Integrated Stewardship Strategy

Sunshine Coast Timber Supply Area

Draft Modelling and Analysis Report

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1 Introduction

The Resource Practices Branch (RPB) of the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) is developing a new sustainable forest management planning framework. This framework was initially called the Integrated Stewardship Strategy (ISS) with the objective to integrate all aspects of landscape-level and operational planning for each Timber Supply Area (TSA). It is now evolving to a new plan with a wider scope and a greater First Nations and stakeholder engagement. The new plan is called a Forest Landscape Plan (FLP).

This project, the Sunshine Coast TSA ISS, takes a forward-looking approach at resource management through generating management scenarios based on different harvesting and silviculture practices. These management scenarios evaluate the potential impacts of harvesting and silviculture activities on numerous resource values.

Given the ongoing ISS, the Sunshine Coast TSA was chosen as one of five FLP pilot projects provincially to help inform policy and legislation changes to the Forest Range and Practises Act (FRPA). In order to transition from an ISS to an FLP pilot, the work completed under the Sunshine Coast ISS is limited to investigating incremental silviculture opportunities. The Sunshine Coast ISS will provide an incremental silviculture strategy for the FLP to consider and improve upon with additional First Nations and stakeholder input. The FLP pilot for the Sunshine Coast TSA will build upon the ISS and commence after this project is completed.

2 Analysis Assumptions

This analysis relied on the district staff and stakeholder meetings to determine analysis assumptions that would reflect current management in the Sunshine Coast TSA. The Analysis assumptions are detailed in the Sunshine Coast TSA ISS Data Package (FESL 2020).

2.1 Forest Level Analysis

This report describes the forest level analysis results for the Sunshine Coast 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.

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. This analysis uses this timber-based definition as a guideline to complete various scenarios. The upcoming FLP will attempt to evaluate the sustainability of a wider range of biological, social, or economic values that are affected by timber harvesting.

2.2 Indicator Forecasts

A single forecast is not sufficient to depict the supply of various values in the Sunshine Coast 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 setting 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 Sunshine Coast TSA. The following forecasts are presented in this report:

ISS Reference Forecasts: The ISS Reference Forecasts are the standard against which other forecasts are compared when assessing the effects of uncertainty or different management emphases on indicator's values. The ISS Reference Forecast reflects the best available knowledge about current management and immediate future activities and forest development. This analysis presents two Reference Forecasts.

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 Sunshine Coast TSA through several stakeholder meetings. The objectives for this project were developed mostly for timber in anticipation of the Forest Landscape Plan (FLP), which will consider all resource values.

Selected Scenario: The ISS scenarios will be used to inform options in the FLP process for a Selected Scenario.

2.3 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 used in this analysis using the highest volume first harvest rule. 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.

2.4 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 related to how minimum harvest criteria are defined and may not reflect true constraints on timber supply.

Pinch points are only useful as indicators of sustainability if minimum harvest ages are equal or close to the culmination ages of mean annual increment (CMAI). 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. 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 the growing stock in the long term.

2.5 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).

3 Analysis Results

3.1 ISS Reference Forecasts

This analysis first built a dataset as per the conventional approach to TSR (such as the latest Sunshine Coast TSA TSR). The dataset was updated for depletions and ownership changes. The analysis assumptions were revised through stakeholder meetings to reflect current management in the Sunshine Coast TSA. Table 1 shows the ISS Reference Forecast assumptions in a nutshell.

Scenario analysis will be used to test the impact of different management approaches on various indicators.

Table 1: ISS Reference Forecast Assumptions

Objectives and overall assumptions	Characterize current management to the extent practicable
Land base assumptions	• Follow the conventional TSR approach with updates to ownership and resources layers • Roads from the Digital Road Atlas (DRA) and Forest Tenure Road Section Lines (FTEN) • All OGMAs (legal and non-legal) are removed from the THLB • Consider First Nations Cultural Areas and remove them from the THLB. • Run an alternate ISS Reference Forecast, where the First Nations Cultural Areas are included in the THLB. • Unstable terrain, remove class 5 terrain and ES1 100% from the THLB, 50% reduction for class 4 terrain and ES2 • Inoperable as per last TSR with past harvest areas and proposed harvest areas classified as operable • Riparian was acquired from the Fresh Water Atlas, classified by a computer algorithm. Buffers reflect other coastal management units. • Ocean buffer of 15 m removed from the THLB. • THLB first ISS Reference Forecast 170,470 ha. • THLB second ISS Reference Forecast 184,446 ha.
Harvest assumptions	• Incorporate available proposed harvest into the harvest forecast • Use highest volume first harvest rule • Incorporate 95% MAI culmination in the minimum harvest criteria • Use different minimum harvest criteria for helicopter harvesting and conventional harvesting • Include deciduous in conifer leading stands in harvest and modelling (biodiversity values and silviculture implications).
Silviculture and log 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 intensive silviculture treatments (juvenile spacing, fertilization) • Separate existing managed stands into eras to reflect different management • Use generic industrial second growth log sort specifications and market values to track production value from the harvest of managed stands.
Habitat assumptions	• Report on Marbled Murrelet habitat • Report on NOGO forage habitat.

3.1.1 ISS Reference Forecast 1

The ISS Reference Forecast 1 excludes the First Nations Cultural Areas from the THLB. Figure 1 illustrates the ISS Reference Forecast 1. The initial harvest level of 1,381,200 m^3 per year can be maintained for 15 years. At year 16 the forecast is reduced by 7.2% to 1,281,453 ^{3} per year for another 15 years. Two more reductions are required until the mid-term harvest level of 1,081,520 m^3 per year is reached at year 46. The long-term harvest level of 1,121,870 m^3 per year is reached at year 76.

Figure 2 illustrates the predicted development of the growing stock for the ISS Reference Forecast 1. The stable long-term growing stock indicates a sustainable timber supply.

During the first 15 years of the planning horizon, the majority of harvest is predicted to come from natural stands, i.e. Douglas-fir stands established prior to 1958 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 35 years, half of the harvest is forecasted to come from managed stands.

Figure 4 shows the harvest forecast by species. The share of Fd is predicted to increase over the long term at the expense of HemBal. As illustrated in Figure 4, current practises are predicted to result in the decrease of Cw in the harvest forecast.

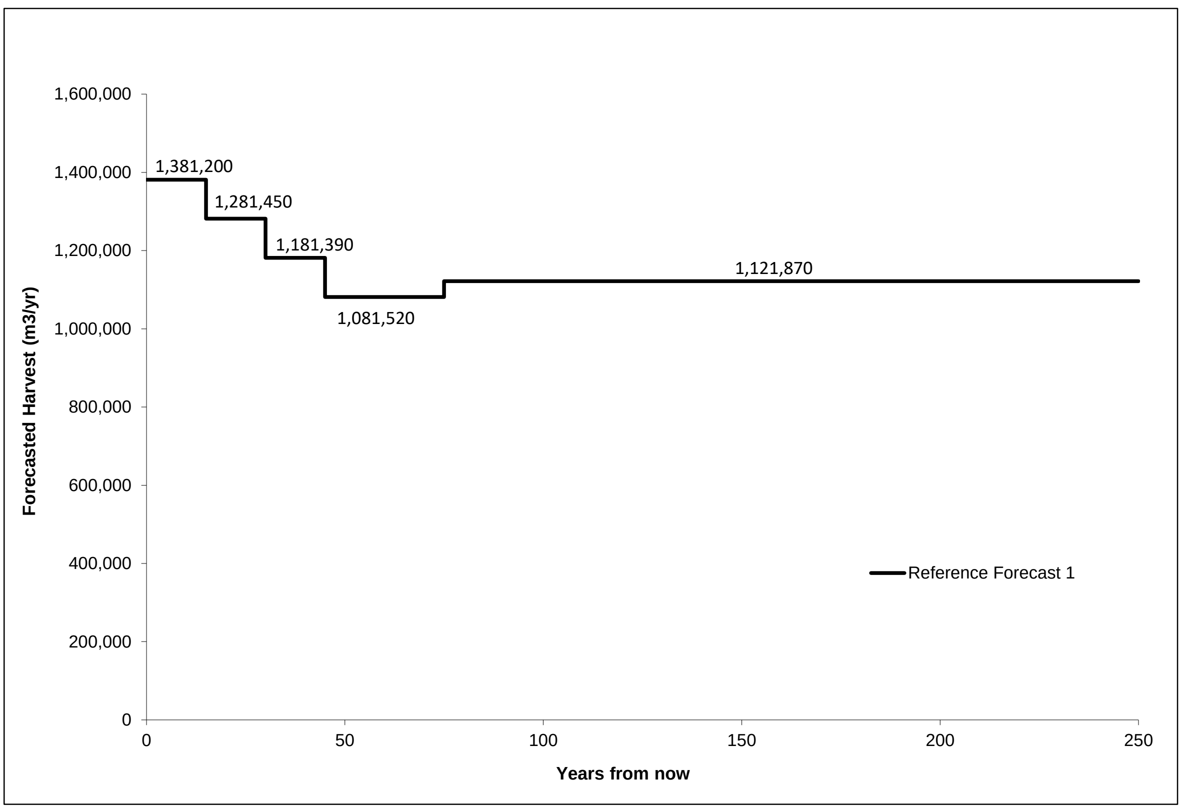

Figure 1: ISS Reference Forecast 1

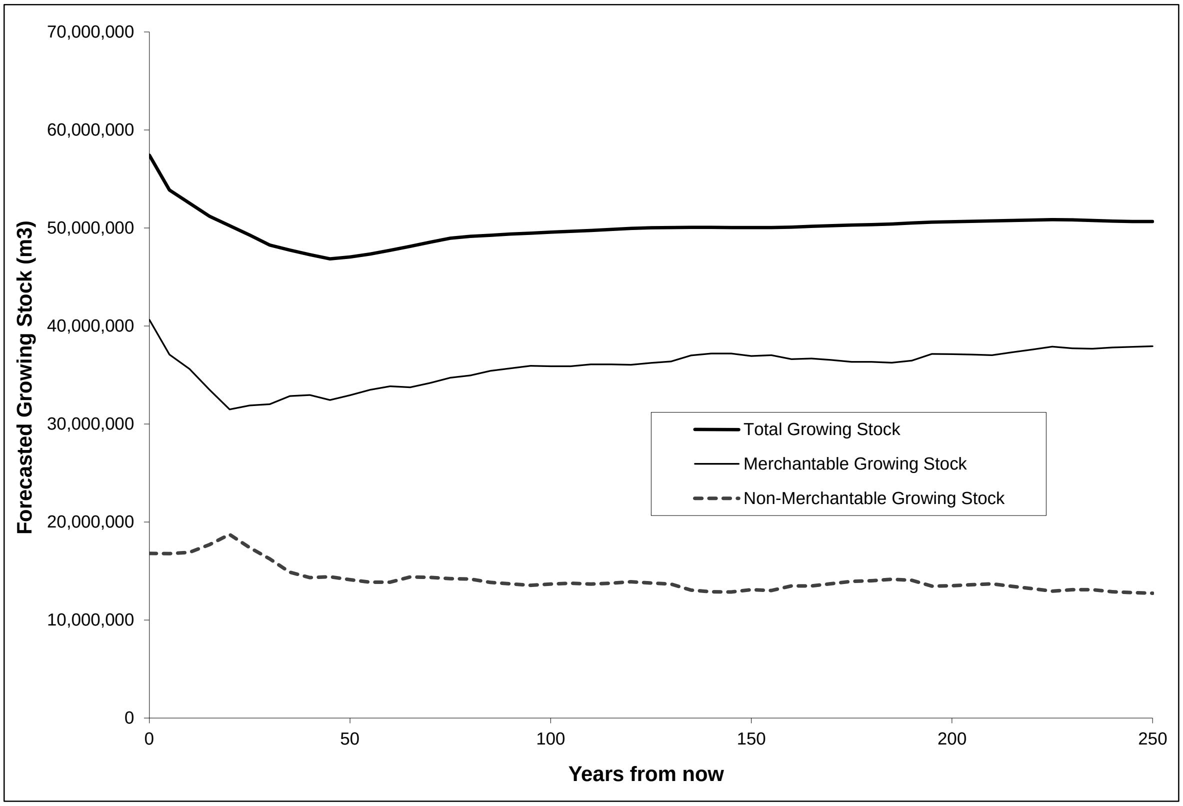

Figure 2: Predicted growing stock development, ISS Reference Forecast 1

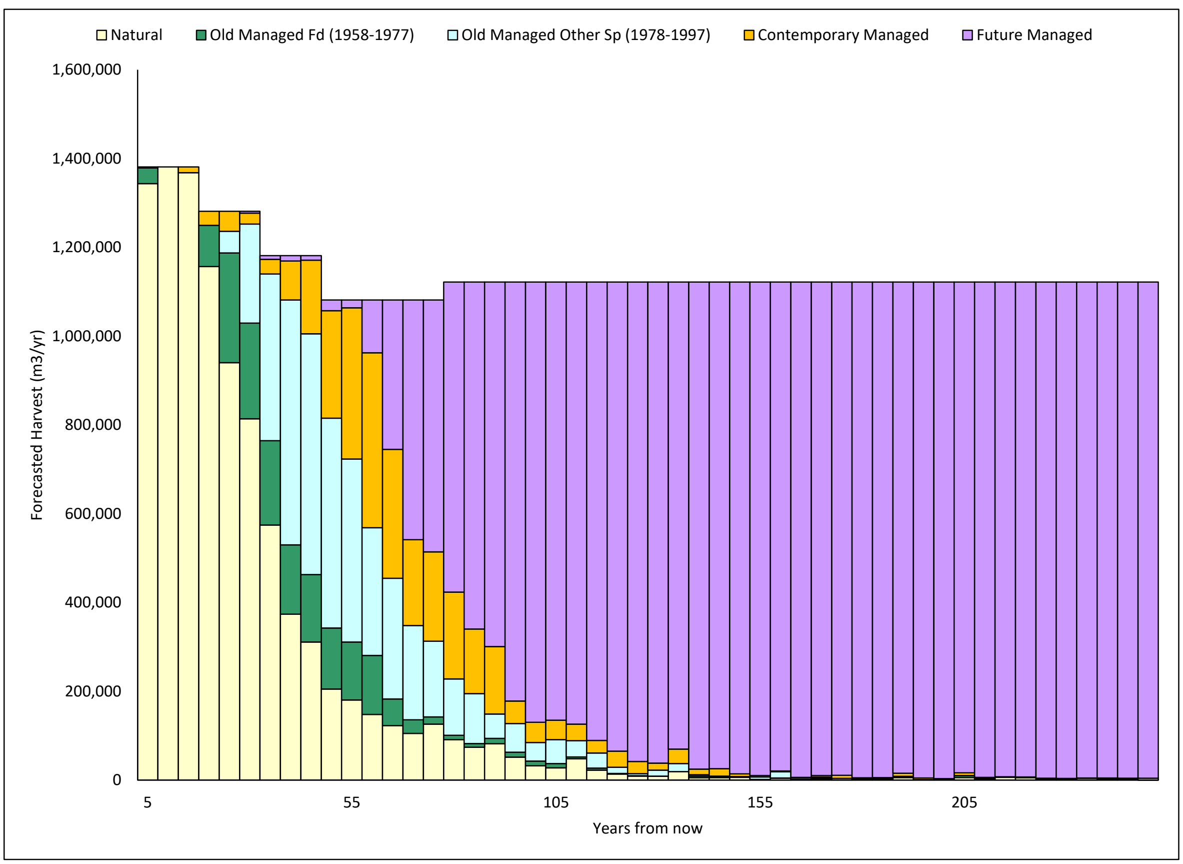

Figure 3: ISS Reference Forecast 1 by stand type

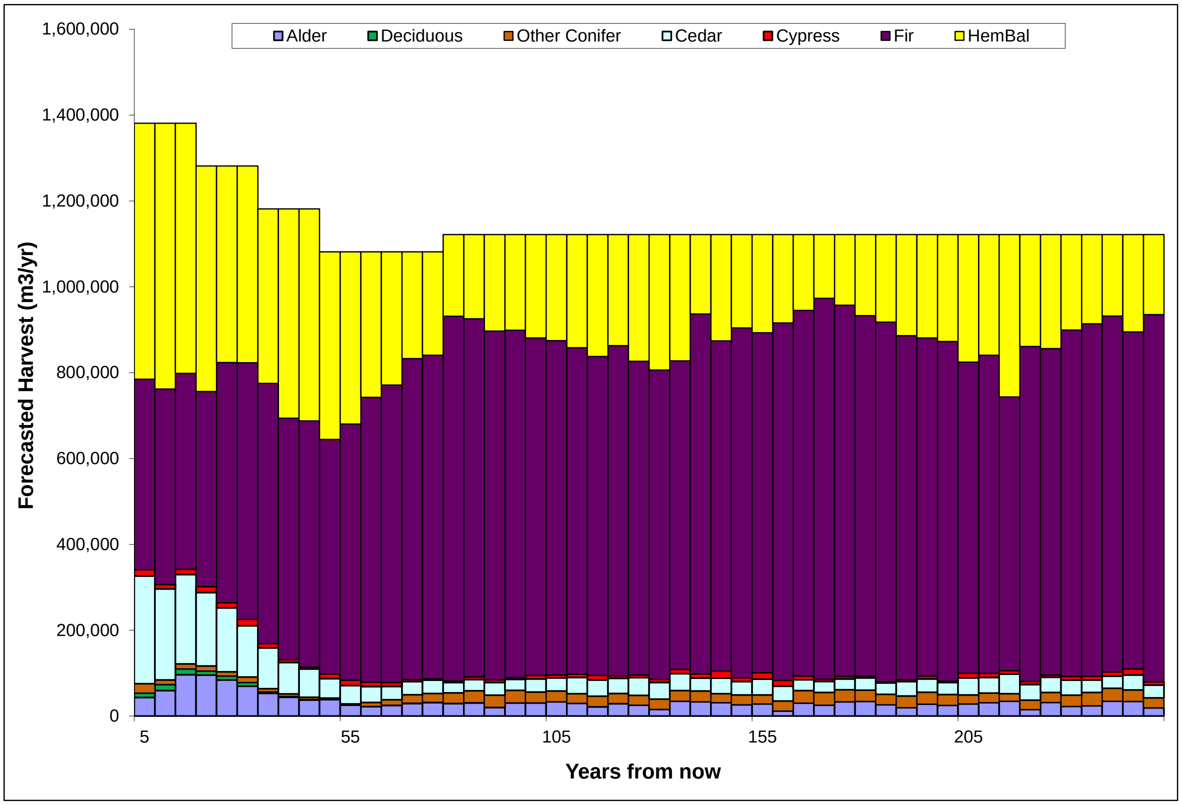

Figure 4: ISS Reference Forecast 1 by species

Figure 5 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 30 years, the harvest share of younger stands of the total volume is significant. From year 31 on 50% or more of the harvest is predicted to come from stands between 41 and 80 years old. This is also reflected in Figure 6 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 below 80 years in the long term. Note that after 60 years over 25% of the harvest is expected to come from stands less than 60 years old.

Figure 7 illustrates the harvest forecast by vol/ha classes, while Figure 8 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.

The predicted average annual harvest area is illustrated in Figure 9. In the long term, the predicted annual harvest area is approximately 1,800 ha.

Almost the entire harvest is predicted to come from areas where conventional (ground-based and cable) harvest systems are prevalent; however, some helicopter harvesting is also predicted (Figure 10).

Figure 11 and Figure 12 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 11). Older age classes, especially age class 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 12).

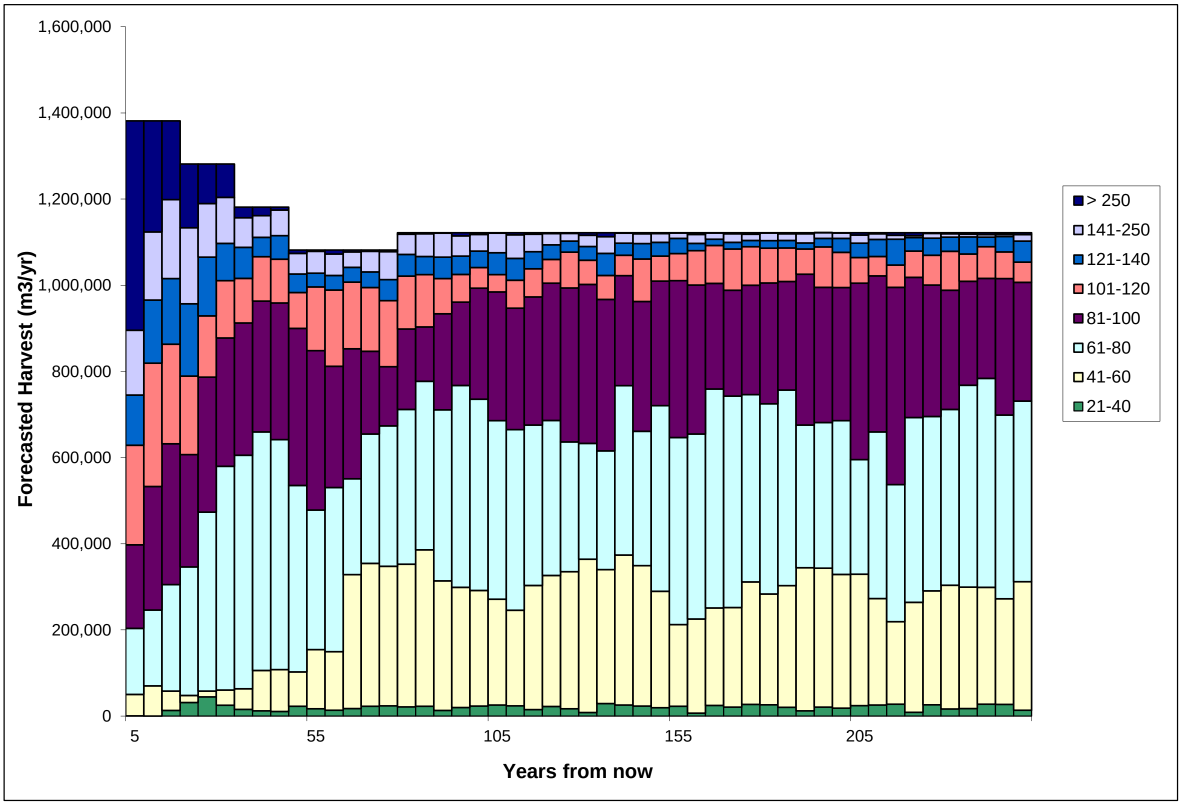

Figure 5: ISS Reference Forecast 1 by age class

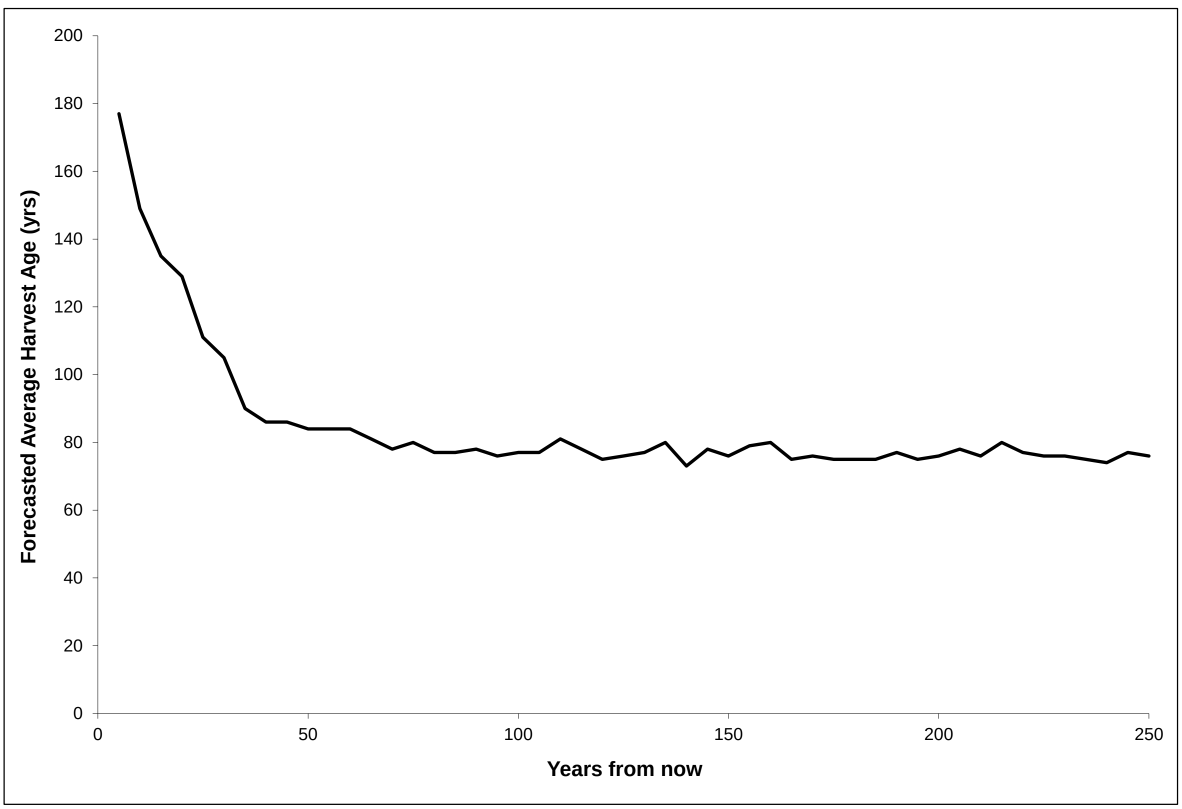

Figure 6: Average harvest age, ISS Reference Forecast 1

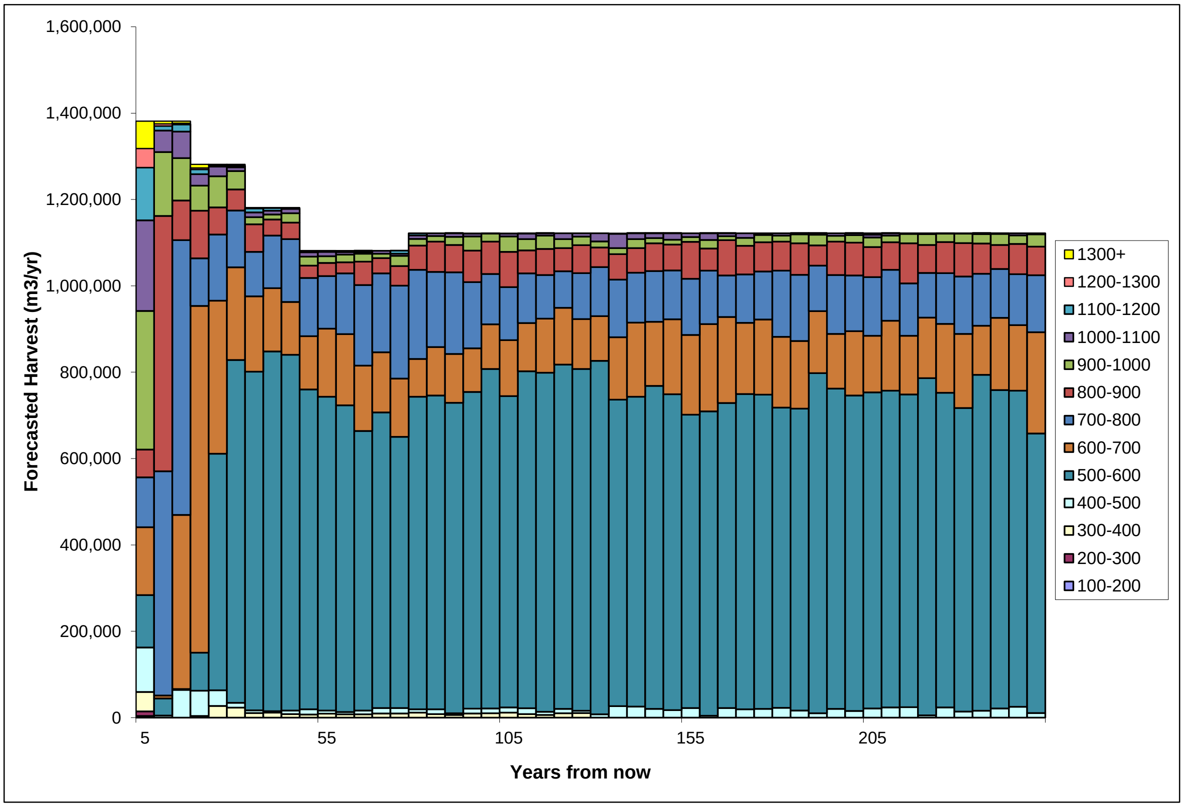

Figure 7: ISS Reference Forecast 1 by volume per ha class

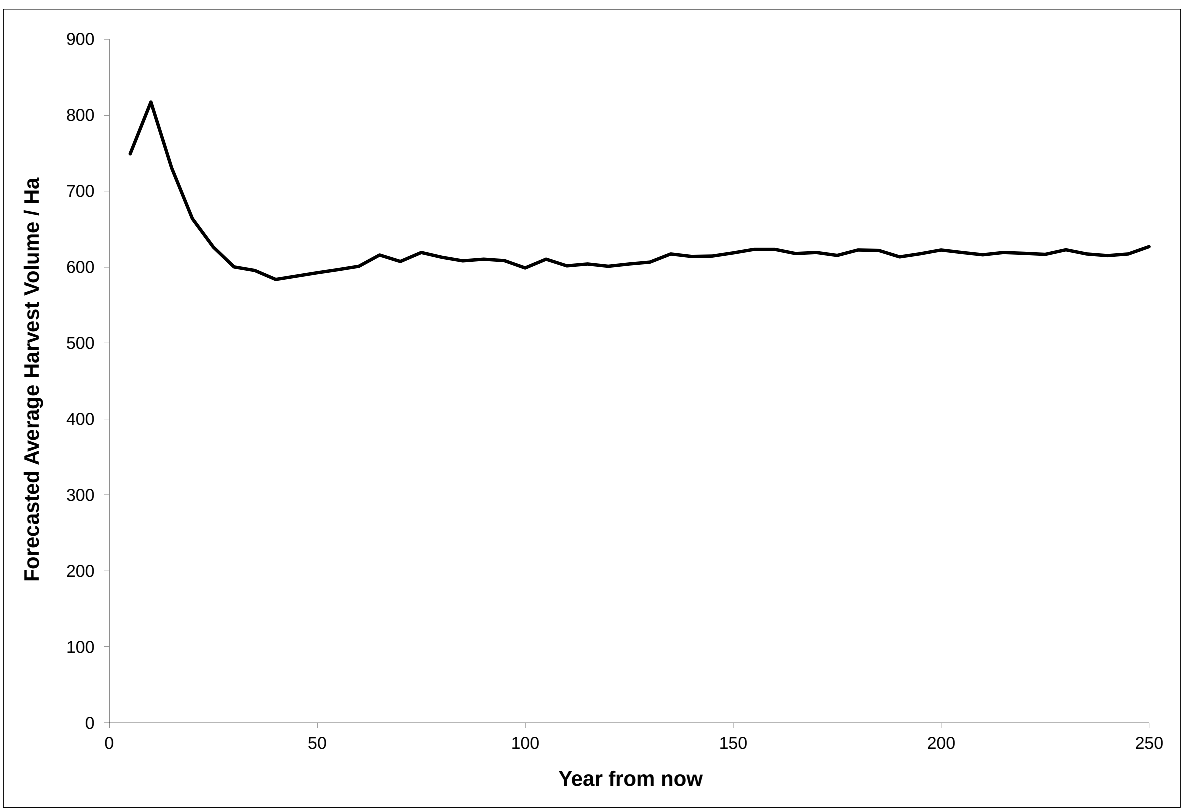

Figure 8: Predicted average harvest volume per ha, ISS Reference Forecast 1

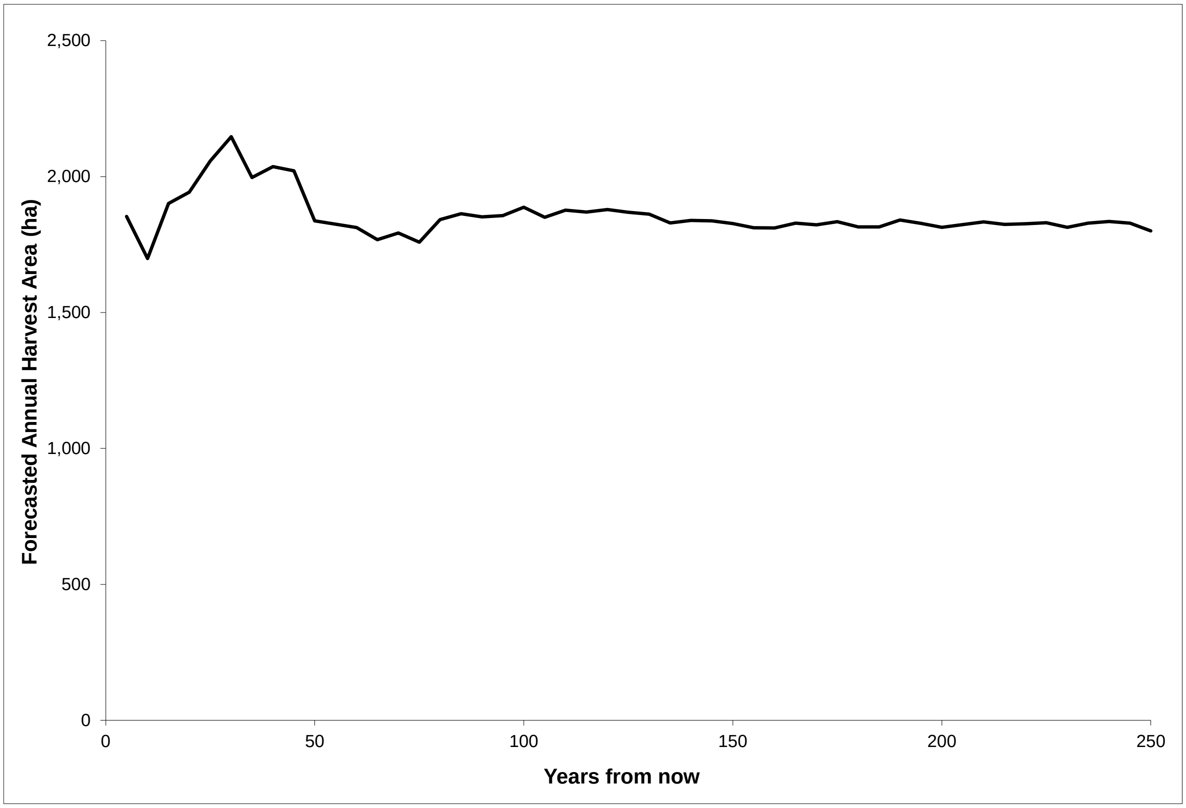

Figure 9: Predicted average harvest area, ISS Reference Forecast 1

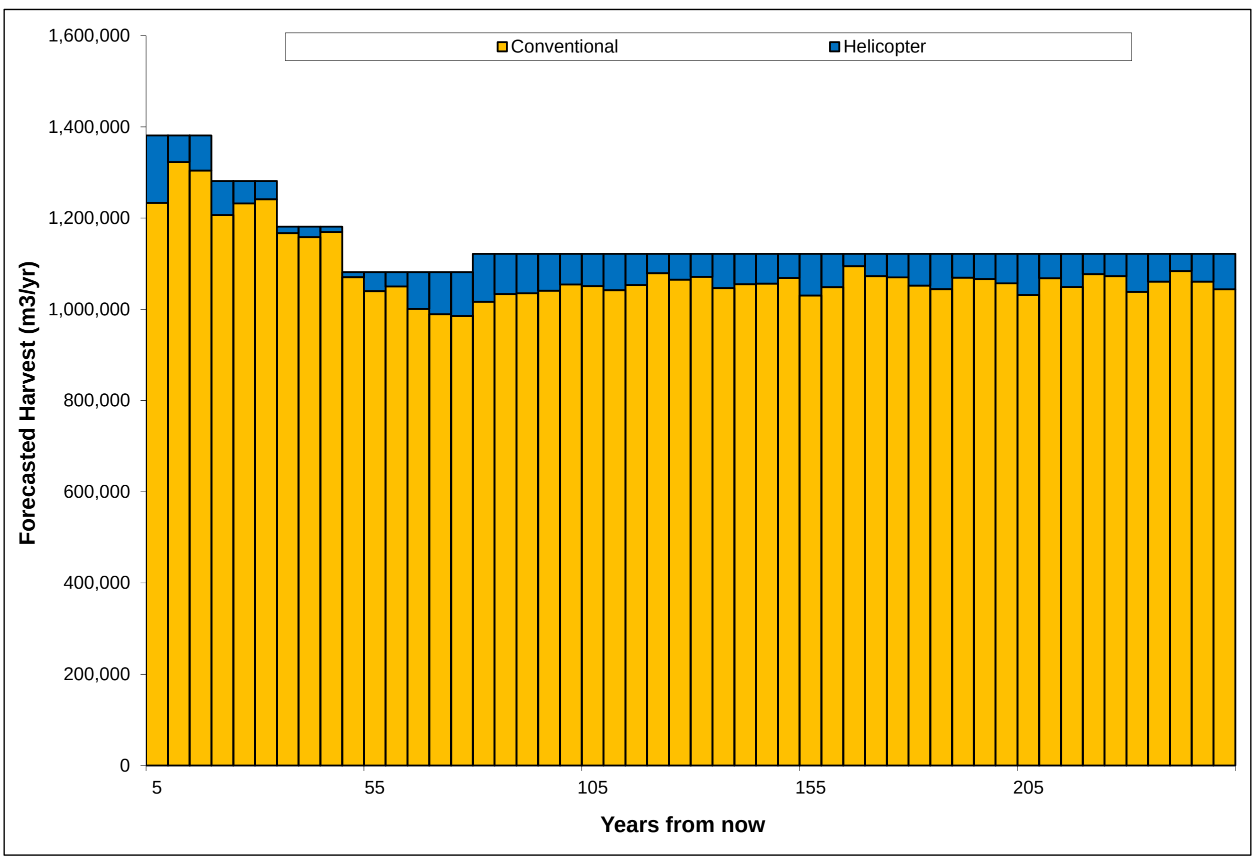

Figure 10: ISS Reference Forecast 1 by harvest method

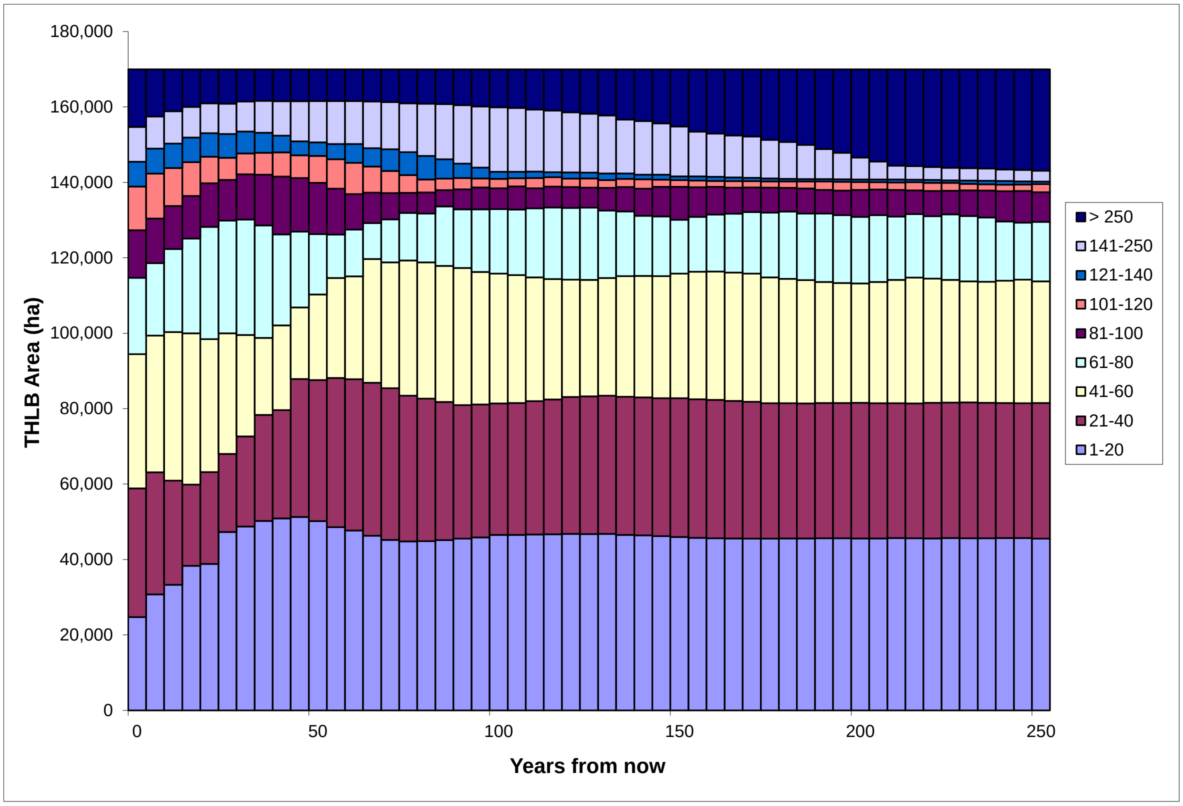

Figure 11: Predicted age class distribution over time on the THLB, ISS Reference Forecast 1

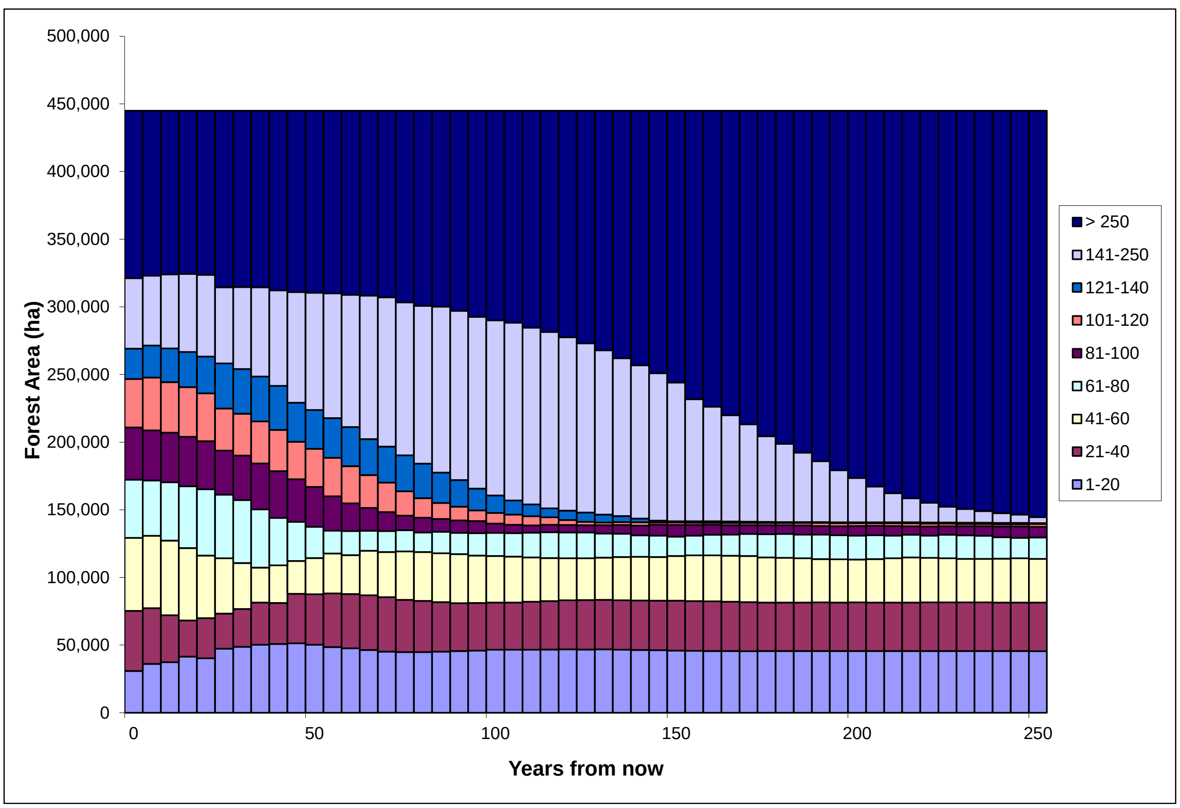

Figure 12: Predicted age class distribution over time on the CFLB, ISS Reference Forecast 1

3.1.2 ISS Reference Forecast 2

The ISS Reference Forecast 2 does not remove the First Nations Cultural Areas from the THLB. The THLB in this forecast is 13,976 ha greater than the THLB in the ISS Reference Forecast 1.

Figure 13 illustrates the ISS Reference Forecast 2 and compares it to the ISS Reference Forecast 1. The ISS Reference Forecast 2 harvest level is 4.3% to 5.6% higher during the first 75 years of the planning horizon than that of the ISS Reference Forecast 1. In the long term, the forecast is 7.1% higher. The initial harvest level of 1,441,330 m^3 per year can be maintained for 15 years. At year 16 the forecast is reduced by to 1,341,450 ^{3} per year, where it stays until year 30. Two more reductions are required until the mid-term harvest level of 1,141,900 m^3 per year is reached at year 46. As with the ISS Reference Forecast 1, the long-term harvest level of 1,201,620 m^3 per year is reached at year 76.

Figure 14 illustrates the predicted development of the growing stock for the ISS Reference Forecast 2. The stable long-term growing stock indicates a sustainable timber supply.

As with the ISS Reference Forecast 1, the majority of harvest is predicted to come from natural stands during the first 15 years of the planning horizon, i.e. Douglas-fir stands established prior to 1958 or all other stands established prior to 1978 (Figure 15). In 35 years, approximately one half of the harvest is forecasted to come from managed stands.

Figure 16 shows the harvest forecast by species. The share of Fd is predicted to increase over the long term at the expense of HemBal. As illustrated in Figure 16, current practises are predicted to result in the decrease of Cw in the THLB.

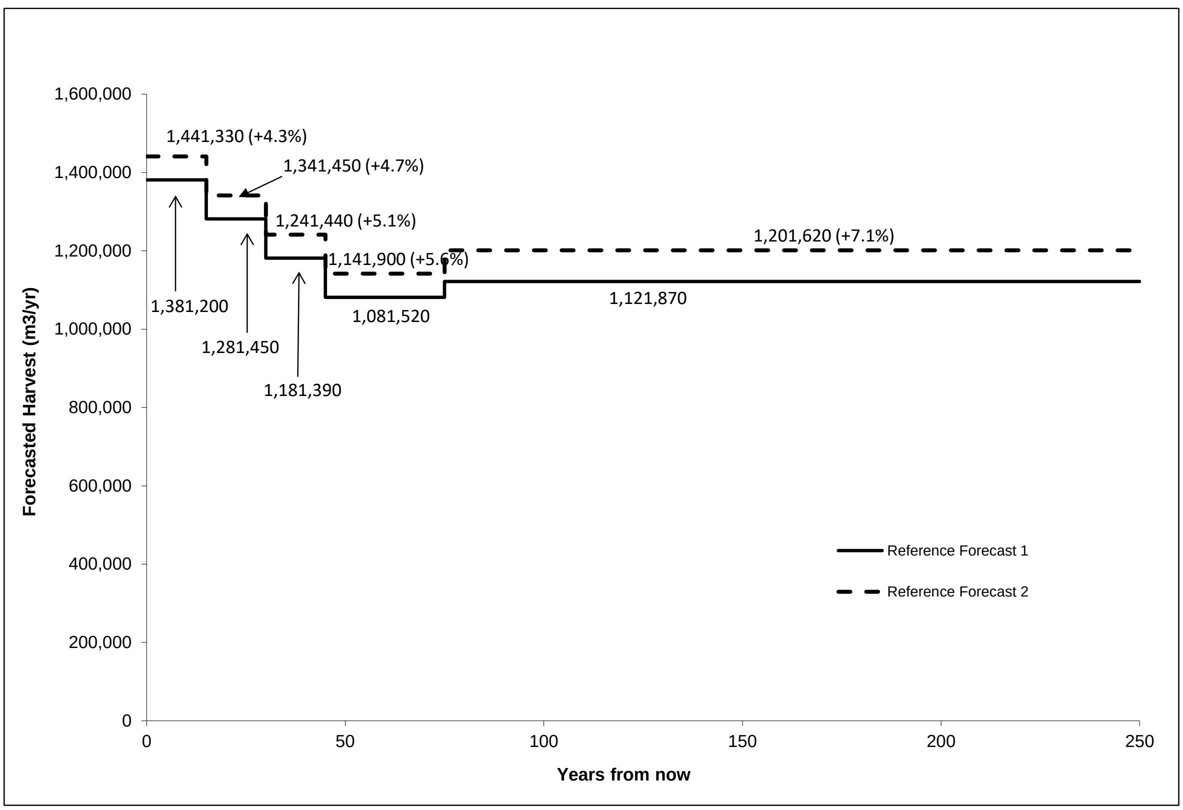

Figure 13: ISS Reference Forecast 2

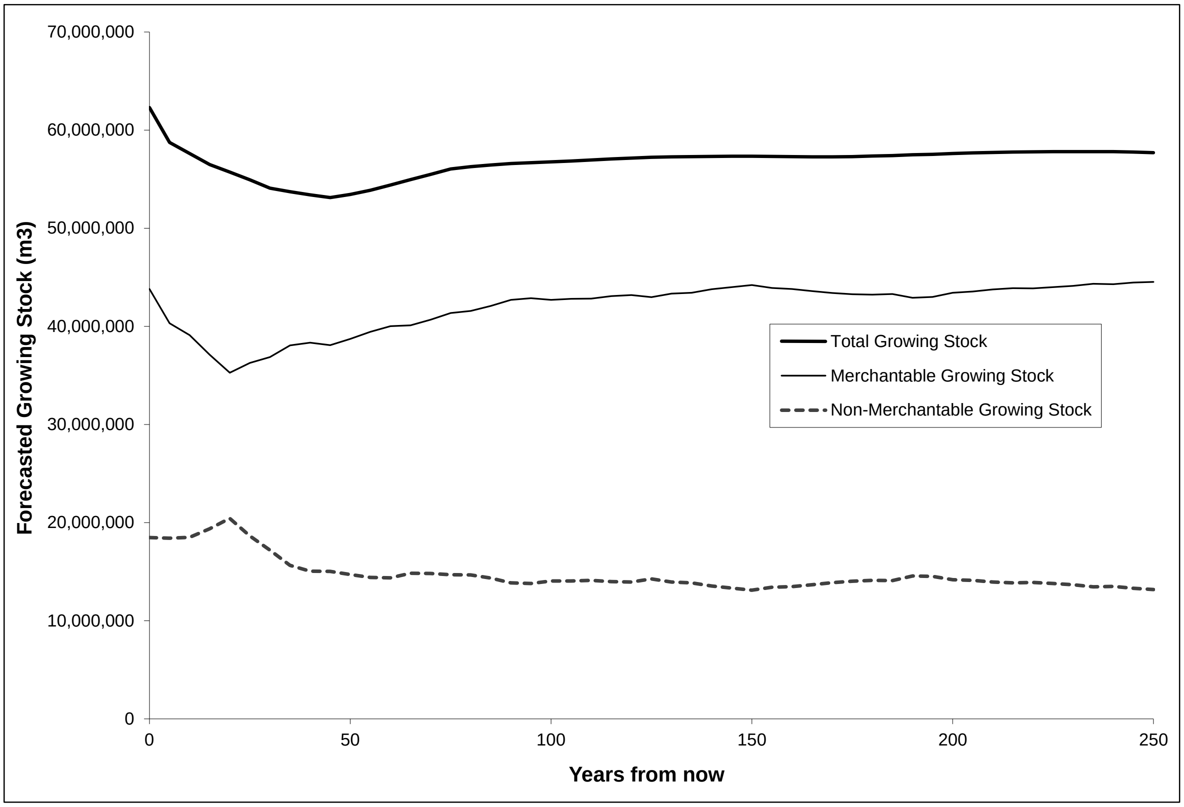

Figure 14: Predicted growing stock development, ISS Reference Forecast 2

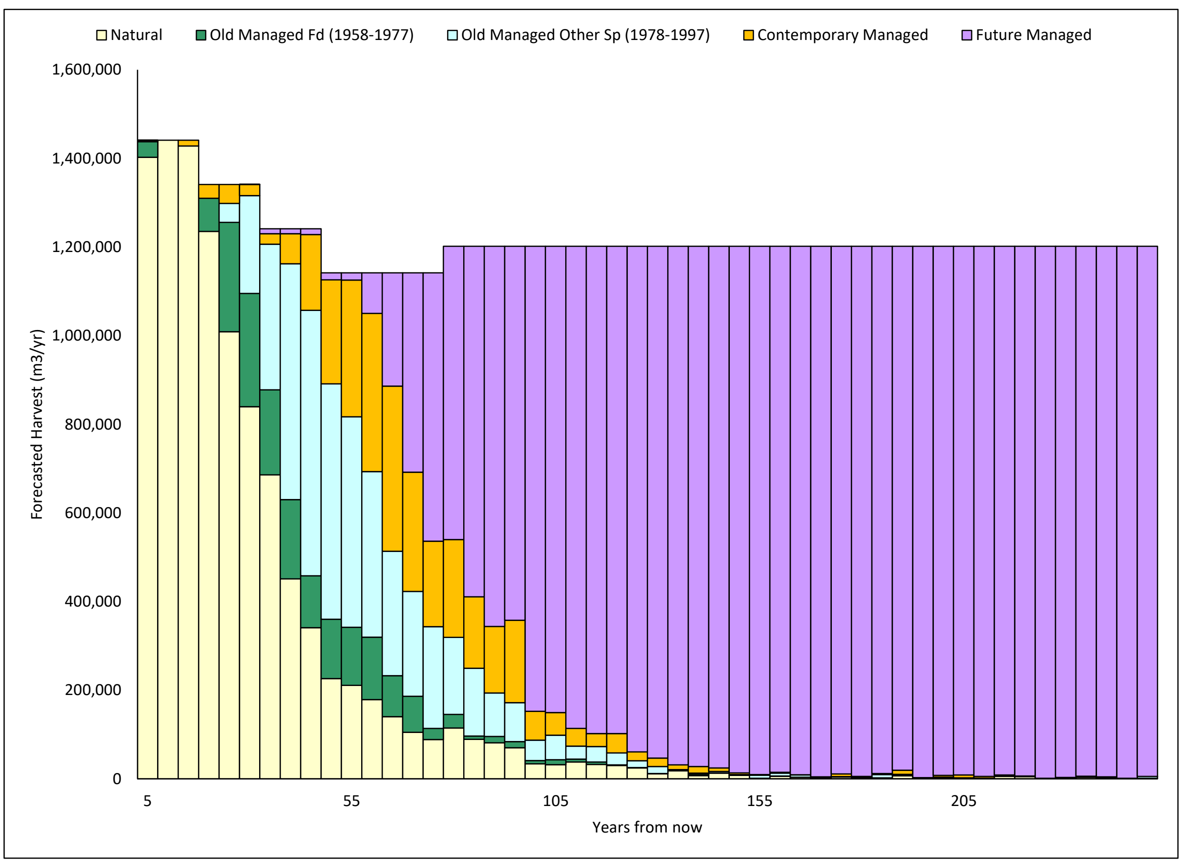

Figure 15: ISS Reference Forecast 2 by stand type

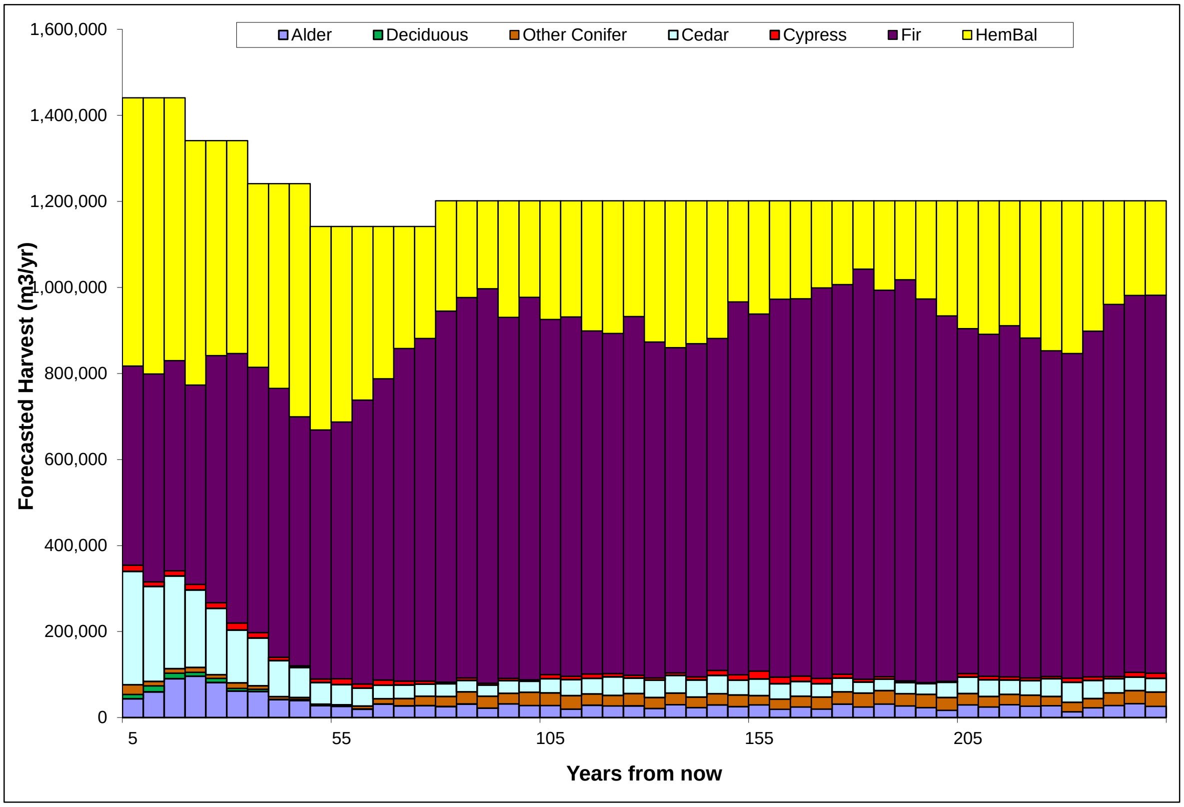

Figure 16: ISS Reference Forecast 2 by species

The rest of the timber supply metrics reflect those of the ISS Reference Forecast 1. Older stands are harvested in the first 30 years; however, the harvest share of younger stands of the total volume is significant (Figure 17) and from year 31 on 50% or more of the harvest is predicted to come from stands between 41 and 80 years old. ISS Reference Forecast 2 results in a smaller proportion of the harvest coming from stands <60 years old after 60 years as compared to ISS Reference Forecast 1.

Figure 18 illustrates the predicted average harvest age, which remains high at first due to the harvest of older stands but stabilizes and settles below 80 years in the long term.

Figure 19 illustrates the harvest forecast by vol/ha classes, while Figure 20 shows the predicted average harvest volume over time. The larger THLB in the ISS Reference Forecast 2 results in higher volumes per ha in the long term compared to the ISS Reference Forecast 1. In the long run, most of the harvest is predicted to come from stands with the volume per ha between 600 to 700 m^3 (Figure 19) with the average harvest volume trending close to 650 m^3 per ha (Figure 20) vs. 600 m^3 for Reference Forecast 1..

The predicted average annual harvest area is illustrated in Figure 21. In the long term, the predicted annual harvest area is close to 1,900 ha.

Almost the entire harvest is predicted to come from areas where ground-based harvest systems are prevalent; however, some helicopter harvesting is also predicted (Figure 22).

Figure 23 and Figure 24 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 23). Older age classes, especially age class 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 24).

