	**12,941**	**12,591**	**12,881**
			Nesting	**7,276**	**6,889**	**7,507**	**9,094**	**9,822**	**9,822**

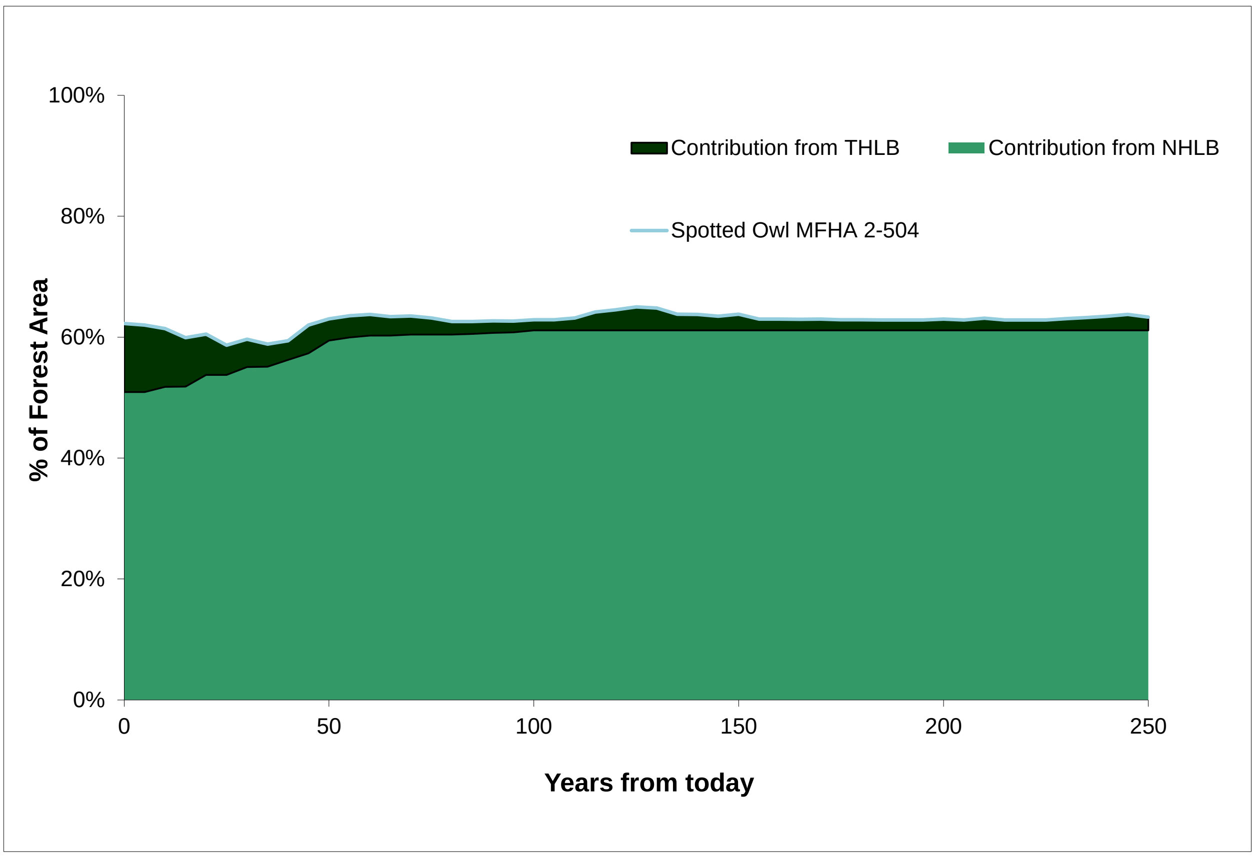

Figure 19: Predicted spotted owl forage habitat in Spotted Owl MFHA 2-504

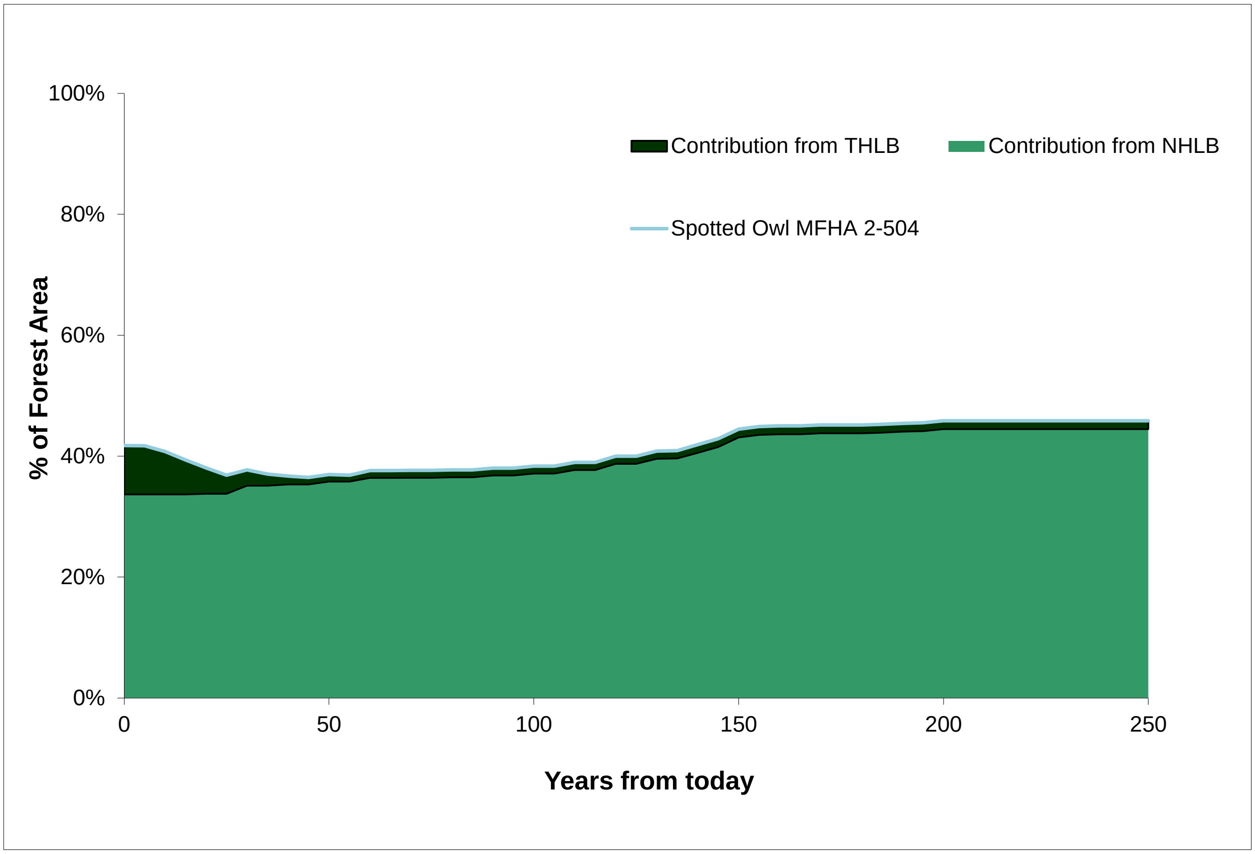

Figure 20: Predicted spotted owl nesting habitat in Spotted Owl MFHA 2-504

Figure 21 illustrates the forecasted spotted owl forage habitat in one LU (Spuzzum), while Figure 22 shows predicted nesting habitat in the same LU. As no targets are imposed on the forage habitat or nesting habitat, most of the habitat is predicted to come from the NHLB. This applies throughout the TSA in most LUs.

As noted above, the spotted owl forage and nesting habitat were tracked in each LU. The summed up habitat of all LUs provides forage and nesting habitat estimates for the entire TSA are shown in Figure 23 and Figure 24.

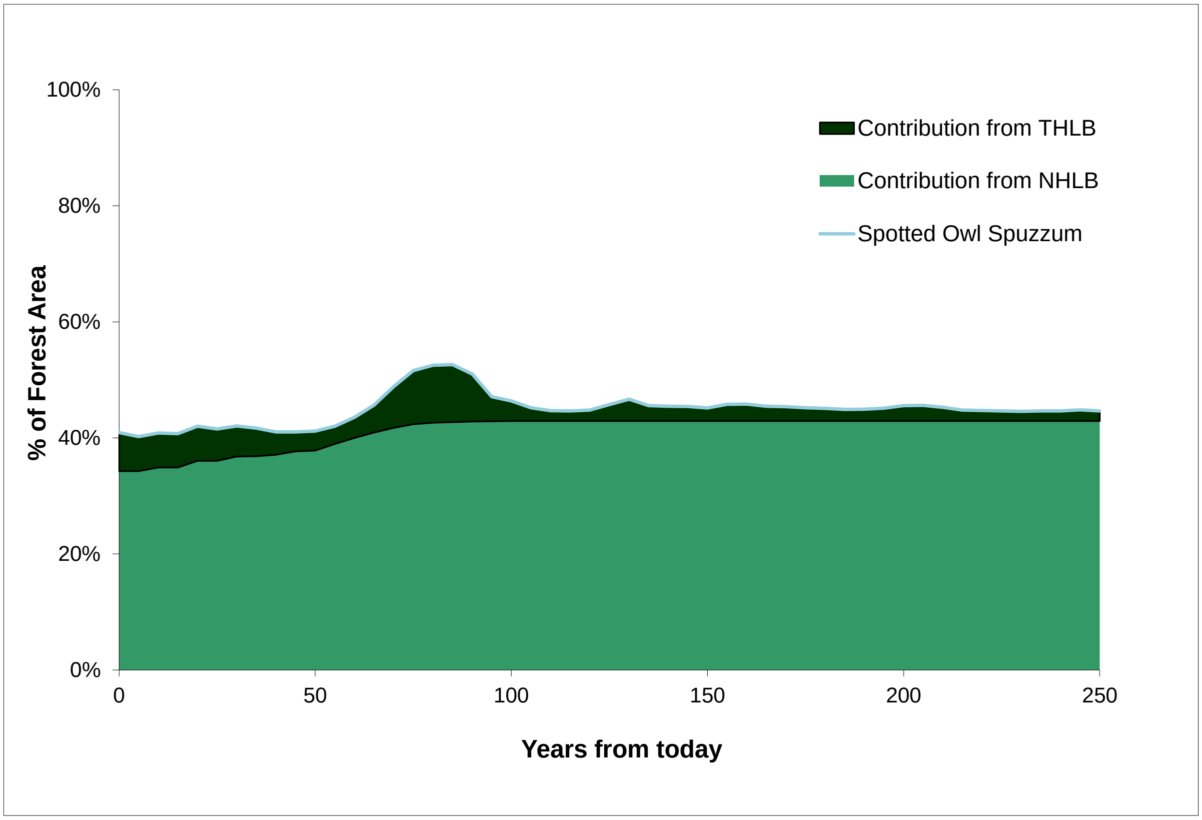

Figure 21: Spotted owl forage habitat in Spuzzum Landscape Unit, ISS Base Case

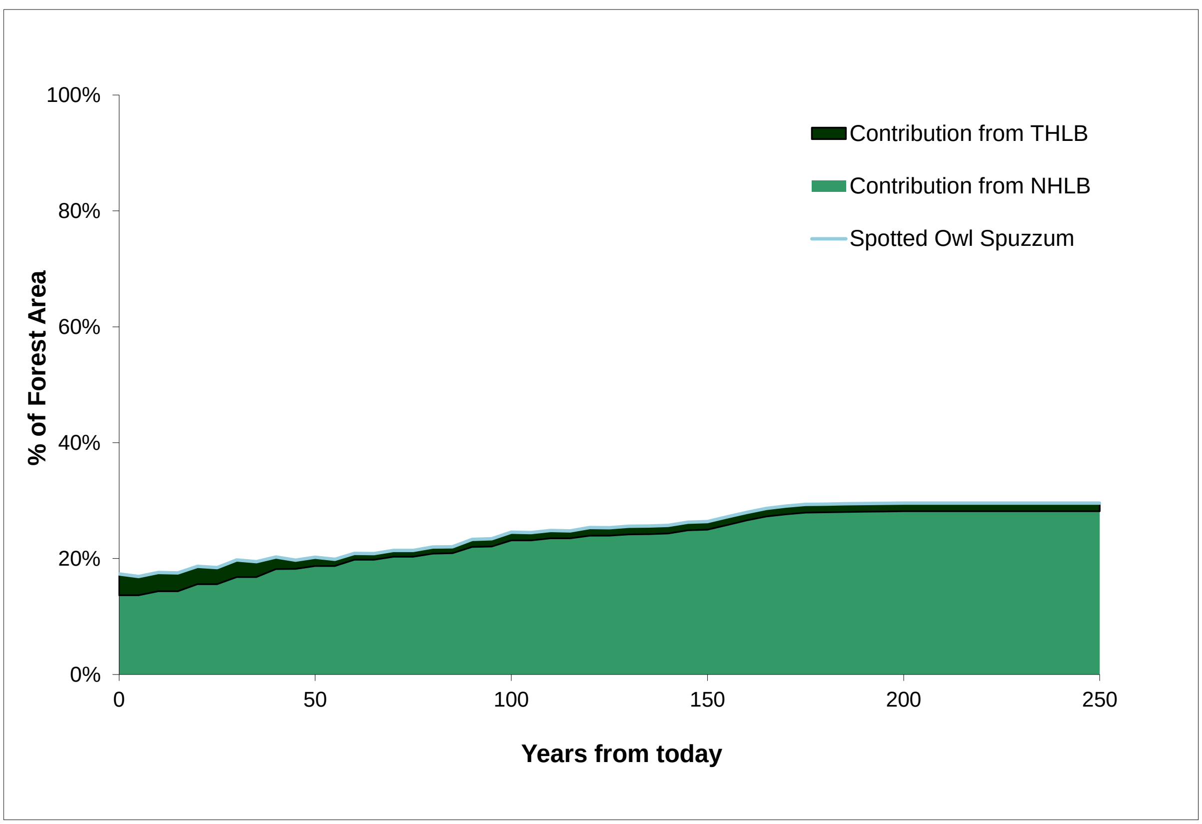

Figure 22: Spotted owl nesting habitat in Spuzzum Landscape Unit, ISS Base Case

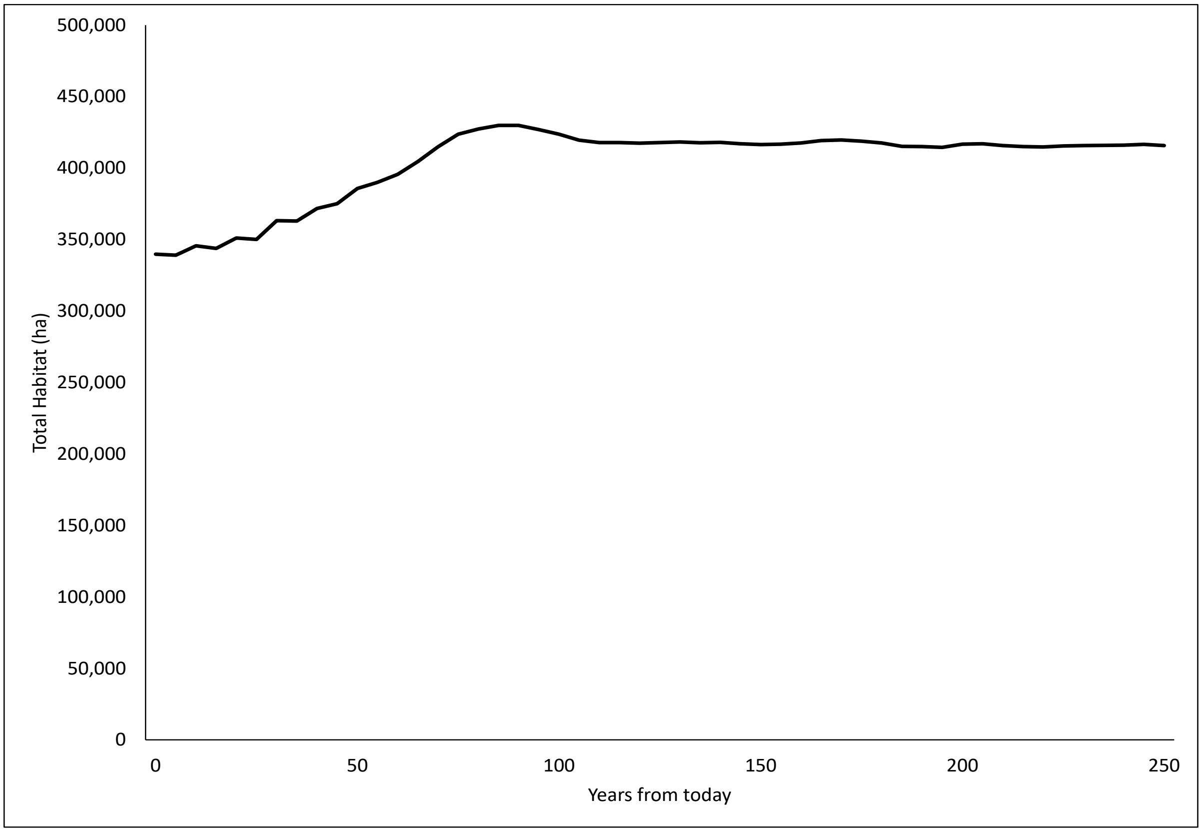

Figure 23: Predicted spotted owl forage habitat for the Fraser TSA

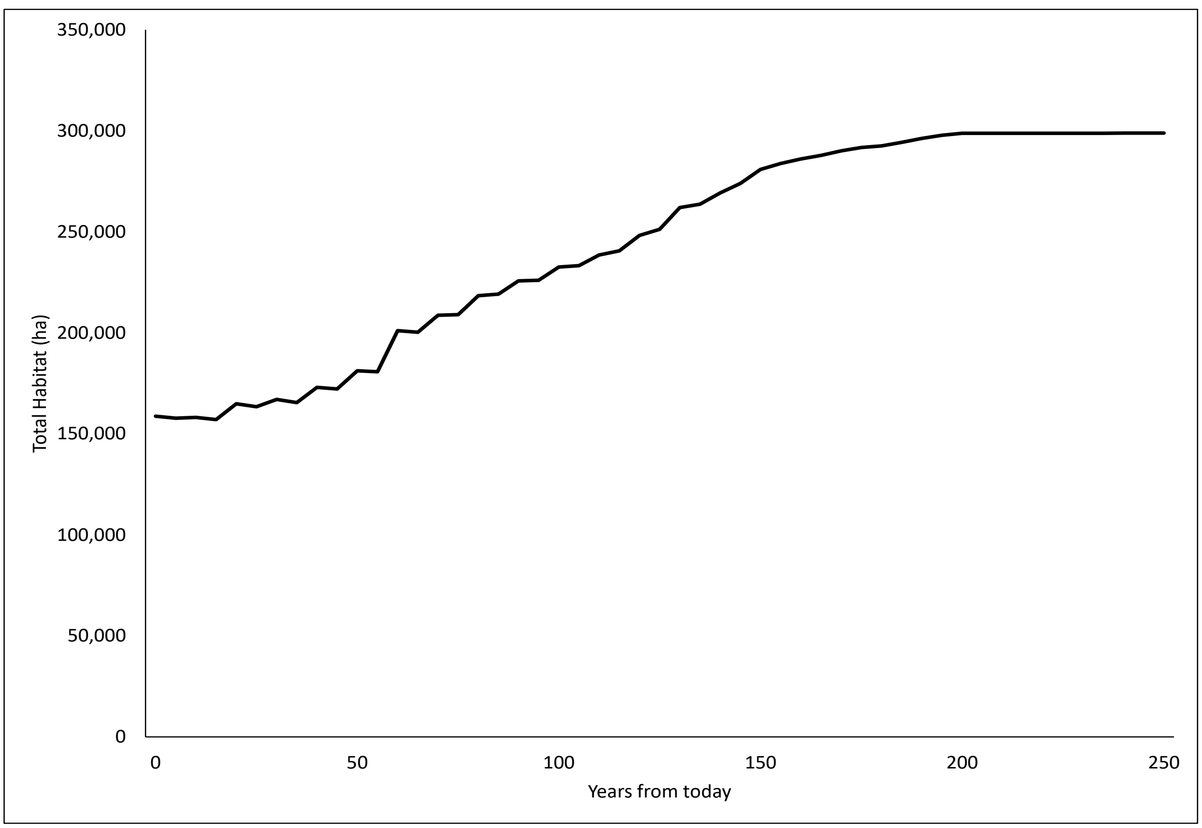

Figure 24: Predicted spotted owl nesting habitat for the Fraser TSA

4.1.4 Marbled Murrelet (MAMU)

The Marbled Murrelet (MAMU) is an important species in the TSA requiring old growth forest stands for its nesting habitat. The ISS Base Case included MAMU habitat as an indicator. A habitat suitability layer was provided for the analysis by the FLNRORD, South Coast Region. Harvesting a suitable area is assumed to convert it into unsuitable habitat with no recruitment of habitat within the planning horizon of the analysis.

The suitable MAMU habitat in the Fraser TSA consists of 21,670 ha forest; only 2,100 ha are classified as THLB. The ISS Base did not set a habitat target, the retention of habitat is reported only.

Over 90% of the MAMU habitat within the suitability layer comes from the NHLB as shown in Figure 25, while the THLB portion of the MAMU habitat is harvested.

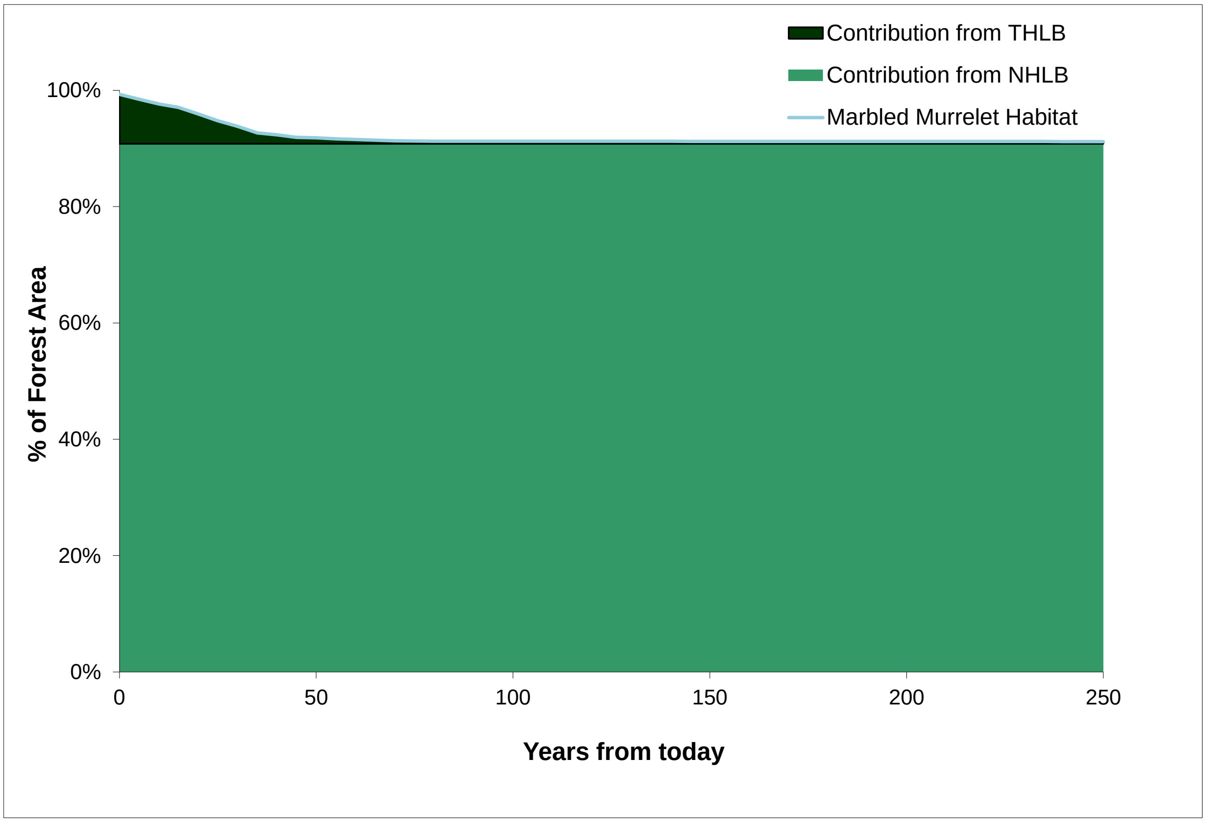

Figure 25: Mamu habitat; ISS Base Case

4.1.5 Late Seral

In the ISS Base Case, the management of old growth is modeled through old growth management areas (OGMA), which are removed from the THLB. Some of the learning scenarios investigate different ways of managing old forests in the TSA. For this reason, late seral stages were also tracked in the ISS Base Case by NDT, LU and BEC variant. This aspatial tracking of late seral provides a means to compare other scenarios in their achievement of old growth to the ISS Base Case.

In most LU/BEC Variant groups throughout the TSA, OGMAs provide sufficient old growth to meet the aspatial requirements of the Order Establishing Provincial Non-Spatial Old Growth Objectives (Old

Growth Order). Figure 26 illustrates an example of an NDT/LU/BEC unit (Coquihalla, CWHm1), where the old growth targets are met from the NHLB throughout the planning horizon. This is typical for many TSA NDT/LU/BEC units.

In some units, an old growth deficit exists, and recruitment of old growth happens over time as the forest ages within the NHLB, as shown in Figure 27.

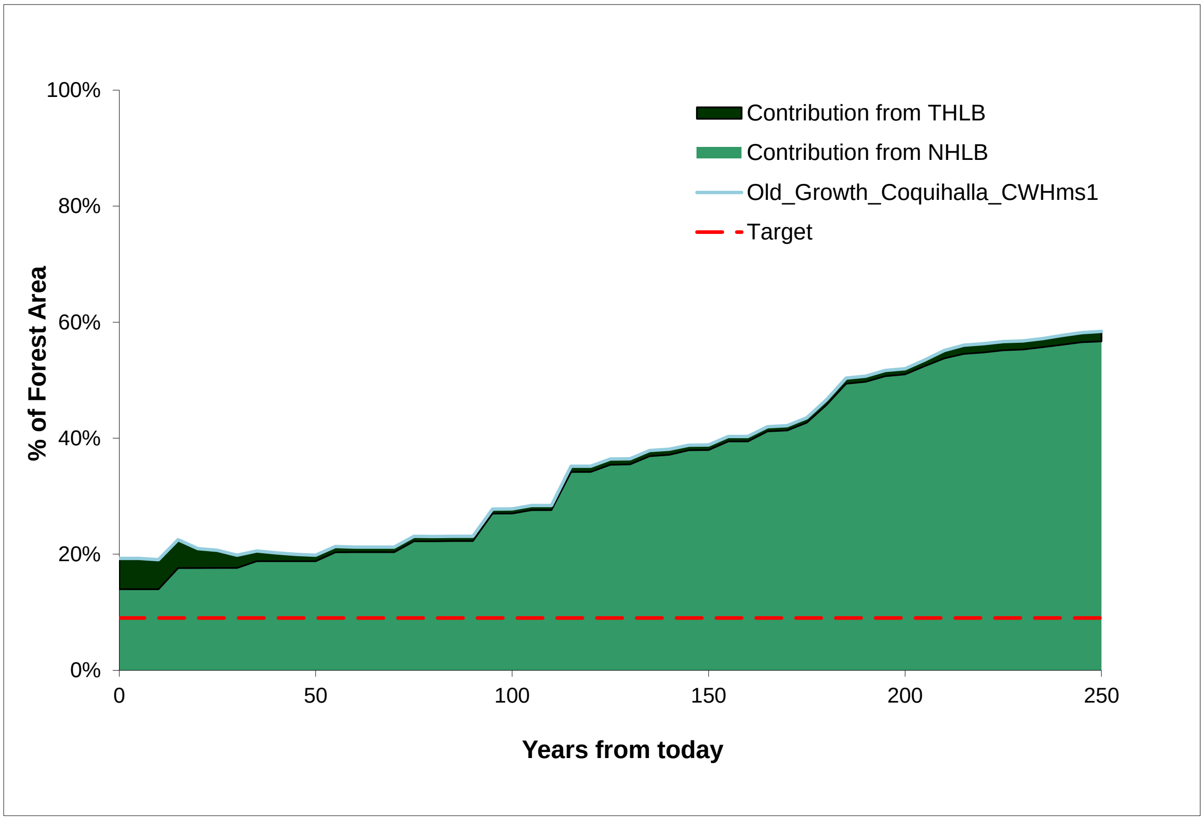

Figure 26: Old growth in Coquihalla/CWHms1 when tracked aspatially

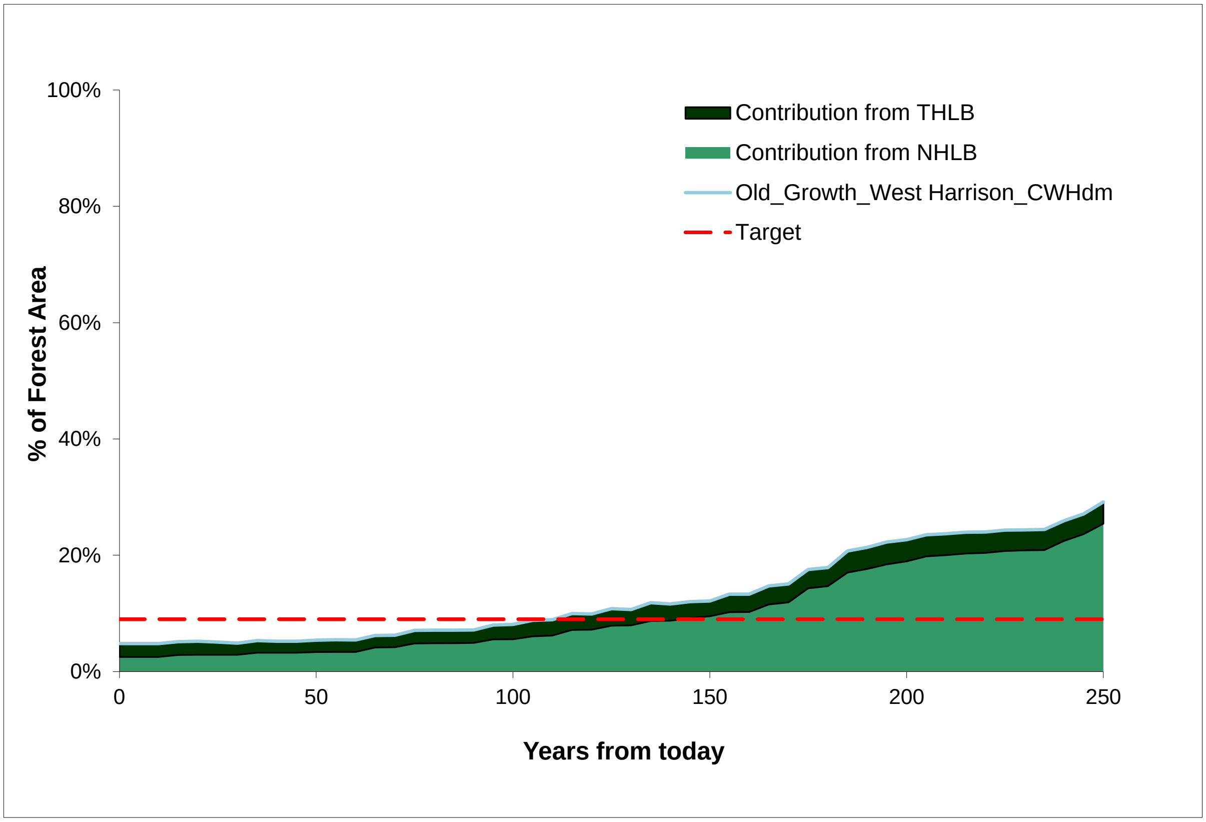

Figure 27: Old growth in West Harrison/CWHdm when tracked aspatially

4.2 Sensitivity Analyses

Three sensitivity analyses were completed:

1. Douglas-fir stands currently younger than 115 years were given high harvest priority: the harvest limits for old stands and HemBal volume were maintained as in the ISS Base Case. The THLB was unchanged from the ISS Base Case.
2. The harvest limit for old stands was maintained as an absolute number, HemBal volume limit was removed. The THLB was unchanged from the ISS Base Case.
3. The low productivity HemBal stands removed in the ISS Base Case were added back into the THLB. The harvest limits for old stands and HemBal stands were maintained as in the ISS Base Case.

4.2.1 Harvest Priority on Young Douglas-fir

This sensitivity analysis tested the impact of prioritizing the harvest of Douglas-fir stands that are currently younger than 115 years old. All the other analysis parameters were kept the same as in the ISS Base Case.

Prioritizing the harvest of Douglas-fir stands reduced the harvest forecast for the first 40 years as shown in Figure 28. The long-term harvest level was not impacted.

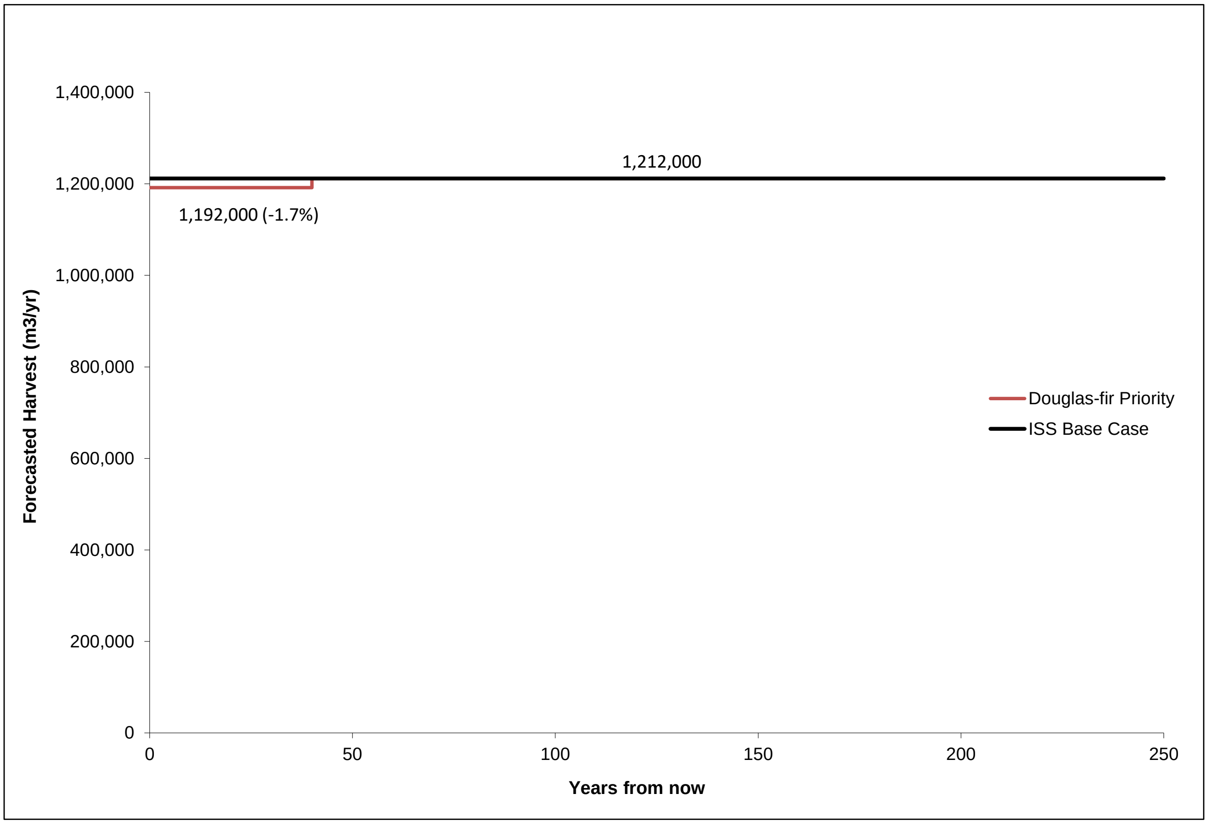

Figure 28: Harvest forecast: prioritize the harvest of young Douglas-fir

4.2.2 Maintain harvest limit for old stands and remove HemBal volume limit

This sensitivity analysis tested the impact of not controlling the harvest of HemBal. The harvest limit for old stands was unchanged from the ISS Base Case (m^3 per year limit). The THLB in this sensitivity analysis was the same as in the ISS Base Case.

If the harvest of HemBal is not controlled in the model, substantially more harvest can be achieved in the first 30 years of the planning horizon (Figure 29).

