DETAILED CONTENTS CHAPTER **TWO**

CHAPTER TWO BIODIVERSITY AND LAND

BACKGROUND

This chapter assesses the status of Victoria's land and terrestrial biodiversity. Aquatic biodiversity is discussed in the Inland Waters and Marine and Coastal Environments sections. The management of Victoria's land and biodiversity on private land is discussed in Foundation Paper Two: *Land and Biodiversity Victoria: The Science, Our Private Land Holders, Incentives and Connectivity*.[1] The impacts of climate change on land and biodiversity is discussed in Foundation Paper One: *Climate Change Victoria: The Science, Our People, and Our State of Play*.[2]

Healthy land and biodiversity are essential for all Victorians. They provide vital services such as clean air and water, control of pests and fertile soil, and help to regulate our climate. These are necessary to support the production of water resources, food, fibre and timber. Healthy ecosystems are also important for our own health and wellbeing, providing places for cultural, spiritual and recreational activities.

Degradation of land and biodiversity resources impact on the services they provide. Biodiversity loss or decline can have significant consequences for natural processes such as pollination and nutrient cycling, decrease the availability of habitat, and impact on predator–prey relationships. In severe cases, biodiversity loss can lead to significant alterations in ecosystem type and the functions ecosystems provide. It is important to maintain and, where necessary, improve the biodiversity and health of Victoria's ecosystems to ensure the continued provision of the services on which all Victorians depend.

The degradation of terrestrial ecosystems has far reaching consequences for many Victorian environments. Terrestrial ecosystems are intimately connected to aquatic ecosystems, including the marine environment.

Poor terrestrial health has implications for the condition of rivers, lakes, wetlands, estuaries and coastal waters (see Part A: 3 Inland Waters and Part A: 4 Marine and Coastal Environments).

Pressures on Victorian land and biodiversity

The historic clearing of native vegetation in much of Victoria has resulted in the widespread loss of habitat and the decline of many species. Victoria is the most cleared state in Australia with nearly two-thirds of Victoria's landscape now modified for agriculture and urban purposes. This, combined with ongoing pressures from further clearing, habitat fragmentation, altered hydrology, inappropriate land-use and fire regimes, and invasive species, puts enormous stress on land and biodiversity across Victoria.

Despite the efforts of governments, non-government organisations, communities and individuals over many decades, the health of our species and ecosystems continues to decline.[3] The highest number of threatened species in any one region in Australia occurs in north-western Victoria.

Although many land and biodiversity concerns are focused on extensively cleared private land, the management of Victoria's relatively intact public land remains a significant problem. The condition of land and biodiversity on public land is variable because of ongoing impacts from previous land use and current pressures. Consequently, improved management of land and biodiversity is required on both public and private land.

Historic broad-scale clearing of native vegetation has also changed Victorian landscape functions in ways that are now presenting major challenges to land managers. Accelerated erosion, acidification, and salinity, as well as the loss of soil nutrients and organic content, are problems facing land managers.

Climate change

Climate change is predicted to compound existing pressures on Victoria's biodiversity and ecosystems.[2] Projections of significant shifts in local climates and increases in drought, bushfires and storms, will impact on Victoria's natural ecosystems and primary production industries alike.

Climate change is likely to threaten species with limited capacity to migrate, such as those restricted to particular habitats and fragmented landscapes, or those that tolerate only narrow ranges of temperature and rainfall. Ecosystems such as rainforest, wetlands, alpine areas and coastal and marine habitats have been identified as being at greatest risk in Victoria. Climate change will exacerbate current environmental pressures, and therefore the capacity of natural ecosystems to adapt to climate change will be improved if existing threats are addressed.

In addition to impacts on natural ecosystems, climate change also threatens agriculture and forestry through impacts on land health, water availability, agricultural yields, and increased damage from bushfires and storms.

Future land-use patterns and the location of primary industries in Victoria may have to alter in order to adapt to climate change. Changes to the distribution of primary production will have significant socioeconomic implications for Victorian communities.

A BIODIVERSITY

MAIN FINDINGS

Conservation of Victorian ecosystems and species

- While conservation areas provide protection by excluding damaging land uses and activities, they are still at risk from a range of pressures. Invasive species, inappropriate fire regimes, pathogens and diseases can all threaten ecosystem health and require ongoing intervention to minimise impacts.
- Climate change will threaten conservation areas, especially where changes to temperature and rainfall, and the occurrence of fire, exceed the tolerances of ecosystems.
- In 2010, there were 2,945 parks and reserves in Victoria covering approximately 4 million hectares, around 18% of the state. The area of parks and reserves increased by more than 160,000 hectares between 2005 and 2010. The large majority of Victoria's conservation reserves are very small, isolated and/or fragmented.
- In 2010, 15 out of Victoria's 28 bioregions had less than 20% of their area within parks, and eight of these had less than 10%. Only seven bioregions had conservation levels of 50% or higher.
- The majority of Victoria's Ecological Vegetation Classes have less than 50% of their total area protected in parks, with six having less than 25% of their area in the parks system. The most under-represented Ecological Vegetation Divisions include Basalt Grassland and Inland Plains Woodland (4% of total area), Foothills Forest and Western Plains Woodland (18% of total area) and Forby Forest (21% of total area).
- The majority of rare and threatened flora and fauna species have been recorded in the Victorian parks system.
- In 2010, all 37 Victorian flora and fauna communities listed as threatened under the *Flora and Fauna Guarantee Act 1998* were represented in parks. However, most were represented in only one, or less than five parks.
- With some 62% of Victoria's land under private ownership, significant conservation effort is required outside of public land reserves to protect native ecosystems and species.
- Between 2008 and 2012, the area of land under private conservation agreements increased from 212,000 to 242,000 hectares, an increase of some 30,000 hectares.
- Despite the rise in conservation agreements on private land, the area is still very small compared to that on public land.

Threatened species

- Expert advice indicates that there is an overall decline in threatened species and populations because of habitat loss and fragmentation, and ongoing degradation of remaining habitat.

Fauna

- A total of 294 vertebrate fauna species across all habitats were listed on the *Advisory List of Threatened Vertebrate Fauna in Victoria, 2013.* This included nine extinct fauna species, 15 species extinct in Victoria, and one extinct in the wild. A further 50 species were listed as critically endangered, 57 endangered, 84 vulnerable and 64 near threatened. Data was found to be deficient for 14 species.
- All vertebrate groups have a considerable proportion of their extant species listed as threatened, including 22% of terrestrial mammals, 19% of birds, 30% of reptiles, 43% of amphibians and 55% of freshwater fish.
- Between 2007 and 2013, Victoria's threatened vertebrate species (all habitats) continued to decline. The conservation status of 33 species worsened over the period and 13 species were added to the Advisory List of threatened species because of decreasing populations. The number of critically endangered species increased by 13, endangered by five, and vulnerable by 12. Some species are showing signs of recovery, with eight improving their conservation status and three removed from the list as a result of species population increases.
- For terrestrial species, the status of 18 vertebrate species declined between 2007 and 2013, and seven were added to the list because of decreasing populations. Only five species improved their threatened status. The period also saw the extinction in the wild of the Eastern Barred Bandicoot (*Perameles gunnii* un-named subspecies), which was critically endangered in 2007.
- There remains a large number of species whose population trend is inconclusive, unclear or variable.

Flora

- The most recent Advisory List for plants was released in 2005. Consequently, it is not possible to determine changes in the status of plant species since 2005. Expert opinion indicates that the overall trend is one of decline.
- In 2005, 51 species of flora had become extinct from Victoria, with a further 778 species listed as vulnerable or endangered, 838 species as rare, and 305 were poorly known.

Invertebrates

- As at 2009, one invertebrate species had become extinct and another five species extinct in Victoria. A further 127 species were listed as critically endangered, endangered, or vulnerable, seven species listed as near threatened, and 38 were poorly known.
- There is little information on invertebrates in Victoria and for most of Australia. Consequently, data on conservation status is limited and the current number of threatened species likely to be vastly under-reported.

Threatening processes

- The most commonly identified threatening processes to Victorian species are habitat loss (109 species), weed invasion (108 species), grazing (99 species) and inappropriate fire regimes (63 species).

Knowledge

- Victoria's conservation planning efforts and conservation needs are still hampered by the lack of integrated and well-designed monitoring. Knowledge of the status of invertebrates, lichens and fungi remains poor.

Extent and condition of Victoria's native vegetation

- Historic land clearing has resulted in the loss of approximately half of Victoria's native vegetation, causing a serious and ongoing loss of habitat for Victoria's native species. The majority of this has been on private land, where only 20% of native vegetation cover remains, compared to 80% of the original vegetation on public land.
- The most significant losses of vegetation in Victoria have occurred in native grasslands, grassy woodlands and box ironbark forests.
- Less than a quarter of native vegetation cover remains in the Victorian Volcanic Plain, Victorian Riverina, Warrnambool Plain and Wimmera.
- Currently, the major source of native vegetation loss is the chronic degradation of habitat condition, mainly in fragmented landscapes.
- Substantial native vegetation (over 1 million hectares) is found on roadside reserves in many of Victoria's most cleared landscapes. These provide important habitat and wildlife corridors across fragmented landscapes.
- Vegetation quality is generally stable on public land and in largely intact landscapes, but likely to be declining on private land and in fragmented landscapes.
- Victoria's extended drought and increase in large fires is likely to have significantly impacted on vegetation quality.
- Between 2006–07 and 2011–12, the annual total area of State forest harvested ranged between 7,900 and 11,600 hectares or between 0.3% to 0.4% of the total State forest area.
- Fire salvage operations increased between 2007–08 and 2010–11 in response to the occurrence of fires over the period, fire salvaging can be detrimental to biodiversity by removing important habitat. The harvesting of unburnt forest is also an issue in areas where significant fires have occurred because they provide an important refuge for displaced fauna.

Pest plants and animals

- Pest plant and animal species (invasive species) continue to establish in Victoria and pose a major threat to biodiversity, ecosystem health and primary production.
- Pest plants are considered one of the major factors in the loss of biodiversity.
- Predation by pests is a threatening process for at least 47 species of threatened fauna in Victoria.
- Coordinated ongoing management can have positive outcomes for biodiversity. Fox management programs have increased populations of Southern Brown Bandicoots (*Isoodon obesulus*) and Long-nosed Potoroos (*Potorous tridactylus*) in treatment areas.
- Statewide information on the number of introduced species has not been updated since the 2008 Victorian State of the Environment report. Consequently, it is not possible to determine changes in the number of pest plants and animals since 2008
- Comprehensive data on the extent of pest plant and animal management is not available for Victoria, particularly for private land. However, some data is available for specific management programs on public land. Between 2008 and 2011, some 1.5 million hectares of public land was treated for pest animals, the majority for foxes. Another 282,000 hectares was treated for weeds.

Fire impacts

Planned burning

- Between 2001–02 and 2012–13, 1.7 million hectares of native vegetation was burnt by planned fires in Victoria. The total area burnt represents over a fifth of the total area of public land, and is equivalent to nearly half of the total area burnt by bushfires over the period.
- Some 85% of planned burns were carried out for fire suppression purposes (fuel reduction).
- The Gippsland region accounted for 37% of the total planned burn area between 2001–02 and 2012–13, with the North East region accounting for 28%. The Orbost and Mallee districts accounted for 16% and 15% of the total area burnt over the period respectively.
- The annual area of planned burning for fuel reduction purposes has been increasing, with annual burns of 120,000 hectares or higher since 2006–07. The annual area of planned burning for ecological purposes has also increased significantly since 2008–09.
- The Victorian Government has been progressively increasing the annual planned burning target. Prior to 2010–11, the annual target was 130,000 hectares. This increased to 200,000 hectares in 2010–11, 225,000 hectares in 2011–12 and 250,000 hectares in 2012–13.
- The increase in planned burning has been in response to recommendations from various inquiries into large bushfires since 2002.

Bushfires (unplanned burning)

- Victoria has experienced three extensive bushfire seasons in less than a decade – 2002–03 (1.3 million hectares), 2006–07 (1.2 million hectares) and 2009 (430,000 hectares).
- This period saw prolonged drought and higher temperatures across Victoria, which increased the frequency and severity of large bushfires. This is consistent with predictions that climate change will increase the occurrence and risk of bushfires in the future.
- Victorian regions most impacted by bushfires were the North East and Gippsland, which accounted for nearly 80% of the area burnt between 2001–02 and 2012–13.
- The 2009 bushfires have been another significant event for Victoria's biodiversity. The once healthy population of the endangered Leadbeater's Possum on the Lake Mountain plateau was decimated by the fires, with only a few individual animals known to have survived the fire.
- Adding to fire impacts is the detrimental impacts of salvage logging. The removal of dead trees and the important habitat they provide can lead to ongoing impacts on biodiversity greater than the impact of the fire alone.

Fire regimes

- In 2012, 40% of native vegetation was estimated to be below minimum tolerable fire intervals (TFI), with 3% above the maximum TFI. Only 18% of native vegetation assessed was found to be within the required TFI to maintain vegetation communities. TFI could not be calculated for 39% of native vegetation due to the lack of fire history.
- For the 32 Ecological Vegetation Divisions (EVD) assessed, only eight had 25% or more of their assessable area within TFI, none had over 50% of their area within TFI. Fourteen EVDs had less than 10% of their assessable area within TFI.
- Over the next decade, large areas of Victoria will remain below minimum TFI irrespective of the level of planned burning and future fire events. This places species with life cycles dependent on particular fire intervals at increased risk.
- The increase in large-scale bushfire events means that early growth stages are now over-represented in Victoria's vegetation growth stages. Of the assessed native vegetation, 35% were found to be in early growth stages compared to only 25% in mature or over mature stages. This has severe implications for biodiversity, especially fauna that require older growth stages.

INDICATOR ASSESSMENT

Indicator Summary

Indicator	Summary	Status and trends (Good / Fair / Poor / Unknown)	Data quality
LB1 Conservation of Victorian ecosystems and species	Conservation areas are increasing both on public and private land. However, many bioregions and vegetation communities remain under-represented in parks and reserves.	Fair, Improving	Good
LB2 Threatened species in Victoria	Between 2007 and 2013, the conservation status of many threatened vertebrate species continued to decline, with far fewer species showing improvement. The status of flora species has not been updated since the previous State of the Environment report, however, expert opinion indicates a general decline. Information on invertebrate species is improving but remains limited.	Poor, Deteriorating	Fair
LB3 Extent and condition of Victoria's native vegetation	The extent and condition of native vegetation continues to decline in Victoria particularly through the chronic degradation of habitat condition, mainly in fragmented landscapes. Although assessments of vegetation extent and condition are improving, it is difficult to accurately determine statewide trends because of methodology changes.	Poor, Deteriorating	Fair
LB4 Pest plants and animals	Pest plant and animal species continue to establish and pose a major threat to biodiversity, ecosystem health and primary production. Data on pest plants and animals and their management is poor.	Poor, Deteriorating	Poor
LB5 Impact of fire on Victorian ecosystems	Victoria has experienced an increase in large fires over the last decade. Planned burning has also increased. Most vegetation in Victoria is now outside of its tolerable fire intervals.	Poor, Deteriorating	Good

Indicator Assessment Legend

Status

Good | Fair | Poor | Unknown

- Environmental condition is healthy across Victoria, **OR** comprehensive protection of natural ecosystems and biodiversity.
- Environmental condition is neither positive or negative and may be variable across Victoria, **OR** moderate protection of natural ecosystems and biodiversity.
- Environmental condition is under significant stress, **OR** inadequate protection of natural ecosystems and biodiversity.
- Data is insufficient to make an assessment of status and trends.

Data Quality

- Good — Adequate high-quality evidence and high level of consensus
- Fair — Limited evidence or limited consensus
- Poor — Evidence and consensus too low to make an assessment

Trends

Deteriorating | Improving | Stable | Unclear

NA Assessments of status, trends and data quality are not appropriate for the indicator.

Indicator LB1: Conservation of Victorian Ecosystems and Species

Conservation on public land

Conservation areas are vital for the protection of Victoria's remaining natural ecosystems and the biodiversity they support. Parks and reserves include many threatened communities and species, and Victoria's largest and least disturbed ecosystems. These areas also protect remnant vegetation within urban and agricultural environments.

While conservation areas provide protection by excluding damaging land uses and activities, they are still at risk from a range of pressures. Invasive species, inappropriate fire regimes, pathogens and diseases can all threaten ecosystem health and require ongoing intervention to minimise impacts.

Climate change will also threaten conservation areas, especially where changes to temperature and rainfall, and the occurrence of fire, exceed the tolerances of ecosystems.

In 2010, there were 2,945 parks and reserves in Victoria protecting approximately 4 million hectares, around 18% of the state (see Indicator LB6: Land Use). The area of parks and reserves increased by more than 160,000 hectares between 2005 and 2010. This included additions of River Red Gum parks in northern Victoria, with four new National Parks: Barmah, Gunbower, Lower Goulburn River and Warby–Ovens, and the Cobboboonee National Park in Victoria's west.

Approximately 10% of Victoria's parks and reserves account for some 90% of the total area protected in the parks and reserves system. Consequently, the large majority of Victoria's conservation reserves are very small, isolated and/or fragmented.

In addition to parks and reserves, around a quarter of Victoria's State forest (753,000 hectares) are classed as Special Protection Zones. These areas are managed for conservation and are excluded from timber harvesting (see Indicator LB3: Extent and Condition of Victoria's Native Vegetation).

Conservation of bioregions

There are 28 bioregions in Victoria, each one representing unique ecological characteristics and the biodiversity they contain. Many of Victoria's bioregions have been heavily cleared, with four of Australia's five most cleared bioregions occurring in Victoria. In 2010, 15 out of Victoria's 28 bioregions had less than 20% of their area within parks, and eight of these had less than 10% (Figure A.2.1). Only seven bioregions had conservation levels of 50% or higher. Bioregions with high proportions of vegetated public land generally have a higher proportion protected in parks.

The majority of bioregions are under-protected. This, in part, reflects the high proportion of private land in these bioregions, the extent of vegetation loss and the consequent difficulties in reserve establishment. However, some bioregions such as the Strzelecki Ranges, Wimmera, Central Victoria Uplands and Goldfields, have significant areas of vegetated public land not in the reserve system.[4]

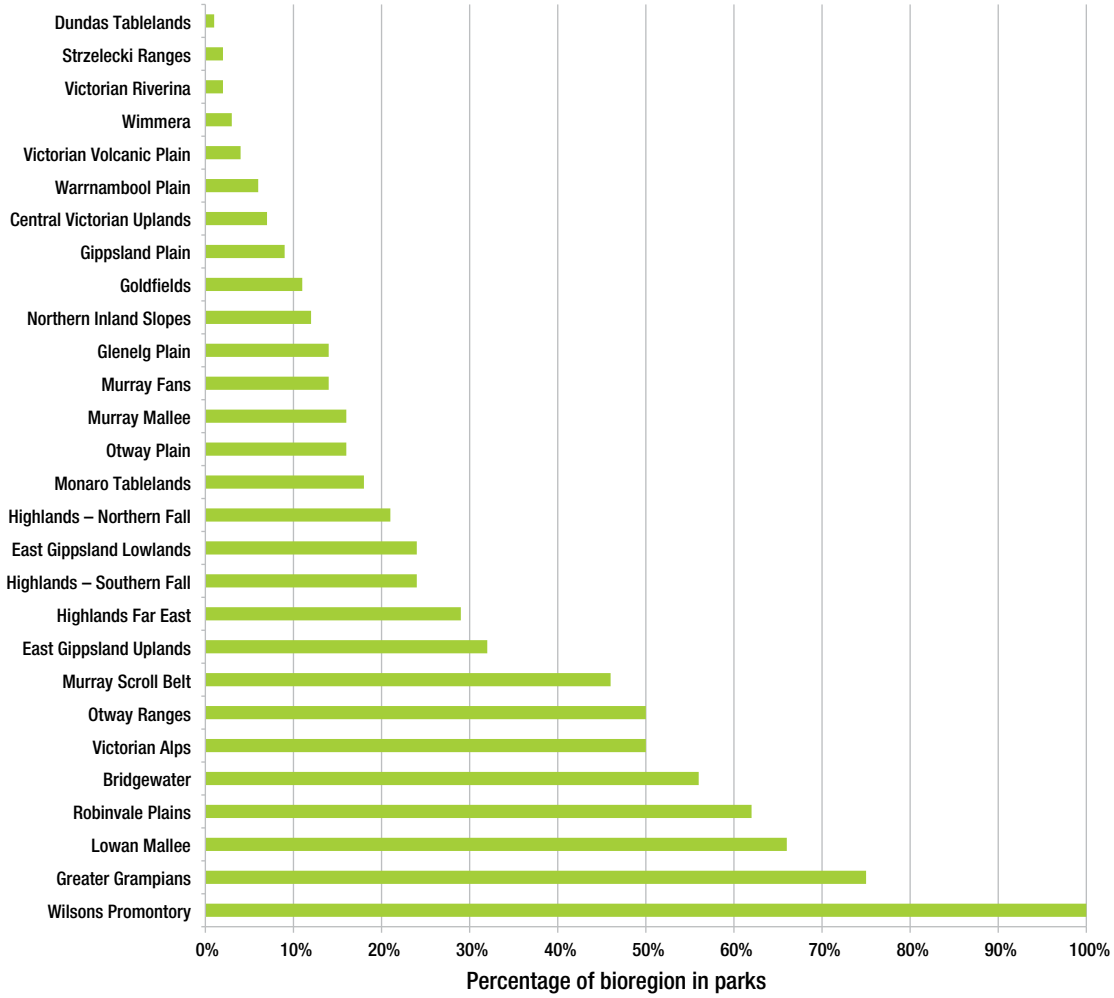


Figure A.2.1: Proportion of Victoria's terrestrial bioregions protected in parks and reserves, 2010

Source: Parks Victoria.

