Ministry for Primary Industries
Manatū Ahu Matua

Wood Availability Forecasts – Canterbury 2015

Prepared for the Ministry for Primary Industries
by Indufor Asia Pacific Limited

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New Zealand Government

Growing and Protecting New Zealand

Ministry for Primary Industries Wood Availability Forecasts

A new series of Wood Availability Forecasts is being prepared by Indufor Asia Pacific, for the Ministry for Primary Industries (MPI), covering the period from 2014 to 2050. These forecasts are intended as a planning tool for the forest industry, councils, and infrastructure and service providers. New forecasts for all nine regional wood supply regions will be published over the next eighteen months, along with new national forecasts.

MPI is working in association with the National Exotic Forest Description (NEFD) Steering Committee to prepare the new regional and national wood availability forecasts. NEFD user surveys have emphasised that wood availability forecasts are the most used and valued product delivered under the NEFD programme. The previous regional and national forecasts prepared between 2006 and 2010, and the new forecasts, are available here:
http://www.mpi.govt.nz/news-and-resources/open-data-and-forecasting/forestry/

Tables providing annual harvest volumes for each scenario are included in the appendix.

MPI wishes to express its appreciation to the forest owners, managers and consultants of Canterbury for their support in preparing these wood availability forecasts. The work would not be possible without this assistance.

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PREFACE

This report was prepared at the request of the Ministry for Primary Industries (the Client) by Indufor Asia Pacific Limited.

The project involved development of a series of regional and national wood availability forecasts for New Zealand's plantation estate.

This report may only be used for the purpose for which it was prepared and its use is restricted to consideration of its entire contents. The conclusions presented are subject to the assumptions and limiting conditions noted within.

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DISCLAIMER

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1. INTRODUCTION

This report presents the findings from a 2015 wood availability study of the Canterbury planted forest estate. This is based on the Ministry for Primary Industries (MPI) National Exotic Forest Description (NEFD) as at 1 April 2015. The study was undertaken by MPI, in association with the major plantation owners. The modelling supporting the study was undertaken by Indufor Asia Pacific Limited (Indufor).

Indufor prepared four production scenarios for radiata pine potential wood availability and one for Douglas-fir availability. The scenarios indicate how the forest resource in Canterbury could be harvested over the 2015 to 2051 period. The scenarios are based on the available resource in each region and a series of forecasting assumptions. Only radiata pine and Douglas-fir are included in the scenarios and wood availability forecasts. There are areas of other species but these are not included in the availability forecasts.

The forecasts incorporate the harvesting intentions of the region's large-scale forest owners. Large-scale owners are defined as:

- Those with 1 000 ha of forest or more in the region of interest; and
- With more than three age-classes; and
- Not a part of a syndicate.

There was also consultation with forest managers and consultants to ensure the scenarios represented a realistic range of future wood availability.

The scenarios clearly show there are different ways for the forest resource to be harvested. In examining the scenarios, it is important to recognise that forests are normally managed in a way that maximises the benefits to the enterprise that owns them. Each enterprise has its own harvesting strategy based on the owner's objectives and market conditions. Any change in harvesting strategies by forest owners affects the age-structure and maturity of the forests they own. This in turn feeds back into future wood availability.

A key issue is the timing of harvesting by small-scale forest owners of their forests or woodlots. The harvest age can vary markedly, even between neighbouring properties. The timing of the harvest of these forests is driven by a range of factors, including individual forest owner's objectives, forest age, log prices, demand by local wood processing plants, and perceptions about future log prices and future wood supply.

There are different levels of uncertainty associated with the wood availability from each component of the estate. While the volumes forecast from larger forest owners are subject to alteration because of changes in harvesting intentions or changes in the resource description (for example, areas and yields), a higher level of confidence can generally be assumed for these forecasts than for the small-scale owners' estate. Not only are harvest intentions less clear for small-scale owners, the resource description is potentially less accurate.

2. SCENARIOS

Four wood availability scenarios have been modelled for radiata pine and one for Douglas-fir. These scenarios show the range of potential ways the forests in the region could be harvested in the future.

The scenarios were developed by the NEFD Steering Committee. Indufor undertook initial modelling of the scenarios, and these were presented to the major forest owners and consultants in the Canterbury wood supply region. Their feedback was taken into account in the final derived profiles.

2.1 Scenario 1: Large-scale Owners Harvest at Stated Intentions, Small-scale Owners Harvest at Age 28

Large-scale owners' wood availability is based on stated harvest intentions for the period 2015 to 2024 (calendar year estimates). After 2024, a modelling assumption is that the wood availability from large-scale owners will not decrease.

Small-scale owners are assumed to harvest their forest holdings at age 28.

This is similar to scenario 2 in the 2007 Wood Availability Forecasts, although the target rotation age for small-scale owners was 30 years in the earlier analysis.

2.2 Scenario 2: Non-declining Yield (NDY) – Target Rotation 28 years

Large-scale owners' wood availability is assumed to be at stated harvest intentions for the period 2015 to 2024. For total radiata pine supply, the standard scenario 2 specified by the NEFD Steering Committee is that the supply is to be non-declining in perpetuity with a target rotation age of 28 years (30 years in scenario 3 in the 2007 Wood Availability Forecasts). However, due to the age-class distribution in Canterbury it is not possible to achieve such a profile without unrealistic variances in the clearfell age range. It was agreed that the non-declining yield constraint would be relaxed from the early 2040s.

2.3 Scenario 3: Split NDY – Target Rotation 28 years

This is the same as scenario 2 except that the total wood availability of radiata pine from the region is allowed to decline after 2034 for a period of five years. Over this five-year period, an annual change of up to 10% is allowed. The yield is then required to be non-declining from 2039.

2.4 Scenario 4: Target Rotation Age Variations

This is similar to scenario 3 except that target rotation ages of 26 and 30 years are also modelled (28 and 32 years in the 2007 Wood Availability Forecasts).

2.5 Discussion of the Scenarios - Radiata Pine

Figure 2-1A to Figure 2-1C illustrate the differences between Scenarios 1 to 3 (respectively) using the Canterbury radiata pine resource as an example (more detailed discussion is provided in Section 4).

In scenario 1 (Figure 2-1A), the forests owned by small-scale owners are assumed to be harvested at age 28. The scenario shows the "potential" availability of mature forest from small owners in any given year. This scenario directly reflects the area of forest in the small ownership category in each age-class in the Canterbury region. For practical reasons, it is unlikely that the future harvesting would occur this way. The intention of this scenario is to show the potential magnitude of harvesting under favourable market conditions in any given year.

Scenarios 2 and 3 (Figure 2-1B and Figure 2-1C, respectively) are based on yield regulation. Yield regulation refers to where, when, and how these recoverable volumes should be extracted, and provides a more orderly harvesting volume profile that, to some degree, reflects logistical and market constraints. Under these scenarios, the future harvesting model is (where possible) constrained to be non-declining: that is, each year the volume must either be the same or higher than in the previous year.

Scenarios 2 and 3 avoid the large year-to-year fluctuations in volume seen in Scenario 1. A fundamental property of the forests in Canterbury (like many regions in New Zealand) is the large area of forests established during the 1990s. Scenarios 3 and 4 illustrate the harvesting of these forests by applying a non-declining yield constraint for the period 2014 to 2034. Then once the "bulge" of forest area planted during the 1990s has been harvested, the model lets the volume decline again.

The main limitations of Scenarios 2 to 4 are that log prices and other market factors are a significant determinant of harvesting in any given year. When log prices go up, harvesting will generally increase. When log prices fall, the level of harvesting will generally decrease. It is beyond the scope of this analysis to predict future log prices.

2.6 Scenario for Douglas-fir

One scenario is presented for Douglas-fir (all owners). It is based on the harvest intentions of large-scale owners for 2015 to 2024, with the yield regulated in subsequent years. After 2024, the wood availability from large-scale owners is modelled in five-year period non-declining yield (NDY) blocks (i.e. 2024-2028, 2029-2033, etc). The total wood availability of the combined estate is also modelled to be non-declining within each of the five-year period NDY blocks. The target rotation age is 40 years for Douglas-fir (45 years was used in the 2007 forecasts).

Illustration of Wood Availability Scenarios (Canterbury Radiata Pine Forecasts)

Figure 2-1A: Scenario 1: Large-scale Owners Harvest at Stated Intentions, Small-Scale Owners Harvest at Age 28

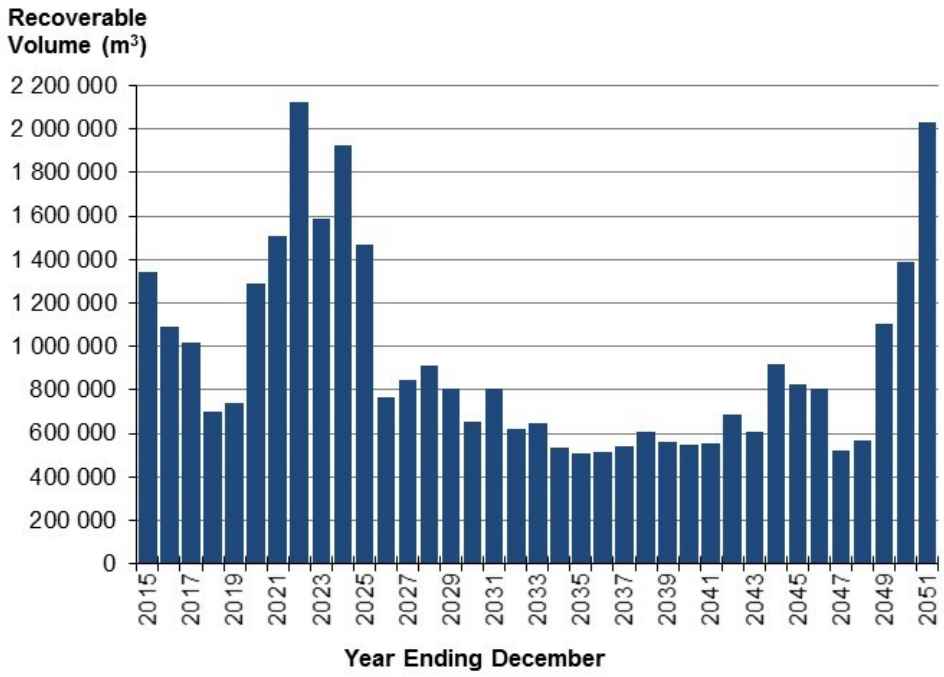


Figure 2-1B: Scenario 2: Large-Scale Owners Harvest at Stated Intentions. Overall Non-Declining Yield to 2042 with a Target Rotation of 28 Years

