3. Terrestrial Ecosystems

A GUIDE TO CHAPTER 3

The focus in this chapter is terrestrial biodiversity, particularly native vegetation and the national park and conservation system. There is some overlap with coastal ecosystems and inland waters (chapters 2 and 4).

Section 3.1 highlights the high natural, social and economic values of Victoria's terrestrial ecosystems, and describes the major habitat types. Section 3.2 outlines the current state of biodiversity, native vegetation and public and private protected areas. Section 3.3 is a gap analysis of the national park and conservation system in terms of its protection of subregional ecological vegetation classes, applying criteria defined for this review (the 'NCR reserve targets'). Section 3.4 describes and exemplifies four major categories of threat to terrestrial biodiversity and ecological processes – climate change, habitat loss and degradation, invasive species and altered fire regimes. Finally, sections 3.5 and 3.6 identify major policy gaps and high priority reforms in the following areas: the national park and conservation system (public, private and Indigenous), protection of native vegetation, including forests, and the management of bushfires and invasive species.

Topics covered

3.1 Values

3.2 State of terrestrial ecosystems

- Biodiversity
- Land use
- Native vegetation
- Lands managed for conservation

3.3 Gaps in the national park and conservation system

3.4 Major threats

- Climate change
- Invasive species
- Habitat loss and degradation
- Fire regimes

3.5 Gaps and priorities

- National park and conservation system
- Native vegetation protection
- Bushfire management
- Invasive species management

3.6 Future directions

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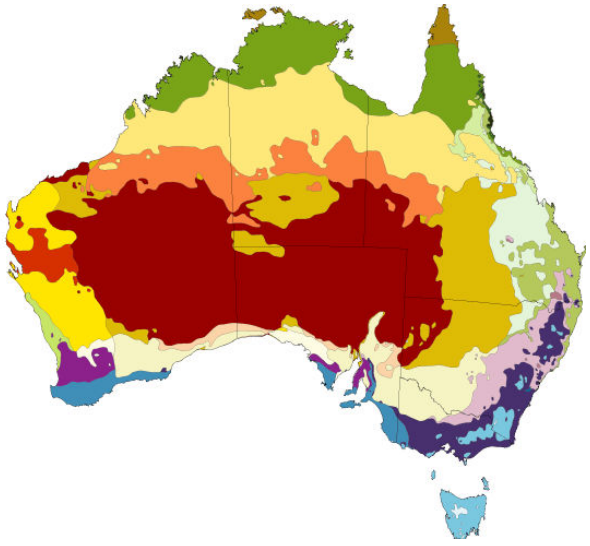
3.1 VALUES

From sprawling salt-sprayed coastal scrubs to high alpine herbfields, from grasslands and heathlands of intricate beauty to rainforests of mossy lushness, from stunted dry mallee woodlands to wet eucalypt forests of towering grandeur, Victoria offers an abundance of natural diversity and beauty. The state's 23 million hectares of climatically, geographically and geologically diverse landscapes are inhabited by a multitude of different life forms. But with less than half the land retaining its original vegetation and only a quarter with largely intact vegetation, major challenges lie ahead to protect the precious remnants, avert major threats and restore health to Victoria's terrestrial ecosystems.

Although Victoria accounts for just 3% of Australia's land mass, it spans two of six national climate zones (Figure 3.1) and 11 of 85 bioregions (Figure 3.2). The northwest is climatically classed as 'grassland' (hot and semi-arid) and the rest as 'temperate'.[1] Victoria's wide climate range is exemplified by median annual rainfalls of more than 1800 mm in some of the north-east to less than 250 mm in the Mallee, and by temperatures that have peaked at a searing 48.8 °C (in 2009) and a chilly −11.7 °C.[2]

Figure 3.1 Climate classification of Australia[3]



Source: Bureau of Meteorology. The classification is based on mean rainfall, maximum temperature and minimum temperature from 1961-1991. Victoria encompasses two climate zones: grassland (cream) and temperate (blues & purple), and four climate classes within the temperate zone.

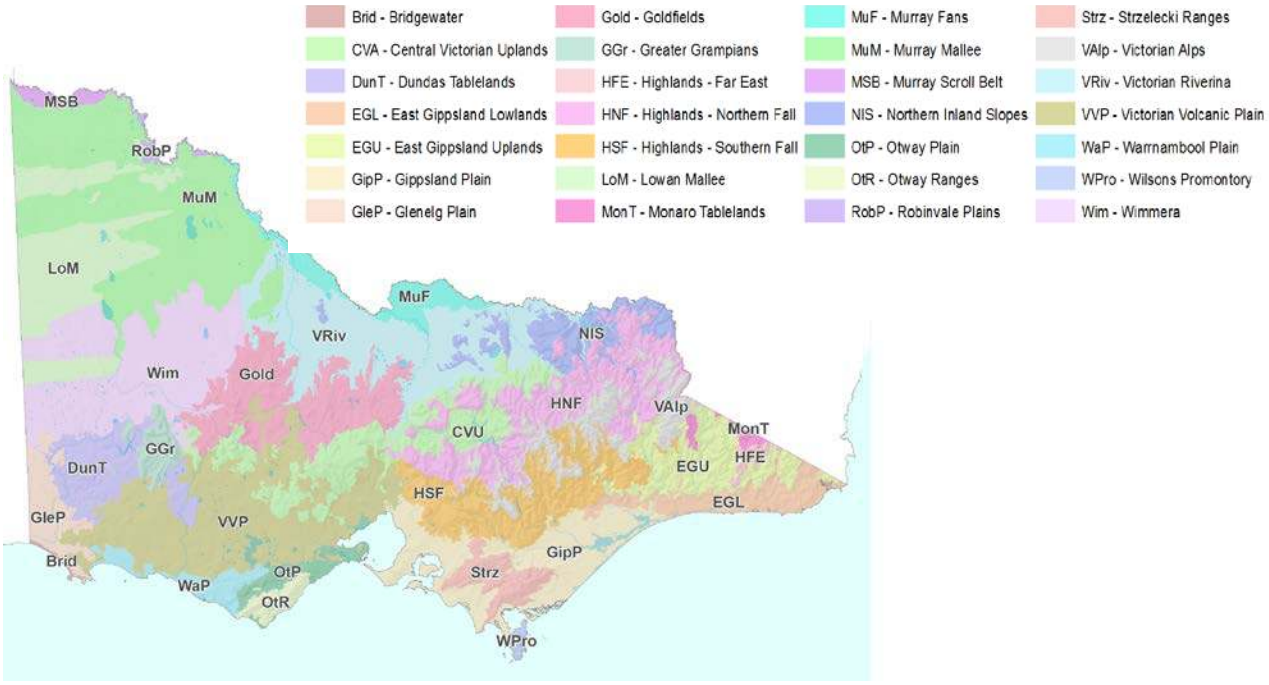
3.1.1 Biodiversity

Victoria's varied climates, landforms, soils and vegetation types provide a diverse suite of habitats for an outstandingly rich biological diversity. Landscape diversity is reflected in the 11 national bioregions represented in Victoria, which encompass 28 subregions.[4] The diversity of native vegetation communities is represented by about 300 vegetation types (known as ecological vegetation classes) and more than 2000 subregional ecological vegetation classes (see chapter 2, Box 2.3, for an explanation). Ecological vegetation classes at the subregional level are the main basis for analysis in this review.

Victoria's terrestrial habitats support some 80,000 to 100,000 species, including about 3600 plants and more than 600 vertebrates (animals with backbones) (Table 3.1). There are many species yet to be identified or described, particularly invertebrates (animals without backbones), fungi and non-vascular plants (mosses for example). The majority of species are small and overlooked – the likes of insects, worms and fungi (Figure 3.3) – but their ecological importance is immense.

Australia is recognised as one of the world's megadiverse countries,[5] and on the 3% of land area constituting Victoria can be found about half of Australia's bird species, more than a quarter of mammals and lichens, and about one-fifth of vascular plants. More than 500 species are unique to the state (endemic), mostly plants and invertebrates (Table 3.1). With only a small land area, it is unsurprising that just three terrestrial vertebrate species – one mammal (Leadbeater's possum), one frog (baw baw frog) and one reptile (alpine bog skink) – are endemic to Victoria but there are several endemic subspecies of birds and mammals, and Victoria provides a substantial proportion of habitat for many species confined to southeast Australia. (For endemic freshwater fish, see chapter 4.)

Figure 3.2 Victoria's 28 subregions



Map: VNPA. Data source: Department of Environment and Primary Industries

Vascular plants: Almost one-fifth of Australia's known plant species are native to Victoria and 344 (about 10% of Victoria's indigenous plants) are endemic to the state. Victoria has one of the world's richest flora of terrestrial orchids with about 420 known species.[6] This is more than one-quarter of Australia's ground orchids, and 40% or so are endemic to Victoria.[7]

Bryophytes (mosses, liverworts and hornworts): Victoria has at least 750 mosses and liverworts, about one-third of Australia's estimated total.[8] Small (and beautiful), bryophytes are largely overlooked vital components of most ecosystems – early colonisers after fire, protectors of soil, shelter for invertebrates and important for nutrient cycling.[9]

Fungi: Estimates for Australia vary from 50,000 to 250,000, and Victoria has an estimated 30,000 species, only about 20% named, several hundred of which are expected to be endemic.[10]

- *Macrofungi*: an estimated 5000 species in Victoria (50% named) with less than 5% endemism.[11]
- *Microfungi*: an estimated 25,000 species (5-10% named), with an uncertain level of endemism, but likely to be less than 10%.
- *Lichens* (a composite of a fungi and a green alga or cyanobacteria): close to a third of Australia's known species and 45 known endemics. [12]

Frogs: Victoria has 38 frogs, 16% of Australia's known species, including the endemic (and critically endangered) baw baw frog.

Reptiles: Victoria has 130 species, about 15% of Australia's total, including the endemic (and endangered) alpine bog skink.

Mammals: Victoria has 100 terrestrial species, about 30% of Australia's total, including the endemic (and endangered) Leadbeater's possum. There are also two endemic subspecies: an eastern barred bandicoot (extinct in the wild) and a Grampians subspecies of dusky antechinus.[13]

Birds: With 370 species, Victoria hosts more than half of Australia's terrestrial birds. No species is endemic, but seven subspecies are: the helmeted honeyeater (critically endangered), rufous bristlebird (Otway Ranges), white-browed scrubwren (Otway Ranges and South Gippsland), large-billed scrubwren (central Gippsland), brown-headed honeyeater (Otway Ranges and South Gippsland), olive whistler (Otway Ranges and South Gippsland) and pied currawong (western Victoria).[14]

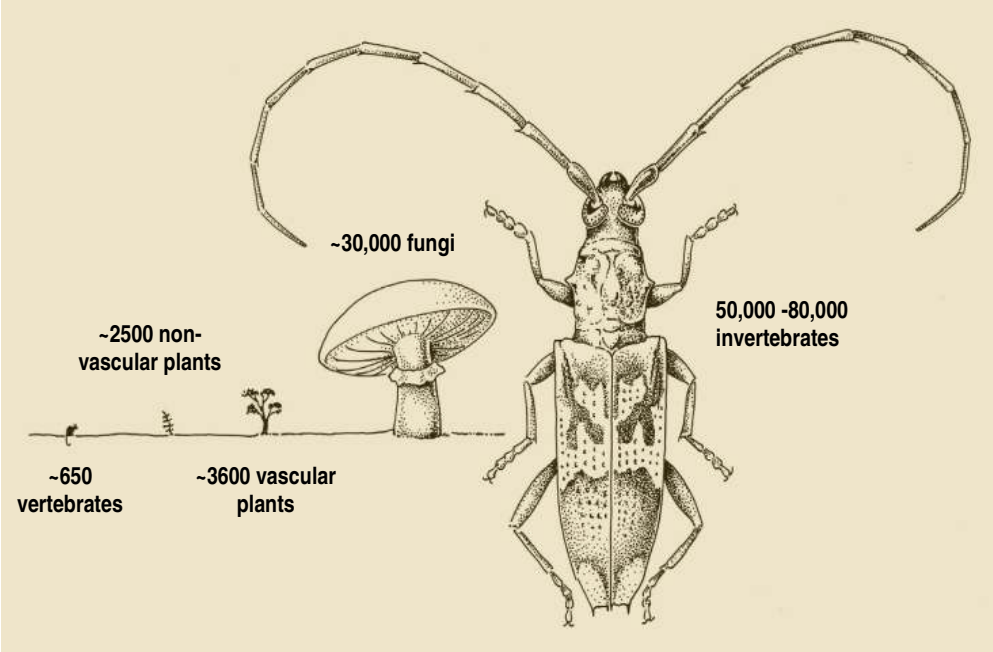
Invertebrates: Victoria probably has at least 50,000 invertebrate species, including 137 known endemic species in terrestrial and freshwater habitats (for freshwater invertebrates, see chapter 4). The giant

Gippsland earthworm and Eltham copper butterfly are two well-known and threatened endemic invertebrates.

About one-fifth of Victoria's terrestrial vertebrates (mammals, birds, reptiles, frogs) and plants are threatened (Table 3.2), and just as many are rare or near threatened or too poorly known to determine their status. More than half of Victoria's ecological vegetation classes are threatened and 11 terrestrial ecological communities are listed nationally as threatened (Figure 3.6).

As well as the intrinsic value of each component of Victoria's biodiversity, many species and ecological communities have great value for their contribution to ecosystem services. Mountain ash forests, for example, have the highest known biomass carbon density in the world, of value for mitigating global warming[15]; insects, birds and mammals provide pollination services, including for economically valuable timber trees; worms and many other soil organisms maintain productive soils; and natural places provide clean water and fresh air as well as great recreational opportunities and aesthetic pleasures. The services provided are numerous and of immense value for humans, but poorly documented and appreciated. Attempts are being made to estimate the economic values of ecosystem services, and to incorporate these values into accounting, decision-making and policy setting but much more work is needed to achieve this.[16]

Figure 3.3 Relative numbers of native species in Victoria represented by size



Graphic: VNPA. The size of the images is proportionate to the relative number of species in Victoria, which total 80,000-100,000. See table 3.1 for relative numbers.

Table 3.1 Status of some terrestrial (non-marine) groups in Victoria[17]

	Indigenous to Victoria[(1)]	Proportion of Australian species	Endemic to Victoria	Extinct[(2)]	Threatened[(3)]
Mammals	100	~30%	1	19	18 (18%)
Birds[(4)]	370	>50%	0	2	79 (21%)
Reptiles	130	~15%	1	1	32 (24%)
Frogs	38	16%	1	0	15 (39%)
Invertebrates	>50,000	unknown	137	6	121
Vascular plants	3596	~20%	344	49	745 (21%)
Bryophytes	750	40%	unknown	2	28
Lichens	1018	29%	47	0	0

Notes: [(1)] Includes extinct and extant. [(2)] Includes extinct from Victoria only, nationally extinct and extinct in the wild. [(3)] Includes critically endangered, endangered and vulnerable, based on Victoria's advisory lists. [(4)] This is for land birds and breeding species; it excludes pelagic species and penguins that do not breed in Victoria, vagrants and introduced species. Three pelagic species breed in Victoria: white-faced storm-petrel, common diving-petrel, short-tailed shearwater. The little penguin is the only penguin breeding in Victoria.

3.1.2 Important places

Protected areas

Of immense environmental, social and economic value is the 17% of Victoria's land area in the national park and conservation system. In 2005, there were 4303 native flora and 948 native animal taxa recorded on public lands in the national park and conservation system; 1282 plants and 177 animals are known only from these lands and about 90% of listed threatened species are recorded there.[18]

About two-thirds of the national park and conservation system is in largely intact landscapes, contributing to the maintenance of landscape-scale ecological processes. In fragmented landscapes, the national park and conservation system often protects the last remaining large areas of natural vegetation and forms core areas for restoration and repair. It also provides the following social and economic benefits:[19]

- protection of cultural heritage
- support of human health and wellbeing, including due to recreation
- nature based tourism – in 2012-13, there were 96 million visits to parks and waterways, including 35 million to national and state parks[20]
- economic benefits – an estimated $960 million (a 2002-03 estimate)
- clean water – up to one third of the state's water run-off
- climate control – sequestration and storage of large amounts of carbon.

Private lands permanently managed for conservation – close to 100,000 hectares – that form part of the national park and conservation system, also provide many of these benefits, particularly in areas where protected public land is scarce.

Biodiversity hotspots

Some Victorian sites have been recognised for outstanding biodiversity values. The Australian Alps is one of 11 Australian centres of plant endemism.[21] A large proportion of alpine species are endemic and most have restricted ranges.

The Victorian Volcanic Plain has been recognised as one of 15 national biodiversity hotspots, due to its combination of high values and high levels of threat, with 65 species listed as nationally threatened and more than 170 threatened at a state level.[22] The grasslands and grassy eucalypt woodlands of the bioregion are listed nationally as critically endangered. It is rich in endemic orchids. Nine of its lakes are recognised as internationally significant and 26 are listed as nationally significant.[23]

Important bird areas

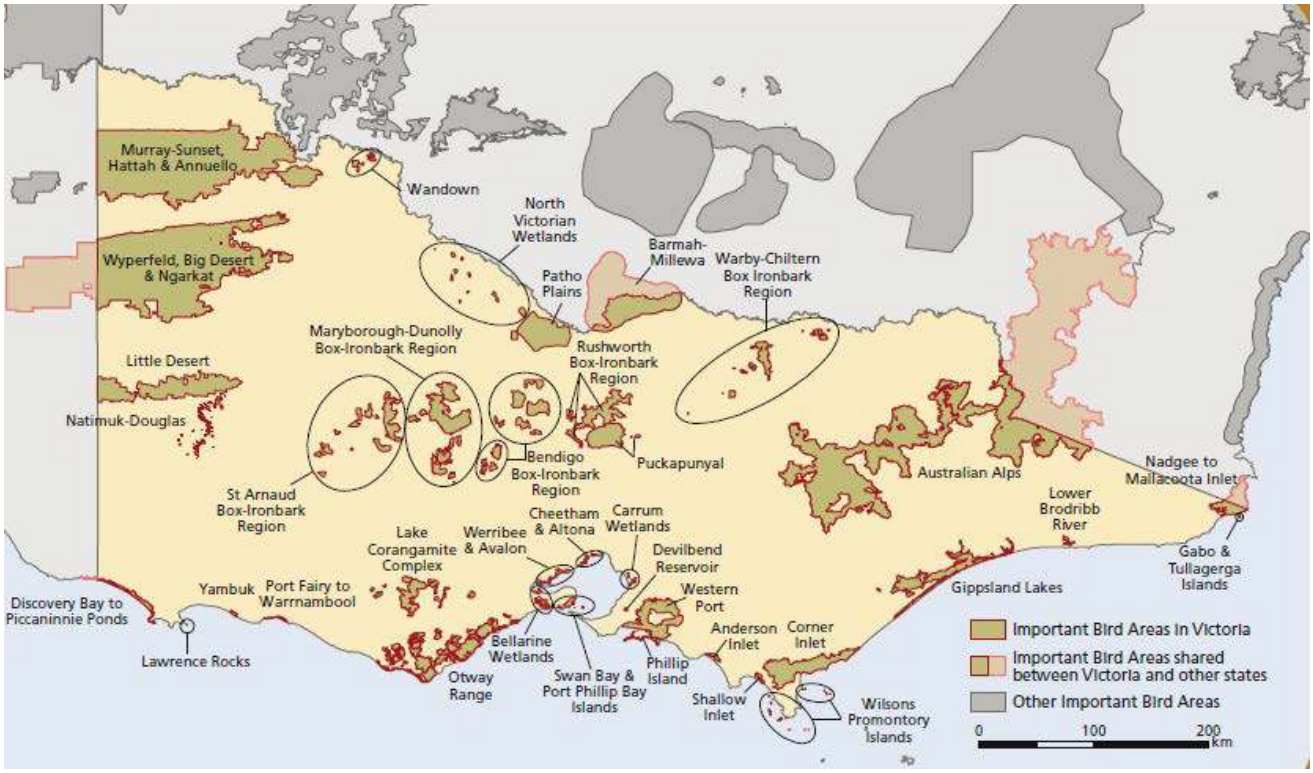
Of Victoria's 37 'important bird areas' (Figure 3.4), the following 17 are important for terrestrial birds (and many other species as well).[24]

- *Mallee birds*: Little Desert, Murray-Sunset, Hattah and Annuello, Wandown, Wyperfeld, Big Desert and Ngarkat.
- *Threatened woodland birds*: Barmah-Millewa, Bendigo Box-Ironbark Region, Maryborough-Dunolly Box-Ironbark Region, Puckapunyal, Rushworth Box-Ironbark Region, St Arnaud Box-Ironbark Region, Warby-Chiltern Box-Ironbark Region.
- *Other birds*: Australian Alps (pilotbird), Nadgee to Mallacoota Inlet (eastern bristlebird), Otway Range (rufous bristlebird), Patho Plains (plains-wanderer).

Tall trees

Victoria specialises in giant trees, with the tallest flowering plant in the world, mountain ash, found only in Victoria and Tasmania. One felled in 1880 at Thorpdale (south-east of Melbourne) was over 114 metres, only a metre or so less than the current tallest tree in the world, a north American coast redwood (a conifer, which is not a flowering plant).[25] Several mountain ashes in Victoria currently exceed 90 metres.[26] Large old trees are immensely important habitats, providing shelter, nesting sites and food (fruits, flowers, leaves and nectar) for many species, creating microenvironments with high levels of soil nutrients and plant species richness and playing a crucial role in local hydrological regimes (Box 3.8).[27] They also store large quantities of carbon.[28] In stands of trees more than 100 years old, mountain ash forests in the Central Highlands have the highest biomass carbon density known. Conserving forests with large stocks of biomass avoids significant carbon emissions to the atmosphere.[29]

Figure 3.4 Important bird areas of Victoria[30]



Source: Birds Australia (now BirdLife Australia). These areas were selected for their significant contributions to habitat for threatened bird species, birds with restricted ranges or shorebirds, waterbirds or seabirds.

3.1.3 Major habitat types

The following descriptions convey something of the rich diversity of Victoria's terrestrial ecosystems. They are mainly a summary of information from the Viridians biological database.[31]

Alpine and sub-alpine ecosystems occur in the eastern highlands mostly above 1300 metres, with rainfall and snowfall usually more than 1400 milimetres a year. Most of the area is on public land, about three-quarters protected. The vegetation consists of snow gum woodlands (small, multi-stemmed eucalypts with an understorey of shrubs, herbs and grasses), grasslands (tussock grasses, small sedges and a wide range of herbs) and heathlands (shrubs on dry shallow soils and heaths, sedges, rushes and sphagnum in peaty wet depressions). The alps have a greater range of tussock grasses, herbaceous daisies, buttercups, eyebrights and small sedges than any other Victorian ecosystem and support a rich invertebrate fauna. Four skink species, three frogs and one mammal (mountain pygmy-possum) are mostly restricted to alpine and sub-alpine areas. Each is threatened, mostly critically endangered. There has been little clearing of native vegetation but alpine and sub-alpine habitats have been damaged by cattle grazing, and are increasingly impacted by feral horses, deer and weed invasion. All cattle licenses in the Alpine National Park were ended in 2006 in recognition of the damage caused by grazing, but there are ongoing attempts to reintroduce them. Alpine ski resorts in Victoria have increased in number and size over the past 50 years. There are six designated resort areas on public land, with four as separate tenured inholdings surrounded by national park.

Wet sclerophyll forests occur on deep soils of sheltered hillsides mostly 600 to 1300 metre above sea level (asl), with more than 1100 millimetres rainfall. A little over one third of their area is protected. They are the tallest of all Victorian forests with eucalypts (mainly mountain ash), regularly reaching 80 metres, some more than 90 metres, over an understorey of climbers, broad-leafed shrubs, tree ferns, ground ferns, small herbs and coarse grass. They have a deep leaf litter (rich in fungi and invertebrates) and diverse fleshy-fruited plants. These are the most productive forests for timber,

with growth rates almost double that for other forests, but most of the old-growth forest has been severely depleted by logging and fires. Hollows, which are vital for many animals, take at least 120 years to form.

Damp sclerophyll forests are the most widespread and variable forest type, found on relatively sheltered hillsides, mostly at 200 to 1100 metres asl, with a rainfall of 750 to 1200 millimetres. About a third have been lost to clearing and a little over one fifth are protected. In wetter parts, trees (mostly messmate) may grow to 60 metres or more, over an understorey of climbers, broad-leafed and small leafed shrubs, occasional tree ferns, ground ferns, dense wire-grass and herbs. In drier parts, trees (mostly messmate and narrow-leaf peppermint) are usually less than 40 metres, with an understorey of a few climbers and scramblers, wattles, small-leafed shrubs, tussock-forming and rhizomatous grasses, occasional ferns, and soft-leafed herbs. These are some of the most botanically diverse ecosystems in the state (particularly rich in *Eucalyptus* and *Pomaderris*) and also support a rich fauna (including long-footed potoroo, the spot-tailed quoll, the grey goshawk and large owls). They are heavily used – logged in higher rainfall areas, cleared for farming, harvested for firewood and burned frequently. Most stands are relatively young regrowth.

Dry sclerophyll forests grow on shallow rocky soils on exposed hillsides, mostly 200 to 1000 metres asl, with rainfall of 550 to 1000 millimetres. About 45% have been lost to clearing and a little over one fifth are protected. They feature fairly small and often crooked, spreading trees (a diverse array of eucalypts), usually less than 25 metres tall, over a normally sparse understorey of wattles and small-leafed shrubs, and a dense, diverse ground cover of grasses and small herbs. These forests have been heavily used and degraded – they are the most invaded forest type, with abundant rabbits, foxes, thistles, gorse, blackberries and introduced grasses, and are often burned.

Riparian forests (see chapter 4) grow along the sheltered banks of rivers over a wide altitude range, with rainfall between 800 and 1500 millimetres a year. About 45% of their area has been lost to clearing and less than one sixth is protected. They are characterised by tall, straight trees (such as manna gum) with an understorey of climbers, broad-leafed and narrow-leafed shrubs, ferns (including tree ferns), scrambling grasses and soft-leafed herbs. Riparian forests are the most diverse (because they are in an overlap zone) and most disturbed forest type. They support about 80% of Victoria's possums, gliders and bats and most of the common forest birds and tree skinks, and have a deep leaf litter with a rich invertebrate fauna. Apart from clearing, most have been degraded by runoff from farms, housing and industry and invaded by weeds and exotic animals. Nonetheless, most stands still have more native species than most other ecosystems. They are of immense ecological value.

Box-ironbark forests occur on flat to undulating landscapes on rocky soils, mainly in central Victoria, at 150 to 600 metres asl with rainfall of 500 to 800 millimetres. About 55% have been lost to clearing and less than one fifth of their extent is protected. They feature box, ironbark and gum-barked eucalypts to 25 metres height, over a sparse understorey of wattles and shrubs, herbs and grasses. The trees are amongst the most prolifically flowering eucalypts, a major source of nectar for wildlife. There are more species and greater numbers of honeyeaters and lorikeets in these forests than elsewhere. During the gold rush years in the mid-1800s, these forests were subjected to intensive digging and clearing, and large areas were then cleared for grazing. The vegetation has been heavily fragmented and invaded by weeds.

Rainforests occupy only small areas, in sheltered gullies ranging from about 200 to 1200 metres asl, with rainfall of 800 to 1500 millimetres. A little over one third of their area is in protected areas, and all are protected from clearing and timber harvesting. Rainforests are dominated by a dense canopy of non-eucalypt trees over an understorey of climbers (which often climb into the canopy), broad-leafed shrubs, tree-ferns, epiphytic ferns, ground ferns and small soft-leafed herbs. There are two main types in Victoria: cool temperate rainforest found at higher altitudes with higher rainfall and warm temperate rainforest along steep creeklines at lower altitudes. Both are listed as threatened ecological communities under the Flora and Fauna Guarantee Act. Cool temperate rainforest is affected by myrtle wilt, a native fungus that infects the dominant beech trees, and warm temperate rainforest is often weedy and disturbed where the surrounding forest has been removed or altered.

Red gum ecosystems are found in flat to undulating country at low altitudes, with rainfall of 250-1000 millimetres, near watercourses or on alluvial soils subject to periodic floods. Although river red gum trees

remain widespread, over 70% of the native understorey has been cleared or substantially altered. Just over 10% of the area has been protected. The understorey typically consists of grasses, sedges and herbs, and small and prostrate shrubs, many adapted to inundation by floodwaters. With a wide geographic spread and varying distance from watercourses, they are one of the most variable habitat types in the state. Because most have been used for grazing, weeds are abundant – more than half of the 50 most common plants are introduced. River red gums need floods for germination, and excessive regulation of rivers in Victoria (chapter 4) has caused widespread deterioration of the ecosystem and a lack of regeneration. Dependent wildlife – frogs, wetland birds, hollow-dependent birds and mammals – are declining.

Black box woodlands occur on flat to slightly undulating landscapes on alluvial soils in north-west Victoria, generally at 50 to 150 metres asl, with rainfall of 250 to 450 millimetres. About 65% have been lost to clearing, and just over 15% of the area is protected. They are characterised by black box, usually 15-20 metres tall, over a sparse to dense understorey of saltbushes and short-lived herbs and grasses, with occasional patches of lignum. Saltbushes are successful in this salty, changing and uncertain environment, and have become increasingly dominant due to heavy grazing by stock, rabbits and kangaroos, as more nutritious grasses and herbs have declined. Much of the ground cover is highly weedy, with limited value for grazing animals. Regeneration of black box relies on an adequate water supply after seed fall, which has been compromised by extended droughts and diversion of water flows. The seedlings are highly susceptible to trampling and browsing by stock and rabbits.

Mallee occurs on flat to undulating landscapes on sandy, clay or rocky soils in north-western Victoria, generally at 50 to 200 metres asl, with rainfall of 250 to 400 millimetres. About 35% has been lost to clearing and less than one-third is protected. Mallee habitats are characterised by high summer temperatures, relatively infertile soils and low, unreliable rainfall. The mallee trees are small, multi-stemmed trees, with a ligno-tuber that allows them to survive long dry periods. The understorey consists of shrubs, grasses and herbs. Some of the wildlife (malleefowl, mallee emu-wren) are mallee specialists. Reptiles make up close to one-fifth of vertebrate species, the highest proportion of any Victorian ecosystem. Most of the agricultural areas are on the more fertile alluvial soils (less than 20% protected), where extensive clearing has led to dryland salinity, and overgrazing has caused severe erosion.

Pine-buloke woodlands occur on flat to slightly undulating landscapes on sandy-loam soils in north-west Victoria, generally at 50 to 150 metres asl with a rainfall of 250 to 450 millimetres. About half have been lost to clearing and just over 35% of the area has been protected. They are characterised by a generally sparse canopy of slender cypress-pine and/or buloke (and in some places white cypress-pine or belah), over an often dense understorey of shrubs and short-lived herbs and grasses. They are the only inland woodland or forest type not dominated by eucalypts. The four main tree species are wind-pollinated and produce their seeds within small woody cones. The understorey varies considerably, and several species produce nectar-rich flowers and fleshy fruits that feed local bird and insect populations. In good years, nomadic nectar-eating, fruit-eating and insect-eating birds are present in large numbers. When native grasses and herbs are abundant after rain, ground-feeding birds become common. Pine-buloke woodlands are one of the most widespread but fragmented of inland ecosystems. Early settlers sought them out for their comparative fertility and for timber. Much of the area was cleared and the trees don't regenerate well when grazed by sheep or rabbits. Buloke populations (which extend beyond the pine-buloke ecosystem across 30% of Victoria) have been reduced to less than 5% of what they were at the time of European settlement. Weeds are common.

Heathlands (other than alpine heathland) occur on gently undulating, acidic, nutrient-poor sandy soils in southern and western Victoria, generally at 50 to 300 metres asl, with rainfall of 600 to 1100 millimetres. About 55% have been lost to clearing and about a quarter are protected. Heathland ecosystems are characterised by a dense layer of small-leafed shrubs, usually 1-2 metres tall, over a ground layer of sedges, coarse lilies, rope-rushes, prostrate shrubs and herbs. They may occasionally have small spreading eucalypts on deeper soils. The key ecological feature is extremely low nutrient soils, to which plants have adapted by small stature, slow growth, storage lignotubers, associations with soil fungi (mycorrhizae) and parasitism. Relatively frequent fires return nutrients to the soils and open the canopy for regeneration of small, ground-layer species such as orchids, sundews, and lilies. Heathlands support the greatest proportion

of orchids in Victoria, many of which respond quickly to fire. But too frequent or poorly timed burning of some areas has led to domination by bracken and prickly tea-tree. Areas with deeper and slightly more fertile soils have been cleared for marginal agriculture, where sheep grazing has been enabled by fertilisers and introduced pasture grasses.

