# Integrated Resource Management Plan
# Arrowsmith Timber Supply Area

## Modelling and Analysis Report

V 4.0

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Ministry of Forests, Lands, Natural Resource Operations and Rural Development

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# 1 Introduction

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

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

This project in the Arrowsmith TSA is a pilot project and it has been completed in conjunction with the on-going TSR.

# 2 Context

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

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

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

**3 Modeling and Analysis report –provides modeling outputs and rationale for choosing a preferred scenario.**

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

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

# 3 Analysis Assumptions

This analysis first built a dataset similar to the one constructed for the Arrowsmith TSA TSR. The intent was to use this TSR equivalent dataset to benchmark our forest estate model runs with those based on the current Arrowsmith TSA TSR, particularly the TSR Base Case. After benchmarking, the data set was modified by incorporating additional THLB netdowns and management objectives that reflect the goals and objectives of the IRMP. Hal MacLean of the Forest Analysis and Inventory Branch (FAIB), FLNRO provided most of the required data in ESRI file geodatabase format. Additional data layers were also provided by the South Island Natural Resource District in Port Alberni and the West Coast Region in Nanaimo. Analysis assumptions are detailed in the Arrowsmith TSA IRMP Data Package (FESL 2017).

## 3.1 Forest Level Analysis

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

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

## 3.2 Indicator Forecasts

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

**TSR Base Case Benchmark:** As the analysis assumptions are similar to those used in the on-going TSR, the benchmarking ensures that the general approach used in this analysis is consistent with that used in the TSR.

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

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

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

**Preferred Scenario:** Scenario that may combine components from learning scenarios; the basis of the IRMP.

## 3.3 Model

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

## 3.4 Sustainable Harvest

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

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

## 3.5 Determining the Harvest Level

Growing stock becomes stable when the rate of harvest equals the rate of growth of the forest. At low harvest levels stands are harvested after their MAI culmination age - provided that they have achieved their minimum harvestable volume - and the growing stock accumulates until an equilibrium is reached, often way 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 average MAI culmination of the land base. However, the presence of forest cover constraints such as VQOs can limit the ability of the model to harvest stands at culmination age. As a result, long-term harvest levels are typically somewhat lower than the maximum possible growth rate of the forest.

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

# *4 Analysis Results*

## 4.1 TSR Base Case Benchmarking

Figure 1 depicts the base case harvest forecast for the on-going TSR in comparison with a forecast carried out under this project. This project prepared an independent vector dataset from individual data layers and used mostly the same analysis assumptions as those in the TSR.

The medium and long-term harvest levels are almost identical to those of the TSR; however the difference in the short-term harvest is 5.7%. Note that the short-term harvest had to be reduced to avoid a timber constraint driven pinch point (VQOs) in around 30 years. We believe these differences in analysis results are acceptable given the differences in model function and data processing (raster vs. vector).

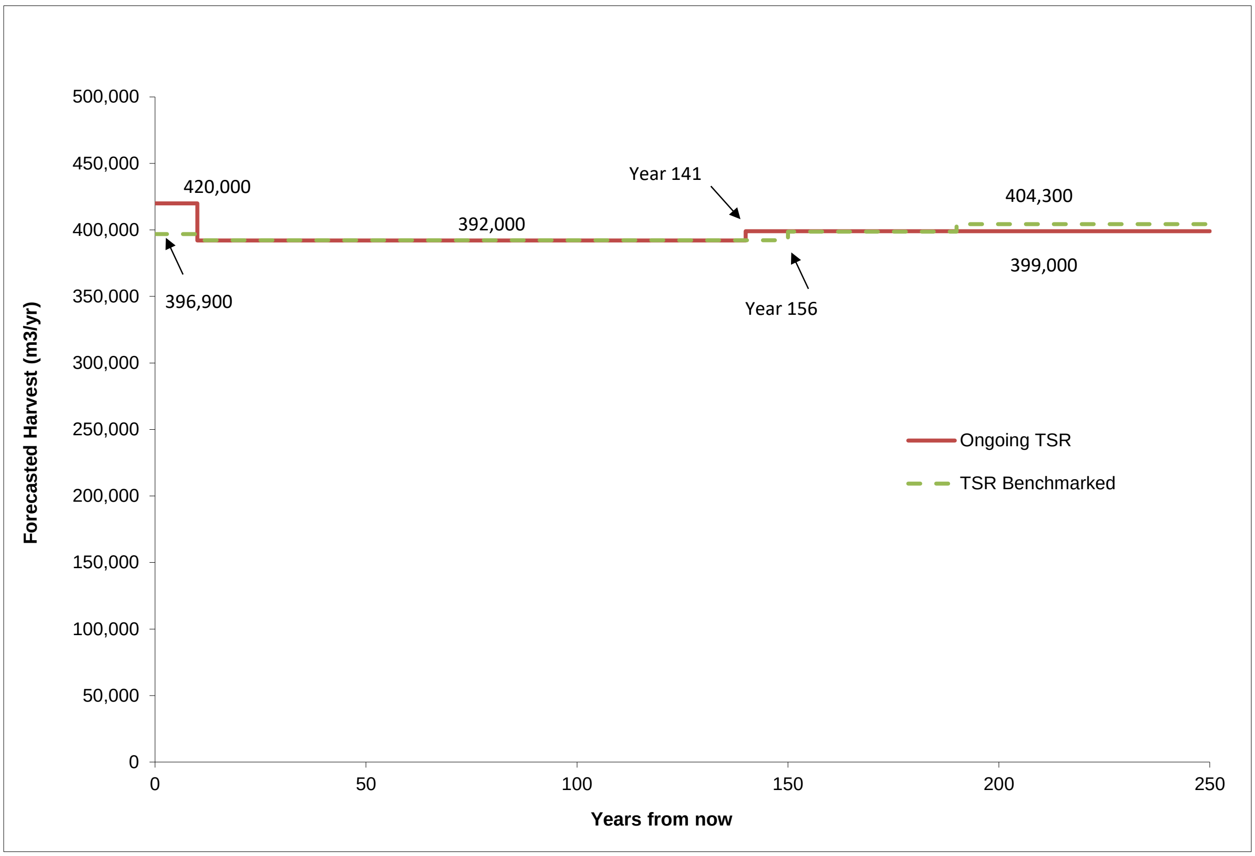


***Figure 1: Benchmarked TSR base case***

## 4.2 TSR Base Case Benchmarking using TASS

The IRMP harvest forecasts used revised managed stand yield curves modeled with TASS. Stand yields modeled using TASS tend to be somewhat different from those modeled with TIPSY. Also, these yield curves included impacts of past spacing and past fertilization not accounted for in the TSR.

It is important to understand the cumulative impact of incorporating past treatments in the analysis, and using a different growth and yield model on timber supply. Figure 2 depicts the harvest forecast using TASS as a growth and yield model for managed stands, while incorporating past spacing and fertilization in the analysis. As seen in Figure 2, the harvest in the medium and long terms had to be reduced compared to the TSR base case and the benchmark run with TIPSY yields. The medium - term reduction was around 4.8%, while the in the long term it varied from 3.0 % to 4.6%.

The short-term forecast was only 1.6% less than the TSR base case, but 4.1% higher than the benchmark run with TIPSY yield curves.

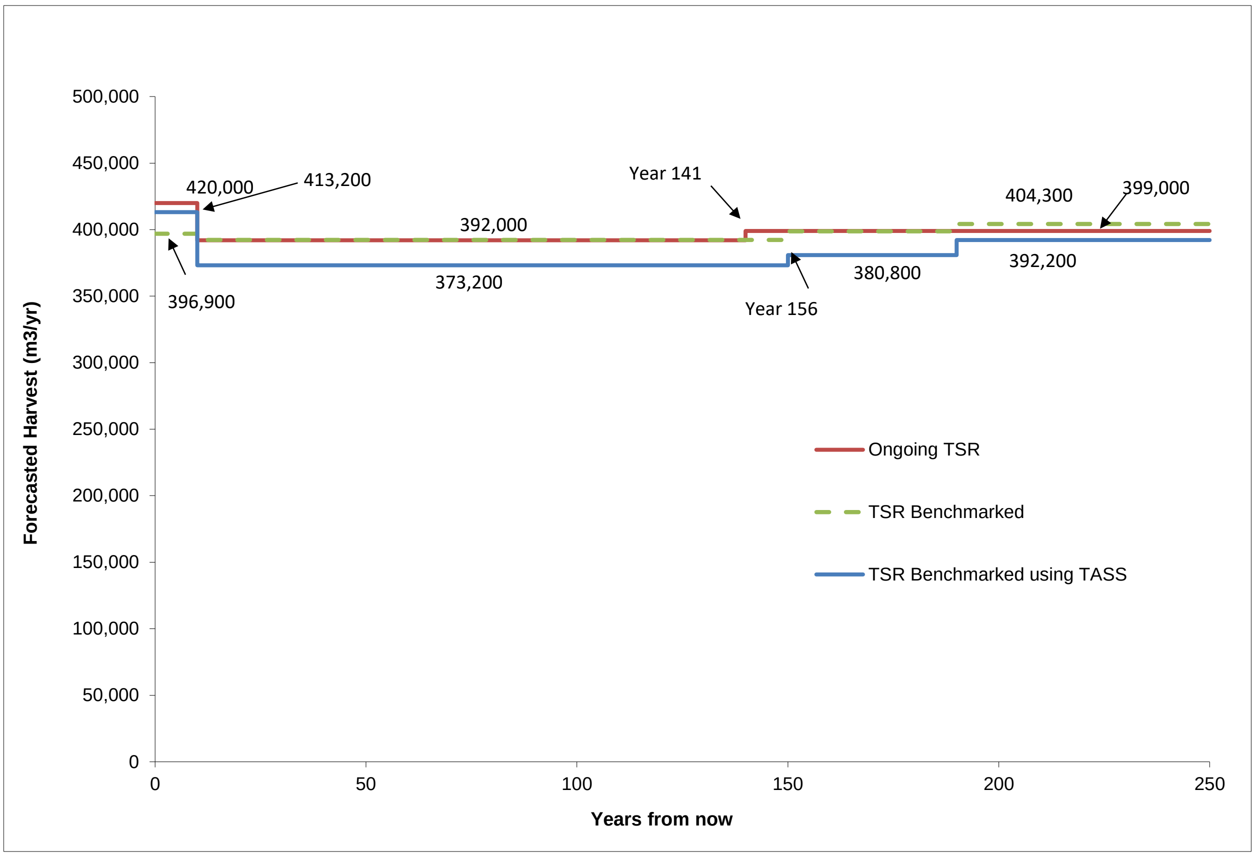


***Figure 2: Benchmarked TSR base case using TASS***

## 4.3 IRMP Base Case

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

***Table 1: IRMP Base Case assumptions***

| **Objectives and overall assumptions** | **Characterize current management to the extent practicable** |
|---|---|
| Land base assumptions | • Incorporate projected tenures in the analysis;<br>• Remove Ditidaht red zone from the THLB;<br>• Exclude Clayoquot Sound from the analysis;<br>• Incorporate proposed Northern Goshawk (NOGO) WHAs and nests currently outside of WHAs in the analysis;<br>• Use most TSR assumptions as they are;<br>• Incorporate woodshed volume targets, woodshed based NOGO restrictions and woodshed based harvest deferrals in the analysis. |
| Harvest assumptions | • Attempt to harvest 100,000 $m^3$/year on average off the east zone;<br>• Use oldest first harvest rule in the west zone. |
| Silviculture assumptions | • Use revised managed stand yield curves; include impacts of past spacing and impacts of past fertilization;<br>• Incorporate shading effect as in TSR. |
| Habitat assumptions | • Report on NOGO forage habitat;<br>• Report on Marbled Murrelet (MAMU) habitat. |

The additional land base reductions and excluding the Clayoquot zone from the analysis reduced the Timber Harvesting Land Base (THLB) to 43,853 ha (21,607 ha reduction). This is reflected in the timber supply forecast; a harvest level of 280,900 $m^3$ per year can be maintained for 160 years after which the harvest can be elevated to the long-term harvest level (LTHL) of 292,365 $m^3$ per year (Figure 3).

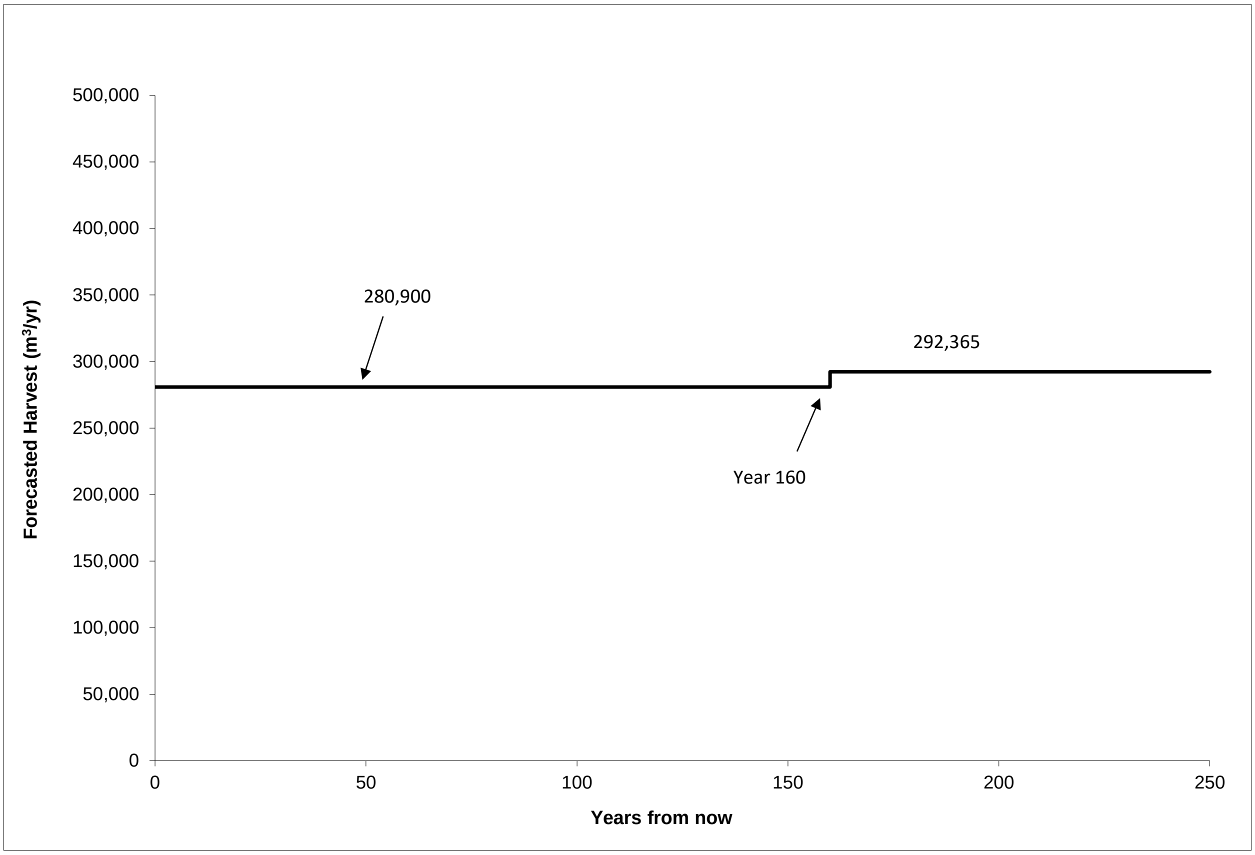


***Figure 3: IRMP Base Case harvest forecast***

Figure 4 illustrates the predicted development of the growing stock for the IRMP Base Case. In spite of the increasing growing stock in the long term, it was not possible to increase the LTHL due to constraints on the land base, mainly VQOs.

Figure 5 shows the harvest forecast by species. Note that a substantial volume of Hw is expected to be harvested over time. During the first 75 years almost one third of the harvest is predicted to be Hw.

Figure 6 depicts the harvest forecast by age class. The harvest of old growth is expected to continue for some time. Throughout the mid and the long term, approximately 50% of the harvest is expected to come from stands between 41 and 80 years old. This is also reflected in Figure 7 illustrating the predicted average harvest age. The average harvest age is high at first due to the harvest of older stands; however it stabilizes at around 75 years in the long term.

Figure 8 illustrates the harvest forecast by vol/ha classes while Figure 9 shows the predicted average harvest volume over time. In the long run, the average harvest volume is predicted to fluctuate around 600 $m^3$ per ha. This corresponds to an average annual harvest area of approximately 450 ha (Figure 10).

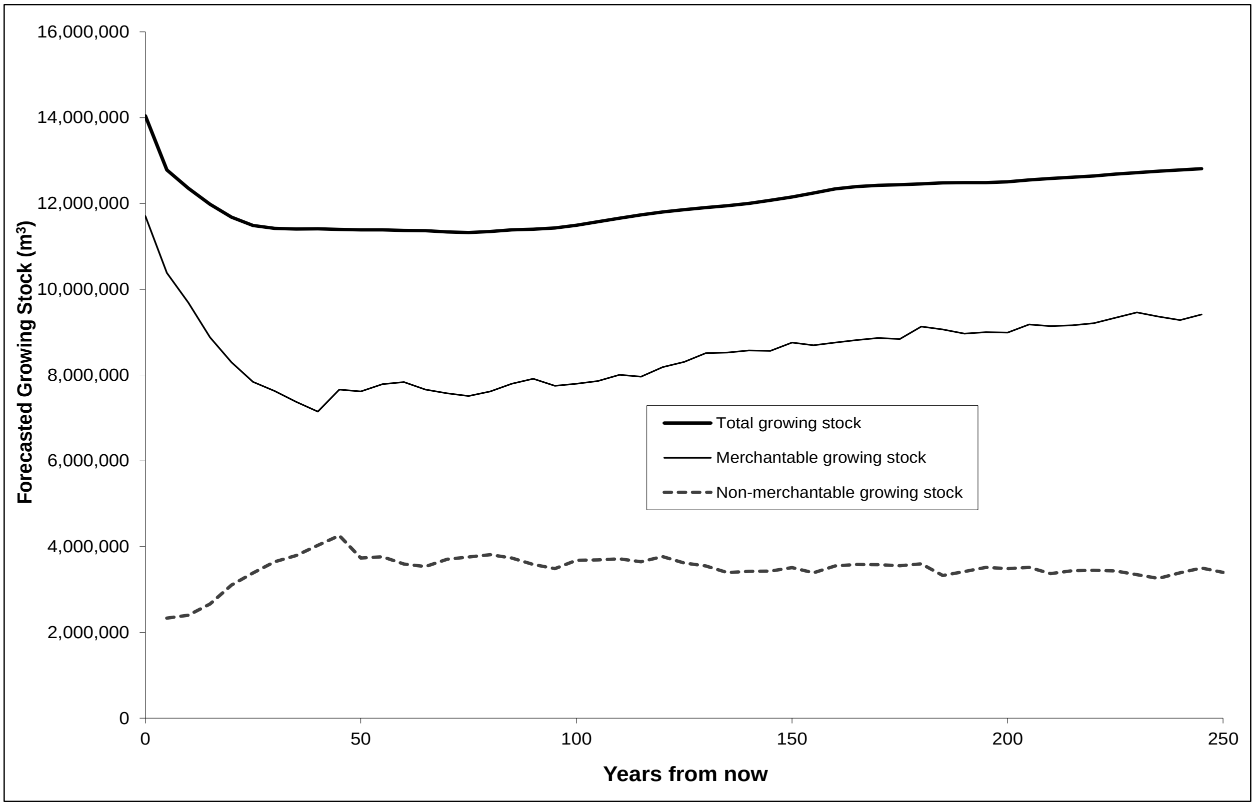


*Figure 4: Predicted growing stock development, IRMP Base Case*

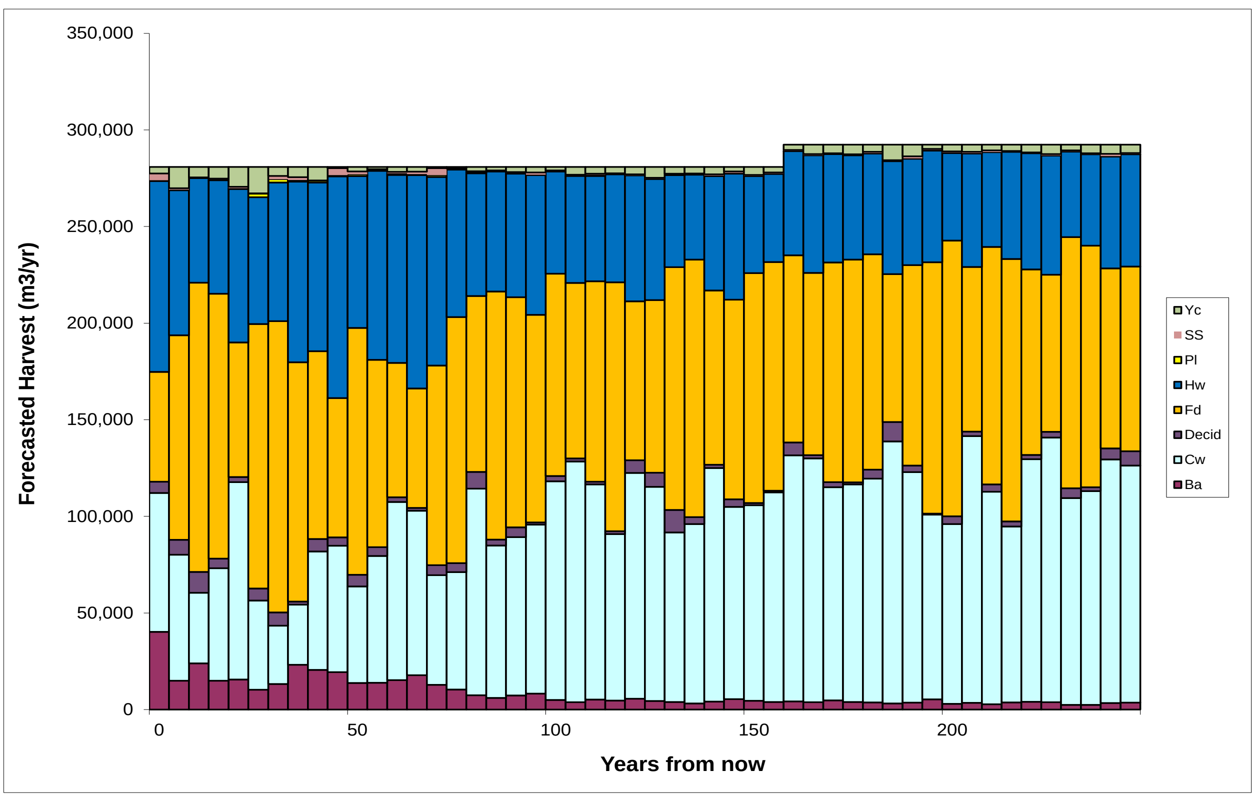


*Figure 5: Harvest forecast by species, IRMP Base Case*

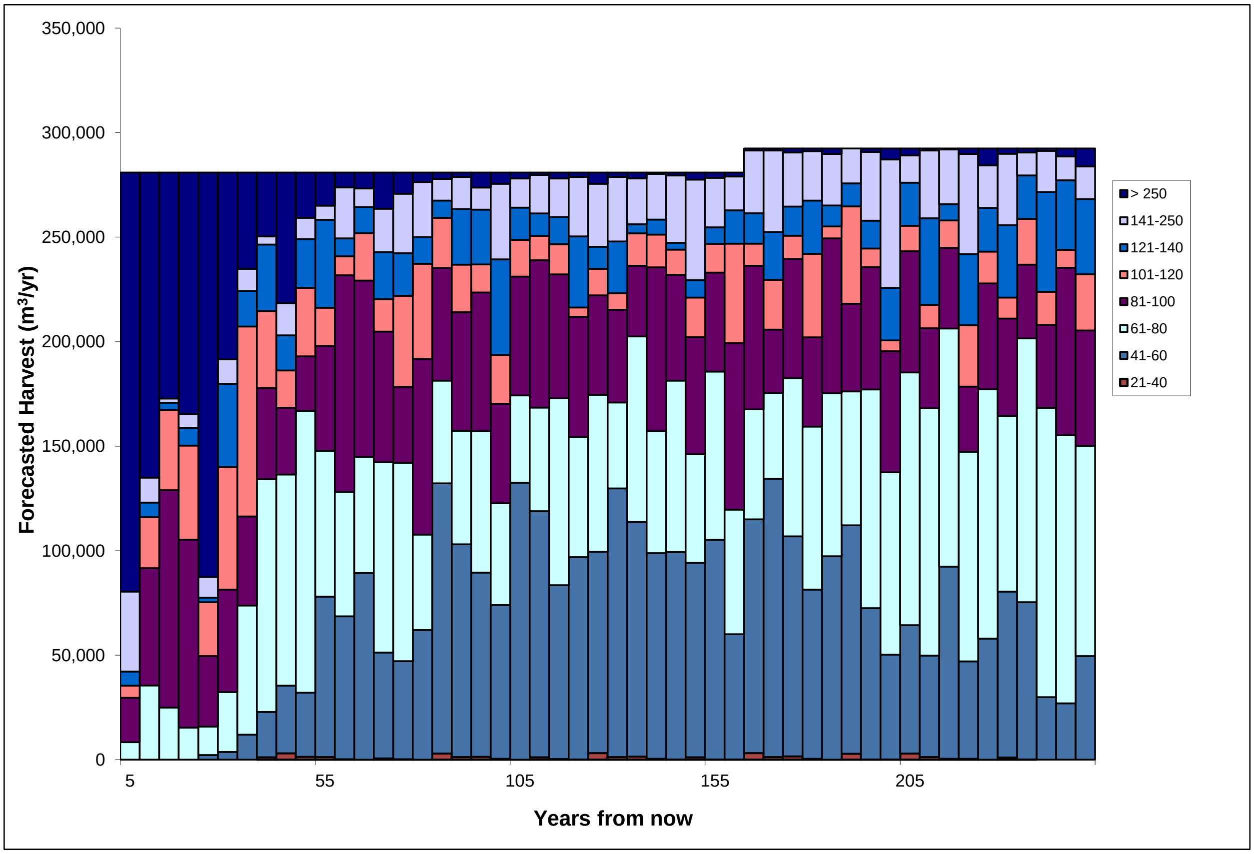


***Figure 6: Harvest forecast by age class, IRMP Base Case***

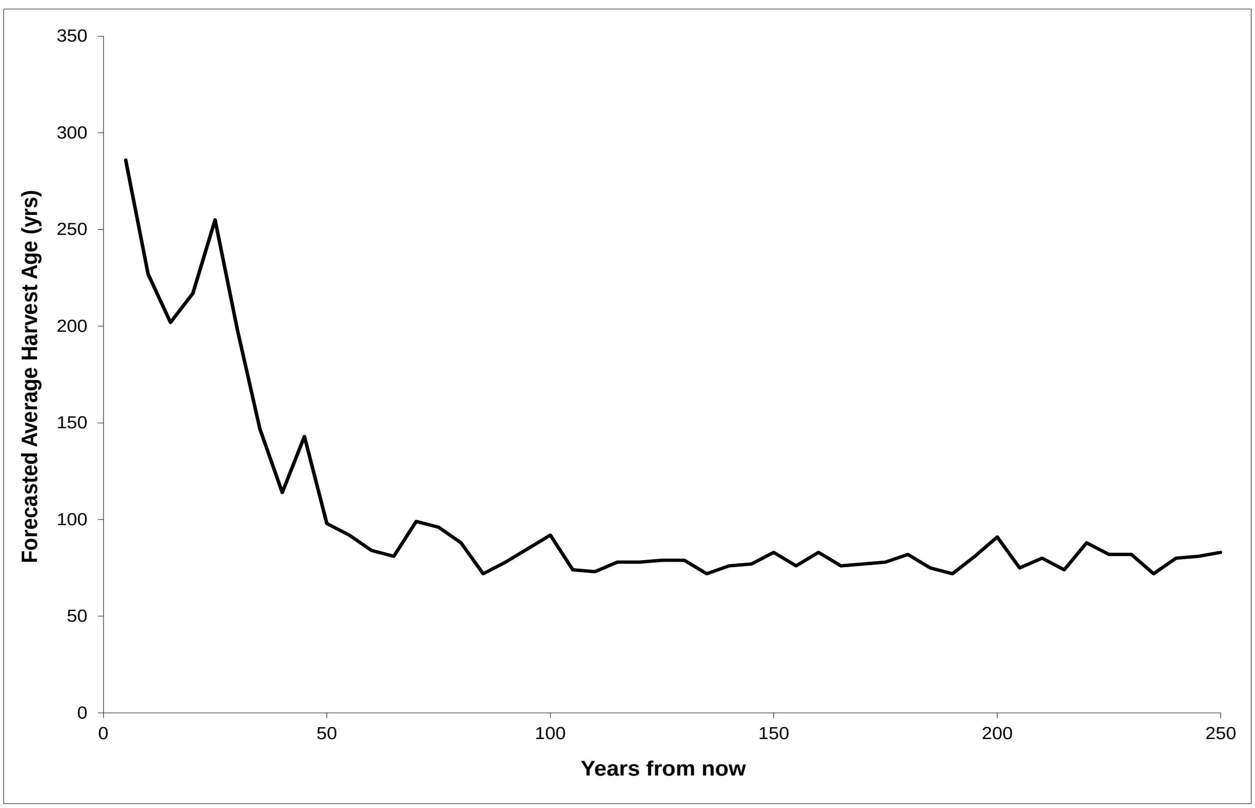


***Figure 7: Average harvest age, IRMP Base Case***

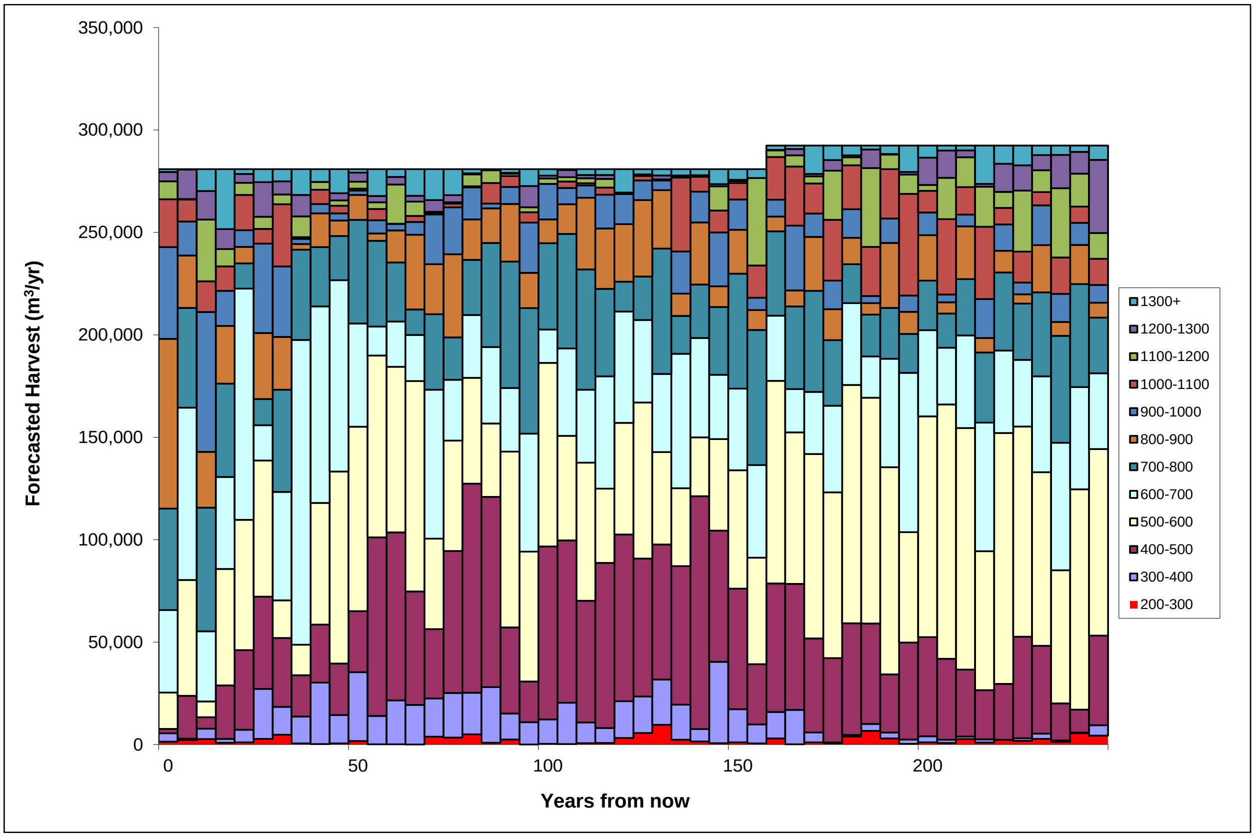


***Figure 8: Harvest forecast by volume per ha class, IRMP Base Case***

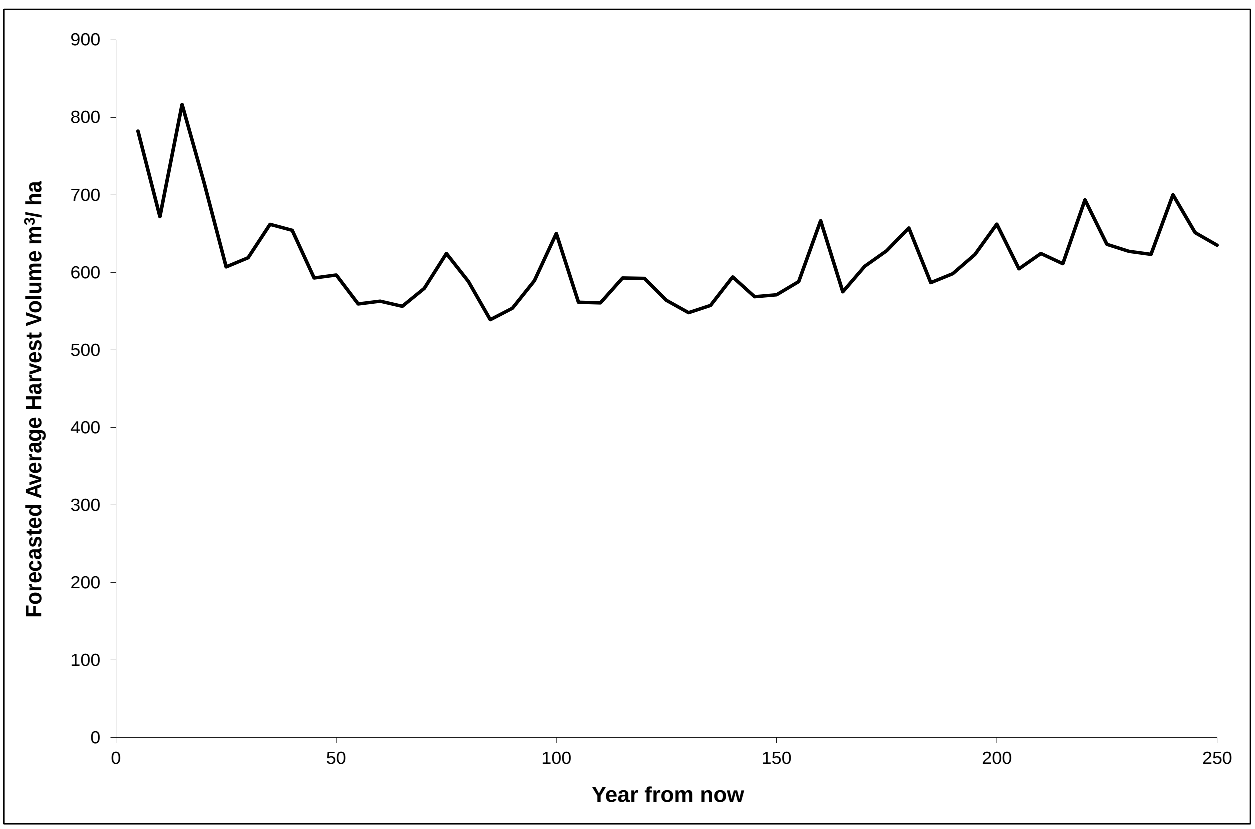


***Figure 9: Predicted average harvest volume, IRMP Base Case***

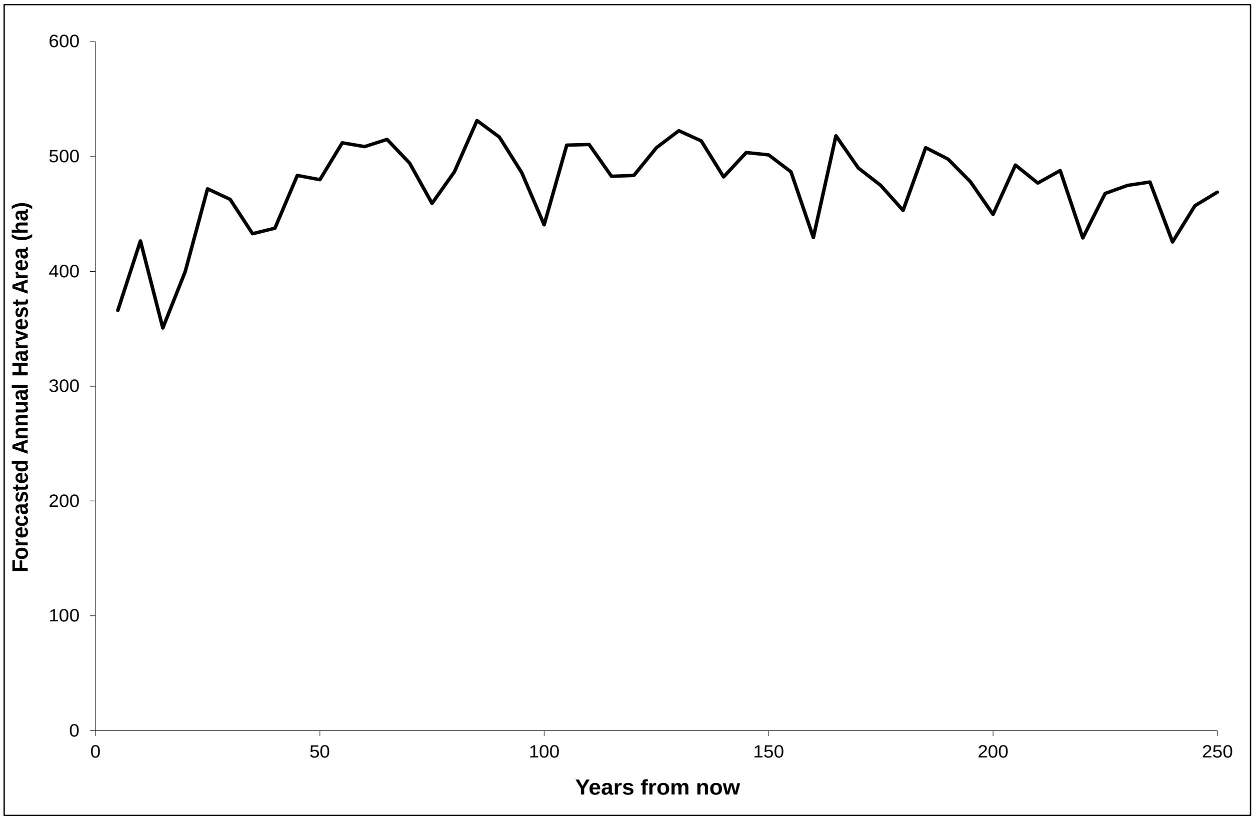


***Figure 10: Predicted average harvest area, IRMP Base Case***

Figure 11 illustrates the IRMP Base Case harvest forecast by zone. On average, around 95,000 $m^3$ (33% – 34%) is expected to be harvested annually from the east zone over time, with the west zone harvest averaging 190,000 $m^3$ per year (66% - 67%).

The majority of the harvest is predicted to come from areas where conventional harvesting is prevalent (around 64% over time); however, cable and helicopter harvesting methods are also significant (11% and 25% over time correspondingly, Figure 12).

Figure 13 and Figure 14 depict the predicted age class distribution over time in the THLB and the Crown Forested Land Base (CFLB) correspondingly. Over time age classes 1 to 4 are forecasted to cover approximately 80% of the THLB (Figure 13). Older age classes, especially age classes 8 and 9 are well represented in the Non-Harvestable Land Base (NHLB) and contribute significantly to the mature and old seral stages of the CFLB (Figure 14).