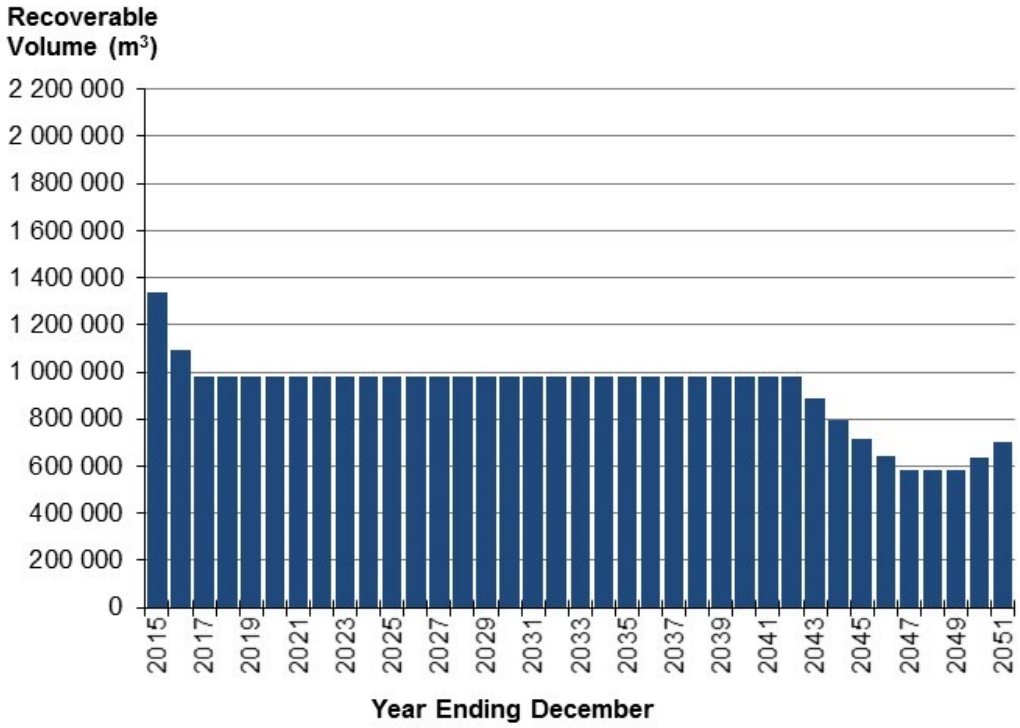
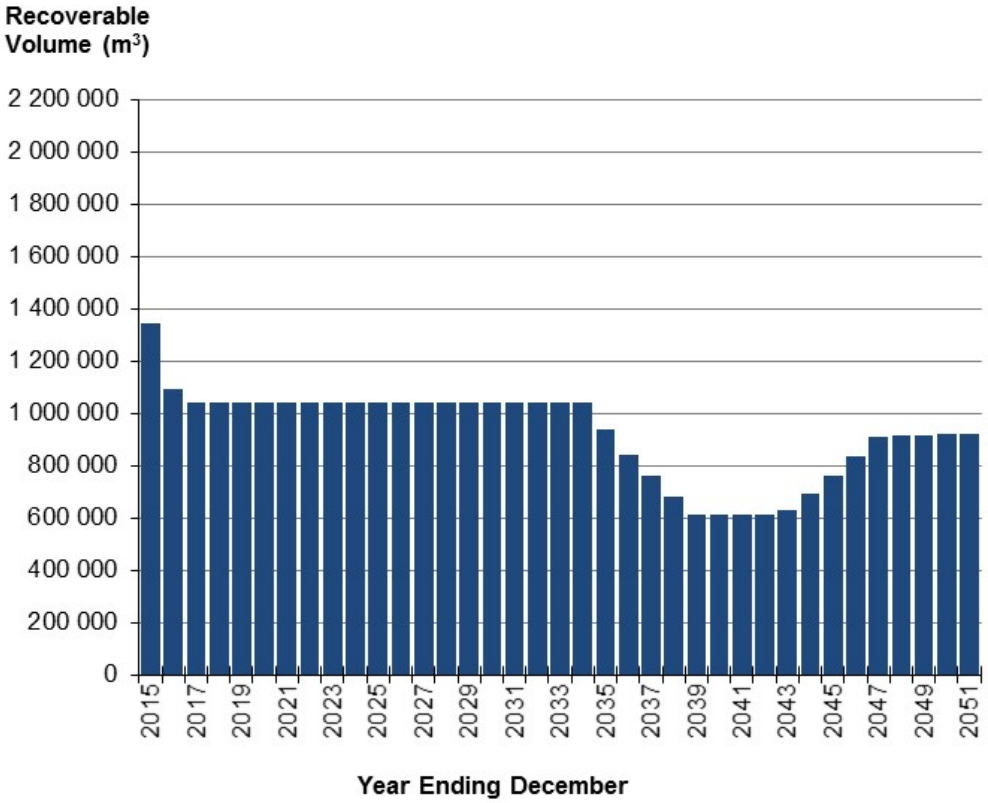


Figure 2-1C: Scenario 3: Large-scale Owners Harvest at Stated Intentions. Overall Split Non-Declining Yield with Target Rotation of 28 Years



3. DATA AND METHODOLOGY

3.1 Method Used to Obtain Forest Areas

The forest areas were sourced from the NEFD as at 1 April 2015 (MPI 2015). The area for the large-scale owners was unadjusted, while the area for the small-scale owners' estate was modified to reflect the results of a 2014 remapping exercise undertaken by the University of Canterbury. This resulted in the modelled small-scale owner resource being 45% less than that shown in the NEFD (see Appendix 1).

In other regions, the standard approach has been to reduce the small-scale resource by 15%, as small-scale owners generally report on a gross area basis rather than net stocked areas. In addition, planted area aged 20 and over described in the '2004 Small Forest Grower Survey Report' has been excluded from the other regions due to uncertainties over the reliability of the data. In the case of Canterbury, both of these adjustments have effectively been superseded by the 2014 remapping exercise.

In addition to this, reductions were made to the area of over-mature stands. For large-scale owners, areas older than 35 years of age were considered non-commercial and excluded. For small-scale owners, the maximum age was 40 years.

A further downwards adjustment of 5% was applied to all areas age 1 to 4 to reflect losses in stocked area due to factors such as erosion, slips, and various setbacks.

3.2 Method Used to Develop Yield Tables

For the 2007 WAF, new yield tables for Canterbury were developed in the following way:

- Large-scale forest owners provided yield tables for their forest estates.
- These tables were averaged on an area-weighted basis to derive regional yield tables for each crop-type.
- The area-weighted average regional yield tables for "old" radiata pine (planted before 1989), and Douglas-fir were then calibrated to match the harvest intentions data provided by large-scale owners. The assumption is that the harvest intentions data is the most accurate information available, as it is based predominantly on detailed inventory.
- The area-weighted average regional yield tables for "young" radiata pine crop-types (planted in 1990 and later) were also adjusted based on consultation with large-scale owners.
- The area-weighted average regional yield tables developed for the large-scale owners' estate were also applied to the small-scale forest owners' estate.

For the latest forecasts the yield tables developed in 2007 were utilised, but were again calibrated to the harvest intentions information provided by large forest owners. After consultation with regional forest owners and managers, it was agreed that, unlike other regions, the small-scale owner yield tables *would not* share the same yield tables as the calibrated large-scale owners. This was because the large-scale owner yields are heavily influenced by the low productivity forests on the Canterbury plains, and most of the small-scale owner resource is located in the higher yielding foothills. Therefore, the small-scale owner yield tables have been based on calibrated yield tables from large-scale owner forests located on the foothills only. As a result, the small-scale owner yield tables show volumes approximately 18% higher than the large-scale owner yield tables.

3.3 Large-Scale Owners' Harvest Intentions

Large-scale owners were asked to provide details of their projected harvest volumes (by log grade, area and average harvest age) for the 2015 to 2034 period. All of the large owners in the region provided yearly (31 December) summary data for the project. Inclusion of actual

levels of intended harvest by the large-scale owners is considered a critical step, as it provides the best estimate of future wood availability for the first ten years (2015-2024) of the forecast horizon.

The owners who provided harvest intentions were:

- Ashburton District Council
- NZ Carbon Farming Ltd
- Mackenzie District Council
- Matariki Forests Ltd
- Southern Forests NZ Ltd
- Blakely Pacific Ltd
- Environment Canterbury

3.4 Modelling Assumptions

The wood availability forecasts for the Canterbury region are based on the following modelling assumptions:

- All areas are replanted, with a regeneration lag of one year. Replanting is as follows:
  - All radiata pine areas are maintained as radiata pine.
  - Large-scale forest owners: 30% of all pruned areas will be replanted as a pruned regime, with 70% transferring to an unpruned regime.
  - Small-scale forest owners: 5% of all pruned areas will be replanted as a pruned regime with 95% transferring to an unpruned regime.
  - Douglas-fir: 100% of existing Douglas-fir will be replanted as Douglas-fir.
- Based on discussions with major forest owners and consultants in the region, it was determined that conversion of forests to other land uses has been occurring and is likely to continue at a sufficient rate for it to be incorporated into the wood availability forecasts. 5 000 ha are assumed to be converted out of forestry by 2020.
- The area awaiting replanting as at 31 March 2015 is included as area at age 0 (that is, the area to be replanted in the 2015 planting season).
- After harvest of first rotation areas, the replanted area for the second rotation is reduced by 3% to reflect the establishment of new roads and landings, and inaccessible areas.
- Total roundwood removals in the Canterbury region were estimated to be 1.63 million m^3 for the year ended 31 March 2015 and 1.34 million m^3 for the year ended 31 March 2016. These were used to set the harvest level for the first year of the model.
- Radiata pine area in the large-scale owners' estate aged over 35 years is assumed to be non-commercial and therefore will not be harvested.
- Radiata pine area in the small-scale owners' estate aged over 40 years is assumed to be non-commercial and therefore will not be harvested.
- Douglas-fir stands over 60 years of age are assumed to not be harvested (all owners)

4. WOOD AVAILABILITY FORECASTS FOR CANTERBURY REGION

4.1 Canterbury Region Area Description

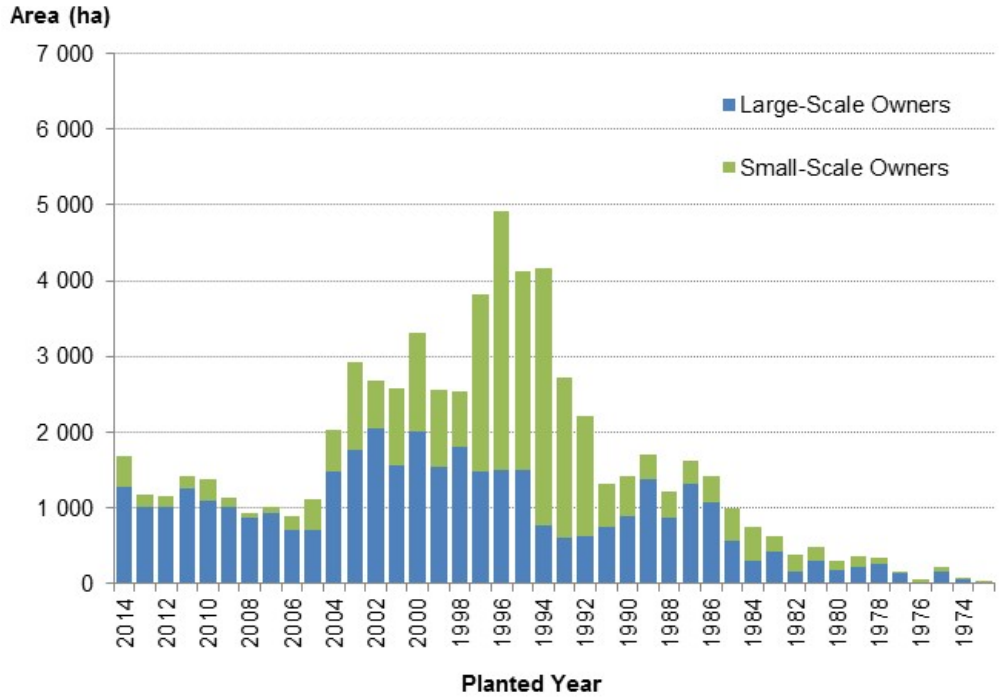
According to the 1 April 2015 NEFD, the Canterbury region has a plantation resource of 98 223 ha spread across eight territorial authorities. Of this, 72 546 ha consists of radiata pine and 16 903 ha are Douglas-fir.