Grassland ecosystems (excluding alpine grasslands) occur in flat to gently undulating country at low altitudes, with rainfall of 400 to 1000 millimetres, on relatively nutrient-rich soils. About 85% have been lost to clearing or modification, and less than 5% of their area is protected. Grassland communities vary considerably over a large climatic and geographic range – from the volcanic plains to the south-west, the calcareous flats of the Wimmera in the west, the alluvial plains of the north and South Gippsland, the high-altitude hillsides of East Gippsland and the low country around Port Phillip Bay and Westernport. The ground layer is dominated by perennial grasses, with some rhizomatous or stoloniferous species and a few annuals, and often with a wide range of perennial and annual herbs, sedges, lilies and small shrubs. Some areas have occasional trees and there may be scattered shrubs. This most widespread of habitat types is also the most damaged and threatened, most of it used for crops or grazing. Grasslands were heavily grazed by sheep in the early days of European settlement, which substantially altered their composition. Exotic pasture grasses and clovers were sown over large areas and fertilisers were applied. Invasive plants and animals are widespread. Some of the last areas of critically endangered grassland are to be cleared for urban expansion around Melbourne. Many once common grassland species are extinct or gravely threatened – eg plains wanderers, Australian bustards, eastern barred bandicoots, bush stone-curlews and striped legless lizards.

Banksia woodlands occur on flat to undulating sandy soils in coastal and near-coastal parts of southern and eastern Victoria, generally at 10 to 100 metres asl with rainfall of 700 to 1000 millimetres. At least a quarter have been lost to clearing and about 40% are protected. There are two main types – one coastal (dominated by coast banksias) and one near-coastal that occurs up to 30 kilometres inland (dominated by saw banksias). The banksias grow with other small trees (wattles, tea-trees, she-oaks, eucalypts) over an understorey of small shrubs, herbs, sedges and grasses. The soils are extremely infertile and have little water-holding capacity.

Coastal scrubs (chapter 2) occur on sand dunes or coastal limestone soils, at 0 to 200 metres asl, with rainfall of 700 to 1200 millimetres. About 60% have been lost to clearing and about one-fifth of their area is protected. They consist of a dense layer of sprawling shrubs, usually 2-5 metres tall, interspersed with grasses, herbs and sedges. They are more of a grassland and herbland closer to the sea and grade into banksia woodland on the landward side.

Saltmarshes (chapter 2) occur on intertidal mud-flats in southern, eastern and far-western Victoria, with rainfall of 650 to 900 millimetres. About 30% have been lost to clearing and close to a quarter of their area is protected. The usually narrow bands of vegetation consist of small succulent shrubs, succulent and semi-succulent herbs, grasses and sedges, often bordered on the seaward edge by a mangrove shrubland.

3.2 State of terrestrial ecosystems

3.2.1 Biodiversity

200 years of human activity has severely affected Victoria's species and ecosystems. ... Despite the conservation efforts of governments, non-government organisations, communities and individuals over many decades, the health of our species and ecosystems continues to decline.

Department of Sustainability and Environment, 2010[32]

Victoria's terrestrial ecosystems have suffered grievous losses: more than 80 species known to be extinct since European colonisation, more than 1000 threatened and another 1000 or so rare, near threatened or with their status unknown, and 60% of ecological vegetation classes threatened.

Threatened species

Table 3.2 Threatened and extinct taxa in some terrestrial groups[33]

	CR	E	V	Total threatened	Extinct(1)
Mammals	3	7	9	19 (19%)	19
Birds	12	28	41	81 (22%)	2
Reptiles	13	11	10	35 (27%)	1
Frogs	8	4	3	15 (39%)	0
Molluscs	3	2	5	10	0
Annelids	0	1	0	1	0
Insects	14	10	37	102	5
Vascular plants	NA	270	475	745 (21%)	49

Sources: State government advisory lists. Notes: CR: critically endangered. E: endangered. V: vulnerable. Includes some species that inhabit freshwater habitats (covered in chapter 4). (1) Extinct includes extinct from just Victoria, totally extinct and extinct in the wild. With mammals, nine species are globally extinct, nine are extinct from Victoria (surviving elsewhere in Australia) and one is extinct in the wild.

Mammals have suffered the greatest losses, especially small to medium-sized and ground-dwelling species (quolls, small wallabies, bandicoots, marsupial mice and rats): at least 14% of Victoria's terrestrial mammals are extinct and a fifth threatened. Regional losses have been greater. A Gippsland study of sooty owl pellets (comparing contemporary and sub-fossil pellets) found that mammal prey diversity had declined by two-thirds, from 28 species 150 years ago to just 10 today.[34] The current small mammal community is 'a small fraction of its former state'. However, there is potential for future recovery of some species, for about half the mammal species lost from Victoria survive elsewhere in Australia. This will require much better control of foxes and cats, and habitat restoration.

The losses and severe declines of mammals and other animals have disrupted many ecological processes (section 3.4), with consequences for vegetation structure and composition and soil quality. Many of the lost mammals, for example, dug for food or to create burrows, in the process mixing, aerating and breaking down the soil, creating pits that captured leaf litter, faeces, seeds and water, and spreading the spores of mycorrhizal fungi that benefit trees. Their loss is likely to have compromised the productivity and composition of native plant communities.[35] Some declining birds are important long-range pollinators that help eucalypts adapt to changing conditions (Box 3.6). Both the status of invertebrates and the consequences of declines are very poorly known.

Many species in Victoria have yet to suffer the eventual consequences of what is known as an 'extinction debt' for losses that occurred decades ago, which means that maintaining the status quo will not be sufficient to halt declines and extinctions. For example, even if all old paddock trees are protected, animals that use their hollows face a major shortage in future because the trees are mostly not regenerating. Hollows take more than a century to form.[36] Small populations isolated in habitat patches might hang on for many generations (decades or even centuries) before going extinct due to chance events (such as extreme weather events), inbreeding, or loss of genetic diversity, which reduces their ability to adapt to new environmental conditions.[37]

Only some threatened species in Victoria are formally listed under the Flora and Fauna Guarantee Act (Table 3.3). Because there is no systematic approach, the listings are highly inadequate for tracking the conservation status of species and ecological communities (chapter 5).[38] Assessments of habitat condition and other indicators suggest a downward

trend in Victorian biodiversity.[39] Table 3.3 shows that the number of species considered extinct or threatened in state government advisory lists has grown since the 2001 nature conservation review. Some changes are due to an increased (or decreased) potential for extinction, but many are due to changes in knowledge, taxonomy or methods of data collection, processing and categorisation, so it is not possible to track trends with any precision.[40]

Table 3.3 Extinct and threatened taxa, current and 2001, formally listed and advisory[41]

	State-listed (FFG Act)(1)	Current state advisory lists(2)	2001 state advisory lists(3)
Mammals	38	38 (2013)	43 (1999)
Birds	78	83 (2013)	75 (1999)
Reptiles	29	36 (2013)	28 (1999)
Frogs	11	15 (2013)	10 (1999)
Invertebrates	72	127 (2009)	26 (1995)
Vascular plants	352	794 (2005)	646 (2000)

Sources: (1) Taxa listed under the Flora and Fauna Guarantee Act. (2) Current state government advisory lists: 2005 (plants), 2009 (invertebrates) and 2013 (vertebrates). (3) State government advisory lists current in 2001: 2000 (plants), 1995 (invertebrates), 1999 (vertebrates).

According to the 2013 state of the environment report, from 2007 to 2013 the conservation status of eight species improved and the status of 33 worsened; 13 were added to the advisory list due to decreasing populations and three were removed due to increases; but for many species population trends were 'inconclusive, unclear or variable'. [42]

Concern should extend beyond rare and threatened species to some widespread species as well. The greater glider, living along the Great Dividing Range from northern Queensland to southern Victoria, is generally thought to be secure. But monitoring from 1997 to 2010 at 160 sites in the Central Highlands found dramatic declines over 12 years, at an annual rate of 8.8%, thought to be driven by declining rainfall, forest landscape changes, logging and wildfire.[43] Apart from the potential for decline as conditions change, reasons to focus on more common species include the contribution of some to ecological processes such as seed dispersal and pollination, their role in food webs, and contributions to structure and biomass in ecosystems and to variance in species richness.

Threatened ecological communities

The conservation status of the state's 300 ecological vegetation classes was assessed by the Victorian government in 2007 using criteria that take into account their estimated pre-European extent, current extent and level of degradation. At a subregional level, less than one-quarter are classed as 'least concern' and more than 60% as threatened (Table 3.4). Predictably, the most heavily cleared subregions have the highest numbers of endangered ecological vegetation classes: the Victorian Volcanic Plains has 45 (35% of vegetation classes in the subregion) and the Wimmera has 40 (30% of vegetation classes in the subregion) (Figure 3.5).

Thirty-seven terrestrial ecological communities (including coastal and freshwater communities) have been listed under the state Flora and Fauna Guarantee Act and 11 under the federal Environment Protection and Biodiversity Conservation Act (Figure 3.6).

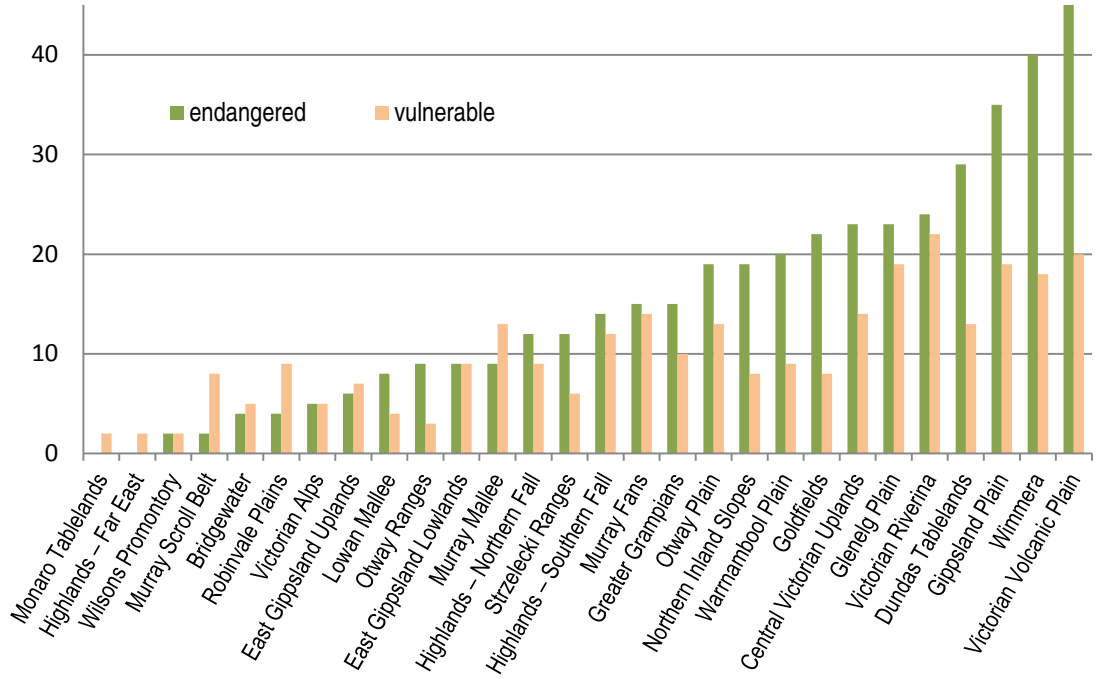
Table 3.4 Conservation status of subregional ecological vegetation classes (EVCs), 2007[44]

Status	EVCs	EVC mosaics complexes & aggregates(1)	Total (#)	Total (%)
Endangered	425	278	703	37
Vulnerable	283	188	471	24
Rare	77	21	98	5
Depleted	138	98	236	12
Least concern	255	162	417	22
Total	1178	747	1925	100

Source : Department of Sustainability and Environment.

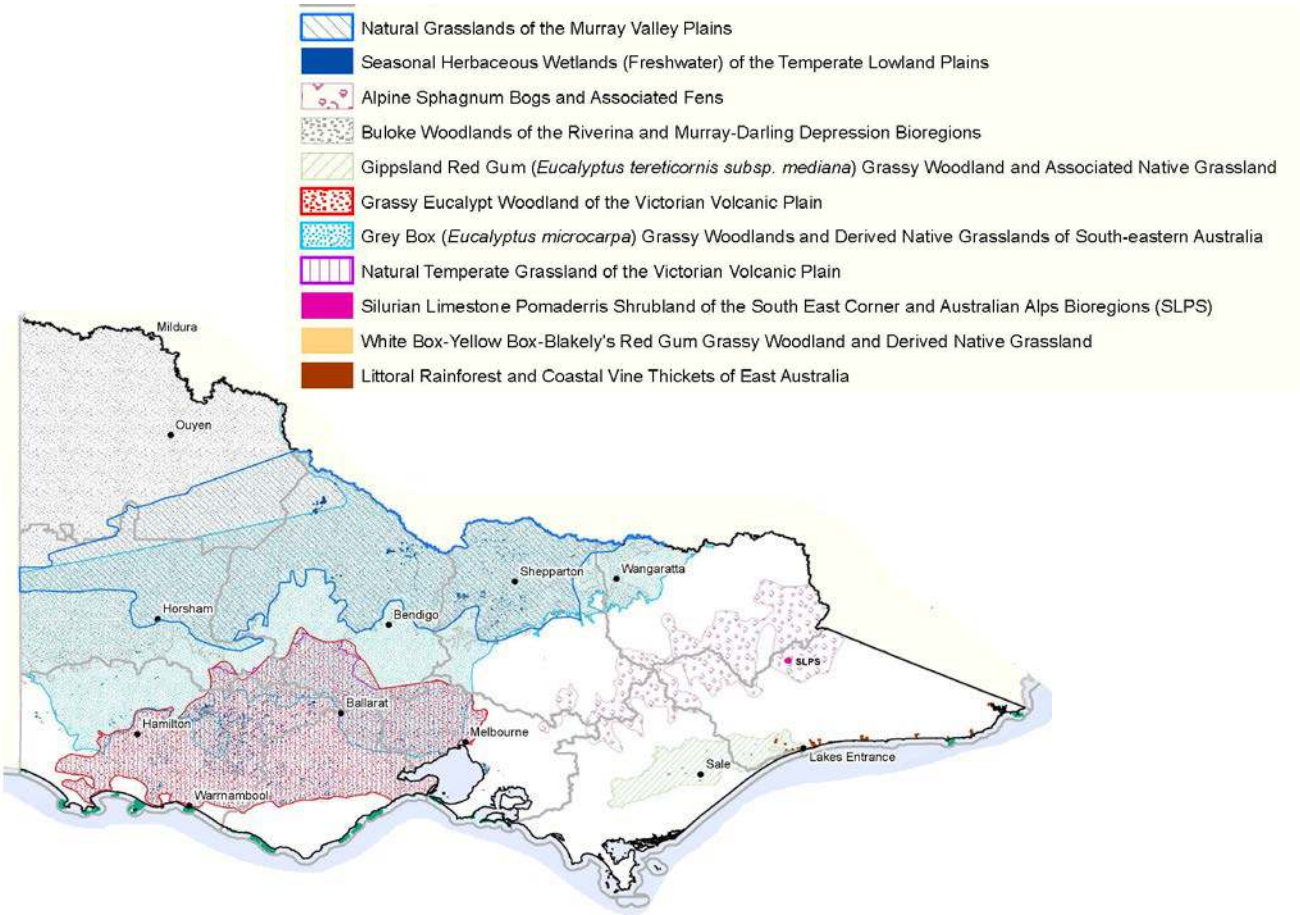
Notes: The EVC dataset was produced by combining modelled pre-1750 EVCs, subregions and current native vegetation extent. The pre-1750 dataset is based on field data, environmental spatial data (soils, rainfall, topography etc) and historical records such as parish plans. Wetland EVCs are included. (1) EVC complexes, mosaics and aggregates apply to sites where specific EVCs cannot be identified at the spatial scale used for vegetation mapping.

Figure 3.5 Numbers of endangered and vulnerable ecological vegetation classes in Victorian subregions



Data source: Department of Environment and Primary Industries

Figure 3.6 Nationally listed ecological communities in Victoria[45]



Source: Australian Government, Department of the Environment

Introduced species

Much of Victoria is now dominated by non-indigenous plants and animals. The majority of land area, including the most fertile and productive areas, is dedicated to sustaining cropped plants, sheep and cattle (some on exotic pastures). Other exotic species, established in the wild, also have a dominant presence, sequestering much of Victoria's natural productivity, compromising ecological processes, degrading habitats and causing extinctions and declines (section 3.4.2).

Table 3.5 Non-native species established in the wild[46]

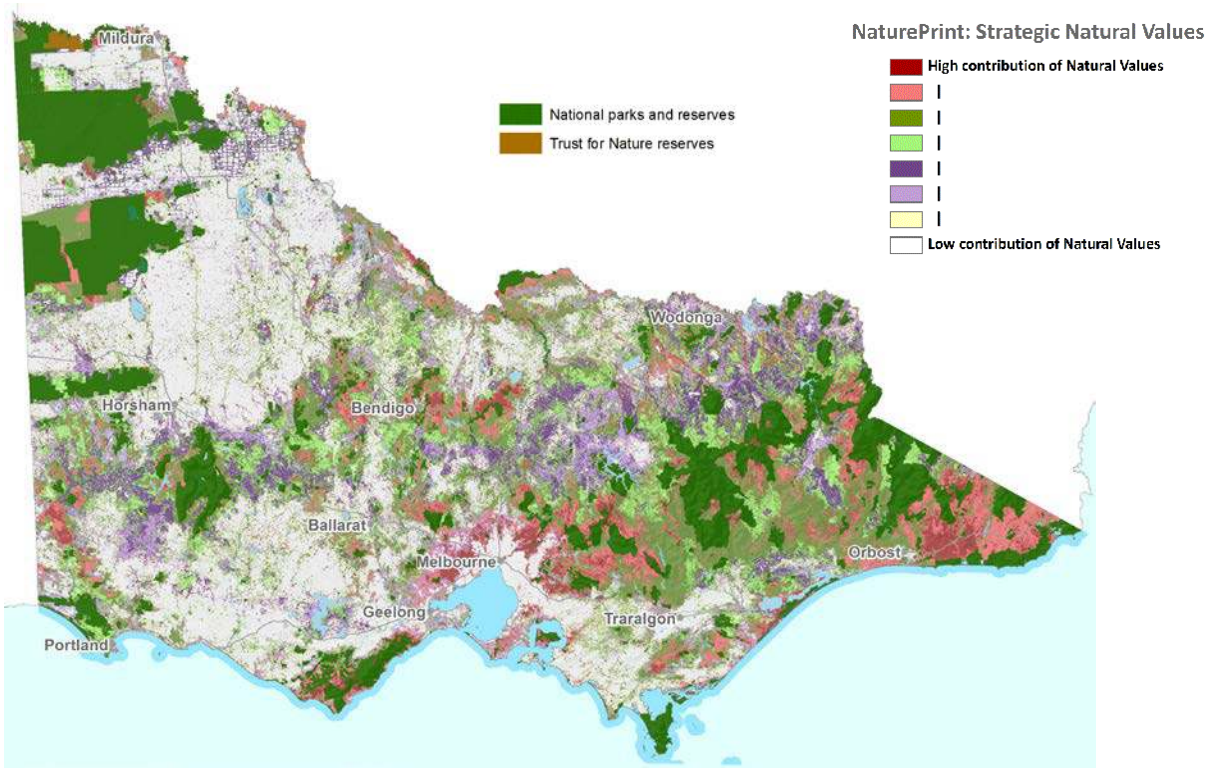
	Naturalised species	Proportion of Victorian species
Vascular plants	1237	26%
Mammals	18	12%
Birds	20	5%
Slugs & snails (SE Australia)	22	~25%

More than 1200 exotic plant species (including some native to elsewhere in Australia) now make up more than a quarter of Victoria's flora and include some of the most abundant and widespread plants in Victoria (Table 3.5). Non-indigenous species make up more than 10% of Victoria's mammals and about 5% of the birds. The numbers of introduced invertebrates are unknown. More than 200 species of fungi that cause plant diseases, including myrtle rust, have been introduced to Victoria, although many have not moved into natural ecosystems from their cultivated plant hosts.[47]

Areas with high biodiversity values

Through a method known as NaturePrint, the state government has mapped areas that contribute most to maintaining Victoria's biodiversity values (Figure 3.7). The modelling combines information on the distribution or co-location of mammals, birds, amphibians, reptiles, fish and plants; rare and threatened species; and the connectivity and recoverability potential of habitats.[48] It doesn't include aquatic ecosystems but does include information on fish and freshwater crayfish distribution. Information from NaturePrint has been used by Trust for Nature as the basis for its prioritisation of areas for private land conservation (Figure 3.16) and by VNPA to assist in identifying priority landscapes for conservation effort (section 5.3).

Figure 3.7 Relative habitat values identified through NaturePrint



Map: VNPA. Data source: Department of Environment and Primary Industries. The red, pink and dark green colours signify high value areas where it is essential to protect existing values. The areas of light green, purple and mauve are more likely to signify areas with potential for re-establishing and improving habitat values including connectivity.

3.2.2 Land use

More than three-quarters of Victoria's land area is used primarily for economic or residential purposes, mostly for agriculture (56% land area) (Table 3.6, Figure 3.8).

Table 3.6 Land uses in Victoria[49]

Major land use	% land area
Public land (7.9 million hectares)	34.6
National park & conservation system	16.8
State forest	13.8
Services & utilities (roads, sewerage etc)	2.6
Parks (metropolitan, regional, forest)	0.5
Private land (14.9 million hectares)	65.4
Agricultural holdings	55.8
Urban & industrial	3.5
Plantation forestry	2.2
Rural residential	0.9
National park & conservation system (included in above categories)	0.4

Sources: Department of Environment and Primary Industries, Australian Bureau of Statistics, Trust for Nature, Victorian Environmental Assessment Council

Victorian farms, consisting (in June 2012) of 32,500 enterprises, occupy about 13 million hectares.[50] In 2011-12, crops were grown on about 35% of farmland (4.4 million hectares) and more than 16 million sheep and 4 million cattle grazed across about 7 million hectares of land on mainly 'improved' pastures (sown with exotic species).[51] About 28% of farms used irrigation across 558,000 hectares, and 58% applied fertiliser.[52]

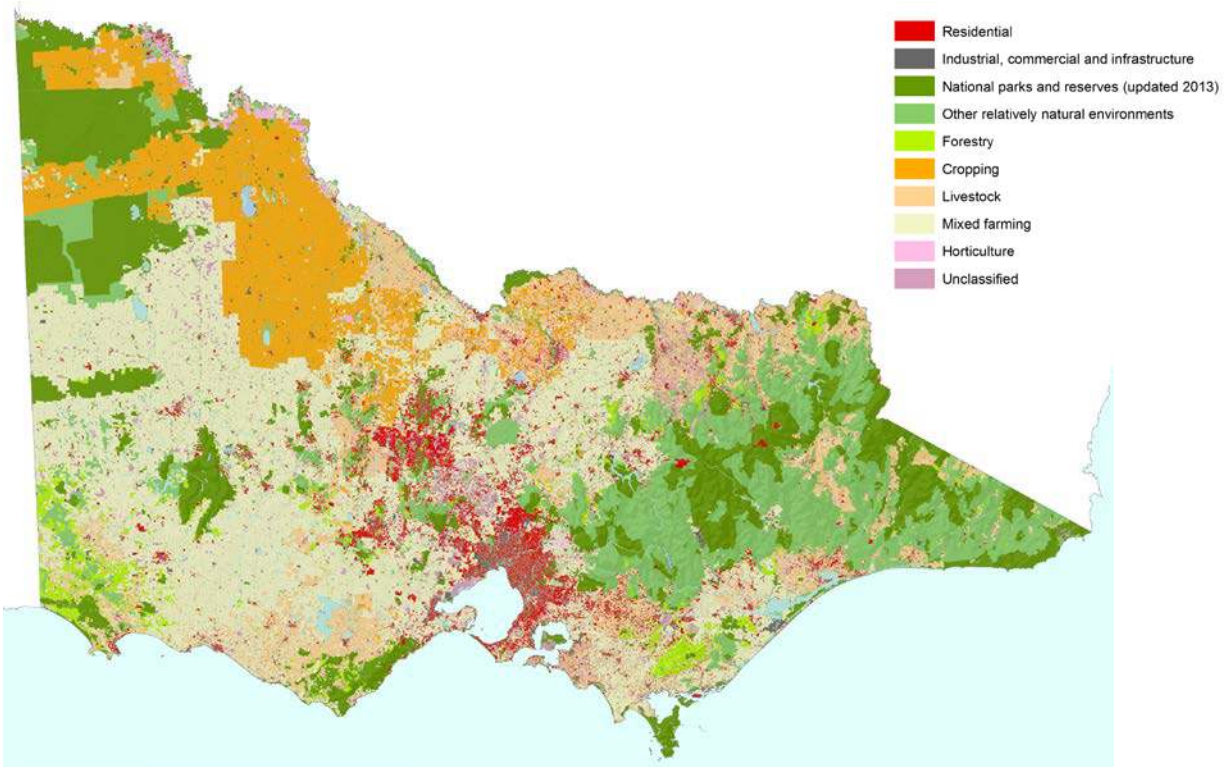
Although agriculture dominates land use, the sector employs just 3% of the Victorian workforce and contributes about 2.5% of the gross state product.[53] In many areas agriculture is increasingly being combined with conservation activities, although the area managed for conservation (2.8% of farmland) is small (Table 3.7). There is much potential to revitalise rural economies by combining low impact agriculture with conservation supported in part by stewardship payments.

Table 3.7 Agricultural land uses, 2011-2012[54]

Activity	Area (million hectares)	% of farmland
Grazing	6.86	54.0
(on improved pastures)	(5.35)	(42.1)
Crops	4.45	35.0
Set aside for conservation	0.35	2.8
Other not used for agriculture	0.36	2.8
Forestry production	0.05	0.4
Total agricultural holdings	12.70	100.0

Source: Australian Bureau of Statistics

Figure 3.8 Land use in Victoria



Map: VNPA. Data source: Department of Environment and Primary Industries

3.2.3 Native vegetation

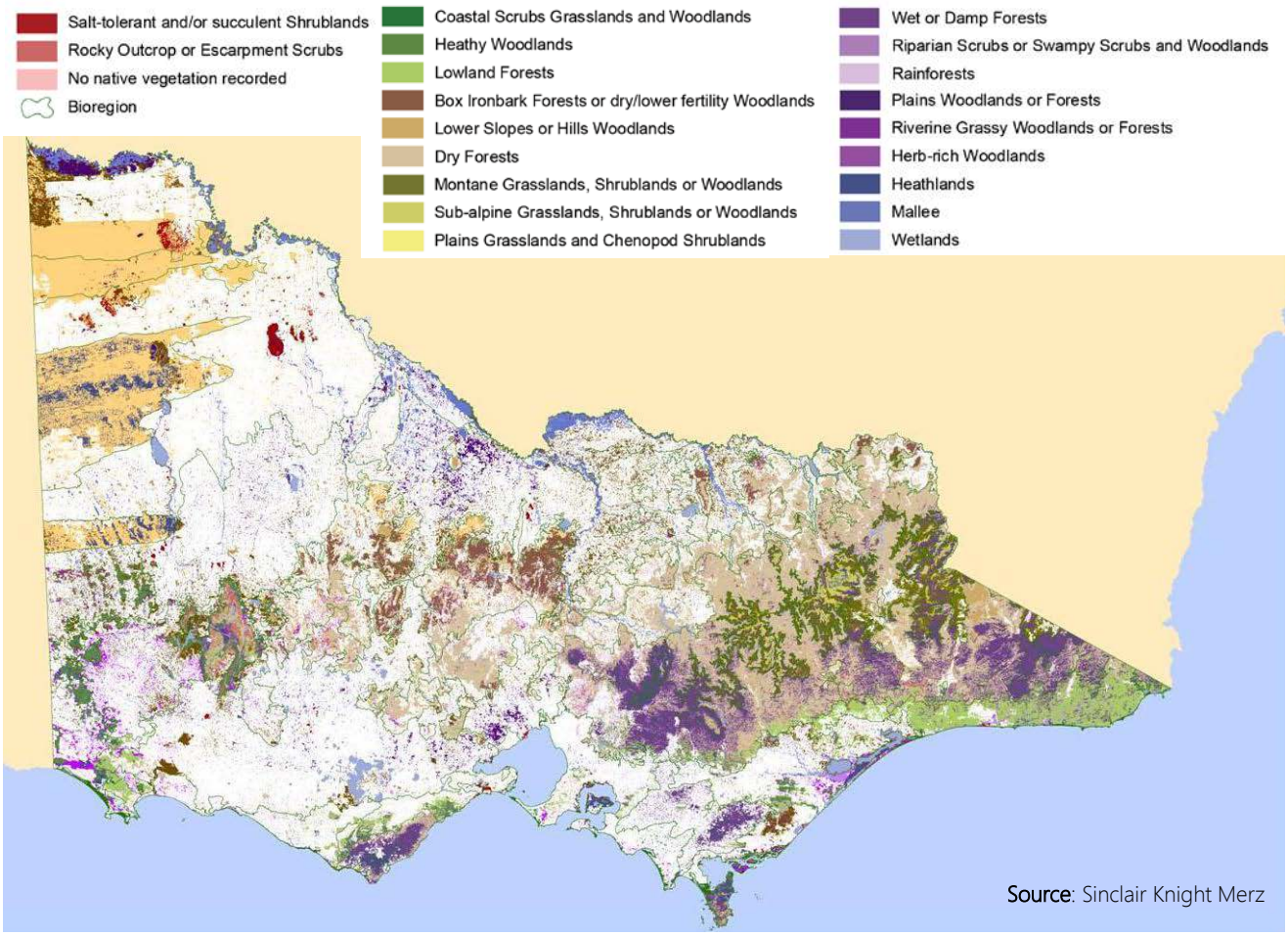
More than half (54%) of Victoria's native vegetation has been cleared.[55] Exceeding all other states for the proportion cleared, Victoria, with 3% of Australia's land area, has been responsible for 12% of the total clearing.[56] Of the remaining area with native vegetation (10.4 million hectares), more than half has been fragmented, leaving only 21% (4.9 million hectares) of Victoria's land area with largely intact vegetation.[57] Because of vegetation loss and degradation, almost half (48%) of Victoria's 28 subregions have been assessed nationally as having poor landscape condition.[58]

The losses have been greatest on private land, where 80% has been cleared, leaving about 2.9 million hectares of remnant vegetation. The most productive landscapes have been almost totally usurped for agriculture. More than 99% of remnant vegetation on private land is fragmented and about 60% is of a threatened vegetation type.[59]

The five most cleared subregions, covering 41% of the state, each have less than 25% native vegetation cover (almost all fragmented) and four have less than 10% of native vegetation in protected areas (Table 3.8, Figure 3.10). They are mostly flat, with fertile soils, under private tenure, and used for agriculture. Another eight subregions, covering 22% of land area, each have less than 50% native vegetation cover, almost all fragmented, and also mostly used for agriculture. Twelve subregions, covering 30% of the state, have more than 75% native vegetation cover. These least cleared areas are mostly mountainous and small, with a large proportion of land in public tenure.

