



State of the Environment
Biodiversity Update 2021 Report



Traditional Owners

The Commissioner for Environmental Sustainability proudly acknowledges Victoria's Aboriginal community and their rich culture and pays respect to their Elders past and present. We acknowledge Aboriginal people as Australia's First Peoples and as the Traditional Owners and custodians of the land and water on which we rely. We recognise and value the ongoing contribution of Aboriginal people and communities to Victorian life, and how this enriches us. We embrace the spirit of reconciliation, working towards the equality of outcomes and ensuring an equal voice.

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Commissioner's Foreword

I am pleased to present this State of the Environment Biodiversity Update 2021 Report.

The next Victorian State of the Environment (SoE) Report is due in 2023. However, given the severity and impact of the 2019-20 black summer bushfires on Victoria's ecosystems, this report has been prepared ahead of the SoE 2023 Report and uses science undertaken by the Victorian Government since the fires included in DELWP's Victoria's Bushfire Emergency: Biodiversity Response and Recovery. It also utilises important science contributed by the community, such as the Victorian National Parks Association and local East Gippsland conservation groups' report *After the Fires: protecting our forest refuges – critical areas for protecting fauna and flora affected by the 2019–20 bushfires*. Complementing the Victorian Government's ongoing scientific analysis, we apply an independent lens and present a statewide view bringing together the available science through an expert review process.

This report goes beyond the fire affected areas to consider refuges and areas not burnt by the 2019-20 fires. It assesses 43 indicators and will inform the Victorian Government's evaluation of the Protecting Victoria's Environment – Biodiversity 2037 (Bioplan) and the SoE 2023. It is also a valuable source of information for the Major Event Review into the Victorian Regional Forest Agreements (RFAs) initiated in December 2020, as a result of the fires. The Victorian Auditor General's audit *Protecting Victoria's Biodiversity* was tabled in Parliament after this report was finalised, however the findings of the audit, specifically concerns related to the availability of science and data, are consistent with those presented here.

The indicator assessments have largely retained their SoE 2018 status, trend and data confidence with some exceptions. Data availability remains a challenge and while monitoring and research continue, since the fires, much of this data is yet to be peer-reviewed or made publicly available. Preliminary estimates suggest that approximately 20% of above-ground biomass and debris was burnt in the 2019–20 bushfires. Up to 30 plant species could be threatened because of the damage caused

by the 2019–20 bushfires, five threatened frog species had significant percentages of their modelled habitats within the fire extent and the eastern bristlebird, threatened small-bodied native fish and macroinvertebrates were the focus of emergency post-fire extractions. With large areas of forest severely impacted by fire in north-eastern and far-eastern Victoria, those areas that remain unburnt are now more critical to species recovery as refuges and genetic storehouses.

My job as Commissioner is to provide independent and objective reporting to inform policymakers, regulators, environmental managers, scientists, and the wider Victorian community about the state of our natural environment, and to advise government. Another critical part of my job is to shine a light on the areas of Victoria's environment that are working well, and those we need to improve. I am sincerely grateful to the many scientists who contributed their time and academic expertise to generously help peer-review the assessments included in this report. Thank you.

I also thank my dedicated team and colleagues from across Victoria. We are indebted to DELWP and other Victorian government teams for their time, expertise, and support. Thanks also to our non-government partners and stakeholders - from citizen scientists to academics and members of the Commissioner's Reference Group - who have generously volunteered their time and knowledge. Your guidance and feedback are invaluable.

It is an honour to serve as Victoria's Commissioner for Environmental Sustainability. I am pleased to present the State of the Environment Biodiversity Update 2021 Report, and hope that the findings are utilised in ways that benefit Victoria's environment and communities, now and into the future.

I invite you to keep in touch with our work through your preferred social media channels.



Dr Gillian Sparkes AM

Commissioner for Environmental Sustainability, Victoria

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Environment Protection Agency Victoria	Trust for Nature
Glenelg Hopkins Catchment Management Authority	Zoos Victoria
Goulburn Broken Catchment Management Authority	

Abbreviations

AUSRIVAS O/E	Australian River Assessment System Observed/Expected Index
CAM	Common Assessment Method
CAR	Comprehensive Adequate and Representative
CFA	Country Fire Authority
CMA	Catchment Management Authority
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DELWP.....	Department of Environment, Land, Water and Planning
DJPR.....	Department of Jobs, Precincts and Regions
eDNA.....	Environmental DNA
EPBC Act.....	Environment Protection and Biodiversity Conservation Act 1999
EVC	Ecological Vegetation Class
GMA	Geometric Mean Abundance
GSS	Growth Stage Structure
IUCN	International Union for Conservation of Nature
JANIS.....	Joint ANZECC/MCFFA National Forest Policy Statement Implementation Subcommittee
KTBA	Known to be Alive
LiDAR.....	Light Detection and Ranging
MERI	Monitoring, Evaluation, Reporting and Improvement
RCP	Representative Concentration Pathway
RFA	Regional Forest Agreements
RiverMAP.....	River Monitoring and Assessment Program
SEPP	State Environment Protection Policy
SIGNAL2.....	Stream Invertebrate Grade Number Average Level
SoE.....	State of the Environment
TFI.....	Tolerable Fire Interval
TSX.....	Threatened Species Index
VEFMAP	Victorian Environmental Flows Monitoring and Assessment Program Commissioner's foreword

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Commissioner
for Environmental
Sustainability
Victoria

Part I – Executive summary

Report structure

This State of the Environment Biodiversity Update 2021 Report contains two parts.

Part I summarises the report's structure, and provides summaries of the assessments of Status, Trend and Data Confidence and key findings. It also includes a summary of the public policy context for biodiversity conservation and management in Victoria (discussed in detail under each indicator theme in Part II) and outlines current and emerging research supporting the scientific assessments. Part I concludes with indicator report card summaries that include the metrics for each indicator, a key comment arising from the assessment, the region to which the indicator applies, and identification of the data custodian

Part II contains the assessments for 37 of the 43 indicators that were reviewed (see Table 1). Six of the 43 were not assessed due to insufficient data, however narratives have been written for four of them.

The 43 indicators reviewed have been grouped into seven themes:

- Fire
- Climate change
- Invasive plants and animals
- Threatened species and communities
- Wetlands and rivers
- Forests
- Victoria's biodiversity targets

The scientific assessments of the indicators rely on publicly available scientific data that include reports, professional journal articles, submissions to Parliamentary and other government inquiries, citizen science projects and interviews with experts in relevant fields. The data are subsequently assessed and synthesised by the science team supporting the Commissioner for Environmental Sustainability. The assessments have been conducted on a statewide basis and have evaluated the impact of the 2019–20 bushfires on Victoria's biodiversity.

Part II concludes with a list of the key references used in preparing the report.

Summary of 2021 indicator assessments for Status, Trend and Data Confidence

Table 1 (on the next page) provides a summary of the Status, Trend and Data Confidence in the 43 indicator assessments for 2021. The colour keys for the assessments are as follows:

Key to Status



Good



Fair



Poor



Unknown



Narrative but
not assessed



Not assessed
and no narrative

Key to Trend



Improving



Stable



Deteriorating



Unclear

Key to Data Confidence



High



Moderate



Low



Unknown

Table 1: Indicators assessed for the State of the Environment Biodiversity Update 2021 Report.

THEME: Fire										
	STATUS					TREND	DATA CONFIDENCE			INSUFFICIENT EVIDENCE TO ASSESS
	GOOD	FAIR	POOR	UNKNOWN	N/A or NARRATIVE		HIGH	MODERATE	LOW	
Fi:01 Area of native vegetation burnt in planned fires and bushfires Data Custodian DELWP						↙				
Fi:02 Impacts of bushfires Data Custodian Various						?				
Fi:03 Actual fire regimes compared to optimal fire regimes Data Custodian DELWP						↙				
Fi:04 Bushfire risk Data Custodian DELWP; BoM						↙				
THEME: Climate change										
	STATUS					TREND	DATA CONFIDENCE			INSUFFICIENT EVIDENCE TO ASSESS
	GOOD	FAIR	POOR	UNKNOWN	N/A or NARRATIVE		HIGH	MODERATE	LOW	
CC:11 Victorian ecosystem carbon stocks: Land (Marine not assessed) Data Custodian DELWP						→				
CC:13 Extent and condition of climate-sensitive systems Data Custodian DELWP, Parks Victoria						?				
THEME: Invasive plants and animals										
	STATUS					TREND	DATA CONFIDENCE			INSUFFICIENT EVIDENCE TO ASSESS
	GOOD	FAIR	POOR	UNKNOWN	N/A or NARRATIVE		HIGH	MODERATE	LOW	
B:01 Invasive freshwater plant and animal species (other than carp) Data Custodian DELWP						?				
B:01A European carp Data Custodian DELWP; Catchment management authorities						↙				
B:02 Invasive terrestrial plant species Data Custodian DELWP; DJPR						↙				
B:03 Invasive terrestrial animal species Data Custodian DELWP; DJPR; Parks Victoria						↙				

Table 1: Indicators assessed for the State of the Environment Biodiversity Update 2021 Report.

THEME: Invasive plants and animals (cont'd)											
	STATUS					TREND	DATA CONFIDENCE			INSUFFICIENT EVIDENCE TO ASSESS	
	GOOD	FAIR	POOR	UNKNOWN	N/A or NARRATIVE		HIGH	MODERATE	LOW		
B:03A Feral deer species Data Custodian DELWP; DJPR						↙					
B:03B Feral horses Data Custodian DELWP; Parks Victoria						↙					
THEME: Threatened species and communities											
	STATUS					TREND	DATA CONFIDENCE			INSUFFICIENT EVIDENCE TO ASSESS	
	GOOD	FAIR	POOR	UNKNOWN	N/A or NARRATIVE		HIGH	MODERATE	LOW		
B:19 Landscape-scale change Data Custodian DELWP						↙					
B:04 Threatened freshwater species in the wild Data Custodian DELWP						?					
B:04A Trout cod Data Custodian DELWP						→					
B:04B Macquarie perch Data Custodian DELWP						→					
B:04C Murray crayfish Data Custodian DELWP						↙					
B:04D Spotted tree frog Data Custodian DELWP						↙					
B:04E Booroolong frog Data Custodian DELWP						↙					
B:04F Baw Baw frog Data Custodian DELWP						↙					
B:05 Threatened wetland-dependent species Data Custodian DELWP						?					

Table 1: Indicators assessed for the State of the Environment Biodiversity Update 2021 Report.

THEME: Threatened species and communities (cont'd)										
	STATUS					TREND	DATA CONFIDENCE			INSUFFICIENT EVIDENCE TO ASSESS
	GOOD	FAIR	POOR	UNKNOWN	N/A or NARRATIVE		HIGH	MODERATE	LOW	
B:06 Threatened terrestrial species Data Custodian DELWP						↙				
B:06A Terrestrial vascular plant species Data Custodian DELWP						↙				
B:06B Terrestrial vertebrate species Data Custodian DELWP						↙				
B:06C Terrestrial invertebrate species Data Custodian DELWP						↙				
B:07 The conservation and management of biodiversity on private land Data Custodian DELWP; Trust for Nature; Catchment management authorities						↗				
B:08 The conservation and management of Victorian ecosystems on public land Data Custodian DELWP; Parks Victoria						→				
THEME: Wetlands and rivers										
	STATUS					TREND	DATA CONFIDENCE			INSUFFICIENT EVIDENCE TO ASSESS
	GOOD	FAIR	POOR	UNKNOWN	N/A or NARRATIVE		HIGH	MODERATE	LOW	
B:09 River health Data Custodian DELWP; Catchment management authorities; Melbourne Water						→				
B:10 Riparian vegetation habitat extent Data Custodian DELWP; Catchment management authorities; Melbourne Water						→				
B:11 Area of functional floodplain Data Custodian DELWP; Catchment management authorities; Victorian Environment Water Holder						?				
B:12 Threatened native frog species Data Custodian DELWP						↙				
B:13 Native fish species Data Custodian DELWP						?				

Table 1: Indicators assessed for the State of the Environment Biodiversity Update 2021 Report.

THEME: Wetlands and rivers (cont'd)										
	STATUS					TREND	DATA CONFIDENCE			INSUFFICIENT EVIDENCE TO ASSESS
	GOOD	FAIR	POOR	UNKNOWN	N/A or NARRATIVE		HIGH	MODERATE	LOW	
B:14 Waterbirds in the Murray-Darling Basin Data Custodian DELWP										
B:15 Freshwater macroinvertebrate species Data Custodian Nil										
B:16 Wetland extent and condition Data Custodian DELWP										
B:17 Health and status of Ramsar wetlands in Victoria Data Custodian DELWP										
THEME: Forests										
	STATUS					TREND	DATA CONFIDENCE			INSUFFICIENT EVIDENCE TO ASSESS
	GOOD	FAIR	POOR	UNKNOWN	N/A or NARRATIVE		HIGH	MODERATE	LOW	
Fo:03 Area of forest type by growth stage distribution in protected zones Data Custodian DELWP; Parks Victoria										
Fo:06 Threatened forest-dependent species Data Custodian DELWP										
THEME: Victoria's biodiversity targets										
	STATUS					TREND	DATA CONFIDENCE			INSUFFICIENT EVIDENCE TO ASSESS
	GOOD	FAIR	POOR	UNKNOWN	N/A or NARRATIVE		HIGH	MODERATE	LOW	
B:18 Net gain in extent and condition of native vegetation Data Custodian DELWP										
B:20 Change in suitable habitat for threatened native species Data Custodian DELWP										
B:21 Area of management in priority locations Data Custodian DELWP										
B:22 Victorians value nature Data Custodian DELWP										
B:23 Number of Victorian government organisations that manage environmental assets that contribute to environmental economic accounting Data Custodian DELWP										

Summary of status assessments

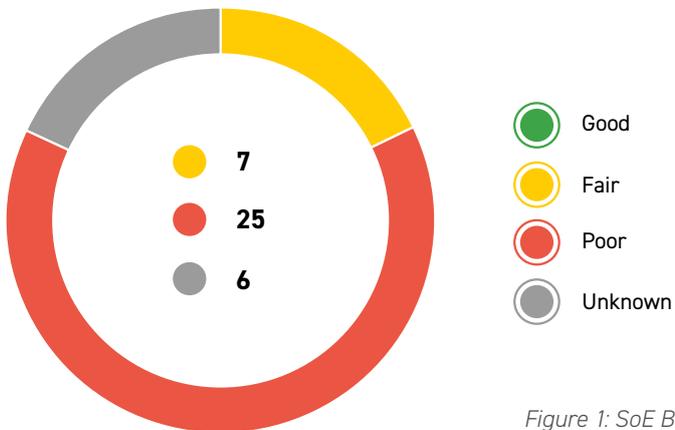


Figure 1: SoE Biodiversity Update 2021 summary of status assessments.

Summary of trend assessments

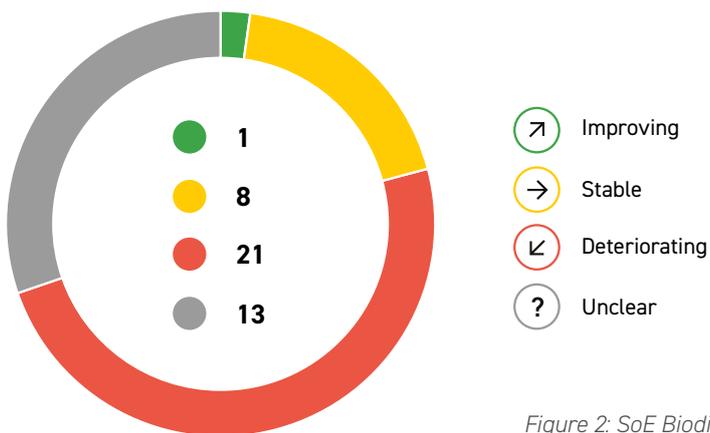


Figure 2: SoE Biodiversity Update 2021 summary of trend assessments.

Summary of data confidence

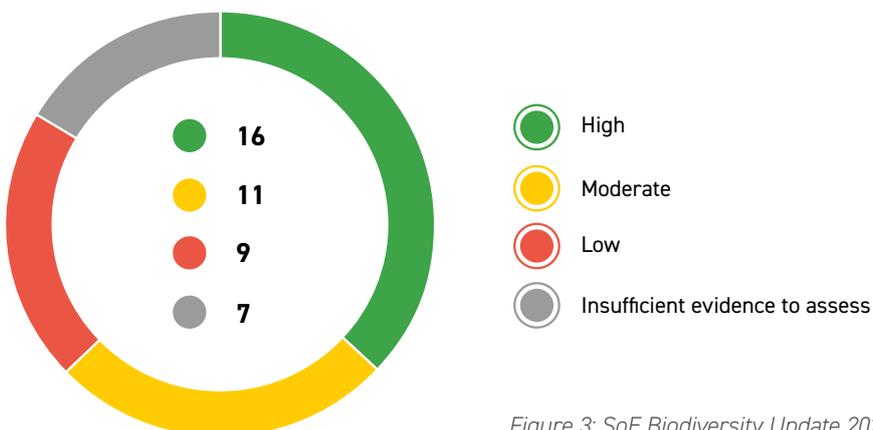


Figure 3: SoE Biodiversity Update 2021 summary of data confidence assessments.

Key findings

Forty-three indicators from the SoE 2018 Report were assessed again in this report. Generally, the indicators have retained their 2018 assessments for Status, Trend and Data Confidence with some exceptions. In 2018, availability of data for 65% of the indicators was assessed as being poor or fair; similarly, in this report, data availability for 63% of the indicators was assessed as insufficient, low or moderate. Hence, limited data availability is still a challenge for environmental condition reporting and implementation of Recommendation 5 from the SoE 2018¹ remains critical.

Of the 43 indicators reviewed, 37 were given Status assessments, and narratives have been included for four of the six not assessed. As Figure 1 asserts, 26 of the 37 indicators that were assessed for Status in 2021 have been rated as Poor, six as Fair and five as Unknown.

Trend assessments for the 43 indicators found that one was Improving and most were either Deteriorating or Unclear (Figure 2).

Post-fire Data Confidence

Data Confidence is assessed on a statewide basis. The Data Confidence assessments of the 43 indicators in this report are 16 High, 11 Moderate and 16 Low or Insufficient (Figure 3). Data availability remains a challenge and while monitoring and research continue since the fires, much of this data is yet to be peer-reviewed or made publicly available.

Of 35 biodiversity indicators assessed in the SoE 2018 report, the metrics for a small number of them (e.g., frogs, fish, terrestrial vertebrates and forest-dependent species) were measurably impacted by the 2019-20 bushfires centred around eastern and north-eastern Victoria. The metrics for the other indicators were either little affected or the impact was not measurable due to insufficient data.

The scale of devastation in the 2019-20 bushfires initiated immediate and collaborative government and community biodiversity response and recovery actions that were resourced, coordinated and targeted at threatened species and ecological communities. Satellite mapping of the fire extent and its correlation with the modelled habitats of species, post-fire fieldwork, extraction of plant and animal species and the culling of invasive herbivores were highlights of the response in the fire-affected areas. The DELWP report, 'Victoria's bushfire emergency: Biodiversity response and recovery', released in January 2020 and revised in August 2020, provides an excellent snapshot in time of the impact that the fires had on plant and animal species and ecological communities. The DELWP report is an important source of publicly reported data but is largely based on modelled species habitats (and some on-ground observations) and correlation with the mapped fire extent in north-eastern and eastern Victoria.

For many species there are few baseline data sets from which to monitor change in abundance and distribution over time. There are also many species that have been given little attention in on-ground research e.g., reptiles, insects, freshwater invertebrates and small-bodied freshwater fish. Additional indicators could be used in future state of the environment reports to address knowledge gaps for these species and improve reporting on Victoria's biodiversity. There is also the need to expand monitoring and public reporting and to conduct targeted research to better understand the interactions between species within ecological communities.

Fire

Four indicators from the SoE 2018 Report's Fire Chapter were reviewed for this report. Two retained their Poor Status and one retained its Fair Status, while the fourth, Fi:03 Actual fire regimes compared to optimal fire regimes, had its Status changed from Fair to Poor.

- Preliminary estimates suggest that approximately 20% of above-ground biomass and debris was burnt in the 2019-20 bushfires, some of which may be returned as forests regrow, although this is uncertain.
- The severity, extent, frequency and duration of bushfires have all increased, fire seasons are now longer and more dangerous, and the

1. Recommendation 5: That DELWP streamline the governance and coordination of investment in the science and data capability of all government biodiversity programs and improve the coherence and impact of the publicly funded, scientific endeavour. Further, that DELWP establish the position of the Chief Biodiversity Scientist to oversee this coordinated effort and provide esteemed counsel to the DELWP Secretary and the Minister for Environment to improve the impact of investment in biodiversity research across the Victorian environment portfolio. Victorian Government Response December 2020: Supported in Part.

Key findings

window for fuel management is closing, changes that are driven by the drier, hotter and stormier conditions generated by climate change.

- Many areas are now experiencing increased frequency of fires, the area of public forests below the minimum Tolerable Fire Interval (TFI) is increasing, and the area with a no-burn history decreasing. This threatens species and communities that lack resilience to fire.

Climate change

Two indicators from the SoE 2018 Report's Climate change chapter were reviewed for this report. There was no change made to the assessment of either indicator for Status, Trend and Data Confidence. The Status of CC:11 Victorian ecosystem carbon stocks was again rated as Fair for land-based carbon stocks and Unknown for marine stocks, while the Status of CC:13 Extent and condition of climate-sensitive systems remains Unknown.

- Climate change impacted the scale and intensity of the 2019–20 bushfires and, for biodiversity, a warming climate will place further stress on species and ecological communities already under extreme pressure from other threats.
- Rainforest communities are sensitive to climate change, were severely impacted by the 2019–20 bushfires and could take decades or longer to recover.
- Maintaining or increasing forest carbon stocks will be critical in the mitigation of climate change. Native forest regeneration, carbon and environmental plantings, soil carbon removal and restoration of degraded lands could help maintain and increase carbon stocks.

Invasive plants and animals

Of the 35 indicators that appeared in the SoE 2018 Report's Biodiversity Chapter, the six covering invasive plants and animals were assessed for this report. The 2018 Status and Trend for five of the indicators remained Poor and Deteriorating. However, Data Confidence for B:01 Invasive freshwater plant and animal species dropped from Poor to Insufficient and the Status was not assessed.

In the other change, Data Confidence for B:02 Invasive terrestrial plant species was moved from High to Moderate.

- Invasive plants, predators and herbivores are increasing in abundance and range and are the major threat to most threatened species.
- The full effect of the 2019–20 bushfires on invasive species is yet to be determined, however there is concern that they could exploit the post-fire vulnerability of native species.
- There remains very limited data on the number, abundance and distribution of invasive species.
- Various government and community projects are targeting the control of invasive plants and animals.

Threatened species and communities

Fifteen indicators from the SoE 2018 Report's Biodiversity chapter under this theme were reviewed. Except for a Status change for B:04B Macquarie perch from Fair to Poor, and Data Confidence changes from Moderate to High for B:19 Landscape-scale change, the 2018 assessments for the 15 indicators were retained i.e., the Status of nine remained Poor, three Fair and two Unknown.

- The 2019–20 bushfires mostly burnt across areas of high biodiversity value. Many species and ecological communities impacted might require reassessment of their conservation status and could in future be added to the Flora and Fauna Guarantee Threatened List.
- Up to 30 plant species could be threatened because of the damage caused by the 2019–20 bushfires, and some could become extinct.
- Five threatened frog species had significant percentages of their modelled habitats within the fire extent, while the eastern bristlebird, threatened small-bodied native fish and macroinvertebrates were the focus of emergency post-fire extractions.
- Victoria's native fish, frogs and freshwater invertebrates remain threatened by the loss and degradation of their habitats and the introduction of invasive predators such as trout and disease.
- The fires also impacted existing species monitoring and recovery efforts, such as the Southern Ark's long-nosed potoroo recovery project in eastern Victoria.

Key findings

- The use of more rigorous assessment criteria has resulted in many threatened species having their conservation status upgraded e.g., from Vulnerable to Critically Endangered, a recognition of their ongoing stress and risk of extinction.
- Expanding the conservation of native vegetation on private land can make an important contribution to filling the gaps that currently exist in Victoria's protected areas network.

Wetlands and rivers

The assessments under this theme cover nine indicators from the SoE 2018 Report's Biodiversity chapter. For five of the indicators, their Poor Status in 2018 is unchanged, while B:17 Health and status of Ramsar wetlands in Victoria has changed from Poor to Fair (Data Confidence was also changed from Poor to Moderate). For B:13 Native fish species, the Trend changed from Deteriorating to Unknown and Data Confidence from High to Moderate, while for B:10 Riparian vegetation habitat extent, the Trend changed from Unknown to Stable. Data Confidence was changed from Low to Insufficient for B:11 Area of functional floodplain (a narrative is included rather than an assessment), and B:15 Freshwater macroinvertebrate species was not assessed this time due to Insufficient Data.

- The upper reaches of rivers in eastern Victoria were most affected by the 2019–20 bushfires, impacting frogs and small-bodied fish such as the galaxiids.
- The many threats facing Victoria's rivers and wetlands are leading to declines in the abundance and distribution of native fish, frog and waterbird species.
- Long-term surface water availability in Victoria has declined, and is projected to continue due to climate change, increasing pressure to allocate more water to human consumption in response to population growth and agricultural development, rather than the environment.
- Catchment management authorities and other agencies are working in regional communities to improve river health, the extent of riparian vegetation and the abundance and distribution of native freshwater species.

Forests

To provide a focus on the habitat most impacted by the 2019–20 bushfires, two indicators from the SoE 2018 Report's Forests chapter were reviewed for this report. Although there are no changes to Status, the Trend for Fo:03 Area of forest type by growth stage distribution in protected zones was changed from Improving to Stable. The Status for Fo:06 Threatened forest-dependent species remains Fair, however the forest impacts of the 2019–20 bushfires has been severe and, as field research improves the understanding of those impacts, a change to Poor could be considered in the SoE 2023 Report.

- Large areas of forest in north-eastern and far-eastern Victoria were impacted by the 2019–20 bushfires.
- Forest-dependent threatened species are continuing to experience declines in abundance due to habitat loss, bushfires and drought.
- With large areas of forest severely impacted by fire, those areas that remain unburnt are now more critical to species recovery as refuges and genetic storehouses for genetic rescue.

Victoria's biodiversity targets

The SoE 2018 Report included six indicators aligned with the actions of Protecting Victoria's Environment – Biodiversity 2037 (Biodiversity 2037), the Victorian Government's policy response to addressing the decline in the state's biodiversity. On consideration, B:19 Landscape-scale change has been moved from this theme to Invasive Plants and Animals in this update report. The 2018 Poor Status for B:18 Net gain in the extent of native vegetation has been retained, while there was Insufficient Data Confidence to assess the other four indicators. Narratives have been included for three of the four; B:23 Number of Victorian government organisations that manage environmental assets that contribute to environmental economic accounting was not assessed.

- The assessment of B:18 Net gain in the extent of native vegetation revealed an ongoing net loss.
- Biodiversity 2037 has five-yearly milestone targets for each of its key indicators. The initial data suggest that except for weed and pest control, considerable effort will be needed to meet the 2022–23 milestone targets.

Report card summaries

Introduction

This report reviews 43 indicators from the Biodiversity (35 indicators), Forests (two indicators), Fire (four indicators) and Climate change (two indicators) chapters of the SoE 2018 Report. Six of the indicators were not assessed due to insufficient data, although narratives have been included for four of them.

These report card summaries are drawn from the scientific assessments of each indicator that are discussed in more detail in Part II. Each report card includes the metrics for the indicator, the region covered by the indicator, an overall comment on the assessment, a traffic-light summary of Status, Trend and Data Confidence (from both the 2018 report and this 2021 update report), and identification of the data custodian.

Region

Although most of the indicators are assessed on a statewide basis, some apply to rivers or parks or the distribution of a species with a limited range.

Data custodian

The custodian or supplier of data includes government agencies such as the Department of Environment, Land Water and Planning (DELWP), Parks Victoria and the Victorian Environment Protection Authority, as well as third-party providers including academic institutions and community organisations.

Comment

Each report card summary contains a general comment that provides an explanation of an indicator's Status and/or Trend.

Status

The Status of an indicator can be assessed as 'Good', 'Fair' or 'Poor'. Where there is insufficient data, the indicator status is assessed as 'Unknown'. The legend for Status in the report card summary is from the SoE 2018 Report and was applied across all of its indicator assessments, not just those covering Victoria's biodiversity.

The legend reads as follows:

-  **Good:** Environmental condition is healthy across Victoria, OR pressure is likely to have negligible impact on environmental condition/human health, OR comprehensive protection of natural ecosystems and biodiversity is evident.
-  **Fair:** Environmental condition is neither positive nor negative and may be variable across Victoria, OR pressure is likely to have limited impact on environmental condition/human health, OR moderate protection of natural ecosystems and biodiversity is evident.
-  **Poor:** Environmental condition is under significant stress, OR pressure is likely to have significant negative impact on environmental condition/human health, OR inadequate protection of natural ecosystems and biodiversity is evident.
-  **Unknown:** Data is insufficient to assess Status or Trend.
-  **N/A (Not Applicable):** The indicator assessment is based on future projections or the change in environmental condition and providing a status assessment is not applicable. Only a trend assessment is provided.
-  **Narrative**

Trend

The Trend identifies whether the Status of the indicator is 'Deteriorating', 'Improving', 'Stable' or 'Unclear'. The legend for Trend in the report card reads as follows:

-  **Improving**
-  **Stable**
-  **Deteriorating**
-  **Unclear**
-  **N/A Not applicable:** This indicator assessment is based on current environmental condition only and it is not applicable to provide a trend assessment. Only a status assessment is provided.

Data Confidence

Data Confidence reflects on knowledge gaps and data limitations when assessing the Status and Trend of the indicator, which may have also been influenced by the impacts of the 2019–20 bushfires. The legend for Data Confidence in the report card reads as follows:

-  **High:** Evidence and consensus too low to make an assessment with confidence
-  **Moderate:** Limited evidence or limited consensus
-  **Low:** Adequate high-quality evidence and high level of consensus
-  **Insufficient** evidence to assess

THEME: Fire

Fi:01 Area of native vegetation burnt in planned fires and bushfires Region Statewide Measures Annual planned burn area; Annual total area affected by bushfires Data Custodian DELWP	Comment An area-based target (5% annual burn of public land) for planned burning was replaced in 2016–17 with a risk-based approach in three-year fire management plans. The average annual extent and frequency of bushfires has increased since 2003.	2018 Status 	2018 Trend 	2018 Data 
		2021 Status 	2021 Trend 	2021 Data 
Fi:02 Impacts of bushfires Region Statewide Measures Impacts of bushfires on human settlements, businesses and natural resources Data Custodian Various	Comment Since 2000, the annual extent and frequency of bushfires has increased, however, there is a lack of clarity regarding responsibility for data collation and dissemination for use in evidence-based decision making.	2018 Status 	2018 Trend 	2018 Data 
		2021 Status 	2021 Trend 	2021 Data 
Fi:03 Actual fire regimes compared to optimal fire regimes Region Statewide Measures Tolerable Fire Interval (TFI) and Growth Stage Structure (GSS) distribution on public forests Data Custodian DELWP	Comment The area of native vegetation (data only for vascular plants, which are a proxy for biodiversity) subject to fires below the minimum Tolerable Fire Interval is increasing, while the area of native vegetation with no fire history or long periods without fire is decreasing. Both trends threaten biodiversity that lacks resilience to fire.	2018 Status 	2018 Trend 	2018 Data 
		2021 Status 	2021 Trend 	2021 Data 
Fi:04 Bushfire risk Region Statewide Measures Residual risk; Impact of climate change on fire weather Data Custodian DELWP; BoM	Comment The risk-based planned-burning approach has the protection of life and property as its highest priority, with the maintenance and improvement of ecosystem resilience the second priority. An audit by the Victorian Auditor-General's Office concluded that the impacts of bushfire management on the state's biodiversity have not been well monitored or assessed.	2018 Status 	2018 Trend 	2018 Data 
		2021 Status 	2021 Trend 	2021 Data 

THEME: Climate change and carbon stocks

CC:11 Victorian ecosystem carbon stocks Region Statewide Measures Land sector carbon stocks; Blue carbon stocks Data Custodian DELWP	Comment There was a net 1% growth in land-sector carbon stocks from 2007–16, largely due to increased carbon in forests. The 2019–20 bushfires will reduce carbon stocks in the short term. These may be rebuilt as the forests regrow; however, increased fire frequency could limit that process. Forest biomass is an indicator of biodiversity and an important element in climate change mitigation. Preliminary estimates suggest that approximately 20% of above-ground biomass and debris was burnt in the 2019–20 bushfires, some of which may be returned as forests regrow, although this is now open to scientific debate.	2018 Status	2018 Trend	2018 Data
		Land 		Land 
		Marine 		Marine 
		2021 Status	2021 Trend	2021 Data
		Land 		Land 
		Marine 		Marine 
CC:13 Extent and condition of climate-sensitive systems Region Statewide Measures Case study examples Data Custodian DELWP, Parks Victoria	Comment Alpine regions, rainforests, red gum plains and estuarine areas are examples of where ecosystems and species are under threat from climate change.	2018 Status 	2018 Trend 	2018 Data 
		2021 Status 	2021 Trend 	2021 Data 

THEME: Invasive plants and animals

<p>B:01 Invasive freshwater plant and animal species (other than carp)</p> <p>Region Statewide</p> <p>Measures Number, abundance and distribution; Threatening processes impacting on native freshwater plants and animals</p> <p>Data Custodian DELWP</p>	<p>Comment An area-based target (5% annual burn of public land) for planned burning was replaced in 2016–17 with a risk-based approach in three-year fire management plans. The average annual extent and frequency of bushfires has increased since 2003.</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>?</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>?</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		?		2021 Status	2021 Trend	2021 Data		?	
2018 Status	2018 Trend	2018 Data												
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2021 Status	2021 Trend	2021 Data												
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<p>B:01A European carp</p> <p>Region Statewide</p> <p>Measures Abundance and distribution</p> <p>Data Custodian DELWP; Catchment management authorities</p>	<p>Comment The European carp is a highly successful and invasive fish species that in some rivers can represent 85% of fish biomass. They are a major threat to native fish species. The National Carp Control Plan has been driving a comprehensive program of research to determine whether the release of a carp virus will be an effective and safe control measure. A decision on the release is expected in 2021–22.</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>↙</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>↙</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		↙		2021 Status	2021 Trend	2021 Data		↙	
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2021 Status	2021 Trend	2021 Data												
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<p>B:02 Invasive terrestrial plant species</p> <p>Region Statewide</p> <p>Measures Number, abundance and distribution</p> <p>Data Custodian DELWP; DJPR</p>	<p>Comment The number of naturalised plants and environmental weeds in Victoria continues to increase and their control is a major focus of actions by government agencies, landholders and the community.</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>↙</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>↙</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		↙		2021 Status	2021 Trend	2021 Data		↙	
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<p>B:03 Invasive terrestrial animal species</p> <p>Region Statewide</p> <p>Measures Number, abundance and distribution</p> <p>Data Custodian DELWP; DJPR; Parks Victoria</p>	<p>Comment Invasive animals are an immediate threat to native fauna and the target of control programs by government agencies. These programs were expanded in the wake of the 2019–20 bushfires due to concerns that invasive herbivores and predators would flourish and increase the risks to native species.</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>↙</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>↙</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		↙		2021 Status	2021 Trend	2021 Data		↙	
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<p>B:03A Feral deer species</p> <p>Region Statewide</p> <p>Measures Number, abundance and distribution</p> <p>Data Custodian DELWP; DJPR</p>	<p>Comment Four deer species have been expanding their distribution and numbers across public and private land since their introduction. The Victorian Deer Control Strategy was released in 2020, however, there is limited understanding of deer ecology to guide deer management. In response to likely increased impacts of deer on fire affected areas, deer control by government agencies has intensified across the extent of the 2019–20 bushfires.</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>↙</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>↙</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		↙		2021 Status	2021 Trend	2021 Data		↙	
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2021 Status	2021 Trend	2021 Data												
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<p>B:03B Feral horses</p> <p>Region Statewide</p> <p>Measures Abundance and distribution</p> <p>Data Custodian DELWP; Parks Victoria</p>	<p>Comment Feral horse population surveys have shown that without management control, and severe natural events such as fire, feral horse populations can increase by 10–20% every two to four years. Although court action to prevent a culling program was eventually unsuccessful, it delayed Parks Victoria's control programs, which commenced in 2021–22.</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>↙</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>↙</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		↙		2021 Status	2021 Trend	2021 Data		↙	
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THEME: Threatened species and communities

<p>B:19 Landscape-scale change</p> <p>Region Statewide</p> <p>Measures Native vegetation extent and land use from 1987–2020</p> <p>Data Custodian DELWP</p>	<p>Comment Analysis of landscape-scale change shows an increase in landscapes associated with human-based activities, along with an overall decrease in native vegetation and intermittent and seasonal wetlands (not of a marine water source).</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>↙</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>↙</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		↙		2021 Status	2021 Trend	2021 Data		↙	
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2021 Status	2021 Trend	2021 Data												
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<p>B:04 Threatened freshwater species in the wild</p> <p>Region Statewide</p> <p>Measures Changes in conservation status; Number, abundance and distribution; Management of threatened species; Recovery and action plans for threatened species; Re-established threatened species in the wild</p> <p>Data Custodian DELWP</p>	<p>Comment Since European settlement, three freshwater fish are known to have become extinct and 55% of freshwater fish are considered threatened. There is a lack of statewide data for the majority of threatened freshwater fauna and flora species.</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>?</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>?</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		?		2021 Status	2021 Trend	2021 Data		?	
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<p>B:04 Trout cod</p> <p>Region Ovens River; Murray River; Goulburn River; Seven Creeks</p> <p>Measures Abundance and distribution</p> <p>Data Custodian DELWP</p>	<p>Comment Although translocations and stocking have increased the abundance and expanded the distribution of the trout cod in the four rivers above, and its conservation status has changed from Critically Endangered to Endangered, it remains under serious threat. This update report suggests that a Status of 'Poor' in the SoE 2018 Report would have better reflected the circumstances for the species. This is not intended to indicate that its plight is worse than in 2018.</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>→</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>→</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		→		2021 Status	2021 Trend	2021 Data		→	
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<p>B:04B Macquarie perch</p> <p>Region Ovens River; Lake Dartmouth; Seven Creeks; King Parrot Creek; Hughes Creek; Yea River; Hollands Creek; Yarra River; Broken River; Buffalo (upper) River</p> <p>Measures Abundance and distribution</p> <p>Data Custodian DELWP</p>	<p>Comment Although translocations and stocking have increased the abundance and expanded the distribution of the Macquarie perch in the 10 waterways above, its conservation status remains as Endangered. This update report suggests that a Status of Poor in the SoE 2018 Report would have better reflected the circumstances for the species.</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>→</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>→</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		→		2021 Status	2021 Trend	2021 Data		→	
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<p>B:04C Murray crayfish</p> <p>Region Southern Murray-Darling</p> <p>Measures Abundance and distribution</p> <p>Data Custodian DELWP</p>	<p>Comment The abundance and distribution of Murray crayfish in the southern Murray-Darling Basin have been decreasing due to cumulative pressures of recreational harvesting, river regulation, pesticides and pollutants, habitat change and events of low dissolved oxygen (hypoxic 'blackwater' events).</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>↙</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>↙</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		↙		2021 Status	2021 Trend	2021 Data		↙	
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<p>B:04D Spotted tree frog</p> <p>Region Ovens River; Murray River; Goulburn River; Seven Creeks</p> <p>Measures Abundance and distribution</p> <p>Data Custodian DELWP</p>	<p>Comment Spotted tree frog populations have been declining due to the infectious disease chytridiomycosis and the introduction of predatory fish, specifically brown trout and rainbow trout, which prey on tadpoles.</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>↙</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>↙</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		↙		2021 Status	2021 Trend	2021 Data		↙	
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THEME: Threatened species and communities (cont'd)

<p>B:04E Booroolong tree frog</p> <p>Region North-eastern Victoria</p> <p>Measures Abundance and distribution</p> <p>Data Custodian DELWP</p>	<p>Comment Booroolong tree frog populations have been declining due to the infectious disease, chytridiomycosis, and the introduction of predatory fish, specifically European carp, Redfin perch and Mosquito fish, which prey on tadpoles.</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>↙</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>↙</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		↙		2021 Status	2021 Trend	2021 Data		↙	
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<p>B:04F Baw Baw frog</p> <p>Region Mt Baw Baw Plateau and escarpment</p> <p>Measures Abundance and distribution</p> <p>Data Custodian DELWP</p>	<p>Comment The Baw Baw frog is Victoria's only endemic frog species. Reasons for the decline in its numbers and distribution include habitat loss and degradation in their restricted range (totalling only 135 km²) on the Baw Baw Plateau and escarpment, and the spread of the infectious disease, chytridiomycosis.</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>↙</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>↙</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		↙		2021 Status	2021 Trend	2021 Data		↙	
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<p>B:05 Threatened wetland-dependent species</p> <p>Region Statewide</p> <p>Measures Number, abundance and distribution</p> <p>Data Custodian DELWP</p>	<p>Comment The use of more rigorous criteria in preparing the new Flora and Fauna Guarantee Threatened List has led to an upgrading of the conservation status (e.g., from Vulnerable to Critically Endangered) of some threatened wetland-dependent species (some have also remained the same or been downgraded). Although the on-ground situation e.g., population size and habitat area and quality for these wetland-dependent species might not have changed since their last assessment, the new conservation status gives greater public recognition of their plight. There could also be other species not assessed for the new list that could meet the criteria for threatened species conservation status in the future, particularly those impacted by the 2019-20 bushfires.</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>?</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>?</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		?		2021 Status	2021 Trend	2021 Data		?	
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<p>B:06 Threatened terrestrial species</p> <p>Region Statewide</p> <p>Measures Changes in the conservation status of terrestrial threatened species; Number, abundance and distribution of selected threatened terrestrial species; Threatening processes impacting and affecting native terrestrial threatened species</p> <p>Data Custodian DELWP</p>	<p>Comment Although government agencies and communities are engaged in various recovery actions, the abundance and distribution of threatened terrestrial species are in decline. See B6A, B6B and B6C below.</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>↙</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>↙</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		↙		2021 Status	2021 Trend	2021 Data		↙	
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THEME: Threatened species and communities (cont'd)

<p>B:06A Terrestrial vascular plant species</p> <p>Region Statewide</p> <p>Measures Changes in the conservation status of terrestrial threatened species; Number, abundance and distribution of selected threatened terrestrial species; Threatening processes impacting and affecting native terrestrial threatened species</p> <p>Data Custodian DELWP</p>	<p>Comment The use of more rigorous criteria in preparing the new Flora and Fauna Guarantee Threatened List has led to an upgrading of the conservation status (e.g., from Vulnerable to Critically Endangered) of some threatened terrestrial vascular plant species (some have also remained the same or been downgraded). Although the on-ground situation e.g., population size and habitat area and quality for these threatened terrestrial vascular plant species might not have changed since their last assessment, the new conservation status gives greater public recognition of their plight. There could also be other species not assessed for the new list that could meet the criteria for threatened species conservation status in the future, particularly those impacted by the 2019-20 bushfires.</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>↙</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>↙</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		↙		2021 Status	2021 Trend	2021 Data		↙	
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<p>B:06B Terrestrial vertebrate species</p> <p>Region Statewide</p> <p>Measures Changes in the conservation status of terrestrial threatened species, which measures changes in the status of threatened terrestrial species; Abundance and distribution of selected threatened terrestrial species over time; Threatening processes impacting and affecting native terrestrial threatened species</p> <p>Data Custodian DELWP</p>	<p>Comment The use of more rigorous criteria in preparing the new Flora and Fauna Guarantee Threatened List has led to an upgrading of the conservation status (e.g., from Vulnerable to Critically Endangered) of some threatened terrestrial vertebrate species (some have also remained the same or been downgraded). Although the on-ground situation e.g., population size and habitat area and quality for these threatened terrestrial vertebrate species might not have changed since their last assessment, the new conservation status gives greater public recognition of their plight. There could also be other species not assessed for the new list that could meet the criteria for threatened species conservation status in the future, particularly those impacted by the 2019-20 bushfires.</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>↙</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>↙</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		↙		2021 Status	2021 Trend	2021 Data		↙	
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<p>B:06C Terrestrial invertebrate species</p> <p>Region Statewide</p> <p>Measures Changes in the conservation status of terrestrial threatened species; Number, abundance and distribution of selected threatened terrestrial species; Threatening processes impacting and affecting native terrestrial threatened species</p> <p>Data Custodian DELWP</p>	<p>Comment There is limited information on threatened terrestrial invertebrate species in Victoria. Of 42 terrestrial invertebrates on the new Flora and Fauna Guarantee Threatened List, most of which are butterflies or moths, as well as five land snails and an earthworm, the conservation status of 15 has worsened, for 10 it has improved and for 17 it is unchanged.</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>↙</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>↙</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		↙		2021 Status	2021 Trend	2021 Data		↙	
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<p>B:07 The conservation and management of biodiversity on private land</p> <p>Region Statewide</p> <p>Measures Conservation on private land which assesses the area of private land under conservation agreements; Management of biodiversity on private land which assesses activities taken to conserve species, conserve communities and maintain, improve or restore habitat on private land</p> <p>Data Custodian DELWP; Trust for Nature; Catchment management authorities</p>	<p>Comment Trust for Nature continues to slowly expand the number of its reserves and works with landowners to establish covenants to secure native vegetation on their properties. Catchment management authorities, Landcare and other organisations also work with landholders to improve the conservation and management of biodiversity on private land. Data on the on-farm efforts of individual farmers are limited. Although there have been small increases in spatial coverage, it remains well below the annual targets of Biodiversity 2037.</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>↗</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>↗</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		↗		2021 Status	2021 Trend	2021 Data		↗	
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THEME: Threatened species and communities (cont'd)

<p>B:08 The conservation and management of Victorian ecosystems on public land</p> <p>Region Statewide</p> <p>Measures Victorian conservation categories, area in hectares and the number of threatened species in conservation areas</p> <p>Data Custodian DELWP; Parks Victoria</p>	<p>Comment The spatial extent of the various conservation categories across the Parks Victoria estate has changed little in recent years. Records show that 90% of rare or threatened plant species and 76% of threatened animal species are found inside the parks estate. In June 2021, the Victorian Government announced that it would establish the Wombat-Lerderderg, Mount Buangor and the Pyrenees national parks, and several other parks and reserves. Together they will add more than 50,000 hectares of additions to the parks estate if approved by the Victorian Parliament.</p>	2018 Status	2018 Trend	2018 Data
			→	
		2021 Status	2021 Trend	2021 Data
			→	

THEME: Wetlands and rivers

<p>B:09 River health</p> <p>Region Statewide</p> <p>Measures Percentage of major rivers that remain in a near pristine or largely unmodified state; Assessment of freshwater biodiversity information; Area of management in priority locations; Restoration of habitat</p> <p>Data Custodian DELWP; Catchment management authorities; Melbourne Water</p>	<p>Comment The health of Victorian rivers is influenced by grazing, clearing, bushfires, invasive species, timber harvesting and urban development, which can cause disturbances in river dynamics and impact native aquatic species.</p>	2018 Status	2018 Trend	2018 Data
			→	
		2021 Status	2021 Trend	2021 Data
			→	

<p>B:10 Riparian vegetation habitat extent</p> <p>Region Statewide</p> <p>Measures Riparian vegetation cover and extent</p> <p>Data Custodian DELWP; Catchment management authorities; Melbourne Water</p>	<p>Comment DELWP, Melbourne Water, catchment management authorities, communities, farmers and other landowners are involved in many projects to restore riparian vegetation. Actions include stock exclusion, weed removal and revegetation. However, 21 one of 29 Victorian river basins had less than 50% of their assessed river length with riparian vegetation in good condition due to agricultural activities, drainage, channelisation and invasive plants e.g. willows.</p>	2018 Status	2018 Trend	2018 Data
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		2021 Status	2021 Trend	2021 Data
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<p>B:11 Area of functional floodplain</p> <p>Region Statewide</p> <p>Measures Change to floodplain area as a natural approach to mitigate, and reduce the risk, of flood and drought impacts and provide refuge to plants and animals during extreme weather events</p> <p>Data Custodian DELWP; Catchment management authorities; Victorian Environment Water Holder</p>	<p>Comment Environmental water is being used to return some floodplain wetlands e.g. Ramsar sites, Living Murray and Victorian River Murray Restoration projects to more natural flood cycles. However, data confidence remains low and the status is unknown.</p>	2018 Status	2018 Trend	2018 Data
			?	
		2021 Status	2021 Trend	2021 Data
			?	

<p>B:12 Threatened native frog species</p> <p>Region Statewide</p> <p>Measures Number, abundance and distribution</p> <p>Data Custodian DELWP</p>	<p>Comment The abundance and distribution of native frog species have continued to decline due to habitat loss and degradation, introduced fish species and the chytridiomycosis disease.</p>	2018 Status	2018 Trend	2018 Data
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		2021 Status	2021 Trend	2021 Data
			↙	

THEME: Wetlands and rivers (cont'd)

<p>B:13 Threatened native fish species</p> <p>Region Statewide</p> <p>Measures Number, abundance and distribution</p> <p>Data Custodian DELWP</p>	<p>Comment Although localised efforts to improve the abundance and distribution of the larger native fish species such as the trout cod, Murray cod and Macquarie perch have been relatively successful, smaller fish such as the galaxiids are in a perilous situation exacerbated by predation from brown and rainbow trout and the 2019–20 bushfires. Determining statewide trends will require data over longer time periods.</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>→</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>?</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		→		2021 Status	2021 Trend	2021 Data		?	
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<p>B:14 Waterbird species in the Murray-Darling Basin</p> <p>Region Murray-Darling basin</p> <p>Measures Number, abundance and distribution</p> <p>Data Custodian DELWP</p>	<p>Comment The annual Eastern Australian Waterbird Survey, which has been conducted since 1983, continues to show the long-term decline in waterbird abundance and distribution along two regular transects across the southern Murray-Darling Basin.</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>↙</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>↙</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		↙		2021 Status	2021 Trend	2021 Data		↙	
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<p>B:15 Freshwater macroinvertebrate species</p> <p>Region Statewide</p> <p>Measures Total macroinvertebrate richness; Total Ephemeropter (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies); Stream Invertebrate Grade Number Average Level (SIGNAL2); Australian River Assessment System observed/expected index (AUSRIVAS O/E)</p> <p>Data Custodian Nil</p>	<p>Comment The RiverMAP program, now discontinued, gathered data on water bugs, water beetles and other macroinvertebrates across 66 long-term monitoring sites in several Victorian waterways. The data were gathered to serve as indicators of ecosystem condition, not measures of abundance or distribution. This indicator was not reassessed and will be reviewed for the SoE 2023 report.</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>↙</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>?</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		↙		2021 Status	2021 Trend	2021 Data		?	
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<p>B:16 Wetland extent and condition</p> <p>Region Statewide</p> <p>Measures Extent and condition of wetlands</p> <p>Data Custodian DELWP</p>	<p>Comment Environmental watering programs and government agency and community efforts at habitat improvements have been positive for a small number of priority wetlands e.g., Ramsar sites. Although the extent of wetlands on both private and public land has been mapped, data on wetlands condition remain poor. Drainage, cropping, urbanisation and altered water flows are impacting wetland condition.</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>?</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>?</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		?		2021 Status	2021 Trend	2021 Data		?	
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<p>B:17 Health and status of Ramsar wetlands in Victoria</p> <p>Region Statewide</p> <p>Measures Ecological condition of Ramsar wetlands</p> <p>Data Custodian DELWP</p>	<p>Comment Limitations in the governance and management of Victoria's 12 Ramsar sites have been addressed since the 2016 Victorian Auditor-General Office's report identified serious weaknesses. Management plans are largely consistent with national standards and ecological character is being maintained in all but three of the sites.</p>	<table border="1"> <thead> <tr> <th>2018 Status</th> <th>2018 Trend</th> <th>2018 Data</th> </tr> </thead> <tbody> <tr> <td></td> <td>?</td> <td></td> </tr> <tr> <th>2021 Status</th> <th>2021 Trend</th> <th>2021 Data</th> </tr> <tr> <td></td> <td>→</td> <td></td> </tr> </tbody> </table>	2018 Status	2018 Trend	2018 Data		?		2021 Status	2021 Trend	2021 Data		→	
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THEME: Forests

Fo:03 Area of forest types by growth stage distribution in protected areas

Region Statewide

Measures IUCN-defined protected areas; Implications of changes in protected areas for threatened species

Data Custodian DELWP; Parks Victoria

Comment There has been a significant increase in the IUCN-defined formal protected area of forested parks and reserves since the 1950s, although there has been little change in recent years. Biodiversity 2037 indicated that there were gaps in the comprehensiveness, adequacy and representativeness of formal protected areas.

2018 Status 2018 Trend 2018 Data



2021 Status 2021 Trend 2021 Data



Fo:06 Threatened forest-dependent species

Region Statewide

Measures Number, abundance and distribution

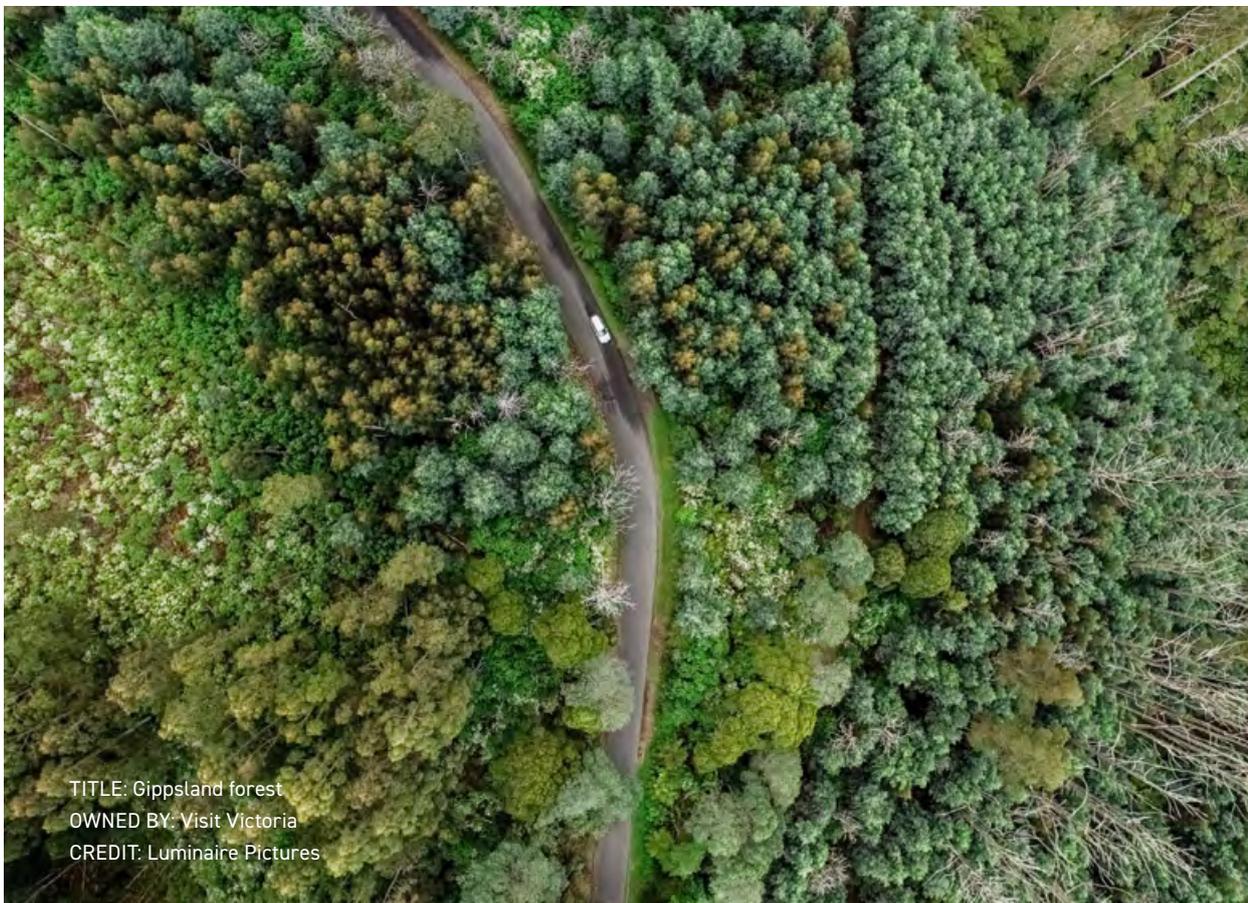
Data Custodian DELWP

Comment The use of more rigorous criteria in preparing the new Flora and Fauna Guarantee Threatened List has led to the upgrading of the conservation status (e.g., from Vulnerable to Critically Endangered) for some threatened forest-dependent species (some have also remained the same or been downgraded). Although the on-ground situation (e.g., population size and habitat area) and quality for these threatened forest-dependent species might not have changed since their last assessment, the new conservation status gives greater public recognition of their plight. There could also be other species not assessed for the new list that could meet the criteria for threatened species conservation status in the future, particularly those impacted by the 2019-20 bushfires.

2018 Status 2018 Trend 2018 Data



2021 Status 2021 Trend 2021 Data



THEME: Victoria's biodiversity targets

<p>B:18 Net gain in extent and condition of native vegetation</p>	<p>Comment There is a continuing net loss of native vegetation (habitat hectares) on private land in Victoria, with a smaller net gain on public land. The largest contributors are grazing, removal of trees and fallen logs, environmental weeds and clearing exempt from requiring a permit (e.g., fences and fire protection).</p>	<p>2018 Status 2018 Trend 2018 Data</p>
<p>Region Statewide</p>		<p>  </p>
<p>Measures Estimates of the overall rate of change in extent and quality of native vegetation on public and private land in Victoria</p>		<p>2021 Status 2021 Trend 2021 Data</p>
<p>Data Custodian DELWP</p>		<p>  </p>
<p>B:20 Change in suitable habitat for threatened native species</p>	<p>Comment Data from 2019 and 2020 show that the average percentage Change in Suitable Habitat in 50 years for threatened species is 11.4%, based upon on-ground management actions taken. For some species, the percentage Change in Suitable Habitat was much higher than the average (e.g., frogs 30.2% and mammals 31.4%). However, these averages fall short of the 100% target set in Biodiversity 2037.</p>	<p>2018 Status 2018 Trend 2018 Data</p>
<p>Region Statewide</p>		<p>  </p>
<p>Measures Estimating net improvement in suitable habitat and the most effective options for improving the future of threatened native species across the state under climate change</p>		<p>2021 Status 2021 Trend 2021 Data</p>
<p>Data Custodian DELWP</p>		<p>  </p>
<p>B:21 Area of management in priority locations</p>	<p>Comment The Ark and Eden projects, along with other management programs and actions after the 2019–20 bushfires, have significantly increased the area of weed and pest predator and herbivore control by government agencies. However, the bushfire response has led to a short-term (less than five years) intense response that could decline following the short and medium-term recovery periods.</p>	<p>2018 Status 2018 Trend 2018 Data</p>
<p>Region Statewide</p>		<p>  </p>
<p>Measures Achieving targets for hectares of management in priority locations, including weed and animal pest predator and herbivore control, revegetation on public and private land, and permanent protection on private land</p>		<p>2021 Status 2021 Trend 2021 Data</p>
<p>Data Custodian DELWP</p>		<p>  </p>
<p>B:22 Victorians value nature</p>	<p>Comment The 2019–20 bushfires and the COVID-19 pandemic have restricted the engagement of people in nature-based activities and the achievement of targets in Biodiversity 2037.</p>	<p>2018 Status 2018 Trend 2018 Data</p>
<p>Region Statewide</p>		<p>  </p>
<p>Measures Number of Victorians connecting with nature; Number of Victorians acting to protect the natural environment</p>		<p>2021 Status 2021 Trend 2021 Data</p>
<p>Data Custodian DELWP</p>		<p>  </p>
<p>B:23 Number of Victorian government organisations that manage environmental assets that contribute to environmental economic accounting</p>	<p>Comment Comment: The SoE 2018 Report revealed that only 12% of Victorian Government organisations who manage Victoria's natural assets have contributed to environmental economic accounting. There are no new data to assess this indicator in 2021.</p>	<p>2018 Status 2018 Trend 2018 Data</p>
<p>Region Statewide</p>		<p>  </p>
<p>Measures Measures: % of natural resource management organisations that manage environmental assets that contribute to environmental economic accounting</p>		<p>2021 Status 2021 Trend 2021 Data</p>
<p>Data Custodian DELWP</p>		<p>  </p>

Spatial information and Earth observation

State of the Environment reports have always made use of data gathered by spatial technology. In this report it has been critical to understanding the spatial extent and impacts of the 2019–20 bushfires. Many of the enduring images of the bushfires, such as billowing clouds of smoke across south-eastern Australia, were generated by satellite cameras.

The ongoing response to the bushfires will also make extensive use of LiDAR (Light Detection and Ranging), a remote sensing system that uses laser light generated from an aircraft (or vessels for marine surveys) to measure on-ground features such as topography and vegetation.

Satellite imagery was used to map the severity of the 2019–20 bushfires. The associated data analysis showed that the bushfires impacted approximately 1.5 million hectares of predominantly forested public land in eastern and north-eastern Victoria between November 2019 and March 2020. The analysis used machine learning classification from pre- and post-fire Sentinel 2 satellite imagery.

Sentinel 2 imagery is also being used by the federal Department of Agriculture, Water and the Environment in developing a national approach to fire-severity mapping. The Department's 2020 report on the approach revealed that, 'The intention of AUS GEEBAM [Australian Google Earth Engine Burnt Area Map] is not to replace fire severity maps from each state and territory but to provide a nationally consistent fire severity map. It is likely that individual state and territory fire severity maps will more accurately represent variation in fire severity as they benefit from local expertise and local calibration data. However, the state and territory datasets do not fulfil the need for a national fire severity dataset built with a common methodology.'²

The report also stated that to 'mitigate against bushfire events and assist with the species recovery effort it is important to understand the spatial extent of fires across species distributions and landscapes as well as to rapidly identify refugia habitat for targeted post-bushfire conservation actions.' It also observed that Victoria's fire severity mapping 'is based on a large collection of point data from previous fires and visual interpretation of high spatial resolution remote sensing data. However, it has not been implemented more widely'.

Remote sensing is also used as part of the data gathering for the Victorian Land Cover Time Series,³ with the most recent analysis released in July 2020. Digital Earth Australia delivered Landsat Surface Reflectance statistics for land-cover mapping to DELWP and the Arthur Rylah Institute. Both agencies used the data to map the dynamic changes in land cover through time in Victoria (from 1985 to 2020). The approach models land cover across the state, including native vegetation (herbaceous, woody and wetlands), intensive agriculture, forestry, recreation, and the built environment, including urban areas. This product enables DELWP to produce a consistent and repeatable statewide view of the current and past vegetation cover, allowing for reporting on change trends over time, and the use of statistical and machine-learning modelling to produce maps for the above-mentioned areas.

The Bushfire Earth Observation Taskforce Report,⁴ which was released by the Australian Space Agency in May 2020, 'examined the decisions required to manage bushfire risk management in the pre-fire, during-fire, and post-fire phases. It then analysed the satellite imagery data needed to support those decisions.' The analysis identified that the potential of Earth observation has not been fully operational for bushfire management in Victoria and proposed four pathways 'to provide regular, assured satellite imagery and its derived products and services'.

They are:

- better partnerships across relevant institutions
- greater capacity to task satellite data to get the data down to delivery products for land managers
- improvement of tools that support tackling bushfires and recovery (e.g., fuel load and the earlier detection and indication of bushfires)
- diverse satellite imagery options.

2. Department of Agriculture, Water and the Environment 2020, 'Australian Google Earth Engine burnt area map: a rapid, national approach to fire severity mapping', Canberra, Australia.

3. DELWP, 'Victorian land cover time series', East Melbourne, Victoria <https://www.environment.vic.gov.au/biodiversity/Victorias-Land-Cover-Time-Series> Accessed 9 May 2021.

4. Australian Space Agency 2020, 'Bushfire earth observation taskforce report May 2020', Canberra, Australia.

5. <https://discover.data.vic.gov.au/dataset/aggregated-fire-severity-classes-from-1998-onward>.

Spatial information and Earth observation

In addition, the Department of Defence is partnering with industry to access their early bushfire detection platforms by updating foundational spatial data from government, and for ensuring delivery of on-ground works through effective communications with land managers. Harnessing an earlier detection and support capacity and improving communication between incident controllers and on-ground works through Earth observation can be revolutionary for better bushfire management in Victoria.

The rapid-fire severity map of the major fires in Gippsland and north east Victoria has been completed and published at Data Vic. Since this was made available in April 2020, numerous updates have been made to analyse fire severity for areas where local fires have occurred. This information has been useful in the preparation of this update report.

The NSW Bushfire Inquiry⁶ held during 2020 at the same time as the national Royal Commission. Among its 76 recommendations, the Inquiry urged the trialling of early aerial suppression in areas of high bushfire risk and for the NSW Government to 'establish a spatial technology acceleration program to maximise the information available from the various remote sensing technologies currently in use and to plan for inclusion of new remote sensing systems that can sense precisely and rapidly through heavy smoke, cloud, fog and dust.'

6. Owens D and O'Kane M 2020, 'Final report of the NSW bushfire inquiry', Sydney, NSW.

Public policy context

Victorian, national and international public policies are of direct relevance to this SoE Biodiversity Update 2021 Report.

International

The Montreal Process is a voluntary United Nations agreement with its origins at the 1992 Earth Summit, where a resolution was passed calling for the conservation and sustainable management of forests.⁷ A set of seven criteria and 44 indicators were developed in 1995. Victoria has retained the seven criteria and adjusted the indicators (now 45) to better suit local conditions.

When the parties to the United Nations Convention on Biological Diversity met in 2010 at Aichi, Japan, they committed to the Strategic Plan for Biodiversity 2011–2020. This set five strategic goals and 20 targets for countries to slow and reverse biodiversity loss during the United Nations Decade on Biodiversity. The draft of a new Global Biodiversity Framework with four goals and 21 action targets is currently under consideration by the Conference of the Parties to the Convention.

The 2030 Agenda for Sustainable Development was adopted by the United Nations in 2015 and comprises 17 goals with 169 targets.⁸

The Ramsar Convention⁹ aims to halt the loss of wetlands and conserve those that remain. Victoria has 12 wetland sites on the List of Wetlands of International Importance, including the Gippsland Lakes, the Barmah Forest, the Kerang Wetlands and Lake Albacutya. As a signatory to the Convention, Australia has committed to wetlands conservation, reserves and education. The first of a series of national action plans was released in 2016, forming part of Australia's implementation of the four goals and 19 strategies of the Ramsar Strategic Plan 2016–24. Victoria's contribution to the conservation of Ramsar wetlands is reviewed in the assessment of indicator B:17 Health and status of Ramsar wetlands in Victoria.

National

There are a number of national policies, strategies, plans and laws that are relevant to the scope of this SoE Biodiversity Update 2021 Report.

The Federal Department of Agriculture, Water and Environment is responsible for protecting and strengthening Australia's agriculture, water resources, environment and heritage. The relevant Ministers administer various national laws that include the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).¹⁰ The Department has been closely involved in bushfire recovery through the Environment Minister's convening of an Expert Panel to advise on priority species and communities that required urgent attention, and the distribution of funds for bushfire recovery projects.

The EPBC Act is Australia's key piece of environmental legislation and covers environment and heritage protection and biodiversity conservation. Actions that will lead to changes in land use or land management in Victoria (or the other states and the territories) may be subject to provisions in the EPBC Act. In the case of firefighting and fire management actions in emergency situations, 'they are unlikely to be subject to compliance actions or other penalty under the national environment law. However, the department strongly recommends that, wherever possible, nationally protected matters are identified in bushfire risk management plans and local and regional operational mapping.'¹¹ Fire prevention actions may be subject to the provisions of the EPBC Act if they could significantly impact a nationally protected matter or are not exempted from those provisions.

There are nine Matters of National Environmental Significance that are protected under the EPBC Act and include: listed threatened species and communities, listed migratory species and Ramsar wetlands of international importance.

7. Department of Agriculture, Water and the Environment, 'The Montreal Process', Canberra, Australia <https://www.agriculture.gov.au/forestry/international/forums/montreal>

8. United Nations, 'Sustainable Development Goals' <https://sdgs.un.org/> Accessed 6 June 2021.

9. Ramsar Convention, 'Wetlands of international importance' www.ramsar.org Accessed 6 June 2021.

10. Commonwealth of Australia, '*Environment Protection and Biodiversity Conservation Act 1999*', Canberra, Australia.

11. Department of Agriculture, Water and Environment 2021, 'Bushfire management and national environment law', Canberra, Australia <https://www.environment.gov.au/epbc/publications/factsheet-bushfire-management-and-national-environment-law> Accessed 8 May 2021.

Public policy context

Australia's Strategy for Nature 2019–2030¹² was agreed to by the Commonwealth, state and territory governments in 2019. It has three goals – 'Connect all Australians with nature,' 'Care for nature in all its diversity' and 'Share and build knowledge' – and 12 objectives. The strategy cross-references its goals and objectives with existing national policies, programs and legislation, the Sustainable Development Goals and the Aichi Biodiversity Targets.

The National Bushfire Management Policy Statement for Forests and Rangelands¹³ was agreed to by the Commonwealth, state and territory governments in 2014. It aims for a more effective, coordinated and ecologically sustainable approach to fire management. Its vision is: 'Fire regimes are effectively managed to maintain and enhance the protection of human life and property, and the health, biodiversity, tourism, recreation and production benefits derived from Australia's forests and rangelands.'¹⁴ Actions to achieve this vision must fall under the following objectives:

- effectively managing the land with fire
- involved and capable communities
- strong land, fire and emergency partnerships and capability
- actively and adaptively managing risk.