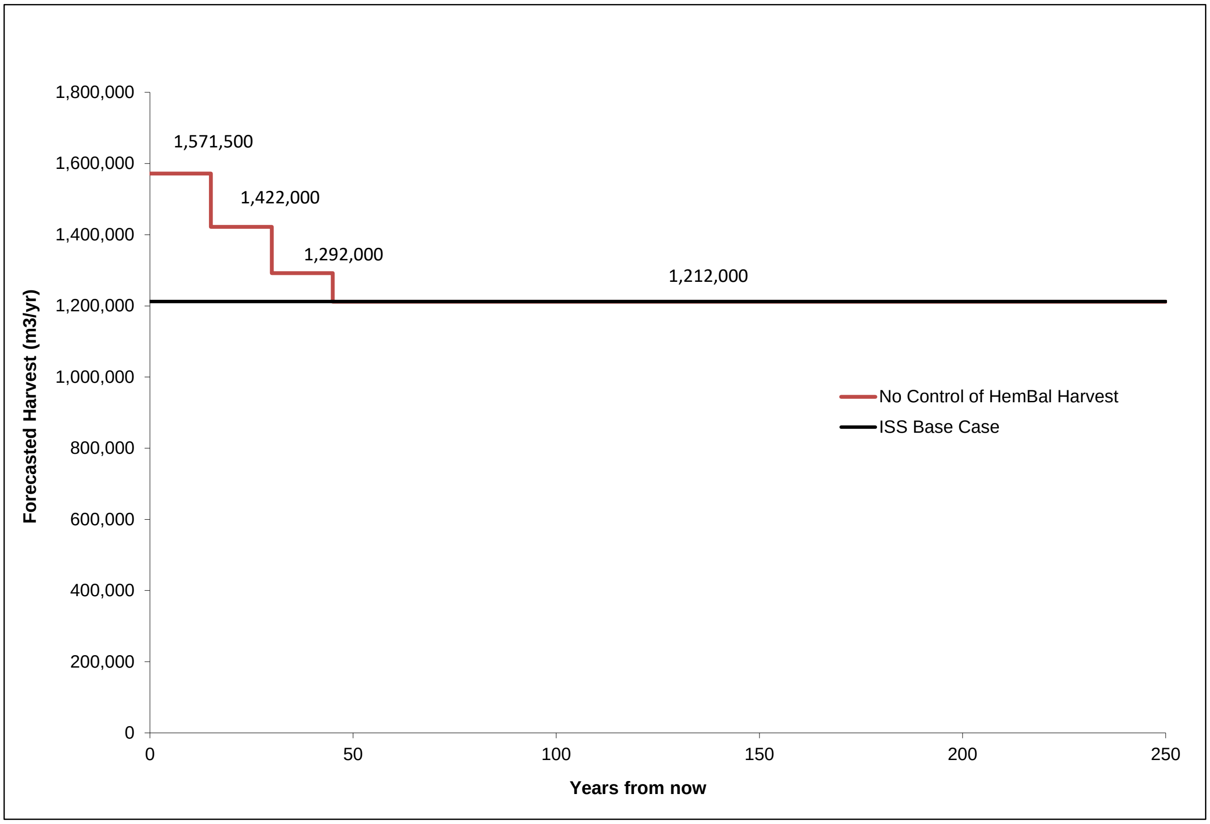

Figure 29: Harvest forecast; remove HemBal volume limit

4.2.3 Include the Previously Removed Low Productivity HemBal Stands in the THLB

Including the low productivity HemBal stands in the THLB increased the THLB by approximately 4.5%. However, the timber supply forecast increased only by a modest 1.2% over the entire planning horizon (Figure 30). The limits placed on the harvest of old stands and particularly HemBal stands constrained the timber supply and limited further increases in the harvest forecast.

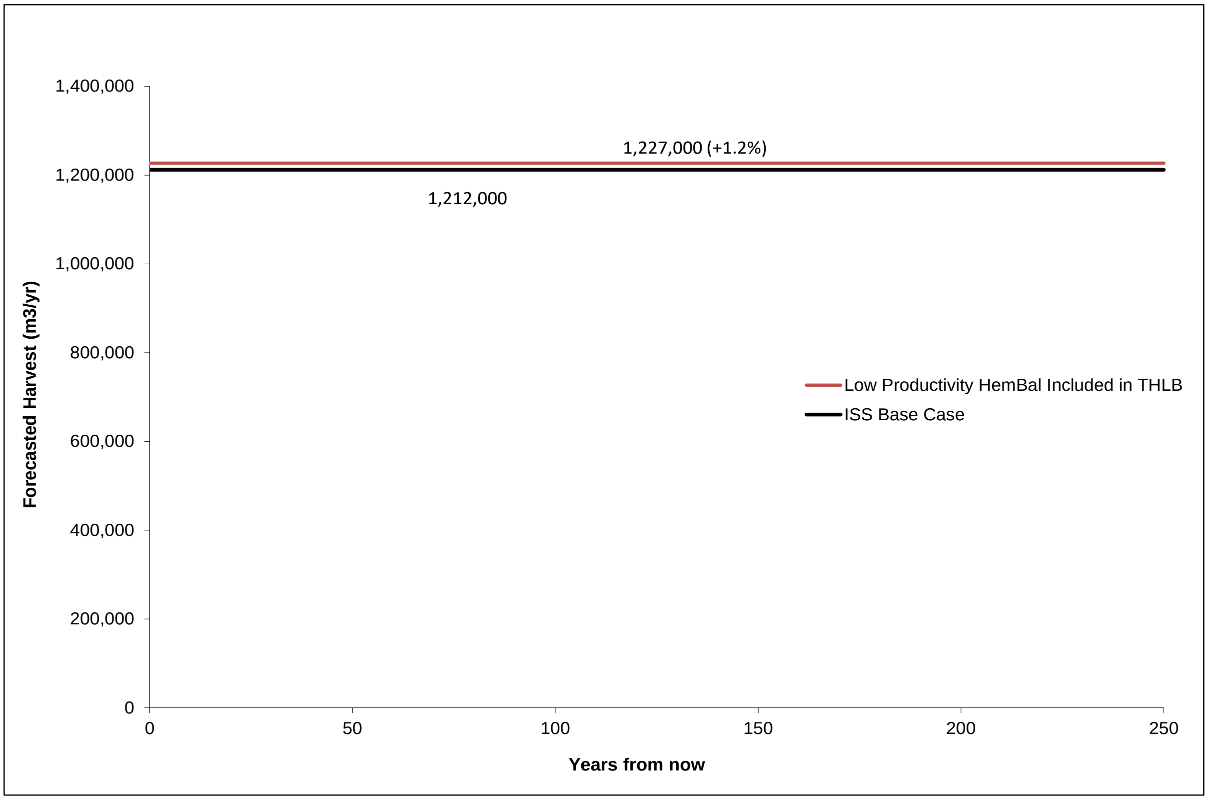

Figure 30: Low productivity HemBal included in the THLB; old harvest and HemBal harvest limited as in the ISS Base Case (max m^3 per year)

4.3 Learning Scenarios

The following strategies were explored in this analysis:

1. Remove OGMAs and use the Stó:lō Plan and other spatial reserves (spotted owl WHAs and UWR) as the vehicles for managing old growth. Monitor the achievement of old growth as per the Non-Spatial Old Growth Order.
2. Incorporate the Impact of Swiss Needle Cast, Elk management and root rot;
3. Silviculture Scenarios; attempt to increase the quantity and improve the quality of timber supply through silviculture.

4.3.1 Remove OGMAs and use the S'ólh Téméxw Use Plan and other NHLB areas as vehicles for managing old growth

This scenario removed all OGMAs and reclassified the land base within them as THLB, where appropriate. The THLB in this scenario was 230,128ha, 5 % larger than in the ISS Base Case of 219,490 ha.

The intent of this scenario was to investigate whether the Stó:lō Plan and other existing constraints in the land base provide adequate retention for old growth. The achievement of old growth was tracked by landscape unit (LU) and BEC as per the Old Growth Order; however, the old growth targets were not enforced. The harvest limits for old stands and HemBal volume were maintained as in the ISS Base Case.

Removing OGMAs as reserves and including them in the THLB increased the THLB by 10,638 ha (4.8%) and the timber supply by 3.3% throughout the planning horizon (Figure 31).

The achievement of old growth, however, was not impacted significantly. Most LU/BEC areas in the TSA contain large areas of other reserves, which allow for the old growth targets to be met without OGMAs (Figure 32 and Figure 33). Figure 34 compares the total reserved old growth area over time in the TSA between the ISS Base Case (OGMAs) and this scenario, where OGMAs were included in the THLB. The total area reserved for old growth is only marginally larger in the ISS Base Case; approximately 1.5% over time.

MAMU habitat, spotted owl habitat or NOGO forage habitat was either not impacted, or the impact was negligible.

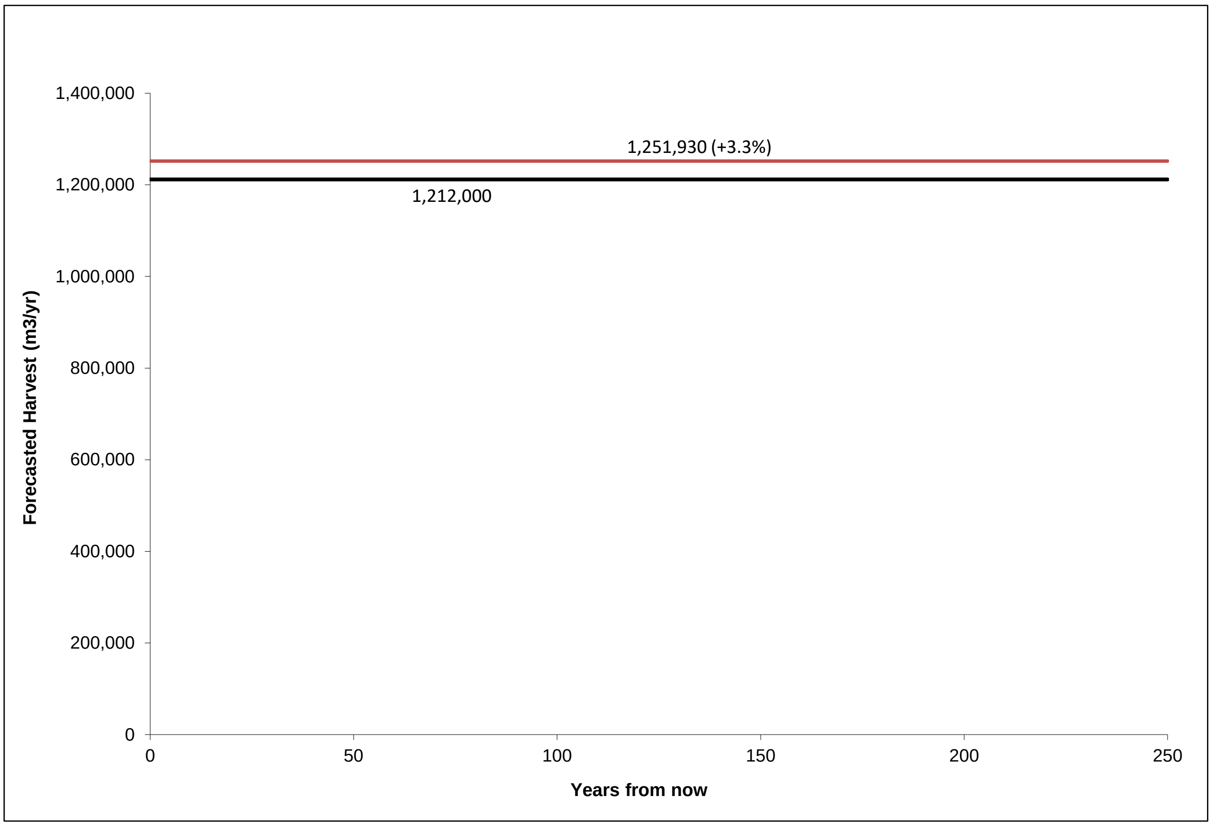

Figure 31: Harvest forecast, remove OGMAs scenario

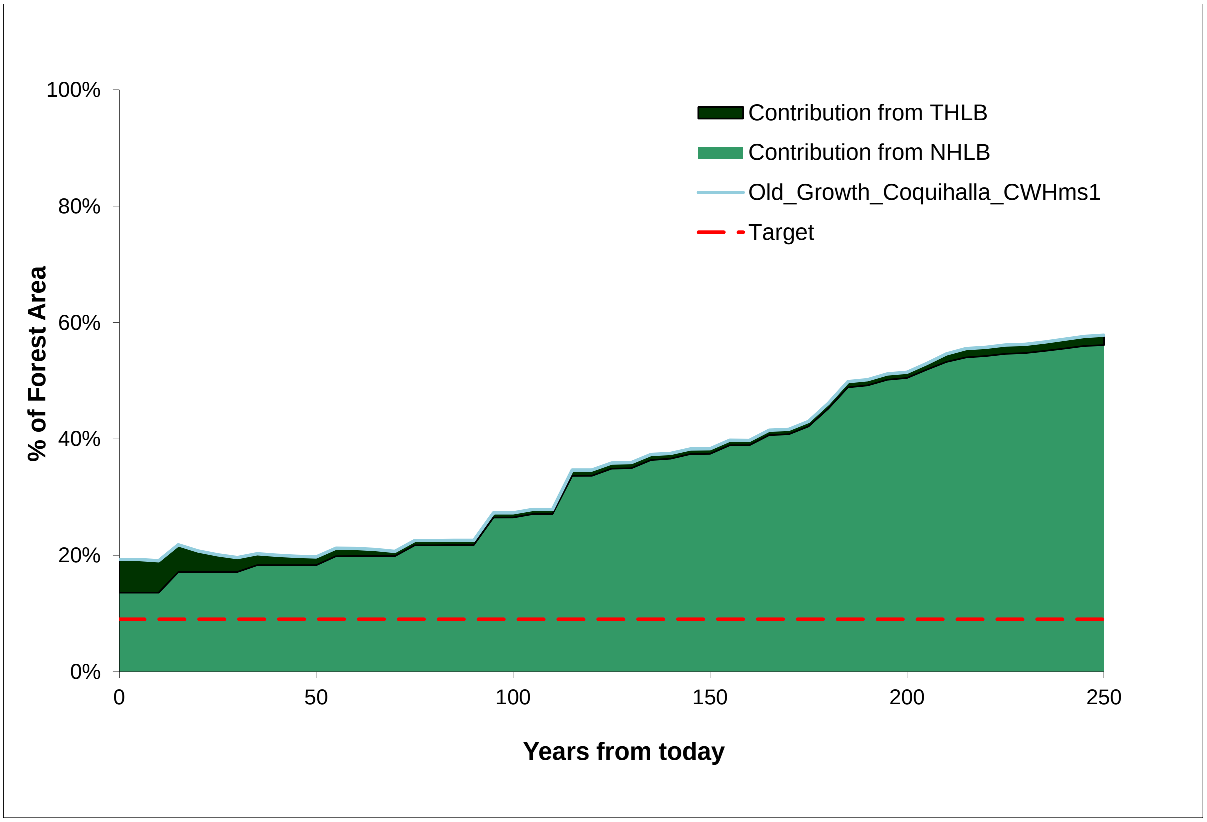

Figure 32: Old growth in Coquihalla/CWHms1 when tracked aspatially; no OGMAs

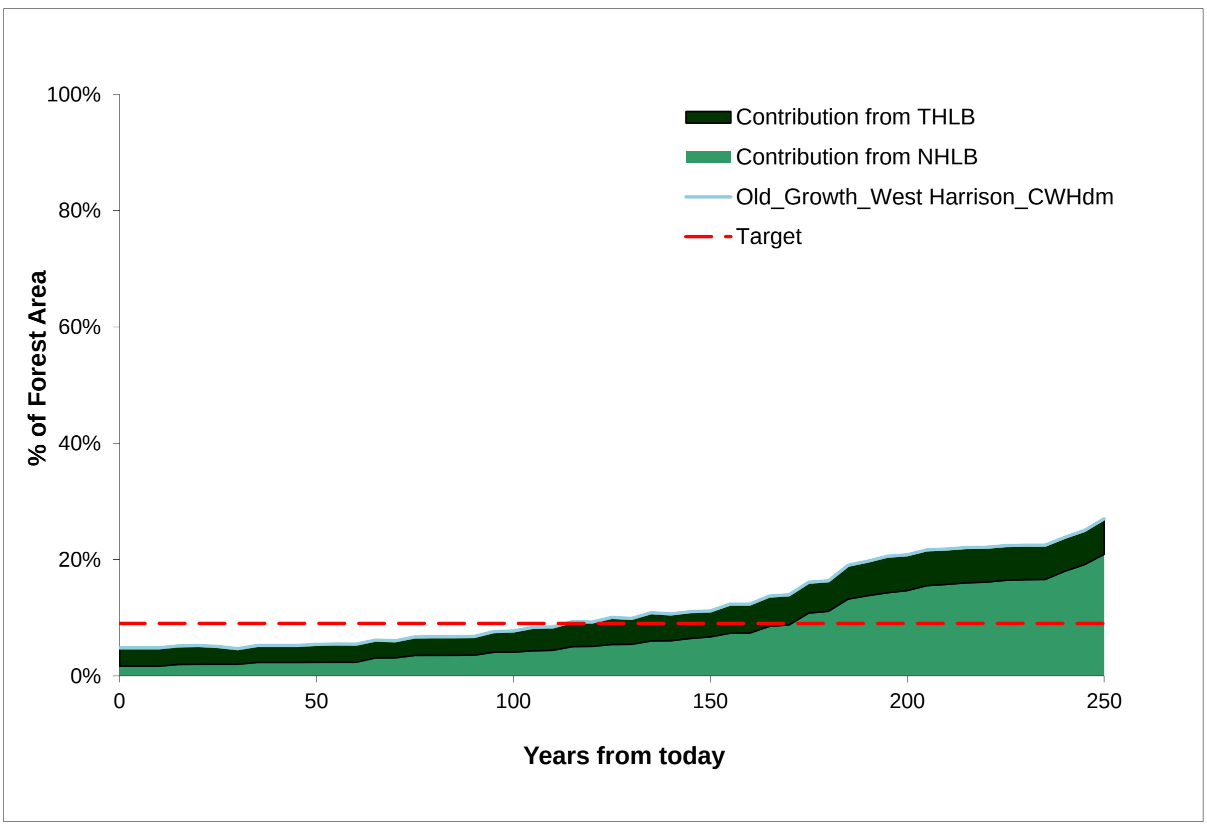

Figure 33: Old growth in West Harrison/CWHdm when tracked aspatially; no OGMAs

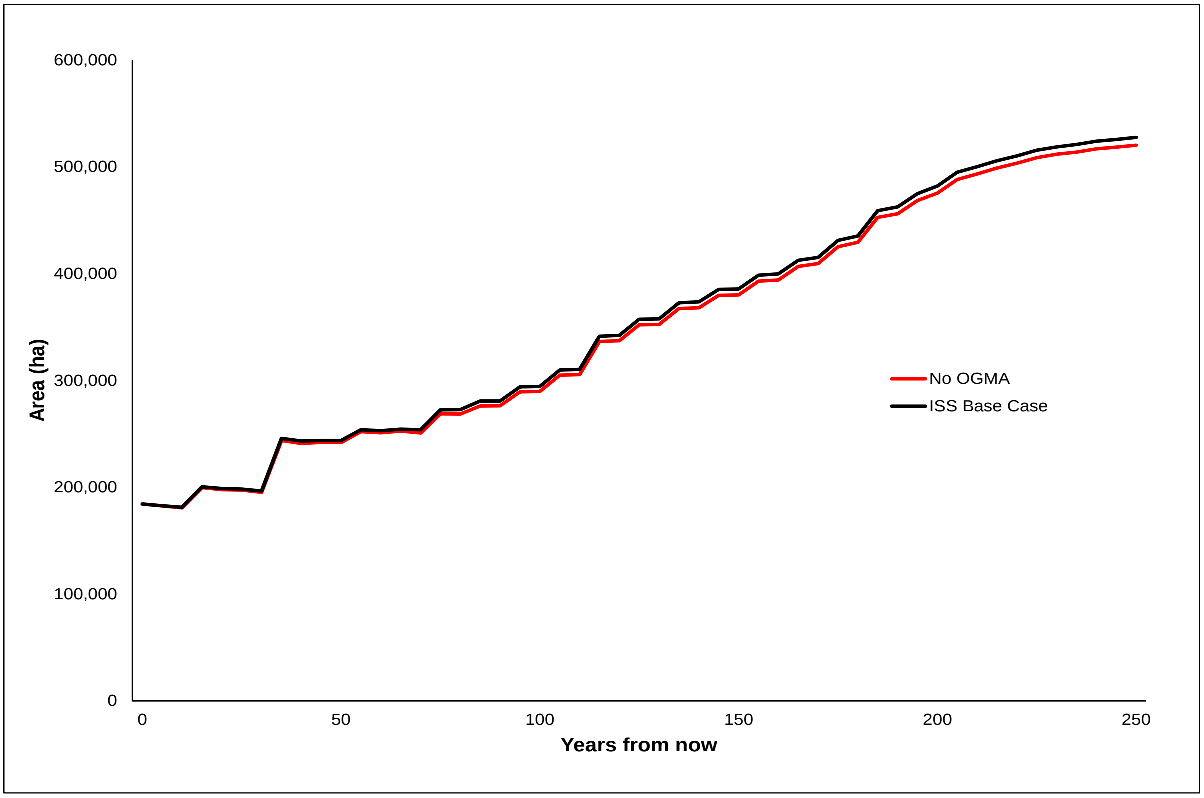

Figure 34: Total old growth area reserved in the Fraser TSA; ISS Base Case vs. no OGMAs

The analysis further revealed that:

- Late seral targets for all NDT/LU/BEC combinations can be met entirely from the NHLB over time without OGMAs;
- Removing OGMAs increases the THLB by 10,638 ha; however, the achievement of old growth targets from the NHLB is delayed in some NDT/LU/BEC combinations. Table 7 shows a comparison of the area deficit in meeting old growth targets from the NHLB between the ISS Base Case and the No OGMA scenario. The total target for old growth retention in the TSA is 91,827 ha.
- The largest deficits in meeting old growth area targets occur in CWHdm and IDFww variants, 34% and 30% respectively.

Table 7: Old growth retention deficit for the Fraser TSA; ISS Base Case vs. No OGMA Scenario

Scenario	Old Growth Deficit from the NHLB (Area, ha)					
	Now	Year 50	Year 100	Year 150	Year 200	Year 250
ISS Base Case	-12,315	-6,259	-3,219	-588	-1	0
No OGMA Scenario	-14,765	-7,814	-4,826	-1,701	-7	0

The analysis also revealed that in many NDT/LU/BEC combinations, the old seral requirements from the NHLB were projected to be met at the same time in both the ISS Base Case and the No OGMA Scenario.

Removing OGMAs in these NDT/LU/BEC combinations would not impact the schedule of meeting the old growth requirements; however, the THLB would increase by 5,363 ha.

4.3.2 Swiss Needle Cast, Root Rot and Elk Impacts

A silviculture/timber working group (WG) was formed at the beginning of this project to help develop managed stand yield curves for the ISS Base Case. The ISS Base case inputs were finalized, and the yield curves developed in early 2018.

In the summer of 2018, the WG had meetings and field tours and became concerned about Swiss Needle Cast (SNC), root rot (RR) and elk impacts on some growing sites. As a result, these forest health agents were incorporated in the analysis as a scenario. ***This scenario was adopted as the new reference forecast for silviculture scenario comparisons after consultation with the Fraser TSA ISS implementation group. In this report the forest health scenario is referred to as "Incorporate Forest Health and Elk" or "Base Case (forest health incorporated)".***

The detailed assumptions regarding Swiss Needle Cast, root rot and elk are provided in Fraser TSA ISS Data Package (FESL, 2020).

Figure 35 shows the results of incorporating Swiss Needle Cast, root rot and elk impacts compared to the ISS Base Case. The harvest forecast is reduced by 3.3% for the first 70 years of the planning horizon and 9.5% in the long term.

Based on the planting regimes used in the ISS Base Case, the share of Fd harvest of the total harvest is expected to increase. It does not, due to the assumptions regarding Swiss Needle Cast, elk management and root rot (Figure 36 and Figure 37).

Figure 38 and Figure 39 provide the harvest forecast by age class and volume per ha class for this scenario.

MAMU habitat, spotted owl habitat or NOGO forage habitat was either not impacted, or the impact was negligible.

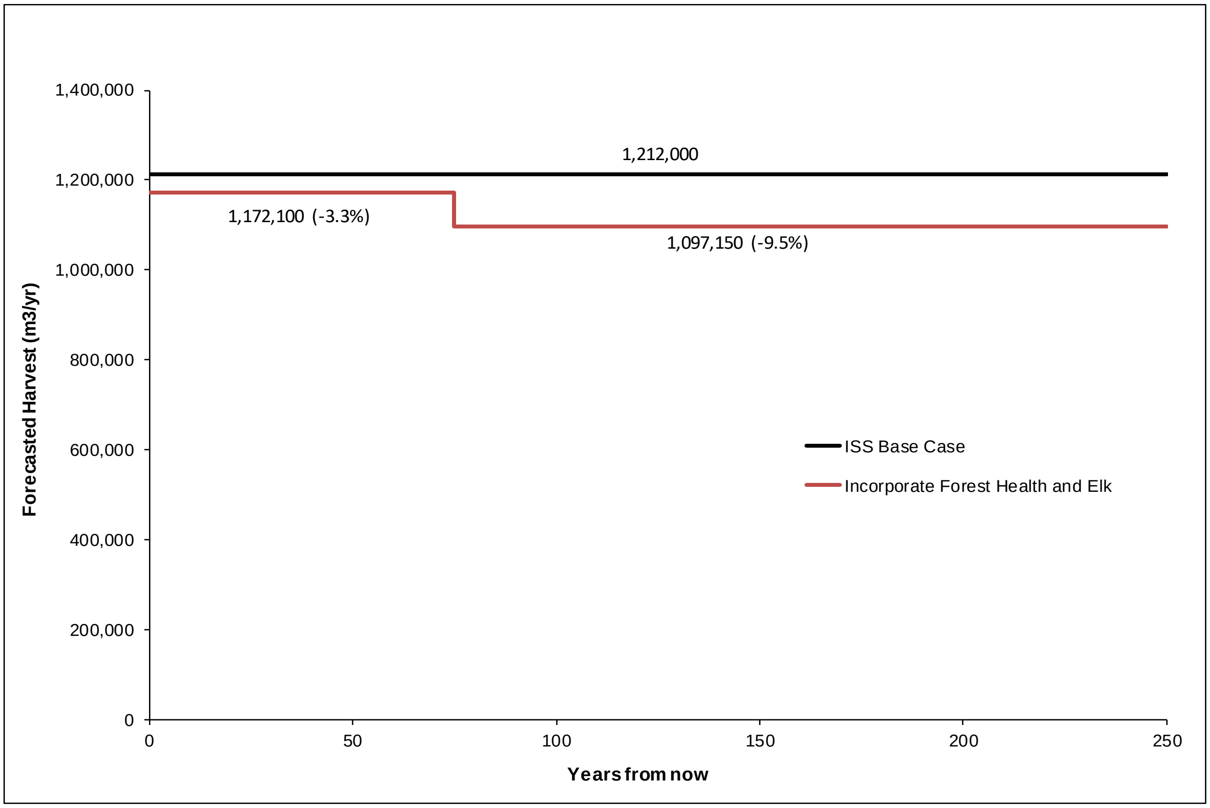

Figure 35: Harvest forecast; incorporate forest health and elk

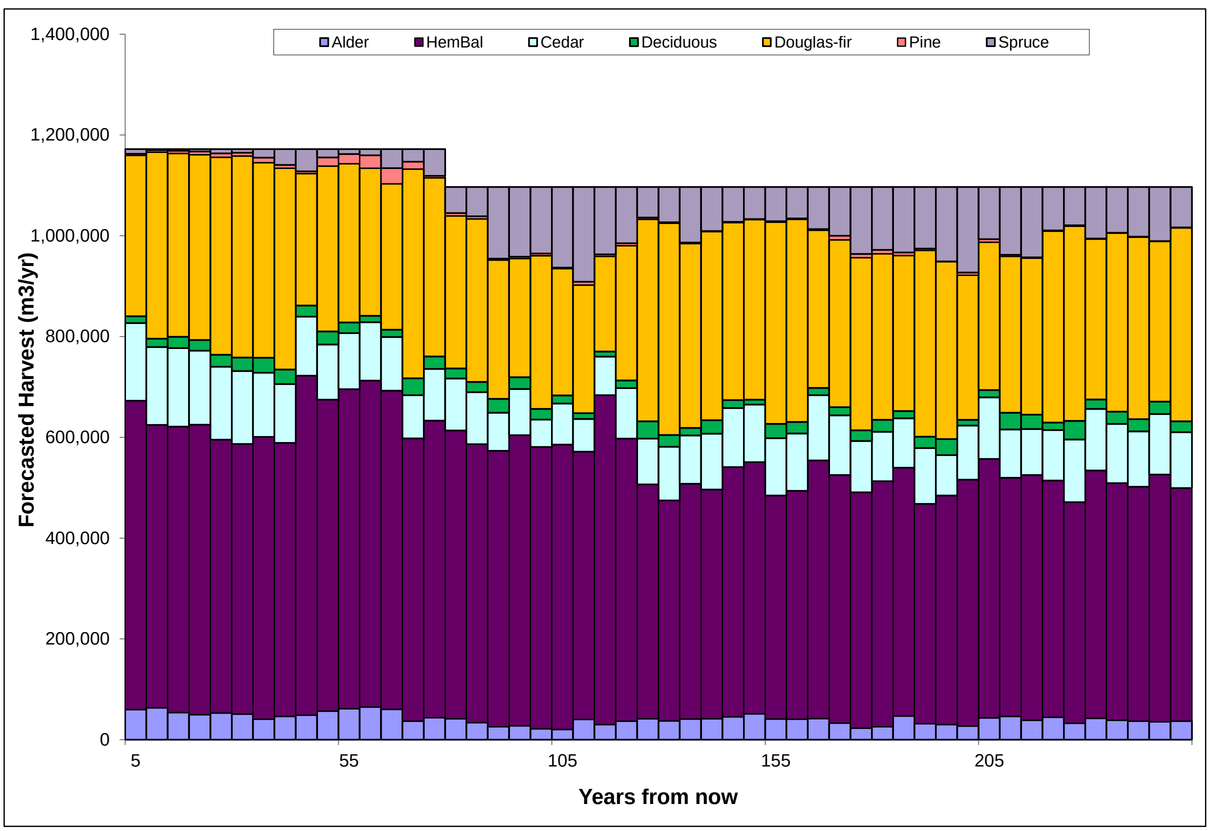

Figure 36: Harvest forecast by species; incorporate forest health and elk

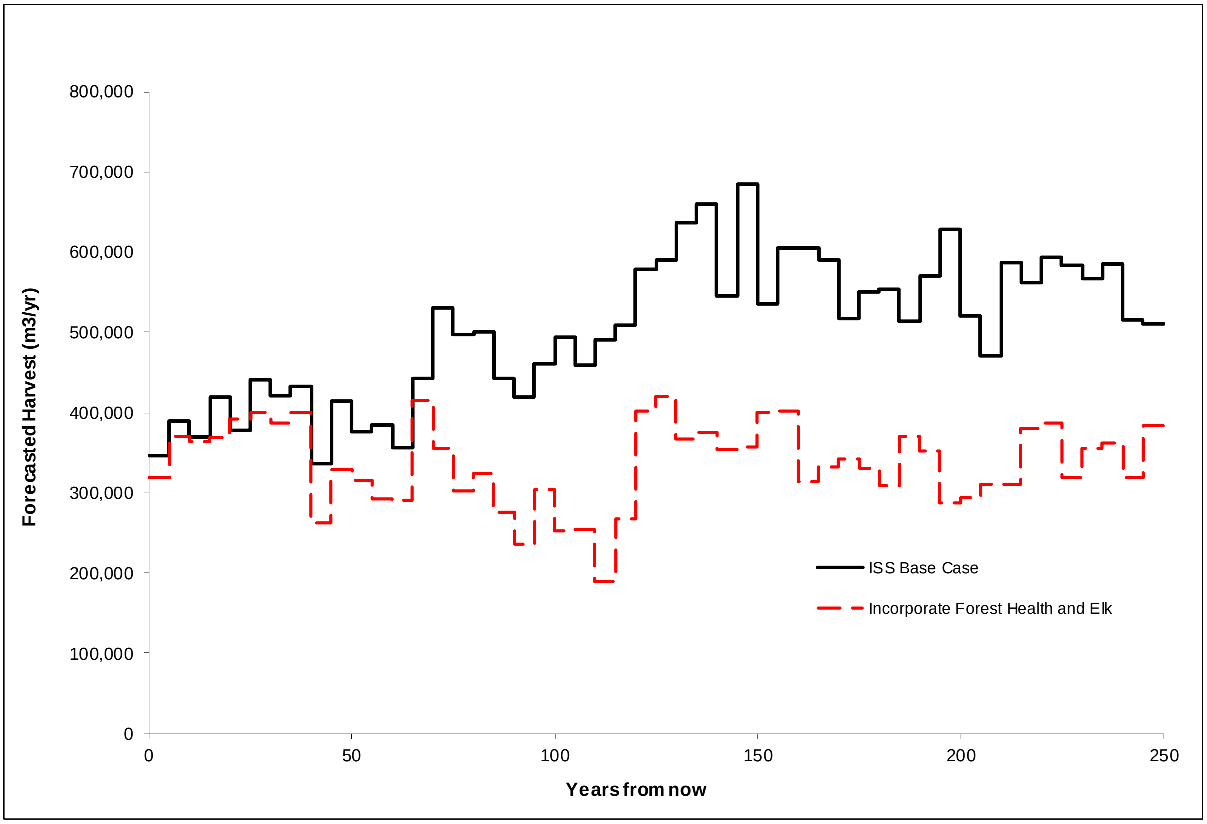

Figure 37: Douglas fir harvest forecast; incorporate forest health and elk

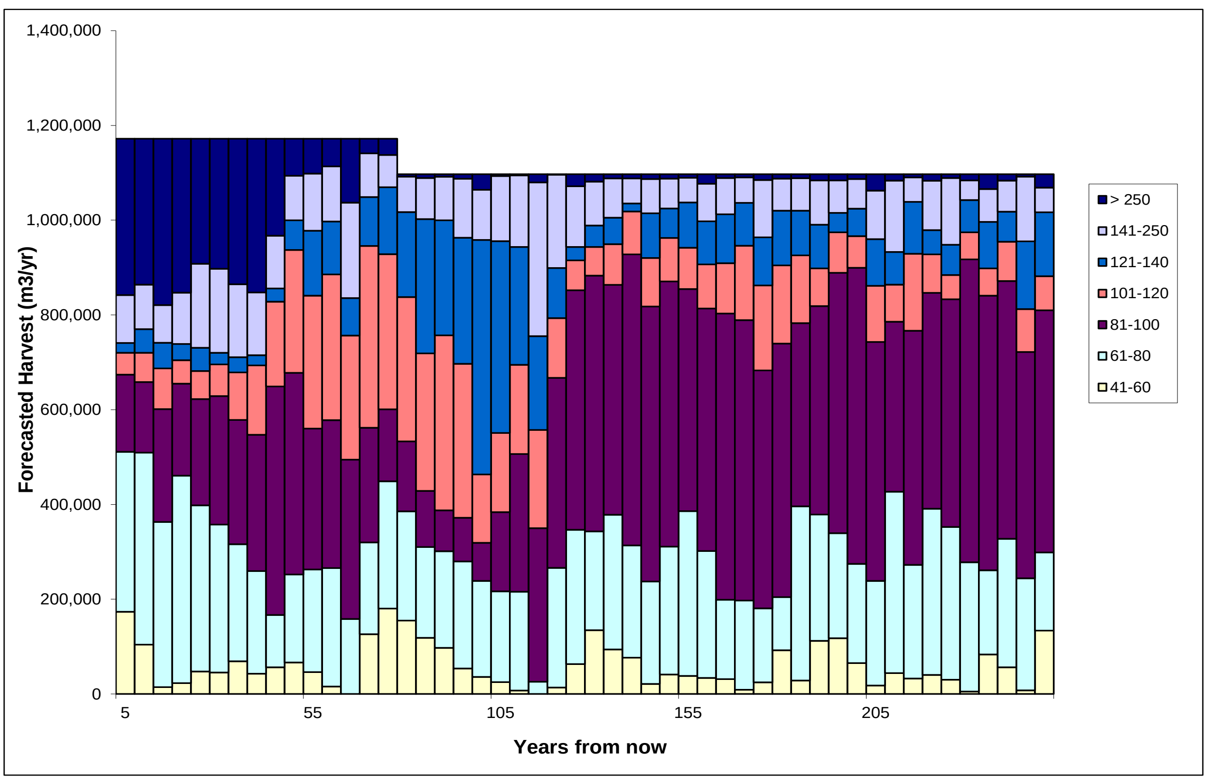

Figure 38: Harvest forecast by age class; incorporate forest health and elk

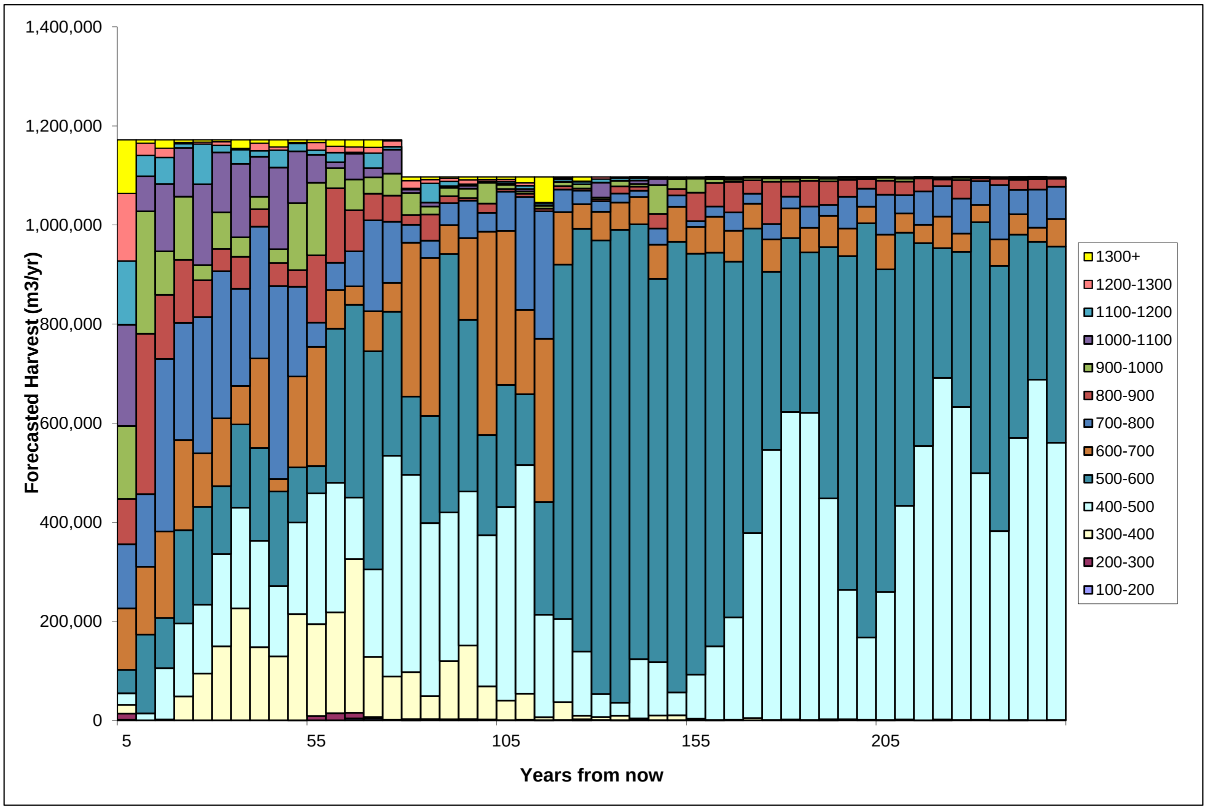

Figure 39: Harvest forecast by volume per ha class; incorporate forest health and elk

4.3.3 Volume and Value Scenarios

The THLB in the Fraser TSA was zoned to direct management actions; the zoning is described in the Fraser ISS Data Package. Three zones were developed: green, yellow and red. Green depicts areas where management actions and investments are generally recommended due to a higher site productivity, lower harvest costs and smaller anticipated risk for efficient future harvest. In the yellow zone caution is recommended, while the red zone denotes areas where management actions and investments in forest management should be avoided due to costs and risks. The zoning was developed for all THLB areas.