Vegetation losses have been greatest in grasslands and woodlands, which occur on the most fertile lands targeted for agriculture.[60] Native grasslands are Victoria's most endangered vegetation type. Nine ecological communities have been nationally listed as threatened due to clearing (Box 3.2).[61]

Figure 3.9 Remnant native vegetation types (ecological vegetation class groups)[62]



Source: Sinclair Knight Merz

Box 3.1 Road reserves

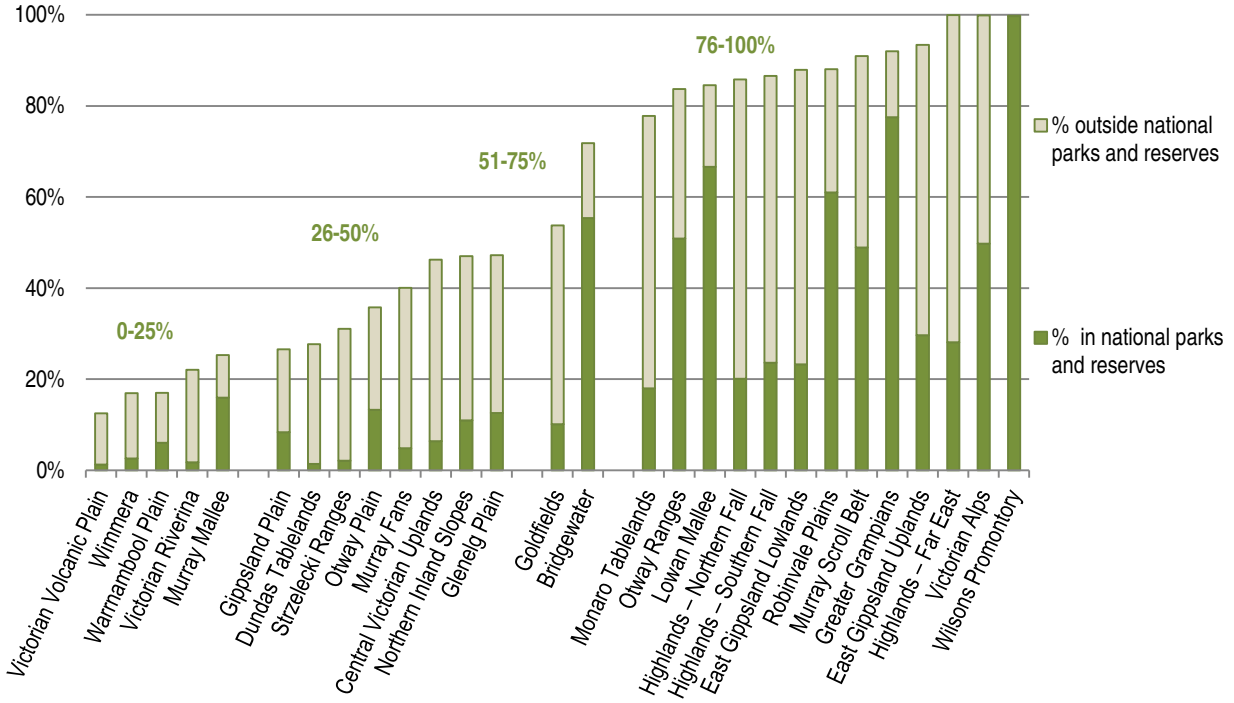
So extensive have been losses in Victoria's most cleared bioregions that road reserves now support a significant proportion of remnant vegetation: 9.4% in the Murray Mallee and 6.8% in the Warrnambool Plain. Statewide, 245,000 hectares of road reserves (used and unused) support native vegetation.[63] Their value as remnants and wildlife corridors is high but increasingly under threat. Pasture grasses (particularly Phalaris and Tall Wheat Grass) invading from adjoining farmland could destroy many over the next few decades. They are highly vulnerable to fire damage, 'cleaning up' for supposed fuel reduction, firewood pilfering, eutrophication, climate change, road construction and invasive species, and generally lack some critical habitat elements such as water (although they tend to have large trees, which have very high habitat values).[64]

Table 3.8 Subregional native vegetation cover, fragmentation and protection

Subregion	% native vegetation	% fragmented	% vegetation protected	Area (million ha)
Subregions with 0-25% native vegetation: 41% of the state (9.35 million hectares)				
Victorian Volcanic Plain	12	100	1	2.30
Wimmera	17	100	3	2.00
Warrnambool Plain	17	100	6	0.26
Victorian Riverina	22	100	2	1.89
Murray Mallee	25	90	16	2.50
Subregions with 26-50% native vegetation: 22% of the state (5.07 million hectares)				
Gippsland Plain	27	100	8	1.19
Dundas Tablelands	28	99	1	0.69
Strzelecki Ranges	31	100	2	0.34
Otway Plain	36	96	13	0.24
Murray Fans	40	100	5	0.43
Central Victorian Uplands	46	97	6	1.22
Glenelg Plain	47	100	13	0.40
Northern Inland Slopes	47	100	11	0.57
Subregions with 51-75% native vegetation: 6% of the state (1.34 million hectares)				
Goldfields	54	100	10	1.33
Bridgewater	72	100	55	0.02
Subregions with 76-100% native vegetation: 30% of the state (6.81 million hectares)				
Monaro Tablelands	78	64	18	0.07
Otway Ranges	84	68	51	0.15
Lowan Mallee	85	36	67	1.42
Highlands – Northern Fall	86	36	20	1.41
Highlands – Southern Fall	87	33	24	1.20
East Gippsland Lowlands	88	33	23	0.53
Robinvale Plains	88	65	61	0.06
Murray Scroll Belt	91	100	49	0.11
Great Grampians	92	40	77	0.24
East Gippsland Uplands	93	20	30	0.79
Highlands – Far East	100	1	28	0.07
Victorian Alps	100	2	50	0.71
Wilsons Promontory	100	2	100	0.04

Data Source: Department of Environment and Primary Industries, Victorian Environmental Assessment Council (2010)

Figure 3.10 Percentage of native vegetation in each subregion, within and outside protected areas



Box 3.2 Ecological communities threatened by clearing

Grasslands and grassy woodlands on Victoria's lowland plains (in the Mallee, Wimmera, Northern Plains, Grampians hinterland, Western Plains, Melbourne area and Gippsland Plains) used to cover about one-third of the state. Most have been cleared, leaving grassy ecological communities the most endangered in the state.[65] Less than 5% of the original extent of natural temperate grassland and grassy eucalypt woodland communities of the Victorian Volcanic Plain remain, and probably less than 1% is in good condition.[66]

Despite their great rarity, grasslands continue to be lost – due to agricultural intensification, urban expansion and weed invasion. About 3000 hectares were lost yearly in the decade to 2004.[67] The natural temperate grasslands to the west of Melbourne declined by at least 44% between 1985 and 2000, and further clearing has been approved for urban development. The proposed offsets are unlikely to compensate for losses, due to the difficulty of restoring degraded grassland communities.[68]

More than three-quarters of Victoria's woodlands (5.9 million hectares) have been cleared, leaving about 1.8 million hectares, two-thirds on private land.[69] About one-quarter of the woodland ecological vegetation classes are not represented in the national park and conservation system and more than three-quarters are inadequately represented.[70] One of the most important conservation decisions of the past decade was the declaration of box-ironbark national parks. But still only 2% of their original (pre-1750) extent is permanently protected.

0-25% remnant

The following nine ecological communities have been listed as nationally threatened under the Environment Protection and Biodiversity Conservation Act due mainly to clearing (two others are listed for other reasons).[71]

Natural temperate grassland of the Victorian Volcanic Plain	critically endangered	<2% remaining (5000 ha)
Grassy eucalypt woodland of the Victorian Volcanic Plain	critically endangered	<3% remaining (18,000 ha)
Natural grasslands of the Murray valley plains	critically endangered	<5-10% remaining
Seasonal herbaceous wetlands (freshwater) of temperate lowland plains	critically endangered	declined by ~ 44% in area
Gippsland red gum (*Eucalyptus tereticornis* subsp. *mediana*) grassy woodland and associated native grassland	critically endangered	~1-5% remaining (900 to 5600 ha)
White box–yellow box–Blakely's red gum grassy woodland and derived native grassland	critically endangered	<6% remaining (61,360 ha)
Littoral rainforest and coastal vine thickets of east Australia	critically endangered	279 ha remaining (plus areas in NSW & Qld)
Buloke woodlands of the Riverina and Murray-Darling Depression	endangered	
Grey box (*Eucalyptus microcarpa*) grassy woodlands and derived native grasslands of south-eastern Australia	endangered	~13% remaining (200,000 ha)

Native vegetation condition

Up to 2005, several thousand hectares – mostly in native grasslands – was estimated to be lost annually and there is no reason to believe that this rate of loss has slowed. More substantial now, however, is the effect of ongoing pervasive degradation – as a result of weed invasion, and activities such as stock grazing and removal of undergrowth and fallen timber – across the remaining remnant native vegetation.

Victorian Environmental Assessment Council, 2011[72]

Recent measures of native vegetation extent combine losses due to clearing and degradation by the habitat hectares method. The first and only state-wide account of vegetation using this method in 2008 estimated an annual loss of 17,410 habitat hectares, of which about 90% was due to decline in vegetation condition rather than extent, and a gain of 13,320 habitat hectares due to management and revegetation, leaving a net loss of 4000 habitat hectares.[73] This figure is not directly comparable with past measures, which are only of clearing. However, the habitat hectares method underestimates loss – for example, it does not count permitted clearing or logging as a loss because they are presumed to be compensated for by offsets and regeneration – and it overestimates gain by assuming that the condition of vegetation in protected areas automatically improves. [74] Although clearing is still causing substantial damage, particularly in highly endangered communities such as grasslands and buloke woodlands, the major cause of vegetation loss in Victoria is now chronic degradation – due to fragmentation, grazing, invasive species (plants, animals, diseases), firewood collection and regeneration failure.[75] Native vegetation on private land is generally in poorer condition than that on public land.[76]

Nearly 80% of Victoria consists of 'fragmented landscapes' (defined in Box 3.3), encompassing more than half (54%) the remaining native vegetation (Table 3.9, Figure 3.11).[77] Much native vegetation is in small patches: 88% of 2.72 million patches documented in 2010 are less than one hectare in size, while 68% of the total vegetation extent is in patches larger than 1000 hectares.[78] Vegetation fragments are often vital for biodiversity, as harbour for rare and declining species, and often highly biologically productive, as they are mostly in landscapes favoured for agriculture because of their high productivity. About 40% of Victoria's terrestrial vertebrates are virtually restricted to fragmented landscapes, and another 45% rely on fragmented landscapes across much of their range.[79]

Smaller habitat patches usually support fewer individuals because they have fewer resources and because increasing habitat patchiness disrupts multiple ecological processes. Patch isolation prevents species movements – for food and breeding, for seasonal migrations, to escape disturbance or in response to climate change. Fragmentation alters interactions between species – affecting competition, predation, parasitism and mutualisms. In Victoria, it has facilitated domination by invasive pasture grasses and aggressive (native) noisy miners for example (Box 3.7). As fragmentation increases, the resilience of native vegetation remnants to external pressures is lowered and they become increasingly influenced by processes and land uses in modified areas. Patches are subject to edge effects – changes in physical and biological conditions at a boundary, such as altered microclimates and weed invasion – which can penetrate metres to kilometres into patches.[80]

Small populations isolated in habitat patches are highly vulnerable to extinction from chance events and loss of genetic diversity.[81]

Box 3.3 Intact versus fragmented landscapes[82]

Largely intact landscapes are defined by the state government as contiguous areas of native vegetation greater than 20,000 hectares in good condition. The 'underlying stock' of native vegetation is stable; natural or semi-natural dynamics are the dominant drivers. They correspond closely with Victoria's major parks and state forests.

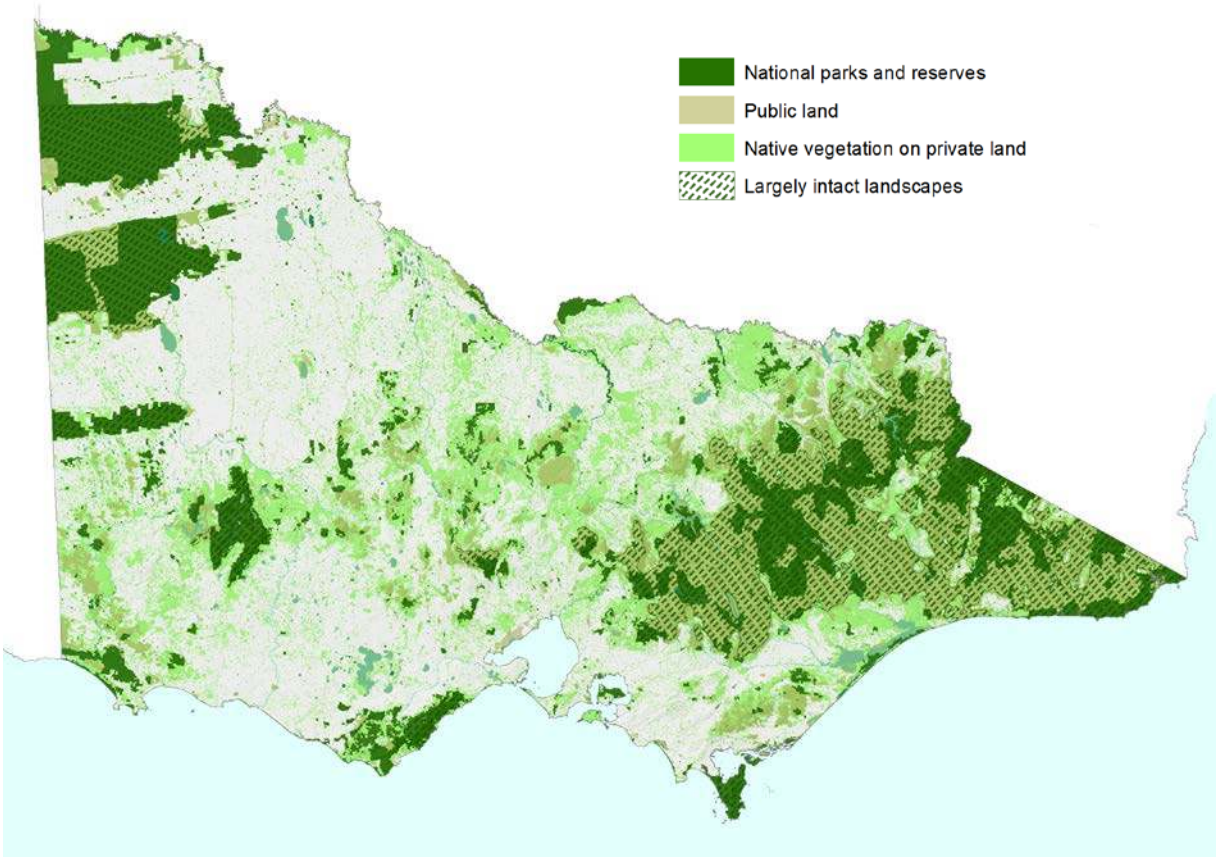
Fragmented landscapes are areas outside largely intact landscapes where there has been widespread removal and use of native vegetation for economic development. The 'underlying stock' of native vegetation is declining or at risk of decline; degradation and recovery from degradation are the dominant factors in vegetation change.

Table 3.9 Fragmented versus largely intact landscapes, public and private land[83]

	Fragmented (million ha)	Fragmented (%)	Largely intact (million ha)	Largely intact (%)	Total area (million ha)
Total land area	17.8	79	4.9	21	22.7
Private land	14.0	>99	0.02	<1	14.1
Public land	3.8	44	4.8	56	8.6
Native vegetation	5.6	54	4.9	46	10.5
Native vegetation on private land	2.8	97	0.1	3	2.9
Native vegetation on public land	2.8	37	4.8	53	7.6

Source: Victorian Environmental Assessment Council

Figure 3.11 Largely intact landscapes



Map: VNPA. Source: Department of Environment and Primary Industries.

Native vegetation and fire regimes

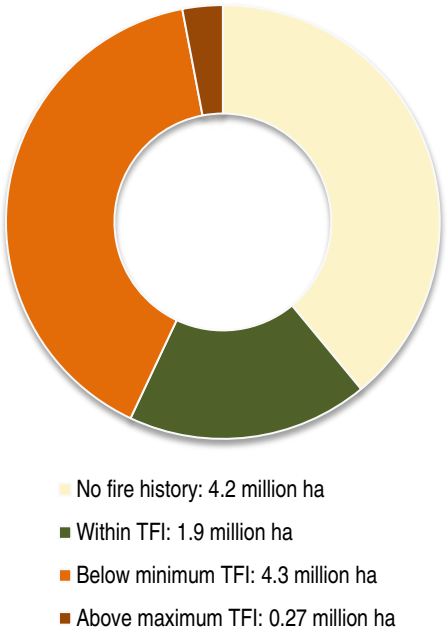
[It] is likely that inappropriate fire regimes exist for the majority of Victoria's native vegetation.

Victoria State of the Environment 2013

Particular patterns of ecological disturbance – by fire, flood, wind, storms, droughts, for example – are essential for maintaining diversity in certain ecosystems. Fire is a particularly powerful disturbance in many Victorian ecosystems, shaping the structure and composition of habitats, and determining the availability of resources (nutrients, light, space). Too much fire or too little, the wrong type or wrong timing can drive species declines.

Many habitats in Victoria are subject to inappropriate fire regimes, which are skewing vegetation communities to domination by early growth stages and, in some cases, transforming them into different vegetation types. A 2012 assessment found that only 18% of the native vegetation assessed on public lands was within the 'tolerable fire intervals' needed to maintain the vegetation communities and 39% could not be assessed due to lack of knowledge of its fire history (Figure 3.12).[84] (The minimum tolerable fire interval for a vegetation type is set by the slowest plants to reach reproductive age and produce seed; the maximum is set by the earliest time when plants start to senesce.[85]) The large-scale bushfires of recent times have engendered domination by early growth stages over extensive areas. Of assessed native vegetation (excluding the area with an unknown fire history), 35% was found to be in early growth stages compared to 25% in 'mature' or 'over mature' stages. Much of Victoria's wildlife depends on older growth stages, which have already been much depleted by land clearing and forestry.

Figure 3.12 Tolerable fire interval (TFI) status of native vegetation on public land (% area, June 2012)[86]



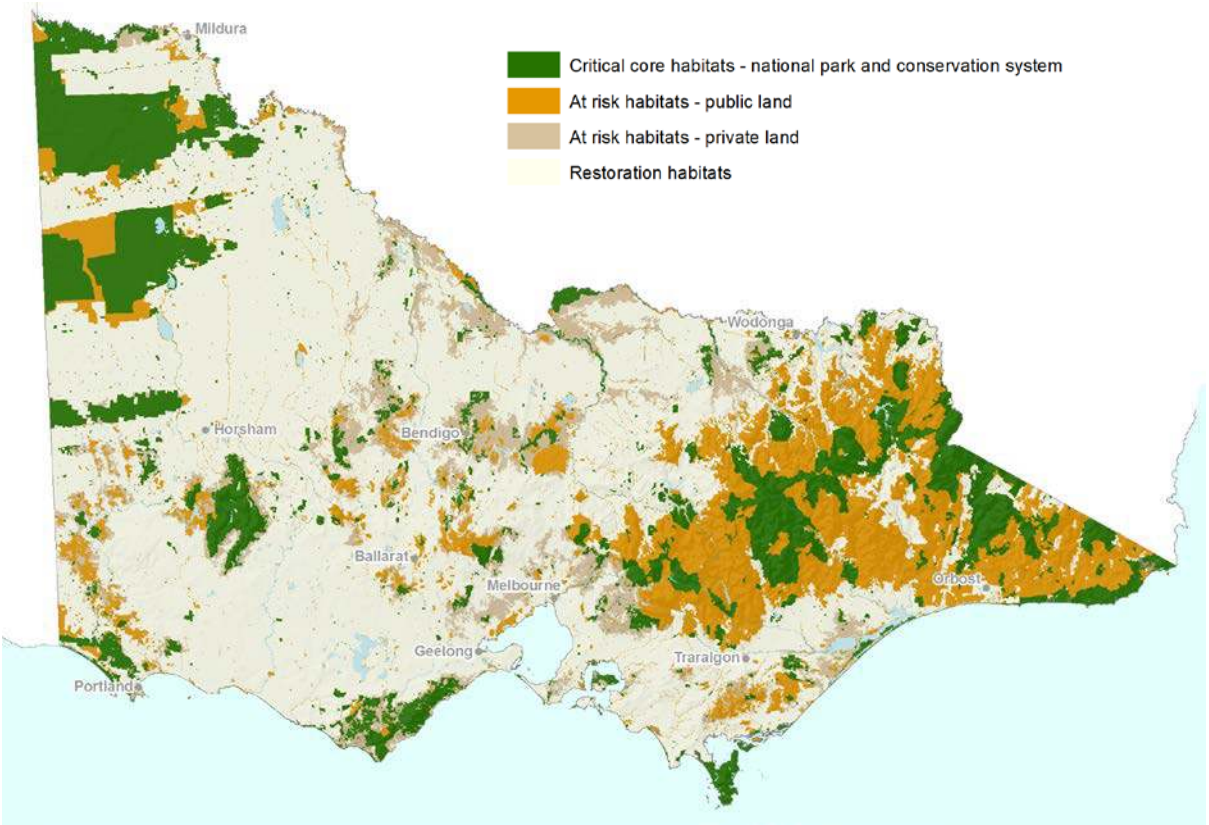
Data source: State of the Environment Victoria 2013.

VNPA habitat classification

The extent and condition of remnant vegetation is the major determinant of ecosystem health, and the stark differences in vegetation cover between different subregions imply very different conservation priorities. VNPA has developed the following three tier classification for habitats, based on condition and potential contribution to state-wide conservation objectives (Figure 3.13), as a framework for determining conservation priorities (discussed in section 5.3).

- **Critical core habitats** have largely intact vegetation with natural ecological processes still functioning. They are mostly larger properties or networks of smaller properties in the national park and conservation system (public or private tenure). The conservation goal is to maintain their biodiversity values and ecological processes.
- **At risk habitats** still have extensive areas of native vegetation but habitat values are declining or at risk because of unsustainable exploitation and lack of environmental management. Most occur on public lands outside the national park and conservation system and there are also some highly significant areas on private land. The conservation goal is to permanently protect them from further intensive land-uses and manage them for conservation.
- **Restoration habitats** are extensively cleared, often degraded and used primarily for economic purposes, but have some areas retaining important natural values. They are almost entirely on private land. The conservation goal is a net improvement in native habitat within a productive landscape by maintaining and improving the extent and quality of vegetation and habitats.

Figure 3.13 VNPA habitat classification: critical core, at risk and restoration habitats



Map & analysis: VNPA. Data sources: Department of Environment and Primary Industries; Trust for Nature. At risk habitats include vegetated public lands outside the national park and conservation system, and private lands outside the national park and conservation system that are within 'biodiversity priority zones' (as identified by the Trust for Nature in its *Statewide Conservation Plan 2013*). Restoration habitats are the balance of lands outside urban areas.

Native forests

A century and a half of bushfires and European forest management has left Victoria with a native forest estate that is returning decreasing yields of quality wood and pushing forest managers into more marginal country.

National Institute of Economic and Industry Research, 2010[87]

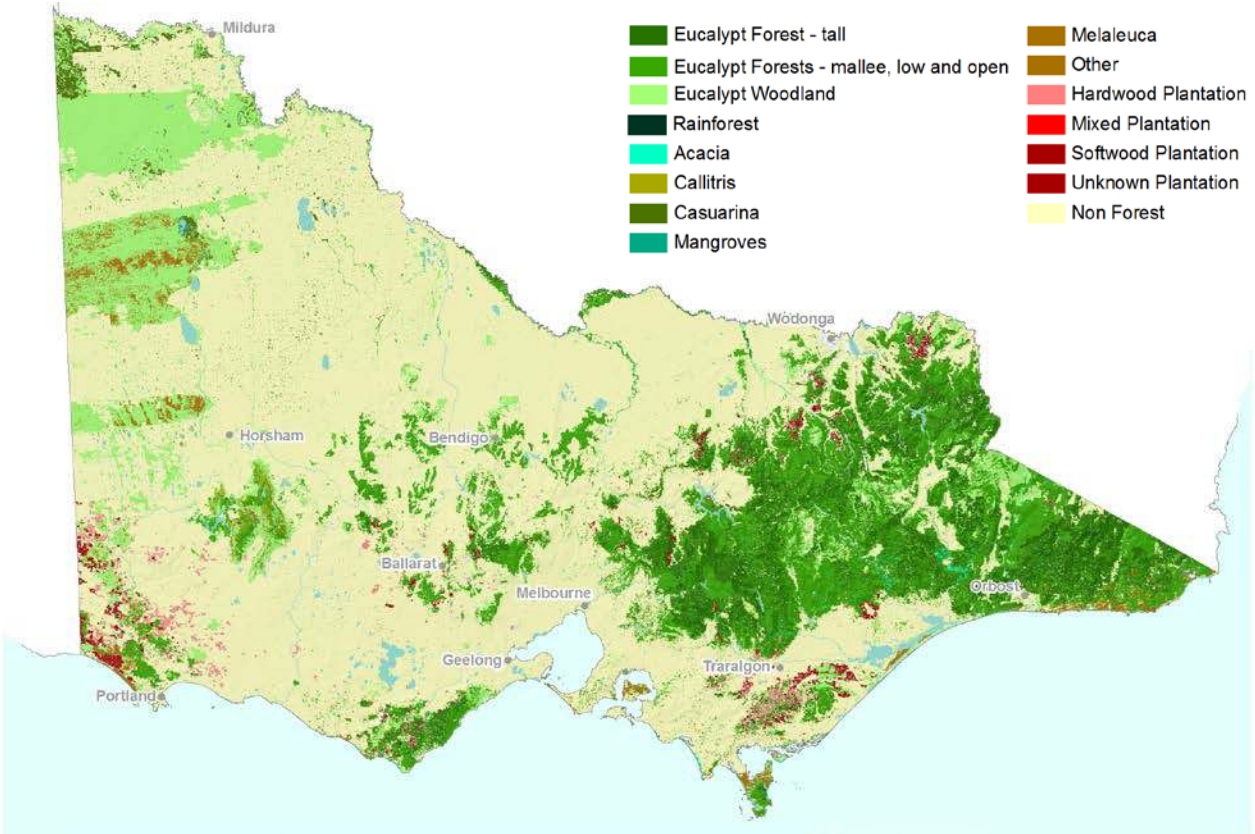
More than half of Victoria's forests have been cleared, leaving one-third of the state (7.8 million hectares, 35%) with native forest, most dominated by eucalypts (Table 3.11, Figure 3.14). The majority of forests (87%) are on public land, of which about 1.2 million hectares are available for commercial harvesting (Table 3.10). About 1 million hectares of native forest occur on private land. There are also more than 400,000 hectares of plantations in Victoria, 99% on private land, about half hardwood (eucalypt species) and half softwood (exotic pines).[88]

Table 3.10 Victoria's native forest tenures[89]

Forest tenure/use	Area (million ha)	% of native forest
Total native forest	7.85	100
Native forest on private land	1.02	13
Native forest on public land	6.83	87
Conservation reserves(1)	3.50	45
Leasehold land	0.11	1
Other crown land	0.03	<1
State forests	3.14	40
Timber production area (eastern Vic)	2.48	32
Available for harvesting(2)	1.20	15
Exempt from harvesting(3)	1.28	16

Sources: Department of Environment and Primary Industries, VicForests (1) These include national parks, nature reserves, state parks and other conservation areas managed by Parks Victoria, and reserves for the protection of water supply catchments. They differ in their level of protection, but more than 90% can be regarded as part of the national park and conservation system. (2) These areas are zoned general management or special management (the latter have conditions on harvesting to conserve particular species or features). (3) These areas are special protection zones and other reserves.

Figure 3.14 Victoria's forest types[90]



Map: VNPA. **Data source**: Australian Bureau of Agricultural and Resource Economics and Sciences 2008. Significant areas of native forest in the Strzelecki Ranges have been incorrectly designated by government as plantation (as noted in the 2001 nature conservation review).

Despite their high biodiversity values and extensive damage caused by historic over-logging and frequent fires, Victoria's native forests continue to be commercially logged, including clear-felling of about 5000 hectares a year, and also exploited for firewood (section 3.4.3). More than a century of logging and large wildfires have depleted most of Victoria's 'old-growth' forest. Just 1.2% of mountain ash forests – a highly fragmented 1885 hectares – are in an old-growth stage, down from an estimated 60-80% prior to European colonisation.[91] When Victoria's regional forest agreements were signed in 1997-2000, there was an estimated 842,000 hectares of old-growth (although what counts as old-growth is contested)[92] of which, by 2006, at least 5.3% (more than 44,000 hectares) had been lost to logging.[93] Fire has destroyed even larger areas – more than 100,000 hectares of old-growth forest between 2003 and 2006 – the impacts exacerbated by salvage logging (the removal of dead and live trees from burnt areas).[94] There is a risk that mountain ash forests will disappear over large areas due to a 'landscape trap' resulting from the combined effects of wildfire, logging and salvage logging.[95]

Many Victorian species rely on forests for all or part of their life cycle, including at least 37 frog species, 117 reptiles, 272 birds, 87 mammals and 2853 vascular plants.[96] More than a quarter of forest vertebrate animal species and about 10% of plants are considered extinct or threatened.[97] Wildlife dependent on old-growth forest have lost most of their habitat, including Leadbeater's possums and about 30 other species reliant on cavities in mountain ash, which take more than 120 years to develop.[98] With fewer than 2000 Leadbeater's possums left, there is a high risk this species will go extinct in the near future. In the 2009 fires, more than one-third of public land within its highland habitat range was burnt and logging continues to deprive it of existing and future regrowth habitat (Box 3.15).[99]

Little is known about the status of invertebrates, fungi and non-vascular plants. Ecological knowledge of forest species varies from 'comprehensive' for about 10% of birds and mammals, 40% of frogs, 2% of reptiles and 5% of vascular plants to 'poor' for 45% of vascular plants and more than 90% of invertebrates, fungi, lichen and algae.[100]

Table 3.11 Victoria's forest types and extent (million hectares)[101]

State forest	Parks & conservation reserves(1)	Other crown land	Private land	Leasehold land	Total area
Woodlands: *Acacia, Callitris, Casuarina*, eucalypt tall, eucalypt medium, eucalypt low, eucalypt mallee, other					
0.496	1.788	0.033	0.485	0.004	3.118
17.7%	63.7%	1.2%	17.3%	0.1%	100%
Forests: eucalypt tall open, tall closed, medium open, medium closed, low open & low closed; rainforest					
2.608	1.464	0.074	0.519	0.030	4.693
55.6%	31.2%	1.6%	11.0%	0.6%	100%
Total eucalypt woodlands and forests					
3.103	3.250	0.107	1.004	0.034	7.497
Estuarine or wetland forests: mangroves, *Melaleucas*					
<0.001	0.020	<0.001	0.005	<0.001	0.027
Total native forest area					
3.164	3.506	0.109	1.025	0.035	7.838
Total plantation area					
0.019	0.007	0.009	0.272	0.133	0.441
Total forest area					
3.184	3.513	0.118	1.297	0.168	8.278
38.5%	42.4%	1.4%	15.7%	2.0%	100%

Source: Department of Sustainability and Environment, with advice from The Wilderness Society. (1) Not all parks and conservation reserves are in the national park and conservation system.

3.2.4 Land managed for conservation

Victoria's terrestrial national park estate (national parks, state parks, wilderness parks and reference areas) covers about 3.3 million hectares (14% of Victoria's land area, about one third of the public land area) (Table 3.12). These properties are highly protected by virtue of their legislated security (they cannot easily be revoked), permanence and requirement that they be managed primarily for nature conservation. Nonetheless, some current and proposed activities in the national park estate, such as grazing, prospecting and resort development, are inconsistent with conservation (section 3.5.1).

An additional 600,000 hectares of private and public land are part of the national park and conservation system (see section 1.4 for an explanation of this term). These properties are generally smaller than those in the national park estate, averaging 150 hectares compared to 25,000 hectares, and have less rigorous legal requirements to manage them for conservation. IUCN protected area management categories 1-4 (nature reserve, wilderness area, natural monument or feature, national park or habitat/species management area) and properties described by the Victorian Environmental Assessment Council as part of the conservation reserve system are mostly consistent with VNPA's national park and conservation system category. The list of protected area categories in Victoria, their respective legislation and how VNPA classifies their level of protection is shown in section 1.4.

Victoria's national park and conservation system offers uneven and highly inadequate protection to its great variety of terrestrial ecosystems, as Figure 3.15 shows. In 2011 at a meeting of the Convention on Biological Diversity, the Australian government adopted the *Strategic Plan for Biodiversity 2011-2020* and its 'Aichi targets', which include a target to protect at least 17% of terrestrial areas. Only half of Victoria's subregions meet this target. Figure 3.15 also shows that a substantial proportion of remnant vegetation in the least protected subregions occurs on private lands.