After the deductions described in Section 3.1 are applied to the NEFD area, the modelled area reduces to 68 784 ha.

The modelled resource consists of both radiata pine and Douglas-fir. Figure 4-1 shows the age-class distribution for the Canterbury estate by owner size. Some 58% of the modelled resource is held by large-scale owners and 42% by small-scale owners. The age-class distribution of the small-scale owners' estate is irregular, with nearly 60% of the area established between 1992 and 1997. The large-scale owner age-class distribution is comparatively even, although the highest levels of planting are apparent from the mid-1990s to mid-2000s.

Also of note in Figure 4-1 is the low rates of planting observed over the last ten years, particularly in the small-scale owner resource. This has implications of medium to long term harvest levels, as will be apparent in later sections.

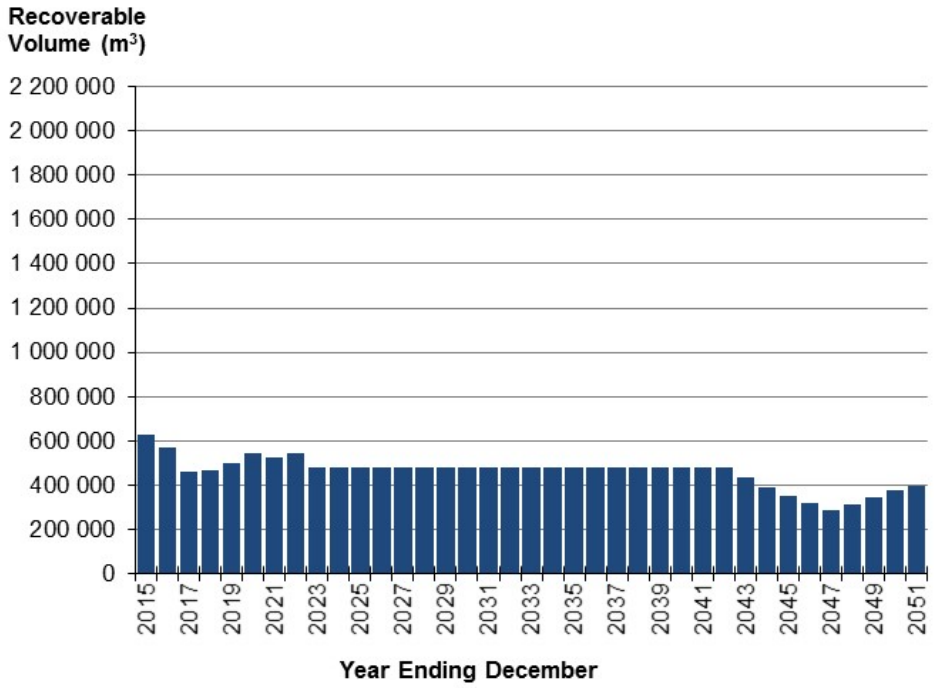
Figure 4-1: Canterbury Age-Class Distribution by Owner – All Species as at 1 April 2015



4.2 Scenario 1

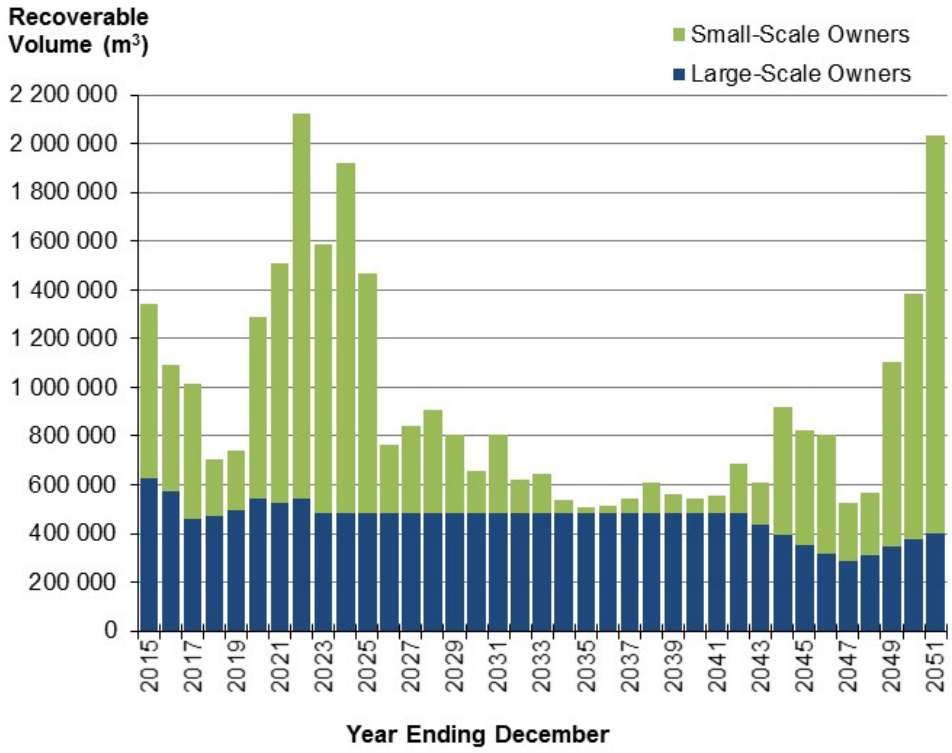
For this scenario, the availability of wood from large-scale owners is based on their stated harvest intentions for 2015 to 2024. Thereafter, the availability is constrained to be non-declining with a target rotation age of 28 years. However, due to the age-class distribution of the Canterbury resource, it was not possible to apply these constraints and obtain a feasible solution. The NDY constraint was therefore partially relaxed from 2043. The wood availability of large-scale owners (Figure 4-2) is forecast to be relatively static through to this time.

Figure 4-2: Canterbury Radiata Pine Availability under Scenario 1 – Large-Scale Owners



The wood availability from all owners in Canterbury is presented in Figure 4-3. The large-scale owners' resource is shown as the "base" volume, and the forecasts match the volumes in Figure 4-2. The fluctuation in the total annual forecast volumes reflects the variation in the areas in each age-class of the small-scale owners' estate, and the assumption that this estate is harvested at age 28.

Figure 4-3: Canterbury Radiata Pine Availability under Scenario 1 – All Owners

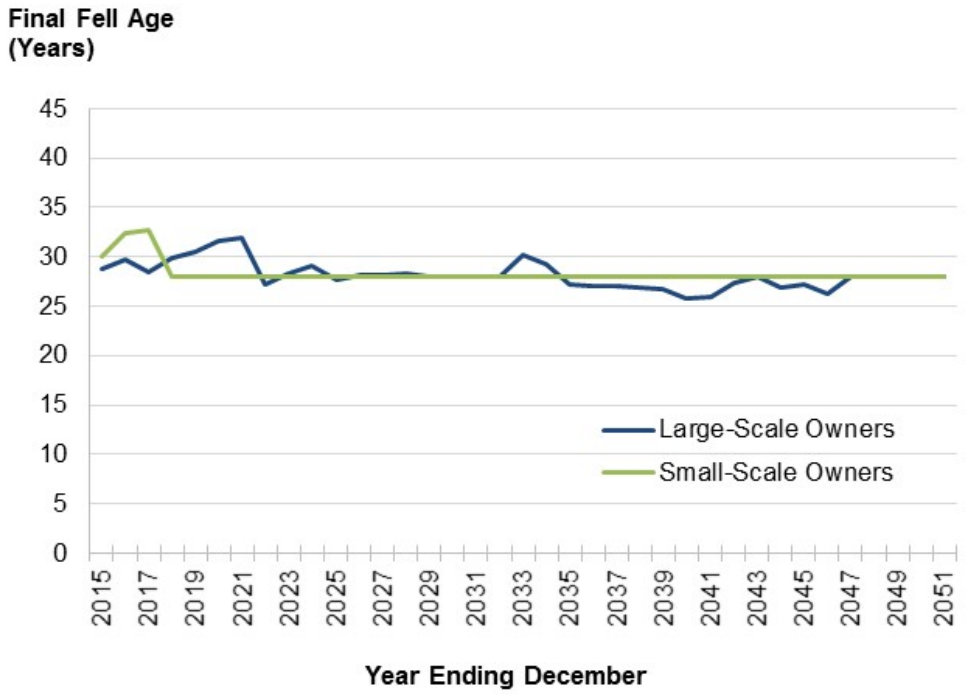


The large increase in harvest volume after 2019 (Figure 4-3) reflects the maturing of the small-scale owners' estate. For example, the increase in 2020 is a consequence of the 1 497 ha planted by small-scale owners in 1992 (Figure 4-1) being harvested at age 28 years.

Fluctuations in harvest volumes of the magnitude shown in Figure 4-3 would be impractical due to operational constraints (for example - availability of harvest machinery, harvesting crews and transport operators) and market absorption constraints (for example - limited domestic wood processing capacity and levels of export demand).

Figure 4-4 shows that, apart from the near-term harvest (which is constrained to the intentions of the large-scale owners), the harvest age settles at the target of 28 years.