Conservation of flora and fauna

Figure A.2.2 shows percentage of selected Ecological Vegetation Divisions (EVDs) protected in parks.*

All EVDs occur in Victoria's parks network to some extent. Eleven EVDs have 50% or more of their total area within the parks system. Hummock-grass Mallee (86% of total area), Alpine Treeless (77% of total area), High Altitude Wetland (72% of total area) are all particularly well represented. The majority of EVDs have less than 50% of their total area protected in parks, with six having less than 25% of their area in the parks system. The most under-represented EVDs include Basalt Grassland and Inland Plains Woodland (4% of total area), Foothills Forest and Western Plains Woodland (18% of total area) and Forby Forest (21% of total area).

* Native vegetation in Victoria has been classified according to Ecological Vegetation Classes (EVCs). EVCs are classifications described through a combination of floristics, life forms and ecological characteristics and are associated with particular environmental attributes such as soil, rainfall and topography. There are approximately 300 EVCs statewide. Ecological Vegetation Divisions are aggregations of similar EVCs.

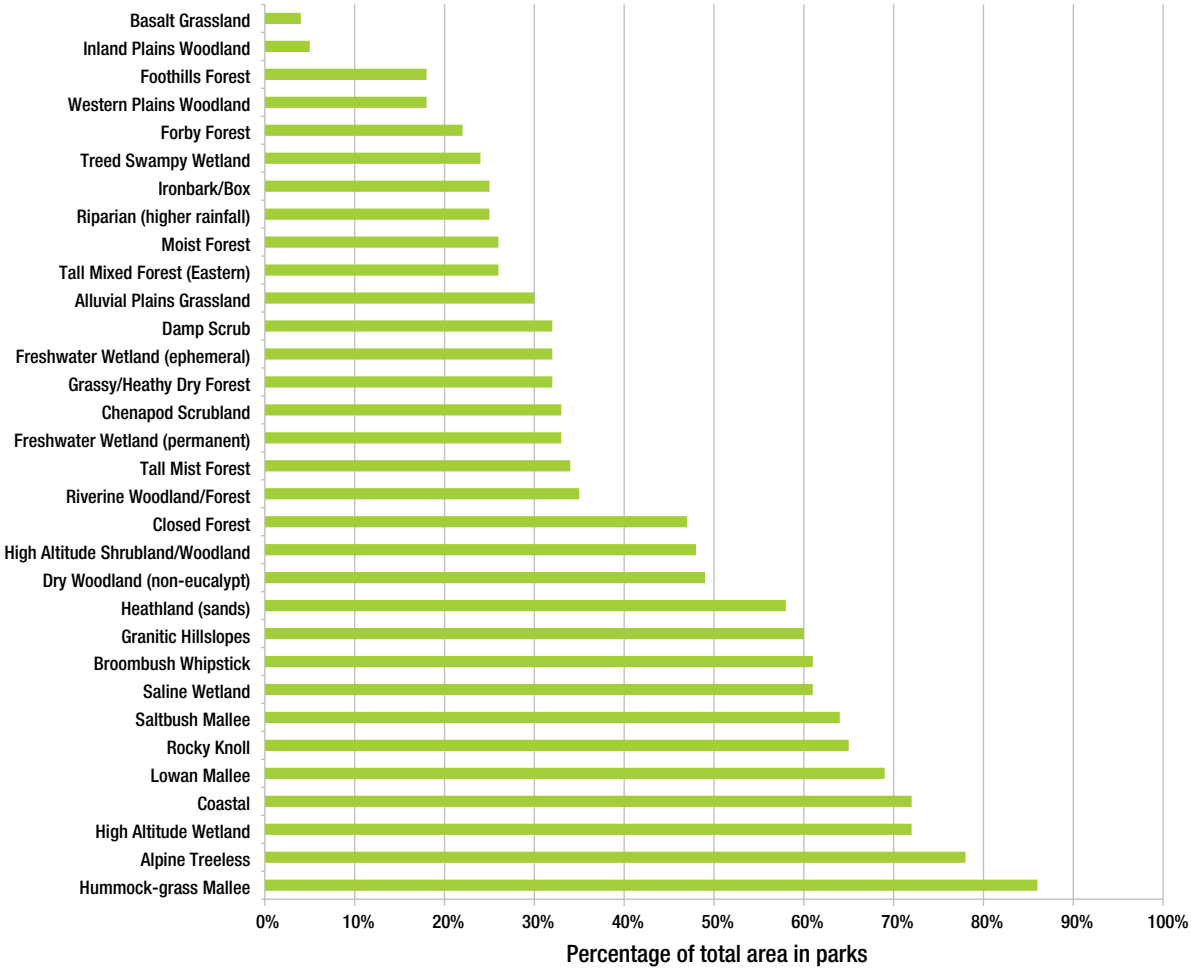


Figure A.2.2: Percentage of Ecological Vegetation Divisions protected in parks, 2010

Source: Parks Victoria.

The number of rare and threatened species found in parks and reserves are shown in Figure A.2.3. Species include those protected under the *Flora and Fauna Guarantee Act 1998* (FFG Act), the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), and those that are allocated a Victorian conservation status but not under legislative protection.

The majority of rare and threatened flora and fauna species have been recorded in the Victorian parks system. However, their presence in the parks system alone does not guarantee ongoing survival. Populations of rare and threatened species will only increase if pressures such as invasive species are managed.

Figure A.2.3: Rare and threatened species recorded in Victorian parks and reserves, 2010

Source: Parks Victoria.

	Total species listed in Victoria	Species recorded in parks and reserves
Flora		
Total rare and threatened flora species	**1,758**	1,570 (89%)
FFG Act listed flora species	**308**	260 (84%)
EPBC Act listed flora species	**134**	119 (89%)
Victorian Conservation Status – flora	**1,745**	1,561 (89%)
Fauna		
Total rare and threatened fauna species	**306**	280 (92%)
FFG Act listed fauna species	**210**	193 (92%)
EPBC Act listed fauna species	**74**	69 (93%)
Victorian Conservation Status fauna	**283**	266 (94%)

In 2010, 37 communities of flora and fauna (31 flora and six fauna) were listed as threatened under the FFG Act.

All 37 communities are represented in parks. However, most are represented in only one, or less than five parks (Figure A.2.4). For many communities this is due to their restricted distribution. However, that many threatened communities are limited to one or few parks, highlights the high risk posed by localised impacts such as fire. Communities more broadly represented across the parks network are better able to withstand such impacts.

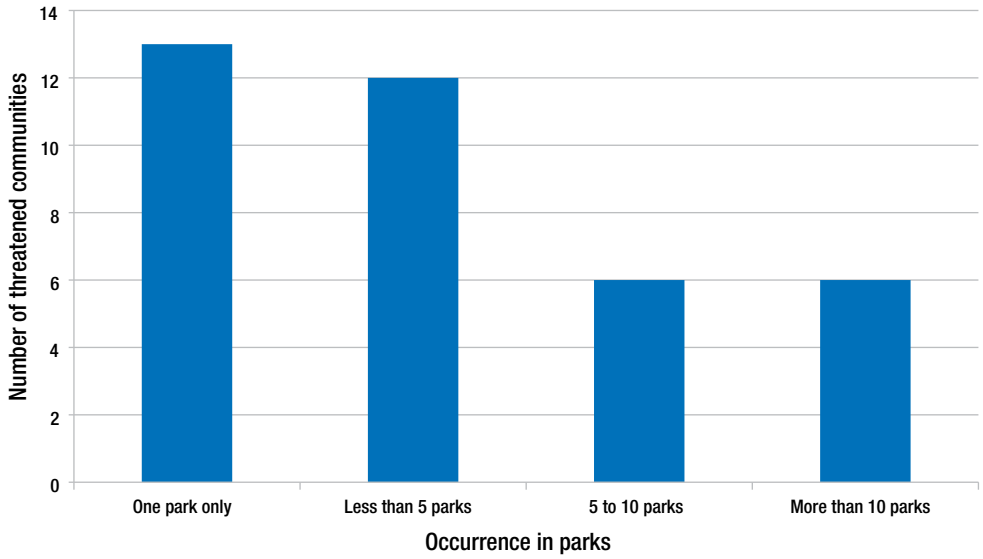


Figure A.2.4: Occurrence of threatened communities listed under the *Flora and Fauna Guarantee Act 1998*, 2010

Source: Parks Victoria.

Conservation on private land

With some 62% of Victoria's land under private ownership, significant conservation effort is required outside of public land reserves to protect native ecosystems and species.

Although only 20% of native vegetation remains on private land, it provides habitat for at least 30% of Victoria's threatened species populations.[4]

Conservation on private land comes from a variety of voluntary conservation mechanisms These range from permanent protection binding on the title of the land (Trust for Nature conservation covenants), fixed-term management agreements linked to financial incentives and specific agreed management actions (BushTender and related market-based schemes) to non-binding agreements (Land for Wildlife). There is also a range of grants and rebate schemes available to encourage biodiversity conservation on private land.

Between 2008 and 2012, the area of land under private conservation agreements increased from 212,000 to 242,000 hectares, an increase of some 30,000 hectares (Figure A.2.5). The largest increases were for Trust for Nature, which increased by 13,000 hectares, and BushTender, which increased by 11,500 hectares. Land for Wildlife agreements are responsible for the majority of land under private conservation, with nearly 70% of the total area in 2012.

Despite the rise in conservation agreements on private land, the area is still very small compared to that on public land. Given that nearly two-thirds of Victoria is private land, it is clear that opportunities for conservation needs to be increased across the state.

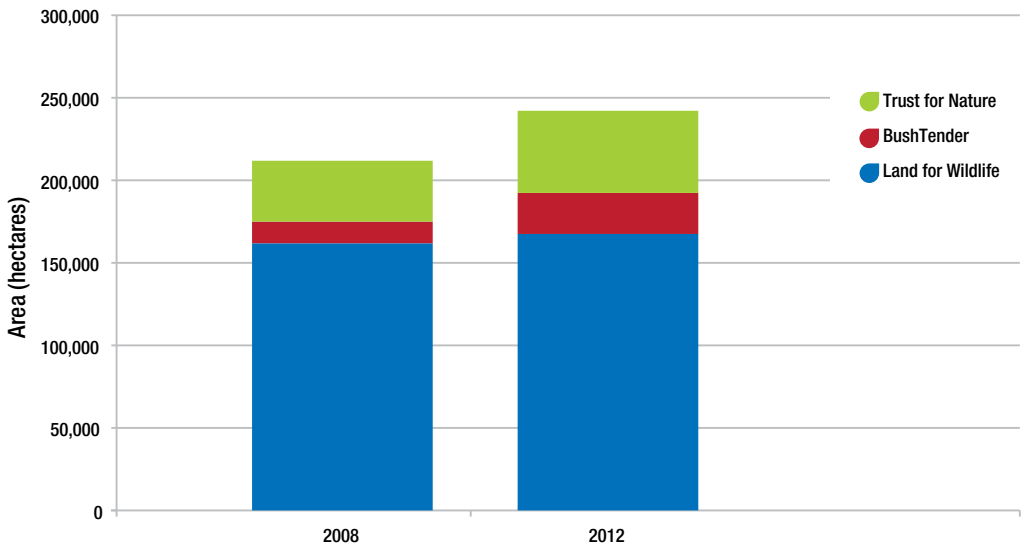


Figure A.2.5: Area of private land conservation agreements in Victoria, 2008 and 2012

Source: DEPI and Trust for Nature 2012.[5]

Indicator LB2: Threatened Species in Victoria

Number of threatened species in Victoria

Although the classification of threatened species highlights those species at risk, it is often of limited value in determining changes in environmental condition. This is because a species may be affected by a combination of pressures, or by subtle drivers that do not impact on the wider ecosystem.

The Department of Environment and Primary Industries (DEPI) maintains threatened species Advisory Lists which document a species' threat status.[6–11] The lists are based on information and advice obtained from a range of experts. They are periodically reviewed by DEPI. There are no legal requirements or consequences that flow from the inclusion of a species in an Advisory List. However, the lists are commonly used in planning processes such as the development of management plans and strategies, local government planning schemes and in setting priorities for actions to conserve biodiversity.

Victorian threatened species are also listed under the Victorian *Flora and Fauna Guarantee Act 1988* (FFG Act) and the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). These provide legal protection for species listed.

DEPI's Advisory Lists are used here in preference to the FFG Act which reflects the rate of public nominations, rather than changes in either knowledge or actual status. However, in using the Advisory Lists the following should be noted and results interpreted with caution:

- Conservation status for a species is assessed for all of Victoria, it does not reflect regional variations in population status, nor the status of species in other Australian States.
- The number of threatened species may reflect improved knowledge, rather than changes in the number of species actually at risk.
- Changes in the rules used to assign categories or in the taxonomy of plant and animal groups may strongly influence the results.
- Not all taxa are reviewed regularly.

Vertebrate fauna

All fauna

A total of 294 vertebrate fauna species across all habitats (terrestrial, freshwater and marine) were listed on the *Advisory List of Threatened Vertebrate Fauna in Victoria, 2013*.[11] This included nine extinct fauna species, 15 species extinct in Victoria, and one extinct in the wild. A further 50 species were listed as critically endangered, 57 endangered, 84 vulnerable, and 64 near threatened. Data was found to be deficient for 14 species (Figure A.2.6).

All vertebrate groups have a considerable proportion of their extant species listed as threatened (includes regionally extinct, critically endangered, endangered and vulnerable categories), including 22% of terrestrial mammals, 19% of birds, 30% of reptiles, 43% of amphibians, and 55% of freshwater fish.[12] This shows that many natural ecosystems and the biodiversity they support are under pressure in Victoria.

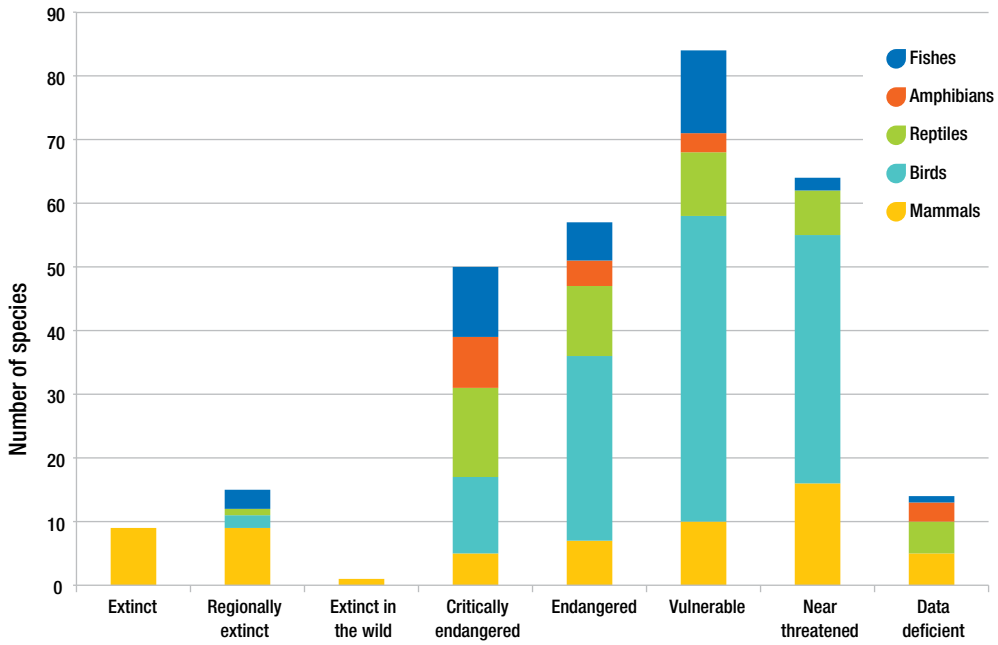


Figure A.2.6: Number of Victorian vertebrate species listed on the *Advisory List of Threatened Vertebrate Fauna in Victoria, 2013*

Source: DEPI.

Change 2007 to 2013

Between 2007 and 2013, Victoria's threatened vertebrate species continued to decline.[9, 13] The conservation status of 33 species declined over the period and 13 species were added to the Advisory List because of decreasing populations. The number of critically endangered species increased by 13, endangered by five, and vulnerable by 12 (Figure A.2.7). The period also saw the extinction in the wild of the Eastern Barred Bandicoot (*Perameles gunnii* un-named subspecies), which was critically endangered in 2007.

Some species are showing signs of recovery over the period with, eight improving their conservation status and three removed from the list as a result of population increases. There was no change in status for 237 species.

There remains a large number of species whose population trend is inconclusive, unclear or variable. These species require ongoing monitoring. Considerable re-establishment of habitat and restoration of environmental flows will be required to significantly improve the conservation status of many species and regional ecosystems.

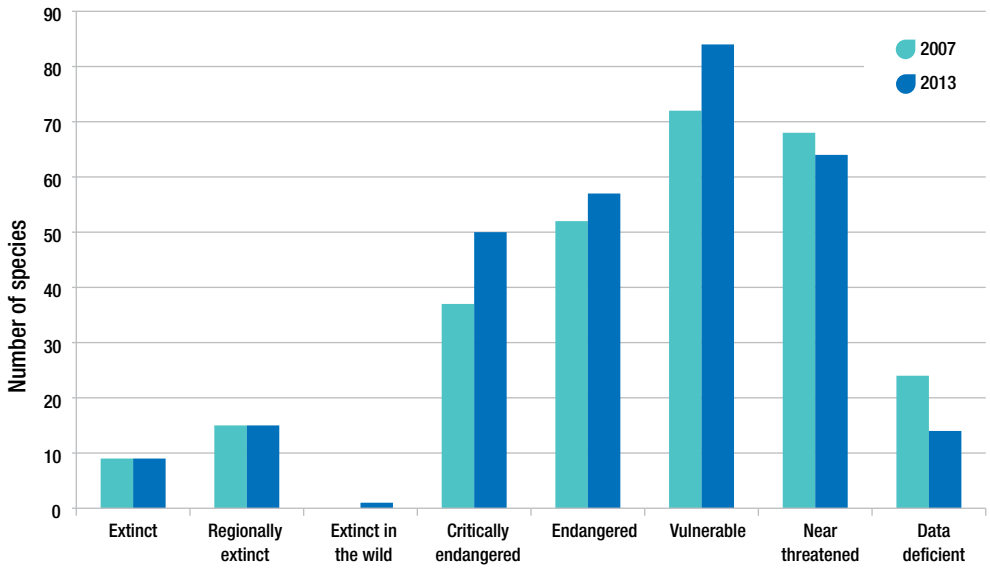


Figure A.2.7: Change in status of Victorian terrestrial vertebrate species, 2007 to 2013

Source: DEPI.

Terrestrial fauna

For terrestrial vertebrate fauna, nine species had become extinct, 12 species extinct in Victoria, and one extinct in the wild. A further 24 species were listed as critically endangered, 31 endangered, 38 vulnerable, and 44 near threatened. Data was found to be deficient for six species (Figure A.2.8).

Among the threatened terrestrial fauna species are Victoria's mammal emblem, the Leadbeater's Possum (*Gymnobelideus leadbeateri*) and bird emblem, the Helmeted Honeyeater (*Lichenostomus melanops cassidix*).

Terrestrial vertebrate fauna accounted for all but three species in the extinct categories, and approximately 50% of threatened species (critically endangered, endangered and vulnerable). This demonstrates the significant impact of habitat loss from historic land clearing on terrestrial species, as well as ongoing pressures from a range of impacts such as invasive species.

Between 2007 and 2013, the status of 18 terrestrial vertebrate species declined and seven were added to the Advisory List because of decreasing populations. Only five species improved their threatened status. These results indicate a further decline in terrestrial biodiversity.

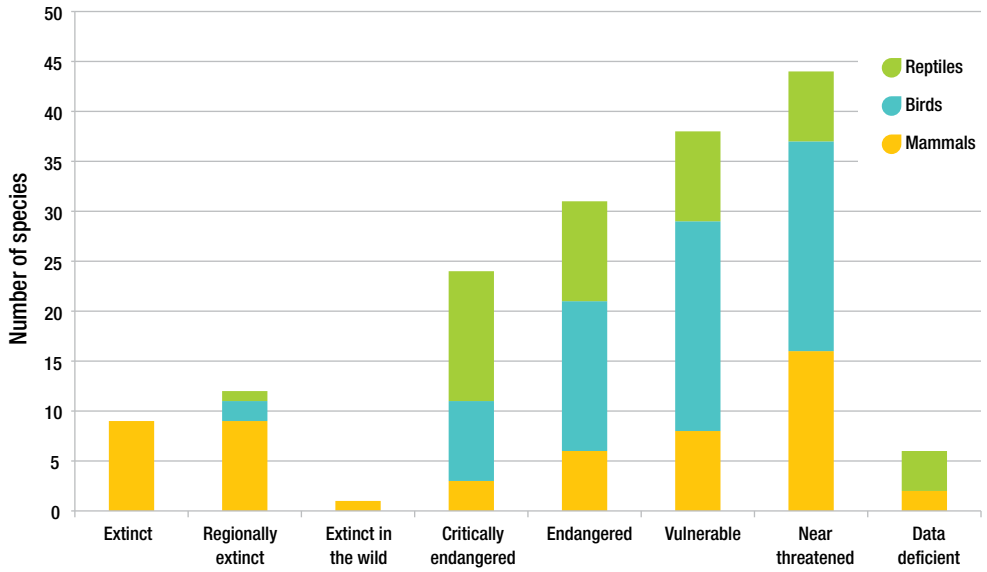


Figure A.2.8: Number of Victorian terrestrial vertebrate species listed on the *Advisory List of Threatened Vertebrate Fauna in Victoria, 2013*

Source: DEPI.