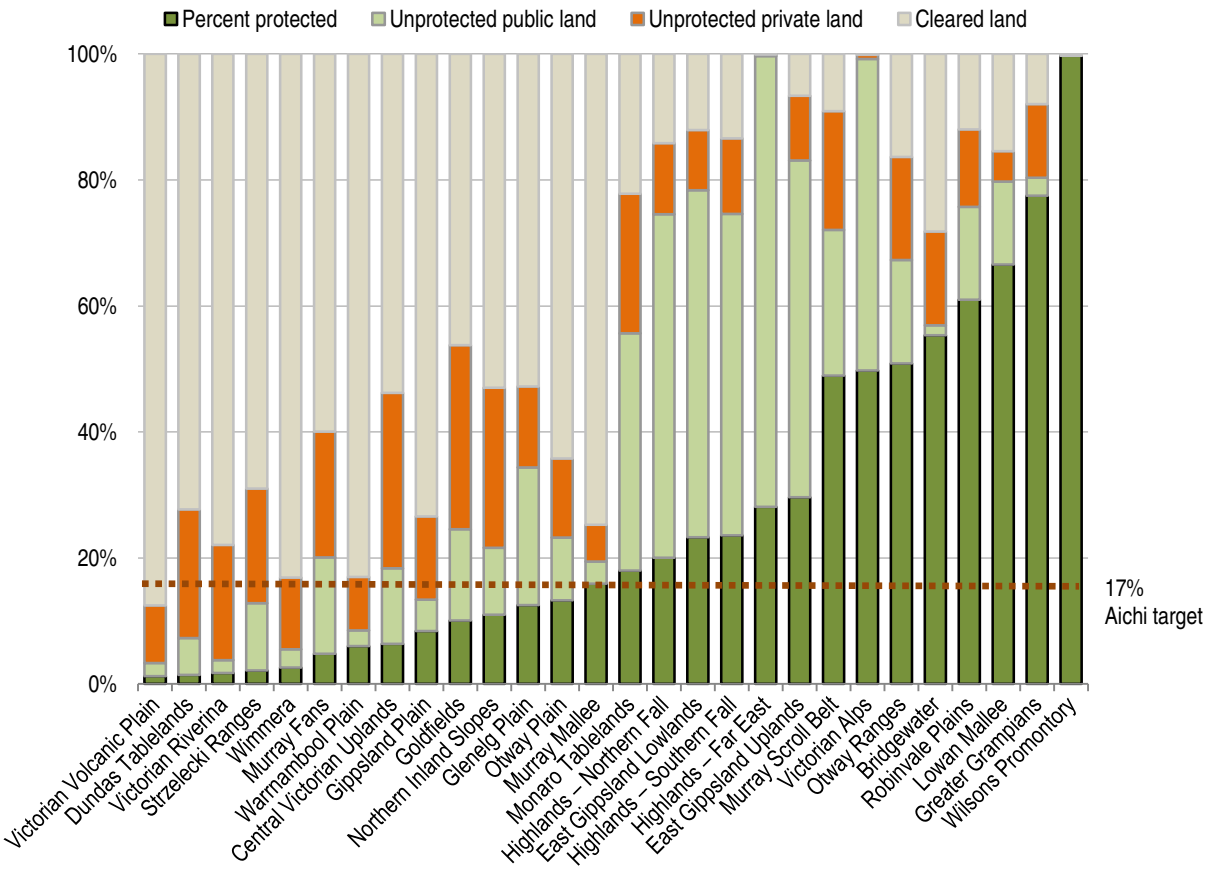
Section 3.3 provides much more detail on gaps in Victoria's national park and conservation system by analysing the extent to which it meets specific targets for comprehensiveness, adequacy and representativeness.

Table 3.12 Victoria's national park and conservation system[102]

Conservation property types	Legislation	Number	Area (hectares)	% of state
National park estate				
National parks(1)	National Parks Act	45	2,901,284	12.8
State parks(1)	National Parks Act	26	157,825	0.7
Wilderness parks(1)	National Parks Act	3	200,699	0.9
Reference areas (included in above)(2)	Reference Areas Act	105	89,369	0.4
Reference areas (additional to above)(2)	Reference Areas Act	54	22,636	0.1
Subtotal		128	3,282,444	14.4
Other conservation properties, public lands (as defined in table 1.3)				
Schedule 3 parks & reserves(1)	National Parks Act	18	76,555	0.3
Nature conservation reserves(2)	Crown Lands (Reserves) Act, Wildlife Act	259	130,725	0.6
Natural features reserves(2)	Crown Lands (Reserves) Act	2,496	315,900	1.4
Others		2	2,861	-
Other conservation properties, private lands				
Trust for Nature(3)	Conservation Trust Act	1,330	93,456	0.4
Subtotal public and private		>4,000	619,497	2.7
Total		**>4,000**	**3,901,941**	**17.2**

Data sources: (1) Department of Environment and Primary Industries (2013), (2) CAPAD 2012, (3)Trust for Nature (March 2014). Trust for Nature properties counted here include covenants, reserves and revolving fund purchases. The number of public 'other conservation properties' is higher than shown here because it relies on data from 2012.

Figure 3.15 The proportion of remnant, cleared and protected vegetation in each Victorian subregion



Private protected areas

As Figure 3.15 above illustrates, private protected areas will necessarily have an increasingly important role in Victorian conservation. The majority of land with remnant vegetation in the least protected subregions is privately owned. The Trust for Nature found that about 60% of the 452 subregional classes without any representation in protected areas have more than 70% of their remaining extent on private land.[103] A substantial proportion of this remnant vegetation has very high conservation value because it is of a threatened ecological vegetation class.

Only a few mechanisms provide protection on private land of sufficient security, permanence and conservation management focus to meet the criteria for the national park and conservation system. Of 16 mechanisms (under law or by contract) for protection of private land in Victoria identified in Table 3.16, only properties with Trust for Nature conservation covenants, Trust for Nature and some other non-government reserves meet the VNPA criteria (section 1.4).

The Trust for Nature plays a central role in private land conservation. Since 1972, it has secured the protection of about 100,000 hectares through conservation covenants, a revolving fund (land is bought, covenanted and sold), private reserves and the purchase and transfer of land to the state (Table 3.13).[104] Its role is particularly important in highly cleared areas such as the Victorian Volcanic Plains, the Warrnambool Plain and the Wimmera, where there are few national parks and mostly small vegetation remnants. In 2013, the organisation identified 12 'focal landscapes' that 'provide the best opportunities for maintaining priority ecosystems and species on private land' (Table 3.22, Figure 3.16).[105] These priority areas were determined by identifying connected landscapes of more than 20,000 hectares that integrate:

- large patches of land with consistently high biodiversity values of statewide significance (as identified in NaturePrint, see Figure 3.7)

- ecosystem replication at the bioregional or catchment scale
- landscape connectivity
- additional biodiversity assets of statewide significance on private land in the intervening landscape.

Apart from the mechanisms identified in Table 3.16, Victorian landholders are contributing to conservation in multiple ways, the extent of which is poorly documented. Much of it is outside formal programs. The extent of participation in a few programs is outlined in Table 3.14. The Land for Wildlife program, for example, recognises and supports landholders for maintaining and restoring habitat for wildlife. It is valuable for educating landholders and providing extension, with the potential to motivate participants to aim for more secure forms of biodiversity protection.

A small proportion of agricultural land is managed for conservation: 0.5% is under a conservation agreement, and activities such as protection of native vegetation, revegetation, and livestock exclusion are occurring on 1-2% of agricultural land area (Table 3.17). About 750 conservation agreements are in perpetuity.

Table 3.13 Private land permanently protected for conservation through Trust for Nature

Mechanism	Properties	Area (ha)
Trust for Nature covenants	1279	56,080
Trust for Nature reserves	44	36,093
Trust for Nature revolving fund purchases(1)	7	1,283
Total(2)	1330	93,456

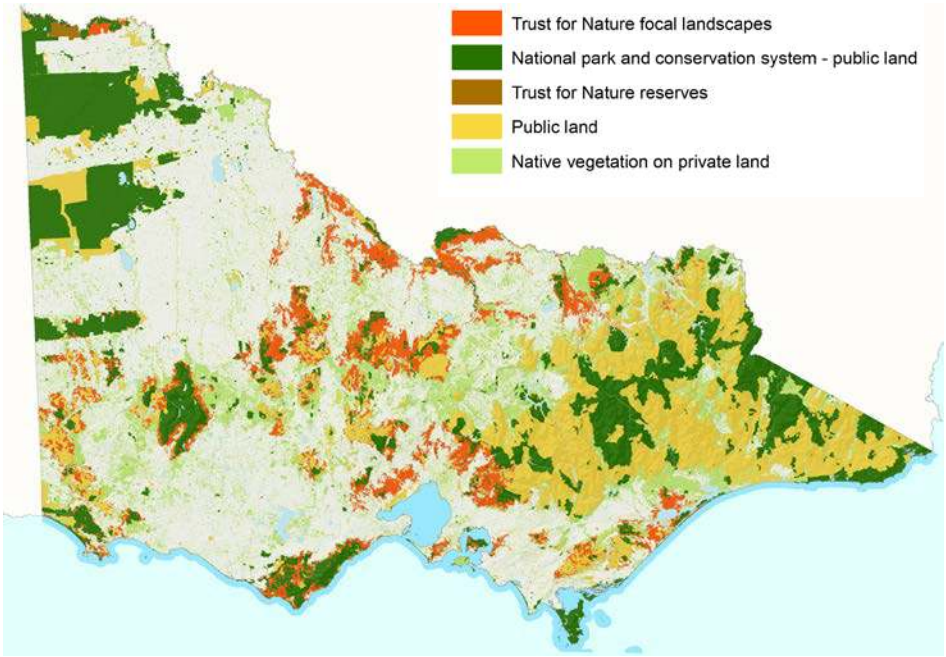
Source: Trust for Nature, 24 March 2014. (1) Addition of covenants to these properties is imminent, prior to resale. (2) In addition, Trust for Nature bought 65 properties (6744 hectares) that were transferred to the state, almost entirely for addition to the national park estate.

Table 3.14 Other private land managed for conservation (non-permanent protection)[106]

Mechanism	Properties	Area (ha)
BushTender & similar incentive schemes (2001 -2010)		26,000
National Action Plan & Natural Heritage Trust incentive schemes		35,500
Land for Wildlife (2014)(1)	5300	170,000

Sources: Department of Sustainability and Environment, (1)Personal Communication, Peter Johnson, Statewide Coordinator, Land for Wildlife.

Figure 3.16 Trust for Nature focal landscapes



Map: VNPA. Data Sources: Trust for Nature; Department of Environment and Primary Industries

Table 3.15 Trust for Nature focal landscapes[107]

Focal landscape	Significant biodiversity assets on private land (hectares)
Eastern Riverina	170,000
Gippsland Plain & Gippsland Lakes catchment	81,000
Murray Scroll Belt	52,000
Northern Inland Slopes	114,000
Otway Ranges & coast	80,000
Port Phillip & Westernport	25,000
South-West	179,000
Strzelecki Ranges & Plains	37,000
Victorian Midlands	567,000
Western Melbourne ranges & plains	57,000
Western Riverina	179,000
Yarra-Cardinia Catchments	157,000

Table 3.16 Mechanisms for private land conservation, and whether they meet criteria for the national park and conservation system[108]

Agreement / property type	Legislation	Secure?	Permanent?	Conservation management intent?	Meets criteria for the NP&C system?
Trust for Nature conservation covenants	Conservation Trust Act	✓	✓	✓	Yes
Trust for Nature reserves	Conservation Trust Act	✓	✓	✓	Yes
Trust for Nature revolving fund	Conservation Trust Act	✓	✓	✓	Yes
NRSP private protected areas(1)	N/A	✓	✓	✓	Yes
Land management cooperative agreements	Conservation, Forests & Lands Act	X	Depends on terms	Depends on terms	No
Wildlife management cooperative areas	Wildlife Act	✓	Depends on terms	Depends on terms	Depends on terms
Wildlife sanctuaries	Wildlife Act	✓	X	X	No
BushTender & similar agreements – *with covenant*	Conservation Trust Act	✓	✓	✓	Yes
BushTender & similar agreements – *permanent*	Conservation, Forests & Lands Act	X	Depends on terms	Depends on terms	No
BushTender & similar agreements –*fixed-term*	N/A	X	X	✓	No
Section 173 agreements	Planning & Environment Act	X	Depends on terms	X	No
Public authority management agreements	Flora & Fauna Guarantee Act	X	Depends on terms	✓	No
Interim conservation orders	Flora & Fauna Guarantee Act	X	X	Depends on terms	No
Indigenous protected areas	N/A	✓	✓	✓	Yes
Land for Wildlife properties	N/A	X	X	✓	No
Local government reserves	N/A	X	X	✓	No

Source: Fitzsimons (2006), with minor modifications. (1) NRSP is the National Reserve System Program. For properties purchased with funding from the NRSP, an agreement is signed with the federal government committing the landholder to manage the site according to guidelines and agreeing to it becoming a private protected area.

Table 3.17 Agricultural conservation activities[109]

Conservation activities per area of agricultural businesses	Area (ha)	%
Native vegetation protected for conservation	246,263	1.9
Total livestock exclusion	179,198	1.4
Controlled livestock access	210,389	1.7
Managed weeds	417,215	3.3
Managed invasive animals	514,703	4.1
Retained existing native vegetation	162,310	1.3
Revegetated with native vegetation	149,187	1.2
Wetlands protected for conservation	19,807	0.2
River or creeks protected for conservation	74,480	0.6
Total livestock exclusion to protect river or creek banks	32,670	0.3
Controlled livestock access to protect river or creek banks	22,746	0.2
Managed weeds to protect river or creek banks	150,892.5	1.2
Managed invasive animals to protect river or creek banks	52,151.5	0.4
Conservation agreement (1,829 holdings, average of 10.9 years, 732 perpetual agreements)	59,578.9	0.5
Trees and shrubs planted or sown for nature conservation	8,916	<0.1
Total agricultural area	12,697,842	
Conservation activity per number of agricultural businesses	**Number**	**%**
Member of a landcare group (29%) (number)	9,434	29.0
Participating in projects or receiving funding from Caring for our Country (including Landcare)	2,100	6.5
Participating in projects or receiving funding from non-government groups (number)	242	0.7
Participating in projects or receiving funding from Community Action Grants	282	0.9
Conservation agreements (total, averaging 10.9 years)	1,829	5.6
Conservation agreements in perpetuity	732	2.3
Total number of agricultural businesses	32,529	

Indigenous lands managed for conservation

Indigenous Victorians have had an intimate connection to the land, sea and natural processes reaching back tens of thousands of years. During most of the period of European colonisation, they were deliberately separated from their country, denied access to traditional foods and discouraged from maintaining their culture. After continual resistance and struggle this is changing, with Aboriginal culture becoming increasingly recognised and respected.

Through legal instruments associated with native title or by government agreement, some protected areas are being jointly managed by Traditional Owners and government agencies. Others are being managed under cooperative management agreements. The federal Indigenous protected areas program supports Traditional Owners to establish protected areas on their land, and the Indigenous Land Corporation assists Aboriginal people to acquire freehold lands. All offer a way for Traditional Owners to maintain connections with their country, practice their culture and contribute to the conservation of biodiversity. There is growing support for drawing on the skills and knowledge of Indigenous people to assist in management of the national park and conservation system.

The state government has six agreements regarding management of national parks and reserves with five Indigenous Owner groups over about 300,000 hectares of protected areas.[110] Three are for 'cooperative' management and three are for 'joint' management (Table 3.18). These agreements recognise the ongoing connection of Traditional Owners to their land and allows Indigenous owners and public land managers to share their knowledge to manage specific areas.[111] Under joint agreements, national parks and reserves within a Traditional Owner group's agreement area may

be transferred to the Traditional Owner corporation as 'Aboriginal title'. Management rights for the land are then transferred back to the state, to be jointly managed in perpetuity by the state and the Traditional Owner land management board. Joint management is also possible without the granting of Aboriginal title, as is the case for the agreement with the Yorta Yorta people for Barmah National Park (Box 3.11).

In all cases, the cooperatively or jointly managed protected areas continue to be managed under the same legislation under which the parks and reserves were dedicated. Jointly managed lands are subject to a joint management plan developed by the Traditional Owner land management board (of which Traditional Owners have majority membership), and approved by the environment minister following public consultation.

An additional benefit of joint management arrangements is helping park visitors to learn more about the culture, history and aspirations of Traditional Owners.

Under the federal government's Indigenous protected area program, Indigenous landowners agree to manage their land or sea estate as a protected area in the national reserve system and receive support from the federal government to do so. Five Indigenous protected areas (declared under the federal program) have been established in Victoria (Table 3.19).

Table 3.18 Cooperative and joint management agreements

Agreements	Area (hectares)
Yorta Yorta Nation Aboriginal Corporation Cooperative Management Agreement (2004)	22,000
Barengi Gadjin Land Council Aboriginal Corporation Cooperative Management Agreement (2005)	194,000
Gunditj Mirring Traditional Owners Aboriginal Corporation Cooperative Management Agreement (2007)	8,000
Gunaikurnai Land & Waters Aboriginal Corporation Traditional Owner Land Management Agreement (2010)	46,000
Yorta Yorta Nation Aboriginal Corporation Traditional Owner Land Management Agreement (2010)	29,000
Dja Dja Wurrung Clans Aboriginal Corporation Traditional Owner Land Management Agreement (2012)	49,000

Table 3.19 Indigenous protected areas

Indigenous protected areas	Area (hectares)
Deen Maar (southwest coast, 1999)	453
Tyrendarra (near Portland, 2003)	248
Framlingham Forest (2009)	1,142
Kurtonitj (between Mt Eccles and the coast, 2009)	353
Lake Condah (next to Mount Eccles, 2010)	1,700

3.3 Gaps in the national park & conservation system

Although, Victoria has a fairly extensive national park and conservation system, particularly compared with most Australian states and territories, it offers very uneven protection to the great variety of terrestrial ecosystems in the state, and is far from being a comprehensive, adequate and representative system, the accepted national goal, explained in Box 3.4. There are various interpretations of what is needed to meet the goal. The targets adopted for this review – called the 'nature conservation review (NCR) reserve targets' – are based on subregional ecological vegetation classes and are slightly modified from targets developed in the *Nature Conservation Review 2001* (Box 3.4), which were modified from JANIS targets, adopted by governments for forest ecosystems in regional forest agreements. The NCR targets are defined and compared with the JANIS targets in Table 3.20. The NCR reserve targets range from 30% protection of the remaining extent of least concern ecological vegetation classes in fairly intact bioregions to 90-100% protection of endangered and rare vegetation classes and 100% protection of vegetation within 500 metres of the coastline.

Box 3.4 Targets for a comprehensive, adequate and representative reserve system

Since 1992, Australian governments have been committed to the development of a comprehensive, adequate and representative (CAR) reserve system, by which is meant the following:

- *Comprehensive*: the reservation of examples of regional-scale ecosystems in each bioregion.
- *Adequate*: the reservation of sufficient levels of each ecosystem to provide ecological viability and to maintain the integrity of populations, species and communities.
- *Representative*: the reservation of areas at a finer scale, to encompass the variability of habitats within ecosystems.

Reserve targets for a CAR system have changed over time as scientific understanding of and public and political support for the concept have grown. In 2011 the IUCN and the Australian government adopted the *Strategic Plan for Biodiversity 2011-2020* and its 'Aichi targets' at a meeting of the Convention on Biological Diversity, which include a target to protect at least 17 per cent of terrestrial and inland water and 10 per cent of coastal and marine areas by 2020 in an 'ecologically representative and well-connected systems of protected areas'. The Victorian government will need to consider how to apply the Aichi targets to Victoria.

The regional forest agreements have used the 'nationally agreed criteria for the establishment of a comprehensive, adequate and representative reserve system for forests in Australia' (known as the JANIS criteria or the national agreed reservation targets). JANIS targets for forest ecosystems are 15% of the pre-1750 extent of each forest ecosystem, except where ecosystems are endangered or vulnerable, in which case the targets are 100% and 60% respectively of the existing area (Table 3.20). There are also JANIS objectives for species, which are 'to maintain viable populations of native forest species throughout their natural ranges, and to maintain genetic diversity of native forest species'.[112]

VNPA's *Nature Conservation Review 2001* concluded that the JANIS targets were inadequate and developed more robust reserve targets for Victorian ecosystems (not just forests). The main changes were (1) a minimum target of 30% of the current extent of each 'least concern' ecological vegetation class (rather than 15% of their pre-European extent) to provide greater surety of protection and (2) higher targets for fragmented bioregions (defined as bioregions with less than 35% of remnant native vegetation) because of evidence of declines and extinctions of vertebrates, such as woodland birds, in fragmented habitats.[113]

This review recommends one addition to the targets: that 100% of coastal vegetation is reserved because of its vital role this in maintaining coastal processes and protecting the coastal environment.

These justified and achievable targets – known here as the 'NCR reserve targets' – are used in this review as the measure to assess progress towards a comprehensive, adequate and representative national park and conservation system. Many assessments use only partial measures and therefore do not provide a complete picture of the extent of reservation required to establish a comprehensive, adequate and representative system.

Table 3.20 Nature conservation review (NCR) reserve targets and JANIS targets for ecological vegetation classes (EVCs)[114]

Conservation status or location of EVC	NCR reserve targets	JANIS targets (for forests)
Extinct	Rehabilitate, revegetate, and reserve	No specific target
Endangered	90% (preferably 100%) of remaining extent	100% of remaining extent
Vulnerable	60% of remaining extent, 90% in fragmented subregions	15% of pre-1750 extent or 60% of remaining extent (whichever is largest)
Depleted	60% of remaining extent, 90% in fragmented subregions	No specific target
Rare	90% (preferably 100%) of remaining extent	100% of remaining extent
Least concern	30% of remaining extent, 50% in fragmented subregions	15% of pre-1750 extent, except where other targets apply.
Coastal	100% of remaining extent within 500 metres of coastline	No specific target
Wilderness	No specific target	90% of remaining extent
Old-growth	No specific target	60%-100% of remaining extent, depending on rarity
All other	Not applicable	15% of pre-1750 extent

Notes: The status of ecological vegetation classes is as defined by the Department of Sustainability and Environment. The NCR reserve targets are slightly modified from those of the 2001 VNPA nature conservation review by Traill and Porter.

Table 3.21, Table 3.22 and Figure 3.17 show the extremely uneven and inadequate protection for biodiversity (represented by subregional ecological vegetation classes) in Victoria's national park and conservation system. The least protected subregions typically have the highest proportions of vegetation loss, endangered ecological vegetation classes and unrepresented ecological vegetation classes (Table 3.21). They typically also have a high proportion of land in private ownership and high diversity (as represented by numbers of ecological vegetation classes). Eleven subregions have less than a quarter of remnant vegetation protected in the national park and conservation system, eight of which have had more than half their native vegetation cleared and nine of which have more than a quarter of their ecological vegetation classes endangered. The converse is also true: the least cleared subregions have the highest level of protection in the national park and conservation system and the fewest endangered ecological vegetation classes.

Only four of Victoria's 28 subregions have a high level of protection with at least three-quarters of their ecological vegetation classes achieving the NCR reserve target (the subregions marked green in Table 3.22) and another two subregions have more than half their vegetation classes meeting the NCR target (marked a paler green). But in more than three-quarters of subregions fewer than half the ecological vegetation classes meet the NCR target (subregions marked orange or pale orange). Overall, less than a third of subregional ecological vegetation classes meet either the NCR reserve targets or the JANIS targets (Table 3.22).

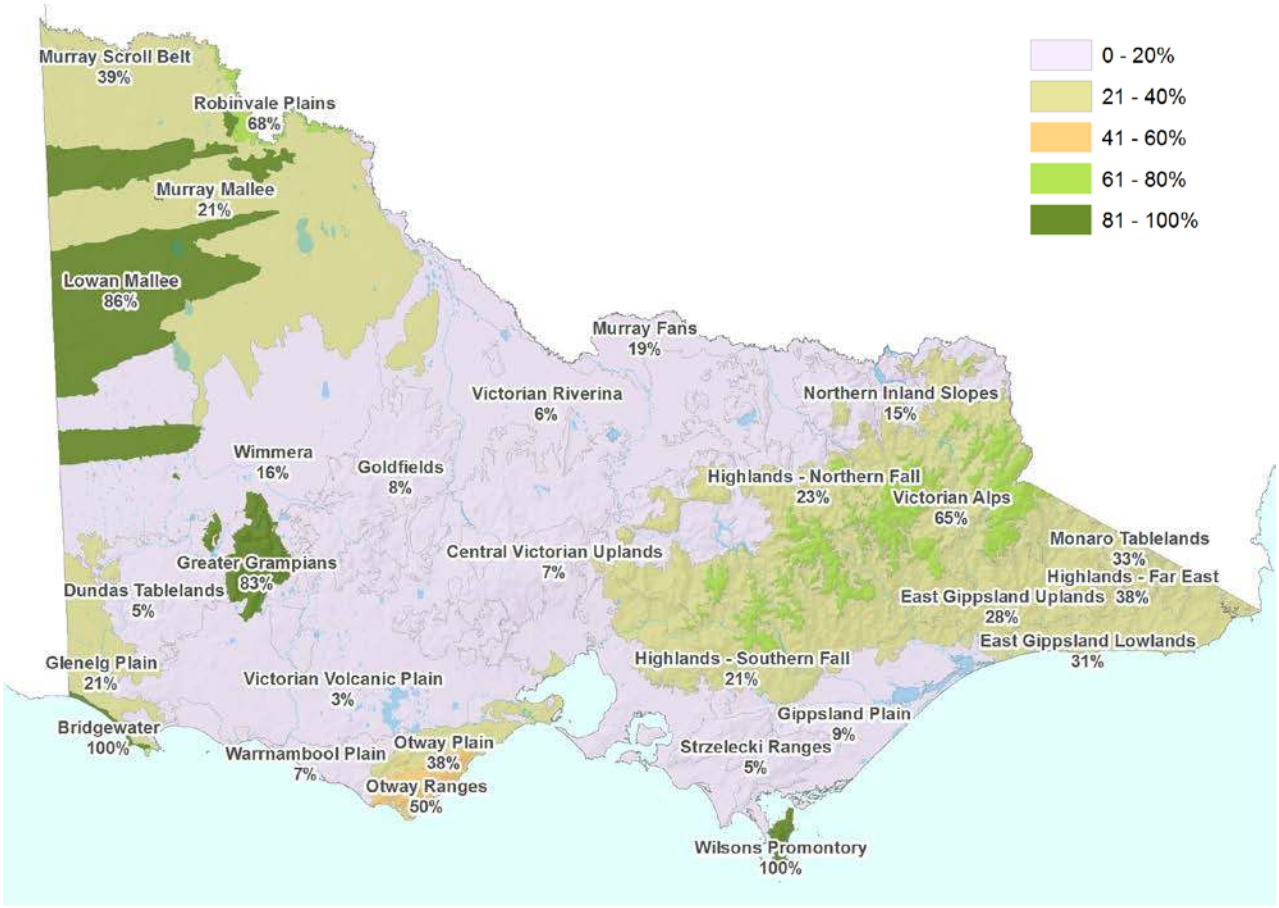
Only two of Victoria's 21 vegetation types (groups of ecological vegetation classes have more than half their ecological vegetation classes meeting the NCR reserve targets (Table 3.23). The seven least protected types, with less than a quarter of ecological vegetation classes meeting the NCR targets, are those that have been most heavily targeted for agriculture. Victoria's four most threatened vegetation types, with 15% or less of their original extent remaining, have less than one third of their remaining extent protected in the national park and conservation system (Table 3.24).

The gap analysis shows the importance of private land conservation. The five subregions with the lowest proportion of native vegetation have more than two-thirds of their area in private land tenure and in four of them more than a third of ecological vegetation classes are endangered (Table 3.21). Of the 50% of Victoria's subregions that are more than 50% privately owned, all but one have lost more than 50% of their native vegetation and all but one have less than 50% of their remnant vegetation protected.

In some categories, the NCR reserve targets are more demanding than the JANIS targets (which are now more than 15 years old) but, even so, a similar pattern applies for the JANIS targets, with only nine subregions having more than half their ecological vegetation classes meeting the targets (one fully) (Table 3.22). Other analyses also show that Victoria's national park and conservation system has substantial gaps. A WWF-Australia analysis based on the JANIS criteria (with a

target of 15% of the pre-1750 extent of 'major vegetation groups' at a subregional scale) found that only 58% of the target area in Victoria was protected in the national park estate, with a gap of 1.4 million hectares.[115] In addition, only 30% of nationally threatened species had at least 30% of their distribution in the national park estate. Another gap analysis of Victoria's protected area in 2012 using a range of environmental variables that influence the distribution and abundance of many terrestrial species and ecosystems (rainfall, temperature, solar radiation, terrain wetness and radiometry) found that many environmental classes had little or no representation.[116] Thus, by multiple interpretations of what is needed to achieve a comprehensive, adequate and representative reserve system – including by targets adopted by the state government – it is clear that Victoria's national park and conservation system needs to expand, on both public and private land tenures (section 3.5.1).

Figure 3.17 The proportion of ecological vegetation classes in Victorian subregions that meet the nature conservation review reserve targets



Map & analysis: VNPA (See Table 3.21 for method). Data source: Department of Environment and Primary Industries.

Table 3.21 Victorian subregions: remnant vegetation, public tenure, vegetation protection, ecological vegetation classes (EVCs) and representation in the national park and conservation system

Bioregion	Protected (%)	Subregion	Public tenure (%)	Remnant vegetation (%)	Remnant vegetation protected (%)	EVCs (#)	Endangered EVCs (# / %)	EVCs with no protection (%)[3]
Australian Alps	50	Victorian Alps	99	100	50	48	6 / 12	2
Flinders	100	Wilsons Promontory	100	100	100	34	2 / 6	0
Murray Darling Depression	23	Lowan Mallee	80	85	79	35	8 / 23	3
		Murray Mallee	21	25	63	46	9 / 20	11
		Wimmera	7	17	15	135	60 / 44	19
Naracoorte Coastal Plain	14	Bridgewater	58	72	77	13	4 / 31	15
		Glenelg Plain	42	47	27	88	36 / 41	27
SW Slopes[1]	11	Northern Inland Slopes	24	47	23	70	42 / 60	35
Riverina	6	Murray Fans	22	40	12	127	35 / 28	22
		Murray Scroll Belt	50	91	54	21	2 / 10	5
		Robinvale Plains	76	88	69	29	4 / 14	7
		Victorian Riverina	6	22	8	125	62 / 50	38
South East Coastal Plain	9	Gippsland Plain	19	27	32	124	60 /48	24
		Otway Plain	30	36	37	50	21 / 42	12
		Warrnambool Plain	7	17	35	44	27 / 61	36
South East Corner	27	East Gippsland Lowlands	79	88	26	50	12 / 24	30
		East Gippsland Uplands	83	93	32	52	7 / 13	23
		Highlands – Far East	100	100	28	18	0 / 0	18
South Eastern Highlands	21	Highlands – Northern Fall	78	86	23	60	15 / 25	19
		Highlands – Southern Fall	76	87	27	72	18 / 25	18
		Monaro Tablelands	56	78	23	17	0 / 0	12
		Otway Ranges	70	84	61	27	9 / 33	8
		Strzelecki Ranges	19	31	7	30	17 / 57	18
Victorian Midlands	12	Central Victorian Uplands	22	46	14	93	44 / 47	40
		Dundas Tablelands	9	28	5	104	54 / 52	36
		Goldfields	26	54	19	74	39 / 53	48
		Greater Grampians	81	92	84	212	26 / 12	11
VVP[2]	1	Victorian Volcanic Plain	30	12	10	127	84 / 66	38

0-25%	26-50%	51-75%	76-100%

In public tenure, remnant vegetation, remnant vegetation protected, percentile for number of EVCs, percentile for number of endangered EVCs, percentile for % unrepresented ecosystems.

Notes: [1] NSW South Western Slopes. [2] Victorian Volcanic Plain. [3] No protection was defined as those with <1 hectare in protected areas as defined in methods. Methods: VNPA applied the NCR reserve targets to the EVC dataset supplied by the Department of Environment and Primary Industries (DEPI) (last updated March 2008) and as updated by Trust for Nature in 2011 to include Trust for nature covenants and reserves. Areas were considered 'protected' if they were designated as 'conservation reserve' by DEPI or protected by a Trust for Nature covenant or reserve. The NCR reserve targets were based on the criteria in Table 3.20. The conservation status of each EVC was based on the status assigned by DEPI in the EVC dataset. A fragmented subregion is defined as one that has less than 35% of its vegetation remaining. EVCs that are minor occurrences in a subregion were excluded from the analysis. A minor occurrence was defined as those subregional EVCs for which the pre-European extent in the subregion was less than 1% of the statewide extent of that class and less than 1000 hectares. EVC mosiacs, complexes, aggregates and wetland map units were included in the analysis since a conservation status was ascribed. Due to a lack of data it has not been possible to apply the targets comprehensively to freshwater systems or to the coastal zone. The analysis also does not take into account the spatial arrangement of reserves, the need to protect core habitats, corridors and isolated remnants, the specific needs of species and requirements for climate change adaptation.

Table 3.22 The extent to which Victoria's national park and conservation system meets the NCR reserve targets and JANIS targets for each subregion

Subregion	Remnant vegetation protected (%)	EVCs meeting NCR targets (%)	EVCs meeting JANIS targets (%)	Subregion	Remnant vegetation protected (%)	EVCs meeting NCR targets (%)	EVCs meeting JANIS targets (%)
Victorian Volcanic Plain	10	3	6	Highlands – Northern Fall	23	23	32
Strzelecki Ranges	7	5	17	East Gippsland Uplands	32	28	37
Dundas Tablelands	5	5	12	East Gippsland Lowlands	26	31	32
Victorian Riverina	8	6	10	Monaro Tablelands	23	33	59
Warrnambool Plain	35	7	16	Highlands – Far East	28	38	44
Central Victorian Uplands	14	7	11	Otway Plain	37	38	38
Goldfields	19	8	11	Murray Scroll Belt	54	39	57
Gippsland Plain	32	9	15	Otway Ranges	61	50	67
Northern Inland Slopes	23	15	11	Victorian Alps	50	65	60
Wimmera	15	16	20	Robinvale Plains	69	68	72
Murray Fans	12	19	28	Greater Grampians	84	83	78
Glenelg Plain	27	21	26	Lowan Mallee	79	86	71
Highlands – Southern Fall	27	21	31	Bridgewater	77	100	62
Murray Mallee	63	21	41	Wilsons Promontory	100	100	100
Statewide						29	32

0-25% 26-50% 51-75% 76-100%

Source: VNPA analysis of data from Department of Environment and Primary Industries (protection on public land) and Trust for Nature (protection on private land). See Table 3.21 notes for method.

