Fibre and wood supply

Assessment report

April 2017

Victorian Environmental Assessment Council

VICTORIA

Victorian Environmental Assessment Council

The Victorian Environmental Assessment Council (VEAC) was established in 2001 under the *Victorian Environmental Assessment Council Act 2001*. It provides the State Government of Victoria with independent advice on protection and management of the environment and natural resources of public land.

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James Fitzsimons

VEAC

Foreword

This report describes the assessment carried out by VEAC of the viability of and capacity for, current volumes and potential fibre and wood supply areas in state forests in the four regional forest agreement areas in eastern Victoria. In February this year VEAC completed and submitted its assessment of conservation values of state forests in the same areas.

VicForests is the state-owned enterprise responsible for sustainable harvest, regrowing and commercial sale of timber from Victoria's state forests on behalf of the Victorian government. The assessment therefore relied on published and unpublished data and information from VicForests, and the Council is grateful for the cooperation of VicForests staff. The approach taken for this assessment also included commissioning an independent expert evaluation of the wood and fibre supply modelling that VicForests conducts to set its sustainable harvest levels, and a consideration of the risks and uncertainties that may impact on projected wood supply. VEAC's consultants specifically addressed potential impacts of bushfires, Leadbeater's possum detections and climate change.

This is the second assessment we have completed under amendments to the VEAC Act in 2016 that allow the Minister to request VEAC to provide advice or conduct assessments in addition to conducting investigations. VEAC was not required to provide recommendations in this report. Like VEAC's recent assessment of conservation values in state forests, the assessment in this report is an independent input to the information base for government in its consideration and decision making about native forests in eastern Victoria.

Phil Honeywood
Chairperson

Acknowledgement of Country

The Victorian Environmental Assessment Council acknowledges and pays its respects to Victoria's Native Title Holders and Traditional Owners within the assessment area, and the rich cultural and intrinsic connection they have to Country. The Council also recognises and acknowledges the contribution and interest of other Aboriginal peoples and organisations in the management of land and natural resources.

Acronyms

DEDJTR	Department of Economic Development, Jobs, Transport and Resources
DELWP	Department of Environment, Land, Water, and Planning
FMA	Forest management areas
FGF	Forest growth function
HVMS	High-value mixed species
LA	Legislated Agreement
LBP	Leadbeater's possum
MAT	Mean annual temperature
SFRI	Statewide Forest Resource Inventory
SWSM	Strategic wood supply modelling
TMV	Total merchantable volume
VEAC	Victorian Environmental Assessment Council

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Executive summary

1. On 23 November 2016, the Minister for Energy, Environment and Climate Change requested the Victorian Environmental Assessment Council (VEAC) to carry out an assessment of the viability of and capacity for, current volumes and potential fibre and wood supply areas in state forests in the Central Highlands, North East, Gippsland and East Gippsland regional forest agreement areas. The completion date for the assessment is 28 April 2017.
2. The purpose of the assessment is to:
    a. identify the current, and currently projected, fibre and wood supply to industry from eastern Victoria, taking into consideration current contractual supply commitments
    b. identify the current and likely future constraints to this supply
    c. report on public land use and management
    d. report on the viability of and capacity for current and potential wood and fibre supply over appropriate time scales.
3. VEAC used VicForests' published and unpublished data and information to address the terms of reference. VEAC also commissioned an independent expert review of the strategic wood supply modelling process employed by VicForests to set wood supply levels from Victoria's state forests and an analysis of a range of potential risks and uncertainties that Victoria's native forest industry may face in the coming decades.
4. The age structure of the ash forests in Victoria's Central Highlands forest region is very unbalanced. Forest stands originating from the 1939 bushfires dominate the area of regrowth forest in eastern Victoria. This 1939 regrowth is the primary source of high-value sawlogs in Victoria due to the size and wood quality of the mountain ash and alpine ash. The impacts of subsequent fires, in particular the 2009 Black Saturday fires, have further skewed the age class distribution of ash species. A primary challenge facing VicForests and the native forest industry is the exhaustion of the 1939 ash regrowth after 2030, but before sufficient new forest resources from subsequent regeneration events are available to harvest.
5. VicForests employs a widely-used modelling approach to estimate sustainable fibre and wood supply levels for the state forests of eastern Victoria. Their approach applies industry-standard modelling tools (*Woodstock* and *Stanley*), makes appropriate assumptions, and produces reasonable estimates of sustainable wood supply levels. While VicForests' current strategic wood supply modelling process is rigorous and repeatable, there are some potential areas which could be improved such as the currency of the data underpinning the resource assessment, now 15-25 years out of date.
6. These findings are consistent with previous reviews of Victoria's strategic wood supply modelling process that found that the modelling approach is sound, that the assumptions that underpin the approach are appropriate, and that the sustainable harvest levels are reasonable.
7. The modelling framework, which requires diverse data inputs, sub-models, constraints, and adjustment factors, is unavoidably complex. This complexity is difficult to explain to non-experts and makes the process seem opaque to the public.
8. While VicForests' projections based on current assumptions are reasonable, further fires, detection of additional new Leadbeater's possum colonies, or reductions in volume due to climate or other disturbances, will exacerbate pressures for further downward revisions of wood supply level.
9. Sustainable harvest levels have been reduced by more than 50 per cent over the past decade. In 2009, Statewide estimated sustainable harvest levels were 500,000 m^3 $year^{-1}$ for D+

sawlogs, of which 293,000 m^3 $year^{-1}$ were D+ ash sawlogs. The 2013 resource outlook forecast 220,000 m^3 $year^{-1}$ of ash sawlog. VicForests' current medium term resource outlook is for 132,000 m^3 $year^{-1}$ D+ ash sawlogs and 100,000m^3 $year^{-1}$ of mixed species D+ sawlog.

10. These reductions have occurred due to the impacts of unexpected events, such as major landscape level bushfires and Leadbeater's possum discoveries, which are addressed in the strategic wood supply modelling reviews. VicForests primarily manages these risks through updates to model inputs, adjusting model outputs for future changes, and contract terms and tenure. Accounting for future potential losses due to unexpected events such as bushfires presents a significant challenge for VicForests and creates a potential vulnerability for the native forest industry, which is looking for some security in the forest resource in the medium term.

11. Native timber harvesting in Victoria is currently based on an integrated supply model of timber for both sawlog and pulplog. Timber harvesting generates both sawlog and residual wood. Residual wood is sold as pulplog. VicForests' current commitments comprise 265,000 m^3 $year^{-1}$ ash pulplog to be supplied to Australian Paper by the State of Victoria to 2030 in accordance with the *Forests (Wood Pulp Agreement) Act 1996*, and a number of shorter-term sawlog and pulplog timber sales agreements between VicForests and 22 purchasers, including Australian Paper. In addition, VicForests has some 70 contracts for the harvesting of trees and haulage of the logs to purchaser locations, with some contractors holding multiple contracts including a mix of harvest and haulage.

12. Based on a typical split of ash sawlog and pulplog the forecast decline in ash sawlog supply indicates that additional alternative sources of pulp, such as thinnings, will be required to meet the current commitments of 265,000 m^3 $year^{-1}$ of ash pulplogs until 2030 arising from the legislated supply agreement to Australian Paper.

13. Analyses conducted for this assessment provide estimates of potential levels of Leadbeater's possum discovery rates and fire activity over the next 20 years based on a range of data sources, as well as Forest Management Area-level variation in these potential impacts. Both bushfires and additional new Leadbeater's possum colony discoveries have the potential to reduce the harvestable area of 1939 ash regrowth by about 20 per cent. Because the 1939 ash regrowth accounts for approximately 40 per cent of the additional new Leadbeater's possum discoveries, the combined impacts of major bushfires and new discoveries would likely be a 25-35 per cent reduction in wood supply over the next 20 years over that already factored in by VicForests. These impacts are based on the recent policy of harvesting exclusions for Leadbeater's possum, which is currently being reviewed.

14. Climate change presents a longer-term threat to the viability of the native forest resource. Modelling of climate change impacts predicts that by the end of the century there may be reductions in standing volume and stand density of 15 per cent.

1. Introduction

In November 2016, the Victorian Environmental Assessment Council was requested by the Minister for Energy, Environment and Climate Change, the Hon Lily D'Ambrosio MP to carry out an assessment of the viability of and capacity for, current volumes and potential fibre and wood supply areas in state forests in the Central Highlands, North East, Gippsland and East Gippsland regional forest agreement areas.

A separate assessment of the conservation values of state forests in the same four RFA areas was requested in October 2016. This assessment was completed and submitted to the Minister for Energy, Environment and Climate Change on 28 February 2017.[1] The assessment report is available on VEAC's website at www.veac.vic.gov.au.

1.1 Background to the assessment

The assessment has its origins in the work of the Forest Industry Taskforce in 2016, and is undertaken under the provisions of the *Victorian Environmental Assessment Act 2001*.

1.1.1 Forestry Industry Taskforce

As part of implementing its 2014 election policy *Our Environment, Our Future*, the Victorian government established a Forest Industry Taskforce, made up of key stakeholders across industry, the union movement and forest conservation groups.[2] The government endorsed the terms of reference developed by representatives of the major stakeholders in November 2015, and committed to ongoing support of their work through a taskforce secretariat.[3] More information about the taskforce, its membership, terms of reference and key documents can be found at http://forestindustrytaskforce.com.au/.

The purpose of the taskforce is for the major stakeholders to reach common ground on a durable, long-term set of recommendations and proposals to government, about future issues facing the industry, job protection, economic activity, protection of our unique native flora and fauna and threatened species, such as the Leadbeater's possum. The focus is on future use and management of regional forest agreement (RFA) state forests east of the Hume Highway (see figure 1.1).

In September 2016, the taskforce released its Statement of Intent, which had been provided to the Premier of Victoria. The Statement of Intent identified agreed opportunities for change relating to parks and reserves, fibre and wood supply security, and jobs and regional employment. The taskforce stated that it was working on six processes to inform its final recommendations, including the following Victorian Environmental Assessment Council (VEAC) assessments or investigations:

- an initial Victorian Environmental Assessment Council investigation of forest conservation values
- an initial Victorian Environmental Assessment Council investigation into the viability of fibre and wood supply.

In December 2016 the taskforce reported to the government. The government is considering the matters the taskforce has been working on, and has stated that the members of the taskforce will continue to play an important advisory role for government in relation to these issues.[4]

Section 1.1.3 provides details of the request to VEAC to conduct the assessment of the viability of and capacity for, current volumes and potential fibre and wood supply areas in state forests in the

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1 See http://www.veac.vic.gov.au/investigation/assessment-of-conservation-values-of-state-forests

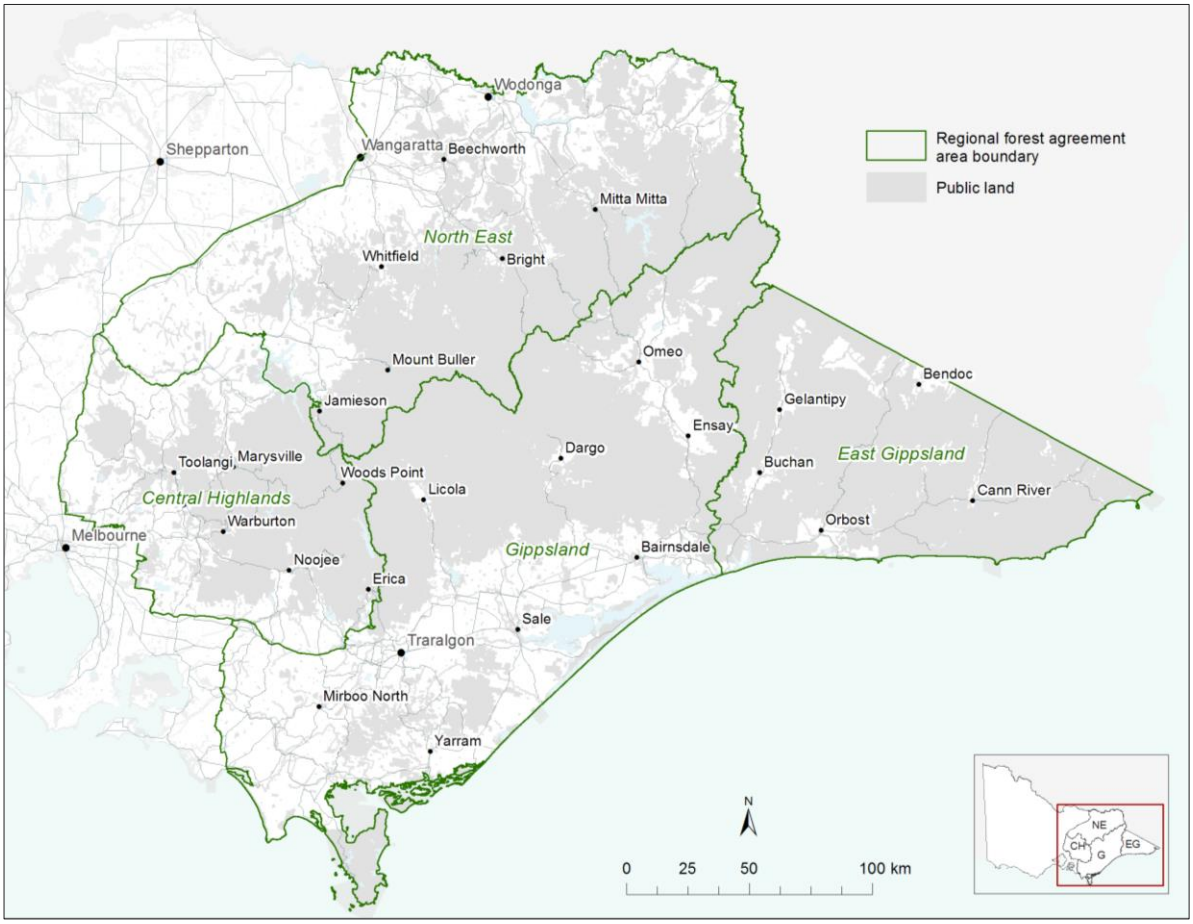
2 Victorian Labor 2014 *Our Environment, Our Future*

3 Premier of Victoria media release 20 November 2015 http://www.premier.vic.gov.au/forest-industry-taskforce-terms-of-reference-released/

4 Parliament of Victoria Legislative Council Hansard Tuesday 7 February 2017 page 15

Central Highlands, North East, Gippsland and East Gippsland regional forest agreement (RFA) areas.

Figure 1.1 Regional Forest Agreement areas east of the Hume Highway



1.1.2 Victorian Environmental Assessment Council

The *Victorian Environmental Assessment Council Act 2001* (VEAC Act) came into effect on 31 December 2001. This Act established the Victorian Environmental Assessment Council (VEAC) to conduct investigations and make recommendations relating to the protection and ecologically sustainable management of the environment and natural resources of public land. VEAC is a successor organisation to the Land Conservation Council (LCC), established in 1971, and the Environment Conservation Council, which replaced the LCC in 1997.

Public land is defined in the VEAC Act and includes Crown land and land owned by state government public authorities. It excludes private freehold land, land owned by local councils and Commonwealth land. VEAC does not make recommendations for private land, local councils' freehold land or Commonwealth land.

The current five members appointed to VEAC are Hon. Phil Honeywood (Chairperson), Ms Joanne Duncan, Ms Anna Kilborn, Dr Charles Meredith and Dr Geoffrey Wescott. A brief biography of each of the current Council members can be found on VEAC's website at www.veac.vic.gov.au. The Council is supported by a small research, policy and administrative secretariat. The VEAC Act requires the Council to consult with departments and public authorities, and requires departments and public authorities to give practicable assistance to the Council in carrying out investigations. VEAC papers and reports are prepared independently.

Amendments to the VEAC Act came into operation in September 2016. The amendments established a second process by which VEAC is able to provide advice and assessments, in

addition to being able to carry out investigations. The amended Act allows for VEAC to provide advice or carry out assessments on matters that, because of their limited scale or scope or their technical nature, might not require an investigation under the current provisions.

This assessment is the second to be carried out under the new provisions.

1.1.3 Terms of reference

On 23 November 2016, the Minister for Energy, Environment and Climate Change requested VEAC conduct an assessment of fibre and wood supply from state forests in the Central Highlands, North East, Gippsland and East Gippsland regional forest agreement (RFA) areas. The assessment is required to be completed by 28 April 2017.

The request for the assessment was made under section 26B of the VEAC Act. The terms of reference are provided in the box below.

Terms of Reference

Pursuant to section 26B of the *Victorian Environmental Assessment Council Act 2001*, the Minister for Energy, Environment and Climate Change hereby requests the Council to carry out an assessment of the viability of and capacity for, current volumes and potential fibre and wood supply areas in state forests[1] in the Central Highlands, North East, Gippsland and East Gippsland regional forest agreement areas.

The purpose of the investigation is to:

a. Identify the current, and currently projected, fibre and wood supply to industry from the specified area. The Council is required to take into consideration current contractual supply commitments;

b. Identify the current and likely future constraints to this supply;

c. Report on public land use and management; and

d. Report on the viability of and capacity for current and potential wood and fibre supply over appropriate time scales.

VEAC is required to consult with technical and industry experts to gather and confirm source data, and to document any relevant caveats to this data.

The Council is required to consult with the Forest Industry Taskforce, including providing the taskforce with information on progress by 28 February 2017 in line with the reporting requirements for the Conservation Values of State Forests Assessment.

The Council must take into account relevant state or federal regulation and legislation.

As specified in section 26D of the *Victorian Environmental Assessment Council Act 2001* the Council must confer with any Department or public authority which may be affected by the provision of the assessment including VicForests, Department of Environment, Land, Water and Planning, and Department of Economic Development, Jobs, Transport and Resources; and the departments and public authorities must give practicable assistance to the Council in preparing an assessment.

The Council must report on the completed assessment as soon as practicable but no later than 28th April 2017.

[1] For the purposes of this assessment, state forest is defined as the areas of public land depicted as General Management Zone, Special Management Zone and Special Protection Zone in the maps accompanying the regional forest agreements as updated from time to time and expressed in the DELWP forest zoning data set (FMZ 100) as at the time of commencement of the investigation.

1.1.4 Addressing the terms of reference

The first specific topic (a) in the terms of reference is to identify the current, and currently projected, fibre and wood supply to industry from eastern Victoria, taking into consideration current contractual

supply commitments. This topic was addressed firstly through describing the most recent resource projections from published material and updated data provided by VicForests, and secondly through examining the characteristics (including volume) of the legislated and contracted from published information and data provided by VicForests commitments (see sections 2 and 3 of this report).

The second specific topic (b) is to identify the current and likely future constraints to this supply. This topic was addressed through commissioning an independent evaluation to:

- provide a detailed summary of the modelling process that forms the basis of VicForests sustainable wood supply estimates
- conduct a sensitivity analysis of various aspects of the strategic wood supply modelling process
- evaluate the potential risks to fibre and wood supply such as from protecting Leadbeater's Possum, future climate variability, and major bushfires.

The outcomes of the evaluation are summarised in section 4. The full report is available in appendix A.

The third specific topic (c) is to report on public land use and management. This topic is addressed in section 1, and has also been covered in VEAC's report in February 2017 on the Conservation Values of State Forests Assessment.