Figure 15 illustrates the predicted volume of Cw in the CFLB over time. Due to the large areas in reserves in the Arrowsmith TSA, it is expected that older age classes of Cw containing large timber volumes will remain in the land base.

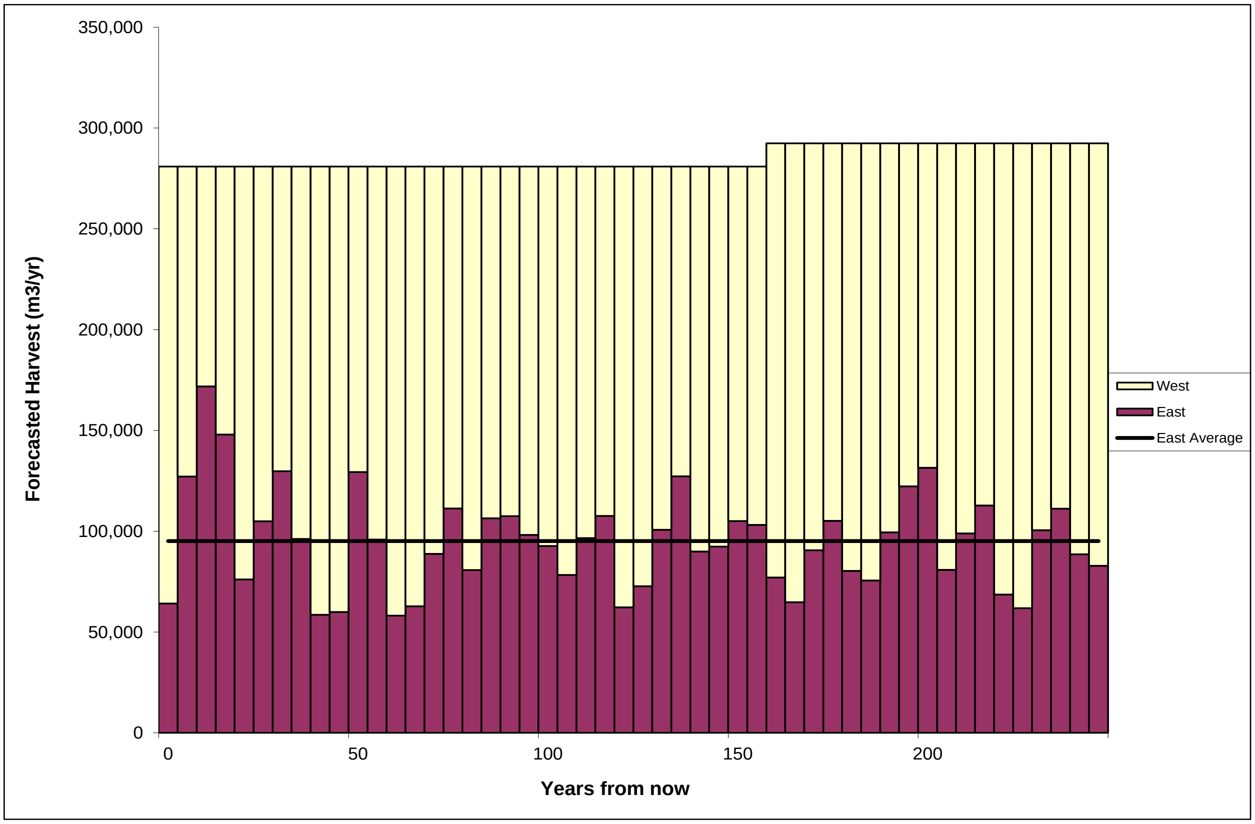


***Figure 11: Harvest forecast by zone, IRMP Base Case***

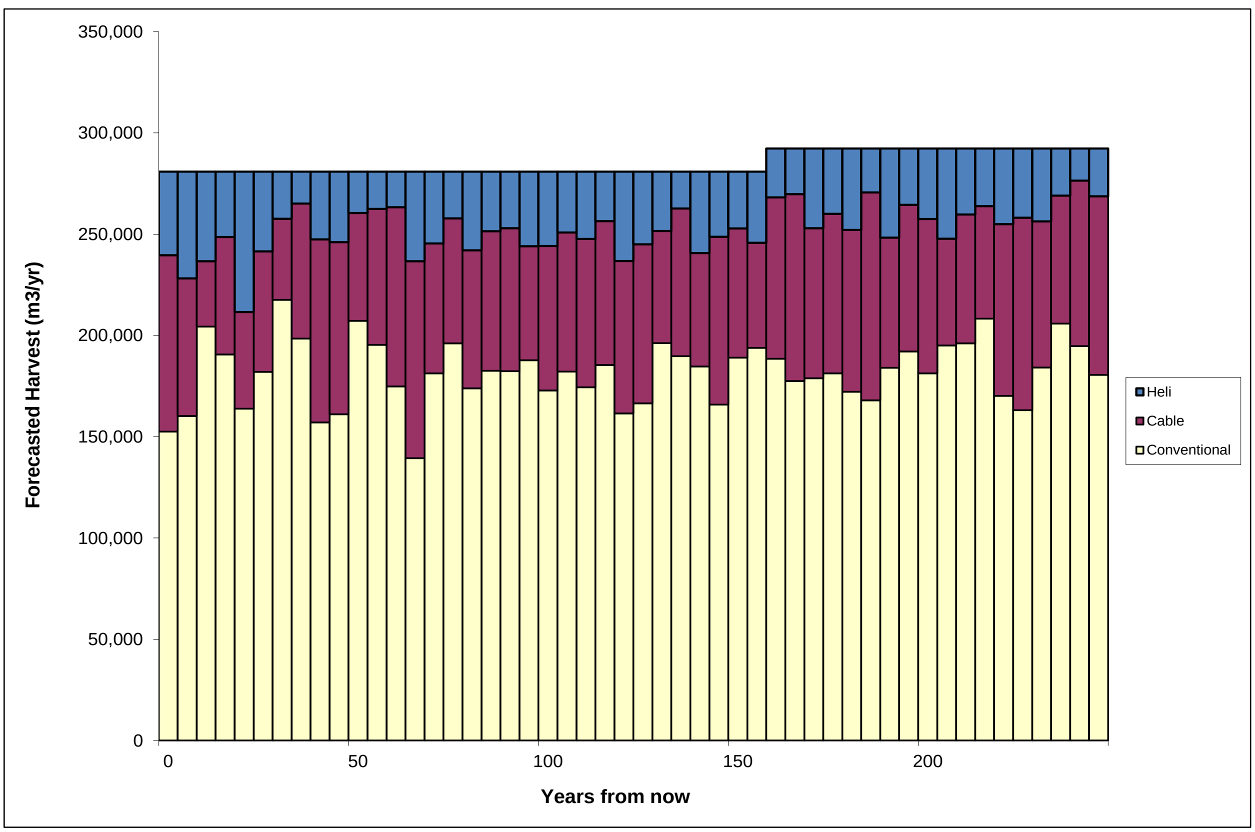


***Figure 12: Harvest forecast by harvest method, IRMP Base Case***

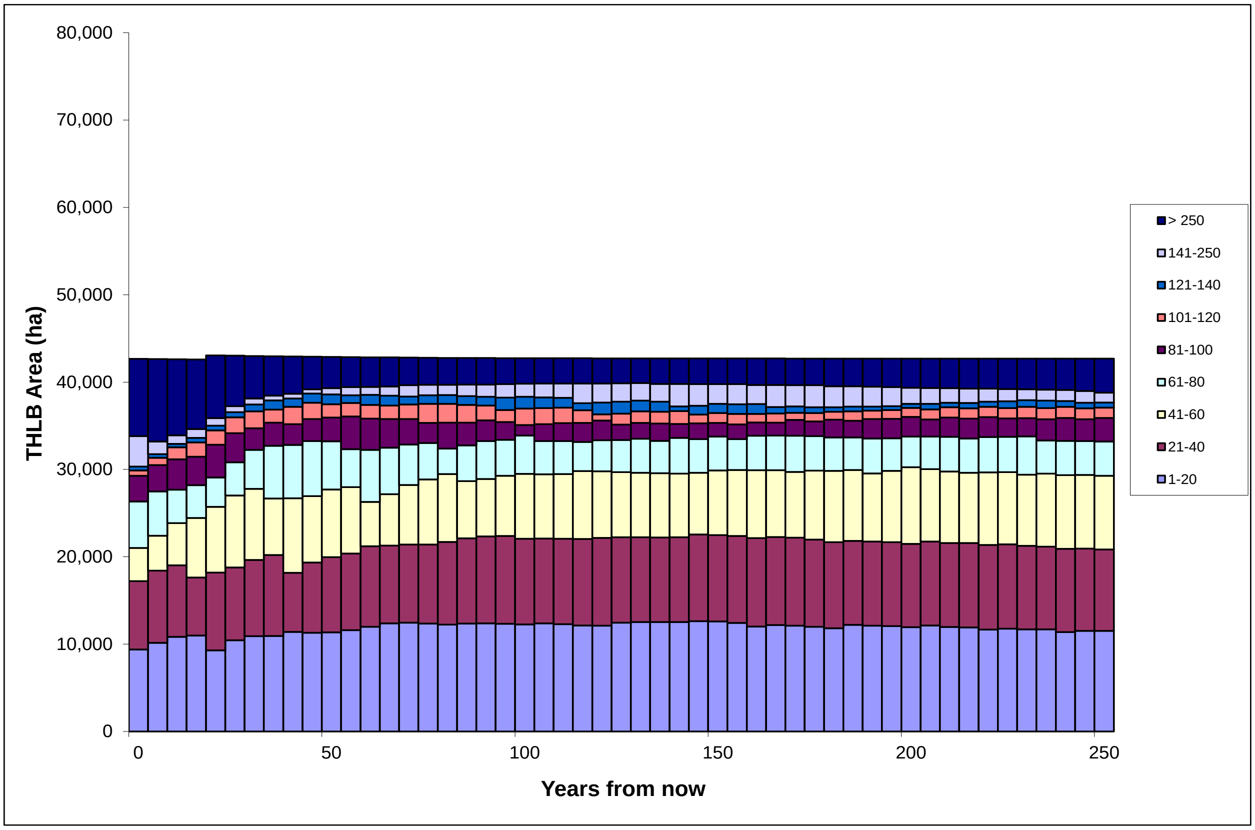


***Figure 13: Predicted age class distribution over time on the THLB, IRMP Base Case***

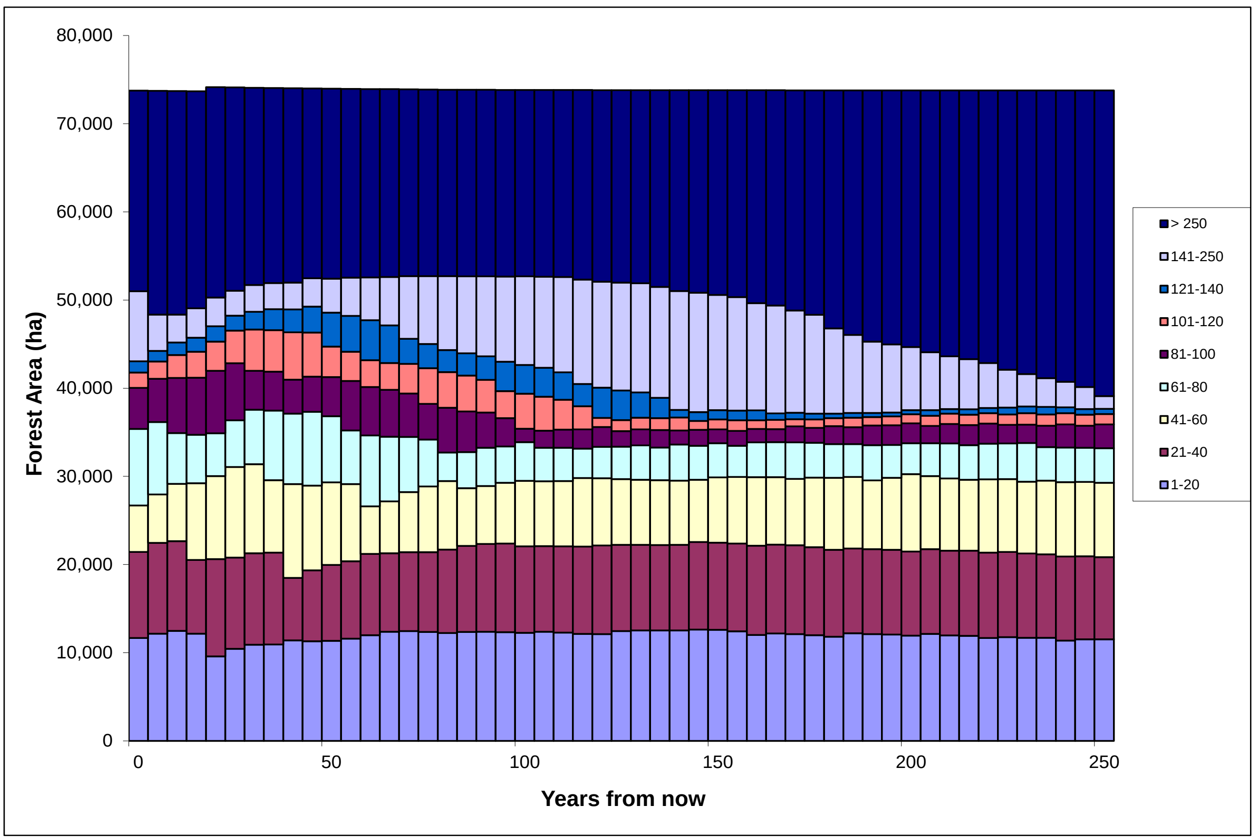


***Figure 14: Predicted age class distribution over time on the CFLB, IRMP Base Case***

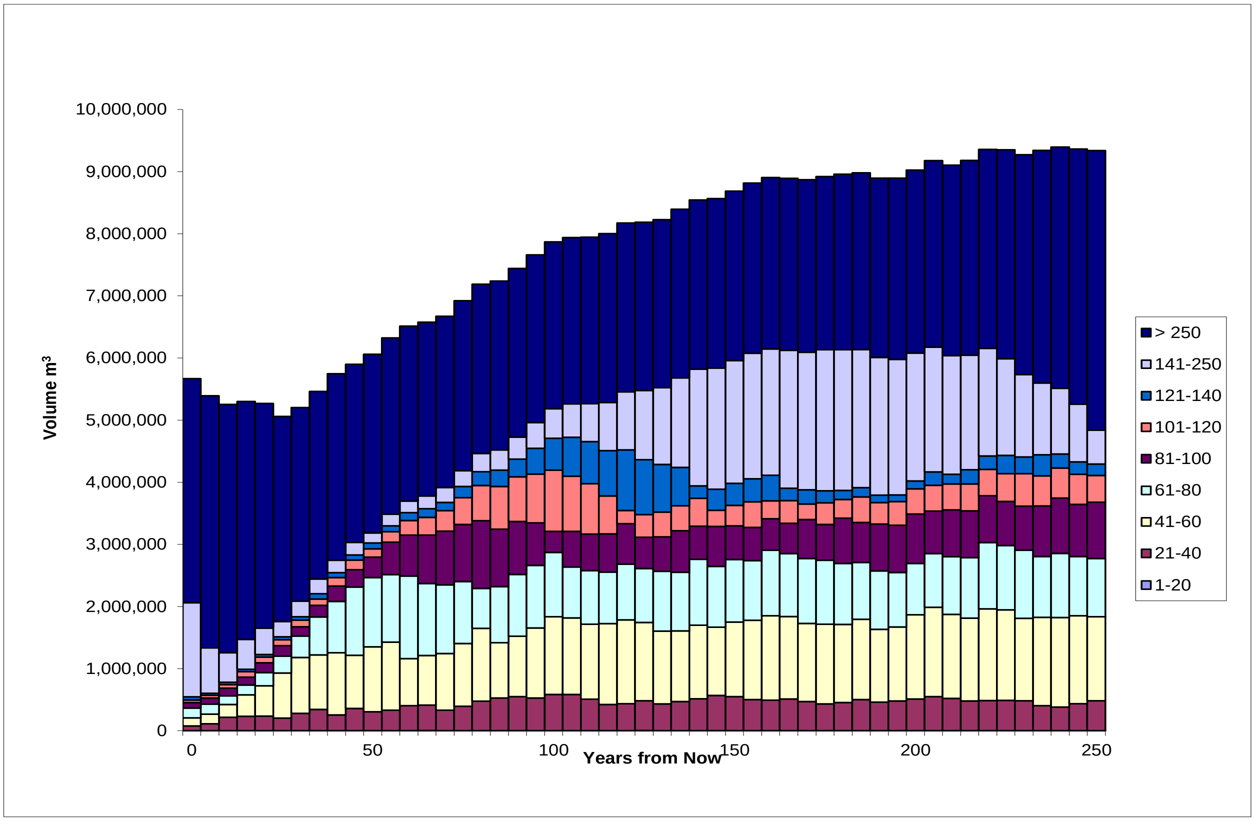


***Figure 15: Predicted volume of Cw by age class in the CFLB, IRMP Base Case***

Figure 16 depicts the predicted MAMU habitat over time in the west zone for the IRMP Base Case. A large portion of the habitat is met from the NHLB. Over time the MAMU habitat stabilizes at around 60% of the 2002 habitat in the west zone.

Figure 17 illustrates the forecasted NOGO foraging habitat for the entire CFLB over the planning horizon. In the long run, approximately 47% of the CFLB remains as NOGO foraging habitat. However, as the foraging habitat distribution is not controlled in the model, individual forage areas may or may not contain adequate foraging habitat. Figure 18 shows the predicted NOGO forage habitat in the Holland Creek forage area (1,225 ha of forest). In this area, the foraging habitat is not maintained and only around 16% of the forest remains as foraging habitat in the long term coming mainly from the NHLB.

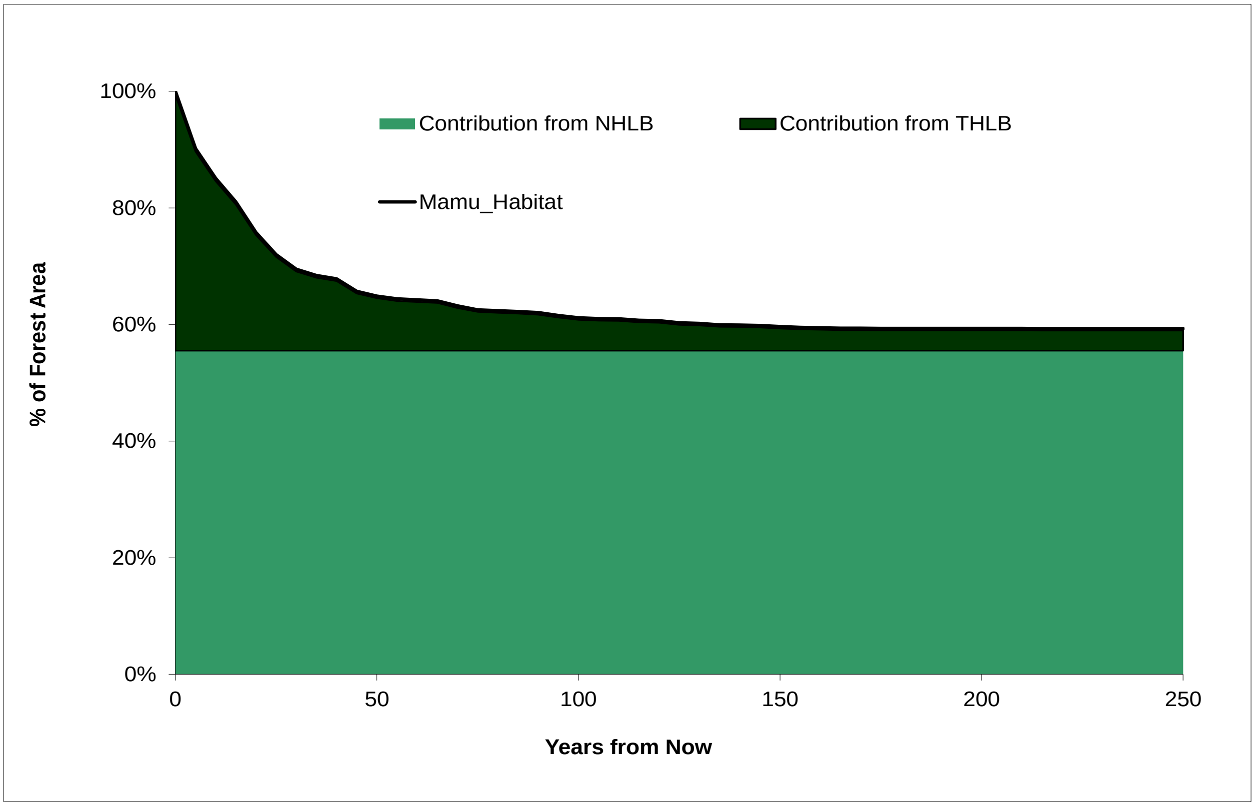


***Figure 16: MAMU habitat in the CFLB, west zone, IRMP Base Case***

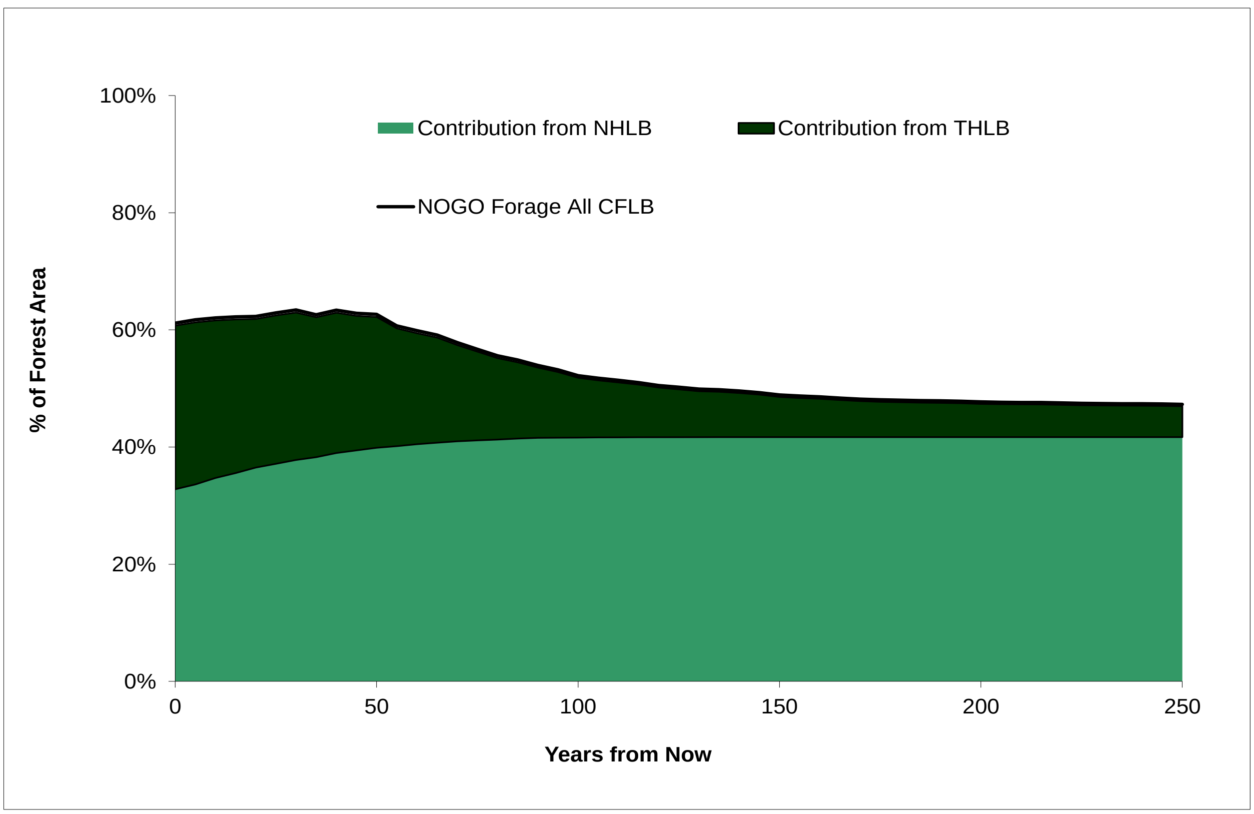


***Figure 17: NOGO foraging habitat in the CFLB, IRMP Base Case***

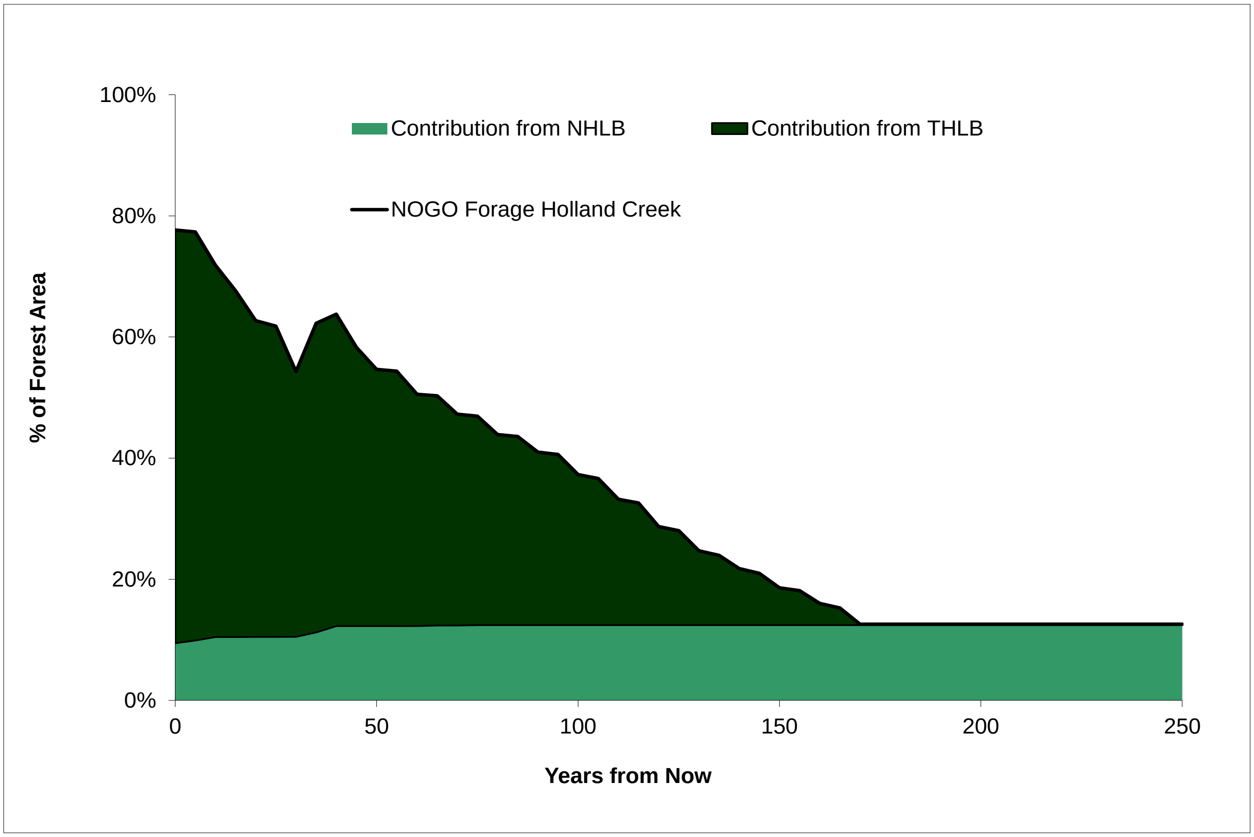


***Figure 18: NOGO foraging habitat in the Holland Creek forage area, IRMP Base Case***

## 4.4 Learning Scenarios

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

The following strategies were explored in this analysis:

### 4.4.1 Volume Scenarios

#### *4.4.1.1 Treat existing and future managed stands for volume; minimum harvest criteria 350 m³ per ha in conventional harvest areas and at 450 m³ per ha in helicopter harvest areas*

1. Existing managed stands: fertilize existing managed Fd stands at ages 30, 40, 50, 60 and 70 on good and medium sites.
2. Future stands: where ecologically suitable, plant hi-gain genetically improved Hw (GW=20%) instead of Cw or Fd.

   On potential root rot sites in the east region complete stumping (and reduce OAF2 to 5%) and plant a higher density of a mix of Fd and Pw.

Fertilize future Fd stands on good and medium sites at ages 30, 40, 50, 60 and 70.

The minimum harvest criteria was this run were kept the same as in the IRMP Base Case, i.e. minimum volume of 350 $m^3$ per ha for conventional harvest areas and 450 $m^3$ per ha for helicopter harvest areas.

#### 4.4.1.2 Treat existing and future managed stands for volume; minimum harvest criteria set at age where 95% of the mean annual increment (MAI) culmination is achieved for each managed stand yield curve

1. Existing managed stands: fertilize existing managed Fd stands at ages 30, 40, 50, 60 and 70 on good and medium sites.
2. Future stands: where ecologically suitable, plant hi-gain genetically improved Hw (GW=20%) instead of Cw or Fd.

   On potential root rot sites in the east region complete stumping (and reduce OAF2 to 5%) and plant a higher density of a mix of Fd and Pw.

   Fertilize future Fd stands on good and medium sites at ages 30, 40, 50, 60 and 70.

   The minimum harvest criteria were set at age where 95% of the mean annual increment (MAI) culmination is achieved for each managed stand yield curve.

<u>Treatment areas and costs</u>

Table 2 and Table 3 show the annual average treatment areas and treatment costs over 20, 50 and 250 years. The treatment costs were assumed to be $500 per ha for fertilization and $2,500 per ha for juvenile spacing.

***Table 2: Annual average treatment areas, volume scenarios***

| Scenario | Average Fertilized Area (ha/yr) | | | Average Juvenile Spaced Area (ha/yr) | | |
|---|---|---|---|---|---|---|
| | 20 | 50yrs | 250yrs | 20yrs | 50yrs | 250yrs |
| Vol MHA | 150 | 225 | 413 | 0 | 0 | 4 |
| Vol 95% MAI | 155 | 253 | 462 | 0 | 0 | 5 |

***Table 3: Annual average treatment costs, volume scenarios***

| Scenario | Average Fertilization Costs ($/yr) | | | Average Juvenile Spacing Costs ($/yr) | | |
|---|---|---|---|---|---|---|
| | 20yrs | 50yrs | 250yrs | 20yrs | 50yrs | 250yrs |
| Vol MHA | 75,000 | 112,000 | 207,000 | 0 | 0 | 10,000 |
| Vol 95% MAI | 77,000 | 127,000 | 231,000 | 0 | 0 | 13,000 |

#### 4.4.1.3 Relax VQOs by one class to simulate impact of partial harvesting

As a surrogate to model partial cutting, relax retention and partial retention VQOs by one class. The intent was not to actually relax VQOs but to gauge what the maximum impact of partial harvesting might be. The scenario would then assume that only a part of the benefit would be realized due to partial harvesting. This approach was chosen due to the difficulty in modelling partial harvesting.

### 4.4.2 Value Scenarios

#### *4.4.2.1 Treat existing and future managed stands for value; minimum harvest criteria 350 m³ per ha in conventional harvest areas and at 450 m³ per ha in helicopter harvest areas*

1. Existing stands: space available Cw stands in the west region on good and medium sites to favour Cw and fertilize at ages 30, 40, 50, 60 and 70.
2. Future stands: where ecologically suitable, plant Cw instead of Hw or Fd and space to favour Cw and fertilize at ages 30, 40, 50, 60 and 70.

   On Dr sites in the east region plant Dr (as per the IRMP Base Case) and juvenile space and schedule harvesting for between age 25 and 35 years.

#### *4.4.2.2 Treat existing and future managed stands for value; minimum harvest criteria set at age where 95% of the mean annual increment (MAI) culmination is achieved for each managed stand yield curve*

1. Existing stands: space available Cw stands in the west region on good and medium sites to favour Cw and fertilize at ages 30, 40, 50, 60 and 70.
2. Future stands: where ecologically suitable, plant Cw instead of Hw or Fd and space to favour Cw and fertilize at ages 30, 40, 50, 60 and 70.

   On Dr sites in the east region plant Dr (as per the IRMP Base Case) and juvenile space and schedule harvesting for between age 25 and 35 years.

As the volume regimes involving Fd (stumping and fertilization) and Dr stands (spacing and early harvest) also provide increases in value, these regimes are also included in the value scenarios runs.

<u>Treatment areas and costs</u>

Table 4 and Table 5 show the annual average treatment areas and treatment costs over 20, 50 and 250 years. The treatment costs were assumed to be $500 per ha for fertilization and $2,500 per ha for juvenile spacing.

***Table 4: Annual average treatment areas, value scenarios***

| Scenario | Average Fertilized Area (ha/yr) | | | Average Juvenile Spaced Area (ha/yr) | | |
|---|---|---|---|---|---|---|
| | 20 | 50yrs | 250yrs | 20yrs | 50yrs | 250yrs |
| Value MHA | 150 | 233 | 464 | 74 | 95 | 182 |
| Value 95% MAI | 154 | 252 | 523 | 74 | 90 | 126 |

***Table 5: Annual average treatment costs, value scenarios***

| Scenario | Average Fertilization Costs ($/yr) | | | Average Juvenile Spacing Costs ($/yr) | | |
|---|---|---|---|---|---|---|
| | 20yrs | 50yrs | 250yrs | 20yrs | 50yrs | 250yrs |
| Value MHA | 75,000 | 117,000 | 232,000 | 185,000 | 238,000 | 454,000 |
| Value 95% MAI | 77,000 | 126,000 | 262,000 | 185,000 | 225,000 | 316,000 |

#### 4.4.2.3 Increase the MHA to MAI culmination and observe the impact on timber supply and value.

This scenario tested the impact of setting the minimum harvest age at the age where the MAI culmination is achieved. No future silviculture investments were included.

### 4.4.3 Habitat and Biodiversity Scenarios

#### 4.4.3.1 NOGO Forage Habitat

Three analysis runs were completed:

1. The first analysis follow the NOGO federal recovery strategy management direction with a 40% target of forage habitat within each forage area.
2. The second analysis increased the forage area target to 60%.
3. The third analysis tested the impact of setting just one TSA-wide forage habitat target. The target was set at 40%.

#### 4.4.3.2 MAMU Habitat

This scenario followed the recovery strategy for MAMU with the conservation area targets. The target was set at 60% of the 2002 habitat in the west zone and 90% in the east zone.

#### 4.4.3.3 Increase Retention in Riparian Management Zones (RMZ)

This scenario tested the impact of higher retention levels for riparian management zones (RMZ). RMZs were removed from the THLB.

## 4.5 Learning Scenario Results

### 4.5.1 Stand level results

#### 4.5.1.1 Existing stands

Figure 19 and Figure 20 illustrate the predicted merchantable volume and log volume impact of four fertilization treatments of a contemporary Fd leading stand on a good site in the East zone (this analysis unit represents about 860 hectares of THLB). Multiple fertilizations of this stand type result in a large increase in stand volume (about 250 $m^3$/ha with 5 treatments).

Figure 19 and Figure 20 also allow for a comparison between the predicted merchantable volume and the log volume for the IRMP Base Case; the log volume is about 6% lower than merchantable volume at 60 years and about 2% less at 80 years. The reduced log recovery at younger harvest ages reflects the economic challenges of utilizing smaller piece sizes and is a factor that may need to be considered in TSR in management units where early harvesting is expected to be prevalent. TSR yields are usually predicted using merchantable stand volumes.

Multiple fertilizations can also create a marginal increase in average log value, if harvesting is carried out between ages 45 and 75 years (Figure 21). This is likely because this treatment regime produces a higher proportional volume of large gang and sawlogs. Figure 22 shows that this intensive fertilization regime creates about $18,000 per hectare in additional stand value at 60 years (42% increase) and $32,000 per hectare at 80 years (48% increase). With an average fertilization cost of $500 per hectare and 2% interest rate, this intensive fertilization regime is financially viable at stand level.