Table 3.23 The extent of protection of ecological vegetation class (EVC) groups

EVC group	EVCs (#)	EVCs meeting NCR targets (%)	EVC group	EVCs (#)	EVCs meeting NCR targets (%)
Plains woodlands or forests	137	6	Coastal scrubs grasslands and woodlands	53	38
Plains grasslands and chenopod shrublands	22	14	Heathy woodlands	71	41
Rainforests	28	18	Salt-tolerant and/or succulent shrublands	29	41
Riverine grassy woodlands or forests	165	18	Mallee	29	45
Riparian forests or woodlands	37	19	Montane grasslands, shrublands or woodlands	22	45
Riparian scrubs or swampy scrubs and woodlands	113	20	Lowland forests	35	46
Box ironbark forests or dry/lower fertility woodlands	22	23	Wet or damp forests	45	49
Wetlands	185	28	Sub-alpine grasslands, shrublands or woodlands	16	50
Lower slopes or hills woodlands	82	28	Rocky outcrop or escarpment scrubs	47	53
Herb-rich woodlands	95	28	Heathlands	70	54
Dry forests	132	34	**Total**	**1435**	**29**

0-25% 26-50% 51-75% 76-100%

Source: VNPA analysis of data from Department of Environment and Primary Industries (protection on public land) and Trust for Nature (protection on private land).

Table 3.24 The extent of protection for Victoria's most threatened vegetation types

Ecological vegetation class group	Remaining pre-1750 extent (%)	Protected (%)	EVCs that meet NCR targets (%)
Plains grasslands and chenopod shrublands	6	18	14
Plains woodlands or forests	7	19	6
Lower slopes or hills woodlands	11	19	28
Herb-rich woodlands	15	26	28

Source: VNPA analysis of data from the Department of Environment and Primary Industries (protection on public land) and Trust for Nature (protection on private land).

3.4 Major threats

Victoria's terrestrial ecosystems suffer from a multitude of human-driven extinction processes. Listed under the Flora and Fauna Guarantee Act, for example, are about 30 'potentially threatening processes' affecting terrestrial habitats, ranging from the very specific, such as collection of native orchids and disturbance from marble mining, to the very broad, such as climate change.

Following is a focus on the four major threats or threat categories: climate change, habitat loss and degradation, invasive species and inappropriate fire regimes. They are each pervasive, affecting virtually all Victoria's habitats to some degree, and have multiple, complex and interacting (often synergistic) impacts on biodiversity.

Protection of assets will not be effective unless the ecological processes that sustain them are maintained.

Andrew Bennett and others, 2009[117]

As well as directly affecting specific sites and species ('assets'), these threats disrupt natural ecological processes, thereby compromising 'the interactions and connections between living and non-living systems' (or more colloquially, 'the natural machinery that connects living and non-living things and keeps nature healthy').[118] Table 3.25 lists seven categories of ecological processes with examples of processes and the ways they are disrupted by these and other threats.

Table 3.25 Categories and examples of ecological processes and process-disrupting threats[119]

Ecological processes category	Examples of ecological processes	Threats that disrupt natural ecological processes	Examples of priority actions
Climate	Natural patterns of rainfall, temperature and extreme events	Climate changes exceeding the capacity of organisms to adapt, increasing frequency of severe fire weather	Protect natural carbon sinks, promote resilience and adaption (chapter 5)
Primary productivity	Water, nutrient and soil cycles	Clearing, agriculture, weed invasion	Stop clearing, promote natural regeneration, restore riparian zones, control weeds
Hydrological processes (chapter 4)	Stream flows and connections between surface and groundwater flows, flood events that carry water across floodplains	Dams and other barriers to stream flow, clearing, altered soil conditions affecting runoff, pollution, coal seam gas extraction	Deliver environmental flows, reinstate natural flooding regimes
Formation of biophysical habitats	Soil crust formation, accumulation of leaf litter, decomposition of organic matter, soil turnover due to animal digging	Soil compaction, erosion, salinity, loss of animal diggers	Protect and restore native vegetation, retain woody debris and litter, restore populations of native digging animals
Interactions between organisms	Pollination, seed dispersal, predation, competition, parasitism	Invasive species, loss of pollinators, decline in top predators	Manage invasive weeds, animals and diseases, restore populations of top predators
Movements of organisms	Seasonal migrations, searches for food and shelter, dispersal of propagules	Fragmentation, barriers (fences and roads), droughts	Restore aquatic-terrestrial links, remove barriers to movement, link isolated vegetation remnants
Natural disturbance regimes	Patterns of fire, floods, droughts, storms, extreme temperatures	Altered fire regimes and increases in extreme events due to climate change	Implement ecologically appropriate fire regimes

3.4.1 Climate change

Climate change will lead to most places in Australia having, by 2070, environments that are more ecologically different from current conditions than they are similar.

Mike Dunlop and others, 2012[120]

Like the rest of the world, Victoria has been heating up: in the past century the state's average annual mean temperature has increased by 0.9°C.[121] Some of the most severe impacts of climate change are being manifested in more extreme or more frequent weather extremes, as exemplified by recent heatwaves:[122]

- In the last week of January 2009, record high temperatures were set at several places, along with an unprecedented three days above 43.0°C in Melbourne.
- On 7 February 2009, Victoria recorded its hottest ever temperature of 48.8°C at Hopetoun (1.6°C above the state's previous record). Of the 35 long-term temperature-recording stations in Victoria, 24 recorded their hottest temperature that day.
- On 29 November 2012, Victoria recorded its highest spring temperature on record (45.8 °C at Ouyen) and it was the hottest November day on record over a third of the state.
- Victoria had its warmest winter on record in 2013.
- In January 2014, Victoria had its hottest four-day period on record for maximum and daily mean temperatures. The statewide average maximum temperature exceeded 41°C on four successive days from 14 to 17 January, another record.

Figure 3.18 Trends in maximum (left) and mean (right)temperatures, 1910-2013[123]

Source: Bureau of Meteorology, Australian climate variability and change trend maps

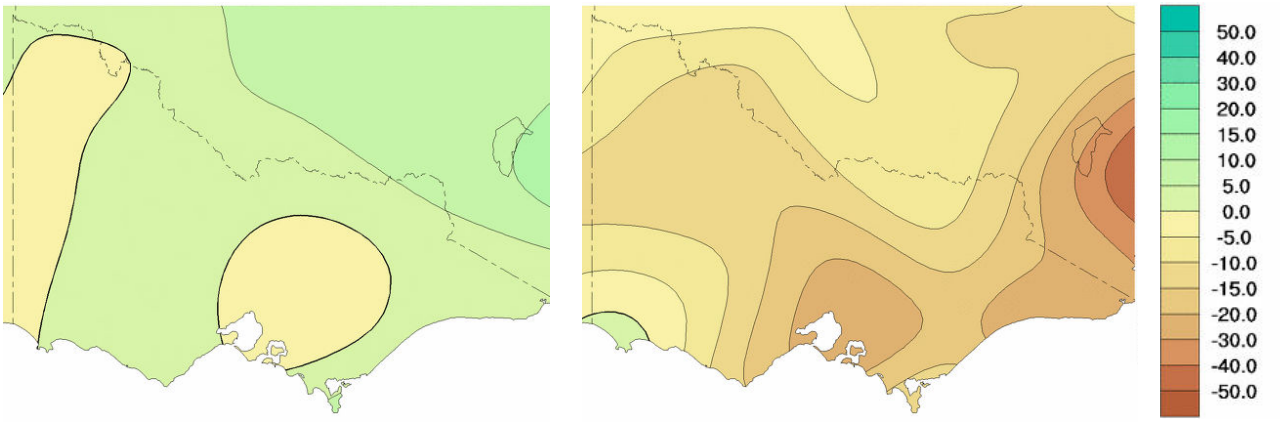
Victoria's rainfall has experienced large yearly and decadal variations over the past century, and there have been no clear trends. During the 1997–2010 drought, the longest and worst on record for south-eastern Australia, Victoria's average rainfall declined by about 15%. By 2009, stream-flow volumes in Victoria were 32% of the long-term average, and the total water storage for Victoria by mid-2009 was 17% of capacity. The drought ended with the fifth wettest year on record, when rainfall was 31% above average.

The drought was associated with higher fire danger, with unprecedented fire risks in several places in February 2009, due to a combination of record high temperatures, very low relative humidity, high wind speeds and a lack of rain. The Black Saturday bushfires burnt 430,000 hectares and killed 173 people. Fire danger and the length of the fire season have increased in Victoria in recent decades.[124]

South-Eastern Australian Climate Initiative researchers have found a strong relationship between climate change and the millenium drought, via the influence of a high pressure belt known as the subtropical ridge, which is strengthened by warmer temperatures. The strengthening of the subtropical ridge accounted for an estimated 80% of the recent rainfall decline in south-eastern Australia. [125]

It is predicted that Victoria's mean temperature will rise by 1.4°C by 2050 (under a mixed fossil and renewable fuels scenario), within a range of 0.9°C to 1.9°C.[126] The rainfall trend is less predictable, but the state is likely to become drier while extreme events (intense bursts of rainfall and heatwaves) become more common. The most likely change by 2050 is a 6% reduction in mean rainfall (under a mixed fossil and renewable fuels scenario). The extent and frequency of droughts may more than double by 2050.[127] Bushfire vulnerability will increase.

Figure 3.19 Rainfall trends in Victoria, 1900-2013 (left) and 1960-2013 (right)[128]



Source: Bureau of Meteorology, Australian climate variability and change trend maps. Rainfall trends as a change in millimetres per decade. Brown indicates a drying trend and green indicates a wetting trend.

Box 3.5 Impacts of climate change on biodiversity[129]

Primary impacts: Habitat for particular species is rendered unsuitable due to changes and extremes in temperature, rainfall, soil or air moisture levels, availability of free water, hydrology, wind and seasonal conditions.

Secondary impacts: Changes in fire regimes (particularly high intensity megafires), increased flooding, waterlogging and erosion, sea-level rises, and changes in competition from other species, including exotic species and overabundant native species.

Tertiary impacts: Resulting from human responses to climate change, eg shift of intensive agriculture into new areas, increased fire hazard reduction activities, development and introduction of 'climate change adapted' plants and animals including biofuels.

The different processes of ecological change, each driven by climate change, will combine to make prediction about the details of change and likely loss of biodiversity very difficult.

Michael Dunlop and others, 2012[130]

Predicting the consequences of human-caused climate changes is a great ecological challenge for they will involve changes in 'species distributions and abundances, interactions between species, ecological processes, threats to biodiversity, the rates of ecological change, and the role of habitat and landscape diversity in mediating changes'.[131] Changing land use by humans will add to the complexity.132 Most Australian species have endured great climatic swings over the past few million years, but in many respects future climatic changes will be unlike any previous because of the extensive loss and fragmentation of habitat, the presence of exotic species, and human domination of many resources (all at their extreme in Victoria).

A 2008 national assessment of climate change impacts on the National Reserve System cautions that people 'run the risk developing one simple mental model of what changes will occur based on a single type of impact, and using that implicitly to drive expectations and proposed management actions'.[133] The researchers described three models of change for populations, all of which will occur to varying degrees. All three models 'should be regarded as equally important for the purposes of designing monitoring

programs, interpreting observed changes, anticipating future changes, assessing conservation implications and considering management options'.

Changes in abundance: Under this model, climate change will result in changes to ecosystem structure and function and species abundance. Dramatic changes could result – restriction of fire-sensitive species to fire refuges, increases in sleeper populations of invasive species and replacement of dominant species. Outcomes will be the result of many interacting factors and hard to predict.

Long-distance or rapid distribution change: Under this model, changes lead to opportunities for a small proportion of species to establish beyond their current distributions – for example if higer carbon dioxide levels increase their competitive ability or if reduced frost and snow open up new habitat or if they are dispersed by more extreme floods or storms. This could have dramatic impacts on ecosystems if the newly establishing species have a major impact on other species or ecosystem structure or function, such as some invasive species have had.

Gradual distribution shift: Under this model, species gradually change their distribution, in different directions and at varying rates – some expand, others contract, some disappear and others don't change. Ecosystem composition, structure and function also gradually change, with novel ecosystems forming and some current ones disappearing.

Climate change is already affecting biodiversity due to higher temperatures, drier conditions and more frequent extreme events (although the degree of contribution by climate change to specific events is difficult to say).[134] At particular risk in the near term are alpine, moist and coastal habitats. Species with low ecological tolerances and specialised requirements, low genetic variability, long generation times, poor dispersal ability and narrow geographic range are likely to have the greatest difficulties adapting to climate change.[135] Other species will benefit and become more abundant, some adding to threats faced by others if they are predators, competitors, pathogens or parasites (Box 3.7).[136] Because of the complex changes that will result, climate change will undoubtedly produce 'surprises and nasty synergies'.[137] Other threats – particularly altered fire regimes, invasive species, altered hydrology and changing land use – are likely to be amplified under climate change. There has already been a reported shift in land use from sheep grazing to dryland cropping in south-west Victoria due to drier conditions, and conversions of now rarely inundated wetlands to crops or exotic pastures.[138]

Box 3.6 Interactions of habitat loss and a changing climate – collapsing bird populations[139]

The climatic conditions expected under rapid climate change render [bird] populations even less resilient to land-use change than previously thought. … The urgency and magnitude of remedial action required are many-fold greater than current practice.

Ralph Mac Nally and others, 2009

Bird surveys in central Victoria (over 15 years to 2008) have revealed major declines in about two-thirds of bird species. The 30,000 km^2 area retains only 17% of its original vegetation cover of mostly box and ironbark forests and woodlands. The decline was similar in largely intact native vegetation (including in national parks) and in heavily cleared landscapes, and occurred for all types of birds. There was almost no breeding detected in the last survey period and eucalypt flowering had significantly declined over 12 years of drought. The collapses are thought to be due to a crash in availability of all types of food due to drought exacerbating losses due to past clearing and ongoing habitat degradation. Most remnant vegetation is on sites with shallow, infertile soils. On the better soils of the plains, remnant vegetation is scarce and highly fragmented.

Enhancing resilience of birds in the box and ironbark system in the face of climate change will require improving habitat quality in remnant forest, retaining large old trees, protecting fallen timber from firewood harvesting and recreating spatial patchiness in ground layers. The greatest gain will come from restoring more fertile areas, where tree growth is faster and warm-season flowering species will provide more year-round food resources.

3.4.2 Dysfunction of biological interactions – invasive species

[The] most widespread mammals and vascular plants in the state are all non-natives.

Viridians Biological Databases[140]

The cornucopia of exotic plants and animals inhabiting Victoria cause immense damage to terrestrial biodiversity and ecological processes, as reflected in the 17 listings of various invasive species as potentially threatening processes under the Flora and Fauna Guarantee Act, and as stressed also in the last two VNPA nature conservation reviews. In the 2001 review, Traill and Porter said: 'After direct destruction of habitat, existing environmental weeds and feral animals are probably the current most important cause of habitat loss and degradation in Victoria. In the long-term they may become the most important cause.'

Many of Victoria's most widespread species are exotic, most deliberately introduced for agriculture and gardens. A smaller proportion are accidental introductions, arriving with traded goods. Most still have much potential to spread and increase, and new species keep arriving, which means invasive species' impacts will worsen unless laws, policies and programs are greatly strengthened. Information about their extent and impacts is patchy and particularly sparse for groups like invertebrates, microbes and fungi.[141]

Invasive plants

Of about 1000 exotic plants established in native vegetation in Victoria, about 580 are known to threaten biodiversity, landscape or social values, 129 seriously so.[142] Environmental weeds in general, as well as each of blackberry, tall wheat grass and *Spartina*, are listed as potentially threatening processes. The days of irresponsible introductions haven't passed – new agricultural plants are being bred to be more drought-resistant and tolerant of low nutrients, for example, and there are almost no restrictions to prevent introductions of new plants known to be weedy elsewhere in Australia.[143] From 1970 to 1995, an average of more than seven new plants (mostly garden escapees) established in the wild in Victoria each year, and the rate was increasing.[144]

Weeds cause major damage by:[145]

- outcompeting or shading out other plants and creating weed monocultures (eg invasive pasture grasses, blackberry, willows)
- intensifying fire regimes by adding flammable biomass (eg gorse and large grasses like phalaris)
- swamping waterways with dense plant mass, depleting oxygen (eg *Sagittaria* species and alligator weed)
- transforming ecosystem processes (eg willows alter stream hydrology and marram grass alters sand dune dynamics)
- providing havens for damaging invasive animals (eg blackberry and gorse shelter rabbits and foxes)
- hybridising with native plant species.

Severe weeds like blackberry, English broom, phalaris and tall wheat grass can completely transform ecosystems by replacing almost all native plants.[146]

Invasive animals

At least a dozen invasive animals rate amongst Victoria's most serious threats. Cats and foxes have contributed to several extinctions and threaten many more: foxes are known to threaten 91 Victorian vertebrate species and cats at least 27.[147] Large hard-hoofed creatures – feral goats, horses and deer among them – are causing widespread degradation and loss of rare plants. Rabbits, another major cause of degradation, are on the increase. Invertebrates like feral European honeybees, European wasps, English wasps, Argentine ants and unknown numbers of others are competing with native animals and compromising ecological processes such as pollination in mostly undocumented ways. A new amphibian – the smooth newt – was recently found in Melbourne's south-eastern suburbs and may pose a serious threat to aquatic biodiversity.[148] Argentine ants, feral cats, foxes, rabbits, sambar, horses and goats are each listed as potentially threatening processes. The impacts of invasive animals are too variable to list. For feral deer alone, which are accorded protected status under the Wildlife Act for the benefit of hunters, impacts include the following:[149]

- damaging and eating rare plants (due to browsing, grazing or antler rubbing)
- altering the structure and composition of vegetation communities

- disrupting ecological processes, especially in rainforest
- facilitating access for introduced predators by creating paths in dense vegetation
- competing with native herbivores
- causing erosion, which affects water quality
- trampling sensitive areas (such as alpine bogs, mossbeds, wetlands)
- spreading weeds
- hindering revegetation efforts
- maintaining elevated populations of wild dogs (which feed on carcases dumped by hunters).

Invasive pathogens

Invasive pathogens of native plants and animals are an alarming and escalating threat. *Phytophthora cinnamomi* (a water mould) infects a wide variety of native plants and could occur over 60% of Victoria.[150] Many habitats of threatened plant species are in areas classified as high risk. So far, *Phytophthora* dieback has been concentrated in ash and stringybark trees in coastal forest in east and south Gippsland. Heathlands and coastal forest communities are particularly susceptible. Infections can dramatically alter species composition and vegetation structure. Myrtle rust, which arrived in Victoria in 2011, infects plants from family Myrtaceae, the dominant plant family in Victoria (and Australia) that includes eucalypts, paperbarks and teatrees.[151] It could substantially alter composition and structure of some plant communities and threaten highly susceptible species. Several new plant pathogenic fungi establish each year in Australia.[152]

Of animal diseases, chytrid fungus is the most severe (probably responsible for the greatest disease-caused loss of global biodiversity in recorded history), lethally infecting several Victorian frog species in montane and foothill forests (see section 4.4).[153] It is listed as a potentially threatening process. Pigeon paramyxovirus, which arrived in 2012 (probably via smuggled racing pigeon eggs), could infect several bird species but its potential impacts are unknown.

Much of the damage caused by invasive species is synergistic with other threats such as habitat fragmentation and degradation, inappropriate fire regimes and climate change. Three invertebrate invaders likely to affect alpine and subalpine ecosystems have recently been recorded for the first time above 1500 metres in the Victorian Alps – European honey bees, grey field slugs and European wasps – exemplifying one of the greatest threats to alpine habitats under climate change.[154]

Harmful native species

Several native species have also become invasive or threats to other wildlife, when introduced outside their natural range or because they benefit from human-caused changes such as altered habitats, altered fire regimes and soil disturbance. Coast tea-tree, coast wattle and sweet pittosporum (the last listed as a potentially threatening process) are three examples of native plants that threaten rare vegetation communities in Victoria. Landscape changes now favour native noisy and yellow-throated miners, which tend to monopolise habitats at great cost to many other species (Box 3.7).[155] Most remaining box woodlands in northern Victoria are thought to be dominated by noisy miners, which are listed as a potentially threatening process. Disturbances such as logging and thinning are thought to have significantly increased the incidence of myrtle wilt, a fungal disease that kills mature myrtle beech trees in cool temperate rainforests.[156] It has reached epidemic levels only in the past 40 years, and is listed as a potentially threatening process.[157]

Box 3.7 Climate change and noisy miners

Changing interactions between species will be one of the most influential impacts of climate change. Noisy miners, a native honeyeater, have been recognised as a potentially threatening process in Victoria because they aggressively exclude other birds from their territory.[158] They are a major threat to woodland birds across eastern Australia. Noisy miners have benefited enormously from fragmentation of woodlands, and are likely to gain even more habitat under climate change due to more droughts killing trees. By excluding migratory and nomadic honeyeaters, which carry pollen large distances, noisy miners are also likely to undermine the capacity of eucalypts to adapt to climate change via cross-pollination.[159] Because eucalypt seeds don't disperse far, they rely on nectar-eating birds and bats to spread adaptive genes via their pollen. Protecting long range pollinators and managing noisy miner populations therefore should facilitate eucalypt adaption to climate change.[160]

3.4.3 Habitat loss and degradation

Continued degradation of remaining native vegetation is currently the major threat to Victoria's biodiversity.

Victorian Environmental Assessment Council, 2010[161]

Clearing, fragmentation and degradation

The clearing of more than half of Victoria's native vegetation cover has been the major cause of biodiversity decline. The losses have been compounded by their concentration on the most fertile and productive soils and the destruction of particular habitat elements such as tree hollows and logs.[162] The fragmentation (break-up of continuous habitat into patches), and degradation (gradual deterioration of quality) of what remains – 'a long-drawn-out version of clearing' – is now the greater threat.[163] About 40% of grassland remnants around western Melbourne were lost between 1985 and 2000 due to degradation through weed invasion.[164]

Patterns of loss have changed over time. From 1972 to 1987, an average 15,000 hectares or so of woody vegetation was cleared yearly, mostly for agriculture.[165] Rules introduced in 1989 (requiring a planning permit to clear native vegetation) slowed the clearing of woody vegetation to about 1600 hectares a year (estimated in 2005).[166] Grassland clearing during the same period was much greater, about 3000 hectares a year, mostly due to intensification of agriculture.[167] According to the habitat-hectares method, decline in habitat condition has accounted for nine times greater loss of habitat than clearing in recent years (but the clearing counted in the method did not include that under permit due to an assumption that it is compensated for by offsets or regeneration). The annual loss due to both clearing and degradation was estimated in 2008 at about 17,000 habitat-hectares a year.[168]

Most losses, of extent and condition, have been on private land. Victoria's 2013 state of the environment report concluded that losses of native vegetation on private land are most likely still exceeding gains (those due to revegetation and natural regeneration).[169] Recent drivers of loss have been urban expansion to accommodate population growth, agricultural intensification and clearing to reduce bushfire risk. Threats will be exacerbated by the recent weakening of vegetation laws (section 3.5.2). Peri-urban areas are at particular risk of further clearing, especially in the state's most heavily depleted bioregion, the Victorian Volcanic Plain, north and west of Melbourne, including endangered ecological communities.[170] Clearing for agriculture is due to the conversion of grazing lands to cropping, and the use of larger machinery and centre-pivot irrigation.

The extensive fragmentation of habitat in Victoria disrupts ecological processes (such as wildlife movement and seed dispersal), and increases exposure to other threats such as invasive species and changes in the microclimate (eg drying and exposure to wind). Some of Victoria's most valuable remnants are roadsides, road reserves and stream reserves, which are highly fragmented and vulnerable to degradation, including due to fuel reduction burning, ploughing to create firebreaks, invasive species, grazing, firewood collection and climate change.[171] Victoria's 2.4 million patches of native vegetation less than one hectare in size are at great risk.[172]

Forest exploitation – logging

In the past decade, some 40,000 to 50,000 hectares of native forest have been clearfelled, for production of about 10 million m3 of pulpwood and 5 million m3 of sawlogs.[173] Additional areas have been subject to 'thinning' or 'single tree selection' or post-fire salvage logging. Over the five years to mid-2012, 7900 to 11,600 hectares of state forest were logged each year, about half of it clearfelling of ash forests and including post-fire salvage logging on areas burnt in 2006–07 and 2009.[174] Logging also occurs to an unknown extent on the 1 million hectares of privately owned land with native forest.

Although considerably lower than historical rates, logging is occurring in forest ecosystems already much depleted by past logging and fires, affecting habitats for a growing number of threatened species and undermining ecological processes (such as fire regimes, hydrology and climate).

Clearfelling is highly destructive, with complete or partial clearing of coupes of up to 40 hectares, aggregated up to 120 hectares, following by burning

and aerial seeding. Direct impacts of clearfelling include loss of hollow-bearing trees and their dependent fauna (Box 3.8), and changes in plant composition such as depletion of epiphytic and some ground ferns and long-lived, slow-growing and slow-to-recruit species such as tree ferns and resprouting shrubs.[175] Vegetation changes have many flow-on impacts – for example, loss of tree ferns reduces foraging sites for mountain brushtail possums and other mammals, and old-growth forest remnants become isolated, reducing habitat availability for wide-ranging species such as sooty owls and yellow-bellied gliders, and fragmenting populations of animals such as mountain brushtail possums and greater gliders in these refugia.

Logging undermines the recruitment, decay and collapse of large old trees, a key ecological process in forests.[176] Large old mountain ashes are predicted to decline from 5.1 per hectare in 1997 to 0.6 by 2070.[177] Endangered Leadbeater's possums are on an extinction trajectory as they continue to lose this habitat from fire and logging (Box 3.15).[178]

Logging alters fire regimes and changes the way fires spread in the landscape. Research in moist forests around the world suggests that logging can increase susceptibility of young regenerating forests to burning: (1) large quantities of logging slash can sustain fires for longer than fuels in unlogged forest, (2) lightning strike ignition is more likely to occur in harvested stands where there are fine fuels of logging slash, and (3) the removal of trees creates microclimatic conditions that dry the understorey vegetation and forest floor.[179] Logging creates drier forests for at least some forest types in the short to medium term when damp ferny understoreys are converted to more flammable shrubs.[180]

There is a risk that large areas of mountain ash forests will disappear due to a 'landscape trap' resulting from the combined effects of wildfire, logging, and salvage logging. Young regrowth forest is more fire prone than old-growth forest, and the increased risk of severe repeat fires in young forest due to a drying climate, logging and previous fires 'decreases the probability that the landscape can return to its former mature state'.[181] If fires occur in intervals of less than 20-30 years, the period required for mountain ash trees to begin bearing seed, wattle and other species are likely to take over. The more widespread that young regenerated forest becomes, the greater is the risk for the spread of wildfire through landscapes. Although tens of thousands of hectares of mountain ash forest were burned in the 2009 fires, there has been no reduction in logging targets. 'This has ramped up pressure on the reduced available green (unburned) mountain ash forest, making over-cutting inevitable.' [182]

Conversion of mature forests to commercial forestry has climate change implications, resulting in a 40% loss of stored carbon (which also has an economic value) (Box 3.16).[183]

For several years, commercial native forest logging in Victoria has only occurred east of the Hume Highway (in Gippsland and the Central Highlands) but the Victorian government has recently re-opened Mount Cole State Forest (near Beaufort) to logging and signalled it may do so elsewhere in western Victoria.[184] Mt Cole has substantial conservation values that warrant protection in the national park estate (as a state park), as recommended by VNPA in 2010. Most of its ecological vegetation classes (87%) are under-represented in the national park and conservation system and it has already been over-logged.[185] Resumption of logging in western Victoria's highly fragmented and high conservation value forests is a major backward step for conservation.

It is preferable to focus commercial forestry on plantations, but plantations too can have detrimental environmental impacts unless they are established on already cleared land, use non-invasive species and are sited to limit their hydrological impacts on wetlands and native vegetation.[186] Hydrological impacts may be significant in the west and south-west of the state, where plantations are in close proximity to extensive wetland and groundwater-dependent systems.[187] Diverse plantings using local plant materials are likely to deliver greater biodiversity benefits than monocultures of non-local origin.

Box 3.8 Losses of big old trees

Victoria is losing big old trees – to logging, land clearing, agricultural intensification, fires and fire management, and concerns for human safety. On current trends, within 50 to 100 years southeastern Australia's grazing lands are likely to have no more than 1.3% of the historical densities of large old trees.[188] Many currently common birds and bats would decline because of their dependence on resources provided by farmland trees. The loss of old trees is a particularly grave threat to the many birds, mammals, reptiles and invertebrates that rely on tree hollows, which take 100 years or more to form.[189]

Long-term studies in Victoria's mountain ash forests, where cavities in large living and dead trees are critical nesting and denning sites for 40 species of native vertebrates, have revealed 'an ecosystem-wide large tree crisis'.[190] Hollows start to develop in mountain ash trees after 120 years but the large hollows essential for many birds and mammals usually take at least 190 years. Most of the large trees survive now in the less than 1.2% of mountain ash forest that is old-growth (less than 2000 hectares of a total forest area of 160,000 hectares). About 99% of the forest area is dominated by trees less than 75 years old, with scattered large trees that suffer high rates of mortality. These forests need at least another 50–120 years for development of habitat hollows.

Extensive young forest is 'susceptible to a feedback process between logging and fire', leading to an altered fire regime with more frequent and more severe fires. Forests burned less than 20–30 years after logging or a previous fire may be replaced by wattles or other vegetation.[191] Within the past century there have been five major and three substantial fires in the mountain ash forests. State government intentions to log more than 17,000 hectares over five years (2011 to 2016) will put 'considerable harvesting pressure on existing areas of unlogged and unburned 1939 regrowth forest'.[192] The ecological consequences of loss of large trees include lack of habitat for cavity-dependent animals, reduced levels of carbon storage and impaired ecosystem processes such as recruitment of large logs to the forest floor. Needed are continued protection of all remaining unlogged and unburned forest, continued exclusion of salvage logging in burnt old-growth forest, protection of much of the 40,000 hectares of remaining unburned areas of 1939 regrowth forest, exclusion of logging where there are large trees in forests of 1939 regrowth, exclusion of logging from areas likely to be fire refuges and avoidance of processes that increase fire risk (such as building new roads).

Forest exploitation – firewood collection

Also threatening forest biodiversity is excessive collection of firewood.[193] Victorians burn an estimated 600,000 cubic metres of wood each year, a volume comparable to the amount of wood harvested annually for woodchips (750,000 cubic metres in 2012-2013). About 14% of firewood is thought to come from public land – mostly state forests, forest parks and regional parks.[194] An additional amount due to illegal collection is likely to be 'considerable'.[195] Much of the rest comes from native forests in NSW or from Victorian private lands. The amount from public forests is likely to grow with the state government's removal in 2011 of a requirement for a licence for personal collection in state forests.

Firewood collectors are only supposed to take fallen wood, and not logs with hollows or those growing moss and fungi. But over the long term, the continual removal of fallen wood and the illegal removal of live and dead trees will deplete the numbers of old fallen logs, one of the critical habitat elements in forests.[196]

That extensive firewood collection is harmful to biodiversity is recognised by the listing of the loss of coarse woody debris (standing dead trees, stumps, dead branches, fallen trees, coarse roots and wood pieces) as a potentially threatening process under the Flora and Fauna Guarantee Act. Coarse woody debris is vital habitat for many plants, animals and microorganisms, and vital for ecological functions including nutrient cycling and energy flows, carbon storage, soil conditioning, moisture reservoirs and refugia from environmental extremes.

Nine state-listed and three nationally listed vegetation communities, about 60 threatened plant species and several animal species are likely to be detrimentally affected.[197] There may also be impacts due to soil disturbance and changed light regimes, for example encouragement of weeds. Nineteen Victorian bird species are considered to be threatened by firewood collection nationally. Brown treecreepers, for example, forage mostly amongst standing dead trees and logs and their densities are higher where fallen timber loads are high. In Victorian box-ironbark forests, bird numbers were nine times greater, and bird species

diversity three times greater, in areas containing piles of coarse woody debris than where it was lacking. About 10% of Australian reptiles use hollows either for shelter or for hunting for prey, including the endangered inland carpet python, which uses hollows in large logs and large trees in the 'firewood' regions of Victoria. Fallen wood often serves as fire refuges. Too little is known about the impacts of firewood collection on invertebrates, flora and cryptogams, and ecosystem processes such as nutrient, carbon and energy cycling.