The National Climate Resilience and Adaptation Strategy¹⁵ follows on from the National Climate Change Adaptation Framework agreed to by the Commonwealth, state and territory governments in 2007. The vision of this strategy, which was released in 2015, is 'We act together to support prosperity and wellbeing in Australia and beyond by building the resilience of communities, the economy and the environment to a variable and changing climate.' Its four priorities for national engagement are 'Understand and communicate,' 'Plan and act,' 'Check and reassess' and 'Collaborate and learn.'

The Australian Weeds Strategy 2017–2027¹⁶ 'aims to guide coordination of effort across all jurisdictions and affected stakeholders and to inform plans and actions by state and territory governments, local governments, regional natural resource management agencies, as well as by industry, landholders and the wider community.' Its vision is to: 'Protect Australia's economic, environmental and social assets from the impacts of weeds' and its goals are 'Prevention, detection and early intervention,' 'Minimise the impact of established weeds' and 'Enhance Australia's capacity and commitment to weed management.'

The Australian Pest Animal Strategy 2017–2027¹⁷ 'provides national guidance on best-practice vertebrate pest animal management in striving towards the national vision of protecting Australia's economy, environment and social wellbeing from the impact of pest animals.' Its three goals are to: 'Prevent the establishment of new pest animal species,' 'Minimise the impact of established pest animals' and 'Improve leadership and coordination for the management of pest animals.'

The National Forest Policy Statement¹⁸ was signed by the Commonwealth, state and territory governments in 1992 with a shared vision of the ecologically sustainable management of Australia's forests on both public and private land. It has 11 goals that include 'Conservation' and 'Wood production and industry development,' and others covering water and catchment development, tourism, employment, public awareness and research. A major outcome of the policy was the establishment of Regional Forest Agreements (RFAs) in Victoria, NSW, Tasmania and Western Australia. The agreements 'seek to balance economic, social and environmental demands on forests by setting obligations and commitments for forest management that deliver:

- certainty of resource access and supply to industry – building investment confidence
- ecologically sustainable forest management – ensuring forests are appropriately managed and regenerated
- an expanded and permanent forest conservation estate – to provide for the protection of Australia's unique forest biodiversity.'

12. Commonwealth of Australia, 'Environment Protection and Biodiversity Conservation Act 1999', Canberra, Australia.

13. Forest Fire Management Group 2014, 'National bushfire management policy statement for forests and rangelands', report for the Council of Australian Governments, Canberra, Australia.

14. Forest Fire Management Group 2014, 'National bushfire management policy statement for forests and rangelands', report for the Council of Australian Governments, Canberra, Australia.

15. Commonwealth of Australia 2015, 'National climate resilience and adaptation strategy', Canberra, Australia.

16. Department of Agriculture, Water and Environment, 'Australian weeds strategy 2017–2027', Canberra, Australia.

17. Department of Agriculture, Water and Environment, 'Australian pest animal strategy 2017–2027', Canberra, Australia.

18. Department of Agriculture, Water and Environment, 'National forest policy statement', Canberra, Australia.

Public policy context

An Expert Panel convened in early 2021 has completed a Major Event Review into the impacts that the 2019–20 bushfires have had on the implementation of Victoria's five RFAs in the Central Highlands, East Gippsland, Gippsland, North East and West Victoria.

The Australian Agricultural Sustainability Framework¹⁹ is part of the Australian Government's Agriculture Stewardship Package (2018–19 to 2022–23) that was established in 2019. The Package aims to support the development of arrangements to reward farmers for protecting biodiversity and the identification of other sustainability opportunities.

The National Carp Control Plan was established in 2016 with funding from the Commonwealth Government. Its principal aim is to determine the feasibility of using a carp virus as a biological control agent to significantly reduce carp numbers. A decision on whether to release the virus or not is yet to be made. Refer to indicator B:01A European carp for more details.

The vision of the National Feral Pig Action Plan 2021–2031²¹ is to: 'Actively suppress, or eradicate, Australian feral pig populations to reduce their impacts on environmental, agricultural, cultural and social assets.' Its three goals are to:

- provide leadership and strategic coordination for sustained feral pig management
- build community awareness of impacts of feral pigs and enhance capacity and capability of land managers to apply humane, best practice management
- increase the adoption of best practice methods and systems.

*The Water Act 2007*²² provides the legislative framework for managing the Murray-Darling Basin, established the Murray-Darling Basin Authority and the Commonwealth Environmental Water Holder, and recognises that South Australia, Victoria, NSW and Queensland manage the basin's water resources within their jurisdiction.

The purpose of the Murray-Darling Basin Plan,²³ finalised in 2012, is to manage the basin as a whole and connected system to improve its health and ensure the sustainable use of water. It sets the amount of water that can be taken from the basin each year.

The vision of the Native Fish Recovery Strategy²⁴ for the Murray-Darling Basin is to recover native fish for future generations. The 2020 strategy replaces the 2003 Native Fish Strategy, which ended in 2013, and has four outcomes to achieve over the next 30 years:

- recovery and persistence of native fish
- threats to native fish are identified and mitigated
- communities are actively involved in native fish recovery
- recovery actions are informed by best available knowledge.

Victoria

Departments, agencies and organisations

Victorian Traditional Owners and their Elders past and present are the original custodians of Victoria's land and waters. Traditional Owners are delivering bushfire recovery projects aimed at reading and healing Country, and recovering cultural heritage, community connection and resilience. Bushfire recovery funding from the Victorian and Commonwealth governments provided grants for the reading and healing of Country to Traditional Owners that included Taungurung, Gunaikurnai, Nindi Ngujarm Ngarigo Monero, Moogji, Jaithmathang Traditional Ancestral BloodLine Original Owners First Nation Aboriginal Corporation, Dalkawarramittung Aboriginal Corporation, Duduroa Dhargal Aboriginal Corporation, Cann River Community, and the Gunditj Mirring Traditional Owner Aboriginal Corporation.

A number of Victorian government agencies and organisations are part of the collaborative governance arrangements that influence biodiversity conservation and bushfire management and recovery in the state. They interact with a diverse and complex set of policies, laws, regulations, strategies, plans and monitoring frameworks.

19. National Farmer's Federation, 'Australian agricultural sustainability framework', Canberra, Australia <https://nff.org.au/programs/australian-agricultural-sustainability-framework/>, Accessed 14 May 2021.

20. National carp control plan <https://carp.gov.au> Accessed 22 May 2021.

21. Australian Pork Limited 2021, 'National feral pig action plan 2021–2031', Kingston, ACT.

22. Department of Agriculture, Water and Environment, 'Commonwealth water legislation', Canberra, Australia <https://www.agriculture.gov.au/water/policy/legislation> Accessed 22 May 2021.

23. Murray-Darling Basin Authority, 'A plan for the Murray-Darling Basin', Canberra, Australia <https://www.mdba.gov.au/basin-plan/plan-murray-darling-basin> Accessed 22 May 2021.

24. Murray-Darling Basin Authority 2020, 'Native fish recovery strategy 2020', Canberra, Australia.

Public policy context

The most recent biodiversity policy response emerged in the immediate aftermath of the 2019–20 bushfires: Commonwealth and Victorian government-funded projects that flowed from the identification of priority threatened species and ecological communities most affected by the bushfires. Whether the projects are a one-off response to the bushfires or part of a longer-term alignment of funding for biodiversity is yet to become clear. However, the projects will provide valuable data for the scientific assessments of indicators in the SoE 2023 report.

The following Victorian government and non-government organisations are engaged in biodiversity management and conservation, and bushfire management and recovery. Many have also provided critical data for use in this SoE Biodiversity Update 2021 Report's scientific assessments of indicators in Part II.

The portfolio of the Department of Environment, Land, Water and Planning (DELWP) includes more than 100 major agencies and 1,200 small committees of management of crown land reserves. DELWP brings together eight business groups that have four divisions of relevance to this update report: 'Catchments, Waterways, Cities and Towns,' 'Climate Change,' 'Biodiversity' and 'Forest and Fire Operations.' For example, the biodiversity division is responsible for the development and implementation of a range of biodiversity and wildlife policies, legislation and regulations, investment programs, and the knowledge and science that underpins their design. DELWP has been coordinating the state biodiversity response to the 2019–20 bushfires, leading a program of works across seven key themes to support impacted wildlife and biodiversity:

- immediate reconnaissance of critical species and habitat
- wildlife welfare
- emergency extraction to prevent extinction and limit species decline
- intensified management of threats
- reading and healing Country, and maximising biodiversity resilience
- knowledge, data, and preparedness
- nature-led community recovery.

The Arthur Rylah Institute is a biodiversity science institute within DELWP and a leading centre for applied ecological research that has an emphasis on flora, fauna and biodiversity, and includes bushfire research. It is also increasingly engaging in social science research with a focus on Victorians valuing nature (a goal of Biodiversity 2037). It has teams of staff in fire ecology, vegetation monitoring, ecological analysis and synthesis, wetlands and waterbirds, and disturbance ecology programs. These teams conduct research on a range of threatened and introduced taxa including vegetation, birds, reptiles and mammals, and develop specialist spatial modelling systems to inform policy and management for a range of organisations. The Institute carried out emergency extractions of some threatened species in the wake of the 2019–20 bushfires and its breadth of biodiversity research has been critical for this SoE Biodiversity Update 2021 Report.

The Department of Jobs, Precincts and Regions (DJPR) is responsible for ensuring a strong economic performance for Victoria. Its work supports seven ministers, spans 15 portfolios and operates across metropolitan and regional offices. It has supported a number of bushfire recovery initiatives for businesses, farmers, tourism operators, sporting organisations and regional communities.

Parks Victoria manages the state's conservation estate that includes national, state and regional parks and has been involved in the delivery of a number of bushfire recovery projects.

The Environment Protection Authority is an independent statutory authority that operates under the *Environment Protection Act 1970* and works with community and industry to prevent and reduce environmental and health impacts from pollution and waste. The Authority monitored the impacts of the 2019–20 bushfires on air and water quality.

The Commissioner for Environmental Sustainability provides independent and objective scientific reporting to inform policymakers, scientists and the wider Victorian public on the state's natural environment. The Commissioner does this by preparing the five-yearly State of the Environment, State of the Marine and Coasts, State of the Yarra and its Parklands and the State of the Forests reports.

Public policy context

Melbourne Water manages water supply catchments to supply high-quality water to the city, manages waterways and major drainage systems in the Port Phillip and Westernport region, removes and treats sewage and helps to create natural community spaces.

The work of the 18 urban and rural water corporations, such as Barwon Water, Coliban Water and East Gippsland Water, includes the supply of water, the management of sewage, the delivery of irrigation water, and the creation of recreational spaces. They may also be involved in projects to conserve aquatic biodiversity.

Victoria's 10 catchment management authorities are responsible for the integrated planning and coordination of land, water and biodiversity management in their region through regional catchment strategies. They have been responsible for the delivery of a number of bushfire recovery projects and work closely with their regional communities and landholders to tackle issues such as invasive species, the restoration of riparian, terrestrial and wetland vegetation and water quality.

Forest Fire Management is the lead agency for bushfire management on public land and aims to reduce the risk and impact of bushfires on Victoria's parks, forests and other public land. It includes staff from DELWP, Parks Victoria, VicForests and Melbourne Water. The Country Fire Authority (CFA) is a volunteer fire and rescue service that works across five regions of Victoria: Loddon Mallee; Grampians; Barwon South-West; Hume; Gippsland. The Fire Rescue Service covers metropolitan Melbourne and major regional centres.

Bushfire Recovery Victoria is a dedicated Victorian Government agency working directly with local communities to help deliver statewide and regional bushfire recovery programs.

VicForests is a state-owned business responsible for the harvest, commercial sale and regrowing of timber from Victoria's State Forests on behalf of the Victorian Government. Its operations intersect with a number of values measured by several indicators in this update report.

The Game Management Authority is an independent authority responsible for the regulation of game hunting in Victoria through education, research and enforcement. It aims to achieve responsible and sustainable game hunting in Victoria, which is of

relevance to the 'Invasive species' and 'Threatened species and communities' indicator themes in Part II of this update report.

The Victorian Fisheries Authority is an independent statutory authority established to effectively manage Victoria's fisheries resources and ensure sustainable fishing and aquaculture. It oversees commercial and recreational fishing and coordinates the stocking of inland waters with native and exotic fish species. As a result, its work is relevant to the 'Invasive species' and 'Threatened species and communities' indicator themes in Part II of this update report.

The Victorian Environmental Water Holder, established under Victorian legislation in 2011, is an independent statutory body responsible for holding and managing Victoria's environmental water entitlements. The water holder works with catchment management authorities and Melbourne Water to ensure environmental water achieves the best environmental outcomes with the available water.

Sustainability Victoria is a statutory authority responsible for facilitating and promoting environmental sustainability in the use of resources.

The Victorian Environmental Assessment Council provides the Victorian Government with independent and strategic advice relating to the protection and sustainable management of Victoria's environment and natural resources.

The Inspector-General for Emergency Management has an independent statutory role providing assurance to government and the community in respect of emergency management arrangements in Victoria and fostering their continuous improvement. The Inspector-General is currently conducting an inquiry in the 2019–20 bushfires and released a Phase 1 Report in October 2020.

The Victorian Auditor-General is an independent officer of the Victorian Parliament tasked with providing assurance to Parliament and the Victorian community on the effectiveness of public sector agencies in providing services and using public money. The Victorian Auditor-General's Office released its audit, 'Reducing bushfire risks'²⁵ in October 2020 and is currently preparing an audit on 'Protecting Victoria's biodiversity.'²⁶

25. Victorian Auditor-General's Office 2020, 'Reducing bushfire risk', Melbourne, Victoria.
26. Victorian Auditor-General's Office, 'Protecting Victoria's biodiversity', Melbourne, Victoria <https://www.audit.vic.gov.au/report/protecting-victorias-biodiversity>
Accessed 8 May 2021.

Public policy context

Trust for Nature is a not-for-profit organisation that works with private landholders in Victoria to protect native plants and wildlife for future generations. It was established under Victorian legislation to enable people to donate land or money for nature conservation, and to sign conservation covenants with landholders. Together with conservation covenants and reserves, it has protected more than 100,000 hectares of native vegetation across Victoria. Forty-six covenanted properties were damaged by the 2019–20 bushfires, with 12 in the Upper Murray, nine in Omeo and 25 in East Gippsland. The Trust is assisting landowners in their recovery efforts.

Landcare Victoria is an independent representative body and works to secure increased recognition, resourcing and support for Landcare actions on the ground. It aims to foster community learning and action, participates in government policy development, and facilitates collaboration between Landcare, catchment management authorities, local governments and the Victorian government. There are approximately 600 Landcare groups and 64 Landcare networks across Victoria, as well as more than 500 community-based natural resource management groups, working to care for the environment.²⁷ While most groups conduct their activities on private land, a number also help with the management of public land. Landcare networks have been involved in the delivery of several government-funded bushfire recovery projects.

The Royal Botanic Gardens Victoria is a statutory authority established by legislation and dedicated to the conservation, display and enjoyment of plants. It extends over two locations, Melbourne and Cranbourne, and incorporates the National Herbarium of Victoria. The Royal Botanic Gardens has established a seed bank of Victorian plants and has extracted seeds of threatened species from bushfire areas as part of bushfire recovery projects.

Zoos Victoria is a not-for-profit, zoo-based conservation organisation involved with the recovery of threatened species and ecological communities. A number of Zoos Victoria programs have been impacted by the fires and they are involved in several bushfire recovery projects.

Local governments have policies, planning scheme arrangements and bylaws that can affect biodiversity within their council boundaries. In eastern Victoria they have also been working to support their fire-affected communities.

Various non-government organisations are involved in biodiversity monitoring and advocacy, government advisory committees and bushfire recovery projects. Birdlife Australia is Australia's largest bird conservation and monitoring organisation. It is involved in the delivery of bushfire recovery projects that include the installation of nesting boxes in East Gippsland. Conservation Volunteers Australia is an Australian not-for-profit conservation organisation that co-ordinates volunteers for environmental restoration projects. It has been coordinating the efforts of community groups involved in bushfire recovery projects. The Victorian National Parks Association is an advocate for the expansion of and improved management of the marine and terrestrial parks estate.

Melbourne, Monash, Latrobe and Deakin universities, as well as research organisations like the Bushfire and Natural Hazards Cooperative Research Centre, are invaluable sources of data on biodiversity and bushfire impacts. The Rural Industries Research and Development Corporation has conducted research on biodiversity conservation in agricultural systems.

Policies relevant to the indicator themes

Victoria has many policies, laws, regulations, frameworks and strategies of direct relevance to biodiversity, bushfires and climate change. They are summarised in Table 2 (on the next page), grouped into the seven indicator themes used in Part II of this SoE Biodiversity Update 2021 Report (where they may be discussed in more detail). Some of the policies and statutes listed may be relevant to more than one of the seven indicator themes.

27. DELWP, 'Landcare', East Melbourne, Victoria <https://www.environment.vic.gov.au/landcare> Accessed 17 May 2021.

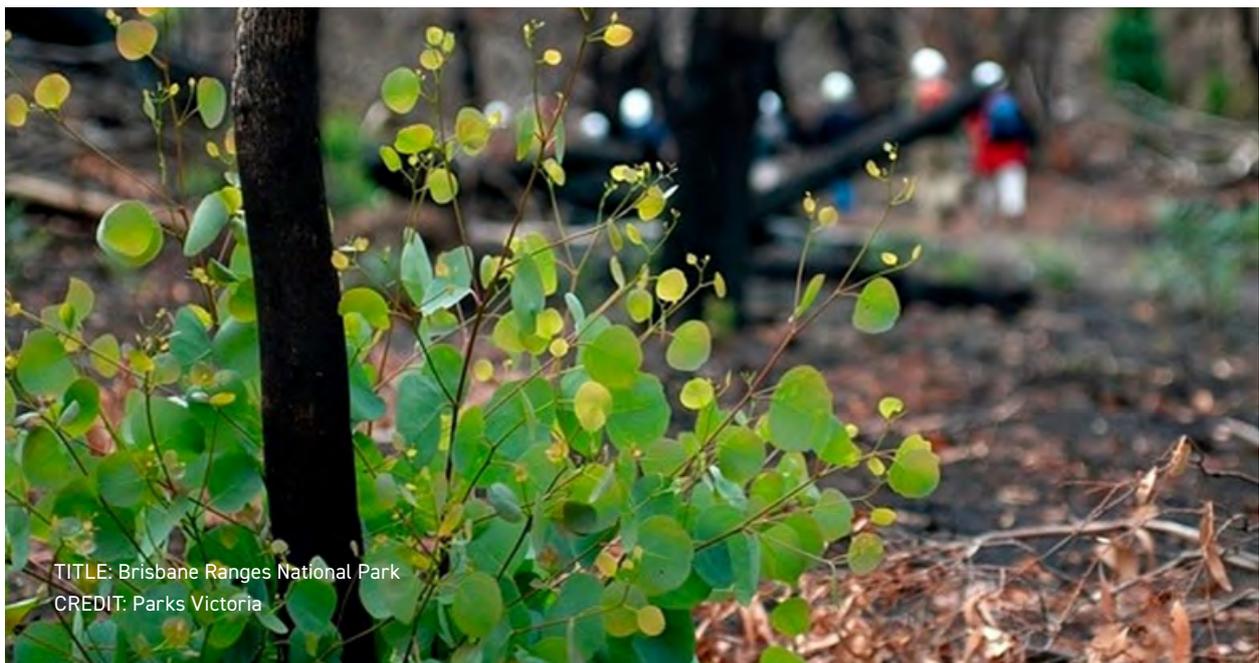
Public policy context

Table 2: Victorian policies and statutes relevant to the State of the Environment Biodiversity Update 2021 Report.

Indicator Theme	Statutes, Policies, Strategies and Plans
Fire	<p>Code of Practice for Bushfire Management on Public Land 2015 Joint Fuel Management Program Safer Together Strategic bushfire management plans</p>
Climate change	<p><i>Climate Change Act 2017</i> Victoria's Climate Change Adaptation Plan 2017-2020 Take 2 Victoria's Climate Change Strategy 2021</p>
Invasive plants and animals	<p><i>Catchment and Land Protection Act 1994</i> Freshwater Fisheries Management Plan 2018-2028 Guidelines for assessing translocations of live aquatic organisms in Victoria Invasive Plants and Animals Policy Framework Protection of the Alpine National Park Feral Horse Strategic Action Plan 2018-2021 Protocols for the translocation of fish in Victorian inland public waters Strategic Action Plan: Protection of floodplain marshes in Barmah National Park and Barmah Forest Ramsar site (2020-2023) Victorian Deer Control Strategy 2020</p>
Threatened species and communities	<p><i>Aboriginal Heritage Act 2006</i> <i>Alpine Resorts (Management) Act 1997</i> <i>Catchment and Land Protection Act 1994</i> <i>Climate Change Act 2017</i> <i>Conservation, Forests and Land Act 1987</i> <i>Crown Land (Reserves) Act 1978</i> <i>Emergency Management Act 2013</i> <i>Environment Protection Act 2017</i> <i>Flora and Fauna Guarantee Act 1988</i> <i>Flora and Fauna Guarantee Amendment Act 2019</i> <i>Forests Act 1958</i> <i>Guidelines for the removal, destruction or lopping of native vegetation</i> <i>Heritage Rivers Act 1992</i> <i>Land Act 1958</i> <i>Marine and Coastal Act 2018</i> <i>Melbourne Strategic Assessment (Environment Mitigation Levy) Act 2020</i> <i>National Parks Act 1975</i> <i>Parks Victoria Act 2018</i> Parks Victoria Conservation Action Plans Parks Victoria Landscape Management Plans Parks Victoria Nature Conservation Strategy <i>Planning and Environment Act 1987</i> Procedure for the removal, destruction or lopping of native vegetation on Crown land Protection of Large Trees Policy <i>Sustainable Forests (Timber) Act 2004</i> <i>Traditional Owner Settlement Act 2010, Victorian Conservation Trust Act 1972</i> <i>Victorian Conservation Trust Act 1972</i> <i>Victorian Environmental Assessment Council Act 2001</i> <i>Water Act 1989</i> <i>Wildlife Act 1975</i></p>

Public policy context

Indicator Theme	Statutes, Policies, Strategies and Plans
Wetlands and rivers	<p><i>Water Act 1989</i> Regional Catchment Strategies Regional Riparian Action Plan 2015–2020 Regional Waterway Strategies State Environment Protection Policy (Waters of Victoria) Victorian Waterway Management Strategy Water for Victoria: Water Plan</p>
Forests	<p>Code of Practice for Timber Production 2014 Forest Management Plans <i>Forests Act 1958</i> Regional Forest Agreements <i>Sustainable Forests (Timber) Act 2004</i> The Timber Release Plan The Victorian Forest Monitoring Program Timber Utilisation Plan Victorian Forestry Plan</p>
Victoria's Biodiversity Targets	<p>Biodiversity 2037 Monitoring, Evaluating, Reporting and Improvements Framework Biodiversity Knowledge Framework Biodiversity Response Planning Biodiversity Response Planning Protecting Victoria's Environment: Biodiversity 2037 Strategic Management Prospects</p>





TITLE: Ovens River
CREDIT: Visit Victoria

Introduction

Indicator selection

The purpose of this SoE Biodiversity Update 2021 Report is to review the SoE 2018 Report's scientific assessments in light of the 2019–20 bushfires and availability of new data.

Although the initial focus of this report was to be the 35 indicators in the SoE 2018 Report's Biodiversity chapter, the assessments of another eight indicators from its Forests, Fire and Climate Change chapters have been included because:

- The forests habitat was the most impacted by the 2019–20 bushfires, yet there is no forests-specific indicator in the Biodiversity chapter. The inclusion of forest-specific indicators informs an assessment of these bushfire impacts.
- Bushfires are a key threat to threatened species and ecological communities. Assessment of the Fire chapter's indicators has provided some measure of the impacts of the 2019–20 bushfires, as well as consideration of future bushfire risks to biodiversity. This will also assist preparation of the SoE 2023 report.
- Assessment of two indicators from the Climate Change chapter draws links between bushfires, biodiversity and climate change mitigation and adaptation.

Geographical scope of the assessments

The 2019–20 bushfires severely impacted the eastern part of Victoria where, for a time, the fires joined with those in NSW to become a megafire. Smaller, more localised fires occurred in other parts of Victoria e.g. the Budj Bim Cultural Landscape World Heritage Area in south-western Victoria.

Eastern Victoria and its burnt areas have been the focus of government and community concerns and media reports. However, the unburnt areas were considered because of their potential role as refugia in bushfire recovery programs. Wilsons Promontory, for example, escaped the fires in eastern Victoria and is now the likely location for a translocated population of the endangered eastern bristlebird from Cape Howe and Jervis Bay (in NSW). Other areas beyond eastern Victoria, and unburnt areas within the region, could also be seen as refuges or places for translocation.

The original Biodiversity Chapter in the SoE 2018 Report assessed indicators on a statewide basis, as will the SoE 2023 report. This update report also presents a statewide view of the science, as well as the perspectives of scientists and stakeholders who have contributed through a structured expert review process. Statewide assessments will also assist DELWP's current review of Biodiversity 2037, which is also a statewide plan.

The indicator assessments in Part II provide data and case studies on some of the species and ecological communities impacted by the bushfires across eastern Victoria. However, they also provide some new data (where available) on the state of biodiversity more generally across Victoria to assist the preparation of the Biodiversity Chapter in the SoE 2023 report. Although the bushfires were devastating for biodiversity in eastern Victoria, large areas of the state and many species and ecological communities were not impacted. For example, DELWP's Biodiversity response and recovery report²⁸ in August 2020 identified Victoria's²⁹ threatened species of most concern that were impacted by the bushfires. It revealed that 10 of Victoria's 15 threatened amphibian species were of most concern due to the fires, six of 104 bird species, seven of 37 fish species, 14 of 49 mammal species and seven of 40 reptile species. Although the majority of the threatened species in each taxon group were not impacted by the bushfires, except for threatened amphibians, those species (and threatened amphibians) face a number of other threats considered by this report.

Limits of data

Many of the indicators assessed in the SoE 2018 Report had access only to data with Low or Moderate Data Confidence. A wider net has been cast to help address this issue and to include data from published scientific journals, research institutions and non-government organisations. Interviews with experts who have extensive knowledge of the species, communities or issues for one or more indicators have also been held to assist indicator assessments and the construction of the report's narrative.

28. DELWP 2020, 'Victoria's bushfire emergency: biodiversity response and recovery, version 2', East Melbourne, Victoria.

29. Based on the Flora and Fauna Guarantee Act Threatened List gazetted in May 2021.

Introduction

The 2019–20 bushfires and the COVID-19 pandemic have impacted monitoring sites, data collection, analysis and reporting. Many monitoring sites and in-situ equipment, including cameras (more than 100 lost in Gippsland), have been destroyed (they have been, or continue to be, replaced). However, as land managers and agency, academic and citizen scientists returned to the 'bush', they began measuring the impact of the bushfires on biodiversity and monitoring the recovery of species and ecological communities. For example, in East Gippsland, the Southern Ark project has been closely monitoring the recovery of long-footed potoroos and other small mammals. The most recent news from there is encouraging.³⁰

Although the focus of the response to the fires has been on the recovery of threatened species, including species extractions, food drops and seed drops – 4.5 tonnes of ash seed were sown across 11,500 hectares of immature ash forest³¹ – new research projects have also been initiated with funding from the Victorian and Commonwealth governments. The results from these projects will assist the preparation of the SoE 2023 report. Post-fire responses also established well-resourced predator and herbivore control programs that could provide new data on the distribution and number of feral animals, as well as the effectiveness of biodiversity recovery projects.

Features of indicator assessments in 2021

This report reviews 43 indicators from the Biodiversity (35 indicators), Forests (two indicators), Fire (four indicators) and Climate change (two indicators) chapters of the SoE 2018 Report. Five of the 43 were not assessed due to insufficient data, however narratives have been written for three of them. The indicators are grouped into the following seven themes:

Theme 1. Fire

Theme 2. Climate change and carbon stocks

Theme 3. Invasive species

Theme 4. Threatened species and communities

Theme 5. Wetlands and rivers

Theme 6. Forests

Theme 7. Victoria's biodiversity targets.

Each indicator's scientific assessment is structured around the following subheadings.

Region

Although most of the indicators are assessed on a statewide basis, several apply to selected rivers, the Murray-Darling Basin or regional areas.

Data custodian

The custodian or data supplier includes government agencies such as DELWP, Parks Victoria and the Environment Protection Authority, as well as third-party providers including academic institutions and community organisations.

Potential thresholds for Status in the SoE 2023 report

Potential thresholds for use in the SoE 2023 report have been developed for the indicators to assist the traffic-light assessment of Status. The threshold could refer to being less than or equal to a value, greater than or equal to a value, between a range of values or to increases, decreases or stability in, for example, abundance and distribution of a species.

The thresholds will be reliant on the availability of good data which, unfortunately, remains poor for many indicators. As a result, the thresholds will be more useful for the SoE 2023 report and beyond rather than for this report. Evolving data bases such as the Threatened Species Index (TSX),³² which currently includes the Threatened Plants Index, Threatened Birds Index and Threatened Mammals Index, will be invaluable in the future. Each of these is being developed at the University of Queensland in partnership with government agencies, community organisations and universities. The TSX website describes the scope of the research and the data gathered: 'The first of its type in the world, the TSX provides reliable and robust measures of changes in the relative abundance of Australia's threatened and near-threatened species at national, state and regional levels. Understanding these changes in species populations is crucial for monitoring progress towards global conservation targets; allowing users to justify and measure the benefits of conservation investments, stimulate targeted responses and raise the public profile of threatened species.'

30. DELWP 2020, 'Victoria's bushfire emergency: biodiversity response and recovery, version 2', East Melbourne, Victoria.

31. Andrews D 2020, 'Airlift operation to bring forest back to life after bushfire', media release, Premier of Victoria, 2 October 2020.

32. TSX Threatened Species Index, 'About' <https://tsx.org.au/about/>, Accessed 21 August 2021.

Introduction

Status

The Status summary presents an overall analysis of the assessment for each selected indicator. An indicator can be assessed as having a 'Good', 'Fair' or 'Poor' status (see Status thresholds below). Where there is insufficient data, the indicator status is assessed as 'Unknown'.

The legend for Status in the report card is:

-  **Good:** Environmental condition is healthy across Victoria, OR pressure is likely to have negligible impact on environmental condition/human health, OR comprehensive protection of natural ecosystems and biodiversity is evident.
-  **Fair:** Environmental condition is neither positive nor negative and may be variable across Victoria, OR pressure is likely to have limited impact on environmental condition/human health, OR moderate protection of natural ecosystems and biodiversity is evident.
-  **Poor:** Environmental condition is under significant stress, OR pressure is likely to have significant negative impact on environmental condition/human health, OR inadequate protection of natural ecosystems and biodiversity is evident.
-  **Unknown:** Data is insufficient to assess Status or Trend.
-  **N/A (Not Applicable):** The indicator assessment is based on future projections or the change in environmental condition and providing a status assessment is not applicable. Only a trend assessment is provided.
-  **Narrative**

Trend

The Trend summary presents an overall analysis of the trend assessments for each selected indicator. The Trend identifies whether the Status of the indicator is deteriorating, improving, remaining stable or unknown.

The legend for Trend in the report card is:

-  **Improving**
-  **Stable**
-  **Deteriorating**
-  **Unclear**
-  **N/A Not applicable:** This indicator assessment is based on current environmental condition only and it is not applicable to provide a trend assessment. Only a status assessment is provided.

Data Confidence

Data Confidence reflects on knowledge gaps and data limitations when assessing the Status and Trend of the indicator, which could have also been influenced by the impacts of the 2019–20 bushfires.

The legend for Data Confidence in the report card is:

-  **High:** Evidence and consensus too low to make an assessment with confidence
-  **Moderate:** Limited evidence or limited consensus
-  **Low:** Adequate high-quality evidence and high level of consensus
-  **Insufficient** evidence to assess

Indicator performance

The analysis of the indicators seeks to categorise them as either High Performance or Low Performance.

-  High Performance indicators are those with a 'Good' Status assessment, a 'Stable' or 'Improving' Trend assessment, and 'High' Data Confidence. 'High' suggests that not only is the indicator performing well, and expected to continue to do so, there is a high level of confidence in the assessment.
-  Low Performance indicators are those with a 'Poor' Status assessment, 'Stable' or 'Deteriorating' Trend assessment, and 'High' Data Confidence. This suggests that not only is the indicator of concern and not demonstrating improvement, there is a high level of confidence in the assessment. That is, there is confidence that this indicator is showing 'Poor' condition and will remain so without intervention.

Why this indicator?

The comment under this heading explains the importance of the indicator.

Why is this the assessment in 2021?

This section in the report card explains the assessment ratings for the indicator's Status, Trend and Data Confidence.

Should the indicator be used in the SoE 2023 report?

Answers to this question are an assessment of whether the indicator, in its current form, should be retained for the SoE 2023 report. Comments on the usefulness of the indicator's measures might also be included under this heading.

Introduction

Other features of each indicator's assessment

Three sections below the full report card for each indicator are headed:

- Summary of SoE 2018 Report assessment
- The 2019–20 bushfires: Impacts and responses
- SoE Biodiversity Update 2021 Report assessment.

A comparison of the 2018 and 2021 assessments

Table 3 summarises the assessment of Status, Trend and Data Confidence in the 43 indicator assessments chosen from the SoE 2018 Report and used in this SoE Biodiversity Update 2021 Report.

Table 3:
A comparison of the 2018 and 2021 indicator assessments.

Assessment	2018	2021
Status		
Unknown	9	6
Poor	22	24
Fair	12	8
Good	0	0
Not assessed	0	2
Narrative	0	3
Trend		
Unknown	11	13
Deteriorating	22	21
Stable	8	8
Improving	2	1
Data Confidence		
Low	14	8
Moderate	13	13
High	16	15
Insufficient	0	7

Most of the indicators have retained their 2018 ratings for Status, Trend and Data Confidence. Those indicators for which adjustments have been made to either their Status, Trend or Data Confidence are:

- Fi:03 Actual fire regimes compared to optimal fire regimes (Status changed from Fair to Poor)
- B:01 Invasive freshwater plant and animal species (Data Confidence from Poor to Insufficient)
- B:02 Invasive terrestrial plant species (Data Confidence from High to Moderate)
- B:04B Macquarie perch (Status changed from Fair to Poor)
- B:10 Riparian vegetation habitat extent (Trend changed from Unknown to Stable)
- B:11 Area of functional floodplain (Data Confidence changed from Low to Insufficient)
- B:13 Native fish species (Trend changed from Deteriorating to Unknown and Data Confidence from High to Moderate)
- B:17 Health and status of Ramsar wetlands in Victoria (Status changed from Poor to Fair and Data Confidence from Low to Moderate)
- B:19 Landscape-scale change (Data Confidence changed from Moderate to High)
- Fo:03 Area of forest type by growth stage distribution in protected zones (Trend changed from Improving to Stable)
- Fo:06 Threatened forest-dependent species (Status changed from Poor to Fair).

The following indicators were not assessed due to insufficient data, although a narrative is included:

- B:20 Change in suitable habitat for threatened native species
- B:21 Area of management in priority locations
- B:22 Victorians value nature.

The following indicators were not assessed due to insufficient data and no narrative is included:

- B:15 Freshwater macroinvertebrate species
- B:23 Number of Victorian government organisations that manage environmental assets that contribute to environmental economic accounting.

Fire

Background

Victoria is one of the world's most fire-prone regions and where two-thirds of all Australian bushfire deaths have occurred since 1900.³³ The Forest Fire Management Victoria website lists 32 major bushfires between Black Thursday 1851 and 2013, including Red Tuesday 1898, Black Friday 1939, Ash Wednesday 1983 and Black Saturday 2009. Figure 4 maps the location and frequency of Victorian bushfires between 1995 and 2020.

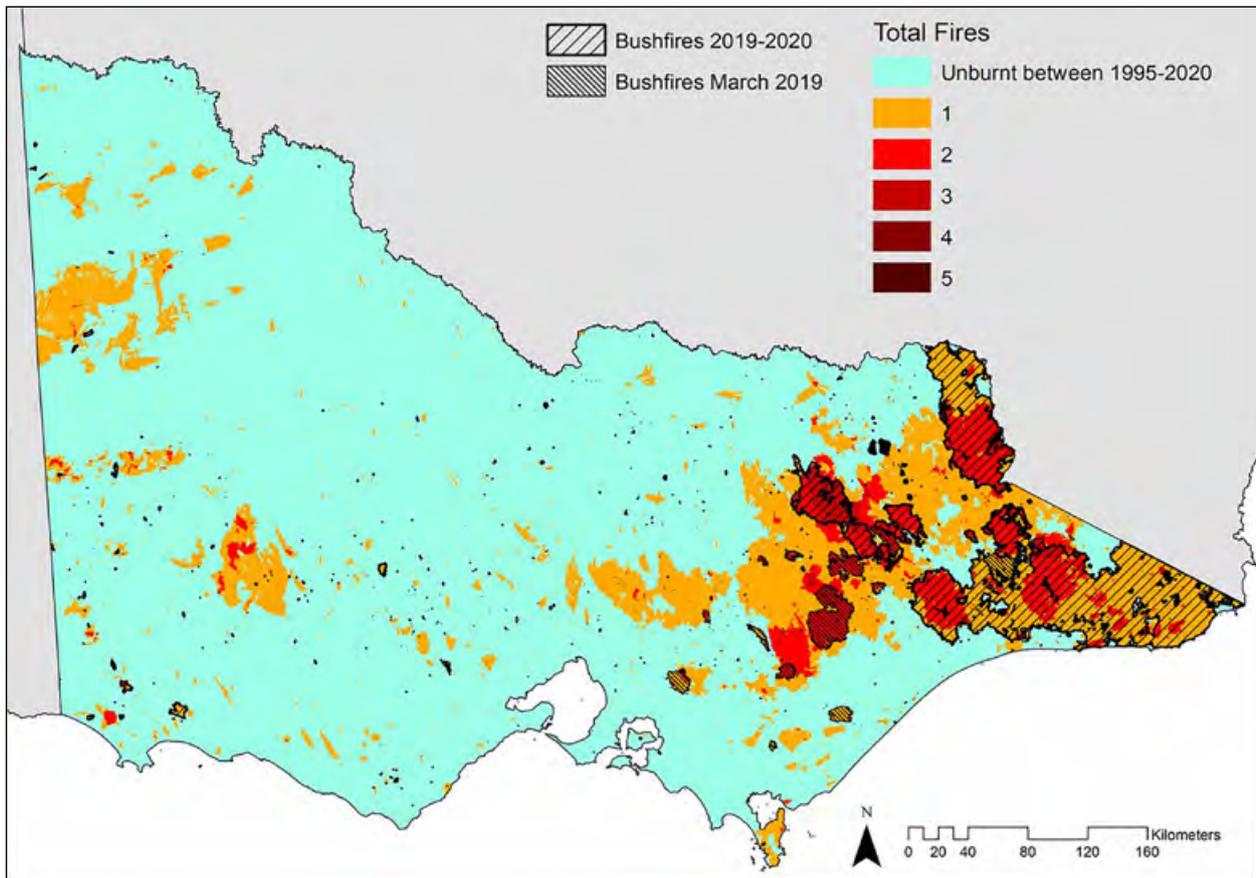


Figure 4: Number of bushfires in Victoria 1995-2020.³⁵

For the CFA, Black Saturday 2009 was 'a unique and devastating event that changed Victoria and CFA forever.'³⁶ In response to that devastating fire, which claimed the lives of 173 people, changes were made to fire mapping, modelling and warnings, fuel management, building codes, the fire danger rating system (a 'Code Red' or 'Catastrophic' rating was added) and bushfire risk assessment in Victoria.

While these changes were being made, bushfires were also changing, driven by the drier, hotter and stormier conditions generated by climate change. The 6th report of the Intergovernmental Panel on Climate Change³⁷ released in August 2021 included a regional fact sheet for Australia. It confirmed that:

- Australian land areas have warmed by around 1.4°C (very high confidence), and annual temperature changes have emerged above natural variability in all land regions (high confidence).

33. Hughes L and Alexander D 2017, 'Climate change and the Victoria bushfire threat: update 2017', Climate Council of Australia, Sydney, Australia.

34. Forest Fire Management Victoria, 'Past bushfires', Melbourne, Victoria <https://www.ffm.vic.gov.au/history-and-incidents/past-bushfires> Accessed 10 May 2021.

35. Lindenmayer D and Taylor C 2020, 'New spatial analyses of Australian wildfires highlight the need for new fire, resource, and conservation policies', PNAS, 117, pp. 12481-12485. Map Courtesy of David Lindenmayer and Chris Taylor.

36. Country Fire Authority, 'Major fires', Burwood East, Victoria <https://www.cfa.vic.gov.au/about/major-fires> Accessed 10 May 2021.

37. IPCC, 2021: Summary for policymakers. In: 'Climate change 2021: the physical science basis', contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, prepared by V Masson-Delmotte, P Zhai, A Pirani, S Connors, et al. (eds), Cambridge University Press, in press.

Fire

- Heat extremes have increased, cold extremes have decreased, and these trends are projected to continue (high confidence).
- Frequency of extreme fire weather days has increased, and the fire season has become longer since 1950 at many locations (medium confidence). The intensity, frequency and duration of fire weather events are projected to increase throughout Australia (high confidence).

The Victorian 2019-20 bushfires commenced on 21 November 2019 when lightning ignited three large fires in East Gippsland. Across the state, 150 fires started on that day and burnt more than 32,000

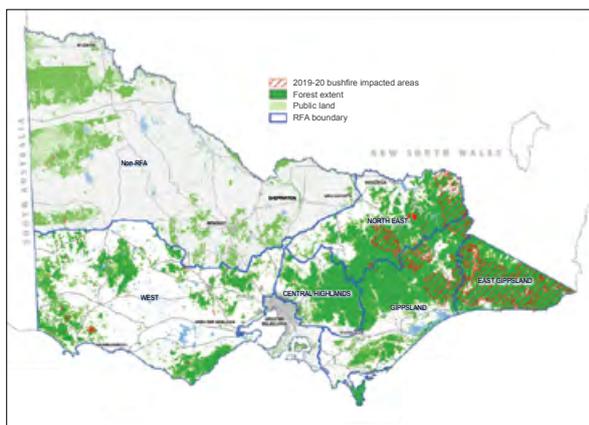


Figure 5: Fire extent of the 2019-20 bushfires in Victoria.³⁸

hectares near Shepparton, Ballarat, Bruthen, Buchan and Gelantipy. Figure 5 maps the entire extent of the 2019–20 bushfires, which covered a total area of 1,465,304 hectares in Victoria.

The 2019–20 bushfires occurred during Australia's hottest year on record. December 2019 was also the hottest of any December. Increases in the Forest Fire Danger Index (calculated using rainfall, evaporation, wind speed, temperature and humidity data) have been predicted by scientists over the past three decades, including in 1995,³⁹ 2001,⁴⁰ 2007⁴¹ and 2011,⁴² and by CSIRO and the Bureau of Meteorology in 2015.⁴³ The two scientific organisations predicted severe fire days would increase from between 160% and 190% by 2090. In addition, Hasson et al. (2009) found that the frequency of extreme fire weather events would 'increase from around 1 event every 2 years during the late 20th century to around 1 event per year in the middle of the 21st century and 1 to 2 events per year by the end of the 21st century.'⁴⁴

Policy and legislative settings

The Victorian Traditional Owner Cultural Fire Strategy was released in 2018 'to reinvigorate cultural fire through Traditional Owner led practices across all types of Country and land tenure; enabling Traditional Owners to heal Country and fulfil their rights and obligations to care for Country.'⁴⁵ The strategy's vision is that: 'Future generations of Victorian Traditional Owners will grow-up observing their Elders leading the use of the right fire for Country. They will be trusted to know the special reasons why fire is used and how it brings health to the land and people. Their children and grandchildren will see culturally valuable plants and animals return to Country and know their stories.' The strategy has four objectives:

- develop operational pathways that enable Traditional Owners to lead the planning and to undertake cultural burns across all land tenures and Country types according to their cultural obligations
- build Traditional Owner governance and capacity in cultural fire knowledge and practice
- improve management of state forest reserves and private land through the application of collaborative management to heal country and build resilience in people and landscapes
- facilitate the development and strengthening of institutional frameworks that support cultural fire practice.

38. Department of Agriculture, Water and the Environment 2021, 'Victorian regional forest agreements major event review of the 2019-20 bushfires summary report: information and data to inform public consultation', Canberra, Australia.
 39. Beer T and Williams A 1995, 'Estimating Australian forest fire danger under conditions of doubled carbon dioxide concentrations', *Climatic Change*, 29, pp. 169–188.
 40. Williams A, Karoly D and Tapper N 2001, 'The sensitivity of Australian fire danger to climate change', *Climatic Change*, 49, pp. 171–191.
 41. Lucas C, Hennessy K, Mills G and Bathols J 2007, 'Bushfire weather in southeast Australia: recent trends and projected climate change impacts', Bushfire CRC and Australian Bureau of Meteorology, September 2007, consultancy report prepared for the Climate Institute of Australia.
 42. Clarke H, Smith P and Pitman A 2011, 'Regional signatures of future fire weather over eastern Australia from global climate models', *International Journal of Wildland Fire*, 20, pp. 550–562.
 43. CSIRO and Bureau of Meteorology 2015, 'Climate change in Australia: information for Australia's Natural Resource Management Regions', technical report, CSIRO and Bureau of Meteorology, Australia.
 44. Hasson A, Mills G, Timbal B and Walsh K 2009, 'Assessing the impact of climate change on extreme fire weather even over southeastern Australia', *Climate Research*, 39, pp. 159–172.
 45. The Victorian Traditional Owner Cultural Fire Knowledge Group 2018, 'The Victorian Traditional Owner cultural fire strategy', Federation of Victorian Traditional Owner Corporations, Melbourne, Victoria.

Fire

The Victorian Traditional Owner Cultural Landscapes Strategy aims to redefine the connection to Country for the world's oldest living culture.

Through partnership in a co-design process, the Federation of Victorian Traditional Owner Corporations, with Parks Victoria and DELWP, worked in self-determination mode with Traditional Owners to understand how Traditional Owners wish to express their cultural values, practices, interests and knowledge associated with planning and management for all Countries in Victoria. A collaborative governance model was created that built upon the learning from the development of the Victorian Traditional Owner Cultural Fire Strategy.

The purpose of the Strategy is to embed, at a statewide level, Traditional Owner management of Country. The Strategy achieves this by supporting the development of institutional frameworks and operational and procedural pathways that are tailored to each Traditional Owner Group's self-determined pathway. The Strategy frames Victorian Traditional Owner rights and interests and pathways for development in public forest and park planning and management. The Strategy will help guide Victorian land management strategies and policies, including the implementation of the Commonwealth and Victorian Government's modernised Victorian RFAs and the development and implementation of Forest Management Plans (DELWP) and the Land Management Strategy and Land Management Plans (Parks Victoria).

Launched in 2015, Safer Together aims to reduce the bushfire risk in Victoria. Its focus is the management of bushfire fuels on public land to protect communities and the environment. A residual risk reduction target is used when identifying areas where bushfire management activities, such as planned burning, will have the greatest effect.

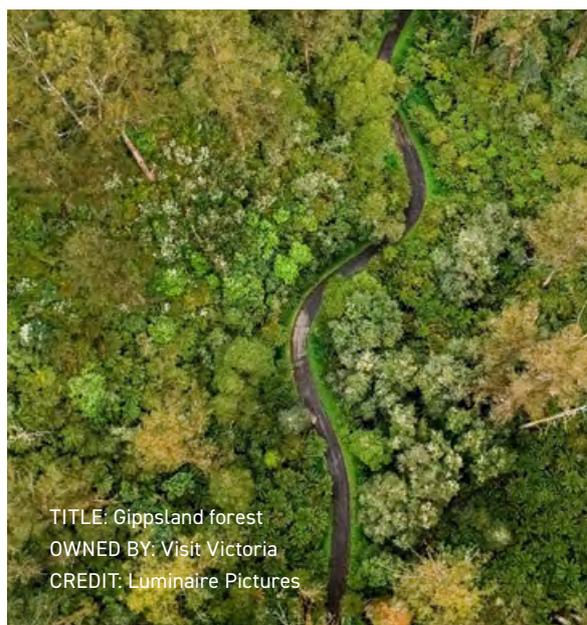
The Joint Fuel Management Program aims for an integrated and risk-focused fuel management program across public and private land. It is designed to implement long-term strategic bushfire management strategies, which outline how the risk of bushfires is managed for the protection of life and property on public and private land while maintaining and improving natural ecosystems.

The Code of Practice for Bushfire Management on Public Land 2015 has two objectives:

- to minimise the impact of major bushfires on human life, communities, essential and community infrastructure, industries, the economy and the environment. Human life will be afforded priority over all other considerations
- to maintain or improve the resilience of natural ecosystems and their ability to deliver services such as biodiversity, water, carbon storage and forest products.

Strategic bushfire management plans are developed for the public land in each DELWP region. The plans outline the fuel management strategy that DELWP and Parks Victoria will use to minimise the impact of major bushfires on people, property, infrastructure, economic activity and the environment to achieve the two above objectives of the Code of Practice. The plans establish fire management zones – asset protection; bushfire moderation; landscape management; planned burning exclusion – on public land only.

The Monitoring, Evaluation and Reporting Framework for bushfire management on public land guides DELWP and its partner agencies on assessing the effectiveness of their work, which is measured against the primary objectives in the above Code of Practice.



TITLE: Gippsland forest
OWNED BY: Visit Victoria
CREDIT: Luminaire Pictures

Fire

Indicator Fi:01 Area of native vegetation burnt in planned fires and bushfires

Region Statewide	Indicator Performance:	2018 Status	2018 Trend	2018 Data
Measures Annual planned burn area; Annual total area affected by bushfires	2018:  2021: 			
Data Custodian DELWP	Why this indicator? This indicator can provide a baseline for the spatial extent and nature of planned and unplanned fires, which is also used to calculate residual risk	2021 Status	2021 Trend	2021 Data
				

Potential thresholds for status in the SoE 2023 report

Planned burns

Good: ≥75% to 100% of targeted land area meets planned burning targets and both objectives of the Code of Practice, with impacts on ecosystem resilience monitored, reported and mitigated.

Fair: ≥50 to <75% of targeted land area meets planned burning targets and both objectives of the Code of Practice, with impacts on ecosystem resilience in part monitored, reported and mitigated.

Poor: <50% of targeted land area meets planned burning targets and both objectives of the Code of Practice, with impacts on ecosystem resilience neither monitored, reported nor mitigated.

This will depend on how fuel reduction targets are set.

Bushfires

Good: The average annual bushfire area significantly reduced.

Fair: The average annual bushfire area slightly reduced.

Poor: The average annual bushfire area significantly increased.

Why this assessment in 2021?

Status: The average area of the fire extent has increased in the past 20 years, which means that the Status of bushfires would be Poor. The meeting of planned burning targets does not necessarily measure the impacts of that achievement on biodiversity. The Victorian Auditor-General's Office's report on reducing bushfire risk was critical of DELWP's effort to monitor the impacts of planned burning on ecosystem resilience. Although all fire is important when assessing the impacts on ecosystems and species, combining bushfires and planned burning in this indicator makes it difficult to assess the Status.

Trend: The average fire extent is increasing and, as the fire season lengthens due to hotter and drier conditions, the window for planned burning is narrowing. This suggests that the Trend could continue to deteriorate.

Data Confidence: Spatial data on planned burn area and bushfire extent are available.

Should this indicator be used in the SoE 2023 report?

Yes, it should be retained in the Fire chapter, however consideration should be given to splitting it into two indicators, one for planned burns and the other for bushfires. The two metrics cannot be averaged to determine the overall Status.

Summary of SoE 2018 Report assessment

- In 2016–17, the annual planned burning target was replaced by a residual risk-reduction target focussed on asset protection.
- Planned burns are heavily dependent on weather, with burning not possible when conditions are too hot, too dry or too wet.
- Most planned burns occur in eastern Victoria, in DELWP's Hume and East Gippsland regions, due to the large areas of public land near assets.
- Four bushfires accounted for 85% (approx. 3.7 million hectares) of the area burnt by bushfires between 2003–04 and 2016–17.

The 2019–20 bushfires: Impacts and responses

At the end of the 2019–20 bushfires, 1,465,304 hectares, almost all in eastern Victoria, had been burnt. The 2019–20 fuel management program proposed a planned burning target of 230,000 hectares. However, it was reduced to 100,000 hectares due to the 2019–20 bushfires.

SoE Biodiversity Update 2021 Report assessment

Figure 6 presents data on planned burning and bushfires in Victoria from 1932–33 to 2019–20. It shows that the bushfire extent has been much higher since 2002–03, with three fire seasons burning at least 1.2 million hectares. Prior to that, the only fire that had reached that scale was Black Friday in 1939.

Figure 6 also shows that planned burning has been used for decades to manage fuel in Victoria. The area of planned burning (also known as prescribed burning and hazard reduction burning) has been variable over the time period, with the largest areas burnt in the 1980s. The aim of planned burning is to reduce the fuel load in the undergrowth, ground surface and tree bark while largely avoiding the trees. It is not designed to ensure an area does not burn, its focus is to ensure that if an area does burn, it will burn at lower intensity and be more controllable by firefighters.⁴⁷

The science indicates that climate change is driving warmer and drier conditions, lengthening the fire season, increasing fire danger and reducing the time available for planned burning.⁴⁹ However, modelling by Clarke et al. (2019)⁵⁰ and di Virgilio et al. (2020)⁵¹ suggests that as the summer window closes for planned burning, a winter window could be opening.

The Senate Inquiry into the 2019–20 bushfires heard that planned burning faces three challenges:

- The window for planned burning was becoming increasingly smaller because of climate change.
- Planned burning policies were ill-equipped to cope with severe weather associated with climate change.
- Limited research on when and how planned burning should be applied in different conditions.⁵²

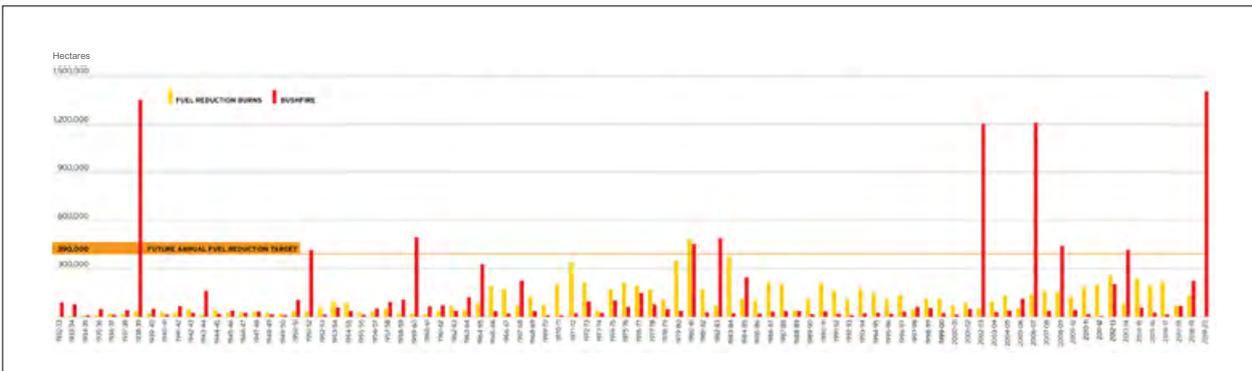


Figure 6: Area of fuel reduction burns and bushfires from 1932–33 to 2019–20.⁴⁸

47. Climate Council of Australia 2020, 'Setting the record straight on hazard reduction burning, fact sheet', Sydney, Australia.

48. Victorian National Parks Association 2020, 'Fuel reduction and bushfire in Victoria: fact sheet', Carlton, Victoria.

49. Climate Council of Australia 2020, 'Setting the record straight on hazard reduction burning, fact sheet', Sydney, Australia.

50. Clarke H, Tan B, Boer M, Price O et al. 2019, 'Climate change effects on the frequency, seasonality and interannual variability of suitable prescribed burning weather conditions in southeastern Australia', *Agricultural and Forest Meteorology*, 271, pp. 148–157.

51. Di Virgilio G, Evans J, Clarke H, Sharples J et al. 2020, 'Climate change significantly alters future wildfire mitigation opportunities in southeastern Australia', Faculty of Science, Medicine and Health, University of Wollongong, Wollongong, NSW.

52. Senate Standing Committees on Finance and Public Administration, 'Lessons to be learned in relation to the Australian bushfire season 2019–20', Parliament of Australia, Canberra.

Fire

The reports of the Royal Commission on National Natural Disaster Arrangements and the Victorian Inspector-General of Emergency Management, both following the 2019–20 bushfires, observed that although it is an important tool in bushfire mitigation, planned burning is not a panacea. The reports also noted the polarisation of views on planned burning, which receives strong expressions of opposition and support across the community.

Victoria's three-year Joint Fuel Management Program (2020–21 to 2022–23) covers private and public land and outlines the importance of planned burning in achieving its targets: 'The Joint Fuel Management Program includes planned burns which will re-introduce fire into these landscapes over the coming years, to reduce the scale, severity and impact of future landscape fires. These planned burns will be critically important to achieving the objectives of our long-term bushfire management strategies and minimise the impact of future fire.'⁵³

For the plan's first year 2020–21, the statewide fuel management program included 70 burns with Traditional Owners, more than 19,000 hectares of slashing, mowing and mulching vegetation, and 600 planned burns covering more than 220,000 hectares.⁵⁴ This had a projected bushfire risk of 59%

by June 2021, i.e. the impacts on life and property would be reduced by 41% if residual risk targets were met. The regional fuel management program for 2020–2021 is summarised in Table 4.

Hume and Loddon Mallee had the largest areas scheduled for planned burning, while Barwon South West had the largest number of planned burns. Regional bushfire risk varies due to differences in the size and location of communities and their assets, fuel loads and topography.⁵⁵

Morgan et al. (2020) argue that 'there is compelling evidence for the greater use of prescribed burning to reduce wildfire risks and impacts, rather than committing increasing resources to wildfire suppression. The potential negative impacts of prescribed burning can be managed effectively using existing knowledge and tools. Clear communication of the benefits of prescribed burning can influence political and public opinion in its favour. More investment in training, human capacity and supporting resources is required to safely and effectively deploy prescribed burning more widely to reduce future wildfire risks.'⁵⁶ However, other scientists have reported that the reduction of fuel loads did little to stop fires ignited in extreme weather and during drought.⁵⁷

Table 4: Joint fuel management programs for Year 1 (2020–21) of three-year program.⁵⁸

Region	Traditional Owner Cultural Burns	Mechanical Works (ha)	Planned Burns No. and (ha)	Number of Cross-tenure Burns	Ecological Burns	Residual Bushfire Risk June 2021 (Target)
Statewide	70	19,000	600 (220,000+)			59% (70%)
Barwon South West	8	4,472	482 (35,282)	6827 ha over three years	12,500ha*	59%
Gippsland	6	6,334	133(62,808)	31	Yes	42%
Grampians	6	4,600	256 (31,600)	10	Yes	66%
Hume	2	5,758	196 (71,498)	3	Yes	65% (69%)
Loddon Mallee	98	7,000	338 (72,363)	6	10	66%
Greater Melbourne	4	1,532	111 (5,342)		Yes	82% (85%)

* for south-eastern red-tailed black cockatoo.

53. Forest Fire Management Victoria and Country Fire Authority 2020, '2020/21–2022/23 Joint fuel management program', Melbourne, Victoria.

54. Ibid

55. Safer Together, 'Understanding risk', Melbourne, Victoria <https://www.safertogether.vic.gov.au/understanding-risk> Accessed 10 May 2021.

56. Morgan G, Tolhurst K, Poynter M, Cooper N et al. 2020, 'Prescribed burning in south-eastern Australia: history and future directions', *Australian Forestry*, 83(1), pp. 4–28.

57. Penman T, Parkins K and McColl-Gausden S 2019, 'A surprising answer to a hot question: controlled burns often fail to slow a bushfire', *The Conversation*, 15 November 2019.

58. Forest Fire Management Victoria and Country Fire Authority 2020, 2020/21–2022/23 Joint fuel management program, Melbourne.

In an analysis⁵⁹ of planned burning in 30 regions in south-eastern Australia from 1975 to 2009, Price et al. (2015) found that leverage (the reduction in bushfire area burnt resulting from previous planned burning) occurred in only four bioregions in the forested mountains of the Great Dividing Range along the east coast: New England Tableland, NSW North Coast, Sydney Basin and Australian Alps/South Eastern Highlands. The scientists concluded that: 'In most Bioregions prescribed burning is likely to have very little effect on subsequent extent of unplanned fire, and even in regions where leverage occurs, large areas of treatment are required to substantially reduce the area burned by unplanned fire.'

Floreac et al. (2020) evaluated the long-term costs and benefits of planned burns at the wildland-urban interface and in rural landscapes. There was a greater reduction in damages at the interface, although it was also more expensive and less economically efficient.⁶⁰ A broad review of planned burning research by the Bushfire Recovery Project also found it most effective (although more expensive) when in proximity to the assets, and fuel reduction 'close to houses also creates a defensible space in which fire suppression has a better chance of being successful, except in extreme fire weather conditions.'⁶¹ The distance between planned burns and assets would vary depending on house ignitability, housing density and vegetation type.

Bowman et al. (2020) argue that planned burning 'can reduce carbon losses from subsequent wildfire, yet the "carbon costs" of it may equal or outweigh the "carbon benefits" in reduced wildfire emissions. Likewise, mechanical thinning of vegetation to reduce fuel loads also carries heavy carbon costs with uncertain carbon benefits.'⁶²

Analysis by Bowman et al. (2021) found that 'extreme fire weather conditions and topography have a much greater influence compared to disturbance history in causing severe fires' ... and ... 'Fuel loads are likely to become less important than climate drivers in determining fire extent and severity, making it increasingly difficult, if not impossible, to maintain large areas of unburnt forest in a low-fuel state sufficient to impede rapid fire spread and thus limit the extent, frequency and severity of future forest fires.'⁶³

Planned burning has been likened to cultural burning, however there are significant differences. Cultural burning is becoming more common and is an important part of the Joint Fuel Management Plan for each Victorian fire region. For 2020–21, there were 202 cultural burn events planned in partnerships between land management agencies and Traditional Owners.

Cultural burns are also being conducted by Traditional Owners in partnership with catchment management authorities. The Red Tails of the Glenelg Plain Burning Project, a partnership between the Gunditjmara Traditional Owners and the Glenelg Hopkins Catchment Management Authority (CMA), is monitoring the results of a cultural burn on 16 hectares of habitat for the south-eastern red-tailed black cockatoo in Nangeela State Forest, south-western Victoria. Conventional fuel reduction burning can scorch the forest canopy and remove the cockatoo's food source. It is hoped that the cultural burn will reduce the site's flammability.⁶⁴ The Gunditjmara Traditional Owners, along with the Budj Bim Rangers, also conducted a cultural burn in the Tyrendarra Indigenous Protected Area in 2019 to reduce phragmites reed growth and improve the habitat for the Australasian bittern, develop cultural skills and regenerate native species (dense reeds can dry out the wetland and reduce connectivity for eels, frogs and fish).⁶⁵

The Victorian Auditor General's Office released its audit 'Reducing bushfire risk' in October 2020.⁶⁶ The audit found that: 'With the exception of some isolated case studies, DELWP does not know the effect of its burns on native flora and fauna' and made a number of recommendations to improve planned burning processes.

59. Price O, Penman T, Bradstock R, Boer M and Clarke H 2015, 'Biogeographical variation in the potential effectiveness of prescribed fire in south-eastern Australia', *Journal of Biogeography*, 42(11), pp. 2234–2245

60. Floreac V, Burton M, Pannell D, Kelso J, and Milne G 2020, 'Where to prescribe burn: the costs and benefits of prescribed burning close to houses', *International Journal of Wildland Fire*, 29, pp. 440–458.

61. Mackey B, Gould S, Lindenmayer D, Norman P et al. 2021, 'Bushfire science report no.1: how does climate affect bushfire risks in the native forests of south-eastern Australia?', Bushfire Recovery Project, Griffith University and the Australian National University.

62. Bowman D, Williamson G, Price O, Ndalila M et al. 2020, 'Australian forests, megafires and the risk of dwindling carbon stocks', *Plant, Cell and Environment*, 44(2) <http://dx.doi.org/10.1111/pce.13916>

63. Bowman D, Williamson G, Gibson R, Bradstock R et al. 2021, 'The severity and extent of the Australia 2019–20 Eucalyptus forest fires are not the legacy of forest management', *Nature Ecology and Evolution*, doi.org/10.1038/s41559-021-01464-6.

64. Zeeman B and King M 2020, 'Red tails of the Glenelg Plain burning project', Glenelg Hopkins Catchment Management Authority, Hamilton, Victoria.

65. Glenelg Hopkins Catchment Management Authority 2019, 'Cultural burns benefit more than just Bittern', 27 June 2019.

66. Victorian Auditor General's Office 2020, 'Reducing bushfire risk', Melbourne, Victoria.

Among them was that DELWP, in partnership with the CFA and Fire Rescue Victoria, develop performance metrics to demonstrate, among other things, 'the impact that planned burning has on public and private land on ecosystem resilience.'

It also recommended that DELWP 'conducts more effective ecosystem resilience monitoring by:

- setting a target for regions on the quantity of ecosystem resilience monitoring assessments that they should complete annually
- setting an outcomes-level target that defines desirable values for key ecosystem resilience metrics
- reporting publicly against all of the metrics in its Measuring Ecosystem Resilience in Strategic Bushfire Management Planning policy in its fuel management reports.'

The effects of fire on the landscape, flora and fauna and human activity are linked to the type of fire, its temporal nature and its spatial pattern.⁶⁷ The response by flora and fauna also varies across species at different stages of their life cycle. Some require fire or tolerate it, while others are highly sensitive, and their responses will vary depending on the frequency, severity and pattern of the fires i.e. the fire regime.⁶⁸ According to a 2016 DELWP report, planned burns reduce the availability of hollow-bearing trees, although further study was required to determine how this affected hollow-dependent fauna.⁶⁹

Such variations make planned burning complex. Research in the Lofty Ranges of South Australia by Prowse et al. (2017) found that of 60 bird species surveyed, '37% were both declining and negatively impacted by recent burning.'⁷⁰ Modelling by the researchers showed that the impacts on birds would be ameliorated if long-unburnt woodland habitats were retained.

From 2018 to 2021, Parks Victoria conducted research into the impacts, recovery and future of fire and biodiversity across three themes:⁷¹

Theme 1: Improved understanding of vegetation responses to planned fire

This theme targeted the Northern Plains Grasslands, one of Australia's most endangered ecosystems. It sought to understand the impacts of fire and inform the development of planned ecological burns. The project was a collaboration with the region's Traditional Owner groups: Dja Dja Wurrung Clans Aboriginal Corporation, Yorta Yorta Nation Aboriginal Corporation, Barapa Barapa, and Wamba Wamba, which allowed greater inclusion of cultural objectives.

Theme 2: Improved understanding of the responses of fauna in fire-prone environments

The focus of this theme was the Wannon Heathland, a long unburnt habitat in Gariwerd National Park. The aim was to inform bushfire management planning and planned burning prescriptions at small-patch scales to ensure small-scale refugia for native animals are identified and protected.

Theme 3: Improved understanding of the vulnerability of fire sensitive environments to bushfire

This theme examined the recovery from fire by Cool Temperate Rainforest in the Yarra Ranges National Park and identified areas of alpine ash at risk from future fires, along with the effects of management interventions such as re-seeding. The results will assist pre-fire prevention planning and post-fire recovery management.

67. Altangerel K and Kull C 2013, 'The prescribed burning debate in Australia: conflicts and compatibilities', *Journal of Environmental Planning and Management*, 56(1), pp. 103-120.

68. Ibid

69. Bluff L 2016, 'Reducing the effect of planned burns on hollow-bearing trees', fire and adaptive management report no. 95, DELWP, East Melbourne, Victoria.

70. Prowse T, Collard S, Blackwood A, O'Connor P et al. 2017, 'Prescribed burning impacts avian diversity and disadvantages woodland-specialist birds unless long-unburnt habitat is retained', *Biological Conservation*, 215, pp. 268-276.

71. Parks Victoria 2021, 'STE1 fire and biodiversity - impacts, recovery and future planning', project closure report, Melbourne, Victoria.

Indicator Fi:02 Impacts of bushfires

Region Statewide Measures Impacts of bushfires on human settlements, businesses and natural resources Data Custodian Various	Indicator Performance: 2018 & 2021: Unable to be assessed due to Low Data Confidence and Unknown Trend Why this indicator? This is used to monitor and evaluate the cumulative impacts of bushfires on society. The Victorian Government's highest priority in bushfire management is the protection of human life.	2018 Status	2018 Trend	2018 Data
			?	
		2021 Status	2021 Trend	2021 Data
			?	

Potential thresholds for status in the SoE 2023 report

The nature of the threshold will depend on which metrics are used. It could be lives lost, houses damaged and destroyed, insurance claims for damaged and destroyed infrastructure and property on public and private land, area burnt, health impacts such as hospitalisations, livestock and crop losses e.g. wine grape crop tainted by smoke.

One option could be:

Good: The five-year rolling average of insurance claims for loss and damage of property and infrastructure on public and private land is declining significantly.

Fair: The five-year rolling average of insurance claims for loss and damage of property and infrastructure on public and private land is stable or slightly increasing.

Poor: The five-year rolling average of insurance claims for loss and damage of property and infrastructure on public and private land is increasing significantly.

Why this assessment in 2021?

Status: The Status for bushfire impacts in Victoria over the past two decades is Poor, including the 2019–20 bushfires (and also for the other devastating bushfires in Figure 7).

Trend: A comparison of bushfire data from the past two decades with that from the 20th Century suggest that the Trend in the Status could be deteriorating, and predictions of increasing bushfire severity, duration, frequency and extent would also suggest a deteriorating Trend. However, Data Confidence is Low and the Trend not evident.