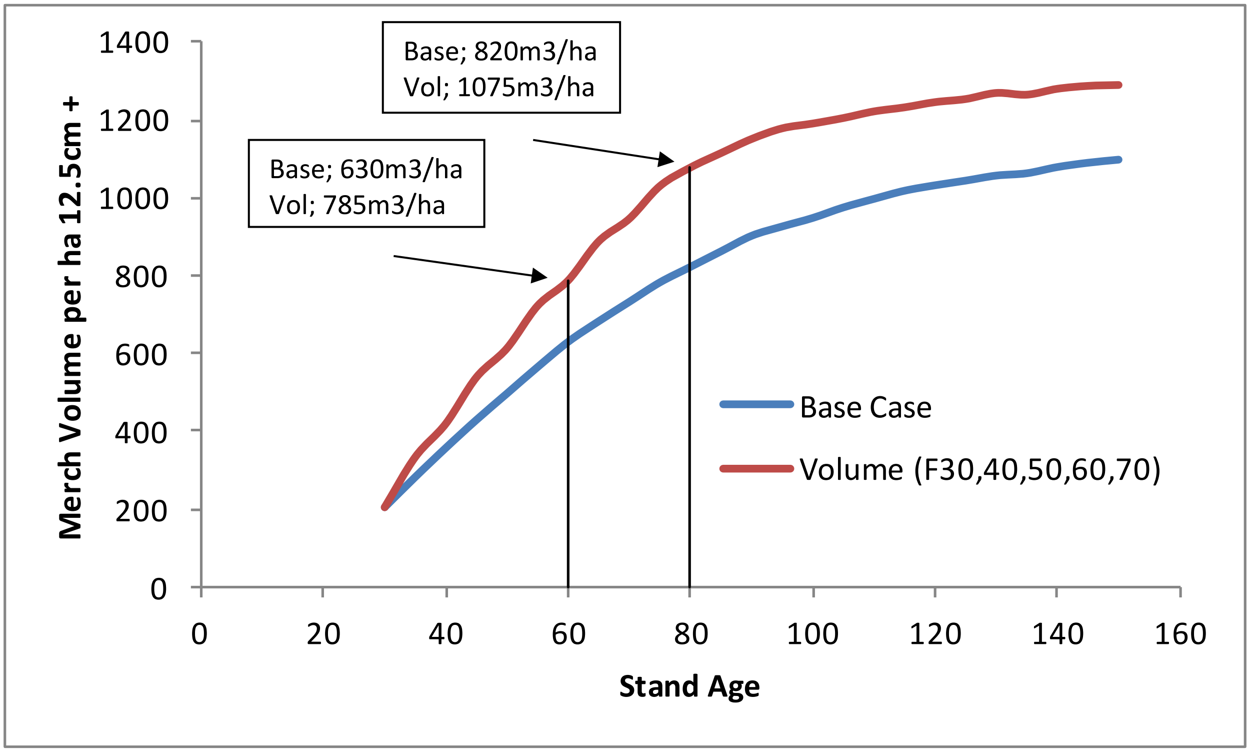


***Figure 19: Volume scenario yield forecast for Fd leading, good site contemporary plantations in the East zone using merchantable volume per hectare***

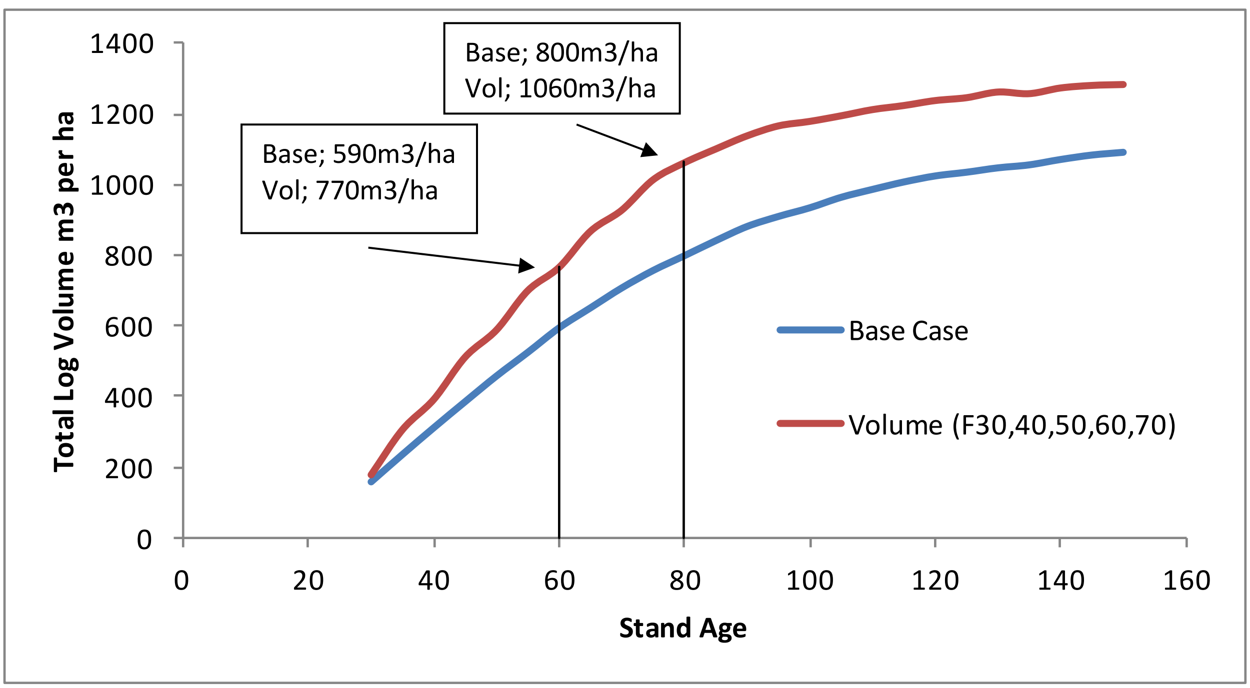


***Figure 20: Volume scenario yield forecast for Fd leading, good site contemporary plantations in the East zone using total log volume per hectare***

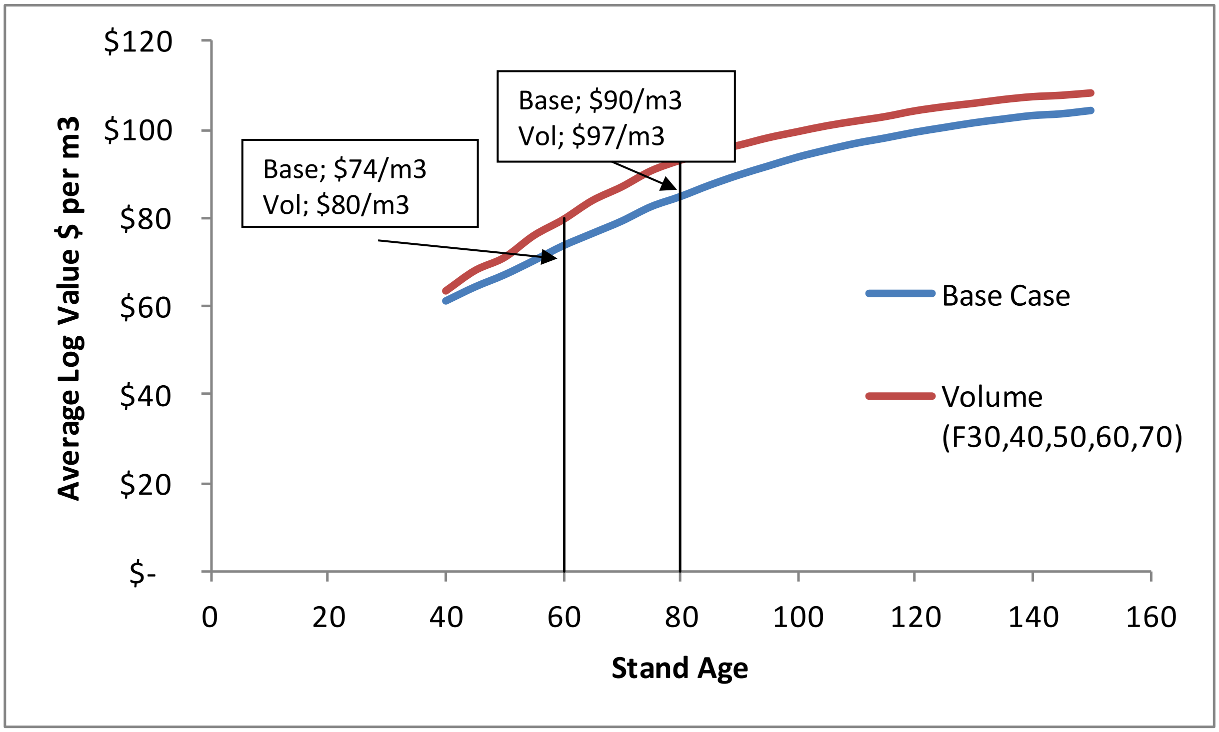


*Figure 21: Volume scenario average log value forecast for Fd leading, good site contemporary plantations in the East zone*

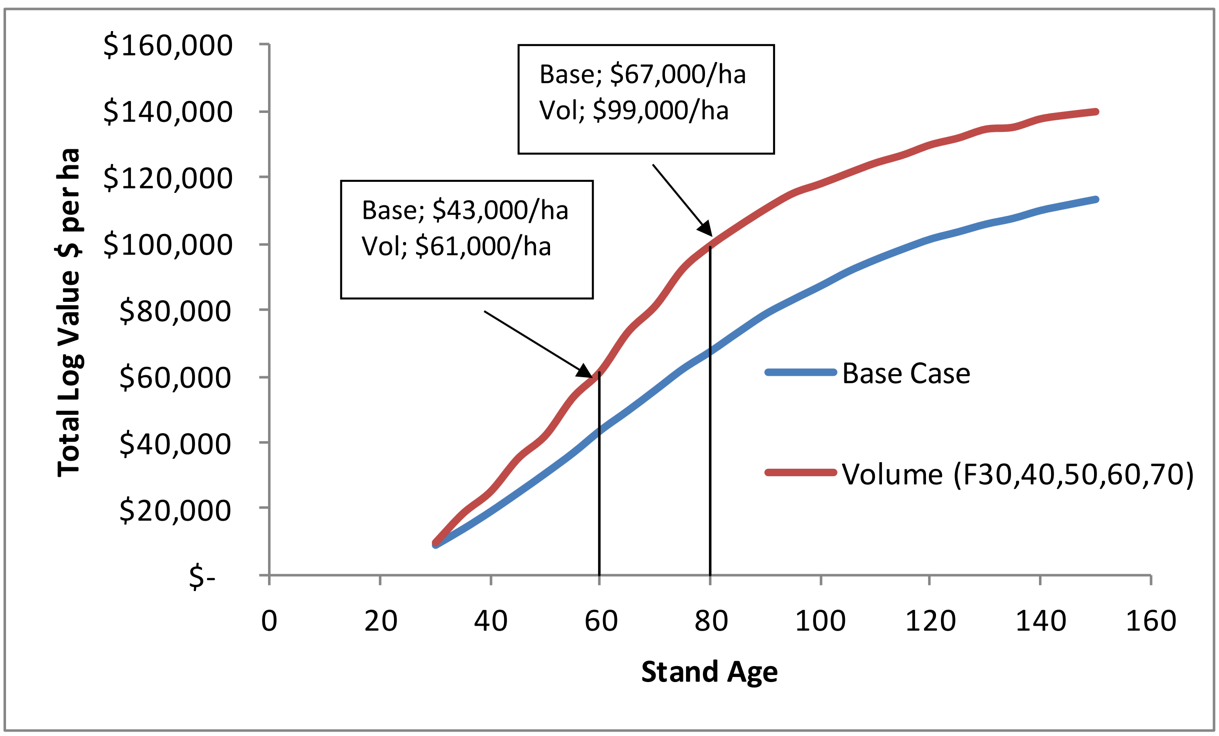


*Figure 22: Volume scenario total log value forecast for Fd leading, good site contemporary plantations in the East zone*

Figure 23 and Figure 24 illustrate that the juvenile spacing (JS) has little to no impact on merchantable volume or log volume on Cw leadings stands on good sites in the West zone. In the IRMP Base Case these stands were assumed to be planted with 900 stems per hectare (sph) of Cw and have about 1,500 sph of HwBa natural regeneration. In the value scenario these stands were assumed to be spaced at age 12 years to 900 sph favouring Cw. This stand type accounts for about 1,460 hectares of THLB.

A comparison between the merchantable volume (Figure 23) and the log volume (Figure 24) in the IRMP Base Case shows that the log volume is predicted to be about 12% lower than merchantable volume at 60 years and about 6% less at 80 years. JS narrows the gap between the merchantable volume and log volume to 6% and 2% at ages 60 and 80 years respectively (Figure 23 and Figure 24). As with the previous Fd fertilization example, these results indicate that log volume recoveries from harvesting of managed stands at early ages may result in lower actual volume recoveries than are being assumed in TSR.

Figure 25 compares images for different stages of stand development for these Cw-leading stands between the IRMP Base Case model (TASS) simulation and the value scenario simulation incorporating JS. According to the model results, a fair component of natural HwBa will overtop the planted Cw in the absence of JS. This is expected to happen primarily due to the difference in site indices and it is predicted to reduce the growth of some of the Cw. On the other hand, JS is expected to lead to an almost pure Cw stand and a higher proportion of larger trees. Both of these factors impact stand value.

Figure 26 and Figure 27 show that JS results in large increases in average log value (19%, 25% and 26% at 60, 80 and 100 years respectively) and total log value (17%, 26% and 26% at 60, 80 and 100 years respectively). However, harvesting has to occur after about 60 years to achieve the majority of the benefit. Figure 28 shows that JS 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 occur after approximately 50 years compared to the non-spaced stand. Based on today's markets and prices, Cw harvesting of these spaced stands should not occur early to get the majority of the value benefit from JS.

Using an average JS cost of $2,500 per hectare and a 2% interest rate, this JS regime is financially viable at harvest ages between 60 and 100 years. It is most beneficial if the harvest were to occur at about 100 years.

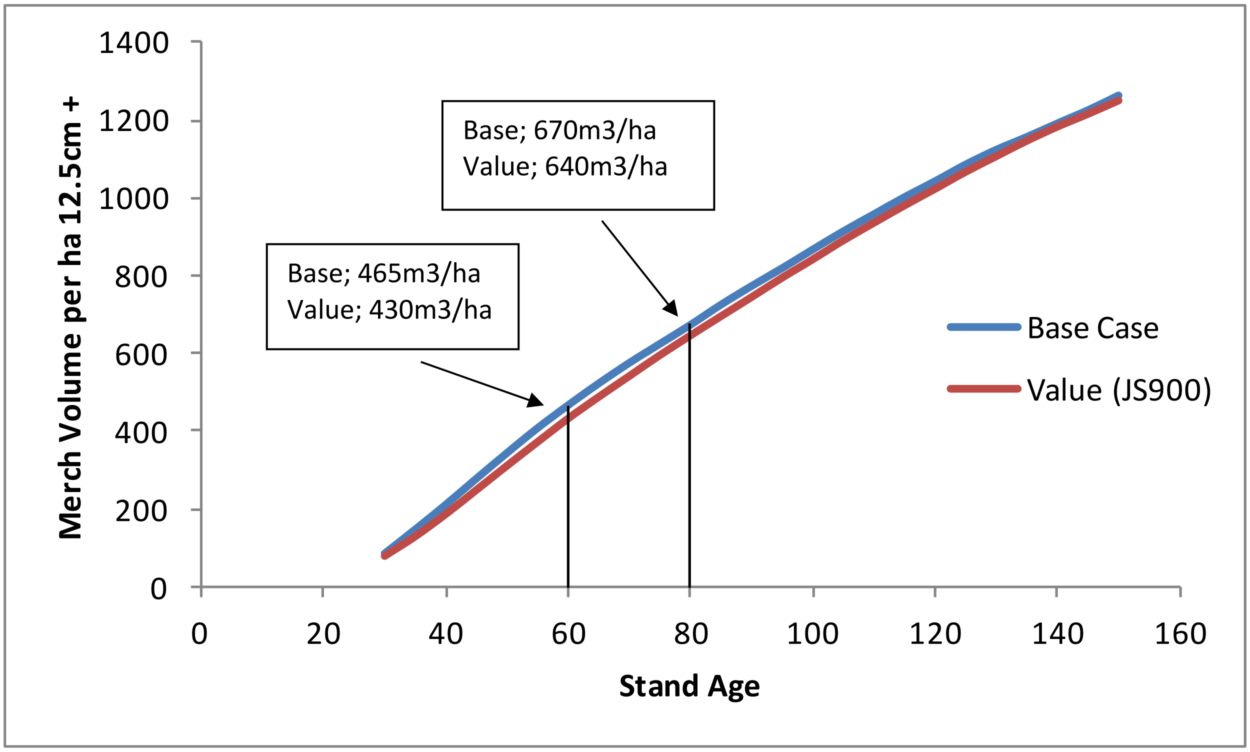


***Figure 23: Value scenario yield forecast for Cw leading, good site contemporary plantations in the West zone using merchantable volume per hectare***

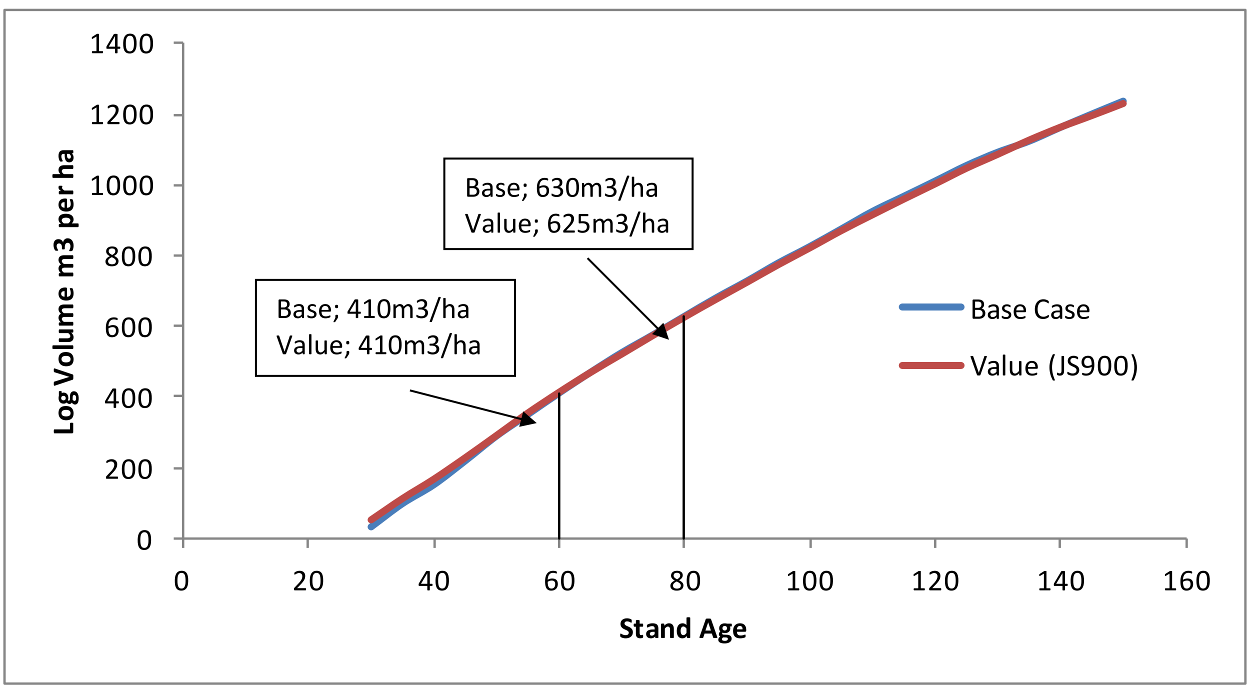


***Figure 24: Value scenario yield forecast for Cw leading, good site contemporary plantations in the West zone using total log volume per hectare***

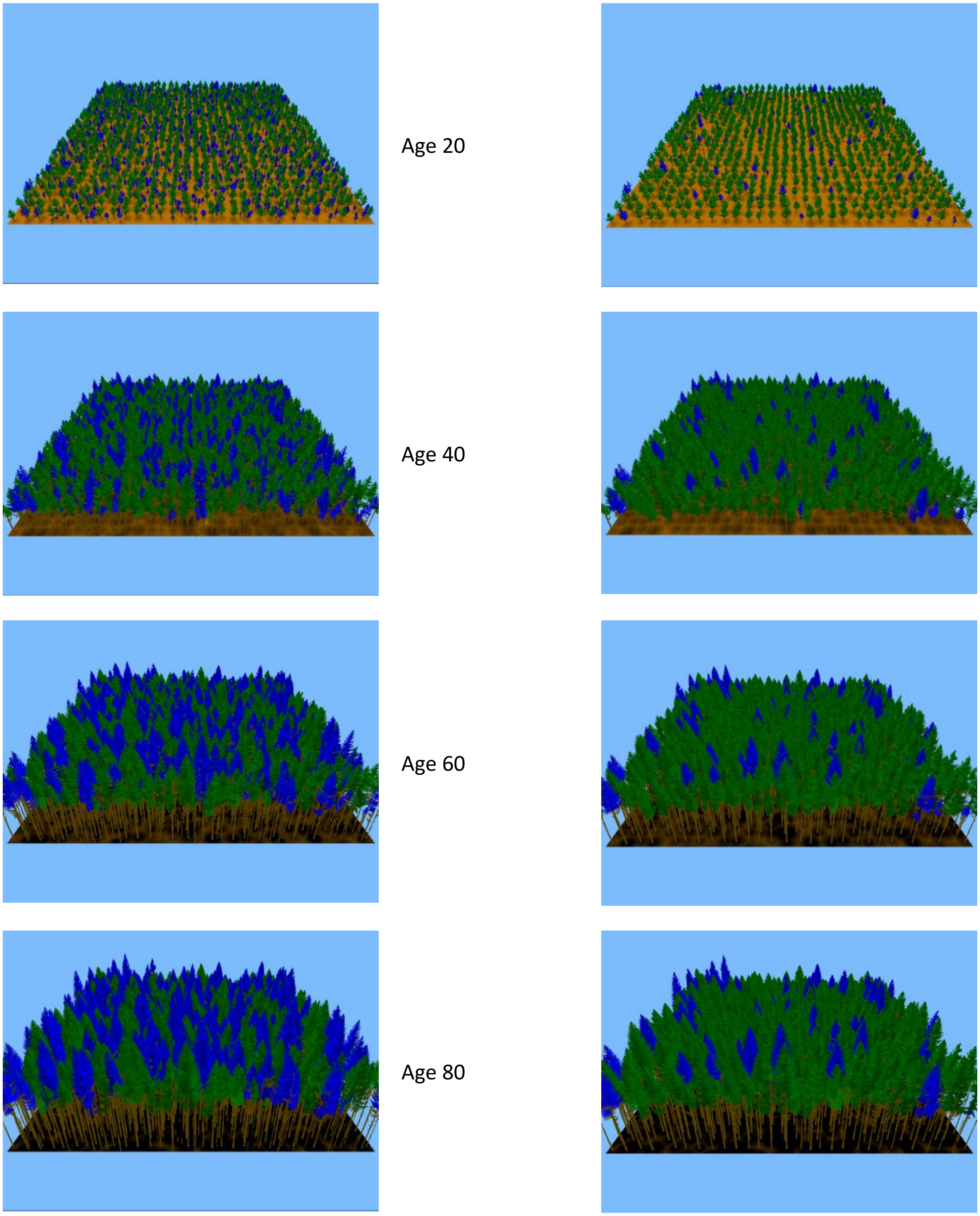


***Figure 25: TASS II images of Cw leading, good site Contemporary Plantations in the West Region, no JS (left) and JS (right) showing Cw (green) and HwBa (blue)***

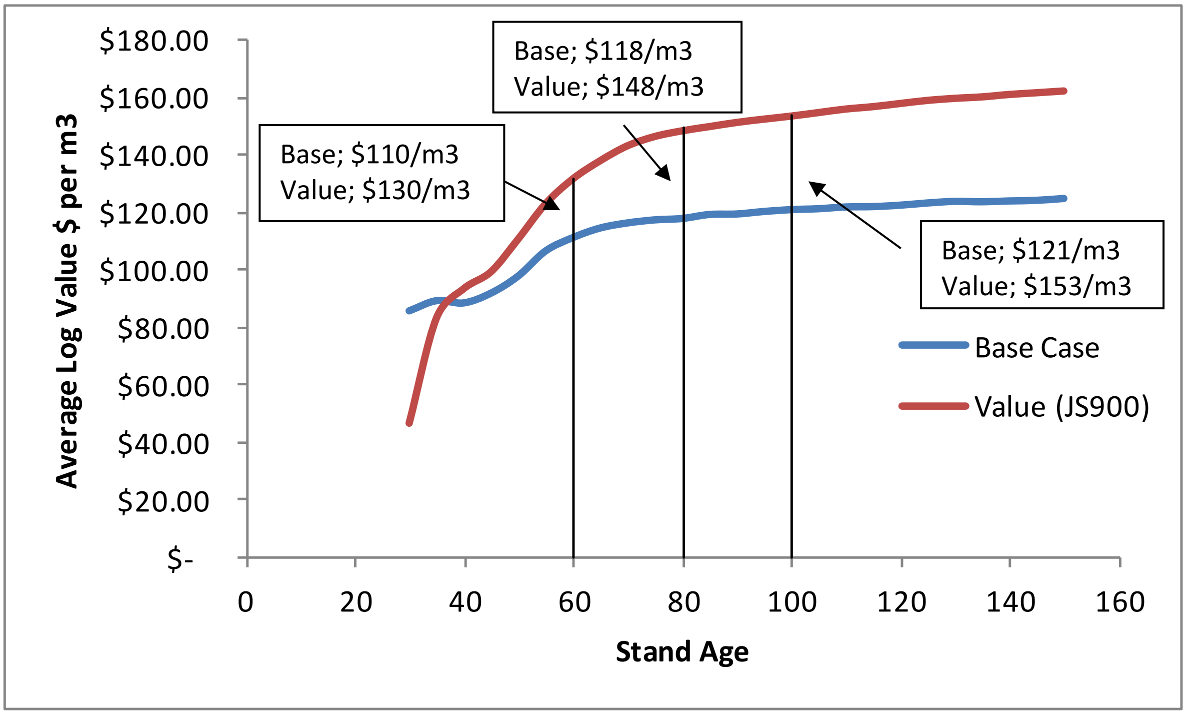


***Figure 26: Value scenario average log value forecast for Cw leading, good site contemporary plantations in the West zone***

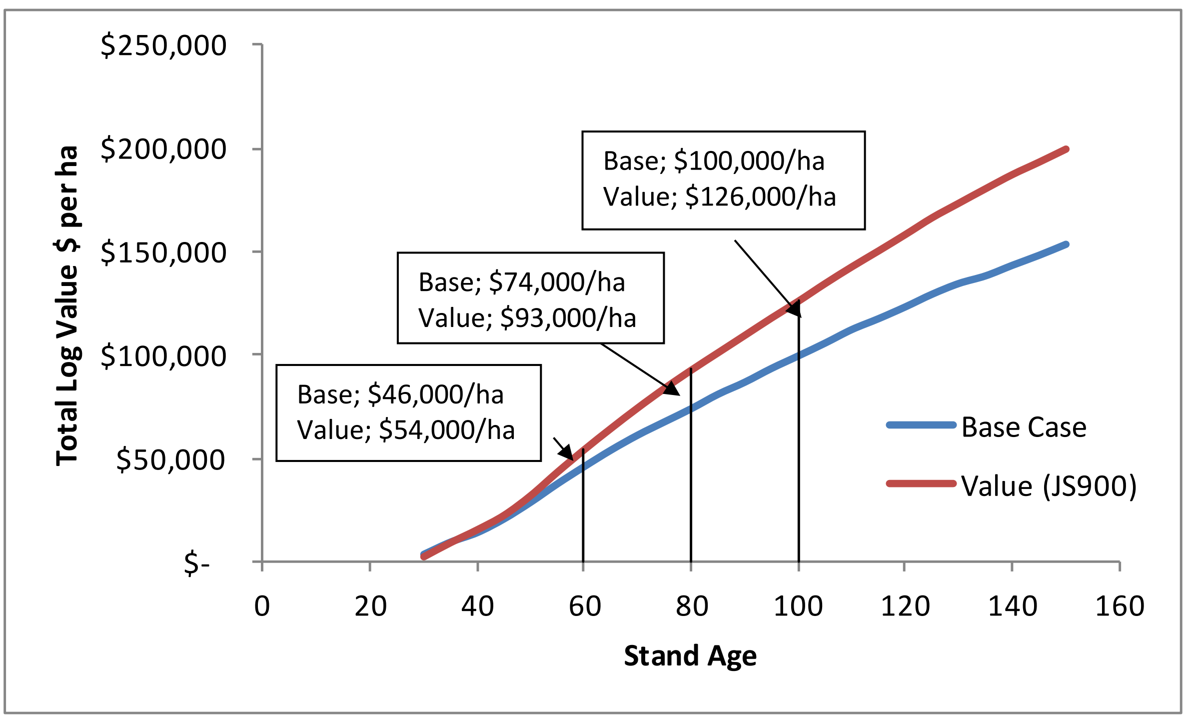


***Figure 27: Value scenario total log value forecast for Cw leading, good site contemporary plantations in the West zone***

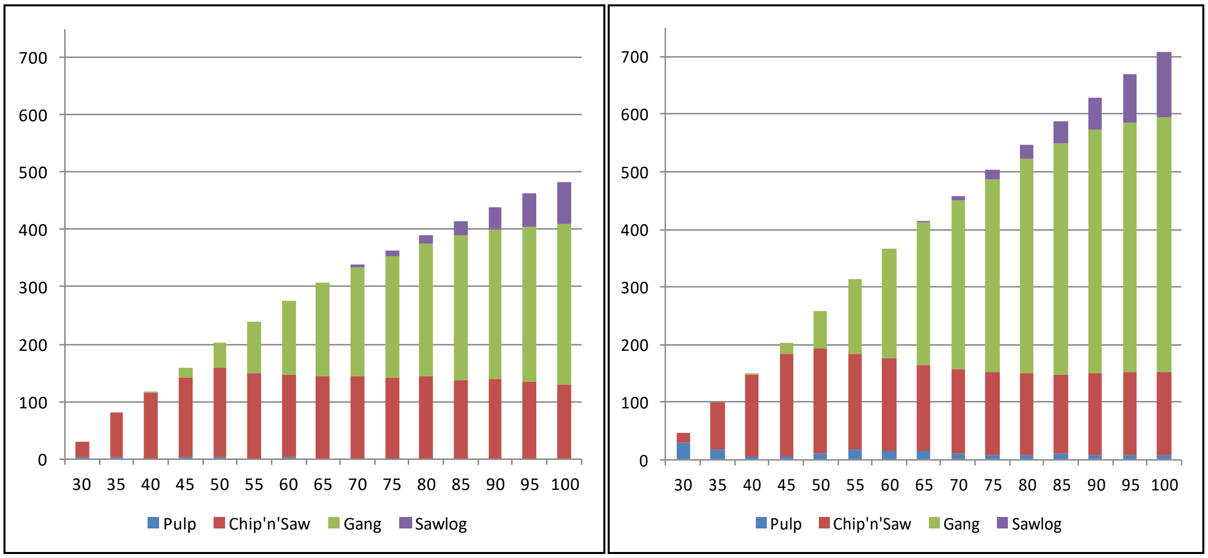


***Figure 28: Comparison of Cw log volumes by sort for the non-spaced stand (left) and spaced stand (right) for Cw leading, good site contemporary plantations in the West zone***

### *4.5.1.2 Future Stands*

The volume scenario that focused on increasing the harvest volume through silviculture tested the impact of planting genetically improved Hw instead of Cw or Fd on ecologically suitable sites. The primary value scenario, on the other hand, favored planting of genetically improved Cw instead of Hw; it also incorporated JS to support Cw.

Figure 29 compares the impact of volume and value scenarios on predicted log volumes for stands managed for HwBa on a good site in the West zone. This analysis unit represents about 4,600 ha of THLB. The results show that from about the TSR minimum harvest criterion age (volume of 350 m3 per ha, conventional harvest) of about 44 years to about 90 years, the volume scenario provides about an 18 to 25% increase in log volume over the IRMP Base Case assumptions for this analysis unit. The value strategy managing these stands for Cw, on the other hand, results in no significant difference relative to the IRMP Base Case assumptions before year 95.

Figure 30 and Figure 31 show that the volume strategy reduces the average log value (53 to 54% at 60, 80 and 100 years) and total log value (42%, 63% and 46% at 60, 80 and 100 years respectively) significantly compared to the IRMP Base Case assumptions. The differences are even larger when compared to the value scenario, in particular if the stands are harvested after 50 years.

The value strategy favoring Cw results in large increases in average log value (25%, 27% and 29% at 60, 80 and 100 years respectively) and total log value (26%, 27% and 32% at 60, 80 and 100 years respectively) over the IRMP Base Case for this analysis unit.

As noted earlier, this value scenario is financially viable at stand level between harvest ages of 50 and 100 years; it is most beneficial if harvest occurs at around 90 to 100 years.

Despite the modest incremental costs associated with the volume strategy (mostly higher seed costs), it is not financially viable.

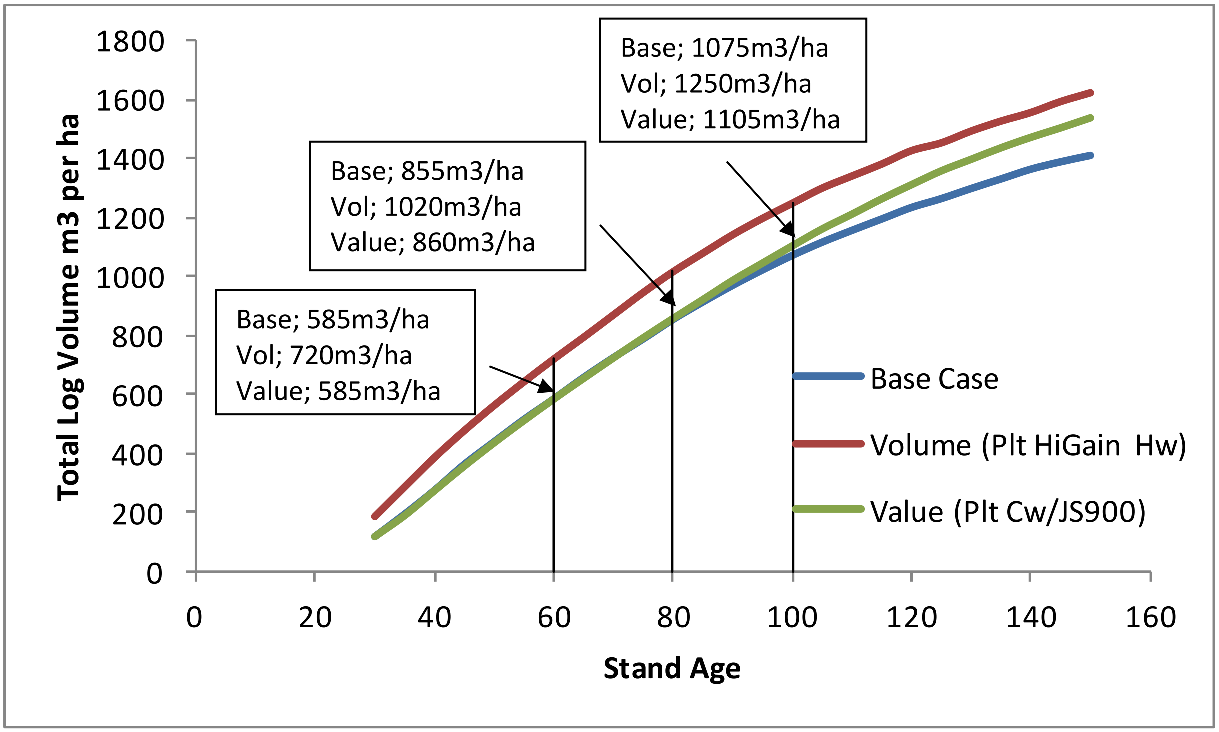


***Figure 29: Volume and Value scenario yield forecasts for future managed HwBa leading stands on good sites in the West zone using total log volume per hectare***

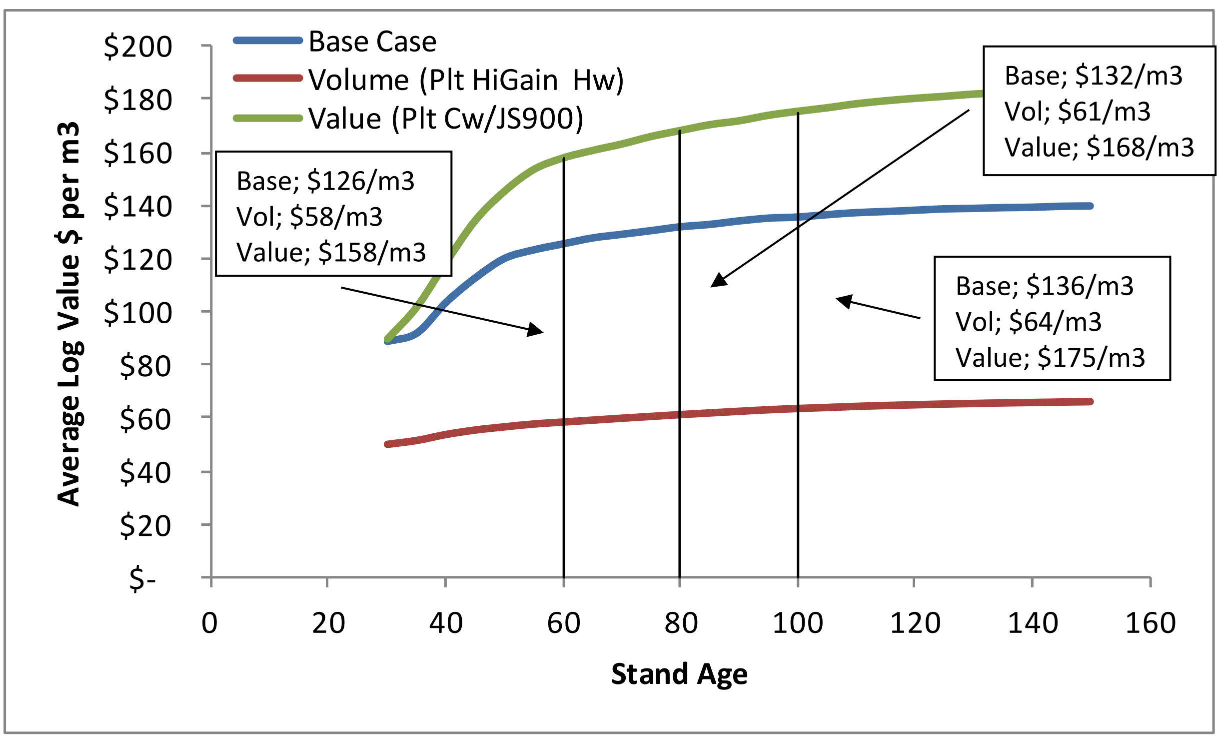


***Figure 30: Volume and Value scenario average log value forecasts for future managed HwBa leading stands on good sites in the West zone***

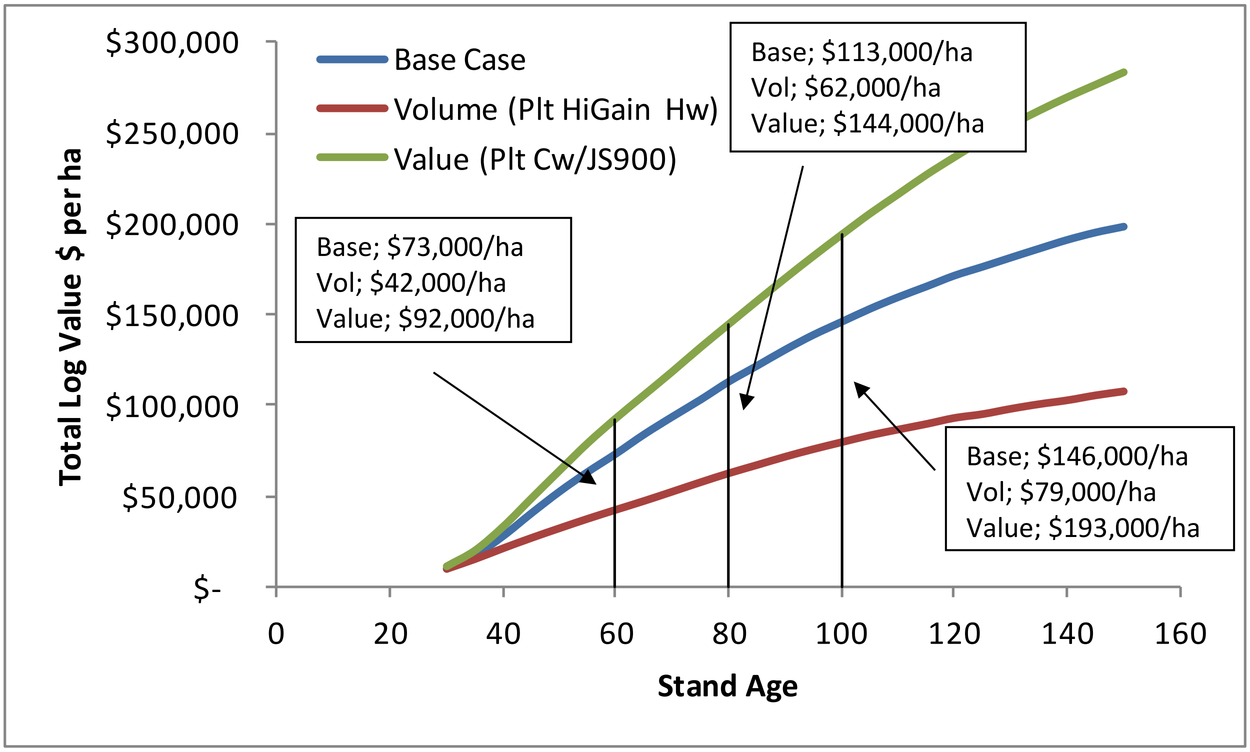


***Figure 31: Volume and Value scenario total log value forecasts for future managed HwBa leading stands on good sites in the West zone***

Other volume and value scenarios at stand level were also tested and incorporated in the analysis. The volumes of Fd leadings stands were increased on good and medium sites through fertilization at ages 30, 40, 50, 60 and 70. These yield curves were used in the forest level volume scenarios.

The value impacts were further tested by modelling planting of genetically improved Cw instead of Fd on suitable sites. JS was incorporated to favour the Cw after planting.

Figure 32 compares the impacts on log volume of the volume and value approaches on stands being managed for Fd, or alternatively Cw, on a medium site in the West zone. This analysis unit represents about 540 hectares of THLB. The results show that from about the TSR minimum harvest criterion age (volume of 350 m3 per ha, conventional harvest) of about 38 years to about 80 years the volume scenario provides approximately 22 to 26% increase in log volume over assumptions used in the IRMP Base Case. On the other hand, before about 80 years the value strategy employing Cw on these sites results in no significant difference relative to the IRMP Base Case.

Figure 33 and Figure 34 show that the value strategy (Cw planting and JS) results in large increases in average log value (107%, 93% and 84% at 60, 80 and 100 years) and total log value (75%, 100% and 105% at 60, 80 and 100 years respectively) versus the IRMP Base Case. The largest benefit is achieved if harvesting occurs at around 60 years. On the other hand, the volume scenario focusing on Fd, results in modest increases in average and total log value compared to the IRMP Base Case.

Both the value and volume approached are financially viable at stand level with harvest occurring between ages of 50 and 100 years; it is most beneficial if harvest occurs at around 90 to 100 years. However, the value scenario generates significantly better returns.