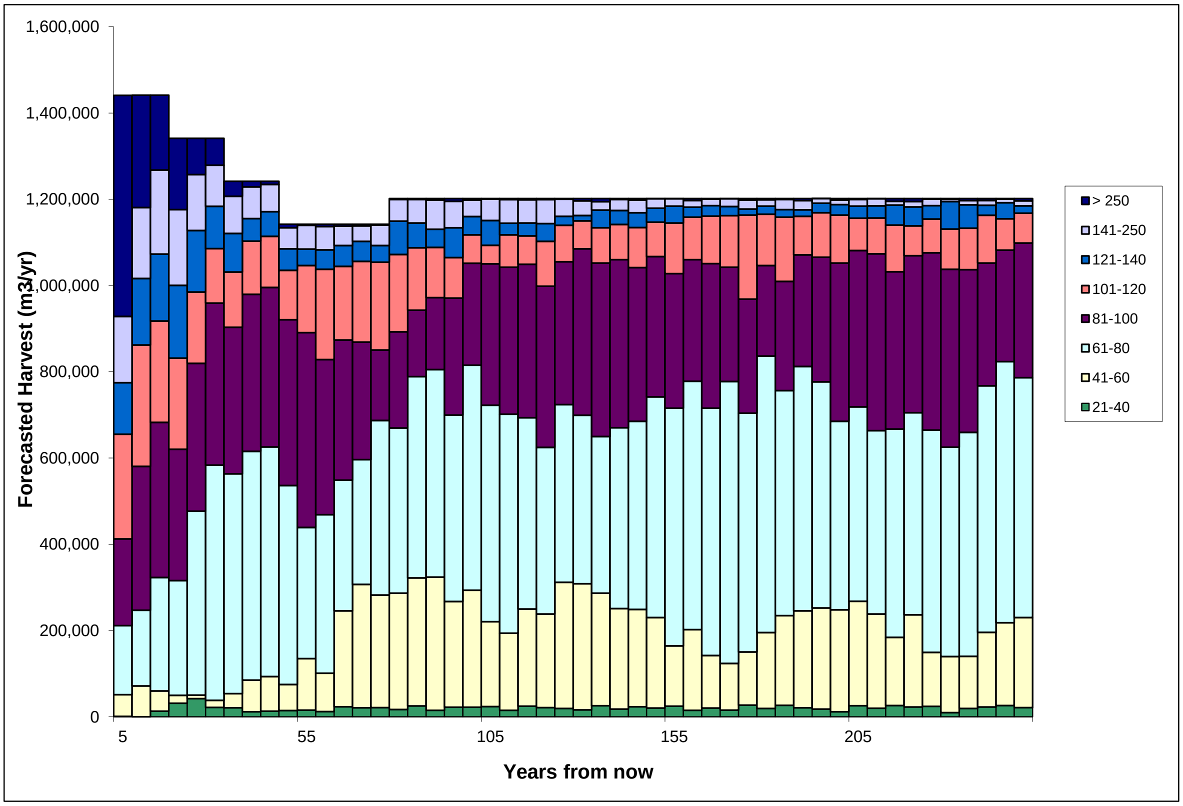

Figure 17: ISS Reference Forecast 2 by age class

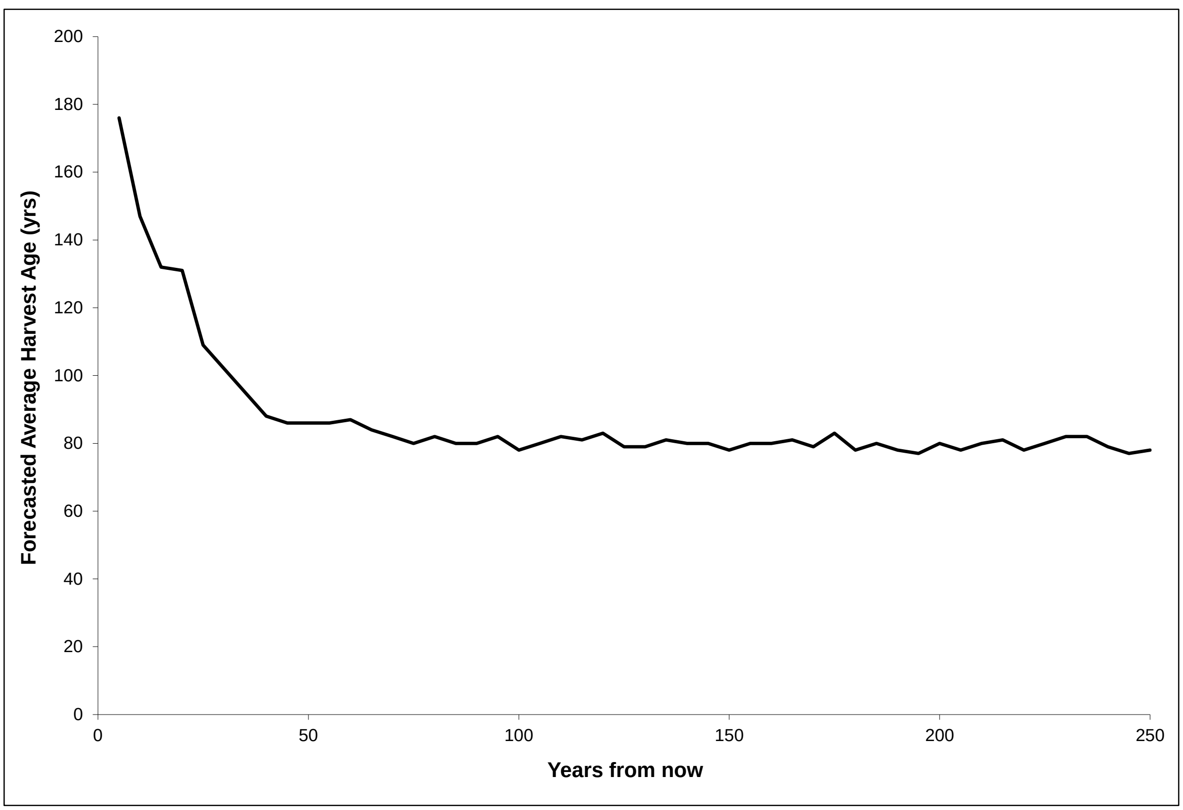

Figure 18: Average harvest age, ISS Reference Forecast 2

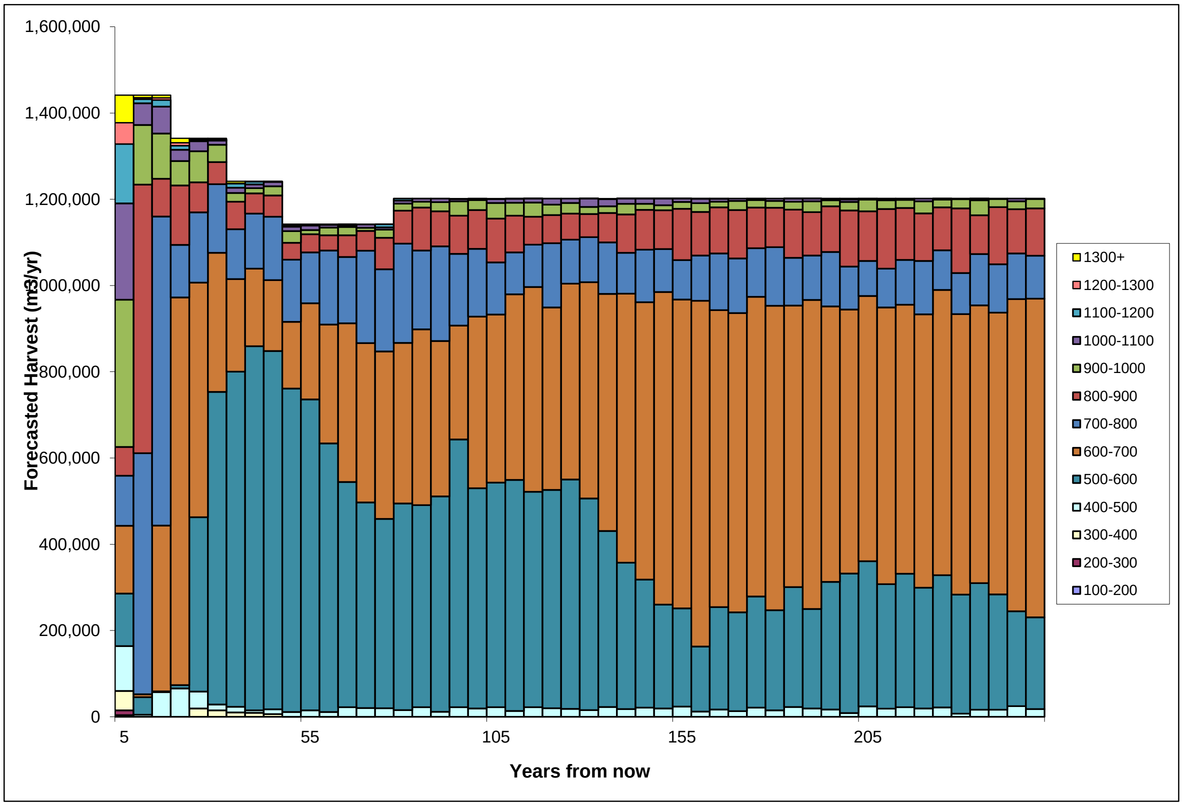

Figure 19: ISS Reference Forecast 2 by volume per ha class

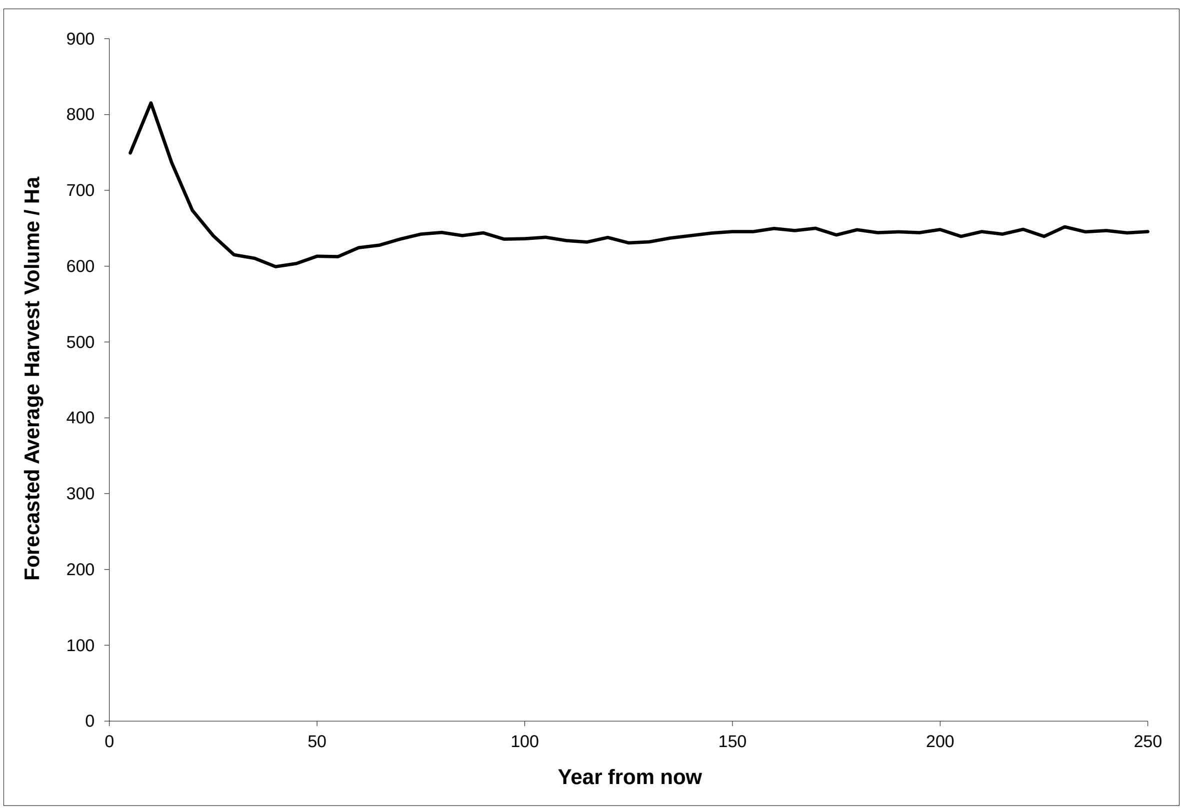

Figure 20: Predicted average harvest volume per ha, ISS Reference Forecast 2

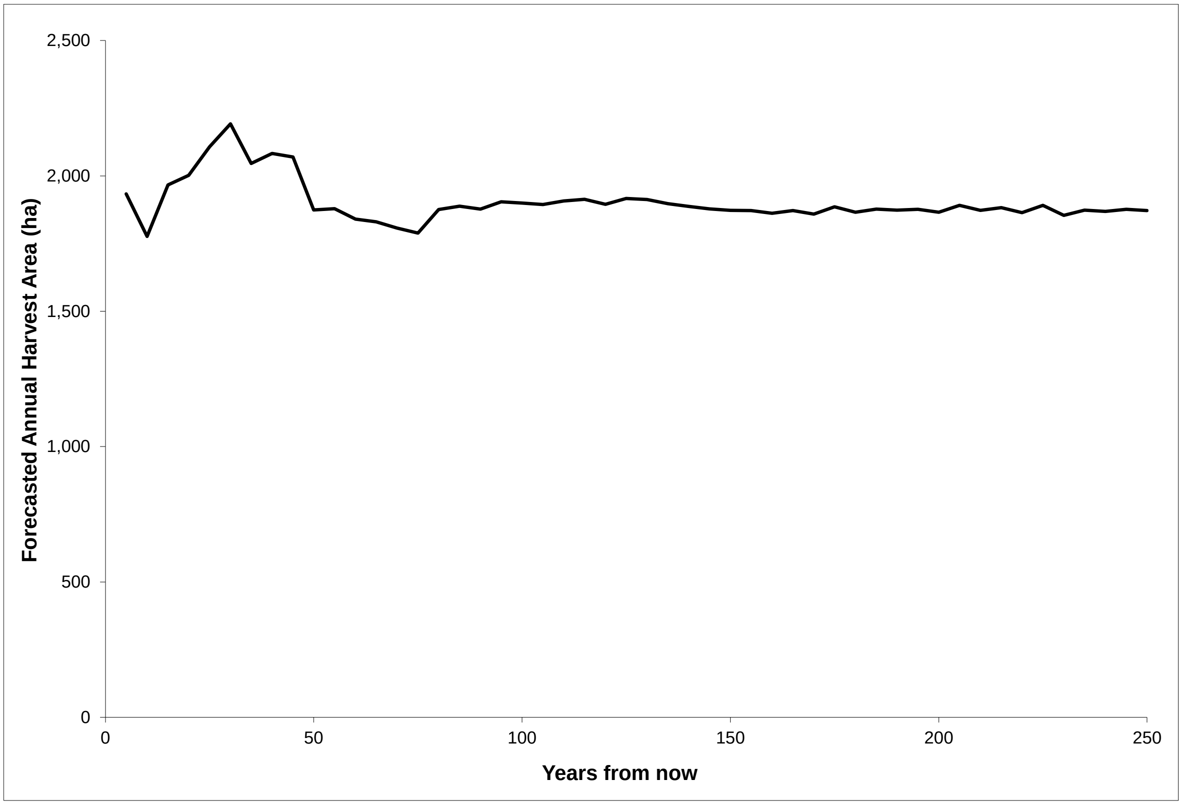

Figure 21: Predicted average harvest area, ISS Reference Forecast 2

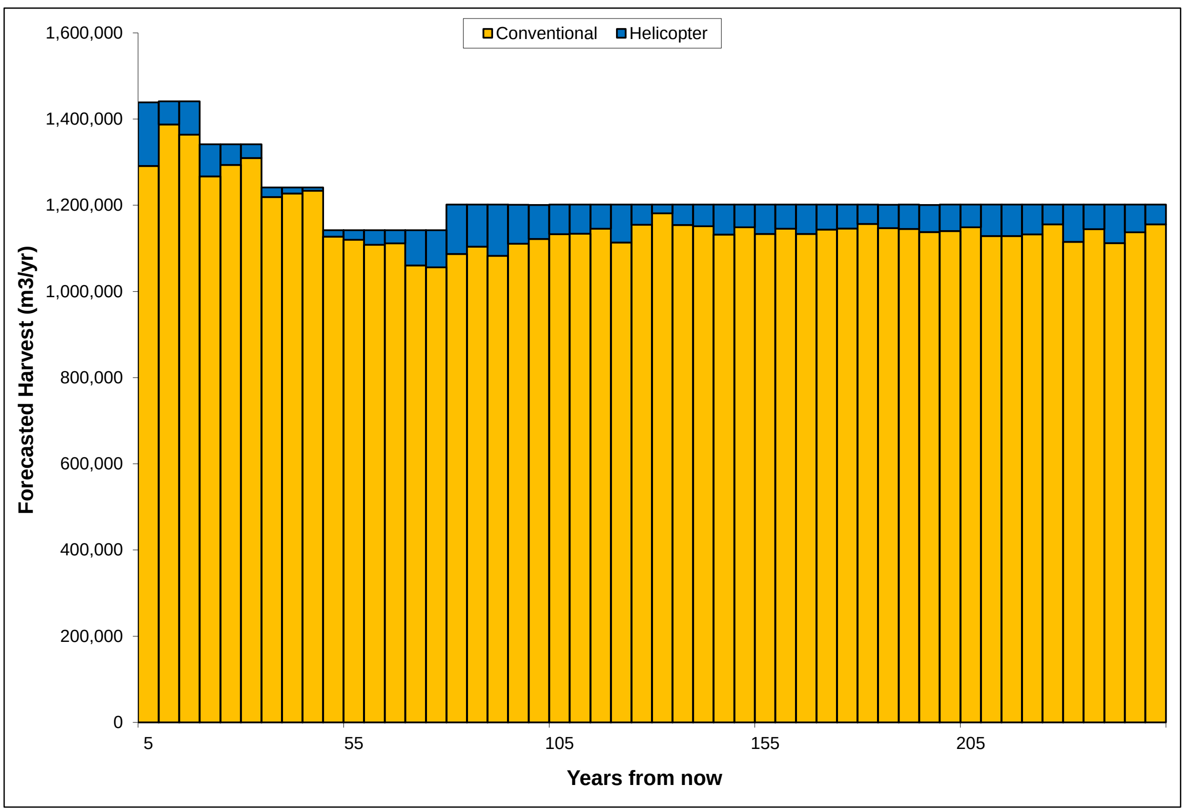

Figure 22: ISS Reference Forecast 2 by harvest method

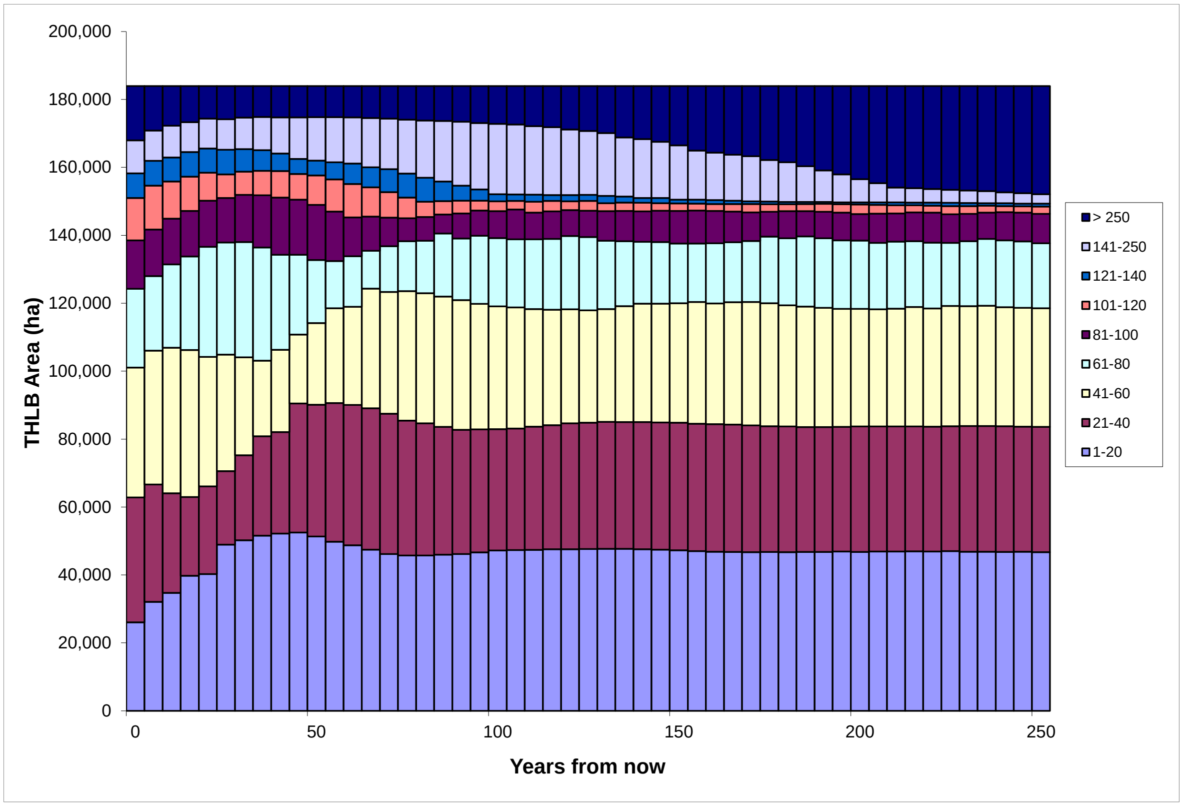

Figure 23: Predicted age class distribution over time on the THLB, ISS Reference Forecast 2

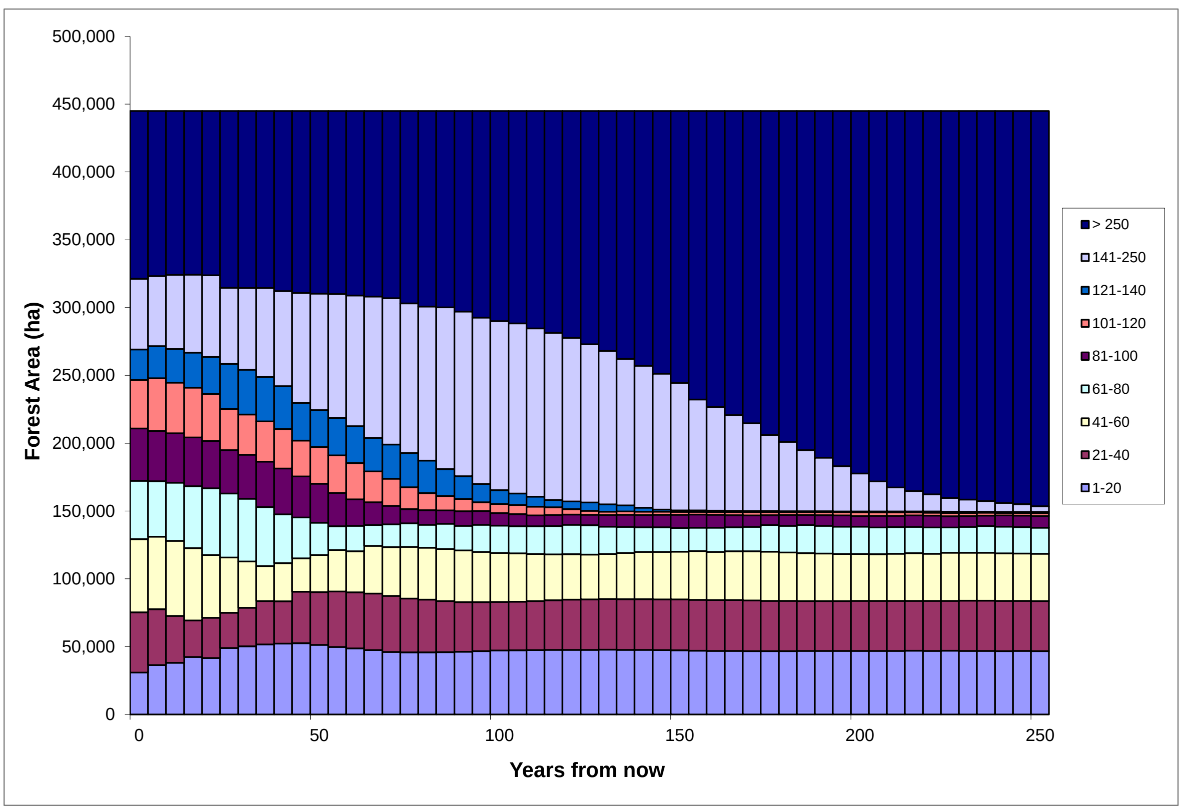

Figure 24: Predicted age class distribution over time on the CFLB, ISS Reference Forecast 2

3.1.3 Woodsheds

The Sunshine Coast TSA is divided into woodsheds; subunits of the TSA serviced by common road systems and timber gathering points. This analysis includes rules to account for costs associated with mobilization and demobilization. Most woodsheds are subject to minimum volume requirements; they are applied to 5-year periods in the model.

Woodshed minimum volume requirements were not applied in the reference forecasts. Their impact on timber supply were tested through sensitivity analysis (section 3.2).

The minimum volume targets for woodsheds were generally met in larger woodsheds as shown in Figure 25 depicting forecasted annual harvest for Reference Forecast 1 in East Redona South. East Redona South is a large woodshed with approximately 3,480 ha of THLB.

As the woodsheds targets were not forced in either of the reference forecasts, the small woodsheds often did not meet the periodic/annual minimum harvest target as illustrated in Figure 26. The harvest forecast is shown for the Deserted woodshed with only 1,343 ha of THLB.

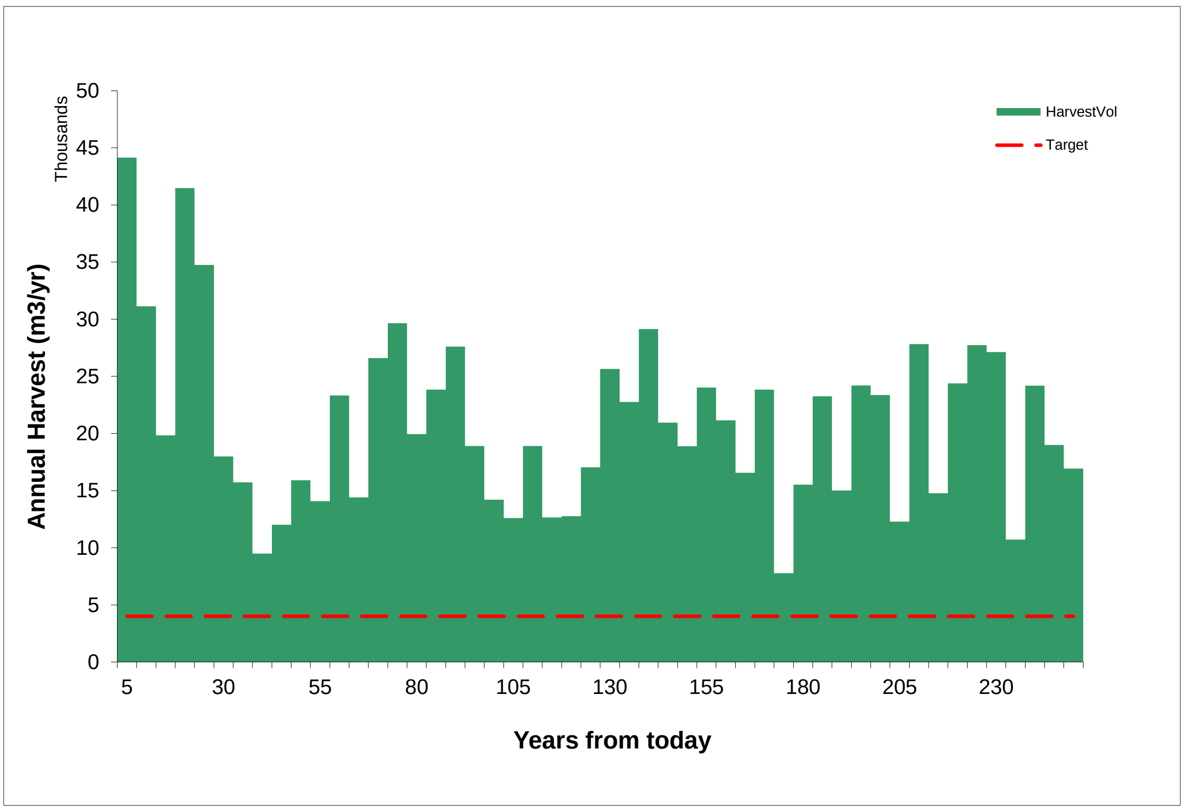

Figure 25: Predicted annual harvest in East Redona South; Reference Forecast 1

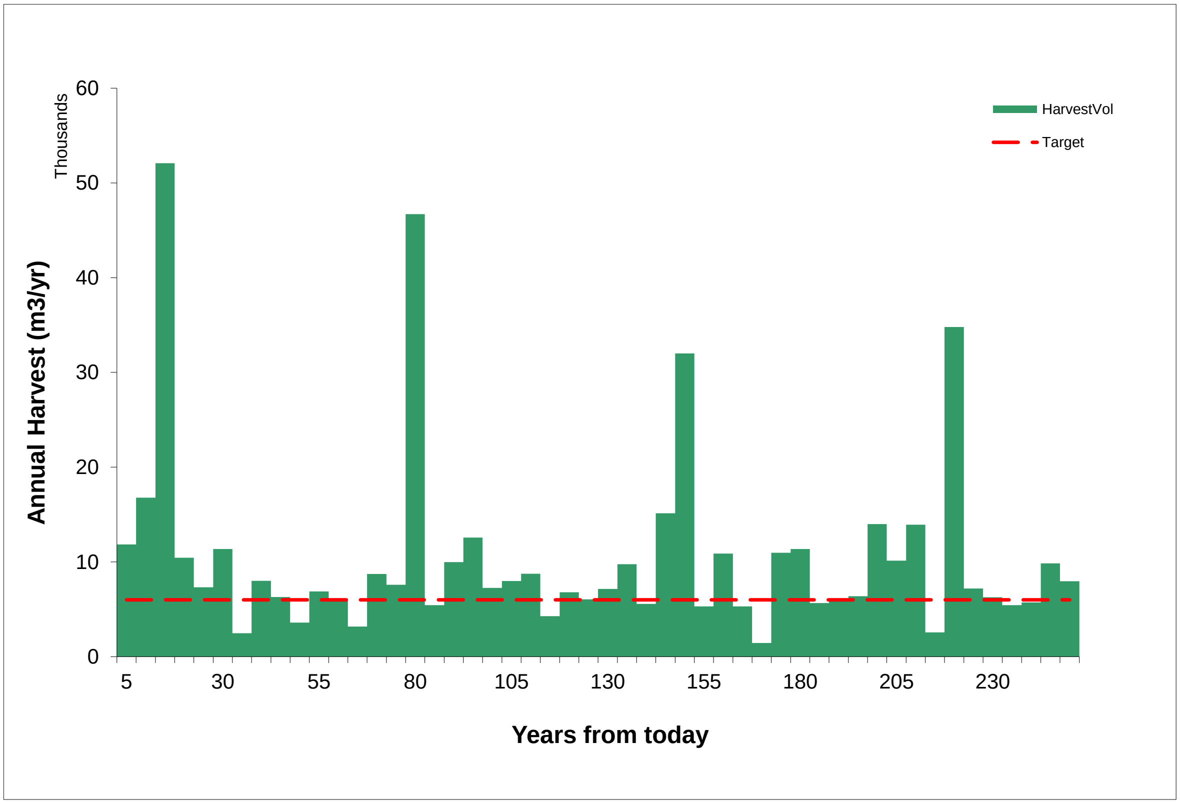

Figure 26: Predicted annual harvest in Deserted; Reference Forecast 1

3.1.4 Northern Goshawk (NOGO)

The ISS Reference Forecasts were set up to report on NOGO forage habitat around NOGO nests. Buffers of 2,500 m (1962.5 ha) were placed around the NOGO nests and the amount of forage habitat is reported for each forage area.

There are 14 forage areas within the Sunshine Coast TSA that are classified as forest. They are shown in Table 2.

Table 2: NOGO forage areas in the Sunshine Coast TSA

Forage Area Name	Forest Area (ha)
Clowhom	2,032
Giovanno	4
Glacial Creek	1,966
Granite	646
Homathko7Mile	835
Landmark Mtn	1,498
Maurell Island	1,774
McNair	2,579
Mt. Pearkes	1,596
Osgood	1,725
Phantom	2,377

Forage Area Name	Forest Area (ha)
Potlatch	1,703
Ruby Lake	1,900
Skaiakos	2,663

3.1.4.1 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:

- 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.

A detailed description of the foraging model is provided in the Sunshine Coast ISS Data Package (Forest Ecosystem Solutions Ltd, 2020).

Table 3 and Table 4 illustrate the forecasted NOGO foraging habitat for the NOGO forage habitat areas. All forage areas achieve greater than the 40% target throughout the planning horizon in both Reference Forecasts.

Table 3: NOGO forage habitat; ISS Reference Forecast 1

Forage Area Name	Forest Area (ha)	Forage Habitat Percent					
		Now	50 Yrs	100 Yrs	150 Yrs	200 Yrs	250 Yrs
Clowhom	2,032	52.7%	55.5%	64.3%	69.1%	59.7%	64.7%
Giovanno	4	96.3%	100.0%	100.0%	100.0%	100.0%	100.0%
Glacial Creek	1,966	81.0%	72.3%	78.3%	73.3%	78.0%	74.4%
Granite	646	85.9%	98.4%	87.5%	98.3%	88.2%	97.7%
Homathko7Mile	835	88.4%	98.9%	97.0%	91.0%	94.7%	99.1%
Landmark Mtn	1,498	78.9%	86.4%	92.4%	76.2%	85.7%	94.3%
Maurell Island	1,774	76.0%	75.2%	82.6%	79.4%	80.1%	79.5%
McNair	2,579	69.6%	77.2%	74.2%	77.0%	75.7%	74.6%
Mt. Pearkes	1,596	66.8%	76.0%	72.0%	72.9%	73.9%	72.6%
Osgood	1,725	81.4%	92.7%	96.0%	97.0%	97.6%	96.7%
Phantom	2,377	48.3%	57.6%	68.3%	71.3%	72.0%	64.3%
Potlatch	1,703	72.0%	68.4%	70.1%	74.3%	70.6%	72.6%
Ruby Lake	1,900	89.0%	84.2%	85.4%	87.1%	86.8%	86.8%
Skaiakos	2,663	82.5%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 4: NOGO forage habitat; ISS Reference Forecast 2

Forage Area Name	Forest Area (ha)	Forage Habitat Percent					
		Now	50 Yrs	100 Yrs	150 Yrs	200 Yrs	250 Yrs
Clowhom	2,032	52.7%	56.8%	65.3%	73.9%	64.8%	68.9%
Giovanno	4	96.3%	100.0%	100.0%	100.0%	100.0%	100.0%
Glacial Creek	1,966	81.0%	73.5%	78.9%	74.6%	76.6%	73.6%
Granite	646	85.9%	98.4%	86.9%	100.0%	88.2%	97.8%
Homathko7Mile	835	88.4%	98.9%	96.0%	96.6%	96.0%	98.9%
Landmark Mtn	1,498	78.9%	90.2%	89.7%	85.3%	93.8%	90.9%
Maurell Island	1,774	76.0%	78.0%	82.3%	80.2%	81.1%	81.7%
McNair	2,579	69.6%	77.4%	74.0%	78.9%	76.9%	74.0%
Mt. Pearkes	1,596	66.8%	76.0%	71.9%	73.4%	74.3%	73.0%
Osgood	1,725	81.4%	92.9%	96.2%	97.3%	97.3%	97.0%
Phantom	2,377	48.3%	59.2%	77.3%	73.4%	72.7%	73.5%
Potlatch	1,703	72.0%	69.2%	71.7%	74.8%	71.6%	80.4%
Ruby Lake	1,900	89.0%	84.0%	86.1%	87.1%	86.1%	85.8%
Skaiakos	2,663	82.5%	58.4%	71.9%	63.5%	70.3%	66.2%

3.1.5 Marbled Murrelet (MAMU)

Suitable Marbled Murrelet (MAMU) habitat is defined as old, natural forest with specific attributes based on field surveys. A spatial file identifying MAMU habitat was received from Darryn McConkey of FLNRORD. These areas remain habitat until they are harvested.

Targets for MAMU habitat by aggregated landscape unit were also provided by FLNRORD. The MAMU habitat was tracked by aggregated landscape unit in the Reference Forecasts, but not enforced. There are 30,405 ha of suitable MAMU habitat polygons within the CFLB of the Sunshine Coast TSA of which 27,725 ha are currently older than 140. Only polygons older than 140 were considered habitat in this analysis.

Most of the suitable habitat in each aggregated landscape unit is in the NHLB as shown in Table 5. The area of suitable habitat, the target for each aggregated landscape unit group and the achieved habitat % are show shown in Table 6 and Table 7.

Table 5: Aggregated landscape unit areas

Aggregated Landscape Unit	Suitable Habitat (ha)	Suitable Habitat THLB (ha)	Suitable Habitat NHLB (ha)	NHLB %
Bute	9,011	1,660	7,351	81.6%
Georgia	4,231	787	3,443	81.4%
Homatho	3,373	275	3,098	91.9%
Jervis	8,511	901	7,610	89.4%
Powell	409	135	274	67.0%
Sechelt	4,870	1,000	3,871	79.5%

Table 6: Achieved Marbled Murrelet habitat, ISS Reference Forecast 1

Aggregated LU	LUs in Group	Suitable Habitat CFLB (ha)	Target (%) of Suitable CFLB	Habitat % Now	Habitat % 50 Years	Habitat % 100 Years	Habitat % 150 Years	Habitat % 200 Years	Habitat % 250 Years
Bute	Brem Bute East Bute West Quatam	9,011	85%	88%	73%	73%	73%	73%	73%
Georgia	Bunster Cortes Homfray	4,231	91%	97%	88%	87%	87%	87%	87%
Homathko	Bishop Homathko Southgate Toba	3,373	85%	94%	90%	89%	89%	89%	89%
Jervis	Brittain Deserted Jervis Narrows Skwawka	8,511	90%	88%	83%	83%	83%	83%	83%
Powell	Haslam Lois Powell Daniels Powell Lake Texada	409	81%	92%	90%	89%	89%	89%	89%
Sechelt	Chapman Howe Salmon Inlet Sechelt	4,870	85%	95%	83%	81%	81%	81%	81%

Table 7: Achieved Marbled Murrelet habitat, ISS Reference Forecast 2

Aggregated LU	LUs in Group	Suitable Habitat CFLB (ha)	Target (%) of Suitable CFLB	Habitat % Now	Habitat % 50 Years	Habitat % 100 Years	Habitat % 150 Years	Habitat % 200 Years	Habitat % 250 Years
Bute	Brem Bute East Bute West Quatam	9,011	85%	88%	73%	73%	73%	73%	73%
Georgia	Bunster Cortes Homfray	4,231	91%	97%	88%	87%	87%	87%	87%
Homathko	Bishop Homathko Southgate Toba	3,373	85%	94%	90%	89%	89%	89%	89%
Jervis	Brittain Deserted Jervis Narrows Skwawka	8,511	90%	88%	83%	83%	83%	83%	83%
Powell	Haslam Lois Powell Daniels Powell Lake Texada	409	81%	92%	90%	89%	89%	89%	89%
Sechelt	Chapman Howe Salmon Inlet Sechelt	4,870	85%	95%	83%	81%	81%	81%	81%

3.2 ISS Reference Forecasts with Woodshed Minimum Volume Targets Enforced

The impact of enforcing the woodshed minimum harvest targets was tested for both reference forecasts. Timber supply was not impacted. As noted earlier in this document, the small woodsheds often did not meet the periodic/annual minimum harvest target, when the minimum volume targets were not enforced. Figure 27 shows the harvest forecast for the Deserted woodshed (1,343 ha of THLB; the minimum volume requirement is enforced, and no harvest occurs, if the requirement cannot be met.

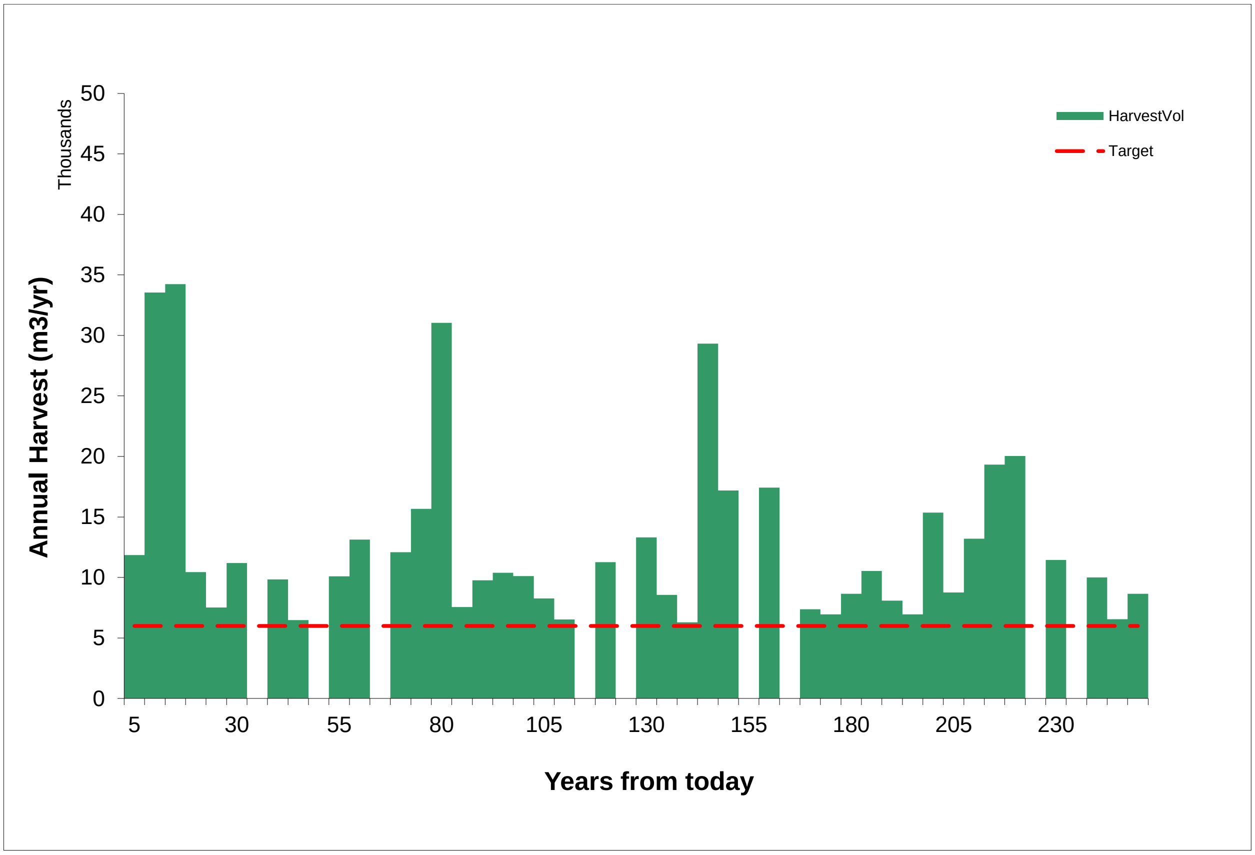

Figure 27: Predicted annual harvest in Deserted, woodshed targets enforced; Reference Forecast 1

3.3 ISS Reference Forecasts with Current and Projected Elk and Deer Damage

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 late 2019.

In the winter of 2020, the WG had meetings and field tours and became concerned about elk and, in some cases deer, damage to young managed stands in some locations. As a result, current and projected elk damage and future deer browse was incorporated in the analysis as a scenario. Some yield curves were adjusted and both Reference Forecasts were rerun. The two forecasts presented below were adopted as the new Reference Forecasts for silviculture scenario comparisons, because it was considered important that elk damage be incorporated in the Sunshine Coast ISS fully.

The detailed assumptions regarding elk damage modelling are provided in Sunshine Coast TSA ISS Data Package (FESL, 2020).

3.3.1 Stand Level Results

Current predicted elk impacts on a representative Reference Forecast yield curve (CWHdm gentle cool zonal med-poor) for the Sechelt Peninsula are shown in Figure 28 and Figure 29. At 60 years elk damage results in about a 10% reduction in merchantable volume and log value; however, by year 120 the elk damage volume and value forecasts are slightly higher or about the same compared to the Reference Forecast yield curve.

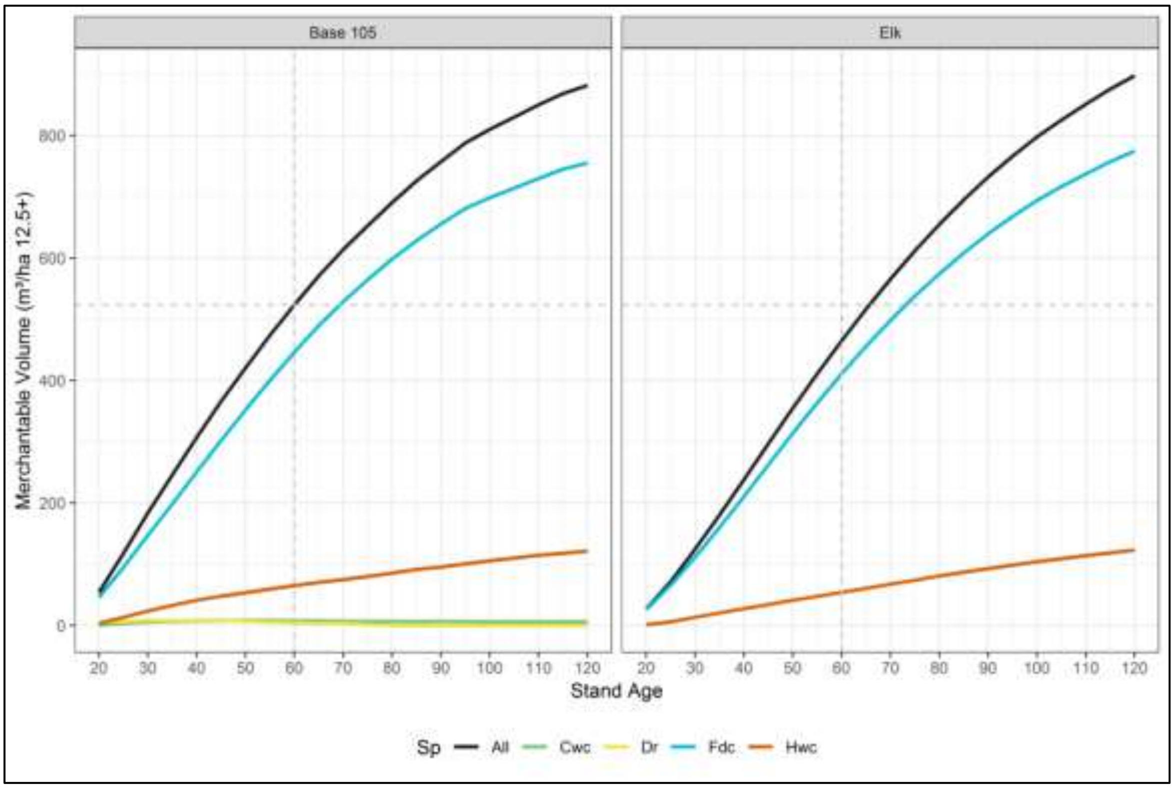

Figure 28: Merchantable volumes for the Reference Forecast (Base 105) versus the elk damage forecast for the CWHdm gentle cool zonal med-poor

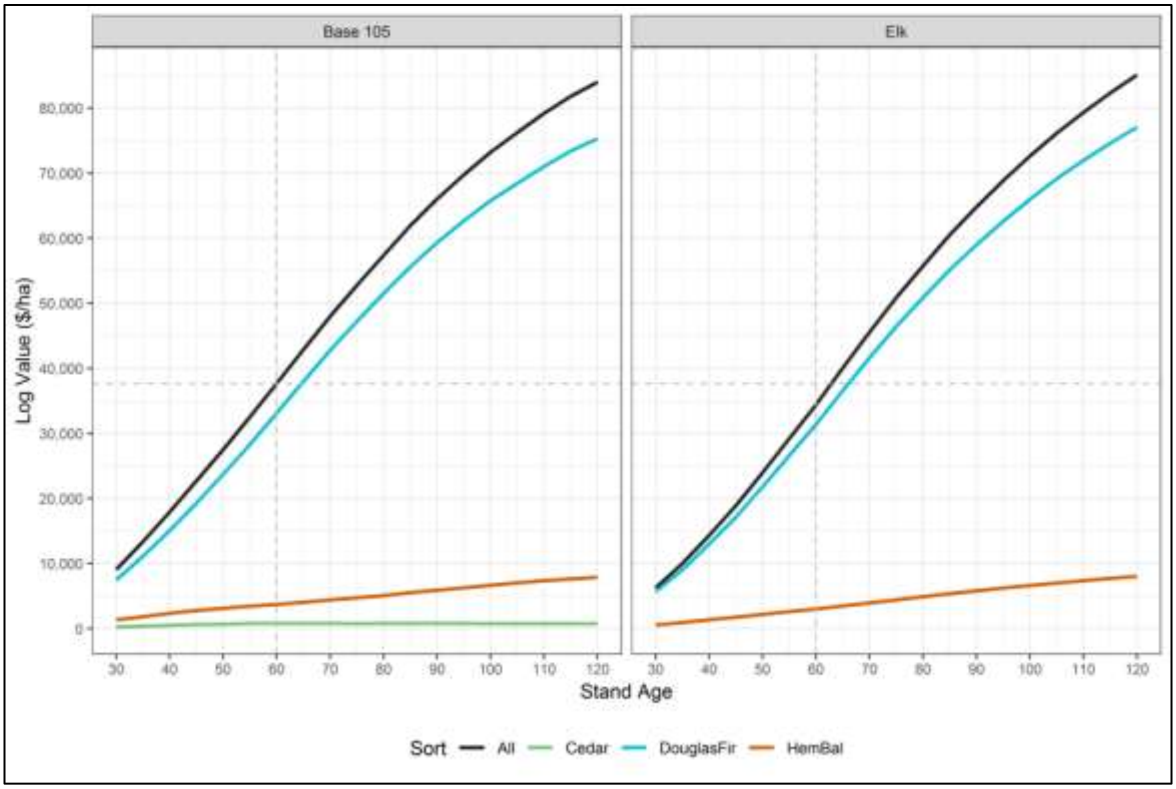

Figure 29: Log values for the Reference Forecast (Base 105) versus the elk damage forecast for the CWHdm gentle cool zonal med-poor

Figure 30 shows a similar, minor impact of current elk damage on the Reference Forecast yield curve for an enhanced site in the CWHdm gentle cool on the Sechelt Peninsula. However, due to the assumption that the Fd logs will have a low value on an elk site (due to being open grown on a very productive site), the elk damage results in about a 27% reduction in total log value at 60 years (Figure 31).

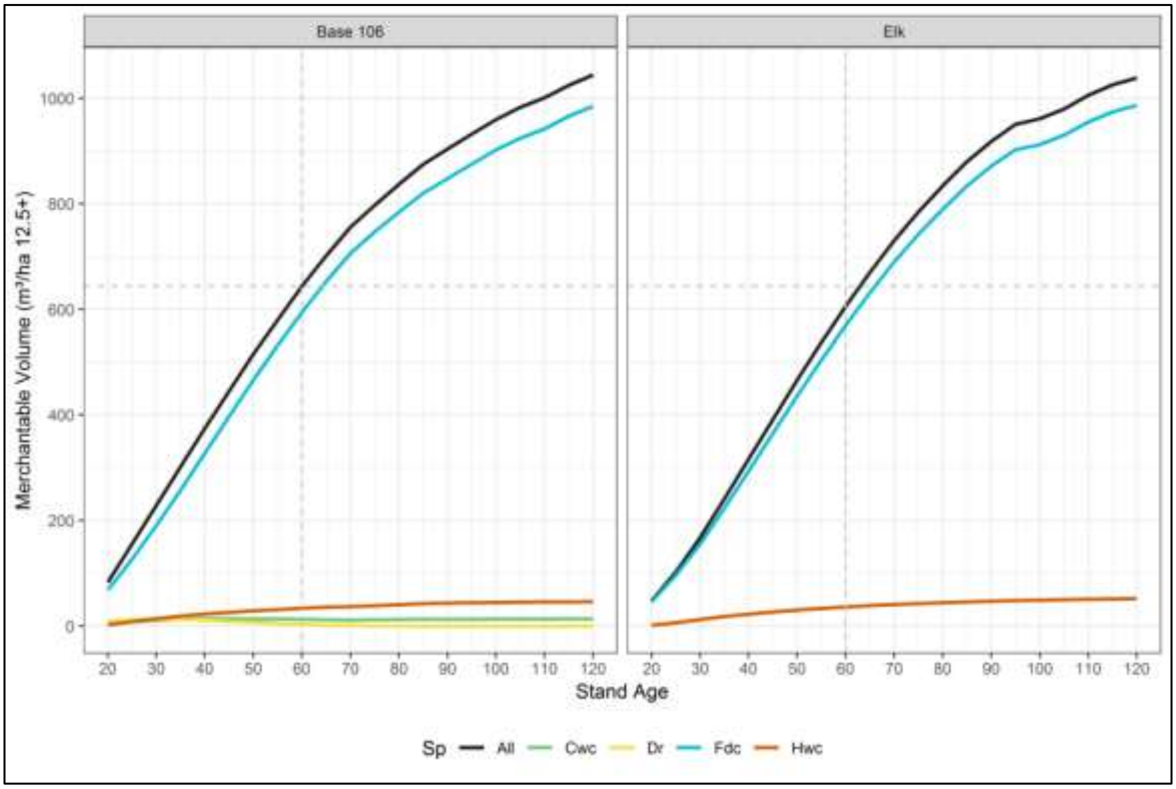

Figure 30: Merchantable volumes for the Reference Forecast (Base 106) versus the elk damage forecast for the CWHdm gentle cool enhanced

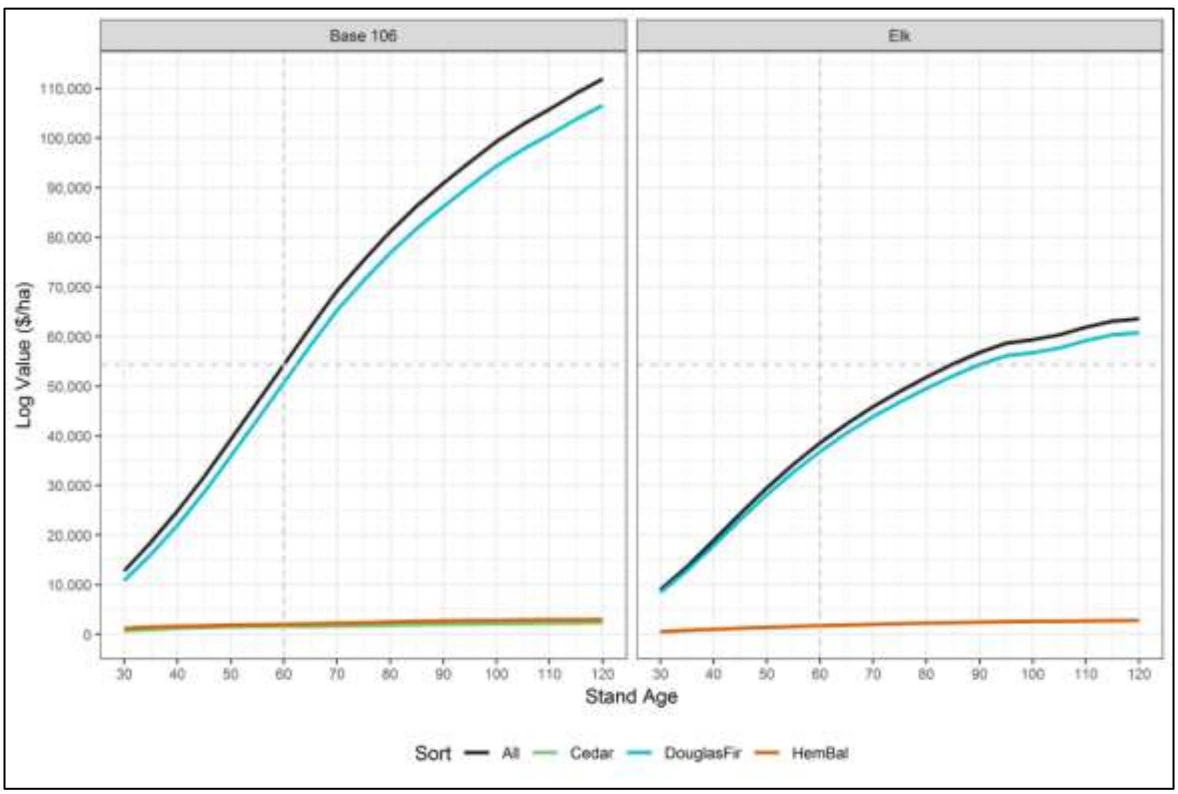

Figure 31: Log values for the Reference Forecast (Base 106) versus the elk damage forecast for the CWHdm gentle cool enhanced

3.3.2 ISS Reference Forecast 1 with Elk

The ISS Reference Forecast 1 excludes the First Nations Cultural Areas from the THLB. Figure 32 illustrates the impact of current and projected elk damage on timber supply (ISS Reference Forecast 1 with elk). The impact is modest; during the first 75 years the elk damage reduced the harvest forecast less than 1%. There was no impact on the long-term timber supply and the impacts on other timber supply metrics were minimal.

Accounting for elk damage had no impact on the average per ha stand value of managed stands over time.

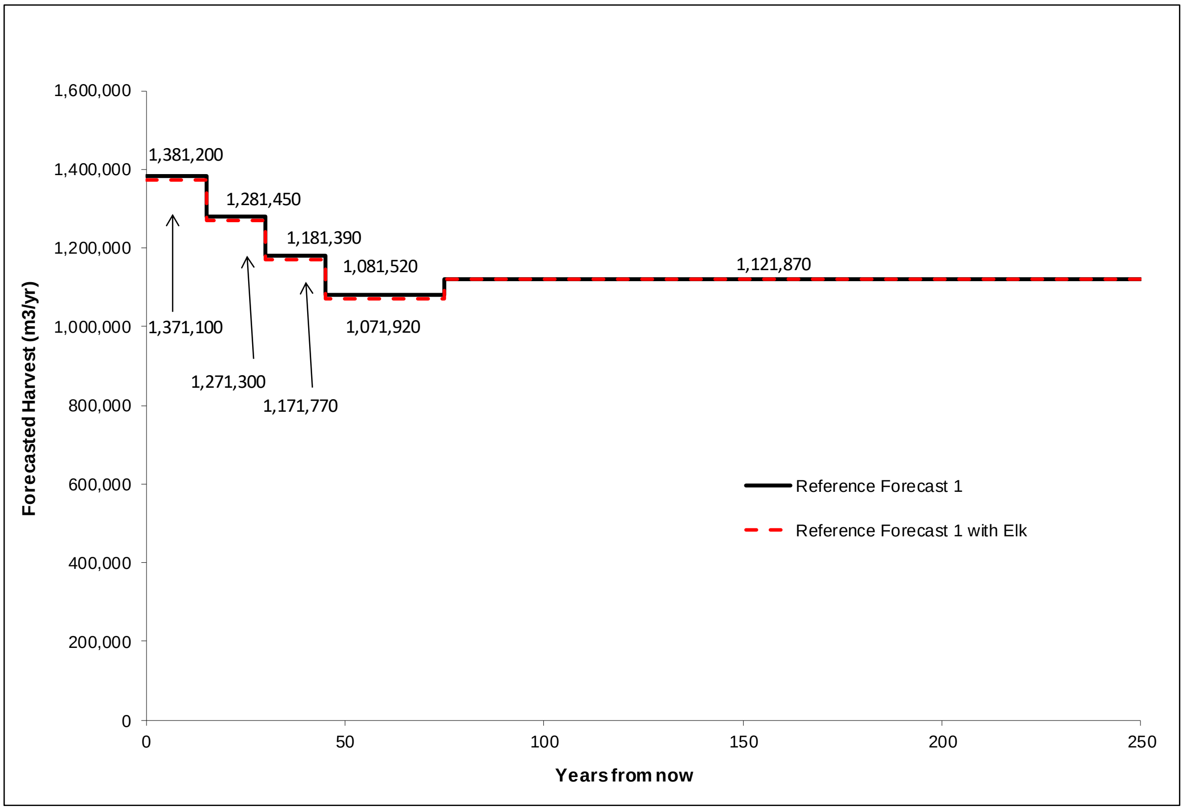

Figure 32: ISS Reference Forecast 1 with elk compared to ISS Reference Forecast 1

3.3.3 ISS Reference Forecast 2 with Elk

The ISS Reference Forecast 2 does not remove the First Nations Cultural Areas from the THLB. The THLB in this forecast is 13,976 ha greater than the THLB in the ISS Reference Forecast 1.

Incorporating the elk damage into the ISS Reference Forecast 2 had no impact on timber supply.

Figure 33 depicts the forecasted value of managed stand harvest over time. Accounting for elk damage reduced the predicted per ha value of managed stand harvest modestly from year 86 on.