Flora

The most recent Advisory List for plants was released in 2005.[8] Consequently, it is not possible to determine changes in the status of plant species since 2005. Expert opinion indicates that the overall trend is one of decline due to the effects of past habitat clearance and fragmentation, and ongoing degradation of remaining habitat.[12] The exception is intact landscapes where large, contiguous areas of remnant native vegetation occur. Some gains have been made through targeted recovery efforts and other management activities.

For vascular plants, 2005 data showed that 49 species had become extinct from Victoria, with a further 745 species listed as vulnerable or endangered, 804 species as rare, and 228 were poorly known (Figure A.2.9). For lesser known groups of non-vascular flora – bryophytes, lichens and fungi – two species are known to have become extinct from Victoria, 33 were listed as endangered or vulnerable, 34 were rare, and 77 were listed as poorly known.

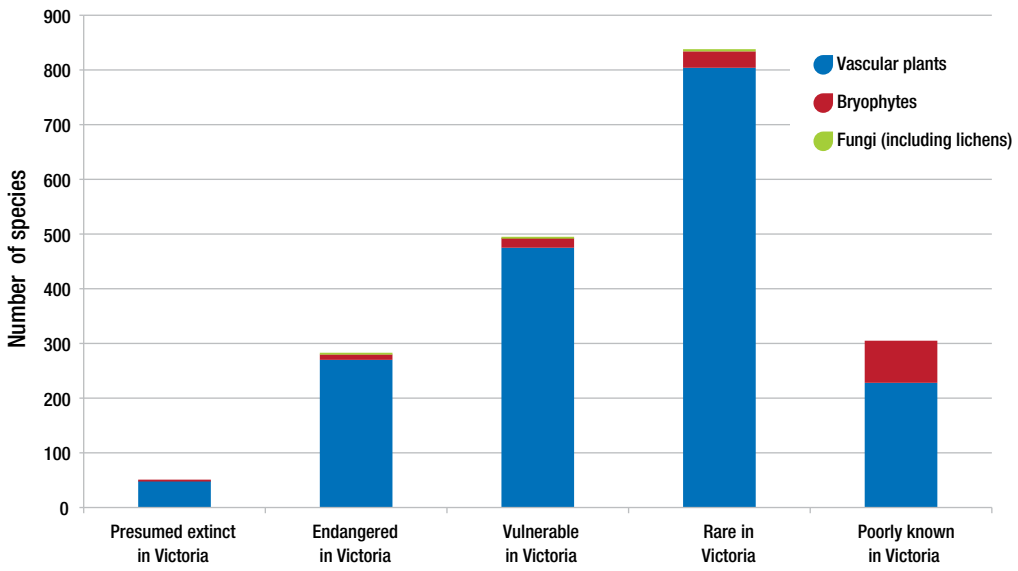


Figure A.2.9: Number of Victorian plant species listed on the *Advisory List of Rare and Threatened Plants in Victoria, 2005*

Source: DEPI.

Invertebrates

Currently, only one Advisory List of invertebrate species has been released.[10] As at 2009, one invertebrate species had become extinct in Australia and another five species extinct in Victoria. A further 127 species were listed as critically endangered, endangered or vulnerable, seven species listed as near threatened, and 38 were poorly known (Figure A.2.10).

There is little information on invertebrates in Victoria and for most of Australia.[14] This is mainly due to the lack of research and monitoring on invertebrate species. Even the total number of invertebrate species is unknown in Victoria. Consequently, data on conservation status is limited and the current number of threatened species likely to be vastly under-reported.

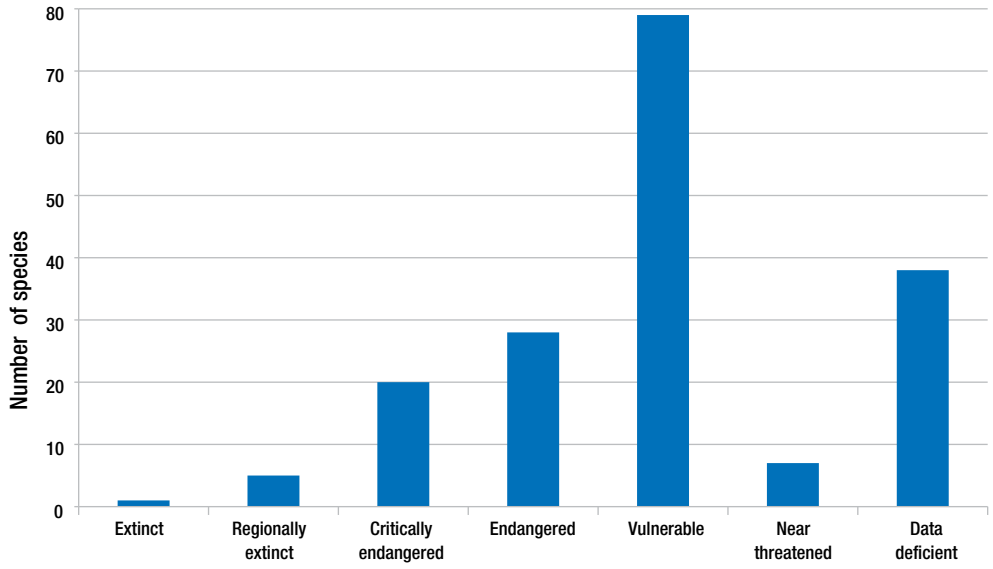


Figure A.2.10: Number of Victorian invertebrate species listed on the *Advisory List of Threatened Invertebrate Fauna in Victoria, 2009*

Source: DEPI.

Impact of threatening processes on native species

A range of threatening processes impact on Victoria's native species, both threatened and non-threatened. These processes range from effects of past clearing, fragmentation and modification of habitat, the impacts of pest plants and animals, the alteration of hydrological regimes and the increasing threat of climate change.

The most commonly identified threatening processes to Victorian species are habitat loss (109 species), weed invasion (108 species), grazing (99 species), and inappropriate fire regimes (63 species) (Figure A.2.11).

However, the relative impact of particular threatening processes varies between flora and fauna, for example, weed invasion and grazing threaten mostly for plant species. Other significant threatening processes include human disturbance, decline in water quality, predation by invasive species and habitat fragmentation. Climate change has now been included as a threatening process and is likely to apply to more species as impacts become evident and better understood.

It should be noted that the number of species impacted does not necessarily determine the severity of threatening process impacts. Some threatening processes have significant impacts on specific species or groups of species, the loss of which can severely degrade ecosystem health. For example, disease is identified as an immediate threat for only a small number of threatened species but the spread of Cinnamon fungus (*Phytophthora cinnamomi*) has wide-ranging impacts on forest health by causing dieback disease in Eucalyptus trees.

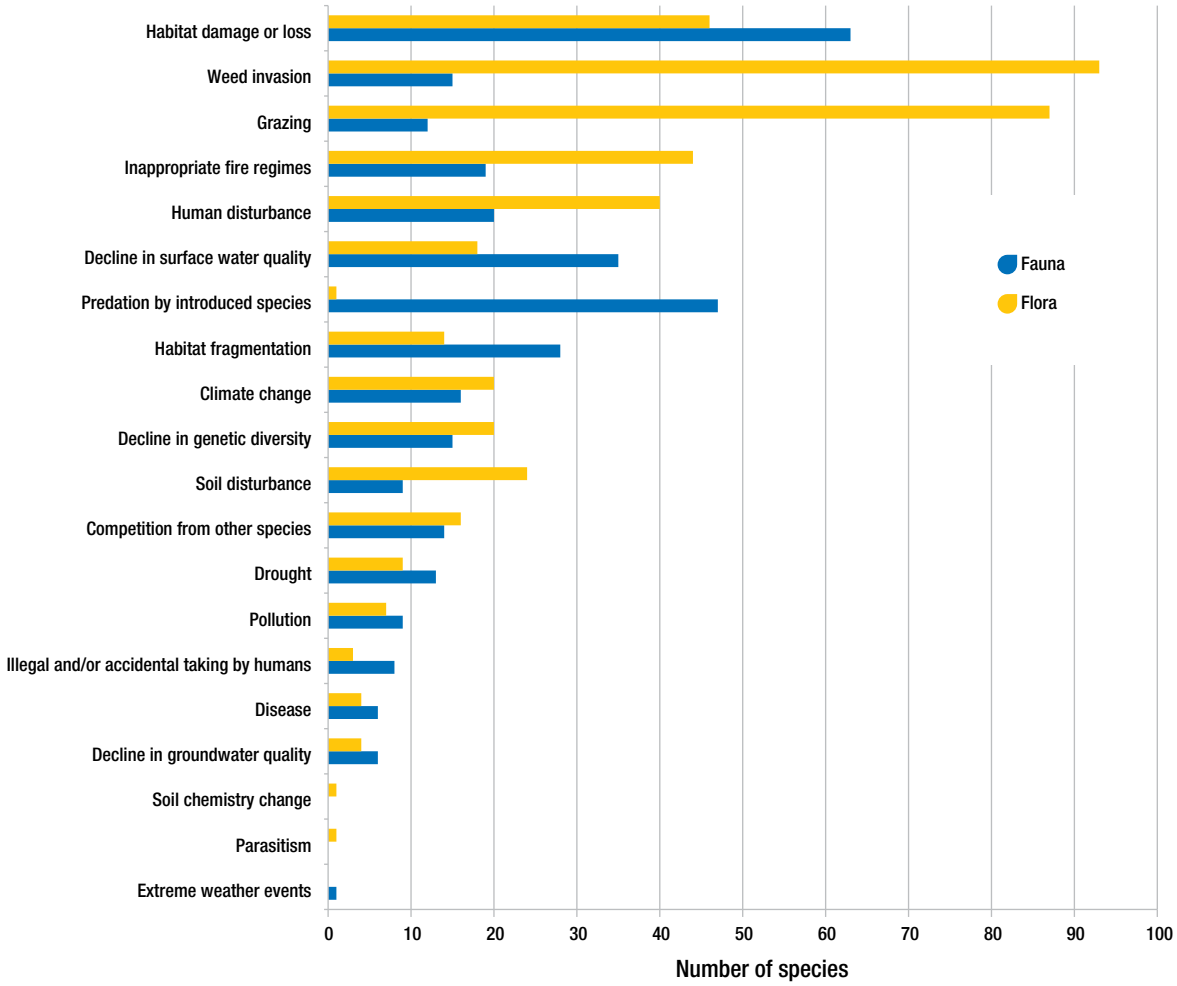


Figure A.2.11: Number of threatened flora and fauna species affected by threatening processes as listed in the Actions for Biodiversity Conservation database

Source: DEPI.

Note: Data is derived from the Actions for Biodiversity Conservation (ABC) Information System. Data is for DSE Advisory List species under active management – does not include 2013 vertebrate fauna list. Data is for a total of 259 species. Only threats identified as currently operating and of moderate, major or catastrophic impact are included.

Indicator LB3: Extent and Condition of Victoria's Native Vegetation

Native vegetation provides many ecosystem services such as provision of habitat, protection of biodiversity, protection of soil health and water quality, and sequestration of carbon. Consequently, declining extent and quality of native vegetation has profound ecosystem health implications. The loss of vegetation is considered to be the main threat to biodiversity in Victoria.

Historic land clearing has resulted in the loss of approximately half of Victoria's native vegetation, causing a serious and ongoing loss of habitat for Victoria's native species. The majority of this has been on private land where only 20% of native vegetation cover remains, compared to 80% of the original vegetation on public land. Areas most suitable for agriculture and urban development have lost the most native vegetation, especially the Victorian Volcanic Plain, west of Melbourne, and the Riverina in northern Victoria, which each retain less than 25% of their original native vegetation cover.

The extensive historic clearing of Victoria has produced a legacy of highly fragmented native vegetation throughout the agricultural areas of the state. Fragmented landscapes prevent the movement of species, limiting opportunities for mating and dispersal, and potentially creating genetic isolation. Fragmentation can also exacerbate the impacts of land use change and climate change by restricting opportunities for fauna to migrate or adapt. Although clearing has been significantly reduced, Victoria's native vegetation is under continuing pressure from intensification of agricultural production and urban expansion.

Native vegetation remnants are often small, isolated and subject to disturbance and degradation arising from human activities. However, this vegetation is vital for Victoria's biodiversity. Native vegetation in fragmented landscapes supports the majority of the state's biodiversity, with around 40% of vertebrate species virtually restricted to fragmented landscapes. A further 45% rely on fragmented landscapes across a major part of their distribution in Victoria. Only about 15% of land vertebrates are mainly restricted to largely intact landscapes.[15] In addition, about 60% of the remaining vegetation on private land are threatened vegetation types, and support 30% of Victoria's threatened species populations.[16]

Native vegetation in landscapes dominated by public land (such as National Parks and State forests) has not been extensively cleared and is more intact than native vegetation on private land. In these largely intact landscapes, natural disturbances such as fire, drought or flood, as well as timber harvesting, have produced a complex range of different vegetation types and age structures. Such vegetation communities are more likely to be highly resilient and of good quality.

In fragmented landscapes, native vegetation remnants are vulnerable to natural disturbance events such as drought, fire and flood, as well as pressures arising from agriculture and residential activities.

This results in vegetation declining, or at risk of decline, in extent, quality and regenerative capacity. Declining vegetation quality is now a key driver of vegetation loss in many parts of Victoria, although clearing remains the main cause of loss for native grasslands.

Native timber harvesting

Native timber harvesting in Victoria is carried out in State forests. Although timber harvesting is more benign than historic broad-scale vegetation clearing and land degradation, it does affect the vegetation structure and species composition of Victoria's forests and woodlands. This has implications for biodiversity and habitat availability. For example, the harvesting of mature trees impacts on species such as possums and owls, which nest in tree hollows, the availability of which is strongly influenced by tree age. The length of harvest rotation, which is usually shorter than the normal lifespan of the trees, further disrupts forest vegetation structure and natural succession.

In addition, firewood collection in some woodland ecosystems, such as Box Ironbark and Red Gum forests, has significantly reduced the amount of coarse woody debris, reducing habitat for a range of ground-dwelling and hollow-dwelling species.

Extent of native vegetation

The current extent of native vegetation in Victoria is approximately 10.9 million hectares (Figure A.2.12). Although private land covers approximately two-thirds of Victoria, it retains only 20% of its original vegetation.

Public land retains over 80% of its original vegetation cover and now accounts for the majority (approximately two-thirds) of Victoria's native vegetation.

Improvements in the detection of native vegetation from satellite data have meant that the current estimate of native vegetation extent is greater than that reported in the previous Victorian State of the Environment (10.3 million hectares). However, the vast majority of this increase represents improved data and not actual increases in vegetation extent.

Substantial native vegetation (over 1 million hectares) is found on roadside reserves (used and unused) in many of Victoria's most cleared landscapes (see Indicator LB6: Land use). In three large bioregions (Victorian Riverina, Victorian Volcanic Plains and the Wimmera), for example, more than 15% of public land native vegetation is on road reserves.[15] Road reserves provide important habitat and wildlife corridors across fragmented landscapes. In many cases, road reserves provide the best or only examples of native vegetation in heavily cleared landscapes.

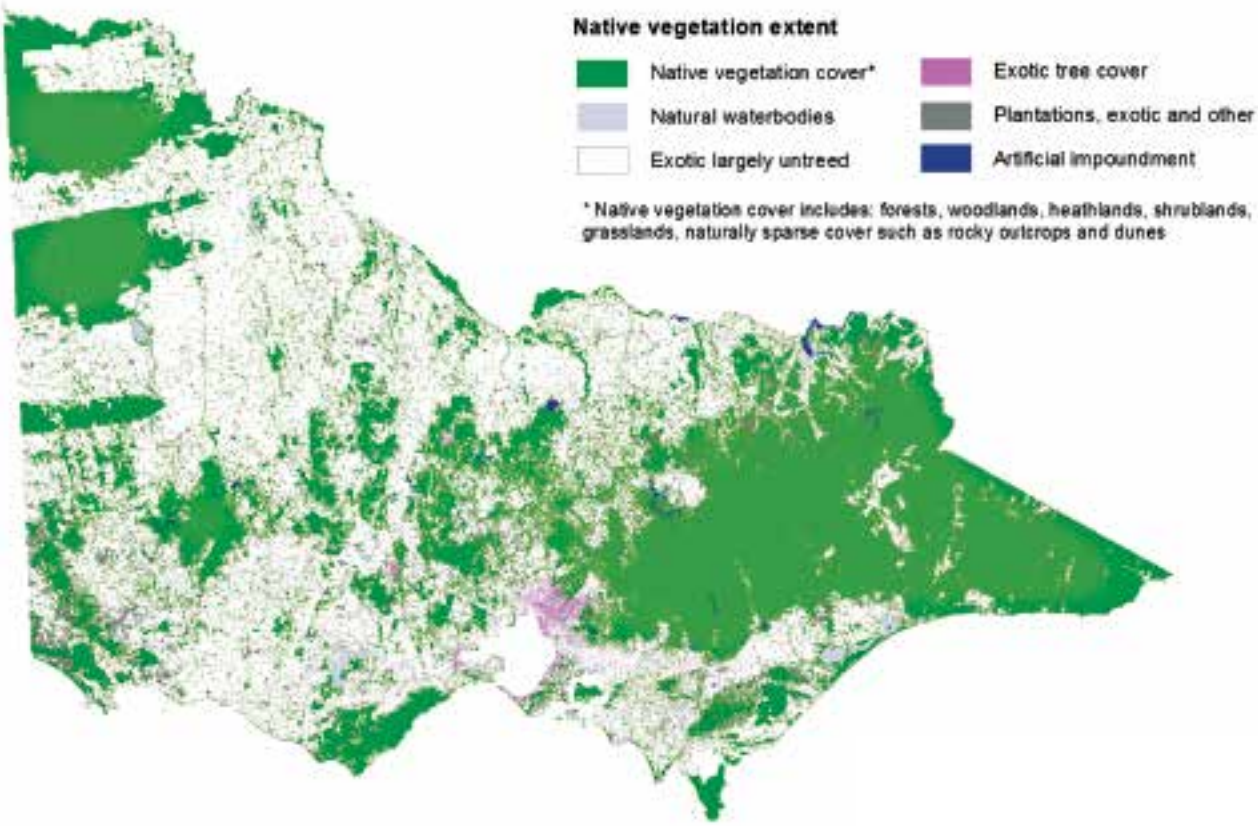


Figure A.2.12: Native vegetation extent in Victoria, as at 2010

Source: DEPI.

Depletion of native vegetation

Since European settlement, some 52% of Victoria's native vegetation has been cleared. The most significant losses of vegetation in Victoria have occurred in native grasslands, grassy woodlands and box ironbark forests.[15] The most cleared Ecological Vegetation Classes (EVCs)* occur in areas most suitable for agriculture. Less than 20% of the original extent of Plains Grasslands and Chenopod Shrublands, and Plains Woodlands or Forests remain (Figure A.2.13). Ongoing losses, particularly of grasslands, continue from illegal clearing and decline in condition. In contrast, montane and subalpine ecosystems, rainforests and rocky outcrops or escarpment scrublands retain over 90% of their original extent. Some EVC groups, such as Mallee and Riverine Grassy Woodlands or Forests, occur in areas that are both suitable for agriculture (which have largely been cleared) and areas not suitable due to soil type or flooding (which have largely retained vegetation).