Data Confidence: In 2018, the Trend for this indicator was assessed as 'Unknown', largely due to Low Data Confidence. The reports of the National Royal Commission and other inquiries have provided useful data on the impacts of the 2019–20 bushfires, as have media reports. However, except for the three metrics from Figure 7, data remains scarce, and is especially poor regarding bushfire impacts on private land e.g. farms. Data on the costs (budget impact of fires) of preparedness, response and recovery in relation to life and property would important data for assessing bushfire impacts.

Should this indicator be used in the SoE 2023 report?

Yes, it could be retained in the Fire Chapter if data on social, cultural and economic impacts are significantly improved. Otherwise, bushfire impacts should simply be referred to in the report's narrative.

Summary of SoE 2018 Report assessment

- Given the cost of fire responses, the drain on water resources, and the devastating impact of bushfires on biodiversity and communities, it is critical to identify data custodians responsible for collating information on the impacts of fire on essential community infrastructure (i.e. hospitals, power supplies), businesses, water resources, biodiversity and the cost of fire responses.
- Previously reported data on the social, economic and health impacts of bushfires were no longer available. Since 2013, the only data identified to be held by emergency management agencies were property loss from bushfires over the past three years. No specific bushfire-related information was available from the Department of Health and Human Services.

Fire

The 2019–20 bushfires: Impacts and responses

The Inspector-General for Emergency Management's Phase 1 report⁷² has provided the most comprehensive data on the environmental, economic and social effects of the 2019–20 bushfires in Victoria. This is summarised in Table 5. The economic sectors most impacted by the 2019–20 bushfires were tourism, agriculture, forestry, winemaking and beekeeping. Except for estimates of the economic impact on tourism, data are limited, although insurance claims can provide some insight. The Insurance Council of Australia reported in May 2020 that Victorian bushfire-related insurance claims had reached \$186 million.⁷³

Along with the direct impacts at the fire front, the spread of smoke and ash to populated rural and urban areas beyond the fire zone caused serious health impacts.⁷⁵ In the wake of the fires and the impacts of climate change, medical experts from the Australian National University called for deaths caused by hot weather and bushfire smoke exposure to be listed as causes of death on death certificates.⁷⁶

The Victorian Treasury estimated that the bushfires caused a reduction in the Gross State Product of \$500 million.⁷⁷ However, according to Dixon (2020), such measures miss the longer-term costs such as ongoing physical and mental health issues, damage to ecosystems, including water resources, downgraded tourism activity, increased costs of living in bushfire-prone areas and reduced consumer confidence,⁷⁸ which are far more difficult to measure.

The Victorian Premier indicated in January 2020 that the 2019–20 Bushfire Season had burnt 40% of the coupes earmarked for timber harvesting in East Gippsland. He was quoted at the time as saying: 'We've said for a while now that the sustainability of this industry could be directly impacted by a significant fire event and that's exactly what's happened here.'⁷⁹

72. Inspector-General of Emergency Management 2020, 'Inquiry into the 2019–20 Victorian fire season: phase 1 community and sector preparedness for and response to the 2019–20 fire season', Melbourne, Victoria.
 73. Insurance Council of Australia 2020, 'Insurance bill for season of natural disasters climbs over \$5.19 billion' [https://insurancecouncil.com.au/wp-content/uploads/resources/Media%20releases/2020/2020_05/2020_05_Insurance%20bill%20for%20season%20of%20natural%20disasters%20climbs%20over%20\\$5.19b.pdf](https://insurancecouncil.com.au/wp-content/uploads/resources/Media%20releases/2020/2020_05/2020_05_Insurance%20bill%20for%20season%20of%20natural%20disasters%20climbs%20over%20$5.19b.pdf) Accessed 4 November 2021.
 74. Inspector-General of Emergency Management 2020, 'Inquiry into the 2019–20 Victorian fire season, phase 1 community and sector preparedness for and response to the 2019–20 fire season', Melbourne, Victoria.
 75. Australian Institute of Disaster Resilience 2020, 'Australian disaster resilience knowledge hub: bushfires black summer, Victoria, November 2019–February 2020' <https://knowledge.aidr.org.au/resources/black-summer-bushfires-vic-2019-20/> Accessed 10 May 2021.
 76. Longden T, Quilty S, Haywood P, Hunter A et al. 2020, 'Heat-related mortality: an urgent need to recognise and record', *The Lancet Planetary Health*, 4 [https://doi.org/10.1016/S2542-5196\(20\)30100-5](https://doi.org/10.1016/S2542-5196(20)30100-5)
 77. Willingham R 2020, 'Coronavirus impact on Victorian economy to be 140 times worse than bushfires, Treasury expects', *ABC News*, 15 May 2020.
 78. Dixon J 2020, 'Take care when examining the economic impact of fires. GDP doesn't tell the full story', *The Conversation*, 17 January 2020.
 79. Ilanbey S 2020, 'Big impacts: almost half of areas in East Gippsland approved for logging', *The Age*, 20 January 2020.

Table 5: Social and economic costs of the 2019–20 bushfires in Victoria.⁷⁴

Impacts	Statewide	Gippsland	North East and Alpine
Hectares burned (ha)	1,507,895	1,163,248	319,401
Native forest burned (ha)	1,387,000	n/a	n/a
Deaths	5	4	1
Primary residences destroyed/damaged	313	n/a	n/a
Non-Primary residences destroyed/damaged	145	n/a	n/a
Livestock lost	6,829	1,152	4,135
Softwood Plantations (ha)	831	10	821
Crops (ha)	n/a	19,089	20,765
Sheds	n/a	232	246
Properties registered for clean-up	745	550	189
Tourism (January-March) \$million	330-350	n/a	n/a

Fire

In other estimates of the bushfire impacts:⁸⁰

- 371,245 hectares of ash wood volume and 335,310 hectares of mixed species wood volume, and 6,400 hectares of Victoria's 416,000 hectares of plantation forest were affected.
- There was a \$330-350 million impact on Victorian tourism which, in total, is valued at \$11.3 billion.
- 49 state forests and 98 parks and reserves were affected, including the closure of recreation sites and tracks.
- The Country of three Registered Aboriginal Parties were affected - however, 80% of the fire extent covered Country where Traditional Owner Groups are yet to receive formal recognition.
- More than 130 known non-Aboriginal heritage places were in the fire extent, while in the North East and East Gippsland Regional Forests Agreement areas there were 21 sites directly affected.
- Soil erosion to major waterways was expected to increase by 130,000-261,000 tonnes over 2020 and 2021.
- There is an expected net reduction of 55 million tonnes in carbon sequestration by forests i.e. a loss of 57 million tonnes and a gain of 2 million tonnes (returned in forest regrowth after the fires).

Akter and Grafton (2021) analysed the relationship between the Index of Relative Socio-Economic Disadvantage and the 2019–20 wildfire hazard exposure in Victoria (using the National Indicative Aggregated Fire Extent). They found that the 'most socioeconomically disadvantaged communities bore a disproportionately higher hazard exposure in the Black Summer than relatively advantaged communities.' Those disadvantaged were in the 'inner regional, outer regional and remote areas of New South Wales and Victoria, the two worst-hit states of the Black Summer catastrophe.'⁸¹ Both East Gippsland and north-eastern Victoria had high levels of socio-economic disadvantage and hazard exposure. The authors suggested that a possible explanation for the disparity was that communities with higher levels of socio-economic advantage had access to more resources for fire suppression and hazard reduction.

The social and economic impacts of fire can be exacerbated by those from other natural disasters occurring at around the same time. In the USA, recent research has shown that nearly 1 in 3 Americans experienced a weather disaster – severe storms, fires, hurricanes, coastal storms and floods – in that nation's 2021 summer.⁸² The Australian Institute of Disaster Resilience catalogued 19 major natural disasters that had occurred in Australia during 2019–20. These included bushfires, storms, floods, cyclones and hailstorms that placed great pressure on emergency services, resourcing, recovery and the affected communities. According to the Institute, 'It is widely acknowledged that meaningful community engagement and community-led approaches are essential to effectively supporting disaster resilience. So too are the systems, frameworks and enabling environments created through well-considered policy and coordination – most often formulated with community in mind.'⁸³

Nicholas and Evershed (2020) reported on the Multiple Disaster Index that was created by *The Guardian* Australia. The index was constructed by combining measures of drought, storms and flooding, the area burned in 2019–20, and COVID-19 cases and job losses. It used data from the Australia Bureau of Statistics, the Commonwealth Government, state health departments and the Insurance Council of Australia.⁸⁴ The highest scores were in eastern Victoria, NSW and southern Queensland, the regions hardest hit by bushfires and COVID-19.

80. Department of Agriculture, Water and the Environment 2021, 'Victorian regional forest agreements major event review of the 2019-20 bushfires: summary report: information and data to inform public consultation', Canberra, Australia.

81. Akter S, Grafton Q 2021, 'Do fires discriminate? Socio-economic disadvantage, wildfire hazard exposure and the Australian 2019–20 "Black Summer" fires', *Climatic Change* (2021) 165: 53.

82. Kaplan S and Ba Tran A 2021, 'Nearly 1 in 3 Americans experienced a weather disaster this summer', *The Washington Post*, 3 September 2021.

83. Australian Institute of Disaster Resilience, 'Meeting in the middle: community voices and complex choices' <https://www.aidr.org.au/programs/australian-disaster-resilience-conference/> Accessed 10 May 2021.

84. Nicholas J and Evershed N 2020, 'Interactive map: which areas of Australia were hit by multiple disasters in 2020?' *The Guardian*, 22 December 2020.

Fire

Table 6 lists the local government areas in eastern Victoria affected by the 2019–20 bushfires. The Alpine, East Gippsland and Towong local government areas had the highest percentages of their areas burnt and also had high Multiple Disaster Index scores. Although Wellington Shire had only a small percentage of its area affected by fire, its Multiple Disaster Index was lifted to be the second highest due to drought and COVID-19 job losses.

Table 6: Multiple Disaster Index for fire affected local government areas in eastern Victoria.⁸⁵

LGA	Drought	% Burned	Flood or Storm	COVID Cases	% COVID Job Losses	Disaster Index
Alpine	No	30.3	Yes	1	2.31	1.326
Campaspe	No	0.2	No	8	5.3	0.059
East Gippsland	Yes	54.1	Yes	5	6.8	2.611
Mansfield	No	0.9	Yes	8	6.1	1.074
Strathbogrie	Yes	0.1	No	0	6.1	1.062
Towong	No	39.4	Yes	0	2.3	1.417
Wangaratta	Yes	3.4	No	1	3.8	1.072
Wellington	Yes	0.4	Yes	7	11	2.117
Wodonga	No	0.7	Yes	1	2.3	1.03

To minimise the impacts of single and multiple disasters will require the building of community resilience. CSIRO (2020) observed that:

Much has already been done and achieved by all levels of government, response agencies and the community to increase Australia's resilience. However, there is a need and an opportunity to take this to the next level as we face increasing climate variability and hazard exposure and drive a truly national response to further build the resilience of our infrastructure, our land use practices, our communities, our industries and our environment.⁸⁶

The longer it takes to detect fires, the larger the area over which the fire can spread and the greater the impact. Research by CSIRO revealed that an observer in a fire tower could detect a new fire in around 30 minutes after ignition, however most fires are reported by calls to '000', which can delay suppression activity further. The development of fire-detection technology is aimed at reducing fire

detection time. The use of fit-for-purpose satellites, drones and ground-based cameras could potentially bring detection time down to one minute in the coming decade.⁸⁷ Ground-sensing cameras on fire towers are being piloted by the ACT Rural Fire Service and will operate day and night throughout the year.⁸⁸

Biddle et al. (2020) analysed the costs of Australian bushfires and the future economic impact of early bushfire detection. They estimated that under several climate change scenarios, the annual future cost of bushfires over the next 30 years could reach up to \$2.2 billion (\$1.2 billion at Net Present Value).⁸⁹ Over the same period, and assuming a growth in large fires as well as increased early detection reducing the probability of large fires (and detection within 30 minutes of ignition), the authors estimated a total economic benefit of \$14.4 billion (\$8.2 billion at Net Present Value).

85. Ibid

86. CSIRO 2020, 'Climate and disaster resilience: technical report', CSIRO, Australia.

87. Purtil J 2021, 'Australia's first satellite that can help detect bushfires within one minute of ignition set for launch', *ABC Science*, 14 March 2021.

88. The Minderoo Foundation, 'Automated bushfire detection', Nedlands, Western Australia <https://www.minderoo.org/fire-and-flood-resilience/fire-shield/detect/automated-bushfire-detection/> Accessed 31 July 2021.

89. Biddle N, Bryant C, Gray M and Marasinghe D 2020, 'Measuring the economic impact of early bushfire detection', The Australian National University Centre for Social Research and Methods, Canberra, Australia.

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The Climate Council in 2017 reported that the economic cost of bushfires in Victoria is expected to double by 2050,⁹⁰ and that the science indicates increasing fire severity, frequency, extent and duration.⁹¹ However, the economic, social and cultural impacts of bushfires vary depending on many factors that include the weather leading up to the fire season, the nature of the landscape where they burn, their proximity to human settlements and the actions taken by governments and the community prior to, during and after the bushfires.

The impacts of bushfires will also vary from one season to the next, as shown in Figure 7, which includes a range of numbers for lives lost, homes destroyed and area burnt for six bushfire seasons in Australia, four of which have impacted Victoria: Black Summer 2019–20, Black Saturday 2009, Ash Wednesday 1983 and Black Friday 1939. Although there are only three metrics presented in the graphs, they correlate with the Victorian Government’s highest priority in bushfire management, which is to protect people, property and infrastructure.

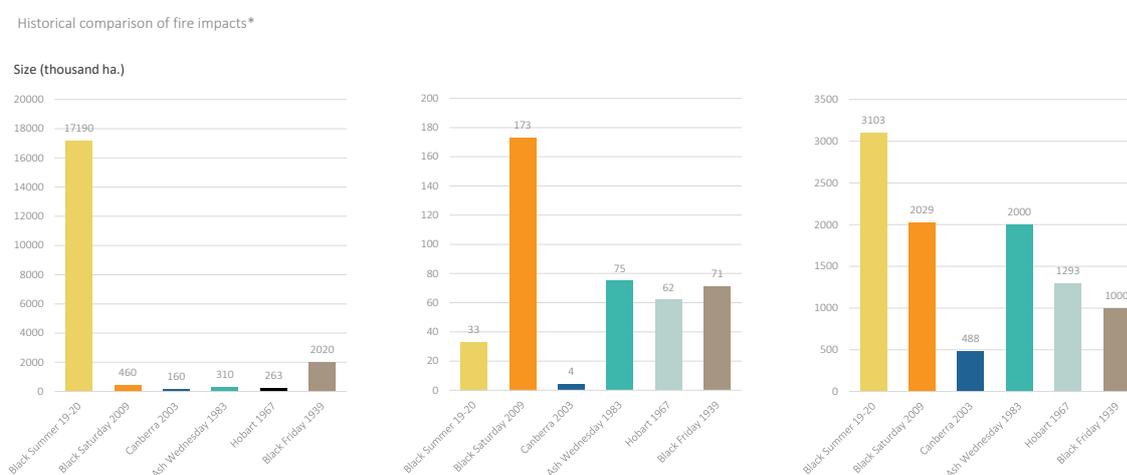


Figure 7: Areas burnt ('000s of hectares), number of lives lost, and number of homes lost in some significant fires between 1939 and 2019-20.⁹²

The Victorian Farmers Federation believes that many of the bushfire impacts on agriculture are poorly understood and costed,⁹³ with implications for regional economies. Although hectares of crops, kilometres of fences and numbers of dwellings destroyed are counted, the Federation says that there are no data on the following costs incurred during previous fires and those in 2019–20:

- the burning of soil organic content and the subsequent loss of farm productivity (over a number of years) and the costs of replacing organic content
- the rehabilitation of land after the fire and the measures taken to fight the fires e.g. control lines bulldozed in paddocks, fences cut for access by firefighters
- the loss of breeding lines after livestock losses and limitations on restocking due to the absence of fences
- restricted or lost access to markets due to road closures.

90. Hughes L and Alexander D 2017, 'Climate change and the Victoria bushfire threat: update 2017', Climate Council of Australia, Sydney, Australia.

91. Ibid

92. Figure supplied courtesy of Australasian Fire and Emergency Service Authorities Council.

93. Victorian Farmers Federation 2020, 'Landholder view of preparation, incident management and recovery', PowerPoint presentation to the Land and Fire Stakeholders Forum October 2020.

Fire

Indicator Fi:03 Actual fire regimes compared to optimal fire regimes

Region Statewide	Indicator Performance:	2018 Status	2018 Trend	2018 Data
Measures Tolerable Fire Interval (TFI) and Growth Stage Structure (GSS) distribution on public forests	2018: Unable to be assessed due to Low Data Confidence and Unknown Trend			
Data Custodian DELWP	2021:	2021 Status	2021 Trend	2021 Data
	Why this indicator? Inappropriate fire regimes can cause disruption to sustainable ecosystems and result in a loss of biodiversity by changing the long-term structure of plant communities and the composition of fauna communities.			

Potential thresholds for status in the SoE 2023 report

Good: Significant reduction in % of public forests below TFI

Fair: Stable or small reduction in % of public forests below TFI

Poor: Significant increase in % of public forests below TFI

OR

Good: Significant increase in area of public forests within TFI

Fair: No change or small reduction in area of public forests within TF

Poor: Significant increase in area of public forests below TFI

Why this assessment in 2021?

Status: Many areas are now experiencing increased frequency of fires, the area of public forests below the minimum TFI is increasing, and the area with a no-burn history decreasing. The 2019–20 bushfires had a significant impact on TFI metrics. This would suggest that the Status is now Poor.

Trend: The Trend is for an increasing area of public forests to be below the minimum TFI, while the area unburnt is decreasing, thus the deteriorating Trend.

Data Confidence: There is a high level of Confidence in the data. However, there are some limitations. TFI and GSS are based only on the vascular plants for which there is some understanding of their fire response. These are used as proxies for biodiversity in general and not for threatened Ecological Vegetation Classes (EVCs) or the impacts on threatened species.

Should this indicator be used in the SoE 2023 report?

Yes, it should be retained in the Fire Chapter.

Summary of SoE 2018 Report assessment

- A fire regime is a combination of factors including frequency, intensity, size, pattern, season, interval and severity.
- In 2017, more than half of Victoria's native vegetation was below the minimum TFI and in a state where another fire would threaten the vegetation persistence. Future fires below the TFIs could lead to the localised extinction of some plant species.
- Alpine Treeless, High Altitude Shrubland/ Woodland, and Tall Mist Forest were the three ecological groups that had more than 75% of their area below the minimum TFI.
- Areas with no fire history declined by 11% between 2007 and 2017, creating concern that habitat features requiring long time periods for development, such as hollow-bearing trees and logs, could be lost.

Fire

The 2019–20 bushfires: Impacts and responses

DELWP reported⁹⁴ in August 2020 that since 2000, and including the 2019–20 fires, there had been a large increase in the proportion of the area of vegetation subjected to multiple bushfires. Bennett et al. (2020)⁹⁵ found that forests in eastern Victoria burned by large fires in 2003, 2007 and 2013–14 were again burned during the 2019–20 bushfires (see Figure 8), and that they were suffering from too much severe fire (high-severity fire is 80% crown scorch and/or full crown burn). The scientists also reported that:

- A broad range of forest types were affected. Although most were mixed-species eucalypt forests, which are common, forest types with more limited ranges were also burnt, including banksia woodlands, warm temperate rainforests and mountain communities such as alpine ash forests and snow gum woodlands.
- High-severity fires increase death rates of eucalypt trees (e.g. two high-severity fires four years apart almost eliminated alpine ash from Victoria's Alps) and hinder resprouting (e.g. West Gippsland after high-severity fires six years apart).
- Alpine ash trees need 20 years before there are sufficient seeds to regenerate.

94. DELWP 2020, 'Victoria's bushfire emergency: biodiversity response and recovery version 2', East Melbourne, Victoria.
 95. Bennett LT, Kasel S, Fairman TA and Ruizhu J 2020, 'Why Australia's severe bushfires may be bad news for tree regeneration', *Australasian Plant Conservation: Journal of the Australian Network for Plant Conservation*, 28(4), pp. 10-12.
 96. Ibid

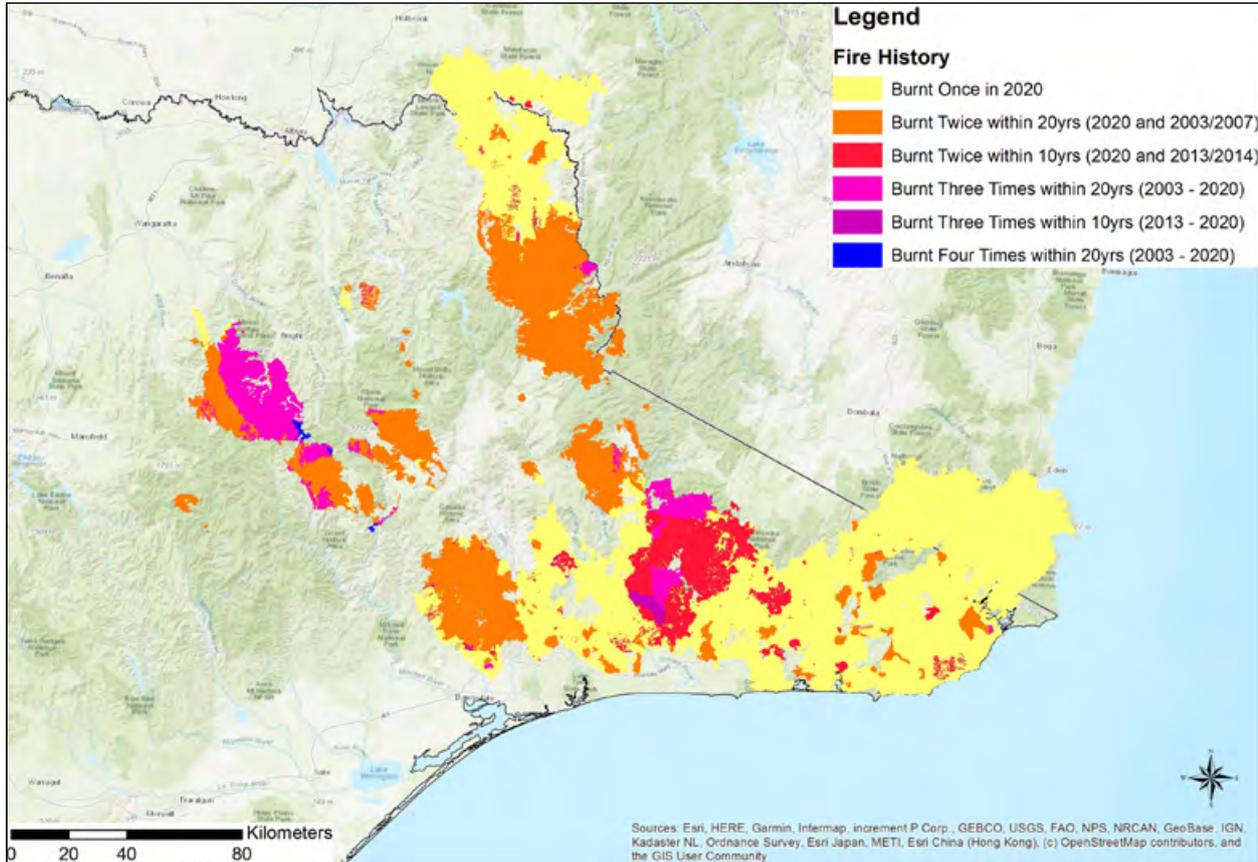


Figure 8: Fire history of eastern Victoria 2003 to 2020.⁹⁶

Fire

Fire-sensitive alpine ash and mountain ash forests have experienced multiple burns since 2000. Young ash trees are also under pressure from feral herbivores such as deer and goats. Figure 9 maps young mountain ash and alpine ash forests that are less than 20 years old (red areas on map) and which were affected by the 2019–20 bushfires. The blue areas indicate the entire extent of ash forests, while the 2019–20 fire extent is hatched.

Across all tenures, 4,286 hectares of mountain ash were impacted by the 2019–20 bushfires, with young mountain ash affected covering 1,741 hectares and which included 1,277 hectares impacted by high-severity fires. For alpine ash, the total area impacted was 52,516 hectares, with 20,460 hectares of young alpine ash affected, of which 13,051 hectares experienced high-severity fire.⁹⁷ In response, aerial seed drops were used in mid-2020 to help regeneration.

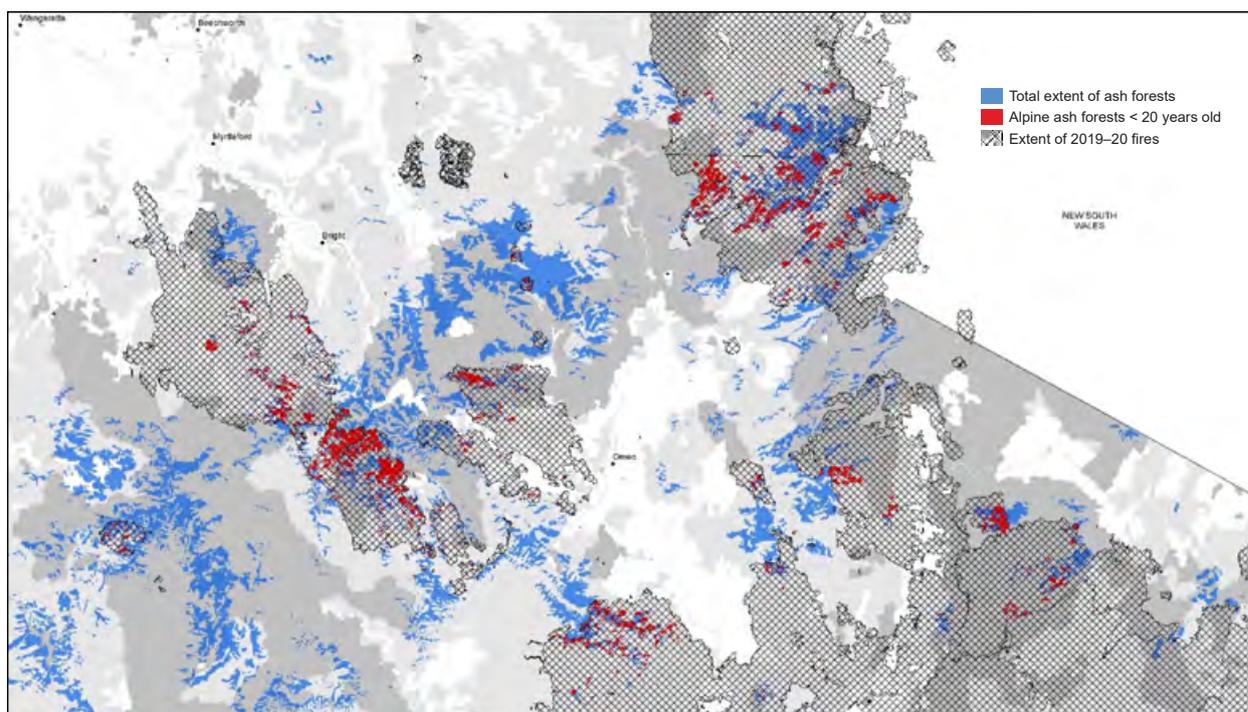


Figure 9: Indicative extent of young Alpine Ash and Mountain Ash forest impacted by 2019–20 fires.⁹⁸

Table 7 (on the next page) provides data on the TFI Status of native vegetation on Victoria's public land and includes data collected after the 2019–20 bushfires. The TFI for a vegetation community is the minimum and maximum intervals between fires of the species most sensitive to fire. If fire frequency is above or below minimum fire tolerance intervals, species may not be able to reproduce and repopulate.

The data in Table 7 show the significant impacts that the 2019–20 bushfires had on TFIs:

Above maximum TFI: declined significantly after Black Saturday 2009 and the 2019–20 bushfires, remaining relatively stable between those years. However, the bushfires caused a reduction of 17,297 hectares between 2019 and 2020.

Below minimum TFI: the area of forest for this metric had been increasing since 2007.

No burn history: has been in decline since 2007, with a drop of 76,619 hectares in 2020.

Over the 14 years from 2007 to 2020, it has dropped by 386,020 hectares.

Within TFI: gradual decline from 2007 before increasing between 2015 and 2019 (312,934 hectares in 2019), due to vegetation burnt in 1939 reaching maturity.⁹⁹ Although the 2019–20 bushfires caused a large decrease of 281,525 hectares, the area of vegetation within the TFI is now similar to what it was in 2007.

97. DELWP 2020, 'Victoria's bushfire emergency: biodiversity response and recovery, version 2', Melbourne, Victoria.

98. Ibid

99. Forest Fire Management Victoria, 'The year's achievements: bushfire risk', Melbourne, Victoria <https://www.ffm.vic.gov.au/fuel-management-report-2018-19/statewide-achievements/bushfire-risk> Accessed 10 May 2021.

Fire

Table 7: TFI status of vegetation on public land, Victoria, 2007–20.¹⁰⁰

Year	Above Maximum TFI	Below Minimum TFI	No Burn History	Within TFI
2007	155,924	3,517,113	2,249,996	1,561,506
2008	164,026	3,565,713	2,224,712	1,529,701
2009	148,372	3,616,904	2,181,921	1,536,953
2010	147,428	3,675,302	2,163,356	1,498,200
2011	159,132	3,705,859	2,140,272	1,479,179
2012	156,201	3,735,429	2,119,724	1,473,110
2013	155,814	3,808,596	2,086,751	1,433,359
2014	152,480	3,937,133	1,995,829	1,400,064
2015	150,155	3,974,234	1,976,812	1,387,304
2016	149,235	3,915,738	1,968,640	1,455,255
2017	148,053	3,875,259	1,964,267	1,501,287
2018	148,520	3,818,797	1,957,529	1,564,019
2019	150,856	3,519,638	1,940,595	1,876,953
2020	133,559	3,895,147	1,863,976	1,595,428

Growth State Structure (GSS) and Geometric Mean Abundance (GMA) are two other indices that can be used to monitor the impact of fire on biodiversity and ecosystem resilience.

At any time, terrestrial ecosystems and landscapes will have flora at various states of growth: juvenile, adolescent, mature and old. Ecosystem resilience to disturbances such as fire can be enhanced by maintaining that diversity of growth stages. Figure 10 illustrates the proportion of the four growth stages in Victoria, as well as for areas with no fire history. Each of the 2002–03 fires and the 2008–09 fires caused a reduction in the proportion of the growth stages except for 'Juvenile'. This change also occurred after the 2019–20 bushfires. The reduction in the area of forests with 'No fire history' can increase pressure on those species that are less resilient to fire, reduce the availability of refuges for food and shelter and impact post-fire species recovery.

In its audit, 'Reducing bushfire risk', the Victorian Auditor-General's Office commented on DELWP's use of TFIs and GSS: 'DELWP reports on the number of hectares with vegetation below tolerable fire intervals (TFI) that it applies planned burning to. This gives the public some insight into this practice, which DELWP aims to minimise. DELWP also publicly reports the number of ecosystem resilience assessments it conducts in each region. However, it does not report the results or outcomes that these assessments demonstrate. It also reports on the mix of TFIs and growth stage structure (GSS) of vegetation across the state but does not compare this with the set thresholds that show desired states. This makes it difficult to understand whether the reported mix of vegetation represents a high or low level of ecosystem resilience. These metrics, like that for residual risk, also combine the effects of planned burning and bushfire.'

100. Data supplied by DELWP.

Fire

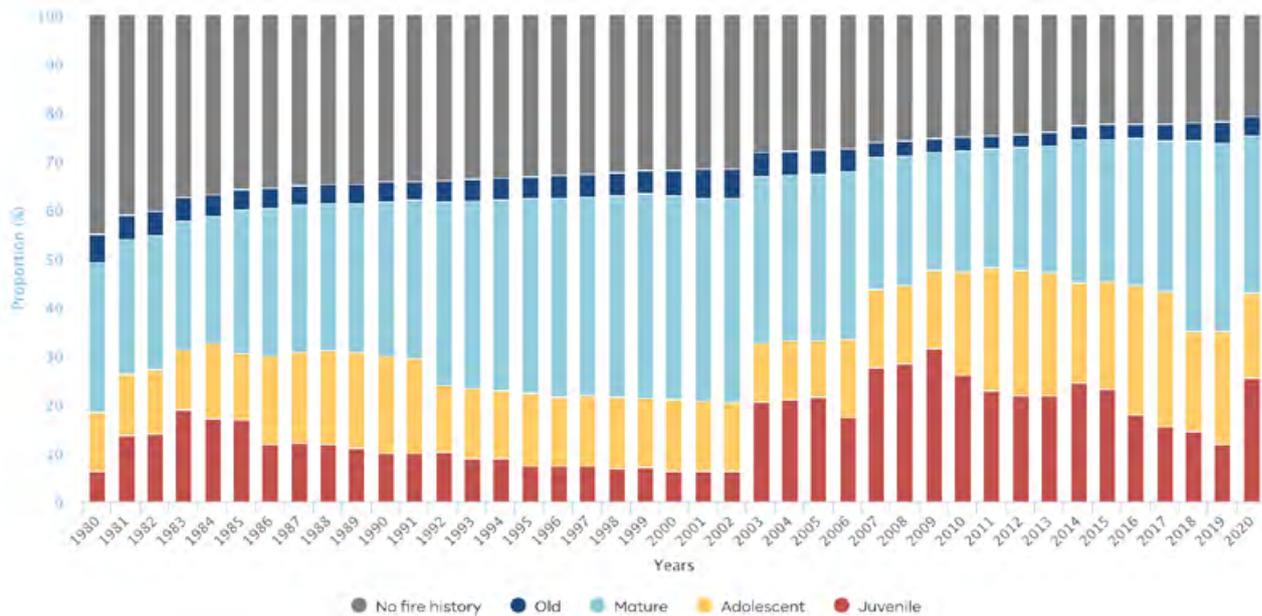


Figure 10: Growth stage structure status of vegetation on public land, Victoria, 1980–2020.¹⁰¹

In the same audit, the Victorian Auditor-General's Office defined Geometric Mean Abundance (GMA) as 'the relative abundance of all known species within an ecosystem. This provides a measure of an ecosystem's biodiversity, which is a good indicator of resilience.'¹⁰² The audit then noted that: 'Despite having committed to doing so, DELWP also does not publicly report on geometric mean abundance (GMA), which is an indicator of ecosystem resilience. DELWP advised that it has recently developed additional tools within its Fire Analysis Module for Ecological Values (FAME), that will enable it to report on GMA and better understand the specific effects of its activities on ecological values.'¹⁰³

DELWP has funded research in 2021 that aims to better address ecosystem resilience in Victoria by developing evidence-based approaches to inform resilience targets that include TFIs and GMA.

SoE Biodiversity Update 2021 Report assessment

Enright et al. (2015)¹⁰⁴ found that more frequent fires in a warming and drying landscape 'affect species – particularly fire-intolerant woody plants – by simultaneously reducing recruitment, growth, and survival' and could drive some species to extinction. They predicted that this interval squeeze could also change ecosystem structure, composition and carbon storage.

Zylstra (2018), after analysis of 58 years of fire history data from the Australian Alps, contends that increased fire frequency increases the flammability of the region's forests. He found that in ash-type eucalypt forests, 'post-disturbance stands have been more than eight times as likely to burn than have mature stands,' and increased fire frequency could transition forest to either shrubland or open forest and increase flammability.¹⁰⁵

101. Safer Together, 'Healthy environment', Melbourne, Victoria <https://www.safertogether.vic.gov.au/healthy-environment> Accessed 9 August 2021.

102. Victorian Auditor-General's Office 2020, 'Reducing bushfire risk', Melbourne, Victoria.

103. Ibid

104. Enright N, Fontaine J, Bowman D, Bradstock R et al. 2015, 'Interval squeeze: altered fire regimes and demographic responses interact to threaten woody species persistence as climate changes', *Frontiers in Ecology and the Environment*, 13(5), pp. 265–272.

105. Zylstra P 2018, 'Flammability dynamics in the Australian Alps', *Austral Ecology* <https://doi.org/10.1111/aec.12594>

When studying fire data from 1983 to 2017, Tran et al. (2020) found that along with increased frequency, fires in Australian forests have increased in severity.¹⁰⁶ Bradstock (2008) argued that although fires can lead to erosion and redistribute soil and nutrients, they are not homogenous in their extent and intensity, most flora and fauna are resilient and the most important impacts are driven by the fire recurrence rate.¹⁰⁷ Bowman et al. (2014) argue that increasing fire severity and frequency could lead to the loss of mature alpine ash forest in Victoria.¹⁰⁸ Modelling by Dutta et al. (2016)¹⁰⁹ showed that Australian weekly bushfire frequencies increased by 40% in the previous five years, indicating a climatic shift. According to research by Bennett et al. (2016), high-severity fire can lead to more open and simplified forests due to increased tree mortality.¹¹⁰ Fairman, Bennett and Nitschke (2019) found that the increased frequency of fires can lead to the failure of fire-tolerant trees to resprout on their trunk or base.¹¹¹

In an Arthur Rylah Institute study of the responses of Gippsland flora and fauna to fire, Muir et al. (2015) found that fires below the minimum TFI benefited rhizomatous herbs. Although most species appeared resilient to fire, there were negative impacts on ground dwelling birds, nectar-feeding birds and two species of bats.¹¹² The scientists concluded that: 'The broad spectrum of responses to fire regime found in this study indicates that species have different growth stage preferences, and thus confirms the benefits of managing the landscape as a mosaic of fire age classes.'

Kelly et al. (2020) argue that fire regimes are being altered by climate change, land use and the introduction of pest species and threatens more than 4,400 native species. According to the researchers:

- climate change influences the dryness of fuel loads, lightning strikes and extreme fire weather
- land use changes include for farming, forestry and urbanisation and affect fire suppression and arson
- invasive species can alter the flammability of vegetation.¹¹³

The SoE 2018 Report Recommendation 9 stated: 'That the Victorian Government establish a structured framework based on the findings of the dual-scale ecosystem resilience monitoring program, piloted by DELWP in 2017–18, and undertake a detailed analysis of the persistence of key fire-response species to increased fire frequency in Victoria, particularly in areas where below-minimum Tolerable Fire Interval (TFI) exists.' In response, the Victorian Government supported this recommendation and said: 'The statewide ecosystem resilience monitoring program has commenced and surveys of the first two Ecological Fire Groups began in Spring 2019.'¹¹⁴

The initial results of the pilot project conducted across 106 sites 'showed that the time since fire and the fire interval had mostly small effects on the occurrence and abundance of species and habitat features. This suggests that fire regimes in this ecosystem are maintaining the resilience of the ecosystem, but further analysis is needed.'¹¹⁵ The monitoring program will eventually collect data on the flora, habitat, birds and mammals in 11 priority ecosystems across Victoria at 2,200 sites. Data collection is currently underway in three of the ecosystems. A statewide stream addresses long-term relationships between biodiversity and fire regimes across the landscape, while a regional stream assesses the short-term effects of fuel management on regionally important biodiversity.

106. Tran B, Tanase M, Bennett L and Aponte C 2020, 'High-severity wildfires in temperate Australian forests have increased in extent and aggregation in recent decades', *PLoS ONE*, 15(11), e0242484.

107. Bradstock R 2008, 'Effects of large fires on biodiversity in south-eastern Australia: disaster or template for diversity?' *International Journal of Wildlands Fire*, 17, pp. 809–822.

108. Bowman D, Murphy B, Neyland D, Williamson G et al. 2014, 'Abrupt fire regime change may cause landscape-wide loss of mature obligate seeder forests', *Global Change Biology*, 20(3), pp. 1008–1015.

109. Dutta R, Das, A and Aryal J 2016, 'Big data integration shows Australian bush-fire frequency is increasing significantly', *Royal Society Open Science*, 3, 150241.

110. Bennett L, Bruce M, MacHunter J, Kohout M, et al. 2016, 'Mortality and recruitment of fire-tolerant eucalypts as influenced by wildfire severity and recent prescribed fire', *Forest Ecology and Management*, 380, pp. 107–117.

111. Fairman T, Bennett L and Nitschke C 2019, 'Short-interval wildfires increase likelihood of resprouting failure in fire-tolerant trees', *Journal of Environmental Management*, 231, pp. 59–65.

112. Muir A, MacHunter J, Bruce M, Moloney P et al. 2015, 'Effects of fire regimes on terrestrial biodiversity in Gippsland, Victoria: a retrospective approach', report for DELWP, Arthur Rylah Institute, Heidelberg, Victoria.

113. Kelly L, Smith A, Giljohann, K and Clarke M 2020, 'Humans are changing fire patterns, and it's threatening 4,403 species with extinction', *The Conversation*, 23 November 2020.

114. DELWP 2020, 'Victorian Government response to the State of the Environment 2018 Report', East Melbourne, Victoria.

115. DELWP, 'Fuel management report 2019-20: Victorian bushfire monitoring program', East Melbourne, Victoria <https://www.ffm.vic.gov.au/fuel-management-report-2019-20/statewide-achievements/victorian-bushfire-monitoring-program> Accessed 12 May 2021.

Fire

In 2017–18 there were 732 ecosystem resilience surveys across each of DELWP's six fire management regions, including 627 in Loddon-Mallee and 53 in Gippsland.¹¹⁶ In 2019–20, the regional monitoring was focused on the before-and-after impacts of planned burning on issues of local significance and included:

Barwon South West: training of Traditional Owners to conduct monitoring; trialing artificial refuges to support the persistence of small mammals after fire

Gippsland: mapping of glossy black cockatoo habitat in black sheoak; remote camera monitoring of New Holland mouse populations

Grampians: monitoring of greater glider and brush-tailed phascogale; resurveying of fire effects in Wombat State Forest

Hume: monitoring and mapping of greater glider populations; complementing overall fuel hazard assessments with habitat condition assessments to develop a baseline dataset

Loddon-Mallee: monitoring Eltham copper butterfly populations in areas planned for burning

Port Phillip: monitoring greater glider populations in areas planned for burning; improving knowledge of hairpin banksia responses to fire.¹¹⁷

In a global review of the relationship between fire and biodiversity in the Anthropocene,¹¹⁸ Kelly et al. (2020) found that 4,400 terrestrial and freshwater species were threatened by modified fire regimes: increased frequency and intensity but also, in some places, the exclusion of fire.¹¹⁹ They identified a number of actions that are emerging to address the issue, including:

- reintroduction of mammals that reduce fuels
- green fire breaks comprising low-flammability plants
- strategically letting wildfires burn under the right conditions
- managed evolution of populations aided by new genomics tools
- deployment of rapid response teams to protect biodiversity assets
- Indigenous fire stewardship and reinstatement of cultural burning in a modern context
- international efforts to reduce greenhouse gas emissions as crucial to reduce the risk of extreme fire events that contribute to declines in biodiversity.



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116. DELWP, 'Fuel management report 2017-18: Victorian bushfire monitoring program', East Melbourne, Victoria <https://www.ffm.vic.gov.au/fuel-management-report-2017-18/victorian-bushfire-monitoring-program/victorian-bushfire-monitoring-program> Accessed 12 May 2021.

117. DELWP, 'Victorian bushfire monitoring program', East Melbourne, Victoria <https://www.ffm.vic.gov.au/fuel-management-report-2019-20/statewide-achievements/victorian-bushfire-monitoring-program> Accessed 12 May 2021.

118. The period of history dating from the time when human activities began to have significant impact on the Earth's systems.

119. Kelly L, Giljohann K, Duane A, Aquilu Net et al. 2020, 'Fire and biodiversity in the Anthropocene', *Science*, 370, eabb0355.

Fire

Indicator Fi:04 Bushfire risk

Region Statewide Measures Residual risk; Impact of climate change on fire weather Data Custodian DELWP; BoM	Indicator Performance: 2018 & 2021: Unable to be assessed due to Low Data Confidence Why this indicator? Changes in the bushfire risks in fire-affected areas and refugia will influence conservation efforts for threatened species and ecological communities, and also fire-fuel management processes.	2018 Status	2018 Trend	2018 Data
		2021 Status	2021 Trend	2021 Data

Potential thresholds for status in the SoE 2023 report

Good: >75% to 100% of actual regional long-term residual bushfire risk target met and its impacts on ecosystem resilience monitored, reported and mitigated

Fair: >50% to <75% of actual regional long-term residual bushfire risk improving but target not met and its impacts on ecosystem resilience in part monitored, reported and mitigated

Poor: <50% of actual regional long-term residual bushfire risk well below target and its impacts on ecosystem resilience neither monitored, reported nor mitigated

Why this assessment in 2021?

Status: Based on the Potential Thresholds for Status, which rely on DELWP risk targets, the Status would remain as Fair. However, the multiple metric complicates the assessment of this indicator. Residual risk targets are largely achieved by planned burning. The Victorian Auditor-General's 2020 audit, 'Reducing bushfire risk', concluded that the impact of that on ecosystem resilience is not well monitored or reported. Planning regulations have not prevented settlements in fire-prone peri-urban areas. Climate change is exacerbating fire weather and increasing bushfire risk.

Trend: Fire weather changes are increasing fire frequency and severity, which will likely increase risks associated with bushfires and thus cause a deteriorating Trend. The Trend in biodiversity responses is also assessed as deteriorating. However, movement towards meeting the residual risk targets would suggest an improving Trend for one of the three measures.

Data Confidence: The Auditor-General's audit also found that there was little information about the effectiveness and impacts of bushfire risk-reduction actions. Data on the biodiversity responses to fire are also limited, as are detailed data on the influence of climate change on fire weather.

Should this indicator be used in the SoE 2023 report?

Yes, it should be retained in the Fire chapter, however the measure could simply be bushfire risk, with the influence of climate change forming part of the narrative rather than being a measure. The measure could be reworded as 'Outcomes of the bushfire risk-reduction approach.'

Summary of SoE 2018 Report assessment

- Bushfire risk is composed of two variables: the likelihood of a fire starting and its impact on communities and the environment. Planned burns are the main tool used to reduce bushfire risk.
- The Victorian Government's fire management agencies estimate bushfire risk by comparing the predicted difference in house loss in a maximum-risk scenario and maximum fuel load, with a scenario that has fuel loads after a planned burn on public land. The difference between the two scenarios is known as 'residual risk'.
- Residual risk can be expressed as a ratio of the average property impact from a modified risk scenario following planned burning, to the average impact of the maximum risk scenario, reported as a percentage.
- The Victorian Government's goal is to keep residual risk below 70%. In 2018, DELWP estimated that residual risk in Victoria was 63%.

Fire

The 2019–20 bushfires: Impacts and responses

DELWP's 2019–20 Annual Report revealed that its fire management activities included:

- removing hazardous trees from along 81 kilometres of forest roads and tracks
- undertaking roadside vegetation management along 1,398 kilometres of roads and tracks in our forest and parks, creating firebreaks across the landscape that are used in fire response operations
- improving and maintenance work on 2,584 kilometres of fire access roads, improving access and egress for fire fighters, making response times faster and enabling the safe evacuation of 376 Cann River residents when the Princess Highway was closed
- upgrading of 28 bridges and crossings and construction of one additional fire tower.

SoE Biodiversity Update 2021 Report assessment

Fire management agencies seek to reduce fire risk by preventing fire ignition (e.g. total fire bans), suppressing the fire once it has started (e.g. water and fire breaks), and the management of fuel (e.g. planned burning).

The 2009 Victorian Bushfire Royal Commission recommended a 5% planned burning target across the state. The approach was changed in 2016–17 in favour of risk-based planned burning i.e. residual risk reductions in fire-prone areas to reduce the risk remaining after fuel reduction, with a focus on the protection of assets.

Residual risk is expressed as a percentage, with the statewide target set at 70% (regional areas may be above or below that figure depending on the level of risk and the capacity to minimise bushfire impacts). In this case, the target is 70% of what would be if there were no risk-reduction actions taken, expressed as the number of houses that would be destroyed in extreme fire conditions. If a 70% target is achieved, then 30% of houses would have been saved. Table 8 lists the residual risk and the long-term residual risk targets for Victoria's fire management regions.

Fuel management, largely by planned burning, is the main technique for reducing bushfire risk in Victoria. Other methods include mechanical methods, town planning and building codes. Grazing is also used, however, the Emergency Leaders for Climate Action said in its submission to the Senate Inquiry that such a method in national parks 'leads to serious environmental and ecological damage, particularly in fragile alpine environments, with no reduction in bushfire risk or fire intensity where it is applied.'

Table 8: Fire management regions residual risk targets for June 2021 and long term.¹²²

Region	Residual Bushfire Risk June 2021	Long-Term Residual Risk Target
Statewide	59%	70%
Barwon South West	59%	60%
Gippsland	42%	71%
Grampians	66%	70%
Hume	65%	69%
Loddon Mallee	66%	75%
Greater Melbourne	82%	85%

120. DELWP 2020, 'Annual report 2020', East Melbourne, Victoria.

121. Emergency Leaders Climate Action 2020, 'Submission to the Senate Standing Committees on Finance and Public Administration, lessons to be learned in relation to the Australian bushfire season 2019–20', Parliament of Australia, Canberra, Australia.

122. Data supplied by Forest Fire Management Victoria.

Fire

Figure 11 charts the burnt area (planned burns and bushfires) in each year between 1980 and 2019 (2019–20 bushfire data are not included), along with the trend in bushfire risk. It shows that as the fuel load recovered, bushfire risk increased after major fires in 1983 (Ash Wednesday) and 2009 (Black Saturday). However, it declined after the 2003 fires, which had caused a significant reduction in fuel. Based on previous fires, the bushfire risk could either increase or decrease depending on the fire effects on fuel. The chart suggests two alternative scenarios, one rising to 80% by 2022 and the second falling to 62%.

The 2020 Auditor-General's audit 'Reducing bushfire risk', assessed the risk-reducing processes and identified a number of failings. It concluded that: 'DELWP and CFA, are collaborating to reduce the risks that bushfires pose to life, property and the environment, and do so with strong commitment. However, there is insufficient information available to understand the effectiveness and impacts of their risk-reduction activities.'¹²³

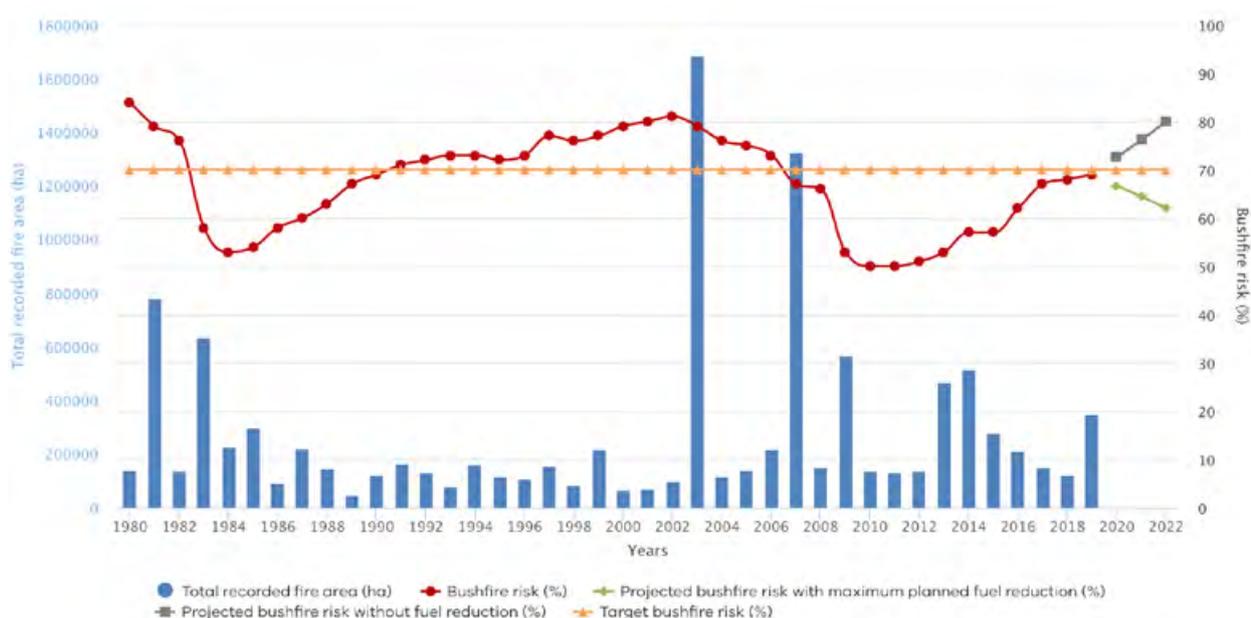


Figure 11: Victoria's bushfire risk profile 1980-2022.¹²⁴

The risk of fire to communities and their infrastructure is also heavily influenced by where people choose to live. In a hearing of the Senate Inquiry into lessons learned from the 2019–20 bushfires, Richard Thornton, CEO of the Bushfire and Natural Hazards CRC, said that some people chose to live where they do 'because of the trees. They don't want those trees cleared, because that's why they live there. So that community may be more prepared to live with a high level of risk. In other areas, people were clearly saying that they have been trying to clear properties and reduce the fuel. So I think local input as to what risk level a community is willing to accept is a critical part of how we go forwards in looking at what the fuel levels are across the country.'¹²⁵

McKenzie (2018) reviewed demographics and bushfire risk analysis for regional and peri-urban Victoria.¹²⁶

The report's findings included:

- 'Fire is a natural part of the Australian landscape but its incidence and impact can be increased by the presence of people.
- Population vulnerabilities have a geographical distribution. Some communities will have a greater measure of vulnerability than others, and some locations may display multiple types of vulnerability.

122. Data supplied by Forest Fire Management Victoria.

123. Victorian Auditor-General's Office 2020, 'Reducing bushfire risk', Melbourne, Victoria.

124. Forest Fire Management Victoria, 'The year's achievements: bushfire risk', Melbourne, Victoria <https://www.ffm.vic.gov.au/fuel-management-report-2018-19/statewide-achievements/bushfire-risk>

125. Thornton, R 2020, 'Senate Finance and Public Administration References Committee Inquiry into the lessons to be learned in relation to the Australian bushfire season 2019–20', Committee Hansard, 27 May 2020, Parliament of Australia, Canberra, Australia.

126. McKenzie F 2018, 'Demographics for bushfire risk analysis: regional Victoria and peri-urban Melbourne', DELWP, East Melbourne, Victoria.

Fire

- Population mobility presents particular challenges for risk assessment and emergency management. Towns may vary in population size by a factor of four or five during particular seasons of the year.
- Popular visitor and holiday locations such as the Dandenong Ranges and Great Ocean Road have particularly high fire risk. Planning for fire therefore requires an understanding of both permanent and part-time populations.¹

Table 9: Population vulnerability indicators relevant to natural hazard risk analysis.¹²⁷

Indicator	Comments
Young at risk	The very young are at risk because they are dependent on others for care.
Elderly at risk	Elderly people tend to be more frail, have more health issues and may be dependent on others for care. While individual older people may be fit and active, aggregate data show that the number of people needing assistance increases with age.
Single parents	Single parents may face the demands of dependent children but with no additional support.
Volunteering	People who undertake volunteer activity within their community are more likely to have social networks which can be of assistance in times of emergency by providing information, support and resources.
Income	Low-income households may face more difficulty in recovering materially from a disaster. They may also be underinsured or uninsured.
New to region	If a person has moved to an area in recent years, they may be unfamiliar with local environmental hazards and may be unaware of procedures for preparing for, or responding to, an emergency.
Public housing	Socio-economic disadvantage is a requirement for receiving public housing and those who are disadvantaged are likely to have a variety of social and economic problems that may require additional support in an emergency situation.
Education level	People with high levels of education are more likely to understand a range of information related to risk and preparation as well as warnings information.
Need assistance	People who identify that they have a need for assistance with self-care are likely to need help in an emergency, for instance with evacuation.
Car ownership	People with no car access will be unable to evacuate themselves in an emergency.
Insufficient English	People with limited English may find it more difficult to access or understand various emergency messages and information.
Unoccupied	Absentee owners may not have high levels of engagement with the local community nor may they have the time to attend meetings or undertake full fire preparations on their property.

The different demographic mix of each community leads to a range of vulnerabilities to natural hazards such as bushfires. Table 9 presents population vulnerability indicators described by McKenzie (2018) that include age, income, education levels, language and transportation.

Norman et al. (2020) commented on the conflict between settlement and bushfire risk: 'In Australia the past 50 years has seen a movement to rural and coastal areas with housing that is positioned within forested areas, located a few hours from big cities, called "sea change" or "tree change" settlement. Peri-urban development is now 15% of Australian settlements and rural settlements just 3%.¹²⁸

128. Norman B, Newman P and Steffen W 2021, 'Apocalypse now: Australian bushfires and the future of urban settlements', *npj Urban Sustainability*, 1, Article 2.

Fire

Buxton (2020) observed: 'The 2019–20 fires demonstrated yet again that dispersed rural dwellings and housing on the outskirts of towns are most vulnerable, and often undefendable. Yet extensive subdivision and dwelling construction continues in these areas. A noticeable feature of the fires was the number of small towns abandoned in whole or part by fire authorities and the entry of some fires into larger towns and even town centres' ... and ... 'The population of the 24 fastest-growing local government areas on the edges of Australia's major cities has risen to 4.5 million over the past decade, much of it in some of the world's most fire-prone areas. The existence of many thousands of small lots in vulnerable areas on the fringes of major cities and regional towns is a deadly time bomb, yet these developments proceed with little or no fire-danger oversight.'¹²⁹

Changes to planning regulations were made after the 2009 Black Saturday fires to provide planners with more options to manage bushfire hazards in rural and peri-urban areas. However, the Victorian Auditor-General found in the 'Reducing bushfire risk' audit that the new regulations only apply to new developments and extensions to existing buildings, not to those built before the planning changes.¹³⁰

Revegetation of agricultural landscapes to enhance biodiversity could be viewed as increasing fire risk. However, research by Jenkins et al. (2019) suggests that at a landscape scale, revegetation does not: 'There was no significant influence of planting design on fire intensity. Weather and suppression had the strongest influence on both fire size and intensity, with larger and more intense fires under extreme weather conditions, with higher adjacent pasture loads and with no simulated suppression. Management of fuel loads in the pasture surrounding revegetation, weather and suppression are far greater risk factors for fire in these landscapes than planting design.'¹³¹

Ecosystem engineers are animals that turn over the soil and litter on the forest floor and increase the rate of leaf litter breakdown. Hayward et al. (2020) surveyed ecosystem engineers in three Australian Wildlife Conservancy sanctuaries surrounded by fox and cat exclusion fences.¹³² They found that ecosystem engineers such as the bilby, brodie, numbat, greater stick nest rat, woylie and bridled-tailed wallaby reduced leaf litter by 24% compared to non-exclusion plots. The researchers argued that as leaf litter is a major source of fuel for bushfires, the return of ecosystem engineers to areas where they are now absent could be an important fire management strategy to reduce flame height and the rate of fire spread. Although none of these species occur in Victoria, bandicoots and potoroos would be fulfilling this role in the state.

129. Buxton M 2020, 'Do we need homes among the gum trees?' *The Australian*, 10 November 2020

130. Victorian Auditor-General's Office 2020, 'Reducing bushfire risk', Melbourne, Victoria.

131. Jenkins M, Price O, Collins L, Penman T et al. 2019, 'The influence of planting size and configuration on landscape fire risk', *Journal of Environmental Management*, 248, 109338-1-109338-7.

132. Hayward M, Ward-Fear G, L'Hotellier F, Herman K et al. 2016, 'Could biodiversity loss have increased Australia's bushfire threat?' *Animal Conservation*, 19, pp. 490–497.

Climate change

Background

Every two years the Bureau of Meteorology and CSIRO release their State of the Climate Report. The 2020 edition revealed that 2019, the year leading up to the 2019–20 bushfires, was Australia's warmest year on record, and the seven years prior were in the top nine warmest years.¹³³ The report also showed that rainfall had declined by 12% in south-eastern Australia since the 1990s and stream flows had decreased across southern Australia since 1975.

The 6th report of the Intergovernmental Panel on Climate Change¹³⁴ released in August 2021 included a regional fact sheet for Australia. It confirmed that:

- 'Australian land areas have warmed by around 1.4°C (very high confidence), and annual temperature changes have emerged above natural variability in all land regions (high confidence).
- Heat extremes have increased, cold extremes have decreased, and these trends are projected to continue (high confidence).
- Frequency of extreme fire weather days has increased, and the fire season has become longer since 1950 at many locations (medium confidence). The intensity, frequency and duration of fire weather events are projected to increase throughout Australia (high confidence)
- Snow cover and depth have decreased and are projected to decrease further (high confidence).'

For the south-eastern region of southern Australia, the fact sheet also reported:

- 'Observed rainfall decrease, increase in agricultural and ecological droughts (medium confidence)
- Projected reduction in mean rainfall, particularly in the cool season, increase in aridity, and increase in meteorological and agricultural and ecological droughts (medium confidence).'

DELWP's Climate Science Report 2019 showed that since 1910, temperatures in Victoria had increased by more than 1.0°C, average rainfall had declined and fire danger had increased.

The report also estimated that by 2050, average annual temperatures could increase by up to 2.4°C, alpine snowfall could drop by 35–75%, the number of very hot days could double and there could be up to 60% more very high fire danger days. These changes will cause more frequent and intense droughts, fires, heatwaves and rainfall events, and significantly impact ecosystems and biodiversity.

For biodiversity, a warming climate will place further stress on species and communities already under extreme pressure from other threats. Some species will move south or to higher elevations, however others, like alpine species, will be unable to move higher to find cooler conditions. Habitat fragmentation will make migration difficult and extreme weather events will add to the stress. At the same time, disturbance to habitats will encourage the invasion of pest plants and animals that prey on or outcompete native species, while increases in fire severity and frequency could undermine the survival of vegetation communities such as alpine ash forests.

The projected long-term averages in rainfall will not be uniform across Victoria based on four Representative Concentration Pathways (RCPs). RCPs are 'prescribed pathways for greenhouse gas and aerosol concentrations, together with land use change, that are consistent with a set of broad climate outcomes used by the climate modelling community.'¹³⁶ The four pathways are:

- RCP 8.5: Ongoing high greenhouse gas emissions
- RCP 6.0: Lower emissions, achieved by application of some mitigation strategies and technologies
- RCP 4.5: Emissions peak around 2040
- RCP 2.6: Emissions peak around 2020, then decline rapidly.¹³⁷

133. Bureau of Meteorology and CSIRO 2020, 'State of the climate 2020', Australia.

134. IPCC, 2021: Summary for policymakers, In: 'Climate change 2021: the physical science basis', contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, prepared by V Masson-Delmotte, P Zhai, A Pirani, S Connors et al. (eds), Cambridge University Press, in press.

135. DELWP 2019, 'Victoria's climate science report 2019', East Melbourne, Victoria.

136. Jubb I, Canadell P and Dix M, 'Representative Concentration Pathways (RCPs)', Australian Climate Change Science Program Information paper, Department of the Environment, Canberra, Australia.

137. DELWP 2019, 'Victoria's climate science report 2019', East Melbourne, Victoria.

Climate change

In 'Victoria's Climate Science Report 2019', DELWP provides projections for the median number of hot days per year for the 2050s under RCP 8.5.¹³⁸ Although temperatures vary, each of Victoria's major cities will experience at least twice the number of very hot days in 2050 compared with the period from 1986 to 2005 (except for Bairnsdale, which is slightly below a doubling). The report also gives projections for a longer-term average decline in rainfall under RCP 8.5. In this case, the modelling projects that rainfall will decrease by 14% in Shepparton, Wodonga and Bendigo, 8% in Melbourne and 9% in Bairnsdale. Any variations in temperature and rainfall under a warming and drying climate will have implications when assessing the impact of climate change on the state's biodiversity, as well as the frequency and severity of bushfires.

The DELWP report, 'Victoria's water in a changing climate', observes that in addition to changes in rainfall, there will be changes to the rainfall-runoff relationship: 'During the Millennium Drought, more than half of the Victorian catchments analysed experienced an extra 20–40% decline in their annual streamflow due to the shift in rainfall-runoff relationships. The current generation of hydrologic models do not replicate well the observed changes in the rainfall-runoff relationship during and after extended drought.'¹³⁹

Reducing greenhouse gas emissions is a critical step in mitigating the impacts of climate change and a key Victorian Government policy.

The SoE 2018 Report identified the challenges that Victoria will face as its climate changes, including:

- reducing greenhouse gas emissions to mitigate the speed and severity of climate change as part of the national and global effort
- developing understanding of the impacts of climate change through better real-time monitoring, trend analysis and predictive capabilities to enable strategic and timely responses to protect the environment and communities
- reducing the health burden associated with heatwaves and other natural disasters

- maintaining secure water supplies across the state as population grows, average rainfall reduces and evaporation increases, leading to less available water
- protecting biodiversity from the impacts of climate change.

Policy and legislative setting

Victoria's *Climate Change Act 2017* established a long-term emissions reduction target of net zero by 2050, with interim emissions reduction targets set for five-year periods from 2021. The *Act* also required the government to develop a climate change strategy (released in May 2021), along with five-yearly adaptation action plans for the following key systems vulnerable to climate change impacts: built environment; education and training; health and human services; natural environment; primary production; transport; water cycle. Each five-year plan is now being finalised for activation in 2022.

Victoria's Climate Change Adaptation Plan 2017–2020¹⁴⁰ aimed to build a detailed understanding of Victoria's exposure to climate change risks and impacts, catalyse partnerships for integrated and effective responses to climate change and tackle immediate priorities to reduce climate change risks. The Monitoring, Evaluation, Reporting and Improvement (MERI) Framework for Climate Change Adaptation in Victoria is being used to monitor and evaluate the adaptation plan's implementation and effectiveness. It provides for:

- monitoring, to track implementation of actions by government
- evaluation, to determine effectiveness of government's adaptation actions
- reporting, to disseminate lessons learned
- improvement of implementation of actions, through feedback to government programs and policy.

138. This is a projection of longer-term climatic averages and may not represent extreme events. For example, there will be years with many more days above 35°C than the average, as well as years with many less.

139. DELWP 2020, 'Victoria's water in a changing climate: Insights from the Victorian Water and Climate Initiative', Amended February 2021, East Melbourne, Victoria.

140. DELWP 2016, 'Victoria's climate change adaptation plan 2017–2020', East Melbourne, Victoria.

Climate change

The *Climate Change Act 2017* also requires the Minister to seek independent advice on the setting of future emissions targets. In June 2019 an independent expert panel appointed by the government recommended the following interim targets for 2021–25 and 2026–30:

- 2021–25: 32–39% below 2005 levels in 2025
- 2026–30: 45–60% below 2005 levels in 2030.¹⁴¹

Figure 12 shows that Victoria's overall emissions in 2019 were 24.8% below 2005 emissions. Most of the reduction has occurred in the energy sector and the land use, land use change and forestry sector.



Figure 12: Victoria's emissions (Mt CO₂-e) from 2005 to 2019.¹⁴²

141. Independent Expert Panel on Interim Emissions Reduction Targets for Victoria (2021–2025, 2026–2030) 2019, 'Interim emissions reduction targets for Victoria 2021–2030, final report', Melbourne, Victoria.

142. DELWP, 2021, 'Victoria's Climate Change Strategy' https://www.climatechange.vic.gov.au/data/assets/pdf_file/0026/521297/Victorian-Climate-Change-Strategy.pdf

Climate change

The contribution of each sector to emissions in 2019 is shown in Figure 13. The burning of fossil fuels in the energy sector accounted for 70% of emissions, transport 25%, agriculture 17%, the industrial processes and product use sector 4%, and the waste sector 4%. Trees in forests and plantations in the land use, land use change and forestry sector absorbed and removed 19% of the state's emissions.

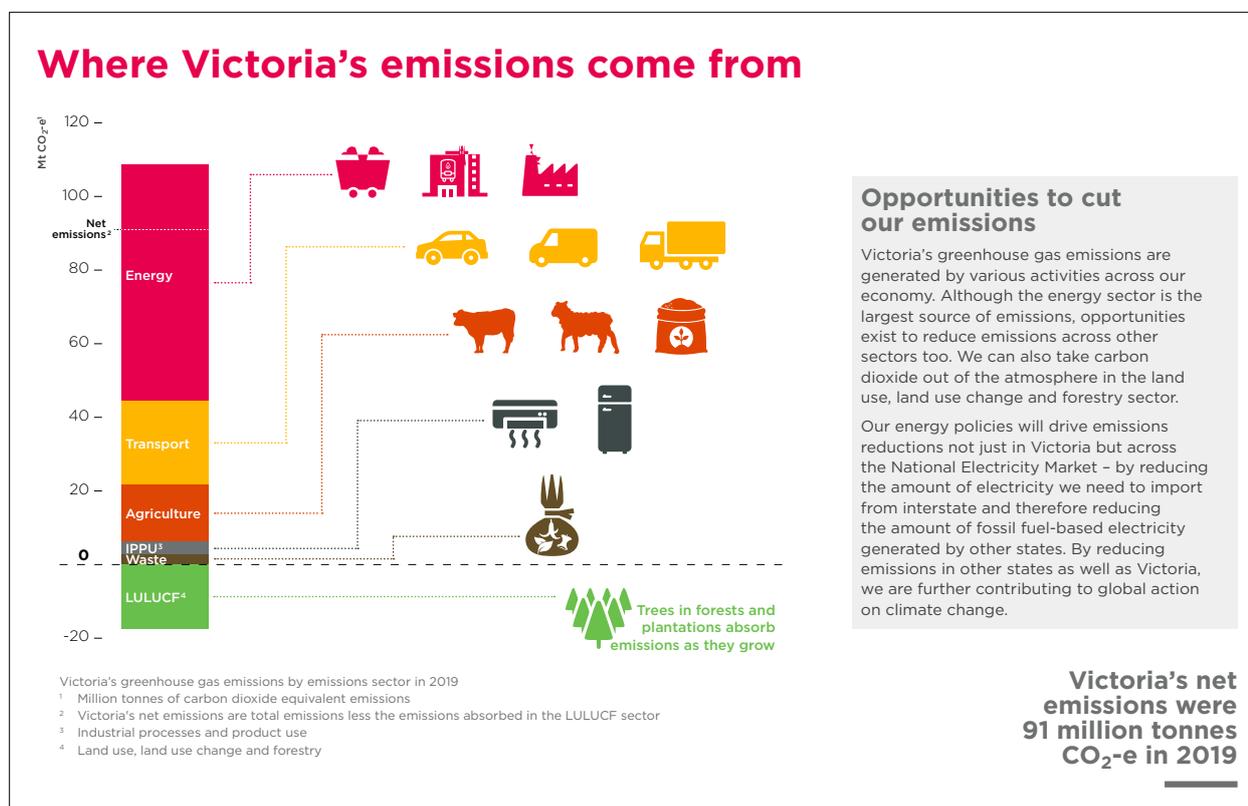


Figure 13: Victoria's greenhouse gas emissions by sector in 2019.¹⁴³

Victoria's Climate Change Strategy¹⁴⁴ was released in May 2021 and sets out the state's current responses to climate change and its next steps. It contains Victoria's five-point plan for tackling climate change and reaching net zero emissions by 2050:¹⁴⁵

1. A clean energy economy
2. Innovation for the future
3. Resilient farms and forests
4. Climate smart businesses and communities
5. A climate resilient Victoria.