The land base is constrained; large areas were classified as red (no investment):

- Green: 9,117 ha (4%)
- Yellow: 86,392 ha (39%)
- Red: 123,981 ha (57%)

In many cases the volume and value strategies can be very similar; in both strategies, regimes that produce larger logs with similar quality more quickly contribute to increased volume and value. Two volume strategies and one value strategy were tested. In the first volume strategy (Volume Strategy 1) portions of existing and future Fd leading managed stands were fertilized on green and yellow silviculture zones every 10 years from 30 to 70 years.

The second volume strategy (Volume Strategy 2) involved revised reforestation regimes for future stands and assumed the following:

- For medium to good sites which are expected to be managed primarily for timber, a mosaic of ecologically suitable single species stands with enhanced densities specifically designed to optimize the production and value of each species were established ("unmix the mixes"). The species portfolio for each BEC unit was developed with consideration to climate change through the use of Climate Change Informed Species Selection (CCISS) tool and forest health risks;
- Average expected genetic worth for each species from seed available under the Climate Based Seed Transfer (CBST) rules was used;
- On operable sites where root rot is a hazard, stumping was assumed with Fd and Hw regimes;
- On SNC hazard sites, the Fd percent was reduced in the species portfolio;
- Reduced stocking was assumed on sites with high or moderate elk hazard;
- High future log prices were assumed for all enhanced regimes;
- Fd stands were fertilized every 10 years from 30 to 70 years.

The Value Strategy is like Volume Strategy 2 with the following exceptions:

- Include Cw planting and juvenile spacing favoring Cw, where ecologically appropriate, on yellow and green sites;
- Assume high log prices for enhanced Cw regimes;
- In addition to Cw, focus on Fd where appropriate to maximize timber value.

4.3.4 Stand Level Results

4.3.4.1 Volume Scenarios for Existing Managed Stands

The volume strategy for existing managed stands consists of fertilizing portions of the existing old managed and contemporary managed Fd leading stands in parts of the green and yellow silviculture zones every 10 years from age 30 to age 70. The average volume responses are predicted to be marginal on many sites and in operations care should be taken to choose appropriate stands for treatment. Fertilization efficiency may be reduced by lack of Fd in some stands or forest health factors in others. The following figures illustrate four fertilization regimes for Fd leading contemporary managed stands.

Figure 40 illustrates the predicted volume and value responses of a contemporary era CWHds1 cool Fd leading stand with root rot to intensive fertilization. On average, the regime is considered financially viable; however, only 70% of the candidate stands are assumed to be fertilized due to the prevalence of root rot and the amount of non-Fd species in these stands. Based on previous analysis of similar sites, it is likely that this regime is financially viable at a 2% discount rate and at the fertilization cost of $500 per hectare.

In Figure 41, the predicted volume and value responses to fertilization are shown for a contemporary era CWHdm cool Fd leading stand. The stand is assumed to have root rot and SNC. Due to the prevalence of root rot, SNC and the amount of non-Fd species, only 30% of all the candidate stands are considered viable and are fertilized in this analysis. This regime is likely financially viable.

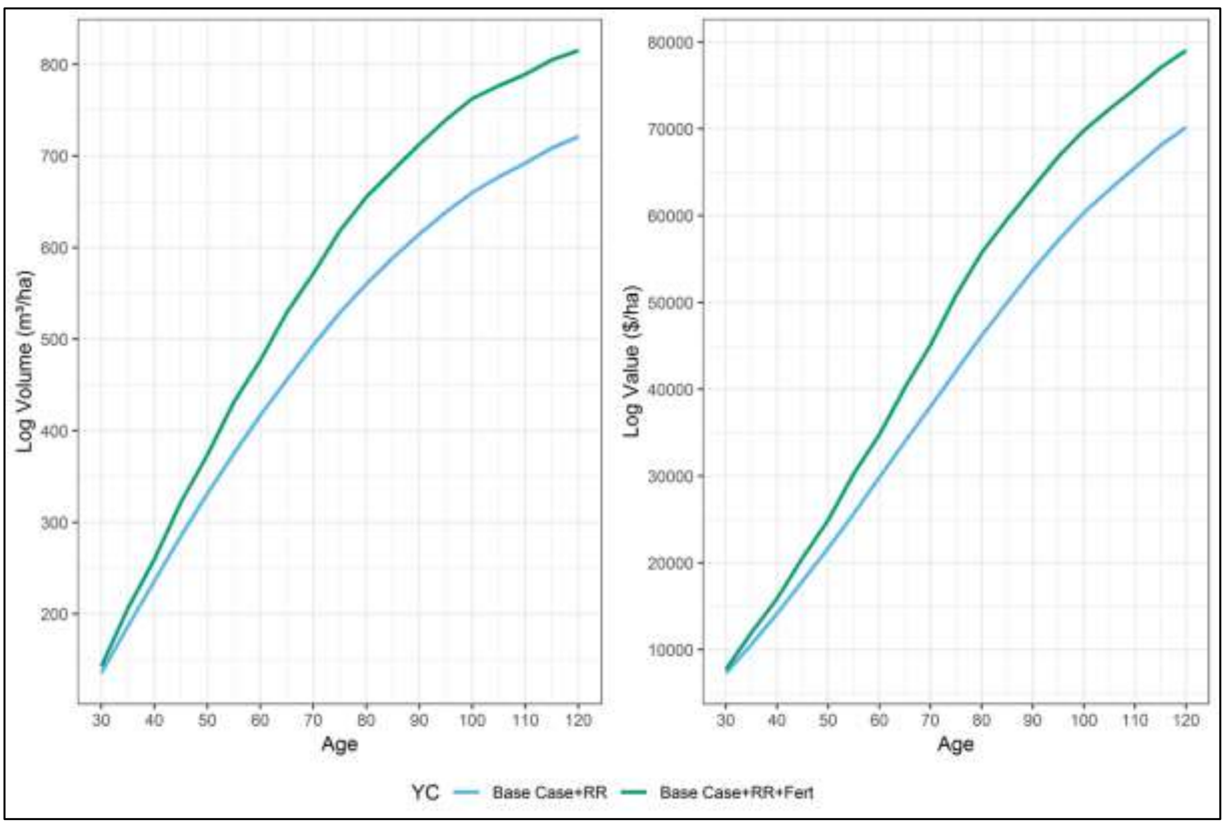

Figure 40: Predicted volume and value responses; contemporary era; CWHds1 cool

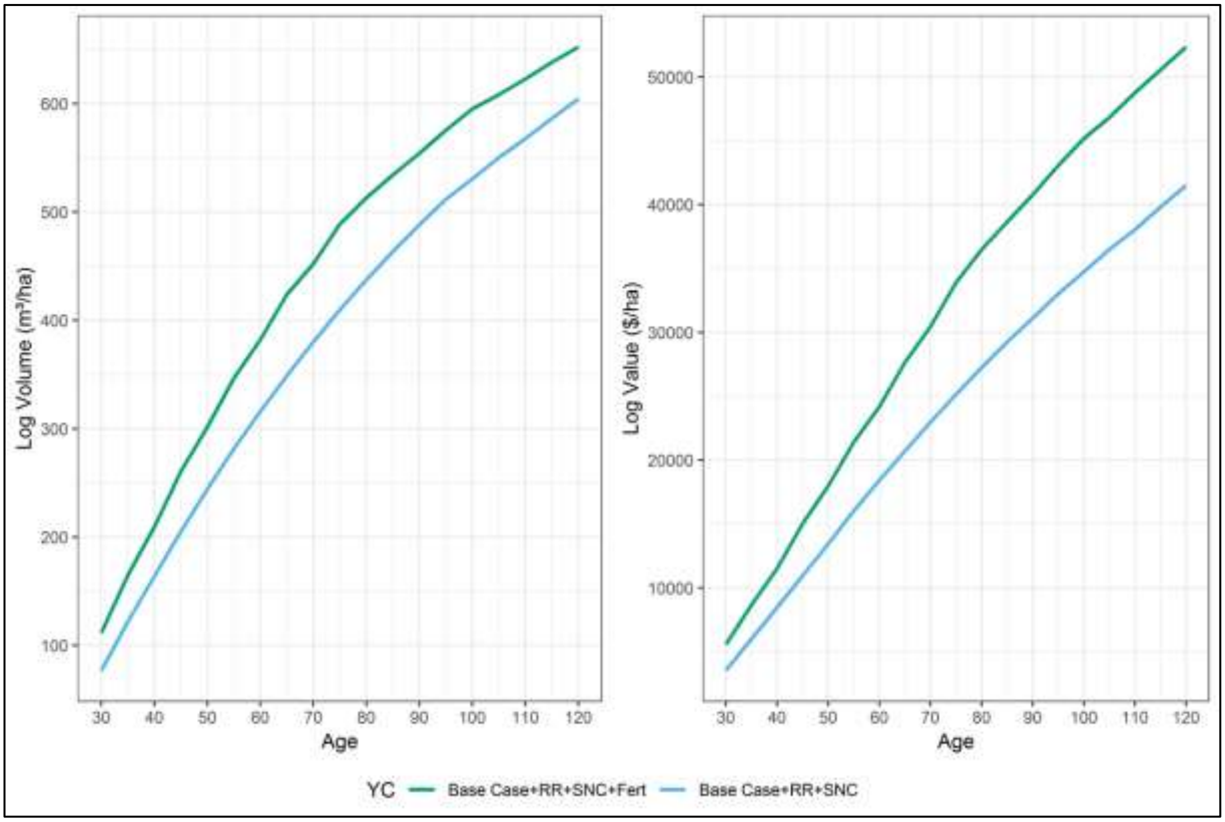

Figure 41: Predicted volume and value responses; contemporary era; CWHdm cool

Figure 42 illustrates the predicted volume and value responses to fertilization for a contemporary era CWHms1s warm Fd leading stand. Only 30% of all the candidate stands are fertilized due to existing stand and site factors, such as species distribution and productivity. Assuming that the best 30% of the stands are chosen for treatment, fertilization is considered marginally financially viable.

Figure 43 shows an example of a likely non-viable fertilization regime; the average fertilization response is not adequate in contemporary era CWHvm1 cool Fd leading stands and field work is required to identify those stands with a better disposition to ensure adequate fertilization response. Only 30% of all the candidate stands are fertilized in this analysis unit due to the prevalence of SNC and the amount of non-Fd species in the stands.

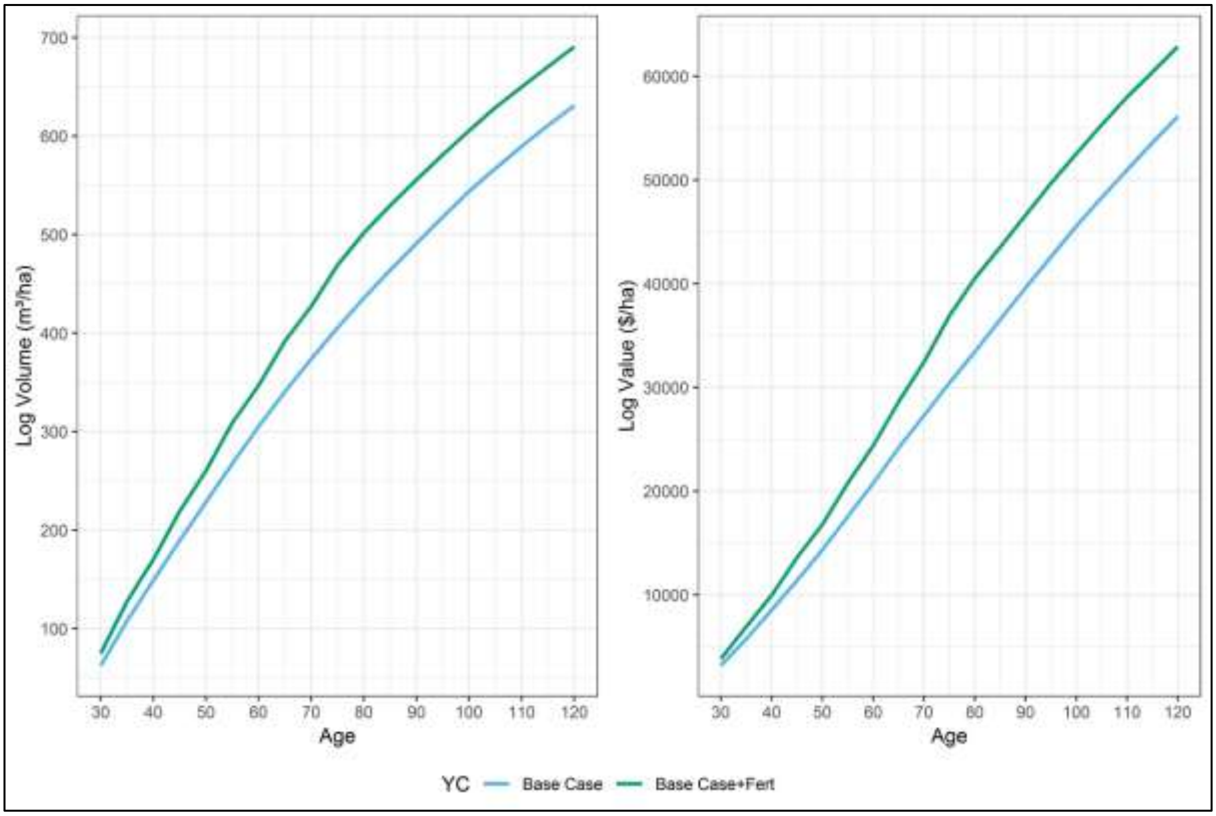

Figure 42: Predicted volume and value responses; contemporary era; CWHms1s warm

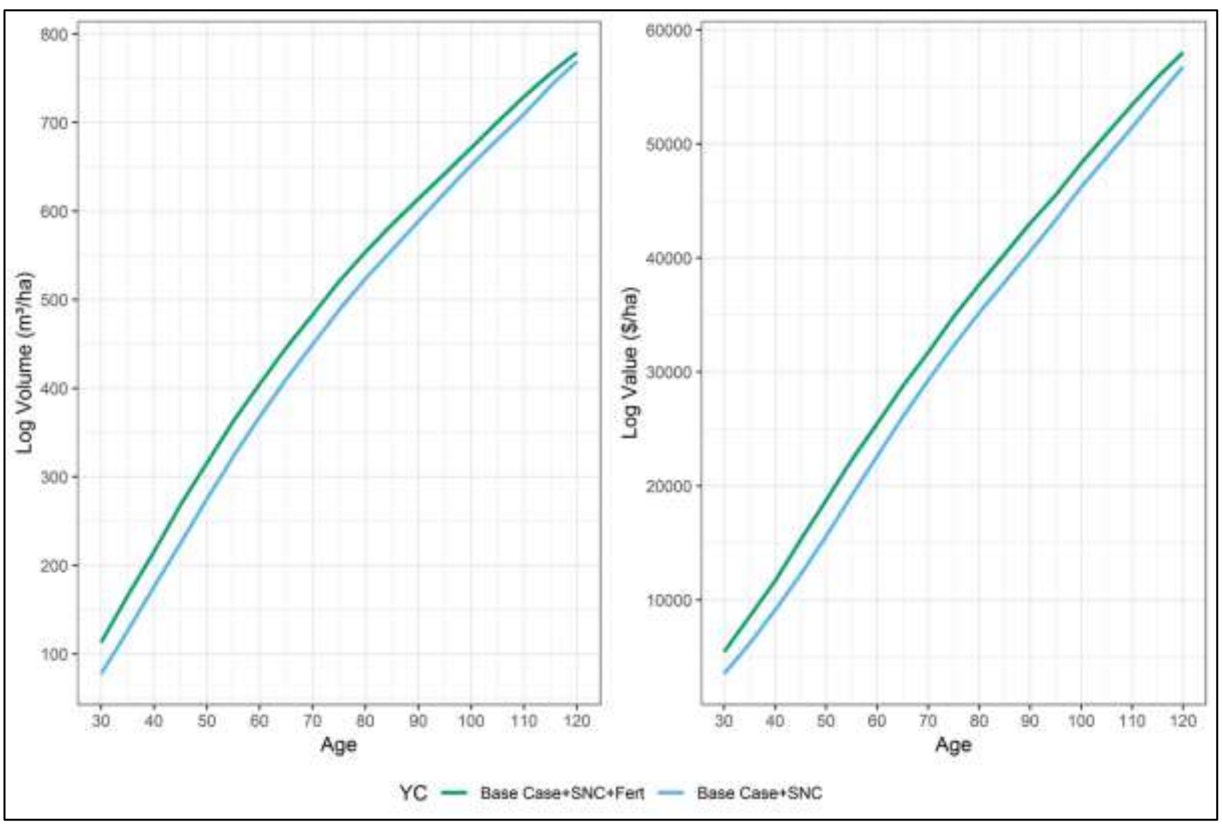

Figure 43: Predicted volume and value responses; contemporary era; CWHvm1 cool

4.3.4.2 Volume Scenario for Future Stands

Volume Strategy (Scenario) 1: On green and yellow silviculture zones, fertilize portions of the Fd leading managed stands - established with the ISS Base Case assumptions regarding species mixes in planting (current management) - every 10 years from age 30 to age 70. Account for forest health impacts as per the forest health scenario. See section 4.3.4.4 for volume and value responses for selected analysis units for this scenario.

4.3.4.3 Volume and Value Scenarios for Future Stands Established with Enhanced Reforestation Regimes

Volume Strategy (Scenario) 2: On green and yellow silviculture zones, establish a mosaic of ecologically suitable single species stands with increased densities specifically designed to optimize the production (and value) of each species. Fertilize Fd leading stands every 10 years from age 30 to age 70. The species portfolio for each BEC unit was developed with consideration to climate change through the use of Climate Change Informed Species Selection (CCISS) tool and forest health risks. Further considerations were:

- Use average expected genetic worth for each species from seed available under the Climate Based Seed Transfer (CBST) rules;
- Where root rot is a hazard, employ stumping in Fd and Hw leading stands;
- Reduce Fd% on SNC hazard sites;
- Assume high log prices for all increased planting density regimes on green and yellow silviculture zones;
- Focus planting on Fd and Hw, where ecologically appropriate to maximize timber volume;

Table 8 shows the species portfolio options for volume strategy 2. All other BEC units were assumed to be regenerated as per the forest health scenario.

Table 8: Regime options for volume strategy 2

BEC Unit	Sp1/Target Planting (sph)/ Treatments	Sp2/Target Planting (sph)/ Treatments	Sp3/Target Planting (sph)/ Treatments
CWHds1 cool all (RR)	Fd/1600/stump/fert	Base Case (Fd80Cw20/1200) fert	
CWHdm cool all (RR, SNC)	Fd/1600/stump/Fert	Hw/1200/stump	
CWHms1s warm all	Fd/1600/fert	Base Case (Fd25Cw22Hw44Ba9/1600) fert	Hw/1200
CWHms1s cool all	Fd/1600/fert	Hw/1200	
CWHms1m warm	Fd/1600/fert	Cw/1400/JS900	Hw/1200

BEC Unit	Sp1/Target Planting (sph)/ Treatments	Sp2/Target Planting (sph)/ Treatments	Sp3/Target Planting (sph)/ Treatments
CWHvm1 cool all (SNC,weevil)	HwSx/1200	Hw/1200	
CWHvm2 warm all	HwSx/1200	Fd/1600/fert	

“Unmixing the Mixes”

Where timber production is the key objective, volume Strategy 2 employs the concept of “unmixing the mixes” at the stand-level and proposes to achieve species diversity at the landscape-level by establishing a mosaic of ecologically suitable single species stands. Different species in mixed stands often have different site indices as shown in Table 9. This may result in unexpected species compositions at harvest. Different rotation ages for different species are also likely to reduce the potential for volume and value maximization from mixed species stands.

Table 9: SIBEC Site indices (50) for Fd, Hw and Cw for common BEC site series in the Fraser TSA

BEC Site Series	Fd SI50	Hw SI50	Cw SI50
CWHdm ss01	34	30	27
CWHdm ss07	41	N/A	31
CWHvm1 ss01	36	28	23
CWHds1 ss01	34	?	20
CWHms1 ss01	24	20	20

“Unmixing the mixes” creates species diversity at the landscape level, while allowing for volume and value maximization. Figure 44 illustrates a conceptual example where mixed species are planted everywhere within stands across the landscape, while Figure 45 demonstrates an approach where the same landscape-level species composition is achieved by planting patches of single species as a mosaic. This approach also allows for the incorporation of non-timber emphasis sites which are assumed to be managed less intensively for timber (longer rotations, more retention, mixed species etc.). The key for this kind of landscape-level management is a zonation differentiating between timber emphasis and non-timber focused management areas and the use of temporal and spatial patterns.

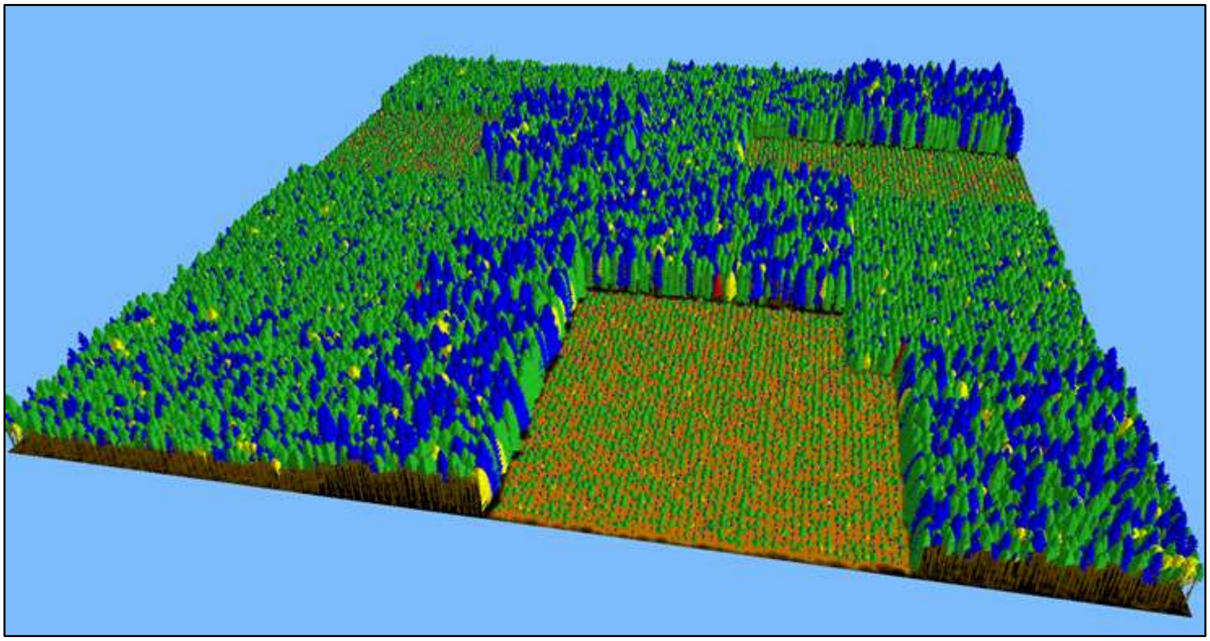

Figure 44: Mixed species planting everywhere

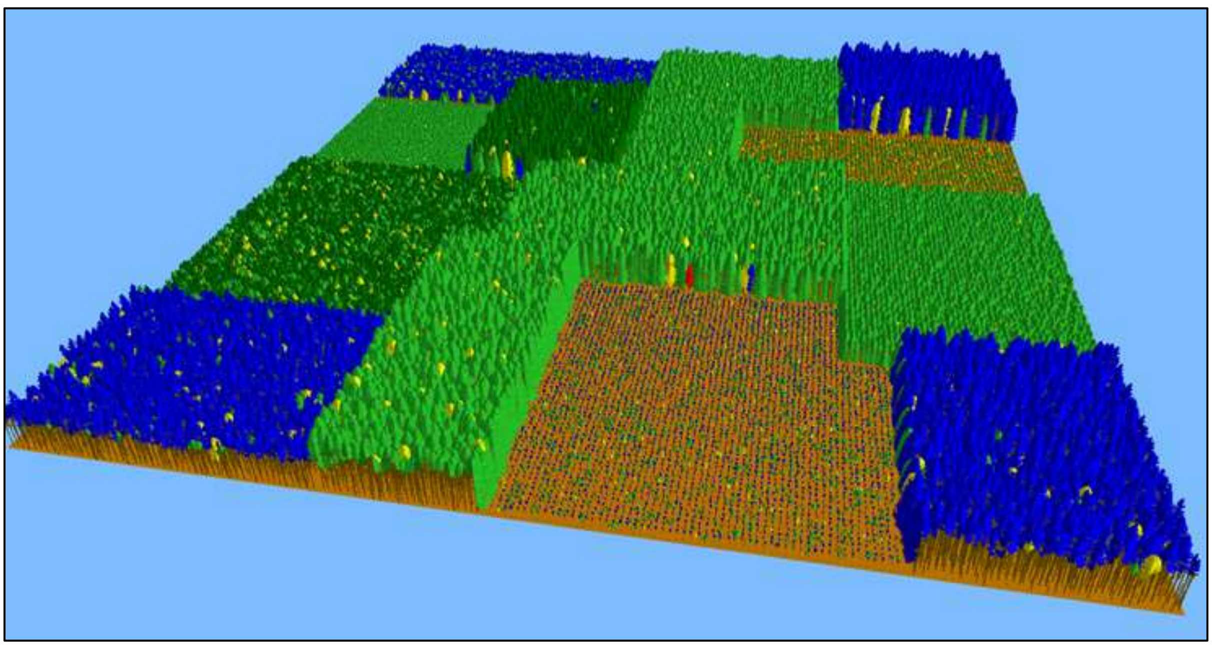

Figure 45: Single species planting to achieve the same landscape-level species portfolio as in mixed species planting on timber producing sites

Value

The Value Strategy (Scenario) for future managed stands is the same as Volume Strategy 2 with the following exceptions:

- Include Cw planting and juvenile spacing favoring Cw where ecologically appropriate on yellow and green silviculture zones
- Assume high log prices for Cw enhanced regimes;
- In addition to Cw, focus on Fd planting, where appropriate, to maximize timber value;
- Opportunities to fertilize Cw in the future are likely; however, Cw fertilization was not modeled in this analysis (this is a research opportunity);
- Opportunities to intensively manage Dr on selected sites would also likely contribute to a higher value. This was not modelled due to the small areas involved.

Cw Planting and Juvenile Spacing

As noted above, the value strategy includes planting of Cw, where ecologically appropriate. Juvenile spacing may be required to ensure that the planted Cw seedlings perform as expected; the main competition is expected from Hw.

Despite its known value, Cw is not given enough prominence in forest management in coastal British Columbia. If one was able to convert 10% to 20% of the coastal THLB from Fd to Cw, the projected stumpage revenue at harvest would be roughly equal to the current average coastal stumpage revenue (UBC Research Forest Valuation Report, 2013).

While Cw, Hw and Fd grown on the same site exhibit different growth rates and different projected harvest volumes per ha at rotation, the difference are relatively small as shown in Figure 46. However, the differences in projected stand value are significant; this is illustrated in Figure 47.

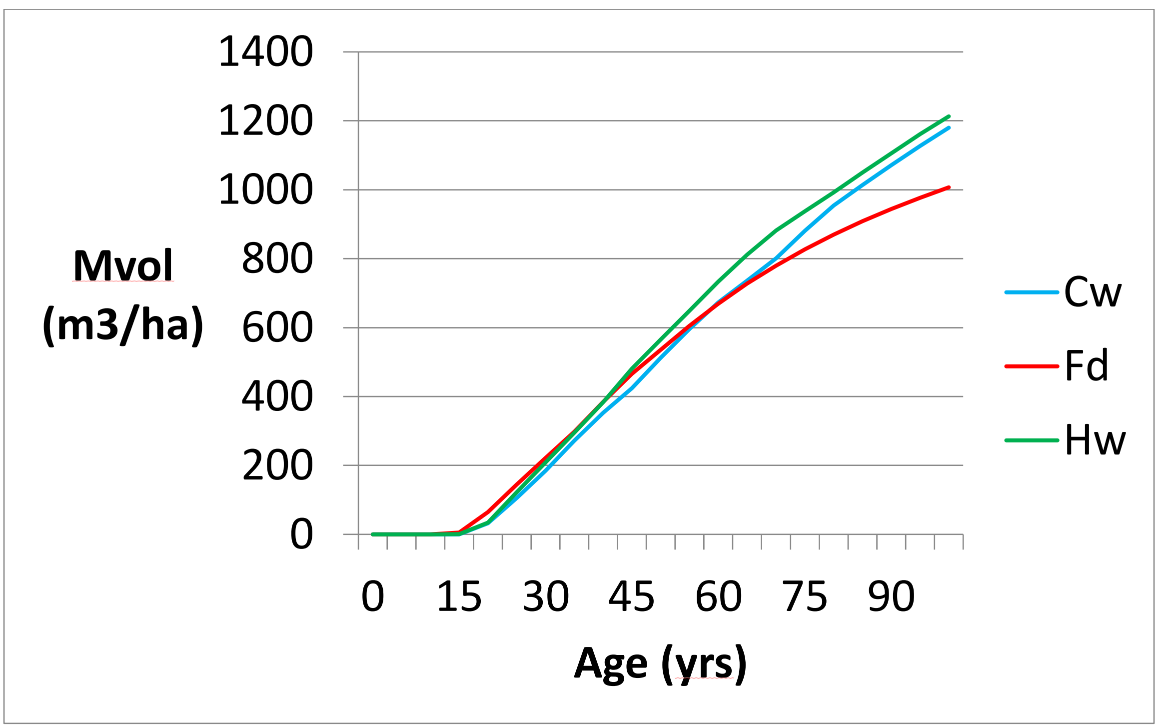

Figure 46: Projected stand volume, CWHdm ss01 planted with 1400sph

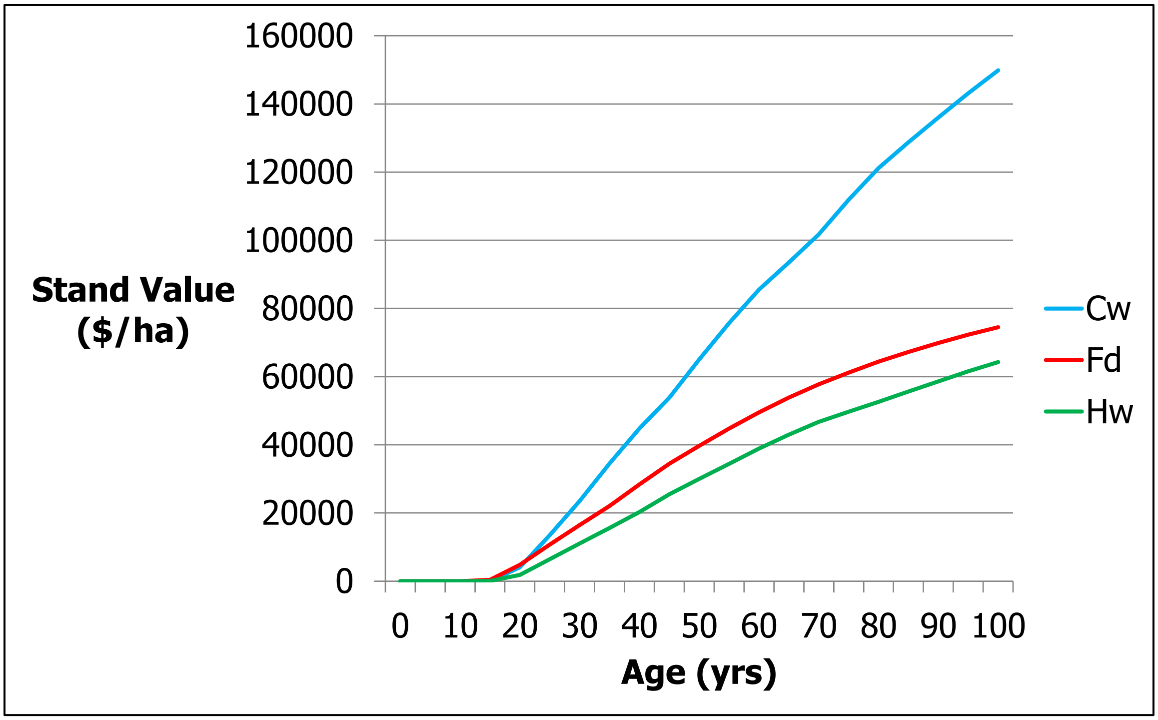

Figure 47: Projected stand value, CWHdm ss01 planted with 1400sph

Figure 48 compares images for different stages of stand development for a Cw-leading stand with and without juvenile spacing. The model results predict that natural HwBa trees will overtop many of the planted Cw in the absence of spacing. This is expected to happen primarily due to the difference in site indices and it is predicted to suppress some of the Cw. On the other hand, juvenile spacing is predicted to lead to an almost pure Cw stand and a higher proportion of larger trees; both factors impact stand value.