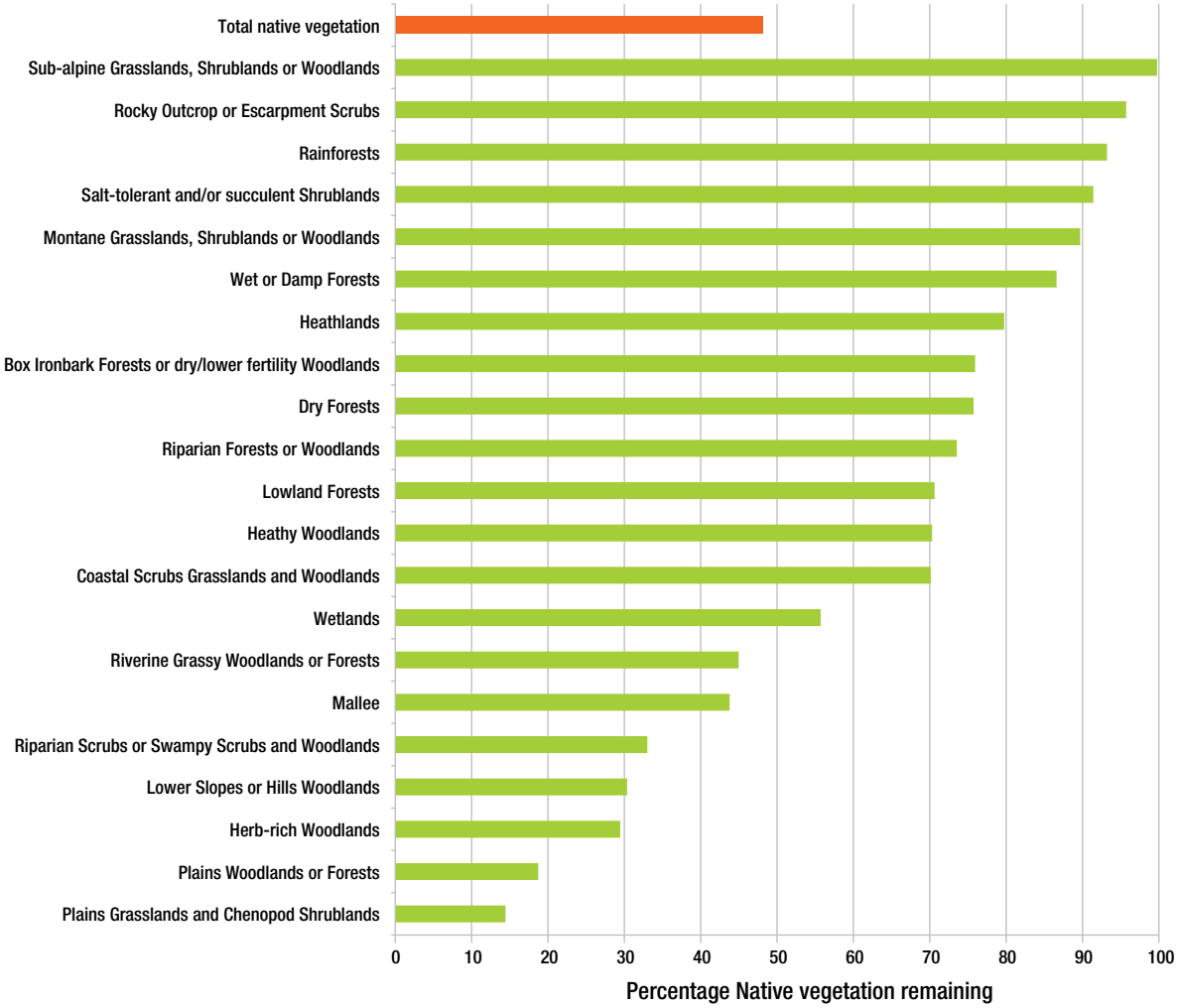


Figure A.2.13: Change in extent of ecological vegetation class broad groupings in Victoria, 1750 to 2012

Source: DEPI.

* Ecological Vegetation Classes (EVCs) are a native vegetation classification described through a combination of floristics, life forms and ecological characteristics and are associated with particular environmental attributes such as soil, rainfall and topography.

Depletion of native vegetation in Victorian bioregions

The loss of native vegetation has varied across Victorian bioregions. Relatively flat, agriculturally productive bioregions in western Victoria have been most heavily cleared, with less than a quarter of native vegetation remaining in the Victorian Volcanic Plain, Victorian Riverina, Warrnambool Plain and Wimmera, while less than one-third of the Gippsland Plain, Dundas Tablelands and Murray Mallee retain native vegetation (Figure A.2.14). In contrast, of the 12 bioregions with greater than 80% of their native vegetation remaining, nine are in mountainous regions of the state, and three occur in the desert (Lowan Mallee) and floodplain (Murray Scroll Belt, Robinvale Plains) of the north-west of the state. Generally the most heavily cleared bioregions have proportionately lost the highest number of species.[17]

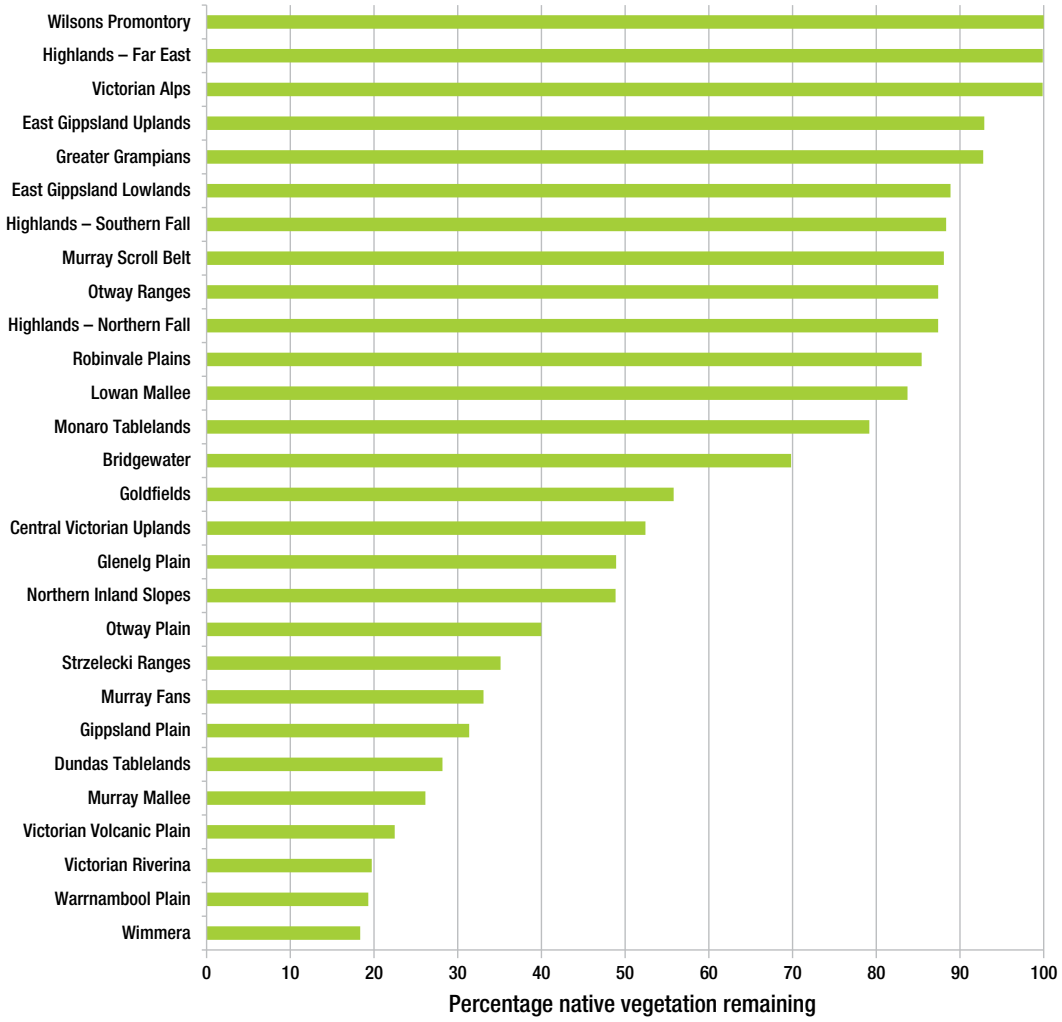


Figure A.2.14: Change in extent of native vegetation by Victorian bioregion, 1750 to 2012

Source: DEPI.

Annual vegetation loss

There has been no update on the clearance of native vegetation since 2008, when it was estimated that Victoria lost 4,000 hectares of native vegetation per year on private land.[17] The majority of native vegetation lost was from endangered native grasslands, of which only 5% remain in Victoria, with less than 1% in good condition.[18]

While the clearing of native grasslands remains of concern, particularly in urban and peri-urban areas with high population growth to the west of Melbourne, it is no longer the largest source of native vegetation change in Victoria. The major source of native vegetation loss is the chronic degradation of habitat condition, mainly in fragmented landscapes.[17] This is compounded by the decrease in rainfall and increased temperatures associated with climate change.

Expert opinion suggests that the extent of native vegetation is most likely to be continuing to decline on private land and in fragmented landscapes, and most likely to be stable in largely intact landscapes. Much of the actively cleared vegetation loss will have occurred through 'allowed actions' such as bushfire protection. Revegetation through investment programs partially mitigates the overall decline in vegetation extent. Overall, however, losses in native vegetation extent from clearance on private land are likely to have exceeded gains from revegetation and natural regeneration.[12, 15]

Quality, condition and fragmentation of native vegetation

Vegetation quality is modelled at a landscape scale across Victoria. Assessments are based on biophysical components of the site (site condition), and the size of a patch of remnant native vegetation and its proximity to adjacent patches of remnant native vegetation (landscape context). Changes in either component can drive changes in vegetation quality.

The bioregions most suitable for urban development and agriculture have not only suffered the greatest loss of vegetation, but the quality of the remaining vegetation is among the lowest in the state (Figure A.2.15 and Figure A.2.16). Furthermore, these regions are characterised by high levels of vegetation fragmentation and low connectivity, which further limits the ecological functionality of these landscapes.[4] Broad-scale clearing has led to the fragmentation of approximately two-thirds of native vegetation in Victoria.

Generally, native vegetation on private land is in poorer condition than that on public land.

Furthermore, native vegetation on public land tends to be better connected structurally than vegetation on private land, mostly because the larger patches of native vegetation are on public land.[15]

In some parts of Victoria, specifically the well-vegetated and mountainous eastern highlands and the Mallee country in the north-west, ecosystems, vegetation condition and quality are considered to be high. Bioregions with the highest levels of low and medium quality vegetation include Dundas Tablelands, Warrnambool Plain, Victorian Volcanic Plain, Strzelecki Ranges, Wimmera, Victorian Riverina, Gippsland Plain and Bridgewater.

It is not possible to compare current vegetation quality data with that reported in the last State of the Environment report due to methodology changes. However, expert opinion suggests the following trends:[12]

- Vegetation quality is generally stable on public land and in largely intact landscapes, but likely to be declining on private land and in fragmented landscapes.
- Improved management through investment programs partially reduces the overall decline in vegetation condition. However, this accounts for only a small proportion of native vegetation on private land.
- Victoria's extended drought is likely to have significantly impacted on vegetation quality, with widespread mature tree death observed in areas of foothills forests.
- Large bushfires in the last decade have also impacted on vegetation quality.

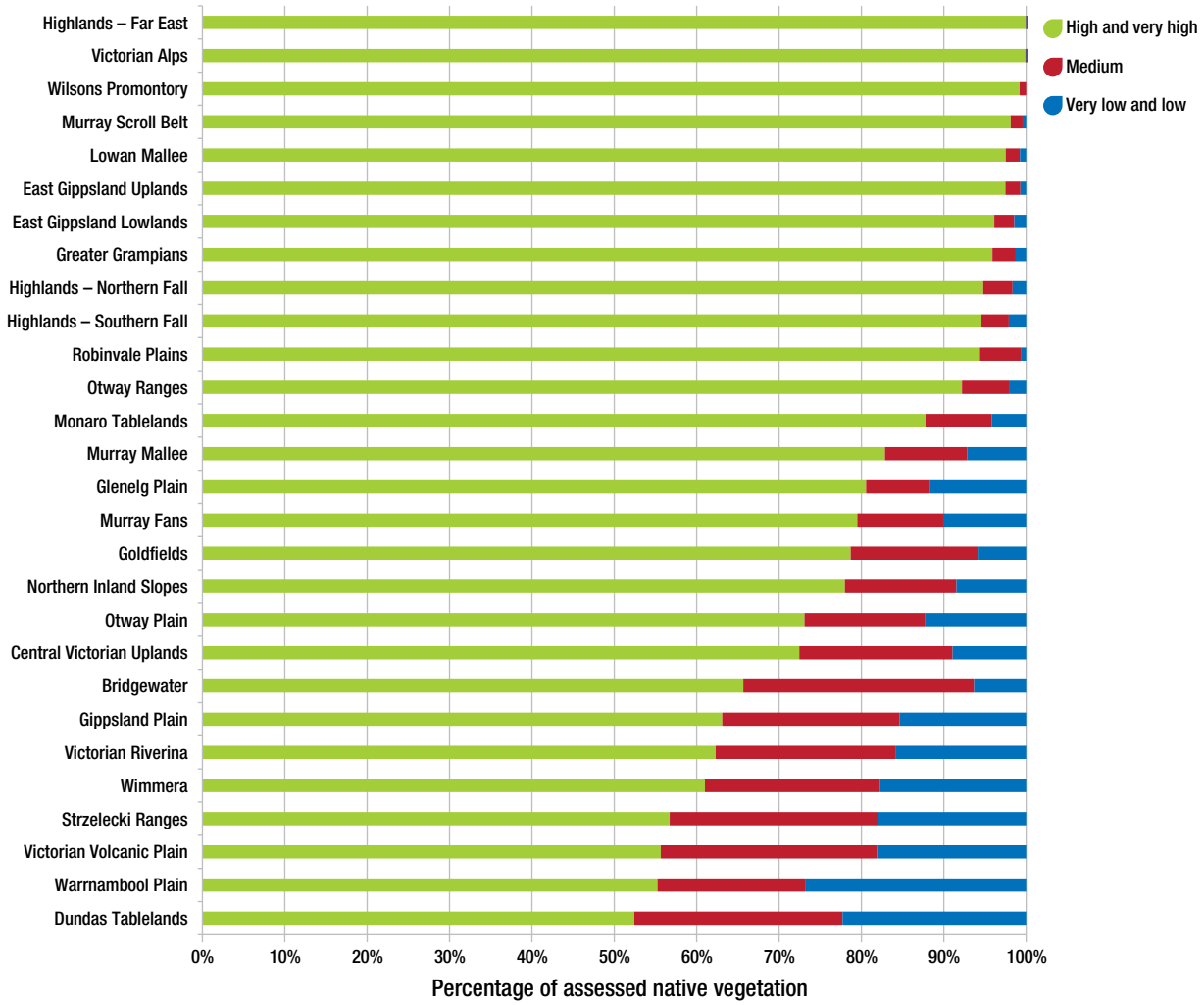


Figure A.2.15: Condition of native vegetation (modelled) by Victorian bioregion, as at 2010

Source: DEPI.

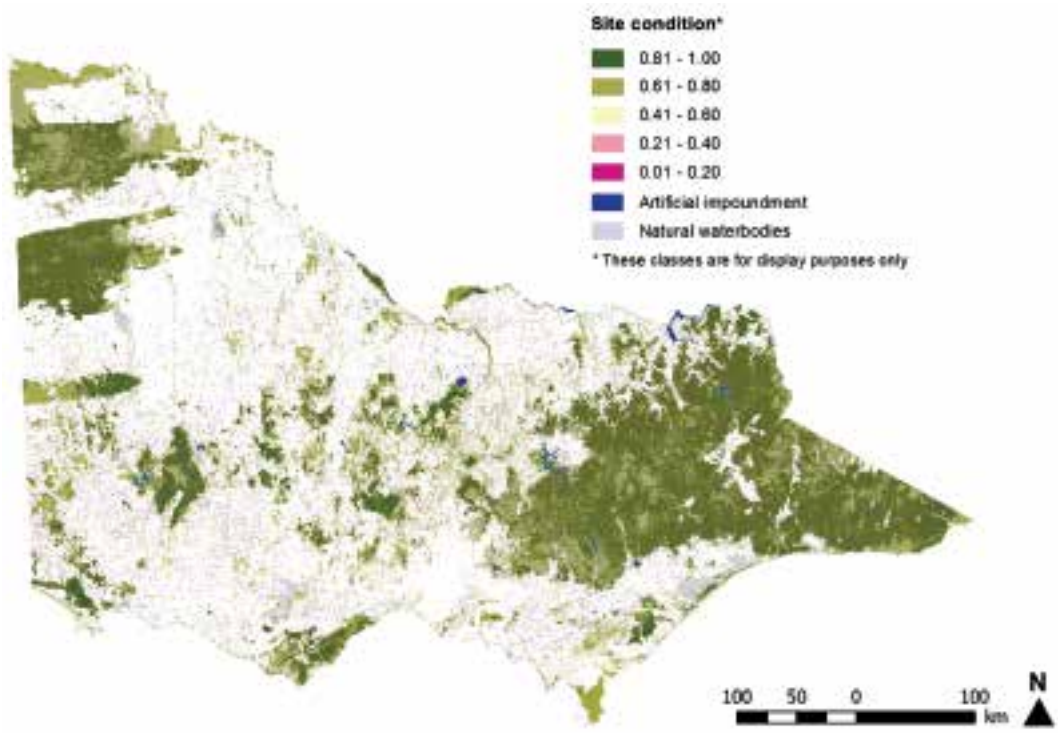


Figure A.2.16: Modelled condition of native vegetation, as at 2010

Source: DEPI.

Native forest timber harvesting

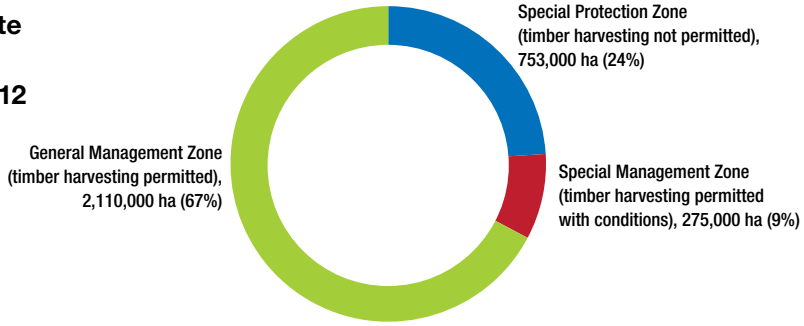
The harvesting of native forest on public land is mainly restricted to State forest, which comprises 3.14 million hectares, approximately 40% of public land and 14% of Victoria (See Indicator LB6: Land Use). Apart from the supply of timber resources, State forest is managed for a variety of purposes, including the conservation of flora and fauna, protection of water catchments, protection of heritage values, and the provision of recreational and educational opportunities.

Forest management zones are used to determine the types of activities that can take place in State forests. In 2012, timber harvesting was permitted in over three-quarters of the State forest area (Figure A.2.17). This includes General Management Zones (2,110,000 hectares, 67% of State forest), and Special Management Zones (275,000 hectares, 9% of State forest) which allow harvesting in accordance with specified conditions. Less than a quarter of Victoria's State forest (753,000 hectares) is covered by Special Protection Zones that are exempt from timber harvesting.

It should be noted that for areas in which timber harvesting is permitted, not all forests are suitable for forestry operations. For example, it is estimated that between 30–40% of forest in General Management Zones is not suitable for harvesting because of timber production exclusions such as excessive slope and proximity to waterways.

Figure A.2.17: Area and percentage of State forest by Forest Management Zone, 2012

Source: DEPI.



Area of native forest harvested

Between 2006–07 and 2011–12, the annual total area of State forest harvested (including fire salvage harvesting) ranged between 7,900 and 11,600 hectares (Figure A.2.18), around 0.3% to 0.4% of the total State forest area and less than 1% of the area available for timber harvesting. The majority of State forest harvested for timber lies within Ash, Red Gum and mixed species forests.

A range of silvicultural systems are used to harvest different forest types, depending on the regeneration requirements of the forest, particularly the availability of suitable seed in the surrounding forest. Victorian silvicultural systems include clearfelling, clearfell with seedtree retention, thinning and single-tree selection. These systems determine the area harvested, for example single-tree selection is less intensive but utilises larger areas. Typically, a quarter or less of the annual harvested area is clearfell, which is the most intensive of the harvesting systems. Clearfelling mainly occurs in Ash forests, whereas single-tree selection method is used for Red Gum forests and mixed species forests.

The sustainability of timber harvesting in Victoria was reviewed in 2001 and timber yields were found to be unsustainable. As a result, the industry was significantly restructured and the sustainable harvest level was substantially reduced. Consequently, the volume of sawlogs harvested from native forest has decreased to meet the reduced, sustainable harvest levels. Since 2005, harvest levels have been within sustainable harvest levels.

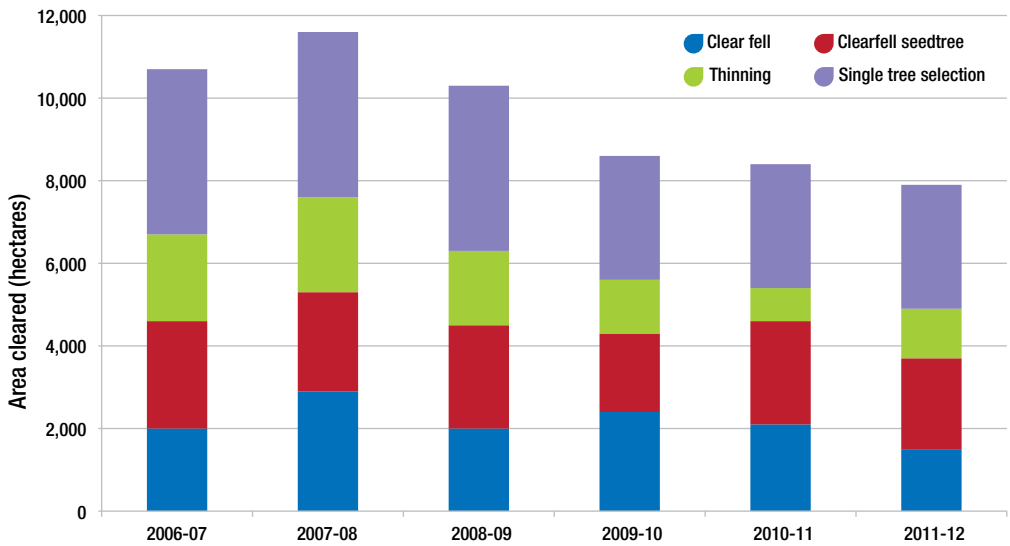


Figure A.2.18: Area of native timber harvest by silvicultural system (including fire salvage harvesting), Victorian State forest, 2006–07 to 2011–12

Source: DEPI.

Note: The silvicultural system used determines the total area harvested; for example, single-tree selection and thinning are less intensive but utilise larger areas. Data does not include area of forest harvested for domestic firewood production.