For 'Resilient farms and forests', the Victorian Government set a target of 100,000 hectares of restored biodiverse habitat by 2030 and allocated:

- \$120 million to phase out commercial native forest harvesting by 2030
- \$110 million for plantations
- \$30 million for trees in plantations and shelterbelts
- \$20 million for the agriculture sector's response to a changing climate.¹⁴⁶

Take2 is the Sustainability Victoria pledge program helping Victorians, including individuals, businesses, local governments, schools and community organisations, to act on climate change.¹⁴⁷ Its goal is to give every home, business and organisation the information they need to reduce their greenhouse emissions and plan for a low carbon future.

143. Ibid

144. DELWP 2021, 'Victoria's Climate Change Strategy', East Melbourne, Victoria.

145. Ibid

146. Government of Victoria 2021, 'Victoria's Climate Change Strategy', Infographic, Melbourne, Victoria.

147. Sustainability Victoria, 'Take2', Melbourne, Victoria <https://www.sustainability.vic.gov.au/campaigns/take2> Accessed 10 May 2021.

Climate change

Indicator CC:11 Victorian ecosystem carbon stocks

Region Statewide Measures Land sector carbon stocks; Blue carbon stocks Data Custodian DELWP	Indicator Performance: 2018 & 2021: Unable to assess due to Moderate Data Confidence and multiple Trends Why this indicator? Terrestrial, aquatic and marine-based carbon stocks and their trends play an important role in the global carbon cycle and greenhouse gas balance, and provide an indication of biodiversity.	2018 Status 2018 Trend 2018 Data				
		Land		→	Land	
		Marine		?		
		2021 Status 2021 Trend 2021 Data				
		Land		→	Land	
		Marine		?	Marine	

Potential thresholds for status in the SoE 2023 report

Good: Significant increases in carbon stocks and the securing of carbon stocks

Fair: Stable or small decline in carbon stocks and some securing of carbon stocks

Poor: Significant declines in carbon stocks and the failure to secure carbon stocks

Why this assessment in 2021?

Status: Data beyond 2017 are unavailable. The 2018 Status is retained.

Trend: The available data are insufficient to determine whether there has been any change in the Trend since 2018.

Data Confidence: No new data are available to improve the Data Confidence level for either land-based or marine-based carbon. There was insufficient data to assess marine-based carbon.

Should this indicator be used in the SoE 2023 report?

Yes, it could be retained in the Climate Change chapter, however the measures could be reworded as 'Carbon stocks in terrestrial, freshwater and marine ecosystems.' Alternatively, terrestrial stocks, for which there are more data, could be the focus, with carbon stocks in marine and freshwater covered by a separate indicator or as part of the report's narrative.

Summary of SoE 2018 Report assessment

- Carbon stocks are vulnerable to climate variation such as drought.
- Bushfires had temporarily decreased carbon stocks in some areas, with implications for the mitigation of climate change.
- There was a 1% average growth in land sector carbon stocks from 2007 to 2016, when there were more than 2,800 million tonnes of carbon. Forest carbon stocks grew at 2%.
- Although the bushfires in 2002–03 and 2006–07 reduced carbon stocks, they were recovering up until 2016.
- Blue carbon was estimated at 1,000,000 tonnes in Port Phillip and Western Port.

The 2019–20 bushfires: Impacts and responses

The 2019–20 bushfires have had a major, short-term impact on emissions and the current and future stores of forest carbon.

The Commonwealth Department of Industry, Science, Energy and Resources reported after the 2019–20 bushfires that: 'This season's fires have affected some of Australia's highest-biomass forests with an average above-ground biomass and debris estimated at around 300 tonnes per hectare. The fires are estimated to have burnt an average of around 20% of the above-ground biomass and debris ...' and ... 'Bushfires mainly affect debris and grasses or understorey vegetation, and sometimes forest canopy (leaves, twigs), which all rapidly build up carbon again following fire – within 10–15 years.'

Even in rare patches of fire-induced mortality, there is minimal loss of carbon at the landscape level, which is usually balanced within a few years by fast-growing regrowth.¹⁴⁸

On the future trend in carbon sequestration in the burnt forests, the Department wrote: 'Generally, over time and in the absence of new disturbances, Australia's eucalypt forests re-absorb carbon to balance the carbon emitted during the fires. Forests burnt this year are expected to continue sequestering carbon over the next decade and beyond as they recover. As an example, more than 98% of forest cover was observed to return within 10 years after the 2002–03 bushfires.'

The information and data report of the Major Event Review into the 2019–20 bushfires revealed that there would be an expected net reduction of 55 million tonnes in forest carbon sequestration. This estimate comprises a loss of 57 million tonnes and a gain of 2 million tonnes, which would be returned, under the forest neutrality assumption, in forest regrowth after the fires.¹⁴⁹

However, Bowman et al. (2020) have challenged the long-held assumption that bushfires in fire-adapted forests are carbon neutral after reviewing the impacts of the 2019–20 bushfires.¹⁵⁰ The assumption of carbon neutrality in burnt forests is based on the view that fire-adapted forests, such as eucalypts, rapidly recover and there is only a negligible net effect on their carbon stocks. Bowman et al. (2020), however, argue that the 'combination of drought and frequent fires is likely reducing the capacity to recover from the fire so future Australian forests may store less carbon,'¹⁵¹ preventing forests from replacing the carbon lost to the atmosphere. Research by Jiang et al. (2019) also casts doubt on the uptake of carbon from the atmosphere and its storage in forests. They found that much of the carbon is released back into the atmosphere through tree and soil respiration.¹⁵²

SoE Biodiversity Update 2021 Report assessment

By removing carbon dioxide from the atmosphere, forest trees store carbon and help mitigate climate change. The level of forest biomass is an indicator of biodiversity and an important element in climate change mitigation.

Carbon stocks are found in marine and freshwater ecosystems (blue carbon) and terrestrial ecosystems (green carbon). A study of carbon stocks in Victoria's land-based parks estimated that they store more than 270 million tonnes of carbon or one billion tonnes of carbon dioxide equivalent,¹⁵³ while the state's marine protected areas store 850,000 tonnes. The Alpine National Park stores 70 million tonnes, while the mountain ash forests are the world's densest carbon store, with an estimated 1,867 tonnes of carbon per hectare.

Most research into carbon stocks has focussed on green carbon. Tables 12 to 15 provide data on carbon stocks on public land across Victoria's five RFAs and published by DELWP in 2019. Data for 2009, the year of the Black Saturday bushfires, have been included, along with data for the years from 2014 to 2017.

Table 10 reveals that forest carbon stocks are concentrated in the forests of eastern Victoria, and that carbon stocks in all RFA regions increased between 2014 and 2017. Table 11 provides data on the losses of carbon in each RFA region. Losses can be caused by fire, timber harvesting, dieback, storms and drought. Generally, the losses of carbon have declined over the time period covered by Table 11. As well as losses, forests also sequester carbon, and Table 12 shows that additions to forest carbon stocks in the RFA regions were greater than the losses. Finally, Table 13 provides data on the estimated \$ value of carbon sequestration in the RFA regions and reveals that it is increasing in all regions except East Gippsland.

The impact of the 2009 bushfires on carbon losses, carbon sequestration and the value of that sequestration can be seen in Tables 13, 14 and 15 for the Central Highlands, East Gippsland, Gippsland and North East RFA areas. For example, carbon losses in the Central Highlands were 17,882,447 tonnes, in contrast to less than 2.4 million tonnes in each of the years from 2014–17. Similar impacts could be expected in the areas affected by the 2019–20 bushfires.

148. Department of Industry, Science, Energy and Resources 2020, 'Estimating greenhouse gas emissions from bushfires in Australia's temperate forests: focus on 2019–20', Canberra, Australia.

149. Department of Agriculture, Water and the Environment 2021, 'Victorian regional forest agreements major event review of the 2019–20 bushfires: summary report: information and data to inform public consultation', Canberra, Australia.

150. Bowman D, Williamson G, Price O, Ndali M et al. 2020, 'Australian forests, megafires and the risk of dwindling carbon stocks', *Plant, Cell and Environment*, 44(2) <http://dx.doi.org/10.1111/pce.13916>

151. Ibid

152. Jiang M, Medlyn B, Drake J, Duursma R et al. 2019, 'The fate of carbon in a mature forest under carbon dioxide enrichment', *Nature*, 580, pp. 227–231.

153. DELWP 2019, 'Fact sheet 8: valuing forest carbon', East Melbourne, Victoria.

Climate change

Table 10: Above-ground carbon stocks (tonnes) on public land in Victorian RFAs.¹⁵⁴

RFA	2009	2014	2015	2016	2017
Central Highlands	136,794,017	146,434,798	148,031,688	149,438,923	152,161,090
East Gippsland	230,304,338	230,705,018	238,487,266	240,166,082	241,730,001
Gippsland	238,939,012	260,185,428	270,443,530	279,086,586	289,052,292
North East	209,722,374	223,382,085	230,726,349	235,818,934	242,279,663
West	129,153,286	130,866,747	131,221,008	130,680,297	135,871,573
Total	944,913,286	991,574,076	1,018,909,841	1,035,190,823	1,061,094,620

Table 11: Carbon losses (tonnes) from forests on public land in Victorian RFAs.¹⁵⁵

RFA	2009	2014	2015	2016	2017
Central Highlands	136,794,017	146,434,798	148,031,688	149,438,923	152,161,090
East Gippsland	230,304,338	230,705,018	238,487,266	240,166,082	241,730,001
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West	129,153,286	130,866,747	131,221,008	130,680,297	135,871,573
Total	944,913,286	991,574,076	1,018,909,841	1,035,190,823	1,061,094,620

Table 12: Carbon sequestration (additions) to forests on public land in Victorian RFAs.¹⁵⁶

RFA	2009	2014	2015	2016	2017
Central Highlands	136,794,017	146,434,798	148,031,688	149,438,923	152,161,090
East Gippsland	230,304,338	230,705,018	238,487,266	240,166,082	241,730,001
Gippsland	238,939,012	260,185,428	270,443,530	279,086,586	289,052,292
North East	209,722,374	223,382,085	230,726,349	235,818,934	242,279,663
West	129,153,286	130,866,747	131,221,008	130,680,297	135,871,573
Total	944,913,286	991,574,076	1,018,909,841	1,035,190,823	1,061,094,620

Table 13: Value (\$) of carbon sequestration (additions) to forests on public land in Victorian RFAs.¹⁵⁷

RFA	2009	2014	2015	2016	2017
Central Highlands	136,794,017	146,434,798	148,031,688	149,438,923	152,161,090
East Gippsland	230,304,338	230,705,018	238,487,266	240,166,082	241,730,001
Gippsland	238,939,012	260,185,428	270,443,530	279,086,586	289,052,292
North East	209,722,374	223,382,085	230,726,349	235,818,934	242,279,663
West	129,153,286	130,866,747	131,221,008	130,680,297	135,871,573
Total	944,913,286	991,574,076	1,018,909,841	1,035,190,823	1,061,094,620

154. DELWP 2019, 'Ecosystem services from forests in Victoria: assessment of regional forest agreement regions', East Melbourne, Victoria.

155. Ibid

156. Ibid

157. Ibid

Climate change

Changing land uses can impact ecosystem carbon stocks. Research by Keith et al. (2014) found that the carbon stored in a harvested forest is 55% less than that in an unharvested old-growth forest.¹⁵⁸ They also found that the reduction was due to the timber being converted into short-term wood products, along with the lower average age of the harvested forests.

Land-based carbon dioxide removal options for Victoria, in support of achieving the goal of net-zero emissions, were reviewed by Dooley, Christoff and Burdon (2020). They reported that although the land sector has been operating as a net carbon sink in recent years, it is projected to decline over the next decade.¹⁵⁹ To address this and increase carbon dioxide removal, they proposed four options: native forest regeneration; carbon and environmental

plantings; soil carbon removal; restoration of degraded lands.

Estimates of carbon stocks largely focus on public land. Victoria's Trust for Nature commissioned research on the amount of carbon storage in covenanted properties and in its reserves.¹⁶⁰ The research found that covenanted properties stored 9.76 million carbon equivalents, while reserves stored 2.31 million carbon equivalents.

Deakin University, DELWP and Victoria's 10 catchment management authorities investigated carbon sequestration at more than 100 sites in Victoria's wetlands.¹⁶¹ Although based on a very small sample of wetlands, the study found a total carbon stock of 68 million tonnes of organic carbon and estimated the wetlands sequestered 3,117,682 tonnes of carbon dioxide equivalents per year i.e. the same as the emissions of 659,129 cars. The highest carbon stocks were in alpine peatlands, the lowest in permanent open freshwater wetlands. The study also concluded that the loss of wetlands since European settlement had released an estimated 22.5 million to 74.2 million tonnes of carbon dioxide equivalent.

158. Keith H, Lindenmayer D, Mackey B, Blair D et al. 2014, 'Managing temperate forests for carbon storage: impacts of logging versus forest protection on carbon stocks', *Ecosphere*, 5(6), Article 75.

159. Dooley K, Christoff P and Burdon R 2020, 'Land-based carbon dioxide removal options for Victoria, review paper', Melbourne Sustainable Society Institute, The University of Melbourne, Melbourne, Victoria

160. Rimmer L and Young V 2016, 'Conserving carbon: a desktop assessment of forest carbon stocks in properties and covenants owned or managed by Trust for Nature Victoria', Melbourne, Victoria.

161. Carnell P, Windecker S, Brenker M, Yukate B et al. 2016, 'Carbon sequestration by Victorian inland wetlands', Blue Carbon Lab, Deakin University, Victoria.

Climate change

Indicator CC:13 Extent and condition of climate-sensitive systems➤

Region Statewide	Indicator Performance:	2018 Status	2018 Trend	2018 Data
Measures Case study examples	2018 & 2021: Unable to be assessed due to Moderate Data Confidence and Unknown Trend			
Data Custodian DELWP, Parks Victoria	Why this indicator? This measures the impacts of climate change and the level of climate risk for Victoria's natural ecosystems.	2021 Status	2021 Trend	2021 Data

Potential thresholds for status in the SoE 2023 report

Good: Extent and condition of climate-sensitive systems improving significantly

Fair: Extent and condition of climate-sensitive systems stable or small improvement

Poor: Extent and condition of climate-sensitive systems declining significantly

Why this assessment in 2021?

Status: It is difficult to define Status (and thresholds) when only case studies are being used. However, of those case studies, the Status would likely be Poor, especially after bushfires.

Trend: It is difficult to define Trend when only case studies are being used. However, alpine areas, ash forests and rainforests are under increasing stress from climate change and were also impacted by the 2019–20 bushfires.

Data Confidence: Data are limited, although it is improving for alpine areas and ash forests.

Should this indicator be used in the SoE 2023 report?

Yes, it could be retained in the Climate Change chapter, however the use of case studies as the measure for this indicator is too vague. Consideration should be given to a focus on specific systems e.g. alpine, rainforest, wetlands, marine and coastal and choose those where long-term data are available or increasing (maps and models on extent and condition will be critical). Otherwise, the case studies could vary from SoE report to SoE report and prevent comparison.

Summary of SoE 2018 Report assessment

- Climate-sensitive ecosystems include those in the mountains e.g. sphagnum bogs, cool-temperate rainforests, freshwater wetlands and seagrasses.
- Victoria has been experiencing biodiversity loss, partly due to reduced resilience under climate change e.g. repeated fires inhibiting growth of alpine ash trees.
- Climate change is likely to exacerbate the impacts of invasive species.
- Native fauna has little if any predictable resilience to significant change in crucial environmental factors.

The 2019–20 bushfires: Impacts and responses

East Gippsland rainforests and alpine bog communities are climate sensitive ecosystems that were impacted by the 2019–20 bushfires.

Tolsma (2020) reported on the impacts of the 2019–20 bushfires on the threatened ecological community of alpine bogs.¹⁶² The fires potentially burnt 537 hectares of alpine bogs or about 20% of the total area of bogs in fire-affected north-eastern Victoria. Table 14 provides details on the area of bog potentially affected in each of eight regions, while Figure 14 maps their locations. Table 15 details the pre-fire condition of the bogs, the fire impact level, fire history and threats. Most of the bogs were in poor condition, had experienced frequent fires and were also under threat from invasive weeds and feral herbivores.

¹⁶² Tolsma A 2020, 'BBRER theme 1 immediate reconnaissance activity 9, threatened flora and vegetation communities, post-fire assessment report: Alpine bogs', Bushfire Biodiversity Response and Early Recovery Program, Arthur Rylah Institute, Heidelberg, Victoria.

Climate change

Tolsma (2020) concluded that ‘Some bogs were burnt severely, and some have now been burnt twice or more in recent decades, and they will require long times without disturbance to recover.’ The report also identified that after the fires, the greatest risk to the bogs and other alpine systems was from feral

horses, deer, pigs, cattle and willows (these threats already existed but could have been exacerbated by the impacts of the fires). The scientist concluded that unless the threats were addressed, the bogs would shrink or disappear, a process that would be exacerbated by climate change.

Table 14: Areas of alpine bog within the extent of the 2019–20 fires, by broad region.¹⁶³

Broad Region Containing Burnt Alpine Bogs	Area of Bog Potentially Burnt 2019–20 (ha)	Burnt Bog as Percentage of all Bog Area in Region
Mount Buffalo	60	45
Dargo High Plains	13	8
Bogong High Plains	125	9
Cobungra	66	26
Nunniung Plateau	60	24
Forlorn Hope	35	32
Rocky Plains/Cowombat	48	16
Davies Plain	130	83

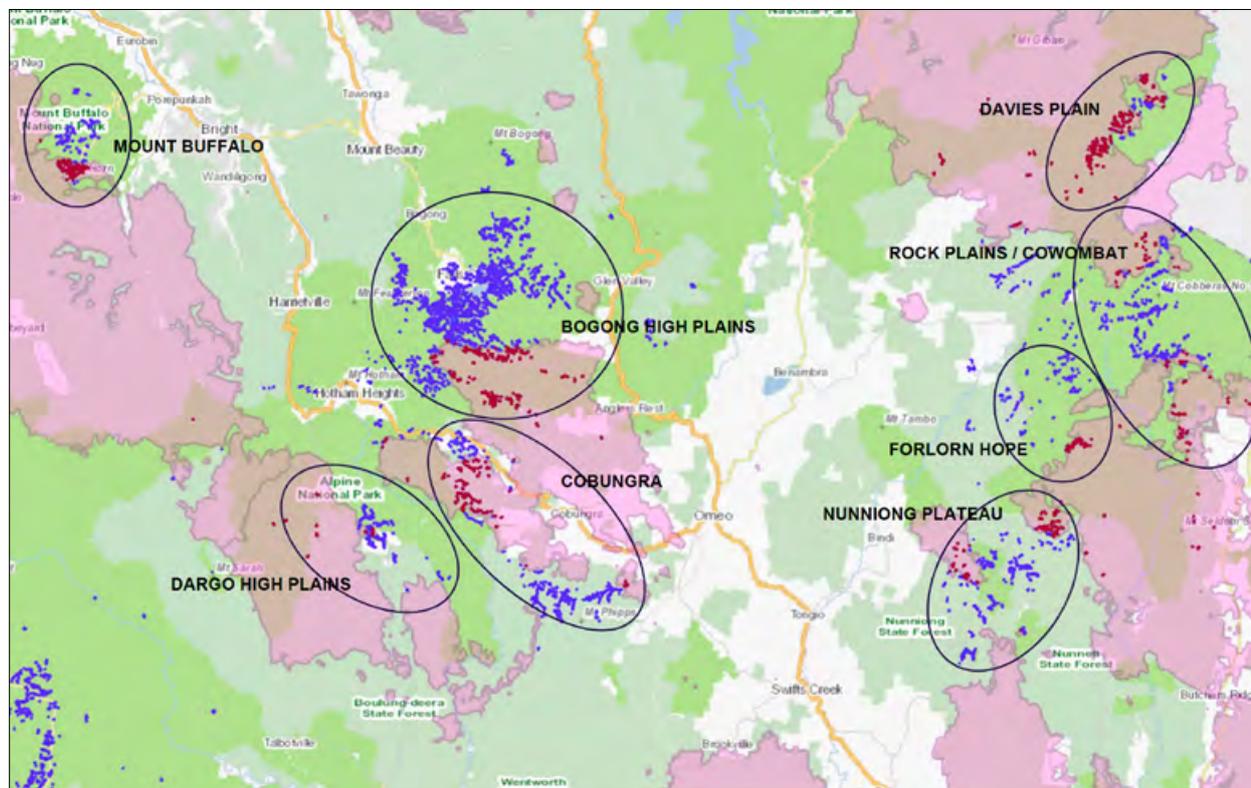


Figure 14: Alpine bogs with respect to the 2019–20 fire extent (pink), by broad region and with burnt bogs (red) and unburnt bogs (blue).¹⁶⁴

163. Ibid

164. Ibid

Climate change

Table 15: Condition and threat information for alpine bogs within the extent of the 2019–20 fire.¹⁶⁵

Broad Region	Pre-2019–20 Fire Bog Condition	2019–20 Fire Impact 1 (No Impact) 5 (Severe Impact)	Fire History	Existing Threats that Pose a Risk to Recovery, Ranked by Potential Impact	Potential Threats that Pose a Risk to Recovery
Mount Buffalo	Mostly good	n/a	1985, 2003, 2006-07	Deer, willows	
Dargo High Plains	Mostly good	n/a	2003	Deer	Cattle, willows
Bogong High Plains	Medium to poor	n/a	2003, some 2006-07	Feral horses, deer, willows	
Cobungra	Medium to poor	n/a	2003	Feral horses, cattle, deer	Willows
Nunniong Plateau	Mostly poor	n/a	Some 2003	Feral horses, cattle, deer, willows, blackberries	Pigs
Forlorn Hope	Poor	4	2003	Feral horses, deer	Pigs, willows
Rocky Plains/ Cowombat	Mostly poor	n/a	2003	Feral horses, pigs, deer	Willows
Davies Plain	Mostly poor	4	2003	Feral horses, deer	Pigs, willows

Rainforest communities are also sensitive to the changes in temperature and rainfall associated with climate change. Although they have generally remained unburnt for decades, they were severely impacted by the 2019–20 bushfires. Figure 15 maps the location of East Gippsland’s rainforest ecosystems, while Table 16 lists eight rainforest ecosystems and the percentage of each community within the fire extent. Five of the ecosystems listed had from 70% to 90% of their area within the fire extent and are now also at risk from soil erosion, weed invasion and feral herbivore grazing.

¹⁶⁵. Ibid

Climate change

Table 16: FFG-listed rainforest ecosystem in the 2019–20 fire extent.¹⁶⁶

Community	Fire Extent	% of Community within Current Fire Extent
Cool Temperate Mixed Forest Community	Substantial areas of Cool Temperate Mixed Forest estimated to be in excess of >10,000 hectares are within the currently mapped fire-ground largely within the Errinundra National Park and adjacent areas.	~40%
Dry Rainforest (Limestone)	The extent of this rainforest community is extremely restricted and likely to be less than 100 hectares in area.	44%
Limestone Grassy Woodland	Potentially up to 50,000 hectares of this community remain in the Buchan and Murrindal areas. Largely previously cleared for agriculture.	>90%
Warm Temperate Rainforest (Coastal East Gippsland)	Less than 7,500 hectares remain.	>80%
Warm Temperate Rainforest (East Gippsland Alluvial Terraces)	Less than 3,500 hectares remain.	~90%
Warm Temperate Rainforest (Far East Gippsland)	Less than 2,000 hectares remain.	>70%
Warm Temperate Rainforest (Cool Temperate Overlap, Howe Range) Community	Less than 5,500 hectares of this community remain in Victoria.	>90%
Cool Temperate Rainforest	Less than 15,000 hectares of this community remain in Victoria.	8%

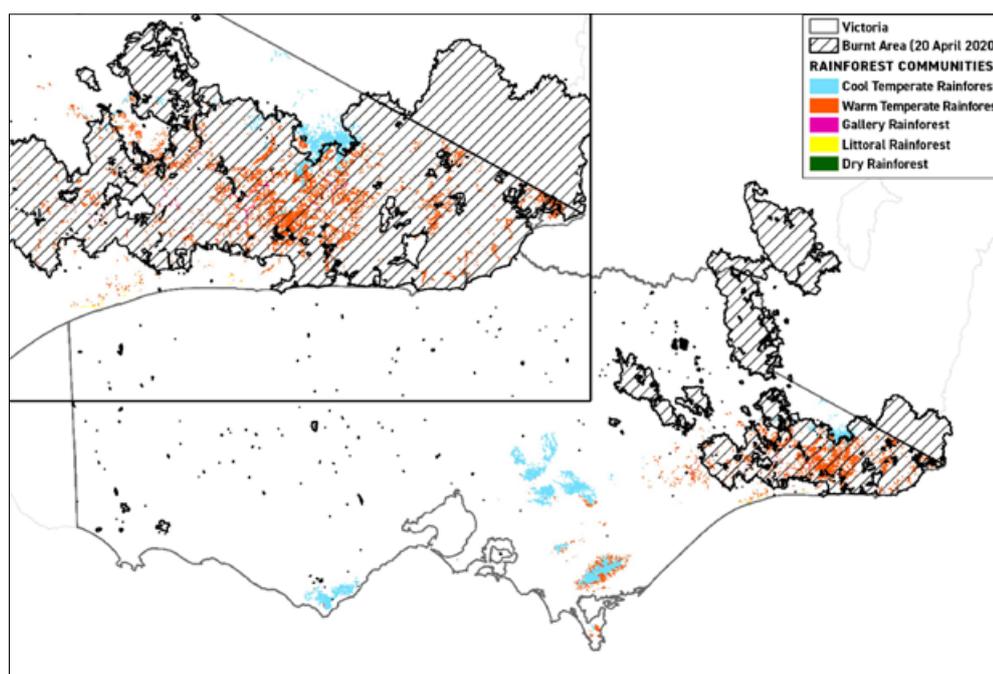


Figure 15: East Gippsland rainforest communities and the 2019–20 fire extent.¹⁶⁷

Climate change

SoE Biodiversity Update 2021 Report assessment

Regan et al. (2020) reported on research that predicts warming rates in alpine systems to be higher than at lower elevations, that shrubs are encroaching on grasslands at higher elevations, and that some mammals are moving to higher elevations.¹⁶⁸ This was part of a study that developed risk assessment and management priorities for alpine ecosystems under climate change using the International Union for Conservation of Nature (IUCN) Red List of Ecosystems risk assessment method.¹⁶⁹ Two ecosystems were the focus of their research, snow patch herbfields and alpine bogs.

'Snow patch herbfields were assessed as Critically Endangered due to its restricted geographic distribution and ongoing declines associated with reduced snow persistence and shrub encroachment under a changing climate. Alpine bogs were assessed as Vulnerable due to their restricted range as well as decline in climatic moisture over a 50-year period.'

A 2016 Conference on Australian Alps Climate Future reviewed the changes that could occur in the Alps as the result of climate change. Table 17 is a summary of the impacts raised during the conference and published in the conference's summary report.¹⁷⁰

Table 17: Alpine attributes that could change due to climate change.¹⁷¹

Value Aspect of the Alps	Attributes that will Change (Inevitable Change, Loss)	Attributes that could Persist (Feasible to Maintain**)
Alpine peatlands	Lose lots. Many will shrink	Lots of peat bogs. Ephemeral wetlands?
Alpine herbfields	Loss of many to shrubs and grazing	Many (restricted) herbfields. Healthy native ecosystem
Snow patch communities	Will eventually disappear. Some species extinct	Healthy native ecosystem: snowgrass, shrubs
Alpine (treeless) ecosystems	Gradual and persistent elevation in the treeline, more shrubs.	Large areas remain for many decades. Healthy native ecosystem
Snow Gum woodlands	Expand up and down. No old ones. Invaded from below. Thicken	Lots of snow gum woodlands
Montane and wet forests	Widespread loss, in all but fire protected areas	Some restricted populations in refuges. Re-sprouter eucalypt forests**
Alpine fauna	Some species crash. Expansion of lowland natives. More ferals	Some persist. Large diversity of natives. Contained ferals**. Small mammals**
Unique alpine flora and fauna	Abundance and location of populations will change. Declines; extinctions	Very high diversity of uniquely Australian native species
Diversity of native species	Fewer old species. Many new species, including refugees. Many aliens	Very high diversity of Australian native species
Visual amenity	Reduction in classic treeless vistas	Distinctive geographic features; extensive alpine vistas. Great for tourists
'Wilderness' (natural, remote)	Anthropogenic ecological change. Increase in alien plants and animals	Overall remoteness and sense of naturalness maintained
Water supply	Changes in rain, water storage (snow and bogs); changes in flow regimes	Alps will remain sources of plentiful and clean water

168. Regan T, Tolsma A, Rowland J, Muir A et al. 2020, 'Risk assessment and management priorities for alpine ecosystems under climate change: milestone 5 report', Arthur Rylah Institute, Heidelberg, Victoria.

169. International Union for Conservation of Nature, 'IUCN red list of ecosystems', Gland, Switzerland <https://www.iucn.org/resources/conservation-tools/iucn-red-list-ecosystems>.

170. Jacobs P and Anderson G 2016, 'Australian Alps climate futures: taking action now to strengthen resilience, summary report', Australian National University, Canberra 26 and 27 July 2016.

171. Ibid

Climate change

The post-fire changes in a cool temperate rainforest community in the O'Shannassy catchment were studied by Tolsma et al. (2019). They found that two-thirds of the community had been lost in the 10 years after the Black Saturday fires of 2009.¹⁷² Burnt areas were very different in composition to unburnt areas, and non-rainforest species had taken hold and changed the community composition away from rainforest.

Although a rising sea level is the major threat to estuaries, they will also be vulnerable to storm surges, reduced freshwater runoff and changes in fire frequency.

These were the results of a DELWP sensitivity analysis¹⁷³ of the vulnerability of coastal wetlands to climate change, using the Powlett River estuary in West Gippsland as the study area. The analysis was based on five climate change components: increased sea level and storm surge; increased carbon dioxide concentration; decreased rainfall; higher air temperature; higher water temperature. Research by scientists at the Australian National University and CSIRO found that if CO₂ levels doubled, river red gums would produce lower levels of essential oils and put the trees at risk because the oils defend the trees from insect attack.¹⁷⁴



TITLE: Kookaburra
OWNED BY: Parks Victoria

172. Tolsma A, Hale R, Sutter G and Kohout M 2019, 'Post-fire dynamics of cool temperate rainforest in the O'Shannassy catchment', technical report series no. 298, Arthur Rylah Institute, Heidelberg, Victoria.

173. DELWP 2016, 'Climate change vulnerability and adaptive capacity of coastal wetlands, decision support framework, volume 1', East Melbourne, Victoria.

174. Bustos C, Dillon S, Keszei A, Foley W et al. 2017, 'Intraspecific diversity of terpenes of *Eucalyptus camaldulensis* (Myrtaceae) at a continental scale', *Australian Journal of Botany*, 65(3), pp. 257-269.

Invasive plants and animals

Background

It is estimated that each year another 20 new weed species are growing in Australia,¹⁷⁵ while invasive animals such as deer are increasing in number and range. There are 1,235 environmental weeds on Victoria's advisory list – almost double those recognised in 1993 – and another 82 that could become defined as weeds in the future.¹⁷⁶

On their own, invasive species pose a significant risk to ecosystem health and many native species – threatening up to 80% with extinction in Australia.¹⁷⁷ However, their impacts are exacerbated when combined with other threats including climate change, habitat disturbance and fragmentation.

Predator invasive species kill native fauna, while herbivore invasive species destroy habitat and compete with native species for food. When environmental weeds invade native vegetation, often after disturbance by such factors as clearing, grazing and fire, they can:

- outcompete indigenous plants for space, light and nutrients
- lead to changes in ecosystem structure, function and resilience
- add to fuel loads and increase fire risk
- provide food and shelter for invasive animals.

The spread of invasive species can be rapid. The fungal plant disease, myrtle rust, first arrived in Australia in 2010 and spread to Victoria by 2011, where it infests native trees and shrubs.¹⁷⁸

Of the 43 potentially threatening processes listed under the Flora and Fauna Guarantee Act 1988, 21 relate to invasive species and include:

- degradation and loss of habitats caused by feral horses (*Equus caballus*)
- infection of amphibians with chytrid fungus, resulting in chytridiomycosis
- invasion of native vegetation by 'environmental weeds'
- predation of native wildlife by cats (*Felis catus*)
- predation of native wildlife by the introduced red fox (*Vulpes vulpes*)
- reduction in biodiversity of native vegetation by sambar deer (*Cervus unicolor*)

- introduction of live fish into waters outside their natural range within a Victorian catchment after 1770.

Of these 21 listed potentially threatening processes, only four have action statements, those covering the cat (prepared in 1997), the fox (2002) and live fish introductions (2002) above, and the introduction of exotic marine organisms to Victoria's marine waters (prepared in 2002).

Kearney et al. (2019) analysed the threats facing Australia's 'imperiled species' and found that invasive species impacted the most species across all taxons. Invasive species impact 100% of amphibian species, 97% of fish and mammal species, 95% of bird species and 94% of vertebrate species, while agricultural activity threatens 82% of birds, and ecosystem modifications threaten 79% of invertebrate species. Invasive species also threaten 81% of Critically Endangered species, 86.5% of Endangered species and 78.1% of Vulnerable species.

The 2019–20 bushfires brought into sharp relief the need to control invasive species to support the recovery of native flora and fauna heavily impacted by the fires. Priority was given to projects to control deer, weeds, foxes, feral cats and pigs in the fire extent as well as in unburnt refuge areas.¹⁸⁰ Figure 16 (on the next page) compares the suggested (i.e. not necessarily implemented) spatial coverage of pre-fire (green bars) and post-fire (blue bars) projects for the control of invasive species according to DELWP biodiversity decision-support tools. For example, suggested areas for deer control post-fires covered more than 800,000 hectares, whereas pre-fires it was approximately 700,000 hectares. Suggested areas for post-fire weed control were approximately 700,000 hectares, while before the fires it was approximately 400,000 hectares. Actual areas of management actions are reported in indicator B:21 Area of management in priority locations.

175. Dodd A, Burgman M, McCarthy M and Ainsworth N 2015, 'The changing patterns of plant naturalization in Australia', *Diversity and Distributions*, 21, pp. 1038–1050.

176. White M, Cheal D, Carr G, Adair R et al. 2018, 'Advisory list of environmental weeds in Victoria', technical report series no. 287, Arthur Rylah Institute, Heidelberg, Victoria.

177. DELWP 2019, 'Weeds and pests on public land: program activities and achievements 2018–19', Infographic, East Melbourne, Victoria.

178. DELWP 2020, 'Submission to the Legislative Council Environment and Planning Committee Inquiry into Ecosystem Decline in Victoria', Parliament of Victoria, Melbourne, Victoria.

179. DELWP 2020, 'Victoria's bushfire emergency: biodiversity response and recovery, version 2', East Melbourne, Victoria.

180. Ibid

Invasive plants and animals

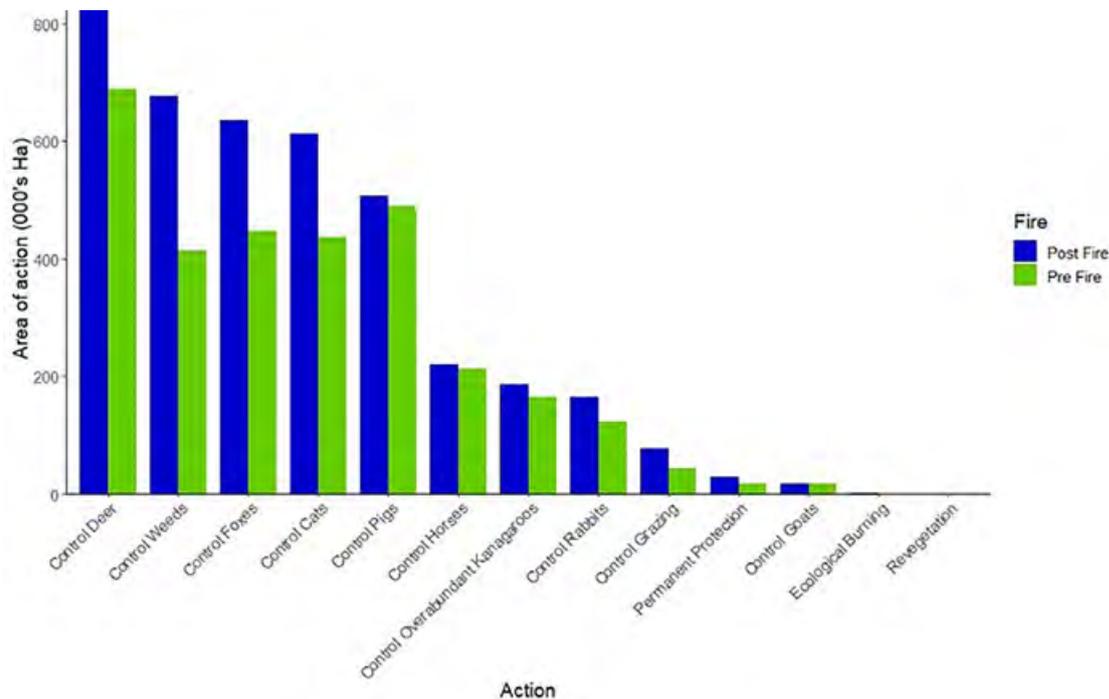


Figure 16: Area (hectares) of recommended priority actions within the statewide 2019–20 fire extent, including the control of invasive species.¹⁷⁹

For the purposes of this report, 'invasive' includes pest animals, overabundant native animals and exotic wildlife (deer), exotic weeds and Australian native plants that are over-abundant or out of their natural range. Invasive species are sometimes declared as 'pests' under the Catchment and Land Protection Act). Two invasive plant categories are:

- **Naturalised flora taxa** – taxa that originate from either outside Australia or interstate, or taxa that are Victorian natives that have become established long-term and self-sustaining populations outside their pre-European range e.g. spotted gum (*Corymbia maculata*) and coastal umbrella-bush (*Acacia cupularis*). Naturalised flora taxa may not adversely impact native plants and/or animals or functioning ecosystems.
- **Environmental weeds** – these are a subset of naturalised taxa. They invade native ecosystems and have the potential to adversely affect the survival of native plants, animals and functioning ecosystems. They include plant species that have been introduced to Australia from other countries, as well as native plant species that have spread beyond their previous

natural range due to changed land management or practices e.g. sallow wattle (*Acacia longifolia*), coast wattle (*Acacia sophorae*) and coast tea tree (*Leptospermum laevigatum*).

Invasive animals include vertebrates and invertebrates and their status can vary within the relevant legislation and regulations that cover them. For example, although several deer species are introduced in Victoria, and numbers, distributions and impacts have increased, they are considered as game and protected under the *Wildlife Act 1975*. Other introduced species, such as feral horses, are not declared under the *Catchment and Land Protection Act*. However, they are considered invasive or pest species and efforts are being made to reduce their numbers in sensitive alpine and wetland areas e.g. Barmah Forest. In some places, native animals such as kangaroos can become 'over-abundant' and permission given to landholders to cull them.

Each of these types of invasive species are considered in this theme's indicator assessments, which focus on invasive species that pose a major threat to biodiversity, ecosystem health, primary production and landscape aesthetics in Victoria.

179. DELWP 2020, 'Victoria's bushfire emergency: biodiversity response and recovery, version 2', East Melbourne, Victoria.

Invasive plants and animals

Policy and legislative setting

The Agriculture Victoria website¹⁸¹ identifies more than 20 laws relevant to the management of invasive plants and animals in Victoria. These include:

- *Catchment and Land Protection Act 1994* - the main statute governing pest plants and animals in Victoria. It is used to declare plant and animal species as noxious weeds and pest animals that threaten primary production, Crown land, the environment and community health
- *Flora and Fauna Guarantee Act 1988* - under this act, a species cannot be declared as noxious under the Catchment and Land Protection Act if it is listed as threatened
- *National Parks Act 1975* - under the Catchment and Land Protection Act, Parks Victoria is stipulated as responsible for noxious weed and pest animal management in parks in Schedule 2 of the National Parks Act
- *Fisheries Act 1995* - under this act an aquatic species can be declared as noxious
- *Wildlife Act 1975* - management of overabundant or out of range wildlife comes under this Act. Provisions allow a permit or authorisation to be granted to a person to take or destroy, buy, sell, acquire, receive, dispose of, keep, possess, control, breed, process or display wildlife. Wildlife can be declared established pest animals under the Catchment and Land Protection Act
- *Planning and Environment Act 1987* - provisions of this Act refer to the removal, destruction or lopping of trees or the removal of vegetation or topsoil as a result of noxious weed and pest animal control works.

The Invasive Plants and Animals Policy Framework,¹⁸² released in 2010, prioritises actions based on a biosecurity approach that aims to:

- prevent the entry of new high-risk invasive species
- eradicate those that are at an early stage of establishment
- contain where possible species that are beyond eradication
- take an asset-based approach to managing widespread invasive species.

The Victorian Deer Control Strategy¹⁸³ was released in 2020 with a vision to create a future where 'Deer are no longer significantly impacting on priority environmental, agricultural and Aboriginal cultural heritage values and public safety in Victoria.'

Its three goals are:

- the impacts of deer on key environmental, agricultural and Aboriginal cultural heritage values and public safety are reduced
- deer control is more effective through partnerships and community collaboration
- awareness, understanding and capacity to control deer is increased.

Two of its objectives are to 'Prevent the establishment of new deer species and populations in Victoria' and 'Facilitate development of a commercial deer harvest industry.'

The five key objectives of the Protection of the Alpine National Park Feral Horse Strategic Action Plan 2018–21¹⁸⁴ were to reduce horse damage to alpine habitats, improve knowledge, protect Aboriginal cultural heritage, prevent new horse populations from establishing and remove isolated horse populations. In March 2021 Parks Victoria released an updated version of this plan for consultation.

The Strategic Action Plan: Protection of floodplain marshes in Barmah National Park and Barmah Forest Ramsar site (2020–23)¹⁸⁵ is also focussed on the major threats posed by feral horses and invasive weeds.

181. Agriculture Victoria, 'Invasive species laws and the Catchment and Land Protection Act 1994', Melbourne, Victoria <https://agriculture.vic.gov.au/biosecurity/protecting-victoria/legislation-policy-and-permits/invasive-species-laws-and-the-catchment-and-land-protection-act-1994> Accessed 19 May 2021.

182. Department of Primary Industries 2010, 'Invasive plants and animals policy framework', East Melbourne, Victoria.

183. DELWP 2020, 'Victorian deer control strategy 2020', East Melbourne, Victoria.

184. Parks Victoria 2018, 'Protection of the Alpine National Park feral horse strategic action plan 2018–2021', Melbourne, Victoria.

185. Parks Victoria 2020, 'Strategic action plan: protection of floodplain marshes in Barmah National Park and Barmah Forest Ramsar Site 2020–2023', Melbourne, Victoria.

Invasive plants and animals

Indicator B:01 Invasive freshwater plant and animal species (other than European carp)

Region Statewide	Indicator Performance:	2018 Status	2018 Trend	2018 Data
Measures Number, abundance and distribution; Threatening processes impacting on native freshwater plants and animals Data Custodian DELWP	2018 & 2021: Unable to be assessed due to Low Data Confidence and Unknown Status and Trend Why this indicator? Invasive freshwater plants and animals can alter freshwater habitats, threaten their long-term function and undermine the outcomes of previous investment in waterway management.		?	
		2021 Status	2021 Trend	2021 Data
			?	

Potential thresholds for status in the SoE 2023 report

Good: Significant reducing trend in the number, abundance and distribution of invasive freshwater plant and animal species

Fair: Small reducing trend in the number, abundance and distribution of invasive freshwater plant and animal species

Poor: Significant increasing trend in the number, abundance and distribution of invasive freshwater plant and animal species

Why this assessment in 2021?

Status: Although lists of priority invasive freshwater plant species have been developed, there is little spatial data on their extent. This is also the case for invasive freshwater animals, except for carp and trout. Although the threatening processes are known, data are limited on their impact levels, especially the impacts of invasive freshwater plants on native fauna. It is likely that the Status is Poor.

Trend: There are insufficient data to determine trends, although there are significant localised programs to remove willows and other weeds and remove carp.

Data Confidence: Available lists provide insufficient data on the extent of invasive freshwater plant species.

Should this indicator be used in the SoE 2023 report?

Yes, however consideration should be given to splitting this indicator into two: invasive freshwater plants and invasive freshwater animals. However, data on invasive freshwater species is generally limited and likely to remain so.

Summary of SoE 2018 Report assessment

- Freshwater invasive plant species can form dense infestations that reduce the diversity of freshwater plants, have secondary impacts on freshwater animals, and impact recreational values and irrigation channels.
- Recent investments in the control of invasive freshwater species had focused on carp, arrowhead (an aquatic weed) and willows.
- There was a lack of comprehensive and accurate statewide data on population numbers and trends of invasive freshwater pest plants and animals, and their threatening processes.

The 2019–20 bushfires: Impacts and responses

The disturbance caused by the loss of riparian vegetation and reduced water quality in the upper Murray and upper Mitta rivers could lead to an increase in the abundance and distribution of invasive species after the 2019–20 bushfires. However, in the case of invasive plants, as early colonisers they could also help stabilise soil, shield riverbanks from erosion and support post-fire recovery.

However, there are scant data on the impacts of the 2019–20 bushfires on invasive freshwater plants and animals. Silva et al. (2020) reported the deaths of European carp, mosquito fish, redfin perch and rainbow trout at sites in fire-affected areas.¹⁸⁶ McInerney et al. (2020) observed that the first sediment pulse after the fires clogged the gills of fish and caused the death of European carp in the Murray River at Burrowye Reserve in Victoria.¹⁸⁷

186. Silva L, Doyle K, Duffy D, Humphries P et al. 2020, 'Mortality events resulting from Australia's catastrophic fires threaten aquatic biota', *Global Change Biology*, 26(10), pp. 5345–5350.

187. McInerney P, Kumar A, Rees G, Joehnk K et al. 2020, 'How bushfires and rain turned our waterways into "cake mix", and what we can do about it', *The Conversation*, 14 September 2020.

Invasive plants and animals

Redfin and European carp were also found dead in the Murray at Thologolong, with a local farmer estimating there were 30 dead carp for every dead Murray cod.¹⁸⁸

Some insight into the potential impacts of the 2019–20 bushfires can be gained from a 2008 analysis by Ecology Australia. The consultancy analysed the response of the willow, grey sallow (*Salix cineria*), to the 2003 bushfires in Victoria, the state's largest since the fires of Black Friday 1939 and of 2006.¹⁸⁹ Prior to the 2003 bushfires, the grey sallow was restricted in its distribution and was mostly in the alpine villages, with only a few records in the Alpine National Park. Along the Fainter Ridge, the study area for the analysis, the researchers found that after the fires there was a widespread and large population of the grey sallow that was strongly associated with bogs and streams.

Protection of the spotted tree frog after the 2019–20 bushfires was the major aim of a willow control project conducted in the Wongungarra River in the upper reaches of the Mitchell River. Although remote and largely inaccessible, willows had colonised the area and were impacting the frog's habitat. Six months after the fires, highly skilled contractors with the East Gippsland CMA removed the juvenile willows and seedlings. They did so while walking along the river for 5–10 days, travelling up to 15 kilometres per day, carrying their food and chemical rations and camping on the riverbanks.¹⁹⁰ Table 18 presents the willow control targets in the East Gippsland CMA's Waterway Goal 2014–2022¹⁹¹ and the high level of target achievement.

Table 18: Willow control in the East Gippsland CMA Waterway Goal 2014–2022.¹⁹²

Waterway Goal	Total Length (km)	Goal Achieved (%)
Willow control		
Mitchell River catchment above Glenaladale Bridge will be free of willows	1,132	94
Nicholson River from the headwaters to the Lakes will be free of willows	106	100
The Tambo River above the Bruthen Bridge will remain free of willows	640	98
The Nicholson and Tambo estuaries below the Princes Highway and the Mitchell River below Picnic Point will be free of willow and poplars	55	76
The Snowy catchment will remain free of willows	1,250	100
All rivers in the Far East catchment will be free of willows	1,200	98

DELWP worked with Parks Victoria and other land management agencies in the Buffalo River area to prioritise willow control and to improve river health for the threatened Macquarie perch, some individuals of which had been extracted and later returned once conditions had improved after the fires.¹⁹³

188. Thomson B 2020, '40kg Murray cod among thousands of fish killed in Upper Murray', *Canberra Times* 24 January 2020.

189. Ecology Australia 2009, 'Fainter Ridge willow infestation assessment', Fairfield, Victoria.

190. Birleson M 2020, 'Weed management in a remote catchment: protecting the critically endangered spotted tree frog', Presentation at a Weed management after fire: supporting native species recovery webinar, 9 December 2020, Weeds at the Early Stage of Invasion (WESI) Project, DELWP, East Melbourne, Victoria.

191. East Gippsland Catchment Management Authority 2020, 'Annual report 2019–2020', Bairnsdale, Victoria.

192. East Gippsland Catchment Management Authority 2020, 'Annual report 2019–2020', Bairnsdale, Victoria.

193. Littlewood D 2020, 'Prioritising weeds in the Hume region after fire', presentation at a Weed management after fire: supporting native species recovery webinar, 2 December 2020, Weeds at the Early Stage of Invasion (WESI) Project, East Melbourne, Victoria.

SoE Biodiversity Update 2021 Report assessment

Invasive freshwater plant species can form dense infestations that reduce the diversity of freshwater plants, have secondary impacts on freshwater invertebrates and fish, and alter freshwater habitats in ways that can threaten their long-term function if not managed. However, data for this indicator are limited, with most from standing water bodies, irrigation channels and the Murray-Darling Basin.

In two reports, Weis, Dugdale and Froid (2017a and 2017b) presented the results of a survey of land managers involved in weed management that identified 41 priority invasive wetland species. The focus was on those weeds under active management^{194, 195} and excluded state prohibited weeds,¹⁹⁶ species that are primarily terrestrial, and native species in engineered waterways. The top 15 of those priority weed species are listed in Table 19, along with information about their impacts. Knowledge gaps identified by the research were the impacts of the invasive species on wetland ecological values and native fauna, and potential control measures. Most available information was related to their socio-economic impacts such as on recreation, navigation and the blockage of drains and irrigation channels.

Willow trees were introduced to south-eastern Australia to control riverbank erosion and add to the rural scenery. Since then, they have invaded thousands of kilometres of rivers and become the target of CMA control programs in the past 20 years.¹⁹⁷ Willows outcompete native plants, reduce available habitat for native birds, mammals and fish, can lead to bank erosion and changed river flows, and use large volumes of water that are then no longer available for riverine habitats and species.

Although regulations do not prevent landholders from planting willows on their land, Victoria's catchment management authorities are actively removing willows on crown frontages. Under the Victorian waterway management strategy, the planting of non-indigenous species on riparian land is discouraged and unfunded, and the management and control of riparian weeds is coordinated on a catchment scale.¹⁹⁸

The Victorian Fisheries Authority lists 179 noxious aquatic species that include freshwater and marine fish, crustaceans, molluscs and several plants.²⁰¹ The listed invasive freshwater species include European carp, marron, mosquito fish and weather loach, however not brown or rainbow trout, which also impact native fauna.

The IUCN lists rainbow and brown trout in the world's top 100 worst invasive alien species.²⁰² Introduced into Australian aquatic environments in 1864,²⁰³ they have established self-sustaining populations, spread widely and become popular targets of recreational fishers who are supported by the stocking of hatchery-bred trout. Brown and rainbow trout compete with native fauna for resources, prey on native fish, frogs and spiny crayfish, and can cause the elimination of native species in some waterways. Figure 17 maps the spread of brown trout in the Murray-Darling Basin prior to and after 1980. It shows the trout's expansion into Victoria's rivers: Wimmera, Loddon, Campaspe, Goulburn, Broken, Ovens, Kiewa, Mitta Mitta and the upper Murray.

According to Victorian Fisheries Authority's Freshwater Fisheries Management Plan 2018–28, 'Redfin perch and trout have been implicated in the decline of small- and large-bodied native fish, such as galaxiids, trout cod, Macquarie perch, silver perch and golden perch.'²⁰⁴ Native Fish Australia reports that 'some populations of redfin carry a virus which poses a threat to other fish.'²⁰⁵

194. Weiss J, Dugdale T and Froid D 2017a, 'Knowledge document of the impact of priority wetland weeds: part 1 – selection of the priority wetland weeds', report prepared for DELWP Water and Catchments Group by Agriculture Victoria, Melbourne, Victoria.

195. Weiss J, Dugdale T and Froid D 2017b, 'Knowledge document of the impact of priority wetland weeds: part 2 – impacts of priority wetland weeds', report prepared for DELWP Water and Catchments Group by Agriculture Victoria, Melbourne, Victoria.

196. State prohibited weeds are the highest category of declared noxious weeds in Victoria. They are: alligator weed; branched broomrape; camel thorn; hawkweed; horsetails; karoo and giraffe thorn; knotweed; lagarosiphon; mesquite; Mexican feather grass; parthenium weed; perennial ragweed; poverty weed; salvinia; tangled hypericum; water hyacinth. It is an offence to buy, sell, display or transport these weeds within Victoria.

197. DELWP 2016, 'Managing willows in Victoria', East Melbourne, Victoria.

198. Department of Environment and Primary Industries 2013, 'Improving our waterways: Victorian waterway management strategy', East Melbourne, Victoria.

201. Victorian Fisheries Authority, 'List of noxious aquatic species in Victoria', Melbourne, Victoria <https://vfa.vic.gov.au/operational-policy/pests-and-diseases/noxious-aquatic-species-in-victoria/noxious-aquatic-species-in-victoria> Accessed 9 May 2021.

202. Lowe S, Browne M, Boudjelas S and De Poorter M 2000, '100 of the world's worst invasive alien species: a selection from the Global Invasive Species Database', The Invasive Species Specialist Group of the Species Survival Commission of the World Conservation Union (IUCN), Updated and reprinted version: November 2004.

203. Nicoletti J 2017, 'On this day: trout arrive in Australia', *Australian Geographic*, 3 May 2017.

204. Victorian Fisheries Authority 2018, 'Freshwater fisheries management plan 2018–2028', Melbourne, Victoria.

205. Native Fish Australia, NFA (Victoria) 'Freshwater fisheries management policy' <https://www.nativefish.asn.au/home/page/Policy> Accessed 10 May 2021.

Invasive plants and animals

Table 19: Top 15 priority invasive plant species in Victoria's wetlands and riparian vegetation, excluding state prohibited weeds^{199,200}

Common Name	Scientific Name	Impacts
Sagittaria	<i>Sagittaria spp.</i>	Amphibious wetland weed. Dense perennial monocultures displace native plants, therefore changing the character of the vegetation. Little information available relating to fauna.
Cabomba	<i>Cabomba caroliniana var. caroliniana</i>	Aquatic wetland weed. Dense perennial monocultures displace native plants (where permanent water regime allows), therefore changing the character of the vegetation. Dense beds reduce access to aquatic fauna (physical and reducing oxygen), however there are no strong data demonstrating this. In fact, the limited data available suggests that there is no impact.
Parrot's feather	<i>Myriophyllum aquaticum</i>	Aquatic wetland weed. Perennial monocultures of extremely dense stems form floating rafts that displace native plants, therefore changing the character of the vegetation, and reduce water quality (anoxia) light penetration and physical access to the water for fauna.
Drain flat-sedge	<i>Cyperus eragrostis</i>	Amphibious wetland weed. No impact reported but threat to six EVCs indicates some impact.
Cord grass	<i>Spartina spp.</i>	Saltmarsh wetland weed. Formation of dense monotypic swards on areas otherwise absent of dense vegetation (intertidal mud flat), or on saltmarshes (resulting in displacement of native plants). Both scenarios result in altered ecosystem function (sedimentation rates, biomass accumulation, water quality, fauna use i.e. waders, benthos, fish).
Spiny rush	<i>Juncus acutus subsp. acutus</i>	Amphibious wetland weed. Dense growth overtops and displaces other vegetation. Formation of dense 2 metre tall clumps may prevent large-bodied fauna from easily accessing water.
Egeria	<i>Egeria densa</i>	Aquatic wetland weed. Dense perennial monocultures displace native plants (where permanent water regime allows), therefore changing the character of the vegetation. Dense beds reduce access to aquatic fauna (physical and reducing oxygen), with different fish assemblages and macroinvertebrate abundance reported from Egeria beds, relative to native macrophytes. Although this species can change aquatic fauna communities, Egeria does provide habitat for aquatic fauna.
Sea lavender	<i>Limonium hyblaenum</i>	Saltmarsh wetland weed. Dense perennial monocultures displacing native plants, therefore changing the character of the vegetation, resulting in altered habitat for fauna.
Senegal tea	<i>Gymnocoronis spilanthoides</i>	Fringing or marginal wetland weed. Dense infestations forming monocultures outcompeting and displacing native flora in wet and moist environments, thus changing the habitat for fauna.
Water couch	<i>Paspalum distichum</i>	Amphibious wetland weed. Dense smothering growth creating monocultures and altering the habitat.
Reed canary-grass	<i>Phalaris arundinacea</i>	Fringing or marginal wetland weed. Dense perennial monocultures displace native plants, therefore changing the character of the vegetation. Altered habitat leads to changes to fauna. Despite this, the changed habitat clearly provides valuable habitat.
Fog-fruit	<i>Phyla canescens</i>	Dense perennial monocultures displace native plants and changes the floristic community structure completely, resulting in a low growing monoculture with no structure for fauna.
Willow	<i>Salix spp.</i>	Willows change the floristic composition of the wetlands and riparian areas in which they grow, changing the ecological character and reducing suitability for native fauna.
Canadian pondweed	<i>Elodea canadensis</i>	Dense perennial monocultures displace native plants (where permanent water regime allows), therefore changing the character of the vegetation. Little information available relating to fauna but has similar, though less robust, growth form as Egeria and Cabomba, so likely to have similar impacts.
Yellow flag iris	<i>Iris pseudacorus</i>	Dense rhizomatous growth on land and floating over the water. Smothers flora, so alters habitat for fauna, and changes physico-chemical properties of water.

199. Weiss J, Dugdale T and Frood D 2017a, 'Knowledge document of the impact of priority wetland weeds: part 1 – selection of the priority wetland weeds', report prepared for DELWP Water and Catchments Group by Agriculture Victoria, Melbourne, Victoria.

200. Weiss J, Dugdale T and Frood D 2017b, 'Knowledge document of the impact of priority wetland weeds: part 2 – impacts of priority wetland weeds', report prepared for DELWP Water and Catchments Group by Agriculture Victoria, Melbourne, Victoria.

Invasive plants and animals

According to the Murray-Darling Basin Authority, the brown trout has also impacted the abundance of frogs such as the spotted tree frog.²⁰⁶

Jackson et al. (2004) reviewed the impacts of alien salmonids e.g. brown and rainbow trout in south-eastern Australia, and identified impediments for their management and control that included:

- lack of monitoring that can detect impacts
- popularity and economic value of the recreational trout fishery combined with the political influence of angler groups
- lack of community awareness about the introduction of trout and their impacts on native fish and other aquatic biota
- legal stockings by fisheries agencies and illegal stockings.

The scientists also observed that: 'Negative impacts of alien salmonids on native aquatic fauna (including fish, frogs, spiny crayfish), mainly through direct predation and to a lesser degree competition for resources, have been noted for over 140 years. Impacts on some faunal groups have been severe enough to eliminate entire populations and severely fragment species across their range. Despite these impacts, salmonid management is focused largely on providing improved recreational angling opportunities, whereas management of their impacts is almost non-existent. Management of the symptom of salmonid impacts, i.e. declining native species, begins only after native species have become imperilled.'²⁰⁹

DELWP is currently leading a feasibility assessment for trout control and a pilot trout control program (including barriers, trout removal, genetic analysis and fish conservation) for management in priority locations.²¹⁰

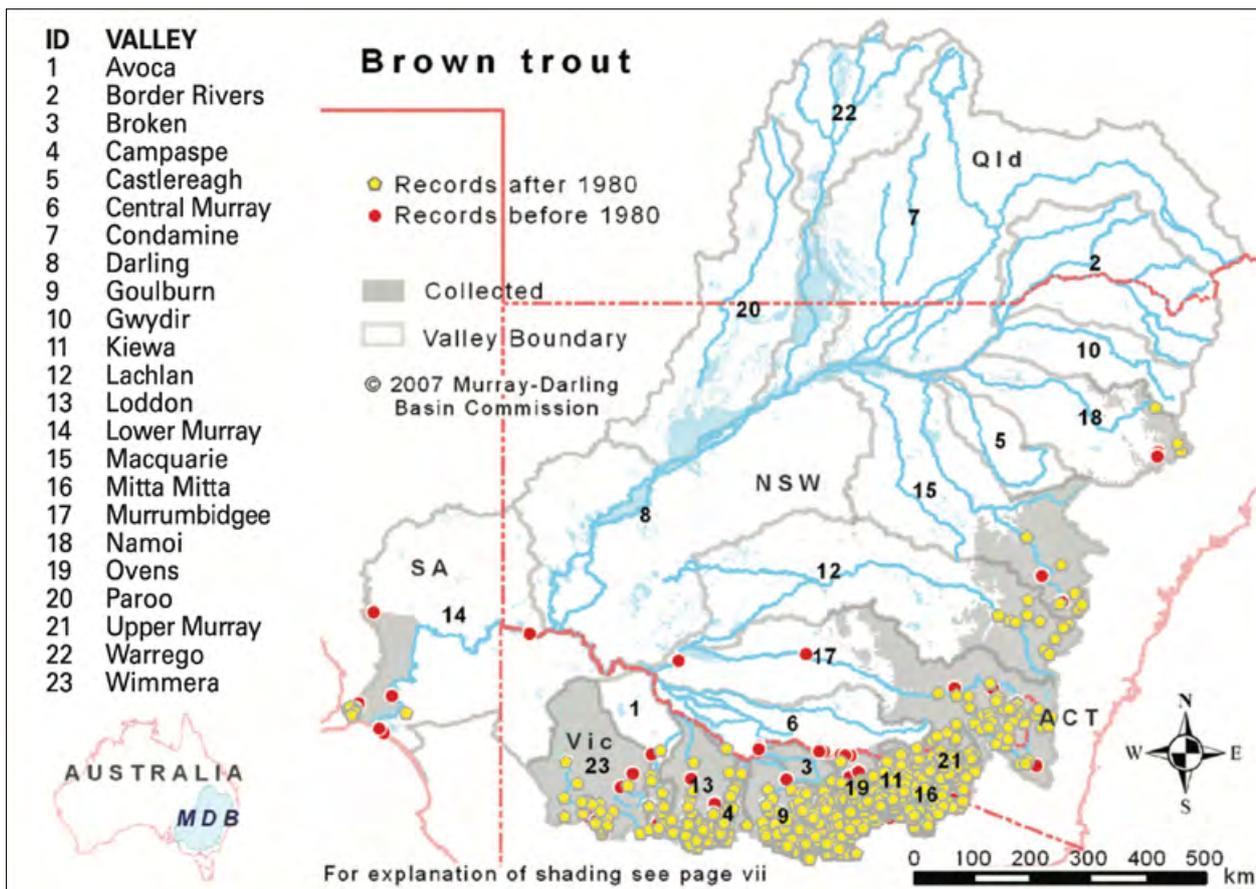


Figure 17: Distribution and spread of brown trout in the Murray-darling basin pre- and post-1980.²⁰⁷

206. Murray-Darling Basin Authority 2007, 'Factsheet: alien brown trout', Canberra, Australia.
207. Ibid

208. Jackson J, Raadik T, Lintermans M and Hammer M 2004, 'Alien salmonids in Australia: impediments to effective impact management, and future directions', New Zealand Journal of Marine and Freshwater Research, 38, pp. 447-455.

209. Ibid

210. Information supplied by DELWP Biodiversity Division.

Invasive plants and animals

Indicator B:01A European carp

Region Statewide	Indicator Performance:	2018 Status	2018 Trend	2018 Data
Measures Abundance and distribution	2018:  2021: 			
Data Custodian DELWP; Catchment management authorities	Why this indicator? Carp are considered pests because they can dominate aquatic environments to the detriment of native fish species and other parts of the freshwater ecosystem.	2021 Status	2021 Trend	2021 Data
				

Potential thresholds for status in the SoE 2023 report

Good: Distribution and abundance of the population declining significantly (>75%)

Fair: Distribution and abundance of the population declining (>50 to <75%)

Poor: Distribution and abundance of the population declining by <50%

OR

Good: carp density <20kg/ha*

Fair: carp density 20-80kg/ha

Poor: carp density > 80kg/ha

*Ecosystem decline occurs where kg/ha between 80 and 100kg, according to Stuart et al. (2019).

Why this assessment in 2021?

Status: Considerable carp research has been delivered under the National Carp Control Program and reaffirms the SoE 2018 status.

Trend: Carp are continuing to increase in abundance and range and the Trend for environmental condition continues to deteriorate.

Data Confidence: The National Carp Control Plan has further added to the available data of a very well-researched invasive species.

Should this indicator be used in the SoE 2023 report?

Yes, however it should be broadened to include other invasive fish species such as trout.

Summary of SoE 2018 Report assessment

- European carp are prolific in waterways across south-eastern Australia and impact native fish and aquatic habitats.
- In 2016, the Commonwealth Government initiated the National Carp Control Plan to estimate carp numbers and inform decisions on the release of a carp biocontrol agent, cyprinid herpesvirus 3, and the subsequent carp cleanup.

The 2019–20 bushfires: Impacts and responses

Carp deaths in fire-affected areas were reported by Silva et al. (2020),²¹¹ McInerney et al. (2020), in the Murray River at Burrowye Reserve in Victoria²¹² and by Thompson (2020) in the Murray at Thologolong, where a local farmer estimated there were 30 dead carp for every dead Murray cod.

SoE Biodiversity Update 2021 Report assessment

European carp were introduced into Australia in the 19th century, however they did not become widespread until the Murray-Darling Basin floods of the 1970s. They now constitute up to 90% of fish biomass²¹⁴ at some sites and continue to expand their range²¹⁵ – between 2004 and 2014 carp numbers tripled.²¹⁶

211. Silva L, Doyle K, Duffy D, Humphries P et al. 2020, 'Mortality events resulting from Australia's catastrophic fires threaten aquatic biota', *Global Change Biology*, 26(10), pp. 5345–5350.

212. McInerney P, Kumar A, Rees G, Joehnk K et al. 2020, 'How bushfires and rain turned our waterways into "cake mix", and what we can do about it', *The Conversation*, 14 September 2020.

213. Thomson B 2020, '40kg Murray cod among thousands of fish killed in Upper Murray', *Canberra Times*, 24 January 2020.

214. Stuart I, Fanson B, Lyon J, Stocks J et al. 2019, 'A national estimate of carp biomass for Australia', unpublished client report by Arthur Rylah Institute, Heidelberg, Victoria.

215. DELWP 2021, 'Impacts of carp in wetlands', East Melbourne, Victoria.

216. National carp control plan <https://carp.gov.au> Accessed 8 May 2021.

Invasive plants and animals

Their impacts include:

- uprooting and eating aquatic plants, which increases turbidity and reduces light in the water column
- increasing nutrients by excretion, which can lead to phytoplankton growth (algal blooms)
- preying on zooplankton and benthic invertebrates, native fish and their eggs and larvae, and frog eggs and tadpoles e.g. spotted tree frog
- competing for space and food e.g. with waterbirds who feed on plants and invertebrates.

In 2016, the Australian Government initiated the National Carp Control Plan to support research into potential control actions, with the focus on the feasibility of releasing a carp herpes virus. The research delivered under the plan has been wide-ranging, including ecological and social risk assessments on the release of the virus, assessment of its potential impacts on Matters of National Environmental Significance²¹⁷ and issues associated with the clean-up of vast amounts of dead carp should the virus be released. The assessments identified the impacts that the death and decay of large numbers of carp could cause, including:

- reduced levels of dissolved oxygen and water quality
- increased risk of algal blooms
- loss of a food source for waterbirds
- increased numbers of other introduced fish such as goldfish, redfin and mosquito fish
- botulism outbreaks affecting native fauna.

The rapid removal of carp carcasses could minimise these risks, along with carefully timed water releases. However, carp removal could be difficult in isolated and sparsely populated areas, especially where waterways become disconnected in dry periods.

In other research for the National Carp Control Plan, Stuart et al. (2021) estimated that carp occupied an area of 17,264 km² of aquatic habitat – '2,502 km² of wetted surface area of rivers, 120 km² of wetted surface area within irrigation channels, and 14,642 km² of standing waterbody and wetland habitat' – and were found in 33 of 191 of Australia's major river drainages.²¹⁹ Carp densities were as high as 826 kg/ha, while some coastal rivers had relatively low densities e.g. Glenelg at 42 kg/ha. However, the density threshold for ecological impacts of 80-100kg/ha was exceeded in 54% of wetland area, 70% of stream area for all rivers and 97% of stream area in large lowland rivers. The total biomass for south-eastern Australia was estimated at 205,774 tonnes in a dry scenario, while in a wet scenario, the estimate was 368,357 tonnes.