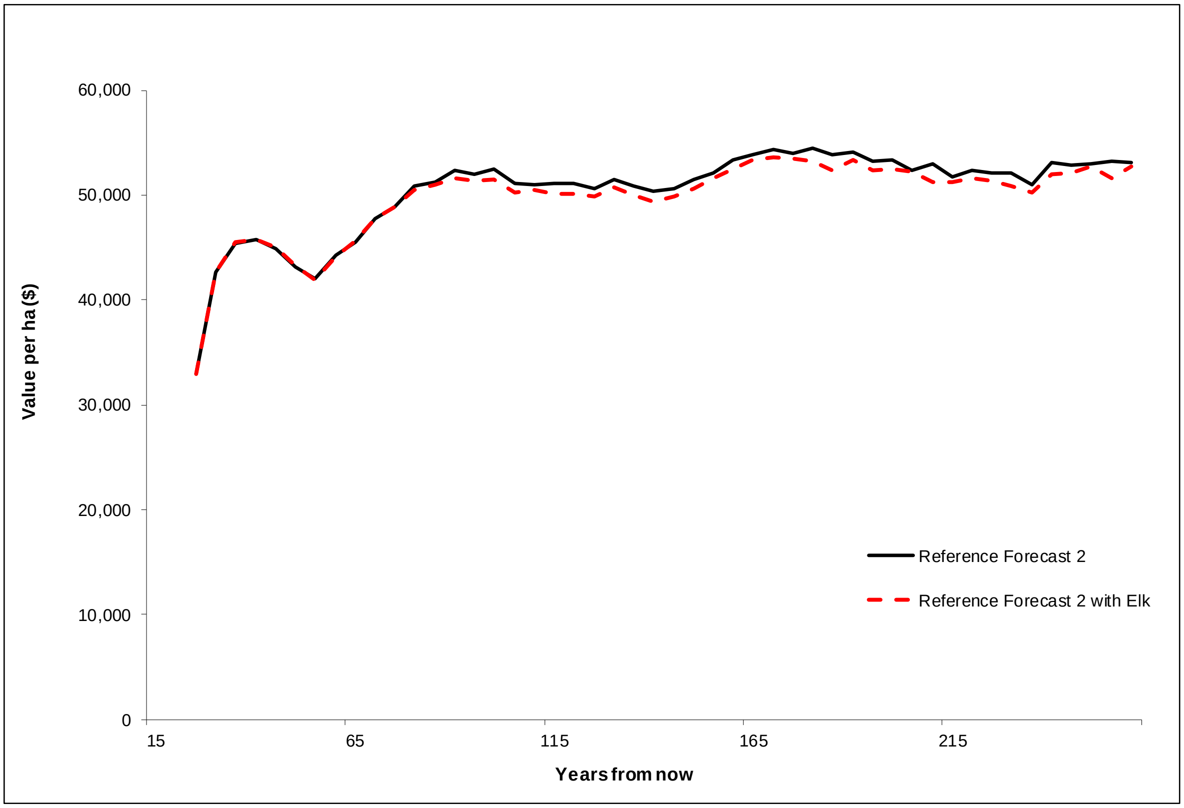

Figure 33: Predicted value per ha of managed stand harvest, ISS Reference Forecast 2 with and without elk

3.4 Volume and Value Scenarios

The THLB in the Sunshine Coast TSA was zoned based on suitability for investment in silviculture treatments for timber production. The detailed assumptions regarding the zoning are provided in Sunshine Coast TSA ISS Data Package (FESL, 2020). Three zones were developed: green, yellow and red. Green depicts areas where management actions and investments are generally recommended due to higher site productivity, lower harvest costs and reduced anticipated risks from constraints and other risks to future harvest. In the yellow zone caution is recommended, while the red zones denote areas where forest management actions and costs should be minimized.

The land base is constrained; large areas were classified as red (Table 8, limited investment).

Table 8: THLB silviculture zone areas

Silviculture Zone	THLB (ha)	
	ISS Reference Forecast 1	ISS Reference Forecast 2
Green	1,513 ha	1,513 ha
Yellow	56,094 ha	56,094 ha
Red	112,863	126,839 ha
Total	**170,470 ha**	**184,446 ha**

Various volume and value strategies will be tested. Initially, a volume scenario (Volume Scenario 1) was constructed.

3.4.1 Stand Level Results Volume Scenario 1

This scenario involved repeated fertilization (every 10 years from age 30 to 70) of portions of non-barge access Fd leading existing and future managed stands on green and yellow silviculture zones expected to generate viable treatment responses (Fd SI's of 25 to 34m). For this analysis, all-inclusive fertilization costs were assumed to be $500 per hectare. The average volume responses are predicted to be marginal on many sites and care should be taken when choosing appropriate stands for treatment. Fertilization efficiency may be reduced by higher site indices; research shows that responses fall quickly above SI 33 m, or due to forest health factors (including ungulate damage). It is assumed that only 50 to 70% of the available area is treated to account for these factors reducing fertilization efficiency.

3.4.1.1 Existing Managed Stands

Figure 34 illustrates the predicted volume response of a contemporary era Fd leading stand in the CWHdm (gentle cool zonal med-poor) to intensive fertilization (not including OAF's). Based on the average response of approximately 100m^3/ha at 80 years after 5 treatments, past analyses indicate that this regime is likely financially viable at a 2% discount rate. Only 70% of the candidate stands are assumed to be fertilized due to the prevalence of root rot and the amount of non-Fd in some of these stands.

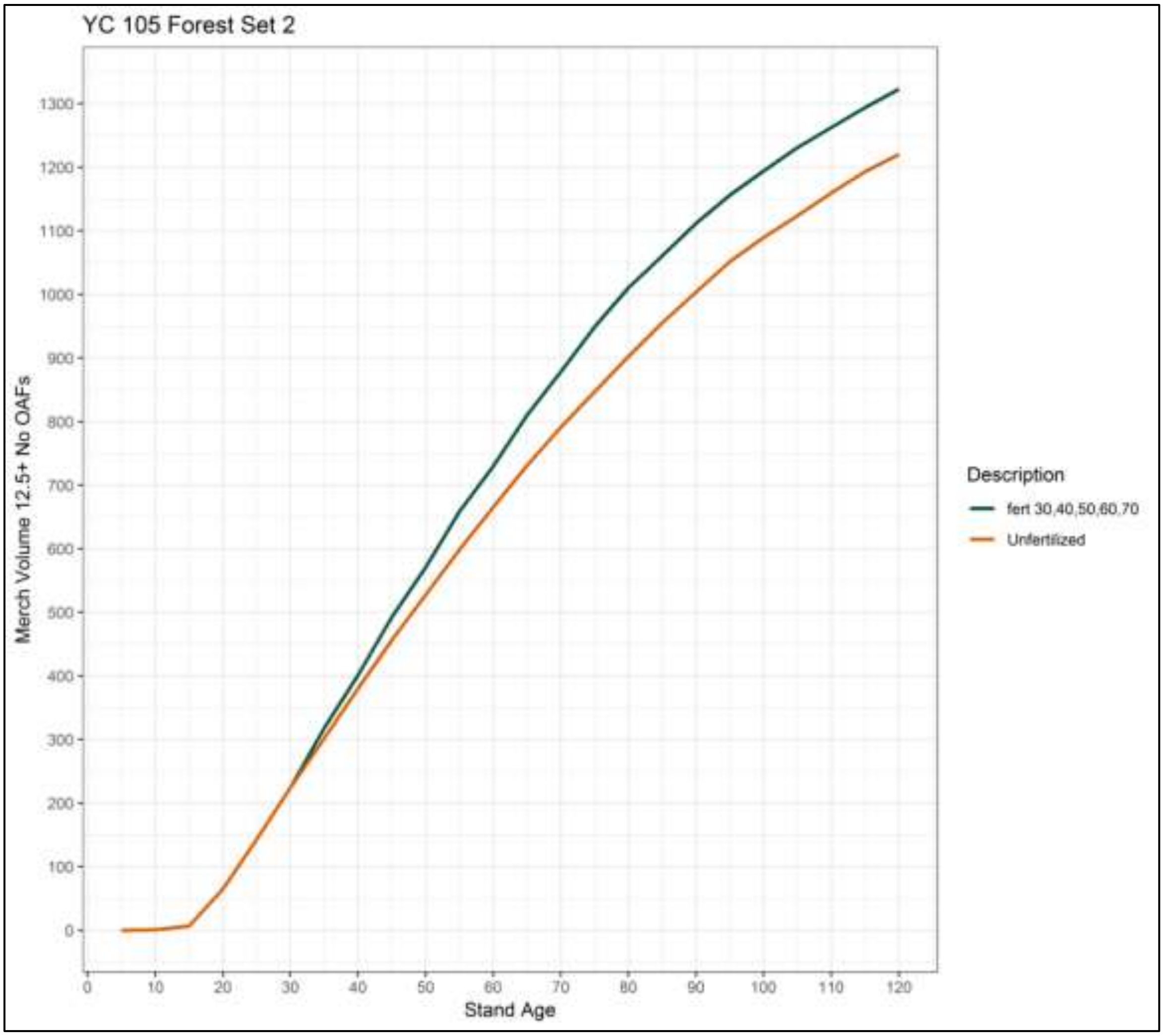

Figure 34: Predicted volume response to fertilization; contemporary era; CWHdm gentle cool zonal med-poor

Figure 35 illustrates the predicted volume response of a contemporary era Fd leading stand in the CWHxm (zonal) to intensive fertilization. Based on the average response of approximately 75 m^3/ha at 80 years after 5 treatments, past analyses indicate this regime is likely to be marginally financially viable at a 2% discount rate. Only 70% of the candidate stands are assumed to be fertilized due to the prevalence of root rot and high Fd site indices (>34m).

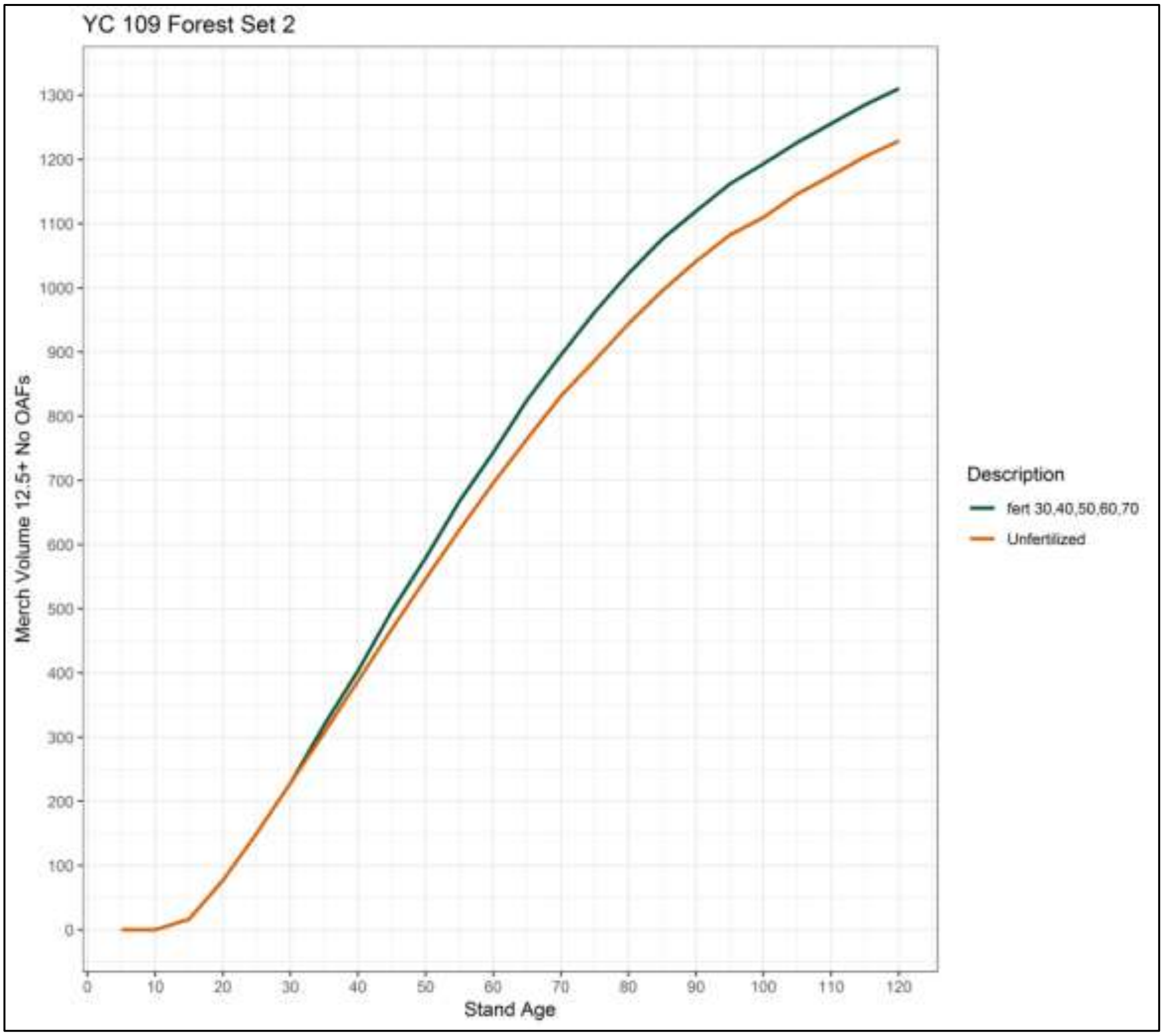

Figure 35: Predicted volume response to fertilization; contemporary era; CWHxm all zonal

Figure 36 shows an example of a likely non-viable fertilization regime; the average fertilization response of approximately 50 m^3 per hectare for 5 treatments in the contemporary era CWHvm1 warm is not high enough to ensure financial viability. Key reasons for the lack of response are the high Fd site index (33.8m) and the low proportion of Fd (55%). As a result this yield curve was not selected for fertilization under Volume Scenario 1. However, it is likely that some stands included within this analysis unit may have higher Fd components and/or lower site indices and could be viable for treatment; field work is required to confirm candidate stands for fertilization.

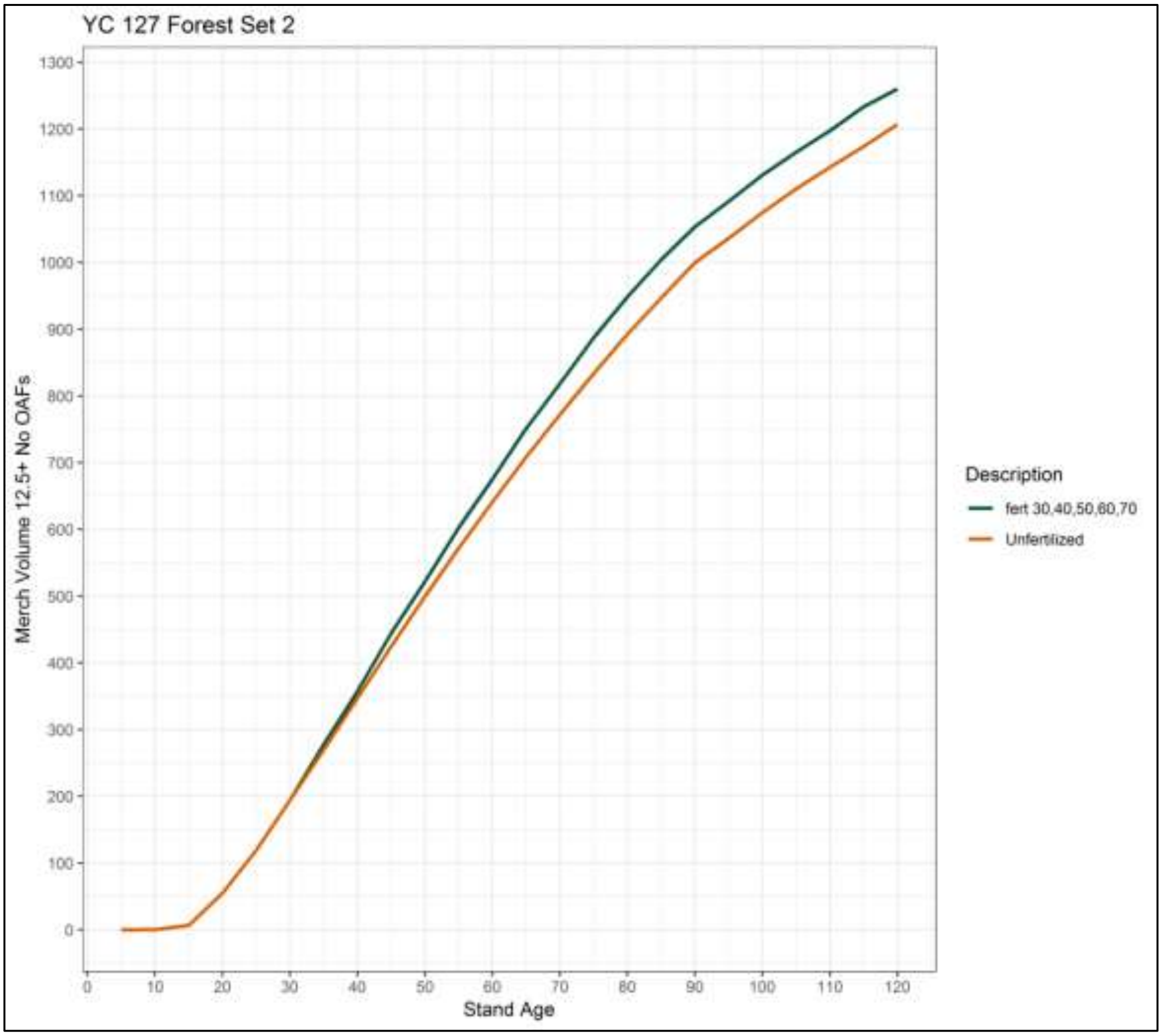

Figure 36: Predicted volume response to fertilization; contemporary era; CWHvm1 warm

Some elk damaged stands on the Sechelt Peninsula with appropriate ecology and site indices were also chosen as candidates for fertilization under Volume Scenario 1. These stands were assumed to be fertilized at ages of 50,60 and 70 years and only 50% of the available populations were assumed to be treated. Figure 37 shows a total response of about 50 m^3 per hectare from 3 treatments of an elk impacted stand in the CWHdm gentle cool zonal med-poor. Based on past analyses, this is likely a viable regime at a 2% discount rate.

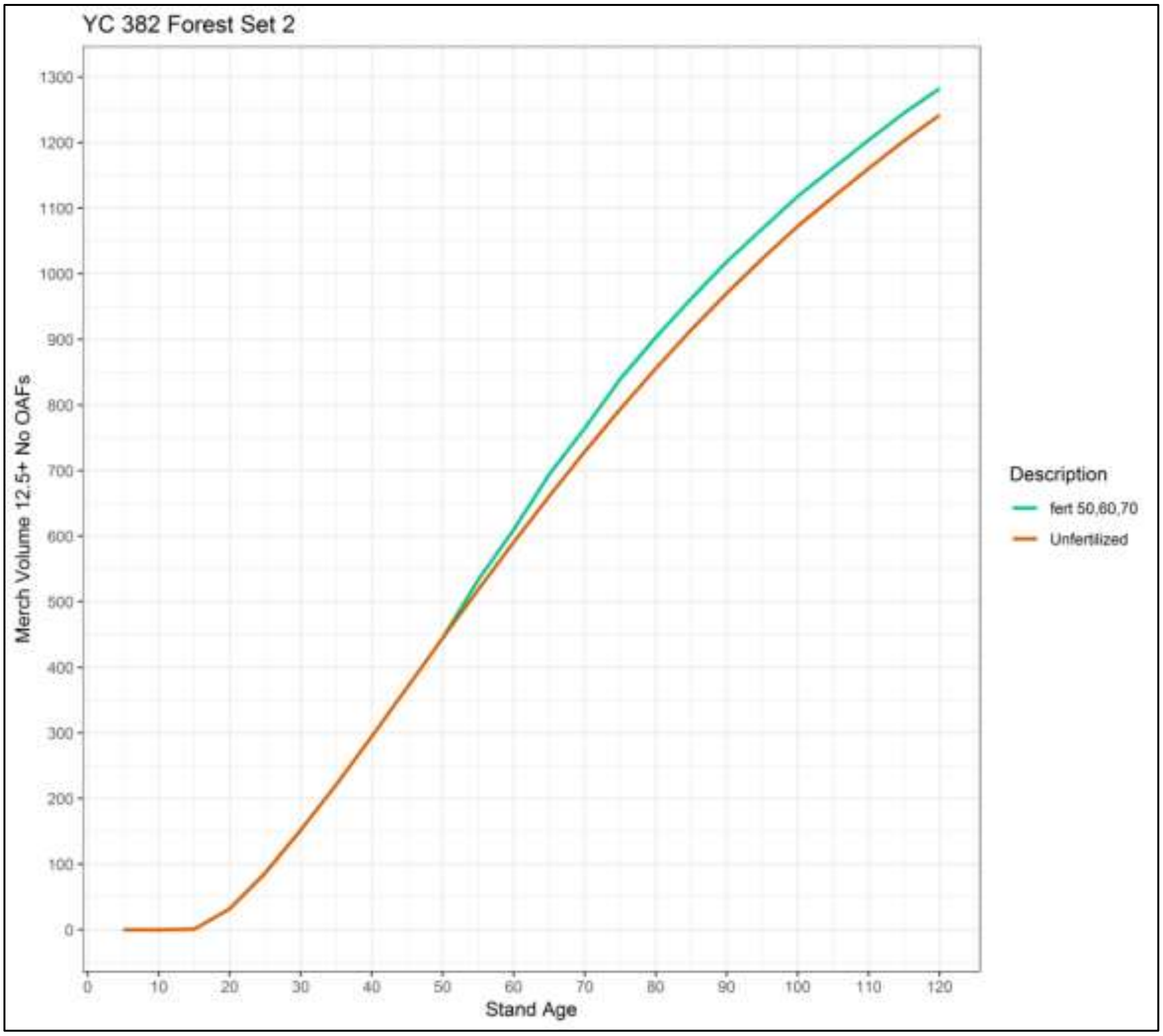

Figure 37: Predicted volume response to fertilization; contemporary era, elk impacted; CWHdm gentle cool zonal med-poor

3.4.1.2 Future Managed Stands Established according to the ISS Reference Forecast Assumptions

The responses to intensive fertilization of future stands follow similar trends as those of existing stands discussed above. However, in some cases differences in Fd site indices and the higher genetic worth associated with future stands can lead to higher responses on the same sites than contemporary era stands. Figure 38 shows that 5 fertilizations gives a total response of about 150 m^3 per hectare for a future managed stand in the CWHdm gentle cool zonal med-poor versus a total response of about 100 m^3 per hectare for a contemporary era stand on the same site.

As with the contemporary era stands, some elk and deer damaged future managed stands with appropriate attributes were chosen for fertilization under Volume Scenario 1.

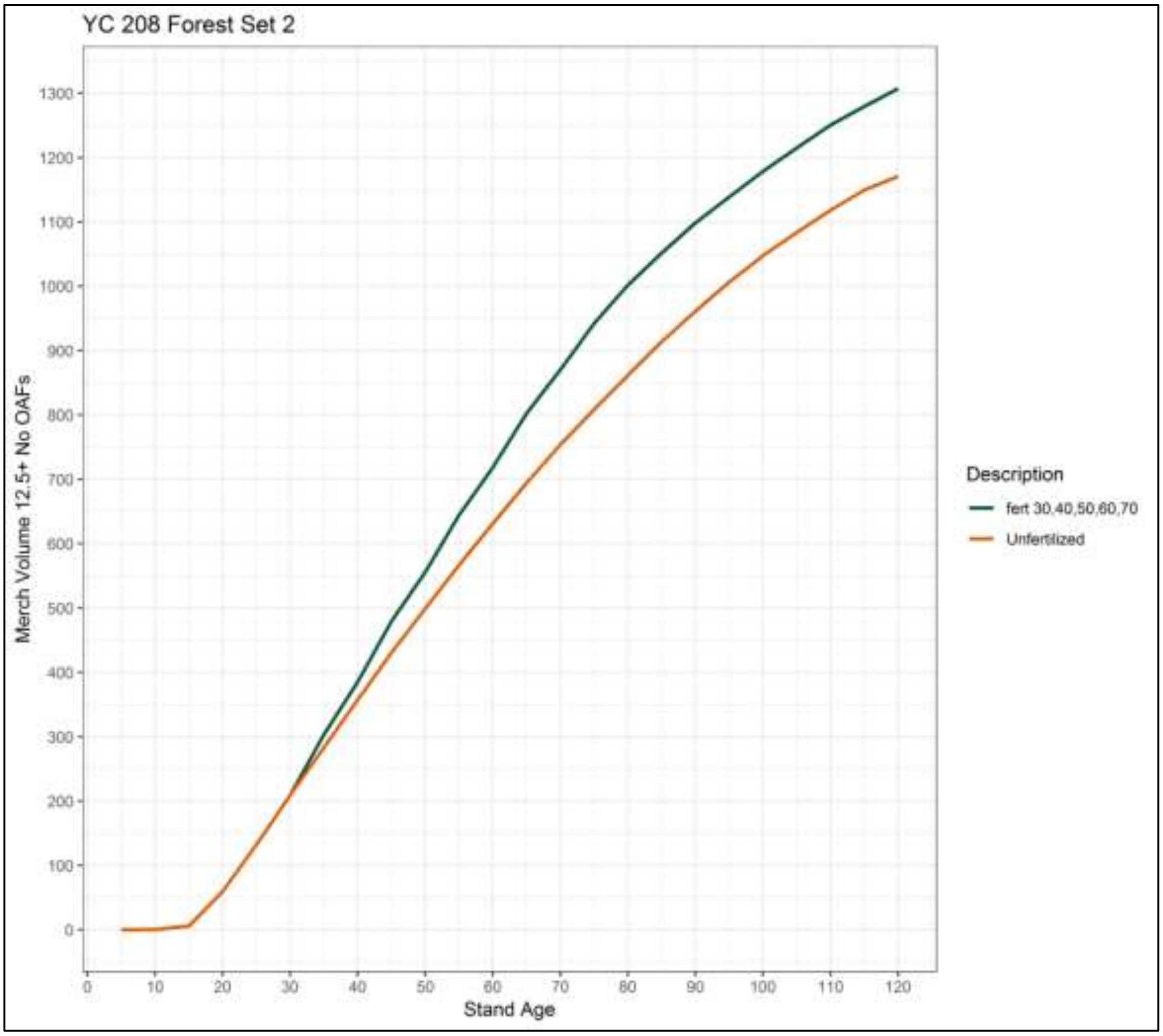

Figure 38: Predicted volume response to fertilization; future era; CWHdm gentle cool zonal med-poor

3.4.2 Forest Level Results; Volume Strategy 1, ISS Reference Forecast 1 Land Base

In this scenario, portions of Fd leading managed stands in non-barge access woodsheds were fertilized on green and yellow silviculture zones every 10 years from age 30 to 70 years. All comparison below are made against the ISS Reference forecasts with elk. The THLB in the scenario is 170,470 ha.

As illustrated in Figure 39, the impact of fertilization was modest. During the first 75 years of the planning horizon the harvest forecast increased less than one percent compared to the ISS Reference Forecast 1 with elk. The small short-term changes shown in Figure 39 are mostly caused by the resolution of the timber supply model. The long-term harvest forecast remained unchanged. There was no impact on the predicted value of managed stands between the two scenarios.

The lack volume impact is not surprising, given the limited fertilization areas in this scenario. Figure 40 shows the predicted annual treatment area over time. Initially close to 600 ha are fertilized annually. These are mostly existing managed stands. Over time the annual treatment area levels off to approximately 200 ha. Figure 41 illustrates the predicted annual incremental silviculture expenditures. The limited area available for fertilization is primarily linked to the lack of non-barge access area in the TSA.

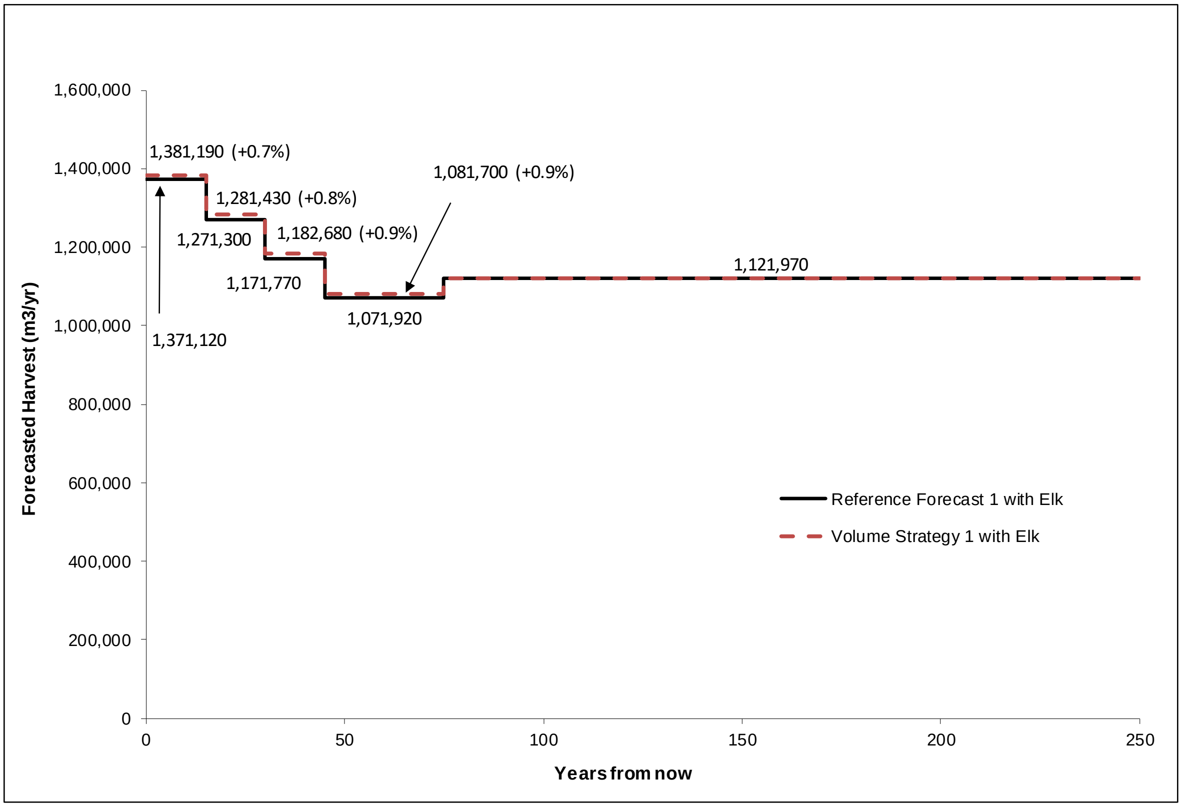

Figure 39: Volume strategy 1, ISS Reference Forecast 1 land base; harvest forecast

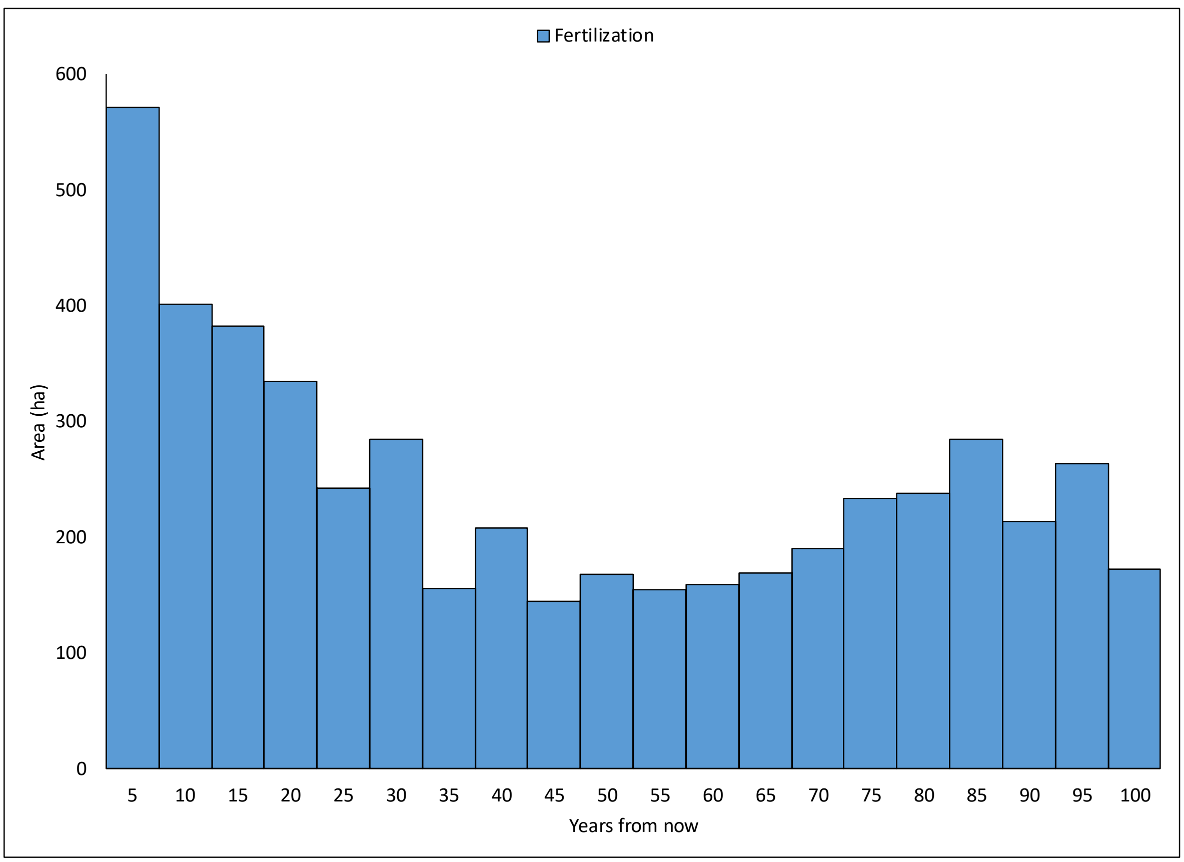

Figure 40; Volume strategy 1, ISS Reference Forecast 1 land base; forecasted treatment areas

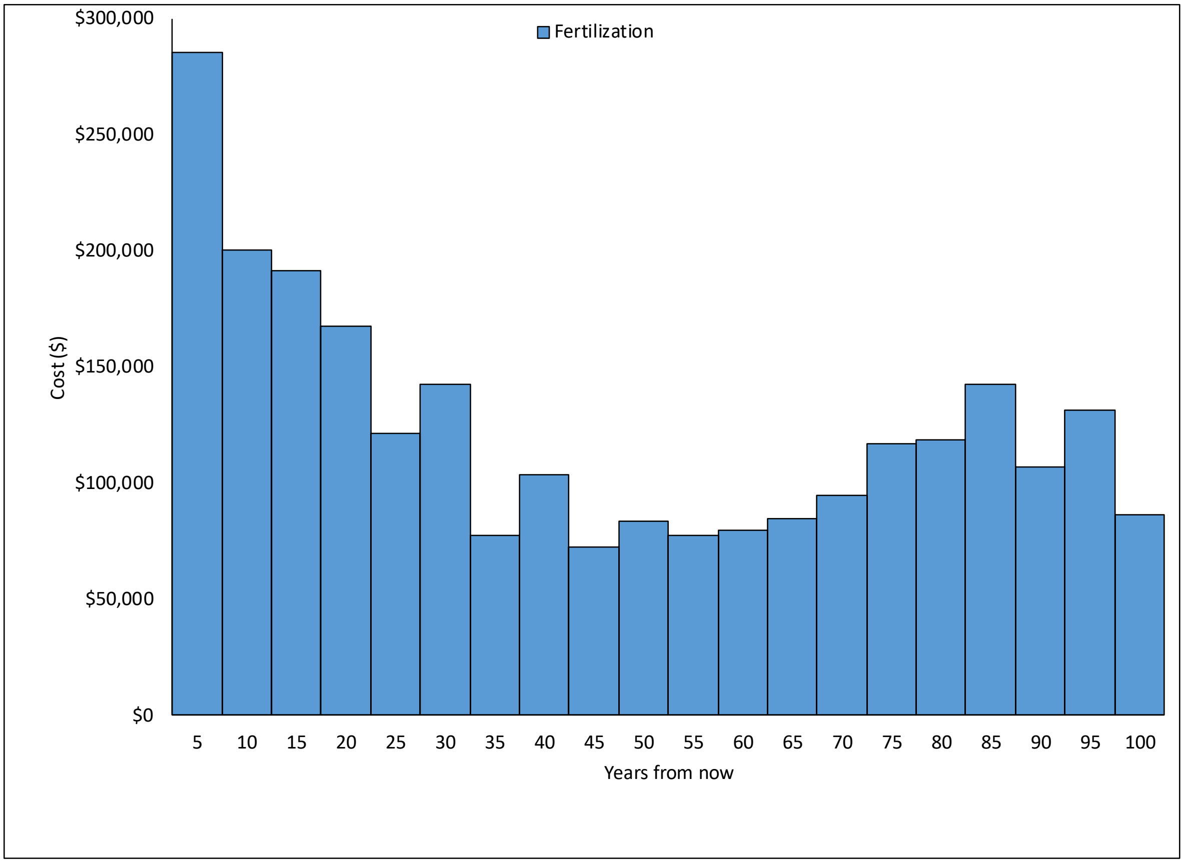

Figure 41; Volume strategy 1, ISS Reference Forecast 1 land base; forecasted silviculture expenditures

3.4.3 Forest Level Results; Volume Strategy 1, ISS Reference Forecast 2 Land Base

As above, in this scenario Fd leading managed stands were fertilized on green and yellow silviculture zones every 10 years from age 30 to 70 years. The THLB in this scenario is larger at 184,446 ha.

Fertilization had no impact on the harvest or value forecast on this larger land base. The treated areas were the same as in the previous scenario, because the First Nations Cultural Areas that were added to the THLB were all classified as red zones for incremental silviculture investment.

3.4.4 Volume Strategy 2 and Value Strategy

Volume Strategy 2 included modified fertilization responses for Fd leading stand on zonal sites in BEC units with Fd SI's>34m[1] and assumed that forest carbon fertilization would occur on selected barge access areas according to the following criteria and assumptions:

[1] Fertilizer trials show a general downward trend in percent volume response with increasing site productivity. This general trend is reflected in both the TASS and TIPSY fertilizer modules. However, there are exceptions to this general trend. Notably the exceptions are high sites characterized by the absence of growing season water deficits and relatively low foliar N. Adjusted fertilizer responses were modelled for these responding high sites.

- Fertilization through the Forest Carbon Initiative (FCI) is expected to continue at least through the fiscal year 2023/24. Conservatively this equates to 4 years of treatments. Marine FCI treatments (the most significant FCI program available in DSC) are restricted to barge access sites and can be within the THLB or NHLB in DSC, the Campbell River Natural Resource District (DCR) and the North Island Natural Resource District (DNI). Based on GIS analysis completed by Strategic Natural Resource Consultants and B.A. Blackwell and Associates Ltd. (BAB) in 2019/20, it is estimated that about 6,000 hectares of FCI fertilization will occur within the THLB in the Sunshine Coast TSA over the next 4 years. In addition to sequestering carbon, this program will increase timber supply.
- Based on the available stands for cost-effective treatment in the Sunshine TSA, approximately 90% of the fertilization on the THLB is expected to occur in Fd - leading old era managed stands, while the rest will be in natural Fd - leading stands between 40 and 80 years old.
- The fertilization responses for natural stands are based on using average absolute responses (from government research in TIPSY) by age and SI and assuming an 80% efficiency and a 5% net down from gross to merchantable volume. Responses for managed stands are based on the adjusted research responses.

Volume Strategy 2 also involved revised reforestation regimes for future stands with the following assumptions:

- For the largest analysis units (by area) of medium to good sites expected to be managed primarily for timber, a mosaic of ecologically suitable single species stands with enhanced densities specifically designed to optimize the volume and value of each species were established consistent with the strategy of "unmixing the mixes"(Section 3.4.4.1). The species portfolios for each BEC unit were developed to maximize volume production with some consideration to climate change and forest health risks.
- Reduced density regimes in the larger analysis units with lower site productivities were evaluated and are recommended to balance out overall reforestation costs. The species portfolios for these yield curves were chose to minimize reductions to overall volume production.
- Average expected genetic worth for each species from seed available under the Climate Based Seed Transfer (CBST) rules was used.
- On operable sites (with slopes <35%) where root rot is a hazard, stumping was assumed with enhanced (higher planting densities) Fd regimes.
- Enhanced regimes were not assigned to sites with high or moderate existing or future elk/deer hazard. In addition, enhanced Cw regimes were not used in the Vancouver, Deserted, Stakawus and Brittan River drainages, where elk damage is expected to become more significant in the future,
- Enhanced Fd stands in green and yellow silviculture zones outside of the CWHvm2 were fertilized every 10 years from age 30 to age 70. In the CWHvm2 warm unit, enhanced Fd stands on green to yellow silviculture zones were fertilized at ages 30, 50 and 70. Enhanced Cw stands on green and yellow silviculture zones were fertilized twice at age 40 and 60[2]. Fertilization occurred on barge and non-barge access sites.
- Enhanced Cw regimes included the option for brushing of competing conifers to increase the harvested Cw recovery. Note that not all Cw stands were brushed.

[2] Using the fertilization responses for Fd

- High future log prices were assumed for all enhanced regimes.

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

- The species portfolios for each BEC unit were developed to maximize the harvest value with some consideration for climate change and forest health risks,

3.4.4.1 "Unmixing the Mixes"

Where timber production is the key objective, Volume Strategy 2 and Value Strategy employ the concept of "unmixing the mixes" at the stand-level. This strategy proposes to achieve species diversity at the landscape-level by establishing a mosaic of ecologically suitable single species stands, while at the same time developing stands with more volume and value. Different species often have different site indices on the same sites as shown in Table 9. This may result in mixed species stands having unexpected species compositions and stand structures especially on shorter rotations. 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 Sunshine Coast 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 on those sites managed primarily for timber. Figure 42 illustrates a conceptual example where mixed species are planted everywhere within stands across the landscape, while Figure 43 demonstrates an approach, where the same landscape-level species composition is achieved by planting patches of the 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 the likely timber emphasis areas and the non-timber focused management areas and the use of temporal and spatial patterns to achieve diversity.

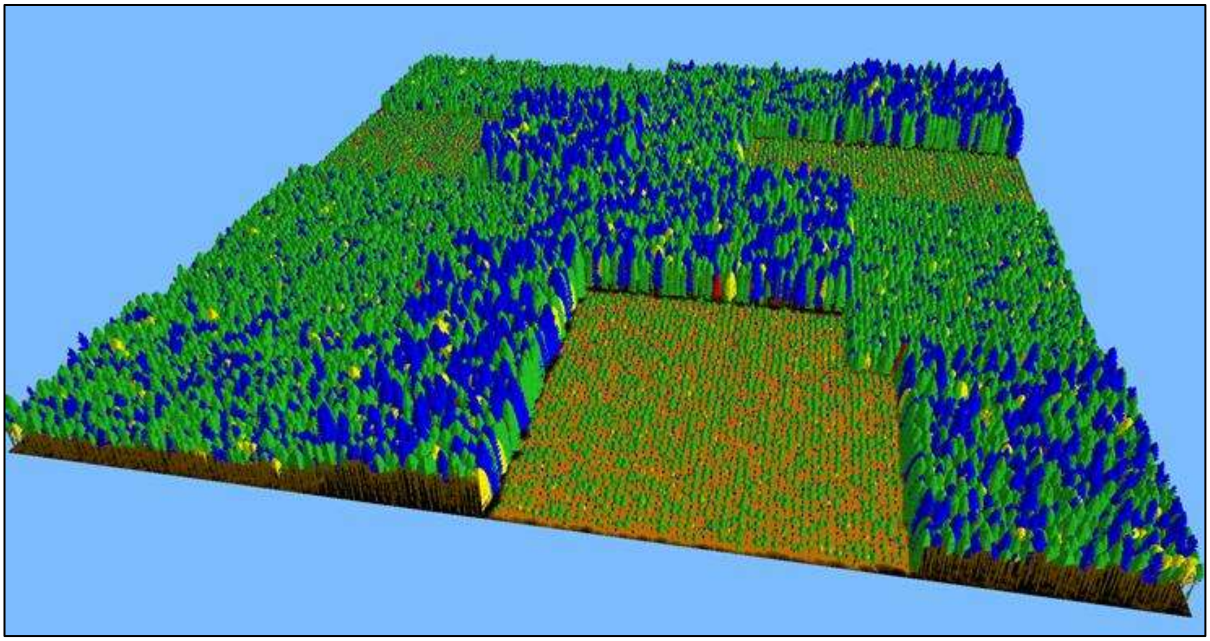

Figure 42: Mixed species planting everywhere

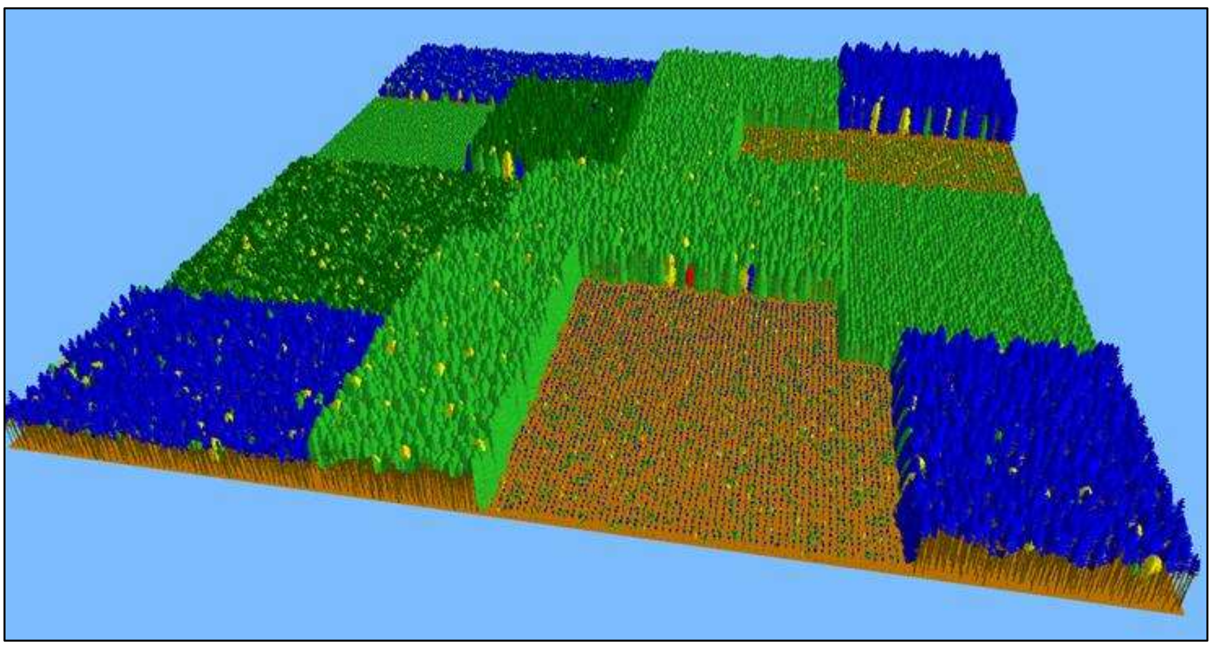

Figure 43: Single species planting to achieve the same landscape-level species portfolio on timber producing sites

3.4.4.2 Cw Regimes and Stand Tending to Maximize Harvestable Cw

The value and volume scenarios include the option of managing for Cw, where it is ecologically appropriate, and where the risk of elk/deer damage is low.

Despite its known value, Cw is not given enough prominence in forest management in coastal British Columbia. Conversion of ecologically suitable Fd stands to Cw would increase the value of these stands significantly. Converting ecologically suitable Hw stands to Cw stands would increase the value of the forest even more.

Many areas in coastal British Columbia are reforested with significant shares of Cw; the amount of Cw used in reforestation on the coast is generally sufficient. However, often Cw is planted mixed with other species. The resulting stands are not operationally feasible to manage and harvest due to the different rotation lengths of the species in the stands (Fd vs. Cw as an example). The same applies to situations where Cw is planted in patches that are too small to manage and harvest them independently of the adjacent stands.

On many sites where Cw forms most of the planted stems natural infill occurs with other faster growing species (Hw). These sites may require tending to ensure that most of the Cw will be harvestable on shorter rotations.

While pure stands of Cw, Hw and Fd grown on the same site exhibit different growth rates and different projected harvest volumes per ha at rotation, the differences are relatively small as shown in Figure 44. However, the differences in projected stand value are significant; this is illustrated in Figure 45.

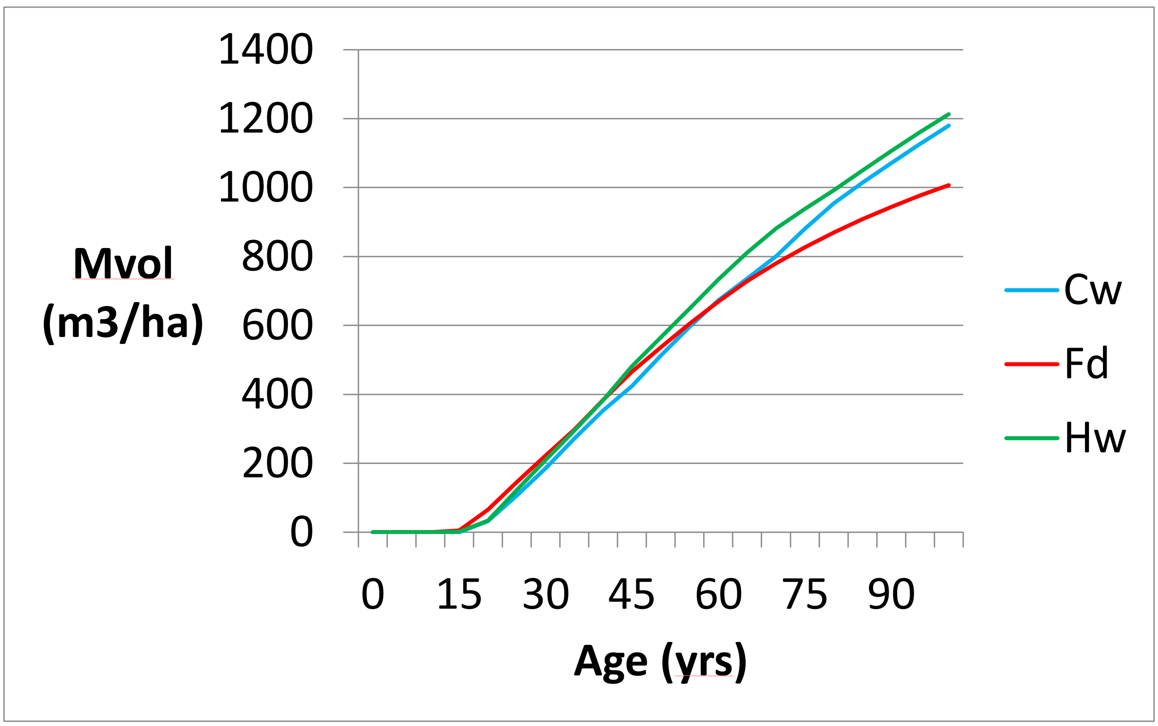

Figure 44: Projected stand volume, CWHdm ss01 planted with 1400sph

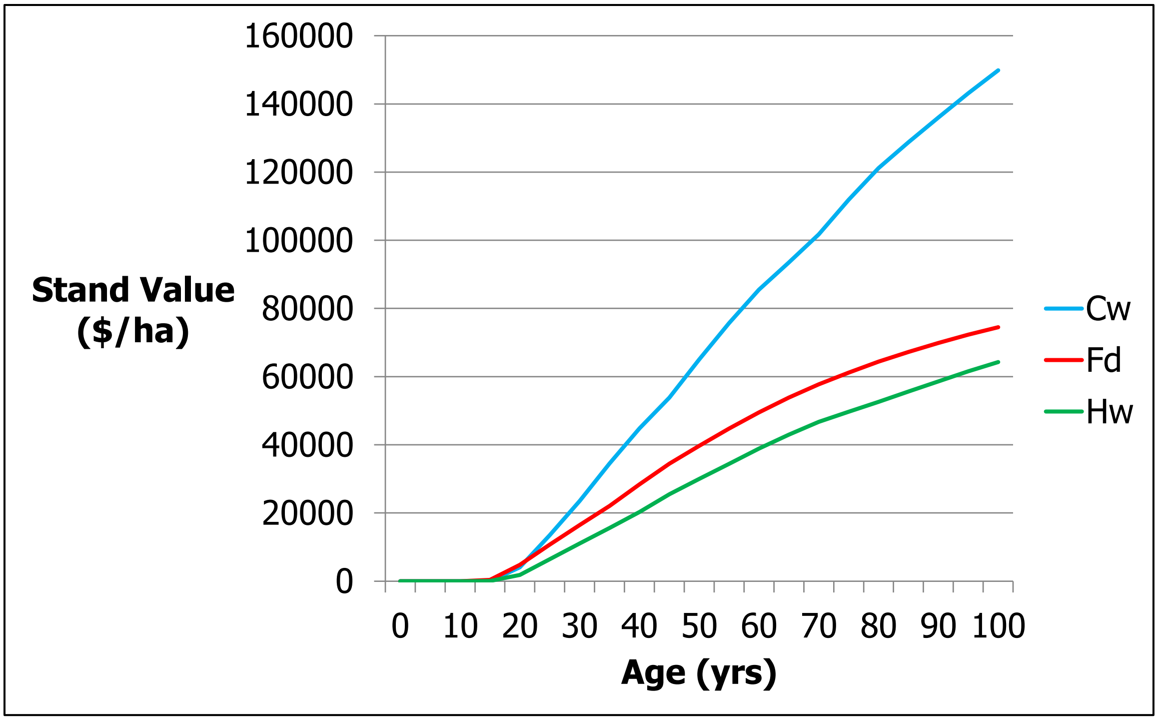

Figure 45: Projected stand value, CWHdm ss01 planted with 1,400sph

Figure 46 compares TASS modeled images for different stages of stand development for a planted Cw (with low genetic worth) stand with natural infill of Hw and Ba with and without tending (brushing or juvenile spacing) to remove the Hw and Ba. As illustrated, the modelling predicts that in the absence of tending, the natural Hw and Ba trees will overtop many of the planted Cw; which leads to reduced growth of Cw. Removing the competing Hw and Ba is predicted to lead to an almost pure Cw stand and a higher proportion of larger Cw stems. Both factors have a significant impact on stand value.

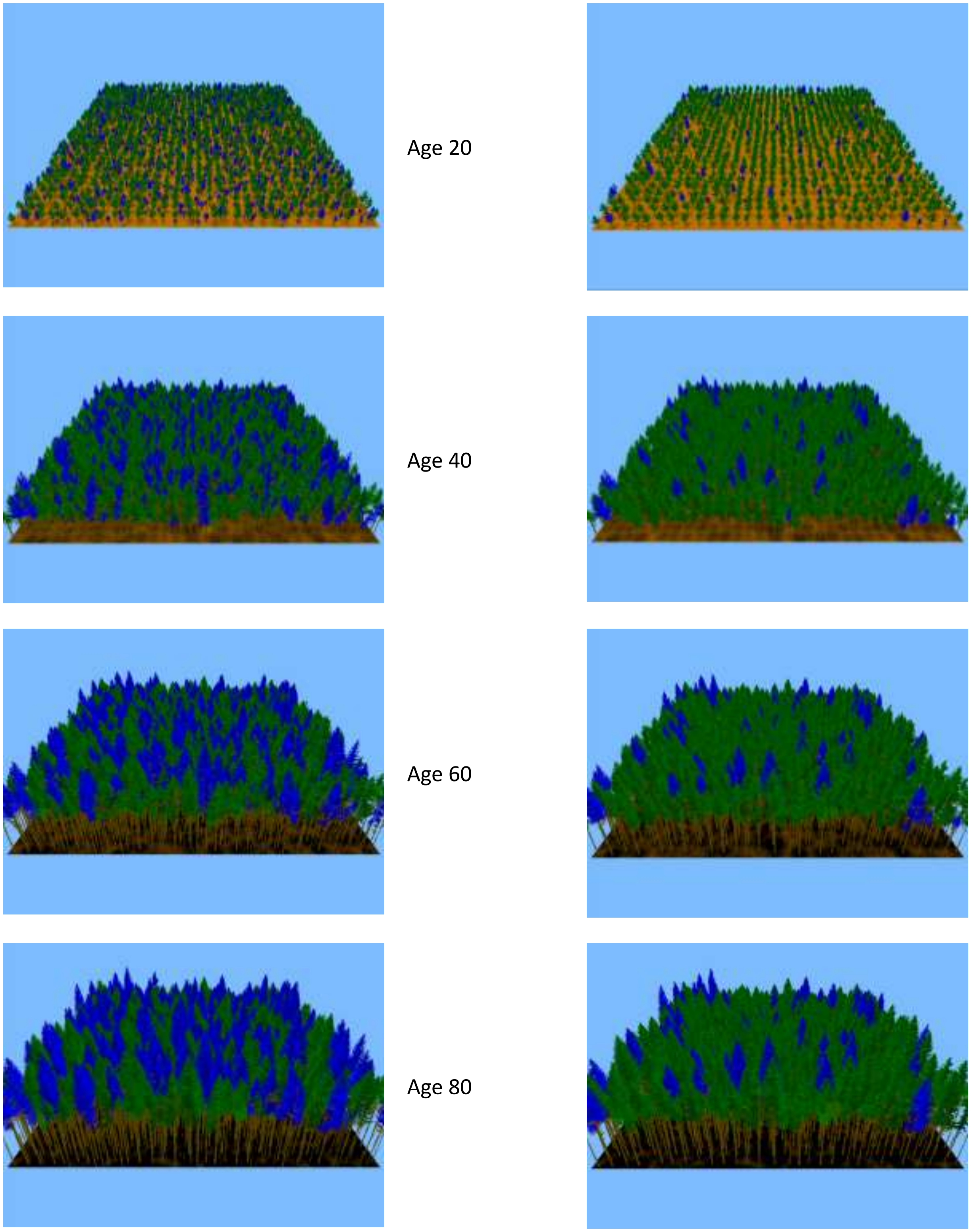

Figure 46: TASS II images of a planted Cw (green) stand with HwBa (blue) infill on a good site on Vancouver Island, no tending (JS or brushing) (left) and JS or brushing (right)

Figure 47 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.

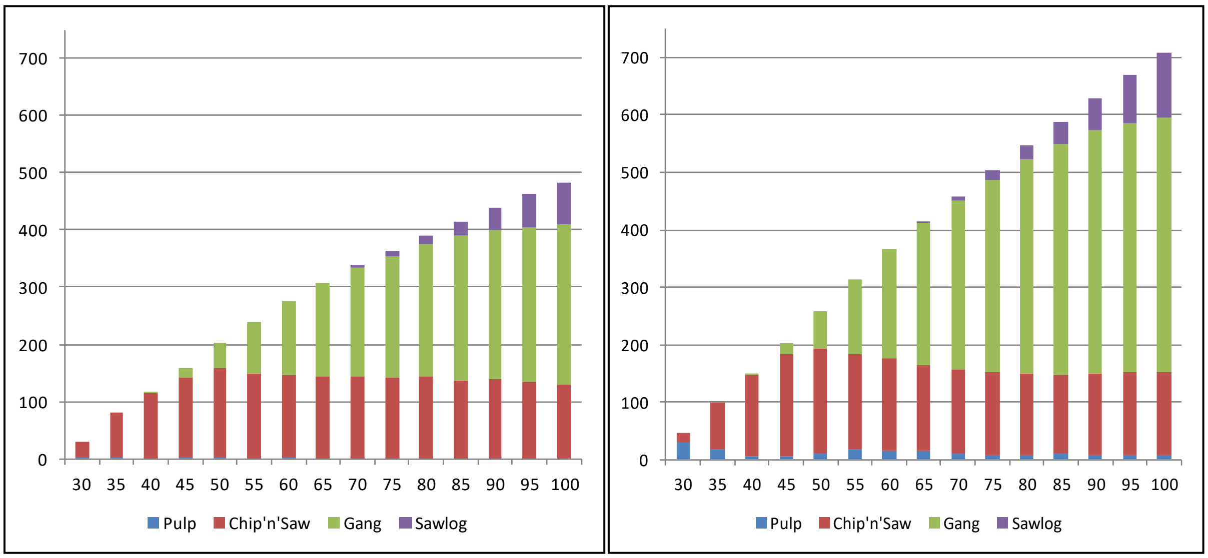

Figure 47: Comparison of Cw log volumes by sort for the non-tended stand (left) and the spaced or brushed stand (right)

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

Description	Fd ($/m^3)	Cw ($/m^3)	Hw ($/m^3)
Average	$74	$127	$53
Range	$55 to $85	$90 to $185	$50 to $60

In past ISS projects (Arrowsmith TSA IRMP and Fraser TSA ISS), juvenile spacing was assumed to be the preferred treatment for removing competing HwBa and deciduous species in Cw plantations. This was assumed to be a post-free growing treatment which was expected to be costly (about $2,500/ha). Subsequently, B.A. Blackwell and Associates Ltd. (BAB) have explored the alternative of removing the competition at a younger stand age. This is expected to be more effective and less costly. In the report, *An Assessment of Opportunities in the Arrowsmith TSA for Density Management in Mixed Cw Hw Stands to Favour Cw* (March, 2020) BAB suggests that instead of spacing, brushing treatments with brush saws be used on stands between 7 and 12 years old, regardless of their free growing status. Based on operational trials in TFL 26 by the District of Mission, the cost of selective brushing on accessible sites was estimated at $550 per hectare. The BAB report notes that changes to the appraisal system would be required to support brushing treatments on non-free growing stands.