Agriculture

Agriculture dominates the land area of Victoria (56%), centred on the most fertile soils, and consuming two thirds of allocated water. It has transformed the landscape and caused great damage through habitat destruction (removal of plants, woody debris, logs, rocks), introduction of invasive organisms, over-exploitation of rivers, drainage of wetlands, use of fertilisers and pesticides and various impacts of livestock on soils, water and vegetation.[198] While the days of broadscale clearing have gone, due to the conversion of most suitable land and vegetation regulations, agricultural use is intensifying in many areas: conversion to cropping, greater fertiliser use, pasture improvement (sowing exotic plants), rotational grazing and higher stocking rates.[199] The introduction of centre-pivot irrigation for broadacre cropping has driven losses of 'paddock trees' and small woodland patches.[200] (It requires removal of all trees within reach of the irrigation arm, which can be 600 metres long.) A study in the western Wimmera found large numbers of buloke paddock trees had been removed for irrigation between 1997 and 2005.[201]

Rural landscapes and agricultural practices have changed considerably over the past few decades and will continue to do so (chapter 1). There are now fewer and larger farms in Victoria, and production is intensifying and diversifying.[202] In some areas, traditional farms are increasingly being replaced by hobby farms, rural residential properties, weekenders and conservation properties.[203] Land within commuting distance of urban centres is being subdivided. Climate change is already driving change in agricultural production patterns, including movement of cropping into wetter areas. There is likely to be development of markets for new goods and services such as carbon sequestration plantings, soil carbon sequestration regimes and biofuels.[204] Other drivers of agricultural change will be increasing world demand for food, especially a demand for protein in large, rapidly developing countries such as China, and increasing competition for resources such as water.[205]

Restoration activity is increasing in agricultural districts, focused largely on tree planting. Restoring ecological processes, including recovering soil structure and biota, re-establishing native ground cover and restoring water flows, will require much more effort and expertise.

3.4.4 Changes to disturbance regimes – fire regimes

Failure to address the needs of biodiversity in fire management will potentially result in a drastic and permanent loss of biodiversity values in Victoria.

Ecology Australia, 2011[206]

Destructive fire regimes are a major threat for many species and habitats in Victoria.[207] This is especially true for fragmented or isolated ecosystems, where post-fire recolonisation by species can be impeded and invasion by weeds and feral animals exacerbated. Inappropriate fire regimes can radically change vegetation structure and distribution, reduce resources for particular species, and alter soil structure and chemistry (nutrient availability, pH, moisture) and water run-off. Current threats arise from a lack of fire management or poorly informed management (due to a lack of research on fire impacts on most organisms) or fire management that ignores ecological goals (eg Victoria's annual burning target of 5% of public land and frequent burning to protect assets).

Within any single locality there are species with vastly different fire sensitivities or requirements. Plants are much affected by the length of time between successive fires but favourable intervals differ between species. If the interval between fires is too short, some plants are not be able to mature and produce seeds to provide for post-fire generation, a problem for many heathland plants, but if the interval is too long, species

dependent on fire for regeneration may die out.[208] Some ecological communities such as grasslands or heathlands seem adapted to frequent burning but rainforests, many wetlands, Raak saline shrublands and inland woodlands dominated by she-oaks are highly sensitive to fire.[209]

Species vulnerable to inappropriate fire regimes include:

- rare species vulnerable to destruction or loss of habitat, eg mallee emu-wren, Leadbeater's possum
- animals vulnerable to predation after fire, eg small, ground-dwelling mammals
- plants sensitive to fire, eg many rainforest species and annual species unable to set seed
- aquatic species sensitive to sedimentation from erosion.

For invertebrates, there are vast numbers of species that could be affected 'combined with massive ignorance over the nature and consequences of those impacts'.[210] Many natural areas with value as refugia or reservoir habitats for invertebrates are susceptible to fire and tend to be ignored by fire planners because they are small or isolated fragments or in urban areas where public safety concerns increase pressure for planned fires. Fire impacts on fungi are also poorly understood, a substantial knowledge gap because of their diversity and importance in ecosystems as symbiotic partners, decomposers, nutrient cyclers and as a food resource for vertebrates and invertebrates.[211]

Lack of knowledge about appropriate regimes

Disturbance regimes (ie. the combination of frequency, duration, intensity and extent of disturbance) have greater long-term influence than single events.

Andrew Bennett and others, 2009

All fires are different, all species and habitats respond differently to fire, and responses vary over space and time.[212] It is the patterns of fire frequency, intensity and regularity across space and time – fire regimes – that shape ecosystems more than single fires. But there is scant knowledge of which regimes are beneficial for biodiversity. Fire responses have been documented over only short periods compared to the decades or centuries over which post-fire changes occur, and mostly over small areas.[213] A few vegetation communities such as heathlands and mountain ash forests have been well studied but, even for them, information on long-term impacts are limited.[214] With such limitations, 'generalisations and simplifications about relationships between disturbance regimes and biodiversity … should be treated as hypotheses to be tested.'[215]

A major limitation is that most ecological fire management is vegetation focused, based on some knowledge of how some plants, but not animals, respond to fire. Much has been assumed, with the dominant assumption being that 'if you look after the vegetation the fauna will be accommodated'.[216] But it is doubtful that the response of animals to fire parallels those of plants (Box 3.9).[217] The understanding that plant species will be lost from a community if fires are either too frequent or too infrequent has led to the calculation of 'tolerable fire intervals' for various plant communities as the basis for ecological fire management.[218] In Victoria, tolerable fire intervals are calculated using the vital attributes of a few fire-sensitive species ('key fire response species') within 32 broad vegetation communities.[219] However, this system relies on simplifications and assumptions which require testing, including that the plant focus provides for the needs of other species.[220]

The diversity of responses to fire has led to the general axiom that 'pyrodiversity begets biodiversity' but the extent to which it is true in Victoria and the types of regimes favouring particular habitats and species are as yet poorly understood. A recent finding that many mallee birds, including threatened species, prefer older vegetation – rather than a good mix of age classes – 'highlights the risk of a blanket application of the "pyrodiversity begets biodiversity" paradigm'.[221]

Box 3.9 Differences between fire responses of plants and animals[222]

Plants that have evolved in fire-prone ecosystems have different strategies for persisting at a site or recovering after fire:[223]

- 'Seeders' die when fully scorched but survive as seeds. Release of seed can be stimulated by the heat of fire and germination can be stimulated by smoke. *Callitris* species and some eucalypts store seed in woody fruits; some wattles store seed with thick coats in the in the soil; others such as mistletoes rely on seed from outside the burned area. Fire can threaten obligate seeders (plants that only produce seeds and do not resprout) such as ash eucalypts if it is too frequent to allow for maturation and seed release.
- 'Sprouters' regenerate after fire from below-ground tubers or from live tissue protected by bark.
- 'Fire ephemerals' are not visible at the time of fire but respond to it by germinating, growing, flowering and fruiting, mostly or entirely before the next fire.

Very few studies have examined the response of animals. Of 82 field-based studies in temperate Australia on vertebrate animals published up to 2009, half were focused on mammals and a quarter on birds, none dealt with the full range of groups, most looked at low-intensity planned fires, and none examined scale or patchiness as factors.[224]

Mobile animals may be able to avoid incineration, but may suffer increased predation due to lack of shelter or a shortage of food after fire. Less mobile animals may become temporarily extinct after fire and rely on recolonisation from another area – provided there are sufficient source populations within dispersing distance, and provided essential habitat features recover. In contrast to plants, some animals need to range over several habitat types with different fire histories to meet their daily or seasonal resource requirements.

There are four broad response types for vertebrate animals.[225]

- Species that quickly benefit from fire, mostly those that move into the burnt area and remain until resources that attracted them decline (eg flame robin and some raptors).
- Species that initially decline but then increase (eg New Holland mouse, marbled gecko, black wallaby).
- Species that show a long-term decline (eg scarlet robin, buff-rumped thornbill, spotted quail-thrush and red-necked wallaby). Fire often reduces the shrub layer, making favourable habitat for these species in the short term, but also promotes prolific regeneration of shrubs that renders habitat unsuitable after a few years.
- Species that decline immediately post-fire and do not recover for very long periods (eg black-eared miner, mallee emu-wren). Repeated burning could produce this response if the fire frequency does not allow the habitat to persist, or the fire intensity removes habitat elements that take a long time to be replaced (e.g. hollow-bearing trees).

Interactions with climate change and other threats

Fire threats are exacerbated by interactions with other threats – habitat fragmentation, invasive species and climate change. Fragmentation is a barrier to species recolonising isolated vegetation remnants destroyed by fire. Weeds can increase fuel loads (eg. pasture grasses such as Phalaris) and dominate after fire; and some animals become more vulnerable to invasive predators in burnt areas through loss of cover. It is predicted that climate change will increase fire frequency and intensity, and increase the risk of megafires.[226] The number of extreme fire danger days in southeastern Australia is projected to increase by 5-40% by 2020 and 15-230% by 2050.[227] Climate change is also likely to undermine post-fire regeneration due to lack of moisture, or increase post-fire erosion by extreme rainfall events.

A drying climate has recently generated fires at a frequency and scale hitherto unknown in Victoria, with close to 3.6 million hectares burnt in bushfires since 2001-02, most in three megafires:

- 2003 alpine fires: 1 million hectares
- 2007 Great Divide fires: 1.1 million hectares
- 2009 Black Saturday fires: 0.4 million hectares.

Megafires have a major impact, resulting in soil loss due to breakdown of soil structure and organic matter, loss of soil-stored seed-banks, loss of habitats, and inability of species to recolonise burnt areas. Major erosion resulting from heavy rainfall on exposed soil can have landscape-scale impacts, and seriously degrade waterways. The threat of megafires has led some authors to suggest 'spreading risk' by retaining some reserves in isolation from others to quarantine them from simultaneous destruction.[228]

3.5 Gaps and Priorities

3.5.1 Victoria's national park and conservation system

Priorities for expanding the national park and conservation system

The analysis in section 3.3 showed that Victoria has substantial gaps in its national park and conservation system, particularly of the vegetation communities most depleted by clearing and subject to degradation. Despite the state government's long-held goal to achieve a comprehensive, adequate and representative reserve system[229] and despite significant progress – mostly resulting from regional investigations by the Victorian Environmental Assessment Council and its predecessors – about three-quarters of Victoria's subregions remain poorly protected. Statewide, less than a third of subregional ecological vegetation classes meet the NCR reserve targets or the JANIS targets adopted by Australian governments for forest ecosystems (Table 3.22). This is consistent with other gap analyses as well (as described in section 3.3).

Table 3.26 shows the extent of native vegetation needing protection to meet the NCR reserve targets and the area available on public lands to potentially meet the targets. To achieve comprehensive, adequate and representative protection will require an additional area of 3.1 million hectares. This does not fully account for the need to protect wetlands, the coastal zone, and habitats for threatened species. About half of the additional area needed can potentially be achieved by upgrading the tenure of about 40% of vegetated public lands. However, in some of the least protected subregions, a substantial proportion of the additional area needed will have to come from private land, either secured by permanent conservation covenants or, for high priority areas, by buying land for the national park estate. Meeting the NCR reserve targets would increase the total land area protected to about 31% of Victoria.

Because of the large gaps in the national park and conservation system, coupled with escalating threats to nature, the Victorian government should commission a state-wide assessment by the Victorian Environmental Assessment Council to determine the most efficacious way for the state to achieve reserve targets. The investigation should prioritise the least protected subregions, and encompass public and private lands.

The Victorian Environmental Assessment Council has already identified six priority subregions for assessment – (a) Wimmera (south), Dundas Tablelands and Glenelg Plain, (b) Gippsland Plain and Strzelecki Ranges and (c) Central Victorian Uplands (Table 3.26).[230] These subregions have highly inadequate protection and suitable areas of public land (larger or intact blocks not already tightly committed to a specific use).

The analysis in Table 3.26 shows there are 12 high priority subregions for a public land investigation based on need (less than half the ecological vegetation classes meet the NCR reserve targets) and opportunity (there are substantial areas of public land potentially available). There are also 11 high priority subregions for protection on private land (half of them overlapping with public land priority subregions). These are subregions where there is insufficient public land to meet the NCR reserve targets. The priority subregions are mostly consistent with the 12 focal landscapes identified as priorities by the Trust for Nature (also shown in Table 3.26).

In a separate analysis (done in conjunction with this review and outlined in section 5.3), VNPA has identified five priority clusters for conservation action, which encompass or partly encompass 12 subregions. They were selected for their high-value intact vegetation, high biodiversity values and poor representation in the national park and conservation system. Recommendations for new protected areas in these priority clusters are shown in Table 3.27. They are mostly consistent with the priority recommendations for investigation proposed by the Victorian Environmental Assessment Council.

Conservation of some public lands can be improved by upgrading protection for some reserves under the Crown Land (Reserves) Act. These reserves, including those designated as nature conservation reserves, currently do not meet criteria for the national park and conservation system because there is no requirement to manage them to any particular standard and mining may be permitted. They should be transferred for protection under the National Parks Act, which provides a stronger statutory basis for conservation management and for preventing damaging activities.

Table 3.26 Priority subregions for expanding the national park and conservation system[231]

Subregional EVC status		Area (ha) needed to meet NCR targets[2]			Public land priorities		Private land priorities		
% EVCs not meeting NCR targets[1]		Total area (left), public land potentially available (middle), private land to make up the balance (right)			NCR protection priorities[3]	VEAC assessment priorities[4]	% EVCs needing >50% protection on private land[5]	NCR protection priorities[6]	Trust for Nature focal landscapes[7]
Victorian Volcanic Plain	97	182,619	35,573	218,192			86	High	SW, ORC, VM, WMRP, YCC
Strzelecki Ranges	95	88,495	36,341	52,154	High	Priority	74	High	GPGLC, PPW, SRP
Dundas Tablelands	95	156,551	37,888	118,663	High	Priority	62	High	SW, VM
Victorian Riverina	94	343,342	37,259	306,083	High		84	High	ER, NIS, WR
Warrnambool Plain	93	25,395	6,448	18,947			89	High	SW, ORC
Central Victorian Uplands	93	281,192	114,319	166,873	High	Priority	79	High	NIS, VM, WMRP, YCC
Goldfields	92	327,778	162,444	165,334	High	Recent investigation	76	High	VM
Gippsland Plain	91	181,204	58,195	123,009	High	Priority	75	High	GPGLC, PPW, WMRP, YCC
Northern Inland Slopes	85	124,513	49,249	75,264		Recent investigation	82	High	ER, NIS, WR
Wimmera	84	240,929	53,050	187,879	High	Priority (south of Little Desert)	76	High	SW, VM, WR
Murray Fans	81	109,736	50,279	59,456	High (implement)	Recent investigation	22		ER, NIS, WR
Glenelg Plain	79	69,513	52,548	16,965	High	Priority	40		SW
Highlands – Southern Fall	79	215,603	194,537	21,066	High		37		YCC
Murray Mallee	79	219,053	85,370	133,683			59	High	SW, MSB, WR
Highlands – Northern Fall	77	276,466	269,428	7,039	For review		33		NIS, YCC
East Gippsland Uplands	72	109,529	92,805	16,725	High		14		
East Gippsland Lowlands	69	104,271	102,280	1,991	High		16		
Monaro Tablelands	67	14,066	11,408	2658	High		33		
Highlands–Far East	62	4,610	4,610	0			0		
Otway Plain	62	26,736	15,022	11,714		Recent investigation	57	Medium	ORC, WMRP
Murray Scroll Belt	61	15,811	13,676	2,135			0		MSB
Otway Ranges	50	4,886	3,308	1,578			50	Medium	ORC
Victorian Alps	35	13,276	12,990	286			8		YCC
Robinvale Plains	32	3,971	2,878	1,093			14		
Greater Grampians	17	4,697	895	3,801			91		VM
Lowan Mallee	14	691	170	521			100		SW
Bridgewater	0	NA							SW
Wilsons Promontory	0	NA							
Totals		3,180,505	1,502,970	1,677,535			61%		

76-100% 51-75% Subregions with a high proportion of EVCs not meeting the NCR targets or with a high proportion of EVCs needing >50% protection on private land.

Notes for Table 3.26

(1) The percentage of ecological vegetation classes (EVCs) within each subregion that do not meet the NCR reserve targets as outlined in Table 3.22. Different colours identify the degree to which the targets are not met for each subregion.

(2) For each subregion, the top figure (uncoloured) is the total area of land required to meet the NRC reserve targets for all EVCs. The second figure (green background) is the area of public land available to meet the NCR targets for that subregion, based on public land within each EVC that is not already within the national park and conservation system. The third figure (orange background) is the area of private land required to reach the balance of the NCR reserve targets.

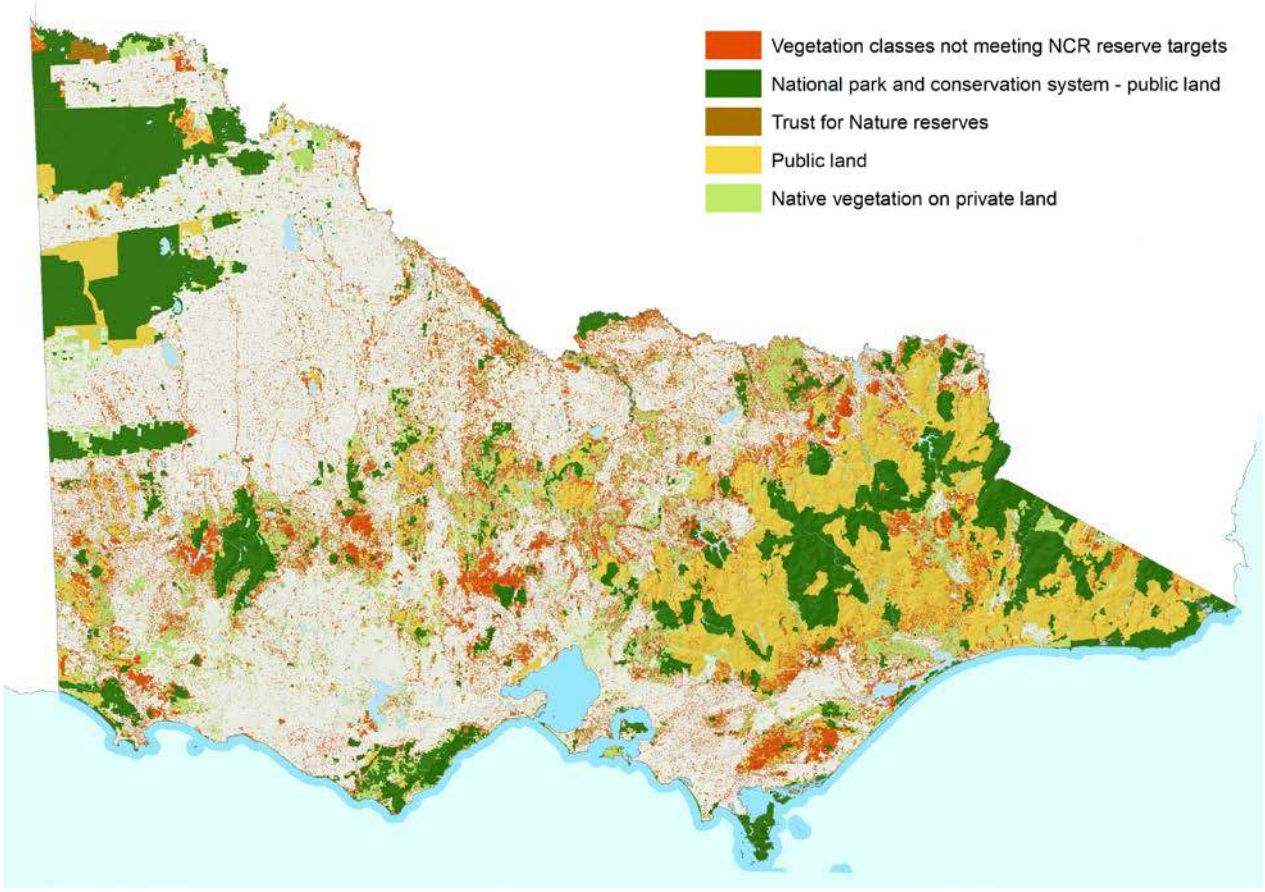
(3) Priorities for public land protection are subregions where less than 50% of EVCs meet the NCR reserve target and where there are substantial areas of public land available to help meet that target.

(4) The percentage of EVCs in each subregion that do not meet the NCR reserve targets and which will depend mainly on private land conservation to meet the NCR targets (ie. at least half of the area required to meet the NCR target will have to be on private land).

(5) High priorities for private land conservation are subregions where 0 to 25% of EVCs meet the NCR reserve targets and where at least 50% of EVCs needing protection will need to be conserved on private land. Medium priorities are those where 26 to 50% of EVCs meet the NCR reserve targets and at least 50% of EVCs needing protection will need to be conserved on private land.

(6) Trust for Nature focal landscapes: Eastern Riverina (ER); Gippsland Plain & Gippsland Lakes Catchment (GPGLC); Murray Scroll Belt (MSB); Northern Inland Slopes (NIS); Otway Ranges & Coast (ORC); Port Philip & Westernport (PPW); South-West (SW); Strzelecki Rangers & Plains (SRP); Victorian Midlands (VM); Western Melbourne Ranges & Plains (WMRP); Western Riverina (WR); Yarra–Cardinia Catchments (YCC).

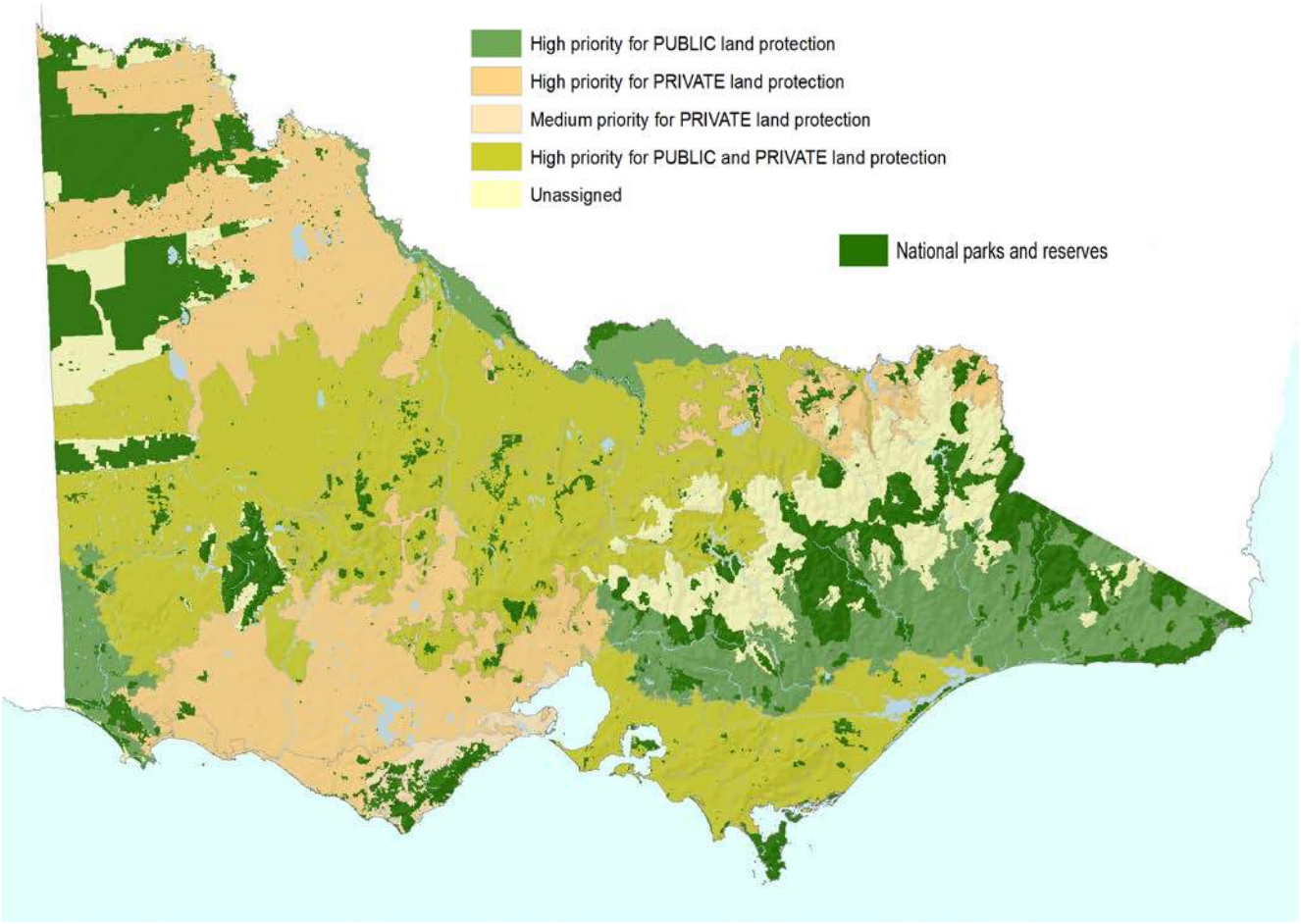
Figure 3.20 Location of ecological vegetation classes needing increased protection to meet the NCR reserve targets for a comprehensive, adequate and representative national park and conservation system



Map & data analysis: VNPA. Data sources: Department of Environment and Primary Industries, Trust for Nature.

Note: As explained in Table 3.21, the analysis on which this is based does not take into account the spatial arrangement of reserves, the need to protect core habitats, corridors and isolated remnants, the specific needs of species and requirements for climate change adaptation.

Figure 3.21 Priority subregions for improved protection to achieve the NCR reserve targets for a comprehensive, adequate and representative national park and conservation system



Map: VNPA. Based on analysis in Table 3.26 of priority subregions to achieve the NCR reserve targets.

Table 3.27 VNPA priority areas for expanding the national park and conservation system

Region	Proposal
Central Victoria	Protect 20 areas in small parks, recommended in VNPA's Small Parks report (**Error! Not a valid result for table.**).
Melbourne Metro & Catchments	Create a Great Forests National Park. Protect Wombat Forest (this is also in Central Victoria). Create a Western Melbourne grassland reserve and a network of smaller grassland reserves.
East Gippsland	Create new national parks from state forest areas.
South West Victoria	Create a Greater Glenelg National Park west of the Grampians between Princes Highway & Little Desert National Park.
South Gippsland & Strzelecki Ranges	Create new national parks from state forest areas.
Riverina	Create red gum parks as previously recommended by the Environmental Assessment Council – the Murray River park and the Leaghur-Koorangie, Loddon and Avoca River floodplains

Note: More details of VNPA's priority clusters are in section 5.4.

Box 3.10 Central Victorian small park proposals[232]

In a 2010 assessment, VNPA identified 20 public land sites in central Victoria (from Stawell in the west to Alexandra in the east) warranting greater conservation protection, most involving a tenure upgrade from state forest to state park or additions to existing national parks and reserves. The box and ironbark forests of central Victoria have suffered great losses and damage since European colonisation and much of the remaining public land exists in blocks of less than 20,000 hectares. Less than 10% of the ecological vegetation classes in the Goldfields and Central Victorian Uplands subregions meet the NCR reserve targets.

The process involved (1) nominations by environment groups and individuals of 61 sites thought worthy of improved management or protection, (2) assessment of natural values and threats for each site, (3) scoring and prioritisation by an expert panel resulting in the section of 20 sites, (4) on ground assessment of some sites and (5) tenure and management recommendations.

Of the 115,000 hectares of public land recommended for improved management, and tenure change in some cases, 111,000 hectares is state forest. Timber and firewood harvesting are a threat to some areas – including at Mt Cole, which is being re-opened to commercial logging – as are pests and weeds, uncontrolled recreation, and inappropriate fire regimes. The sites are proposed as the foundation for a large-scale biolink from the Grampians to the Alps (Figure 3.22).

Priorities for private protected areas

Because of the historical tendency to establish protected areas in 'leftover' areas – mostly rugged, dry or infertile areas not favoured for development – the most cleared subregions of Victoria generally have the smallest proportion of native vegetation in protected areas, the highest numbers of endangered vegetation communities and high rates of private land ownership (Table 3.21). All except one of the 10 subregions with more than 30 endangered ecological vegetation classes have more than two-thirds of land area in private tenure (Table 3.21). Much of the 2.9 million hectares of native vegetation remaining on private lands has very high conservation value as a rare or threatened ecological vegetation class, as habitat for threatened species or in maintaining ecological processes. About three-quarters of it is part of an ecological vegetation class inadequately protected in the national park and conservation system and about 60% is a threatened vegetation class (Table 3.21).[233]

Although about 100,000 hectares of private land, including some very high value areas, have been securely protected, mostly by perpetual covenants or Nature Conservation Trust reserves, the overall contribution of private lands to the national park and conservation system so far is small (about 2.5% of the network). With less than 4% of native vegetation on private lands securely protected, there is great potential to expand private land conservation. In many highly cleared landscapes, private protected areas offer the best or only means to secure essential elements of biodiversity and provide a core for future restoration efforts. This effort will be greatly aided by the Trust for Nature's identification of 12 focal landscapes (Figure 3.16) that 'provide the best opportunities for maintaining priority ecosystems and species on private land'.[234]

Assuming that all potentially suitable public land is protected, about 1.7 million hectares of private lands (58% of the vegetated area) needs to be securely protected to meet the NCR reserve targets (Table 3.26; Figure 3.21). This would require a 20-fold increase in the area of private land protected, either by perpetual conservation covenants (or similar secure mechanism) or by purchase for the national park estate.

To meet the NCR reserve targets, the conservation focus on private lands will need to extend beyond the 12 focal landscapes to include other areas in 41 biodiversity priority zones identified by the Trust for Nature, and other areas of high quality habitat or with habitat suitable for restoration of poorly protected ecological vegetation classes.

As proposed above, the role of the Victorian Environmental Assessment Council should be expanded to include investigation of priorities for improving the national park and conservation system on private as well as public lands. As proposed in chapter 2 for coastal lands, a land acquisition fund is needed to assist with the purchase of private land for addition to the national park estate when land of high conservation priority is available for sale and when its conservation would be best achieved in this way.

Managing protected areas, whether on private or public land, requires commitment, knowledge and resources. Managers need support such as the regular contact and advice provided by the Trust for Nature for managers of covenanted properties, and as is being fostered through 'conservation management networks'. There is potential for fruitful collaboration between non-government organisations (Trust for Nature and Bush Heritage Australia) and government conservation and land management programs.

Except for specifically exempt areas, including national parks, state parks and wilderness areas, all areas in Victoria are open to mining exploration and mining licence applications.[235] A perpetual covenant requires landholders to manage the covenanted site for conservation but doesn't preclude mining even if it will destroy the site's values. All properties in the national park and conservation system, including on private land, should be protected from activities inconsistent with maintaining their conservation values. The Nature Conservation Trust Act should be strengthened to prohibit mining exploration and mining.

Given the importance of private land to Victoria's conservation future, there needs to be a concerted focus on optimising incentives for and removing impediments to private land conservation. This review recommends that the Victorian Environmental Assessment Council be commissioned to investigate barriers to private land conservation and how best to facilitate private conservation through incentives and technical and logistical support.

Priorities for Indigenous land managed for conservation

Indigenous lands will become increasingly important for biodiversity conservation, including as part of Victoria's national park and conservation system. Currently, there are management agreements (joint or cooperative) over about 300,000 hectares of protected areas (Table 3.18). The recognition of Indigenous ownership of protected areas and agreements for their joint or cooperative management are beneficial for maintaining Indigenous connections to their land, incorporating traditional knowledge into management and building respect for and awareness of Indigenous culture. The management arrangements for particular protected areas vary depending on the nature of the agreement and the desires of the Traditional Owners (section 3.2.4).

This review recommends that the government actively engages with Traditional Owner representative bodies to negotiate agreements for management of protected areas (Box 3.11), provide ongoing financial support for joint and cooperative management agreements and work with Indigenous representatives to determine how to better support Indigenous aspirations for conservation management.

Box 3.11 Joint management of national parks

I think the forest is like a human body. The Murray River is the spine, and the Barmah and Moira Lakes are the kidneys on both sides. That is how the old people used to look at it. They would say – 'this is our life'. It is a living thing. We are the land, and we are mother earth. We fit in like that.

Yorta Yorta elder Colin Walker[236]

The creation of the red gum parks recognised traditional ownership over these lands and enacted a new era of joint management of national parks. In November 2010 a Traditional Owner Land Management Agreement was made between the state and the Yorta Yorta People for joint management of the newly established Barmah National Park. This agreement under the Traditional Owner Settlement Act was reached outside the native title process and enabled the establishment of the Yorta Yorta Traditional Owner Land Management Board (appointed in 2013) with majority membership by Yorta Yorta representatives and the development of a joint management plan.

It followed an agreement in October 2010 with the Gunaikurnai people after the Federal Court recognised they held native title rights over areas of crown land in Gippsland. The state entered into a Recognition and Settlement Agreement to transfer 10 parks to the Gunaikurnai as Aboriginal Title, including Tarra-Bulga, Mitchell River and The Lakes national parks. They are jointly managed by the Gunaikurnai and the state under a Traditional Owner Land Management Board appointed in 2012.