Figure 18 maps carp densities in Victoria's rivers and waterbodies estimated by Stuart et al. (2021). It shows the highest carp densities along the Murray River, in the east of the state although carp are absent in Gippsland east of the Snowy River, and in some rivers of south-western Victoria.

Nichols et al. (2019) surveyed²²⁰ and held workshops with experts to determine expectations on the likely outcomes of various carp control scenarios. For the 'do-nothing scenario', the experts expected the environment to continue its decline. They also believed that to achieve an outcome of at least 30-70% environmental improvement would require a greater than 70% reduction in carp numbers. Any sustained ecological recovery would also require the mitigation of other ecological stressors.

A synthesis of the research conducted for the National Carp Control Plan, and prepared by the Fisheries Research and Development Corporation, was scheduled for completion by mid-2021. However, it has been delayed due to COVID-19 and the wait for the results from further research being conducted by CSIRO and due by the end of 2021.²²¹ When completed, the Fisheries Research and Development Corporation review will inform the preparation of a new plan to be shared with all Australian governments for their consideration before a decision is made on whether to release the virus.²²²

217. Beckett S, Caley P, Hill M, Nelson S et al. 2019, 'Biocontrol of European carp: ecological risk assessment for the release of Cyprinid herpesvirus 2 (CyHV-3) for carp biocontrol in Australia', report for the National Carp Control Plan (Fisheries Research and Development Corporation, Canberra, vols 1 and 2.

219. Ibid

220. Nichols S, Gawne B, Richards R, Lintermans M et al. 2019, 'NCCP: The likely medium- to long-term ecological outcomes of major carp population reductions, final report', FRDC Project No 2017-104, FRDC, Canberra.

221. Murphy J 2021, 'Carp herpes virus plan not dead in the water despite unanswered question', *FarmOnline National*, 21 April 2021.

222. Department of Agriculture, Water and the Environment, 'National carp control plan', Canberra, Australia <https://www.agriculture.gov.au/pests-diseases-weeds/pest-animals-and-weeds/national-carp-control-plan> Accessed 6 June 2021.

Invasive plants and animals

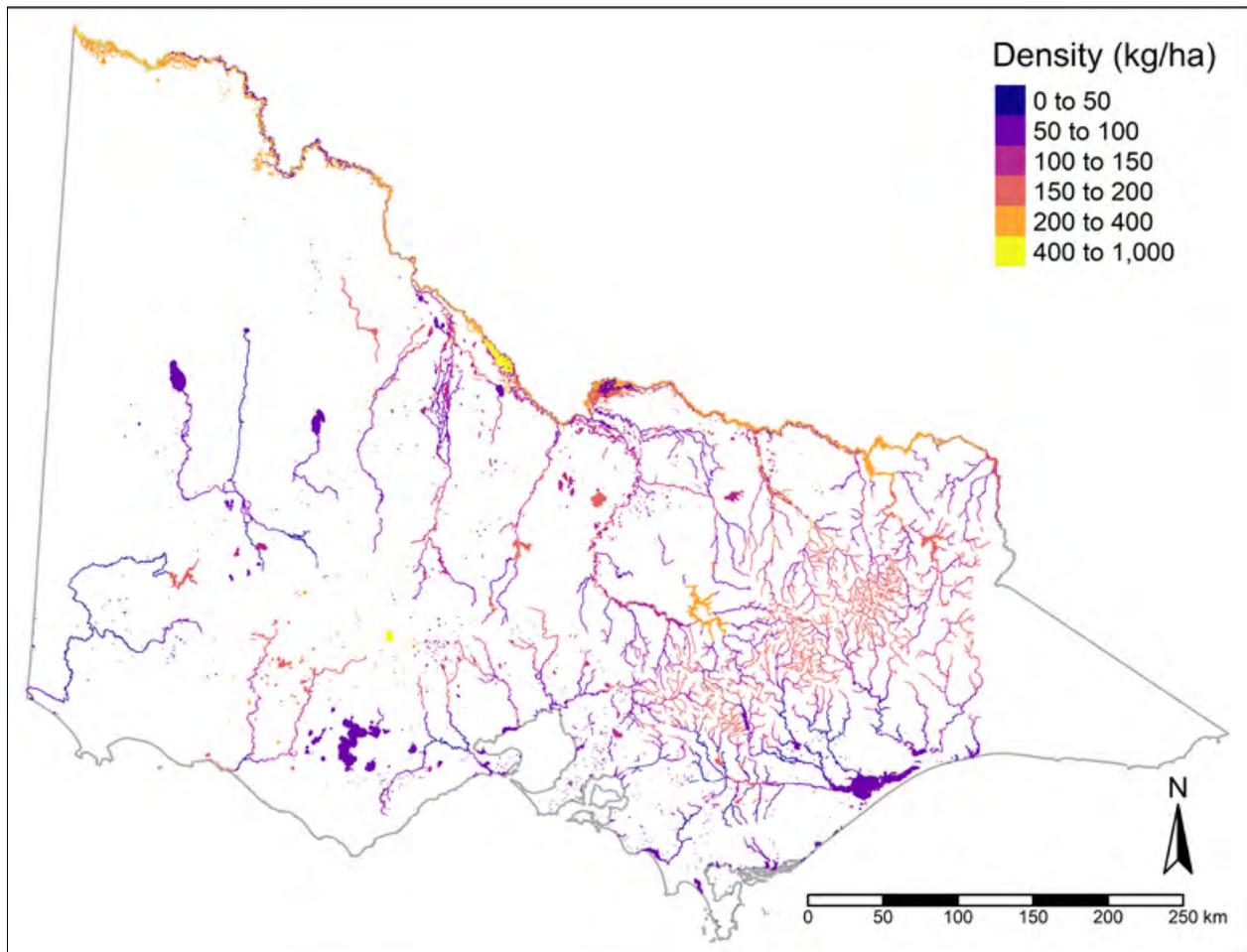


Figure 18: Modelled estimates of carp biomass density (kg/ha) in Victoria.²¹⁸

Boutier et al. (2019) argue that the risks from the release of the herpes virus, including the potential infection of other native fish species, are too high.²²³ Their review of research suggested that wild carp could have a natural resistance to the virus, which loses its efficacy below 14°C and above 28°C. Such temperature variations can exist in Australian freshwater environments. According to the researchers, carp show no signs of the disease below 14°C, while at high temperatures the virus is unable to replicate. They also noted that the assessment of the virus had been in the controlled conditions of aquaculture, not in wild populations where genetic diversity is greater, densities highly variable and environments diverse.

Attempts at carp control in the past have included poisoning, explosives, traps, stunning with electricity, exclusion and commercial and recreational fishing, but with little effect. Carp control is now undertaken at a local scale, guided by local plans and strategies and using methods such as commercial fishing, recreational fishing 'carp out' events, wetland screening and trapping. For example, the Arthur Rylah Institute and the local Wangaratta Sustainability Network partnered to remove 6,000–7,000 kilograms of carp from 30–40 kilometres of the Ovens River.²²⁴ Combined with improving habitat and increased flows, the removal of carp aimed to improve conditions for Murray cod, trout cod and translocated Macquarie perch.

218. Stuart I, Fanson B, Lyon J, Stocks J et al. 2021, 'Continental threat: how many common carp (*Cyprinus carpio*) are there in Australia?', *Biological Conservation*, 254, 108942.

223. Boutier M, Donohoe O, Kopf R, Humphries P et al. 2019, 'Biocontrol of carp: the Australian plan does not stand up to a rational analysis of safety and efficacy', *Frontiers in Microbiology*, 10, Article 882.

224. Arthur Rylah Institute, 'Removing carp from the Ovens River' <https://www.youtube.com/watch?v=hK7pJJSC4xU>

Invasive plants and animals

Genetic manipulation of carp is also being investigated, however it could take a century to bring carp numbers down to acceptable levels.²²⁵ The Williams cage²²⁶ is another method that could be used in the future. In an 11-year trial at a lock in South Australia, 723 tonnes of carp (~289,431 fish) at up to 5 tonnes per day were captured, leading to a significant reduction in numbers in the lower Murray River.

Carp are believed to have arrived in the Glenelg River in south-west Victoria around 2001. The Glenelg Hopkins CMA has worked with the South Australian Research and Development Institute to monitor and control carp in south-western Victoria. The partners developed a carp-tracking system that 'takes advantage of the congregating habits of the carp and utilizes a "Judas" fish – a tagged fish that provides information on the patterns and distributions of large carp groups – allowing more effective targeting and eradications.'²²⁷ The research program estimated carp densities at 16 sites to be <50 kg/ha and four to be >50 kg/ha, the density above which ecosystem impacts would occur.²²⁸

The number of carp in the Glenelg River was estimated to be between 4,019 and 17,707. The most efficient control method was found to be electrofishing. Nets were far less efficient, apparently being avoided by carp and creating a potential risk for platypus and other native fauna. Electrofishing and other control measures such as the carp screen at the Rocklands Reservoir, which prevents carp and their eggs from entering the Glenelg River, will be used to keep carp densities below 50 kg/ha.

Lieschke, Fanson and Pickworth (2020) investigated the movement of carp during an environmental water release in the Gunbower Creek.²²⁹ They found that carp had a strong homing behaviour. Carp that were already on the floodplain, or had followed the flow of environmental water as connectivity improved, eventually returned to their refuge pool in the Little Gunbower Creek Regulator. The primary recommendation of the scientists was that options to remove carp from the refuge pool be investigated.

225. National carp control plan <https://carp.gov.au> Accessed 8 May 2021.

226. Stuart I and Conallin A 2018, 'Control of globally invasive common carp: an 11-year commercial trial of the Williams' Cage', *North American Journal of Fisheries Management*, 38, pp. 1160–1169.

227. Glenelg Hopkins Catchment Management Authority 2018, 'Case study: carp monitoring and control program', in 'Glenelg Hopkins CMA 2015-18 Projects', Glenelg Hopkins Catchment Management Authority, Hamilton, Victoria.

228. Thwaites L, Fredberg J and Ryan S 2016, 'Understanding and managing common carp (*Cyprinus carpio*) in the Glenelg River, Victoria, Australia', final report to the Glenelg Hopkins Catchment Management Authority, SARDI publication no. F2012/000122-4, SARDI research report series 915, South Australian Research and Development Institute (Aquatic Sciences), Adelaide, South Australia.

229. Lieschke J, Fanson B and Pickworth A 2020, 'Carp movements during a managed inundation – Little Gunbower Creek case study', unpublished client report for the North Central Catchment Management Authority 2020, Arthur Rylah Institute, Heidelberg, Victoria.

Invasive plants and animals

Indicator B:02 Invasive terrestrial plant species

Region Statewide	Indicator Performance:	2018 Status	2018 Trend	2018 Data
Measures Number, abundance and distribution	2018:			
Data Custodian DELWP; DJPR	2021: Unable to be assessed due to Moderate Data Confidence	2021 Status	2021 Trend	2021 Data
	Why this indicator? Environmental weeds threaten Australia's biodiversity by displacing native plant species, disrupting ecological processes and altering the genetic composition of native plant populations.			

Potential thresholds for status in the SoE 2023 report

- Good:** Significant reducing trend in the number, abundance and distribution of terrestrial invasive plant species
 - Fair:** Small reducing trend in the number, abundance and distribution of terrestrial invasive plant species
 - Poor:** Significant increasing trend in the number, abundance and distribution of terrestrial invasive plant species
- Need to quantify 'significance'

Why this assessment in 2021?

Status: The Weeds and Pests on Public Land Program is achieving positive outcomes. However, it covers just 10% of the state and not all public land. Its work will need to be well-resourced in the long-term, and broad programs to tackle weeds on private land are needed to influence the Status of this indicator.

Trend: Although there are positive signs in some areas of public land, the action on weeds will need to be long-term and also across private land if the Trend is to be slowed, stabilised and reversed.

Data Confidence: Data on weeds are expanding. The Weeds and Pests on Public Land Program and the river health program's willow control are two significant sources of data. However, there are very limited presence-only records for most weed species and no long-term data sets. There is also a biased distribution of records and effort across land-use types and habitats, and very little data on invasive plants and their management on private land. Landholders have an existing obligation to control weeds under the Catchment and Land Protection Act. However, there are no data available to assess the status of weeds and weed control on private land.

Should this indicator be used in the SoE 2023 report?

Yes, however there is a need for more comprehensive data.

Summary of SoE 2018 Report assessment

- In Victoria there are at least 1,451 naturalised plants, of which 1,235 species are environmental weeds established in native vegetation, almost double the number in 1992.

The 2019–20 bushfires: Impacts and responses

Weeds such as serrated tussock, English broom, gorse and blackberry are early colonisers after fire,²³⁰ outcompeting native species and changing habitats, hydrology and ecosystem functions. After fire, weeds can rapidly germinate from their seed, spread into burnt areas from unburnt areas, and be carried by firefighting vehicles or in runoff after rain.

However, fire can also destroy weeds and allow land managers to focus on weed seedlings that emerge in burnt areas.

Bushcare Mallacoota was confronted with a large-scale outbreak of inkweed after the bushfires that devastated the town in January 2020.²³¹ The invasive plant, a native of South and Central America, had been largely controlled by the group for the previous 15 years. However, a large-scale germination followed the bushfires and the weed spread into bushland, possibly carried by silveryeyes and foxes. Swift action by Bushfire Mallacoota has been effective in managing the seedlings and young plants.

230. Invasive Species Council 2020, 'Bushfire recovery must tackle feral animals and weeds' <https://invasives.org.au/blog/bushfire-recovery-feral-weeds-threat/>. Accessed 10 May 2021.

231. Kohout M, Coupar P and Elliott M 2020, 'Battling and aggressive pioneer after fire: *Phytolacca octandra* (Inkeed)', Arthur Rylah Institute, Heidelberg, Victoria

Invasive plants and animals

In a draft report²³² on the impact of the 2019–20 bushfires on threatened flora species, prepared by scientists at the Arthur Rylah Institute and the Royal Botanic Gardens Victoria, weeds were found to be absent or in low abundance at most sites studied. Moderate weed abundance was found at five sites, including those for the Genoa River correa (*Correa lawrenceana* var. *genoensis*) and the black stem fern (*Adiantum formosum*). Blackberries were observed across the fire area, especially on damp vegetation types, and could in the future present problems by smothering vegetation. The scientists also observed eucalypt seedlings in rainforest vegetation, which could transform the over-storey structure of the vegetation, as had occurred after fires in 2003 (Jones Creek, East Gippsland) and 2009 (O'Shannassy Catchment, Central Highlands).

Theme 4 of Victoria's bushfire response and recovery projects, 'Intensified and sustained management of threats', is targeting weed control. The Weeds at the Early Stage of Invasion project coordinated a series of four webinars about environmental weed management after the 2019–20 bushfires fire. Presentations were given by various presenters from government agencies, community organisations and scientists and included:

- Weed-control strategies used by the Australian Association of Bush Regenerators. As fire flushes out the weed seedbanks, the Association's focus is to ensure weed growth does not suppress the regeneration of native species. Habitat elements such as woody debris and bird perches are also used to attract native fauna, along with creating disturbances that native animals are adapted to, such as low-intensity fire in sclerophyll forests and flooding and drying cycles in wetlands.²³³
- Landscape weed management projects that focused on detection and removal of high-risk weeds e.g. Montpellier broom, flax-leaf broom and spanish heath that threatened biodiversity in the Central Highlands Eden project. A triage decision key was used by the project to prioritise post-fire weeds. Good communications, collaboration, training in weed identification and the use of available expertise were seen as key to the success of the project.

- Development of a vegetation priority matrix by DELWP's Hume Region staff to tackle weeds in remote mountainous country in the Ovens and Upper Murray area burnt by the 2019–20 bushfires. The matrix parameters were boundary of assessment, pathway of spread and impact on biodiversity. The matrix was mapped, along with areas of potential weed impacts to prioritise areas for management of targeted weeds: blackberry, cape broom and willow.

SoE Biodiversity Update 2021 Report assessment

Driscoll (2020) reported that fire kills some weeds but also stimulates their seed banks to germinate²³⁴ and grow into seedlings. He argues that the seedlings should be removed before they have the chance to seed and gives the example of scotch broom in Victoria's high country: 'Mass germination reduces the broom's seedbank to as low as 8% of pre-fire levels, and around half of the remaining seeds die each year. Further, broom usually takes three years to flower and replenish its seedbank, so with no new seeds being produced and the seedbank low and shrinking, this three-year window offers an important opportunity to restore previously infested areas.'

However, Parks Victoria has found that where native vegetation has been removed by fire, weeds may be the only breeding and foraging habitat remaining for threatened species, including frogs.²³⁵ Capon and Palmer (2020) argue that some environmental weeds support a range of critical ecological functions by providing food and shelter, protecting soils, slowing runoff and trapping debris after rains.²³⁶ They also report that there is little evidence 'regarding the effectiveness of most weed control methods over the longer-term. Many weeds can quickly re-establish from soil seed banks, suckers or plant fragments dispersed by wind, water or birds. We also know very little about how weed control methods themselves might affect ecological processes through soil disturbance and herbicides.'

233. McDonald T 2020, 'Prioritising for native regeneration...with weed control per se a lesser goal', presentation at a Weed management after fire: supporting native species recovery webinar, Weeds at the Early Stage of Invasion (WESI) project, DELWP, East Melbourne, Victoria.

234. Driscoll D 2020, 'Pulling out weeds is the best thing you can do to help nature recover from the fires', *The Conversation*, 28 January 2020.

235. Primrose K 2020, 'Collaborating after fire', presentation at the 'Weed management after fire: supporting native species recovery' webinar, 9 December 2020, Weeds at the Early Stage of Invasion (WESI) Project, DELWP, East Melbourne, Victoria.

232. Draft in preparation provided by the Arthur Rylah Institute.

Invasive plants and animals

They conclude by saying that: 'Obviously, not all weeds should be retained. Non-native species can and do have negative effects. However, we now face an opportunity to embark on a more nuanced and open approach to conservation and restoration.'

DELWP's Weeds and Pests on Public Land program delivers 10 landscape-scale targeted pest and weed management projects across 10% of Victoria. Eden projects target weeds and Ark projects target pest predators, herbivores and some weeds (see Figure 19 for project locations). The program aims to support the objectives of Biodiversity 2037 by reducing threats from invasive species and aiding the recovery of threatened species. There are four streams within the program: predator control; weed control; herbivore control; capability building. The two streams relevant to this indicator are:

Weed control: Eden projects detect and control high-risk weed species threatening biodiversity values

Capability building: The Weeds at the Early Stages of Invasion project builds the capability of land managers to respond to early invader weeds.²³⁷ It has developed a six-step decision making framework to deal with weeds at the early state of their invasion: 1. search and detect; 2. name and notify; 3. assess the risk; 4. delimit the invasion; 5. decide the response; 6. implement eradication (if feasible).²³⁸

The Eden projects target high-risk weed species in native vegetation that include English broom, gorse, Montpellier broom, tutsan, sallow wattle, coast tea tree, blue bell creeper, sweet pittosporum and boneseed. Their aim is to support the recovery of threatened ecological communities, along with plants that include the metallic sun-orchid, leafy greenhood, Anglesea grevillea, spiral sun-orchid and Angahook pink fingers.

Some of the achievements of the Eden projects²³⁹ in 2018–19 were:

- Central Highlands Eden: released tutsan rust (biological weed control); weed coverage in treated areas reduced by 30%; 300% increase in rare or threatened flora species recorded in monitoring plots
- Otway Eden: targeted 47 weed species across 130 sites; increase in richness of indigenous flora present
- Glenelg Eden: treated 98% of new and emerging weed infestations; weed cover reduced by 27 hectares.

In 2018–19 and 2019–20, Parks Victoria targeted weeds across 177,429 hectares and 253,030 hectares respectively in its management regions. A significant increase in coverage occurred in eastern Victoria (from 44,659 hectares to 116,886 hectares) and northern Victoria (from 47,839 hectares to 101,164 hectares) between 2018–19 and 2019–20 in response to concerns that weeds could flourish after the bushfires.

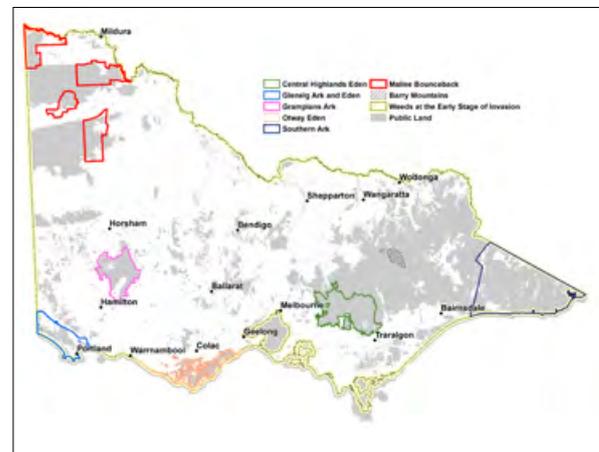


Figure 19: Weeds and Pests on Public Land program Eden and Ark project sites.²⁴⁰

236. Capon S and Palmer G 2020, 'Not all weeds are villains. After a fire, some plants – even weeds – can be better than none', *The Conversation*, 5 February 2020.

236. DELWP, 'Weeds and pests on public land program', East Melbourne, Victoria <https://www.environment.vic.gov.au/invasive-plants-and-animals/invasive-species-on-public-land/weeds-and-pests-on-public-land-program> Accessed 10 May 2021.

236. DELWP 2018, 'Looking for weeds: search and detect guide, a guide for searching and detecting weeds at the early stage of invasion on public land in Victoria', East Melbourne, Victoria.

236. DELWP 2019, 'Weeds and pests on public land: program activities and achievements 2018–19', Infographic, East Melbourne, Victoria.

236. DELWP 2019, 'Weeds and pests on public land annual report 2018–19', East Melbourne, Victoria.

Invasive plants and animals

Indicator B:03 Invasive terrestrial animal species

Region Statewide Measures Number, abundance and distribution Data Custodian DELWP; DJPR; Parks Victoria	Indicator Performance: 2018 & 2021: Unable to be assessed due to due to Low Data Confidence Why this indicator? Established terrestrial pest animals in Victoria are major threats to the state's biodiversity.	2018 Status	2018 Trend	2018 Data
		2021 Status	2021 Trend	2021 Data

Potential thresholds for status in the SoE 2023 report

Good: Significant reducing trend in the number, abundance and distribution of invasive terrestrial animal species

Fair: Small reducing trend in the number, abundance and distribution of invasive terrestrial animal species

Poor: Significant increasing trend in the number, abundance and distribution of invasive terrestrial animal species

Need to quantify 'significance'

Why this assessment in 2021?

Status: The impact of invasive terrestrial animals on environmental condition remains severe.

Trend: Although there are significant localised control of invasive animals, there is no evidence to suggest that the Trend is being slowed or reversed.

Data Confidence: Long-term data on invasive terrestrial animals is severely limited and statewide pest animal population numbers in Victoria are currently unknown.

Should this indicator be used in the SoE 2023 report?

Yes, but consideration could be given to splitting the indicator into separate ones for pest herbivores and predators and merge the herbivore indicator with those for feral deer and feral horses.

Summary of SoE 2018 Report assessment

- Invasive terrestrial animals originate from overseas and have established long-term, self-sustaining populations. They include foxes, rabbits, feral pigs, feral goats, feral horses, deer and feral cats.
- Population numbers of invasive animals were unknown, however it was thought that their numbers and distribution were expanding.
- A parliamentary inquiry had found that Victoria's complex legislative framework and division of responsibilities had contributed to confusion and inefficiencies in controlling invasive animals.
- The inquiry made 33 recommendations, 29 of which were accepted by the Victorian Government.

The 2019–20 bushfires: Impacts and responses

Feral predators such as foxes and cats can more easily find their native prey in areas where fires have removed the cover of vegetation. Threatened native animals that are vulnerable to fox and cat predation include the long-footed potoroo, brush-tailed rock wallaby and long-nosed potoroo.

Theme 4 of Victoria's biodiversity response and recovery projects, 'Intensified and sustained management of threats', targets invasive terrestrial animals. In the first round of funding, \$7 million were allocated to the aerial shooting of introduced pest animals on public land, targeted ground control of introduced pest animals and targeted weed control.

Invasive plants and animals

In a May 2021 update²⁴¹ of the Bushfire Biodiversity Response and Recovery program, DELWP reported that:

- 1,100 feral animals were controlled at Budj Bim Cultural Landscape in April and May of 2021
- more than 450,000 hectares of herbivore control and 130,000 hectares of predator control had been achieved, representing 100% of the program's target
- 15,000 hectares of weed control, which was 50% of the program's target. The target is expected to be met in 2021–22.

The Ewing Morass Wildlife Reserve east of Bairnsdale was unburnt by the 2019–20 bushfires and has become a refuge for threatened frogs that include the Martin's toadlet, green and golden bell frog, leaf green tree frog, growling grass frog and blue mountain tree frog. However, the reserve is also being targeted by feral pigs, which have been looking for food in unburnt areas.²⁴² The pigs dig up plants, reduce water quality and prey on small mammals, reptiles and frogs. In response, the Victorian Government included the reserve in its pig-baiting and trapping as part of the bushfire biodiversity response program.

The Pheasant Creek Flora and Fauna Reserve is home to the Critically Endangered Shelley leek orchid and 40 other threatened species and was burnt in the 2019–20 bushfires. In response, Parks Victoria, DELWP and other agencies conducted integrated weed and herbivore control, including the construction of a five-hectare deer exclusion fence that native fauna can still move through.²⁴³

The Southern Ark project was established in 2004 in East Gippsland as part of the Weeds and Pests on Public Land Program. The 2019–20 bushfires affected much of the project's footprint. Additional bait stations were installed when re-establishing the project's landscape-scale fox control program within the fire extent and inside key refuges. This required rebuilding most of the 3,500 baiting stations destroyed by the fires, as well as replacing camera monitoring sites. The monitoring has demonstrated the resilience of the long-footed potoroo, the species of most interest to Southern Ark, as well as the effectiveness of landscape-scale predator control.

DELWP and Parks Victoria began an 11-week post-fire aerial and ground shooting operation between 10 February 2020 and 8 May 2020 in national parks and State Forests in eastern Victoria. The operation targeted foxes, feral cats, deer, goats and feral pigs. With less shelter, native animals are far more vulnerable to predation in burnt areas where cat numbers can increase five times the normal number.²⁴⁴ Feral herbivores graze and trample vegetation, wallow in waterways, spread weeds and make it harder for native plants to regrow after fire.

Table 20 (on the next page) summarises the regional location and the area in hectares for Parks Victoria's management of feral pest animals. Eastern and western Victoria are the focus of deer and fox control actions, northern Victoria for rabbits, and eastern, northern and western Victoria for pigs. Significant increases occurred in hectare coverage for deer, pig and goat management in 2019–20 in response to the increased vulnerability of native species after the bushfires.

Deakin University is currently delivering a federally funded bushfire recovery project across the Australian Alps, East Gippsland and south-east NSW that is investigating the impacts of severe and extensive fire and interactions with feral herbivores. It is focussed on reptiles and the broad-toothed rat and will examine how fire and large feral herbivores impact on these populations and inform whether translocations and/or feral animal management is needed.

241. DELWP 2021, 'Bushfire biodiversity response and recovery update May 2021', PowerPoint presentation.

242. Perkins M 2021, 'Feral species move on unburnt "refuges" after fires', *The Age* 25 April 2021.

243. Primrose K 2020, 'Collaborating after fire', presentation at the 'Weed management after fire: supporting native species recovery' webinar, 9 December 2020, Weeds at the Early Stage of Invasion (WESI) Project, DELWP, East Melbourne, Victoria.

244. DELWP 2020, 'Bushfire response operation gives native species best chance of survival', 11 February 2020, East Melbourne, Victoria.

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Table 20: Regional and area coverage (ha) of Parks Victoria management actions targeting feral pest animals.²⁴⁵

Animal	Eastern Victoria	Melbourne Marine and Maritime	Metropolitan Parks	Northern Victoria	Western Victoria	Total
Cat						
2019-20	10,085		323	13,678		14,716
Cattle						
2018-19	1535					1535
2019-20	14,629					14,629
Deer						
2018-19	114,379				42,103	156,482
2019-20	297,977			1623	74,067	373,667
European Rabbit						
2018-19		7	282	199,669	3872	203,831
2019-20	280	68	1625	204,400	5001	211,373
Goat						
2018-19	182				41,766	41,498
2019-20	5456		2	182,965	8843	197,266
Horse						
2018-19	29,926			9437		39,363
2019-20	3295					3295
Pig						
2018-19	6083	13	627	3423	346	10,491
2019-20	86,189			113,745	28,676	228,610
Red fox						
2018-19	53,337	284	6707	3268	333,619	397,255
2019-20	395,878	70	4024	74,992	230,859	705,823
Red fox (Southern Ark)						
2018-19	288,125					288,125

245. Data supplied by Parks Victoria.

Invasive plants and animals

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The Victorian Parliament's Environment, Natural Resources and Regional Development Committee released the report of its Inquiry into the control of invasive animals on Crown land in 2017. It found that although there were no accurate population numbers for invasive species in Victoria, the number of feral deer, cats, foxes, horses, rabbits, goats, pigs and dogs had increased over recent decades.²⁴⁶ They prey on native animals, compete for food and degrade habitat.

Kennedy and Ferns (2015) developed predation vulnerability ratings – High, Moderate, Low, Negligible and Not Applicable – for the impacts of cats and foxes on Victoria's mainland native vertebrate fauna. Applying the rating system to 893 native species, the authors found that 26% of the species (232) were scored a 'High' rating, including 30 wetland bird species, 27 wader/coastal species, 12 amphibians, seven mammals and two reptiles.²⁴⁷

Other research has shown that foxes are responsible for 93% of nest predation of the Murray River tortoise,²⁴⁸ and spread blackberries and other weeds. Phillip Island was declared fox-free in 2017, followed by the release of the Critically Endangered eastern barred bandicoot. Foxes have also been removed from French Island, where a program to remove cats is now underway.²⁴⁹

One of the issues for land managers in eastern Victoria has been ensuring that their fox-baiting program does not interfere with an expansion of recreational deer hunting. Deer hunters stalk deer there using bloodhounds and beagles that could be at risk of poisoning from the baits. After negotiations with Sporting Shooters Australia, the fox baits are now used outside the hunting season, which runs from 1 March to 30 November, and a new poison PAPP (para-aminopropiophenone) is buried 15 centimetres below the soil surface. Foxes dig up the bait, whereas the dogs do not, and PAPP only kills animals from five to seven kilograms in weight (hunting dogs weigh 15 kilograms and more).²⁵⁰

Legge et al. (2021) reported that each year across Australia, cats kill 1.7 billion native animals. They are a major cause of the extinction of 34 mammal species, and threaten the extinction of another 120 species.²⁵¹ Pet cats are found in far greater densities around towns than feral cats in the bush: one feral cat per km² compared to 40–70 pet cats per km². The result is that pet cats kill 30–50 times more animals per km² than feral cats in the bush – in total 83 million native reptiles and 80 million native birds each year.²⁵²

Woinarski et al. (2020) reviewed data in 53 feral cat dietary studies and estimated that the annual per capita consumption of frogs by feral cats in wild environments was 44, with a total consumption of 92 million frogs. Pet cats were estimated to take a total of one million frogs each year.²⁵³

Since 2018, Parks Victoria has been working with the Moogji Aboriginal Council to remove feral pigs from the Snowy River National Park and Eastern Alps. Feral pigs damage native vegetation, waterways and impact water quality, spread weeds and prey on frogs, fish, birds and small mammals (in farming areas they can also destroy crops and pastures and prey on lambs). Around 20% of the conservation project area was burnt in the 2019–20 bushfires, and pigs have now been observed further south, having likely moved along the burnt corridor of the Snowy River towards Buchan and Orbost.²⁵⁴

A project to construct a 10-kilometre predator-proof fence across Yanakie Isthmus in the Wilsons Promontory National Park is in the planning stage. The fence will exclude foxes, deer and cats and support the re-establishment of native fauna, flora and habitats by creating a 50,000-hectare wildlife haven. An enclosure is already in place for bandicoots at Woodlands Homestead near Melbourne Airport.²⁵⁵

245. Data supplied by Parks Victoria.

246. Environment, Natural Resources and Regional Development Committee 2017, 'Inquiry into the control of invasive animals on Crown land', Parliament of Victoria, Melbourne, Victoria.

247. Kennedy S and Ferns L 2015, 'Predation vulnerability ratings (PVR) for Victoria's mainland vertebrate fauna, version 1: September 2015', unpublished report, East Melbourne, Victoria.

248. Robley A, Howard K, Lindeman M, Cameron R et al. 2016, 'The effectiveness of short-term fox control in protecting a seasonally vulnerable species, the eastern long-necked turtle (*Chelodina longicollis*)', *Natural Sciences*, 17(1), pp. 63–69.

249. DELWP 2020, 'Submission to the Legislative Council Environment and Planning Committee Inquiry into Ecosystem Decline in Victoria', Parliament of Victoria, Melbourne, Victoria.

250. Information from managers at the Southern Ark project.

251. Legge S, Dickman C, Dielenberg J, Woinarski J et al. 2021, 'Australia must control its killer cat problem. A major new report explains how, but doesn't go far enough', *The Conversation*, 10 February 2021.

252. Ibid

253. Woinarski J, Legge S, Woolley L, Palmer R et al. 2020, 'Predation by introduced cats *Felis catus* on Australian frogs: compilation of species records and estimation of numbers killed', *Wildlife Research* 47(8).

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The expansion of havens free of introduced predators is supported by Legge et al. (2021), although they note that havens currently cover just 1% of Australia. They argue that 'in many parts of Australia, broad-scale habitat management is a more cost-effective way to reduce cat harm. This involves making habitat less suitable for cats and more suitable for native wildlife, for example, by reducing rabbit numbers, fire frequency and grazing by feral herbivores such as cattle and horses.'²⁵⁴ By reducing the number of rabbits, a favoured food source for feral cats, and by restoring vegetation, which makes it harder to find prey, cat numbers decline.

Rabbits, foxes, cats and sambar deer are the subject of potentially threatening processes under the *Flora and Fauna Guarantee Act 1988* and each has an action statement (although they require updating) to deal with the threats they pose for native species. Although other mainland states have designated all deer species as pest species, Victoria has not, nor has it listed deer as invasive species.

DELWP's Weeds and Pests on Public Land program delivers 10 landscape-scale targeted pest and weed management projects across 10% of Victoria. It aims to support the objectives of Biodiversity 2037 by reducing threats from invasive species and aiding the recovery of threatened species. In 2018–19, the program had 27 delivery partners and engaged with four Traditional Owner groups.

In 2018-19 Since their establishment, Ark projects (see Figure 19 for the location of all projects) completed 1,415,000 hectares of predator control and 335,000 hectares of herbivore pest control.²⁵⁷ The projects tackle the red fox to support the recovery of the long-footed potoroo, southern brown bandicoot, long-footed potoroo, brush-tailed rock wallaby, long-nosed bandicoot, spotted-tailed quoll, heath mouse, mountain brushtail possum and common brushtail possum.

Some of the achievements²⁵⁸ in 2018–19 were:

- **Mallee Bounceback** - reduced rabbit numbers to less than one rabbit per km² across 96% of the project area and 63,252 hectares of warrens targeted. This will help protect and restore the biodiversity of semi-arid, non-Eucalypt woodlands
- **Grampians Ark** - smoky mice detected at two new sites in the Mount William Range; 91% of targeted private land baited
- **Barry Mountains** - 10 fox bait runs at over 150 bait station locations; recovery of long-footed potoroo
- **Southern Ark** - 100 students trained in wildlife trapping and handling at Cape Conran; 104% increase in statewide suitable habitat for the long-nosed potoroo
- **Glenelg Ark** - long-nosed potoroos found at 67% more sites in fox control areas; 180,000 images captured on 240 cameras.

By improving pest predator and herbivore management through research and monitoring, DELWP reports that there are positive indications of threatened native species recovery in the Ark project areas. In one example, the Foxnet model has shown a 65% reduction in fox density.

Case study: Over-abundant native fauna

In certain circumstances, native species can become over abundant and impact threatened species, degrade habitat and create issues for land management.

Parks Victoria has a management program to control koala numbers on French Island National Park, Snake Island, Raymond Island and Budj Bim National Park. Koalas were introduced to each of these areas: in 1898 on French Island, in 1945 on Snake Island, in 1953 on Raymond Island and in 1973 at Budj Bim.²⁵⁹ Outbreaks have occurred at various times since. Koala numbers are managed to prevent the overgrazing and loss of manna gums and the subsequent starvation of the animals. Fertility control, relocation and tree protection are used to maintain sustainable koala numbers.²⁶⁰ A number of koalas were killed and 50% of their habitat burnt by the 2019–20 Bushfires in Budj Bim.

254. Parks Victoria 2020, 'Partnership project protects parks from pigs', Melbourne, Victoria <https://www.parks.vic.gov.au/news/2020/09/25/02/37/partnership-project-protects-parks-from-pigs> Accessed 10 May 2021.

255. Information supplied by Parks Victoria.

256. Legge S, Dickman C, Dielenberg J, Woinarski J et al 2021, 'Australia must control its killer cat problem. A major new report explains how, but doesn't go far enough', *The Conversation*, 10 February 2021.

257. DELWP, 'Weeds and pests on public land program', East Melbourne, Victoria <https://www.environment.vic.gov.au/invasive-plants-and-animals/invasive-species-on-public-land/weeds-and-pests-on-public-land-program> Accessed 31 July 2021.

258. DELWP 2019, 'Weeds and pests on public land program: program activities and achievements 2018–19', Infographic, East Melbourne, Victoria.

259. Whisson D and Ashman K 2020, 'When an iconic native animal is overabundant: the koala in southern Australia', *Conservation Science and Practice*, 2(5).

260. Parks Victoria, 'Overabundant native animals', Melbourne, Victoria <https://www.parks.vic.gov.au/get-into-nature/conservation-and-science/conserving-our-parks/overabundant-native-animals> Accessed 10 May 2021.

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National estimates put the number of koalas impacted by the 2019–20 Bushfires at more than 60,000 nationally, including 11,000 in Victoria.²⁶¹ This was at a time when koala populations were already in decline due to habitat loss and fragmentation, disease and low genetic diversity.²⁶²

Whisson and Ashman (2020) argue that a koala conservation management strategy 'must not just focus on issues of overabundance but aim to address the diversity of issues that impact on koala conservation, and to improve our understanding of the ecology of the species in its southern range' ... and ... 'An improved understanding of koala distribution, abundance and population fluctuations, current and future threats, population health and genetic diversity, and gene flow between populations is needed to inform effective conservation actions. Furthermore, management should be considered at the landscape-scale and include both the rehabilitation of degraded habitats, and reforestation to increase habitat area and connectivity.'

Parks Victoria has also targeted over-abundant kangaroos, urchins and galahs in recent years. Galah management actions in northern Victoria covered an area of 944 hectares during 2019–20. Northern Victoria was also a focus for Parks Victoria's kangaroo management program. In 2018–19 the program covered 189,421 hectares, followed by 205,503 hectares in 2019–20.²⁶³

Parks Victoria also manages the number of western grey and red kangaroos in the Mallee national parks where their over-abundance can lead to many of them dying during drought. It can also hinder the restoration of degraded semi-arid ecosystems, such as the Endangered buloke woodlands. A Parks Victoria culling program removed 60,000 kangaroos, 80% of which were the western grey, between 1998 and 2016.²⁶⁴

Populations of eastern grey and western grey kangaroos have increased in Victoria due to the spread of pasture and small dams across the landscape, which provide a steady supply of food and water. Over-abundant kangaroos graze on livestock feed and can cause crop and fence damage, while overgrazing by kangaroos can remove their food supply and expose them to starvation.

Under the Kangaroo Harvesting Program,²⁶⁵ private landowners can allow licensed professional shooters to harvest kangaroos on their land and use the meat for pet food and, from January 2021, for human consumption and the potential sale of skins.²⁶⁶ Although kangaroos can also be culled using an Authority to Control Wildlife, the carcasses cannot be sold.

Caps on the allowable harvest of kangaroos in seven harvest zones are based on the recommendation by the Arthur Rylah Institute that no more than 10% of the population be harvested annually. Ramsey and Scroggie (2021) estimated the statewide population of eastern and western grey kangaroos in 2020 to be 1.9 million, representing an increase of approximately 41% in eastern grey kangaroos and a 12% increase in western grey kangaroos since a 2018 survey.²⁶⁷ As a result, the quota for 2021 was set at 191,200 grey kangaroos, with 95,680 allocated to the harvesting program and 95,520 to the Authority to Control Wildlife system. Kangaroo populations vary across the seven harvest zones, as do the quotas, with more than half of the quota allocated to the Lower Wimmera and Central zones and no commercial harvesting recommended in other zones.

During the 2019–20 bushfires, kangaroo harvesting was suspended across the state. The greatest impacts of the fires on harvesting areas were in the Towong, East Gippsland and Alpine local government areas, where the suspension remained in place for 2020.

DELWP argues that the harvesting program gives landholders no-cost kangaroo control, improves animal welfare through the involvement of professional shooters, and creates less waste as the carcasses can be processed for sale. The Victorian Government views the creation of regional jobs as another benefit.²⁶⁸

261. WWF Australia 2020, 'Impacts of the unprecedented bushfires on Australian animals', Sydney, NSW.

262. Whisson D and Ashman K 2020, 'When an iconic native animal is overabundant: the koala in southern Australia', *Conservation Science and Practice*, 2(5).

263. Data supplied by Parks Victoria.

264. Morris W, Duncan D and Vesk P 2019, 'Control and monitoring of kangaroo populations in the Mallee parks of semi-arid northwest Victoria, version 2', Melbourne, Victoria.

265. DELWP 2020, 'Kangaroo harvest quota for Victoria, 2021, fact sheet', East Melbourne, Victoria.

266. Thomas M-A 2021, 'Paddock to plate option on the table for kangaroo harvest', Ministerial media release, Government of Victoria, 28 January 2021.

267. Ramsey D and Scroggie M 2020, 'Kangaroo harvest quotas for Victoria, 2021', Arthur Rylah Institute technical report series no. 323, Heidelberg, Victoria.

268. Thomas M-A 2021, 'Paddock to plate option on the table for kangaroo harvest', Ministerial media release, Government of Victoria, 28 January 2021.

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The RSPCA acknowledges that there may be valid reasons for culling kangaroos in farming areas or where there are insufficient resources to sustain the population. However, it believes that kangaroo 'management plans treat kangaroos as a sustainable resource available for commercial use, rather than making a decision for control as a result of examining their impact on the environment. Given the effects of drought and climate change, there is debate about the impact of the current sustainable use approach on future populations of commercially exploited species' and the 'process of setting quotas for killing kangaroos does not relate population reduction directly to damage mitigation.'²⁶⁹

Heard and Ramsey (2020) modelled the abundance of the common wombat and estimated that the Victorian population numbered 432,595, with highest densities in the ranges to the north, north-east and south-east of Melbourne.

The highest numbers were recorded in Gippsland.²⁷⁰ They also estimated that as of 21 January 2020, 21% of the suitable habitat for wombats had been burnt in the 2019–20 fires, with 19% or 83,000 wombats affected.

For many years the common wombat was 'unprotected' in 193 Victorian parishes, which meant that culling by landholders could proceed without an Authority to Control Wildlife.²⁷¹ Wombats can damage fences, compete with livestock for pasture and dig holes that can harm livestock and damage farm vehicles. However, in 2020, that 'unprotection' was lifted due to concerns about the impacts of disease, habitat loss and road kills on wombat populations. An Authority to Control Wildlife is now required to cull wombats.

269. RSPCA 2019, 'Is there a need to kill kangaroos or wallabies?' Australia <https://kb.rspca.org.au/knowledge-base/is-there-a-need-to-kill-kangaroos-or-wallabies/> Accessed 10 May 2021.

270. Heard G and Ramsey D 2020, 'Modelling the abundance of the common wombat across Victoria', unpublished client report for Biodiversity Division, DELWP, Arthur Rylah Institute, Heidelberg, Victoria.

271. DELWP 2020, 'Revocation of the order that unprotects the common wombat', East Melbourne, Victoria.

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Indicator B:03A Feral deer species

Region Statewide Measures Number, abundance and distribution Data Custodian DELWP; DJPR	Indicator Performance: 2018 & 2021: Unable to be assessed due to due to Low Data Confidence Why this indicator? Deer are an increasing threat to natural habitats and native species and can also cause soil erosion and the concentration of nutrients.	2018 Status	2018 Trend	2018 Data
		2021 Status	2021 Trend	2021 Data

Potential thresholds for status in the SoE 2023 report

Good: Significant reducing trend in the number, abundance and distribution of feral deer species

Fair: Small reducing trend in the number, abundance and distribution of feral deer species

Poor: Significant increasing trend in the number, abundance and distribution of feral deer species

OR

Good: ≥75% to 100% of targets to reduce feral deer abundance and distribution met

Fair: ≥50% to <75% of targets to reduce feral deer abundance and distribution met

Poor: <50% of targets to reduce feral deer abundance and distribution met

Why this assessment in 2021?

Status: Sambar deer populations, in particular, continue to expand in number and range

Trend: Sambar deer populations, in particular, continue to expand in number and range.

Data Confidence: Research on deer and knowledge about them in Victorian landscapes are limited.

Should this indicator be used in the SoE 2023 report?

Yes, however data need to be improved.

Summary of SoE 2018 Report assessment

- The populations and distributions of four deer species – sambar, fallow, red and hog – were expanding, with sambar deer the most common and widespread.
- Deer impact native vegetation and its regeneration, damage crops and fences, and cause soil erosion and nutrient concentration.

The 2019–20 bushfires: Impacts and responses

Little is known of the impacts of the bushfires on deer however they are able to move around the landscape with ease irrespective of habitat condition. Deer thrive on new green growth after fire and were the target of aerial and ground shooting operations after the 2019–20 bushfires.

Figure 20 maps the aerial shooting operations that covered 260,000 hectares of difficult terrain in national parks, State Forests, a regional park and a wilderness park. In total, the operations involved 150 hours of shooting over 42 days in 73 missions, including 210 hours total flight time (i.e. transit and control time) and 152 control flight hours. More than 1,500 animals were removed, including 1,400 sambar deer and smaller numbers of foxes, fallow deer, feral pigs, goats and cattle. The post-fire shooting operations were enhanced by the parks being closed due to fire damage, the canopy and ground cover reduced and the target animals gathering around food and watering points. Preliminary estimates suggest a 50% reduction in population numbers within managed areas.²⁷²

272. DELWP 2020, 'Emergency response aerial shooting operation, summary report', East Melbourne, Victoria.

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However, there have been no detailed studies on deer population changes, and any such studies would require good pre-fire data that is currently unavailable. Table 21 summarises the operational effectiveness and biodiversity benefits of the program.

The key measures of success for the emergency response aerial shooting operation were: to reduce the abundance of target animals from identified

high-priority habitats (including where vegetation would be soft and tender and vulnerable to damage), to provide immediate relief to native flora and fauna of most concern following the bushfire, and to facilitate their recovery and survival. It was not aimed at deer eradication or establishing a long-term control program.

Table 21: Operational effectiveness and biodiversity benefits of the emergency response aerial shooting operation after the 2019–20 bushfires.²⁷⁴

Indicator	Effectiveness
Extent of target management area treated	255,992 hectares of priority habitat treated
Target species controlled	1,558 target animals controlled: 1,434 sambar deer, 39 fallow deer, 43 feral pigs, 27 feral goats, 9 feral cattle, 6 foxes (total: 1,558)
Reduction in deer abundance and density [^]	Reduced by 50% within the effective search areas
% of animals observed that were controlled*	90% of observed animals were controlled
Average number of animals per minute	1 target animal controlled every 3.7 minutes on average in the Snowy River National Park and surrounds and 1 target animal controlled every 5.9 minutes on average across all priority areas
Localised eradication	Likely localised eradication of feral cattle within the Snowy River Corridor and feral goats within Mount Mittamatite Regional Park.
Ecological Vegetation Communities (EVCs) protected	21 of the 29 EVCs significantly impacted by the 2019–20 bushfires were managed under the aerial shooting operation
	34 of the 47 EVCs impacted by multiple fires since the year 2000 were managed under the aerial shooting operation
	52% of Alpine Bogs, 30% of Littoral Rainforest, 21% of Warm Temperate Rainforest and 12% of Cool Temperate Rainforest within identified priority locations were managed under the aerial shooting operation
Expected increase in probability of local persistence (Change in Suitable Habitat) under sustained long-term management	691 flora and fauna (excluding invertebrates) species in total are expected to increase in probability of local persistence under sustained long-term herbivore control, including 32 EPBC, 64 FFG and 401 DELWP Advisory listed species.
	22 fauna species identified as of most concern in the DELWP biodiversity response and recovery report are expected to increase in probability of local persistence (Change in Suitable Habitat) under sustained long-term herbivore control
	72 flora species identified as of most concern in the DELWP biodiversity response and recovery report are expected to increase in probability of local persistence (Change in Suitable Habitat) under sustained long-term herbivore control.

[^]Based on spatial abundance modelling of sambar deer using operational mission data (DELWP 2021)

*There was no opportunity for the remaining 10% of observed animals under the strict rules of engagement, such as not shooting if the animal is likely to fall into water and only shooting if an instantly fatal shot is highly probable.

274. Ibid

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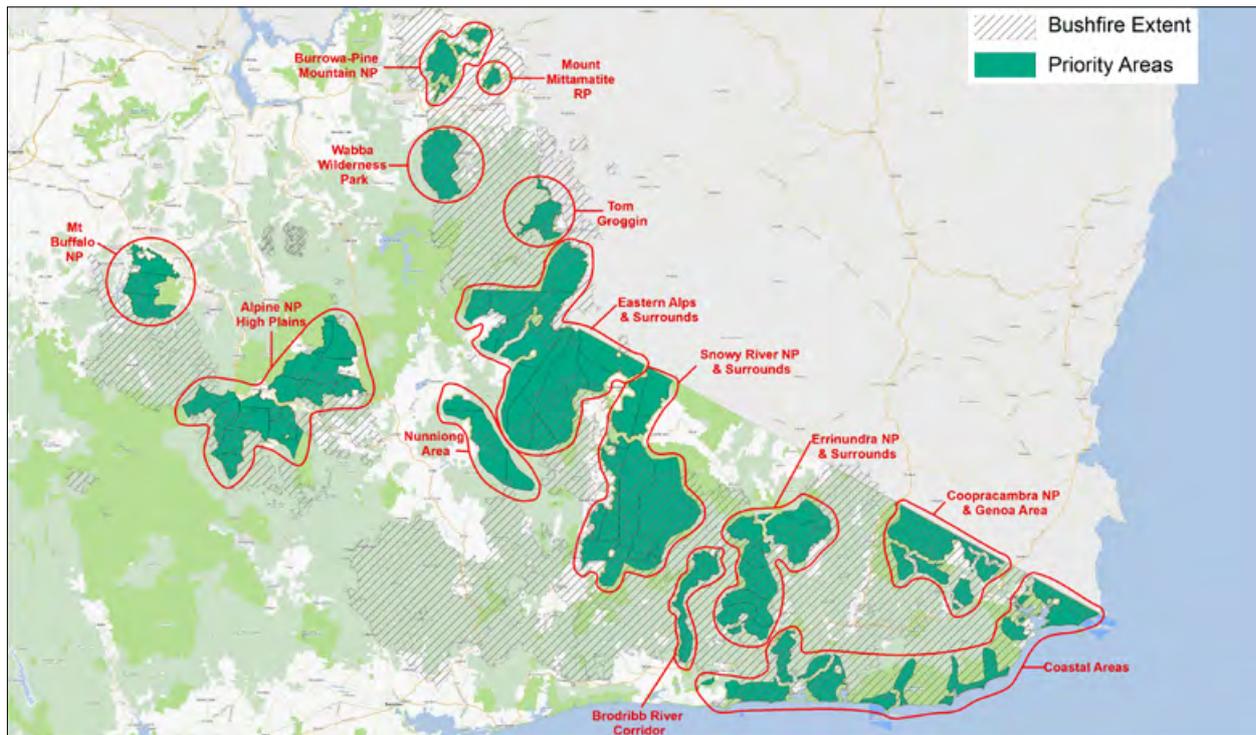


Figure 20: Emergency response aerial shooting operations (10 February to 8 May 2020): Priority areas.²⁷⁵

A report on the aerial shooting program summarised the reasons for controlling introduced animals immediately after fire:

- A fire-reduced understorey can result in a five-fold increase of introduced predators (foxes and feral cats) in fire-affected areas.
- The relative consumption of prey will at least double post-fire, expediting in many cases the risk of localised or species extinction.
- Fire causes a magnet effect for herbivores resulting in a three-fold strengthening of herbivore use.
- Shifts in diet and behaviour are commonly amplified in the first few weeks to months post-fire.
- The open canopy, loss of understorey and congregation of animals around scarce resources provide a time-critical management opportunity perfectly suited for aerial shooting.²⁷³

SoE Biodiversity Update 2021 Report assessment

Feral deer were initially introduced for hunting purposes, however, accidental escapes from deer farms and deliberate releases by hunters have contributed to their growing numbers and spread into new areas. Feral deer in Victoria have environmental, social, cultural and economic impacts that include:

- damage to crops, orchards, vineyards, vegetable gardens, plantations, pastures and fencing
- damage to properties in urban and peri-urban areas
- the spread of weeds
- potential pollution of water supplies
- creating a road and rail safety hazards
- the potential spread of disease
- competition with native animals for food, water and shelter

²⁷³. Ibid
²⁷⁵. Ibid

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- damage to cultural sites from soil compaction and erosion
- exacerbating the impacts of other threats to biodiversity
- destruction of native plants and reductions in plant diversity
- undermining and increasing the costs of revegetation projects
- damage to sensitive ecosystems that include alpine bogs and rainforest

Sambar, red, fallow and hog deer are the main feral deer species found in Victoria and their distributions are shown in Figure 21. Sambar deer, introduced to Victoria in the 1860s, are found in the largest numbers.²⁷⁶ Anecdotal evidence suggests the populations of most species are expanding.

The Victorian Deer Control Strategy released in October 2020 identified deer as a threat to 13 threatened flora species and 12 threatened ecological communities. It also reported that more than 1,000 native flora and fauna species would benefit if deer were successfully controlled.²⁷⁷ The four main deer species are protected wildlife ('game' species for hunting) under the *Wildlife Act 1975* and also defined as game for licensed deer hunters. Estimates of total deer numbers range between 'several hundred thousand up to one million',²⁷⁸ and some are now encroaching on Melbourne's peri-urban areas. The Victorian Farmers Federation²⁷⁹ and the Invasive Species Council²⁸⁰ have both called for the removal of the sambar deer's protected species status under the *Wildlife Act*.

In reviewing the impacts and management of deer in Australia, Davis et al. (2016) found 'a lack of knowledge of the nature, extent and severity of deer impacts' ... 'little rigorous testing of the efficacy of deer management' and 'our understanding of the deer ecology required to guide deer management is limited.'²⁸¹

They identified the following research gaps:

- identifying long-term changes in plant communities caused by deer
- understanding interactions with other fauna
- measuring impacts on water quality
- assessing economic impacts on agriculture (including as disease vectors)
- evaluating efficacy of management for mitigating deer impacts
- quantifying changes in distribution and abundance.

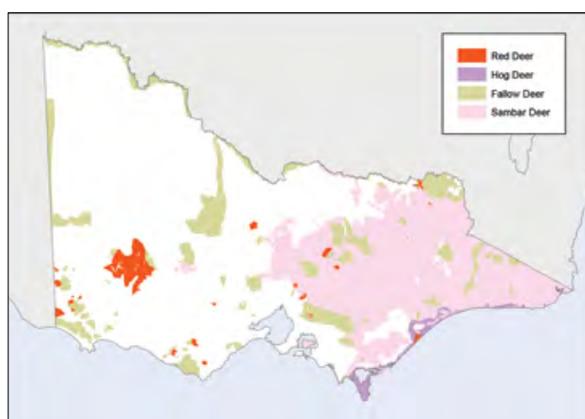


Figure 21: Indicative deer distribution in Victoria.²⁸²

Shooting by professional shooters is the main technique used for deer control. There are also more than 40,000 licensed recreational deer hunters in Victoria.²⁸³ In 2019, recreational shooters harvested an estimated 173,800 deer, which was 43% higher than 2018 and double the average since 2009.²⁸⁴ However, except for targeted local deer control projects, recreational shooting is not seen by the Victorian Deer Control Strategy as 'an effective means of controlling deer numbers.'²⁸⁵

The Australian Deer Association, the peak body for recreational hunters, believes that 'all deer management plans (whether they are using volunteers or paid shooters) should be underpinned by solid data to quantify the problem, a clear understanding of what needs to be achieved, appropriate resourcing to ensure targets can be met, and continuous monitoring and review to ensure that programs are meeting expectations. In almost all instances, this should include monitoring

276. Senate Environment and Communications References Committee 2021 'Impact of feral deer, pigs and goats in Australia', Parliament of Australia, Canberra.

277. DELWP 2020, 'Victorian deer control strategy 2020', East Melbourne, Victoria.

278. Ibid

279. Victorian Farmers Federation 2016, 'Submission to the Environment, Natural Resources and Regional Development Committee Inquiry into the Control of Invasive Animals on Crown Land', Parliament of Victoria, Melbourne, Victoria.

280. Invasive Species Council, 'Feral deer in Victoria', Katoomba, NSW <https://invasives.org.au/our-work/feral-animals/feral-deer/feral-deer-in-victoria/> Accessed 17 May 2021.

281. Davis N, Bennett A, Forsyth D, Bowman D et al. 2016, 'A systematic review of the impacts and management of introduced deer (family Cervidae) in Australia', *Wildlife Research*, 43, pp. 515–532.

282. DELWP 2020, 'Victorian deer control strategy 2020', East Melbourne, Victoria.

283. Game Management Authority, 'Game licence statistics summary report 2019', Melbourne, Victoria.

284. Moloney P and Hampton J 2020, 'Estimates of the 2019 deer harvest in Victoria: results from surveys of Victorian game licence holders in 2019', unpublished client report for the Game Management Authority, Arthur Rylah Institute, Heidelberg, Victoria.

285. DELWP 2020, 'Victorian deer control strategy 2020', East Melbourne, Victoria.

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of vegetation, monitoring of deer abundance and, in the case of programs utilising volunteers, monitoring of volunteer sentiment.²⁸⁶

Greet, Bennett and Fedrigo (2021) studied deer density and its impacts on woody vegetation in Melbourne Water's region and found that:

- distance to waterbodies (>10 ha) and woody vegetation cover within one kilometre was most influential on deer density
- deer densities were greatest in close proximity (<1 km) to waterbodies and at intermediate to high (40–80%) levels of cover
- at low densities, deer impacts increased with only small increases in deer density. At moderate to high densities, the severity of deer impacts was dependent on environmental and landscape context.²⁸⁷

After an extensive literature review on deer control methods, the scientists found that:

- non-lethal methods have no effect on deer population density and consequently, impacts will likely be transferred to other locations
- lethal control using ground-shooting can effectively reduce population densities and consequently reduce impacts to vegetation if they are sufficiently resourced and sustained over long timeframes
- to reduce deer impacts substantial reductions in deer densities may be required
- exclusion fencing remains the most effective non-lethal method to prevent impacts by deer. While applicable to most situations, it is costly, and thus usually limited to small and medium-sized projects
- most non-lethal strategies reviewed are only effective over the short-term (weeks) and those that are effective generally reduce browsing impacts but do not mitigate these impacts completely
- moderately effective methods include plant guards, companion planting and guardian dogs, although their efficacy depends on low herbivore density, scale of the area to be protected and site context.

In May 2021, the Senate Environment and Communications References Committee released the report of its inquiry into the Impact of feral deer, pigs and goats in Australia.²⁸⁸ Recommendations 8 and 9 are of particular relevance to this report:

Recommendation 8: The committee recommends that all Australian jurisdictions make any necessary changes to their existing legislative and regulatory frameworks to:

- ensure that wild deer are treated as an environmental pest
- maximise the ability of landholders to control feral deer on their land
- maximise the ability of park managers to control feral deer in World Heritage Areas and National Parks.

Recommendation 9: The committee recommends that Commonwealth, state and territory governments should commit to eliminating feral deer populations in World Heritage Areas, areas of national environmental significance, and national biodiversity hotspots.

Underpinned by the Biodiversity Knowledge Framework, several research projects are underway to improve knowledge of the efficacy of deer management approaches, as well as the development and improvement of monitoring deer numbers and impacts. The Biodiversity Knowledge Framework is a strategic approach to improve rigour of decision-making and the effectiveness of actions through prioritised knowledge acquisition. The approach improves coordination to invest in critical research that will enable better and timelier decision making and policy interventions. It uses 'causal models' to identify and quantify knowledge gaps so that research investment can be steered to answering the gaps that, when answered, will have the biggest impact. 'Best' and 'Worst' causal models of (positive and negative) impacts of deer control on reptiles, frogs, plants, and small- to medium-sized, ground-dwelling mammals and macropods are being developed.

286. Australian Deer Association 2020, 'A stitch in time saves nine' <https://www.austdeer.com.au/2020/02/10/1379650/a-stitch-in-time-saves-nine> Accessed 10 May 2021.

287. Greet J, Bennett A and Fedrigo M 2021, 'Understanding and mitigating the impact of deer in riparian zones', research note 22.1, Melbourne Waterway Research-Practice Partnership, Melbourne Victoria.

288. Senate Environment and Communications References Committee 2021 'Impact of feral deer, pigs and goats in Australia', Parliament of Australia, Canberra.

Invasive plants and animals

Indicator B:03B Feral horses

B:03B Feral horses Region Statewide Measures Abundance and distribution Data Custodian DELWP; Parks Victoria	Indicator Performance: 2018 & 2021: Unable to be assessed due to due to Moderate Data Confidence Why this indicator? Significant populations of feral horses occur in Alpine National Park and Barmah National Park and threaten native species and habitats.	2018 Status	2018 Trend	2018 Data
		2021 Status	2021 Trend	2021 Data

Potential thresholds for status in the SoE 2023 report

Good: Achieving targets to reduce feral horse abundance and distribution

Fair: No reduction in feral horse abundance and distribution

Poor: Increasing abundance and distribution of feral horses

OR

Good: ≥75% to 100% of targets to reduce feral horse abundance and distribution met

Fair: ≥50% to <75% of targets to reduce feral horse abundance and distribution met

Poor: <50% of targets to reduce feral horse abundance and distribution met

Why this assessment in 2021?

Status: Although measures to reduce feral horse abundance and distribution are beginning to be implemented, the Status of this indicator remains Poor

Trend: Horse numbers are increasing and the trend in environmental condition continues downwards.

Data Confidence: Aerial surveys are providing improved data on horse numbers in the Alpine National Park and Barmah National Park.

Should this indicator be used in the SoE 2023 report?

Yes.

Summary of SoE 2018 Report assessment

- Australia had the world's largest population of feral horses, with significant numbers in Victoria's Alpine and Barmah national parks.
- Research in the Alpine National Park had shown that feral horse numbers can increase by 10–20% every two to four years.

The 2019–20 bushfires: Impacts and responses

Although the Barmah National Park was not affected by fire, some alpine areas were burnt. Surviving horses will put further pressure on unburnt areas as they search for food and water. The culling of horses was not part of the aerial and ground shooting programs initiated immediately after the 2019–20 bushfires.

SoE Biodiversity Update 2021 Report assessment

Feral horses in Victoria are found in the Alpine and Barmah national parks where they damage wetlands, alpine peatlands and stream banks. Numbers in Barmah are estimated at more than 500,²⁸⁹ while the figure is around 5,000²⁹⁰ (double the 2014 estimate) for the eastern Victorian Alps. Each year 150–200 horses have been removed from the Alpine National Park, however this has not reduced their population.

The environmental damage caused by feral horses includes damage to vegetation communities by grazing, browsing and trampling, the pugging of wetlands, which can lead to weed invasion, as well as the drying, erosion and degrading of waterways and competition with native animals for food.

Invasive plants and animals

Parks Victoria's Protection of the Alpine National Park Feral Horse Strategic Action Plan 2018–21 describes the 'where and how' of horse management in the park and adjacent State Forests. The plan's actions focus on 'capture and control, rehoming where possible, and monitoring and research.'

Feral horse control is also a major focus of Parks Victoria's Protection of floodplain marshes Barmah National Park and Barmah Forest Ramsar Site Strategic Action Plan 2020–2023. The horses have been identified as the main driver in the 96% decline in moira grass, a critical vegetation community in the park.²⁹¹ The Yorta Yorta Joint Management Plan for Barmah also includes actions to manage feral horses.

Implementation of the feral horse control plans had been delayed by court action aimed at stopping the program. However, in May 2020, the federal court ruled in favour of Parks Victoria.²⁹² A subsequent appeal in June 2020 to the Victorian Supreme Court also failed.²⁹³ Parks Victoria released its draft Feral Horse Action Plan 2021 in March 2021 for a three-week period of community consultation.

289. Parks Victoria, 'Feral horses in Barmah National Park, fact sheet', Melbourne, Victoria.

290. Parks Victoria, 'Feral horses', Melbourne, Victoria <https://www.parks.vic.gov.au/get-into-nature/conservation-and-science/conserving-our-parks/feral-animals/feral-horses> Accessed 10 May 2021.

291. Parks Victoria, 'Feral horses in Barmah National Park, fact sheet', Melbourne, Victoria.

292. Somerville E 2020, 'Brumby population to be culled in Victoria after Federal Court dismisses heritage concerns', *ABC Goulburn Murray*, 8 May 2020.

293. Morgan S 2020, 'Victoria's brumby cull will go ahead, court rules', *The Land*, 19 June 2020.

Threatened species and communities

Background

Victoria is Australia's most-cleared state, with more than 50% of its native vegetation having been removed since European settlement. The only areas largely spared from clearing are in the far north-west, The Grampians, Central Highlands, the Otway Ranges, Wilsons Promontory and the Great Dividing Range in eastern Victoria. The result is highly fragmented native vegetation and an increasing threat to Victoria's biodiversity.

Victoria's Flora and Fauna Guarantee Act 1988 contains lists of threatened species and communities and 43 Potentially Threatening Processes. The lists have grown since the Act's commencement, including the recent addition of the platypus and the little eagle in January 2021. According to DELWP, 'the longer-term outlook for many threatened species and habitats that rely on Victoria's approximately 8 million hectare public land estate for their conservation is poor.'²⁹⁴

Individual species and ecological communities can become threatened by:

- the loss, decline or fragmentation of their habitat
- competition with or predation by invasive species
- climate change
- inappropriate fire regimes
- timber harvesting
- urban and agricultural development
- altered river flows.

Recent amendments to the *Flora and Fauna Guarantee Act 1988* included a commitment to align Victoria's threatened flora and fauna listing process with the nationally consistent Common Assessment Method (CAM). Between 2015 and 2018, the Commonwealth, state and territory governments signed a memorandum of understanding to deliver the CAM for assessing the conservation status of threatened species. Underpinning the method are the IUCN Red List categories and criteria: Extinct, Critically Endangered, Endangered, Vulnerable and Conservation Dependent.

For Victoria, which signed the memorandum of understanding in 2018, this has involved reassessment of the conservation status of Victorian species listed under the Commonwealth EPBC Act, *Victoria's Flora and Fauna Guarantee Act*

1988 and three Victoria threatened species advisory lists:

- Department of Sustainability and Environment 2009, 'Advisory list of threatened invertebrate fauna in Victoria – 2009', East Melbourne, Victoria
- Department of Sustainability and Environment 2013, 'Advisory list of threatened vertebrate fauna in Victoria – 2013', East Melbourne, Victoria
- Department of Environment and Primary Industries 2014, 'Advisory list of rare or threatened plants in Victoria – 2014', East Melbourne, Victoria.

Under transitional provisions, the Minister for Energy, Environment and Climate Change could recommend changes within, addition to, or removal of species from the Threatened List based on eligibility criteria, resulting in Victoria's single operational list of threatened species. Those that had been assessed nationally or were no longer considered present in Victoria or had unconfirmed taxonomy were excluded.²⁹⁵

A list of provisional assessments was released by DELWP in November 2020. It included the proposed conservation status of each species as well as the conservation status assigned to each one of them in the EPBC Act, FFG Act and the three advisory lists. Following public consultation, assessments were revised, species added and removed, and the final list became the Flora and Fauna Guarantee Threatened List. It was published in June 2021 with 1,993 species comprising 49 mammals, 104 birds, 40 reptiles, 15 amphibians, 37 fish, 124 invertebrates, 1,556 vascular plants, 60 non-vascular plants and 8 fungi and lichens.²⁹⁵ DELWP's advisory lists for threatened species were subsequently retired.

294. DELWP 2020, 'Submission to the Legislative Council Environment and Planning Committee Inquiry into Ecosystem Decline in Victoria', Parliament of Victoria, Melbourne, Victoria.

295. DELWP 2021 'Flora and Fauna Guarantee Act Threatened List', East Melbourne, Victoria <https://www.environment.vic.gov.au/conserving-threatened-species/threatened-list> Accessed 3 November 2021.

Threatened species and communities

The new Flora and Fauna Guarantee Threatened List has two parts: a national section, consisting of EPBC Act-listed species for which the national conservation status is used, and a state section, comprising species that are considered to be threatened in Victoria but not at the national level.

The CAM process resulted in many taxa being upgraded to higher risk categories than in the advisory lists, although some taxa have been downgraded. The reasons²⁹⁶ for changes in the conservation status of a species include:

- many of the plants assigned 'Rare' status in the advisory list for rare and threatened plants, which was largely based on 2005 data, have now been upgraded to Vulnerable, Endangered or Critically Endangered. The 'Rare' category is not used in the CAM
- the application of the 'Critically Endangered' category for plants and fungi (previous assessments had not used this category and many had been assessed as 'Rare')
- the more rigorous assessment approach using the CAM criteria
- new evidence and perspectives, including inferences about the likely future impacts of climate change. The effects of climate-induced change, including warming, drying and increased bushfire frequency, were not considered when assessing the species for the now-retired advisory lists
- consideration of the habitat impacts of the 2019–20 bushfires
- the conservation status of species under the EPBC Act being applied to some species, which could have resulted in an upgrading or downgrading of that status.

