Australian Government
Department of Agriculture
ABARES

Outlook scenarios for Australia's forestry sector: key drivers and opportunities

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Research by the Australian Bureau of Agricultural and Resource Economics and Sciences

Report prepared for the Department of Agriculture
April 2015

Cataloguing data

Burns, K, Gupta, M, Davey, S, Frakes, I, Gavran, M & Hug, B 2015, *Outlook scenarios for Australia's forestry sector: key drivers and opportunities*, ABARES report to client prepared for the Department of Agriculture, Canberra, April. CC BY 3.0.

ISBN 978-1-74323-231-6

ABARES project 43392

Internet

Outlook scenarios for Australia's forestry sector: key drivers and opportunities is available at agriculture.gov.au/abares/publications.

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Acknowledgements

The authors gratefully acknowledge the invaluable contributions made by Kristen Corrie and Kah Low in research and analysis. Support and input provided by Andrew Wilson and Mark Edwards in the Department of Agriculture were also essential in producing this report. Invaluable assistance was provided by various forestry industry and government stakeholders, including state forest agencies, private companies and forestry consultants in the preparation of the scenarios and assumptions used in this report. The final report has been noted by the Forestry and Forest Products Committee (FFPC).

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Summary

Australia's forestry sector has changed significantly over recent decades in response to a range of environmental, market and policy challenges. These changes have resulted in a diverse domestic sector characterised by several forest regions with different forest types, an array of processing technologies and reliance on both domestic and international markets. Forest product markets are dynamic, and Australia's forestry sector will continue to adapt to varying economic, environmental and policy factors over the longer term.

In November 2012 ABARES was commissioned by the Department of Agriculture to examine the future of the Australian forestry sector and to investigate likely wood demand and supply scenarios over the period to 2050. In this report, ABARES describes three outlook scenarios for Australia's forestry sector and analyses the estimated availability and use of logs, opportunities for investment and primary processing of wood products, and the importance of factors affecting these outlooks from 2011–12 conditions to 2050.

The scenarios are:

- business-as-usual
- priority-to-productivity
- constrained-wood-production.

The business-as-usual scenario depicts a future without major changes from present conditions—that is, current economic, policy and environmental parameters are assumed to remain unchanged and current trends to continue. The priority-to-productivity and constrained-wood-production scenarios present alternative trajectories for the forestry sector based on different sets of policy, market and supply assumptions. Sensitivity analyses have also been conducted to identify the potential implications of changes to key parameters.

The analysis presented in this report illustrates the broad trends and key parameters that will shape Australia's forest industry over the longer term. However, several issues are outside the scope of the present analysis. First, the analysis includes only selected industries in the forestry sector and excludes some downstream value-adding and non-wood forest product industries that contribute to incomes and employment in the sector. Second, the projections of output, full-time equivalent employment and investment in the forestry sector reflect a particular set of assumptions for each scenario, relating to resource and market parameters. This report presents the outlook for Australia's forestry sector for each of these scenarios. However, it does not examine parameters such as technological change and climate variability, which may suggest a different output and investment outlook for the sector. Data and assumptions used in this report reflect market and policy parameters current at December 2014.

Business-as-usual scenario

Based on business-as-usual scenario assumptions for forest resource, technology and market parameters, log-equivalent consumption of wood products is estimated to increase by 44 per cent, from 18.7 million cubic metres in 2011–12 to over 27 million cubic metres by 2050. Over the same period, Australia's log availability is forecast to increase from 31 million cubic metres in 2011–12 to over 36 million cubic metres by 2030, before falling to around 33 million cubic metres by 2050.

In this scenario ABARES projects that Australia's log harvest volume will reach almost 30 million cubic metres by 2030, before falling to 28.3 million cubic metres by 2050 (Table 1). Growth is strongest in the harvest of hardwood plantation pulplogs and softwood plantation sawlogs are also projected to increase. Production of all major forest commodities will increase over the period to 2050, with strongest growth in sawnwood and wood-based panels. These changes are driven by forecast growth in consumption of wood products, higher availability of plantation logs and opportunities for profitable investment in processing capacity, particularly in sawmills and plywood mills. Trade in wood products will become increasingly important, with net imports of all major forest commodities projected to increase, along with a rise in the volume of log and woodchip exports to 2050.

Industry value-added (a measure of industry contribution to gross domestic product) generated in the forestry sector (as defined in this report; see glossary for description) will increase by around 34 per cent, from $5.3 billion in 2011–12 to $7.1 billion in 2050 (values expressed in 2011–12 Australian dollars). However, growth in the forestry sector is not projected to match the assumed growth in Australia's gross domestic product (GDP), leading to a decline in the relative contribution of the forestry sector to GDP, from 0.36 per cent in 2011–12 to 0.22 per cent in 2050. Over time, increased log harvest and output of some wood products will generate higher employment and turnover in the sector.

Table 1 Selected forestry sector indicators, 2011–12 and 2050 projections

Parameter	2011–12 a	Business-as-usual in 2050	Priority-to-productivity in 2050	Constrained-wood-production in 2050
			% change from business-as-usual	% change from business-as-usual
Total log harvest (million m^3)	23.50	28.26	+13.7	–11.3
Sawnwood production (million m^3)	4.59	5.40	+7.0	–6.6
Sawnwood net imports (million m^3)	0.34	1.07	+25.0	–27.3
Panels production (million m^3)	1.79	2.42	+69.8	–70.9
Panels net imports (million m^3)	0.26	1.92	–65.2	+66.6
Paper production (Mt)	3.15	3.32	+0.1	–4.6
Paper net imports (Mt)	0.67	3.76	+18.8	–14.7
Log and woodchip exports (Mt)	5.96	6.60	+10.0	–6.0
			Actual values	Actual values
Forest products turnover ($m) **b**	13 974	18 021	19 870	15 637
Total industry value-added ($b)	5.30	7.11	8.67	5.57
Contribution to GDP (%) **c**	0.36	0.22	0.27	0.17
Employment ('000) **d**	23.85	28.78	32.59	24.69
Future investment (no. mills)	na	14 new mills	19 new mills	10 new mills

a 2011–12 is the modelled base year and represents an approximation of current forestry sector activity. Some parameters may vary from those published in ABARES (various years). **b** $m of turnover in sawnwood, panels and pulp and paper sectors. All dollar values expressed in 2011–12 Australian dollars. **c** Differs from figures reported in ABARES (various years) because of different definitions of forestry sector. **d** Full-time equivalent number of workers in log harvesting, transport and primary wood processing (including paper). **na** Not applicable.

Priority-to-productivity scenario

The priority-to-productivity scenario assumes increased log availability from plantation and native forests, greater investment certainty and lower wood processing costs. The benefits of these factors are evident across the forestry sector, leading to increased log harvest and wood products output over the projection period (Table 1). As opportunities for profitable investment in processing infrastructure increase, production of wood-based panels is estimated to be almost 70 per cent higher in 2050 in this scenario than in the business-as-usual scenario.

Consequently, over time domestic consumption of panels will increasingly be supplied by domestic production. Net imports of wood-based panels are projected to be 65 per cent lower in this scenario than in the business-as-usual scenario. Despite greater production of all other forest commodities in the priority-to-productivity scenario, net imports of sawnwood and paper products are projected to rise because of the higher levels of domestic consumption assumed in this scenario.

This scenario also projects increases in industry value-added, employment and forest sector turnover. Industry value-added is projected to increase by around 64 per cent over the projection period to $8.7 billion in 2050 (values expressed in 2011–12 Australian dollars). Even under the favourable investment conditions in this scenario, the contribution of the forestry sector to Australia's GDP is projected to decline from current levels to around 0.27 per cent in 2050.

Constrained-wood-production scenario

In contrast to the favourable conditions in the priority-to-productivity scenario, the constrained-wood-production scenario envisages a future where forest areas and log availability are constrained by factors such as market conditions, native forest conservation and food production concerns, and where consumption of all wood products is lower relative to the business-as-usual scenario. Increased investment uncertainty is also assumed in this scenario, resulting in a higher hurdle rate for investment. Increased competition for wood fibre is projected to particularly affect the wood-based panel products sector. Consequently, log harvest and wood product output are projected to fall in this scenario, relative to the business-as-usual scenario. In particular, panel production is projected to be 71 per cent lower than the business-as-usual scenario in 2050, with a concomitant increased reliance on wood-based panel imports. In the constrained-wood-production scenario, the lower profitability of the domestic forestry sector and the higher investment hurdle rate contribute to lower investment in new wood processing facilities. Overall, imports increase substantially to meet domestic consumption needs.

Based on these factors, industry value-added is projected to increase by only around 5 per cent to $5.6 billion in 2050 (values expressed in 2011–12 Australian dollars), which is below the business-as-usual scenario projection. The contribution of the forestry sector to Australia's GDP is lower than it is in the business-as-usual scenario, falling to around 0.17 per cent in 2050. Forest sector turnover and employment are also lower in this scenario than in the business-as-usual scenario.

Conclusions

The analysis in this report highlights some key opportunities for Australia's forestry sector, as well as the economic and policy factors required for realising these opportunities. The results affirm that a positive investment environment for upgrading and expanding wood processing infrastructure will underpin growth in Australia's forestry sector. In the business-as-usual and priority-to-productivity scenarios, ABARES projects strong growth in many parts of Australia's forestry sector. This result is on the basis of substantial forest resources that will supply large increases in future log availability, and significant future demand for wood products in domestic housing and consumer markets. Despite a large projected increase in Australia's log availability over time, these resources are not always of the appropriate quality or at the appropriate location to facilitate domestic processing. Hence, trade in wood products will continue to expand as forest growers and processors rely on export markets to sell key raw materials (such as

woodchips and logs) and wood products. Additionally, imports will rise to supplement domestic production and meet domestic consumption needs.

The results highlight that processing wood products has the potential to remain an important component of Australia's manufacturing base. The resilience of the industry is contingent on several key economic and policy factors. In particular, domestic and export prices for wood products have a substantial effect on activity in the sector and factors that support investment to upgrade and expand wood processing infrastructure will underpin future growth.

Introduction

Objectives of the outlook study

In November 2012, the Department of Agriculture commissioned ABARES to undertake research into the future of the Australian forestry sector, assessing likely wood demand and supply scenarios to 2050.

Australia's forestry sector has changed significantly over the past four decades and faces increasing environmental, social and economic pressures. Forests remain an important natural resource in Australia, delivering a range of benefits to society. The outlook for Australia's forestry sector is important to policymakers, investors, manufacturers, and consumers.

This report examines three outlook scenarios for Australia's forestry sector, using analysis of the potential availability and use of logs, forecasts of wood products consumption and opportunities for processing of wood products and investment. ABARES conducted several workshops with industry and government stakeholders to refine the scenarios and test assumptions supporting this analysis. Responses from the workshops were incorporated into this analysis where possible.

A business-as-usual scenario and two alternative scenarios (the priority-to-productivity and constrained-wood-production scenarios) are examined in the report. Sensitivity testing was also conducted to identify the extent of the influence of key parameters. The business-as-usual scenario depicts a future without major changes from present conditions; that is, current economic, policy and environmental factors affecting the forestry sector are assumed to remain unchanged over the projection period to 2050, and current trends are assumed to continue. Availability of native forest and plantation wood resources depicted in the business-as-usual scenario are those forecast by government agencies and plantation growers.

The priority-to-productivity and constrained-wood-production scenarios examine how the future of Australia's forestry sector could be influenced by changes to some of these key parameters. They are based on several international outlook studies that have examined the future of the forestry sector in other economies and international trade. The parameters defining these scenarios are derived from international reports and ABARES econometric projections of consumption of wood products and surveys of potential future log availability in Australia. All data and assumptions used in these scenarios represent market parameters and policies as at December 2014. Base year data used in the modelling has been calibrated to 2011–12 estimates. The scenario parameters are analysed using the ABARES Forest Resource Use Model (FORUM, see Modelling approach, chapter 4) to project the implications of log availability and wood products consumption trends for Australia's forestry sector output, investment, employment and trade over the long term. All projected values in the report are presented in 2011–12 Australian dollars.

In addition to describing the scenario projections of future outlook for Australia's forestry sector, the report describes the methods, datasets and assumptions employed in the analysis.

Scope of this analysis: strengths and limitations

This study uses comprehensive ABARES datasets on the forestry sector, including logs harvested, wood products output and processing infrastructure, forest areas and sustainable yields from native forests and plantations. ABARES, working with state government agencies and forestry sector associations, has collected these datasets using surveys for several decades. These datasets are detailed in regular ABARES publications, including *Australian forest and wood products statistics* (ABARES various years), *Australia's State of the Forests Report* (MIG & NFISC 2013) and reports of the *National Plantation Inventory* (Gavran various years). These datasets are used to illustrate and qualitatively assess past trends in Australia's forestry sector and to draw implications for the potential future outlook.

ABARES has developed the FORUM framework to provide a national assessment of the economic potential for forest use in Australia, accounting for domestic and international market parameters, regional forest yields, the geographic location of forests relative to processing centres, and investment opportunities. FORUM is an optimisation model and was first developed by ABARES to analyse the economic implications of forest conservation. In this report, FORUM is used to develop quantitative outlooks for the forestry sector to 2050, estimating the potential optimum uses of Australia's forest resources.

Several issues are not addressed in this analysis. The report examines only primary processing, which is a subset of Australia's forestry sector. Hence, this analysis does not include further processing of wood products that adds value to sawnwood, panels and paper products. This consequently omits a proportion of the contribution to employment and incomes attributable to the forestry sector. Other aspects of Australia's forestry sector that are not included in the report are forest management and services to forestry, and wholesale and retail activities relating to wood products. Each of these subsectors is an important contributor to incomes and employment in regions around Australia. Their omission from this analysis means that the figures presented in the report underestimate the total size and contribution of the forestry sector in Australia and the divergent impacts that some parameter changes may have on these subsectors.

The report does not assess some potential future market opportunities for the forestry sector. In particular, downstream value-adding opportunities may become more important over time. For example, development of innovative engineered wood products may provide the forestry sector with new products that can be produced from abundant log types and compete in new markets. Bioenergy is another area where technological advances and policy developments may afford opportunities in the future. The report includes only limited assessment of bioenergy (the development of wood pellet plants) and hence may understate the potential level of future investment in domestic processing of Australia's forest resources.

Because of data limitations, many regions, log types and wood products have been aggregated in this analysis. Therefore the model does not comprehensively represent the true heterogeneity of log types, wood products and processing technologies presently employed in Australia. The simplifications and aggregations used in this report mean that the modelled allocation of logs, residues and products will often differ from reality. ABARES has calibrated the model outputs to current market conditions; however, this process is an approximate measure. Additionally, model projections are contingent on assumptions regarding future resource and product demand, supply and price. Model results may differ substantially when these assumptions are changed.

The scenarios presented in this report represent a set of policy and market parameters that may affect the future shape of Australia's forestry sector. These parameters are described in detail in this report (Australia's economy, chaper 4). However, many important parameters have not been included in these scenarios because of data and time limitations. For example, the report does not explicitly consider the impacts of climate variability on Australia's forest resources or potential carbon abatement opportunities for the Australian forest industry. Climate variability may have impacts across the forestry value chain, including log availability, investment opportunities and demand for wood products. While ABARES has examined some of these issues in previous research (ABARES 2012), the analysis required to adequately incorporate future climate variability impacts was considered too complex and broad to be within the scope and time frame of the report.

In light of these limitations, the projections provided in this report represent potential future outlooks that may arise given specific assumptions. They do not represent inevitable trajectories that the industry will take. An array of technological, policy, environmental and market factors can substantially change the outlook for the forestry sector. Hence, some processing options considered in the report may be economically feasible under price or resource assumptions other than those included in this analysis, while alternative technologies not considered here may also be feasible under certain conditions. Nevertheless, this analysis highlights some of the key factors that influence the forestry sector's outlook for existing processing technologies, assuming a broad range of potential economic, policy and environmental parameters. The findings from the report will help policymakers and forestry sector stakeholders better understand the key challenges facing the sector and identify opportunities for growth.

1 Overview of Australia's forestry sector

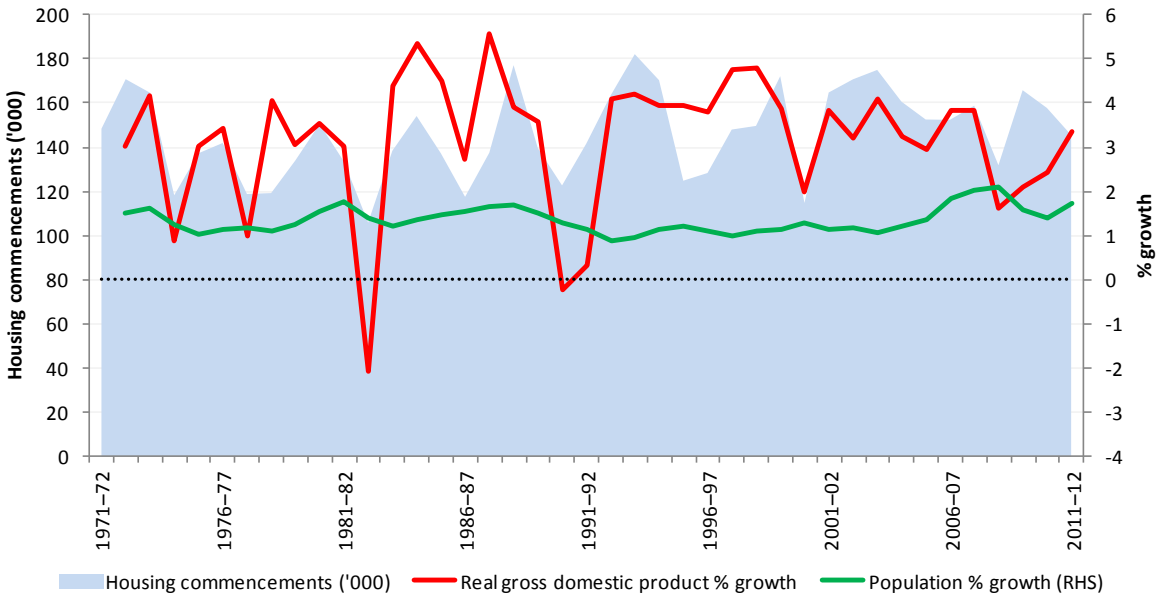
The outlook for the forestry sector is contingent on the sector's capacity to respond to future changes to forest resources, investment, economic and demographic factors in Australia and internationally. Past trends in these parameters have contributed to the current shape of Australia's forestry sector; hence, it is important to examine these trends and identify some of the key relationships that have been evident in recent decades.

Long-term historical trends in Australia's forestry sector

Economic and social parameters

Changes to Australia's economy and demography underlie many of the changes that have occurred in the forestry sector. Figure 1 illustrates long-term historical trends in Australia's housing commencements, real gross domestic product (GDP) growth and population growth. Population growth—which has important implications for housing activity and hence the demand for wood products—has been relatively steady since the 1970s, increasing from 13.3 million people in 1971–72 to 22.7 million in 2011–12. Housing and economic activity (measured by changes in real GDP) generally move in the same direction. Despite the relative consistency of population growth over the 40 years to 2011–12, housing commencements (one of the most significant uses of timber in Australia) averaged around 146 000 dwellings a year but exhibited more volatility, leading to fluctuating demand for structural timber products such as sawnwood and some wood-based panels. This cyclical demand pattern highlights one of the key challenges facing forest growers and wood processors when seeking to maintain reliable incomes and profitability over time.

Figure 1 Historical housing commencements, real gross domestic product and population growth in Australia, 1971–72 to 2011–12

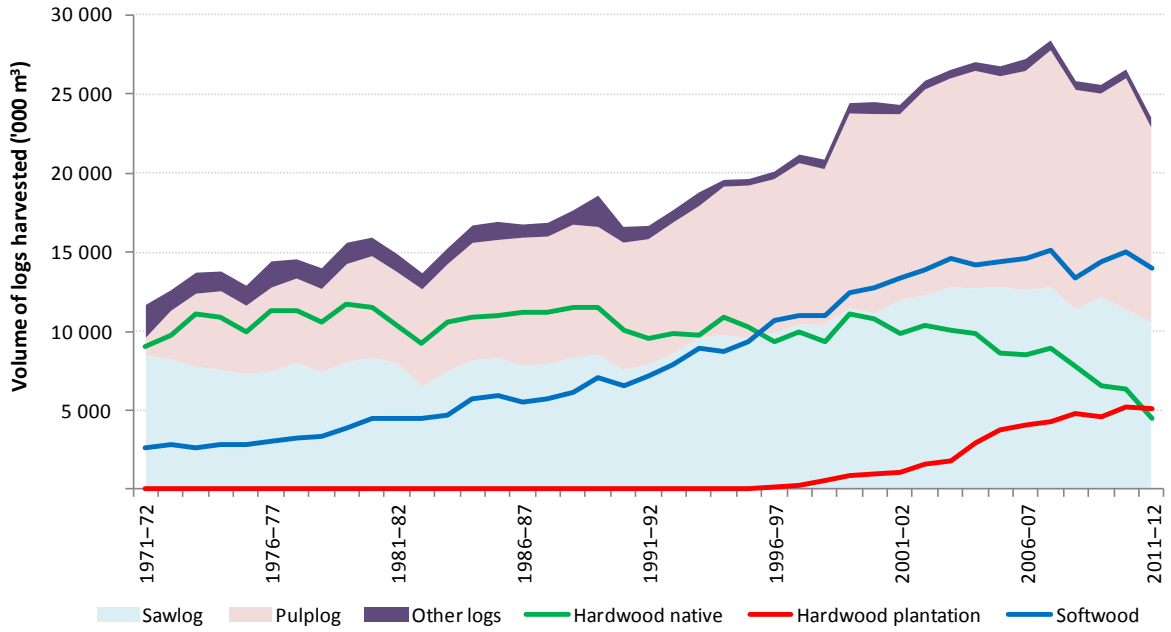


Note: **RHS** Right hand side. Source: ABARES datasets

Logs harvested

The composition of logs harvested in Australia has changed since the early 1970s, and illustrates several important trends (Figure 2). The volume of logs harvested from native forests, while fluctuating in some years, was generally stable at around 10 million cubic metres until the 1990s. The Regional Forest Agreement (RFA) process began around 1996–97 in Australia and since 2001–02 native forest harvesting has declined as a result of reviews to some of the RFAs and weak market demand for some native wood products (such as hardwood woodchips). Native log harvest reached 4.5 million cubic metres in 2011–12.

Figure 2 Historical logs harvested, by log type, 1971–72 to 2011–12



Note: Other logs include poles, piles, fencing and logs not elsewhere included. Excludes fuel logs.

Source: ABARES datasets

Another significant trend has been the shift towards harvest of pulplogs since the 1970s. In 1971–72 pulplogs accounted for 10 per cent of total logs harvested in Australia. By 1986–87 pulplogs had reached 48 per cent of logs harvested, maintaining a stable proportion ever since. This trend reflects the increasing importance of softwood plantations in Australia's log harvest (these forests generally have 30 per cent to 40 per cent pulplogs) and a significant increase in the share of pulplogs harvested from native forests. After averaging around 33 per cent of all native forest logs harvested in the 1970s, pulplogs accounted for over 60 per cent of native forest logs harvested in the 2000s. The increase in pulplog harvest can be linked to emerging markets in Australia for these logs (such as some wood-based panels and pulp) and export opportunities in the form of woodchips. This highlights the way harvesting and log types may adapt in the future, as new products are developed or new markets emerge.

Two of the key turning points apparent in Figure 2 are in 1996–97, when softwood plantation harvest first exceeded native forest harvest, and in 2011–12, when hardwood plantation harvest first exceeded native forest harvest. Both these events were triggered by market and policy drivers. The Softwood Forestry Agreement Acts of the 1970s stimulated public investment in softwood plantations in response to a foreseeable need for increasing supply of sawlogs to provide construction material for Australia's growing population (de Fégely, Stephens & Hansard 2011). This was matched by investments in research and development to create

softwood sawnwood products from these plantations that could match the strength and quality characteristics of native hardwood species (Wood Solutions 2013). Similarly, hardwood plantation development was driven by strong overseas demand for hardwood woodchips, particularly from Japan. Many of the initial hardwood plantation investments in Australia were joint ventures with Japanese paper companies. Later, these investments were favoured by Managed Investment Schemes (MIS), which led to a rapid expansion of the hardwood plantation estate over the 2000s. However, in recent years MIS investments have declined. Many other countries have invested heavily in hardwood plantations (predominantly Australian *Eucalyptus*), resulting in lower prices for Australia's hardwood woodchip exports in an increasingly competitive international market.

Similar turning points are likely in the future, though it is difficult to predict what these will be. While hardwood and softwood plantation areas were relatively equal (at around 1 million hectares each) in 2011–12, concerns about the commercial viability of some plantations may lead to a decrease in area, at least in the short term. Future markets, including for bioenergy or carbon credits, may change the relative competitiveness of different forest types and land uses and drive further changes in the sector.

Wood products consumption and output

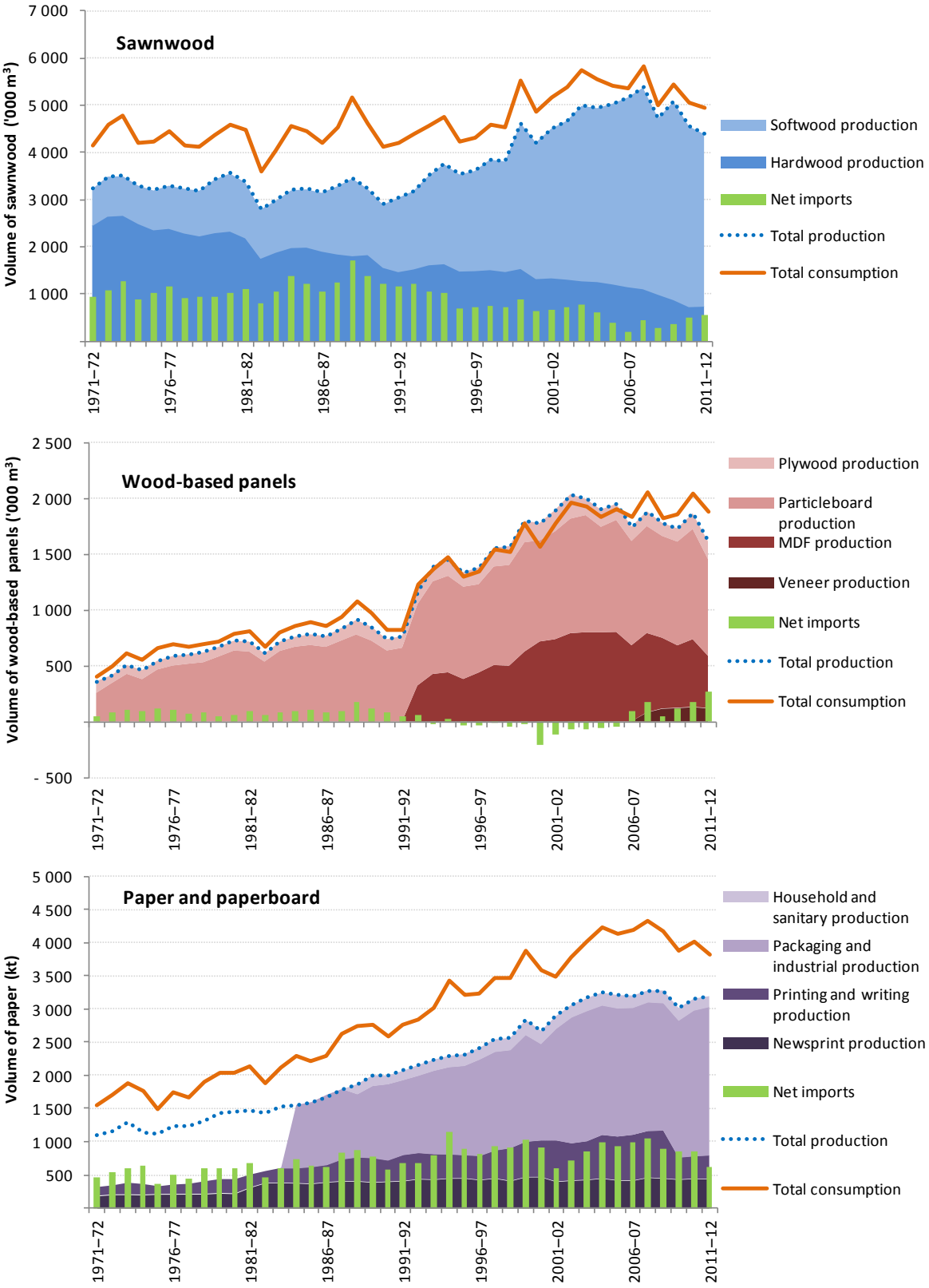
Figure 3 illustrates the changes that have occurred in the broad wood products commodities consumed and produced in Australia since the 1970s. The data shows that sawnwood production and consumption has been well established in Australia since the 1970s, while paper and wood-based panel production has emerged from a low base. Since the 1970s, consumption of all broad wood products groups has increased; however, the extent of growth differs significantly between these commodity groups. There are also significant differences in the production and consumption trends within these commodity groups.

There is a clear trend in the composition of sawnwood productionover this historical period away from hardwood towards softwood. In 1971–72 softwood sawnwood accounted for less than one-quarter of total sawnwood production in Australia; by 1991–92 this figure had reached 51 per cent; and in 2011–12, 83 per cent of sawnwood production in Australia was softwood. While sawnwood consumption increased over this period, the rise was only 19 per cent over 40 years to 2011–12 (an average of 0.43 per cent a year). Softwood sawnwood consumption increased by more than 150 per cent during this period, while hardwood sawnwood consumption declined by 74 per cent. It is also clear that Australia has become more self-sufficient in sawnwood as the supply of softwood has increased, with net imports declining over the past four decades.

Consumption of wood-based panels has been more remarkable, increasing fourfold over the four decades to 2011–12. Net trade has fluctuated over this period and has remained a relatively small component of panels consumption in Australia. While early production comprised particleboard and plywood, medium-density fibreboard emerged in the early 1990s and hardwood veneers in the mid 2000s.

Paper consumption grew steadily in Australia over the 40 years to 2011–12, increasing by almost 150 per cent from 1971–72, although consumption declined after peaking in 2007–08. While paper production has generally followed these trends, a large reduction in domestic production of printing and writing paper in 2009–10 followed the closure of the PaperlinX mills in Tasmania. Net imports have remained a significant component of total apparent consumption, averaging around 28 per cent of consumption until 2000–01 and declining to around 21 per cent on average thereafter.

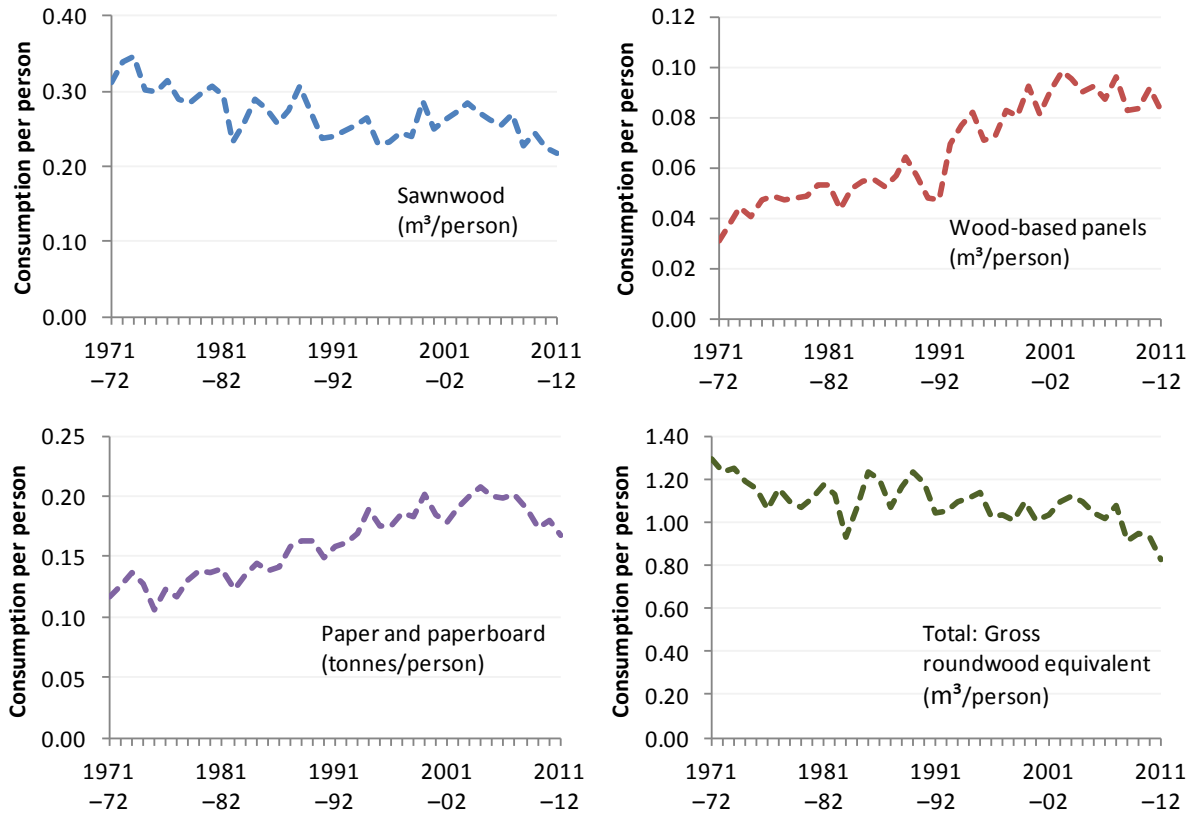
Figure 3 Historical production, consumption and trade of major wood commodities, 1971–72 to 2011–12



Note: Area charts show production of particular components within the broad product categories. Net imports are calculated as total imports minus total exports. Negative values for net imports show periods where exports exceeded imports. Some data for production of particular components within the broad paper and paperboard products category is unavailable for the period between 1971–72 and 1984–85.

While consumption of wood products rose over the 40 years to 2011–12, Figure 4 illustrates that this growth in some cases did not match Australia's population growth. Over that period, the per person consumption of sawnwood products fluctuated as a result of demand factors such as housing construction; however, consumption per person trended downward over the past four decades, falling by around 31 per cent over the period. In contrast, consumption per person of wood-based panel products almost quadrupled between the 1970s and early 2000s, but has since not exhibited significant growth. Consumption per person of paper and paperboard products has increased steadily throughout most of the historical period but has declined in recent years. As discussed later in the report (Consumption of wood products, chapter 4), these historical trends are important for forecasting potential future changes to consumption of wood products. These graphs do not capture trends in individual components of these broad commodities, which may exhibit significantly different trends.

Figure 4 Consumption per person of major wood commodities and gross roundwood equivalent consumption, 1971–72 to 2011–12



The gross roundwood equivalent of log consumption (log-equivalent consumption) is a measure of the volume of logs required to produce the wood products consumed, taking into account the potential to use residue and recycled products in the manufacture of some products such as wood-based panels and paper and paperboard. Figure 4 also indicates that this has exhibited a downward trend over the past four decades. Each person in Australia consumed on average around 1.3 cubic metres of log-equivalent in 1971–72, compared to around 0.8 cubic metres of log-equivalent per person in 2011–12. This reflects both a trend away from solid wood products such as sawnwood towards wood-based panels and an increase in the recovery of paper over the 40 years to 2011–12.

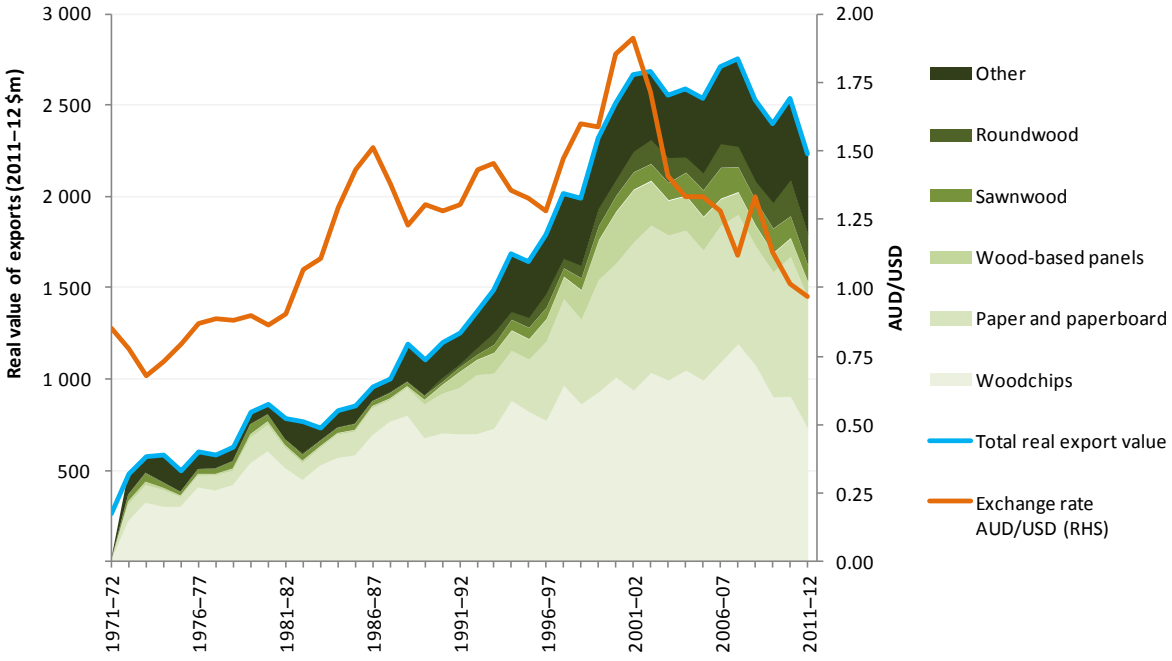
Wood products exports

Total wood products exports from Australia increased significantly between 1971–72 and 2001–02, with the total real value of exports increasing almost ninefold over this period (Figure 5). While woodchips have been the dominant component of export of Australian wood products since the 1970s, the fastest growth (in terms of real value) was in wood-based panels, followed by paper and paperboard. This corresponded to a depreciation of the Australian dollar against the US dollar from A$0.85 per US dollar in 1971–72 to A$1.91 per US dollar in 2001–02 (Figure 5).

From 2001–02 to 2008–09 Australia's wood products exports remained consistently above $2.5 billion (2011–12 Australian dollars), before declining in recent years. The real value of wood products exports declined by 16 per cent between 2001–02 and 2011–12, with falls across all the major commodity groups (sawnwood, panels, paper and woodchips). In contrast to the first three decades in Figure 5, the final decade corresponded to a significant appreciation of the Australian dollar, from A$1.91 per US dollar 2001–02 to A$0.97 in 2011–12.

While there is an apparent correlation between the exchange rate and Australia's wood products exports in some years, a number of other factors have affected exports over time. For example, after 2001 Australia's log availability shifted away from native forests, with corresponding changes in the types of logs harvested and processed domestically. Also, the decline in forestry exports after 2007–08 correlates with the global financial crisis. Hence, it is likely that a range of factors, including the exchange rate, have influenced the observed changes in domestic wood products output and trade.

Figure 5 Historical wood products exports and Australia's exchange rate, 1971–72 to 2011–12

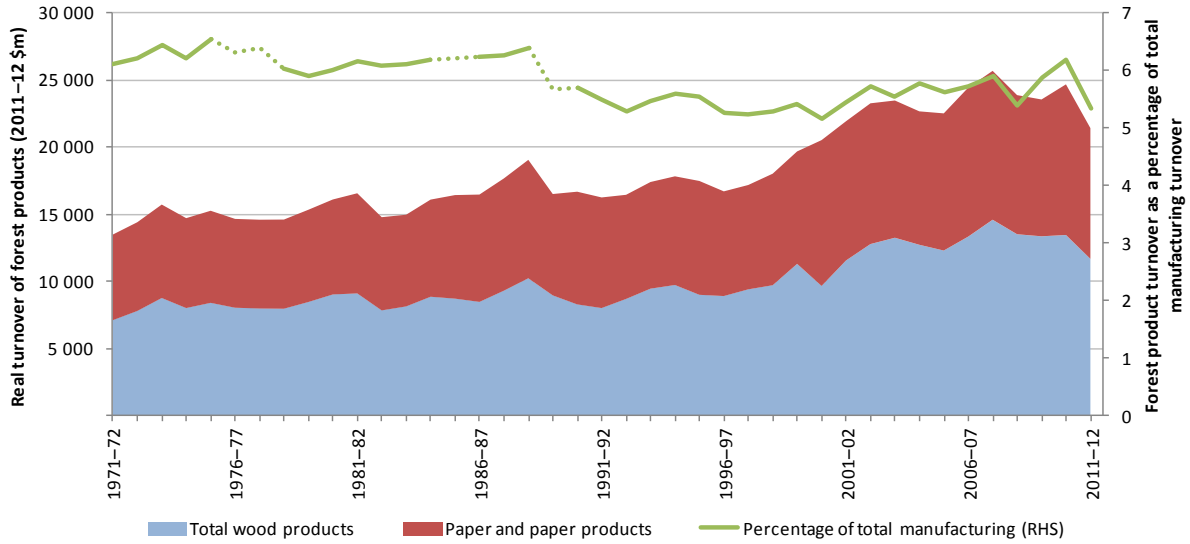


Note: **AUD** Australian dollar. **USD** US dollar. **RHS** Right hand side. Components of wood product exports not available for 1971–72.

Forestry sector turnover and employment

Turnover in the wood products and paper product manufacturing sectors was relatively stable over the 40 years to 2011–12, with slightly higher growth over the past decade. The forestry sector's share of Australia's total manufacturing turnover averaged above 6 per cent until around 1988–89, after which the average dropped to around 5.5 per cent (Figure 6). This contribution reached a low of 5.16 per cent in 2000–01, subsequent to the RFA processes. While the contribution of the forestry sector to total manufacturing turnover moved above 6 per cent in 2010–11, the value of turnover in these sectors has fluctuated in recent years in response to changes in domestic demand and log harvest.

Figure 6 Forest products turnover, 1971–72 to 2011–12



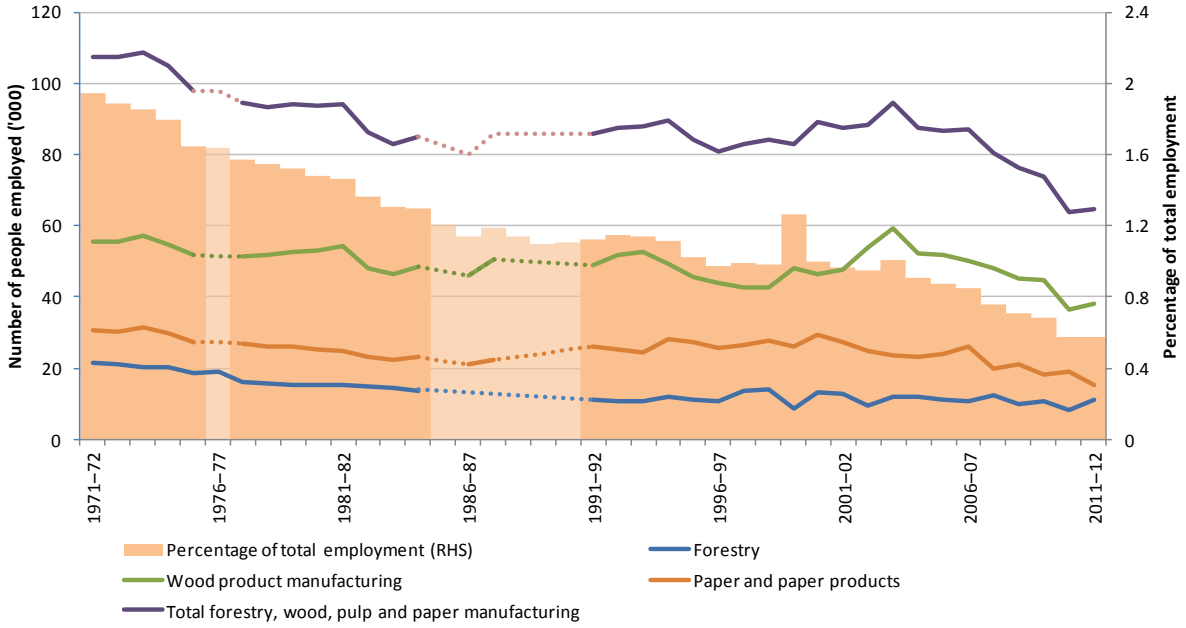
Note: **RHS** Right hand side. Note: ABARES estimated values for 1976–78, 1985–86 and 1989–90.