Management issues and priorities in the national park estate

As pressures on nature are growing, law and policy changes and inadequate resources are at the same time undermining the capacity of park managers to protect the national park estate. Imposition of a damaging annual burning target for public lands (section 3.5.3), limited resources for invasive species management, commercial tourism development (Box 3.12), expansion of fossicking access, the attempt to reintroduce grazing in alpine parks and the potential to allow logging under the guise of ecological thinning are incompatible with maintaining conservation values and focusing on conservation priorities.

A stronger commitment to managing the national park and conservation system to optimise resilience to existing and emerging threats is needed (chapter 5). This is compatible with promoting use of national parks for physical and mental well-being and deriving economic benefits from nature tourism. Incompatible activities such as commercial tourism development, grazing and fossicking should be explicitly forbidden. Also needed is a role for the federal government to ensure that any activities likely to damage protected areas are assessed under the Environment Protection and Biodiversity Conservation Act (discussed in section 5.2.3)

Box 3.12 Private commercial developments in national parks

The Victorian government has passed legislation to allow developers to hold leases for up to 99 years in national parks, and has invited applications for developments in two-thirds of Victoria's national park estate. This will undermine the primary aim of park management of protecting natural values. The IUCN guidelines for national park management specify that visitor use should be managed 'for inspirational, educational, cultural and recreational purposes' without causing 'significant biological or ecological degradation'.[237]

Developers but not most visitors and not the parks usually benefit from private developments – 'the attraction, infrastructure, operational management costs and marketing are all publicly subsidised'.[238] There is no credible evidence in Australia or overseas of commercial developments in parks benefiting conservation.[239] To the contrary, they often divert resources from conservation management and amount to revocation by stealth. History has shown that what starts as small eco-accommodation tends to grow over time – with the addition of more beds and carparks, a café, a shop or two, roads, sewage treatment works etc. There is ample opportunity on nearby private land and in surrounding towns for development of tourism infrastructure.

The guidelines issued by the government are vague and unmeasurable, and the process for approval lacks opportunities for the community to comment on ecological impacts.

Unless shortcomings in invasive species management in the national park estate are addressed, inexorable deterioration in some of Victoria's finest natural environments will result.[240] Shortcomings include limited knowledge of the distribution and impacts of weeds and pests in parks, inadequate resources for control programs, and a lack of monitoring to measure their effectiveness. While successes have been achieved in individual programs, many manageable threats are neglected because of a lack of funds. There is currently a reliance on short-term (3-4 years), species-specific initiative funding, which precludes long-term strategic multi-species control programs. Reliable recurrent funding is essential. State-wide, there is need for more focus on prevention of new weed threats and development of biological controls for environmental weeds as the only potential long-term solution for many threats.

Because of a lack of monitoring, it is not possible to 'provide an overall consistent state-wide assessment of the condition of land and water resources' in Victoria's parks and reserves.[241] Knowledge gaps identified in the 2007 state of parks report included appropriate water and fire regimes, viability of threatened species populations, effective weed and pest management techniques, methods to restore degraded landscapes, impacts of visitor activities and urban growth, impacts of climate change and techniques for assessing threats and trends in park condition.[242] A long-term monitoring program to address such knowledge gaps is a pre-requisite for effective management of the national park and conservation system. The results of this monitoring

should be published in regular state of parks reports (last published in 2007).

Managing threats and monitoring trends in national parks requires high level expertise. With much of the required expertise outside the parks agency, arrangements such as expert advisory bodies are needed to ensure that park managers have ready access to the best available advice. But nothing can replace a high level of in-house knowledge and experience. Staff training and the recruitment of highly qualified staff to replace lost expertise should be a high priority for the parks agency. Fire management, in particular, requires expert advice, for inappropriate regimes are a major threat to many parks and fire management is fraught with knowledge gaps, and technical and social challenges. The current state-wide burning target needs to be replaced with site-based ecological fire management informed by advice from an expert panel (see below).

Park planning

This review recommends the development of a strategic plan for the national park estate to assist in planning for its future, to refocus efforts and resources on the priority conservation tasks such as building resilience to climate change, and to communicate its great environmental, social and economic importance.

National park plans of management are vital documents specifying management objectives, priorities and performance indicators. In 2011-12, only 65% of properties managed under the National Parks Act (schedules 2, 2A, 2B, 3, 4, 7 & 8) had approved management plans less than 15 years old (down from 85% two years previously).[243] Park planning should be the responsibility of a revitalised parks agency with expertise in managing ecological systems (see section 5.2.2 for a proposal to establish a statutory government agency known as Nature Victoria with responsibility for national parks among others).

The agencies jointly responsible for park planning – Parks Victoria and the Department of Environment and Primary Industries – are developing a series of landscape-wide management plans which allow for management programs to be implemented across all land tenures. While this approach is sensible in theory, it has mostly been poorly implemented. With a history of non-cooperation, the two agencies do not agree on the nature of a landscape approach, and there is confusion between a 'tenure blind' approach to planning (where little or no regard is given to tenure type) and a 'cross tenure' approach (where management strategies and plans can be cooperatively applied but with regard for legislated levels of protection). The landscape-wide management plans in preparation, such as for South West Victoria and the alpine region, are broad strategic documents which do not fulfil legislated obligations for national park and state park plans. There is a commitment to correct this through a series of 'implementation plans' but there are currently no such plans in the public domain and no clear indication of how or when they will be developed. Worryingly, the lengthy but selective community consultation in the early stages of planning leads to very long development times, often with minimal input from many with relevant knowledge and experience.

Protected areas and climate change

Protecting habitat is probably the best way to conserve species under climate change. While the species and ecosystems in any one area will change over time, the greater the total area of habitat available, and the more diverse that habitat, the greater the number of ecosystems and species that will be able to survive. The bioregional framework ... is therefore very well suited for building a robust reserve system...

Dunlop & Brown 2008[244]

In the face of climate change, the national park and conservation system is more important than ever. Protecting ecosystems and the variation within each ecosystem maximises the potential for species to adapt to and survive future climates.[245] The national park and conservation system is critical for reducing threats to habitats and species vulnerable to climate change, for maintaining ecological processes central to adaptation (such as pollination, seed dispersal and species movement), and for safeguarding climate refuges, including sites that provide temporary refuge during climatic extremes and ecological disturbance and sites that provide long-term refuge for contracting species.[246]

A 2008 assessment of the implications of climate change for protected areas found that the bioregional approach used to develop the national reserve system (protecting a diversity of habitat types at multiple

scales) is ideal for 'strategically developing a system of protected areas that will remain effective under climate change'.[247] To increase the effectiveness of the national reserve system under climate change, priority areas for protection include:[248]

- large areas of habitat at risk of fragmentation or degradation
- refuges from disturbance, especially associated with climatic extremes, and areas that may provide long-term refuge from changing climate
- areas with high connectivity between diverse habitats, including areas with steep environmental gradients
- areas that reduce the largest gaps between existing protected areas
- areas that support landscape-scale ecological processes, including hydrological processes (eg water sheds, floodplains, wetlands, free-flowing rivers).

National park management will need to adapt to climate change to accommodate high levels of change, loss and uncertainty.[249] Planning is needed to develop adaptation pathways with a long-term outlook 'so that early actions are effective stepping stones to more transformative adaptation actions that can be implemented if required as new information becomes available'.[250] Various recommendations to promote resilience and adaptation to climate change are outlined in chapter 5, including the development of regional climate adaptation plans, targets for biodiversity and land health that drive investment in resilience, monitoring programs and investment in carbon sequestration opportunities that foster biodiversity protection and restoration.

3.5.2 Native vegetation

By far the strongest consensus on any issue in the scientific literature is that for the retention of existing native vegetation.

Victorian Environmental Assessment Council, 2010

Report after report has identified loss and degradation of native vegetation as the major cause of declining environmental health in Victoria.[251] With more than half the state cleared of native vegetation and much of the rest degraded, the priority must be to protect what remains and work to reverse degrading processes, while embarking on restoration of high priority areas.

Priorities for law and policy reform

Primary responsibility for assessing clearing applications rests with local government, under planning laws, and has been guided by the 2002 policy *A Framework for Action: Native Vegetation Management in Victoria*. About one-third of applications – larger projects or those involving higher conservation significance – have been referred to the state government for assessment and much other clearing (such as for mining, logging and urban development in outer Melbourne) is assessed under other legislation. Application of the native vegetation policy has been less-than-rigorous – it is only a 'consideration' for decisions – and some types of clearing (eg for reducing bushfire risk) are exempt from assessment. Very few applications have been refused. In 2010-11 councils refused just 3.6% of applications and the environment department refused 4.5% of applications referred.[252] Those approved frequently included vegetation of 'high' or 'very high' conservation significance.[253]

Instead of strengthening native vegetation protection, the Victorian government has recently weakened the regulations. The objective has been altered from a 'net gain' of native vegetation to the confusing, weaker and unmeasurable 'no net loss in the contribution made by native vegetation to Victoria's biodiversity'.[254] Instead of aiming to improve the extent and condition of native vegetation, this 'effectively acquiesces to continued long-term decline'.[255]
The requirement to prioritise avoidance of clearing (in the hierarchy of avoid, minimise and offset) has been abandoned in favour of a risk-based approach in which most clearing is approved by default except if it cannot be offset.

The impact on biodiversity is to be measured by simplistic site-focused indicators – native vegetation extent, quality and value for threatened species – ignoring impacts on all other aspects of biodiversity.

Avoidance and minimisation apply only if the cost of offsets is higher than the value of the proposed land use. The highly dubious assumption is that offsets deliver a neutral outcome for biodiversity. The 2013 state of the environment report cites concerns from academic institutions and catchment management authorities that the changes focus on reducing cost to government and landowners rather than on maintaining and improving Victoria's biodiversity.[256]

Under the new approach, the state has been mapped into three categories (A, B and C) that supposedly reflect 'the likelihood that removing a small amount of native vegetation at a location could have a significant impact on the habitat of a rare or threatened species'.[257] This focus just on listed rare or threatened species undermines the responsibility of government to protect biodiversity more generally – 'the variety of all life forms, the different plants, animals and microorganisms, the genes they contain and support, and the ecosystems of which they form a part', according to the government's own definition – including many other threatened biota (eg ecological communities and threatened species not formally listed). Mapping has placed more than 95% of native vegetation on private land in category A, 'low risk', which allows as-of-right clearing of any area less than one hectare if offsets are provided. For category A clearing, there is no longer a requirement for on-ground assessment of site values. Less than 2% of private land area has been identified as 'high risk'. Preliminary analysis of the mapping shows many errors that would permit clearing in areas well-known to have high conservation values.[258] Information about the occurrence of threatened species is heavily biased towards public land, which means that where knowledge of biodiversity is poorest – on private land – is also where native vegetation has been most depleted and will be subject to further clearing pressure. Unless these changes are reversed, clearing and biodiversity loss will inevitably escalate.

The extent of illegal clearing in Victoria is unknown. In a 2012 review, Victoria's auditor general strongly criticised the state government for its lack of a compliance framework, including for vegetation laws. The audit concluded that the compliance deficiencies of the then Department of Sustainability and Environment were 'substantial' and included a 'lack of accountability, oversight and risk-based compliance planning needed to drive a robust and consistent approach across the department'.[259] Local governments also have deficient compliance, with too few resources and too little expertise (section 5.2.2). The system of native vegetation management is opaque, with no public reporting on permits issued, permit conditions, offsets, compliance and monitoring.

Because vegetation protection is so foundational to ecosystem and landscape health, and fraught with governance challenges, it needs new legislation and an independent regulator. As proposed by the Victorian Competition and Efficiency Commission, an independent statutory authority should be responsible for operational functions – assessment of clearing applications, offsets regulation, monitoring and compliance, administration and providing expert advice – while policy-making should be retained by the environment department. This review proposes a Native Vegetation Regulator (further detailed in section 5.2.2). Rather than being part of the Planning and Environment Act, controls on vegetation clearing should be part of a new Victorian Environment and Conservation Act, proposed in section 5.2.1. To improve transparency, a public register of documents – including clearing permits, assessment reports, offset agreements and plans, monitoring and audit reports – is essential.

Making offsets work

[H]abitat offset aimed at achieving and detecting no net loss can only be successful where the offset ratio is large, monitoring is long-term, robust and precise and funding is available to substantially increase the amount of habitat if monitoring indicates that this is necessary.

Evan Pickett and others, 2013[260]

The Victorian government relies on offsets to neutralise permitted clearing of native vegetation, with approved offsets including: [261]

- management actions taken since 1989 that have maintained or improved the quality of native vegetation
- increasing the security of native vegetation to prevent future clearing (eg. a covenant or land transfer to a reserve)
- maintaining the quality of native vegetation by foregoing entitled uses and preventing weed spread

- improving the quality and extent of native vegetation or revegetating cleared areas.

As long as the avoidance hierarchy (avoid adverse impacts, minimise impacts and offset impacts) is strictly applied, with clearing permitted only in exceptional circumstances, the principle of offsetting is sound. But in the absence of this, offsets are likely to be used to facilitate clearing, often in return for trivial, uncertain or non-permanent compensation, and result in net vegetation loss (Box 3.13).

Thus far, the area of native vegetation protected and restored through offsets is small and less than what has been lost.[262] Some offsets deliver only paper gains (eg where a change in tenure does not result in greater protection because the vegetation was not under threat or there is little improvement in management). Gains from restoration and management are often uncertain and require long-term commitment, but typically only 10 years of active audited management is required.[263] In the vast majority of cases, offset sites are not monitored, so confirmation of the 'gains' these offsets are meant to have provided are rarely verified. The protection of offsets made under the Planning and Environment Act (section 173 agreements) is inadequate, and they do not meet criteria for the national park and conservation system for there are no management standards specified and they can be altered. Other offsets agreements made under the Conservation Forests and Land Act (section 69 agreements) are more secure but the lack of transparency about offset arrangements make it impossible to assess their adequacy. A central registry with full details of offset agreements is an essential accountability mechanism.

An independent audit is needed to assess the extent to which offset targets are being achieved, their degree of permanence, and how the system can be reformed to deliver genuine compensation for vegetation destroyed or damaged. Offsets should be required for all threatened biodiversity, as identified on government advisory lists. Long-term monitoring is needed. Offset requirements should be reformed to deliver the best value biodiversity outcomes, including requiring fixed rate payments for low risk activities in low value areas to fund protected areas and accrediting services that pool funds to source offsets.

Box 3.13 Issues with offsetting

Offsetting generally involves trading a biodiversity loss in one place with an equivalent gain in another, with the aim being 'no net loss' of biodiversity. The crucial question is 'no net loss *compared to what*?' Compared to biodiversity before the impact? Generally not. For most offsets, the intention is to achieve no net loss *compared to what would have happened in the absence of the impact and the offset*.[264]

Biodiversity offsets can be achieved in two main ways.[265] 'Averted loss offsets' protect existing habitat from ongoing or anticipated degradation or loss. It begs the question of why loss should be permitted to occur in the first place, and is 'an admission that ongoing decline is the norm'.[266] 'Averted loss offsets only work if biodiversity keeps declining' so can entrench the baseline rate of decline.

The second type is 'restoration offsets', which create new habitat or improve existing habitat, and are 'necessary if a cessation or reversal of biodiversity decline is to be achieved.'[267] Creating habitat is difficult because of uncertainties about the outcome and often long time-lags. 'Though created habitat can resemble the composition of existing habitat, certain ecological processes can be difficult to restore, possibly reducing the compatibility for the target species or community.'[268] A high offset ratio, where much more habitat is created than lost, is recommended where there is a risk of failure.

Under the federal government's offsets program (under the Environment Protection and Biodiversity Conservation Act), the permitted destruction of threatened vegetation has been substantial, including 7.2% of the critically endangered natural temperate grasslands of the Victorian Volcanic Plains, and 1.4% to 4.6% of the critically endangered grassy eucalypt woodlands of the Victorian Volcanic Plains. The approved offsets are western grasslands reserves of more than 15,000 hectares and a 1200 hectare grassy eucalypt woodland reserve. But whether they can effectively compensate for the losses is dubious, due to a high level of uncertainty about the ability to manage and improve degraded grassland communities. The Threatened Species Scientific Committee said that regeneration of the grasslands ecological community 'is unlikely within the immediate future, even with positive human intervention.'[269]

Offset programs frequently fail to monitor and report the effectiveness of offsets and apply excessively lenient criteria to determine success.[270]

Stewardship and restoration

In heavily cleared landscapes small remnants have heightened value, as a resource to be protected and as the foundation for improving biodiversity outcomes in the future.

Saul Cunningham and others, 2012[271]

Many of Victoria's 'at risk' habitats and the majority of 'restoration' habitats (based on VNPA's framework, section 3.2.3) are on private land. A high proportion of endangered vegetation types are also on private land (section 3.3) but only 0.4% of private land is securely and permanently protected, in contrast to more than 40% of public land. Private land conservation is an immensely challenging policy area because of the rights afforded property owners and the commercial focus of much land use. It requires motivating and supporting thousands of landholders to adopt new management practices.

Victoria has been a leader in ecomarket schemes (eg BushTender, EcoTender, CarbonTender, WetlandTender), which provide landholders with income for protecting biodiversity and providing ecosystem services. To achieve more private land conservation, these ecomarket schemes will need to be expanded. Public funds for conservation activities should be directed to achieve clearly articulated priorities, monitored to assess outcomes and, wherever feasible, they should be secured by mechanisms such as permanent conservation covenants. Permanent on-title conservation covenants substantially increase the likelihood that remnant or restored habitat will be retained and maintained in the long-term.

The voluntary Land for Wildlife program is another way to foster private landholder's willingness to protect and restore native vegetation. While the program has been popular, involving about 6000 properties, and is valuable for education and outreach, Land for Wildlife agreements are neither binding nor permanent, and there has been no assessment of outcomes. The program needs reviewing to determine how to expand its reach and improve environmental outcomes.

A substantial proportion of remnant vegetation in Victoria's most cleared and damaged landscapes is in multiple small patches on public land – road reserves, stream frontages, and small reserves.[272] There are insufficient public resources to manage each of these patches 'individually to the level that their scarcity and fragility warrants'.[273] As recommended by the Victorian Environmental Assessment Council, organisations and individuals could be encouraged and supported to enter into stewardship agreements to manage these small public land reserves.

To meet its conservation goals, Victoria faces an immense restoration task. Under the VNPA habitat framework (section 3.2.3), restoration is the conservation priority for the majority of Victorian landscapes. Many thousands of Victorians are already engaged in restoration, mostly on private property, under programs including Landcare, Bushcare and various incentive schemes.

There is a lack of long-term data on restoration outcomes, and few long-term studies assessing biodiversity benefits.[274] The lack of demonstrated high biodiversity benefits is in part due to the long time lag between the intervention (such as planting trees) and expected outcomes (eg hollows can take more than 100 years to form).[275] Some shorter-term evaluations suggest that common plants and animals are the immediate beneficiaries.[276] But strategic interventions can help prevent further degradation and loss of ecological function, for example by fencing mature trees in agricultural landscapes to promote recruitment, or connecting areas of isolated habitat to allow recolonisation and outbreeding. Restoration activities are often most beneficial where they enhance already existing biodiversity values, rather than attempting to recreate them from scratch.[277] Sometimes overlooked is that much restoration requires resources for ongoing, long-term maintenance – for example, protection from stock, control of weeds, invasive animals and pathogens, and fire management. These limitations should not discourage investment in restoration, but rather encourage research, monitoring and use of best-practice techniques. All projects should be considered 'experimental', with evaluation of outcomes informing the design of future projects.[278] Goals should be defined and realistic, and take into account potential future changes – such as climate change, impacts of invasive plants and animals, and alterations in hydrological and soil conditions. The issues mentioned here are being addressed in recent projects that aim to create landscape-scale 'biolinks' to connect large areas of high-quality intact vegetation for multiple outcomes, including carbon sequestration, restoration of ecological function and revegetation.[279]

In some regions passive regrowth may be able to deliver conservation benefits over far larger scales, and at far lower costs, than intentional restoration activities, although this remains to be demonstrated.

Luke Geddes and others, 2011[280]

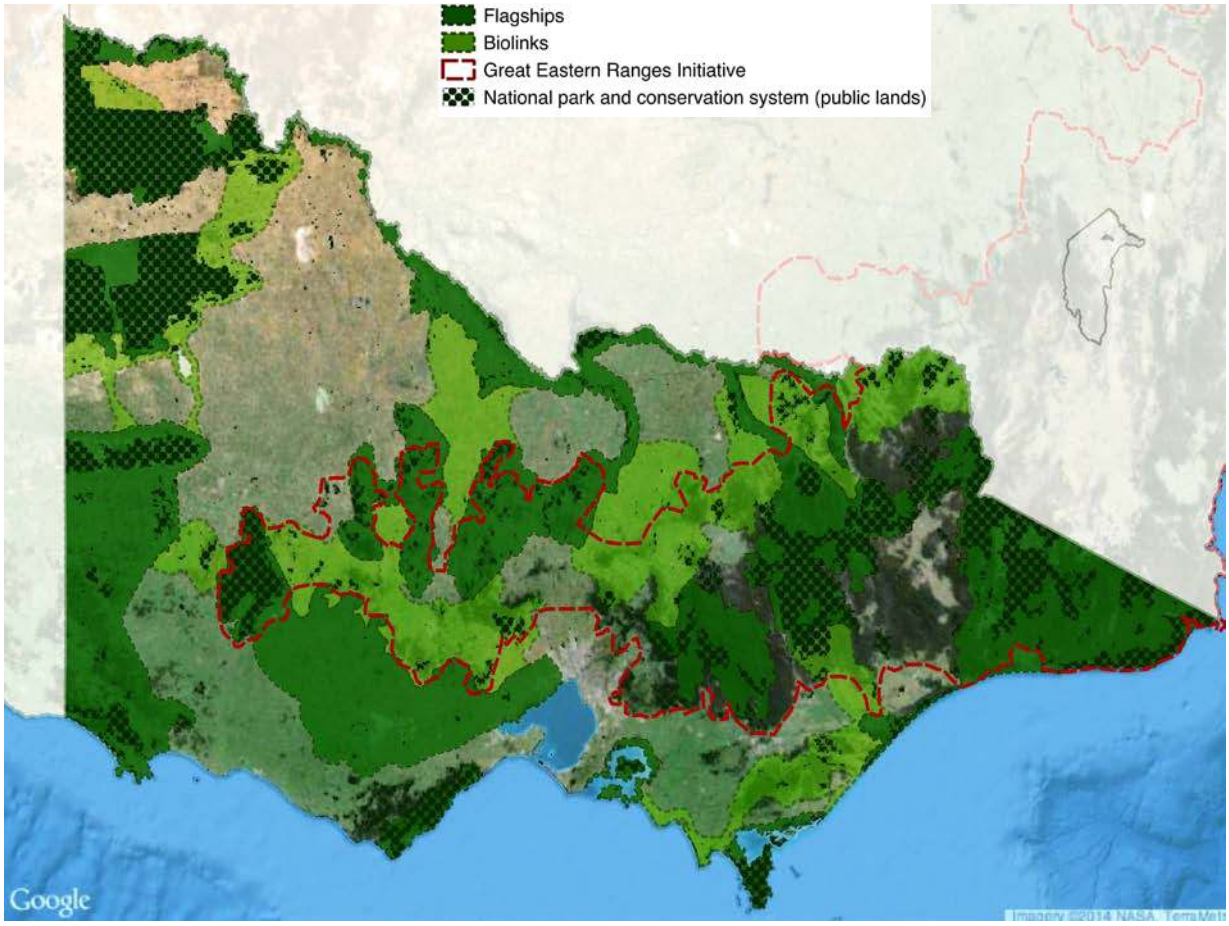
In Victoria, natural regeneration on abandoned or little-used farmland is believed to account for most of the gains in native vegetation extent.[281] A study in a 'rural amenity' area (the Rushworth-Nagambie-Heathcote region) in central Victoria found that 12% of private land had naturally regenerated with native shrubs and trees, mostly since the 1960s.[282] The extent of natural regeneration is far greater than has been achieved from intentional plantings in other similar-size regions. Most natural regeneration (94%) in the region has occurred on low fertility soils – probably because more fertile areas have been retained for agricultural use or because regeneration by woody plants occurs more rapidly on infertile soils due to lower competition from herbaceous species. On current trends, regrowth will occur on 20% of infertile soils on private land in this region by 2025. Techniques to encourage natural regeneration should be used wherever feasible in preference to more technical and expensive interventions.[283] However, there is little information about habitat values provided by large regrowth areas and successional dynamics. It is not known whether the regrowth shrublands (mostly of *Cassinia arcuata*) in central Victoria will eventually resemble intact box-ironbark forests or instead form 'novel ecosystems'. [284]

The Victorian government has noted that levels of investment in restoration are 'well below the size of the task, even just for priority locations'.[285] Restoring ecosystem health will require considerably more investment at a landscape level combining strategic revegetation and management, with covenants on private properties and acquisitions for the national parks estate. It also requires greater knowledge of how to increase the resilience of native vegetation in the face of climate change, including the benefits and risks of greater connectivity in the landscape.

In the 2009 *White Paper for Land and Biodiversity at a Time of Climate Change*, the Victorian government proposed to instigate 'a system of regional-scale biolinks to focus activity on restoring local and regional connectivity, ecosystem function and resilience'.[286] The white paper scientific reference group advised that communities should aim to restore at least a third of the landscape in biolink areas. The white paper also identified 13 flagship areas, as areas to prioritise for 'protection and enhancement'. The areas proposed for biolinks and flagships encompass both public and private lands, as shown in Figure 3.22.

By providing a framework to maximise potential conservation gains, including enhancement of core habitat areas and improved connectivity, a biolinks program would build on the excellent restoration work already being done by many groups and individuals, and focus support and monitoring on the highest priority areas. Biolinks have great potential as a communications and community engagement tool, fostering a positive spirit of contribution to an ambitious landscape-focused program and engendering partnerships across different sectors and land tenures. Despite strong community enthusiasm and much effort being devoted to connectivity projects, the current government has abandoned support for a biolinks policy. This should be reconsidered. The 2013 state of the environment report has recommended that the government 'sponsor efforts to develop biolinks at different scales'.[287] It is recommended here that a statewide biolinks plan be developed to build on the flagships and biolinks identified in the white paper and incorporate the focal landscapes and priority biodiversity zones identified by Trust for Nature.

Figure 3.22 Biolink and flagship proposals



Map: VNPA. Data sources:: Google; Flagships and biolinks data from the 2010 biodiversity white paper (supplied by the Department of Environment and Primary Industries); Great Eastern Ranges (GER) Initiative data from the GER Initiative. This initiative is a national partnership to connect landscapes and ecosystems along 3600km of Australia's eastern seaboard from the Grampians to Cape York

Priorities for forest protection

The current state of Victoria's mountain ash forests is a result of decades of unsustainable forest management practices. There is an urgent need for reform.

David Lindenmayer and others, 2013[288]

Logging advocates talk of a balance between conservation and timber and pulpwood production and point to the reservation of 45% of Victoria's remaining native forests as justification for continued logging. But this ignores the already much depleted state of forests, the continued decline of many forest-dependent species and the impacts of logging beyond logged sites due to compromised ecological processes (eg fire regimes, water flows). There is a strong conservation case to transition from logging of native forests to plantations. In 2006 the Victorian Forest Alliance proposed the exclusion of logging from 970,000 hectares of public forests to protect high conservation values, old-growth forests, water catchments and other non-timber values, leaving a quarter of a million hectares of 'the most productive commercial forest' for logging.[289]

The economic case for a transition is also strong. Forestry on public lands suffered cash and investment losses of about $22 million from 2005 to 2012, equating to a loss of about $1.50 per cubic metre of wood harvested.[290] Typically, about two-thirds of wood harvested from native forests is sold for woodchips, which bring low economic returns.[291] (In 2012-13 VicForests sold 751,000 cubic metres of pulpwood, about 60% of wood sold.)[292]

Victoria receives no payments from VicForests for access to public forests, and its customers pay lower prices because VicForests is subsidised by the state not requiring a commercial return for the use of public assets. If Victoria's public forests were run on the same basis as commercial plantations, the state should receive an income of more than $200 million a year from wood sales.[293] This greatly disadvantages plantations, which are extensive enough to replace the bulk of wood products obtained from Victoria's forests. Harvesting of public native forests is 'no longer necessary'.[294]

VicForests gets free access to Victoria's forest assets and its customers get the benefit of prices that are lower than would be the case if VicForests was required to pay a commercial return for the use of these assets. This both distorts the market by advantaging VicForests and its customers over plantation forestry (in terms of price) and, represents a subsidy that is neither transparent nor accounted for in the State's finances.

National Institute of Economic & Industry Research, 2010

Economic analysis commissioned by the Victorian Forest Alliance found that within 10 years of implementing a transition to plantations and increasing protection of native forests, Victoria would be better off economically than the base case, with more jobs and greater commercially valuable carbon stores (the analysis is sensitive to the price of carbon).[295]

Forestry enjoys exemptions from laws and standards that apply to other industries – harvesting under five Victorian regional forest agreements is exempt from the federal Environment Protection and Biodiversity Conservation Act and from Victorian planning laws, which means there are no requirements for environmental impact assessments when new areas are logged (Box 3.14). Forestry laws and policies are also poorly enforced and lack transparency. Breaches are often reported but seldom acted on.[296] A review of the federal environment laws found that 'the current process for review and auditing [of regional forest agreements] is neither independent nor transparent, and more importantly, in most cases, required reviews are not being undertaken'.[297]

The new Allocation Order provides VicForests with access to all of the timber resources in the General Management and Special Management Zones in State forest in eastern Victoria, on an ongoing basis.

VicForests, 2013[298]

Recent changes to Victoria's Sustainable Forests (Timber) Act have further undermined the potential for sustainable forestry and enforcement of forestry rules.[299] The changes entrench the long-term logging of native forests and remove much of the government's oversight of logging practices – for example, VicForests will no longer need to seek government approval for timber release plans and logging operators will not need to obtain licences. There will be no limit on the lifespan of allocation orders, allowing the government to essentially gift current and future forests to VicForests. It will lock in logging in native forests for the indefinite future.[300]

Another major backward step is the re-opening of western forests (west of the Hume Highway) to logging, with a decision in September 2013 to grant a three-year licence for logging in Mount Cole State Forest. A 2013 government-commissioned review of commercial forestry opportunities in western Victoria imply an intention to also re-establish logging in other forests.[301] In recognition of the conservation values of the greatly depleted and fragmented western forests, most logging in western Victoria (which occurred largely in the Otways) was phased out a decade ago with millions of dollars paid in industry compensation. Rather than returning to exploitation of these highly fragmented and degraded forests, the focus needs to be on securing the protection of high value forests and reversing degradation. In a 2010 assessment, VNPA found that Mount Cole State Forest has high conservation significance and warrants protection as a state park.[302] The Central Victorian Uplands subregion (in which Mount Cole is sited) has less than 10% of ecological vegetation classes adequately protected (Table 3.22). In 2011 the Victorian Environmental Assessment Council recommended that the Central Uplands subregion be the focus of a study to assess options for conserving forests and other public lands in protected areas. A 2010 independent review of regional forest agreements recommended that the agreement for western Victoria be cancelled.[303] Both of these recommendations should be implemented.

Large areas of old-growth forest have been protected informally in 'special protection zones' under the regional forest agreement process and subsequent forest management plans rather than in the national park estate. This is in breach of the regional forest agreements and the JANIS criteria, which state that 'all reasonable effort should be made to provide for biodiversity and old-growth forest conservation and wilderness in the dedicated reserve system on public land'. These informal reserves are not secure as they can be swapped for other sites and logged, provided that there is no perceived net loss of conservation values, and they can also be mined and grazed. Many are fragmented and vulnerable to edge effects (resulting in weed invasion and drying) and fire. Yet they are counted as protected under the regional forest agreement criteria, contributing to the minimum 60% old-growth protection required. These areas warrant permanent and secure protection under the National Parks Act. In the light of climate change and intense environmental stresses on forest ecosystems, the extent of public forest protected in reserves under regional forest agreements needs reviewing.[304]

Under what it calls the 'new strategic approach to biodiversity management' project, the Victorian government is developing a new framework for the management of threatened fauna in state forests based on identifying key habitat areas for 10 species.[305] While the research on these priority species is generating important information, there is concern that it will be used to exempt the forestry industry from threatened species requirements under the Flora and Fauna Guarantee Act, as proposed in 2011.[306] It is unclear how the new information will be used and whether it will reduce the impacts on these species given the current government's unwillingness to reduce timber quotas to protect threatened biodiversity (Box 3.15). As the researchers commissioned to investigate the 10 priority species comment, there is a lack of knowledge on the status, distribution and habitat requirements of many other threatened species besides the 10 priority species in forests subject to timber harvesting. Better knowledge of 10 species won't substitute for knowledge of other species.