Fire salvage harvesting

Between 2006–07 and 2011–12, approximately 7,000 hectares of fire salvage harvesting was undertaken in response to the large bushfires in 2006–07 and 2009 (Figure A.2.19). Nearly a third of the salvage harvesting undertaken was through clearfelling. Although fire salvage harvesting was carried out for only 0.4% of the total area burnt by bushfires over the period, salvaging can be detrimental to biodiversity, particularly for mature forest areas. Large trees killed by fire events provide nesting sites for marsupials and birds, and decaying logs are habitats for a range of animals. Consequently, the removal of dead trees by salvage logging can lead to ongoing impacts on biodiversity greater than the impact of the fire alone (See Indicator LB5: Impact of Fire on Victorian Ecosystems).[19, 20]

The harvesting of unburnt forest is also an issue where significant fires have occurred because they provide an important refuge for fauna. Logging of these unburnt areas reduces the availability of habitat for those species displaced by fires. This is particularly an issue where areas designated for harvesting have been set prior to large fire events. Such areas can greatly increase in importance for the protection of biodiversity.

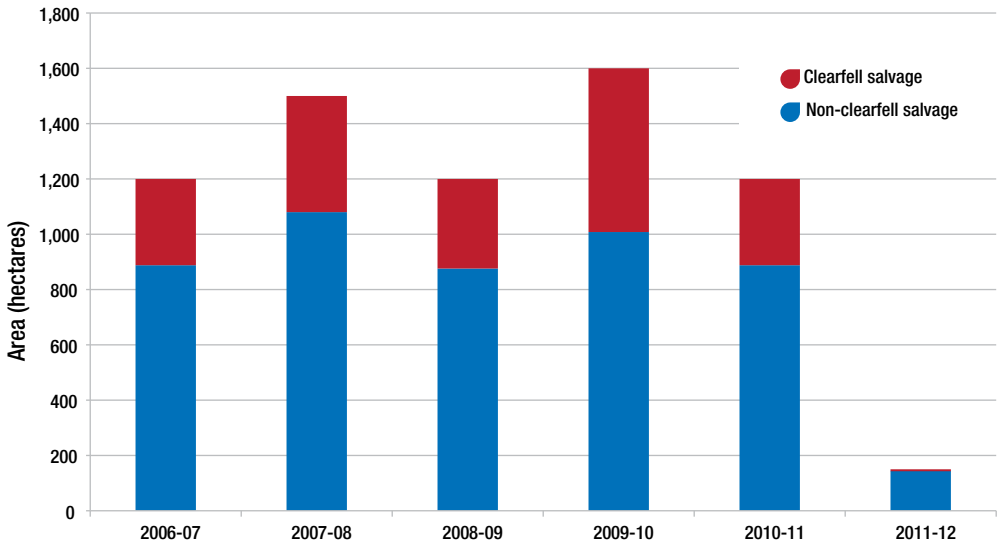


Figure A.2.19: Area of fire salvage harvesting by silvicultural system, Victorian State forest, 2006–07 to 2011–12

Source: DEPI.

Indicator LB4: Pest Plants and Animals

Pest plant and animal species (invasive species) continue to establish in Victoria and pose a major threat to biodiversity, ecosystem health, primary production and landscape aesthetics.

Although this report is mainly concerned with the impacts of invasive species on biodiversity, it must be acknowledged that pest plants and animals are an important and costly issue across all Victorian landscapes and tenures. In 2009 the annual cost to the Victorian economy was estimated to be over $900 million alone.[1] This primarily represents lost production and management costs, as the cost of invasive species to native biodiversity is largely incalculable. Between 2007–08 to 2011–12, the Victorian Government spent $139 million on pest species management on private land alone. The high costs associated with the control of pest species reduce the resources available for other environmental management activities.

Because the eradication of widely established pest species is not feasible, the goal of pest management is to reduce pest numbers to levels where they have no significant impact. This goal requires ongoing and coordinated management. The challenge is to monitor and control established species and, where possible, detect and eradicate new potentially invasive plants and animals before they establish.

Coordinated ongoing management can have positive outcomes for biodiversity. For example, some populations of Southern Brown Bandicoots (*Isoodon obesulus*) and Long-nosed Potoroos (*Potorous tridactylus*) are showing signs of a positive response to the reduction in foxes achieved under the Southern Ark program.[21]

Pest plants and animals are not restricted to exotic species (i.e. those not indigenous to Victoria); over-abundant native animals such as kangaroos and koalas can impact on ecosystem health. Some native species, particularly plants, can also become pests if they become established outside of their natural range.

Climate change may extend the range of many pest plants and animals in Victoria, and may facilitate the introduction and spread of new species (see Foundation Paper One: *Climate Change Victoria: The Science, Our People, and Our State of Play*.)[2]

Pest plants

Plant invasions are considered one of the major factors in the loss of biodiversity through the displacement of native species and the reduction of food and habitat (see Indicator LB2: Threatened Species in Victoria). In addition to threatening native flora and fauna, environmental weeds have other impacts on ecosystem function, including changing hydrological cycles, increased soil erosion, alteration of soil chemistry and nutrient cycling patterns, alteration of geomorphic processes (e.g. dune configuration), and alteration of stream flow and flooding characteristics (e.g. willow invasion of streams).

Pest plants include environmental weeds that threaten natural ecosystems and biodiversity, or agricultural weeds that threaten crops, horticulture, pasture production and may be toxic to livestock.

Weeds have invaded all Victorian landscapes and are a concern across all land tenures, affecting forest, coasts, bushland, farms and urban environments. Twenty of the 32 Australian Weeds of National Significance are known to be present in Victoria.

Pest animals

Pest animals threaten biodiversity through habitat modification, predation of native fauna, and competition for food and habitat. The main pest animal species in Victoria include foxes, rabbits, feral cats and wild dogs. Predation by foxes, cats and dogs is a known threatening process for at least 47 species of threatened fauna in Victoria.

Pest animals can have significant environmental impacts due to soil disturbance from burrowing, grazing and the action of hard hooves (e.g. deer, goats). These promote erosion and can lead to water quality declines. Feral pigs occupying forests and marshes can damage wetlands and habitat of ground-nesting birds. Land disturbance by pigs also facilitates weed invasion. Pest animals can also spread disease and parasites.

Rabbits pose a particular threat to native vegetation, as they prevent regeneration by removing seedlings. Loss of native vegetation by rabbit grazing places pressure on native herbivores and the presence of rabbits can sustain fox and feral cat populations. These predators, in turn, place further pressure on native prey species.

Number of introduced plant and animal species

Statewide information on the number and distribution of introduced species has not been updated since the 2008 Victorian State of the Environment report. Consequently, it is not possible to determine changes in the number of pest plants and animals since 2008. Main findings from the previous State of the Environment report include:[4]

- In 2008, exotic plant species represented approximately 30% of Victoria's flora, with over 1,280 species considered naturalised in Victoria. This increased from 878 naturalised species in 1984. It is estimated that an average of 7.3 new plant species establish in Victoria per year, and that this rate increases each year.
- Weeds affect all Victorian landscapes. Approximately 90% of the native bushland in Melbourne is badly affected by weeds, with more than 50% severely degraded by weeds.
- Almost 80% of recently recorded plant naturalisations in Victoria are of garden origin.
- The area occupied by naturalised plant species increases annually. Some of Victoria's most significant weed species are likely to become more widespread with climate change and land-use change.
- Most pest animals occur and are managed on local scales, and statewide trends in pest species are not monitored. While foxes and rabbits are widespread throughout Victoria, wild dogs and feral pigs are absent or unknown over large areas of Victoria.

Extent of active management

Comprehensive data on the extent of pest plant and animal management is not available for Victoria, particularly for private land. However, some data is available for specific landscape scale management programs on public land. These programs are generally aimed at protecting biodiversity values, such as threatened species, and therefore often target a range of pest plant or animal threats. For example, between 2008 and 2011, some 1.5 million hectares of public land was treated for pest animals through these landscape scale programs, the majority for foxes and 282,000 hectares for weeds. Other pest animals subject to management include rabbits, cats, pigs and goats.

Pest plants and animals on public land are also managed on a local scale through targeted programs for particular pest species. These programs include ongoing maintenance programs, opportunistic control programs and emergency incursion response.

Case Study: Pest Plant and Animal Management in Victorian Parks and Reserves

Source: Parks Victoria.

Pest species are a significant problem in Victoria's parks and reserves. The protection of parks from invasive species represents the largest program of natural values management activity undertaken by Parks Victoria (by area and expenditure).

In 2010, over 1.1 million hectares were treated to control pest animals in Victoria's parks and reserves, including some 800,000 hectares for Red Fox, 200,000 hectares for European Rabbits, and 20,000 hectares for feral cats (Figure A.2.20). In addition, 115,000 hectares were treated for weeds.

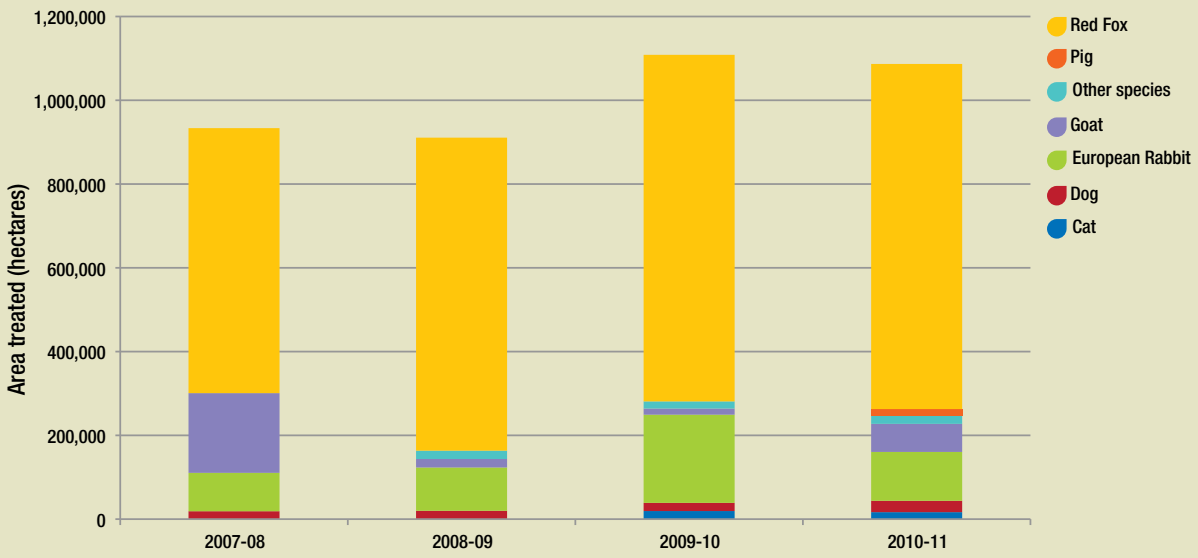


Figure A.2.20: Area treated for pest animal management in Victorian parks and reserves 2007–08 to 2010–11

Source: Parks Victoria.

Pest plants

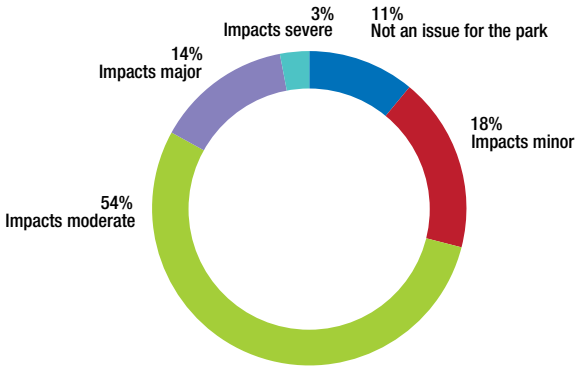
Pest plants are widespread in Victoria's parks and reserves. In 2010, 1,224 introduced plant species (both exotic species from overseas and Australian native species growing beyond their natural range) were known to occur within Victoria's parks. In over 40% of parks where adequate data was available, introduced species constituted up to 20% of the total flora.

Pest species vary in their distribution, extent and impact on natural values. Some weeds are found in a broad range of habitats across the state (e.g. Blackberry) while others are restricted to just one or two parks (e.g. Orange Hawkweed in the Alps). Weeds that have established in parks are often a result of previous land use, or adjacent land use (e.g. garden escapes).

In 2010, 311 parks were assessed for pest plants. Weeds were reported as an issue in 89% of the assessed parks constituting 91% of the assessed area (Figure A.2.21). Weeds were found to have major or severe impacts in 17% of the parks assessed, moderate impacts in 54%, and minor or insignificant impacts in 29% of assessed parks. Impacts of weeds were found to be increasing in 19% of assessed parks, and remaining stable or declining in 52%.

Figure A.2.21: Impacts of all weeds across 311 assessed parks, 2010

Source: Parks Victoria.



Pest animals

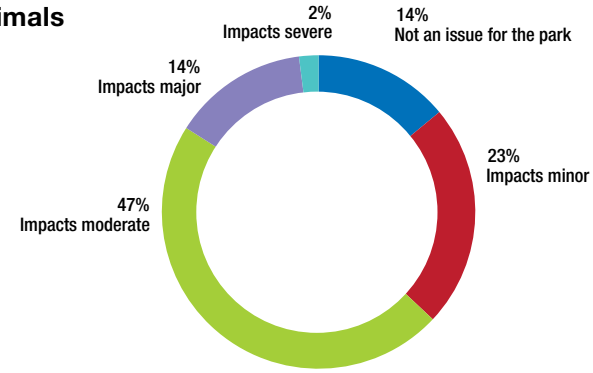
In 2010, pest animals were an issue in 84% of the 311 assessed parks, which represented 94% of the assessed area (Figure A.2.22). Some 54% of parks assessed had moderate impacts from pest animals, with 16% having major or severe impacts. Pest animal impacts were found to be increasing in 17% of assessed parks and remaining stable or declining in 35%.

The severity of impact from priority pest animals species varied with Red Fox, European Rabbit and cats reported as having the greatest impact. The introduced Sambar and Fallow deer, and European Wasp were reported as increasing in impact in around half of the parks where they were considered an issue.

An increased emphasis on landscape scale programs, such as the Southern and Glenelg Arks, Grampians Ark and Mallee Bounceback rabbit control programs, have resulted in a reduction in the level of threat by foxes and rabbits at priority parks.

Figure A.2.22: Impacts of all pest animals across 311 assessed parks, 2010

Source: Parks Victoria.



Indicator LB5: Impact of Fire on Victorian Ecosystems

This chapter examines the impact of fire on native vegetation and terrestrial biodiversity. Information on the occurrence, risks and impacts of fires in Victoria, including the Black Saturday fires in 2009, can be found in Foundation Paper One: *Climate Change Victoria: The Science, Our People, and Our State of Play*.[2]

Victoria has one of the most fire-prone environments in the world, owing to its particular combination of climate, vegetation and topography. Bushfire is a normal feature of our environment and plays a key role in many ecosystems. While it may produce a temporary loss of vegetation, fire is necessary for the regeneration and regrowth of many plant species.

While many plant species need fire to stimulate regeneration, the appropriate fire regime (intensity, frequency, season, extent and type of fire) varies between ecosystems. In general, grasslands and heathlands require more frequent burning than eucalypt forests to maintain diversity and community structure. Too little or too much fire can change the composition of vegetation communities and the ecosystems they support.

However, the ecologically appropriate natural fire regimes to which species have evolved in Victoria have changed, with fire increasing in some areas and decreasing in others. This is due to increased human sources of ignition, the suppression of natural fire to protect human life and assets, and planned burning practices for the management of fuel loads. In addition, the recent period of prolonged drought and higher temperatures has increased the frequency and severity of fires. Climate change is expected to further influence the occurrence of bushfires in Victoria.

Planned burning is used in the management of Victoria's 8.5 million hectares of mostly forested public land. It is mainly used to decrease the occurrence of large bushfires and potential impacts on life, property and the environment through the reduction of fuel loads. Planned burns are also applied for ecological purposes where ecosystems rely on fire for regeneration and the maintenance of vegetation composition and structure. The challenge for land managers is to balance the need for suppression and prevention of fires with the requirement of many ecosystems for ecologically appropriate burning.

The impacts of bushfires are not restricted to terrestrial ecosystems. Fires have important implications for river health, water quality and water yields because of changes in vegetation cover, soil structure and sedimentation (see Part A: 3 Inland Waters). Fire also impacts on air quality, significantly contributing to summer smog and particle pollution (see Part A: 1 Climate Change and Air Quality)

Area of native vegetation burnt in planned fires and bushfires

Planned fires

The Victorian Government has been progressively increasing the annual planned burning target. Prior to 2010–11, the annual target was 130,000 hectares, this increased to 200,000 hectares in 2010–11, 225,000 hectares in 2011–12 and 250,000 hectares in 2012–13. The increase in planned burning has been in response to recommendations from various inquiries into large bushfires since 2002, including the 2009 Victorian Bushfires Royal Commission, which recommended an annual planned burning target of 390,000 hectares (5% of public land).[22] This figure was suggested as sufficient to significantly reduce risk to life and property from major fires.

Regardless of annual burning targets, the actual area of planned burning achieved in any year is highly dependent on the occurrence of favourable weather conditions, both prior to and during planned burning activities. Consequently, it is often not possible to meet planned burning targets.

The increase in the annual planned burning target is the focus of much discussion, particularly around the impacts on native vegetation and ecosystems (see Part B: 1.4 Review of Impacts on Ecosystems due to Planned Burning).

Between 2001–02 and 2012–13, 1.7 million hectares of native vegetation was burnt by planned fires in Victoria (Figure A.2.23 and Figure A.2.24). The vast majority of planned burns were carried out for fire suppression purposes, with 85% of planned burns used for fuel reduction. The total area burnt represents over 20% of the total area of public land, and is equivalent to nearly half of the total area burnt by bushfires over the same period.

The annual area of planned burning for fuel reduction purposes has been increasing in Victoria, with annual burns of 120,000 hectares or higher since 2006–07. The largest area burnt was 201,000 hectares in 2012–13. The area of ecological burns has also increased significantly, with annual burns of between 22,000 hectares and 52,000 hectares between 2008–09 and 2012–13. Prior to 2008, the largest annual area of ecological burning was 14,000 hectares.

The increase in planned burning has been in response to recommendations from various inquiries into large bushfires since 2002.[22–24] These recommend that opportunities for planned burning should be maximised where possible to reduce fuel loads in Victorian forests. However, this only relates to fire suppression and does not take into account ecosystem health.

Despite the increase in planned burning activities, the annual area burnt remains well short of the Victorian Bushfires Royal Commission target of 390,000 hectares per year.[22]

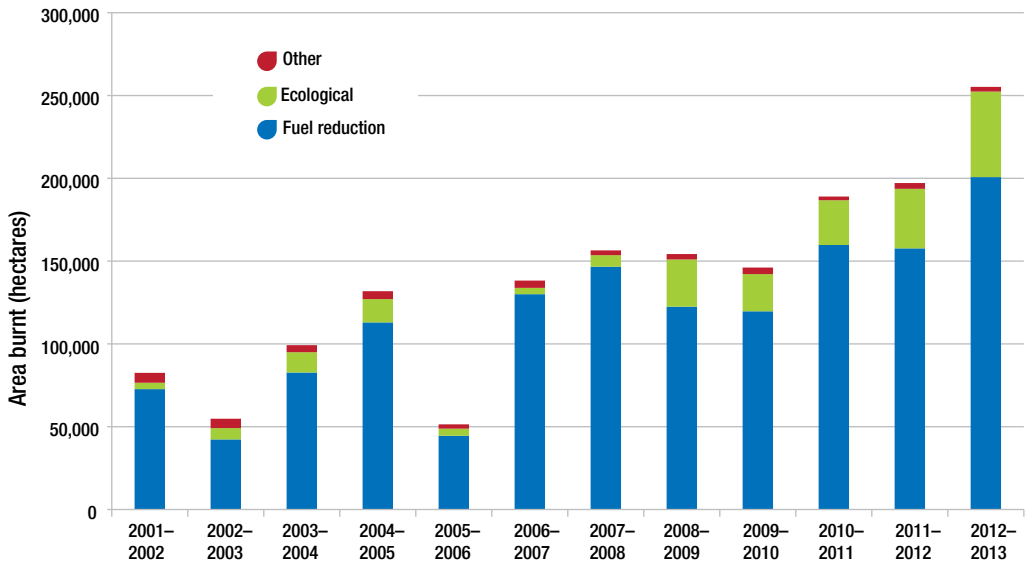


Figure A.2.23: Area of planned burning by type, 2001–02 to 2012–13

Source: DEPI.

Note: Other burns include those for forestry-related activities such as regeneration burns after harvesting.