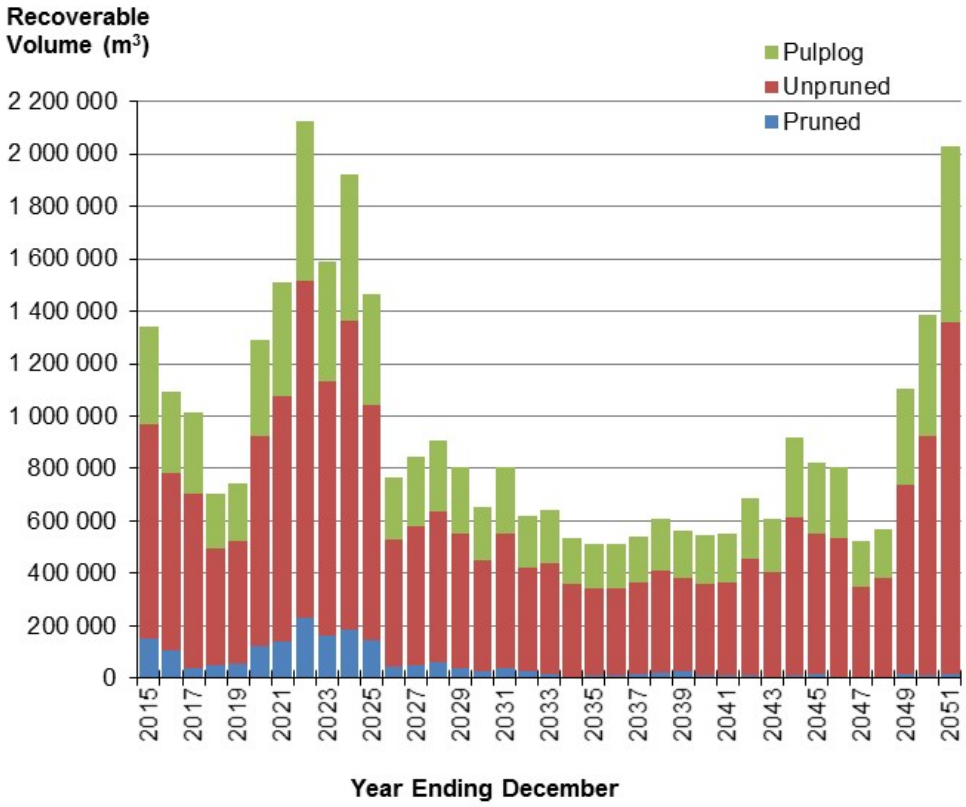
Figure 4-4: Canterbury Average Radiata Pine Clearfell Age under Scenario 1 – by Ownership Category



The harvest volumes forecast under scenario 1 are broken down by log grade in Figure 4-5. Of note is the declining availability of pruned log supply. This is a result of the assumed lack of

re-establishment of pruned regimes after harvest (30% for large owners and 5% for small owners).

Figure 4-5: Canterbury Radiata Pine Availability under Scenario 1 – by Log Grade (All Owners)

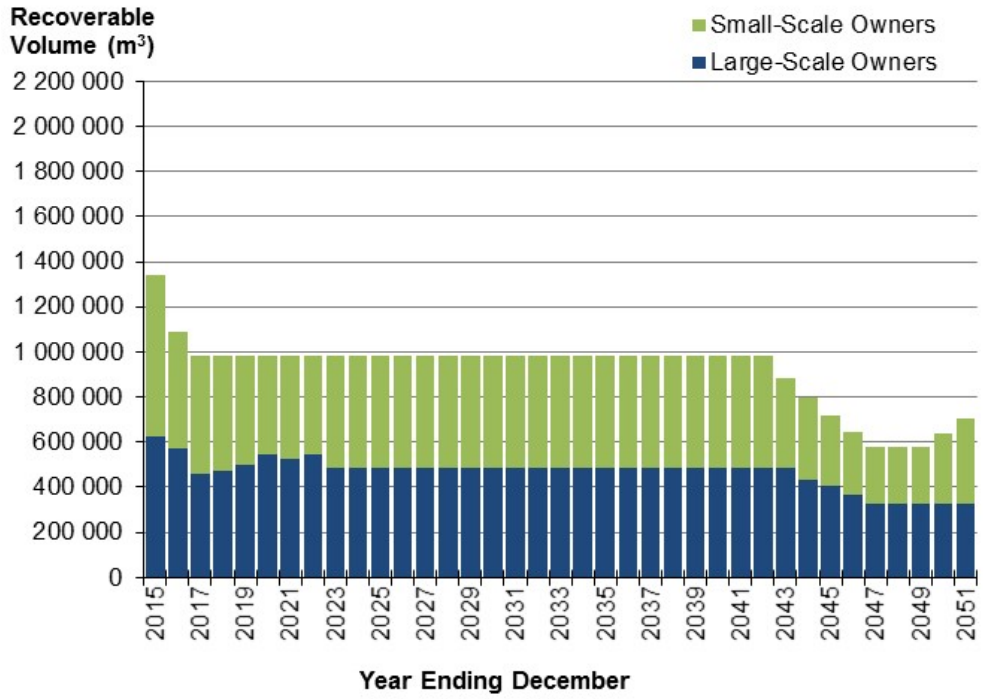


4.3 Scenario 2

The second scenario assumes large-scale owners' resources are harvested as per their harvest intentions for the first 10 years, then a non-declining yield constraint is applied to the large-scale owners' estate after 2024. In addition, a non-declining yield constraint is applied to the total overall radiata pine estate, with a target rotation age of 28 years.

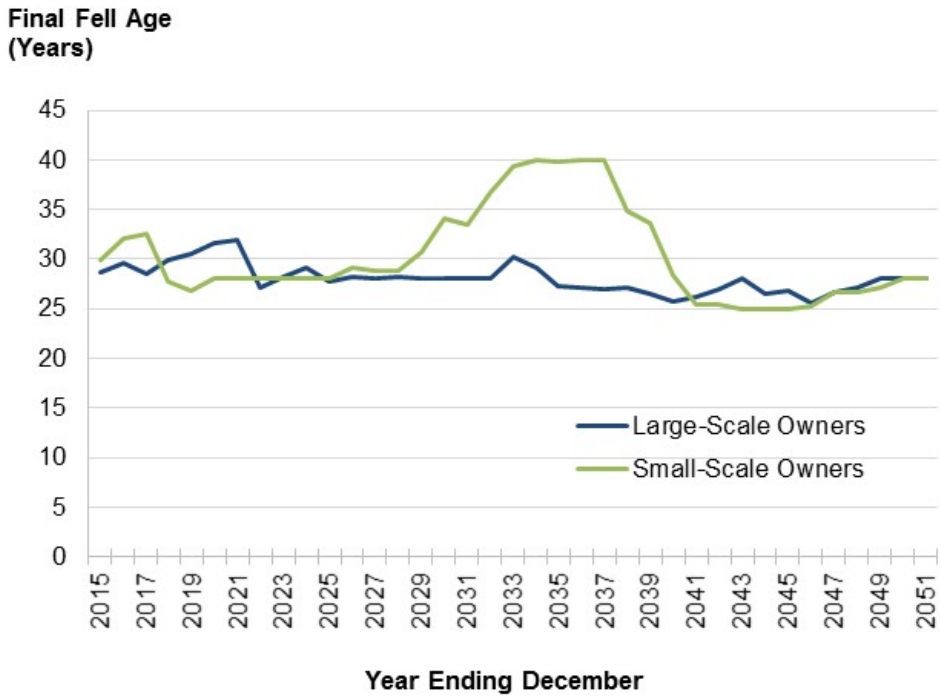
As with Scenario 1, due to the uneven age-class distribution of the Canterbury resource it was not possible to apply these constraints and obtain a feasible solution. The NDY constraint was therefore partially relaxed from 2043 for both the large-scale resource, and the overall resource.

Figure 4-6: Canterbury Radiata Pine Availability under Scenario 2 – All Owners



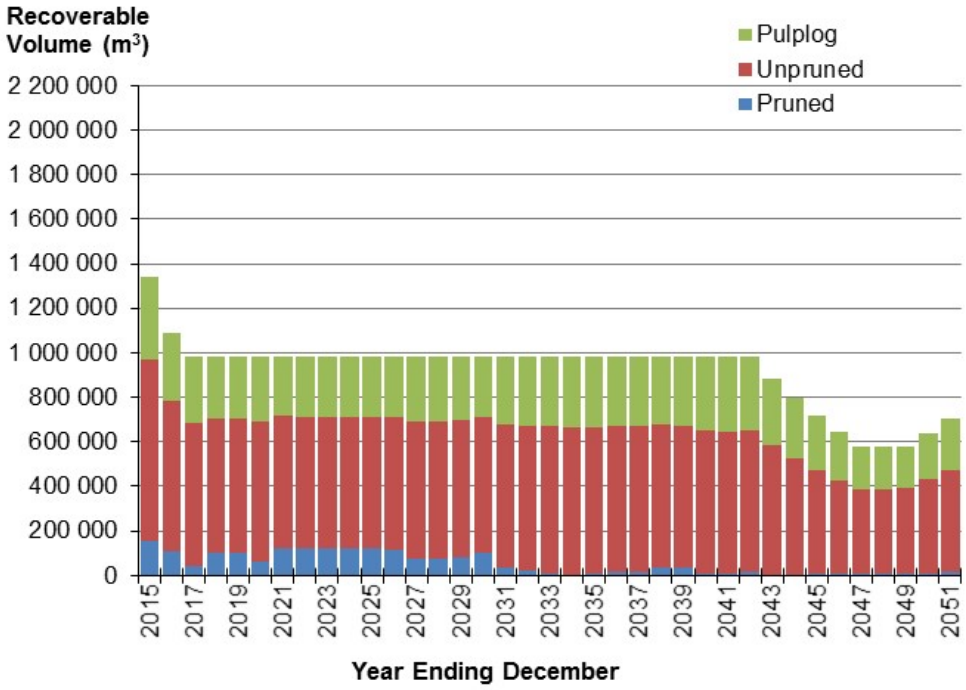
This scenario does at times require that the harvest age varies significantly from the target rotation of 28 years. This is especially the case for small-scale forest owners (Figure 4-7).

Figure 4-7: Canterbury Average Radiata Pine Clearfell Age under Scenario 2 – by Ownership Category



The harvest volumes forecast under Scenario 2 are broken down by log grade in Figure 4-8.

Figure 4-8: Canterbury Radiata Pine Availability under Scenario 2 – by Log Grade (All Owners)



4.4 Scenario 3

The third scenario again assumes large-scale owners' resources are harvested in line with their harvest intentions between 2015 and 2024, and then non-declining after 2024. As was the case with Scenarios 1 and 2, it was not possible to apply these constraints and obtain a feasible solution. The NDY constraint was therefore partially relaxed from 2043. However, the overall yield is based on a split non-declining yield, with a target rotation age of 28 years. As shown in Figure 4-9, a drop in the overall harvest volume is allowed after 2034 for a five-year period (between 2035 and 2039 of no more than 10% per year).

This scenario gives a forecast wood availability that is only slightly different to scenario 2. Because the NDY is held only until 2034 under scenario 3 (compared to 2042 under scenario 2), slightly more volume can be sustained through to 2034 (1 million m^3 p.a. compared to 0.9 million m^3 p.a. in scenario 2).

The main difference from scenario 2 is that the large area of young stands in the small-scale owners' estate is assumed to be harvested over a shorter period of time.

A consequence of there being more flexibility over when the small-scale owner estate is harvested is that the average clearfell age for small-scale owners generally stays closer to the target of 28 years than in scenario 2 (Figure 4-10), albeit still with some fluctuations in the early 2030s.