The conservation status of threatened ecological communities was not reassessed. However, in the future they could once the CAM process for threatened species has been analysed.

The 2019–20 bushfires burnt across approximately 1.5 million hectares, most of which was in areas of high biodiversity value and with many threatened species and communities impacted. For 244 species, which included 215 rare or threatened species, more than 50% of their habitat was burnt. That was also the case for nine habitat types. The extensive burn area in eastern Victoria also impacted many threatened ecological communities listed under either the EPBC Act or the *Flora and Fauna Guarantee Act 1988*.

Policy and legislative setting

There are more than 20 pieces of primary legislation that can be used to support the protection and management of Victoria's natural environment (see Table 2 in Part I of this report). A selection of these is summarised below.

In 2017, the Victorian Environmental Assessment Council recommended that within five years the *National Parks Act 1975* be expanded to include revised categories of national parks, conservation parks, nature reserves, marine protected areas, and other categories and overlays classified as protected areas, to become the 'National Parks and Conservation Reserves Act.' The Victorian Government accepted this recommendation.

The *Flora and Fauna Guarantee Act* was amended in 2019 to modernise a number of its provisions. The changes included:

- a requirement that ministers and public authorities consider the Act when making decisions or taking actions that might impact biodiversity
- consideration of the rights and interests of Traditional Owners
- consideration of climate change
- stronger penalties in its enforcement provisions
- development of a new threatened species list based on IUCN categories and criteria and the CAM
- new guidelines for critical habitat determinations.

Under Victoria's *Wildlife Act 1975* it is an offence to kill, poison, take, control or harm wildlife, which is defined to include both native and non-native animals e.g. deer, pheasants and partridges. The Act also provides for the issuing of an Authority to Control Wildlife, mostly to farmers and other

296. Ibid

Threatened species and communities

landholders wishing to control wildlife damaging their property and has provisions for the creation of wildlife reserves and nature reserves. In May 2020, the Environment Minister announced a review of the Act, which is yet to be completed.

The *Crown Land (Reserves) Act 1978* provides for the reservation of Crown land and its management for public purposes. The reserves can be managed by DELWP or by a committee of management on its behalf.

The *Environment Protection Act 2017* aims to prevent air, land and water pollution and environmental damage by setting environmental quality objectives. The Act is administered by the Environment Protection Authority.

The *Planning and Environment Act 1987* establishes the framework for land use planning, development and protection in Victoria.

The *National Parks Act 1975* includes provisions to establish national parks, state parks, marine national parks and marine sanctuaries, wilderness parks and landscape conservation areas, to protect designated water supply catchments in national parks and for the use of parks by the community.

Parks Victoria is the agency responsible for the management of the state's conservation estate and its operations are guided by the *Parks Victoria Act 2018*. It is currently developing a land management strategy that will guide and inform future planning and decision making and respond to key challenges that include climate change, population growth, changing community needs, increased visitation, invasive pest species and accessibility requirements.

The *Heritage Rivers Act 1992* identifies and provides protection to heritage rivers (currently 18 in the state) that have recreation, nature conservation, scenic and aesthetic values. Certain provisions can be used to prohibit inappropriate activities such as land clearing, the construction of artificial barriers and water diversions.

The purposes of the *Catchment and Land Protection Act 1994* include establishing a framework for the integrated management and protection of catchments, the encouragement of community participation in land and water resource management and establishing a system of controls for noxious weeds and pest animals.

The object of the *Conservation, Forests and Lands Act 1987* is 'to be an effective conservator of the State's lands, waters, flora and fauna; and to make provision for the productive, educational and recreational use of the State's lands, waters, flora and fauna in ways which are environmentally sound, socially just and economically efficient.'²⁹⁷

The *Forests Act 1958* is used to support the management and use of Victoria's State Forests and includes provisions for firewood collection, fire management, forest park establishment and licensing of various uses such as grazing.

The *Sustainable Forests (Timber) Act 2004* includes provisions for the allocation of timber to VicForests through issuance of an Allocation Order, compliance with the Code of Practice for Timber Production, the preparation and implementation of the Timber Release Plan, and the framework for state of the forests reporting.

The 2017 Guidelines for the removal, destruction or lopping of native vegetation²⁹⁸ are an incorporated document in Victoria's planning system, which requires a permit to remove native vegetation. A three-step approach is applied when assessing whether or not to grant a permit, and when determining the conditions on any permits granted. The three steps are:

- Step 1** - Avoid the removal, destruction or lopping of native vegetation
- Step 2** - Minimise impacts from the removal, destruction or lopping of native vegetation that cannot be avoided
- Step 3** - Provide an offset to compensate for the biodiversity impact from the removal, destruction or lopping of native vegetation.

The Procedure for the removal, destruction or lopping of native vegetation on Crown land²⁹⁹ was released in 2018 and sets standards for the removal of native vegetation on public land managed by DELWP and Parks Victoria.

297. Government of Victoria, 'Conservation, Forests and Lands Act 1987', Melbourne, Victoria.

298. DELWP 2017, 'Guidelines for the removal, destruction or lopping of native vegetation', East Melbourne, Victoria.

299. DELWP 2018, 'Procedure for the removal, destruction or lopping of native vegetation on Crown land', East Melbourne, Victoria.

300. DELWP 2019, 'Action statement no. 267 greater glider (*Petauroides volans* subsp. *volans*)', East Melbourne, Victoria.

Threatened species and communities

The Protection of Large Trees Policy aims to protect trees with a diameter of ≥ 2.5 metres in diameter (at 1.3 metres above the ground) from the direct effects of timber harvesting and regeneration burning on public land.

The Greater Glider Action Statement³⁰⁰ signalled the immediate protection of more than 96,000 hectares of forest (Immediate Protection Areas) across Victoria that were exempt from logging. In November 2019, the Victorian Government announced further measures to support southern greater glider populations: the end of timber harvesting in old-growth forest immediately and the phasing out of native forest timber harvesting by 2030.

The Freshwater Fisheries Management Plan 2018–2028 has five objectives:

- healthy recreational fisheries
- a deeper understanding of recreational fisheries
- working with Traditional Owners and Aboriginal Victorians
- improving recreational fishing experiences
- responsible recreational fishing.

Protecting Victoria's environment: Biodiversity 2037 is a 20-year biodiversity conservation strategy and the Victorian Government's policy response to addressing the decline in the state's biodiversity. It presents a long-term vision for Victoria's biodiversity supported by two goals: 'Victorians value nature,' and 'Victoria's natural environment is healthy.' Biodiversity 2037 sets statewide targets and contributing targets for both goals. Contributing targets will be reviewed and updated every five years. Along with a number of overall targets, Biodiversity 2037 has a Monitoring, Evaluating, Reporting and Improvements Framework³⁰¹ with targets, actions and key performance indicators. The Biodiversity Knowledge Framework supports the identification of knowledge gaps to more effectively target investment in biodiversity research, monitoring and data collection.³⁰²

301. DELWP 2017, 'Biodiversity 2037 Monitoring, Evaluation, Reporting and Improvements Framework (MERF) version 2.0', East Melbourne, Victoria.

302. DELWP 2020, 'Biodiversity knowledge framework version 1', East Melbourne, Victoria.

Threatened species and communities

Indicator B:19 Landscape-scale change

Region Statewide	Indicator Performance:	2018 Status	2018 Trend	2018 Data
Measures Native vegetation extent and land use from 1987–2020	2018: Unable to be assessed due to Moderate Data Confidence			
Data Custodian DELWP	2021:	2021 Status	2021 Trend	2021 Data
	Why this indicator? Monitoring change at a landscape scale can provide a statewide view of threats to biodiversity and help shape policy and action.			

Potential thresholds for status in the SoE 2023 report

Good: Native vegetation extent is significantly increasing

Fair: Native vegetation extent is stable

Poor: Native vegetation extent is significantly declining

Why this assessment in 2021?

Status: There has been an increase in the area of landscapes associated with human-based activities and an overall decrease in native vegetation and intermittent and seasonal wetlands.

Trend: There are reductions in the area of native vegetation and wetlands and an increase in the area of human-based activities.

Data Confidence: The Land Cover series provides high-quality data for this indicator, with the most recent release in 2020.

Should this indicator be used in the SoE 2023 report?

Yes, however it should be renumbered (it is not a Biodiversity 2037 indicator) and included earlier in the Biodiversity chapter to introduce the theme of threatened species and communities.

Summary of SoE 2018 Report assessment

- Urban expansion had resulted in a loss of native grasslands and increased pressures on surrounding native vegetation (in terms of asset protection from fire).
- Hardwood plantations, irrigated horticulture and exotic woodlands had increased between 1990 and 2015. Native grasslands, native scattered trees, native shrubs and intermittent seasonal wetlands had all declined in the same period.

The 2019–20 bushfires: Impacts and responses

The 2020 land cover series uses data gathered before the 2019–20 bushfires. Vegetation impacted by the bushfires is expected, by DELWP, to regenerate and is not considered a loss of vegetation in the landscape-scale analysis.

Threatened species and communities

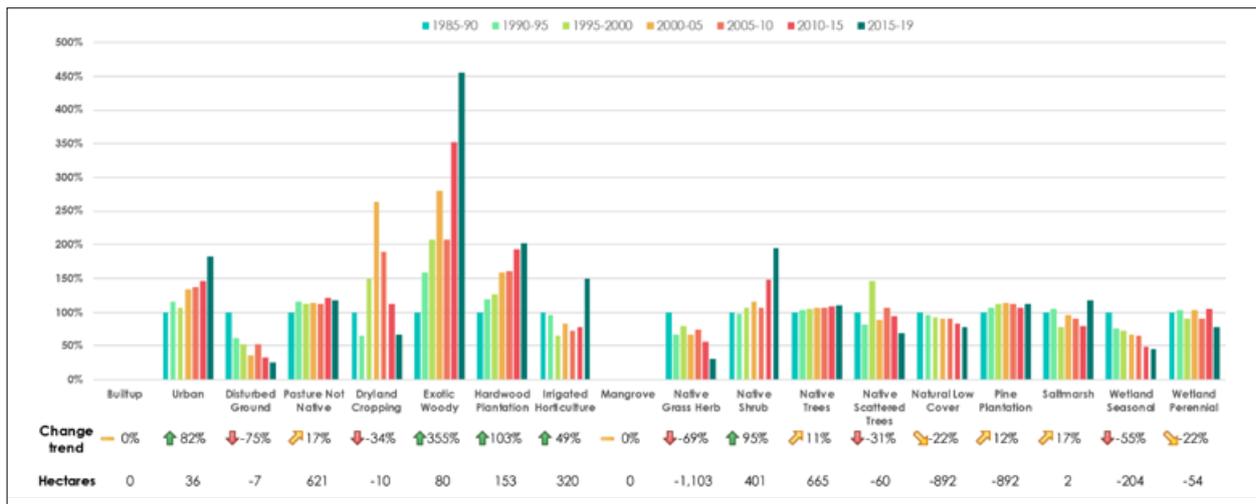


Figure 22: Change trend and hectares presented as a comparison between the 1st and 7th epoch (time period).³⁰³

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Figure 22 provides details on percentage increases and decreases in land cover types across Victoria over the seven five-year time epochs from 1985–2020 (the coloured bars represent different time epochs under each land type). The land types that increased over the 35-year period include exotic

woody (355%), hardwood plantation (103%), urban (82%) and irrigated agriculture (49%). The land types that decreased the most were disturbed ground (75%), native grass herb (69%), wetland seasonal (55%), dryland cropping (34%) and native scattered trees (31%). This continues the trend observed in the SoE 2018 Report that landscapes associated with human-based activities had increased, while natural landscapes had decreased.

303. DELWP, 'Victorian land cover time series', East Melbourne, Victoria <https://www.environment.vic.gov.au/biodiversity/Victorias-Land-Cover-Time-Series> Accessed 9 May 2021.

Threatened species and communities

Indicator B:04 Threatened freshwater species in the wild

Region Statewide	Indicator Performance:	2018 Status	2018 Trend	2018 Data
Measures Changes in conservation status; Number, abundance and distribution; Management of threatened species; Recovery and action plans for threatened species; Re-established threatened species in the wild	2018 & 2021: Unable to be assessed due to Unknown Status, Low Data Confidence and Unknown Trend			
		2021 Status	2021 Trend	2021 Data
Data Custodian DELWP	Why this indicator? This indicator is a statewide overview of the conservation status of freshwater species and is further illustrated by indicators B:04A-B:04F.			

Potential thresholds for status in the SoE 2023 report

Good: Significant increasing trend in the abundance and distribution of threatened freshwater species, and threats are being monitored, reported and mitigated

Fair: Small to no increasing trend in the abundance and distribution of threatened freshwater species, and threats are in part being monitored, reported and mitigated

Poor: Significant declining trend in the abundance and distribution of threatened freshwater species, and threats are not being monitored, reported or mitigated

Why this assessment in 2021?

Status: Although considerable work is being done by agencies and communities to restore habitats and recover species, it is starting from a low base and localised.

Trend: Data are insufficient to determine Trend. However, the 2019–20 bushfires have negatively impacted threatened fish e.g. galaxiids and macroinvertebrates e.g. crayfish in eastern Victoria.

Data Confidence: Data are limited to a relatively small number of species. For example, the mega macroinvertebrates e.g. spiny crayfish and freshwater plants have in the past been largely ignored. However, assessments under the CAM have collated and considered existing data and knowledge and will be a useful resource for the SoE 2023 report.

Should this indicator be used in the SoE 2023 report?

Not in its current form. It is an introductory indicator for a group of indicators that cover two freshwater fish species, three frog species and a freshwater crayfish species. Consideration could be given to replacing it with separate indicators for threatened freshwater plant species and threatened freshwater animal species. However, that consideration should go further to the potential replacement of 4A and 4B with a large-bodied fish indicator, moving 4C to B:06C to cover mega macroinvertebrate species, and merging 4D, E and F with B:12 (Frogs). A new indicator for small-bodied freshwater fish (e.g. galaxiids) could also be created. Consideration could also be given to a reduction in the number of measures and alignment with B:16, which covers threatened wetland-dependent species.

Summary of SoE 2018 Report assessment

- 55% of freshwater fish were considered to be threatened.
- There was a lack of statewide data for the majority of threatened freshwater animal and plant species. Data were presented for three frog species, two fish species and one crayfish species.

The 2019–20 bushfires: Impacts and responses

Freshwater habitats and their threatened species were first impacted by the burning of riparian vegetation during the 2019–20 bushfires, followed by the ash and debris carried into waterways by runoff after rain.

The loss of riparian vegetation reduces shade, increases water temperature and evaporation, and exposes freshwater species to attack from predators. Ash and debris reduce water quality and dissolved oxygen, as well as burying aquatic invertebrates and filling the gaps in pebbly river beds that provide them with important habitat.

Threatened freshwater species of most concern after the 2019–20 bushfires included 12 amphibians, 13 fish, the platypus, nine crayfish and four molluscs.³⁰⁴ Freshwater fish, crayfish and mussels were extracted from fire-affected waterways in eastern Victoria and kept in captivity until conditions were safe for their return. Table 22 lists the aquatic macroinvertebrate species impacted by the bushfires.

304. DELWP 2020, 'Victoria's bushfire emergency: biodiversity response and recovery, version 2', East Melbourne, Victoria.

Threatened species and communities

Macquarie perch were moved from the Buffalo River to other rivers and the Snobs Creek hatchery, while Murray cod from the Ovens River were translocated to unaffected areas.³⁰⁵ The Dargo galaxias, which lives in the Dargo River near Mount Hotham, was one of the threatened fish species extracted. It was at risk from burial or suffocation by ash, rocks, soil and timber washed into the river after the fires. The 200 extracted were kept in tanks at the Arthur Rylah Institute in Heidelberg.³⁰⁶ The other fish extracted were the East Gippsland galaxias, Yalmy galaxias and McDowall's galaxias.

Figure 23 maps the extent of the 2019–20 bushfires in eastern and northeastern Victoria along with the post-fire wildlife food drops, aerial deer shooting operations and native fish extractions. The yellow circles represent the location of threatened aquatic macroinvertebrates within the fire extent.

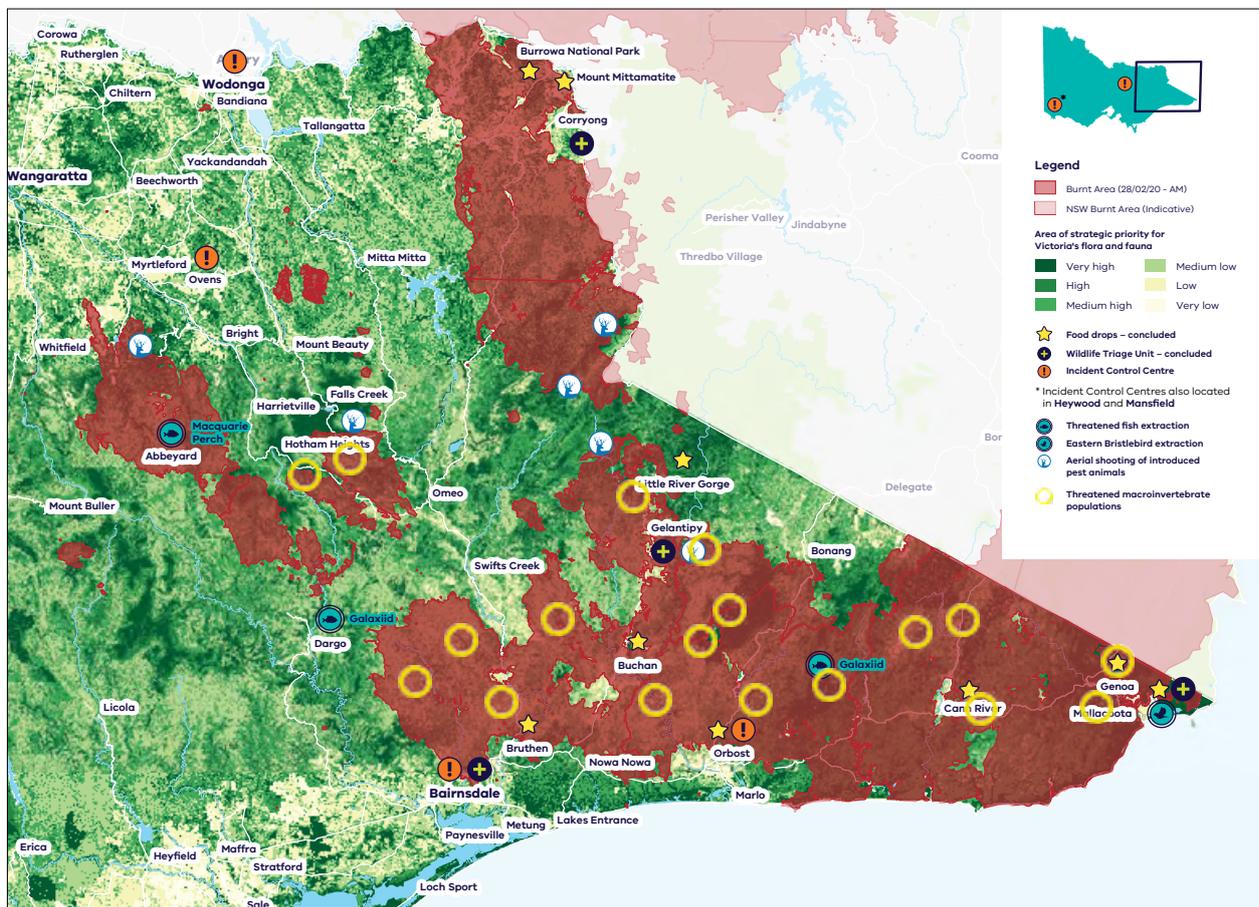


Figure 23: The location of threatened macroinvertebrates within the 2019–20 fire extent.^{307,308}

305. Arthur Rylah Institute 2020, 'ARI aquatic quarterly update: summer 2019/2020', Heidelberg, Victoria.

306. DELWP 2020, 'Noah's Ark approach protects threatened fish from fires', East Melbourne, Victoria <https://www.wildlife.vic.gov.au/media-releases/noahs-ark-approach-protects-threatened-fish-from-fires> Accessed 1 August 2021.

307. DELWP 2020, 'Victoria's Bushfire Emergency: Biodiversity Response and Recovery' https://www.wildlife.vic.gov.au/_data/assets/pdf_file/0023/450329/DELWP0149_Fire_Effect_Maps_A3_v10.pdf Accessed 4 November 2021.

308. Raadik T 2020, 'Of fire and mud: post-fire extraction of threatened aquatic fauna 2020', webinar presentation, 29 October 2020.

Threatened species and communities

Coastal East Gippsland is a national diversity hotspot for freshwater crayfish, with species including the Mallacoota burrowing crayfish, variable spiny crayfish, alpine spiny crayfish, Orbost spiny crayfish, East Gippsland spiny crayfish, Arte spiny crayfish, Cann spiny crayfish and Snowy spiny crayfish.

The Arthur Rylah Institute began to prepare for macroinvertebrate extractions in early February 2020, however, they were unable to access the areas due to active fires, blocked access tracks and hazardous trees.³⁰⁹ Then the rains came, turning some streams to mud, covering fish and burying mussels. Although nothing survived to collect in some devastated locations, a number of freshwater crayfish and freshwater mussels were extracted and housed at the Arthur Rylah Institute's aquarium facility. They were later returned to their extraction location when conditions were more suitable in September 2020.

The extracted species were the Arte spiny crayfish (3 extracted/1 returned), East Gippsland spiny crayfish (40/25), Orbost spiny crayfish (30/65), variable spiny crayfish (15/1) and the depressed river mussel (65/9).³¹⁰ Electrofishing, hand netting and tube traps were used for the crayfish and hand capture for the mussels.

According to Raadik (2020), the extraction processes were successful because of:

- rapid delivery of bushfire recovery funding
- existing expertise in management of fire-impacted aquatic fauna
- aquaria facilities and husbandry expertise
- knowledge of the location of important populations of targeted species
- being alert to the dangers for aquatic fauna from bushfires and ready for a quick and targeted response.³¹²

Table 22: Macroinvertebrate species impacted by 2019–20 bushfires.³¹¹

Species Impacted by Fire	Localised Impacts
Alpine spiny crayfish	Majority of known range in current fire extent, southern population primarily impacted
Arte spiny crayfish	Majority of known range in current fire extent. Individuals extracted
Cann spiny crayfish	Majority of known range in current fire extent. Seeking to extract individuals
Claytons spiny crayfish	Partial area of known range in current fire extent
Depressed freshwater mussel	100% in fire extent
East Gippsland spiny crayfish	Entire known Victorian range in current fire extent. Individuals extracted.
Harpactacid copepod	Entire known range in current fire extent
Orbost spiny crayfish	Majority of known range in current fire extent. Individuals extracted.
Phreatoicid isopod	Majority of known range in current fire extent
Riffle shrimp/eastern freshwater shrimp	Majority of known range in current fire extent
Variable spiny crayfish	Entire known Victorian range in current fire extent. Young individuals extracted, no adults located.
West Snowy spiny crayfish	Entire known range in current fire extent

309. Ibid

310. Raadik T 2021 personal communication.

311. DELWP 2020, 'Victoria's bushfire emergency: biodiversity response and recovery, version 2', East Melbourne, Victoria.

312. Raadik T 2020, 'Of fire and mud: post-fire extraction of threatened aquatic fauna 2020', presentation, Bushfire Biodiversity Recovery Collaboration Meetings 29 October 2020.

Threatened species and communities

However, Raadik (2020) also cited issues that hampered the extraction processes. In particular, the rains following the fires, although not large events, eroded exposed soils and caused major sediment flows that filled streams with black mud. This covered fish, buried mussels and, in some cases, prevented crayfish from escaping from their burrows. In one extraction journey for river blackfish, he and his colleagues observed dead eels (usually very resistant to disturbance) and found no blackfish.³¹³

In September 2020, the Gunditjmarra Traditional Owners welcomed the Glenelg freshwater mussel back on to Country with a smoking ceremony. Dozens of the mussels had been collected from the river in January 2020 to serve as an insurance population in case fires in south-western Victoria impacted their river habitat. Once widespread, the mussels survive in one large population and two very small ones. A catastrophic event such as a bushfire could lead to their extinction.³¹⁴

The federally funded project, 'Saving the spinys: urgent actions to conserve the *Euastacus* freshwater crayfish' will support the recovery of the 22 priority *Euastacus* species (freshwater crayfish) affected by the bushfires, by identifying critical populations, exploring the feasibility of conservation translocations, and determining how to best conserve each species. It is being delivered by Aquasave-NatureGlenelgTrust and several research institutions at multiple locations across Eastern Victoria, through NSW and the ACT, and up to southern Queensland. Seven of the 22 species are found in Victoria: Arte spiny crayfish; Cann River spiny crayfish; West spiny crayfish; Orbost spiny crayfish; Bidhawal crayfish; alpine crayfish; Clayton's crayfish.

Another federally funded bushfire recovery research project is 'Conserving Victoria's unique alpine stonefly genus *Thaumatoperla*'. It will assess the impacts of the 2019–20 fires on the alpine stonefly, establish the distribution of the species, and identify priority actions to support recovery and conservation efforts. The project is being delivered by La Trobe University in partnership with Falls Creek and Mt Buller-Mt Stirling Resort Managements.

The federally funded bushfire recovery project 'Determining landscape-scale impacts of fire on biodiversity using eDNA [environmental DNA]', is assessing the impacts of the recent bushfires on freshwater biodiversity and 14 priority matters³¹⁵ across south-eastern Australia. The project will enable the identification of species and areas in urgent need of management and is being delivered by Monash University at multiple locations across Victoria, NSW and the ACT.

SoE Biodiversity Update 2021 Report assessment

Since European settlement, three freshwater fish are known to have become extinct and 55% of freshwater fish are considered to be threatened. Communities across Victoria are working to reverse the trend. In good news, two southern purple spotted gudgeons, thought to be extinct in the state, were reported in Kerang's Third Reedy Lake in November 2019.³¹⁶

The stocking of native fish in Victorian waterways is used to help recover threatened fish populations and to provide targets for recreational fishers. The Victorian Fisheries Authority releases Australian bass, estuary perch, golden perch, Macquarie perch, Murray cod, silver perch and trout cod into enclosed lakes and water storages, as well as into rivers and creeks. Table 23 presents the numbers of four native species released into rivers and streams in Victoria in 2019–20. Golden perch dominated the fish stocking numbers in that year, with almost half of those released into the Loddon and Goulburn rivers. In the same year, 1,200 Macquarie perch were released into Dartmouth Dam and 700 into the Ovens River, while 26,894 trout cod were released into the Goulburn River.³¹⁷

313. Ibid

314. Johnson S 2020, 'Native Glenelg freshwater mussels return to the river after being evacuated during bushfires', *ABC South West Vic*, 30 September 2020.

315. The Wildlife and Threatened Species Bushfire Recovery Expert Panel identified 801 priority matters i.e. priority species and ecological communities for urgent management intervention following the 2019–20 bushfires.

316. ABC News 2021, 'Scientists rejoice over discovery of native wetland fish thought to be extinct', by Sarah Lawrence, 7 Mar 2021 <https://www.abc.net.au/news/2021-03-07/zombie-fish-found-in-victoria-20-years-after-going-extinct/13219440> Accessed 4 November 2021.

317. Victorian Fisheries Authority, 'Native fish releases', Melbourne, Victoria <https://via.vic.gov.au/db/native-fish-release-summary> Accessed May 2021.

Threatened species and communities

Table 23: Releases of four native fish species into Victorian rivers and streams 2019–20.³¹⁸

Location	Murray Cod	Golden Perch	Estuary Perch	Australian Bass
Avoca River	20,000	20,000		
Avon River				5,000
Barwon River			32,000	
Bemm River			30,000	
Boosey Creek	2,000	15,000		
Broken Creek	10,000	30,000		
Broken River	51,376	35,000		
Campaspe River	50,000	70,000		
Cann River				72,500
Goulburn River	150,000	261,000		
Gunbower Creek	50,690	70,000		
Loddon River		107,000		
Macalister River				7,000
Maribyrnong River			75,000	
Mitchell River				44,000
Ovens River		54,000		
Rainbow Creek				1,000
Serpentine Creek		5,000		
Seven Creeks		1,000		
Snowy River			30,000	120,800
Tambo River				5,000
Thomson River				5,000
Timbarra River				10,000
Traralgon Creek				1,000
Tyers Lake			65,000	
Tyers River				2,000
Valencia Creek				
Wimmera River		80,000		
Total	334,066	748,000	232,000	273,300

318. Ibid

Threatened species and communities

Gillanders, Elsdon, Munro (2006) reviewed the impacts of native fish stocking in the Murray-Darling Basin.³¹⁹ They found that the impacts of stocking could include:

- competition between stocked fish and wild fish for food and habitat
- displacement and predation of native fish
- changes to the genetic structure of wild fish populations
- spread of disease.

The scientists also reported a lack of research on the impacts of fish stocking on the introduction of disease and the abundance and behavioural responses of native fish species, along with their genetics. They urged monitoring and risk assessments be carried out for fish stocking programs. An ecological risk assessment conducted for the release of Murray cod into South Australian waters identified a number of high risks including 'predation on some groups of organisms (e.g. common small-bodied native fish, rare/endorsed small-bodied native fish and other organisms), and displacement of rare/endorsed small-bodied native fish.'³²⁰

The most recent research into stocking of native fish was conducted by Tonkin et al. (2019), who assessed the success of native fish stocking in eight Victorian waterways.³²¹ This followed other research suggesting that stocking of water impoundments was successful, whereas the success of stocking in rivers was highly variable. In summary, their research showed that:

- there were considerable variations in the contribution and survival of stocked fish across and within waterways and species
- golden perch stocking may be contributing to fish populations in some rivers, especially in areas of poor natural recruitment or immigration, however the patterns varied
- stocked Murray cod made up only a small part of the riverine population, however they could contribute in rivers unsuited to self-sustaining populations, such as rivers affected by cold-water pollution from storages
- stocking of trout cod and Macquarie perch was important for the recovery of these threatened species. Hatchery practices that considered genetic structure contributed to the stocking success.

To improve stocking success, the scientists recommended increased investment in stocking programs and their evaluation, enhanced hatchery practices, habitat restoration and flow management.

In December 2019, a community-led project released 60 threatened freshwater catfish to the Mullinmur Billabong on the Ovens River.³²² The fish were translocated from Barham Lake in NSW to re-establish the species, which had become locally extinct due to changes in river management, the loss of habitat and the impact of exotic fish such as the European carp. Prior to the release, the local community had improved the health of the billabong by planting vegetation, removing carp and using pebbles to create catfish nesting sites.

In two releases in early 2020, four local wetlands in the Bendigo and Axe creeks received 1,600 captive-bred southern pygmy perch. The project is part of the North Central CMA's Native Fish Recovery Plan and the Tri-State Alliance 'Magnificent six' project.³²³ Once common, perch numbers in the wild have been in decline due to 'introduced fish such as redfin, trout and carp, as well as habitat destruction, altered flows, disconnection of floodplain wetlands, and more recently the Millennium Drought.'³²⁴

Howard et al. (2020) conducted condition monitoring of the eastern long-necked turtle and frogs in the Barmah-Millewa forest.³²⁵ The results for the turtles were mixed, with little evidence of recent recruitment (individuals less than three years old) but good sub-adult recruitment. This indicated their at least partial recovery from a mass mortality event during the Millennium Drought which, it has been suggested, was due to greater water availability from increased rainfall and environmental water and/or targeted fox baiting to protect nesting sites.³²⁶

319. Gillanders B, Elsdon T and Munro A 2006, 'Impacts of native fish stocking within the Murray-Darling Basin', Report for the Murray-Darling Basin Authority, Canberra, Australia.

320. Ibid

321. Tonkin Z, Kitchingman A, Ingram B, Lieschke J et al. 2019, 'Smarter stocking: a synthesis of existing data to assess native fish stocking success in Victorian rivers', unpublished client report for the Victorian Fisheries Authority, Arthur Rylah Institute, Heidelberg, Victoria.

322. Commonwealth Environmental Water Office, 'Whiskers for Christmas! Santa comes early for threatened catfish', media release, 23 December 2019, Canberra, Australia.

323. North Central Catchment Management Authority 2020, 'Releasing the wild pyggs', Huntly, Victoria <http://www.nccma.vic.gov.au/media-events/media-releases/releasing-wild-pyggs> Accessed 10 May 2021.

324. Ibid

325. Howard K, Durkin L, Beesley L, Gwinn D et al. 2020, 'The living Murray: turtle and frog condition monitoring in Barmah-Millewa Forest, report for the 2019/2020 survey season', unpublished client report for the Goulburn Broken Catchment Management Authority, Arthur Rylah Institute, Heidelberg, Victoria.

326. Information supplied by DELWP.

Threatened species and communities

Hawke, Bino and Kingsford (2019) investigated the link between river regulation and the number of platypus in the Upper Murray, Snowy and Border rivers regions.³²⁷ They found that in general, platypus numbers were lower downstream of the Dartmouth Dam than upstream, possibly due to changes in the seasonality and temperatures of water flows caused by the dam. However, there was no difference in numbers upstream and downstream of dams in the Snowy and Border rivers, possibly due to less severe regulation and also habitat restoration.

Bruce (2020) conducted a special needs elicitation for five threatened freshwater invertebrate species with the help of a number of experts.³²⁸ The purpose of the analysis was to identify key threats and actions required to minimise the risk of population declines in freshwater invertebrates as the result of future disturbances. Table 24 summarises the key actions for each of the five species, including permanent protection, revegetation, removal of stormwater and trout control.

Table 24: Actions required to minimise the risk of population declines from future disturbances.³²⁹

Species	Actions
Giant Gippsland earthworm <i>Megascoliodes australis</i> (Endangered)	Permanent protection • Prevent cultivation • Prevent soil disturbance • Avoid pesticide • Eliminate wastewater • Eliminate stormwater • Restoration Prevent soil compaction
Otway black snail, <i>Victaphanta compacta</i> (Endangered)	Permanent protection • Fire suppression
Ancient greenling damselfly, <i>Hemiphelbia mirabilis</i> (Endangered)	Shrub control • Mow fuel breaks • Restoration of native vegetation
Alpine stonefly, <i>Thaumatoperla alpina</i> (Endangered)	Trout control • Stream buffer • Permanent protection • Protection from resort development • Eliminate runoff
Dandenong burrowing crayfish, <i>Engaeus urostrictus</i> (Critically Endangered)	Fire suppression • Avoid pesticide • Eliminate wastewater • Eliminate stormwater • Control deer

327. Hawke T, Bino G and Kingsford R 2021, 'Damming insights: variable impacts and implications of river regulation on platypus populations', *Aquatic Conservation: Marine Freshwater Ecosystems*, 31, pp. 504–519.

328. Bruce M 2020, 'Biodiversity bushfire response: Taxon group specific needs – terrestrial invertebrates', unpublished client report for the DELWP Biodiversity Division, Arthur Rylah Institute, Heidelberg, Victoria.

329. Ibid

Threatened species and communities

Indicator B:04A Trout cod

Region Ovens River; Murray River; Goulburn River; Seven Creeks
Measures Abundance and distribution
Data Custodian DELWP

Indicator Performance:
2018 & 2021: Unable to be assessed due to Fair Status and Moderate Data Confidence
Why this indicator? Habitat restoration, restocking and environmental water delivery are significant actions being undertaken to help trout cod populations recover.

2018 Status	2018 Trend	2018 Data
2021 Status	2021 Trend	2021 Data

Potential thresholds for status in the SoE 2023 report

Good: No longer threatened and population numbers recovering

Fair: Conservation status is Near Threatened or of Least Concern

Poor: Remains Critically Endangered, Endangered or Vulnerable

OR

Good: Significant increasing trend in the abundance and distribution of the trout cod, and threats are being monitored, reported and mitigated

Fair: Stable or small increasing trend in the abundance and distribution of the trout cod, and threats are in part being monitored, reported and mitigated

Poor: Significant declining trend in the abundance and distribution of the trout cod, and threats are being monitored, reported or mitigated

Why this assessment in 2021?

Status: Although having suffered a widespread and long-term decline in distribution and abundance, major efforts by various government agencies and the community have led to a gradual increase in trout numbers and their return to a number of waterways. The Native Fish Report Cards indicate that the fish are breeding and surviving in the Goulburn and Ovens rivers. It was listed as Critically Endangered on the 2013 advisory list of threatened vertebrate species and is now considered Endangered in the new Flora and Fauna Guarantee Act Threatened List (which has replaced the advisory list). However, its current distribution remains much smaller than its historic distribution and the fish remains threatened.

Trend: The long-term decline in the population of the trout cod has in recent years been halted by management actions and its distribution has expanded, albeit from a low base. Indications are that it is either stable or improving. The Trend has been kept at Stable and will again be reviewed for the SoE 2023 report.

Data Confidence: Data are limited to those waterways subject to actions to improve river condition. The Native Fish Report Cards are a useful source of data on presence, absence, size structure and recruitment. However, the report cards for 2020 were not yet released at time of preparing this report.

Should this indicator be used in the SoE 2023 report?

Not in its current form. Consideration could be given to merging it and B:04B (Macquarie perch) with B:13 Fish and represent large-bodied fish. A new indicator could be established for small-bodied freshwater fish.

Summary of SoE 2018 Report assessment

- Since 2010, populations across the surveyed waterways were stable or increasing in their abundance and distribution.
- The trend was likely due to a combination of drought recovery, riparian and in-stream habitat restoration, environmental water delivery, conservation stocking, community education and fisheries regulations.

The 2019–20 bushfires: Impacts and responses

Trout cod distribution is largely outside the fire-affected areas. However, reports of the impacts of the 2019–20 bushfires in the Towong Shire in north-eastern Victoria indicated that the fires had affected downstream water quality and the trout cod.³³⁰

330. Ortolan M 2020, 'Endangered trout cod may be saved by bushfire recovery efforts', *ABC Goulburn Murray*, 25 April 2020.

Threatened species and communities

SoE Biodiversity Update 2021 Report assessment

The trout cod was once abundant and widespread, however its population declined due to threats that included river regulation, dam construction, cold-water releases from dams, overfishing, invasive species such as brown trout, and the de-snagging of rivers, which removed instream woody habitat. The trout cod was first listed as threatened in 1980.

From the mid-1980s, hatchery-bred trout cod have been released into the waterways of the Murray-Darling Basin, including the lower and mid reaches of the Ovens River as part of an integrated project that included re-snagging of instream woody habitat, fencing and restoration of riparian vegetation and the installation of fishways. Trout cod have also been released into the Goulburn River and, like the Ovens River population, is breeding and self-sustaining.³³¹

Koehn et al. (2013) described the recovery actions of three successive national recovery plans that have helped expand the distribution of the trout cod in the Murray-Darling Basin.³³² The recovery actions included monitoring, habitat restoration, education, strengthened regulations, population modelling and stocking of hatchery-bred fish. The scientists remained cautiously optimistic of the continued recovery of the trout cod, however stressed the need for long-term funding commitments and greater consideration of climate change impacts in recovery plans. Figure 24 shows the contraction from the historic distribution of the trout cod to its 1990 distribution, and then its subsequent expansion to 2012.

The Ovens River Demonstration Reach project (2008–16) brought the community, Arthur Rylah Institute and the Victorian Fisheries Authority together to improve river health and reintroduce trout cod.³³³ The project involved re-snagging, the construction of fishways and fish 'motels' (fish habitat formed from logs placed in the river), the replanting and fencing of riparian vegetation, the removal of European carp and willows, fencing, fish stocking and angler education. Breeding and recruitment in the trout cod population is now occurring (a 270% increase in trout cod numbers was recorded between 2008 and 2014).³³⁴

In 2019 the conservation status of the trout cod on the IUCN Red List was changed from Endangered to Vulnerable. However, the threatened species lists under the EPBC Act and the *Flora and Fauna Guarantee Act* have its conservation status as Endangered. As such, there is a national recovery plan (released in 2008) for the species and a Victorian Flora and Fauna Guarantee action statement (not updated since its release in 1993). The Victorian Fisheries Authority Freshwater Fisheries Management Plan identifies trout cod as a threatened iconic recreational species. Threatened fish, including trout cod, are an environmental value in the regional priority-setting process that underpins the development of regional waterway strategies by catchment management authorities.

The recovery strategy under the trout cod's 2008 national recovery plan continued the 'focus on protection and management of locations with natural and reintroduced populations of trout cod, continuing stockings, and monitoring stocked populations for establishment and reproduction'. The plan suggested that the fish 'could benefit from integrated catchment management initiatives, including maintaining or restoring environmental flows, and protection and revegetation of riparian zones to increase streamside cover and reduce erosion and sediment input into waterways.'³³⁵

331. DELWP 2018, 'Recovering trout cod in the Ovens River: a threatened species success story', East Melbourne, Victoria.

332. Koehn J, Lintermans M, Lyon J, Ingram B et al. 2013, 'Recovery of the endangered trout cod, *Maccullochella macquariensis*: what have we achieved in more than 25 years?' *Marine and Freshwater Research*, 64, pp. 822–837.

333. DELWP 2018, 'Recovering trout cod in the Ovens River: a threatened species success story', East Melbourne, Victoria.

334. Department of Environment and Primary Industries 2014, 'Ovens cod love river rehabilitation', East Melbourne, Victoria.

335. Department of Sustainability and Environment 2008, 'National recovery plan for the trout cod *Maccullochella macquariensis*', East Melbourne, Victoria.

Threatened species and communities

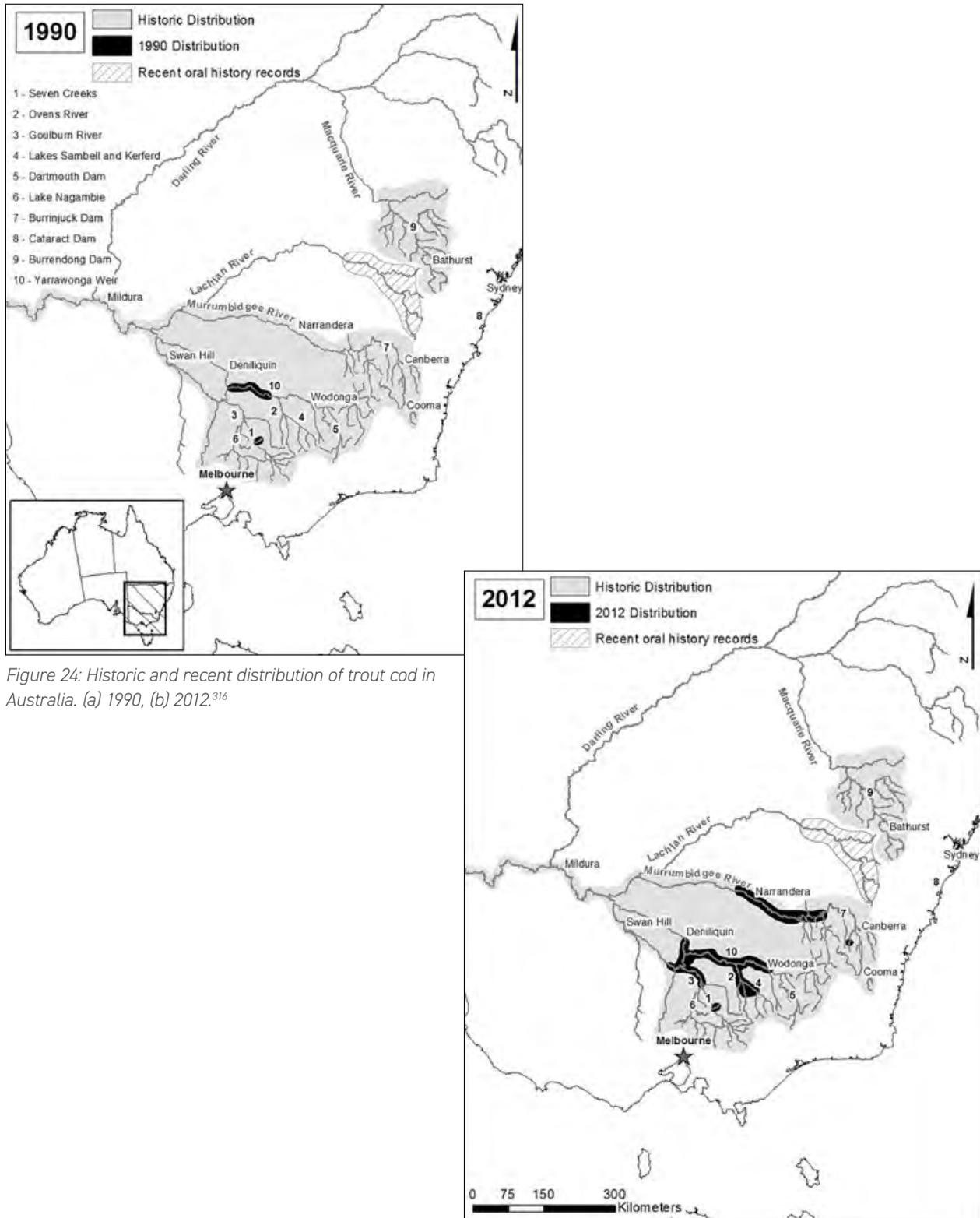


Figure 24: Historic and recent distribution of trout cod in Australia. (a) 1990, (b) 2012.³¹⁶

336. Reproduced with permission from CSIRO Publishing from Koehn JD, Lintermans M, Lyon JP, Ingram BA et al. 2013 'Recovery of the endangered trout cod, *Maccullochella macquariensis*: what have we achieved in more than 25 years? *Marine and Freshwater Research*, 64, pp. 822-837.

Threatened species and communities

Indicator B:04B Macquarie perch

Region Ovens River; Lake Dartmouth; Seven Creeks; King Parrot Creek; Hughes Creek; Yea River; Hollands Creek; Yarra River; Broken River; Buffalo (upper) River

Measures Abundance and distribution

Data Custodian DELWP

Indicator Performance:

2018: Unable to be assessed due to Fair Status

2021: 

Why this indicator? The Macquarie perch is the focus of habitat improvement projects along some of Victoria's rivers. Approximately 20% of the Macquarie perch's modelled habitat in Victoria is within the 2019–20 fire extent.

2018 Status	2018 Trend	2018 Data
		
2021 Status	2021 Trend	2021 Data
		

Potential thresholds for status in the SoE 2023 report

Good: No longer threatened and population numbers recovering

Fair: Conservation status is Near Threatened or of Least Concern

Poor: Remains Critically Endangered, Endangered or Vulnerable

OR

Good: Significant increasing trend in the abundance and distribution of the Macquarie perch, and threats are being monitored, reported and mitigated

Fair: Stable or small increasing trend in the abundance and distribution of the Macquarie perch, and threats are in part being monitored, reported and mitigated

Poor: Significant declining trend in the abundance and distribution of the Macquarie perch, and threats are being monitored, reported or mitigated

Why this assessment in 2021?

Status: Macquarie perch has suffered a widespread and long-term decline in distribution and abundance over the past 30 years and survives in fragmented and isolated populations. Recent stocking has assisted the development of viable populations in several locations e.g. Ovens River, after actions to improve river condition and remove carp. However, the perch remains Endangered and described by Tonkin et al. (2019) as 'imperilled'.

Trend: The long-term trend is one of decline, the short-term Trend is on average, Stable. However, since the SoE 2018 Report, several smaller populations in the Goulburn Broken catchment have declined. The predicted reduction of river flows due to climate change could continue the long-term trend. The impacts of the 2019–20 bushfires are as yet unreported. This report suggests that a Status of Poor in the SoE 2018 Report would have better reflected the circumstances for the species and does not intend to indicate that the Status has worsened between 2018 and 2021 or that there is a contradiction in assigning a stable Trend.

Data Confidence: Although limited, the quality of data is Good.

Should this indicator be used in the SoE 2023 report?

Not in its current form. Consideration could be given to merging it and B:04A (trout cod) with B:13 Fish and focus on large-bodied fish. A new indicator could be established for small-bodied fish e.g. galaxiids

Summary of SoE 2018 Report assessment

- Since 2012, populations across the surveyed waterways were stable or increasing in their abundance and distribution.
- The trend was likely due to a combination of drought recovery, riparian and in-stream habitat restoration, environmental water delivery, conservation stocking, community education and fisheries regulations.

The 2019–20 bushfires: Impacts and responses

Roughly 20% of the Macquarie perch's modelled Victorian habitat was within the 2019–20 fire extent, with populations in Lake Dartmouth and the Buffalo River severely affected. In response to threats from the bushfires, 32 individuals were extracted from the Buffalo River near Abbeyard, where the species was most impacted, and translocated to Snobs Creek.

Threatened species and communities

This was conducted by expert teams including DELWP, Arthur Rylah Institute staff and Parks Victoria, and funded by the Victorian Government's Bushfire Biodiversity Early Relief and Recovery Program. The fish were later returned once river conditions had improved. In May 2021, 400 Macquarie perch were translocated from the Dartmouth Dam to the fire-affected upper Buffalo River.³³⁸

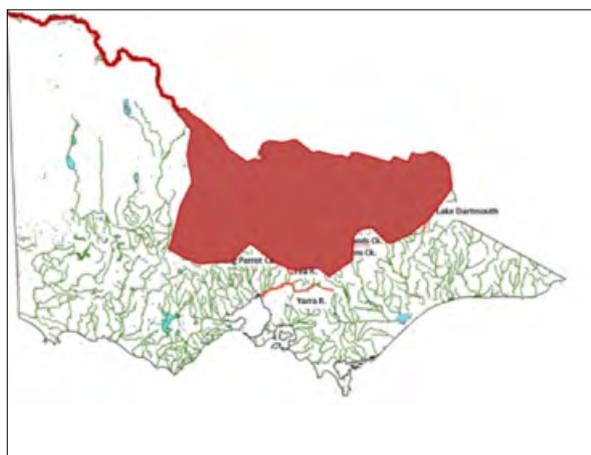
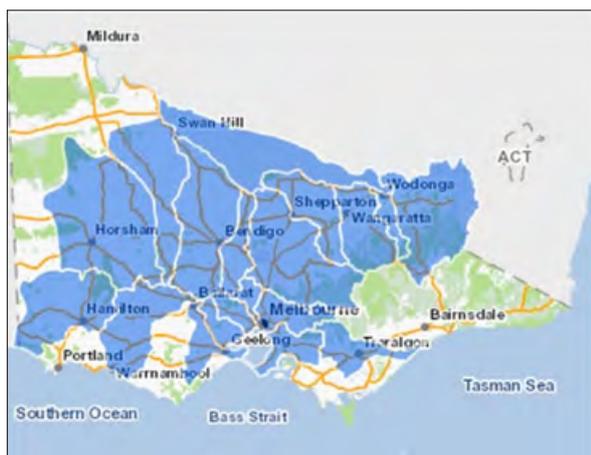


Figure 25: Historic (a) and current (b) distribution of Macquarie perch in Victoria.³⁴⁰

SoE Biodiversity Update 2021 Report assessment

Since 2008, Macquarie perch have been monitored in the following water systems: Ovens River; Lake Dartmouth; Seven Creeks; King Parrot Creek; Hughes Creek; Yea River; Hollands Creek; Yarra River; Broken River; upper Buffalo River. DELWP has been working to relocate Macquarie perch as part of its Natural Environment Program.

Figure 25 maps the historic and current distribution of Macquarie perch. The historic distribution includes areas where the perch had been stocked beyond its natural range and where stocking no longer occurs. The current distribution comprises 11 fragmented populations, each found in degraded habitats and placing the future of the fish in doubt. Since 2018, several smaller populations in the Goulburn Broken catchment have declined.³³⁹

The causes of the Macquarie perch's plight include barriers to migration, cold water releases from dams, habitat fragmentation and degradation, competition with trout and redfin, and overfishing.³⁴¹ Todd and Lintermans (2015) observed that: 'Continuing to simply manage existing populations is unlikely to result in recovery of the species, and the establishment of additional populations is a key recovery activity.'³⁴² However, the scientists also reported that captive breeding programs had been problematic and ceased in the 1990s. Their research project involved the development of a population model to support the translocation of individuals from existing populations to new areas. However, breeding practices remain challenging. Wild-harvest breeding is still being used while work continues to establish captive breeding.³⁴³

A Demonstration Reach project centred on the Ovens River, a largely unregulated waterway, has involved habitat restoration – re-snagging, fencing and restoration of riparian vegetation, removal of carp and improvements to a fishway, a five-year stocking program that began in 2013–14, and the translocation of up to 1,100 individuals from Dartmouth Dam.³⁴⁴ Monitoring indicates that the perch, which had been locally extinct, now has a self-sustaining population.³⁴⁵

338. DELWP 2021, 'Bushfire biodiversity response and recovery update May 2021', PowerPoint presentation.

339. Information supplied by DELWP Biodiversity Division.

341. Ibid.

342. Todd C and Lintermans M 2015, 'Who do you move? A stochastic population model to guide translocation strategies for an endangered freshwater fish in south-eastern Australia', *Ecological Monitoring*, 311, pp. 63–72.

343. Information supplied by DELWP Biodiversity Division.

344. Arthur Rylah Institute, 'Re-introduction of Macquarie perch into the Ovens River 2016' <https://www.ari.vic.gov.au/research/rivers-and-estuaries/victorian-demonstration-reach-program> Accessed 20 August 2021.

345. Arthur Rylah Institute, 'Recovering Macquarie perch', Heidelberg, Victoria <https://www.ari.vic.gov.au/research/threatened-plants-and-animals/recovering-macquarie-perch> Accessed 10 May 2021.

Threatened species and communities

Tonkin et al. (2019) found that the remaining fragmented and isolated populations of Macquarie perch, 'face a heightened risk of poor recruitment periods' due to 'increased vulnerability to stochastic events such as extreme drought, flood and bushfire' ... and ... 'a reduced resilience to environmental extremes, particularly those which are likely to be exacerbated by climate change.'³⁴⁶ They concluded that the 'forecasting and management of long-lived freshwater fish must incorporate multi-year planning to include factors such as the maintenance of refuges, connectivity and increased protection of mature fish to aid recovery.'

The threatened species lists under the EPBC Act and the *Flora and Fauna Guarantee Act 1988* have the Macquarie perch as Endangered. Although there is no Victorian action statement for the species, a national recovery plan for the species was released in 2018.³⁴⁷ Threatened fish, including Macquarie perch, are an environmental value in the regional priority setting process that underpins the development of regional waterway strategies.

The national recovery plan's overarching objective is to: 'Ensure the recovery and ongoing viability of Macquarie perch populations throughout the species' range.'

To achieve this, the plan has six recovery strategies:

1. Conserve existing Macquarie perch populations.
2. Protect and restore Macquarie perch habitat.
3. Understand and address threats to Macquarie perch populations and habitats.
4. Establish additional Macquarie perch populations within the species' natural range.
5. Improve understanding of the biology and ecology of the Macquarie perch and its distribution and abundance.
6. Increase participation by community groups in Macquarie perch conservation.

The federally funded project 'Releasing Macquarie perch and restoring fish habitat in bushfire affected areas', will undertake the restoration of 20 kilometres of riparian habitat impacted by bushfires to improve habitat for turtles, fish and crayfish. The project will also collect mature Macquarie perch to be used in a breeding and release program in the Buffalo River. Landcare Australia, Native Fish Australia and OzFish are delivering the project at multiple locations across Victoria, NSW and Queensland.

346. Tonkin Z, Sharley J, Fanson B, Raymond S et al. 2019, 'Climate variability regulates population dynamics of a threatened freshwater fish', *Endangered Species Research*, 40, pp. 257–270.

347. Department of the Environment and Energy 2018, 'National recovery plan for the Macquarie perch (*Macquaria australasica*)', Canberra, Australia.

Threatened species and communities

Indicator B:04C Murray crayfish

Region Southern Murray-Darling Measures Abundance and distribution Data Custodian DELWP	Indicator Performance: 2018 & 2021: Unable to be assessed due to Moderate Data Confidence Why this indicator? This freshwater crayfish is one of a number of threatened crayfish species found in Victoria.	2018 Status	2018 Trend	2018 Data
		2021 Status	2021 Trend	2021 Data

Potential thresholds for status in the SoE 2023 report

Good: No longer threatened and population numbers recovering

Fair: Conservation status is Near Threatened or of Least Concern

Poor: Remains Critically Endangered, Endangered or Vulnerable

OR

Good: Significant increasing trend in the abundance and distribution of the Murray crayfish, and threats are being monitored, reported and mitigated

Fair: Stable or small increasing trend in the abundance and distribution of the Murray crayfish, and threats are in part being monitored, reported and mitigated

Poor: Significant declining trend in the abundance and distribution of the Murray crayfish, and threats are not being monitored, reported or mitigated

Why this assessment in 2021?

Status: The Murray crayfish has experienced a long-term reduction in distribution and abundance, and its three strongholds are experiencing population declines.

Trend: The long-term decline in abundance is continuing.

Data Confidence: Reports in 2017 and 2018 have improved the quality of data, however knowledge gaps remain e.g. early life history, length-fecundity relationships and survival rates.

Should this indicator be used in the SoE 2023 report?

Not in its current form. Consideration could be given to merging it with B:06C, which would have a renewed focus on mega macroinvertebrates such as freshwater crayfish.

Summary of SoE 2018 Report assessment

- The Murray crayfish is the world's second-largest freshwater crayfish.
- Recreational harvesting, river regulation, pesticides and pollutants, habitat change and events of low dissolved oxygen have contributed to declines in the distribution and abundance of the Murray crayfish.
- Modelling suggested that Murray crayfish face a high risk of population declines due to increasing fishing pressure, particularly when combined with a hypoxic blackwater event.

The 2019–20 bushfires: Impacts and responses

At least one news report suggested that Murray crayfish in the upper Murray were affected by the fires.³⁴⁸

The federally funded biodiversity recovery project, 'Saving the spinys: urgent actions to conserve the *Euastacus* freshwater crayfish', will support the recovery of the 22 priority *Euastacus* species (freshwater crayfish) affected by the bushfires by identifying critical populations, exploring the feasibility of conservation translocations, and determining how to best conserve each species. It is being delivered by NatureGlenelgTrust and several research institutions at multiple locations across eastern Victoria, through NSW and the ACT, and up to southern Queensland.

348. Thomson B 2020, '40kg Murray cod among thousands of fish killed in Upper Murray', *Canberra Times*, 24 January 2020.

Threatened species and communities

SoE Biodiversity Update 2021 Report assessment

The Murray spiny crayfish occurs in the southern Murray-Darling Basin, grows up to 50 centimetres in length and three kilograms in weight and can live for 25 years or more. Its distribution and abundance have declined since the 1950s. For many years it was harvested commercially and, although this was banned in 1987, recreational fishing continues. A conservation stocking program began in 2017 when 200 crayfish were translocated to a downstream area of the Murray River where their numbers had declined significantly.³⁴⁹

A 2017 review of the recreational fishery for the Murray spiny crayfish 'only identified moderate to high relative abundance of the species in three areas – the mid-Goulburn River (from Seymour to upstream of Shepparton), the lower Ovens River (downstream of Wangaratta to Murray junction) and Wodonga Creek,' areas that 'have undergone declines in abundance over the past 25 years.' Elsewhere, the study found the species in low abundance or absent from sample sites.³⁵⁰

Figure 26 shows crayfish distribution and relative abundance as mapped by the survey, with the three key areas indicated by large green circles. The lowland areas are shaded blue, the upland areas dark green.

According to Whiterod (2017), an extreme blackwater event in 2010–11 caused an 80% decline in crayfish numbers in the affected area. Monitoring since then by the NatureGlenelgTrust has shown only a slow recovery, and in some areas the crayfish remains absent. However, monitoring of areas unaffected by the blackwater event show healthy populations that may have benefited from the strengthening of recreational fishing regulations.³⁵¹

The effectiveness of the changes to recreational fishing regulations – bag limits, size limits, shortened fishing season and reduced fishing area – was reviewed by Forbes et al. (2020). They developed a population model that indicated the new fishing regulations introduced in 2013 would help stabilise the population over time – monitoring would be required over decades because of the slow recovery time.³⁵² Their study also identified that illegal fishing and overfishing were important factors in the decline of the species.

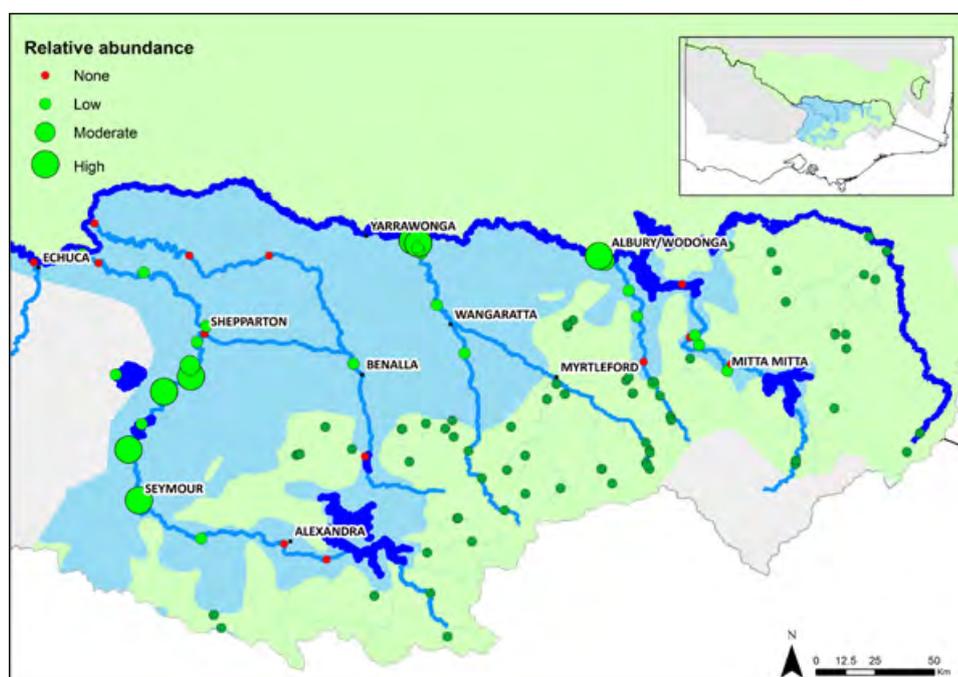


Figure 26: Relative abundance of Murray spiny crayfish in Victoria.³⁵³

349. Lovett S 2018, 'Population models help assess risk for threatened Murray crayfish', *Finterest*, 12 March 2018.

350. Whiterod N and Zukowski S 2017, 'The status of the Murray crayfish recreational fishery in Victoria', Aquasave – Nature Glenelg Trust, Goolwa Beach.

351. Whiterod N 2017, 'Murray crayfish part 1: tracking recovery of populations impacted by blackwater disturbance', Nature Glenelg Trust, Mount Gambier <https://natureglenelg.org.au/murray-crayfish-part-1-tracking-recovery-of-populations-impacted-by-blackwater-disturbance/> Accessed 10 May 2021.

352. Forbes J, Todd C, Baumgartner L, Watts R et al. 2020, 'Simulation of different fishery regulations to prevent population decline in a large freshwater invertebrate, the Murray crayfish (*Euastacus armatus*)', *Marine and Freshwater Research*, 71, pp. 962–971.

353. Whiterod N and Zukowski S 2017, 'The status of the Murray crayfish recreational fishery in Victoria', Aquasave – Nature Glenelg Trust, Goolwa Beach, South Australia.

Threatened species and communities

Indicator B:04D Spotted tree frog

Region Ovens River; Murray River; Goulburn River; Seven Creeks Measures Abundance and distribution Data Custodian DELWP	Indicator Performance: 2018: 2021:		2018 Status	2018 Trend	2018 Data
	Why this indicator? Frogs are a good indicator of environmental health and have been directly impacted by the bushfires.		2021 Status	2021 Trend	2021 Data

Potential thresholds for status in the SoE 2023 report

Good: No longer threatened and population numbers recovering

Fair: Conservation status is Near Threatened or of Least Concern

Poor: Remains Critically Endangered, Endangered or Vulnerable

OR

Good: Significant increasing trend in the abundance and distribution of the spotted tree frog, and threats are being monitored, reported and mitigated

Fair: Stable or small increasing trend in the abundance and distribution of the spotted tree frog, and threats are in part being monitored, reported and mitigated

Poor: Significant declining trend in the abundance and distribution of the spotted tree frog, and threats are not being monitored, reported or mitigated

Why this assessment in 2021?

Status: The spotted tree frog remains critically endangered and 22% of its habitat was impacted by the 2019–20 bushfires.

Trend: Field surveys in 2020 at seven locations confirmed that bushfires, subsequent flooding and the chytrid fungus had significant impacts on the frog's populations.

Data Confidence: 2020 surveys have enhanced the available data.

Should this indicator be used in the SoE 2023 report?

Not in its current form. Consideration could be given to merging this indicator and indicators B:04E and B:04F with B:12 (Frogs)

Summary of SoE 2018 Report assessment

- The endangered spotted tree frog is restricted to the upland streams of south-eastern Australia.
- The frog's two key threats are chytrid fungus and the predatory brown and rainbow trouts, both introduced fish species.

The 2019–20 bushfires: Impacts and responses

Data from the Ovens River, Murray River, Goulburn River and Seven Creeks were used for this indicator in the SoE 2018 report, regions largely outside the 2019–20 fire extent. However, DELWP estimated that 22% of the modelled habitat of the spotted tree frog was within the fire extent, 14% was affected by high-severity fire, and four significant populations were impacted. Following the fires, reconnaissance surveys, genetic testing and a species risk analysis (it was assessed as very high risk) were carried out for the frog.

Threatened species and communities

Researchers from DELWP and the University of Melbourne conducted post-bushfire surveys of the spotted tree frog at seven locations.³⁵⁴ They found significant impacts on frog populations from the fires, subsequent flooding and the chytrid fungus, with exotic fish species also a contributing factor. Before the 2019–20 bushfires the population of the spotted tree frog was estimated to be 1,500, whereas after the fires it is now thought to be only 1,000.³⁵⁵ The eight distinct populations in north-eastern Victoria and southern NSW were reduced to seven, some with populations now in the tens, whereas prior to the fires there would have been hundreds.³⁵⁶

SoE Biodiversity Update 2021 Report assessment

The spotted tree frog is Critically Endangered on the Flora and Fauna Guarantee Threatened List. Its population has been declining due to the chytrid fungus and introduced trout, European carp and redfin. Predation of tadpoles by the non-native fish reduces the capacity of the species to recover.

West (2018) reported on the status of two population of the spotted tree frog in north-eastern Victoria, noting that the species had 'already disappeared from 50% of known historic sites, is rare at all remaining sites and is predicted to continue to decline without intervention.'³⁵⁷ Populations at the two sites surveyed were small, with means of less than 20 individuals, and in a slow decline. Throughout the survey period from 1992–2016, the author observed brown and rainbow trout, carp and redfin, which prey on the eggs and tadpoles of the spotted tree frog.

Earlier research by West (2015) had shown that the frog populations were sensitive to predation in the egg to Year 1 life stages. Although trout removal from these sites had in the past been resisted by anglers, a trout management plan has been agreed to for one of the sites.³⁵⁸ The plan could be seen as a model for the control of exotic fish elsewhere in Victoria.

The action statement for this species has not been updated since it was released in 2000, and the national recovery plan covered just the years from 1998 to 2002. In terms of captive breeding and the re-establishment of populations, the key actions identified in the EPBC Act Conservation Advice (approved 13 July 2017) for the spotted tree frog are to:

'maintain captive populations as a source of animals for re-introduction or assisted migration programs, research into reproductive biology threatening processes and as a public education resource.'

'implement augmentation and re-introduction programs in streams where the species historically occurred and where it has been assessed that key threats can be managed or mitigated. Captive breeding and successful reintroduction have already been demonstrated for spotted tree frogs at Bogong Creek in NSW. A similar reintroduction program is planned for Buffalo Creek in Victoria. These exercises require detailed planning, and lessons learnt during these projects will underpin any similar projects in the future.'

'consider assisted migration of spotted tree frogs into suitable habitat if threats can be better managed at the recipient sites.'³⁵⁹

In March 2021, 26 spotted tree frogs were collected in north-eastern Victoria to commence a captive breeding program, the Spotted Tree Frog Project, at Zoos Victoria's Healesville Sanctuary.³⁶⁰ Nineteen individuals are now housed in temperature-controlled accommodation and, over the coming decades, their offspring will be grown into young frogs for release into the wild when conditions are suitable.³⁶¹

354. DELWP 2020, 'New hope for critically endangered frog species, East Melbourne, Victoria' <https://www.delwp.vic.gov.au/media-centre/media-releases/new-hope-for-critically-endangered-frog-species> Accessed 10 May 2021.

355. Webb C 2021, 'Frog-et them not: "decades-long" quest starts to save endangered frog', *The Age*, 8 July 2021.

356. *Ibid*

357. West M 2018, 'Survey and monitoring of the spotted tree frog populations to inform conservation actions, final report on little brown things project agreement 1', University of Melbourne, Parkville, Victoria.

358. *Ibid*

359. Threatened Species Scientific Committee 2017, 'Conservation advice *Litoria spenceri* spotted tree frog', Canberra, Australia.

360. DELWP 2021, 'Bushfire biodiversity response and recovery update May 2021', PowerPoint presentation.

361. *Ibid*

Threatened species and communities

Indicator B:04E Booroolong tree frog

Region North-eastern Victoria	Indicator Performance:	2018 Status	2018 Trend	2018 Data
Measures Abundance and distribution	2018:  2021: 			
Data Custodian DELWP	Why this indicator? Like the spotted tree frog, this frog's population has been declining due to habitat loss, chytrid fungus and predatory fish. Post-fire sedimentation has also impacted its population.	2021 Status	2021 Trend	2021 Data
				

Potential thresholds for status in the SoE 2023 report

Good: No longer threatened and population numbers recovering

Fair: Conservation status is Near Threatened or of Least Concern

Poor: Remains Critically Endangered, Endangered or Vulnerable

OR

Good: Significant increasing trend in the abundance and distribution of the Booroolong tree frog, and threats are being monitored, reported and mitigated

Fair: Stable or small increasing trend in the abundance and distribution of the Booroolong tree frog, and threats are in part being monitored, reported and mitigated

Poor: Significant declining trend in the abundance and distribution of the Booroolong tree frog, and threats are not being monitored, reported or mitigated

Why this assessment in 2021?