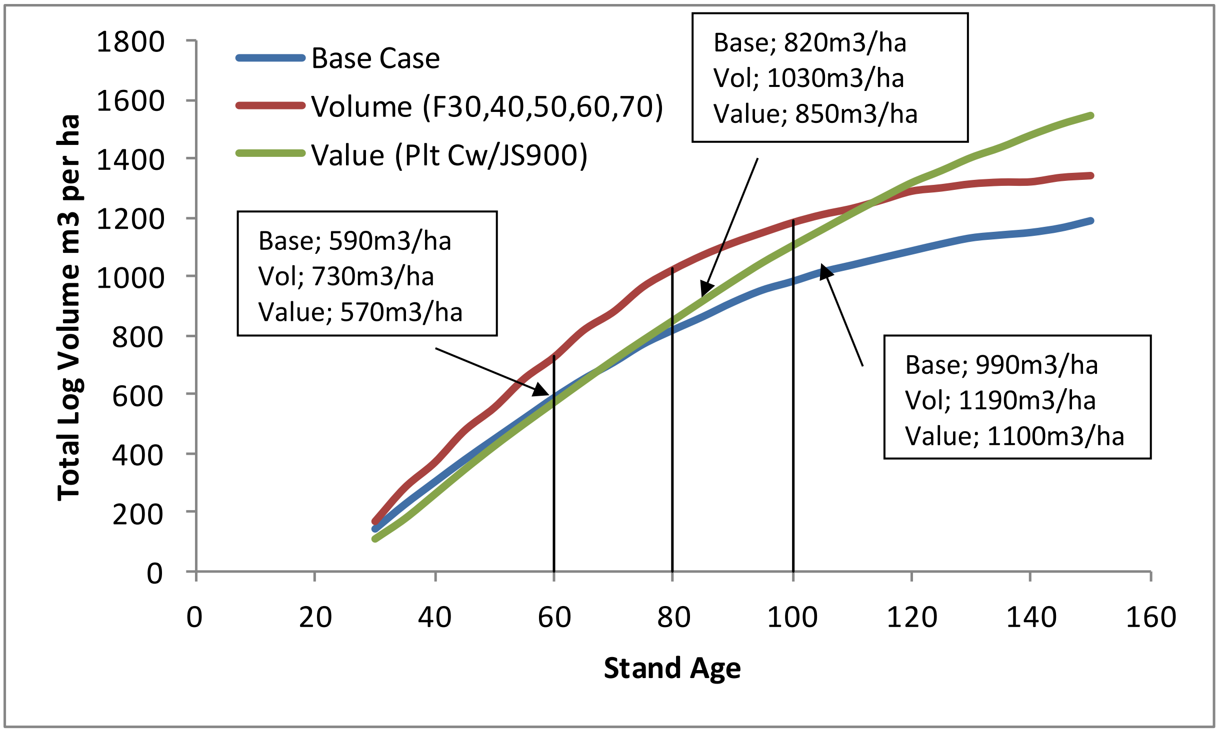


***Figure 32: Volume and Value scenario yield forecasts for future managed Fd leading stands on medium sites in the West zone using total log volume per hectare***

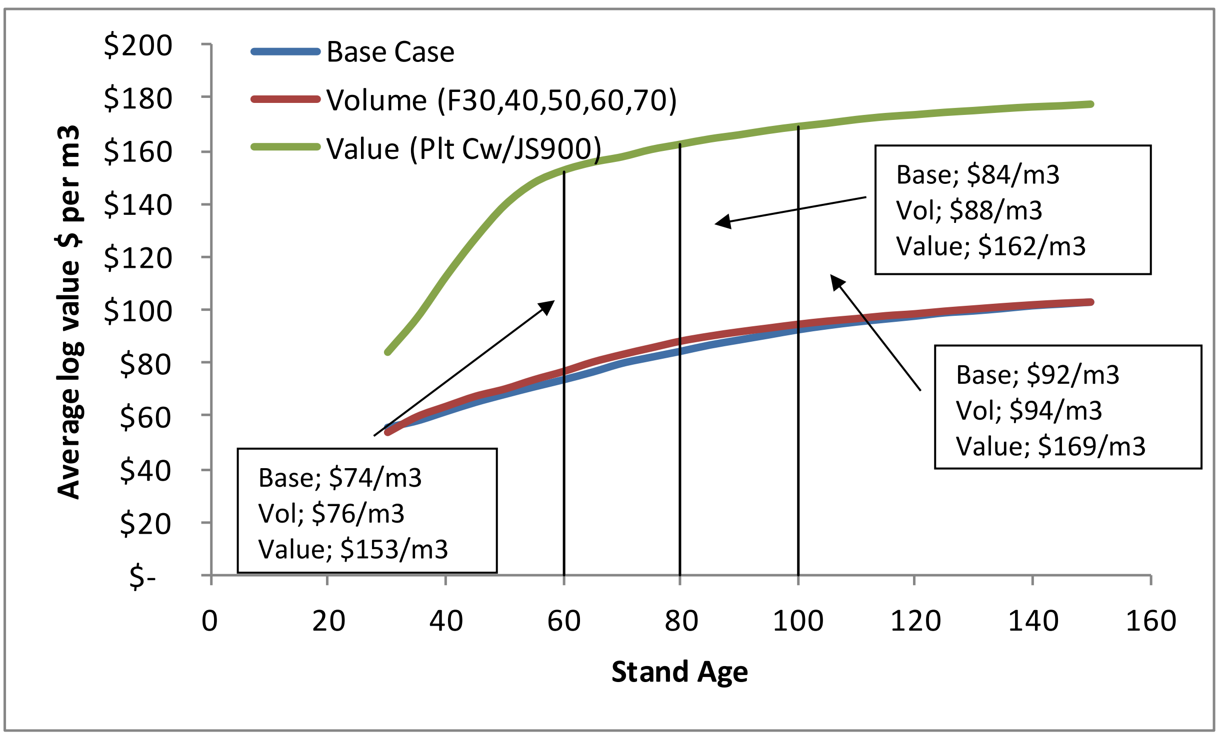


***Figure 33: Volume and Value scenario average log value forecasts for future managed Fd leading stands on medium sites in the West zone***

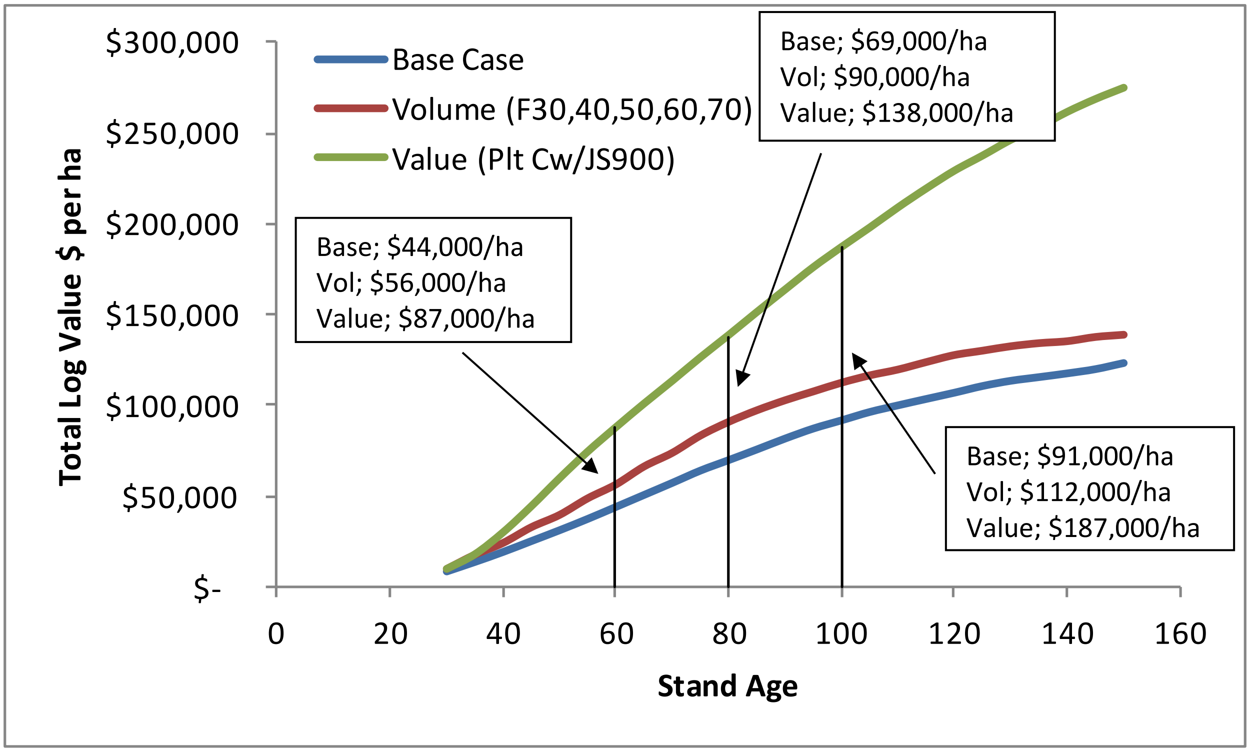


***Figure 34: Volume and Value scenario total log value forecasts for future managed Fd leading stands on medium sites in the West zone***

### 4.5.2 Harvest forecast over time

#### *4.5.2.1 Volume Scenarios*

Figure 35 illustrates the harvest forecast comparison between the IRMP Base Case and the two volume scenarios with two different minimum harvest criteria, one using the minimum volume per ha and the other using the age where 95% of the MAI culmination is achieved.

If the simple minimum harvest volume per ha is used as the minimum harvest criterion (350 $m^3$ per ha conventional, 450 $m^3$ per ha for helicopter harvest) the short and medium term harvest can be increased by 7.4% and 9.1% correspondingly.

Setting the minimum harvest criteria at the age where 95% of the MAI culmination is achieved generally increases the harvest ages modestly (Figure 36) and results in a more moderate increase in harvest volume of 3.2% in the short and medium terms. However, the long-term harvest level is reached earlier at year 105 and the increase in the predicted harvest volume in the long term is significant at 13.6%.

Figure 37 shows the forecasted harvest of managed stands in the volume scenario using the minimum harvest volume as the minimum harvest criteria compared to the IRMP Base Case. Aggressive fertilization has little impact in speeding up the entry into managed stands; significant harvest in these stands will not start until 30 to 40 years from now.

Favoring Hw for volume production has an impact on the predicted harvest by species. If the volume scenarios were to be followed it is likely that the share of Hw of the total harvest would increase at the expense of Cw as shown in Figure 38. The share of Fd is predicted to be about the same as in the IRMP Base Case.

Figure 39 illustrates the harvest forecast when retention and partial retention VQOs are relaxed by one class. This scenario attempts to gauge what the maximum impact of partial harvesting might be. The predicted short and medium term harvest increased by 2.8%. The increase in the long term was moderate at 0.5%.

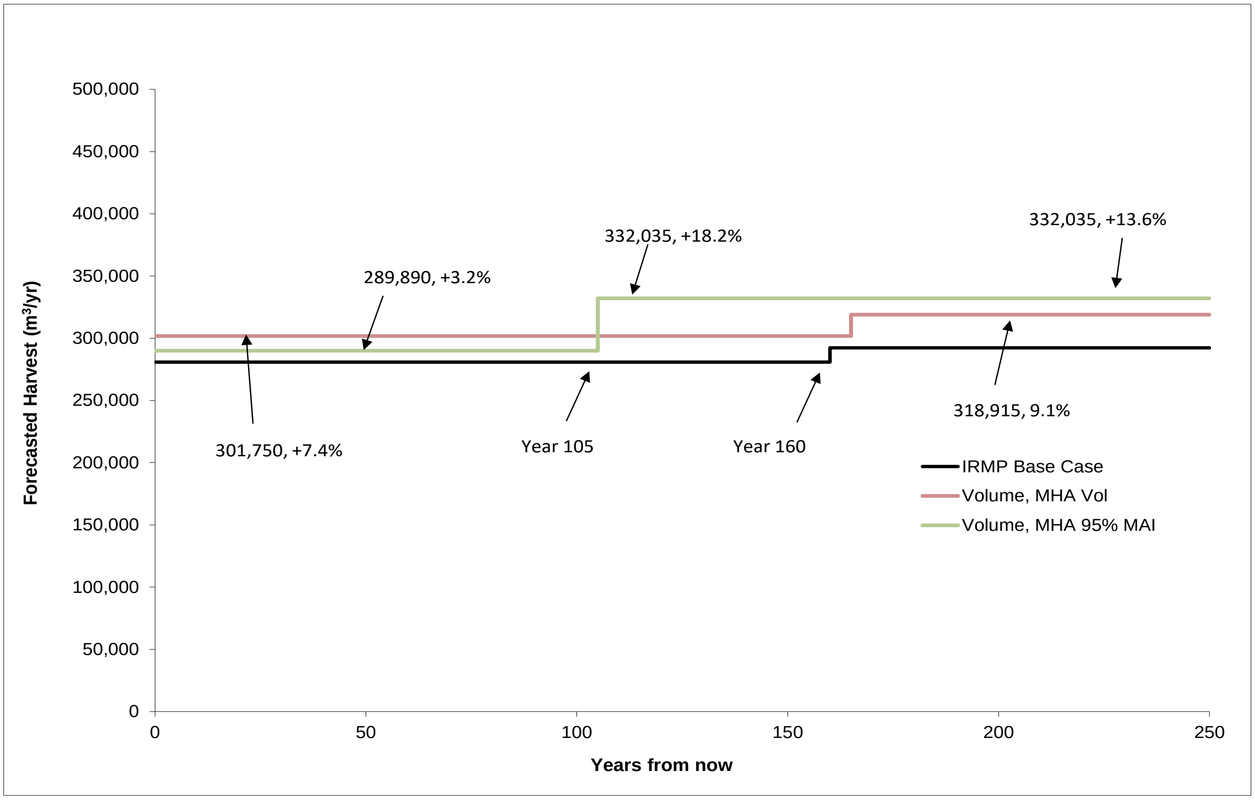


***Figure 35: Harvest forecast, volume scenarios incorporating silviculture treatments***

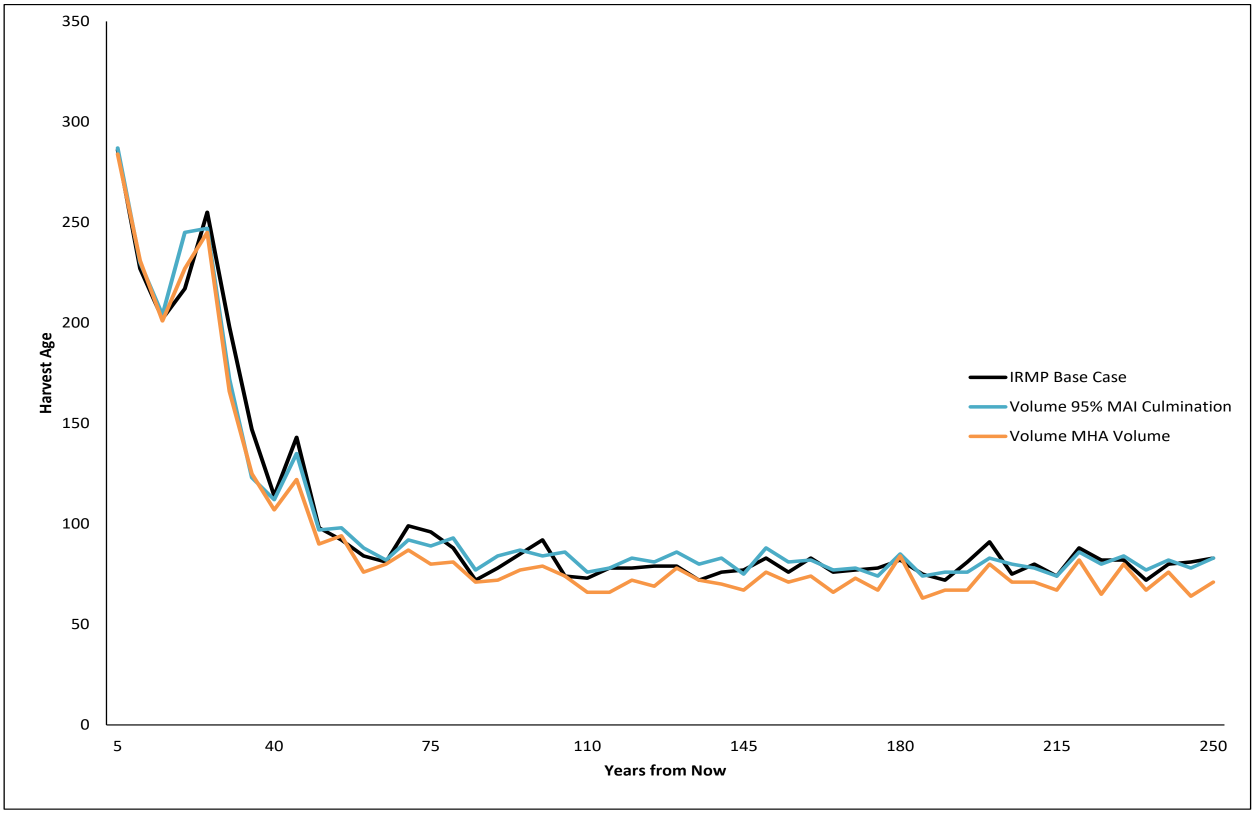


***Figure 36: Predicted average harvest age, volume scenarios***

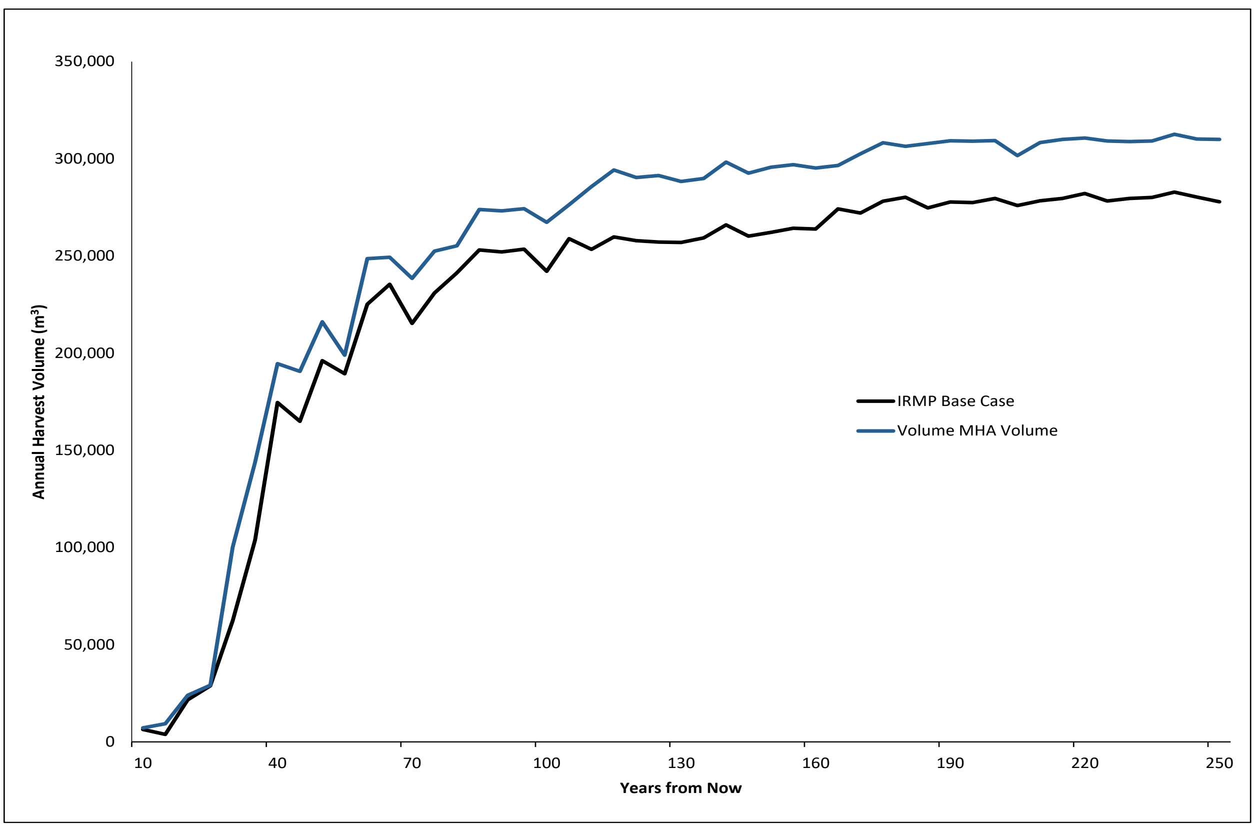


***Figure 37: Harvest forecast for managed stands, volume scenario with minimum harvest volume***

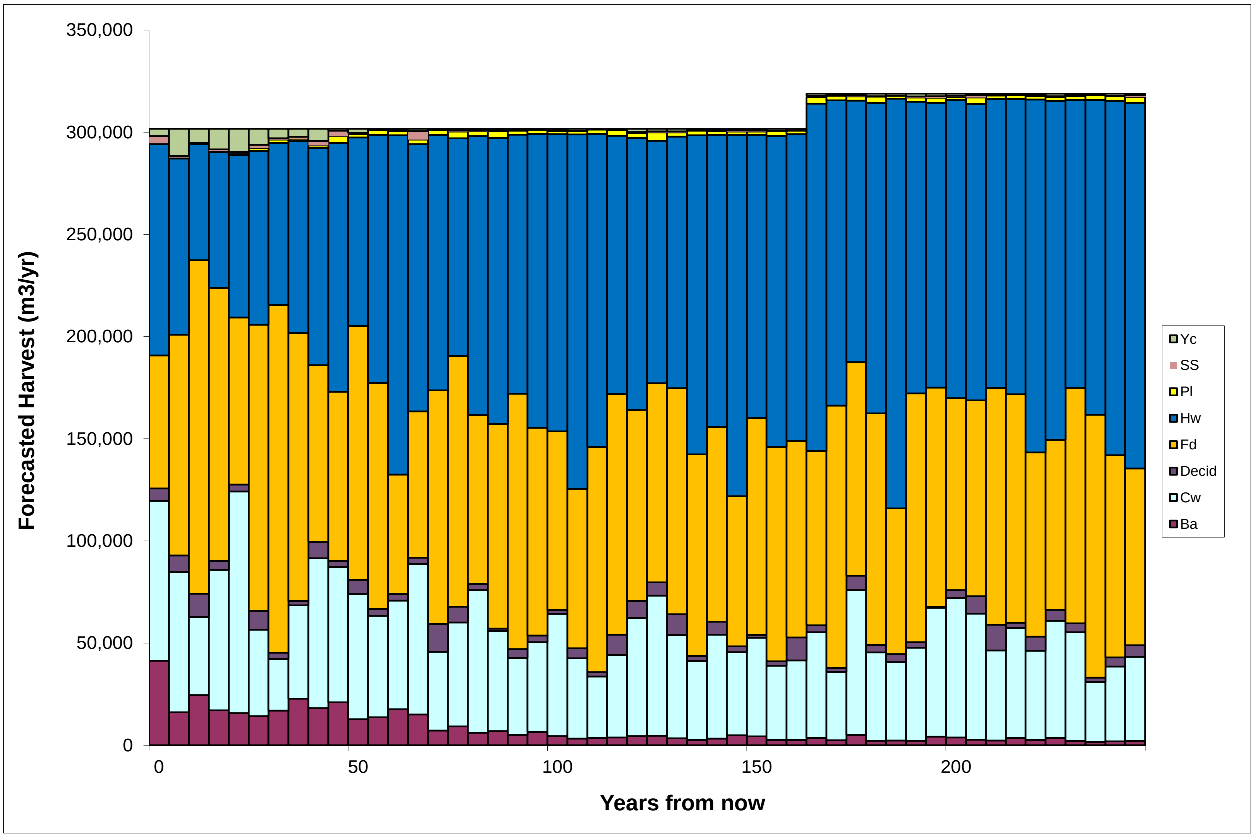


***Figure 38: Harvest forecast by species, volume scenario with minimum harvest volume***

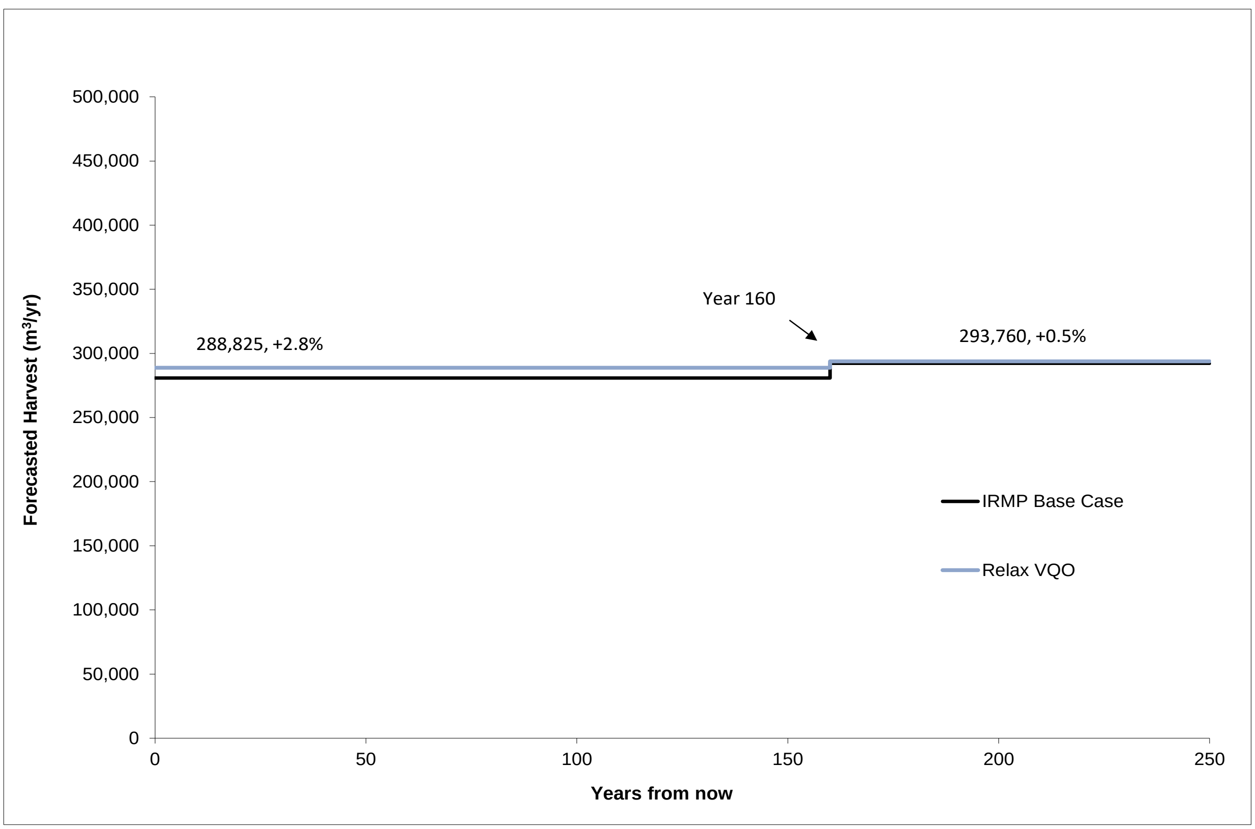


***Figure 39: Harvest forecast, relax retention and partial retention VQOs by one class***

#### 4.5.2.2 Value Scenarios

Figure 40 illustrates a harvest forecast comparison between the IRMP Base Case and a scenario where the minimum harvest criteria for managed stands is set at the age where the MAI culmination occurs. The stands are held much longer than in the IRMP Base Case as indicated by the predicted average harvest age shown in Figure 41. Harvesting managed stands later decreases the harvest forecast significantly in the short and medium terms; the short-term harvest is reduced by 20% and the mid-term harvest is 30.7% less than that of the IRMP Base Case. The LTHL is marginally higher than that of the IRMP Base Case and it is reached at year 91, earlier than in the IRMP Base Case (161).

Figure 42 illustrates the harvest forecast comparison between the IRMP Base Case and the two value scenarios where silviculture treatments were incorporated in the analysis. Two different minimum harvest criteria were employed, one using the minimum volume per ha and the other using the age where 95% of the MAI culmination is achieved.

If the simple minimum harvest volume per ha is used as the minimum harvest criterion (350 $m^3$ per ha conventional, 450 $m^3$ per ha for helicopter harvest) the short - term harvest can be increased by 2.3%. The LTHL is marginally higher (+1.2%) and it is reached at year 126, earlier than in the IRMP Base Case.

Setting the minimum harvest criteria at the age where 95% of the MAI culmination is achieved generally increases the harvest ages modestly (Figure 43) and results in a slight decrease in harvest volume of 0.8% in the short and medium terms. However, the harvest is increased significantly at year 126 and remains higher than that of the Base Case (8.3% in the long term).

Favoring Cw and Fd to create value has an impact on the predicted harvest by species. If the value scenarios were to be followed, it is likely that the shares of Cw and Fd of the total harvest would increase at the expense of Hw as shown in Figure 44.

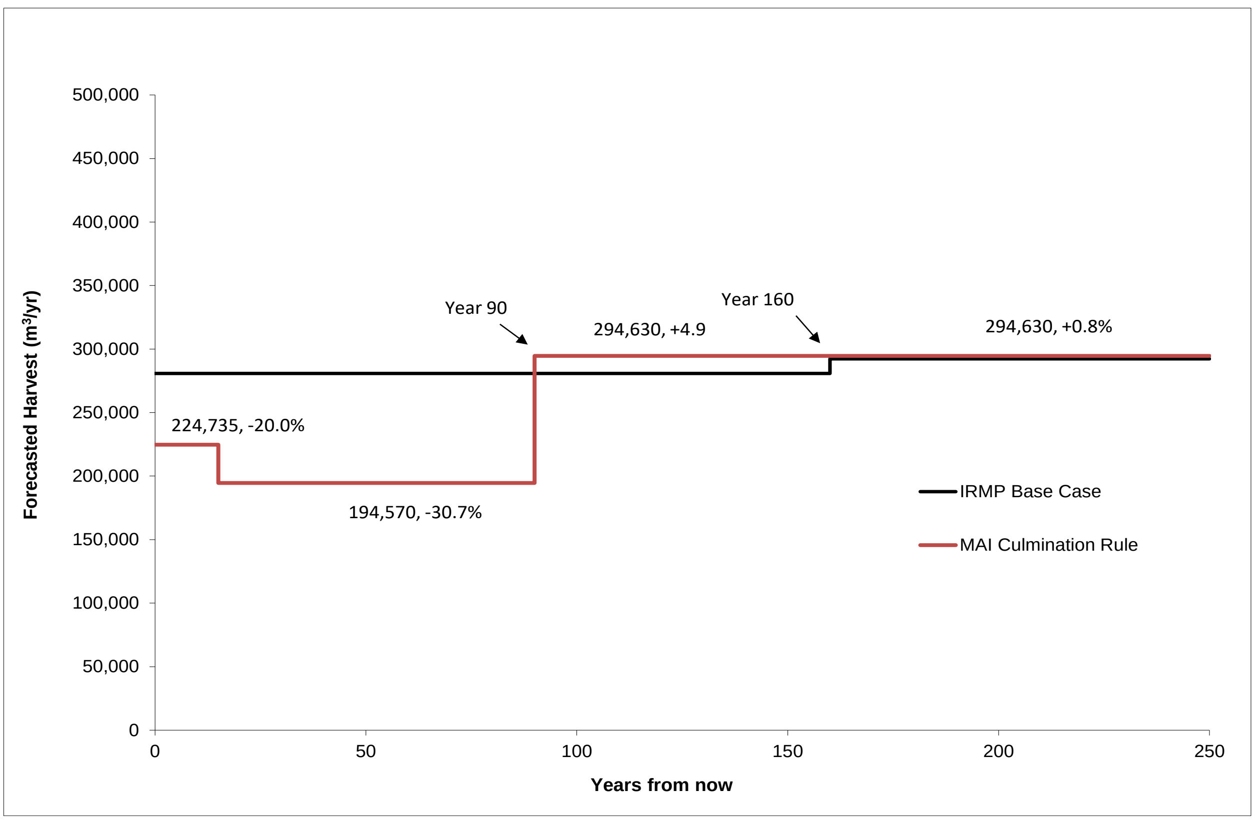


***Figure 40: Harvest forecast, using MAI culmination rule for minumum harvest criteria***

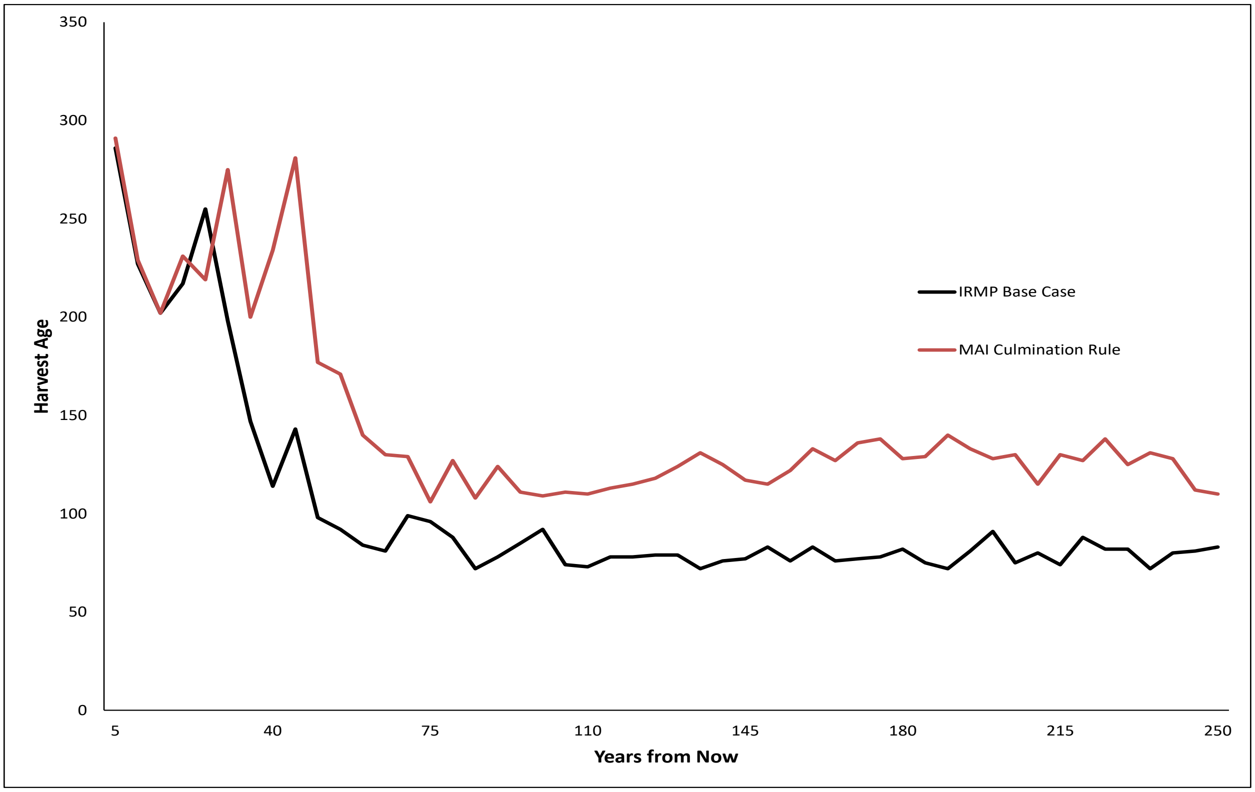


***Figure 41: Predicted average harvest age, using MAI culmination rule for minumum harvest criteria***

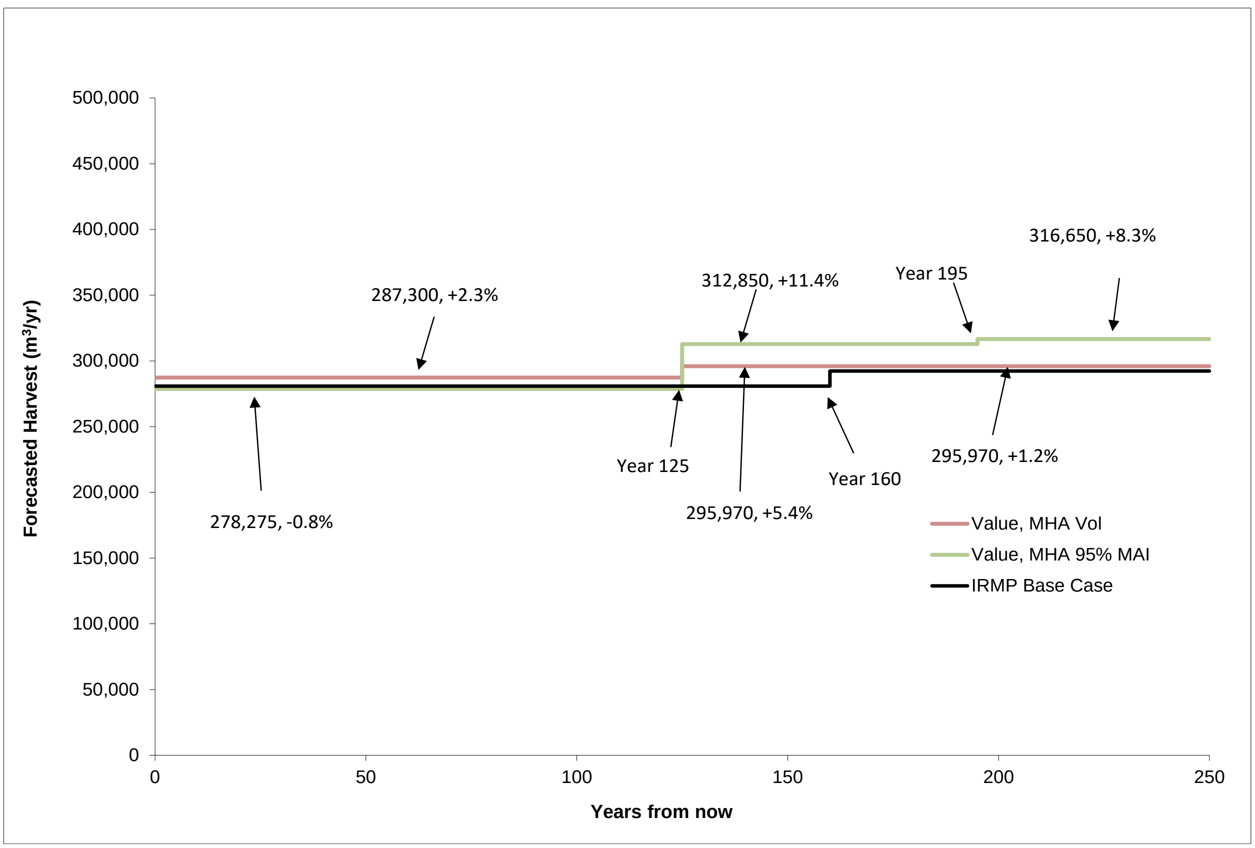


***Figure 42: Harvest forecast, value scenarios incorporating silviculture treatments***

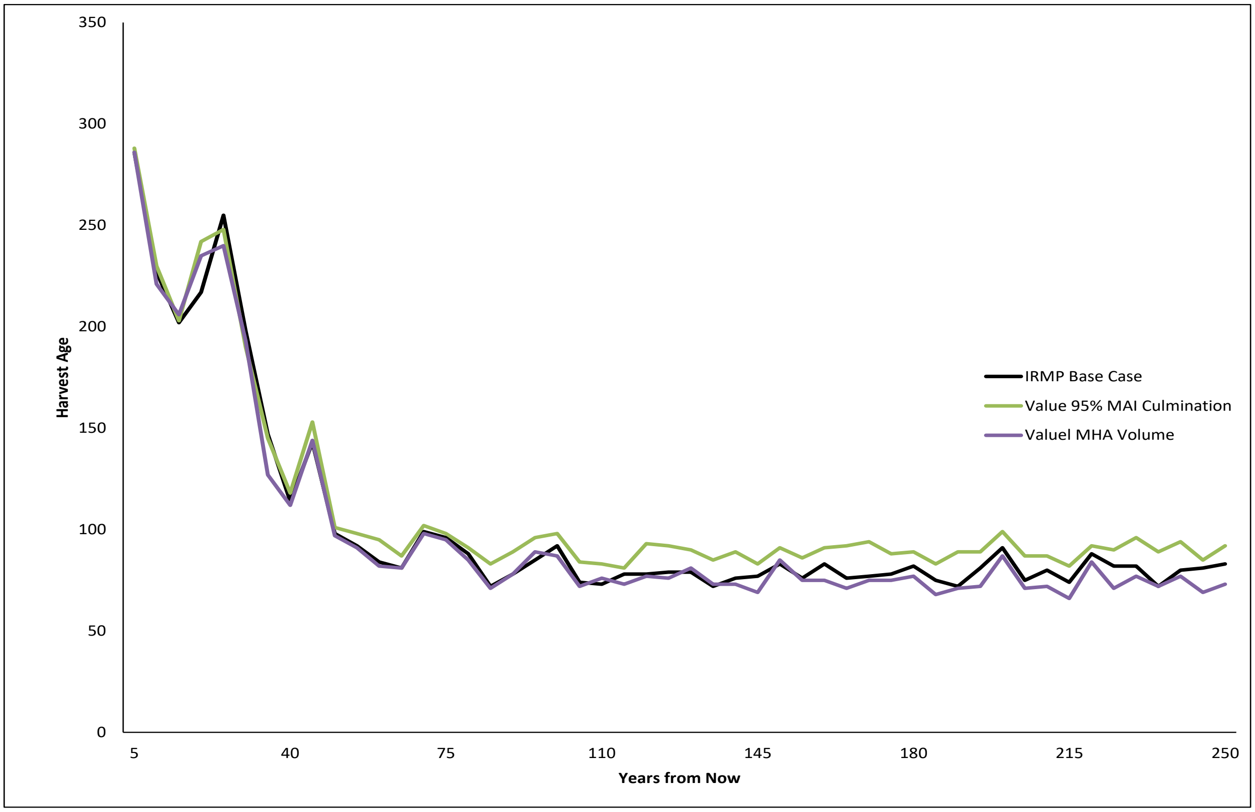


***Figure 43: Predicted average harvest age, value scenarios***

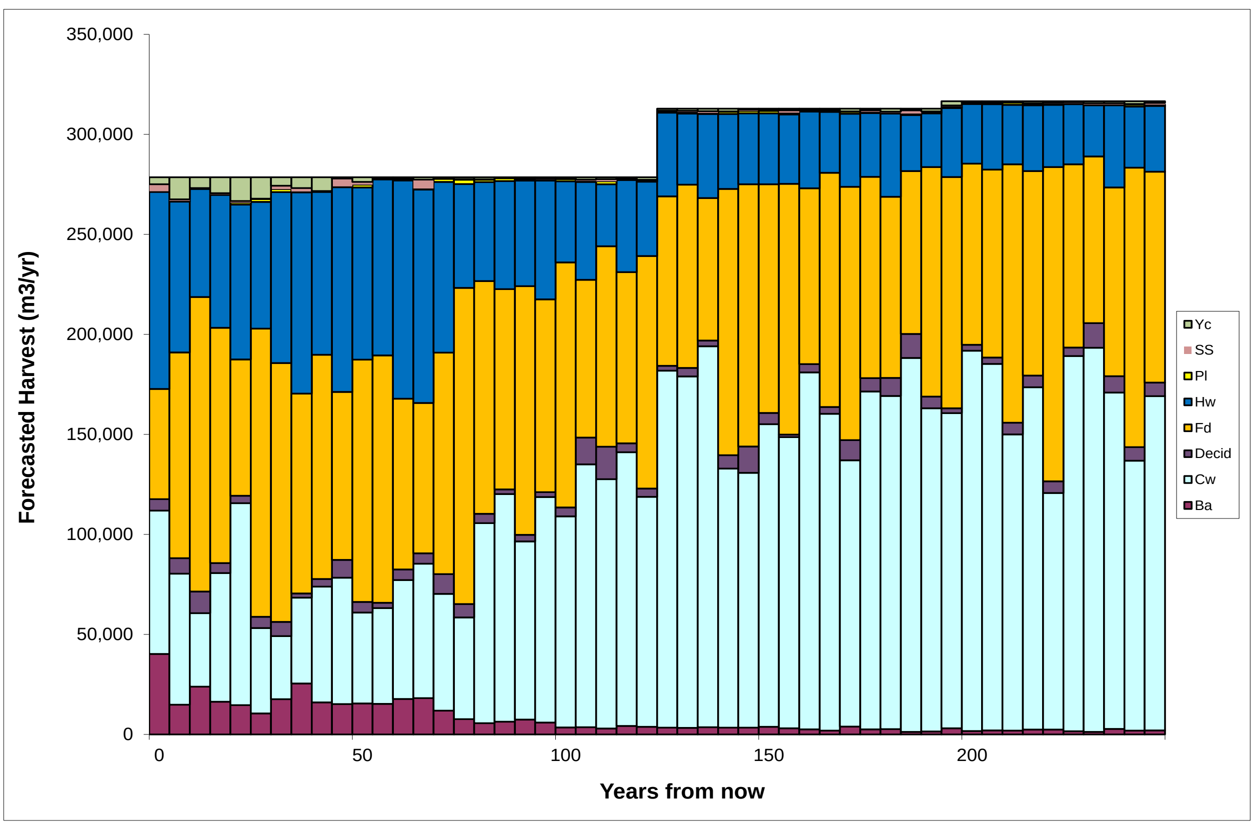


***Figure 44: Harvest forecast by species, value scenario, minimum harvest criteria at 95% of MAI culmination age***

#### 4.5.2.3 Habitat and Biodiversity Scenarios

Figure 45 illustrates the harvest forecast for 4 habitat scenarios:

1. Setting the MAMU habitat target at 68% of the year 2002 habitat in the west zone;
2. Setting the NOGO forage habitat target at 40% within each forage area;
3. Setting the NOGO forage habitat target at 60% within each forage area;
4. Setting one CFLB-wide forage habitat target of 40%, with no spatial distribution requirements.