As the current planting stock of Cw is of high genetic worth and good initial survival, it is not known how much brushing is required. Despite this uncertainty and the required changes to the appraisal system, the Sunshine Coast TSA ISS Silviculture Working Group decided to be conservative and assume that brushing would be required on many Cw plantations.

3.4.5 Stand level Volume Scenario 2 and Value Scenario Results

This section summarizes the stand-level log volume and value, and site value forecasts for most of the largest, future stand analysis units established with enhanced reforestation regimes on green and yellow silviculture zones. These analysis units make up about 57% of the THLB by area and include:

- CWHdm Gentle Cool Zonal Good and Med-Poor
- CWHdm Warm Zonal Good and Med-Poor
- CWHxm Zonal Good and Med-Poor
- CWHxm All Good and Med-Poor
- CWHvm1 Gentle Cool Zonal Good and Med-Poor
- CWHvm1 Gentle Cool Med-Poor
- CWHvm1 Warm Zonal and All
- CWHvm2 Warm All
- CWHds1 Gentle Cool Good and Med-Poor
- CWHms1 Submontane Gentle Cool and
- CWHms1 Montane Gentle Cool (gentle slopes only)

The largest future stand analysis units in the red silviculture zone were considered for reduced density reforestation regimes. These analysis units make up about 22% of the THLB by area and include:

- CWHvm2 Gentle Cool Planted
- CWHms1 Montane Gentle Cool (steep slopes)
- MHmm1/2 ESSF Gentle Cool and
- MHmm1/2 ESSF Warm

The rest of the analysis units and their yield curves for Volume Strategy 2 and Value Strategy are consistent with the reference forecasts with elk and deer incorporated.

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 the NPV of a single rotation does not.

For the site value analysis, the results for two discount rates are presented (2%: which is the current government standard and 4% which is more conservative and closer to what industry generally uses [6 to 8%]). The term “base case” is used in the following comparison. The base case refers to the reforestation assumptions used the two reference forecasts with no consideration for elk and deer. Elk are deer were not considered because no enhanced or incremental regimes were proposed in elk and deer hazard areas. The assumed silviculture costs are:

- Aerial fertilization costs are $500 per treatment ha for non-barge and $650 per treatment per hectare for barge access areas
- Cw brushing costs are $550 pr ha for non-barge and $660 per hectare for barge access areas and,
- Stumping costs are $750 per ha for non-barge and $975 per hectare for barge areas.

The stand level analysis results presented below depict the total stand volume and the total stand value per ha, and site value for various regimes.

CWHdm Gentle Cool Zonal Good and Med-Poor Future (Root Rot Hazard)

As these two analysis units are similar, the stand level results are shown only for CWHdm Gentle Cool Zonal Good._These analysis units are in root rot hazard zones. The gentle slope portions of these sites are suitable for stumping. Figure 48 shows the projected log volumes and values for the regimes developed for consideration:

- Base Case (with root rot): planted 1,150sph of Fd/Cw(Pw) with natural infill of 1,450sph of Hw(FdCwDrAt with OAF2 of 12.5
- Fd regime planted at 1,600sph and fertilized every 10 years between year 30 and year 70 (with root rot)
- Fd regime where the high root rot hazard sites (assumed to be 60% of total area) are stumped (the root rot OAF of 12.5% is reduced to 5% on the whole area), planted at 1,600sph and fertilized every 10 years between year 30 and year 70
- Hw regime planted at 1,200sph
- Cw regime planted at 1,400sph and brushed to remove the competing natural infill and fertilized at year 40 and year 60 and
- Cw regime planted at 1,400sph and fertilized at year 40 and year 60

Figure 48 shows that all the enhanced regimes are superior to the base case for volume production with the Fd regimes being the best before ages 70 to 80 and the Cw regimes having the most volume after this. The highest log values come from the Cw regimes with the brushed regime the best. The Hw regime and the base case are similar with the lowest predicted values.

Figure 49 shows that at a 2% discount rate, the Cw regimes are financially superior (brushed is the best), the Fd regimes second best and the base case and Hw regimes the worst for all operability zones. Financial results are best on the non-barge (roaded) areas, then barge-ground harvest and lowest for the barge-cable harvest sites. The Fd and Cw regimes are viable in all operability classes after about 50 yrs while the base case and Hw regimes break even only beyond 80 yrs on the barge-cable ground. Figure 50 shows that at a 4% discount rate, the Cw regimes are viable on all operability areas, while the base case, Hw and Fd regimes are only viable on shorter rotations on non-barge sites; only the Fd non-stumping regime breaks even on the barge-ground sites.

Based on the above analysis results, the following regimes were recommended by the Silviculture Working Group for the volume 2 and value scenario, respectively:

- 40% Fd stumped regime, 10% Fd no-stump regime, 30% Cw brushed regime, 20% no treatment (base case)
- 20% Fd stumped regime, 10% Fd no-stump regime, 50% Cw brushed regime, 20% no treatment (base case)

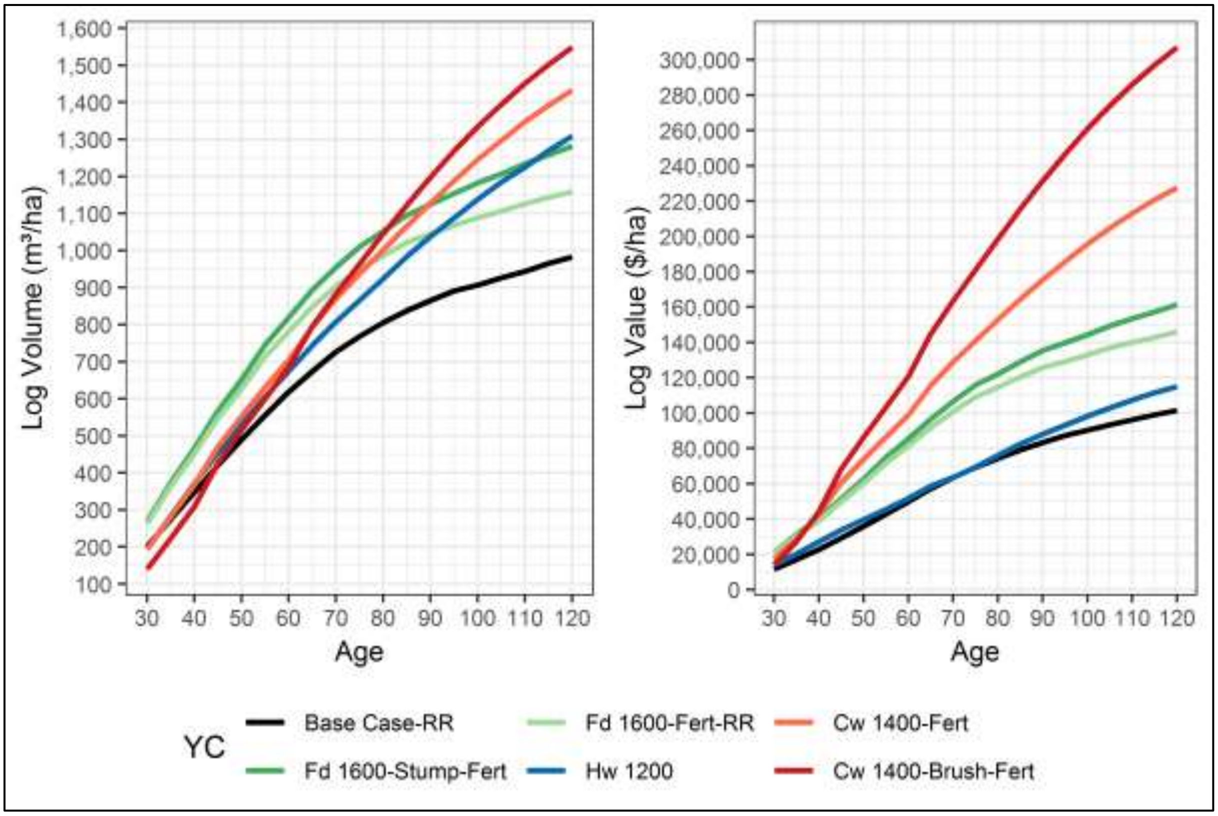

Figure 48: Log volumes and values for the CWHdm gentle cool zonal good future

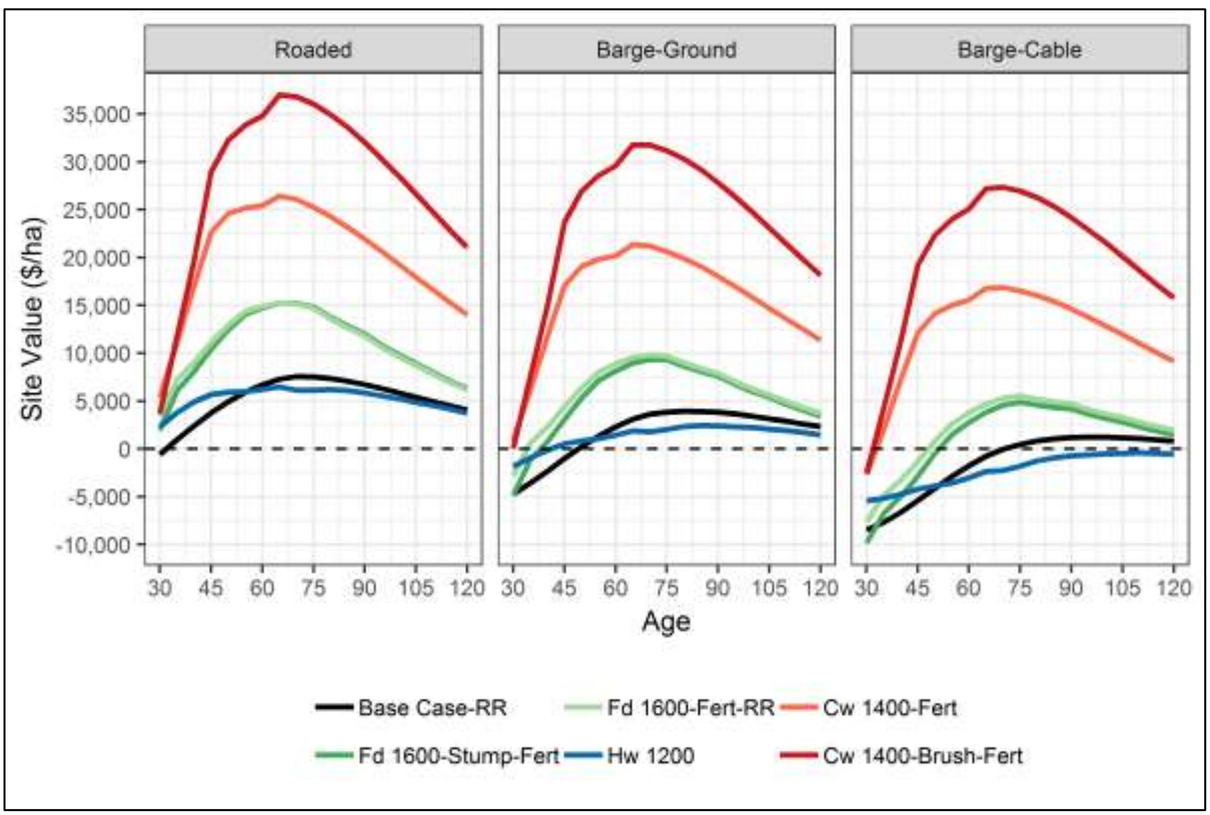

Figure 49: Site values (at 2%) for roaded and barge sites in the CWHdm gentle cool zonal good future

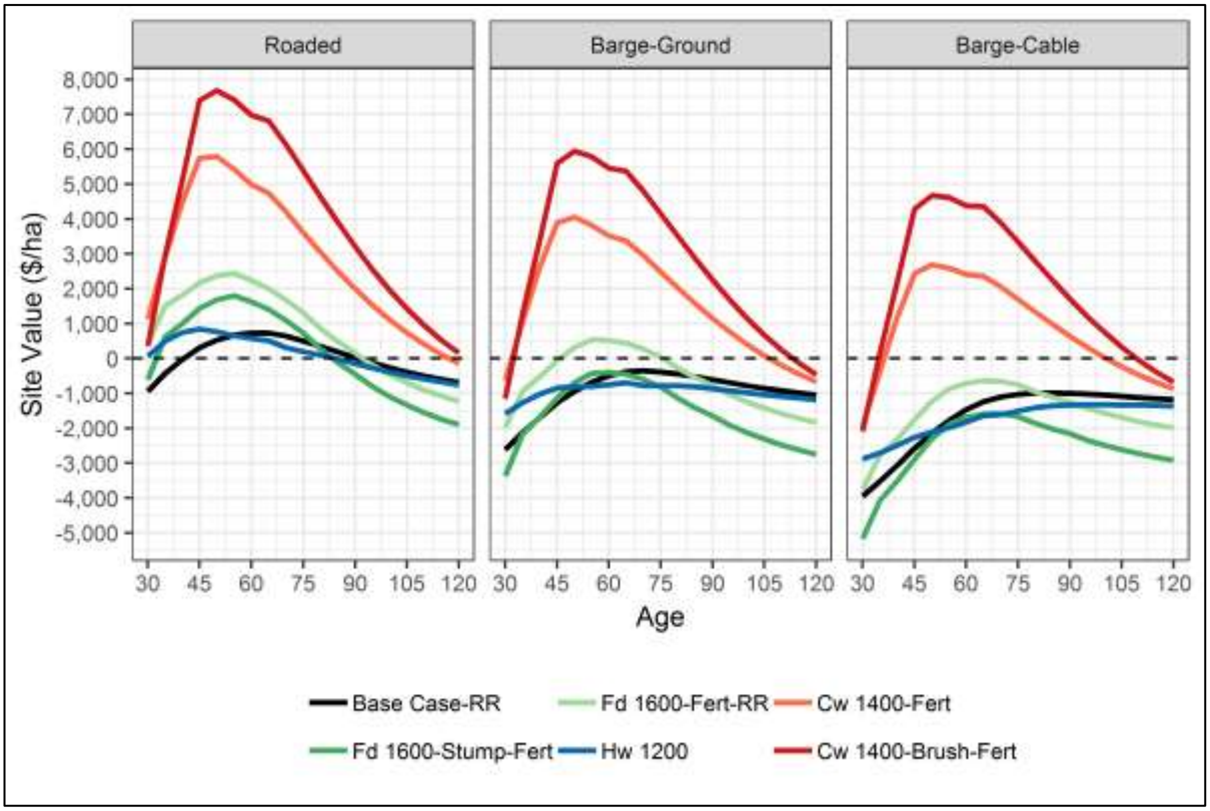

Figure 50: Site values (at 4%) for roaded and barge sites in the CWHdm gentle cool zonal good future

<u>CWHdm Warm Zonal Good and Med-Poor Future (Root Rot Hazard)</u>

As these two analysis units are similar, the stand level results are shown only for CWHdm Warm Zonal Med-Poor. These analysis units are in root rot hazard zones; however, with slopes >35% stumping is not an option. Figure 51 shows the projected log volumes and values for the regimes developed for consideration:

- Base Case (with root rot): planted 1,000sph of Fd(PwCw) with natural infill of 1,200sph of Hw(FdCwDr) with OAF2 of 12.5
- Fd regime planted at 1,600sph and fertilized every 10 years between year 30 and year 70 (with root rot)
- Fd (Pw) regime planted at 1,400sph and fertilized every 10 years between year 30 and year 70. Root rot OAF of 12.5% is reduced to 5% on the whole area
- Fd (Pw)regime planted at 1,400sph and fertilized every 10 years between year 30 and year 70 (with root rot)
- Cw regime planted at 1,400sph and brushed to remove the competing natural infill; fertilized at year 40 and year 60 and
- Cw regime planted at 14,00sph and fertilized at year 40 and year 60

Figure 51 shows that all enhanced regimes are superior to the base case beyond 50 years in producing volume with the Fd regimes best before 80 to 100 years and the Cw regimes the most volume beyond 100 years. The highest log values come from the Cw brushed regime with the non-brushed Cw and Fd regimes producing moderate and generally similar values. The base case creates significantly less value than other regimes.

Figure 52 illustrates that at a 2% discount rate all regimes, including the base case, are viable for the roaded areas with the brushed Cw regime showing the best result. At a 4% discount rate all enhanced regimes are marginally viable while the base case breaks even.

Figure 53 shows similar trends for the barge-cable sites with all returns significantly lower due to the higher costs. At a discount rate of 2% the base case breaks even beyond 80 years, while at a 4% discount rate only the Cw brushed regime is viable between years 50 and 80.

Based on the analysis results above, the Timber and Silviculture WG made the following recommendations for reforestation regimes in the yellow and green silviculture zones:

- 25% Fd 1,600sph with fert (with root rot), 10% Fd (Pw) 1,400sph with fert (the root rot OAF of 12.5% is reduced to 5%), 20% Fd (Pw) 1,400sph with fert (with root rot), 25% Cw brushed regime, 20% no treatment (base case)
- 20% Fd 1,600sph with fert (with root rot), 10% Fd (Pw) 1,400sph with fert (the root rot OAF of 12.5% is reduced to 5%), 15% Fd (Pw) 1,400sph with fert (with root rot), 35% Cw brushed regime, 20% no treatment (base case)

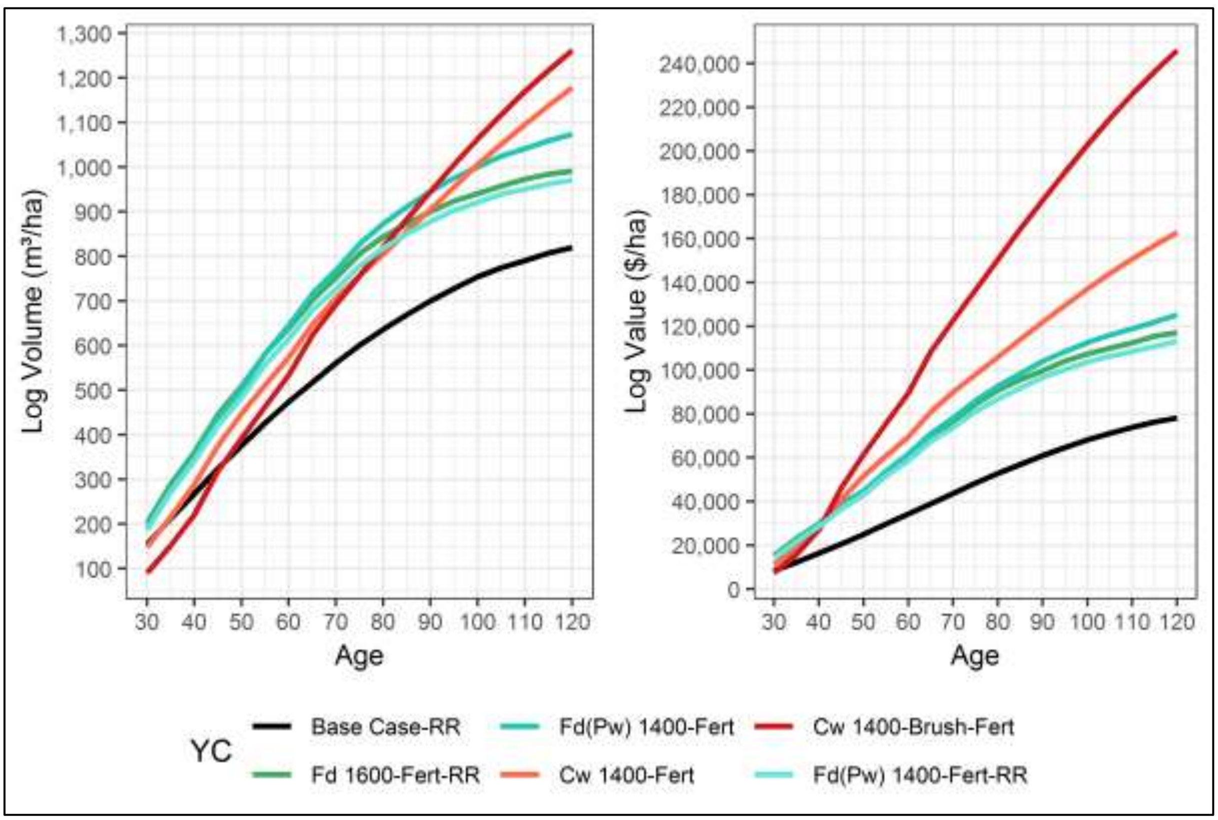

Figure 51: Log volumes and values for the CWHdm warm zonal good future

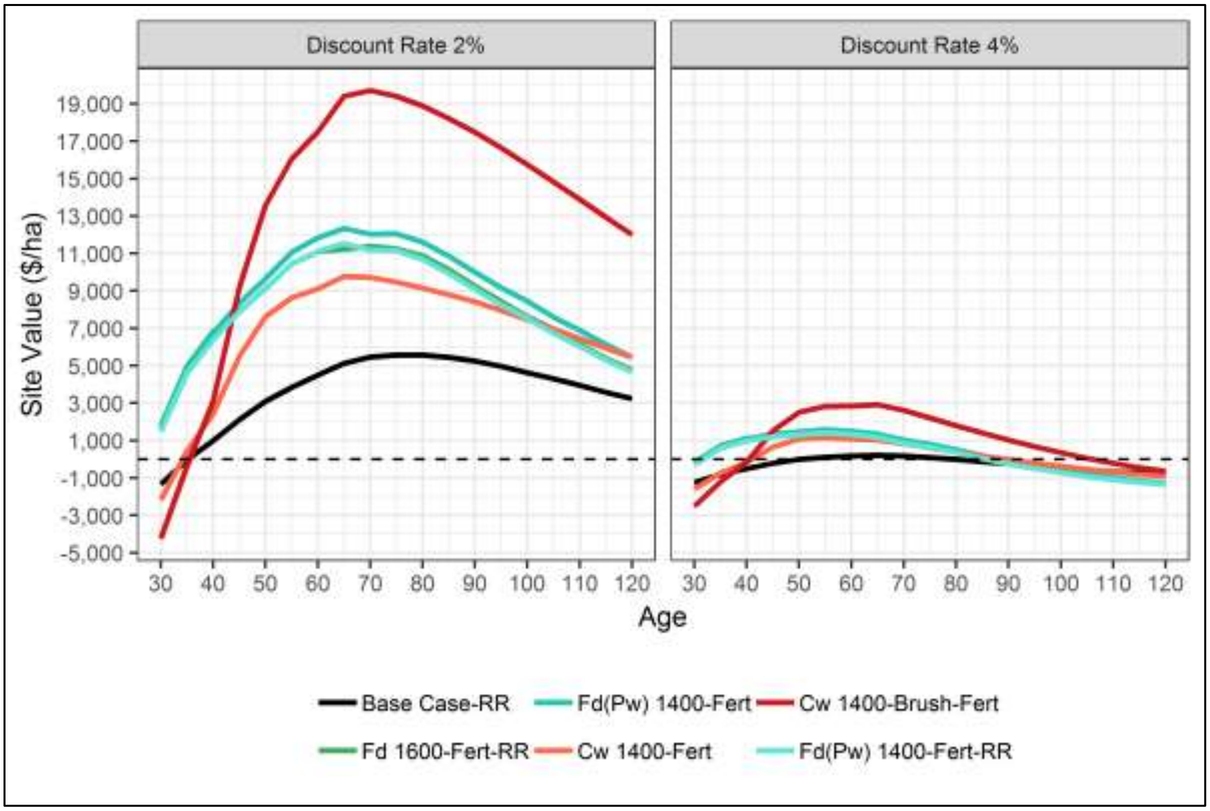

Figure 52: Site values for roaded sites in the CWHdm warm zonal good future

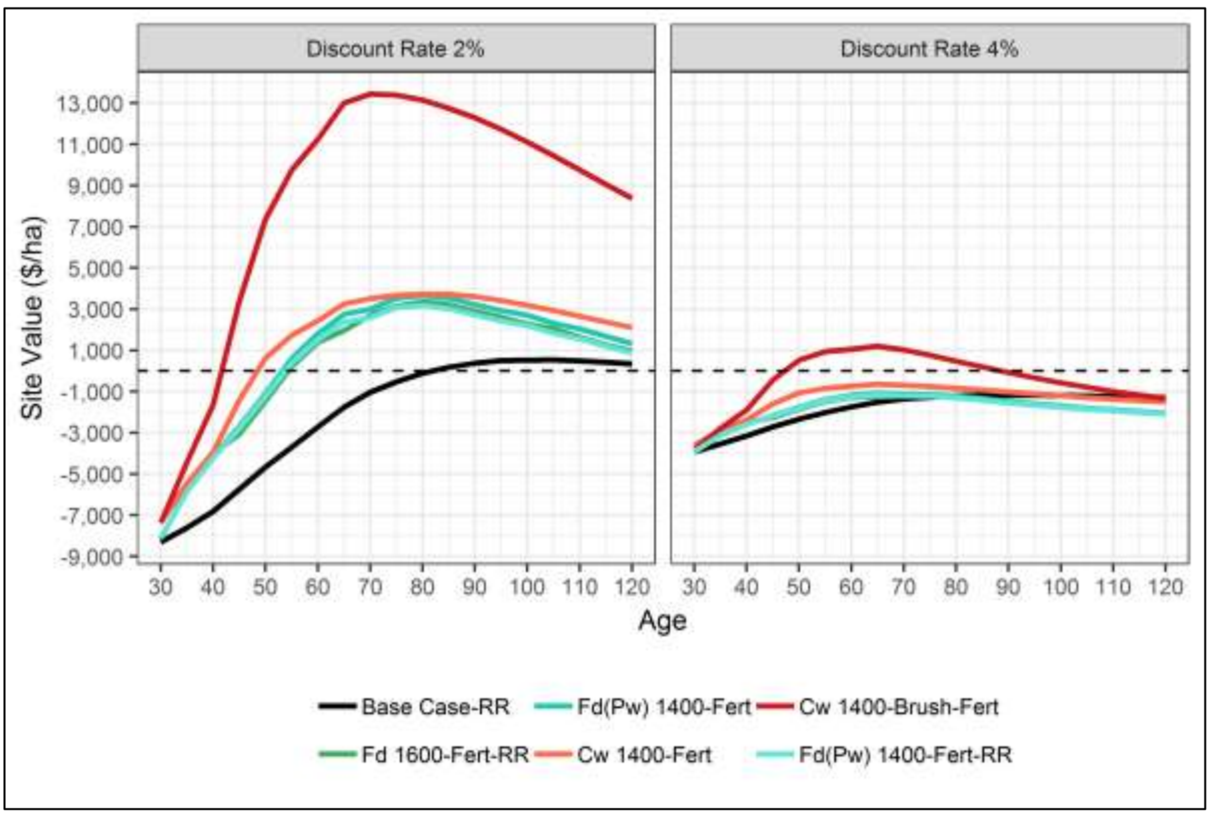

Figure 53: Site values for barge-cable harvest sites in the CWHdm warm zonal good future

<u>CWHxm Zonal, All: Good and Med-Poor Future (Root Rot Hazard)</u>

As these two analysis units are similar, the stand level results are shown only for CWHxm Zonal, All: Good. These analysis units are in root rot hazard zones. As slopes can range from gentle to steep stumping to deal with root rot is an option on some but not all sites. Figure 54 shows the projected log volumes and values for the regimes developed for consideration:

- Base Case (with root rot): planted 950sph of Fd(CwPw) with natural infill of 1,000sph of HwFd(CwDr) with OAF2 of 12.5
- Fd regime where the high root rot hazard sites (assumed to be 60%) are stumped (the root rot OAF of 12.5% is reduced to 5% on the whole area), planted at 1,600sph and fertilized every 10 years between year 30 and year 70
- Fd regime where the high root rot hazard sites (assumed to be 60% of the total area) are stumped (the root rot OAF of 12.5% is reduced to 5% on the whole area), planted at 1,400sph and fertilized every 10 years between year 30 and year 70
- Fd regime planted at 1,600sph and fertilized every 10 years between year 30 and year 70 (with root rot)
- Fd (Pw) regime planted at 1,400sph and fertilized every 10 years between year 30 and year (the root rot OAF of 12.5% is reduced to 5% on the whole area)
- Fd (Pw) regime planted at 1,400sph and fertilized every 10 years between year 30 and year 70 (with root rot)

Modelling the impacts of root rot and reducing the consequences of it using OAF2 is a very cursory approach. Caution is recommended when reviewing the comparative results for choosing the best regimes. More detailed approaches to modeling root rot have been tested using TASS but more research is required before they are available for use.

Figure 54 shows that all enhanced regimes are superior to the base case in producing volume with the stumped regimes marginally better. Log volume trends are virtually the same as those for volume

Figure 55 shows that with at a discount rate of 2% all regimes, including the base case, are viable for the roaded areas. In general, all enhanced regimes are substantially better than the base case. At a 4% discount rate all enhanced regimes are marginally viable, while the base case breaks even. Figure 56 shows similar results for the barge-ground harvest sites with all returns significantly lower due to the higher costs associated with barging.

Based on the analysis results above, the Timber and Silviculture WG made the following recommendations for reforestation regimes in the yellow and green silviculture zones for both the volume and value scenarios:

- 40% Fd stump, 1,600sph with fert (reduced root rot OAF2), 30% Fd 1,600sph with fert (with root rot), with root rot), 20% Fd (Pw) 1,400sph with fert (with root rot), 10% no treatment (base case)

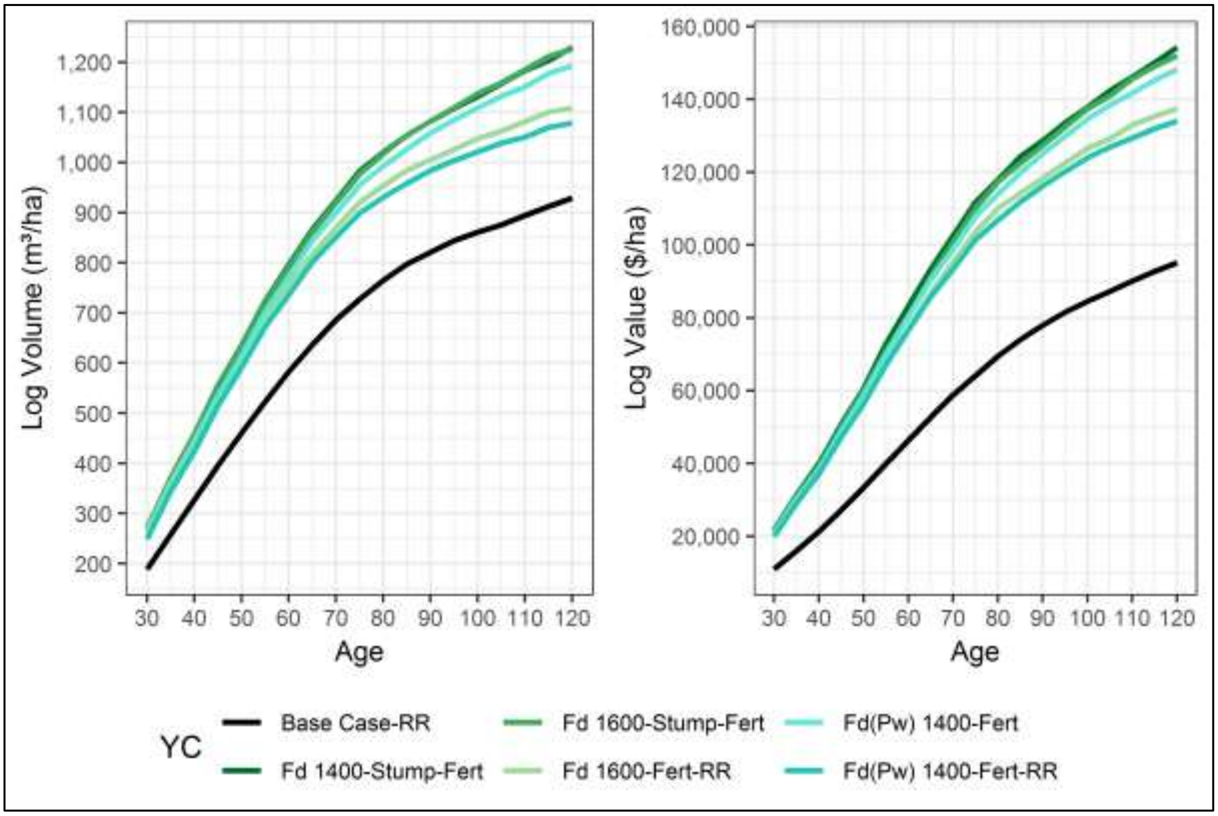

Figure 54: Log volumes and values for the CWHxm zonal good future

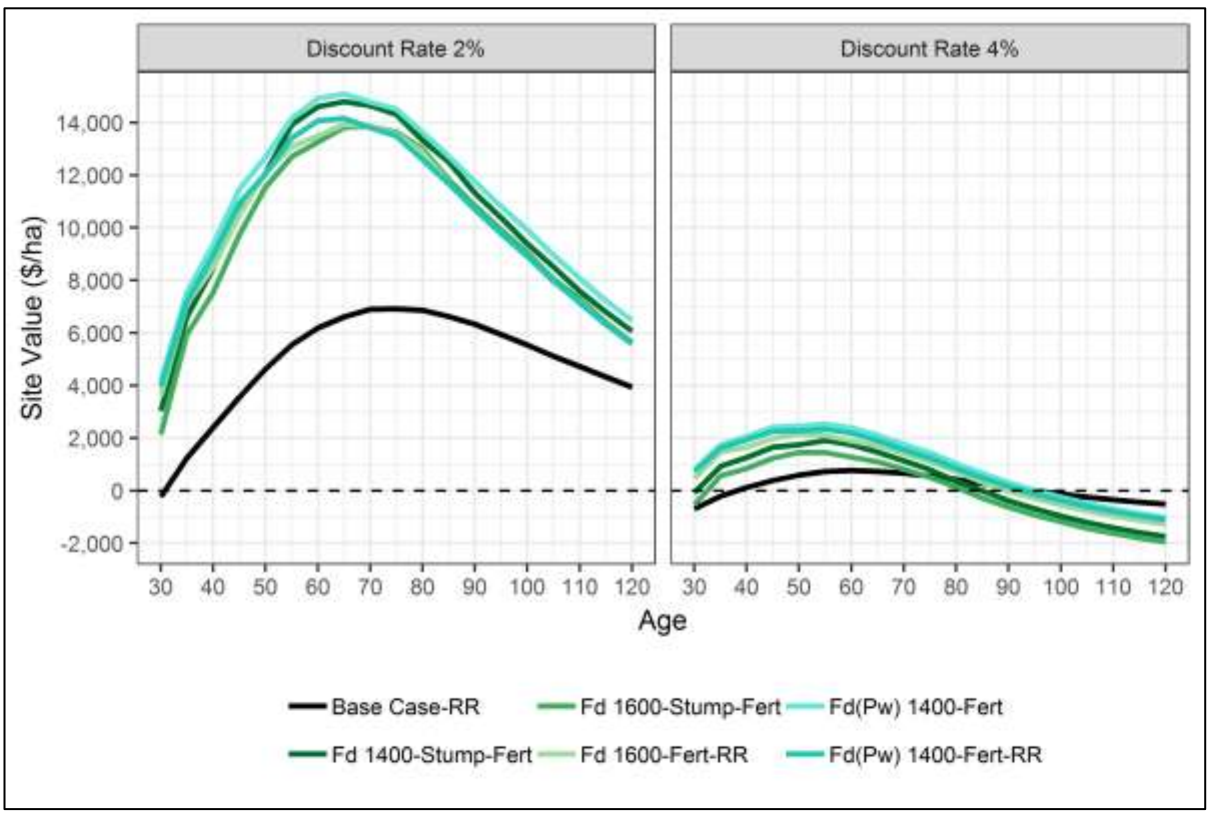

Figure 55: Site values for roaded sites in the CWHxm zonal good

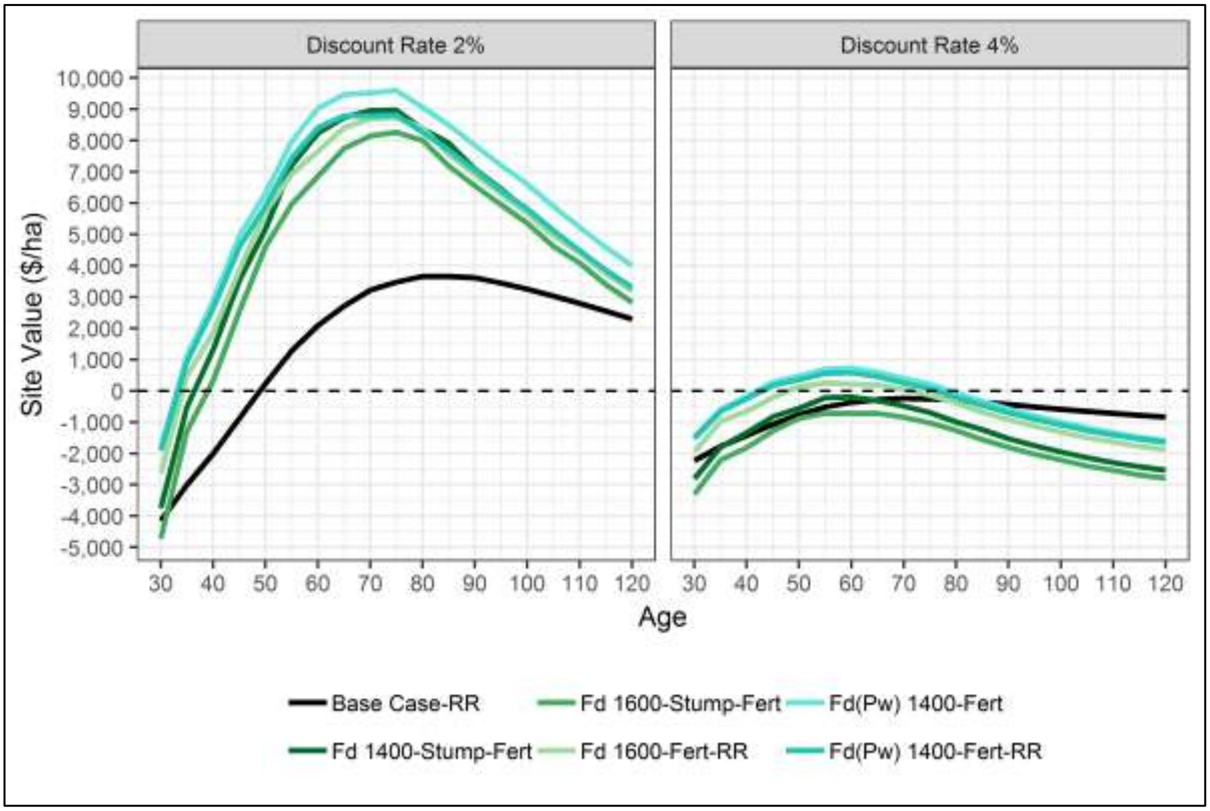

Figure 56: Site values for barge-ground harvest sites in the CWHxm zonal good

CWHvm1 Gentle Cool Zonal, All: Good and Med-Poor Future

As these two analysis units are similar, the stand level results are shown only for CWHvm1 Gentle Cool Zonal Med-Poor. These analysis units are not in root rot hazard zones; however, these areas face a potential risk from Swiss Needle Cast. Care needs to be taken with the use of Fd in reforestation. As there is also a spruce weevil hazard in these areas, the share of spruce in reforestation should be limited. Figure 57 shows the projected log volumes and values for the regimes developed for consideration:

- Base Case: planted 950sph of Fd/Cw with natural infill of 2,000sph of Hw(BaCwDr) with OAF2 of 5
- Fd regime planted at 1,600sph and fertilized every 10 years between year 30 and year 70
- Hw regime planted at 1,200sph
- Hw(Ba) regime planted at 1,200sph
- Hw(Ss) regime planted at 1,200sph
- Cw regime planted at 1,400sph and "brushed" to remove the competing natural infill and fertilized at year 40 and year 60 and
- Cw regime planted at 1,400sph and fertilized at year 40 and year 60

Figure 57 shows that the Fd enhanced regime is clearly superior in producing volume with the base case while the other enhanced regimes are predicted to produce less volume. The Cw brushed and Fd regimes create the most value with the Cw unbrushed regime somewhat less. The base case and Hw regimes are the poorest options for value creation.

Figure 58 shows that at a discount rate of 2 %, the Cw and Fd regimes are financially superior (Cw brushed is the best beyond 45 year) and are viable for all operability zones. The Hw regimes are generally worse than the base case beyond 50 years. They break even on the barge-ground but are not viable on barge-cable sites. The base case breaks even on the barge-cable sites. Figure 59 shows that at a discount rate of 4%, only the Cw and Fd regimes are viable on shorter rotations on the roaded sites. On the barge-ground sites only the Cw brushed regime is viable between year 50 and year 80; it breaks even only on a short age range on the barge-cable sites.

Based on the analysis results above, the Timber and Silviculture WG made the following recommendations for reforestation regimes in the yellow and green silviculture zones for the volume and value scenarios respectively:

- 50% Fd regime, 5% Hw(Ba) regime, 5% Hw(Ss) regime, 10% Cw un-brushed regime, 30% no treatment (base case)
- 35% Fd regime, 45% Cw brushed regime, 20% no treatment (base case)

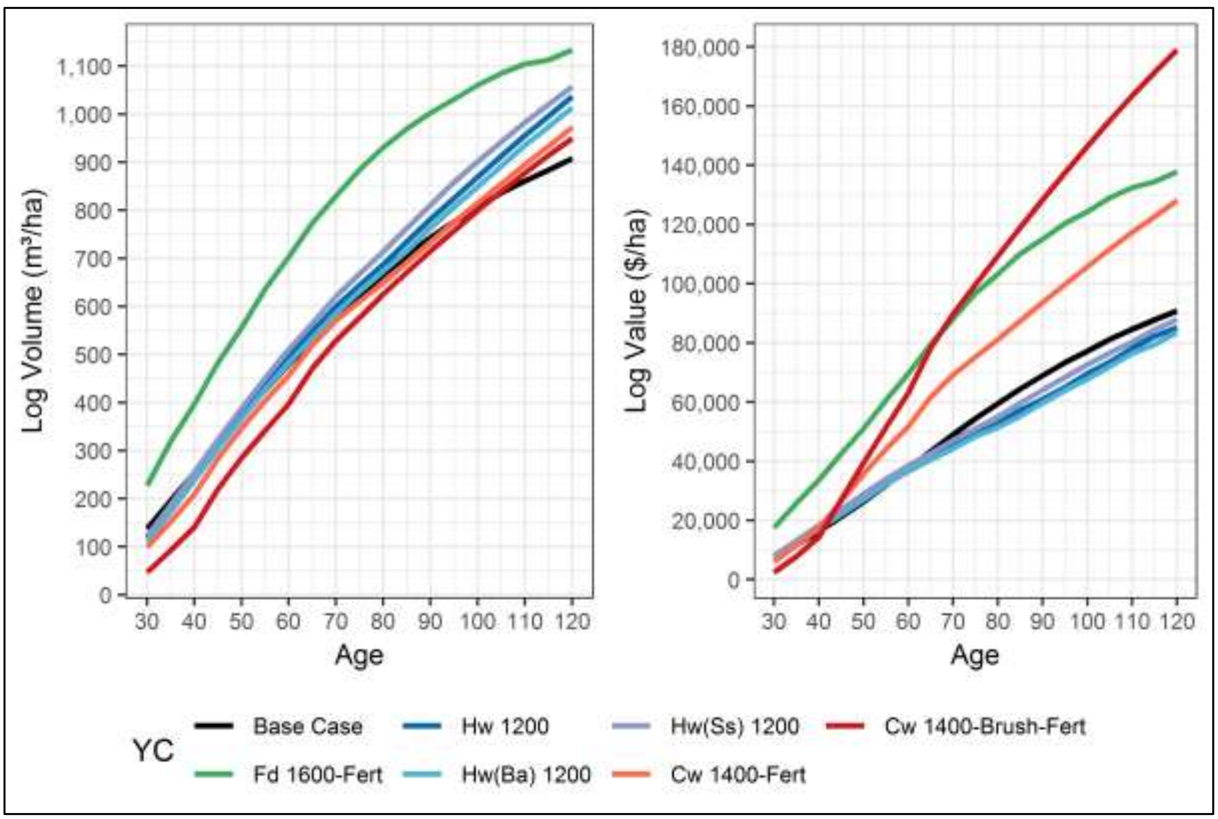

Figure 57: Log volumes and values for the CWHvm1 gentle cool med-poor future

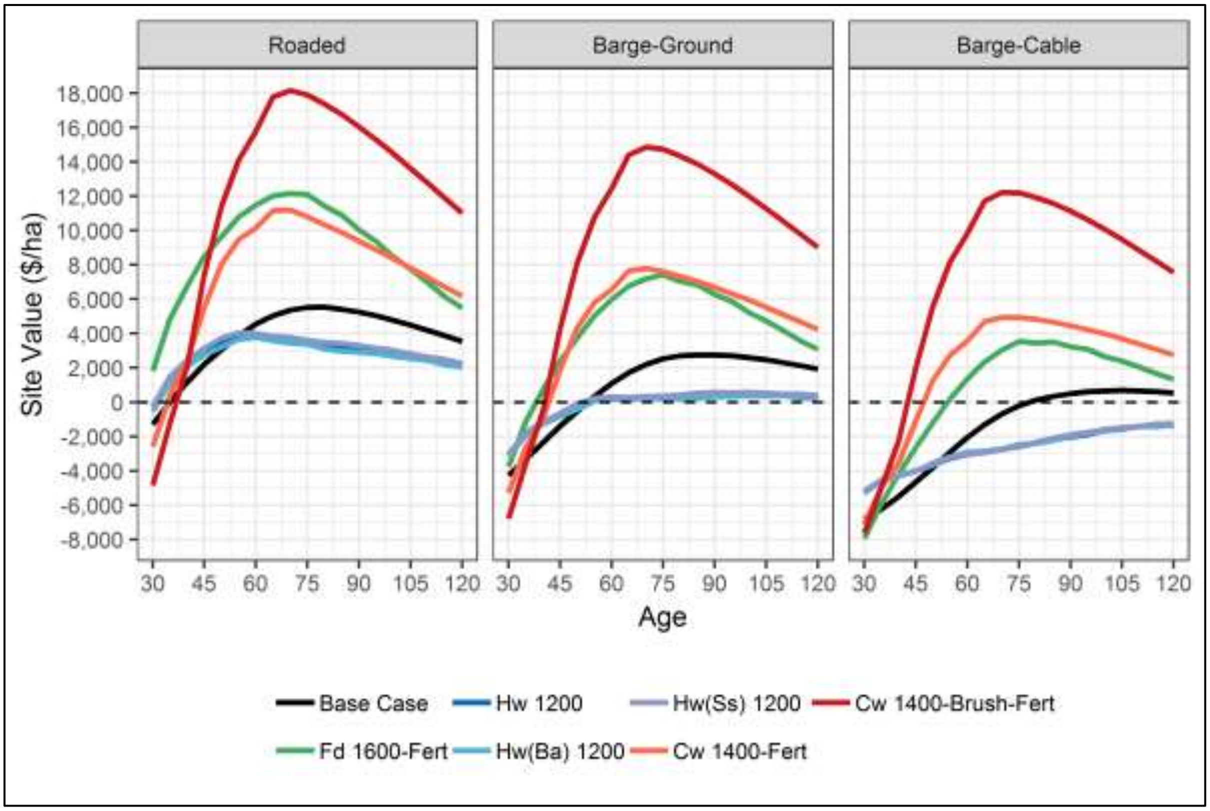

Figure 58: Site values (at 2%) for roaded and barge sites in the CWHvm1 gentle cool med-pr

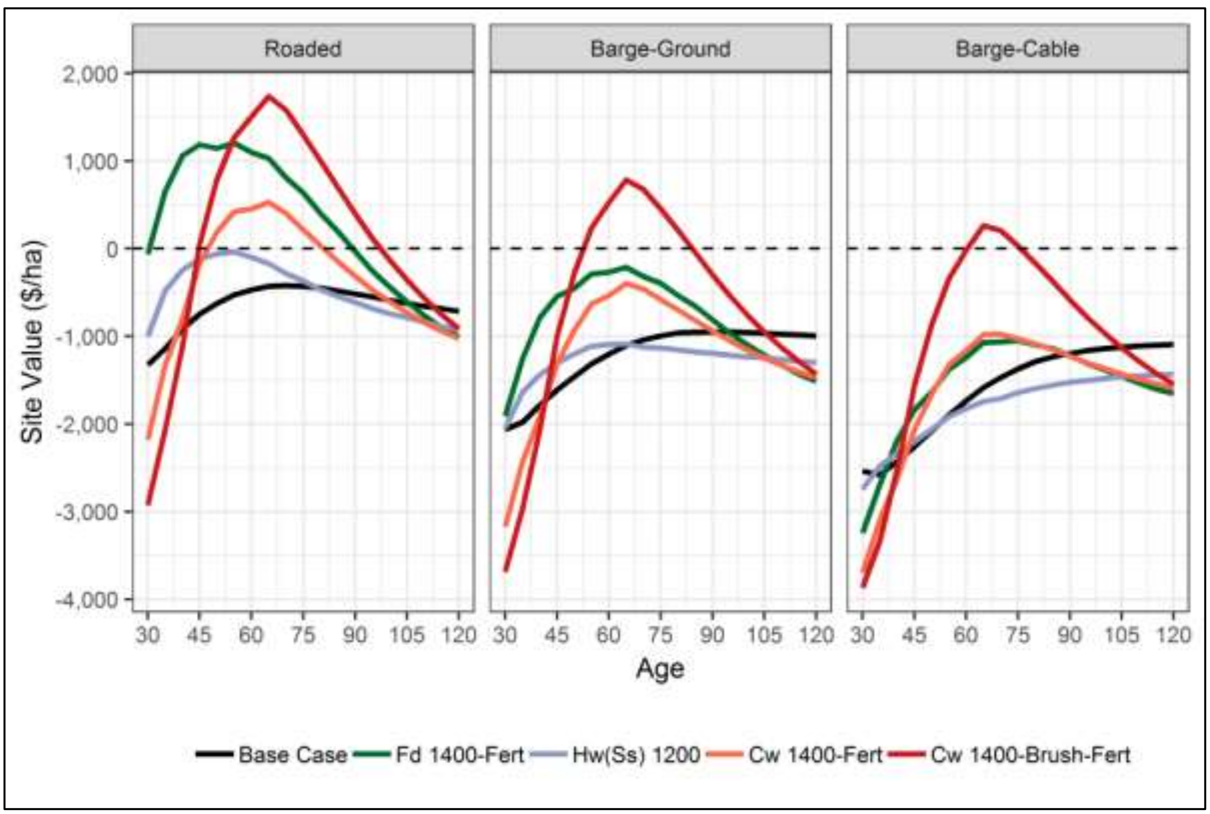

Figure 59: Site values (at 4%) for roaded and barge sites in the CWHvm1 gentle cool med-pr

CWHvm1 Warm Zonal, All

These analysis units are not in root rot hazard zones but are at potential risk from Swiss Needle Cast. Care needs to be taken to use moderate amounts of Fd. There is also a spruce weevil hazard, which limits the opportunities to use much spruce. Figure 60 shows the projected log volumes and values for the regimes developed for consideration:

- Base Case: planted 1,100sph of Fd/Cw with natural infill of 1,450sph of Hw(BaCwDr) with OAF2 of 5
- Fd regime planted at 1,600sph and fertilized every 10 years between year 30 and year 70
- Fd regime planted at 1,400sph and fertilized every 10 years between year 30 and year 70
- Hw regime planted at 1,200sph
- Hw(Ss) regime planted at 1,200sph
- Cw regime planted at 1,400sph and brushed to remove the competing natural infill. Fertilized at year 40 and year 60 and
- Cw regime planted at 1,400sph and fertilized at year 40 and year 60

Figure 60 shows that both Fd enhanced regimes produce similar results. They are superior in volume production. The base case and the Hw regimes yield similar results, while the Cw regimes are the poorest options. The Cw brushed and Fd regimes are the best in creating value with the Cw un-brushed being somewhat lower and the base case and Hw regimes being similar and the poorest options.

Figure 61 shows that with at discount rate of 2 %, the Cw and Fd regimes are financially superior (Cw brushed is the best beyond 45 years) in roaded areas and the Hw regimes are viable but less desirable than the base case. At a 4% discount rate, the Cw and Fd regimes are viable; however, the base case and Hw regimes barely break even. As Figure 62 shows similar relative performances for barge-cable sites at greatly reduced returns. At 2% the base case breaks even only for longer rotations, while the Hw regimes are not viable. At 4% only the Cw regimes are marginally viable and break even.

For all sites, the Fd regimes have similar financial performances with the 1,400sph regime being slightly better than the 1,600sph regime. Until uncertainties with early stand survival are better understood, the Timber and Silviculture WG favours the more conservative regime of Fd planted at 1,600sph. The group's recommendations were:

- 70% Fd regime at 1,600 sph, 5% Hw(Ss) regime, 5% Cw unbrushed regime, 20% no treatment (base case)
- 40% Fd regime at 1,600 sph, 40% Cw brushed regime, 20% no treatment (base case)

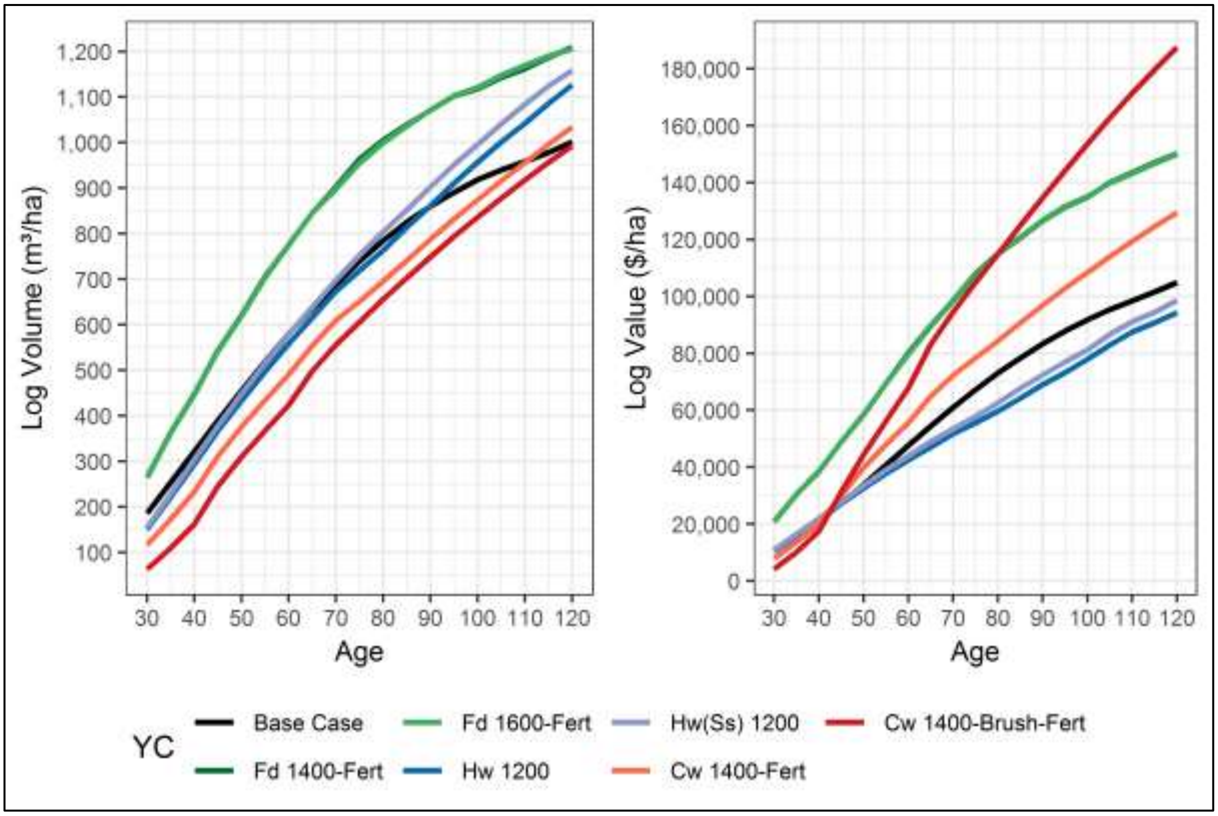

Figure 60: Log volumes and values for the CWHvm1 warm all future

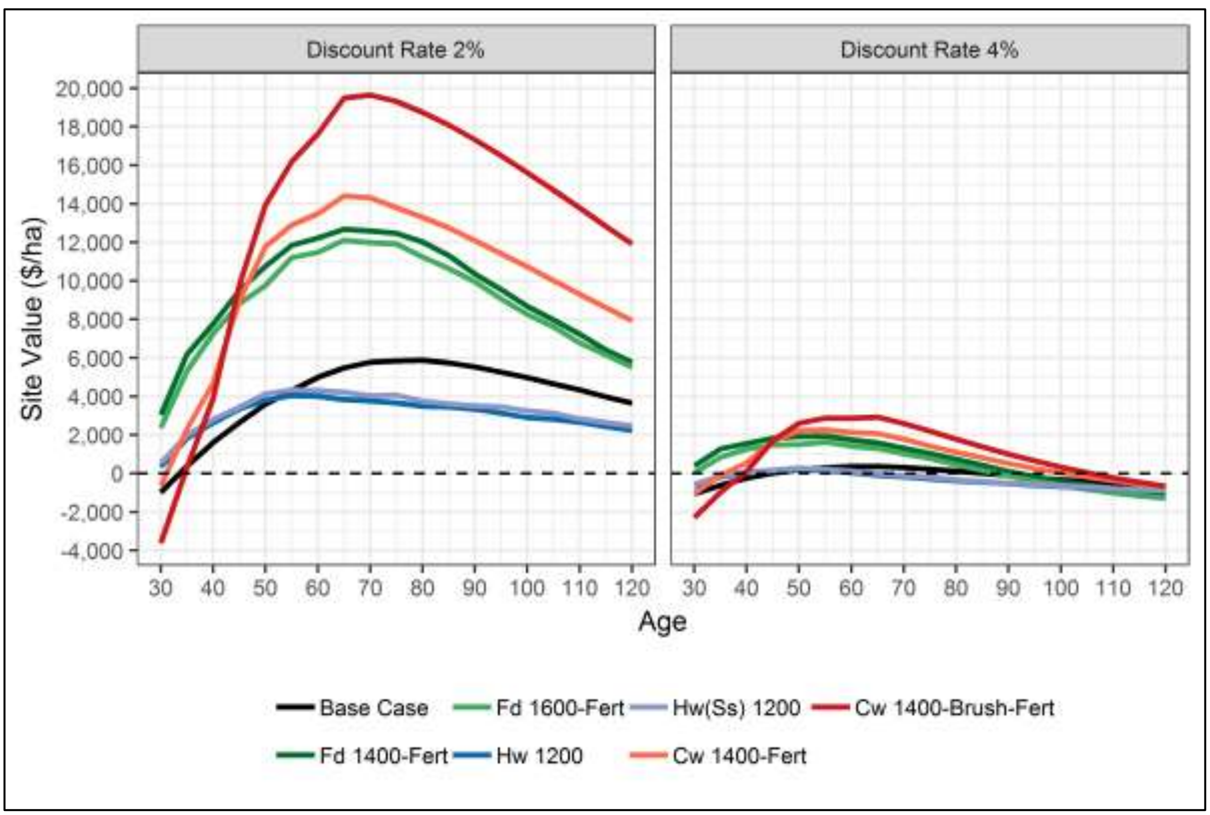

Figure 61: Site values for roaded sites in the CWHvm1 warm all

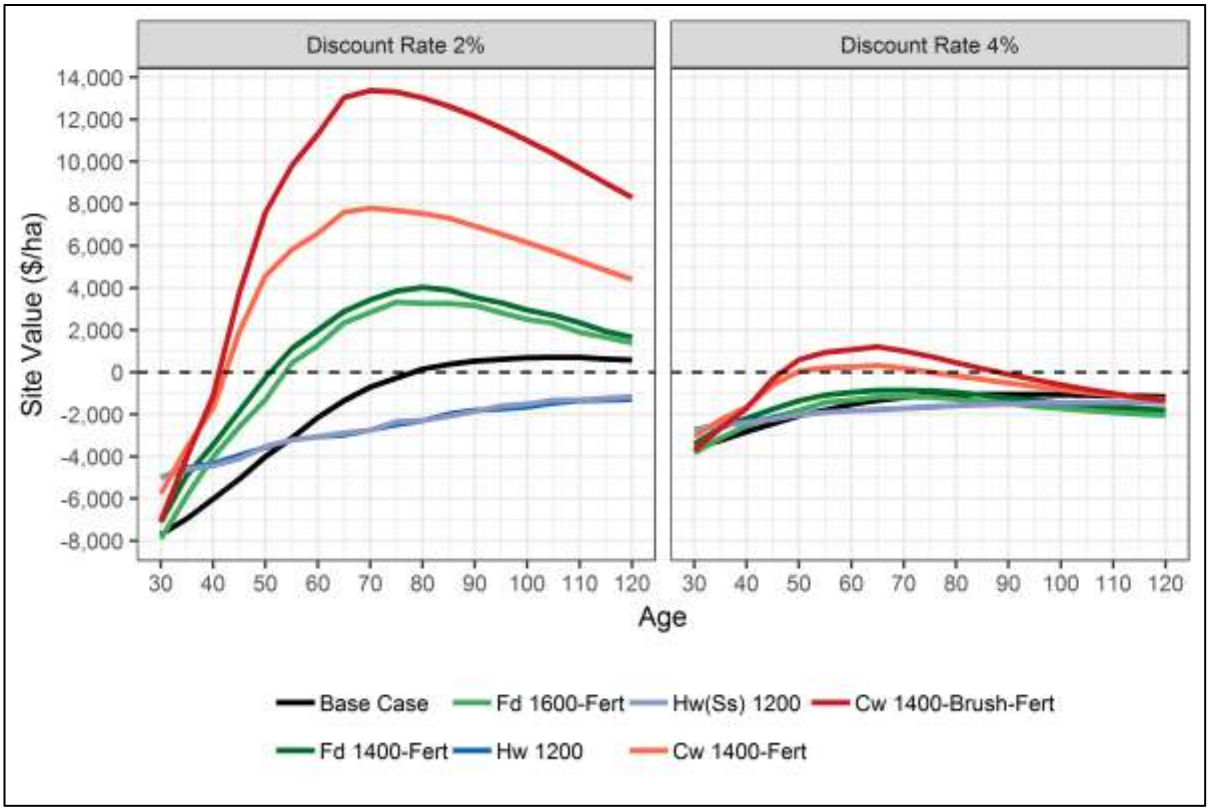

Figure 62: Site values for barge-cable sites in the CWHvm1 warm all

<u>CWHvm2 Warm All</u>

Fd in this analysis unit is at risk from snow damage. Care needs to be taken not to use too much Fd in reforestation. Figure 63 shows the projected log volumes and values for the regimes developed for consideration:

- Base Case: planted 900sph of Cw(FdBa) with natural infill of 2,650sph of HwBa(Dr) with OAF2 of 5
- Fd regime planted at 1,400sph and fertilized every 10 years between year 30 and year 70
- Hw(Ss) regime planted at 1,200sph
- Cw regime planted at 1,400sph and brushed to remove the competing natural infill and fertilized at year 40 and year 60 and
- Cw regime planted at 1,400sph and fertilized at year 40 and year 60

Figure 63 shows that the enhanced Fd regime generates the most volume followed by the Hw regime and then the Cw regimes. Past about 60 years, the base case generates the lowest volume per ha. The Cw brushed and Fd regimes create the highest value, with the Cw unbrushed regime crating less followed by the Hw regime. The base case creates the least value.

