Victoria's State of the Forests Report 2013

Department of Environment and Primary Industries

State Government Victoria

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Department of Environment and Primary Industries

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Secretary's foreword

Victoria's forests are precious natural assets which provide habitat for our remarkable native flora and fauna and form some of our most magnificent landscapes. Our forests provide a range of environmental, social and economic benefits to Victorian communities, including valuable wood and clean water.

Many Victorians have special memories of time spent enjoying these beautiful places and they are places for work as well as play, particularly for people living in regional communities.

Traditional Owners have deep cultural and spiritual connections to these lands and government works closely with Traditional Owners in many aspects of forest management.

In this latest State of the Forests Report, we are able to provide much more comprehensive data about the health of our forests.

Government has developed a more holistic landscape approach to sustainable forest management, with a greater focus on environmental auditing and compliance systems.

There's also a greater focus on monitoring the broad environmental and social outcomes of timber harvesting, and a more strategic approach to the management of threatened species which provides opportunities for sustainable timber harvesting.

Victoria's State of the Forests Report 2013 is produced solely as an interactive online document enabling you to follow areas of interest as you learn more about recent achievements in sustainable forest management and ongoing challenges.

The Report is a detailed snapshot of the health of these natural environments and a clear reflection of the extensive work being done and significant successes achieved towards ensuring our forests are carefully managed for future generations.

Secretary

Credit: Arthur Rylah Institute

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Introduction

Victoria's forests are important natural assets. They provide a wide range of values and services to communities to value, act and enjoy. These include the provision of ecosystem services, biodiversity habitat, wood and non-wood products and water resources. Forests also have significant cultural and spiritual values for Australian communities.

Forests provide areas for tourism and recreation, support regional industries and play an important role in the stability of economic, social and environmental wellbeing. The Department of Environment and Primary Industries (DEPI) has primary responsibility for the sustainable management of Victoria's public forests. This is done for the benefit of the community and includes the conservation of flora and fauna, the protection of water catchments and water quality, fire management, the provision of forest products on a sustainable basis, the protection of landscape, archaeological and historic values, and the provision of recreational and educational opportunities.

A key objective of sustainable forest management (SFM) in Victoria is to protect the health and biodiversity of forests, whilst ensuring they continue to provide a range of social and economic benefits for Victorian communities now and in the future. This objective is consistent with the Sustainability Charter for Victoria's State Forests and the principles of ecologically sustainable development. The Victorian State of the Forests reporting process makes a significant contribution to the knowledge required for informed management and ensuring the right decisions are made about how these important natural assets are sustainably managed.

Following on from reports in 2003 and 2008, the 2013 report is the third Victorian State of the Forests Report (SFR). The SFR is issued every five years and provided to the Minister for Environment and Climate Change by the Secretary, DEPI. SFR fulfils reporting requirements set out in Section 8 of the *Sustainable Forests (Timber) Act 2004*.

Victoria has adopted the Criteria and Indicators for Sustainable Forest Management to monitor and assess the State's performance in achieving its SFM objectives, which set out a range of environmental, economic and social indicators. These are closely aligned with Australia's Sustainable Forest Management Framework of Criteria and Indicators and the international reporting standards developed under the Montreal Process Working Group. This provides a framework with which to evaluate progress towards the objectives set out in the Sustainability Charter and to improve openness, accountability and community engagement in forest management. Victoria's State of the Forests Report 2013 fulfils the reporting requirements for the five years since the 2008 SFR.

Reporting period

The reporting period for *Victoria's State of the Forests Report 2013* (2013 SFR) is from 1 July 2006 to 30 June 2012 (representing six reporting years). This exceeds the reporting requirements set out in Section 8 of the *Sustainable Forests (Timber) Act 2004*, to report on the five years since the 2008 SFR. For some indicator reports however, data trends are extended and reported before 1 July 2006 and beyond 30 June 2012 – this is in order to maximise the currency of available data and information; present information and trends in a broader historical context; and, continue trends from previous reports.

Credit: Christian Pearson

This SFR is the first exclusively digital report. Data and information is presented in the form of indicator summary reports, accessed either via four theme portals (Social, Environmental, Economic and Legal/Frameworks) or the seven SFM criteria.
The seven broad criteria which describe forest values that society seeks to maintain are:

1. Conservation of biological diversity

2. Maintenance of productive capacity of forest ecosystems

3. Maintenance of ecosystem health and vitality

4. Conservation and maintenance of soil and water resources

5. Maintenance of forest contribution to global carbon cycles

6. Maintenance and enhancement of long term multiple socio-economic benefits to meet the needs of societies

7. Legal, institutional and economic framework for forest conservation and sustainable management.

What's new in the 2013 State of the Forests Report

As well as being Victoria's most comprehensive SFR to date, the 2013 report describes new ways and improvements that have been initiated by DEPI for sustainably managing Victoria's public forests. These include:

1. A more holistic landscape approach to SFM, with a greater focus on environmental auditing and compliance systems.

2. A greater focus on monitoring the broad environmental and social outcomes of timber harvesting.

3. Victoria's planned burning program – a commitment to increasing its most extensive land management activity in public forests to reduce bushfire risk to communities, property and the environment.

4. A new strategic approach to the management of threatened species, that provides opportunities for sustainable timber harvesting while managing biodiversity at a species and landscape scale.

Credit: DEPI

5. A commitment to collecting a more comprehensive suite of environmental, social and economic data and information to support SFM reporting.

Data

Since the previous State of the Forests Report (2008), DEPI has made significant improvements to the way it collects forest monitoring data, as well as the quality, coverage and accuracy of spatial (GIS) and other data. In particular, the Victorian Forest Monitoring Program (see VFMP, below) has been established specifically for the collection and analysis of data for detecting trends in the extent, state and condition across all of Victoria's public forests. The number of indicators that contain data with which to report trends is up from 25 in the 2008 SFR to 31 in 2013. DEPI monitoring programs, such as the VFMP, will further greatly improve this capacity into the future. Refer to Indicator 7.4 for further details.

Victorian Forest Monitoring Program

Established in 2010, the VFMP is Australia's most comprehensive statewide public forest monitoring system. The VFMP includes a network of 786 permanent monitoring plots located across State forest and Parks and conservation reserves (Figure 1), together with detailed aerial photography and satellite imagery. These data sets provide the basic attributes (including forest structure, species diversity, canopy condition and soil characteristics) that are used to derive indicators of sustainability and measure changes in the extent, state and condition of Victorian public forests.

VFMP data is being used to report against several SFR 2013 indicators, under SFM Criteria 1 (Conservation of biological diversity), 3 (Maintenance of ecosystem health and vitality) and 5 (Maintenance of forest contribution to global carbon cycles). The remeasurement and re-analysis of VFMP plots and satellite imagery over time allows DEPI to detect trends
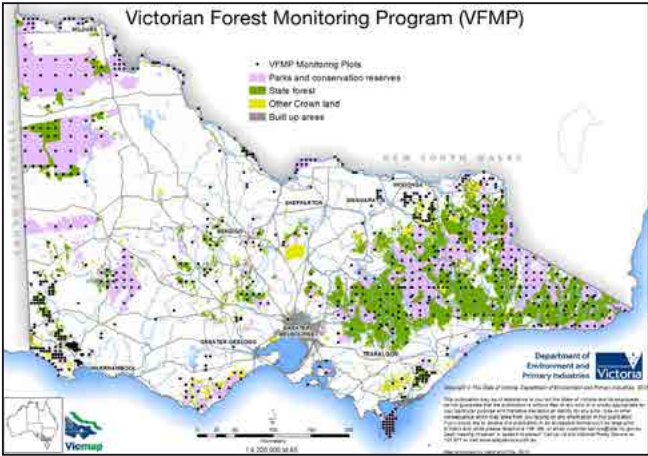
Figure 1. Victorian Forest Monitoring Program - Monitoring Plot locations.
Source DEPI

in forest health and vitality using consistent and scientifically robust data and methods. The detailed information gathered through the VFMP approach is ultimately improving DEPI's evidence-based decision making and policy development across a range of issues, including:

• fire and flood impacts

• habitat protection

• carbon accounting

• biomass

• forest productivity

• forest health and biodiversity.

The 2013 SFR contains a detailed overview of the VFMP, including the field procedures and types of data collected.

Victoria's forests

Hardwood eucalypt forests make up the vast majority of all Victoria's public forests. Public native forests extend to all parts of the State, ranging from the north-west, dominated by low, multi-stemmed Mallee woodland across flat and gently undulating topography. Central Victoria is characterised by sparse to dense canopies of box, ironbark and gum-barked eucalypts up to 25 m tall, on flat to undulating landscapes on rocky, auriferous soils. Medium and tall damp sclerophyll are widespread across much of Victoria, on loamy, clay-loam and sandy-loam soils. Tall wet sclerophyll forests are found mostly in the eastern part of the State on deep loamy soils at higher elevations. Dry sclerophyll forests are common throughout the east, central and southwest of Victoria, characterised by canopies typically less than 25 m with crooked spreading trees[1].

Some of the most common eucalypt species include Red Gum or Red Stringybark (*Eucalyptus macrorhyncha*), brown stringybark (*Eucalyptus baxteri*), narrow-leaved peppermint (*Eucalyptus radiate*), Messmate Stringybark (Eucalyptus oblique), Mountain Ash (*Eucalyptus regnans*), Alpine Ash (*Eucalyptus delegatensis*) and River Red Gum (*Eucalyptus camaldulensis*). The distribution and diversity of Victoria's forests – found in a range of inland, coastal and high elevation areas – are influenced by several factors, including elevation, rainfall, temperature, soil type and natural disturbance.

Prior to European settlement in the mid-nineteenth century, forest covered about 90% of Victorian land[2]. Since that time more than 14 million hectares (60%) of Victorian forest has been cleared, making it proportionally, the most cleared of all Australian States[3]. The period of greatest deforestation occurred between 1830 and 1880, principally the result of agricultural clearance and settlement development by early European explorers and the 1850s Victorian gold rush.

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[1]   Viridans Ecosystems and Vegetation. Available online: http://www.viridans.com/ECOVEG/ (accessed on 27 May 2013).

[2]   Woodgate, P. & Black, P. (1988) Forest Cover Changes in Victoria, 1869-1987. Department of Conservation, Forests and Lands: Melbourne.

[3]   SEAC 1996 - Australia: State of the Environment 1996. An Independent Report Presented to the Commonwealth Minister for the Environment by the State of the Environment Advisory Council. Commonwealth of Australia 1996

Key terms and definitions

The following section introduces and defines some of the key terminology used throughout the report.

Crown land

Crown land broadly refers to all land that has not been "alienated" from the Crown (typically by way of a land title). Victorian Crown land can be either unreserved or reserved and is managed to provide environmental, social, cultural and economic benefits to the people of Victoria. Reserved Crown land is that land set aside for specific public purposes, while unreserved Crown land has not been set aside for a particular public purpose. In this report, the term Crown land is used to describe the terrestrial component only. As of August 2013, DEPI is responsible for managing 7.9 million hectares of Crown land (approximately 35% of Victoria) and a further 136,000 hectares of marine public parks and reserves. Table 1 shows the areas of different Crown land categories (tenure) in Victoria. Non-Crown land covers the remaining 14.8 million hectares of land in Victoria. This comprises mostly private and some leasehold land.

Table 1. Victorian Crown land area by tenure (August 2013)

Tenure	Area (hectares)*
Parks and conservation reserves	3,982,000
State forest	3,138,000
Other Crown land	796,000
Total Crown land	7,916,000

* rounded to nearest 1,000 hectares

Source: Victorian Crown Land Area Statement 2013.

Source DEPI

Tenure

Tenure refers to the specific categories of Crown land (described below). Figure 1 maps the current distribution of Crown land across Victoria.

Parks and conservation reserves
Parks and conservation reserves make up 3.98 million hectares (approximately 50% of all Crown land, covering 18% of Victoria). This category is managed primarily for ecosystem and biodiversity protection (Indicator 1.1c, 1.2), as well as tourism and recreation (Indicator 6.3) and the protection of cultural and historic values (Indicator 6.4). Parks and conservation reserves comprise a variety of land use categories, including National, State, Regional and Wilderness Parks; and Historic and Natural Features Reserves. Over 90% of Victorian Parks and conservation reserves are assigned protected area status category I or II, under the International Union for Conservation of Nature (IUCN) (see Indicator 1.1c).

State forest
Comprising 3.14 million hectares (approximately 40% of Crown land, covering 14% of Victoria), State forest is managed to balance a variety of purposes. These include the conservation of flora and fauna, protection of water catchments and water supply, the provision of timber through sustainable forestry (Indicators 1.1c, 2.1, 2.2, 2.3, 4.1, 5.1, 6.1) , as well as the protection of landscape, archaeological and historic values, and the provision of recreational and educational opportunities. Forest management zones are used to determine which types of activities can take place in State forests (see Indicator 2.1).

Other Crown land
Other Crown land makes up 796,000 hectares (10% of all Crown land) and comprises all remaining Crown land outside of State forest and Parks and conservation reserves. Other Crown land categories include Commonwealth Government managed land, reserves managed by Committees of Management or local government, metropolitan parks and Heritage River parks, together with land held under lease or licence from the Crown.

Key terms and definitions

Forest

Victoria's State of the Forests Report 2013 adopts Australia's current definition of forest, as

> *"a land area, incorporating all living and non-living components, dominated by trees having usually a single stem and a mature or potentially mature stand height exceeding two metres and with existing or potential crown cover of overstory strata about equal to or greater than 20 percent. This definition includes native forests and plantations and areas of trees that are sometimes described as woodlands"*[4].

Native forests are further classified into three height classes, based on mature (or potentially mature) stand height (low: 2-10 m, medium: >10-30 m and tall: >30 m), and three crown cover class, based on mature (or potentially mature) crown cover (woodland: 20-50 per cent, open: >20-80 per cent and closed: >80 per cent).

Public forests

As the majority of the area of Victorian State forest and Parks and conservation reserves tenures are forested (typically greater than 90%) (see Indicator 1.1a), the term "public forests" is used to collectively describe these areas.

Private forests

Native forests and plantations on freehold or vested Crown land are referred to as "private forests" within this report.

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[4] Department of Agriculture Fisheries and Forestry. *Australia's Forest at a Glance*; Department of Agriculture Fisheries and Forestry: Canberra, Australia, 2012.

Credit: DEPI

Key terms and definitions

Forest management in Victoria

Management arrangements for Victorian forests varies with land tenure and other administrative provisions established through legislation. Public forests are managed and regulated by government departments, agencies and businesses. Private forests are managed by private landholders and regulated by Local Government Authorities. This section describes the roles and responsibilities of key parties involved in forest management in Victoria.

Department of Environment and Primary Industries (DEPI)
The Department of Environment and Primary Industries (DEPI) plays a key role in supporting the Victorian Government's priority to boost productivity in the state's food and fibre sector; manage land and natural resources; protect the environment; and respond to fire, flood and biosecurity emergencies. DEPI is responsible for managing 3.14 million hectares of State forest and providing policy guidance for a further 3.98 million hectares of Parks and conservation reserves. The department also provides conservation guidance and incentives to private landholders who manage about 1.2 million hectares of largely native forest and 434,000 hectares of hardwood and softwood plantations. DEPI is directly responsible for the management of timber production activities in western Victoria.

DEPI was formed in 2013, through the merging of parts of the Departments of Sustainability and Environment (DSE) and Primary Industries (DPI). Throughout this report, for consistency and clarity, the former departments DSE and DPI are always referred to as DEPI (including in reference to the former DSE and DPI before 2013).

Parks Victoria
Parks Victoria is a statutory authority, created by the *Parks Victoria Act 1998*. Parks Victoria reports to the Minister for Environment and Climate Change and is responsible for managing over 40,000 square kilometres of National Parks and conservation reserves, including 13 marine parks.

Parks Victoria is responsible for the delivery of on-ground activities relating to land and waterway management of Victoria's Parks and reserves, as well as maintaining infrastructure in these areas. Parks Victoria manages Parks in the context of their surrounding landscape and in partnership with Traditional Owners.

VicForests
VicForests is a Victorian State-owned business responsible for the sustainable harvest, regeneration and commercial sale of timber from public forests in eastern Victoria on behalf of the Victorian Government. Among VicForests' responsibilities are management activities for the sale and supply of timber resources; construction of roads to coupes; fire prevention and suppression activities; and, forest rehabilitation and regeneration.

Private land forests
About 1.2 million hectares of Victorian forests (5% of Victoria's total land area) are located on private land managed by individuals and organisations. Private forest owners manage their estate for a variety of uses in accordance with planning schemes administered by Local Government Authorities.

Local Government Authorities
Local Government Authorities are statutory authorities responsible for the administration of planning schemes. Planning schemes contain a range of controls relevant to the management of forests. These include native vegetation and timber production provisions, and overlays including vegetation protection, heritage, landscape and bushfire management. Timber production and some other forest management activities may require planning permits under planning schemes. The 79 Victorian Local Government Authorities are responsible for issuing and monitoring compliance with planning permits.

Credit: DEPI

IBRA Bioregions

IBRA[5] bioregions (bioregions) are relatively large, geographically distinct areas of land that share common characteristics, including geology, landform patterns, climate, ecological features and plant and animal communities. Bioregions are a framework that divides Australia into units based on natural features which influence functions of entire ecosystems and capture landscape level geophysical patterns across the country. Eleven bioregions are located within Victoria and are the major geographic stratification unit for the Victorian Forest Monitoring Program. Together with public land tenure, bioregions are a geographic unit of analysis used in several Indicator reports. The following section provides an overview of Victoria's bioregions[6].
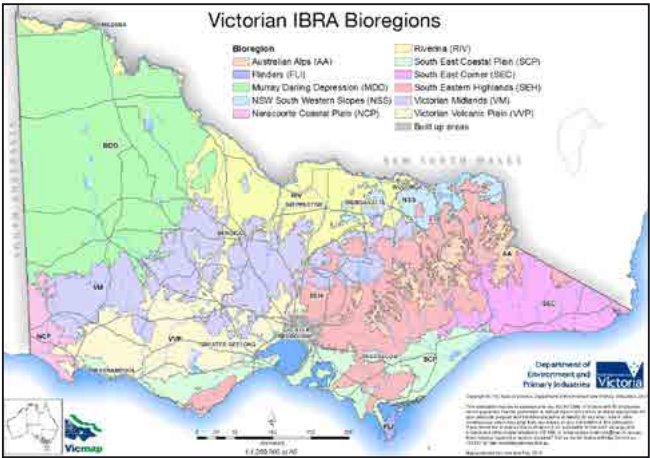
Source DEPI

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5   Interim Biogeographic Regionalisation for Australia

6   Cummings, B., & Hardy, A. (2000). Revision of the Interim Biogeographic Regionalisation for Australia (IBRA) and Development of Version 5.1. Canberra

Credit: DEPI

Victoria's Bioregions: An overview

Australian Alps
Area: 714,300 ha

The Victorian Alpine region falls within this bioregion and at 1,200 metres above sea level, it contains several species that have adapted to survive a severe winter climate. Alpine herbfields, treeless communities, snow gum woodlands and alpine ash are all present throughout the Australian Alps bioregion. The Alpine National Park covers much of this area, protecting the rich diversity that lies above and below the granite and basaltic bedrock.

The Australian Alps supports over 1,100 native plant species and a wide diversity of fauna. Several threatened species in the Australian Alps include the Broad-toothed Rat, Powerful Owl, Spotted Tree Frog and the rare Mountain Pygmy-possum. The Alpine Ash (*Eucalyptus delegatensis*) dominates the higher altitude areas of Victoria. Ranging between 850 – 1500 metres above sea level, this species has evolved to tolerate and become somewhat reliant on snow, ice and heavy frosts during the winter months.

Credit: DEPI

Flinders
41,200 ha

Flinders, in southern Victoria, is Victoria's smallest bioregion. Including areas of both high and low elevation, the landscape has a composite batholith base of Devonian granite bedrock. Finders is a diverse region which comprises wet and dry sclerophyll forest, cool and warm temperate rainforest, woodlands, heathlands, saltmarsh, mangroves and closed tussock grasslands.

This bioregion also includes the most southerly stands of mangroves in the world. Wilsons Promontory National Park is located entirely within this bioregion, managed by Parks Victoria for its outstanding biodiversity, the Park has special significance to the local aboriginal people, as it does with many other Victorians for its environmental, recreational and aesthetic values.

Refuge Cove, Wilsons Promontory National Park.
Credit: Joanne Wallace

Victoria's Bioregions: An overview

Murray Darling Depression
6,356,100 ha

The Murray Darling Depression is the largest bioregion in Victoria. It is located in the north west of the State. This area is largely influenced by its mean annual rainfall which varies between 250 and 400 mm. The flat to gently undulating landscape is largely composed of sandy soils, heavy clay or rocky calcareous soils. *Eucalyptus dumosa* is the most widespread of all Mallee trees in the Murray Darling Depression. Several species of Eucalypt mostly between 5 – 8 metres tall dominate. Semi-arid woodlands, mallee shrublands, heathlands and savanna woodlands are all present throughout the region.

Mallee trees. Credit: DEPI

Naracoorte Coastal Plain
421,400 ha
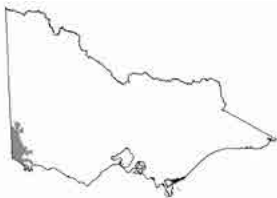
This broad coastal plain of tertiary and quaternary sediments is located almost exclusively in Victoria's south-west corner. Young volcanos, closed limestone depressions and a regular series of calcareous sand ridges are separated by inter-dune swales which characterise this bioregion. At a relatively low elevation (between 0 – 200 metres above sea level) this coastal expanse includes several vegetation types including heathland, grasslands, coastal scrub and saltmarsh. Parks Victoria manages both the Lower Glenelg National Park and Discovery Bay Coastal Park within this region. Discovery Bay Coastal Park in particular protects 55 kilometres of ocean beach, huge rolling sand dunes, freshwater lakes and swamps where coastal wildlife and vegetation thrive in this remote part of south-west Victoria.

Lower Glenelg National Park. Credit: Parks Victoria

NSW South West Slopes
565,900 ha

Throughout the New South Wales South West Slopes bioregion, located in north-east Victoria, large expanses of vegetation have been cleared for agriculture. The most common vegetation classes are wet sclerophyll forests, peppermint forests and Box-Ironbark woodlands. The region comprises the lower inland slopes of the Great Dividing Range through southern New South Wales to western Victoria. Annual rainfall is varied, ranging from 500 mm to over 1000 mm.

Credit: DEPI

Victoria's Bioregions: An overview

Riverina
2,507,900 ha

The Riverina bioregion in northern Victoria is characterised by the regular flooding of major river systems. Located predominantly around the border of Victoria and NSW, the Murray River has provided essential habitat for several flora species in the Riverina bioregion, including River Red Gum and black box forest, box woodlands, saltbush shrublands, extensive grasslands and swamp communities. The Barmah National Park has a large focus on protecting low lying areas around the Murray River, essential habitat for both native and migratory species of national and international significance.

The Riverina bioregion has the highest occurrence of River Red Gums (*Eucalyptus camaldulensis*) in Victoria, with the majority occurring along the channels and floodplains of inland waterways, principally the Ovens, Goulburn and Murray Rivers. The largest areas are the Barmah Forest and Gunbower Island, both on the Murray River. River Red Gum forests often occur in 'pure stands' meaning they are the only tree species in the forest; this generally is the case for areas that are subject to frequent flooding. In a well-watered forest the trees grow up to 45 metres tall with long, twisted trunks. In more open forest and woodland, the trees are often shorter, with thick twisted trunks and large branches.

Credit: Parks Victoria

South East Coastal Plain
1,749,600 ha

The South East Coastal Plains (SCP) are made up of undulating Tertiary and Quaternary coastal plains and scattered hinterlands. The nutrient deficient soils over low calcareous dune formations and a distinctive cliff coastline are typical of this environment. East of Warrnambool the SCP is characterised by deeper soils of volcanic origin overlying stream dissected limestone. The Otway plain – the central region of this bioregion includes coastal plains, river

valleys and foothills. The eastern part (the Gippsland Plain), includes lowland coastal and alluvial plains – characterised by generally flat to gently undulating terrain. Vegetation includes lowland open forests with shrubby or heathy understoreys, grasslands and grassy woodlands. Heathlands, shrublands, freshwater and coastal wetlands, mangrove scrubs, saltmarshes, dune scrubs and coastal tussock grasslands are all present throughout this region.

Lakes Entrance. Credit: DEPI

Victoria's Bioregions: An overview

South East Corner
1,395,400 ha

The South East Corner bioregion covers about 1.3 million hectares in south east Victoria, much of which is public land. The classification is characterised by deeply dissected near coastal ranges composed of Devonian granites and Palaeozoic sediments, inland of a series of gently undulating terraces (piedmont downs) composed of Tertiary sediments and flanked by Quaternary coastal plains, dunefields and inlets. High elevation woodlands, wet and damp sclerophyll forests interspersed with rain-shadow woodlands in the Snowy River Valley. At lower elevations, vegetation consists mainly of lowland and coastal sclerophyll forests, woodlands, warm temperate rainforest and other coastal vegetation communities.

The Snowy River. Credit: Alison Pouliot

South East Highlands
3,178,700 ha

The South Eastern highlands (SEH) bioregion includes some of Victoria's most heavily vegetated land. The majority of vegetation within this region comprises of wet and dry sclerophyll forest, woodland, minor cool temperate rainforest, minor grassland and herbaceous communities. Wet Sclerophyll forest can often reach heights greater than 75 metres making this the tallest of all forested ecosystems within Victoria. The other dominant vegetation class within the SEH is Dry sclerophyll forest, requiring on average, 550 – 1000 mm of rain annually. These forests consist of multiple tree species including a mixture of Stringybarks, boxes and peppermints. Areas receiving higher rainfall and falling into the wet sclerophyll forest category have a higher occurrence of species such as *Eucalyptus regnans* (Mountain Ash). This species of Eucalypt is found in high abundance in Victoria's Central Highlands (east of Melbourne), the Otway Ranges and Strzelecki Ranges in Gippsland. These trees occur in deep soiled areas generally up to 1,000 metres above sea level, that have high rainfall.

Mountain Ash is an evergreen tree with a slight grey trunk which is smooth barked for the most part, they are one of the tallest tree species in the world, some growing to in excess of 110 metres. This makes them the tallest flowering plant in the world. They grow very quickly, at a rate of more than a metre a year and can reach around 65 metres in 50 years and in most cases require fire to regenerate.

Giant mountain ash trees, Black Spur Range, Victoria.
Credit: Bob Beale

Victoria's Bioregions: An overview

Victorian Midlands
3,468,900 ha
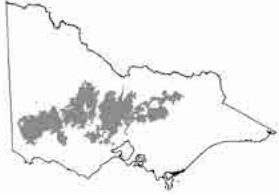
The Victorian Midlands bioregion extends west from the foothills of the Great Dividing Range, encompassing much of central Victoria and almost entirely within the Victoria Goldfields. Box-Ironbark forests were heavily modified during the gold rush years 1851 – 1870. Several eucalypt species are found throughout including Yellow Box (Eucalyptus goniocalyx), White Box (Eucalyptus polyanthemos) Red Ironbark (Eucalyptus tricarpa) and Red Stringy Barks (Eucalyptus macrorhyncha). The trees found in Box-Ironbark forests are amongst the most prolific flowering eucalypts, and as a consequence they attract an array of bird life and have been supporting the honey industry for nearly a century.

Mature Ironbark woodland. Credit: Peter Kinchinton

Victorian Volcanic Plain
2,356,000 ha

Located in South West Victoria exists an undulating basaltic plain with extensive open areas of grasslands and small woodland patches. Long extinct volcanoes dot the landscape as well as numerous scattered large shallow lakes (salt and freshwater) with extensive wetland systems. Of the 2.3 million hectares much of this has been modified for agricultural use however native grasslands dominated by kangaroo grass are still present throughout.

Credit: DEPI

Themes

Environmental

Social

Economic

Governance and law

Nolans Creek. Credit: Alison Pouliot

Environmental

The following values are reviewed in detail under the environmental theme of this report:

- Forest biodiversity
- Ecological processes and productivity within forest ecosystems
- Forest ecosystem health and vitality
- Forest soil and water resources and river health
- Carbon cycling in forests and forest products
- Reuse and recycling of forest products.

Forest biodiversity

Biodiversity refers to the variety of different plants, animals and microorganisms, the genes they contain, and the ecosystems they form.

Forest ecosystem diversity

Victoria's eleven bioregions showcase the wide diversity of Victoria's natural landscape characteristics including geology, landforms, climate, ecology and plant and animal communities. Understanding the extent, geographic distribution, major forest types and growth stages of Victoria's forests underpins the effective management of forest ecosystems, delivered through the development of appropriate legislation and policies, effective monitoring of forest condition, and assessment of forest management outcomes. Forest ecosystems need to support living organisms to reproduce, whilst also being adaptable and capable of self-regeneration in response to disturbance events such as storms, flood and fire. Forest management builds upon the natural ecological components and processes whilst carefully managing human disturbance.

Indicator reports provide data on Victoria's forest area by type and growth stage, and consider land tenure and forest areas that are included in protected conservation reserves. Different land ownership and management structures can affect forest ecosystems in different ways, and data on land tenure can therefore provide information on the extent of protection, clearing, fragmentation or other alterations. Fragmentation of native forest is also monitored as a measure of the effects of various kinds of natural and human disturbance on forest ecosystems.

Species diversity in forests

Knowledge of plant, animal and other species present in a forest is a pre-condition for effective forest management. Information on whether populations of species are increasing or decreasing can indicate the extent and condition of forest habitat and changes in habitat, and is necessary to support conservation strategies. A number of forest-dwelling and forest-dependent species and forest ecosystems are listed as threatened on lists compiled by Victoria and nationally. Knowledge of the threats and threatening processes faced by listed species and ecosystems assists in their protection by forest managers.

Genetic diversity in forests

If not managed appropriately, the harvesting and regeneration of forests over successive generations may reduce their genetic diversity. It is important to ensure that, in making forests available for commercial or other use, the genetic diversity that helps ensure rapid growth, quality wood, resistance to disease and pests and adaptation to climate change is maintained.

Credit: DEPI

Indicators

1.1a: Area of forest
1.1b: Forest growth stage
1.1c: Forest protected zones
1.1d: Forest fragmentation
1.2a: Forest dependent species
1.2b: Indicator species habitat
1.2c: Indicator species monitoring
1.2d: Invasive species
1.3a: Forest species at risk
1.3b: Species conservation
2.1: Timber area available
2.2: Timber volume available
2.3: Wood production
2.4: Non-wood production
2.5: Timber harvest regeneration
3.1: Forest health and vitality
3.2: Human-induced disturbance
4.1: Soil risk
4.2: Forested catchment water yield
4.3: Forested catchment river health
5.1: Forest biomass and carbon
5.2: Global greenhouse gas contribution
6.1d: Wood products reuse and recycling

Environmental

Ecological processes and productivity within forest ecosystems

The maintenance of ecological processes is vital to ensure productive capacity of native and plantation forests over time. This will ensure the provision of forest goods and services required by society today, without compromising the ability of future generations to meet their own needs. Maintaining the productive output of forests requires, among other things, forest regeneration and the maintenance of ecosystem health. Indicator reports set out information on the area of native forest available and suitable for wood production and the size of the plantation resource, the volumes of wood harvested against sustainable harvest levels, the regeneration and re-establishment of harvested native forest and plantations, and the types of non-wood forest products extracted.

Forest ecosystem health and vitality

Monitoring forest health and vitality is important because any decline may have significant economic and ecological consequences for society including a loss of forest benefits and the degradation of environmental quality. A range of natural and human-caused disturbances may affect the health and vitality of forests. In Victoria's forests these include fire, invasive plants, animal pests, fungal pathogens, drought, floods, storms and climate change.

Forest soil and water resources and river health

Good quality forest soil and water resources provide enormous value to society, and underpin ecosystem services such as drinking water. Healthy forests are vital to protect soil and water resources that are required to maintain terrestrial and aquatic ecosystems within and downstream of forests.

Soil, water and topography and their interaction influence the characteristics and health of streams and rivers flowing through and away from forests. Monitoring changes in the chemical, physical, and biological characteristics of soil, water and aquatic systems provides valuable information to support sustainable forest management.

Carbon cycling in forests and forest products

Forests are an important component of the global carbon cycle, and maintaining or increasing forest carbon stocks is a key indicator of sustainable forest management. Managed forests contribute to the global carbon cycle through storage of carbon in wood and wood products in service and, at the end of these products' service life, in landfill.

Reuse and recycling of forest products

Rising global and national demands for forest products have led to calls for greater reuse and recycling. Considerable quantities of wood-based forest products, such as structural timbers, pulp, paper and sawmill residue, are recycled in Victoria.

Credit: DEPI

Indicators

1.1a: Area of forest
1.1b: Forest growth stage
1.1c: Forest protected zones
1.1d: Forest fragmentation
1.2a: Forest dependent species
1.2b: Indicator species habitat
1.2c: Indicator species monitoring
1.2d: Invasive species
1.3a: Forest species at risk
1.3b: Species conservation
2.1: Timber area available
2.2: Timber volume available
2.3: Wood production
2.4: Non-wood production
2.5: Timber harvest regeneration
3.1: Forest health and vitality
3.2: Human-induced disturbance
4.1: Soil risk
4.2: Forested catchment water yield
4.3: Forested catchment river health
5.1: Forest biomass and carbon
5.2: Global greenhouse gas contribution
6.1d: Wood products reuse and recycling

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Social

Ensuring forests are managed in ways that provide good social benefits and outcomes, is a key element of sustainable forest management. This goal has been adopted into forest management policies and practices in Victoria.

The concept of social sustainability refers to maintaining and enhancing the forest to allow for social benefits derived from forest uses, whilst maintaining options for future generations. Forest use activities are considered socially sustainable when they conform to ethical values and social norms, uphold human rights, and do not exceed the broader community's tolerance of perceived damage or change (community resilience).

Credit: DEPI

Recreation and tourism

One of the most common social interactions that the community has with Victoria's forests comes through tourism and recreational activities. Victorian forests provide a magnificent playground for people to undertake a wide range of activities including walking, running, riding, cycling, fishing, picnics, snow and water sports, and rock climbing. Popular activities such as bushwalking allow people to observe unique wildlife and flora values, and the natural scenic attractions on offer.

Forest managers provide a wide range of facilities for the community, such as roads and tracks for vehicles. Roading provide the dual benefit of access for forest management and fire suppression activities, but also increases the area available for recreation and tourism. This access has helped to increase the popularity of activities such as motor bike and four-wheel driving which are used across the network of forest roads and some permitted trail areas. Other facilities, such as walking or riding tracks, picnic sites and campgrounds are also highly valued.

Cultural heritage

Ensuring appropriate protection of the cultural and heritage values contained in the forest areas is a further important consideration under social sustainability. Preserving the collective endowment of knowledge, wisdom, cultural practices and related environmental assets that may be valued by both Aboriginal and other members of the community is important to ensure information can be handed down from one generation to the next.

Many sites in Victoria provide evidence of previous forest use and historical activities, and these can provide insight into the interactions between people and the forests. Such heritage sites may provide a wide range of historical, education, research, aesthetic and cultural values.

Credit: DEPI

Indicators

6.3a: Recreation and tourism area

6.3b: Recreation and tourism opportunities

6.3c: Recreation and tourism visitors

6.4a: Area of indigenous access and rights

6.4b: Cultural heritage values

6.5c: Forest dependant community resilience

6.5d: Forest dependent indigenous community resilience

6.5e: Indigenous cultural and spiritual access

Social

Community resilience to change

Forestry provides direct socio-economic benefits through employment and support for regional communities. Certain regional communities have a high level of dependence on such benefits for their on-going wellbeing. A reduction in harvesting of native forests, lower investment in new plantations, reduced demand for wood products, and structural changes and closure of some milling and manufacturing facilities, can have a significant impact on forest dependent communities. The magnitude of social impacts depends on factors such as community size, structure, location and history.

Aboriginal peoples and forest values

Aboriginal peoples may have a special affinity with certain forest values, which provide for a range of cultural, social and economic requirements. Forest management activities aim to provide an acceptable level of accountability for the protection of Aboriginal peoples' values. Access, management and ownership are key parts of the relationship of Aboriginal peoples with land and forests. The Victorian Government has been working to increase the level of participation of Traditional Owners in the management of forest areas, such as through entering into agreements with Traditional Owner groups for public forests that form part of their traditional land. (See Case Study: *"Gunaikurnai Traditional Owners Settlement Agreement"*.

Credit: DEPI

Indicators

6.3a: Recreation and tourism area

6.3b: Recreation and tourism opportunities

6.3c: Recreation and tourism visitors

6.4a: Area of indigenous access and rights

6.4b: Cultural heritage values

6.5c: Forest dependant community resilience

6.5d: Forest dependent indigenous community resilience

6.5e: Indigenous cultural and spiritual access

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Economic

Forests provide a range of economic benefits including those derived through income, employment, and various goods and services. 'Goods' are material benefits from managed forests including wood, fibre, water, genetic resources and bio-chemicals. 'Services' are the broad range of beneficial outputs derived from ecosystem functions including 'regulating' services benefiting water purity, soil stability, air quality and climate amelioration; 'cultural' services benefiting aesthetic and social experiences, and amenity through recreation and tourism; and, 'supporting' services such as pollination, nutrient and carbon cycling that in turn benefit the sustainable production of other ecosystem services.

The concept of economic sustainability requires that the mixture of forest uses be optimised with due consideration of appropriate environmental constraints (see Environmental Theme). It requires that benefits to society from the extraction of forest resources exceed the costs incurred, and allow some form of equivalent capital to be handed down from one generation to the next. Put simply, today's use of the forest must not prevent similar uses, or permanently exclude other different uses, for future generations.

Production and consumption

Products from forests provide employment in harvesting, transport, and processing, incomes to landholders and businesses, and revenues for government. By purchasing timber from forests that are certified to sustainable forest management standards, consumers invest not only in the products themselves, but also in maintaining a range of longer-term benefits and services provided by the forests, including carbon sequestration and forest regeneration.

Analysis of trends in the value of wood and wood products derived from harvesting Victoria's forests enables an assessment of the economic benefits. Consumption trends of domestically produced and imported products including sawn timber, wooden panels, pulpwood, woodchips, paper, cardboard and fibreboard, provides a measure of the capacity of the forest and wood-processing industries to meet society's demand, and demonstrates the industry's contribution to the economy.

Investment in the forest sector

The level of investment and expenditure in developing, maintaining and obtaining goods and services from native forests is a measure of the economic commitment to forest utilisation and management. Establishment of new plantations and re-establishment of harvested plantations, are indicators of investment in future wood availability over and above that provided by native forests. Investment in education, research and development and new or improved technologies leads to improvements in forest management and industry practices.

Employment in the forest sector

Employment is considered as a socio-economic factor that provides an important measure of the contribution of forests to both viable and resilient communities (see Social Values Theme) and the Victorian economy. The forestry industry creates employment throughout rural and urban Victoria. Victoria's forest and forest products industries maintain their wage rates and workforce health and safety levels at rates that are comparable with national averages for similar occupations.

Ecosystem services

Victoria's forests provide multiple production and environmental benefits for forest industries and the wider community while playing a key role in maintaining ecosystem services. Markets or other economic mechanisms exist for some of these forest-based services providing monetary value as well as social and environmental benefits.

Hives in box woodland.
Credit: DEPI

Indicators

6.1a: Value of wood products
6.1b: Value of non-wood products
6.1c: Ecosystem services
6.1d: Wood products reuse and recycling
6.2a: Forest management investment
6.2b: R&D investment and education
6.2c: New and improved technologies
6.5a: Forest sector employment
6.5b: Forest sector wage and injury rates

Governance and Law

Ensuring continuous improvement in sustainable forest management requires good governance that is supported by an appropriate framework of laws, regulations and guidelines. Good governance principles also promote transparency and public participation in policy and decision-making processes.

The purpose of the legal framework is to provide for multiple aspects of forest management and administration including:

- Protection and conservation of forests

- Bushfire response and emergency management

- Protection of flora and fauna species

- Regulation of forest clearing on private land and sustainable wood harvesting

- Protection of cultural heritage values

- Management of forest fuel loads (bushfire management)

- Public access and participation (e.g. recreation)

- Regular planning and review processes and activities

- Occupational health and safety.

Victoria's legal framework for forest management includes legislation and regulations that clarify property rights, highlight state and regional agreements, encourage periodic planning and review, provide guidance to forest users and land managers through various codes of practice, and allow for public participation.

State and local governments, statutory authorities and regional management authorities administer this legal framework, which varies according to land tenure. A government department (DEPI), a statutory authority (Parks Victoria) and a state-owned business (VicForests) manage forests that occur on the public land estate. Private landholders manage private forests and plantations under regulations administered by Local Government Authorities.

Managing risks to natural values

Natural values in timber production areas are protected through Victoria's regulatory system including the Regional Forest Agreements (RFAs). The Comprehensive, Adequate and Representative (CAR) Reserve System has been established to control the distribution and extent of timber harvesting, and environmental guidelines and prescriptions have been established to retain wildlife habitat, protect waterways and soil, and appropriately regenerate forests.

Several instruments were reviewed during the reporting period. A new requirement was introduced to assess risk to natural values in both the emergency stabilisation and recovery phases of bushfire response in the *Code of Practice for Bushfire Management on Public Land 2012*. At the time of publication, the *Code of Practice for Timber Production 2007* is currently under review.

Aboriginal peoples' participation

Mechanisms that support participation of Aboriginal persons in Victoria's sustainable forest management decision-making process have increased during the reporting period. These mechanisms reflect legislative requirements for Traditional Owners to participate in heritage management as provided under the *Indigenous Partnerships Framework*. More recent forest management plans contain strategies involving partnerships with indigenous communities. DEPI introduced the *Indigenous Partnerships Framework* in 2007. At the time of publication, this policy is under review to ensure it is aligned with the *Victorian Aboriginal Affairs Framework 2013 – 2018*.

Credit: DEPI

Indicators

4.1: Soil risk
6.6a: Native title rights
7.1: Legal framework
7.2: Institutional framework
7.3: Economic framework
7.4: Monitoring capacity
7.5: R&D capacity

Criteria

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Criterion 1: Conservation of biological diversity

Criterion 2: Maintenance of productive capacity of forest ecosystems

Criterion 3: Maintenance of ecosystem health and vitality

Criterion 4: Conservation and maintenance of soil and water resources

Criterion 5: Maintenance of forest contribution to global carbon cycles

Criterion 6: Maintenance and enhancement of long term multiple socio-economic benefits to meet the needs of societies

Criterion 7: Legal, institutional and economic framework for forest conservation and sustainable management

Criterion 1: Conservation of biological diversity

Conservation of biological diversity is recognised by the Montreal process as the first of seven pillars of sustainable forest management. Sustainable forest management is essential for the conservation of Victoria's forests and the biodiversity they contain.

Biological diversity is usually considered at three hierarchical levels: ecosystem diversity, species diversity within ecosystems and genetic diversity within species. Ten indicators are used to assess the conservation of biological diversity in Victoria's forests. They are divided into three elements matching the three levels of biological diversity.

Ecosystem diversity
(Indicator reports 1.1a – 1.1d)

Indicators in this element report the area of public native forest by extent, type, tenure and growth stage and report on how much area has been placed in reserves of various kinds. Fragmentation is monitored as a measure of the effects of natural- and human-caused disturbance on forest ecosystems with results based on the five categories of fragmentation – interior, patch, transitional, perforated and edge – defined in Indicator 1.1d. Similar kinds of information about native forests on private land are not able to be included, as there are no comprehensive data available. However, change in Victoria's forest extent across both private and public land tenures over the period 1988 to 2013 is reported. Between 2008 and 2012, DEPI remapped the Victorian public land management (tenure) base layer, refining its scale from 1:100,000 to 1:25,000. This improvement in the precision and accuracy of boundaries resulted in some change to area estimates.

Victoria has about 8.2 million hectares of forest across both Crown and private land in 2013. About 6.3 million hectares (75%) is in State forest and Parks and conservation reserve. Between 1988 and 2013, forest cover has increased or remained the same across all 11 Victorian bioregions[1]. The South East Highlands is the most forested bioregion in Victoria with about 2.5 million hectares. Eucalypts make up the vast majority of Victoria's public forest types. Mixed and other forest types, which include casuarina, callitris, acacia, melaleuca, rainforest and mangrove, make up less than 10% of Victoria's total public native forests.

Across all public forests (State forest and Parks and conservation reserves), there are approximately 1.4 million hectares of tall (height > 30 metres) open eucalypt forest and 1.7 million hectares of medium (height 10 – 30 metres) open eucalypt forest. Tall and medium open eucalypt forests make up almost 60% of the forest area in Victoria's State forest. There are about 800,000 hectares of non-forest land within State forest and Parks and conservation reserves, with the majority (90%) in the latter.

In 2011/12, there were 434,000 hectares of industrial hardwood and softwood plantations in Victoria, up from 319,000 hectares in 2000. Hardwood plantations (mostly blue gum) covered 207,000 hectares (47% of plantations) while softwood plantations (mainly radiata pine) covered 226,000 hectares (52%). The rate of new plantation establishment has been declining rapidly since 2000.

Forest height class by forest type in Victorian native public forests is reported for the year 2009 as a proxy for growth stage, since growth stage is difficult to measure directly. Medium and tall (height > 10 metres) eucalypt forests make up 78% of native forest, covering an area of 4.3 million hectares across Victoria's State forest and Parks and conservation reserves.

[1] refer Indicator report 1.1a

Credit: Christian Pearson

Indicators

1.1a: Area of forest
1.1b: Forest growth stage
1.1c: Forest protected zones
1.1d: Forest fragmentation
1.2a: Forest dependent species
1.2b: Indicator species habitat
1.2c: Indicator species monitoring
1.2d: Invasive species
1.3a: Forest species at risk
1.3b: Species conservation

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Over the six year period (2006 to 2012), the total area of Victoria's formal and informal reserves increased by 2% (from about 4.66 to 4.74 million hectares). Terrestrial IUCN protected areas make up about a fifth of Victoria's land. Covering 2.4 million hectares, category II (National Parks) make up more than half of the total area of IUCN protected areas in Victoria, followed by categories Ib (Wilderness areas) and Ia (Strict Nature Reserve) — 21% and 10% of IUCN protected areas respectively. Between 2004 and 2012, there has been an 8% increase in the extent of IUCN protected areas in Victoria (from about 3.55 to 3.86 million hectares). Over this period, the area of IUCN category II (National Parks) increased by 11% and category Ia (Strict Nature Reserve) by 9%. In 2012, forest cover was about 85% for both these categories.

Seventy-six per cent of Victoria's forest cover is classed as interior (i.e. core, non-fragmented forest) and 14% as edge, representing the boundary between interior forest and non-forest land cover. Most of Victoria's interior forest is located in the eastern part of the state. Australian Alps (93%), South East Corner (91%) and South East Highlands (87%) bioregions have the highest proportion of interior forest cover. Riverina bioregion has the lowest proportion of interior forest cover (27%) and also the highest proportion of forest patches (24%). Flinders and South East corner bioregions have the lowest degree of landscape division, indicating a very low degree of forest fragmentation. Riverina and Victorian Volcanic Plains bioregions have the highest degrees of landscape division and contain the lowest proportion of forest cover (8% and 7% respectively). These bioregions also have the smallest average forest patch sizes and a high degree of fragmentation. They also have the smallest average core sizes (5.9 and 7.9 hectares respectively). Victorian Midlands and Murray Darling Depression bioregions contain the largest number of forest patches (about 29,000 in each).

Species diversity
(Indicator reports 1.2a – 1.2d)

Indicators in this element identify forest-dwelling species, the level of information to support conservation strategies, and the role of forest management in protecting vulnerable and threatened species. Data are for public forest. Information for private forests is not available. Coverage includes number and type of forest dependent species by conservation status listed in DEPI Advisory Lists for plants, vertebrate fauna and invertebrate fauna, reported by year; diversity of forest structure types by forest type and diversity of plant species by forest type; number and proportion of invasive, exotic, forest-associated weed species to total species; and, occurrence of priority pest species (insects, pathogenic fungi and animals).

There are currently 461 forest dependent species that are considered to be rare or threatened in Victoria. Vascular plants represent by far the greatest proportion of these, most probably because of greater knowledge and awareness of vascular plants within the scientific community, and their relative ease of detection. DEPI has not reviewed plant conservation status during the reporting period, hence there are no changes to report.

DEPI released the first issue of the Advisory List for invertebrate fauna in 2009. Thirty-four forest dependent invertebrates are listed as threatened. These are predominantly crayfish and aquatic insects including stonefly, damselfly and caddisfly. Freshwater crayfish and butterflies are the only 2 of 33 invertebrate phyla considered comprehensively assessed for conservation status in Victoria.

DEPI issued a revised Advisory List of threatened vertebrate fauna in Victoria in 2013. The total number of forest dependent vertebrate fauna considered to be rare or threatened decreased by 2 species during the reporting period. The conservation status of 18% of rare and threatened vertebrate

Credit: Kuba

Indicators

1.1a: Area of forest
1.1b: Forest growth stage
1.1c: Forest protected zones
1.1d: Forest fragmentation
1.2a: Forest dependent species
1.2b: Indicator species habitat
1.2c: Indicator species monitoring
1.2d: Invasive species
1.3a: Forest species at risk
1.3b: Species conservation

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fauna species changed with the revised Advisory List. Fourteen per cent of species became more threatened. These were mostly amphibians and reptiles. Four per cent of species became less threatened.

The ability of indicator species to provide a reliable view of overall forest dependent biodiversity is not well established. Victoria has not as yet identified suitable indicator species for monitoring. Reporting the diversity of habitat structures derived from the Victorian Forest Monitoring Program (VFMP) life form categories has been adopted as an alternative way to monitor habitat available for forest dependent biodiversity. The Australian Alps, Victorian Midlands and South Eastern Highlands bioregions have the greatest overall species diversity at the landscape scale. Nine of the 11 bioregions have a higher number of species represented at a local site (plot) scale meaning that the species diversity and richness were greatest at plot level. In the Riverina bioregion species diversity among plots was greater than within plots.

Overall 115 weed species were recorded across Victorian public forests through the VFMP ground plot program. The Riverina bioregion has by far the highest number and proportion of weed species in the State. An estimated 87 weed species occur in this bioregion, representing 26% of the total flora diversity.

DEPI works closely with industry and state government and local government agencies to develop and conduct ongoing, targeted forest health surveillance programs for established and exotic pests and pathogens. Forest health surveillance programs include road-side surveys, plot monitoring, diagnostic surveys, aerial surveys and pest/pathogen reports from the community. Annual distribution and impact of 29 common insects and pathogens is tabulated in Indicator 1.2d. Cup moth has become a major pest in native forests since 2010/11. Significant infestations have, at some locations, entirely defoliated large areas of native forest, and outbreaks have been widespread across the state. Natural predators have not kept up with increased populations. No control programs have been undertaken. New areas of Phytophthora have been identified since the drought broke in 2010. New hygiene protocols to reduce the spread of the pathogen are being investigated using the DEPI statewide model for Phythophthora risk and impact map. Septoria leaf blight has become a significant pathogen in shining gum plantations in Victoria in both juvenile and adult foliage. This is a result of three warm and wet summers providing conditions conducive to disease development. Outbreaks appear to be localised but the pathogen was found across many plantation sites. Populations of Monterey pine aphid increased across Victoria prior to 2010, then collapsed when the drought broke. Populations increased again over the spring and summer of 2012-13 due to a reemerging significantly dry weather pattern. Defoliation levels have decreased or remained the same as for previous years. Myrtle rust – a serious fungal disease that affects plants in the Myrtaceae family – was first identified in Victoria in December 2011. The arrival of Myrtle rust in Victoria was via infected nursery stock from interstate. As at 30 December 2013 Myrtle rust has been detected at 83 sites, including production nurseries, wholesale nursery outlets, private residences and public parks in metropolitan Melbourne, the Mornington Peninsula, Shepparton, Ballarat and near Bairnsdale. A total of 18 Victorian species of Myrtaceae have been found to be susceptible to infection so far.

Pest animals are a major concern for public land managers. In 2012/13, around 1.1 million hectares of the conservation estate were treated for the control of pest animals. The majority (1 million hectares) of this was in areas prescribed under the *National Parks Act 1975*. Species targeted include cats, rabbits, goats, pigs, foxes, deer, horses and feral cattle.

Indicators

1.1a: Area of forest
1.1b: Forest growth stage
1.1c: Forest protected zones
1.1d: Forest fragmentation
1.2a: Forest dependent species
1.2b: Indicator species habitat
1.2c: Indicator species monitoring
1.2d: Invasive species
1.3a: Forest species at risk
1.3b: Species conservation

Credit: Kuba

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Genetic diversity
(Indicator reports1.3a and 1.3b)

It is not possible to report against Indicator 1.3a at the present time, as there is currently no comprehensive information on the number of forest dependent species at risk from isolation. DEPI works to mitigate the risk of forest dependent species isolation in a number of ways: including captive breeding programs and plant cultivation, collection and storage of reproductive material, maintenance of plant collections and translocated captive populations (Indicator 1.3b); forest planning, including effective forest management zoning (Indicator 2.1); maintaining a comprehensive, adequate and representative (CAR) reserve system (Indicator 1.1c) to provide an integrated network of forest conservation areas across Victoria; and, adopting standards for forest coupe regeneration after harvesting, whereby only local or genetically similar seed is used (Indicator 2.4).

Indicator 1.3b presents the numbers of conservation efforts undertaken for forest dependent rare and threatened species (see Indicator 1.2a) by category across all land tenures in Victoria. The number of conservation efforts for forest dependent species completed or partially completed ranged from approximately 1,800 in 2008/09 to 2,100 in 2010/11.

The number of efforts varied according to population needs, action timing and resource availability. Managing threats and habitat, monitoring and assessment are the most common activities, representing approximately 60% of conservation efforts in any one year, whilst policy, population manipulation and captive management are the lowest, representing around 1 to 5% of the total number of efforts. These statistics should be interpreted with caution, as they do not reflect the overall amount of work associated with each effort. For example, the entire annual captive breeding effort for Eastern Barred Bandicoot is represented in the same way as a single day spent assessing a Marsh Leek Orchid population. The proportion of different types of action is stable between reporting periods. The most commonly undertaken threat management activities during the reporting period were pest animal control, management to prevent habitat loss and fragmentation, and fire management (largely ecological burning) comprising 6, 5 and 4% of all actions respectively. Approximately 90% of conservation efforts are undertaken by government agencies. Committees of management, local government, research institutions, conservation organisations, private companies and landowners are responsible for the remainder. A total of 78 flora and 83 fauna species were subject to conservation efforts over the reporting period. Of these, 92% are on the *Flora and Fauna Guarantee Act 1988* Threatened List.

Credit: Kuba

Indicators

1.1a: Area of forest
1.1b: Forest growth stage
1.1c: Forest protected zones
1.1d: Forest fragmentation
1.2a: Forest dependent species
1.2b: Indicator species habitat
1.2c: Indicator species monitoring
1.2d: Invasive species
1.3a: Forest species at risk
1.3b: Species conservation

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Criterion 2: Maintenance of productive capacity of forest ecosystems

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The productive capacity of forests is recognised under the Montreal process as the second of seven pillars of sustainable forest management. Both the level of timber production and maintenance of ecosystem health and vitality (Criterion 3) are important considerations, as timber production conducted without consideration for ecosystem health and vitality may lead to unsustainable outcomes.

Five indicators are reported on under this criterion. They set out information on the area and percentage of forest available for wood production (Indicator 2.1), the available volume of wood and annual production of wood products compared to sustainable harvest levels (Indicators 2.2 and 2.3), the annual production of non-wood products (Indicator 2.4), and the regeneration of harvested native forest (Indicator 2.5). The extensive estate of native forest that occurs on private land is not reported on because there are no comprehensive data available on wood production from these areas. Plantation data are reported in Indicator 1.1a.

Area of forest available for wood production

Areas available for wood production are split between the western and eastern parts of the State. The area currently available and suitable for timber production in western Victoria is approximately 100,000 hectares while the area available and considered suitable for harvesting by VicForests in eastern Victoria is about 800,000 hectares. The area of State forest zoned as available for wood production in Victoria decreased by 7% between 2006 and 2012, mainly associated with the tenure reclassification of about 196,000 hectares of land from State forest into Parks and conservation reserves.

Source DEPI

Credit: DEPI

Indicators

2.1:   Timber area available

2.2:   Timber volume available

2.3:   Wood production

2.4:   Non-wood production

2.5:   Timber harvest regeneration

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Criterion 2: Maintenance of productive capacity of forest ecosystems

Area of timber harvesting

The area of State forest harvested between 2006/07 and 2011/12 ranged from 7,900 to 11,600 hectares per year. The area harvested represents (on average) less than 1% of the total area available for harvesting. The area of clear fall harvesting ranged from 1,500 hectares in 2011/12 to 2,900 hectares in 2007/08. Between 2006/07 and 2010/11 at least a quarter of clear fall activity was undertaken as salvage harvesting in areas burnt by bushfires (Indicator 3.1).

Volume of wood harvested

Between 2006 and 2012, an average of 1.8 million cubic metres of wood products was harvested annually from Victoria's State forests. An average of 391,000 cubic metres of sawlogs was harvested each year over the period, which was 195,000 cubic metres less than the previous average (2001 to 2006) and 377,000 cubic metres less than the 1996 to 2001 average. Annual pulpwood extraction comprised approximately 68% (on average) of total wood volume harvested. This was down 8% from the previous reporting period.

Annual production of wood products from State forest (1996/97 to 2011/12)
Source DEPI
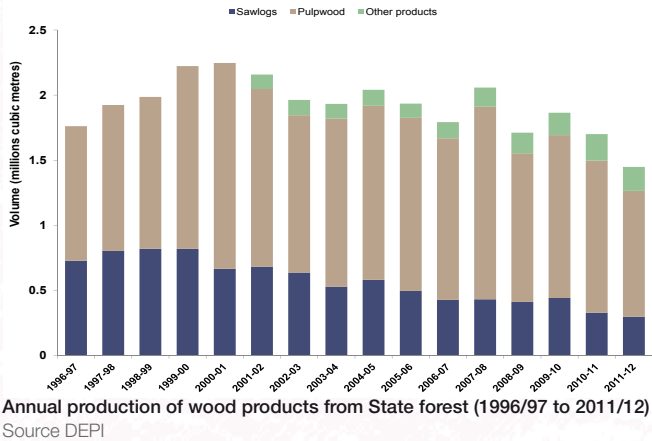
Firewood collection

There was a general decline in the volume of firewood collected over the period 2001 to 2011. The average annual volume of domestic firewood collected between 2006 and 2011 was 31,480 cubic metres, which was lower than the annual average of 50,234 cubic metres collected between 2001 and 2006. In September 2011, the Victorian Government firewood policy was implemented, which saw the cessation of the previous firewood collection license system.

Non-wood products

DEPI issues various types of licences for the extraction and harvest of non-wood products such as rock, sand, seed, honey, essential oils, bush foods, flowers and foliage on public land. Through the number and frequency of licences issued, trends in activity levels associated with the product are monitored. This information is reported through Indicator 6.1b.

Forest regeneration following harvest of wood products

DEPI and VicForests are both responsible for forest regeneration following completion of timber harvesting operations in public forests. Harvesting, managed by DEPI in western Victoria, under single-tree selection silviculture has been followed by almost 100 per cent regeneration success. The area of coupes successfully regenerated each year in eastern Victoria by VicForests increased over the reporting period from 1,620 hectares in 2007/08 to 6,320 hectares in 2011/12. As at 30 June 2012 VicForests was within 1,100 hectares (or 9%) of its target to have no more than three years harvest area not adequately regenerated at any point in time.

Credit: DEPI

Indicators

2.1: Timber area available
2.2: Timber volume available
2.3: Wood production
2.4: Non-wood production
2.5: Timber harvest regeneration

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Criterion 3: Maintenance of ecosystem health and vitality

Any potential decline in forest health and vitality can have significant ecological, social and economic consequences for society. These include loss of opportunity and associated forest-use benefits and the overall degradation of environmental quality. Forest health and vitality is recognised by the Montreal process as the third of seven pillars of sustainable forest management.

Indicators 3.1 and 3.2 report on impacts on ecosystem health and vitality in Victoria's forests. They describe the type, extent and severity of natural and human-caused disturbances in Victoria's forest ecosystems.

Tree canopy condition

This is the first Victorian State of the Forests Report to include detailed assessment of tree canopy condition. Data has been collected across Victoria's public forests to calculate the average percentage of tree mortality (19.5%), crown dieback (23.7%) and defoliation (18.2%). Mortality is particularly high in the Australian Alps and South Eastern Highlands bioregions. These are areas which are recovering from significant bushfires. The 'Alpine' fires in 2003, the 'Great Divide North and South' fires in 2006/07 and the 'Black Saturday' bushfires in 2009.

Whilst the proportion of dead stems in the Riverina is relatively low, the volume of dead wood is the highest for the state. This may be somewhat explained by the consistent drought conditions experienced. During this time, no overbank flooding occurred within the River Red Gum forests of the Riverina between 1997 and 2010. This resulted in severe reduction in forest productivity during the period.

Crown dieback and defoliation are particularly high in the Murray Darling Depression bioregion (38.4% and 32.8% respectively). This area was severely burnt in 2002 and suffered below average rainfall during the 1997 to 2010 drought.

Area and ignition source of bushfires

During the reporting period, Victoria experienced some of its worst recorded bushfire seasons, resulting from prolonged drought and extreme weather events. In total, almost 1.5 million hectares of Victoria's public forest was burnt in bushfires. Of this, lightning was responsible for igniting fires that account for 72% of the area burnt, but represent only 35% of the total number of fire ignitions.

There is significant variation in the total area of forest burnt by bushfire from year to year. This largely reflects the climatic conditions experienced leading up to and during the summer fire season. Two major bushfire events occurred during the reporting period, the 'Great Divide' and 'Black Saturday' fires. In 2006/07, the 'Great Divide North' and 'Great Divide South' bushfires burnt more than 1.2 million hectares, almost entirely in public forests. These fires ignited from multiple lightning strikes in remote areas in the Victorian Alps on 1 December 2006. These fires took over three months to control, with suppression crews hampered by difficult access, high temperatures and lack of rainfall.

The 'Black Saturday' fires occurred in February 2009. They caused substantial loss of human life, loss of private property, and affected approximately 430,000 hectares of both public and private land, including 287,000 hectares of public forest.

Credit: Alison Pouliot

Indicators

3.1: Forest health and vitality

3.2: Human-induced disturbance

Criterion 3: Maintenance of ecosystem health and vitality

Major bushfires (2003-2009)
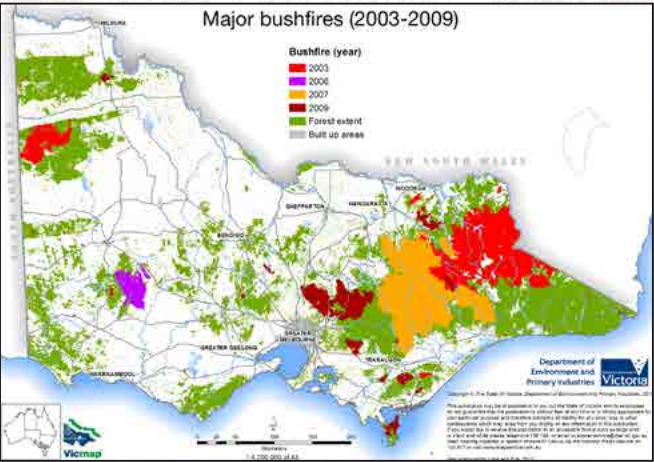
Source DEPI

Following both these fires, recovery teams sowed and planted over 7,000 hectares of fire-impacted State forest to re-establish alpine and mountain ash in areas where the forest was assessed to have inadequate natural seed crops. Major projects were also completed to assist threatened species recovery and prevent the spread of invasive species.

Over 10,000 hectares of alpine ash and snow gum forests in North East Victoria have been burnt three times within the past decade. Without human intervention to assist in regeneration, there is a risk that these alpine ash forests may convert to shrub or grasslands.

Climate

Rainfall

The first half of the reporting period concluded Victoria's longest period of sustained rainfall deficit on record. The state received, on average, 15% less rainfall during the 13-year drought from 1997 to early 2010. The most severe deficits occurred in the Wimmera, on the Great Dividing Range and in the area to the south of this range. Dry autumns were a particularly significant feature of the drought, extending traditional summer fire seasons and contributing to the extent and severity of fires. Rainfall in 2006 was 65% below average.

After the drought broke in January 2010, Victoria experienced its fifth wettest year on record. Rainfall in 2010 was 31% above average for Victoria, with most rain falling as summer storms. These storms caused extensive flooding throughout Victoria, bringing the first overbank flood events to the River Red Gum forests since 1997.

Temperatures

Victoria experienced its third hottest January to May period in 2007. Alpine areas experienced the most severe conditions. These abnormally dry and hot conditions contributed to the extent of the major 2006/07 'Great Divide' fires. In the summer of 2008/09 much of Victoria experienced the hottest conditions in over 70 years. On 7 February 2009, the hottest day on Victorian record combined with high winds drove the disastrous 'Black Saturday' bushfires.

Credit: DEPI

Indicators

3.1: Forest health and vitality

3.2: Human-induced disturbance

Biological Diversity

Productive Capacity

Ecosystem Health

Soil and water

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Socio-economic

Legal Framework

Criterion 3: Maintenance of ecosystem health and vitality

Human-induced disturbance

Forest management activities

Planned burning

Planned burning was the most extensive forest management activity conducted in Victoria's public forests during the reporting period. The total annual area of planned burning on public land increased from 138,000 hectares in 2006/07 to 255,000 hectares in 2012/13.
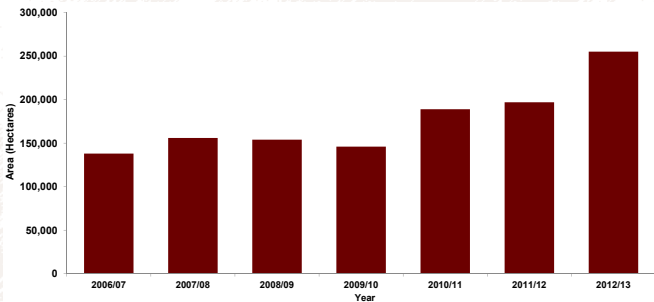
Area of planned burning (2006/07 to 2012/13). Source DEPI

The proportion of the public land estate burnt increased from an average of 0.9% in the previous reporting period to an average of 2.2% in the current reporting period. This increase reflects the Victorian Government's policy to increase planned burning. Planned burning is focussed within priority zones to reduce fuel loads and potential impacts of bushfires on human life, property and key community assets.

Regeneration burning conducted in certain forest types after timber harvesting has remained stable at between 2,000 and 3,500 hectares per year during the reporting period.

Road management

There are approximately 49,000 kilometres of roads within Victoria's public forests, used for a variety of public and operational purposes. Approximately 99% of the public forest road network is unsealed.

This road network requires ongoing maintenance to minimise sediment movement into waterways and maintain users' safety. During the reporting period, with the exception of 2011/12, road maintenance expenditure in public forests has remained stable at between $6-8 million per year. Road maintenance expenditure was increased in 2011/12 as a short-term initiative to improve roads that are strategically important for fire management purposes. This included extra maintenance activities on roads where bridges and crossings were upgraded or replaced. Capital expenditure on roads varied between $1-3 million per year.

Between 2009/10 and 2011/12, the Victorian Government invested $50 million in the Public Land Bridges project. This project replaced / upgraded 300 bridges and major crossings to ensure safe and effective access to forests, water catchments and other areas of public land across the state.

Credit: DEPI

Indicators

3.1: Forest health and vitality

3.2: Human-induced disturbance

Biological Diversity

Productive Capacity

Ecosystem Health

Soil and water

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Criterion 3: Maintenance of ecosystem health and vitality

Economic activities

Timber production

Forest health in timber production areas is managed through Victoria's regulatory system and implementation of the Regional Forest Agreements and the Comprehensive, Adequate and Representative Reserve System. The distribution and extent of harvesting is controlled under this system and regulatory requirements protect key wildlife habitat, waterways and soil, and ensure appropriate regeneration of forests after harvesting. Information about the area of timber production activities within Victorian public forests during the reporting period is included in Indicator 2.3.

Stock grazing

Stock grazing in Victoria's public forests is managed through grazing licences. The licence system assists in minimising forest health impacts by controlling the location and timing of grazing, limiting stock numbers and other management requirements.

Non-wood resource extraction

Non-wood resource extraction activities such as mining and quarrying in Victorian public forests are highly regulated and represent a relatively small footprint. These activities result in the removal of forest resources over a relatively long period of time (multiple years). Sites are usually required to be rehabilitated following the conclusion of an operation (unless required for some other purpose). The scale of non-wood resource extraction activities occurring within Victorian public forests during the reporting period is addressed in Indicator 2.4.

Public activities

Recreation and tourism

Victoria's public forests are used extensively for recreational activities (see Indicator 6.3c). DEPI and Parks Victoria implement management strategies to minimise the impact of recreation and tourism on forest health and vitality. These strategies include provision of infrastructure (campsites, trails, etc), signage and education programs and control of potentially harmful activities through regulation.

Domestic firewood collection

Collection of firewood for personal/domestic use is permitted in specified areas in Victoria's State forests and several Forest Parks. The potential effects are managed through regulation which limits collection to certain times of the year and controls the amounts of wood that can be collected. For further details, refer to Indicator 2.3.

Credit: Alison Pouliot

Indicators

3.1: Forest health and vitality
3.2: Human-induced disturbance

Criterion 4: Conservation and maintenance of soil and water resources

Forests provide vital hydrological services in Victoria to ensure the supply of good quality drinking water to many communities. Monitoring changes in the chemical, physical, and biological characteristics of soil, water and aquatic systems provides valuable information to support these hydrological services and broader sustainable forest management. Conservation of forest soil and water resources is recognised by the Montreal process as the fourth of seven pillars of sustainable forest management and is essential for maintaining ecosystem health and productivity.

Indicators 4.1, 4.2 and 4.3 assess the conservation and maintenance of soil and water resources in Victoria's forests. They describe risks to soil quality and trends in water quality and quantity within forested areas. The reports focus on State forest and Parks and conservation reserves, as little information is available for other land tenures.

Forest activities and soil conservation measures

Forest managers contribute to soil conservation by assessing soil risks and applying appropriate conservation measures to forest activities. These activities include timber harvesting and regeneration, bushfire management (including planned burning), road construction and maintenance, mining and some recreation activities. Most of these activities are undertaken in Victoria within established regulatory frameworks.

Regulatory frameworks

Regulatory frameworks have been established to support soil conservation and river health in Victoria's public forests. These comprise both legally and non-legally binding instruments. Key instruments include Acts of Parliament, Regulations and Codes of Practice. Land managers may also specify soil conservation and river health requirements through commercial contract specifications and other licence conditions.

Timber harvesting and bushfire management involve the use of heavy machinery which can pose a significant risk to soil and water. As such, these activities have established legally binding requirements to assess soil risks and manage them accordingly. The associated regulatory framework for soil and water management has remained relatively stable over the reporting period, although new *Timber Salvage Harvesting Prescriptions* were established after major bushfires in 2006/07 and 2009 and a requirement was introduced to assess risks to natural values in both the emergency stabilisation and recovery phases of bushfire response in the revised *Code of Practice for Bushfire Management on Public Land 2012*.

Timber production

Timber harvesting (including associated road and track construction and regeneration activities) requires the creation of coupe infrastructure such as log landings, snig tracks and boundary tracks. Relevant mandatory requirements include the use of appropriate buffers around waterways, and managing track drainage to reduce erosion risks. These requirements are systematically assessed for risk to soil attributes in a Forest Audit Program (FAP). The 2011 FAP report outlined a high level of timber operator compliance with Code requirements, including for soil conservation and river health.

Credit: DEPI

Indicators

4.1: Soil risk

4.2: Forested catchment water yield

4.3: Forested catchment river health

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# Criterion 4: Conservation and maintenance of soil and water resources

Bushfire management

Victoria established Bushfire Rapid Risk Assessment Teams (Bushfire RRAT) following the Black Saturday bushfires in 2009 (refer to Indicator 3.1). Specialists assess post-fire threats to ecosystems and threatened species, infrastructure, socio-economic wellbeing and human life. A combination of topography, burn severity, forest mapping, fieldwork and aerial surveys are used to determine debris flow risk – a function of burn severity, slope and forest type. To date, Bushfire RRATs have so far assessed over 160,000 hectares of mostly forested bushfire-affected land for flooding and erosion risk.

Water yield from forested catchments

Water catchments supply water required for ecosystem health as well as social, cultural, agricultural and industrial use. In 2012, 5.3 million hectares of land in Victoria was managed as water supply catchments. Ninety-eight percent of water supply catchments are "declared catchments" of mixed land tenure in the upper reaches of Victorian river systems. On average, 68% of land within declared catchments is forested. Forest cover is close to 100% in some catchments in eastern Victoria while it is less than five per cent in some catchments in western Victoria.

Comprehensive data on water yield characteristics from forested areas within Victoria's catchments are not available. The extent of Victoria's water supply catchments (public and private land) is reported along with information about how disturbances in forested parts of these catchments influence water yield characteristics. Improvements in mapping methodologies have resulted in greater accuracy in reporting the land tenure and forest cover information.
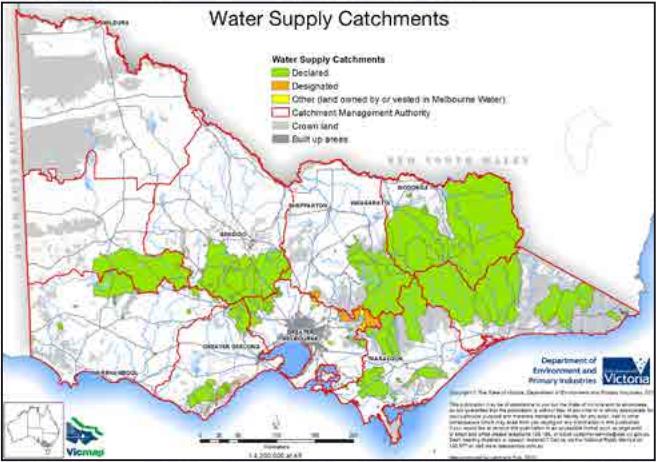
Source DEPI

Bushfire impacts on water yield

Large intense bushfires can have serious, long lasting effects on water yield from forest (in particular Ash-eucalypt forests). Regrowth Ash forests use a greater amount of water than mature Ash forests, and regenerating areas may experience reduced water yields for a number of decades.

Several major bushfires have impacted Victorian catchments during the reporting period. These include the 2006/07 Great Divide fires which burnt large expanses of catchments in the Alpine national Park, the Grampians fires (2006/07) which burnt 130,000 hectares of water catchments and the Black Saturday fires (2009) which burnt about 30% of Melbourne's water catchments.