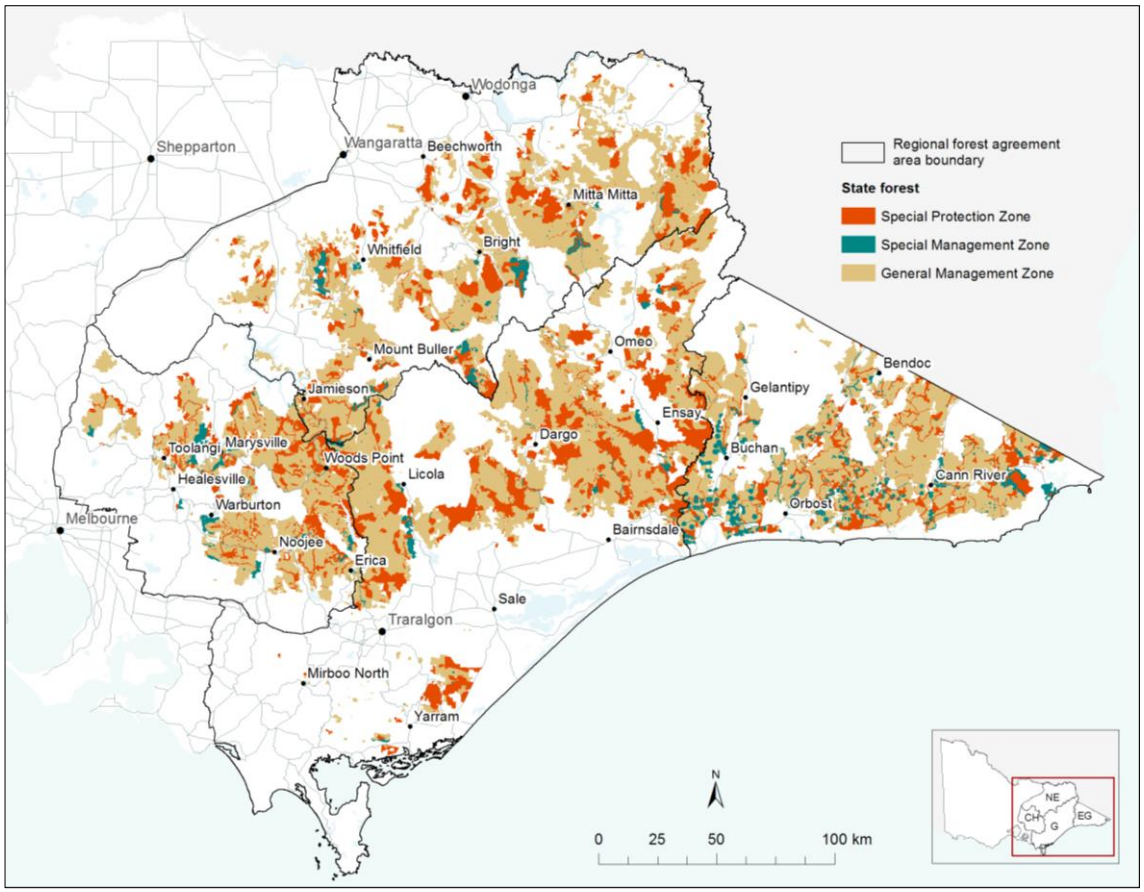
The fourth and final specific topic (d) is to report on the viability of and capacity for current and potential wood and fibre supply over appropriate time scales. The independent evaluation commissioned by VEAC (appendix A) contributed to VEAC's evaluation of the potential of Victoria's state forests to provide a range of fibre and wood supply levels in the coming decades (see section 5).

1.1.5 Assessment area

The four RFA areas east of the Hume Highway are shown in figure 1.1. The assessment area comprises four of Victoria's five RFA areas.

The terms of reference specify that, for the purposes of this assessment, state forest within the RFA areas is defined as the areas of General Management Zone (GMZ), Special Management Zone (SMZ) and Special Protection Zone (SPZ) in the forest zoning data set maintained by the Department of Environment, Land, Water and Planning (DELWP). Figure 1.2 shows the forest management zoning in the assessment area. All the maps published in this report are available on VEAC's website at http://www.veac.vic.gov.au/ where they can be viewed in more detail.

Figure 1.2 Forest management zoning in the assessment area



The distribution of land within the assessment area boundary is shown in table 1.1 and figure 1.3.

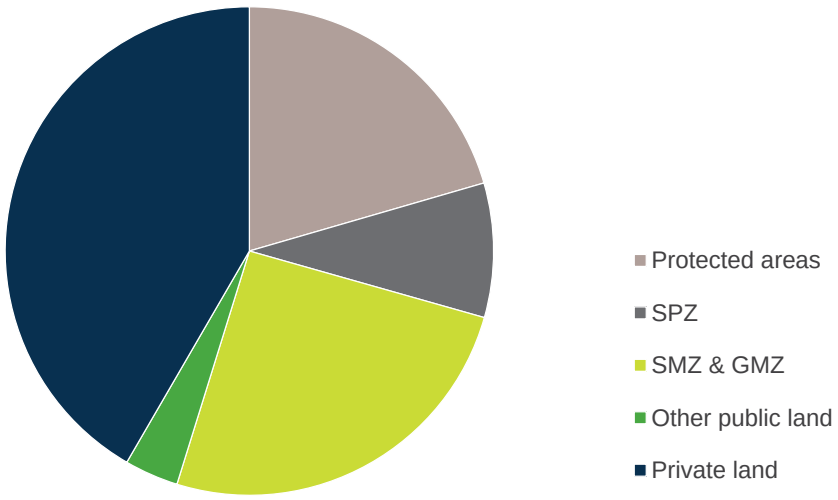
Table 1.1 Land tenures within the assessment area boundary (hectares)

State forest SMZ and GMZ	State forest SPZ	Protected areas*	Other public land	Private land	Total
1,842,877	625,325	1,493,915	418,327	2,948,159	7,328,603
State forest total: 2,468,202					
Public land total: 4,380,444					

*'protected areas' do not include regional parks or historic areas

Source: State forest zoning from FMZ100 December 2016

Figure 1.3 Proportion of land tenures within the assessment area boundary



In the four eastern RFAs 1,842,877 hectares of state forest is zoned GMZ and SMZ. This area differs from the area cited by VicForests as available for harvesting (1,820,000 hectares) because VicForests cites the allocated area in the allocation order[5] which has a different western boundary than that of the eastern RFA areas and excludes some areas. RFAs are described in more detail in section 1.2.2, and timber allocation orders and the forest management zoning scheme in section 1.2.3.

1.2 Legal and policy framework

Management of state forests in Victoria is carried out within a complex legal and policy framework. An overview of national forests policy, regional forests agreements and Victoria's legislative framework is provided in the following sections 1.2.1 to 1.2.3. The environmental management of Victorian forests is described in section 1.3. Similar information was provided in section 4 of VEAC's Conservation Values of State Forests Assessment Report (2017). Additional information is provided in this report on the legislated agreement governing the supply of pulpwood to Australian Paper - the *Forests (Wood Pulp Agreement) Act 1996.*

1.2.1 National forest policy

Australia has endorsed the Global Statement of Principles on Forests, presented at the 1992 United Nations Conference on the Environment and Development. An outcome of this endorsement was the preparation of a strategy for the ecologically sustainable management of Australia's forests, the National Forest Policy Statement[6], which has been signed by the federal and all state and territory governments.

In 1993, Canada convened the International Seminar of Experts on the Sustainable Development of Boreal and Temperate Forests. This led to the development of the Montreal Process criteria and indicators. These criteria are designed to reflect the ecological, economic and social components of sustainable forest management. The Montreal Process criteria are:

- conservation of biological diversity
- maintenance of productive capacity of forest ecosystems
- maintenance of ecosystem health and vitality

5 Allocation (Amendment) Order 2014 Victorian Government Gazette No S 405, 30 October 2014

6 Commonwealth of Australia 1992,1995

- conservation and maintenance of soil and water resources
- maintenance of forest contribution to global carbon cycles
- maintenance and enhancement of long-term multiple socio-economic benefits to meet the needs of societies; and legal, institutional and economic framework for forest conservation and sustainable management.

Regional indicators have been developed within these criteria for use in Australia. *Australia's Sustainable Forest Management Framework of Criteria and Indicators* 2008[7] forms the basis for measuring and reporting on sustainable forest management in Australia.

1.2.2 Regional forest agreements (RFAs)

Regional forest agreements between the federal, state and territory governments are a key outcome of the National Forest Policy Statement. Victoria has five such agreements, signed between 1997 and 2000. The Australian government coordinates a national approach to environmental and industry issues, while Victoria is responsible for managing the forests. These agreements are intended to last for 20 years.

The main objectives of the Victorian RFAs are:

- to identify a comprehensive, adequate and representative reserve system and provide for the conservation of those areas
- to provide for the ecologically sustainable management and use of forests in each RFA region, and
- to provide for the long-term stability of forests and forest industries.

The performance of all RFAs is reviewed together every five years. The first review period was from the date the RFAs were signed to 30 June 2004, and the second review period was from 1 July 2004 to 30 June 2009. These two review periods were assessed in one report, which was tabled in Parliament in 2010.[8] The joint Australian and Victorian government response to the review was tabled in Parliament in 2015.[9] No subsequent reviews have yet been completed.

The Australian and Victorian governments executed an amendment to the East Gippsland RFA in January 2017, extending its expiry from 3 February 2017 to 27 March 2018.

This extension of the agreement for 13 months will line up its expiry with the Central Highlands RFA. It allows the governments to consider the outcomes from the third five-yearly review of Victoria's RFAs which is expected to be completed by September 2017. It also allows the Victorian government to consider the advice from the Forest Industry Taskforce on the future management of forests in eastern Victoria.[10]

1.2.3 Victoria's legislative and administrative framework

A number of state government agencies have roles and responsibilities relating to state forests and/or native timber harvesting in Victoria.

The Department of Environment, Land, Water and Planning (DELWP) manages state forests on behalf of the Victorian community. State forest is managed to balance a variety of uses. These uses include conserving flora and fauna, protecting water catchments and water supply, providing timber for sustainable forestry, protecting landscape, traditional owner, archaeological and historic values, and providing recreational and educational opportunities. DELWP also regulates compliance of

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7 Commonwealth of Australia 2008

8 Wallace, L 2010 *Independent review on progress with implementation of the Victorian Regional Forest Agreements*

9 DEPI 2014

10 http://www.agriculture.gov.au/forestry/policies/rfa/regions/vic-eastgippsland

VicForests' activities with the Code of Practice for Timber Production. DELWP has broader roles in forest policy and forest management zoning, and management roles in relation to fire, biodiversity, recreation, administration of some non-commercial licences.

The Department of Economic Development, Jobs, Transport and Resources (DEDJTR), VicForests and Department of Treasury and Finance (DTF) are the key government agencies with roles and responsibilities in relation to the native timber industry in Victoria.

VicForests was established in 2003 by Order in Council under the *State Owned Enterprises Act 1992*. The Treasurer is the sole shareholder. The responsible Minister is the Minister for Agriculture. VicForests is responsible for the sustainable harvest, regrowing and commercial sale of timber from Victoria's state forests on behalf of the Victorian government. DTF undertakes functions on behalf of the Treasurer as the shareholder of VicForests. DEDJTR manages the allocation orders, has responsibility for forest industries policy, manages public safety zones for timber harvesting operations, supports the Minister for Agriculture in her duties relating to VicForests and, together with DTF, monitors VicForests' corporate governance.

A range of state legislation governs forest management and timber harvesting in Victoria and specifies the areas of state forests that are subject to commercial activities.

Sustainable Forests (Timber) Act 2004

This Act provides a framework for sustainable forest management and sustainable timber harvesting in state forests. Amongst other things, it provides for the allocation of timber to VicForests through an allocation order and the development of a sustainability charter for Victoria's state forests, determines sustainability criteria and indicators and reporting requirements, and establishes the requirement to comply with codes of practice.

Sustainability Charter for Victoria's state forests (2006)

The Sustainability Charter sets objectives for the sustainability of public native forests and the sustainability of the timber harvesting industry on public land in Victoria. The seven objectives set out in the charter are consistent with the Montreal Process for sustainable forest management and the principles of ecologically sustainable development.

Victoria's performance on progressing these objectives is monitored through Victoria's criteria and indicators for sustainable forest management and publicly reported through the five-yearly release of Victoria's state of the forests report.

Criteria and indicators for sustainable forest management in Victoria (2007)

The criteria and indicators were developed by the then Department of Sustainability and Environment with the assistance of key experts, Government partners, and in consultation with the community. These criteria and indicators are consistent with the Montreal Process, and complement the *Australia's Sustainable Forest Management Framework of Criteria and Indicators* (2008). The 45 indicators will inform Victorians on progress toward the objectives set out in the sustainability charter.

State of the forests reporting

DELWP produces a State of the Forests Report every five years to assess progress towards sustainable forest management. The report assesses this progress using the 45 indicators for sustainable forest management in Victoria. The third and most recent report was released in 2013.

Timber allocation order

The Minister for Agriculture allocates timber resources in state forest to VicForests for harvesting and sale through an allocation order. The allocation order is published in the Victorian Government Gazette, and describes the location and extent of forest stands within state forest to which VicForests has access, the maximum area available for timber harvesting in any five-year period, any additional activities that VicForests is allowed to undertake, and a number of conditions VicForests must comply with in carrying out its functions under the allocation order.

VicForests may only harvest and/or sell vested timber resources in accordance with the allocation order. The most recent allocation order is dated 30 October 2014, which was an amendment of the 1 October 2013 order.

Timber release plans

Areas for harvesting in eastern Victoria are managed by VicForests according to timber release plans (TRP). After the allocation order to VicForests has been gazetted by the Minister, the Act requires a plan to be developed for the area to which an allocation order applies.

The TRP is a five-year rolling plan that identifies areas (coupes) that may be harvested for timber over the next three to five years. The TRP lists the coupes, their locations, the type of forest within and the method of harvesting that would be used in each one. Evaluation and feedback is provided on proposed TRPs by a number of stakeholders including DELWP, DEDJTR, Parks Victoria, Aboriginal Affairs Victoria, and the local community.

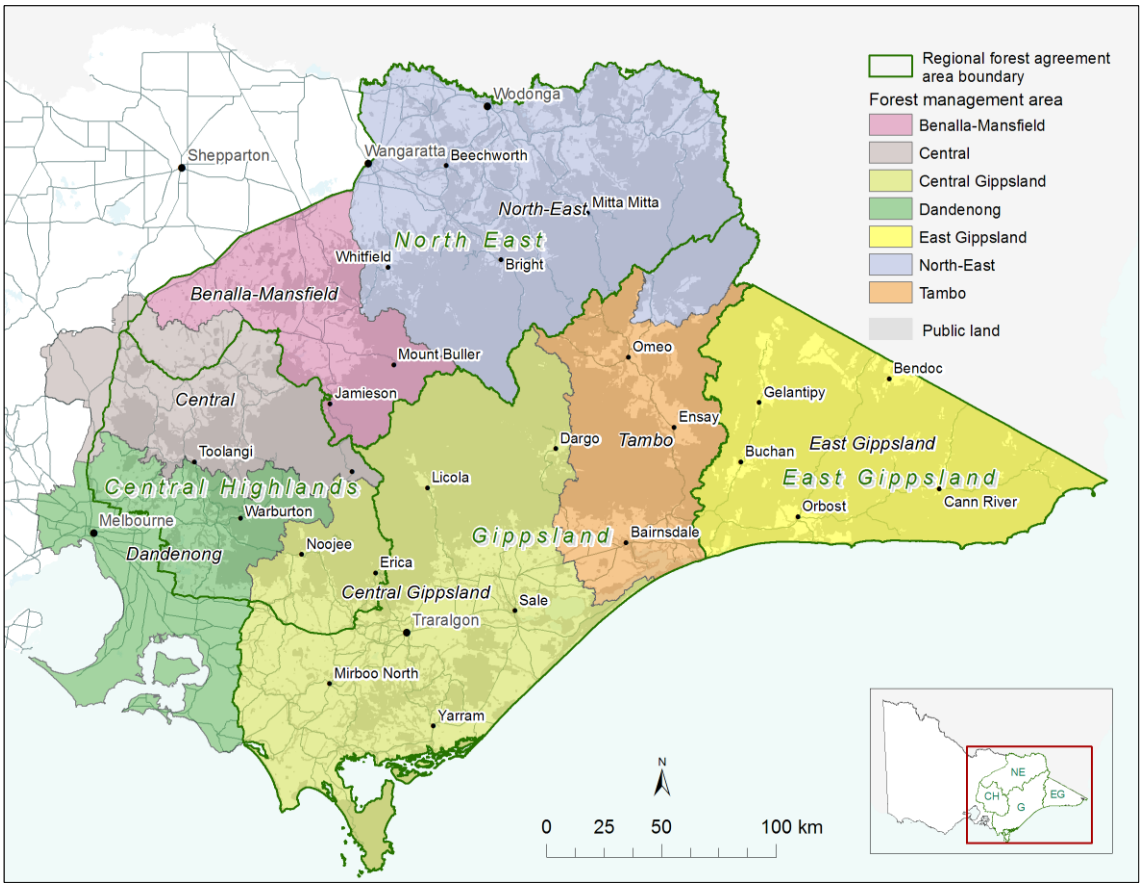
Forests Act 1958

This Act provides for the management of state forests, including the protection of public land from fire, the development of forest management plans, licensed occupations including grazing and beekeeping, and the sale of forest produce.

Forest management areas

Forest management areas (FMAs) are units for planning and managing state forest, and are defined in the Forests Act. Victoria has 15 forest management areas. The Wodonga and Wangaratta FMAs are currently managed together as the North East FMA. The assessment area includes the East Gippsland, Tambo, Central Gippsland, Central, Benalla Mansfield and North East FMAs and part of the Dandenong FMA (see figure 1.4). The FMA boundaries do not fully align with the RFA boundaries.

Figure 1.4 Forest management areas (FMAs) in eastern Victoria



Forest management plans

Section 22 of the Forests Act provides the Secretary of DELWP with a broad power to establish and revise a working plan 'with respect to the control, maintenance, improvement, protection from destruction or damage by fire or otherwise, and removal of forest produce in and from State forests'. For the purposes of section 22, forest management plans are a working plan.

Forest management plans outline information and minimum prescriptive management actions resulting from Victoria's RFA process. They establish strategies for integrating the use of state forest for wood production and other purposes with the conservation of natural, aesthetic and cultural values. To balance these uses, forest management plans include:

- conservation guidelines which specify minimum levels of planned protection provided for natural values in state forest, taking into account the extent of those values in formal reserves
- forest management zones which set priorities and permitted uses in different parts of state forest
- a process for adapting to change in a systematic and orderly manner.

Forest management plans are developed with experts from disciplines such as forestry, botany, wildlife biology, catchment management, water resources, cultural heritage and recreation planning, in consultation with the public. Information on the uses and values of the forest (including natural, cultural, social, resource and economic) arising from the RFA comprehensive regional assessment processes informs the planning process. There are several forest management plans covering the four RFA areas subject to this assessment (see table 1.2). Forest management plans align with the RFA areas and therefore may cover one or more FMAs, and different areas of a FMA may be subject to different management plans.