At a discount rate of 2% the Cw and Fd regimes are financially superior (Cw brushed is the best beyond 45 years) and are viable for all operability zones (Figure 64). For all sites, the Hw regimes are generally slightly better than those in the base case. All regimes, including the base case, are viable for roaded sites. However only the Cw and Fd regimes are viable for the barge sites.

Figure 65 shows that at a 4% discount rate, only the Cw and Fd regimes are viable and on shorter rotations on the roaded sites. On the barge-ground sites, only the Cw brushed regime is viable between year 50 and year 80. It breaks even only within a short age range on the barge-cable sites.

Based on the above analysis, the Timber and Silviculture WG recommended the following regimes for the yellow and green silviculture zones for the volume and value scenarios:

- 45% Fd regime, 15% Hw(Ss) regime, 20% Cw un-brushed regime, 20% no treatment (base case)
- 30% Fd regime, 5% Hw(Ss) regime, 45% Cw brushed regime, 20% no treatment (base case)

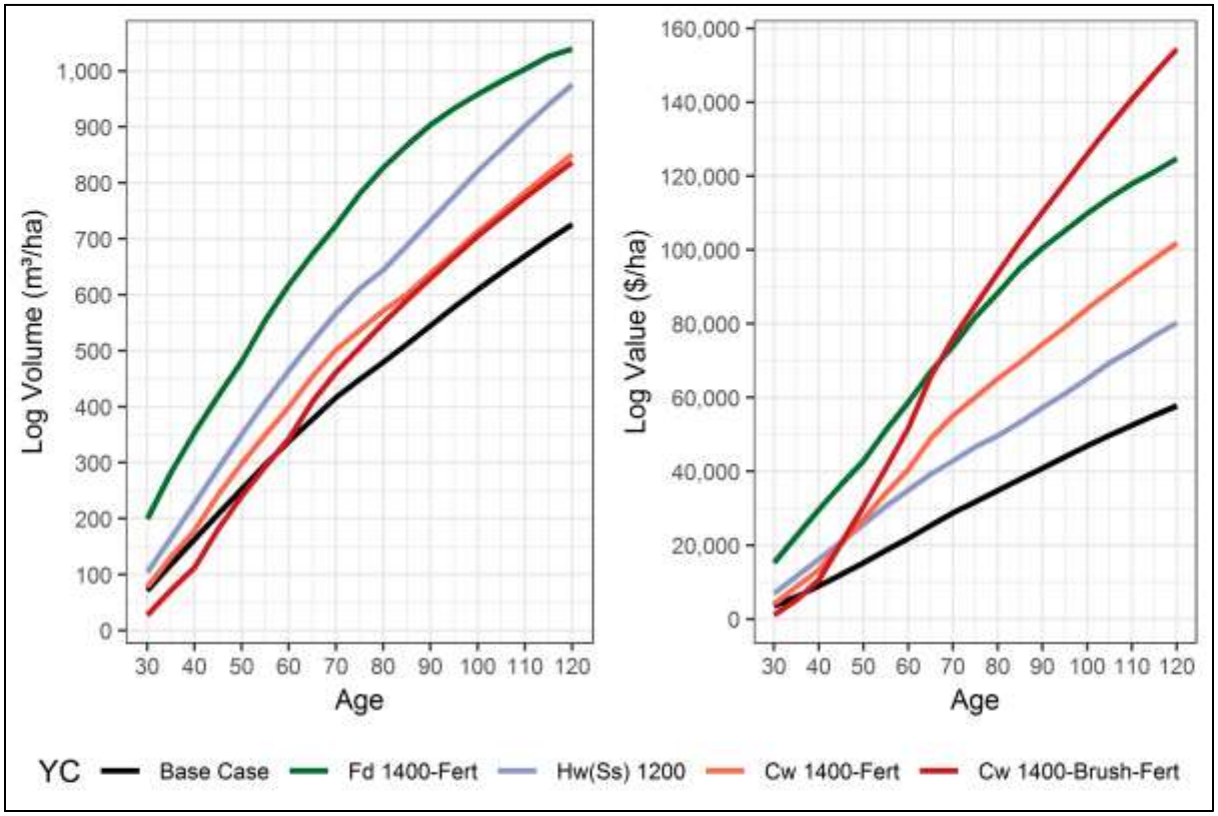

Figure 63: Log volumes and values for the CWHvm2 warm all future

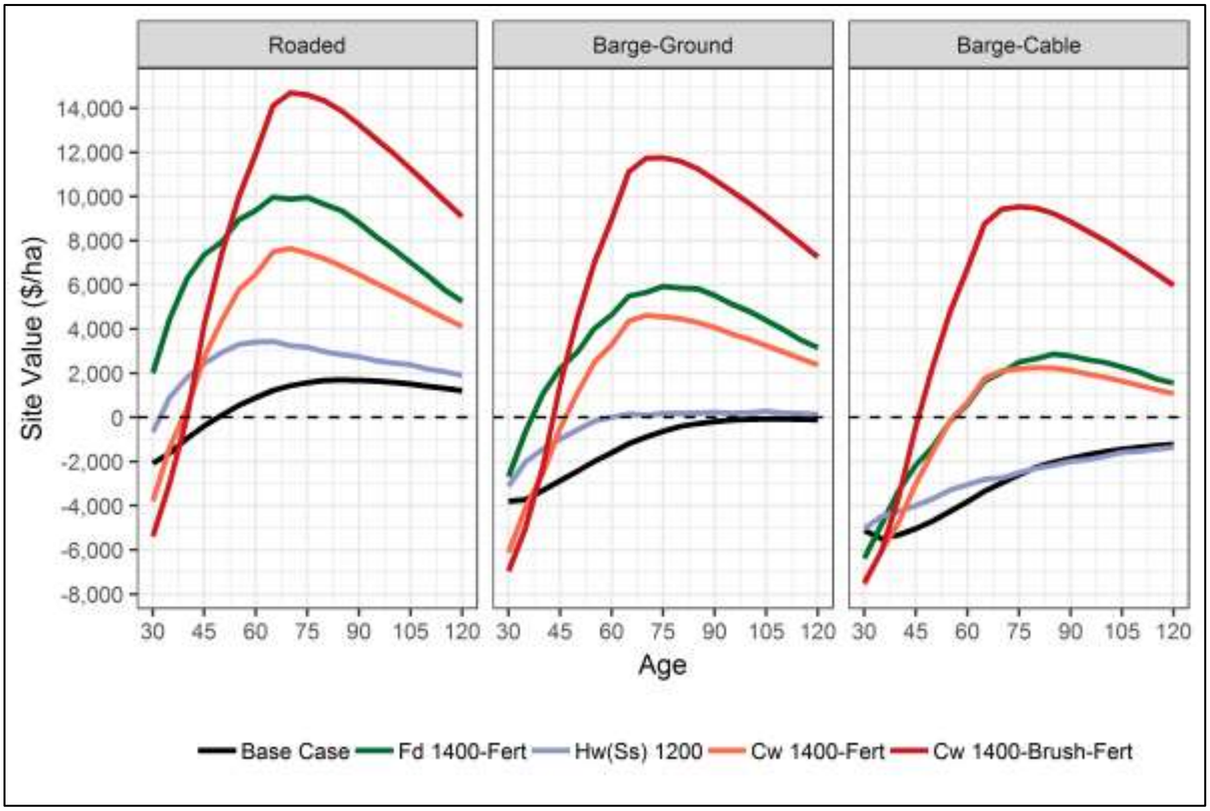

Figure 64: Site values (at 2%) for roaded and barge sites in the CWHvm2 warm all

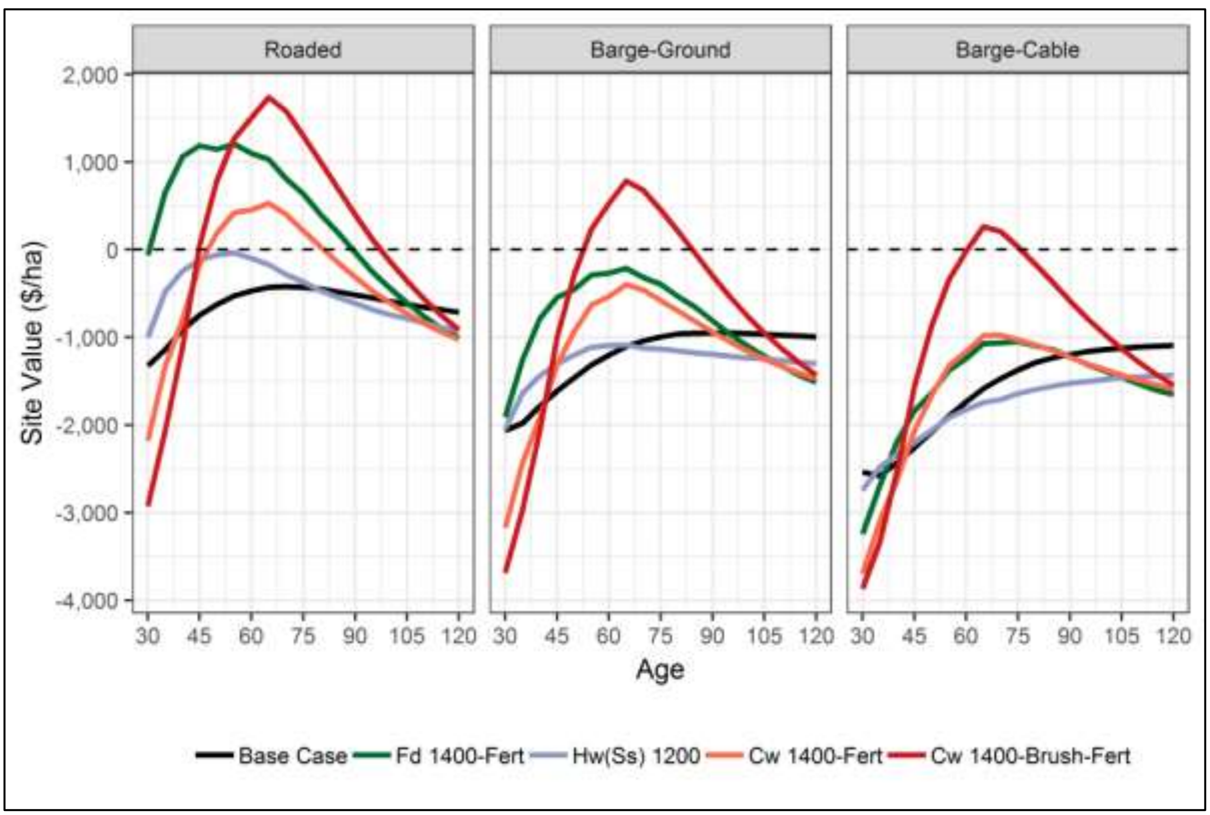

Figure 65: Site values (at 4%) for roaded and barge sites in the CWHvm2 warm all

CWHds1 Gentle Cool Good and Med-Poor Future (Root Rot Hazard)

As the stand level analysis results for these two analysis units are similar, only the CWHds1 Gentle Cool Good results are shown. These analysis units are in root rot hazard zones and the sites with gentle slopes within these units are suitable for stumping. Figure 66 shows the projected log volumes and values for the regimes developed for consideration:

- Base Case (with root rot): planted 750sph of Fd/Cw with natural infill of 1350sph of Hw(DrBaCw) with OAF2 of 12.5
- Fd regime planted at 1,400sph and fertilized every 10 years between year 30 and year 70 (with root rot)
- Fd regime where the high root rot hazard sites (assumed to be 60% of the area) are stumped. (the root rot OAF of 12.5% is reduced to 5% on the whole area), planted at 1,400sph and fertilized every 10 years between year 30 and year 70
- Hw regime planted at 1,200sph
- Cw regime planted at 1,400sph and brushed to remove the competing natural infill and fertilized at year 40 and year 60 and
- Cw regime planted at 1,400sph and fertilized at year 40 and year 60

Figure 66 shows that both enhanced Fd regimes are superior to the base case for volume production. Before year 70, when the Dr in the stands is assumed by TASS to start falling apart, the Cw and Hw regimes and the base case have similar volume development. The Fd regimes and the Cw brushed regime generate the best results for timber value, while the Hw and the unbrushed Cw regimes create the least value.

Figure 67 shows that at a discount rate of 2% the Cw brushed regime is financially superior on barge-ground sites beyond year 50. Both Fd regimes are similar and are the second best followed by the base case. The Hw and unbrushed Cw regimes are marginally viable beyond year 70. Of the two Fd regimes stumping is produces marginally better results.

At 4% discount rate, only the Cw brushed and the Fd regimes barely break even from year 50 to year 80. Figure 68 shows similar trends for the barge-cable sites albeit with lower financial returns for all regimes.

Based on the above analysis, the Timber and Silviculture WG recommended the following regimes for these analysis units on yellow and green silviculture zones for the volume and value scenarios:

- 40% Fd, no stump regime, 10% Fd stump regime, 20% Cw brushed regime, 30% no treatment (base case)
- 20% Fd, no stump regime, 10% Fd stump regime, 40% Cw brushed regime, 30% no treatment (base case)

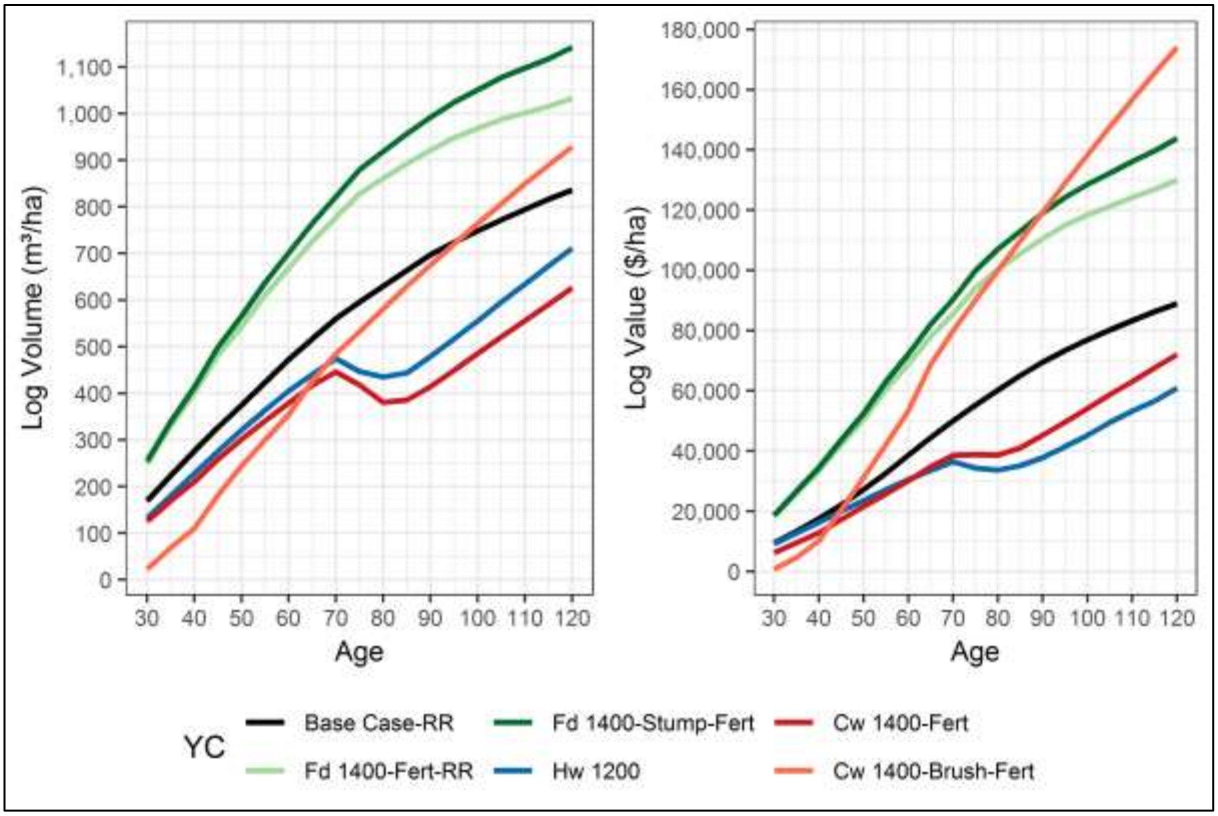

Figure 66: Log volumes and values for the CWHds1 gentle cool good future

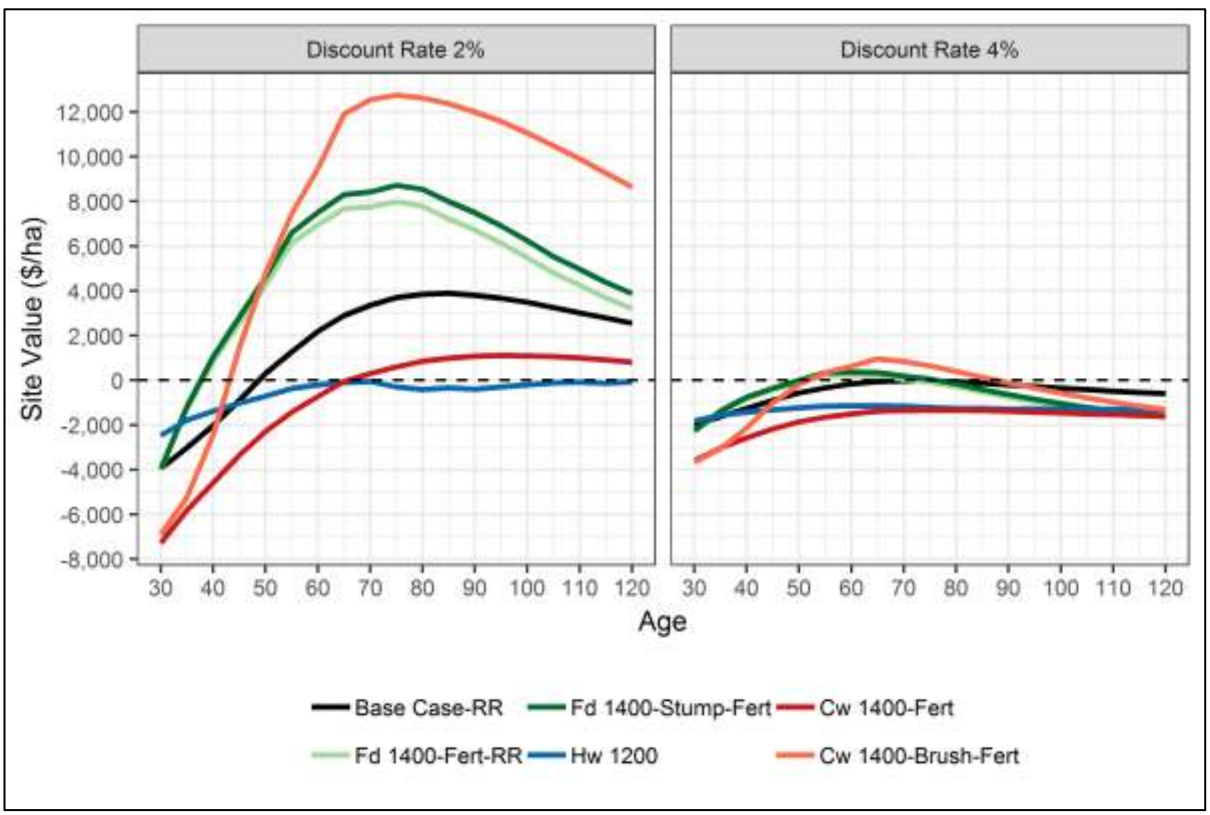

Figure 67: Site values for barge-ground sites in the CWHds1 gentle cool good

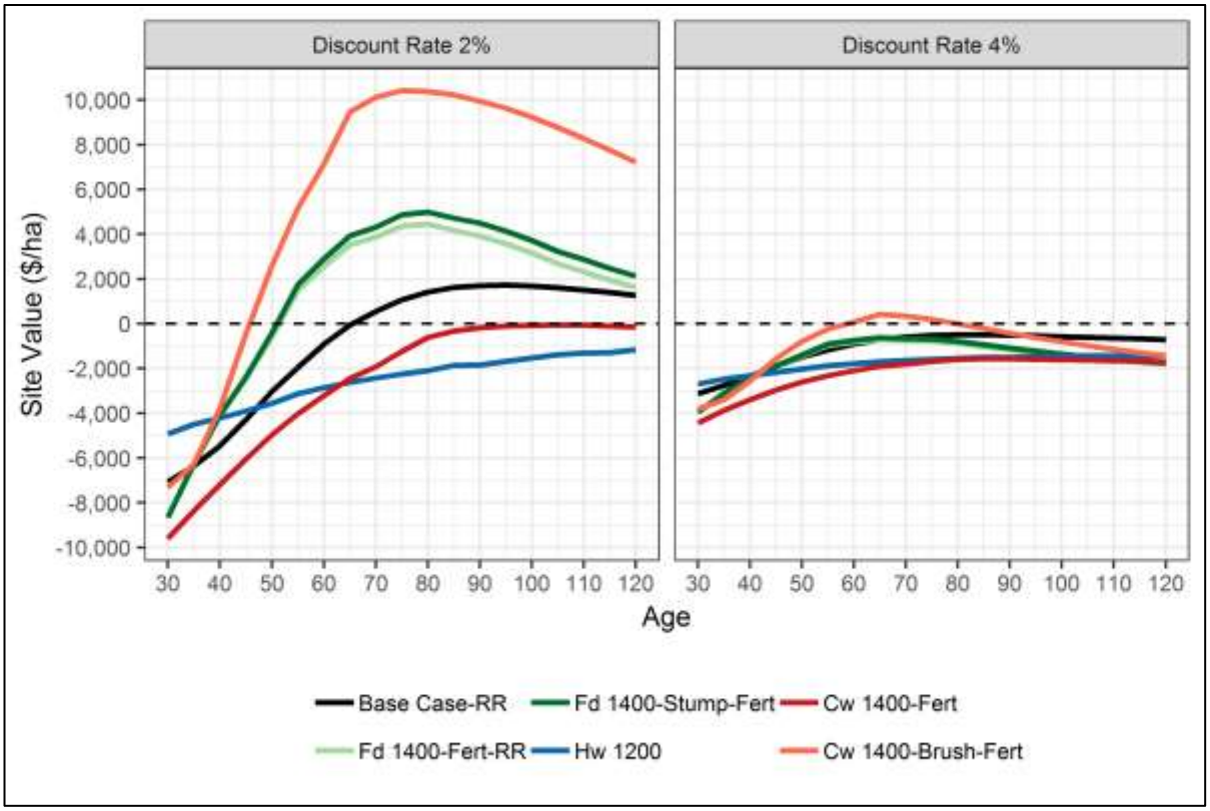

Figure 68: Site values for barge-cable sites in the CWHds1 gentle cool good

<u>CWHms1 Gentle Cool Submontane All</u>

There is a snow damage risk on Fd in this unit. Figure 69 shows the projected log volumes and values for the regimes developed for consideration:

- Base Case (with root rot): planted 750sph of Cw/Fd/Ba/Sx with natural infill of 1,900sph of HwBa with OAF2 of 5
- Cw regime planted at 1,400sph and brushed to remove the competing natural infill and fertilized at year 40 and year 60 and
- Cw regime planted at 1,400sph and fertilized at year 40 and year 60

Figure 69 shows similar volume projections for all regimes with the Cw unbrushed regime exhibiting marginally better results. The Cw regimes are clearly superior to the base case in creating value, with the brushed Cw regime showing the best results beyond year 60.

At a discount rate of 2% the Cw brushed regime on barge-ground sites is financially superior beyond year 50, while the base case is marginally viable (Figure 70). At a 4% discount rate, all regimes barely break even. Figure 71 shows similar trends for the barge-cable sites albeit with lower financial returns for all regimes.

Based on the above analysis, the Timber and Silviculture WG recommended the following regimes for these analysis units on yellow and green silviculture zones for the volume and value scenarios:

- 40% Cw un-brushed regime, 20% Cw brushed regime, 40% no treatment (base case)
- 20% Cw un-brushed regime, 40% Cw brushed regime, 40% no treatment (base case)

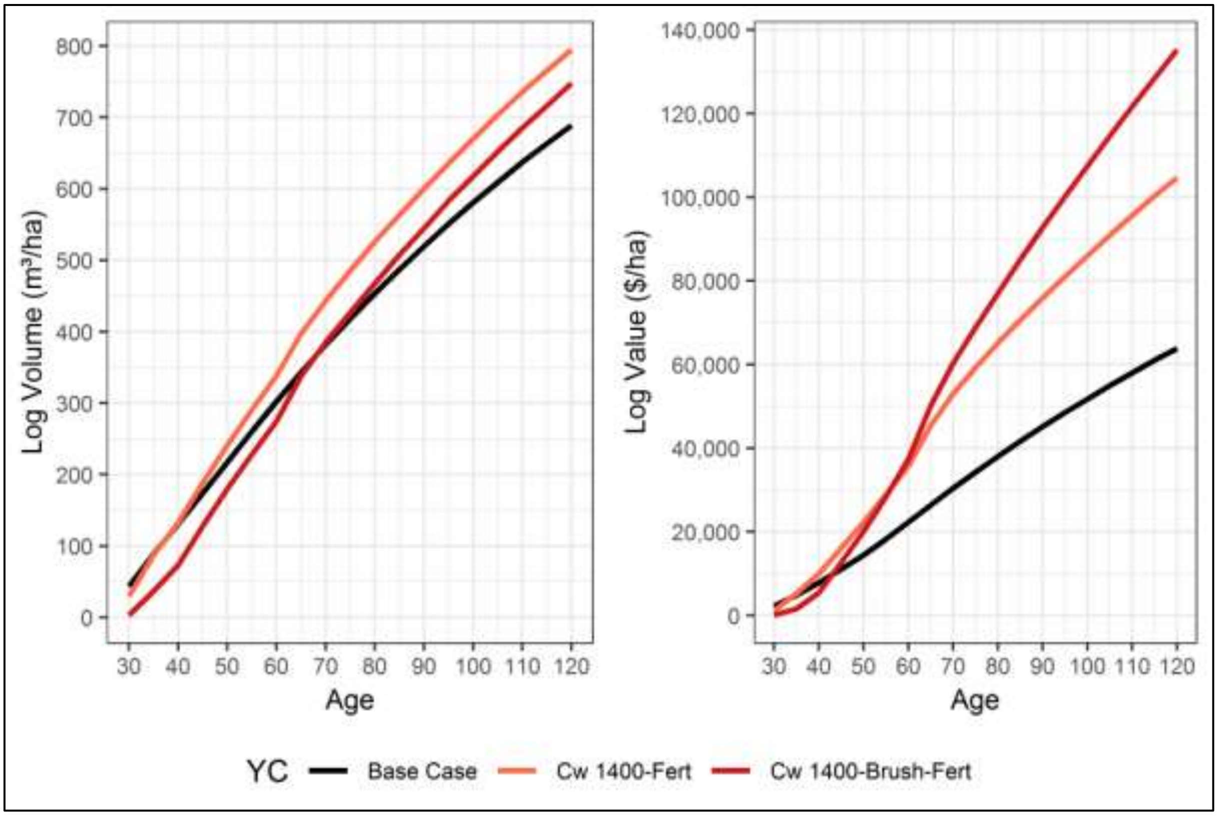

Figure 69: Log volumes and values for the CWHms1 gentle cool submontane future

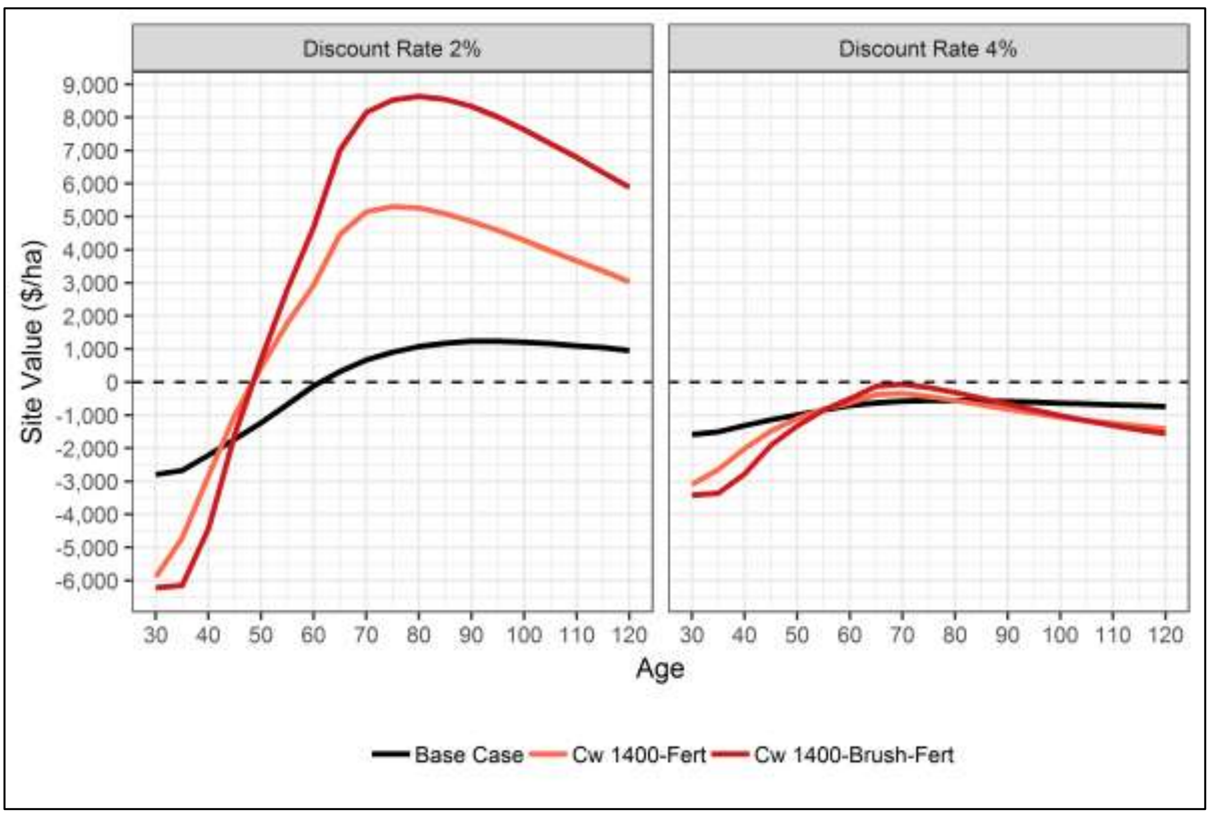

Figure 70: Site values for barge-ground sites in the CWHms1 gentle cool submontane

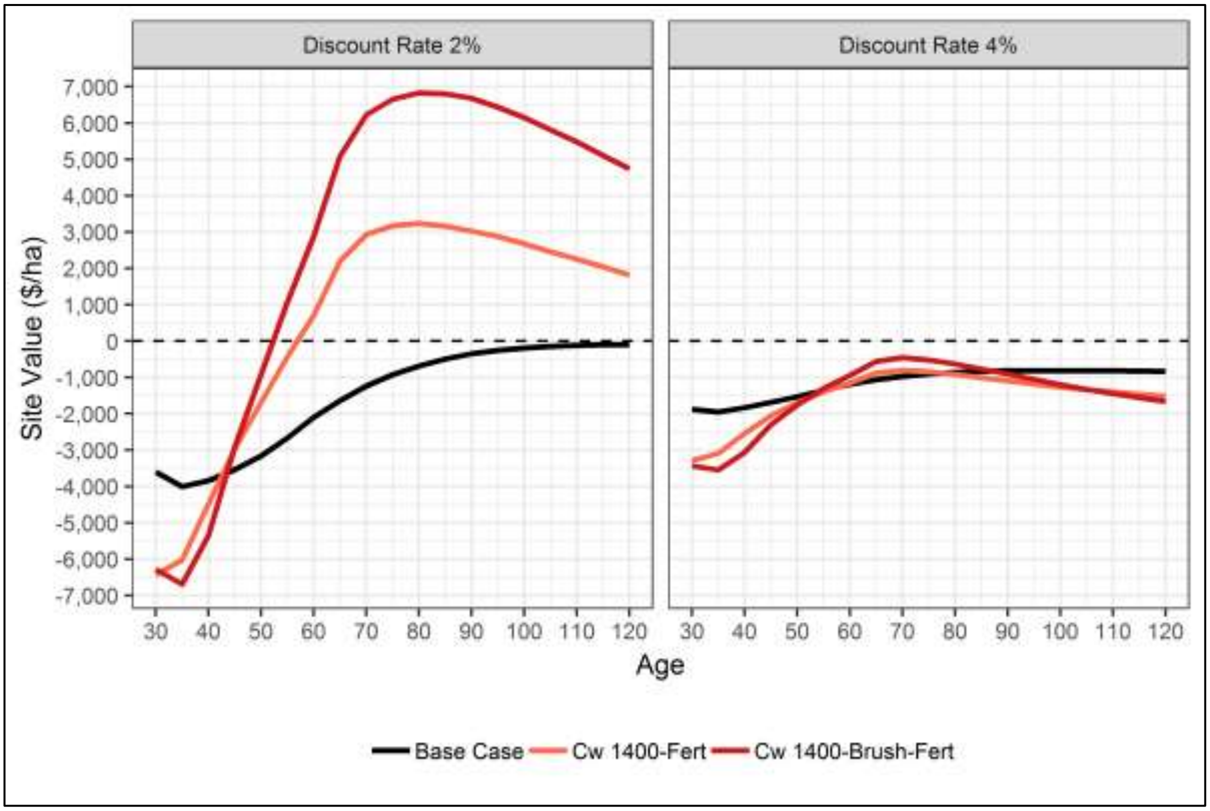

Figure 71: Site values for barge-cable sites in the CWHms1 gentle cool submontane

3.4.6 Stand level Volume Scenario 2 and Value Scenario Results for the Reduced Planting Regimes

The largest future stand analysis units in the red silviculture zones were considered for reduced density reforestation regimes. Reduced regimes were considered to try and balance overall reforestation costs while ensuring acceptable reforestation and volume production. The largest analysis units in the red silviculture zone make up about 22% of the THLB by area and include:

- <u>CWHvm2 Gentle Cool Planted</u>
- <u>CWHms1 Montane Gentle Cool (steep slopes)</u>
- <u>MHmm1/2 ESSF Gentle Cool and</u>
- <u>MHmm1/2 ESSF Warm</u>

Following are the volume, value and site value results for the largest yield curves considered suitable for reduced regimes.

<u>CWHms1 Gentle Cool Montane All</u>

Figure 72 shows the projected log volumes and values for the regimes developed for consideration:

- Base Case: planted 600sph of Cw/Sx/Ba with natural infill of 2,150sph of HwBa with OAF2 of 5
- Cw regime planted at 600sph and
- Se regime planted at 600

Figure 72 shows volume projections for all regimes with the Cw reduced regime producing marginally better results. The Cw regime is clearly superior in creating value, while and the Se regime exhibits the poorest results.

Figure 73 shows that at a 2% discount rate, the Cw regime is financially superior on barge-ground harvest sites. The Se regime is not financially viable. At a 4% discount rate, only the Cw regime is marginally viable between year 50 and year 100. Figure 74 shows similar trends for the barge-cable sites albeit with lower financial returns for all regimes.

Based on the above analysis, the Timber and Silviculture WG recommended the following regimes for these analysis units for the Volume 2 and Value scenarios on the barge-cable sites:

- 65% Cw regime, 5% Se regime, 20% no treatment (base case)
- 80% Cw regime, 20% no treatment (base case)

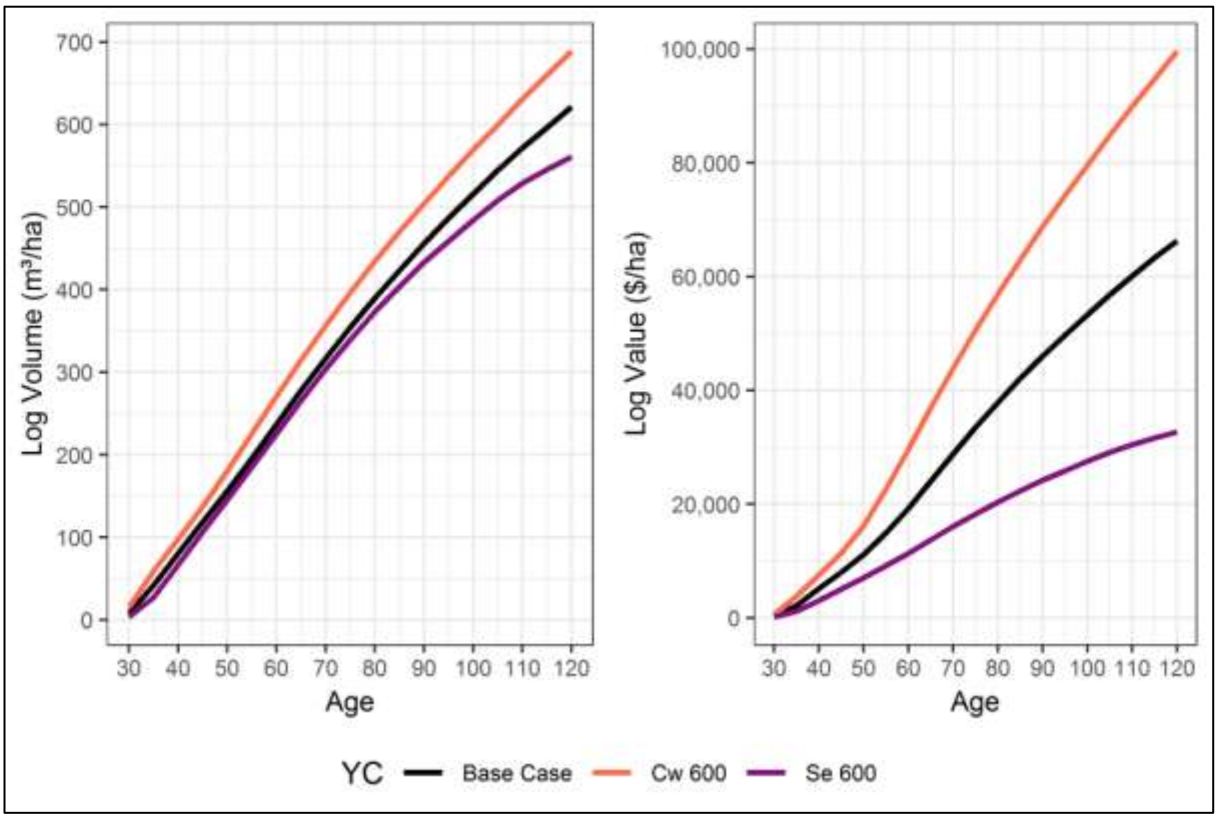

Figure 72: Log volumes and values for the CWHms1 gentle cool montane future

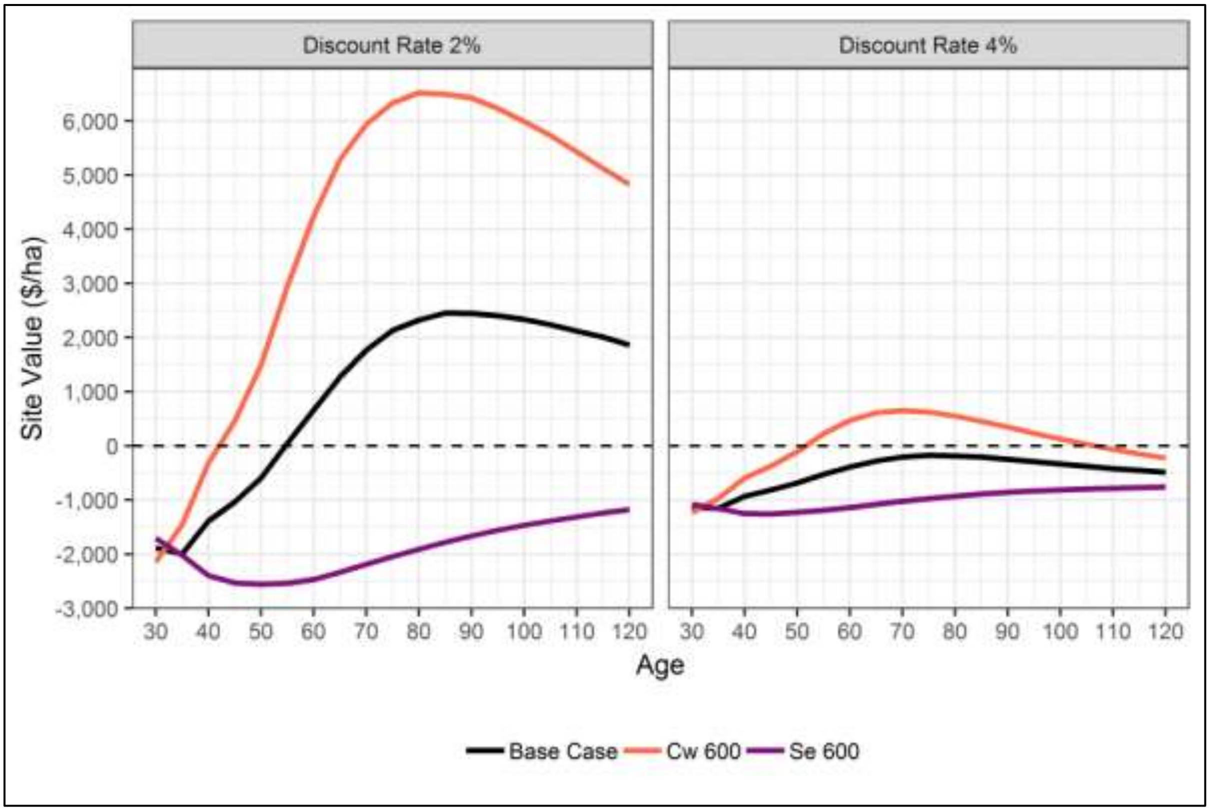

Figure 73: Site values for barge-ground sites in the CWHms1 gentle cool montane

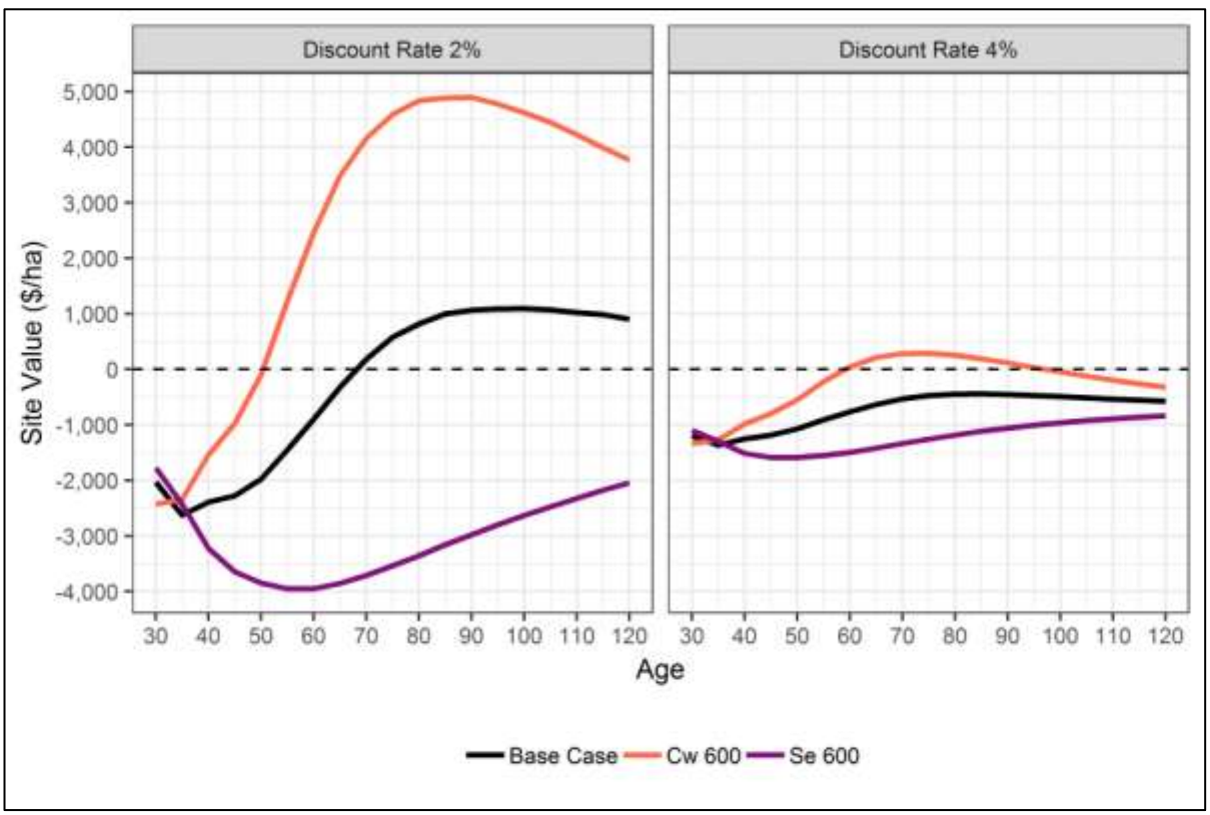

Figure 74: Site values for barge-cable sites in the CWHms1 gentle cool montane

CWHvm2 Gentle Cool Planted

Figure 75 shows the projected log volumes and values for the regimes developed for consideration:

- Base Case: planted 700sph of Cw/Ba with natural infill of 3,250sph of HwBa(Dr) with OAF2 of 5
- Cw regime planted at 600sph

Figure 75 shows that both regimes produce similar volume results. The Cw regime is marginally better than the base case in creating value beyond year 60.

At a 2% discount rate both regimes are viable on roaded sites with the Cw regime being superior (Figure 76). At a 4% discount rate, the Cw regime barely breaks between year 60 and year 70. Figure 77 illustrates that on barge-ground harvest sites only the Cw regime is viable beyond 75 years at a discount rate of 2%. Figure 78 shows that both regimes are non-viable on barge-cable sites.

Based on the analysis results, the Timber and Silviculture WG decided to apply the following portfolios to the Volume 2 and Value scenarios for this analysis unit:

- 65% Cw regime, 35% no treatment (base case)
- 75% Cw regime, 25% no treatment (base case)

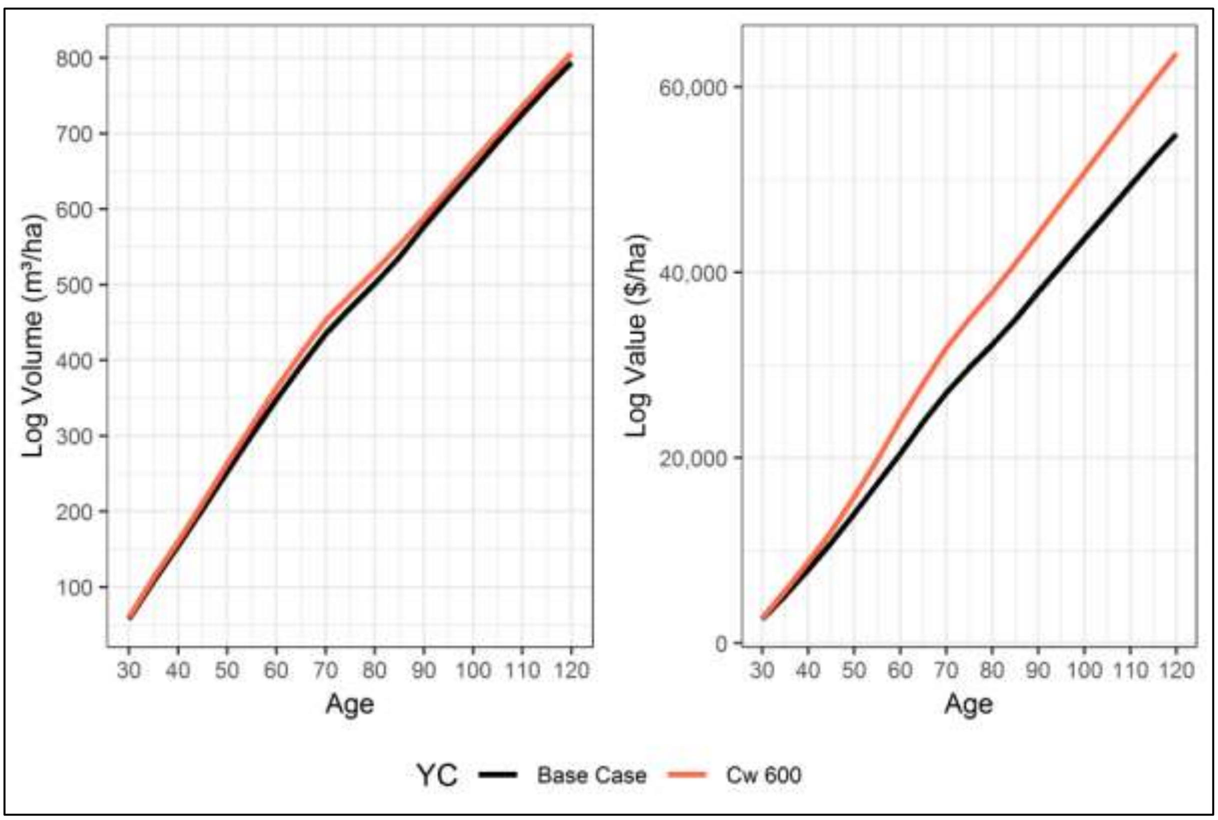

Figure 75: Log volumes and values for the CWHvm2 gentle cool planted future

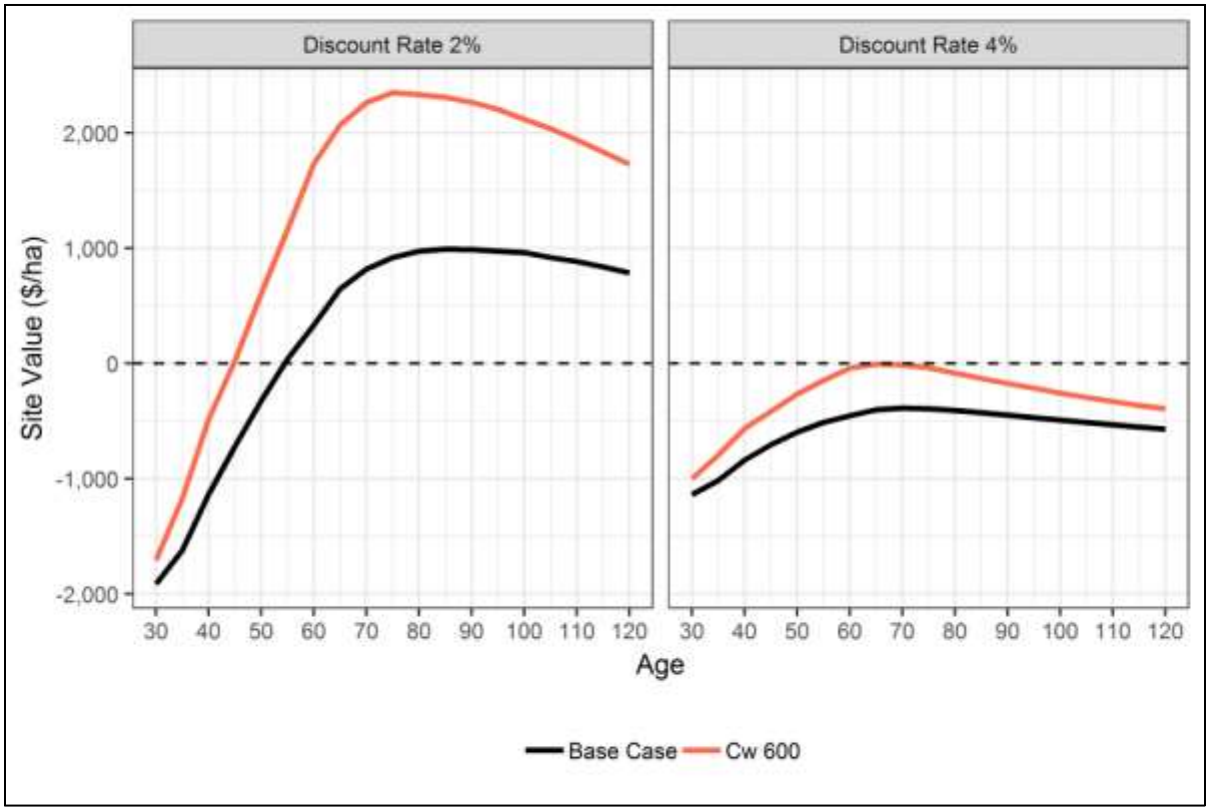

Figure 76: Site values for roaded sites in the CWHvm2 gentle cool planted

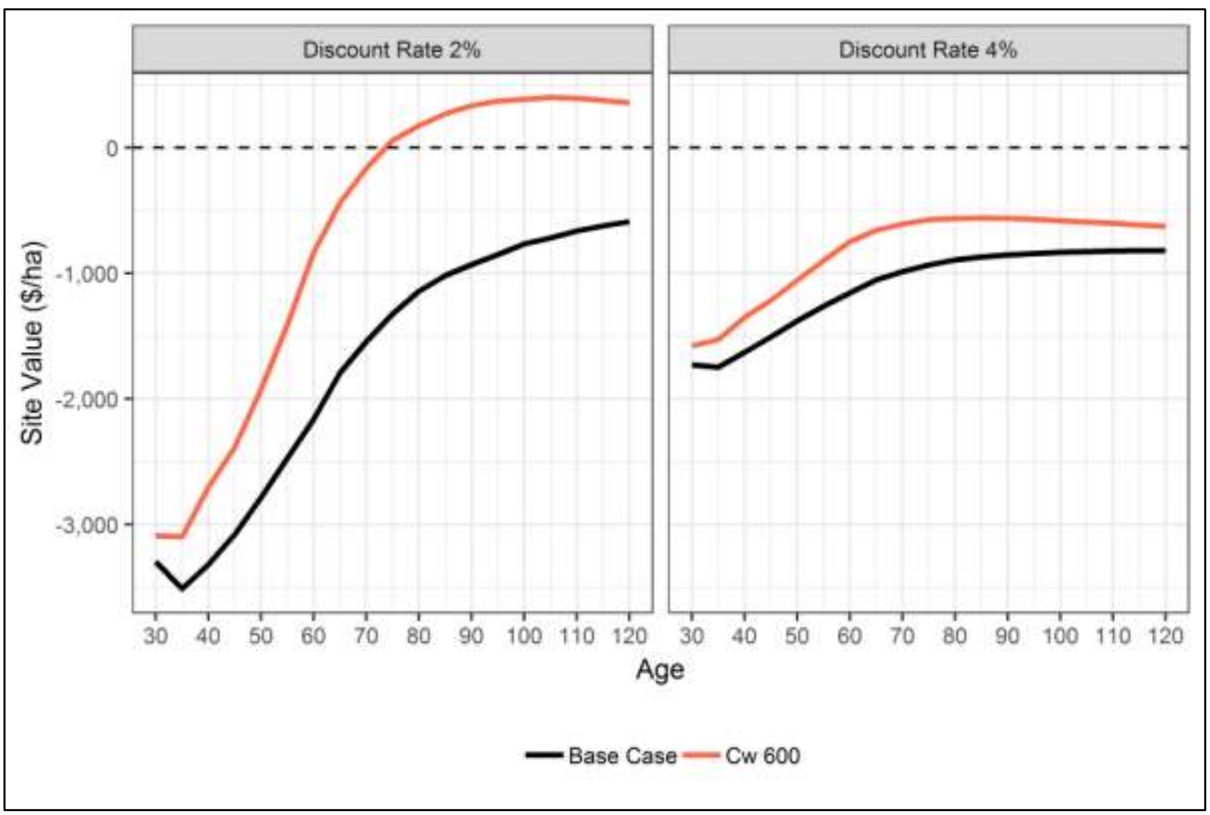

Figure 77: Site values for barge-ground sites in the CWHvm2 gentle cool planted

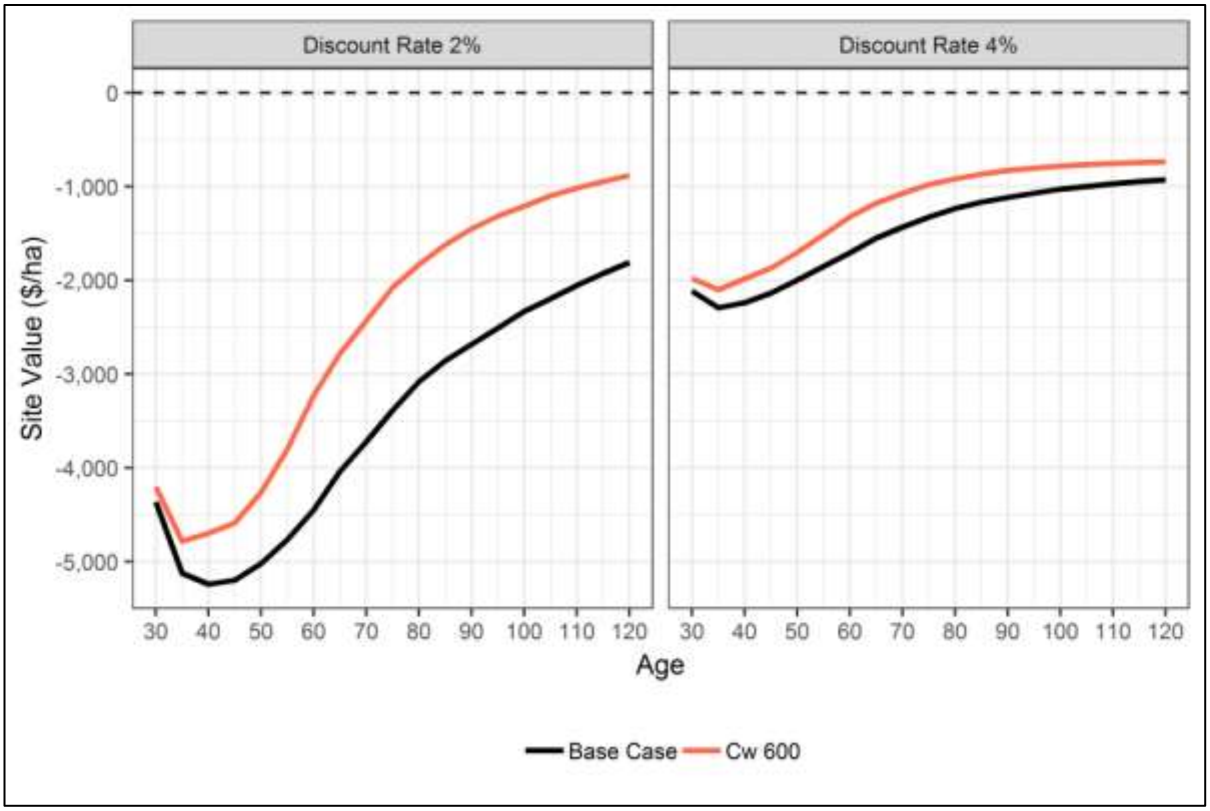

Figure 78: Site values for barge-cable sites in the CWHvm2 gentle cool planted

MHmm1/2, ESSF Gentle Cool Planted

Figure 79 shows the projected log volumes and values for the regimes developed for consideration:

- Base Case: planted 850sph of Cw/Yc/Ba with natural infill of 2,000sph of HwBa(Yc) with OAF2 of 5
- Yc regime planted at 600sph

As Figure 79 shows, the volume and value projections are similar for both regimes.