Credit: Alison Pouliot

Indicators

4.1: Soil risk

4.2: Forested catchment water yield

4.3: Forested catchment river health

Biological Diversity

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Criterion 4: Conservation and maintenance of soil and water resources

Drought and flood impacts on water yield

The first half of the reporting period concluded Victoria's longest period of sustained rainfall deficit on record (refer to Indicator 3.1), markedly reducing stream-flows. Towards the end of the 13-year drought in 2009 stream-flow volumes in Victoria were 32% of the long-term average, with particularly severe low flow effects reported in central and western Victoria. During the drought, floods did not occur on the Murray floodplains for over a decade. On the breaking of the drought, Victoria experienced some of its most damaging floods in history (September 2010 - March 2012).

River health in forested catchments

River health strongly correlates to the degree of disturbance. Bushfire, drought, flood and other forest disturbance all have the potential to impact river health. Mechanisms to protect river health from human induced forest disturbance activities are described in Indicator 4.1. River health is monitored through the Index of Stream Condition (ISC). The ISC provides an overview of the ecological condition of major rivers and tributaries in Victoria at eight-year intervals.

Across Victoria, 23% of total river length is assessed in good to excellent condition and 45% of the total river length within forested catchments is in good to excellent condition. In eastern Victoria 58% of the total river length is in good to excellent condition, compared to 12% in western Victoria. These results correspond closely with the extent of forest cover in each catchment. Within public forests, 56% of the total river length is in good to excellent condition compared with only 7% of total river length within private land.
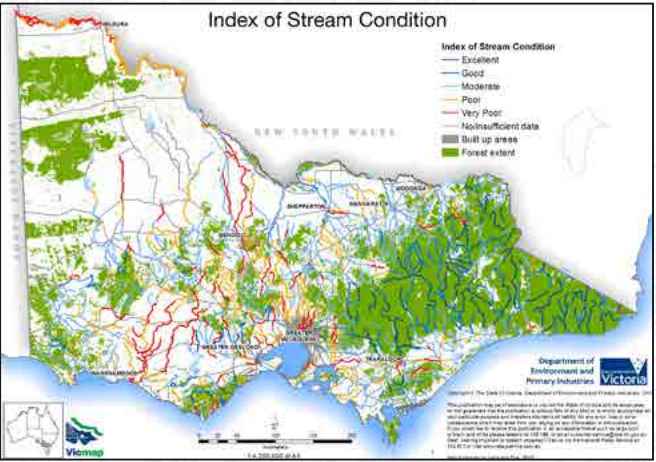
Source DEPI

Bushfire impacts on river health

The impacts of the major bushfires occurring in forested catchment areas during the reporting period appear to have been relatively short term. Whilst significant negative impacts were experienced at the time, the river health has largely recovered within three years of fire.

Drought and flood impacts on river health

Drought conditions between 1997 and 2010 (refer to Indicator 4.2) had a significant adverse impact on water flow and water quality. Some of the poorest ISC scores coincide with streams in southwest Victoria that suffered the greatest drought impacts. Flooding between September 2010 and March 2012 caused blackwater events in the Murray River system, resulting in widespread fish kills and death of other aquatic fauna.

Credit: Alison Pouliot

Indicators

4.1: Soil risk

4.2: Forested catchment water yield

4.3: Forested catchment river health

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Criterion 5: Maintenance of forest contribution to global carbon cycles

Forest is an important component of the global carbon cycle, and maintaining or increasing forest carbon stocks is a key indicator of sustainable forest management. Maintenance of forest contribution to global carbon cycles is recognised by the Montreal process as the fifth of seven pillars of sustainable forest management.

Managed forest also contributes to the global carbon cycle through storage of carbon in wood and wood products in service and, at end of service life, in landfill. The role of forests in the carbon cycle is best interpreted at a macro-scale, because it is the net effect of forests and forest management across the landscape and the economy over a relatively long time that influence the atmosphere, rather than short-term local changes at individual forest sites.

This Criterion comprises two indicators. The first reports on total ecosystem biomass and carbon above and below ground in Victoria's public forests. The second reports the contribution of Victorian forest ecosystems to global greenhouse gas balance compared to other sectors of the economy.

Total forest ecosystem biomass and carbon (Indicator report 5.1)

For the first time, a state-wide assessment of forest ecosystem biomass and carbon pools across Victorian public forests (State forest and Parks and conservation reserves) is presented, using data collected through the Victorian Forest Monitoring Program (VFMP).

Total forest biomass and total carbon (above and below ground) in Victoria's public forests is 2.05 billion tonnes and 1.02 billion tonnes respectively. The South Eastern Highlands bioregion has the most with 0.92 million tonnes of biomass and 0.46 billion tonnes of carbon, approaching half of the state's total. There has been almost no change in forest biomass and carbon stocks in Victoria's public forests over the period 1988 to 2013, despite natural disturbance by fire, drought and flood (Indicator 3.1), and wood harvesting.

Across all Victorian public forests the average carbon and biomass (above and below ground) is 163.2 and 327.7 tonnes per hectare respectively. The Australian Alps bioregion has the highest average carbon and biomass with 241.6 and 484.7 tonnes per hectare respectively. The South Eastern Highlands bioregion ranks second with 229.7 and 460.9 tonnes per hectare respectively. The Murray-Darling Depression has the lowest average carbon and biomass with 12.5 and 25.7 tonnes per hectare respectively.

Emissions and removals of greenhouse gasses (Indicator report 5.2)

Victoria's greenhouse gas emissions were 118.3 Mt of carbon dioxide equivalent (CO_2-e) in 2010/11 (a 12.1% increase on 1989/1990). The greatest contributor to emissions is the Energy sector. This sector includes emissions from the production of electricity and direct combustion of fossil fuels in other industries, such as manufacturing. In 2011, Victoria's Land Use, Land-Use Change and Forestry sector had a negative emission (i.e. greenhouse gas absorption from the atmosphere) of 5.4 Mt CO_2-e.

Credit: Elizabeth Donaghue

Indicators

5.1: Forest biomass and carbon

5.2: Global greenhouse gas contribution

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Criterion 6: Maintenance and enhancement of long term multiple socio-economic benefits to meet the needs of societies

Maintenance and enhancement of long term multiple socio-economic benefits to meet the needs of societies is recognised by the Montreal process as the sixth of seven pillars of sustainable forest management.

Indicators under this criterion show the extent to which Victoria's forests contribute to national and regional economies, benefit personal and community wellbeing, and support cultural values. Socio-economic data are important measures of the monetary and non-monetary value and benefits of forests to society. Victorian communities, especially Aboriginal communities, have strong social, spiritual and cultural attachments to forest, whether for traditional forest needs, the provision of forest products, direct and indirect employment or for recreation and tourism. The 18 Indicators under this Criterion comprise six elements.

Production and consumption
(Indicator reports 6.1a-d)

There has been a sharp decline in the stumpage value of wood products produced from public forests in western Victoria, from $3.3 million in 2006/07 to $488,000 in 2011/12. This is the result of Government policy decisions to limit exploitation of the wood products available in these forests and also to reduce the area available for harvesting (see Indicator 2.1). Sales revenue from wood products sourced from eastern Victoria has remained relatively steady, averaging $121 million (mill door value) per year over the reporting period. The gross value of wood products produced from all forests and plantations in Victoria has shown a steady rise from $376 million in 2006/07

to $449 million in 2010/11. The largest contributor to this rise in value has been broadleaved plantation production as more of these plantations reach harvestable age, with $57 million realised during 2010/11, a 265% increase above 2006/07. During 2010/11 Victoria produced 25% of Australia's wood product value. (Volumes of wood products produced from State forest are presented in Indictor report 2.3)

Five non-wood forest products sourced from Victorian public forests are reported for value: extractive materials, apiary licences, game meat, seed and essential oils. Incomes generated from other non-wood products such as salt and tree ferns are generally relatively small and are not included. Of the extractive materials, sand and gravel make up the largest quantity of removals, peaking at about 545 thousand tonnes and worth about $2 million in 2006/07. New basalt is the highest value extractive material type with an annual value of nearly $4 million in 2007/08.

DEPI manages 3,637 apiary sites on Crown land across Victoria. The number of apiary licences issued has steadily increased from 4,387 in 2006/07 to 5,436 in 2011/12 and revenue from $213,809 to $271,103 over the same period. The Victorian apiary industry has an estimated gross value of production of $15 billion. Pollination services (unpaid) are estimated to add between $680 million and $1 billion in annual value of production to agricultural industries.

The harvesting of game animals is controlled by DEPI through the issue of game licences. The total average annual revenue to DEPI for duck, quail and deer is estimated at approximately $1.4 million. The amount of seed sold annually from State forest was around 10 tonnes worth an average $311,000 per year, between 2008/09 and 2010/11. This is a significant increase over the usual annual average of about 4.5 tonnes because VicForests needed to replace seed stocks drawn

Credit: DEPI

Indicators

6.1a: Value of wood products

6.1b: Value of non-wood products

6.1c: Ecosystem services

6.1d: Wood products reuse and recycling

6.2a: Forest management investment

6.2b: R&D investment and education

6.2c: New and improved technologies

6.3a: Recreation and tourism area

6.3b: Recreation and tourism opportunities

6.3c: Recreation and tourism visitors

6.4a: Area of Indigenous access and rights

6.4b: Cultural heritage values

6.5a: Forest sector employment

6.5b: Forest sector wage and injury rates

6.5c: Forest dependent community resilience

6.5d: Forest dependent indigenous community resilience

6.5e: Indigenous cultural and spiritual access

6.6a: Native title rights

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Criterion 6: Maintenance and enhancement of long term multiple socio-economic benefits to meet the needs of societies

down during fire recovery works following major bushfires in 2006 and 2009 (refer to Indicator 3.1). The amount of eucalyptus oil harvested from Victoria's State forest has declined from about 25 tonnes in 2008/09 to about 11.5 tonnes in 2011/12. The average royalty for eucalyptus oil is 43 cents per kilogram.

Standard methods of assigning values and measuring ecosystem services in Victorian public forests have not been developed fully. In recent years Victoria has devised market-based incentive systems that assign value to improvements in management of natural environments, published an experimental set of ecosystem accounts and continues to develop and pilot new methods. DEPI is committed to expanding its capability to implement the environmental accounting system to provide the State with accounts that meet the international standards and support decision making.

The quantity of wood and paper recycled each year varies according to supply and demand. In 2010/11 more than 1.4 million tonnes of wood and wood products was recycled and reused in Victoria. This represents 18% of all recovered material in the state. Mixed paper recycling made up more than half, and combined cardboard, newspapers and magazines almost a quarter of all recycled wood products in 2010/11. Timber and sawdust made up a further 16 %. Victoria's recycling of wood and wood products has continued to grow to 2010/11 with a total expansion of 24 % since 2006/07.

Investment in the forest sector
(Indicator reports 6.2a-c)

There are two main investment and expenditure streams that support forest management on public land: forest and fire management, and conservation and recreation. The former, while having a relatively constant base, has fluctuated from about $590 million to $758 million per year over the reporting period, as expenditure on fire suppression and recovery activities vary from year to year. About $4 billion was spent on forest and fire management between 2006/07 and 2011/12. Expenditure on conservation and recreation, which include management and governance of Parks, has increased from about $39 million in 2007/08 to about $56 million in 2010/11, with a further 37.5% rise to over $77 million in 2011/12.

Victoria's predominantly privately owned plantation estate continues to increase in area, however, the level of investment has dropped substantially and the rate of establishment has declined markedly over the reporting period.

Between 2006/07 and 2011/12, the Victorian Government contributed approximately $29 million to forest-related research, development and education (an average of $4.8 million per year). The general trend for investment over the period was a steady increase from $3.8 million in 2006/07 to $5.9 million in 2011/12. Data for private industry expenditure on forest research and development is not reported. Data on the level of investment that has occurred in forest education are not available.

Comprehensive investment data on the extension and use of new and improved technologies are not available. A number of technological developments emerging during the reporting period are listed, including the use of synthetic aperture radar, lidar, lasers, thermal imaging and other kinds of remote sensing.

Credit: DEPI

Indicators

6.1a: Value of wood products

6.1b: Value of non-wood products

6.1c: Ecosystem services

6.1d: Wood products reuse and recycling

6.2a: Forest management investment

6.2b: R&D investment and education

6.2c: New and improved technologies

6.3a: Recreation and tourism area

6.3b: Recreation and tourism opportunities

6.3c: Recreation and tourism visitors

6.4a: Area of Indigenous access and rights

6.4b: Cultural heritage values

6.5a: Forest sector employment

6.5b: Forest sector wage and injury rates

6.5c: Forest dependent community resilience

6.5d: Forest dependent indigenous community resilience

6.5e: Indigenous cultural and spiritual access

6.6a: Native title rights

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Criterion 6: Maintenance and enhancement of long term multiple socio-economic benefits to meet the needs of societies

Recreation and tourism
(Indicator reports 6.3a-c)

Parks Victoria and DEPI jointly manage Victoria's forest estate for recreation and tourism. An estimated 97% of Parks and conservation reserves and 99% of State forest is available for recreation. The area actively used is much less because of remoteness, topography, and lack of supporting infrastructure such as roads, recreational trails, and other facilities. The total area of public land available for recreation and tourism increased only slightly over the reporting period, comprising about 4.6 million hectares of protected areas and 2.4 million hectares of State forest in 2012.

Between 2003 and 2013 the number of recreational sites in Parks and conservation reserves increased by 37%. Over the same period, the number of camp grounds increased by over 400 in Parks and conservation reserves. Some of this increase is due to the reclassification of State forest into the formal reserve system (refer to Indicator 1.1c). For State forest, between 2003 and 2013 there has been a net decrease of 13% in the number of recreational sites (day visitor areas and camp grounds) and a net increase of 77% in the kilometres of walking trails.

A major investment in forest tourism and recreation since the last State of the Forests Report in 2008 has been in rebuilding infrastructure following the catastrophic 2009 bushfires (Indicator 3.1) and after major floods in 2011. About 20% of State forest visitor assets have been replaced after damage by fires. The number of visitors to National and State Parks in Victoria has increased substantially from an estimated total of about 25 million in 2002/03 to almost 35 million in 2012/13. Based on staff estimates and field observations, it is estimated that over 5 million people visit Victoria's State forests each year.

Aboriginal cultural, social, and spiritual needs and values
(Indicator reports 6.4a and 6.4b)

Access and rights of Aboriginal Victorians to protect their cultural heritage in forests are recognised formally through legislation, agreements and policies applicable to forests. Victoria has entered into formal agreements with four Traditional Owner groups in connection to the management of a total of almost 300,000 hectares of their traditional lands (4% of public forest), including new agreements made on just over 76,000 hectares of public forest during the reporting period.

In 2012, there were over 8,000 Aboriginal cultural heritage sites across State forest and Parks and conservation reserves. Between 2006 and 2012 there was a 15% increase in the number of registered Aboriginal cultural heritage sites in State forest and an 18% increase in Parks and conservation reserves. Most common site types registered in all public forests were burial/ human remains, low-density artefact distributions, scarred trees, artefact scatters and hearths. There are 169 non-Aboriginal cultural heritage sites on the Victorian heritage register in public forests, including 123 sites in Parks and conservation reserves and 46 sites in State forest. Of non-Aboriginal cultural heritage components (artefacts that exist at a particular place), the most common are associated with mining and mineral processing (146 in Parks and conservation reserves and 82 in State forest).

Credit: DEPI

Indicators

6.1a: Value of wood products
6.1b: Value of non-wood products
6.1c: Ecosystem services
6.1d: Wood products reuse and recycling
6.2a: Forest management investment
6.2b: R&D investment and education
6.2c: New and improved technologies
6.3a: Recreation and tourism area
6.3b: Recreation and tourism opportunities
6.3c: Recreation and tourism visitors
6.4a: Area of Indigenous access and rights
6.4b: Cultural heritage values
6.5a: Forest sector employment
6.5b: Forest sector wage and injury rates
6.5c: Forest dependent community resilience
6.5d: Forest dependent indigenous community resilience
6.5e: Indigenous cultural and spiritual access
6.6a: Native title rights

Criterion 6: Maintenance and enhancement of long term multiple socio-economic benefits to meet the needs of societies

Employment and community needs
(Indicator reports 6.5a and 6.5b)

The number of Victorians employed in the forest industries in 2010 was 21,826 down by 7.8% from 2006. The decline is reflected across all sectors of the industry. Since the value of wood processed over this time has increased (Indicator 6.1a) the employment decline seems to parallel improvements in productivity. Wood product manufacturing is the largest sector of the Victorian forest industry, employing 48% of the industry's workforce in 2010. The pulp and paper sector also employs a significant proportion of forest industry workers (37% in 2010). Indirect employment generated by the Victorian forest industry in 2010 may be in the order of 39,000 to 48,000 jobs.

A Forest Industry Survey (FIS) in 2012 identified 6,836 jobs in the growing, services to forestry and primary processing sectors, with softwood plantation activities employing the largest proportion (43%). Over half of all workers in the forest sector in Victoria are employed in the Melbourne region, reflecting the concentration of secondary processing businesses in or near the metropolitan area. Regional forest industry employment is concentrated in the Gippsland, East Gippsland and Barwon regions, where the forest industry represents a significant proportion of total employment in a number of small towns. In 2012 forest industry workers were:

- slightly older than the typical Victorian worker (11% of forest industry workers aged 15 to 24, compared to the Victorian average of 18%)

- less likely to have completed high school or have a university qualification, but more likely to have a trade qualification

- less likely to be women (one fifth of the forest sector workforce being women compared to almost half of the Victorian total employed workforce)

- likely to have higher incomes and lower housing loan repayments than the overall Victorian workforce.

In 2012 the forest industry in Victoria had approximately 0.4% Aboriginal workers, the same proportion as the overall Victorian workforce. DEPI employed 23 Aboriginal staff (representing about 1% of its forest sector workforce) in forest related positions at the start of 2013.

Wage rates in the wood product manufacturing sector have progressively increased over the reporting period at an average rate of 2.8% per year. Wage rates in the forestry sector are considerably lower than wage rates in the wood product manufacturing sector. In 2011/12, paper products manufacturers paid wage rates 28% higher than wood product manufacturers. The average wage rate for wood manufacturing in 2011/12 was slightly higher (0.5%) than the average for all manufacturing industries in Victoria.

With regard to injury rates, the wood product manufacturing sector has contributed the greatest number of injury compensation claims, followed by the pulp, paper and converted paper product manufacturing sector then the forestry and logging sector. The number of claims in both the forestry and logging, and wood product manufacturing sectors has fallen during the reporting period.

Credit: DEPI

Indicators

6.1a: Value of wood products
6.1b: Value of non-wood products
6.1c: Ecosystem services
6.1d: Wood products reuse and recycling
6.2a: Forest management investment
6.2b: R&D investment and education
6.2c: New and improved technologies
6.3a: Recreation and tourism area
6.3b: Recreation and tourism opportunities
6.3c: Recreation and tourism visitors
6.4a: Area of Indigenous access and rights
6.4b: Cultural heritage values
6.5a: Forest sector employment
6.5b: Forest sector wage and injury rates
6.5c: Forest dependent community resilience
6.5d: Forest dependent indigenous community resilience
6.5e: Indigenous cultural and spiritual access
6.6a: Native title rights

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Criterion 6: Maintenance and enhancement of long term multiple socio-economic benefits to meet the needs of societies

Community resilience

Forest dependent communities
(Indicator 6.5c)

In 2011, there was an average 3.9% forest industry employment across nine Victorian regions with high forest industry employment dependence, down from an average 5.9% in 2006. Alpine West region has the highest proportion of forest industry employment (8.8% in 2011) associated with active native forest and plantation industries, but has experienced the greatest reduction in proportion of forest industry employment over the reporting period. The "Victoria's Forestry Industries" report[1] analysed the adaptive capacity (a component of resilience) of 54 towns with the greatest dependence on the forest industry in Victoria. The study found that towns with higher dependence on the forest industry were more likely to have low adaptive capacity than those with low dependence on the forest industry. However, this pattern was not entirely consistent, suggesting other factors may be just as or more important.

Forest dependent Indigenous communities
(Indicator 6.5d)

Over this reporting period no data have been collected specifically for the resilience of forest dependent Aboriginal communities to changing social and economic conditions. One important source of resilience for Aboriginal communities is the access that they have to their land, including the ability to nurture and manage this relationship. Information about

Aboriginal communities' access and rights is presented within Indicator reports 6.4a and 6.6a. Data, together with associated commentary, from which inferences on economic aspects of resilience can be made, is presented within Indicator reports 6.5a – 6.5c.

Indigenous participation
(Indicator reports 6.5e and 6.6a)

Mechanisms that provide access and recognition of traditional owner rights to manage traditional lands have strengthened during the reporting period because of the introduction of the *Traditional Owner Settlement Act 2010* and three new Agreements. The Agreements recognise Traditional Owner rights to conduct activities which maintain their relationships to land, such as: accessing areas for traditional purposes, like camping and gathering for ceremonies; visiting and protecting important places and sites; and hunting, fishing and gathering food or traditional resources. The Agreements also include arrangements facilitating Traditional Owner management of traditional lands.

Mechanisms that support participation of Aboriginal Victorians in sustainable forest management decision-making have increased during the reporting period. Aboriginal participation is embedded within many plans and procedures within the sustainable forest management framework. These mechanisms reflect legislative requirements for Aboriginal participation in heritage management and native title procedures. More recent forest management plans contain strategies involving partnerships with Indigenous communities. DEPI also introduced the *Indigenous Partnerships Framework* in 2007. This policy is under review to align with the *Victorian Aboriginal Affairs Framework 2013 -2018*.

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[1] Schirmer (2010) Socio-economic characteristics of Victoria's forest industries. Dr Jacki Schirmer, Fenner School of Environment and Society, Australian National University. Report prepared for the Victorian Department of Primary Industries, July 2010

Credit: DEPI

Indicators

6.1a: Value of wood products
6.1b: Value of non-wood products
6.1c: Ecosystem services
6.1d: Wood products reuse and recycling
6.2a: Forest management investment
6.2b: R&D investment and education
6.2c: New and improved technologies
6.3a: Recreation and tourism area
6.3b: Recreation and tourism opportunities
6.3c: Recreation and tourism visitors
6.4a: Area of Indigenous access and rights
6.4b: Cultural heritage values
6.5a: Forest sector employment
6.5b: Forest sector wage and injury rates
6.5c: Forest dependent community resilience
6.5d: Forest dependent indigenous community resilience
6.5e: Indigenous cultural and spiritual access
6.6a: Native title rights

Criterion 7: Legal, institutional and economic framework for forest conservation and sustainable management

This criterion is recognised by the Montreal process as the seventh of seven pillars of sustainable forest management. The five Indicators under this Criterion report on the extent to which the Victoria's legal, institutional and economic frameworks support sustainable forest management, as well as on the capacity to monitor change and to conduct and apply research and development.

Legal, institutional and economic frameworks

Legal framework

Indicator 7.1 tabulates the purpose of each of the principal Acts of the Victorian Parliament that apply within the sustainable management legislative framework, the extent to which that legal framework supports the conservation and sustainable management of forests and the requirement to apply best practice for sustainable forest management activities, all by tenure category.

Since the 2008 State of the Forests Report two new Acts have been legislated:

- The *Traditional Owner Settlement Act 2010* allows the Victorian Government to make agreements with Traditional Owners to recognise their unique relationship to land, provide for rights on Crown land as well as other benefits (refer also to Indicator 6.6)

- The *Climate Change Act 2010* provides a framework for the Government of Victoria's roles and responsibilities in response to climate change.

Five Acts have been amended since 2008:

- The *Forests Act 1958* and the *Crown Land (Reserves) Act 1978* to require tour operators to hold licences to support the sustainable management of forests, a new regulatory approach to domestic firewood licensing and traditional owner settlement related amendments

- The *National Parks Act 1975* to include the creation of new Parks and conservation reserves in East Gippsland and the River Red Gum forests

- The *Sustainable Forests (Timber) Act 2004* to recognise the government's commitment to securing the resource base for VicForests to maximise the long-term economic gain from native forest harvesting

- The *Mineral Resources (Sustainable Development) Act 1990* to strengthen sustainability requirements.

The *Forestry Rights Act 1996* and *Extractive Industries Development Act 1995* were repealed. Reviews of the *Sustainable Forests (Timber) Act 2004*, *Climate Change Act 2010* and *Aboriginal Heritage Act 2006* were completed.

New regulations have been introduced since the 2008 State of the Forests Report, including:

- The *Forests (Recreation) Regulations 2010* to manage the use of forests for recreation. These regulations are a consolidation of former individual reserve regulations. They also encompass a range of forest Parks and reserves previously not covered by recreation-based regulations

Credit: DEPI

Indicators

7.1: Legal framework
7.2: Institutional framework
7.3: Economic framework
7.4: Monitoring capacity
7.5: R&D capacity

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Criterion 7: Legal, institutional and economic framework for forest conservation and sustainable management

- The *Forests (Tour Operator Licence Fee) Regulations 2011* to prescribe fees payable in respect of tour operator licences granted for Crown land in a reserved forest under the *Forests Act 1958*

- The *Forests (Domestic Firewood) Regulations 2012* to regulate or prohibit certain conduct in a firewood collection area during a firewood collection season in State forests.

The *Forests (Licences and Permits) Regulations 2009* updates the 1999 version.

Codes of Practice, *Flora and Fauna Guarantee Act 1988* Action Statements, Forest Management Plans and management tools and procedures for harvesting, roading and regeneration in Victoria's State forests are among regulatory instruments used to assist in implementing the legislation mentioned above. During the reporting period, two new Codes of Practice have been introduced:

- The *Code of Practice for Timber Production 2007*, which revises the previous Code and incorporates advances in scientific knowledge, the substantial changes in legislation and regulation governing forest management in Victoria and improvements in operational practices. The Code contains clearly differentiated guidelines and regulatory requirements for meeting operational goals

- The *Code of Practice for Bushfire Management on Public Land 2012*, which revises the previous Code and is the result of the outcomes of the Victorian Bushfire Royal Commission associated with the 2009 Black Saturday bushfires (refer to Indicator 3.1). The Code is focused on setting clear objectives for bushfire management on public land and provides strategies and actions to achieve these objectives.

Victorian Planning Provisions, from which planning schemes are developed across the state, were amended to include the *Bushfire Management Overlay* (BMO) to identify high-risk bushfire areas and to provide guidance, as well as restrictions on building and development within these areas. The BMO is implemented and administered through local councils across Victoria according to their planning schemes.

Institutional framework

The institutional framework supports the legal framework with plans and policies, institutional structures and decision making processes, mechanisms for public participation, relevant human resource capacity and skills, knowledge, infrastructure and regulatory activities.

Indicator 7.2 outlines the institutional framework elements considered important in supporting conservation and sustainable management of both public and private forests in Victoria. Principal institutions involved, major developments and key activities undertaken during the reporting period are tabulated.

DEPI is the main statutory authority responsible for the regulation of wood production activities in Victoria's State forests using an environmental Forest Audit Program (FAP) with compliance judged against prescriptions in the *Code of Practice for Timber Production* and associated documents. The FAP aims to allow for the independent examination of activities across the lifecycle of harvesting operations, including operational and tactical planning, roading, harvesting, coupe closure and regeneration. Audits indicate a high level of compliance (over 93%) with prescriptions for wood production harvesting and coupe closure activities throughout the reporting period. On average, 74% of non-compliances have nil to minor environmental impact. There have been six confirmed non-compliances related to rainforest management, incursion into National Park and SPZ.

Credit: DEPI

Indicators

7.1: Legal framework
7.2: Institutional framework
7.3: Economic framework
7.4: Monitoring capacity
7.5: R&D capacity

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Criterion 7: Legal, institutional and economic framework for forest conservation and sustainable management

Illegal activities in public forests are reported to DEPI, and where appropriate, compliance action is undertaken. Overall, the reporting of illegal activity in forests increased during the reporting period. This is most likely due to increased effort by DEPI to record illegal activity, rather than to an actual increase in the incidence of environmental crime. Hunting (23%), taking vegetation (23%) and rubbish/ vandalism (23%) were on average the most commonly reported illegal activity types in Victoria's forests.

Economic framework

The economic framework for Victoria's forests consists of government policies on investment, regulation, taxation and trade (Indicator 7.3). In 2011, the Victorian Government introduced the Timber Industry Action Plan (TIAP) to provide the conditions for a productive, competitive and sustainable timber industry. Key actions of the plan include:

- A new strategic approach to biodiversity management that appropriately balances the conservation of biodiversity with the supply of wood and other commercial forest products to generate socio-economic benefits for Victorian communities

- A secure basis for VicForests to maximise the long-term economic returns to Victoria from the harvesting of wood and allow industry to realise a competitive return on investments, support capital upgrades, and drive innovation

- A streamlined legislative and regulatory framework relating to sustainable forest harvesting

- Improvements to the methodology used to estimate sustainable harvest levels from public native forests in eastern Victoria.

Victoria has three programs that form an economic framework that attempts to place a monetary value on ecosystem services for the protection of biodiversity values on private land:

- EcoTender, where landholders are invited to tender contracts to deliver multiple environmental benefits, primarily by means of improved native vegetation management and revegetation works on their properties. The investment per hectare has steadied at around $1,500 per hectare, with just under $3 million invested in 2011/12.

- BushTender, an auction approach to protecting and improving native vegetation on private land. Landholders competitively tender for agreements to better manage their native vegetation

- BushBroker, a trading desk for native vegetation credits. It provides standards and processes for the generation and trade of native vegetation credits. The database of native vegetation offset assets contained 673 records as of October 2013. No trend information is available.

Capacity to measure and monitor changes

Victoria's capacity to report trends has improved significantly since the previous State of the Forests reporting period (2008). In 2013, 70% of indicators have data and information with which to report at least partial trends and just over 50% to report complete trends. In the previous SFR reporting period only 25 indicators (55%) had sufficient data to partially or fully report trends.

Ninety percent of the indicators have at least partial data coverage – a 30% increase on the previous (2008) State of the forest reporting period. Complete data coverage was available for 65% of the indicators. Over 90% of indicators use data and information rated in the highest data currency category (post-2006).

Credit: DEPI

Indicators

7.1: Legal framework
7.2: Institutional framework
7.3: Economic framework
7.4: Monitoring capacity
7.5: R&D capacity

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Criterion 7: Legal, institutional and economic framework for forest conservation and sustainable management

Capacity to conduct research and development and apply the results

A scientific understanding of the characteristics and functions of Victoria's forest ecosystems is needed to underpin their management. Research and development provide the basis for biological, wood and fibre inventories, forest health surveillance, forest management, silviculture of forest intended for harvest, and the development of methods for assessing sustainable forest management. High quality research and development and expert advice are required to inform decision-making and policy development. Examined here in Indicator 7.5 is the institutional capacity to conduct and apply research and development aimed at improving forest management, including development of the scientific understanding of forest ecosystem characteristics and functions. Indicator 6.2b quantifies investments in research and development and shows changes in investment priorities over the reporting period. Associated information about the use of new and improved technologies for sustainable forest management is addressed in Indicator 6.2c.

The Victorian Government conducts a wide-range of forest-related research and development programs. In addition the Government invests in research through a number of Victorian and interstate Australian university and research institutions.

Four case studies describe a range of research activities that are improving Victoria's capacity to monitor forest ecosystems and sustainable forest management.

Credit: DEPI

Indicators

7.1: Legal framework
7.2: Institutional framework
7.3: Economic framework
7.4: Monitoring capacity
7.5: R&D capacity

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Credit: DEPI

Indicator

1.1a: Area of forest

1.1b: Forest growth stage

1.1c: Forest protected zones

1.1d: Forest fragmentation

1.2a: Forest dependent species

1.2b: Indicator species habitat

1.2c: Indicator species monitoring

1.2d: Invasive species

1.3a: Forest species at risk

1.3b: Species conservation

2.1: Timber area available

2.2: Timber volume available

2.3: Wood production

2.4: Non-wood production

2.5: Timber harvest regeneration

Indicator

3.1: Forest health and vitality

3.2: Human-induced disturbance

4.1: Soil risk

4.2: Forested catchment water yield

4.3: Forested catchment river health

5.1: Forest biomass and carbon

5.2: Global greenhouse gas contribution

6.1a: Value of wood products

6.1b: Value of non-wood products

6.1c: Ecosystem services

6.1d: Wood products reuse and recycling

6.2a: Forest management investment

6.2b: R&D investment and education

6.2c: New and improved technologies

6.3a: Recreation and tourism area

Indicator

6.3b: Recreation and tourism opportunities

6.3c: Recreation and tourism visitors

6.4a: Area of Indigenous access and rights

6.4b: Cultural heritage values

6.5a: Forest sector employment

6.5b: Forest sector wage and injury rates

6.5c: Forest dependent community resilience

6.5d: Forest dependent indigenous community resilience

6.5e: Indigenous cultural and spiritual access

6.6a: Native title rights

7.1: Legal framework

7.2: Institutional framework

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Indicator 1.1a: Area of forest by type and tenure

Why is this indicator important?

Knowledge of forest area by type is essential for the effective management of Victoria's forests. It provides a broad measure of the degree to which forest ecosystems and their diversity are being maintained. Reporting change in forest area also provides information about the effect of land management regimes and natural disturbance on forest cover.

What have we measured and why is it relevant to the indicator?

This indicator reports area of forest by type and tenure, as well as change in forest extent (forest cover) over time. Forest types, including height and canopy cover classes, are defined according to Australia's National Forest Inventory (NFI) definitions. Information about forest type is reported for public forests and plantations. Information about native forests on private land is not included, as there are no comprehensive data available. Changes in Victoria's forest extent across both private and public land tenures are reported over the period 1988 to 2013.

Background

The distribution of Victoria's forests and flora species within them is determined by several factors, including elevation, rainfall, temperature, soil type and natural disturbance (such as fire). Victoria's diverse forests are found in a range of environments, including inland, coastal and high elevation alpine areas. Over the past two million years, Victoria's forests have adapted to a drier climate with an increased occurrence of fire, leaving only remnants of forest types that once covered large extents of Victoria, such as cool temperate rainforest.

Large scale clearing for agriculture and urban development have greatly reduced forest extent in Victoria. Prior to European settlement in the mid-nineteenth century, forest covered about 90% of Victorian land. Since that time more than 14 million hectares (60%) of Victorian forest has been cleared, making it proportionally, the most cleared of all Australian States. The period of greatest deforestation occurred between 1830 and 1880, principally the result of agricultural clearance and settlement development by early European explorers and the 1850s Victorian gold rush. The majority of Victoria's remaining forest is on public land. Forest on private land is typically more fragmented and of poorer quality than that on public land.

Forests on public land extend to all parts of the state and range from low multi-stemmed Mallee woodland across flat and gently undulating topography in the north-west and Box-Ironbark forests characterised by sparse to dense canopies of box, ironbark and gum-barked eucalypts up to 25 m tall, on flat to undulating landscapes on rocky, auriferous soils across central Victoria. Highly variable medium and tall canopy damp sclerophyll forests are widespread across the state, found on a range of loamy, clay-loam and sandy-loam soils. Tall wet sclerophyll forests are found mostly in eastern Victoria on deep loamy soils at higher elevations. Dry sclerophyll forests are prevalent throughout the east, central and southwest of Victoria on clay-loam, sandy-loam and shallow rocky soils of exposed hillsides with canopies typically less than 25 m tall, with crooked, spreading trees.

Credit: DEPI

Indicator 1.1a: Area of forest by type and tenure

In Australia, forest is defined as "a land area, incorporating all living and non-living components, dominated by trees having usually a single stem and a mature or potentially mature stand height exceeding two metres and with existing or potential crown cover of overstory strata about equal to or greater than 20 percent. This definition includes native forests and plantations and areas of trees that are sometimes described as woodlands"[1]. Forests are classified into three broad height and three canopy (crown) cover classes, as shown in Figure 1.

Forest which is in transition is covered by this definition, e.g. a successfully regenerated harvested forest coupe (refer to Indicator 2.5), where regenerating trees are expected to have the potential to meet the necessary height and canopy cover thresholds. Forest recovering from bushfire may also meet the definition. Non-forest land is classified as that which comprises no woody vegetation, or woody vegetation that is less than 20 per cent existing or potential crown cover or with a mature or potentially mature stand height less than 2 metres tall.

Figure 1 shows crown cover and canopy height classes used for native forest types[2]

Since Victoria's State of the Forests Report 2008, an updated forest definition and new analysis methods have been used to calculate updated forest area estimates. As a result, direct comparisons between the previous (2003 and 2008) and current (2013) reports would be misleading. In previous Victorian State of the Forests Reports, data used to report forest area were aggregated from different sources, of different spatial and temporal scales and with a greater focus on commercial State forest in the east of Victoria. In this reporting period, the Victorian Forest Monitoring Program (VFMP) (which incorporates a network of permanent ground plots, as well as aerial photography and satellite imagery), has been used to collect a suite of forest data and information. Aerial photography ('photoplots') systematically distributed across all of Victoria's public forests (State forest and Parks and conservation reserves) was used to map forest land cover[3] and calculate area estimates presented in this report. Through the VFMP, for the first time, DEPI is collecting forest data across both major forested public land tenures (State forest and Parks and conservation reserves), using consistent, scientifically

Source: Australian Land Information Group and JA Carnahan (1990). *Atlas of Australian Resources, Vegetation*. Australian Government Publishing Service, Canberra.
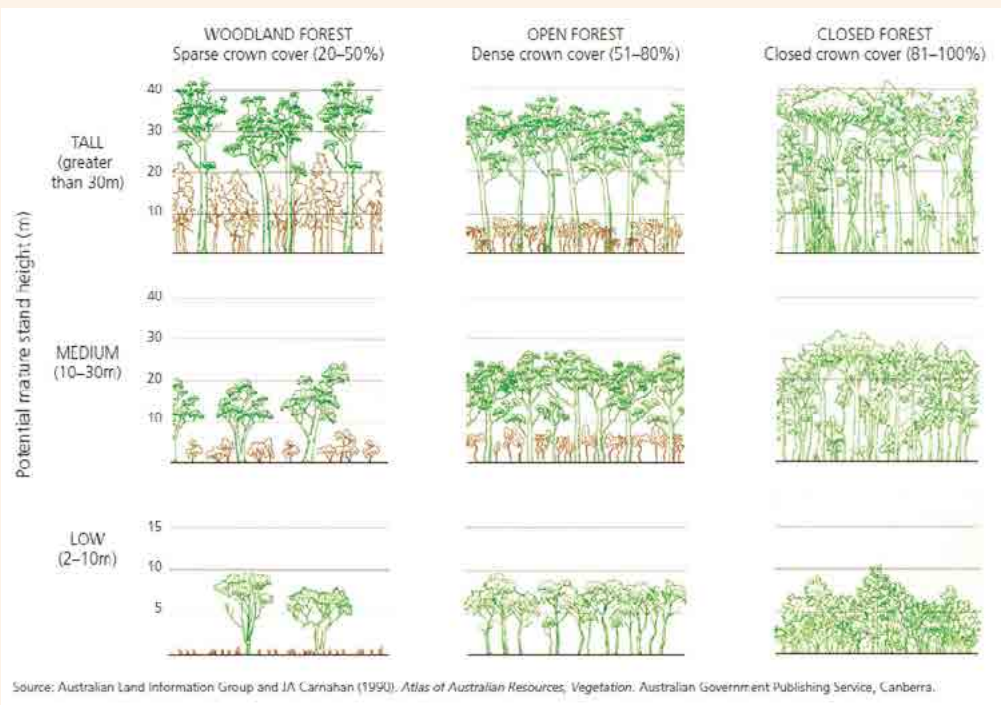
Figure 1. Crown cover and canopy height classes. Source DEPI

robust and repeatable methods. VFMP ground-plot data is also being used in this indicator report to present information about tree species. Species information presented shows the most abundant species measured on VFMP ground plots by bioregion.

Other changes since previous State of the Forests Reports, include improvements made to the accuracy and detail of land tenure maps. Between 2008 and 2013, DEPI updated the public land management base layer from a scale of 1:100,000 to 1:25,000. This improvement in the precision and accuracy of boundaries has resulted in changes in tenure areas (beyond that associated with true changes in tenure, such as the reassignment of categories). A description of land tenure categories is included in the report Introduction section.

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1   Department of Agriculture Fisheries and Forestry. *Australia's Forest at a Glance*; Department of Agriculture Fisheries and Forestry: Canberra, Australia, 2012

2   Australian Surveying and Land Information Group *Atlas of Australian Resources (Volume 6 Vegetation)*; Canberra, 1990.

3   Farmer, E.; Jones, S.; Clarke, C.; Buxton, L.; Soto-Berelov, M.; Page, S.; Mellor, A.; Haywood, A. Creating a large area landcover dataset for public land monitoring and reporting. In *Progress in Geospatial Science Research*; Arrowsmith, C.; Bellman, C.; Cartwright, W.; Jones, S.; Shortis, M., Eds.; Publishing Solutions: Melbourne, 2013; pp. 85–98.

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Indicator 1.1a: Area of forest by type and tenure

Public forest tree species

State and trend

Table 1 lists the most abundant tree species measured in Victoria's public forests, by Victorian bioregion, across 337 VFMP ground plots. Eucalypt tree species were the most abundant in 10 of the 11 Victorian bioregions – with Saw Banksia (*Banksia serrate*) being the most abundantly measured species in Flinders (Wilsons Promontory National Park). However, as only a limited number of VFMP plots have been measured in Flinders at the time of publication, this information is considered indicative only.

River Red-gum trees (*Eucalyptus camaldulensis*) were the most abundant species measured in the Riverina bioregion in northern Victoria, representing nearly 80% of all trees identified in this area. Brown Stringybark (*Eucalyptus baxteri*) made up nearly half of all trees measured in the Naracoorte Coastal Plain bioregion.

Indicating a higher degree of bioregion tree species diversity, Narrow-leaf Peppermint (*Eucalyptus radiate*), Messmate Stringybark (*Eucalyptus oblique*), Silvertop Ash (*Eucalyptus sieberi*) Snow Gum (*Eucalyptus pauciflora*) were the most abundant measured trees, but each made up less than 20% as a proportion of all trees measured in their respective bioregions.

Source DEPI

Table 1. Most abundant public forest tree species, by bioregion. Source VFMP

Victoria bioregion	Common name	Scientific name	VFMP Plots	Proportion of trees measured[†] in bioregion (%)
Australian Alps	Snow Gum	*Eucalyptus pauciflora*	61	19
Flinders	Saw Banksia	*Banksia serrata*	9	73
Murray-Darling Depression	Yellow Mallee	*Eucalyptus costata*	21	22
Naracoorte Coastal Plain	Brown Stringybark	*Eucalyptus baxteri*	32	47
NSW South West Slopes	Red Stringybark	*Eucalyptus macrorhyncha*	27	52
Riverina	River Red-gum	*Eucalyptus camaldulensis*	27	77
South East Coastal Plain	Brown Stringybark	*Eucalyptus baxteri*	24	28
South East Corner	Silvertop Ash	*Eucalyptus sieberi*	29	18
South Eastern Highlands	Narrow-leaf Peppermint	*Eucalyptus radiata*	50	17
Victorian Midlands	Red Stringybark	*Eucalyptus macrorhyncha*	36	22
Victorian Volcanic Plain	Messmate Stringybark	*Eucalyptus obliqua*	21	18

† Measured trees are measured and identified on VFMP 'Large Tree Plots', which are living or dead standing trees with a diameter greater than or equal to 10 cm at 1.3 m above ground level. For further information, refer to the VFMP field standard operating procedures.
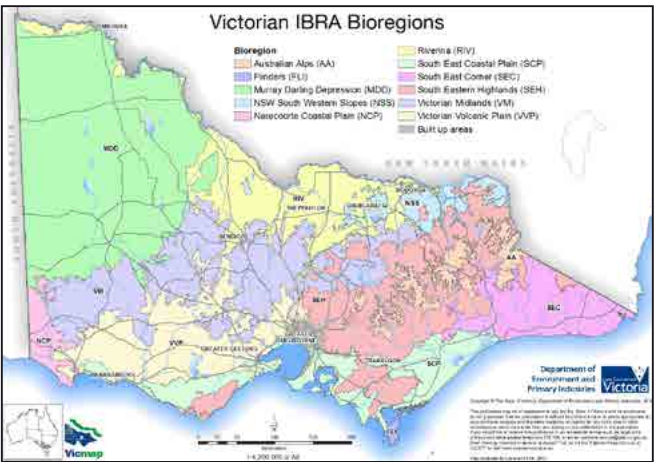
Top left Messmate stringybark. Credit Aurthur Chapman. **Top right Narrow Leaf Peppermint.** Credit GreenFleet Australia. **Bottom Left River Red Gum.** Credit Michael Rawle. **Bottom right SnowGum.** Credit Tatters

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Indicator 1.1a: Area of forest by type and tenure

Mapping Victoria's forests

Many government and private forestry organisations and agencies today utilise geospatial technology such as GIS (geographic information systems[4]) and remote sensing[5] for various applications for the analysis, assessment, monitoring and management of forests. Remote sensing is a very cost effective means of collecting forest and other land cover data across very large areas (i.e. millions of hectares) and DEPI has used statistical data mining[6] techniques, combining 25 years of Landsat satellite imagery, topography and climate data, to generate accurate and precise state wide forest maps. These maps are designed for estimating forest area (extent) over time and deriving information about forest fragmentation (Indicator 1.1d). Aerial photography land cover maps were used as input to the forest modelling process, and as a means of estimating the accuracy of the final forest maps. A detailed description of the state wide forest mapping methodology can be found here[7]

Figure 2 shows changes in forest area associated with the growth (and harvesting) of plantations in eastern Victoria, between 1988 and 2013. Figure 3 shows changes in forest cover associated with harvesting operations and subsequent forest regeneration, in Gippsland, eastern Victoria (1988 to 2013).

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[4]   GIS is a system designed to capture, store, manipulate, analyse, manage, and present all types of geographical data

[5]   Remote sensing is the science of obtaining information about objects or areas from a distance, typically from aircraft or satellites

[6]   The computational process of discovering patterns in large data sets involving methods at the intersection of artificial intelligence, machine learning, statistics, and database systems.

[7]   Mellor, A., Haywood, A., Stone, C., & Jones, S. (2013). The Performance of Random Forests in an Operational Setting for Large Area Sclerophyll Forest Classification. *Remote Sensing*, 5(6), 2838–2856. doi:10.3390/rs5062838
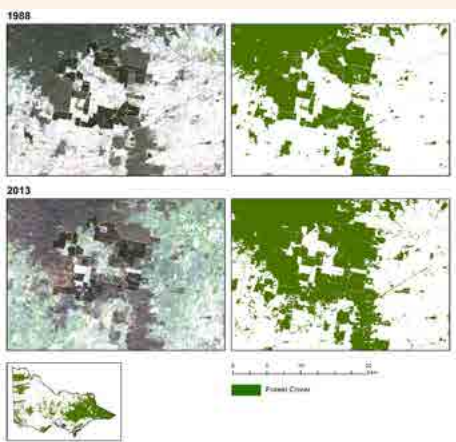
Figure 2. Forest changes associated with commercial plantations, Gippsland, eastern Victoria (1988 to 2013). Left: Satellite imagery, right: forest extent maps. Source DEPI
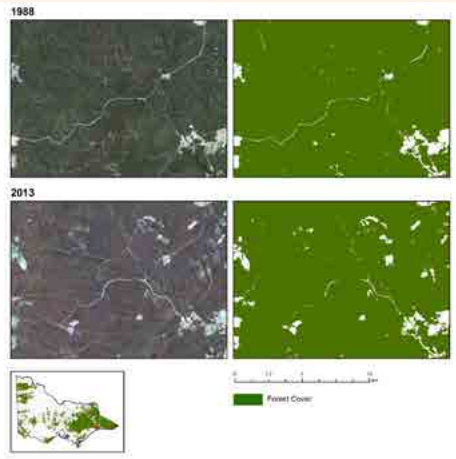
Figure 3. Changes in forest cover associated with harvesting operations and regeneration. Gippsland, eastern Victoria (1988 to 2013). Source DEPI

Forest extent

State and trend

Table 2 shows the estimated forest area on Victorian public and private land (by bioregion) at five-yearly intervals between 1988 and 2013. Table 3 shows forest area estimates on public forest land[8] only (State forest and Parks and conservation reserves).

Approximately 80% of Victoria's forest is on Crown land (75% on public forest land, comprising State forest and Parks and conservation reserve tenure).

Covering around 2.5 million hectares, the South East Highlands is the most forested bioregion in Victoria, followed up the Murray Darling Depression (1.5 million hectares) and the South East Corner and Victorian Midlands (1.2 million hectares). Proportionally, the Australia Alps is the most forested bioregion (95%). The Riverina and Victorian Volcanic Plain bioregions have the lowest amount of forest relative to their area (8% and 7% respectively).

Over the period of reporting (Table 2) the total extent of Victoria's forests has remained relatively stable, at (on average) 7.8 million hectares. Between 1988 and 2013, forest cover has increased or remained the same across all eleven Victorian bioregions. Changes in forest cover are associated with planting, growth and thickening of forest on private land. The stability of forest cover on public land is associated with the cessation of broad scale clearing and the improved protection of forests. Changes in public land forest area are associated with both human and natural processes, including forestry operations (harvesting and regeneration) and bushfires (crown defoliation and post-fire regeneration). Modelling and mapping error (refer to data source and limitations section below) is another source of forest area 'change'.

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[8]   NOTE: Public forest is a land tenure definition and includes a variety of non-vegetated and non-forest vegetation land cover types.

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Indicator 1.1a: Area of forest by type and tenure

Table 2. Victorian forest area on Crown and private land by bioregion (1988 to 2013). Source DEPI

Bioregion	Year and Forest Area* (hectares)					
	1988	1993	1998	2003	2008	2013
South East Highlands	2,445,000	2,478,000	2,472,000	2,494,000	2,459,000	2,514,000
Murray Darling Depression	1,401,000	1,498,000	1,491,000	1,387,000	1,350,000	1,489,000
South East Corner	1,200,000	1,210,000	1,198,000	1,213,000	1,199,000	1,217,000
Victorian Midlands	1,001,000	1,038,000	1,059,000	1,099,000	1,065,000	1,185,000
Australian Alps	680,000	685,000	682,000	683,000	678,000	680,000
South East Coastal Plain	263,000	289,000	273,000	290,000	258,000	305,000
Naracoorte Coastal Plain	189,000	202,000	202,000	234,000	236,000	249,000
NSW South West Slopes	148,000	165,000	166,000	164,000	156,000	172,000
Riverina	140,000	132,000	151,000	171,000	155,000	195,000
Victorian Volcanic Plain	90,000	93,000	100,000	135,000	123,000	158,000
Flinders	30,000	32,000	32,000	33,000	30,000	31,000
Total (Victoria)	**7,587,000**	**7,822,000**	**7,826,000**	**7,903,000**	**7,709,000**	**8,195,000**

*   rounded to nearest 1,000 hectares

Table 3. Victorian forest area public land forests (State forest and Parks and conservation reserves) by bioregion (1988 to 2013). Source DEPI

Bioregion	Year and Forest Area* (hectares)					
	1988	1993	1998	2003	2008	2013
South East Highlands	1,990,000	1,995,000	1,982,000	1,995,000	1,989,000	1,997,000
Murray Darling Depression	1,246,000	1,321,000	1,325,000	1,219,000	1,195,000	1,303,000
South East Corner	1,103,000	1,103,000	1,102,000	1,104,000	1,098,000	1,104,000
Australian Alps	662,000	666,000	665,000	665,000	661,000	662,000
Victorian Midlands	661,000	668,000	660,000	666,000	646,000	667,000
Naracoorte Coastal Plain	123,000	125,000	124,000	124,000	121,000	126,000
South East Coastal Plain	119,000	124,000	119,000	125,000	116,000	124,000
NSW South West Slopes	103,000	106,000	106,000	105,000	103,000	107,000
Riverina	97,000	69,000	99,000	103,000	102,000	103,000
Victorian Volcanic Plain	44,000	45,000	44,000	45,000	44,000	44,000
Flinders	30,000	32,000	32,000	33,000	30,000	31,000
Total	**6,178,000**	**6,254,000**	**6,258,000**	**6,184,000**	**6,105,000**	**6,268,000**

*   rounded to nearest 1,000 hectares

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Figure 4. Victorian forest cover, 2013. Source DEPI

Data source and limitations

While there have been changes in the area of different public land tenures over the time period of analysis, for the purpose of clarity and consistency, the total area of public forest tenure (comprising State forest and Parks and conservation reserves) remains fixed and based on the current public land tenure base. Changes between the respective areas of public and private land tenures are considered negligible.

Global error in the forest maps is estimated to be ± 15%. This is calculated as part of the forest modelling and mapping process, using an independent sample of aerial photography land cover information. Error in forest maps varies geographically, in some parts of the state forest area estimates will be more accurate than others. This error measurement is assumed to be consistent across all forest cover maps over the reporting period (1988 to 2013). Area estimates on public forest land are considered to have a higher degree of accuracy, as this was the source of the majority of ground calibration and validation data used in the mapping process.

Table 4. Area of forest by public forest tenure. Source DEPI

Tenure	Forest crown cover							
	Woodland (20-50%)		Open (51-80%)		Closed (81-100%)		Other/unknown*	
	Area (Ha)	CI (95%)	Area (Ha)	CI (95%)	Area (Ha)	CI (95%)	Area (Ha)	CI (95%)
State forest	357,891	4.2	1,775,934	1.5	544,996	4.5	294,914	6.7
Parks and conservation reserves	807,605	5.2	1,676,876	2.5	364,670	1.8	389,010	9.9

C.I. = Confidence Interval

*   Other/unknown category, includes forest potential land cover (i.e. vegetation with *potential* to meet the 20 per cent crown over and/or a minimum stand height of 2 metres), or, forest that has recently burnt resulting in crown defoliation, but is very likely to recover to meet the forest definition.

Forest Type

Aerial photography land cover maps were used to calculate area estimates for forest type across Victoria's public land forests. 4 km^2 aerial photography maps (systematically distributed across Victoria's public land) were generated by which specialists delineating the boundaries of forests and other land cover on the basis of broad forest type, canopy cover and height. Area and uncertainty estimates were calculated using a *direct expansion* method[9]. A detailed description of the method used to generate aerial photography land cover maps can be found in Farmer et al (2013)[10]. Information about forest type on private land is not reported.

Tables 4 and 5 show the area estimates for forest type, height and canopy cover across Victoria's public forest land (State forest and Parks and conservation reserves). Area estimates are accompanied by confidence intervals, indicating reliability of the area estimate.

Thirty two mile nature conservation reserve. Credit: DEPI

9   Deppe, F. (1998). Forest Area Estimation Using Sample Surveys and Landsat MSS and TM Data. Photogrammetric Engineering and Remote Sensing, 64(4).

10   Farmer, E., Jones, S., Clarke, C., Buxton, L., Soto-Berelov, M., Page, S., Mellor, A., et al. (2013). Creating a large area landcover dataset for public land monitoring and reporting. In C. Arrowsmith, C. Bellman, W. Cartwright, S. Jones, & M. Shortis (Eds.), Progress in Geospatial Science Research (pp. 85–98). Melbourne: Publishing Solutions.

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Indicator 1.1a: Area of forest by type and tenure

Table 5. Area of forest by broad forest type, height and canopy cover. Source DEPI

Forest Type/Land cover	Canopy Height Class	Canopy Cover Class	State forest Area (ha)	State forest C.I. (95%) (%)	Parks and conservation reserves Area (ha)	Parks and conservation reserves C.I. (95%) (%)
Eucalypt	Low	Woodland	19,895	8.3	68,001	4.8
	Medium		179,929	6.5	234,369	1.7
	Tall		58,281	7.9	39,830	5.4
	Low	Open	11,492	6.5	33,105	5.4
	Medium		808,105	2.4	846,636	1.4
	Tall		895,140	2.6	467,166	1.4
	Low	Closed	10,301	15.2	2,877	8.5
	Medium		151,501	8.2	77,993	3.1
	Tall		356,340	5.3	246,887	2.4
Mallee Eucalypt	Low	Woodland	117,872	2.8	665,686	7.7
Mixed and other forest typesA	Low	Woodland	3,683	4.0	12,399	4.9
	Medium		4,601	5.5	18,410	5.0
	Tall		9,637	17.0	13,131	5.8
	Low	Open	3,582	13.7	19,418	5.3
	Medium		17,859	7.4	60,099	2.7
	Tall		3,750	30.5	6,784	8.3
	Low	Closed	6,266	29.5	25,599	1.9
	Medium		14,055	16.3	10,520	2.2
	Tall		6,533	10.6	241	12.8
Forest potential shrub†			100,658	3.8	247,927	15.3
Non-forest			163,719	2.5	739,807	6.3
Forest unclassified (burnt)*			194,257	10.1	141,083	3.9
Plantation			1,028	19.1	498	2.4

† Forest potential shrub: previously forested land cover which has since undergone significant disturbance (e.g. bushfire) or clearance (e.g. clearfell logging), but which is known to be regnerating as "forest", having a potentially mature standard height exceeding two metres and crown cover of overstorey strata equal to, or greater than, 20 per cent.

* Forest unclassified (burnt): refers to forest which due to recent bushfire the type of which is difficult to distinguish.

Non-eucalypt forests

Eucalypt forests make up the vast majority of Victoria's public forests. As a result, other forest types are under-represented in the land cover map sampling and it is difficult to obtain reliable area estimates. For this analysis, these forest types are aggregated into a *mixed and other forest types* class. Based on data presented the previous State of the Forests Report (2008) other forest types make up less than 10% of Victoria's total native forest area. These include: casuarina, callitris, acacia, melaleuca, rainforest and mangrove.

Woodland forests (canopy cover between 21 and 50%) make up 12% of forest in State forest and 25% in Parks and conservation reserves. Closed forests (canopy cover greater than 80%) make up 10% of forests in State forest and 12% in Parks and conservation reserves.

Medium and tall open eucalypt forests make up almost sixty per cent of forest (by area) in Victoria's State forest. Medium open eucalypt forests and low woodland (Mallee) Eucalypt forest are the most extensive forest types in Parks and conservation reserves.

Across all public forests, there are approximately 1.7 million hectares of medium open eucalypt forest and 1.4 million hectares of tall open eucalypt forest. There are about 800,000 hectares of non-forest land within State forest and Parks and conservation reserves, with the majority (90%) on Parks and conservation reserves land.

Indicator 1.1a: Area of forest by type and tenure

Plantation forest

Victoria's planation forests include both hardwood and softwood and provide high grade export and domestic timber products (Indicator 6.1a). Plantation forests are almost all (99%) privately owned. Victoria has developed the third largest statewide industrial hardwood plantation source in Australia, and second largest softwood plantation area. Victorian plantations account of approximately 20 per cent of Australia's total plantation forest estate. Extensive plantation areas are harvested each year and some areas are not replanted and may be left fallow. Plantation is a land use term, which refers to both planted and fallow plantation land.

State and trend

In 2011/12, there were 434,000 hectares of industrial hardwood and softwood plantations in Victoria, located in the Green Triangle (south west Victoria), central Victoria, the Murray Valley (north east Victoria), and central and east Gippsland (eastern Victoria).

Victorian hardwood plantations – comprising mostly blue gum and a small amount of Shinning Gum – covered 207,000 hectares (47% of plantations). Radiata pine softwood plantations cover 226,000 hectares (52% of plantations) (2011/12).

Victoria's plantation area increased from 319,000 ha in 2000 up to 385,000 ha in 2005 and 433,000 ha in 2011. New plantations are those established on land not previously used for plantation, and since 2005, the rate of new planation establishment has been declining (Figure 5).

There is uncertainty as to how much of Victoria's existing plantation area will be retained for subsequent rotations. Victoria's total plantation estate may decrease slightly in the next few years.
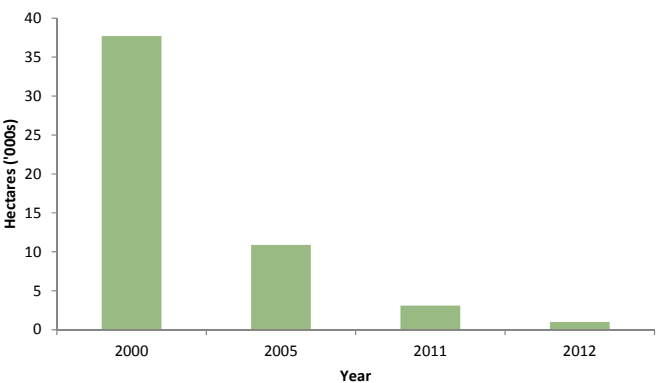
Figure 5. Area of new planation establishment in Victoria by year (2000-2012). Source DEPI

Under the Carbon Farming Initiative the rate of new planation establishment may be expected to increase. Through this initiative, farm forestry plantations less than 30 hectares or 30 per cent of a farm's area, will be eligible to generate carbon credits.

Plantations, Ovens Valley, Victoria. Credit: DEPI

Data source and limitations

Gavran, 2013, *Australian plantation statistics 2013 update*, ABARES technical report 13.3, Canberra, May.

http://www.dpi.vic.gov.au/forestry/about-forestry/publications/victorias-timber-industry-profiles/victorias-timber-plantation-industry-2012

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Mellor, A., Haywood, A., Stone, C., & Jones, S. (2013). The Performance of Random Forests in an Operational Setting for Large Area Sclerophyll Forest Classification. *Remote Sensing*, 5(6), 2838–2856. doi:10.3390/rs5062838

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Gavran, 2013, *Australian plantation statistics 2013 update*, ABARES technical report 13.3, Canberra, May.

http://www.dpi.vic.gov.au/forestry/about-forestry/publications/victorias-timber-industry-profiles/victorias-timber-plantation-industry-2012

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Indicator 1.1b: Area of forest type by growth stage

Why is this indicator important?

Knowledge about growth stage is important for sustainable forest management. Growth stage information is used to estimate forest biodiversity and ecology values. Reporting growth stage by broad forest type provides an indication of the diversity and balance of growth stages across Victoria's forest estate.

What have we measured and why is it relevant to the indicator?

Forests are dynamic systems that go through cycles of growth and development, referred to as growth stages. Effective sustainable forest management depends on the presence of a variety of growth stages to maintain biodiversity (Indicator 1.2b), the supply of wood products (Indicator 2.3) and other ecosystem services (Indicator 6.1c). The maintenance of biodiversity requires a mixture of different growth stages. Some species may depend on earlier forest growth stages, or the presence of more than one growth stage for their survival.

The area of growth stages varies over time because of natural growth stage transitions associated with tree mortality, natural disturbance events such as fire and storms and human disturbance from timber harvesting. The time a forest takes to reach a particular growth stage varies depending on forest type, location, rainfall, climate, soil conditions and disturbance history.

This indicator reports forest height class by forest type in Victorian native public forests as a proxy for growth stage. Forest height is classified according to the National Forest Inventory forest definition whereby a forest is a land area incorporating all living and non-living components, dominated by trees having usually a single stem and a mature or potentially mature stand height exceeding two metres and with existing or potential crown cover of overstory strata about equal to or greater than 20 percent[1]. Forest height classes are based on stand height as follows:

- Low forest: 2-10 m

- Medium: 11-30 m

- Tall: > 30 m

Aerial photography land cover maps were used to calculate area estimates for broad forest type and height class across Victoria's State forest and Parks and conservation reserves (public forests). A description of the method used to calculate areas and associated uncertainty estimates can be found in Indicator 1.1a. A detailed description of the method used to generate aerial photography land cover maps can be found in Farmer et al (2013)[2]. Information about forest type and height on private land is not reported. Table 1 shows the area estimate for forest type and height. Area estimates are accompanied by confidence intervals, indicating the reliability (as a percentage) of the area estimate.

State and trend

- Medium and tall eucalypt forests make up 78% of native forests across Victoria's State forest and Parks and conservation reserves, covering an of area of 4.3 million hectares.

- Low Mallee eucalypt forests cover about 780,000 hectares of land in north-west Victoria, much of which (~85%) is on Parks and conservation reserves land.

- The majority (70%) of the 145,000 hectares of low eucalypt forests are located in Parks and conservation reserves. This land tenure also includes the majority of low and medium mixed/other forest types.

Data source and limitations

Forest height is used as a proxy for growth stage, which is difficult to measure. Data presented in this report comprises only a single (baseline) year (2009) derived from aerial photography land cover maps. For details on the methodology used, including sources of error and data limitations refer to Indicator 1.1a.

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1   Department of Agriculture Fisheries and Forestry. *Australia's Forest at a Glance*; Department of Agriculture Fisheries and Forestry: Canberra, Australia, 2012

2   Farmer, E., Jones, S., Clarke, C., Buxton, L., Soto-Berelov, M., Page, S., Mellor, A., et al. (2013). Creating a large area landcover dataset for public land monitoring and reporting. In C. Arrowsmith, C. Bellman, W. Cartwright, S. Jones, & M. Shortis (Eds.), *Progress in Geospatial Science Research* (pp. 85–98). Melbourne: Publishing Solutions.

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Indicator 1.1b: Area of forest type by growth stage

Table 1. Forest height by broad forest type area estimates, State forest and Parks and conservation reserves.
Source DEPI

Forest type and height class	State forest		Parks and conservation reserves	
	Area (ha)	% C.I. (95%)	Area (ha)	% C.I. (95%)
Low Eucalypt	41,688	6.1	103,983	3.6
Medium Eucalypt	1,139,535	1.8	1,158,997	1.1
Tall Eucalypt	1,309,761	1.8	753,883	1.0
Mallee Eucalypt	117,872	2.8	665,686	7.7
Low Mixed/Other* forest	13,530	15.6	57,416	2.6
Medium Mixed/Other forest	36,514	7.6	89,029	2.7
Tall Mixed/Other forest	19,920	11.9	20,156	6.1
Forest potential shrub†	100,658	3.8	247,927	15.3
Non-forest	359,003	5.5	881,388	5.4

C.I. = Confidence Interval

†Forest potential shrub: previously forested land cover which has since undergone significant disturbance (e.g. bushfire) or clearance (e.g. clearfell logging), but which is known to be regenerating as "forest" (i.e. having a potentially mature standard height exceeding two metres and crown cover of overstorey strata equal to, or greater than, 20 per cent).

*Mixed/Other forest types include casuarina, callitris, acacia, melaleuca, rainforest and mangrove. Eucalypt forests comprise the vast majority of Victoria's public forests. As a result, other forest types are under-represented in the land cover map sampling and it is difficult to obtain reliable area estimates. For this analysis, these forest types are aggregated into a *mixed and other forest types* class. Based on data presented the previous State of the Forests Report (2008) other forest types make up less than 10% of Victoria's total native forest area.

Top Box Ironbark and stringybark woodland, Werribee Gorge State Park.
Credit: Rexness **Bottom Mountain Ash.** Credit: Elizabeth Donoghue

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Indicator 1.1c: Area of forest type by growth stage distribution in protected zones

Why is this indicator important?

The conservation of biodiversity requires areas of forest protected in reserves large enough to sustain forest ecosystems and the species that inhabit them. The area of protected forest is also a measure of the emphasis placed by government and community on the conservation of forest ecosystems and biodiversity.

Credit: DEPI

What have we measured and why is it relevant to the indicator?

The protection of forests is a key objective of sustainable forest management. In Victoria, specific levels of forest protection are used to establish a comprehensive, adequate and representative (CAR) reserve system. This indicator reports on the area and distribution of formal and informal reserves which make up Victoria's CAR reserve system, the majority of which is covered by forest. Internationally adopted and standardised IUCN[1] definitions of protected area categories are used to report on the changes in, and the current extent of, Victoria's CAR reserve system.

Victoria's CAR reserve system

Both Parks and conservation reserves and State forest[2] contribute to Victoria's CAR reserve system, providing an integrated network of forest conservation areas across the state. The CAR reserve system includes formal and informal reserves (described below). The Victorian Environmental Assessment Council (VEAC) has responsibility for conducting investigations associated with the protection and ecologically sustainable management of the environment and natural resources of public land. The creation and maintenance of the CAR reserve system is therefore a consideration in all VEAC recommendations on the appropriate use and management (arrangements) of public land in Victoria.

Formal reserves – Crown land formally reserved for environmental protection and include National Parks, State Parks, nature conservation reserves and other conservation areas.

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[1]   International Union for Conservation of Nature
[2]   refer to Introduction for definitions

The proportion of Victorian land assigned formal protection status has risen from less than 1% in the 1950s to 17% today (Figure 1). The significant growth in formal protected area since the late 1970s is the result of the addition of more than 3,000 protected areas. Much of this increase has occurred under the National Parks Act and Crown Land (Reserves) Act. Between 2000 and 2012, the total area of Parks and conservation reserves increased by almost half a million hectares, much of which was due to the re-assignment of informally reserved (see below) and unreserved State forest.
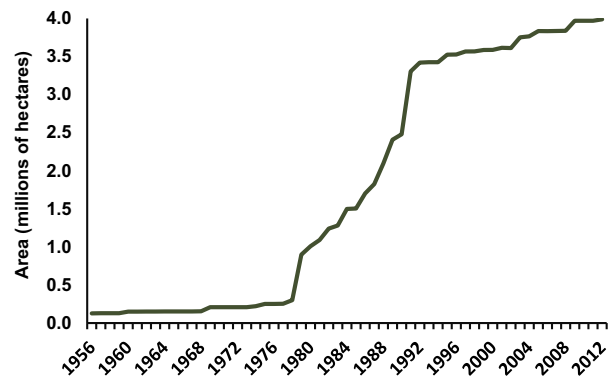
Figure 1. Change in Victoria's formal protected area (Parks and conservation reserves), 1956-2012. Source Parks and Reserves Information Management System 2013 (DEPI)

Informal reserves – Public land protected through administrative instruments by public authorities. Informal reserves within State forest that manage particular conservation values, while excluding timber harvesting, are classified under Forest Management Zoning (refer to Indicator 2.1) as Special Protection Zones (SPZ)

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Indicator 1.1c: Area of forest type by growth stage distribution in protected zones

Table 1. Area of formal and informal reserves in Victoria (2006 – 2012). Source DEPI

Reserve category		Year (Area in millions of hectares)		
		2006	**2008**	**2012**
Formal[A]		3.83	3.84	3.99
Informal[B]	SPZ	0.83	0.78	0.74
	Total	4.66	4.62	4.74

A   Parks and Reserves Information Management System 2013.

B   DEPI 2013. See Indicator 2.1

IUCN Protected Areas

The International Union for Conservation of Nature (IUCN) defines a protected area as a clearly defined geographic space, recognised, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature and associated ecosystem services and cultural values[3]. Under Australia's Strategy for the National Reserves System 2009-2030, all state and territory Governments (including Victoria) have agreed to adopt these IUCN international standards for defining and reporting areas of protected area management. All Victorian formal reserves are assigned an IUCN protected area category on the basis of protection status and primary land management. The IUCN categories assigned to particular areas may be subject to refinement from time to time. Informal reserves are not assigned an IUCN protected area category.

IUCN Protected Area Categories

Ia Strict Nature Reserve: Protected areas that are strictly set aside to protect biodiversity and also possibly geological/geomorphological features, where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation values. Such protected areas can serve as indispensable reference areas for scientific research and monitoring. Ia protected areas are designated to conserve regionally, nationally or globally outstanding ecosystems, species (occurrences or aggregations) and/or geodiversity features: these attributes will have been formed mostly or entirely by non-human forces and will be degraded or destroyed when subjected to all but very light human impact.

Ib Wilderness Area: Protected areas that are usually large unmodified or slightly modified areas, retaining their natural character and influence, without permanent or significant human habitation, which are protected and managed so as to preserve their natural condition. These areas are categorised to protect the long-term ecological integrity of natural areas that are undisturbed by significant human activity, free of modern infrastructure and where natural forces and processes predominate, so that current and future generations have the opportunity to experience such areas.

II National Park: Large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible spiritual, scientific, educational, recreational and visitor opportunities. II protected areas are designated to protect natural biodiversity along with its underlying ecological structure and supporting environmental processes, and to promote education and recreation.

III Natural monument or feature: Protected areas set aside to protect a specific natural monument, which can be a landform, sea mount, submarine cavern, geological feature such as a cave or even a living feature such as an ancient grove. They are generally quite small protected areas and often have high visitor value. These areas are assigned for the protection of specific outstanding natural features and their associated biodiversity and habitats.

IV Habitat/species management area: Protected areas aiming to protect particular species or habitats and management reflects this priority. Many category IV protected areas will need regular, active interventions to address the requirements of particular species or to maintain habitats, but this is not a requirement of the category. The primary objective of these areas is to maintain, conserve and restore species and habitats.

V Protected landscape/seascape: A protected area where the interaction of people and nature over time has produced an area of distinct character with significant ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values. Category V areas are protected to sustain important landscapes/seascapes and the associated nature conservation and other values created by interactions with humans through traditional management practices.

VI Protected area with sustainable use of natural resources: Protected areas that conserve ecosystems and habitats, together with associated cultural values and traditional natural resource management systems. They are generally large, with most of the area in a natural condition, where a proportion is under sustainable natural resource management and where low-level non-industrial use of natural resources compatible with nature conservation is seen as one of the main aims of the area. Category VI areas protect natural ecosystems and use natural resources sustainably, when conservation and sustainable use can be mutually beneficial.

Source: IUCN 2013

3   Dudley, N. (Editor) (2008). *Guidelines for Applying Protected Area Management Categories*. Gland, Switzerland: IUCN. x + 86pp,

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Indicator 1.1c: Area of forest type by growth stage distribution in protected zones

Figure 2 shows the extent of terrestrial[4] IUCN protected areas by category in 2012. Table 2 shows changes in the extent of Victorian protected areas (by IUCN category) between 2004 and 2012, as well as the proportion of forest cover (extent) by category in 2012. Refer to Indicator 1.1a for information about the Victorian forest extent map and forest definition.
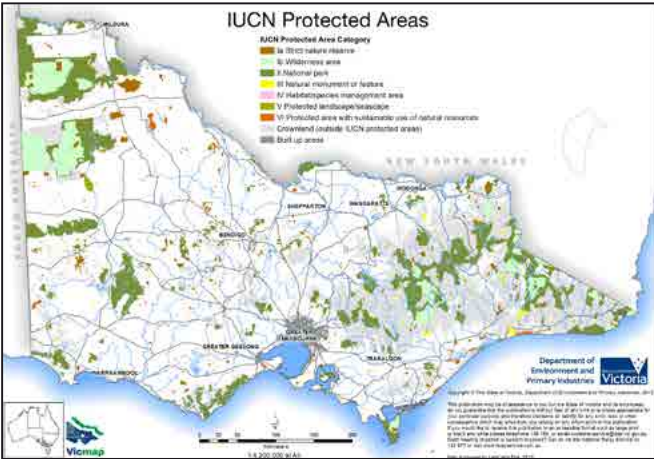
Figure 2. Victorian terrestrial IUCN protected areas (2012). Source DEPI

Table 2. Protected areas by IUCN category and informal Special Protection Zone reserves[†] (2004-2012). Source DEPI

Formal protection	Area (hectares*)					
IUCN Category	2004	2006	2008	2010	2012	Proportion of forest cover (%)[A]
Ia	356,300	366,200	381,900	380,700	388,600	86
Ib	815,500	815,300	815,700	815,700	815,500	84
II	2,128,600	2,182,400	2,224,200	2,309,700	2,371,300	85
III	55,000	48,900	49,500	51,300	78,000	73
IV	48,000	44,900	43,800	43,700	47,400	64
V	58,500	57,800	56,600	49,200	26,800	41
VI	91,100	89,200	94,500	85,100	130,600	87
All IUCN protected areas	3,553,000	3,604,700	3,666,200	3,735,400	3,858,200	
Informal protection						
SPZ	828,100	828,100	783,100	783,100	753,100	87
Total	4,381,100	4,432,800	4,449,300	4,518,500	4,611,300	85

*   rounded to nearest 100 hectares

[†]   Excluding marine/estuarine protected areas.