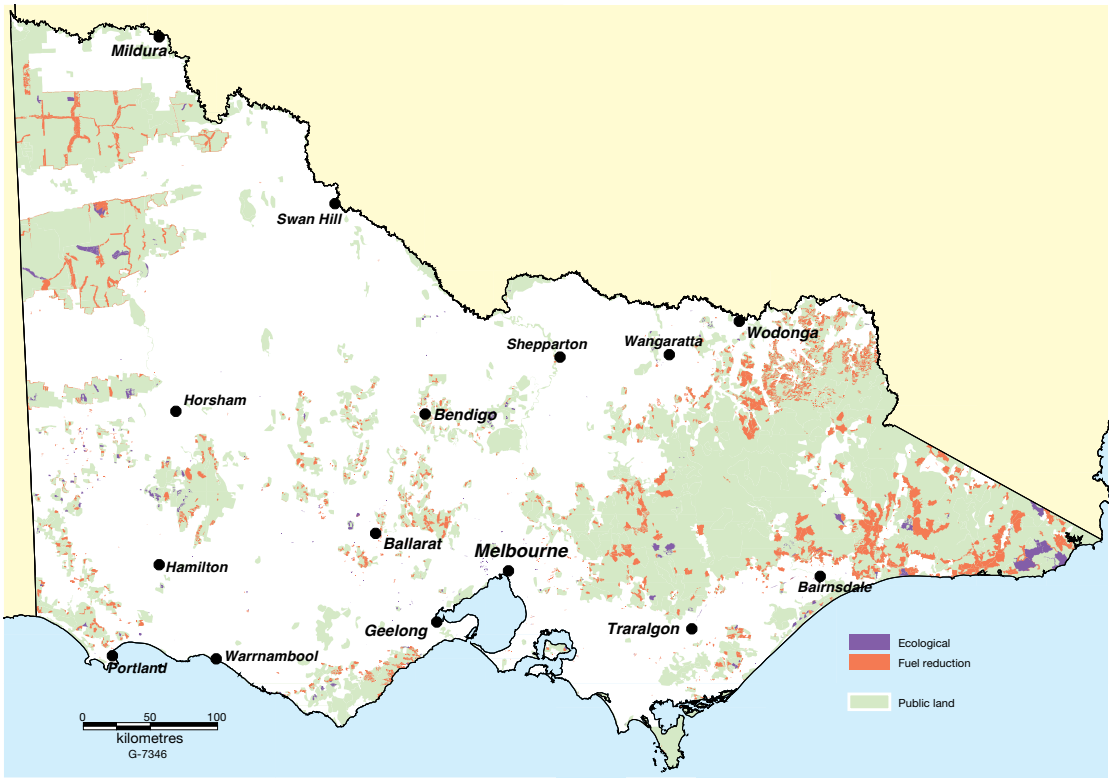


Figure A.2.24: Planned burns in Victoria, 2002 to 2012

Source: DEPI.

The Gippsland region accounted for the largest area of planned burns between 2001–02 and 2012–13, with 501,000 hectares or 37% of the total planned burn area (Figure A.2.24 and Figure A.2.25). The North East region was the next highest accounting for 379,000 or 28% of the total planned burn area. This reflects the highly forested nature of these regions. The Orbost and Mallee districts were subject to extensive burning over the period, accounting for 16% (221,000 hectares) and 15% (201,000 hectares) of the total area burnt over the period respectively (Figure A.2.24 and Figure A.2.26).

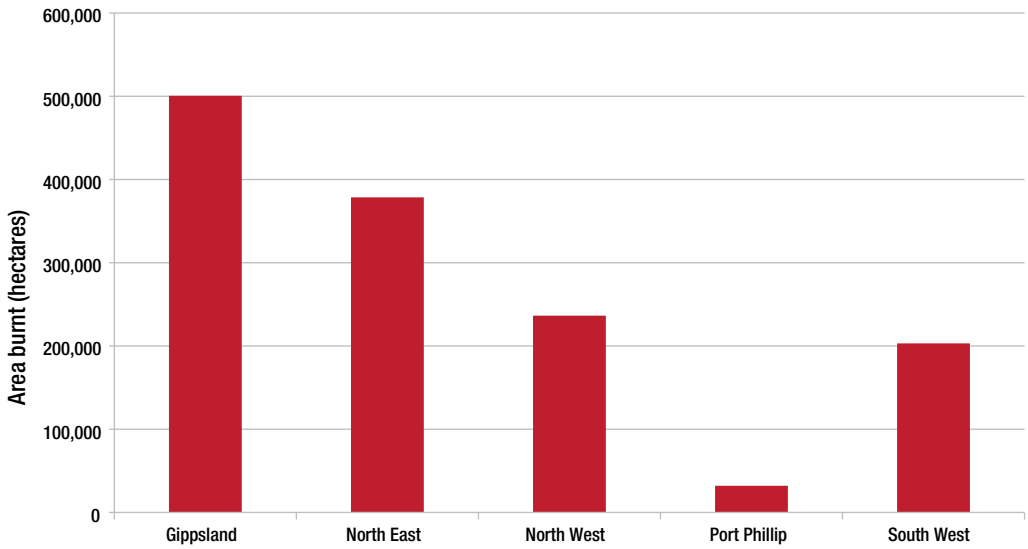


Figure A.2.25: Area of planned burning by region, 2001–02 to 2012–13

Source: DEPI.

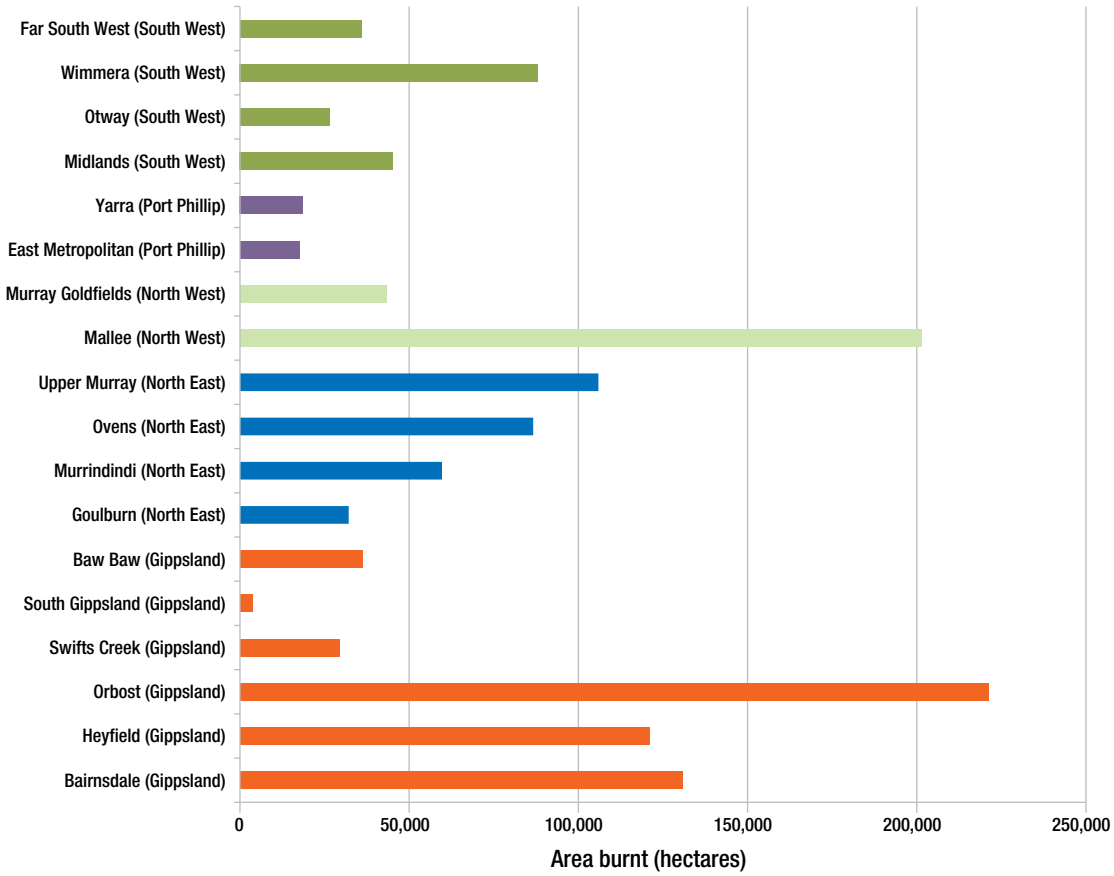


Figure A.2.26: Area of planned burning by fire district, 2001–02 to 2012–13

Source: DEPI.

Bushfires

Between 2001–02 and 2012–13, nearly 3.6 million hectares were burnt in bushfires, the vast majority of which was on public land (Figure A.2.27 and Figure A.2.28).

Some 85% of this area was burnt during three extensive bushfire seasons in less than a decade: 2002–03 (1.3 million hectares), 2006–07 (1.2 million hectares) and 2009 (430,000 hectares). This period saw prolonged drought and higher temperatures across Victoria, which increased the frequency and severity of large bushfires. The dry and hot conditions leading up to these fires are consistent with predictions that climate change will increase the occurrence and risk of bushfires in the future.

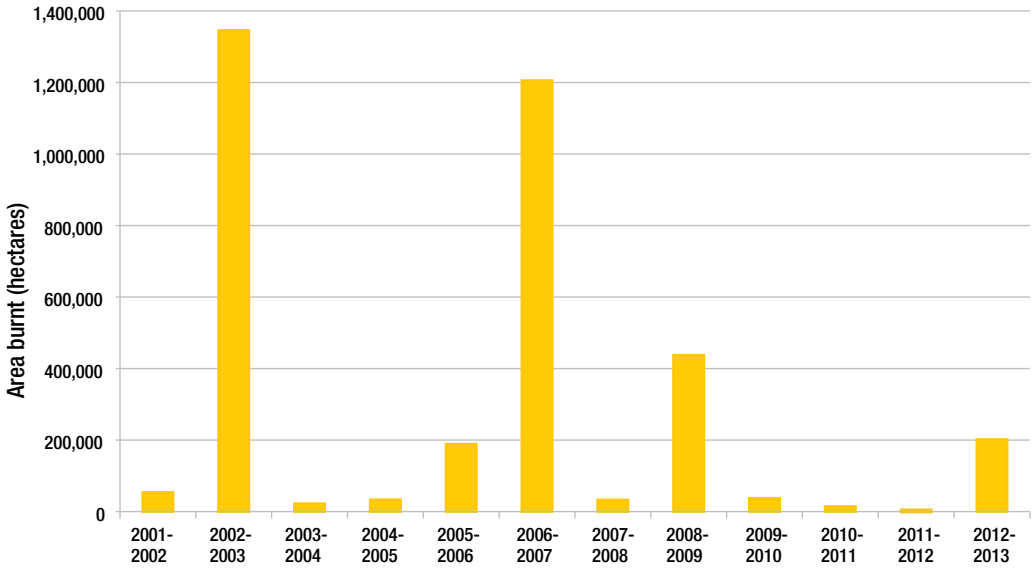


Figure A.2.27: Area burnt in Victorian bushfires, 2001–02 to 2012–13

Source: DEPI.

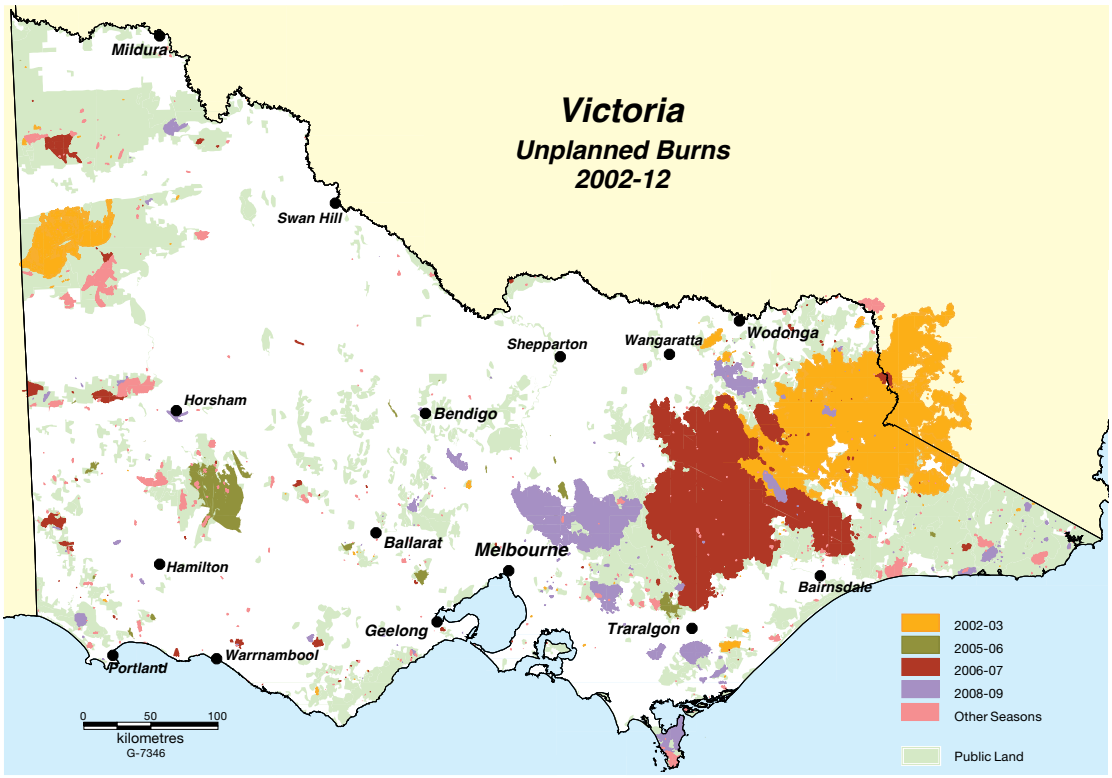


Figure A.2.28: Victorian bushfires, 2002 to 2012

Source: DEPI.

Victorian regions most impacted by bushfires were the North East and Gippsland, which accounted for nearly 80% of the area burnt between 2001–02 and 2012–13 (Figure A.2.28 and Figure A.2.29). This reflects the highly forested nature of these regions. Native vegetation in the Mallee area (North East) and the Grampians (South West) also experienced significant bushfires of over 200,000 hectares over the period. In addition, large areas of Wilsons Promontory were burnt. Over 165,000 hectares of vegetation was burnt more than once as a result of the large fires in 2002–03, 2006–07 and 2009. Changes to vegetation structure and a loss of biodiversity can occur in areas subject to frequent severe bushfires.

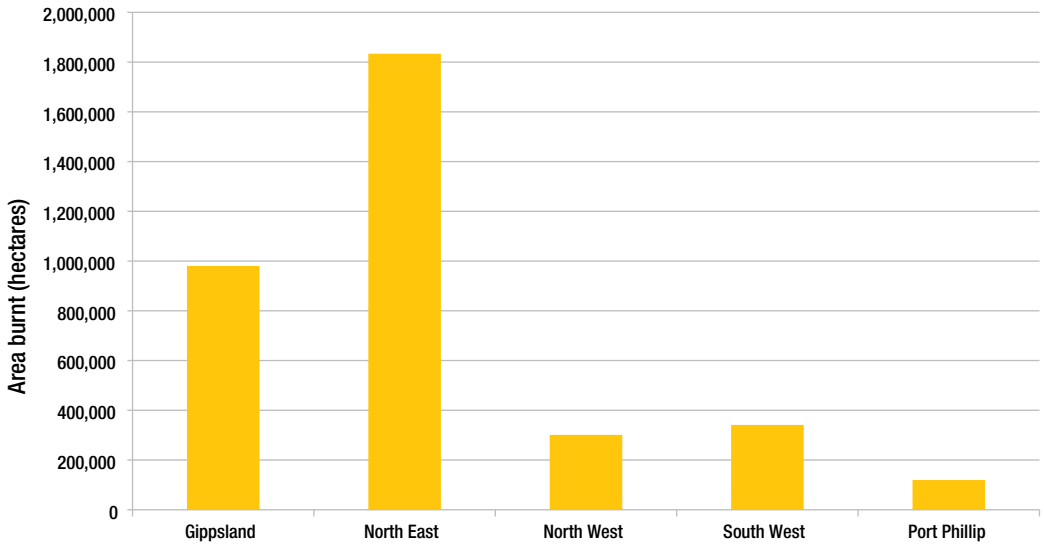


Figure A.2.29: Area burnt in Victorian bushfires by fire region, 2001–02 to 2012–13

Source: DEPI.

Actual fire regimes compared to optimal fire regimes

A fire regime is the frequency, intensity, season, extent and type of fire events in a given area. Inappropriate fire regimes threaten biodiversity by changing the structure of plant communities and is listed as a threatening process under the *Flora and Fauna Guarantee Act 1998*. The appropriate interval between fires for any given plant community is determined by the time taken by each species to reach maturity and set seed, and the time to extinction in the absence of fire. If fire is too frequent, species that are not able to reproduce may be lost from the community. If the interval between fires is too long, species that depend on fire for regeneration may die out.[25]

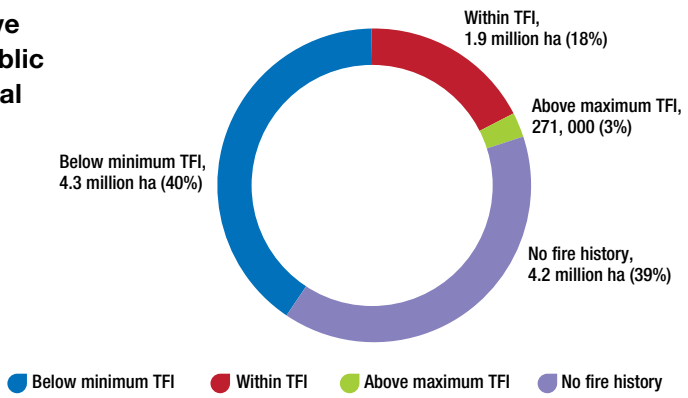
The Department of Environment and Primary Industries has characterised tolerable fire intervals (TFI) for each Ecological Vegetation Division (EVD) on Victoria's public land.[25] TFI reflects the history of bushfires and planned burning in Victoria over recent decades, including the extensive areas affected by bushfire over the past 10 years. In interpreting the results of the TFI analysis, it should be noted that Victoria applies a conservative approach by doubling the time to reproductive age of key fire response species. This provides a greater risk buffer and earlier detection of fundamental ecological change.

In 2012, 40% of native vegetation was found to be below minimum TFI (fire frequency too high to maintain vegetation in its current state) with 3% above the maximum TFI (fire frequency too low to maintain vegetation in its current state). Only 18% of native vegetation assessed was found to be within the required TFI to maintain vegetation communities.

A further 39% of native vegetation had no fire history and consequently TFI could not be calculated (Figure A.2.30). Because of the high percentage of native vegetation without fire history, it is difficult to ascertain the full extent of impacts from fire frequency changes. However, given the high area of vegetation outside of TFIs, it is likely that inappropriate fire regimes exist for the majority of Victoria's native vegetation.

Figure A.2.30: Area of native vegetation on Victoria's public land by tolerable fire interval status, as at 30 June 2012

Source: DEPI.



Note: Below minimum TFI refers to fire frequencies that are too high to enable plant maturation and seeding. Above maximum TFI refers to fire frequencies that are too low for regeneration. Within TFI refers to fire frequencies appropriate for maintaining vegetation communities. No fire history means no data is available for the occurrence of fire.

For the 32 EVDs assessed, only eight had 25% or more of their assessable area within the required TFI, none had over 50% of their area within the required TFI (Figure A.2.31). Fourteen EVDs had less than 10% of their assessable area within the required TFI. Hummock-grass Mallee and Tall Mixed Forest had the highest area within TFI with 43% and 36% respectively.

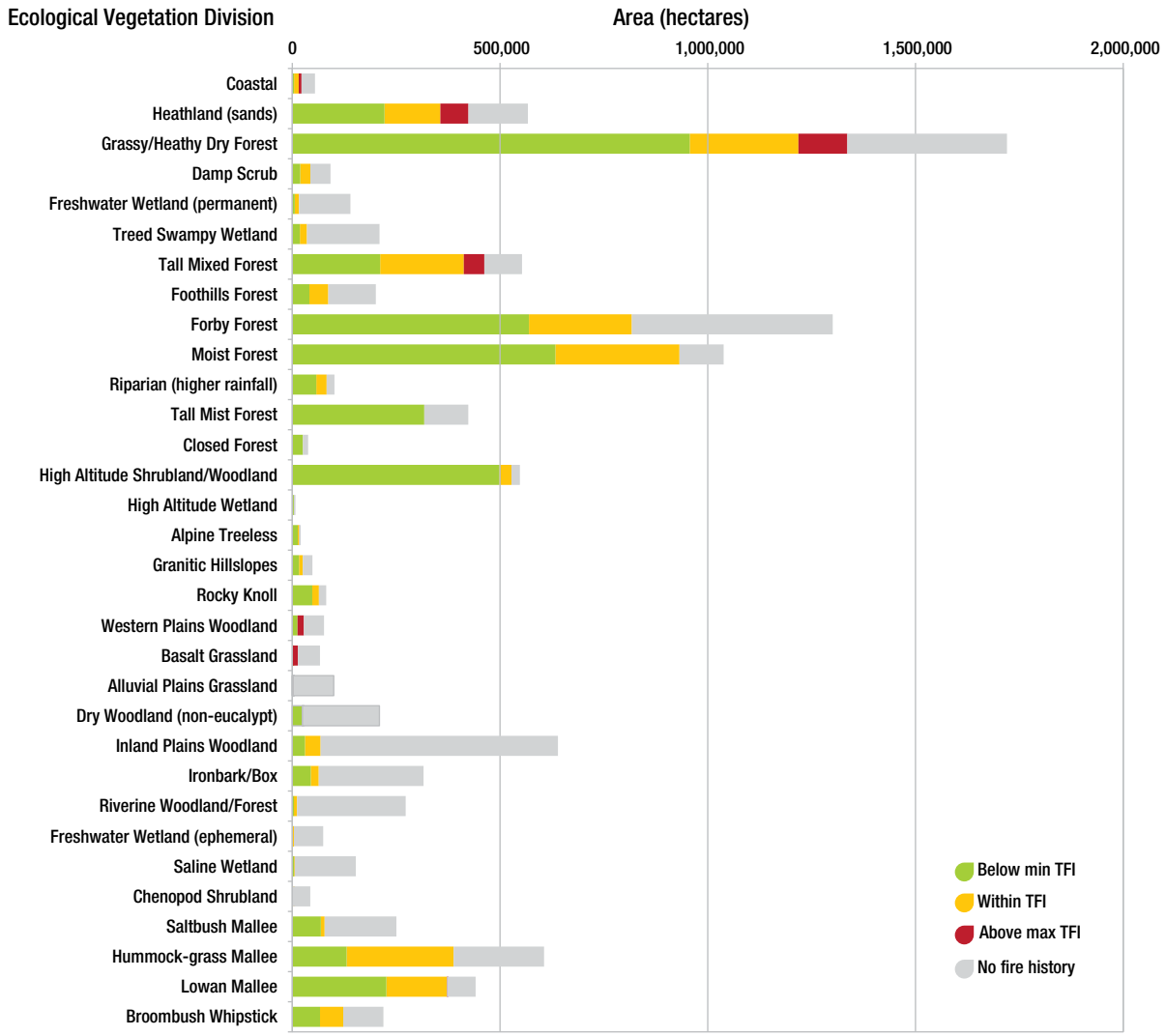


Figure A.2.31: Area of Ecological Vegetation Division on Victoria's public land by tolerable fire interval status, as at 30 June 2012

Source: DEPI.