Figure 80 illustrates that at a 2% discount rate both regimes are viable on roaded sites with the Yc regime producing better results. At a 4% discount rate, the Yc regime is marginally viable, while the base case breaks even for rotations between 50 and 100 years.

Figure 81 shows similar trends on barge-ground harvest sites with lower returns for all situations. At a 4% discount rate, only the Yc regime break even for a limited period. On barge-cable harvest sites similar trends prevail with even lower returns (Figure 82); at a discount rate of 4%, both regimes are unviable.

Based on the analysis results, the Timber and Silviculture WG recommended the following portfolios to the Volume 2 and Value scenarios for this analysis unit:

- 60% Yc regime, 40% no treatment (base case)
- 70% Yc regime, 30% no treatment (base case)

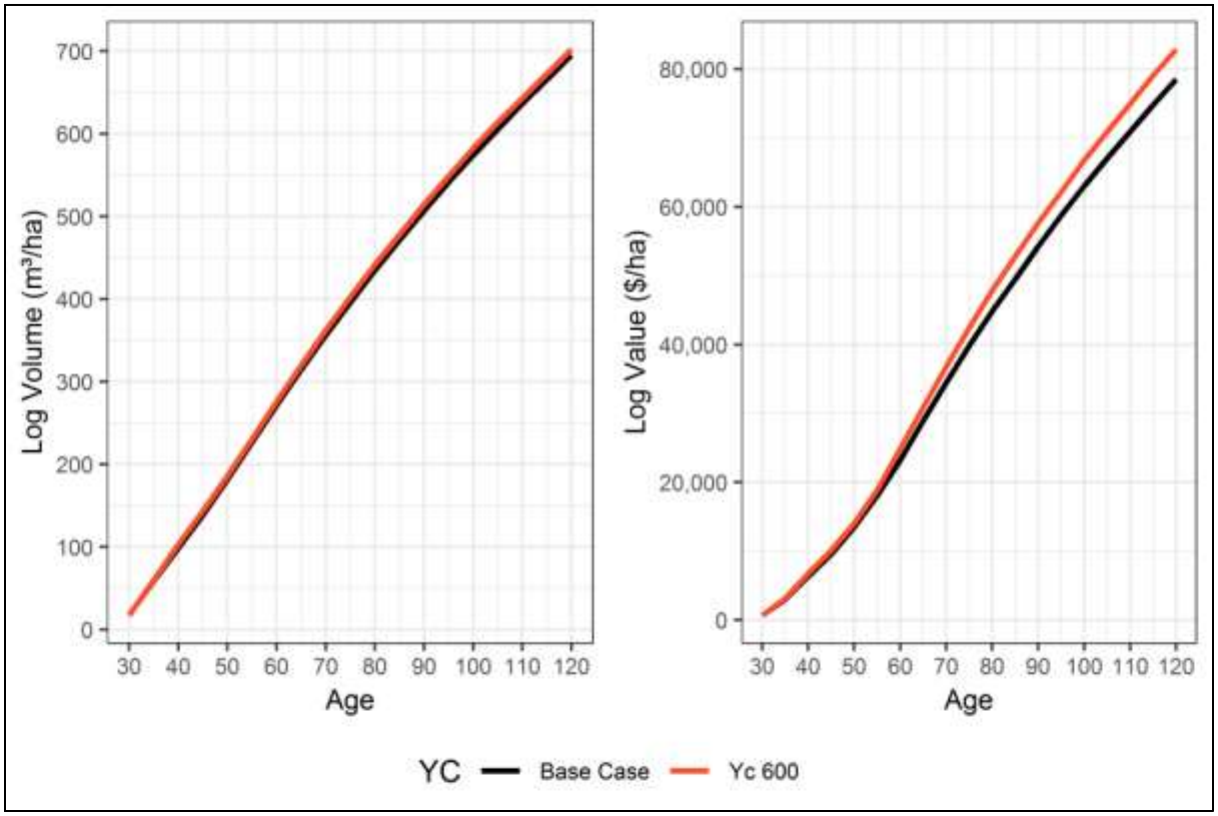

Figure 79: Log volumes and values for the MHmm1/2, ESSF gentle cool planted future

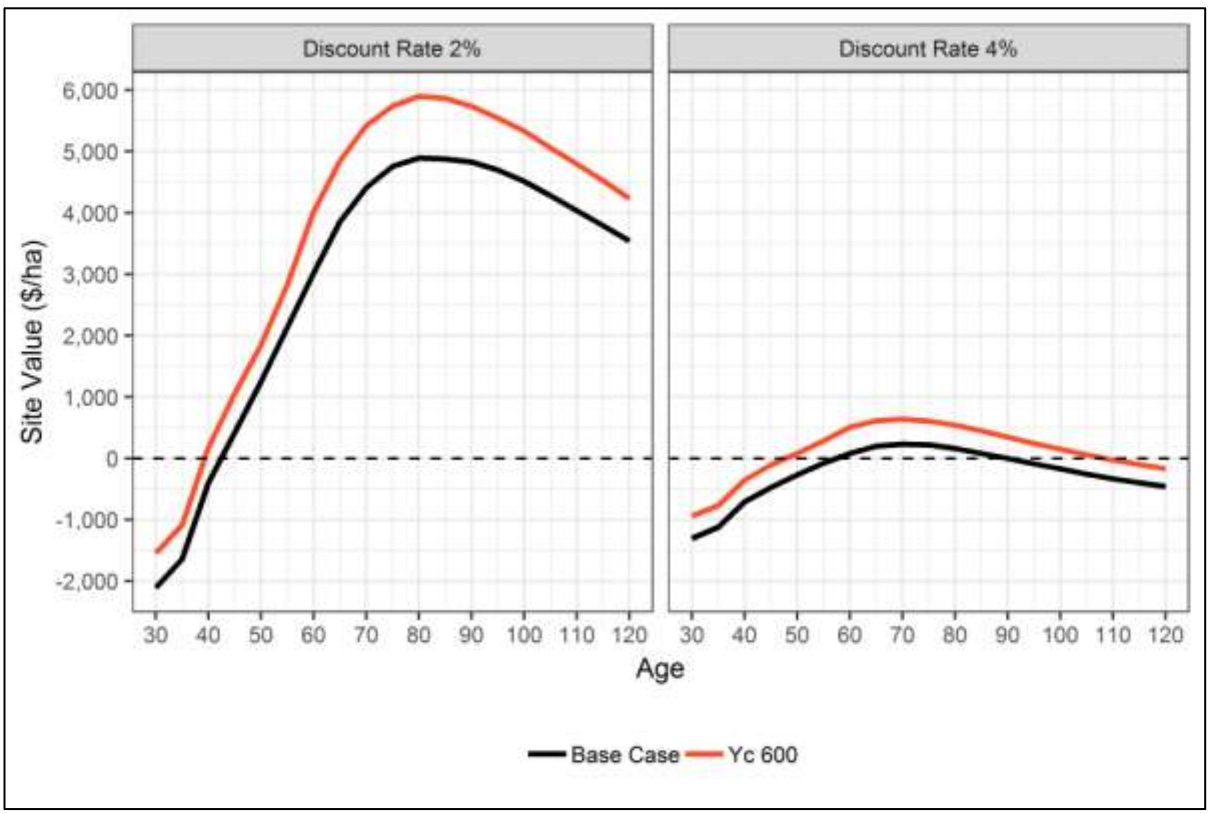

Figure 80: Site values for roaded sites for the MHmm1/2, ESSF gentle cool planted

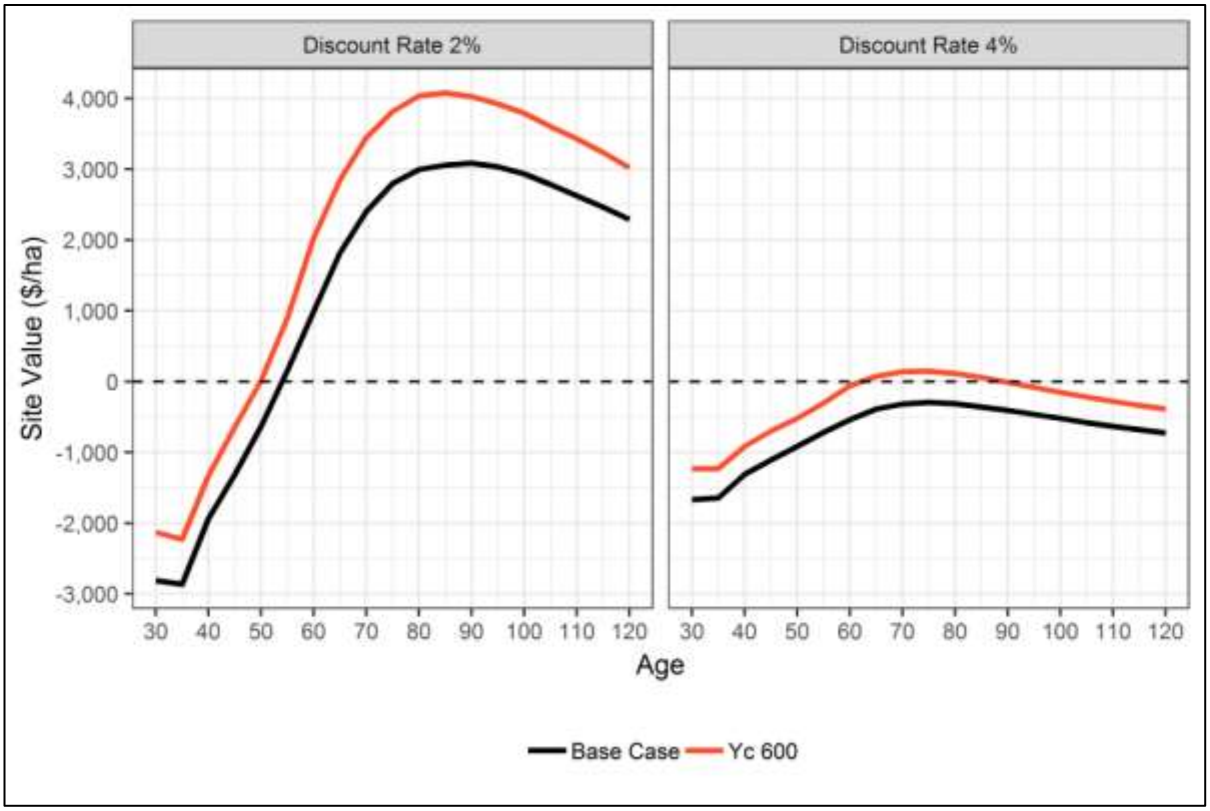

Figure 81: Site values for barge-ground sites for the MHmm1/2, ESSF gentle cool planted

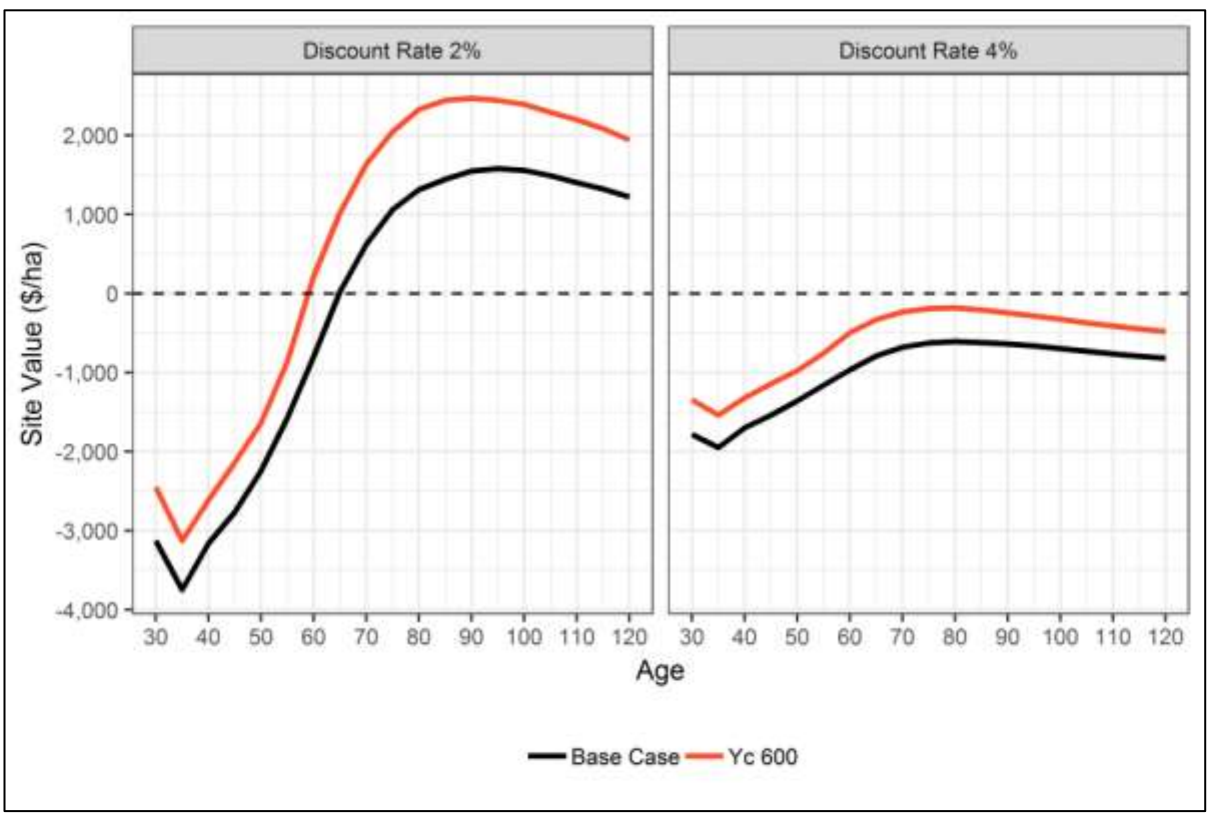

Figure 82: Site values for barge-cable sites for the MHmm1/2, ESSF gentle cool planted

MHmm1/2, ESSF Warm All

Figure 83 shows the projected log volumes and values for the regimes developed for consideration:

- Base Case: planted 850sph of Cw/Yc/Ba with natural infill of 2,000sph of HwBa(Yc) with OAF2 of 5
- Se regime planted at 600sph

Figure 83 shows that the predicted volume production for the Se regime is slightly lower than that for the base case over the entire simulation period. The base case is superior to the Se regime in creating value.

Figure 84 shows that at a 2% discount rate, the base case is superior, while the Se regime is only marginally viable on roaded sites. At a 4% discount rate, the base case is marginally viable between year 60 and year 90; the Se regime is not viable.

On barge-ground harvest sites only the base is viable at a 2% discount rate; neither is viable at 4% (Figure 85). The same applies to barge-cable harvest sites (Figure 86).

Based on the analysis results, the Timber and Silviculture WG recommended the following portfolios for the Volume 2 and Value scenarios for this analysis unit:

- 15% Se regime, 85% no treatment (base case)
- 100% no treatment (base case)

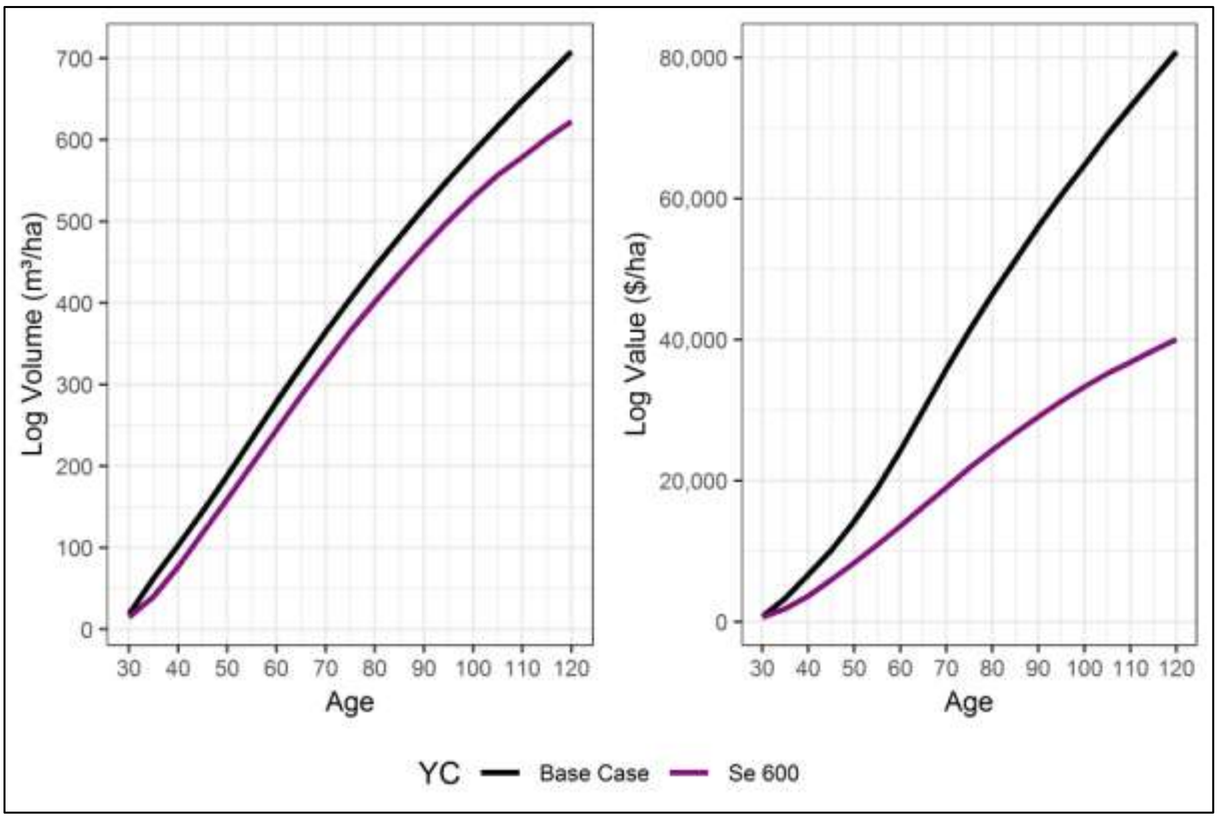

Figure 83: Log volumes and values for the MHmm1/2, ESSF warm future

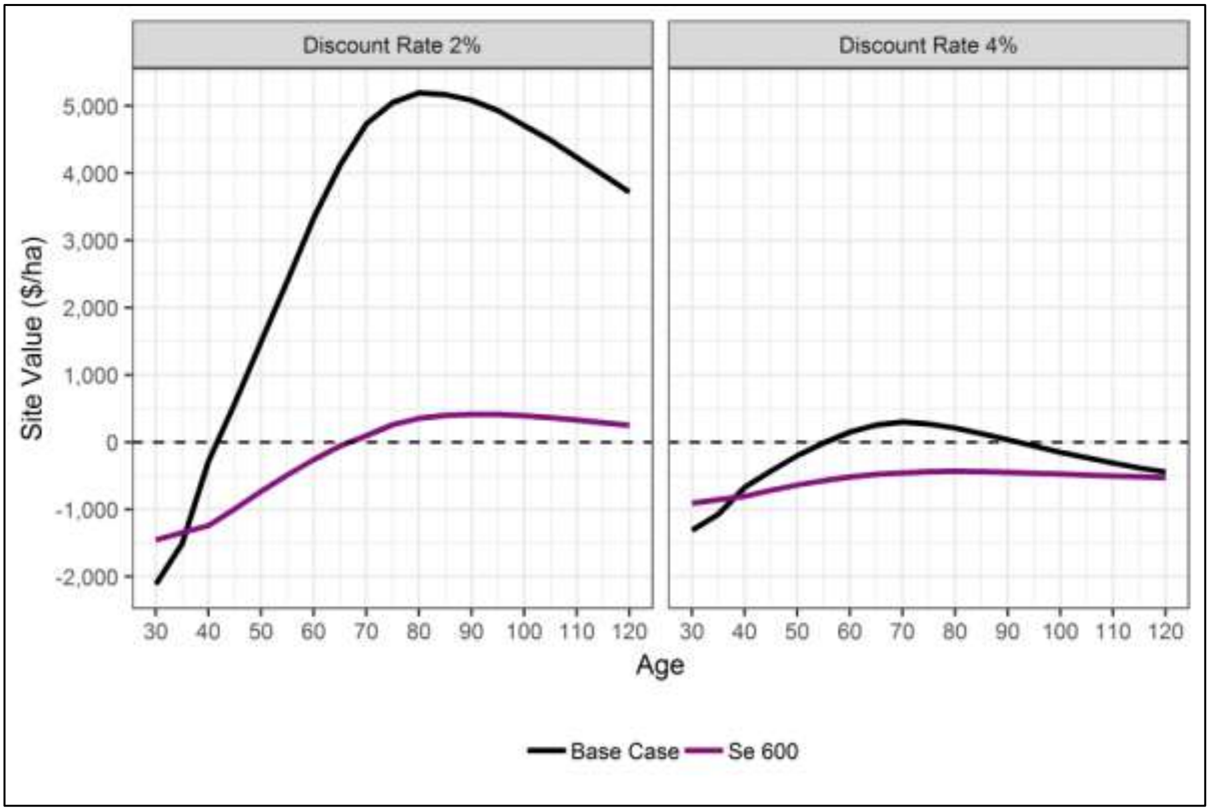

Figure 84: Site values for roaded sites for the MHmm1/2, ESSF warm

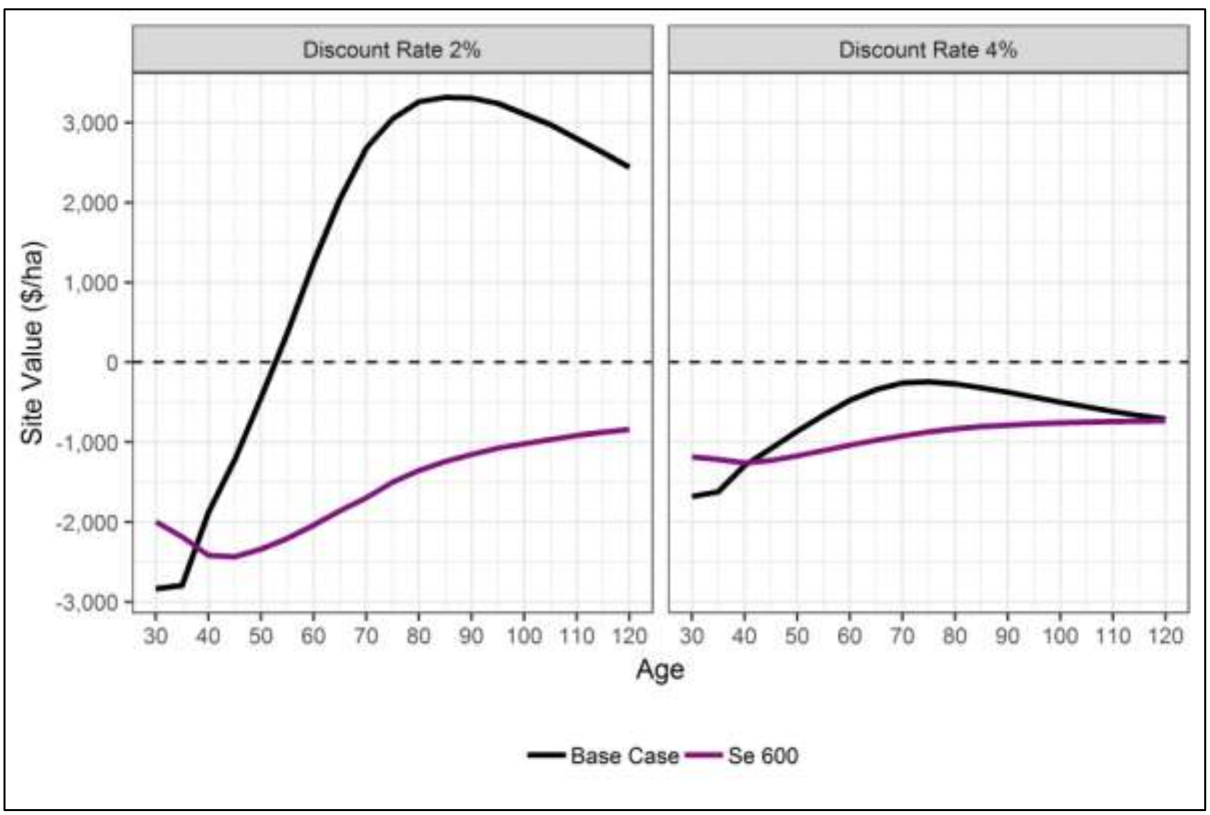

Figure 85: Site values for barge-ground sites for the MHmm1/2, ESSF warm

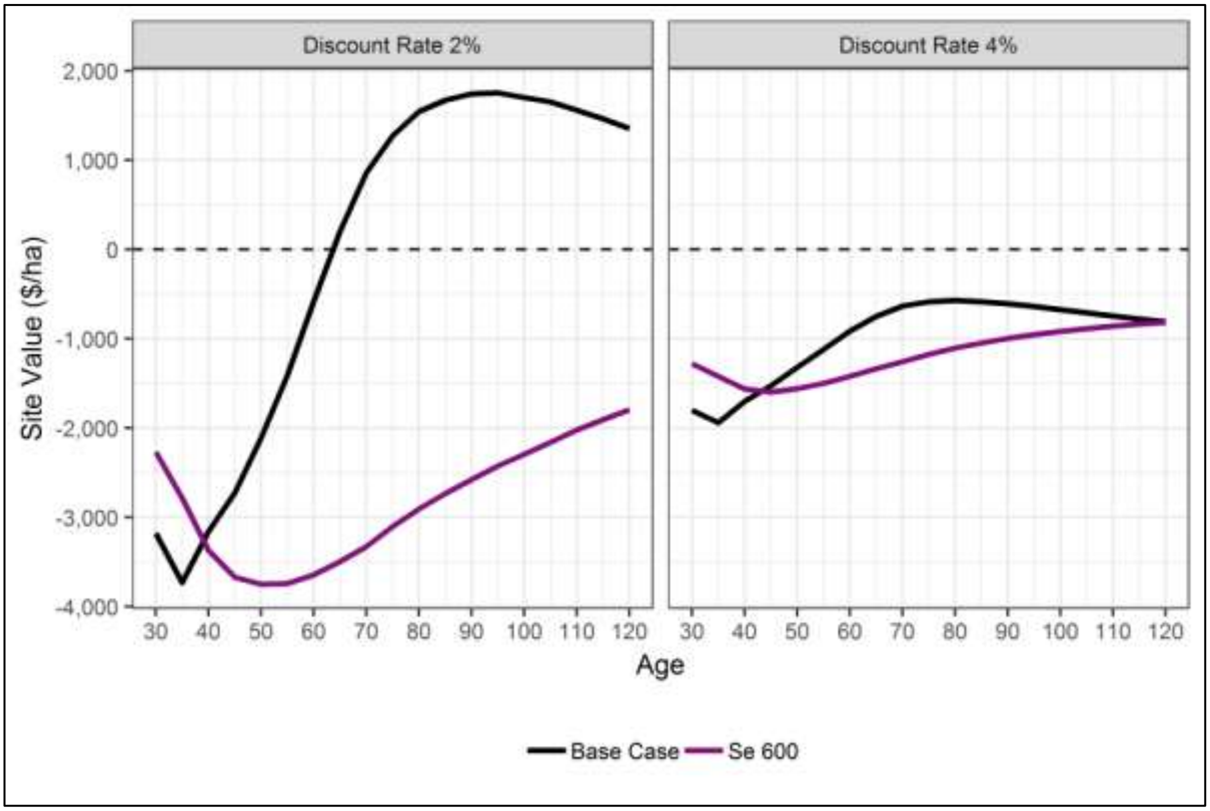

Figure 86: Site values for barge-cable sites for the MHmm1/2, ESSF warm

3.4.7 Forest Level Results; Volume Strategy 2, ISS Reference Forecast 1 Land Base

This section presents the results of Volume Strategy 2 for the Reference Forecast 1 land base. Woodshed targets were enforced for all Volume Strategy 2 and Value Strategy analyses. All comparisons were made against reference forecasts with elk and deer incorporated.

Figure 87 illustrates the volume impact; the long-term impact is +3.5%, while the mid-term impact between years 46 and 75 is +5.6%. There is no short -term impact; the small short-term changes shown in Figure 87 are caused by the resolution of the timber supply model.

Figure 88 illustrates the predicted growing stock development for this scenario, while Figure 89 shows the predicted harvest by species. The species distribution of harvest is not significantly different from the previously presented results, except for a subtle increase in the future harvest of Cw. The predicted harvest by age and by per ha volume class are not expected to be significantly different from the reference forecast (Forest Health and Elk incorporated) (Figure 90 and Figure 91).

The increase in the harvest volume forecast for Volume Strategy 2 compared to Reference Forecast 1 with Elk is attributable to different management 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.

Figure 92 and Figure 93 depict the total value and the value per ha of managed stands respectively. Both are predicted to be somewhat higher than those in the Reference Forecast 1 incorporating forest health.

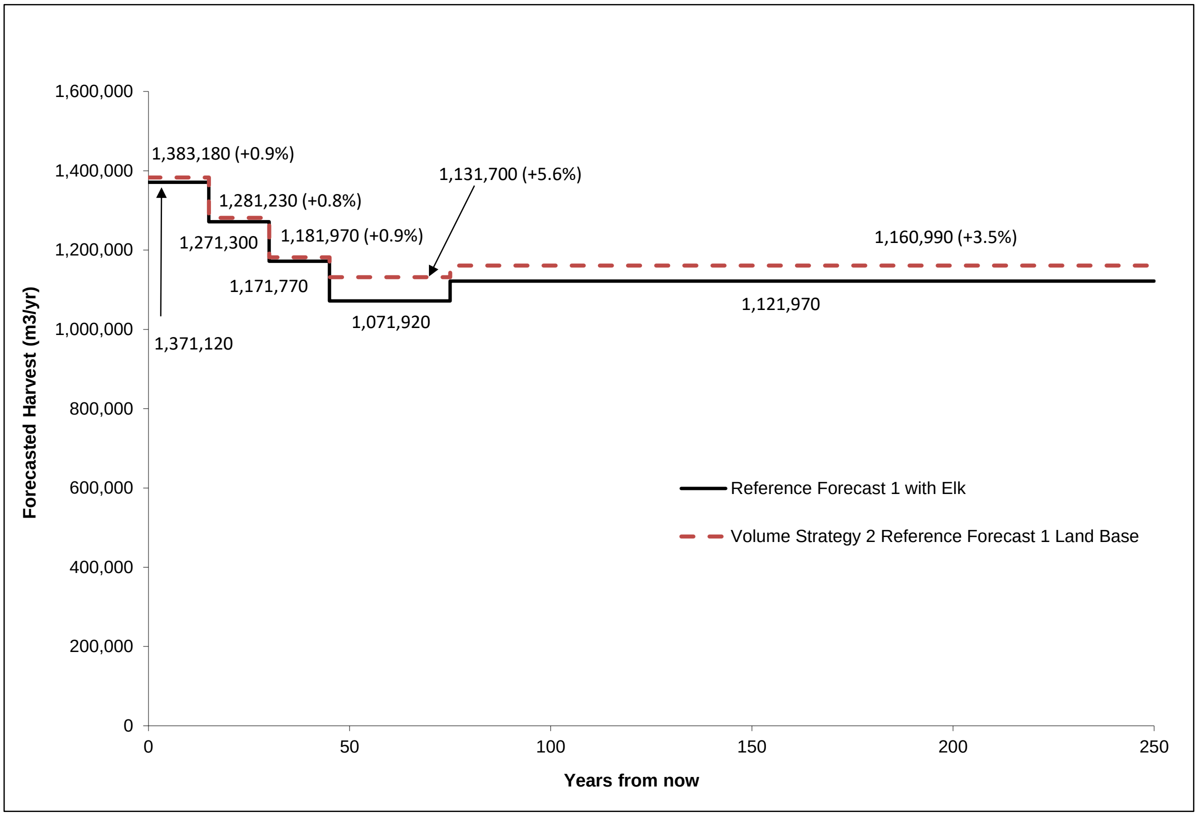

Figure 87: Volume strategy 2 Reference forecast 1 land base; harvest forecast

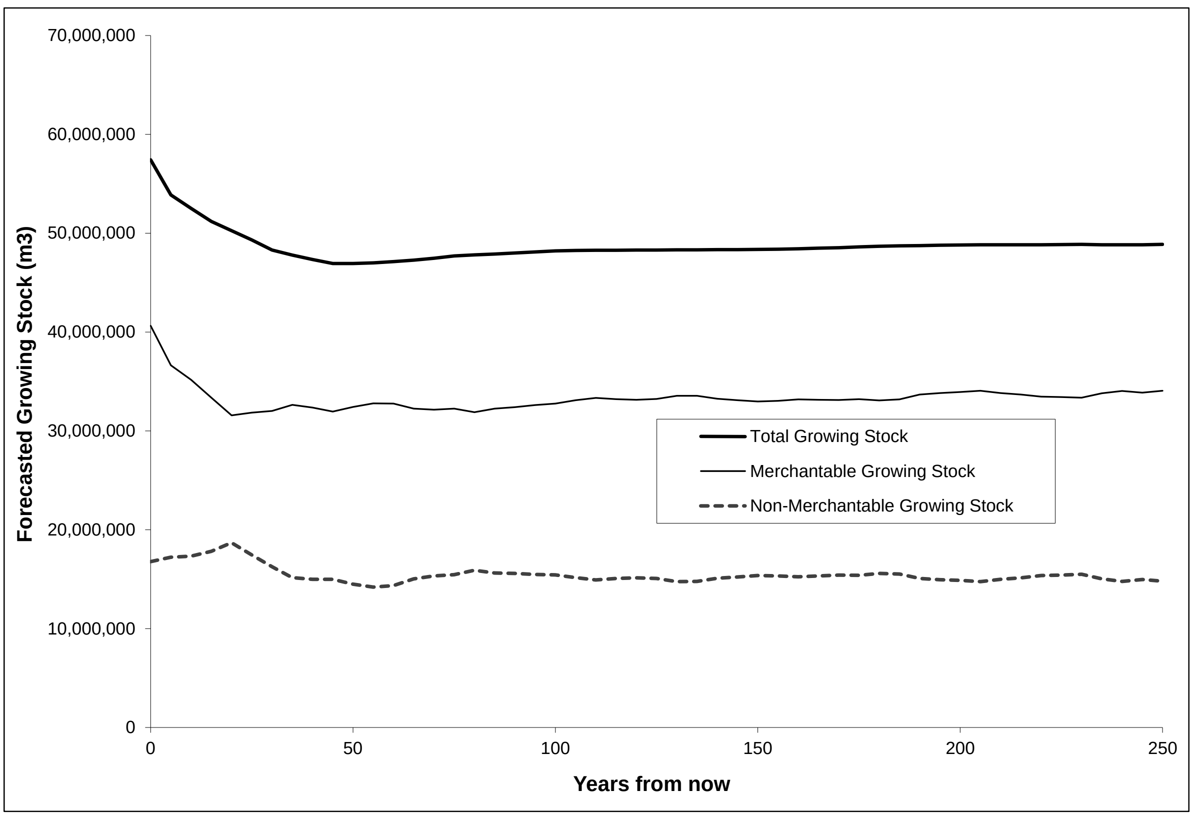

Figure 88: Volume strategy 2 Reference forecast 1 land base; predicted growing stock

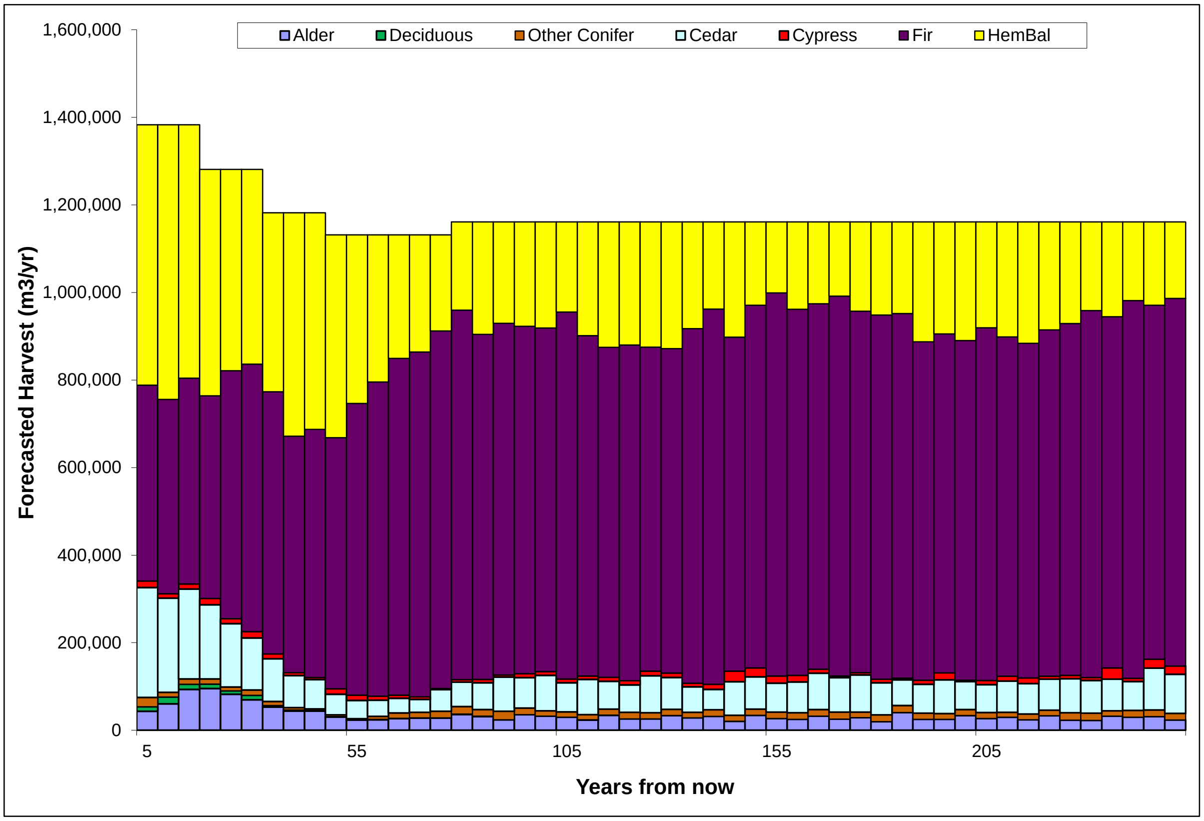

Figure 89: Volume strategy 2 Reference forecast 1 land base; harvest forecast by species

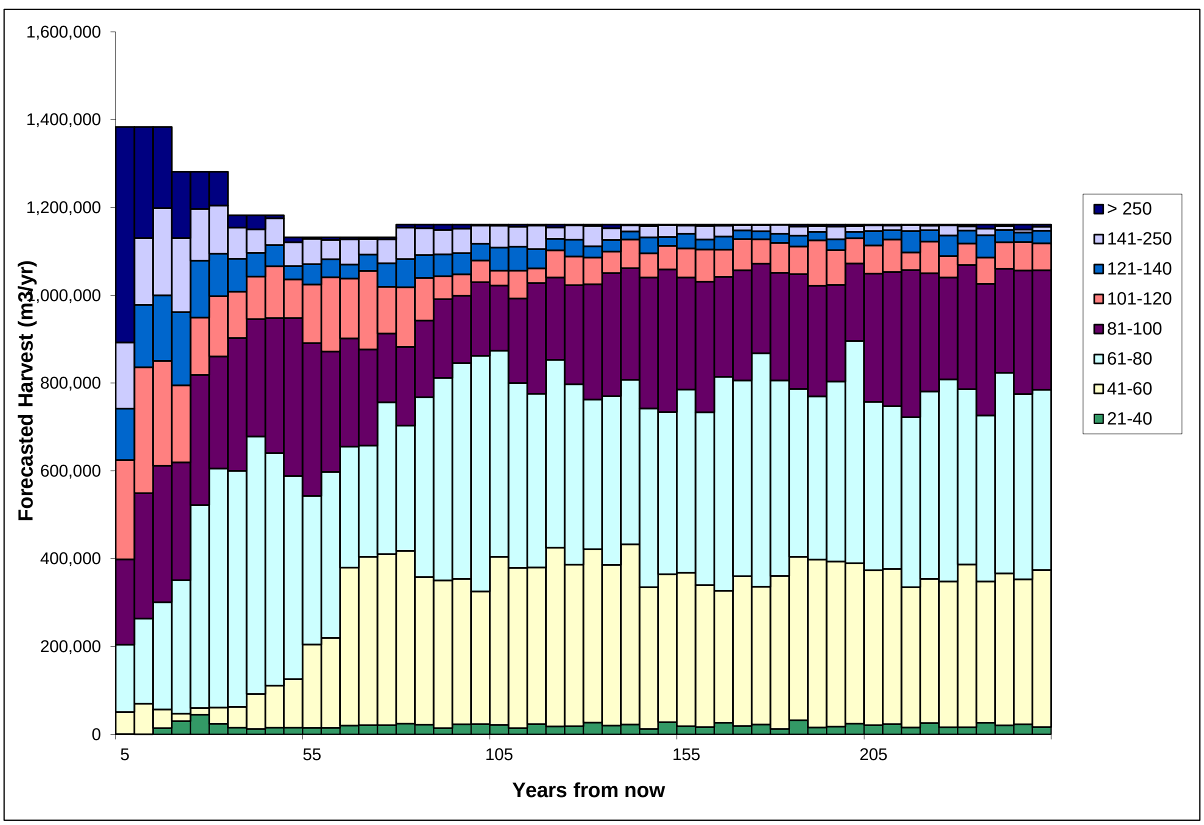

Figure 90: Volume strategy 2 Reference forecast 1 land base; harvest forecast by age class

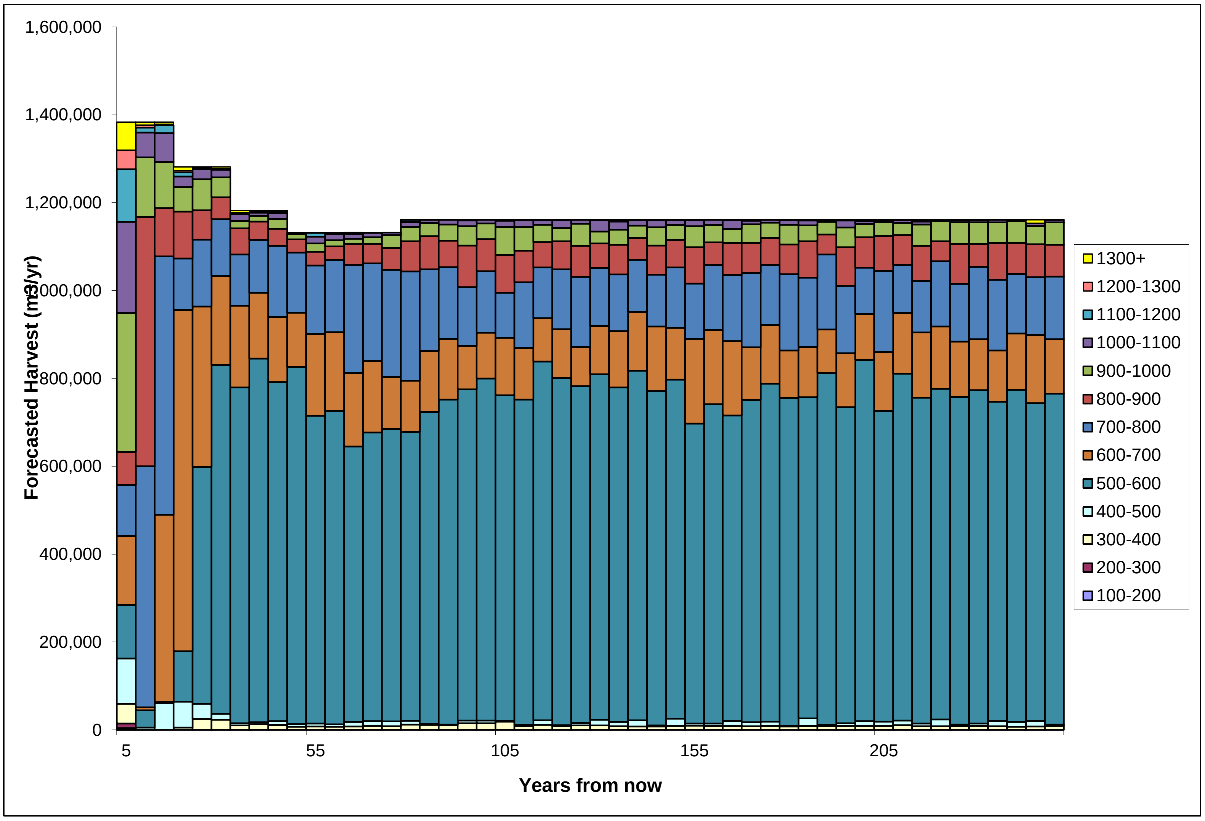

Figure 91: Volume strategy 2 Reference forecast 1 land base; harvest forecast by volume per ha class

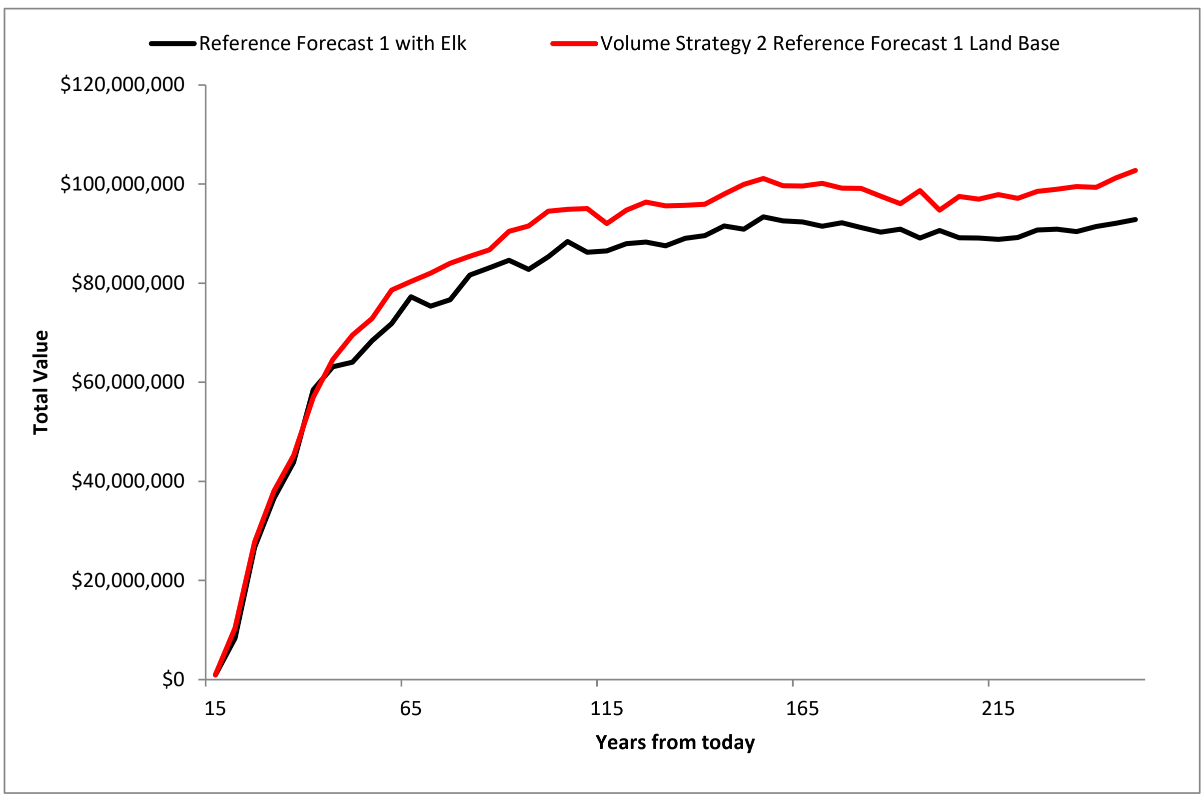

Figure 92: Volume strategy 2 Reference forecast 1 land base; total value, managed stands only

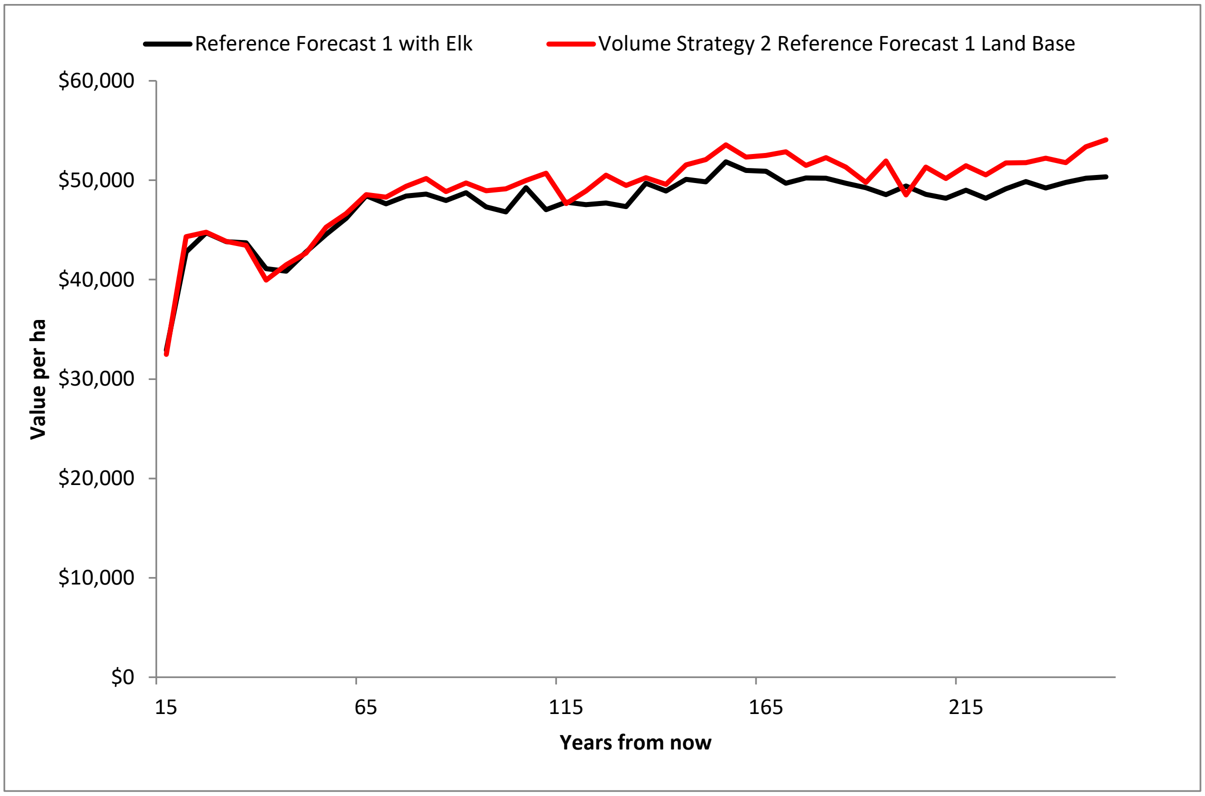

Figure 93: Volume strategy 2 Reference forecast 1 land base; value per ha, managed stands only

Table 11, Figure 94 and Figure 95 present the predicted fertilization areas and costs for this scenario. The areas and costs are separated by funding source and whether the fertilization is barge access only. FCI fertilization of natural stands and existing managed stands in the first 5 years of the planning horizon is predicted to account for 78% (1,176 ha) of the total annual fertilization area of 1,604 ha. The annual cost of fertilization for the next five years is predicted at $978,298 per year. After the first five years fertilization costs remain below $200,000 annually until year 45, when the area and the cost of fertilization is predicted to increase substantially. The fertilization costs are expected to fluctuate between $275,000 and $450,000 between years 46 and 100.

Table 11: Volume strategy 2 Reference forecast 1 land base; fertilization areas and costs

Year	Area (ha)				Costs ($)			
	FCI (Barge)	Barge	Non-Barge	Total	FCI (Barge)	Barge	Non-Barge	Total
5	1,176	0	427	1,604	$764,660	$0	$213,638	$978,298
10	0	0	349	349	$0	$0	$174,745	$174,745
15	0	0	436	436	$0	$0	$217,914	$217,914
20	0	0	375	375	$0	$0	$187,392	$187,392
25	0	0	275	275	$0	$0	$137,298	$137,298
30	0	0	244	244	$0	$0	$122,176	$122,176
35	0	87	246	333	$0	$56,342	$123,152	$179,493
40	0	67	227	293	$0	$43,295	$113,275	$156,570
45	0	228	307	535	$0	$147,972	$153,564	$301,536
50	0	216	268	484	$0	$140,514	$134,146	$274,661
55	0	249	235	484	$0	$161,834	$117,685	$279,520

Year	Area (ha)				Costs ($)			
	FCI (Barge)	Barge	Non-Barge	Total	FCI (Barge)	Barge	Non-Barge	Total
60	0	278	277	555	$0	$180,704	$138,501	$319,205
65	0	332	237	569	$0	$215,836	$118,492	$334,328
70	0	329	256	585	$0	$214,009	$128,064	$342,073
75	0	303	316	619	$0	$196,725	$158,149	$354,874
80	0	289	333	622	$0	$187,776	$166,493	$354,269
85	0	391	404	796	$0	$254,445	$202,164	$456,609
90	0	394	384	778	$0	$256,055	$192,063	$448,118
95	0	414	394	808	$0	$269,094	$197,246	$466,340
100	0	429	344	773	$0	$279,043	$171,817	$450,860

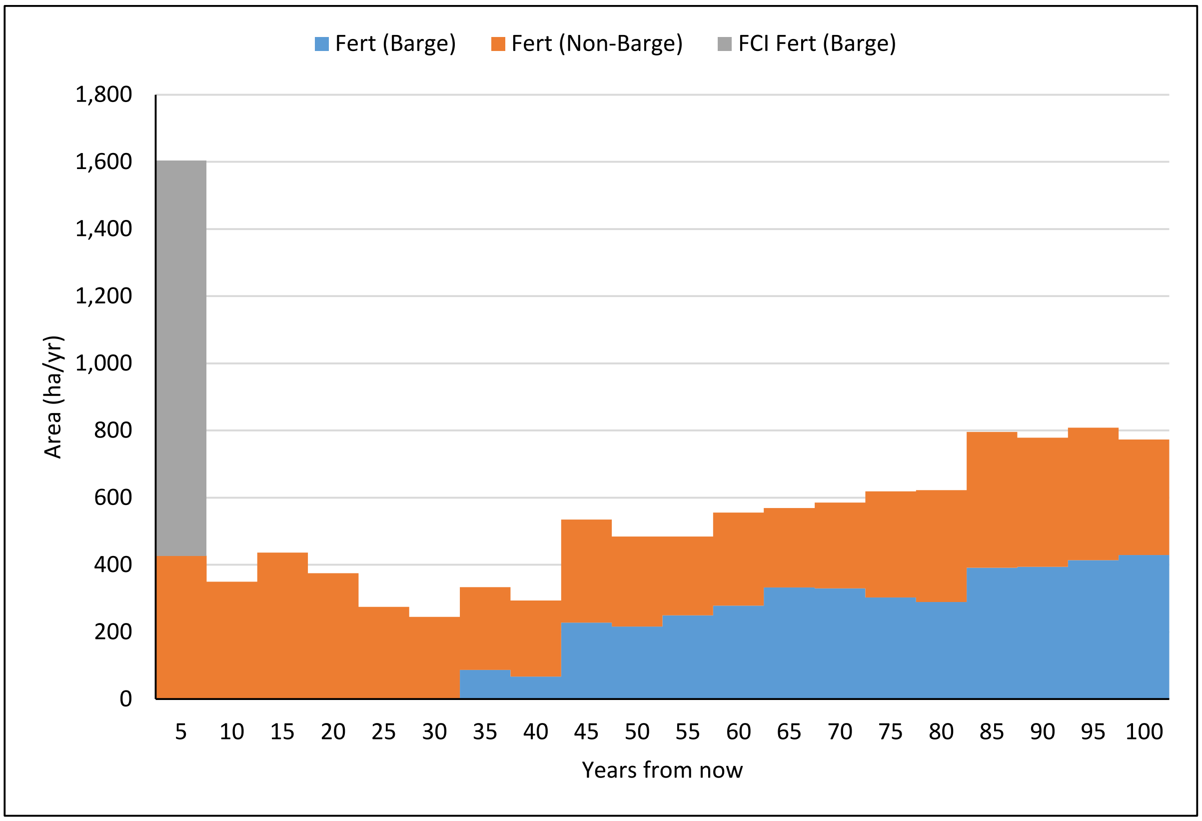

Figure 94: Volume strategy 2, Reference Forecast 1 land base; annual fertilization area

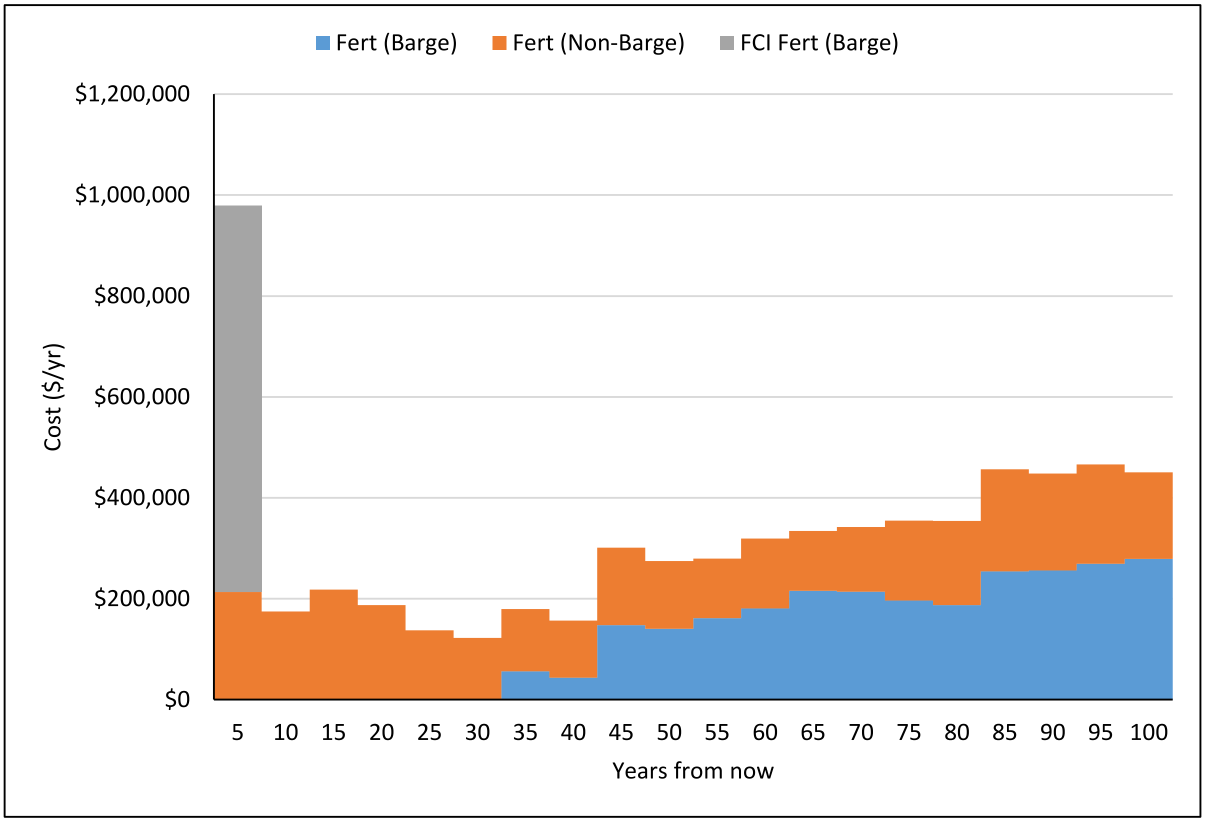

Figure 95: Volume strategy 2, Reference Forecast 1 land base; annual fertilization costs

Table 12 shows the predicted annual enhanced planting areas and areas where reduced planting densities are recommended. Table 13 presents the related costs and costs savings. Figure 96 illustrates the predicted net costs accounting for increased planting densities as well as reduced planting densities.