[A]   Estimated proportion of forest cover (2012) for total area of protected category.

Credit: Arthur Rylah Institute

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[4]   Excludes marine/estuarine protected areas

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Indicator 1.1c: Area of forest type by growth stage distribution in protected zones

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Over the six year period 2006 to 2012, the total area of Victoria's formal and informal reserves increased by 2% (Table 1). While the area of informal reserves decreased by 75,000 hectares, the area of formal reserves increased by about 160,000 hectares. This change was largely due to reassignment of State forest to Parks and conservation reserves status in the East Gippsland, Mid Murray, Mildura, Otways and Portland Forest Management Areas.

Terrestrial IUCN protected areas make up about a fifth of Victoria's land. Covering 2.4 million hectares, category II (National Parks) make up more than half of the total area of IUCN protected areas in Victoria. Followed by categories Ib (wilderness areas) and Ia (Strict Nature Reserve) - 21% and 10% of IUCN protected areas respectively.

Between 2004 and 2012, there has been an 8% increase in the extent of IUCN protected areas in Victoria (Table 2). Over this period, the area of IUCN category II increased by 11% and category Ia, by 9%. In 2012, forest cover was about 85% for both of these categories. Changes in the areas of categories III and V are the result of category reclassification (i.e. the reassignment of category V areas to category II or III status).

Data source and limitations

The data presented in this indicator report is derived from DEPI corporate geospatial datasets FMZ100 (Forest Management Zones) and the Victorian component of the Collaborative Australian Protected Areas Database (CAPAD). CAPAD is a composite spatial dataset encompassing data that includes Victoria's Parks and reserves system, Reference Areas, Wilderness Zones, Remote and Natural Areas, Natural Catchment Areas and Heritage River Overlays. As CAPAD is a composite dataset its scale ranges from 1:25,000 to 1:100,000. These datasets change from time to time, reflecting new land use assignment, revisions of classifications and boundary updates. Boundary updates may include major reviews, minor changes to reflect new information, or improvements in base layers.

Between 2008 and 2012, DEPI remapped the Victorian public land management base layer, refining its scale from 1:100,000 to 1:25,000. This improvement in the precision and accuracy of boundaries resulted in some change to area estimates.

Credit: DEPI

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Indicator 1.1d: Fragmentation of native forest cover

Why is this indicator important?

The fragmentation of forest cover can have a significant effect on forest dwelling species, as well as forest community structure and composition. It is considered one of the greatest threats to biodiversity, the effects of which are a function of the number and distance between forest patches and the amount of edge habitat within each forest patch[1][2]. Loss of forest and the fragmentation of remaining forests pose also affect the sustainable provision of forest ecosystem goods and services[3]. Fragmentation can lead to geographically and genetically isolated populations, limiting flora and fauna species interaction. This interferes with pollination, seed dispersal, wildlife migration and breeding – it can also results in loos of generic variability and increased vulnerability of species.

Changes in the degree or patterns of forest fragmentation can affect habitat quality for a range of biodiverse forest species[4] and as forest fragmentation increases beyond natural forest disturbance, edge effects become more dominant and threaten species adapted to forest patch interiors. Fragmentation is a critical aspect of the extent and distribution of forested systems, with many forest species adapted to either edge or interior habitats.

1 Uuemaa, E., Antrop, M. & Marja, R., 2009. Landscape Metrics and Indices : An Overview of Their Use in Landscape Research. *Landscape Research*, pp.1–28.
2 Gergel, S.E., 2007. New Directions in Landscape Pattern Analysis and Linkages with Remote Sensing. In M. A. Wulder & S. E. Franklin, eds. *Understanding Forest Disturbance and Spatial Pattern*. Taylor & Francis, p. 246.
3 Riitters, K. et al., 2000. Global-Scale Patterns of Forest Fragmentation. *Conservation Ecology*, 43(2). Available at: http://www.consecol.org/vol4/iss2/art3/ .
4 Fahrig, L., 2003. Effects of Habitat Fragmentation on Biodiversity. *Annual Review of Ecology, Evolution, and Systematics*, 34(1), pp.487–515. Available at: http://www.annualreviews.org/doi/abs/10.1146/annurev.ecolsys.34.011802.132419

What have we measured and why is it relevant to the indicator?

This indicator describes the spatial configuration and fragmentation of Victoria's forest cover. Fragmentation refers to processes which result in the conversion of continuous forest into patches of forest separated non-forest lands. Forest spatial configuration broadly refers to the analysis of patch size and shape configuration, the connectivity of patches within the landscape, as well as composition within patches (e.g. disturbance and successional change). In this indicator report, the term fragmentation is used to refer to both forest fragmentation and forest spatial configuration.

Forest fragmentation occurs naturally, through rock outcrops, wetlands and non-forest vegetation, as well as streams and water bodies. Within continuous forest blocks, the fragmentation of spatial arrangement of age-class structure is associated with successional change driven by fire, climate changes and other disturbance (See Indicator 3.1) - a key feature of Australian forests.

In Victoria, as in much of Australia, land use change, associated with agriculture and urban development has been the primary driver of forest fragmentation since European settlement in the 1830s. Since that period, more than 60% (14 million hectares) of Victoria's native forests have been cleared, making Victoria the most cleared (proportionally) of all Australia states and territories. With the increased protection of forests (See Indicator 1.1c) and cessation of broad scale forest clearing, forest fragmentation has stabilised. Furthermore, reforestation though planting new native forests has helped re-establish connectivity between patches.

The 2013 Victorian Forest extent map was used to measure the forest fragmentation and spatial configuration metrics. Forest extent includes both native forest and commercial

Old Channel reserve, Walpeup. Credit: DSE

plantations. A description of the methodology used to generate the forest extent map is included in Indicator 1.1a and Mellor et al. (2013).

The first fragmentation analysis – based on Riitters et al. (2000) – involves using a model to categorise forest fragmentation based on the degree of forest land surrounding each forest pixel in the forest cover maps (each pixel is a square on the map, with sides representing approximately 30 m on the ground). Results are based on five categories of forest fragmentation. Examples of fragmentation classes are shown in Figure 1:

1. **Interior** - forest pixels that are relatively far from the forest-non-forest boundary. Essentially these are forested areas surrounded by more forested areas

2. **Patch** - forest pixels that comprise a small forested area surrounded by non-forested land cover

3. **Transitional** - representing transition areas between connected forest and fragmented forest

Indicator 1.1d: Fragmentation of native forest cover

4. **Perforated** - forest pixels that define the boundary between core forest and relatively small clearings (perforations) within the forested landscape

5. **Edge** - forest pixels that define the boundary between core (interior) forest and large non-forested land cover features.

For each forest cover map, all forest pixels are assigned a fragmentation class. Areas of each fragmentation class are calculated by land tenure and represented a proportion of all forest by land tenure (Figure 3).
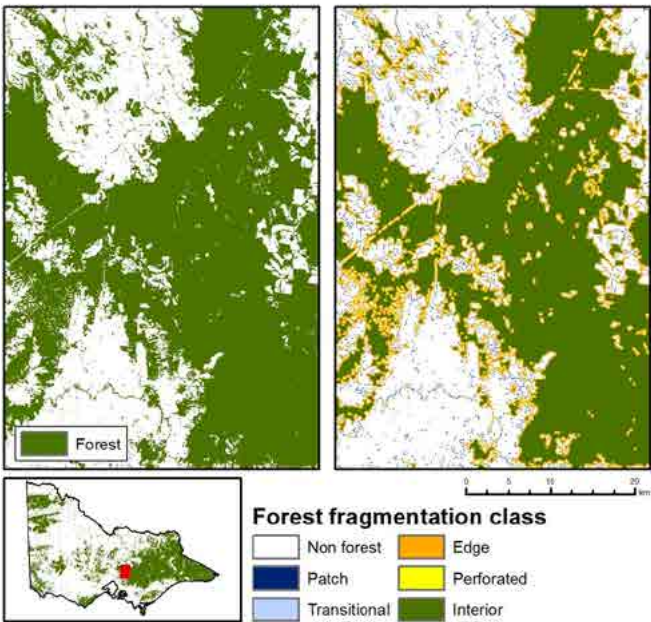
Figure 1. Forest fragmentation classification map. Source DEPI

State and trend

Table 1 shows the proportion of each forest fragmentation class by bioregion.

- 76 percent of Victoria's forest cover is classed as interior (i.e. core, non-fragmented forest) and 14 percent as edge, representing the boundary between interior forest and non-forest landcover.

- Most of Victoria's interior forest is located in the eastern part of the state. The Australian Alps (93%), South East Corner (91%) and South East Highlands (87%) bioregions, have the highest proportion of interior forest cover.

- The Riverina bioregion has the lowest proportion of interior forest cover (27%) and also the highest proportion of forest patches (24%).
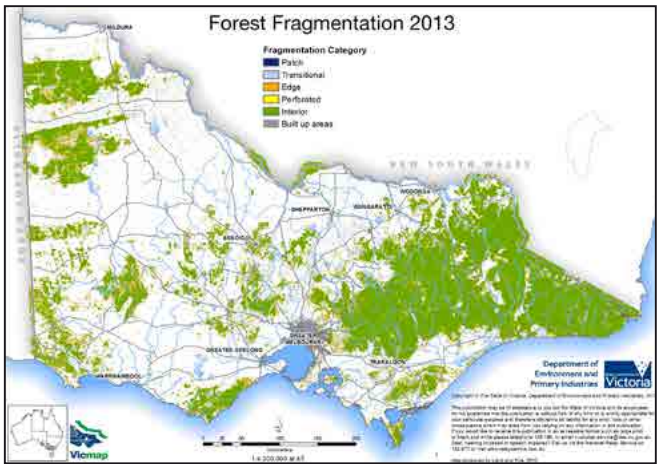
Figure 2. Victorian 2013 forest fragmentation map. Source DEPI
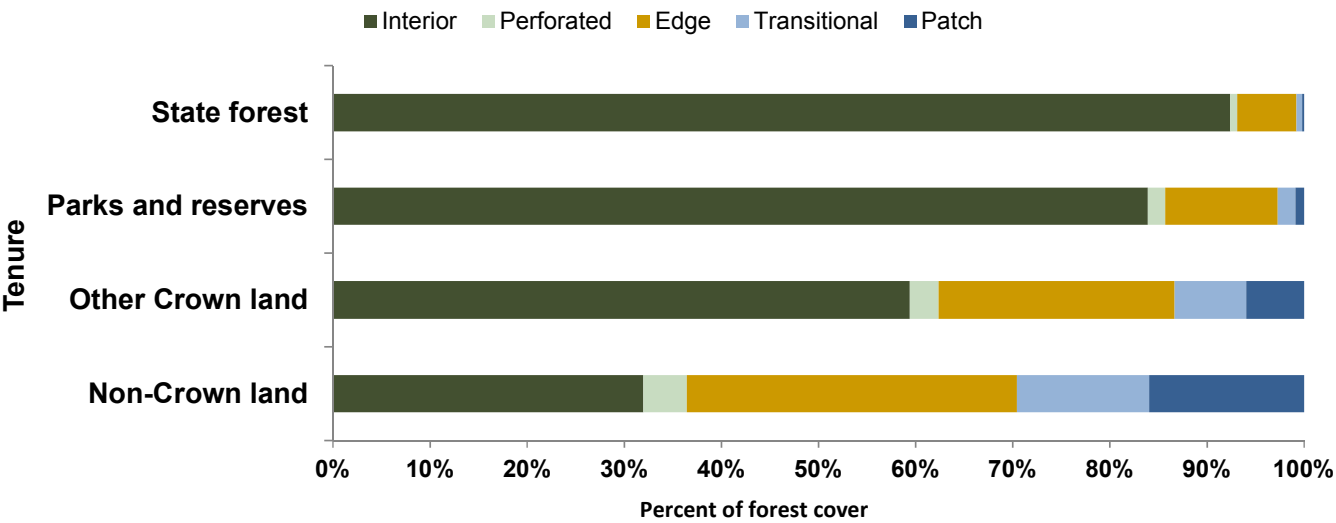
Figure 3 Victorian forest cover fragmentation categories, by land tenure (2013). Source DEPI

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Table 1. Proportion of forest fragmentation category by bioregion (2013). Source DEPI

Bioregion	Forest Cover Fragmentation category (proportion of bioregion total area)				
	Edge	Interior	Patch	Perforated	Transitional
Australia Alps	6	93	<1%	1	<1%
Flinders	23	68	1	4	4
Murray Darling Depression	18	69	5	3	5
Naracoorte Coastal Plain	25	65	2	4	4
NSW South West Slopes	22	64	5	2	6
Riverina	29	27	24	4	16
South East Coastal Plain	30	48	9	4	10
South East Corner	6	91	1	1	1
South East Highlands	9	87	1	1	2
Victorian Midlands	24	60	6	3	7
Victorian Volcanic Plain	29	41	16	3	11
Victoria (Statewide)	14	76	4	2	4

Landscape forest pattern metrics

A second fragmentation analysis considers commonly used spatial configuration metrics calculated using the 2013 Victorian forest extent map. These metrics (described in Table 2), are commonly used to characterise the fragmentation of forested land[5] appropriate for regional and national forest and land cover maps. Victoria's bioregions are used as a unit of analysis, with which to assess and compare forest landscape patterns across Victoria (Table 3).

Table 2. Landscape forest pattern metrics. Source DEPI

Metric	Definition and interpretive value
Proportion of forested area	Proportion of sampling area that is occupied by forest
Number of forest patches	Count of the total number of forest patches
Patch size (mean and SD)	Mean (and standard deviation, (SD)) patch size (area) of the forest patches in the sampling area, is calculated for all forest patches in the sampling area, by dividing the sampling area size by the number of patches. A smaller than average forest patch size is indicative of more fragmented forest. SD is used as a measure of the absolute variation in patch size for the sampling area; the mean patch size can obscure the presence of very large and very small patches.
Forest core size (mean and SD)	Mean (and SD) area of the core of forest patches in the sampling area.
Forest perimeter (total, mean and SD)	Total, mean and SD perimeter length for all forest patches in the sampling area
Forest edge† size (mean and SD)	Mean (and SD) area of the edge of patches in the sampling area. Larger values indicate more forest edge habitat and more fragmentation.
Degree of landscape division	The probability that two randomly chosen places in sampling area are *not* situated in the same undissected area. Varies from 0.0 to 1.0, where 0.0 is undivided and 1.0 is maximum division.
Effective mesh number	Splitting Index. A large number indicates more patches and more fragmentation

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5   Wulder, M., White, J. & Han, T., 2008. Monitoring Canada's forests. Part 2: National forest fragmentation and pattern. *Canadian Journal of Remote Sensing*, 34(6), pp.563–584. Available at: http://pubs.casi.ca/doi/abs/10.5589/m08-081

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Table 3. Landscape pattern metrics for assessing forest by Bioregion in Victoria (2013). Source DEPI

Bioregion	Bioregion Area (ha)	Forest Area (ha)	Proportion forested (%)	No. of forest patches	Patch Size (ha)		Core Size (ha)		Forest perimeter (km)			Forest edge size (ha)		Degree of Landscape Division	Effective Mesh Number
					Mean	SD	Mean	SD	Sum	Mean	SD	Mean	SD		
Australian Alps	714,270	680,249	95	329	2,066.3	16,465.5	1,995.4	15,962.8	11,056	33.6	254.8	70.8	538.2	0.80	5.1
Flinders	41,157	31,257	76	125	249.9	2,734.2	229.4	2,534.1	1,272	10.2	97.9	20.5	200.2	0.03	1.0
Murray Darling Depression	6,356,148	1,488,649	23	29,774	50.0	4,493.6	44.4	4,253.5	84,061	2.8	120.0	5.5	247.8	0.73	3.7
Naracoorte Coastal Plain	421,352	246,309	58	1,904	129.3	3,169.0	117.8	2,941.3	10,488	5.5	106.2	11.5	228.5	0.68	3.2
NSW South Western Slopes	565,869	172,497	30	4,675	36.9	563.0	32.1	524.9	11,428	2.4	19.4	4.7	39.9	0.95	20.0
Riverina	2,507,926	195,497	8	20,911	9.3	267.0	5.9	241.4	38,698	1.9	15.7	3.4	32.1	0.96	25.6
South East Coastal Plain	1,749,586	305,329	17	13,257	23.0	672.8	18.6	629.2	30,593	2.3	22.6	4.5	48.0	0.94	15.5
South East Corner	1,395,426	1,217,358	87	2,460	494.5	23,848.3	482.7	23,407.9	14,395	5.9	210.4	11.9	440.4	0.05	1.1
South Eastern Highlands	3,178,715	2,514,035	79	12,832	195.8	18,345.9	187.0	17,824.3	56,221	4.4	250.2	8.8	523.5	0.32	1.5
Victorian Midlands	3,468,873	1,185,163	34	29,666	39.9	1,769.3	34.3	1,658.1	84,572	2.9	55.4	5.6	115.4	0.93	15.1
Victorian Volcanic Plain	2,355,992	157,760	7	14,644	10.8	230.5	7.9	215.4	22,253	1.5	7.5	2.8	16.2	0.97	31.9

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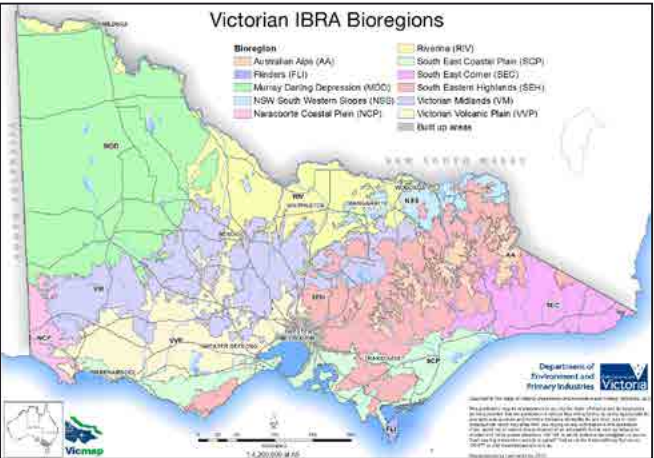
Source DEPI

Wallpolla Island. Credit: DSE

State and trend

- Flinders and South East corner bioregions have the lowest degree of landscape division (0.03 and 0.05 respectively), indicating a very low degree of forest fragmentation in these areas.

- The Riverina and Victorian Volcanic Plains bioregions have the highest degrees of landscape division and contain the lowest proportion of forest cover (8% and 7% respectively). These bioregions also have the smallest average forest patch sizes and highest splitting index scores (effective mesh number), demonstrating the high degree of fragmentation in these areas. They also have the smallest average 'core' sizes (5.9 ha and 7.9 ha respectively).

- The Victorian Midlands and Murray Darling Depression bioregions contain the largest number of forest patches (about 29,000 in each).

Data source and limitations

The data presented in this report (both fragmentation classification and spatial configuration metrics) is calculated from Forest extent 2013, a modelled spatial layer, which itself has an estimated spatial accuracy of ~85%. A description of sources of error can be found in Mellor et al. (2013) and Indicator 1.1a.

Since the previous Victorian State of the Forests Report (2008), an updated forest definition has been adopted and improved data and analysis methodologies are being used. As a result, direct comparisons of forest cover fragmentation data between the 2013 and 2008 reports, would be misleading.

References and further reading

Uuemaa, E., Antrop, M. & Marja, R., 2009. Landscape Metrics and Indices : An Overview of Their Use in Landscape Research. *Landscape Research*, pp.1–28.

Gergel, S.E., 2007. New Directions in Landscape Pattern Analysis and Linkages with Remote Sensing. In M. A. Wulder & S. E. Franklin, eds. *Understanding Forest Disturbance and Spatial Pattern*. Taylor & Francis, p. 246.

Riitters, K. et al., 2000. Global-Scale Patterns of Forest Fragmentation. *Conservation Ecology*, 43(2). Available at: http://www.consecol.org/vol4/iss2/art3/ .

Fahrig, L., 2003. Effects of Habitat Fragmentation on Biodiversity. *Annual Review of Ecology, Evolution, and Systematics*, 34(1), pp.487–515. Available at: http://www.annualreviews.org/doi/abs/10.1146/annurev.ecolsys.34.011802.132419

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Why is this indicator important?

This indicator measures the conservation status of forest dependent species considered to be rare and threatened. Conservation status shows the extent to which biodiversity is being maintained in Victoria's forests and can provide an indication of changes in forest health. Changes in conservation status can be used to assess the effectiveness of biodiversity management and species recovery programs.

What have we measured and why is it relevant to the indicator?

The conservation status of threatened Victorian forest dependent species is determined through two mechanisms: the *Flora and Fauna Guarantee Act 1988* (FFG) Threatened List and DEPI Advisory Lists. The FFG Threatened List is Victoria's legislated mechanism for recognising threatened species. The DEPI Advisory Lists include species that are systematically assessed as having a threatened conservation status[1] across all Victorian land tenures.

This indicator reports the conservation status of threatened forest dependent species on the DEPI Advisory List. These lists are used in preference to the FFG Threatened List because they are comprehensive, based on knowledge rather than rates of nomination, and provide a mechanism to report conservation status.

Conservation status of forest dependent species

Victoria defines conservation status as the extent to which ecosystems or species remain in their natural condition relative to their pre-European distribution[2]. Factors considered in assessing species conservation status include rates of population reduction, geographic range, population size and probability of extinction[3]. A species is considered to be threatened if it is in a state of decline, or is highly susceptible to future threats, which are likely to result in extinction. This assessment is made at a statewide level and does not consider regional, national or international scale.

DEPI maintains separate Advisory Lists for plants, vertebrate fauna and invertebrate fauna. The Advisory Lists assign a conservation status category for each listed species based on IUCN criteria[2]. The term 'rare and threatened' describes species that are regionally extinct, critically endangered, endangered or vulnerable. 'Rare' species are those which are near threatened or data deficient. Advisory Lists are updated periodically based on technical information and advice obtained from a range of experts. Inclusion of a species on the Advisory Lists does not trigger any legal obligations.

Forest dependent species are those that rely on forest habitat for all or part of their life cycle. DEPI experts determine the forest dependency of species on the basis of known habitat requirements.

Powerful owl. Credit: Ian McCann

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[1] See http://www.depi.vic.gov.au/environment-and-wildlife/threatened-species-and-communities/threatened-species-advisory-lists

[2] DSE (2004) Fact Sheet No 14 Native biodiversity assessment – defining conservation status of species and ecosystems.

[3] IUCN Red List Categories and Criteria. Version 3.1, second edition. See www.iucnredlist.org

Indicator 1.2a: The status of forest dependent species at risk of not maintaining viable breeding populations, as determined by legislation or scientific assessment

Data source and limitations

DEPI review Advisory Lists periodically to take into consideration new information and changes in conservation status. The data reported is derived from the DEPI Advisory Lists current to 2013. These include the:

- Advisory list of threatened vertebrate fauna in Victoria – 2013
- Advisory list of threatened invertebrate fauna in Victoria – 2009
- Advisory list of rare or threatened plants in Victoria – 2005.

The Advisory Lists should be interpreted with care. Conservation status is assigned on the best information available at the time of assessment. This varies widely between species, reflecting the level of survey effort and available expertise. Bryophytes, fungi and invertebrates are particularly under studied. Consequently, status changes may reflect changes in knowledge rather than actual risk to species. Taxonomic decisions and changes to the IUCN assessment methodology also result in changes in conservation status.

Sugar glider. Credit: Ian McCann

The period between Advisory List reviews can be lengthy and sometimes exceeds the time between State of the Forests reports. This is the case for the Advisory List of rare or threatened plants in Victoria, which was last reviewed in 2005.

To generate this report, the Advisory Lists are filtered to forest dependent species. This data is sourced from lists of forest dependent species maintained by DEPI for the purpose of this analysis.

State and trend

Table 1 provides a summary of the number of species in each conservation status category by species groups. Figure 2 shows the change in total number of species listed as rare or threatened by group and reporting period since 2003.

- There are currently 461 forest dependent species that are considered to be rare or threatened in Victoria.
- Vascular plants represent by far the greatest proportion of these species. This is most probably due to greater knowledge and awareness of vascular plants within the scientific community, and their relative ease of detection.
- DEPI has not reviewed plant conservation status during the reporting period, hence there are no changes to report.
- DEPI released the first issue of the Advisory List for invertebrate fauna in 2009. 34 forest dependent invertebrates are listed as threatened. These are predominantly crayfish and aquatic insects including stonefly, damselfly and caddisfly. Freshwater crayfish

Table 1. Number of species by conservation status (2013). Source DEPI

Species groupings	Extinct	Extinct in the Wild	Regionally Extinct	Critically Endangered	Endangered	Vulnerable	Near Threatened[4]	Data Deficient[5]	Total
Fauna									
Amphibians				7	3	2		3	15
Birds				4	15	17	15		51
Fish				2		3	1		6
Invertebrates				5	7	12	1	9	34
Mammals	8	1	9	2	7	6	14	2	49
Reptiles				5	7	8	7		27
Flora									
Vascular plants					85	179	5	1	270
Other flora					2	5	1	1	9
Total	**8**	**1**	**9**	**25**	**126**	**232**	**44**	**16**	**461**

[4] Includes flora listed as 'rare' in Victoria

[5] Includes flora 'poorly known' in Victoria

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and butterflies are the only two of 33 invertebrate phyla considered to be comprehensively assessed for conservation status in Victoria.

- The total number of forest dependent vertebrate fauna considered to be rare or threatened decreased by 2 species during the reporting period.

- The conservation status of 18% of rare and threatened vertebrate fauna species changed with the revised advisory list. The Eastern Bettong became extinct and the Eastern Barred Bandicoot became extinct in the wild. 14% of species became more threatened. These were mostly amphibians and reptiles. 4% of species became less threatened.

Yellow-tufted honeyeater. Credit: Ian McCann

References and further information

DEPI Flora and Fauna Guarantee Act webpage. http://www.depi.vic.gov.au/environment-and-wildlife/threatened-species-and-communities/flora-and-fauna-guarantee-act-1988

DSE (2005) Advisory List of Rare or Threatened Plants in Victoria – 2005. DSE, East Melbourne, Victoria.

DSE (2009) Advisory List of Threatened Invertebrate Fauna in Victoria – 2009. DSE, East Melbourne, Victoria.

DSE (2013) Advisory List of Threatened Vertebrate Fauna in Victoria – 2013. DSE, East Melbourne, Victoria.

IUCN (2012) IUCN Red List Categories and Criteria: Version 3.1. Second edition. IUCN, Gland, Switzerland and Cambridge U.

Figure 1. Changes in numbers of rare or threatened species by reporting period. Source DEPI

Bayesian networks

DEPI has developed flexible models called Bayesian Networks (BN) which are used to model the condition of, and level of threat to, selected threatened flora and fauna populations.

These models can be used to track long term changes in a species threat status. They also predict which management actions will be most effective in both managing the habitat as well as the species itself. An example management action may be the exclusion of fire to preserve habitat or the inclusion of fire to ensure a species can regenerate if it requires fire as a part of its lifecycle.

This latest method of using Bayesian Networks is another tool which can aid DEPI, land managers and community groups, to both identify and manage for threatened species and communities across Victoria within, and dependent upon, forests.

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Indicator 1.2b: Area of habitat available for forest dependent indicator species

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Why is this indicator important?

The availability of suitable habitat is fundamental to the survival of forest dependent species, and thus the maintenance of biodiversity and ecosystem function. Monitoring the extent and diversity of habitats aids our understanding about the possible welfare of biota that rely on these habitats. Whilst the existence of habitat does not necessarily indicate the presence of a particular species, monitoring habitat availability trends can identify emerging forest biodiversity management priorities.

What have we measured and why is it relevant to the indicator?

This indicator is intended to report on the area of habitat available for forest dependent indicator species. The ability of indicator species to provide a reliable view of overall forest dependent biodiversity is not well established and Victoria has not as yet identified suitable indicator species for monitoring. Reporting the diversity of habitat structures is an alternative way to monitor habitat available forest dependent biodiversity[1].

During this reporting period the Victorian Forest Monitoring Program (VFMP) collected a range of data about habitat structures and floristic species richness in Victorian public forests. Data for bioregional habitat structure is presented along with a discussion of its relevance to forest dependent biodiversity. Floristic species richness provides a direct estimate of plant biodiversity. Habitat in private forests is not reported in this indicator.

Fern valley. Credit: Laurance Norah

Data source and limitations

The VFMP measures the characteristics of trees, other vegetation and coarse woody debris across Victorian public forests through the ground plot program (see VFMP case study). Data collected through large and small tree plots, and vegetation quadrats[2] was used in preparing this indicator report.

As this is the first round of VFMP measurement, the dataset only permits comparison of habitat elements and species diversity between different parts of the landscape. Over time, these measurements will show the rate and extent of change to habitat structures and species diversity, providing insight into the impacts of forest disturbances on native species and the drivers of change at a statewide scale.

The data presented reflects only that part of the VFMP ground plot program measured between 2011 and 2012. Whilst all bioregions are represented in the data, some plots had not been measured at the time of analysis. The VFMP focusses on terrestrial habitats, and as a plot based monitoring system has acknowledged limitations in detecting rare species. VFMP habitat analysis methods need further development to present an overarching measure of structural habitat.

[1] Lindenmayer et al (2000) Indicators of forest sustainability biodiversity: The selection of forest indicator species. Conservation Biology 14:941-950

[2] Refer to DEPI's Victorian Forest Monitoring Program webpage for further detail on ground plot methodology at http://www.depi.vic.gov.au/forestry-and-land-use/forest-management/forest-sustainability/victorian-forest-monitoring-program#fieldsops

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Native forest habitat

Habitat is broadly defined as 'the range of environments in which a species can occur'[3] or more specifically as 'the resources and conditions present in an area that produce occupancy – including survival and reproduction – by a given organism'[4]. Resources include energy, moisture, and hospitable structures to live, breed, shelter and move.

Forest dependent species rely on a range of structural habitat characteristics specific to forests. These include trees of varying sizes, understorey, organic structures such as logs and dead trees, litter layers and below ground structures.

Living trees provide resources and sites for foraging, nesting, roosting and sheltering for many species of vertebrates and invertebrates. Food resources include nectar, sap, seeds, leaves, wood, and decomposing roots. Nesting sites include hollows, fissures and branches, and resources for building nests such as leaves, branches and twigs. Living trees also provide substrate and structure for other plants and fungi to grow on. Above ground, epiphytes, mosses and lichens grow on tree bark and in perched soil habitats. Below ground, live and dead tree roots provide energy resources and substrate for fungi, invertebrates, microbes and symbiotic plants such as Native Cherry (*Exocarpus cupressiformis*).

Regrowth and large old trees provide different types of habitat. Large old trees create distinct habitats, supporting many species of fungi, vertebrates, invertebrates and in particular a number of threatened hollow dependent mammals, birds and reptiles.

Dead standing trees and logs provide habitat for many forest dependent species, possibly up to 20 percent of species [5]. They provide substrate and microclimates for the germination and growth of plants, habitat for invertebrates, microbes and fungi associated with dead wood, shelter, nesting, denning, basking, perching and foraging sites for many fauna species, and protected runways for terrestrial animals[6]. Again, large dead trees and logs provide distinctly different habitat to smaller dead trees and logs[7], and the state of decay influences its habitat value for different species.

Multiple vegetation layers and understorey vegetation provide food, shelter, nesting and perching sites and movement routes for fauna and substrate and energy resources for fungi, bryophytes and other vascular plants[6]. The VFMP uses the following life form categories to describe the various vegetation layers:

- Tree, a woody plant with a trunk that grows to a height of over five metres at maturity, somewhere within its natural geographic distribution

- Mallee tree, a small, usually multi-stemmed eucalypt that grows larger branches from a lignotuber

- Tree fern, a large, tree like fern with a fibrous or scaly trunk and a crown of very long divided fronds

- Scrambler or climber, plants with their roots in the ground that scramble or climb over other plants, rocks and logs

Tree ferns. Credit: Arwen Twinkle

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4   Hall, L.S., Krausmann, P.R. and Morrison, M.L. (1997) The habitat concept and a plea for standard terminology. Wildlife Society Bulletin 25(1):173-182

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7   Wardlaw, T., S. Grove, A. Hopkins, M. Yee, K. Harrison, and C. Mohammed. 2009. The uniqueness of habitats in old eucalypts: contrasting wood-decay fungi and saproxylic beetles of young and old eucalypts. Tasforests 18:17-22

Indicator 1.2b: Area of habitat available for forest dependent indicator species

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- Shrub, woody plants typically without single trunks that grow up to five metres in height

- Hummock grass

- Tufted grass and sedge, grasses and sedges with multiple flower stalks and leaves that arise from a common base

- Non tufted grass and sedge, grasses and sedges with leaves arranged along a single flower stalk that arise from rhizomes or stolons

- Ground fern, a fern without a trunk

- Herb, plants that are not woody or of the fern or grass and sedge category.

This indicator reports the average volume of live biomass, dead standing trees and coarse woody debris (logs), the average diameter of dominant trees, and cover for each lifeform by bioregion. Cover is the proportion of a given area of ground surface that is covered by the lifeform viewed from above. Cover for each lifeform layer is measured separately. In forests, the total cover of all lifeforms in a given area usually adds up to far more than 100 percent due to multiple layers of vegetation in the canopy.

State and trend

Figure 1 presents the amount of live tree biomass by bioregion. Figure 2 presents dead tree volume, coarse woody debris volumes and the diameter at breast height (dbh) of dominant trees by bioregion. Figure 3 presents the average cover of each lifeform by bioregion[8].

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[8]   Victorian bioregion descriptions are included in the report Introduction.

Source DEPI
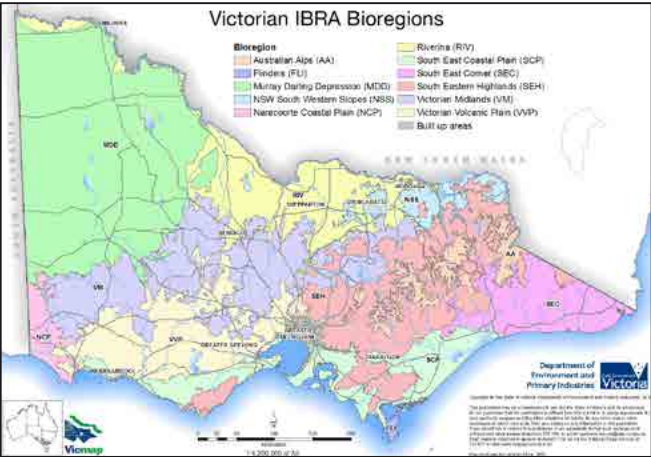
Credit: DEPI
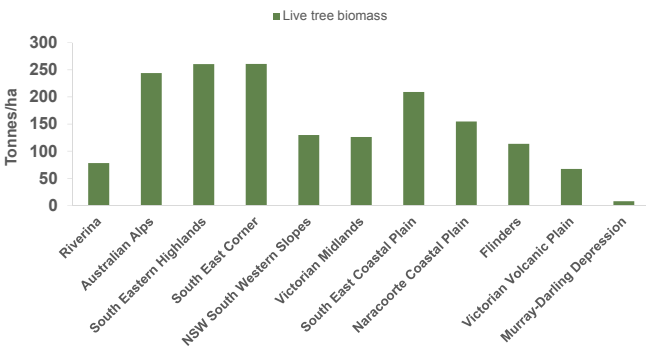
Figure 1. Live tree biomass (tonnes/hectare) by bioregion.
Source VFMP 2013
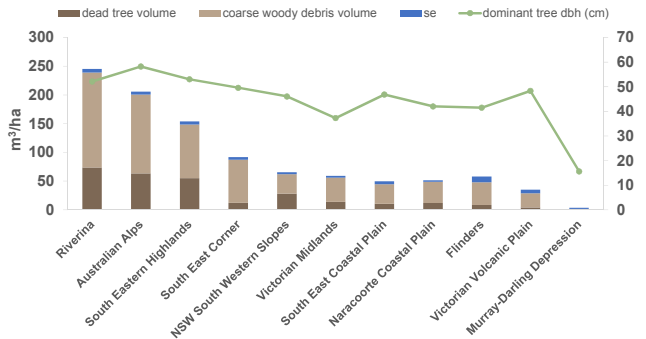
Figure 2. Tree and log structural characteristics by bioregion.
Source VFMP 2013

Indicator 1.2b: Area of habitat available for forest dependent indicator species
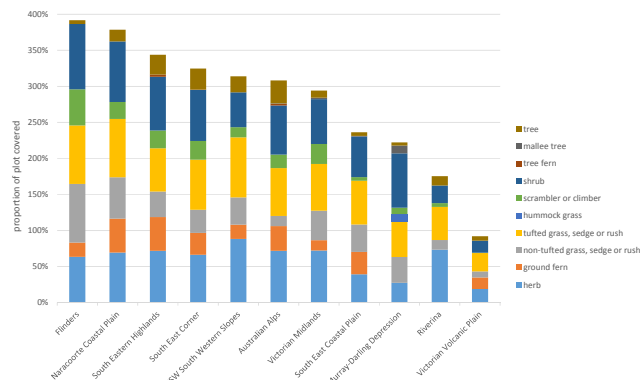
Figure 3. Average lifeform cover by bioregion. Source VFMP 2013

- The Flinders and Naracoorte Coastal Plain bioregions feature the most extensive canopy cover of all bioregions. Both bioregions are coastal, and noted for their high biodiversity. Wilsons Promontory falls entirely within the Flinders bioregion, and the Lower Glenelg and Discovery Bay Coastal Parks occupy much of the Naracoorte Coastal Plain.

- The tall productive forests of the Great Dividing Range also feature high levels of cover. In the South Eastern Highlands, South East Corner, NSW South Western Slopes and Australian Alps bioregions, tree cover reaches its highest levels of around 20 to 30 percent. These bioregions also feature the largest diameter trees. The South Eastern Highlands and Australian Alps bioregions also have high volumes of dead trees and coarse woody debris, which may result from a greater proportion of old growth forests and recent fire history (Indicator 3.1) respectively.

- The Victorian Volcanic Plain has far lower cover levels than other bioregions, with a total average of around 100 percent. The fertile woodlands and grasslands of this bioregion have naturally low volumes of trees which are now highly fragmented and disturbed owing to their high agricultural production capacity. The Victorian Volcanic Plain bioregion has the highest proportion of threatened and extinct biodiversity within Victoria[9].

- Coarse woody debris volumes are highest in the more remote parts of Victoria, and lower in more settled areas.

- Shrubs, tufted grasses and sedges, and herbs have the most extensive cover of all life forms in Victorian forests, each averaging just over 60 percent.

- The least common recorded life form was tree fern. Tree ferns occur in damp, sheltered environments. They were only recorded in VFMP plots in the South Eastern Highlands, South East Corner and Australian Alps bioregions where they covered an average of 3, 0.3 and 2 percent of plots respectively.

- The next least common life form was hummock grass (otherwise known as spinifex). This desert grass was only recorded in the Murray-Darling Depression, where it covers an average of 10 percent of plot area. This bioregion features extensive areas of desert. Its vegetation features very few trees over five metres (4 percent), but a relatively high cover of mallee trees (11 percent), and a very high cover of shrubs (75 percent). Unsurprisingly, this sparsely treed landscape has low levels of dead trees and coarse woody debris.

Vascular plant species richness

Species richness (or diversity) is the number of species represented in a given area. The VFMP measures vascular plant species richness at three scales:

- alpha diversity is the number of species represented at a *local site* (plot) scale

- beta diversity is a measure of the *variation in species between sites or habitats*

- gamma diversity is a measure of *overall species richness* at total landscape (bioregional) scale.

Species richness is computed using a statistical method called 'bootstrapping'[10], which improves the accuracy of data collected from low density sampling. The sampling and analysis methodology are considered an effective and efficient way to collect weed data for strategic purposes.

Hakean Decurrans (bushy needlewood). Credit: Nick Talbot

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9   Department of Natural Resources and Environment (1997) Victoria's Biodiversity – Directions in Management.
    See website http://www.nre.vic.gov.au/plntanml/biodiversity/directions/volcanic.htm

10   Smith, E.P., & G. van Belle (1984). Nonparametric estimation of species richness. Biometrics 40: 119-129

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Indicator 1.2b: Area of habitat available for forest dependent indicator species

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Figure 4 shows landscape level (gamma), site level (alpha) and habitat (beta) diversity (richness) by bioregion.

- The Australian Alps, Victorian Midlands and South Eastern Highlands bioregions have the greatest overall species diversity at the landscape scale.

- The Flinders bioregion has the highest level of species richness at a site level, but relatively low landscape level diversity. This result may be due to low sample numbers at the time of reporting.

- The Flinders and Murray Darling Depression bioregions have the lowest gamma values indicating that the landscapes have greater homogony and as a result, lower species richness and diversity. However, both bioregions had low sample numbers at the time of reporting.

- Nine of the 11 bioregions have a higher alpha value than beta value. This means that the species diversity and richness was greatest at plot level. The Riverina bioregion had a higher beta value than alpha value indicating that the species diversity between plots was greater than within the plots.
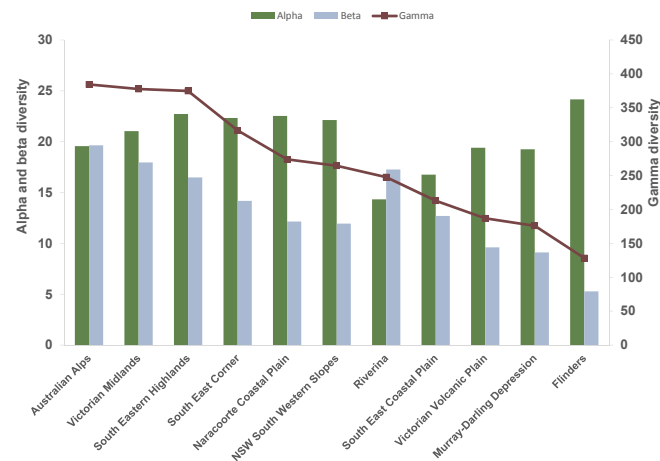
Figure 4. Species richness by bioregion. Source VFMP 2013

River Red Gum forest. Credit: Elizabeth Donaghue

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Indicator 1.2c: Representative indicator species from a range of habitats monitored at scales relevant to regional forest management

Why is this indicator important?

Information about representative forest indicator species can be used to inform management priorities for the conservation of biodiversity. Knowledge about changes in species distribution and population levels can be used to track ecosystem health and provide an early warning of negative impacts on forest biodiversity.

What have we measured and why is it relevant to the indicator?

Four measures were used to provide information on the status of this indicator to represent key elements of biodiversity: (i) diurnal birds, (ii) nocturnal birds, (iii) native mammals, and (iv) introduced mammals.

Diurnal birds require a range of foraging and nesting attributes which provide a degree of surrogacy for other taxa, for which data are unavailable. Nocturnal birds are higher order predators requiring large home ranges. They are limited to large hollows for nesting (likewise their prey), so are useful in gauging the extent and health of older forest in the landscape. Four owl species occurring in forest are listed as threatened in Victoria. They therefore present a critical focus for evaluating forest health. Native mammals are another key element of biodiversity which are sensitive to various activities in forests. Introduced mammals represent a considerable threat to biodiversity, in particular predators such as the Red Fox (*Vulpes vulpes*) which is listed as a threatening process under the *Flora and Fauna Guarantee Act 1988*.

The specific measures that were used are:

- Diurnal birds (species richness per survey using area search by human detection)

- Nocturnal birds (DEPI survey protocols using call playback and spotlighting by human detection)

- Native mammals (species richness per site adjusted by survey effort using remote camera detection)

- Introduced mammals (species richness per site adjusted by survey effort using remote camera detection).

Data inputs

The main data input for this project was the Foothills Fire and Biota database which represents data collected from research and monitoring projects including: (i) Gippsland Retrospective, Hawkeye, Fire Effects Study Areas (DEPI); Faunal Refuges Project (La Trobe University & Deakin University); and Otways Fire, Landscape Pattern and Biodiversity (Melbourne University). Data for nocturnal birds were derived from the 2011 East Gippsland Owl Survey (DEPI). Only data that were readily available and had undergone suitable data cleaning were considered for this report.

Credit: ARI

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Table 1. Summary of data inputs. Source DEPI

Project name	Diurnal birds	Nocturnal Birds	Native Mammals	Introduced Mammals
	Foothills fire and biota	East Gippsland Owl Survey 2011	Foothills fire and biota	Foothills fire and biota
Number of sites	491	245	437	437
Site size	2 ha	100 ha	2 ha	2ha
Area of forest	982 ha	245,000 ha	930 ha	930 ha
Vegetation types	5	12	6	6
Number of species in analysis	117	4	9	3

Result summaries

- Extensive surveys of nocturnal birds in the Gippsland region detected threatened owl species in 67 new locations (Table 2). This information is immensely valuable in informing forest management to help conserve these species.

- The average species richness of diurnal birds was similar across different vegetation types and across different regions.

- Native mammal species richness per camera survey was highest in the Central Highland and the North east. Introduced species made up a greater proportion of the mammal community in heathland vegetation compared to other vegetation types.

Credit: ARI

Table 2. Detections of nocturnal birds across 245 sites in 2011. Source DEPI

Survey sites included 12 forest types: Closed-forest, Coastal, Damp Scrub, Foothills Forest, Forby Forest, Grassy/Heathy Dry Forest, Heathland (sands), High Altitude Shrubland / Woodland, Moist Forest, Riparian (higher rainfall), Tall Mist Forest, Tall Mixed Forest. Note Barking Owl was not detected at any site.

	Number sites with owls detected			
	Masked Owl	Powerful Owl	Sooty Owl	Total
All detections in other public land (127 sites surveyed)	8	17	17	42
All detections in State forest (118 sites surveyed)	11	14	22	47
New detections (all tenures)	16	26	36	67

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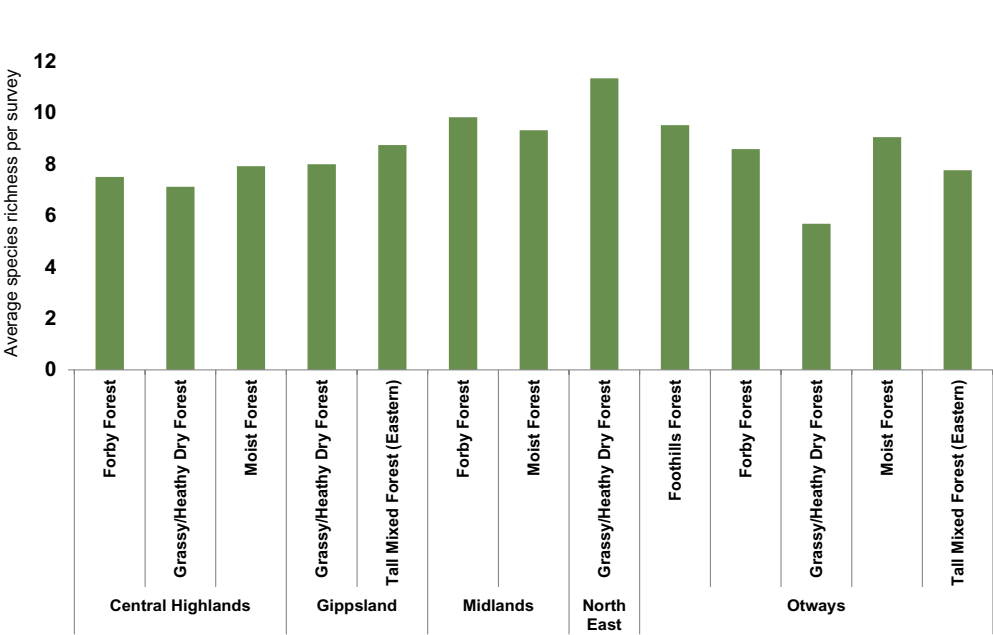
Figure 1. Average diurnal bird species richness per survey in Victorian Foothills Forest. Source DEPI
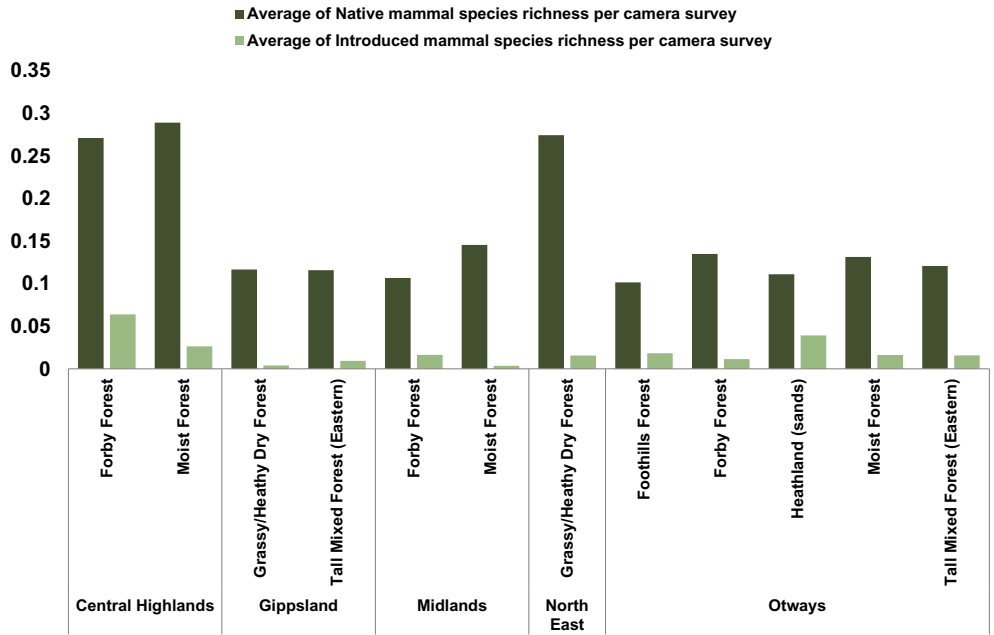
Figure 2. Comparison of native and introduced mammal species richness per camera survey in Victorian Foothill Forest. Source DEPI

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Limitations of current data and future data sources

- Foothills Fire and Biota (FFB) project is a major collaboration between DEPI and three Victorian universities undertaking a meta-analysis of existing data from previous biodiversity research projects on public. Data compilation for these projects underwent a rigorous quality assurance process and provided the majority of the data for this report. Note that flora and habitat data could be extracted from the FFB database to complement measures derived from the Victorian Forest Monitoring Program (VFMP).

- Nocturnal bird data were collated from sites surveyed once to denote presence but not infer absence, i.e. there may be more individuals across the study area than what was detected during the surveys.

- Data from the Statewide Landscape Fire and Environmental Monitoring Program has been collected across 273 sites but requires further processing before it is available for use in State of the Forests reporting. However, the consistency in the sampling methods used across these monitoring sites will make a valuable contribution to the data needed for tracking trends in this indicator in the future. Each site is two

hectares and is monitored before the burn and then at intervals following burning – 6 weeks, 2 years, 5 years, 10 years and then continuing every 10 years. The assessments being undertaken at each site are:

o   bird surveys (20 minutes / 2 hectare area search)

o   fauna remote cameras (Infrared cameras that are heat and motion sensitive with one targeted to herbivores and one to carnivores)

o   flora frequency all species assessments (1m x 1m quadrats with presence of all species and dominant life stage recorded)

o   habitat structure surveys (see Guide to monitoring habitat structure) (DEPI 2012)

o   pitfall traps (Mallee only – pitfall buckets with drift fence lines placed along the habitat transect lines).

State and trend

The data presented provides a reference point to track future trends. Historical data for this indicator were not readily available for this report (i.e. require substantial data management before available for analysis) so trends were not able to be calculated.

References and further information

Foothills Fire and Biota (Steve Leonard, La Trobe University)

Landscape Fire and Environmental Monitoring Program (Shannon Treloar, DEPI)

East Gippsland Owl Survey 2011 (Mark Lutze, DEPI)

Advisory List of Threatened Vertebrate Fauna in Victoria 2013.

APPENDIX 12: Threatening Processes under the FFG Act (1988)

Southern Boobook. Credit: Nick Talbot

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Indicator 1.2d: Degree of disturbance to native forest species caused by invasive species

Why is this indicator important?

Invasive species are species occurring beyond its accepted normal distribution and which threatens environmental, agricultural and social values by the damage it causes. They have the ability to cause substantial damage to forest ecosystems, displacing endemic forest species and degrading the overall health and vigour of the forest. Quantifying the degree of disturbance caused by invasive species assists in setting and evaluating policy and control program priorities.

What have we measured and why is it relevant to the indicator?

Strategic reporting on the degree of impacts of invasive species on biodiversity presents a challenge to environment agencies worldwide. Whilst the impacts of individual invasive species on specific localities may be well studied, methodologies for strategic assessment of impacts of multiple species at larger scales are emergent[1]. This report presents for the first time systematically collected monitoring data on the impacts of weeds on native forest species for the Victorian public forest estate. This data was collected through the Victorian Forest Monitoring Program (VFMP).

This indicator also presents forest health monitoring information on the impact and distribution of insect and pathogen agents in native forests and plantations across all land tenures.

Pest animals are not comprehensively monitored in Victoria at present, as monitoring programs largely focus on the recovery of native species following control efforts. This report provides an overview of Victoria's approach to pest animal control and lists key invasive species control initiatives in public forests during the reporting period.

Weeds in public forests

Weeds are exotic and 'out of place' native species of flora that have become established since European settlement. Weed infestations cause disturbance to native species and ecosystems by changing the availability of resources, altering vegetation structure and ultimately reducing the viability of native species populations. They are one of the most significant risks to threatened flora and fauna in Victoria, with weed control representing 5%[2] of all planned actions in the Actions for Biodiversity Conservation (ABC) database for forest dependent threatened flora in Victoria.

This indicator reports the number of weeds and the ratio of weed to total flora species for each bioregion. These statistics are computed using a statistical method called 'bootstrapping', which improves the accuracy of data collected from low density sampling. The sampling and analysis methodology are considered an effective and efficient way to collect weed data for strategic purposes[1]. The data presented within this indicator varies from other weed reporting for public land because it is based on a strategic sampling methodology rather than records submitted to the Victorian Biodiversity Atlas.

As this is the first round of VFMP measurement, the dataset only permits comparison of the diversity and relative impact of weeds in and across different parts of the landscape. Over time, these measurements will show the rate and extent of change to weed and native species diversity, providing insight into the impacts of weeds on native species and the drivers of change at a statewide scale.

Data source and limitations

The VFMP measures the species and distribution of weeds across Victorian public forests through the ground plot program (see VFMP case study). All weeds are identified through standard vegetation quadrat measurements[3]. The data presented reflects only that part of the VFMP ground plot program measured between 2011 and 2012. Whilst all bioregions are represented in the data, some plots had not been measured at the time of analysis.

Crassula ericoides. Credit: DEPI

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[1]   Ainsworth et al (2008) A Method of Monitoring Biodiversity for Changes Associated with Invasive Plants. DSE

[2]   Note: Not all 'planned' actions in ABC database are commenced. Indicator 1.3b reports 'completed' and 'partially completed' actions.

[3]   Refer to DEPI's Victorian Forest Monitoring Program webpage for further detail on ground plot methodology at http://www.depi.vic.gov.au/forestry-and-land-use/forest-management/forest-sustainability/victorian-forest-monitoring-program#fieldsops

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Quadrat based monitoring methodologies have acknowledged limitations in detecting emerging weed problems. VFMP data does not include weed detection near roads, which are major weed vectors. If systematic roadside weed monitoring were adopted, the number of weed species would likely to be considerably higher.

State and trend

Figure 1 plots the number of weed species and the ratio of weed to total flora species by bioregion.

- Overall 115 weed species were recorded across Victorian public forests through the VFMP ground plot program.

- The Riverina bioregion has by far the highest number and proportion of weed species in the State. An estimated 87 weed species occur in this bioregion, representing 26 percent of the total flora diversity. Victoria's Riverina bioregion forests occur on active floodplains. Floods are an extremely effective weed vector, promoting the abundance, proliferation and spread of weeds throughout floodplain ecosystems[4].

- Weeds also represent approximately a quarter of the total flora diversity in the NSW South Western Slopes bioregion.

- The Flinders and Murray-Darling Depression bioregions recorded negligible weed impacts. Note that data for these regions is based on the sub-set of VFMP ground plots that were measured at the time of calculation.
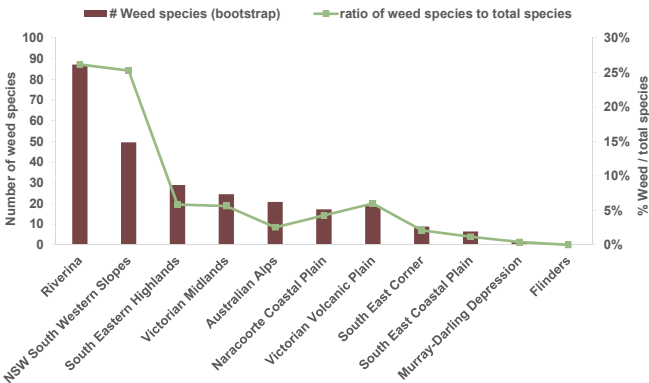
Figure 1. Bioregional weed impact. Source VFMP 2013

Insect and pathogen agents

DEPI works closely with industry and state government and local government agencies to develop and conduct ongoing targeted forest health surveillance programs for established and exotic pests and pathogens. Forest health surveillance programs include road-side surveys, plot monitoring, diagnostic surveys, aerial surveys and pest/pathogen reports from the community.

Data source and limitations

The pest and pathogen data presented in this indicator is summarised from DEPI's detailed forest health surveillance program reports.

State and trend

Table 1 presents annual data on the scale of distribution and impact on native forests and plantations of common insect and pathogen agents monitored through DEPI's forest health surveillance programs during the reporting period. Colour code descriptions for the scale of distribution and impact are shown below.

Scale of Distribution	Impact
Does not occur or observed in time period	No impact
Restricted (<25%)	Minimal
Restricted (<25%)	Adverse
Widespread (>25%)	Minimal
Widespread (>25%)	Localised adverse
Widespread (>25%)	Widespread adverse

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4   Stokes K. and Colloff M. (2009) Weed management on floodplains: A guide for natural resource managers. CSIRO

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Table 1. Common insect and pathogen agent annual distribution and impact. Source DEPI

Agent Common	Agent Scientific	Native forests 2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Plantations 2007/08	2008/09	2009/10	2010/11	2011/12	2012/13
Insects													
Autumn Gum Moth	*Mnesampela privata*							light green	light green	light green	green	green	green
Christmas Beetle	*Anoplognathus spp*	yellow	yellow	yellow	yellow	yellow	orange	yellow	yellow	yellow	yellow	yellow	orange
Chrysomelid leaf beetles	*Chrysophtharta agricola*	orange	orange	yellow	yellow	yellow	orange	orange	orange	orange	yellow	yellow	orange
Cup Moth	*Doratifera spp*	green	green	yellow	orange	orange	orange						
Five-spined bark beetle	*Ips grandicollis*							orange	yellow	orange	yellow	yellow	orange
Goldern-haired beetle	*Hylurgus ligniperda*							green	green	green	green	light green	light green
Gum leaf skeletoniser	*Uraba lugens*	yellow	yellow	yellow	yellow	yellow	orange						
Leaf blister sawfly	*Phylacteophaga froggatti*	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow
Longicorn Borers	*Phorocantha spp*	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow
Monterey pine aphid	*Essigella californica*							red	red	orange	yellow	yellow	orange
Mountain ash psyllid	*Cardiaspina bilobata*	green	green	green	green	light green	light green						
Red gum basket lerp	*Cardiaspina retator*	yellow	yellow	yellow	orange	orange	orange	green	green	green	yellow	yellow	orange
Sawflies	*Perga spp*	yellow	yellow	yellow	yellow	yellow	yellow	light green	light green	light green	light green	light green	green
Sirex	*Sirex noctilio*							orange	yellow	yellow	yellow	orange	yellow
Spurlegged Phasmatid	*Didymuria violescens*	green	green										
Sycamore lace bug	*Corythucha ciliata*												

- Cup moth has become a significant pest in native forests since 2010/11. Significant infestations have, at some locations, entirely defoliated large areas of native forest, and outbreaks have been widespread across the state. Natural predators have not kept up with increased populations. No control programs have been undertaken.

- New areas of Phytophthora have been identified since the drought broke in 2010. New hygiene protocols to reduce the spread of the pathogen are being investigated using the DEPI statewide model for Phythophthora risk and impact map.

- Septoria leaf blight has become a significant pathogen in *Eucalyptus nitens* (Shining gum) plantations in Victoria in both juvenile and adult foliage. This is due to three warm and wet summers providing conditions conducive to disease development. Outbreaks appear to be localised but the pathogen was found across many *E. nitens* sites.

- Populations of Monterey pine aphid increased across Victoria prior to 2010, then crashed due to the drought breaking. Populations increased again over the spring and summer of 2012-13 due to a significantly dry weather pattern. Fortunately defoliation levels have decreased or remained the same as the previous years.

Indicator 1.2d: Degree of disturbance to native forest species caused by invasive species

Table 1. Common insect and pathogen agent annual distribution and impact (continued).

Agent Common	Agent Scientific	Native forests						Plantations					
		2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13
Pathogens													
Armillaria	*Armillaria luteobubalina*	orange	orange	yellow	yellow	yellow	yellow						
Corky leaf spot	*Aulographina eucalypti*	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow
Cyclaneusma needle cast	*Cyclaneusma minus*							orange	yellow	yellow	yellow	orange	orange
Cypress canker	*Seridium sp*												
Diplodia	*Diplodia pinea*							orange	orange	yellow	yellow	orange	orange
Dothistroma needle blight	*Dothistroma septosporum*							green	green	green	light green	light green	light green
Eucalyptus Canker	*Holocryphia eucalypti*				green	yellow	yellow				green	green	green
Lophodermium	*Lophodermium pinastri*							yellow	yellow	yellow	yellow	yellow	yellow
Mycosphaerella leaf disease	*Mycosphaerella spp*	yellow	yellow	yellow	orange	orange		yellow		yellow		orange	orange
Myrtle rust	*Uredo rangelii*												
Myrtle Wilt	*Chalara australis*	light green	light green	light green	green	green	green						
Phytophthora	*Phytophthora cinnamomi*	orange	yellow	yellow	yellow	orange	orange	yellow	yellow	yellow	yellow	orange	orange
Septoria leaf blight	*Kirramyces eucalpti*	yellow	yellow	yellow	yellow	light green	light green				light green	light green	light green

Top cup moth caterpillar. Credit: Bill and Mark Bell. **Bottom Sawfly larvae.** Credit: Neil Saunders

Indicator 1.2d: Degree of disturbance to native forest species caused by invasive species

Puccinia psidii (Myrtle rust)

Myrtle rust – a serious fungal disease that affects plants in the Myrtaceae family – was first identified in Victoria in December 2011. The arrival of Myrtle rust into Victoria was via infected nursery stock from interstate. An emergency response was initiated, followed by a phase of active management when it was determined the disease was not eradicable from Victoria. The aim was to slow the spread while preparing potentially affected industries to manage the disease's impact.

Since July 2012 (when the disease was declared established), monitoring activities have focused on providing training and technical advice to assist the nursery industry, other host plant distributors, general public and forest land managers manage and minimise the impact of the disease. Priorities for this phase focused on investigating reports involving new areas and host species where the disease has not been previously detected.

As at 30 December 2013 Myrtle rust has been detected at 83 sites, including production nurseries, wholesale nursery outlets, private residences and public parks in metropolitan Melbourne, the Mornington Peninsula, Shepparton, Ballarat and near Bairnsdale. Myrtle rust has still not been identified in the natural environment and all new reports have been from public gardens and private backyards. At all sites containment actions are in place. A total of 18 Victorian species of Myrtaceae have been found to be susceptible to infection so far. Communication programs have been successful with well over 100 information sessions held and more than 4000 people attending. A training CD was published and two Myrtle rust media updates were released.

The sentinel site program has been well received and 175 sites have been established across the state and monitored on a fortnightly basis by the general public, Landcare groups, state and local government staff and Botanic parks staff. This program has identified two infected sites and has provided a good early detection program.

Myrtle rust on a *Melaleuca* paperbark. Credit: DEPI

Pest animals

Victoria uses a biosecurity approach to direct investment in pest animal control. Investment is prioritised across prevention, eradication, containment and asset protection. The majority of management interventions in pest animal control on public land are directed at protecting high priority environmental assets, such as threatened species that are at risk from the impacts of pest animals. Significant investment is also made at the public - private land interface. Pest animals are a major concern for public land managers. In 2012/13, around 1.1 million hectares of the conservation estate were treated for the control of pest animals. The majority (1 million hectares) of this was in areas scheduled under the *National Parks Act 1975*. Species targeted include cats, rabbits, goats, pigs, foxes, deer, horses and feral cattle.

Land managers continue to refine approaches to pest animal management through adaptive decision making, innovation and tackling the issues at a scale likely to be effective. Often this means working at a landscape scale in collaboration with neighbours and adjoining land managers. New approaches to complex pest animal issues are being progressed adaptively through pilot projects including progressing the use of techniques not regularly used in Victoria, such as aerial shooting, and improving the way we utilise and work with our volunteer shooters in pest animal and deer control that balances hunting and land management objectives. Major initiatives are listed in Table 3.

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Indicator 1.2d: Degree of disturbance to native forest species caused by invasive species

Managing invasive species on public land

In 2009 and 2010 the Victorian Government released a new biosecurity policy[5] along with specific strategies and guidelines for different jurisdictions including public land[6,7]. Table 3 outlines the key projects undertaken on public land during the reporting period.

Credit: DEPI

Table 3. Major invasive species initiatives on public land 2007/08 to 2011/12. Source DEPI 2013

Initiative	Ha treated[8]	Description
Southern Ark	1,000,000	Landscape scale fox baiting program to protect Long-footed Potoroo, Southern Brown Bandicoot and other threatened fauna
Grampians-Ark	220,000	Landscape scale fox baiting program to protect Brush-tailed Rock Wallaby and other threatened fauna
Glenelg-Ark	200,000	Landscape scale fox baiting program to protect threatened fauna
Urban Rabbit Control Initiative	1800	Landscape scale rabbit control program to protect riparian forest areas on public land in Melbourne's peri-urban areas
Glenelg-Eden	1650	Landscape scale weed management program to protect high value biodiversity assets on public land
Central Highlands-Eden	108,749	Landscape scale weed management program to protect high value biodiversity assets on public land
Central Highlands-Ark	150,000	Landscape scale fox baiting program to protect threatened fauna
Recovering Rangelands: Mallee-Bounceback	230,000	Landscape scale weed, goat and rabbit control program to promote the recovery of Mallee woodlands
Urban Fringe Weed Management Initiative	3,000	Landscape scale weed management projects to protect key biodiversity assets across Melbourne's peri-urban areas (including forested landscapes)
Brown Mountain Fox Control Program	n/a	Landscape scale fox control program to protect key biodiversity assets around the Brown Mountain region.
Large Herbivore Control Program	n/a	Containment of invasive large herbivore populations by eradicating satellite populations threatening key biodiversity assets on public land.
Good Neighbour Program	1,594,016	Manages weeds and pests on public land at the public/private interface to protect assets on private land.
Otway Eden Weed Program	14,000	Managed high threat weeds in the Otway Eden region.
Bush Guardians	16,000	93 community groups involved in weed and pest control projects
Alpine Intensive Management	95,000 (2012-13)	The Alps Intensive Management Program 2011-2015 provides for more intensive management of priority weeds and pest animals in the Victorian Alps.

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5   DPI (2009) Biosecurity strategy for Victoria.
6   DSE (2008) Victoria's Public Land Phytophthora cinnamomi Management Strategy.
7   DSE (2010) Protecting public land from invasive species – towards a biosecurity approach.

8   Area shown is for projects that aim to control invasive species in forested landscapes.

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Indicator 1.3a: The number of forest dependent species at risk from isolation that may lead to loss of genetic variation

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Why is this indicator important?

Isolation can have a significant impact on the genetic variation and long term survival of forest dependent species. This indicator assesses the number of species identified as at risk from isolation. Information on species isolation can be used to inform biodiversity management and threatened species recovery programs.

Isolation can be the result of habitat loss due to clearing, changes to fire regimes (Indicator 3.1) and long term climate patterns. Other drivers may include fragmentation of forest (Indicator 1.1d), pests and disease (Indicator 3.1) and introduced species (Indicator 1.2d). The prevention of movement and interaction of flora and fauna species can lead to geographically and genetically isolated populations. This interferes with pollination, seed dispersal, wildlife migration and breeding, and can lead to further loss of genetic variability. Species with low genetic variation face a higher risk of extinction due to a decreased ability to withstand environmental changes or unexpected threats.

What have we measured and why is it relevant to the indicator?

It is not possible to report against this indicator at the present time, as there is currently no comprehensive information on the number of forest dependent species at risk from isolation. Monitoring is conducted for some threatened forest dependent species and provides information about isolation of particular populations, but this is typically limited to specific study areas and does not adequately provide an overall assessment of isolation at the State level.

DEPI works to mitigate the risk of forest dependent species isolation in a number of ways, including:

Captive management: such as captive breeding programs and plant cultivation; collection and storage of reproductive material, maintenance of plant collections and translocated captive populations. Refer to Indicator 1.3b.

Forest planning: including effective forest management zoning (Indicator 2.1) and the maintenance of a comprehensive, adequate and representative (CAR) reserve system (Indicator 1.1c), to provide an integrated network of forest conservation areas across Victoria.

Forest regeneration: maintaining standards for forest coupe regeneration after harvesting, whereby only local or genetically similar seed is used (Indicator 2.4).

Credit: DEPI

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Indicator 1.3b: Number of in situ and ex situ conservation efforts for forest dependent species

Why is this indicator important?

To maintain biodiversity, active conservation efforts are required to protect and maintain threatened forest dependent species and ecosystems. Monitoring helps identify the effectiveness of conservation efforts in maintaining forest biodiversity. It also indicates the level of commitment by government and community to protect forest dependent species and forest ecosystems in Victoria.

What have we measured and why is it relevant to the indicator?

This indicator report presents the numbers of conservation efforts undertaken for forest dependent rare and threatened species (see Indicator 1.2a) by category across all land tenures in Victoria. This is a direct measure of the indicator. Forest dependent species are defined as species that rely on forest habitat for all or part of their life cycle. DEPI experts determine the forest dependency of species on the basis of known habitat requirements.

Credit: DEPI

Conservation efforts in Victoria

A combination of *in situ* and *ex situ* efforts is generally required to protect forest dependent species. *In situ* (on-site) conservation efforts are those activities conducted in the natural habitat of the species or community. They range from monitoring and compliance activities to habitat protection. *In situ* conservation efforts are categorised as:

- Managing threats and habitat e.g. habitat protection; pest plant and animal control; ecological burning; control / reduce human disturbance

- Assessment

- Monitoring

- Research (only 'in situ')

- Population manipulation.

Ex situ conservation efforts are conducted off site and typically support *in situ* efforts. They range from maintenance of species in zoos and herbariums to development of Flora and Fauna Guarantee action statements. Categories of *ex situ* conservation efforts include:

- Captive management e.g. captive breeding programs and plant cultivation; collection and storage of reproductive material, maintenance of plant collections and translocated captive populations

- Stakeholder interactions

- Planning e.g. Preparing action statements and management plans, management of Actions for Biodiversity Conservation (ABC) database

- Policy development

- Research (only ex situ).

Credit: DEPI

Indicator 1.3b: Number of in situ and ex situ conservation efforts for forest dependent species

Data source and limitations

The data presented within this report is derived from the Actions for Biodiversity Conservation (ABC) database. The ABC database stores conservation management information for over 400 threatened species and communities at approximately 2,000 locations across all land tenures within Victoria. Records include actions undertaken by both government and non-government agents.

Efforts are made to record priority actions for species and communities on both the FFG Act Threatened List and the DEPI Advisory List. Some species or populations with lower threat status and lower priority actions are not captured within the ABC database, and records are limited by the extent of system use by action owners.

To generate this report, the ABC data is filtered to forest dependent flora and fauna species (excluding threatened communities). This data is sourced from lists of forest dependent species maintained by DEPI for the purpose of this analysis. Only complete and partially completed actions are reported.

The data cannot be compared to previous reports as the analysis methodology has changed.

State and trend

Table 1 presents the number of conservation efforts for forest dependent species by year and action category across all land tenures. These are presented as 'in situ' and 'ex situ' categories in Figure 1. Figure 2 shows the proportion of conservation efforts by category in 2011/12.

Table 1. Annual number of conservation efforts for forest dependent species by action category. Source DEPI

Action Category	2007/2008	2008/2009	2009/2010	2010/2011	2011/2012	Grand Total
Assessment	243	285	371	385	328	1,612
Captive management	86	100	125	151	84	546
Community interaction	290	221	207	238	195	1,151
Managing threats and habitat	531	457	501	542	413	2,444
Monitoring	345	367	408	354	286	1,760
Planning	218	158	211	227	173	987
Policy development	7	5	9	6	12	39
Population manipulation	49	56	60	54	27	246
Research	161	149	154	164	142	770
Grand Total	**1,930**	**1,798**	**2,046**	**2,121**	**1,660**	**9,555**

Credit: DEPI

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Indicator 1.3b: Number of in situ and ex situ conservation efforts for forest dependent species
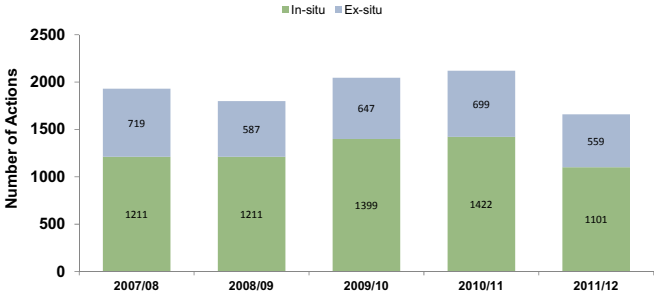
Figure 1. Number of in-situ and ex-situ actions for forest dependent species by year. Source DEPI

Proportion of actions by category (2011/12)
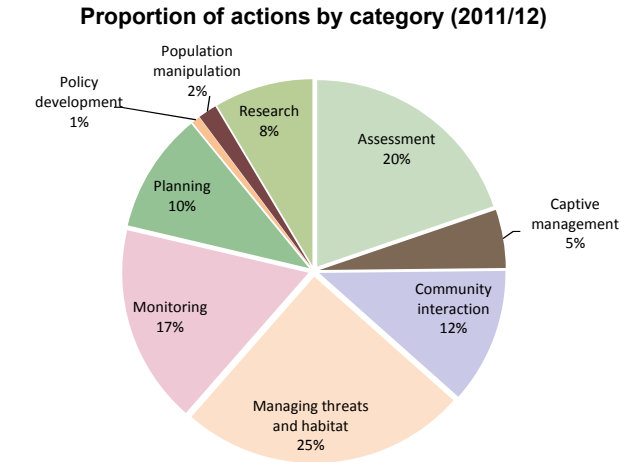
Figure 2. Proportion of conservation actions for forest dependent species by category in 2011/12. Source DEPI

- The number of conservation efforts for forest dependent species completed or partially completed ranged from approximately 1,800 in 2008/09 to 2,100 in 2010/11. The number of efforts varied according to population needs, action timing and resource availability.