Tolerable fire interval status has changed considerably since 2000 due to large fire events. The distribution of areas that are below, within and above TFI are shown for 2012 and 2000 (Figure A.2.32 and Figure A.2.33). These clearly show the increase in the area of native vegetation below the minimum TFI, and decrease of areas within TFI as a result of increased bushfires and planned burning.

Over the next decade, large areas of Victoria will remain below minimum TFI irrespective of the level of planned burning and future fire events. This potentially places species with life cycles dependent on long inter-fire intervals at increased risk, particularly in EVDs with little long unburnt vegetation.

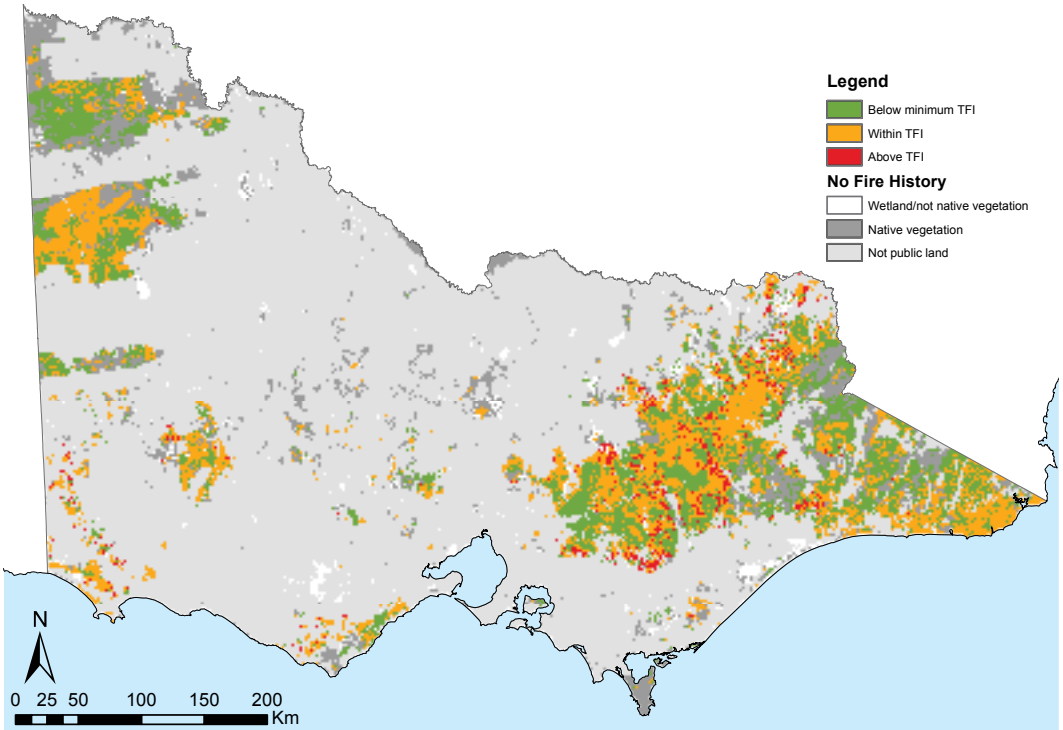


Figure A.2.32: Tolerable fire interval status of vegetation on public land in Victoria as at 2000

Source: DEPI.

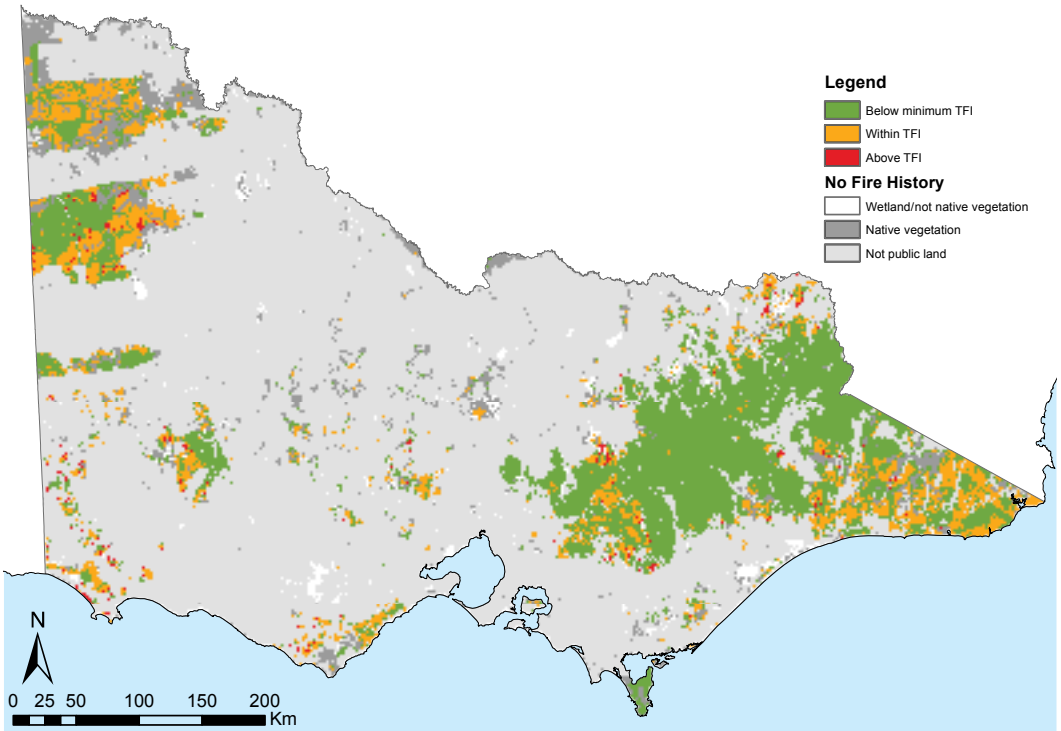


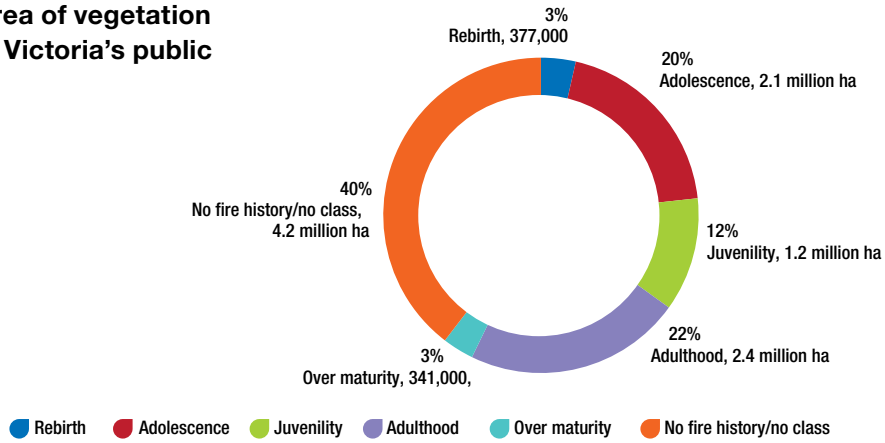
Figure A.2.33: Current tolerable fire interval status of vegetation on public land in Victoria as at June 2012

Source: DEPI.

In addition, recent large-scale bushfire events means that early growth stages are now over-represented in Victoria's vegetation types. Of the assessed native vegetation, 35% were found to be in early growth stages compared to only 25% in mature or over mature stages (Figure A.2.34). These changes have severe implications for biodiversity, especially fauna that require older growth stages.

Figure A.2.34: Area of vegetation growth stage on Victoria's public land, as at 2012

Source: DEPI.



Impacts of fires on biodiversity

The impact of the frequent and extensive bushfires of the last decade on individual species is likely to be varied and is the subject of ongoing research and monitoring. For many species, the impacts can only be assumed based on life history traits and even with initial monitoring it may be too early to determine these impacts. While fire favours some species by triggering seed germination or by opening up new habitat, for threatened or restricted-range species, fires are likely to have had a negative impact where inappropriate fire regimes exist. In addition, many forest species such as possums and owls nest in tree hollows, the availability of which are strongly influenced by fire and tree age.

Adding to fire impacts is the detrimental impacts of salvage logging.[19, 20] Large trees killed by fire events provide nesting sites for marsupials and birds, and decaying logs are habitats for a range of animals.

Consequently, the removal of dead trees by salvage logging can lead to ongoing impacts on biodiversity greater than the impact of the fire alone. Research has shown that salvage logging after the 1939 bushfires contributed to a shortage of cavity trees for more than 40 species of vertebrates. This will take more than 200 years to rectify.

The harvesting of unburnt forest is also an issue where significant fires have occurred because they provide an important refuge for fauna. Logging of these unburnt areas reduces the availability of habitat for those species displaced by fires. This is particularly an issue where areas designated for harvesting have been set prior to large fire events. Such areas can greatly increase in importance for the protection of biodiversity.

The 2002–03 and 2006–07 fires are discussed in the previous State of the Environment report.[4] Their impacts on Victoria's biodiversity, particularly alpine communities, are considered to be severe. Alpine and mountainous vegetation communities were particularly affected by these large bushfires with nearly 2.3 million hectares burnt, including over 145,000 hectares of vegetation burnt in both the 2002–03 and 2006–07 fires. The Mountain Ash (*Eucalyptus regnans*) and Alpine Ash (*Eucalyptus delegatensis*), which dominate Victoria's eastern forests, regenerate from seed following fire and need up to 20 years without fire to start producing seeds. The extent of these species is likely to be severely reduced in the areas that were burnt more than once. They may be replaced with species that resprout quickly from burnt trunks or from roots after fire, such as some *Acacia* species.[4]

The 2009 bushfires have been another significant event for Victoria's biodiversity. The once healthy population of the endangered Leadbeater's Possum on the Lake Mountain plateau was decimated by the fires, with only a few individual animals known to have survived the fire. The fires also threatened aquatic species due to the high risk of sedimentation following substantial rainfall on the exposed, post-fire soils. Populations of Barred Galaxias and Macquarie Perch were brought into captivity to ensure their survival. These fish have subsequently been returned to the wild and appear to be surviving.[12]

Biodiversity data gaps

Victoria generally has a lack of integrated and well-designed monitoring to answer key biodiversity and ecological and management questions. In addition, the accessibility of available data is severely reduced by the disparate nature of biodiversity datasets.

In the 2008 State of the Environment report, it was noted that despite an increase in the number of species listed as threatened and the increasing risks posed to them, monitoring effort for species distribution and abundance was declining. The ongoing lack of data on threatened (and non-threatened) species suggests that this trend has not changed. Victoria's conservation planning efforts and conservation needs are still hampered by the lack of monitoring, which limits the ability to track changes in species populations. Knowledge of the status of invertebrates, lichens and fungi also remains poor.

It is also difficult to determine biodiversity trends over time because of methodology changes. While this can mean improved data quality, it is often unclear whether biodiversity changes are due to actual changes or increased accuracy (e.g. vegetation extent and quality).

Important datasets, such as those on native vegetation, provide the foundation for many other natural resource values and processes. However, these basic datasets are not routinely updated and maintained.[12]

Other data gaps for biodiversity include a lack of knowledge of the distribution and abundance of pest plants and animals and their management, and the impacts of fire on biodiversity, especially individual species populations.

B LAND

MAIN FINDINGS

General

- Current understanding of land and soil health is hampered by the lack of data and long-term monitoring programs, with existing datasets often limited in extent or out of date. This makes it difficult to detect trends in land and soil health over time and remains a critical gap in our understanding of environmental condition.

Land use

- Victoria's public land is mainly divided between parks and reserves (18% of Victoria's total area) and State forests (14% of Victoria's total area), which account for 90% of Victoria's public land.
- Nearly two-thirds of Victoria is privately owned and is predominantly used for agricultural production. Agriculture accounts for 56% of Victoria's total area, making it the dominant land-use type in the state.
- Dryland cropping and grazing (rain-fed or unirrigated) accounts for the vast majority of Victoria's agricultural area, covering 90% of all agricultural land. Irrigated agriculture and horticulture accounts for over 8% of agricultural land.
- The area of parks and reserves has increased with a corresponding decrease in the area State forest due to the transfer of State forest into the reserve system.
- Irrigated agriculture has increased with a corresponding decrease in dryland agriculture. This is likely driven by water trading which is producing significant land-use change in irrigation areas.
- Urban areas have increased with population growth driving urban expansion in Melbourne and regional centres, as well as in coastal areas.

Salinity

- Knowledge of the extent and severity of salinity are poor in Victoria, with ad hoc and infrequent data collection and little information on irrigation salinity.
- It is estimated that around 247,000 hectares is affected by dryland salinity, 2% of the total area of dryland agriculture in the state. Regions most affected include Victoria's north (particularly the Mallee) and west, and near Sale in the state's east.
- Western Victoria is generally more severely affected by salinity than eastern Victoria, largely because it is flatter and poorly drained, and also because conversion of native vegetation to agriculture has been much more extensive in western Victoria.
- The spread of dryland salinity in Victoria slowed or receded in many areas during the recent dry period due to lower groundwater tables. However, the area impacted by salinity is likely to increase with the recent return to wetter conditions.
- There is no current data for irrigation salinity in Victoria.

Soil health

- No new data on soil structure decline and erosion has become available since that reported in the 2008 Victorian State of the Environment report.
- At least 60% of Victoria soils are prone to erosion and soil structure decline.
- Expert opinion indicates that the recent drought conditions experienced across much of Victoria reduced the threat of water erosion, primarily in cropping regions. However, the extended dry is likely to have increased wind erosion because of the decrease in vegetative cover.
- No new data on soil acidification has become available since that reported in the 2008 Victorian State of the Environment report. Expert opinion suggests that soil acidity has generally decreased since the 1990s due to the prolonged drier conditions.
- Data on soil carbon levels is poor in Victoria, particularly for private land.

INDICATOR ASSESSMENT

Indicator Summary

Indicator	Summary	Status and trends (Good / Fair / Poor / Unknown)	Data quality
LB6 Land use	Due to differences in methodology, land-use changes since the previous State of the Environment report cannot be determined. However, the area of parks and reserves, irrigated agriculture and urban land are all known to have increased since 2007, with decreases in State forest and dryland agriculture.	?	◒
LB7 Area affected by salinity	Knowledge of salinity is limited in Victoria. It is believed that around 247,000 hectares are currently affected by dryland salinity. Regions most affected include Victoria's north and west, and near Sale in the state's east. The spread of dryland salinity slowed during the recent dry period but is likely to increase with a return to wetter conditions.	?	◒
LB8 Soil health	No new statewide data on soil structure decline, erosion or acidification is available. Expert opinion indicates that the recent drought conditions reduced the threat of water erosion and acidification but increased wind erosion. Knowledge of land and soil health remains poor in Victoria.	?	○

Indicator Assessment Legend

Status (Good | Fair | Poor | Unknown)

- Environmental condition is healthy across Victoria, **OR** comprehensive protection of natural ecosystems and biodiversity.
- Environmental condition is neither positive or negative and may be variable across Victoria, **OR** moderate protection of natural ecosystems and biodiversity.
- Environmental condition is under significant stress, **OR** inadequate protection of natural ecosystems and biodiversity.
- Data is insufficient to make an assessment of status and trends.

Data Quality

- Good: Adequate high-quality evidence and high level of consensus
- Fair: Limited evidence or limited consensus
- Poor: Evidence and consensus too low to make an assessment

Trends: Deteriorating | Improving | Stable | Unclear

NA Assessments of status, trends and data quality are not appropriate for the indicator.

Indicator LB6: Land Use

Victoria's land is used for a variety of purposes, including urban areas for residential and business, agricultural lands for production of food and fibre, and conservation areas to protect biodiversity. Development for urban and agricultural uses has resulted in declines in the condition of land, water and biodiversity.

Many of the environmental challenges currently facing Victoria are the products of past decisions about land use and land management. Consequently, land use is a key driver of environmental change in Victoria.

Land-use change is driven by a range of social, economic and environmental pressures. For example, population growth is a key driver of urban land-use change (see Part A: 5 Human Settlements), leading to urban expansion in Melbourne's fringe areas and parts of regional Victoria. Urban land use is also strongly affected by social pressures through the property market, which drives land use towards the highest values (for example, housing in fringe areas). In addition, preference for living in coastal or rural areas close to Melbourne is resulting in the loss of natural ecosystems and agricultural land. Such losses threaten biodiversity and promote more intensive agriculture to compensate for reductions in the availability of productive land.

The main drivers of agricultural land-use change are climate (e.g. water availability), commodity prices, supporting infrastructure and land capability (soil type). These factors determine the type of farming that can be carried out as well as those types that will maximise returns.

Availability of water is particularly important for agricultural land-use change. The establishment of a water market in the Murray–Darling Basin has produced an escalation in the price of water and the trading of water away from irrigated pastures (predominantly for dairy production) towards high-value horticulture. Because water shares can now be traded independently of land, water is being permanently transferred between regions, resulting in substantial land-use change.

The environmental impacts of land-use change may be unpredictable and unintended. Areas where land use is not suited to land capability are at most risk from significant environmental impacts. Changes in the condition of land, water and biodiversity resources can be both outcomes and drivers of land use. Impacts of previous land use and management practices on land and water resources limit the capacity of these resources to support future activities and to provide some essential ecosystem services.

Climate change is likely to produce unprecedented changes in the distribution of agricultural enterprises across the State (see Foundation Paper One: *Climate Change Victoria: The Science, Our People, and Our State of Play*).[2]

Land use types in Victoria

Land use in Victoria is shown in Figure A.2.35 and Figure A.2.36. Public land is mainly divided between parks and reserves (18% of Victoria's total area), managed under the *National Parks Act 1975*, and State forests (14% of Victoria's total area) managed under the *Forests Act 1958*. State forests are managed for multiple purposes, including timber harvesting, conservation, recreation and water production. Parks and reserves and State forests account for approximately 90% of Victoria's public land. Other uses include conservation reserves not managed by Parks Victoria (e.g. roadside reserves), water catchments and a small area of plantation forest.

Nearly two-thirds of Victoria is privately owned. This land is predominantly used for agricultural production, which accounts for some 56% of Victoria's total area. Agriculture is Victoria's dominant land-use type, with dryland cropping and grazing (rain-fed or unirrigated) accounting for over 90% of agricultural land. Irrigated agriculture and horticulture accounts for over 8% of agricultural land. Victoria's main agricultural products are beef, dairy, wool, grain crops, and fruit and vegetable crops. Agricultural production occurs mainly in the flatter and more accessible areas in western and northern Victoria. Other private land uses include urban areas (5% of Victoria's area) and plantation forest (2% of Victoria's area). Melbourne occupies less than 1% of Victoria's land area but is home to 75% of Victoria's population.

The total area of land-use types is not necessarily a good indicator of the potential impacts on the environment. For example, urban and irrigated agriculture each account for only 5% of the total land area. However, their impacts on Victoria's environment are significant because of the degree of land change they require and the resources they consume. Consequently, these land uses have greater impacts on land and water health and biodiversity.

Figure A.2.35: Major land-use classes in Victoria, as at 2012

Source: DEPI.

Land use	Area (million hectares)	% of Victoria
Public land		
Parks and reserves	3.98	18
State forest	3.14	14
Other public [A]	1.10	5
Coastal parks and reserves	0.75	0.3
Marine parks and reserves	0.12	NA
Private land		
Dryland agriculture	11.50	51
Irrigated agriculture	1.07	5
Plantation forest	0.52	2.3
Urban/built environment [B]	1.13	5
Total area	**22.70**	

Notes:

[A] Conservation reserves, including roadsides.

[B] Includes residential, commercial, industrial and community services land uses.