Table 12: Volume strategy 2 Reference forecast 1 land base; enhanced and reduced planting areas

Year	Enhanced Planting			Reduced Planting		
	Non-Barge	Barge	Total	Non-Barge	Barge	Total
5	80	120	200	7	137	144
10	57	100	157	10	82	92
15	71	114	185	23	120	143
20	69	129	197	28	123	151
25	62	100	161	30	133	163
30	58	131	189	34	130	163
35	53	128	181	41	140	181
40	68	122	190	18	226	244
45	61	117	177	21	193	214
50	52	124	176	20	162	182
55	94	187	281	33	108	141
60	84	184	269	17	127	144
65	69	161	230	27	86	112

Year	Enhanced Planting			Reduced Planting		
	Non-Barge	Barge	Total	Non-Barge	Barge	Total
70	68	187	255	19	73	93
75	62	108	169	14	76	90
80	49	157	205	7	64	71
85	61	195	256	17	128	145
90	63	164	228	19	89	108
95	71	139	210	14	103	117
100	75	140	215	32	111	144

Table 13: Volume strategy 2 Reference forecast 1 land base; enhanced and reduced planting costs

Year	Enhanced Planting (costs)			Reduced Planting (savings)			Enhanced Planting Total
	Non-Barge	Barge	Total	Non-Barge	Barge	Total	
5	$34,520	$71,542	$106,062	-$1,080	-$20,541	-$21,621	$84,441
10	$27,012	$63,403	$90,415	-$1,020	-$12,453	-$13,472	$76,943
15	$31,667	$72,252	$103,919	-$2,287	-$19,967	-$22,253	$81,666
20	$29,443	$75,137	$104,581	-$2,994	-$19,998	-$22,992	$81,589
25	$27,922	$54,770	$82,692	-$3,117	-$18,011	-$21,128	$61,564
30	$24,644	$78,246	$102,891	-$3,492	-$18,989	-$22,482	$80,409
35	$21,819	$80,131	$101,950	-$4,491	-$18,327	-$22,818	$79,132
40	$28,678	$79,759	$108,436	-$1,818	-$29,831	-$31,649	$76,787
45	$25,704	$80,023	$105,727	-$2,457	-$26,129	-$28,586	$77,141
50	$23,280	$79,754	$103,034	-$2,448	-$26,233	-$28,681	$74,353
55	$42,337	$122,085	$164,422	-$3,553	-$19,460	-$23,014	$141,409
60	$40,748	$123,264	$164,011	-$1,902	-$22,332	-$24,234	$139,777
65	$31,514	$104,543	$136,056	-$3,485	-$13,421	-$16,906	$119,150
70	$32,169	$122,464	$154,633	-$2,183	-$13,094	-$15,278	$139,355
75	$26,587	$67,553	$94,140	-$1,449	-$11,263	-$12,712	$81,429
80	$21,341	$94,836	$116,177	-$1,328	-$10,219	-$11,547	$104,630
85	$25,705	$135,669	$161,374	-$1,867	-$18,025	-$19,892	$141,482
90	$28,372	$109,471	$137,842	-$2,097	-$12,664	-$14,761	$123,081
95	$31,425	$82,409	$113,833	-$1,506	-$15,289	-$16,795	$97,038
100	$31,523	$89,583	$121,105	-$3,263	-$15,857	-$19,120	$101,985

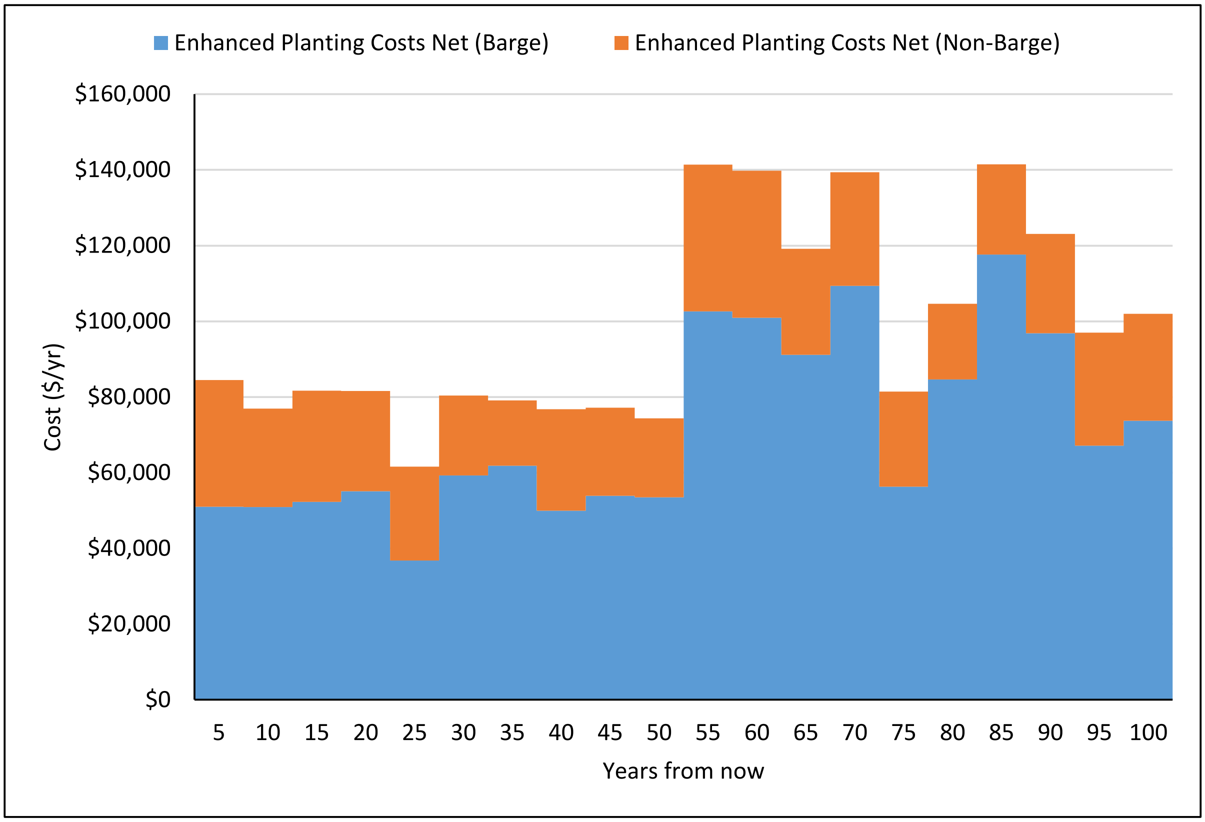

Figure 96: Volume strategy 2 Reference forecast 1 land base enhance planting costs (net)

Table 14 and Table 15 present the predicted annual treatment areas and costs for stumping and CW brushing, while Table 17 shows the predicted annual costs for incremental reforestation (enhanced planting, stumping and CW brushing). The same can be seen in Figure 97.

The total incremental silviculture costs are presented in Figure 98.

Table 14: Volume strategy 2 Reference forecast 1 land base; stumping areas and costs

Year	Stumping Area (ha)			Stumping Costs ($)		
	Non-Barge	Barge	Total	Non-Barge	Barge	Total
5	38	29	67	$28,727	$28,150	$56,877
10	20	16	36	$14,943	$15,653	$30,596
15	22	30	52	$16,610	$29,050	$45,660
20	18	42	60	$13,419	$41,073	$54,492
25	15	38	54	$11,389	$37,521	$48,910
30	18	44	62	$13,319	$43,375	$56,693
35	17	28	46	$12,953	$27,787	$40,740
40	18	15	33	$13,823	$14,202	$28,025
45	19	26	45	$14,489	$25,476	$39,965
50	13	33	46	$9,484	$32,106	$41,590
55	35	51	86	$26,162	$49,948	$76,110

Year	Stumping Area (ha)			Stumping Costs ($)		
	Non-Barge	Barge	Total	Non-Barge	Barge	Total
60	24	50	73	$17,718	$48,489	$66,207
65	29	41	70	$21,649	$40,087	$61,736
70	32	54	87	$24,356	$52,897	$77,252
75	14	39	53	$10,687	$38,150	$48,838
80	16	53	69	$11,643	$51,801	$63,444
85	16	35	51	$12,121	$33,700	$45,822
90	15	33	47	$11,026	$31,803	$42,829
95	26	24	50	$19,658	$23,677	$43,335
100	19	34	52	$14,160	$32,769	$46,929

Table 15: Volume strategy 2 Reference forecast 1 land base, CW brushing areas and costs

Year	CW Brushing Area (ha)			CW Brushing Costs ($)		
	Non-Barge	Barge	Total	Non-Barge	Barge)	Total
5	16	29	45	$8,837	$18,994	$27,831
10	8	18	26	$4,186	$12,184	$16,369
15	14	20	34	$7,761	$12,963	$20,724
20	13	27	40	$7,355	$17,540	$24,895
25	16	16	32	$8,693	$10,888	$19,581
30	15	22	38	$8,487	$14,671	$23,158
35	17	12	30	$9,492	$8,108	$17,600
40	18	18	36	$9,908	$11,709	$21,617
45	11	21	32	$6,124	$13,647	$19,772
50	8	30	38	$4,625	$19,576	$24,201
55	14	25	39	$7,816	$16,244	$24,060
60	2	37	39	$1,250	$24,273	$25,523
65	8	23	31	$4,430	$15,167	$19,597
70	1	23	24	$414	$15,028	$15,442
75	16	16	31	$8,762	$10,268	$19,029
80	8	31	39	$4,611	$20,478	$25,089
85	14	53	67	$7,733	$35,161	$42,894
90	13	25	38	$7,207	$16,385	$23,593
95	11	27	37	$5,817	$17,528	$23,346
100	18	22	40	$9,941	$14,597	$24,538

Table 16: Volume strategy 2 Reference forecast 1 land base; incremental reforestation costs

Year	Incremental Reforestation Costs ($)			
	Enhanced Planting	Stumping	CW Brushing	Total
5	$84,441	$56,877	$27,831	$169,148
10	$76,943	$30,596	$16,369	$123,908
15	$81,666	$45,660	$20,724	$148,050
20	$81,589	$54,492	$24,895	$160,976
25	$61,564	$48,910	$19,581	$130,056
30	$80,409	$56,693	$23,158	$160,260
35	$79,132	$40,740	$17,600	$137,472
40	$76,787	$28,025	$21,617	$126,429
45	$77,141	$39,965	$19,772	$136,878
50	$74,353	$41,590	$24,201	$140,144
55	$141,409	$76,110	$24,060	$241,579
60	$139,777	$66,207	$25,523	$231,507
65	$119,150	$61,736	$19,597	$200,483
70	$139,355	$77,252	$15,442	$232,050
75	$81,429	$48,838	$19,029	$149,295
80	$104,630	$63,444	$25,089	$193,162
85	$141,482	$45,822	$42,894	$230,197
90	$123,081	$42,829	$23,593	$189,504
95	$97,038	$43,335	$23,346	$163,719
100	$101,985	$46,929	$24,538	$173,452

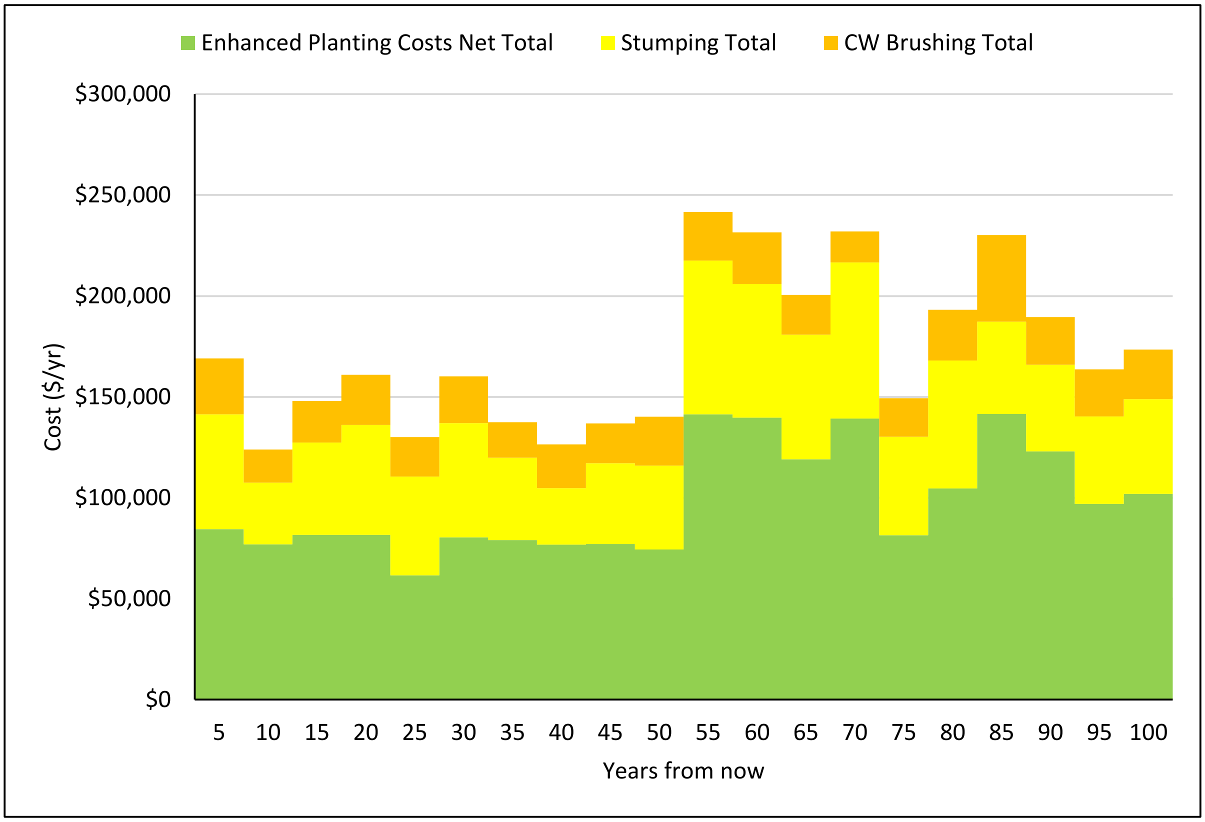

Figure 97: Volume strategy 2 Reference forecast 1 land base; incremental reforestation costs

Table 17: Volume strategy 2 Reference forecast 1 land base; incremental silviculture costs

Year	Incremental Silviculture Costs ($)				
	Fertilization	Enhanced Planting	Stumping	CW Brushing	Total
5	$978,298	$84,441	$56,877	$27,831	$1,147,446
10	$174,745	$76,943	$30,596	$16,369	$298,653
15	$217,914	$81,666	$45,660	$20,724	$365,964
20	$187,392	$81,589	$54,492	$24,895	$348,369
25	$137,298	$61,564	$48,910	$19,581	$267,354
30	$122,176	$80,409	$56,693	$23,158	$282,437
35	$179,493	$79,132	$40,740	$17,600	$316,966
40	$156,570	$76,787	$28,025	$21,617	$282,999
45	$301,536	$77,141	$39,965	$19,772	$438,414
50	$274,661	$74,353	$41,590	$24,201	$414,804
55	$279,520	$141,409	$76,110	$24,060	$521,099
60	$319,205	$139,777	$66,207	$25,523	$550,712
65	$334,328	$119,150	$61,736	$19,597	$534,811
70	$342,073	$139,355	$77,252	$15,442	$574,124
75	$354,874	$81,429	$48,838	$19,029	$504,170
80	$354,269	$104,630	$63,444	$25,089	$547,431

Year	Incremental Silviculture Costs ($)				
	Fertilization	Enhanced Planting	Stumping	CW Brushing	Total
85	$456,609	$141,482	$45,822	$42,894	$686,806
90	$448,118	$123,081	$42,829	$23,593	$637,622
95	$466,340	$97,038	$43,335	$23,346	$630,059
100	$450,860	$101,985	$46,929	$24,538	$624,312

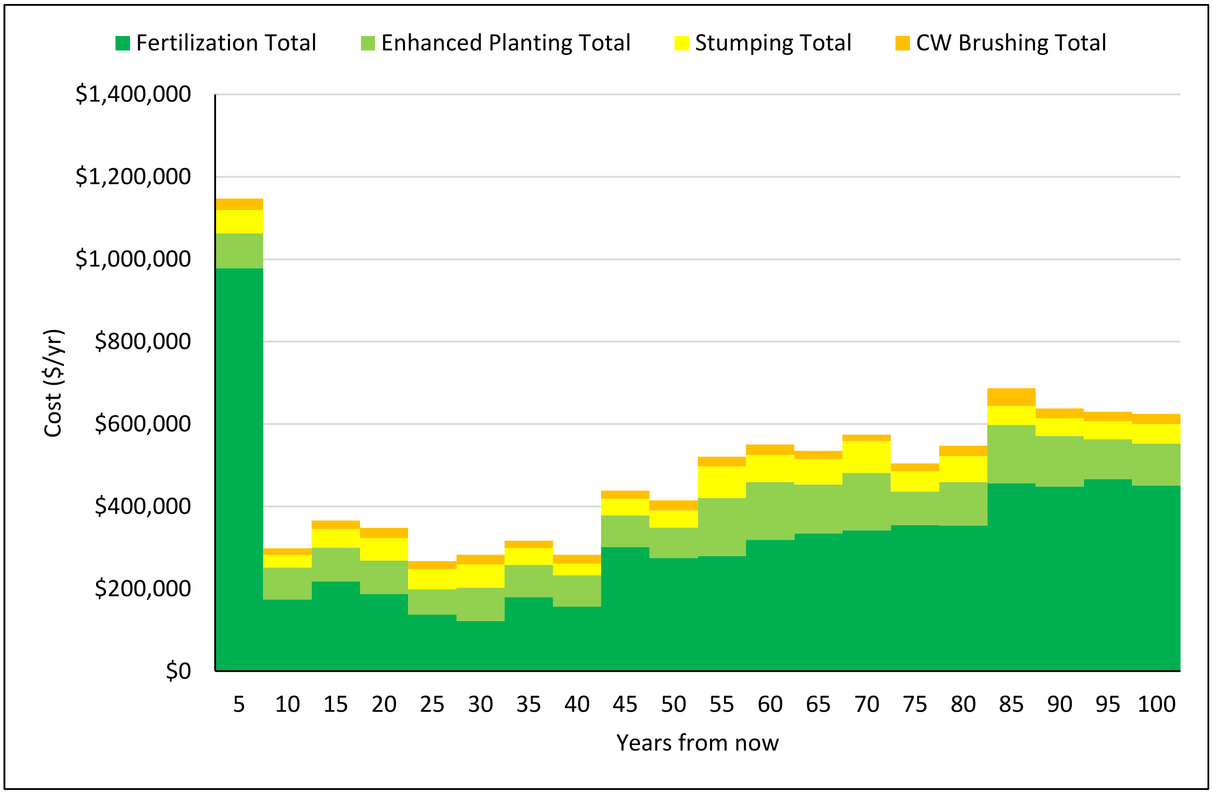

Figure 98: Volume strategy 2 Reference forecast 1 land base; incremental silviculture costs

3.4.8 Forest Level Results; Volume Strategy 2, ISS Reference Forecast 2 Land Base

This section presents the Volume Strategy 2 results for the Reference Forecast 2 land base. Figure 99 illustrates the volume impact of this strategy. The long-term harvest level is +4.0% higher than that of the Reference Forecast 2 with Elk, while the mid-term harvest forecast between years 46 and 75 is +9.5% higher. There is no short -term impact.

Figure 100 illustrates the predicted growing stock development for this scenario, while Figure 101 shows the predicted harvest by species. As with the Reference Forecast 2 land base, there is a subtle increase in the future harvest of Cw. The predicted harvest by age and by per ha volume class are not expected to be significantly different from the reference forecast (Forest Health and Elk incorporated) (Figure 102 and Figure 103).

The increase in the harvest volume forecast for Volume Strategy 2 compared to Reference Forecast 2 with Elk is attributable to different management 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.

Figure 104 and Figure 105 illustrate the predicted total value and the predicted value per ha of managed stands over time. While the total value of managed stands is predicted to increase in this scenario, the value per ha is not. The additional THLB in this forecast receives no incremental silviculture treatments, which dilutes the per ha value response.

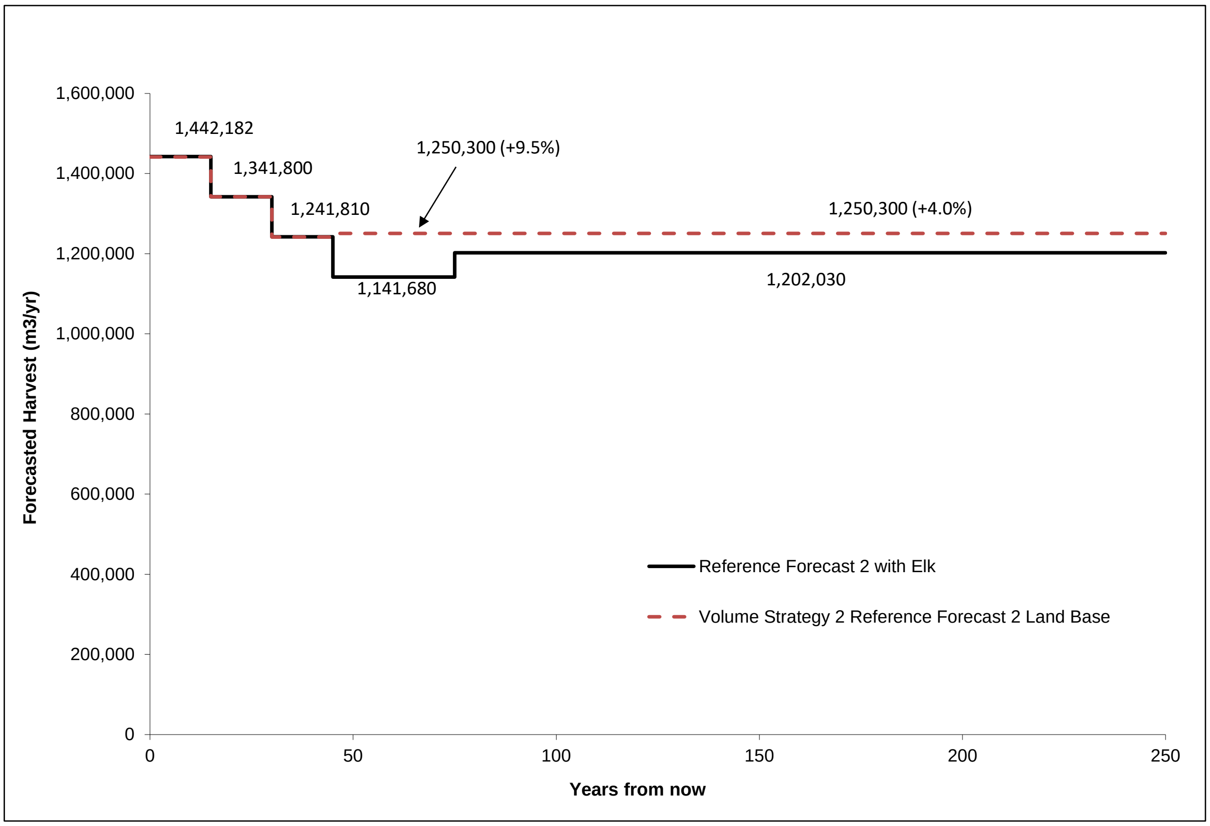

Figure 99: Volume strategy 2 Reference forecast 2 land base; harvest forecast

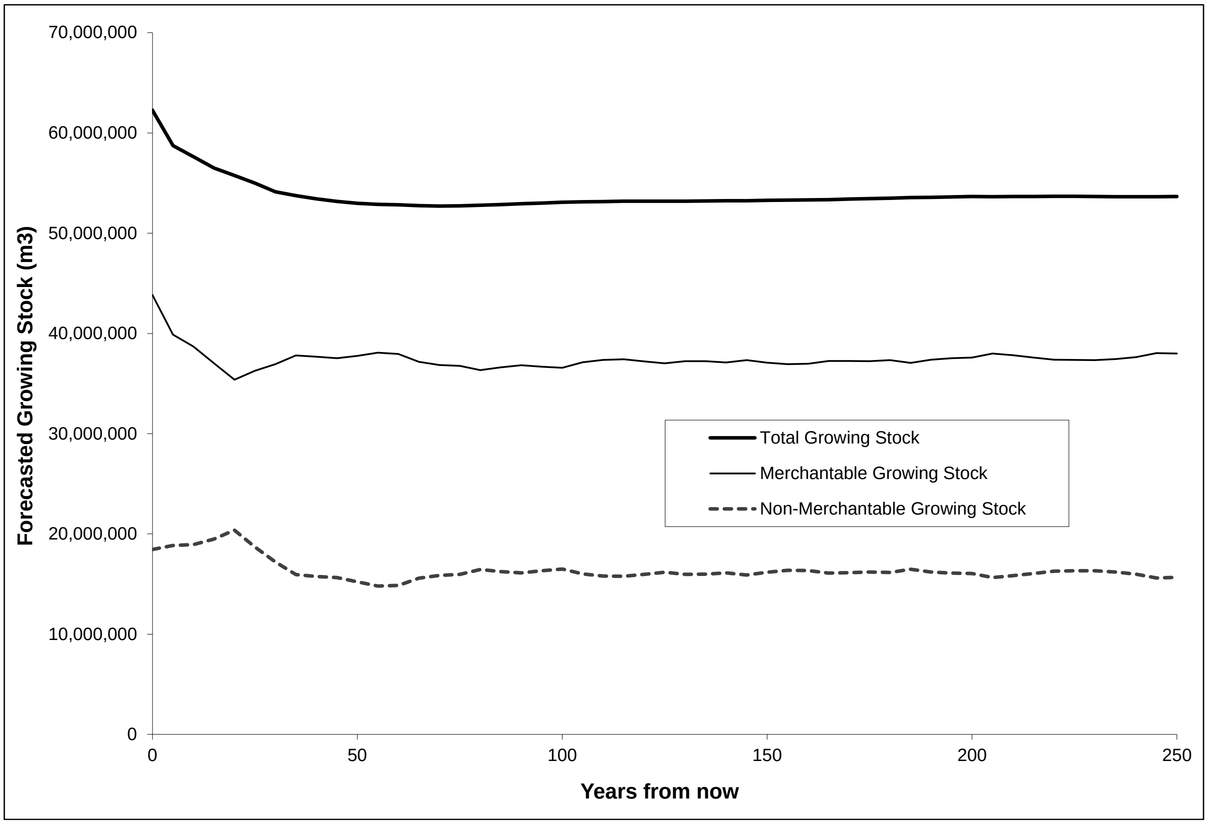

Figure 100: Volume strategy 2 Reference forecast 2 land base; predicted growing stock

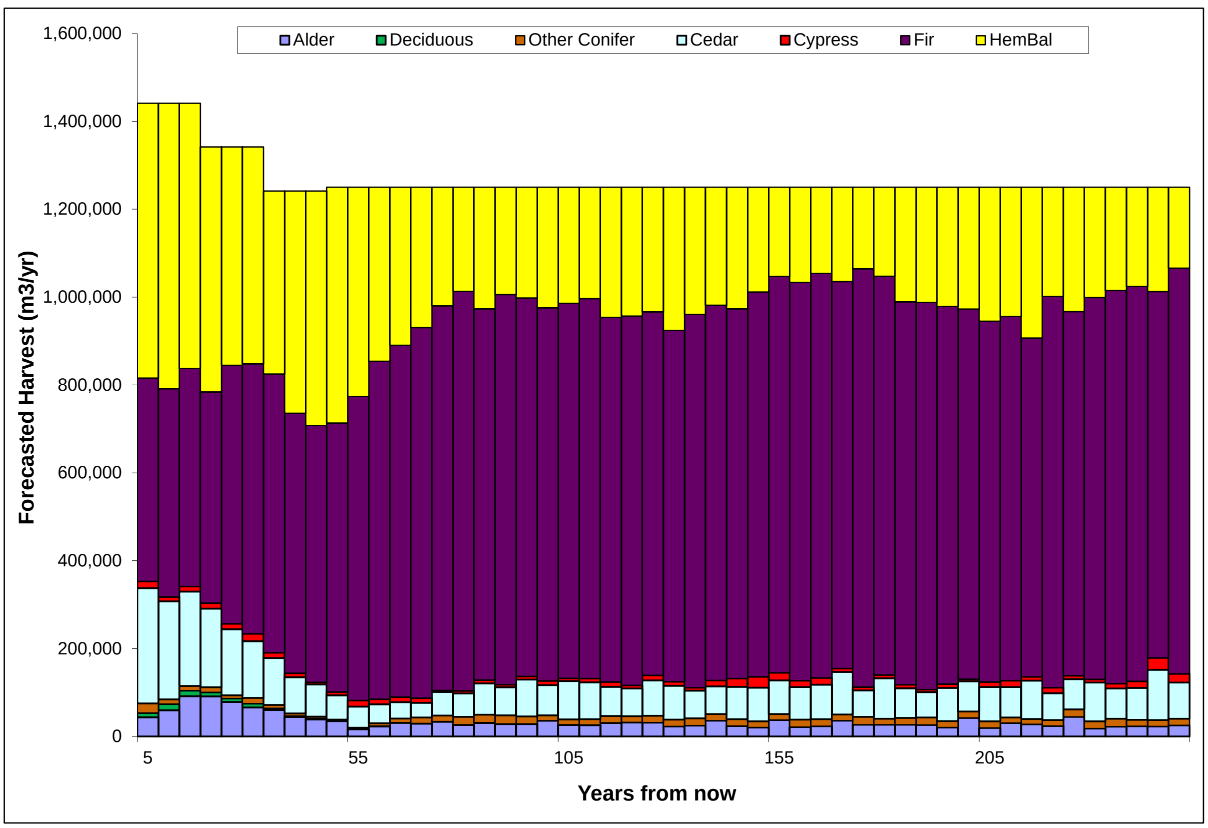

Figure 101: Volume strategy 2 Reference forecast 2 land base; harvest forecast by species

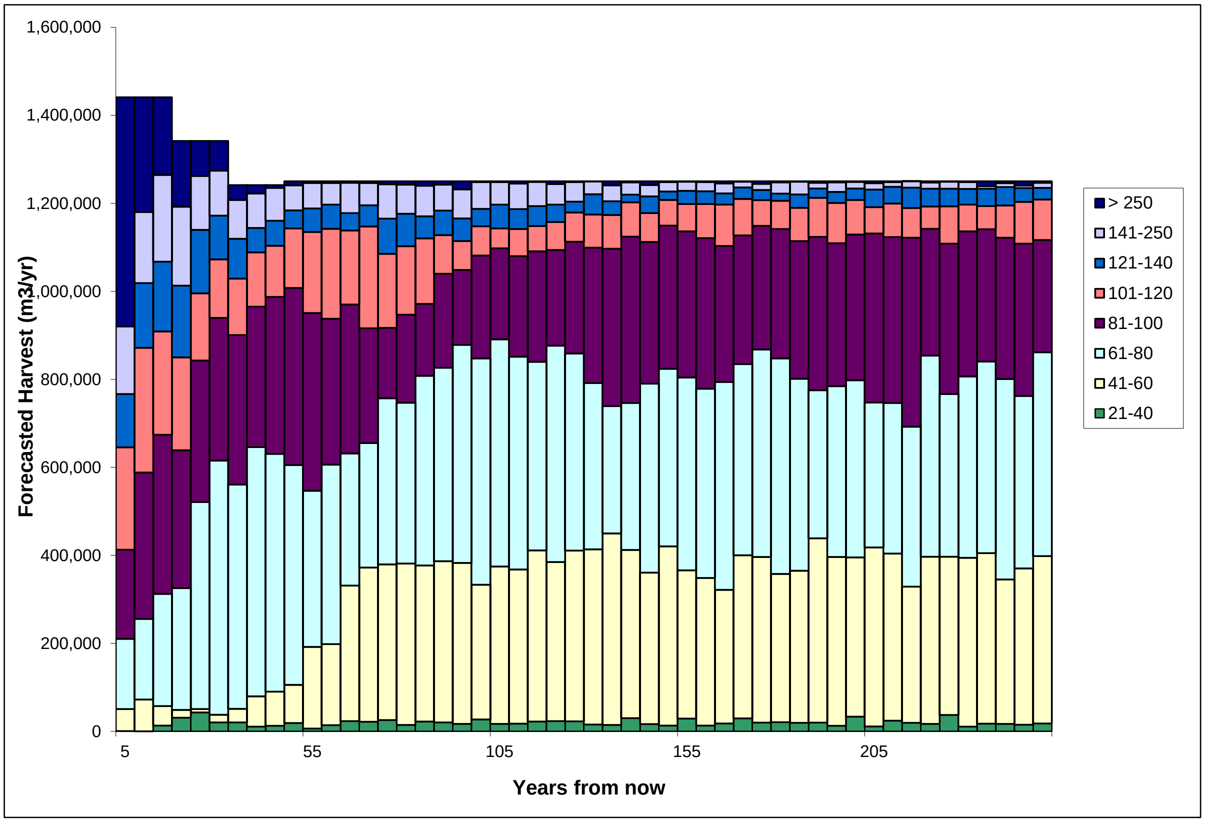

Figure 102: Volume strategy 2 Reference forecast 2 land base; harvest forecast by age class

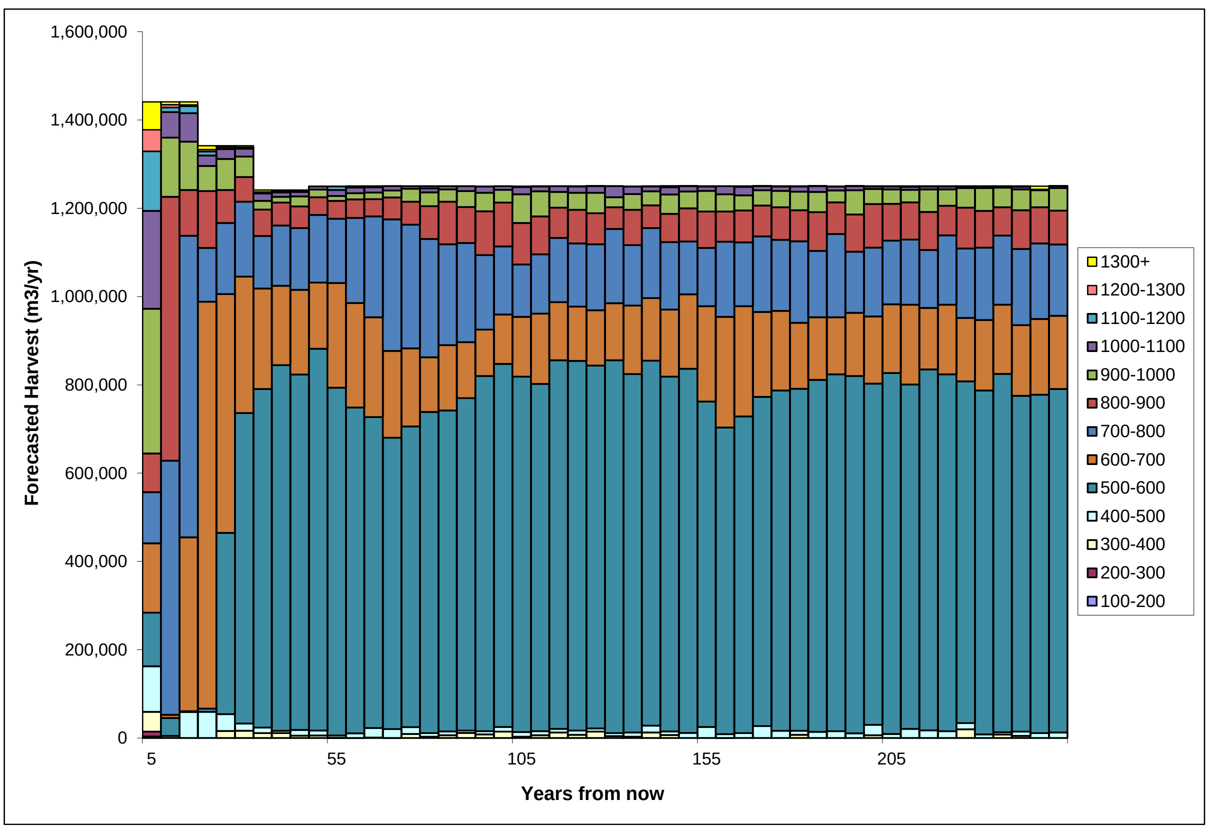

Figure 103: Volume strategy 2 Reference forecast 2 land base; harvest forecast by volume per ha class

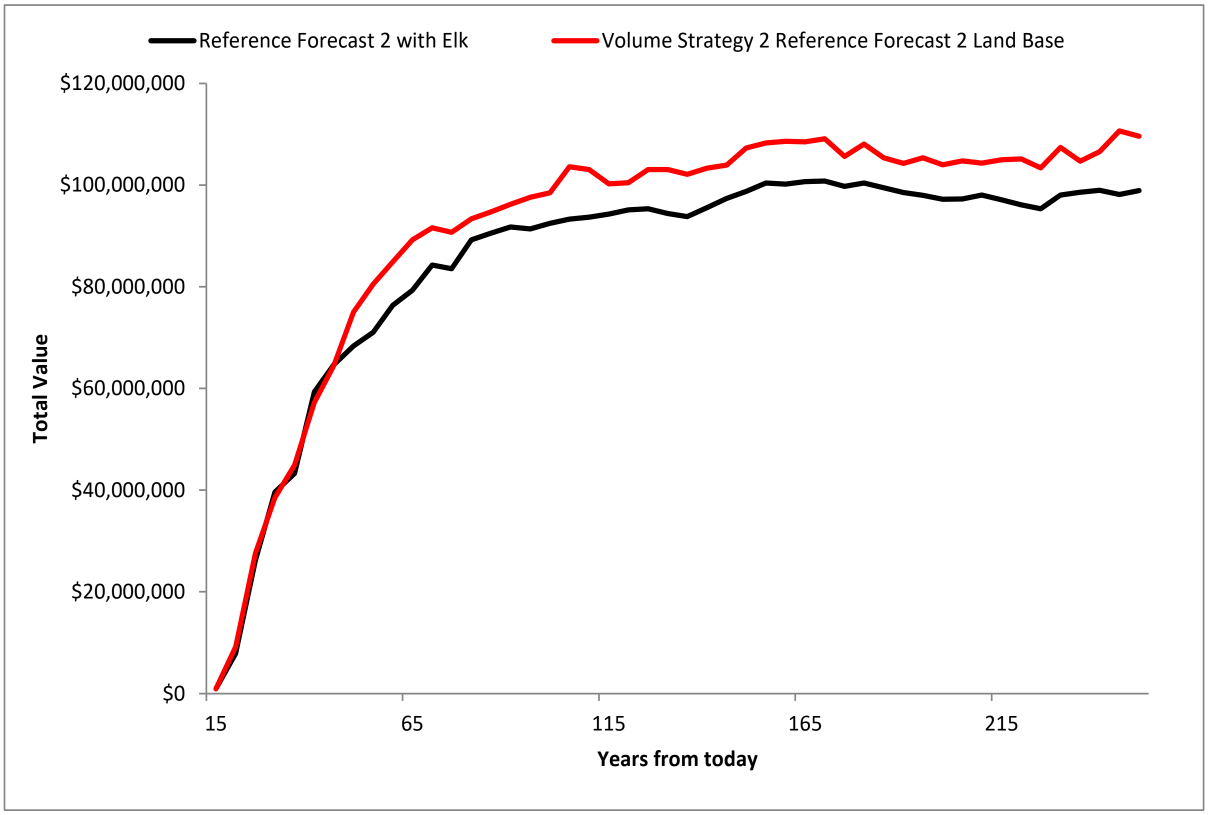

Figure 104: Volume strategy 2 Reference forecast 2 land base; total value, managed stands only

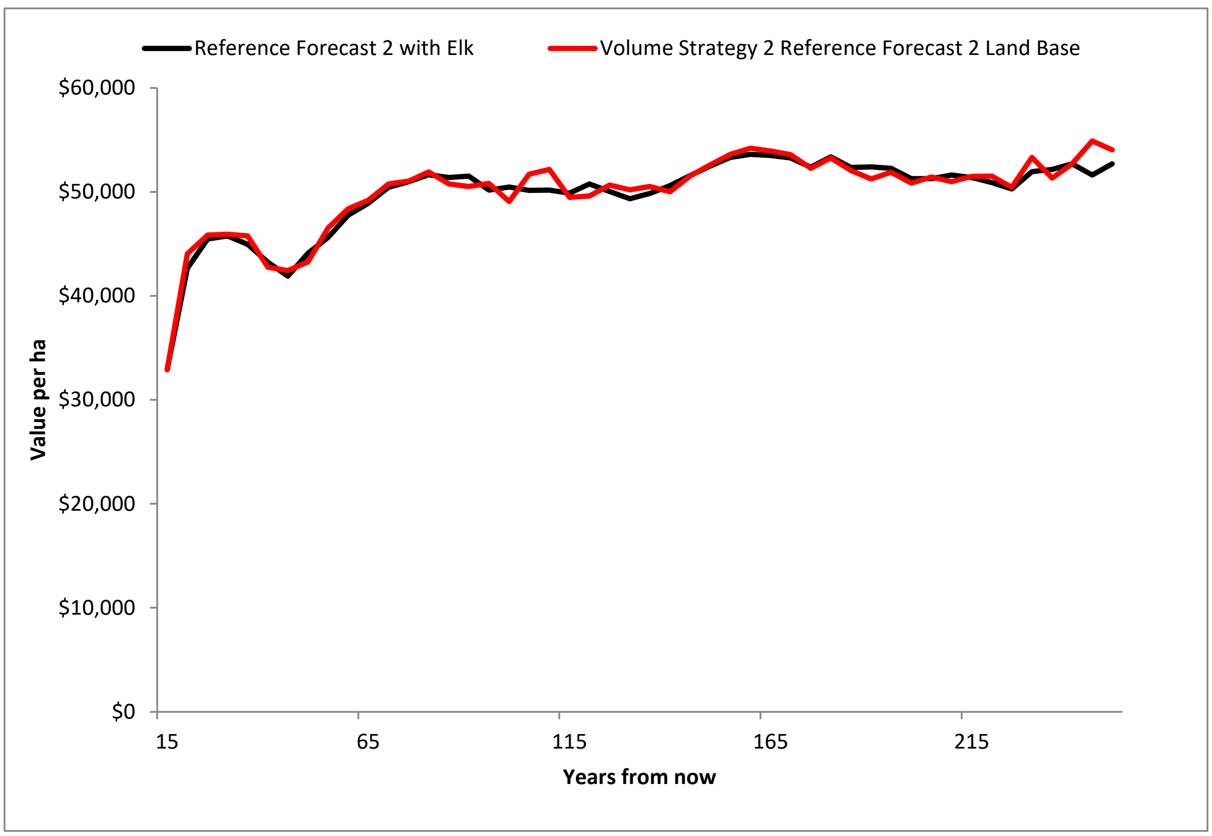

Figure 105: Volume strategy 2 Reference forecast 2 land base; value per ha, managed stands only

As there are no green or yellow silviculture zones within the incremental THLB in Reference Forecast 2 land base, the candidate areas for incremental silviculture in this forecast are identical to those in the Reference Forecast 1 land base. For this reason, there are only small differences in treatment areas and costs between the two Volume Strategy 2 runs. Consequently, no detailed area and cost breakdown are presented. Table 18 shows the predicted incremental silviculture expenditures for Volume Strategy 2 on the Reference Forecast 2 land base. The same is illustrated in Figure 106.

Table 18: Volume strategy 2 Reference forecast 2 land base; incremental silviculture costs

Year	Incremental Silviculture Costs ($)				
	Fertilization	Enhanced Planting	Stumping	CW Brushing	Total
5	$978,298	$83,881	$56,877	$27,831	$1,146,886
10	$174,745	$75,025	$30,554	$16,248	$296,572
15	$217,914	$79,841	$42,649	$20,559	$360,963
20	$187,527	$69,027	$51,597	$22,904	$331,054
25	$138,777	$54,798	$47,144	$18,975	$259,694
30	$127,022	$64,822	$56,486	$20,104	$268,434
35	$187,725	$75,410	$34,792	$17,891	$315,818
40	$165,850	$65,070	$25,143	$23,346	$279,409
45	$300,260	$41,191	$31,532	$16,688	$389,670
50	$263,624	$91,432	$47,333	$22,642	$425,031
55	$291,875	$122,241	$64,120	$25,125	$503,362
60	$302,242	$140,659	$68,199	$9,838	$520,939
65	$336,002	$109,475	$66,482	$27,173	$539,132
70	$327,779	$149,384	$77,714	$21,317	$576,194
75	$325,037	$86,053	$53,122	$19,607	$483,819
80	$352,753	$94,894	$57,216	$26,681	$531,544
85	$414,139	$117,344	$43,775	$35,531	$610,789
90	$448,502	$111,737	$35,645	$28,091	$623,975
95	$456,050	$84,722	$47,994	$27,643	$616,409
100	$453,573	$101,025	$42,683	$17,047	$614,328

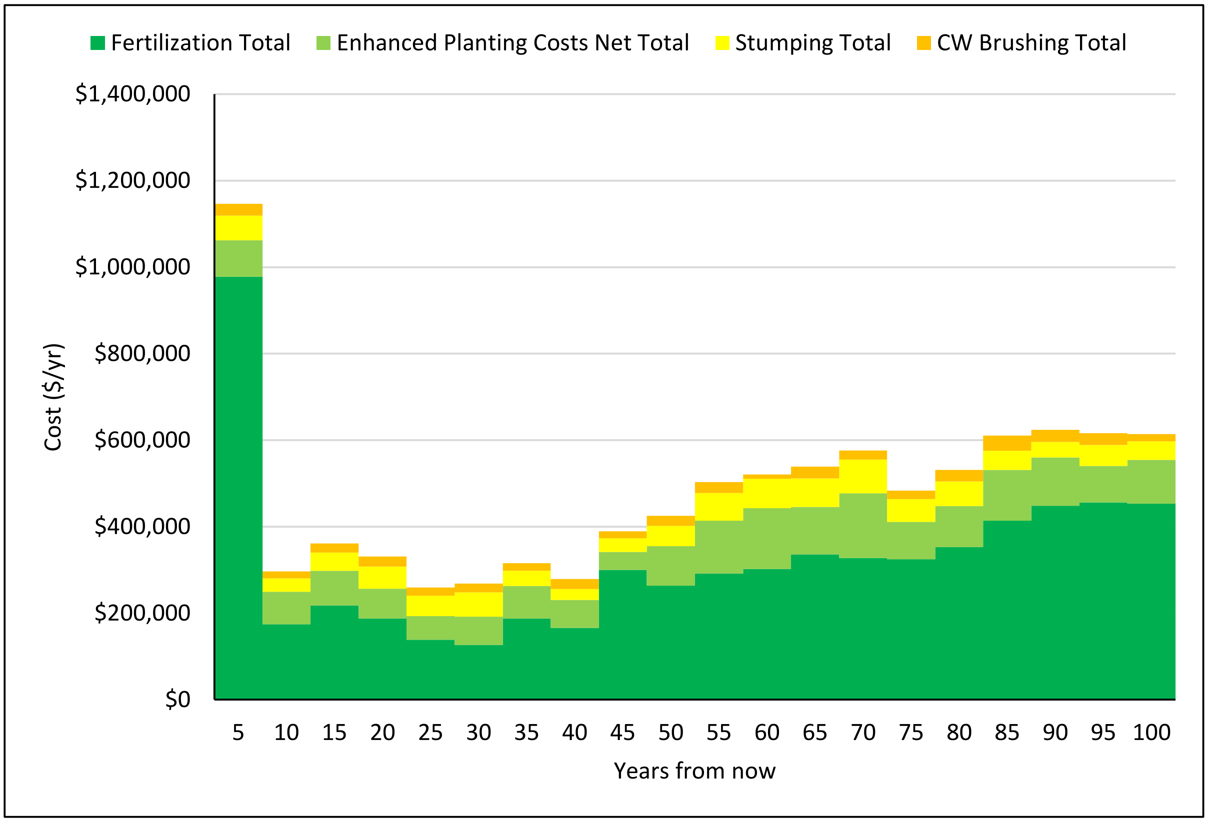

Figure 106: Volume strategy 2 Reference forecast 2 land base; incremental silviculture costs

3.4.9 Forest Level Results; Value Strategy, ISS Reference Forecast 1 Land Base

This section presents the Value Strategy results for the Reference Forecast 1 land base. Figure 107 illustrates the volume impact of this strategy, which is identical to that of Volume Strategy 2. The long-term harvest level is +3.5% higher than that of the Reference Forecast 1 with Elk, while the mid-term harvest forecast between years 46 and 75 is +5.6% higher. There is no short -term impact; the small impact shown in Figure 107 is caused by the resolution of the timber supply model.

Figure 108 illustrates the predicted growing stock development for this scenario, while Figure 109 shows the predicted harvest by species. This strategy aims at increasing the share of Cw in the land base. This can be seen in Figure 109 with more Cw harvest predicted in the future compared to the reference forecasts. The predicted harvest by age and by per ha volume class are not expected to be significantly different from the reference forecasts (Forest Health and Elk incorporated) (Figure 110 and Figure 111).

The increase in the harvest volume forecast for Value Strategy compared to Reference Forecast 1 with Elk is attributable to different management assumptions and the spatial distribution of various tree species in planted areas. Value Strategy 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 and Cw forests by creating a mosaic of ecologically suitable single species stands, which increases the fertilization efficiency and ensures the survival and competitiveness of Cw.

Figure 112 and Figure 113 illustrate the predicted total value and the predicted value per ha of managed stands over time. Both the total value and value per ha are predicted to increase compared to the reference forecast.

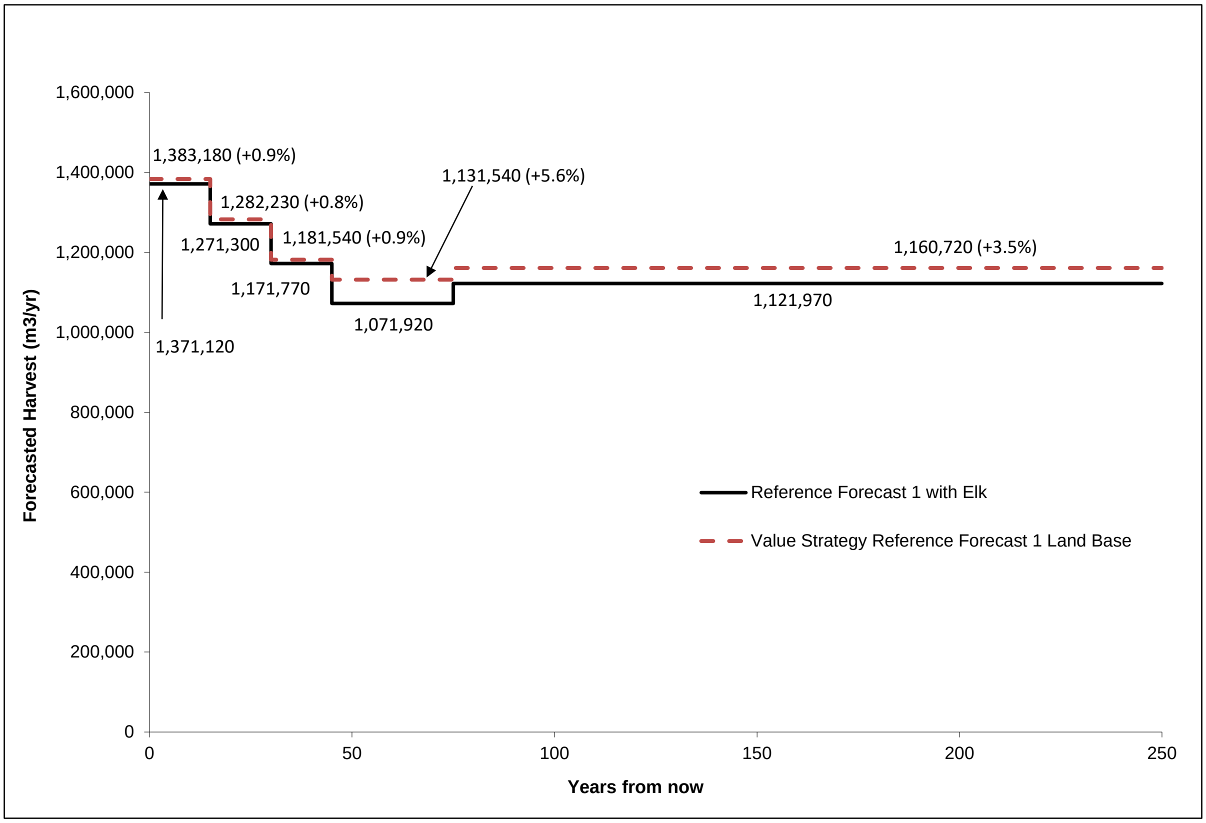

Figure 107: Value strategy, Reference forecast 1 land base; harvest forecast

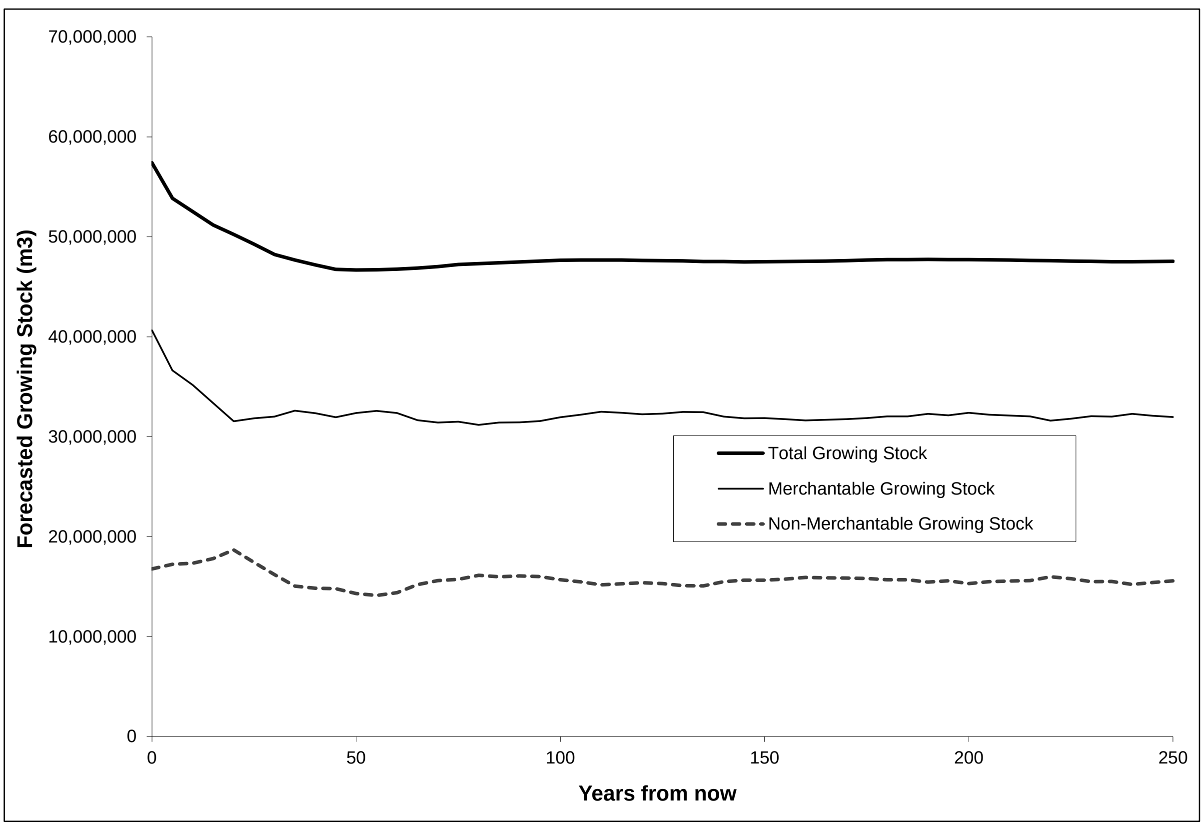

Figure 108: Value strategy, Reference forecast 1 land base; predicted growing stock