In contrast to turnover, employment in Australia's forestry sector (based on the Australian Bureau of Statistics Labour Force survey) has declined over the 40 years to 2011–12 (Figure 7). Total employment in the forestry sector fell by 40 per cent between 1971–72 and 2011–12, and the contribution of the forestry sector to Australia's total employment declined from 1.9 per cent in 1971–72 to 0.58 per cent in 2011–12. The largest decline in forestry sector employment was in the paper and paperboard manufacturing sector, which fell by around 51 per between 1971–72 and 2011–12. Total forest and wood product sector employment was relatively stable between 1991–92 and 2006–07, and averaged around 87 000. However, from 2007–08 onwards total employment in the forestry sector declined, driven by corresponding falls in employment in the wood product and paper product manufacturing sectors. Australia's forestry sector also contributes to employment in other sectors of the economy such as transport and wholesaling, which are not represented in Figure 7.

In 2011 total direct employment in the forestry sector was estimated at 73 267 people (based on the Australian Bureau of Statistics census), down from 85 254 people in 2006. This decline in employment was largely in full-time direct employment in the forestry sector, which fell by 14.3 per cent between 2006 and 2011, from 69 930 to 59 896 employees. Total part-time employment in the forestry sector also fell over the same period but by a smaller percentage (8 per cent), from 11 116 to 10 198 people. These employment numbers for the forestry sector include the forestry and logging, wood products manufacturing, pulp, paper and paper product manufacturing, timber wholesaling and forestry support services subsectors. This is broader

than the modelled employment presented in the results of the report, which include only log harvesting, transport and primary wood processing (including paper).

Figure 7 Forestry sector employment, 1971–72 to 2011–12



Note: **RHS** Right hand side. ABARES estimated values for 1976–77 and 1985–86 to 1990–91.

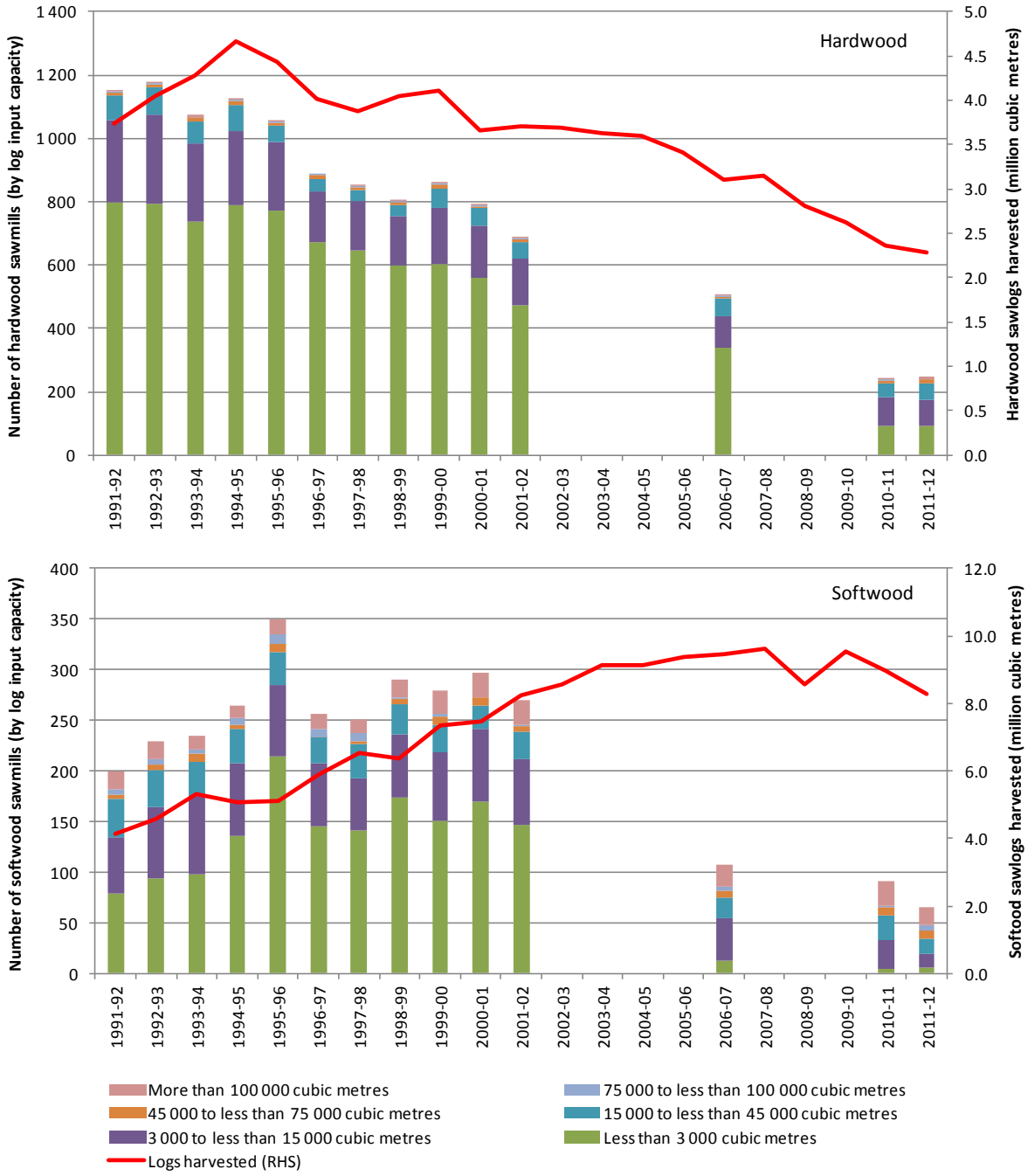
Recent trends in sawnwood processing

Over the decade to 2011–12, Australia's forestry sector changed substantially. Managed investment schemes, which were the largest source of new plantation investment between 1997 and 2009, declined after the global financial crisis. New plantation establishment has also virtually ceased in Australia since 2009.

Other changes in the sector include closures of major sawmills, panel mills, paper mills and wood pellet mills. The number of sawmills processing logs in Australia has declined significantly over the past two decades (Figure 8). The total number of sawmills in 2011–12 is estimated to have declined by 77 per cent since 1991–92, from 1 348 in 1991–92 to only 313 sawmills in 2011–12. This decline has been significant for both hardwood mills and softwood mills, with small-scale wood processors experiencing the most dramatic declines. Over the same period the volume of hardwood sawlogs harvested has declined by 40 per cent, while the volume of softwood sawlogs harvested has doubled. The restructuring of Australia's hardwood sawmilling sector over the past two decades has resulted in a large contraction of the sector. In contrast, the rationalisation in softwood sawmilling has led to a smaller number of larger processors and the volume of logs processed by these mills has increased over the same period.

New investments in wood processing in Australia include the recently commissioned softwood sawmill in Bombala and the Ta Ann veneer mill in Tasmania. At the same time, some proposed investments have not eventuated, such as the Gunns pulp mill and the Penola pulp mill.

Figure 8 Number of sawmills by type and log harvest trends, 1991–92 to 2011–12



Note: **RHS** Right hand side. Data to 2001–02 collected from state forest services records. From 2006–07 sawmill numbers are based on ABARES wood processing surveys and ABARES infrastructure database. Excludes cypress pine sawmills.

2 Global outlook and trends in international markets

For this analysis, ABARES has drawn on outlook studies undertaken by international research bodies that examine major global trends likely to affect forests and wood products markets over the long term. The qualitative commodity outlooks discussed in this chapter draw on these global analyses.

The outlook for consumption and trade of wood products in Australia is influenced by world trade, prices and economic drivers in other countries. China's rapid economic growth has affected the forestry sectors of the Asia-Pacific region and the United States through demand for raw materials and exports of processed wood products (Katsigris and colleagues 2004). Over the decade to 2011–12, investment in South America led to rapid expansion in pulp mill capacity and in the availability of hardwood pulp fibre used for production of paper and paperboard products. Economic growth in developing countries may lead to increased demand for wood products in regions such as Asia and Latin America.

In addition to trade and economic drivers, climate change and associated policies may have an impact on global forestry. Buongiorno and colleagues (2012) use the Global Forest Products Model to examine global and regional forest economy parameters, such as forest area, inventory, prices, consumption and trade, under the Intergovernmental Panel on Climate Change (IPCC) climate change scenarios. While these issues guided the development of price projections and outlook scenarios, this report does not explicitly consider climate change impacts.

The 2011 United Nations Economic Commission for Europe (United Nations 2011) report on the outlook for the European forestry sector explores a range of policy issues, including climate change and renewable energy supply. In the commission's reference scenario (similar to the business-as-usual scenario described in this report), consumption of wood products and wood energy is forecast to grow steadily, with wood supply expected to grow to meet this demand. Overall, the commission's report (2011) suggests that Europe will remain a net exporter of wood and forest products in all scenarios. The policy issues discussed in the commission's report played a role in the development of the three outlook scenarios for this ABARES report.

Aside from its role in woodchip markets, Australia plays a relatively small role in internationally traded wood products and it will be affected by the major supply and demand trends in global markets and the outlook for world prices. Some of the price assumptions described in the following section are based on the Buongiorno and United Nations outlook studies but use projection periods that extend to 2060. A per annum equivalent price was derived and used for this report. A summary of the assumed long-term growth in wood products prices is presented in Table 7, chapter 4.

Sawnwood

Supply of sawnwood is influenced by availability of wood fibre inputs, international prices and costs of production. Demand for sawnwood is generally driven by the housing market, although furniture manufacturing is also a significant market for sawnwood. The global sawnwood market has been weak in recent years, with decreased demand in the United States and Europe following the global financial crisis (GFC). It is expected that these markets will continue to recover and the strength of global long-term sawnwood demand will largely be influenced by economic and population growth in developing countries and concomitant rates of housing

construction. Over the long term, the US economy is assumed to return to sustainable economic growth and US population is projected to expand to 398 million by 2050, stimulating activity in the US housing market. Demand for sawnwood products in housing and furniture is expected to expand because urbanisation is likely to continue in China and world population is projected to increase to around 9 billion people by 2050.

This potential demand growth may lead to a corresponding rise in sawnwood prices—particularly where future availability of logs suitable for sawmilling may be constrained. For example, increasing pressure to sustainably manage and protect native forests and to limit the expansion of timber plantations may affect the availability and growth of sawlogs volume over time. Potential price increases may be tempered by increased availability and use of substitutes for sawnwood, such as wood-based panels and engineered wood products.

Softwood sawnwood

Softwood sawnwood production is well established in North America and Europe, where producers have access to large volumes of softwood fibre supply, mostly from natural forests (see glossary). Supply of softwood sawnwood in Europe will be further supported in the near future as the Russian Federation decreases sawlog export tariffs (European Parliament 2012). This may reduce production costs for mills in Europe because the Russian Federation is the European Union's largest supplier of imported wood. Production in the United States remains below capacity and is unlikely to reach pre-GFC levels in the future because of the loss of secondary service providers (WRI 2012). Hence, US demand for softwood sawnwood may be met by increasing imports over time.

Demand for softwood sawnwood is largely influenced by housing activity. While the United States has historically been one of the largest softwood sawnwood consumers in the world, demand has fallen below historical trends because of a reduced number of housing starts following the GFC. The recent recovery in housing experienced since 2010 is expected to continue in the short term (RISI 2012c). A long-term recovery in the US housing market may be driven by growth in population.

Consumption of softwood sawnwood continues to expand in China and Japan. Estimates suggest that growth in Chinese sawnwood demand will continue to increase over the next 20 years (RISI 2012c). This may partly be a result of increased urbanisation and the Chinese Government's commitment to ensuring increased availability of affordable housing (BRITCHAM/CBBC 2011).

Globally, the Food and Agriculture Organization of the United Nations (FAO) forecasts suggest softwood sawnwood consumption will continue to grow to 2030, particularly in Asia, North America and Europe (Jonsson & Whiteman 2008).

Hardwood sawnwood

Hardwood sawnwood production is well established in Asia and the United States. In Asia, mills have access to large volumes of hardwood fibre supply, particularly tropical hardwoods, which are high-value products used for furniture and decorative purposes. Recently, international focus on sustainability and legality of log harvest and timber products has increased, as evidenced by recent developments of the US Lacey Act, EU timber regulations and various third-party timber legality verification schemes.

In Australia, native forest logging regulations have led to a rationalisation of the hardwood sawmilling sector and prompted plans to increase the availability of hardwood sawlogs from

plantation forests. Some technical issues associated with the use of plantation hardwood sawlogs in Australian sawmills (Harwood 2010) may be overcome in the long term, with changes to costs of production and the recovery rate of sawnwood products. Concerns may arise about the economic feasibility of hardwood plantation sawlogs if long growth periods are required to produce them.

Hardwood sawnwood is primarily used for flooring, decking, joinery, mouldings, pallets and furniture in Australia (Standards Australia 1999). Global consumption of hardwood sawnwood has been slow in recovering from the GFC as weakness in EU economies has undermined economic confidence in Europe and recovery of the US housing sector has been sluggish (United Nations 2012a). While hardwood oak species account for the dominant share of consumption in European flooring and joinery sectors, consumption of tropical hardwood species has fallen (United Nations 2012a), reflecting recent environmental and sustainability concerns. China is the largest consumer of hardwood sawnwood, primarily for furniture production (RISI 2011). Overall, FAO forecasts suggest hardwood sawnwood consumption will increase to 2030, particularly in North America and Asia (Jonsson & Whiteman 2008).

Substitute products

While technological advances have improved the structural reliability and lowered production costs of wood-based panels, an increasing number of engineered wood products can be used as substitutes for sawnwood. These products can be manufactured using low-grade logs and sawmill residue (Thoemen, Irle & Sernek 2010) and in many cases offer a cheaper alternative to sawnwood. Wood-based panels are a relatively mature product, having gained popularity in the 1980s (Shutt 2006). Continued steady consumption growth of these products may adversely affect future sawnwood consumption. High quality sawlogs—particularly hardwood sawlogs—may face supply constraints in the future. The potential to utilise lower grade logs to produce high-value appearance and structural wood products may lead to increasing substitution of wood-based panels over time. Sawnwood (and panels) will also face competition from non-wood materials such as aluminium, steel, concrete and plastics.

Outlook for prices

The global outlook for sawnwood consumption suggests an increase in demand, particularly in Asia and North America, driven by population growth and urbanisation in developing countries. This may lead to a corresponding rise in prices. As environmental concerns increase, the availability of particular types of timbers—such as high-value tropical timbers—may be limited, which could positively influence prices. However, these factors are tempered by increased availability and use of substitute products. In the B2 scenario (representing intermediate economic and population growth assumptions) presented in Buongiorno and colleagues (2012), the real world price of sawnwood is estimated to increase by around 9 per cent in 2060 relative to 2006, or around 0.16 per cent a year.

Wood-based panels and engineered wood products

The major grades of wood-based panels and engineered wood products used in Australia are particleboard, fibreboard (including medium-density fibreboard and hardboard), plywood and laminated veneer lumber. Some additional engineered wood products have significant potential for market penetration in the future. Supply of panel products is driven by price, availability of wood fibre and costs of production (RISI 2007; United Nations 2012b). Panels are primarily used for structural and decorative purposes so demand is generally influenced by housing activity.

At present, global market conditions are weak as a result of low demand in Europe and North America following the GFC. These markets are expected to improve over time. Long-term demand for panel products will depend on economic and population growth in developed economies and competitiveness in housing and furniture markets (Gupta and colleagues 2013). However, demand is also influenced by consumption of substitutes such as other wood products (sawnwood) and non-wood products (including plasterboard, cement and metal) (Allday 2012).

An assessment of global markets suggests future growth in demand for boards (fibreboard and particleboard) and limited supply constraints relative to other wood products. In contrast, plywood products are a mature technology and face competition from emerging substitutes.

Particleboard and fibreboard

Particleboard and fibreboard (boards) are mature products with established uses and rates of market adoption (Spelter 2000). They are primarily used in housing for non-structural internal applications such as benches, shelving and furniture. While processing capacity for board products has been established in Europe and North America for many decades, significant investment in East Asia has occurred over the decade to 2011–12. In China, production of these products is reliant on imported fibre, so securing sustainable future supply of wood fibre may place upward pressure on wood costs over time (RISI 2007). FAO forecasts suggest substantial growth in particleboard production across all major regions and growth in production of fibreboard in Asia to 2030 (Jonsson & Whiteman 2008).

Boards have relatively low costs of production because they can use a wide range of low quality log types and have well established markets. Therefore these products are expected to maintain competitiveness against other wood products. However, the future availability of wood fibre may have implications for costs of production. For example, mills producing boards must compete for logs with other wood processors. The UNECE (United Nations 2012b) study found that production of boards was significantly curtailed in scenarios with high production of wood bioenergy. Therefore changes in competition for wood fibres may affect future costs of board production. Availability of wood fibre also faces increasing environmental and sustainability concerns. This may not be a significant issue for boards because pulplogs can be easily sourced from short rotation plantations or certified natural forests in North America or Europe.

Historically, consumption growth of boards has been strong in North America and Europe. These markets are well established and opportunities for new applications may be limited (Spelter 2000). Future consumption growth in these regions will depend on economic and population growth. There is potential for growth in consumption in emerging East Asian economies as these products gain market share, possibly at the expense of other wood products such as sawnwood. In China, consumption has grown strongly as a result of increased market penetration and substantial demand from furniture markets (RISI 2007). Following this trend, consumption is expected to increase in China over the next decade. However, as China's economy develops, the growth rate is likely to decrease. Following the trend in production, the FAO (Jonsson & Whiteman 2008) forecasts particleboard consumption will increase strongly in most regions, while fibreboard consumption will primarily increase in Asia with modest growth in Europe and North America to 2030.

These factors suggest future growth in consumption and production of boards, tempered by limited opportunities for new applications in developed countries. However, growth is expected in emerging economies such as China. Production of boards is expected to remain cost competitive relative to other wood products but will compete for log inputs with other wood processing sectors, which may increasingly include bioenergy. Overall, these trends suggest an increase in the future world price of particleboard and fibreboard.

In the B2 scenario in Buongiorno and colleagues (2012), the real world price of particleboard is forecast to increase by around 19 per cent in 2060 relative to 2006, or around 0.32 per cent a year. The real world price of fibreboard is forecast to increase by around 5 per cent relative to 2006, or around 0.09 per cent a year.

Plywood and veneer

The wide range of plywood product types are used internally and externally for structural and decorative purposes. Plywood products are manufactured from veneers, either from slicing sawlog-quality logs or peeling lower grade logs. Factors such as quality, species and the type of glue used to bond the veneers have implications for the use and value of the final product. High quality products are used for exterior and decorative applications. Increasing the thickness of low quality plywood can make a product more suitable for structural applications.

The supply of these products depends on the availability of veneer and peeler logs, as well as costs of production (RISI 2007). While softwood veneer logs can be sustainably supplied from Europe and North America, the supply of high quality hardwood veneer logs may be constrained over time because of limited sustainable supply and environmental concerns associated with harvesting tropical hardwood forests. Low quality veneers may not face the same supply constraints because these products can use lower quality logs from shorter rotation forests. As with other wood-based panels, production of plywood may also need to compete for wood fibres with bioenergy in the long term (United Nations 2012b). These issues of sustainability of supply and competition for wood fibres may increase the price of these log inputs, thereby increasing costs of production of plywood and veneer over time. Globally, the FAO forecasts plywood production will grow strongly in Asia and increase moderately in Europe and Latin America to 2030.

Plywood products are a mature technology and are likely to have achieved maximum market penetration in developed economies (Spelter 2000). However, there is potential for growth in some Asian economies because plywood offers an alternative to sawnwood in housing and furniture markets. The FAO forecasts substantial growth of plywood consumption in Asia and limited growth in Europe and Latin America (Jonsson & Whiteman 2008).

For this analysis, based on the B2 scenario in Buongiorno and colleagues (2012), ABARES has assumed aggregate prices for plywood and veneer will remain stable over time, with a marginal decrease of around 1 per cent in 2060 relative to 2006, or around 0.02 per cent a year. Supply constraints may lead to increased prices for high quality appearance-grade plywood products, while prices may decrease for structural plywood products as a result of mature markets and competition from emerging technologies.

Emerging technologies

Engineered wood products are emerging technologies with potential for applications in new markets such as high-rise building construction. Research into these technologies may also enable use of a broader range of tree species in the manufacture of these products relative to existing technologies.

A number of engineered wood products are already established in developed economies. For example, laminated veneer lumber and I-beams are structural products that compete with sawnwood and other panel products in North America and Australasia (Neufeld 2005). Oriented strandboard is a structural product prevalent in North America, with potential to expand in Asian markets. More recently, cross-laminated timber has emerged as a product with a wide range of technical applications, extending into commercial and multistorey building construction.

Many of these products are in early stages of their life cycle. They have significant potential for rapid market penetration and consumption growth in both developed and developing countries in future decades (Spelter 2000). Technological developments can improve the structural qualities of these products, potentially expanding their market access and reducing production costs. These products can also utilise a range of log types and qualities and are unlikely to face supply restrictions because of environmental concerns. Based on these factors and the substantial potential for increase in demand, prices of many of these products are expected to increase over time. With the exception of laminated veneer lumber (LVL) products, ABARES has not modelled these products in this report because many of the prices and cost parameters are not available for Australia. For LVL products, it was assumed that the technology only makes use of softwood fibre. Future technological developments that could include the use of hardwood fibre are not examined in this report.

Another emerging technology is wood thermoplastic composites (WPC) made from wood particulates or short wood fibres. WPC can incorporate a high proportion of plastic, sometimes greater than 70 per cent (Carus, Gahle & Korte 2008). Major markets for WPC are in building construction (Caulfield, Clemons & Rowell 2010), with emerging markets in maritime, automotive and aerospace applications (Clark and colleagues 2012). The long-term prospects for WPC are promising and may be investigated in future research.

Paper and paperboard

Four major categories of paper and paperboard products are analysed in this study: newsprint; printing and writing; packaging and industrial; and household and sanitary. Generally, supply of paper products is driven by availability of pulp and costs of production. Paper products have a wide range of end uses and several demand drivers account for changes in consumption trends (Gupta and colleagues 2013).

Global demand for paper products has remained reasonably stable in recent years by balancing decreased demand in Western Europe and North America with increased demand in Asian markets. Higher incomes in emerging economies and growth in manufacturing sectors may contribute to future demand. However, development and increased use of electronic devices may encourage some consumers to use these alternatives instead of paper grades used for communication purposes.

Newsprint

The primary use for newsprint is in the newspaper industry and thus the demand for newsprint is closely linked with newspaper advertising.

Production of newsprint in North America has decreased dramatically since 2006 and the majority of newsprint production currently occurs in Asia and Western Europe. Future investment in newsprint capacity is likely to remain stagnant because of changes in consumer preference towards electronic media and electronic devices (Flynn 2011).

Consumption of newsprint, particularly in North America and Western Europe, has fallen in recent years as consumers have increasingly switched over to use of electronic devices. This trend is expected to continue in the long term, leading to reduced demand for newspapers and hence newsprint. Despite a global downward trend, consumption of newsprint has increased in Asia and Eastern Europe. Nevertheless, although newspaper consumption is expected to increase in emerging economies, these countries are not likely to follow the consumption paths of developed nations as a result of the adoption of electronic devices.

Overall, these trends suggest a decrease in demand for newsprint, which may lead to a decrease in the world price for newsprint. However, this trend is in part offset by demand from emerging economies. In the long term, in the B2 scenario in Buongiorno and colleagues (2012), the real world price of newsprint is forecast to decrease by around 19 per cent by 2060 relative to 2006, or around 0.32 per cent a year.

Printing and writing

Printing and writing paper is generally used in books, magazines and catalogues. In 2011 Asia produced around 44 per cent of global printing and writing paper, with more than half produced in China. Slowing growth in consumption may limit future investment, thereby decelerating the expansion path for production in Asia. Production in Western Europe and North America has decreased in recent years (RISI 2012a). In comparison, production in China has increased by over 30 per cent.

Supply of printing and writing paper relies on the availability of hardwood pulp fibre. Over the decade to 2011–12, investment in hardwood plantations in South America led to rapid expansion in pulp mill capacity. In the next 10 years, South America could theoretically add another 30 million tonnes to pulp mill capacity based on already announced projects (United Nations 2012a). Access to this fast-growing hardwood fibre will contribute to lower operating costs for South American pulp mills (Highbeam Business 2013). Recent investment will also lead to increased pulp production capacity and timber plantations in Indonesia over the next few years (Obidzinski & Dermawan 2012).

While consumption of printing and writing paper has grown in Asia, driven by consumer income and population growth, it has declined in developed countries such as the United States, United Kingdom, Japan, Sweden and France (RISI 2012a), leading to slowing growth in global consumption. The overall implications of the increased use of electronic devices on the demand for printing and writing paper are ambiguous because of conflicting effects. For example, reading electronic editions of books and magazines may reduce paper demand; however, this may be counterbalanced by the positive effect of having greater access to information and the convenience of printing such information (Lei 2007). Nevertheless, it is assumed in this report that, over the long term, technological development will slow growth in printing and writing paper consumption.

Based on these factors, ABARES assumes that the real world price of printing and writing paper will remain stable to 2050 relative to the price in 2011–12.

Packaging and industrial

Packaging and industrial paper is a thicker grade of paper generally used for wrapping or storage purposes and consumed primarily by retail and industrial sectors. Supply of this grade of paper is influenced by availability of pulp and recycled paper. Packaging and industrial paper can be manufactured using a diverse range of different pulp input types (chemical, mechanical and recycled pulp). The strength of softwood pulp is desirable for production of packaging paper. However, sustainability, environmental and economic factors have led to increased use of recycled fibres in production. As a result, global availability of, and demand for, recycled paper has increased substantially.

Softwood forests provide most of the virgin fibre input for packaging and industrial paper. Both in Australia and overseas there is limited scope for expansion of softwood pulplog supply, as much of the investment in new timber forests has been in hardwood plantations (New Forests 2013). The largest producer of packaging and industrial paper is China, followed closely by the

United States. China's domestic production has increased by over 40 per cent in the past five years. However, the trend in future production may depend on imported softwood fibre.

Asia and North America, particularly China and the United States, are the largest consumers of packaging and industrial paper. Consumption in China increased substantially in the decade to 2011–12, while consumption decreased in developed nations, including the United States and Japan (RISI 2012a). As with other wood and paper products, growth in global consumption of packaging paper will be underpinned by increasing disposable incomes and economic growth, particularly in developing countries. Additionally, demand for packaging materials will be driven by stronger manufacturing output in developing countries and international commodity trade. These factors are tempered by availability and consumer preference for some substitute products such as plastics.

Overall trends in factors affecting supply suggest production of packaging and industrial paper will remain stable in the future. Minimal changes are expected in global softwood forest plantation areas. Decreased use of softwood fibre in packaging and industrial paper production is expected to be balanced by increased use of recycled paper. Demand for this grade of paper is likely to increase, driven by consumer income and growth of manufacturing sectors in developing countries. Based on these trends, ABARES assumes that the real world price of packaging and industrial paper will increase by 15 per cent by 2050 relative to 2013, or around 0.38 per cent a year.

Household and sanitary

Household and sanitary paper is primarily a lightweight tissue used for household purposes and personal hygiene. Although softwood pulp is used in the production process, this grade of paper can also be manufactured using 100 per cent recycled fibres. China and the United States are the largest producers of household and sanitary paper products. World production has risen consistently over the past two decades, driven by growth in demand. Because of the nature of the product, few competitive substitute products exist and it is unlikely prices will have a significant impact on consumption (Edquist and Morris 1986).

Consumption of household and sanitary paper is influenced by household income and population growth. The United States is the largest consumer of this grade of paper. While China is the second-largest consumer, the annual per person consumption in China is only 3.9 kilograms (Flynn 2012). This is below the world average and well below per person consumption in developed countries, representing significant future market potential. Over the decade 2011–12, consumption in developing regions (such as Latin America and particularly in Asia) increased substantially, driven by macroeconomic growth.

These trends suggest demand for household and sanitary paper will continue to increase, particularly in developing regions, leading to further investment and growth in production. Further, consumption is relatively price inelastic and limited substitutes are available for this grade of paper. Based on these factors, ABARES assumes that the real world price of household and sanitary paper will increase by 20 per cent by 2050 relative to 2013, or around 0.49 per cent a year.

Pulp

Globally, four broad types of pulp are available: chemical, mechanical, recycled and non-wood. This report does not examine non-wood pulp. Pulp is the primary input in the making of paper and paperboard. North America is the largest consumer of wood pulp, primarily consuming

chemical pulp (RISI 2012a). Production of chemical and mechanical pulp is mainly driven by the availability of pulpwood and wood residues, which are converted to woodchips before being manufactured into pulp. The price of woodchips is hence a significant material cost for the industry (Stephen 2012).

Paper industries in developing countries continue to grow rapidly and provide a source of demand for wood pulp. China imports around 22 per cent of the world's total supply of pulp because of limited domestic availability. India's domestic supply of raw fibre inputs for paper manufacturing is also limited, which drives demand for imported pulp (Stephen 2012). As the consumption and production of some grades of paper and paperboard are expected to increase, the derived demand for wood pulp will also increase.

Chemical pulp

Chemical pulp is largely used for manufacturing packaging and industrial paper and printing and writing paper (PPISG 2009). The chemical pulping process has a relatively low yield from wood inputs and tends to have higher costs than other pulping methods. However, this type of pulp produces higher quality and stronger paper. The energy costs of producing chemical pulp can be reduced by burning the by-product removed during the pulping process.

Globally, chemical pulp accounts for the majority of total wood pulp production (RISI 2012a). Over the past few years, investment has occurred in chemical market pulp capacity in Brazil, Chile and Uruguay. Over the next 10 years, South American chemical market pulp capacity could theoretically add another 30 million tonnes based on already announced projects (United Nations 2012a).

Mechanical pulp

Mechanical pulp is mainly used to produce newsprint and for publication grades of printing and writing paper (PPISG 2009). It is an efficient process with a much higher yield and lower use of water than chemical pulping. However, mechanical pulp is usually used to produce lower grade papers and is more energy intensive.

Mechanical pulp accounts for a relatively small proportion of global wood pulp production (RISI 2012a). In recent years, investment has primarily been in chemical pulp because the process yields a higher grade of paper that meets increasing demand in developing countries.

Hardwood and softwood: uses and supply of fibre

Hardwood fibres are especially suited for producing smooth papers for printing and writing. They can also achieve good stiffness and bulk depending on the tree species and pulp refining conditions. Hardwood pulps tend to produce paper products with more uniform formation than softwood fibres (Hubbe 2013).

Softwood fibres have high tearing strength, can withstand multiple folding and have a range of other strength-related properties. Pulp made from softwood fibre is used to produce corrugated containers and bag grade papers. It is also used for printing papers because of the reinforcing ability it offers (Hubbe 2013).

While hardwood and softwood fibres have very different characteristics and are suited to production of particular grades of paper, their uses are complementary. For example, while the production of writing paper primarily uses hardwood pulp for its smooth, uniform qualities, it also uses a small amount of softwood pulp for its strength qualities. Similarly, while softwood

pulp is the primary component in the production of corrugated containers (made from paperboard), the interior of the box is made from hardwood pulp because it has good stiffness qualities (Hubbe 2013).

Over the past few years, most of the investment in availability of wood fibre has been in hardwood plantations—particularly in Latin America and Asia. Fast-growing hardwood fibre is desirable as it offers reduced production costs and higher quality paper. In contrast, expansion of softwood fibre availability has limited potential. This suggests pulp mills will have a stable supply of hardwood woodchips but limited supply of softwood woodchips in the future.

Outlook for prices of hardwood and softwood pulp and mechanical pulp

Overall, these trends suggest that demand for hardwood pulp is likely to be high in the future as a result of competitive prices for hardwood pulpwood and its use in manufacturing high quality paper. Demand for hardwood pulp is likely to be particularly high in Asia, where the majority of global investment in paper manufacturing capacity has occurred. Growth in hardwood pulp output will in turn be supported by the increased availability of lower cost hardwood fibre from recent investments in hardwood plantations in Latin America and Asia. As a result of these balancing supply and demand factors, ABARES assumes that the real world price of hardwood pulp will remain stable to 2050 relative to the price in 2011–12.

The strength qualities offered by softwood fibres make it particularly suitable for production of packaging-grade paper, the demand for which is expected to increase in developing countries over the short and long terms. Limited supply of logs from softwood forests is likely to lead to upward pressure on softwood fibre prices, tempered by the potential to substitute with recycled fibre. Reflecting this, ABARES assumes that the real world price of softwood pulp will increase by 10 per cent in 2050 relative to 2013, or around 0.26 per cent a year.

Mechanical pulp can use both hardwood and softwood fibres but produces lower quality paper than chemical pulp, and has not been the focus of significant investment in pulp capacity in Latin America and Asia. Together with lower assumed demand for newsprint, these factors suggest a weaker market for mechanical pulp in the future. Hence, ABARES assumes that the real world price of mechanical pulp will decrease by 20 per cent by 2050 relative to 2013, or around 0.49 per cent a year.

Recycled pulp or recovered paper

Recycled pulp uses mechanical or chemical pulping techniques with recovered paper inputs instead of woodchips or logs. Recycled pulp is usually blended with virgin fibre (such as woodchips or logs) to improve paper quality (PPISG 2009).

World recovered paper demand has grown by around 45 per cent in the past 10 years (RISI 2012e). This is possibly because of growing environmental and sustainability concerns. Companies are aiming to minimise the environmental impact of their production and seeking to use recycled and biodegradable materials. This is evidence of a change in consumer preferences to encompass environmental externalities (Allday 2013). Demand is also expected to be particularly strong in fibre-poor developing countries such as China and India.

Over the past two decades, production of recovered paper has increased in countries such as the United States, Japan, Germany and Australia. China in particular has substantially increased production in the past six years (RISI 2012a). Based on these factors, ABARES assumes that supply of recovered paper will meet demand and prices will remain stable to 2050.

Woodchips

Woodchips are produced from hardwood and softwood pulpwood and sawmill residues. In Australia they are primarily exported or used for domestic pulp, paper and paperboard manufacturing, although they also have applications in some wood-based panel and bioenergy production processes.

Increasing environmental and sustainability concerns in recent years have led to globally reduced demand for woodchips sourced from native forests. Hardwood plantation forests in Asia and Latin America will provide an important source for future supply of hardwood woodchips. Demand from China and other emerging economies is likely to rise in the future, driven by increased production of printing and packaging paper.

Hardwood woodchips

Hardwood woodchips are primarily used for production of pulp for printing and writing paper. Japan is one of the largest consumers and importers of hardwood woodchips, with large-scale paper manufacturing operations. Demand from Japan has decreased in recent years. In contrast, demand from China has strongly increased, driven by growth in its paper industry (RISI 2012d).

Hardwood woodchips can be sourced from native and plantation forests. A range of market factors, including the uniform quality of plantation woodchips and concerns in export markets about the sustainability of native forest woodchips, has led to lower demand and market prices for native forest hardwood woodchips relative to plantation woodchips.

Based on these factors combined with increased competition from hardwood plantation forests in Chile, Vietnam and Indonesia, ABARES assumes that the real world price of hardwood woodchips sourced from native forests will decrease by 25 per cent by 2050 relative to 2013, or around 0.61 per cent a year.

While Japan has reduced imports of hardwood woodchips sourced from native forests in Australia in recent years, it has increased imports sourced from plantation forests in other countries, such as Chile. Japanese demand for hardwood woodchips is expected to trend downwards as a result of increased use of recovered paper and reduced pulp production. Production of pulp has fallen in the past five years and RISI is forecasting a further decline over the next five years (RISI 2012d).

This is counterbalanced by Chinese demand for hardwood woodchips, which has been increasing rapidly in recent years, driven by growth in production of printing and writing paper. South-East Asia has been the dominant supplier for China, partly because of proximity (RISI 2012d); however, supply from hardwood plantations is likely to increase from Latin America and Asia – particularly in Chile and Vietnam. As consumption and production of paper continues to grow in Asia, it is expected that demand for hardwood plantation woodchips will remain strong.

Overall, higher demand for hardwood plantation woodchips in China and other emerging countries in Asia is likely to be counterbalanced by increased supply from hardwood plantations in Latin America and South-East Asia. Based on these factors, ABARES assumes that the real world price of hardwood woodchips sourced from plantation forests will remain stable to 2050 relative to the price in 2011–12.

Softwood woodchips

Softwood woodchips are primarily used for production of packaging and industrial paper. In addition to being influenced by demand for this grade of paper, supply of softwood woodchips can also be affected by factors that affect the sawmilling sector, such as weakness in housing markets. For example, weak housing markets can reduce domestic processing of logs and hence the production of residual woodchips from sawmills. Australia is one of the largest softwood chip suppliers in the world (RISI 2012d).

Historically, Japan has been a leading importer of softwood woodchips. However, in recent years, Japanese demand for imported softwood woodchips has reduced. In 2012, softwood woodchips represented less than 5 per cent of China's total woodchip imports (RISI 2012d). However, China is the largest producer of packaging and industrial paper and may increase imports of softwood woodchips to support future growth in paper production. Further, as noted previously, consumption of packaging paper in developing countries will continue to increase and may drive demand for softwood woodchips.

In terms of supply, most of the growth in plantation area in the world is in hardwood forests (primarily in Latin America and South-East Asia) and there is unlikely to be any expansion in global supply of logs from softwood forest plantations beyond existing resources.

Overall, decreased demand from Japan may be partially offset by a potential increase in demand from China and emerging economies in Asia, where there is an increase in consumption and production of packaging paper. Supply of softwood fibre is limited and is unlikely to increase, leading to upward pressure on prices. This is tempered by competition from alternative inputs such as recovered paper. Based on these factors, ABARES assumes that the real world price of softwood woodchips will increase by 10 per cent by 2050 relative to 2013, or around 0.26 per cent a year.

3 Description of outlook scenarios

The forestry sector can choose from multiple paths, depending on a range of economic, policy and environmental factors in Australia and internationally. Because of the large number of potential futures facing Australia's forestry sector, and the uncertainty associated with these parameters, ABARES (in consultation with industry and government stakeholders) has developed a discrete set of potential scenarios and sensitivity parameters to model for this report. These scenarios will have implications for the modelling results, such as the outlook for output, employment and investment in the sector. These scenarios are not comprehensive, and alternative outlooks for Australia's forestry sector will exist, based on alternative scenarios and model assumptions.

This section describes the principal assumptions used by ABARES to forecast the long-term demand and supply of wood products in Australia. ABARES has examined a business-as-usual scenario and two alternative scenarios: the priority-to-productivity scenario and the constrained-wood-production scenario. The business-as-usual scenario depicts a future in which current policies are assumed to remain unchanged and current trends to continue. The alternative scenarios use different sets of policy, market and supply assumptions to present two alternative trajectories for the forestry sector. Sensitivity analyses have also been conducted to identify the importance of key parameters on the outlook for Australia's forestry sector. These parameters include the principal factors that will influence the forestry sector's potential to grow or decline over the coming decades.

The outlook scenarios and sensitivity analyses—developed and refined through a series of stakeholder workshops undertaken during March 2013 (Appendix A)—reflect some of the principal issues that will influence the future of the forestry sector. While an array of additional outlook scenarios and sensitivity parameters could have been considered, developing these would require additional consultation, data collection and model development outside the scope of this analysis. Some other factors that could have been considered include international supply and demand and changes to other sectors of the Australian economy. For example, de Fégely and colleagues (2006) undertook modelling with a number of additional assumptions that may affect the future of the forestry sector, including labour supply and energy costs. The methodology developed in this report has the potential to incorporate these and other issues in future research.

Table 2 summarises the key broad forestry, processing and market assumptions made in each of the three scenarios analysed in this report. Table 3 outlines the specific assumptions applied to state-based public and private native forest resource availability for each outlook scenario. The parameters and assumptions used in these scenarios represent the market and policy parameters as at December 2014. As a result of potential market or government policy changes, some of these parameters may have changed by the time this report is published.

Table 2 Parameter assumptions for the three outlook scenarios

Parameter	Business-as-usual scenario assumptions	Priority-to-productivity scenario assumptions	Constrained-wood-production scenario assumptions
Log availability and forest areas	Existing multiple-use native forest areas (including mainland states' Regional Forest Agreements and Tasmanian Forest Agreement 2012) and some reduction in plantation areas	Increased log availability from native and plantation forests, relative to business-as-usual scenario	Decreased log availability from native and plantation forests, relative to business-as-usual scenario
	Forestry codes of practice are the same as current practice	Forestry codes of practice are the same as current practice	Forestry codes of practice have stricter prescriptions than current practice
Wood processing costs and technologies	Current wood processing technologies and costs	Lower processing costs driven by increased research and development	Higher processing costs representing low levels of research and development
Economic and price variables	Range of base assumptions and forecasts using existing ABARES reports, analysis of global trends and other outlook studies	Lower hurdle rates for investment	Higher hurdle rates for investment
		Higher domestic consumption of wood products	Lower domestic consumption of wood products
		No change in wood products prices relative to business-as-usual scenario	Lower prices for native woodchip exports; other prices unchanged from business-as-usual scenario

Note: All market and policy parameters current at December 2014.

Business-as-usual scenario

ABARES has assumed a set of business-as-usual parameters over the outlook period to 2050. These long-term assumptions are intended to benchmark the forestry sector to current forest resource, technology and market parameters, which can then be used to develop the assumptions used in the alternative outlook scenarios. The outlook for many business-as-usual parameters is based on the best available market and resource data and current government policies. Hence, business-as-usual scenario assumptions do not include potential future changes to markets, environmental conditions or government policies that may affect the forestry sector.

Resource assumptions

Table 3 presents assumptions relating to the management of native forests for log harvest over the projection period to 2050, and the regulatory environment under which these forests are managed in each outlook scenario. In general, the business-as-usual scenario assumes no changes to native forest areas or management regimes. The Regional Forest Agreements covering the major forestry regions around mainland Australia are assumed to remain unchanged. Tasmania's estimated native log supply is based on the May 2013 Tasmanian Intergovernmental Agreement and the Tasmanian Forest Agreement 2012 (and remains unchanged as a result of legislative changes under the *Forestry (Rebuilding the Forest Industry Act 2014*). The outcome of the Tasmanian Forest Agreement 2012 is reported in Forestry Tasmania (2014a, b), and existing softwood plantation areas are assumed to be replanted.

Changes in estimates of resource availability from eastern Victorian public forests (VicForests 2014b) incorporate the effects of fire on resource supply following broadscale Victorian wildfires from 2002 to 2009 (MIG & NFISC 2013). Bassett and colleagues (2013) undertook a wood resource estimate of western Victorian public forests. ABARES projections are based on changes in policy discussed in the *Queensland Forest and Timber Industry Plan* (FTIWG 2012); data provided by the Queensland Government reflects these changes in policy (Table 3).