None of the scenarios had short and medium term timber supply impacts. Controlling the spatial distribution of NOGO forage habitat and setting the forage habitat target at 60% reduced the long term harvest forecast by 2.8%.

Figure 46 and Figure 47 provide examples of habitat output from the forest estate model. Figure 46 illustrates the achievement of NOGO forage habitat in the Holland Creek forage area. A significant area of THLB is required over time to maintain the 60% target in the 60% NOGO forage area target scenario.

Figure 47 depicts the achievement of the MAMU habitat in the west zone in the MAMU habitat scenario. While most of the habitat located in the NHLB, some THLB is required as well to meet the 68% habitat target.

Figure 48 shows the timber supply impact of higher retention levels in RMZs. In this scenario the harvest forecast was reduced by 2.8% throughout the planning horizon.

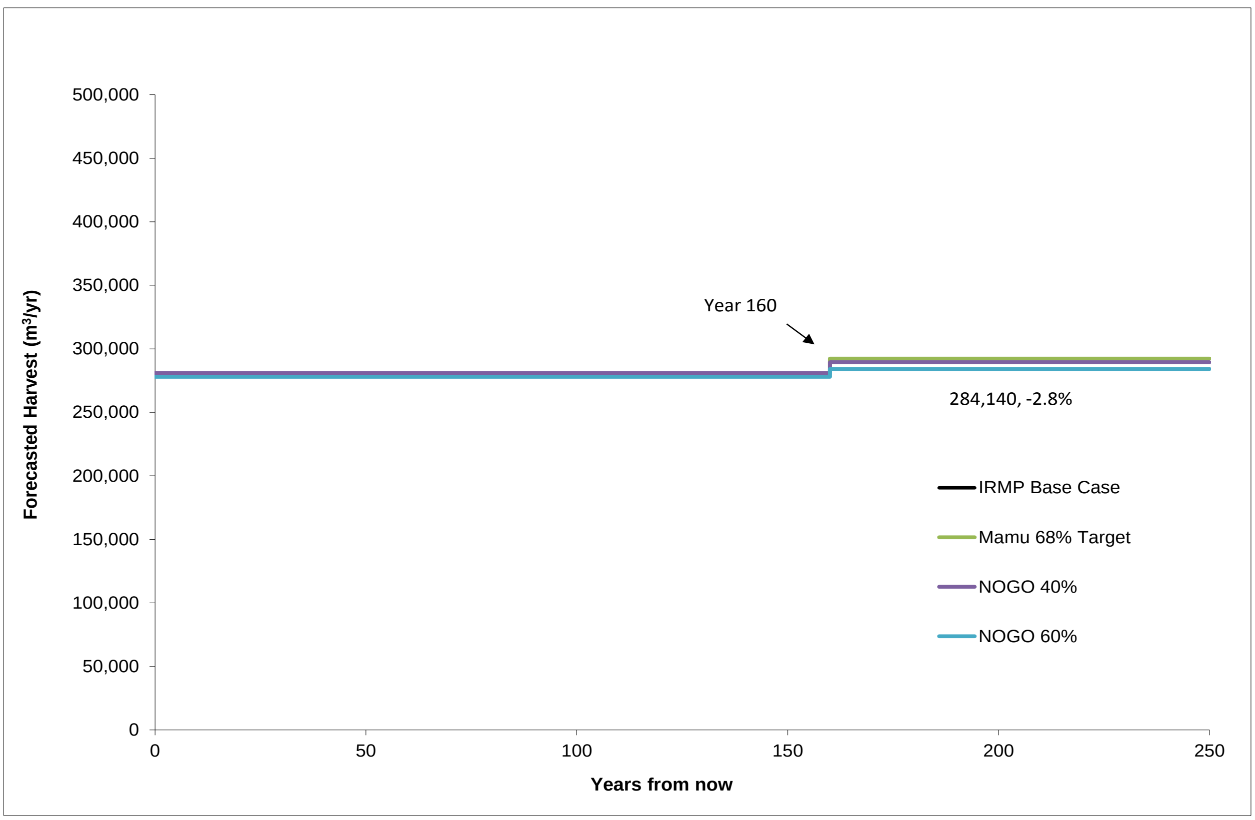


***Figure 45: Harvest forecast, MAMU habitat and NOGO foraging habitat***

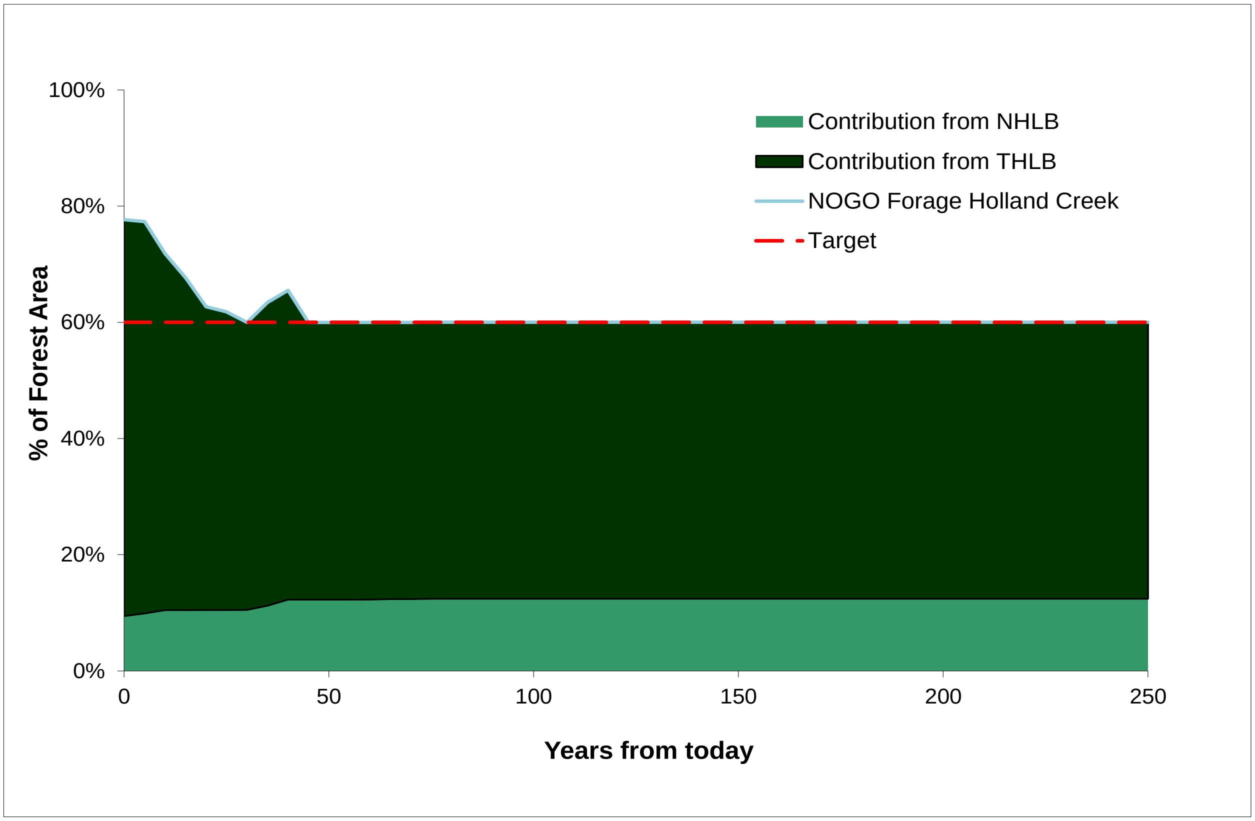


*Figure 46: NOGO forage habitat at Holland Creek, habitat target 60% within forage area*

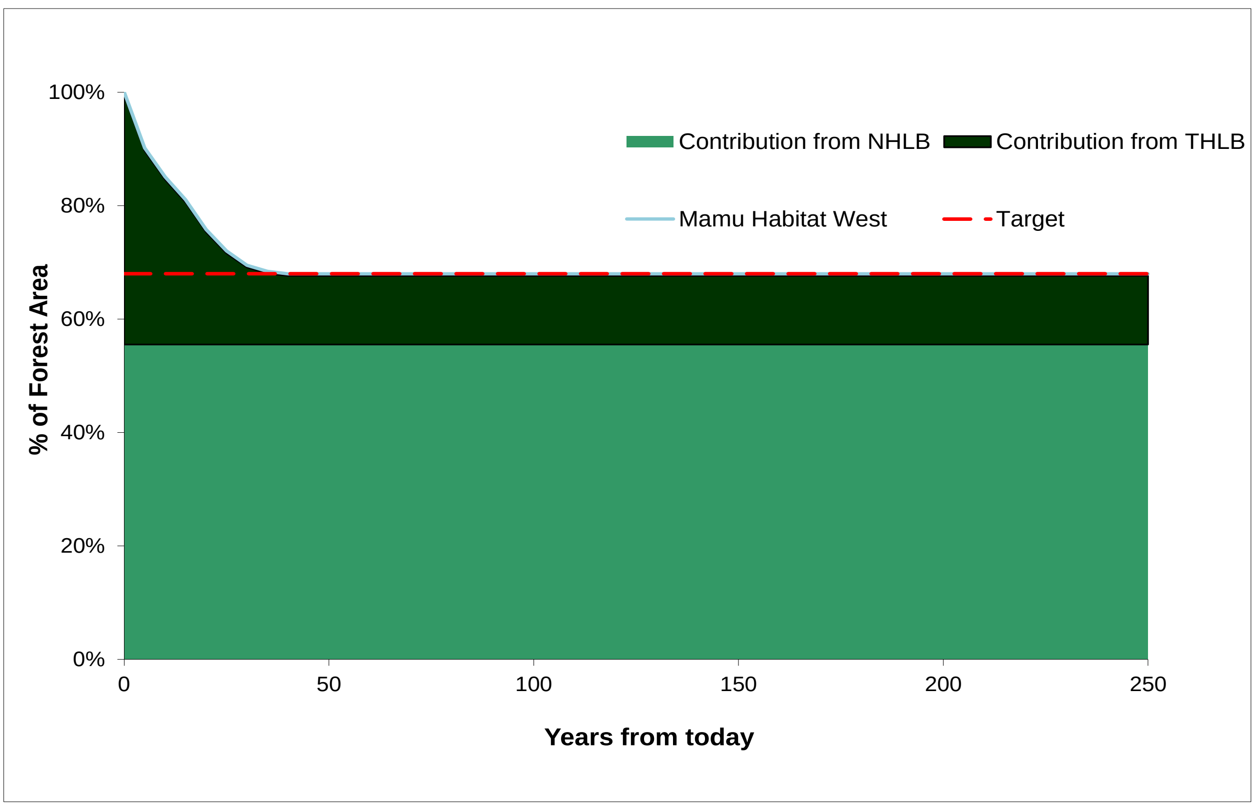


*Figure 47: MAMU habitat in the west zone, habitat target at 68%*

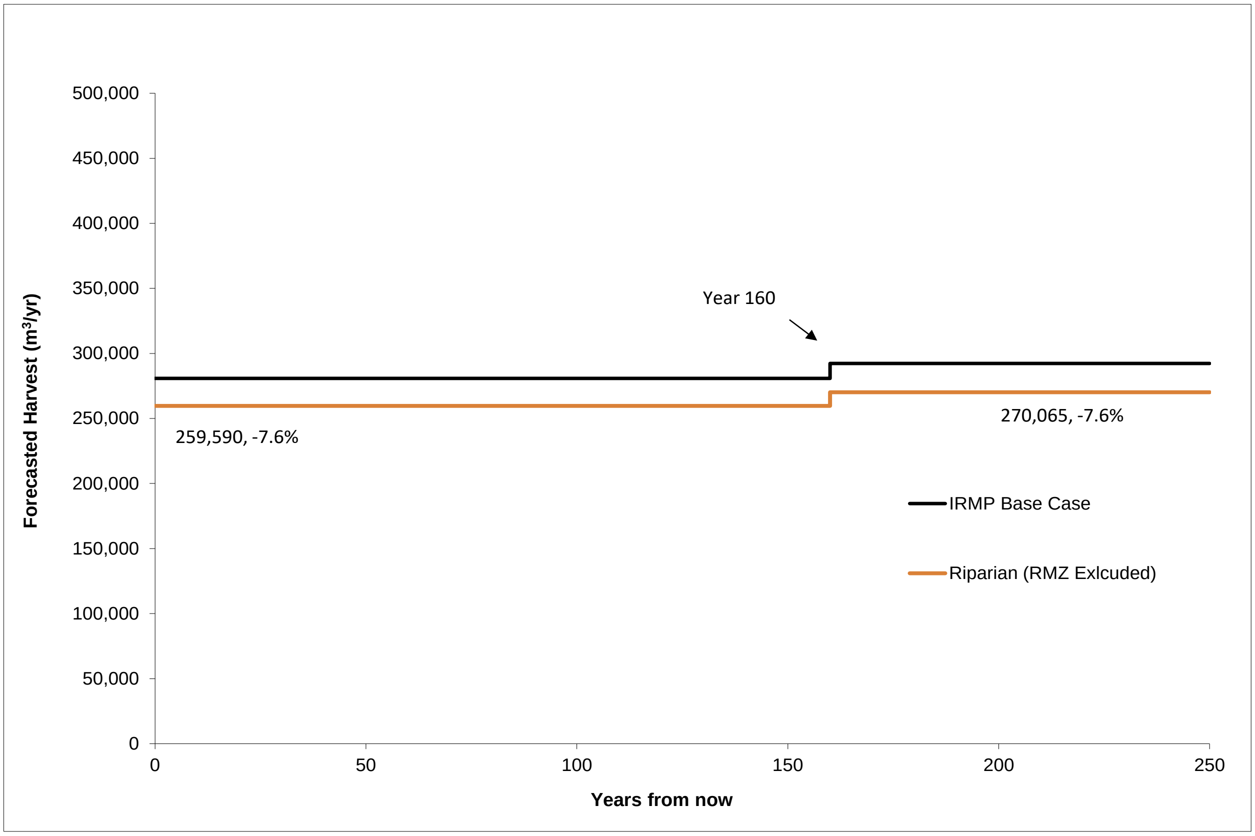


***Figure 48: Harvest forecast, remove RMZ from the THLB***

### 4.5.3 Timber Value Over time

Timber value in this analysis was assessed only for managed stands. See the Arrowsmith IRMP Data Package for further detail.

#### *4.5.3.1 Volume Scenarios*

Figure 49 illustrates the total predicted harvested timber value comparison for managed stands between the IRMP Base Case and the two volume scenarios with two different minimum harvest criteria, one using the minimum volume per ha and the other using the age where 95% of the MAI culmination is achieved. The harvest of managed stands is not predicted to be significant until around year 40. This is also reflected in the total value, which starts accumulating at the same time. In the long run the IRMP Base Case is predicted to provide more total value than either of the volume scenarios. This is due to the species preference in the volume scenarios; lower value Hw is favored over the higher value Cw.

The same trend can be seen in Figure 50 depicting the predicted value per ha of managed stands. The higher harvest levels are achieved through enhanced productivity by fertilization and species selection generally requiring large annual harvest areas as well, particularly when stands are harvested at younger ages using the minimum volume harvest criteria (Figure 51).

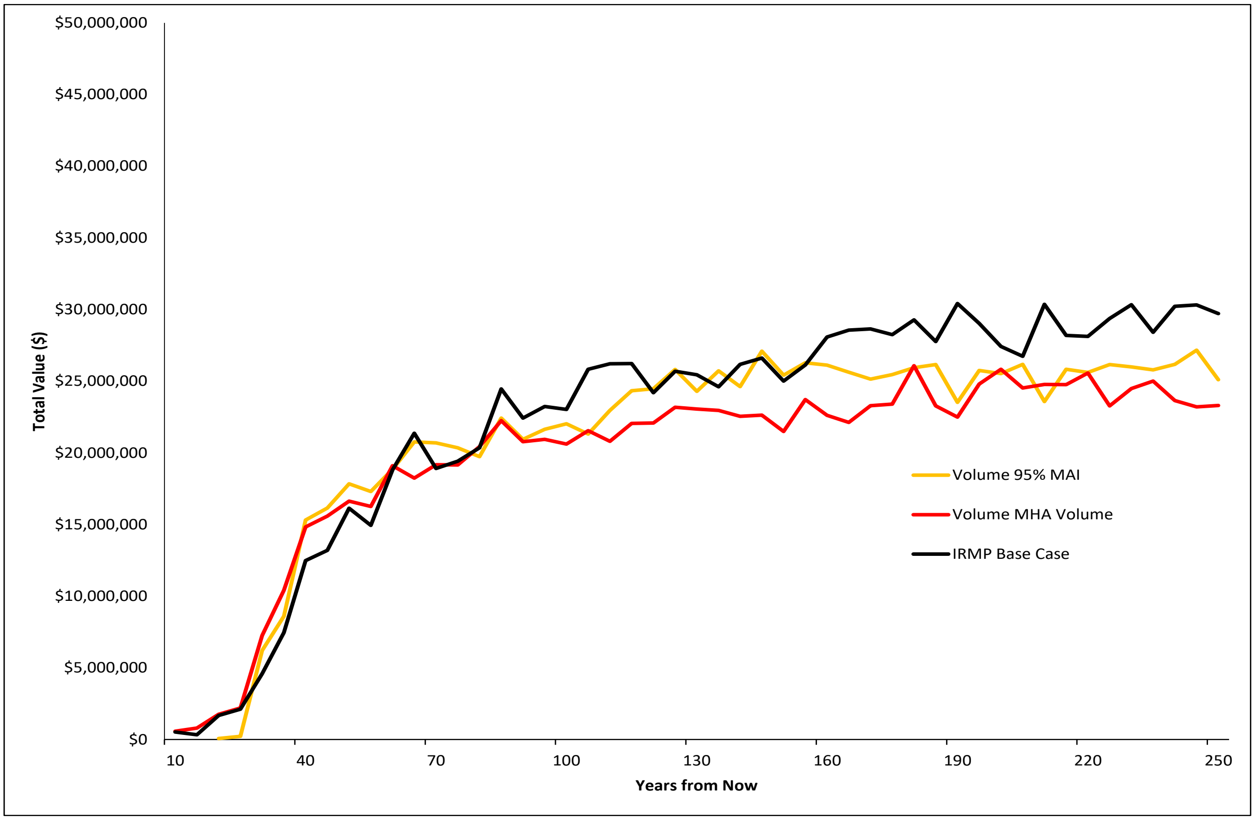


***Figure 49: Predicted total value of managed stands, volume scenarios, silviculture treatments***

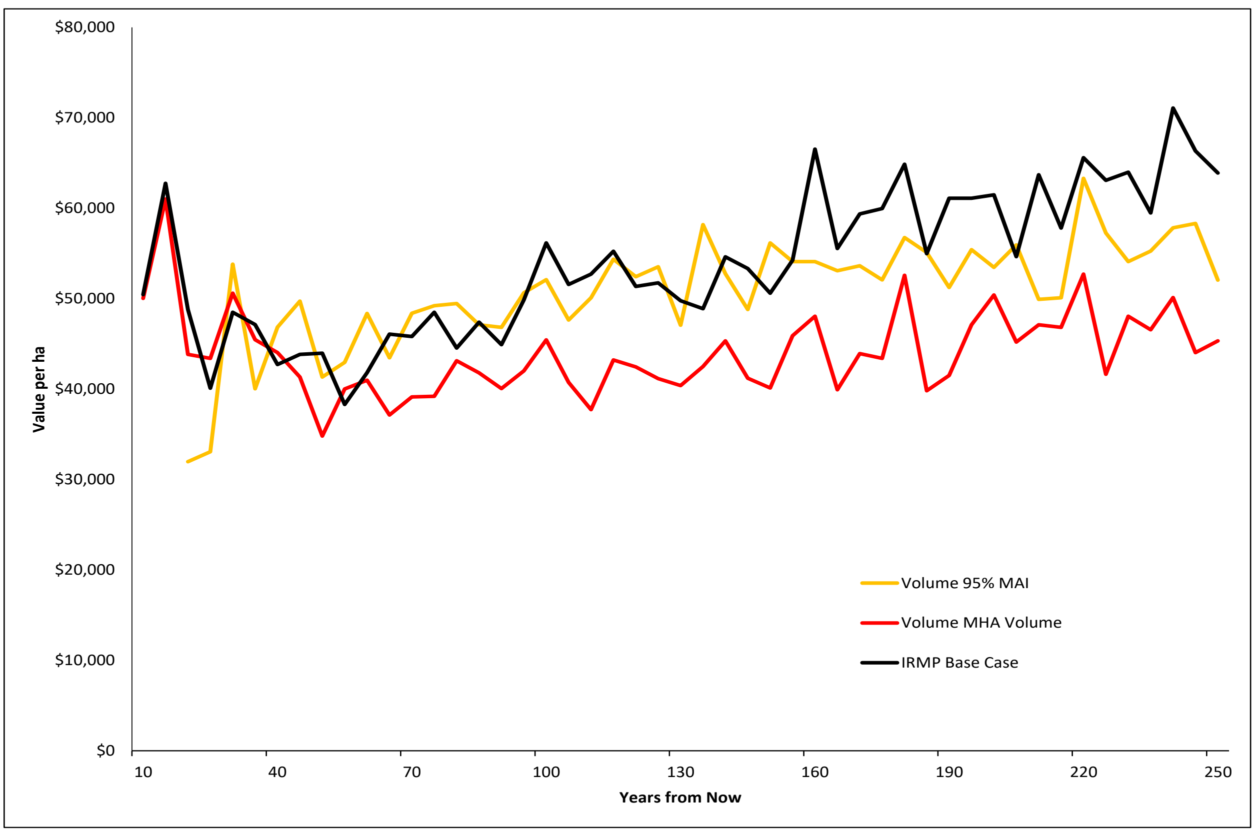


***Figure 50: Predicted value per ha of managed stands, volume scenarios, silviculture treatments***

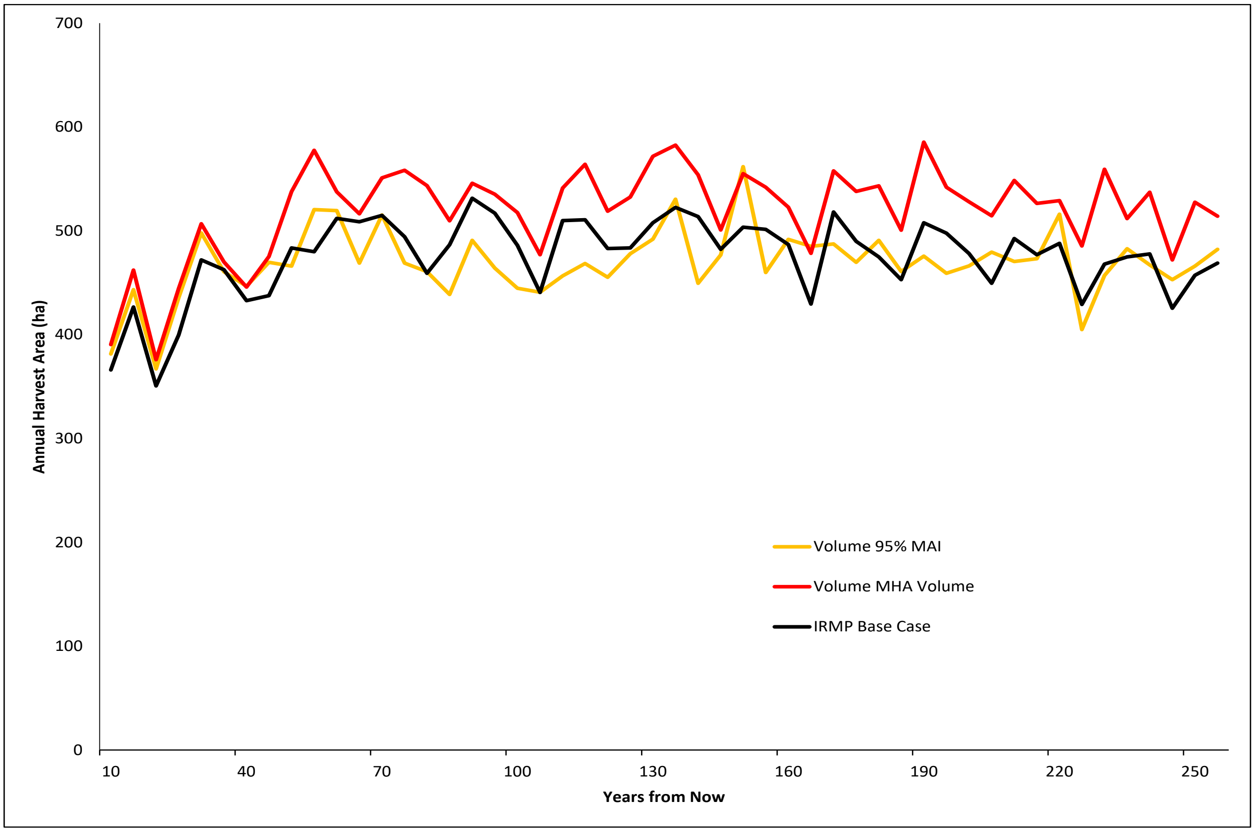


***Figure 51: Predicted average annual harvest area, volume scenarios, silviculture treatments***

### *4.5.3.2 Value Scenarios*

Figure 52 and Figure 53 illustrate the predicted total value and value per ha of managed stands over time for the scenario where the minimum harvest criteria for managed stands was set at the culmination age of the MAI. The managed stands are harvested significantly older than in the IRMP Base Case as shown in Figure 54. The total value of managed stands, when observing the MAI culmination minimum harvest criteria, is predicted to be considerably less than in the IRMP Base Case up to year 100 due to the significantly reduced harvest levels as discussed earlier. In the long term, the total value in the MAI culmination scenario is generally somewhat higher than that of the IRMP Base Case.

Harvesting stands later has a significant impact on predicted per ha timber value. This can be seen in Figure 53. In the long term the predicted per ha value of the harvest is almost twice as high as that of the IRMP Base Case. As a result, less harvest area is required in the long term to produce approximately the same total value (Figure 55) and volume (Figure 40).

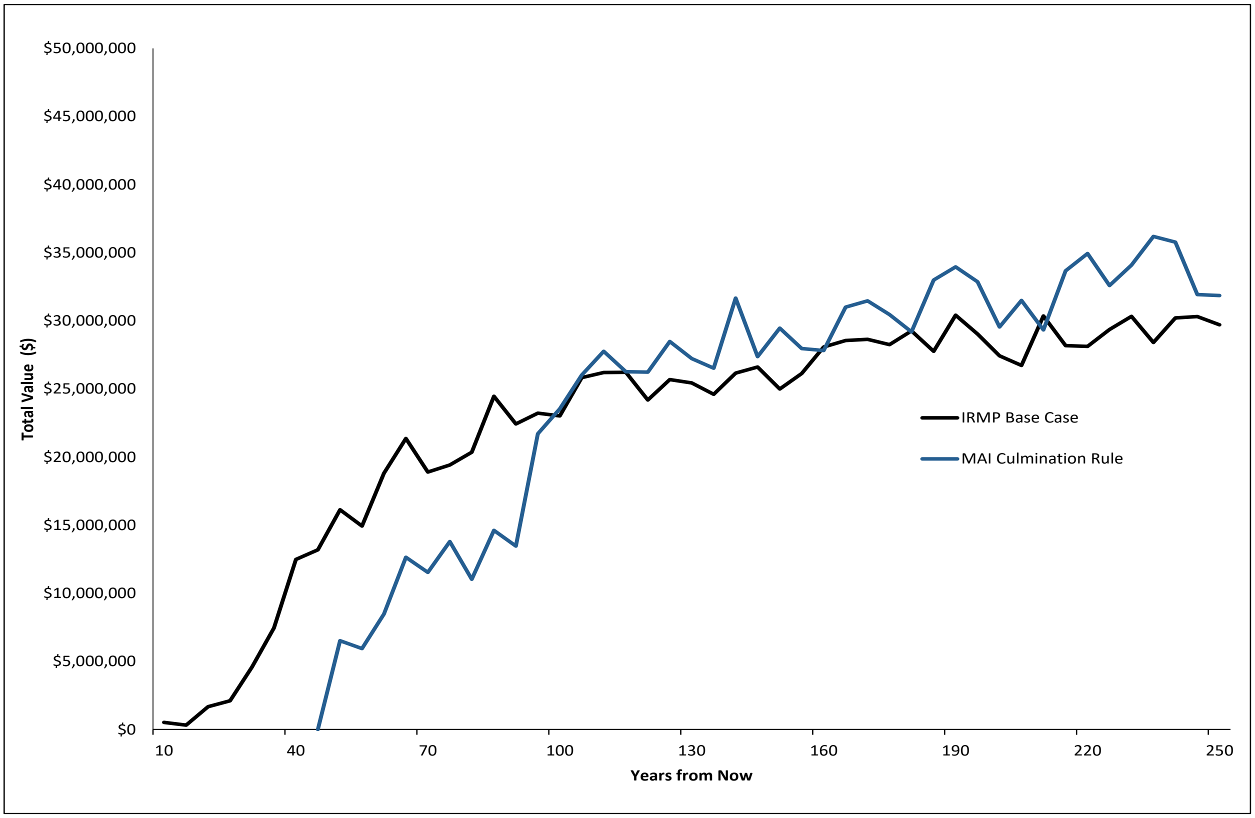


***Figure 52: Predicted total value of managed stands, MAI culmination rule***

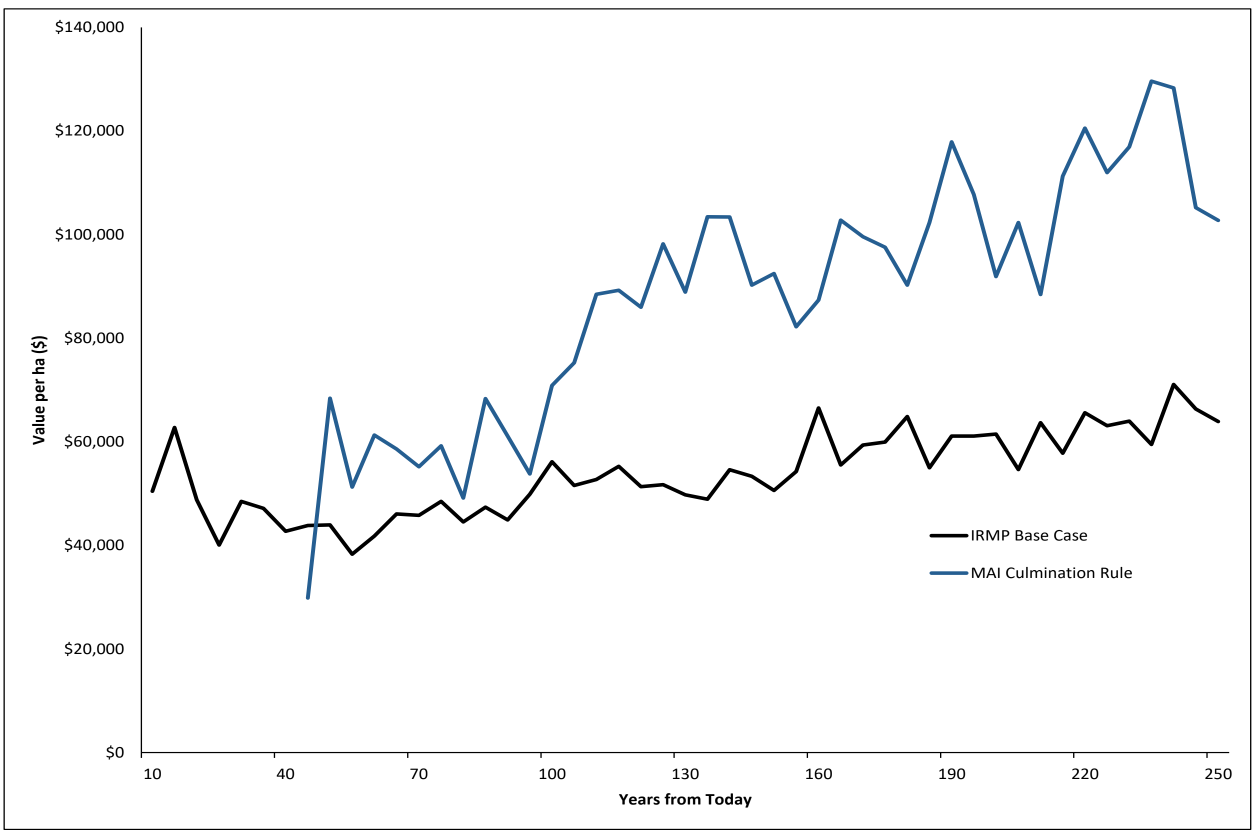


***Figure 53: Predicted value per ha of managed stands, MAI culmination rule***

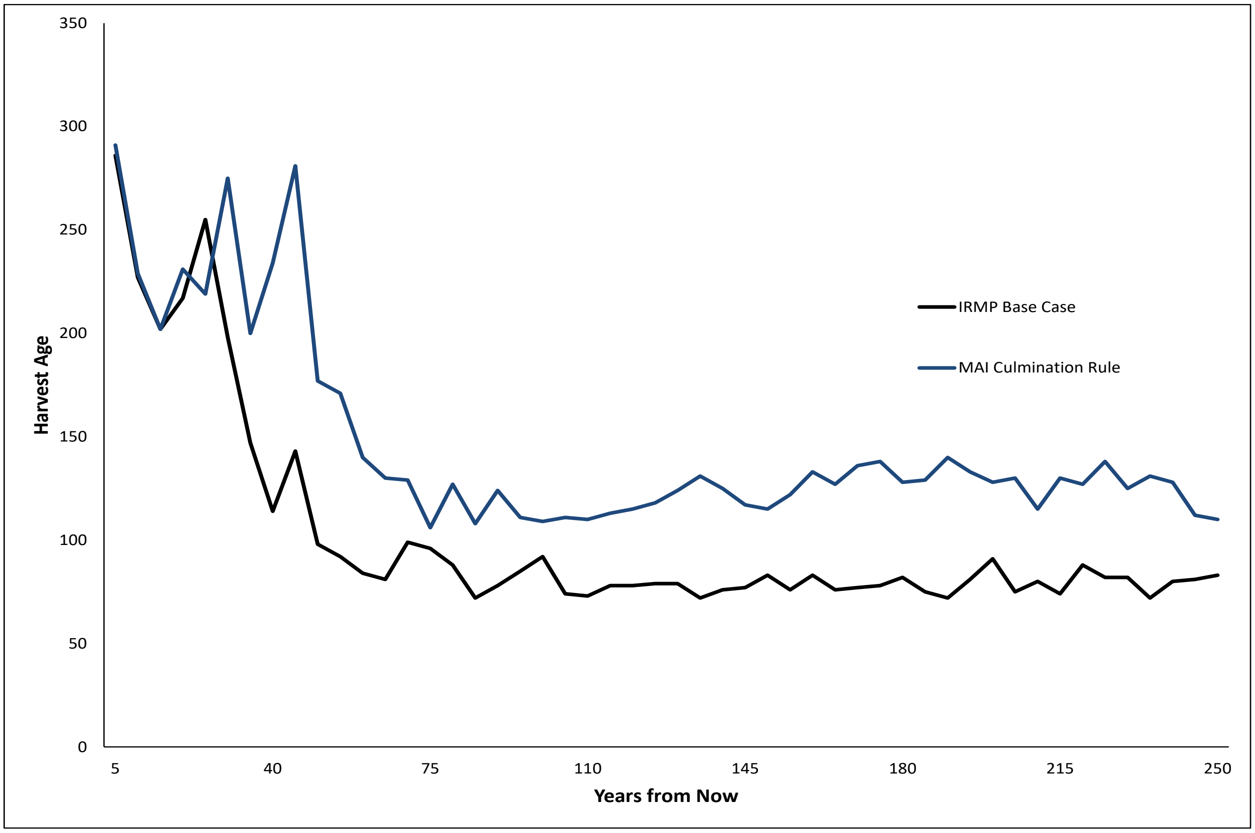


***Figure 54: Predicted average harvest age, MAI culmination rule***

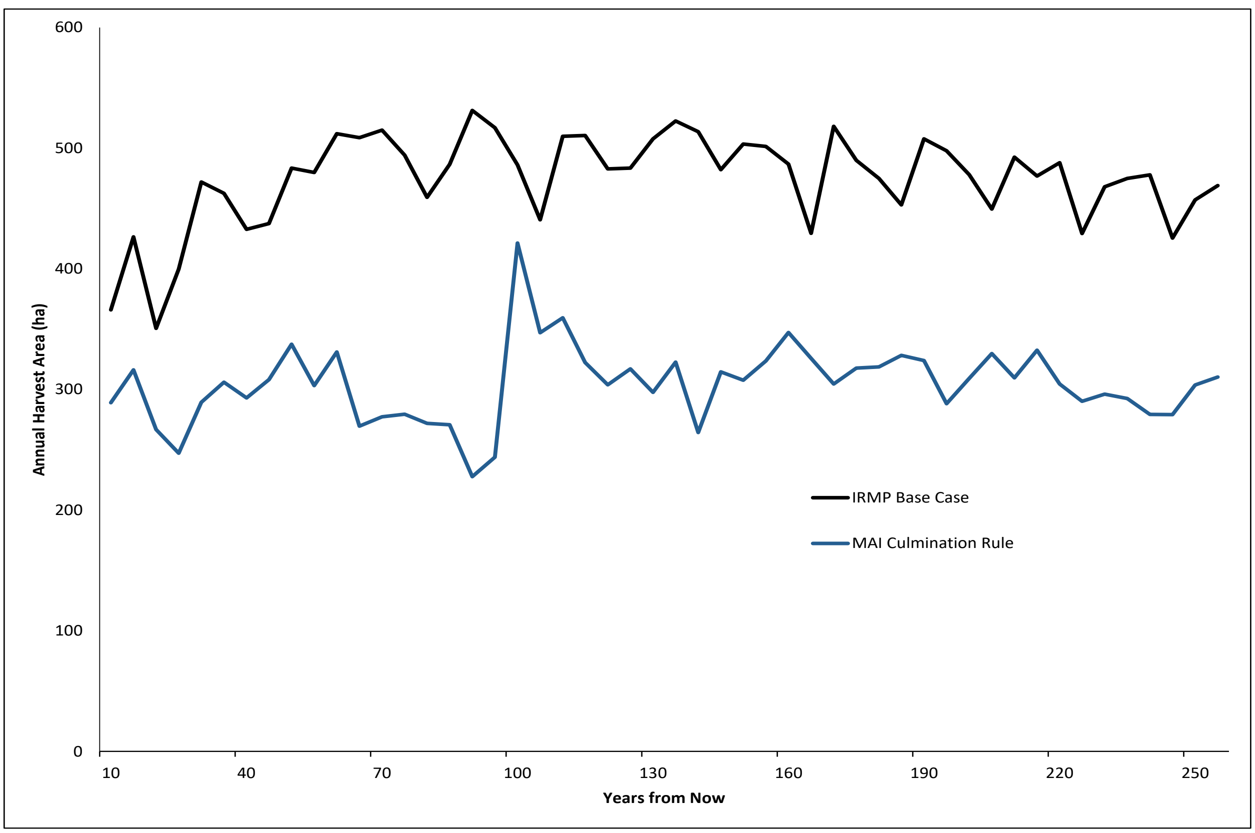


***Figure 55: Predicted average annual harvest area, MAI culmination rule***

Figure 56 compares the total predicted harvest value of all value scenarios. In the long term the IRMP Base Case creates the least amount of total timber value and the value scenario where the minimum harvest criteria was set at the age of 95% of MAI culmination creates the most. The differences are more striking when observing Figure 57 depicting the predicted per ha value of managed stands over time; the scenario where the MAI culmination rule is used produces the highest per ha value over time; however, the scenario with silviculture treatments combined with the 95% MAI culmination rule is also predicted create significantly more value than the IRMP Base Case and the value scenario that used a minimum volume as the minimum harvest criteria (350 $m^3$ per ha for conventional and 450 $m^3$ per ha for helicopter harvest).