Table 1.2 Forest management plans applying to the assessment area

Plan	Date created	Forest management areas (FMA)
Forest Management Plan for the East Gippsland Forest Management Area	1995	East Gippsland FMA
East Gippsland Forest Management Plan Amendment: amendments subsequent to the East Gippsland RFA	1997	East Gippsland FMA
Forest Management Plan for the Central Highlands	1998	Central FMA, western part of Central Gippsland FMA, northern part of Dandenong FMA (no forests in the southern part of this FMA)
Forest Management Plan for the North East	2001	Benalla–Mansfield FMA, Wangaratta FMA, majority of Wodonga FMA (Wangaratta and Wodonga FMAs are managed as North east FMA)
Forest Management Plan for Gippsland	2004	Entire Tambo FMA, eastern part of Central Gippsland FMA, 11 south-eastern blocks of Wodonga FMA (now North-east FMA)

Forest zoning

The forest management zoning scheme is the spatial representation of a working plan, or forest management plan. This detailed zoning system allows for the protection and management of a range of values and uses of state forest.

The zoning scheme includes special protection zones (SPZ), special management zones (SMZ), and general management zones (GMZ).[11]

Special protection zones are managed for the conservation of natural, cultural, recreation and amenity values. Larger components of SPZs include old-growth forest, habitat for rare and threatened species, areas of rainforest, and representative examples of ecological vegetation classes. SPZs form part of the Comprehensive, Adequate Reserve (CAR) System, which is a key element of delivering on the conservation objectives set out in Regional Forest Agreements. A number of smaller areas such as historic and recreation sites are also included in SPZs. Each component of this zone is managed to minimise disturbances or processes which threaten conservation values, and timber harvesting is excluded. Timber resources in the SPZ are not included in sawlog sustainable yield forecasts. SPZs may be removed or amended, for example, if the values they are protecting no longer exist, or review processes demonstrate that alternative areas are a higher priority for protection.

Special management zones are managed to maintain specific values while catering for some timber production. This zone primarily includes areas of high landscape value, the protection of which require modification to timber harvesting or other land use practices rather than their exclusion. Management of this zone tends to be considered on a case-by-case basis within the constraints outlined in relevant forest management plans. Timber and other forest produce may be harvested from this zone. This zone forms part of the area that contributes to the sustainable yield of sawlogs, provided that modifications to normal management practices adequately address the protection of the identified values, or positively contribute to their conservation.

[11] Descriptions of zones are drawn from forest management plans, particularly the Forest Management Plan for Gippsland 2004

General management zones cater for a range of uses, with timber production being a high priority. Forest in this zone will be managed for the sustainable production of sawlogs in accordance with the Code of Practice for Timber Production (see section 1.3) and more detailed local management prescriptions. Other management aims include protection of landscape and water quality, provision of recreation and educational opportunities, fire protection and conservation of natural values to complement adjacent zones.

A number of sub-zones apply within the SMZ and GMZ, as follows:

Timber production sub-zones are used to produce sawlogs on a sustainable basis in accordance with the Code of Practice for Timber Production and regional prescriptions. This sub-zone corresponds to the net area in both the GMZ and the SMZ that is both available and suitable for producing sawlogs. It generally corresponds to sites where soil and rainfall conditions enable suitable tree species to grow to a height of about 28 m or greater. Harvested areas will be regenerated with local species, and the regrowth across the sub-zone will produce a mosaic of native forest of different ages.

Other uses sub-zones apply to forest within the GMZ and SMZ where productivity is too low for sawlog harvesting under current arrangements. This sub-zone contributes to the conservation of drier forest types and associated fauna. While activities such as fuel-reduction burning, harvesting of other forest produce (such as firewood, poles and honey) and recreation are permitted, they will generally be localised, leaving much of the area relatively undisturbed.

Code exclusions sub-zones identify areas within the GMZ and SMZ that are excluded from harvesting operations due to the requirements of the Code of Practice for Timber Production. It includes stream buffers and slopes generally greater than 30 degrees. Much of this area will remain largely undisturbed and contributes to the conservation of a number of ecological vegetation classes and related fauna.

The Secretary of DELWP may amend the forest management zones at any time, subject to administrative processes. Amendments must also be consistent with Regional Forest Agreements. The *Code of Practice for Timber Production 2014* (the Code) discussed below incorporates a set of planning standards that were transcribed from relevant forest management plans and action statements under the *Flora and Fauna Guarantee Act 1988*. These planning standards are the basis for decision making but are not binding on the Secretary. Where these planning standards do not reflect the latest information or are silent, other relevant information may also be taken into account. For example, Action Statements written since 2014 and the advice of biodiversity experts may be used to create an interim planning standard that forms the basis for zoning decisions until the Code can be updated. For significant updates of the forest management zones, public consultation is required.

Table 1.3 indicates the activities permitted in each zone. Soil and water conservation, maintenance of native forest cover and wildfire suppression are high priorities in all zones.

Table 1.3 Activities permitted in forest management zones

Activity	SPZ	SMZ	GMZ
Timber production: sawlog, residual log, sleepers	No	Conditional	Yes
Timber production: firewood, posts, poles	No	Conditional	Yes/ Conditional[1]
Regrowth thinning	No	Conditional	Yes
Prescribed fire	Conditional	Conditional	Yes/ Conditional
Recreation and tourism[2]	Conditional	Yes/ Conditional	Yes
Apiculture	Conditional	Yes/ Conditional	Yes
Seed collection	Conditional	Yes/ Conditional	Yes
Eucalyptus oil production[3]	No	Conditional	Yes
Stock grazing	No/ Conditional	Conditional	Yes/ Conditional
Extractive activities[4]	No/ Conditional	Conditional	Yes/ Conditional
Mining activities	Yes	Yes	Yes
Road construction	Conditional	Conditional	Yes/ conditional

Notes

1. The collection of firewood, posts, poles is only described as conditional in the East Gippsland and Midlands FMAs.
2. Recreation includes bushwalking, fishing, hunting, four wheel driving, horse riding, and camping.
3. The collection of eucalyptus oil is only described in the Bendigo FMP.
4. Extractive activities includes extraction of rock, sand, gravel, clay and soils and is regulated under the *Extractive Industries Development Act 1995* (EIDA).

   Yes: permitted under standard conditions.

   Conditional: permitted with additional conditions specified in FMP, or to the extent it does not conflict with the values identified for the respective area.

   No: not permitted.

   Yes/ conditional or No/ conditional: this activity is permitted (or not) in some FMPs and conditional in others.

Conservation, Forests and Land Act 1987

This Act addresses requirements for the protection of land, water and wildlife prior to the commencement of harvesting or construction activities, as met through approval of the Timber Release Plan process, and enforces compliance with the Code of Practice for Timber Production.

Forests (Wood Pulp Agreement) Act 1996

The State has supplied Australian Paper (AP) and its predecessors in accordance with legislative commitments since the 1930s. Australian Paper's Maryvale mill was established in 1937. The first commercial production of pulpwood in Victoria (for paper manufacture) was in 1937-38 when approximately 5000 m^3 was made available to APM Ltd under the terms of the *Wood Pulp Agreement Act 1936.* The 1936 agreement was extensively amended in 1961 to provide for increased supplies required due to the 1939 fires which substantially reduced the quantity and quality of pulpwood in the Forest Area defined in the original agreement, and to support expansion of the Maryvale operations. Other major amendments to the agreement were made in 1966, 1974 and 1984. The Victorian Government is currently committed to supply AP pulpwood until 30 June 2030 through the current legislated agreement.

Approximately one-third of AP's wood fibre is supplied from native forests under two long-term agreements. These are:

- the Forests Wood Pulp Agreement, otherwise referred to as the Legislated Agreement (LA), ratified by the *Forests (Wood Pulp Agreement) Act 1996* (FWPA Act), and
- a commercial supply agreement between VicForests and AP.

AP also sources pulpwood from other suppliers. Significant supplies of pine and eucalypt pulplog is sourced by AP from Hancock Victoria Plantations. This supply and supply from other sources (e.g. waste wood from local sawmills, waste paper and imported pulp) operates under commercial contracts between AP and the supplier - the State has no role in these arrangements. In AP's 2013 Sustainability Report it noted its fibre sources as being 56.7 per cent from plantation, 9.4 per cent recycled fibre and 33.9 percent from native forests and sawmill waste.

Roles and responsibilities.

The Minister for Agriculture administers the FWPA Act. The Secretary of the Department of Environment, Land, Water and Planning (DELWP) (as the 'body corporate') delegated all of the FWPA Act's functions, duties and powers to the Department of Economic Development, Jobs, Transport and Resources (DEDJTR) Secretary and other senior positions in June 2015.

VicForests acts as the State's agent in meeting the supply obligations within the LA. The Secretary to the former Department of Sustainability and Environment delegated responsibilities to VicForests in 2009.

AP pays the royalty (as determined in accordance with the LA), the licence fee and the department price (bona fide cost of extraction, felling and delivery of pulpwood to the Maryvale mill gate). VicForests receives all revenue generated from fulfilling the supply obligation after it has been paid into the State government's consolidated revenue.

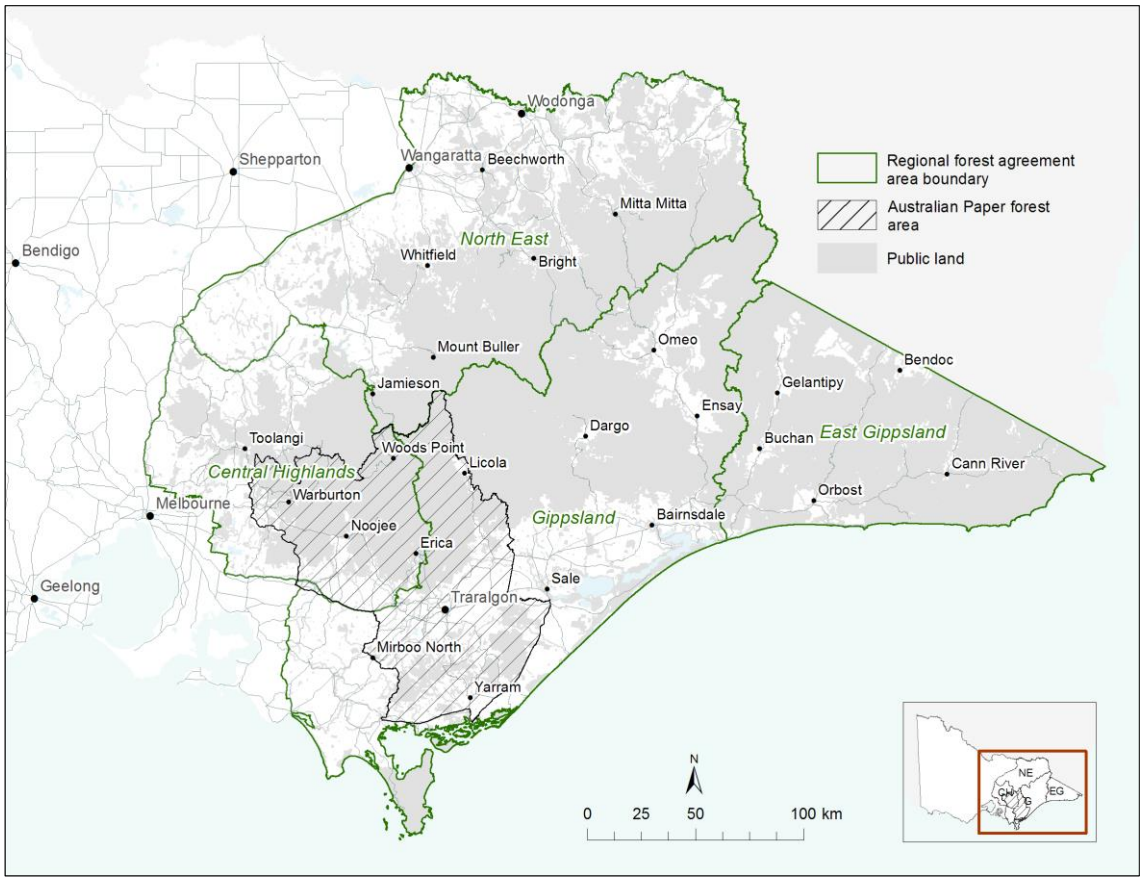
Forest Area and supply

The LA identifies a 'Forest Area' that is an acceptable haulage distance from AP's mill (see figure 1.5).

Clause 14(2) of the LA sets out the State's minimum annual pulpwood supply obligations. The LA requires the state to supply a minimum of 350,000 m^3 of pulpwood per year to AP until 2030. At least 300,000 m^3 must be made available or delivered from Ash forests within the Forest Area.

The State is liable for the cost of supply shortfalls from the Forest Area.

Figure 1.5 Forest Area defined in the legislated agreement



1.3 Environmental management of Victoria's forests

In addition to the formal conservation reserve system and forest management zones, there is a comprehensive regulatory system for activities that occur in state forest that may impact biodiversity and other natural values. The primary regulatory document is the *Code of Practice for Timber Production 2014* which applies to all commercial timber production activities in public and private native forests and plantations in Victoria.

1.3.1 Code of practice for timber production

The purpose of the code is to provide direction and guidance to forest managers and operators to deliver sound environmental performance when growing and harvesting commercial timber in a way that:

- permits an economically viable, internationally competitive, sustainable timber industry;
- is compatible with the conservation of the wide range of environmental, social and cultural values associated with forests;
- provides for the ecologically sustainable management of native forests proposed for cyclical timber harvesting operations; and
- enhances public confidence in the management of timber production in Victoria's forests and plantations.

Timber production on all native forest and plantations in Victoria is guided by six code principles, which are developed from the internationally recognised Montreal Process criteria, and are consistent with the objectives of the sustainability charter.

The six principles are that:

- biological diversity and the ecological characteristics of native flora and fauna within forests are maintained
- the ecologically sustainable long-term timber harvesting capacity of forests managed for timber harvesting is maintained or enhanced
- forest ecosystem health and vitality is monitored and managed to reduce pest and weed impacts
- soil and water assets within forests are conserved. River health is maintained or improved
- cultural heritage values within forests are protected and respected
- planning is conducted in a way that meets all legal obligations and operational requirements.

The *Management standards and procedures for timber harvesting operations in Victoria's State forests* 2014 are derived from the Code of Practice for Timber Production, and are intended to assist managing authorities, and harvesting entities in interpreting the requirements of the code. These management standards include a number of planning standards. Prior to 2014, prescriptions that specified particular management actions, such as threatened species protections or stream buffers, were stated in Forest Management Plans and Action Statements. With the 2014 revision of the code, many of these prescriptions (e.g. for Leadbeater's possum) were transcribed directly into the planning standards.

1.3.2 Flora and Fauna Guarantee Act 1988

The *Flora and Fauna Guarantee Act 1988* (FFG Act) is the key piece of Victorian legislation for the conservation of threatened species and communities and for the management of potentially threatening processes. It provides for the listing of threatened plant and animal species, ecological communities and potentially threatening processes. Under the Act, action statements are required to be prepared for listed species and ecological communities. Action statements outline research and actions to help threatened species or ecological communities or mitigate potentially threatening processes and are available on DELWP's website.

The Act also requires the preparation of a Flora and Fauna Guarantee Strategy. The most recent strategy was published in 2017 as *Protecting Victoria's Environment – Biodiversity 2037*.

The FFG Act is currently being reviewed by the Victorian government.[12]

1.3.3 Forest management and Leadbeater's possum

The Leadbeater's possum is a small marsupial, endemic to Victoria. It is Victoria's state faunal emblem. While it occurs in three habitat types, the greatest population occurs in area of approximately 5,600 square kilometres within ash forests and sub-alpine woodlands in the Central Highlands. The species is listed as threatened under the Victorian Flora and Fauna Guarantee Act, and critically endangered under the Commonwealth Environment Protection and Biodiversity Conservation Act. Habitat loss and fragmentation, through bushfires and timber harvesting, is the main threat to the persistence of the species.

Leadbeater's possum 'reserve'

The Central Highlands Forest Management Plan divided the known range of the Leadbeater's possum into 21 management units (LMUs), based on the extent and distribution of its preferred habitat type, ash forest. Within each LMU, the goal was to identify and protect over 600 hectares of suitable habitat so that each unit could support a viable population of the species.

[12] DELWP 2017 Review of the Flora and Fauna Guarantee Act 1988 Consultation Paper

The so-called Leadbeater's possum reserve was designated in 2008. This 'reserve' contained 30,500 hectares of high-quality Leadbeater's possum habitat in 127 patches greater than 50 hectares in size and containing predominantly old-growth ash forest. Areas for inclusion in the reserve were assessed irrespective of public land use category; 58 per cent of the reserve occurred in existing parks and reserves, and 27 per cent occurred in pre-existing SPZs in state forest. Less than 2,500 hectares fell within productive forest areas available for timber harvesting, and these areas became SPZs in 2008. In the February 2009 fires, 45 per cent of the 30,000 hectares Leadbeater's possum reserve was burnt.[13]

Zoning

A special zoning system exists for managing Leadbeater's possum in areas of state forest. This was first proposed in the 1995 FFG Act action statement and implemented through the Central Highlands Forest Management Plan. Timber harvesting and the construction of associated roads is excluded from areas of forest meeting the criteria for Zone 1A or Zone 1B through timber harvesting prescriptions contained in the Code of Practice for Timber Production. The definition of Zone 1A habitat was modified in 2014 from greater than 12 trees to greater than 10 trees as a result of a recommendation of the Leadbeater's possum advisory group.

Zone 1A - Special Protection Zone

Greater than 10 living mature or senescing hollow-bearing trees (comprising Mountain Ash, Alpine Ash or Shining Gum) per 3 hectares in patches greater than 3 hectares.

Zone 1B - General Management Zone
(excluded from timber harvesting while Zone 1B attributes remain)

Greater than 12 dead mature or living senescent trees containing hollows per 3 hectares in patches greater than 10 hectares, with wattle density (basal area) of greater than $5m^2$ per hectare.

Zone 2 - General Management Zone

Consists of the remaining ash-eucalypt forest: regrowth ash forest of varying ages; or areas with features of Zone 1A or Zone 1B but less than 3 hectares or 10 hectares respectively.

Leadbeater's Possum Advisory Group

To support the recovery of Leadbeater's possum while maintaining a sustainable timber industry, the then Minister for Environment and Climate Change and then Minister for Agriculture and Food Security established the Leadbeater's possum advisory group in June 2013. The group was co-convened by the CEO of Zoos Victoria and the CEO of the Victorian Association of Forest Industries, with representatives from Parks Victoria, VicForests and the Leadbeater's possum recovery team.

In January 2014, the advisory group made 13 recommendations to government. In April 2014, the Victorian government accepted all of the recommendations and committed $11 million for implementation over the following five years.

One recommendation of the advisory group was to establish timber harvest exclusion zones around all recorded locations for Leadbeater's possums. These zones have a radius of 200 metres (12.6 hectares) and are centred on the detection site. Exclusion zones have now been applied to all pre-existing records for Leadbeater's possums from 1999 to 2014, except for records in areas that were severely burnt in the 2009 fires. As of 30 September 2016, new exclusion zones have been applied to 270 new colonies (2,983 hectares) that have been detected in state forest since 2014.[14]

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[13] DEPI 2014 Action Statement #62 Leadbeater's Possum *Gymnobelideus leadbeateri* Flora and Fauna Guarantee Act 1988

[14] DELWP 2016 *Supporting the Recovery of the Leadbeater's Possum Progress Report December 2016*

Of the 270 new colonies detected in state forest at that time, 79 were from records submitted by the community. To assist in the timely verification of these records, DELWP released a new survey standard for Leadbeater's possum which details the acceptable methods to determine the presence or absence of the possum. This standard is being applied in targeted surveys to identify new colonies. It also specifies the evidence required from the community when reporting new possum colonies and the process for verification of these records.