- Managing threats and habitat, monitoring and assessment are the most common activities, representing approximately 60 percent of conservation efforts in any one year, whilst policy, population manipulation and captive management are the lowest representing around one to five percent of the total number of efforts. These statistics should be interpreted with caution as they do not reflect the overall amount of work associated with each effort. For example, the entire annual captive breeding effort for Eastern Barred Bandicoot is represented in the same way as a single day spent assessing a Marsh Leek Orchid population.

Credit: DEPI

- The proportion of different types of actions is stable between reporting periods.

- The most commonly undertaken threat management activities during the reporting period were pest animal control, management to prevent habitat loss and fragmentation, and fire management (largely ecological burning) comprising 6, 5 and 4 percent of all actions respectively.

- Approximately 90% of conservation efforts are undertaken by government agencies. Committees of management, local government, research institutions, conservation organisations, private companies and land owners are responsible for the remainder.

- A total of 78 flora and 83 fauna species were subject to conservation efforts over the reporting period. Of these, 92 percent are listed on the FFG Threatened List.

References and further information

For more information see the DEPI Conserving threatened species and communities webpage at http://www.depi.vic.gov.au/environment-and-wildlife/threatened-species-and-communities

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Indicator 2.1: Area and percentage of forest and net area of forest available and suitable for timber production

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Why is this indicator important?

The area of forest available for timber production, forest types and age classes are key planning inputs for determining long term sustainable timber production rates. Monitoring trends in available forest area assists the forest sector to manage change affecting resource availability. It also provides insight into the changing balance of management objectives across the forested landscape.

What have we measured and why is it relevant to the indicator?

This report groups forest available for timber production in Victoria into public forest, plantation or private native forest.

Land tenure and forest management zones (FMZ) determine the area of public forest available for timber production in Victoria. Each public land tenure and FMZ is managed to a specific set of objectives. This indicator reports on the area of public land by tenure and FMZ, highlighting the area available for timber production tenures and zones where the management objectives include timber production.

The area of plantation in Victoria is reported in Indicator 1.1a.

Victoria has extensive areas of native forest under private ownership, some of which are used for timber production purposes. The area of private native forest available for timber production is regulated through local government planning schemes. Additionally, the management objectives of private forest owners and the characteristics of their forests determine what area of private native forest is available to the timber industry. This category of forest is not reported because at present there is no comprehensive data on the area of private native forest available for timber production.

Area available for timber production in public forests

Victoria's public forests are managed under a variety of land tenures. Around 56 percent of public forests are managed exclusively for conservation such as National and State Parks and a range of Crown land Reserve tenures. This area is reported as Parks and conservation reserves (no timber production).

Firewood and minor forest product harvesting is permitted in several relatively small Forest Parks.

The remaining area of Victoria's public forests is managed as State forest tenure. State forests are divided into three FMZs: General Management Zone (GMZ); Special Management Zone (SMZ); and Special Protection Zone (SPZ). Forests in GMZ are managed for a range of objectives, with timber production given high priority. SMZs are managed to conserve specific features, whilst catering for timber production under specific management conditions. SPZs are managed for particular conservation values, forming a network designed to complement the formal conservation reserve system. Timber production is excluded from SPZ. The area reported as available for timber production in State forests is the sum of the GMZ and SMZ areas.

Credit: DEPI

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Indicator 2.1: Area and percentage of forest and net area of forest available and suitable for timber production

Net area of public forest available for timber production

The net area of public forest available for timber production excludes areas that are available but not suitable for timber production. Areas may not be suitable for timber production due to operational factors such as accessibility, low productivity, harvesting and haulage costs, and regulatory factors such as mandatory slope and waterway exclusions or a range of biodiversity values. Data is not available for these 'available but unsuitable areas' as they are generally identified at an operational level and change according to economic and regulatory circumstances. Net area is therefore not presented in this indicator report. However, the current estimate of the area suitable and available for sawlog timber production in western Victoria is approximately 100,000 hectares (DEPI 2013). The area available and suitable to VicForests for timber harvesting in eastern Victoria is approximately 490,000 hectares. An additional 310,000 hectares is potentially suitable depending on future market demand.

Data source and limitations

The data presented in this indicator report is derived from DEPI corporate geospatial datasets FMZ100 (Forest Management Zones) and PARKRES (Parks and conservation reserves). These datasets change from time to time, reflecting new land use decisions and FMZ updates. FMZ updates may include major reviews, minor changes to reflect new information, or improvements in base layers.

Between 2008 and 2012, DEPI remapped the public land management base layer from a scale of 1:100,000 to 1:25,000. This improvement in the precision and accuracy of boundaries resulted in some change to area statements.

Table 1. Public forest availability for timber harvesting by tenure and zone. Source DEPI 2013

Timber production availability	Tenure[2]	Forest Management Zone	Year and Area[1] ('000 ha)		
			2006	2008	2012
Available	State forest	GMZ	2,403	2,318	2,110
		SMZ	182	172	275
	Parks and conservation reserves	Limited timber production	12	12	18
Total available			**2,597**	**2,502**	**2,403**
Not available	State forest	SPZ	828	783	753
	Parks and conservation reserves	No timber production	3,820	3,825	3,982
Total not available			**4,648**	**4,608**	**4,735**
Grand Total			**7,245**	**7,110**	**7,138**[3]

Logging coupe. Credit: DEPI

State and trend

Table 1 provides areas of public forest available for timber production by tenure and FMZ between 2006 and 2012. Figure 1 shows the distribution of Victoria's FMZs in 2012.

- Between 2006 and 2012 the area of forest available for timber production in Victoria decreased by 7% (Table 1), from 2.6 million hectares in 2006, to 2.4 million hectares in 2012.

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[1] Some change is due to changes in spatial data resolution and projections

[2] Movement of State forest to Crown land managed for objectives other than conservation are not recorded in this table.

[3] Area has changed due to acquisitions and disposals

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- The 194,000 hectare reduction in public forest available for timber production reported over the past 6 years continues the trend reported in the previous 2008 State of the Forests Report (a 80,000 hectare decrease between 2001/02 and 2005/06).

- This reduction in public forest available for timber production is primarily associated with major land use decisions to reclassify approximately 196,000 hectares of State forest to Parks and conservation reserves in the East Gippsland, Mid-Murray, Mildura, Otway and Portland FMAs[4].

- Between 2006 and 2012, the area of SPZ decreased by 8% (828,000 hectares to 753,000 hectares) resulting primarily from the transfer of SPZ to Parks and conservation reserves.

- Between 2006 and 2012, the area of SMZ increased by 51% (182,000 hectares to 275,000 hectares). This change is largely due to the conversion of 123,000ha[5] of GMZ to SMZ in the East Gippsland FMZ review.

- Other minor increases and decreases in area available for timber production are the result of improvements in the accuracy of public land boundary mapping and minor changes to FMZs and land tenure.

Figure 1. Map of Victoria's Forest Management Zones 2012. Source DEPI

References and further reading

DEPI Forest Management Plans
http://www.depi.vic.gov.au/forestry-and-land-use/forest-management/forest-management-plans

Department of Environment and Primary Industries (DEPI) (2013) Review of commercial forestry management in western Victoria. Timber Resources, Harvest levels, Silviculture and Systems and Processes. Department of Environment and Primary Industries. State of Victoria

Department of Sustainability and Environment (2007). Code of Practice for Timber Production 2007.

Department of Sustainability and Environment (2009) Management Procedures for timber harvesting, roading and regeneration in Victoria's State forests.

National Parks and Crown Land (Reserves) Acts (Amendment) Act 2006
http://www.legislation.vic.gov.au/

National Parks and Crown Land (Reserves) Acts Amendment Act 2008
http://www.legislation.vic.gov.au/

Parks and Crown Land Legislation Amendment (East Gippsland) Act 2009
http://www.legislation.vic.gov.au/

Parks and Crown Land Legislation Amendment (River Red Gums) Act 2009
http://www.legislation.vic.gov.au/

VEAC investigations
http://www.veac.vic.gov.au/

VicForests Area Statements
http://www.vicforests.com.au/files/urqjidwfde/Area-Statement-2013.pdf

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[4] Victorian legislation online, various National Parks and Crown Land Reserves Amendment Acts

[5] DEPI East Gippsland Forest Management Zoning Review 2011 webpage

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Indicator 2.2: Volume of wood by forest type in State forest that is available and suitable for timber production

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Credit: DEPI

Why is this indicator important?

Changes in the volume of wood available for timber production will affect Victoria's capacity to supply wood products into the future. Information about the volume of wood in forests available and suitable for timber production is important for identifying impacts on the long-term sustainability of timber production, understanding future availability of forest resources and for informing the sustainable management forest resources.

What have we measured and why is it relevant to the indicator?

Since the creation of VicForests[1] in 2003, DEPI's role in forest timber harvesting has moved away from being operational towards a greater focus on stewardship and the regulation of harvesting activities. Initially, in allocating a forest area

to VicForests, the department modelled merchantability, productivity and sustainable harvest levels (as reported in the 2008 State of the Forests Report). Following a five-year review, the Allocation Order was amended in May 2010, by the Allocation to VicForests (Amendment) Order 2010.

The primary amendment involved allocating an equal proportion of the gross area of State forest that is defined as available for timber harvesting rather than a volume-based allocation. The Allocation Order specifies the maximum gross area of Ash and Mixed Species forest stand types that can be harvested in a specified five year period. VicForests are now responsible for calculating the volume of timber that can be harvested sustainably from the allocated area of Victorian public native forests.

Information about the availability of timber is therefore included in Indicator 2.3, which includes data on sustainable harvest levels, annual volume of harvested wood products and the annual area of timber harvesting activities.

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[1]   A state business corporation established in 2003, principally responsible for commercial sale and supply of timber resources from Victorian State forests

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Credit: DEPI

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Indicator 2.3: Annual production of wood products from State forest compared to sustainable harvest levels

Why is this indicator important?

Monitoring and reporting on the state and trends of wood production from native Victoria's forests is an essential part of sustainable forest management. Tracking annual wood product volumes and the extent of harvesting operations against established sustainable harvest levels is necessary for understanding whether timber resources are being managed sustainably.

What have we measured and why is it relevant to the indicator?

This indicator reports annual volumes of wood products and the annual area of timber harvesting activities in State forests for the reporting period. Production values are compared to sustainable harvest levels. Harvesting activities in eastern and western Victoria are reported separately because of the different mechanisms used to specify sustainable harvest levels. Commercial and domestic firewood extraction are also reported.

Sustainable harvest levels

Sustainable harvest levels are specified and reported via different mechanisms in eastern and western Victoria. In eastern Victoria, sustainable harvest levels are managed through an Allocation Order, which describes the location and extent of timber resource available for timber harvesting. In western Victoria, sustainable harvest levels for sawlog and in some areas firewood are specified by volume, by Forest Management Area. Figure 1 shows the location of Victoria's eastern and western regions delineated by Forest Management Area[1].

Figure 1. Map showing eastern and western Victorian Forest Management Areas. Source DEPI

Allocation Order

The **Allocation Order** (AO) is created under Section 13 of the *Sustainable Forests (Timber) Act 2004*. It describes the location and extent of timber resources allocated for harvesting and sale to VicForests. The Allocation Order has been reviewed on three occasions since its introduction, with major changes resulting. During the current reporting period, the AO specified the maximum area available for timber harvesting over a set five-year period. This maximum area limit is now described as a five-year rolling average.

Table 1 shows the area available for timber harvesting in the Allocation Order periods 1 (August 2004 to July 2009) and 2 (August 2009 to July 2014). These sustainable harvest levels were relevant during the reporting period. The significant difference in available area for both ash and mixed-species forests between AO period 1 (2004 to 2009) and AO period 2 (2009 to 2014) is due to the change in methodology used to calculate the available area through the Allocation Amendment Order 2010[2] (refer to breakout box for details).

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1   A Forest Management Area (FMA) is an administrative geographic unit, the extent of which is associated with a Forest Management Plan under section 22 of the *Forest Act 1958*. Victoria contains 14 FMAs (7 in the western region and 7 in the eastern region).

2   DSE (2010) VicForests allocation of State forests fact sheet, September 2010

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Indicator 2.3: Annual production of wood products from State forest compared to sustainable harvest levels

Table 1. Area available for timber harvesting in the Allocation Order period 1 (August 2004 to July 2009[3]) and period 2 (August 2009 to July 2014[4]). Source DEPI

Forest Stands	Area allocated for timber harvesting (ha) during the AO period[C]
Period 1: August 2004 to July 2009[A]	
Ash	28,620[†]
Mixed Species	58,575[*]
Period 2: August 2009 to July 2014[B]	
Ash	17,400
Mixed Species	71,800

[A] Allocation to VicForests (Amendment) 2007

[B] Allocation to VicForests (Amendment) Order 2010

[C] The August 2004 to July 2009 area allocation figure is net area. The August 2009 to July 2014 area allocation figure is gross area

[†] Includes 1,200 hectares of 2003 fire salvage and 19,610 hectares of fire affected ash.

[*] Includes 35,730 hectares of fire affected mixed species

[3] As a result of the Great Divide fires in 2006/07, an amendment was made to the Allocation Order to enable VicForests to undertake salvage harvesting of trees killed by the fires. This amendment was published in the Government Gazette on 21 March 2007. http://www.dse.vic.gov.au/__data/assets/pdf_file/0013/102118/Amendment_to_Allocation_Order.pdf

[4] An amendment to the Allocation Order was published in October 2013. However this is outside of the current 2013 State of the Forests Reporting period. http://www.dpi.vic.gov.au/forestry/public-land-forestry/timber-allocation-order

Table 2. Annual sustainable harvest levels (sawlog volumes in cubic metres) for western Victoria Forest Management Areas. Source The Estimates of Sawlog Resource (ESR) 2002

Forest Management Area	Year and Volume (m^3)				
	2007/08	2008/09	2009/10	2010/11	2011/12
Mid Murray[A]	5,200	5,200	814	814	814
Bendigo	730	730	730	730	730
Horsham	900	900	900	900	900
Midlands	8,600	8,600	8,600	8,600	8,600
Otway[B]	27,100	-	-	-	-
Portland	7,600	7,600	7,600	7,600	7,600
Total	**50,130**	**23,030**	**18,644**	**18,644**	**18,644**

[A] Adjusted based on 2008 VEAC River Red Gum Investigation calculations

[B] Based on estimate of saw log resource calculations 2002, harvested operations ceased on implementation of tenure change in the Otways, associated with the 2004 VEAC Investigation.

Western Victoria

Sustainable harvest levels (defined as sawlog volume in cubic metres) for western Victoria's Forest Management Areas are shown in Table 2. These sustainable harvest levels are based on estimate of saw log resource calculations published in 2002 (except Bendigo FMA[5]). These figures reflect the officially published sustainable harvest levels for western Victoria current during the reporting period. DEPI has recently published recommendations for new sustainable harvest levels in western Victoria[6].

[5] Calculated during the ECC Box-Ironbark Forests and woodlands Investigation (2001)

[6] DEPI (2013) Review of Commercial Forestry Management in Western Victoria, Timber Resources, Harvest Levels, Silviculture, and Systems and Processes.

Mature ironbark woodland. Credit: Peter Kinchinton

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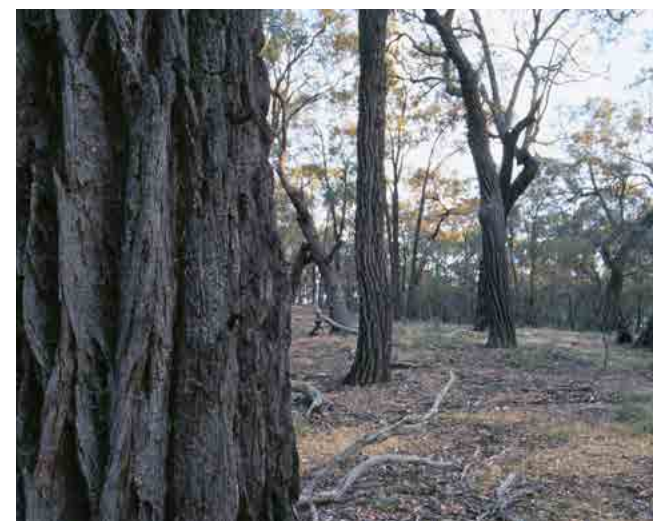
Indicator 2.3: Annual production of wood products from State forest compared to sustainable harvest levels

Changes to the Allocation Order (2010)

The Allocation Order was first created in 2004 to allocate timber resources for harvest and sale to VicForests. Reviews were initially scheduled at five year intervals but in practice have occurred more frequently due to bushfires and policy changes. The Allocation Order was first reviewed in 2007 to enable salvage harvesting in unallocated stands affected by the 2006/07 bushfires. A scheduled review of the Allocation Order occurred in 2010 and introduced a revised approach to calculating area available for harvest. Most recently in October 2013 the Allocation Order was amended to reflect major changes to the *Sustainable Forests (Timber) Act 2004*.

Two Allocation Order periods applied during the reporting period: 2004-2009 and 2009-2014. For the first Allocation Order period, DEPI modelled merchantability, productivity and sustainable harvest levels in order to allocate harvesting area to VicForests by FMA and detailed forest type.

The 2010 Allocation Order review introduced a simpler allocation method, which applies to the second period. The method allocates a set proportion of all GMZ and SMZ in eastern Victoria for harvest during the reporting period. With this change, the area of forest allocated to VicForests significantly changed, as did responsibility for strategic resource planning.

The new approach and amendments made by the Allocation to VicForests (Amendment) Order 2010, were designed to ensure consistency with changed management and governance arrangements outlined in the 2009 Victoria's Timber Industry Strategy and to provide clearer separation of the government's commercial operations and environmental regulation functions[7].

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[7]   DSE (2010) VicForests allocation of State forests fact sheet, September 2010 and http://www.dse.vic.gov.au/forests/publications/plans/allocation-order.

Annual volume of wood products

The main wood products harvested in Victoria's public forests are sawlogs and pulpwood. Sawlogs are processed into structural grade and appearance grade timber products. Pulpwood comprises logs used for paper and wood-based panel products and is usually a residual product of sawlog harvesting. Other wood products harvested in native forests include low-quality sawlogs, posts and poles, bush sawn/hewn timber, firewood, speciality timber and sleepers. These are also usually a residual product of sawlog harvesting. For information about the value of wood products, refer to Indicator 6.1a.

State and trend

Table 3 and Figure 2 show the annual production of wood products (sawlog, pulpwood and other products) from 1996 to 2012. A breakdown of timber production (volume) in western Victoria is shown in Table 4.

Credit: DEPI

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Table 3. Total annual production from Victorian State forest (eastern and western Victoria), 1996-97 to 2011/12.
Source DPI 2012

Year	Volume (cubic metres)			
	Sawlogs[A]	Pulpwood	Other products[B]	Total
1996/97	729,000	1,033,000	na	1,762,000
1997/98	804,000	1,120,000	na	1,924,000
1998/99	821,000	1,165,000	na	1,986,000
1999/00	820,000	1,403,000	na	2,223,000
2000/01	667,000	1,580,000	na	2,247,000
2001/02	682,000	1,365,000	111,000	2,158,000
2002/03	638,000	1,208,000	117,000	1,963,000
2003/04	530,000[C]	1,291,000	112,000	1,933,000
2004/05	583,000[D,E]	1,335,000	123,000	2,041,000
2005/06	497,000[D,F]	1,329,000	109,000	1,935,000
2006/07[G]	428,000	1,241,000	124,000	1,793,000
2007/08	433,000	1,478,000	147,000	2,058,000
2008/09	413,000	1,141,000	158,000	1,712,000
2009/10	443,000	1,250,000	172,000	1,865,000
2010/11	330,000	1,168,000	203,000	1,701,000
2011/12	298,000	967,000	184,000	1,449,000

[A] Prior to 2004/05 sawlog volume is expressed as net volume (gross volume minus allowances for defects).

[B] Other products include E grade (low grade) logs and cull logs. Data not available before 2001/02;

[C] Includes 118,000 m3 fire salvage, normal harvest was 412,000 m³

[D] Gross sawlog volume

[E] Includes 50,000 m³ fire salvage, normal harvest was 533,000 m³

[F] Includes 27,000 m³ fire salvage, normal harvest was 470,000 m³

[G] Over the six year period (2006/07 to 2011/12) approximately 650,000 m³ of D+ sawlog was harvested from areas burnt by fire.
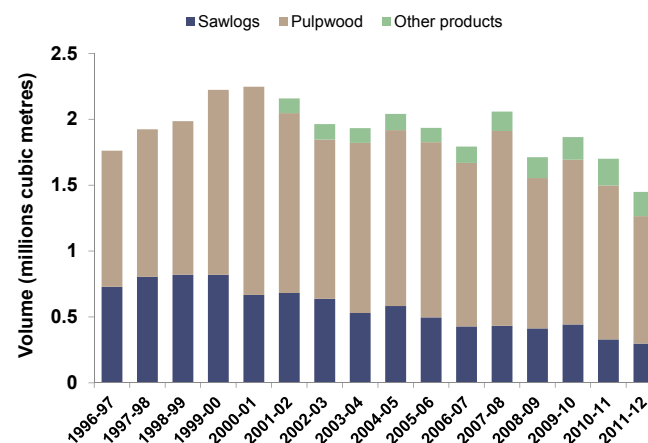
Figure 2. Annual Production of wood products from State forest, 1996-97 to 2011-12. Source DPI 2012

Credit: DEPI

Table 4. Volume (m³) of harvest products in western Victoria (2006 to 2012). Source DPI 2012

Year	Volume (cubic metres)			
	Sawlogs	Pulpwood	Other	Total
2006/07	36,000	80,000	3,000	119,000
2007/08	27,000	63,000	5,000	95,000
2008/09	10,000	10,000	7,000	27,000
2009/10	5,000	na	4,000	9,000
2010/11	4,000	na	2,000	6,000
2011/12	4,000	5,000	9,000	18,000

For consistency with previous State of the Forests Reports, E grade sawlog is included in the 'Other' product category

'Other' includes: fencing timbers, residual logs (not meeting sawlog quality). The end use of residual logs in not specified, but may include firewood, fence posts, poles and garden landscape timbers.

These figures do not include domestic firewood

Ungraded fire salvage sawlog has been included in the Sawlogs category

[A] Included timber harvested as part of suppression and recovery operations during the 2006/07 Great Divide Fires.

- Between 2006 and 2012, each year an average of 1.8 million cubic metres of wood products were extracted from Victoria's public forests. The vast majority of this volume (97%) is extracted from eastern Victoria.

- In western Victoria, the significant reduction in the annual volume of timber products over the reporting period was primarily associated with a cessation of harvesting due to the reclassification of State forests to Parks and conservation reserves in the Mid-Murray, Mildura, Otway and Portland FMAs (refer to Indicator 2.1 for further details).

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- An average 391,000 m^3 of sawlogs per annum were extracted over the period 2006 to 2012. This is 195,000 m^3 less than the annual average sawlog extraction between 2001 and 2006 (average 586,000 m^3 per annum) and 377,200 m^3 less than the annual average between 1996 and 2001 (average 768,200 m^3 per annum).

- Over this period, pulpwood extraction made up (on average) 68% of total volume, ranging from 962,000 cubic metres in 2011/12 to 1.5 million cubic metres in 2006/07. Despite increases in total volume in 2007/08 and 2009/10, there was an overall decrease of 20% in annual volume extraction between 2006/07 and 2011/2012.

- Average annual pulpwood extraction was approximately 8% less during the period 2006/2012 than the previous reporting period (2001/2006).

- Annual sawlog volumes harvested for the period 2006/07 and 2010/11 were between 22% and 67% of the total volume of harvested products in western Victoria.

- Government decisions to reclassify approximately 196,000 hectares of State forest to Parks and conservation reserves resulted in the cessation of harvesting[7] in the Mildura and Otway FMAs and reduction of harvesting in the Mid Murray FMA during the reporting period.

Data source and limitations

Up to 2008, forest produce volumes are derived from DEPI's Logsales system. After 2008, forest produce volumes are derived from the DEPI Forest Produce Sales System. Volume figures are rounded to the nearest thousand cubic metres and product classification is by end use. Log dimensions may vary depending on different product specifications across Victoria.

[7]   Limited sustainable harvesting of minor forest produce and firewood is permitted in the Otway FMA

Credit: DEPI

Annual area of timber harvesting

Silvicultural systems and forest types are a key consideration in harvest planning and strongly influence the area of forest harvested. The primary silviculture methods used in Victoria are: clear fall; seed tree; thinning and single tree selection.

Clear fall is a system involving the harvesting of all trees (excluding retained habitat trees) within an area. Following harvest, regeneration is achieved by burning and sowing the site using seed either collected prior to harvest, or from a nearby site. Clear fall is currently practiced in ash forests in Victoria to provide the best chance of successful regeneration. These forests are dominated by *Eucalyptus regnans* (Mountain ash), *Eucalyptus delegatensis* (Alpine ash) and *Eucalyptus nitens* (Shining gum).

Seed tree differs from clear fall in that suitable mature trees are retained within the harvest area for the purpose of regeneration from the seed they carry. A regeneration burn may be conducted at the completion of harvesting to establish a receptive seedbed for germination, and to encourage seed fall from the seed trees. Seed tree silviculture is currently used in eastern Victoria, predominantly in mixed species forest types. Mixed species stands include two or more eucalypt species, generally of peppermint, messmate, gum or stringybark species.

Single tree and group selection is undertaken mainly in the central and western Box-Ironbark forests and River Red Gum forests in the north and north-west of the state. These silviculture systems involve the periodic removal of single or small groups of trees across a large area of forest. Regeneration, often of coppice origin, generally occurs without need for burning, producing an unevenaged forest.

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Thinning is a tending operation generally undertaken in regenerating forest stands that are heavily stocked. Thinning promotes overall forest productivity and health by reducing competition. Thinning is versatile in that the type of trees retained can be varied to cater for different management objectives. Thinning is currently practiced in most forest types across Victoria.

Clear fall and seed tree can be described as intensive silviculture methods, in that they produce high volumes of relative to their area. In contrast, extensive silvicultural systems, which include group and single tree selection, produce low volumes relative to their large area. Thinning (the selective removal of trees to improve) similarly has a low volume to area ratio.

State and trend

The area of State forest harvested annually across all Victoria is shown in Table 5. Table 6 compares the area harvested by VicForests with the allocated area for the associated period. Note that only three of the five years within period 2 of the Allocation Order occurred during the reporting period.

- The area of State forest harvested between 2006/07 and 2011/12 was between 7,900 and 11,600 hectares per year. The area harvested represents (on average) less than 1% of the total area available for timber harvesting (Indicator 2.1).

- The area of clear fall ranged between 1,500 hectares in 2011/12 to 2,900 hectares in 2007/08.

- On average, 3,500 ha per annum of State forest was managed using the single tree selection silvicultural system over the period 2006/07 to 2011/12. Single tree selection made up, on average 37% of the total area harvested each year across Victoria.

Table 5. Annual area of Victorian State forest harvested, 2006/07-2011/12. Source DEPI 2012[†]

	Area harvested (Hectares) by silvicultural method				
Year	Clear fall	Seedtree	Thinning	Single tree selection	Total (all systems)
2006/07	2,000	2,600	2,100	4,000	10,700
2007/08	2,900	2,400	2,300	4,000	11,600
2008/09	2,000	2,500	1,800	4,000	10,300
2009/10	2,400	1,900	1,300	3,000	8,600
2010/11	2,100	2,500	800	3,000	8,400
2011/12	1,500	2,200	1,200	3,000	7,900

[†] Harvesting managed by VicForests and DEPI

Table 6. Annual area harvested by forest stand type and the Allocation Order (area available for timber harvesting). Source DEPI 2012

Year	Ash (Area, Hectares)		Mixed species (Area, Hectares)	
	Area Harvested[A]	Area available for harvesting in Allocation Order period[†]	Area Harvested[A]	Area available for harvesting in Allocation Order period[†]
2004/05	2,000	2004 – 2009	3,100	2004 - 2009
2005/06	1,700		2,900	
2006/07	1,700		2,900	
2007/08	2,100		3,200	
2008/09	1,600		2,900	
Total (2006-2009)	9,100	28,620	15,000	58,575
2009/10	1,900	2009-2014[B]	2,400	2009-2014[B]
2010/11	1,600		3,000	
2011/12	1,200		2,500	
Total (2009-2012)	4,700	17,400	7,900	71,800

[A] Net area of Clear fall and seed tree type harvesting

[†] The August 2004 to July 2004 area allocation figure is a net area allocation. The August 2009 to July 2014 area allocation figure is a gross area allocation

[B] Data available for three years within the current State of Forests 2013 reporting period.

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- The next most extensive silvicultural systems by area harvested between 2006/07 and 2011/12 were seedtree (average 2,350 hectares per annum).

- During the reporting period, fire salvage harvesting was a significant part of harvesting and silviculture operations. Between 2006/07 and 2010/11 at least a quarter of clearfall activity was undertaken in areas burnt by bushfire. Following the Black Saturday Fires (Indicator 3.1) in 2009, nearly 40% of clear fall harvesting (in the year 2009/10) took place in fire affected forests. The area of fire salvage harvesting dropped to below 5% in 2011/12. Extensive salvage operations were also undertaken following bushfires which burnt 1.2 million hectares of north-east and Gippsland regions of Victoria.

- The increase in fire salvaging operations, resulted in a decreased capacity to undertake thinning in eastern Victoria, which decreased by 65% between 2007/08 (2,300 ha) and 2010/11 (800 ha).

- For the six year period up to 2011/12, the area of seed tree systems has remained relatively stable (average 2,350 ha per annum). This stability is because the mixed species forests, in which seed tree systems are usually practiced, don't die after bushfires.

- The average area of ash harvested annually over the period 2008/09 to 2011/12 was 1,575 hectares. Over the three years 2009/10 to 2011/12, 4,700 hectares of ash forest was harvested, representing about a quarter of the total Allocation Order area available for harvesting for the period 2009 to 2014. It should be noted that only part of the allocation order period coincides with the reporting period, thus a reconciliation cannot be made.

- The total area of mixed species forest harvested from 2009/10 to 2011/12 represents 11% of the total are available for harvesting in the Allocation Order period 2009 to 2014. Between 2008/09 and 2011/12, an average 2,700 hectares of mixed species forest was harvested per year.

Data source and limitations

- Harvest areas are reported to the nearest 100 hectares.

- Due to difficulties in boundary delineation for single tree selection harvesting (where only a few trees per hectare are harvested), the area of single tree selection reported is a general estimate.

Credit: DEPI

Firewood

For many Victorians, firewood is an important energy source for heating and cooking. The majority of the firewood used is collected by households for domestic use from the forest with the remainder by commercial firewood collectors. Firewood collection within the forest estate is restricted to certain areas, and times of the year. In September 2011, the Victorian Government firewood policy was implemented, discontinuing the previous licence system for firewood collection in order to make domestic collection less bureaucratic and more affordable.

State and trend

Table 7 shows the annual volume of domestic and commercial firewood collected through licences. Approximately 89,000 hectares of State forest were opened as Domestic Firewood Collection Areas in Autumn 2012 (3,000 hectares in western Victoria and 86,000 hectares in eastern Victoria).

Indicator 2.3: Annual production of wood products from State forest compared to sustainable harvest levels

Table 7. Volume (m³) of firewood collected through licences for domestic and commercial in State forest (2001/02 to 2011/12). Source DEPI

Year	Domestic	Commercial	Total
2001/02	48,207	12,256	**60,463**
2002/03	54,826	16,022	**70,848**
2003/04	54,454	18,736	**73,190**
2004/05	56,660	26,980	**83,640**
2005/06	51,330	14,149	**65,479**
2006/07	35,926	9,061	**44,987**
2007/08	24,484	12,184	**36,668**
2008/09	24,365	12,530	**36,895**
2009/10	33,645	8,348	**41,993**
2010/11	38,981	6,106	**45,087**
2011/12[1]	11,652	6,400	**18,052**

Notes: 1. The domestic volume is for approximately half the year as the Government's firewood policy removed the requirement to licence domestic collection at the end of 2011.

- There has been a general decline in the volume of firewood collected over the period 2001 to 2011, with an average volume of domestic firewood of 50,234 m³ over the period 2001 to 2006 and 31,480 m³ between 2006 and 2011.

- In 2011, the final year where domestic licensing occurred, the total licenced firewood collected from State forest represented approximately 2.5% of wood products for State forest.

- Firewood consumption within Victoria in 2007 was estimated to be 630,000 m³ indicating that licenced firewood accounts for a small part of the overall demand.

Data source and limitations

Firewood data is derived from DEPI summary firewood sale reports and the Forest Produce Sale System (FPSS). The DEPI reports compiled regional firewood sale records for the period 2001 to 2008. After 2008 regional firewood sale records have been recorded in the FPSS which has centralised licencing and payments, resulting in improvements to data quality, accuracy and ability to report.

References

DEPI 2012, Harvested Logging Coupes (LOG_SEASON). GIS layer. ANZVI0803002394

Allocation to VicForests (Amendment) 2007

Allocation to VicForests (Amendment) Order 2010

DEPI 2013, Review of Commercial Forestry Management in Western Victoria

Indicator 2.4: Annual production of non-wood forest products

Why is this indicator important?

The livelihoods of many Victorians are supported by the production of non-wood forest products. Monitoring annual production of non-wood forest products improves understanding of trends and influences in production of these resources, and the significance of these activities to the community and environment. This information can inform their management.

What have we measured and why is it relevant to the indicator?

Non-wood products include a diverse range of physical products such as rock, sand, seed, honey, essential oils, bush foods, flowers and foliage. DEPI issues various licence types for the extraction and harvest of these products on public land. Some licence types specify the amount of product that can be taken, and directly address the indicator. Other licence types simply permit the holder to conduct the activity under specified conditions. In this instance trends in activity levels associated with the product can be monitored, but not actual production levels. Annual licence statistics for major non-wood product types produced on public land are reported in Indicator 6.1b, along with information on the value of these products.

There is no comprehensive data available for production of non-wood products from private land.

Eucalypt seed. Credit: DEPI

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Indicator 2.5: Proportion of timber harvest area successfully regenerated by forest type

Why is this indicator important?

Regeneration following timber harvesting activities is a key part of maintaining the productive capacity of forests. Monitoring the success of forest regeneration informs understanding of the future availability of forest resources and any impacts to long term forest ecosystem function. This information supports forest policy and planning activities, and continual improvement in regeneration practices.

What have we measured and why is it relevant to the indicator?

Forest regeneration is the process of renewal or re-establishment of native forest flora by natural or artificial means following disturbance such as timber harvesting or fire[1]. The focus of this indicator report is regeneration associated with timber harvesting, with discussion of post fire regeneration where relevant.

The *Code of Practice for Timber Production 2007* requires action be taken to successfully regenerate harvested coupes in native forest. Regeneration success is assessed between 18 to 30 months after treatment according to a standard methodology[2]. Coupes that are not successfully regenerated at the first attempt are retreated and assessed until they are successfully regenerated. These are referred to as backlog regeneration.

Victorian regeneration reporting mechanisms vary according to land tenure and administrative arrangements (see Introduction). This indicator reports on regeneration in public forests only, as regeneration information is not centrally collected for private native forests in Victoria.

VicForests and DEPI are both responsible for regeneration activities on public land. Their activities are reported separately within this report due to differences in management arrangements. For VicForests regeneration activities, the report presents the area of coupes finalised by year. Finalised coupes are considered to be successfully regenerated.

An overview of DEPI regeneration is provided. This addresses activities associated with regeneration obligations arising prior to the creation of VicForests in 2004 (backlog regeneration), routine harvesting in western Victoria and fire recovery regeneration activities.

VicForests regeneration

VicForests is responsible for taking action to successfully regenerate the coupes they harvest. They typically harvest around 4,500 hectares of forest per year using silvicultural systems that require regeneration including clear fell and seed tree (see Indicator 2.3). Regeneration success is generally reported around four years after harvesting.

During the reporting period, VicForests nominated successfully regenerated coupes to DEPI annually for coupe finalisation[3]. The coupe finalisation process was first introduced in 2007/08. Nominated coupes were audited for compliance with the Code under a DEPI regeneration audit until 2010 and subsequently by the Forest Audit Program.

Regeneration of Granite Flat Coupe, North East Victoria, 2003-2009.
Credit: David Sayce

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1   Department of Sustainability and Environment (2007) Code of Practice for Timber Production. See DEPI website http://www.dpi.vic.gov.au/forestry/about-forestry/legislation
2   Department of Natural Resources and Environment (1997) Native Forest Silviculture Guidelines No. 10 Eucalypt Stocking Surveys. See DEPI website http://www.dpi.vic.gov.au/forestry/about-forestry/publications/silviculture-guidelines/eucalypt-stocking-surveys

3   The *Sustainable Forests (Timber) Act 2004* and the Allocation Order 2013 were amended in 2013, affecting VicForests regeneration reporting arrangements. VicForests are now required to report regeneration results annually.

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Credit: DEPI

Data source and limitations

The data presented in this indicator report is extracted from DEPI coupe finalisation audits reports. All reports (except for 2012[4]) are available online.

Status and Trends

Figure 1 shows the area of forested coupes which have been finalised (i.e. successfully regenerated and transferred to DEPI) between 2007/08 and 2011/12.

■ Finalised Coupes (regenerated and transferred)
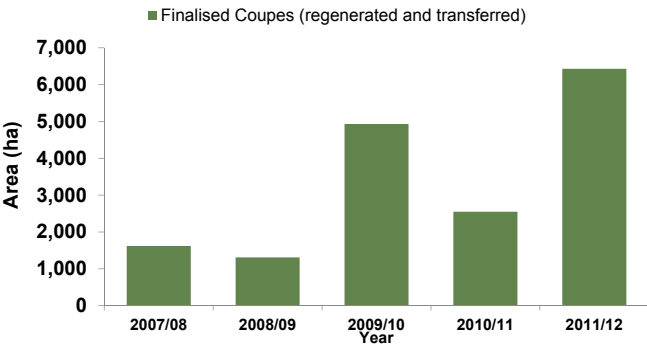
Figure 1. Area of forest accepted for coupe finalisation during the reporting period. Source DEPI

- VicForests first nominated coupes for finalisation in 2007/08.

- The area of coupes successfully regenerated each year increased over the reporting period from 1,620 hectares in 2007/08 to 6,320 hectares in 2011/12.

- The annual area of coupes finalised varied largely as a result of environmental conditions and additional effort by VicForests to achieve successful regeneration when conditions were good.

- Key causes of low regeneration levels were drought, bushfires, poor burning conditions and new administrative processes in 2007/08.

- VicForests aims to have no more than three years harvest area unregenerated at any point in time. As at 30 June 2012 VicForests was within 1,100 hectares (or 9 %) of this target[5].

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[4]   Not published at time of this report.

[5]   VicForests (2012) Sustainability report 2012. See VicForests website http://www.vicforests.com.au/files/lovmpnowas/VicForests-2012-Sustainability-Report.pdf

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DEPI Regeneration

DEPI has responsibility for regenerating harvested coupes in western Victoria and coupes harvested in eastern Victoria prior to the creation of VicForests in 2003.

Harvesting in western Victoria during the reporting period was restricted to single tree selection silviculture in River Red Gum and Box-Ironbark forest types and thinning operations in most forest types. Regeneration following single tree selection operations relies on coppice regrowth and some seedling regrowth from natural seed fall in small gaps. Historically this regeneration method has achieved almost 100 percent success.

Thinning operations aim to promote forest health and vigour by reducing competition between trees in dense stands. There is no requirement to successfully regenerate stands following thinning operations.

Not all first attempts and regeneration are successful and DEPI still has responsibility for backlog regeneration originating prior to 2004 in eastern Victoria. In 2012, DEPI completed a comprehensive review of its backlog regeneration responsibilities in eastern Victoria[6]. This review concluded that around 28,400 hectares of forest requires survey to confirm its regeneration status.

Based on the results of survey work associated with projects in the East Gippsland and North East Forest Management Areas (FMAs) during the reporting period, it is expected that around 5,500 to 7,000 hectares of this area could require remedial treatment. DEPI anticipates a significant proportion of this area will be in the Tambo and East Gippsland FMAs in high elevation mixed species forest types. The department is developing a governance framework to manage these areas into the future. Indicator report 2.3 includes a map showing Victoria's FMAs.

The East Gippsland Enhanced Productivity Project ran between 2009/10 and 2011/12. Through this project DEPI confirmed the regeneration status of over 10,000 hectares of forest, identifying just over 1,000 hectares needing further regeneration work. Establishment activities were completed for 630 hectares of this area.

DEPI also conducted regeneration activities as part of the 2006/07 Great Divide and 2009 Black Saturday fire recovery programs. These activities involved assessing areas of immature fire killed Alpine and Mountain Ash stands to identify those areas needing reseeding or replanting to assist regeneration. Native eucalypts were sown over 7,500 hectares and over 100,000 seedlings were planted as part of these recovery programs. 900 kilograms of eucalypt seed was collected to rebuild DEPI's seed stocks for future regeneration activities[7,8].

Regenerating eucalypt on harvested forest coupe. Credit: DEPI

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6   Department of Primary Industries (2012) *DPI Backlog Regeneration Program. Stage 1 Identifying potential backlog coupes in Victoria's working forest area. July 2012*. State of Victoria. Department of Primary Industries.

7   Department of Sustainability and Environment (2010) 2006-2007 Great Divide Fire – Fire Recovery Program Final Report.

8   Department of Sustainability and Environment (2012) 2009 Bushfire Recovery Program Public Land, 2012 Update. See DEPI website http://www.depi. vic.gov.au/__data/assets/pdf_file/0008/192941/2009-Bushfire-Recovery-Program-public-land-2012-update.pdf

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Indicator 3.1: Scale and impact of agents and processes affecting forest health and vitality

Why is this indicator important?

A range of natural agents and processes affect the health and vitality of Victoria's forests. These include bushfire, browsing, disease, drought, wind and flooding. Natural cycles of disturbance and regeneration play an important role in the maintenance of forest health; however major shifts in the frequency, scale and intensity of these agents and processes can cause significant change in the health of forest ecosystems.

Monitoring the scale and impact of natural agents and processes on forest health assists in detecting shifting trends. This is important as predictions indicate Victorian forest ecosystems will be increasingly affected by these agents as a result of climate change[1]. Detected trends may trigger further research, consideration of new forest management practices or inform the need to adapt to new conditions.

What have we measured and why is it relevant to the indicator?

Forest health may be defined as a measure of the organisation, productivity and resilience of a forest ecosystem. Monitoring based on this definition of forest health at an ecosystem level is however extremely difficult.

Tree canopy condition is recognised internationally as a strong indicator of overall forest health[2]. Tree canopy condition reflects tree health, and tree health affects wildlife, soil and understorey biota through processes such as energy exchange, creation of microclimates, regeneration, competition and habitat provision.

Tree canopy condition responds to the major agents driving forest health in Victoria – bushfire, climate, insect browsing and disease. These agents often interact in complex ways to affect tree health, so it is important to measure tree health as well as the agents and processes affecting it.

This report presents for the first time a statewide assessment of tree canopy condition in Victorian public forests, collected through the VFMP (See Indicator 7.4 and the Victorian Forest Monitoring Program case study). The report also presents data on the extent and causes of bushfires and climatic conditions for the reporting period. These agents are the strong drivers of tree canopy condition in Victoria for the reporting period.

Tree canopy condition

Three measures of tree canopy condition are presented in this report: mortality, crown dieback, and crown defoliation.

1. **Mortality** is represented by dead basal area as a proportion of total basal area[3] (where basal area is calculated as m^2/hectare)

2. Crown **dieback** is a condition where branches within the tree canopy die out, often over a protracted period. The VFMP measures crown dieback as the proportion of major branches in tree crowns that have no live foliage.

3. Crown **defoliation** is a condition where live branches in the canopy have lower amounts of foliage than could potentially be carried. The VFMP measures crown defoliation as the percentage of current foliage as a proportion of potential foliage volume[4].

Defoliated tree crowns, State forest, Moorabool. Credit: DEPI

All three measures may have no obvious cause, but can be the result of one or more factors including disease or insect attack, drought, high temperatures, fire or soil conditions. They can be isolated to particular species or localities affected by a specific agent, or can be a more widespread indication of trees under stress from a range of interacting factors.

Data source and limitations

The mortality, crown dieback and defoliation data presented below was collected through the VFMP. VFMP ground plot measurements occur once every five years, with the first round of monitoring commencing in 2011. The measurement results are presented as an average for each IBRA bioregion (see Introduction). Crown defoliation is cyclical, and several cycles may occur within the five years between ground plot measurements. The timing of the measurement in relation to the crown defoliation cycle will obviously influence the results. Reliable regional trends in crown defoliation may take several rounds of measurement to establish, so the results presented in this report should be viewed as baseline data.

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1   Understanding climate change webpage, climatechange@vic.gov.au

2   Stone, C. and A. Haywood (2006). "Assessing canopy health of native eucalypt forests." Ecological Management & Restoration 7: S24-S30.

3   Basal area is defined as a given area of land that is occupied by the cross-section of tree trunks and stems at their base.

4   DSE (2011) Guidelines for Ground Plot Measurement, Standard Operating Procedure 13 – measuring a large tree plot

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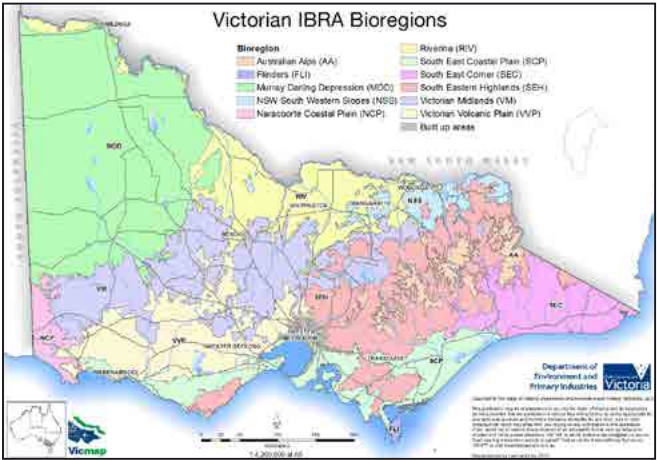
Source DEPI

State and trend

Figure 1 shows the average tree dieback and defoliation rates for each bioregion during the reporting period.
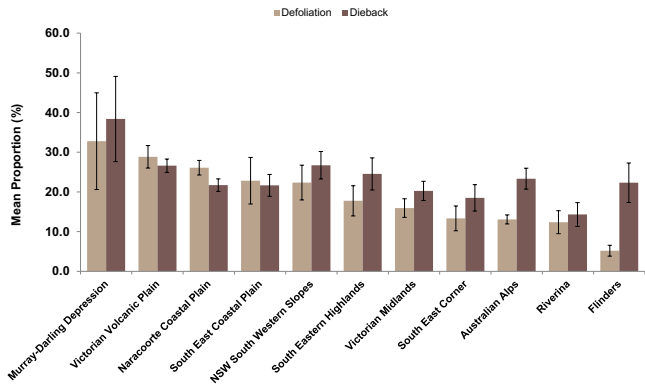
Figure 1. Average tree dieback and defoliation rates for measured plots by bioregion. Source VFMP
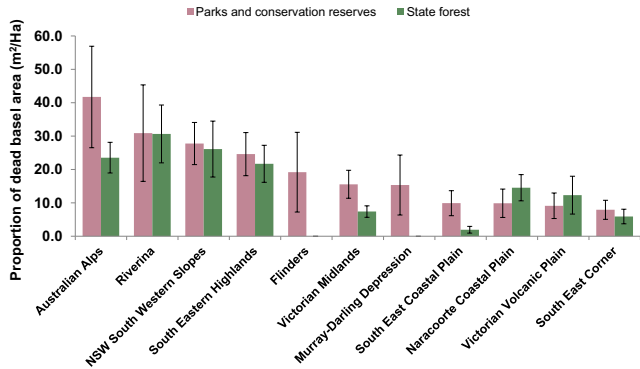
Figure 2. Average mortality by bioregion and public land tenure for measured plots, as the proportion of dead basal area to total basal area. Source VFMP

- Across all Victorian bioregions the average percentage of mortality, crown dieback and defoliation is 19.5, 23.7 and 18.2 per cent respectively.

- Mortality is particularly high in the Australian Alps and South Eastern Highlands. These areas are recovering from the Alpine Fires in 2003, the Great Divide North and South Fires in 2006/07 and the Black Saturday Bushfires in 2009.

- Whilst the proportion of dead stems in the Riverina is relatively low, the volume of dead wood is the highest for the state. This suggests that large trees have died throughout the bioregion. No overbank flooding occurred within the River Red Gum forests of the Riverina between 1997 and 2010. This resulted in severe reductions in forest productivity during the period[5].

5   DEPI (2009), unpublished River Red Gum forest inventory

- The Riverina has the lowest rates of dieback at 14.3 percent and has low defoliation rates. This may be due to the timing of plot measurement. Riverina plots were measured between spring 2012 and summer 2012/13 following extended flooding along the Murray floodplains associated with above average rainfall in 2010 and 2011 (see figure 3). The River Red Gum forests could be expected to be in a health recovery phase following flood events.

- Crown dieback and defoliation is particularly high in the Murray Darling Depression bioregion, at 38.4 and 32.8 percent respectively. This area was severely burnt in 2002 and suffered very much below average rainfall during the 1997 to 2010 drought (see figure 3).

- Dieback elsewhere generally falls between 20 and 25 percent.

- Defoliation rates are above average on the coastal and inland plains, and lower around the foothills and mountains of the Great Dividing Range.
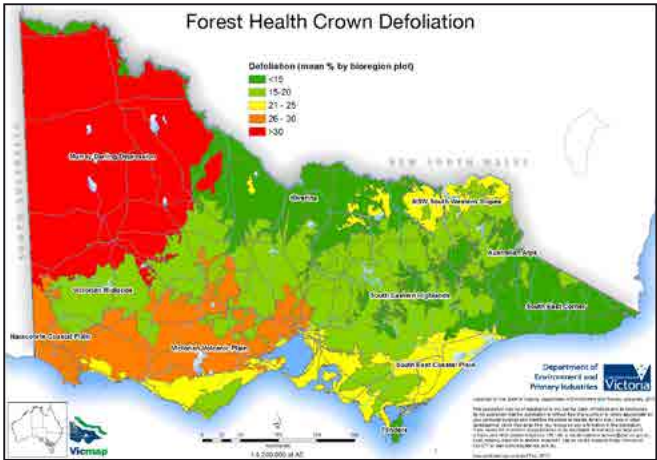
Source DEPI

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Indicator 3.1: Scale and impact of agents and processes affecting forest health and vitality

Area and ignition source of bushfires

Much of Australia's flora and fauna has evolved with fire and relies on natural fire regimes for its continued health and survival. Fire regimes are defined by the period of time between fires (frequency), the intensity of fires and the season in which fires occur.

Individual species vary in their response to fire regime, depending on their tolerance of fire, regeneration requirements, time to reproductive maturity and longevity. Fire frequencies outside tolerable ranges may result in fundamental change to the structure, composition and function of a forest ecosystem, particularly where canopy tree species are impacted.

Bushfire recovery 2012. Credit: DEPI

The intensity of fire also determines the degree of change to a forest ecosystem. Very intense canopy fires, as sometimes occur in the hot, dry and windy conditions during Victoria's summer, can result in landscape scale replacement of mature tree cohorts with regeneration. Changes are particularly dramatic in Victoria's mountain and alpine ash forests, where canopy tree species are fire intolerant. Large, intense fires also have lasting impacts on streamflow, the viability of threatened species and may enable invasion by exotic species.

Fires occurring in cooler conditions or moister environments often don't result in canopy fire, thus resulting in relatively little change to the forest structure in the longer term. Forests subject to lower intensity fire and unburnt patches are important areas for refuge and recovery in fire affected landscapes.

Ignition sources can affect the scale and frequency of fire. There are three categories of ignition used in this report:

- Natural - lightning strikes
- Accidental - power lines, escaped campfires / burnoffs, exhaust, cigarettes, waste disposal
- Deliberate - arson

Data source and limitations

Fire data presented in this indicator report is derived from the DEPI corporate geospatial datasets Fire100 and PLM25, and Fireweb. These datasets are constantly updated with information about new fires. Ignition statistics cover all land tenures and include forested and non-forested areas. Area statistics are for all areas of public land and include small amounts of non-forested land.

State and trend

Victoria has experienced some of its worst recorded bushfire seasons during the reporting period, resulting from prolonged drought and extreme weather events. Table1 shows the area of public land affected by bushfire between 2006/07 and 2011/12.

- In total, almost 1.5 million hectares of Victorian public forest was burnt in bushfires during this period. Of this, 72 percent of the burnt area was ignited by lightning, although lightning accounted for 35 percent of all ignitions for the period.
- There is significant variation in the total area of forest burnt by bushfire from year to year. This largely reflects climatic conditions leading up to and during the fire season.
- Two major bushfire events occurred during the reporting period, the Great Divide and Black Saturday fires.
- In the 2006/07 fire season, the 'Great Divide North' and 'Great Divide South' bushfires burnt more than 1.2 million hectares, almost entirely in public forests. These fires ignited from multiple lightning strikes during a single storm event in remote areas in the Victorian Alps on 1 December 2006[6]. They took over 3 months to control, hampered by difficult access, high temperatures and severe rainfall deficit (See figure 3).
- The 'Black Saturday' fires occurred in February 2009. These fires included substantial loss of human life, loss of private property, and in total, affected approximately 430,000 hectares of both public and private land, including 287,000 hectares of public forest. These fires resulted from a range of causes including arson, electrical failure, accidental causes and lightning[7].

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[6] DSE (2010) 2006-07 Great Divide Fire – Fire Recovery Program Final Report

[7] 2009 Victorian Bushfires Royal Commission – Final Report, Volume 1 The fires and the fire-related deaths

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Table 1. Area of public land impacted by bushfire. Source DEPI

	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
State forest (ha)	715,988	2,145	177,971	8,040	7,621	617
Parks and reserves (ha)	420,217	26,963	130,234	3,360	4,138	1,257
Total area (ha)	**1,136,205**	**29,108**	**308,205**	**11,400**	**11,759**	**1,874**

Note: Some areas of Parks and reserves may have been tenured as state forest at the time of fire.

- Following both the 2006/07 and 2009 fires, fire recovery teams sowed and planted over 7,000 hectares of State forest to re-establish alpine and mountain ash forest in areas with inadequate natural seed crops[5]. Major projects were also completed to assist threatened species recovery and prevent spread of invasive species.

- Over 10,000 hectares of alpine ash and some areas of snow gum forests in North East Victoria have burnt three times within the past decade. Without human intervention, the alpine ash forests may convert to shrub or grasslands[8].

Climate

The Australian climate occurs in cyclical patterns which can extend over multiple years. Rainfall deficit and high temperatures can have a severe impact on forest health and vitality, causing mortality, defoliation and dieback in both trees and understory, decreased productivity, reduced reproductive capacity and resources for forest dependant species. Prolonged rainfall deficit (drought) and high temperatures can also contribute to increased fire activity and general land degradation. In addition, drought-stressed forests are more susceptible to disease and insect infestations.

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[8] DEPI (2013) 2013 Alpine Fires North East Victoria and Gippsland February 2013 – Risk Identification.
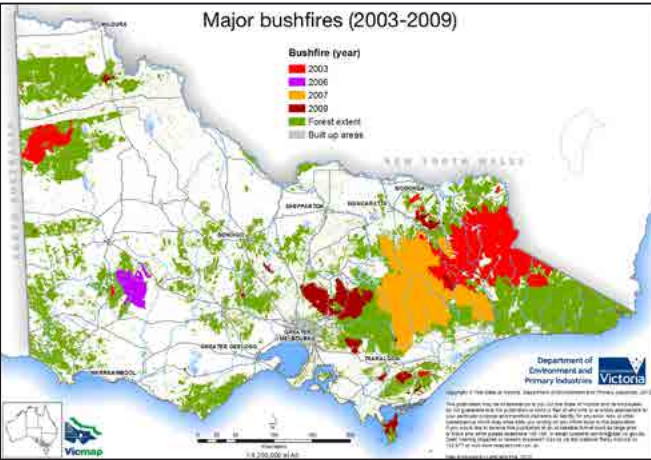
Source DEPI

Climate data from the Bureau of Meteorology is presented for the period 1997 to 2012. This time series shows the reporting period within the context of the 1997 to 2010 drought[9]. Inter-annual rainfall and temperature anomaly statistics show variation around long term averages for the state. Australia wide cumulative regional variations around long term average rainfall are also presented for 1997 to 2011. Variations are presented as deciles[10].

[9] See Bureau of Meteorology website for more detailed data http://www.bom. gov.au/cgi-bin/climate/change/timeseries.cgi?graph=tmean&area=vic&seaso n=0112&ave_yr=0

[10] Refer to About Climate Statistics on the Bureau of Meteorology website

State and trend

Figures 3 to 5 show annual rainfall anomaly, annual temperature anomaly and rainfall deciles respectively.

Figure 3. Annual rainfall anomaly Victoria 1997 – 2012. Source BOM
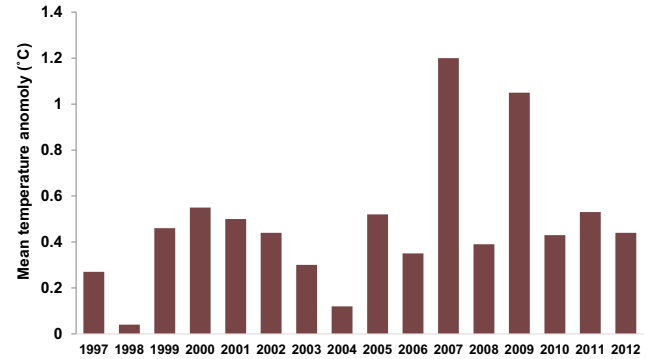
Figure 4. Annual mean temperature anomaly 1997 – 2012. Source BOM

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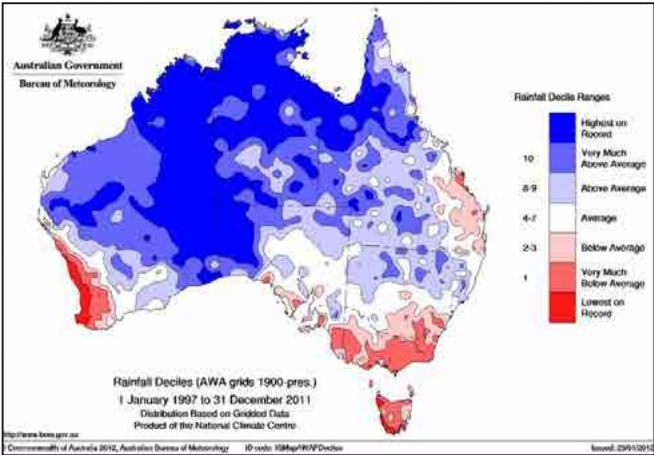
Figure 5. Australian rainfall deciles for January 1997 – December 2001.
Source BOM

- The first half of the reporting period concluded Victoria's longest period of sustained rainfall deficit on record. The state received on average 15% less rainfall during the 13 year drought from 1997 to early 2010[11].

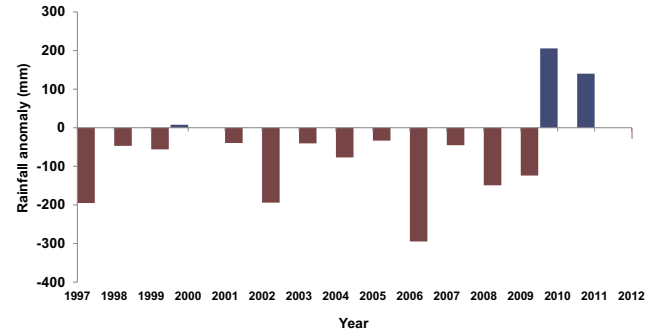- Below to very much below average rainfall was experienced across most parts of the state over this period. The most severe deficits occurred in the Wimmera and on and south of the Great Dividing Range.

- Dry autumns were a particularly strong feature of the drought[11], extending fire seasons and contributing to the extent of fires.

- Rainfall in 2006 was 65% below average[12]. Victoria also experienced its third hottest January to May period in 2007[13]. Alpine areas experienced the most severe anomalies. These abnormally dry and hot conditions contributed to the extent of the 2006/07 Great Divide fires which affected x% of Victoria's forests.

- In the summer of 2008/09 much of Victoria experienced the hottest conditions in over 70 years. On 7 February 2009, the hottest day on Victorian record combined with high winds played a major role in the disastrous Black Saturday bushfires[11].

- After the drought broke in January 2010, Victoria experienced its 5th wettest year on record. 2010 rainfall was 31% above average for Victoria, with most rain falling as summer storms[11]. These storms caused extensive flooding throughout Victoria, bringing the first overbank flood events to the River Red Gum forests since 1997.

References and further information

Bureau of Meteorology (2013) Rainfall deficit data provided by Department of Sustainability and Environment.

Bureau of Meteorology (2013)a Annual climate summaries for Victoria. www.bom.gov.au

Bureau of Meteorology Special Climate Statements www.bom.gov.au

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Department of Sustainability and Environment (2012) Standard Operating Procedure 13, Measuring a Large Tree Plot. FPMRIS Guidelines for Ground Plot Measurement. Department of Sustainability and Environment.

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Stone, C. and A. Haywood (2006). "Assessing canopy health of native eucalypt forests." Ecological Management & Restoration 7: S24-S30.

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[11] DSE (2012) Report on Climate Change and Greenhouse Gas Emissions in Victoria

[12] BOM (2006) Climate conditions preceding the December 2006 southeast Australian bushfires

[13] BOM (2007) Warmest May and autumn on record in eastern Australia

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Indicator 3.2: Area and type of human-induced disturbance

Why is this indicator important?

Human-induced disturbance, whether intentional or unintentional, has potential to affect forest ecosystem health. Monitoring the extent and type of these disturbances assists in understanding and addressing the impacts of human activities on forest health.

What have we measured and why is it relevant to the indicator?

Distinguishing between human-induced and natural disturbances can be difficult. For example, bushfire can be caused by lightning as well as human activities, and flooding regimes are highly influenced by river regulation. This report looks specifically at disturbances caused by deliberate human activity in public forests.

This indicator discusses three categories of human-induced disturbance activities: forest management, economic and public. The extent of planned burning and roading activities are reported in detail as they are significant management activities conducted throughout public forests. The extent of other significant activity types is covered in detail elsewhere in this report. Links are provided to these materials within the indicator.

The extent of a number of activity types is not monitored. Background information relevant to the area and control of these activities is provided.

Forest management activities

Management activities are implemented in Victoria's public forests to maintain public safety, access and ecosystem health and vitality. Activity types that fall within this category include:

- fuel management (planned burning and mechanical)
- road management (road, track and firebreak construction, upgrade and maintenance)
- invasive species management
- ecological thinning
- environmental watering
- various forms of disaster recovery
- hazardous tree removal.

Most of these activities have several objectives, often including one that addresses forest health. Planned burning and roading are the most extensive forest management activities conducted in public forests. The extent and forest health implications of these disturbances are both reported in more detail below.

Planned burning

The *Code of Practice for Bushfire Management on Public Land* (2012) defines planned burning as '*the deliberate application of fire under specified environmental conditions to a predetermined area and at the time, intensity and rate of spread required to achieve planned resource management objectives*'.

Planned burning is the most extensive forest management activity conducted in public forests during the reporting period. This focus recognises the importance of planned burning in limiting the damage potential of bushfire, thus protecting human life and maintaining forest health (see discussion of the role of fire regimes in maintaining forest health in Indicator 3.1).

In Victoria, the three key management objectives for planned burning are:

- fuel hazard modification
- improving ecological resilience through appropriate fire regimes
- regeneration following timber harvesting[1].

These objectives are expressed in Fire Management Zone mapping. The four Fire Management Zones are:

- Asset Protection Zone (APZ)
- Bushfire Moderation Zone (BMZ)
- Landscape Management Zone (LMZ)
- Planned Burning Exclusion Zone (PBEZ)[2].

DEPI conducts planned burns to meet the objectives of the relevant Fire Management Zone and other site specific objectives.

Following the 2003, 2006/07 and 2009 Black Saturday Bushfires, and the subsequent 2009 Victorian Bushfires Royal Commission, the Victorian Government committed to expansion of planned burning on public land to reduce fuel hazards and protect human life. This policy should also improve forest health by reducing the incidence of large, intense bushfires and maintaining fire regimes within the tolerable fire intervals for forest ecosystems.

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[1]   DSE (2012) *Code of Practice for Bushfire Management on Public Land*.
[2]   DSE (2012) *Code of Practice for Bushfire Management on Public Land*.

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Data source and limitations

Planned burning data presented in this indicator report is sourced from the DEPI fireweb burns and works database and the FireFMZ spatial layer.

New Fire Management Zone boundaries were introduced in 2012/13. The Fire Management Zone areas used for calculations in this report reflect the boundaries operational at the time of burning.

State and trend

Table1 shows the area and proportion of public land burnt per year since 2001/02.

Figure 1 shows the area of public land subject to planned burning between 2006/07 and 2012/13 by Fire Management Zone.

- The total annual area of planned burning on public land increased by 59,000 hectares during the reporting period, from 138,000 hectares in 2006/07 to 197,000 hectares in 2011/12. In 2012/13 the area increased to 255,000 hectares.

- The proportion of the public land estate burnt annually increased from an average of 0.9 percent in the previous reporting period to an average of 2.2 percent in the current reporting period.
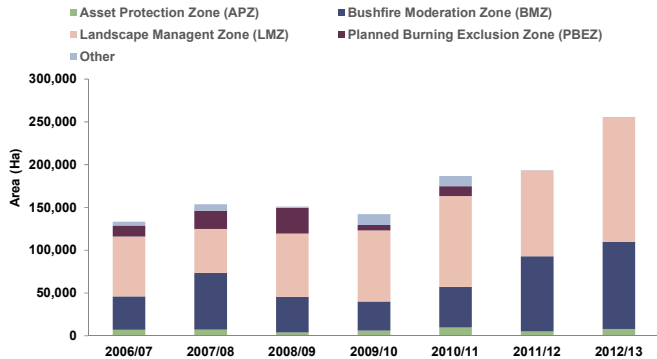
Figure 1. Annual area of planned burning on public land by Fire Management Zone. Source DEPI 2013

- Variation in the annual area of planned burning reflects the Victorian Government policy to increase planned burning, as well as ability to burn due to seasonal conditions and commitment of resources to fire response.

- During the reporting period, an average of 5% of APZ, 7% of BMZ, 2% of LMZ and 1% of PBEZ were burnt each year. Planned burning is focussed within the APZ and BMZ to reduce potential impacts of bushfires on human life, property and key community assets.

- Regeneration burning has remained stable at between 2000 and 3500 hectares per annum during the reporting period.

Table1. Proportion of public land burnt through planned burning 2006/07 to 2012/13. Source State of the Forests 2008 and DEPI 2013

Year	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13
Area (hectares)	138,000	156,000	154,000	146,000	189,000	197,000	255,000
% of public land burnt	1.8	2.1	2.1	1.9	2.6	2.6	3.5

Prescribed burn. Credit: Daniel Nielsen

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Indicator 3.2: Area and type of human-induced disturbance

Road management

There are approximately 49,000 kilometres of roads within Victoria's public forests, used for a variety of public and operational purposes. DEPI, as the responsible road authority under the *Road Management Act 2004*, is required to manage public roads and bridges to specified standards.

Approximately 99 percent of the public forest road network is unsealed. Inappropriate maintenance of unsealed roads can result in negative impacts to river health and affect road safety. The road network therefore requires ongoing maintenance to minimise sediment movement into waterways and maintain safety. Maintenance activities include reforming surfaces and drains, replacing drainage structures, resheeting and potholing surfaces, removing vegetation from batters, and replacing signage.

Bemm River. Credit: Alison Pouliot

DEPI also undertake capital improvements on road and bridge infrastructure. Capital improvements include realigning or upgrading existing roads, and replacing bridges to meet required standards. Where a new road footprint is required, these activities result in the removal of forest from the landscape. However, when constructed to modern road standards, overall impacts on forest and river health may be reduced in the longer term, especially where poorer old roads are rehabilitated.

New permanent roads are also considered capital improvements, however none were constructed within the reporting period.

The categories of maintenance and capital improvement are reflected in expenditure categories for reporting purposes.

Data source and limitations

The data presented in this report is sourced from public accounts.

State and trend

Figure 2 shows the annual expenditure on road management in public forests between 2006/07 and 2011/12 by expenditure category.

During the reporting period, with the exception of 2011/12, road maintenance expenditure in public forests has remained stable at between $6-8 million per year. All public roads and associated crossings have an annual inspection regime which identifies maintenance requirements and schedules works accordingly. Maintenance also occurs based on operational requirements, including access for fire prevention and suppression activities. The increase in maintenance expenditure in 2011/12 reflects a short term road maintenance initiative which increased maintenance on roads that are
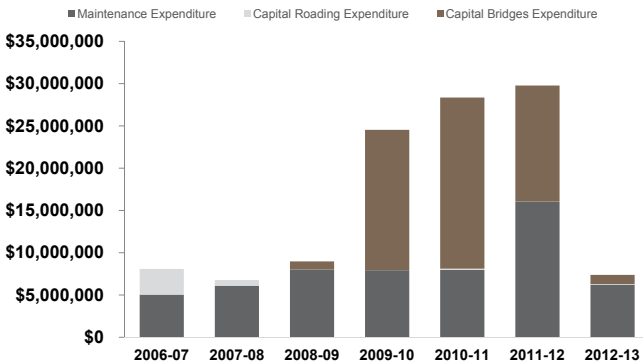
Figure 2. Annual expenditure on roads and bridges by expenditure category. Source DEPI

strategically important for fire management purposes. This included extra maintenance activities on roads where bridges and crossings were replaced.

Capital expenditure is generally lower, varying between $1-3 million per year.

Between 2009/10 to 2011/12, the Victorian Government invested $50 million in the Public Land Bridges project. This project replaced / upgraded 300 bridges and major crossings to ensure safe and effective access to forests, water catchments and other areas of public land across the state. This project was successfully delivered on time and on budget. Indicator 4.1 discusses the project standards implemented to minimise impacts to soil and river health.

Seasonal road closures are also implemented in public forests as a means to minimise road impacts on river health. DEPI declare seasonal road closures on many roads between June and October each year. Closures protect roads from vehicle damage during winter when they are soft, reducing their susceptibility to erosion. They also protect drivers from unsafe conditions.

Indicator 3.2: Area and type of human-induced disturbance

Economic activities

Economic activities occurring in Victoria's public forests that affect forest health include timber production, grazing and resource extraction (such as the removal of gravel for road construction).

Timber production

Timber production in Victoria's public forests (primarily State forests) is regulated under the *Sustainable Forests (Timber) Act 2004,* the *Forests Act 1958* and Regional Forest Agreements to minimise impacts to forest health impacts whilst providing economic benefits to the community. At a coupe level, timber production activities can change forest ecosystems by:

- removing canopy trees
- changing forest growth stage
- reducing dead wood structures
- reducing soil and water quality.

These physical changes affect the biota, and ecological functions and processes occurring on the site. Overall forest health effects depend on the intensity and extent of timber production activities within the landscape and the management methods employed to mitigate these effects.

Key ways forest health is protected through Victoria's regulatory system include maintenance of the Comprehensive, Adequate and Representative (CAR) Reserve System, controls on the distribution and extent of harvesting, and prescriptions to retain wildlife habitat, protect waterways and soil, and appropriately regenerate forests.

The area of timber production activities occurring within Victorian public forests during the reporting period is addressed in Indicator 2.3.

Stock grazing

Stock grazing in Victoria's public forests is managed through grazing licenses, which are issued under the *Forests Act 1958* and the *Land Act 1958*. Stock grazing can impact forest health by changing understory vegetation composition, inhibiting regeneration, compacting soil and spreading pest plants. Grazing licences assist in minimising forest health impacts by controlling the location and timing of grazing, limiting stock numbers and imposing other management requirements where necessary.

Resource extraction

Resource extraction activities are regulated under the *Extractive Industries Development Act 1995*[3], the *Forests Act 1958* and the *Mineral Resources (Sustainable Development) Act 1990*. Resource extraction activities in Victorian public forests are generally long-term disturbances occurring on relatively small footprints. These activities result in the removal of forest from the disturbance footprint until extraction activities conclude, at which time site rehabilitation is usually required.

The scale of resource extraction activities occurring within Victorian public forests during the reporting period is addressed in Indicator 2.4.

Stock in Murray River. Credit: Alison Pouliot

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[3]   Repealed during the reporting period

Indicator 3.2: Area and type of human-induced disturbance

Public activities

Public activities carried out in Victoria's public forests that may affect forest health include recreation and tourism and domestic firewood collection.

Recreation and tourism

Much of Victoria's public forests including Parks, reserves and State forests are used for recreational activities (see Indicator 6.3c). The key impacts of recreational activities on forest health include:

- Removal and/or damage of vegetation including ground covers, shrubs and trees

- Increased risk of the spread of diseases and pest plants via weed seeds in soil attached to vehicles, wheel treads and shoes

- Soil compaction and erosion via vehicular, wheeled, animal (horses, stock) and foot traffic

- Disturbance of wildlife and habitat for wildlife

- Increase of litter and/or pollutants (such as engine oils) that can enter the waterways, threaten wildlife, damage soils and vegetation.

DEPI and Parks Victoria implement a number of management strategies to minimise the impact of recreation and tourism on forest health. These strategies include provision of infrastructure, education programs and regulation of the activities themselves through legislation including the *Land Conservation (Vehicle Control) Act 1972, Forests (Recreation) Regulations 2010,* and *National Parks (Park) Regulations 2003*.

Domestic firewood collection

Domestic firewood collection is permitted in Victoria's State forests and several Forest Parks. Firewood collection can affect forest health through removal of canopy tree and dead wood structures, and soil compaction through off track vehicle use. The effects of domestic firewood collection on forest health are managed by controlling the timing and location of collection, and limiting the amounts and types of firewood that can be collected. These controls are enforced under provisions within the *Forests Act 1958* and the *Crown Land (Reserves) Act 1978*. For further details, refer to Indicator 2.3.

Planned burning in the Otways Credit: DEPI

References and further reading

DSE (2012) Code of Practice for Bushfire Management on Public Land

DSE (2006) Code of Practice for Fire Management on Public Land, revision 1.