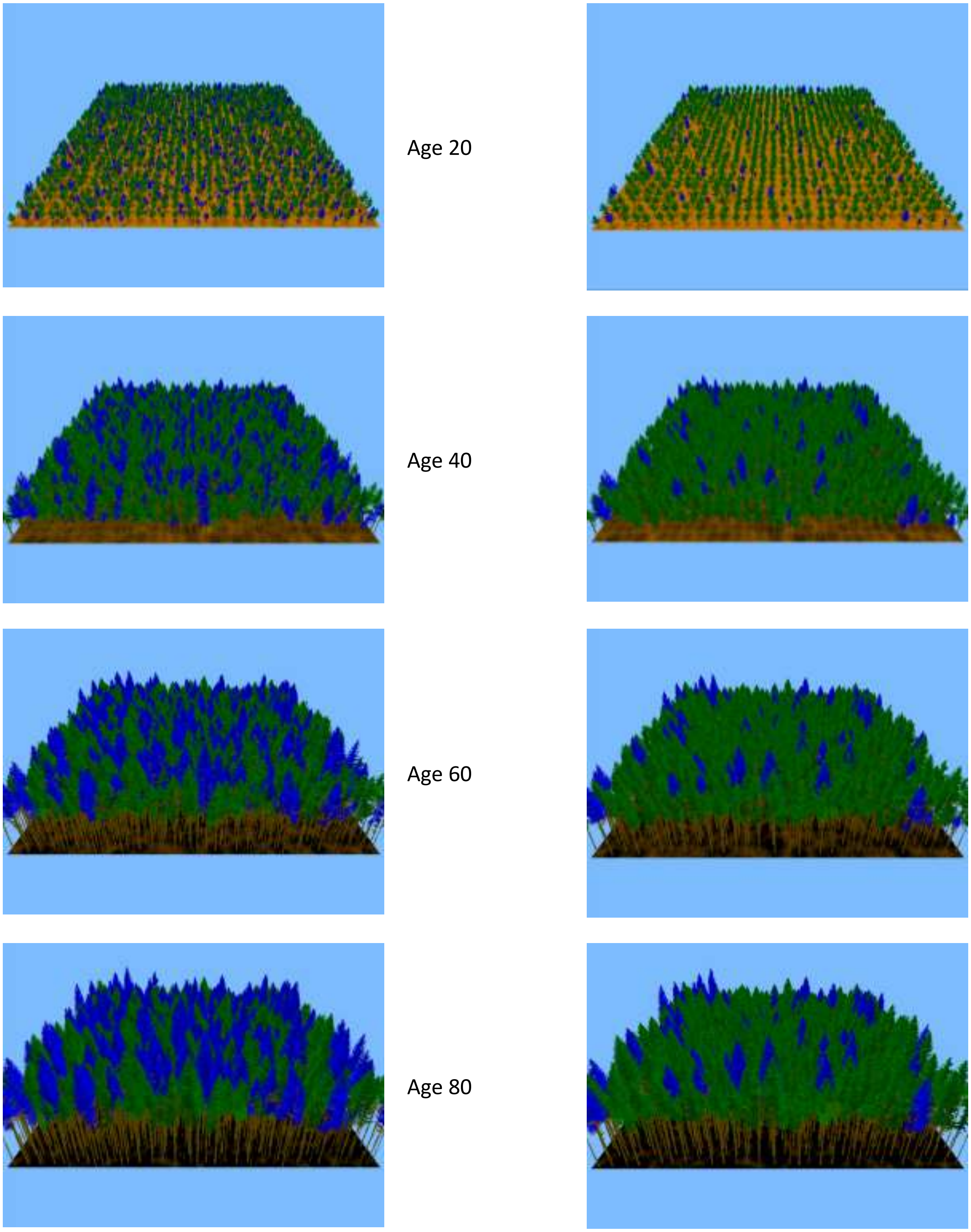

Figure 48: TASS II images of Cw leading, good site on Vancouver Island, no JS (left) and JS (right) showing Cw (green) and HwBa (blue)

Figure 49 shows that juvenile spacing results in a higher volume of Cw logs through the merchantable age range with a significant increase in gang volume after about 50 years. This increase in Cw gang volume is primarily responsible for the large marginal increase in average and total log value, which occurs after approximately 50 years compared to the non-spaced stand (Table 10). Based on today's markets and prices, Cw harvesting of these spaced stands should not occur too early or else the value benefit from juvenile spacing will not be realized.

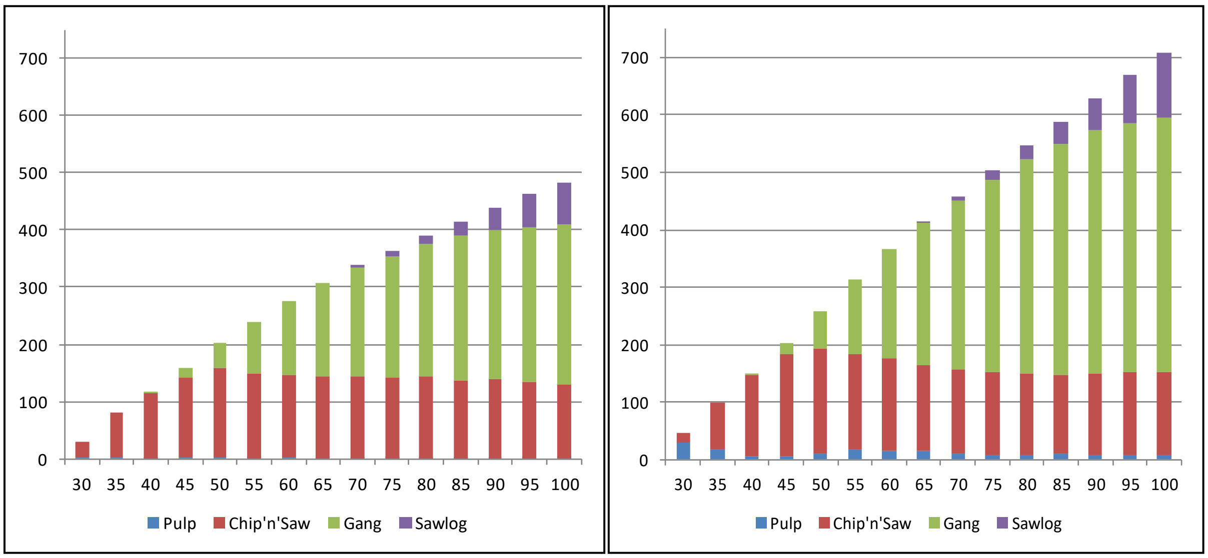

Figure 49: Comparison of Cw log volumes by sort for the non-spaced stand (left) and spaced stand (right) for Cw leading, good site on Vancouver Island

Table 10: Industrial second growth gang (20 to 38 cm top diameter) prices, 2000 to 2015

Description	Fd (\$/m³)	Cw (\$/m³)	Hw (\$/m³)
Average	$74	$127	$53
Range	$55 to $85	$90 to $185	$50 to $60

Table 11 shows the species portfolio options for the value strategy. All other BEC units were assumed to be regenerated as per the ISS Base Case (forest health incorporated).

Table 11: Regime options for the value strategy

BEC Unit	Sp1/Target Planting (sph)/ Treatments	Sp2/Target Planting (sph)/ Treatments	Sp3/Target Planting (sph)/ Treatments
CWHds1 cool all (RR)	Fd/1600/stump/fert	Cw/1400/JS900	
CWHdm cool all (RR, SNC)	Base Case (Fd80Cw20/1,200), fert	Cw/1400/JS900	
CWHms1s warm all	Fd/1600/fert	Cw/1400/JS900	Base Case (forest health incorporated) (Fd25Cw22Hw44Ba9/1600) +fert
CWHms1s cool all	Fd/1600/fert	Cw/1400/JS900	
CWHms1m warm	Fd/1600/fert	Cw/1400/JS900	
CWHvm1 cool all (SNC,weevil)	Cw/1400/JS900	HwSx/1200	
CWHvm2 warm all	Cw/1400/JS900	Fd/1600/fert	

4.3.4.4 Stand-level Modelling Results for Future Stands for Selected Analysis Units for the Volume and Value Scenarios

This section summarizes the stand-level log volume and value, and site value forecasts for most of the largest future stand analysis units established in green and yellow silviculture zones according to the forest health scenario or with enhanced reforestation regimes.

Site value is the present value of all cash flows produced by an infinite series of identical rotations. It is the value one would pay for bare ground if the intent were to manage an infinite series of rotations under an assumed management regime. Site value differs from the net present value (NPV) of a single rotation because site value recognizes the cost of prolonging the start of the next rotation, while NPV of a single rotation does not.

The site value analysis presents the results for two discount rates: 2%, the current government standard and a more conservative rate of 4%. The assumed silviculture costs are $1 per tree for incremental planting, $750 per ha for stumping (assuming that only 60% of the sites require stumping at $1,250 per ha) and $500 for fertilization per application; 5 applications are assumed.

<u>CWHds1 Cool Good Future (Root Rot Hazard)</u>

This analysis unit is prone to root rot. Figure 50 shows the projected log volumes and values for:

- Base Case (forest health incorporated);
- Base Case (forest health incorporated) subject to an intensive fertilization regime;
- Regime, where the sites with significant root rot are stumped and planted to 1,600 stems per ha (sph) of Fd and fertilized; and

- Regime with a plantation of 1,400 sph of Cw, where juvenile spacing to 900 sph favouring Cw is assumed.

Fertilization of the Base Case is projected to produce marginal volume and value gains as seen in Figure 50. On the other hand, stumping followed by enhanced reforestation with Fd and fertilization produced the highest volume per ha over the entire modelling period (30 to 120 years) and had significantly higher value than the fertilized Base Case (forest health incorporated). The Cw regime volume forecast was not much different than that of the Base Case (forest health incorporated) or fertilized Base Case (forest health incorporated). However, the Cw regime created the most value providing that the stand is not harvest until the age 70.

Figure 51 compares the site value of the Base Case (forest health incorporated) with the intensive Fd regime. Both regimes produce positive site values at a discount rate of 2% with the intensive regime being far superior over the whole projection period. However, if the discount rate is increased to 4%, the intensive Fd regime, while being superior before age 95, is only modestly better.

Based on the analysis results, the timber and silviculture working group made the following recommendation for this analysis unit in yellow and green silviculture zones:

- 80% intensive Fd regime and 20% Base Case (forest health incorporated); volume strategy
- 80% intensive Fd regime and 20% Cw regime; value strategy

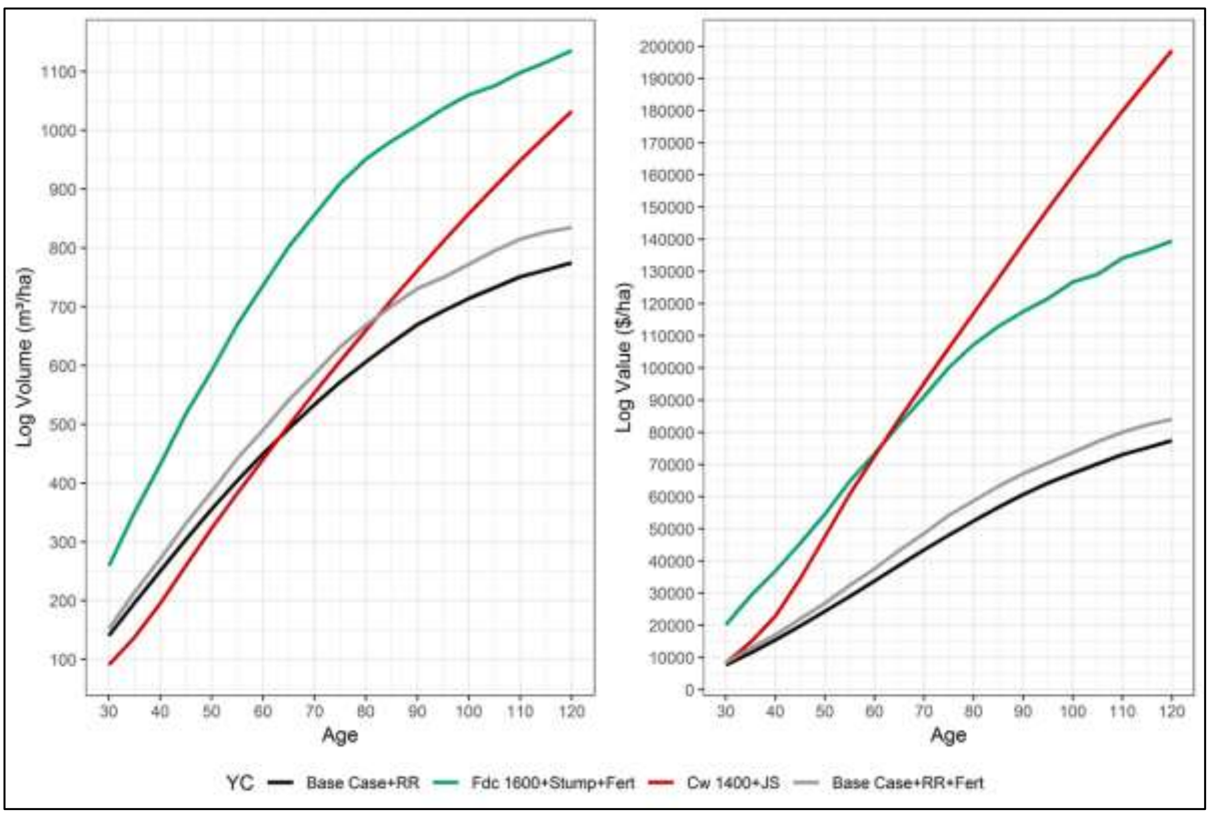

Figure 50: CWHds1 cool good future (root rot hazard)

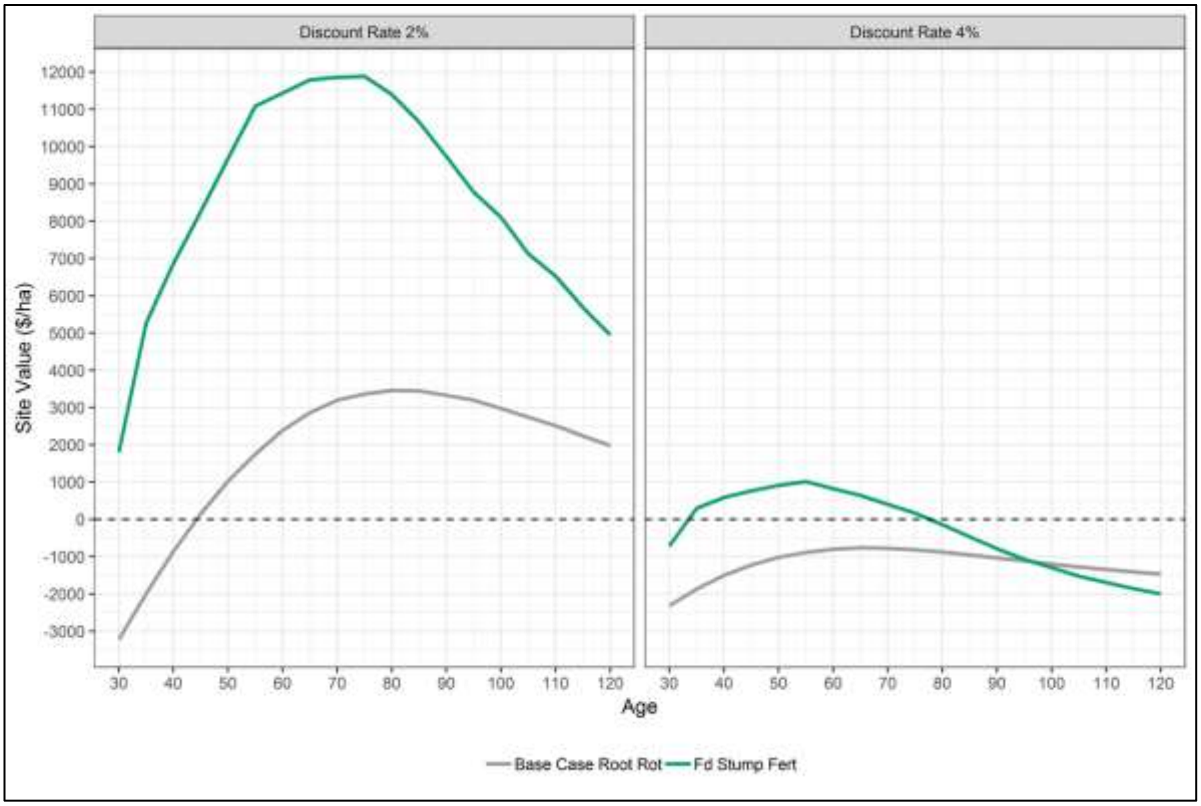

Figure 51: Site value for CWHds1 cool good future (root rot hazard)

<u>CWHdm Cool Good Future (SNC and Root Rot Hazards)</u>

This analysis unit is prone to SNC and root rot. Figure 52 shows the projected log volumes and values for:

- Base Case (forest health incorporated);
- Base Case (forest health incorporated) subject to a fertilization regime;
- Regime where the sites with significant root rot are stumped and planted to 1,200 stems per ha (sph) of Hw; and
- Regime with a plantation of 1,400 sph of Cw where juvenile spacing to 900 sph favouring Cw is assumed.

Fertilization of the Base Case (forest health incorporated) is projected to produce reasonable marginal volume and value gains relative to the unfertilized regime (Figure 52). However, beyond age 50 the best volume forecasts come from the intensive Hw and Cw regimes, which are very similar. While the intensive Hw regime generates an improvement in log value versus the fertilized Base Case (forest health incorporated), by far the best value response is from the Cw regime.

Figure 53 shows that the Cw regime is the most financially viable, while the Hw regime is also preferred to the Base Case (forest health incorporated).

Based on the analysis results, the timber and silviculture working group made the following recommendation for this analysis unit in yellow and green silviculture zones:

- 80% fertilized Base Case (forest health incorporated) and 20% Hw regime[1]; volume strategy
- 60% fertilized Base Case (forest health incorporated) and 40% Cw regime; value strategy

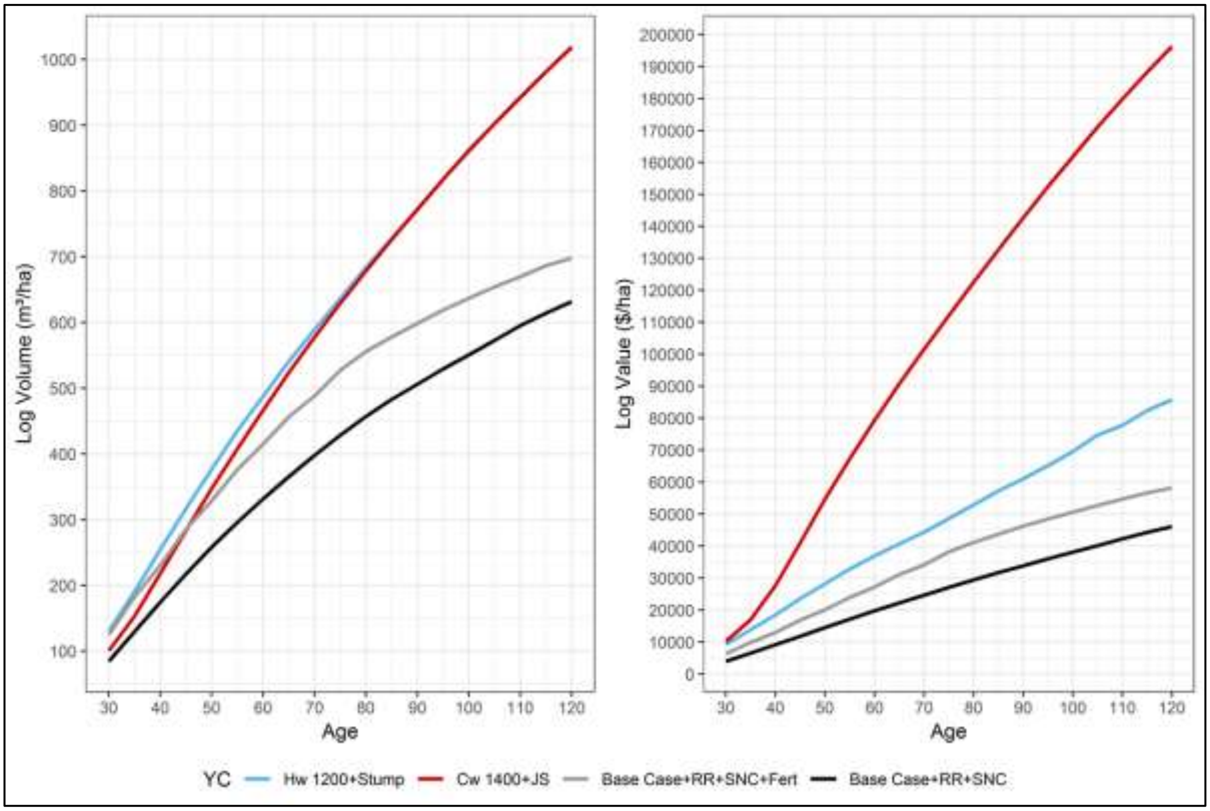

Figure 52: CWHdm cool good future (SNC and root rot Hazards)

[1] Subsequently it was identified that an intensive Fd regime (stumping, planting of 1600sph and fertilization) would have been a preferred option replacing potentially significant components of the fertilized Base Cases for both the volume and value scenarios

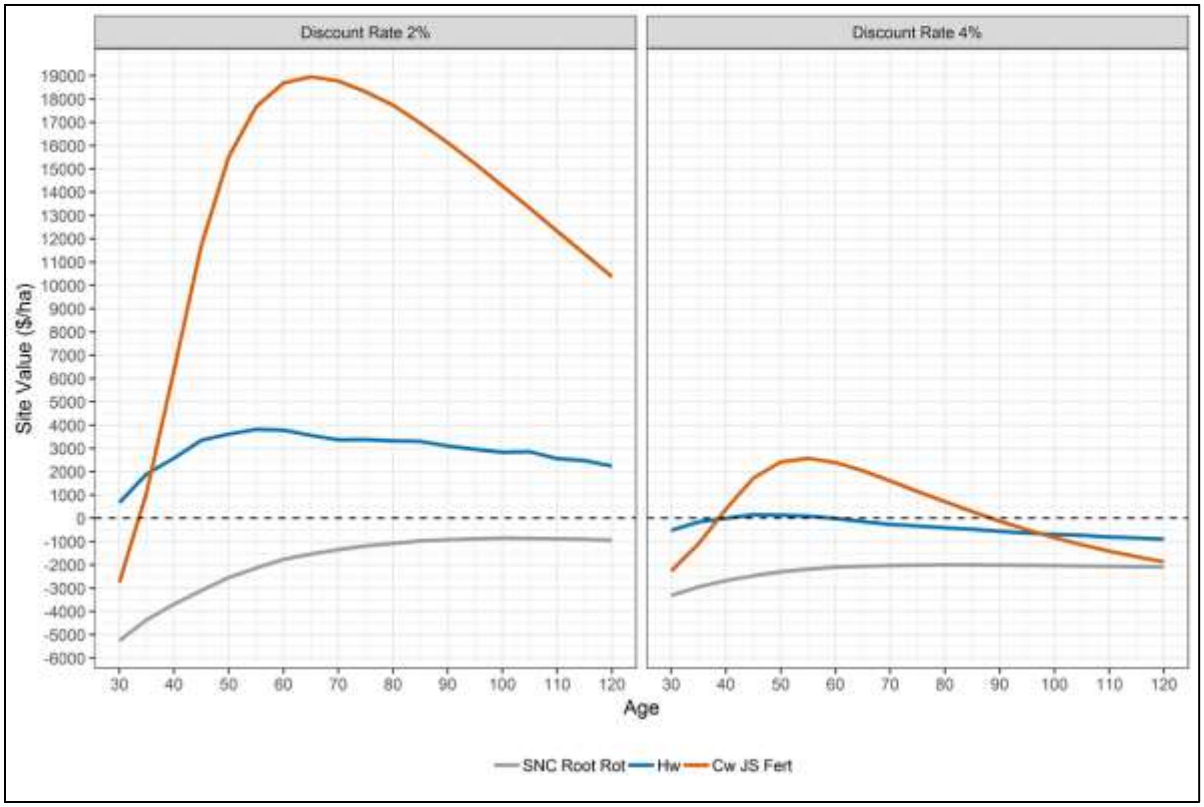

Figure 53: Site value for CWHdm cool good future (SNC and root rot Hazards)

<u>CWHms1s Warm Medium to Poor Productivity Future</u>

This analysis unit has no significant forest health issues. Figure 54 shows the projected log volumes and values for:

- Base Case (forest health incorporated);
- Base Case (forest health incorporated) subject to a fertilization regime;
- Regime with a plantation of 1,200 stems per ha (sph) of Hw;
- Regime with a plantation of 1,400 sph of Cw where juvenile spacing to 900 sph favouring Cw is assumed; and, and
- Regime where 1,600 stems per ha (sph) of Fd is planted and fertilized.

All regimes are predicted to increase the volume and value per ha compared to the Base Case (forest health incorporated) beyond 60 years with the intensive Fd regime producing the best response in volume and the Cw regime generating the best response in value (Figure 54).

Figure 55 illustrates the site value forecasts for this analysis unit. At a discount rate of 2% all regimes are predicted to be economically viable with the Cw regime creating significantly higher site values beyond 50 years. If the discount rate is increased to 4%, all regimes have similar site value forecasts. The enhanced regimes are only marginally better than the Base Case (forest health incorporated) for portions of the forecast period.

Based on the analysis results, the timber and silviculture working group made the following recommendation for this analysis unit in yellow and green silviculture zones:

- 70% intensive Fd regime, 20% fertilized Base Case (forest health incorporated) and 10% Hw regime; volume strategy
- 50% intensive Fd regime, 30% Cw regime and 20% fertilized Base Case (forest health incorporated); value strategy

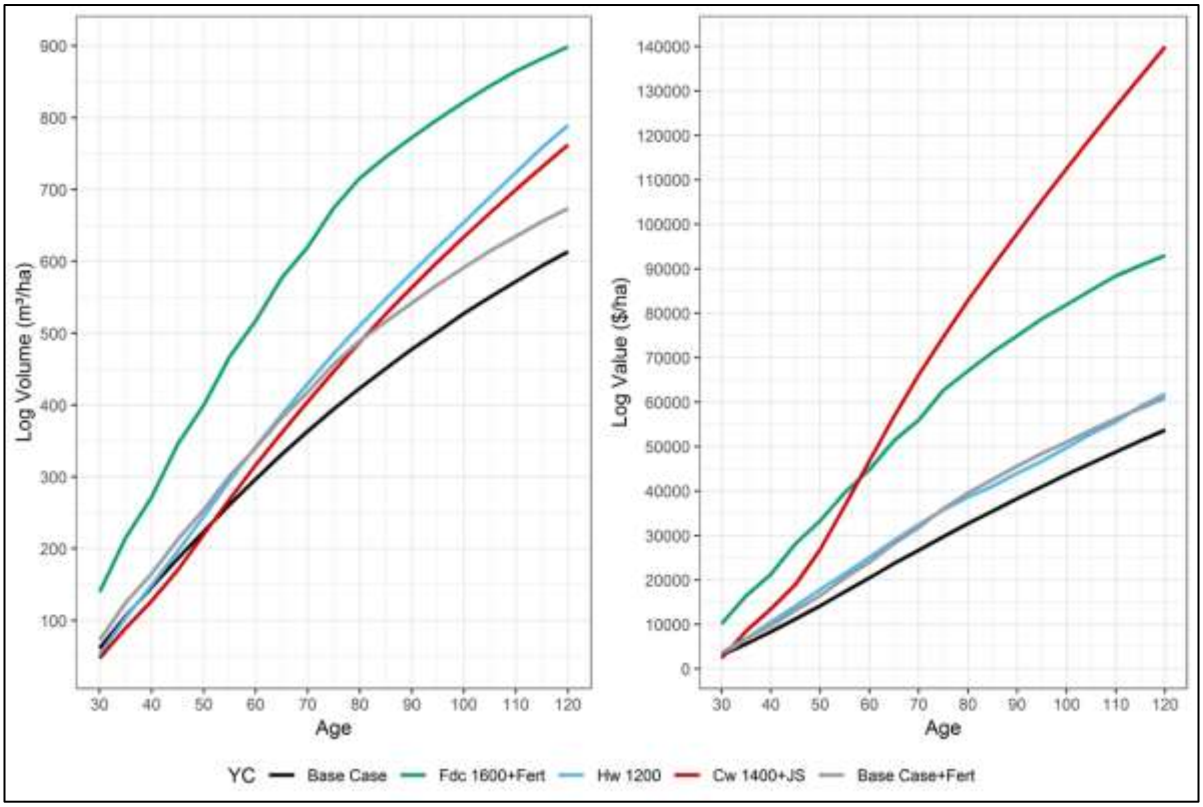

Figure 54: CWHms1s warm medium to poor productivity future

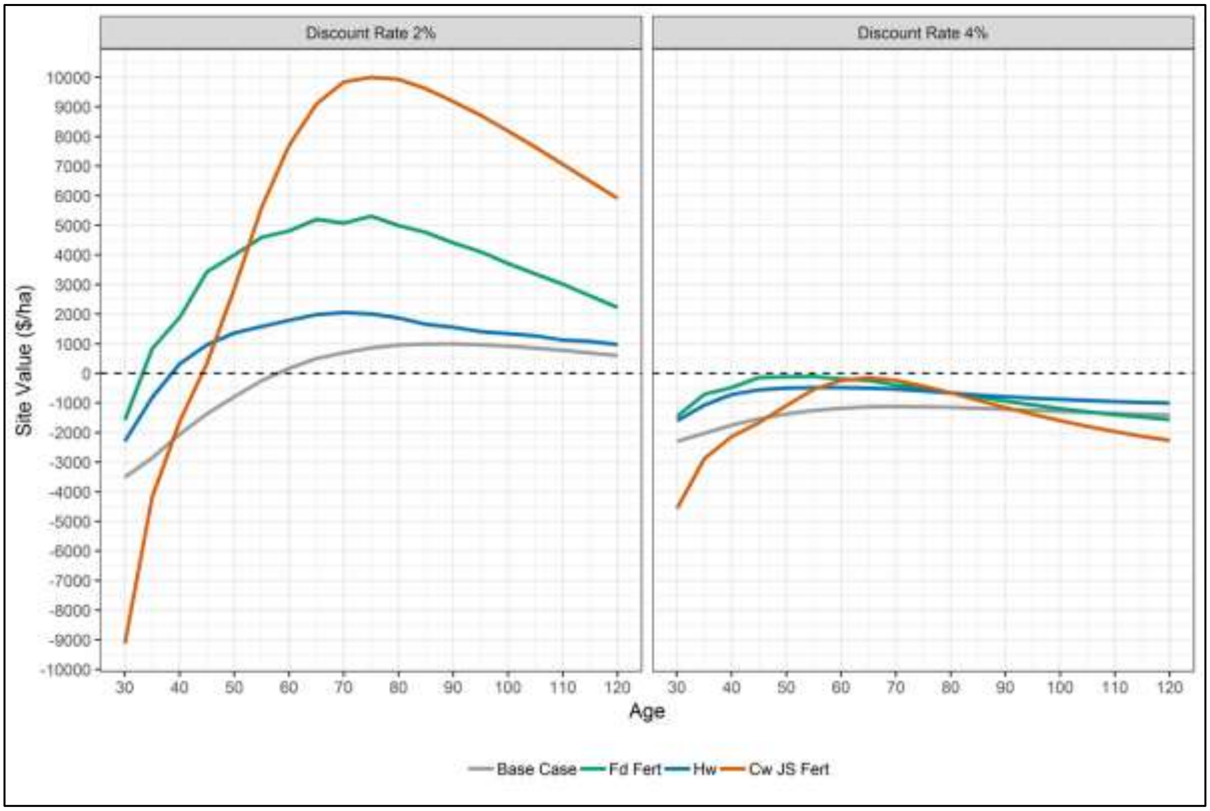

Figure 55: Site value for CWHms1s warm medium to poor productivity future

CWHms1s Cool Medium to Poor Productivity Future

This analysis unit has no significant forest health issues. Figure 56 shows the projected log volumes and values for:

- Base Case (forest health incorporated);
- Base Case (forest health incorporated) subject to a fertilization regime;
- Regime with a plantation of 1,200 stems per ha (sph) of Hw;
- Regime with a plantation of 1,400 sph of Cw where juvenile spacing to 900 sph favouring Cw is assumed; and, and
- Regime where 1,600 stems per ha (sph) of Fd is planted and fertilized.

The volume, value and financial analysis results are similar to those of the previous analysis unit, CWHms1s warm medium to poor productivity (Figure 56, Figure 57).

Based on the analysis results, the timber and silviculture working group made the following recommendation for this analysis unit in yellow and green silviculture zones:

- 80% intensive Fd regime and 20% Hw regime[2]; volume strategy
- 50% intensive Fd regime and 50% Cw regime; value strategy

[2] In discussions It was noted that the Cw regime could have been substituted for the Hw for the volume strategy

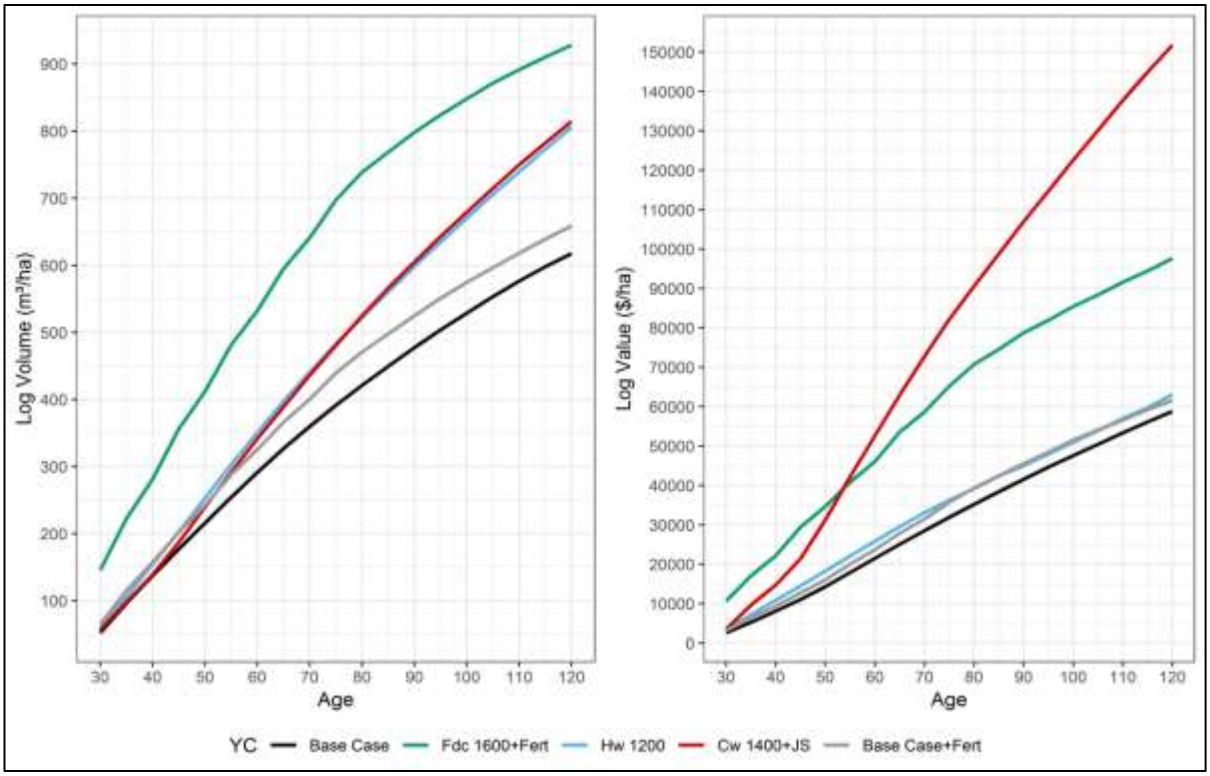

Figure 56: CWHms1s cool medium to poor productivity future

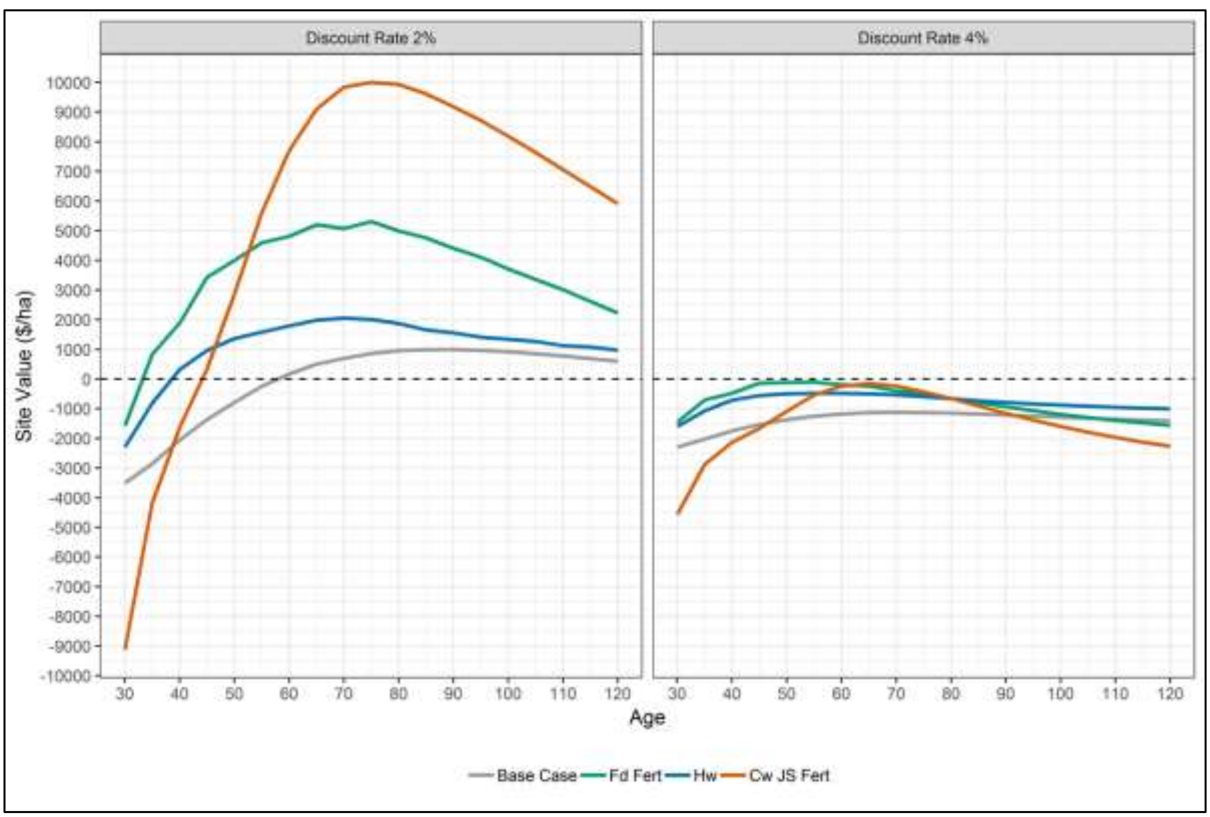

Figure 57: Site value for CWHms1s cool medium to poor productivity future

CWHms1m Warm Future

This analysis unit has no significant forest health issues. Figure 58 shows the projected log volumes and values for:

- Base Case (forest health incorporated);
- Base Case (forest health incorporated) subject to a fertilization regime;
- Regime with a plantation of 1,200 stems per ha (sph) of Hw;
- Regime with a plantation of 1,400 sph of Cw where juvenile spacing to 900 sph favouring Cw is assumed; and, and
- Regime where 1,600 stems per ha (sph) of Fd is planted and fertilized.