The exclusion zones have been introduced into the *Planning Standards for timber harvesting operations in Victoria's State forests* 2014.

As of 18 April 2017, the number of new Leadbeater's possum colonies located in State forest since the program commenced in 2014, is 366 colonies.[15]

Review of 200 metre radius timber harvesting exclusion zones

It was agreed that the effectiveness of the 200 metre radius exclusion zones in supporting the recovery of the possum would be reviewed after two years of targeted surveys, or once 200 new colonies were located in State forest. The review commenced in late 2016.

The objectives of the review are to:[16]

- document the extent of improved protection for Leadbeater's possum colonies from the 200 metre radius exclusion zone rule
- assess the effectiveness of this additional protection in supporting the species' recovery
- assess the impact on the timber industry of these additional timber harvesting exclusion zones.

The review will also explore possible alternative options for protecting Leadbeater's possum colonies, and compare their potential effectiveness for the possum's recovery and impact on the timber industry.

The review will be limited to exploring alternative ways of protecting individual verified colonies in State forests.

The review is expected to report in April 2017. This report will collate and synthesise the evaluation of the benefits to Leadbeater's possum recovery and impact on industry of this action, and present an exploration of alternative options, to assist in subsequent decision making. The report and the methodology applied will be independently reviewed.

1.3.4 Additional areas of value for water and biodiversity

VicForests has also made additional reductions in the forest area available for harvesting in eastern Victoria, by excluding areas assessed as unlikely to be harvested for a range of commercial and ecological forest management reasons.

1.4 Forest resource description

1.4.1 Native forests in the eastern Victoria RFAs

For the purposes of planning, harvest and sale, VicForests groups forests into broad forest types. In the Eastern Forest Management Unit, which includes the four eastern RFA areas, the native forests are grouped into two main forest types: ash forest and mixed species forest. The mixed species

15. http://www.vicforests.com.au/leadbeaters-possum1/leabeaters-possum-population-numbers
16. https://www.wildlife.vic.gov.au/our-wildlife/leadbeaters-possum

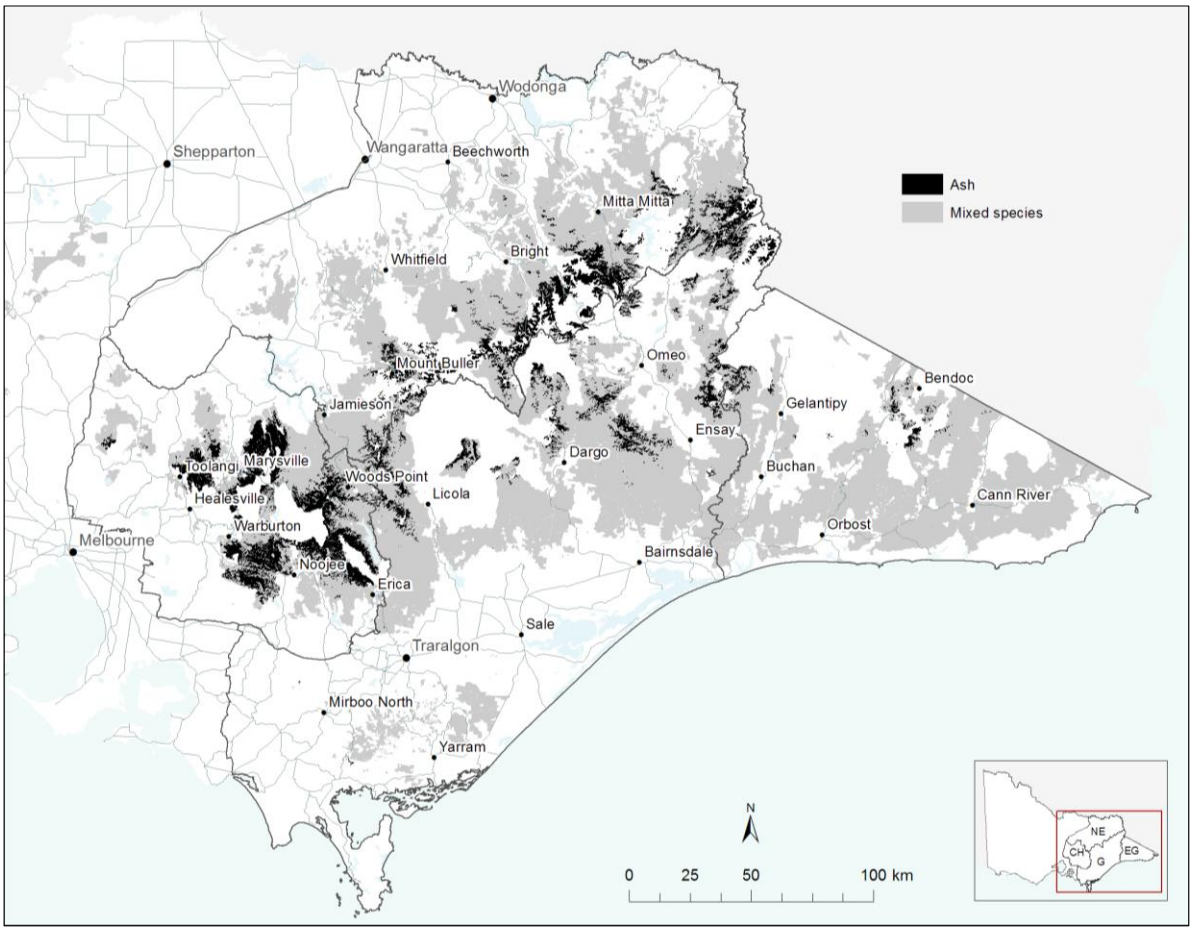
forest is further classified into low elevation and high elevation mixed species forest.[17] The two main forest types are mapped in figure 1.6.

Ash forest is a term used by VicForests for tall open wet forests dominated by mountain ash (*Eucalyptus regnans*), alpine ash (*E. delegatensis*) and/or shining gum (*E. nitens*). These forests are generally naturally dominated by a single overstorey species but may be mixed with other species, most commonly messmate (*E. obliqua*) and manna gum (*E. viminalis*).

Low elevation mixed species forests occupy extensive areas of the North East, West Gippsland and East Gippsland, and comprise much of the coastal and foothill forests of Victoria. They are generally located at elevations less than 700 metres and contain key indicator species such as silvertop (*E. sieberi*), mountain grey gum (*E. cypellocarpa)*, messmate (*E. obliqua*), yellow stringybark (*E. muelleriana*) and white stringybark (*E. globoidea*).

High elevation mixed species forests occupy extensive areas of East Gippsland. They are generally located at elevations greater than 700 metres and contain species mixtures of messmate (*E. obliqua*), cut-tail (*E. fastigata*), Errinundra shining gum (*E. denticulata*), mountain grey gum (*E. cypellocarpa*) and/or manna gum (*E. viminalis*).

Figure 1.6 Distribution of broad forest types in the state forests of the assessment area



Source: DELWP corporate digital dataset – FORESTS.SFRIMAP_2007

[17] VicForests 2016 *Ecologically sustainable forest management plan* Draft version 2.0

1.4.2 Timber from Victorian native forests

Native timber harvesting in Victoria is currently based on an integrated supply model of timber for both sawlog and pulplog. Timber harvesting generates both sawlog and residual wood. Residual wood is sold as pulplog.[18]

Sawlog is high quality timber from the lower–middle part of the trunk of the tree. Sawlog from the lower part of the trunk has few defects and is used in appearance grade products such as furniture and flooring. Structural grade sawlog comes from the middle section of the trunk which has more defects as branches are found at this height. Smaller diameter sawlogs and larger defective logs are used for lower value products such as pallets and battens.

Residual wood is from the branches and upper trunk, and parts of the tree that contain significant structural defects such as spikes, knots, gum pockets, fire damage and rot. This timber has lower structural integrity preventing its use for construction-grade and appearance-grade products.

Log sections cut from trees are each graded according to their quality and potential end use, currently into four main sawlog grades, two durable species sawlog grades, three pulpwood grades and some other minor forest produce, including firewood, posts and poles. Log grades B, C and D (often referred to as D+) are the appearance and structural grade sawlogs, and are the primary high-value timber asset in state forests. ‘A’ grade sawlog is a veneer quality not currently differentiated from B grade due to there being no facility in Victoria to utilise the grade.

VicForests reports that, for harvested timber in eastern Victoria in 2014-15, 32 per cent of mixed species went to sawlog and 68 per cent to pulplog, and 43 per cent of ash went to sawlog and 57 per cent to pulplog.

1.4.3 Age class distribution of ash

Due to the influence of major landscape level bushfires, the available ash species forests can be broadly grouped into three stands:

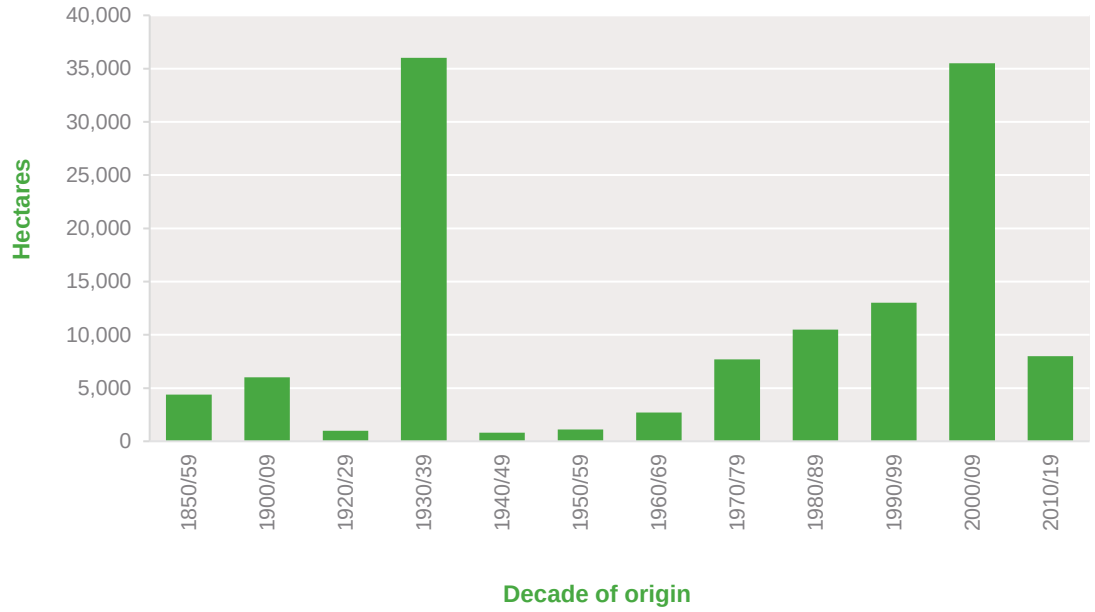
- stands regenerated from 1939 fires
- stands regenerated from disturbance activities between 1940-2000, and
- areas of forest regenerating from the three landscape fires of the 2000s (2003, 2006/07, 2009).

The age structure of the ash forests in Victoria’s Central Highlands forest region is very unbalanced (see figure 1.7). Forest stands originating from the 1939 bushfires dominate the area of regrowth forest in eastern Victoria.

In 1939, major bushfires burnt about 2 million hectares of forest in and around Central Highlands, and led to the establishment of hundreds of thousands of hectares of even-aged forest dominated by the commercially valuable species mountain ash (*Eucalyptus regnans*) and alpine ash (*Eucalyptus delegatensis*). This 1939 regrowth is the primary source of high-value sawlogs in Victoria due to the size and wood quality of the two species. The impacts of subsequent fires, in particular the 2009 Black Saturday fires, have further skewed the age class distribution of ash species.

18. VicForests 2016 *Ecologically sustainable forest management plan* Draft version 2.0

Figure 1.7 Ash age class distribution



1.5 Approach to the assessment

Section 1.1.4 describes how VEAC addressed the specific topics in the terms of reference, largely through access, both directly and via a commissioned independent evaluation, to VicForests published and unpublished data and projections. VEAC and its consultants also benefited from discussions with VicForests staff, external and government technical experts, and policy specialists and managers throughout the assessment. The Council is very grateful for the cooperation and support of these organisations and individuals.

1.5.1 Consultation

The provisions of the VEAC Act under which this assessment was requested do not include mandatory consultation requirements or the release of draft reports for public comment.

The terms of reference for this assessment required VEAC to consult with technical and industry experts to gather and confirm source data, and to document any relevant caveats to this data.

The Council was also required to consult with the Forest Industry Taskforce, including providing the taskforce with information on progress by 28 February 2017 in line with the reporting requirements for the Conservation Values of State Forests Assessment. No meetings of the Forestry Industry Taskforce were available to VEAC for briefings in the specified period in 2017.

1.5.2 Field inspection

Council members visited sites in the Central Highlands in January 2017 to familiarise themselves with timber harvesting planning and operations.

2. Resource availability and supply

As described in section 1.2.3, DELWP is responsible for the sustainable management of Victoria's entire public forest estate in a manner that complies with the broad principles of sustainability detailed in Victoria's Sustainability Charter. The goal is that Victoria's forests be managed to maintain forest health, biological diversity, and the capacity to produce wood and non-wood values. The provisioning of wood and fibre from the state forests is a critical component of this management of Victoria's public forests in a manner that complies with the broad principles of sustainability.

A range of information and modelling is used by VicForests to develop estimates of sustainable levels of harvesting from Victoria's state forests. These are used to set the total merchantable volumes that are available for harvesting in the near term, and identify trajectories for sustainable harvesting levels over the medium and long terms.

2.1 Concepts of sustainability

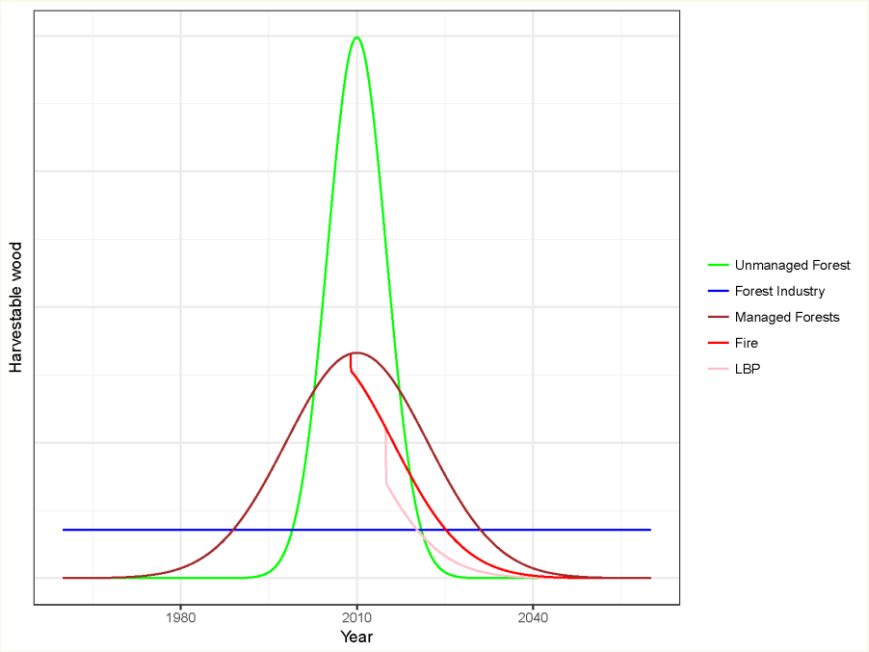
Although the estimated harvest levels are described as 'sustainable', the term is used in two different contexts in discussions about forests and the forest industry. A third context is introduced through the concept of 'ecologically sustainable' forest management.

A sustainably managed forest may provide an even flow of wood if the distribution of age classes is relatively evenly distributed over the length of the standard forest rotation. A sustainable forest industry requires an even flow of wood to ensure predictable revenues, job security, and sensible infrastructure planning. However, in native forests that are subject to large-scale disturbances and have historical legacies of exploitation, a balanced age structure across the managed forest estate is rare.

As described in section 1.4.3, the major 1939 bushfires led to the establishment of hundreds of thousands of hectares of forest dominated by the commercially valuable mountain ash and alpine ash species. This 1939 regrowth is the primary source of high-value sawlogs in Victoria due to the size and wood quality of the two species. The rotation age for mountain and alpine ash species is about 70-80 years which means that the period of peak harvesting should have already occurred. Due to the extremely unbalanced age distribution of the high-value ash forests in the Central Highlands, the Victorian government has over the past 30 years actively managed the resource to provide a more even flow to the native forest industry—to spread the relatively narrow age distribution out over as broad a period as possible (see box below).

In effect, this means harvesting the more productive sites earlier (as they will reach harvestable size sooner) and the less productive sites later, or harvesting some areas earlier than the optimal age and other areas later than the optimal age, or both. Unless the forest managers intentionally delay a large proportion of the harvesting, there should be a decline in harvesting levels in the years after the rotation age has passed.

Definitions of sustainability



The definition of sustainability differs for forest industry and forest management. In a landscape with a single large age cohort of trees, the area of harvestable wood will peak at the optimal rotation age (green line). Due to variability in site quality some areas will reach harvestable size earlier than others. Sawmills and pulpmills would ideally want a constant, even flow of wood to process (blue line). Forest management (brown line) attempts to reduce the difference between the uneven age distribution and the forest industry's need for an even flow by spreading the harvesting activity out across a longer time period. Unforeseen events such as fires (red line) and new sightings of Leadbeater's Possum (pink line) will further reduce the amount of wood available for harvesting.

Current modelling of sustainable harvest rates in Victoria's state forests suggest that this decline has begun and that in 15-20 years there will be a wood supply bottleneck as the available 1939 mountain and alpine ash regrowth (i.e. not in reserves, protected areas, or other forest practices code exclusions) that dominates the timber supply from the Central Highlands is exhausted and new regrowth from the 2000s is not yet commercially viable. This dynamic has been further exacerbated by the impacts of, in particular, the 2009 Black Saturday fires, and the establishment over the past three years new exclusion zones to protect newly discovered Leadbeater's possum colonies.

The National Forest Policy Statement (1992) states:

> There is no common definition in the literature for the term 'ecologically sustainable development'. In considering this issue, the Ecologically Sustainable Development Working Group on Forest Use specified three requirements for sustainable forest use: maintaining the ecological processes within forests (the formation of soil, energy flows, and the carbon, nutrient and water cycles); maintaining the biological diversity of forests; and optimising the benefits to the community from all uses of forests within ecological constraints. The National Forest Policy Statement adopts these principles as the basis for ecologically sustainable development.

VicForests has subsequently developed a working definition of ecologically sustainable forest management as:

> Active forest management that integrates timber production with intrinsic, environmental, social, cultural, and economic benefits to ensure that all these values are maintained for current and future generations.[19]

In other documents VicForests defines ecologically sustainable forest management as 'actively managing forests to maintain ecosystem function and the quality of life for current and future generations'.[20]

2.2 Overview of resource modelling

The development of a strategic wood supply model (SWSM) for any organisation, whether public or private, responsible for managing a large forest estate is a complex process. While specific SWSMs may differ in their details, the broad structure of many SWSMs, including VicForests', is quite similar due to the nature of the forest resource, planning constraints, and strategic objectives.