DEPI website – Planned Burning, http://www.depi.vic.gov.au/fire-and-emergencies/planned-burns

DEPI website – Domestic Firewood, http://www.depi.vic.gov.au/forestry-and-land-use/forest-management/firewood

DEPI website – Recreation, http://www.depi.vic.gov.au/forestry-and-land-use/visiting-parks-and-forests

Parks Victoria website – Recreation, http://parkweb.vic.gov.au/

Victorian Legislation and Parliamentary documents website – http://www.legislation.vic.gov.au/

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Indicator 4.1: Area and percentage of forest by activity type systematically assessed for risk to soil attributes

Why is this indicator important?

The maintenance of soil quality is vital for forest and river ecosystem health and productivity. Disturbance caused by natural processes and human activities can degrade forest soil attributes to the extent that ecosystem function and productivity are impaired. Forest managers can conserve soil by proactively assessing risks to soil attributes and applying appropriate conservation measures to forest activities.

What have we measured and why is it relevant to the indicator?

Soil conservation and forested catchment river health is addressed in a variety of instruments applying to forest activities. Some activities have specific requirements for systematic assessment of risk to soil attributes and prescribed soil conservation measures. For other activities, risk to soil attributes is managed through controls over the type and location of activities that have potential to cause soil degradation. These assessments or controls are systematically applied to individual situations rather than as a regular forest wide assessment. This indicator reports on the instruments that address soil conservation and river health in public forests and the area of forest activities where soil attribute risk assessment is required.

Risks to soil attributes

Soil sustains plant production and other ecological and hydrological functions of the forest through its ability to hold and supply water and nutrients, store organic matter, and provide suitable habitat for plant roots and a wide range of organisms. Soil attributes are the physical and chemical properties of the soil that determine the type of ecosystem the site can sustain and its health.

Forest activities can put soil attributes at risk through compaction, topsoil removal, topsoil and subsoil mixing, exposure to erosive processes and clogging of soil pores. These processes reduce the suitability of the soil as habitat for plant roots, soil flora and fauna by changing the supply of oxygen, water and nutrients.

As well as reducing ecosystem health and productivity on site, these processes may trigger erosion, redistributing soil downslope and potentially into waterways.

A variety of forest activities can cause risk to soil attributes. These include timber harvesting and regeneration, bushfire management (including burning), roading, mining and some recreation activities. Bushfire management and timber harvesting have potential to pose the most serious risks to soil attributes due to their extent and use of heavy machinery.

Instruments that address soil conservation and river health

A regulatory framework has been established in Victoria to support soil conservation and river health in public forests. This framework, presented in table 1, comprises legally and non-legally binding instruments. Legally binding instruments are those that are recognised by law and can be enforced, for example, Acts of Parliament or Codes of Practice which are legislated.

Table 1 identifies the type of forest activities and public land tenure the instrument applies to, and categorises how the instrument assists in soil conservation and river health. Only instruments that specifically address soil conservation or river health are listed[1]. A full list of instruments within the sustainable forest management framework is provided in Indicator 7.1.

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[1]   Legislation that gives effect to the instruments in table 1 is not listed

Land managers may also specify soil conservation and river health requirements through contract specifications and licence conditions. Specifications for bridge replacement programs include requirements to protect soil from erosion via various mechanisms, to conserve soil for possible re – use at site and to manage soil that may become contaminated. Additionally, the specifications require monitoring and reporting of soil erosion and stream turbidity, and provide details on when and how this is to occur. Similarly, contracts for the repair of roads and crossings damaged during natural events also include specifications to protect soil in a similar way to standard asset replacement programs.

Auditor assessing soil sample at forestry coupe for water permeability and erosion risk. Credit: Alison Pouliot

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Table 1. Instruments that address soil conservation and river health. Source DEPI

Instrument	Legally binding	Public Land Tenure	Forest activity	Category
Catchment and Land Protection Act 1994	Yes	All	All	3
Heritage Rivers Act 1992	Yes	All	Timber production, mining, grazing, roading, clearing, water regulation	2, 3
Land Conservation (Vehicle Control) Act 1972	Yes	All	Vehicle use, general recreation	2
Water Act 1989	Yes	All		3
Environment Protection Act 1970	Yes	All	All	3
Sustainable Forests (Timber Harvesting) Regulations 2006	Yes	State Forest	Timber production	2
Forests (Recreation) Regulations 2010	Yes	State Forest	General recreation	2
National Parks (Park) Regulations 2003	Yes	National and State Parks	General recreation	2
Code of Practice for Timber Production 2007	Yes	All	Timber production	1
Code of Practice for Bushfire Management on Public Land 2012	Partially	All	Bushfire management	1
Forest Management Plans	Partially	State Forest	All	4
Management Procedures for timber harvesting, roading and regeneration	Partially	State Forest	Timber production and roading	1
Native Forest Silviculture Guidelines	No	State Forest	Timber production	4
Mining and exploration guidelines	No	All	Mining	4

Category:

1 Specifies requirements to assess risk to soil attributes, and standards and procedures for forest activities to control risks to soil attributes

2 Specifies controls over the type and location of forest activities for soil conservation or river health purposes e.g. the *Land Conservation (Vehicle Control) Act 1972* prohibits use of vehicles in declared erosion hazard areas.

3 Provides for the administration of soil conservation or river health e.g. the *Catchment and Land Protection Act 1994* provides for the establishment of special areas (including special water supply catchment areas) and establishes management responsibilities.

4 Provides guidance on soil conservation methods

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State and trend

- The regulatory framework has remained stable over the reporting period, however some content relevant to soil conservation and river health has changed.

- Several instruments were revised during the reporting period, including the *Forests (Recreation) Regulations 2010*, the *Code of Practice for Bushfire Management on Public Land 2012* and the *Management Procedures for timber harvesting, roading and regeneration 2009*.

- The only change relevant to soil conservation and river health is the introduction of a new requirement to assess risk to natural values in both the emergency stabilisation and recovery phases of bushfire response in the *Code of Practice for Bushfire Management on Public Land 2012*.

The area of forest activities where soil attribute risk assessment is required, and compliance with soil conservation controls

Timber production and bushfire management are the only forest activities with legally binding and systematic requirements to assess risk to soil attributes. This is appropriate due to the relative risk of these activities to soil conservation and river health. The Forest Audit Program (FAP) also systematically assesses risks to soil attributes through audits of compliance with soil conservation controls in timber production operations. The state and trend of these assessments is presented separately below for timber production. A description of the new arrangements for bushfire management activities is also provided as state and trend data is not yet available.

Timber production

Timber harvesting, associated road and track construction and regeneration activities have potential to cause significant risks to soil attributes and river health. Roads and coupe infrastructure such as log landings, snig and forwarder tracks and boundary tracks are of particular concern.

The *Code of Practice for Timber Production 2007* requires all forest coupe plans map soil erosion hazard classes. Topography, rainfall, and measurements of soil physical and chemical properties determine soil erosion hazard. This requirement for systematic assessment of soil attributes supports soil conservation planning.

The Code and *Management Procedures for timber harvesting, roading and regeneration* set compliance standards for the location, drainage and rehabilitation of roads, tracks and log landings, wet weather suspensions, and the protection of waterways and erosion prone slopes through vegetation retention and excluding disturbance. These standards have been regularly audited under the FAP since 2003.

The FAP is an independent statutory audit implemented under the *Environment Protection Act 1970*. From 2003 through to 2007 the FAP was administered by the Environment Protection Authority. The former DSE became responsible for administering the audit in 2008, and commissioned its first audit under a redesigned FAP in 2010.

The FAP currently comprises seven modules focussing on different elements of the timber production lifecycle (see Indicator 7.2). Table 2 presents information from the 2011 module 5 harvesting and closure audit[2], and the Environmental audit – Timber production on public land 2003[3] and 2007 [4]relevant to soil conservation and river health. Direct comparisons between audit years 2007 and 2011 should not be drawn, due to changes made to the audit methods in 2010.

Table 2. FAP audit results for standards relating to soil conservation and river health. Source FAP audit reports 2003, 2007, 2011

Audit Administrator	EPA	EPA	DEPI
Year of Report	2003	2007	2011
Overall audit compliance rate %	87	94	93
Focus Area	Score (%)		
Log Landings and Dumps	86	89	77
Reserved Area Protection – Buffers	83	95	97
Reserved Area Protection – Filters	83	81	90
Snig and Forwarding Tracks	90	92	93
Boundary Tracks	64	82	82
Roading	93	96	92

[2] Environmental Audit – Forest Audit Program, Module 5 – Harvesting and Closure. 25 March 2011
[3] Environmental Audit: Timber Production on Public Land 2003
[4] Environmental Audit: Timber Production on Public Land 2007

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Indicator 4.1: Area and percentage of forest by activity type systematically assessed for risk to soil attributes

State and trend

- The area of timber production activity where assessment of risks to soil attributes is required is the equivalent of the total area of timber production activity for the reporting period. This data is reported under Indicator 2.2.

- Overall, the 2011 audit results demonstrate a high level of compliance with Code requirements, including soil conservation and river health.

- A compliance score of 77% for log landings and dumps in 2011 is attributed to non-conformances with rehabilitation standards for log landings.

- Compliance rates between 2007 and 2011 cannot be compared due to changes in methodology.

Bushfire Management

Victoria's Bushfire Rapid Risk Assessment (Bushfire RRAT) program was established following the Black Saturday bushfires in 2009 (see Indicator 3.1). The Bushfire RRAT program collects intelligence to inform the emergency stabilisation and initial recovery phase of a bushfire event[5]. The information and data collected during the 'response' phase of the fire, is used in conjunction with field observations and post fire satellite imagery, to generate a Bushfire RRAT report.

The content of the reports may feed back into 'response' phase work and inform the development of a recovery plan. Each Bushfire RRAT report includes an assessment of risk and associated mitigation measures, across a range of disciplines, including forest management, biodiversity, cultural heritage, tourism, built assets and flooding and soil erosion. Since their inception, Bushfire RRAT teams have assessed over 160,000 hectares of mostly forested, bushfire affected land.

[5]   Refer to the *Code of Practice for Bushfire Management on Public Land 2012* for information on the different phases of bushfire response and recovery.

Bushfire RRAT flooding and erosion specialists assess post-fire hydrological processes that can threaten ecosystems and species, infrastructure, socio-economic wellbeing and human life. A combination of topography, burn severity, forest maps, field work and aerial surveys are used to determine debris flow risk – a function of burn severity, slope and forest type. Post-fire debris flow and landslips triggered by rain events are commonly witnessed after major fires. They require a relatively common rainfall event (2–5 year annual recurrence interval) to initiate the mass movement of soil, rock, ash and vegetative debris in areas of risk.

Major fires assessed for flooding and erosion risk (including debris flow, water quality and flooding), are shown in table 3.

Table 3. Major fires assessed for flooding and erosion risk. Source DEPI

Fire name/location	Season	Area (ha)
Alpine Fires, Victorian Alps	2012/13	38,500
Heyfield Group, Gippsland	2012/13	87,600
Grampians Victoria Valley Complex, Grampians	2012/13	35,900
Buangor-Ferntree Waterfalls Road, Buangor	2009/10	1,400
Keystone Road, Cann River	2009/10	~1,000

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Commissioner for Environmental Sustainability Victoria (2013) State of the environment report 2013 – Part 4.2.5 Soil Structure and Erosion Sourced from <http://www.ces.vic.gov.au/victorias-environment/state-of-environment-victoria-2008/part-4-state-of-the-environment/land-and-biodiversity/soil-structure-and-erosion> Accessed July 2013.

Department of Agriculture, Forestry and Fisheries, ABARES (2008), Australian State of the Forests Report 2008, Criterion 4 : Soil and Water <http://adl.brs.gov.au/forestsaustralia/publications/sofr2008.html> accessed 1 May 2013.

Department of Sustainability and Environment supplied and collated Forest Audit Report data from 2010, 2011 and 2012.

Department of Sustainability and Environment (2008), Victorian State of the Forests Report 2008, Criterion 4: Conservation and maintenance of soil and water resources. < http://www.dse.vic.gov.au/forests/victorias-forest-landing-page/state-of-the-forests-report-2008 > accessed 1 May 2013.

Environment Protection Authority Victoria website <http://www.epa.vic.gov.au/your-environment/water/protecting-victorias-waters/point-and-nonpoint-sources-of-water-pollution> accessed 1 May 2013.

URS Forestry (2011), Harvesting and Closure Forest Audit Report March 2011. <http://www.dse.vic.gov.au/forests/managing-our-forests/management-framework/timber-harvesting-compliance> accessed 1 May 2013

Victorian Legislation and Parliamentary Documents. Various Acts, Regulations, Codes and guidelines. <http://www.legislation.vic.gov.au/> accessed 1 May 2013.

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Indicator 4.2: Change in forested catchment water yield characteristics through time

Why is this indicator important?

Water yield characteristics indicate the amount of water available for ecosystem health and human use. Many upstream areas within Victorian water supply catchments are forested (see figure 2). Climatic conditions, natural disturbances and human activities in these forests all contribute to variation in water yields. By monitoring this variation, the indicator may inform the management of forested areas within catchments to assist in maintaining stream flow and water supplies.

What have we measured and why is it relevant to the indicator?

Comprehensive data on water yield characteristics from forested areas within catchments is not available. Whilst water level and discharge data is collected throughout Victorian catchments, most operational sampling gauges are located downstream of forested sections of catchments[1]. Current Victorian water measurements are therefore influenced by activities in the broader landscape and not suitable for the indicator[2].

This indicator report instead describes the extent of water supply catchments on public and private land in Victoria. It also describes how disturbances in forested parts of these catchments during the reporting period may have influenced water yield characteristics.

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1   Victorian Water Measurement Information System http://data.water.vic.gov.au/monitoring.htm

2   Victorian Catchment Management Council (2012) Catchment Condition and Management Report 2012.

Extent of water supply catchments

Catchments are areas of the landscape that supply surface water to a common body of water downstream. Whilst all parts of the landscape fall within catchments, some catchments provide important sources of domestic and irrigation water for cities, towns and agricultural regions. In Victoria these catchments are protected by legislation.

The *Catchment and Land Protection Act 1994* enables catchments to be declared as special water supply catchment areas. Special area plans set out how land management issues must be addressed within these 'declared' catchments. Declared catchments cover both public and private land and include forested and non-forested landscapes.

The *National Parks Act 1975* defines a number of catchment areas located within Parks and conservation reserves as designated water supply catchment areas. The Act enables water authorities to protect water quality values within 'designated' catchments whilst allowing Parks Victoria to manage these areas for broader Parks and conservation objectives. Designated catchments may overlap declared catchments in some instances.

Several catchments around Melbourne are also owned or vested in Melbourne Water for water supply purposes. Figure 1 shows the location of declared, designated and Melbourne Water catchments in Victoria.

Data source and limitations

The data presented in this indicator report is derived from DEPI forest extent 2013 (See Indicator 1.1a), Designated Water Supply Catchments and Public Land Management (PLM25)

Improvements in mapping methodologies have resulted in changes in the reported extent of land tenure and forest cover in catchments. These new layers are sufficiently different to make comparison of extent data between reporting periods inappropriate.
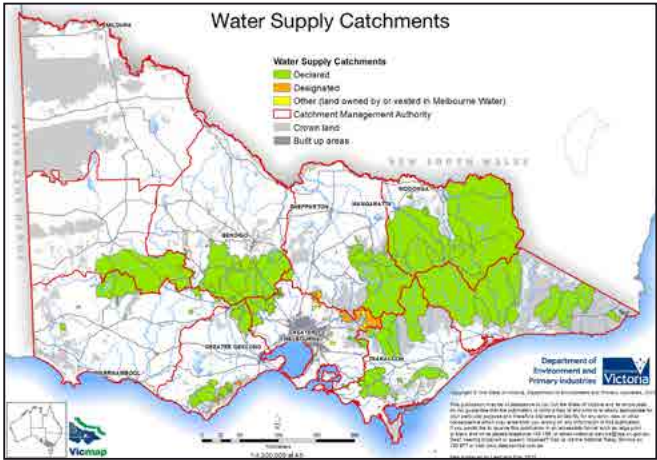
Figure 1. Declared, designated and Melbourne Water catchments in Victoria. Source DEPI 2013

Credit: DEPI

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Indicator 4.2: Change in forested catchment water yield characteristics through time

State and trend

Table 1 provides the extent of declared, designated and Melbourne Water catchments in Victoria by land tenure and forest cover. The percentage of forest cover is shown as a total across all catchments of a specific type, and as an average of individual catchments for each catchment type. Figure 2 shows the extent of forest cover within Victorian water supply catchments.

- In 2012 5.3 million hectares of land in Victoria was managed as water supply catchment.

- The majority (98 percent) of water supply catchments are declared catchments of mixed land tenure in the upper catchments of Victorian river systems.

- On average 68 percent of land within declared catchments is forested. Forest cover varies widely between catchments from close to 100 percent in some eastern Victorian catchments to less than 5 percent in western Victoria.

- Public forests comprise 57 percent of the land within declared catchments and are largely forested.

- Designated catchments comprise 1.7 percent of Victorian water supply catchments and are largely located in National Parks east of Melbourne. These catchments remain almost entirely forested to assist with managing drinking water quality.

- The remaining 0.3 percent of catchments are vested or freehold land managed by Melbourne Water specifically for water supply purposes

Table 1. Catchment extent by type, tenure and forest cover. Source DEPI

Tenure	Area (hectares)*			
	Declared	Designated	Other[A]	Grand Total[C]
Parks and conservation reserves	1,150,000	90,000	<200	1,240,000
State forest	1,827,000	<50	13,000	1,839,000
Other public land	270,000	<50	7,000	277,000
Private (Non-Crown land)	1,977,000	<50	<500	1,978,000
Grand Total[C]	**5,224,000**	**90,000**	**21,000**	**5,334,000**
Total % forest cover	67	99	83	68
Average[B] % forest cover	68	97	39	69

*   Rounded to nearest 1,000 hectares
[A]   Owned or vested in Melbourne Water
[B]   The average proportion of forest cover of individual catchments
[C]   May not add due to rounding error

Figure 2. Forest extent within water supply catchments. Source DEPI 2013

Martins Creek – Gooloongook. Credit: Misheye - Christian Pearson

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Indicator 4.2: Change in forested catchment water yield characteristics through time

Water yield from forested areas of catchments

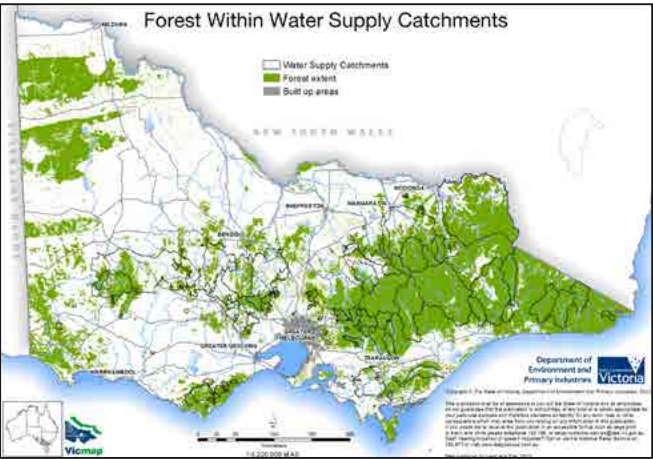Water yield reflects the climatic, topographic and geological characteristics of a catchment and the nature of its vegetation. Forest type, cover, growth stage and condition affect water yield by changing runoff patterns and the amount of water used by vegetation. Forest characteristics are influenced by climate, herbivory and disease, bushfires and timber production.

Bushfires, drought, floods were a feature of the reporting period. Their impacts on water yield characteristics are described below. Indicator 3.1, Indicator 3.2 and Indicator 4.3 provide further discussion of these disturbances on forest and river health.

Bushfire impacts on water yield characteristics

Several major bushfires have impacted catchments during the reporting period. These include:

- the Great Divide fires (2006/07) which burnt large expanses of the Alpine National Park affecting a number of catchments;

- the Grampians fires (2006/07) which burnt 130,000 ha of water catchment area; and

- the Black Saturday fires (2009) which burnt approximately 30% of Melbourne Water catchments.

Large intense bushfires can have serious, long lasting effects on water yield from some Victorian forest types (in particular Ash forests). Immediately following bushfires, water yields from rain events may increase due to reductions in vegetative cover and increased runoff. As vegetative cover returns, its use of available water increases, lowering water inputs into streams. Regrowth Ash forests use a greater amount of water than mature Ash forests, and reduced water yield characteristics from these forests after bushfires persist for many decades[3].
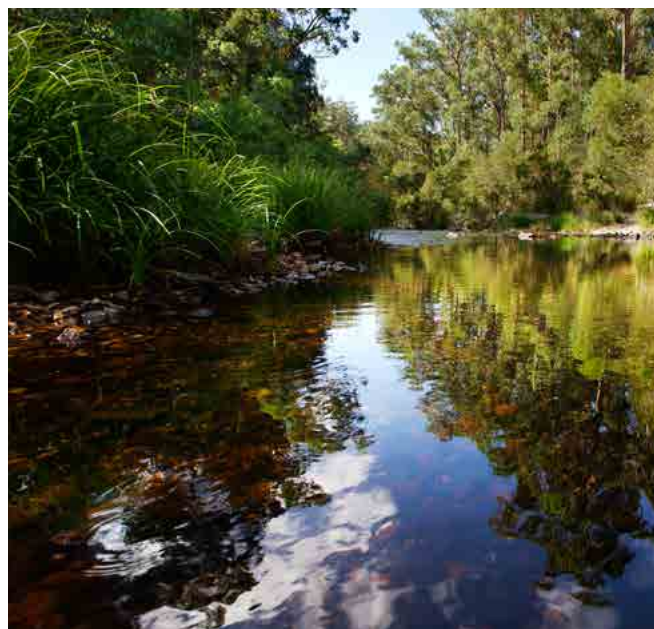
Credit: DEPI

Drought and flood impacts on water yield characteristics

The first half of the reporting period concluded Victoria's longest period of sustained rainfall deficit on record. Towards the end of the 13 year drought in 2009, stream-flow volumes in Victoria were 32% of the long-term average, with particularly strong effects in central and western Victoria [4,5]. These conditions led to reduced stream flows in upland sites, and dry streambeds and isolated pools in many river reaches[6]. Floods were absent from the Murray floodplains for over a decade[7].

Following the drought, between September 2010 and March 2012, Victoria experienced some of its worst floods in history. This resulted in widespread damage across Victoria[8] but particularly in the north and west of the state.

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[3] Vertessy R.A. (1999) The Impacts of Forestry on Streamflows: A review. In "Forest Management for Water Quality and Quantity, proceedings of the Second Forest Erosion Workshop, May 1999". Cooperative Research Centre for Catchment Hydrology.

[4] Victorian Catchment Management Council (2012) Catchment Condition and Management Report 2012
[5] DSE (2012) Report on Climate Change and Greenhouse Gas Emissions in Victoria
[6] EPA Victoria (2007) Drought and river health in Victoria. Publication 1171.
[7] Department of Sustainability, Environment, Water, Population and Communities (2012) National wetlands update September 2012- Issue No. 21
[8] Water in the Environment website. http://www.water.vic.gov.au/environment

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Indicator 4.3: Change in forested catchment river health characteristics through time

Why is this indicator important?

Rivers play a vital role in the economy, ecology and social fabric of Victoria. They supply water, generate energy, support fisheries, provide recreational settings and ecosystem services through the diverse ecosystems they support. Disturbances in forested catchments can have adverse effects on river health. Monitoring river health characteristics enables forest managers to develop and refine targeted river health programs to ensure the maintenance of benefits.

What have we measured and why is it relevant to the indicator?

River health is monitored through the Index of Stream Condition (ISC). The ISC provides an overview of the ecological condition of major rivers and tributaries in Victoria at eight year intervals. The use of ISC data for this indicator supports strategic reporting of the ecological condition of river reaches in catchments with a high proportion of forested land. This information is useful when planning for river health programs and land management.

Nariel Creek. Credit: Alison Pouliot

River health in forested catchments

River health is an umbrella term for the overall state of key feature and processes that underpin functioning waterway ecosystems (such as species and communities, habitat, connectivity, water quality, riparian vegetation, physical form and ecosystem processes including nutrient cycling and carbon storage[1]. Measures of ecological condition describe how a river supports diversity of habitat and biota, links with the broader landscape, and maintains ecological processes relative to its pre European condition.

The ISC measures river health for individual reaches using a standard assessment methodology which assesses the following five indicators:

1. Hydrology (river flow characteristics);

2. Physical form (artificial barriers, in-stream large wood, bank);

3. Streamside zone (riparian or streamside vegetation condition);

4. Water quality (turbidity and chemical characteristics); and

5. Aquatic life (macroinvertebrate condition)

The average integrated score for the reach corresponds to one of five condition classes ranging from excellent to very poor[2].

All Victorian catchments contain forest to differing degrees. For the purpose of this report, forested catchment statistics presented include all ISC reaches within designated, declared and Melbourne Water catchments (see Indicator 4.2), regardless of land tenure and forest cover.

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[1] DEPI (2013) *Victorian Waterway Management Strategy*
[2] DEPI (2013) Index of stream condition the third benchmark of Victorian river condition

Indicator 4.3: Change in forested catchment river health characteristics through time

Data source and limitations

The data presented in this indicator report is derived from DEPI Index of Stream Condition 2013, forest extent 2013 (See Indicator 1.1a), Designated Water Supply Catchments and Public Land Management (PLM25)

The ISC dataset is completely updated every eight years. The ISC is a strategic assessment, focussing on covering as much of Victoria's river system as possible in a consistent manner. The 2013 ISC measures 1,200 river reaches, which represents 29,000 kilometres of Victoria's major rivers and tributaries. Reaches are generally between 10 and 30 kilometres long, with similar hydrological, vegetation and landscape characteristics. For a stream to be included in the ISC, it must have a catchment area of at least 5,000 hectares. This means that many waterways within forested catchments are not assessed through the ISC, including most tributaries in Melbourne's domestic water supply catchments.

For the 2013 ISC report, DEPI introduced major improvements in the method of assessing physical form and streamside zone. The new methodology is fundamentally different so it is not possible to reliably compare current stream conditions with those of previous reporting periods. It does however support reporting of stream condition at a forested catchment scale.

State and trend

Table 1 shows the percentage of ISC stream length in each condition category at a state level, and across all catchments, public forest, other Crown land and private land.

Figure1 shows the percentage of reaches in good to excellent condition in each catchment.

Table 1. Percent length of ISC reaches by condition, catchment and tenure in 2013. Source ISC 2013

	% of ISC stream length by condition[A]				
	Victoria	Catchments	Public forest[B]	Other Crown land[C]	Private land
Excellent	12	26	33	4	3
Good	11	19	23	10	4
Moderate	43	37	32	55	48
Poor	19	12	8	19	26
Very Poor	13	6	5	11	18

[A] 2% have insufficient data

[B] Public forest includes State forest and Parks and conservation reserves

[C] Other Crown land includes all areas of Crown land that are not State forest or Parks and conservation reserves

Wombat Creek. Credit: Alison Pouliot

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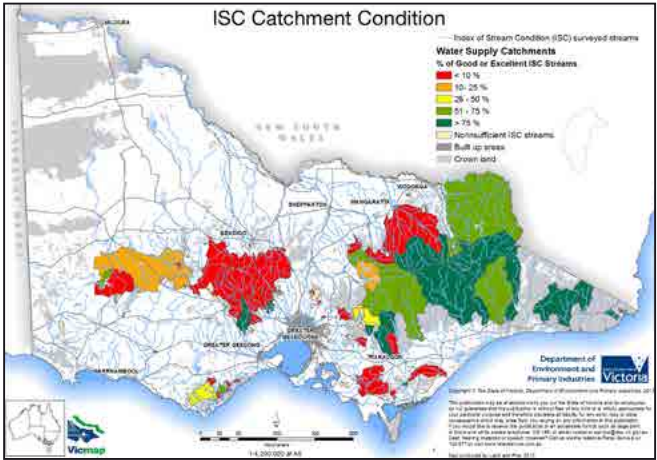

Figure 1. Percentage of ISC streams within water supply catchments in good or excellent condition. Source DEPI

A map of all ISC reaches by condition category shown against forest cover is provided in Figure 4.3.2.
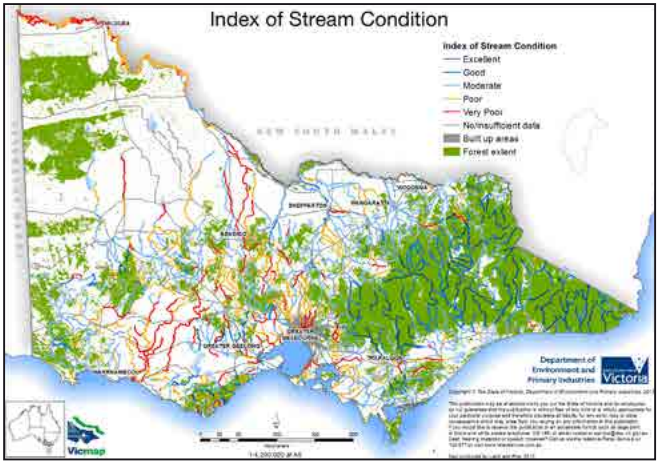

Figure 2. Condition category of all Victorian ISC reaches. Source DEPI

- Across Victoria, 23 percent of total river length is in good to excellent condition. In contrast, 45 percent of the total river length within catchments is in good to excellent condition.

- River health varies considerably between catchments in eastern (58 percent length in good to excellent condition) and western Victoria (12 percent length in good to excellent condition). These trends correspond closely with the extent of river reach in forest in each catchment.

- River health in streams on public land is considerably higher than those on private land. Just 7 percent of total river length within private land is in good to excellent condition, contrasting with 56 percent within public forests. Private land also has the highest proportion of poor to very poor condition, totalling 44 percent of the total river length on private land.

- Major trends in river health relate strongly to the degree of naturalness of the riverine environment. Agents such as bushfire, drought, flood and forest disturbance activities also have potential to impact river health. Mechanisms to protect river health from human induced forest disturbance activities are described in Indicator 4.1. The impacts of significant natural disturbance events within the reporting period on river health are discussed below.

Bushfire impacts on river health

Three major bushfires impacting on forested catchments during the reporting period are reported in Indicator 4.2.

Intense fires in forested areas can cause a loss of vegetative cover and erosion along stream banks leading to significantly reduced water quality for several years post fire[3]. The most serious impacts of fire on river health in forested catchments are associated with sediment slugs. Sediment slugs occur in fire affected areas following high rainfall events when high volumes of exposed topsoil wash into streams. The sediment slugs change stream chemistry and streambed profiles, impacting on aquatic biota. These effects appear to be short term, and largely recovered within three years of fire[4].

Drought and flood impacts on river health

Drought conditions between 1997 and 2009 (See Indicator 4.2) had a large impact on the ISC hydrology indicator, and variable impacts on the water quality indicator. Some of the poorest ISC scores coincide with streams in south western Victoria which suffered the greatest drought impacts.

Flooding between September 2010 and March 2012 caused blackwater events in the Murray River system, resulting in death of aquatic fauna. These events occurred outside the timeframe of the ISC reporting period, so are not reflected in measures of river health.

[3]   Sheridan et al (2007) Quantification of hillslope runoff and erosion processes before and after wildfire in a wet Eucalyptus forest. Journal of Hydrology 343 (1) p12-28

[4]   EPA Victoria (2006) The health of streams in north-eastern Victoria in the three years following the 2003 bushfires. Publication 1061.

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DEPI (2013) Index of stream condition the third benchmark of Victorian river condition. http://www.depi.vic.gov.au/water/water-resource-reporting/Third-Index-of-Stream-Condition-report

Sheridan et al (2007) Quantification of hillslope runoff and erosion processes before and after wildfire in a wet Eucalyptus forest. Journal of Hydrology 343 (1) p12-28

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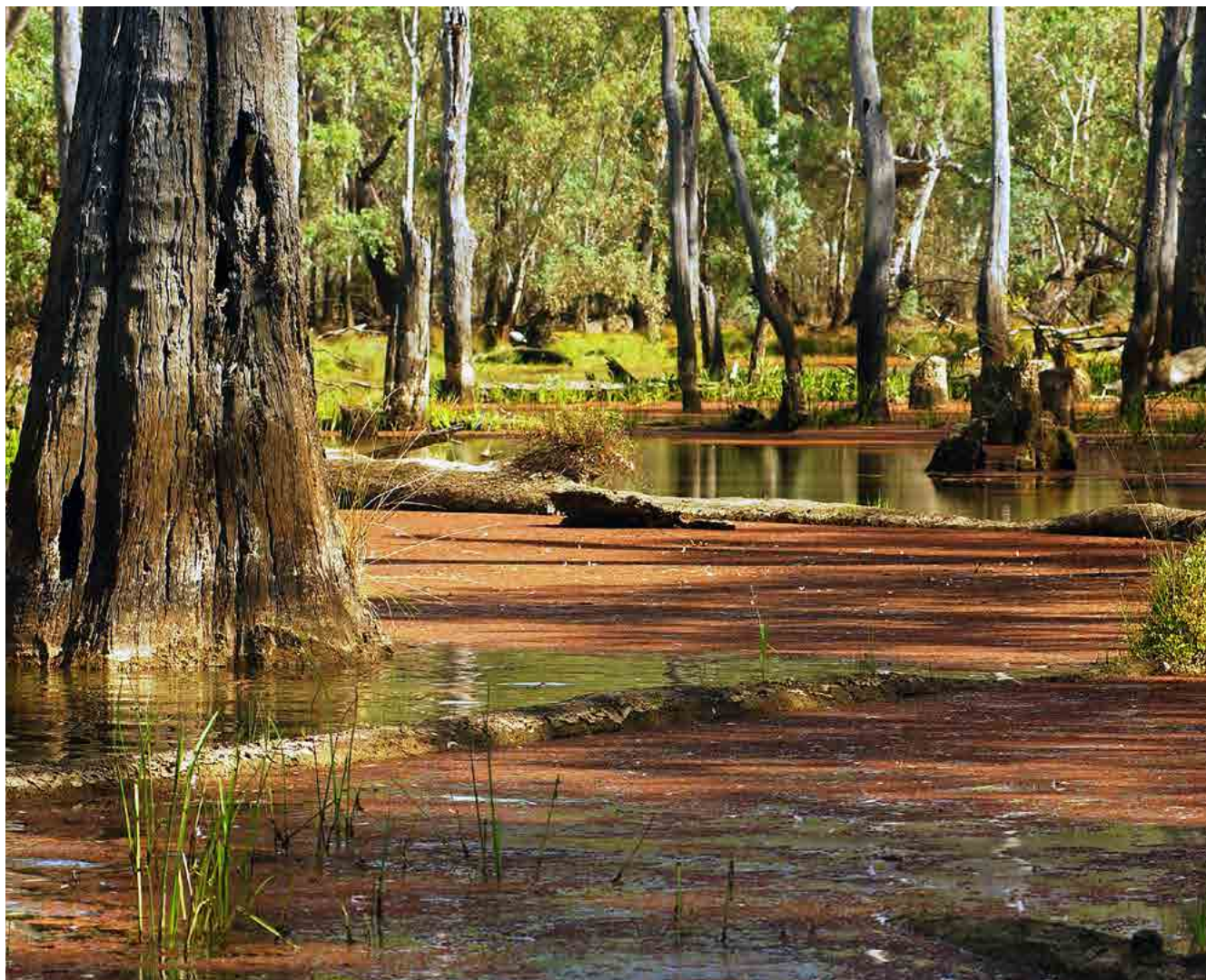
Ovens River wetland. Credit: Alison Pouliot

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Indicator 5.1: Total forest ecosystem biomass and carbon pool by forest type, age class and successional stages

Why is this indicator important?

This indicator provides information on the contribution of Victorian forests to the global carbon cycle. Estimates of total forest biomass allow changes in the total carbon pool to be assessed. Estimation by forest type and age class improves understanding of these changes. This information is vital for the development of strategies designed to mitigate human-induced climate change

What have we measured and why is it relevant to the indicator?

Forest ecosystems play a vital role in the global carbon cycle and global greenhouse gas balance by storing carbon in trees, soil and other pools. Victoria's forests store a considerable amount of carbon, and the ability of the forest to take up carbon may factor in future attempts to mitigate climate change.

Carbon absorption rates are greatest in forests during the earliest stages of regeneration and decline as forests mature. This is because regenerating forests require a greater amount of carbon for growth, whereas the carbon uptake of mature forests is usually low. Carbon is returned to the atmosphere, mainly in the form of CO_2, when plant matter decomposes, or as a result of natural disturbance, such as fire. CO_2 is also released by vegetation through respiration, although the amount is minimal relative to uptake.

This report presents, for the first time, a state-wide assessment of forest ecosystem biomass and carbon pools across Victorian public forests (State forest and Parks and conservation reserves), using data collected through the Victorian Forest Monitoring Program (VFMP).

Credit: Arthur Rylah Institute

Biomass and carbon stocks are estimated for six plot-scale pools and aggregated to estimate carbon and biomass in Victoria's public forests at the state and bioregion levels. Through the VFMP, DEPI has adopted a statistical inventory approach using a stratified systematic sampling design to collect statistically valid estimates of carbon and measure changes in biomass and carbon over time. This approach for estimating carbon is based on IPCC Guidelines. While it cannot be compared to previous estimates, it represents a baseline from which to estimate change in carbon and biomass using VFMP data in the future.

The following plot-level forest carbon pools were derived from VFMP data. For detailed information on methods of data collection, refer to the VFMP field Standard Operating Procedures.

- Large (> 10cm Diameter at Breast Height (DBH)) live trees
- Large dead trees
- Small (< 10cm DBH) live trees
- Small dead trees
- Ground woody vegetation
- Ground non-woody vegetation
- Tree stumps
- Slash piles
- Coarse woody debris (fallen logs/branches)
- Fine litter
- Medium litter
- Live aboveground trees
- Dead aboveground trees

Indicator 5.1: Total forest ecosystem biomass and carbon pool by forest type, age class and successional stages

Pools were aggregated to calculate total above-ground and total below-ground biomass and carbon. To estimate total carbon at 5-yearly intervals (1988-2013) (Figure 1), average carbon per hectare was calculated for each bioregion, from which a direct expansion method was applied using forest area estimates for each year (refer to Indicator 1.1a for further information on the forest extent area estimation method)

State and trend

Total forest ecosystem biomass and carbon in Victorian public forests by bioregion is shown in Table 1. Figure 1 shows public forest carbon and biomass over time (at 5-yearly intervals between 1988 and 2013). The average carbon and biomass in Victorian public forests by bioregion is shown in Figures 2 and 3.
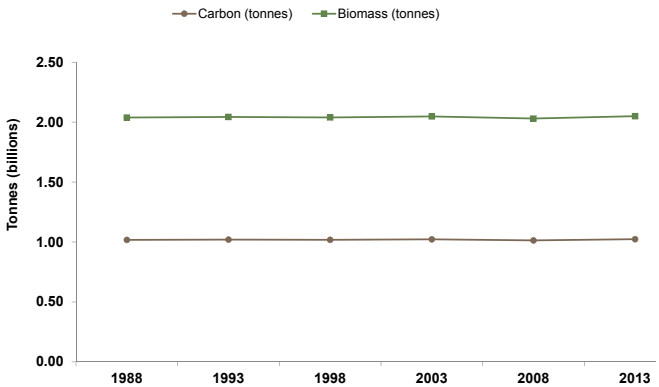
Figure 1. Forest carbon and biomass in Victoria's public forests (1988 to 2013). Source DEPI

Table 1. Total forest biomass and carbon (tonnes) in Victoria's public forests by bioregion (2013). Source VFMP

Bioregion	Tonnes	
	Total Biomass	Total Carbon
South Eastern Highlands	920,417,300	458,710,900
South East Corner	487,526,400	243,321,600
Australian Alps	320,871,400	159,939,200
Victorian Midlands	154,477,200	76,438,200
South East Coastal Plain	42,891,600	21,179,200
Naracoorte Coastal Plain	35,620,200	17,740,800
Murray-Darling Depression	33,487,100	16,287,500
NSW South Western Slopes	25,070,100	12,476,200
Riverina	21,990,500	10,938,600
Victorian Volcanic Plain	6,094,000	3,040,400
Flinders	6,035,700	3,016,300
Total	**2,054,481,500**	**1,023,088,900**

- Across all Victorian public forest the average carbon and biomass per ha is 163.2 and 327.7 tonnes per hectare respectively.

- The Australian Alps bioregion has the highest average carbon and biomass per ha with 241.6 and 484.7 tonnes per hectare respectively.

- The Murray-Darling Depression has the lowest average carbon and biomass per ha with 12.5 and 25.7 tonnes per hectare respectively.

- The total forest ecosystem biomass and carbon in Victorian public forests over time is relatively stable (Figure 1). This is likely due to the natural resilience of Victoria's ecosystems to natural disturbances (fire, drought, flood) (refer to Indicator 3.1)

Credit: Parks Victoria

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Indicator 5.1: Total forest ecosystem biomass and carbon pool by forest type, age class and successional stages
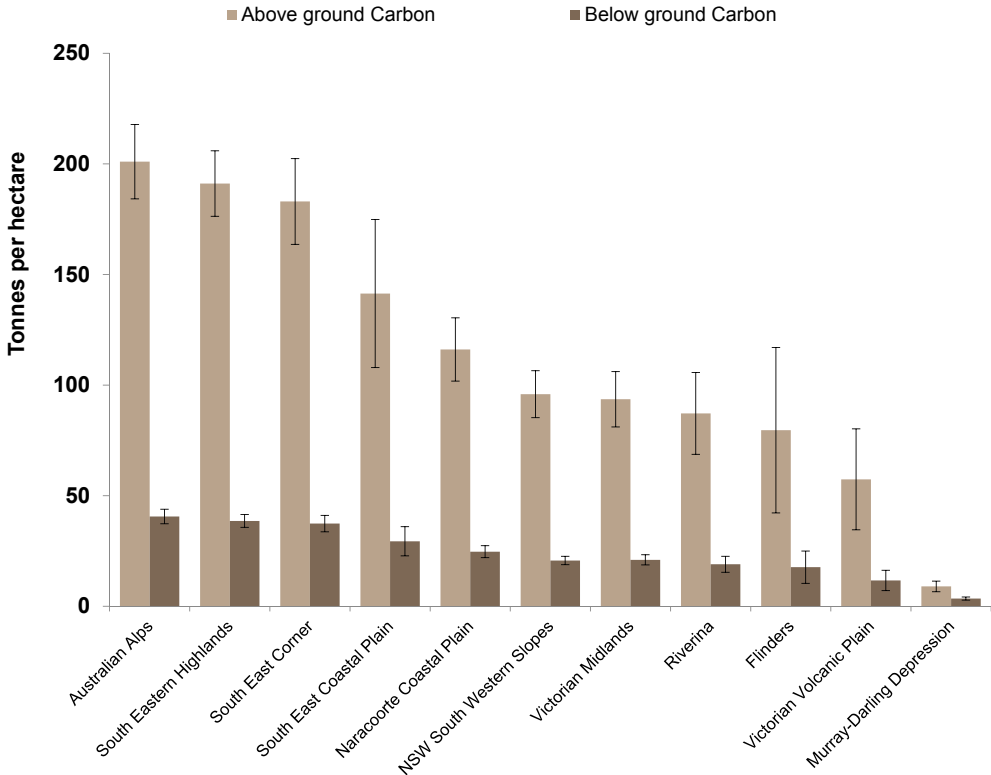
Figure 2. Average above and below ground carbon (tonnes per hectare) in Victorian public forests by bioregion (2013). Source DEPI
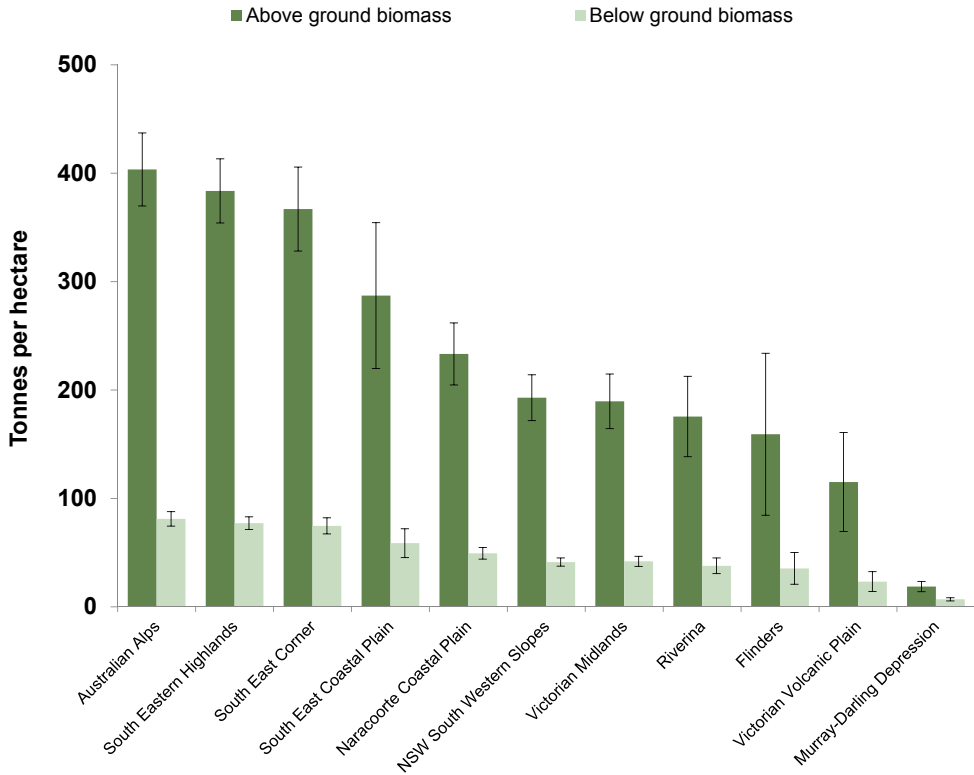
Figure 3. Average above and below ground biomass (tonnes per hectare) in Victorian public forests by bioregion (2013). Source DEPI

Indicator 5.2: Contribution of forest ecosystems to the global greenhouse gas balance

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Why is this indicator important?

Forest ecosystems play an important role in the global greenhouse gas balance. This indicator provides information on emissions and removals of greenhouse gases from forest ecosystems over time for comparison with other land cover types or other sectors of the economy. This information is vital for the development of strategies designed to mitigate human-induced climate change. The indicator deals with the 'balancing of the books' for carbon – a forest removes carbon dioxide (CO_2) from the atmosphere during growth through photosynthesis and stores it in its woody biomass. A forest also emits CO_2 back into the atmosphere through respiration and other processes.

What have we measured and why is it relevant to the indicator?

Forests absorb carbon through photosynthesis and sequestering it as biomass and creating a natural storage of carbon. Carbon release results from several forest processes, including respiration, bushfires, regeneration burns, decaying vegetation and soil disturbance. Harvesting and forest clearance are both processes which result in the cessation of carbon sequestration. Once a tree is harvested, a proportion of the wood from the tree remains stored as wood products or remains in place belowground or stored as soil carbon. Land use change however, is a permanent loss of carbon from the biomass to the atmosphere. Post-disturbance, in the absence of land use change, the forest will begin to re-accumulate carbon.

This indicator reports contribution of Victorian forest ecosystems to global greenhouse gas balance (as carbon equivalent, CO_2-e) compared to other sectors of the economy.

Credit: DEPI

State and trend

Greenhouse gas emissions were 118.3 Mt CO2-e in 2010/11 (a 12.1% increase on 1989/1990). The sectoral composition, level and trend of these emissions are shown in Figure 1. Figure 1 indicates the greatest contributor to emissions is the Energy sector. This sector includes emissions from the production of electricity and direct combustion of fossil fuels in other industries, such as manufacturing. In 2011, Victoria's Land Use, Land-Use Change and Forestry sector had a negative emission (i.e. greenhouse gas absorption) of 5,430 Gigagrams[1]. Victoria's native public forests play an important role in the sequestration of carbon across the state. However, a proportion of carbon sequestered over the reporting period is associated with private commercial forestry. The rate of carbon sequestration is declining as these private commercial forests reach maturity and are harvested. Furthermore, over the past decade, the rate and area of new plantation establishment has been in decline (refer to Indicator 1.1a).

[1] emissions from wildfires are excluded from reporting
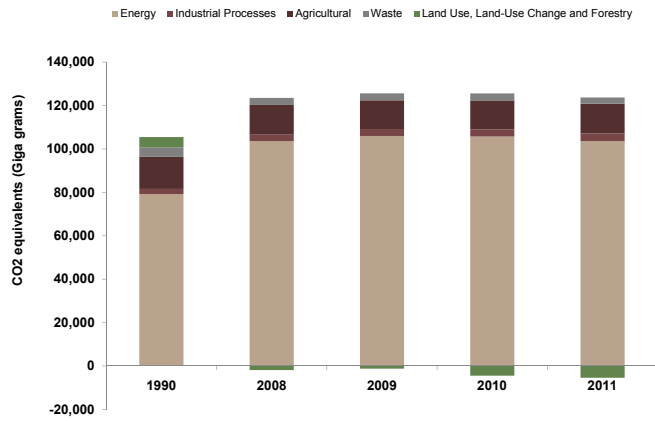
Figure 1. Victorian greenhouse gas emissions by sector (1990-2011[2]). Source DEPI

Data source and limitations

Emission and removal rates are calculated from State and Territory Greenhouse Gas Inventories in the Australian National Greenhouse Accounts[3]. Data for the land use, land use change and forestry sector is unavailable for the period 1991 to 2007.

References and further information

Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (2013). Australian National Greenhouse Accounts – State and Territory Greenhouse gas Inventories, 2010-11. Commonwealth of Australia 2013.

[2] Data for the land use, land use change and forestry sector is unavailable for the period 1991 to 2007

[3] http://www.climatechange.gov.au/climate-change/publications

Indicator 6.1a: Value ($) of wood and wood products

Why is this indicator important?

Marketed timber products, including primary and secondary manufacturing provide livelihoods (particularly in rural and regional areas), government revenues for public services (including forest management), profits to businesses and income to forest owners. A measure of the value of wood and wood products enables socio-economic benefits to be monitored and to ascertain trends for comparison with management objectives.

What have we measured and why is it relevant to the indicator?

This indicator provides three measures of the value of wood and wood products, the value of wood production from State forest, the value of log production from all forests and plantations and the Australian log production values.

The first measure records revenue from sales of wood products from State forest from western and eastern Victoria where the management arrangements differ. These revenues are available to the State of Victoria for re-investment in forest operations and management or for other public services. The volumes of wood products produced from State forest are available in Indicator 2.3.

The second measure is the gross value from all wood products from forests and plantations in Victoria regardless of ownership. These values are comparable between the States of Australia as provided in the third measure. These revenues are available to forest owners as a return on investment in productive forest management and quantify wood production's value as a primary industry.

The value measures do not report the gross value to the economy of Victoria. Multipliers can be used to estimate the total economic benefit of an industry from its gross value. Multipliers of three are used in the agricultural sector, so that for every dollar value to the grower there are three dollars value to the total economy.

Credit: DEPI

Value of wood production from State forest

The types of wood products harvested from State forests across Victoria are dependent on the forest types, features of the different timber species and the management arrangements. In western Victoria DEPI controls wood production. In the east, VicForests is responsible for managing, harvesting and selling timber resources as governed through relevant legislation.

There are three main categories of wood products, sawlogs, pulpwood, and other products.

Sawlogs are used for the manufacture of sawn timber, with sawdust and wood chips as useful by-products. Pulpwood is sourced from wood not suitable for sawlog. Pulpwood is used to produce pulp, paper and composite board products domestically or exported as log or woodchips.

The other products harvested from State forests are firewood, low quality sawlogs, posts and poles, fire salvage logs and specialty craft timbers.

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Indicator 6.1a: Value ($) of wood and wood products

Data source and limitations

The data for Figure 1 was sourced from the DEPI internal records and reports value as stumpage which is the gross value from the sale of the wood products before harvesting and delivery.

The data for Figure 2 is from the VicForests Annual Reports. VicForests includes other products with pulpwood to simplify reporting and uses the mill door value which is the gross return after the harvest and delivery of the wood products to the customer.

Credit: DEPI

State and trend

Figure 1 shows the stumpage value of wood products produced from public forest in western Victoria. Figure 2 shows the mill door value of wood products produced from State forests in eastern Victoria.
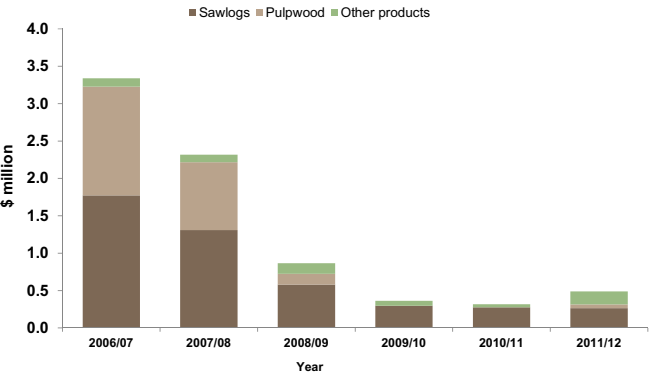
Figure 1. The stumpage value of wood products from western Victoria from 2006/07 to 2011/12. Source DEPI
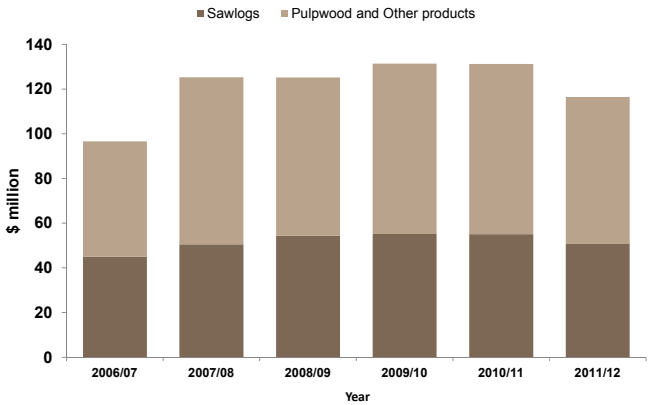
Figure 2. The mill door value of wood products from eastern Victoria from 2006/07 to 2011/12. Source VicForests

Figure 1 shows a sharp decline in the value of wood products produced from western Victoria over the last six years.

- This decline is due to Victorian Government policy decisions affecting the area available for timber production (refer to Indicator 2.1).

- Figure 2 shows steady performance of sales revenue from wood products over the last six years.

- Revenue was down during the 2006/07 year due to interruptions to supply caused by the 2006 bushfires.

Value of log production from all forests and plantations, Victoria

The value of total state log production is categorised by three types, broadleaved native, broadleaved plantation and softwood plantations. These are international definitions. The production operations are controlled by a variety of forest owners.

The broadleaved native wood products are from native forests of eucalypts on private and public land producing hardwood timber. The values include those from State forest and those estimated to be from private native forest timber production operations.

The broadleaved plantation wood products are from privately owned hardwood plantations, the majority of which were established to grow woodchips from blue gum trees.

Softwood wood products are from plantations of introduced pines, predominately *Pinus radiata* owned by various private plantation owners. There is no production from native softwood forest or State owned plantations.

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Indicator 6.1a: Value ($) of wood and wood products

Data source and limitations

The data is sourced from the ABARES national report on forest and wood product statistics which is available to 2010/11. The gross value is that estimated at the customers gate. The data excludes firewood production and GST. Private native forest values are estimated from ABARES sawmill survey reports and private industry sources.

State and trend

Figure 3 shows the gross value of wood products produced from all forests and plantations in Victoria.
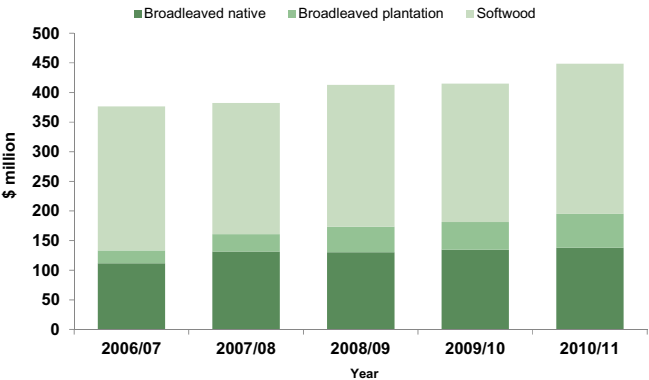
Figure 3. The gross value of wood products from Victoria from 2006/07 to 2010/11. Source ABARES (2013) Table 8b Australian Forest and Wood Product Statistics

- Broadleaved native value show the same trends as Figure 2 as State forest production makes up the largest proportion of the value.

- Broadleaved plantation production value has reached $57 million during 2010/11.

- The trend of value here is of a steady and rapid increase as more of these plantations reach their harvestable age and are processed and delivered to market. The increase in value from 2006/07 to 2010/11 for this type of wood product is 265%. This trend was planned to continue however as many of these plantations are under new ownership arrangements and market conditions are rapidly changing there are some uncertainties over the future trend.

- The value from softwood wood products has been steady during the period 2006/07 to 2010/11 with fluctuations year by year due to market conditions tied predominately to housing starts and the general economy. The exception to the steady trend occurred during 2010/11 when a record high value of $254 million was produced. This record was 3% higher than the previous record set in 2006/07.

- The value of softwood wood products will remain relatively steady as the resource availability and market demand are in relative balance.

Value of log production, Australia

The total value of log production is compared between the states for the 2010/11 year.

The data is sourced from the same ABARES reports as the previous measure.

State and trend

- During 2010/11 Victoria produced 25% of the nation's wood product value.

- Victoria has a natural advantage in growing wood products due to its soils, rainfall and land availability.

References and further information

ABARES (2013) Australian Forest and Wood Product Statistics, March and June quarters 2012. Department of Agriculture, Fisheries and Forestry <http://www.daff.gov.au/abares/publications_remote_content/publication_series/australian_forest_and_wood_products_statistics > accessed 24 April 2013

VicForests (2007-2012) VicForests Annual Reports 2007-2012. Melbourne.

Western Victorian wood product value data sourced from Department of Primary Industries.

Indicator 6.1b: Value ($) and yield of non-wood forest products

Why is this indicator important?

Non-wood products provide a range of economic benefits for Victorian communities. They support livelihoods, particularly in rural and regional areas and provide government revenues for public services including forest management, profits to businesses and income to forest owners. The value of non-wood products reflects the scale of these benefits. This measure enables socio-economic benefits to be monitored and to ascertain trends for comparison with management objectives.

What have we measured and why is it relevant to the indicator?

This indicator reports the value of five non-wood forest products sourced from Victorian public forests. The products reported are extractive material, apiary licences, game meat, seed and essential oils.

The value of these products are expected to account for the great majority of income generated for the State from non-wood products. Incomes generated from other non-wood products such as salt and tree ferns are generally relatively small and are not included in this indicator report.

The value measures report the gross revenue to the State and does not measure value to the economy of Victoria. Extractive material is used for construction and infrastructure development of considerable total value. The Apiary industry makes an important contribution to the agricultural and rural economy of Victoria through pollination services. The other products support many small to medium enterprises and cottage industries in rural Victoria. These broader values currently cannot be measured.

Value and Production of Extractive Materials from Crown land.

Victoria's extraction industries are a vital part of the building and infrastructure industries. Extractive materials such as stone and rock products are mined from registered quarries and pits in State forest. A larger proportion of the industry operates on private land.

Hard rock materials including basalt, granite, hornfel, limestone and rhyodacite are used in the construction and maintenance of buildings, and road infrastructure. Soft rock products including sedimentary materials, sand and gravel are used extensively in landscaping, roading and concrete.

Data source and limitations

The data for the extractive material information comes from DEPI internal records. The data covers four years from 2006/07 to 2009/10. The production is in tonnes and the value of royalties are presented by the main rock types. Data for 2010/11 and 2011/12 were unavailable at the time of reporting.

State and trend

Table 1 shows the quantity in tonnes and value in dollars of the major rock types from State forest in Victoria from July 2006 to June 2010.

- Sand and gravel make up the largest quantity of removals peaking at around 545,000 tonnes in 2006/07.

- New basalt is the highest value extractive material type with an annual value of nearly $4 million in 2007/08.

- Revenue was greatest in 2007/08, largely due to increased sales of new basalt.

- The trends of quantity and value fluctuate year by year according to demand.

Mirrinatwa Gap quarry, Ararat. Credit: Boo Book

Indicator 6.1b: Value ($) and yield of non-wood forest products

Table 1. Yield and value of extractive material by rock type from State forest (2006/07 to 2009/10). Source DEPI

Major Rock Type	Yield/value	2006/07	2007/08	2008/09	2009/10
Basalt new	tonnes	136,222	262,730	192,624	150,640
	$	$1,907,108	$3,914,309	$2,885,520	$3,012,800
Basalt old	tonnes	16,059	8,640	6,400	-
	$	$47,832	$43,200	$64,000	-
Granite	tonnes	7,847	32,048	4,369	16,572
	$	$167,991	$261,529	$131,232	$157,709
Hornfels	tonnes	160	800	-	4,653
	$	$2,278	$11,390	-	$42,799
Limestone	tonnes	5,376	3,320	4,722	-
	$	$21,052	$10,375	$24,700	-
Rhyodacite	tonnes	44,165	43,996	7,882	10,705
	$	$375,403	$373,966	$90,560	$148,533
Sand & gravel	tonnes	545,228	523,381	325,911	508,085
	$	$2,005,397	$2,133,815	$857,820	$1,580,589
Sedimentary	tonnes	54,609	71,349	92,149	43,390
	$	$154,382	$605,268	$566,095	$401,760
Total	**tonnes**	**809,666**	**946,264**	**634,057**	**734,045**
	$	**$4,681,442**	**$7,353,852**	**$4,619,927**	**$5,344,100**

Apiary

Victorian honey production is concentrated in the eucalypt forests of Victoria. For this reason the apiary industry is largely dependent on access to public forests and the flowering cycles of eucalypt species.

DEPI manage access to 3,637 apiary sites on Crown land across Victoria. Apiary licences can be issued for these sites for a period of up to one year. A licence fee is payable by apiarists for access to the site regardless of whether they use the site or not. The measures used are the number of apiary licences issued for all Crown land each year and the value of invoiced licence fees.

In addition to honey production, the apiary industry has other values associated with it, including providing pollination services to the agricultural sector; sale of bees for commercial and domestic/hobby apiarists; beeswax for making candles; furniture waxes and other products; and a range of other products.

The Victorian apiary industry has an estimated annual gross production value of $15 million. However, this estimate does not fully account for the industry's contribution to agriculture or the broader economy through pollination services that the bees provide. Pollination services add between $680 million and $1 billion in annual production value to the agricultural industries sectors[1].

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[1] Rural Industries Research and Development Corporation (2012) Honeybee RD&E Plan 2012-2017. Publication No 12/049. RIRDC, Australian Government. <http://www.rirdc.gov.au/docs/default-document-library/the-honeybee-five-year-r-amp-d-plan-2012-2017.pdf?sfvrsn=0> accessed on 8 May 2013

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Indicator 6.1b: Value ($) and yield of non-wood forest products

Bee hives in box woodland forest. Credit: DEPI

Data source and limitations

Data on apiary licences and revenue is sourced from the DEPI Land Information Management System.

State and trend

Figure 1 shows the number of apiary licences issued and the value of invoiced licence fees for each year during the reporting period.
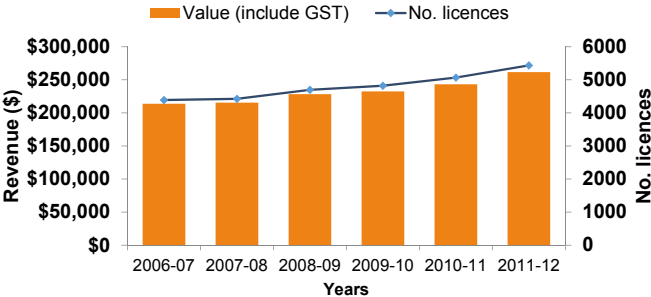
Figure 1. Revenue, based on invoices, of licences to access the 3,637 bee sites on Crown land (2006/07 to 2011/12). Source DEPI

- The number of apiary licences issued in any year fluctuates with the availability of sites (some sites may be closed for management reasons), flowering, and the number of sites with multiple licences issued during a year.

- The number of licences and the revenue generated from them has steadily increased during the period from July 2006 to June 2011, due to increased demand for sites from the industry that prompted government policy changes to restore and create apiary sites[2].

2   Coalition Govt puts the buzz back into agriculture, The Hon Peter Walsh MP, 13 May 2011

Game Licences

The harvesting of game animals is controlled by DEPI through the issue of game licences. Licences entitle hunters to hunt according to the restrictions specified on the licence which may limit the season of hunting, the number of animals to be taken and the accessible areas depending on the species covered by the licence. Revenue is generated from the sale of these licences. Licences are issued for individual game types and hunting type or in combination. These are referred to as 'entitlements'. Licences are issued for deer hunting by stalking, deer hunting using hounds, duck hunting and hunting for other game bird species (mostly quails).

The value of the hunting includes a combination of the experience for the licence holder and the non-commercial value of the meat harvested, which are not measured in this indicator.

Data source and limitations

The data on licence numbers, entitlements and licence fees is derived from two DEPI sources: Hunter Mail Survey Reports (2005/06 to 2008/09); and the Game Licensing System (2009/10 onwards). The introduction of the Game Licensing System has improved the quality of data reported, however revenue is only indicative. The supply of animals to these licences is estimated in a research report by Moloney and Turnbull 2012[3]. The value of the animals removed is not estimated.

3   Moloney, P. D. and Turnbull, J. D. (2012) Estimates of harvest for deer, duck and quail in Victoria: results from surveys of Victorian game licence holders in 2012. Arthur Rylah Institute for Environmental Research Technical Report Series No. 239. Department of Sustainability and Environment, Heidelberg, Victoria

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Indicator 6.1b: Value ($) and yield of non-wood forest products

State and trend

Figure 2 shows the revenue and number of game hunting licences by financial year issued by DEPI. It shows the value of the activity to DEPI and represents a measure of demand for game hunting. Figure 3 shows the number of animals harvested in the calendar years from 2009 to 2012 that is an estimate of the total hunter success.
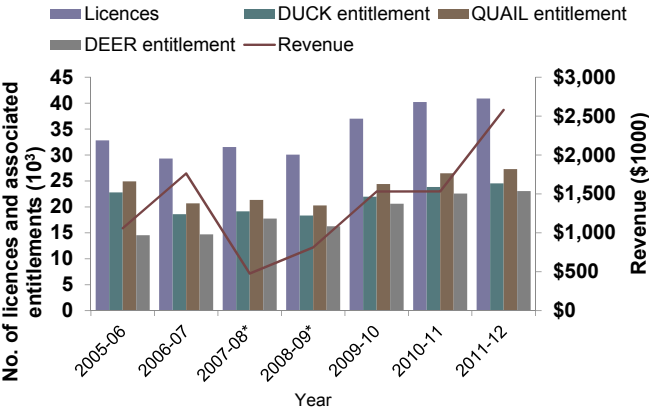
Figure 2. Revenue from gaming licences and the associated entitlements (2005/06 to 2011/12). Source DEPI

Note: A single licence can have multiple entitlements

* Duck hunting season cancelled

** Duck hunting season restricted
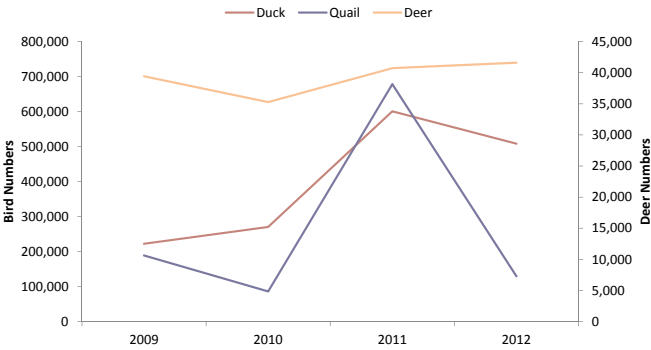
Figure 3. Number of Game Animals harvested in Victoria (2009 to 2012). Source Moloney, P. D. and Turnbull, J. D. (2012)

- The number of game licenses has steadily increased over the period from 2006 to 2011, an apparent response to a increase in the popularity of the activity.

- Licence fees range from $25.60 to $231.00 depending on the duration, the species to be hunted and concessions. The total average annual revenue to DEPI for all three game types is estimated at approximately $1.4 million.

- The number of deer harvested from Victorian State forest is relatively steady with a dip in numbers during 2010 due to a fall in hunter success, especially for Sambar Deer.

- Duck hunting seasons were closed in both 2006/07 and 2007/08 due the lack of water in wetlands because of the extended drought and to protect breeding populations. The Victorian Government issued a one year credit to entitlement holders, resulting in the number of licences and entitlements remaining similar but significantly reduced revenues in 2007/08 and 2008/09.

- The numbers of ducks harvested has increased from a low base following the closed seasons during the drought to around 550,000.

- The numbers of quail harvested was steady at around 130,000 until a peak year during 2011 of nearly 680,000 birds. The seasonal conditions in 2011 were conducive to high bird numbers and high hunter success[4]. Quail are mostly hunted on private grasslands.

Credit: DEPI

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[4] Moloney, P. D. and Turnbull, J. D. (2012)

Seed

The quantity of native seed collected varies between species and is influenced by the demand for particular species. Eucalypt species, which make up the majority of commercial seed production, do not set the same amounts of seed every year, and the quantity and quality of seed available for collection varies over time. The largest quantities of seed harvested are for use on State forests for harvesting regeneration and fire recovery operations. Smaller quantities of seed are harvested for commercial tree growing in nurseries and sale.

Seed is collected by DEPI, VicForests and some private collectors. This indicator reports on seed collection activities that attract a royalty. With the exception of 2007/08, seed collected by DEPI is not reported as the State derives no revenue from this seed.

Data source and limitations

The data is sourced from DEPI internal records for the quantities and royalties paid for extracted seed sold during the reporting period. DEPI and VicForests seed records from 2007/08 could not be reliably separated for the purposes of this report and thus seed quantities for this year include DEPI collection. The majority of seed is accounted for in the financial year after its collection.

Eucalypt seed. Credit: DEPI

State and trend

Figure 4 shows the total yield and revenue generated by seed collection activities that attract royalties from State forest in Victoria by year.
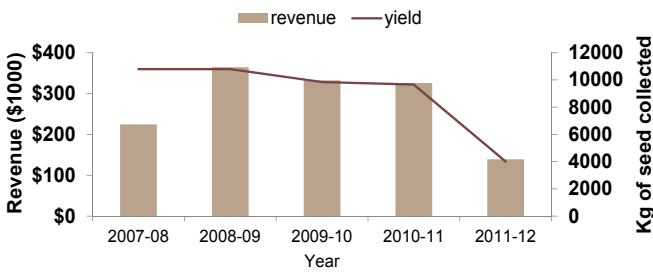
Figure 4. Volume of seed sold and royalty revenue (2007/08 to 2011/12).
Source DEPI

- The amount of seed sold from State forest was around 10 tonnes per year between 2007/08 and 2010/11. This level of seed sales represents a significant increase from the average annual production of 4.6 tonnes during the previous reporting period. This increase in seed sales was due to VicForests replacement of seed stores used during fire recovery works following major bushfires in 2006 and 2009 (refer to Indicator 3.1).

- Sales fell to around 4 tonnes per year in 2011/12, reflecting a return to routine seed collection patterns.

- The average royalty for seed capsules is $33.75 per kilogram.

Indicator 6.1b: Value ($) and yield of non-wood forest products

Essential Oils

The harvesting of eucalypt leaves from State forest for the extraction of essential oils is practiced in western Victoria around Bendigo. Harvesting targets areas of blue mallee *Eucalyptus polybractea* cut on short rotations. The industry started in the 1860s and production declined in the 1950s due to competition from imported Chinese oils. The number of licenses issued for extraction during 2010/11 was six, down from seven in the previous periods.

Data source and limitations

The data is sourced from DEPI internal records for the quantities of eucalypt leaves harvested, and the values are estimated by multiplying the quantity by the average royalty rate. Data for 2011/12 was not available at the time of data extraction.

State and trend

• The amount of eucalyptus oil harvested from State forest has remained steady over the period 2006/07 to 2009/10 and declined during 2010/11 due to a decrease in the number of licenses operating.

• The average royalty for Eucalyptus oil is 43 cents per kilogram.

Table 2 shows the revenue generated from eucalypt leave sales and the quantity of eucalypt leaves harvested from State forest in Victoria.

Table 2. The revenue generated and quantity of Eucalyptus Oil harvested in Victorian State forest from 2006/07 to 2010/11. Source DEPI

Financial Year*	Oil extracted (kg)	Royalty revenue
2008/09	25,100	$20,500
2009/10	15,600	$13,500
2011/12	11,500	$10,500

* data unavailable for financial year 2010/11

Indicator 6.1c: Value ($) of forest derived ecosystem services

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Why is this indicator important?

Forests provide a broad range of ecosystem services ranging from the provision of oxygen and clean water, to flood and erosion protection, climate regulation and recreational or spiritual opportunities.

In May 2012 the Statistical Commission of the United Nations published the System of Environmental-Economic Accounting – Experimental Ecosystem Accounts (SEEA-EEA)[1]. The SEEA-EEA builds on the SEEA Central Framework (SEEA-CF) by recognising forests as ecosystems extending the production boundary beyond standard economic products. The SEEA provides a framework to link ecosystem assets and services to current economic activity.

The SEEA recognises three broad categories of ecosystem services. These are **provisioning services** (materials and energy), **regulating services** (water filtration and flow regulation), and **cultural services** (recreation and amenity).

Indicators 6.1a and 6.1b cover the provisioning services of forests including the value of wood, wood products and non-wood forest products. Indicator 7.3 includes information about markets for native vegetation improvements. However, there are many other ecosystem services (regulating and cultural) provided by forests which are not priced in markets. In the past these have not been measured and accounted for in decision-making.

Understanding trends in the **economic** value of benefits associated with the full range of ecosystem services provided by forests will assist decision makers in prioritising investment and considering competing interests in the management of forests.

[1] http://unstats.un.org/unsd/envaccounting/seea.asp

What have we measured and why is it relevant to the indicator?

It has not been possible to report on the full range of ecosystem services at the present time as standard methods of assigning values and measuring ecosystem services in Victorian public forests have not been fully developed.

In recent years Victoria has developed market based incentive systems which assign value to improvements in management of natural environments[2]. Studies have also been undertaken into the value of water produced from Victorian parklands and waterways[3] and ecosystem benefits from the Victorian River Red Gum forests and the forests of East Gippsland[4]. There is also a significant emerging literature on the application of accounting methods and valuation frameworks to ecosystem assets and services of relevance to Victorian public forests.[5,6,7]

[2] http://www.depi.vic.gov.au/environment-and-wildlife/environmental-partnerships/innovative-market-approaches/ecotender

[3] Van Raalte, L. and Gentle G. (2005) The value of water from the Victorian Alpine National Park. URS Australia.

[4] URS 2007, Non-use values of Victorian Public Land: Case studies of River Red Gum and East Gippsland Forests, prepared for the Victorian Environmental Assessment Council

[5] Australia 21 Limited 2012, Discussion Paper on Ecosystem Services, prepared for the Department of Agriculture, Fisheries and Forestry.