Forestry operations on public and private land, including plantations of native and exotic species, do not adequately address the risks of invasive species, pathogens and hybridisation with plants in the wild. Although the principles under which forests are managed, under the code of timber production, require monitoring and management to 'reduce pest plant and weed impacts', only the relatively few weed species listed under regulation (which bind all landholders) are addressed; further measures are advisory only.[307] Similarly, there is a lack of regulation over what can be planted in plantations – any species is permitted, whether weedy or likely to breed with native species, other than the relatively few expressly prohibited – and there are no requirements for plantation owners to control escapes. This is likely to become a more significant issue as potentially weedy biofuels are promoted as alternative energy sources. There is need for duty-of-care provisions for plantations to require control of wildings (from plantations of exotic species) and prevent hybridisation with plants in the wild (from plantations of native species).

The impacts of plantations on hydrology, wetlands and other groundwater-dependent communities are not given adequate consideration under forestry codes and regulations. The native vegetation management framework commits to 'develop an improved understanding of the water yield impacts of private forestry enterprises on wetlands and associated aquatic vegetation and develop guidelines for plantation establishment to avoid further impacts'.[308] This issue requires further investigation and action.

Native vegetation on private land of medium or low conservation significance subject to timber harvesting is considered under the native vegetation management framework to be subject to temporary loss only, and the framework's former net gain requirements were considered to be met by 'regeneration'. This does not accurately reflect the consequences of forestry, which is likely to degrade vegetation quality through weed invasion, alteration to soil and drainage conditions, changes in species age and composition, impacts on habitat and loss of large old trees. The framework should apply to private forestry.

There is insufficient control over firewood collection to prevent adverse impacts on biodiversity. In 2011, the state government removed the need for permits to collect firewood from public land for private use. This decision should be reversed so that the collection of firewood and the impact on the forests can be properly monitored and controlled. Although the firewood strategy, applied to commercial collection on public land, requires retention of sufficient coarse woody debris for biodiversity and prohibits removal of hollow

logs or logs with moss or lichen, there is no indication of the process by which areas are selected and assessed. Areas designated for firewood collection should at a minimum be subject to the same biodiversity criteria as other timber production methods. It is also vital to examine the impact of firewood removal on the biodiversity values of private land, where 87% of collection occurs. This is an as-of-right use for domestic purposes, although commercial firewood harvesting is subject to the national vegetation management framework and its offset requirements. Much of the need for firewood could be met from plantation forests. The collection of firewood from public land should be phased out with a new licence system introduced in the interim to limit impacts. This review recommends a regional development program to provide incentives for farm forestry production of firewood.

Box 3.14 Regional forest agreements (RFAs)[309]

With the exception of the Tasmanian RFA, there are no obligations within the RFAs imposing a legally enforceable obligation upon the state to ensure the protection of species or ecological communities listed in the [Environment Protection and Biodiversity Conservation Act].

Federal Department of Agriculture, Fisheries and Forestry 2009

RFAs are 20-year agreements between the federal and state governments outlining responsibilities for native forest management, which aim to protect some forest areas through the forest reserve system while maintaining and developing native forest logging industries that are ecologically and economically sustainable. Forestry activities covered by a regional forest agreement (approved under the Regional Forest Agreements Act) are not required to obtain approval under the federal Environment Protection and Biodiversity Conservation Act (strictly speaking, the development of an RFA constitutes a form of assessment and approval for the purposes of the act). There are five RFAs in Victoria: East Gippsland (1997), Gippsland (2000), Central Highlands (1998), North East (1999), West (2000).

The main advantage of RFAs is the incentive they have provided for conservation of a proportion of state-owned forests to meet requirements for a comprehensive, adequate and representative reserve system.

The 'sustainable' forestry regime accredited under the Victorian RFAs has three main environmental elements: forest management plans, the *Code of Practice for Timber Production* and threatened species laws (the Flora and Fauna Guarantee Act). The code of practice requires compliance with forest management plans and action statements prepared under the Flora and Fauna Guarantee Act for species identified in the areas proposed for logging. The state-owned business enterprise VicForests does most native forest logging in Victoria and, in an inherit conflict of interest, is also responsible for conservation measures, such as pre-logging surveys and forest coupe plans.

In Victoria, action statements for threatened species listed under the Flora and Fauna Guarantee Act are the principal mechanism for protection under the forest management regime. But threatened species listings are not comprehensive, fewer than half the listed species have action statements, and many action statements are out-of-date or of poor quality. Compliance with forestry laws has been highly inadequate, as revealed in numerous examples identified by community groups, in audits by the Environmental Protection Authority and in a 2009 review by the Victorian auditor general of administration of the Flora and Fauna Guarantee Act.[310] Climate change is ignored under the RFAs and there is no requirement to take into account the loss of forest resources due to bushfires. Some of the RFA failings are exemplified in Box 3.15..

Box 3.15 Leadbeater's possum – a case study of RFA failings[311]

Leadbeater's possum is at 'very high risk of extinction in the next 20-30 years' due to the rapid loss of large hollow-bearing trees from bushfire, logging and natural attrition. Forestry results in their losses due to removal (including from salvage logging), incineration from high-intensity fires to regenerate logged stands and accelerated rates of collapse in forest adjacent to logged areas. Logging also changes fire regimes in wet forests, rendering them more fire prone and more likely to burn at high severity. The 'fundamental ecological importance of large old hollow-bearing trees' needs much greater recognition in forestry management. Existing strategies to conserve the species are more than 15 years old and were watered down, leading to logging of suitable habitat

areas.

The 2009 fires burned 42% of the known habitat of Leadbeater's possum, and they no longer occur in those burned areas. Populations were lost from extensive areas such as the Lake Mountain region. But there is no requirement under the RFA for this to be taken into account in forestry decisions. In a 2012 case brought by *MyEnvironment*, the Supreme Court found that despite the changed circumstances since the 2009 fires, VicForests was not required to apply any higher standard than that accredited in the existing RFA.[312] Sustainable yields had not been re-assessed, and the rate of logging of green forest was higher than before the fires.

Most logging in montane ash forests is by clearfelling, which means that logged areas will take almost 200 years to develop suitable habitat for Leadbeater's possum. VicForests has refused to adopt 'retention harvesting' (retaining patches of undisturbed forest) as an alternative more sustainable approach.

Box 3.16 Carbon value of Victoria's forests[313]

Victoria's native forests are rich stores of carbon. Any decisions about their future should take into account their value for mitigating climate change. Natural forests in southeast Australia store an average 640 tonnes of carbon per hectare (360 tonnes biomass carbon plus soil carbon) and each year they absorb a net average 12 tonnes of carbon. The highest biomass carbon stocks are in the mountain ash forests of Victoria's Central Highlands and Tasmania, with an average of more than 1200 tonne of carbon per hectare. The majority of biomass carbon in natural forests resides in the wood of large old trees. By reducing the average age of trees, commercial logging reduces the amount of stored carbon. 'The result is a significant (more than 40%) reduction in long-term average standing stock of biomass carbon compared with an unlogged forest.'

The commercial value of these carbon stores depends on the carbon price. On a $25/tonne price, logging of undisturbed forests in East Gippsland, based on the average harvest area in the years to 2007, would amount to a loss of almost half a million tonnes annually of carbon costed at $40 million. The loss to Victoria of logging this forest (after allowing for stumpage income of about $6 million) would be $33 million annually.

3.5.3 Bushfire management

Unfortunately, with many major wildfires in recent years there is increased public pressure on politicians and agencies for more extensive prescribed burning to protect assets, particularly during droughts when flammability levels are high. Such pressure creates an urgency for burning simply to 'meet the targets' or so as to be 'seen to be doing something', irrespective of whether or not such burning will actually protect assets or achieve ecologically desirable outcomes.

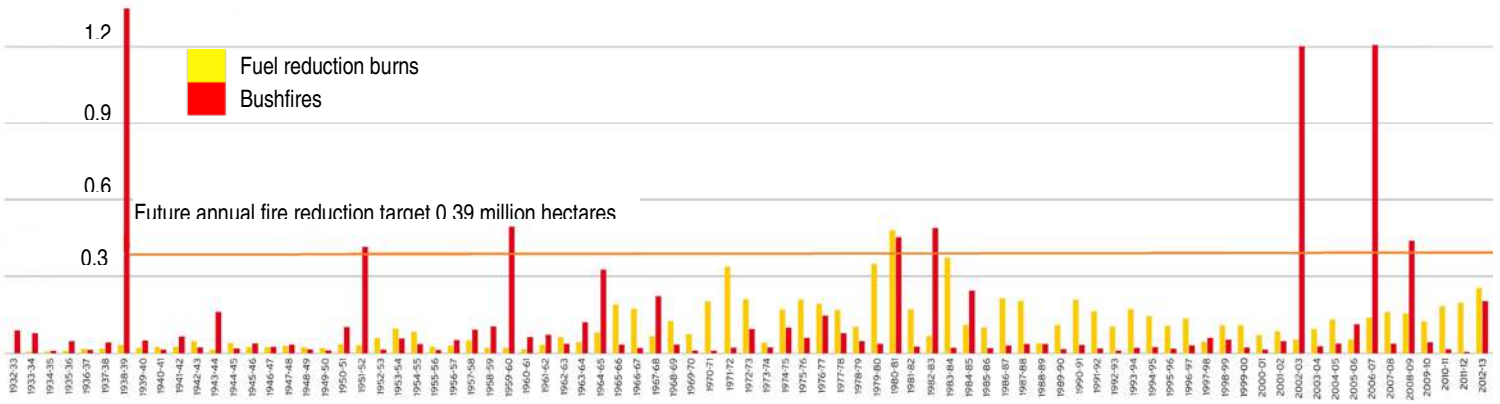
Michael Clarke, 2008

In 2010, the Victorian government adopted a recommendation by the Victorian Bushfires Royal Commission to increase 'planned burning' to a minimum annual target of 390,000 hectares (5% of public land). But there is no credible evidence that the program can achieve the goal of significantly reducing risks to life and property. There has been no cost-benefit analysis of fuel reduction burning in relation to other life-saving measures and no rigorous assessment of the effectiveness of prescribed burning, including under climate change, which is predicted to increase the frequency of extreme fire weather.[314] Losses of houses and human lives generally occur only under severe fire conditions, when weather (strong winds, high temperatures, low humidity) rather than fuel loads exerts the main influence over fire severity.[315] A recent analysis of the 2009 Victorian fires found that the effect of weather is so dominant that fuel reduction burning is ineffective under 'very high' or 'catastrophic' weather conditions. Only relatively small amounts of fuel are needed to generate high fire intensity in these conditions.[316] The probability of crown fires was found to be 'higher in recently logged areas than in areas logged decades before, indicating likely ineffectiveness as a fuel treatment.' This and other studies have found that while fuel reduction does reduce risk under some conditions, a prescribed annual level of 5% is 'likely to result in considerable residual risk', and that a large

(unrealistic) increase in rates of treatment may be required to substantially reduce risk and to counteract the effects of climate change.[317]

An 80 year history of fuel reduction burning and bushfires on Victoria's public lands shows that they have not been subjected during this time to the extreme level of fuel reduction burning currently intended by the state government (Figure 3.23). Only in one previous year, in 1980-81, was the current target of 390,000 hectares reached, and that was likely to be an overestimate, extrapolated from a pattern of ridge burning.

Figure 3.23 Area burned (million hectares) by fuel reduction burning and bushfires on public lands in Victoria over 80 years, from 1933-34 to 2012-13



Sources: Compiled by VNPA from figures for fuel reduction burns and bushfires on public land published in the annual reports of the Forests Commission of Victoria, and its successors, or from the Department of Sustainability and Environment.

In 2013, the implementation monitor for the Victorian Bushfires Royal Commission, whose job it is to review progress in implementing the recommendations of the bushfires commission, reported he was 'not convinced' that the annual rolling target of 5% minimum of public land (390,000 ha) is 'achievable, affordable or sustainable'.[318] He quoted fire ecologist Malcolm Gill: 'The real issue with targets is not the total area per year burned by prescription: it is the effect of fire regimes, including prescribed fires, on assets (human, property and biodiversity). There is a possibility that in meeting targets, the real issue of meeting ultimate objectives is overlooked.'[319]

This has already become clear in the Mallee area, where extensive planned burns are neither useful for public safety nor for biodiversity protection. Indeed, planned burning designed to reach the annual target is compromising biodiversity objectives in many areas, including reference areas normally excluded from management burns. It may also be compromising public safety. A high annual target skews burn plans towards the more remote areas, where large burns are easier and cheaper to achieve, but the most effective burns for public safety are the smaller but more difficult burns close to communities.[320]

As well as being a major drain on public resources for no clear benefit, the 5% target is likely to cause considerable harm to biodiversity.[321] The 2009 Victorian Bushfires Royal Commission endorsed the need for an improved 'understanding of the effects of different fire regimes on flora and fauna' so that 'prescribed burning regimes could meet conservation objectives as well as accommodating bushfire safety considerations'.[322] The recent increased frequency and scale of fires (megafires) under a drying climate challenge long-established tenets and require a different approach to protect human life, assets and biodiversity. The simplistic and ecologically irresponsible 5% target needs to be replaced with regional operational plans that focus on risk reduction for human assets in high risk areas and apply targets appropriate to particular ecosystems.

Because is not feasible to eliminate risks in many areas under the extreme circumstances that led to the Black Saturday bushfires, revised planning rules and building codes are required to avoid placement of assets in high-risk areas. In some forest types, such as

tall ash forests, it will be more useful and cost-effective to fund fire shelters or strategies for people to leave the fire danger area rather than focus on fuel reduction. Wide-ranging comparative analyses (including cost-benefit analyses) are required to determine the best strategies to reduce risks for people, assets and biodiversity. There is a great need for public education on fire safety and fire management for conservation.

Most decision-making about ecologically appropriate fire regimes is driven by knowledge of a subset of vegetation, and a hope that the rest of the biota will follow. But the impacts of fire on most species are unknown, a knowledge deficiency that will be exacerbated by climate change.[323] Researchers have attempted to identify 'natural fire regimes', with limited success, in part because of limited knowledge of pre-European fire regimes. There is an urgent need for research to provide a stronger evidence base for ecological fire management, including the long-term effects of different fire regimes on wildlife in different parts of the landscape and interactions with invasive species. Long-term monitoring is essential.

3.5.4 Invasive species management

Effectively, [Victoria holds]that the desire of some citizens to shoot deer on public land for sport is of greater value than the conservation of our natural heritage and the burden imposed by deer on farmers.

Roger Bilney, 2013[324]

Victoria's already dire invasive species problems will continue to worsen unless there is substantial reform of laws, policies and programs to prevent the introduction of new harmful species, eradicate newly established species, and more effectively contain and control established threats. New stand-alone biosecurity legislation is warranted. Recognising that invasive species are both an environmental and agricultural problem, equivalent powers should be accorded to the relevant ministers to implement measures to protect the environment and economy respectively.

There is a well-accepted hierarchy of responses to invasive species starting from the most effective and least costly: prevention, eradication, containment and control. The only sensible approach to prevention is to ban the entry of new taxa (species, subspecies and variants) unless they are assessed as low risk (a 'permitted-list' approach). Risk assessments should be precautionary and account for the risks and uncertainties of invasive species under climate change conditions. Currently, Victoria takes the opposite approach with plants, which is to allow all species in unless they have been specifically prohibited. This means that invasive species management is inevitably reactive and piecemeal and more costly as the numbers of deliberately introduced weed species grow. There also needs to be a greater focus on systematically identifying priorities for eradication, containment and control. Many opportunities have been lost to remove newly established species.

The reactive approach also leads to lack of action on environmentally harmful invasive species with economic or social value. Feral deer, for example, are protected for the benefit of hunters under the Wildlife Act rather than managed as a highly damaging environmental and agricultural pest species – despite one of the species, sambar, being listed as a potentially threatening process. And the government continues to promote tall wheat grass as a pasture grass despite it being listed as a potentially threatening process. Strong duty of care obligations and polluter pays provisions are needed to require land managers to take responsibility for the spread of invasive species.

Effective control of entrenched invasive species requires collaborations, planning, government support and monitoring. This can be facilitated by the establishment of regional weed committees involving government, community representatives and land managers to develop strategies and allocate resources. Training is needed for all workers and contractors undertaking weed control on public lands. More research is required on ecological solutions for entrenched invasive species.

3.6 Future Directions

With less than half the state retaining native vegetation and only a quarter of that area having largely intact vegetation, major challenges lie ahead to avert degradation and loss of biodiversity and restore health to Victoria's landscapes. For a great many reasons – environmental, social and economic – this mission is worthy of a concerted state-wide effort. A great many Victorians have embraced it and are contributing in multiple ways – for there is much to treasure about Victoria's terrestrial ecosystems: diverse landscapes, an outstandingly rich array of wildlife, and a plenitude of nature-based recreational opportunities. They also provide essential ecosystem services of great economic value.

The recognised mega-diversity of Australia is amply represented in Victoria. Although only 3% of the continent's land mass, the state has more than a quarter of Australia's mammals and lichens, about a fifth of vascular plants and about half of its bird species. Many species and ecological communities are unique to Victoria, including about 10% of plants, and hundreds of invertebrate animals and fungi. But a dire number are threatened – about a fifth of terrestrial vertebrates and plants and more than half the ecological vegetation classes.

Over large areas, the damage from extensive land clearing and logging, a multitude of invasive species and altered fire regimes has been severe. With climate change already pushing out the extremes of heat, drought and fire, reducing these existing threats to nature has become more urgent, to foster resilience and adaptation to further inevitable changes.

Securely protecting land in the national park and conservation system, on both public and private land, and optimising conservation management in these core habitats is more important than ever as a core conservation strategy, important also to maintain ecosystem services and low-impact recreational opportunities.

Victoria still has a substantial way to go to achieve its goal of a comprehensive, adequate and representative protected area network. High priorities for improved protection include areas with high biodiversity values and low levels of protection, threatened ecological communities and climate change refugia. There need to be stricter safeguards against harmful exploitation of the national park and conservation system and more focus on conservation priorities such as implementing beneficial fire regimes and controlling harmful invasive species.

The future of many species and ecological communities relies on increasing the extent and quality of private land conservation. This warrants an independent investigation into conservation barriers and priorities for private land.

Protecting and restoring native vegetation is the essential foundation to environmental health in Victoria, and its continued loss and degradation show the need for stronger and independently administered vegetation laws, and expanded stewardship programs. Victoria's remaining native forests should all be protected, with a transition within 10 years to a sustainable plantations industry and a phase out of firewood collection on public lands

With both human safety and biodiversity at stake, it is vital that burning regimes in Victoria are based on sound science and take account of future climate change. The state-wide target of 5% prescribed burning on public lands should be replaced by a risk-based approach and locale-specific objectives to reduce risks to life, property and biodiversity. Strong planning rules, building codes and cost-benefit assessments of different safety measures are essential to avoid future risks and unnecessary loss of vegetation.

With invasive species having caused many extinctions and declines and widespread degradation, much higher priority needs to be given to preventing new harmful introductions and managing existing threats. With invasive species having caused many extinctions and declines and widespread degradation, much higher priority needs to be given to preventing new harmful introductions and managing existing threats. Stronger laws are needed – to require risk assessment of all proposed introductions, duty-of-care obligations and more systematic regulation of the use of harmful species.

Following is a summary of reforms recommended as high priorities over the next decade to make substantial progress on the protection and restoration of Victoria's terrestrial ecosystems.

Victoria's national park and conservation system

Comprehensive, adequate and representative protection

T1 Commission the Victorian Environmental Assessment Council to investigate how to most effectively achieve a comprehensive, adequate and representative national park and conservation system in Victoria across both public and private lands. High priority areas for protection include:

- Central Victoria: 20 areas recommended in VNPA's Small Parks report[325]
- Melbourne Metro and catchments: a Great Forests National Park, Wombat Forest, a western Melbourne grassland reserve and a network of smaller reserves
- East Gippsland: forest reserves (transfer state forest to the national park estate)
- South West Victoria: a Greater Glenelg National Park (west of the Grampians between the Princes Highway and Little Desert National Park)
- South Gippsland and Strzelecki Ranges: forest reserves (transfer state forest to the national park estate)
- Riverina: Red gum parks as previously recommended by the Environmental Assessment Council – the Murray River park and the Leaghur-Koorangie, Loddon and Avoca River floodplains.

T2 Upgrade protection for conservation reserves listed in schedules of the Crown Land (Reserves) Act:

- Transfer nature conservation reserves to schedule 2C (with protection equivalent to that for properties under schedules 2, 2A and 2B) of the National Parks Act.
- Transfer all other relevant reserves – cultural and natural heritage reserves, natural features reserves, historic and cultural features reserves, regional parks, miscellaneous reserves, water reserves and forest parks – to the National Parks Act, listing them temporarily as a new schedule.
- Commission the Victorian Environmental Assessment Council to assess the most appropriate future management arrangements for these properties.

T3 Establish an acquisition fund for the purchase of high priority lands for addition to the national park estate.

Indigenous land conservation

T4 Actively engage with Indigenous owners to develop land management agreements for biodiversity conservation.

T5 Provide ongoing financial support for joint and cooperative management agreements over existing national parks and reserves.

T6 Work with Indigenous representatives to determine how to better support Indigenous aspirations for conservation management.

Private land conservation

T7 Commission the Victorian Environmental Assessment Council to conduct a review of private land conservation, with a focus on:

- the potential contribution of private land conservation to achieve a comprehensive, adequate and representative national park and conservation system
- priorities for private land conservation and incentives needed to achieve these priorities
- barriers to private land conservation and how to overcome them
- the role of government in promoting private land conservation.

T8 Implement measures and incentives to support conservation on private land:

- exempt properties with Trust for Nature covenants from local government rates
- exempt sales of properties with Trust for Nature covenants from stamp duty
- pay for Trust for Nature covenants in priority areas through the BushTender program
- fund a base transaction fee for all new Trust for Nature covenants
- establish a land improvement fund to support landholders to maintain and improve the conservation values of covenanted properties.

T9 Provide support for non-government organisations that manage large areas for

conservation (eg Trust for Nature and Bush Heritage Australia) through capacity building, collaboration with Parks Victoria and other measures.

T10 Ensure that conservation gains on private lands secured with public funds are monitored and maintained into the future, by mechanisms such as permanent conservation covenants.

Planning and management

T11 Develop a strategic plan to guide the future of Victoria's national park estate that also communicates its role and importance.

T12 Improve community education to build broad support for national parks.

T13 Promote conservation-compatible, broad community uses of national parks to encourage physical and mental well-being rather than high-end tourism uses.

T14 Strengthen protection of the national park and conservation system from activities incompatible with the primary purpose of nature conservation:

- Amend the National Parks Act to prohibit mineral exploration and fossicking in the national park estate.
- Maintain a ban on cattle grazing.
- Rule out commercial-scale ecological thinning or logging by stealth.
- Reverse the decision to allow private commercial developments and limit leases to existing structure in parks (no new buildings and structures for commercial purposes).
- Amend the Nature Conservation Trust Act to prohibit mining and mineral exploration in areas under a perpetual conservation covenant and in Trust for Nature reserves.

T15 Strengthen the focus on management planning for national parks and improve the policy development capacity within the parks agency.

T16 Improve the scientific skills base of staff employed by the parks agency, including for monitoring.

T17 Set up scientific advisory panels for specific national park management issues as they arise.

T18 Upgrade and expand invasive plant and animal control programs, and monitor their effectiveness.

T19 Conduct ecologically beneficial fire management with advice provided by an expert panel.

T20 Provide dedicated funding for management and monitoring of national parks, with a specific budget line to allow tracking of spending levels.

T21 Review existing state charges and levies, such as the parks and waterways levy, to identify funding options for improving management of the national park and conservation system.

T22 Build the resilience of the national park and conservation system to climate change by improving the knowledge base, protecting climate refugia, connecting the national park estate along environmental gradients and including a climate adaptation focus in national park management plans (other recommendations in chapter 5).

T23 Implement recommendations by the Victorian Environmental Assessment Council to facilitate stewardship agreements with organisations and individuals for small public land reserves, including voluntary and payment-based agreements. They should clarify appropriate public land uses, and provide training programs and additional resources if required for conservation outcomes.[326]

Native vegetation protection

Effective regulation

T24 Develop new vegetation laws, as part of the proposed Victorian Environment and Conservation Act (described in chapter 5) that include the establishment of an independent Native Vegetation Regulator to assess clearing applications, oversee monitoring, conduct enforcement, administer offset schemes and provide expert advice for policy-making.

T25 Strengthen the native vegetation management framework, including by the following measures:

- Revert to a clear state-wide objective of 'net gain'.

- Reinstate the three-step hierarchical approach of (1) avoid adverse impacts, (2) minimise impacts and (3) offset impacts.
- Assess the indirect impacts of agricultural activities (cropping, grazing) on vegetation and hydrology.
- Develop a knowledge base to predict the likely responses of different vegetation types to climate change.

T26 Implement a systematic approach to compliance monitoring and enforcement of vegetation rules at local and state levels:

- Establish a native vegetation monitoring program, with oversight by the Native Vegetation Regulator.
- Audit the performance of permit-holders, including at offset sites.
- Establish environmental monitors to ensure compliance with approval conditions, especially for large developments.
- Publish online all relevant information, including permits, plans, assessment and monitoring reports, enforcement notices and actions.
- Provide resources to local governments to perform their duties.
- Regularly audit and report on the effectiveness of the system, including estimates of illegal clearing.

T27 Improve the offsets framework to deliver genuine conservation gains:

- Commission an independent audit of offsets under the native vegetation management framework to assess the extent to which offset targets are being achieved, their degree of permanence, and improvements needed to deliver a state objective of 'net gain'.
- Require offsets for all approved actions that are likely to be detrimental to species on the state government's advisory lists of threatened plants and animals.
- Establish a long-term monitoring program for offsets.
- For low risk activities in low value areas, require offset payments according to a fixed rate and where the funds can be used to support existing protected areas.
- Support the accreditation of pooled services that can bank offset credits and source required offset outcomes.
- Ensure that any offsets to provide for improved management of existing protected areas will achieve genuine 'additionality'.

Biolinks and stewardship

T28 Develop a statewide biolinks plan to enhance landscape connectivity and manage and restore conservation values at the landscape level:

- Build on the flagships and biolinks identified in the 2009 Securing Our Natural Future: A White Paper for Land and Biodiversity at a Time of Climate Change.
- Incorporate focal landscapes and priority biodiversity zones identified in the Trust for Nature's Statewide Conservation Plan.
- Supports the community to undertake detailed landscape, regional and local biolink ecological assessments and planning.
- Include a framework for engaging the community, building land manager capacity and communication.

T29 Expand the use of ecomarkets, such as BushTender and offsets, within a framework of delivering genuine, permanent conservation gains (by perpetual covenants).

T30 Review the Land for Wildlife program to recommend how it can be expanded and its environmental outcomes improved.

T31 Commission research on how to increase the ecological and evolutionary resilience of native vegetation in the face of climate change, including consideration of changes in local provenance requirements and the role of connectivity.

Native forest protection

Timber harvesting and forest protection

T32 Transition Victoria's wood products industry from native forests to plantations. For woodchip, pulp and paper customers complete the transition within five years and for sawn timber customers within 10 years. Aim to be employment positive in five years and economically positive in 10 years. Provide security of supply to the restructured timber industry and support the use of leading-

edge technology. Elements of this transition would include:

- an immediate moratorium on logging of high value conservation sites, such as Leadbeater's possum habitat in the Central Highlands
- industry assistance and a regional development package to support the transition to plantations and investment in new technology
- additions to the national park and conservation system after detailed regional investigations by an appropriately qualified independent body such as the Victorian Environmental Assessment Council.

T33 Immediately ban logging in western Victoria and cancel the regional forest agreement applying to south-west Victoria.

T34 Apply the federal Environment Protection and Biodiversity Conservation Act to all relevant forestry activities by removing the exemption for forestry conducted under regional forest agreements.

T35 Reform forestry policies and guidelines including the regional forest agreements, the code of timber production and timber contracts to require that all threatened species are protected, and climate change and invasive species threats are properly considered.

T36 Establish Victoria as a world-leader in protecting forest-based carbon stores that assist the state in meeting carbon pollution reduction targets.

T37 Incorporate informal forestry reserves such as 'special protection zones' into the national park and conservation system by protecting them under the National Parks Act.

Firewood collection

T38 Introduce a new approach to managing firewood in Victoria that ensures continued firewood supply and protection of native forests:

- Establish a regional development program to provide incentives to support private farm forestry growers to provide firewood.
- Phase out firewood collection from public land.
- In the interim, require all collection from public land to be licenced with stringent conditions to protect conservation values.

Bushfire management

Planning for public safety and biodiversity

T39 Assess the need for prescribed burning programs at a local level in the context of other potentially more useful public safety measures, such as building designs, public and private fire shelters, fire-wise planning provisions, building regulations, powerline maintenance and location and public education.

T40 Do cost-benefit assessments of a range of safety measures when planning fire management, acknowledging that strategies other than fuel reduction are likely to be more useful and cost-effective in some areas.

T41 Give priority in fuel reduction planning to prescribed burns that are (a) critical for public safety and (b) beneficial to both public safety and biodiversity.

T42 Replace any annual state-wide target (5% or otherwise) for prescribed burning by a risk-based approach, focussed on meeting local objectives in regional fire operation plans that reduce risks to life, property and biodiversity.

T43 Apply strong planning rules and building codes in bushfire prone areas to avoid placing homes and people at risk and to reduce the need to remove or modify native vegetation. Take climate change predictions for more frequent and more severe fire events into account.

Ecologically beneficial fire regimes

T44 Establish a suitable range of age classes for each ecological vegetation division (or ecological vegetation class as appropriate) and incorporate this into long-term fire operations planning, making provision for wildfire events as well as planned burns. In particular, this applies to the retention of adequate long-unburnt areas as they cannot be recovered for decades or, in some

cases, centuries. Apply the precautionary principle to these decisions.

T45 Revise minimum and maximum tolerable fire intervals for each ecological vegetation division (and in critical cases, for each ecological vegetation class) allowing as far as possible for the full range of species likely to be affected. Develop clear guidelines for burn severity and patchiness for different ecological vegetation classes.

Prescribed burning practices and responses to wildfire

T46 Plan fuel reduction across all land tenures, including private land, and include slashing and other methods as well as burning.

T47 Include both planned burns and wildfire, and the effectiveness of burns, in assessing whether fuel reduction aims and biodiversity protection have been achieved.

T48 Take account of the condition of ecological vegetation classes (such as drought stress) at the time of proposed burning.

T49 In fire plans require protection of a sufficient number and range of hollow-bearing trees for the long-term protection of hollow-dependent fauna. Apply this requirement also to tree clearing that is conducted for safety reasons in advance of prescribed burns.

T50 Include fire-sensitive species and ecological communities (eg rainforest) as 'assets' warranting protection from both wildfire and planned burns.

Research, monitoring and adaptive management[327]

T51 Include adaptive management, in response to short term and long-term monitoring, as an essential component of fire management planning.

T52 Develop rapid monitoring methods (such as DNA sampling) for invertebrates, non-vascular plants, fungi and microbes, to assess short and long-term impacts of fires on biodiversity.

T53 Conduct research and/or monitoring to investigate:

- the effectiveness of fuel reduction burns in different ecological vegetation classes
- whether fire regimes are trending towards or away from long-term maintenance of an appropriate range of age classes, with particular reference to old age classes
- the effects of different fire regimes (frequency, severity, patterns and scales of patchiness) on different species and ecological vegetation classes
- changes in vegetation composition after repeated fires, including changes in flammability
- seasonal differences in post-fire recovery, and post-fire pest plant and animal invasion
- how long seeds and eggs remain viable in soil
- the effects of below-ground fire.

Education and communication

T54 Conduct ongoing public education on the following topics:

- the full range of options for increasing personal safety in the face of fire, especially local options for increasing safety
- the limitations of fuel reduction burn programs in relation to public safety, especially in severe fire weather
- an understanding of the impacts of different fire regimes on an area's natural values
- the need for adaptive management in the face of new knowledge.

Invasive species management

T55 Develop stand-alone biosecurity legislation to strengthen the approach to harmful invasive organisms (details in chapter 5):

T56 Establish regional weed committees involving local governments, other land managers and community representatives to develop strategies and allocate resources for weed eradication and control.

T57 Develop training and certification systems for weed control to be required for all workers and

contractors involved with weed control on public lands, modelled on the DPI Weedstop certification.

T58 Expand programs facilitating community engagement in pest plant and animal management and ecological monitoring.

T59 Reclassify deer, a 'game' species currently protected under the Wildlife Act, as a pest species, map current populations and implement coordinated control programs, eradicating populations where feasible.

T60 Undertake a control program to rapidly reduce the population of feral horses in the alpine national parks and surrounding areas, primarily using aerial shooting under RSPCA-endorsed protocols.

T61 Develop guidelines for managing native species whose distribution is changing dramatically as a consequence of climate change or other anthropogenic drivers and which may have adverse impacts on biodiversity.

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