Part 2 of appendix A describes in detail the process that VicForests uses to determine a sustainable fibre and wood supply level for the state forests of eastern Victoria. Details are provided of the various data inputs, models, and adjustments that are made to produce an estimate of sustainable yield from the Victorian forest estate, as well as the assumptions that underpin them. The description is based on discussions between VEAC and its consultants with VicForests' staff responsible for the modelling, existing documents describing the modelling process, and our independent assessments of a range of model inputs, outputs, and assumptions. The goal is to identify each component of the modelling process, describe how it is calculated and its underlying assumptions, and to consider the potential uncertainties associated with it.

Estimating the sustainable wood supply level for a forest estate the size of Victoria's state forests is an inherently complex process. The diversity of forests, topography, and various constraints that must be taken into account requires a hierarchical, multi-staged planning process (see figure 2.1 and figure 2.2).

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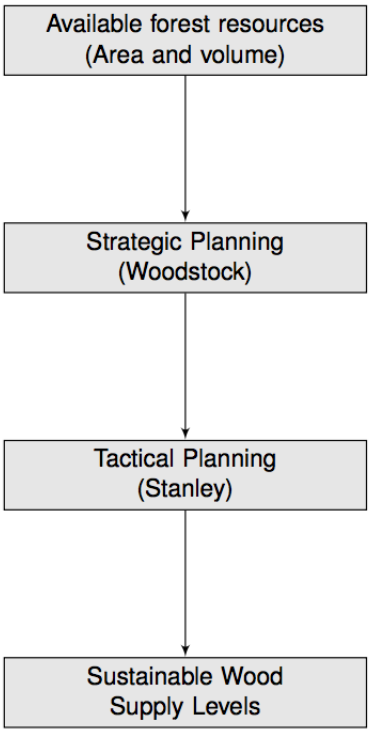
19. VicForests 2016 *Ecologically sustainable forest management plan* Draft version 2.0

20. VicForests 2015 *Ecologically sustainable forest management policy*. http://www.vicforests.com.au/vicforests-forest-management-system/policies-procedures-and-instructions

Figure 2.1 Schematic overview of wood supply modelling process



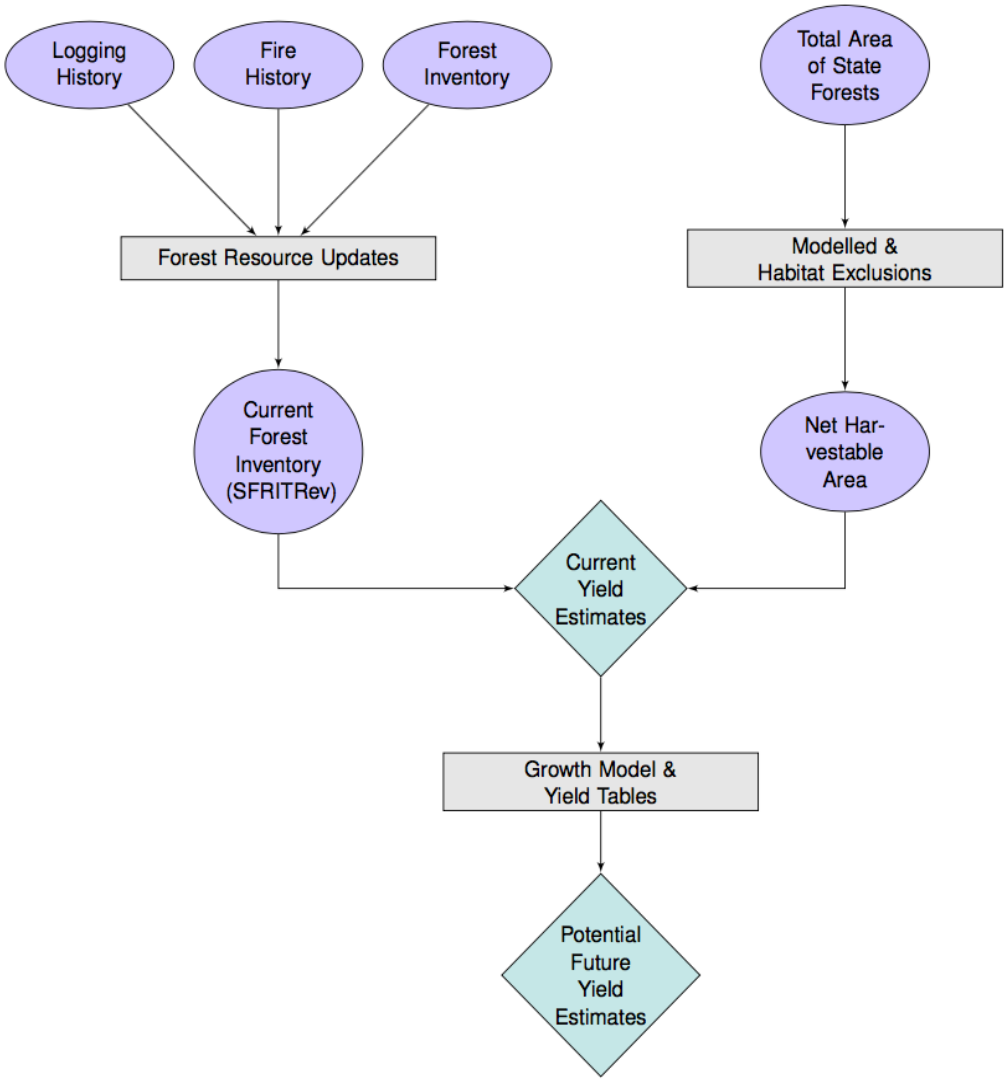
The first step in developing a SWSM is to quantify the resource. At its most fundamental level this involves an assessment of the area of harvestable forest and the volume of merchantable wood that occurs in that area. The Net Harvest Area is a spatial database that describes the area of Victoria's state forests that is available to harvest once all exclusions have been removed. This forms the basis of the SWSM as it represents the most up-to-date description of the available forest area. The Net Harvest Area is described spatially by 10 themes such as forest management area (FMA), forest block, species, fire impacts and stand maturity that represent the main areas of native forests in eastern Victoria.

The second step takes the identified forest resource and applies specific constraints regarding existing sawlog commitments and restrictions on harvesting in water catchments, and some loose constraints on volumes and areas harvested by FMA to prevent large fluctuations through time, to develop a solution that maximises total merchantable volume (TMV) of wood over the planning period. The impacts of constraints are explored through scenario analyses. This is referred to as the strategic-level planning and is conducted using the Woodstock modelling framework (see section 2.2.2 below) to identify potential wood supply levels across the entire forest estate (i.e. all seven FMAs).

The third step in the modelling process takes the Woodstock output and applies a spatial harvest scheduling algorithm Stanley (see 2.2.3 below) to identify harvest units by grouping adjacent or nearby available areas. This is referred to as tactical-level planning and addresses spatial issues such as coupe size and adjacency. Typically, this step reduces the estimated wood volume from the strategic wood supply model by 20-30 per cent.

The fourth step involves running dozens of scenarios to develop a range of plausible wood supply options and discussions with senior managers and district foresters regarding the proposed supply levels. The final sustainable wood supply levels are then set based on an assessment of the modelled scenarios, commercial commitments and realities, and logistical considerations.

Figure 2.2 Key components of the strategic wood supply model



2.2.1 Quantifying the resource

The total merchantable volume (TMV) available for harvest varies widely across the areas of the State forest that are available to harvest due to site-level differences in species composition, productivity, and stand age. The standing current and future merchantable volume of wood across the net harvest area is based on existing forest inventory data and growth and yield models.

The current forest volumes—that is, the amount of merchantable wood in any given location at the time of modelling—are based on the State Forest Resource Inventory (SFRI). The SFRI was initiated in 1993 and completed in 2004 and provides a snapshot of wood volume benchmarked at 2002. The current system The SFRI has not been repeated since, so current (i.e. 2016-17) estimates of wood volume in State forests are based on updating the forest description annually to reflect harvesting and fire events and modelled yields. The most recent update is 2016. In stands where harvesting or fires have occurred, the stand is reset to zero at the time of the event. Estimates of stand volume are derived from the current forest description and projected forward. In stands that have not been impacted by harvesting or fire, current volume is estimated by projecting the 2002 volumes forward using a forest growth model.

The forest growth model that is used to project the current forest inventory forward in time and which underpins VicForests' yield estimates was developed for VicForests in 2014-15. It is

described in detail in a series of reports commissioned by VicForests.[21] The model is cohort-based, which means that the model projects the TMV of wood for a cohort that is defined by a forest growth function. Forest growth functions (FGFs) are growth and yield functions that are grouped by individual species or groups of similar species. For example, alpine ash is sufficiently widespread, valuable, and distinct that it is given its own FGF. In contrast, the high-value mixed species (HVM) FGF includes about a dozen non-ash eucalypt species that are commercially valuable.

2.2.2 Woodstock modelling

Woodstock is the core component of VicForests' SWSM. Woodstock is proprietary software developed by RemSoft and widely used by government and industry around the world to develop strategic timber harvesting plans across large forest estates. Woodstock has been a central component of the SWSM process for more than 10 years, having been used by both VicForests in its current role and the Department of Sustainability and Environment (DSE) before it. Woodstock is a linear optimisation program that attempts to find the best solution to a complex scheduling problem while maximising a specified objective function. Figure 2.2 is a schematic presentation of the key components and constraints to the Woodstock part of the SWSM. Boxes to the left are constraints on the model, boxes to the right are scaling factors used to adjust the TMV during the modelling.

Scaling factors

A core element of the SWSM process is the estimation of stand growth and yield at the scale of individual polygons (which are later grouped into coupes based on proximity and homogeneity). However, the estimates of TMV are often biased, whether by species group, by FMA, by block within FMA, or by fire history. To adjust the predicted TMVs to align with observed TMV (based on recent harvest operations and timber sales), several scaling factors are multiplied against predicted TMV to obtain a final TMV that is used in Woodstock.

One of the most important scaling factors is the TMV scaling, which is the ratio of actual to predicted TMV within an FGF by FMA (e.g. mountain ash in Central Gippsland). A variety of scaling factors are applied to the TMV predicted by the growth and yield model to align it with historical observations of actual TMV obtained from harvested coupes.

Comparisons of actual and predicted harvest volumes show significant variability. Comparisons of the actual and predicted volumes demonstrate that VicForests' current growth and yield model consistently overpredicts total merchantable volume. The reasons for this are unclear. However, this overprediction of yield is addressed through the application of a TMV scaling factor during the Woodstock modelling process.

Section 4.4 discusses the results of analyses conducted for the assessment of scaling factors.

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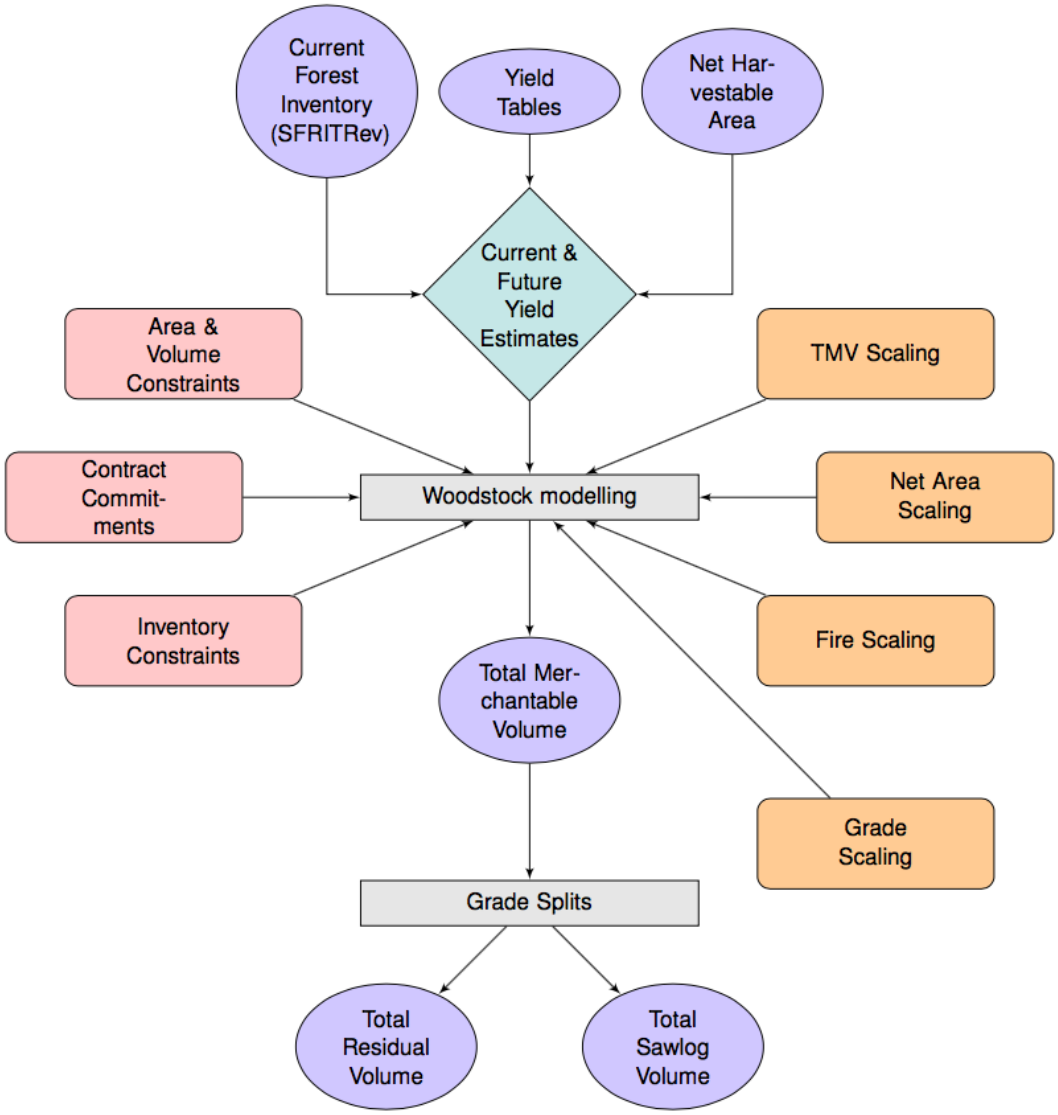
21. Wang, Y 2013 Development of stand level age-independent yield projection models for the VicForests' forest regions in Central Victoria. Technical Report 5, VicForests, Melbourne.

Figure 2.3 Key components and constraints to the Woodstock modelling



2.2.3 Stanley and spatial planning

Stanley is a tactical planning tool that uses spatial data to identify groups of polygons that Woodstock has identified as harvestable and aggregate them into coupes based on logistical constraints. It takes the long-term, statewide assessments of potential wood supply modelled in Woodstock and develops tactical plans over shorter planning horizons (i.e. 20 years) and smaller spatial scales (i.e. individual FMAs). The spatial focus of Stanley allows it to account for adjacency rules, minimum and maximum coupe sizes, proximity to road access, and a variety of other spatial features that are relevant to developing tactical harvesting plans within each FMA. It identifies areas of forest that are too small in area to be harvested and either aggregates them with other adjacent polygons to form a larger aggregate or eliminates them from the list of potentially harvestable polygons. Areas can also be held until they can be grouped with adjacent or nearby polygons to form harvest units. For instance, minimum and maximum coupe sizes are 5 and 120 hectares respectively, with a target coupe size for ash of 15 hectares and a maximum of 40 hectares. For mixed species, the target size is 40 hectares with a maximum of 120 hectares. Stanley will aggregate adjacent polygons to form individual coupes that fall between these bounds. If a polygon cannot be grouped with others to form a coupe larger than 5 hectares, then it is excluded from harvesting, or held until it can be grouped with adjacent polygons at a later time. On-ground survey and field assessment of proposed coupes is used to confirm their suitability for harvesting before

they are added to the published 5-year Timber Release Plan. This operational planning leads to some reduction in the available coupes.

2.2.4 Sustainable harvest levels

The development of VicForests sustainable wood supply levels involves running a large number of scenarios through Woodstock and Stanley. These scenarios vary in their constraints, land areas, assumptions about changes to tenure, industry activity, and other factors. The final sustainable harvest levels are then set based on evaluations of the Woodstock/Stanley scenarios, commercial commitments, potential risks and uncertainties, and other factors.

2.2.5 Assessment of VicForests planning processes

The complexity of this planning process limits the degree to which the public can understand or interpret how VicForests sets sustainable wood supply levels. Based on VEAC's assessment of the planning process, however, it appears that VicForests approach is a sound one. It uses industry-standard models to develop its strategic and tactical wood supply levels and has staff who are well-trained in their use and interpretation. The assumptions that underpin the various components of their modelling approach are both reasonable and appropriate and the calculations that they perform appear accurate.

While there are some areas where the process could be improved (see appendix A), overall the strategic wood supply modelling that VicForests conducts is rigorous and repeatable. This assessment of the quality of the SWSM process employed in Victoria is not unique. Previous reviews have delivered similar assessments.

For instance, Vanclay and Brack (2008) in evaluating the Joint Sustainable Harvest Level Statement (JoSHL) endorsed the SWSM approach used by DSE and VicForests at the time. They concluded that, 'JoSHL is a robust process that should inspire confidence that the proposed timber harvest of up to 500,000 m^3 $year^{-1}$ of D+ sawlogs is sustainable for the next 15 years, given the specified assumptions.'[22] Notably, their assessment was made in May 2008, nine months before the Black Saturday bushfires would cause dramatic losses of ash forests in the Central Highlands and a significant reduction in the sustainable timber harvest levels–circumstances that could not have been foreseen during the JoSHL process.

In 2013 the Victorian Auditor-General's Office (VAGO) reviewed the management of Victoria's native forest timber resources.[23] Amongst other things, this audit examined the accuracy and reliability of VicForests' sustainable harvest level estimate. It concluded that VicForests has developed an accurate and reliable approach to estimating the sustainable harvest rate, demonstrating its capability to manage the risks and the environmental, economic and social sustainability issues involved—in both the short and long term.

2.2.6 Potential improvements

While VicForests' approach is rigorous and repeatable, there are some potential areas which could be improved when time and resources are available.

SFRI data

The fundamental data that underpins any resource management model must be an accurate assessment of the available resource. The SFRI data are now 15-25 years out of date and are only updated to reflect changes to forest status from harvesting or fire. Over that period a range of factors will have led to changes in the structure, composition, and dynamics of Victoria's state

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22. Vanclay J and Brack C 2008 Appendix 6 Expert Independent Advisory Panel report In *Joint sustainable harvest level statement*. DSE and VicForests, East Melbourne

23. VAGO 2013 Managing Victoria's Native Forest Timber Resources

forests–and these changes may vary widely spatially and temporally. For example, the Millennium Drought may have increased mortality rates and reduced growth rates of trees across much of Victoria, but the effects would have been mitigated or exacerbated by edaphic conditions, species-level variability in drought-susceptibility, and forest structure. Other disturbances such as windstorms, breakage from snow, injury from insect attacks would also impact the forest condition. Partial harvesting of stands can result in a poorer stand description for the remaining stand. An up-to-date resource inventory, repeated at intervals, would provide a more accurate assessment of the forests and their ability to provide wood to the native forest industry.