[6] Bateman et al 2011 UK National Ecosystem Assessment: Economic Values from Ecosystems (Chapter 22 of the technical report from the UK National Ecosystem Assessment).

[7] Economics for the Environment Consultancy 2011 Scoping Study on Valuing Ecosystem Services of Forests Across Great Britain, prepared for the Forestry Commission Great Britain.

Victoria recently published an experimental set of ecosystem accounts and continues to develop and pilot new methods[8]. DEPI is committed to expanding its capability to implement the environmental accounting system to provide the State with accounts that meet the international standards and support decision making.
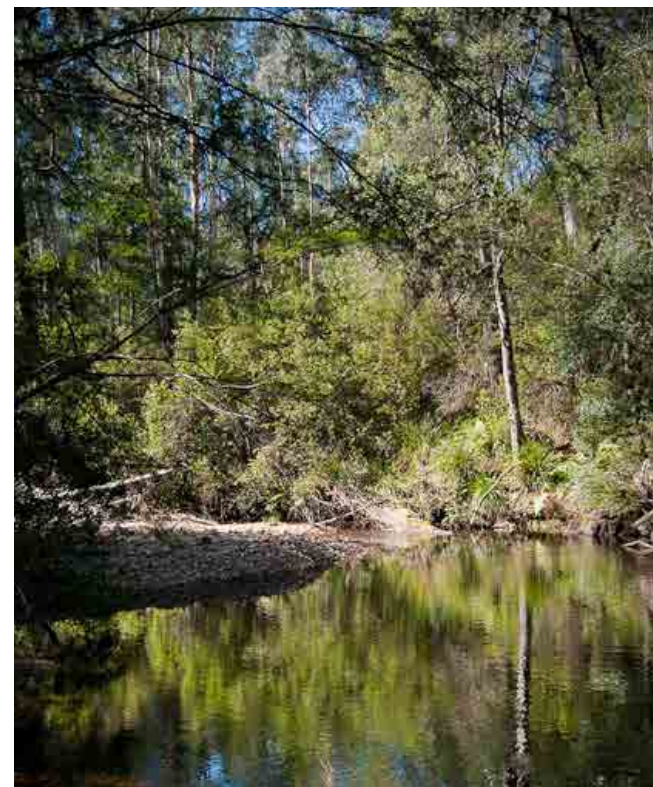
Snowy River National Park. Credit: DEPI

[8] https://ensym.dse.vic.gov.au/cms/index.php?option=com_content&view=article&id=60&Itemid=71

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Indicator 6.1d: Degree of reuse and recycling of wood products

Why is this indicator important?

Reuse and recycling of forest products conserves Victoria's forest resource base, reduces the volume of solid waste to land-fill and can help to reduce greenhouse gas emissions. This indicator identifies the extent to which recycling or reuse of forest products occurs. It can be used to identify further opportunities for recycling.

What have we measured and why is it relevant to the indicator?

Used wood products, such as paper and timber, have a secondary life when recycled or reused. Collections of used wood products occur at both the commercial and domestic level, for re-processing into recycled materials or simply re-used[1] in their current form.

This indicator includes measures of the type, amount and sources of wood and paper products recycled and reused. Together these measures quantify the effectiveness of recycling programs.

Recycling and reuse of wood products in Victoria.

Recovery of wood products includes both reuse and recycling. Reuse refers to when a material is re-used, usually in the same form in which it already exists. It may be for the same or different end purpose but prolongs the life of the material in its current form. An example of wood product reuse is timber floor boards. These are usually re-laid as flooring in their original form, sometimes after removing old varnishes or blemishes.

Recycling involves conversion of the wood product into a new form of product. It involves the processing of wood and wood products back into raw materials, such as re-pulping used paper, and then subsequently re-manufacturing the 'raw' material to produce a new product.

For example, newspaper can be converted back into pulp before being re-manufactured into another paper product such as cardboard.

Recycled timber is processed by chipping and reprocessing into composite products. Sawdust is a waste-stream from timber sawing and manufacture of timber products. It is reclaimed and used for wood energy, either directly or as fuel pellets, and also used in the manufacture of composite wood products.

The quantity of wood and paper recycled each year varies according to supply and demand. The effectiveness of collection and recovery processes affect supply. General economic conditions and markets affect demand.

The main sources for this wood and wood product are the commercial and industry sectors.

Data source and limitations

The data on recycling of wood products has been sourced from the annual survey of Victorian recycling industries[1]. In 2009/10 re-processors changed how they reported yearly paper and paper product recycling results. This should be considered when interpreting trends.

Paper recycling. Credit Telstar Logistics

1   Sustainability Victoria (2010/11) Victorian Recycling Industries Annual Survey.

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Indicator 6.1d: Degree of reuse and recycling of wood products

State and trend

Figure 1 provides an overview of the types of recycled wood and wood products in Victoria in 2010/11.
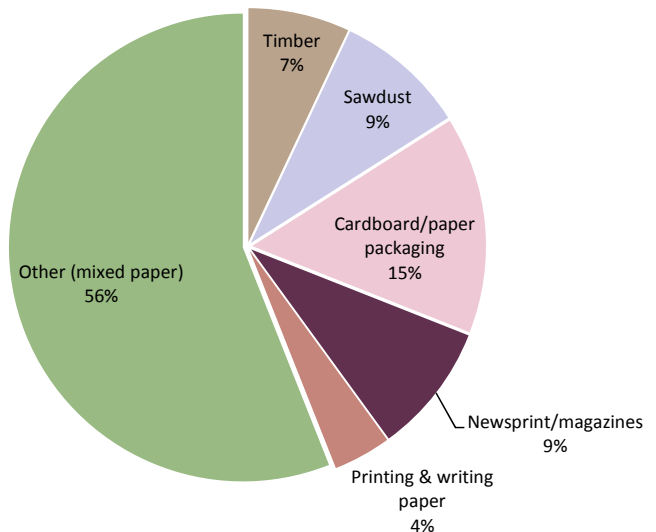
Figure 1. Proportion of wood products reused and recycled during 2010/11. Source Victorian Recycling Industries Annual Survey 2010/11

Table 1 shows the volume of wood products that were reused and recycled between 2006/07 and 2010/11 by product type.

- In 2010/11 more than 1.4 million tonnes of wood and wood products were recycled and reused in Victoria. These represent 18 % of all recovered material in Victoria, increasing by 1 % from the previous year.

- Mixed paper recycling made up more than half, and combined cardboard, newspapers and magazines almost a quarter of all recycled wood products respectively in 2010/11. Timber and sawdust made up a further 16 %.

Table 1. Volume of recycled and reused wood and paper products from 2006/07 to 2010/11 ('000 tonnes). Source Victorian Recycling Industries Annual Survey 2010-11

	2006/07	2007/08	2008/09	2009/10	2010/11
Cardboard/paper packaging	389	422	468	196	211
Newsprint/magazines	122	132	159	114	137
Printing & writing paper	73	124	92	44	58
Other (mixed paper)	236	275	410	644	805
Timber	196	123	158	163	107
Sawdust	144	67	154	127	126
TOTAL ('000 tonnes)	**1,160**	**1,143**	**1,441**	**1,288**	**1,444**

- Victoria's recycling of wood and wood products, has continued to grow in 2010/11 with a total expansion of 24 % since 2006/07. This is primarily due to recycling of mixed paper products.

- Industry was the source of 83 % of all recyclable materials in 2010/11. Of this the commercial and industrial sectors contributed 67 % of Victoria's recovered paper and cardboard during 2010/11 representing an increase of 58 % from 2009/10.

- The commercial and industrial sectors also provided the majority of timber and sawdust materials collected for reuse and recycling.

- Offices and schools were the main source of printing and writing paper for recycling, whilst cardboard and paper packaging materials were supplied predominantly from retailers and industrial facilities.

- Domestic collection makes up only a very small proportion of total wood and wood products for recycling.

- Recycling of wood products is expected to continue to increase in the immediate term as businesses and industries become more aware of the importance of recycling paper and cardboard products.

References and further information

Sustainability Victoria (2012) Victorian Recycling Industries Annual Survey 2010-11 Sustainability Victoria, State Government of Victoria

Sustainability Victoria (2011) Victorian Recycling Industries Annual Survey 2009-10 Sustainability Victoria, State Government of Victoria

Sustainability Victoria Recycling in Victoria <http://www.sustainability.vic.gov.au/www/html/1352-recycling-in-victoria.asp> accessed 20 May 2013.

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Indicator 6.2a: Investment and expenditure in forest management

Why is this indicator important?

Effective sustainable forest management relies on adequate investment and expenditure. Investment and expenditure are necessary to ensure infrastructure, facilities, forest health and conservation values are maintained.

What have we measured and why is it relevant to the indicator?

This indicator reports on the Victorian Government expenditure on forest management related activities. This includes State forests and Parks and conservation reserves.

State and trend

Investment and expenditure in public forest management
There are two main investment and expenditure streams that support forest management: forest and fire management; and conservation and recreation.

Forest management services include the management of Victoria's State-run Parks, reserves and other public land, including State forest. Investment and expenditure in forest management services is essential for enabling access and appropriate and sustainable use of public forests whilst protecting environmental, social and cultural values.

Fire management includes fire prevention and operations, including responding to bushfires (Indicator 3.1). It includes the preparation of plans, codes, prescriptions and guidelines to establish the framework for effective fire management. It also includes training and support of personnel to conduct fire related activities including prescribed burning (Indicator 3.2), fire prevention and bushfire suppression, as well as the maintenance and upkeep of associated infrastructure and equipment.

Conservation and recreation investment and expenditure provides funding to support biodiversity conservation, tourism and recreation, culture and heritage, ensuring sustainable use and management of Victoria's public forests. This stream of investment and expenditure also supports the management and governance of parks (including national, state and metropolitan parks).

Short term investment and expenditure by the Victorian Government, such as project initiatives, also play an important role injecting extra funding into forest management and supplementing the annual baseline funding.

Table 1 provides an overview of Victorian Government expenditure in forest management by expenditure category between 2006/07 and 2011/12.

The trend of investment and expenditure over the reporting period has generally been steady within the range of $600 million to $800 million annually, with a slight upward trend over the reporting period. There were two significant increases within this period, both associated with increased fire activities. Most notably, in 2008/09 due to fire suppression activities undertaken in response to the Black Saturday bushfires of February 2009 (refer to Indicator 3.1).

Planned burn operations, Colac 2012. Credit: DEPI

Table 1. Victorian Government Expenditure on Forest Management, 2006/07 to 2011/12
Source DEPI

Expenditure Category	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
	Expenditure ($ millions)					
Forest and Fire Management[1]	629.9	737.5	758.2	588.9	627.3	691.2
Conservation and Recreation	na	39.2	48.4	46.7	55.8	77.4
Total Yearly Expenditure	**629.9**	**776.7**	**806.6**	**635.6**	**683.1**	**768.6**

[1] Forest and Fire Management expenditure includes suppression, which fluctuates depending on the fire and weather conditions.

na Forest related expenditure for 2006/07 cannot be separately identified.

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Indicator 6.2a: Investment and expenditure in forest management

Expenditure on commercial management of Victoria's State forests (VicForests)

VicForests is a State Owned Enterprise and commenced operations in August 2004. It was established to undertake the sale, harvest and regeneration of timber resources from areas of Victoria State forests set aside for wood production. The *Sustainability Charter for Victoria's State Forests* sets out a number of objectives for the sustainability of Victoria's State forests, and the sustainability of the timber harvesting industry that operates within those forests (refer to Indicator 2.3). VicForests is required by the *Sustainable Forests (Timber) Act 2004* to operate in support of those objectives.

Total expenditure on commercial management of the Victoria's State forests, by VicForests, is shown in Table 2.

Between 2006/07 and 2011/12, commercial forest management expenditure by VicForests totalled $770.9 million, with an average $128.5 million per year. Apart from 2006/07 and a slight decrease in 2011/12, the trend in expenditure by VicForests has been steady and generally within the range of $130 million to $140 million per annum. For detailed analysis of VicForests' production (including area harvested, annual wood production and forest regeneration, refer to criterion 2).

Data source and limitations

Plantations in Victoria are predominantly privately owned. Investment and expenditure in these plantations is not available. Information about changes in Victoria's plantations is included in Indicator 1.1a.

References and further information

DEPI Annual Reports, 2006/07 to 2011/12

Vic Forests Annual Reports, 2006/07 to 2011/12

Table 2. VicForests expenditure in commercial forest management, 2006/07 to 2011/12 .
Source VicForests

	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
	Expenditure ($ millions)					
Total Expenditure	103.3	132.0	136.1	143.0	137.2	119.3

Notes: These figures only include expenditure by VicForests for State forest in eastern Victoria. They do not include expenditure by contractors or DEPI.

Indicator 6.2b: Investment in research and development, and education

Why is this indicator important?

Investment in research, development (R&D) and education is critical for continually improving the way forests are managed and effective sustainable forest management. This information is used to assess the degree to which Victoria is committed to long-term sustainable forest management and making continual improvements to the way its forests are managed.

What have we measured and why is it relevant to the indicator?

This report presents data on Victorian Government investment in forest management R&D and education for the reporting period. Over the reporting period it has not been possible to compile the level of investment that has occurred in forest education. Data on enrolment in forest industry related education and training courses are used as a proxy for Forest related education.

Forest research and development has resulted in improved forest management over the period, as well as the creation of new and improved technologies which have increased the efficiency of forestry operations. Investment in formal education is also vital to the provision of a skilled forestry workforce, further supporting the sustainable management of our forests. The investment in research, development and education has in turn contributed to the development of new and improved technologies, as outlined in Indicator 6.2c *Extension and use of new and improved technologies*.

In addition, investment in community education increases the awareness of environmental issues and encourages environmentally, socially and culturally responsible behaviour by visitors to Victorian forests.

Research and Development

State and trend

The level of direct annual investment by the Victorian Government in forest-related R&D between 2006/07 and 2011/12 is presented in Table 1.

Between 2006/07 and 2011/12, the Victorian Government contributed approximately $29 million to forest-related research, development and education (an average of $4.8 million per year). The general trend for investment over the period is a steady increase from $3.8 million in 2006/07 to $5.9 million in 2011/12 (as shown in Figure 1).

Credit: DEPI

Table 1. Victorian Government investment in forest management research and development, and education, 2006/07 to 2011/12. Source DEPI

Research provider*	Year						
	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	Total
The Arthur Rylah Institute	558,000	187,000	271,000	130,000	975,000	710,000	2,831,000
Department of Forest and Ecosystem Science[A]	3,000,000	3,200,000	3,500,000	2,900,000	3,200,000	3,100,000	18,900,000
Victorian Forest Monitoring Program					727,000	1,253,000	1,980,000
CRC for Forestry	50,000	75,000	42,500	50,000	50,000	50,000	317,500
Bushfire CRC		137,000	1,700,000	1,300,000	213,000	746,000	4,096,000
Toolangi Forest Discovery Centre	235,000	330,000	78,000	33,000	48,000	52,000	777,000
Total	**$3,843,000**	**$3,929,000**	**$5,591,500**	**$4,413,000**	**$5,213,000**	**$5,911,000**	**$28,901,500**

A   Formerly the School of Forest and Ecosystem Science, The University of Melbourne

*   Refer to the "Forest R&D and Education Providers" breakout box for further information

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Indicator 6.2b: Investment in research and development, and education

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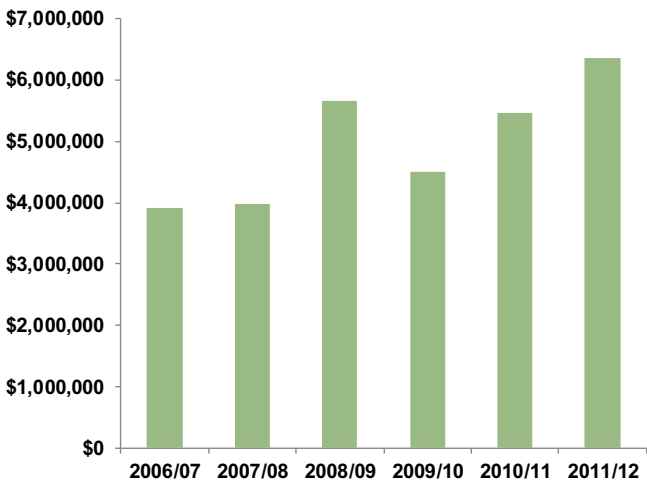
Figure 1. Total direct investment in forest-related research, development and education. Source DEPI

Forest-related education in Victoria

There are three broad types of forestry education models providing the forestry-related skills and education:

1. Formal training, involving University or TAFE education;

2. Vocational Education and Training (VET), a skill based training completed while a person is already employed within the industry (TAFE and industry specific programs);

3. Informal or 'on the job' training. The latter is a large component of the forestry skills knowledge base and includes volunteer training.

Table 2 shows some of the institutions offering forest industry related training as well as examples of the types of courses offered. Table 2 includes both Victorian and interstate training and education providers.

Victorian forest R&D and education providers

1. The **Arthur Rylah Institute for Environmental Research (ARI)**, delivers scientific programs via research, survey and monitoring, and technical services for DEPI. Based at Heidelberg, the ARI was established by the Victorian Government in 1970 as a leading centre for applied ecological research. Its main focus is to provide strategic research and management advice on environmentally sustainable land management and resource-use policies. DEPI provided nearly $3 million of direct funding to the Institute for forest-related research programs over the reporting period.

2. The **Department of Forest and Ecosystem Science (DFES)** at the University of Melbourne is a regional leader in forest research. DFES is a long-term joint initiative between DEPI and The University of Melbourne. It applies rigorous scientific methods to investigate issues such as salinity, carbon sequestration, farm forestry, hardwood and softwood plantations for sawlogs and fibre, sustainable native forest management, and fire ecology and management. DEPI contributed almost $19 million to the DFES partnership over the reporting period.

3. During the reporting period, DEPI also contributed $5.4 million to **Cooperative Research Centres (CRCs)**, including the CRC for Forestry and the Bushfire CRC. These CRCs are nationally important research priorities that are jointly funded by governments and public and private enterprises.

The Victorian Government also established the Victorian Forest Monitoring Program (VFMP) in 2009/10.

Table 2. Forest industry related education and training institutions. Source DEPI

Institution	Forest-related course or training type
University of Melbourne	Bachelor degree*, post graduate studies - Masters, PhD, Doctorate
Australian National University (ANU)	Bachelor degree, post graduate studies - Masters, PhD, Doctorate
Vocational Education and Training (TAFEs, and Registered Training Organisations)	Certificates (I, II, III, IV, Diplomas, Advanced Diplomas) in saw-doctoring, processing, wood panel products, silviculture, harvesting and haulage, Occupational Health and Safety
DSE, VicForests, DPI, environmental groups	Informal training and work experience

*   phased out during the reporting period

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Indicator 6.2b: Investment in research and development, and education

Formal Training

Formal education at higher education institutes provides professional skills training in policy, technical management, and also provides future forest industry leadership. The University of Melbourne is currently the only Victorian University offering forestry related training. The University of Melbourne ended its undergraduate forestry degree during the reporting period, replacing it with a postgraduate course.

Vocational Education and Training

Vocational Education and Training (VET) provides education and training in technical and operational forest industry skills. This category of providers includes TAFEs which offers a range of certificates and diplomas in the areas of forest management and silviculture, harvesting, haulage and timber processing. Other VET education resources include industry specific Registered Training Organisations (RTOs). There are currently 29 RTOs in Victoria providing forestry related training, servicing the forestry and wood products industries.

In recent years, skills shortages have been identified throughout the forestry and forest products industries. This has been driven by declining numbers of forestry graduates, the shrinking of the forest industry as a result of economic factors since 2009 and an overall reduction in resource availability. Table 3 shows the number of Victorian forest and wood product industry worker enrolments in timber industry training (providing a qualification) from 2009 to 2011.

Overall enrolment in vocational skills training has declined in recent years. There were 1,993 forest and wood product industry workers enrolled in industry training during 2011, representing a 35% decrease since 2009. Enrolments have declined for each training package in 2011 compared to 2009, with the exception of wood panel and board construction, which has more than doubled its enrolments since 2009.

Table 3. Forestry training package enrolments (2009 to 2011). Source Forestworks Skills Scan in VAFI Sustainability Report 2012

Industry qualification	Enrolments			Change 2009 -2011 (%)
	2009	2010	2011	
Forest Growing & Management	1,555	1,174	1,146	-26%
Harvesting and haulage	498	480	326	-35%
Sawmilling and Processing	427	389	201	-53%
Timber Manufactured Products	110	78	91	-17%
Wood Panel and Board Construction	38	30	80	111%
Timber Merchandising	39	64	36	-8%
Pulp and Paper Manufacturing	393	458	113	-71%
Total	**3,060**	**2,673**	**1,993**	**-35%**

Informal training

The decline in enrolments for formal forestry training has led to increased opportunities for informal training within the various forest industries. This mode of training contributes significantly to the forest industry skill base and is an important component of forest industry education. Volunteer staff working for government agencies (e.g. DEPI) or for environmental corporations and interest groups receive on the job training in a variety of forest management areas. This approach has provided skills training to people interested in forest science and related disciplines and prepares individuals for work within the industry.

Informal training also refers to learning and education that forest industry employees receive while working, either through mentoring or practical experience.

Public Education

DEPI operated the Toolangi Forest Discovery Centre during the reporting period. This Centre is located approximately 80 km northeast of Melbourne, within the Toolangi State Forest, and was used for public forest education, focusing on the education of school student groups. Funding for the Discovery Centre totalled approximately $780,000 between 2006/07 and 2011/12. The Discovery Centre was closed on 30 June 2012 due to issues associated with building regulations introduced after the 2009 Black Saturday bushfires.

Data source and limitations

Data for private industry expenditure on forest research and development is not reported.

Data on the level of investment that has occurred in forest education is not available, and proxy data on enrolments has been used to report against this indicator.

References and further information

Arthur Rylah Institute for Environmental Research, see: http://www.depi.vic.gov.au/environment-and-wildlife/arthur-rylah-institute

Department of Forest and Ecosystem Science (DFES), The University of Melbourne, see: http://land-environment.unimelb.edu.au/about-us/our-departments/dfes/

CRC for Forestry, see: http://www.crcforestry.com.au/

Bushfire CRC see http://www.bushfirecrc.com/research

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Indicator 6.2c: Extension and use of new and improved technologies

Why is this indicator important?

Continuous improvement underpins many principles of sustainable forest management. New technology can support continuous improvement through better tools, systems, techniques and methods of organisation. Benefits potentially include enhanced environmental outcomes and services, safer more productive workplaces, and more competitive industries. The extent to which new technology is developed and used informs understanding of the degree of improvement in different areas of sustainable forest management.

What have we measured and why is it relevant to the indicator?

Comprehensive data on the extension and use of new and improved technologies is not available.

Instead, this indicator lists a number of technological developments emerging during the reporting period, which have or will lead to improvements in sustainable forest management.

Projects undertaken by Victorian Government agencies involved in forest management are listed. They focus on new and improved technology for monitoring, recreation, fire management and forest industries in public forests, and biodiversity and waterway management in both public and private native forests.

Time lapse photograph of VEGNET laser scan. Credit: Environmental Sensing Systems

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Indicator 6.2c: Extension and use of new and improved technologies

New Technologies

Research and development of new and improved technologies relevant to sustainable forest management is undertaken by various agencies in collaboration with research institutions and other land and emergency managers around Australia.

Table 1 lists technology projects relevant to sustainable forest management that were conducted by DEPI, VicForests, Parks Victoria and collaborators during the reporting period.
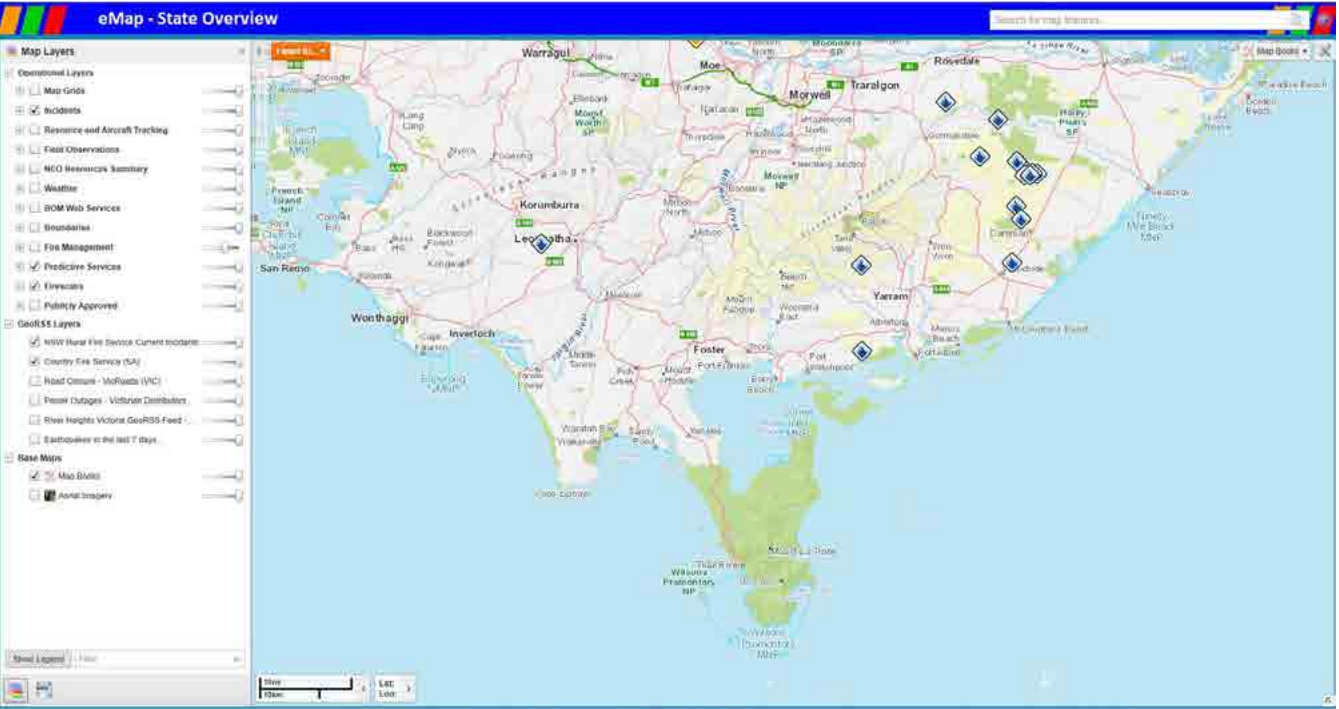
eMap, a standardised operational mapping and information system for bushfires and other hazards developed in response to recommendations from the Victorian Bushfires Royal Commission and deployed in 2012. Source DEPI

Leadbeater's Possum (yellow spot in the centre of the image) detected by thermal imaging camera. Source DEPI

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Indicator 6.2c: Extension and use of new and improved technologies

Table 1. Technology projects undertaken during the reporting period. Source DEPI

Description	Agency	Collaborators
Produce tools to combine spatial composition, configuration and contextual descriptors with key native woody vegetation aspatial attributes.	DEPI	ARC Linkage Grant, RMIT
A collaborative program that combines research, research training expertise and infrastructure from the Biophysical Remote Sensing Group with remote sensing groups supporting the Queensland, New South Wales and Victorian governments.[1]	DEPI	Joint Remote Sensing Research Program 2010
Investigate the operational monitoring of key climate variables using synthetic aperture radar.[2]	DEPI	CRCSI2 Project 4.15 2011-2013.
Produce tools and procedures to auto-generate landscape level woody vegetation features (ie spatial layers) from field and remote sensing woody vegetation data.[3]	DEPI	CRCSI2 Project 2.07 2010-2014
To develop and validate methodologies for measuring and mapping above ground biomass in woody vegetation and grasslands at a national scale.[4]	DEPI	DEPI/CSIRO Vegnet Project
A statewide public forest monitoring system combining 786 field plots with a range of remote sensing data to provide comprehensive and consistent information about Victoria's forests.[5]	DEPI	DEPI Victorian Forest Monitoring Program
Bringing disparate data together with key stakeholders from TERN eMAST, NSW OEH & DPI, VIC DEC and QLD DERM the project will work towards criteria for monitoring / managing native vegetation condition, structure and extent under changing climatic variability across South-eastern Australia.	DEPI	OEH/DEPI Climate Change Project 2013
A rolling 4 year collaborative project between Melbourne University and Department of Environment and Primary Industry to develop improved capacity and evidence base to manage the impacts of fire, climate change and forest management regimes on water quality/quantity, biodiversity values, carbon assets and other social and economic values.	DEPI	Integrated Forest Research Program
Public Access Map, an online interactive mapper showing full and partial closures to roads, tracks and recreation sites introduced in 2011.	DEPI	
Forest Produce Sales System, an online computerised licensing and invoicing system introduced in 2009.	DEPI	
Large scale use of lidar remote sensing technology to generate monitoring data for the 2013 Index of Stream Condition.	DEPI	

[1]   Refer to the University of Queensland Joint Remote Sensing Research Program website for further information http://www.gpem.uq.edu.au/jrsrp

[2]   Refer to the CRC-SI SAR Climate Monitoring (P 4.15) webpage for further information http://www.crcsi.com.au/Research/4-1-Agriculture,-Natural-Resources/4-15-SAR-Climate-Monitoring

[3]   Refer to the CRC-SI Woody vegetation (2.07) webpage for further information http://www.crcsi.com.au/Research/2-Feature-Extraction/2-07-Woody-Vegetation

[4]   Refer to webpage http://due.esrin.esa.int/files/m283/Culvenor_CSIRO.pdf for further information

[5]   Refer to DEPI's Victorian Forest Monitoring Program webpage for further information http://www.depi.vic.gov.au/forestry-and-land-use/forest-management/forest-sustainability/victorian-forest-monitoring-program

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Indicator 6.2c: Extension and use of new and improved technologies

Table 1. Technology projects undertaken during the reporting period (continued)

Description	Agency	Collaborators
Combined thermal imaging / call playback fauna technique used in 2011/12 survey of Leadbeater's Possum.	DEPI	
Broad based adoption of infra-red cameras for baseline and project monitoring across the Parks estate.	Parks Victoria	
Woody weed extent monitoring in the Alpine National Park and south west Victoria using integrated remote sensing techniques.	Parks Victoria	
Species and ecosystem distribution modelling advances resulting from more sophisticated statistical techniques, greater understanding of ecological drivers and progressive improvements in input data, models and processing. These models inform a broad range of threatened species and biodiversity management activities within forests.	DEPI (Arthur Rylah Institute)	
Phoenix RapidFire, a computer forecasting tool that predicts the direction, speed and intensity of bushfires introduced in 2010 to support fire response, fuel management and land use planning decisions.	DEPI	Bushfire CRC
eMap, a standardised operational mapping and information system for bushfires and other hazards developed in response to recommendations from the Victorian Bushfires Royal Commission and deployed in 2012.	DEPI, Country Fire Authority	State Emergency Services, Metropolitan Fire Brigade
Cengea, an integrated timber production coupe database, Geographic Information System and supply chain management system deployed in 2012/13.	VicForests	
Silviculture Reference Manuals for Mountain Ash[6] and high elevation mixed species[7] forest types. These manuals provide a synthesis of research and operational knowledge for management of major Victorian forest types, addressing ecology, disturbance patterns and silviculture systems.	DEPI	
Environmental Simulation Modelling (ENSYM), software package introduced to predict environmental benefits of investment. Used widely to support incentive programs such as Bush Tender and Eco Tender.	DEPI	

[6] Flint, A. & P. Fagg (2007). Mountain Ash in Victoria's State forests. Silviculture Reference Manual No. 1. Department of Sustainability and Environment, Melbourne, Victoria

[7] Sebire, I. D. & P.C. Fagg. (2009). High Elevation Mixed Species in Victoria's State forests. Silviculture Reference Manual No.2, Department of Sustainability and Environment, Victoria

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Indicator 6.3a: Area and quality of forest actively utilised for recreation and tourism

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Why is this indicator important?

Recreation and tourism experiences in Victoria's public forests, provide a range of social, economic and environmental benefits to visitors, as well as local and regional communities. Information about the area of forest available, and that used for recreation and tourism, is important for land management planning and improving visitor experiences.

What have we measured and why is it relevant to the indicator?

This indicator reports on the area of forest by land tenure category and includes information about the types of land use and some of the restrictions to tourism and recreation access and activities. Land tenure determines the permitted activities and therefore its availability for active tourism and recreation use. Refer to Indicator 6.3b for information about the range of forest tourism and recreation opportunities, and Indicator 6.3c for the number of forest visitors per year.

Tourism and Recreation

Most of Victoria's public forests, including State forests and Parks and conservation reserves, are available for recreation and tourism. The terms 'tourism' and 'recreation' are related but distinct. Tourism refers to the activities of people who are travelling to, and staying in places away from their usual environment. Tourism activities include ecotourism, cultural tourism and indigenous tourism activities. Recreation refers to a range of social, cultural, sporting and other activities, undertaken as leisure. Recreation activities include bushwalking, mountain biking, skiing, camping and four-wheel driving.

Credit: DEPI

State forest

Victoria's State forests are managed for a range of values including recreation, conservation and timber production. State forest is an important part of the public forest estate, providing a broad range of recreational opportunities, some of which may be not be catered for elsewhere. State forests provide for bushwalking, mountain biking, camping and four-wheel driving, as well as horse riding, hunting and trail bike riding. State forest is also used for events such as car rallies, mountain biking and orienteering.

State forests are zoned for managing the multiple uses and objectives of the forests. These are:

- General Management Zones (GMZ) – these zones include forest areas that are available for timber harvesting

- Special Management Zones (SMZ) – these zones identify significant ecological or other forest attributes and have some restrictions on the types of activities that can occur within them including timber harvesting and recreation use

- Special Protection Zones (SPZ) – these zones have restricted activities and access due to their significant ecological or other values and exclude timber harvesting.

For detailed information about forest management zones, refer to Indicator 2.1.

Permitted recreation activities differ between these management zones and are guided by the specific management objectives within each. Most recreational activities are allowed in GMZ areas.

Recreation activities within SMZ and SPZ areas of State forests may be restricted to low impact activities to protect natural and cultural values. For example, within an SPZ recreational activity may be either totally excluded or restricted to walks on formed walking tracks or boardwalks, with no camping allowed. Within

Indicator 6.3a: Area and quality of forest actively utilised for recreation and tourism

SMZ areas, restricted vehicle access and camping restrictions may apply depending on the values to be protected within the zone.

Recreation activities within all State forest management zones may be temporarily or permanently restricted to allow for:

- Flora and fauna protection
- Safety around prescribed burning and harvesting activities (GMZ, SMZ areas)
- Protection of water catchments and infrastructure
- Public events
- Natural disturbance response, including landslips, floods and/or fire danger.

Parks and conservation reserves

Parks and conservation reserves in Victoria are categorised according to the International Union for Conservation of Nature (IUCN) protected area categorisation[1]. The management objectives of Victoria's Parks and conservation reserves are focussed primarily on biodiversity and conservation. As such, permitted tourism and recreation activities are subject to the conservation significance of the area, as outlined in a zoning scheme of a park management plan. Zones include *Conservation*, *Conservation and Recreation* and *Recreation Development*. Additionally there are a range of legislative overlays that influence the allowable access and recreational use. These include Wilderness Zones, Remote and Natural Zones and Reference Areas. The conservation of forest values in, for example, National Parks, brings unique opportunities for ecotourism, cultural and wildlife tourism. These nature based tourism activities serve to enhance awareness, understanding and support for forest conservation.

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[1] Note: In addition, State forest Special Protection Zones (part of the informal reserve network) are also classified under IUCN protected areas.

An estimated 97% of Parks and conservation reserves and 99% of State forest is available for recreation. However, the actual area actively utilised for recreation and tourism is in practice significantly less, as remoteness and topography of many park and forest areas and the lack of supporting infrastructure such as roads and recreational trails into these areas, limit access and use of the public land estate.

Table 1 shows the area of public land available for recreation and tourism, by IUCN protected area category and State forest management zone. For further details about these categories refer to Indicator 1.1c.

Exclusions and restrictions

Public access to public forests may be permanently or temporarily restricted for the following reasons:

- Safety exclusion zones, established around forest management operations (such as timber harvesting coupes) (Refer to Indicator 2.3)
- Water catchments (access to about 90,000 hectares of catchments is restricted to the public). They are closed to public entry, except where bushwalking is permitted on specified tracks). Refer to Indicator 4.2.
- Public safety zones, identified on public land associated with high fire danger. Victoria has adopted the national system of Fire Danger Ratings. On days of forecast Code Red Fire Danger Rating, DEPI and Parks Victoria will close Parks and forests (including State forests and National Parks) in the relevant weather district.

Some types of recreation and tourism is normally strictly limited or prohibited in some IUCN protected areas, including the 'Strict Nature Reserve (Ia)' category land. Within 'Wilderness Area (Ib)' category land, access and use is limited, catering more specifically to recreation and tourism opportunities for solitude and appropriate self-reliant recreation.

State and trend

The total area of public land available for recreation and tourism remained largely static over the reporting period. Whilst there is some movement of land between protected area categories (refer to Indicator 1.1c) and State forest, these changes have minimal impact as the land continues to remain available for recreation and tourism use.

Over the period 2004 to 2012, the total area of formally protected areas increased by about 8%. Increases in predominantly forested land tenures (i.e. > 80% forest cover) of public land available for recreation and tourism included 11% (National Park category II) and 43% (category VI).

Craigs Hut, Mt Stirling. Credit: DEPI

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Indicator 6.3a: Area and quality of forest actively utilised for recreation and tourism

Table 1. Area of public land available for tourism. Source DEPI

| | IUCN Category | Area (hectares*) | | | | | |
		2004	2006	2008	2010	2012	Proportion of forest cover 2012 (%)[A]
Formal protected area	Strict Nature Reserve (Ia)	356,300	366,200	381,900	380,700	388,600	86
	Wilderness Area (Ib)	815,500	815,300	815,700	815,700	815,500	84
	National Park (II)	2,128,600	2,182,400	2,224,200	2,309,700	2,371,300	85
	Natural Monument or Feature (III)	55,000	48,900	49,500	51,300	78,000	73
	Habitat/Species Management Area (IV)	48,000	44,900	43,800	43,700	47,400	64
	Protected Landscape/ Seascape (V)	58,500	57,800	56,600	49,200	26,800	41
	Protected area with sustainable use of natural resources (VI)	91,100	89,200	94,500	85,100	130,600	87
Informal protected area	NA (State forest SPZ)	828,100	828,100	783,100	783,100	753,100	87
	Sub total	**4,381,100**	**4,432,800**	**4,449,300**	**4,518,500**	**4,611,300**	**85**
	State forest						
	General Management Zones (GMZ)	-	2,403,000	2,318,000	-	2,110,000	94
	Special Management Zones (SMZ)	-	182,000	172,000	-	275,000	98
	Sub total		**2,585,000**	**2,490,000**		**2,385,000**	**95**

[A] Based on 2013 forest cover map (refer to Indicator 1.1a for further details)

* Rounded to nearest 100 hectares
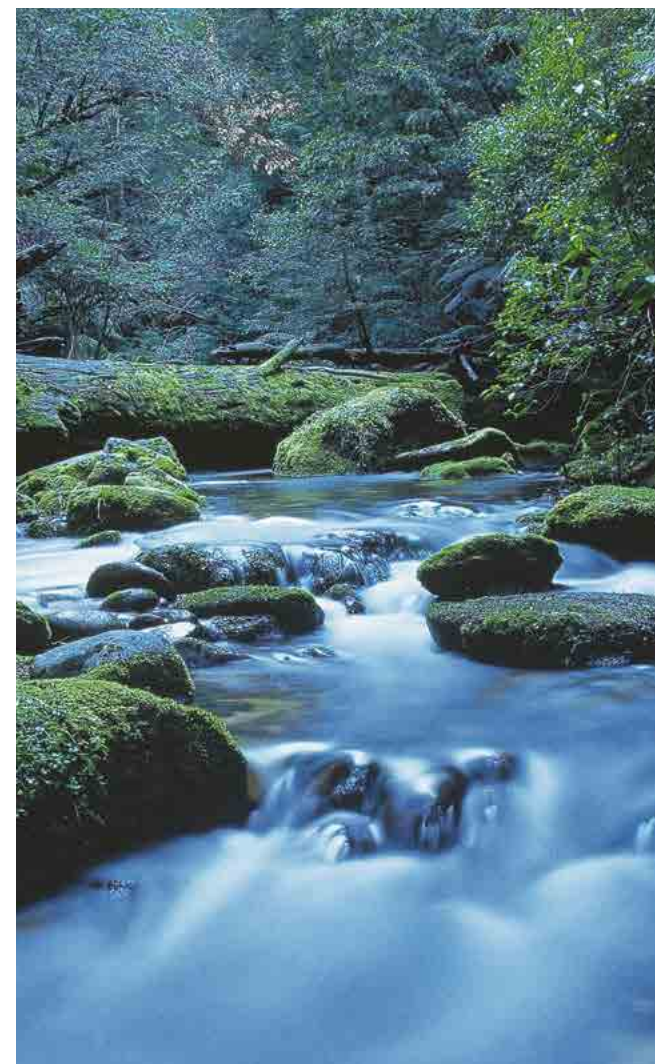
Credit: DEPI

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Indicator 6.3a: Area and quality of forest actively utilised for recreation and tourism

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The Steavenson Falls reconstruction project

The Steavenson Falls reserve, near Marysville in the Yarra Valley, was severely damaged by the Black Saturday bushfires of 2009. The falls attract more than 150,000 visitors every year. They are one of the highest waterfalls in Victoria, cascading 122 metres down into the Steavenson River valley. The reserve area is an important tourist and recreation attraction for the region, and an iconic landmark for the town of Marysville. The 2009 bushfire damaged the visitor information centre facilities as well as the natural values of the reserve.

In early 2010, a $2.8 million redevelopment bushfire recovery project was announced for the reserve to be implemented in three-phases. The project was funded by both Victorian and Commonwealth governments through the 'Rebuilding Together' Statewide Bushfire Recovery plan. The project has been a collaborative effort between DEPI, the Steavenson Falls Committee of Management, the Shire of Murrindindi, and the Victorian Bushfire Reconstruction and Recovery Authority. The project received strong community and council support reflecting the social and economic importance of the reserve.

The first stage of the project involved the reconstruction of the Falls Road enabling visitor access to the site once again. A new car park was also built including bus parking, and a new viewing platform at the base of the falls. Steavenson Falls reserve was re-opened to the public on 21 September 2010, following the completion of the first stage of the redevelopment project.

The second and third stages of redevelopment involved the construction of new walking tracks, interpretive material, lighting, rebuilding of bridges and stairs and a new viewing platform at the top the falls. The entire project was completed in April 2011. Reconstruction of the reserve facilities and reinstatement of public access has allowed visitors to view the recovery of the forest since the 2009 fires as well as providing for improved visitor facilities.

Steavenson Falls reserve, 2008 Credit: Griffin Graphics

Indicator 6.3b: Range and use of recreation and tourism opportunities that are available within forests

Why is this indicator important?

Victoria's forests are managed to provide a broad range of recreation and tourism opportunities. Appropriate and well-managed recreation and tourism facilities improve visitor satisfaction and minimise impacts on environmental and other forest values. The type of visitor infrastructure directly influences the levels of use, accessibility and the type of experience enjoyed by visitors to Victoria's public forests.

What have we measured and why is it relevant to the indicator?

This indicator reports on the type of visitor infrastructure and the activities provided for forest-based recreation and tourism. For information about visitor numbers, refer to Indicator 6.3c. Information about the area of forest available for recreation and tourism is included in Indicator 6.3a.

Victoria's forests provide a broad range of recreation and tourism activities including walking, mountain bike riding, camping, picnicing, fishing and four-wheel driving. Facilities that typically cater for these activities include campgrounds and day-visitor areas, walking and mountain bike trails and visitor information infrastructure as well as roads and parking areas. Victoria's public land managers apply a *Levels of Service* framework to determine the appropriate level and type of visitor infrastructure and services to be delivered at a specific site or group of sites. This helps ensure that appropriate visitor expectations on levels of infrastructure and servicing can be sustainably maintained.

Credit: DEPI

In State forests, facilities are maintained by DEPI. Facilities in Parks and conservation reserves are managed by Parks Victoria. Tour operators also provide a range of nature-based activities for visitors to Victoria's forests. These operators require a licence to operate on public land. Licences are managed by Parks Victoria.

Recreation and tourism opportunities

Table 1 shows the range of recreation and tourism opportunities catered for in Victoria's State forest and Parks and conservation reserves. Gaps in the table are associated with missing data or changes in data collection methods and new categories introduced since previous State of the Forests reports.

Indicator 6.3b: Range and use of recreation and tourism opportunities that are available within forests

Table 1. Range of sites and tracks available in forests for recreation and tourism activities. Source DEPI Recweb database, Parks Victoria, State of the Forests Reports 2003 and 2008

Activity	State forest			Parks and conservation reserves		
	2003	2008	2013	2003	2008	2013
Day visitor areas	300	227	261	790	668	752
Camp grounds	280	226	249	252	599	680
Total recreational sites	-	-	**398**	**1042**	**1267**	**1432**
Short walks (<3 km) – Number	53	-	113	811	-	-
Medium walks (3-8 km) - Number	51	-	44	204	-	-
Day trails (8-12 km) - Number	14	-	12	50	-	-
Overnight trails (>12 km) - Number	17	-	11	35	-	-
Walking trails (km)	550	715	916	-	3,700	-
Mountain biking trails (km)	-	-	334	-	-	-
Horse riding trails (km)	-	-	71	-	-	-
Four Wheel Driving touring routes (km)	-	-	251	-	-	-
Scenic Drives (km)	-	-	403	-	-	-
Trail bike touring routes (km)	-	-	58	-	-	-

State and trend

Between 2003 and 2013 the number of recreational sites in Parks and conservation reserves increased by 37%. Over the same period, the number of camp grounds increased by over 400 in Parks and conservation reserves. Some of this increase is due to the reclassification of State forest into the formal reserve system (refer to Indicator 1.1c).

For State forests, between 2003 and 2013 there has been a net decrease of 13% in the number of recreational sites (day visitor areas and camp grounds) and a net increase of 77% in the kilometres of walking trails. An improved asset management system (RecWeb) for Victorian State forest assets was launched in 2006, which accurately captures comprehensive spatial and textural data for recreational sites and tracks. This improved data capture of existing sites and tracks between 2006 and 2013 largely explains much of the increase in the number of recreational sites and kilometres of walking trails from 2008 to 2013.

Transfer of State forest sites into the Parks and conservation reserve system, as a result of conversion of State forest to National Parks in the Angahook-Otway VEAC investigation (2004) and River Red Gum Forests VEAC investigation (2008), contributed to a decrease in State forest recreational sites between 2003 to 2008. Some increase to reported kilometres of State forest trails is likely in future State of the Forests Reports, when long distance trail data is captured and reported on.

Across State forest, there are currently an estimated 916 km of walking trails (up from 550 km in 2003). In 2008, there were an estimated 3,700 km of walking trails in Parks and conservation reserves.

Data source and limitations

There are significant gaps in data on tourism sites and infrastructure, particularly on tracks and trails in Parks and conservation reserves. Changes in data capture methods and asset management systems, as well as reassignment of land tenure categories, limits the degree to which direct comparisons between different years can be made.

Credit: DEPI

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Indicator 6.3b: Range and use of recreation and tourism opportunities that are available within forests

Investment in forest tourism and recreation infrastructure facilities

A major investment in forest tourism and recreation since the State of the Forests Report in 2008 has been rebuilding infrastructure following the catastrophic 2009 bushfires (Indicator 3.1) and major floods in 2010/11. About 20% of State forest visitor assets have been replaced as a result of these fires.

Infrastructure for multiple purposes

The Land Bridges Project was completed in 2011/12. The project was implemented over a period of four years and involved the investment of $60 million to replace or upgrade 300 bridges and crossings on Victorian public land.

Although this investment was primarily for firefighting and to support planned burning work, it has indirectly improved tourism and recreation opportunities by increasing access in and around public forests.

DEPI and Parks Victoria apply a Levels of Service framework across public land sites and infrastructure, to guide the strategic management of visitor services across the forests estate. This framework provides a statewide context for the establishment and delivery of services and infrastructure

to meet the needs of visitors as well as guidance for the management of a sustainable and diverse network. A *Very High* level of service refers to a highly serviced site with high levels of supporting visitor infrastructure (e.g. Tidal River, Wilsons Promontory National Park). A *Very Basic* level of service refers to sites with low levels of park ranger presence and low/little supporting visitor infrastructure.

Table 2 shows that sites and tracks within State forest typically provide less developed sites and tracks, whilst Parks Victoria provides more of the highly developed sites and tracks catering for tourism as well as recreational use. The proportion of sites and tracks by Levels of Service category provides a useful measure of the type and spread of services being offered to visitors to Parks and forests.

Table 2. Percentage of sites and tracks by Levels of Service category. Source DEPI

Levels of Service category	State forest		Nature conservation reserves*	
	Sites	Tracks	Sites	Tracks
Very High Catering for tourists and park/forest visitors seeking comfort and convenience in a popular/icon park/forest area	0%	1%	0.1%	
High Catering for tourists and park/forest visitors seeking quality facilities in a predominantly natural setting	2%	4%	2%	
Mid Catering for active and passive recreationalists seeking some facilities in a predominantly natural setting	19%	33%	33%	
Basic Catering for independent, experienced park visitors prepared to sacrifice comfort in order to avoid high use areas.	62%	54%	57.9%	
Very Basic Catering for self-sufficient active recreationalists, highly experienced in their preferred activity	17%	7%	6%	
Extremely Basic	n/a	1%	0%	

* Excludes metropolitan parks

Indicator 6.3c: Number of visits per annum

Why is this indicator important?

Victoria's forests, including its Parks and conservation reserves and State forests, attract millions of visitors every year from within Victoria, interstate and overseas. This indicator measures annual visitor numbers to Victoria's forests and provides information about demand for recreation and tourism activities. This information is important for understanding what levels of recreation and tourism in Victoria's forests are sustainable, providing social and economic benefits while maintaining ecosystem health and other environmental and cultural forest values.

What have we measured and why is it relevant to the indicator?

This report presents annual visitor numbers to Victoria's predominantly forested State and National Parks and estimates of State forest visitors, as a measure of forest visits per annum. Visitor numbers per annum is one measure of the socio-economic benefits provided by forests. Parks Victoria also undertakes research on community perceptions of management and visitor experience to profile and refine the organisation's understanding of its various Park visitors. For information about the area of forest used for tourism and recreation, refer to Indicator 6.3a and for forest tourism opportunities, refer to Indicator 6.3b.

The number of visitors to forests has implications for the ongoing management of the forest. This includes managing for environmental and cultural values as well as ongoing infrastructure maintenance and upgrades. The number of visitors also has implications for surrounding local communities and towns dependent on income via food, fuel, accommodation and retail associated with forest recreation and tourism. Halls Gap nestled in the Grampians National Park is one such example.

Credit: DEPI

Credit: ???

Credit: DEPI

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Indicator 6.3c: Number of visits per annum

Data source and limitations

Visitors to State and National Parks

Parks Victoria and DEPI jointly manage Victoria's forest estate for recreation and tourism. Visitor numbers are influenced by the availability and type of facilities that provide access for recreational activities as well as the experience that the setting provides. It is generally difficult to measure annual visitor numbers to forests because the use of these areas is widely dispersed and most forests have multiple entry and exit points. Furthermore, visitor numbers vary significantly, according to the day of the week, the season, and during holiday periods.

Visitor numbers to areas managed by Parks Victoria are obtained via a random telephone survey conducted every second year to provide an indication of who is visiting and where, as well as how many visitors are using the Parks and conservation reserves. This data is supplemented by more detailed information collected through counts of vehicles, entry fees, camping permits and surveys at high use visitor sites. Table 1 and Figure 1 show the annual number of visitors to State and National Parks between 2002/03 and 2012/13, including a breakdown of visitor numbers (in millions) by geographic origin.

Visitors to State forest

There is no current program of visitor monitoring within State forests. However, based on staff estimates and field observations, it is estimated that over 5 million people visit Victoria's State forests each year.

Table 1. National and State Park visitors between 2002/03 through to 2010/11. Source Parks Victoria

Origin of Visitors	Number of visits (millions)					
	2002/03	2004/05	2006/07	2008/09	2010/11	2012/13
Melbourne	16.46	16.89	18.87	21.08	20.03	22.73
Rest of Victoria	7.22	9.56	9.52	9.23	10.86	9.99
Total Victorian	**23.68**	**26.45**	**28.39**	**30.30**	**30.89**	**32.72**
New South Wales and South Australia	0.79	1.54	1.17	1.98	1.50	1.35
International	0.45	0.60	0.59	0.67	0.68	0.75
Total	**24.92**	**28.58**	**30.16**	**32.95**	**33.07**	**34.8**

Credit: DEPI

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Indicator 6.3c: Number of visits per annum

State and trend

Between 2002/03 and 2012/13, the overall number of visitors to Victoria's State and National Parks increased by about 40%. In 2012/13 the 35 million visitors included 750,000 international visitors and 1.35 million interstate visitors. The greatest increase over this period was from interstate visitors from New South Wales and South Australia (71% increase) and international visitors (67% increase).

More than 90% of all visitors originate from Victoria with two thirds of those visitors coming from Melbourne. This trend has not changed over the last ten years.

Since the last Victorian State of the Forests Report in 2008, the number of annual visitors to State forest is estimated to have increased by about 1 million per year, to now be over 5 million (based on staff estimates and field observations).
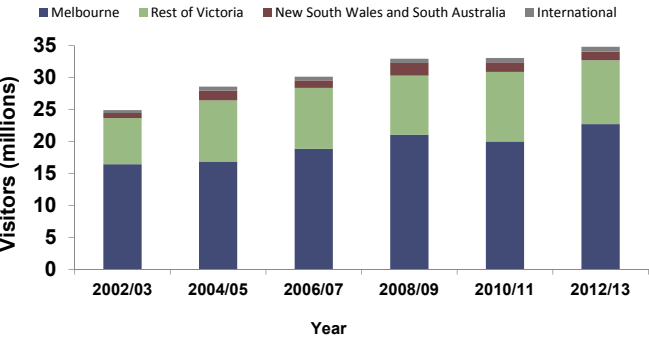

Figure 1. Change in visitor numbers to Victoria's National and State Parks (2002/03 to 2012/13). Source Parks Victoria

Credit: Sally Bateman

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Indicator 6.4a: Area of forest to which Indigenous people have access and rights that protect their cultural heritage and are recognised through formal and informal management regimes

Why is this indicator important?

Cultural heritage is a fundamental part of the community life and cultural identity of Aboriginal Victorians. Forests contain many places and objects of cultural importance. Public forests have particular significance as they provide opportunity for Aboriginal people to have an increased role in the ongoing management of their cultural heritage. This indicator provides insight into the extent to which Aboriginal Victorians are supported in protecting their heritage, and where further effort is required.

What have we measured and why is it relevant to the indicator?

Access and rights of Aboriginal Victorians to protect their cultural heritage in forests are recognised formally through legislation, agreements and policies applicable to forests. This indicator provides an overview of these arrangements and reports on the area of public forest to which these arrangements apply.

Management regimes and area of public forest under agreements

Aboriginal cultural heritage is protected in Victoria through the *Aboriginal Heritage Act 2006*. This Act commenced operation on 28 May 2007, replacing the *Archaeological and Aboriginal Relics Preservation Act 1972*. The Act introduced the system of Registered Aboriginal Parties which provides for Aboriginal groups with connections to country to be involved in decision making processes regarding cultural heritage. Indicator 6.4b provides further information about the protection of Aboriginal cultural heritage.

Rights of Traditional Owners to protect and maintain places and sites of cultural importance are also recognised in determinations made under the Commonwealth *Native Title Act 1993* and in agreements made under the *Traditional Owner Settlement Act 2010*. Victoria has entered formal agreements with four Traditional Owner groups in connection to the management of their traditional lands. The agreements are unique, reflecting the legislation available at the time of negotiation, native title determination status and the interests of the parties. Some agreements include joint management arrangements under the *Conservation, Forests and Lands Act 1987*. These agreements increase the involvement of and recognition of rights of Traditional Owners to protect and manage cultural heritage in specific areas of Crown land comprising primarily public forest.

Data source and limitations

The data presented in this report was sourced from DEPI's internal cooperative and joint management spatial layer. The data is current to July 2012.

State and trend

Table 1 summarises agreements within Victoria by location and area. Figure 1 shows a map of areas of public forest under agreement.

- Formal management regimes that provide access and recognise rights of Aboriginal Victorians to protect and maintain their cultural heritage have strengthened during the reporting period due to the commencement of the *Aboriginal Heritage Act 2006*, the introduction of the *Traditional Owner Settlement Act 2010* and three new agreements.

- At the end of the reporting period, 299,000 hectares, or 4 percent, of public forest was covered by agreements.

- Agreements covering just over 76,000 hectares of public forest were entered during the reporting period. This area is associated with the Gunditj Mirring Traditional Owners Aboriginal Corporation Cooperative Management Agreement (2007), the Yorta Yorta Nation Aboriginal Corporation Traditional Owner Land Management Agreement (2010) and the Gunaikurnai Land and Waters Aboriginal Corporation Traditional Owner Land Management Agreement (2010).

Table 1. Areas under Agreements in Victoria.
Source DEPI

Agreement Name	Area (hectares)
Yorta Yorta Nation Aboriginal Corporation Co-operative Management Agreement (2004)	22,000
Gunaikurnai Land & Waters Aboriginal Corporation Traditional Owner Land Management Agreement (2010)	46,000
Gunditj Mirring Traditional Owners Aboriginal Corporation Co-operative Management Agreement (2007)	8,000
Barengi Gadjin Land Council Aboriginal Corporation Co-operative Management Agreement (2005)	194,000
Yorta Yorta Nation Aboriginal Corporation Traditional Owner Land Management Agreement (2010)	29,000
Total	**299,000**

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Figure 1. Area of Crown land under agreements. Source DEPI

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Indicator 6.4b: Proportion of places of Indigenous and non-Indigenous cultural values in forests formally managed to protect those values

Why is this indicator important?

All Aboriginal and non-Aboriginal cultural heritage is protected by law. Formal recognition of individual values assists land managers to more easily identify correct management and appropriately communicate the importance of these values to the wider community. Monitoring the proportion of places where Aboriginal and non-Aboriginal cultural values are formally recognised provides insight into the level of knowledge and active management of these sites within forests.

What have we measured and why is it relevant to the indicator?

Since European settlement in Victoria, forest clearing has resulted in the loss of much cultural heritage, particularly Aboriginal cultural heritage. Remaining sites form an important part of Victoria's rich cultural heritage. This indicator reports the number of registered Aboriginal cultural heritage places in Victorian public forests (State forest and Parks and conservation reserves) by year. Registered non-Aboriginal cultural heritage places are reported by land tenure and place type. Components are distinct features or artefacts that can exist within a place.

Aboriginal Cultural Heritage Sites

Aboriginal cultural heritage places are often jointly managed between the local Aboriginal communities and DEPI or Parks Victoria, depending on the land management tenure on which the site is located. Aboriginal Cultural Heritage Places include:

- Archaeological sites pre-dating European occupation
- Historic sites relating to European contact and post-contact periods
- Places of contemporary or traditional social significance.

Scarred tree, Healesville Sanctuary. Credit: Kara Brugman

All known Aboriginal cultural heritage places are listed on the Victorian Aboriginal Heritage Register and are formally protected under the *Aboriginal Heritage Act 2006*. Sites not on the Victorian Aboriginal Heritage Register are also protected through the Act. In this indicator the term *sites* is used to refer to sites and/or places.

Non-Aboriginal Cultural Heritage Sites

Non-Aboriginal cultural heritage sites are also found in Victorian public forests. These sites, known and unknown, are protected under the *Heritage Act 1995*. Registered sites are sites that have been reviewed and approved by the Heritage Council of Victoria. These represent sites deemed to be of statewide significance, which, when listed on the Victorian Heritage Register, are afforded the highest level of protection.

Aboriginal and non-Aboriginal cultural heritage sites cannot be disturbed without a permit. In State forest, known non-Aboriginal cultural heritage sites are listed in Forest Management Plans[1]. Due to the sensitivity of Aboriginal cultural heritage, the identity of these sites remains unpublished. All known cultural heritage sites are however taken into consideration during planning for forest management activities.

In many Forest Management Areas, there are specific management actions used to protect each site from potential damage from forest management activities. Sites of particular significance can have specific management prescriptions and objectives associated with them, such as establishing exclusion zones and buffers around sites to protect them.

To protect and conserve the Aboriginal cultural heritage sites within its stewardship, Parks Victoria has prescriptions and objectives specific to Aboriginal cultural heritage management integrated into its overarching management of Parks and reserves. These prescriptions include cultural heritage assessments, heritage surveys, and site specific management plans. For example, at some rock art sites, visitor exclusion areas have been established within the immediate vicinity.

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[1]   871 non-Aboriginal cultural heritage sites have management prescriptions associated with Forest Management Plans

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Cultural heritage protection legislation

The protection of cultural heritage values on Victorian public forested land is provided for by specific provisions under both Commonwealth (i.e. *Environment Protection and Biodiversity Conservation Act 1999*) and State legislation (e.g. *Heritage Act 1995*). The *Heritage Act 1995* also established the Victorian Heritage Register which lists all non-Aboriginal historic places of State significance. The *Planning and Environment Act 1987* and the *Mineral Resources (Sustainable Development) Act 1990* provide further protection for sites listed under the Victorian Heritage Register. Cultural heritage sites may also be protected under legislation specific to public land use categories such as the *Forests Act 1958* and the *National Parks Act 1975*. Other Acts that apply within the Victorian sustainable forest management legislative framework are listed in Indicator 7.1.

State and trend

Aboriginal Cultural Heritage Sites

The total number of Aboriginal cultural heritage sites registered between 2007 and 2012 is shown in Table 1. Table 2 provides a breakdown of Aboriginal cultural heritage sites (by place type) registered in 2012.

In 2012, there were over 8,000 Aboriginal cultural heritage sites across State forest and Parks and conservation reserves (public forests). The total number of Aboriginal cultural heritage sites in Victoria's forests in difficult to ascertain, as it would require comprehensive surveys of all forest land in the State.

Table 1. Registered Aboriginal cultural heritage sites in Victorian public forests, other Crown land and private land (2006 to 2012). Source Aboriginal Affairs Victoria

Tenure		Year						
		2006	2007	2008	2009	2010	2011	2012
Public forests	Parks and conservation reserves	5,467	5,595	5,801	5,868	6,075	6,192	6,450
	State forest	1,449	1,456	1,478	1,495	1,524	1,595	1,667
Other Crown land		220	292	377	480	542	579	654
Private		1,216	1,893	2,795	3,343	4,348	6,077	7,088

Between 2006 and 2012 there was a 15% increase in the number of registered Aboriginal cultural heritage sites in State forest and an 18% increase in Parks and conservation reserves. It is likely that the number of Aboriginal cultural heritage sites will increase as further surveys are undertaken. The rapid and significant increase in registered sites, particularly on private land is likely to be associated with requirements of the Aboriginal Heritage Regulations introduced in 2007. The private land statistics reported include both forested and non-forested land cover, as further breakdown was not available.

The majority of Aboriginal cultural heritage sites registered in public forests in 2012 were in Parks and conservation reserves (85%). The most common place types registered in all public forests were burial/ human remains, low density artefact distributions, scarred trees, artefact scatters and hearths.

Table 2. Aboriginal cultural heritage sites by type, registered on public land in 2012. Source Aboriginal Affairs Victoria

Site components	Parks and conservation reserves	State Forest
Artefact Scatter	2	38
Burial/ Human Remains	97	
Collection	9	
Hearth	36	2
Mound	3	
Rock Art	1	
Scarred Tree	47	4
Shell Deposit	24	2
Low Density Artefact Distribution	63	1
Cultural Place	1	
Total	**283**	**47**

Biological Diversity

Productive Capacity

Ecosystem Health

Soil and water

Carbon

Socio-economic

Legal Framework

Indicator 6.4b: Proportion of places of Indigenous and non-Indigenous cultural values in forests formally managed to protect those values

Biological Diversity

Productive Capacity

Ecosystem Health

Soil and water

Carbon

Socio-economic

Legal Framework

Gariwerd (Grampians National Park)

The National Heritage List is established under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act 1999) and is compiled by the Australian Heritage Council.

The Grampians National Park (Gariwerd), is one of two Victorian Aboriginal heritage places currently on the National Heritage List (the other being Budj Bim Landscape Heritage area). The Grampians National Park in western Victoria is a series of rugged sandstone mountain ranges and wildlife rich forests. The park was added to the National Heritage List in 2006 for its outstanding natural beauty and being home to one of the richest collections of Aboriginal rock art sites in south-east Australia. The Jardwadjali and Djab Wurrung people have been intimately linked with Gariwerd for more than 20,000 years.

Grampians National Park (Gariwerd). Credit: Mark Mikkonen

Manja (Cave of Hands) Aboriginal rock art site, Gariwerd (Grampians National Park). Credit: Patrick Medved

There are a number of rock art sites throughout the park including the depiction of human figures, animal tracks and birds of the area, notable sites include:

- Billimina (Glenisla shelter)
- Jananginj Njani (Camp of the Emu's Foot)
- Manja (Cave of Hands)
- Larngibunja (Cave of Fishes)
- Ngamadjidj (Cave of Ghosts)
- Gulgurn Manja (Flat Rock).

Parks Victoria manages the Grampians National Park and, through the implementation of specific management objectives and prescriptions, ensures the protection of the rock art sites. The Brambuk Information Centre, run by local Aboriginal groups, provides extensive Indigenous cultural heritage awareness and education for Park visitors.

Non-Aboriginal Cultural Heritage Sites

Table 3 shows a breakdown of non-Aboriginal cultural heritage sites by place type registered in Victoria's public forests. Sites and components listed in Table 3 include those registered on the Victorian Heritage Register and Heritage Inventory[2].

There are 169 non-Aboriginal cultural heritage sites on the Victorian heritage register in public forests: 123 sites in Parks and conservation reserves and 46 sites in State forest.

Of non-Aboriginal cultural heritage components (artefacts that exist at a particular place), the most common are associated with mining and mineral processing (146 in Parks and conservation reserves and 82 in State forest).

Many other non-Aboriginal cultural heritage sites are known to exist within public forests, however as these are not formally registered, they are not reported in this indicator.

Data source and limitations

Data presented in this report are sourced from Aboriginal Affairs Victoria and Heritage Victoria.

Cultural heritage site locations are intersected with DEPI corporate geospatial datasets (including FMZ100 (Forest Management Zones) and PARKRES (Parks and conservation reserves). The datasets and registers change from time to time, reflecting additions, deletions and updates. Updates may include major reviews, minor changes to reflect new information, or improvements in base information and data structure.

Some inaccuracies in the data and analysis assumptions may have resulted a number of sites being included in the report that are not in forests and the omission of other sites that are within forests.

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[2]   Heritage Inventory is to specifically protect archaeological sites, under the *Heritage Act 1995*.

Table 3. Registered and inventory non-Aboriginal sites in Victorian public forests (2013). Source Heritage Victoria

Heritage Victoria Group Name	Parks and conservation reserves		State forest	
	Victorian Heritage Register	Heritage Inventory	Victorian Heritage Register	Historic Inventory
Cemeteries and Burial Sites	10	20		25
Collections	1			
Commercial	1	15		19
Community Facilities		3		
Education		8		1
Exploration, Survey and Events	1	10		3
Farming and Grazing	8	79		9
Forestry and Timber Industry	12	134	13	162
Government and Administration	2	1		
Health Services	3			
Heritage Inventory Site Type		45		36
Institutional Places		1		
Landscape - Cultural	3	11		1
Landscape - Natural	1	1		
Law Enforcement	16			
Manufacturing and Processing	9	33		7
Maritime Industry	3	8		
Military	4	9		7
Mining and Mineral Processing	146	1,911	82	949
Monuments and Memorials	4	7		2
National Heritage Process Group	2			
Parks, Gardens and Trees	8	16		
Postal and Telecommunications	5	2		2
Recreation and Entertainment	2	2		1
Residential buildings (private)	8	52		6
Retail and Wholesale		2		
Transient Accommodation	3			
Transport	31	40	4	10
Unknown Item Group		10		1
Urban Area		5		2
Utilities - Fire Control			1	
Utilities - Water	1	14		
Grand Total Components[A]	**284**	**2,439**	**100**	**1,243**
Total number of Places	**123**	**1,422**	**46**	**608**

[A]   Components are used to describe multiple cultural and historical artefacts that exist in a particular site (or place)

Indicator 6.5a: Direct and indirect employment in the forest sector and forest sector employment as a proportion of total employment

Why is this indicator important?

Employment is an important measure of the contribution of forests in meeting community needs, maintaining viable communities and supporting the economy.

The forest industry is particularly important for regional Victoria, as it creates many direct and indirect jobs in regional locations that support regional economies and communities. Reporting on direct and indirect employment in the forest sector provides insight into the impacts of changes in availability of resources and investment on those communities.

What have we measured and why is it relevant to the indicator?

This report presents forest industry data on direct and indirect employment, employment by forest type, worker characteristics, distribution of employment locations and indigenous employment. These statistics provide a comprehensive and direct assessment of forest industry employment in Victoria. National and broader workforce data are also presented for broader comparison.

Direct Employment in the Victorian and National Forest Industry by sector

The number of people employed in the forest industry is estimated in a number of sectors across the Victorian industry, and nationally. Sectors include forestry and logging, wood product manufacturing, pulp and paper, support services and timber wholesaling. The total Victorian workforce across all industries is also presented. The proportion of total employment is a measure of the dependency on the forest industry.

Credit: DEPI

Biological Diversity

Productive Capacity

Ecosystem Health

Soil and water

Carbon

Socio-economic

Legal Framework

Indicator 6.5a: Direct and indirect employment in the forest sector and forest sector employment as a proportion of total employment

Data source and limitations

The Australian forest and wood product statistics provides the employment data by sector and state for 2006 and 2010. These estimates are derived from the Australian Bureau of Statistics (ABS) 2011 Census of Population and Housing[1]. The classifications for employment have changed from previous reports.

State and trend

Table 1 shows employment in Victoria and nationally in the forest industry sectors, estimated for 2006 and in 2010 and compared with total employment.

Credit: DEPI

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[1] ABARES (2013) Australian Forest and Wood Product Statistics. Australian Bureau of Agricultural and Resources Economics, Department of Agriculture, Fisheries and Forestry. Sept/Dec Quarters 2012.

Table 1. Employment by forest industry sector for 2006 and 2010. Source Australian Forest and Wood Products Statistics Table 68 (June 2013)

	Victoria		Australia		% Victorian	
Year	2006	2010	2006	2010	2006	2010
Sector						
Forestry and Logging	1,183	1,091	6,872	5,399	17%	20%
Wood Product Manufacturing	11,357	10,471	47,312	41,672	24%	25%
Pulp and Paper Product Manufacturing	8,863	8,172	23,485	19,356	38%	42%
Forestry Support Services	470	433	2,051	2,166	23%	20%
Timber Wholesaling	1,799	1,659	5,534	4,674	33%	35%
Total	23,672	21,826	85,254	73,267	28%	30%
Total Employment	**2,228,973**	**2,469,460**	**8,867,695**	**9,824,445**	**25%**	**25%**
Forestry Dependency	1.1%	0.9%	1.0%	0.7%		

- The number of Victorians employed on the forest industries in 2010 was 21,826 – down by 7.8% from 2006. The decline is reflected across all sectors of the industry. The value of wood processed over this time has increased (see Indicator 6.1a). The employment decline is expected to be from productivity improvements.

- Wood product manufacturing was the largest sector of the Victorian forest industry, employing 48% of the industry's workers in 2010. The pulp and paper sector also employed a significant proportion of forest industry workers (37%) in 2010.

- Employment in the forest industry fell to below 1% of the total Victorian workforce since 2006.

- There is an overall reduction of employment in the industry nationally, however the Victorian proportion of national employment in the forest industry increased to 30% compared to the all industry average of 25%, indicating that reductions have been greater in other states.

- Victoria provides the greatest levels of employment in the pulp and paper product manufacturing sector representing 42% of the sector nationally.

Biological Diversity

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Indicator 6.5a: Direct and indirect employment in the forest sector and forest sector employment as a proportion of total employment

Credit: DEPI

Indirect Employment.

The forest sector generates 'flow on' or 'indirect' employment in local and regional communities. This indirect employment results from the expenditure of forest industry businesses and workers on goods and services, which in turn generate further employment throughout the economy.

Data source and limitations

Indirect employment is typically estimated by using input-output models to generate multipliers (the multiple of jobs generated indirectly per direct job). A recent review[2] of available studies found that no recent national or Victorian estimates for forest industry multipliers were available. The most recent applicable multipliers are very broad estimates and do not differentiate between the different stages of processing[3].

State and trend

- On average, the Australian forest industry generates between 1.8 and 2.2 indirect jobs for every direct job.

- Indirect employment generated by the Victorian forest industry in 2010 may be in the order of 39,287 to 48,017 jobs.

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[2] Schirmer (2010) Socio-economic characteristics of Victoria's forest industries. Part 1: Profile of forest industry business, employment and spending, and impacts of recent changes on businesses. Dr Jacki Schirmer, Fenner School of Environment and Society, Australian National University. Report prepared for the Victorian Department of Primary Industries, July 2010

[3] Hayter (2003). Review of Studies of the Socio-Economic Impact of Forest Industries in Australia. Prepared for FWPRDC by URS Corporation. Project Number PN03.1314

Employment by forest type

Victoria's forest industry encompasses three forest types: hardwood plantations, softwood plantations and native forests. Some jobs, such as consultants, cover multiple forest types.

Data source and limitations

In 2012 DEPI commissioned a study on the socio-economic characteristics of Victoria's forest industries (the 2012 Forest Industry Survey (FIS)[4]). This included a survey of businesses in the forest industry across the growing, support and primary processing sectors and analysis of data from the 2011 ABS Census of Population and Housing. The results from this study have been used to report on estimated employment by forest type but only for the growing, services to forestry and primary processing sectors. Employment in the secondary processing industry cannot be attributed to a forest type because wood sourced from different forest types may be mixed during this stage of processing.

State and trend

Figure 1 shows the proportions of employment by forest type for jobs generated in the growing, services to forestry and primary processing sectors.

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[4] Schirmer and Mylek (2013), Socio-economic characteristics of Victoria's forestry industries, 2009-2012. In Press

Indicator 6.5a: Direct and indirect employment in the forest sector and forest sector employment as a proportion of total employment

- The FIS identified 6,836 jobs in the growing, services to forestry and primary processing sectors in 2012.

- Softwood plantations employ the largest proportion of workers in these sectors (43%).