Figure 4-9: Canterbury Radiata Pine Availability under Scenario 3 – All Owners

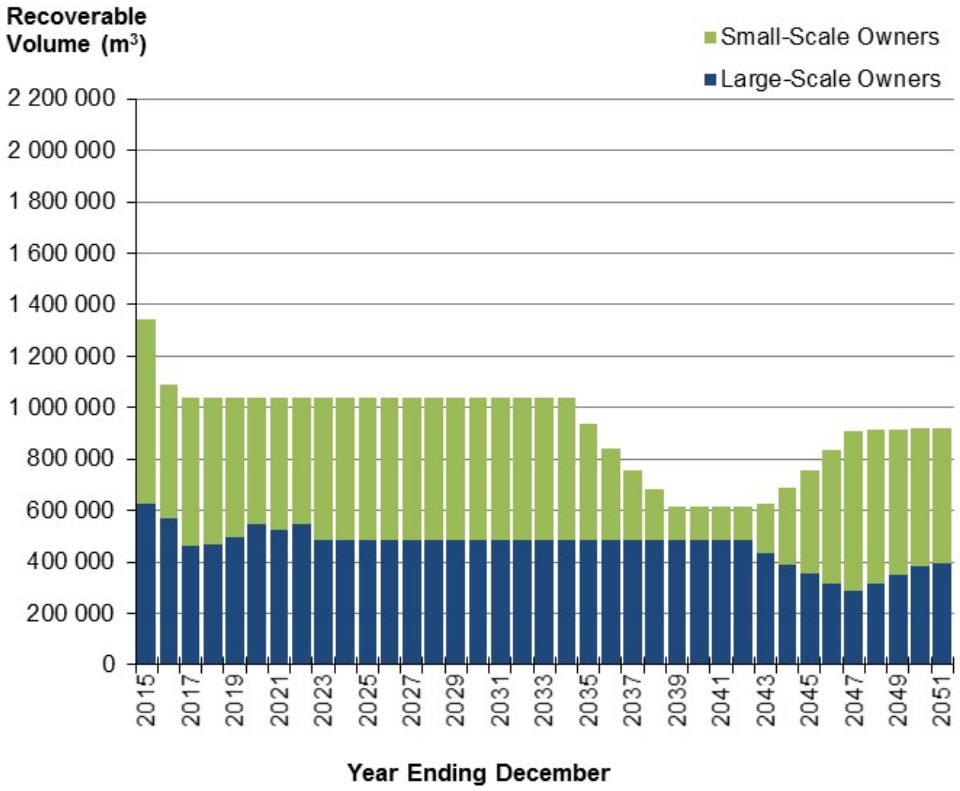
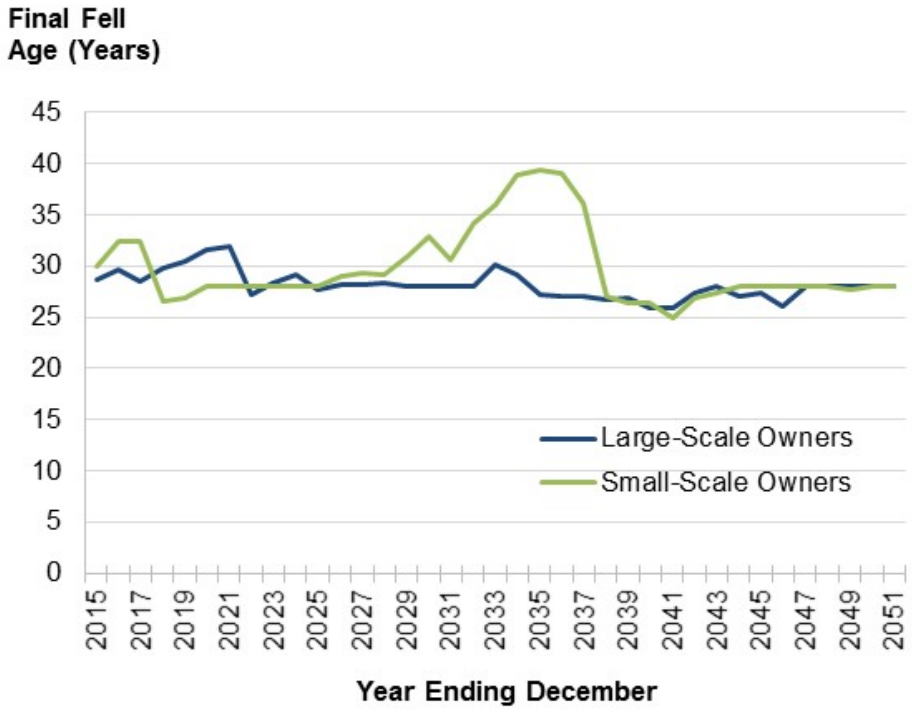
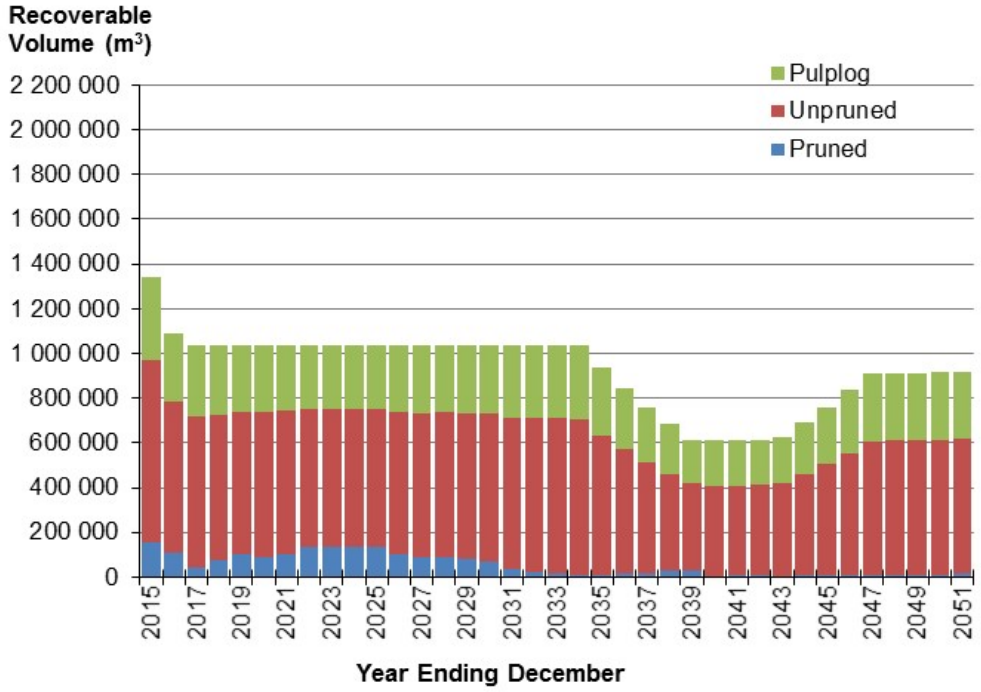


Figure 4-10: Canterbury Average Radiata Pine Clearfell Age under Scenario 3 – by Ownership Category



The harvest volumes forecast under scenario 3 are shown by log grade in Figure 4-11.

Figure 4-11: Canterbury Radiata Pine Availability under Scenario 3 – by Log Grade (All Owners)



4.5 Scenario 4

In this scenario, target rotation ages of 26 or 30 years are used (rather than 28 years) and the same constraints are applied as in scenario 3 (Figure 4-12).

The harvest ages are somewhat constrained for the first ten years by the large-scale owners' harvest intentions and the requirement for a non-declining yield for the large owner's estate as well as the overall radiata pine estate. These constraints are partially relaxed for the 26 and 30-year target rotations to allow these rotation lengths to be more closely matched. The general pattern of the alternate harvest ages is apparent in Figure 4-12: a lower harvest age (26 years) means more volume can be harvested earlier, while the higher harvest age (30 years) delays the harvest.

Figure 4-13 illustrates, however, the difficulty in achieving the desired rotation lengths within the overall harvesting constraints imposed by the scenario.

Figure 4-12: Canterbury Radiata Pine Availability by Target Rotation Age under Scenario 4 – All Owners

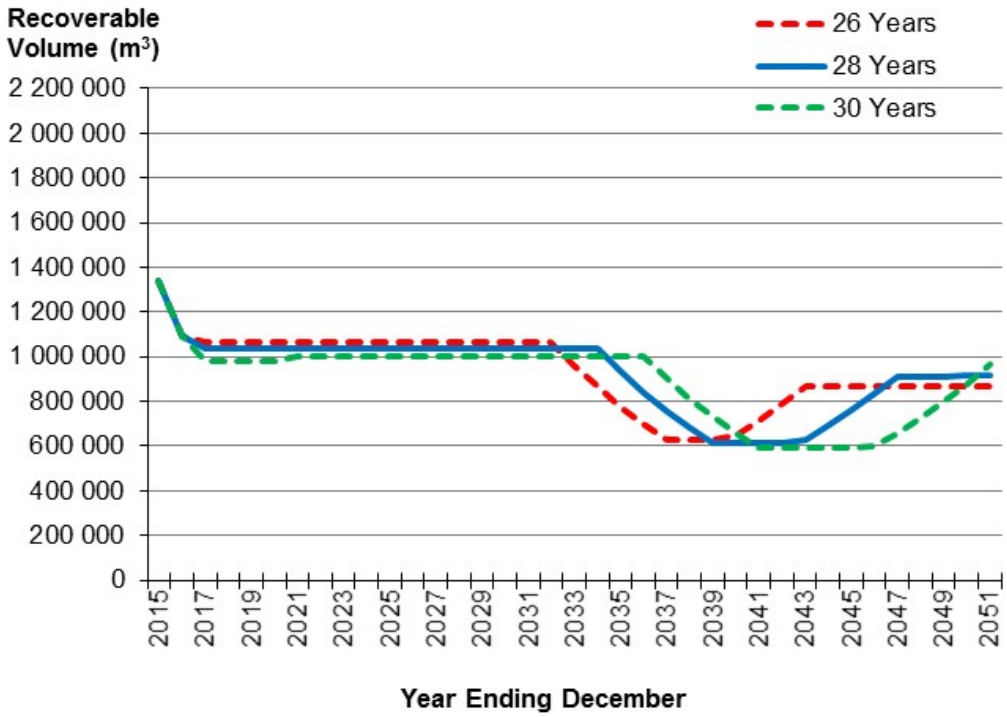
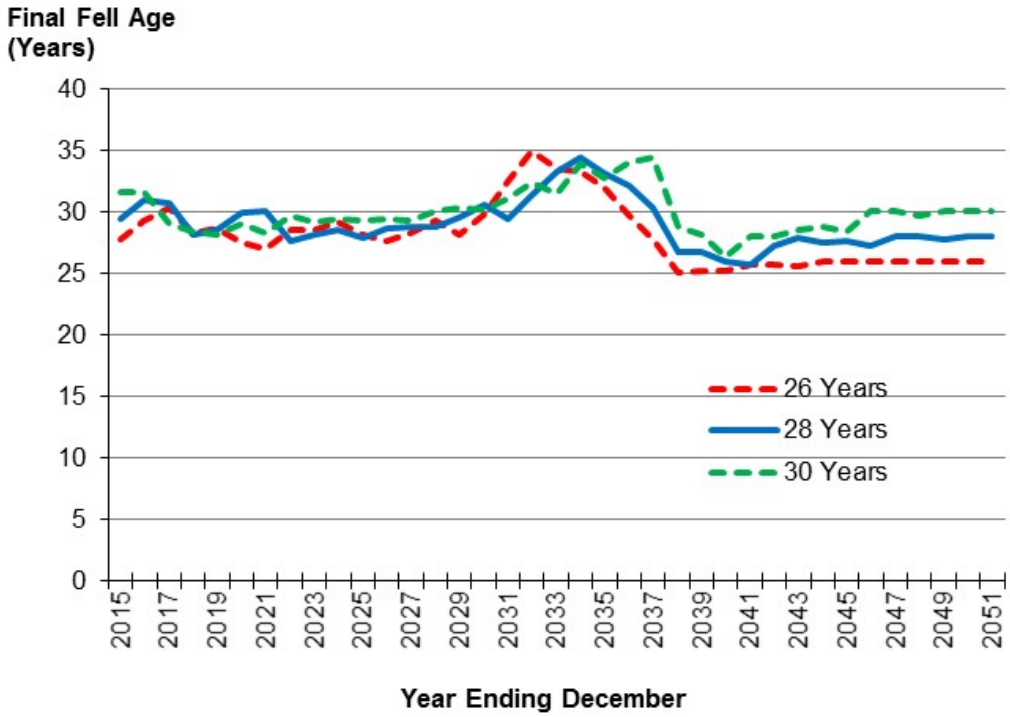