While the MAI culmination rule scenario requires the least harvest area over time, the value scenario where the minimum harvest criteria was set at the age of 95% of MAI culmination also creates a significantly smaller footprint than the IRMP Base Case and the value scenario that used a minimum volume as the minimum harvest criteria (Figure 58).

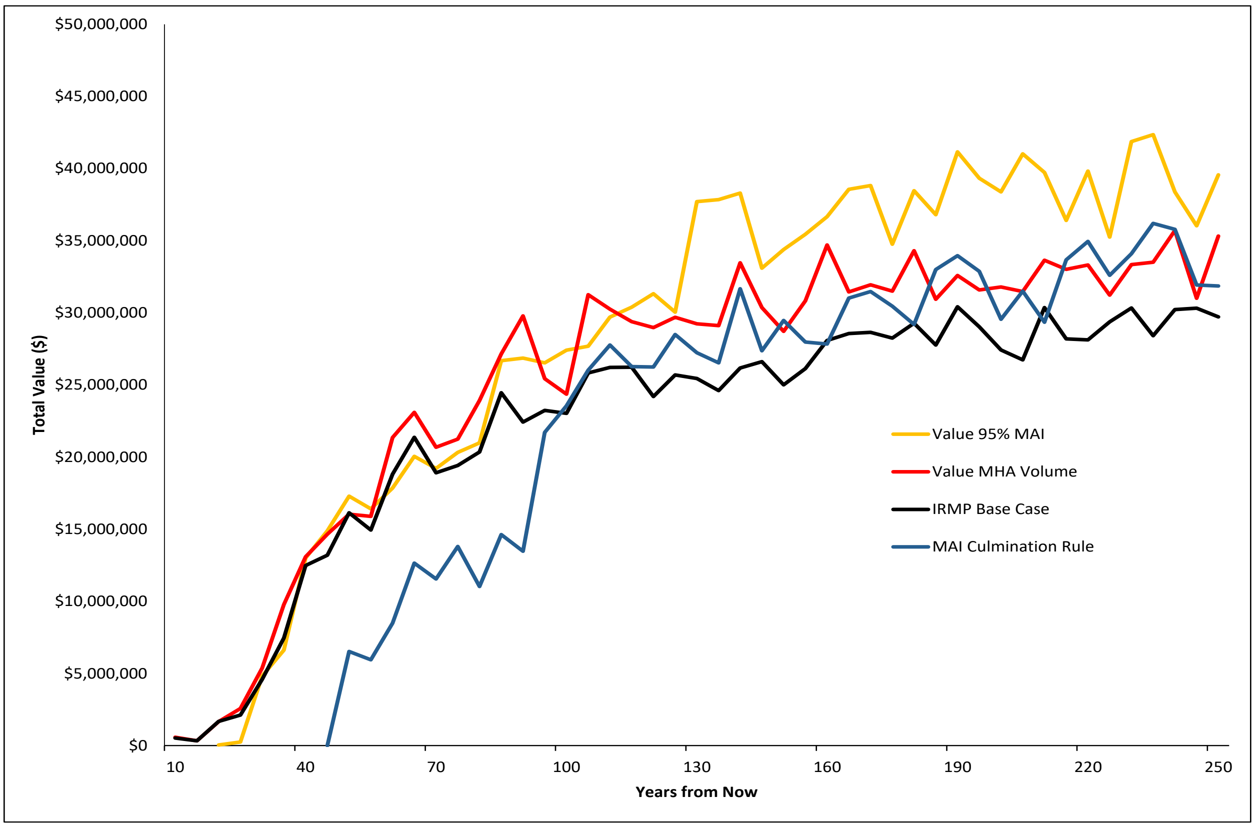


***Figure 56: Predicted total value of managed stands, value scenarios***

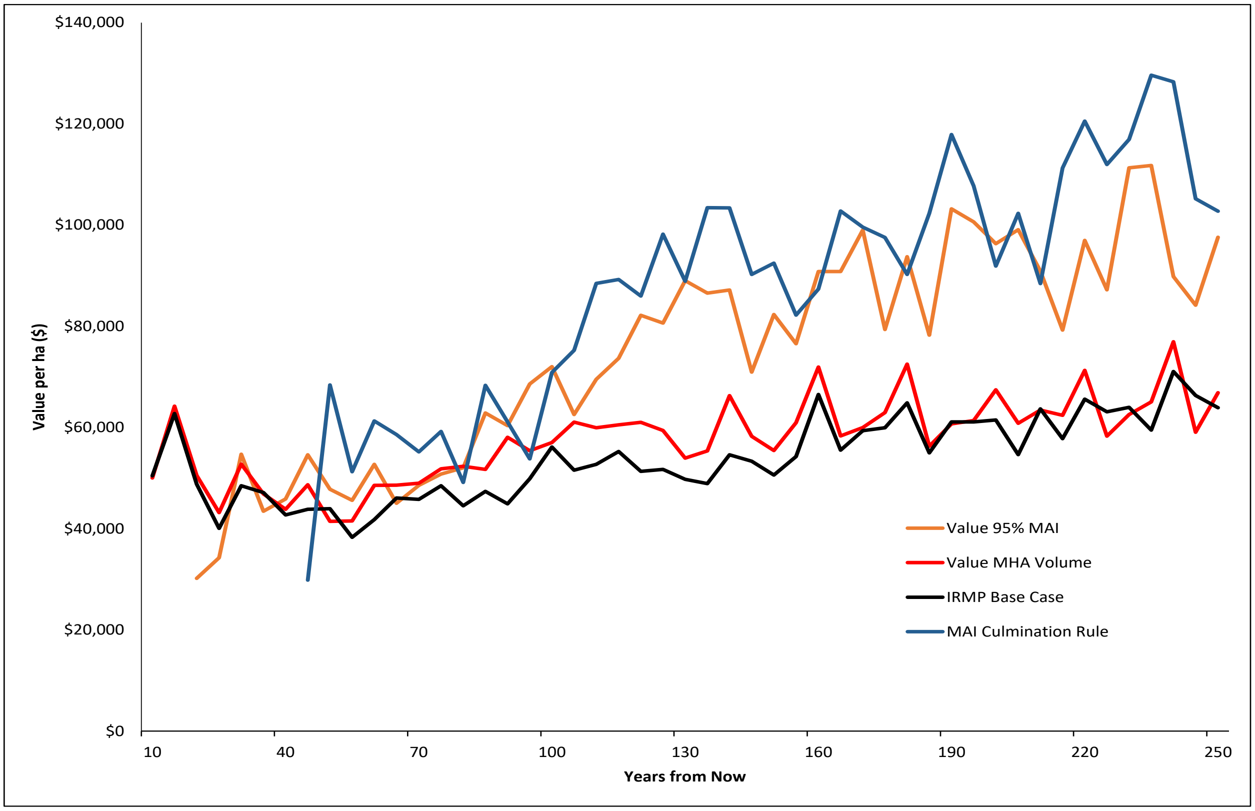


***Figure 57: Predicted value per ha of managed stands, value scenarios***

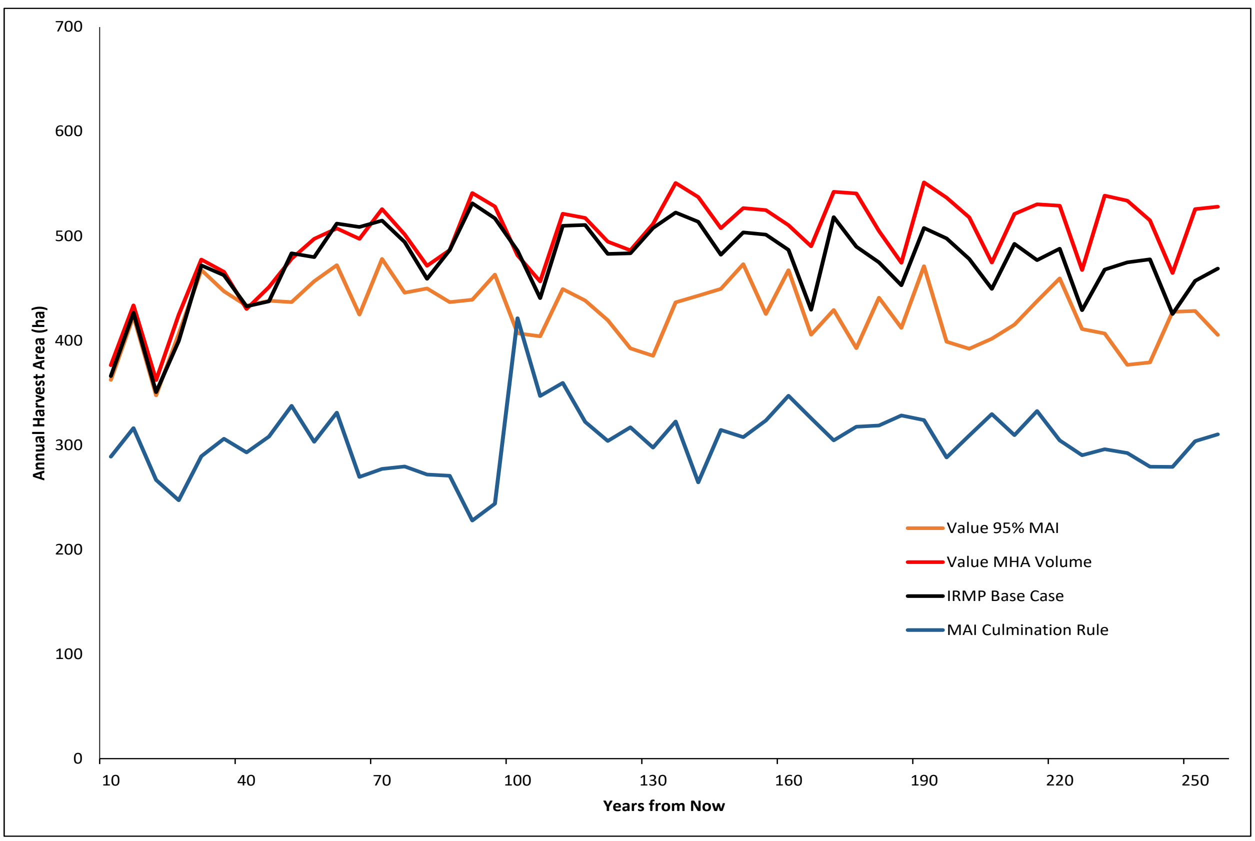


***Figure 58: Predicted average annual harvest area, value scenarios***

### 4.5.4 Habitat and Biodiversity Indicators

This analysis reported on four habitat indicators:

1. MAMU habitat in the west zone;
2. NOGO forage habitat in the CFLB;
3. Volume of old (>250 years) Cw in the CFLB;
4. Area of old seral stage (>250 years) in the CFLB.

Figure 59 depicts the predicted development of MAMU habitat in the west zone. The differences in MAMU habitat between scenarios were generally negligible. The scenario where the habitat target was set at 68% produced most habitat.

The riparian scenario increased the retention in riparian zones by removing the RMZ from the THLB. Some of this reduced THLB is also currently MAMU habitat; the increased protection of riparian areas resulted in a modest increase of MAMU habitat over time.

The riparian scenario also created most NOGO foraging habitat, while the scenario with relaxed VQOs crated the least (Figure 60). The reduced harvest in the short and medium term in the MAI culmination rule scenario creates much habitat; however in the long term the amount of NOGO forage habitat in this scenario is not significantly different from most other scenarios.

The same trend applies to the predicted volume of old Cw and predicted area of old seral stage in the CFLB (Figure 61 and Figure 62). In both cases the riparian scenario and MAMU scenario produce most old cedar volume and maintain largest areas of old seral stage, while the scenario with relaxed VQOs produced the least amount of both.

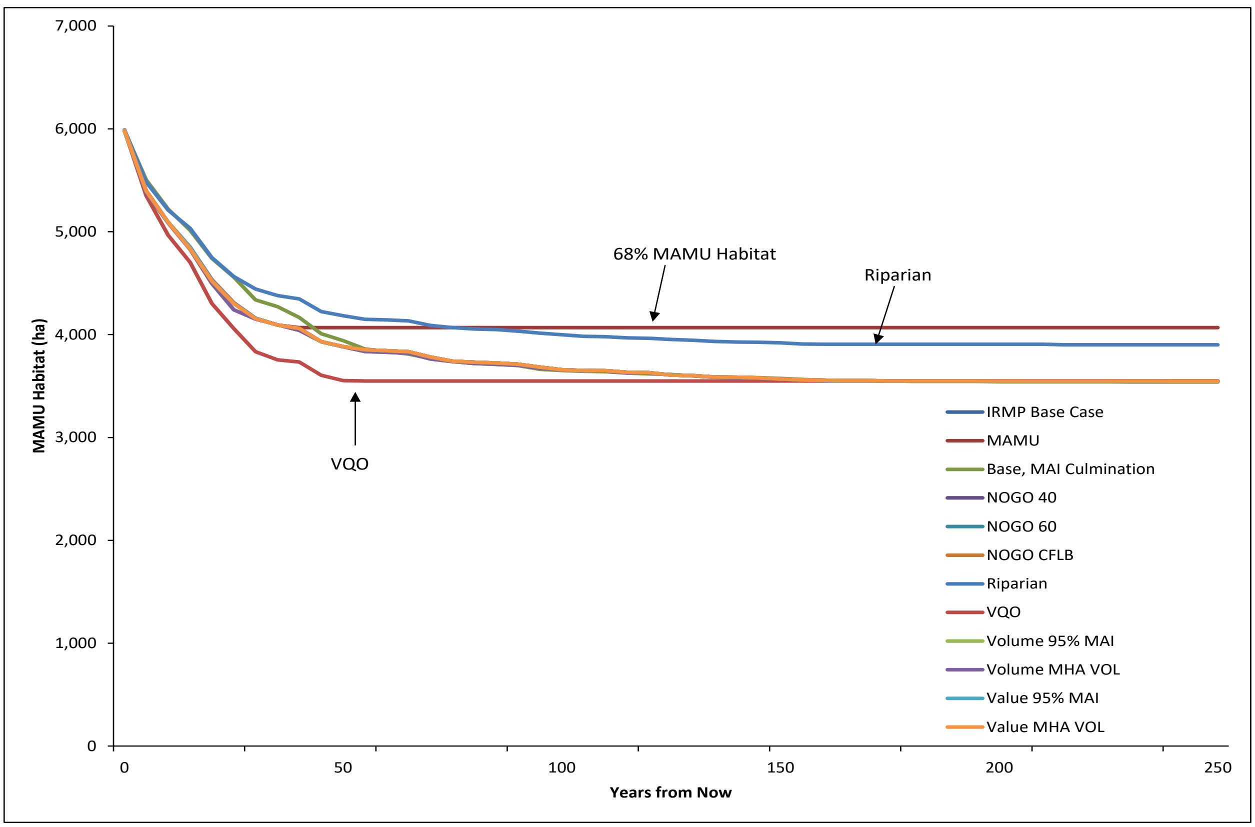


***Figure 59: Predicted MAMU habitat in the west zone***

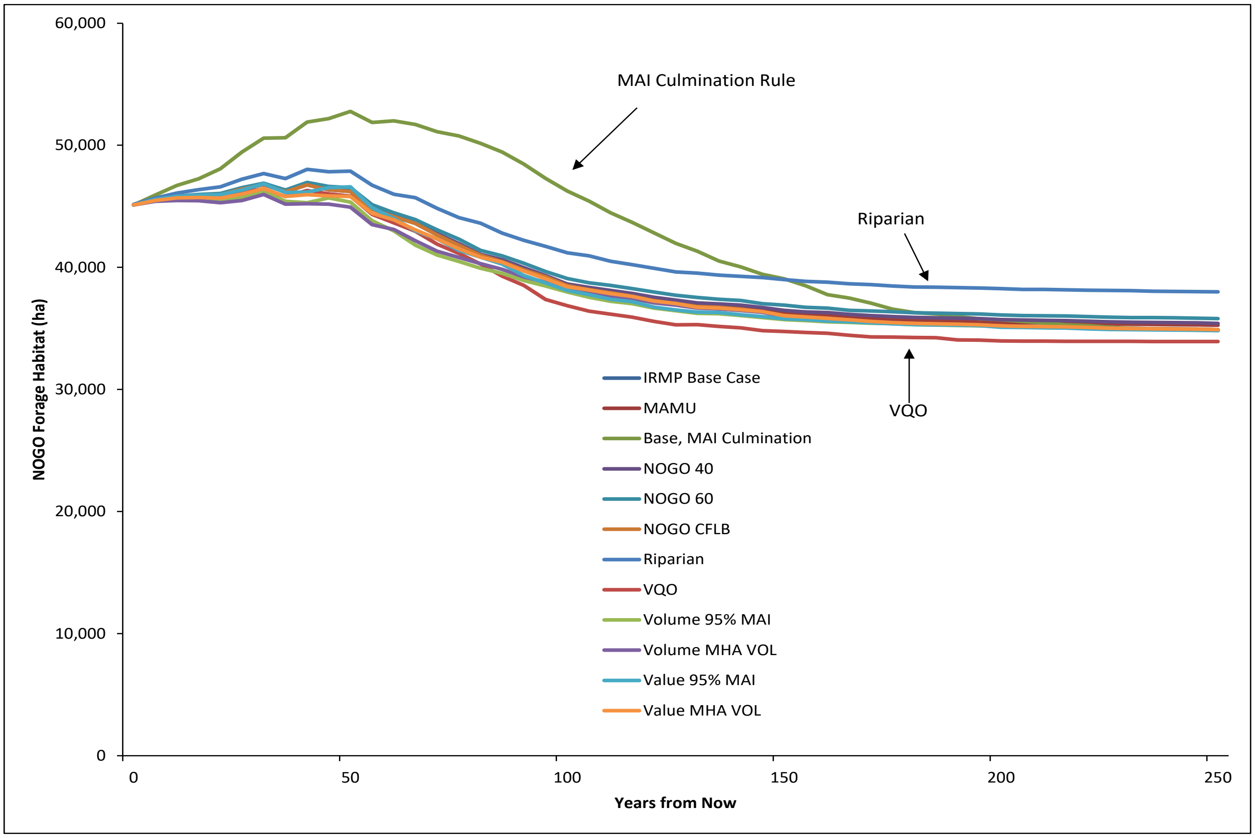


***Figure 60: Predicted NOGO forage habitat in the CFLB***

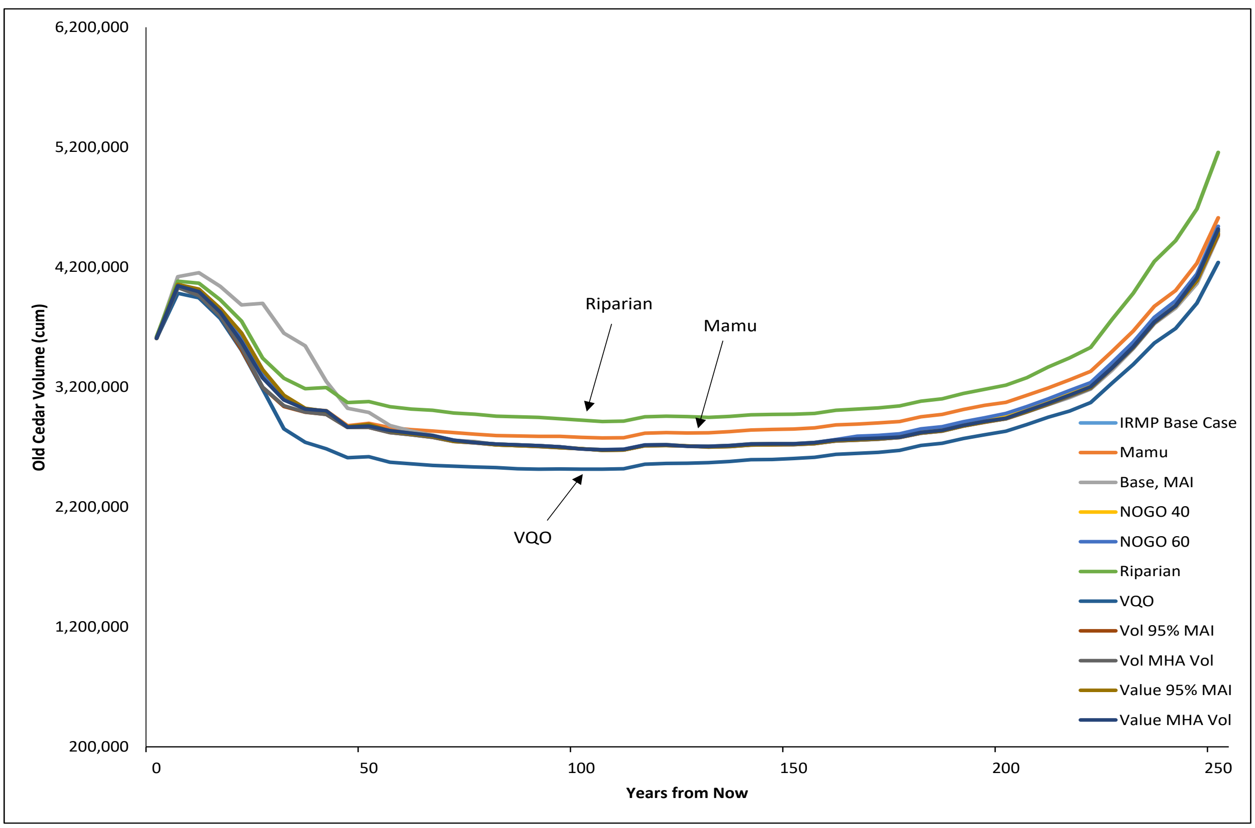


***Figure 61: Predicted old (>250 years) Cw volume in the CFLB***

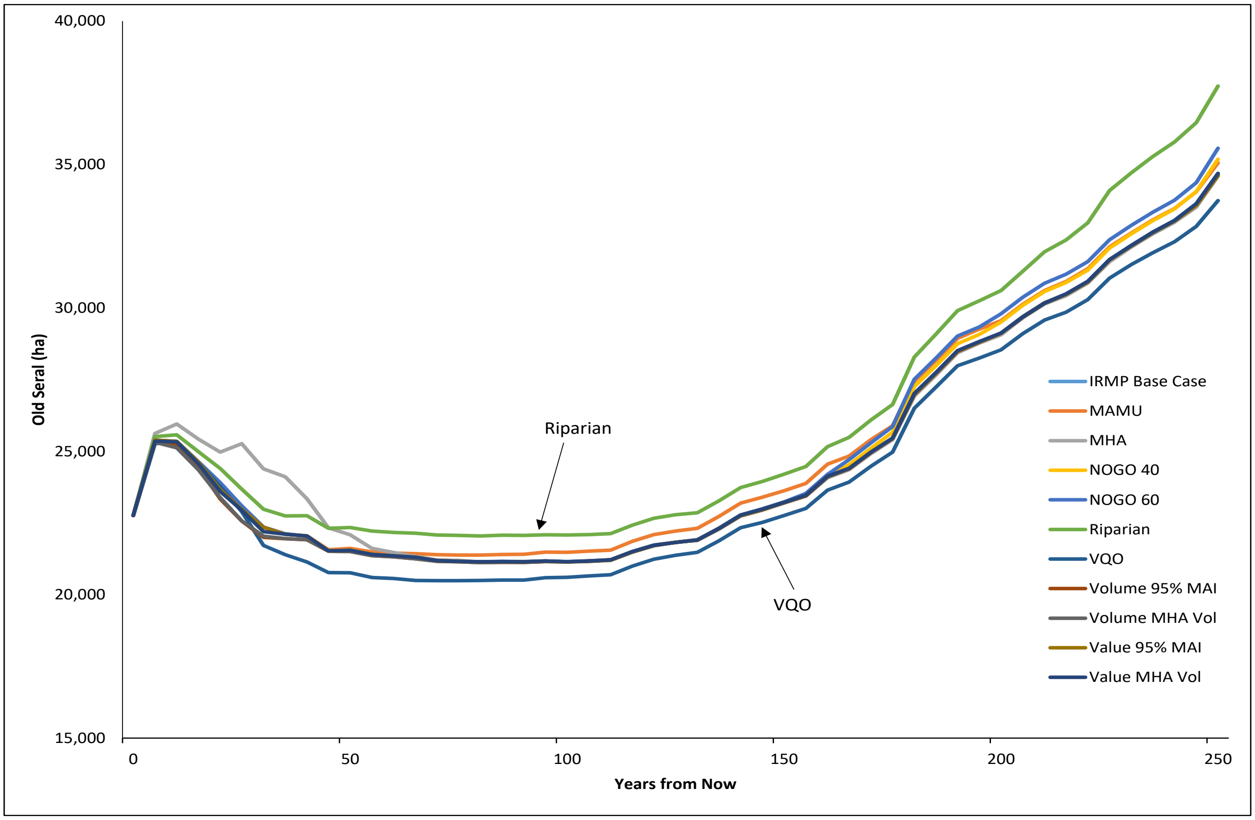


***Figure 62: Predicted old seral (>250 years) in the CFLB***

### 4.5.5 Scenario Results Summary

Table 6 provides a summary of the scenario results for various indicators. The pluses and minuses depict a somewhat subjective classification of predicted indicator values for each scenario. More is depicted with pluses and less is depicted with minuses. The only indicator that is not directly related to indicator results is Habitat General. Habitat General is a subjective indicator intended to depict whether more or less habitat in a generic sense is created. In Table 6 in most cases its rating is the inverse of Harvest Area, i.e. less harvest area creates less of a footprint, which is in turn assumed to maintain more habitat.

***Table 6: Scenario results summary***

| Scenario | Indicator | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Volume | Value | Harvest Area | NOGO Forage HabitatH | MAMU Habitat | Old CW Volume | Old Seral Stage Area | Habitat General |
| **Volume; TSR MHA** | ++ | -- | ++ | 0 | 0 | 0 | 0 | - |
| **Volume; 95% MAI** | + MT, +++ LT | + LT | 0 | 0 | 0 | 0 | 0 | 0 |
| **Value; TSR MHA** | + | + LT | + | 0 | 0 | 0 | 0 | - |
| **Value; 95% MAI** | 0 ST, ++ LT | +++ | -- | 0 | 0 | 0 | 0 | ++ |
| **Strict MAI** | --- | +++ LT | --- | +++ ST, 0 LT | + ST, 0 LT | 0 | + ST, 0 LT | --- |
| **Riparian** | -- | 0 | - | + | + | + | + | + |
| **VQO** | + | 0 | + | - | - | - | - | - |
| **NOGO 40** | 0 | 0 | 0 | + (dist) | 0 | 0 | 0 | 0 |
| **NOGO 60** | - (LT) | 0 | - (LT) | + (dist & area) | 0 | 0 | 0 | + |
| **NOGO CFLB** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **MAMU** | 0 | 0 | 0 | 0 | ++ | + | + | + |

## 4.6 Revised IRMP Base Case

In April 2017, the FLNRO discovered that a parcel of municipal lands near the Goldstream River had been inadvertently included in the TSR. The inclusion of this parcel overestimated the THLB by 849 ha, which was accounted for in the subsequent AAC determination meeting. For this analysis, the parcel was removed from the THLB and the revised land base was used as the basis for a revised IRMP Base Case and the Preferred Scenario.

The first set of TASS yield curves developed for the project by FAIB overestimated fertilizer responses in multi-species stands. Within the model (TASS), individual species fertilizer responses were applied to all trees in the stand resulting in overestimation. This was corrected by FAIB for the final set of yield curves used for this project (revised IRMP base case and the preferred scenario).

### 4.6.1 Revised IRMP Base Case Harvest Forecast

The revised THLB of 43,004 ha is 1.9% smaller than the THLB before the removal of the Goldstream River parcel. This THLB reduction and the corrected, smaller response to fertilization of existing older managed stands are reflected in the timber supply forecast; a harvest level of 275,000 $m^3$ per year (as opposed to 280,900 $m^3$, 2.1% reduction) can be maintained for 190 years (30 later than in the original Base Case) after which the harvest can be elevated to the long-term harvest level (LTHL) of 284,400 $m^3$ per year (previously 292,365 $m^3$, 2.8% reduction) (Figure 63). The predicted growing stock is illustrated in Figure 64.

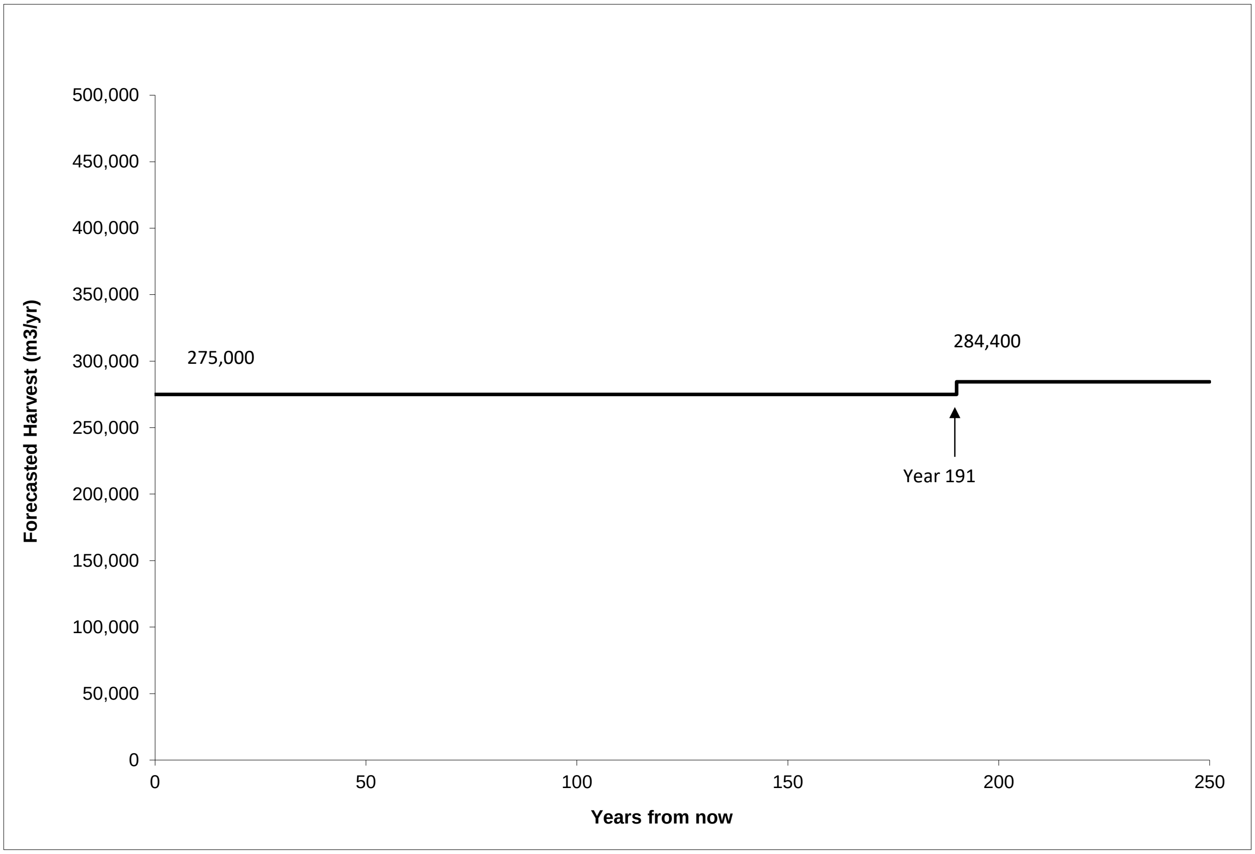


***Figure 63: Revised IRMP Base Case harvest forecast***

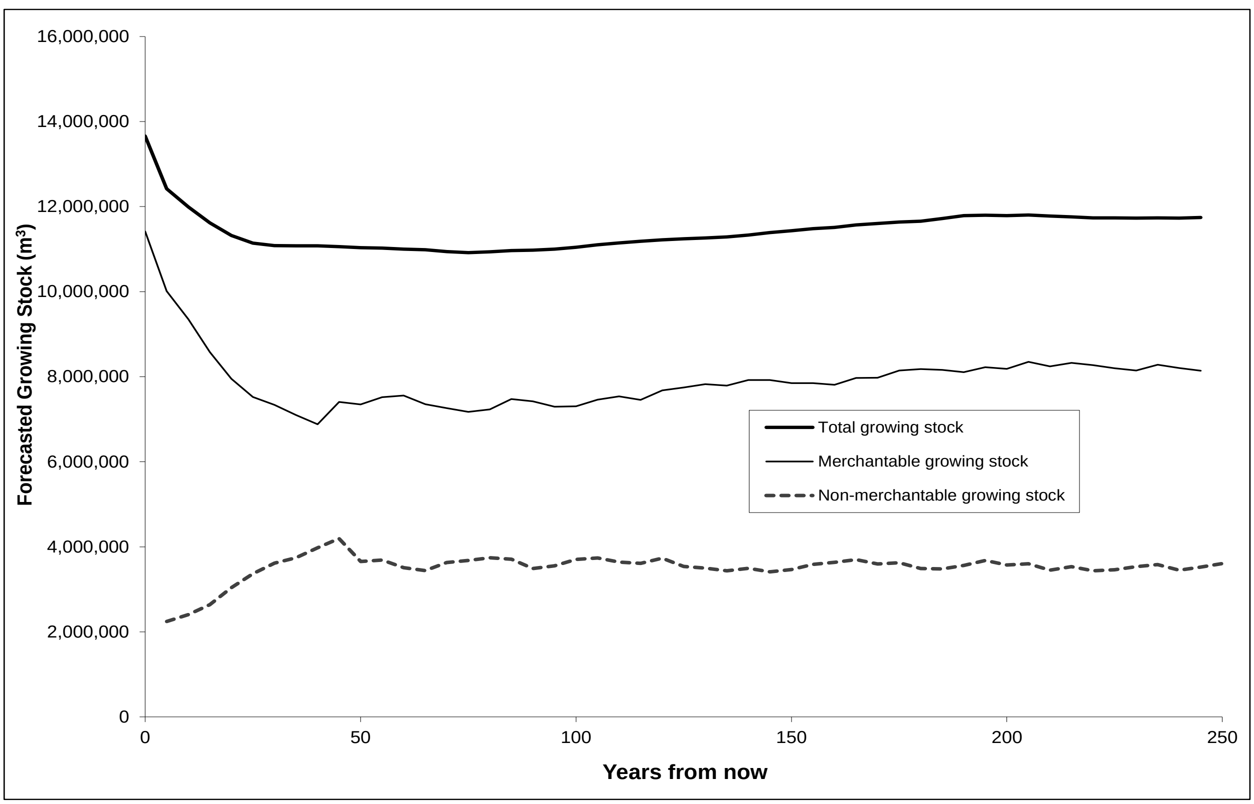


***Figure 64: Revised IRMP Base Case; predicted growing stock***

## 4.7 Preferred Scenario

The analysis results were presented to the Arrowsmith IRMP implementation group on March 10, 2017. The group agreed that the value scenario with some control over the harvest age of the managed stands should be the basis for the preferred scenario and the ensuing tactical silviculture treatment schedule. The following changes were incorporated into the preferred scenario:

- Extreme and high fire threat areas within the urban interface buffers were classified as red, i.e. not candidates for incremental silviculture investments as described in the value scenarios above. However, stand-level treatment regimes will be introduced in these zones to reduce fire risk.
- Suitable future Cw stands were included in the fertilization program.
- Minimum harvest criteria outside of green and yellow zones is the same as used in the latest TSR (350 $m^3$ per ha conventional and 450 $m^3$ per ha helicopter). Within the green and yellow zones the harvest criteria was set at the age where 95% of the MAI culmination is achieved.
- NOGO forage areas targets were be applied.

### 4.7.1 Silviculture Treatments

#### *4.7.1.1 Fertilization and Spacing*

Figure 65 and Figure 66 show the annual treatment areas and budgets by treatment type for the Preferred Scenario for fertilization and spacing. Initially, the treatment population is modest, consisting only of existing managed stands. In the course of time the annual area treated increases from 141 ha to about 1,300 ha, where it stabilizes.

In the short term the predicted fertilization and spacing costs are modest at around $132,000 annually during the first 5 years and around $212,000 annually between years 6 and 10. In the long term, approximately $1.2 million is required annually to maintain the proposed incremental silviculture program of fertilization and spacing.