The SFRI data would also benefit from being expanded to include non-eucalypt species. Victoria's state forests are managed for a range of goods and services, including timber, habitat, carbon, water, and soil health. Developing strategic wood supply models that accommodate non-timber values requires having data on non-timber values. While data on non-commercial, non-eucalypt species may not be directly relevant to timber harvest planning, it is relevant for understanding habitat availability. The existing SFRI dataset has almost no data on, for example, *Acacia* species, a key component of Leadbeater's possum habitat. This inevitably means that our planning for timber and non-timber values is conducted independently. A systematic, repeated inventory of forest resources–as standard practice in most countries with large public forest estates and well-established forest industries–would provide a foundation for integrated forest management that allowed wood supply modelling to inform habitat availability models and vice versa. Recent developments in remote sensing for forest inventory using LiDAR have made this an increasingly affordable option, although it needs to be paired with ground-based inventory assessments as well.

Polygons versus coupes

A significant challenge in understanding and managing the SWSM process for Victoria's state forests arises from the nature of the spatial data that inform the development of the Net Harvest Area and Stanley reductions. The state forests are represented in a GIS database as several hundred thousand polygons. Each polygon represents a relatively homogeneous area of forest defined by species, topography, condition, productivity class, and a range of other factors. The Net Harvest Area layer contains 238,028 polygons, the median size of which is 0.5 hectares. There are nearly 3,500 polygons with areas less than 1 m^2. The large number of small polygons arises from the fragmentation of the landscape due to complex topography, diverse exclusion zones, and the inherent diversity of the forests.

However, once the spatial database becomes so atomised, it becomes increasingly complex to manage the data, quantify variability in the resource, and aggregate the polygons into coupes. It may also lead to unintended biases in the spatial database. For example, Stanley reductions aggregate polygons into minimum coupe sizes. If individual polygons are too small or too isolated, they are not included. Consequently, small and isolated polygons should tend to accumulate in the spatial database. Rationalising the many polygons into coherent management units would make the relationship between the modelled resource data and the eventual coupes more closely aligned and would enable more effective on-the-ground assessments of timber and non-timber resources.

Probabilistic supply level assessments

Current sustainable harvest levels are set as a single figure (e.g. 175,000 $m^3 year^{-1}$). This ignores the considerable uncertainty in the yield estimates that arises from uncertainty in the forest inventory data, bias in the growth and yield model, and variability in the scaling factors. Developing a probabilistic framework that explicitly accounts for uncertainty in wood supply forecasts would provide a better description of the forest resource and allow for better risk management by VicForests and, more broadly, the native forest industry. This framework would be akin to weather forecasting in which a specified outcome is made with some estimate of certainty (e.g. 75 per cent chance of rain tomorrow).

The projection of D+ ash sawlogs at the end of 2016 was 175,000 $m^3 year^{-1}$. However, it is unclear what the uncertainty around that estimate is. Is the credible range of potential ash supply 150,000-200,000 $m^3 year^{-1}$? Or is it 75,000-275,000 $m^3 year^{-1}$? The difference is of fundamental importance for planning and managing risk. A probabilistic framework for assessing uncertainty in the data and models that underpin these forecasts would enable VicForests to say that they estimate a 75 per cent chance of being able to provide a sustainable harvest of D+ ash sawlogs of 175,000 $m^3 year^{-1}$. Such estimates would allow for more transparent estimates of risk in contract negotiations for government planning of the forest resource.

2.2.7 Current resource availability

Major fires in 2003, 2006, and 2009 have had a significant impact on the wood resource by killing trees over hundreds of thousands of hectares. Recent discoveries of Leadbeater's possum colonies in the Central Highlands have led to more than 4,000 hectares of harvestable forest being excluded from future harvests over the past three years. Together these have led to major reductions in the sustainable annual harvest levels.

Ash sawlog

In 2009, Statewide estimated sustainable harvest levels were 500,000 m^3 $year^{-1}$ for D+ sawlogs, of which 293,000 m^3 $year^{-1}$ were D+ ash sawlogs. In its 2013 Resource Outlook VicForests estimated 220,000 m^3 $year^{-1}$ of D+ ash sawlogs. By late 2016 the sustainable harvest level had been reduced to 175,000 m^3 $year^{-1}$ of D+ ash sawlogs. Based on expected future regulatory impacts associated primarily with new Leadbeater's possum detections, VicForests has further reduced its expectations for sustainable harvest levels to 132,000 m^3 $year^{-1}$ of D+ ash sawlogs.

VicForests advise that the reduction of 88,000 m^3 $year^{-1}$ since 2013 is due to a range of factors related to the protection of environmental values and changes to the regulations governing timber harvesting operations including:

- 22,000m^3 reduction per year due to the impact (direct and indirect) of current measures in place to protect the Leadbeater's Possum
- 23,000m^3 reduction per year due to the removal of areas which VicForests has assessed as unlikely to be harvested for a range of commercial and ecological forest management reasons
- 43,000m^3 reduction per year due to the expected future impact of measures in place to protect the Leadbeater's Possum.

Mixed species sawlog

VicForests' 2017 20-year resource outlook forecasts a supply level of 100 000 m^3 $year^{-1}$ of mixed species sawlog can be produced each year for the medium term, from the mixed species forests currently available for timber production in eastern Victoria.

Pulplog

Based on a typical split of ash sawlog and pulplog of 43 per cent sawlog and 57 per cent pulplog (see section 1.4.2) the forecast decline in ash sawlog supply indicates that additional alternative sources of pulp, such as thinnings, will be required to meet the current commitments of 265,000 m^3 $year^{-1}$ of ash pulplogs until 2030 arising from the legislated supply agreement to Australian Paper.

3. Current commitments

3.1 Nature of current commitments

Current fibre and wood commitments comprise pulplog to be supplied to Australian Paper by the State of Victoria in accordance with the *Forests (Wood Pulp Agreement) Act 1996* as explained in sections 1.2 and 1.4 (with VicForests responsible for delivery of this commitment), and a number of sawlog and pulplog timber sales agreements (TSAs) between VicForests and 22 purchasers, including Australian Paper, at many locations as shown in figure 3.1.

The TSAs between VicForests and purchasers have a range of variations reflecting individual circumstances but the key common specifications are:

- the duration of the contract
- the specified volumes of particular grades of logs to be supplied in each year of the contract
- the location to which the logs are to be delivered
- the price to be paid for the logs.

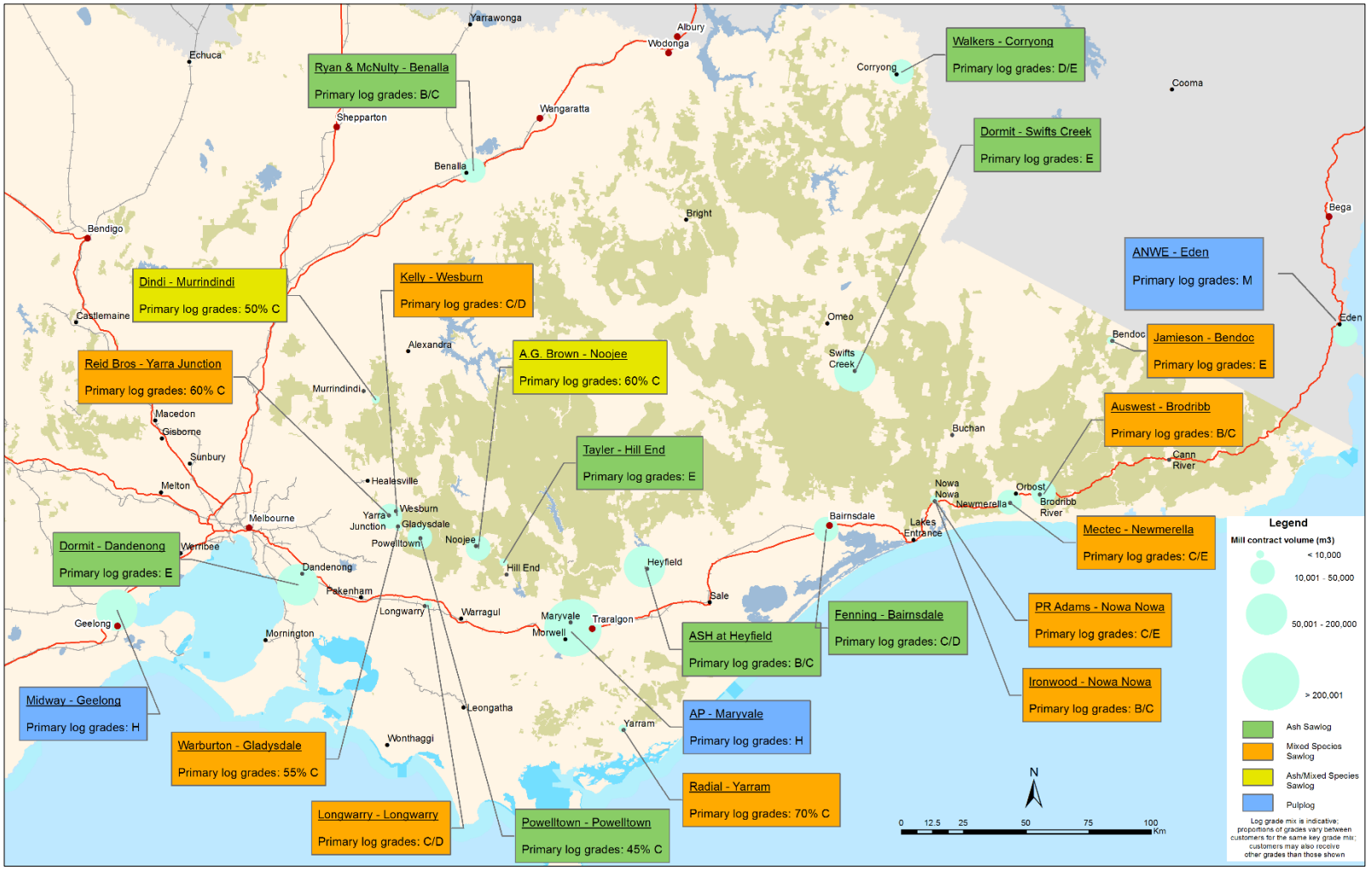
Logs are graded according to the system summarised in table 3.1, with the additional differentiation between ash logs and mixed species logs. Ash logs come from three eucalypt species: mountain ash (*Eucalyptus regnans*), alpine ash (*E. delegatensis*) and shining gum (*E. nitens*) which generally grow in single-species, single-age stands in tall wet forests in the Central Highlands and higher elevations of the Dividing Range (see figure 1.6). Mixed species logs come from the remaining state forests of the assessment area, with a much longer list of species potentially harvested – although most logs come from silvertop (*E. sieberi*), mountain grey gum, (*E. cypellocarpa*), messmate (*E. obliqua*), yellow stringybark (*E. muelleriana*) and cut-tail (*E. fastigata*) trees. Trees of these species generally grow in multi-species stands and are much more likely to survive wildfires than ash trees and hence tend to form multi-aged stands. These differences lead to key differences for forestry and log buyers as well, in terms of planning and management of harvesting, stand productivity, and wood qualities including consistency of logs and their eventual uses and marketing – as 'Vic Ash', for instance.

TSAs also specify locations from where logs are to be harvested, in terms of forest management areas (FMAs; see figure 1.4) but this specification is neither especially insightful nor limiting – given some flexibility in contracts if a commitment cannot be met from the prescribed FMA – and so is not considered further in this assessment.

The system of log grading is designed to satisfy the overall objective of making the most beneficial possible use of all timber harvested. The most beneficial use is that which provides the greatest 'value-add', for example, economic and employment return to Victoria. So while virtually all wood harvested is suitable for making pulp or firewood, the target is to extract the best value. Hence the intention is for the highest grade log to be produced that in turn can provide the best return for VicForests and the state for a public resource. This rationale is reflected in the returns to VicForests of different log grades as shown in figure 3.2.

However, as well as these and other complexities on the forest management and timber harvesting side of the process (see section 1) there are of course many complexities on the demand side of the equation with business required to balance a large range of risk factors such as market needs and trends, long term business objectives and investment decisions, unexpected orders from customers, the security and consistency of the log supply, competition from other products including fibre and wood produced locally and internationally, and so on.

Figure 3.1 Map showing the purchaser name, location and primary log grades for the contracts comprising current sawlog and pulplog commitments



Notes: map provided by VicForests, showing projected contracts for 2017/18 as at April 2017; beyond 2017/18 mills not shown on this map may successfully bid for new contracts, as has happened in the past; mills may also source hardwood and softwood logs from public land interstate and within Victoria but outside the assessment area, and from plantations and native forest on private land.

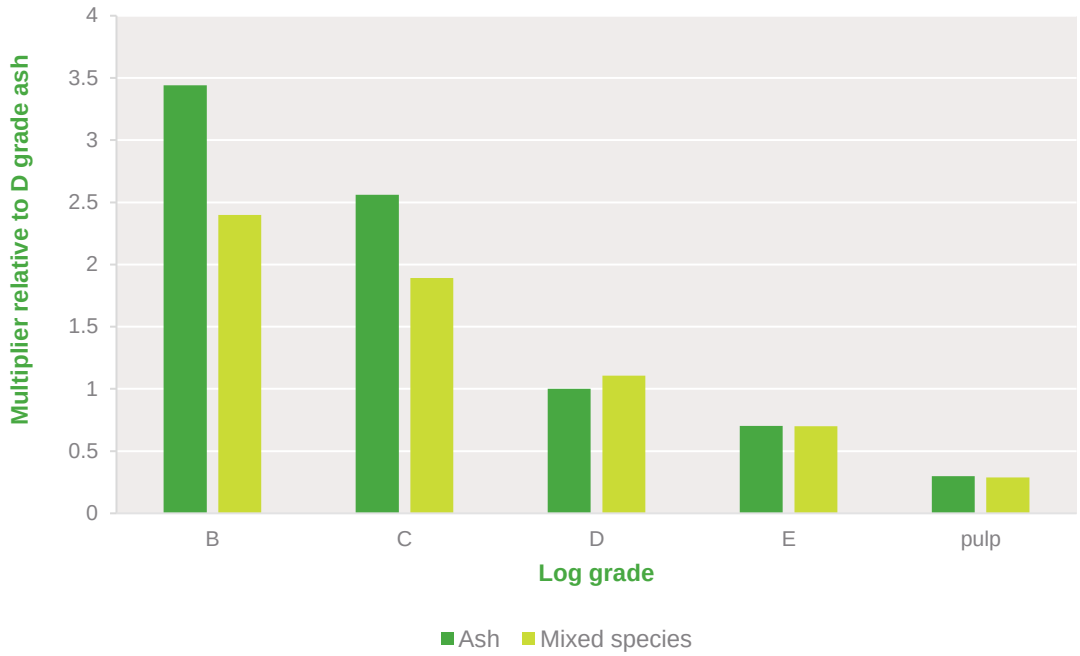
Table 3.1 Summary of log grading

	Grade	Log characteristics	Typical uses	Sources
Sawlogs	B	Long straight lengths with +/-no defects	Appearance grade products such as flooring and furniture	Lower trunks (below the lowest branches)
	C	Long straight lengths with few defects	Structural grade construction timbers, framing feature flooring and furniture	Middle trunks; lower trunks with defects
	D	Long straight lengths with more defects	Structural timbers, framing and external decking	Upper trunks; lower trunks with defects
	E1	Small diameter logs	Pallets, battens, skids, etc.	Upper trunks; smaller trees
	E2	Larger diameter logs (than E1) but with more defects		
Pulplogs	H	High quality pulp, mostly from ash	High quality printing and copy paper	Smaller trees; high-defect logs and upper branches from larger trees
	M	Medium quality pulp, from mixed species	Paper, cardboard and packaging paper	
	L	Low quality pulp, from mixed species	Cardboard and packaging paper	
Durable species	Grade 1	Long straight lengths with +/-no defects	High quality joinery, furniture, flooring, decking, cladding and sleepers	Lower trunks (below the lowest branches)
	Grade 2	Shorter or more defective lengths	Construction timbers, fencing	Middle section trunks
Other	F	Trees previously felled and left to dry	Dry firewood	Smaller trees including thinnings; high-defect logs and upper branches from larger trees
	G	Living trees	Green firewood	
	P	Short straight lengths	Fence posts, poles, house stumps	

Notes

1. This table shows the full range of log grades in Victoria but in the assessment area, very few ‘durable species’ and ‘other’ logs are produced, although firewood production has been increasing in recent years.
2. The overall aim is to maximise the volume of higher grade logs. Logs are graded according to the presence and/or severity of a range of features. These include size, pipe defect, stem defect (limbs), gum vein, stain, straightness and slope of grain. Logs are then prepared to facilitate safe and efficient haulage.
3. A small proportion of the current sawlog commitment is categorised as ‘ungraded: D grade or better’ with the grade code U.

Figure 3.2 Stumpage revenue from different log grades relative to D grade ash logs



Notes: Stumpage price reflects the value of the timber to VicForests; it does not include the cost of harvest and delivery to the mill. These relative values are based on average prices to VicForests in recent years; commercial-in-confidence precludes the publication of actual prices. The columns show that if a cubic metre of D grade ash logs returned $1 (actual revenues are considerably greater) then a cubic metre of, say E grade mixed species logs would be expected to return about 70 cents.

In attempting to match the complex demands of the supply (forestry) and demand (industry) sides of the public land native forest timber production, VicForests has a number of measures that provide some flexibility such as only issuing relatively short term contracts and selling some logs to the spot market when appropriate. Any effects of these measures are unpredictable and relatively small compared to overall commitments and so are not considered further in this report. All TSAs have a *force majeure* clause which frees both parties from liability under the contract if an extraordinary event prevents them from fulfilling their contractual obligations. VicForests issued *force majeure* notices for contracts in the Central Highlands as a result of the fires of February 2009. Such occurrences, while rare, can have significant consequences for commitments but are too unpredictable to include their effects on the commitments as described below.

The following sections show the current commitments in terms of the key elements listed above. Note that these commitments include offers recently made to purchasers but not yet actually under contract on the basis that if the potential purchasers accept any offers then there is a commitment to honour them with a contract and, if not accepted, the standard process is to offer the same contract to other potential purchasers.

On the other hand, some TSAs mention provisions for ‘extension’ of the contract – continuing supply under an extension to the existing TSA after the current term expires – subject to availability and entirely at VicForests’ discretion. Because of this discretion, these extensions cannot be considered commitments, and are not presented here. The purpose of the extensions is to provide some indication of future supply in order to assist purchasers with business planning.

As well as the logs provided by VicForests, there is a ‘secondary market’ with mills selling products such as sawdust, or sawlog offcuts for pulp, firewood or chips to various customers including other mills. Such transactions are not included in the current commitments described below.