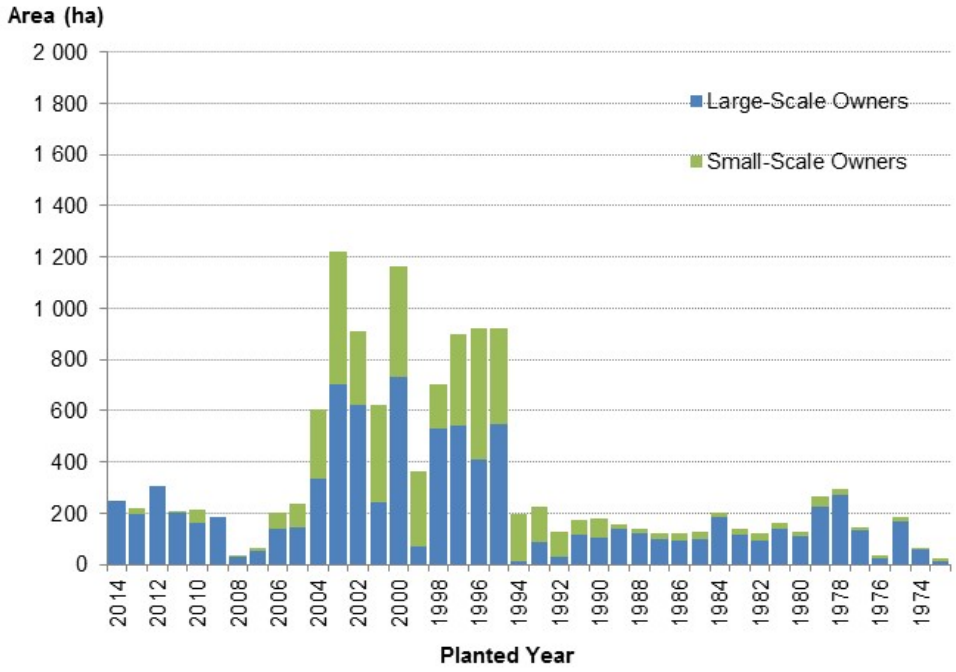
Figure 4-13: Canterbury Average Radiata Pine Clearfell Age by Target Rotation Age under Scenario 4 – All Owners



4.6 Douglas-fir

The age-class distribution of Douglas-fir in Canterbury is shown in Figure 4-14. Due to the area planted in Douglas-fir in this region being relatively small, none of the large owners indicated their harvest intentions for Douglas-fir. The Douglas-fir harvest for the large-scale and small-scale owners' estate is modelled in five-year period non-declining yield (NDY) blocks (i.e. 2024-2028, 2029-2033, etc). The total wood availability of the combined estate is also modelled to be non-declining within each of the five-year period NDY blocks (Figure 4-15).

Figure 4-14: Canterbury Age-Class Distribution of Douglas-fir – All Owners as at 1 April 2015



The target rotation age is 40 years for Douglas-fir. Figure 4-16 shows that the modelled average age sits reasonably close to this target over the medium to long term.

Figure 4-15: Canterbury Douglas-fir Availability – All Owners

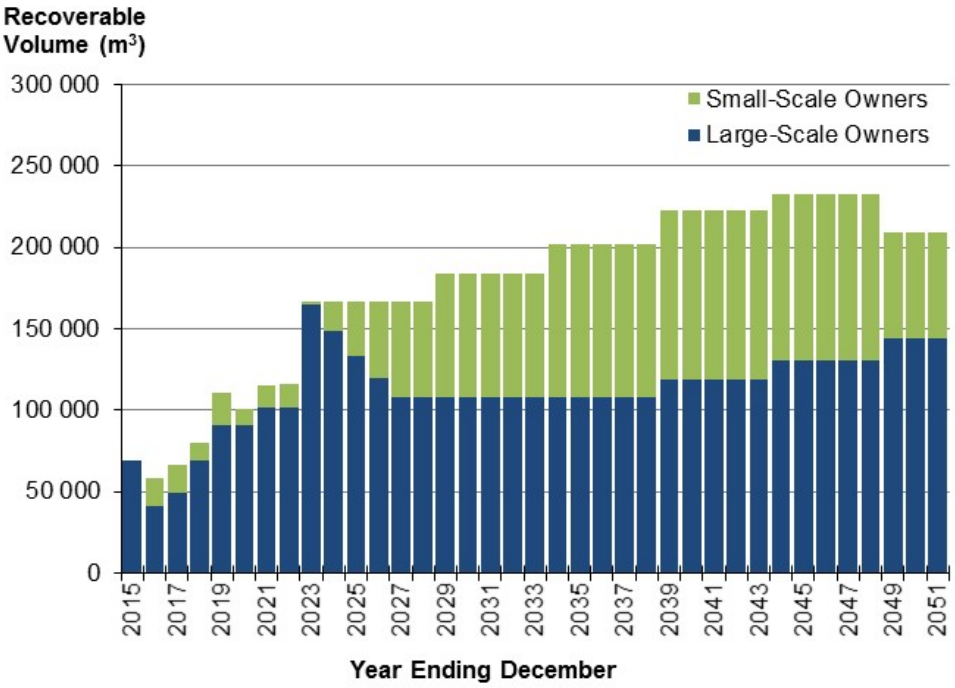
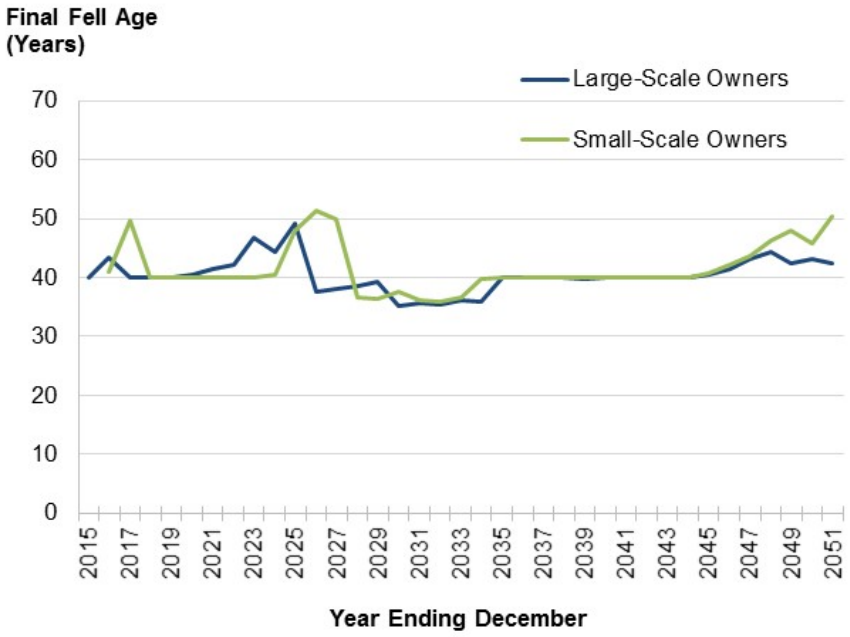
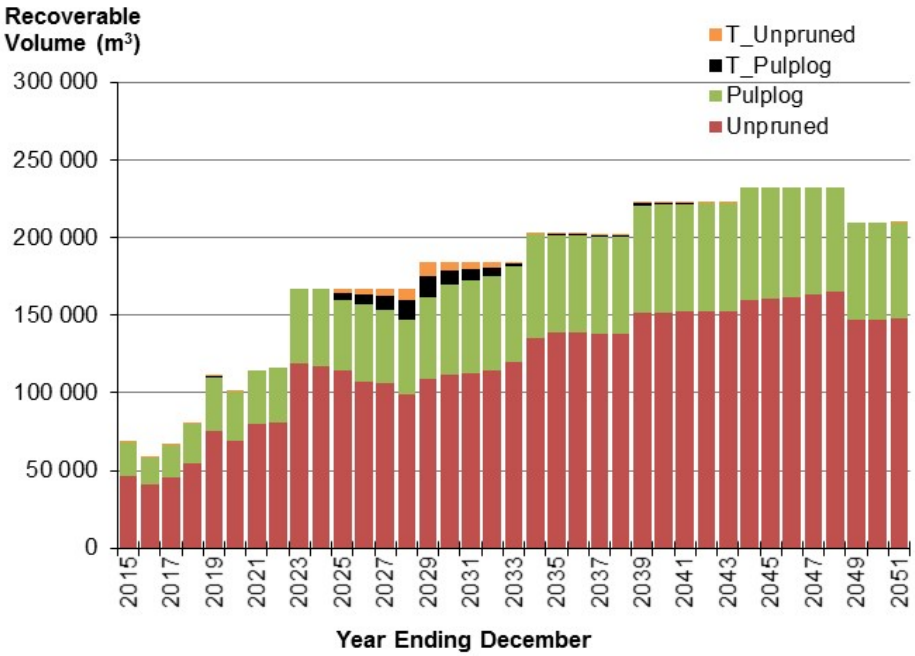


Figure 4-16: Canterbury Average Douglas-fir Clearfell Age – by Ownership Category



The harvest volumes forecast under the Douglas-fir scenario are shown by log grade in Figure 4-17.