Table 3 Native forest log availability assumptions for the three outlook scenarios

Parameter	Business-as-usual scenario assumptions	Priority-to-productivity scenario assumptions	Constrained-wood-production scenario assumptions
NSW and WA public and private, Vic. private, Tas. private, NT private	As reported in ABARES (2012). Victorian private estimates adjusted for impacts of Victorian wildfires (2002–2009).	Increased log availability relative to business-as-usual scenario, forestry codes of practice the same as current practice, increased emphasis on private forest management	Decreased log availability relative to business-as-usual scenario, forestry codes of practice have stricter prescriptions than current practice
Vic. public	Estimates based on Bassett and colleagues (2013) data and VicForests (2014b) outlook projections using state supplied data, NFI (2014) data and NFI wildfire data.	As above with the area identified as potentially suitable for harvest but currently uneconomic in VicForests (2014a) being available for harvest because they are economic.	Decreased log availability relative to business-as-usual scenario, forestry codes of practice have stricter prescriptions than current practice
Qld. public	ABARES (2012) estimates corrected to state government estimates from multiple-use public forest and leasehold forest using 2014 state supplied data, and updated tenure and forest cover data (NFI 2014)	Increased log availability relative to business-as-usual scenario, forestry codes of practice the same as current practice.	Decreased log availability relative to business-as-usual scenario, forestry codes of practice have stricter prescriptions than current practice
Qld. private	Based on ABARES (2012) estimates from private forest only and using updated tenure and forest cover data (NFI 2014)	Increased log availability relative to business-as-usual scenario, forestry codes of practice the same as current practice, an increase in forestry emphasis on private forests.	Decreased log availability relative to business-as-usual scenario, forestry codes of practice have stricter prescriptions than current practice
Tas. public	As reported in Forestry Tasmania (2014b)–from outcome of the Tasmanian Forest Agreement 2012–using 2014 state supplied data.	As reported in ABARES (2012)–from Tasmanian Regional Forest Agreement based on Forestry Tasmania (2007)	Based on business-as-usual scenario and applying a 20 per cent headroom and a non-declining yield assumption from 2015
SA and ACT public and private	No harvesting	No harvesting	No harvesting
NT public	No harvesting	No harvesting	No harvesting

Note: In all states and territories other than Queensland, leasehold forest projections are included in estimates for private. In Queensland leasehold forest, estimates are included in public based on Queensland supplied data. All other state estimates of wood resources from public forests are only from multiple-use public forest. All market and policy parameters current at December 2014.

In addition, based on information collected at a series of ABARES workshops with forestry sector stakeholders in March 2013, this analysis assumes that some existing plantation areas will not be replanted after the first rotation because they are not commercial under prevailing market conditions (Appendix A). The extent of these non-commercial plantations has been estimated based on ABARES datasets and feedback from industry stakeholders. Other factors that may affect plantation areas over the projection period, such as carbon pricing, water regulations and changes to market circumstances, are not assumed to affect the plantation area.

Productivity and processing assumptions

Productivity growth in forest resources and wood processing is an important assumption for long-term forecasting, and is a key consideration for Australia's forestry sector over the outlook period. Over time, any changes in forest genetic stock, silvicultural practices and environmental conditions will affect the growth rates of trees, the range of species used for wood production, the rotation length over which they are grown, products derived from these forests and the regions in which they can be established. These changes may be driven by research and development, by factors such as climate change and the incidence of fire and disease, or by government policies or market incentives.

Similarly, technological change in wood processing may expand the range of products available that can be manufactured from log types or may reduce the costs of processing existing wood products. Some of these productivity gains may be global (such as those relating to production technologies and costs), while others may be regional (such as production technologies and growth rates in Oceania that concern specific tree species).

For the business-as-usual scenario, ABARES assumes that existing forest growth rates, processing costs and processing technologies remain unchanged, and that no new species or technologies are introduced into the market (Table 4). The range of wood processing technologies used in this analysis is discussed later in this report. Existing processing technologies are assumed to be potential investment options, although data and time constraints prevented the inclusion of a broad range of these options. For example, production of cross-laminated timber (CLT) is not considered in this report. CLT is manufactured overseas and relevant data such as processing costs for Australian species and potential penetration of the product in the Australian market are unavailable. Wood pellet production is included as a potential investment option, as these processes have been developed in Australia; however, large-scale technologies to produce electricity from biomass domestically have not been included. Other biofuels that may be developed over the projection period but are not currently commercial are also not considered in this scenario. Nevertheless, these technologies are likely to be important for future wood processing. Further research could examine the economic potential for such investments.

Alternative outlook scenarios

Future trends in economic, environmental and policy parameters cannot be predicted with certainty. To reflect uncertainties and examine their potential impact on the long-term outlook for the forestry sector, ABARES has prepared two alternative scenarios: the priority-to-productivity scenario and the constrained–wood-production scenario. The parameters used in these scenarios were prepared in conjunction with key stakeholders at workshops held in March 2013. They are not uniformly high or low scenarios; they represent a set of parameters that may eventuate under alternative futures. The two alternative scenarios analysed in this report do not represent a comprehensive set of future possibilities for the forestry sector—this is beyond the scope of this report. Many other parameters will be important for the forestry sector's outlook

over the period to 2050; some of these are discussed under options for future research in chapter 7.

Table 4 Key productivity and processing assumptions in business-as-usual scenario

Parameter	Description	Business-as-usual scenario assumptions
Forest growth rates	Relative to current, resulting from genetic research or climate change	No change to growth rates
Forest species or silviculture	New tree species or additional silvicultural management regimes (e.g. sawlog production) in plantations	No change from current species and plantation regimes
Wood processing costs and recovery rates	Domestic and international real costs of production and relative competitiveness	No change in real costs or relative competitiveness
Mill investment options: current technologies	Existing wood processing technologies, or products currently consumed in the domestic market or exported from Australia	Sawnwood, wood-based panels, pulp and paper, wood pellets
Mill investment options: alternative technologies	Allowing investment in emerging wood processing technologies used overseas but not currently in Australia	Not included in this analysis

Priority-to-productivity

This scenario is drawn from a United Nations study (2011) and describes a future where the supporting infrastructure necessary for a vibrant and productive forestry sector is more strongly supported, including facilitation of physical infrastructure and support for research and development, education and training. Policies and strategies are focused on supporting wood-producing industries within the scope of sustainable forest management. There is broad public support for wood products and forest use, and greater investment certainty in the forestry sector.

In this scenario, it is assumed that there is no further expansion of public native forest conservation areas, codes of practice governing the use of private native forest are streamlined to allow some expansion of this resource to a sustainable wood yield and non-market restrictions on land use change do not inhibit reforestation. Wood products compete in end-use markets against alternative materials and internationally traded wood products, although non-market values, such as carbon intensity of alternative products, are not explicitly recognised in market decisions.

Economic and population growth is also assumed to be higher in this scenario, driving greater demand for housing and wood products. Development of innovative wood products lead to greater demand for these products as they enter new markets.

In summary, the main parameter changes relative to the business-as-usual scenario are:

- Increased availability of public and private native forest logs
- Increased availability of hardwood and softwood plantation logs, based on assumed research and development and improvements to genetic stock
- Higher domestic demand for sawnwood, panel and paper products, based on assumed higher population growth, housing development, development of new products and greater public preference for wood products

- Increased competition and productivity mitigate price increases for wood products; however, lower processing costs support profitability in the forestry sector
- Investment options are the same as in business-as-usual scenario; however, hurdle rates for investment are lower as a result of greater market certainty.

Constrained-wood-production

This outlook scenario assumes a future where society is less inclined to support harvesting of native forests and the use of agricultural land for growing trees, and where negative perception of wood products leads to lower domestic demand. Urban sprawl is restricted, the ratio of multi-unit dwellings in construction is greater and wood use in housing is limited. Lower demand and lower supply is assumed to maintain the same wood products prices as the business-as-usual scenario. However, a decline in the export price for hardwood native woodchips is assumed. There is limited incentive to invest in more efficient processing technology, and investment uncertainty results in higher hurdle rates.

In summary, the main parameter changes relative to the business-as-usual scenario are:

- Lower log availability from public and private native forests
- Lower plantation log availability as issues such as water pricing and food production restrict the land area under plantation forests
- Higher domestic processing costs as a result of low levels of investment and innovation in the sector
- Lower demand for wood and paper products as a result of negative perceptions of forest use and wood products and restrictions on housing development
- Limited investment options available: environmental restrictions prevent investment in pulp mills and bioenergy that make use of native forests or residues
- Higher hurdle rates for investment as a result of increased investment uncertainty.

Sensitivity analyses

In addition to the alternative outlook scenarios described in this chapter, this report examines the individual contribution of selected key parameters on the performance of Australia's forestry sector. While the scenarios include these parameters, the purpose of this analysis is to identify the individual contribution of these key parameters.

Restricted log availability

This sensitivity analysis examines the potential implications that constrained log availability may have for the economic contribution of Australia's forestry sector. For example, this may arise if the area of native forests used for production of wood products is limited, if some existing plantation areas are not replanted and instead are returned to alternative uses such as agriculture, or if environmental parameters (such as lower rainfall or increased incidence of destructive events such as cyclones) lower the growth rate of existing forests.

Terms of trade

Another factor that may be important to the existing and future competitiveness of domestic wood processing is the value of the Australian dollar. This will affect the competitiveness of

domestic processors against imported products and the ability to compete in export markets. The implications of an exchange rate movement on a particular sector are complicated. This is because exchange rate movements will have flow-on effects through the Australian economy via changes to the prices of tradeable commodities and factors of production. This will have implications for resource allocation across the economy, which cannot be isolated in one specific sector.

A comprehensive assessment of the relative effects of exchange rate movements on the forestry sector against the effects on the Australian economy as a whole requires a broader analysis than presented in this report. The implications of a depreciation of the exchange rate for the forestry sector may be ambiguous because the forestry sector must compete with other sectors for factors of production, investment funds and market share. It is not possible within this report to assess the effects of an exchange rate movement. However, it is possible to examine the potential implications of changing prices for wood products and costs of imported capital and inputs in isolation, and draw some conclusions about the sensitivity of the sector to the exchange rate.

For the business-as-usual scenario, ABARES assumed an exchange rate of A$1 to US$1. For this sensitivity analysis, a change to wood products prices and imported components corresponding to a depreciation of the Australian dollar to US80 cents is examined.

It is assumed that Australia plays a relatively small role in international wood products markets and is influenced by fluctuations in world prices and global supply and demand trends. For this sensitivity analysis, ABARES has assumed that the prices of all wood products change in accordance with the Australian and US dollar exchange rate movement. Hence, the international price of wood products is assumed to increase by 25 per cent in Australian dollar terms; this is reflected in Australia's import, export and domestic prices for wood products. This analysis also assumes that investment costs increase for technologies requiring substantial imported components (principally pulp and paper, and to a lesser extent panel products) and the costs of production increase slightly to reflect the higher cost of some imported components, such as fuel.

In summary, the assumptions for this sensitivity analysis include:

- Assumed increase in wood products domestic prices, import costs and export prices of 25 per cent (based on a hypothetical reduction in the exchange rate for the Australian dollar from US$1 to US80 cents, with no assumed effects on other parts of the economy)
- Increased investment costs of 17 per cent for pulp and paper, 11 per cent for panel products, and processing costs of 2 per cent for all products
- No effects on the Australian economy as a whole.

Industry investment

Ongoing investment in domestic processing infrastructure is a key parameter influencing the future of the forestry sector. This report examines only investment in new wood processing mills (or greenfield developments), which is a subset of all potential investments. Factors that have not been considered in this report, and which may be investigated in future research, are: improvements to or expansions of existing facilities; downstream value-adding industries; research and development; transport and other infrastructure such as ports, roads and equipment (or brownfield improvements).

This sensitivity analysis will examine the impact of higher hurdle rates on industry investment. Hurdle rates reflect the rate of return required by investors to undertake investments. Higher hurdle rates reflect greater preference for short-term returns, which reflect perceptions about the greater risk or opportunity costs of long-term investments. This report uses a hurdle rate for investment of 5 per cent in the business-as-usual scenario (in addition to the 7 per cent discount rate assumed for all intertemporal values). This hurdle rate is increased to 8 per cent for this sensitivity analysis.

4 Long-term parameters and modelling approach

This chapter presents parameters estimated outside the model, which are used as inputs for ABARES analysis.

Australia's economy

Over the period to 2050, Australia's economy may experience significant changes. ABARES assumptions for changes to these broad macroeconomic parameters are discussed in Gupta and colleagues (2013). Most are taken from the report *Strong growth, low pollution: modelling a carbon price* (Commonwealth of Australia 2011) (Table 5).

Table 5 Description and source of market parameters used in business-as-usual scenario

Parameter	Description	Business-as-usual scenario assumptions
Australian economic growth	Growth in real gross domestic product (GDP) and manufacturing output to 2050	Gupta and colleagues (2013)
International demand and supply of wood products	Parameters such as real GDP in principal wood product markets, changes to global forest resources, global investments in processing infrastructure	Not modelled explicitly; implied in wood products price assumptions used in other outlook studies
Population growth rate	National	Gupta and colleagues (2013)
Housing sector activity	National–number of new dwellings commenced every year, type of housing, timber used in housing	ABARES estimate of long-term trend; no change to current parameters
Domestic consumption of wood products	By broad product category (sawnwood, wood-based panels, paper and paperboard)	Broad commodities from Gupta and colleagues (2013); assumed individual products change uniformly
Wood products prices	Real prices for imports, exports and the domestic market by wood product	ABARES assumptions based on global trends and other outlook studies
Recognition of ecosystem services	Including non-wood forest products, carbon sequestration, water management, etc.	Not included in this report
Exchange rate	Australian dollar to US dollar	A$1.00 = US$1.00
Discount rate	Weight used to convert future dollar value to current dollars	7 per cent (Australian Government 2010)
Investment hurdle rate	Return required for long-term capital investments (in addition to discount rate)	5 per cent (ABARES assumption for business-as-usual scenario)

Table 6 summarises the parameters used to model Australia's forestry sector in this report, and describes the assumptions and sources used to derive these. For this analysis ABARES has made a simplifying assumption that domestic and international prices for wood commodities follow identical trajectories to 2050. Based on analysis of international markets in the outlook studies described in this report, ABARES has estimated long-term price movements for wood commodities for the business-as-usual scenario. These are summarised in Table 7. ABARES has

not made assumptions about the size of export markets for wood products. Given that Australia generally accounts for only a small proportion of world trade in wood commodities, it is assumed that Australian supply into export markets is unconstrained and does not affect world prices.

In broad terms, the Australian dollar exchange rate is assumed to remain at parity with the US dollar over the projection period in the business-as-usual scenario. By 2050 Australia's population is assumed to reach 35.7 million, and real GDP growth is assumed to average 2.1 per cent a year, reaching $3.1 trillion in 2050 (in 2011–12 Australian dollars). Over this period, the number of total housing commencements is assumed to reach around 215 000 a year by 2050 (compared with 166 000 in 2011–12); however, an assumed increase in the share of multi-dwellings in total household construction will result in this share increasing from 32 per cent in 2011–12 to 48 per cent by 2050 (Table 6).

In relation to housing, ABARES has analysed historical trends in population, household size and the type of houses constructed to estimate the long-term outlook for housing in Australia. This is described in detail in Gupta and colleagues (2013). While average household size is estimated to contract to 2.14 people by 2050, the number of housing commencements is expected to increase to almost 215 000 units. However, despite this growth, the number of detached houses commenced is estimated to remain static to 2050 relative to commencements in 2011–12. In contrast, the number of multi-dwellings commenced is forecast to almost double, from over 53 000 units in 2010 to almost 103 000 units by 2050. Renovation activity is also estimated to grow strongly based on GDP and population growth over the period.

Finally, ABARES has assumed a discount rate of 7 per cent for the analysis. For wood processing infrastructure investments, the investment hurdle rate is assumed to be 5 per cent (in addition to the 7 per cent discount rate) to account for additional returns required by investors to compensate for perceived risk or opportunity costs of investment.

Table 6 Market parameters used in business-as-usual scenario

Parameter	Unit	2011–12	2020	2030	2040	2050
Domestic markets						
Real GDP	$billion	1 474	1 814	2 227	2 664	3 124
Population	million	22.7	25.5	29.0	32.4	35.7
Real GDP per person	$/person	65 032	71 217	76 696	82 189	87 389
Manufacturing turnover	$billion	102.1	134.3	138.5	139.1	136.9
Household size	People per household	2.52	2.45	2.38	2.31	2.24
Total housing commencements	'000	165.5	184.3	193.6	198.3	214.7
Detached dwellings	'000	112.1	114.8	114.0	110.0	111.8
Multi-dwellings	'000	53.4	69.5	79.6	88.3	102.9
Share of multi-dwellings	%	32	38	41	45	48
Value of renovations	$billion	6.5	9.9	13.8	18.3	23.6
Interest rate	%	6.0	6.8	6.8	6.8	6.8
Discount rate	%	7.0	7.0	7.0	7.0	7.0
Investment hurdle rate	%	5.0	5.0	5.0	5.0	5.0
World markets						
Exchange rate	US$/A$	1.03	1.00	1.00	1.00	1.00

Note: **GDP** Gross domestic product. All dollar values are shown in 2011–12 Australian dollars. Source: ABARES datasets; Commonwealth of Australia (2011); Gupta and colleagues (2013)

Australia's major wood products

The large range of wood products available in Australia each represent specific features such as structural performance and quality of appearance. Many wood products made from different fibres and using alternative technologies can be substituted with each other or with non-wood products in downstream markets. Nevertheless, to undertake analysis of these products some degree of aggregation is necessary.

For the long-term consumption forecasts used in this outlook study, domestic wood products were highly aggregated into three broad commodity groups: sawnwood, wood-based panels and paper and paperboard. In the present study, these broad commodity groups have been disaggregated into the products presented in Table 7, which presents these products along with examples of further disaggregated wood products from each group.

Some of these aggregated products represent products that cover a relatively wide range of uses and prices. For example, plywood covers a wide range of structural and appearance applications, using very different log qualities and deriving divergent prices in final markets. While it would be preferable to disaggregate these types of products, it was beyond the scope of this report.

Note that the prices specified here are wholesale market prices and represent the returns to the primary wood products listed in Table 7. This report does not examine the entire value chain of wood processing in Australia. Many of these primary wood products will undergo some downstream value-adding before reaching the final (retail) market, which will consequently employ more people, create more value-added and increase the market prices of products. These downstream value-added processes are important for capturing the aggregate contribution of the forestry sector and could be addressed in future research.

One important issue for future sawnwood output in Australia is the limited supply of hardwood sawlogs from native forests and the potential for some increased supply of plantation hardwood sawlogs. The supply of these different log types is described in the next section. For this report, the wholesale price of sawnwood manufactured from hardwood plantation sawlogs is assumed to be equivalent to that of hardwood native sawlogs.

Table 7 Wood products considered in this report

Broad commodity/primary product	Examples	Price range (2011–12)	Long-term growth (% every year)
Sawnwood			
Hardwood appearance	Special species, select grade, flooring, mouldings	$650–2 000/m^3	+0.16
Hardwood structural	Green framing (F8, F11, F14 grades); dry framing (F17, F27 grades)	$500–1 300/m^3	+0.16
Hardwood utility grade	Pallets, fencing	$300–500/m^3	+0.16
Plantation softwood treated	F5/F7 H3 treated, treated framing, flooring, furniture, decking, boards and lining	$540–750/m^3	+0.16
Plantation softwood untreated	F7 untreated, MGP10, MGP12, untreated boards, lining	$440–510/m^3	+0.16
Plantation softwood utility (treated)	Pickets, palings, sleepers, fencing, handrails	$210–400/m^3	+0.16

Table 7 Wood products considered in this study (continued)

Broad commodity/primary product	Examples	Price range (2011–12)	Long-term growth (% every year)
Wood-based panels			
Particleboard	Flooring, melamine, standard	$340–540/m³	+0.32
Medium-density fibreboard	Standard (E0, E1 grades), HMR, melamine	$400–700/m³	+0.09
Hardwood/softwood plywood	exterior/interior; appearance (A, S, B grades); structural (C, D, PG grades)	$900–910/m³	–0.02
Laminated veneer lumber	300 x 45 0 or 302 x 44 0	$1 160/m³	–0.02
Hardboard	Pegboard, standard, stud packers, tempered, underlay	$780–980/m³	+0.09
Pulp and paper			
Hardwood pulp	Bleached hardwood kraft pulp	$660–685/t	0.00
Softwood pulp	Northern bleached softwood kraft	$750–790/t	+0.26
Mechanical pulp	Hardwood/softwood; coated/uncoated	$607–695/t	–0.49
Newsprint	–	$750–1 025/t	–0.32
Household and sanitary	Tissue, nappies	$1 580–1 670/t	+0.49
Packaging and industrial	Carton board, container materials, sack kraft	$830–2 000/t	+0.38
Printing and writing	Coated/uncoated, woodfree, copier	$1 030–2 000/t	0.00
Recovered paper	For export and domestic use	$150–180/t	0.00
Other wood products			
Hardwood log exports	Sawlog/pulplog	$75/m³	0.00
Softwood log exports	Sawlog/pulplog	$48/m³	0.00
Native hardwood woodchip exports	na	$162/bdt	–0.61
Plantation hardwood woodchip exports	na	$198/bdt	0.00
Softwood woodchip exports	na	$167/bdt	+0.26
Bioenergy – wood pellets	Wood or torrefied pellets	$165/t	0.00
Bioenergy – biofuels	Biomethane, pyrolysis oil	na	0.00

Note: **bdt** Bone dry tonnes. **m³** Cubic metres. **t** Tonnes. **na** Not applicable. Domestic prices are wholesale; export prices are free on board. Source: ABARES survey datasets; Industry Edge (2012); URS (2012b)

Consumption of wood products

For the modelling analysis of the business-as-usual scenario, ABARES used consumption forecasts developed by Gupta and colleagues (2013). ABARES modelled a simple 10 per cent increase in the consumption growth rate for the priority-to-productivity scenario and a 10 per cent decrease for the constrained-wood-production scenario.

These consumption growth rates for each scenario have been assumed to apply uniformly across all individual products within a broad commodity group—with the exception of newsprint consumption, which is assumed to remain constant between 2015 and 2050 in all scenarios.

Sawnwood

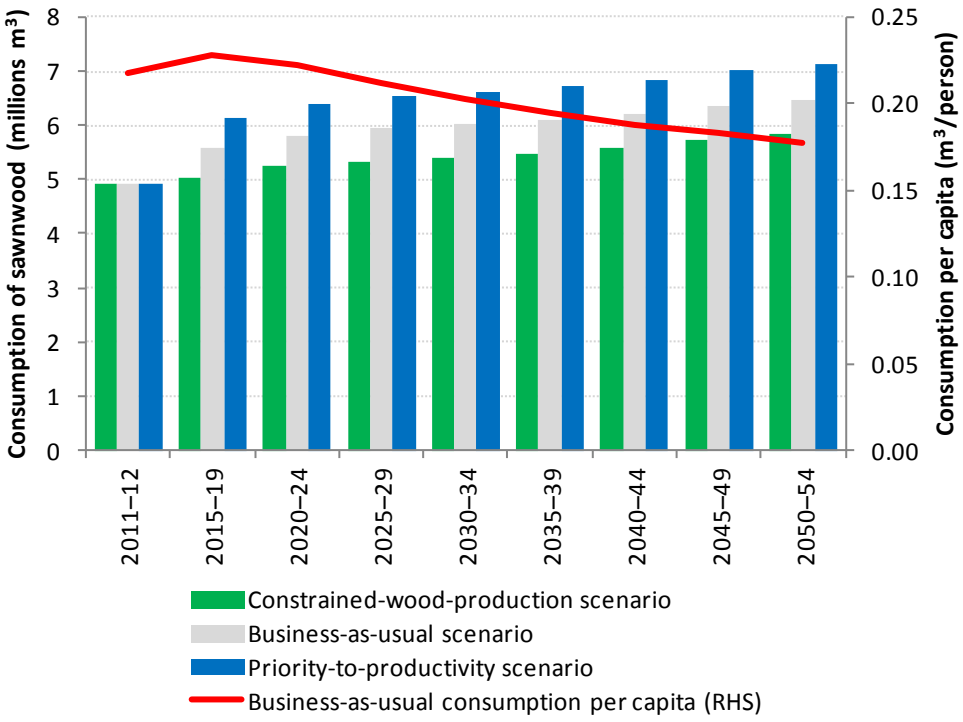
Figure 9 shows the assumed consumption growth of sawnwood over the projection period. For the consumption forecasts presented here, the sawnwood estimates represent an aggregation of the species and product types presented in Table 8 (see Log types analysed). ABARES has modelled the total quantity of sawnwood consumption for the period 2011–12 to 2050–54.

Gupta and colleagues (2013) further explains the methodology used to derive these forecasts. Briefly, the sawnwood consumption model is largely determined by the assumed number of detached houses and multi-unit dwellings constructed over the outlook period.

In the business-as-usual scenario, forecast sawnwood consumption is estimated to grow by 32 per cent between 2011–12 and 2050–54. This is driven by the increasing number of housing commencements . While sawnwood consumption is forecast to increase overall to 2050–54, sawnwood consumption per person is forecast to decrease over the long term. This is consistent with historical trends (Figure 4) and reflects a projected structural shift in housing over the forecast period towards an increasing proportion of multi-dwellings, as well as the increasing use of substitute products (such as wood-based panels) over time.

In the constrained-wood-production scenario, consumption is assumed to remain between 5 million and 6 million cubic metres between 2015–19 and 2050–54. In the priority-to-productivity scenario, consumption is assumed to extend above 7 million cubic metres by 2050–54.

Figure 9 Sawnwood consumption forecasts, 2011–12 to 2050–54



Note: **RHS** Right hand side. Source: ABARES datasets; Gupta and colleagues (2013)

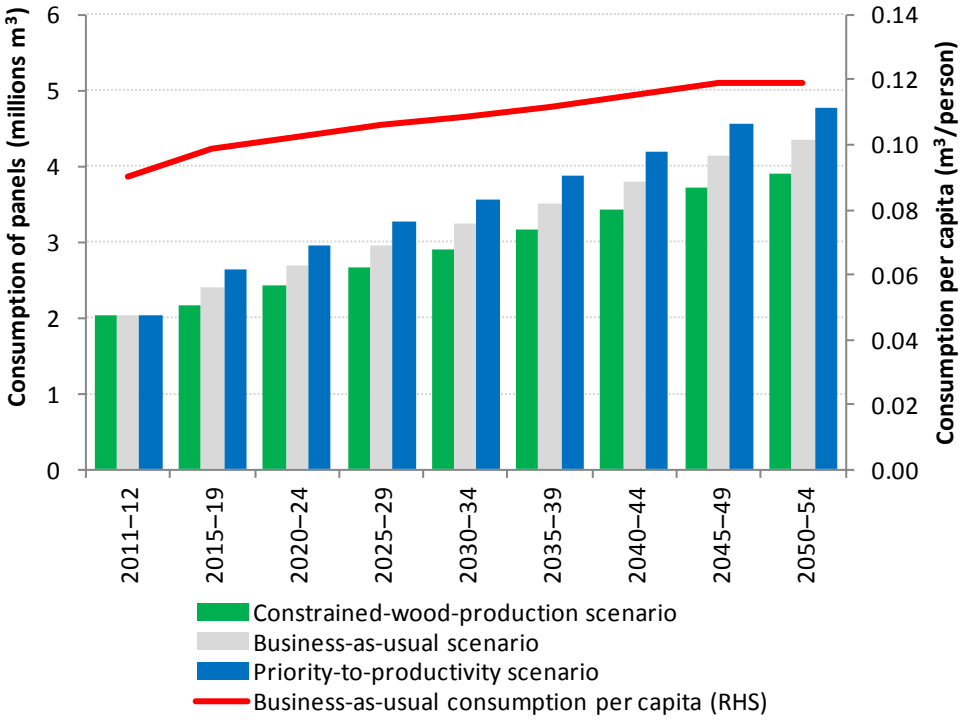
Wood-based panels

Wood-based panel consumption estimated by ABARES consists of plywood, particleboard and medium-density fibreboard. The housing industry is a large user of wood-based panels—primarily in wall, roof and floor sheathing—but also in cabinets, mouldings and doors. Wood-based panels are also used in furniture construction.

Wood-based panel consumption grew strongly over the 40 years to 2011–12, and the forecasts in Gupta and colleagues (2013) suggest that this strong growth will continue to 2050–54. This increase is driven by significant assumed growth in the number of multi-dwelling commencements and the real value of renovations over the projection period. In the business-

as-usual scenario, wood-based panel consumption in Australia is forecast to more than double between 2011–12 and 2050–54 (Figure 10). As this consumption growth is forecast to exceed population growth, the per person consumption of wood products is also forecast to increase. In the constrained-wood-production scenario, panel consumption is assumed to remain below 4 million cubic metres to 2050–54, while stronger consumption growth is expected in the priority-to-productivity scenario.

Figure 10 Wood-based panel consumption forecasts, 2011–12 to 2050–54



Note: **RHS** Right hand side. Source: ABARES datasets; Gupta and colleagues (2013)

Pulp and paper

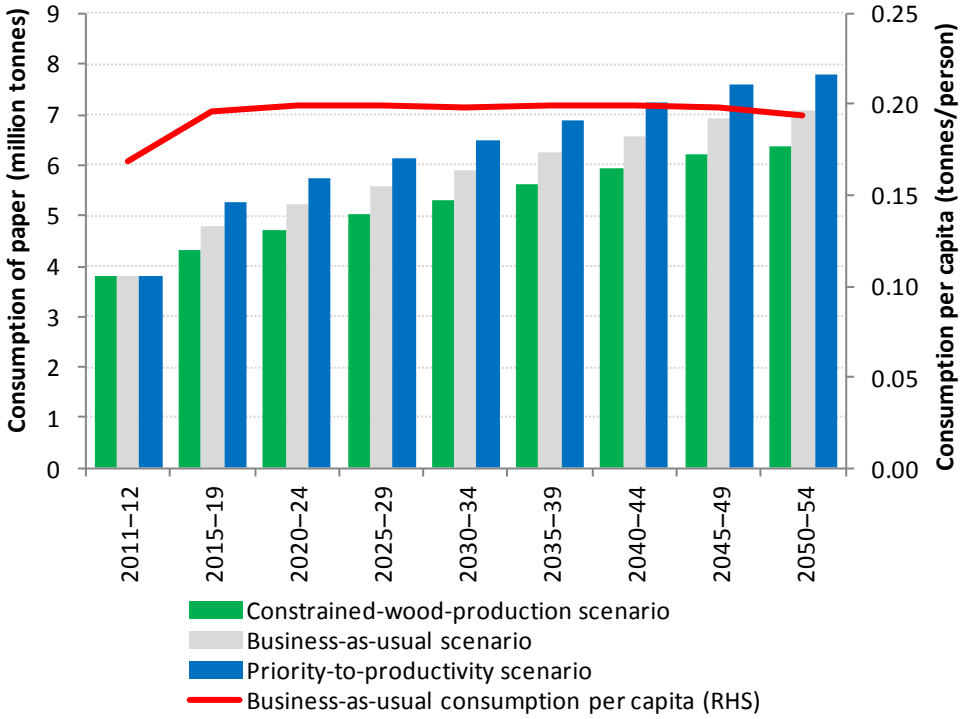
For this analysis, paper and paperboard consumption comprises paper grades presented in Table 7: newsprint; household and sanitary paper; packaging and industrial paper; and printing and writing paper. Gupta and colleagues (2013) estimated a significant relationship between paper and paperboard consumption and the industry value-added of Australian manufacturing output. This reflects the fact that the manufacturing sector is a large user of packaging and industrial paper and printing and writing paper.

This report does not include a forecast for the domestic consumption of pulp. This is because pulp is a derived demand, driven by the domestic consumption of paper. Consumption of pulp may include domestically produced virgin fibre or recycled pulp and imported pulp products, and is modelled explicitly in this report.

For the business-as-usual scenario, this report assumes equivalent growth in consumption of all paper grades except newsprint, which is assumed to remain constant over the projection period. Based on relatively robust manufacturing industry value-added to 2050 (Gupta and colleagues 2013), Australia's paper consumption is forecast to increase to above 7 million tonnes by 2050–54 (Figure 11). This growth results in relatively stable per person consumption between 2015–19 and 2050–54. In the priority-to-productivity scenario, paper consumption is estimated

to double over the period to 2050–54. In the constrained-wood-production scenario, consumption growth is lower, though still strong, at 67 per cent between 2011–12 and 2050–54.

Figure 11 Paper and paperboard consumption forecasts, 2011–12 to 2050–54



Note: **RHS** Right hand side. Source: ABARES datasets; Gupta and colleagues (2013)

Log and woodchip exports

In this report, no constraints have been placed on the modelled demand for Australia's wood product exports over the projection period. Hence, Australia's export of wood products is determined in the modelling framework (Modelling approach, chapter 4) using the relative returns of selling domestically or exporting and taking into account the marginal costs of production. Logs are sold for woodchip and log export where the returns to these exceed the potential returns from selling to domestic processors. This may arise where export free on board prices exceed the milldoor prices paid by domestic processors or where there is insufficient domestic capacity to process all the logs harvested from Australian forests. In the modelling framework, Australian forest growers are assumed to be able to sell as much woodchip and logs as can be produced, up to the volume where the marginal cost of production and delivery to ports equals the free on board price received for these products, after taking into account potential higher returns from selling and processing logs domestically.

Other wood products

This report also examines potential recovered paper exports and wood pellet exports. There is assumed to be a domestic derived demand for recovered paper, driven by the demand for recycled pulp by the domestic paper industry. Additional recovered paper collected above the volume required by domestic paper processors can potentially be exported. The volume of recovered paper available each period is assumed to be equal to that period's paper consumption multiplied by the estimated paper collection rate, which was 83.4 per cent in 2011–12.

There is assumed to be no domestic market for wood pellets over the projection period, and hence demand is solely directed to exports. However, the Australian market for wood products and energy products is likely to change significantly over the coming decades. Emerging markets for engineered wood products, bioenergy products and other downstream wood products were not examined in this report. This could be examined in future research.

Wood products that were not considered in this analysis may be important future options for wood processing in Australia over the period to 2050. Some of these, such as types of bioenergy or engineered wood products, may become very important to incomes, employment and fibre use in the future. Time and data constraints prevented their inclusion in the present analysis.

Outlook for log availability in Australia

Assumptions behind log availability projections

Projections of log availability from plantations are based on industry-supplied data. Projections of log availability from public and private native forests are based on published forecasts of log supply and ABARES estimates for sustainable yield (ABARES 2012). Recent developments in the Tasmanian Forests Intergovernmental Agreement have been incorporated into the projections and the log availability estimates reflect all available information as of June 2013.

ABARES has also assumed that some existing hardwood plantations in some regions will not be replanted after the first rotation because they are not considered commercially viable—the returns to land under these plantations is assumed to be inferior to the potential land returns under alternative uses. This information is based on stakeholder discussions and the workshops described in Appendix A. ABARES has not undertaken economic analysis of potential land use change so these reductions in hardwood plantation area should be considered assumptions.

Several aspects relating to log availability were not considered in this study. While ABARES has assumed that some proportion of existing hardwood plantations will not be replanted, other factors that may have a bearing on future volume and quality of log supply have not been included in this analysis, and hence remain unchanged in the business-as-usual scenario. This may include: silvicultural changes to plantations, which may improve growth rates; the impacts of climate variability, which may affect tree growth rates; the regions in which trees can grow; and the competitiveness of wood-yielding plantations with other land uses. While the alternative scenarios for log availability are intended to indicate the potential consequences of such changes for log supply, they do not represent sophisticated analysis of the potential magnitude of these effects.

Native forests log availability

Long-term native forest log availability projections are based on data analysed in ABARES (2012). These projections were reviewed and discussed in state-based workshops in March 2013, and the comments from these discussions were incorporated into all three outlook scenarios (Appendix A). Various stakeholders provided advice on what they expect to happen in the business-as-usual scenario, and workshop consensus was used to develop the lower bounds of uncertainties about potential changes to harvesting prescriptions, resource access, domestic demand, intent of private forest owners and productivity of private native forests.

For the business-as-usual scenario, native forest log availability projections were updated with more recently available data, reflecting changes in resource access and product demand for a range of wood products and wood supply regions to 2050. Updated projections for Victorian public forests were based on Bassett and colleagues (2013) and VicForests (2014b). Projections

for northern NSW public forests were based on NSW Government (2014); other regions in New South Wales remained unchanged being based on Forests NSW (2010). Availability projections for Tasmania were updated with the following changes:

- During the production of the report, Tasmanian forestry sector stakeholders, Australian and state governments, and environmental non-government organisations were negotiating the Tasmanian Forests Intergovernmental Agreement (TFIGA). These negotiations resulted in an increase in native forest reserves and a significant reduction in the volume of native forest logs supplied to the forestry sector. The outcomes of these negotiations are documented in state-supplied data, Forestry Tasmania (2014b, 2011), Burgman and Robinson (2012) and Robinson (2012). ABARES used these sources to update projections from its 2011 report (ABARES 2012).

- The market for Tasmanian peeler logs has changed significantly since 2006–07. The supply of export peeler log has declined. In contrast, supply of domestic peeler log has increased with a corresponding reduction in pulpwood log supply. ABARES projections for Tasmanian peeler logs were updated with the latest projections from Forestry Tasmania (2014b) and TFIGA reports.

Consistent with the business-as-usual scenario, the priority-to-productivity scenario assumes there will not be a decrease in public native forest area available for log production. However, comparing contrast to the business-as-usual scenario, this scenario assumes greater access to private forest resources will lead to an increase in log harvest (these assumptions differ from those made in ABARES 2012). In this scenario, public native forest area in Tasmania does not include the effects of TFIGA 2013. For Tasmania, the assumptions for native log availability reflect the Tasmanian Regional Forest Agreement with the existing code of practice. The consequential increase in forest area available for harvesting in Tasmania contributes to an increase in log availability.

In contrast to the business-as-usual scenario, the constrained-wood-production scenario assumes an increased conservation focus on ecologically sustainable forest management principles, which leads to increased restrictions on availability of logs from public and private native forests. This scenario also assumes that society is less inclined to support log harvest from native forests. These factors contribute to lower log availability in the constrained-wood-production scenario.

Plantation forests log availability

Long-term projections for availability of logs from Australia's plantation estate are based on Gavran (2012). Plantation log availability projections were compiled and summarised from a series of surveys completed by plantation owners and managers. Where data was unavailable from such surveys, ABARES estimated log availability based on yield models developed by Ferguson and colleagues (2002) and Parsons and colleagues (2007) using data on plantation areas by species and region, as reported in Gavran and Parsons (2011). These ABARES estimates compare well with those supplied by various companies where sufficient information about age class distributions and silvicultural regimes applied is available. ABARES updated estimates for public plantations for Tasmania (Forestry Tasmania 2014b), north-eastern New South Wales (NSW Government 2014) and south-eastern Western Australia (unpublished) using updated grower supplied data and reports.

Previous ABARES analysis has used a suite of climate models sourced from the CSIRO to identify a range of potential climate change impacts (ABARES 2012). These potential impacts were not

considered in this report as they were based on different parameters and influences to those examined here.

In the business-as-usual scenario, projections for availability of sawlogs include logs suitable for veneer and plywood manufacture. It was beyond the scope of this report to provide estimates for individual sawlog quality classes because the quality of sawlogs produced within and across plantations varies greatly across species and regions. Projections for pulplog availability include logs suitable for pulp, paper, particleboard, fibreboard, other reconstituted fibre products, posts and poles. Pulplog projections do not account for sawmilling and other residues that are used for woodchips, pulp, paper, particleboard and other reconstituted fibre products. The projections for log availability from plantation forests in the business-as-usual scenario are subject to several assumptions, including the following:

- Plantation yield tables have been developed based on the assumption that markets exist for products from silvicultural thinnings (such as pulplogs and small-diameter sawlogs).
- The timing of silvicultural thinnings is based on optimising wood yields, and is not assumed in this framework to be affected by market cycles.
- Aside from selected hardwood plantations, all other plantations are assumed to be replanted and managed using the previous silvicultural regime.

In contrast to the business-as-usual scenario, the priority-to-productivity scenario assumes a slight increase in plantation area—for example, a mahogany plantation in the Northern Territory. This scenario also assumes an increase in research and development and improvements to genetic stock. These factors are the primary drivers leading to increased log availability in this scenario and are based on similar trends in South American plantations (New Forests 2013).

In the constrained-wood-production scenario, it is assumed that issues such as water pricing and preference for food production restrict the area of land under plantation forests. Current genetic stock will not improve and yield forecasts are reduced (incorporating industry concerns around replanting some plantation areas—see Appendix A). In contrast to the business-as usual-scenario, these factors lead to lower log availability in the constrained-wood-production scenario.

Potential limitations of log availability projections

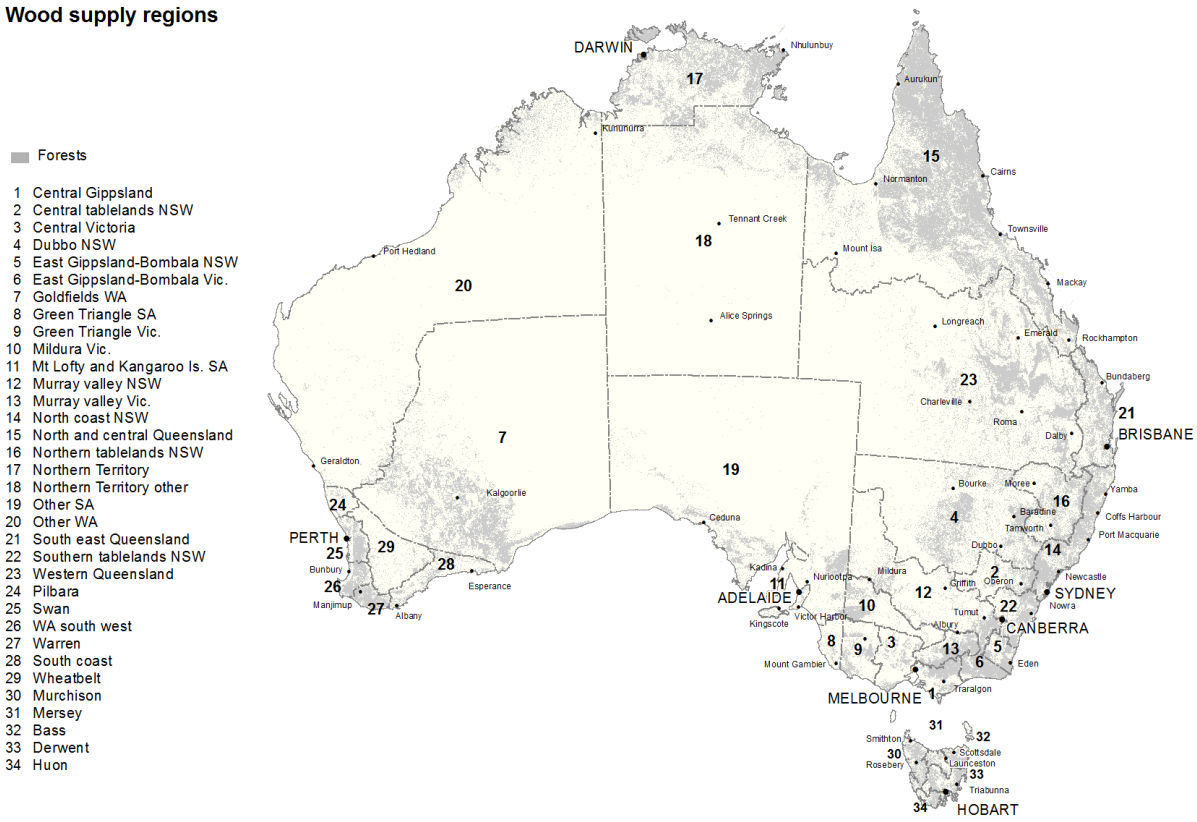
Projecting future log availability is inherently uncertain because of the variability of natural resources, market cycles and unpredictable natural events such as fire. Advances in building technology can alternately reduce the demand for particular wood products (for example, steel-framed house construction) or increase it (for example, cross-laminated timber multistorey construction). Projecting log availability to 2050 under these uncertainties can provide only an overview and care must be taken not to extrapolate to the operational level.

Regional analysis

For this report, forecasts of the availability of logs and assessment of existing wood processing infrastructure were developed at a regional level; however, results for this report have been aggregated to a state level. Regional level results are in Appendix B. While forecasts of consumption and trade were developed at the national level, there is scope to add state or regional detail in future work.

The forest regions used in this analysis (Map 1) are based on ABARES assessment of existing regions for the supply of logs from both native and plantation forests. These regions represent the principal source of log supply in Australia for the business-as-usual scenario over the forecast period. These regions may change over time under a range of alternative outlook scenarios, particularly if environmental factors, such as a change in climate, shift the biophysical potential for forest resources. The regions presented in Map 1 were used to develop datasets for wood processing infrastructure and forecasts of log availability.