#### *4.7.1.2 Enhanced Cedar Reforestation*

Planting densities for future Cw stands were increased to 1,200 stems per ha (sph) in green and yellow silviculture zones in the Preferred Scenario. Where ecologically suitable (good and medium Fd and Hw), Cw is planted instead of Hw or Fd. Note that this activity is directly related to the forecasted harvest schedule.

Approximately 164 ha and 85 ha of increased density planting of Cw are predicted annually for years 1 to 5 and 6 to 10 correspondingly (Figure 67). This increase of 300 sph is estimated to increase planting costs by approximately $300 per ha. The predicted annual incremental planting costs for years 1 to 5 are $49,000 and $25,500 for years 6 to 10 (Figure 68).

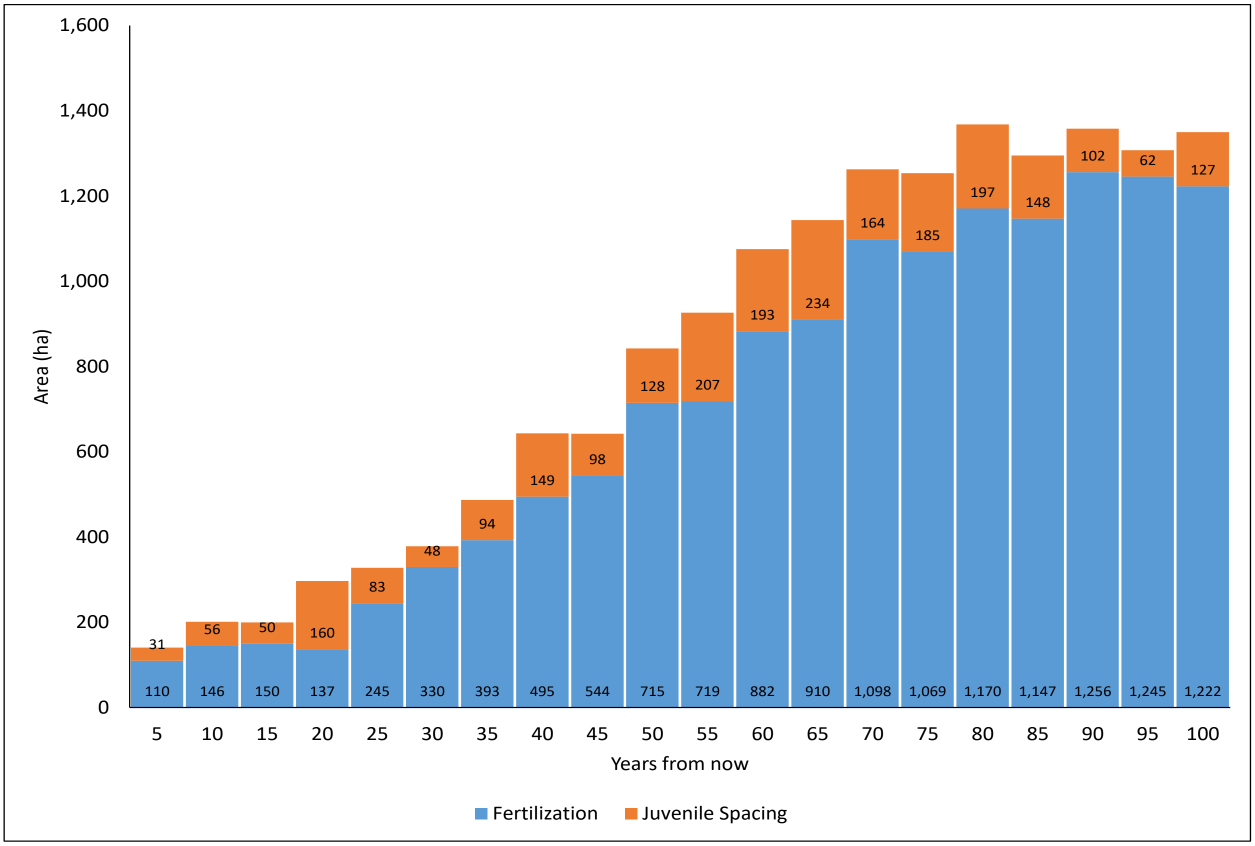


***Figure 65: Annual fertilization and spacing areas; Preferred Scenario***

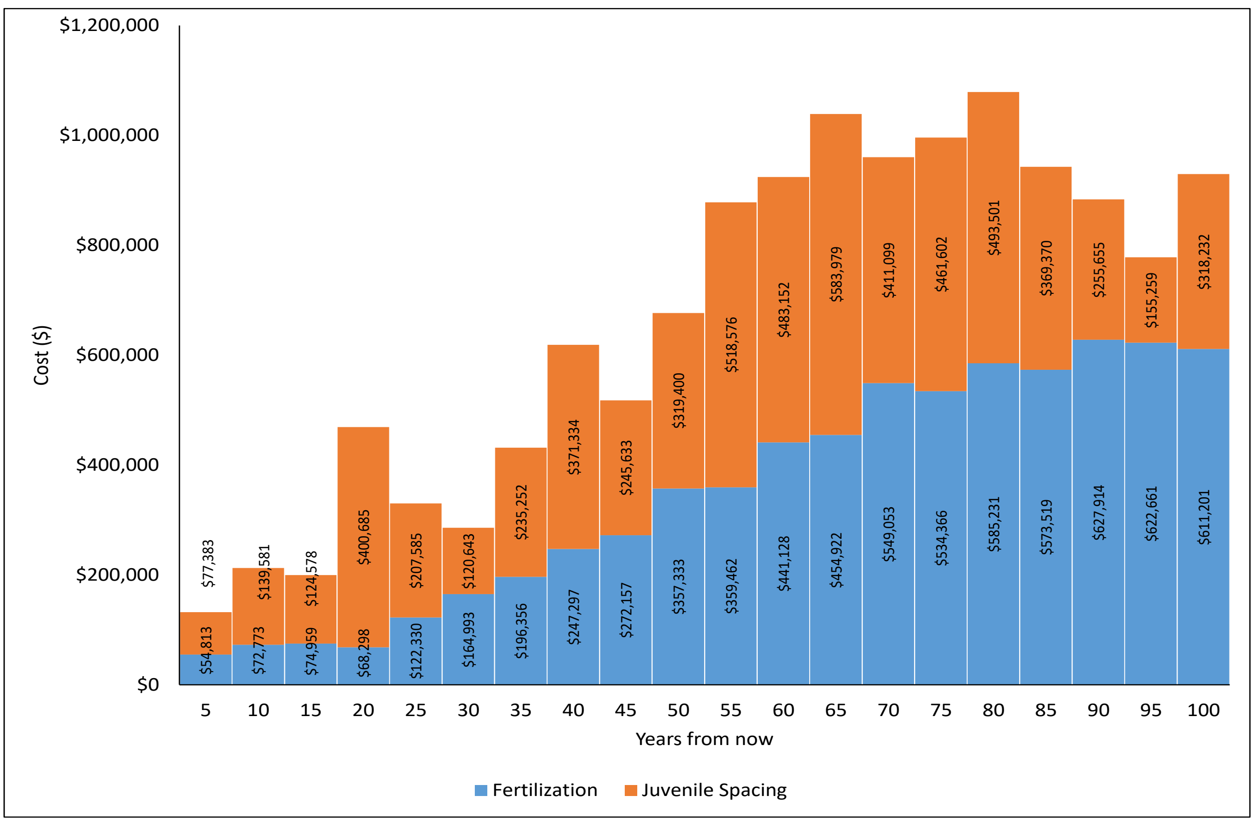


***Figure 66: Annual fertilization and spacing expenditures; Preferred Scenario***

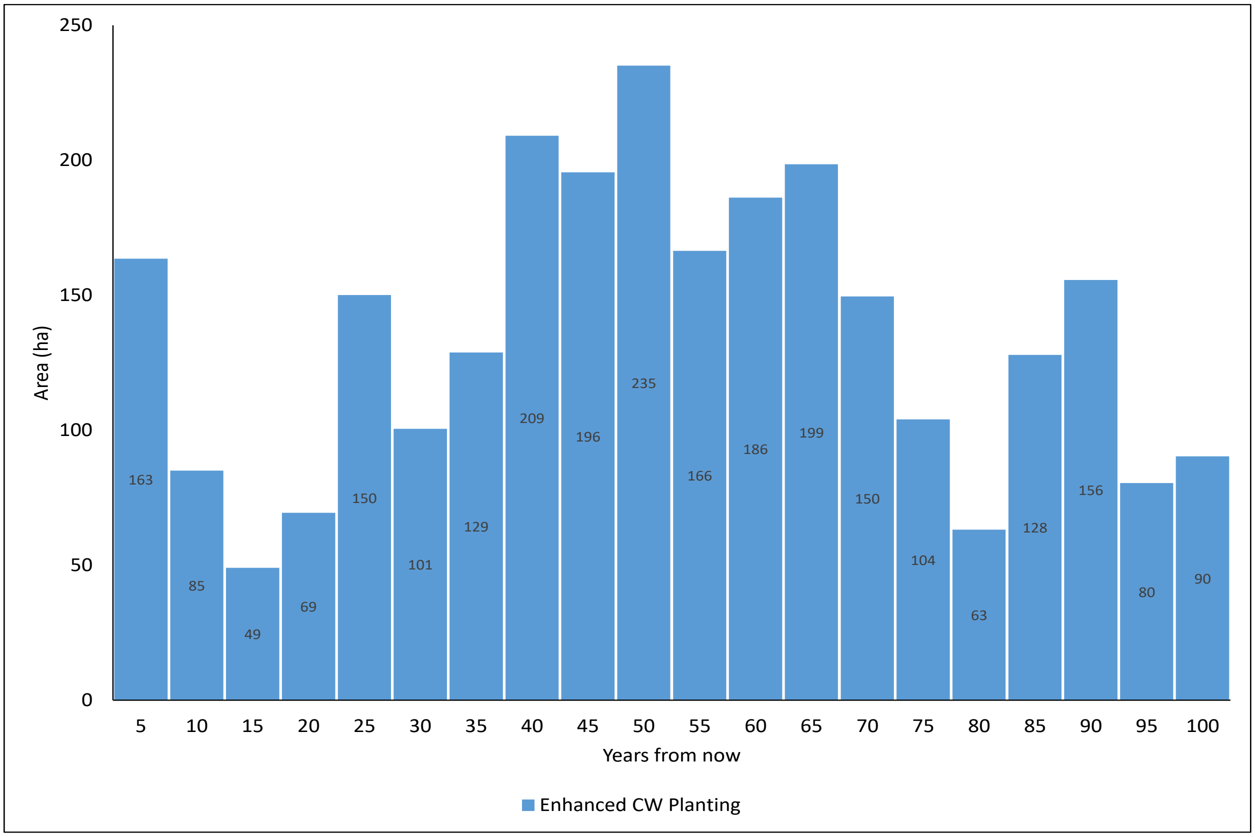


***Figure 67: Annual enhanced CW reforestation areas; Preferred Scenario***

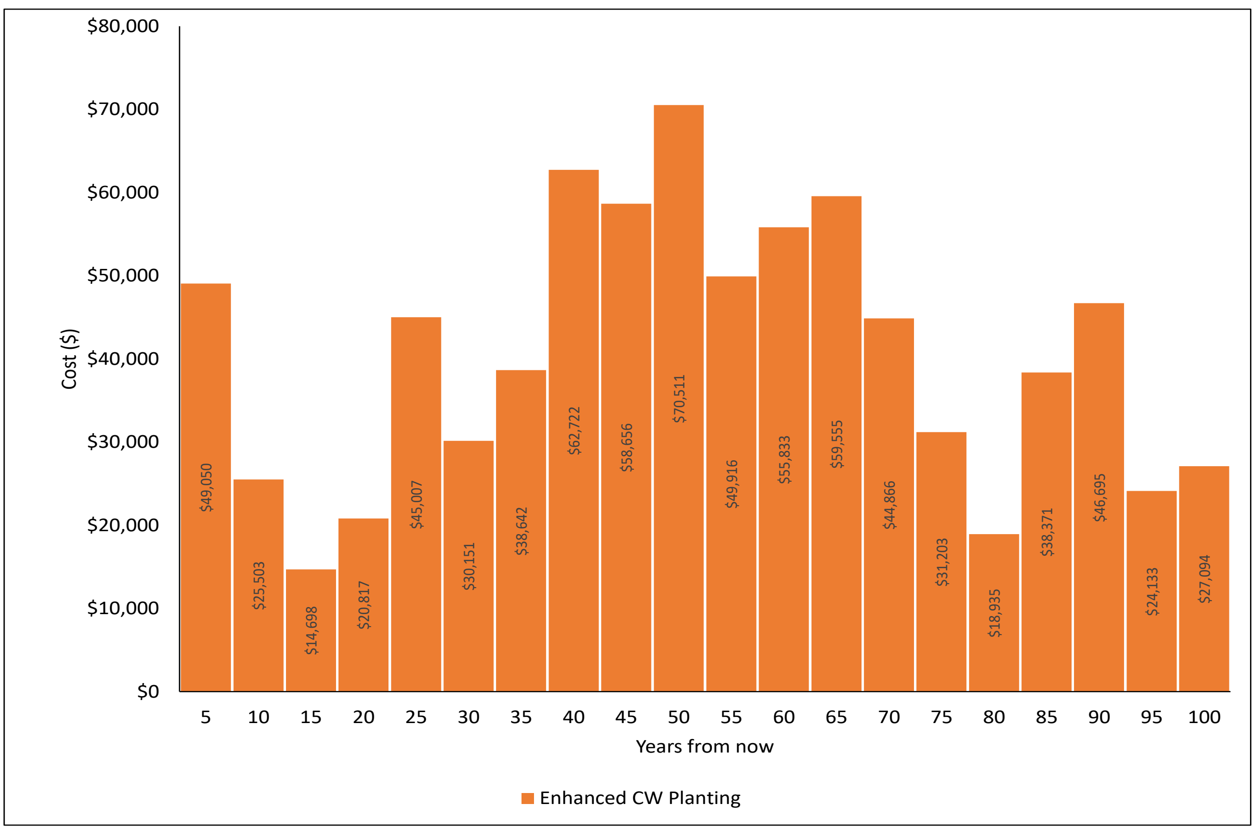


***Figure 68: Annual enhanced CW reforestation expenditures; Preferred Scenario***

### 4.7.2 Analysis Results

Note that all references to the IRMP Base Case below refer to the revised IRMP Base Case. Figure 69 illustrates a harvest forecast comparison between the IRMP Base Case and the Preferred Scenario. The Preferred Scenario harvest level remains 3.1% lower than that of the IRMP Base Case until year 125, when the transition to the LTHL occurs. The Preferred Scenario harvest level is predicted to be 8.2 % higher than that of the IRMP Base Case between years 126 and 190 (297,550 $m^3$ per year vs. 275,000 $m^3$ per year), and 4.6% higher in the long term (297,550 $m^3$ per year vs. 284,400 $m^3$ per year).

The stands are held somewhat longer than in the IRMP Base Case as indicated by the predicted average harvest age shown in Figure 70. The higher harvest age and increased productivity through fertilization result in a higher average harvest volume and a higher long-term growing stock compared the IRMP Base Case (Figure 71 and Figure 72).

The Preferred Scenario favors Cw and Fd to create value; the predicted shares of Cw and Fd of the total harvest increase at the expense of Hw as shown in Figure 73.

The Preferred Scenario relies on the harvest of older, mostly age class 9 stands in the short term (Figure 74). In the long term, the majority of the harvest is expected to come from age class 3 and 4 stands (41 to 80 years old).

On average, approximately 93,000 $m^3$ of the future harvest is expected to occur in the east zone over the planning horizon as shown in Figure 75, while between 7% and 24% (12% on average) of the harvest is predicted to come from helicopter harvested stands over the planning horizon as illustrated in Figure 76.

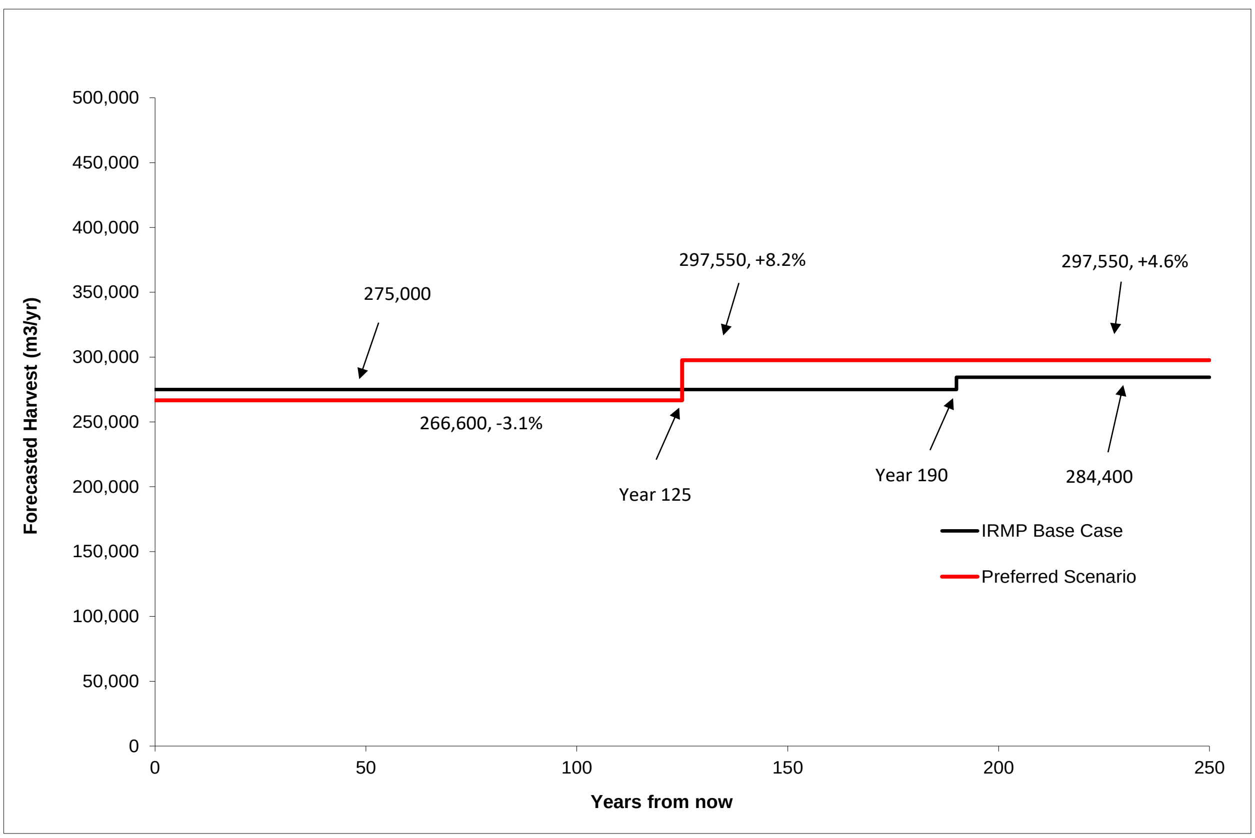


***Figure 69: Harvest forecast; Preferred Scenario***

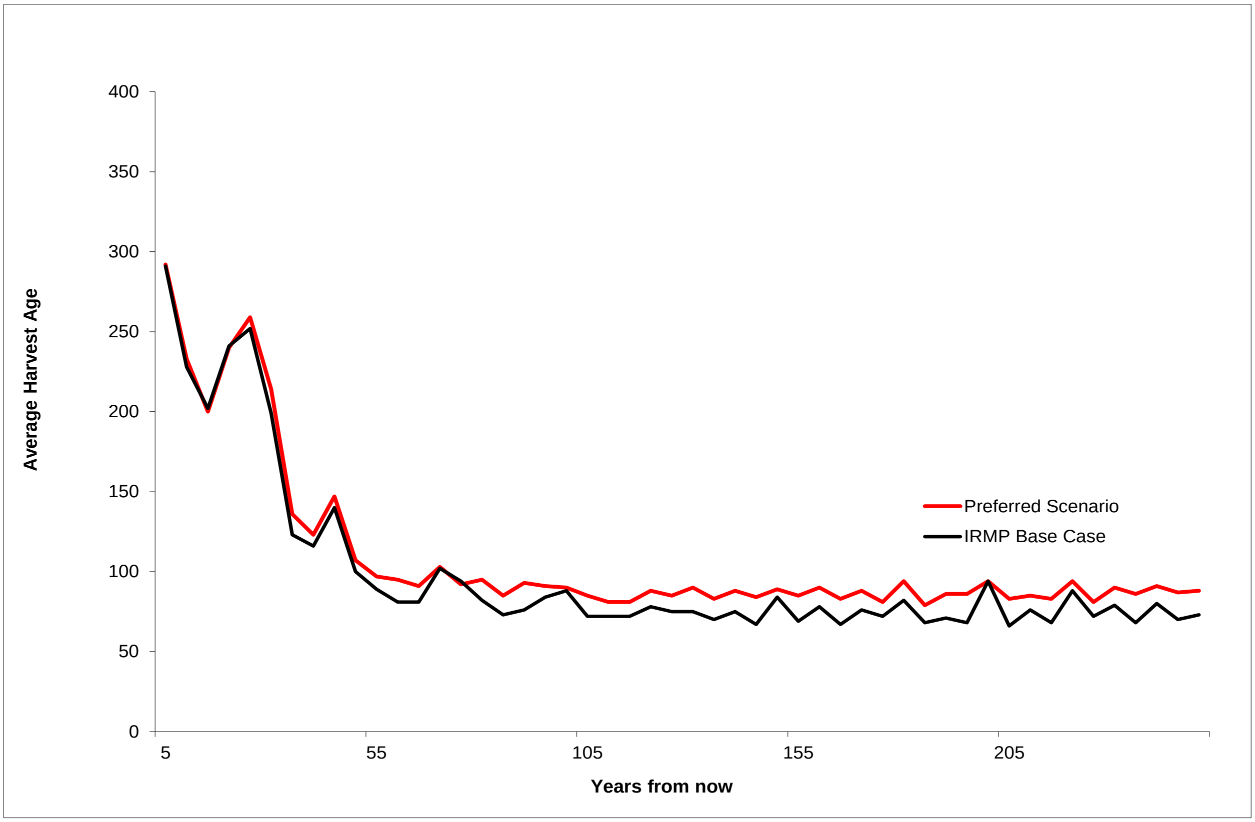


***Figure 70: Predicted average harvest age; Preferred Scenario***

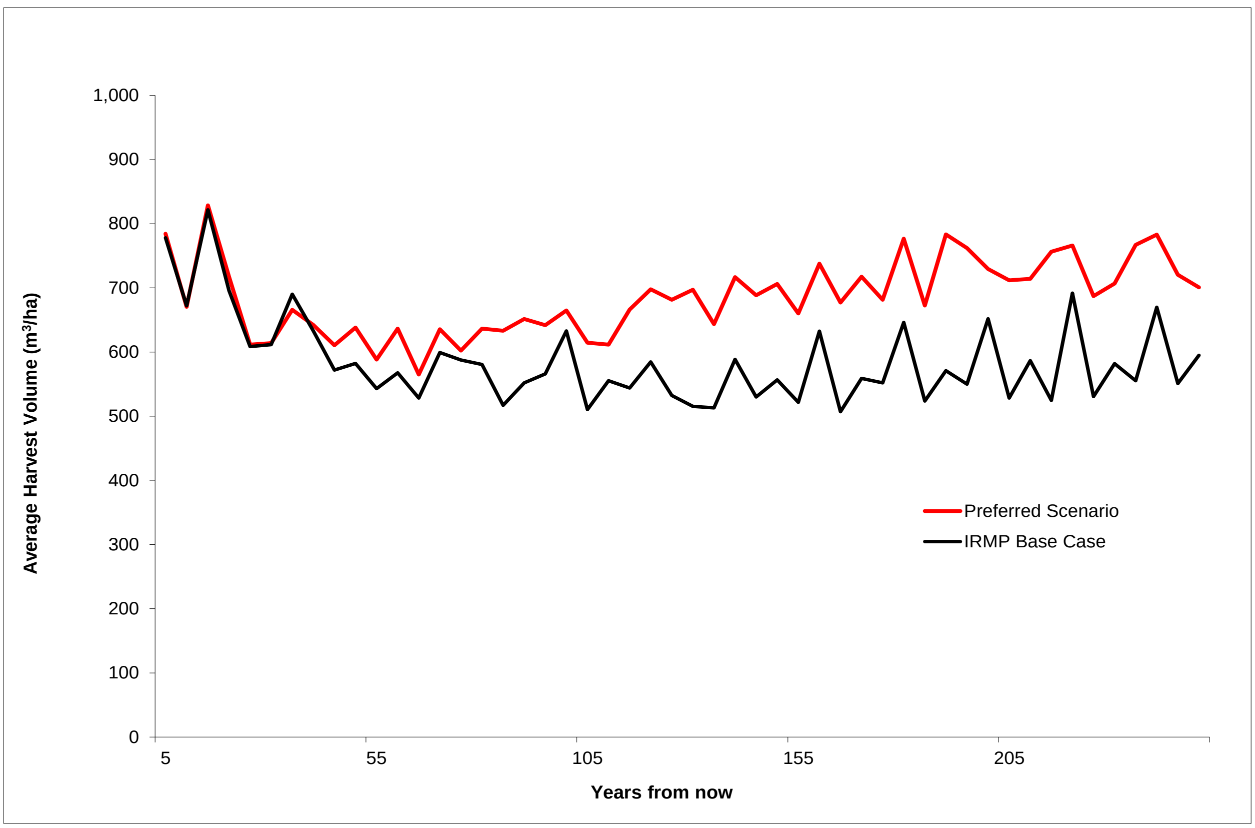


***Figure 71: Predicted average harvest volume; Preferred Scenario***

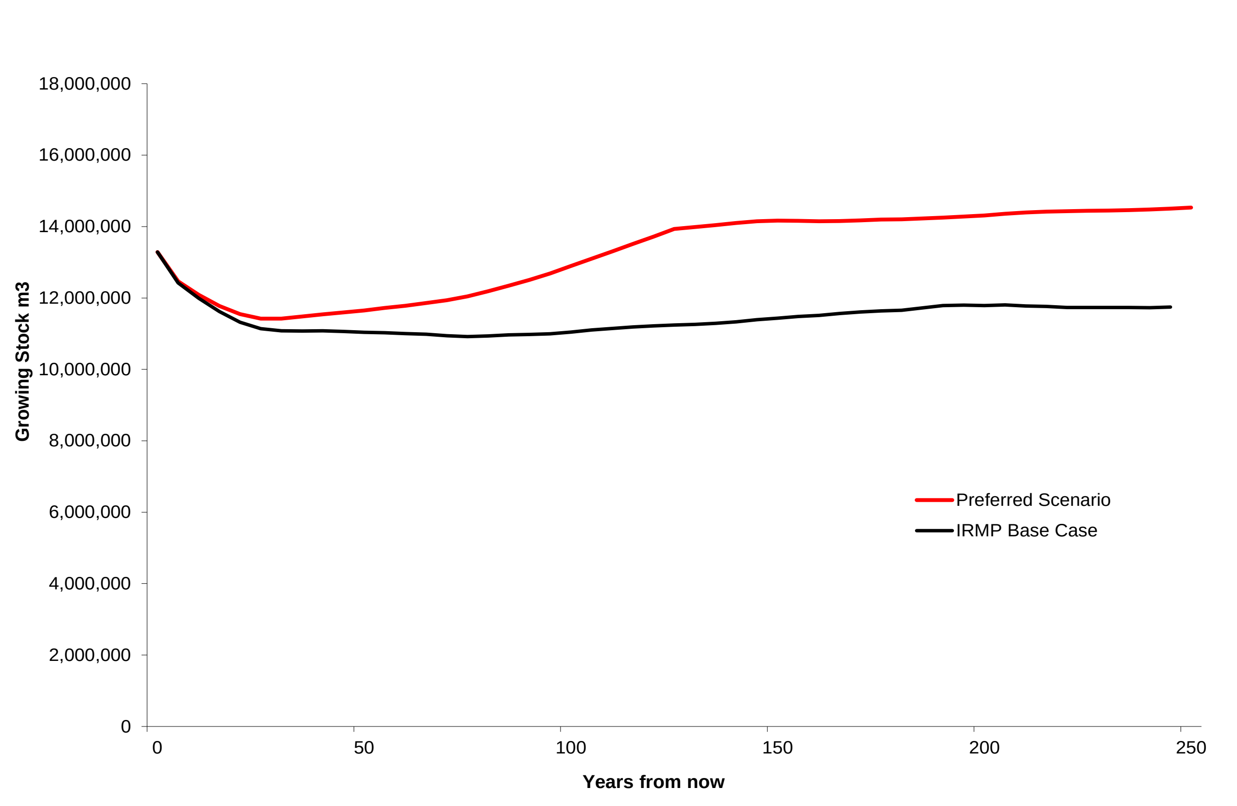


***Figure 72: Predicted growing stock; Preferred Scenario***

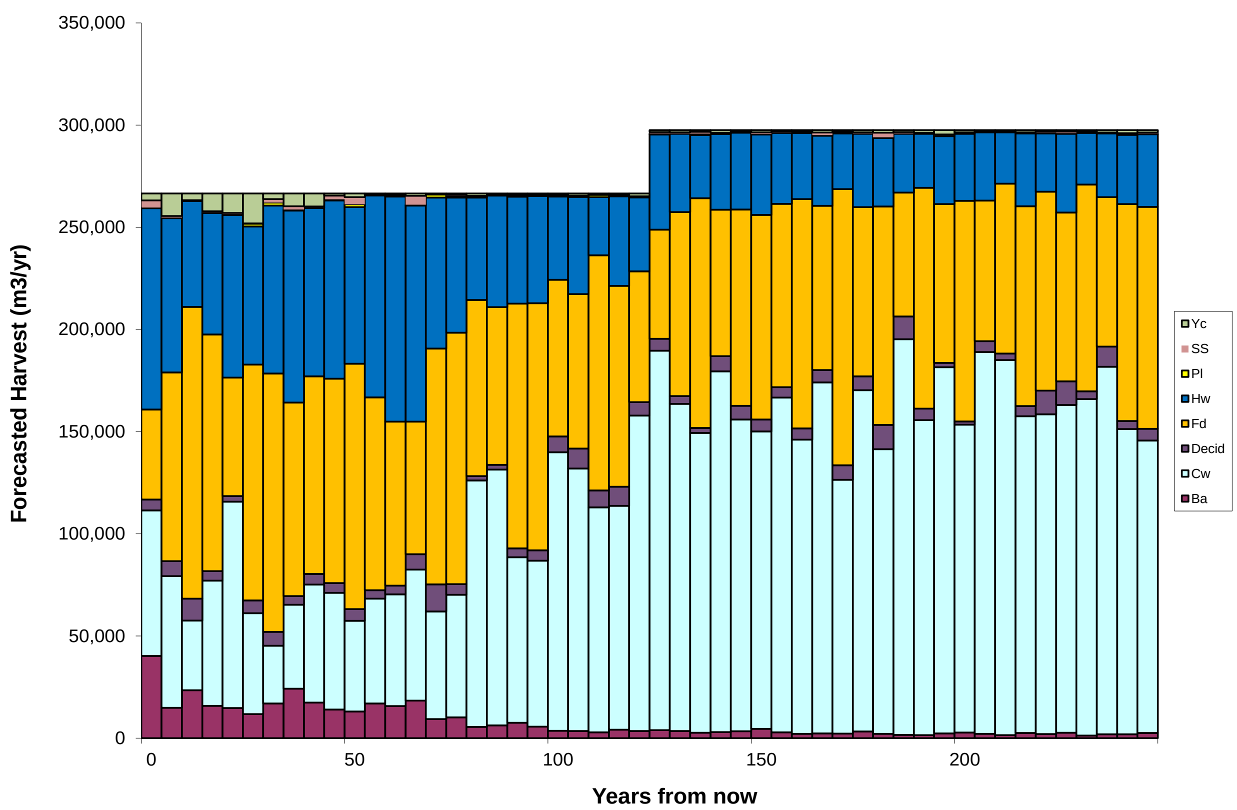


***Figure 73: Harvest forecast by species; Preferred Scenario***

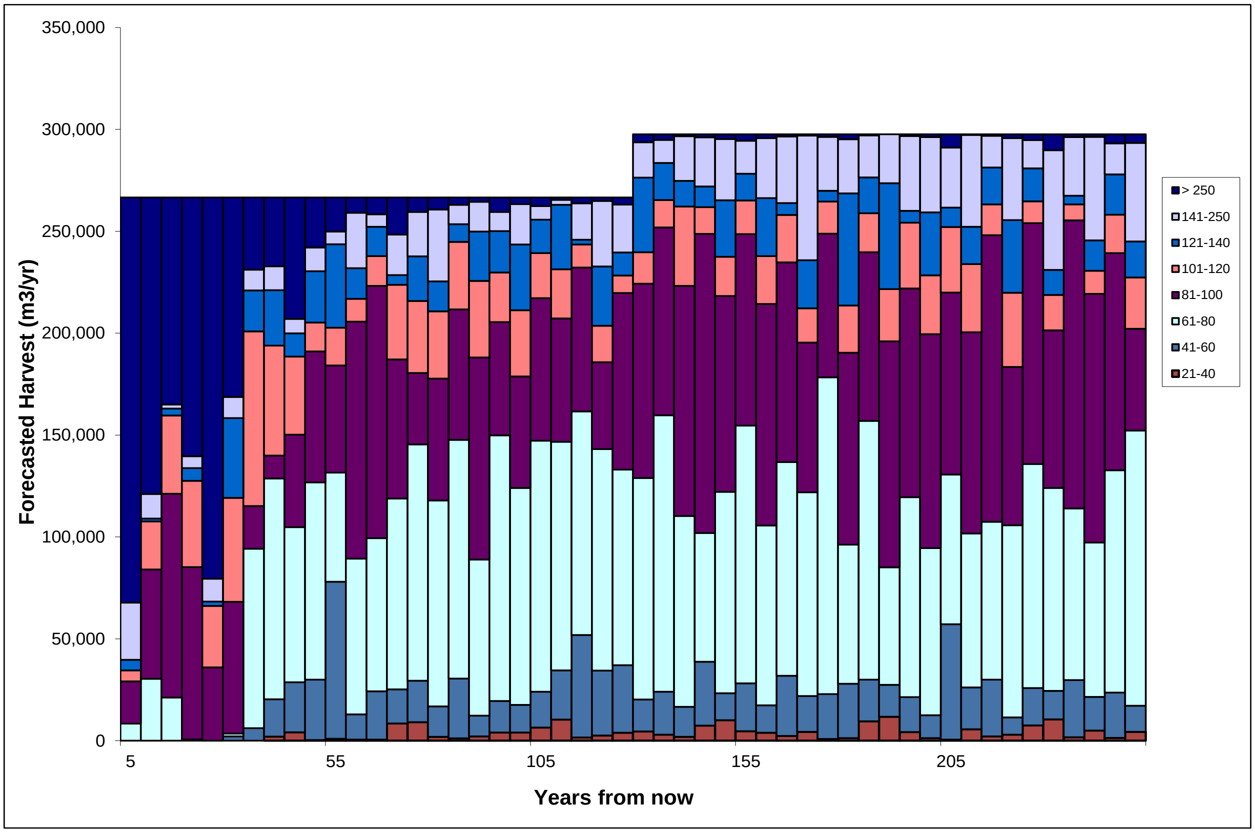


***Figure 74: Harvest forecast by age class; Preferred Scenario***

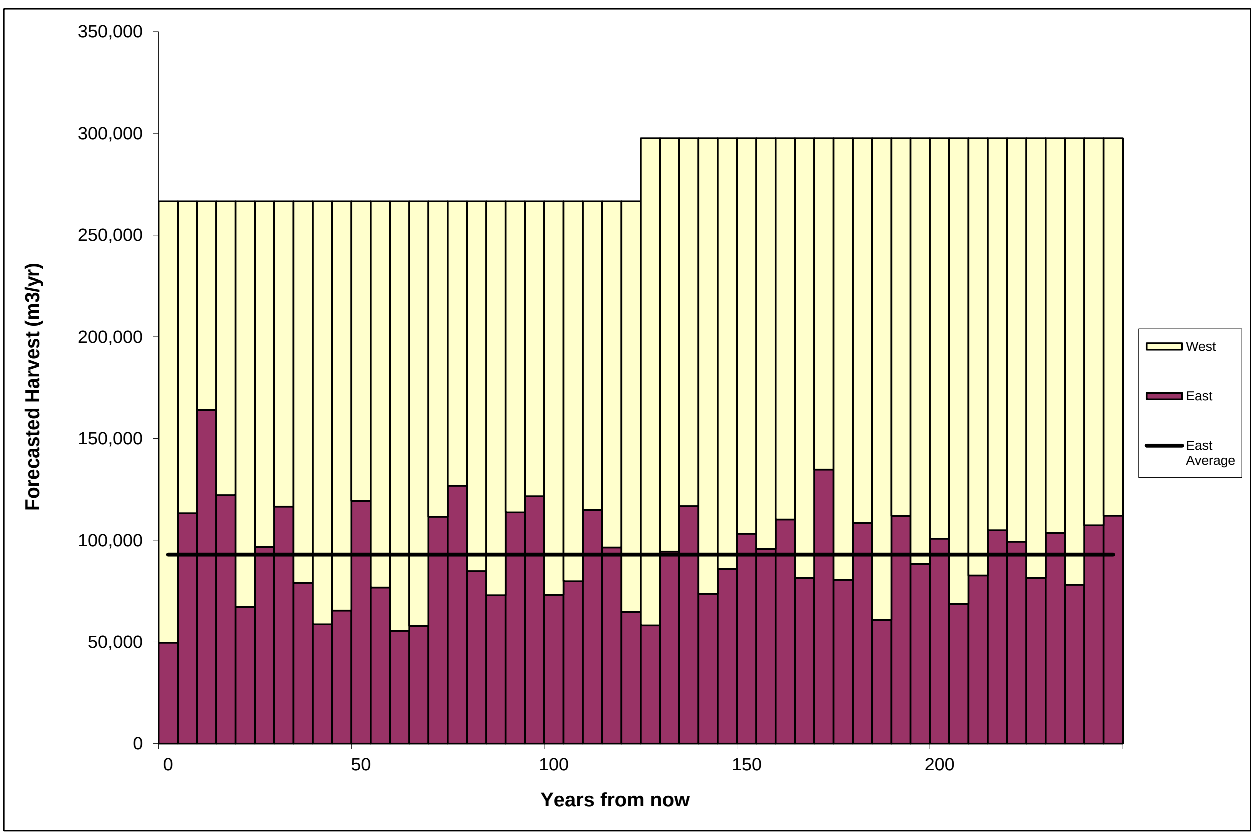


***Figure 75: Harvest forecast by zone (east/west); Preferred Scenario***

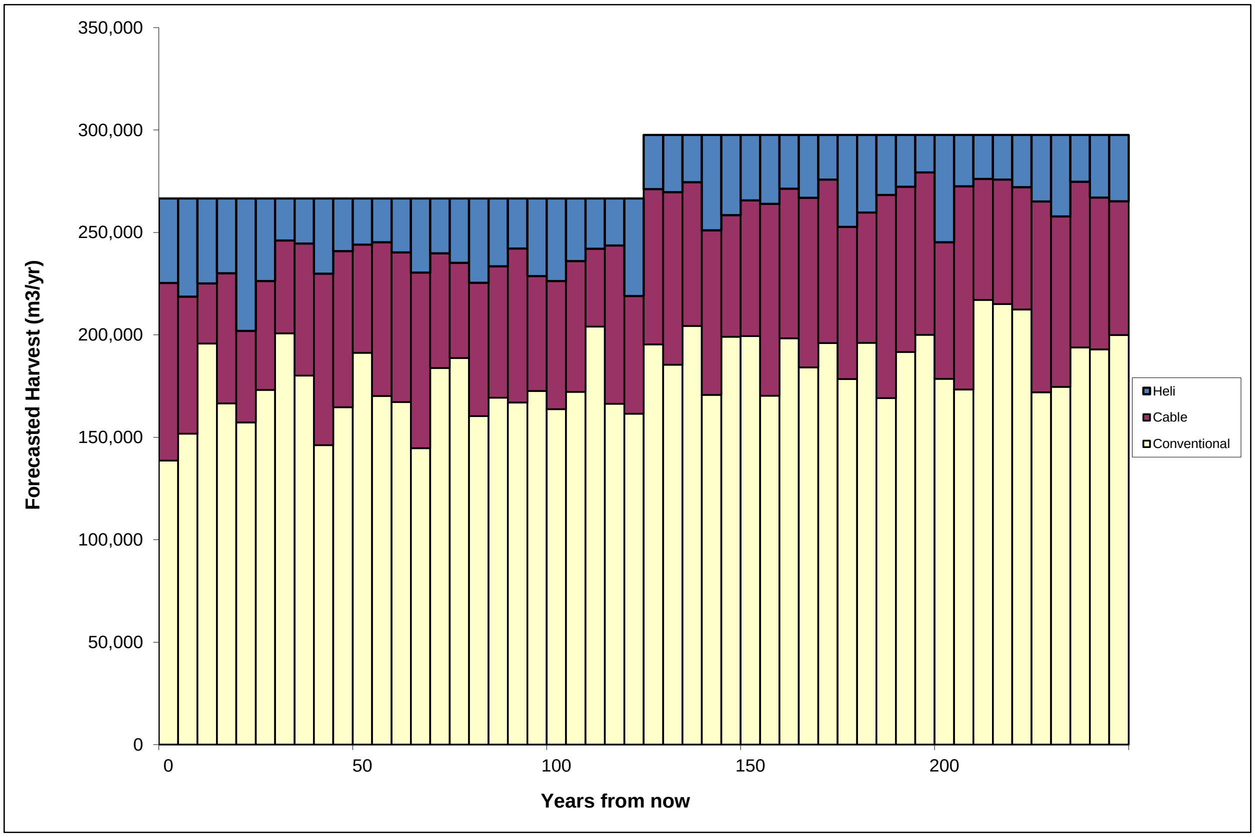


***Figure 76: Harvest by method; Preferred Scenario***

Figure 77 and Figure 78 illustrate the total value and value per per ha forecast for managed stands in the Preferred Scenario. In the long term, the Preferred Scenario is predicted to create significantly more value from managed stands. Compared to the IRMP Base Case, the value increase starts between years 70 and 80 coinciding with the increase in Cw harvest as illustrated earlier in Figure 73.