Figure 4-17: Canterbury Douglas-fir Availability – by Log Grade (All Owners)



5. COMPARISON TO PREVIOUS FORECASTS

The results of the 2014 wood availability forecasts were compared with the previous forecasts, undertaken in 2007 (Figure 5-1). The comparison is based on radiata pine Scenario 2 (which is equivalent to Scenario 3 in the 2007 forecast) plus Douglas-fir. It can be seen that recent and current harvest levels are significantly higher than was predicted in the 2007 forecast; this has largely been driven by the windthrow recovery operations from the 2014 event. From 2018 to 2042, the latest forecast shows a sustained yield (1.1-1.2 million m^3 p.a.) around 11% lower than the 2007 forecast (1.2 to 1.3 million m^3 p.a.). From the early to mid-2040s onwards, there is a significant divergence with the previous forecast being maintained at 1.3 million m^3 p.a., but the latest forecast dropping to 0.80 million m3, before gradually building back up. The main drivers for this reduction have been land conversion out of forestry, windthrow and remapping of the small-scale forest resource.

Figure 5-1: Wood Availability Forecasts (Radiata Pine + Douglas-fir): 2007 vs 2014 – Canterbury

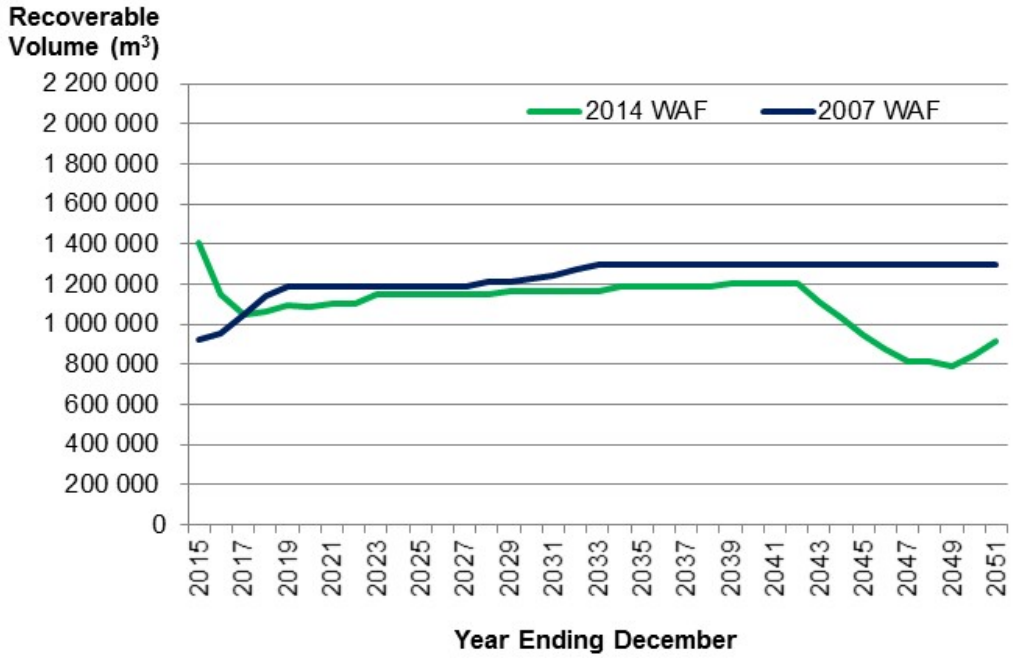


Table 5-1 compares area and yield measures from the 2007 and 2014 WAFs. The following trends are apparent:

- A decline in modelled stocked area since the 2007 WAF of 27%
- An increase in productivity across all croptype groups
- Most of the area reduction has been in the radiata pine resource, and within this, the pruned croptype. In effect there is a higher proportion of the higher yielding unpruned croptype in the 2014 WAF.
- Almost all of the reduction has also been from the lower yielding pre-1990 croptypes, resulting in a higher proportion of the higher yielding post-1989 croptype in the 2014 WAF.

The other key change since the 2007 WAF has been a reduction in the target rotation age from 30 years to 28 years.

Overall, while there has been a gain in productivity (m^3/ha) since the 2007 WAF, this can only partially offset the significant loss in plantation area: overall harvested volume over the modelling period is 10% lower in the 2014 WAF compared to the 2007 WAF.

Table 5-1: Area by Croptype and Croptype Yields (Radiata pine + Douglas-fir)

Croptype Group	Yield Tables (age 28/40 TRV)			Area (ha)		
	2007 WAF	2014 WAF	% Change in TRV	2007 WAF	2014 WAF	% Change in Area
By Regime						
Pruned	394	462	17%	28 951	18 047	-38%
Unpruned	403	468	16%	50 436	36 871	-27%
Douglas-fir	454	518	14%	15 021	13 866	-8%
Total				**94 408**	**68 784**	**-27%**
By Maturity Class						
Pre-90	368	453	23%	36 701	11 007	-70%
Post-89	418	468	12%	57 706	57 777	0%
Total				**94 408**	**68 784**	**-27%**

Figure 5-2 and Figure 5-3 compare the area-age-class distribution between the WAF data used in 2007 and 2014 for radiata pine and Douglas-fir, respectively. As well as the normal removal of the oldest age-classes due to harvesting, and the addition of younger age-classes through planting, there is evidence of reductions in area of other age-classes due to land conversion, and wind damage.

Figure 5-2: Radiata Pine Area Age-Class Comparisons: WAF 2007 vs WAF 2014

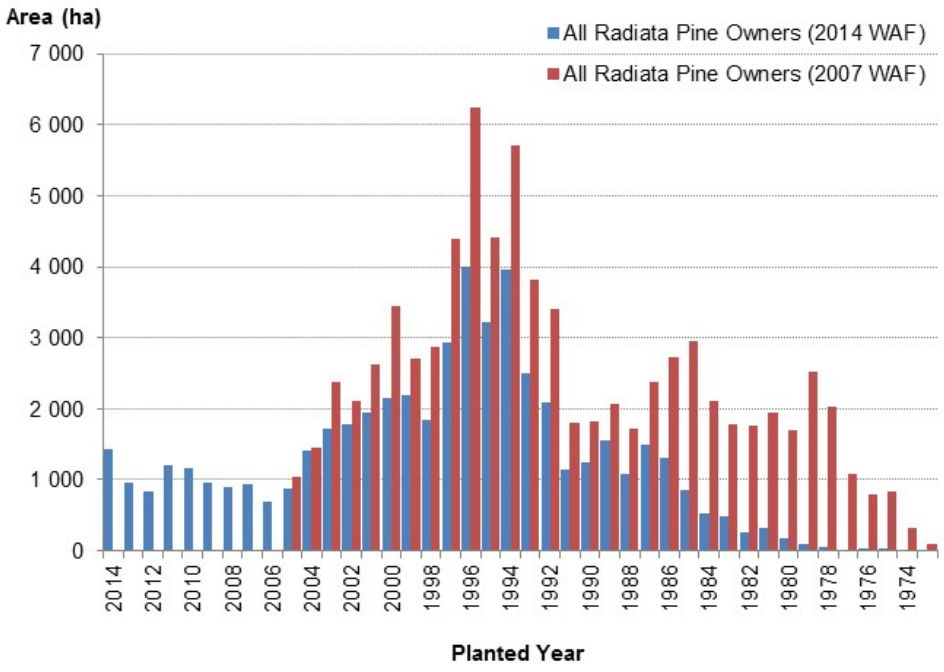
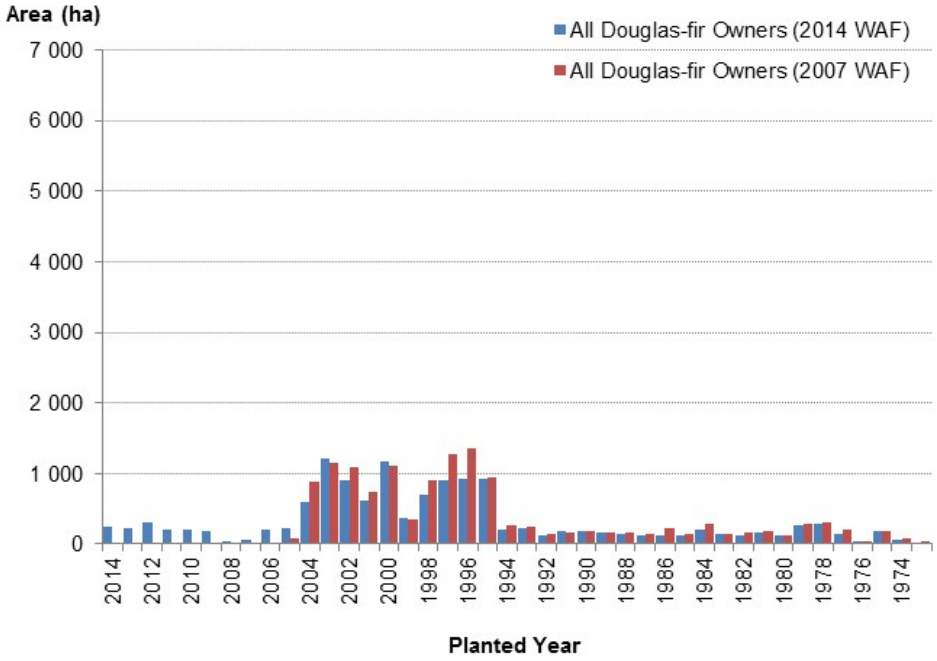


Figure 5-3: Douglas-fir Area Age-Class Comparisons: NEFD 2007 vs NEFD 2015



6. CONCLUDING COMMENTS

Under scenario 2, the radiata pine wood availability from the Canterbury wood supply region's planted forest resource will decline from current levels of around 1.3 million m^3 to just under 1 million m^3 by 2017. The wood availability can be sustained at this level through to the early 2040s.

Scenario 3 shows that a harvest at a slightly higher level could be sustained through to the mid-2030s (1.05 million m^3 p.a.), but this cannot be maintained beyond 2034 at which time it progressively reduces to 0.6 million m^3, is maintained at this level for around five years before gradually climbing again to 0.9 million m^3 p.a.

There is some scope to alter the wood availability profile by modifying the target harvest age, as shown in scenario 4. An average harvest age of 26 years (rather than 28 years) allows the harvest to be higher in the short to medium term, but the consequence is that it reduces earlier in the 2030s. Conversely, if the average harvest age is 30 years, then the short to medium term harvest levels are a little lower, but can be sustained longer.

Compared to most of the New Zealand wood supply regions, Canterbury has a high proportion of Douglas-fir, at 20% of the plantation resource. From the 2020s, this species contributes 150-250 000 m^3 p.a. to the regional wood availability.

Over the long-term around 55% of the ongoing Canterbury wood supply will come from the region's small-scale forest owners. However, this ratio has the potential to be much higher during the 2020s (up to 75%) should market conditions and logistical constraints permit.