Map 1 Regions used in forecasting analysis



Source: ABARES datasets; forest cover as used in MIG & NFISC (2013)

Log types analysed

Table 8 lists the broad log types examined in this analysis. As with wood products, these broad log types represent aggregations of the true heterogeneous range of log types harvested from Australia's forests, examples of which are provided in Table 8 for each state.

Table 8 Log definitions used in this report

Log type used in analysis	Tasmania	Western Australia	Victoria/NSW and SA plantations	NSW north coast/Queensland
Hardwood native sawlog – high quality	High quality sawlog categories 1 and 3; Special category 4 (including utility logs)	Jarrah sawlog; Karri sawlog	High quality large sawlog; High quality small sawlog; Sawlog specialty; Durable species; Girders, poles, piles; Red gum	Eucalypt sawlog; High quality large sawlog; High quality small sawlog; Sawlog specialty; Durable species
Hardwood native sawlog – low quality	Low quality sawlog category 2	Marri sawlog	Low quality small sawlogs; Optional sawlogs	Other hardwood sawlogs
Hardwood plantation sawlog – high quality	High quality hardwood sawlog	High quality hardwood sawlog	High quality hardwood sawlog	High quality hardwood sawlog
Hardwood plantation sawlog – low quality	Low quality hardwood sawlog	Low quality hardwood sawlog	Low quality hardwood sawlog	Low quality hardwood sawlog
Softwood plantation sawlog – high quality	High quality softwood sawlog	High quality softwood sawlog	High quality softwood sawlog	High quality softwood sawlog
Softwood plantation sawlog – low quality	Low quality softwood sawlog	Low quality softwood sawlog	Low quality softwood sawlog	Low quality softwood sawlog
Softwood native sawlog	Special species	na	Cypress sawlog	Cypress sawlog
Hardwood native pulplog	Native hardwood pulpwood	Native hardwood pulpwood	Native hardwood pulpwood	Eucalypt pulpwood
Hardwood peeler log – export	Low grade export peeler log	na	na	na
Hardwood peeler log – domestic	High grade domestic peeler log	na	na	na
Hardwood plantation pulplog	Pulpwood	Pulpwood	Pulpwood	Pulpwood
Softwood pulplog	Pulpwood	Pulpwood	Pulpwood	Pulpwood
Hardwood veneer log	Veneer log	na	Hardwood veneer log	Hardwood veneer log
Softwood veneer log	na	na	Softwood veneer log	na
Not allocated	na	na	Residual sawlogs; Residual durable species sawlogs; Residue red gum	Residual sawlogs

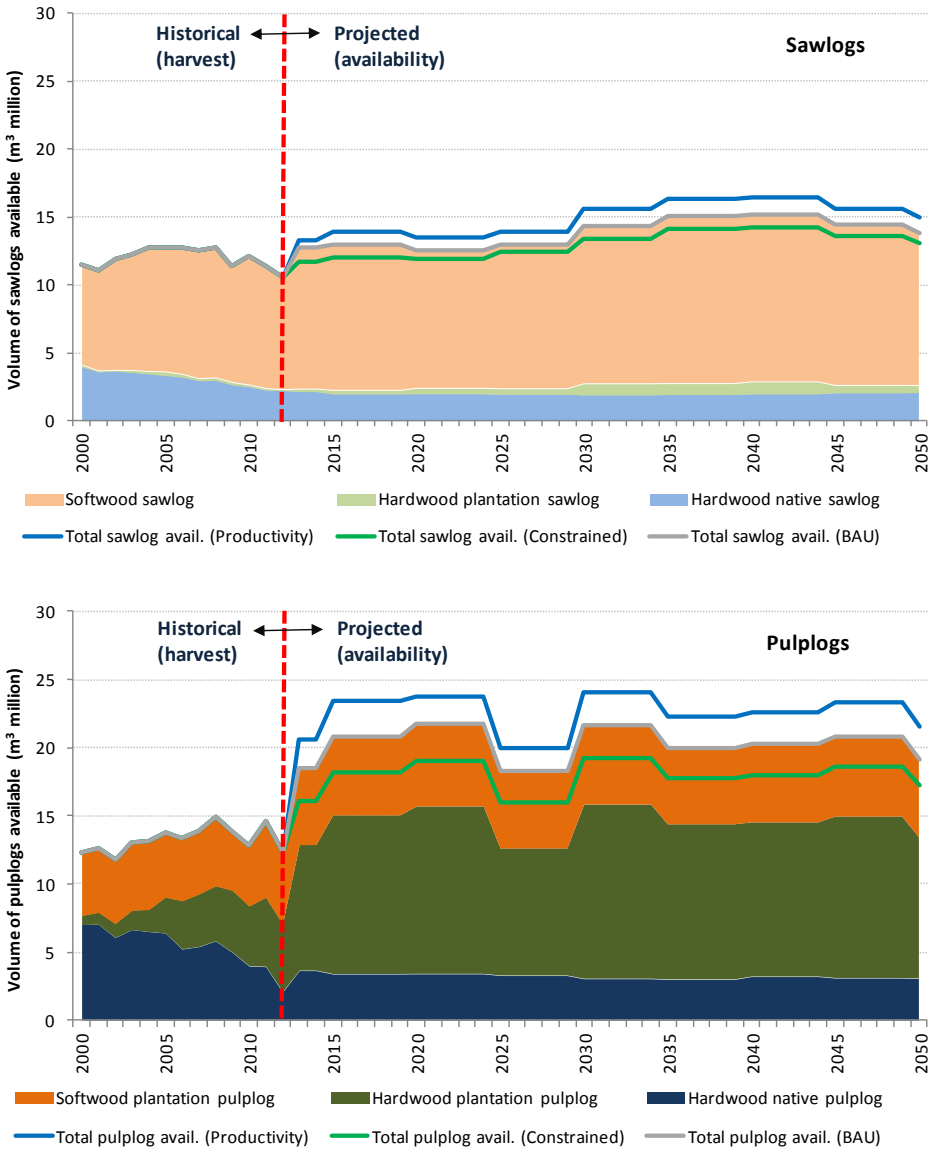
Note: **na** Not applicable. South Australia does not harvest logs from native forests.

National log availability

The forecast log supply from 2010–14 to 2050–54 is the annual average volume of logs that is potentially available from Australia's native forests and plantation estate for each five-year period. The national log availability from native forests in the business-as-usual scenario is based on sustainable yield estimates, and is projected to decline from around 6.0 million cubic metres in 2015–19 to around 5.4 million cubic metres by 2050–54, averaging around 5.5 million cubic metres over the projection period.

In the business-as-usual scenario, the potential supply of hardwood logs from Australian plantations is forecast to increase from levels in 2010–14, peaking at an annual average of 13.7 million cubic metres in the 2030–34 period, then decreasing gradually to around 10.9 million cubic metres by 2050–54. The majority of these hardwood logs are pulplogs because most regions do not manage hardwood plantations for high quality sawlogs.

Figure 12 Historical and projected national log availability, 2000–50



Note: **avail.** availability. **BAU** Business-as–usual scenario. **Constrained** Constrained-wood-production scenario. **Productivity** Priority-to-productivity scenario. Historical log volumes are actual log harvest; forecast log volumes are average annual availability for each time period. Softwood sawlog includes plantation and native softwood sawlogs.

Source: ABARES datasets

The potential supply of softwood logs from Australian plantations for the business-as-usual scenario is forecast to increase over the projection period, peaking at around 17.8 million cubic metres in 2040–44. Total plantation softwood log availability is forecast to average around 16.7 million cubic metres over the projection period. In contrast to the hardwood plantation estate, the vast majority of softwood plantations are managed for sawlog production.

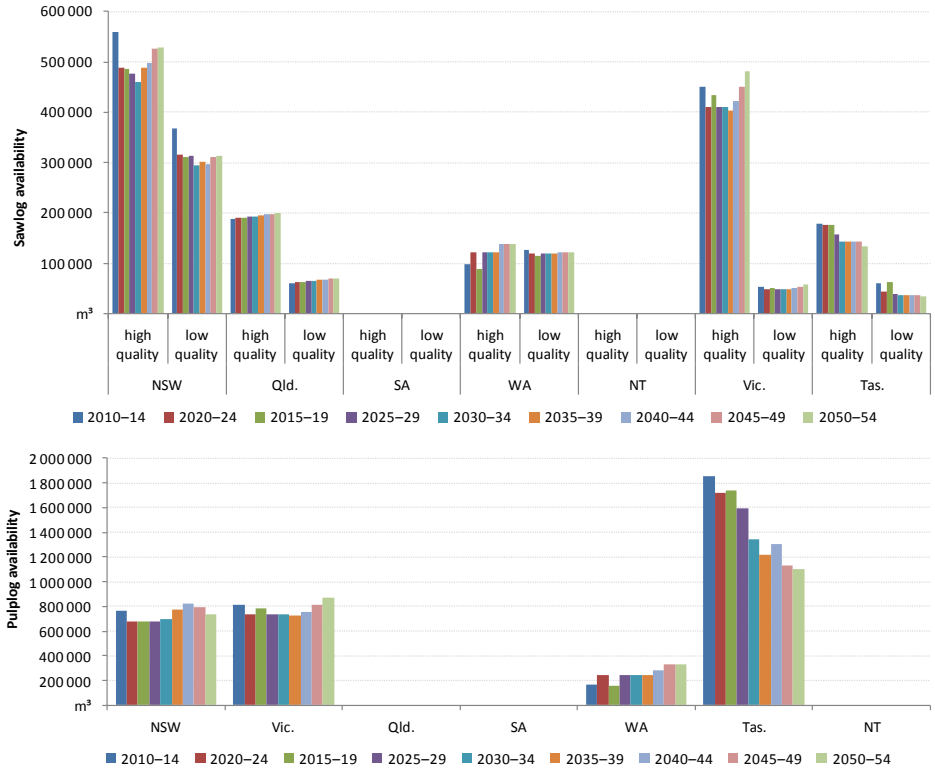
Native forests

Figure 13 shows the assumed changes to native forest log availability to 2050–54 in the business-as-usual scenario. The assumptions used to derive these estimates are described in Assumptions behind log availability projections, chapter 3.

Nationally, native forest sawlog availability is projected to decline between 2010–14 and 2035–39. While native forest sawlog supply is projected to decline in New South Wales and Tasmania, in all other states (excluding South Australia and the territories, which do not harvest native forests for timber) the availability of sawlogs from native forests is expected to increase from current levels. In Victoria, native sawlog availability increases from current levels in 2050–54; however, availability is lower across all periods until 2050–54. Over the projection period to 2050–54, around three-quarters of sawlogs sourced from native forests are estimated to be high quality logs.

The availability of native forest pulplogs is projected to decline more sharply over the projection period, although this reduction is restricted to New South Wales and Tasmania, where availability is projected to decline by 5 per cent and 36 per cent, respectively. While Queensland does not harvest pulplogs from native forests, native forest pulplog availability is projected to increase in Victoria (up by 6 per cent) and especially Western Australia (up by 89 per cent).

Figure 13 Projections of native forest log availability, business-as-usual scenario, 2010–54



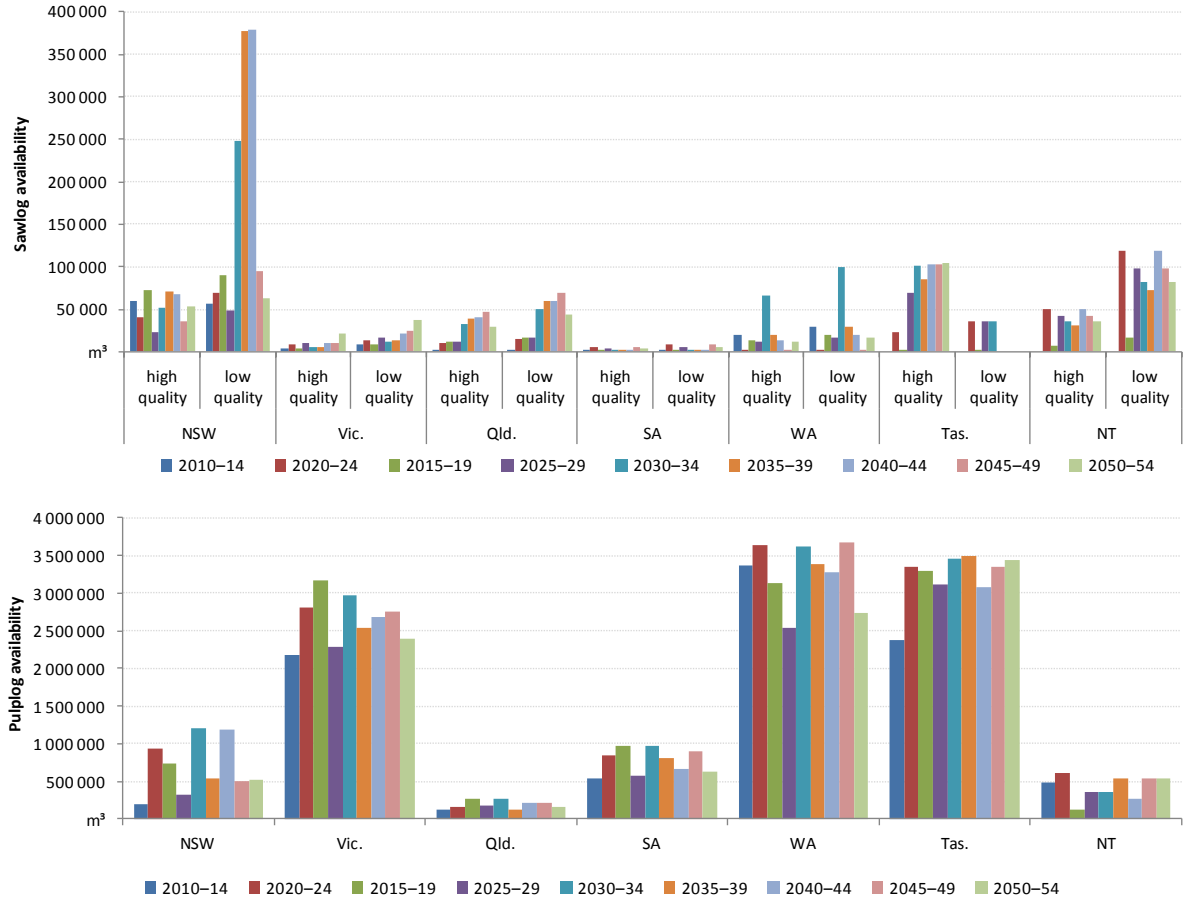
Note: Australian Capital Territory included with New South Wales. Australian Capital Territory and South Australia do not have native forests available for log harvest. Harvest of native forest logs is negligible in the Northern Terriority. Includes cypress pine log availability.

Hardwood plantations

Figure 14 shows the forecast availability of hardwood plantation sawlogs and pulplogs for the business-as-usual scenario. The figure shows that New South Wales and Tasmania have the largest projected volumes of hardwood plantation sawlogs available to 2050. While the majority of these logs in New South Wales are grown in long-rotation plantations and are expected to be low quality logs (especially between 2030–34 and 2040–44), the majority of Tasmania's hardwood plantation sawlogs are expected to be high quality logs.

Hardwood plantation pulplog availability is expected to increase by 34 per cent between 2010–14 and 2015–19, peaking at around 12.2 million cubic metres annually. While Western Australia has the largest availability in 2010–14, supply in that state is forecast to decline over time. In contrast, significant growth is expected in Victoria and Tasmania. Over the period to 2050–54 some volatility is expected in this potential pulplog availability based on the assumptions for harvesting and replanting of these plantations.

Figure 14 Projections of hardwood plantation log availability, business-as-usual scenario, 2010–54



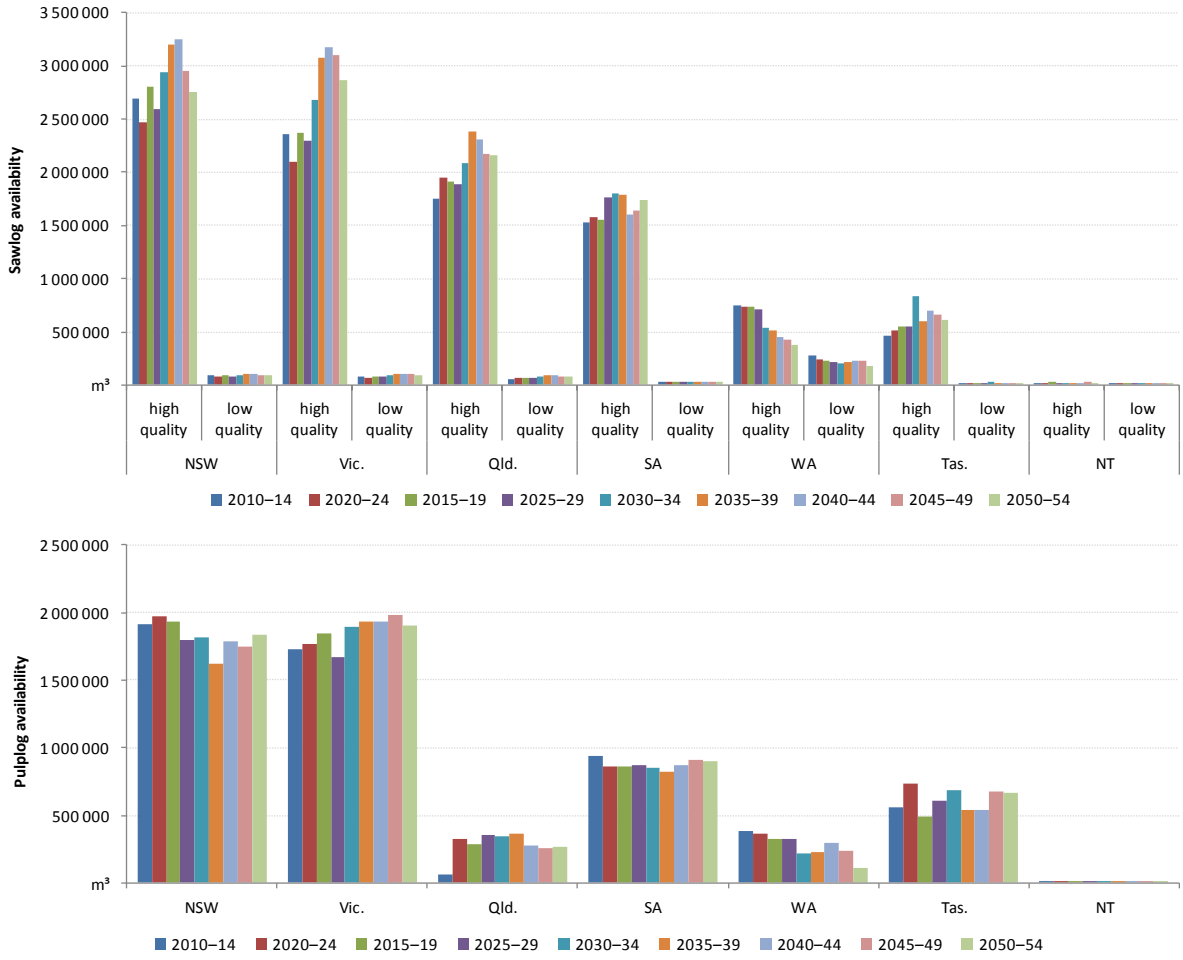
Note: Australian Capital Territory included with New South Wales.

Softwood plantations

Despite the relative maturity of softwood plantations in Australia, some growth is expected in the availability of logs from these plantations over the projection period in the business-as-usual scenario (Figure 15). Nationally, around 95 per cent of sawlogs available over the projection period from softwood plantations are high quality logs. However, Western Australia is forecast to have the highest proportion of low quality softwood plantation logs (28 per cent of total

softwood plantation sawlog availability over the projection period). The availability of softwood sawlogs is expected to increase by more than 20 per cent in Tasmania, Queensland and Victoria between 2020–24 and 2050–54, while availability is forecast to decline in Western Australia. Nationally, availability of softwood plantation pulplogs is assumed to remain relatively stable to 2050–54.

Figure 15 Projections of softwood plantation log availability, business-as-usual scenario, 2010–54



Note: Australian Capital Territory included with New South Wales.

Implications for demand and supply of logs in Australia

In order to compare these consumption forecasts with log availability, ABARES calculated a log-equivalent estimate of the wood products consumption forecasts using wood products recovery rates from the Forest and Resouce Use Model (FORUM). These take into account the use of non-log fibres by some wood processors, such as wood-based panels and pulp manufacturing; processors that utilise a proportion of sawmill residues or recovered products in their total inputs are assumed to require a smaller volume of logs to derive a given output volume.

Table 9 shows that the log-equivalent of wood products consumption is forecast to increase by 44 per cent over the projection period, to over 27 million cubic metres of log by 2050 in the business-as-usual scenario. Most of this growth is estimated to be in wood-based panels, which more than doubles over the period, and paper and paperboard, which rises by almost 60 per cent. Hence, most of the estimated consumption growth is projected to be for pulplogs.

Australia's population growth is projected to exceed growth in volume of logs consumed. Therefore, per person consumption of logs is estimated to decline over the projection period, from around 0.83 cubic metres per person 2011–12 to 0.74 by 2050. This decline is consistent with the historical trend between 1970–71 and 2011–12, during which logs consumed per person declined from around 1.3 cubic metres per person to 0.83 cubic metres per person (Figure 4).

In the business-as-usual scenario, total log availability in 2050–54 is projected to increase to around 33.0 million cubic metres (6 per cent above log availability in 2010–14). Log availability fluctuates significantly between 2010−14 and 2050−54, and is projected to peak at 36.0 million cubic metres in 2030–34. Total availability of hardwood sawlogs and veneer logs is projected to roughly equate to forecast log-equivalent consumption by 2050, while Australia's softwood sawlog and veneer log-equivalent consumption is forecast to slightly exceed projected log availability in 2030–34 and 2050–54. Overall, pulplog availability is projected to significantly exceed Australia's log-equivalent consumption of wood-based panels and paper and paperboard by 2050; however, most of the growth in consumption of pulplogs is for softwood species, while most of the growth in availability of pulplogs is hardwood species.

These comparisons are similar for the alternative scenarios modelled in this report. In the priority-to-productivity scenario, log-equivalent consumption is estimated to be around 28.5 million cubic metres in 2050 (5 per cent above the business-as-usual scenario). This is significantly less than projected log availability in 2050–54 (36.6 million cubic metres). In the constrained-wood-production scenario, log-equivalent consumption of wood products is estimated to be 25.2 million cubic metres in 2050, compared with projected log availability of 30.3 million cubic metres in 2050–54.

Overall, these estimates suggest that Australia's potential log supply is more than sufficient for domestic consumption requirements: log availability in 2050 (33.0 million cubic metres in the business-as-usual scenario) significantly exceeds forecast log-equivalent consumption (27.1 million cubic metres in the business-as-usual scenario). In general, Australia has sufficient sawlogs and pulplogs to match domestic consumption requirements. However, this simple comparison ignores the important role of trade in Australia's forestry sector. For many forest managers, export returns for their logs may exceed the stumpage prices they can receive by selling logs domestically. This may arise because they are not located close to domestic processors, because their log species or specifications do not match domestic processor requirements or because there is insufficient domestic processing capacity for all logs grown domestically. Similarly, for some processors it may be more profitable to export products than to sell them to the domestic market, while many consumers may choose imported wood products based on quality, price or other factors.

As highlighted by past trends in Australia's forestry sector, and as the results presented in Projections for Australia's forestry sector (chapter 5) confirm, trade in wood products will remain an integral part of Australia's wood processing and wood products consumption. Forest managers will base their decisions about the optimal use of forestry resources on domestic and international market factors. Their decisions about the appropriate area of forests utilised for wood production (particularly plantations) will be based on these market factors as well. Their decisions to expand or contract the production of logs domestically will be based on the potential returns available in all markets, both domestic and international. Hence, log production in Australia will not necessarily be correlated with future domestic consumption of wood products.

Table 9 Log-equivalent consumption and log availability, business-as-usual scenario

Log-equivalent consumption ('000 GRWE)	**2011–12**	**2030**	**2050**
Hardwood sawnwood and veneer	2 344	2 837	3 008
Softwood sawnwood and veneer	9 729	12 169	12 905
Wood-based panels	953	1 561	2 041
Paper and paperboard	5 716	7 615	9 105
Total log-equivalent consumption	18 742	24 183	27 059
Per person consumption	0.827	0.813	0.743
Log availability ('000 m^3/year)	**2010–14**	**2030–34**	**2050–54**
Hardwood sawlogs and veneer logs	2 579	3 242	3 047
Softwood sawlogs and veneer logs	10 128	11 657	11 261
Pulplogs	18 465	21 666	18 690
Total	31 172	36 041	32 997

Note: **GRWE** Gross roundwood equivalent, a measure of the log-equivalent of wood products. GRWE estimates based on wood products recovery rates and log input composition from the ABARES Forest Resource Use Model. The 2011–12 data for log-equivalent consumption is based on estimates available at the time of writing this report and may differ from data reported in ABARES biannual *Australian forest and wood products statistics*. Annual log availability is based on an average over a five year period. Source: ABARES datasets

Estimating investment potential in Australian wood processing

Investment in wood processing infrastructure is a key parameter influencing the future of Australia's forestry sector. Changes to the volume, type and quality of logs available over the long term, the emerging regions for future log supply and changes to markets and the types of wood products consumed will all contribute to potential for investment in Australian wood processing, as the forestry sector adapts to changing circumstances. The economic viability of investment in Australian wood processing will ultimately depend on the profitability of such investments.

Future investment may take many forms. Investments may represent wholly new mills (greenfield developments) or modifications and improvements to existing infrastructure (brownfield developments). Mills may be constructed to take advantage of additional log availability or may use current log supplies, leading to the replacement of existing processing facilities. New investments may also represent further downstream processing, providing a means to value-add to current domestic processing.

This section presents a brief summary of existing wood processing infrastructure in Australia and outlines the future investment options considered in this report. It also describes the analytical framework used to estimate the economic potential for some of these investment options.

Existing wood processing infrastructure

Australia's wood processing sector has undergone significant restructuring over the past 20 years. This has been the result of a range of market and policy factors, including: international investment trends in forest resources and processing infrastructure; changes to exchange rates and the costs of factors of production; and domestic and international regulations governing the management of forests and trade in wood products. Such trends will

continue to exert pressures, provide opportunities for domestic processing in Australia and affect the future of Australia's wood processing infrastructure.

Table 10 presents ABARES estimates of the number of wood processors operating or mothballed (not currently operating but with potential to re-open) in Australia at June 2013, along with their aggregated input or output capacity. Overall, Australia has an estimated 228 hardwood sawmills and 68 softwood sawmills, with capacity to process around 3 million and 10 million cubic metres of sawlogs, respectively. The hardwood sawmilling industry is characterised by a large number of relatively small mills, mostly in New South Wales, Queensland and Tasmania. Softwood sawmills tend to be large scale, with more than half Australia's processing capacity located in New South Wales and South Australia. Australia also has an estimated 22 relatively small native cypress sawmills in New South Wales and Queensland. The post and pole industry is distributed across most states, with average mill size similar to that of the cypress industry.

Australia has an estimated 26 wood-based panel mills, comprising all major panel products described in this report. The majority of these mills process softwood fibres, although several mills produce hardwood plywood and veneer, and one mill in New South Wales processes hardboard. The input capacities for these mills represent the total volume of fibre they are capable of processing, which may consist of pulplogs, sawmilling residues or a mixture of both.

Table 10 Wood processing capacity in Australia, 30 June 2013

Jurisdiction	Hardwood sawmill		Softwood sawmill		Cypress pine sawmill		Posts and poles	
	No. of mills	Input capacity '000m³	No. of mills	Input capacity '000m³	No. of mills	Input capacity '000m³	No. of mills	Input capacity '000m³
New South Wales	74	980	17	3 130	5	70	3	na
Victoria	34	670	9	1 880	0	0	7	160
Queensland	53	430	16	1 680	17	150	3	na
South Australia	0	0	19	2 560	0	0	0	0
Western Australia	16	350	3	na	0	0	3	na
Tasmania	51	640	4	630	0	0	2	na
Australia **a**	228	3 070	68	9 880	22	220	18	160
Jurisdiction	**Wood-based panels**		**Paper and paperboard**		**Pulp**		**Log and woodchip exports b**	
	No. of mills	Input capacity **c** '000m³	No. of mills	Output capacity kt	No. of mills **d**	Output capacity kt	No. of mills	Input capacity '000m³
New South Wales	7	1 100	5	1 730	3	na	3	na
Victoria	3	na	5	1 080	2	na	8	7 560
Queensland	6	800	3	na	1	na	3	na
South Australia	3	na	1	na	0	0	1	na
Western Australia	2	na	0	0	0	0	5	4 180
Tasmania	5	370	1	na	1	na	7	4 710
Australia **a**	26	2 270	15	2 810	7	na	27	16 450

Note: **a** Total does not include capacities of those jurisdictions with small numbers of processors. **b** Includes ports used for exporting woodchips from infield mobile chipping. **c** Total potential input capacity; actual input may be logs or residues. **d** Includes pulp machines co-located with paper mills and mills utilising recovered paper. **na** Not available – data for jurisdictions with small numbers of processors are included in modelling analysis but have not been provided in the table. Data in table represents mill numbers and capacities that operated or were mothballed during the 2012–13 financial year; modelling analysis presented in this report considered all such mills as available for processing logs and residues.

Source: ABARES datasets based on published sources

Australia is a relatively small producer of paper and paperboard products. Eight companies make up the bulk of Australia's pulp and paper production, with some operating integrated

facilities producing both pulp and paper products. Australia has an estimated 15 separate paper and paperboard mills and seven pulp mills (which may be integrated with the paper and paperboard mills and may include recovered pulp plants). The industry is characterised by limited competition between companies in final products and end-use markets. Recent expansion in plantation-based pulpwood and easier access to recovered paper are expected to be the main drivers of future investment in the Australian paper and paperboard industry. However, Australia is likely to continue relying on imported newsprint and printing and writing paper to meet domestic consumption needs. Approximate locations of existing wood processing infrastructure in Australia are presented in regional and national maps in Appendix C.

ABARES has used the primary product groups and average prices to model potential changes to Australia's forestry sector over the period to 2050. ABARES collects some generalised data relating to processing recovery rates for sawmills and some panel mills, and has derived recovery rates from other sources for other panel mills and paper and pulp facilities. Various assumptions have been made for estimating processing costs, wages, employment and depreciation rates. These assumptions are the result of ABARES research, surveys of wood processors and extensive workshops with industry and government stakeholders.

Future investment options

The log availability projections suggest substantial increases in the supply of some log types in some regions, and these may extend beyond existing processing capacity. The important question faced by Australia's forestry sector is how best to maximise the value of these logs and the forest and land resources producing them. This section examines some of the issues affecting the viability of domestic processing. It also assesses potential options for investments in additional processing capacity, based on the projected log demand (existing processing capacity) and supply (forecast log availability) balances in each state. Figure 16 and Figure 17 illustrate the differences between existing log processing capacity (in each state and by log type) and the projected annual average supply of logs in the business-as-usual scenario.

The economic viability of plantations in Australia will ultimately depend on the profitability of harvesting and processing these logs into wood products. This processing may take place in Australia or overseas. The former possibility implies that some investment in additional processing capacity, and modernisation of existing processing capacity, will be required over the period to 2050. The latter possibility implies that the returns from exporting raw wood fibre (either logs or woodchips) are sufficient to achieve land returns that exceed the potential returns for other land uses (such as agriculture).

As this is primarily a national-level study, many regional factors have not been incorporated. Many states and regions have distinct land use restrictions and environmental or development regulations associated with major infrastructure projects. Many investments may also require additional inputs or resources, such as available labour force, road or port infrastructure or water availability. These factors have not been modelled specifically in this report, although some have been considered when determining the set of investment options to model.

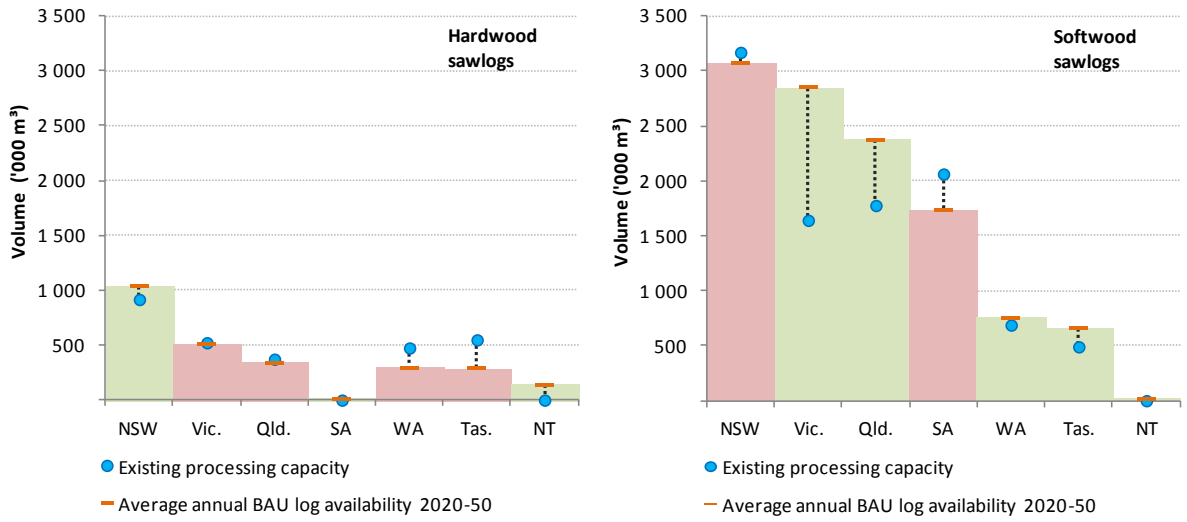
While the analysis in this report considers a limited set of investment options, it provides an appreciation of overall profitability based on broad log type availability, the main factors affecting this profitability and the potential impact on Australia's forestry sector. This analysis has been developed based largely on existing practices; future research can investigate a wider range of investment options, including many emerging opportunities for the industry such as bioenergy and carbon sequestration.

Sawlog availability and processing potential

Figure 16 illustrates the difference between existing sawlog processing capacity in each state, and the projected average supply of sawlogs between 2020 and 2050. Note that these are state aggregates and may disguise some regional differences within each state. Sawlog processing capacity includes sawmills, post and pole mills and veneer and plywood mills that process high quality logs (excluding hardwood peeler log veneer operations, but including laminated veneer lumber). Softwood sawlog availability excludes native species because there is no projected expansion in the availability of these logs and hence limited prospect for investment in processing capacity. The existing processing capacity presented in these graphs excludes log and woodchip export facilities. Thus some differences between availability and processing capacity may reflect the prevalence of current exporting activities for these log types. The purpose of this analysis is to illustrate the potential for further domestic value-adding, based on consideration of available logs alone.

The comparison presented in Figure 16 suggests potential for the expansion of softwood sawlog processing capacity in Victoria, Queensland and Tasmania, based on forecast softwood plantation log availability and existing infrastructure. In Victoria, the potential surplus of softwood sawlogs is estimated to occur in the Green Triangle region, although some of these logs may also be utilised by mills in South Australia and New South Wales. In Queensland, log availability estimates incorporate the long-term impacts of Cyclone Yasi (which made landfall in 2011) on long-term yield from softwood plantation forests. However, scope remains for expansion of processing capacity in Queensland over the 40-years to 2050. There is also some potential for additional softwood sawlog capacity in Tasmania and additional hardwood sawlog capacity in New South Wales and Northern Territory. Some additional hardwood sawmill options have also been included in the analysis to simulate the potential rationalisation of the industry that may occur (as it has historically in the softwood sawmilling sector) over the 40 years to 2050 towards more large-scale processing facilities (Figure 8).

Figure 16 Average annual sawlog availability in the business-as-usual scenario and aggregate existing input processing capacity, by log type and state, 2020–50



Note: **BAU** Business-as-usual scenario. Processing capacity includes sawnwood, post and pole and wood-based panels, and excludes raw materials such as woodchip and log export capacity. Green columns indicate insufficient existing capacity compared with projected log availability. Red columns indicate surplus existing capacity compared with projected log availability.

Based on this data and the factors discussed in this section, the analysis presented in this report assesses the potential for the following investments in sawlog processing capacity (the regions in brackets are from Map 1; see Table 11 for an explanation of mill types):

- large hardwood sawmill—New South Wales (Murray valley, North coast, Southern tablelands); Victoria (Murray valley); Northern Territory
- medium softwood sawmill—Victoria (Murray valley, Green Triangle); Queensland (North and central); Tasmania (Murchison)
- small softwood sawmill—New South Wales (North coast)
- hardwood ply—New South Wales (Murray valley); Victoria (Murray valley); Tasmania (Derwent, Huon, Murchison)
- softwood ply—New South Wales (Northern tablelands); Victoria (Green Triangle); Western Australia (South coast, Warren); Tasmania (Mersey); Queensland (North)
- laminated veneer lumber—New South Wales (Northern tablelands); Victoria (Green Triangle); Western Australia (South coast); Tasmania (Mersey).

Pulplog availability and processing potential

Figure 17 illustrates the difference between existing pulplog and residue processing capacity in each state and the projected average supply of pulplogs between 2020 and 2050. These have been aggregated across states and may disguise some regional differences within each state. The processing capacity considered in Figure 17 includes panel mills (particleboard, hardboard, MDF), peeler veneer operations and pulp manufacturing. Existing processing capacity presented in this figure excludes log and woodchip export facilities. The fibre availability presented depicts only log supply—many pulplog processors can also utilise chip residues from other manufacturers such as sawmills.

Overall, considerably more surplus pulplog is available relative to existing processing capacity, compared with surplus sawlog availability. This is because most existing hardwood pulplog processing facilities are geared towards woodchip exports and are excluded from the estimate for existing processing capacity presented in Figure 17. Hence, hardwood pulplog availability is projected to significantly exceed existing primary processing capacity in most states, with the exception of Queensland. The potential surplus availability of hardwood pulplogs exceeds 1 million cubic metres in four states: New South Wales, Victoria, Western Australia and Tasmania. While this suggests opportunities for development of large-scale production facilities (based on future wood fibre availability), other factors will dictate the economic feasibility of such investments, such as the potential market available for these products, prices attainable, costs of other production inputs and the hurdle rate for investment. These factors are considered in the modelling results in chapter 5.

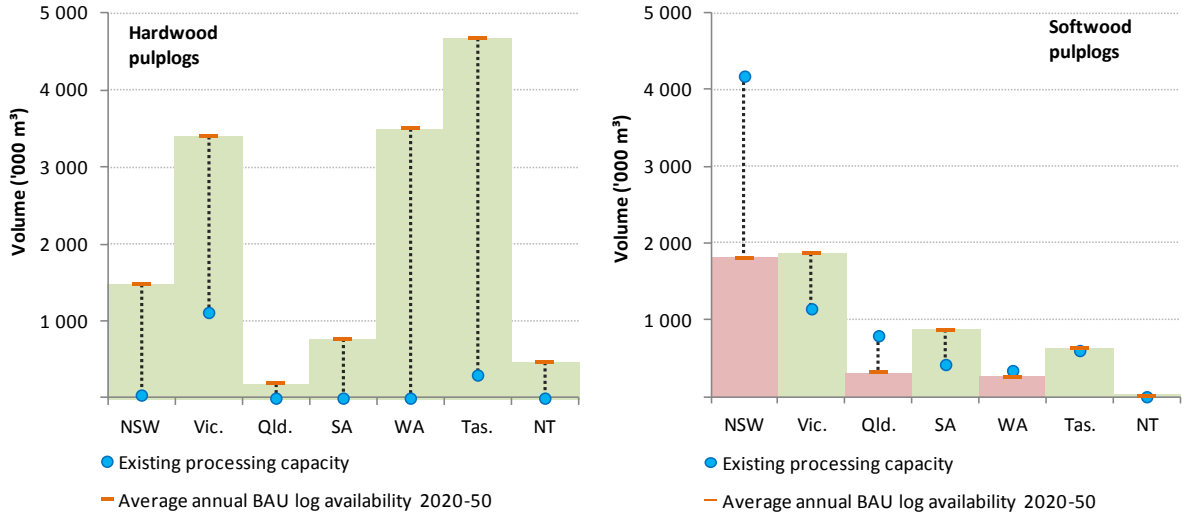
The projected surplus of softwood pulplogs is far smaller, with only Victoria and South Australia demonstrating potential for investment based on this resource. Many pulplog processing facilities also utilise sawmill residues; hence, the potential availability of softwood fibre is higher than indicated in Figure 17. While this additional resource is not incorporated in Figure 17, it is included in the modelling framework and provides additional scope for investment.

Based on this data, the analysis presented in this report will assess the potential for investments in the following options (the regions in brackets are from Map 1; see Table 11 for an explanation of mill types):

- peeler veneer—Tasmania (Bass, Huon)
- medium-density fibreboard or particleboard mills: New South Wales (Bombala); Victoria (Green Triangle, Murray valley); South Australia (Green Triangle)
- hardboard—New South Wales (North coast); Victoria (Central Victoria, East Gippsland, Murray valley); Queensland (South east); Western Australia (Warren); Tasmania (Derwent, Murchison)
- chemical hardwood pulp—New South Wales (North coast); Victoria (Green Triangle); Tasmania (Bass, Derwent, Murchison)
- mechanical (hardwood and softwood) pulp—South Australia (Green Triangle)
- paper – packaging and industrial—South Australia (Green Triangle)
- paper – printing and writing—Victoria (Green Triangle); Tasmania (Bass, Derwent, Murchison)
- recycled pulp (associated with paper options)—Victoria (Green Triangle), South Australia (Green Triangle); Tasmania (Bass, Derwent, Murchison).

ABARES assumed that all states (and the Northern Territory) have sufficient port capacity to expand log and woodchip export facilities where these products can be exported profitably. This is a simplifying assumption that may not reflect actual constraints affecting some port expansions in Australia. Table 11 provides more detail on inputs for the future investment options considered in this report.

Figure 17 Average annual pulplog availability in the business-as-usual scenario and aggregate existing input processing capacity, by log type and state, 2020–50



Note: **BAU** Business-as-usual scenario. Processing capacity includes wood-based panels and pulp and paper, and excludes raw materials such as woodchip and log export capacity. Green columns indicate insufficient existing capacity compared with projected log availability. Red columns indicate surplus existing capacity compared with projected log availability; some input capacity exceeds log availability because estimates include capacity to process wood residues.

These future investment options deliberately overstate the potential for new processing investments in Australia in order to provide an upper bound for the modelling analysis. The economic viability of investment opportunities within the modelling framework will depend on their ability to generate sufficient profits to offset both the capital costs of investment and the opportunity costs of wood fibre inputs (the potential profits that could be derived from selling potential wood fibre inputs into other markets). Because of the competition for wood fibre in the modelling framework, many of these wood processing investment options are likely to be found to be uneconomic in the modelling analysis.

Table 11 Investment options—modelling parameters

Mill type	Input capacity ('000 m^3)	Capital cost ($m)	Employment (FTE/unit output)	Input type
Utilising sawlogs				
Large hardwood sawmill	100	50	4.6	High and low quality hardwood plantation sawlog
Medium softwood sawmill	300	69	2.3	High quality softwood sawlog
Small softwood sawmill	100	30	2.3	High and low quality softwood sawlog
Hardwood ply mill	200	100	2.2	High quality hardwood native and plantation sawlog; hardwood veneer
Softwood ply mill	200	100	2.2	High quality softwood plantation sawlog; softwood veneer
Laminated veneer lumber	200	150	5.0	High quality softwood sawlog
Utilising pulplogs and residues				
Medium-density fibreboard	300	150	0.7	Softwood pulplog/residue
Particleboard	300	115	0.8	Softwood pulplog/residue
Veneer – peeler	160	30	0.7	Hardwood peeler log
Hardboard	150	60	5.2	Hardwood pulplog/residue
Chemical pulp – hardwood	3 000	2 300	1.0	Hardwood pulplog/residue
Mechanical pulp	700	1 300	1.0	Hardwood/softwood pulplog/residue
Recycled pulp	80	90	1.0	Recovered paper
Paper – packaging and industrial	3 600	400	1.0	Chemical/mechanical pulp – softwood; recycled pulp
Paper – printing and writing	3 600	400	1.0	Chemical pulp – hardwood; recycled pulp
Wood pellets	250	25	0.1	Hardwood pulplog/residue

Note: **FTE** Full-time equivalent. Source: ABARES datasets; ESD Consulting (2005); FFIC (2011); Gunns (2011); Industry Edge (2012); RISI (2007); URS (2012a)

In developing these investment options, ABARES evaluated surplus log availability and did not consider other factors such as electricity, water, labour or the environmental or social impacts of particular investments. Aside from assuming the potential for large-scale hardwood sawmills that use hardwood plantation logs, ABARES has not considered potential technological advances that may produce existing products from lower grade logs or new products from existing log

types. Nevertheless, the options presented reflect one necessary requirement of all future investment options: that they have sufficient access to wood or residue fibre over the long term.