As with the two previous analysis units, all regimes are predicted to increase the volume and value per ha compared to the Base Case (forest health incorporated) beyond 50 years with the intensive Fd regime producing the best response in volume and the Cw regime generating the best response in value (Figure 58). However, only the Cw planting and juvenile spacing regime is predicted to increase the value of the stand significantly.

Figure 59 illustrates the site value forecasts for this analysis unit. At a discount rate of 2% all regimes are predicted to be economically viable with the Cw regime creating significantly higher site values beyond 50 years. If the discount rate is increased to 4%, all incremental regimes have similar site value forecasts, while the Base Case (forest health incorporated) generates the best result over the whole forecast period.

Based on the analysis results, the timber and silviculture working group made the following recommendation for this analysis unit in yellow and green silviculture zones:

- 70% intensive Fd regime, 20% Cw regime and 10% Hw regime; volume strategy
- 50% intensive Fd regime and 50% Cw regime; value strategy

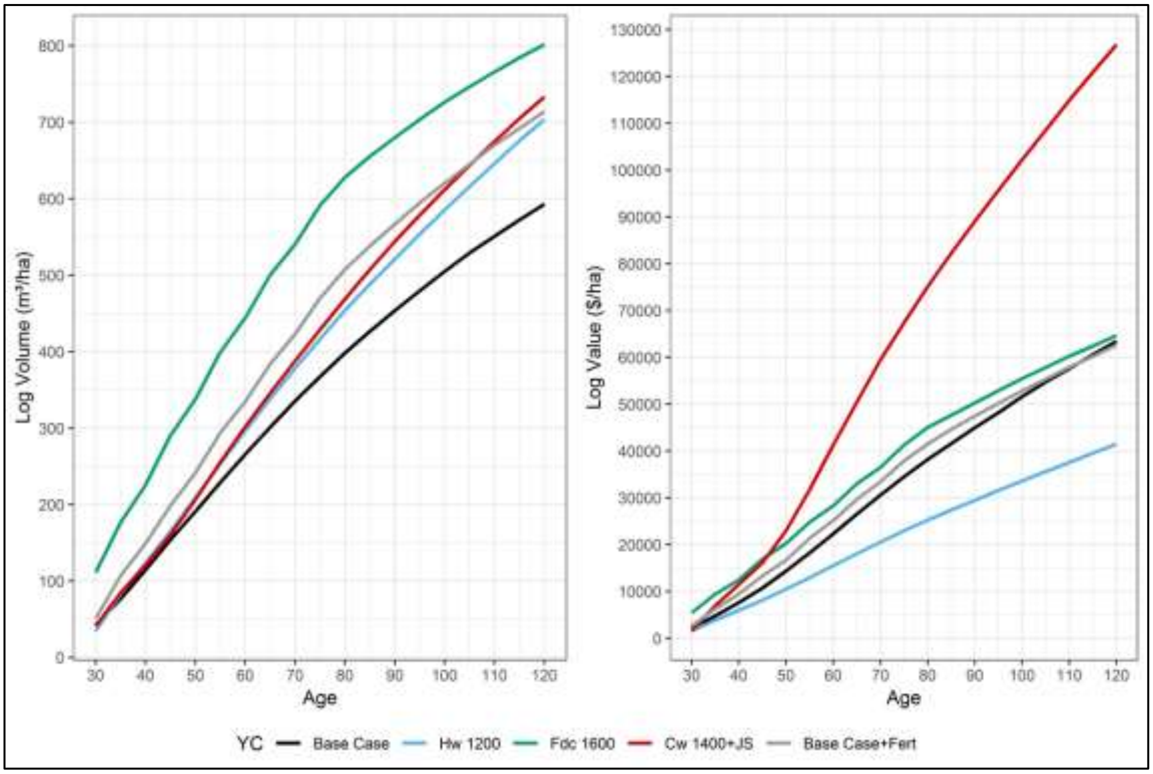

Figure 58: CWHms1m warm future

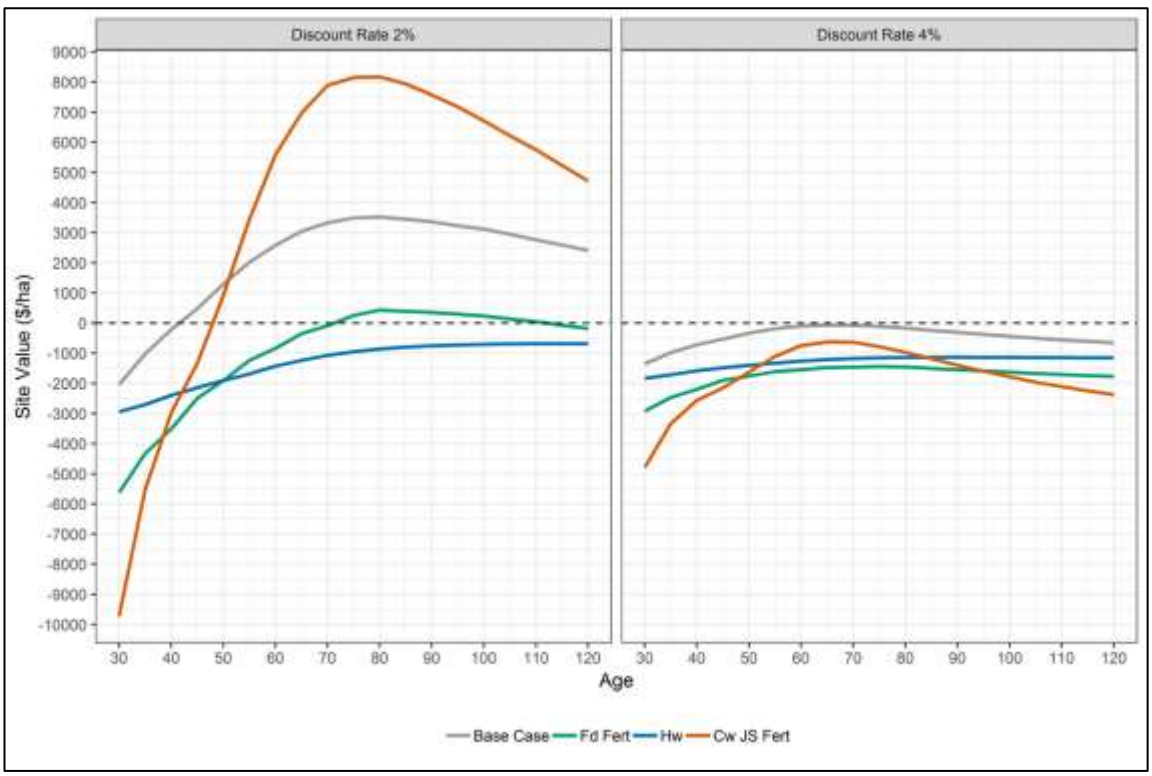

Figure 59: Site value for CWHms1m warm future

CWHvm1 Cool Good Future (SNC, Spruce weevil Hazards)

This analysis unit is prone to SNC and spruce weevil. Figure 60 shows the projected log volumes and values for:

- Base Case (forest health incorporated);
- Regime with a plantation of 1,200 stems per ha (sph) of Hw;
- Regime with a plantation of 1,400 sph of Cw where juvenile spacing to 900 sph favouring Cw is assumed; and, and
- Regime where 1,200 stems per ha (sph) of mixed Hw and Ss is planted[3,4].

All regimes are predicted to significantly increase the volume and value per ha compared to the Base Case (forest health incorporated), with the Hw/Ss regime generating the best volume forecast and the Cw regime producing a superior value projection (Figure 60).

Figure 61 illustrates the site value forecasts for the four regimes. At a discount rate of 2%, all regimes are predicted to be economically viable with the Cw planting and juvenile spacing regime creating the highest site values. If the discount rate is increased to 4%, all enhanced regimes are superior to the Base Case (forest health incorporated), however the spread in performance is greatly reduced. At 4% the Cw regime is still preferred throughout most of the forecast period.

Based on the analysis results, the timber and silviculture working group made the following recommendation for this analysis unit in yellow and green silviculture zones:

- 80% Hw/Ss regime and 20% Hw regime; volume strategy
- 80% Cw regime and 20% Hw/Ss regime; value strategy

[3] Due to the similar growth pattern and spatial requirements on this BEC unit, mixes of Hw and Ss were considered compatible and viable as timber crops for the volume and value scenarios

[4] Assumes that weevil-resistant seed will be used

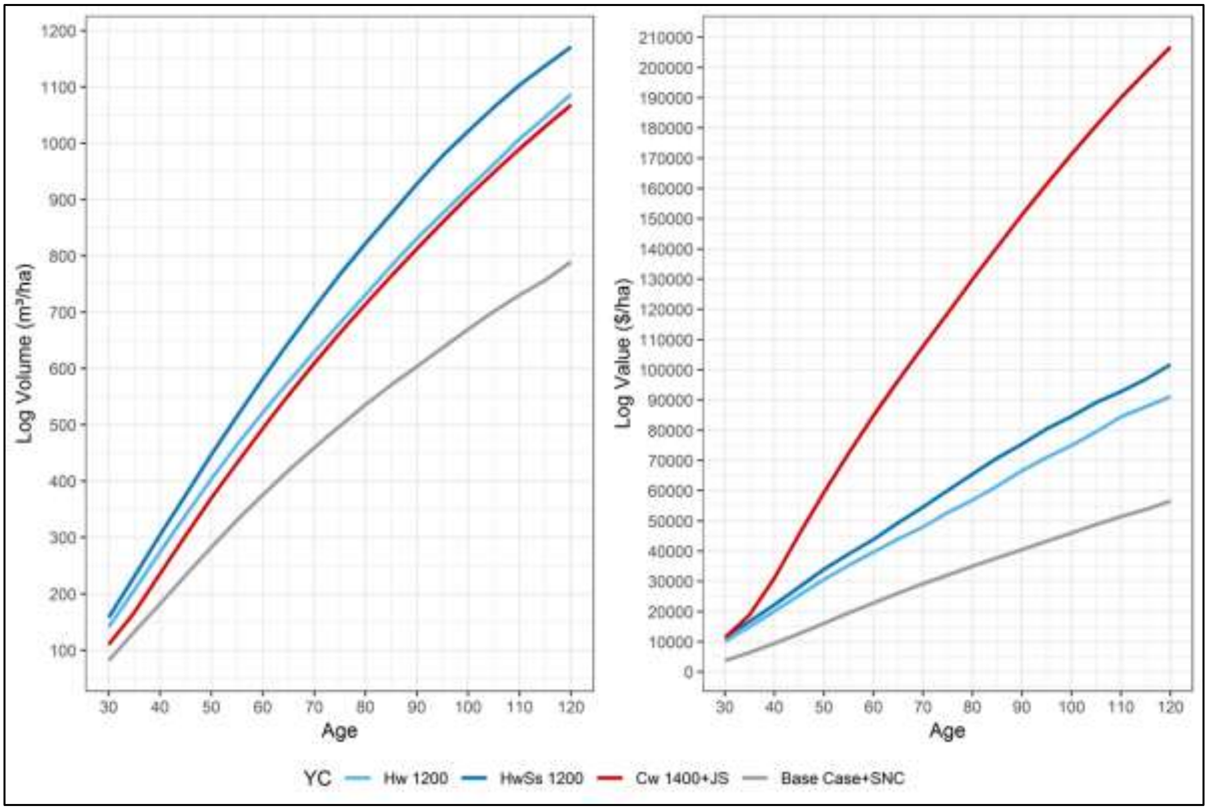

Figure 60: CWHvm1 cool good future (SNC, Spruce weevil hazards)

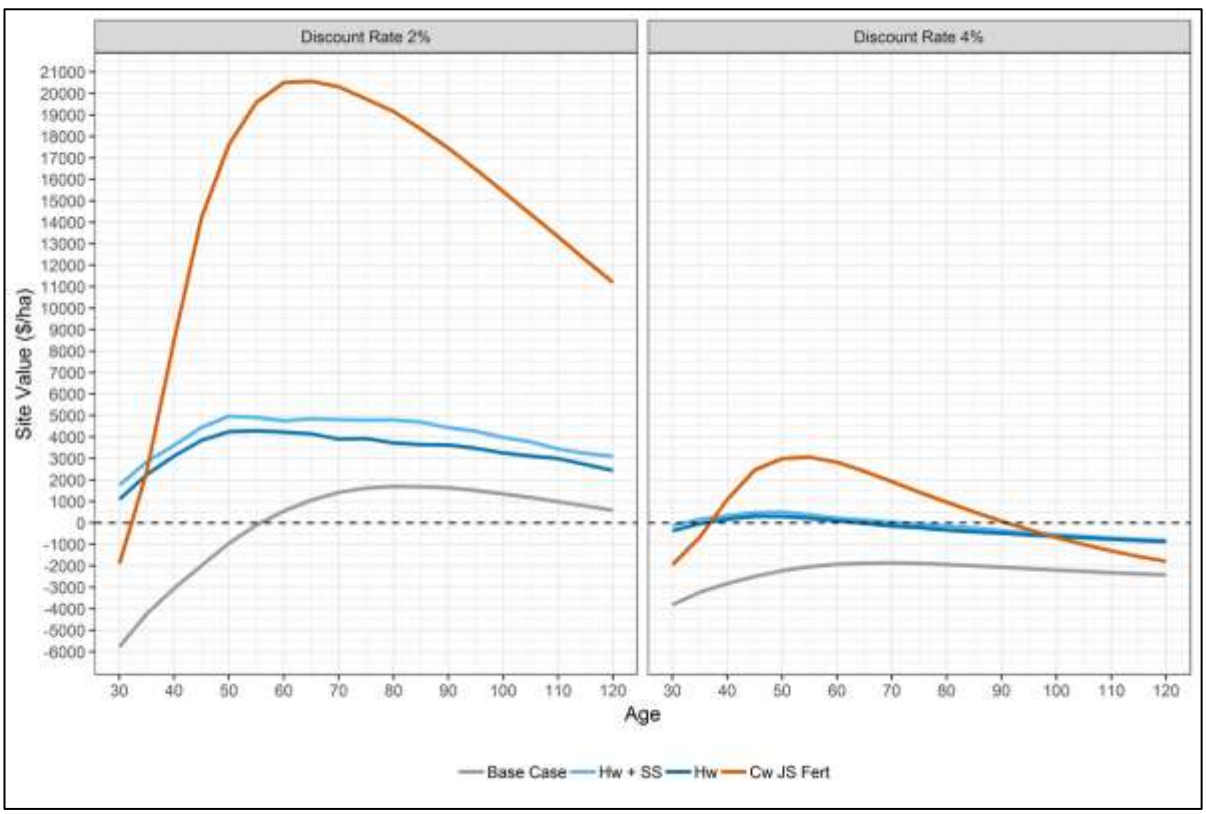

Figure 61: Site value for CWHvm1 cool good future (SNC, Spruce weevil hazards)

CWHvm2 Warm Medium to Poor Productivity Future (Snow Risk on Fd)

This analysis unit has no significant forest health issues; however, the risk of snow damage on Fd exists. Figure 62 shows the projected log volumes and values for:

- Base Case (forest health incorporated);
- Regime with a plantation of 1,200 stems per ha (sph) of Hw and Ss[5];
- Regime with a plantation of 1,400 sph of Cw where juvenile spacing to 900 sph favouring Cw is assumed; and, and
- Regime where 1,600 stems per ha (sph) of Fd is planted and fertilized.

The Fd and Hw/Ss regimes are predicted to significantly increase the volume per ha compared to the Base Case (forest health incorporated) with the Cw regime being moderately better than the Base Case (forest health incorporated) after about 70 years (Figure 62). For the value forecasts, the Cw regime is substantially better than any of the alternatives after 50 years, with the Fd regime being a reasonable improvement on the Base Case (forest health incorporated). On the other hand, the Hw/Ss regime generates a similar to slightly poorer value forecast than the Base Case (forest health incorporated).

Figure 63 compares the site value forecasts for the four regimes. At a discount rate of 2% only the Cw regime is economically viable compared to the Base Case (forest health incorporated). The Fd regime is marginally worse than the Base Case (forest health incorporated) beyond 80 years, which indicates that a component of the sites represented by this analysis unit could be financially viable with this regime. With a 4% discount rate even the Cw regime is only marginally viable between years 50 and 65.

Based on the analysis results, the timber and silviculture working group made the following recommendation for this analysis unit in yellow and green silviculture zones:

- 70% Hw/Ss regime and 30% Fd regime; volume strategy
- 70% Cw regime and 30% Fd regime; value strategy

[5] Due to the similar growth pattern and spatial requirements on this BEC unit, mixes of Hw and Ss were considered compatible and viable as timber crops for the volume and value scenarios

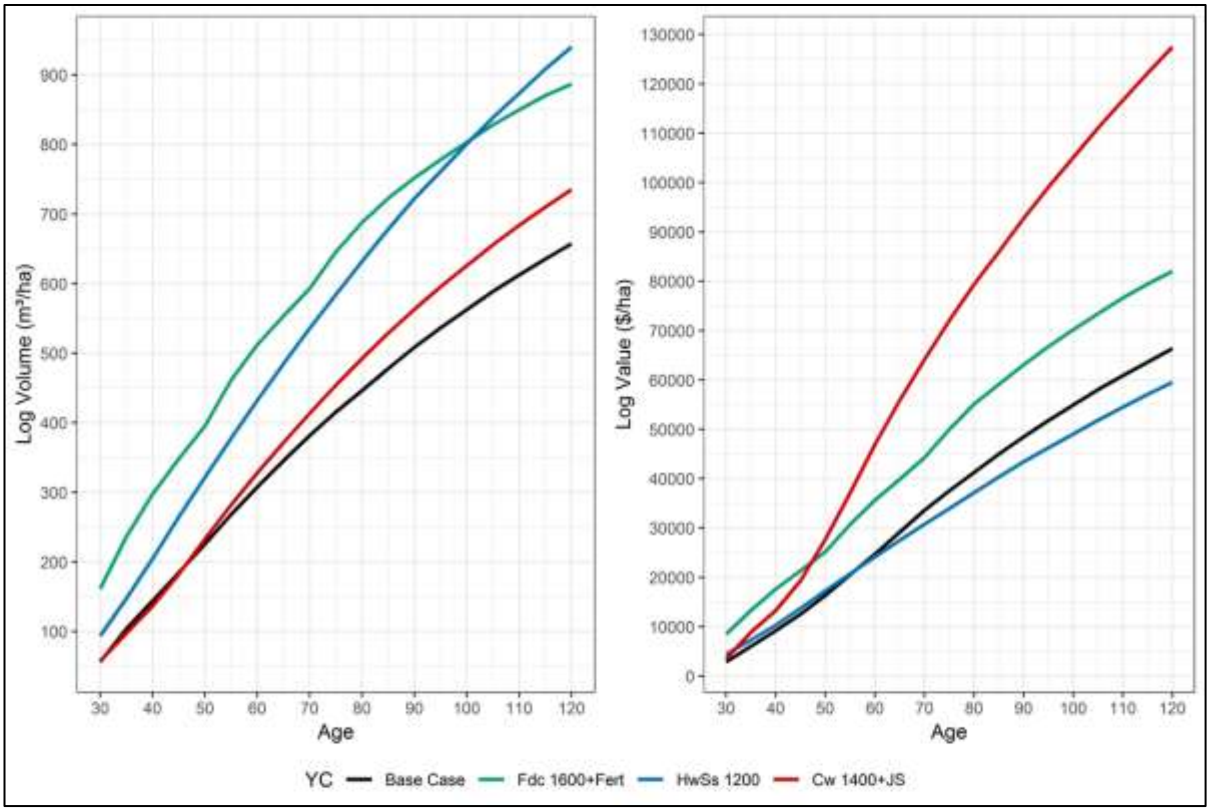

Figure 62: CWHvm2 warm medium to poor productivity future (snow risk on Fd)

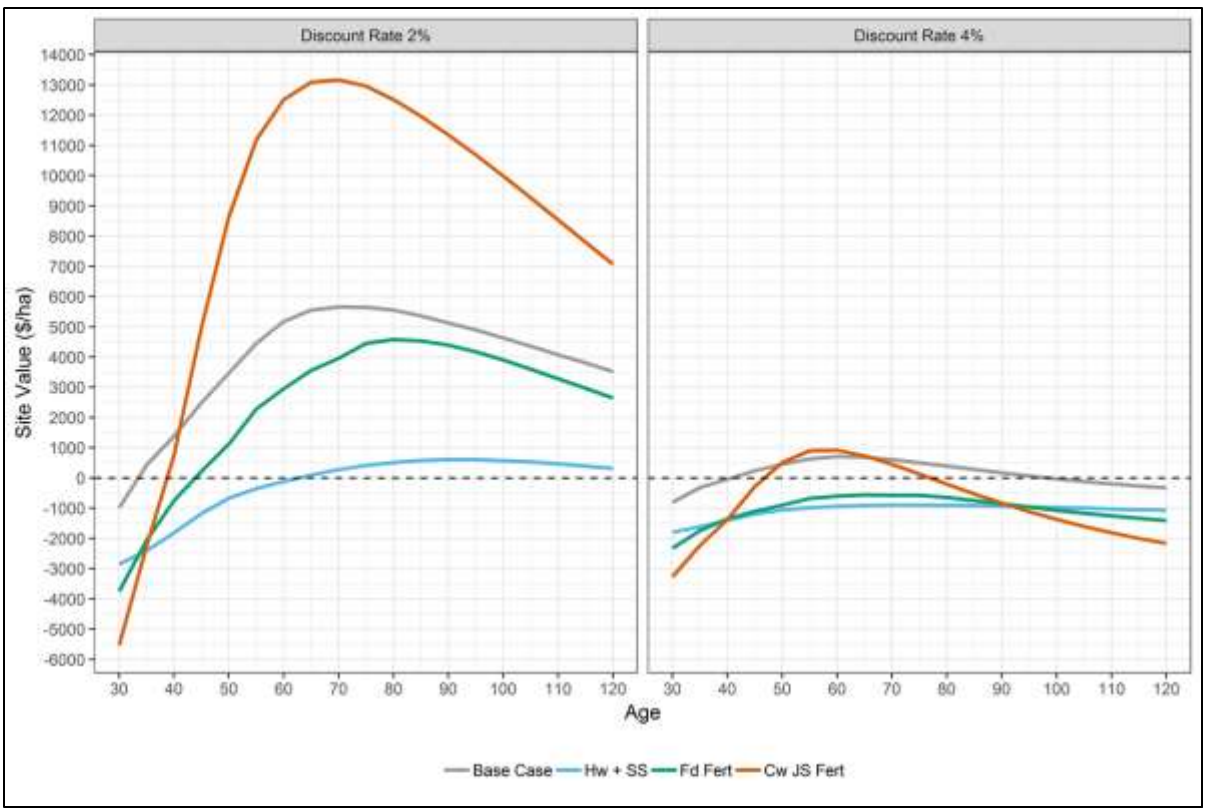

Figure 63: Site value for CWHvm2 warm medium to poor productivity future (snow risk on Fd)

Silviculture Regimes in Elk Hazard Areas

Experience has shown that in moderate and high elk hazards areas currently occupied by resident elk populations, reforestation regularly fails and requires multiple efforts to re-plant failed plantations. This is expensive and may not be cost effective. Even with multiple plantings, established stands generally remain sparse, with irregular distribution of seedlings of less valuable species. Producing valuable timber stands may not be possible in these areas. An alternative could be to reduce the reforestation targets and therefore the expenditures on these sites. The money saved on the elk hazard sites could then be allocated to enhanced reforestation on preferred sites in non-elk hazard zones. These concepts were explored by the timber and silviculture working group as components of the volume and value scenarios.

The forest health scenario, which was adopted as the reference harvest forecast against the volume and value scenarios, includes assumptions regarding the locations of significant current elk damage. Furthermore, predictions are made about where elk damage it is expected to occur in the future based on the government plans for elk management. Based on the current estimates of reforestation costs and reforestation failures elk hazard areas, alternative reforestation regimes were developed for the main analysis units in elk hazard areas (Table 12). The regimes focus on Dr, Hw and Ss. These are ecologically appropriate species for the growing sites and historically not susceptible to elk damage.

Table 12: Reforestation regime options for elk hazard areas for volume/value scenarios

BEC Unit	Sp1/Target Planting (sph)/ Treatments	Sp2/Target Planting (sph)/ Treatments
CWHdm cool good (RR, SNC, Elk)	HwSs/600	Dr/900
CWHvm1 cool good (RR, Elk)	HwSs/600	Dr/900

Elk Zones; CWHdm Cool Good Future

This analysis unit is in elk hazard areas. It is also prone to root rot, SNC and Spruce weevil. Figure 64: shows the projected log volumes and values for:

- Base Case (forest health incorporated). Also included is a 4-year regeneration delay with two fill-plants);
- Regime with a plantation of 900 stems per ha (sph) of Dr with no re-planting required; and,
- Regime where 600 stems per ha (sph) of Hw and SS are planted[6] with one fill-plant required.

The Hw/Ss regime is forecast to significantly improve the volume and value outcomes compared to the Base Case (forest health incorporated) (Figure 64). If short rotations are employed (<50 years), Dr planting also creates somewhat more volume and value than the Base Case (forest health incorporated).

Figure 65: illustrates the site value forecasts for the three regimes. Note the Base Case (forest health incorporated) with two Fd fill plants. The assumed costs for the different regimes are:

[6] Assumes that weevil-resistant seed will be used

- Base Case (forest health incorporated) is approximately $2,200/ha,
- The Hw/Ss regime is estimated to cost $780 per ha; and,
- The approximate cost of the Dr regime is $1,110 per ha.

At 2 and 4% discounts rates both alternative regimes have similar site value forecasts and both regimes show better results than the Base Case (forest health incorporated).

Based on the analysis results, the timber and silviculture working group made the following recommendation for this analysis unit in elk hazard areas:

- 50% Hw/Ss regime and 50% Dr regime

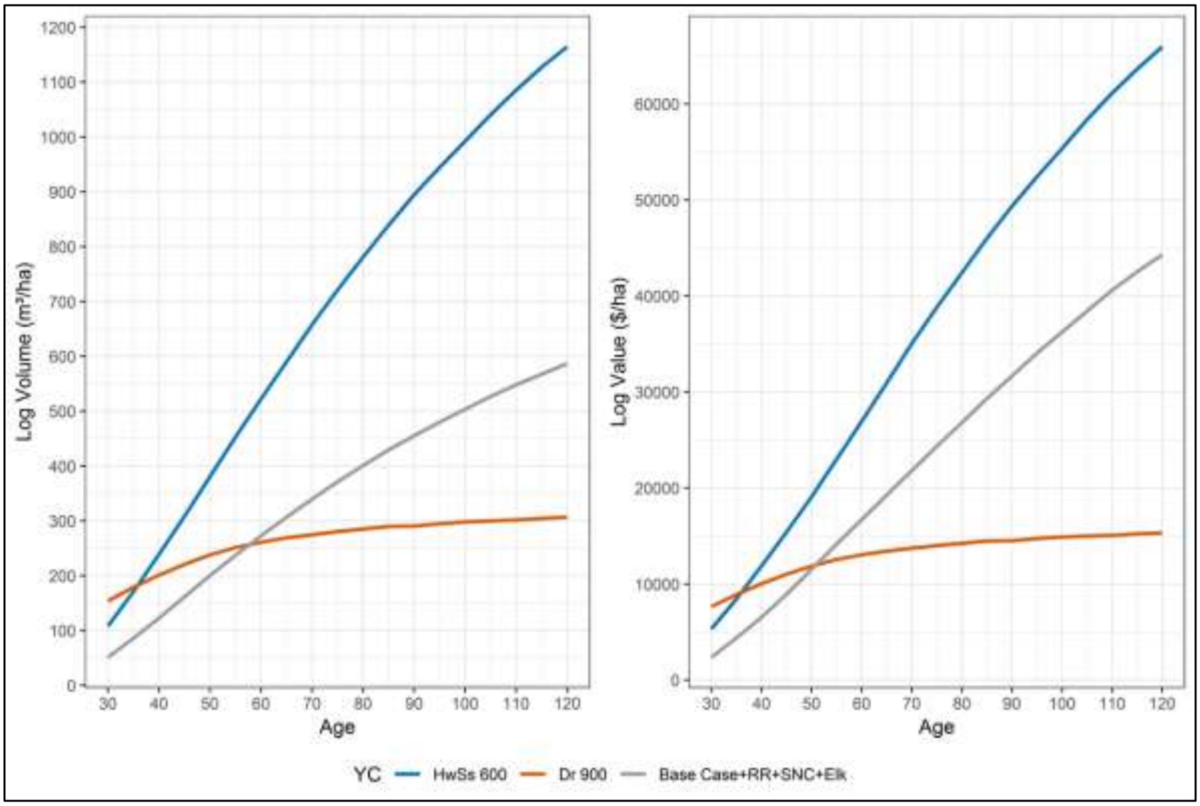

Figure 64: Elk zones; CWHdm cool good future (root rot, SNC, spruce weevil hazards)

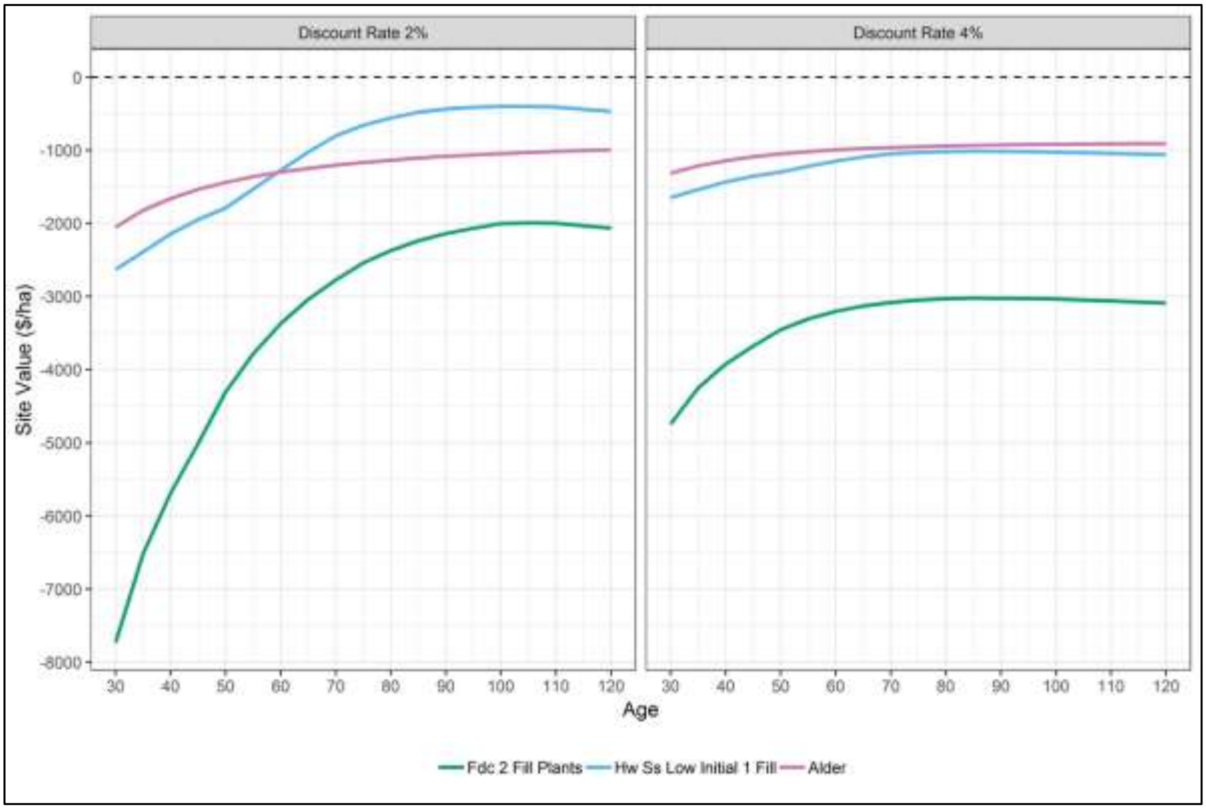

Figure 65: Site value for Elk zones; CWHdm cool good future (root rot, SNC, spruce weevil hazards)

Elk Zones; CWHvm1 Cool Good Future

This analysis unit is in elk hazard areas. It is also prone to SNC and Spruce weevil. Figure 66: shows the projected log volumes and values for:

- Base Case (forest health incorporated). Also included is a 4-year regeneration delay with two fill-plants;
- Regime with a plantation of 900 stems per ha (sph) of Dr with no re-planting required; and,
- Regime where 600 stems per ha (sph) of Hw and SS are planted[7] with one fill-plant required.

The Hw/Ss regime is forecast to significantly improve the volume and value outcomes compared to the Base Case (forest health incorporated) (Figure 66). If short rotations are employed (<50 years), Dr planting also creates somewhat more volume and value than the Base Case (forest health incorporated).Figure 67: illustrates the site value forecasts for the three regimes. Note the Base Case (forest health incorporated) with two Fd fill plants. The assumed costs for the different regimes in the Upper Pitt or Upper Stave River areas are:

- Base Case (forest health incorporated) is approximately $3,000/ha,
- The Hw/Ss regime is estimated to cost $980 per ha; and,
- The approximate cost of the Dr regime is $1,360 per ha.

[7] Assumes that weevil-resistant seed will be used

At 2% and 4% discounts rates both alternative regimes have better site value forecasts than Base Case (forest health incorporated). With a 2% discount rate the Hw/Ss regime shows better results than the Dr regime for rotations beyond 60 years.