Status: There is no evidence to support a change of this status from Poor. The 2019–20 bushfires impacted 39% of its habitat.

Trend: As above.

Data Confidence: The Booroolong tree frog is the focus of considerable research.

Should this indicator be used in the SoE 2023 report?

Not in its current form. Consideration could be given to merging this indicator and indicators B:04D and B:04F with B:12 (Frogs)

Summary of SoE 2018 Report assessment

- The endangered Booroolong frog is found in streams to the west of the Great Dividing Range.
- The frog's three key threats are habitat loss, chytrid fungus and the predatory carp, redfin perch and mosquito fish, all introduced fish species.

The 2019–20 bushfires: Impacts and responses

The 2019–20 bushfires had direct impacts and post-fire aquatic impacts on this frog with 38% of its modelled habitat in the fire extent and 36% impacted by high-severity fire. Two of its three Victorian populations were affected³⁶² and the genetic risk for the species was assessed as very high.

SoE Biodiversity Update 2021 Report assessment

The Booroolong tree frog is listed as Critically Endangered under the *Flora and Fauna Guarantee Act* Threatened List. In Victoria it is found predominantly in streams west of the Great Dividing Range, although most of its population is found in NSW, and a number are held in captivity.

362. DELWP 2020, 'Victoria's bushfire emergency: biodiversity response and recovery, version 2', East Melbourne, Victoria.

363. Zoo and Aquarium Association 2020, 'Strategic biobanking for threatened frogs', Mosman, NSW <https://zooaquarium.org.au/public/Public/Conservation/-Strategic-biobanking-for-threatened-frogs.aspx> Accessed 9 May 2021.

Threatened species and communities

The Booroolong tree frog is one of four frogs (spotted tree frog is another) that are having their sperm collected and frozen to preserve their genetics for future captive breeding and release programs.³⁶³ The frog biobank is a joint project between Zoos Victoria, Taronga Zoo, the University of Wollongong and University of Newcastle, and the NSW Department of Planning, Industry and Environment.

The Victorian Flora and Fauna Guarantee action statement for this tree frog has not been updated since it was released in 2001, while the national recovery plan was released in 2012. The recovery plan identified the main threats facing the Booroolong tree frog as the chytrid fungus, declining stream flows, disease, habitat degradation, trout and other introduced fish, and the use of herbicides. To minimise the probability of the frog's extinction in the wild, and to increase the probability of self-sustaining and viable populations, the plan aims to, among other things, reduce and manage the impact of perceived threats, including climate change, and determine population distributions and trends.

363. Zoo and Aquarium Association 2020, 'Strategic biobanking for threatened frogs', Mosman, NSW <https://zooaquarium.org.au/public/Public/Conservation/-/Strategic-biobanking-for-threatened-frogs.aspx> Accessed 9 May 2021.
364. Office of Environment and Heritage NSW 2012, 'National recovery plan for Booroolong frog *Litoria booroolongensis*', Sydney, NSW.

Indicator B:04F Baw Baw frog

Region Mt Baw Baw Plateau and escarpment

Measures Abundance and distribution

Data Custodian DELWP

Indicator Performance:

2018:  2021: 

Why this indicator? This is Victoria's only endemic frog and is in decline due to chytrid fungus, habitat loss and degradation in their restricted range on the Baw Baw Plateau and escarpment.

2018 Status 2018 Trend 2018 Data

2021 Status 2021 Trend 2021 Data

Potential thresholds for status in the SoE 2023 report

Good: No longer threatened and population numbers recovering

Fair: Conservation status is Near Threatened or of Least Concern

Poor: Remains Critically Endangered, Endangered or Vulnerable

OR

Good: Significant increasing trend in the abundance and distribution of the Baw Baw frog, and threats are being monitored, reported and mitigated

Fair: Stable or small increasing trend in the abundance and distribution of the Baw Baw frog, and threats are in part being monitored, reported and mitigated

Poor: Significant declining trend in the abundance and distribution of the Baw Baw frog, and threats are not being monitored, reported or mitigated

Why this assessment in 2021?

Status: The frog remains Critically Endangered and its population continues to decline.

Trend: Its population continues to decline.

Data Confidence: The Baw Baw frog is the focus of considerable research.

Should this indicator be used in the SoE 2023 report?

Not in its current form. Consideration could be given to merging this indicator and indicators B:04D and B:04E with B:12 (Frogs)

Threatened species and communities

Summary of SoE 2018 Report assessment

- The Critically Endangered Baw Baw frog is Victoria's only endemic frog.
- Habitat loss and degradation and the chytrid fungus are its key threats.

The 2019–20 bushfires: Impacts and responses

The remaining population of the Baw Baw frog is outside the area burnt by the 2019–20 bushfires.

SoE Biodiversity Update 2021 Report assessment

The Baw Baw frog lives on the Mount Baw Baw Plateau and escarpment. It is classified as Critically Endangered on the Flora and Fauna Guarantee Threatened List and its population continues to decline³⁶⁵ – numbers are below 1,000³⁶⁶ in the wild.

Geyle et al. (2021) used expert elicitation to assess the probability of extinction by 2040 for 26 Critically Endangered and Endangered Australian frogs. The Baw Baw frog was assessed as having a 65% chance of extinction. For the frogs in general, the scientists concluded that: 'Increased resourcing and management intervention are urgently needed to avert future extinctions of Australia's frogs. Key priorities include developing and supporting captive management and establishing or extending in-situ population refuges to alleviate the impacts of disease and climate change.'³⁶⁷

The frog's small population is spread across an area of approximately 135 km² of sub-alpine heathland and woodland on the plateau and montane habitats on the escarpment, which include cool temperate rainforest, mixed forest and wet forest. Once considered relatively common, since 1983 its population has dramatically declined, with the likely causes including climate change and the chytrid fungus, along with habitat disturbance, timber harvesting, fire, ski resort operations, increased UV-B radiation, predation by invasive species and potentially air pollution.³⁶⁸

Burns et al. (2020) investigated the transmission process of the chytrid fungus from a reservoir host, the common froglet, to a susceptible host species, the Baw Baw frog. The common froglet was unaffected by the fungus, whereas all Baw Baw frogs in the research project died. The analysis showed that neither species 'need to be in the same place at the same time, or within an aquatic environment for transmission to occur.'³⁶⁹ Transmission of the chytrid fungus from the common froglet has been implicated in the decline of several frog species in south-eastern Australia.³⁷⁰

Zoos Victoria established a captive breeding program in 2011 and research has begun on the impact of the chytrid fungus.³⁷¹ In 2020, there were 25 male and 25 female adult frogs released into the wild with radio transmitters attached.³⁷² In the past, only frog eggs had been released into the wild. Zoos Victoria monitors and collects the data, which is then analysed by staff at the Baw Baw Shire.

In an effort to increase community awareness of the frog's plight, National Baw Baw Frog Day was launched on 18 November 2015 and is celebrated each year by the Zoos Victoria and other organisations.³⁷³

The Victorian Flora and Fauna Guarantee action statement for this species has not been updated since it was released in 2004. However, the national recovery plan for the species was prepared by Victoria's then Department of Sustainability and Environment and released in 2011. Its overarching objective was to improve the conservation status of the species, then Endangered. It is now regarded as Critically Endangered on both of the threatened species lists under the EPBC Act and the *Flora and Fauna Guarantee Act 1988*. Recovery plan actions include: population monitoring; chytrid fungus research; investigation of climate change impacts; habitat management, including pest plant and animal control and rehabilitation; captive management; raising community awareness.

365. DELWP, 'Baw Baw frog', East Melbourne, Victoria <https://www.environment.vic.gov.au/conserving-threatened-species/threatened-species/baw-baw-frog> Accessed 10 May 2021.

366. Zoos Victoria 2020, 'New hope for wild future of critically-endangered Victorian frogs', Parkville, Melbourne <https://www.zoo.org.au/melbourne/whats-on/news/new-hope-for-wild-future-of-critically-endangered-victorian-frogs/> Accessed 10 May 2021.

367. Geyle H, Hoskin C, Bower, Catullo R et al. 2021, 'Red hot frogs: identifying the Australian frogs most at risk of extinction', *Pacific Conservation Biology* <https://doi.org/10.1071/PC21019>.

368. Hollis G 2011, 'National recovery plan for the Baw Baw frog *Philoria frostii*', Department of Sustainability and Environment, East Melbourne, Victoria.

369. Burns T, Scheele B, Brannelly L, Clemann N et al. 2020, 'Indirect terrestrial transmission of amphibian chytrid fungus from reservoir to susceptible host species leads to fatal chytridiomycosis', *Animal Conservation*, doi.org/10.1111/acv.12665.

370. Ibid

371. DELWP, 'Baw Baw frog', East Melbourne, Victoria <https://www.environment.vic.gov.au/conserving-threatened-species/threatened-species/baw-baw-frog> Accessed 10 May 2021.

372. Zoos Victoria 2020, 'New hope for wild future of critically-endangered Victorian frogs', Parkville, Melbourne <https://www.zoo.org.au/melbourne/whats-on/news/new-hope-for-wild-future-of-critically-endangered-victorian-frogs/> Accessed 10 May 2021.

373. Ferguson Z 2015, 'Endangered Baw Baw frog has its own national awareness day', *ABC Gippsland*, 18 November 2015.

Threatened species and communities

Indicator B:05 Threatened wetland-dependent species

Region Statewide Measures Number, abundance and distribution Data Custodian DELWP	Indicator Performance: 2018 & 2021: Unable to be assessed due to Low Data Confidence and Unknown Status and Trend. Why this indicator? Wetlands provide essential services to the environment and the community that include food, nurseries and refuge for native wildlife, and recreational and cultural spaces. The status of wetland-dependent species can be an indicator of wetlands health.	2018 Status	2018 Trend	2018 Data
		2021 Status	2021 Trend	2021 Data

Potential thresholds for status in the SoE 2023 report

Good: No longer threatened and population numbers recovering

Fair: Conservation status is Near Threatened or of Least Concern

Poor: Remains Critically Endangered, Endangered or Vulnerable

OR

Good: Significant increasing trend in the abundance and distribution of the threatened wetland-dependent species, and threats are being monitored, reported and mitigated

Fair: Stable or small increasing trend in the abundance and distribution of the threatened wetland-dependent species, and threats are in part being monitored, reported and mitigated

Poor: Significant declining trend in the abundance and distribution of the threatened wetland-dependent species, and threats are not being monitored, reported or mitigated

Why this assessment in 2021?

Status: The use of more rigorous criteria in preparing the new Flora and Fauna Guarantee Threatened List has led to the conservation status of some threatened species of threatened wetland-dependent flora and fauna being upgraded e.g. from Vulnerable to Critically Endangered (some have also remained the same or been downgraded). Although the on-ground situation e.g. population size and habitat for the wetland-dependent species might not have changed since its last assessment, the new conservation status gives greater public recognition of their plight. The conservation status has been upgraded for 29 of the 75 species of fauna listed for this indicator (see Table 32). However, Low Data Confidence prevents a determination of Status.

Trend: Low Data Confidence prevents a determination of Status of Trend.

Data Confidence: Threatened wetland-dependent species are generally not monitored, except where they are a critical part of a Ramsar site ecological character description.

Should this indicator be used in the SoE 2023 report?

Yes, if the level of Data Confidence can be improved.

Summary of SoE 2018 Report assessment

- The majority of threatened wetland-dependent species of fauna are birds, followed by amphibians, fish, reptiles and mammals.
- The highest percentage of wetland-dependent species in each fauna group was associated with amphibians, followed by birds, fish, reptiles and mammals.

The 2019–20 bushfires: Impacts and responses

There are limited data on how the 2019–20 bushfires impacted wetlands and threatened wetland-dependent species. The bushfires burnt riparian vegetation along rivers and streams and around wetlands. The ash and debris that flowed into streams and rivers after rains could have also flowed into or through some wetlands.

Threatened species and communities

Table 25 summarises the impact that the fires had on 10 threatened amphibian, fish, mammal and reptile species that occur in Victoria's wetlands (for a larger list of threatened wetland species, see Table 26). The five threatened amphibian species had the greatest percentages of their modelled habitats within the fire extent and were also

impacted by high-severity fires. Although only 14% of its modelled habitat was affected by the fires and 9% by high-severity fires, it was reported that all of the sites of the alpine bog skink that had been monitored for the past 10 years were damaged by the fires.³⁷⁴

Table 25: Threatened species that occur in wetlands and impacted by the 2019-20 fires.³⁷⁵

Scientific Name	Common Name	% Modelled Habitat within Fire Extent	% Modelled Habitat Impacted by High-severity Fire
<i>Heleioporus australiacus</i>	Giant burrowing frog	75%	38%
<i>Litoria aurea</i>	Green and golden bell frog	53%	24%
<i>Litoria dentata</i>	Keferstein's tree frog	84%	53%
<i>Litoria littlejohni</i>	Large brown tree frog	88%	47%
<i>Uperoleia martini</i>	Martin's toadlet	31%	13%
<i>Galaxias rostratus</i>	Flatheaded galaxias	25%	unknown
<i>Ornithorhynchus anatinus</i>	Platypus	14%	6%
<i>Pseudomoia cryodroma</i>	Alpine bog skink	14%	9%
<i>Eulamprus kosciuskoi</i>	Alpine water skink	22%	14%
<i>Lisssolepis coventryi</i>	Swamp skink	17%	7%

SoE Biodiversity Update 2021 Report assessment

Since European settlement, Victoria has lost two-thirds³⁷⁶ or 4,000 (191,000 hectares) of its natural wetlands. Their decline in number, extent and condition continues due to climate change, water regulation, cropping, drainage and grazing. As a result, it would be expected that those species dependent on wetlands would also experience population declines and a reduced distribution. This has occurred with waterbirds in the Murray-Darling Basin, for example (see B:14).

Table 26 lists 73 threatened species of amphibians, freshwater fish, birds, mammals and reptiles that occur in Victoria's wetlands (their dependence on wetlands might not necessarily be throughout their entire life cycle). This list has been in part compiled from appendices in Morris (2012), which reviewed dispersal and biological connectivity for wetland species in Victoria.³⁷⁷ Threatened amphibian specialist and generalist species found in wetlands are included in the table, but not stream-based amphibians. Although the list excludes seabirds, it does include threatened migratory shorebirds that can also be found in coastal waters, saline wetlands or tidal mudflats. The list of fish species excludes those in marine habitats however it does include threatened species that can occur in estuaries as well as freshwater wetlands. Table 26 also includes

376. Environmental Defenders Office 2012, 'Protecting Victorian wetlands', Carlton, Melbourne.

377. Morris K 2012, 'Wetland connectivity: understanding the dispersal of organisms that occur in Victoria's wetlands', Arthur Rylah Institute technical report series no. 225, Heidelberg, Victoria.

Threatened species and communities

the conservation status of each species according to the new Flora and Fauna Guarantee Threatened List and the 2013 Advisory list of threatened vertebrate fauna in Victoria.^{378,378,380}

The conservation status in the Flora and Fauna Guarantee Threatened List for each fauna group in Table 26 are as follows:

- **Amphibians** - six critically endangered, four endangered, one vulnerable.
- **Freshwater fish** - three critically endangered, nine endangered, two vulnerable
- **Birds** - 12 critically endangered, 13 endangered and 15 vulnerable
- **Mammals** - two vulnerable.
- **Reptiles** - one critically endangered, five endangered.

When a comparison is made between the conservation status of each of the 73 species in the 2013 advisory list and the Flora and Fauna Guarantee Threatened List, 32 have had their status upgraded, eight have been downgraded and 33 have remained the same. Of the:

- 11 threatened amphibians - six remained the same, one was downgraded and four upgraded
- 14 threatened freshwater fish species - six remained the same, two were downgraded, and six upgraded
- 40 threatened bird species - 19 remained the same, three downgraded, 18 upgraded
- two threatened mammal species - both were upgraded
- six threatened reptile species - two remained the same, two downgraded and two upgraded.

Some caution is needed when comparing the conservation status of threatened wetland-dependent animal species between the 2013 threatened vertebrates advisory list and the 2021 Flora and Fauna Guarantee Threatened List. The new list was developed using the CAM and adhering strictly to IUCN Criteria, a more rigorous process than for the advisory lists. Overall, the re-assessment resulted in many taxa being upgraded to higher risk categories than in the advisory lists, although some taxa have also been downgraded to lower risk categories. Two factors responsible for the trend towards upgrading of threatened vertebrate species include new evidence and perspectives, including inferences about the likely future impacts of climate change, and the more rigorous CAM.

The IUCN's Criteria A to E were applied when preparing the Flora and Fauna Guarantee Threatened List. Criteria A to E are:

- A Population size reduction (measured over the longer of 10 years or 3 generations)
- B Geographic range
- C Small population size and decline
- D Very small or restricted population
- E Quantitative Analysis.

Each of Criteria A to E has thresholds for whether the taxon is Critically Endangered, Endangered or Vulnerable. For example, for Criteria D 'Very small or restricted population', Critically Endangered is <50 mature individuals, Endangered is <250 and Vulnerable is <1,000.

378. Flora and Fauna Guarantee Act Threatened List.

379. Department of Environment and Primary Industries 2013, 'Advisory list of threatened vertebrate fauna in Victoria - 2013', East Melbourne, Victoria.

380. Morris K 2012, 'Wetland connectivity: understanding the dispersal of organisms that occur in Victoria's wetlands', Arthur Rylah Institute technical report series no. 225, Heidelberg, Victoria.

Threatened species and communities

Table 26: Threatened fauna species that occur in Victorian wetlands.³⁸¹

Common Name	Scientific Name	Conservation Status 2021*	Conservation Status 2013**
Amphibians			
Alpine tree frog	<i>Litoria verreauxii alpina</i>	CR	CR
Baw Baw frog	<i>Philoria frosti</i>	CR	CR
Brown toadlet	<i>Pseudophryne bibronii</i>	EN	EN
Giant bullfrog	<i>Limnodynastes interioris</i>	EN	CR
Giant burrowing frog	<i>Heleioporus australiacus</i>	CR	CR
Growling grass frog	<i>Litoria raniformis</i>	VU	EN
Keferstein's tree frog	<i>Litoria dentata</i>	CR	VU
Large brown tree frog	<i>Litoria littlejohni</i>	CR	EN
Martin's toadlet	<i>Uperoleia martini</i>	CR	CR
Rugose toadlet	<i>Uperoleia rugosa</i>	EN	EN
Southern toadlet	<i>Pseudophryne semimarmorata</i>	EN	VU
Freshwater fish			
Australian mudfish	<i>Neochanna cleaveri</i>	EN	CR
Cox's gudgeon	<i>Gobiomorphus coxii</i>	EN	EN
Dwarf galaxias	<i>Galaxiella pusilla</i>	EN	EN
Empire gudgeon	<i>Hypseleotris compressa</i>	CR	VU
Flat-headed galaxias	<i>Galaxias rostratus</i>	VU	VU
Flinders pygmy perch	<i>Nannoperca sp. 1</i>	VU	VU
Freshwater catfish	<i>Tandanus tandanus</i>	EN	EN
Little galaxias	<i>Galaxiella toourtkoourt</i>	EN	VU
Murray cod	<i>Maccullochella peelii</i>	EN	VU
Murray river rainbowfish	<i>Melanotaenia fluviatilis</i>	EN	VU
River blackfish (upper Wannon River form)	<i>Gadopsis marmoratus (upper Wannon)</i>	CR	CR
Silver perch	<i>Bidyanus bidyanus</i>	EN	VU
Southern purple-spotted gudgeon	<i>Mogurnda adspersa</i>	CR	Regionally extinct
Variegated pygmy perch	<i>Nannoperca variegata</i>	EN	VU

381. Ibid

Threatened species and communities

Table 26: Threatened fauna species that occur in Victorian wetlands cont'd.

Common Name	Scientific Name	Conservation Status 2021*	Conservation Status 2013**
Birds			
Australasian bittern	<i>Botaurus poiciloptilus</i>	CR	EN
Australasian shoveler	<i>Spatula rhynchotis</i>	VU	VU
Australian little bittern	<i>Ixobrychus dubius</i>	EN	EN
Australian painted snipe	<i>Rostratula australis</i>	CR	CR
Australian painted-snipe	<i>Rostratula australis</i>	CR	CR
Bar-tailed godwit	<i>Limosa lapponica</i>	VU	Not listed
Black bittern	<i>Ixobrychus flavicollis</i>	EN	VU
Black-tailed godwit	<i>Limosa limosa</i>	CR	VU
Blue-billed duck	<i>Oxyura australis</i>	VU	EN
Brolga	<i>Antigone rubicunda</i>	EN	VU
Caspian tern	<i>Hydroprogne caspia</i>	VU	NT
Common greenshank	<i>Tringa nebularia</i>	EN	VU
Common sandpiper	<i>Actitis hypoleucos</i>	VU	VU
Curlew sandpiper	<i>Calidris ferruginea</i>	CR	EN
Eastern curlew	<i>Numenius madagascariensis</i>	CR	VU
Eastern great egret	<i>Ardea alba</i>	VU	VU
Fairy tern	<i>Sternula nereis</i>	CR	EN
Freckled duck	<i>Stictonetta naevosa</i>	EN	EN
Great knot	<i>Calidris tenuirostris</i>	CR	EN
Greater sand plover	<i>Charadrius leschenaultii</i>	VU	CR
Grey plover	<i>Pluvialis squatarola</i>	VU	EN
Grey-tailed tattler	<i>Tringa brevipes</i>	CR	CR
Gull-billed tern	<i>Gelochelidon nilotica</i>	EN	EN
Hardhead	<i>Aythya australis</i>	VU	VU
Hooded plover	<i>Thinornis rubricollis</i>	VU	VU
Inland dotterel	<i>Charadrius australis</i>	VU	VU
Lesser sand plover	<i>Charadrius mongolus</i>	EN	CR
Lewin's rail	<i>Lewinia pectoralis</i>	VU	VU
Little egret	<i>Egretta garzetta nigripes</i>	EN	EN
Little Tern	<i>Sternula albifrons</i>	CR	VU

Threatened species and communities

Table 26: Threatened fauna species that occur in Victorian wetlands cont'd.

Common Name	Scientific Name	Conservation Status 2021*	Conservation Status 2013**
Magpie goose	<i>Anseranas semipalmata</i>	VU	NT
Marsh sandpiper	<i>Tringa stagnatilis</i>	EN	VU
Musk duck	<i>Biziura lobata</i>	VU	VU
Pacific golden plover	<i>Pluvialis fulva</i>	VU	VU
Plumed egret	<i>Ardea intermedia plumifera</i>	CR	EN
Red knot	<i>Calidris canutus</i>	EN	EN
Ruddy turnstone	<i>Arenaria interpres</i>	CR	VU
Terek sandpiper	<i>Xenus cinereus</i>	EN	EN
Whimbrel	<i>Numenius phaeopus</i>	EN	VU
Wood sandpiper	<i>Tringa glareola</i>	EN	VU
Mammals			
Platypus	<i>Ornithorhynchus anatinus</i>	VU	Not listed
Swamp antechinus	<i>Antechinus minimus maritimus</i>	VU	NT
Reptiles			
Alpine bog skink	<i>Pseudemoia cryodroma</i>	EN	EN
Alpine water skink	<i>Eulamprus kosciuskoi</i>	EN	CR
Broad-shelled turtle	<i>Chelodina expansa</i>	EN	EN
Corangamite water skink	<i>Eulamprus tympanum marnieae</i>	EN	CR
Murray river turtle	<i>Emydura macquarii</i>	CR	VU
Swamp skink	<i>Lissolepis coventryi</i>	EN	VU

Threatened species and communities

Table 27: Change in conservation status of threatened wetland dependent plants from 2014 to 2020.³⁸³

Conservation Status Category	2021	2014
Extinct	5	5
Critically Endangered	79	0
Endangered	239	63
Vulnerable	39	116
Rare	0	189
Poorly known	0	63
Not on list	0	4
Total	362	440

DELWP has provided a list of 440 significant wetland-dependent plant species³⁸² (in part based on the 2014 advisory list of rare and threatened plants) and it was used to assess changes in conservation status between the 2014 advisory list and the 2021 Flora and Fauna Guarantee Threatened List. Of the 440 species on the DELWP list, 362 were found on the Flora and Fauna Guarantee Threatened List (most of those not included had insufficient knowledge of their status). Four were not included in either the 2014 or 2021 lists, four were on the 2014 list but not the 2021 list, 63 were listed as poorly known in Victoria in 2014 and not included in the 2021 list. Their conservation status in 2014 and in 2021 are compared in Table 27.

It should be noted that the 'Critically Endangered' category was not used when preparing the 2014 advisory list (hence the zero) and the 'Rare' category is not used in the 2021 Flora and Fauna Guarantee Act Threatened List (hence the zero). This has contributed to substantial changes in the conservation status assessment of many plants. Of the 362 species, 325 had their conservation status upgraded (for example, from Rare to Critically Endangered or from Vulnerable to Endangered), one had it downgraded (i.e. improved) and for 36 there was no change, with five of those remaining extinct on both lists.

Although caution is required when comparing conservation status assessments on the advisory lists and the Flora and Fauna Guarantee Threatened List, and the on-ground situation e.g. population size and habitat for the wetland-dependent species might not have changed since the last assessment, the new conservation status gives greater public recognition to the plight of these species and the urgency of action. There could also be other species not assessed for the Flora and Fauna Guarantee Threatened List that could meet the criteria for threatened species conservation status in the future, particularly those impacted by the 2019–20 bushfires.

382. The list provided by DELWP also identified aquatic and river dependent species, which were excluded from the analysis.

383. Department of Environment and Primary Industries 2014, 'Advisory list of rare and threatened plants', East Melbourne, Victoria. Flora and Fauna Guarantee Act Threatened List.

Threatened species and communities

Indicator B:06 Threatened terrestrial species

Region Statewide	Indicator Performance:	2018 Status	2018 Trend	2018 Data
Measures Changes in the conservation status of terrestrial threatened species; Number, abundance and distribution of selected threatened terrestrial species; Threatening processes impacting and affecting native terrestrial threatened species	2018 & 2021: Unable to be assessed due to Low Data Confidence			
	Why this indicator? This indicator is a statewide overview of the conservation status of threatened terrestrial species and is further illustrated by indicators B:06A-B:06C	2021 Status	2021 Trend	2021 Data
Data Custodian DELWP				

Potential thresholds for status in the SoE 2023 report

Good: No longer threatened and population numbers recovering

Fair: Conservation status is Near Threatened or of Least Concern

Poor: Remains Critically Endangered, Endangered or Vulnerable

OR

Good: Significant increasing trend in the abundance and distribution of threatened terrestrial species, and threats are being monitored, reported and mitigated

Fair: Stable or small increasing trend in the abundance and distribution of threatened terrestrial species, and threats are in part being monitored, reported and mitigated

Poor: Significant declining trend in the abundance and distribution of threatened terrestrial species, and threats are not being monitored, reported or mitigated

Why this assessment in 2021?

Status: The conservation status of many species has been upgraded when a comparison is made between the now-retired advisory lists of threatened species and the new Flora and Fauna Guarantee Threatened List. Although caution is needed in making direct comparisons between the old and new lists, it provides greater public recognition of the plight of these threatened terrestrial species.

Trend: The Deteriorating Trend is continuing.

Data Confidence: The development of the Flora and Fauna Guarantee Act Threatened List will hopefully improve the level of Data Confidence for threatened terrestrial species.

Should this indicator be used in the SoE 2023 report?

Not in its current form. Consideration could be given to reorganising it and B:06A, B:06B and B:06C to create separate indicators for birds, mammals, reptiles, vascular plants and non-vascular plants. This broader reorganisation is covered when assessing B:06A, B:06B and B:06C.

Summary of SoE 2018 Report assessment

- No data were presented for this indicator.
- Indicators B:06A, B:06B and B:06C are sub-indicators of this indicator.

The 2019–20 bushfires: Impacts and responses

DELWP's August 2020 'Victoria's bushfire emergency: Biodiversity response and recovery' report summarised the number of species (including threatened and non-threatened species) that had habitat within the fire extent and were impacted by high-severity fires during the 2019–20 bushfire season.

Table 28 (on the next page) presents data on the percentage of each taxon group's modelled habitat distribution impacted by the fires, while Table 29 provides data on the percentage of their modelled habitat distribution impacted by high-severity fires (>80% canopy scorch). For example, 80–100% of the modelled habitat of 111 species was impacted by the fires. For birds, 86 species had some part of their habitat impacted. In the case of amphibians, 24 species were impacted by fires and 15 by high severity fires.

Threatened species and communities

The DELWP report also identified Victoria's³⁸⁴ threatened species of most concern that were impacted by the bushfires. It revealed that 10 of Victoria's 15 threatened amphibian species were of most concern due to the fires, six of 104 bird species, seven of 37 fish species, 14 of 49 mammal species and seven of 40 reptile species.

Although the majority of the threatened species in each taxon group were not impacted by the bushfires, except for threatened amphibians, those species (and threatened amphibians) face a number of other threats to which this report has also turned its attention.

Table 28: General terrestrial species and the percentage of their modelled habitat within the 2019–20 fire extent.³⁸⁵

Taxon Group	% of Modelled Habitat Distribution Impacted by Fire				
	OVER 95%	80% to 95%	50% to 80%	30% to 50%	10% to 30%
Amphibians	0	2	5	6	11
Birds	0	1	6	17	62
Mammals	0	0	1	11	31
Plants	13	93	118	242	926
Reptiles	0	1	0	6	22
Total	13	97	130	282	1,052

Table 29: General terrestrial species and the percentage of their modelled habitat impacted by high severity fire.³⁸⁶

Taxon Group	% of Modelled Habitat Distribution Impacted by High-Severity Fire				
	OVER 95%	80% to 95%	50% to 80%	30% to 50%	10% to 30%
Amphibians	0	0	1	4	10
Birds	0	0	1	2	35
Mammals	0	0	0	1	26
Plants	0	2	39	131	731
Reptiles	0	0	0	1	14
Total	0	2	41	139	816

384. Based on the Flora and Fauna Guarantee Act Threatened List gazetted in May 2021.

385. DELWP 2020, 'Victoria's bushfire emergency: biodiversity response and recovery, version 2', East Melbourne, Victoria.

386. Ibid

Threatened species and communities

DELWP and Parks Victoria are together conducting research on refugia and unburnt areas in East Gippsland and the alpine foothills. They are first identifying unburnt areas where there are no threats from timber harvesting or bushfires and which may be fire resistant, long unburnt and able to persist and survive extreme events. Once identified, the two agencies will work to ensure the areas are given long-term protection.³⁸⁷

Some of the bushfire response and recovery projects that are underway are designed to improve the resilience of terrestrial species and ecological communities of concern. They include:

- genetic testing to support identification and prioritisation of species based on a Genetic Risk Index and species risk analyses. Species include the spotted tree frog, New Holland mouse, smoky mouse, broad-toothed rat and several plant species
- feasibility and cultural assessments of Gunditj Mara Country to create a safer haven for eastern quoll and other species
- assessing the response of alpine ash when there is no reseeded after bushfires to increase the resilience of alpine ash in areas impacted by multiple fires.³⁸⁸

When commenting on the impact of Australia's 2019–20 bushfires, Evans (2020)³⁸⁹ reported on his study of pollination processes in burnt and unburnt areas in Portugal. Although flowers were more abundant in the burnt areas, pollinating moths were less abundant and pollination transport in the burnt areas was 20% of that occurring in unburnt areas. Plant-insect communities were less able to resist further disturbance without suffering extinction. Evans (2020) stressed that to build ecosystem resilience required consideration of ecological interactions.

SoE Biodiversity Update 2021 Report assessment

DELWP conducted a risk assessment³⁹⁰ of 70 threatened species and nine threatened ecological communities during 2020 and found that invasive species and inappropriate fire regimes posed significant or high risks to the highest number of species, followed by climate change and forestry operations. Table 30 lists the main hazards, their impacts, the number of species at risk and examples of those species, while Table 31 provides more detail on the numbers of each taxon impacted by each hazard. Invasive species, inappropriate fire regimes and climate change threaten the most species, with the highest numbers in the aquatic and plant taxon groups. The risk assessments will be used to determine future recovery pathways and measures.

In April 2021, DELWP's Biodiversity Division followed up the report with a set of interim protections and management actions across Victoria's five RFA regions.³⁹¹ Table 32 summarises the type and number of the protections and actions that are in place until April 2022, which have a focus on the East Gippsland and Gippsland regions, with pest control and research the dominant actions in both regions. 'The assessment undertaken by Biodiversity Division determined that the actions proposed are appropriate and proportionate management actions to mitigate the risk of serious or irreversible damage from timber harvesting over the next 12 months.'

Table 33 lists the threatened species and communities targeted in East Gippsland and the mitigation actions for the hazards of inappropriate fire regimes and pest plants and animals. Deer control and the retention of undisturbed habitat patches and their exclusion from harvesting are the focus of hazard mitigation for bird species, while for mammals it is predator and herbivore pest control, with an emphasis on expansion of the Southern Ark project, and genetic analysis. Herbivore control is also important for reptiles and communities, while buffers will be used in forest management zones to protect rainforests.

387. Information supplied by Parks Victoria.

388. DELWP 2020, 'Victoria's bushfire emergency: biodiversity response and recovery, version 2', East Melbourne, Victoria.

389. Evans D 2020, 'Bushfires: can ecosystems recover from such dramatic losses of biodiversity?' *The Conservation*, 16 January 2020.

390. DELWP 2020, 'Threatened species and communities risk assessment, Victoria's regional forest agreements', East Melbourne, Victoria.

391. DELWP 2021, 'Threatened species and communities risk assessment: interim protections and management actions April 2021, Victoria's Regional Forest Agreements', East Melbourne, Victoria.

Threatened species and communities

Table 30: Hazards, their impacts, and the number of species at risk.³⁹²

Key Hazard	Impacts	No. Of Species	Examples of Species
Inappropriate fire regimes	Population decline; changed habitat structure; decline or loss of local plant species; competition with fire-adapted species; increased erosion and sedimentation; changed nutrient cycling, seed dispersal and seed establishment	55	Glossy black-cockatoo, southern greater glider, long-footed potoroo, tall astelia, diamond python and cool temperate rainforest.
Bushfire management	Direct mortality; soil disturbance; altered hydrology; sedimentation and pollution (retardants) of streams; loss of unburnt remnants and hollow-bearing trees	10	Glossy black cockatoo, brush-tailed phascogale, New Holland mouse, Grampians bitter-pea and diamond python
Forestry	Direct mortality; habitat loss and fragmentation; soil disturbance and compaction; edge effects	24	Glossy black-cockatoo, Leadbeater's possum and diamond python.
Invasive species	Direct mortality; reduced vegetation cover; competition for food and shelter; soil erosion and compaction; weed and pathogen spread	60	Broad-toothed rat, candy spider-orchid, alpine bog skink and Strzelecki warm temperate rainforest
Roading and strategic fuel breaks	Habitat loss and fragmentation; edge effects; soil disturbance; sedimentation of streams; weed and pathogen spread	10	Gorae leek-orchid and Whitfield spider-orchid
Climate change	Droughts, reduced stream flows, bushfires, heat, rising sea levels	48	Red-tailed black-cockatoo (south-eastern), grey-headed flying-fox, ben major grevillea and Strzelecki Warm Temperate Rainforest
Others: incl. dams, drought; pollution; land clearance; mining; recreation		40	Regent honeyeater, white-footed dunnart, dwarf kerrawang and warm temperate rainforest (Far East Gippsland).
Total	362	440	440

392. DELWP 2020, 'Threatened species and communities risk assessment, Victoria's regional forest agreements', East Melbourne, Victoria.

Threatened species and communities

Table 31: Hazards and the number of terrestrial species in each taxon at risk.³⁹³

Hazards	Birds	Mammals	Plants	Reptiles	Communities	Total
Invasive species	2	9	18	4	9	60
Inappropriate fire regimes	5	11	13	3	6	55
Climate change	5	8	12	3	1	48
Forestry operations	4	5	1	1	0	24
Bushfire management	3	2	4	1	0	10
Roading and strategic fuelbreaks	0	0	2	0	0	10
Other	4	4	16	3	5	40
Number of species and communities assessed (79)	7	12	25	4	9	

Table 32: Summary table of interim protection and management actions recommended after the Threatened Species and Communities Risk Assessment.³⁹⁴

Protection or Management Actions	RFA Region				
	East Gippsland	Gippsland	Central Highlands	North East	West Victoria
Active management (e.g. pest control)	19	8	1	2	1
Research (incl. important population mapping and feasibility studies)	17	8	1	1	1
Tailored adaptive responses (part of VicForests' precautionary principle approach – see note below)	7	1	-	-	-
Targeted zoning amendments	6	4	-	-	-
Procedures and guidelines (incl. values checking)	6	3	-	-	-
Pre-harvest surveys	3	1	-	-	-

³⁹² Ibid

³⁹³ DELWP 2021, 'Threatened species and communities risk assessment: interim protections and management actions April 2021, Victoria's Regional Forest Agreements', East Melbourne, Victoria.

Threatened species and communities

Table 33: Mitigation of hazards in the East Gippsland Regional Forest Agreement region.³⁹⁵

Species or Community	Pest Plants and Animals	Inappropriate Fire Regimes
Birds		
Masked owl	Deer control	Tailored Adaptive Protections: Retain undisturbed habitat patches containing dense understorey and hollow-bearing trees within the harvestable area; Protect patches from harvesting and regeneration activities
Powerful owl		As for masked owl
Sooty owl	Deer control	As for masked owl
Mammals		
Long-footed potoroo		Improve understanding of genetic risk to Critical Weight Range Mammals ³⁹⁶ and identify management priorities
Long-nosed potoroo	Expansion of Southern Ark program: Continued operational infill and expansion over additional 100,000 ha	As for long-footed potoroo
Southern greater glider		Mapping of most important unburnt habitat areas in East Gippsland
Spot-tailed quoll	Fox Control program Translocation feasibility study	
Broad-toothed rat	Large herbivore control (deer, pigs, goats); feral horse management. Predator control feasibility study	As for long-footed potoroo
Southern brown bandicoot	East Gippsland Expansion of Southern Ark program – Continued operational infill and expansion over additional 100,000 ha	As for long-footed potoroo
White-footed dunnart	Expansion of Southern Ark program: Continued operational infill and expansion over additional 100,000 ha (note: not a target species for this program but benefits expected in the absence of landscape scale cat control) Fox control Mt Stradbroke	Gene-mixing project
Reptiles		
Diamond python	Predator control	Update values checking processes for burn planning.
Eastern she-oak skink	Predator Control and deer control (non-target species but expected benefit)	

³⁹⁵. Ibid

³⁹⁶. Critical-weight range mammals are species that are 35–5,500 grams in weight and which, it is hypothesised, have suffered the most severe population declines and also extinctions.

Threatened species and communities

Table 33: Mitigation of hazards in the East Gippsland Regional Forest Agreement region cont'd.

Species or Community	Pest Plants and Animals	Inappropriate Fire Regimes
Plants		
Colquhoun grevillea		Update values checking processes for weed spraying and burn planning. Survey and mapping of populations to improve species extent and enhance signage
Rufous pomaderris		Deer control; species survey and bushfire recovery monitoring
Blue tongued greenhood	Large herbivore control (deer, pigs, goats); feral horse management, species survey and bushfire recovery monitoring	
Communities		
Alpine Sphagnum Bogs and Associated Fens	Large herbivore control; feral horse management; fencing to reduce grazing pressure; removal of high threat weeds	Large herbivore control; feral horse management; fencing to reduce grazing pressure.
Warm Temperate Rainforest (East Gippsland Alluvial Terraces) and Warm Temperate Rainforest (Far East Gippsland)	Deer control	Application of Special Management Zone buffers to where the two sub-communities of rainforest have been severely burned by the 2019-20 bushfires This buffering will be in place until April 2022.

Geary et al. (2020) 'identified 346 species in Victoria that had >40% of their modelled habitat affected by the megafire, including 45 threatened species, and 102 species with >40% of their modelled habitat affected by high severity fire.'³⁹⁷ Species of immediate concern were identified and numbered 154 flora and 67 vertebrate species listed under federal and Victorian legislation. Direct mortality, critical habitat loss and change in the importance of other populations were threats to more than 60 species of concern. Using Victoria's 2019–20 bushfires as their case study, the authors outlined a framework to guide conservation responses to megafires within and beyond the fire extent that applied species distribution maps, trait databases, fire severity mapping and other datasets.³⁹⁸ The framework 'identified a range of single-species (e.g. supplementary feeding, translocation) and landscape-scale actions (e.g. protection of refuges, invasive species management) that can help biodiversity recover from megafires.'

Ward et al. (2019) reviewed the EPBC Act and found it to be ineffective in protecting potential habitat for threatened species, terrestrial migratory species and threatened ecological communities. They recommended the demarcation of critical habitat for species and communities to provide absolute protection that is enforced, monitored, and investigated by the regulator, otherwise without a fundamental change in how environmental law is enforced, 'Australia faces an increasing extinction rate.'³⁹⁹

Following the 2019-20 bushfires, Fitzsimons (2020) also urged the protection of critical habitat by implementing new processes to 'rapidly assess and designate critical habitat under existing provisions and future reforms to legislation implemented in order to deal with future events such as these extensive bushfires.'⁴⁰⁰ For Victoria, Fitzsimons recommended greater use of critical habitat determinations and habitat conservation orders under the *Flora and Fauna Guarantee Act 1988*. For example, he wrote that these could be used to give protection to unburnt areas as refuges.

397. Geary W, Buchan A, Allen T, Attard D et al. 2020, 'Responding to the biodiversity impacts of a megafire: a case study from south-eastern Australia's Black Summer', *Diversity and Distributions*, 00, pp.1–16.

398. Ibid

399. Ward M, Simmonds J, Reside A, Watson J et al. 2019, 'Lots of loss with little scrutiny: the attrition of habitat critical for threatened species in Australia', *Conservation Science and Practice*, 1(11), e117.

400. Fitzsimons J 2020, 'Urgent need to use and reform critical habitat listing in Australian legislation in response to the extensive 2019–2020 bushfires', *Environmental and Planning Law Journal*, 37.

Threatened species and communities

Indicator B:06A Threatened terrestrial vascular plant species

Region Statewide Measures Changes in the conservation status of terrestrial threatened species; Number, abundance and distribution of selected threatened terrestrial species; Threatening processes impacting and affecting native terrestrial threatened species Data Custodian DELWP	Indicator Performance: 2018 & 2021: Unable to be assessed due to Moderate Data Confidence Why this indicator? The SoE 2018 Report noted an increasing trend in the number of endangered, vulnerable and rare vascular plants in Victoria.	2018 Status 	2018 Trend 	2018 Data 
		2021 Status 	2021 Trend 	2021 Data 

Potential thresholds for status in the SoE 2023 report

Good: No longer threatened and population numbers recovering

Fair: Conservation status is Near Threatened or of Least Concern

Poor: Remains Critically Endangered, Endangered or Vulnerable

OR

Good: Significant increasing trend in the abundance and distribution of threatened terrestrial vascular plant species, and threats are being monitored, reported and mitigated

Fair: Stable or small increasing trend in the abundance and distribution of threatened terrestrial vascular plant species, and threats are in part being monitored, reported and mitigated

Poor: Significant declining trend in the abundance and distribution of threatened terrestrial vascular plant species, and threats are not being monitored, reported or mitigated

Why this assessment in 2021?

Status: The use of more rigorous criteria in preparing the new Flora and Fauna Guarantee Threatened List has led to the conservation status of some threatened terrestrial plant species to be upgraded e.g. from Vulnerable to Critically Endangered (some have also remained the same or been downgraded). Although the on-ground situation e.g. population size and habitat for the terrestrial species might not have changed since the last assessment, the new conservation status gives greater public recognition of their plight.

Trend: The deteriorating Trend continues.

Data Confidence: Although the process for establishing the Flora and Fauna Guarantee Threatened List has given a renewed focus to the status of threatened plant species, data remain limited.

Should this indicator be used in the SoE 2023 report?

Not in its current form. Consideration could be given to at least splitting it into two indicators: terrestrial vascular plants (dicots, monocots, ferns and allies) and terrestrial non-vascular plants (mosses, lichens, fungi, algae.) Another option for consideration could be an indicator for endemic plants with limited ranges.

Summary of SoE 2018 Report assessment

- There had been an increasing trend of endangered, vulnerable and rare vascular plants in Victoria. Of the 3,330 known Victorian species, 49 were extinct and 2,097 (63%) were on the Threatened Species Advisory Lists.

The 2019–20 bushfires: Impacts and responses

Godfree et al. 2021⁴⁰¹ analysed the impacts of the 2019–20 bushfires on the conservation of Australian vegetation. They found that '17 major native vegetation groups were severely burnt, and up to 67–83% of globally significant rainforests and eucalypt forests and woodlands' and greater than 50% of the ranges of 816 vascular plants. Although most of the affected plants are resilient to fire, they concluded that 'the massive biogeographic, demographic and taxonomic breadth of impacts of the 2019–20 fires may leave some ecosystems,

401. Godfree R, Knerr N, Encinas-Viso F, Albrecht D et al. 2021, 'Implications of the 2019–2020 megafires for the biogeography and conservation of Australian vegetation', *Nature Communications*, 12(1), 1023.

Threatened species and communities

particularly relictual [a population with a smaller range than it had in previous geological time period] Gondwanan rainforests, susceptible to regeneration failure and landscape-scale decline.'

Evans (2020) also questioned the survival of ecosystems after the devastating fires and urged governments and land managers to build the resilience of ecosystems by considering ecological interaction networks i.e. how different species interact rather than just focusing on individual species.⁴⁰²

Gallagher et al. (2021) quantified the impacts of the 2019–20 bushfires on plant diversity and the influence of fire history on plant recovery across the ranges of 26,062 species. They found that between 36% and 69% of all Australian species had part of their range impacted by the bushfires and concluded that 'many Australian plant species have strategies to persist under certain fire regimes, and will recover given time, suitable conditions and low exposure to threats. However, short fire intervals both before and after the 2019–2020 fire season pose a serious risk to the recovery of at least 595 species.'⁴⁰³

The DELWP August 2020 biodiversity response and recovery report estimated that 224 species of flora had 50% or more of their modelled habitat within the fire extent, with 154 species of most concern.

Figure 27 shows large decreases in the biodiversity values of flora across the fire extent in eastern Victoria. Many plants had high proportions of their modelled habitat in the fire extent and were also affected by high-severity fire. For example, Figure 28 maps the modelled habitat distribution of the Betka bottlebrush *Callistemon kenmorrisonii*. Both of its populations were impacted, with 93% of its modelled habitat within the fire extent and 71% affected by high-severity fire.

The Royal Botanic Gardens Victoria is concerned that the survival of up to 30 species could be threatened because of the damage caused by the 2019–20 bushfires, and some could become extinct.⁴⁰⁴ The seeds of 57 plant species and the cuttings of 63 plant species were collected from within the fire extent and included Cobungra wattle (*Acacia ureniae*), mountain celery (*Aciphylla glacialis*), royal bluebell (*Wahlenbergia gloriosa*), carpet sedge (*Carex jackiana*), alpine pepper (*Tasmannia xerophila* subsp. *xerophila*), alpine ash (*Eucalyptus delegatensis*) and spinning gum (*Eucalyptus perriniana*).⁴⁰⁵ The Victorian Conservation Seedbank coverage of listed species increased from 45% to 50% as a result of seed extractions.⁴⁰⁶ There is also a proposed project to establish a spore bank of all fern species in Victoria, as well as selected bryophytes and fungi.⁴⁰⁷

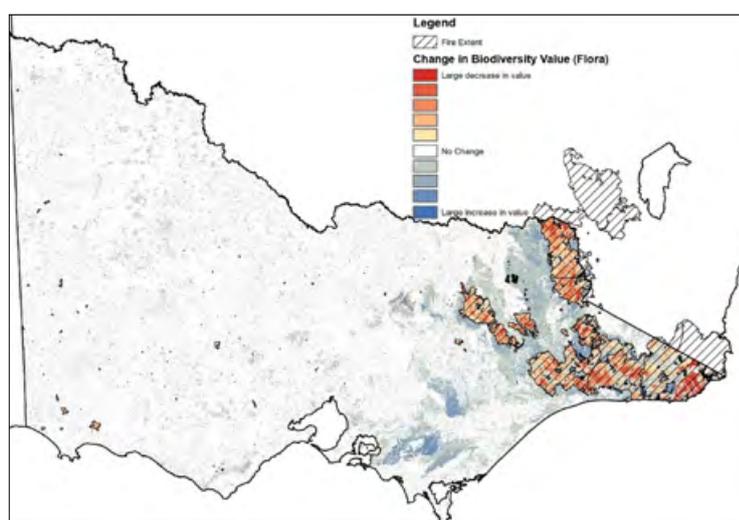


Figure 27: Indicative change in the biodiversity values for rare and threatened species of flora.⁴⁰⁸

402. Evans D 2020, 'Bushfires: Can ecosystems recover from such dramatic losses of biodiversity?' *The Conversation*, 16 January 2020.

403. Gallagher R, Allen S, Mackenzie B, Yates C et al. 2020, 'High fire frequency and the impact of the 2019–2020 megafires on Australian plant diversity', *Diversity and Distributions*, 00, pp. 1–14.

404. van Loon M 2020, 'Seed bank throws lifeline to fire-threatened species', *The Age*, 17 January 2020.

405. DELWP 2020, 'Victoria's bushfire emergency: biodiversity response and recovery, version 2', East Melbourne, Victoria.

406. DELWP Biodiversity Division.

407. Ibid

408. DELWP 2020, 'Victoria's bushfire emergency: biodiversity response and recovery, version 2', East Melbourne, Victoria.

Threatened species and communities

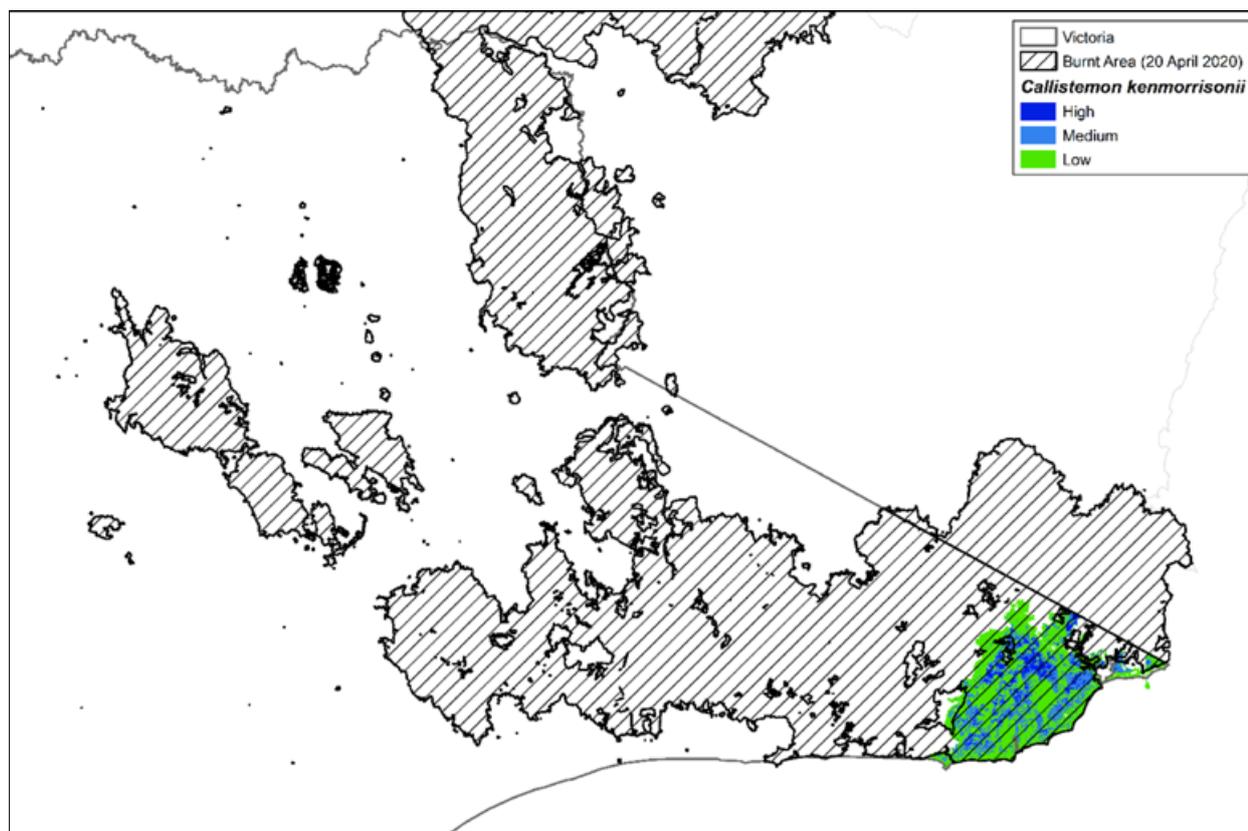


Figure 28: Modelled habitat distribution of *Callistemon kenmorrisonii* in Victoria and the burn extent as at 20th April 2020.⁴⁰⁹

Before the 2019–20 bushfires, the population of Victoria's Critically Endangered and endemic Colquhoun grevillea (*Grevillea celata*) was estimated at from 1,000 to 1,600 plants. It is only found in nine locations across 11 km² in the Colquhoun State Forest⁴¹⁰ in East Gippsland. After the fires, DELWP estimated that 56% of the grevillea's distribution had been within the fire extent, of which 24% was classified as having experienced high-severity fire. A majority if not all of its populations were impacted and its genetic risk was rated as very high.⁴¹¹

Figure 29 maps the location of existing and new records of the Colquhoun grevillea and their location with regards to the 2019–20 bushfires and timber harvesting⁴¹² The existing records are from the Victorian Biodiversity Atlas and the Atlas of Living

Australia, while new records were found in surveys by the Wildlife of the Central Highlands/Fauna and Flora Collective. None of the remaining populations are within conservation reserves⁴¹³ or inside the Immediate Protection Areas declared in November 2019 and could be subject to timber harvesting.

There were also concerns about the survival of the black cypress pine and mountain ash and alpine ash forests after the 2019–20 bushfires. To support the post-fire recovery of mountain ash and alpine ash forests, 4.5 tonnes of eucalypt seeds were sown by helicopter across 11,500 hectares in Gippsland and north-east Victoria.⁴¹⁴ These areas had experienced fires in 2003, 2007 and 2014, as well as in 2019–20.

The black cypress pine is a slow-growing species found in the Burrowa-Pine Mountain National Park and the Mount Mitta Mitta Regional Park in the Upper Murray region. It plays an important role by hosting insects under its bark and providing seed for parrots and cockatoos. However, fire and grazing by deer and feral goats are major threats. In good news, monitoring by Parks Victoria found seedlings in the Mount Mitta Mitta Regional Park in November

⁴⁰⁹. Ibid

⁴¹⁰. Department of Sustainability and Environment 2009, 'Action statement no 211: Colquhoun grevillea *Grevillea celata*', East Melbourne, Victoria.

⁴¹¹. DELWP 2020, 'Victoria's bushfire emergency: biodiversity response and recovery, version 2', East Melbourne, Victoria.

⁴¹². Victorian National Parks Association 2021, 'After the fires: protecting our forest refuges', Carlton, Victoria.

⁴¹³. Department of Sustainability and Environment 2009, 'Action statement no 211: Colquhoun grevillea *Grevillea celata*', East Melbourne, Victoria.

⁴¹⁴. D'Ambrosio L and Symes J 2020, 'Airlift operation to bring forest back to life after bushfire', Ministerial media release, Government of Victoria, 2 October 2020.

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2020, indicating that the post-fire aerial and ground shooting of deer and feral goats had worked.⁴¹⁵ Herbivore control will now be required because it takes 15–20 years for the trees to mature and provide seeds for birds and habitat for thornbills.⁴¹⁶

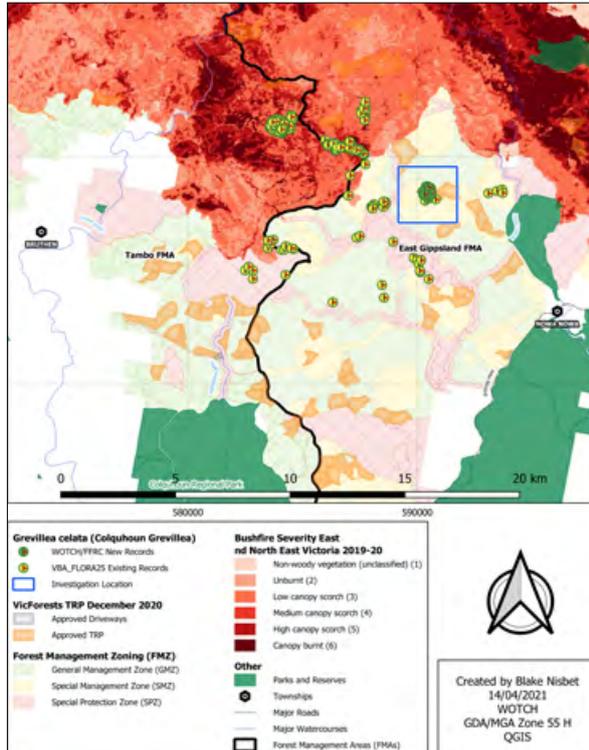


Figure 29: Existing and new records of the Colquhoun grevillea in relation to the 2019–20 bushfires, forest management zoning and timber harvesting.⁴¹⁷

Muir et al. (2020) reported on the threat to the hairpin banksia in East Gippsland and its vulnerability to local extinction from too frequent fires – in the 2019–20 fires almost all of its habitat was burnt.⁴¹⁸ Features of the hairpin banksia's vulnerability are that adult trees are killed by fires and it is slow to reach reproductive maturity. However, its seeds do persist in soil. The scientists concluded that two fires in 10 years would cause a severe decline in the hairpin banksia's local persistence.

Tolsma, Sutton and Coates (2012)⁴¹⁹ reported that after the fires in 2009, there had been no decline in populations of threatened flora species, with many germinating profusely. However, they concluded that another fire would be a major threat, with many woody species having not reached maturity two years after the fires. Scientists at the Arthur Rylah Institute and the Royal Botanic Gardens Victoria conducted similar surveys of threatened plant species after the 2019–20 bushfires in eastern Victoria.

In a draft of their report, the key findings included:

Threatened flora species

'Over three-quarters of threatened plant species searched for were found and were regenerating successfully post-fire.'

'Immediate threats to populations were generally minor. Deer activity was usually low or absent, but will increase with time since fire, and weeds present were considered low threat at time of sampling.'

'A long fire-free period is now required to allow many species to reach viable reproductive maturity.'

Vegetation type

'Nine to ten months post-fire, tree canopy cover in severely burnt forests remained at only 5–10%, and shrub cover was largely absent. In contrast, the ground layer vegetation generally showed strong recovery.'

Rainforest

'The opening up of the canopy by fire has led to prolific germination of soil-stored seed. The understorey composition is currently very different to that of unburnt rainforest and is dominated by short-lived species that are substantially less common in unburnt rainforest.'⁴²⁰

415. Parks Victoria 2020, 'Tiny tree represents huge success for fire recovery in parks', Melbourne, Victoria <https://www.parks.vic.gov.au/news/2020/11/09/00/54/tiny-tree-represents-huge-success-for-fire-recovery-in-parks>

416. Information from Parks Victoria.

417. Nisbet B and Lincoln A 2020, 'Colquhoun grevillea detection report', Wildlife of The Central Highlands and Fauna and Flora Research Collective, Victoria.

418. Muir A, Bluff L, Moloney P, Amos N et al. 2020, 'Hairpin banksia: a widespread plant threatened with decline by frequent fires', *Australian Plant Conservation*, 29(1).

419. Tolsma A, Sutter G and Coates F 2012, 'Recovery of Victorian rare or threatened plant species after the 2009 bushfires', natural values fire recovery program, Arthur Rylah Institute, Heidelberg, Victoria.

420. Draft supplied by Arthur Rylah Institute.

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SoE Biodiversity Update 2021 Report assessment

The 2014 advisory list for Victoria's rare and threatened plants was used for this indicator in the SoE 2018 report, which reported that threatened vascular plants had increased in number from 1,900 in 2003 to 2,103 in 2014. Over the same time period, Endangered plants had increased from 250 to 366, Vulnerable plants from 473 to 516, Rare plants from 818 to 854 and Poorly known plants from 311 to 318.

The conservation status of Victoria's threatened vascular plants in the new Flora and Fauna Guarantee Threatened List is summarised in Table 34 (note that marine and freshwater species have not been removed from the listed numbers). In line with IUCN conservation status categories, the 'Rare' status has been removed and the 'Critically Endangered' status added. In total, 1,551 vascular plant species were finally assigned

a conservation status using the CAM, including 30 that were deemed extinct. Although there are some differences in the categorisations and fewer plants assessed in 2021 than in 2014, the number of Endangered or Vulnerable plants in 2014 numbered 882, whereas in 2021 the number is 1,097. In addition, plants in the new Critically Endangered category numbered 424. Three factors are primarily responsible for the trend towards upgrading: new evidence and perspectives, including inferences about the likely future impacts of climate change; the application of the Critically Endangered category (not used previously for plants and fungi), which replaced the 'Rare' category; and the more rigorous CAM.

Although caution is needed when interpreting the significant upgrading, and the on-ground situation e.g. population size and habitat for the plants species might not have changed since their last assessment, the new conservation status gives greater public recognition of their plight.

Table 34: Vascular plant species on the Flora and Fauna Guarantee Threatened List.⁴²¹

Conservation Status	Dicotyledons	Monocotyledons	Ferns and Allies	Total
Extinct	18	10	2	30
Critically endangered	270	134	20	424
Endangered	625	231	26	882
Vulnerable	171	44	0	215
Total	1,084	419	48	1,551

Muir et al. 2021 summarised the results of a workshop on six Victorian banksias, which heard that banksia persistence is threatened by habitat loss and fragmentation, increased fire frequency and climate change. Table 35 summarises the threatening processes and impacts on the life stages of the species. However, there was no consensus in the workshop about how these factors are driving declines and the extent of declines.⁴²² Recommendations from the workshop included modifications to planned burns to ensure sufficient time 'between fires for non-sprouting species to mature and produce seed, and for resprouters to

recover,' and regional seed banking to 'compensate for large-scale losses of banksias in some areas through bushfires, drought or disease.'

The Royal Botanic Gardens Victoria established the Victorian Conservation Seedbank in 2005 and it now houses the seeds of more than 1,000 plant species and 50% of Victoria's threatened plant species. The seeds can be used for research, propagation and the translocation of plant species. Seed banks are also

421. Flora and Fauna Guarantee Act Threatened List.

422. Muir A, Heyes S, Morgan J, Hoebee S et al. 2021. 'Conservation challenges for Victorian banksias: workshop, May 2020', Ecological Management and Restoration, doi: 10.1111/emr.12448.

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found in the Wimmera, Murray Mallee, Goulburn Broken, Portland and Ballarat regions, each supplying native seed to revegetation projects.⁴²³ For example, the Goulburn Broken Indigenous Seedbank is a not-for-profit seedbank established in 2001 and part of the Euroa Arboretum. Its mission is to

provide genetically healthy seed to support landscape restoration activities.⁴²⁴ Indigenous plant nurseries are also found scattered across Victoria, often operated by not-for-profit community groups. One such nursery is the Queenscliffe Indigenous Nursery operated by the Swan Bay Environment Association.⁴²⁵

Table 35: Threatening processes and impacts on the life stages of six Victorian banksias.⁴²⁶

Species	Seed Production Limited	Seedling Recruitment Limited	Mature Plant Dieback
Silver banksia	Fragmentation and inbreeding Pollinators less effective Granivory (seed predation) increased	Climate warming and drying Competition for water increased	
Desert banksia	Climate warming and drying Fire intervals shorter		Climate warming and drying
Coast banksia			Climate warming and drying Competition for water increased
Saw banksia			Climate warming and drying
Hairpin banksia	Pollinators less effective	Climate warming and drying	
Mountain banksia	Climate warming and drying Fire intervals shorter		

Snow gums in the Bogong High Plains in Victoria and alpine areas in NSW are suddenly dying due to outbreaks of the longicorn beetle, a native wood borer (*Phoracantha sp.*) that is now devouring trees.⁴²⁷ The reasons for the outbreak are unclear, however drought and warmer temperatures have stressed the trees, and the warmer temperatures also encourage the beetles to emerge and lay eggs.

The Australian Threatened Species Index for plants lists 22 plant taxa as imperilled in Victoria and reveals that 'on average the size of threatened plant populations in our dataset have decreased by 65% between 1995 and 2015.⁴²⁸ For the 11 threatened plant taxa in the Index subject to management such as herbivore control, they have experienced a 71% decline in populations over the same time period, while for taxa with no targeted management, the decrease is 60%.

423. Seeding Victoria, 'Seeding Victoria seedbanks' https://www.seedingvictoria.com.au/cb_pages/seed_banks.php Accessed 7 June 2021.

424. Goulburn Broken Indigenous Seedbank https://www.gbcmavic.gov.au/our-region/land_and_biodiversity/resources_publications/goulburn_broken_indigenous_seed_bank Accessed 10 May 2021.

425. Swan Bay Environment Association, 'Queenscliffe Indigenous nursery' <https://swanbayenvironment.org.au/queenscliffe-indigenous-nursery/> Accessed 10 May 2021.

426. Muir A, Heyes S, Morgan J, Hoebee S et al. 2021, 'Conservation challenges for Victorian banksias: workshop, May 2020', *Ecological Management and Restoration*, doi: 10.1111/emr.12448.

427. Clarke M 2021, 'The sudden death of the snow gums', *ABC News*, 10 March 2021.

428. Threatened Species Recovery Hub, 'Threatened plant index of Australia: 2020 results' <https://www.nespthreatenedspecies.edu.au/news-and-media/media-releases/threatened-plant-index-of-australia-2020-results> Accessed 10 May 2021.

Threatened species and communities

Across Australia, the index reveals that between 1995 and 2017, there was more than a 70% reduction in the populations of threatened plant species. Auld (2020) summarises the reasons for the decline in plant species and they include:

- small ranges and low populations that make them susceptible to habitat loss caused by feral grazers, weeds, inappropriate fire regimes and climate change
- poorly resourced plant conservation programs
- insufficient legislative protection
- extreme events such as the 2019–20 bushfires.⁴²⁹

According to Auld (2020), the actions needed to reduce the decline in Australian plants and allow their conservation include:

- a comprehensive and up-to-date listing of threatened plants (the new Flora and Fauna Guarantee Act Threatened List is Victoria's comprehensive list)
- increased resourcing for plant conservation
- more effective action to tackle the threat to plants, including limits to clearing, mitigation and control of threats from grazers, weeds and pathogens, and the implementation of fire tolerance thresholds
- resources for comprehensive seed banks
- best-practice ecological restoration and translocation
- better integration of threat management for plants and animals within ecosystems.

⁴²⁹ Auld T 2020, 'Conservation of Australian plants', presentation to the 'Halting the decline: efforts to track and save Australia's threatened plants' webinar by the National Environmental Science Program, 8 December 2020.

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Indicator B:06B Threatened terrestrial vertebrate species

Region Statewide	Indicator Performance:	2018 Status	2018 Trend	2018 Data
		2021 Status	2021 Trend	2021 Data
Measures Changes in the conservation status of terrestrial threatened species, which measures changes in the status of threatened terrestrial species; Abundance and distribution of selected threatened terrestrial species over time; Threatening processes impacting and affecting native terrestrial threatened species	2018 & 2021: Unable to be assessed due to Moderate Data Confidence			
	Why this indicator? There has been an increasing trend in the number of critically endangered and vulnerable vertebrate groups. Many of the bushfire recovery actions are focussed on terrestrial vertebrate species.			
Data Custodian DELWP				

Potential thresholds for status in the SoE 2023 report

Good: No longer threatened and population numbers recovering

Fair: Conservation status is Near Threatened or of Least Concern

Poor: Remains Critically Endangered, Endangered or Vulnerable

OR

Good: Significant increasing trend in the abundance and distribution of threatened terrestrial vertebrate species, and threats are being monitored, reported and mitigated

Fair: Stable or small increasing trend in the abundance and distribution of threatened terrestrial vertebrate species, and threats are in part being monitored, reported and mitigated

Poor: Significant declining trend in the abundance and distribution of threatened terrestrial vertebrate species, and threats are not being monitored, reported or mitigated

Why this assessment in 2021?

Status: The more rigorous process in preparing the new Flora and Fauna Guarantee Threatened List has led to the conservation status of some threatened terrestrial vertebrate species to be upgraded e.g. from Vulnerable to Critically Endangered (some have also remained the same or been downgraded). Although the on-ground situation e.g. population size and habitat for the species might not have changed since their last assessment, the new conservation status gives greater public recognition of their plight.

Trend: The deteriorating Trend continues.

Data Confidence: Although the process for establishing the Flora and Fauna Guarantee Threatened List has given a renewed focus to the status of threatened vertebrate species, data remain limited.

Should this indicator be used in the SoE 2023 report?

Not in its current form. Consideration could be given to at least splitting it into indicators for birds, mammals and reptiles. Fish, frogs and invertebrates are covered by other indicators.

Summary of SoE 2018 Report assessment

- There had been an increasing trend in the number of Critically Endangered and Vulnerable vertebrate taxon groups, specifically reptiles. To a lesser extent, there had been an increase in the number of Endangered vertebrates.
- Of the known species, those that are threatened include 22% of terrestrial mammals, 19% of birds, 30% of reptiles and 43% of amphibians.

The 2019–20 bushfires: impacts and responses

Table 36 lists the terrestrial vertebrate species impacted by the 2019–20 bushfires, including the percentage of their habitat within the fire extent, the percentage affected by high-severity fire and some of the localised fire impacts. For example, at least 79% of the Victorian modelled distribution of the long-footed potoroo was in the fire extent (a very high proportion of its East Gippsland range was burnt), 41% was affected by high-severity fire (see Table 26 earlier in this report) and its genetic

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risk was rated as very high. The darker colour on the map indicates areas of relatively higher habitat suitability compared to the lighter colours.