Figure 79 shows the predicted average annual harvest area for the Preferred Scenario. From around year 50 on, less area is generally harvested compared to the IRMP Base Case.

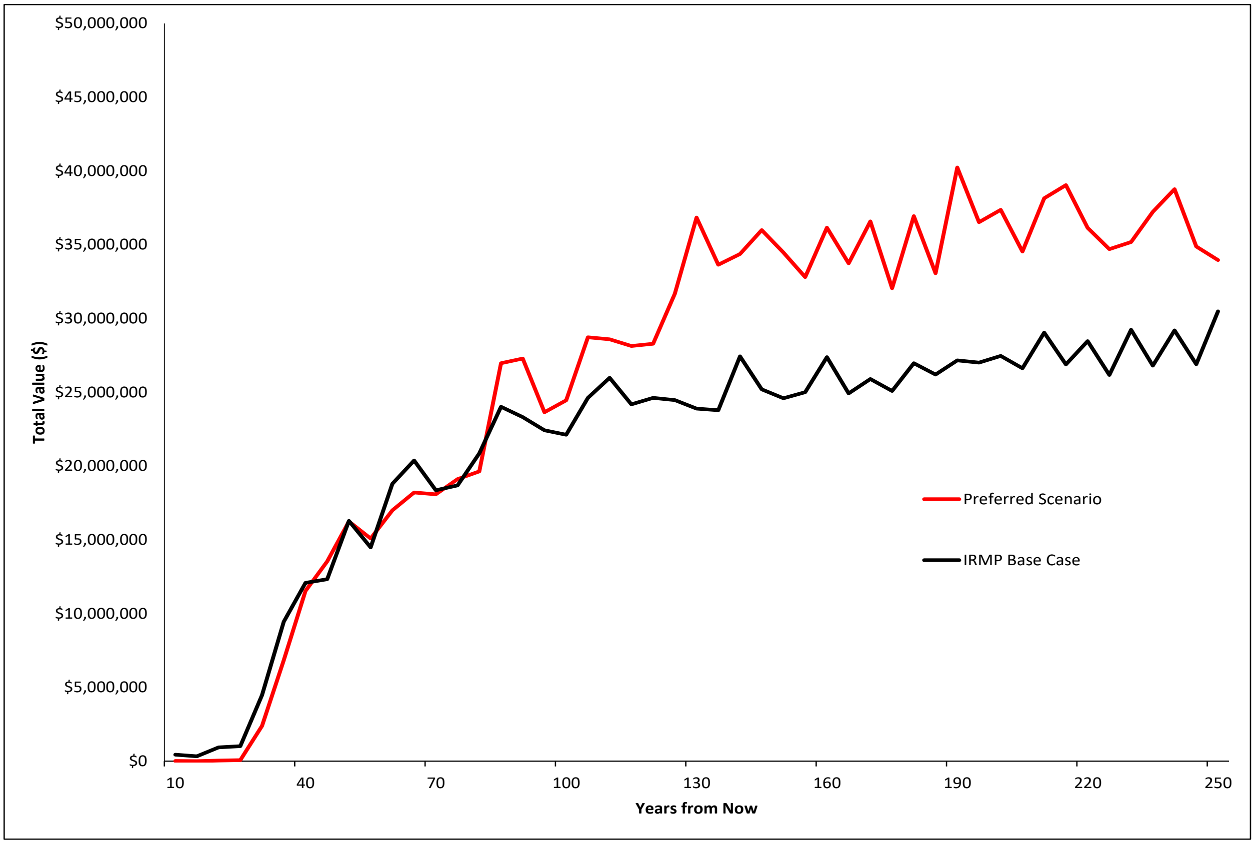


***Figure 77: Total value forecast, managed stands; Preferred Scenario***

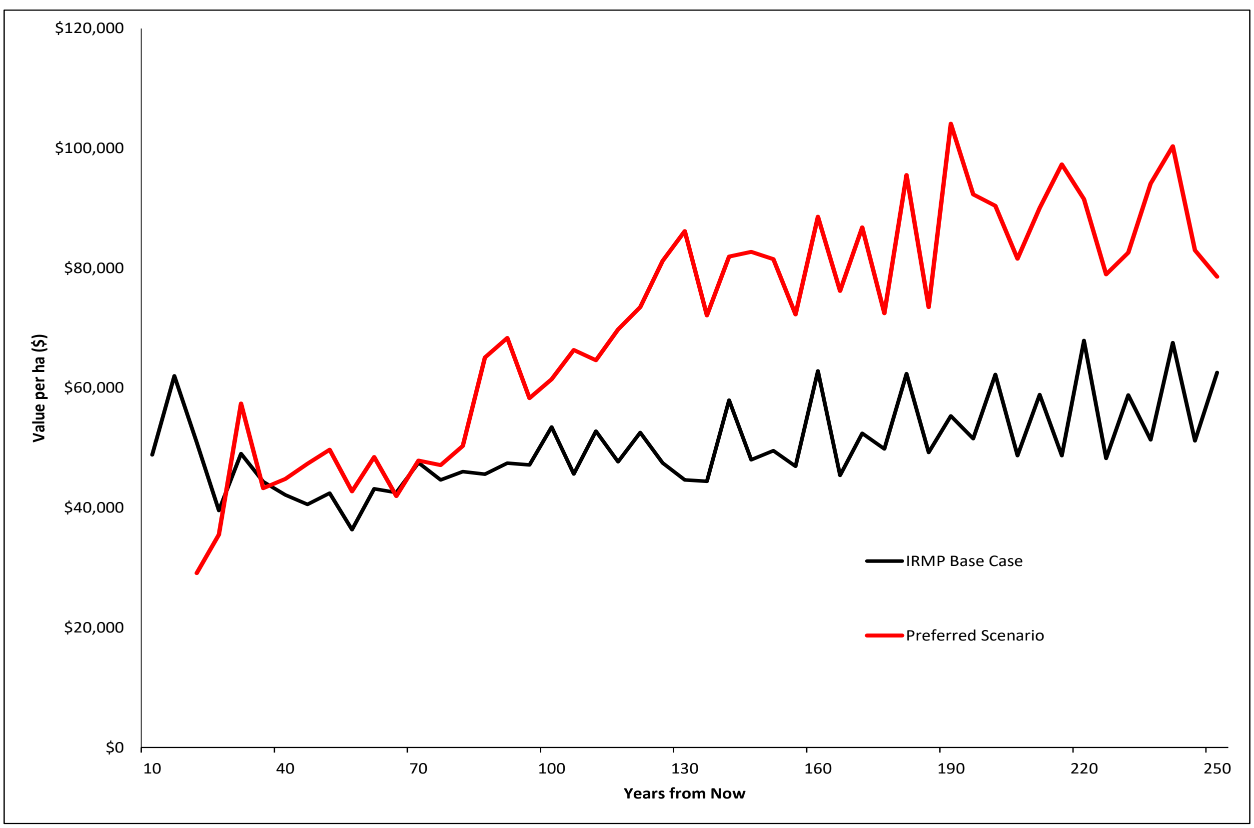


***Figure 78: Value per ha forecast, managed stands; Preferred Scenario***

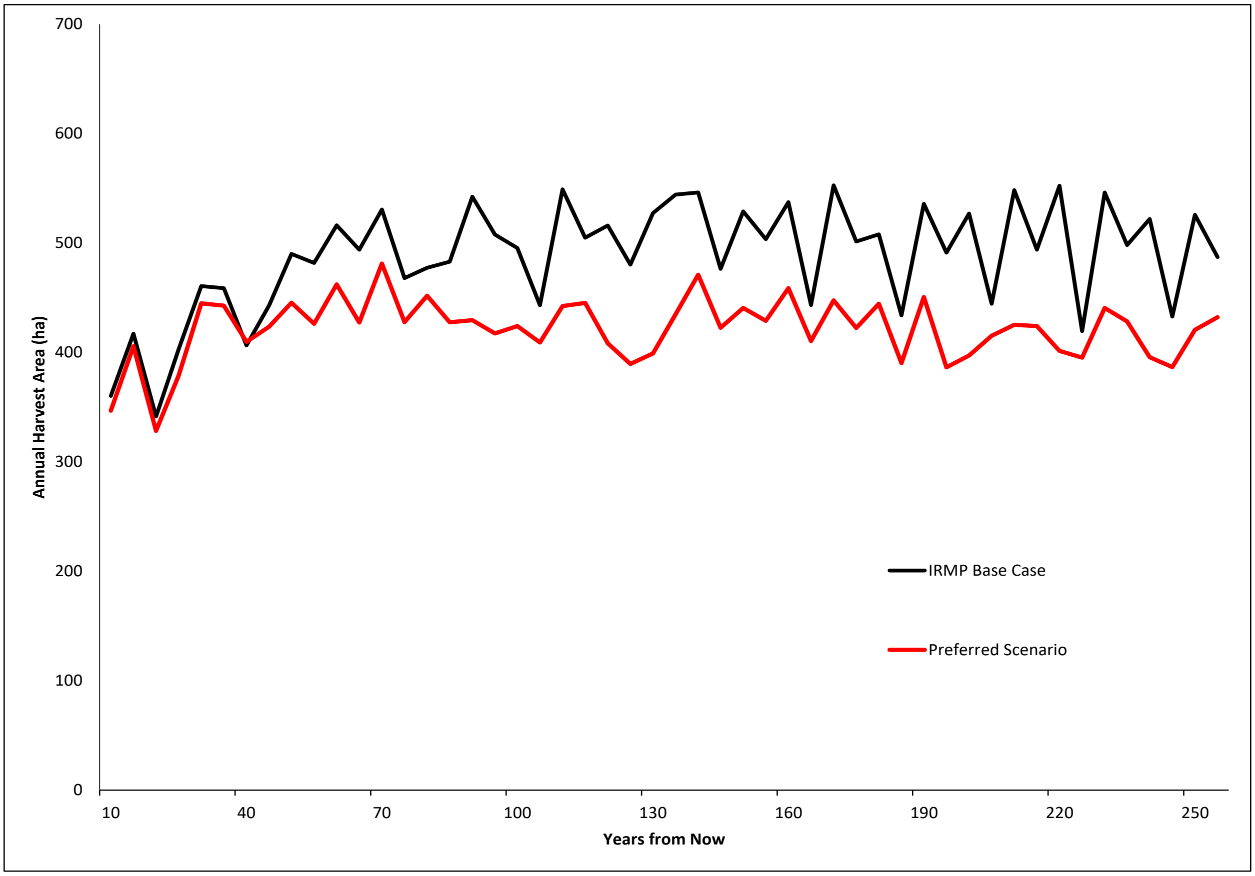


***Figure 79: Average harvest area; Preferred Scenario***

Figure 80 depicts the predicted development of MAMU habitat in the west zone. The Preferred Scenario MAMU habitat outcome is identical to that of the IRMP Base Case; no THLB is reserved for MAMU habitat in the long run. In both the Preferred Scenario and the IRMP Base Case the habitat provided by the NHLB is considered adequate.

The total NOGO foraging habitat projected in the Preferred Scenario is almost identical to that of the IRMP Base Case (Figure 81). However, the Preferred Scenario set forage habitat targets for each forage area, ensuring that the total habitat is well distributed across the landscape. Figure 84, Figure 85, Figure 82 and Figure 83 illustrate the predicted NOGO foraging habitat in the largest forage areas within the Arrowsmith TSA; Holland Creek (1,225 ha of forest), Kelvin Creek (591 ha of forest), McNaughton (176 ha of forest) and Cous Creek (52 ha of forest). In McNaughton all the foraging habitat can be achieved from the NHLB, while in all other foraging areas, harvest is constrained because large contributions of foraging habitat are required from the TLHB.

The predicted volume of old Cw and predicted area of old seral stage in the CFLB are not significantly different in the Preferred Scenario as compared to the IRMP Base Case (Figure 86 and Figure 87). This is expected as both indicators are controlled by the THLB netdown and rules for late seral retention, which are identical in both scenarios.

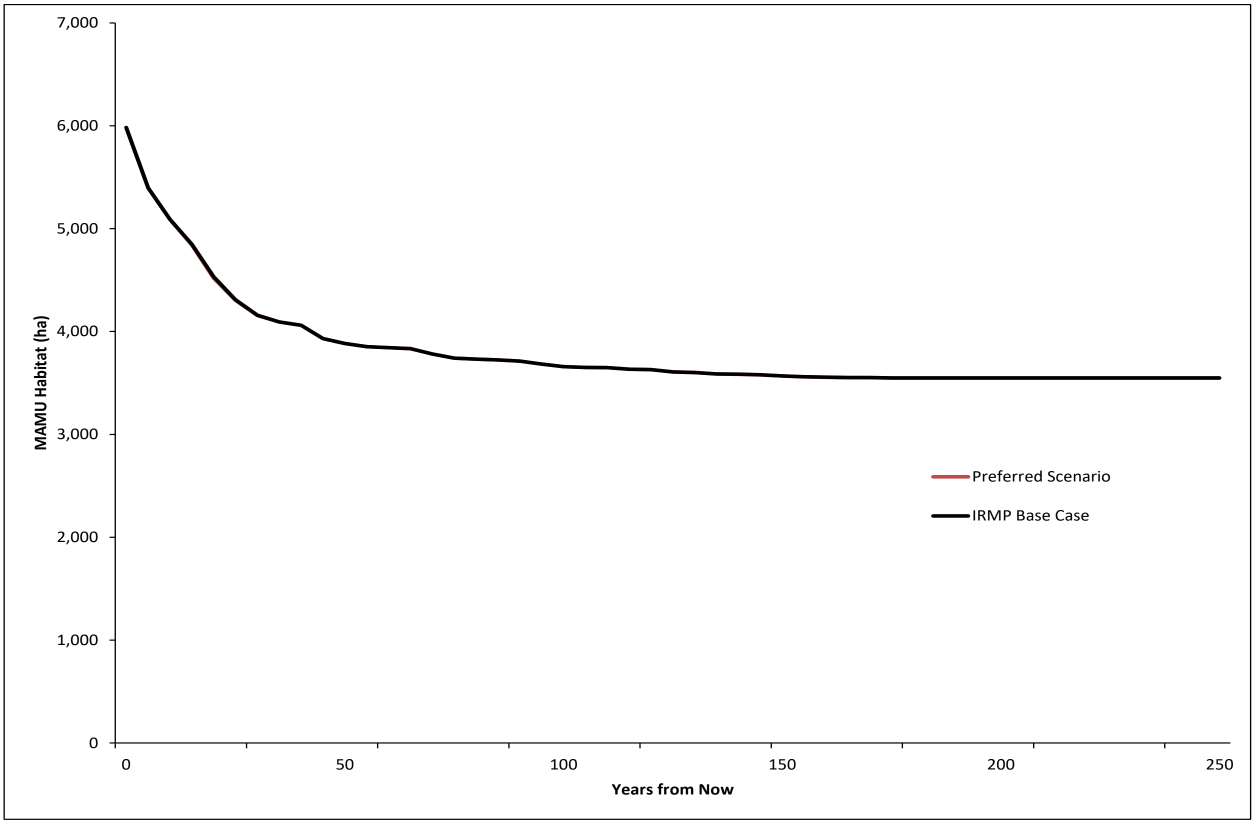


***Figure 80: MAMU habitat in the west zone; Preferred Scenario***

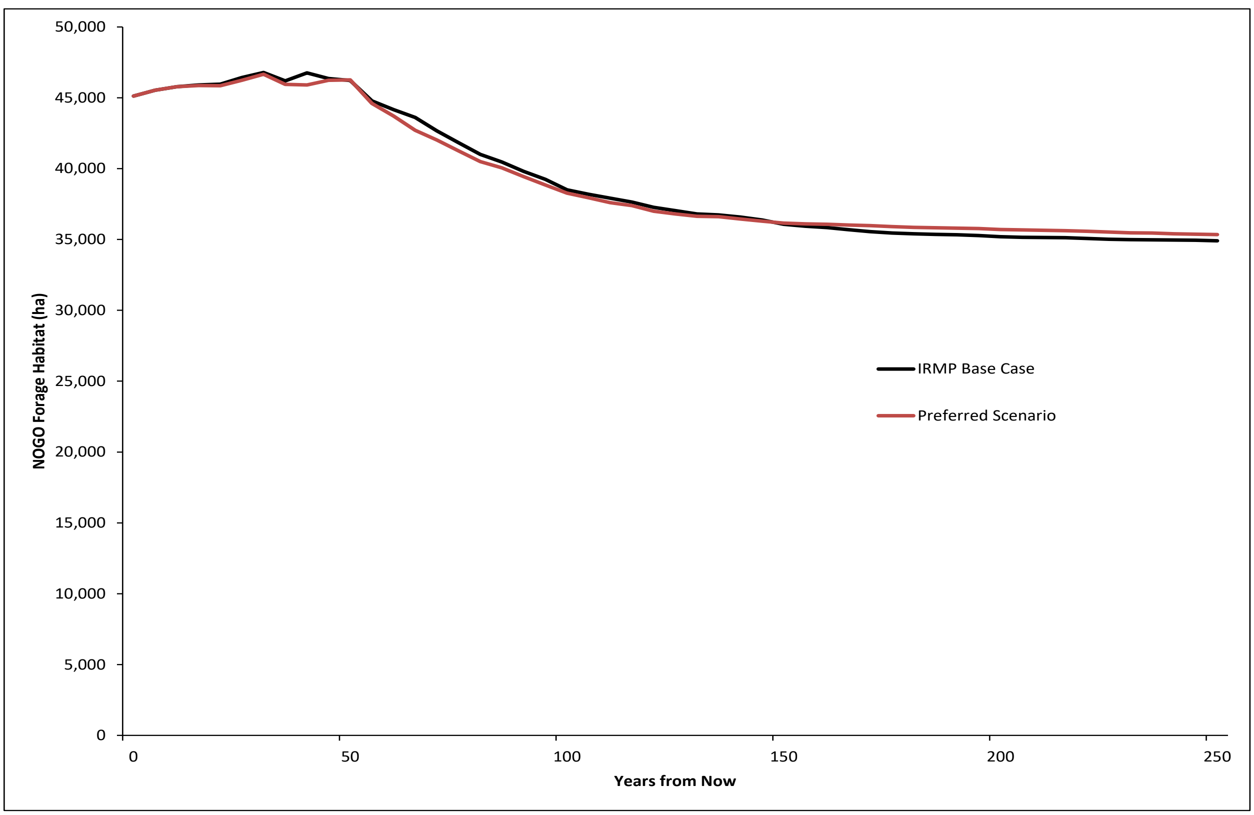


***Figure 81: NOGO forage habitat in the CFLB; Preferred Scenario***

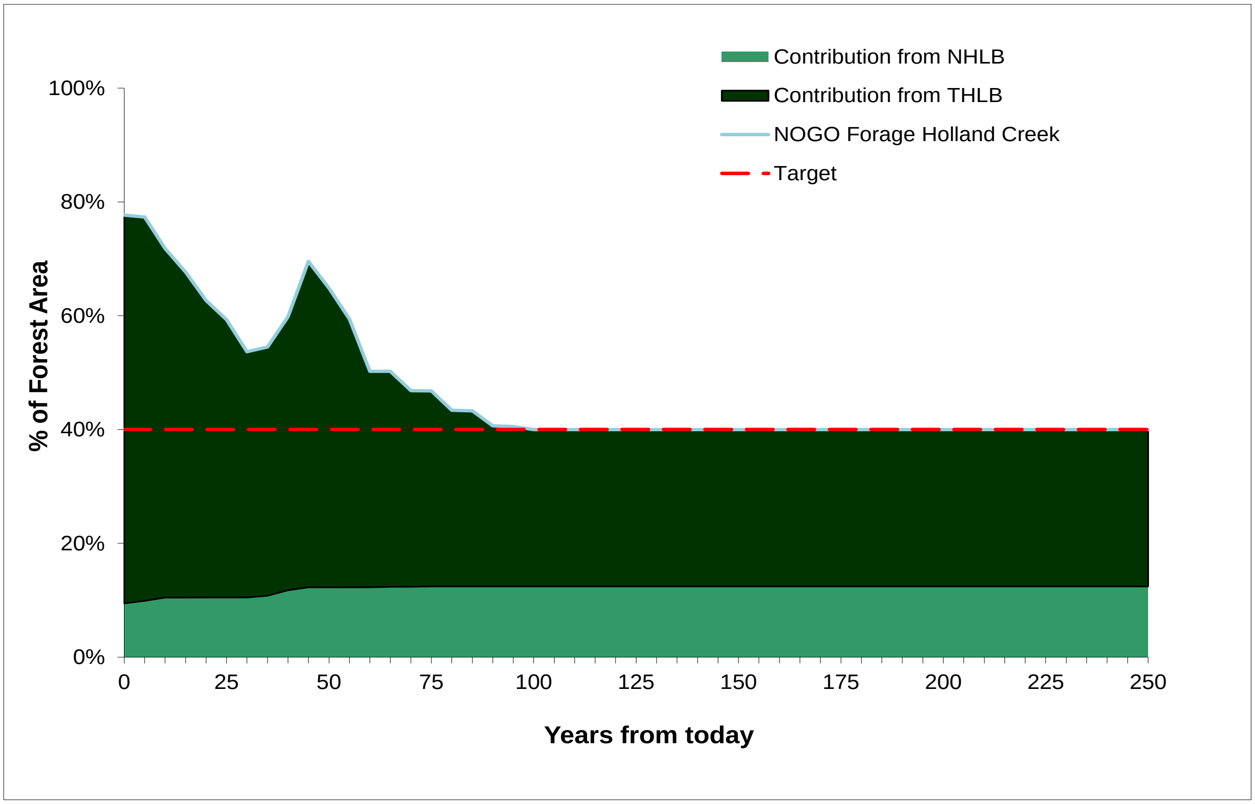


*Figure 82: NOGO forage habitat, Holland Creek; Preferred Scenario*

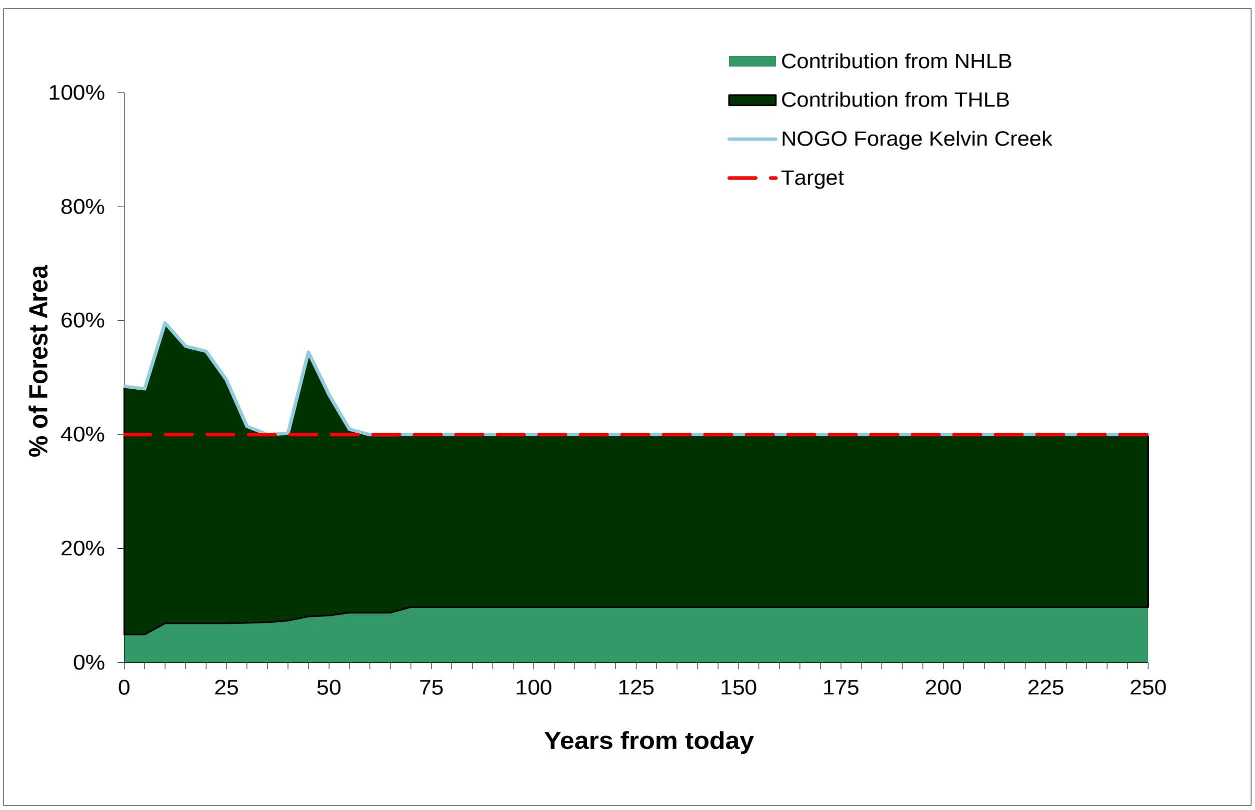


*Figure 83: NOGO forage habitat, Kelvin Creek; Preferred Scenario*

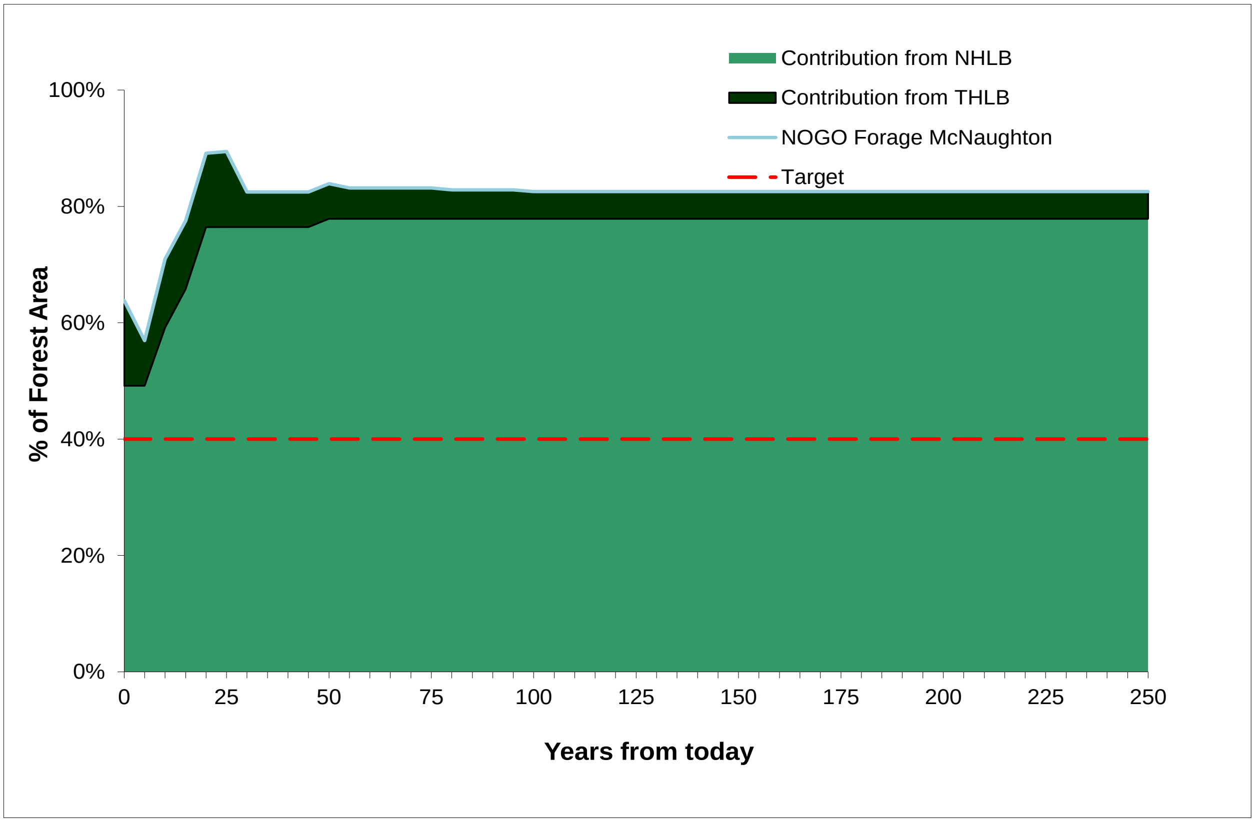


***Figure 84: NOGO forage habitat, McNaughton; Preferred Scenario***

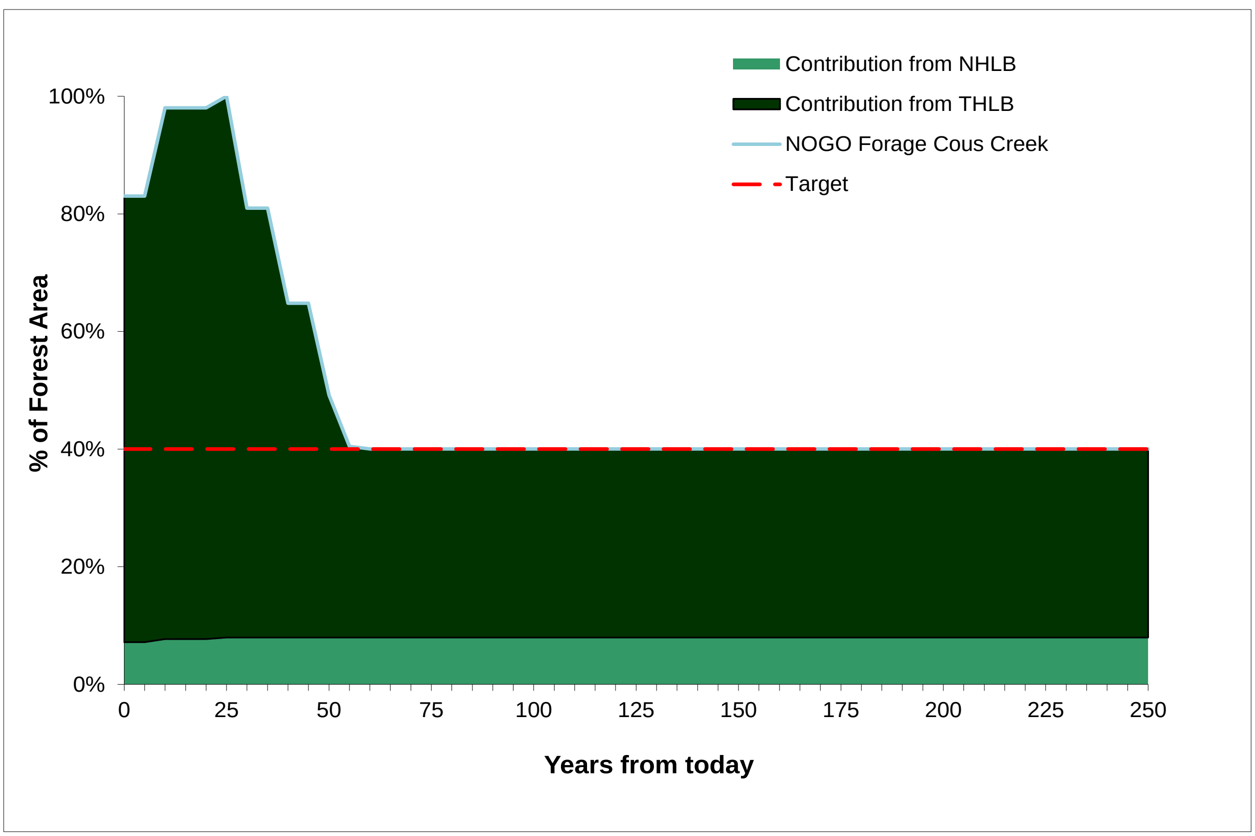


***Figure 85: NOGO forage habitat, Cous Creek; Preferred Scenario***

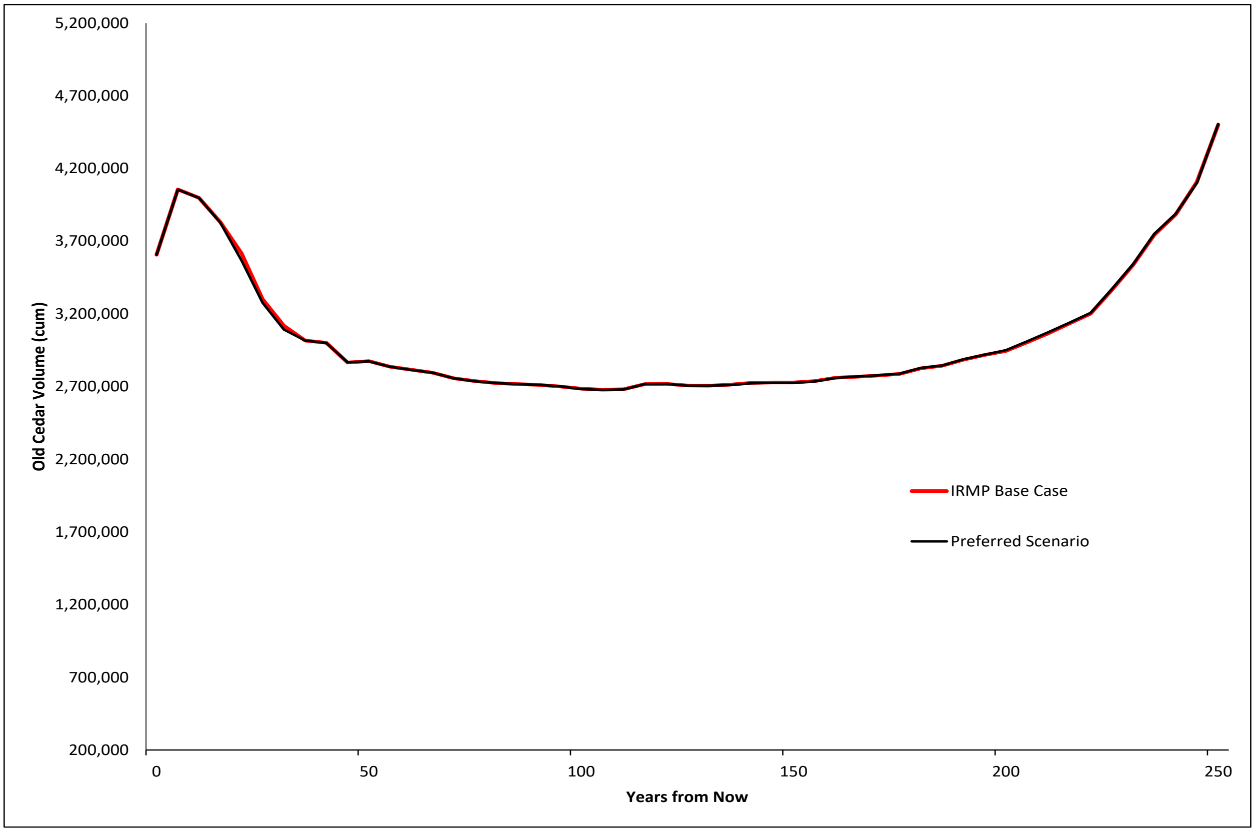


***Figure 86: Predicted old cedar volume in the CFLB; Preferred Scenario***

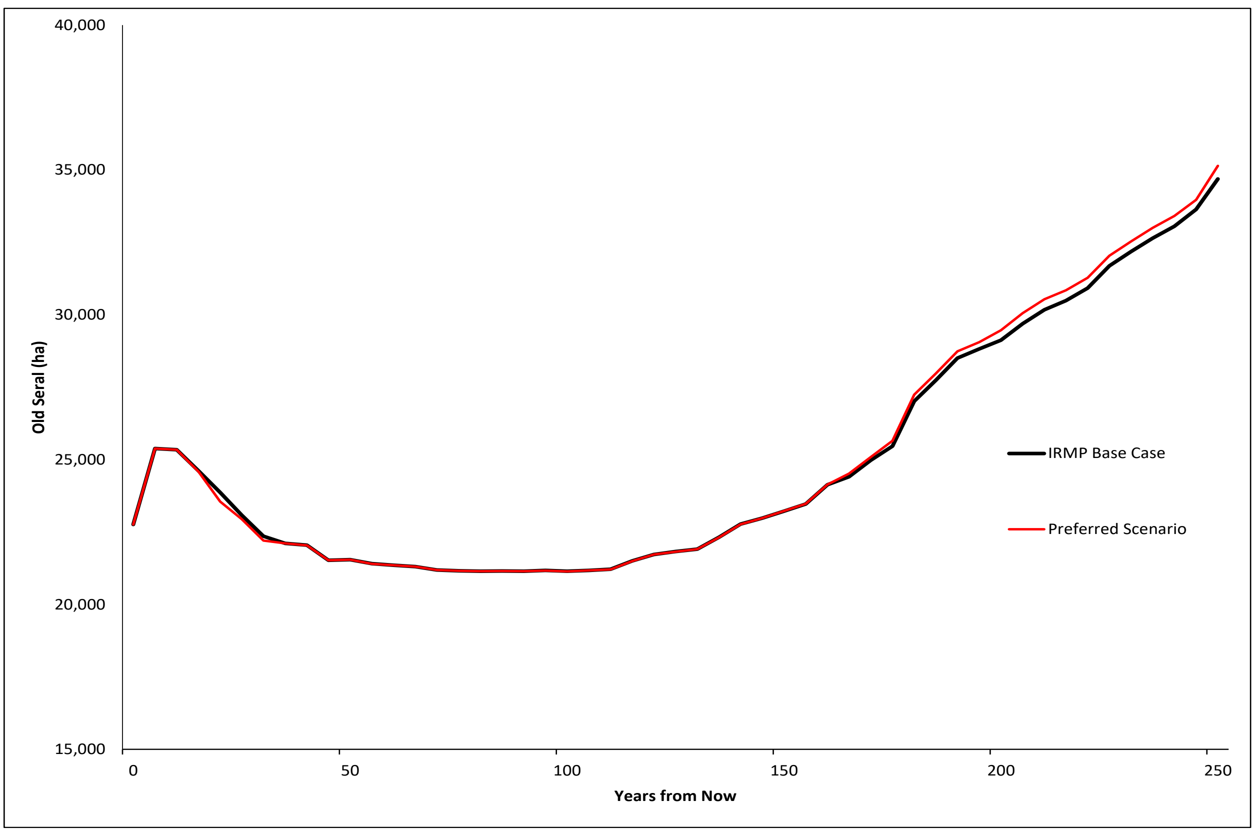


***Figure 87: Predicted area of late seral stage in the CFLB; Preferred Scenario***

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