Modelling approach

The analysis presented in this report uses the Forest Resource Use Model (FORUM), a modelling framework developed at ABARES to assess the optimal uses of Australia's forest resources for wood production under the assumptions described for each scenario. ABARES uses FORUM to project future harvest volumes, allocate logs among processors, assess future processing investment opportunities and determine the economically efficient mix of domestic production and net trade to meet Australia's future wood products consumption needs.

FORUM is a dynamic mixed-integer linear programming model that uses a cost–benefit analysis approach to simulate the flow of resources within the forestry sector and maximise returns from the use of the wood resource. The model used in this report maximises the aggregate profits in the forestry sector value chain, from harvesting to primary processing (including paper manufacturing). However, the present version of the model does not assess social and environmental values of forests, optimal land use change or forest management decisions, or the values of downstream processing and marketing of wood products.

Using this modelling framework, it is possible to measure and quantify the direct economic impact of changes in log availability, industry development options (at the local, regional, state and national level) and domestic and international market outlooks. FORUM links directly to other components of the forecasting analysis through its inputs and outputs (Figure 18).

FORUM uses ABARES spatial datasets relating to forest and wood processor locations to track the flow of wood resources from the forest to the mill and subsequently from mill to markets over a 40-year period, from 2010 to 2050. The purpose of the model is for each resource configuration to estimate an optimal allocation of logs to achieve the highest net return. FORUM considers the proximity and quality of logs as well as the available infrastructure and investment opportunities to determine the economic viability of harvesting available logs. These factors are considered using a range of parameters including harvesting costs, processing costs, mill types and recovery rates. Forests, wood processors and markets are mapped spatially and the transport costs between these locations are also incorporated in FORUM. Labour requirements across the value chain of the forestry sector are also calculated. The FORUM model has been described in previous studies (for example, Dann and colleagues 1997).

FORUM is implemented using GAMS (General Algebraic Modelling System) software (Brooke, Kendrick & Meeraus 1988). GAMS was designed in cooperation with the World Bank for large and complex mathematical programming models used in economic analysis.

Model assumptions

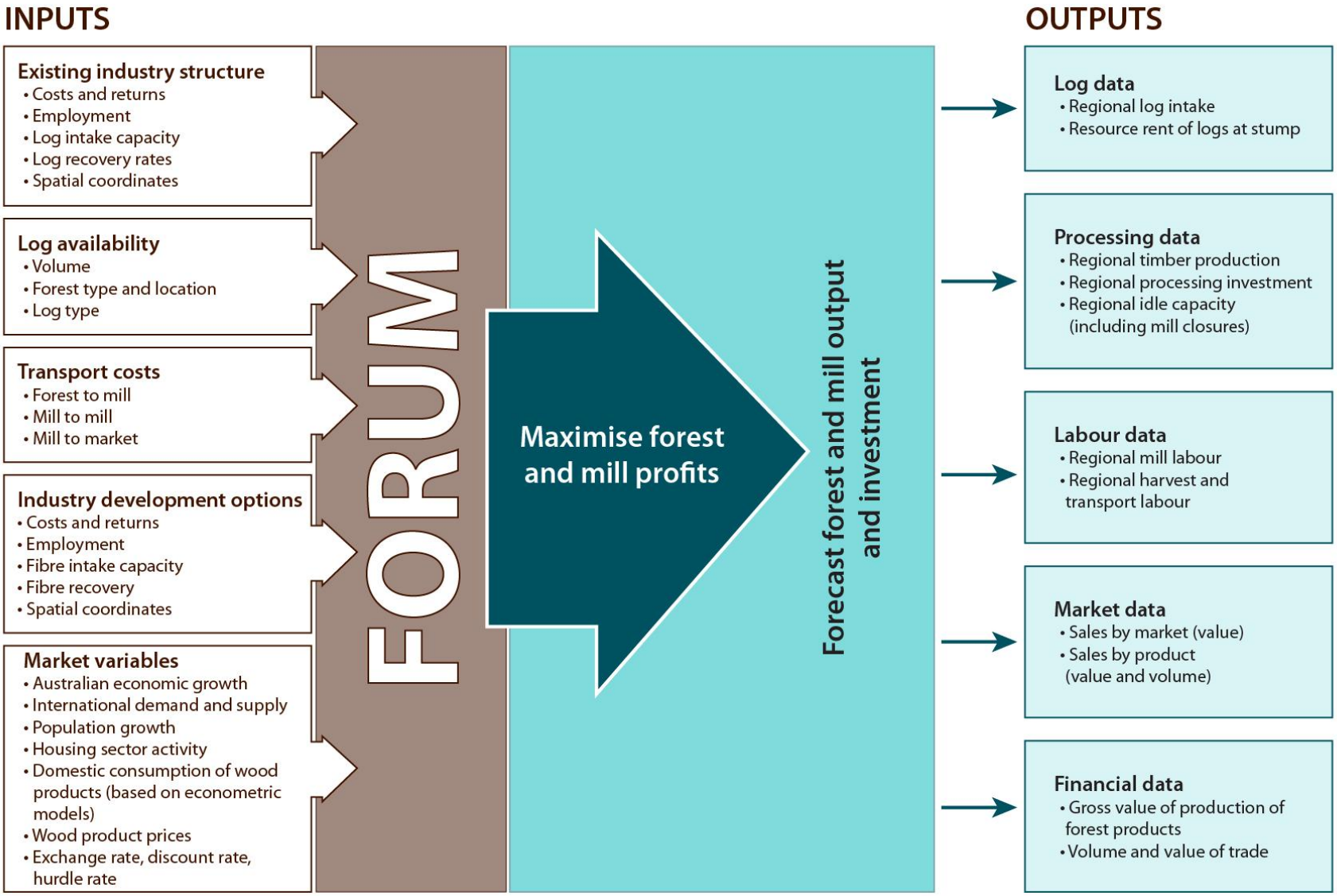
The FORUM simulations are based on several assumptions relating to wood resources, industry cost structures and wood markets. In particular, prices and costs are based on constant 2010 values (although projected future changes in real prices and costs will be assumed); net revenue is measured on a pre-tax basis; and trade and other policies, except where specified, are unchanged from those currently in place. Factors relating to forest management and timber processing, such as rotation lengths, wood conversion factors, real prices for end-use wood products and real per unit harvesting, processing, transport and investment costs are estimated outside the model. Australia is assumed to be a small trading nation in wood products, so wood product prices are determined by the rest of the world.

FORUM is a simplified modelling framework that reflects the resource allocation decisions made by people operating in the forestry sector. In the model, this allocation is based on profit-maximising assumptions only and does not necessarily reflect other considerations that may affect the allocation of logs among wood processors, such as supply agreements between forest managers and wood processors or information constraints. Some of these non-market considerations can be built into the FORUM framework; however, in general the modelling framework is a simplified abstraction from the complex range of considerations that comprise real-world resource allocation decisions.

The FORUM analysis uses several inputs estimated outside the model, also known as exogenous parameters. Outputs determined by the model are known as endogenous parameters. While FORUM endogenously determines the volume of logs harvested each year, the maximum volume is exogenously set as the log availability estimate (see previous section). However, forest managers or wood processors might stockpile logs between years, so some intertemporal endogeneity of log availability is allowed. Plantation development is assumed to be exogenous for each scenario developed. FORUM uses ABARES spatial datasets relating to forest and wood processor locations to analyse transport costs. Forests, wood processors and markets are mapped spatially and the transport costs between these locations are exogenous inputs incorporated in FORUM.

Wood product prices, comprising domestic and export prices, are assumed to be exogenous to the forest production estimates modelled in FORUM. It is assumed that domestic production will be set at a level where the marginal cost of production of each product equals these exogenous prices. As discussed in Chapter 1, the FORUM analysis for this forecasting project assumes that wood products imports and consumption are exogenous to FORUM (derived from structural econometric models independently of FORUM), while wood products output will be determined by the demand from domestic and export markets. The FORUM model was constrained to ensure that domestic production is sufficient to provide the domestic consumption less import market. Exports are assumed to be an additional market to which wood products will be delivered if export market prices are sufficient to compensate for the costs of production.

Figure 18 Structure of the Forest Resource Use Model (FORUM)



5 Projections for Australia's forestry sector

This section presents projections for key forestry sector parameters. Three scenarios are discussed: the business-as-usual, the priority-to-productivity and the constrained-wood-production scenarios. Log availability and consumption estimates are inputs estimated outside the model (exogenous). Other parameters presented in this section are outputs determined by the model (endogenous). Results are presented for selected years. Short-term results are omitted to avoid comparisons with short-term forecasts of wood commodities, which are based on factors that differ from the long-term parameters examined in this report.

Log harvest

Log availability in Australia is projected to increase from around 31.1 million cubic metres in 2011–12 to 36.0 million cubic metres by 2030, before declining to just below 33.0 million cubic metres by 2050. While the availability of these forest resources is an important component for future industry growth, several other factors will determine whether these logs are harvested and, if so, how they are processed.

In 2011–12 the volume of logs harvested from Australia's forests was around 23.5 million cubic metres, representing around 75 per cent of estimated log availability. This utilisation rate may reflect relatively weak economic conditions in global wood markets in recent years, or that some forest resources are located too far from wood processing infrastructure (and may only become economic when market prices for wood products are very high). In some years, log harvest may exceed availability, for example because positive market parameters favour increased log harvest. Also note that log availability in this report represents a five-year average, which is not necessarily a restriction on annual harvest levels. Over the projection period, ABARES projects a return to long-term trends in economic growth and wood products demand and consequent increases in log harvest above current levels.

Business-as-usual scenario

The aggregate volume of logs harvested is projected to fluctuate between 2020 and 2050, peaking at around 30.0 million cubic metres in 2030, before falling to around 28.3 million cubic metres by 2050 (Table 12) because of the reduced availability of wood from plantations. The estimated rate of log utilisation is projected to increase, reaching around 86 per cent by 2050.

Over the 40 years to 2050, native log harvest is projected to decline from levels in 2011–12 (Figure 19), in line with the projected decline in native forest log availability (based on state-level projections from public native forests and ABARES workshops on private native forests). Plantation log harvest is projected to increase strongly. Hardwood plantation harvest is projected to grow strongly in Victoria and Tasmania; and softwood plantation harvest is projected to increase in Victoria and South Australia.

The utilisation of logs differs by forest type. Over the projection period, more than 95 per cent of softwood logs are projected to be harvested. In contrast, less than three-quarters of native forest logs and hardwood plantation logs are projected to be harvested. The relatively low utilisation of hardwood plantation logs is a result of the lack of commercial incentives for harvesting and processing some of these logs under business-as-usual scenario assumptions—despite a projected increase in availability. Similarly, a large proportion of native forest pulplogs is

projected to remain unutilised because of the assumed lack of profitable markets for these logs (based on current conditions). However, potential changes to markets outside the parameters assumed in this analysis may provide market opportunities for hardwood pulplogs. For example, the development of bioenergy and new composite product markets may offer a profitable and reliable income for forest growers and sawmills under the right market and policy conditions.

Table 12 Projected volume of logs available and logs harvested in Australia, business-as-usual scenario, 2011–12 to 2050

Forest and log types	Log availability ('000 m³/year)				Log harvest ('000 m³)			
	2011–12	2020	2030	2050	2011–12	2020	2030	2050
Native forests								
Sawlog	2 397	2 228	2 145	2 326	2 159	1 977	1 899	2 116
Pulplog	3 612	3 374	3 016	3 032	2 485	1 735	1 700	1 924
Hardwood plantation								
Sawlog	182	405	824	508	85	339	588	443
Pulplog	9 260	12 338	12 836	10 426	4 981	9 234	9 173	7 698
Softwood plantation								
Sawlog	10 128	9 867	11 406	11 014	8 505	9 599	10 922	10 507
Pulplog	5 593	6 020	5 814	5 693	5 283	5 850	5 681	5 575
Total	**31 172**	**34 232**	**36 041**	**32 997**	**23 497**	**28 734**	**29 963**	**28 262**

Note: Pulplog includes peeler logs. Annual log availability is based on an average over a five year period.

Priority-to-productivity scenario

Under more favourable economic conditions in the priority-to-productivity scenario, log harvest is projected to reach 32.1 million cubic metres by 2050 (Table 13), representing around 88 per cent of total log availability. The gains in log harvest (relative to the business-as-usual scenario) are shared across all forest types; in 2050 native log harvest is 28 per cent higher, hardwood plantation log harvest is 20 per cent higher and softwood plantation log harvest is 7 per cent higher (Figure 19).

Table 13 Projected volume of logs available and logs harvested in Australia, priority-to-productivity scenario, 2011–12 to 2050

Forest and log types	Log availability ('000 m³/year)				Log harvest ('000 m³)			
	2011–12	2020	2030	2050	2011–12	2020	2030	2050
Native forests								
Sawlog	2 397	2 596	2 522	2 756	2 159	2 303	2 226	2 468
Pulplog	3 612	3 907	3 863	4 182	2 485	2 163	2 240	2 700
Hardwood plantation								
Sawlog	182	506	1 054	663	85	419	782	599
Pulplog	9 260	13 484	14 006	11 405	4 981	10 404	10 489	9 183
Softwood plantation								
Sawlog	10 128	10 366	12 012	11 594	8 505	10 003	11 616	11 237
Pulplog	5 593	6 339	6 140	6 003	5 283	6 157	5 996	5 950
Total	**31 172**	**37 198**	**39 596**	**36 605**	**23 497**	**31 449**	**33 351**	**32 136**

Note: Pulplog includes peeler logs. Annual log availability is based on an average over a five year period.

Constrained-wood-production scenario

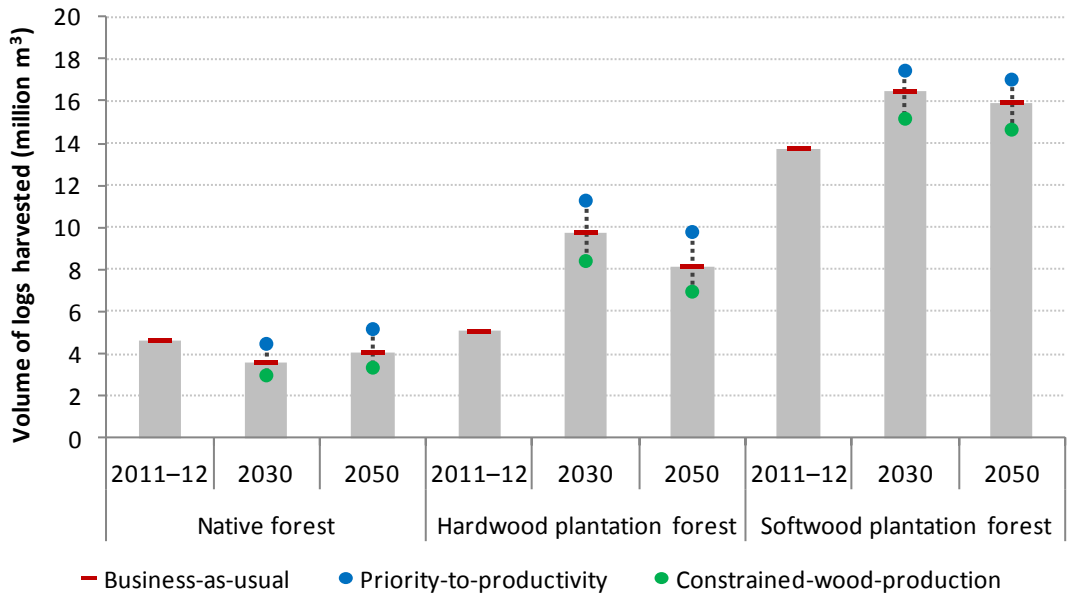
In the constrained-wood-production scenario, lower availability of logs and wood-product consumption limit the volume of logs harvested over the projection period. Harvest volume is projected to increase marginally from 23.5 million cubic metres in 2011–12 to 25.1 million cubic metres in 2050 (Table 14). In this scenario, 83 per cent of the assumed logs available are harvested. Reductions in log harvest (relative to the business-as-usual scenario) are shared across all forest types; in 2050 native log harvest is 17 per cent lower, hardwood plantation log harvest is 15 per cent lower and softwood plantation log harvest is 8 per cent lower (Figure 19). Compared with the business-as-usual scenario, the volume of hardwood plantation sawlogs harvested increases in this scenario, representing a substitution away from native forest sawlogs.

Table 14 Projected volume of logs available and logs harvested in Australia, constrained-wood-production scenario, 2011–12 to 2050

Forest and log types	Log availability ('000 m³/year)				Log harvest ('000 m³)			
	2011–12	2020	2030	2050	2011–12	2020	2030	2050
Native forests								
Sawlog	2 397	1 943	1 905	2 094	2 159	1 701	1 658	1 843
Pulplog	3 612	2 716	2 620	2 883	2 485	1 318	1 311	1 493
Hardwood plantation								
Sawlog	182	819	924	815	85	729	682	623
Pulplog	9 260	10 789	11 268	9 067	4 981	7 826	7 720	6 324
Softwood plantation								
Sawlog	10 128	9 130	10 518	10 178	8 505	8 937	10 141	9 711
Pulplog	5 593	5 534	5 343	5 236	5 283	5 355	5 164	5 071
Total	**31 172**	**30 931**	**32 578**	**30 272**	**23 497**	**25 865**	**26 677**	**25 066**

Note: Pulplog includes peeler logs. Annual log availability is based on average annual log availability over a five year period.

Figure 19 Projected volume of logs harvested in the three outlook scenarios, 2011–12 to 2050



Future investment and volume of logs used

One of the most important factors that will determine the value and contribution of Australia's forestry sector over the long term is the extent and type of investment that occurs in domestic wood processing infrastructure. Ongoing investment will play a key role in maintaining productivity growth and enabling the sector to adapt to changing resource and market conditions. Investment also contributes directly to national and regional economies through the value-added and employment generated. A key issue for Australia is whether the large projected increase in supply of wood from plantation forests (particularly hardwood) over the coming decades will be processed domestically or exported overseas as logs and woodchips. This issue will be directly influenced by the extent and type of future investment.

An economic assessment of investment options is therefore an essential component of long-term analyses. The economic competitiveness of wood processing investment options is considered explicitly in FORUM, based on forecast log availability, estimates of existing infrastructure, market analysis of the costs of investment and processing and the returns from selling wood products. Only a limited set of investment options was considered for this analysis because detailed investment and processing cost data were not available for some wood processing technologies. In particular, this analysis has not considered bioenergy options (other than wood pellets) or engineered wood products technologies. Under certain conditions these technologies may become suitable for Australia's future forest resources and markets. Additionally, investment analysis has been undertaken for a limited set of outlook scenarios. The economic feasibility of the investment options considered in this report is assessed only for the scenarios described in this report; however, these investment options may be more or less favourable under alternative scenario assumptions not considered in this report.

Business-as-usual scenario

In the business-as-usual scenario, ABARES projects sufficient economic returns to support ongoing investment in Australia's wood processing infrastructure, predominantly in sawmills and panel mills utilising both softwood and hardwood resources (Map 2). Investment is projected in four new large-scale hardwood sawmills over the period to 2050, in New South Wales and the Northern Territory. Some of these mills are likely to replace existing capacity, but this will not lead to a significant increase in hardwood sawnwood output. Additional softwood sawmills are also projected in New South Wales, Queensland and Victoria. Economic potential is projected for investment in plywood mills in New South Wales, Victoria and Tasmania, additional particleboard mills in New South Wales and Victoria and an additional laminated veneer lumber mill in Western Australia.

The majority of logs used by domestic processors continue to be sourced from softwood plantations, while the majority of hardwood logs continue to be exported in the form of raw materials such as logs or woodchips (Figure 20). An increasing volume of logs, particularly from softwood plantations, is projected to be directed to the panels sector, driven by investment in plywood and particleboard mills. This is based on forecast future growth in demand for wood-based panels, particularly structural panel products, which are assumed to have increased uses in housing construction over the projection period.

In 2050 around 28.3 million cubic metres of logs are projected to be harvested from Australia's forests, of which 63.2 per cent are used domestically. The remainder are exported as logs and woodchips. This projection is sensitive to the range of investment options considered. For example, if wood processing technologies that utilise Australia's forecast pulplog availability

(particularly from hardwood plantation resources) were analysed, the proportion of logs used domestically may be higher than projected in this analysis.

Priority-to-productivity scenario

The more favourable economic conditions assumed in the priority-to-productivity scenario (such as a lower hurdle rate for investment, increased log availability and higher domestic demand for wood products) are projected to induce higher investment in panel mills relative to the business-as-usual scenario (Map 3). While business-as-usual investments in sawmills and panel mills are projected to remain feasible in this scenario, potential exists for additional plywood mills in New South Wales and Western Australia, a medium-density fibreboard (MDF) mill in Victoria, hardboard mills in Western Australia and Queensland, and a particleboard mill in South Australia.

In 2050, 32.1 million cubic metres of logs are harvested in this scenario, around 3.9 million cubic metres more than in the business-as-usual scenario. This scenario estimates a 72 per cent increase in the volume of logs processed by the domestic panels sector by 2050 (Figure 20), based on the supplementary investment in medium-density fibreboard and hardboard mills. In contrast to the business-as-usual scenario, this increased competition for logs reduces the volume of logs processed by the domestic pulp and paper sector. Overall, around 61.9 per cent of logs harvested are used domestically in 2050, with the rest exported as logs and woodchips.

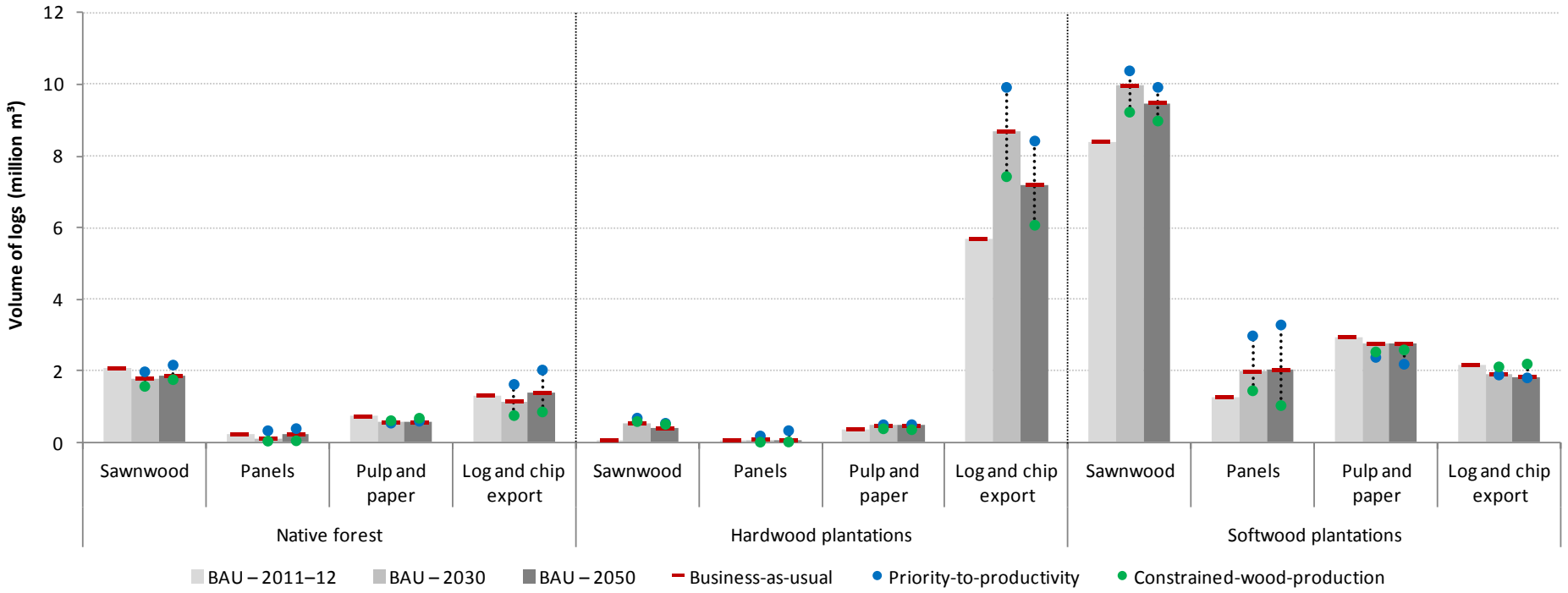
The results for mill development options presented in this scenario reflect the scenario assumptions relating to lower costs of production, lower hurdle rates and higher log availability and domestic demand for wood products. However, these results should not be considered as the only potential mill development that may occur. In reality several factors can positively or negatively affect the economic potential of these investments and whether or not they occur.

Constrained-wood-production scenario

In contrast, less favourable economic conditions in the constrained-wood-production scenario (such as higher hurdle rates and higher processing costs) lead to reduced investment in panel mills relative to the business-as-usual scenario (Map 4). While the sawmill investments projected to be economic in the business-as-usual scenario remain feasible in this scenario, economic potential is projected for only two additional plywood mills in this scenario, in Victoria and Tasmania. No particleboard mills are estimated to be economically feasible in this scenario.

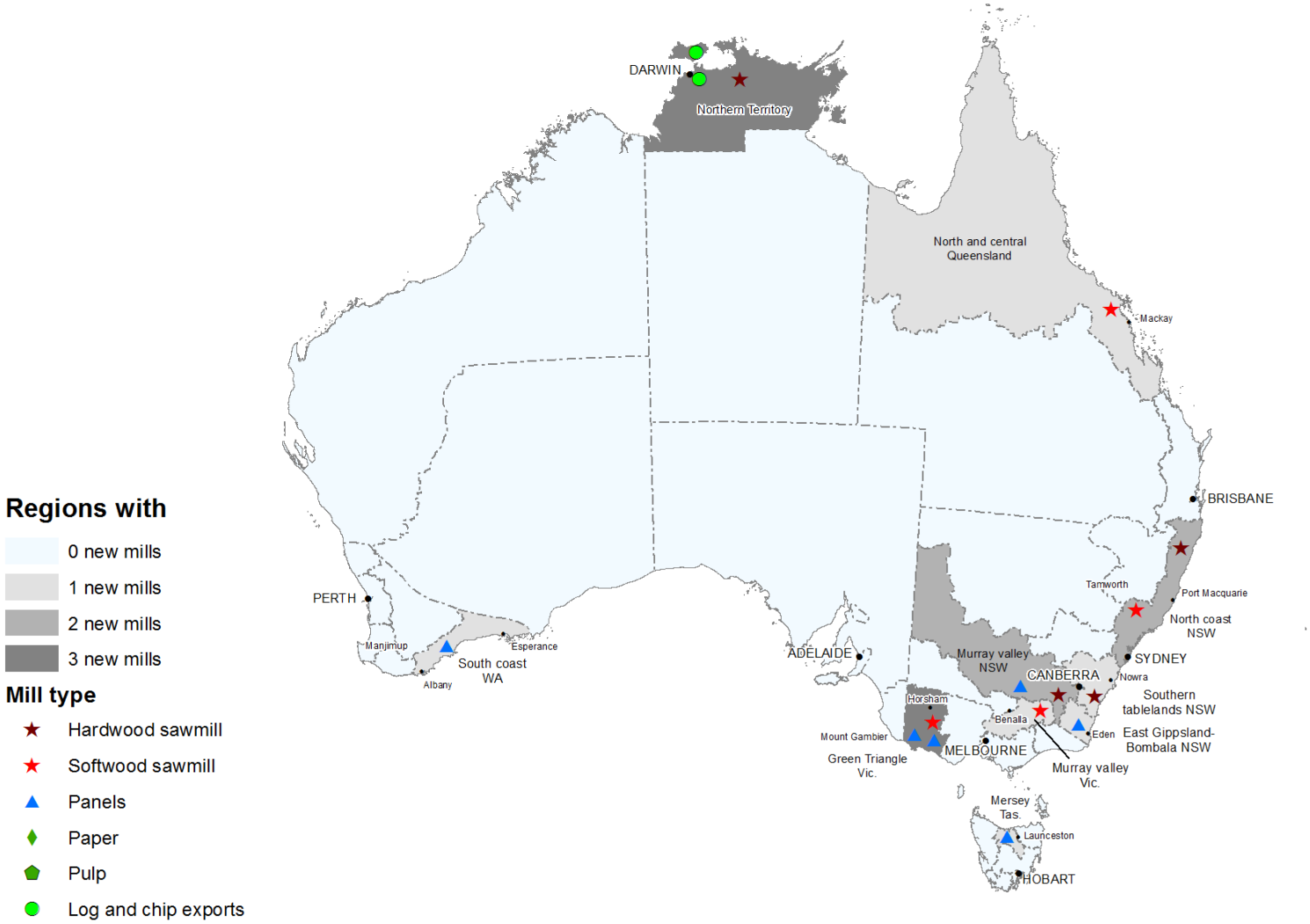
While the total volume of logs harvested in 2050 (around 25.1 million cubic metres) is projected to be 11 per cent lower than in the business-as-usual scenario, the volume of logs used in panels manufacturing is projected to be 53 per cent lower than in the business-as-usual scenario, as a result of the lower level of investment in this sector. Overall, the proportion of logs used domestically is 63.7 per cent in the constrained-wood-production scenario, which is slightly higher than the business-as-usual scenario. This is because of a projected 12 per cent decline in the volume of harvested logs exported as woodchips or roundwood by 2050.

Figure 20 Projected volume of logs used by forestry sector, by forest type and outlook scenario, 2011–12 to 2050



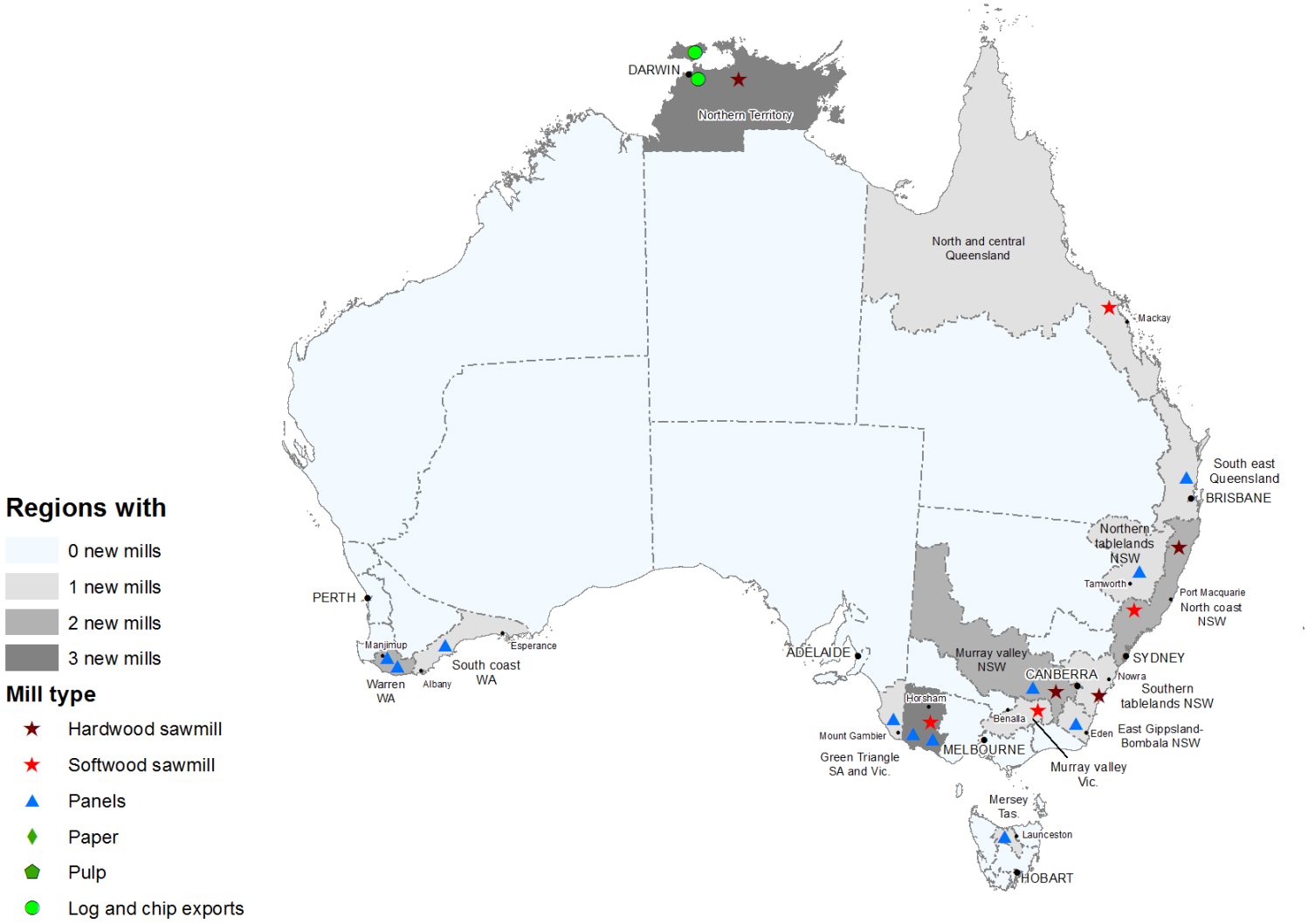
Note: **BAU** Business-as-usual scenario.

Map 2 Projected investment in domestic processing, business-as-usual scenario, 2015 to 2050



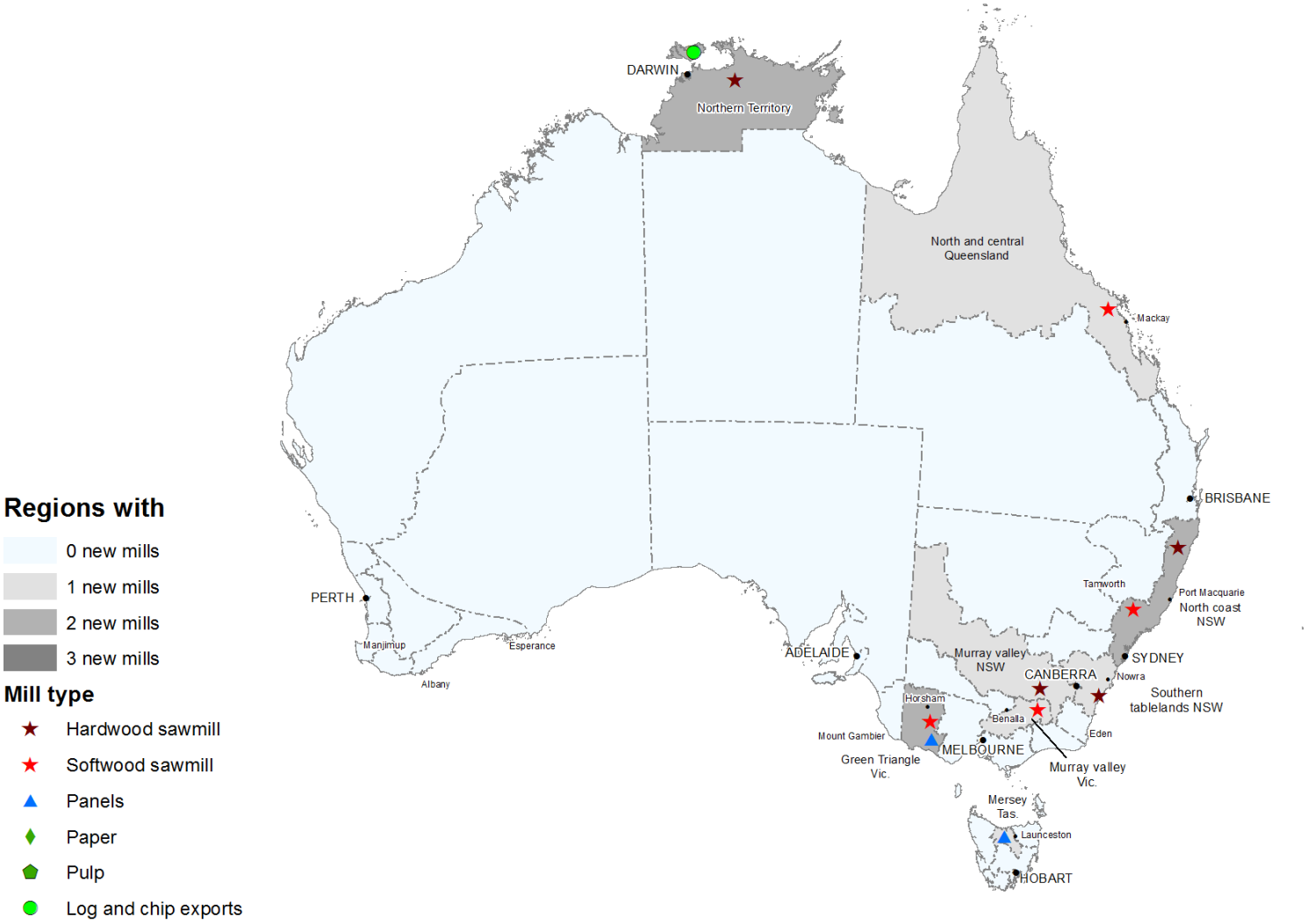
Note: Regions were constructed specifically for this analysis. Not all mill types were profitable in this scenario and they may not appear on the map.

Map 3 Projected investment in domestic processing, priority-to-productivity scenario, 2015 to 2050



Note: Regions were constructed specifically for this analysis. Not all mill types were profitable in this scenario and they may not appear on the map.

Map 4 Projected investment in domestic processing, constrained-wood-production scenario, 2015 to 2050



Note: Regions were constructed specifically for this analysis. Not all mill types were profitable in this scenario and they may not appear on the map.

Domestic wood products output

Business-as-usual scenario

As a result of the changes to log harvest and wood processing investment discussed in the previous section, production of major wood-based commodities is projected to increase under business-as-usual scenario assumptions over the period to 2050 (Figure 21). However, some divergent trends exist within these broad commodity groups. While production of softwood sawnwood is estimated to increase strongly, production of hardwood sawnwood is estimated to remain relatively stable. This is because restricted native forest hardwood sawlog supply is partially offset by increased supply of hardwood sawlogs from plantation forests and new investments in hardwood processing capacity replace older, existing infrastructure.

Production of domestic plywood and particleboard is projected to increase, driven by increased investment in processing facilities and forecast strong domestic consumption growth for these products. In contrast, domestic production of medium-density fibreboard and hardboard is projected to remain relatively weak as a result of competitive imports and a lack of investment in new capacity for these products (Figure 21).

Paper production is not projected to change substantially from current levels because no additional investment in pulp or paper capacity is projected under business-as-usual scenario assumptions. Consumption of paper products is forecast to remain strong and sufficient resources are available to support increased output. However, the modelling indicates that, under the parameters assumed in this scenario, profitability in Australia's paper sector is insufficient to promote additional processing capacity investment and output. Hence, an increasing share of domestic paper consumption is estimated to be sourced from imports.

Priority-to-productivity scenario

Favourable economic conditions in the priority-to-productivity scenario are projected to mainly benefit the wood-based panel sector. Additional investments enable enhanced output of plywood and medium-density fibreboard and, to a lesser extent, hardboard. Particleboard output is estimated to decline slightly in 2030, relative to the business-as-usual scenario, as a result of competition for wood fibre with other processors such as medium-density fibreboard. As with the business-as-usual scenario, limited change is projected in paper manufacturing output (Figure 21).

The results suggest that, even under the more favourable assumptions used in this scenario, the economic competitiveness of new pulp and paper facilities in Australia is uncertain. This does not mean that such investments will not or cannot occur; the actual competitiveness of new pulp or paper mills will depend on a range of assumptions broader than those examined in this scenario and may change as the costs of resources, investments or processing technologies change. For example, this scenario assumes that the terms of trade for forestry products are unchanged from current levels; hence, imported paper products remain very competitive compared with domestic paper products. Under alternative assumptions not analysed in this report, investments in pulp and paper mills may be feasible. Nevertheless, these results suggest that several factors will constrain the viability of pulp and paper investments in Australia, in particular the scale of investment (and log supply) required and the competitiveness of international markets (and hence imports) for these products.

Constrained-wood-production scenario

The constrained-wood-production scenario provides a lower range estimate for wood products output, based on a projected decline in softwood, sawnwood and panel output relative to the business-as-usual scenario. Production of panels appears to be particularly sensitive to the changes in this scenario, with particleboard and medium-density fibreboard production down by over 65 per cent by 2050 (compared with the business-as-usual scenario) and hardboard production ceasing entirely. Production of all paper grades appears to be relatively resilient to the changes in this scenario, with only small decreases in newsprint and packaging and industrial paper manufacturing (Figure 21). This partly reflects the large scale and competitive returns of paper production compared with panel production. Availability of hardwood and softwood pulplogs is reduced in this scenario, which increases the competition for these logs between processors. Thus paper production is projected to retain access to the remaining wood fibre, while domestic panel producers lose access to some fibre inputs and hence have to reduce output.

Other wood products

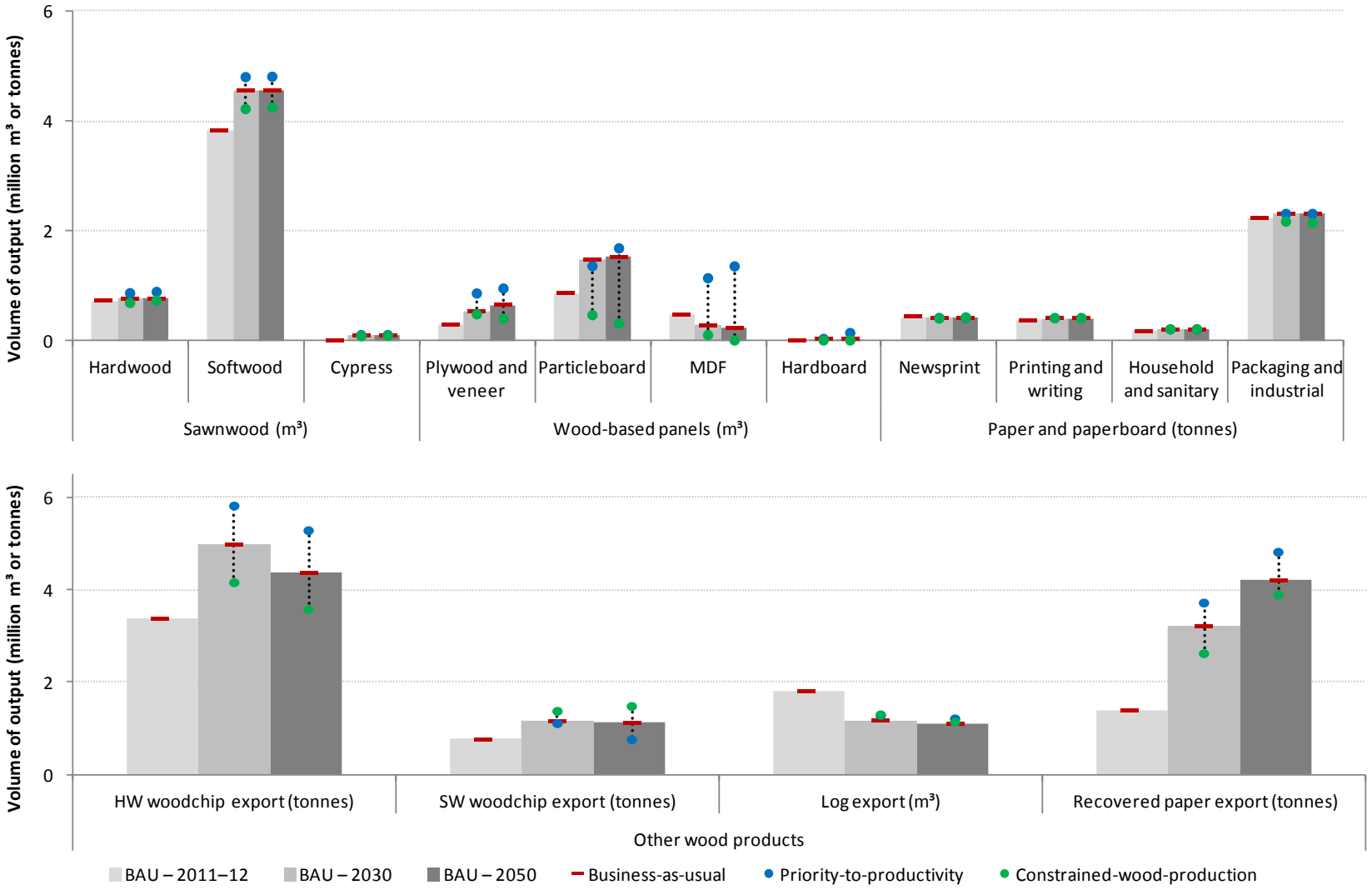
Figure 21 also shows projected exports of raw materials such as logs, woodchips and recovered paper. These raw materials are inputs for domestic production. However, if returns from domestic production are limited (for example, as a result of low domestic demand), these materials may be exported if returns in overseas markets are more profitable.