Based on the analysis results, the timber and silviculture working group made the following recommendation for this analysis unit in elk hazard areas:

- 50% Hw/Ss regime and 50% Dr regime

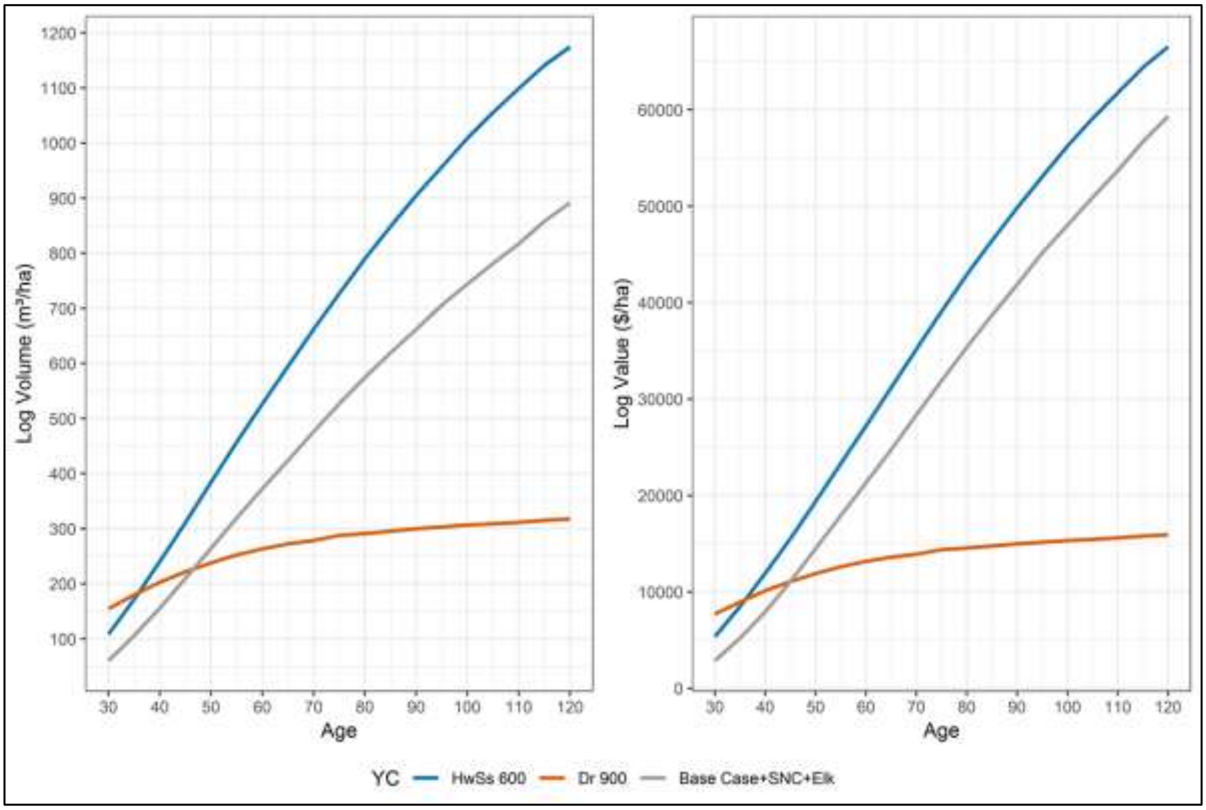

Figure 66: Elk zones; CWHvm1 cool good future (SNC, Spruce weevil hazards)

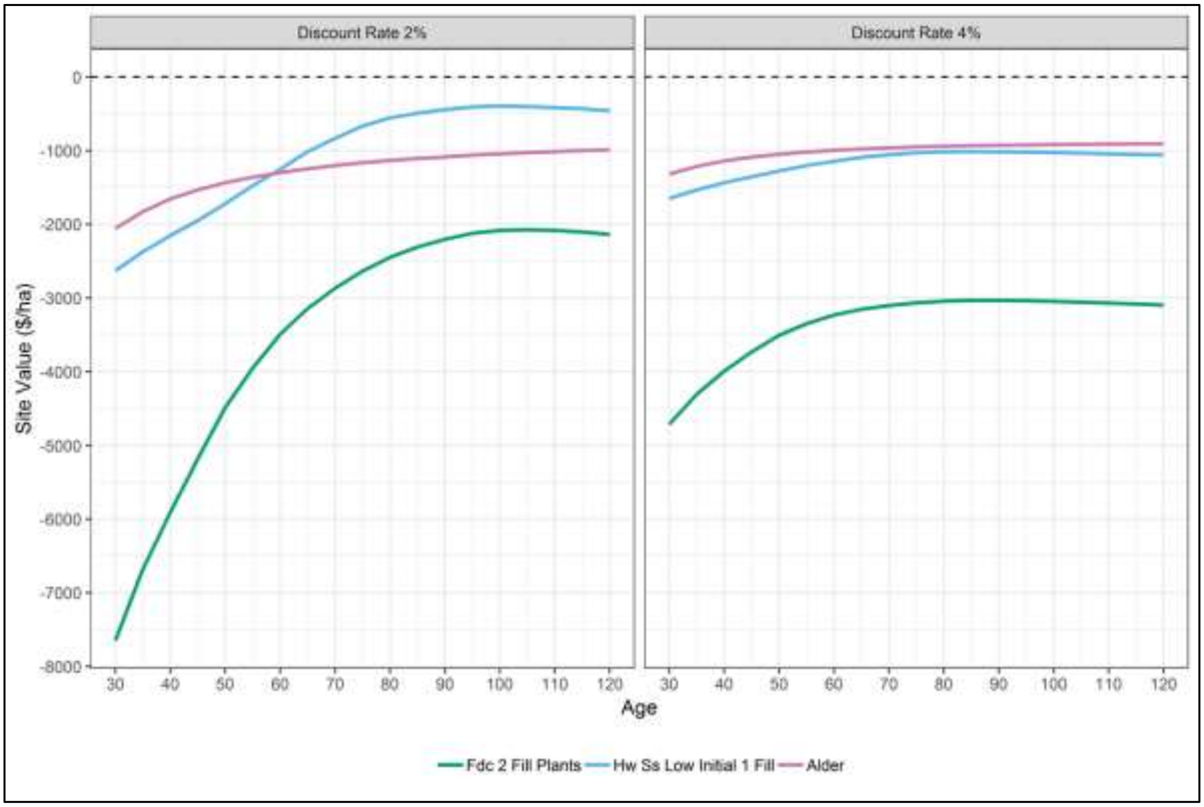

Figure 67: Site value for elk zones; CWHvm1 cool good future (SNC, Spruce weevil hazards)

4.3.5 Forest Level Results; Volume Strategy 1

In this scenario a portion of the Fd leading existing and future managed stands were fertilized on green and yellow silviculture zones every 10 years from age 30 to 70 years. The future managed stands were assumed to be established via mixed species planting. Figure 68 illustrates the impact; the long-term impact is +2.3%, while the short-term impact is +4.3%; the short-term impact is not meaningful, as it is a modelling artifact.

The strategy increases the Fd harvest forecast (Figure 69). Also, per ha volumes in the long term are expected to be higher (Figure 71). The value per ha of managed stands is predicted to be marginally higher than in the scenario accounting for forest health and elk (Figure 72).

Figure 73 and Figure 74 show the predicted annual treatment area and predicted annual incremental silviculture expenditures. Based on a cursory review of the long-term costs and benefits, average annual expenditures of about $750,000 on fertilizer treatments result in a timber supply gain of about 25,000m^3 per year or about 2.3%. This is not significant.

MAMU habitat, spotted owl habitat or NOGO forage habitat was either not impacted, or the impact was negligible.

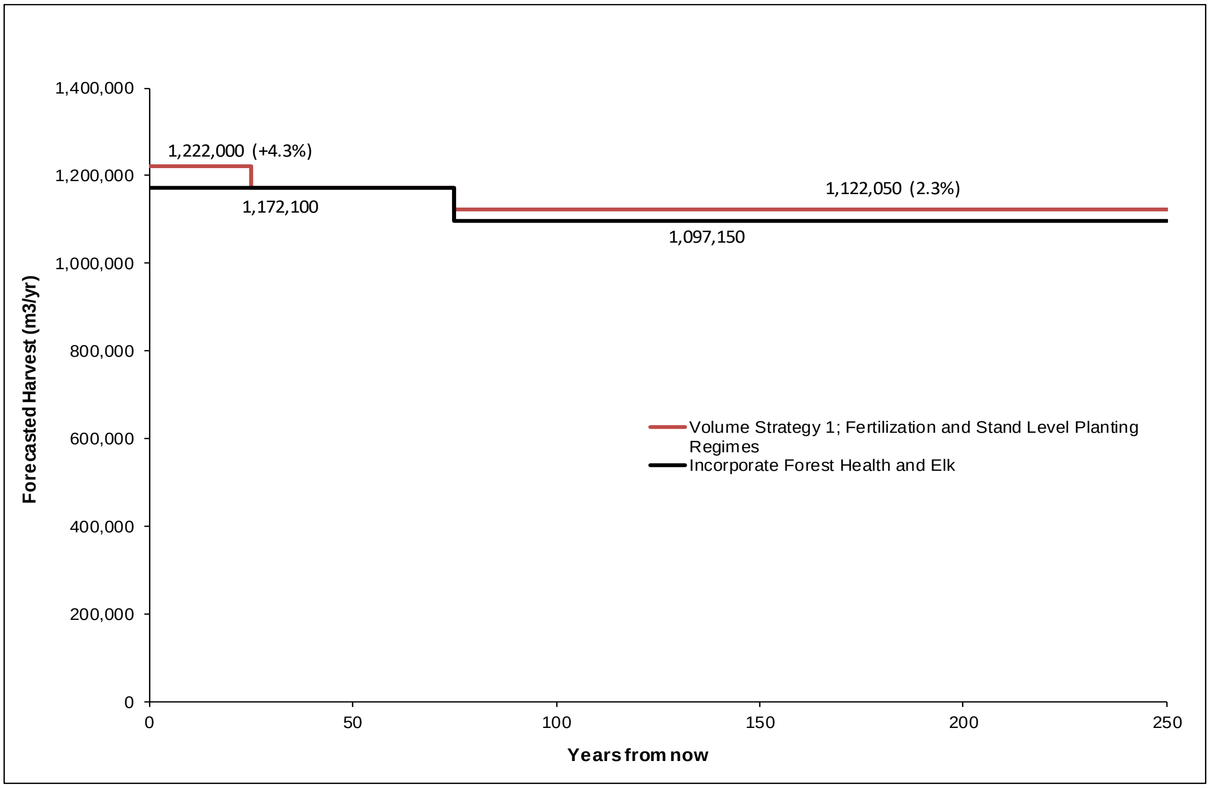

Figure 68: Volume strategy 1; harvest forecast

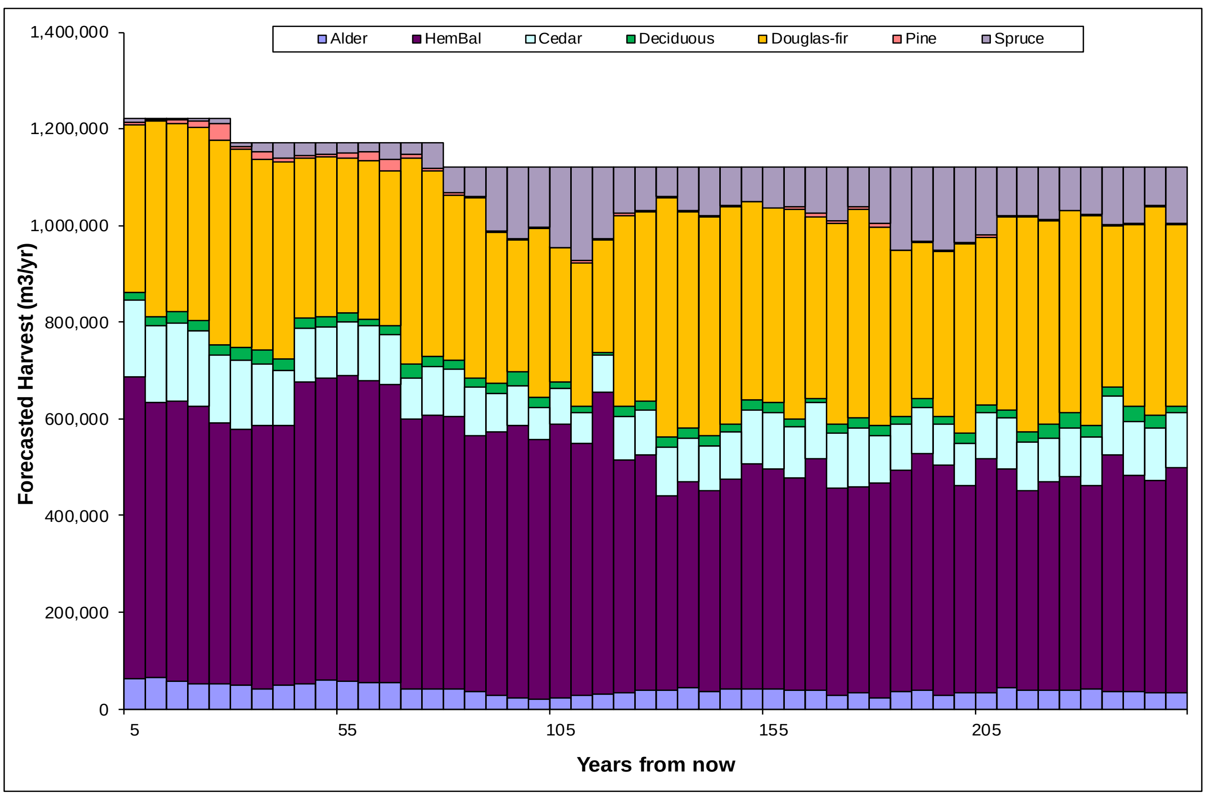

Figure 69: Volume strategy 1; harvest forecast by species

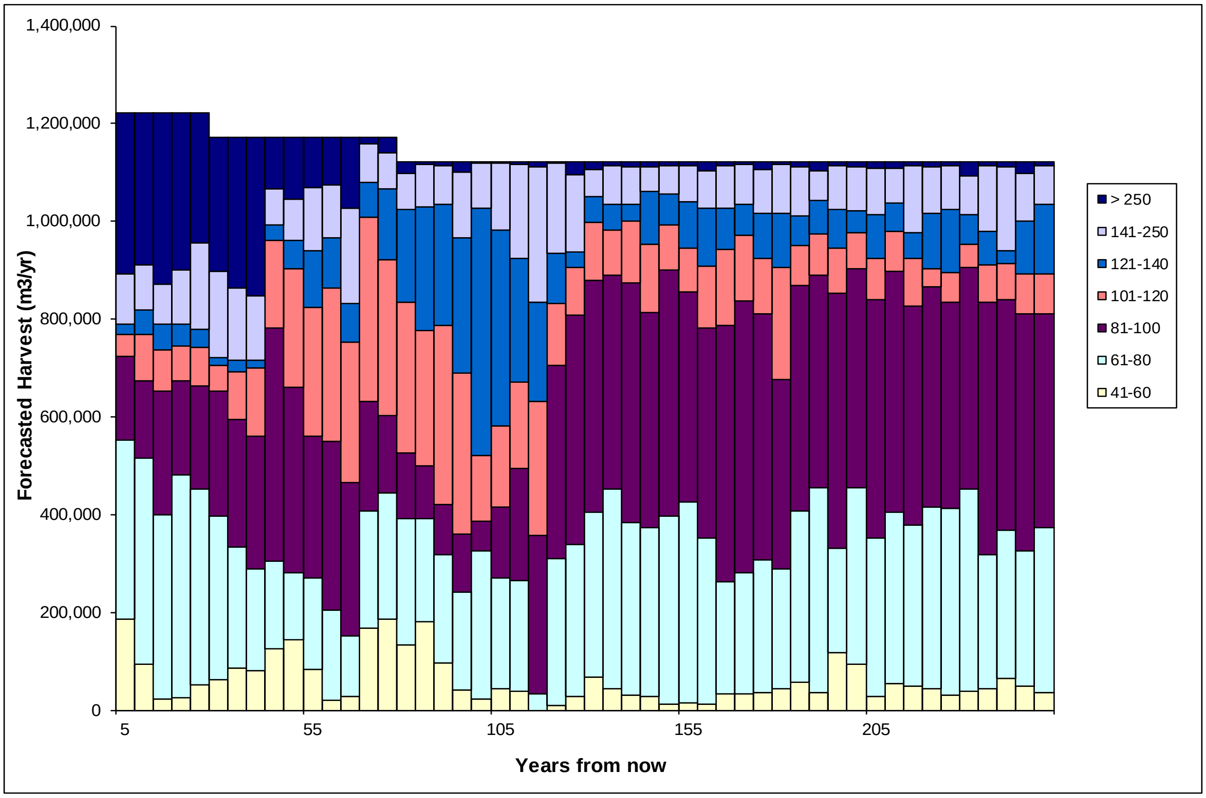

Figure 70: Volume strategy 1; harvest forecast by age class

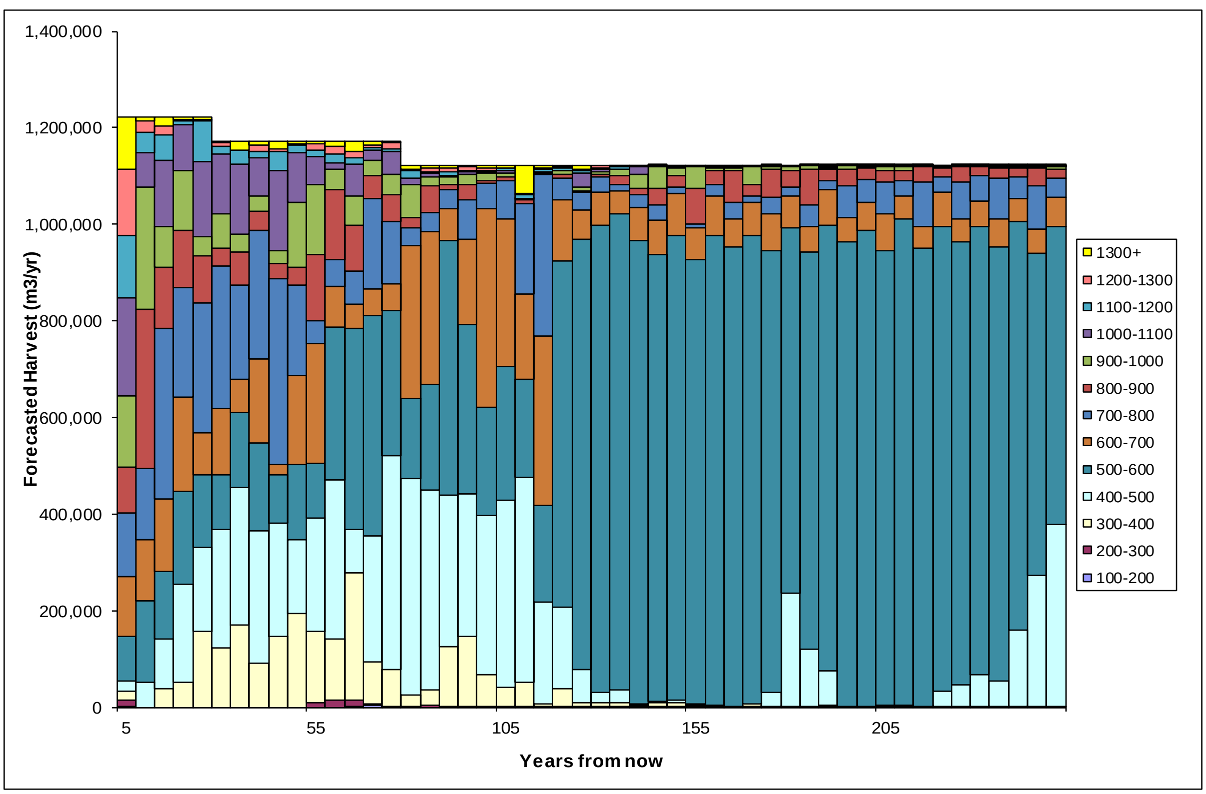

Figure 71; Volume strategy 1; harvest forecast by volume per ha class

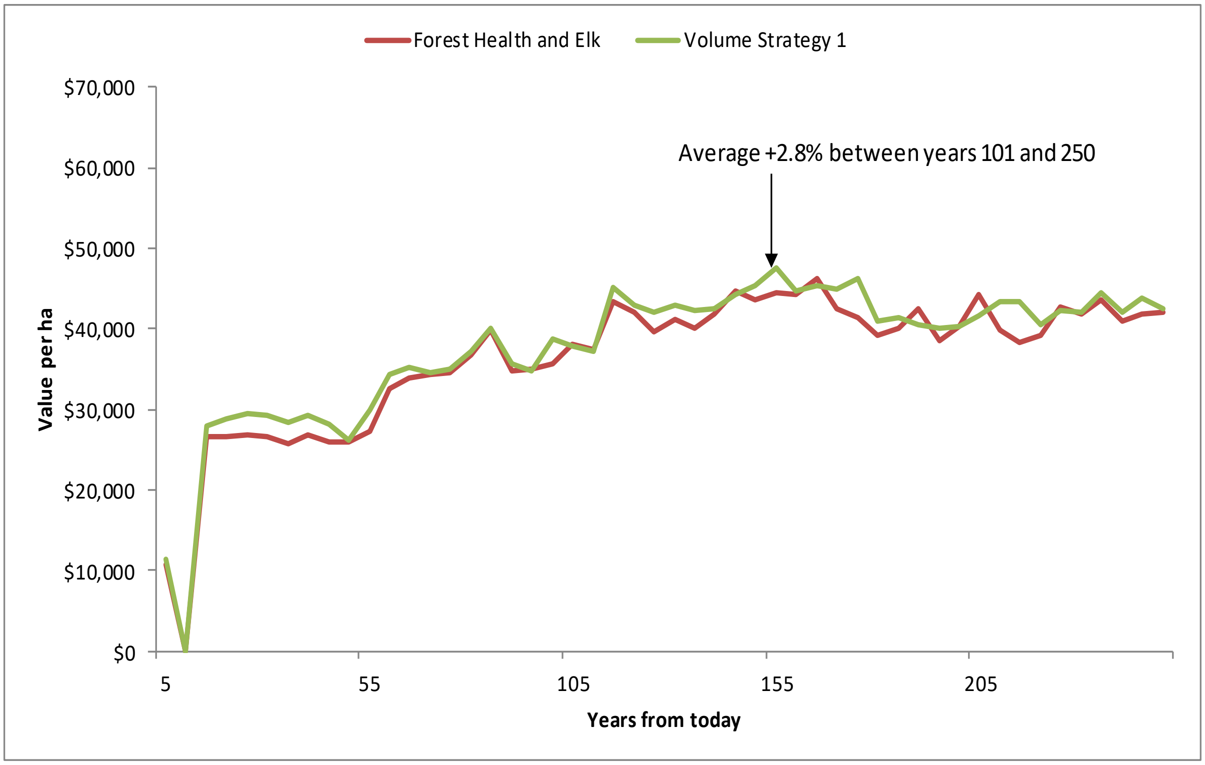

Figure 72; Volume strategy 1; value per ha forecast, managed stands only

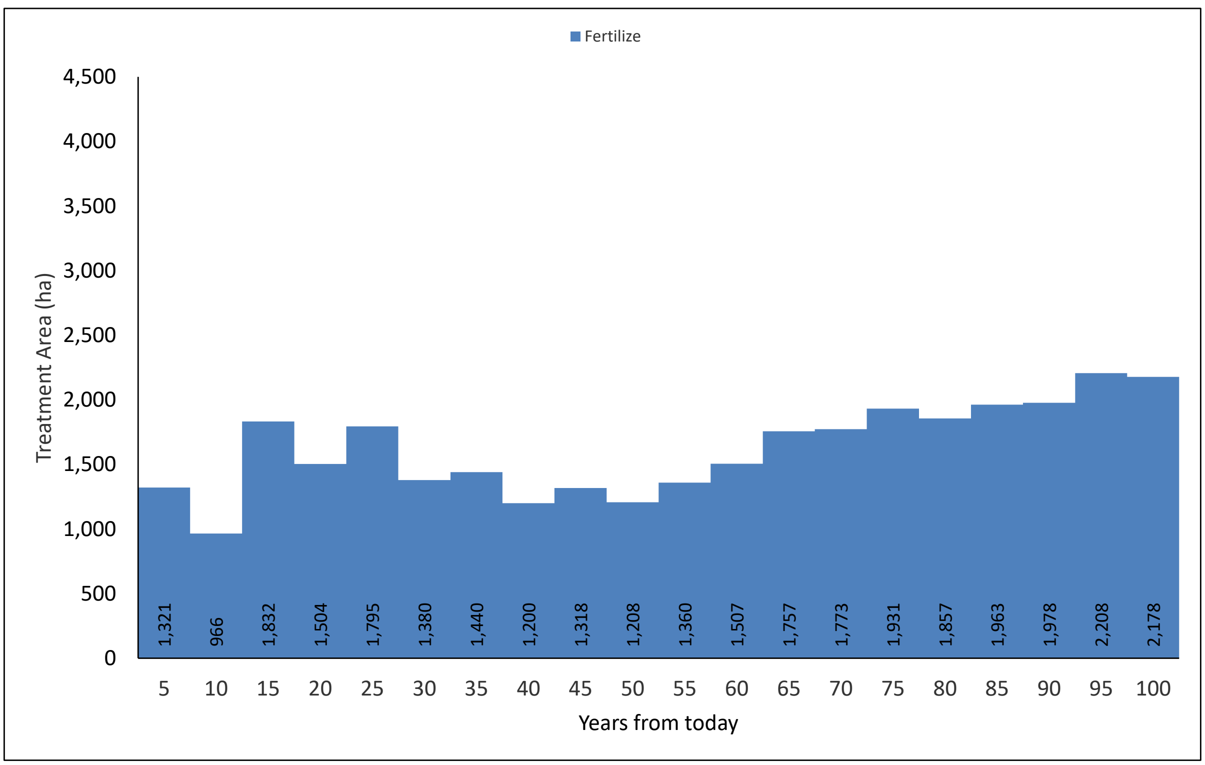

Figure 73; Volume strategy 1; forecasted treatment areas

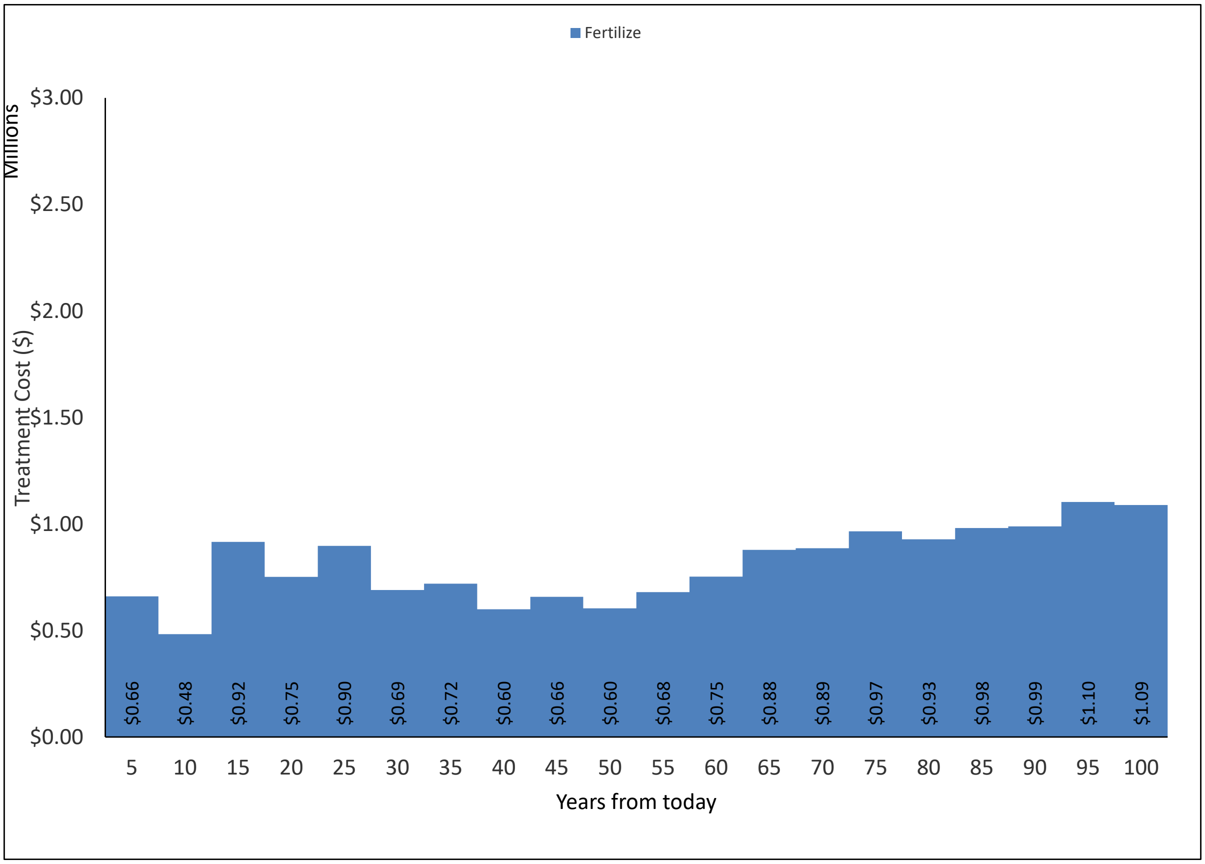

Figure 74; Volume strategy 1; forecasted silviculture expenditures

4.3.6 Forest Level Results; Volume Strategy 2

The following summarizes Volume Strategy 2:

- A mosaic of ecologically suitable single species stands with enhanced densities specifically designed to optimize the production and value of each species were established ("unmix the mixes") on medium to good sites. These sites are expected to be managed primarily for timber. The species portfolio for each BEC unit was developed in consideration of climate change through the use of Climate Change Informed Species Selection (CCISS) tool and forest health risks;
- Average expected genetic worth for each species from seed available under the Climate Based Seed Transfer (CBST) rules was used;
- On operable sites where root rot is a hazard, stumping was assumed with Fd and Hw regimes;
- On SNC hazard sites, the Fd percent was reduced in the species portfolio;
- Reduced stocking was assumed on sites with high or moderate elk hazard;
- High future log prices were assumed for all enhanced regimes;
- Fd stands were fertilized every 10 years from 30 to 70 years.

Figure 75 illustrates the volume impact; the long-term impact is +15.0%, while the short-and mid-term impacts are +3.4% and 10.5% respectively. The strategy increases the Fd harvest forecast further (Figure 76). Also, per ha volumes in the long term are expected to be higher than those in the reference scenario (Incorporate Forest Health and Elk) and somewhat higher than the ones produced by Volume Scenario 1 (Figure 78).

The large difference in the harvest volume forecasts between Volume Scenario 1 and Volume Scenario 2 is attributable to different regeneration assumptions and the spatial distribution of various tree species in planted areas. Volume Scenario 2 employs enhanced reforestation regimes (high densities) with higher genetic worth seed available through CBST. Also, this scenario generates more well-stocked contiguous planted Fd forests by creating a mosaic of ecologically suitable single species stands, which increases the fertilization efficiency.

The value per ha of managed stands is predicted to be somewhat higher than the reference scenario incorporating forest health (Figure 79) and slightly higher than for Volume Scenario 1.

Figure 80 and Figure 81 show the predicted annual treatment areas and predicted annual incremental silviculture expenditures. Note that this strategy proposes higher planting densities on selected sites in the TSA. This strategy also proposes to reduce planting densities for high and moderate elk hazard areas. The reduced planting densities result in cost savings; the additional planting costs shown in Figure 81 depict the net costs, i.e. the difference between increased and decreased planting costs.

MAMU habitat, spotted owl habitat or NOGO forage habitat was either not impacted, or the impact was negligible.