- Hardwood plantation harvest volumes should continue to increase in coming years. This is expected to generate additional employment, although the market for hardwood plantation products has been affected by the global financial crisis and this may slow the growth in employment.
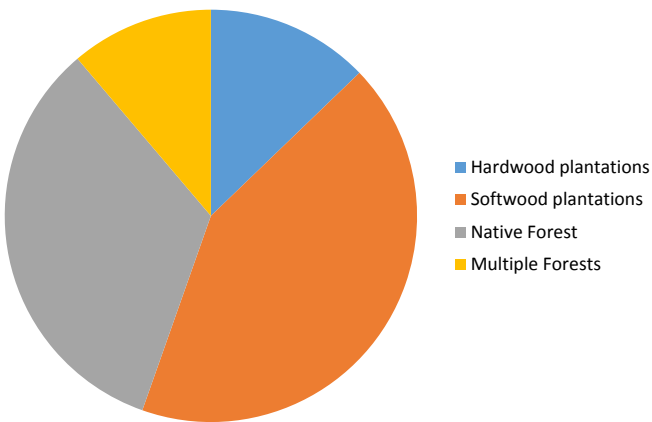

Legend:
- Hardwood plantations
- Softwood plantations
- Native Forest
- Multiple Forests

Figure 1. Employment by Forest Type in Victoria during 2012.
Source Schirmer and Mylek (2013), In Press

Regional Distribution of Employment

The distribution of employment in the forest industry is dependent on the location of industry activities. These are generally located close to timber resources, and therefore vary significantly across regions.

Data source and limitations

The data presented is sourced from the FIS. It represents regional forest-industry employment distribution in 2011.

State and trend

Table 2 shows the total number of people employed in the forest industry by region.

Table 2. Regional forest industry employment. Source Schirmer and Mylek (2013, In Press)

Region (statistical division)	Total forest industry employment 2011
Melbourne	13,329
Barwon	1,344
Western District	535
Central Highlands	581
Wimmera	59
Mallee	156
Loddon	439
Goulburn	800
Ovens-Murray	935
East Gippsland	1,239
Gippsland	2,078
Total	**21,495**

- Over half of all workers in the forest sector in Victoria are employed in the Melbourne region, reflecting the concentration of secondary processing businesses in the area.

- While Melbourne has the largest number of employees in the forest sector, these workers represent a small proportion of Melbourne's total labour force.

- Regional forest industry employment is concentrated in the Gippsland, East Gippsland and Barwon regions, where the forest industry represents a significant proportion of total employment in a number of small towns.

Credit DEPI

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Indicator 6.5a: Direct and indirect employment in the forest sector and forest sector employment as a proportion of total employment

Types of Employees

Workforce demographics are measured by age, education, gender and income, enabling comparison of the forest industry with the overall Victorian workforce. Statistics for Indigenous persons are also presented. Indigenous persons are employed in a range of positions in the forest industry including cultural heritage, project fire fighters and administration officers.

Data source and limitations

The data presented is sourced from the FIS. It represents forest industry demographics for 2012 only and represents all sectors, including secondary processing. DEPI indigenous employment data was sourced from internal records.

State and trend

In 2011 forest industry workers were:

- Slightly older than the typical Victorian worker, with only 11% of forest industry workers aged 15 to 24, compared to the Victorian average of 18%.

- Less likely to have completed high school or have a university qualification, but more likely to have a trade qualification.

- Less likely to be women, with about one fifth of the forest sector workforce being women compared to almost half of the Victorian total employed workforce.

- Likely to have higher incomes and lower housing loan repayments than the overall Victorian workforce.

Credit: DEPI

The findings for workers identifying themselves as indigenous are outlined below.

- In 2011 the forest industry in Victoria had approximately 0.4% indigenous workers, the same proportion as the overall Victorian workforce.

- This is a slight decline from the 0.5% of workers in the forest industry identifying as indigenous in the 2009 study.

- DEPI employed 23 indigenous staff in forest related positions at the start of 2013.

- This equates to approximately 1% of the DEPI forest sector workforce.

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Indicator 6.5b: Average wage rates and injury rates in major employment categories within the forest sector

Why is this indicator important?

A sustainable forest industry will ensure high levels of workforce health and welfare and demonstrate wage rates that are comparable with other rural industries. Decreasing injury rates indicate improving employment quality and social benefits. This is important in an industry that features extensive outdoor work in the natural environment. Wage rates indicate income security for communities, the degree of skills required and the supply of workers.

What have we measured and why is it relevant to the indicator?

This indicator reports average national wage rates and Victorian injury rate statistics for major sectors of the forest industry.

National forest industry sector wage rates are reported, as comprehensive wage rate data for the Victorian industry could not be identified.

Injury rate statistics on serious workers compensation claims, by sector, are available for Victoria. These indicate the rate of injuries with major consequences for worker welfare.

Wage Rates in the forest industry

Wage rates for the forest industry are reported separately for the forestry and wood product manufacturing sectors. The forestry sector accounts for activities related to forestry and logging whilst the wood product manufacturing sector accounts for the processing end of the forest industry supply chain.

Data source and limitations

Wage rates are calculated from wage and employment data published in the Australian Forest and Wood Product Statistics[1]. These quarterly reports source data from the Australian Bureau of Statistics (ABS) industry wide statistics (8155.0). Inaccuracies are reported for a number of industry categories including roading, firewood and timber sales, policy development and haulage. The ABS industry classification (ANZSIC) changed in 2006 preventing direct comparison with wage rates in previous reports. Data for employment numbers for 2007/08 was limited in the tables and therefore wages rates could not calculated for all categories in that year.

State and trend

Table 1 shows the wage rates estimates for national forest and wood product manufacturing sectors during the period July 2007 to June 2012.

- Wage rates in the wood product manufacturing sector have progressively increased over the period at an average rate of 2.8% per year.

- Wage rates in the forestry sector are considerably lower than wage rates in the manufacturing sector. They varied during the reporting period, as is expected from a relatively small sample.

- In 2011/12, paper products manufacturers paid wage rates 28 percent higher than wood product manufacturers.

- The average wage rate for wood manufacturing in 2011/12 was slightly higher (0.5%) than the average for all manufacturing industries.

Injury rates in the forest industry

Injury rates presented in this indicator report are the total number of standardised compensation claims for forest industry categories, per annum. Data is presented for a decade to show longer term trends. Injury rates are reported by the ANZSIC industry categories: forestry; wood product manufacturing and pulp, paper and converted paper product manufacturing.

Hazards common to most workers in the forest industry include tools, equipment, plant, fatigue, noise, dust, falls and manual handling. In addition, forestry sector workers are exposed to hazards associated with working in a forest environment including slips and trips, stings and bites, extreme temperature and sun exposure[2].

Data source and limitations

Injury rates are sourced from the WorkSafe Victoria Statistical Summary 2011/12[3].

Standardised compensation claims exclude injuries associated with travel to and from work, non-fatal claims with up to 10 days compensation and payment below $612 (in 2011/12), and injuries to self employed and Commonwealth Government workers.

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1   http://www.daff.gov.au/abares/publications_remote_content/publication_topics/forests

2   See WorkSafe Victoria website http://www.worksafe.vic.gov.au/safety-and-prevention/your-industry

3   WorkSafe Victoria (2012) WorkSafe Victoria Statistical Summary 2011/12. Sourced from *www.worksafe.vic.gov.au/__data/.../Statistical-Summary-2011-12.pdf*

Indicator 6.5b: Average wage rates and injury rates in major employment categories within the forest sector

Table 1. Average wage rates by Australian forestry and wood products industry sectors for the period 2007/08 to 2011/12. Source AFWPS Statistics Reports Sept 2013

Year	2007/08	2008/09	2009/10	2010/11	2011/12
	AU$/year				
Forestry					
Forestry and logging	27,778	28,400	30,000	34,467	31,867
Wood product manufacturing					
Log sawmilling and timber dressing					
Log sawmilling	-	41,214	43,625	39,598	40,111
Wood chipping	-	54,054	56,511	63,516	59,016
Timber resawing and dressing	-	50,415	54,805	57,475	63,702
Average log sawmilling and timber dressing	**-**	**46,744**	**50,595**	**50,315**	**52,829**
Other wood product manufacturing					
Prefabricated wooden building	-	41,308	41,459	41,502	39,427
Wooden structural fitting and component	-	40,852	42,542	46,305	48,665
Veneer and plywood	-	55,312	53,840	60,067	63,687
Reconstituted wood product	-	62,199	59,306	69,328	73,108
Other wood products	-	36,894	38,970	37,686	39,896
Average other wood product manufacturing	**-**	**42,695**	**44,003**	**47,839**	**49,837**
Average wood products	*42,377*	*43,866*	*45,847*	*48,556*	*50,649*
Paper and paper products					
Pulp, paper and paperboard	-	66,235	81,727	71,615	76,334
Corrugated paperboard and paperboard container	-	85,888	75,744	77,394	88,659
Paper bag	-	56,695	54,815	66,071	67,736
Paper stationary	-	46,848	45,303	58,331	57,481
Sanitary paper product	-	82,610	91,919	94,785	111,723
Other converted paper product	-	54,656	51,344	50,291	52,691
Average paper and paper products	**66,522**	**70,506**	**70,942**	**73,120**	**82,149**
Average wood product manufacturing	*49,684*	*51,843*	*53,316*	*56,383*	*59,790*
Average total manufacturing (all industries)	51,390	53,801	54,578	56,966	59,521

Note: Employment data for 2007/08 was not available for all categories so wage rates could not be calculated.

State and trend

Figure 1 provides an overview of the total number of claims made in the Victorian forest industry over the last ten years.
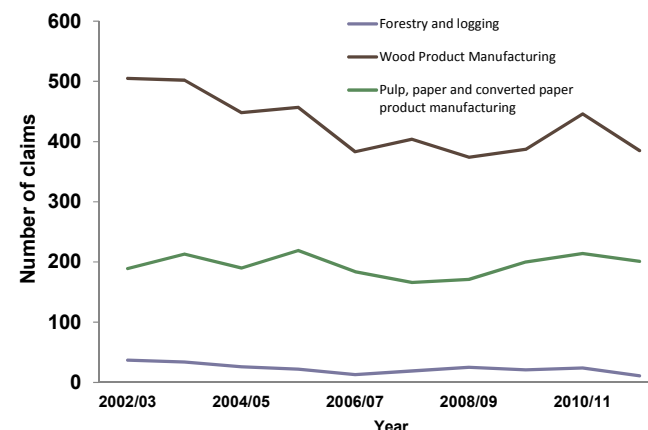

Figure 1. WorkSafe Victoria summary of all claims in the forest industry. Source Worksafe Victoria Statistical Summary

- The wood product manufacturing sector has the greatest number of claims of the three sectors, followed by the pulp, paper and converted paper product manufacturing sector.

- These statistics reflect a national trend. In 2010/11 the wood and paper sector had nearly triple, and the forestry and logging sector nearly double the average annual incidence rate of 12.2 injuries per thousand workers across all Australian industries[4].

- The number of standardised claims in the forestry and logging, and wood product manufacturing sectors has fallen during the reporting period.

[4]   Safe Work Australia (2013) Compendium of workers compensation statistics Australia 2010/11

Indicator 6.5c: Resilience of forest dependent communities to changing social and economic conditions

Why is this indicator important?

This indicator provides a measure of the extent to which communities with a high economic and cultural dependence on forest and forest-related industries are able to respond and adapt to social and economic change. This information is used to identify those communities that may be adversely affected by increases or decreases in forestry-related industry activity.

What have we measured and why is it relevant to the indicator?

Measuring the resilience of forest-dependent communities to changing social and economic conditions, particularly social conditions, is difficult. Forest dependent communities are generally found in close proximity to forests and are often relatively small. Larger population centres tend to have less dependency on a single industry or sector (and so greater resilience to economic change) because of their larger economic base, greater economic diversity and alternative employment opportunities. While forests provide a range of work and economic opportunities, e.g. through tourism and recreation (Indicator 6.3a) and non-wood forest production (Indicator 6.1b), community resilience in this report is described in relation to forestry and associated industries. Specific data on direct and indirect employment in the forest sector and wage rates are reported through Indicators 6.5a and 6.5b.

Factors that determine forest dependent community resilience include:

- diversity of industry in the community and its proximity to regional centres

- changes in access to forests (i.e. occurrence, extent and intensity of bushfires; changes in forest management and forest management planning and legislation)

- the long term financial viability of forestry

- effective implementation of government policy to support these communities or associated forest industries.

It is difficult to measure, predict or infer judgements about the extent to which forest-dependent communities are able to successfully respond and adapt to social and economic change. However, analysis of employment, demographic and socio-economic data can highlight communities and regions which have a high dependence on forest-related industries for employment and therefore may be more vulnerable to changing social and economic conditions.

Within this reporting period, two studies into Victorian forestry-dependent communities were published[1,2] and a third study in 2013[3]. Coakes' 2010 study focused on forestry-dependent communities and estimated level of dependence on forestry and their adaptive capacity to change. Schirmer and Mylek (2013) estimated the latent vulnerability of Victorian forestry-dependent communities to possible shocks affecting the forestry industry, using a framework adapted from international literature on community vulnerability to change. The 2013 study estimated the level of exposure of Victorian towns to forestry-related shocks (as a percentage of workforce in forestry), and published an index of the adaptive capacity (AC) of these towns. This AC index incorporated a wide range of measures including remoteness, population change, economic diversity, unemployment, income levels, ratio of income to housing cost, and social capital.

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[1] Schirmer (2010) Socio-economic characteristics of Victoria's forest industries. Dr Jacki Schirmer, Fenner School of Environment and Society, Australian National University. Report prepared for the Victorian Department of Primary Industries, July 2010

[2] Coakes Consulting (2010), Victoria's Forestry Communities: Adapting to Change in the Forestry Industries

[3] Schirmer and Mylek (2013), Socio-economic characteristics of Victoria's forestry industries, 2009-2012. In Press
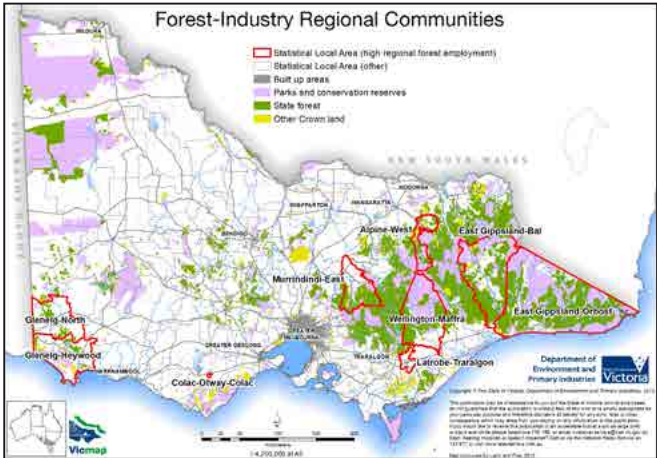
Source DEPI

State and trend

Building on data presented in Victoria's 2008 State of the Forests Report, Table 1 shows regional areas with high employment dependence on the forestry industry. Inferences of economic resilience can be drawn from the level of economic diversity in an area and the trend in wages rates (refer to Indicator reports 6.5a and 6.5b).

- In 2011, there was an average 3.9% forest industry employment across the Victorian regions with high forest industry employment dependence (shown in Table 1), down from an average 5.9% in 2006.

- Alpine West has the highest proportion of forest industry employment (8.8% in 2011) associated with active native and plantation industries.

- Glenelg-Heywood and Glenelg-North areas experienced the greatest reduction in percentage of forestry industry over this reporting period, which for Glenelg-Heywood is a continuation of the trend in the previous reporting period.

Indicator 6.5c: Resilience of forest dependent communities to changing social and economic conditions

Table 1. Changes in % of forest industry employment 2006 to 2011 (in Victorian areas with high regional forest industry employment dependence). Source DEPI

Statistical Local Area	% forest industry employment 2006[A]	% change in forest industry employment, 2001-2006	% forest industry employment 2011[B]	% change in forest industry employment, 2006-2011
Alpine West	13	-16.8	8.8	-33
Colac-Otway-Colac	4.5	-16.2	4.8	6
East Gippsland-Bal	3.9	-29.6	3.1	-21
East Gippsland-Orbost	5.8	-50.4	4.4	-25
Glenelg-Heywood	5.4	-47.2	2.0	-63
Glenelg-North	6.0	-9.4	2.1	-65
Latrobe-Traralgon	6.7	-11.5	5.1	-24
Murrindindi-East	4.1	-20.7	1.8	-57
Wellington-Maffra	3.9	n/a	3.3	-16

[A] Source: Victoria State of the Forests Report 2008

[B] Source: 2006 and 2011 Census of Population and Housing - Level 3 Industry descriptors - Forestry and Logging, Log Sawmilling and Timber Dressing, Other Wood Product Manufacturing, Pulp, Paper and Converted Paper Product Manufacturing, Pulp, Paper and Paperboard Manufacturing.
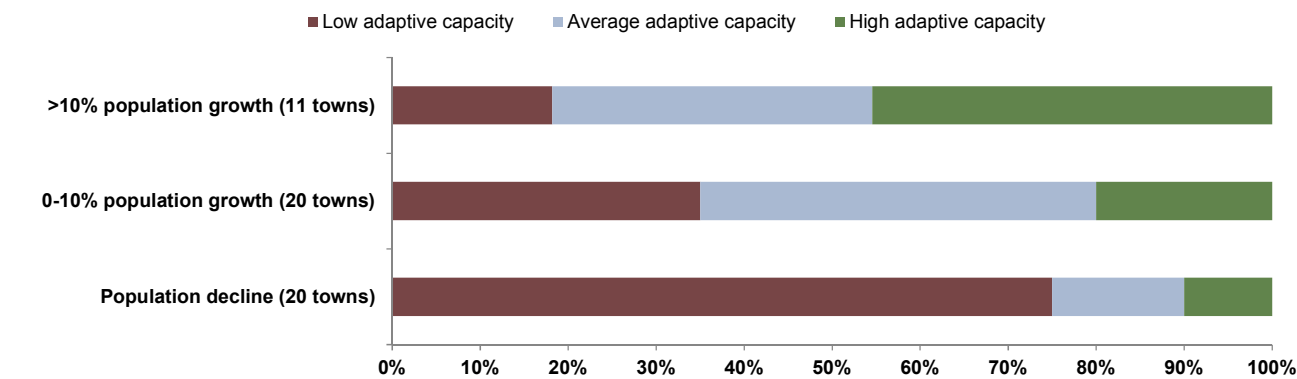

Figure 1. Comparison of population change (2001 to 2006) and adaptive capacity of 54 Victorian towns with highest dependence on the forest industry. Source ABS 2001, 2006

- Between 2001 and 2006, areas shown in Table 1 experienced, on average, a 25% reduction in the percentage of forest industry employment. The average reduction in percentage of forest industry employment has continued to fall between 2006 and 2011, by an average of 34%.

- Only the Colac-Otway-Colac region saw an increase of 6% in the proportion of forest industry employment over the reporting period.

Data source and limitations

Data are sourced from Australian Bureau of Statistics (2011 Census of Population and Housing). Victorian studies also utilised data from Forest Industry Surveys conducted in 2009 and 2012-2013.

State and trend

The *'Victoria's Forestry Industries'* report[4] analysed the adaptive capacity (a component of resilience) of 54 towns with the greatest dependence on the forest industry in Victoria. The study found that towns with higher dependence on the forest industry were more likely to have low adaptive capacity than those with low dependence on the forest industry. However, this pattern was not entirely consistent, suggesting other factors may be just as or more important than the extent of forest industry dependence in influencing adaptive capacity. For example, the rate of population change (Figure 1) was found to be more strongly correlated with adaptive capacity than the extent of forest industry dependence. Further work is needed to identify the reasons why towns with higher dependence on the forest industry are more likely than others to have low adaptive capacity, and the various factors influencing this capacity.

[4] Schirmer (2010) Socio-economic characteristics of Victoria's forest industries. Dr Jacki Schirmer, Fenner School of Environment and Society, Australian National University. Report prepared for the Victorian Department of Primary Industries, July 2010

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Indicator 6.5d: Resilience of forest dependent Indigenous communities to changing social and economic conditions

Why is this indicator important?

It is important to understand the extent to which Aboriginal communities are dependent on forest resources for their viability, maintenance of their traditional values and cultural use. This indicator reports on the extent to which forest-dependent Aboriginal communities are able to respond and adapt to changing social and economic conditions.

What have we measured and why is it relevant to the indicator?

It is difficult to measure the resilience of forest-dependent Aboriginal communities to social and economic change because such change encompasses a complex range of factors including economic status, health and wellbeing, education, employment, and access to the forest to engage in cultural practices.

Data from which inferences on economic aspects of resilience (together with associated commentary) is presented within indicator reports *6.5a Direct and indirect employment in the forest sector and forest sector employment as a proportion of total employment*, *6.5b Average wage rates and injury rates in major employment categories within the forest sector* and *6.5c Resilience of forest dependent communities to changing social and economic conditions*.

Economic viability of a community may not necessarily increase (or represent) resilience if it does not address other socio-economic factors. One important source of resilience for Aboriginal communities is the access that they have to their land, including the ability to nurture and manage this relationship[1].

Information about Aboriginal communities access and rights is presented within indicator reports 6.4a and 6.6a.

Over this reporting period no data has been collected specifically for the resilience of forest dependent Aboriginal communities to changing social and economic conditions.

The Victorian Government's recently developed *Victorian Aboriginal Economic Strategy 2013 -2020* seeks to build on efforts across government and the private sector towards delivering strong outcomes in education, training, employment and business enterprise. Outputs of this strategy should help address this indicator in the future. The strategy leverages the strengths of Aboriginal Victorians and the State economy to build opportunities and economic prosperity.

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[1] http://unu.edu/publications/articles/land-use-climate-change-adaptation-and-indigenous-peoples.html

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Indicator 6.5e: Area of forest available and accessible for Indigenous people to exercise their inherent rights to meet subsistence or individual and family cultural and spiritual needs

Why is this indicator important?

As descendants of Australia's first people, Aboriginal peoples hold distinct cultural rights, including the right to maintain their close spiritual connection with their country. The State has entered into formal agreements which recognise traditional owner rights and interests in Crown land, including public forests. Monitoring the availability and accessibility of forests for Aboriginal people to exercise their inherent rights provides insight into the extent to which Aboriginal peoples are supported more broadly.

What have we measured and why is it relevant to the indicator?

The rights of Aboriginal Victorians to meet subsistence, cultural and spiritual needs are supported through legislation, agreements and policies applicable to public forests. These mechanisms recognise rights, and formalise access and management arrangements to traditional lands. This report describes how agreements in particular address the indicator and refers to other related reports for further detail.

Mechanisms that support Indigenous rights

Native Title rights are recognised formally through the commonwealth *Native Title Act 1993* and Traditional Owner rights are recognised formally through the *Traditional Owner Settlement Act 2010* (See Indicator 6.6a)

Victoria has entered agreements with four Traditional Owner groups over public forest in connection to the management of their traditional lands (See Indicator 6.4a). The agreements recognise Traditional Owner rights to conduct activities which maintain their relationships to land, such as:

• accessing areas for traditional purposes, like camping and gathering for ceremonies

• visiting and protecting important places and sites

• hunting, fishing and gathering food or traditional resources.

The agreements also include arrangements facilitating Traditional Owner management of traditional lands. Connection with land is a fundamental aspect of Aboriginal peoples' spiritualities.

State and trend

Mechanisms that provide access and recognition of traditional owner rights to manage traditional lands have strengthened during the reporting period due to the introduction of the *Traditional Owner Settlement Act 2010* and three new agreements.

See Indicator 6.4a for details on the area of public forest under agreements.

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See Indicator 6.4a.

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Indicator 6.6a: Extent to which the management framework includes the exercise of customary, custodial, traditional and native title rights as an essential component in achieving sustainable forest management

Why is this indicator important?

Active involvement in management of land and cultural heritage is a key way Aboriginal Victorians exercise their customary, custodial, traditional and native title rights. Their knowledge, skills and perspectives can also improve public forest management for the benefit of all Victorians. These rights and benefits can be facilitated through the sustainable forest management framework for Victorian public forests. Monitoring the extent to which the framework supports Indigenous involvement provides insight into the extent to which land and policy managers recognise the rights of Aboriginal Victorians.

What have we measured and why is it relevant to the indicator?

The sustainable forest management framework supports Aboriginal Victorians to exercise customary, custodial, traditional and native title rights through a range of legislation, agreements, policies and procedures applicable to public forests. This indicator reports on these mechanisms and the levels of Indigenous participation in sustainable forest management decision making they support.

Mechanisms that support Indigenous participation in sustainable forest management

Indigenous participation in land management is facilitated through Victorian and Commonwealth legislation such as the *Aboriginal Heritage Act 2006,* the *Traditional Owner Settlement Act 2010* and the *Native Title Act 1993.* Many levels of the sustainable forest management framework in Victoria (see Indicator 7.1) also support the participation of Aboriginal Victorians in decision making for public forests. These mechanisms are presented in Table 1 along with the land tenure, activities they apply to and the level of participation prescribed.

State and trend

- Mechanisms that support participation of Aboriginal Victorians in sustainable forest management decision making have increased during the reporting period.

- Indigenous participation is embedded within many plans and procedures within the sustainable forest management framework.

- These mechanisms support legislative requirements for Indigenous participation in heritage management and native title procedures and in the case of more recent forest management plans contain strategies involving partnerships with Indigenous communities.

- DEPI also introduced the Indigenous Partnerships Framework in 2007. This policy is under review to align with the Victorian Aboriginal Affairs Framework 2013 -2018.

- The three new joint/cooperative management agreements (see Indicator 6.4a) entered during the reporting period increase the land management decision making role of Traditional Owners for the public land where they apply.

References and further information

DSE 2008. Bendigo Forest Management Area Forest Management Plan.

DSE 2010 Portland Horsham forests, Forest Management Plan.

Victorian legislation online website

Department of Environment and Primary Industries *Land Management – Indigenous and native title* pages. Sourced from: <http://www.dse.vic.gov.au/land-management/indigenous-and-native-title> accessed May 2013.

Office of Aboriginal Affairs Victoria http://www.dpc.vic.gov.au/index.php/aboriginal-affairs/aboriginal-affairs-overview

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Indicator 6.6a: Extent to which the management framework includes the exercise of customary, custodial, traditional and native title rights as an essential component in achieving sustainable forest management

Table 1. Mechanisms which support Indigenous participation in sustainable forest management. Source DEPI

Mechanism	Public Land Tenure	Forest activity	Participation level
Aboriginal Heritage Act 2006	All and private	All	Registered Aboriginal parties formally participate in approvals for cultural heritage management plans and cultural heritage permits
Native Title Act 1993	All	Activities considered to be future acts under this legislation	Future acts referred to registered Native Title claimants as required
Traditional Owner Settlement Act 2010	All	All	Confers rights to Traditional Owners to participate in public land management decision making in areas under agreement
Joint management arrangements under the Conservation, Forests and Lands Act or co-operative management agreements	Any within scope of agreement	Any within scope of agreement	Traditional Owners formally and actively participate in decision making about management of specific areas of public land
Code of Practice for Timber Production 2007	All	Timber production planning	Traditional Owners and other relevant Aboriginal groups consulted in regards to mitigation of impacts on Aboriginal cultural heritage values
Fire Operations Planning Guidelines	All	All	
Indigenous partnerships framework	State Forest		Policy applicable between 2007-2010 promoting Traditional Owner and Aboriginal participation in DEPI activities.
Forest Management Plans	State Forest	All	Specify strategies to conserve Aboriginal heritage in partnership with communities and comply with *Native Title Act 1993*.
District Action Plan Guidelines	State Forest	Forest management activities (except timber production, fire and burning)	Cultural heritage management plans and cultural heritage permits referred to registered Aboriginal Parties under the *Aboriginal Heritage Act 2006* as required Future Act assessments conducted and referred to registered Native Title claimants as required
VicForests Timber Release Plan consultation	State Forest	Planning for timber harvesting	Key processes for engagement are mostly contained within the following documents: 1. *VicForests Instruction - Identification and Protection of Indigenous Values and Native Title Rights v3.2* 2. *VicForests Instruction - Timber Release Plan v6.0* All "roadline construction" coupes are submitted to DEPI for engagement with Native Title Services Victoria Ltd to seek comment from Native Title Claimants as required under Subdivision J (s.24JA) of Division 3 of Part 2 of the *Native Title Act 1993*. All coupes proposed for inclusion on a Timber Release Plan are submitted to Aboriginal Affairs Victoria via the "application for advice" process for checks on any sites VicForests may need to manage/ protect or undertake further consultation on. VicForests maintains relationships with Registered Aboriginal Parties (RAPs) within its areas of operation. VicForests additionally consults with RAPs on specific management actions relating to identified sites of cultural significance.
Indigenous Partnership Strategy and Action Plan 2005	Parks and conservation reserves	All	Policy applicable between 2005-2012 promoting Traditional Owner and Aboriginal participation in Parks Victoria's activities.

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Indicator 7.1: Extent to which the legal framework (laws, regulations, guidelines) supports the conservation and sustainable management of forests

Why is this indicator important?

A legal framework (laws, regulations and guidelines) is essential for the sustainable management of forests. A legal system that ensures transparency and public participation in policy and decision-making processes is necessary to support continuous improvements in sustainable forest management.

Victoria's legal framework for forest management includes legislation and regulations to clarify property rights, codes of practice, international, national, state and regional agreements, periodic planning and review, and public participation. The legal framework is administered by State and local governments, statutory authorities and regional management authorities.

The purpose of the legal framework is to provide:

- Protection and conservation of forests
- Protection of flora and fauna species
- Regulation of forest clearing and sustainable forest activities
- Protection of cultural heritage values
- Public participation (e.g. recreation)
- Planning and review activities.

What have we measured and why is it relevant to the indicator?

This indicator reports on the extent to which the legal framework supports the conservation and sustainable management of forests. The indicator reports on legislation and regulations that govern sustainable forest management in Victoria, new regulations and amendments to existing Acts since the previous State of the Forests Report (2008) and management tools and regulatory instruments.

Credit: DEPI

State and trend

Victoria has a comprehensive legal framework for the conservation and sustainable management of forests. Whilst this framework is generally comprehensive for forests on public land, many aspects of sustainable forest management legislation are not applicable on private forested land.

The legal framework for sustainable forest management has been strengthened within the reporting period through creation of new legislation (e.g. *Traditional Owner Settlement Act 2010*), regulations and other instruments including the *Code of Practice for Timber Production 2007* and the *Code of Practice for Bushfire Management on Public Land 2012*.

Legislation and regulations governing sustainable forest management

Victoria's legal framework covers multiple aspects of forest management and administration, including protection of environmental and heritage values, planning processes, and occupational health and safety. The legal framework includes Acts of Parliament, regulations established to support implementation of the Act and other subordinate instruments that support best practice for various forest management activities such as Codes of Practice.

The relevant Acts that apply within the Victorian sustainable forest management legislative framework are shown in Table 1.

Since the 2008 State of the Forests Report, there have been changes to the legal framework including the creation of two new Acts related to sustainable forest management. For example, the:

- *Traditional Owner Settlement Act 2010* allows the Victorian Government to make agreements with Traditional Owners to recognise their unique relationship to land, provide for rights on Crown land as well as other benefits (refer to Indicator 6.6)
- *Climate Change Act 2010* provides a framework for the Government of Victoria's roles and responsibilities in response to climate change
- *Forests Act 1958* and *Crown Land (Reserves) Act 1978* were amended to require tour operators to hold licences to support the sustainable management of forests, a new regulatory approach to domestic firewood collection and traditional owner settlement related amendments. Firewood collection permit requirements in State forests have been removed.
- Amendments to the *National Parks Act 1975* include the creation of new Parks and conservation reserves in East Gippsland and the River Red Gum forests

Indicator 7.1: Extent to which the legal framework (laws, regulations, guidelines) supports the conservation and sustainable management of forests

Table 1. Acts that apply within the Victorian sustainable forest management legislative framework. Source DEPI

Main legislation	Purpose	Tenure
Forests Act 1958	Consolidates the management and protection of State forest, including timber harvesting and fire management.	State forest
Sustainable Forests (Timber) Act 2004	Provides a framework for sustainable forest management and sustainable timber harvesting in State forest, including the provision of a Sustainability Charter and the regular reporting against agreed criteria and indicators.	State forest
Conservation, Forests and Lands Act 1987	Provides a framework for a land management system including necessary administrative, financial and enforcement provisions.	Public land
Traditional Owner Settlement Act 2010	Provides for the Victorian Government to make agreements with Traditional Owners to recognise their unique relationship to land, provide for rights on Crown land as well as other benefits.	Public land
National Parks Act 1975	Provides a framework for the establishment and management of National Parks and other conservation reserves.	Nature conservation reserves
Crown land (Reserves) Act 1978	Provides a framework for the establishment of conservation reserves.	Nature conservation reserves
Flora and Fauna Guarantee Act 1988	Establishes a legal and administrative structure for the conservation of Victoria's native flora and fauna, including the management or control of flora and fauna, and the management of potentially threatening processes.	All tenures
Victorian Plantations Corporation Act 1993	Established the Victorian Plantations Corporation to manage state plantations and to require that timber harvesting comply with a code of practice.	Public land
Climate Change Act 2010	Provides a framework for the Government of Victoria's roles and responsibilities in response to climate change, forest carbon sequestration and private forestry.	All tenures
Catchment and Land Protection Act 1994	Provides a framework for the integrated management and protection of catchments, including community participation in land and water management, and pest plan and animal management.	All tenures
Environment Protection Act 1970	Provides a framework for preventing pollution and environmental damage by setting environmental quality objectives and establishing programs to meet them.	All tenures
Road Management Act 2004	Establishes a framework for the management of the road network and establishes the general principles which apply to road management.	Public land
Safety on Public Land Act 2004	Provides for public safety in State forest by providing for the establishment and enforcement of public safety zones.	State forest
Aboriginal Heritage Act 2006	Protects cultural heritage sites that are of significance to Indigenous Australians.	All tenures
Heritage Act 1995	Provides for the protection and conservation of places and objects of cultural heritage significance	All tenures

Indicator 7.1: Extent to which the legal framework (laws, regulations, guidelines) supports the conservation and sustainable management of forests

- *Sustainable Forests (Timber) Act 2004* was amended to recognise the government commitment to securing the resource base for VicForests to maximise the long-term economic gain from native timber harvesting

- *Mineral Resources (Sustainable Development) Act 1990* strengthened sustainability requirements

- *Forestry Rights Act 1996* and *Extractive Industries Development Act 1995* were repealed. Provisions of the *Forestry Rights Act 1996* were incorporated into the Climate Change Act. Provisions of the *Extractive Industries Development Act 1995* were incorporated into the *Mineral Resources (Sustainable Development) Act 1990*.

A review of the *Sustainable Forests (Timber) Act 2004*, *Climate Change Act 2010* and *Aboriginal Heritage Act 2006* has also been completed.

New regulations have been introduced since the 2008 State of the Forests Report. For example:

- *Forests (Recreation) Regulations 2010*
- *Forests (Licences and Permits) Regulations 2009*
- *Forests (Tour Operator Licence Fee) Regulations 2011*
- *Forests (Domestic Firewood) Regulations 2012*.

The *Forests (Recreation) Regulations 2010* relates to managing the use of forests for recreation. The *Forests (Recreation) Regulations 2010* is a consolidation of former individual reserve regulations and also encompass a range of forest Parks and reserves previously not covered by recreation based regulations. The *Forests (Tour Operator Licence Fee) Regulations 2011* prescribe fees payable in respect of tour operator licences granted for Crown land in a reserved forest under the *Forests Act 1958*. The *Forests (Domestic Firewood) Regulations 2012* mainly regulate or prohibit certain conduct in a firewood collection area during a firewood collection season in State forests.

In Victoria, most regulations expire after 10 years and therefore the *Forests (Licences and Permits) Regulations 1999* has been updated and remade as the *Forests (Licences and Permits) Regulations 2009.* The regulations remain essentially the same with improvements in clarity, the removal of obsolete provisions, and the formalisation of reporting.

A DEPI officer discussing compliance with a VicForests officer. Credit: DEPI

Codes of practice, management plans, action statements and management procedures

In addition to the Acts of Parliament and associated regulations, management tools and regulatory instruments are used to assist in implementing the legislation and regulations to achieve sustainable forest management. These instruments include:

- Codes of practice
- Flora and Fauna Guarantee Act 1988 Action Statements
- Forest Management Plans
- Management procedures for timber harvesting, roading and regeneration in Victoria's State forests.

Since the previous State of the Forests Report in 2008, two new Codes of Practice have been introduced:

- *Code of Practice for Timber Production 2007*
- *Code of Practice for Bushfire Management on Public Land 2012*.

The *Code of Practice for Timber Production 2007* was a revision of the previous Code and incorporated advances in scientific knowledge, the substantial changes in legislation and regulation governing forest management in Victoria and improvements in operational practices. The *Code of Practice for Timber Production 2007* contains both guidelines and regulatory requirements for meeting operational goals. Guidelines and legal requirements are clearly differentiated within the document.

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The *Code of Practice for Bushfire Management on Public Land 2012* provides a framework for bushfire management in Victoria including planned burning and bushfire response procedures. It's primary objectives are: to minimise the impact of major bushfires on human life, communities, essential and community infrastructure, industries, the economy and the environment; and to maintain or improve the resilience of natural ecosystems and their ability to deliver services such as biodiversity, water, carbon storage and forest products.
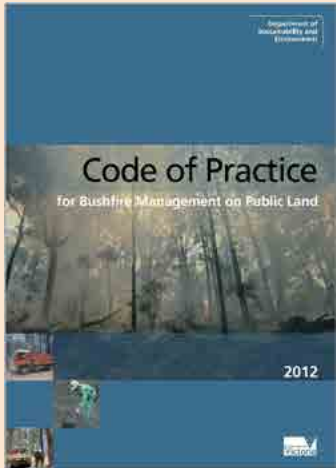
Credit: DEPI

The *Code of Practice for Bushfire Management on Public Land 2012* is also a revision of the previous Code and is the result of the outcomes of the Victorian Bushfire Royal Commission associated with the 2009 Black Saturday bushfires (refer to Indicator 3.1). The code is focused on setting clear objectives for bushfire management on public land; and providing strategies and actions to achieve these objectives.

In addition to the new bushfire code, the Victorian Planning Provisions, from which planning schemes are developed across the state, were amended to include the *Bushfire Management Overlay* (BMO). This too was an outcome of the 2009 Victorian Bushfires Royal Commission. The core purpose of the overlay is to identify high risk bushfire areas and to provide guidance, as well as restrictions, on building and development within these areas. The BMO is implemented and administered through local councils across Victoria according to their planning schemes.

Best practice

Victoria's legal framework requires the application of best practice measures for sustainable forest management. Best practice seeks to ensure that management activities do not impact on forest values such as biodiversity, soil and water quality, and cultural heritage. Best practice is also vital for occupational health and safety in forests.

The extent to which the legal framework requires the application of best practice is shown in Table 2. The legal framework is generally comprehensive, requiring the application of best practice for a range of activities across the majority of forest tenures.

References and further information

Department of Sustainability and Environment (2013) Legislation framework multiple pages <http://www.dse.vic.gov.au/forests/managing-our-forests/legislation-framework> accessed on 20/03/2013

Department of Sustainability and Environment (2009) Victoria's State of the Forests Report 2008.

Department of Primary Industries (2011) Timber Industry Action Plan

Department of Sustainability and Environment (2012) Code of Practice for Bushfire Management on Public Land 2012

Department of Primary Industries (2013) Review of the Sustainable Forests (Timber) Act 2004 <http://www.dpi.vic.gov.au/forestry/about-forestry/projects-and-initiatives/review-of-the-sustainable-forests-timber-act-2004/review-of-the-sustainable-forests-timber-act-2004> accessed 15 May 2013.

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Indicator 7.1: Extent to which the legal framework (laws, regulations, guidelines) supports the conservation and sustainable management of forests

Table 2. Extent to which the legal framework supports the conservation and sustainable management of forests by tenure category, 2011/12. Source DEPI

Extent to which the legal framework provides for	Rating[A]		
	State forest	Parks and conservation reserves	Private forest
Forest management planning and review			
Forest management/policy planning and review	Yes	Yes	Yes
Property rights	Partly	Partly	Yes
Periodic assessment of forest related resources	Partly	Partly	No
Public participation			
Public consultation for forest related policy	Partly	Partly	Yes
Public consultation to develop forest related management plans	Partly	Partly	No
Publication of specific forest-related information	Yes	Yes	No
Indigenous participation			
Formal Indigenous participation in management and planning	Partly	Partly	No
Recognition of cultural values	Yes	Yes	No
Recognition of Native Title Rights, customary and traditional rights, forest access, and protection of Indigenous intellectual property	Yes	Yes	No
Conservation			
Recognition of scientific values	Yes	Yes	No
Recognition of voluntary reserves on private land	Yes	Yes	No
Regulation of forest clearing	Yes	Yes	Yes
Sustainable Forest Management an explicit objective	Yes	Yes	Yes

[A] Yes = the legislation exists and is comprehensive; Partly = the legislation or mechanism exists but does not cover all aspects or is limited in its application; No = the legislation does not exist.

Indicator 7.1: Extent to which the legal framework (laws, regulations, guidelines) supports the conservation and sustainable management of forests

Table 3. Legislative requirement to apply best practice for sustainable forest management activities by tenure category, 2011/12. Source DEPI

Activities	Rating[A]		
	State forest	Parks and conservation reserves	Private land
Access to the forest			
Road planning, design and construction, maintenance and upgrades, construction of bridges and river crossings	Yes	Yes	Yes
Harvesting			
Harvesting design and planning, equipment use, wet weather and steep country restrictions, track and landing maintenance, water quality and stream protection	Yes	NA[B]	Yes
Conservation of other values			
Biodiversity, landscape, cultural heritage, soil and water quality	Yes	Yes	Yes
Forest establishment			
Reforestation	Yes	Yes	Yes
Maintaining forests			
Fire management	Yes	Yes	Yes
Pest, disease, weed control	Yes	Yes	Yes
Use of chemicals	Yes	Yes	Yes
Thinning	Yes	NA[B]	No
Non-wood products	Partly	Partly	No
Apiary	Yes	Yes	No
Grazing	Yes	Yes	No
Recreation	Yes	Yes	No
Socio-economic			
Occupational health and safety	Yes	Yes	Yes

[A] Yes = there is a legislative requirement to apply best practice; Partly = there is a legislative requirement to apply best practice for this activity but this requirement does not cover all aspects or is limited in its application; No = there is no legislative requirement to apply best practice for this activity.

[B] Not applicable - commercial harvesting is not carried out in nature conservation reserves.

Indicator 7.2: Extent to which the institutional framework supports the conservation and sustainable management of forests

Why is this indicator important?

Institutional frameworks are the institutions and mechanisms established to shape activity and behaviour in a sector. The processes, resources and activities provided through institutional frameworks create an environment which influences how effectively and efficiently the aims of the framework are delivered. Monitoring the extent to which conservation and sustainable forest management aims are supported by the current institutional framework indicates the level of commitment and ability of the framework to deliver these outcomes.

What have we measured and why is it relevant to the indicator?

This indicator outlines the institutional framework elements considered important in supporting conservation and sustainable management of both public and private forests and key developments during the reporting period. It also examines the effectiveness of the framework in shaping behaviour by reporting the level of compliance with timber production regulations and the incidence of illegal activities in public forests. Comprehensive information relevant to regulatory activities in private forests is not available.

Victoria's institutional framework for supporting conservation and sustainable management of forests

Institutional frameworks include laws, plans and policies, institutional structures and decision making processes, mechanisms for public participation, relevant human resource capacity and skills, knowledge, infrastructure and regulatory activities. Institutional arrangements provided through Victorian legislation are addressed in Indicator 7.1.

Table 1 provides an overview of the institutional framework elements considered important in supporting conservation and sustainable management of both public and private forests in Victoria. It outlines the tenures they apply to, the key institutions involved in their delivery and major activities undertaken during the reporting period.

Auditors assess recently harvested logging coupe. Credit: DEPI

Rates of compliance with sustainable forest management regulations in public forests

Whilst the emphasis of Victoria's institutional framework is to encourage voluntary behaviour compatible with conservation and sustainable forest management aims, regulatory activities are carried out to uphold the institutional framework as a whole. In public forests statutory authorities achieve this through auditing, patrols, investigating reported potential offences and, where warranted, regulatory action.

Timber production compliance

DEPI is the main statutory authority responsible for the regulation of timber production activities in Victoria's State forests. DEPI implements an environmental auditing program called the Forest Audit Program (FAP) to monitor compliance of timber harvesting activities with Victorian regulations and to assess the environmental impacts of these activities. The FAP aims to allow for the independent examination of activities across the lifecycle of timber harvesting operations, including operational and tactical planning, roading, harvesting, coupe closure and regeneration[1]. This indicator reports audit results for roading, harvesting and coupe closure activities conducted in 2006/07, 2008/09, 2010/11 and 2011/12.

[1] For more information, visit http://www.depi.vic.gov.au/forestry-and-land-use/timber-production/timber-harvesting-regulation/monitoring-compliance-and-auditing

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Indicator 7.2: Extent to which the institutional framework supports the conservation and sustainable management of forests

Table 1. Institutional framework elements for Victorian conservation and sustainable forest management. Source DEPI

Element	Public	Private	Key institutions	Key activities during reporting period
Institutional structures	Yes	Yes	DEPI Local Government Parks Victoria VicForests	Transfer of State forest to Park (River Red Gum, East Gippsland) 2011 machinery of government change
Public participation	Yes	Yes	DEPI Local Government Parks Victoria VicForests	Engagement and communications for legislation, policy, planning and operational activities Forest discovery centre forest education programs Web based interactive maps and other publications
Periodic forest-related planning	Yes	No	DEPI Parks Victoria VicForests	Bendigo FMA Forest Management Plan Portland-Horsham Forest Management Plan Great Otway National Park and Otway Forest Park Management Action Plan Wood Utilisation Plans Fire Operations Plans Timber Release Plans
Periodic assessment of forest values	Yes	No	DEPI VicForests	Victorian Forest Monitoring Program, Forest Biodiversity, 2006/07 and 2009 fire recovery programs, East Gippsland Forest Management Zoning review, Resource Outlook, VEAC River Red Gum Investigation
Periodic review of forest-related policy	Yes	Yes	DEPI	RFA review, Timber Industry Action Plan, Firewood on Public Land, Biosecurity Strategy for Victoria, Bushfire Code, Putting the Buzz into Agriculture
Relevant skills development and maintenance	Yes	Yes	Universities Registered Training Organisations DEPI	Forestry, natural resource and environmental management courses Environmental Care, OHS and other training, Fire training
Infrastructure	Yes	Part	DEPI Parks Victoria Local Government	Access roads Recreation and fire management infrastructure
Regulatory activities	Yes	Yes	DEPI Parks Victoria Local Government	Forest Audit Program General forest and park compliance

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Monitoring timber harvesting activities

FAP audits assess a sample of coupes in each target year for compliance with prescriptions in the Code of Practice for Timber Production and associated documents. These prescriptions are called audit elements. When an auditor finds non-compliance, they assess the situation to determine which of the following environmental impact categories applies:

- Severe – poses a severe threat to human life, or irreversible or extensive impact to the environment

- Major – poses a potential threat to human life, or significant impact to the environment

- Moderate – poses a moderate impact to the environment

- Minor – poses a minor impact to the environment, however further risk reduction opportunities exist

- Negligible – poses negligible impact to the environment and/or provides for continuous improvement

- No impact – poses no impact to the environment

The environmental impact assessment takes account of the extent and duration of actual or potential impacts and the environmental asset value. More information on the FAP is available under Indicator 4.1.

In 2010 DEPI introduced a formal process for stakeholders to report allegations of non-compliance with timber production regulations. Stakeholders may include the general public, DEPI staff and VicForests staff or contractors. DEPI investigates allegations of non-compliance where it is likely the matter can be assessed, and evidence is provided that a likely breach of the regulatory requirements has occurred.

Data source and limitations

The timber production audit results presented in this report are sourced from the Environment Protection Authority Environmental Audit of Timber Production on Public Land 2007 and the 2011 and 2013 harvesting and coupe closure audits. A new FAP methodology was introduced in 2010 following a major review of the program. As a result, direct comparisons between audit results before and after this review should not be made.

Data for allegations and investigations of non-compliances with timber production regulations are sourced from DEPI internal records.

State and trend

Table 2 presents the overall percentage of compliant and non-compliant audit elements by environmental impact category for harvesting and coupe completion in the target harvesting year. Table 3 presents the number of reported allegations of non-compliance with timber production regulations and DEPI investigation activities conducted between 2010 and 2012.

Forest Audit Program Auditor assessing harvest coupe.
Credit: DEPI

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Credit: DEPI

Table 2. Audit results for harvesting and coupe completion operations. Source FAP reports

	Environmental impact	2006-07[2]	2008-09[3]	2010-11 & 2011-12[4]
% Compliant elements		94	93	96
% Non-compliant elements	Severe	0	0	0
	Major	1	0	0
	Moderate	1	1	1
	Minor	1	1	1
	Negligible	2	2	1
	No impact	1	2	1

Table 3. Number of alleged timber production non-compliances and investigations by year. Source DEPI

Year	Allegations	Investigated	Confirmed	Still under investigation
2010	18	8	1	0
2011	15	5	3	0
2012	22	6	2	2
Total	**55**	**19**	**6**	**2**

[2]   Byrne G. (2008) Environmental audit: Timber Production on Public Land 2007, Findings and Recommendations. Environmental Protection Authority Victoria

[3]   Mason J. (2011) Environmental Audit – Forest Audit Program: Module 5 – Harvesting and Closure. URS Australia Pty Ltd.

[4]   Clifton C., Poynter M., Pallozzi D., Hanson-Boyd C., Endersby D., Sandercock P. and Selwyn G. (2013) 2012-13 Audit of harvesting and coupe closure. Sinclair Knight Merz.

- Audits indicate a high level of compliance (over 93 percent) with prescriptions for timber production harvesting and coupe closure activities throughout the reporting period.

- On average, 74 percent of non-compliances have nil to minor environmental impact.

- Most audits identified at least one non-compliance with either potential or actual major environmental impact. These related to rainforest management, harvesting outside planned coupe boundaries, waterway protection and log landings and dumps.

- DEPI received 55 alleged timber production non-compliances, reported by stakeholders and/or self reports by industry. Of the 55 only 19 provided sufficient information and evidence to reasonably conclude that a non-compliance with the regulatory framework may have occurred and therefore warranted further investigation by DEPI. These subsequent investigations confirmed 6 allegations.

- Confirmed non-compliances related to rainforest management, and incursion into National Park and SPZ.

Reported incidence of illegal activity in Victoria's forests

DEPI monitors and conducts compliance operations for a range of activities in public forests. Illegal activities are reported and, where appropriate, compliance action is undertaken. Illegal activities are grouped for reporting purposes into the following activity types: fire, hunting, rubbish / vandalism, taking vegetation and other forest produce, off road use of vehicles and other miscellaneous offences. These activities represent the main types of offences occurring within forests.

Indicator 7.2: Extent to which the institutional framework supports the conservation and sustainable management of forests

Data source and limitations

Data for illegal activities are sourced from DEPI internal records. These records come from a range of sources including DEPI staff, other agencies and members of the public. DEPI's data relies on sources registering reports centrally. The proportion of illegal activities actually reported is unknown, therefore the information presented is only indicative.

State and trend

Figure 1 presents each illegal activity type as a proportion of the total reported illegal activity by year (2006/07 to 2011/12).

Hunting (23%), taking vegetation (23%) and rubbish/ vandalism (23%) were on average the most commonly reported illegal activity types in forests.

- Transfer of portfolio responsibilities between government departments may have affected reporting of hunting offences, which decreased from 26% in 2009/10 to 9% in 2011/12.

- The incidence of taking vegetation offences rose significantly in 2011/12 to 33% of reported offences. This coincides with changes in policy and law relating to firewood collection. However as the new approach to firewood also coincided with DEPI conducting training to encourage submission of information reports, it is not possible to determine whether there was an actual increase in illegal activities or just an increase in the frequency of reporting of incidents that have historically always occurred.

- Reported vehicle offences increased in 2009/10 and 2010/11 by 7%. This coincides with an increased compliance effort associated with trail bike management.

- Overall, the reporting of illegal activity in forests increased during the reporting period. This is most likely due to increased effort by DEPI to record illegal activity, rather than an actual increase in the incidence of environmental crime.
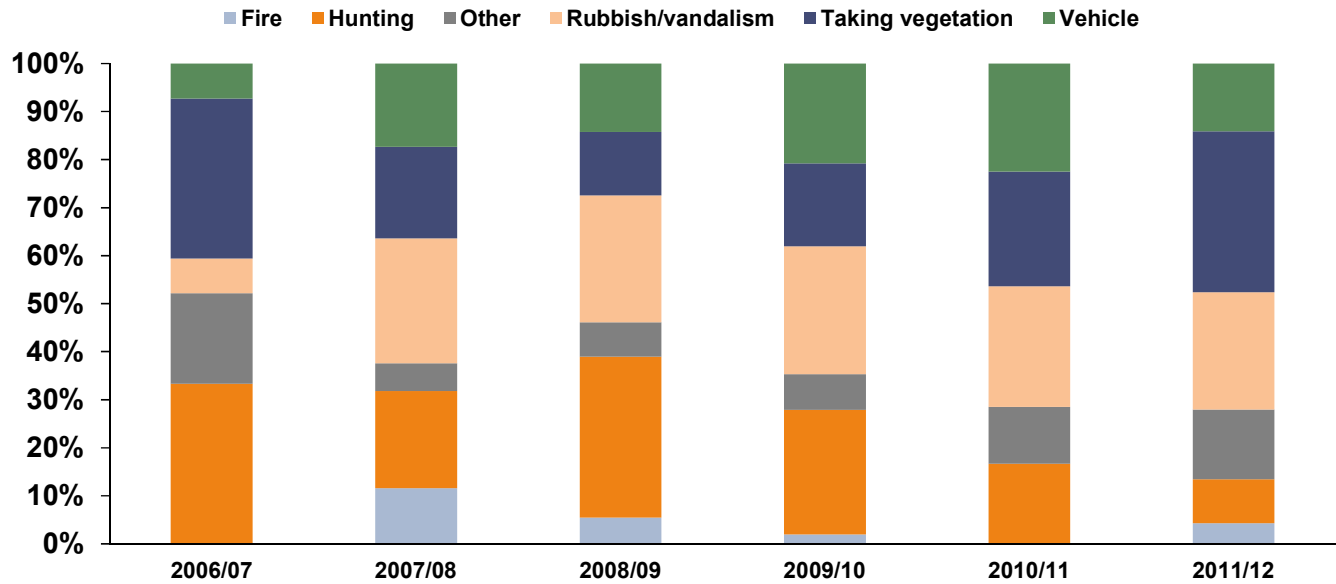
Figure 1. Percentage reported illegal activity type by year. Source: DEPI

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Indicator 7.3: Extent to which the economic framework supports the conservation and sustainable management of forests

Why is this indicator important?

The economic framework for Victoria's forests consists of government policies on investment, regulation, taxation and trade. These settings influence the level of investment in conservation and sustainable management of forests, as well as the sustainable production of forest products, ecosystem services and access to national and international markets. Reporting change to economic frameworks can provide insight into the role of Government in driving trends in the sector.

What have we measured and why is it relevant to the indicator?

This indicator describes, for the reporting period, key economic policy changes and initiatives relevant to the timber industry and biodiversity markets across all land tenures and the conservation of private native forests.

Timber Industry Action Plan

In 2011, the Victorian Government introduced the Timber Industry Action Plan (TIAP) to provide the conditions for a productive, competitive and sustainable timber industry. Key actions of the plan include:

- Introducing a new strategic approach to biodiversity management that appropriately balances the conservation of biodiversity with the supply of timber and other commercial forest products to generate socio-economic benefits for Victorian communities

- Providing VicForests with a secure basis to maximise the long-term economic returns to Victoria from the harvesting of timber and allow industry to realise a competitive return on investments, support capital upgrades, and drive innovation

- Streamlining of the legislative and regulatory framework relating to sustainable forest harvesting

- Implementing improvements to the methodology used to estimate sustainable harvest levels from public native forests in eastern Victoria

- Improving freight infrastructure and logistics to support the timber supply chain

- Reviewing the Sustainable Forests (Timber) Act 2004 to introduce a simplified legislative system to deliver clarity, efficiency, security and sustainability to the State and the native timber industry

- Developing a Forests and Timber Biosecurity Framework

- Developing a Victorian Farm Forestry Industry Action Plan.

Several TIAP actions have been delivered, including revisions to the Sustainable Forests (Timber) Act 2004 and development of the Forests and Timber Biosecurity Framework. Other actions are significantly progressed.

Biodiversity markets in Victoria

Victoria has three programs that form an economic framework for the protection of biodiversity values on private land. These programs, part of the Environmental Partnerships program, show that, with the right information and policy settings, markets can be very efficient at allocating resources for protecting the environment.

EcoTender

Under EcoTender, landholders are invited to tender for contracts to deliver multiple environmental benefits, primarily by means of improved native vegetation management and revegetation works on their properties. Tenders are evaluated using the EnSym process which considers value for money for ecosystem outcomes, environmental asset significance and cost. Successful landholders receive periodic payments as they deliver the management actions under contractual agreements with DEPI.

The numbers of projects evaluated each year using the EnSym process in the EcoTender program are detailed in Table 1. The number of projects evaluated and successfully signed off varies with demand from land holders and has fluctuated during the reporting period. The investment per hectare has steadied at about $1,500 per hectare.

Native vegetation on farm. Credit DEPI

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BushTender

BushTender is an auction approach to protecting and improving native vegetation on private land. Landholders competitively tender for agreements to better manage their native vegetation. Successful bids are those that offer the best value for money. Successful landholders receive payments for environmental services for their management actions under agreements signed with DEPI. These actions are based on management commitments over and above those required by current obligations and legislation.

A summary of the BushTender projects that have been conducted during the reporting period is provided in Table 2. The area under agreement has fluctuated with the projects proposed by DEPI and the landholder demand.

Bushbroker

BushBroker is a trading desk for native vegetation credits. It provides standards and processes for the generation and trade of native vegetation credits. The program encourages landholders to permanently protect and manage their native vegetation for biodiversity benefits, whilst providing reliable quality offset sites for clearing permits where third party offsets are required.

Native vegetation offsets include any works or actions that improve and protect native vegetation to compensate for its removal, such as managing weeds, controlling rabbits and fencing-out stock access. The gains achieved must be permanent and on-going, and are permanently protected. They must also be linked to a specific clearing site.

The Bushbroker database of native vegetation offset assets contains 673 records as of October 2013. Trends on the acquisition and take up of assets is not available for the reporting period.

Table 1. Details of EcoTender Projects evaluated and committed using the EnSym process. Source DEPI

Year	2008/09	2009/10	2010/11	2011/12
Projects	2	1	10	6
Farms assessed	169	20	655	196
Area assessed (ha)	1,921	4,606	10,189	2,590
Investment (approx.)	$1,914,298	$1,264,000	$7,506,620	$2,953,072
Land under contract (ha)	565	2,330	5,337	1,768
Investment per hectare	$3,388	$542	$1,407	$1,670

Table 2. Details of BushTender Projects evaluated and committed using the tender process. Source DEPI

Year	2008	2009	2010	2011	2012
BushTender projects	South West Targeted	Northern Plains North West	Goulburn Broken North Central	Avoca Plains Mega Murray 1 Mega Murray 2 North East Central Victoria	Western Grassland Reserves
Region	South West Northern	Northern North West	Goulburn Broken Central	Avoca Plains West of Dimboola Mallee North East Central	Western
Area under agreement (Hectare)	9,930	4,965	4,158	9,252	88
Gain accrual (Habitat Hectares)	1,536	922	690	1,395	14

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References and further information

Department of Primary Industries (2011) Timber Industry Action Plan (TIAP) http://www.depi.vic.gov.au/__data/assets/pdf_file/0011/177707/TIAP_web.pdf

DEPI (2014) EcoTender, http://www.depi.vic.gov.au/environment-and-wildlife/environmental-partnerships/innovative-market-approaches/ecotender

DEPI (2014) BushTender http://www.depi.vic.gov.au/environment-and-wildlife/environmental-partnerships/innovative-market-approaches/bushtender

DEPI (2014) BushBroker http://www.depi.vic.gov.au/environment-and-wildlife/biodiversity/native-vegetation/native-vegetation-permitted-clearing-regulations/native-vegetation-offsets/bushbroker

Indicator 7.4: Capacity to measure and monitor changes in the conservation and sustainable management of forests

Why is this indicator important?

The conservation and sustainable use of forests depends on the capacity to measure and monitor social, economic and environmental conditions and governance. This, in turn, informs the management of forests so appropriate decisions are taken to mitigate or address present and emerging issues. The availability of data and information about Victoria's forests provides a measure of the capacity to demonstrate sustainable forest management, and allows forest managers to review and prioritise data and information collection activities to make future monitoring more timely, relevant and effective.

What have we measured and why is it relevant to the indicator?

This indicator assesses Victoria's capacity to report on sustainable forest management. The indicator provides an assessment of data and trends for each of the indicator reports in Victoria's State of the Forests Report 2013. The indicator assessment looks at ability to report trend, data coverage, currency and frequency for each of the criteria and indicators contained in *Criteria and Indicators for Sustainable Forest Management in Victoria* (Department of Sustainability and Environment, 2007). The reporting of these criteria and indicators meets the requirement under the *Sustainable Forests (Timber) Act 2004* to report on the condition and management of the forest every five years.

Victoria has adopted the *Criteria and Indicators for Sustainable Forest Management (SFM) in Victoria* to monitor and assess the State's performance in achieving its SFM objectives, which set out a range of environmental, economic and social indicators. These are closely aligned with *Australia's*

Sustainable Forest Management Framework of Criteria and Indicators and the international reporting standards developed under the *Montreal Process Working Group*. This provides a framework with which to evaluate progress towards the objectives set out in the *Sustainability Charter* and to improve openness, accountability and community engagement in forest management.

Assessing capacity to measure and monitor change

Table 1 describes the rating criteria used to assess each indicator in the context of the capacity to measure and monitor changes in the conservation and sustainable management of forests. *Trend reporting capacity* assesses the degree to which there is suitable data and/or information which can be used to identify change (i.e. monitor) over time. *Data coverage* refers to either a broad measure of the geographic extent of the indicator (e.g. Victorian public forests) or the completeness of data available for the indicator (e.g. total volume of all Victorian saw-log harvested in a particular year). In some instances, coverage may be associated with tenure, for other indicator reports data may be restricted to a particular region, natural or administrative unit (e.g. water catchments). Coverage may also relate to the understanding of an issue at a social, policy and scientific level. *Data currency* looks at how recent the data is and *data frequency* at how often (for how many years) the data is reported in the indicator.

Table 1. Assessment rating key to Table 2. Source DEPI

Rating	Trend reporting capacity	Data coverage	Data currency	Data Frequency
🟢	Capacity to report trends*	Complete	2006+	Annual – 5-yearly*
🟠	Partial capacity to report trends	Partially complete	Pre 2006	> 5 years
🔵	Limited capacity to report trends	Case study /narrative	Incomplete	Once only
🔴	No capacity to report trends	No data	No data	No data

* The partial capacity *Report Trend* category includes data which has been collected using *systematic* and *repeatable* methods for which a baseline has been established. Through the collection of additional data, comprehensive trends will be present during the next State of the Forests reporting period.

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State and trend

The capacity to report trends and the availability, coverage, currency and frequency of data used to address indicators is shown in Table 2. Due to differences in the requirements for each indicator (for example, some indicators depend on data, others more qualitative information or are more narrative in nature), it is not appropriate to compare data status between indicators. Detailed information about data availability is included in the individual indicator pages of this report. In some instances, a data or information 'proxy' has been used to address the indicator.

The 2013 State of the Forests Report (SFR) is the second to use the *Criteria and Indicators for Sustainable forest management in Victoria*.

During the reporting period DEPI has made significant improvements to the way it collects forest monitoring data, as well as the quality, coverage and accuracy of spatial (GIS) and other data. In particular, the Victorian Forest Monitoring Program (VFMP) has been established specifically for the collection and analysis of data for detecting trends in the extent, state and condition of Victoria's public forests. Through the VFMP and other monitoring programs, DEPI is collecting forest data and information using systematic and repeatable methods. VFMP data in particular is being used to establish baseline data for several indicator reports (e.g. 1.1a, 1.2b, 1.2d, 3.1 and 5.1). These monitoring programs demonstrate the Victorian Government's commitment to making significant improvements in the state's capacity to achieve and demonstrate sustainable forest management.

As a result of the monitoring improvements outlined above, Victoria's capacity to report trends has improved significantly since the previous State of the Forests reporting period (2008). In 2013, almost 70% of indicators have data and information with which to report at least partial trends and nearly 60% to report complete trends. In the previous reporting period only 55% of indicators had sufficient data to at least partially report trends.

Ninety percent of the indicators have at least partial data coverage – a 30% increase on the previous State of the Forests reporting period. Complete data coverage was available for 65% of the indicators. Over 90% of indicators use data and information rated in the highest data currency category (post-2006).

Table 2 shows the data and information gaps identified in the 2008 State of the Forests Report and how these gaps have been fully or partially addressed in 2013. Since 2008 there has been a greater commitment by DEPI to collect a more comprehensive suite of environmental, social and economic data and information to support SFM reporting.
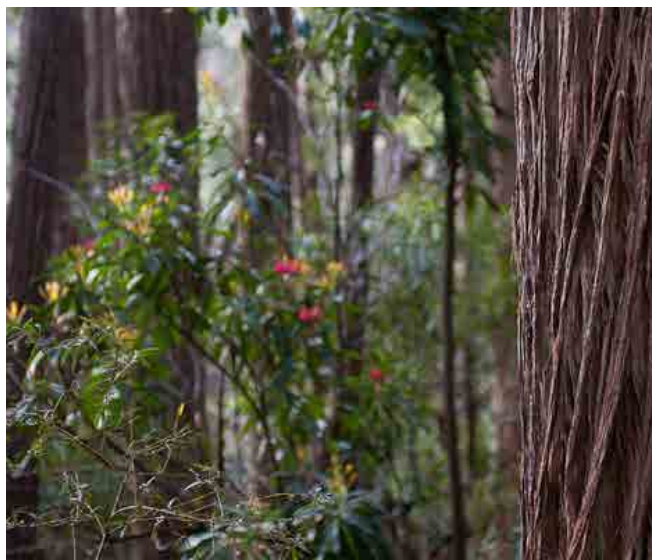
Errinundra National Park. Credit DEPI

Victoria is progressing work on data and information for the sustainable forest management indicators that it has not as yet been able to report on. Current gaps are:

- Number of species at risk of isolation
- Change in forested catchment water yields, including the impacts of fire and timber production
- Extension and use of new technologies
- Resilience of forest-dependent communities, including Indigenous communities
- Level to which Indigenous cultural and subsistence needs are met by forest management
- Availability of data and information is generally poor for native forests on private land
- Annual number of visitors to State forest
- Value of forest-derived ecosystem services.

Victoria's Environmental Partnerships policy contains a number of priority actions that should assist future reporting of some of these indicators. As reported in Indicator 6.1c, Victoria is building its capability to implement a new environmental accounting system. This should support improved monitoring of ecosystem services values as methodologies and datasets are developed. Understanding what Victorians value about public land and reflecting this in management is also a key priority. Current research on this topic should assist Victoria to redevelop social indicators to better reflect public values.

The recently released Victorian Aboriginal Economic Strategy 2013 -2020 aims to deliver strong outcomes in education, training, employment and business enterprise by building on efforts across government and the private sector. Outputs of this strategy should help address reporting of Aboriginal community resilience in the future.

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Table 2. Identified data and information gaps in Victoria's State of the Forests Report 2008. Source DEPI

Data and information gap (2008)	2013 State of the Forests Report: How the data and information gaps have been addressed
Application of consistent methodologies to enable comparisons over time	Victorian Forest Monitoring Program (VFMP) Other DEPI monitoring programs (e.g. Hawkeye) Improved spatial (GIS) data and other databases (e.g. accuracy, completeness, archives and metadata)
Representative forest dependent indicator species need to be identified and monitoring programs developed	**Indicator 1.2c**. DEPI and University research and monitoring projects, including: • Hawkeye, • Gippsland Retrospective, • Fire Effects Study Areas, • Faunal Refuges Project, • Otways Fire, Landscape Pattern and Biodiversity. • 2011 East Gippsland Owl Survey
Level of forest fragmentation and long term changes in the extent of forest types	**Indicator 1.1d**. New standardised fragmentation and spatial configuration analysis methods, implemented using up-to-date state-wide forest cover maps.
Distribution of invasive species and their impacts on forest dependent native species	**Indicator 1.2d**. VFMP systematically collected monitoring data on the impacts of weeds on native forest species for the Victorian public forest estate. Pest and pathogen data from DEPI's detailed forest health surveillance program reports.
Annual production of non-wood forest products	**Indicator 6.1b**. Sources of data and information include the Game Licensing System and Forest Produce Sales System (both implemented in 2009/10); collated DEPI internal records for quantity and royalties for extracted seed and extractive materials.
Severity and extent of a range of impacts on forest health including fire, invasive species, drought, stock grazing, recreation and water regulation	**Indicators 1.2d and 3.1** Systematically collected VFMP data on canopy health and mortality, distribution of invasive species (see above); improved fire monitoring and data management systems.
Degree of reuse and recycling of wood products	**Indicator 6.1d** Annual survey of Victorian recycling industries

Appropriate and cost effective monitoring methods are yet to be identified for some indicators such as water yield and more generally private native forests. Legislation, prescriptions and planning frameworks generally manage risks associated with these values, and Victoria will continue to explore methods of monitoring and reporting to address these information gaps.

Social values

Central to the Victoria's Environmental Partnerships policy are the three aspirations:

• Value the environment and what it has to offer

• Act to protect, conserve and maintain the environment

• Enjoy the wide range of benefits of a healthy environment now and into the future.

A key priority within the policy is to listen to and work with the community around management of public land, including forests. Although it is recognised that social values are important, they are not well understood. This is mainly due to the complexity of social values and the challenge of monitoring them effectively. DEPI is developing systems and processes to acquire, manage and make available information on community values to inform land management decisions.

A joint research project with University of Melbourne and McGill University, Canada "Defining the Intangible: Incorporating contested social values into native forest management", is investigating how social values influence public acceptance of forest management in Victoria's Central Highlands region. The research will provide new insights to assist in balancing forest management outcomes in ways that align with community social values.

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Indicator	Ability to report trend	Data coverage	Data currency	Data frequency
Criterion 1: Conservation of biological diversity				
1.1a Area of forest by type and tenure	🟢	🟢	🟢	🟢
1.1b Area of forest by type by growth stage	🔵	🟢	🟢	🔵
1.1c Area of forest type in protected zones	🟢	🟢	🟢	🟢
1.1d Fragmentation of native forest cover	🔵	🟢	🟢	🔵
1.2a The status of forest dependent species	🟠	🟢	🟢	🟠
1.2b Area of habitat available for forest species	🟠	🟢	🟢	🟠
1.2c Representative indicator forest species	🔵	🟠	🟢	🔵
1.2d Degree of disturbance by invasive species	🟢	🟢	🟢	🟢
1.3a Number of species at risk of isolation	🔴	🔴	🔴	🔴
1.3b Conservation efforts for forest species	🟢	🟢	🟢	🟢
Criterion 2: Maintenance of productive capacity of forest ecosystems				
2.1 Forest available timber production	🟢	🟢	🟢	🟢
2.2 Volume of wood available and suitable	*Data presented in Indicator 2.3*			
2.3 Annual production of wood products	🟢	🟢	🟢	🟢
2.4 Annual production of non-wood products	*Data presented in Indicator 6.1b*			
2.5 Timber harvest area regeneration	🟢	🟠	🟢	🟢

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Indicator 7.4: Capacity to measure and monitor changes in the conservation and sustainable management of forests

Indicator	Ability to report trend	Data coverage	Data currency	Data frequency
Criterion 3: Maintenance of ecosystem health and vitality				
3.1 Agents and processes affecting forest health	🟢	🟢	🟢	🟢
3.2 Area and type of human-induced disturbance	🟢	🟢	🟢	🟢
Criterion 4: Conservation and maintenance of soil and water resources				
4.1 Forest assessed for risk to soil attributes	🔵	🟠	🟢	🟢
4.2 Change in forested catchment water yield	🔴	🟢	🟢	🔵
4.3 Change in forested catchment river health	🔵	🟠	🟢	🔵
Criterion 5: Maintenance of forest contribution to global carbon cycles				
5.1 Total forest biomass and carbon pool	🟢	🟢	🟢	🟢
5.2 Contribution to to greenhouse gas balance	🟢	🟢	🟢	🟢
Criterion 6: Maintenance and enhancement of long term socio-economic benefits				
6.1a Value ($) of wood and wood products	🟢	🟢	🟢	🟢
6.1b Value ($) and yield of non-wood forest products	🟢	🟢	🟢	🟢
6.1c Value ($) of forest derived ecosystem services	🔴	🔴	🔴	🔴
6.1d Reuse and recycling of wood products	🟢	🟢	🟢	🟢

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Indicator 7.4: Capacity to measure and monitor changes in the conservation and sustainable management of forests

Indicator	Ability to report trend	Data coverage	Data currency	Data frequency
6.2a Investment in forest management	green	green	green	green
6.2b Investment in R&D and education	green	green	green	green
6.2c Extension and use new technologies	red	orange	green	blue
6.3a Forest utilised for recreation and tourism	orange	green	green	green
6.3b Recreation and tourism opportunities	orange	orange	green	green
6.3c Number of visits per annum	green	orange	green	green
6.4a Indigenous access and rights	blue	green	green	blue
6.4b Places of cultural value	green	green	green	green
6.5a Employment in the forest sector	green	green	green	green
6.5b Average wage rates and injury rates	green	orange	green	green
6.5c Resilience of forest dependent communities	blue	orange	green	green
6.5d Resilience Indigenous communities	red	blue	blue	red
6.5e Indigenous subsistence and cultural needs	*Data presented in Indicator 6.4a*			
6.6a Indigenous values in management frameworks	red	blue	green	blue

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Indicator 7.4: Capacity to measure and monitor changes in the conservation and sustainable management of forests

Indicator	Ability to report trend	Data coverage	Data currency	Data frequency
Criterion 7: An effective legal, institutional and economic framework				
7.1 Legal framework	🟠	🟢	🟢	🟢
7.2 Institutional framework	🟢	🟢	🟢	🟢
7.3 Economic framework	🟢	🟠	🟢	🟢
7.5 Capacity to conduct and apply R&D	*Data presented in Indicator 6.2b and 6.2c*			

Data source and limitations

This information is included in each of the indicator reports.

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Indicator 7.5: Capacity to conduct and apply research and development aimed at improving forest management, including development of scientific understanding of forest ecosystem characteristics and functions

Why is this indicator important?

Research that improves scientific understanding of forest ecosystem characteristics and functions, social values and forest policy, as well as economics is critical to underpin sustainable forest management. This indicator reports on Victoria's capacity to conduct and apply research and development aimed at improving sustainable forest management practices. Sustainable forest management requires in-depth knowledge of ecological, economic and social systems. This knowledge forms the basis for the development and implementation of:

- High level strategy and policy
- Improved management practices
- Operational procedures and standards
- Strategic and operational plans
- Training programs
- Performance monitoring and improvement systems.