Availability of recovered paper is linked to domestic consumption of paper products. In the business-as-usual scenario, while consumption of paper products and availability of logs is forecast to increase, no additional investment in paper manufacturing is projected, leading to relatively stable production of paper (and demand for recovered paper as an input to paper production) over time. As a result of increasing availability of pulplogs and domestic paper consumption, this scenario assumes an excess supply of inputs used for paper production; thus exports of hardwood woodchips and recovered paper are projected to increase.

In the priority-to-productivity scenario, exports of hardwood woodchips and recovered paper are even higher than in the business-as-usual scenario because log availability and paper consumption (which represents the future supply of recovered paper) are assumed to be higher, while domestic paper production does not increase significantly. In comparison, exports of softwood woodchips decrease marginally as these inputs are used in greater volumes for domestic production.

In the constrained-wood-production scenario, log availability and paper consumption are considerably reduced, thereby decreasing the volume of hardwood logs and recovered paper available for exports. In contrast, lower domestic processing of softwood in this scenario leads to an increase in the export of softwood woodchips (Figure 21).

Figure 21 Projected volume of wood products output in the three outlook scenarios, 2011–12 to 2050



Note: **BAU** Business-as-usual scenario. **HW** Hardwood. **SW** Softwood. **MDF** Medium-density fibreboard.

Consumption, production and trade of wood products

Consumption of wood products is estimated outside (exogenous to) the FORUM modelling framework and is derived from projections described in Gupta and colleagues (2013). The FORUM framework explicitly considers the competitiveness of domestic wood processing with imports and within export markets, and hence projects Australia's production and net trade to balance the domestic supply and demand of wood products.

Business-as-usual scenario

In the business-as-usual scenario, ABARES projects that the modest forecast growth in aggregate sawnwood consumption to 2030 will be met by increased domestic production. In the period after 2030 domestic sawnwood production is projected to remain relatively stable and net imports to increase in order to meet domestic consumption requirements (Figure 22). For wood-based panels, domestic production is projected to increase but is insufficient to meet the strong forecast growth in consumption; hence, panel imports are expected to bridge the difference and increase strongly. Australia's paper production is projected to remain stable, increasing marginally over the period to 2050. As a result, growth in domestic consumption is projected to be met by a large increase in paper imports.

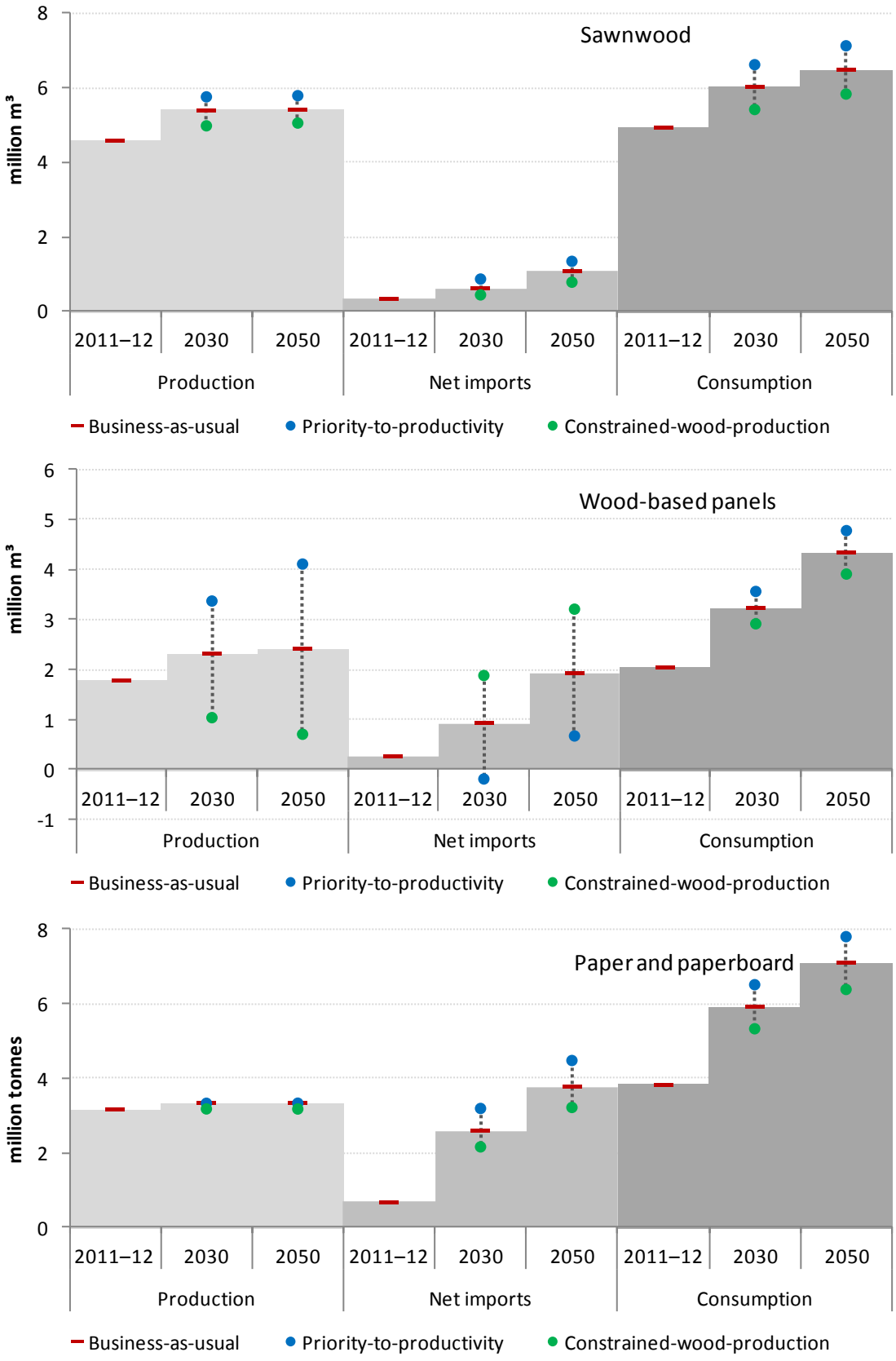
Priority-to-productivity scenario

In the priority-to-productivity scenario, favourable domestic economic conditions are assumed to lead to higher consumption of wood products than in the business-as-usual scenario. Additional consumption of sawnwood and panel products is projected to be met largely by higher domestic production, while additional paper and paperboard consumption is almost entirely met by imports (Figure 22). The increased investment in the processing capacity of domestic panels results in a substantial increase in domestic production, resulting in the projected increase in production exceeding the increase in consumption. Consequently, exports of panels are projected to increase significantly, reducing net imports in 2030 and 2050.

Constrained-wood-production scenario

Together with lower log availability, the assumed lower domestic consumption of wood products in the constrained-wood-production scenario contributes to reduced domestic production of sawnwood. Consumption of paper products is also lower than in the business-as-usual scenario and is primarily accounted for by a reduction in imports of paper products. In contrast to the business-as-usual scenario, this scenario projects lower investment in the processing capacity of domestic panels and reduced competitiveness of panel mills, leading to a substantial fall in domestic production of these products and a consequent increase in imports to meet domestic consumption needs.

Figure 22 Projected consumption, production and trade of wood products for the three outlook scenarios, 2011–12 to 2050



Turnover, value-added and employment

The analysis in this report includes only a portion of the total value chain of forestry production in Australia and omits some downstream value-added parts of the forestry sector such as structural components, prefabricated buildings and timber wholesaling and retailing. Hence, the values of production, value-added and employment in this report are lower than those reported for the forestry sector in ABARES *Australian forest and wood products statistics* (AFWPS) report. The subsectors covered in this report correspond to around 61 per cent of the forestry sector's turnover and 66 per cent of the sector's industry value-added (IVA) as reported in the AFWPS. Similarly, some employment is not included in this analysis because it does not cover forest management and support services and downstream parts of the industry, particularly those involved in wholesaling, retailing and value-adding. Nevertheless, the trends exhibited here are representative of the primary aspects of the sector, which would also affect downstream value-adding processes.

Business-as-usual scenario

Forestry sector turnover is projected to grow relatively strongly to 2050 (Figure 23). The turnover of sawnwood and wood-based panels generally moves in line with projected output over the period to 2050; sawnwood turnover remains relatively static and panel turnover increases. Most of the projected growth in turnover is a result of the assumed increase in the price of packaging paper, which leads to higher paper turnover despite little change in output and a decline in prices of other paper grades.

Industry value-added generated in the forestry sector is also projected to increase (to around $7.1 billion in 2050). As this growth is not projected to match Australia's assumed gross domestic product (GDP) growth over the projection period (Commonwealth of Australia 2011), the relative contribution of the forestry sector to Australia's GDP is projected to decline from around 0.36 per cent in 2011–12, to 0.22 per cent in 2050 (Figure 24). In the modelling, all changes to aggregate value-added are assumed to be reflected in changes to log prices. As a result, in FORUM the projected changes to aggregate value-added are primarily reflected in the forestry and logging subsector. In reality, changes to value-added will be distributed across the value chain.

Employment is projected to increase in the sawmill and panels sectors, driven by investment in new wood processing facilities. Modelled forestry sector employment is projected to increase from 23 850 in 2011–12 to 28 780 in 2050 (Figure 25). Employment estimates in this analysis include people involved in harvest and haulage of logs and the primary processors described in this report (sawmills, panels, pulp and paper and log and woodchip exports). The figures exclude employment in forest management and services and in downstream wood products activities, such as further manufacturing and timber wholesaling and retailing. Hence, the employment estimates provided here represent only a proportion of employment estimates provided in the AFWPS (Figure 7).

Priority-to-productivity scenario

As a result of additional investment in domestic wood processing in this scenario, industry value-added is higher (around $8.7 billion by 2050) than in the business-as-usual scenario. The economic contribution of the forestry sector to Australia's GDP is at around 0.27 per cent, or 0.05 percentage points above the business-as-usual projection in 2050 (Figure 24).

The increase in projected industry value-added to 2050 is largely driven by the panels sector, as a result of investment in medium-density fibreboard and hardboard mills. A large increase is

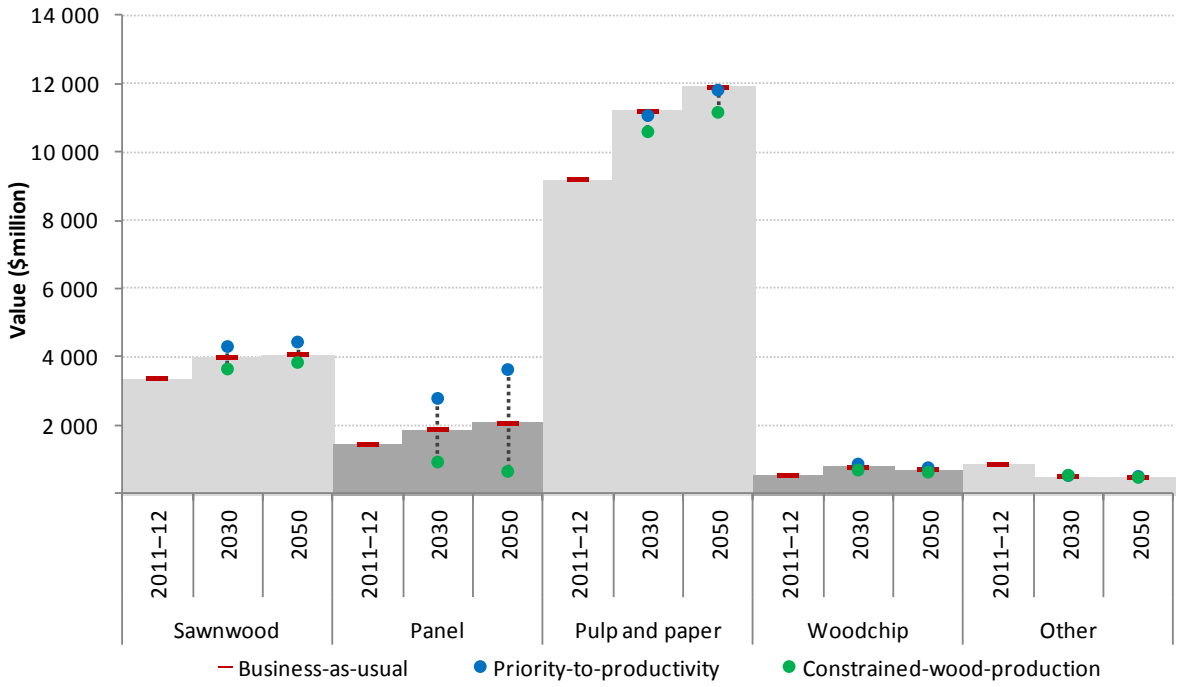
also projected in the contribution from the forestry and logging (for reasons noted previously in the Business-as-usual scenario) and sawnwood sectors. Similar trends are observed in projections for industry turnover in this scenario (Figure 23).

More favourable outlook for profits in this scenario will drive an increase in total direct forestry employment, primarily in the sawmill and panels sectors (Figure 25). Total modelled employment is estimated to increase from 23 850 in 2011–12 to 32 590 in 2050.

Constrained-wood-production scenario

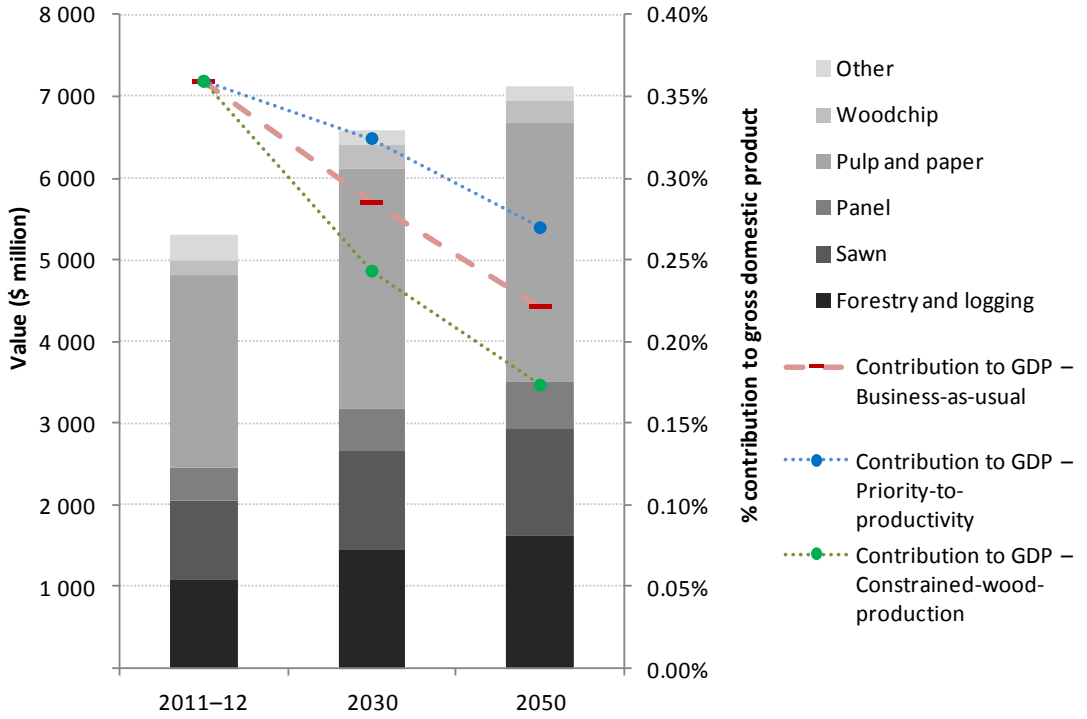
Reflecting tight economic conditions in this scenario, IVA of the forestry sector is lower (around $5.6 billion in 2050) than the business-as-usual scenario, as is the contribution to Australia's GDP (around 0.05 per cent below business-as-usual) (Figure 24). Most of the decrease in contribution is attributed to the forestry and logging, panels and paper subsectors. Similar trends are also observed in industry turnover (Figure 23). Total employment is projected to decrease, primarily in the sawmill and panel subsectors as a result of a reduction in logs processed (Figure 25).

Figure 23 Projected forestry sector turnover in the three outlook scenarios, 2011–12 to 2050



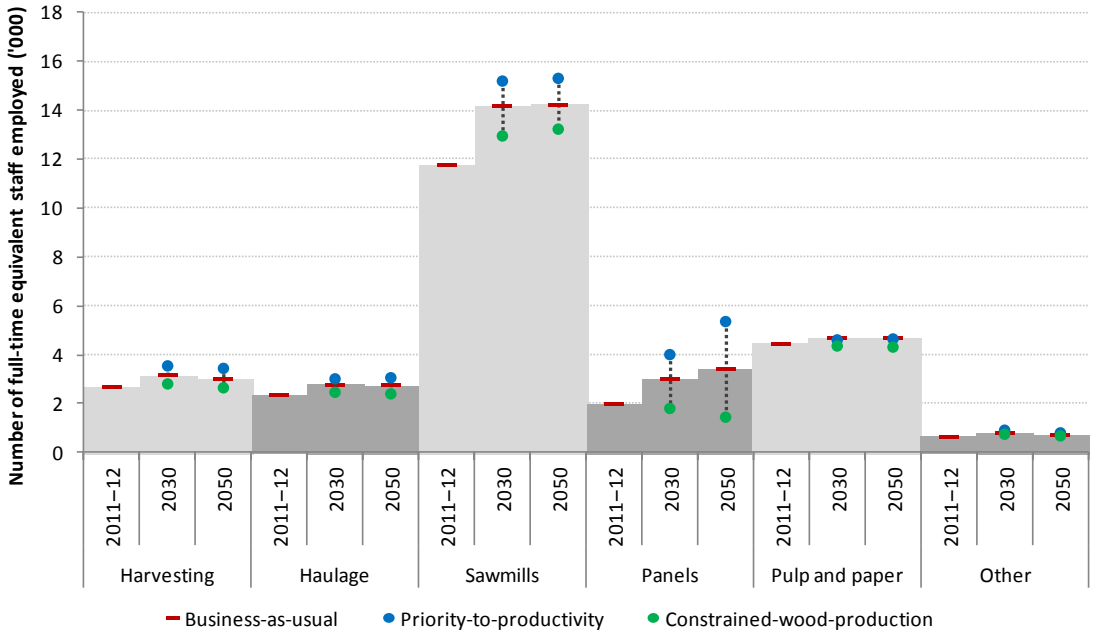
Note: Other includes sale of logs for export and sawmill residues. While industry value-added is cumulative across industries, the turnover graph is not stacked because there is some double-counting across industries of the forestry sector. Value in grey columns shows results for business-as-usual scenario.

Figure 24 Projected forestry sector value-added in the three outlook scenarios, 2011–12 to 2050



Note: **GDP** gross domestic product. Industry value-added (IVA) in forestry and logging assumes all changes in forestry sector profitability are reflected in log stumpage values. In reality, changes to value-chain profits will be shared between forest managers and wood processors, so some forestry and logging IVA presented here will instead be realised by downstream processors. Other includes sale of logs for export and sawmill residues. Contribution to gross domestic product differs to that presented in ABARES (various years) due to different definitions of forestry sector. Values in grey columns show results for business-as-usual scenario.

Figure 25 Projected employment in the forestry sector in the three outlook scenarios, 2011–12 to 2050



Note: Other primarily comprises woodchip export processing facilities. Grey columns show results for the business-as-usual scenario.

6 Sensitivity analyses

This report also examines the influence of selected key parameters on the performance of Australia's forestry sector. Table 15 details the parameter assumptions designed to investigate three areas of interest:

- the importance of resource availability to the forestry sector's outlook
- the implications of changing forestry terms of trade in isolation
- the impact of higher investment hurdle rates (which represent a risk premium) on forestry sector investment.

The sensitivity analyses were constructed to examine specific parameter changes without assessing flow-on effects on other model inputs. For example, a change in terms of trade is assumed to have no effect on log availability, such as through changes to forest management or land use change. Future research that uses a more comprehensive framework could assess such flow-on effects. Sensitivity analyses are described in Description of outlook scenarios (chapter 3).

Table 15 Parameter assumptions for sensitivity analyses relative to the business-as-usual scenario

Parameter	Restricted log availability	Terms of trade	Industry investment
Log availability	Lower native forest and plantation forest log availability	No change	No change
Processing costs and technologies	No change	For some processors, higher processing costs associated with imported materials	Higher processing costs
Economic and price variables	No change	Increase in investment costs for imported capital Increase in wood products prices for domestic, import and export markets No effects on wood products consumption or the Australian economy as a whole	Higher hurdle rates for investment

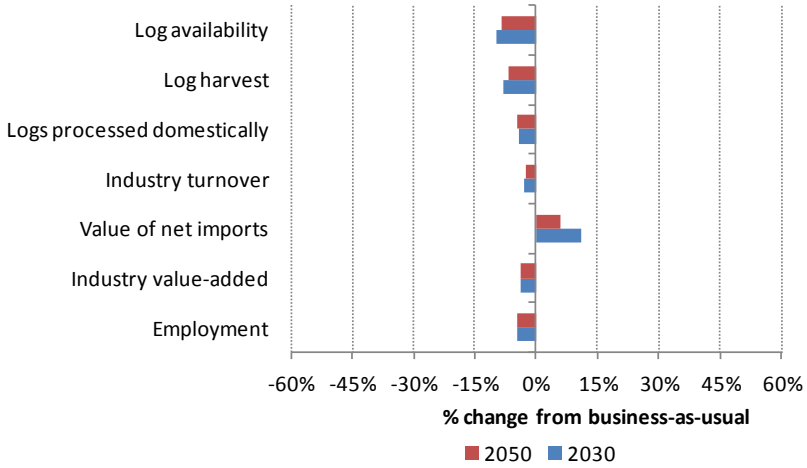
Restricted log availability

This sensitivity analysis isolates the impact of restricted log availability and examines the sensitivity of the forestry sector's outlook to resource availability. To test this, it is assumed that overall log availability by 2050 is around 10 per cent lower than in the business-as-usual scenario. This assumed reduction in log availability is not uniform across log and forest types or regions.

Figure 26 illustrates the sensitivity of the forestry sector towards this supply constraint. As expected, the result is a negative impact on the forestry sector, with reductions in logs harvested and processed domestically. This in turn reduces log and woodchip exports. While domestic processing of logs is negatively affected, it is projected to fall by less than the volume of logs harvested. As a result, the impact on forestry sector turnover, value-added and employment is

also relatively small. Net imports increase above levels in the business-as-usual scenario as a result of a decline in log and woodchip exports and an increased reliance on imports for domestic consumption.

Figure 26 Projected effect on the forestry sector of restricted availability of logs, percentage change relative to business-as-usual scenario

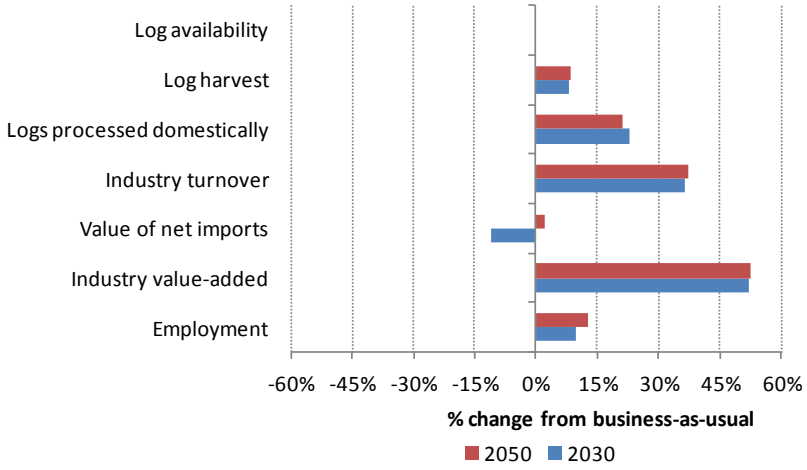


Terms of trade

This sensitivity analysis uses FORUM to examine changes in domestic, import and export wood products prices and the effect on domestic competitiveness and production. See chapter 3 for an explanation of the assumptions corresponding to this sensitivity analysis.

Figure 27 illustrates the projected impact of a 25 per cent increase in forestry terms of trade, relative to the business-as-usual scenario. Despite no change to log availability, this increase has a positive impact on log harvest and the volume of logs processed domestically, and hence on domestic production of wood products. Driven by higher domestic prices and an increase in logs processed domestically, forestry sector turnover is estimated to be 36 per cent above the business-as-usual scenario, and industry value-added is 52 per cent larger than business-as-usual in 2050. As a result of higher import prices, the value of net imports is projected to increase slightly in 2050, despite lower import volumes.

Figure 27 Effect on the forestry sector of a 25 per cent increase in terms of trade, percentage change relative to business-as-usual scenario



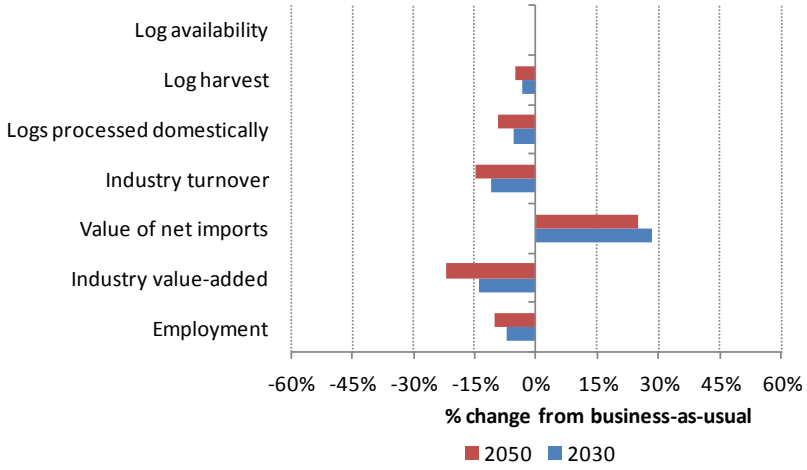
Industry investment

The results provided in this chapter show that investment in wood processing will play a key role in determining the future structure of the forestry sector, the use of Australia's forestry resources and the sector's contribution to Australia's economy.

This sensitivity analysis examines the impact of a higher hurdle rate for investment (3 percentage points higher than in the business-as-usual scenario) on the future outlook for Australia's forestry sector.

Despite no change in log availability, the increased hurdle rate is projected to lead to a 5 per cent reduction in the volume of logs harvested by 2050 and a 9 per cent reduction in the volume of logs processed domestically by 2050 (Figure 28). This has negative flow-on effects for industry turnover, value-added and employment. Thus, imports of wood products increase significantly to meet domestic consumption and the value of net imports is 25 per cent higher in 2050 relative to business-as-usual scenario results. These results highlight the significance of ongoing infrastructure investment for future growth in Australia's forestry sector, including industry turnover, industry value-added and employment.

Figure 28 Effect on the forestry sector of an increase in the hurdle rate, percentage change relative to business-as-usual scenario



7 Conclusions and future research

This report examines three potential outlook scenarios for Australia's forestry sector and details analysis of the potential availability and use of logs, opportunities for primary processing of wood products and the importance of factors affecting these outlooks to 2050. Sensitivity analyses have also been conducted to identify the importance of key economic parameters. The results highlight some key opportunities for Australia's forestry sector, as well as the economic and policy factors required for realising these opportunities.

The changes to Australia's forestry sector over the 40 years to 2011–12 may be an indication of some of the future challenges facing the sector. The results of this report highlight that domestic environmental, economic and policy factors and international trends in investment are likely to continue to shape the structure of the sector into the future.

ABARES projects growth in many aspects of Australia's forestry sector, in the business-as-usual scenario. This assumes the availability of substantial forest resources that will provide significantly more log volumes into the future and significant ongoing demand for wood products in domestic housing and consumer markets. As a result of these factors, ABARES projects future investment in sawmilling and wood-based panel mills into the future and the maintenance of existing pulp and paper processing capacity. Trade in wood products will continue to be necessary and beneficial to the Australian economy, as forest growers and processors rely on export markets for key raw materials and products and imports supplement domestic production to meet domestic consumption needs.

While domestic production and employment in the forestry sector will increase, the relative contribution of the sector to the Australian economy overall will continue to decline in line with past trends. This is a reflection of the structural change that occurs in all developed economies, and does not diminish the important contribution of the forestry sector to regional incomes and natural resource management. Instead, the results highlight that processing wood products has the potential to remain an important component of Australia's manufacturing base into the future.

The results also highlight that the resilience of the industry is contingent on a several key economic and policy factors. In particular, domestic and export prices for wood products have a substantial effect on activity in the sector and factors that encourage a positive investment environment for upgrading and expanding wood processing infrastructure will underpin future growth.

It is important to recognise the strengths and limitations of this outlook study. The analysis in this report makes use of comprehensive ABARES datasets on the forestry sector, including logs harvested, wood products output and trade, existing processing infrastructure, forest areas and sustainable yields. ABARES FORUM framework uses these datasets to account for domestic and international market parameters, regional forest yields, the geographic location of forests relative to processing facilities and investment opportunities. This has enabled ABARES to draw implications for the future structure of the sector.

Several important issues relating to the forestry sector and its future have not been addressed in this study.

- This study examines only primary wood processing and pulp and paper manufacturing; hence, the results presented here exclude some downstream aspects of the sector such as further value-adding to wood products and timber wholesaling activities.
- This study has assessed a restricted set of market opportunities that the sector may face in the future. In particular, the processing capacity investment results presented in this report are based on the parameters modelled; under alternative demand and price assumptions, other investment options may be economically feasible. In addition, only qualitative assessments were undertaken of bioenergy and engineered wood products. Future research could examine the potential for emerging technologies to provide further opportunities for value-adding to Australia's forest resources. Non-wood forest products, carbon sequestration, water management and other ecosystem services have not been included in this analysis. Explicitly modelling the monetary values of these services may change projections of the optimal use and extent of forest growing and processing in Australia.
- Because of data limitations, many regions, log types and wood products have been aggregated in this analysis, leading to the loss of some detail on parameters affecting particular log types or wood products. While a calibration process was undertaken, the simplifications and aggregations used in this report mean that the modelled allocation of logs, residues and products may sometimes differ from reality. Other considerations, such as social and environmental benefits, have not been taken into account.
- Many important parameters that may affect the forestry sector have not been included in the scenarios because of data and time limitations. For example, climate variability has not been considered in the development of these scenarios. Climate variability may have impacts across the forestry value chain, including log availability, investment opportunities and demand for wood products.

Nevertheless, this report provides an important and timely outlook for Australia's forestry sector and establishes some of the key opportunities and threats facing the sector. This information can be used by policymakers and industry stakeholders to highlight the ongoing contribution of the sector and identify parameters key to its continued contribution. Further research that addresses the limitations of this study could highlight additional opportunities to maintain and enhance this contribution.

Appendix A: Workshops with government and industry groups

In November 2012 the Department of Agriculture commissioned ABARES to:

1) provide an indication of the current trajectory of Australia's forest and wood products sector, based on existing policy and market settings

2) provide possible alternative trajectories, based on changes to sets of selected policy and market parameters

3) examine the individual importance of key policy and market parameters on the future outlook for Australia's forestry sector, with the view to identifying the key constraints and opportunities facing the sector.

Consultation process

Before commencing the modelling work for this report, ABARES conducted a series of workshops in March, 2013 with key industry and government stakeholders to test a large range of assumptions, datasets and modelling approaches. The workshops provided an opportunity for constructive discussions with principal forestry sector stakeholders in Australia to help shape the ABARES modelling approach for this report and review the underlying assumptions used for the analysis.

Prior to the workshops, ABARES developed a set of draft assumptions to describe the potential outlook for the forestry sector under existing economic and policy settings, as well as for alternative outlook scenarios. At the workshops, ABARES presented the data requirements for the analysis and provided current estimates and forecasts for discussion around the scope and nature of these assumptions. Through these workshops, ABARES also identified omissions or errors in these draft estimates and sought advice and feedback from the industry and government groups attending the meetings.

Discussions focused on clarification of the purpose of the project and the potential uses of its results, the proposed modelling approach, market data relating to wood products, and ABARES regional forecasts of log availability over the period to 2050. Stakeholders expressed interest in additional analysis such as including an assessment of carbon balances through the wood processing chain, extending this value chain to include more value-adding of wood products and the development of more detailed datasets relating to log and product types and regional demand for wood products. However, because of resource and data constraints, quantification of these additional outputs was not possible for this project.

As a result of these workshops, ABARES was able to refine many of the assumptions and datasets used for this analysis. ABARES also recognised the need to make the outputs from the research applicable and useful to government and industry groups and present results in a meaningful manner.

Industry and government participants (varies across workshops)

Australian Forest Contractors Association (AFCA), Australian Forests Products Association (AFPA), Department of Agriculture, Department of Agriculture and Food Western Australia, Engineered Wood Panels Association of Australasia (EWPAA), Forest and Wood Products Australia (FWPA), Forestry SA, Forests Corporation of NSW, ForestWorks, Housing Industry Association (HIA), Institute of Foresters Australia (IFA), NSW Forest Products Association (NSW FPA), Queensland DAFF, Queensland DERM Salisbury Research Facility, Timber Communities Australia (TCA), Timber Veneer Association, VicForests, Victoria DPI, Victorian Association of Forest Industries (VAFI), industry consultants and wood processors (various).

Workshop dates and locations

Workshop 1: 1 March 2013, Canberra, 2 pm–4.30 pm

Workshop 2: 7 March 2013, Adelaide, 2 pm–4.30 pm

Workshop 3: 8 March 2013, Mount Gambier, 10.30 am–1.00 pm

Workshop 4: 12 March 2013, Melbourne, 2 pm–4.30 pm

Workshop 5: 14 March 2013, Sydney, 12 pm–3 pm

Workshop 6: 20 March 2013, Brisbane, 1 pm–3.30 pm

Workshop 7: 22 March 2013, Melbourne, 3 pm–4.30 pm

Workshop 8: 28 March 2013, teleconference, 1.30 pm–2.30 pm

Workshop 9: 4 April 2013, teleconference, 10.30 am–12 pm

Appendix B: Detailed log availability projections

The graphs in this appendix show projections for log availability by state, region, quality and log type for the business-as-usual scenario. These regions have been grouped by state. Note that some region volumes are positive but may be too low to be seen on the appendix figures.