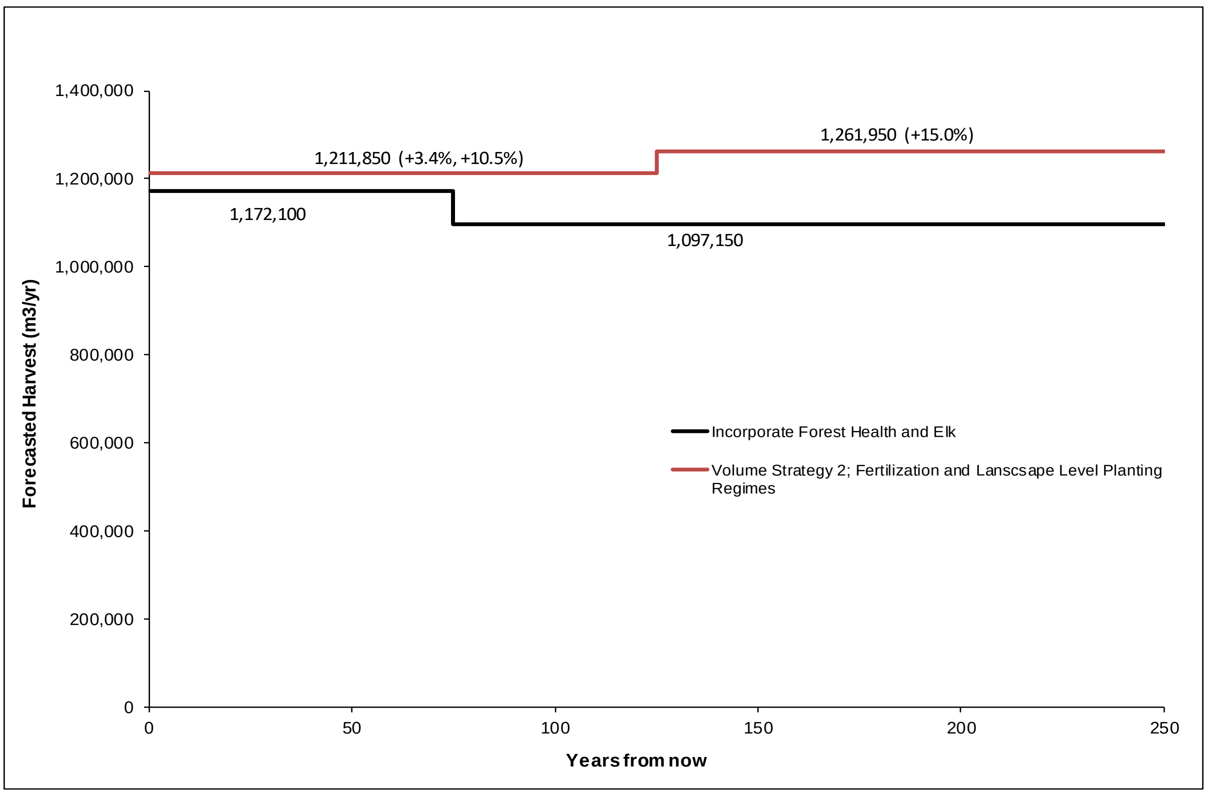

Figure 75: Volume strategy 2; harvest forecast

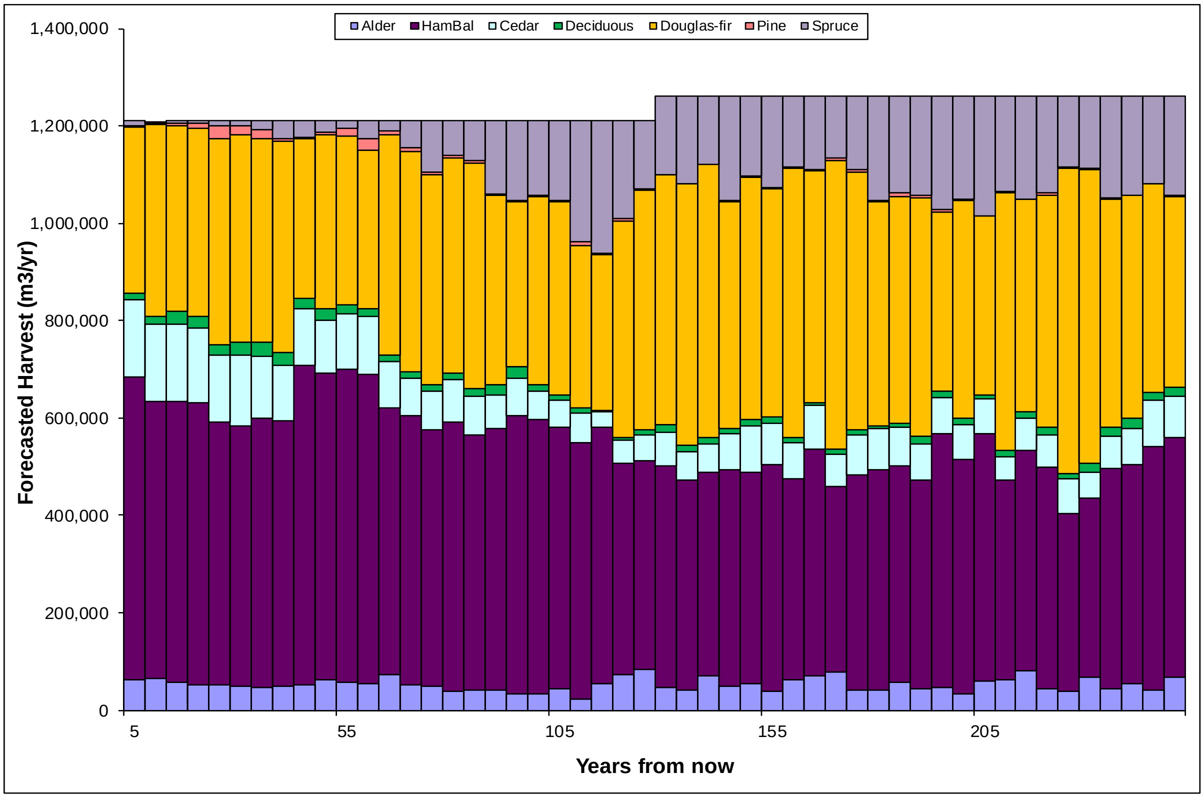

Figure 76: Volume strategy 2; harvest forecast by species

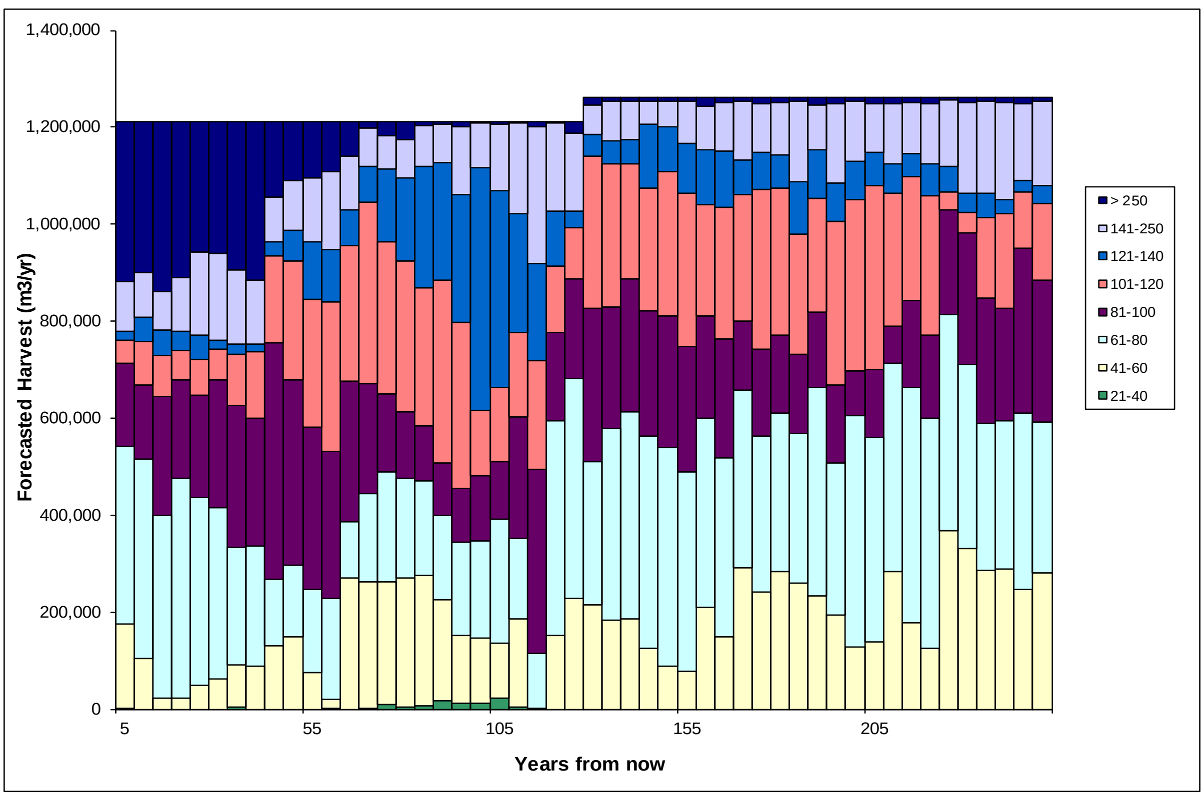

Figure 77: Volume strategy 2; harvest forecast by age class

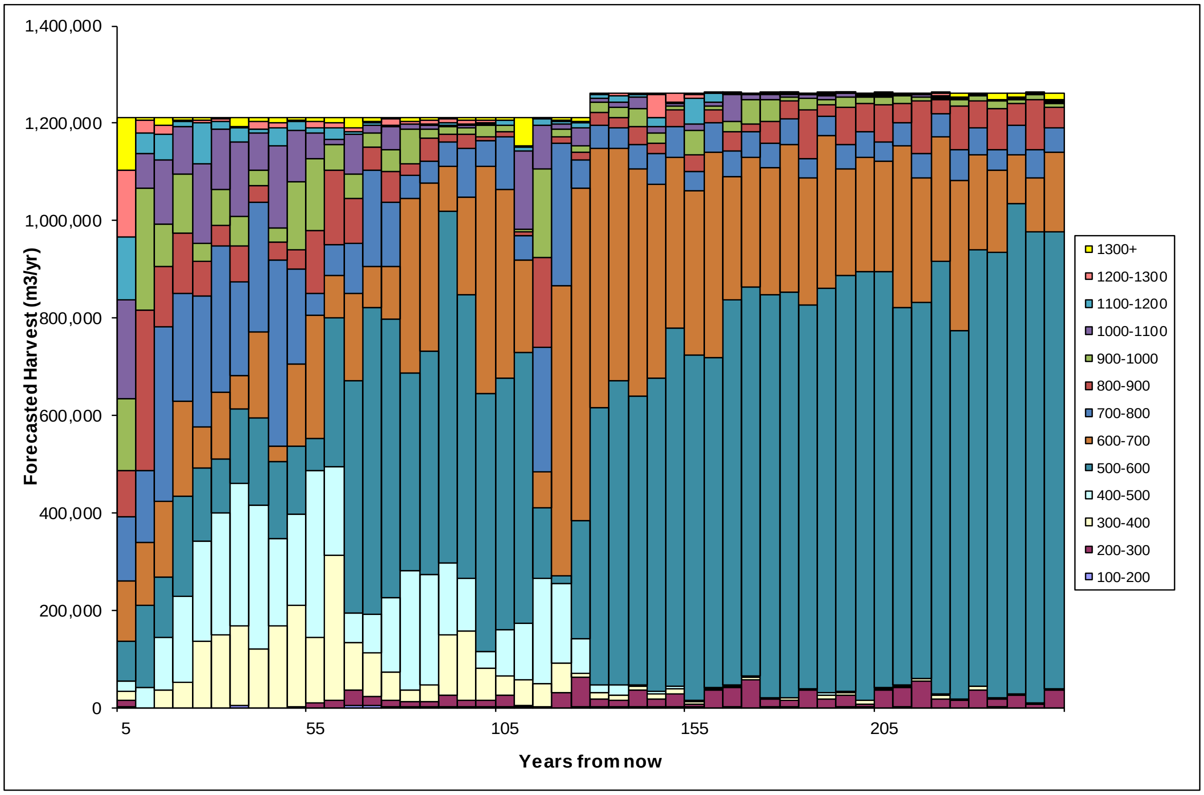

Figure 78: Volume strategy 2; harvest forecast by volume per ha class

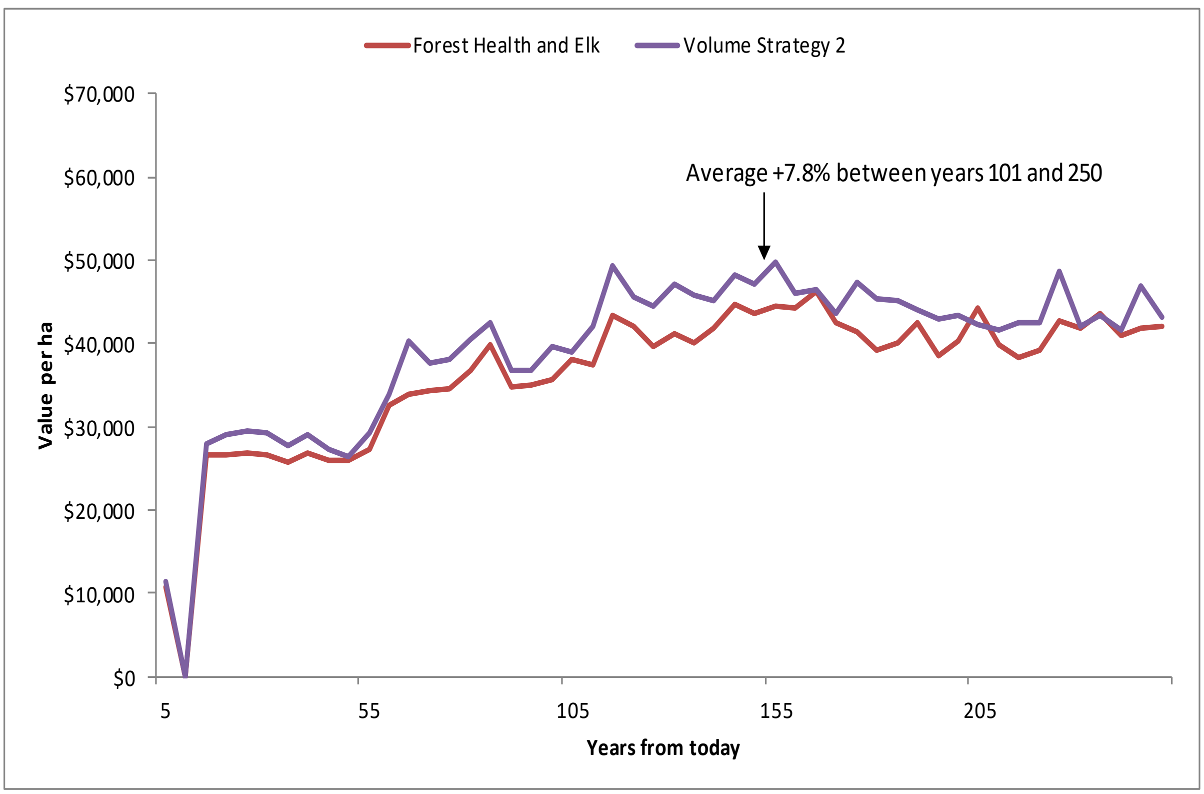

Figure 79: Volume strategy 2; value per ha forecast, managed stands only

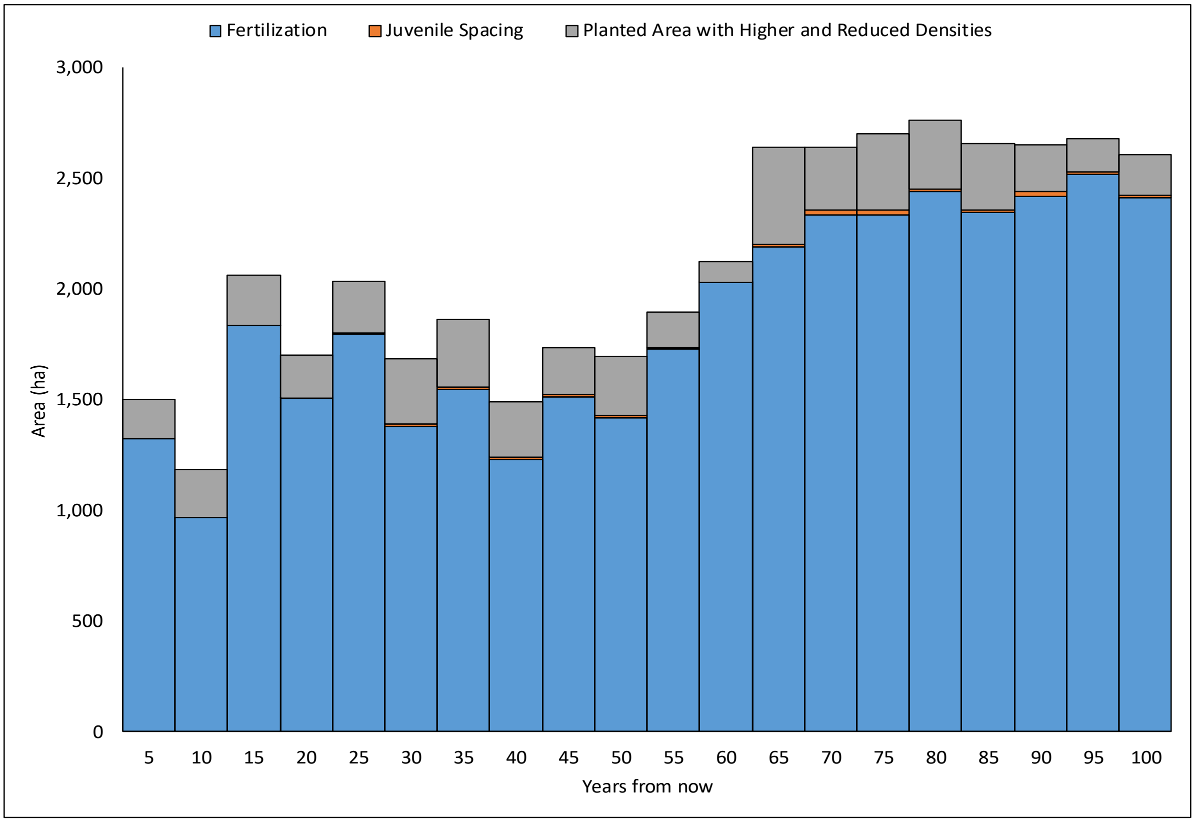

Figure 80; Volume strategy 2; forecasted annual treatment area

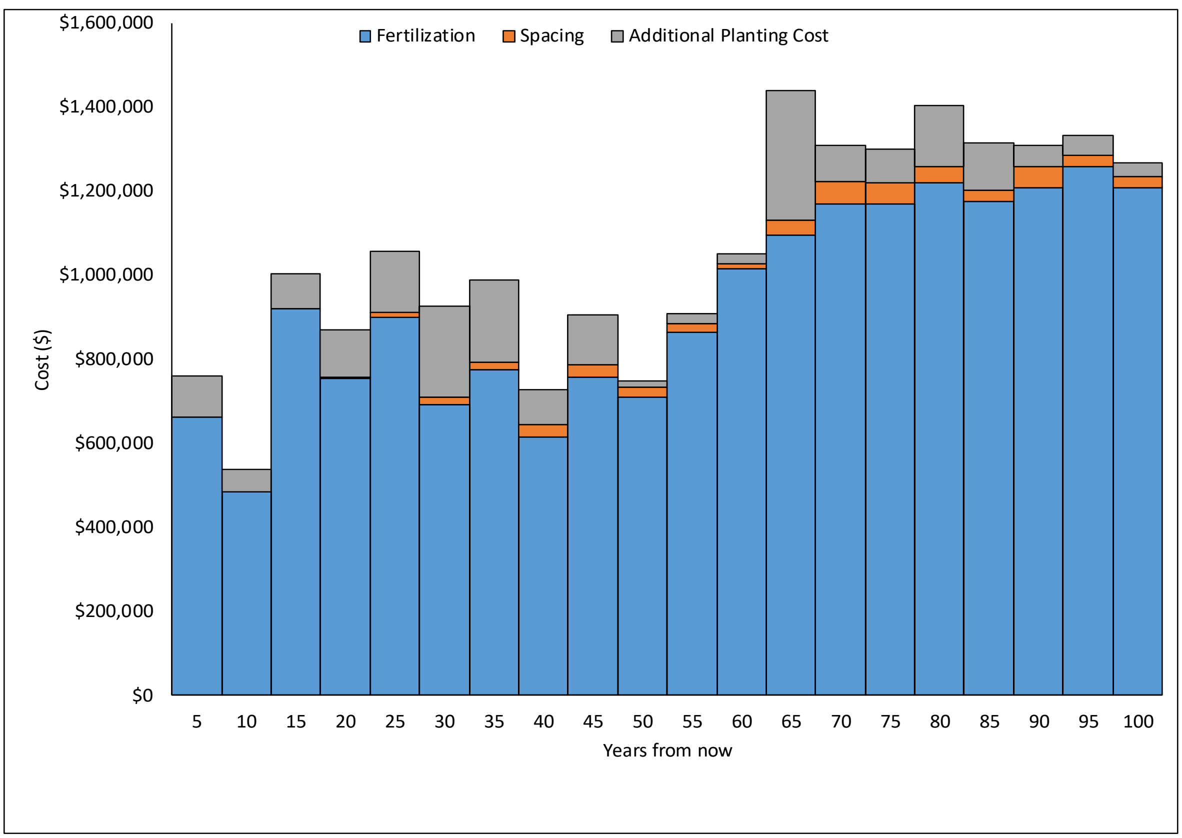

Figure 81: Volume strategy 2; forecasted annual expenditures

4.3.7 Forest Level Results; Value Strategy

Value Strategy is like Volume Strategy 2 with the following exceptions:

- Include Cw planting and juvenile spacing favoring Cw where ecologically appropriate on yellow and green silviculture zones;
- Assume high log prices for all enhanced Cw regimes;
- In addition to Cw, focus on planting Fd where appropriate to maximize timber value.

4.4 Selected Scenario

The analysis results were presented to the Fraser ISS implementation group in February 2018. The group agreed that the value scenario presented here is also the selected strategy/scenario and will serve as the basis for the Fraser TSA Integrated Silviculture Strategy.

4.4.1 Harvest Forecast

Figure 82 illustrates the harvest forecast for the selected scenario. Some volume is compromised when attempting create value compared to the Volume Strategy 2. The long-term impact is +12.7% increase in harvest forecast rather than +15.0% achieved in Volume Strategy 2 when compared to the scenario that incorporated forest health and elk.

Figure 83 illustrates the predicted development of the growing stock for the Selected Scenario. The stable long-term growing stock indicates a sustainable timber supply. The analysis was run for 400 years to ensure the sustainability of the long-term harvest level (shown only for 250 years).

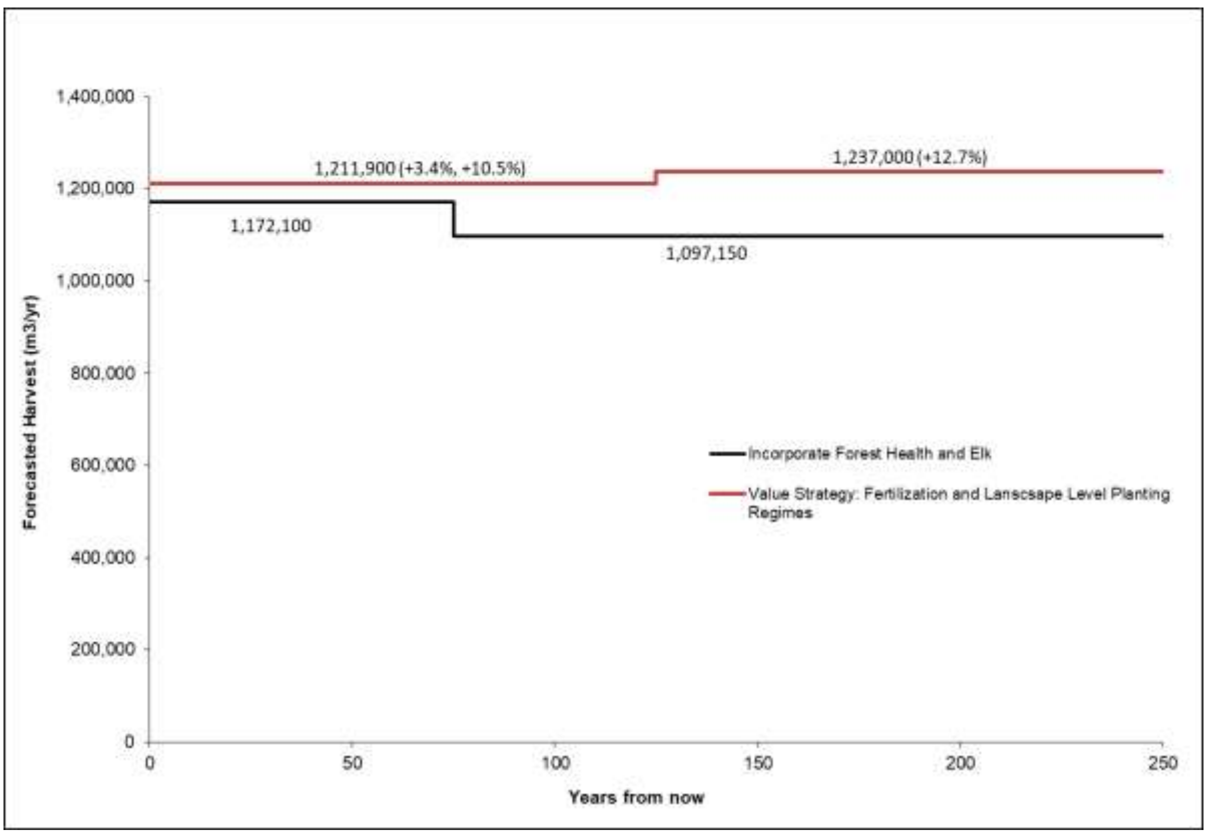

Figure 82: Harvest forecast; selected scenario

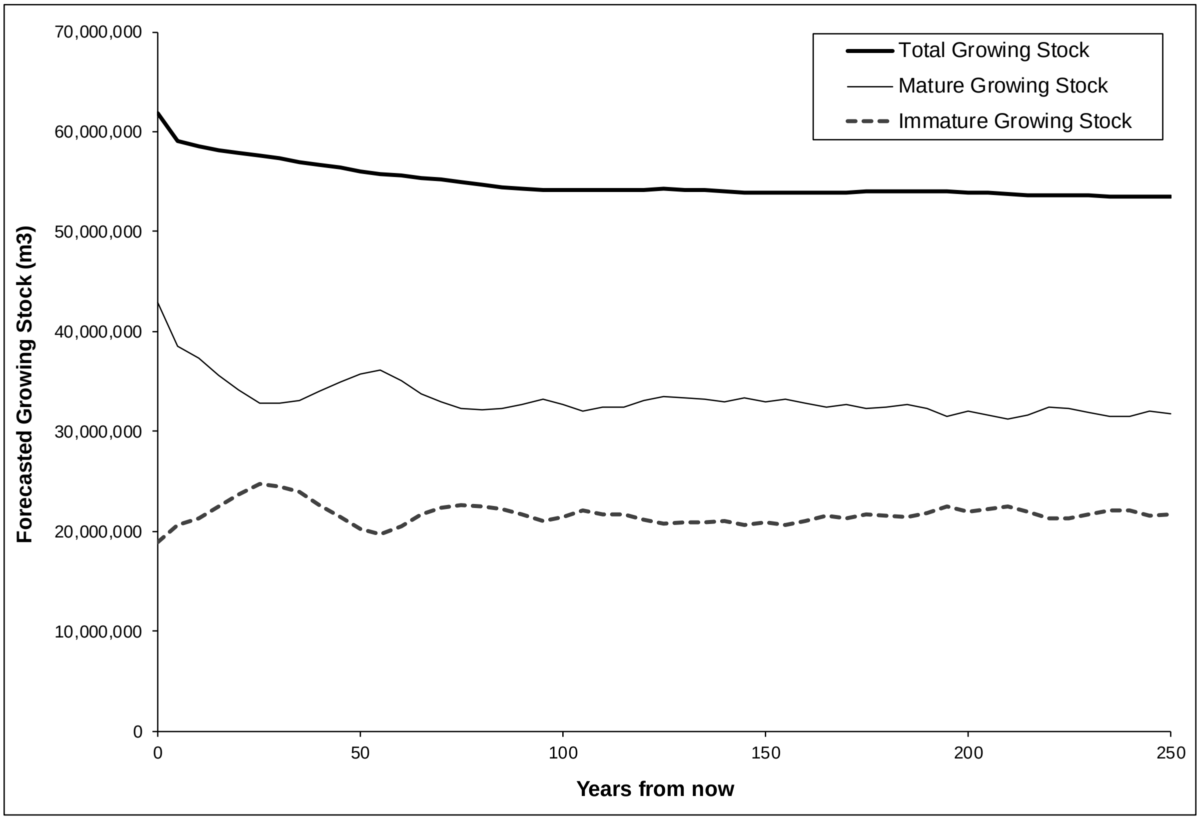

Figure 83: Predicted growing stock development; Selected Scenario

As with the ISS Base Case, during the first 50 years of the planning horizon, the majority of harvest is predicted to come from natural stands (Figure 84). After year fifty-five, the harvest of natural stands declines significantly and by year 100 almost the entire harvest is predicted to come from managed stands.

This Selected Scenario maintains the Fd harvest forecast, and most significantly, shows a large increase in the harvest of Cw beyond 60 years. (Figure 85). In addition, there the harvest of Ss is predicted to increase. The harvest of HemBal was limited to approximately 50% to reflect their current share of the merchantable volume in the land base. Over time the share of HemBal decreases.

The harvest from stands 115 years and older was limited to 460,000 m^3 per year for 50 years. The share of these stands declines after 40 years (Figure 86).

As in previous scenarios, limiting the harvest of old stands is reflected in Figure 87, which depicts the harvest forecast by age class. Older stands, particularly age class 8 and 9 stands (older than 140 years), are harvested in the first 50 years; however, the harvest of younger stands is significant. Approximately 50% of the harvest in this time period is predicted to come from stands between 41 and 100 years old. In the long term, more than 50% of the harvest is predicted to come mostly from age classes 3 and 4 (41 to 80 years).

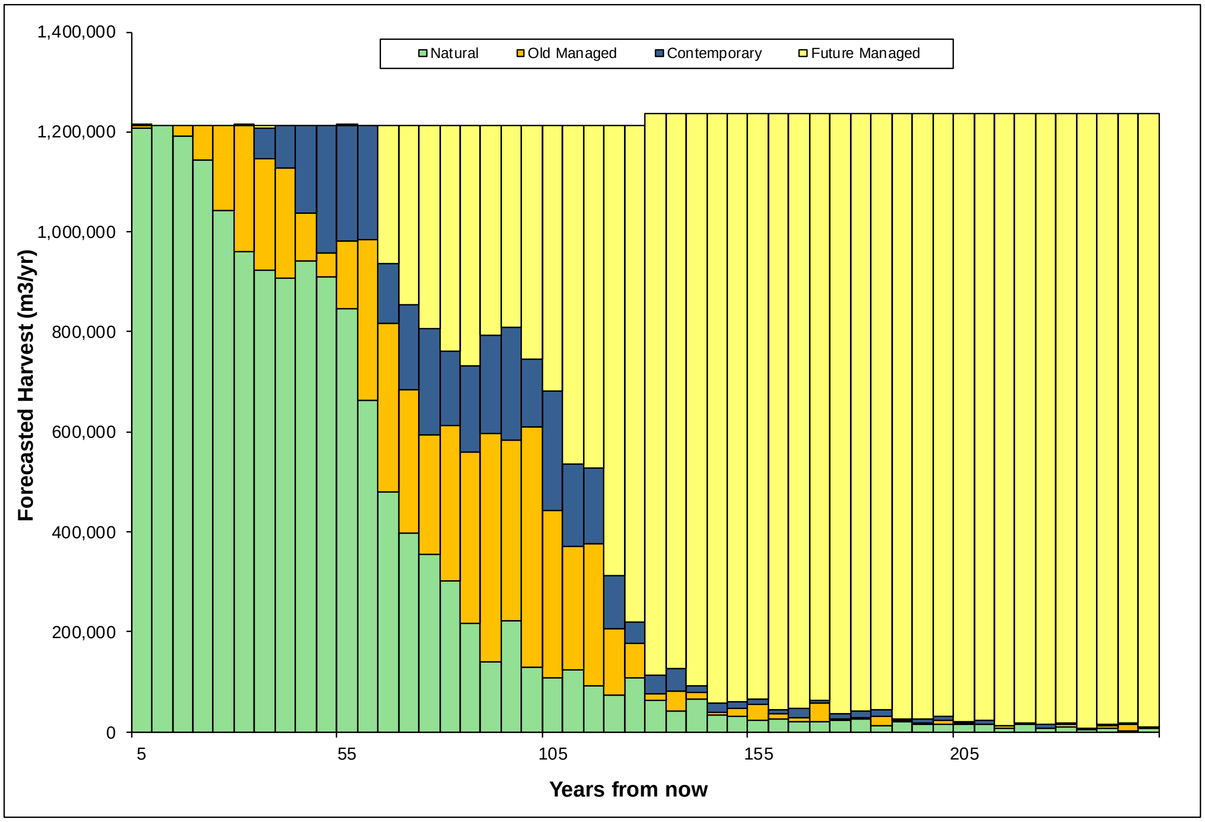

Figure 84: Harvest forecast by stand type; Selected Scenario

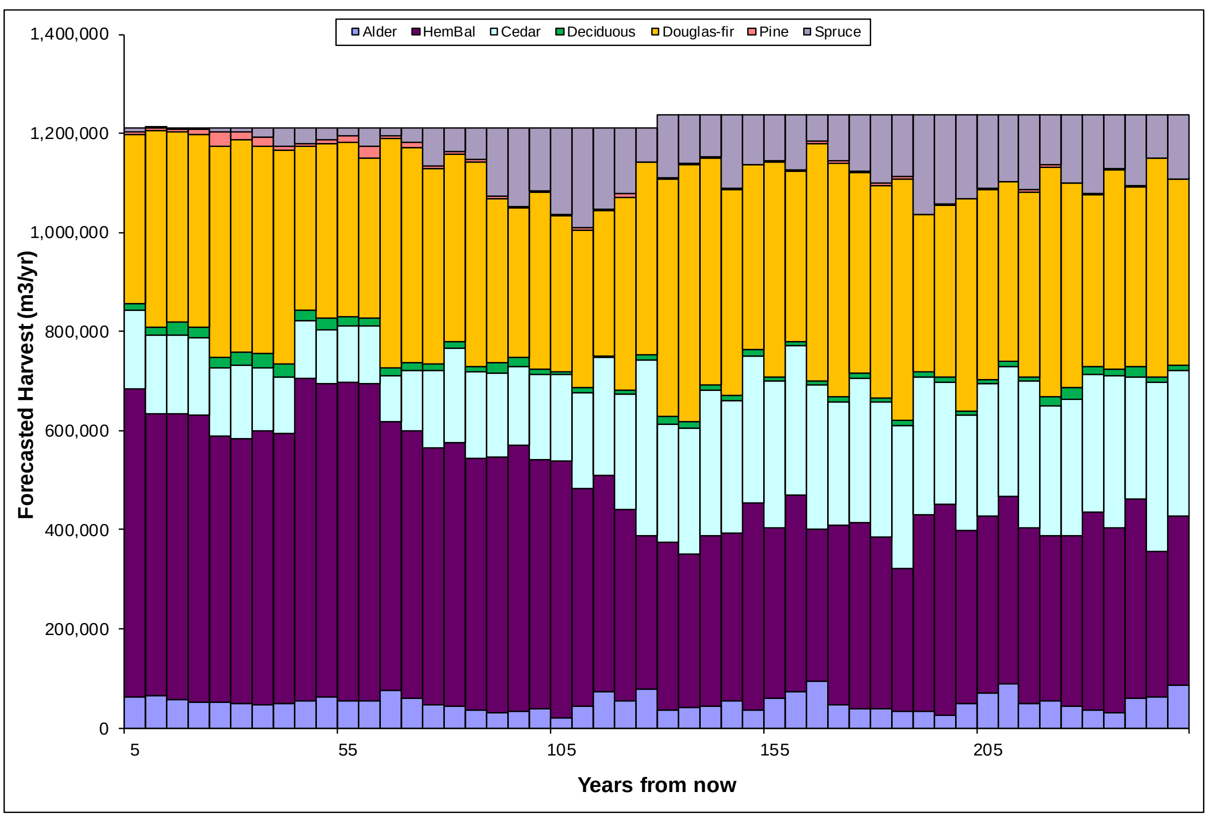

Figure 85: Harvest forecast by species; Selected Scenario

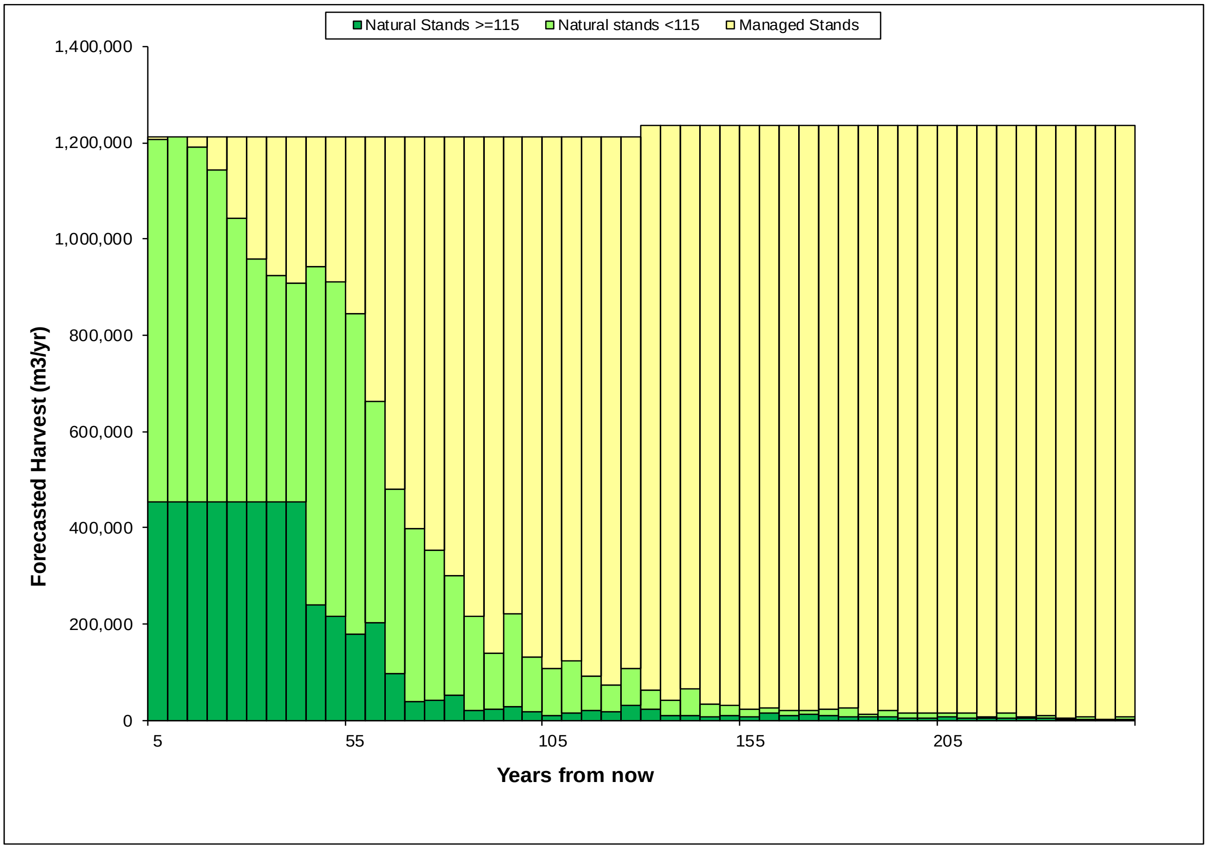

Figure 86: Harvest forecast by stand age; Selected Scenario

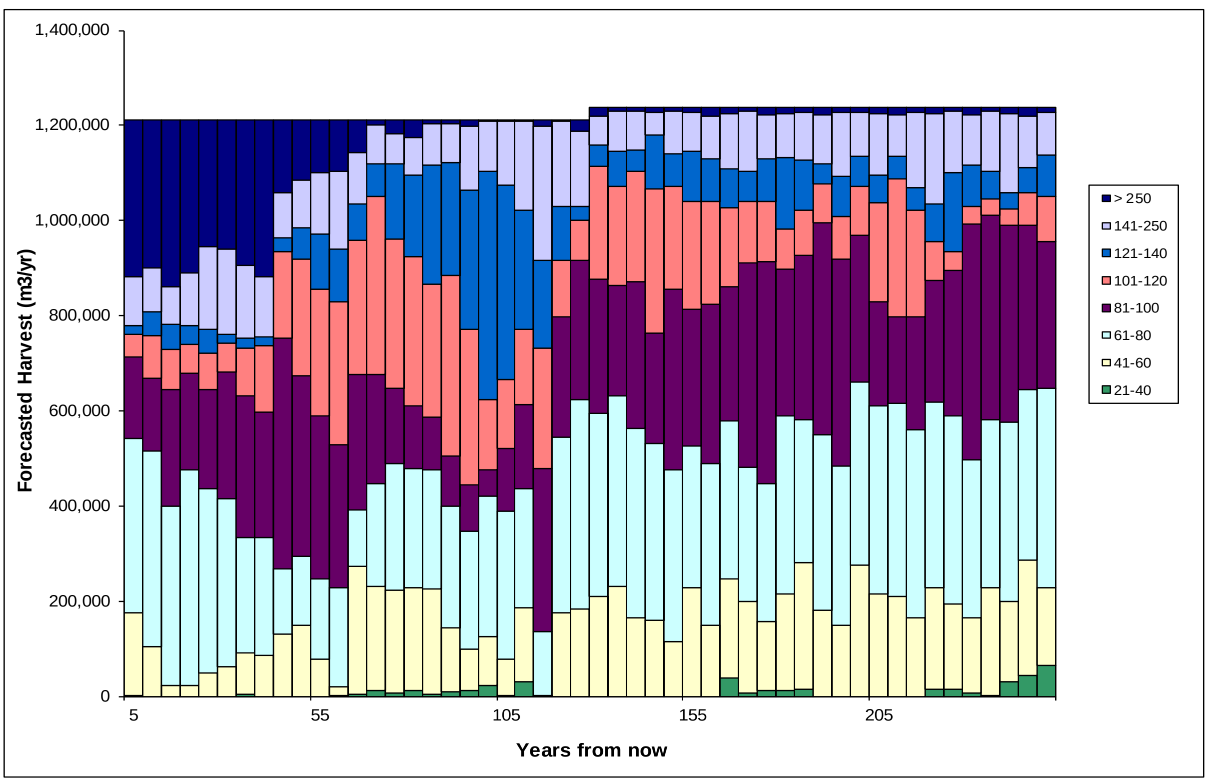

Figure 87: Harvest forecast by age class; Selected Scenario

Limiting the harvest of older stands (50 years) and HemBal stands (100 years) necessitates the harvest of lower volume stands during the first 100 years as in previous scenarios. This shows in Figure 88; some stands with volumes between 300 and 500 m^3 per ha are harvested in this time period. In the long run, the harvest forecast is dependent on the 500 to 600 m^3 per ha class with the average harvest volume trending close to 550 m^3 per ha.

The harvest priority in all scenarios was governed by distance from road and the timber supply block (TSB) as follows:

- Harrison, Stave Chilliwack, high harvest priority;
- Pitt, Yale, medium harvest priority;
- Maple Ridge, Nahatlatch low harvest priority.

Figure 89 illustrates the Selected Scenario harvest forecast by TSB.

Figure 90 and Figure 91 depict the predicted age class distribution over time in the THLB and the Crown Forested Land Base (CFLB) correspondingly. Over time age classes 1 to 4 are forecasted to cover almost 80% of the THLB (Figure 90). Older age classes, especially age classes 9, are well represented in the Non-Harvestable Land Base (NHLB) and contribute significantly to the mature and old seral stages of the CFLB (Figure 91).