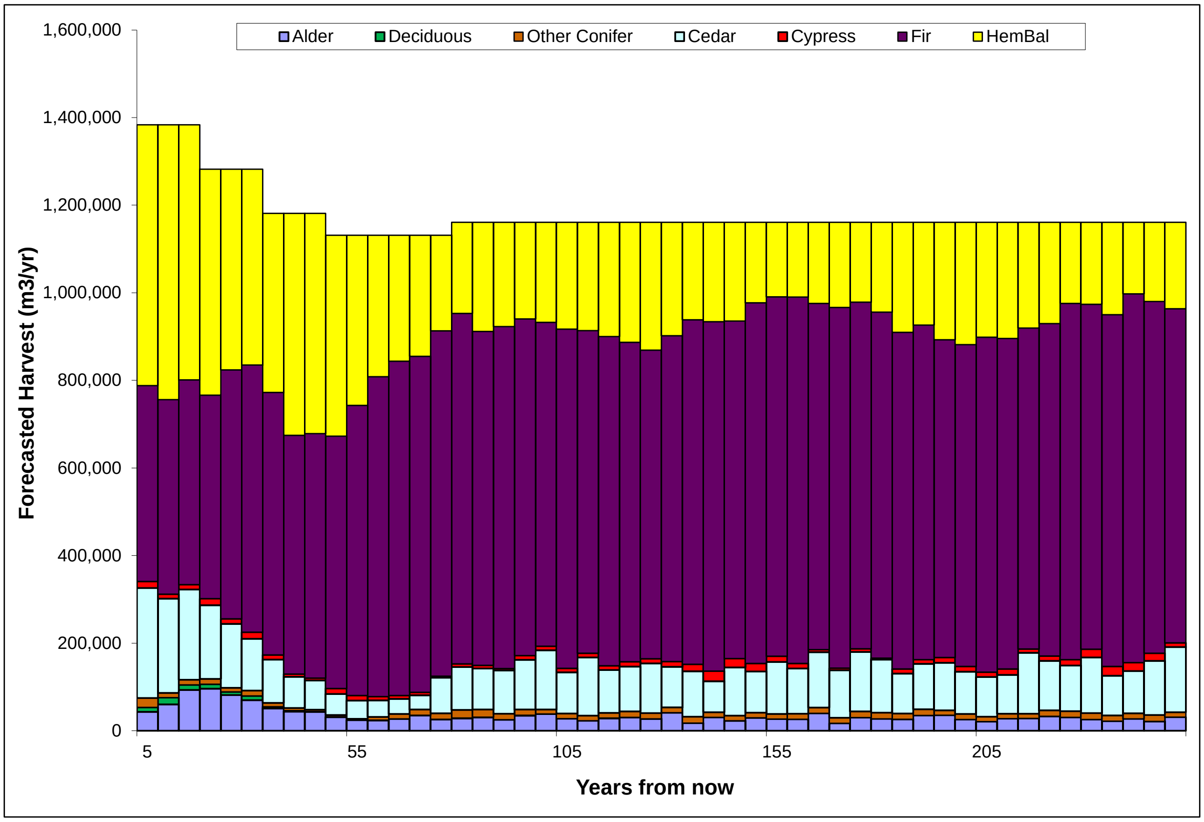

Figure 109: Value, Reference forecast 1 land base; harvest forecast by species

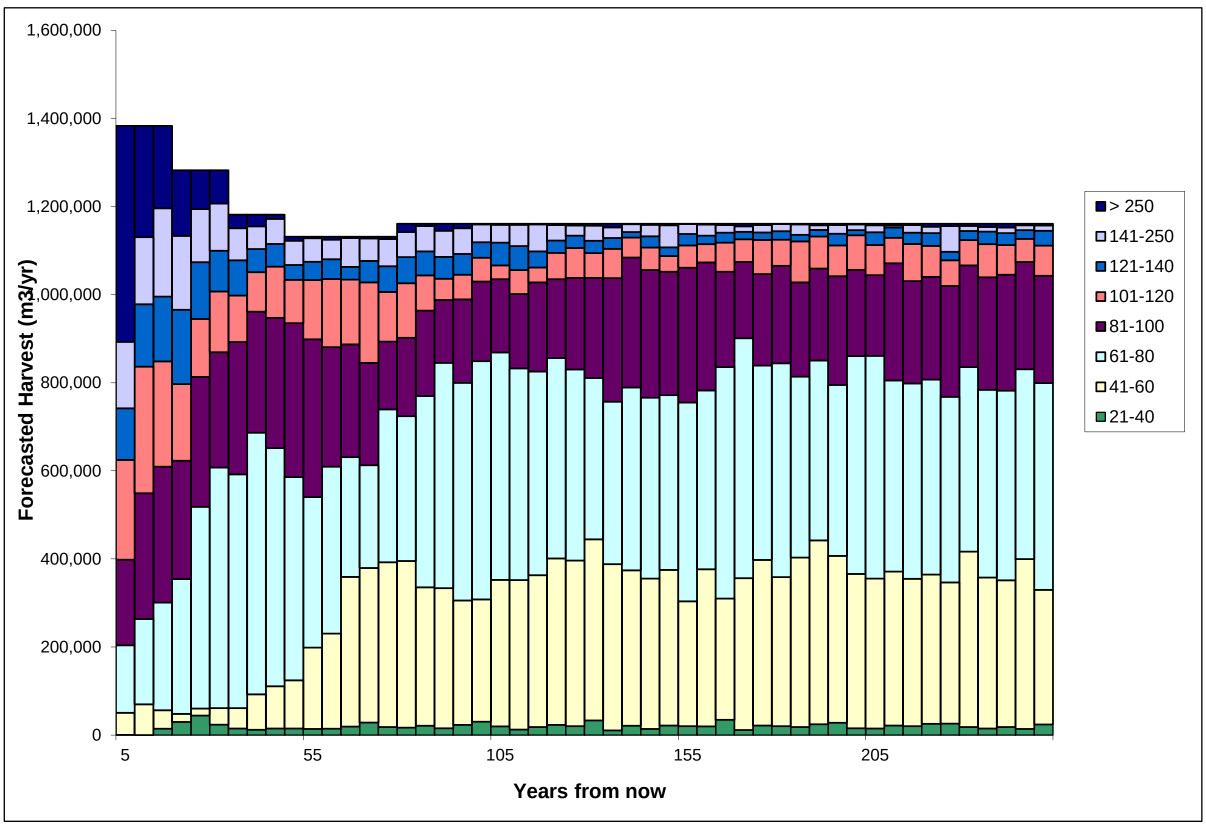

Figure 110: Value strategy, Reference forecast 1 land base; harvest forecast by age class

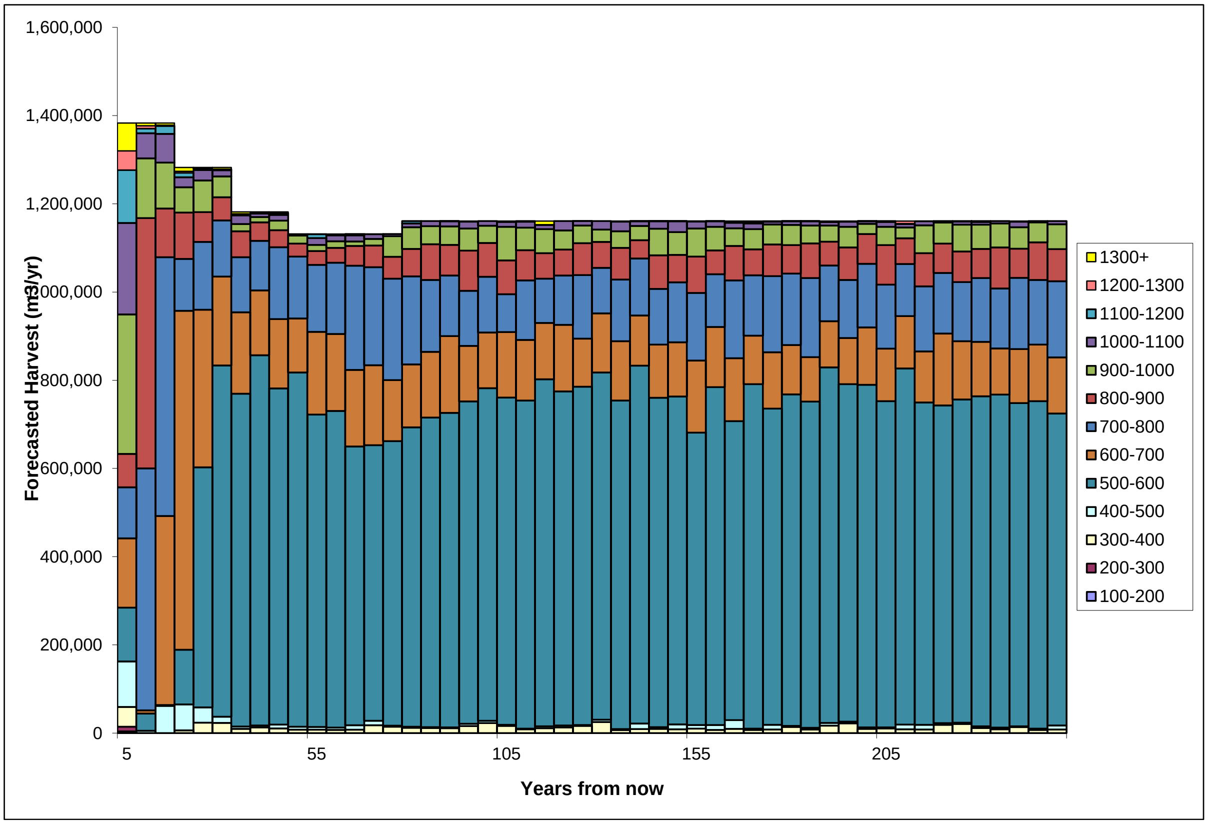

Figure 111: Value strategy, Reference forecast 1 land base; harvest forecast by volume per ha class

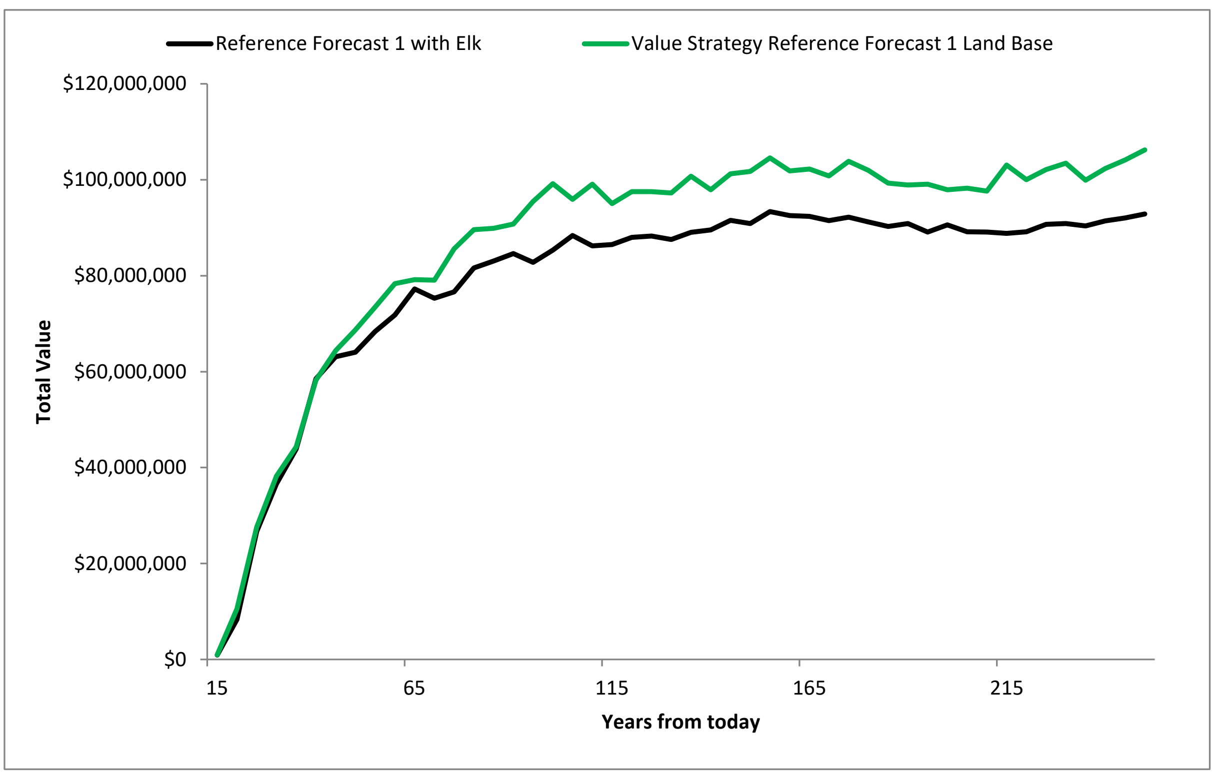

Figure 112: Value strategy, Reference forecast 1 land base; total value, managed stands only

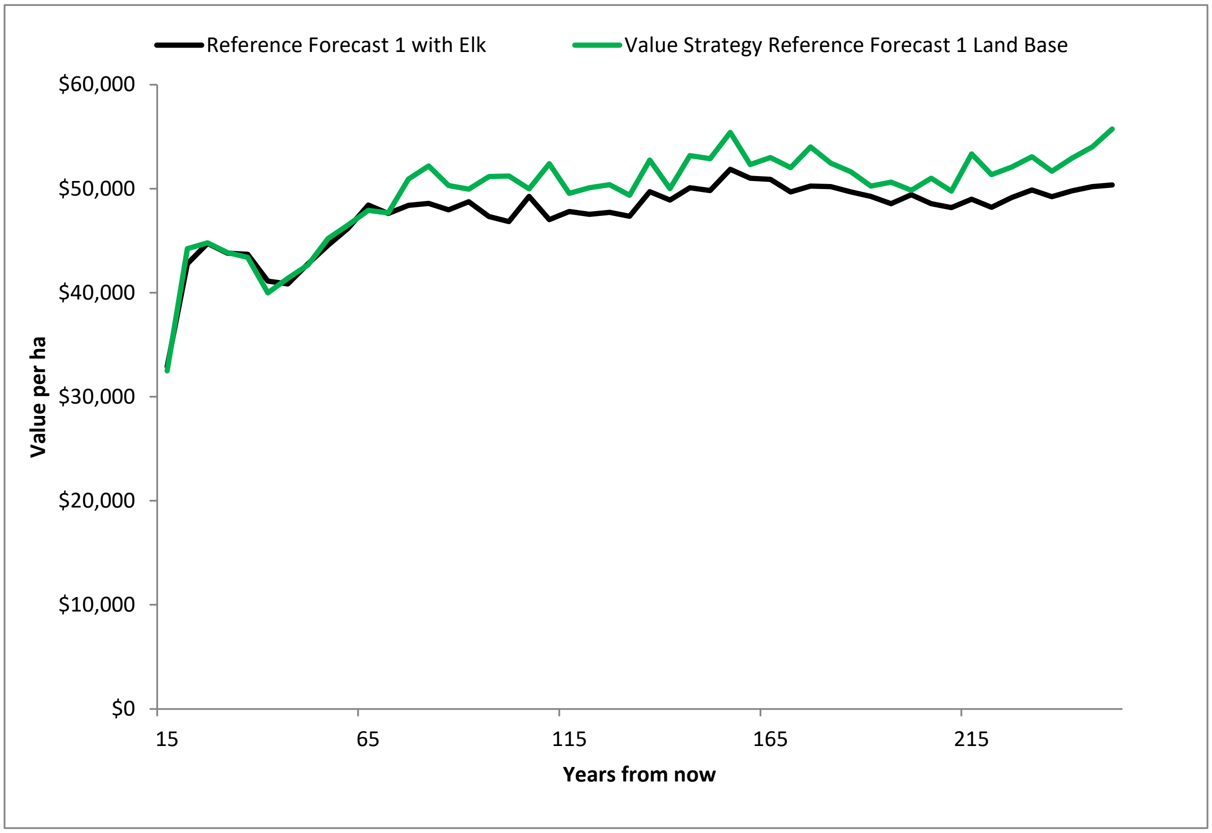

Figure 113: Value strategy, Reference forecast 1 land base; value per ha, managed stands only

The differences between Volume Strategy 2 and Value Strategy treatments are subtle. Value Strategy contains more Cw planting and brushing, which is reflected in the total costs of incremental silviculture, which are somewhat higher than in Volume Strategy 2 (Table 19). The costs are also illustrated in Figure 114. See Section 3.4.11 for a cost summary.

Table 19: Value strategy, Reference forecast 1 land base; incremental silviculture costs

Year	Incremental Silviculture Costs ($)				
	Fertilization	Enhanced Planting	Stumping	CW Brushing	Total
5	$978,298	$90,364	$44,002	$73,728	$1,186,392
10	$174,745	$71,271	$25,814	$56,461	$328,291
15	$217,914	$81,695	$30,933	$65,557	$396,099
20	$187,392	$80,680	$47,834	$52,958	$368,864
25	$137,298	$67,040	$38,375	$58,087	$300,801
30	$122,176	$74,133	$46,513	$52,993	$295,815
35	$167,399	$78,542	$38,351	$66,229	$350,521
40	$134,610	$74,039	$21,666	$75,003	$305,319
45	$299,287	$58,016	$22,538	$51,758	$431,599
50	$266,728	$81,856	$44,683	$48,624	$441,891
55	$272,856	$135,614	$65,484	$65,409	$539,363
60	$290,891	$102,310	$55,383	$34,767	$483,351
65	$342,792	$94,989	$49,490	$48,134	$535,405

Year	Incremental Silviculture Costs ($)				
	Fertilization	Enhanced Planting	Stumping	CW Brushing	Total
70	$336,127	$104,141	$50,194	$29,323	$519,784
75	$354,154	$87,635	$52,375	$50,775	$544,939
80	$363,459	$106,258	$52,752	$68,354	$590,824
85	$447,813	$107,922	$31,915	$77,216	$664,866
90	$412,420	$81,062	$44,592	$47,390	$585,463
95	$477,210	$94,781	$31,812	$64,782	$668,585
100	$429,549	$104,083	$40,960	$75,591	$650,182

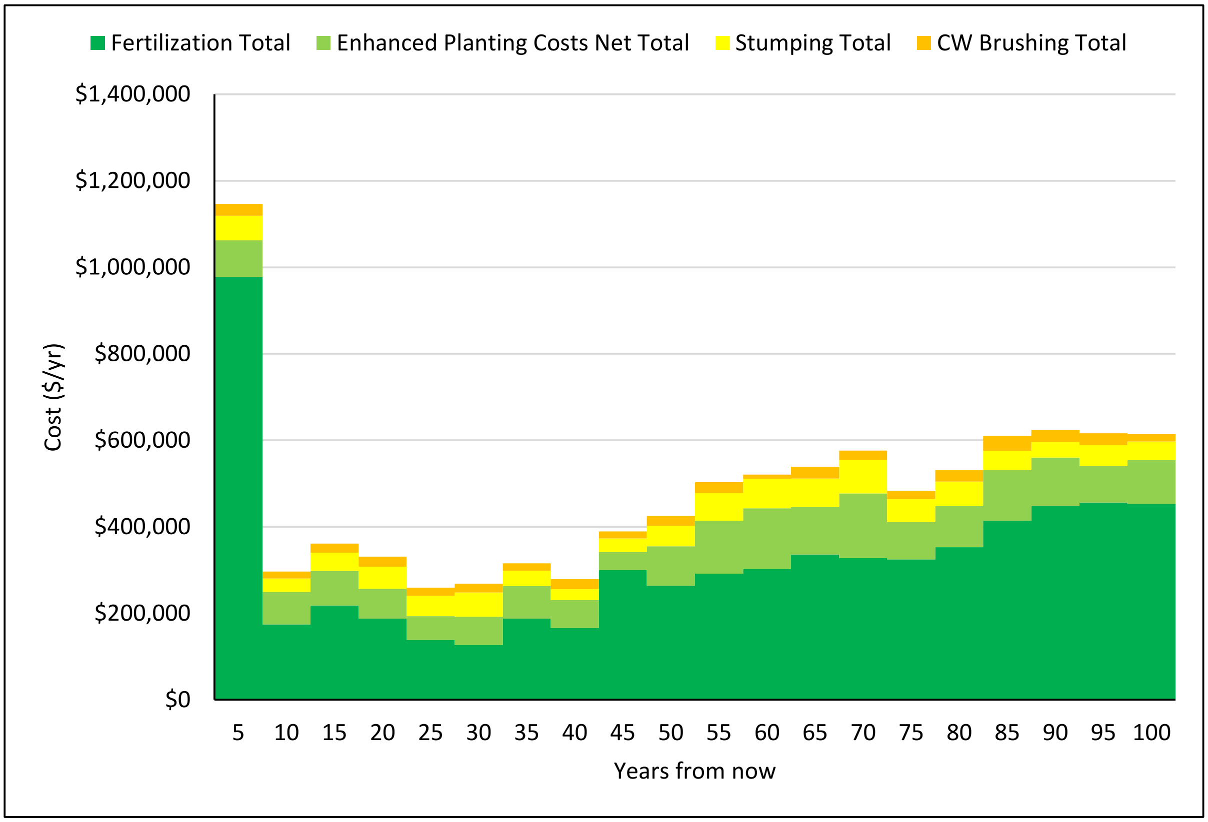

Figure 114: Value strategy, Reference forecast 2 land base; incremental silviculture costs

3.4.10 Forest Level Results; Value Strategy, ISS Reference Forecast 2 Land Base

This section presents the Value Strategy results for the Reference Forecast 2 land base. Figure 115 illustrates the volume impact of this strategy, which is identical to that of Volume Strategy 2. The long-term harvest level is +4.0% higher than that of the Reference Forecast 2 with Elk, while the mid-term harvest forecast between years 46 and 75 is +9.5% higher. There is no short -term impact.

Figure 116 illustrates the predicted growing stock development for this scenario, while Figure 117 shows the predicted harvest by species. As noted, above in this document, the Value Strategy aims at increasing the share of Cw in the land base. This can be seen in Figure 117 with more Cw harvest predicted in the future compared to the reference forecast. The predicted harvest by age and by per ha volume class are not expected to be significantly different from the reference forecasts (Forest Health and Elk incorporated) (Figure 118 and Figure 119).

The increase in the harvest volume forecast for Value Strategy compared to Reference Forecast 1 with Elk is attributable to different management assumptions and the spatial distribution of various tree species in planted areas. The Value Strategy 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 and Cw forests by creating a mosaic of ecologically suitable single species stands, which increases the fertilization efficiency and ensures the survival and competitiveness of Cw.

Figure 120 and Figure 121 illustrate the predicted total value and the predicted value per ha of managed stands over time. The total value is predicted to increase, while the changes in value per ha are not consistent.

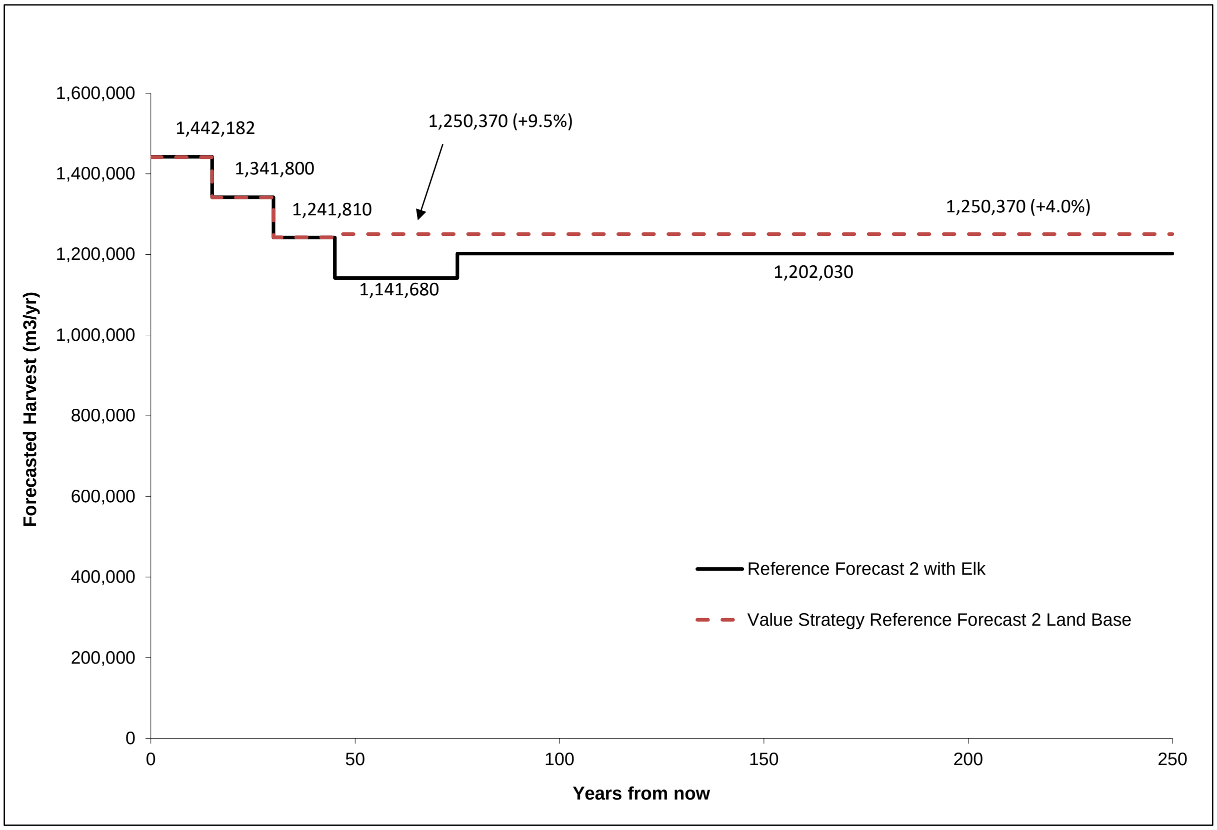

Figure 115: Value strategy, Reference forecast 2 land base; harvest forecast

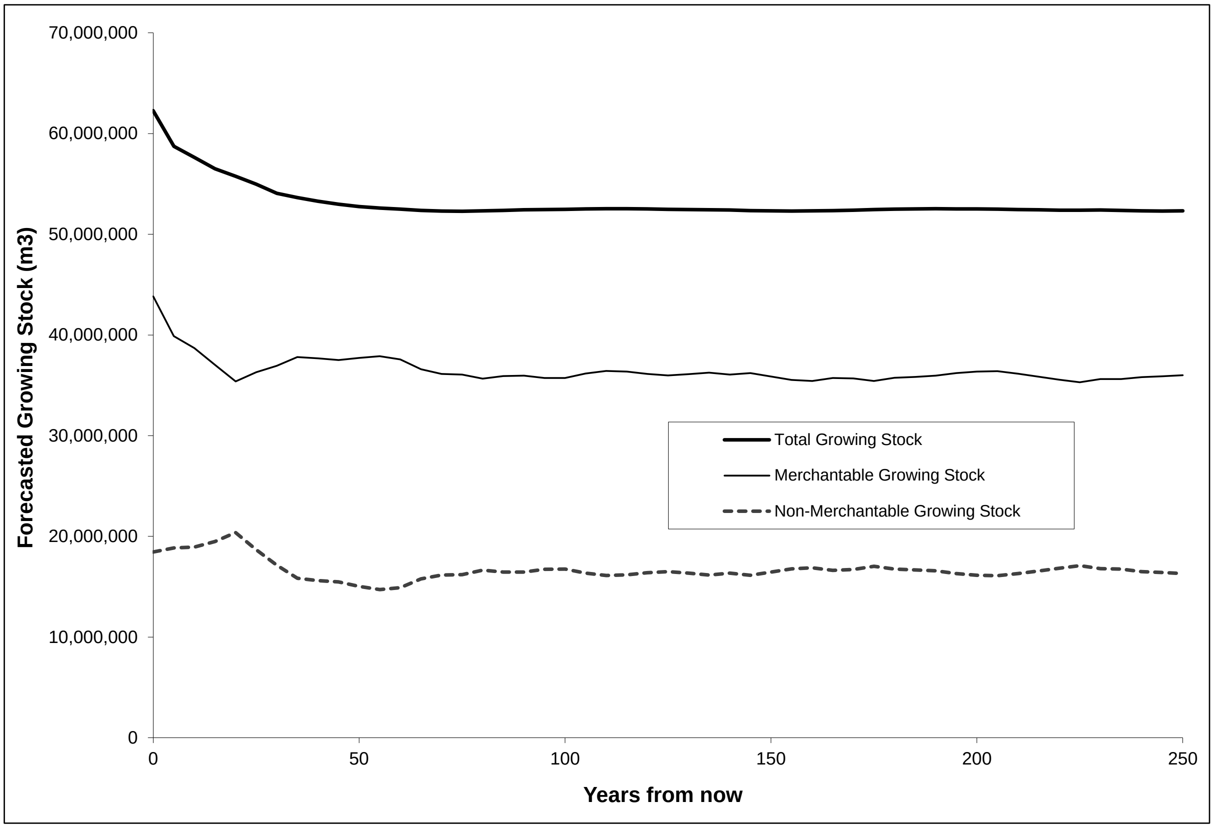

Figure 116: Value strategy, Reference forecast 2 land base; predicted growing stock

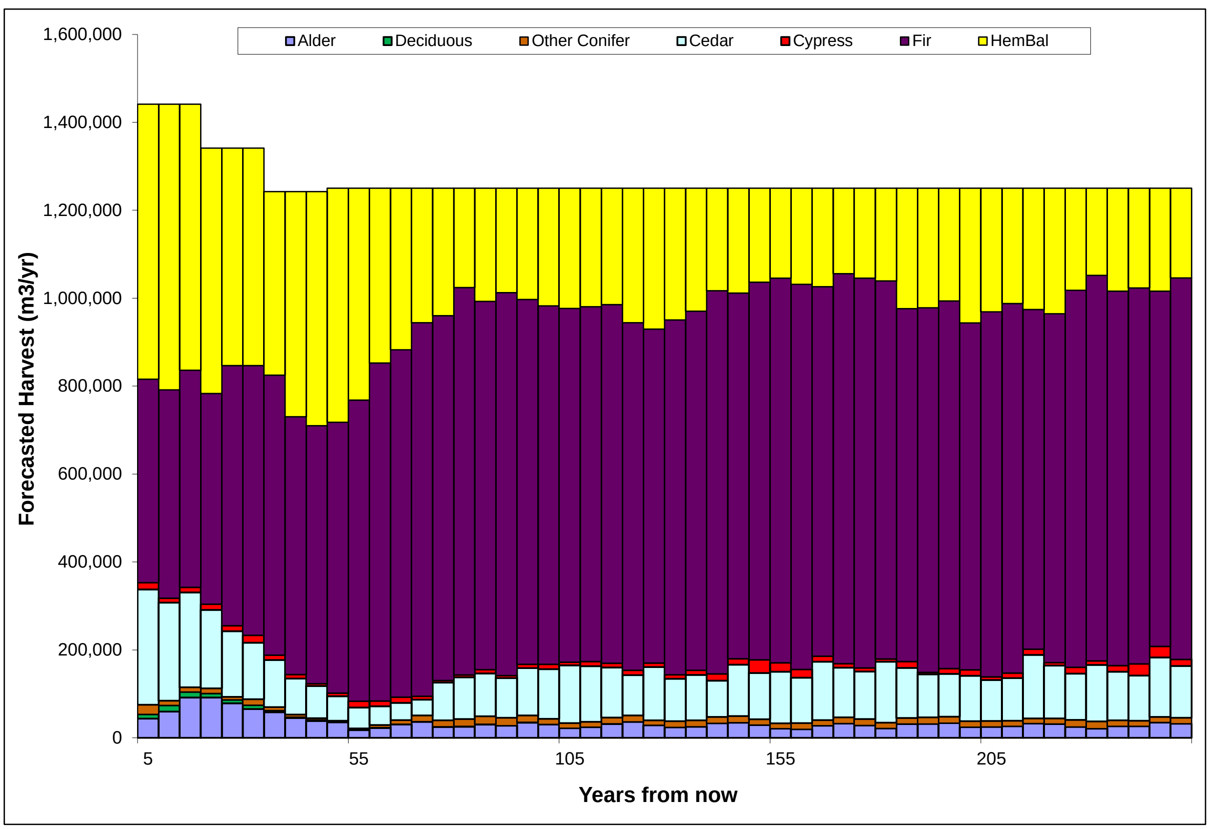

Figure 117: Value strategy, Reference forecast 2 land base; harvest forecast by species

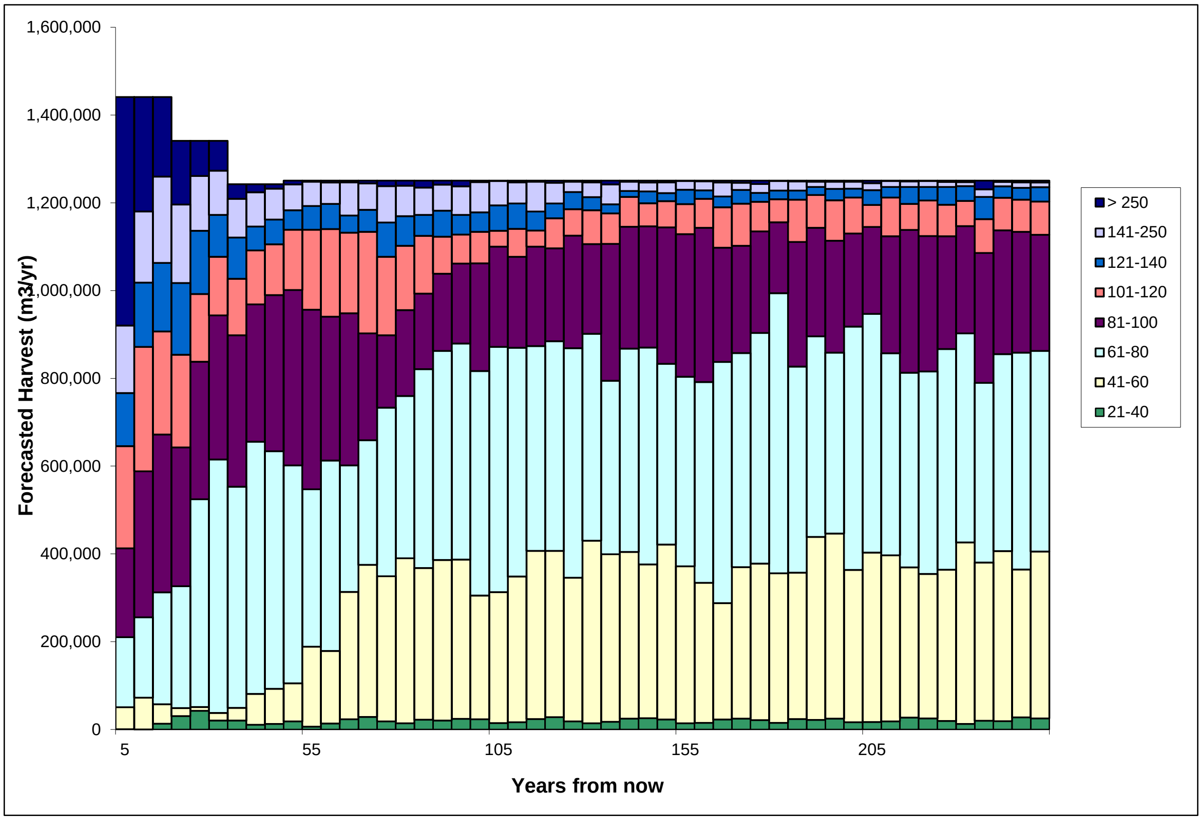

Figure 118: Value strategy, Reference forecast 2 land base; harvest forecast by age class

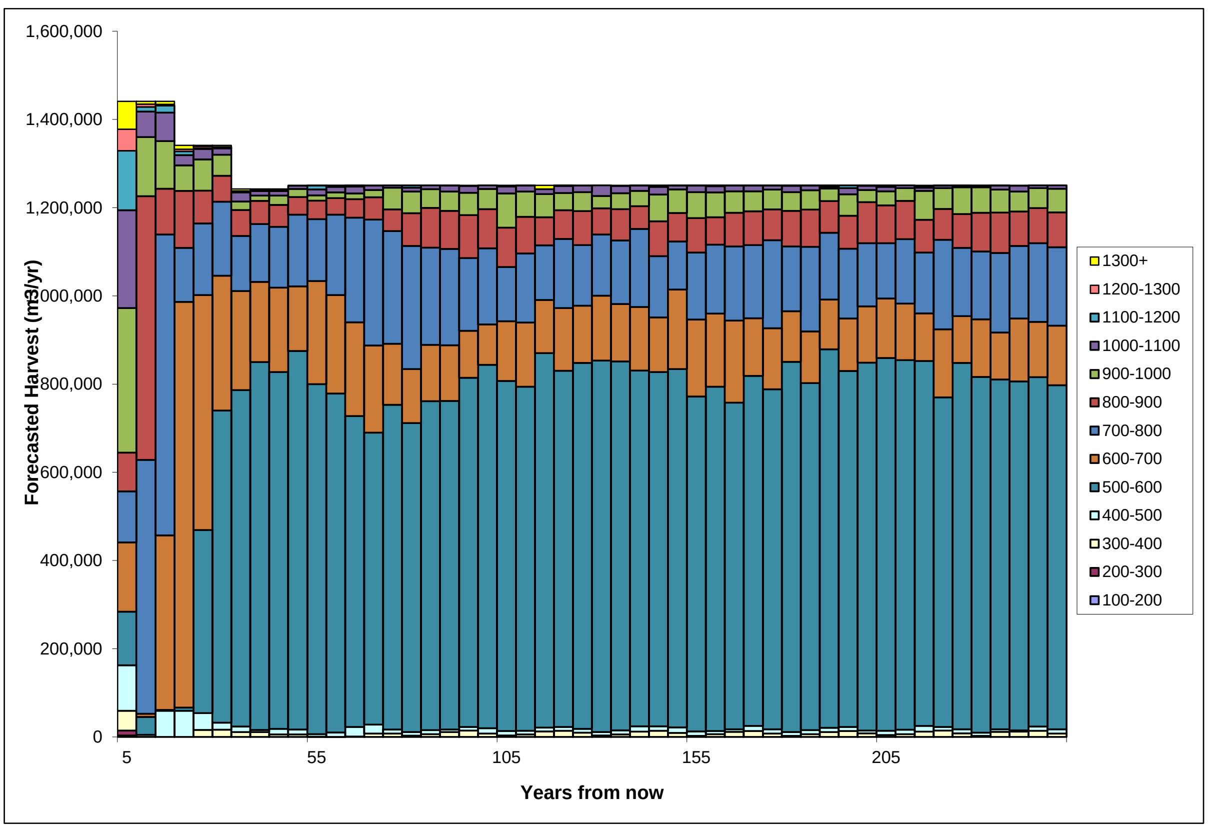

Figure 119: Value strategy, Reference forecast 2 land base; harvest forecast by volume per ha class

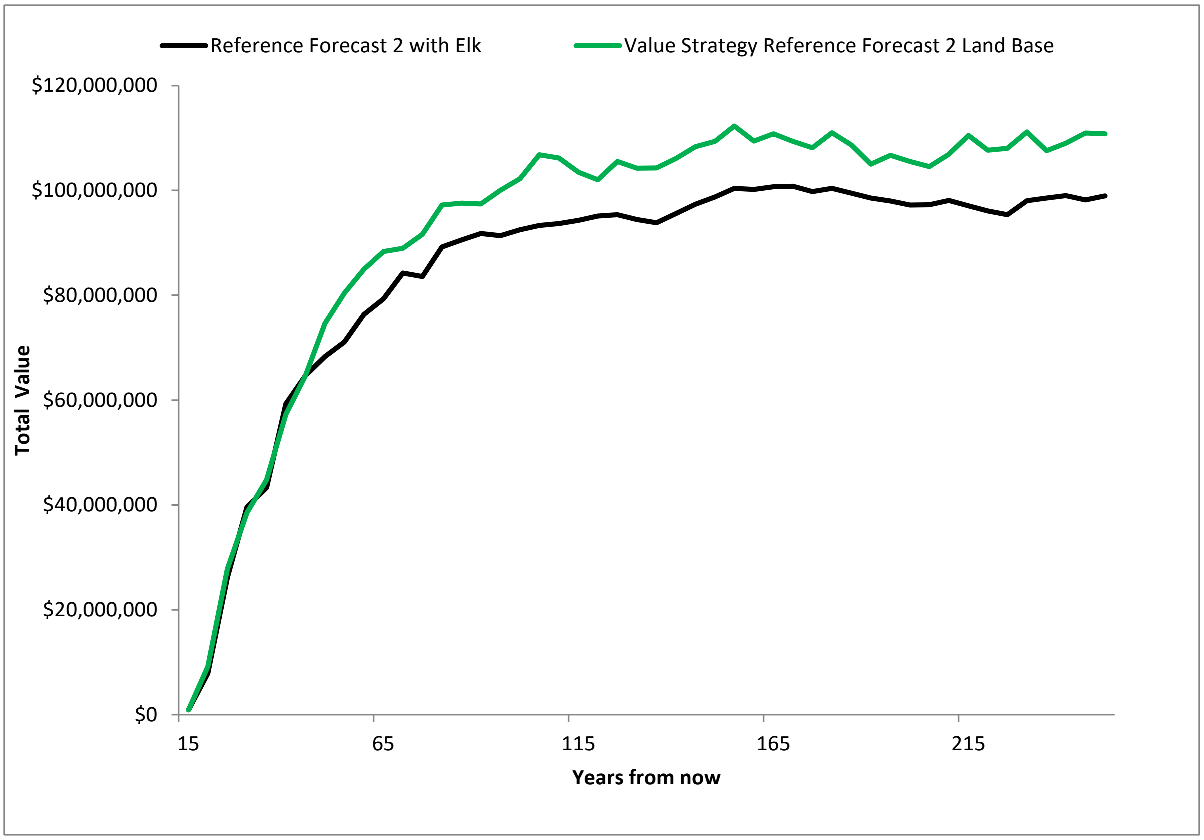

Figure 120: Value strategy, Reference forecast 2 land base; total value, managed stands only

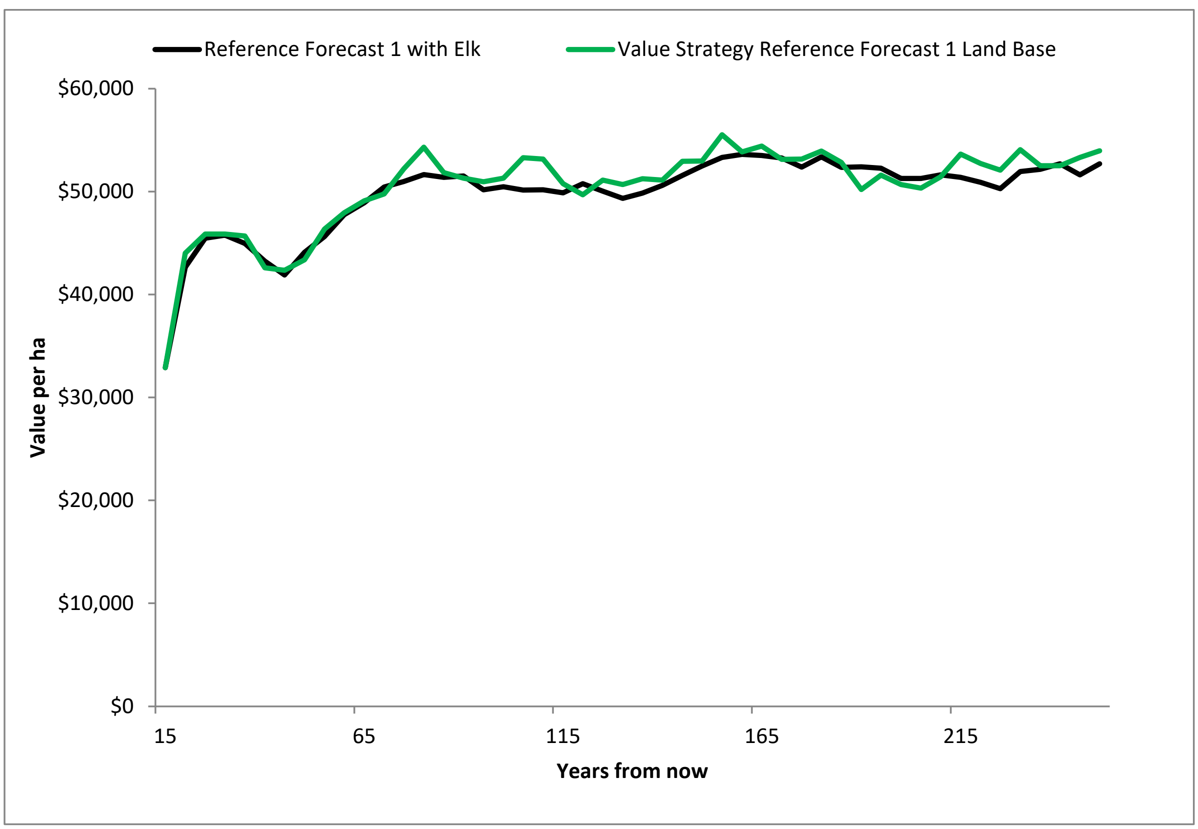

Figure 121: Value strategy, Reference forecast 2 land base; value per ha, managed stands only

As discussed above, the differences between the Volume Strategy 2 and the Value Strategy treatments are subtle. Value Strategy contains more Cw planting and brushing, which is reflected in the total costs of incremental silviculture, which are somewhat higher than in the Volume Strategy.

Table 20 and Figure 122 show the predicted incremental silviculture costs for this scenario. See Section 3.4.11 for a cost summary.

Table 20: Value strategy, Reference forecast 2 land base; incremental silviculture costs

Year	Incremental Silviculture Costs ($)				
	Fertilization	Enhanced Planting	Stumping	CW Brushing	Total
5	$978,298	$89,747	$44,002	$73,728	$1,185,775
10	$174,745	$69,681	$25,605	$55,833	$325,863
15	$217,914	$79,601	$29,663	$65,066	$392,244
20	$187,527	$67,252	$45,453	$47,512	$347,743
25	$138,777	$55,948	$38,168	$53,242	$286,135
30	$127,022	$58,231	$42,620	$42,258	$270,131
35	$175,668	$70,959	$37,001	$57,551	$341,179
40	$144,423	$64,205	$24,381	$78,031	$311,039
45	$298,879	$41,233	$19,932	$47,854	$407,899
50	$257,582	$80,212	$43,229	$49,445	$430,467
55	$274,430	$113,363	$55,470	$57,792	$501,054
60	$278,206	$115,247	$62,340	$49,746	$505,539
65	$338,415	$79,995	$50,119	$36,796	$505,326
70	$326,029	$116,148	$49,389	$41,859	$533,425
75	$335,549	$93,037	$50,137	$61,623	$540,345
80	$346,528	$94,146	$48,807	$56,188	$545,669
85	$405,406	$99,889	$35,600	$82,068	$622,963
90	$398,263	$87,881	$44,760	$45,419	$576,323
95	$448,567	$58,547	$25,088	$52,481	$584,682
100	$461,270	$91,439	$34,991	$61,912	$649,612

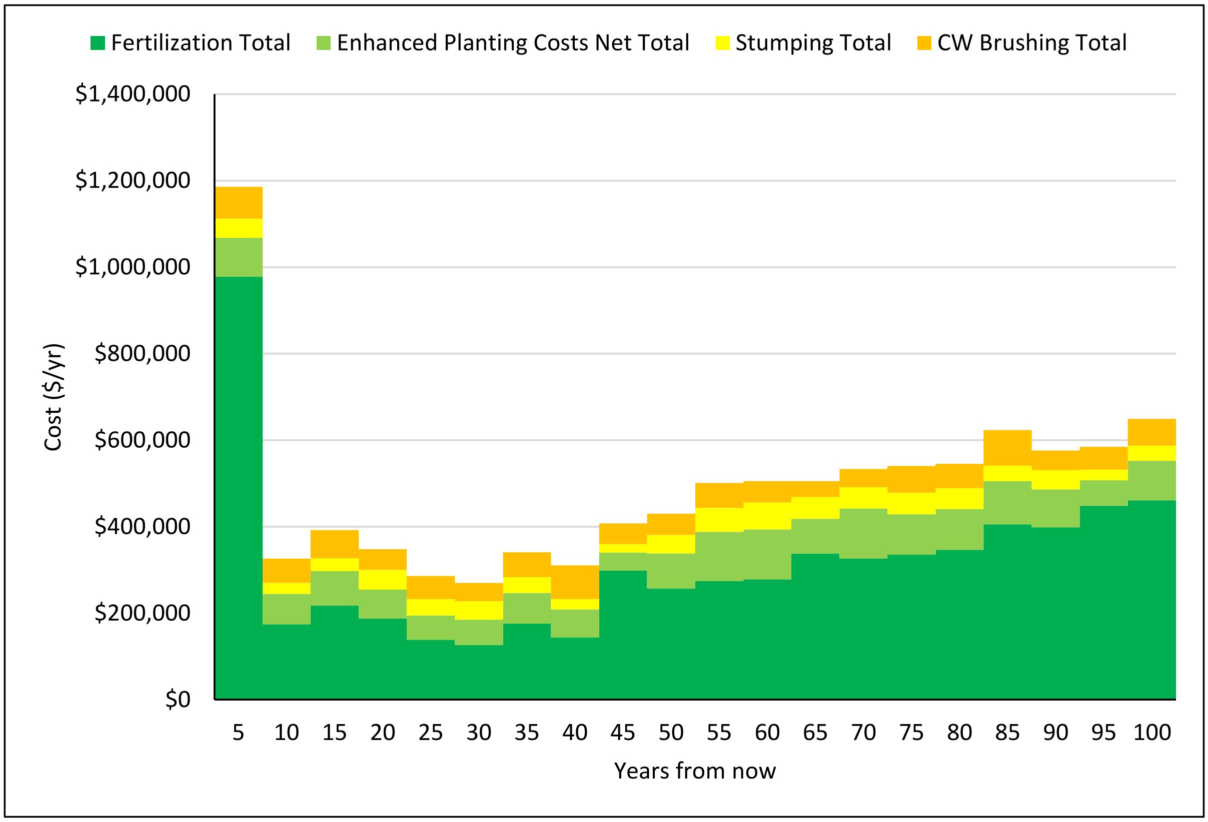

Figure 122: Value strategy, Reference forecast 2 land base; incremental silviculture costs

3.4.11 Summary of Volume Strategy 2 and Value Strategy Results

The tables and figures below provide comparisons for harvest volume, predicted value of managed stands and incremental silviculture costs for Volume Strategy 2 and the Value Strategy. Table 21 presents a harvest forecast comparison, while Figure 123 and Figure 124 illustrate the predicted total value and value per ha.

Predicted incremental silviculture costs are presented in Table 22 and illustrated in Figure 125.

Table 22

Table 21: Harvest forecast comparison; Volume Strategy 2 and Value Strategy

Year	Predicted Harvest Volume (m^3 per year, % change)					
	Reference Forecast 1 with Elk	Volume Strategy 2, Reference Forecast 1 Land Base	Value Strategy, Reference Forecast 1 Land Base	Reference Forecast 2 with Elk	Volume Strategy 2, Reference Forecast 2 Land Base	Value Strategy, Reference Forecast 2 Land Base
1 to 15	1,371,120 m^3/yr	No impact (marginal increase)	No impact (marginal increase)	1,442,181 m^3/yr	No impact	No impact
16 to 30	1,271,300 m^3/yr	No impact (marginal increase	No impact (marginal increase	1,341,800 m^3/yr	No impact	No impact
31 to 45	1,171,770 m^3/yr	No impact (marginal increase	No impact (marginal increase	1,241,810 m^3/yr	No Impact	No Impact
46 to 75	1,070,920 m^3/yr	+5.6%	+5.6%	1,250,300 m^3/yr	+9.5%	+9.5%
76 to 250	1,121,970 m^3/yr	+3.5%	+3.5%	1,250,300 m^3/yr	+4.0%	+4.0%

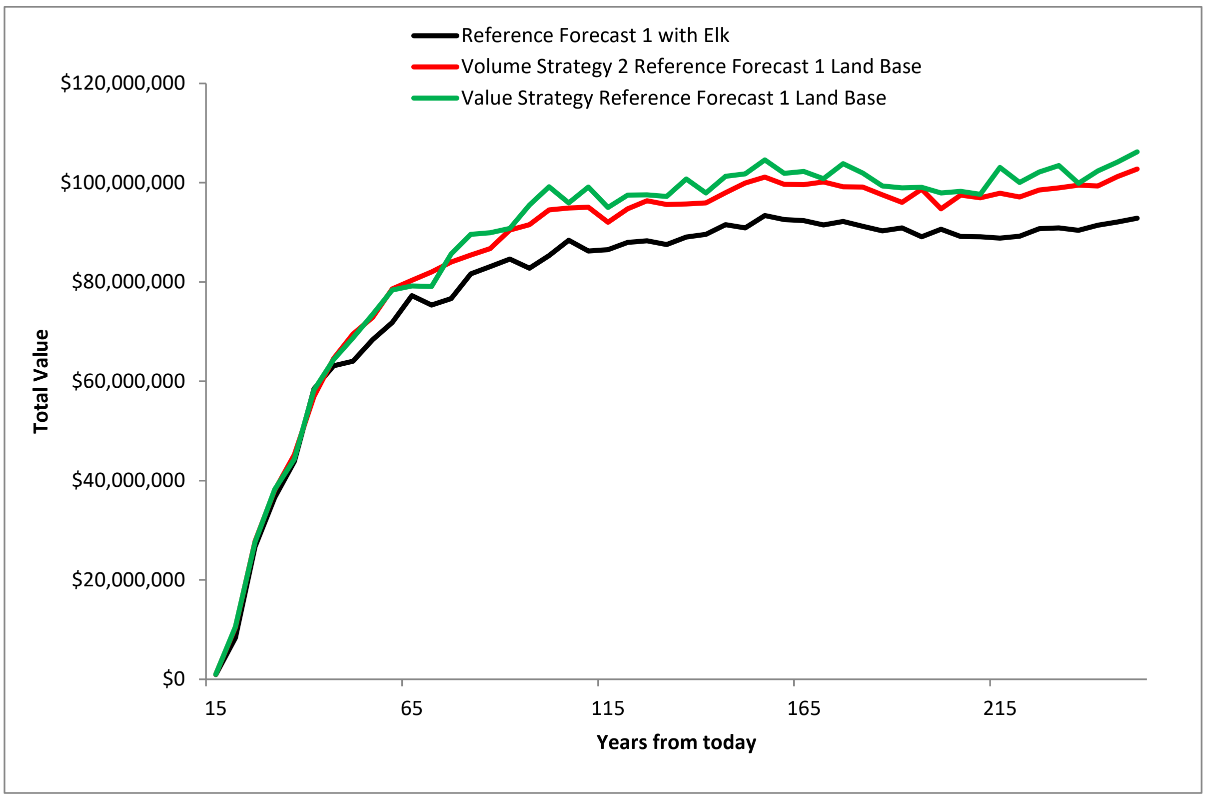

Figure 123: Predicted total value, managed stands; Volume Strategy2 and Value Strategy

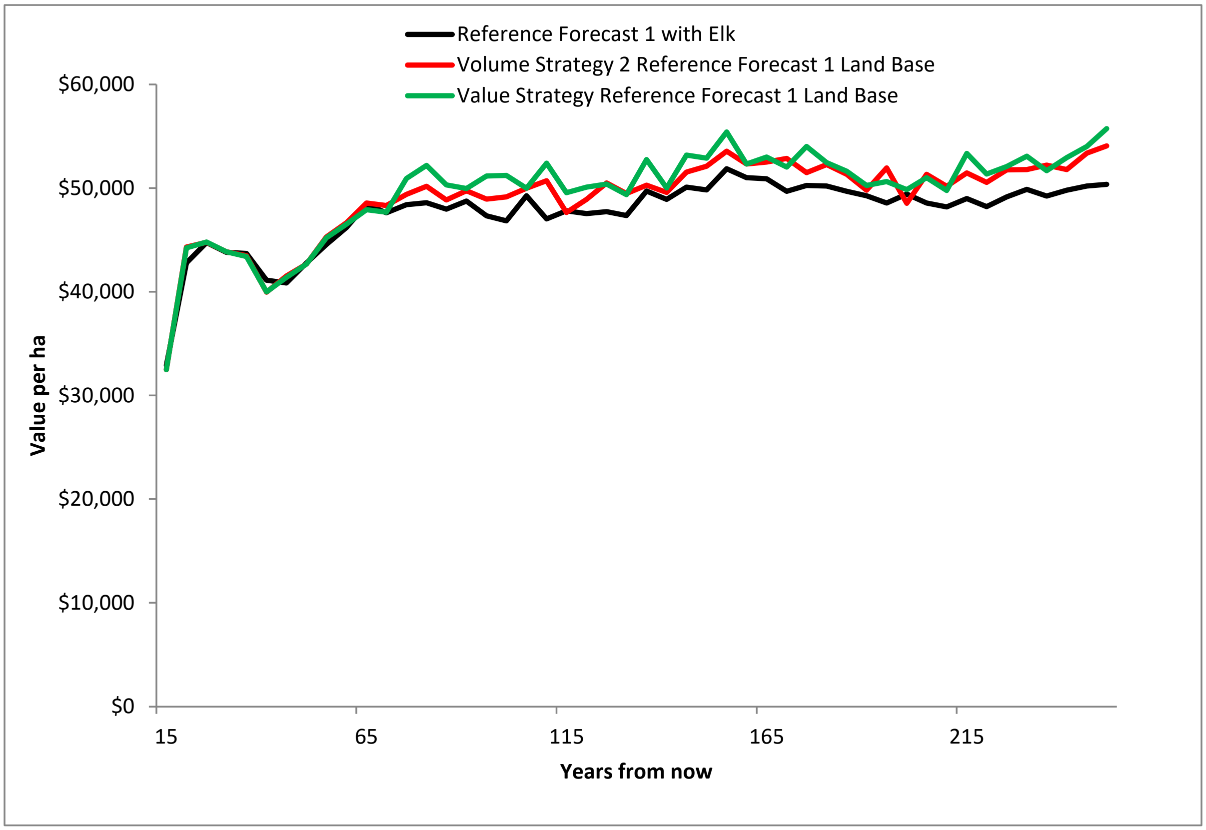

Figure 124: Predicted value per ha, managed stands; Volume Strategy2 and Value Strategy

Table 22: Predicted incremental silviculture expenditures; Volume Strategy 2 and Value Strategy

Year	Incremental Silviculture Expenditures ($/year)			
	Volume Strategy 2 Reference Forecast 1 Land Base	Volume Strategy 2 Reference Forecast 2 Land Base	Value Strategy Reference Forecast 1 Land Base	Value Strategy Reference Forecast 2 Land Base
5	1,147,446	1,146,886	1,186,392	1,185,775
10	298,653	296,572	328,291	325,863
15	365,964	360,963	396,099	392,244
20	348,369	331,054	368,864	347,743
25	267,354	259,694	300,801	286,135
30	282,437	268,434	295,815	270,131
35	316,966	315,818	350,521	341,179
40	282,999	279,409	305,319	311,039
45	438,414	389,670	431,599	407,899
50	414,804	425,031	441,891	430,467
55	521,099	503,362	539,363	501,054
60	550,712	520,939	483,351	505,539
65	534,811	539,132	535,405	505,326
70	574,124	576,194	519,784	533,425
75	504,170	483,819	544,939	540,345
80	547,431	531,544	590,824	545,669

Year	Incremental Silviculture Expenditures ($/year)			
	Volume Strategy 2 Reference Forecast 1 Land Base	Volume Strategy 2 Reference Forecast 2 Land Base	Value Strategy Reference Forecast 1 Land Base	Value Strategy Reference Forecast 2 Land Base
85	686,806	610,789	664,866	622,963
90	637,622	623,975	585,463	576,323
95	630,059	616,409	668,585	584,682
100	624,312	614,328	650,182	649,612

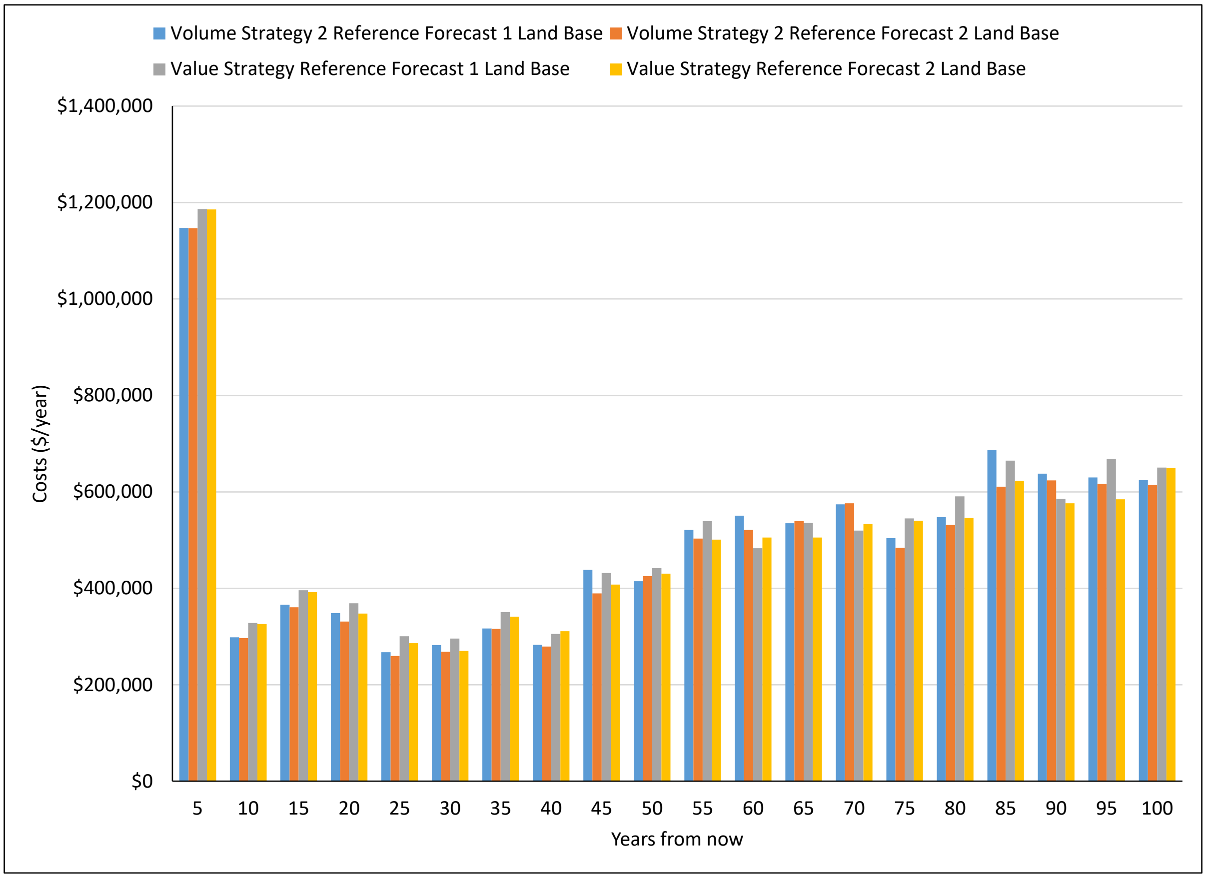

Figure 125: Predicted incremental silviculture expenditures; Volume Strategy 2 and Value Strategy

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