3.2 Current sawlog commitments

Figure 3.3 Current sawlog commitments by product type and grade

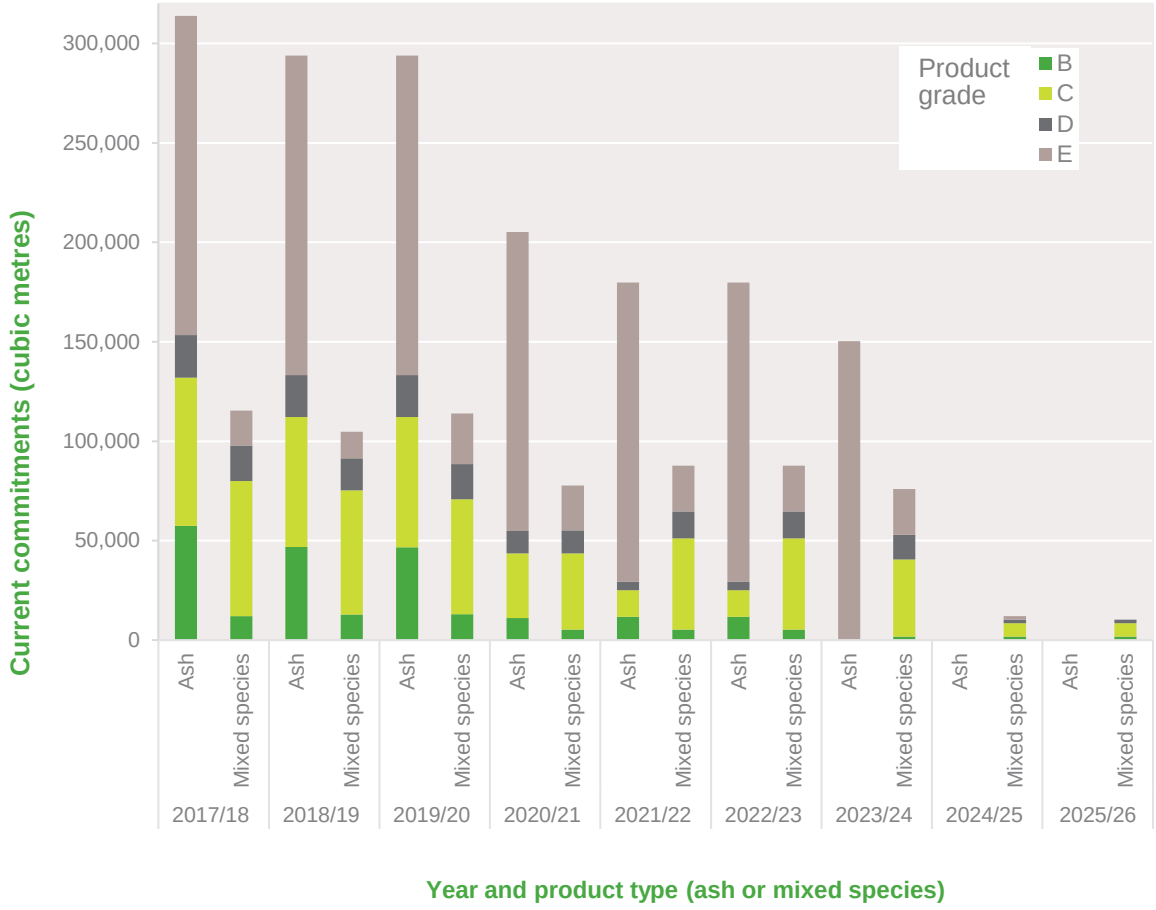


Figure 3.3 is a column chart showing the current commitments for each of the four main sawlog grades. The columns generally decrease successively with time as contracts expire, although the mixed species commitments increase slightly after 2018/19 and also after 2020/21 as a result of some contracts committing higher volumes in later years.

Ash sawlog commitments expire at the end of 2023/24 with only E grade logs committed in the final year. There are no sawlog commitments at all after 2025/26.

Figure 3.3 also shows the higher proportion of E grade logs committed from ash logs (44 per cent in 2017/18) than from mixed species logs (12 per cent in the same year). This high percentage of E grade logs obscures detail for the other log grades and so figure 3.4 shows the current sawlog commitments just for the B, C and D grade logs.

Figure 3.4 Current D+ sawlog commitments by product type and grade

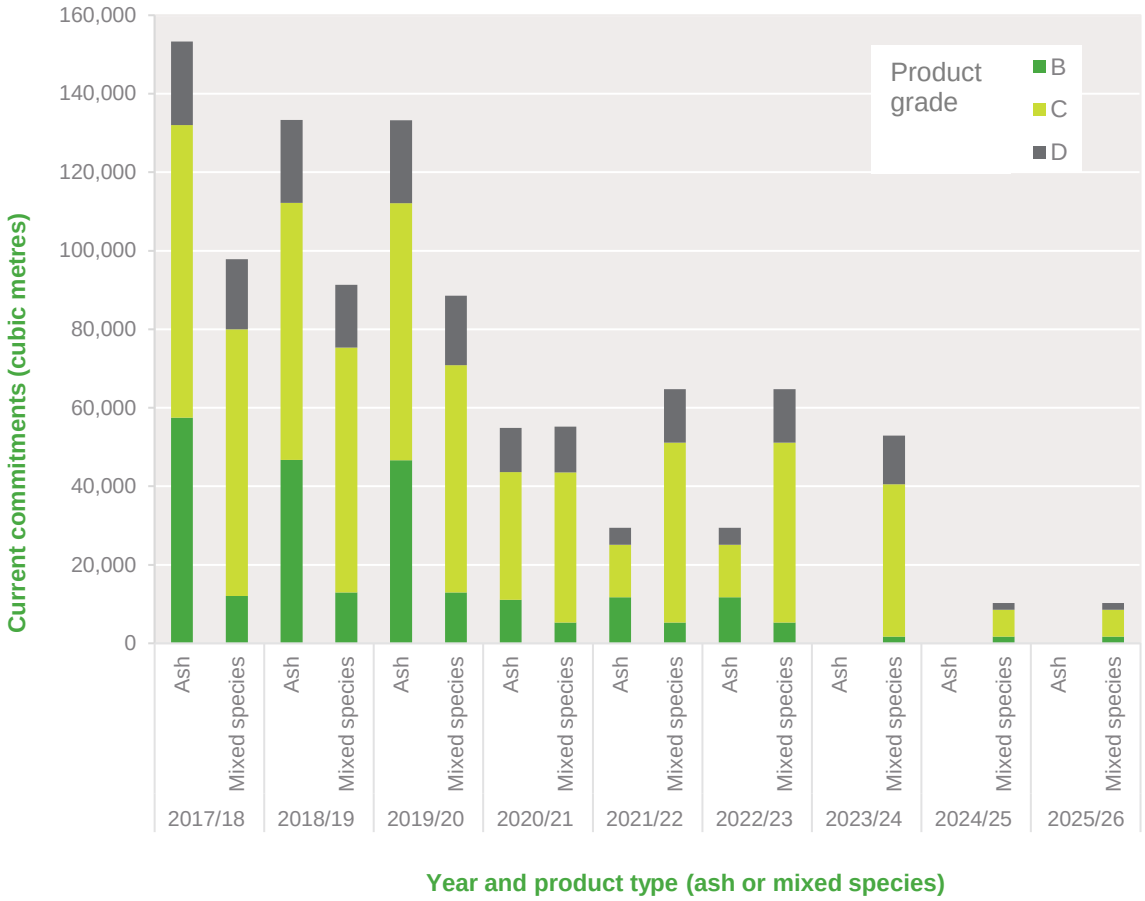


Figure 3.4 portrays the commitments for B, C and D grade sawlogs. 'D+ logs' is a common term in the industry to practically describe the key objective of the industry – the highest quality logs that are generally kiln-dried enabling the highest value-add. This figure shows that about 50 per cent of D+ logs come from ash forests – exemplified in the first few years of the period shown, before the commitments decline more noticeably as contracts expire.

The figure also shows that, overall, the ash commitment has a much higher proportion of higher grade logs (typically 35-40 per cent B grade logs) than the mixed species commitment (3-17 per cent B grade logs). The mixed species commitment has a higher proportion of both C and D grade logs (around 70 per cent and 20 per cent) than the ash commitment (around 50 per cent and 15 per cent).

3.3 Current pulplog commitments

Figure 3.5 Current pulplog commitments by product type

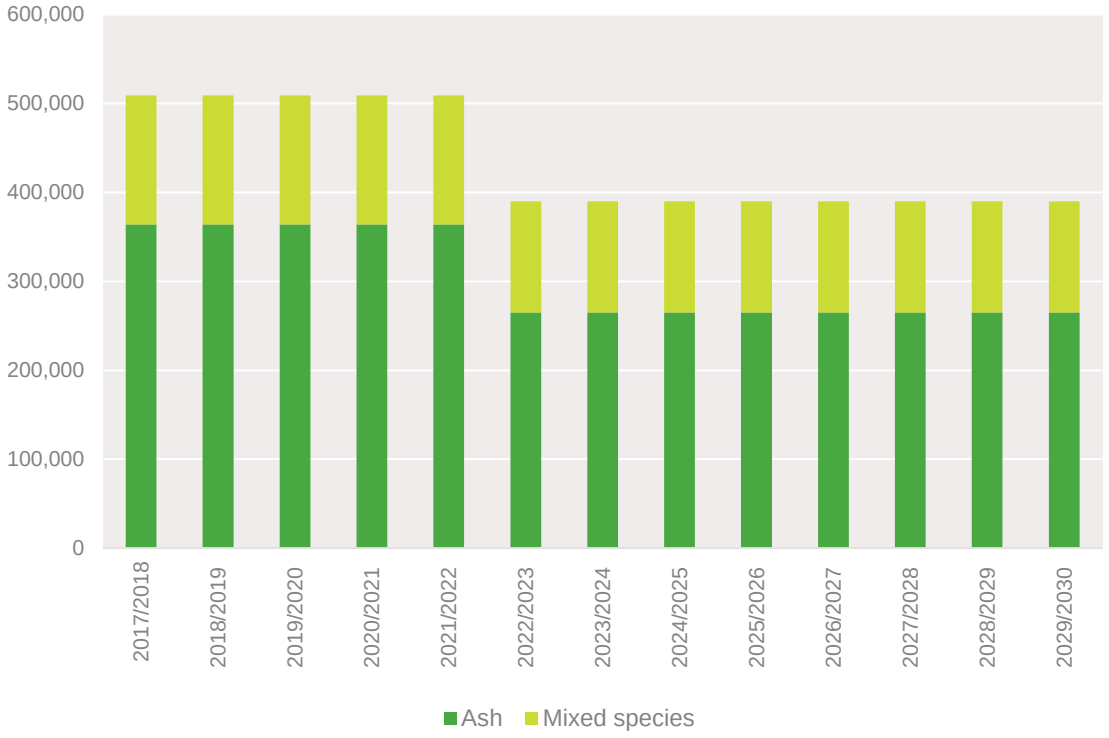
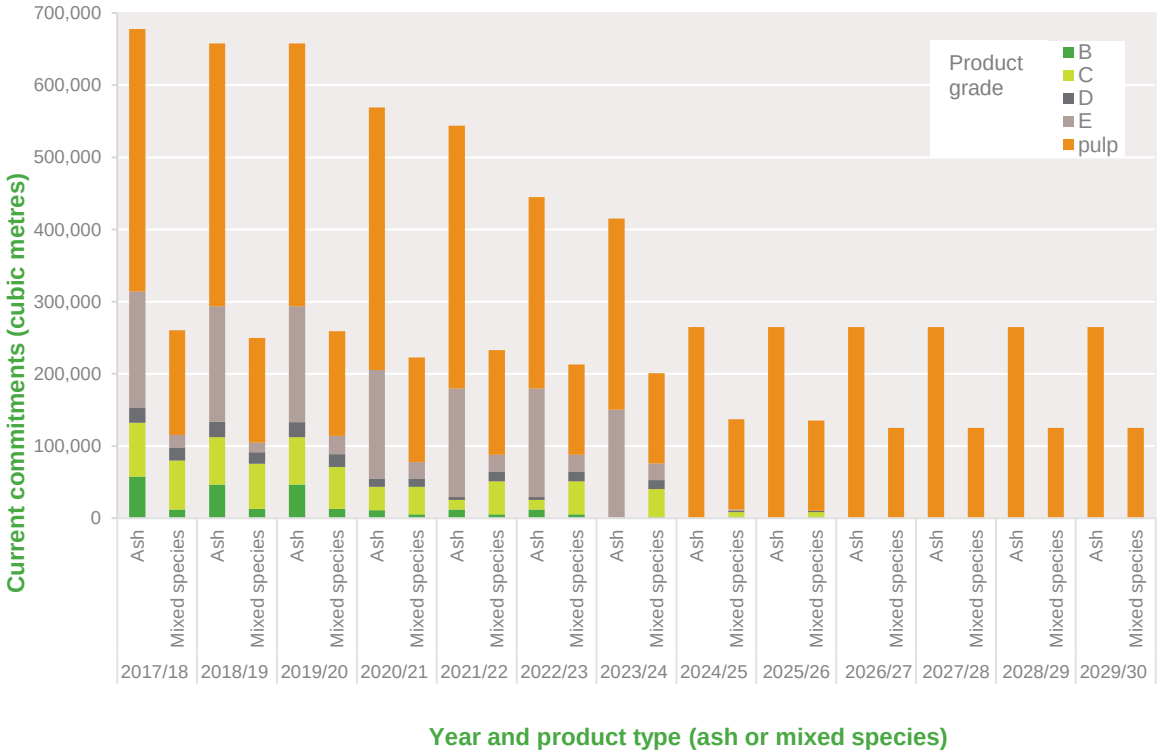


Figure 3.5 shows the current pulplog commitments in terms of ash and mixed species logs, the former more or less equating to logs for high value pulp and the latter for medium quality pulp (as per table 3.1). The apparent simplicity of this graph belies a more complex underlying set of factors involving details such as spot market sales and details in the legislated agreement between Australian Paper and the State including the area from where the pulplogs are to be sourced and provisions that apply if other considerations cannot be met.

Broadly, though, the chart portrays to total commitments under the legislated agreement with Australian Paper and other TSAs with variations due to the tenure of different agreements. It shows that around 70 per cent of the pulplog volume is from ash forests mostly for high quality pulp.

3.4 Current sawlog and pulplog commitments combined

Figure 3.6 Current sawlog and pulplog commitments by product type and grade



For context, figure 3.6 depicts current sawlog and pulplog commitments together. It shows that pulplogs and E grade sawlogs account for over 50 per cent and nearly 20 per cent of the logs harvested (by volume), increasing over time as current sawlog contracts expire while the pulplog commitments continue with little reduction until 2030.

The longer term component of the pulplog commitment is contingent on there being sufficient sawlog supply for new TSAs to be issued as current contracts expire and maintain supply of D+ ash logs around the 130,000 cubic metres of 2017/18. VicForests advises that any overall sawlog commitment significantly lower than this will not provide enough 'residual' pulplogs to meet the commitments to Australian Paper. This problem is most acute for the ash sawlogs from which Australian Paper produces high quality paper. A similar problem – albeit smaller and shorter term – applies to E grade logs between about 2020 and 2024.

Should the longer term sawlog supply be insufficient to provide for the pulplog commitment, alternative sources would need to be found. Alternative supply options include such measures as thinning younger regrowth and using the thinned trees for pulplogs. Such thinning would increase the growth rate of retained trees to the benefit of future sawlog production and, potentially, forest biodiversity. However, Leadbeater's possums have been found in younger regrowth and this option might encounter the same problem as current harvesting of 1939 ash forests.

Figure 3.7 Previous harvest levels compared to current commitments for ash (upper) and mixed species (lower) sawlogs, pulplogs and other logs

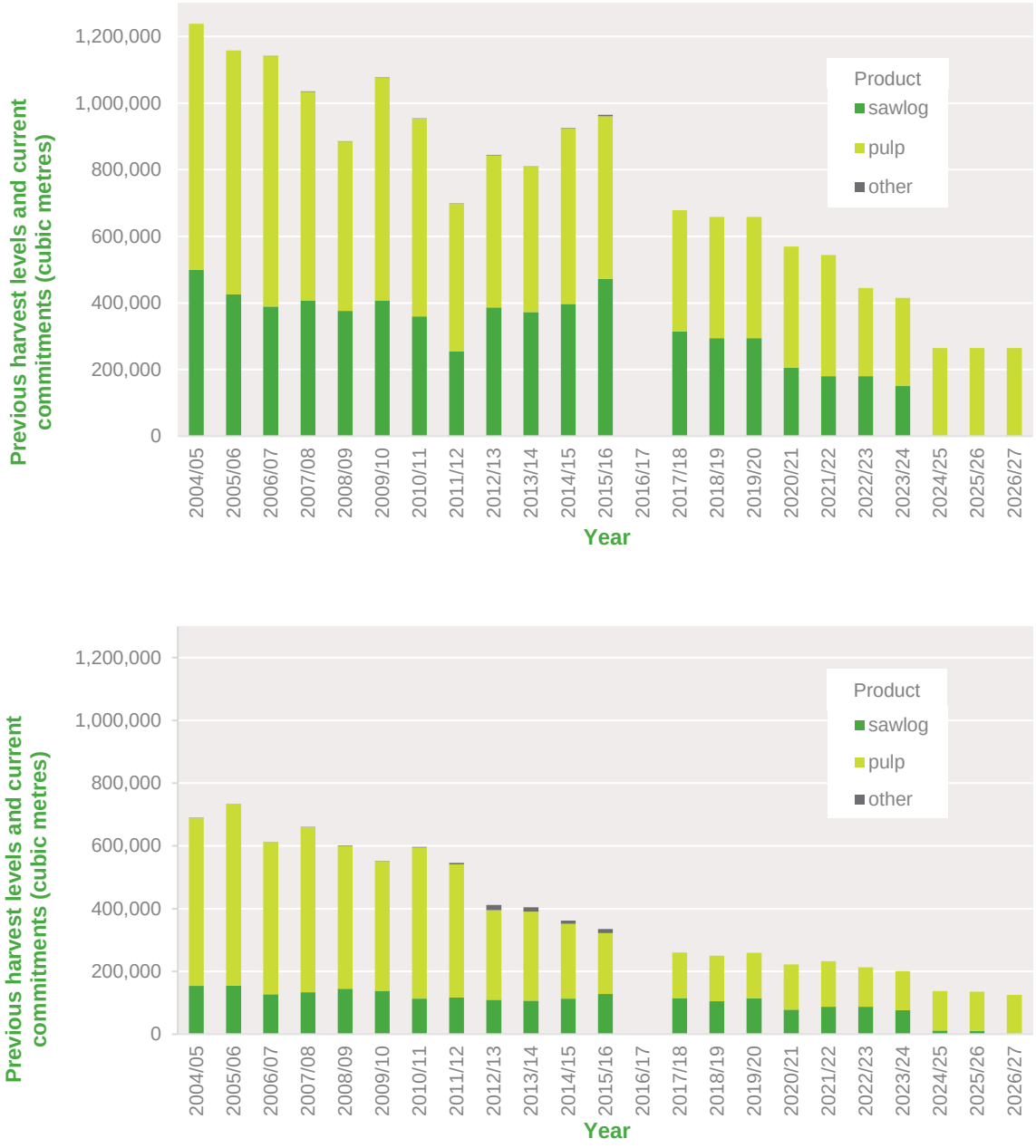


Figure 3.7 compares actual harvest levels for the period 2004-16 with current commitments in two charts – for each of ash and mixed species. The graphs need to be interpreted with caution because the previous harvesting data are drawn from two different data sources with some changes in the nature of the data collected across that period, Interpretation should be largely limited to broad trends.

For both graphs, broad trends include a generally consistent or slightly declining sawlog harvest and a consistently declining pulplog harvest (especially for mixed species) with a noticeable drop in both at the start of future commitments for both product types. Compared to mixed species, ash harvest levels show more variations, mostly as a result of the 2009 bushfires which were largely in ash forests. The subsequent years reflect a complex interplay of initial effects, salvage logging, longer term effects and attempts by VicForests and purchasers to ‘smooth out’ these fluctuations.