Figure B1 Log availability, public native forests, New South Wales, 2010–54

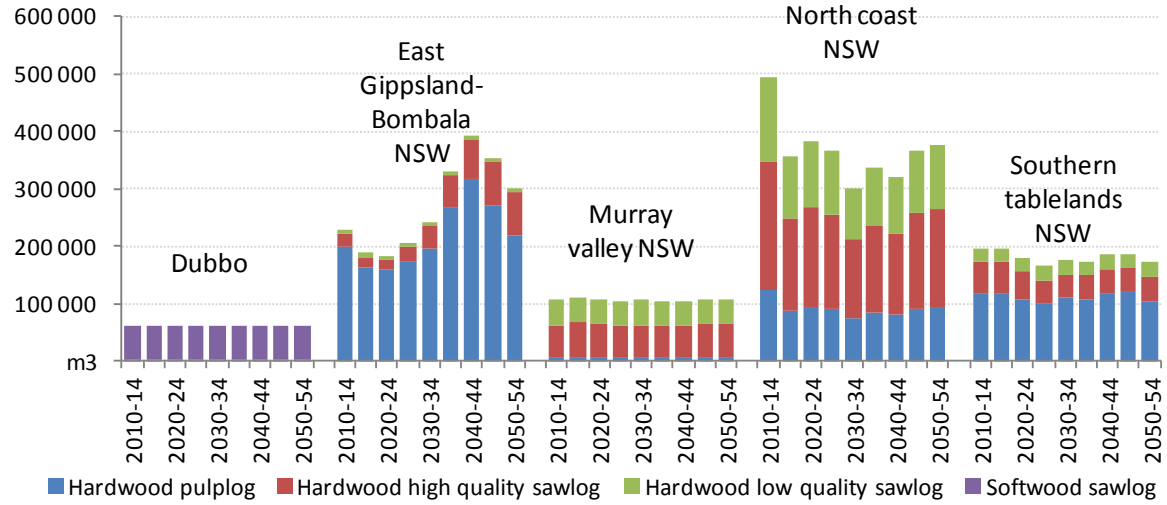


Figure B2 Log availability, private native forests, New South Wales, 2010–54

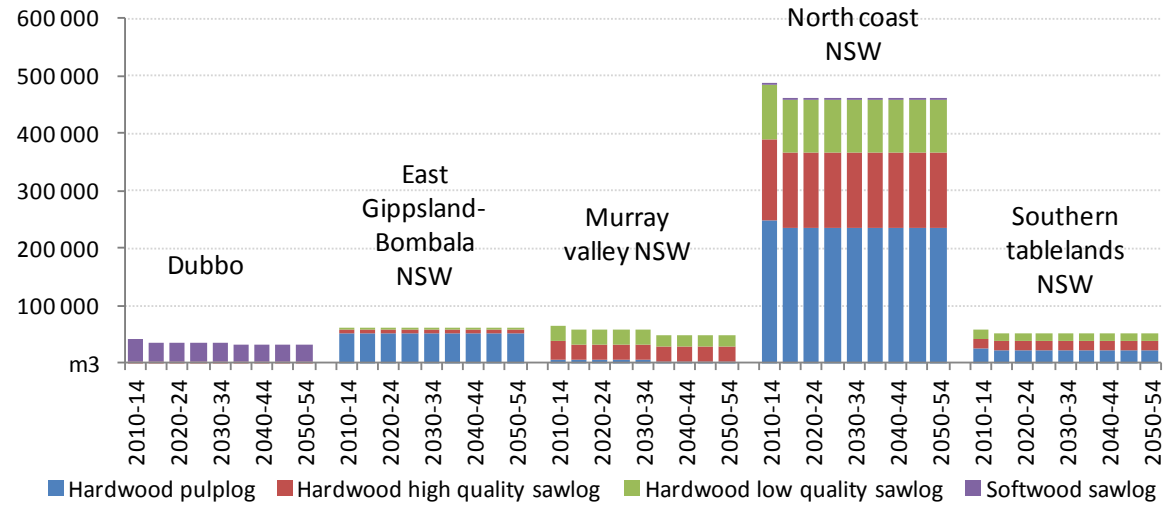


Figure B3 Log availability, hardwood plantations, New South Wales, 2010–54

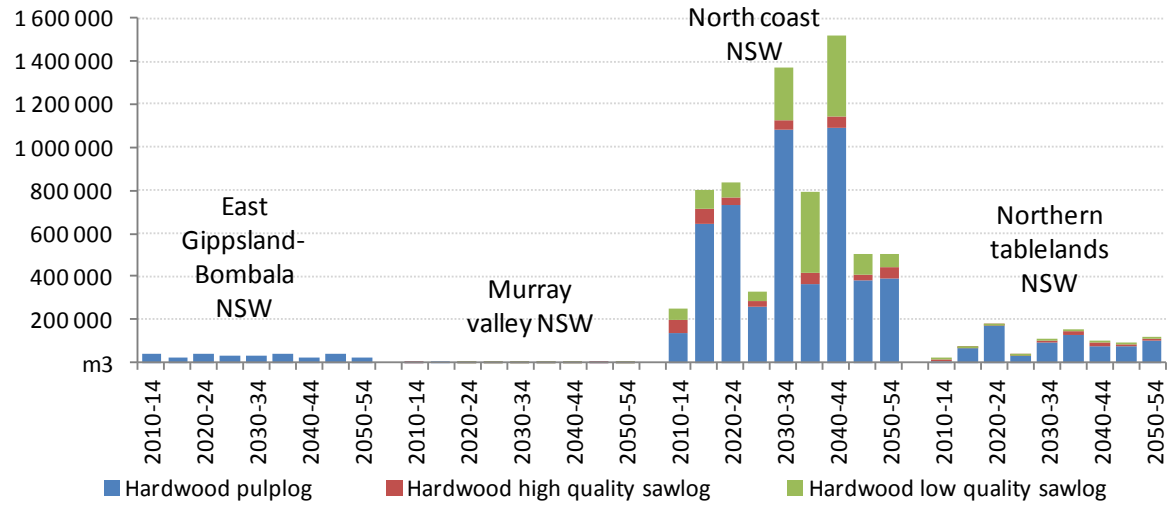


Figure B4 Log availability, softwood plantations, New South Wales, 2010–54

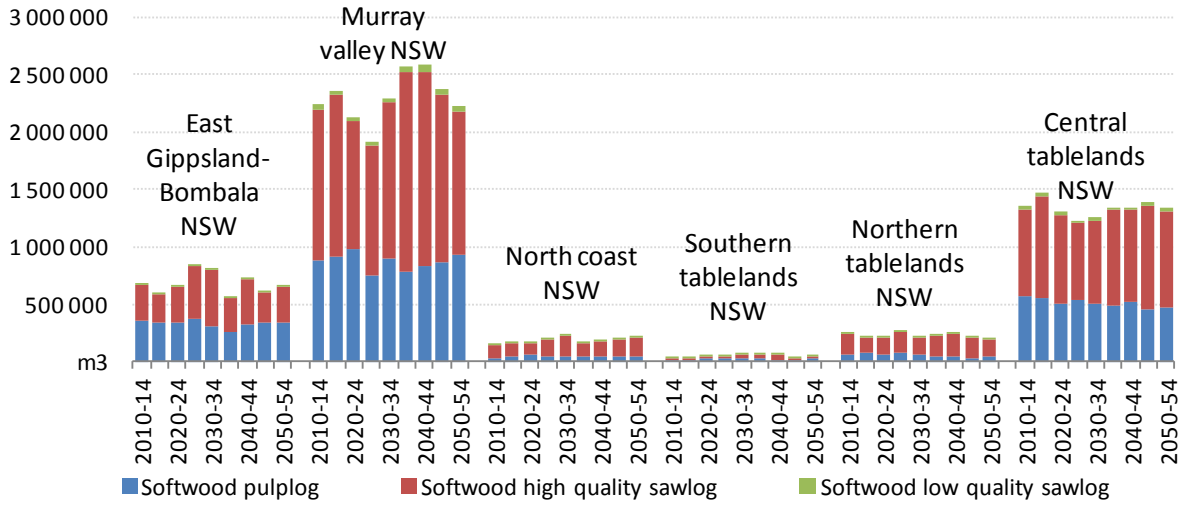


Figure B5 Log availability, public native forests, Victoria, 2010–54

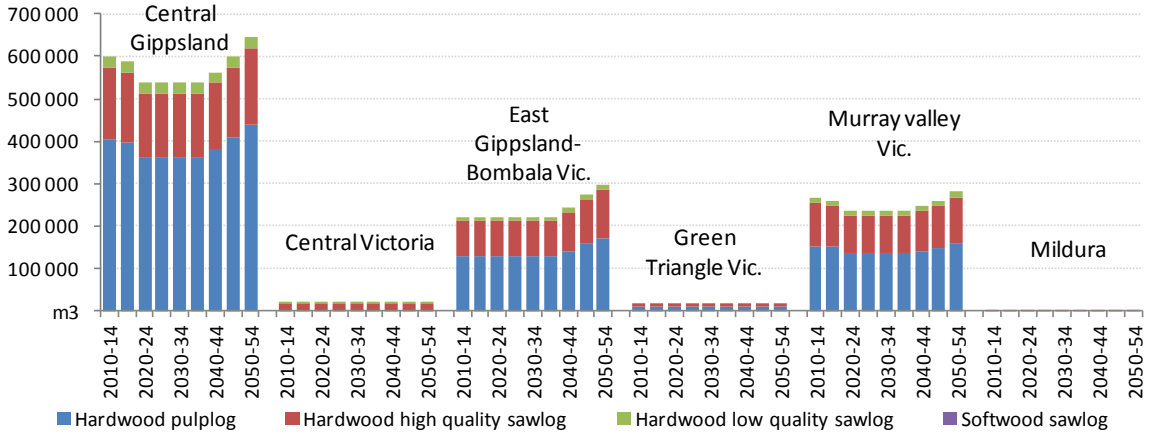


Figure B6 Log availability, private native forests, Victoria, 2010–54

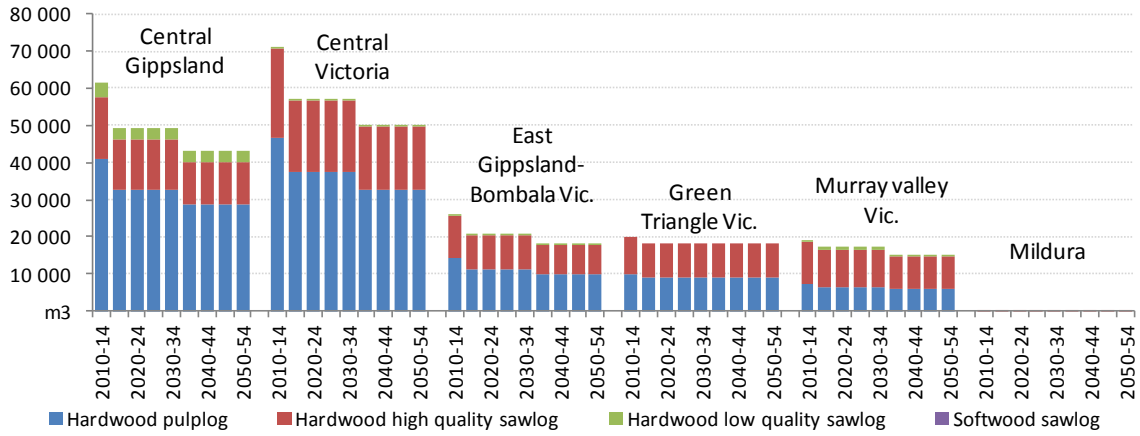


Figure B7 Log availability, hardwood plantations, Victoria, 2010–54

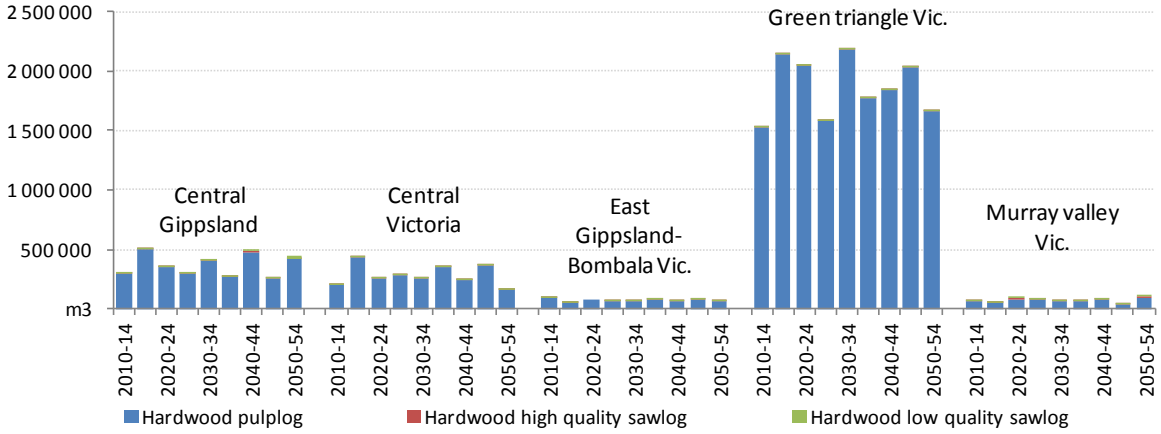


Figure B8 Log availability, softwood plantations, Victoria, 2010–54

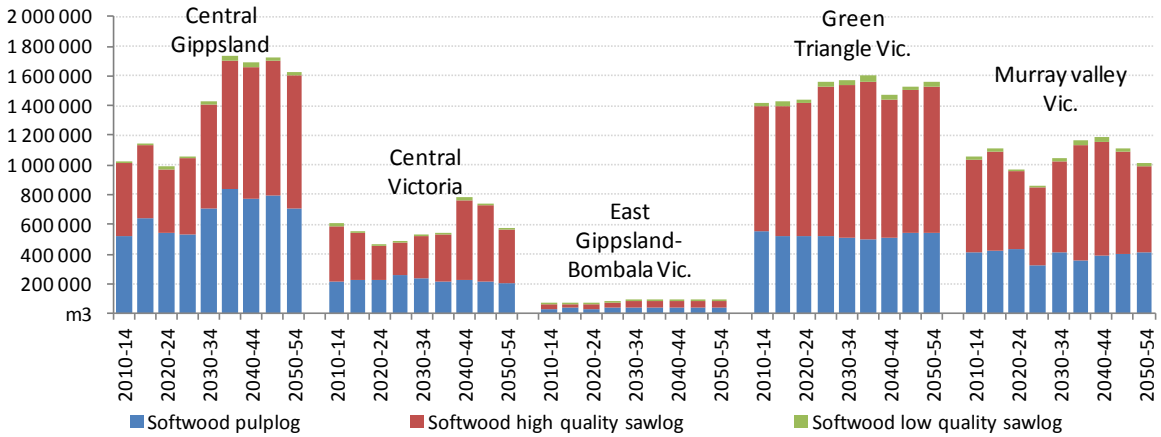


Figure B9 Log availability, public native forests, Queensland, 2010–54

Figure B10 Log availability, private native forests, Queensland, 2010–54

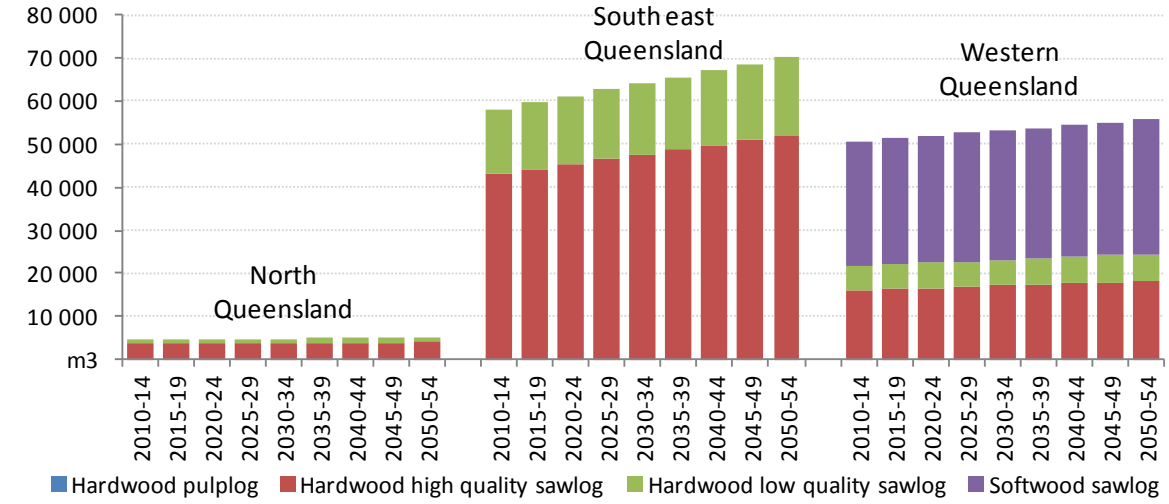


Figure B11 Log availability, hardwood plantations, Queensland, 2010–54

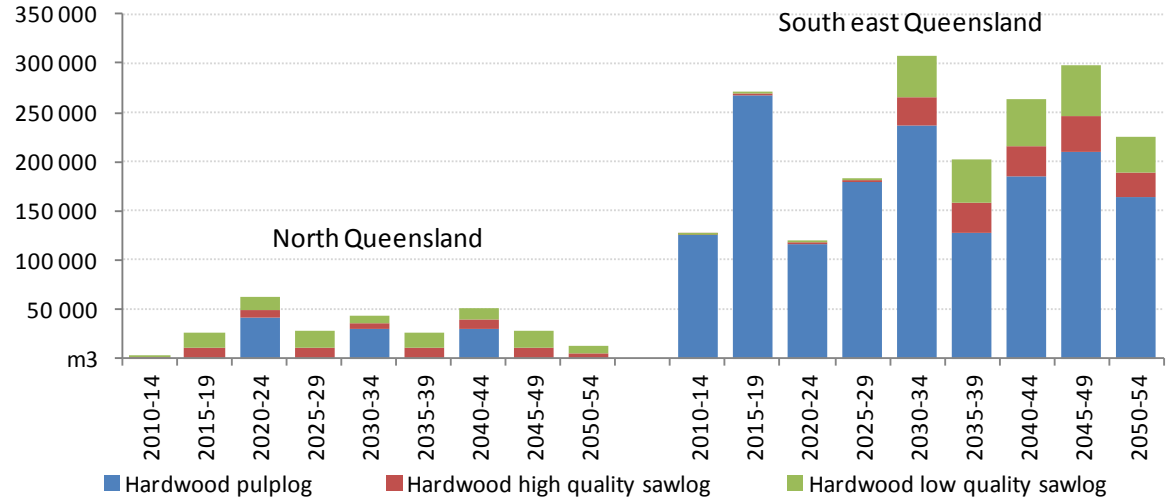


Figure B12 Log availability, softwood plantations, Queensland, 2010–54

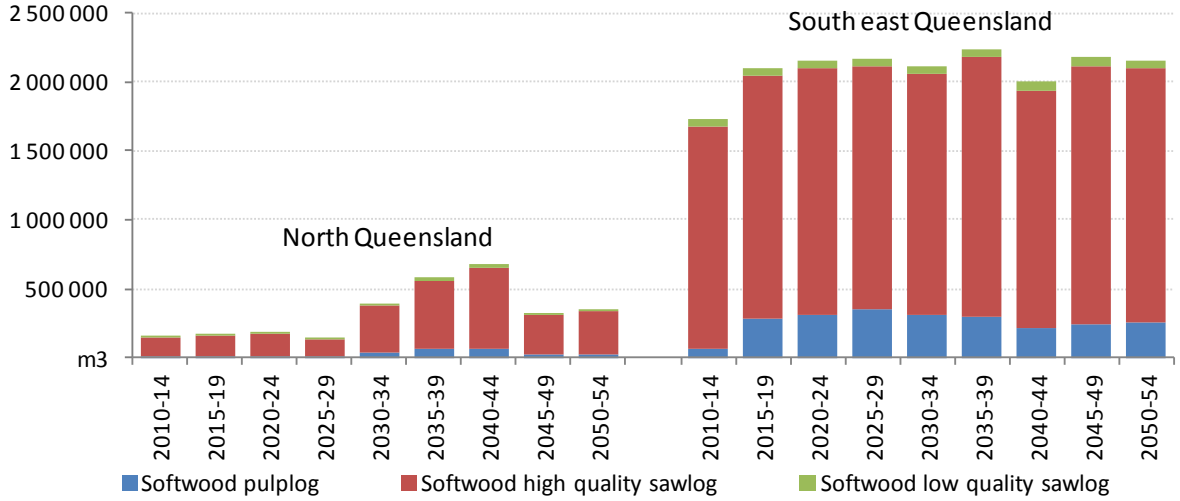


Figure B13 Log availability, public native forests, Western Australia, 2010–54

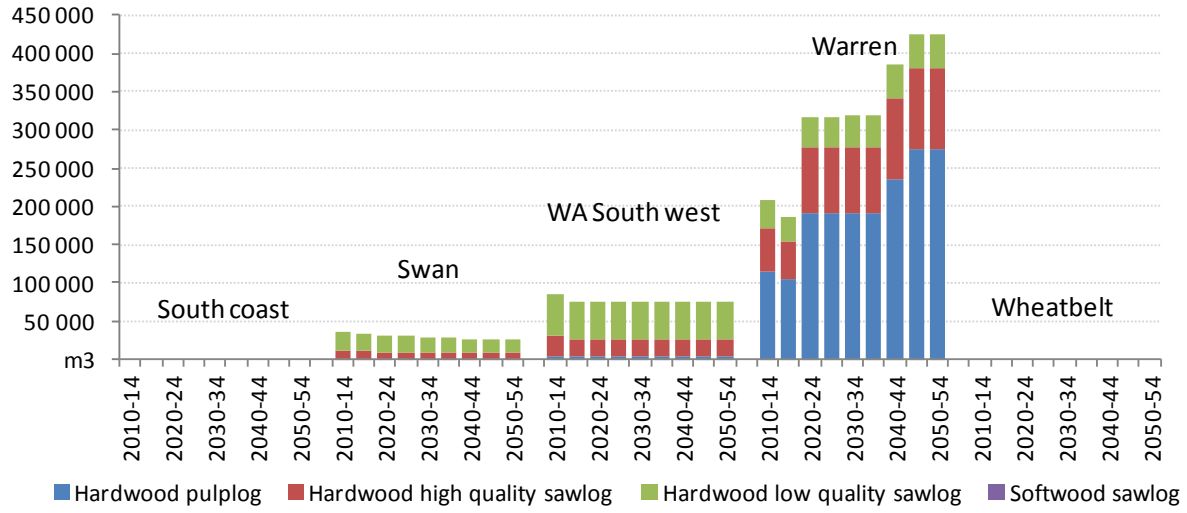


Figure B14 Log availability, private native forests, Western Australia, 2010–54

Figure B15 Log availability, hardwood plantations, Western Australia, 2010–54

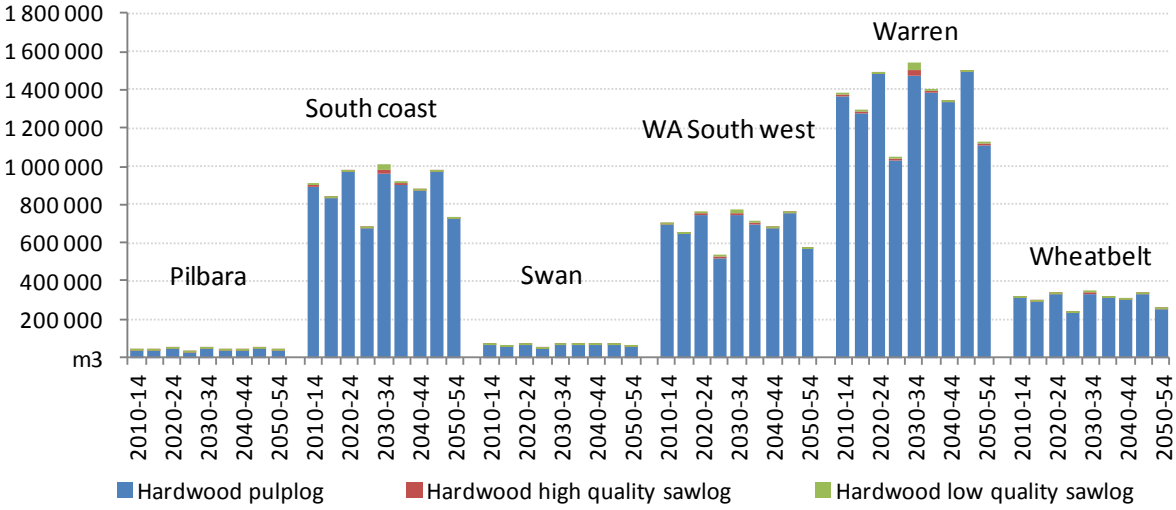


Figure B16 Log availability, softwood plantations, Western Australia, 2010–54

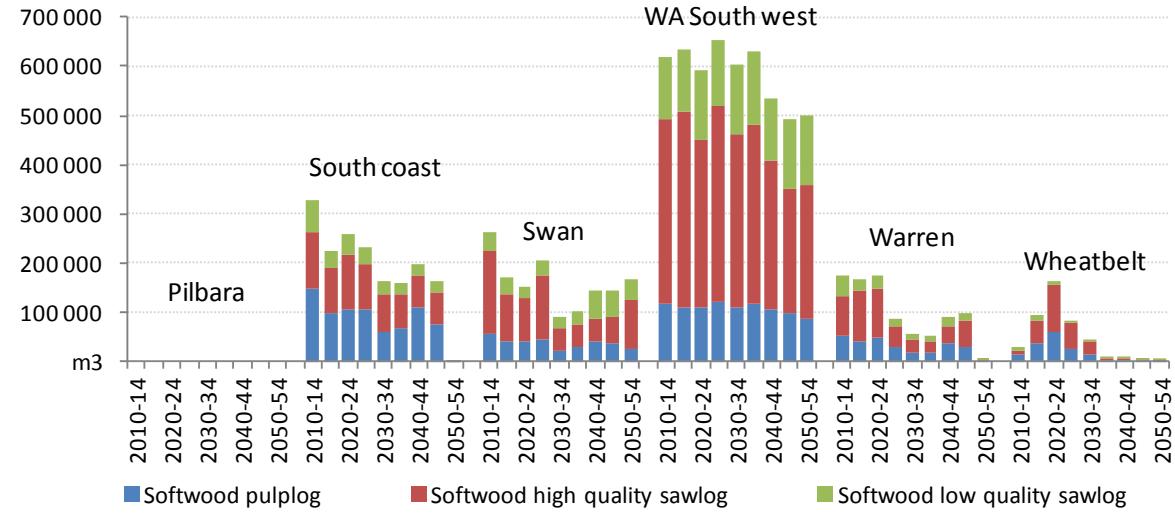


Figure B17 Log availability, hardwood plantations, South Australia, 2010–54

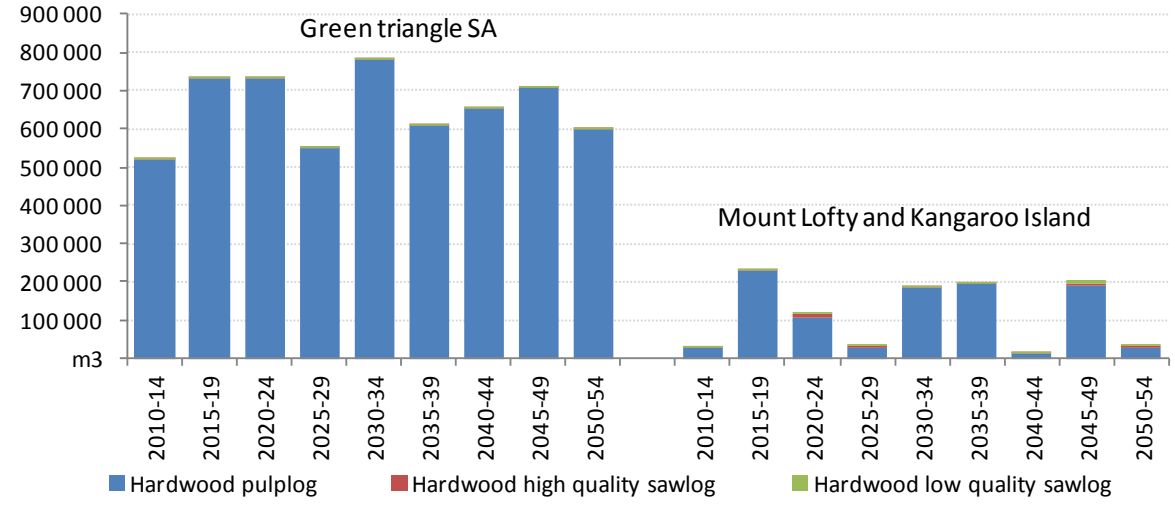


Figure B18 Log availability, softwood plantations, South Australia, 2010–54

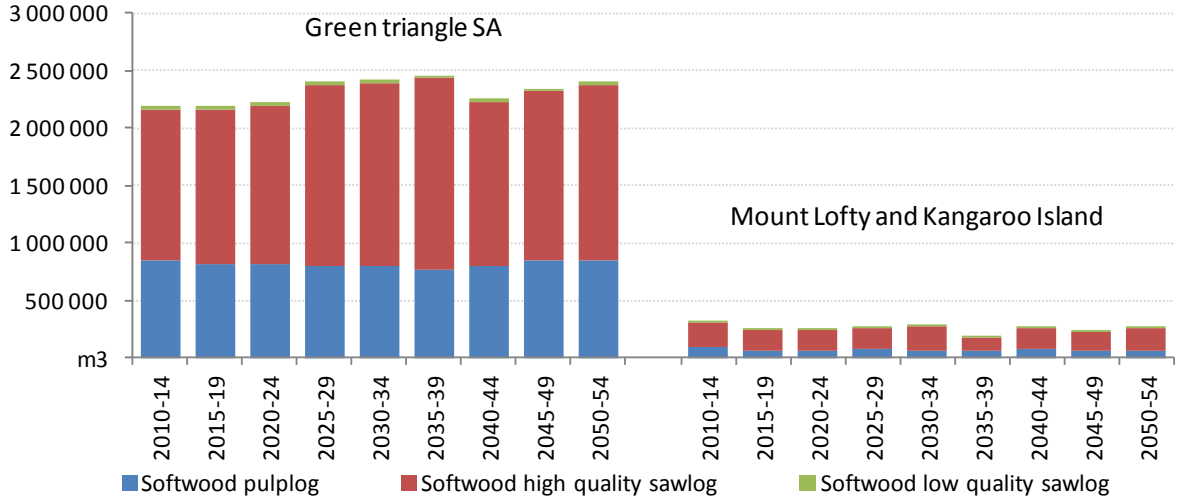
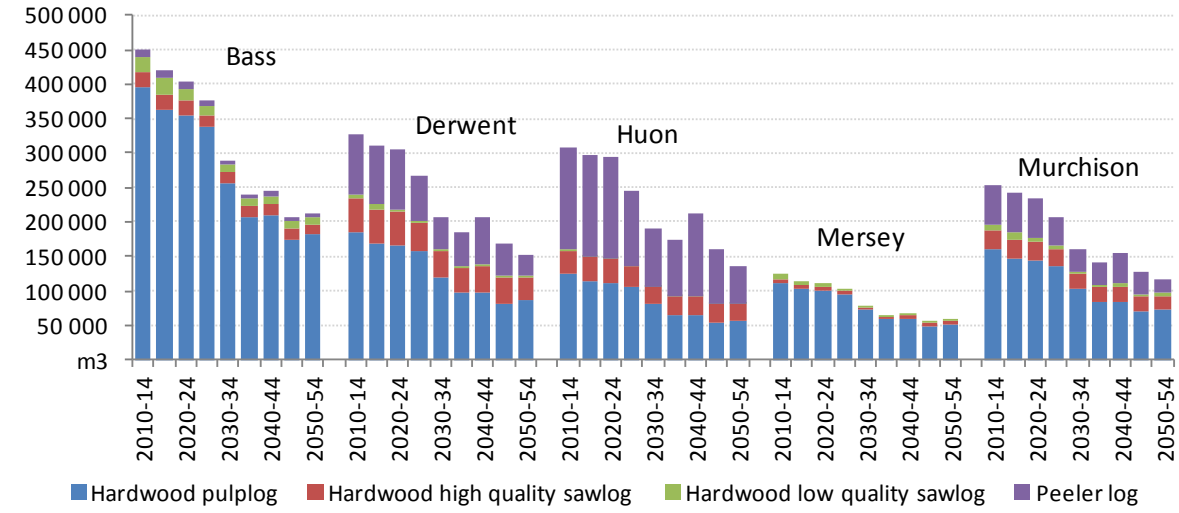
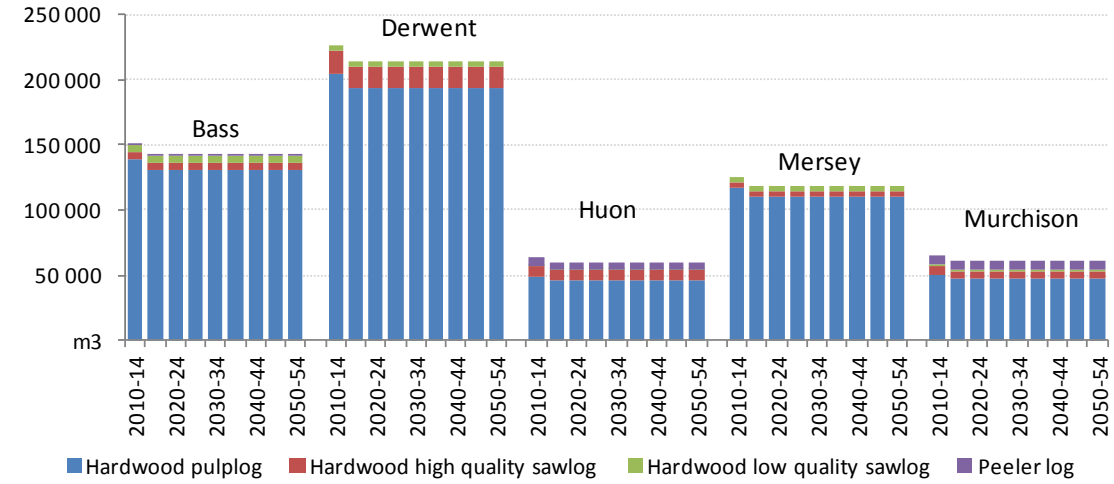


Figure B19 Log availability, public native forests, Tasmania, 2010–54



Note: Peeler log includes domestic and export peeler logs.

Figure B20 Log availability, private native forests, Tasmania, 2010–54



Note: Peeler log includes domestic and export peeler logs.

Figure B21 Log availability, hardwood plantations, Tasmania, 2010–54

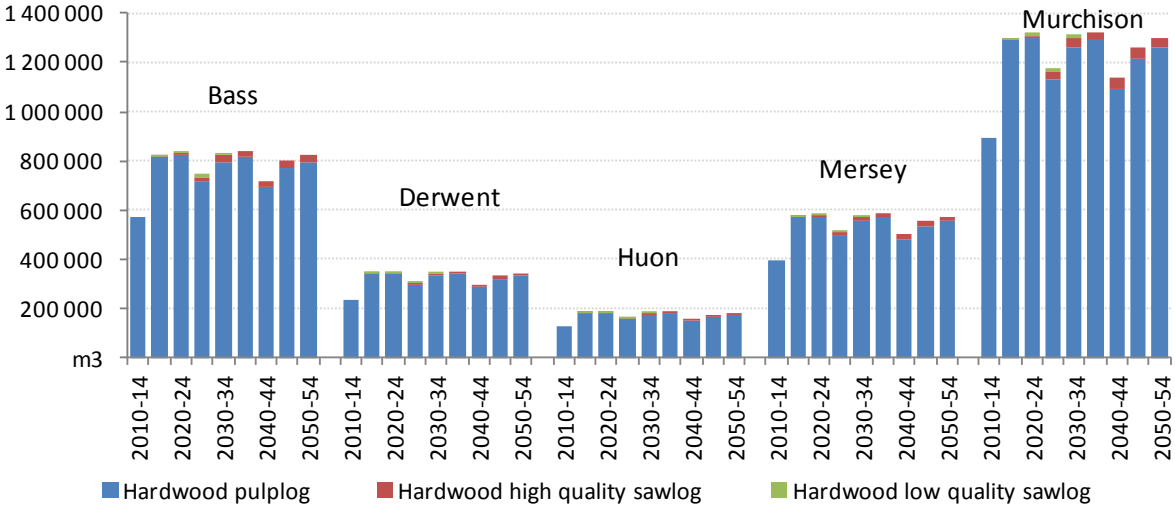


Figure B22 Log availability, softwood plantations, Tasmania, 2010–54

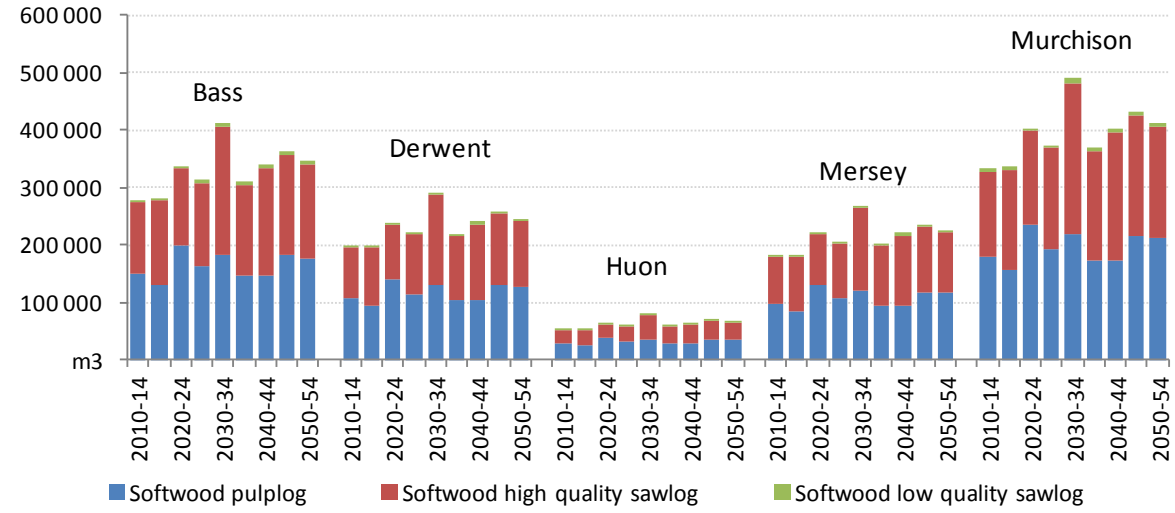


Figure B23 Log availability, hardwood plantations, Northern Territory, 2010–54

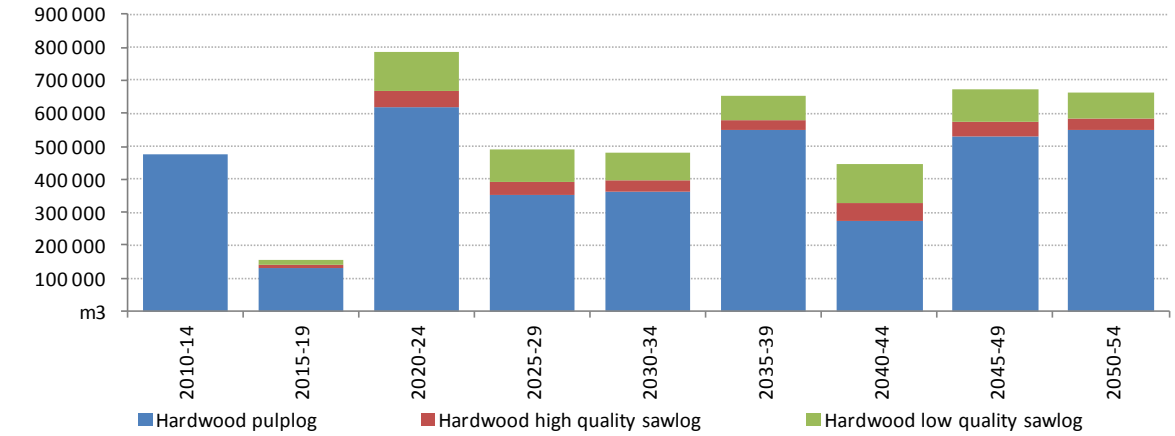
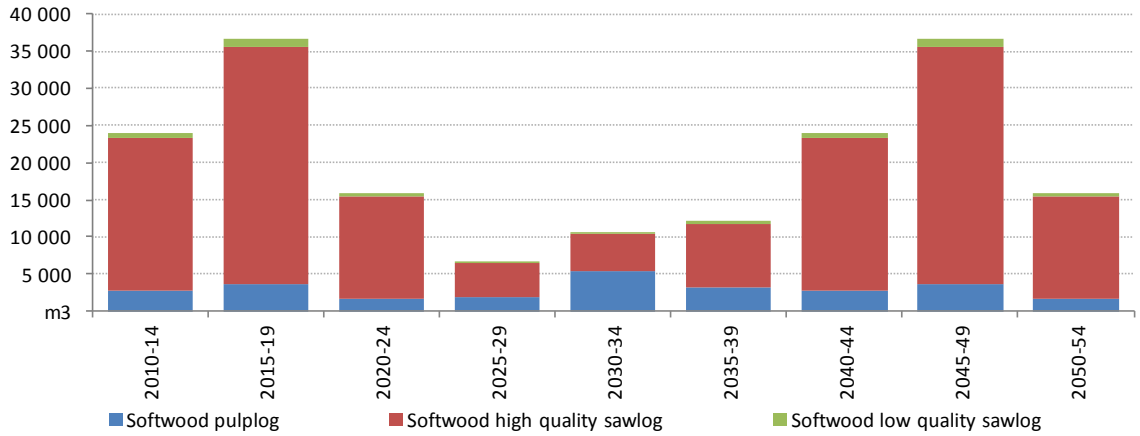


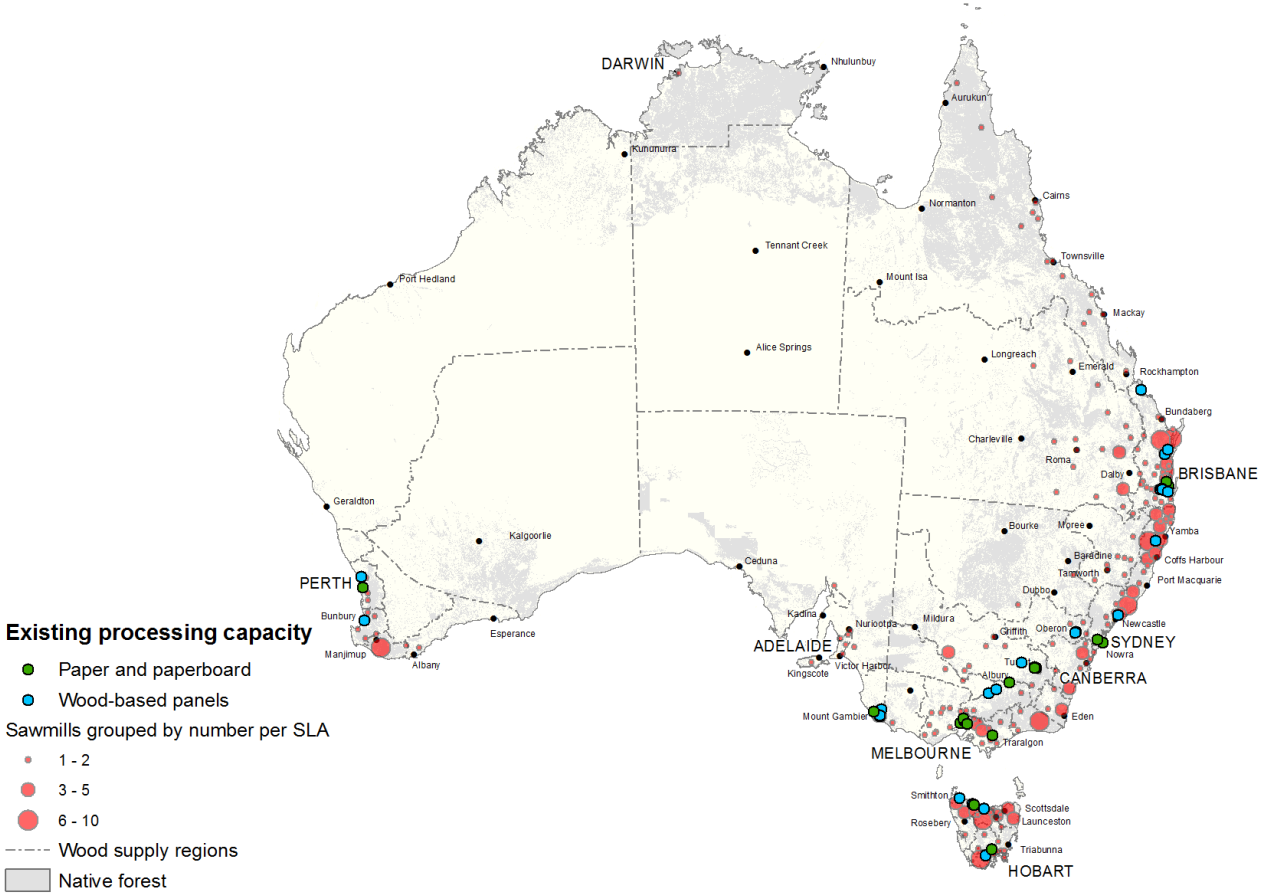
Figure B24 Log availability, softwood plantations, Northern Territory, 2010–54



Appendix C: Maps of existing wood processing infrastructure

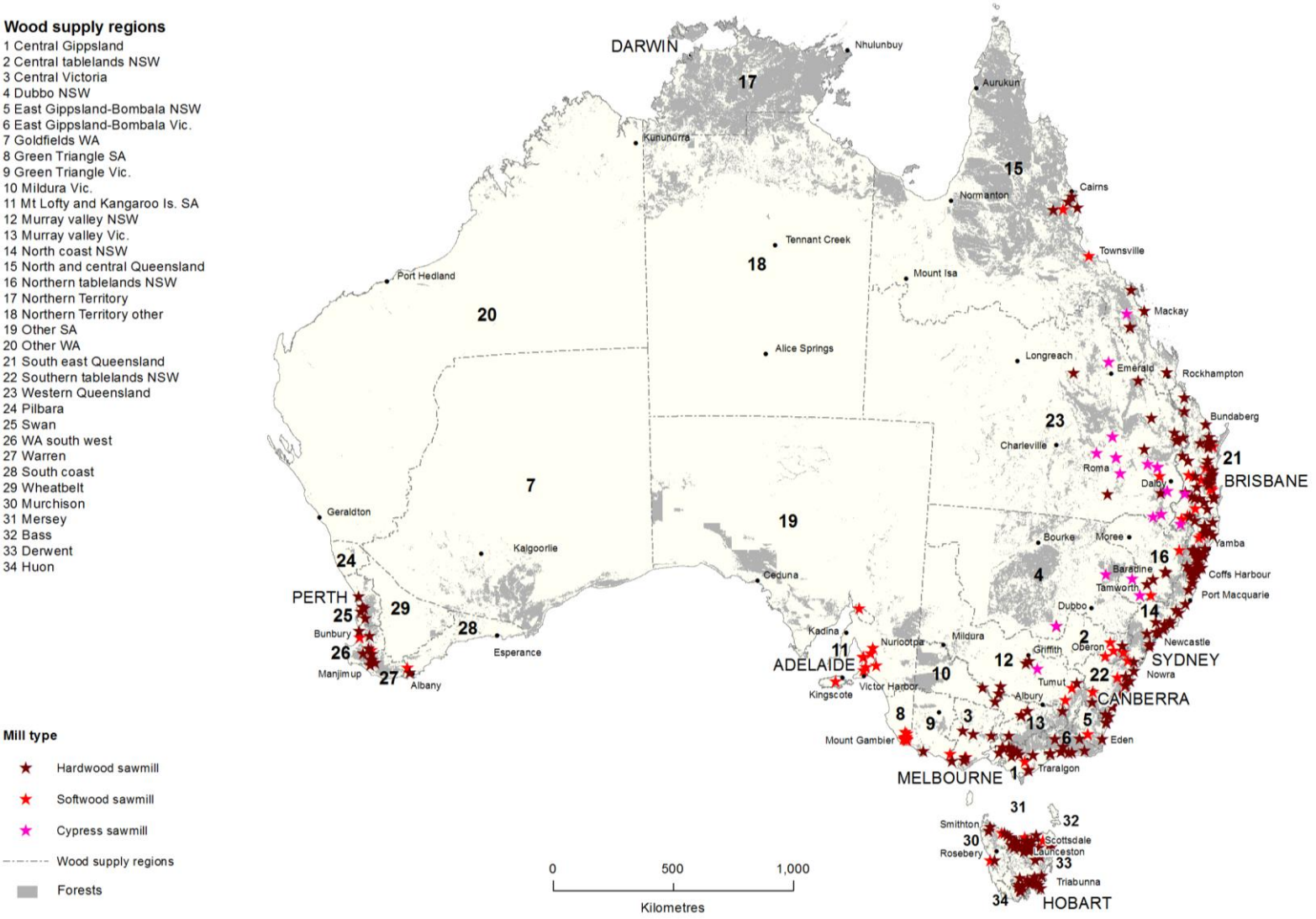
The maps in this appendix show approximate mill locations and broad mill types and ABARES forest regions.