The Victorian Government conducts a wide-range of forest-related research and development programs. In addition, the Victorian Government invests in research through a number of Victorian and interstate Australian university and research institutions. Among the research institutions which play a leading role in delivering forest ecology and related research are The University of Melbourne Department of Forest and Ecosystem Science, the Arthur Rylah Institute (ARI) for Environmental Research, Monash University, Royal Melbourne Institute of Technology (RMIT) School of Mathematical and Geospatial Sciences, CSIRO , Deakin University and Australian Government Cooperative Research Centres (CRC) (including the Bushfire CRC and the CRC for Spatial Information).

What have we measured and why is it relevant to the indicator?

Data addressing this indicator, including associated commentary, is presented within Indicator 6.2b *Investment in research and development, and education*. Associated information about the use of new and improved technologies for sustainable forest management is addressed in Indicator 6.2c. Four case studies in the 2013 State of the Forests Report describe a range of research activities that are improving Victoria's capacity to monitor forest ecosystems and sustainable forest management:

1. A new strategic approach to biodiversity management
2. Joint Remote sensing Research Program (JRSRP)
3. Collaborative research for forest assessment and monitoring
4. Technology applications for forest assessment and monitoring

Victorian rainforest. Credit Tal Gur

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Case studies

Warburton, Victoria. Credit Kuba

Case study 1: The Victorian Forest Monitoring Program

Theme(s): Environmental

Criteria: 1 (Conservation of biological diversity), 3 (Maintenance of ecosystem health and vitality) and 5 (Maintenance of forest contribution to global carbon cycles), 7 (Legal, institutional and economic framework for forest conservation and sustainable management).

Introduction

In January 2010, DEPI initiated the Victorian Forest Monitoring Program (VFMP) to conduct a range of monitoring activities across Victoria's public forests. This approach represents a significant advance in the way Victoria has historically collected information about the State forests and Parks and conservation reserves which cover 7.9 million hectares (about 35% of the State).

Growing concern about forest environments and global and regional stressors, which threaten forest structure and composition, requires extensive forest data collection at a range of scales to support environmental policy. Furthermore, there is an increasing need for scientifically sound data for consistent comparison between jurisdictions, such as member states of international organisations, or from the voluntary entry to agreements or protocols (e.g. Montréal Process, Australian Regional Forest Agreements).

The VFMP is Australia's most comprehensive statewide public forest monitoring system, involving the widespread and repeated collection of consistent data and information with

Credit: Alison Pouliot

which to assess and monitor changes in the extent, state and condition of public forests over time at the landscape scale. Monitoring is aligned with sustainable forest management indicators and the data and derived information collected through the VFMP has been used extensively throughout Victoria's State of the Forests Report 2013. The detailed information gathered through the VFMP approach is improving DEPI's evidence-based decision making and policy development across a range of issues, including:

- Fire and flood impacts
- Habitat protection
- Carbon accounting
- Biomass
- Forest productivity
- Forest health and biodiversity.

VFMP design

The VFMP comprises a network of 786 permanent ground plots, based on a sampling design stratified by Victoria's eleven bioregions[1] (Figure 1) and by public tenure (State forest and Parks and conservation reserves). State forest is managed for multiple purposes, including timber resource extraction, tourism and recreation. Parks and conservation reserves are primarily managed for conservation outcomes as well as recreation and tourism. As well as the network of ground-plots, the VFMP also incorporates the systematic use of high-resolution aerial photography and statewide multi-year satellite imagery.

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[1] Bioregions are relatively large, geographically distinct areas of land that share common characteristics, including geology, landform patterns, climate, ecological features and plant and animal communities. Refer to Introduction for more information.

Ground Plots

Each VFMP ground plot involves multi-stage fieldwork, including tree, soil and ecological measures. Standard Operating Procedures have been developed in close consultation with scientists and international forest mensuration experts. These detail field techniques and data collection processes for all VFMP fieldwork components. The following describe the VFMP ground plot measurement components (illustrated in Figure 2):

- A 15 m radius circular plot (Large Tree Plot, 0.04 hectares) around the ground plot centre point, in which a range of physical and biotic characteristics are assessed, including slope, aspect, topographic position, surface water, and any evidence of disturbance.
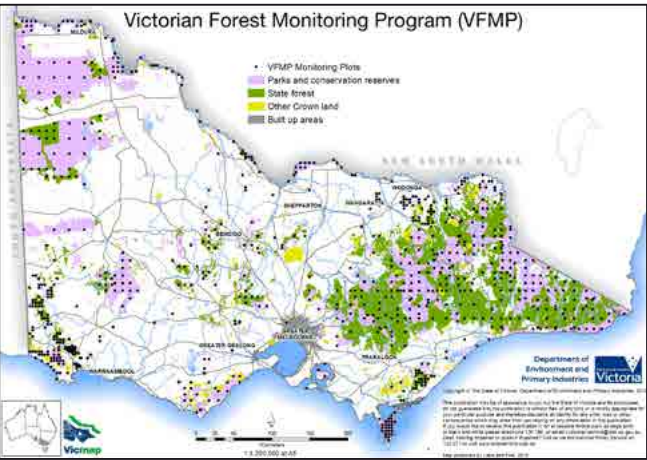
Figure 1. VFMP Ground Plots. Source DEPI

- Large trees (>10 cm in diameter at breast height (DBH)) within the Large Tree Plot, are assessed for: species, diameter at breast height over bark (dbhob), tree status, decay class, crown class. Additional measurements such as tree height, canopy cover, canopy health (discoloration, dieback, foliage density, epicormic growth, crown clumping) are made on a subset of these trees. Coarse woody debris (> 10 cm), stumps and slash piles are also assessed across this plot.

- A 3.99 m radius circular plot (Small Tree Plot, 0.005 ha) inside the Large Tree Plot, in which all small trees (<10 cm DBH) are measured (species, frequency and height).

- Twelve 1 m^2 vegetation quadrats in which a range of understory vegetation and groundcover parameters are measured. These include frequency, cover and height of understorey species, total projected foliage cover, woody species cover and percentage ground cover.

- Four 0.25 m^2 soil quadrats in which a range of soil and surface litter samples are collected for laboratory analysis. Analyses include humus (structure, litter, type) and soil (texture, buk density, volumetric mass, moisture content, carbon and nitrogen).

- A 1 m soil pit where soil profile observations are conducted.

Additional measures are undertaken on plots located within forests burnt by bushfires over the past 10 years. These include charing of wood, scorch heights and post-fire recruits. All VFMP ground plots are established and later re-located using the latest GPS technology, with high precision and accuracy.

Case study 1: The Victorian Forest Monitoring Program

Ground plots are installed and measured by teams of highly experienced and qualified contractor field crews. A detailed Quality Assurance program comprising regular training, certification, and auditing of field crews and data, is carried out by DEPI to ensure the field data meets standards required.

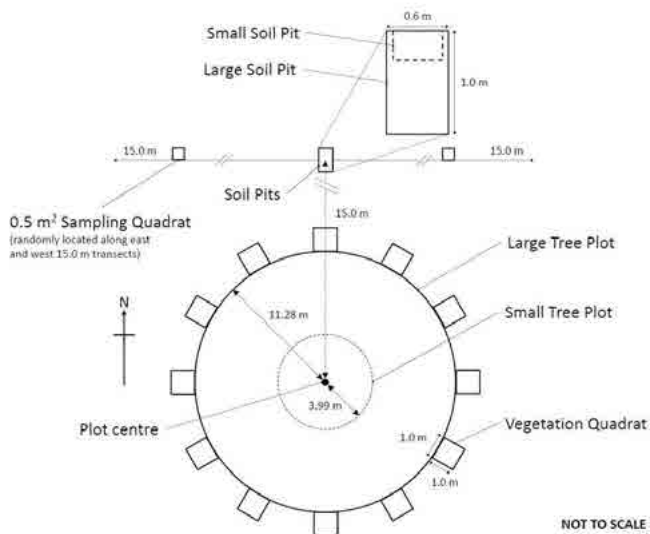As at December 2013, 356 VFMP ground plots have been installed and measured. Installation of the remaining plots is scheduled for completion by June 2015.

Figure 2 VFMP Ground Plot measurements

Measuring tree diameter. Credit DEPI

Measuring coarse woody debris. Credit DEPI

Remote Sensing

Aerial photography is used in the VFMP as the primary source of land cover information. Detailed digital aerial photography is used to identify broad forest types and structure across 2 km x 2 km photo plots located on each VFMP ground plot (Figure 3). Multi-year satellite imagery makes up a third tier of VFMP data, from which is mapped forest extent[2] (Indicator 1.1a) and derived forest fragmentation metrics (Indicator 1.1d).
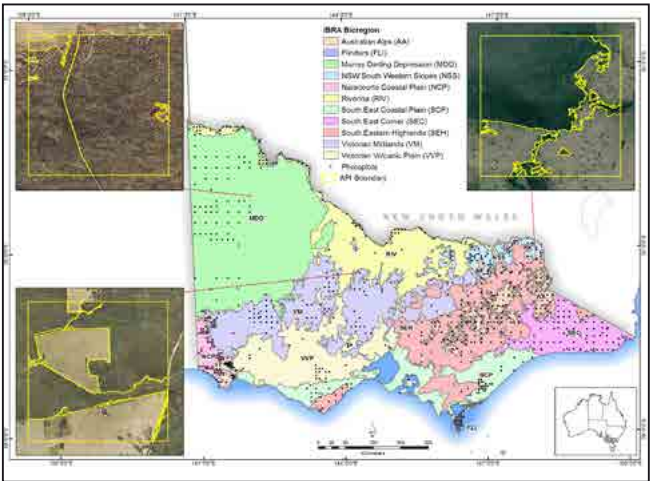
Figure 3 Example VFMP aerial photography land cover mapping. Source DEPI

Further information on the VFMP can be found at: http://www.depi.vic.gov.au/forestry-and-land-use/forest-management/forest-sustainability/victorian-forest-monitoring-program

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[2] Mellor A, Haywood A, Stone C, Jones S. The Performance of Random Forests in an Operational Setting for Large Area Sclerophyll Forest Classification. Remote Sensing. 2013; 5(6):2838-2856.

Case study 2: Gunaikurnai Traditional Owners Settlement Agreement

Theme: Social

Criterion: 6 - Maintenance and enhancement of long term multiple socio-economic benefits to meet the needs of societies (Indicators 6.4a, 6.4b, 6.5d, 6.5e, 6.6a)

On 22 October 2010, the Federal Court of Australia recognised that the Gunaikurnai people held native title over areas of land within the Gippsland region in Victoria's east (Figure 1). On the same day, the Victorian Government entered into an agreement with the Gunaikurnai people under the *Traditional Owner Settlement Act 2010* – the first to be made under the Victorian Act. The agreement also settled a native title claim dating back to 1997 (the Gunaikurnai people first lodged their claim with the National Native Title
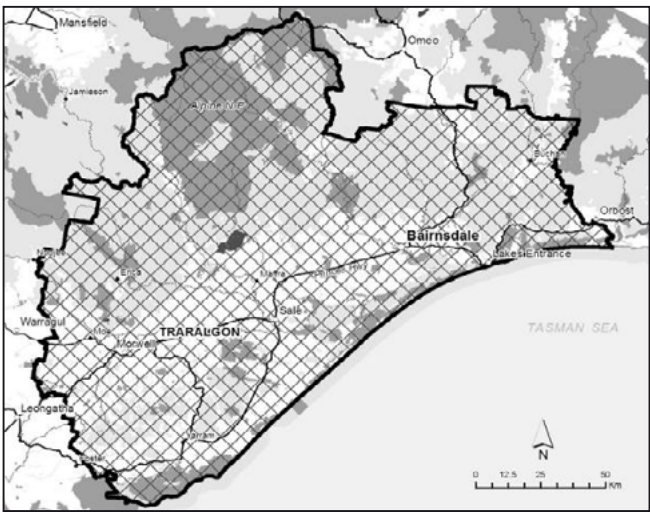
Figure 1. Settlement Agreement Boundary Map. Source DEPI

Tribunal in 1997). These developments formally recognised the Gunaikurnai people as the Traditional Owners of a designated area in Gippsland and that the Gunaikurnai hold native title over many areas of Crown land in the Gippsland region.

The agreement area extends from West Gippsland near Warragul, east to the Snowy River and north to the Great Dividing Range. It also extends 200 metres offshore. The determination of native title under the *Native Title Act 1993* covers the same area. Both the agreement and the native title determination only affect Crown land within this area.

The agreement includes:

- transfer of ownership of some National Parks and other Crown land reserves to the Gunaikurnai people to be jointly managed with the State of Victoria

- rights for the Gunaikurnai people to access and use the Crown land within the settlement area for traditional purposes, including hunting, fishing, camping and gathering in accordance with existing laws

- funding for the Gunaikurnai people to manage their affairs, including responding to their obligations under the settlement

- an undertaking to develop protocols to recognise the Gunaikurnai people and strengthen the Gunaikurnai culture.

As part of the Gunaikurnai settlement agreement, the State entered into a Traditional Owner Land Management Agreement to establish a **Gunaikurnai Traditional Owner Land Management Board,** to jointly manage ten National Parks and reserves in their agreement area. The board will be made up of 11 members, comprising 6 Gunakurnai members, and 5 general members. The board will jointly manage the Parks and reserves and will develop a management plan that will set the strategic direction for the land.

Federal Court Judge, Justice North with Gunaikurnai Elder Uncle Albert Mullett at the signing of the historic agreement. Credit: DEPI

The agreement allows for the Parks and reserves within the agreement area to be reclassified as `Aboriginal Title' (as a grant of Crown land to Traditional Owners for the sole purpose of being jointly managed with the State). They will continue to be managed under the same legislation through which they were originally reserved, with the same use and access provisions.

Case study 2: Gunaikurnai Traditional Owners Settlement Agreement

The following areas are classified as Aboriginal Title and subject to joint management:

- The Knob Reserve, Stratford (59 hectares)
- Tarra Bulga National Park (2,015 hectares)
- Mitchell River National Parks (14,250 hectares)
- Lakes National Park (2,390 hectares)
- Gippsland Lakes Coastal Park (17,610 hectares)
- New Guinea Cave (within Snowy River National Park) (location)
- Lake Tyers Catchment Area (8,500 hectares)
- Buchan Caves Reserve (232 hectares)
- Gippsland Lakes Reserve at Raymond Island (248 hectares)
- Corringle Foreshore Reserve (159 hectares).

The total area of land that will be managed under the agreement is approximately 45,463 hectares.

The establishment of joint management is seen as benefiting both the Gunaikurnai people and the wider community, recognising and incorporating Gunaikurnai culture and knowledge into park management – by conserving, protecting and enhancing natural and cultural values whilst providing quality tourism and educational experiences within the region. Many benefits – social and economic – will flow from joint management for the Gunaikurnai Traditional Owners, through improved recognition and continued strengthening of the cultural, historical and contemporary significance of this land to the Gunaikurnai people, as well as addressing their views and aspirations for the future.

Access and use on these areas of land will be outlined through a joint management plan, which will include a public consultation process and will be consistent with the statewide policy of maintaining public access to Crown land. Specifically:

- existing licences or leases within the joint management area will be protected – joint management will not impact on rights of existing lease and licence holders
- friends groups can continue to operate, subject to the direction of the State (who will remain the day-to-day manager) as well as the Traditional Owner Land Management Board
- recreational fishing and hunting will be able to continue to the extent that they currently do (any changes regarding access to hunting and recreational fishing would continue to be subject to a consultation process and approval by the Minister as part of the development of a joint management plan).

The establishment of "Aboriginal Rangers" is a program to be delivered under the agreement that will provide a platform for developing expertise and setting up long term employment opportunities, including building community capacity, in key aspects of the joint management. This will lead to the creation of transferrable skills that will help to address many of the socio-economic outcomes sought by both the Aboriginal and broader communities, in the longer term.

Key areas identified for building capacity include: tourism (interpretation-marketing), partnership development (commercial), land management operations and specific-skills training. These areas will provide the foundation for members of the Gunaikurnai to be effective partners in the management of key areas of Crown land, establishing a broader role as key stakeholders within public land management in the Gippsland region.

Other Agreements

Yorta Yorta Cooperative Management Agreement

The Yorta Yorta Cooperative Management Agreement was signed in June 2004 and establishes the Yorta Yorta Joint Body (YYJB), which comprises five representatives from the Yorta Yorta Nations Aboriginal Cooperation and three from the State. The YYJB provides advice and makes recommendations on a broad range of issues over designated areas of Crown land in north-eastern Victoria totalling 50,000 hectares, other specific parcels of public land and waters along the Murray and Goulburn Rivers.

Budja Bim Council

The settlement of the Gunditjmara Native Title claim includes a cooperative management agreement over Mount Eccles National Park in South West Victoria, that provided for the establishment of the Budja Bim Council. With six representatives of the Gunditjmara and four representatives of the State, the Council provides advice to the Minister for Environment and Climate Change on the management of Mount Eccles National Park. The Council will facilitate an exchange of ideas and information between the Gunditjmara Traditional Owners, land managers, Parks Victoria and the broader community.

References

http://www.justice.vic.gov.au/home/your+rights/native+title/Gunaikurnai+native+title+agreement

http://www.depi.vic.gov.au/forestry-and-land-use/managing-land/indigenous-land-management/agreements-with-traditional-owners#gunaikurnai

Case study 3: A new strategic approach to biodiversity management

Theme: Environmental

Criterion: 1 - Biological Diversity (Indicators 1.2a, 1.2b, 1.2d, 1.3b)

Background

The forests of eastern Victoria provide habitat for several threatened species as well as being an important source of timber. The Timber Industry Action Plan released by the Victorian Government in 2011 aims to provide for a productive, competitive and sustainable Victorian timber industry. In response to this plan, the 'A New Strategic Approach to Biodiversity Management' project was established to develop an effective landscape approach to the management of threatened species that provides opportunities for sustainable timber production while managing biodiversity at a species and landscape scale.

This project has both research and policy components. The aim of the research component is to provide extensive new data on the status, distribution and habitat use of priority threatened fauna species in the forests of eastern Victoria. This will then inform the development of the new landscape management approach developed in the policy component.

The Central Highlands was a high priority for investigation, due to the number of threatened species occurring in the area, the impact of the Black Saturday bushfires in February 2009 on both threatened species habitat and the timber resource, and the current review of the Forest Management Zoning Scheme for this area.

Credit: Arthur Rylah Institute

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Case study 3: A new strategic approach to biodiversity management

Central Highlands Project

Targeted surveys for nine high priority fauna species (Table 1) were conducted within the Central Highlands Regional Forest Agreement (RFA) area (Figure 1). Surveys were conducted across all public land, including State forests, and Parks and reserves.

The sampling strategy was designed to complement existing data sources and to provide the maximum information on species' current distribution and preferred habitat across the public land estate. Surveys were designed for each of the faunal groups using rigorous, randomised sampling designs. The survey methodology used to collect the new data included the most up-to-date survey methods for each group. Each survey site was visited on multiple occasions to increase the likelihood of detecting the target species. In addition, for cryptic species such as Leadbeater's Possum, a new survey method was developed in which thermal imaging cameras were used in conjunction with the playing of their alarm calls through a loudspeaker. This greatly increased the chances of locating this difficult-to-detect species during surveys (Figure 2).

Leadbeaters Possum. Credit: Tamara Leitch and Claire McCall

Table 1. Species selected for field sampling within the Central Highlands. Source DEPI

Faunal Group	Species	
Mammals	Leadbeater's Possum	*Gymnobelidus leadbeateri*
	Smoky Mouse	*Pseudomys fumeus*
	Greater Glider	*Petauroides volans*
	Yellow-bellied Glider	*Petaurus australis*
Birds	Powerful Owl	*Ninox strenua*
	Sooty Owl	*Tyto tenebricosa*
	Masked Owl	*Tyto novaehollandiae*
Fish	New species of galaxias	*Galaxias sp.* 8 (Stoney)
		Galaxias sp. 9 (Rintoul)
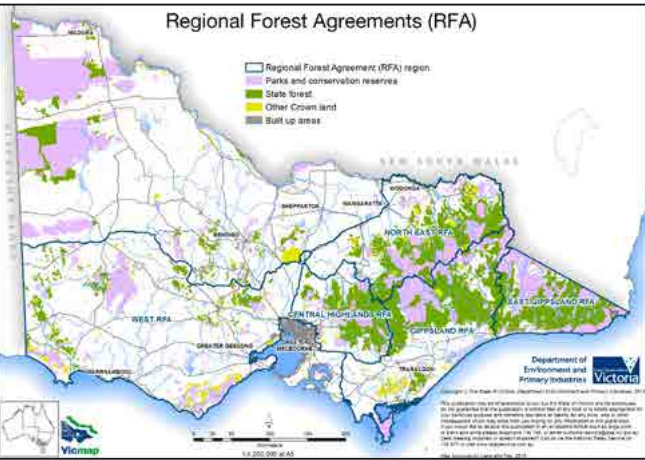
Figure 1. Regional Forest Agreement regions in Victoria. Source DEPI

Figure 2. Leadbeater's Possum (yellow spot in the centre of the image) detected by thermal imaging camera. Source DEPI

A large area of the Central Highlands was burnt in the Black Saturday bushfires, including approximately 34% of the potential ash forest habitat of Leadbeater's Possum, and 45% of the 30,500 ha Leadbeater's Possum reserve system established in 2008 as a key strategy for the conservation of the species. As Leadbeater's Possum only occurs in the Central Highlands and was severely affected by this fire, additional surveys were undertaken targeting unburnt islands of potential habitat within the fire-affected area. These refuges were initially identified by examining aerial infrared images taken 1 month after the fire (Figure 3).

Case study 3: A new strategic approach to biodiversity management

Figure 3. An unburnt island of vegetation (deep pink) with adjacent areas that were scorched (understorey burnt but the canopy unburnt; paler pink), surrounded by severely burnt areas where all vegetation was killed (brown) as revealed by aerial infrared imagery. Source DEPI

Data analysis and modelling

Survey data collected for each of the target species were used to update Species Distribution Models which predict the likely occurrence of suitable habitat for the target species throughout eastern Victoria. Occupancy models were also developed to represent the current distribution of six of the target species. These models reflect the impact of recent disturbances (e.g. the 2009 bushfires) on current patterns of habitat occupancy, while Species Distribution Models reflect patterns of habitat use over a longer time horizon.

A Population Viability Analysis was undertaken for Leadbeater's Possum to assess the current status, population trend and whether current reserves are sufficient to sustain viable populations under different scenarios including future bushfires.

Key findings

- Overall, 660 sites were surveyed in the Central Highlands RFA generating 293 new records of the targeted threatened species.

- Only a small number of records were obtained of Leadbeater's Possum (16% of 180 sites sampled), with no possums detected at sites burnt during the 2009 bushfires, irrespective of the fire intensity, confirming the strongly negative impact of the fire on this species. Current strongholds for the species include unburnt habitat mainly in the south of the Central Highlands.

- Surveys of unburnt refuges revealed that Leadbeater's Possums persist in some unburnt patches of habitat within the larger fire-affected area. If these colonies are able to persist in these 'refuges' this may greatly facilitate the species' ability to recolonise burnt areas once the habitat becomes suitable. As such, these sites will be critical for the long-term conservation of the species.

- Population Viability Analysis revealed that under scenarios of habitat loss due to the death and collapse of nest trees, and future bushfires, the Leadbeater's Possum reserve system alone is insufficient to ensure the long-term conservation of the species. These results indicate that additional management actions will be needed to reduce the extinction risk of Leadbeater's Possum throughout its range.

- No additional populations of galaxiids were located from the LaTrobe River or Thomson River catchments; the entire distribution of *Galaxias* sp. 8 is confined to a short section of Stoney Creek and *Galaxias* sp. 9 (Figure 4) to a short section of the east branch of Rintoul Creek.

Figure 4. *Galaxias* sp. 9 (Rintoul). Image of a 65 mm long gravid female. Source DEPI

Figure 5. Smoky Mouse photographed at a bait station during camera trap surveys in the Central Highlands. Source DEPI

- Smoky Mice were detected using camera trapping (Figure 5) from several areas within the Central Highlands RFA increasing its known distribution. Modelling highlighted the sparse and patchy distribution of this species and the importance of dry ridge-top habitats.

- Sooty Owls and Powerful Owls were widespread throughout the Central Highlands RFA, with Sooty Owls more likely to occur in wet gullies in the south, and Powerful Owl more likely to occur on drier rugged terrain in the south-east and north-east of the survey area. Both species were less likely to occur in areas burnt in 2009. Only two records of Masked Owls were obtained from the 200 sites surveyed for large forest owls.

- Greater Gliders were detected at less than 20% of survey sites and have undergone a marked decline throughout the Central Highlands from being common and widespread until recently. This species prefers moist, rugged areas with lush vegetation, and areas most likely to be occupied are now patchily distributed in the centre and east of the Central Highlands (Figure 6).

- Occupancy models developed for Leadbeater's Possum, Powerful Owl, Sooty Owl, Smoky Mouse and the two glider species predicted where each of this species were most likely to occur in the survey area and the habitats that were most likely to be occupied.
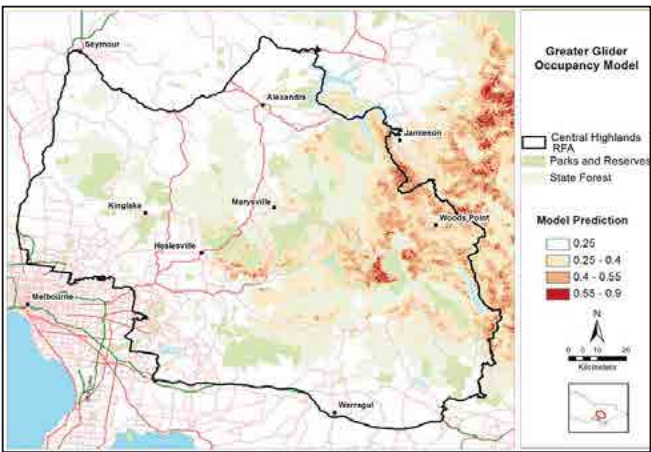
Figure 6. Areas most likely to be currently occupied by the Greater Glider, as predicted using occupancy modelling. Source DEPI

Outcomes

The collection of new data for the nine key species included in the research component of this project has been instrumental in gaining an accurate and up-to-date understanding of the species' status, distribution and habitat requirements. The population and habitat models developed have been used to predict current distribution and where suitable habitat is likely to occur to help identify the most important areas for the conservation and management of these species. This information will contribute to the development of a new, strategic approach to the management of threatened fauna species across the public land estate.

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Greater Glider. Credit: Ed McNabb

Case study 4: Victorian Bushfire Rapid Risk Assessment Teams

Bushfire Rapid Risk Assessment Teams

When a major bushfire or other emergency event occurs, Victoria is able to call in Bushfire Rapid Risk Assessment Teams (Bushfire RRATs) to help rapidly identify, assess, prioritise and evaluate any risks on public land and neighbouring private land, to minimise further threat to life and property, critical infrastructure and the environment.

Credit: DEPI

BRRAT aerial survey of fire severity over bushfire affected area.
Credit: DEPI

Case study 4: Victorian Bushfire Rapid Risk Assessment Teams

The Bushfire RRATs are multi-disciplined Victorian Government teams with expertise in areas such as biodiversity, flooding and erosion, cultural heritage, asset management, mapping and forest science.

The Bushfire RRATs are modelled on the USA Burnt Area Emergency Response Teams (BAER) that were successfully deployed to Victoria during the 2009 bushfire season. The BAER reports provided a starting point for local recovery planning, and helped regional staff identify the biggest risks that needed to be addressed.

Among the common risks within bushfire affected forested areas are:

- Debris flows, landslides and falling trees

- Sedimentation of water courses, loss of biodiversity habitat and decline in water quality

- Damage to trees and young regeneration, loss of timber supply and productive capacity

- Soil erosion (see Indicator 4.1)

- Increased weed invasion and predation (see Indicator 1.2d)

- Damage to cultural heritage sites

- Damage to built infrastructure (roads, bridges and culverts).

Bushfire RRATs are a statewide resource who contribute to the emergency stabilisation and initial recovery phase of an emergency and assist emergency and land managers' transition from response to recovery.
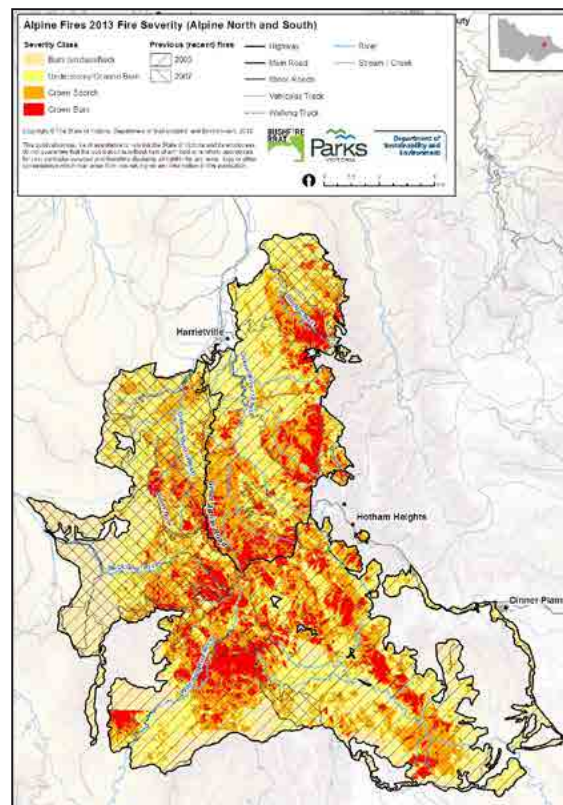
Bushfire burn serverity map. Source DEPI

BRRAT team. Credit: DEPI

Case study 4: Victorian Bushfire Rapid Risk Assessment Teams

When deployed, the Bushfire RRATs assess potential impacts to the area through a combination of desktop analyses, aerial surveys and site assessments (where safe). Desktop analyses draw upon inputs such as GIS layers, information from regional contacts, and RRATs' own experience and expertise.

Within seven days the Bushfire RRATs provide the local land manager with a snapshot assessment of the priority risks identified following a bushfire (or other emergency) and provide practical treatment solutions and approximate costs for risk mitigation. The risk assessment process focuses on potential risks to life and property, critical infrastructure and the environment (both natural and cultural) on public land, including potential impacts on properties adjoining public land. The report can be used to support a funding application, initiate recovery planning and insurance claims, and help determine workforce planning beyond the initial emergency response stage.

By providing a rapid assessment of the risks, and identifying the problems that need to be fixed quickly, the Bushfire RRATs enable land managers to start their own recovery planning. By helping the land managers start their recovery planning sooner, the Bushfire RRATs are able to improve the recovery outcomes for threatened species, forest regeneration and public safety.
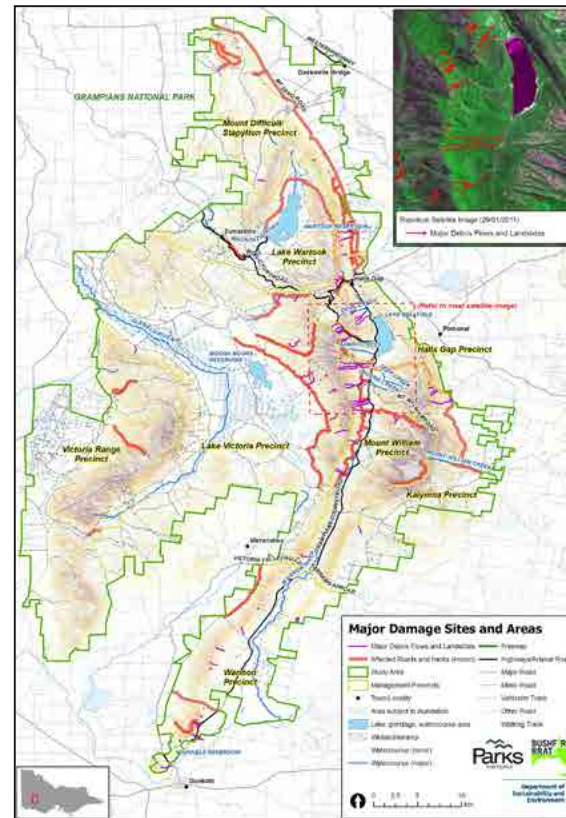
Landslides map, Grampians National Park. Source DEPI

Credit: DEPI
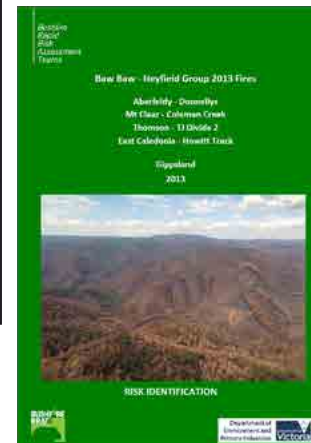
Credit: DEPI

Case study 5: Collaborative research for forest assessment and monitoring

Theme: Environmental, Social and Governance and law

Criterion: 1 (Conservation of biological diversity), 3 (Maintenance of ecosystem health and vitality) and 5 (Maintenance of forest contribution to global carbon cycles), 7 (Legal, institutional and economic framework for forest conservation and sustainable management)

Mountain ash. Credit: Sitkasitchensis

Introduction

DEPI is required to map, monitor and report on the condition (i.e. extent, configuration and health) of native woody vegetation, including forests. Research being undertaken by DEPI and RMIT University through the Cooperative Research Centre for Spatial Information (CRCSI) is aimed at developing new tools for characterising woody vegetation and forests at landscape scales using satellite imagery, aerial survey and ground measurements. The research will identify and derive a set of variables for some of southeast Australia's unique woody vegetation and forest environments, such as canopy height, canopy cover and leaf area index[1] and ultimately produce spatial layers (digital maps) for use in carbon accounting, biodiversity and ecosystem health assessment and fire management.

The research is being undertaken in collaboration with other interstate agency partners in Queensland (Department of Science, Information Technology, Innovation and the Arts) and New South Wales (Department of Primary Industries). Research tools will be available to organisations to support Australia land management agencies' sustainable land and forest management decision making and for monitoring, mapping and natural resource management activities.

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[1] A measure used to quantify canopy density and characterise plant canopies

Data collection

Several sources of remote sensing (i.e. aerial and satellite data) were acquired over each research site, including

- LiDAR (Light detection and ranging technology)
- Hyperspectral data
- Digital aerial photography
- Multispectral satellite imagery (RapidEye and Landsat).

Concurrent to image acquisition, field inventory data were collected across the three sites, including tree measurements (such as height and diameter), coarse woody debris, canopy hemispherical photography and terrestrial laser scans (Figure 5).

Data processing and results

A range of forest parameters (e.g. Leaf Area Index, canopy chemical composition, vertical structure and canopy complexity) have been derived from active (LiDAR, Figure 6a) and passive (RapidEye, Figure 6b) sensors. Tools for landscape forest assessment are being created in open-source software so they can be adopted by state agencies as part of their reporting and monitoring programs.

Case study 5: Collaborative research for forest assessment and monitoring

Research sites

Three research sites have been established for the project, each located in undisturbed forest areas representing an important Victorian forest ecosystem (Figure 4) and described below:

1. **Short open canopy forest, Rushworth, central Victoria**. Box-Ironbark forest dominated by red iron bark (*Eucalyptus tricarpa*), red stringy bark (*Eucalyptus macrorhyncha*), red box (*Eucalyptus polyanthemos*), yellow box (*Eucalyptus melliodora*) and grey box (*Eucalyptus microcarpa*) (Figure 1).

Figure 1. Box-Ironbark forests, Rushworth, central Victoria. Credit: DEPI

2. **Tall closed canopy forest, Watts Creek, Victorian Central Highlands**. Wet Sclerophyll forest representative of the plateaux and slopes of the upper watershed areas south of the Great Dividing Range. Species composition is characterised by a mature open forest of mountain ash (*Eucalyptus regnans*), Shining Gum (*Eucalyptus nitens*) and Alpine Ash (*Eucalyptus delegatensis*), vegetation is much denser and predominantly consists of two or more canopy layers (Figure 2).

Figure 2. Wet ash forests in the Victorian Central Highlands. Credit: DEPI

3. **Mixed-Species Dry Sclerophyll forest, Zig Zag Creek, east Victoria**. The vegetation of this region is dominated by Shrubby Dry Forest and Damp Forest on the upland slopes; Wet Forest ecosystems which are restricted to the higher altitudes; and Grassy Woodland, Grassy Dry Forest and Valley Grassy Forest ecosystems are associated with major river valleys (Figure 3).

Figure 3. Mixed species forest in Victorian south east corner. Credit: DEPI

Other forest monitoring research activities are co-located at each site, including VEGNET, VFMP ground plots and field data collected through the Terrestrial Ecosystem Research Network (TERN) calibration/validation program[2]. Collaborative research ventures such as this[3], involving infrastructure and data sharing, allow multiple stakeholders to benefit from research outcomes that might otherwise be cost prohibitive. This collaborative framework results in extensive data collected over the research sites which can be used to train new models and tools for large area forest assessment at different scales.
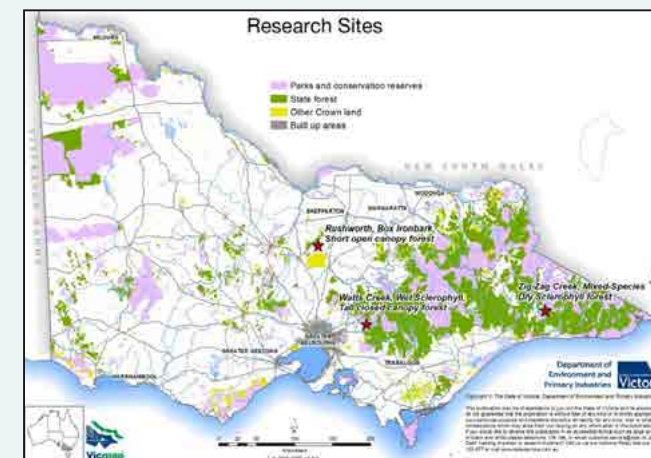

Figure 4. Location of CRCSI Project Research Sites. Source DEPI

[2] Through the TERN calibration and validation (CALVAL) program, Auscover coordinates and conducts an extensive field data collection campaign across many Australian forest ecosystems (including sclerophyll forests, savanna woodlands, grasslands and tropical forests).

[3] Soto-Berelov, M.; Jones, S.; Mellor, A.; Culvenor, D.; Haywood, A.; Suarez, L.; Wilkes, P.; Woodgate, W.; Newnham, G., "A collaborative framework for vegetated systems research: A perspective from Victoria, Australia," Geoscience and Remote Sensing Symposium (IGARSS), 2013 IEEE International , vol., no., pp.3934,3937, 21-26 July 2013

Case study 5: Collaborative research for forest assessment and monitoring

Figure 5. 3D terrestrial laser scan at Watts Creek (Riegel Vz400) (courtesy of Kim Calders, Wageningen University)
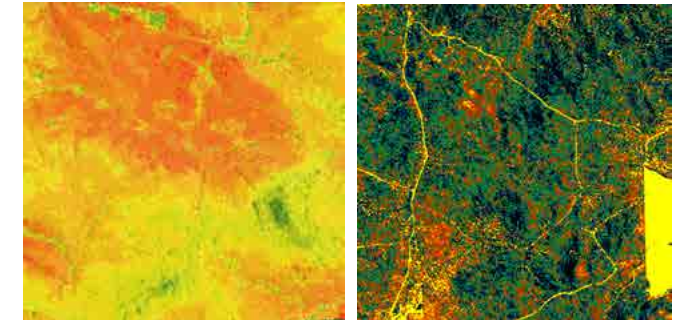

a   b

Figure 6. Examples of large area assessment. (a) Canopy height in Watts Creek where canopy height ranges between 10 (green) and 90 m. (orange). (b) Map representing different pigmentation levels in Rushworth forest. Yellow-red areas denote low pigment content and dark areas represent higher pigment concentration. Source RMIT University

Project outcomes

This project aims to develop tools to characterise woody vegetation at the regional scale using field, airborne and satellite data. First, field inventory data collection has been optimised by comparing different instruments and sampling designs. Then, the project has developed tools to derive canopy properties using image data on open-source software packages. These tools can be used by state agencies for large area forest reporting and monitoring. Final attribute maps will be combined into landscape features which can help management decision making.

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Case study 6: Technology applications for forest assessment and monitoring

Theme: Environmental, Social and Governance and law

Criterion: 1 (Conservation of biological diversity), 3 (Maintenance of ecosystem health and vitality) and 5 (Maintenance of forest contribution to global carbon cycles), 7 (Legal, institutional and economic framework for forest conservation and sustainable management)

Introduction

This case study describes some of the ways in which technology and research is being used to improve the way Victoria assesses monitors and manages its native forests. Coordination and investment in new technology infrastructure by land management, academic and scientific communities is improving the quality and effectiveness of forest ecosystem assessment and monitoring in Victoria. The following sections describe some of these forest monitoring activities and how outcomes are being used by the Victorian Government to improve forest management decision making.

Time lapse photograph of VEGNET laser scan. Credit: Environmental Sensing Systems

'VEGNET' In-Situ Monitoring Laser Scanning System

Forests are inherently dynamic environments, affected by a range of disturbance and other change processes. This includes slow, continuous and subtle forest development and succession, as well as discontinuous and sudden natural (e.g. insect attack) and human disturbance (e.g. timber harvesting[1] and bushfires[2]). 'VEGNET' In-Situ Monitoring Laser Scanning System. Traditional fieldwork methods can be unsuitable and expensive for identifying and monitoring subtle forest disturbance and changes.

Developed in collaboration with CSIRO[3], Environmental Sensing Systems and DEPI, 'VEGNET' sensors are a world-first laser-scanning technology being trialled in three Victorian forests. VEGNET automated *in-situ* forest monitoring scanners are designed to capture daily three-dimensional profiles of forest structure. The main strength of VEGNET is the ability to take automated measurements of forest structure over long periods of time with high temporal frequency (i.e. months to years, with daily measurements).

Benefits of the VEGNET system include:

1. **Low cost** VEGNET scanners use an 'off-the-shelf' laser distance meter and are built at a fraction of the cost of alternative laser scanning technology. As such, they offer a low-risk investment, which is particularly important for installation in remote, harsh and bushfire prone areas over long periods of time.

2. **Weatherproof and solar powered**, suitable for remote areas.

3. **Autonomous**. VEGNET scanners are built to sleep during the day and activate at a set time each night to scan the forest.

4. **Wireless.** Scanning data is sent wirelessly each night to a central secure database.

As well as detecting subtle and abrupt changes in forest phenology, the ground-based VEGNET data can be used to validate and complement forest change analysis and monitoring from satellite imagery.

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1   Refer to Indicator 2.3
2   Refer to Indicator 3.1

3   Commonwealth Scientific and Industrial Research Organisation

Case study 6: Technology applications and research for forest assessment and monitoring

VEGNET Specifications

Scan Angle: 57.5 degrees zenith   **Wavelength**: 635 nm   **Scan Data**: 1000 spot measurements of canopy structure

Range: 50-60 m   **Scan Time**: 40 minutes each night   **Data Transfer**: near real-time transferred wirelessly to the internet

Figure 1 are graphs showing cumulative results (scanning data) collected over sixteen months at a research site in Box-Ironbark forest in Central Victoria. The graphs show different representations of Plant Area Index (PAI)[4] measured over an area of approximately 1 hectare. Plant area is a dynamic entity, changing in response to growing conditions, succession and disturbance. VEGNET data is providing insights into how plant area changes vertically (from the ground to the top of the canopy), and seasonally. The graph in the top-left shows the cumulative increase in PAI from the ground upwards. Each line in the graph represents daily VEGNET data aggregated at a monthly timescale. Change in the cumulative PAI vertically through the canopy is depicted as the Plant Area Volume Density (PAVD) as shown in the top-right. This graph paints a structural picture of the forest. It shows some emergent trees up to 31 m tall, but the majority of the vegetation in this area of forest is distributed below 16 m and there is little vegetation above 24 m. The lower graph shows the change in total PAI over time, capturing the inherent seasonality of forest growth.

Left: Upward and downward looking VEGNET scanner instruments. ***Top middle:*** VEGNET instrument interior. ***Top right:*** Time-lapse VEGNET laser scan. ***Bottom right:*** Solar panel charger and research site weather station. ***Bottom middle:*** Example 'off-the-shelf' laser distance meter used in VEGNET.
Credit: CSIRO and Environmental Sensing Systems

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[4] A quantity which describes the one-sided area of foliage and plant material (including stems and branches) per unit of ground area. Conceptually, this is equivalent to laying all plant material within a given area flat against the ground and measuring its area. PAI is a dynamic entity. Measuring the change in PAI over time is important as an indicator of vegetation growth and condition.

Case study 6: Technology applications and research for forest assessment and monitoring

As more data is acquired, researchers and land managers will be able to quantitatively compare the structural dynamics of forests and their response to different growing conditions or disturbance. Figure 2 shows maximum mean temperature recorded by the VEGNET site weather station.

Still from the VEGNET research video. Click the image to view the video on youtube. Credit: DEPI

VEGNET instruments are co-located at three Victorian forest collaborative research sites, where forest monitoring research is being undertaken through Australia's Terrestrial Ecosystem Research Network and RMIT University. For further information on this collaborative research and the field sites, refer to Case study 5: Collaborative forest assessment and monitoring research.
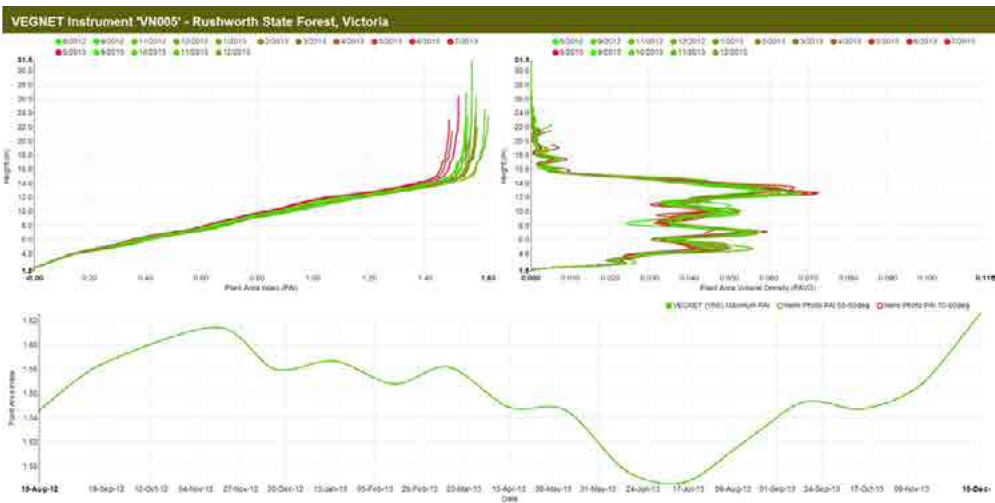

Figure 1. Graphs showing time-series VEGNET scanning data over 16 months (Sept 2012 – December 2013). Source DEPI
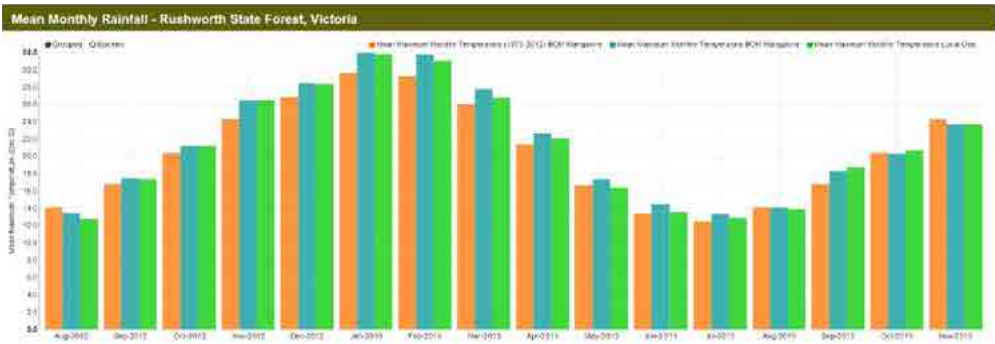

Figure 2. Mean maximum temperature, from the box-ironbark forests research site. Source DEPI

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Case study 7: The Joint Remote Sensing Research Program

Theme: Environmental

Criteria: 1 (Conservation of biological diversity), 3 (Maintenance of ecosystem health and vitality) and 5 (Maintenance of forest contribution to global carbon cycles)

Introduction

The Joint Remote Sensing Research Program (JRSRP) aims to provide a hub of expertise which increases capacity to conduct pure and applied remote sensing research, with a focus on monitoring biophysical properties of the environment (including forests and woody vegetation) at local, state, regional and national scales.

Initially a partnership between the University of Queensland and the Queensland Department of Science, Information Technology, Innovation and the Arts (DSITIA) beginning in 2007, the program has since grown to include the New South Wales Office of Environment and Heritage (OEH) in September 2008, the Terrestrial Ecosystem Research Network (TERN) Auscover (Brisbane node) and the Victorian Department of Environment and Primary Industries (DEPI) in 2010.

Remote Sensing

Remote sensing is the science and technology by which characteristics of objects of interest can be identified without direct contact, such as satellite imagery or aerial survey. Remote sensing is a relatively low cost means of repeatedly acquiring up-to-date information about land cover and over large geographical areas. However, as data are not direct samples of land cover phenomenon, they must be calibrated against field data.

Satellite and airborne imaging of terrestrial, atmospheric and aquatic environments is used to map, monitor and model the biophysical properties and processes in our ecosystems. Through quality science, the JRSRP build, implement, assess and improve procedures for state governments to monitor
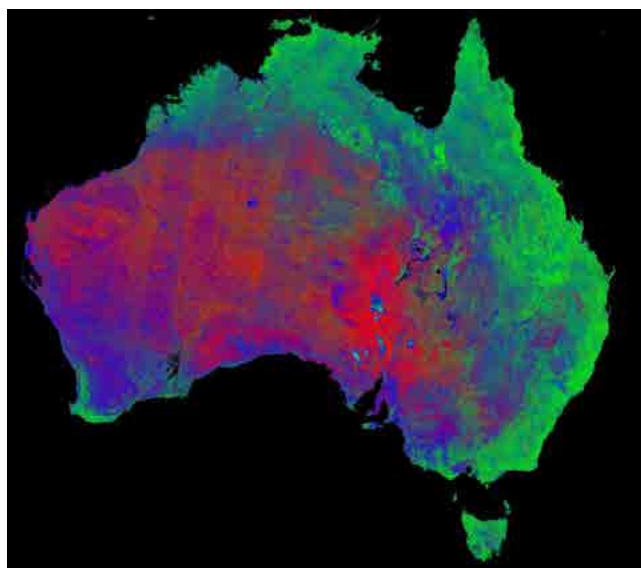
Vegetation Fractional Cover across Australia. Source: JRSRP

changes to our natural environments, specifically forest and vegetation composition, structures and processes. The JRSRP translate research into operational processes to meet government monitoring requirements to assist in the development of effective environmental management policies and legislated activities for:

- Vegetation management
- Catchment management
- Land use planning and practices
- Carbon stock assessment

Case study 7: The Joint Remote Sensing Research Program

The JRSRP has invested considerable resources into the development of a range of time-series image correction algorithms and analysis tools to support research efforts. The focus of which is to produce standardised, calibrated and validated biophysical map products. Among the current research initiatives are:

- Development of automated image-georegistration software

- Calibration of airborne and satellite-based camera systems

- Development and assessment of Landsat sensor replacement options and procedures

- Development of fully corrected time series images

- Atmospheric and topographic correction of satellite imagery

- Integration of field, LiDAR and imaging radar to map vegetation structure and biomass.

Through the JRSRP, the DEPI Victorian Forest Monitoring Program (VFMP) is using remote sensing technology to produce time-series forest cover maps, incorporating 20 years of satellite imagery, topographic and climate data. Through access to high performance computing infrastructure and international best practice image processing techniques and procedures, DEPI is making significant improvements in the way Victoria's forests are mapped and monitored over time.
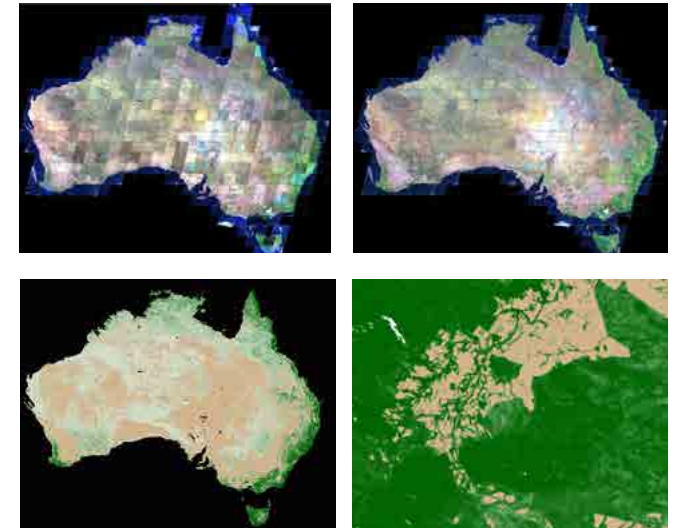
Australian persistent green vegetation (PGV) map derived from standardised Landsat satellite imagery. Source: JRSRP

Glossary of Terms

Acronyms

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ABC	Actions for Biodiversity Conservation database
ABS	Australian Bureau of Statistics
AC	Adaptive Capacity
ANZSIC	Australian and New Zealand Standard Industrial Classification
AO	Allocation Order
APZ	Asset Protection Zone
BAER	Burnt Area Emergency Response Teams
BMO	Bushfire Management Overlay
BMZ	Bushfire Moderation Zone
BN	Baysian Networks
Bushfire RRAT	Bushfire Rapid Risk Assessment Teams
CAPAD	Collaborative Australian Protected Areas Database
CAR	Comprehensive, Adequate and Representative
CI	Confidence interval
CRCSI	Cooperative Research Centre for Spatial Information
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Cth	Commonwealth
DBH	diameter at breast height

DEPI	Department of Environment and Primary Industries
DPI	Department of Primary Industries (former)
DSE	Department of Sustainability and Environment (former)
ECC	Environmental Conservation Council (now known as Victorian Environmental Assessment Council (VEAC))
EPA	Environment Protection Agency
EPBC	Environmental Protection and Biodiversity Conservation
FAP	Forest Audit Program
FFB	Foothills Fire and Biota project
FFG	Flora and Fauna Guarantee
FIS	Forest Industry Survey
FMA	Forest Management Area
FMZ	Forest Management Zones
FPSS	Forest Produce Sales System
GIS	Geographic Information System
GMZ	General Management Zone
GPS	Global Positioning System
GST	Goods and Services Tax
IBRA	Interim Biogeographic Regionalisation for Australia
ISC	Index of Stream Condition
IUCN	International Union for Conservation of Nature

JRSRP	Joint Remote Sensing Research Program
LAI	Leaf Area Index
LiDAR	Light detection and ranging technology
LMZ	Landscape Management Zone
NSW	New South Wales
PAI	Plant Area Index
PAVD	Plant Area Volume Density
PBEZ	Planned Burning Exclusion Zone
RFA	Regional Forest Agreement
SD	Standard deviation
SEEA-CF	System of Environmental-Economic Accounting –Central Framework
SEEA-EEA	System of Environmental-Economic Accounting – Experimental Ecosystem Accounts
SFM	Sustainable Forest Management
SMZ	Special Management Zone
SFR	State of the Forests Report
SPZ	Special Protection Zone
TERN	Terrestrial Ecosystem Research Network
TIAP	Timber Industry Action Plan
VEAC	Victorian Environmental Assessment Council (previously known as ECC)
VFMP	Victorian Forest Monitoring Program
YYJB	Yorta Yorta Joint Body

Glossary of Terms

Glossary

Allocation Order
See Indicator 2.3

Ash forests
A collective term used for forests comprising mainly Eucalyptus regnans (Mountain Ash), Eucalyptus delegatensis (Alpine Ash) and Eucalyptus nitens (Shining Gum) species.

Asset Protection Zone
A Fire Management Zone where fuel is treated intensively to provide the highest level of localised protection to human life and property and key community assets.

Biodiversity
The natural diversity of all life: the sum of all our native species of flora and fauna, the genetic variation within them, their habitats, and the ecosystems of which they are an integral part.

Bioregions
Large, geographically distinct areas of land that share common characteristics, including geology, landform patterns, climate, ecological features and plant and animal communities.

Buffer (strip)
A protective margin of vegetation abutting a stream, spring, wetland, body of standing water, swampy ground or an area of rainforest, which protects it from potentially detrimental disturbances in the surrounding forest. Buffer width is defined as horizontal distance from which various operations are excluded. A protective margin of vegetation around the edge of an area which shields or protects the surrounding forest from the effects of, for example, a fire or timber harvesting activities.

Bushfire
A general term used to describe a fire in any vegetation.

Bushfire management
All those activities undertaken to reduce bushfire hazard and impacts on communities, industries and the environment including:

- Actions directed to risk management, prevention, preparedness, fuel management, response, recovery, monitoring, evaluation and reporting

- Actions under legislation, policy, planning, community engagement, training, equipment, communications, and research

- The use of fire to meet land management and ecological objectives

Bushfire Moderation Zone
A Fire Management Zone which aims to reduce the speed and intensity of bushfires. It complements the Asset Management Zone in that the use of planned burning is designed to protect nearby assets, particularly from ember spotting during a bushfire.

Bushfire RRAT
A team of specialists who assess post fire threats to ecosystems and threatened species, infrastructure, socio-economic wellbeing and human life.

Catchment
Areas of the landscape that supply surface water to a common body of water downstream.

Clear fell system
A silvicultural method of harvesting a coupe whereby all merchantable trees, apart from those to be retained for wildlife habitat, are removed.

Coarse Woody Debris
Piece(s) of dead woody material, e.g. tree trunks, limbs, roots, on the ground in stands or in streams.

Competition
(In the context of forest growth) the relative growth of trees (stem and canopy) as a consequence of limited availability of water, nutrient and light due to other neighbouring vegetation.

Coupe
as defined in the *Sustainable Forests (Timber) Act 2004* means a specific area of State forest identified for the purposes of a timber harvesting operation in a timber release plan or, on private land a single area of forest or plantation of variable size, shape and orientation from which timber is harvested in one operation.

Critically Endangered
An IUCN Red List conservation status category used for individual taxon when the best available evidence indicates that it is considered to be facing an extremely high risk of extinction in the wild.

Crown cover
The percentage of the ground covered by a vertical projection of the outermost perimeter of the natural spread of the foliage of plants. Cannot exceed 100 percent.

Crown Land
See Introduction key terms and definitions

Data Deficient
An IUCN Red List conservation status category used for individual taxon when there is inadequate information to make a direct, or indirect assessment of its risk of extinction based on its distribution and/or population status.

Glossary of Terms

Decile
Ranking of a climate element, compared with the average for an area. To calculate deciles data is arranged in ascending order (from lowest to highest), then divided into ten equal parts (i.e. ten blocks of 10%). The first group (the lowest 10% of rainfall totals on record) is decile range one, the second group decile range two, up to the highest 10% of rainfall totals being in decile range 10.

Declared
catchment Areas of the landscape set out in the *Catchment and Land Protection Act 1994* as special water supply catchment areas.

Designated catchment
Catchment areas within Parks and conservation reserves set out in the *National Parks Act 1975* as designated water supply catchment areas.

Disturbance
Any range of factors affecting the condition of natural areas. Disturbance may be natural or human-induced. Natural disturbance includes bushfires and storms and is part of natural ecological processes. Human-induced or 'unnatural' disturbance includes timber harvesting, agricultural clearing, mining and grazing. The factors that are important when considering disturbance are the origin, duration, and intensity of the disturbance and its impact on the environment.

Diversity
A measure of the physical or biological complexity of a system. It refers to a range of features from artefacts to species present.

Ecological Vegetation Class
The components of a vegetation classification system. They are groupings of vegetation communities based on floristic, structural and ecological features.

Ecosystem
All the organisms (including plants and animals) present in a particular area together with the physical environment with which they interact.

Ecosystem function
The physical, chemical, and biological processes or attributes that contribute to the self-maintenance of an ecosystem. Some examples of ecosystem functions are wildlife habitat, carbon cycling, or trapping nutrients.

Endangered
An IUCN Red List conservation status category used for individual taxon when the best available evidence indicates it is considered to be facing a very high risk of extinction in the wild.

Environmental watering
Delivery of environmental water to sustain river, wetland and floodplain ecosystems.

Erosion risk
The likelihood of erosion occurring due to soil erodibility, rainfall erosivity, slope and soil disturbance.

Exotic
Introduced to Australia, not native.

Extinct
An IUCN Red List conservation status category used for individual taxon when there is no reasonable doubt that the last individual has died.

Extinct in the wild
An IUCN Red List conservation status category used for individual taxon when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range.

Fauna
A general term for animals including: amphibians, birds, fish, invertebrates, mammals and reptiles.

Filters
A strip of vegetated ground adjacent to a waterway (with merchantable overstorey removed) retained to minimise soil compaction and erosion. Trees may be felled from within a filter strip subject to certain conditions, however machinery entry is generally not permitted.

Fire Management Zone
Areas of public land where fire is used for specific asset, fuel and overall forest and park management objectives.

Fire prevention
All activities concerned with minimising the incidence of bushfire, particularly those of human origin.

Fire regime
The frequency, intensity, season and scale of fire in a given area over a period of time.

Fire suppression
The activities connected with restricting the spread of bushfire following its detection and making it safe.

Flora
A general term for vascular plants and other flora of a particular area or time.

Forest
a land area, incorporating all living and non-living components, dominated by trees having usually a single stem and a mature or potentially mature stand height exceeding two metres and with existing or potential crown cover of overstory strata about equal to or greater than 20 percent. This definition includes native forests and plantations and areas of trees that are sometimes described as woodlands

Glossary of Terms

Forest coupe plan
A plan that must be prepared for each timber harvesting operation in State forest, containing a map identifying the area and a schedule incorporating the specifications and conditions under which the timber harvesting operation is to be administered and controlled.

Forest dependent species
Taxon that rely on forest habitat for all or part of their life cycle.

Forest health
A measure of the organisation, productivity and resilience of a forest ecosystem.

Forest Management Areas
The basic units for forest planning and management in Victoria. Currently Victoria is divided into fifteen Forest Management Areas as defined in the *Forests Act 1958*.

Forest Management Plan
A plan developed to address the full range of values and uses in State forest by Forest Management Area.

Forest Management Zone
An area of similar physical capability or forest value to which a particular strategy and specific prescriptions may apply. There are three zones: the Special Protection Zone (SPZ), Special Management Zone (SMZ) and the General Management Zone (GMZ).

Forest Park
An area of land permanently reserved under section 47D and described in Part 7 Schedule 5 of the *Crown Land (Reserves) Act 1978*.

Forest Structure
the spatial arrangement of the various components of a forest ecosystem.

Forested catchment
Victorian catchments identified as being designated, declared or vested in Melbourne Water.

Formal reserves
Crown lands formally reserved for environmental protection and including National Parks, nature conservation reserves, State Parks and conservation areas.

Fuel hazard
A fuel complex defined by volume, type, condition, arrangement and location that determines both the ease of ignition and of fire suppression difficulty.

General Management Zone
Areas of State forest managed for a range of uses and values, with high priority for timber production.

Geographic Information System
A system which holds spatially referenced data which can be classified, overlaid, analysed and presented in map, tabular or graphic form.

Group selection system
Harvesting of small groups of trees so that new trees can replace them in the small to medium gaps created.

Growth stages
A system used to describe the life cycle of trees based mainly on crown form - the main ones being seedling, sapling, pole, spar, mature and senescent.

Guidelines
The directing principles adopted to establish decisions (zoning, actions or prescriptions) for the protection and management of forest values. They are not necessarily mandatory, rather they are to be interpreted and applied based on the information available and in context of the protection and management of other values in the forest.

Habitat
The range of environments in which a species can occur.

Habitat tree
A tree identified and protected from harvesting to provide habitat or future habitat for wildlife. A habitat tree may be living or dead, and often contains hollows that are suitable shelter and/or nesting sites for animals such as possums and parrots.

Heritage
Things inherited from previous generations and which are valued. It includes places, objects and folklore.

Heritage River
Land that is a heritage river area under section 5 of the *Heritage Rivers Act 1992*. Each area of land described in a part of Schedule 1 of the Act is a heritage river under the name specified in that part, and subject to specific land and water use controls.

High Elevation Mixed Species
Mixed eucalypt species forests in Victoria generally above 700 m elevation, but which also may include some forests in frost hollows and on wetter aspects greater than 600 m. Major component species include messmate, cut-tail, and mountain grey gum. Successful eucalypt regeneration generally occurs from spring germination.

Historic place
A building, a garden, a tree, the remains of a ship or part of a ship, an archaeological site, a precinct, a site or the land associated with any of these things that has cultural heritage significance.

Index of Stream Condition
A system of river health measurement used in Victoria for strategic monitoring.

Glossary of Terms

Informal reserves
Public land protected through administrative instruments by public authorities.

Land use
The primary level of public land classification in Victoria. Determined through the Victorian Environmental Assessment Council process establishing National Parks, State forest and other categories.

Landing
A place where trees and parts of trees are snigged for sorting, processing and loaded for transport from the forest.

Landscape Management Zone
A Fire Management Zone where planned burning is used for three broad aims:

- Bushfire protection outcomes by reducing the overall fuel and bushfire hazard in the landscape

- Ecological resilience through appropriate fire regimes

- Management of the land for particular values including forest regeneration and protection of water catchments at a landscape level.

Mature
Forest stands and/or individual trees where the tree crowns are well foliated and rounded. The height and crown development of the trees has effectively ceased (compared with regrowth) but decline of the crown (loss of limbs, development of epicormic growth) has not yet significantly begun (as in the senescent or over mature growth stage).

Mixed species
Forest which has two or more eucalypt species commonly found within the canopy. Generally consisting of peppermint, messmate, gum or stringybark species. Does not include ash, red gum or box ironbark forests.

Montreal process
An international process that led to the signing of the Santiago Declaration in 1995. This declaration includes a criteria and indicator framework which articulates what sustainable forest management means, and provides a framework for describing, assessing and evaluating progress towards its aims.

National Park
Land described as a National Park on Schedule Two of the *National Parks Act 1975*. These are generally extensive areas of land of nationwide significance because of their outstanding natural features and diverse land types.

Native vegetation
Plants that are indigenous to Victoria, including trees, shrubs, herbs and grasses.

Natural Catchment Area
Land that is a natural catchment area under section 6 of the Heritage Rivers Act 1992. Each area of land described in a part of Schedule 2 of the Act is a natural catchment area under the name specified in that part, and subject to specific land and water use controls.

Nature Conservation Reserves
Areas of publicly owned land, including forested land, managed primarily for nature conservation and providing multiple benefits and uses, such as recreation and water catchment but excluding wood production.

Near Threatened
An IUCN Red List conservation status category used for individual taxon when it has been evaluated against the IUCN criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

Old-growth forest
Forest which contains significant amounts of its oldest growth stage - usually senescent trees- in the upper stratum and has been subjected to any disturbance, the effect of which is now negligible.

Other Crown land
See Introduction key terms and definitions

Parks and conservation reserves
See Introduction key terms and definitions

Permanent Road
A generally high standard road permanently required for the continuing management of the forest including timber harvesting operations.

Planned burning
The deliberate application of fire under specified environmental conditions to a predetermined area and at the time, intensity and rate of spread required to achieve planned resource management objectives.

Planned Burning Exclusion Zone
A Fire Management Zone which excludes the use of planned burning.

Plantation
Managed stands of trees of either native or exotic species, planted or sown primarily for timber harvesting operations purposes.

Private forests
See Introduction key terms and definitions

Glossary of Terms

Private land
A land tenure category comprising:

- land alienated from the Crown;

- unalienated land of the Crown managed and controlled by other than the Minister for Environment and Climate Change, the Minister for Agriculture and Food Security, or the Secretary to the Department of Environment and Primary Industries;

- unalienated land of the Crown occupied under a lease from the Crown; or

- land licensed under the *Victorian Plantations Corporation Act 1993*.

Public forests
See Introduction key terms and definitions

Public land
Unalienated land of the Crown managed and controlled by the Minister for Environment and Climate Change, the Minister for Agriculture and Food Security, or the Secretary to the Department of Environment and Primary Industries, whether or not occupied under a licence or other right (but not including land occupied under a licence under the *Victorian Plantations Corporation Act 1993*).

Pulpwood
See *Residual log*.

Rare species
A collective term used by the IUCN Red List to denote taxa that are Near Threatened or Data Deficient.

Recreation site
An area with developed recreation facilities (including toilets and tables) designed for a high level of visitor use.

Reference Areas
Where the Minister, after having considered a recommendation of the Victorian Environmental Assessment Council under the *Victorian Environmental Assessment Council Act 2001*, is of the opinion that any area of public land should be preserved in its natural state as far as is possible, because the area is of ecological interest and significance. The Minister may recommend to the Governor in Council that that area be proclaimed to be a reference area.

Reforestation
The re-establishment of a stand of trees by planting or sowing with species native to the locality on previously cleared or poorly forested land.

Regeneration (noun)
See Indicator 2.5

Regeneration (verb)
The renewal or re-establishment of native forest flora by natural or artificial means following disturbance such as timber harvesting or fire.

Regional Forest Agreement
An agreement between the Commonwealth and a State Government about the long term management and use of forests in a region.

Regrowth
(a) forest stands regenerated either naturally or by seeding following death or removal of the forest overstorey. *(b)* a growth stage of a forest stand or individual tree in which the crowns have a narrow conical form and where trees are actively growing.

Rehabilitation
Restoration and revegetation of a site of disturbance usually associated with fire damage, forest road works, landings and mining.

Remote and Natural Area
An area described as a remote and natural area on Schedule Six of the *National Parks Act 1975* or recommended by the Land Conservation Council in its special Wilderness Investigation as an area with remote and natural attributes.

Residual log
Logs, not of sawlog quality, produced as a consequence of a sawlog harvesting operation. Unlike pulpwood the end-use of a residual log is not specified.

Richness
See Indicator 1.2b

River health
The ecological condition of a river.

River regulation
The process of planned human intervention in the course, characteristics, or flow of a river with the intention of producing some defined benefit.

Rotation
The planned number of years between the regeneration of a forest stand and its final harvesting, taking into account the full range of values and uses the owner wishes to derive from the forest.

Sawlog
Any length of a log of merchantable species which is at least 2.7 m in length, has a small-end diameter of 25 cm or greater, does not have a sweep or crook which exceeds 1/5 diameter from a 2.4 m straight edge and is of grade D or better.

Sclerophyll
Hard leaved trees (e.g. members of the genus *eucalyptus* and *acacia*).

Seed trees
Trees retained on harvested coupes to provide seed for natural regeneration of that coupe.

Glossary of Terms

Seed tree systems
Harvesting and regeneration system used for particular forest types. All merchantable trees are harvested apart from those specifically retained for regenerating the coupe by natural or artificial seedfall and for habitat purposes.

Selection systems
Trees are harvested either singly or in groups at relatively short intervals indefinitely. Used to harvest and regenerate particular forest types. By this means, regeneration is established continually and an uneven-aged stand is maintained.

Senescent
A growth stage of a forest stand or individual tree that is characterised by dead branches and declining crown area and irregular crown shape due to the loss of branches and epicormic growth.

Silviculture
The science and practice of managing harvesting, forest establishment, composition, and growth, to achieve specified objectives.

Single tree selection system
Used for harvesting of single trees so that new trees can replace them in the small gaps created.

Snig-track
Track along which a log is snigged.

Special Management Zone (SMZ)
Areas of State forest managed to conserve specified values, while catering for timber production under specific management conditions.

Special Protection Zone (SPZ)
Areas of State forest managed for particular conservation values in which timber harvesting is excluded.

Stand
As defined in the *Sustainable Forests (Timber) Act 2004* means a group of trees within a State forest that share common characteristics relating to eucalypt species composition and age.

State forest
As defined in section 3 of the *Forests Act 1958*. State forest comprises publicly owned land which is managed for the conservation of flora and fauna; for the protection of water catchments and water quality; for the provision of timber and other forest products on a sustainable basis; for the protection of landscape, archaeological, historical and other cultural values; and to provide recreational and educational opportunities.

State–owned business corporation
A statutory corporation declared by Order in Council under s. 17 of the *State Owned Enterprises Act 1992* to be a State business corporation.

State Park
Land described as a State park on Schedule Two B of the *National Parks Act 1975*. These are generally tracts of land containing one or more land types complementing those found in National Parks to provide a system representing the major land types of the State.

Stocking
A measure of density of any given forest stand, which can be expressed in a variety of terms, such as the number of trees per hectare, basal area per hectare, and the percentage of stocked plots.

Succession
The progressive change of species composition within a stand over time. If left undisturbed this succession will continue to a climax where the species composition will remain largely unchanged.

Sustainable Forest Management
The management of forests to maintain their full range of environmental, social and economic values. In Victoria, detailed principles and methods of sustainable forest management are set out in the *Sustainable Forests (Timber) Act 2004*.

Sustainable Yield
The maximum level of commercial timber production which can be maintained in perpetuity under a given management regime. This figure may increase in the future if the condition of the forest is improved but should not decrease except in the case of a catastrophic event such as fire.

Tenure
See Introduction key terms and definitions

Threatened species
A collective term used by the IUCN Red List to denote taxa that are Extinct, Extinct in the Wild, Regionally Extinct, Critically Endangered, Endangered or Vulnerable.

Thinning
The removal of part of a forest stand or crop, with the aims of increasing the growth rate and/or health of retained trees and, in commercial thinning, obtaining timber from trees that would otherwise eventually die before final harvest.

Timber harvesting
Includes tree felling, log snigging and forwarding, and the sorting, loading and carting of timber.

Timber production
Growing and harvesting of timber from native forests and plantations.

Traditional Owners (Victorian)
Aboriginal peoples with traditional and cultural associations to certain lands in Victoria.

Glossary of Terms

Unevenaged stand
Forest stand that contains a continuum of age classes resulting from more or less continuous regeneration within the stand over a number of years.

Vegetation type
An aggregate of plant species, such as an Ecological Vegetation Class or Broad Vegetation Class, recognised by DEPI, which consistently occur together in the landscape and provide a convenient descriptive unit, and is recognisable in the field.

Vulnerable
An IUCN Red List conservation status category used for individual taxon when the best available evidence indicates it is considered to be facing a high risk of extinction in the wild.

Weed
Exotic and 'out of place' native species of flora that have become established since European settlement.

Wilderness area
Land described as a wilderness park on Schedule Two A of the *National Parks Act 1975* or land within a National Park described as a wilderness zone on Schedule Five of the *National Parks Act 1975*. These areas are generally tracts of land remote at their core from access and settlement, substantially unmodified by modern technological society or capable of being restored to that state and of sufficient size to make practical the long-term protection of their natural systems.

Wood Utilisation Plan
Details the area to be harvested and the type of wood to be produced from an FMA in any one year and provisionally for the succeeding two years; together with the allocation of timber to licensees

Units of measurement

km	kilometre
km²	square kilometre
m	metres
m²	square metres
m³	cubic metres
mm	millimetres
ha	hectares

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