3.5 Harvest and haulage commitments

As well as contracts with purchasers of logs, VicForests has contracts for the harvesting of trees in the forest and haulage of the resultant logs to the purchaser locations as per figure 3.1. Essentially the harvest and haulage contracts follow on from the sawlog commitments (and the resultant pulplogs) and amount to commitments to provide logs to be harvested and delivered. So harvest and haulage commitments follow a similar profile to that shown for sawlogs in figure 3.3 – with minor variations for factors such as scheduling and harvesting locations. That is, there are not currently harvest and haulage commitments to match the longer term pulplog commitments (i.e. beyond those resulting from current sawlog commitments) that ultimately extend to 2030.

Table 3.2 shows the number of harvest and haulage contractors and their associated employees. Contractors tend to be based in towns near the forests they harvest or the mills to which they deliver. Table 3.2 shows that compared to other forests there are fewer employees relative to the volume of wood harvested in the Central Highlands, reflecting the greater abundance of highly productive forests. This difference would add to the higher value of ash forests apparent in figure 3.2.

Table 3.2 Summary of harvest and haulage commitments (Source: VicForests)

	Central Highlands	Other	Total
Number of harvest contracts	24	10	34
Number of haulage contracts	24	10	34
Storage facility contractors	2	0	2
Employment (full time equivalents)	253	96	349
Approx. harvest volumes (cubic metres)	1,000,000	250,000	1,250,000
Employment/10,000 cubic metres	2.5	3.8	2.8

Note: Some contractors hold multiple contracts including a mix of harvest and haulage.

4. Resource risks and uncertainties

This section of the report explores some of the risks and uncertainties around the provision of a sustainable supply of wood from Victoria's state forests. In addition to addressing some parameter uncertainty in the forest growth modelling process, this section specifically addresses potential impacts of bushfires, Leadbeater's Possum detections, and climate change. While there are likely to be different opinions about the immediacy of these threats, it is important to acknowledge them and explore the potential risks that they present to Victoria's wood supply levels over the coming decades.

The Joint Sustainable Harvest Level Statement (2008) known as JoSHL noted that any predictions of future availability of timber are subject to the assumptions of the model as well as imperfect area, volume and growth data. The following brief discussion is drawn from JosHL.

Uncertainty has been described as 'incompleteness in knowledge (either information or context) that causes model based predictions to differ from reality'.[24] Potential sources of error can be grouped into two categories; those affecting estimates of current volume and those affecting predictions of growth and future availability.

Imprecision and uncertainty in forest resource estimates cannot be completely eliminated.

4.1 Uncertainties in scaling factors

As described is section 2.2.2, the strategic wood supply modelling (SWSM) process is used to estimate future sustainable harvest levels across Victoria's state forests. A core element of the SWSM process is the estimation of stand growth and yield at the scale of individual polygons (which are later grouped into coupes based on proximity and homogeneity). However, the estimates of total merchantable volume (TMV) are often biased, whether by species group, by FMA, by block within FMA, or by age class. To adjust the predicted TMVs to align with actual TMV (based on observations from recent harvest operations and timber sales), several scaling factors are multiplied against predicted TMV to obtain a final TMV that is used in Woodstock. One of the most important scaling factors is the TMV scaling, which is the ratio of actual to predicted TMV within a forest growth function (FGF) x FMA combination (e.g. mountain ash in Central Gippsland).

Mean values of the ratio of actual to predicted TMV are used to re-align predicted TMV in Woodstock. In the absence of disturbances, total merchantable volume per year is known with ± 10 per cent certainty. The uncertainty is higher if TMV is broken down by species group (around ± 15 per cent for alpine ash and mountain ash, ± 20 per cent for high-value mixed species and messmate, ± 40 per cent for other mixed species and silvertop). The uncertainty is even greater when species groups are split by FMA. While some of these differences may 'average out' at the strategic level, the application of point estimates of TMV scaling factors masks considerable uncertainty in the predicted TMV.

4.2 Bushfires and risks to wood supply

Major bushfires have had a profound effect on wood supply levels in Victoria's state forests. A large proportion of commercially valuable ash forests in the Central Highlands is regrowth from the extensive 1939 bushfires. The uneven age distribution of the forests of the Central Highlands has fundamentally shaped sustainable wood supply levels in Victoria over the past three decades. More recently, the 2009 Black Saturday bushfires burned more than 400,000 hectares of forest in and near the Central Highlands, including 80,000 hectares of ash forests. As a consequence, wood supply levels from the state forests were reduced.

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24. Haywood A, O'Brien N and Cowie A 2007 *An overview of uncertainty in the context of forest sink carbon estimation systems*. Paper presented to ANZIF 2007 Growing Forest Values Conference, Coffs Harbour.

If stochastic events such as fires are likely to occur in the future, then incorporating some estimate of their impacts may provide some guidance to forest planning about the potential risk to the forest resource. The challenge, though, with stochastic events is that when they will occur and how much damage they will do to the forest is unknown. Developing SWSMs that incorporate unforeseen events to modify sustainable harvest levels is a significant challenge that remains unresolved. Instead, VEAC commissioned analyses to examine what the probability is that a certain proportion of the 1939 regrowth ash forests will be impacted by bushfires over the next 20 years (see appendix A for full analysis and caveats).

Two separate approaches were taken to answer this question. Firstly, historical fire data was used to quantify the frequency and extent of fires over the Central Highlands. Secondly, a landscape fire succession simulator was used to simulate periods of fire and vegetation change. The focus is on the Central Highlands for two reasons. First, the 1939 regrowth is a critical forest resource that is the primary source of commercial harvesting revenues for VicForests and the State. If a large proportion of the 1939 regrowth is lost to bushfires in the next two decades, it could potentially spell the end of Victoria's native forest industry. Second, alpine and mountain ash are more susceptible to bushfires as they are obligate seeders and do not resprout following intense fires. A sufficiently large, high-intensity bushfire has the potential to kill most of the ash. The eucalypts of the mixed species forests, which dominate the East Gippsland FMA and account for more than half of the total state forest area, are much more resilient to fire and can survive even relatively intense fires.

The modelling approach attempts to quantify the risk that bushfires pose to the 1939 ash regrowth in the Central Highlands. The results indicated that it is highly unlikely that the entire 1939 resource would be lost over the next 20 years due to its spatial distribution and varying risk of bushfire across FMAs. The risk to the 1939 resource is not spatially uniform, with the greatest risk in the Central FMA.

Across a range of simulations using historical fire data and a landscape fire succession model, it was found that the mean proportion of Central Highlands broadly and the 1939 resource specifically that can be expected to burn is 20 per cent or less over the next 20 years. While loss of 20 per cent of the 1939 ash regrowth would impact sustainable wood supply levels, it would be unlikely to eliminate the native forest industry.

4.3 Leadbeater's Possum and risk to wood supply levels

Using the largest available dataset on Leadbeater's possum surveys, a new model was developed to estimate the probability of possum occurrence as a function of stand age, elevation, and FMA. Table 4.1 provides a summary of the Leadbeater's possum survey dataset. Analyses of these data and any insights they generate regarding Leadbeater's possum habitat are conditional on the survey design, which focused on current expectations where Leadbeater's possum is known to exist or is believed to have a high probability of occurrence based on other knowledge. The model estimated a median of 518 new observations in harvestable 1939 ash regrowth forests in the Central, Central Gippsland, and Dandenong FMAs (see table 4.2).

Table 4.1 Summary of Leadbeater's possum survey data by forest management area (FMA)

	Surveys	Presences	Absences	Age (year)		Elevation (m)	
FMA	n	n	n	median	range	median	range
Central	105	26	79	73	(1-166)	830	(447-1235)
Dandenong	88	38	50	73	(14-84)	657	(209-1061)
Central Gippsland	162	70	92	73	(3-166)	904	(199-1308)
Total	355	134	221	73	(1-166)	783	(199-1308)

Depending on the size of the buffer applied (100, 200, or 300 metre radius), losses of harvestable 1939 ash regrowth area ranged from 1,605 to 8,081 hectares, losses of D+ sawlogs ranged from approximately 350,000 to 1,750,000 m^3, and losses of residual wood ranged from approximately 705,000 to 3,520,000 m^3. These losses varied among the three FMAs, with the Dandenong FMA having substantially less loss of harvestable 1939 ash regrowth area and volume than the Central and Central Gippsland FMAs (see table 4.3 and table 4.4).

Table 4.2 Median estimates of new detections of Leadbeater's possum and total harvestable1939 ash regrowth lost based on modelled detection probabilities

FGF	FMA	All LBP detections (N)	LBP in 1939 regrowth (N)	Total area in 100m exclusions (ha)	Total area in 200m exclusions (ha)	Total area in 300m exclusions (ha)
AAS						
	CG	283	109	337.9	1035.5	1700.4
	CT	163	105	325.5	997.5	1638
	DD	5	1	3.1	9.5	15.6
MAS						
	CG	333	124	384.4	1178	1934.4
	CT	212	108	334.8	1026	1684.8
	DD	244	71	220.1	674.5	1107.6
Total		1240	518	1605.8	4921	8080.8

Notes: The values for new detections are median values derived from the statistical model. 'All LBP detections' includes ash regrowth in all age classes. 'LBP in 1939 regrowth' includes new detections in the single 1939 age class. Total area lost to exclusions is calculated from the 1939 ash regrowth detections and the expected area lost for different exclusion zone sizes. Forest growth function (FGF) codes are alpine ash (AAS) and mountain ash (MAS). FMA codes are Central Gippsland (CG) Central (CT) and Dandenong (DD).

Table 4.3 Estimated volume of D+ sawlog from ash regrowth lost for different exclusion zone sizes based on simulated Leadbeater's possum detections

		TMV D+ available (m^3)				TMV D+ loss (m^3)		
FGF	FMA	No buffer	100m buffer	200m buffer	300m buffer	100m buffer	200m buffer	300m buffer
AAS								
	CG	894,166	822,032	673,218	534,534	72,134	220,948	359,632
	CT	1,227,548	1,153,431	1,000,964	856,102	74,117	226,584	371,446
	DD	7,420	6,356	4,159	3,993	1,064	3,261	3,427
MAS								
	CG	1,199,644	1,124,165	968,467	821,272	75,479	231,177	378,372
	CT	1,506,370	1,428,424	1,267,569	1,116,895	77,946	238,801	389,475
	DD	806,064	755,377	651,659	554,738	50,687	154,405	251,326
Total		5,641,212	5,289,786	4,566,035	3,887,534	351,426	1,075,177	1,753,678

Notes: Volume losses are grouped by FGF and FMA (codes as in table 4.2). TMV D+ available is the total merchantable volume of D+ sawlogs available under different exclusion zone scenarios. The No Buffer options represents the baseline volume estimates for the FGF x FMA classes. The other three buffer scenarios is total TMV available under different buffer sizes. TMV D+ is the difference between the TMV available under a given buffer condition and the baseline (i.e. no buffer). All values (except LBP count) are in m^3.

Table 4.4 Estimated volume of residual wood from ash regrowth lost for different exclusion zone sizes based on simulated Leadbeater's possum detections

		TMV RL available (m^3)				TMV RL loss (m^3)		
FGF	FMA	No buffer	100m buffer	200m buffer	300m buffer	100m buffer	200m buffer	300m buffer
AAS								
	CG	1,818,162	1,671,489	1,368,896	1,086,900	146,673	449,266	731,262
	CT	2,250,496	2,114,614	1,835,091	1,569,512	135,882	415,405	680,984
	DD	15,866	13,590	8,892	8,537	2,276	6,974	7,329
MAS								
	CG	2,438,218	2,284,800	1,968,331	1,669,145	153,418	469,887	769,073
	CT	3,062,903	2,904,417	2,577,354	2,270,993	158,486	485,549	791,910
	DD	1,723,094	1,614,747	1,393,036	1,185,857	108,347	330,058	537,237
Total		11,308,739	10,603,657	9,151,599	7,790,944	705,082	2,157,140	3,517,795

Notes: as for table 4.3.

VicForests has forecast annual reductions of 1939 ash regrowth D+ sawlogs of 43,000 m^3 $year^{-1}$. For the purposes of comparison, in the present assessment the estimate of lost volume (assuming a 200 metre buffer exclusion) by 22 years (as 1939 regrowth is assumed to be unavailable for harvest after 2039 at 100 years of age) to get an average annual loss of 48,872 m^3 $year^{-1}$. This is quite similar to VicForests estimate. However, of their 43,000 m^3 $year^{-1}$ loss of D+ sawlogs, they estimated that only 18,000 m^3 $year^{-1}$was directly attributable to new possum detections. Their total estimated volume reduction included a range of other factors such as loss of access to harvestable forests caused by new possum detections that the analyses in this report did not consider, confounding direct comparisons between the approaches.

4.4 Climate change and risk to wood supply levels

Regional and global warming has already begun to have direct and indirect impacts on plants and plant communities around the world. Climate change has the potential to affect all aspects of forest population dynamics—recruitment, growth, and mortality—as well as the disturbances that often influence them. A growing number of studies has shown that warmer, drier conditions can lead to widespread mortality in forests. Stand density—the number of trees per unit area—is an important determinant in stand-level responses to extreme climatic conditions. Stands growing at lower densities tend to have lower mortality rates than stands growing at higher densities when subjected to the same climatic conditions. As mean temperatures increase, the rate of density-dependent mortality is likely to increase as well, resulting in fewer trees in a stand for a given average tree size.

The self-thinning line defines the upper limit of stand density for a given average tree size and has been the empirical basis for forest density management techniques for more than half a century. Using a recently developed modelling approach to quantify the relationship between the number of trees in a stand and their mean diameter, VEAC's consultants examined how stand density will change with increasing mean annual temperature (MAT) and how that will impact on potential future wood volume in the forests. The analysis was limited to a single species, the commercially valuable mountain ash (*Eucalytpus regnans*), to illustrate the approach and the scale of the potential impacts on future wood supply.

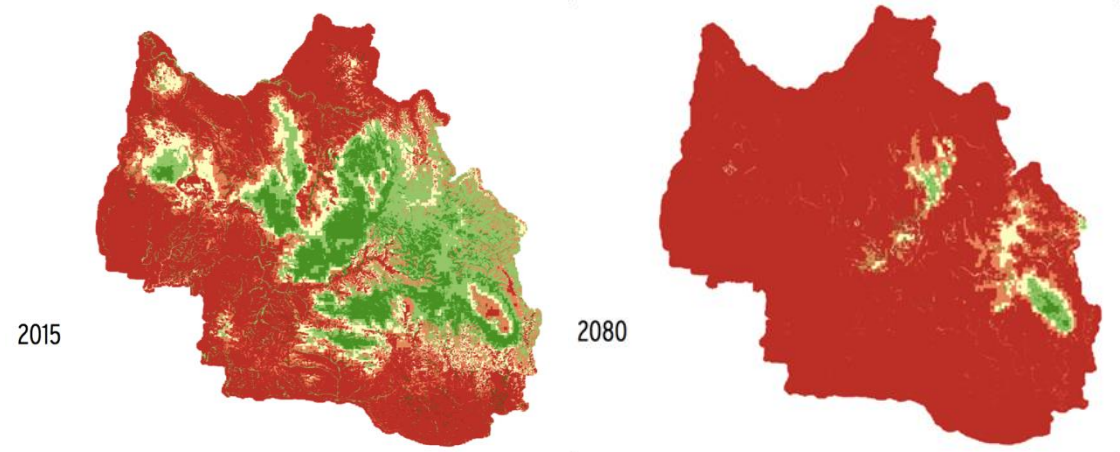
Recent work that has explored the impacts of predicted climate change on recruitment and productivity in the forests of the Central Highlands is also summarised. As temperatures increase and water becomes more limiting, germination and seedling establishment, two processes that are highly sensitive to environmental conditions, will be directly affected. In addition, overall forest productivity in these water-limited environments will be reduced in many sites (and increased in

others, particularly at higher elevations). Current and projected recruitment and productivity patterns across the Central Highlands are compared and the impacts of these dynamics on future wood supply considered. These analyses provide a framework for assessing the impacts of changes in MAT on maximum stocking levels and total stand volume in eucalypt forests in Victoria, as well as regeneration and growth dynamics at landscape scales. It was found that a 3ºC increase above current MAT (consistent with expectations for MAT at the end of this century) would be expected to reduce total stand density and stand volume in mountain ash stands by 15 per cent. See part 6 of appendix A for more details of the analyses and results.

In addition, an increase in MAT of that scale would lead to a dramatic reduction in the area of forest suitable for natural regeneration from seed for certain species (see figure 4.1). Separate analyses have demonstrated that planted seedlings will be able to grow across much of the area that is defined as productive (see figure 4.2). The mismatch between future sites that are productive and those that are suitable for regeneration from seed suggests that future forest regeneration practices may need to be modified across the Central Highlands landscape.

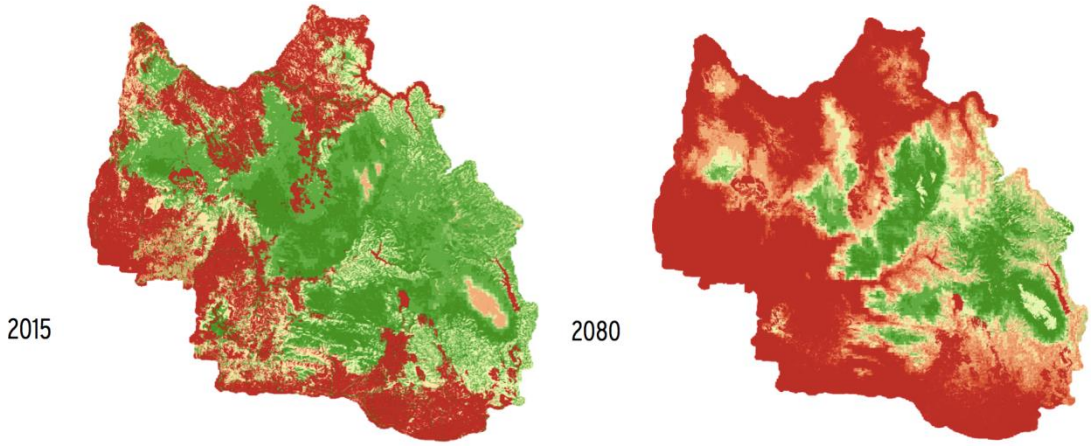
The mountain ash forests of the Central Highlands are amongst the most commercially valuable in Victoria. While the timing of the impacts of future climate change on stand productivity is contingent upon on-going rates of regional and global warming, and is therefore uncertain, a 15 per cent reduction in total stand volume multiplied across an entire landscape would be significant. Current growth and yield models do not account for the potential reduction in future harvest volume.

Figure 4.1 Regeneration suitability of mountain ash (*Eucalyptus regnans*) across the Central Highlands under current climate (left) and a future climate that is 3˚C warmer (right)



Note: the colour scale runs from unsuitable for natural regeneration (red) to well suited for natural regeneration (green). The total area suitable for regeneration of mountain ash decreases by ~80 per cent between the two scenarios.

Figure 4.2 Forest productivity of mountain ash (*Eucalyptus regnans*) across the Central Highlands under current climate (left) and a future climate that is 3˚C warmer (right)



Note: the colour scale runs from non-productive (red) to highly productive (green).

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