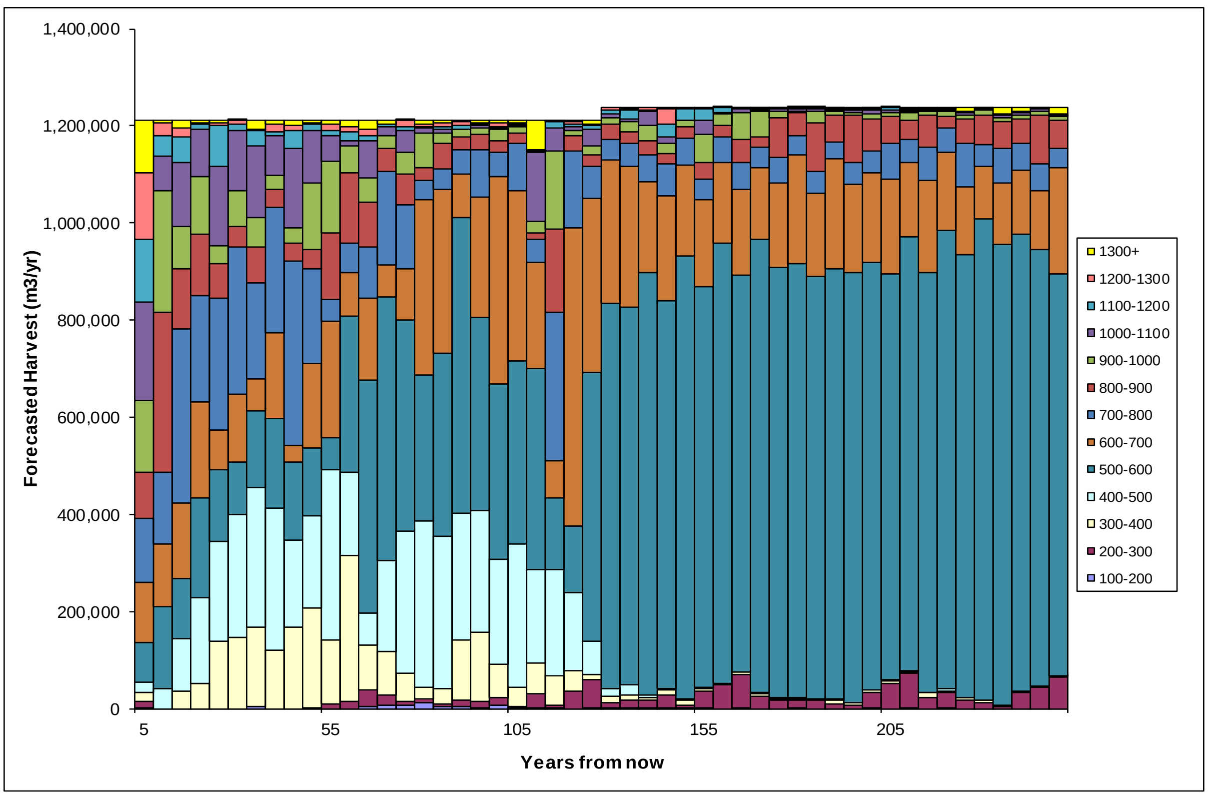

Figure 88: Harvest forecast by volume per ha class; Selected Scenario

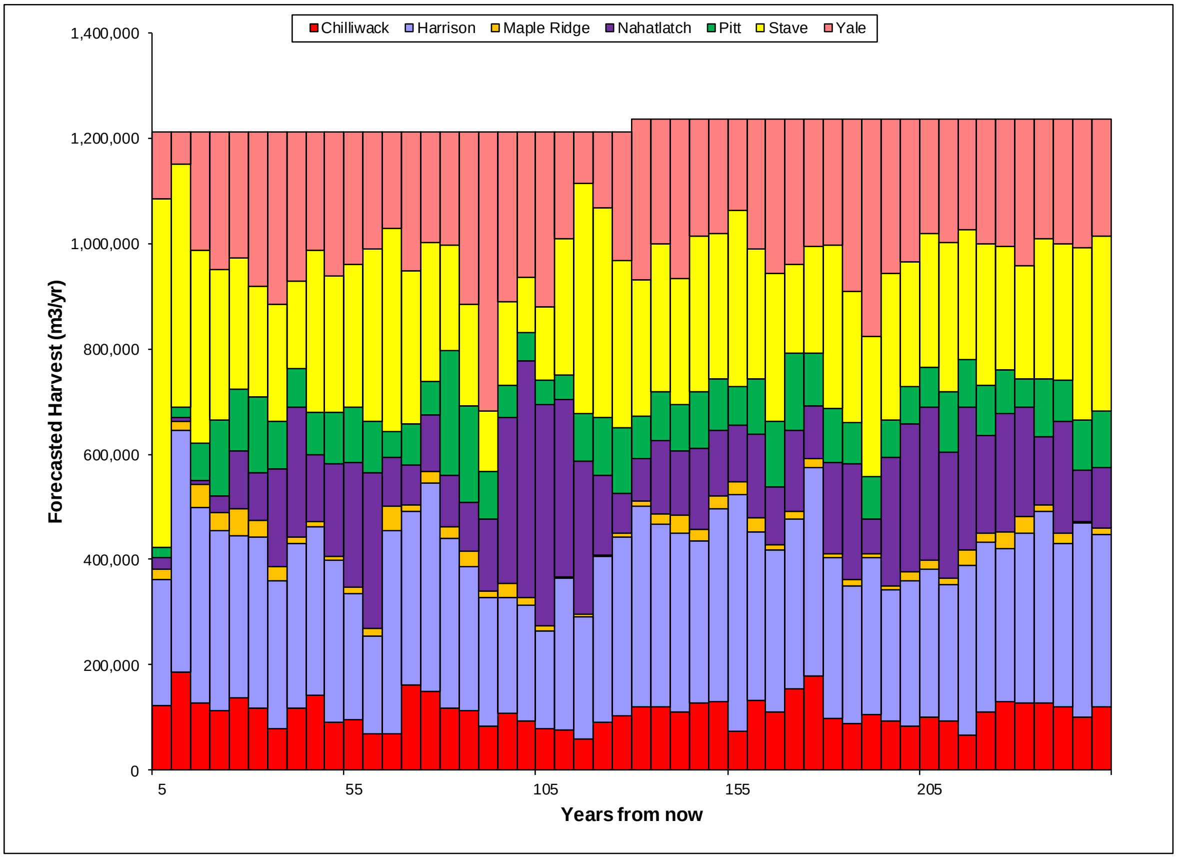

Figure 89: Harvest forecast by timber supply block; Selected Scenario

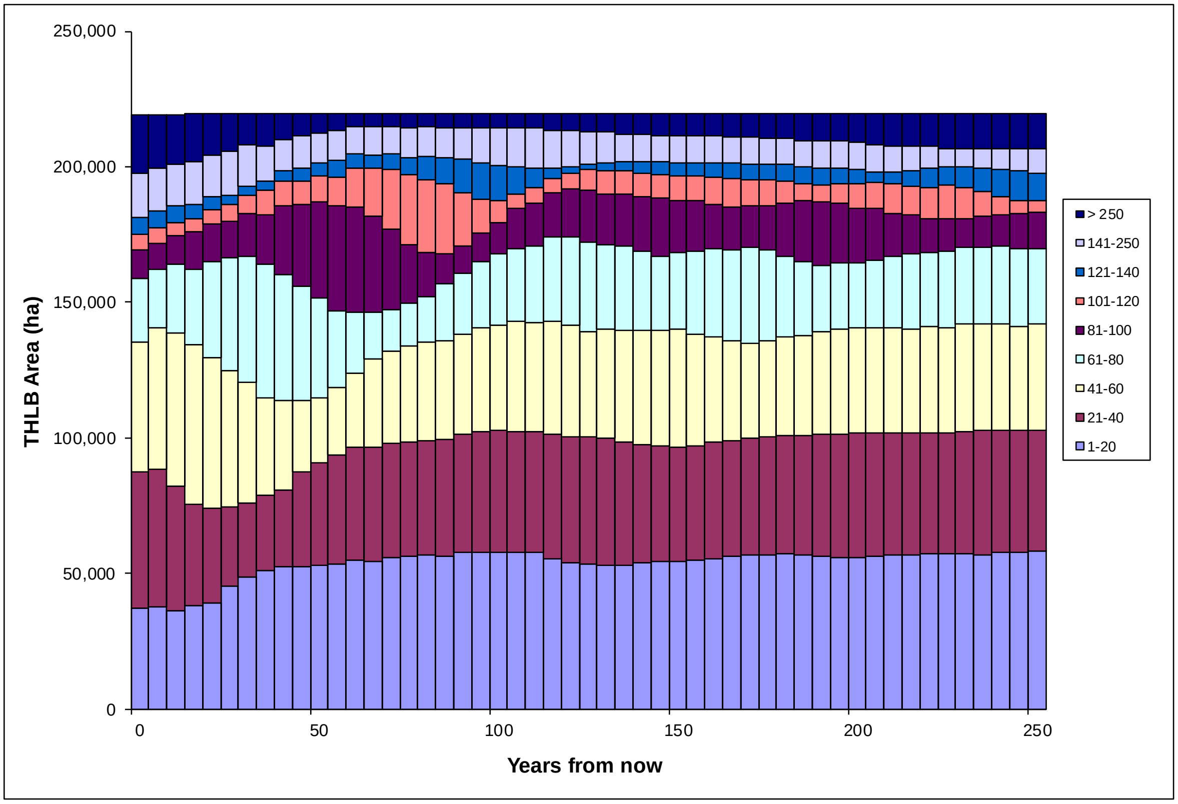

Figure 90: Predicted age class distribution on the THLB; Selected Scenario

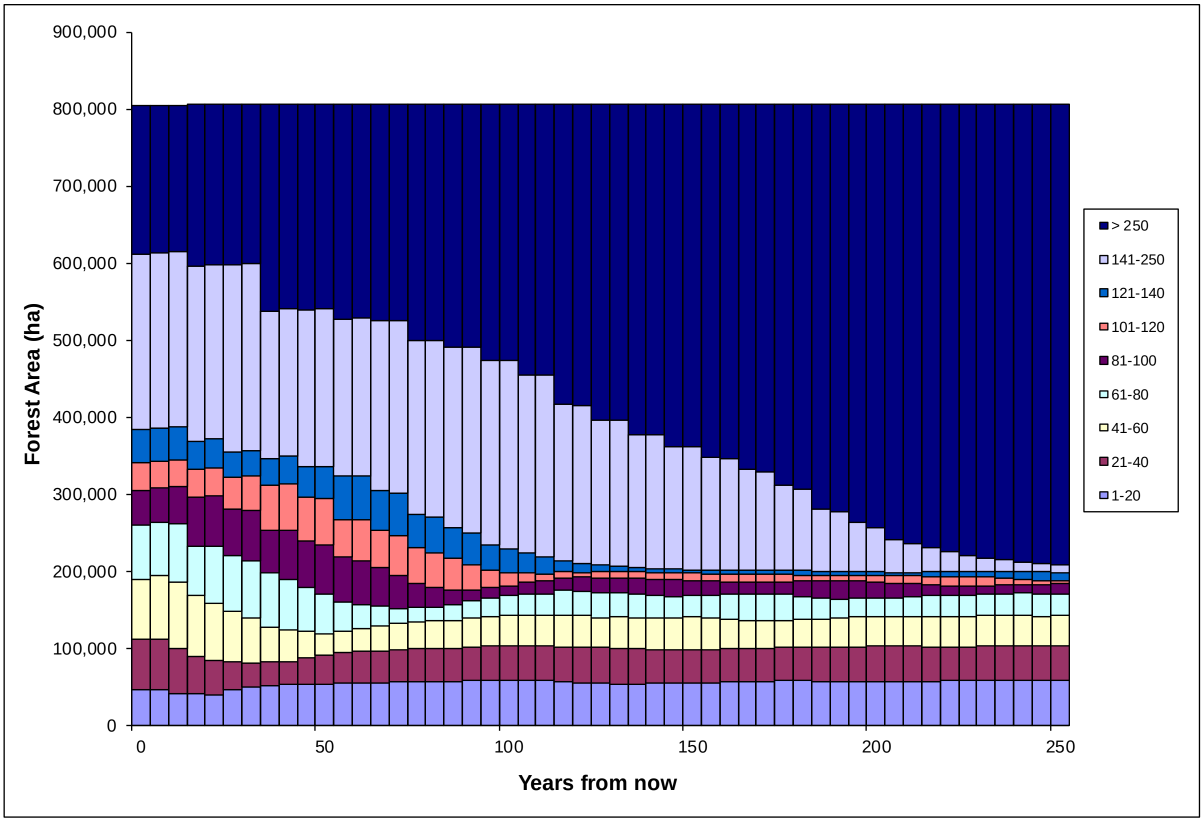

Figure 91: Predicted age class distribution on the CFLB; Selected Scenario

4.4.2 Projected Timber Value

Figure 92 and Figure 93 illustrate the value per ha and the total value forecasts for managed stands in the Selected Scenario. In the long term, the Selected Scenario is predicted to create significantly more value from managed stands. Compared to the Forest Health and Elk Scenario, the value increase starts around year 65. Most of the increase in value is derived from a significant increase in the harvest of managed Cw.

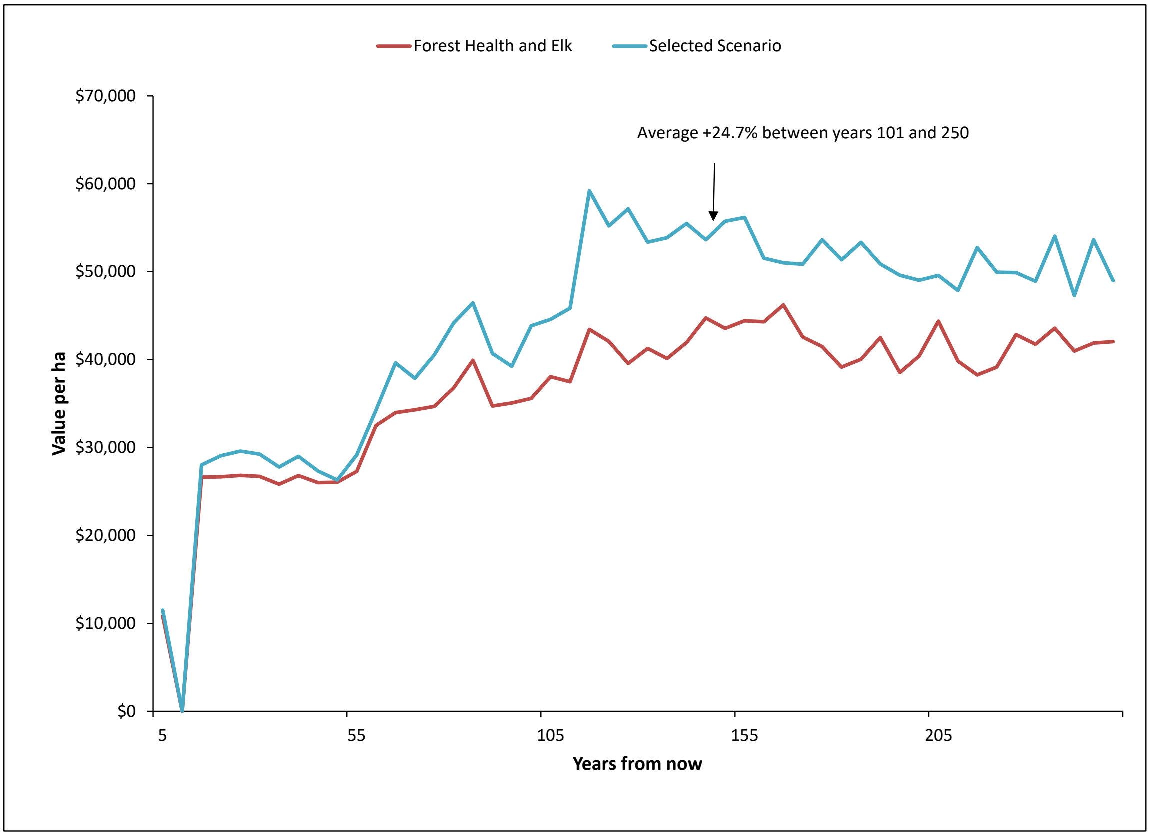

Figure 92: Selected Scenario; value per ha forecast, managed stands only

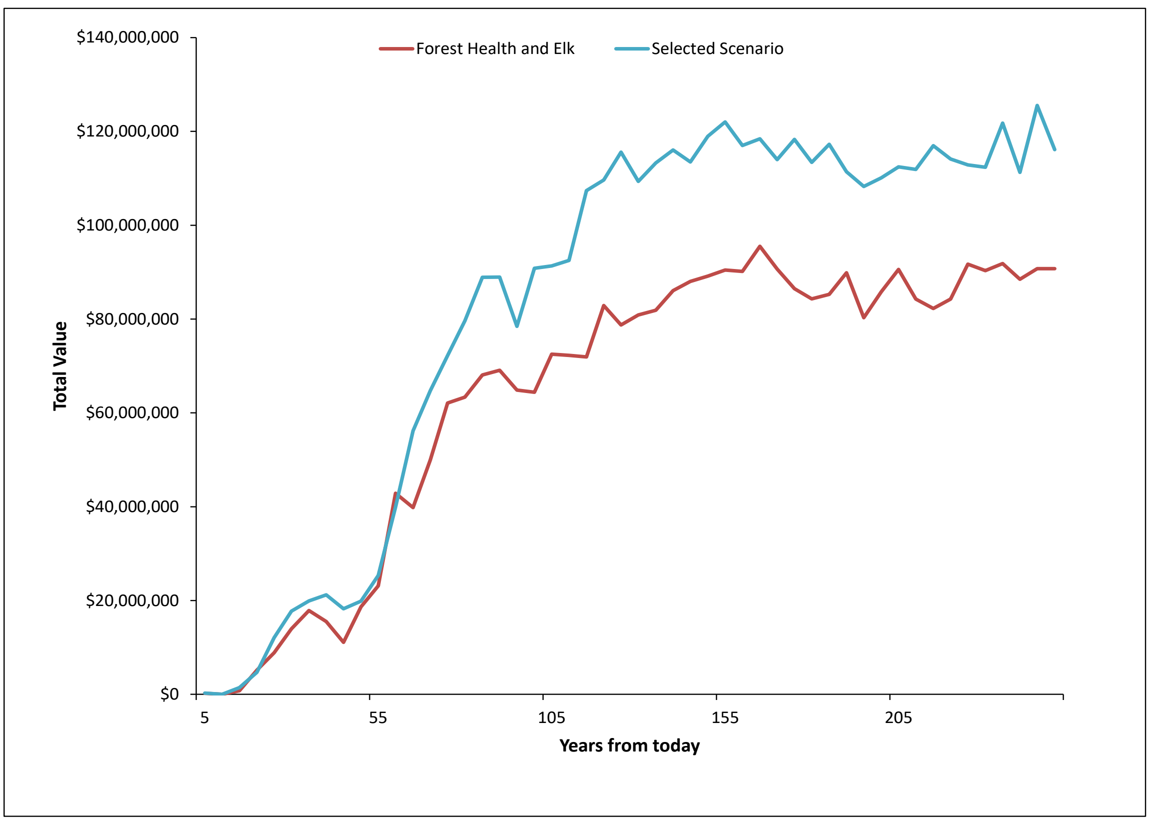

Figure 93: Selected Scenario; total value forecast, managed stands only

4.4.3 Treatment Areas and Treatment Costs

Figure 94 and Figure 95 show the annual treatment areas and costs by treatment type for the Selected Scenario. Initially, the treatment population is modest. In the course of time, the annual area treated increases from 2,000 ha to about 4,500 ha at year 50.

In the short term, only fertilization and enhanced reforestation are implemented. The predicted fertilization and spacing costs are approximately $660,000 annually during the first 5 years and around $500,000 annually between years 6 and 10. In the long term, up to $1.5 million is required annually to maintain the proposed incremental silviculture program of fertilization.

This strategy proposes higher planting densities on selected sites in the TSA. This strategy also proposes to reduce planting densities for high and moderate elk hazard areas. The reduced planting densities result in cost savings; the additional planting costs shown in Figure 95 depict the net costs, i.e. the difference between increased and decreased planting costs due higher and lower densities.

No spacing is expected over the next 10 years. A modest Cw spacing program is predicted to start in year 16 and continue with annual spacing areas ranging from 240 ha to 400 ha.

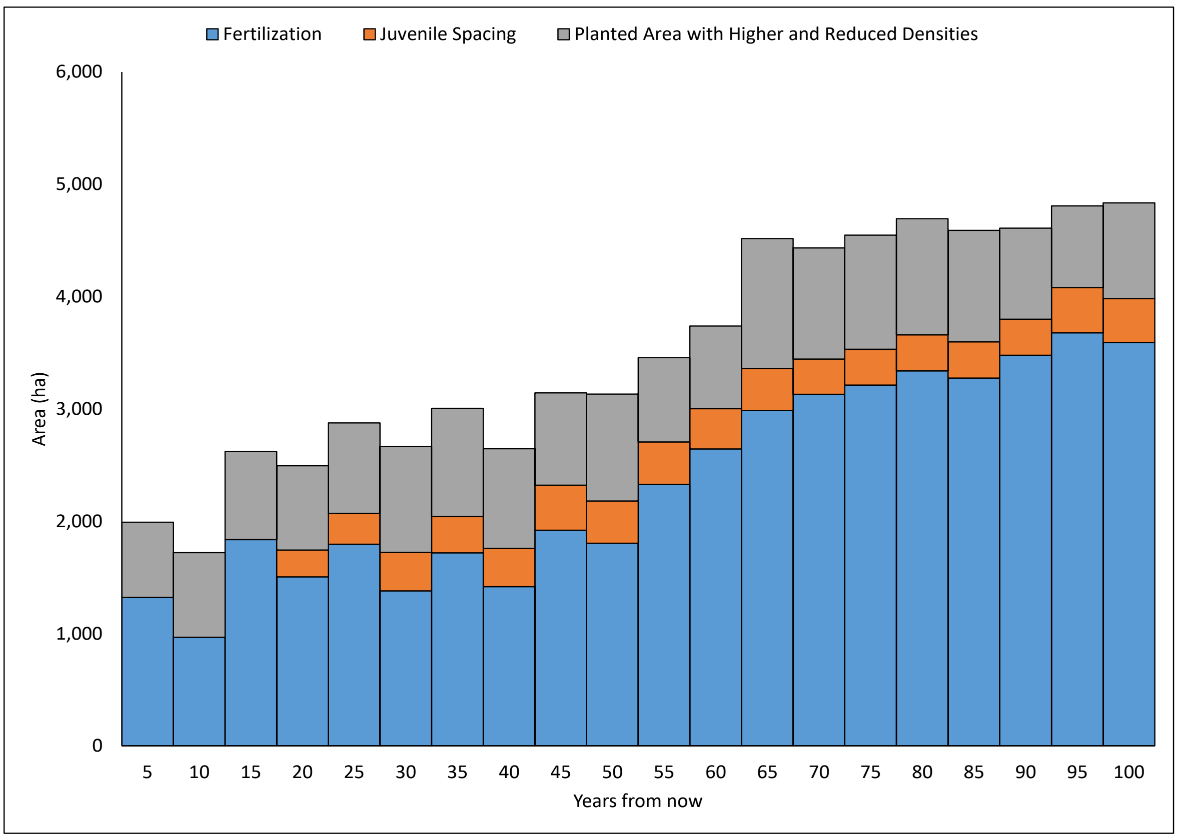

Figure 94: Selected Scenario; forecasted annual treatment area

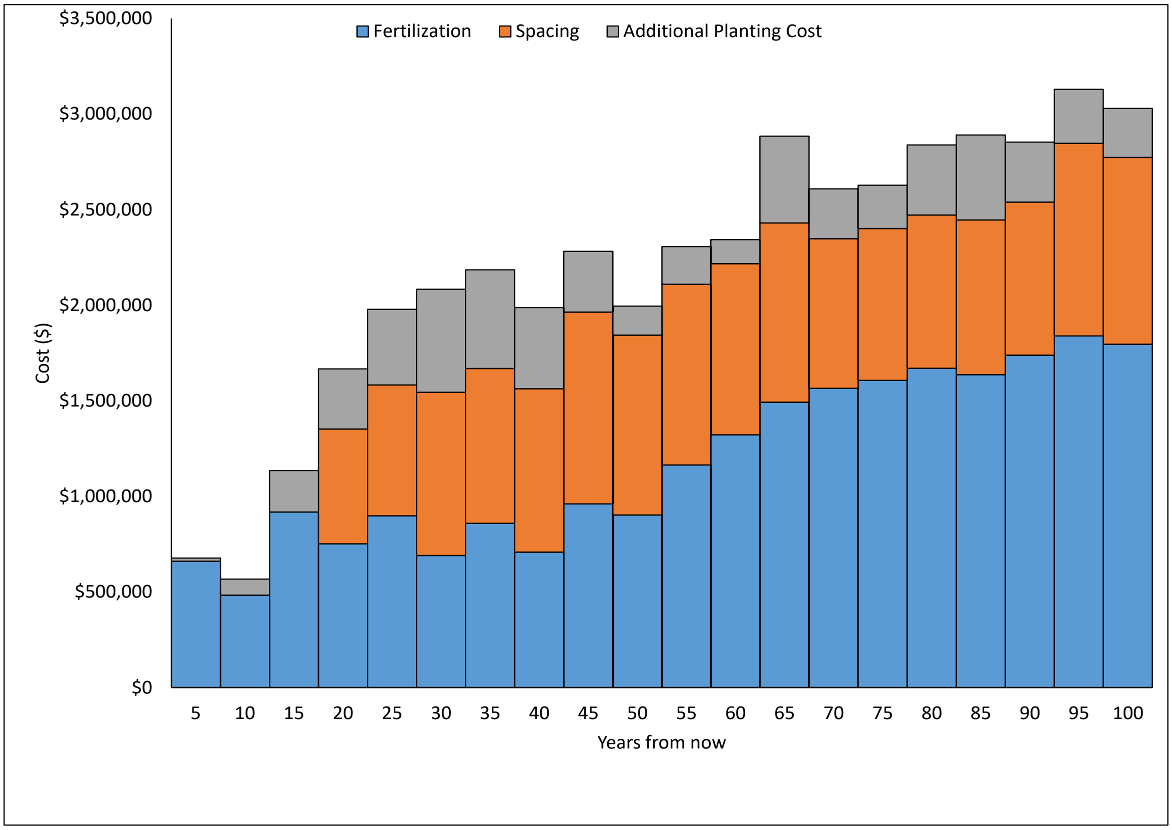

Figure 95: Selected Scenario; forecasted annual increment silviculture expenditures

4.4.4 Spotted Owl Habitat

The analysis accounted for the legal spotted owl management requirements; the long-term owl habitat areas (LTOHA) were removed from the THLB and the harvest in managed forest habitat areas (MFHA) was constrained. Nesting and foraging habitat was tracked in each LTOHA and MFHA.

Table 13 shows the predicted spotted owl forage and nesting habitat in each LTOHA within the Fraser TSA. No harvesting can occur in these areas and the area of both forage and nesting habitat is increasing over time.

Table 14 presents the predicted spotted owl forage and nesting habitat in each MFHA within the Fraser TSA. Over time both the forage and nesting habitat within MFHAs are forecasted to increase moderately.

Nesting and foraging habitat was also tracked in each landscape unit (LU). Large areas of both foraging and nesting habitat exist in the TSA according to the analysis as shown in Table 15.

Table 13: Forecasted spotted owl habitat in LTOHAs

LTOH ID	Forest Area (ha)	THLB Area (ha)	Habitat Type	Habitat (ha)					
				Now	Year 50	Year 100	Year 150	Year 200	Year 250
Spotted Owl LTOH 2-494	4,158	0	Forage	3,335	3,584	3,764	3,764	3,764	3,764
			Nesting	640	1,661	2,837	3,031	3,053	3,053
Spotted Owl LTOH 2-495	2,819	0	Forage	1,293	2,042	2,482	2,490	2,490	2,490
			Nesting	22	927	1,168	1,896	2,311	2,311

LTOH ID	Forest Area (ha)	THLB Area (ha)	Habitat Type	Habitat (ha)					
				Now	Year 50	Year 100	Year 150	Year 200	Year 250
Spotted Owl LTOH 2-496	6,569	0	Forage	4,221	4,916	5,817	5,817	5,817	5,817
			Nesting	1,635	2,634	3,786	4,457	5,003	5,003
Spotted Owl LTOH 2-497	9,53	0	Forage	534	766	921	921	921	921
			Nesting	226	226	670	792	844	844
Spotted Owl LTOH 2-498	6,937	0	Forage	4,970	5,896	6,627	6,627	6,627	6,627
			Nesting	2,492	3,668	4,373	5,166	5,885	5,885
Spotted Owl LTOH 2-501	2,417	0	Forage	1,606	1,723	1,753	1,965	1,965	1,965
			Nesting	508	715	1,432	1,482	1,702	1,702
Spotted Owl LTOH 2-502	19,070	0	Forage	12,979	14,567	17,037	17,037	17,037	17,037
			Nesting	6,221	9,445	12,394	13,849	15,095	15,095
Spotted Owl LTOH 2-503	3,061	0	Forage	1,695	2,329	2,935	2,935	2,935	2,935
			Nesting	768	1,226	1,575	2,199	2,789	2,789
Spotted Owl LTOH 2-505	3,081	0	Forage	2,078	2,496	2,974	2,974	2,974	2,974
			Nesting	1,133	1,677	1,996	2,399	2,873	2,873
Spotted Owl LTOH 2-506	3,343	0	Forage	2,407	2,599	3,042	3,042	3,042	3,042
			Nesting	1,302	1,674	2,120	2,287	2,678	2,678
Spotted Owl LTOH 2-507	3,022	0	Forage	2,057	2,307	2,833	2,833	2,833	2,833
			Nesting	497	1,154	1,943	2,156	2,593	2,593
Spotted Owl LTOH 2-508	1,656	0	Forage	1,320	1,619	1,619	1,619	1,619	1,619
			Nesting	690	1,083	1,302	1,455	1,455	1,455
Total	**67,912**	**0**	**Forage**	**46,733**	**53,847**	**61,528**	**61,748**	**61,748**	**61,748**
			Nesting	**20,776**	**32,348**	**43,477**	**49,728**	**55,411**	**55,411**

Table 14: Forecasted spotted owl habitat in MFHAs

MFHA ID	Forest Area (ha)	THLB Area (ha)	Habitat Type	Habitat (ha)					
				Now	Year 50	Year 100	Year 150	Year 200	Year 250
Spotted Owl MFHA 2-497	502	372	Forage	0	75	54	74	77	73
			Nesting	0	0	0	41	55	55
Spotted Owl MFHA 2-499	2,295	1,063	Forage	224	324	467	502	526	498
			Nesting	186	128	159	397	393	393
Spotted Owl MFHA 2-500	10,031	5,571	Forage	4,258	3,675	4,370	4,460	4,298	4,507
			Nesting	2,728	2,489	2,503	3,067	3,094	3,094
Spotted Owl MFHA 2-503	3,067	1,412	Forage	1,446	1,228	1,577	1,579	1,581	1,603
			Nesting	261	672	1,081	1,175	1,328	1,328
Spotted Owl MFHA 2-504	9,826	3,439	Forage	6,117	6,175	6,183	6,267	6,180	6,245
			Nesting	4,101	3,617	3,772	4,375	4,426	4,426
Total	**25,721**	**11,857**	**Forage**	**12,044**	**11,478**	**12,652**	**12,882**	**12,663**	**12,926**
			Nesting	**7,276**	**6,906**	**7,514**	**9,054**	**9,296**	**9,296**

Table 15: Forecasted spotted owl habitat in the Fraser TSA

Spotted Owl Habitat	Forest Area (ha)	THLB Area (ha)	Habitat Type	Habitat (ha)					
				Now	Year 50	Year 100	Year 150	Year 200	Year 250
Total in LTOH	67,912	0	Forage	46,733	53,847	61,528	61,748	61,748	61,748
			Nesting	20,776	32,348	43,477	49,728	55,411	55,411
Total in MFHA	25,721	11,857	Forage	12,044	11,478	12,652	12,882	12,663	12,926
			Nesting	7,276	6,906	7,514	9,054	9,296	9,296
Total in LTOH and MFHA Combined	**93,633**	**11,857**	**Forage**	**58,778**	**65,324**	**74,180**	**74,630**	**74,410**	**74,674**
			Nesting	**28,051**	**39,254**	**50,991**	**58,783**	**64,708**	**64,708**
Total within Fraser TSA when Tracked by LU	**831,182**	**218,947**	**Forage**	**339,190**	**383,909**	**423,755**	**420,789**	**419,699**	**419,378**
			Nesting	**158,408**	**180,117**	**232,922**	**281,544**	**293,696**	**293,243**

4.4.5 Northern Goshawk

The two draft northern goshawk (NOGO) WHAs were removed from the THLB in the ISS Base Case and all the analysis scenarios. The ISS Base Case was also set up to report on NOGO forage habitat; 2,500 m buffers (1962.5 ha) were placed around the draft WHAs to represent forage areas. There was no provision for the discovery of future nests. The amount of forage habitat was reported for each forage area.

The 40% target for each forage area was incorporated in the ISS Selected Scenario as the desired management direction. While there is only limited area of potential forage area within the Fraser TSA, the analysis indicates that it is possible to manage for NOGO forage habitat for the two draft WHAs in the TSA without timber supply impacts; the forage habitat is achieved from the NHLB.

4.4.6 Marbled Murrelet

All scenarios included MAMU habitat as an indicator. Harvesting a suitable area is assumed to convert it into unsuitable habitat with no recruitment of habitat within the planning horizon of the analysis.

There are 21,679 ha of suitable MAMU habitat within the forested area of the Fraser TSA; only 2,100 ha (approximately 10%) are classified as THLB. This suggests that the MAMU could be managed in the TSA without significantly reducing the future harvest. In the analysis the harvest in the THLB portion of the MAMU habitat was not constrained.

4.4.7 Late Seral

The management of old growth in the Fraser TSA is accomplished through old growth management areas (OGMA). The late seral stages were tracked in this analysis by NDT, LU and BEC variant. This aspatial tracking of late seral provided a means to compare scenarios in their achievement of old growth.

In most LU/BEC Variant groups throughout the TSA, OGMAs provide the designated amount of old growth if observed aspatially. In some cases, an old growth deficit exists, and recruitment of old growth happens over time through OGMAs.

In the Selected Scenario old growth was modelled through OGMAs and while small differences existed in meeting the late seral targets for all NDT/LU/BEC combinations compared to the ISS Base Case or the Forest Health and Elk Scenario, they are not significant.

One of the learning scenarios removed all OGMAs and reclassified the land base within them as THLB. The scenario investigated whether the Stó:lō Plan and other existing constraints in the land base provide adequate retention for old growth. The achievement of old growth was not impacted significantly. The analyses showed that the late seral targets for all NDT/LU/BEC combinations can be met entirely from OGMAs, or from the NHLB over time without OGMAs.

4.4.8 Scenario Results Summary

Table 16 provides a summary of the scenario results for various indicators. The pluses and minuses depict a somewhat subjective classification of predicted indicator values for each scenario. More is depicted with pluses and less is depicted with minuses.

Table 16: Scenario results summary (Forest health and elk scenarios as point of comparison)

	Volume	Value	NOGO Forage Habitat	MAMU Habitat	Spotted Owl LTOH	Spotted Owl MFHA	Old Seral
Stó:lō Plan (remove OGMAs)	+	0	0	0	0	0	-
Volume Scenario 1	+	0	0	0	0	0	0
Volume Scenario 2	++	+	0	0	0	0	0
Selected Scenario	+	++	0	0	0	0	0

5 List of Acronyms

Acronym	Description
AAC	Annual Allowable Cut
AU	Analysis Unit
BCGW	BC Geographic Warehouse
BCTS	BC Timber Sales
BEC	Biogeoclimatic Ecosystem Classification
CBST	Climate Based Seed Transfer
CCISS	Climate Change Informed Species Selection
CFLB	Crown Forested Land Base
DBH	Diameter at Breast Height
DIB	Diameter Inside Bark
EM	Existing Managed
ESA	Environmentally Sensitive Areas
EVQO	Established Visual Quality Objective
EXLB	Excluded Land Base
FAIB	Forest Analysis and Inventory Branch
FC1	Former Forest Cover Inventory Standard
FESL	Forest Ecosystem Solutions Ltd
FLNRORD	Ministry of Forests, Lands, Natural Resource Operations and Rural Development
FMLB	Forest Management Land Base (from VRI)
FNWL	First Nations Woodland License
FREP	Forest and Range Evaluation Program
FSOS	Forest Simulation and Optimization System
GAR	Government Action Regulation
GIS	Geographic Information System
ISS	Integrated Silviculture Strategy
ITG	Inventory Type Group
LCC1	Land Cover Class 1
LTOH	Long Term Owl Habitat
LUP	Landscape Unit Plan
MAI	Mean Annual Increment
MFHA	Managed Forest Habitat Area (Spotted Owl)
MFLB	Managed Forest Land Base (Netdown)
MOE	Ministry of Environment
MRVA	Multiple Resource Values Assessment
NHLB	Non-Harvestable Land Base
NOGO	Northern Goshawk
NRL	Non-Recoverable Losses
NSR	Not Sufficiently Restocked
OAF	Operational Adjustment Factor
OGMA	Old Growth Management Area
PSP	Permanent Sample Plot

Acronym	Description
RMA	Riparian Management Area
RPB	Resource Practices Branch
ROG	Rate of Growth
SNC	Swiss Needle Cast
SRMP	Sustainable Resource Management Plan
SRRMC	Stó:lō Research and Resource Management Centre
STUP	S'ólh Téméxw Use Plan
TASS	Tree and Stand Simulator
TEM	Terrestrial Ecosystem Mapping
TFL	Tree Farm License
TIPSY	Table Interpolation Program for Stand Yields
THLB	Timber Harvesting Land Base
TSA	Timber Supply Area
TSL	Timber Sale License
TSR	Timber Supply Review
UWR	Ungulate Winter Range
VAC	Visual Absorption Capacity
VDYP	Variable Density Yield Prediction
VEG	Visually Effective Greenup
VRI	Vegetation Resource Inventory
VQO	Visual Quality Objective
WG	Working Group
WHA	Wildlife Habitat Area
WTP	Wildlife Tree Patch
WUI	Wildland Urban Interface
YSM	Young Stand Monitoring

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