APPENDIX 1: SMALL-SCALE OWNER RESOURCE REMAPPING

As described in Section 1, the latest WAF is based on the 1 April 2015 NEFD areas. While the NEFD is updated annually for large-scale owners, for small-scale owners it is updated every second year only, with the next update being 1 April 2016. Therefore, the latest WAF would have been using small-scale owner areas from the 2014 NEFD. As there have been some quite significant changes to areas since the 2014 NEFD data was assembled, it was considered appropriate to incorporate the results of a remapping exercise carried out in 2014 by final year students at the School of Forestry (University of Canterbury).

The remapping was undertaken using the 1 April 2014 NEFD as a start point, and updating the areas (at a territorial authority level), using satellite and aerial imagery.

It was found that the assessed stocked area in the small-scale owners' estate was 45% less than the 2014 NEFD area as shown in Table A-1 (this ranged from 15% to 63% depending on territorial authority). The percentage reductions were then applied by Indufor to the 1 April 2015 NEFD small-scale owners' resource, and these areas were used in the latest WAF wood-flow model. Because the remapping assessment did not differentiate between species or age-class, the adjustment was applied by Indufor across all species and age-classes.

Table A-1: 2014 School of Forestry Student Remapping Results

Territorial Authority	2014 NEFD Small-Scale Owner Area (ha)	Student Remapping Stocked Area (ha)	Area Reduction (ha)	Area Reduction (%)
Hurunui District	26 188	12 198	- 13 990	53%
Waimakariri District	8 457	3 123	- 5 334	63%
Christchurch City	8 435	3 785	- 4 651	55%
Selwyn District	6 077	5 175	- 902	15%
Ashburton District	1 892	1 188	- 704	37%
Timaru District	7 408	5 812	- 1 596	22%
Mackenzie District	3 451	2 924	- 528	15%
Waimate District	6 720	3 308	- 3 412	51%
Total (All Species)	**68 628**	**37 513**	**- 31 116**	**45%**

Appendix – Canterbury Wood Availability Forecasts for the Period 2015 to 2051

Canterbury Wood Availability under Scenario 1 (Figures 4-2 and 4-3)

(Assumes that large-scale owners harvest at stated intentions and then at non-declining yield, and small-scale owners harvest at age 28 years).

Year Ending December	Large-Scale Owners (000 m3 IB)	Small-Scale Owners (000 m3 IB)	All Owners (000 m3 IB)
2015	628	713	1 341
2016	572	519	1 091
2017	461	554	1 015
2018	470	233	703
2019	497	244	742
2020	545	744	1 289
2021	526	984	1 510
2022	547	1 579	2 126
2023	484	1 104	1 588
2024	484	1 438	1 922
2025	484	984	1 468
2026	484	280	764
2027	484	359	843
2028	484	425	909
2029	484	323	807
2030	484	170	654
2031	484	322	806
2032	484	136	620
2033	484	161	645
2034	484	54	538
2035	484	26	510
2036	484	30	514
2037	484	58	542
2038	484	125	609
2039	484	77	561
2040	484	62	546
2041	484	70	554
2042	484	202	686
2043	436	173	609
2044	392	525	917
2045	353	471	823
2046	318	489	807
2047	286	238	524
2048	313	254	567
2049	344	761	1 105
2050	379	1 008	1 387
2051	400	1 633	2 032

Notes:
m3 cubic metres
IB inside bark.

Canterbury Wood Availability under Scenario 2 (Figure 4-6)

(Assumes that large-scale owners harvest at stated intentions and then at non-declining yield, and total wood availability is modelled at a non-declining yield).

Year Ending December	Large-Scale Owners (000 m3 IB)	Small-Scale Owners (000 m3 IB)	All Owners (000 m3 IB)
2015	628	713	1 341
2016	572	519	1 091
2017	461	522	983
2018	470	513	983
2019	497	486	983
2020	545	438	983
2021	526	457	983
2022	547	437	983
2023	484	499	983
2024	484	499	983
2025	484	499	983
2026	484	499	983
2027	484	499	983
2028	484	499	983
2029	484	499	983
2030	484	499	983
2031	484	499	983
2032	484	499	983
2033	484	499	983
2034	484	499	983
2035	484	499	983
2036	484	499	983
2037	484	499	983
2038	484	499	983
2039	484	499	983
2040	484	499	983
2041	484	499	983
2042	484	499	983
2043	484	401	885
2044	436	361	796
2045	406	311	717
2046	365	280	645
2047	329	252	581
2048	329	252	581
2049	329	252	581
2050	329	310	639
2051	329	374	703

Notes:
m3 cubic metres
IB inside bark.

Canterbury Wood Availability under Scenario 3 (Figures 4-9 and 4-11)

(Assumes that large-scale owners harvest at stated intentions then at non-declining yield, and total wood availability is modelled at a split non-declining yield).

Year Ending December	Large-Scale Owners (000 m3 IB)	Small-Scale Owners (000 m3 IB)	All Owners (000 m3 IB)	Pruned (000 m3 IB)	Unpruned (000 m3 IB)	Chip Logs (000 m3 IB)	Total (000 m3 IB)
2015	628	713	1 341	153	816	372	1 341
2016	572	519	1 091	108	677	306	1 091
2017	461	578	1 039	39	681	319	1 039
2018	470	569	1 039	76	649	313	1 039
2019	497	542	1 039	99	640	300	1 039
2020	545	494	1 039	91	650	298	1 039
2021	526	513	1 039	102	645	292	1 039
2022	547	492	1 039	135	616	288	1 039
2023	484	555	1 039	134	620	285	1 039
2024	484	555	1 039	132	622	285	1 039
2025	484	555	1 039	132	620	287	1 039
2026	484	555	1 039	99	641	300	1 039
2027	484	555	1 039	87	647	305	1 039
2028	484	555	1 039	88	646	304	1 039
2029	484	555	1 039	83	651	305	1 039
2030	484	555	1 039	69	661	309	1 039
2031	484	555	1 039	37	675	327	1 039
2032	484	555	1 039	25	686	328	1 039
2033	484	555	1 039	17	694	328	1 039
2034	484	555	1 039	7	700	333	1 039
2035	484	451	935	11	624	301	935
2036	484	358	842	12	558	271	842
2037	484	274	758	14	498	246	758
2038	484	198	682	26	435	221	682
2039	484	130	614	28	389	196	614
2040	484	130	614	5	400	209	614
2041	484	130	614	6	398	210	614
2042	484	130	614	11	400	203	614
2043	436	191	627	2	415	210	627
2044	392	298	690	7	452	230	690
2045	353	406	759	11	497	251	759
2046	318	517	834	7	547	280	834
2047	289	619	907	8	598	301	907
2048	318	595	913	9	601	302	913
2049	349	564	913	12	599	302	913
2050	384	534	919	11	605	303	919
2051	393	525	919	14	603	302	919

Notes:
m3 cubic metres
IB inside bark.

Canterbury Wood Availability under Scenario 4 (Figures 4-12 and 4-13)

(Assumes that large-scale owners harvest at stated intentions then at non-declining yield, and total wood availability is modelled at a split non-declining yield with target rotation ages of 26, 28 and 30 years).

Year Ending December	Recoverable Volume target age 26 (000 m3 IB)	Average Age (Years)	Recoverable Volume target age 28 (000 m3 IB)	Average Age (Years)	Recoverable Volume target age 30 (000 m3 IB)	Average Age (Years)
2015	1 341	27.7	1 341	29.4	1 341	31.6
2016	1 091	29.2	1 091	30.9	1 091	31.5
2017	1 067	30.2	1 039	30.6	982	29.1
2018	1 067	28.3	1 039	28.1	982	28.4
2019	1 067	28.6	1 039	28.6	982	28.1
2020	1 067	27.4	1 039	29.9	982	29.0
2021	1 067	27.0	1 039	30.0	1 004	28.2
2022	1 067	28.6	1 039	27.6	1 004	29.7
2023	1 067	28.5	1 039	28.1	1 004	29.1
2024	1 067	29.2	1 039	28.5	1 004	29.4
2025	1 067	28.1	1 039	27.9	1 004	29.3
2026	1 067	27.6	1 039	28.6	1 004	29.4
2027	1 067	28.3	1 039	28.7	1 004	29.2
2028	1 067	29.2	1 039	28.8	1 004	30.1
2029	1 067	28.1	1 039	29.6	1 004	30.4
2030	1 067	29.8	1 039	30.6	1 004	30.1
2031	1 067	32.5	1 039	29.4	1 004	31.0
2032	1 067	34.9	1 039	31.3	1 004	32.3
2033	961	33.6	1 039	33.2	1 004	31.5
2034	865	33.2	1 039	34.3	1 004	33.8
2035	778	31.9	935	33.1	1 004	32.7
2036	700	29.7	842	32.1	1 004	34.0
2037	630	27.7	758	30.3	904	34.4
2038	630	25.0	682	26.8	813	28.8
2039	630	25.2	614	26.8	732	28.1
2040	650	25.2	614	25.9	659	26.3
2041	715	25.7	614	25.7	593	28.0
2042	787	25.7	614	27.2	593	28.0
2043	866	25.6	627	27.8	593	28.5
2044	866	25.9	690	27.4	593	28.8
2045	866	26.0	759	27.7	593	28.4
2046	866	25.9	834	27.3	598	30.0
2047	866	26.0	907	28.0	658	30.0
2048	866	26.0	913	28.0	724	29.7
2049	866	26.0	913	27.8	796	30.0
2050	866	26.0	919	28.0	876	30.0
2051	866	26.0	919	28.0	963	30.0

Notes:
m3 cubic metres
IB inside bark.

Canterbury Wood Availability under Scenario 5 for Douglas-fir (Figure 4-15)
(Assumes that large-scale owners harvest at stated intentions with yield regulated in subsequent years and a target rotation of 40 years).

Year Ending December	Large-Scale Owners (000 m3 IB)	Small-Scale Owners (000 m3 IB)	All Owners (000 m3 IB)	Average Age (Years)
2015	69	0	69	40.0
2016	41	17	59	42.7
2017	49	17	66	42.5
2018	69	11	80	40.0
2019	91	19	111	40.0
2020	91	10	101	40.4
2021	102	13	115	41.4
2022	102	15	116	41.9
2023	165	2	167	46.7
2024	148	19	167	43.9
2025	134	34	167	48.9
2026	120	47	167	41.7
2027	108	59	167	42.6
2028	108	59	167	37.8
2029	108	76	184	37.9
2030	108	76	184	36.3
2031	108	76	184	35.8
2032	108	76	184	35.7
2033	108	76	184	36.3
2034	108	94	202	37.7
2035	108	94	202	40.0
2036	108	94	202	40.0
2037	108	94	202	40.0
2038	108	94	202	40.0
2039	119	104	222	39.8
2040	119	104	222	40.0
2041	119	104	222	40.0
2042	119	104	222	40.0
2043	119	104	222	40.0
2044	131	102	233	40.0
2045	131	102	233	40.6
2046	131	102	233	41.7
2047	131	102	233	43.4
2048	131	102	233	45.2
2049	144	66	209	44.1
2050	144	66	209	44.0
2051	144	66	209	44.9

Notes:
m3 cubic metres
IB nside bark.

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