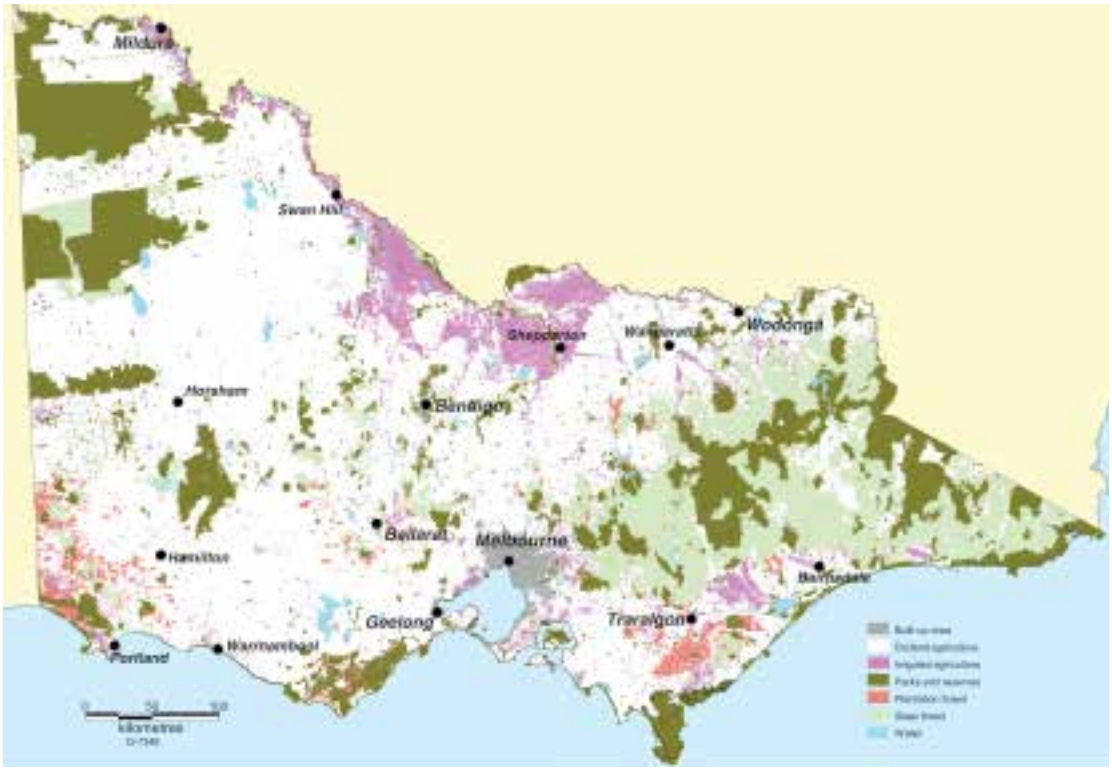


Figure A.2.36: Land use in Victoria, as at 2012

Source: DEPI.

Changes in major land uses in Victoria

Because of differences in methodologies, it is not possible to compare current land-use areas with that reported in the last State of the Environment report. However, the following changes are known to have occurred:

- The area of parks and reserves has increased, with a corresponding decrease in the area State forest. This is due to the transfer of State forest into the reserve system.
- Irrigated agriculture has increased, with a corresponding decrease in dryland agriculture. This is likely driven by water trading which is driving the distribution of irrigation water towards highest value uses and producing significant land-use change in irrigation areas. In addition, changes may be in response to market forces leading to changes in production types, or the migration of irrigation industries.
- Urban areas have increased, with population growth driving urban expansion in Melbourne and regional centres, as well as in coastal areas (see Part A: 5 Human Settlements).

Indicator LB7: Area Affected by Salinity

Salinity refers to the presence of salt in soils as a result of raised water tables. While Victoria has significant naturally occurring saline areas, most salinity has been caused by, or exacerbated by, the clearing of native vegetation (dryland salinity) and excess irrigation (irrigation salinity). These actions alter the hydrology of Victorian landscapes, increasing drainage to groundwater.

The area affected by salinity changes over time in response to water availability. Seasonal and long-term variation in rainfall leads to fluctuations in groundwater levels and salinity impacts. In addition, improved irrigation technology and water management also reduces the area impacted by salinity.

Salinity caused by human land-use practices is a significant issue for land management and biodiversity. Salinity produces extensive on and offsite effects, and often has long management time frames and lasting effects on soil and water resources. As most plants have evolved in the absence of salt, the majority of plant species (both native and introduced) are unable to grow in saline soils. This leads to a decline in the condition of native flora and the loss of agricultural productivity. Salinisation of surface water is also an important consequence of rising saline groundwater.

Salinity can severely degrade rivers and wetlands, and can prevent water from being used for agriculture and other purposes. Wetlands and surrounding native vegetation are particularly at risk because their low elevation coincides with groundwater discharge areas.

In addition to implications for natural and agricultural systems, salinisation of soil and water has implications for the built environment. Increased salt content of water can corrode pipes, pumps and taps, and increase costs for water treatment. At the same time, high saline water tables affect infrastructure such as roads, bridges, building foundations, footpaths and paving, fencing and railways.

Area of salt-affected land

Available data on the area of land affected by dryland salinity is shown in Figure: A.2.37. Estimates of the extent and severity of salinity are poor in Victoria, with ad hoc and infrequent data collection and little information on irrigation salinity. This has resulted in fragmented data that does not provide a complete picture of current soil salinity in Victoria.[26]

Best available information from the Department of Environment and Primary Industries estimates that around 247,000 hectares of soil in Victoria is affected by dryland salinity – 2% of the total area of dryland agriculture in the state.[27] Regions most affected include substantial areas of Victoria's north (particularly the Mallee) and west, and near Sale in the state's east.[12] Western Victoria is generally more severely affected by salinity than eastern Victoria, largely because it is flatter and poorly drained, and also because conversion of native vegetation to agriculture has been much more extensive in western Victoria.

The spread of dryland salinity in Victoria slowed or receded during the recent dry period due to lower groundwater tables, although many incidences of dryland salinity still occurred during the drought. The area impacted by salinity is likely to increase with the recent return to wetter conditions. Periods of higher rainfall will renew the threat that salinity poses to agricultural productivity and land and water.[28]

There is no current data for irrigation salinity in Victoria. However, in the previous State of the Environment report a substantial decline was found for the area affected by irrigation salinity. This was due to improvements in drainage and land management.

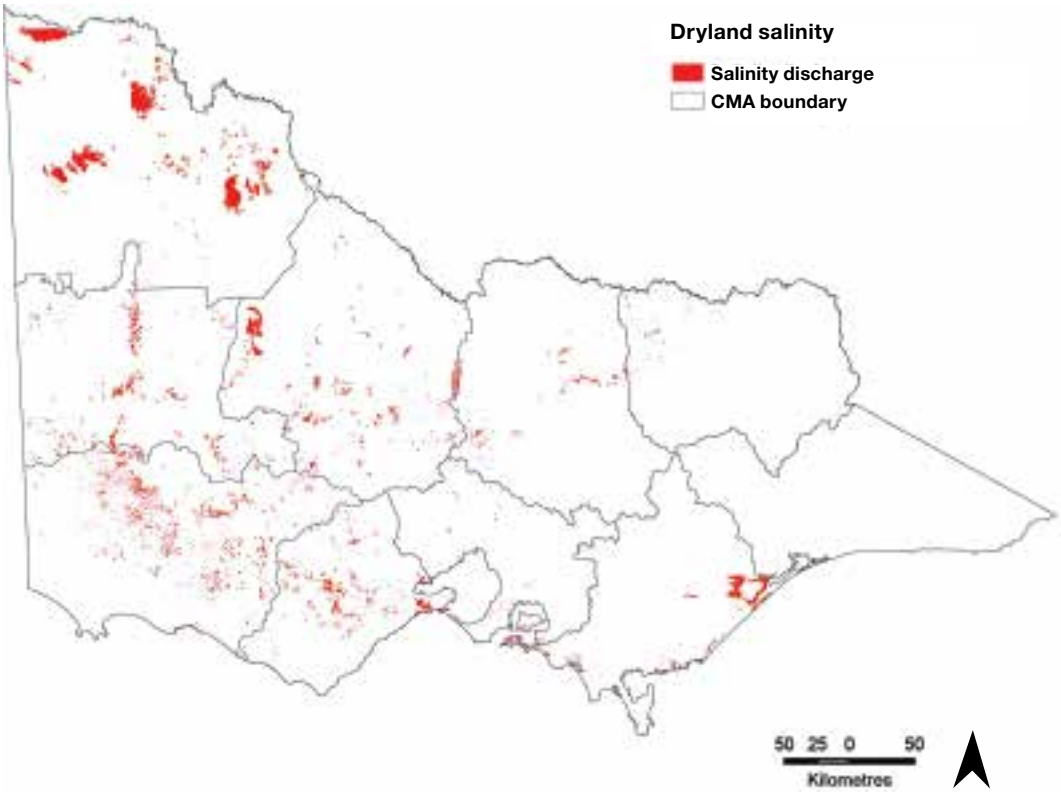


Figure A.2.37: Estimate of area affected by dryland salinity in Victoria (data from 1976–2011)

Source: DEPI.

Indicator LB8: Soil Health

Good soil health is vital for Victoria's agriculture, native ecosystems and ecosystem services. Healthy soils support essential ecosystem services such as the production of food, fibre, timber and clean water, as well as the decomposition and detoxification of wastes.

Victoria's soils are subject to a range of pressures, including clearing, cropping, grazing and fire. Activities that leave soils bare of vegetation promote erosion, while those that physically disrupt or compact soil threaten soil structure.

In particular, extensive erosion has been caused by historic broad-scale vegetation clearing, especially in higher rainfall, sloping regions of Victoria. Cropping activities such as cultivation and sowing physically disrupt soil structure, while the repeated passage of vehicles can cause soil compaction, as can overstocking.

Such impacts degrade soil structure and biological activity, and reduce the ability of soil to cycle and store nutrients and carbon, and to decompose and detoxify organic wastes. In addition, soil lost during erosion events is not readily replaced because soil-forming processes are extremely slow, occurring over tens of thousands of years.

Degraded soil has a range of social, economic and environmental impacts, including:

- Erosion of topsoil can result in the loss of seedbanks for native vegetation, limiting the capacity for regeneration and promoting the spread of weeds. Removal of topsoil also exposes subsoil layers, which may be hard or impermeable to water, limiting the establishment of seedlings.
- Eroded soil can be deposited into rivers and streams, increasing sediment, nutrient and other pollutant levels. These affect streamflow, riparian vegetation, aquatic biodiversity and water quality, and increase the risk of flooding (see Part A: 3 Inland Waters).
- Sediments transported to estuarine and enclosed marine environments can smother habitat and raise nutrient levels, impacting on ecosystem health (see Part A: 4 Marine and Coastal Environments).
- Wind erosion has implications for human health due to the impacts of dust storms (see Part A: 1 Climate Change and Air Quality).
- Erosion can also damage fencing, undermine roads and buildings and decrease the storage capacity of water reservoirs.
- Increased reliance of fertiliser to restore soil fertility to the levels needed to support agricultural production.
- Loss of land productivity through reduction in capacity to support crop and pasture growth. Also additional costs from increased fertiliser use.

Climate change is likely to further increase soil degradation (see Foundation Paper One: *Climate Change Victoria: The Science, Our People, and Our State of Play*). More frequent drought and fires will reduce vegetation cover, and more severe storms and rainfall are likely. These will create great potential for severe erosion and reductions in soil nutrients and carbon.

Soil structure decline and erosion

Soil structure decline and erosion are intimately linked. The disruption of soil structure increases the likelihood of erosion, which removes the top layer of soil. This layer is vital for soil health because it contains organic matter and nutrients, and provides habitat for biological populations (for example, microorganisms, fungi, earthworms) that bind and stabilise soil structure.

Soil erosion and structure decline is a natural process, determined by factors such as soil type and slope. However, it can be accelerated by human activities, including vegetation clearing, some cropping activities (e.g. cultivation, sowing, harvesting, burning of crop residues), soil compaction from farm traffic and livestock, forestry activities (heavy vehicle compaction), mining, and development of land for residential and other purposes. Impacts on soil can also occur as a result of bushfires which remove ground cover.

Since the 1980s, impacts from cropping activities have been alleviated to some extent by the adoption of minimum and zero-tillage farming systems, and the use of stubble retention instead of crop residue burning. However, conventional cultivation is still the dominant methodology across Victoria and burning is still widely practised.[4]

Extent of soil structure decline and erosion

No new data on soil structure decline and erosion has become available since that reported in the 2008 Victorian State of the Environment report. Main findings included:

- At least 60% of Victorian soils are prone to erosion and soil structure decline. Climate, land form and management practices also contribute to risks of erosion and soil structure decline.
- Erosion still ranks as a significant concern on agricultural land in Victoria, with 37% of farm businesses reporting erosion as a land management problem in 2006–07. It is also a challenge on public land, particularly in the context of fire, which greatly increases the likelihood of erosion.
- Victorian soils naturally vary in their susceptibility to water erosion, ranging from low in the relatively dry, flat areas of western Victoria to very high in the Central Highlands and East Gippsland. Over 55% of soil in Victoria's public land is highly susceptibility to water erosion due to the higher rainfall and steep slopes that dominate public land in central and eastern Victoria. Only 0.2 million hectares of Victoria's cropping land is highly susceptible to water erosion.
- The soils of greatest susceptibility to wind erosion occur mostly in the drier areas of north-western and western Victoria. Nearly 1.2 million hectares of soils in Victoria's cropping region are considered highly susceptible to wind erosion, with a further 1.7 million hectares classed as moderately susceptible. On public land, approximately 1.5 million hectares of soil area is considered highly susceptible to wind erosion, mainly in the Wimmera and Mallee regions. In contrast, 84% of forest on public land is of low susceptibility to wind erosion.
- The extent of gully erosion in Victoria was mapped in detail in the 1970s and early 1980s but has not been comprehensively mapped since 1982.
- The real significance of soil structure decline as an environmental issue in Victoria is unclear, as no statewide data have been collected since 1991. At that time approximately 30% of the state's agricultural land was considered to be severely degraded due to soil structure decline. Nearly half of Victorian farmers still consider soil compaction to be a significant issue. Soils in central and western Victoria are generally more susceptible to soil structure decline than those in eastern Victoria.
- Advances in farming systems and awareness of the issues have reduced erosion and may have reduced soil structure decline in some areas, but significant episodes still occur during severe weather events.

Expert opinion indicates that the recent drought conditions experienced across much of Victoria reduced the threat of water erosion, primarily in cropping regions. However, the extended dry is likely to have increased wind erosion because of the decrease in vegetative cover. In addition, any rainfall that fell during the drought conditions is likely to have caused erosion of bare soil. The return to wetter conditions has improved the amount of ground cover, reducing the threat of wind erosion.[12]

Rate of soil acidification

Soil acidification is a naturally occurring soil chemical process. This process occurs very gradually in undisturbed ecosystems but can be accelerated by agriculture (particularly the increased use of fertiliser soils which has increased threefold since the 1960s)[4] and vegetation clearing.

Soil acidification impacts include a reduction in plant growth and productivity, decreased availability of nutrients, reduction in soil biological activity, loss of vegetation, and increased risks of soil structure decline and erosion.

No new data on soil acidification have become available since that reported in the 2008 Victorian State of the Environment report. Main findings included:

- The cost of lost productivity due to soil acidification to Victoria is estimated at $470 million per year.
- Productivity declines due to soil acidification also reduce the amount of land that could be used for biodiversity conservation in agricultural landscapes.
- Soil acidification is accelerated by some land management practices and the area of acid soil is increasing. Almost half of Victorian farm businesses reported soil acidity as a land management issue in 2006–07. However, Victoria has large areas of naturally acidic soils that cannot be distinguished from soils acidified by agriculture;
- The use of acidifying fertiliser is increasing to support the increasing cropping intensity in Victorian agriculture.
- Only 5.5% of the area requiring treatment to restore critical pH levels is sufficiently treated with lime.
- The last statewide assessment of soil pH was made in 1994.
- Victorian regions most at risk of soil acidification are the North East, Goulburn Broken, Glenelg Hopkins, West Gippsland, southern parts of the North Central region and the southern Wimmera.

The most recent statewide assessment of soil acidity made in 1994 estimated that 23%, or 3 million hectares, of Victoria's agriculturally productive soil were affected by soil acidification.[29] Expert opinion suggests that soil acidity has generally decreased since the 1990s due to the prolonged drier conditions.[12]

Soil carbon content

Soil organic carbon is a measure of the organic content (e.g. plant roots, vegetation debris, soil organisms) held in the soil. Soil organic matter, most of which is organic carbon, is a vital component of soil health, with higher amounts generally indicating more healthy soils. It builds soil structure, prevents erosion, increases soil water-holding capacity and drainage, improves soil nutrition and maintains soil micro-organism diversity. Carbon content determines the productivity of soil for both agriculture and natural ecosystems. The stable fraction of soil organic matter (humus) also sequesters carbon in soil, potentially helping to mitigate climate change. Organic matter and carbon are lost when soils are cultivated, although this loss is decreased for minimum tillage practices, when soils are less disturbed.

Data on soil carbon levels is poor in Victoria, particularly for private land (for information on above-ground carbon stocks on public land see Part A: 1 Climate Change and Air Quality). Figure A.2.38 shows modelled total soil carbon on public land. Because the majority of public land is forested, soil carbon differences are mostly related to forest types and rainfall. High soil carbon is particularly evident in the dense, upland forests of eastern Victoria.

It is likely that soil carbon on private lands is lower than on public land and will vary with agricultural type and climate. Soil organic carbon levels are usually higher in high rainfall regions and under pasture compared to cropping.[30] In general terms, soil carbon levels in topsoils (up to 30 cm in depth) are thought to be relatively high in Victoria compared with some other parts of Australia, although they remain low by world standards.[12]

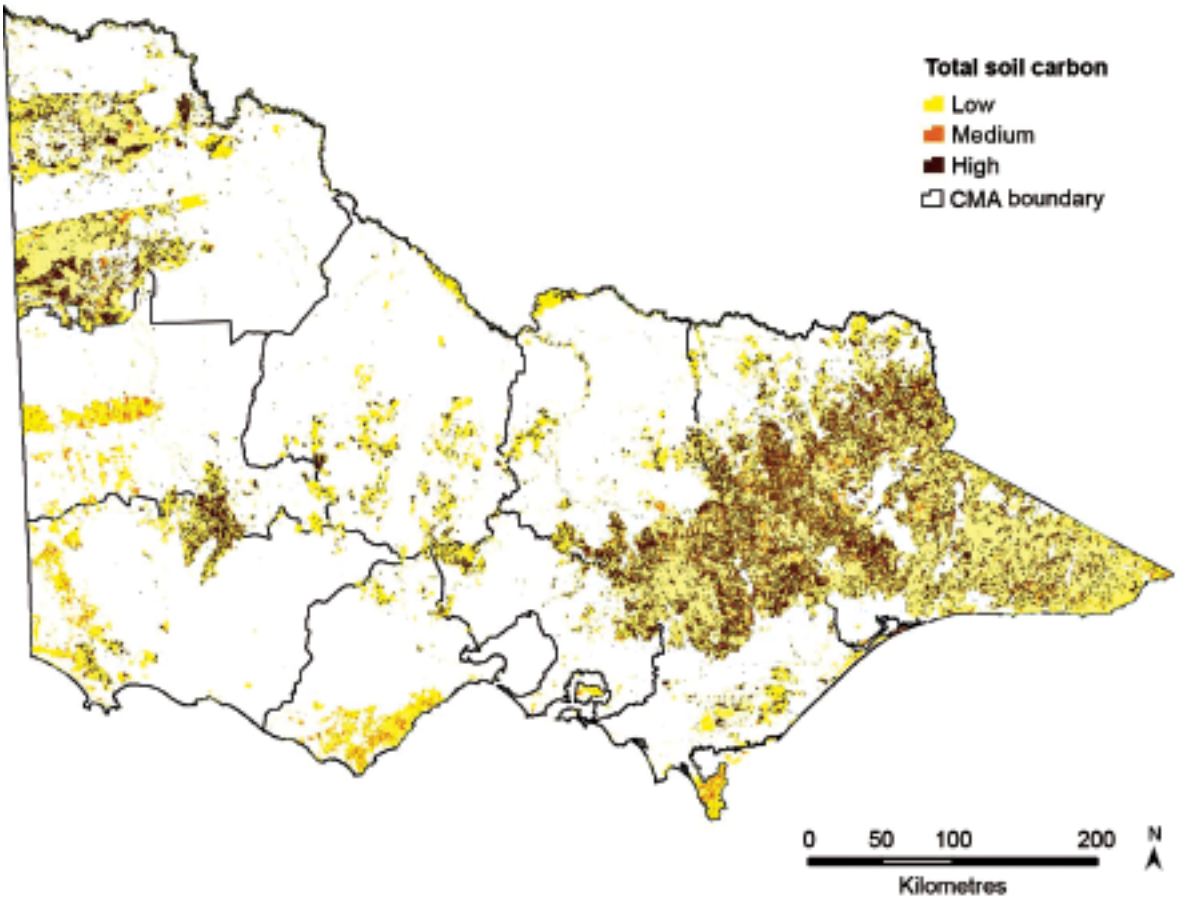


Figure A.2.38: Amount of total soil carbon in Victoria's public lands (modelled)

Source: Department of Sustainability and Environment LandCarbon Project 2011.

Land data gaps

Current understanding of land and soil health is hampered by the lack of data and long-term statewide monitoring programs, with existing datasets often limited in extent or out of date. Although local-scale data has been collected for specific land and industry management programs, there has been no statewide assessment of soil health in Victoria. The lack of strategic, long-term monitoring makes it difficult to detect trends in land and soil health over time and remains a critical gap in our understanding of environmental condition.

Soil health data gaps include:

- Neither soil structure decline nor erosion is routinely monitored in Victoria, so our understanding of the true extent of these problems is limited.
- Data on the spread of soil acidification is also very limited, particularly in areas containing irrigated agriculture. The last statewide assessment of soil acidity was made in 1994.
- Estimates of the extent and severity of salinity are poor in Victoria, with ad hoc and infrequent data collection and little information on irrigation salinity.
- Some information on soil carbon concentrations is becoming available, but much of this is modelled with no program of routine or systematic on-ground monitoring. This precludes the analysis of trends in soil carbon in response to changes in land management and climate change.

Agnes Falls, Foster
Courtesy of Dean Gorissen