Map C1 Approximate locations of total existing processing capacity in Australia



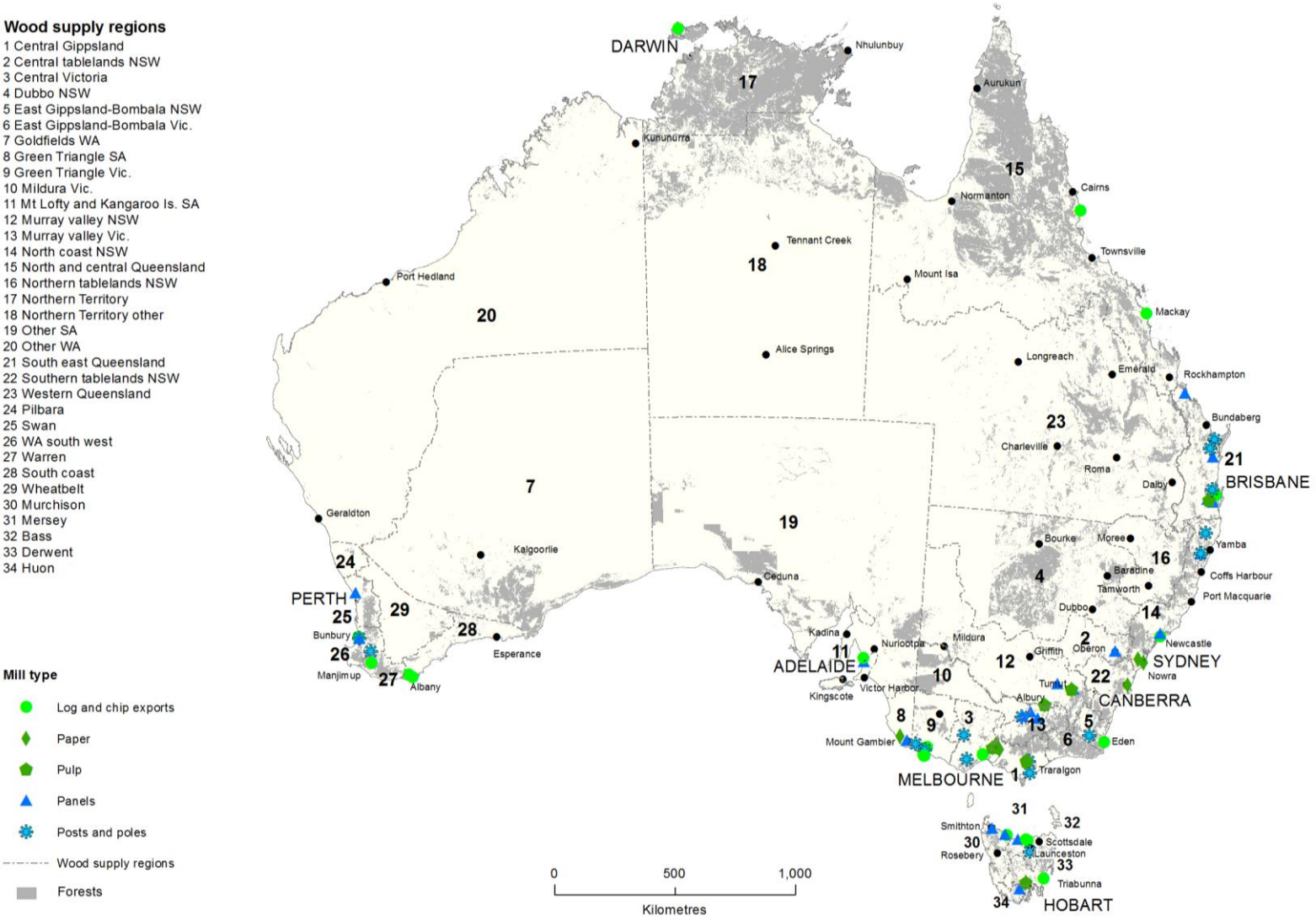
Note: **SLA** Statistical local area. ABARES regions were constructed specifically for this analysis. Locations are approximate. See regional maps for greater detail. Existing infrastructure as at 30 June 2013

Map C2 Approximate locations of existing sawmills in Australia, by input type



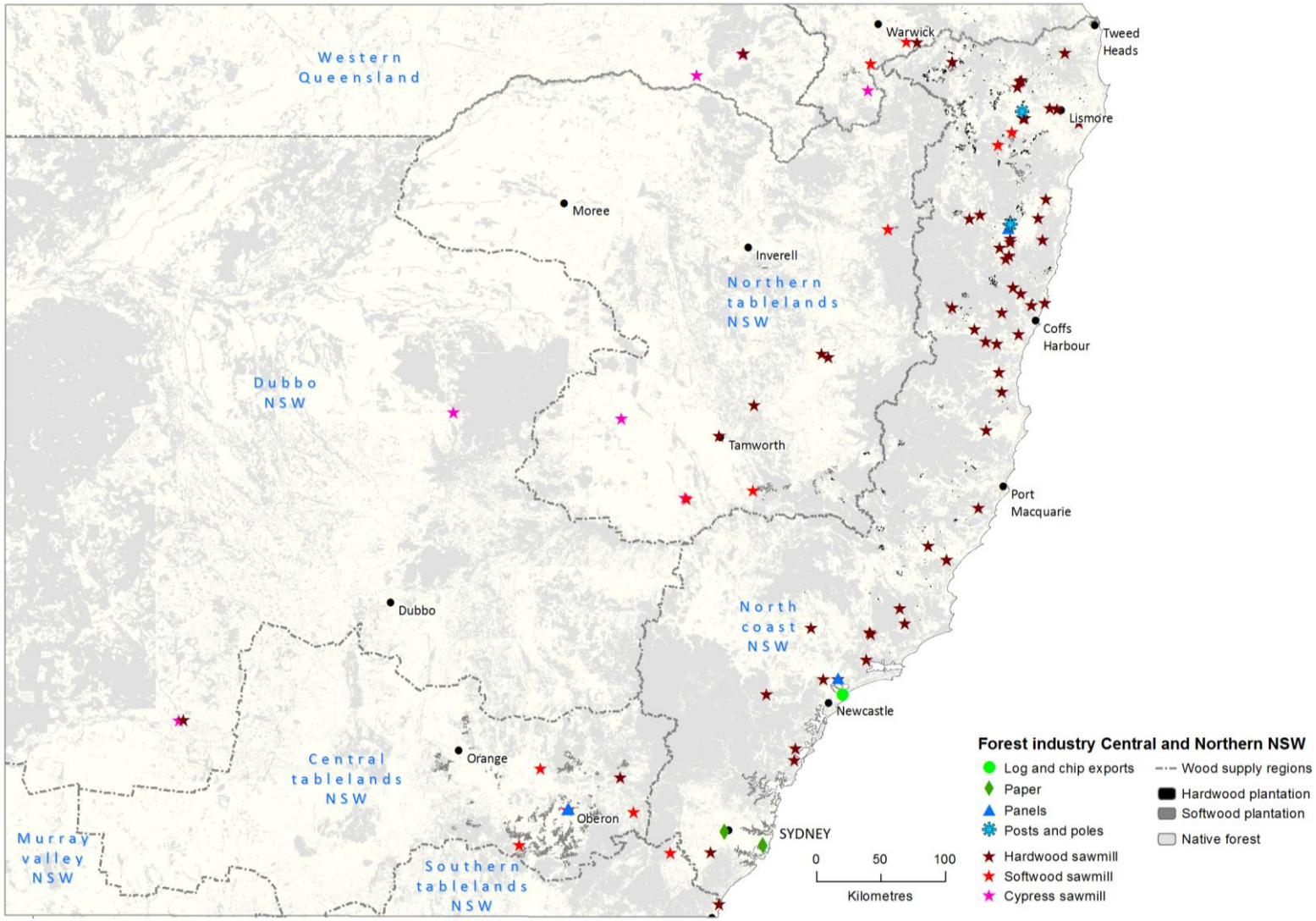
Note: Regions were constructed specifically for this analysis. Locations are approximate. See regional maps for greater detail. Existing infrastructure as at 30 June 2013

Map C3 Approximate locations of other existing processing capacity in Australia, by broad industry type



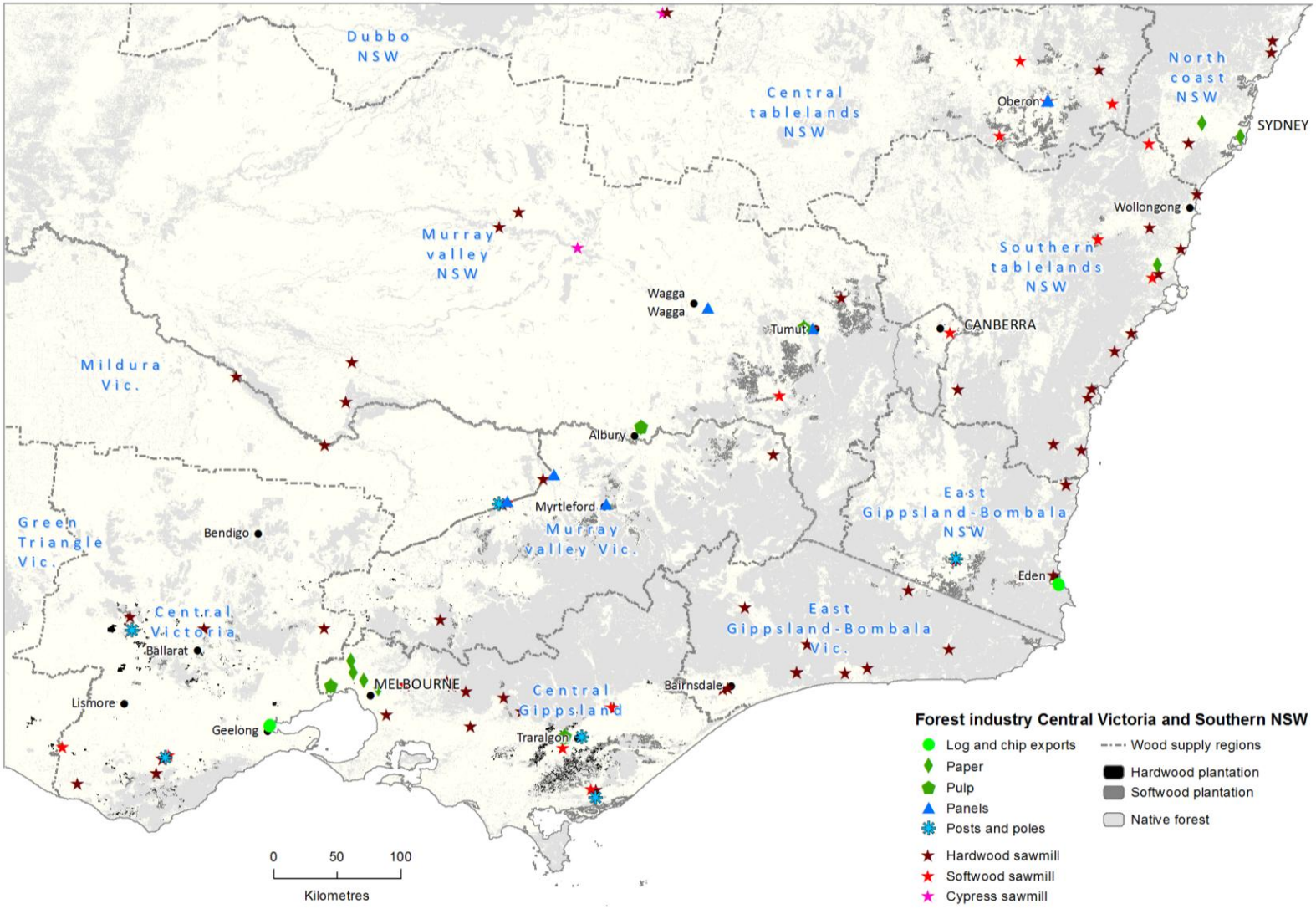
Note: Regions were constructed specifically for this analysis. Locations are approximate. See regional maps for greater detail. Existing infrastructure as at 30 June 2013

Map C4 Approximate locations of existing processing capacity in Northern New South Wales, by broad industry type



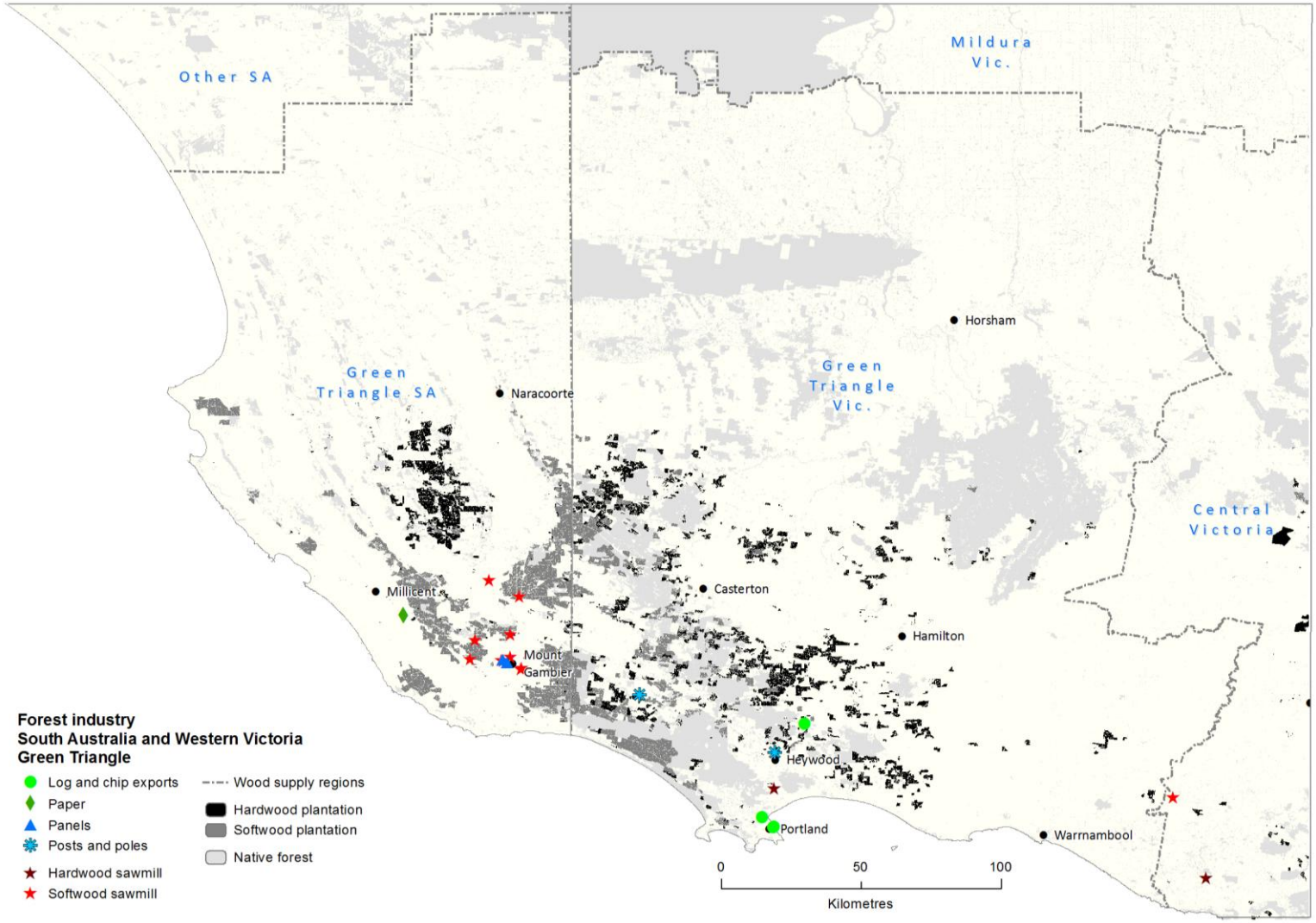
Note: Regions were constructed specifically for this analysis. Locations are approximate. Existing infrastructure as at 30 June 2013

Map C5 Approximate locations of existing processing capacity in Central Victoria and Southern New South Wales, by broad industry type



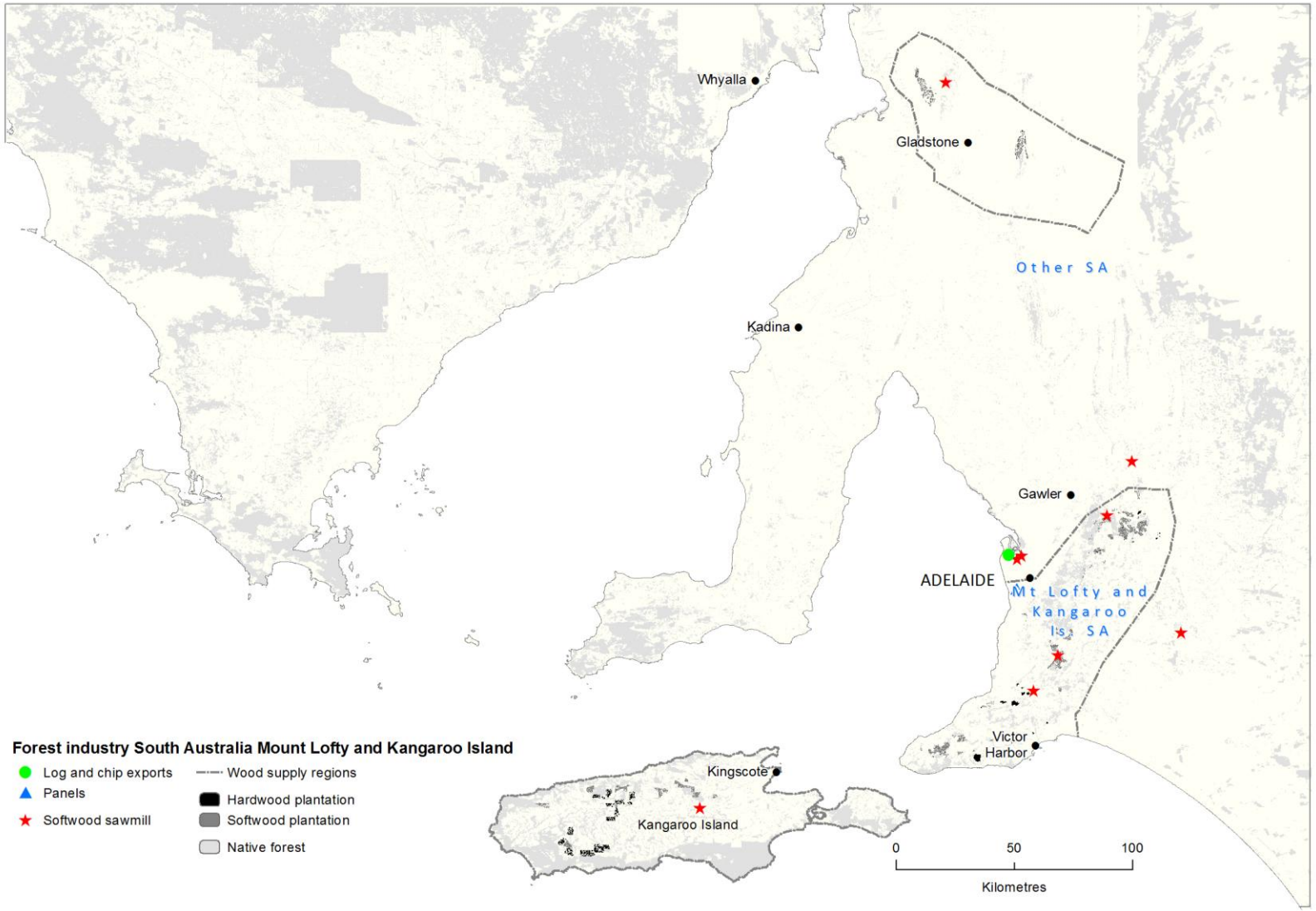
Note: Regions were constructed specifically for this analysis. Locations are approximate. Existing infrastructure as at 30 June 2013

Map C6 Approximate locations of existing processing capacity in South Australia and Western Victoria (Green Triangle), by broad industry type



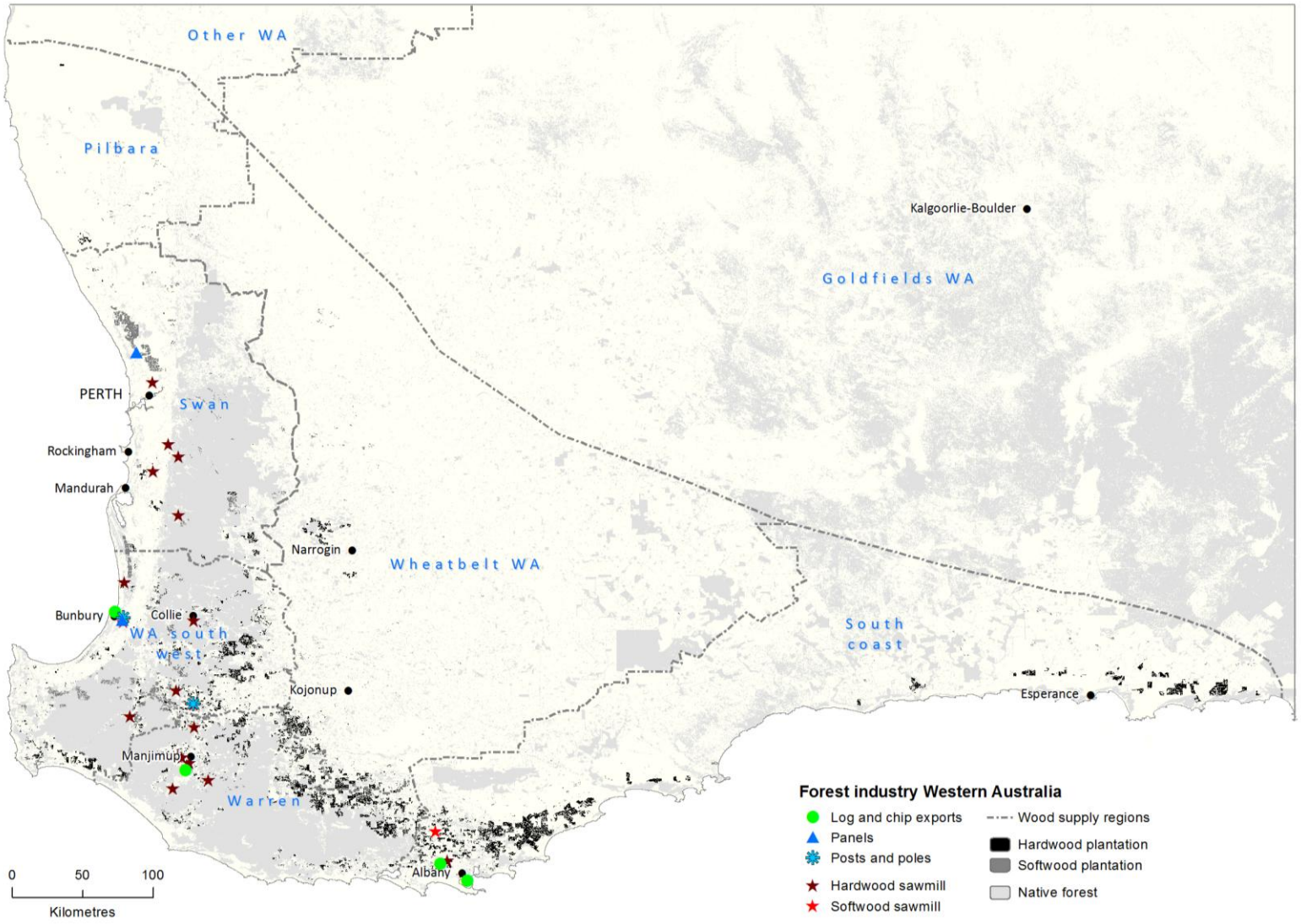
Note: Regions were constructed specifically for this analysis. Locations are approximate. Existing infrastructure as at 30 June 2013

Map C7 Approximate locations of existing processing capacity in South Australia (selected regions), by broad industry type



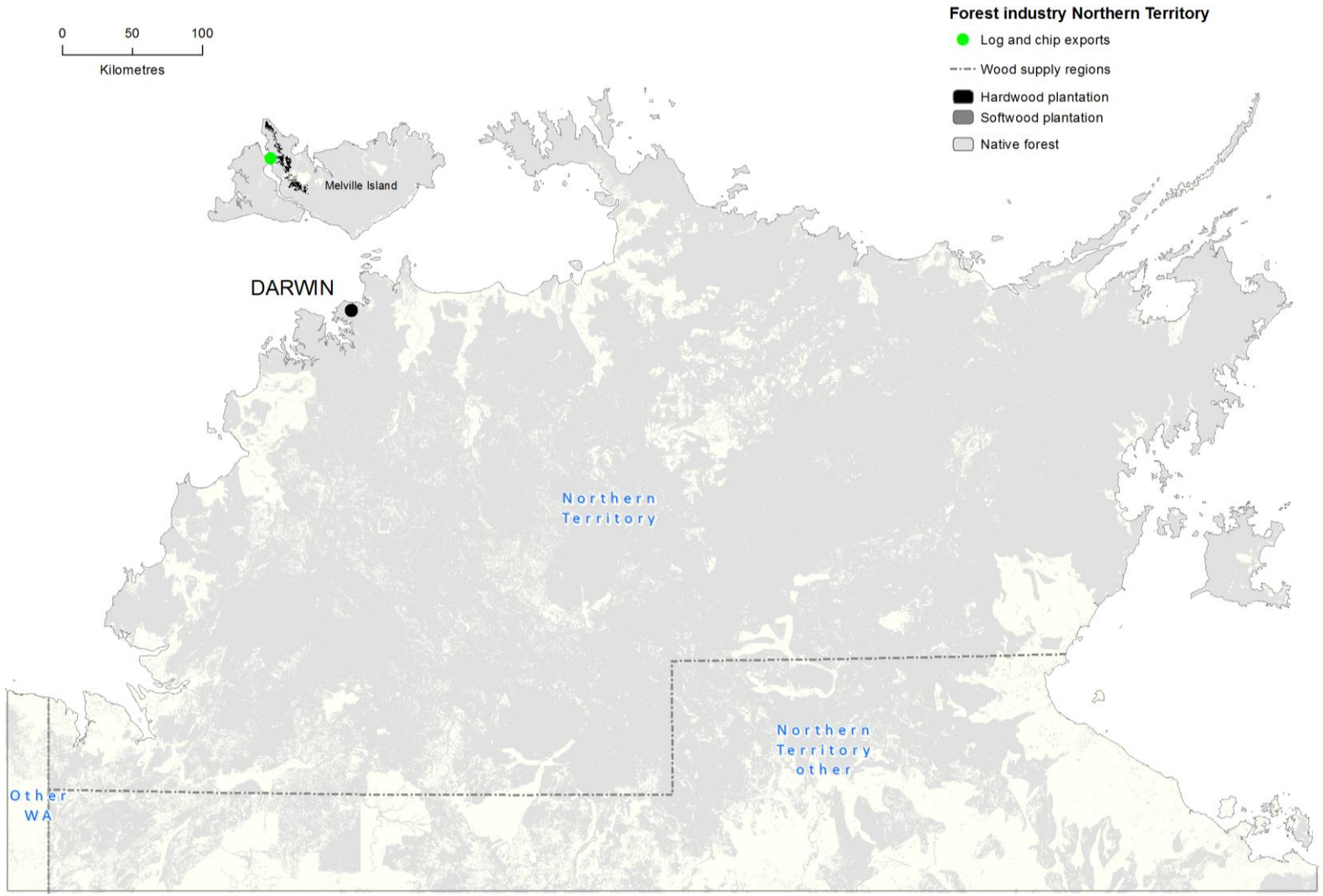
Note: Regions were constructed specifically for this analysis. Locations are approximate. Existing infrastructure as at 30 June 2013

Map C8 Approximate locations of existing processing capacity in Western Australia, by broad industry type



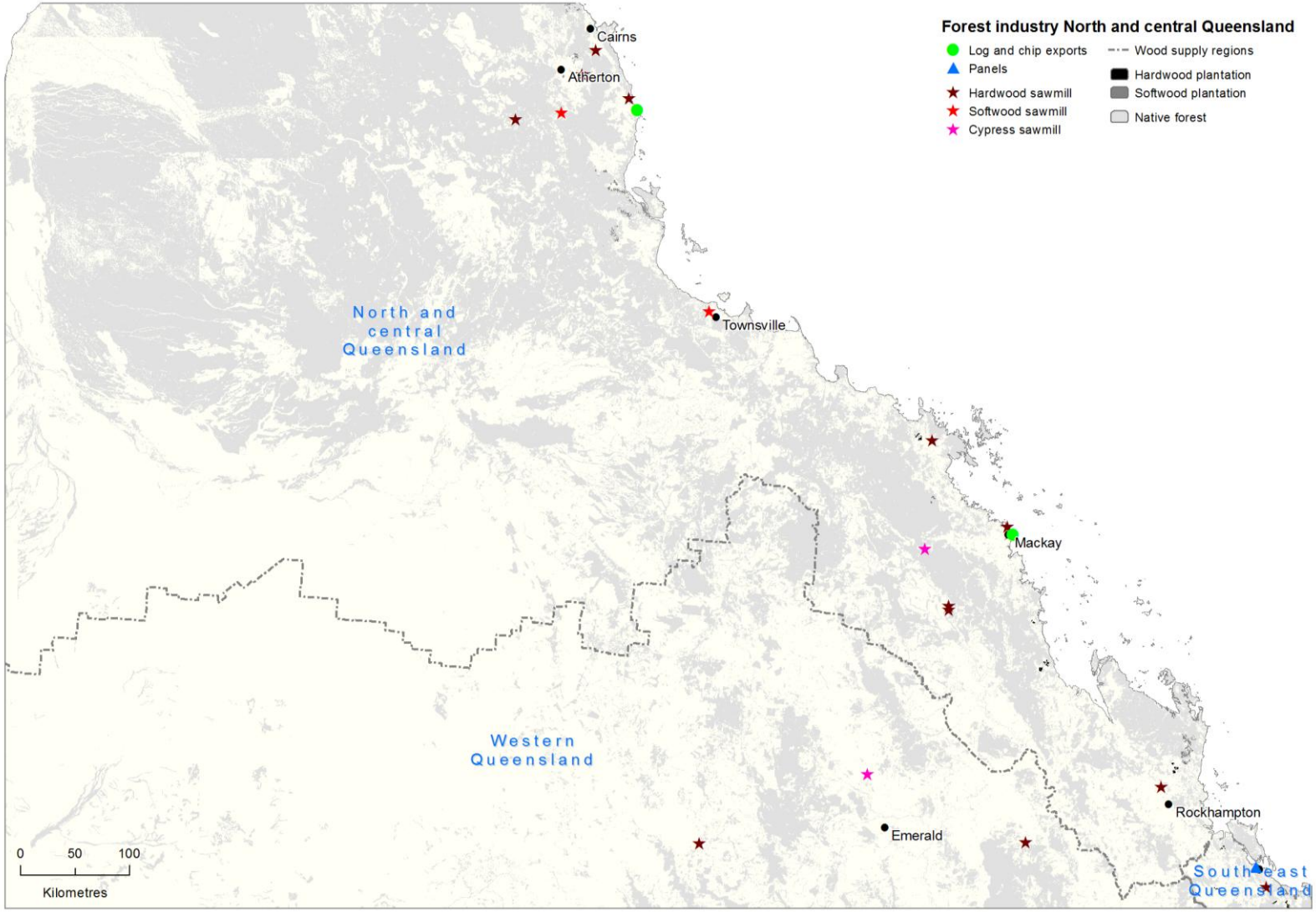
Note: Regions were constructed specifically for this analysis. Locations are approximate. Existing infrastructure as at 30 June 2013

Map C9 Approximate locations of existing processing capacity in Northern Territory, by broad industry type



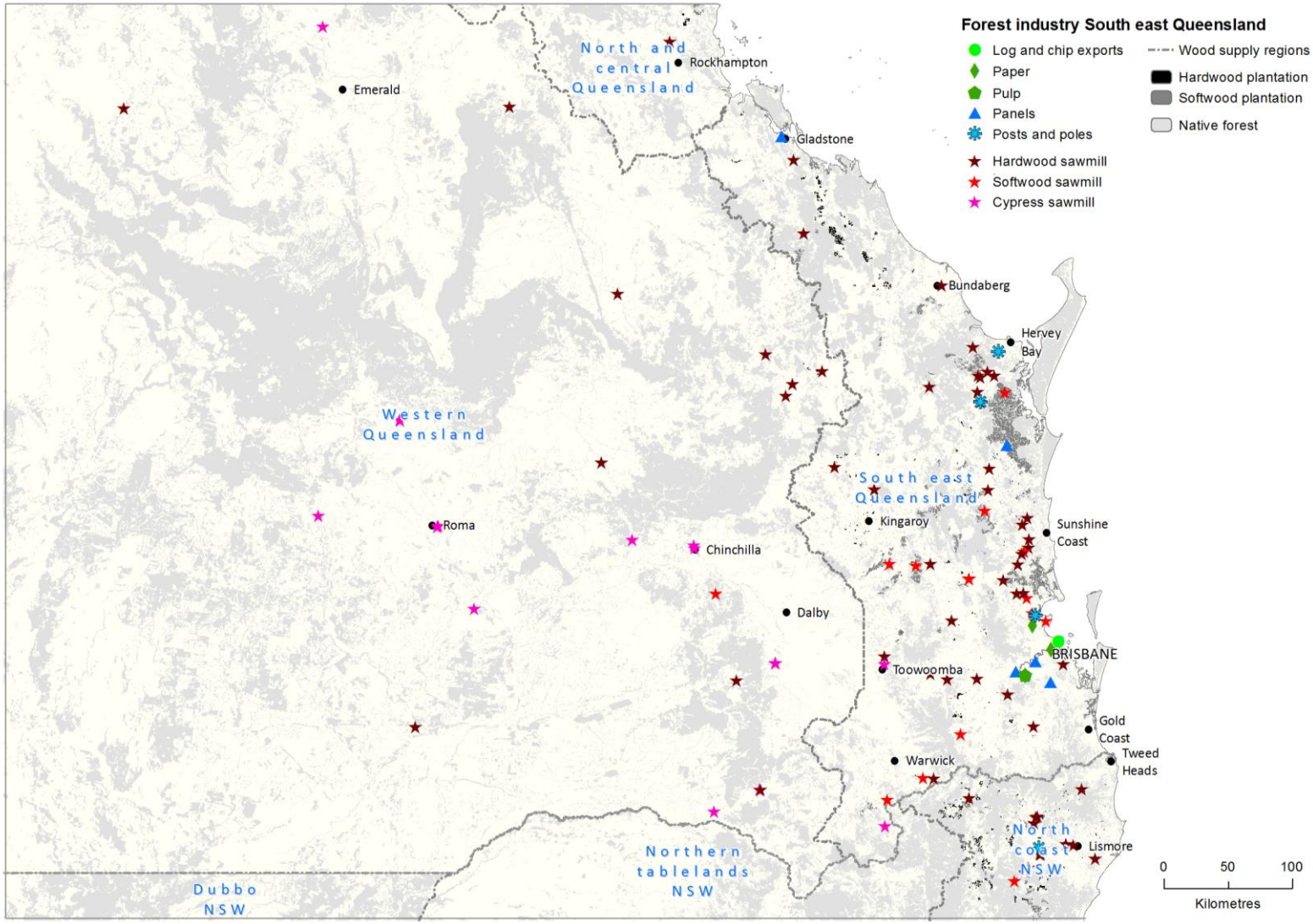
Note: Regions were constructed specifically for this analysis. Locations are approximate. Existing infrastructure as at 30 June 2013

Map C10 Approximate locations of existing processing capacity in North and central Queensland, by broad industry type



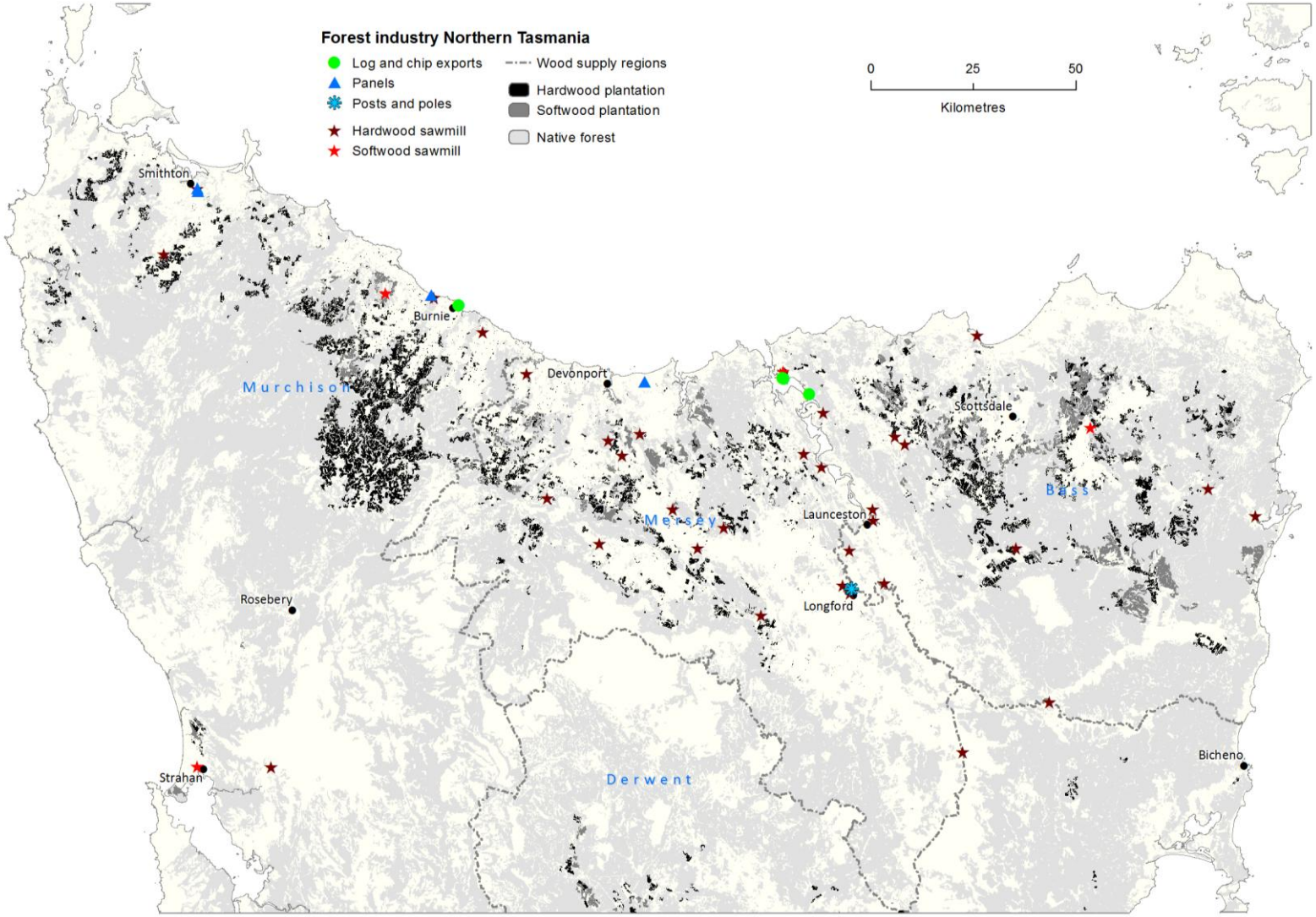
Note: Regions were constructed specifically for this analysis. Locations are approximate. Existing infrastructure as at 30 June 2013

Map C11 Approximate locations of existing processing capacity in South east Queensland, by broad industry type



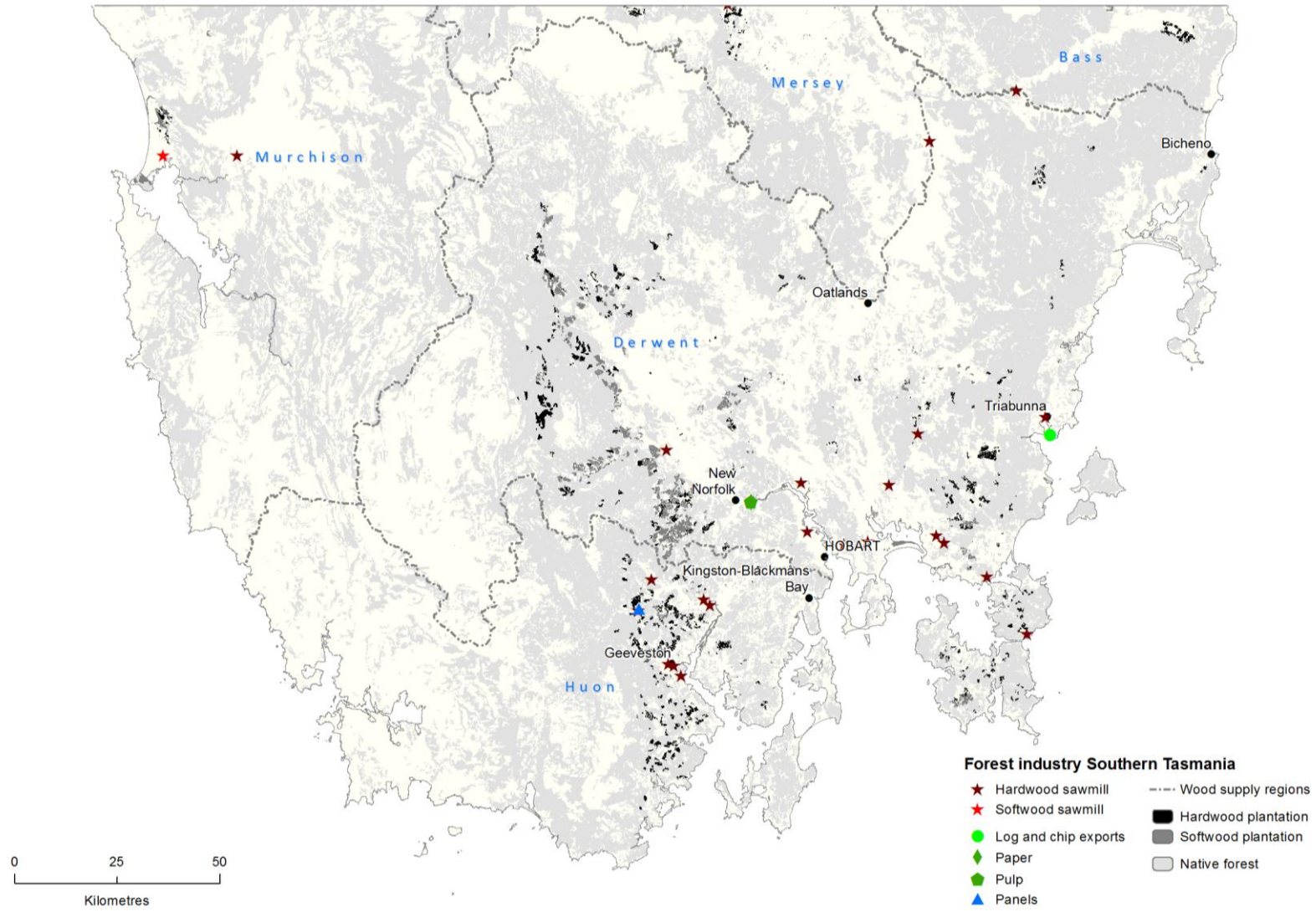
Note: Regions were constructed specifically for this analysis. Locations are approximate. Existing infrastructure as at 30 June 2013

Map C12 Approximate locations of existing processing capacity in Northern Tasmania, by broad industry type



Note: Regions were constructed specifically for this analysis. Locations are approximate. Existing infrastructure as at 30 June 2013

Map C13 Approximate locations of existing processing capacity in Southern Tasmania, by broad industry type



Note: Regions were constructed specifically for this analysis. Locations are approximate. Existing infrastructure as at 30 June 2013

Glossary

brownfield investment	investment in existing wood processing facilities and technologies
business-as-usual scenario	describes long-term assumptions intended to benchmark the forestry sector to current forest resource, wood processing technology and market parameters
constrained-wood-production scenario	envisages a future where forest areas and log availability are constrained by factors such as market conditions and lower investments and conservation and food production concerns; and where consumption of all wood products is lower relative to the business-as-usual scenario
discount rate	represents the weighted average of before-tax market returns on investment in Australia, after-tax returns on investments and the marginal cost of borrowing foreign funds; all future values are discounted in the modelling analysis to estimate the net present value of returns and costs
forestry codes of practice	a set of principles, procedures, guidelines and standards that defines and prescribes minimum acceptable practices in harvesting and associated forest management operations.
forestry sector	this analysis uses a restricted definition of the forestry sector to facilitate modelling analysis: the forestry sector comprises harvesting of native and plantation timber forests, haulage of logs and primary wood products, and processing of sawn timber, wood-based panels, pulp and paper products and other products such as woodchips, log exports, recovered paper and limited bioenergy technologies; the contribution of Australia's forestry sector to economic parameters such as employment, incomes and gross domestic product (GDP) is less than reported in ABARES (2013); this is because some subsectors have been omitted from the analysis because of data or modelling limitations (such as forestry establishment and management, forestry support services, downstream value-added such as frame and truss manufacturing, and timber wholesaling and retailing); ecosystem services (including non-wood forest products, carbon sequestration and water management) have not been included in this analysis
greenfield investment	investment in new wood processing facilities and technologies

industry value-added (IVA)	represents the value added by an industry to the intermediate inputs used by the industry; it is the measure of the contribution by manufacturing businesses to GDP; the value chain used in this study omits some downstream parts of the industry, particularly those involved in wholesaling, retailing and value-adding, and hence the manufacture of commodities that contribute significantly to IVA
investment hurdle rate	minimum return on investment required by prospective investors to commit capital to a project; incorporates the perceived risks and opportunity costs of the project; for this analysis, investment hurdle rate is in addition to the discount rate
natural forests	forest composed of indigenous trees and not classified as a forest plantation; the term generally applies to forests in Europe and parts of Asia and North America that have a long history of human use and disturbance leading to re-plantation of indigenous tree species; natural forests are referred to as native forests in Australia
priority-to-productivity scenario	based on the scenario developed in United Nations (2011); describes a future where infrastructure for a vibrant and productive forestry sector is supported
real value	inflation adjusted value, presented in this report in 2011–12 Australian dollars.
terms of trade	describes the relative price of exports to imports; this analysis incorporates changes to forestry sector terms of trade for a sensitivity analysis to partially examine the potential effects of exchange rate movements on the sector; ABARES has assumed that the price of wood products and imported components used in the forestry sector increase as the result of potential exchange rate depreciation; impacts on other sectors of the Australian economy are not incorporated into this analysis
turnover	total value of sales of all goods and services, whether or not manufactured by the business, exclusive of goods and services tax; this estimate does not deduct the costs of inputs or intermediate goods and services; some double-counting occurs across subsectors of the forestry sector and it is not possible to sum total turnover

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