DELWP, Parks Victoria and their partners are delivering various recovery actions for vertebrate species including: eastern bristlebird, glossy black

cockatoo, eastern ground parrot, southern greater glider, eastern horseshoe bat, southern brown bandicoot, spot-tailed quoll, long-footed potoroo, smoky mouse, broad-toothed rat, mountain pygmy possum, large brown tree frog, diamond python, lace monitor, alpine tree frog, alpine sheoak skink.

Table 36: Bird, mammal and reptile species of most concern impacted by the 2019–20 bushfires.⁴³⁰

Species Impacted by Fire	% Modelled Habitat in Fire Extent	% Modelled Habitat Impacted by High-Severity Fire	Localised Impacts
Birds			
Brown gerygone	52	26	Key population in south of range may be impacted (~85% of populations occur within current fire extent).
Eastern bristlebird	58	39	Fire boundaries very close to key sites. Individuals extracted and returned. The population in adjacent Nadgee Nature Reserve has been severely impacted.
Eastern ground parrot	33	31	Most of the population in East Gippsland has been impacted; effect of fire on food (Casuarina seeds) likely to be severe. Has since been observed eating other sheoak species.
Glossy black cockatoo	64	26	Most of population in East Gippsland affected, including casuarina seeds food source.
Ground parrot	33	21	Most of the population in East Gippsland has been impacted. Species may have been in decline across Victorian Range before fires.
Lewin's honeyeater	39	20	
Masked owl	54	26	Area burnt includes best habitat in Victoria and covers most of the recent records.
Red-browed treecreeper	31	16	
Sooty owl	47	24	Likely impacted by fire, impact on species depends on fire severity.
Spotted quail-thrush	29	14	
Mammals			
Broad-toothed rat	23	14	Populations in sub-alpine areas may be impacted.
Brush-tailed rock-wallaby	43	26	Wild Little River Gorge population not directly impacted.
Eastern Bent-wing Bat	21	10	Most important Gippsland cave site is outside burnt area, however much of the foraging habitat of bats using this cave was burnt

430. DELWP 2020, 'Victoria's bushfire emergency: biodiversity response and recovery, version 2', East Melbourne, Victoria.

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Table 36: Bird, mammal and reptile species of most concern impacted by the 2019–20 bushfires cont'd.

Species Impacted by Fire	% Modelled Habitat in Fire Extent	% Modelled Habitat Impacted by High-Severity Fire	Localised Impacts
Eastern Bent-wing Bat	21	10	Most important Gippsland cave site is outside burnt area, however much of the foraging habitat of bats using this cave was burnt
Eastern false pipistrelle	26	13	
Eastern horseshoe bat	39	18	Two of the three maternity sites were within the burnt area, and foraging habitat used by bats from the third was also burnt.
Eastern pygmy-possum	25	13	High proportion of best habitat in East Gippsland has been burnt; some tableland sites have been impacted. Most of the highest density sites in East Gippsland (on tableland near Bendoc) not burnt.
Feathertail glider	22	11	
Greater glider	32	21	Extensive areas of habitat were burnt.
Grey-headed Flying Fox	23	11	Major population in Mallacoota may be impacted.
Koala	13	6	
Long-footed potoroo	79	41	Populations may be impacted. Very high proportion of East Gippsland distribution burnt. Evidence of individuals in recently burnt areas.
Long-nosed bandicoot	35	17	
Long-nosed Potoroo	45	22	Very high proportion of East Gippsland distribution has been burnt. Recent (pre-fire) detections of this species have been few; high priority to assess status.
Mountain pygmy possum	7	4	
Platypus	14	6	
Smoky mouse	20	11	
Southern brown bandicoot	28	14	Very high proportion of East Gippsland distribution has been burnt.
Spot-tailed quoll	36	19	Most Upper Snowy sites (north of Gelantipy) were not in the current fire extent.
White-footed Dunnart	36	18	
Yellow-bellied glider	35	18	Populations on foothill sites may be impacted.

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Table 36: Bird, mammal and reptile species of most concern impacted by the 2019–20 bushfires cont'd.

Species Impacted by Fire	% Modelled Habitat in Fire Extent	% Modelled Habitat Impacted by High-Severity Fire	Localised Impacts
<i>Reptiles</i>			
Alpine she-oak skink	5	2	Minor impact Bogong High Plains. Extent extensive NSW impacts and impacts from previous fires.
Copper-tailed skink			
Diamond python	86	45	Most of the population may be impacted. Likely to be individuals on Howe Flat.
Eastern she-oak skink			
Lace monitor	16	8	High proportion of E. Gipps distribution burnt.
Red-throated skink			

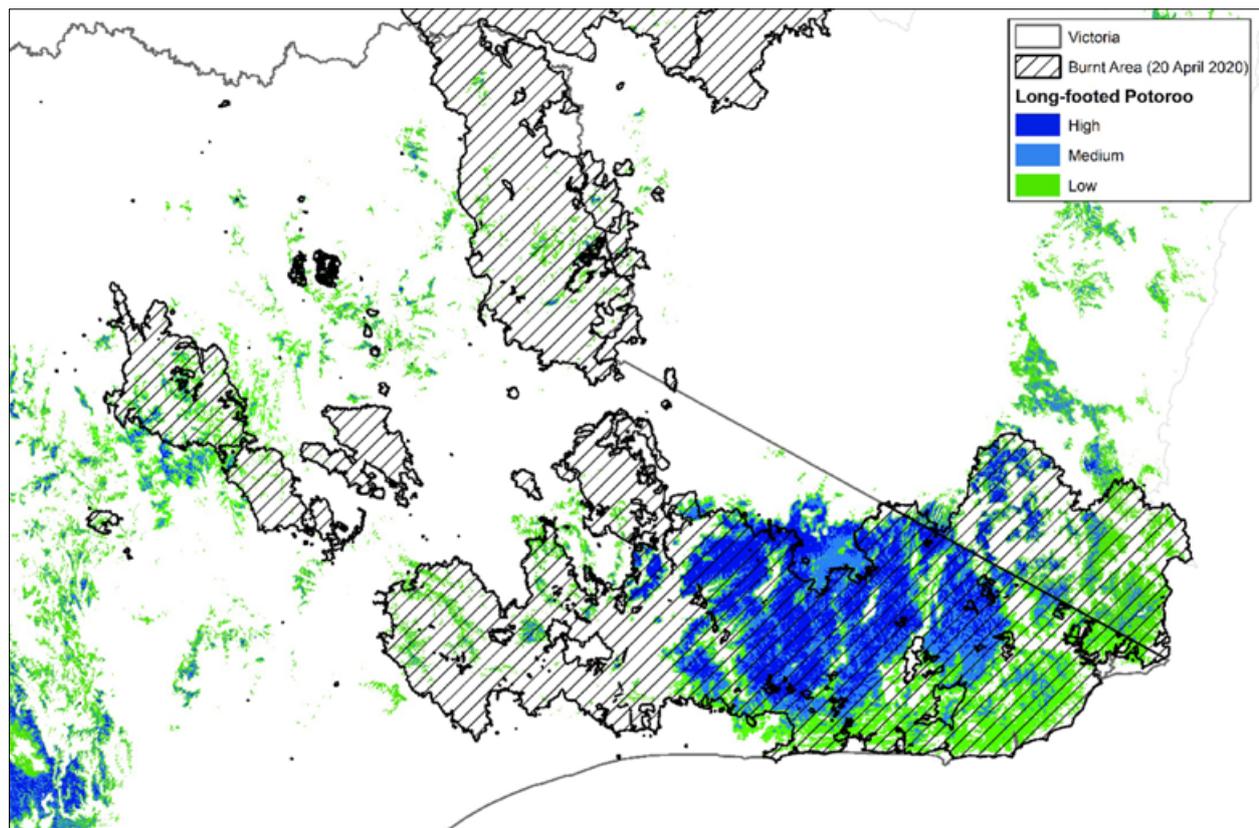


Figure 30: Modelled distribution of long-footed potoroo for south eastern Australia and current fire extent as at 20th April 2020.⁴³¹

431. Ibid

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The airlifting of 15 Endangered eastern bristlebirds threatened by fires approaching the Howe Flat in far East Gippsland involved a complex collaboration between Zoos Victoria, Parks Victoria, DELWP, the Australian Defence Force (the Singaporean Government provided the helicopter), Currumbin Sanctuary, Monash and Wollongong universities and the Orbost Incident Management Team. This was the first time in Australia that a threatened species had been extracted as a fire front approached its habitat. Although six of the captured birds died from fungal respiratory disease, and one due to complications

from a broken leg, the remaining eight birds were released back onto the Howe Flat once conditions had improved.⁴³²

Figure 31 shows that the 2019–20 bushfires have decreased biodiversity conservation values for fauna in eastern Victoria. The red-coloured areas indicate decreases in relative value, while blue coloured areas indicate increases in relative value. Note that locations with no change in value (white) do not imply the location has no biodiversity value, just that there has been no change.

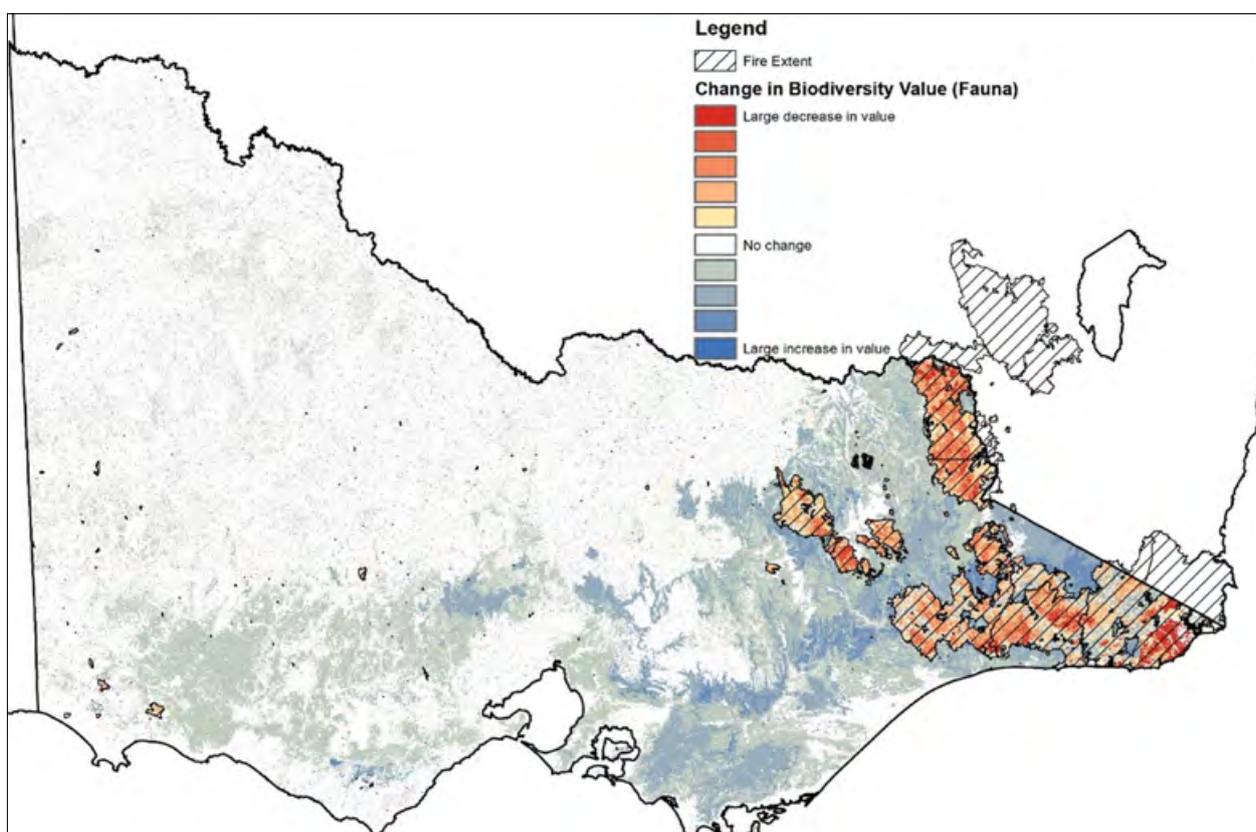


Figure 31: Map of the indicative change in relative biodiversity values for rare and threatened terrestrial vertebrate fauna species across eastern Victoria with current fire extent as at 20th April 2020.⁴³³

Burns (2020) used camera trapping surveys, historical records and overlays of the 2019–20 fire extent to assess the fire response of the smoky mouse and the long-footed potoroo in the Victorian High Country (Alpine National Park and Tea Tree Range State Forest).⁴³⁴ Burns and Atkins (2021) conducted similar research for the yellow-bellied and greater gliders in East Gippsland.⁴³⁵ Survey

sites ranged from unburnt to canopy scorching and burning. The results of the field research included:

- smoky mouse: detected at three of the 83 sites surveyed, with two of those in unburnt habitat
- long-footed potoroo: found at 38 of 83 sites, with all but five of the 38 in unburnt habitat. Site occupancy decreased with fire severity

432. Clarke R, Selwood K and Mott R, 'Our helicopter rescue may seem a lot of effort for a plain little bird, but it was worth it', *The Conversation*, 13 July 2020.

433. DELWP 2020, 'Victoria's bushfire emergency: biodiversity response and recovery, version 2', East Melbourne, Victoria.

434. Burns PA 2020, 'Post-fire surveys for smoky mouse and long-footed potoroo in the Victorian high country, 2020', Native Mouse Ecological Consulting, Melbourne, Victoria.

435. Burns PA and Atkins ZS 2021, 'Gliding from the ashes: post-fire surveys for the greater glider and yellow-bellied glider in Far East Gippsland', Snowline Ecology and Native Mouse Ecological Consulting, Melbourne, Australia.

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- yellow-bellied glider: detected at 14 of 30 sites and at 11 of 19 previously occupied sites. The likelihood of site occupancy decreased with fire severity (Figure 32)
- greater glider: found at one of 30 sites, 12 of which were previously occupied sites (see Figure 32 and Figure 33).

For the scientists, the results pointed to a probable decline in smoky mouse populations in recent decades, declines in the occurrence of both glider species, and the critical importance of the region for the long-footed potoroo, it having lost large areas of habitat to the fires. The results also highlighted the need to protect remaining unburnt habitat and areas of low-medium canopy scorching from fire and logging in Gippsland.

These areas would act as critical refugia and 'ensure the persistence of forest biodiversity that is currently so precariously positioned.'⁴³⁶

The Southern Ark team in East Gippsland was also involved in monitoring the presence and recovery of the long-footed potoroo after the 2019–20 bushfires, investigating 82 camera sites during April and May 2020 across a broader area than Burns (2020). The species had been seen at each of the sites before the bushfires, however 75 of the sites had been burnt. The reconnaissance survey found potoroos at the seven unburnt sites, at 40 of the burnt sites and right across their known distribution in East Gippsland, which are encouraging signs for their recovery.⁴³⁷

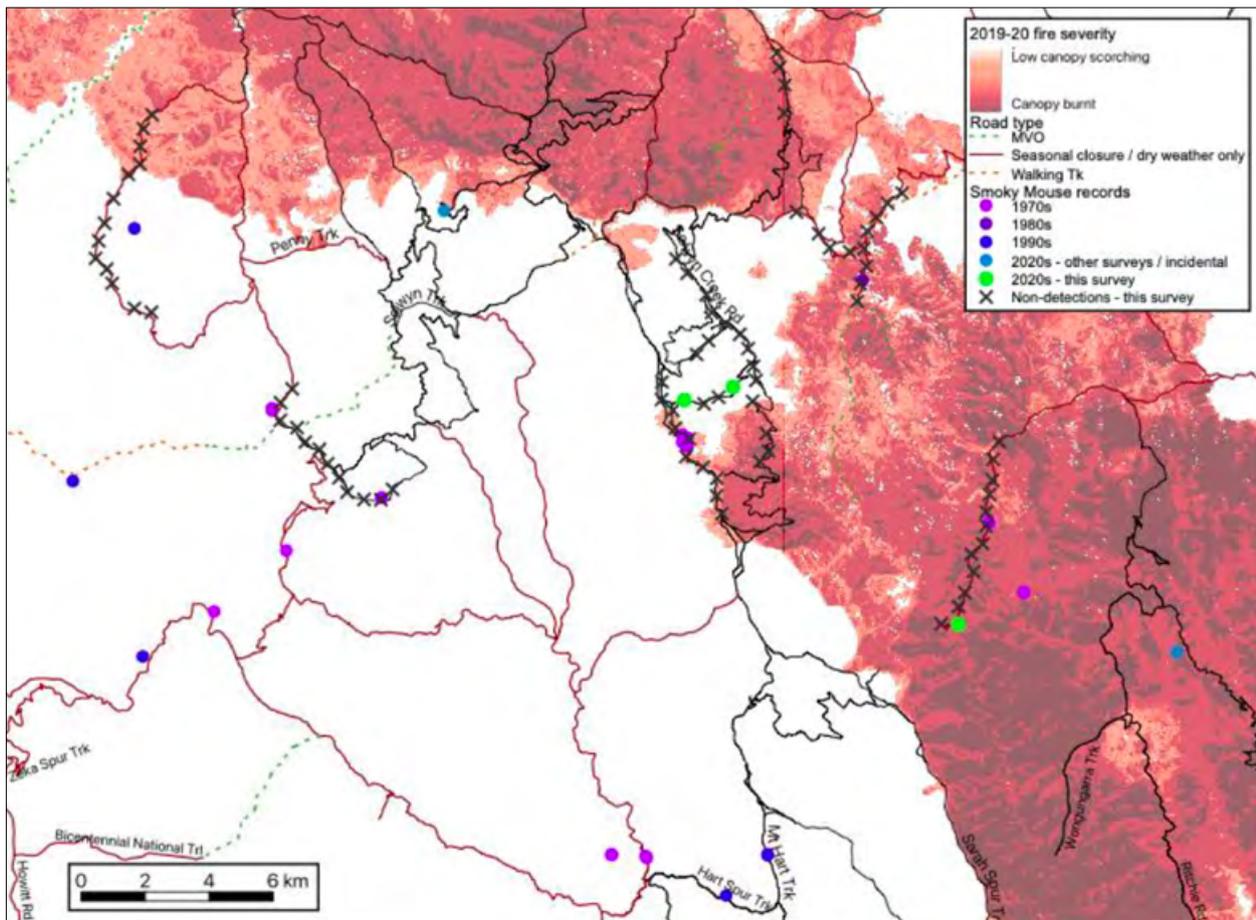


Figure 32: Historical records for yellow-bellied glider and greater glider and fire severity of the 2019–20 bushfires in East Gippsland.⁴³⁸

438. Burns PA and Atkins ZS 2021, 'Gliding from the ashes: post-fire surveys for the greater glider and yellow-bellied glider in Far East Gippsland', Snowline Ecology and Native Mouse Ecological Consulting, Melbourne, Australia.

Threatened species and communities

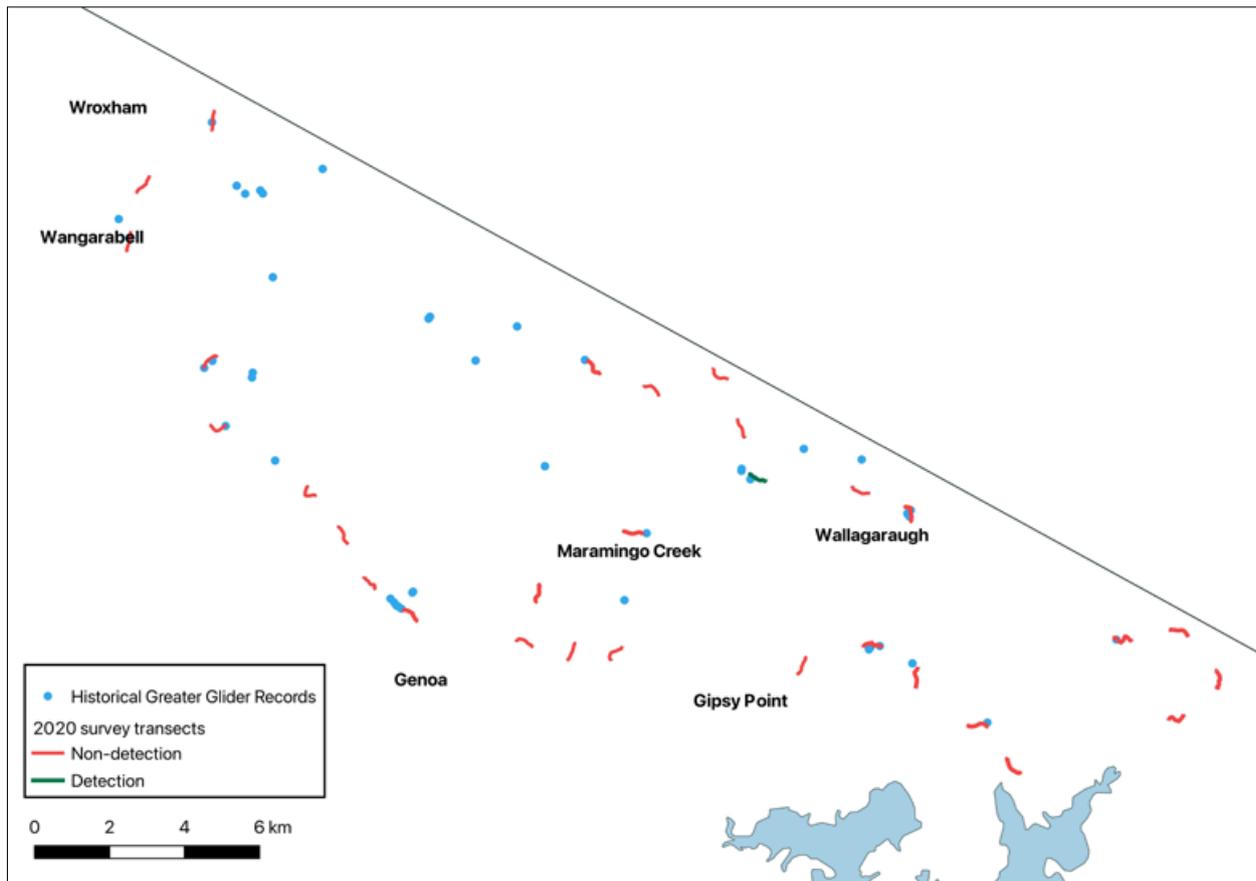


Figure 33: Historical records for the greater glider and detection and non-detection sites in the 2020 survey.⁴³⁹

Three projects funded through the Commonwealth's Wildlife and Habitat Bushfire Recovery Program are seeking to improve the recovery of threatened vertebrate species after the 2019–20 bushfires and will also assist this indicator's assessment in the SoE 2023 report.

The 'Bushfire recovery of cryptic threatened birds in the eastern heathlands' project is being delivered by Birdlife Australia. The project will be a comprehensive national assessment of fire-affected mainland ground parrots and eastern bristlebirds across their known ranges from Victoria to Queensland and will identify critical gaps in bushfire recovery efforts.

Birdlife Australia is also implementing a South-eastern Glossy Black-Cockatoo Bushfire Recovery Project to protect the bird's food supply and increase its long-term food security. The birds feed on the cones of female she-oak trees, which were burnt by the 2019–20 bushfires. The project, funded by the Commonwealth Government's Wildlife and Habitat Bushfire Recovery Program, involves the East Gippsland community and government agencies protecting unburnt stands, planting she-oaks and installing 'cockatubes' to cover the loss of natural hollows in the fires.⁴⁴⁰

The third project is investigating the use of artificial arboreal hollows cut into trees, and terrestrial hollows cut into fallen logs, for use by arboreal and terrestrial animals in burnt and unburnt areas. The targeted arboreal animals are the glossy black cockatoo, gang gang cockatoo, southern greater glider, yellow-bellied glider and red-browed treecreeper. Terrestrial animals targeted are the dusky antechinus, glossy grass skink, smoky mouse, southern water skink, spot-tailed quoll and the broad-toothed rat.⁴⁴¹

⁴³⁹. Ibid

⁴⁴⁰. Birdlife Australia, 'South-eastern glossy black-cockatoo bushfire recovery project', Carlton, Victoria <https://birdlife.org.au/projects/bushfire-recovery/south-eastern-glossy-black-cockatoo-bf> Accessed 19 August 2021.

⁴⁴¹. Treteec, 'Recent contracts, collaborations and grants', Melbourne, Victoria <https://www.tretec.net.au/contact/> Accessed 19 August 2021.

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SoE Biodiversity Update 2021 Report assessment

The conservation status of threatened vertebrate species in the new Flora and Fauna Guarantee Threatened List is summarised in Table 37, which excludes seabirds and the bird, mammal and reptile species that occur in wetlands.

Clemann, Atkins and Gilbert (2018) surveyed threatened reptiles, frogs and threatening processes in the Victorian Alps during 2017 and 2018.

They 'noted continuing, and likely worsening, impacts on the habitat of threatened lizards and the Alpine tree frog *Litoria verreauxii alpina*, from feral horses and deer, as well as probable emerging damage caused by pigs. These impacts, and the raft of impacts associated with a warming climate, are being exacerbated by human impacts, such as ongoing destruction and fragmentation of Alpine she-oak skink and Alpine tree frog habitat at Mt Hotham, and intentional disturbance to rocks used by Guthega skinks on the Bogong High Plains.⁴⁴³

Table 37: Vertebrate species on the Flora and Fauna Guarantee Threatened List.⁴⁴²

Taxon	Mammals	Birds	Reptiles	Total
Extinct	16	3	1	20
Critically Endangered	4	15	13	32
Endangered	11	18	18	47
Vulnerable	13	19	1	33
Total	44	55	33	132

The rocks are being disturbed by people using them to create small rock stacks (a social media trend) as they walk through the natural areas. Arthur Rylah Institute ecologist, Nick Clemann says: 'Some reptiles such as the critically endangered Guthega skink, which has only about a dozen tiny colonies in Victoria, are completely reliant on rocks for habitat; and those rocks are being disturbed. A few minutes of rock disturbance can be enough to destroy a small colony of Guthega skinks. We have found rock stacks right in the middle of Guthega skink colonies; where only a week or two earlier those rocks were home for these disappearing skinks. Rock stacks command our attention, because they stand out so obviously from the surrounding landscape. The reason for this is that they don't occur naturally, and those rocks should be elsewhere, where you wouldn't notice them. Once torn up, the carefully constructed burrows beneath these rocks are abandoned, and even if the rocks are replaced it may be a very long time before they once again provide suitable habitat. In that time, we may have lost those colonies for good; and that is irreversible environmental vandalism.'⁴⁴⁴

A survey by Burns (2019) in south-eastern Victoria determined that the New Holland mouse, a small and endangered native rodent, had been lost from seven of the 12 isolated areas where it once occurred due to habitat loss and fragmentation, invasive predators and genetic isolation.⁴⁴⁵ To reverse the decline, Burns recommended 'dedicated investment in ongoing habitat management and predator control, carefully considered reintroductions, and continued research into probable causes of decline, including novel disease and genetic inbreeding.'

Clemann (2015) reviewed the history of listing threatened reptiles in Victoria and their conservation. The review found that the 'deteriorating status of Victorian reptiles mirrors worrying documented trends in reptile conservation status around the world' and 'as in other parts of the world the threats common to most listed taxa are climate change, habitat loss and degradation

442. Flora and Fauna Guarantee Act Threatened List.

443. Clemann N, Atkins Z and Gilbert D 2018, 'Monitoring and survey of threatened alpine reptiles, frogs and threatening processes in the Victorian alps: 2017-2018 season', unpublished client report for Zoos Victoria, Arthur Rylah Institute, Heidelberg, Victoria.

444. DELWP, '#rockstacks don't rock', East Melbourne, Victoria <https://www.wildlife.vic.gov.au/media-releases/rockstacks-dont-rock-how-one-insta-worthy-trend-is-putting-endangered-species-at-risk> Accessed 9 May 2021.

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and elevated rates of predation by exotic predators.⁴⁴⁶ The review also identified 'poor advice and planning as a considerable threat to Victorian reptiles; this threat is rarely reported, but may be more pervasive than currently recognised.' Clemann (2015) recommended the 'prevention of habitat loss and degradation, research to underpin listing and management, improved policy so that unproven management strategies are not sanctioned, and vetting of consultant's reports so that unproven "mitigation" strategies and inadequate pre-impact surveys do not mask the true cost of loss and degradation of habitat.'

Woodford, Forsyth and Hampton (2020) found that scavenging birds could be at risk of lead ingestion from lead-based bullets used to shoot kangaroos and deer. The scientists monitored deer carcasses in north-eastern Victoria and kangaroo carcasses in Hattah-Kulkyne National Park. They observed eight bird species, including the brown goshawk, wedge-tailed eagle, little eagle and whistling kite feeding on the carcasses.⁴⁴⁷ The wedge-tailed eagle spent the most time feeding on the carcasses and was deemed to be the bird most at risk from ingesting lead fragments.

Declining populations of threatened species are at risk of genetic isolation. High genetic risk for many species affected by the bushfires was reported in DELWP's bushfire response and recovery report in August 2020.⁴⁵⁰ In the case of the regent honeyeater, their small populations are contributing to a loss of their songs. Cates et al. (2021) have found that isolation and small numbers (fewer than 300 in the wild) are preventing young regent honeyeaters from learning important behaviours, including songs. In some cases they have adopted the songs of other species. The scientists conclude that the loss of song could be a warning that the bird is nearing extinction and recommended the restoration and protection of habitat, protection from invasive predators and teaching captive-bred birds to sing.

Lindenmayer, Bowd, McBurney (2021) used insights from observational studies and experiments conducted over 18 years to analyse the direct and interactive effects of fire and logging on birds. They found that: 'The extent and severity of wildfires have major negative effects on almost all bird species and have persisted for more than a decade after the last major conflagration (in 2009). Logging has markedly different effects on birds than those quantified for fire, and may have resulted in elevated levels of site occupancy in remaining uncut areas in the landscape. Both fire and logging have led to marked losses in the extent of old growth forest in Mountain Ash and Alpine Ash ecosystems.' The scientists' recommendations included the conserving of all existing stands of old-growth forest, significantly expanding the extent of the old-growth estate and the banning of post-fire (salvage) logging operations.

The Threatened Mammal Index for Victoria, released by the Threatened Species Recovery Hub, reported that for seven threatened and near-threatened species for which data were available, their relative abundance had decreased on average by 72% between 1995 and 2016.⁴⁵¹ For individual species, the declines ranged from 55% to 82%. The Threatened Bird Index for Victoria has indicated that for 18 threatened bird species, their relative abundance had decreased on average by 61% between 1985 and 2016.⁴⁵² For individual species, the declines ranged from 28% to 77%. The two indices have used available but limited data. Over time, the number of species included will increase and the indices 'will allow Australian governments, non-government organisations, stakeholders and the community to better understand and report on which groups of threatened species are in decline by bringing together monitoring data. It will potentially enable us to better understand the performance of high-level strategies and the return on investment in threatened species recovery and inform our priorities for investment.'⁴⁵³

445. Burns P 2019, 'Testing the decline of the New Holland mouse (*Pseudomys novaehollandiae*) in Victoria', *Australian Mammalogy*, 42(2), pp. 185-193.

446. Clemann N 2015, 'Cold-blooded indifference: a case study of the worsening status of threatened reptiles from Victoria, Australia', *Pacific Conservation Biology*, 21, pp. 15-26.

447. Woodford L, Forsyth D and Hampton J 2020, 'Scavenging birds at risk of ingesting fragments of lead bullets from kangaroo and deer carcasses in south-eastern Australia', *Australian Field Ornithology*, 37, pp. 112-116.

448. DELWP 2020, 'Victoria's bushfire emergency: biodiversity response and recovery, version 2', East Melbourne, Victoria.

449. Crates R, Stojanovic, Langmore N and Heinsohn R 2021, 'Only the lonely: an endangered bird is forgetting its song as the species dies out', *The Conservation*, 17 March 2021.

450. Lindenmayer D, Bowd E and McBurney L 2021, 'Long-term empirical studies highlight multiple drivers of temporal change in bird fauna in the wet forests of Victoria, south-eastern Australia', *Frontiers in Ecology and Evolution*, 9, Article 610147.

451. Threatened Species Recovery Hub, 'Factsheet: a threatened mammal index for Victoria', National Environmental Science Programme, Canberra, Australia.

452. Ibid

453. Ibid

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Through the Victorian Government's Biodiversity On-Ground Action Icon Species Grants program, DELWP funded targeted actions to protect and conserve Icon Species. Table 38 lists the nine icon species that are terrestrial vertebrates and the actions being funded. Other funded projects target actions to conserve the southern bent-wing bat,

Eltham copper butterfly, southern brush-tailed rock-wallaby, Australian fairy tern and Australasian bittern. Zoos Victoria's current Fighting Extinction program targets 27 largely Victorian Critically Endangered species, including the brush-tailed rock wallaby, the plains wanderer, Baw Baw frog, golden-rayed blue butterfly and the grassland earless dragon.

Table 38: Icon species and the conservation actions.⁴⁵⁴

Icon Species	Conservation Actions
Brush-tailed rock-wallaby	Supporting captive breeding and release programs at Tidbinbilla Nature Reserve and Mt Rothwell Biodiversity Interpretation Centre
Eastern barred bandicoot	Supporting the management of four reintroduction sites including predator fences, control of feral animals and weed control
Helmeted honeyeater	Supporting staff and volunteers to monitor the wild population, as well as the release and monitoring of captive bred birds
Hooded plover	Recruitment, training and support of citizen scientists to protect nesting pairs along Victoria's coastline
Leadbeater's possum	Protect critical habitat for lowland animals and work towards restoring hydrological conditions at Yellingbo Nature Conservation Reserve
Mountain pygmy-possum	Develop translocation plans to increase population size of isolated populations of pygmy-possums
Orange-bellied parrot	Supporting the four-year Mainland Release Trial, which is undertaken as a partnership between DELWP and Zoos Victoria
Plains-wanderer	Identifying suitable and occupied habitat across the Northern Plains, using song meters to record breeding female plains-wanderers' calls
Regent honeyeater	Supporting the implementation of the Regent Honeyeater Captive Release and Community Monitoring Program

DELWP's Caring for the Environment – Faunal Emblems program has been running for three years and is aimed at improving the survival chances of the Leadbeater's possum and the helmeted honeyeater. Actions that are part of the \$4 million program, which was extended to July 2021, include habitat protection and restoration, the surveying and monitoring of populations, captive breeding and release, genetic research and health inspections, and community engagement activities. A proposed translocation of helmeted honeyeaters to a new location was scheduled for July 2021, on the back of successful captive breeding and genetic rescue programs. Habitat suitability at Yellingbo

Conservation Reserve has been identified as a limiting factor in the recovery of the population, as it has for the lowland Leadbeater's possum.

Almost 10,000 nesting boxes are being used across Victoria to improve habitat for hollow-dependent native fauna, according to a DELWP survey in 2018.⁴⁵⁵ The survey found that 33 mammal and bird species were using the boxes and that there was potential for their better use.

454. DELWP, 'Icon species', East Melbourne, Victoria <https://www.environment.vic.gov.au/biodiversity/biodiversity-on-ground-action/icon-species> Accessed 3 July 2021.

455. Macak P 2020, 'Nest boxes for wildlife in Victoria: an overview of nest box distribution and use', *The Victorian Naturalist*, 137, pp. 4-14.

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Landcare groups, Friends groups and conservation groups had installed the most nest boxes (72% of total), and these were being used to build habitat connectivity, cover the absence of natural hollows, support a particular species, such as possum, parrots, ducks, gliders, owls and kookaburras, and as monitoring and education tools. Challenges for the nest box projects found by the survey included:

- lack of time and resources for monitoring and recording data, coordinating volunteers and landholders
- uncertainty about what details to monitor
- reaching boxes: reluctance to use ladders, with the need to engage an arborist.

While the aim might be to cover the absence of natural hollows, nest boxes are not used by all species, do not provide all types of hollows and should not be seen as replacements for natural hollows. For example, Griffiths et al. (2017) found in a long-term bat-box monitoring project that Gould's wattled bat (*Chalinolobus gouldii*) was the dominant user of the bat boxes, with the region's other 13 bat species making little or no use of them.⁴⁵⁶

Biodiversity in urban areas can be often overlooked in discussions about nature conservation and its benefits. Melbourne Water manages a number of urban wetlands and sites of biodiversity significance in the Melbourne metropolitan area. Surveys by Birdlife Australia, after the removal of willows and the restoration of riparian vegetation in the Plenty River and Arthurs and Olinda creeks, found bird abundance had increased in each area, while species richness increased along the two creeks.⁴⁵⁷ McNabb (2020) surveyed nocturnal birds at four of Melbourne Water's 44 sites of biodiversity significance and found two Vulnerable species (the powerful and sooty owls), along with the southern boobook and Australian owl-nightjar, indicating that the sites provide foraging habitat and may support breeding.⁴⁵⁸

456. Griffiths S, Bender R, Godinho L, Lentini P et al. 2017, 'Bat boxes are not a silver bullet conservation tool', *Mammal Review*, 47, pp. 261–265.

457. Birdlife Australia 2020, 'Melbourne Water regional bird monitoring project, annual report 2019–2020', report for Melbourne Water, Carlton, Victoria.

458. McNabb E 2020, 'Assessment of nocturnal avifauna populations at four Sites of Biodiversity Significance', Report for Melbourne Water, Ninnox Pursuits Environmental Services, Gembrook.

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Indicator B:06C Threatened terrestrial invertebrate species

Region Statewide	Indicator Performance:	2018 Status	2018 Trend	2018 Data
Measures Changes in the conservation status of terrestrial threatened species; Number, abundance and distribution of selected threatened terrestrial species; Threatening processes impacting and affecting native terrestrial threatened species	2018 & 2021: Unable to be assessed due to Moderate and Low Data Confidence respectively Why this indicator? The SoE 2018 Report noted that there is limited trend information on the number of threatened invertebrates.			
		2021 Status	2021 Trend	2021 Data
Data Custodian DELWP				

Potential thresholds for status in the SoE 2023 report

Good: No longer threatened and population numbers recovering

Fair: Conservation status is Near Threatened or of Least Concern

Poor: Remains Critically Endangered, Endangered or Vulnerable

OR

Good: Significant increasing trend in the abundance and distribution of threatened terrestrial invertebrate species, and threats are being monitored, reported and mitigated

Fair: Stable or small increasing trend in the abundance and distribution of threatened terrestrial invertebrate species, and threats are in part being monitored, reported and mitigated

Poor: Significant declining trend in the abundance and distribution of threatened terrestrial invertebrate species, and threats are not being monitored, reported or mitigated

Why this assessment in 2021?

Status: The use of more rigorous criteria in preparing the new Flora and Fauna Guarantee Threatened List has led to the conservation status of some threatened terrestrial invertebrate species to be upgraded e.g. from Vulnerable to Critically Endangered (some have also remained the same or been downgraded). Although the on-ground situation e.g. population size and habitat for the species might not have changed since their last assessment, the new conservation status gives greater public recognition of their plight. Although the 2019–20 bushfires took a heavy toll on invertebrates, it has not been quantified.

Trend: See above.

Data Confidence: There are limited data on terrestrial invertebrates in Victoria.

Should this indicator be used in the SoE 2023 report?

Not in its current form. Consideration could be given to at least splitting it into an indicator for butterflies and moths.

Summary of SoE 2018 Report assessment

- There is limited trend information on the number of threatened invertebrates. In 2018, 178 known species were considered to be threatened.
- Of the 178, there were 20 listed as Critically Endangered, 28 Endangered and 79 Vulnerable.

The 2019–20 bushfires: Impacts and responses

Lee (2020) estimates that across Australia, at least 740 species of insects could have been imperilled by the 2019–20 bushfires. Associate Professor Michael Braby of the Australian Entomological Society's Conservation Committee was quoted as saying that 'few insects have strategies to escape fire. This means most are killed in the event of a bushfire, and their recovery relies on recolonization from unburnt areas' ... and ... 'the severity and extent of the current fires means insects would have few, if any, refuges for survival. Many species may well go extinct, especially rare species, or those with specialised requirements, such as specific host plants.'⁴⁵⁹

459. Fagan J 2020, 'Bushfire crisis spells trouble for Aussie insects', *Phys.org*, 5 January 2020.

Threatened species and communities

SoE Biodiversity Update 2021 Report assessment

There are 42 threatened terrestrial invertebrate species on the Flora and Fauna Guarantee Act Threatened List: butterflies, moths, ants, land snails, beetles, a bee and an earthworm. Of the 42 listed species, there are nine Critically Endangered, 23 Endangered, six Vulnerable, one Threatened and

three Extinct, while the conservation status of 14 has been upgraded, 10 have been downgraded, 17 have had no change and one was not on the 2009 advisory list. Although caution is needed when interpreting the upgrading of the conservation status of threatened invertebrates, and the on-ground situation e.g. population size and habitat for the species might not have changed since the last assessment, the new conservation status gives greater public recognition of the plight of the species.

Indicator B:07 The conservation and management of biodiversity on private land

Region	Statewide	Indicator Performance:	2018 Status	2018 Trend	2018 Data
Measures Conservation on private land which assesses the area of private land under conservation agreements; Management of biodiversity on private land which assesses activities taken to conserve species, conserve communities and maintain, improve or restore habitat on private land		2018 & 2021: Unable to be assessed due to Fair status			
		Why this indicator? Private land conservation is an important part of strategies for biodiversity conservation across the state.			
Data Custodian	DELWP; Trust for Nature; Catchment management authorities				

Potential thresholds for status in the SoE 2023 report

Good: ≥75% to 100% of annual percentage target for private land conservation met

Fair: ≥50 to <75% of annual percentage target for private land conservation met

Poor: <50% of annual percentage target for private land conservation met

Why this assessment in 2021?

Status: The 2020 report⁴⁶⁰ on the implementation of Biodiversity 2037 reveals that since 2017 there have been 5,373 hectares of private land given permanent protection or an average addition of less than 1,400 hectares per year, well short of the annual target needed to achieve 200,000 hectares by 2037. Based on the Potential Thresholds for Status, this indicator's Status would be Poor. However, this will be reassessed in the SoE 2023 report, which will coincide with the end of the Biodiversity 2037's first five-year milestone target. Fair will remain the Status for now.

Trend: Trust for Nature is slowly increasing the area of land protected by covenants and other legal mechanisms, as well as working with landholders to enhance biodiversity on their properties. Although data are sparse, other programs are also seeking to increase private land conservation. However, permanent protection is less likely in these other programs.

Data Confidence: Detailed data are provided by Trust for Nature and DELWP.

Should this indicator be used in the SoE 2023 report?

Not in its current form. There is considerable overlap of the data needs for this indicator and that of B:21. Consideration could be given to merging them. Alternatively, data on progress conserving biodiversity on private land outside the covenanting process e.g. land management agreements and other programs (see below narrative) could be the focus of an indicator were data available.

Summary of SoE 2018 Report assessment

- Private land occupied 63% of Victoria's 23 million hectares.
- Trust for Nature had assisted with the permanent protection of more than 100,000 hectares since its establishment in 1972.

- There were 1,416 voluntary conservation covenants and 43 Trust for Nature properties and/or reserves.

460. DELWP, 'Implementing Biodiversity 2037' <https://www.environment.vic.gov.au/biodiversity/Implementing-Biodiversity-2037> Accessed 13 September 2021.

Threatened species and communities

- Trust for Nature had a target of an additional 50,000 hectares added to Victoria's protected area network through direct protection and partnership in permanent protection by 2021.

The 2019–20 bushfires: Impacts and responses

Forty-six Trust for Nature covenants and one reserve covering approximately 1,400 hectares of native vegetation were affected by the bushfires.⁴⁶¹ Trust for Nature obtained funding from a range of sources (fundraising, Commonwealth and Victorian governments) to assist with supporting landholders

restore their burnt covenanted land. These funds have been used to support both on-ground and landholder engagement activities, including land management advice, fencing, weed control, pest control, fauna and flora surveys, weed distribution surveys and revised management plans.⁴⁶²

DELWP's August 2020 biodiversity and bushfires report estimated that 404 hectares of permanent protection on private land was within the fire extent, with 130 hectares impacted by high-severity fire (see Table 39). The report also estimated that the total area of permanent protection on private land was 49,025 hectares.

Table 39: Land tenure and the extent of the 2019–20 bushfires.⁴³⁹

Land Tenure	Area in Fire Extent (Ha)	Area Impacted by High Severity Fire (ha)	Total Area across State (ha)
National parks and nature conservation reserves	446	285,462	3,900,480
Permanent protection on private land	404	130	49,025
Special Protection Zone in State Forests	203,758	127,966	765,900

SoE Biodiversity Update 2021 Report assessment

Victoria is the most-cleared state in Australia, with 66% of native habitat removed since 1835.⁴⁶⁴ On private land, which covers 63% of Victoria, 80% of native habitat has been lost. Almost 90% of the EVCs that are poorly represented in parks and reserves are found on private land.⁴⁶⁵ However, only 1–2% of private agricultural land is managed for conservation e.g. native vegetation protection, revegetation and livestock exclusion.⁴⁶⁶ A smaller 0.5% is managed under a conservation agreement. The way in which private land is used and managed in the future will be critical in Victoria's efforts to secure, restore and conserve biodiversity.

The Victorian Environmental Assessment Council analysed and mapped the terrestrial bioregional conservation status on private land (see Figure 34). It found that:

'When bioregions are grouped by the level of clearing, differences become apparent between the relative extent of vegetation on public and private land. In the most cleared bioregions (e.g. Wimmera, Dundas Tablelands and Victorian Volcanic Plain), a much higher proportion of native vegetation occurs on private land. Furthermore, much more of the native vegetation on private land comprises endangered and vulnerable EVCs. For example, in the Victorian Volcanic Plain, 19% of native vegetation on public land has a conservation status of "least concern", and 48% has a conservation status of "endangered" or "vulnerable". On private land in this bioregion, 96% of native vegetation has a conservation status of "endangered" or "vulnerable".⁴⁶⁷

461. Fagan J 2020, 'Bushfire crisis spells trouble for Aussie insects', *Phys.org*, 5 January 2020.

462. Trust for Nature 2021, 'Annual report 2019–2020', Melbourne, Victoria.

463. DELWP 2020, 'Victoria's bushfire emergency: biodiversity response and recovery, version 2', East Melbourne, Victoria.

464. Trust for Nature 2020, 'Trust for Nature: covenanting for conservation', Melbourne, Victoria <https://connectingcountry.org.au/the-concept-of-covenanting-for-conservation/> Accessed 7 May 2021.

465. Trust for Nature, 'Victoria's ecosystems', Melbourne, Victoria <https://trustfornature.org.au/resources/victorian-ecosystems/> Accessed 7 May 2021.

466. Victorian National Parks Association, 'Private land conservation', Melbourne, Victoria <https://vnpa.org.au/future-parks/private-land-conservation/> Accessed 9 May 2021.

467. Victorian Environmental Assessment Council 2016, 'Map E: Terrestrial bioregional conservation status – private land', in 'Statewide Assessment of Public Land, Discussion Paper', Melbourne, Victoria

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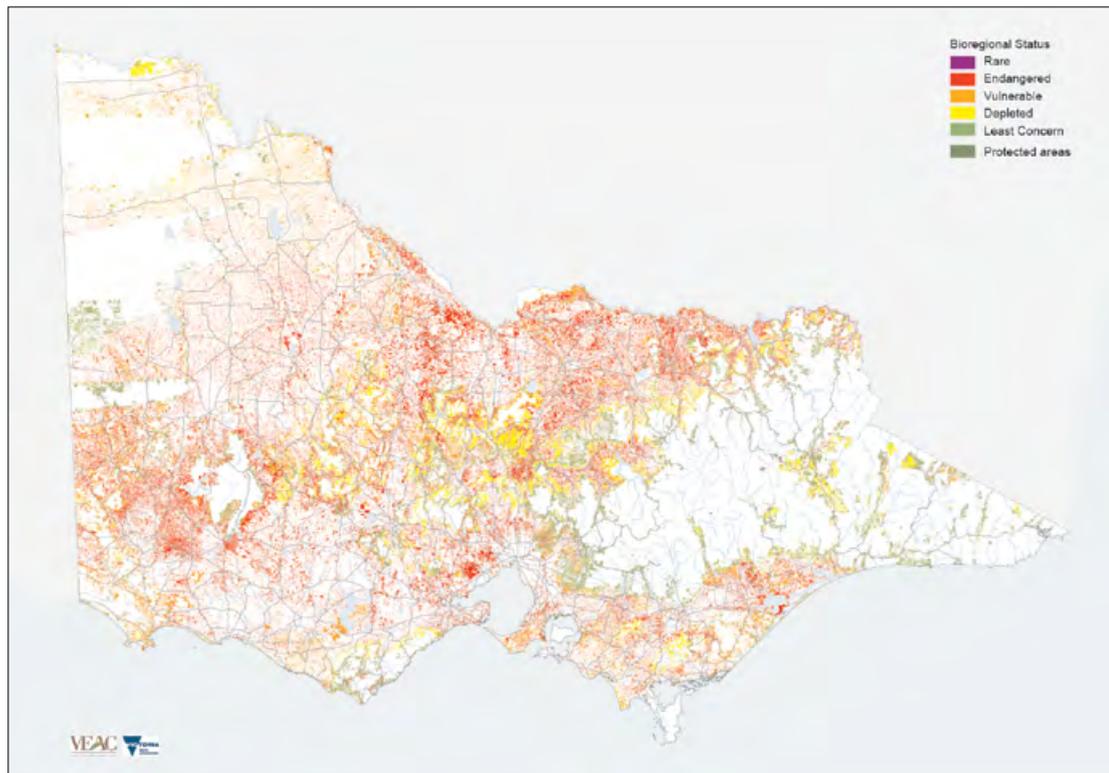


Figure 34: Terrestrial bioregional conservation status on private land in Victoria⁴⁶⁸

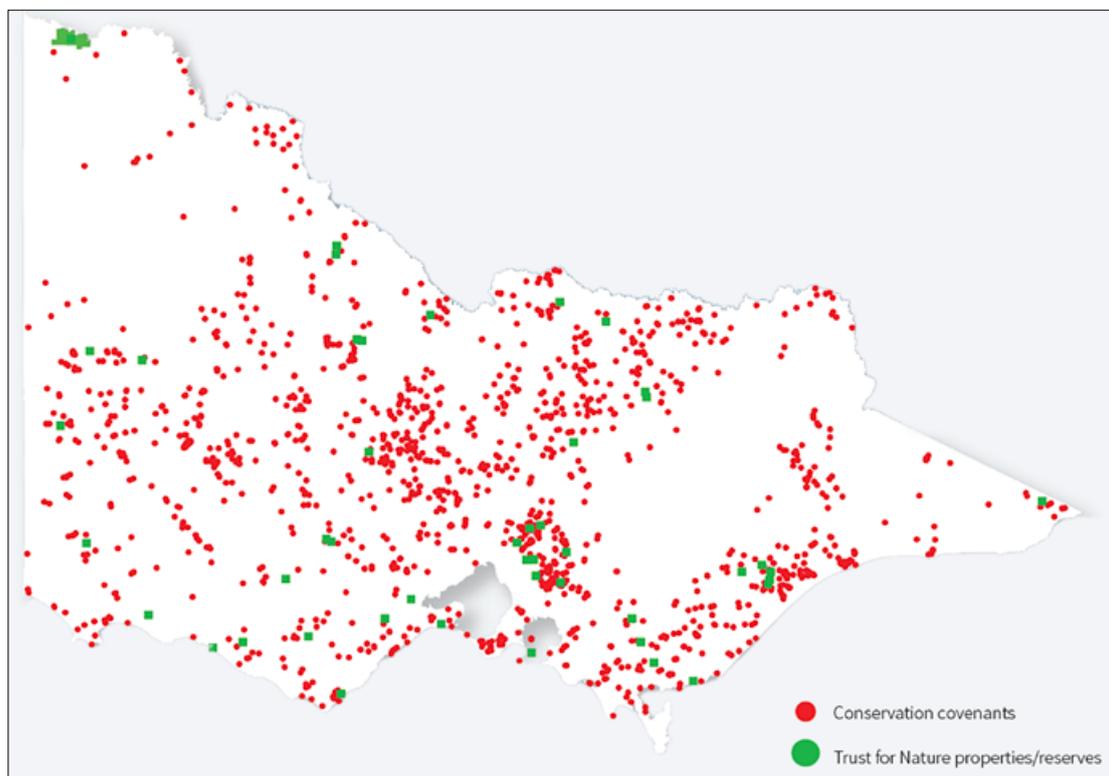


Figure 35: Land protected by conservation covenants and Trust for Nature reserves as in 2020.⁴⁶⁹

468. Victorian Environmental Assessment Council 2016, 'Statewide assessment of public land, discussion paper', Melbourne, Victoria.
 469. Trust for Nature 2021, 'Annual report 2019-2020', Melbourne, Victoria.

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Since its establishment by Act of Parliament in 1972, with a mission to protect and restore biodiversity on private land across Victoria, the Trust for Nature has secured more than 100,000 hectares of native habitat. This includes 70,142 hectares in more than 1,503 covenant⁴⁷⁰ on private land, and another 36,000 hectares in 46 reserves owned by the Trust (Figure 35).⁴⁷¹ Table 40 details the outcomes of Trust for Nature activities in the 2017–18, 2018–19 and 2019–20 financial years. For example, in 2019–20 the Trust:

- registered 30 covenants covering 1,772 hectares
- helped deliver feral animal control across 48,109 hectares
- assisted with weed management on more than 17,800 hectares of covenanted land

- assisted the preparation of 130 conservation management plans for covenanted properties and the delivery of 255 ecological surveys on covenanted properties and Trust reserves
- collaborated with partners on more than 70 projects to protect threatened species e.g. plains-wanderer, regent honeyeater and striped legless lizard.⁴⁷²

Over the four years of its five-year target of 50,000 hectares by 2021, Trust for Nature has helped permanently protect approximately 8,665 hectares of additional habitat on private land through covenants, acquisitions, donations of land and its Revolving Fund.

Table 40: Outcomes of Trust for Nature activities for the 2017–18, 2018–19 and 2019–20 financial years.⁴⁷³

Activity	2017-18	2018-19	2019-20
Covenants registered (No.)	31	36	30
Covenants registered (ha)	1,449	1,918	1,772
Covenants under negotiation (ha)	1,932	1,707	6,377
Conservation management plans	131	157	130
Offset agreements under negotiation	6	15	32
Offset covenants registered	4	7	4
Ecological surveys	135	205	255
No of partner collaborations	100	85	130
Weed management (ha)	3,700	10,900	17,854
Feral animal management (ha)	68,000	54,000	48,109
Fencing (km)	19	20	7.25
Improved grazing regime (ha)	850	800	925
Other habitat improvements (ha)	6,100	3,500	2,253
Conservation reserves (no.)	n/a	42	43
Revolving Fund (\$)	3,822,181	3,846,214	3,959,061

470. Ibid

471. Trust for Nature, "Trust for Nature reserves", Melbourne, Victoria <https://trustfornature.org.au/resources/trust-for-nature-reserves/> Accessed 7 May 2021.

472. Trust for Nature 2021, 'Annual report 2019–2020', Melbourne, Victoria.

473. Trust for Nature annual reports.

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As part of its work⁴⁷⁴ in 2020, the Trust:

- secured a covenant over the 77-hectare Flanagan Island in the Ramsar-listed Gippsland Lakes
- with the North Central CMA, offered landholders a financial incentive of \$1,000/hectare to protect grassland habitat for the Critically Endangered plains-wanderer. There are fewer than 1,000 of this bird left in the wild
- with the North East CMA, offered financial support to landholders for fencing remnant bushland, planting trees and shrubs, thinning of dense regeneration and the control of weeds to enhance habitat for the regent honeyeater (400 in the wild) and swift parrot (2,000 in the wild)
- provided financial support for fencing and planting indigenous vegetation along the shores of Jones Bay and Lake King in the Gippsland Lakes
- worked with the Mornington Peninsula Shire to establish covenants over more than 130 hectares in Warringine Park and areas of the Tootgarook Wetland
- secured 146 hectares of a 208-hectare property in far East Gippsland, home to the threatened long-footed potoroo, glossy-black cockatoo and coast grey-box.⁴⁷⁵ The owners realised the urgent need to give the land greater protection after it was burnt during the 2019–20 bushfires. This covenanting is part of the Trust's three-year Iconic Estates Eastern Forests project, which has secured 250 hectares in covenants.

The Trust for Nature has also partnered with Bank Australia as it restores woodlands in the West Wimmera along the route of the Habitat 141 corridor, a landscape-scale biolink project. The bank began the purchase of five properties in 2008 and the Bank Australia Conservation Reserve⁴⁷⁶ now covers more than 1,000 hectares. The reserve includes habitat of the endangered south-eastern red-tailed black-cockatoo and also hosts more than 270 fauna species, of which 13 are threatened, and 237 flora species, of which 11 are threatened. It is also the

traditional lands of the Wotjobaluk, Jardwadjali, Jaadwa, Wergaia and Jupagulk people, with whom the bank is engaging. Community volunteers are also involved, with 680 of them having planted more than 70,000 seedlings.

The native vegetation offset market is another area of engagement for the Trust, ensuring that offset agreements involve covenants on the land. In 2019–20, there were four offset covenants registered covering 129.17 hectares, while a further 32 covering 1,557.76 hectares were in negotiation.⁴⁷⁷

The Trust for Nature Revolving Fund was the first of its kind established in Australia and enables the Trust to engage in the property market to buy and sell land for conservation benefit. The proceeds from the sale of Trust properties are deposited in the revolving fund, which is used to purchase, protect with covenants and then sell other properties and secure habitat protection. Since 1972, the Trust has bought 75 properties and sold 67 and, in doing so, has protected 6,710 hectares.⁴⁷⁸ In 2019–20 the total value of the revolving fund was \$3,959,061.

Selinske et al. (2019) surveyed 527 covenanted landholders in Victoria, Tasmania and NSW and found 'that landholders are mainly motivated to participate in order to protect their land in perpetuity, but come to expect financial and technical assistance as a benefit of the program.'⁴⁷⁹ Of those surveyed, 71.1% achieved their land management goals, 44.7% struggled with covenant management due to their age and financial and time constraints, while 8% were disaffected with their participation in the covenanting program. They felt unable to personally manage the biodiversity on their land and lacked interactions with the covenanting organisation. To increase the effectiveness of the privately protected area programs, the authors recommended that the programs 'regularly monitor landholder satisfaction and management needs, schedule conservation actions based on landholder capacity, and utilize

474. See Trust for Nature 2020, 'Conservation bulletin no 72' for further details of this work.

475. D'Ambrosio L 2020, 'East Gippsland land to be haven for endangered animals', Ministerial media release, Government of Victoria, 7 December 2020.

476. *The Guardian*, 'Nature bank: inside the reserve where Australia's threatened natives thrive', 26 November 2020.

477. Trust for Nature 2021, 'Annual report 2019–2020', Melbourne, Victoria.

478. Ibid

479. Selinske M, Howard N, Fitzsimons J, Hardy M et al. 2019, 'Monitoring and evaluating the social and psychological dimensions that contribute to privately protected area program effectiveness', *Biological Conservation*, 229, pp. 170–178.

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landholder networks to spread information and foster communities of stewardship. Additionally, given the older demographics of landholders, programs should engage in PPA [Personal Profile Analysis] successional planning.'

Hardy et al. (2018) interviewed the managers of Australia's five main revolving fund programs and identified three broad categories and 10 main factors influencing the selection of properties for purchase. They were:

- ecological: threatened species and communities; complements reserve system; landscape attributes
- social: amenity; aesthetics; social/community context; conservation story
- economic: purchase costs; sale price; sale time.⁴⁸⁰

The selection of properties was inevitably, according to Hardy et al. (2020), a trade-off between these factors. However, it was heavily influenced by the likelihood of profit or the recovery of costs. The authors concluded that: 'as a market-based approach, the central influence of property resale on the conservation gains made by revolving funds likely constrains the applicability of this tool to certain types of properties, meaning its role needs to be considered as part of a broader conservation policy mix.'⁴⁸¹

Trust for Nature has identified 225,000 hectares of high-priority private land suitable for protection⁴⁸² as it seeks to contribute to the achievement of the Biodiversity 2037 target of 200,000 hectares of protection by 2037. Protecting biodiversity on private land contributes to Biodiversity 2037 indicators – B:18 Net gain in extent and condition of native vegetation, B:20 Change in Suitable Habitat, B:21 Area of management in priority locations and B:22 Victorians valuing nature – where private land conservation contributes to environmental stewardship.

Although the Trust for Nature and DELWP have been working to significantly increase the area of native vegetation that is conserved on private land,

the outcomes are currently well below the annual target of 6,000–10,000 hectares for Biodiversity 2037. In its submission to the parliamentary inquiry into ecosystem decline in Victoria, the Victorian Farmers Federation argued that there are a number of factors preventing landholders from establishing covenants and other protection measures on their land:

- native vegetation controls 'designed for urban areas have led to cessation of "agroforestry" projects that maintained habitat links, lowered saline water tables, and provided firewood and timber resources'
- government inaction on managing invasive species reduces private sector investment in environmental stewardship
- landholders avoiding revegetation that could create a refuge for foxes that prey on sheep
- insufficient perceived direct benefit from revegetation and protection e.g. land protected under covenants is subject to land tax and habitat is not valued highly in the market and therefore does not provide an income stream.⁴⁸³

The Federation recommended improvements in recurrent funding for invasive species management by government agencies, and compensation and stewardship payments to landholders for land management outcomes.

Tax concessions such as capital gains tax concessions and income tax deductions do exist for landholders who establish conservation covenants with approved programs e.g. Trust for Nature. Tax incentives such as income tax deductions and capital gains tax exemptions are also available to landholders for donations of land.⁴⁸⁴

Land for Wildlife is a Victorian government program that began in 1981 and encourages landowners to create or protect habitat on their properties. To date, 12,500 people with 5,000 properties covering more than 530,000 hectares have joined the program.⁴⁸⁵ Prado et al. (2018) reviewed Land for Wildlife programs across Australia and concluded that: 'While there has been an increased focus on

480. Hardy M, Fitzsimons J, Bekessy S and Gordon A 2018, 'Factors influencing property selection for conservation revolving funds', *Conservation Biology*, 32(2), pp. 276-286.

481. Ibid

482. Trust for Nature 2019, 'Annual report 2018-2019', Melbourne, Victoria.

483. Victorian Farmers Federation 2020, 'Submission to the Legislative Council Environment and Planning Committee Inquiry into Ecosystem Decline in Victoria', Parliament of Victoria, Melbourne, Victoria.

484. Department of Agriculture, Water and the Environment, 'Conservation covenants', Canberra Australia <https://www.environment.gov.au/biodiversity/conservation/covenants> Accessed 26 July 2021.

485. DELWP, 'Land for Wildlife', East Melbourne, Victoria <https://www.wildlife.vic.gov.au/protecting-wildlife/land-for-wildlife> Accessed 8 May 2021.

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the growth of permanently protected private land (conservation covenants) and tender-based fixed-term agreements that target specific ecological values, the majority of landholders with habitat values on their land would not necessarily qualify for these schemes. Land for Wildlife programs provide the ability for landholders with a range of habitat values on their land to be recognised for the contribution they (and their properties) are making to conservation.⁴⁸⁶

In a major survey of the effects that revegetation in rural landscapes has on bird populations, Haslem et al. (2020) collected data at 43 landscapes in 2006–07 and 23 landscapes in 2019.⁴⁸⁷ The aim of the survey was to determine how the value of revegetation for birds changed over time at two scales: landscape and individual plantings. The results showed that:

- the richness of bird species increased with wooded vegetation cover, extent of scattered trees and rainfall
- in 2006–07, remnant vegetation supported larger numbers of species than revegetation areas, and species composition also differed
- by 2019, species richness had increased in the revegetation areas to match that in remnant vegetation
- in 2019, species composition in remnant vegetation was associated with mature eucalypt trees, while species in revegetation areas were associated with denser shrub layers.

The scientists concluded that:

‘revegetation restores biodiversity to cleared agricultural landscapes: it facilitates the return of many species of woodland birds to landscapes from which they have been lost due to clearing of remnant vegetation.’

‘a primary goal of restoration in rural landscapes is to increase the overall amount of wooded habitat (both remnant and revegetation): more habitat provides

resources for larger, more stable populations of more bird species.’

‘give priority to the protection of remnant native vegetation in agricultural landscapes because it provides invaluable habitat and resources for native species; it retains elements of the original complex ecosystem and enhances the value of revegetation at a range of scales.’

‘retaining mature scattered trees through farmland is vital: these trees provide habitat, assist animal movements through the landscape, and complement the value of remnant vegetation and revegetation.’

Jelinek, O'Brien and Bennett (2020) evaluated revegetation outcomes through community-based monitoring at 675 sites containing 137 plots. They found that average rainfall and plant guards were strong predictors of plant survival, which averaged 61% but varied across Victoria's bioregions and CMA regions. Plant survival in East Gippsland, West Gippsland and the Port Phillip and Westernport CMA regions average more than 60%, whereas that in the North Central and Corangamite CMA regions averaged below 50%. The three scientists also concluded that:

‘community groups need to be supported in undertaking revegetation monitoring through funding and the development of a cloud-based database and associated app.’

‘survival of plantings is greatest in higher rainfall areas and where plants are protected by tree guards. Planting survival is also likely to be influenced by factors such as extreme temperatures and climate change, so adaptive revegetation activities for future climates may be necessary. This could include altering the timing of revegetation actions and using climate-adapted plant provenances during planting.’⁴⁸⁸

486. Prado J, Puszka H, Forman A, Cooke B et al. 2018, 'Trends and values of "Land for Wildlife" programs for private land conservation', *Ecological Management and Restoration*, 19, pp. 136-146.

487. DHaslem A, Maisey A, Clarke R, Holland G et al. 2020, 'Conservation values of revegetation plantings in farm landscapes: insights from a multi-scale, long-term study', Arthur Rylah Institute, unpublished report, Heidelberg, Victoria.

488. Jelinek S, O'Brien T and Bennett A 2020, 'Evaluating revegetation outcomes through community based monitoring', technical report series no. 321, Arthur Rylah Institute, Heidelberg, Victoria.

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The National Farmers Federation received funding from the Department of Agriculture, Water and the Environment to develop and trial from 2019 to 2022 the Australian Agricultural Sustainability Framework, which is part of the Australian Government's \$34-million Agriculture Stewardship Package (2018–19 to 2022–23). The Framework has two overall objectives:

- integrate productivity, sustainability and biodiversity on Australian farms to provide lasting benefits to farmers and the community
- ensure Australian farmers can showcase best practice sustainability/biodiversity management of natural resources – and ensure these actions are recognisable by supply chains, markets, investors, the community and other farmers.⁴⁸⁹

The Agriculture Stewardship Package will develop arrangements to reward farmers for protecting biodiversity and identify other sustainability opportunities and currently funds the Framework as well as the:

- Carbon + Biodiversity Pilot: which will develop a market-based mechanism to reward farmers who replant areas to increase biodiversity on their property and maintain those areas for at least 25 years. In return they will receive payments and could become eligible for carbon credits. In Victoria it is being piloted in the North Central Region.⁴⁹⁰
- Enhanced Remnant Vegetation Pilot: farmers could receive payments by protecting biodiversity using fencing, weed and pest control, and replanting.
- Australian Farm Biodiversity Certification Scheme: enabling consumers to identify produce from farms where land stewardship and biodiversity conservation are occurring.
- Agriculture Biodiversity Policy Statement: will set out agriculture's role in protecting biodiversity.⁴⁹¹

- The 2021–22 federal budget allocated a further \$32.1 million to the package, including \$23.5 million to a pilot program for farmers who manage and protect existing high-value native vegetation on their properties.⁴⁹²

In a review of biodiversity, farming and forestry, McIntyre (2014) concluded that:

- less-intensive methods of agricultural and forestry production provide opportunities for the coexistence of native species, while enhanced biodiversity can in turn provide agricultural benefits
- to retain most native plants and animals where intensive farming and forestry occur, these landscapes need to be embedded in larger areas of less intensive production as well as among areas of native vegetation that are managed for conservation
- biodiversity conservation in agricultural landscapes has been strongly driven by the voluntary actions of landholders, and continuing progress will rely on technical support, policies, legislative arrangements and financial assistance.⁴⁹³

The Victorian Government's Carbon Farming Program, which is part of its actions to reduce the state's net carbon emissions, focuses on the sequestration of carbon in agriculture and can also benefit on-farm biodiversity. The program supports private landholders to 'plant agroforestry and shelterbelt trees, access existing carbon markets and realise on-farm benefits and new income streams.'⁴⁹⁴

Improving the management of biodiversity on private land is also the focus of the 10-year management agreements entered into between catchment management authorities and landholders. Such agreements can include changes in the grazing regime and vegetation management. In 2019–20 there were 708 management agreements in place, with livestock grazing control covering 3,946 hectares.⁴⁹⁵

489. National Farmer's Federation, 'Australian agricultural sustainability framework', Canberra, Australia <https://nff.org.au/programs/australian-agricultural-sustainability-framework/> Accessed 14 May 2021.

490. Department of Agriculture, Water and the Environment, 'Carbon + biodiversity pilot', Canberra, Australia <https://www.agriculture.gov.au/ag-farm-food/natural-resources/landcare/sustaining-future-australian-farming/carbon-biodiversity-pilot> Accessed 14 May 2021.

491. Department of Agriculture, Water and the Environment, 'Agriculture stewardship package', Canberra, Australia <https://www.agriculture.gov.au/ag-farm-food/natural-resources/landcare/sustaining-future-australian-farming> Accessed 14 May 2021.

492. Littleproud D 2021, '\$32.1 million for agriculture biodiversity stewardship', Ministerial media release, 12 May 2021, Canberra, Australia.

493. McIntyre S 2014, 'Farming, pastoralism and forestry', Chapter 7 in S Morton, A Shephard and M Lonsdale (eds), 'Biodiversity', CSIRO, Australia.

494. Agriculture Victoria, 'Agriculture and climate change', Melbourne, Victoria <https://agriculture.vic.gov.au/climate-and-weather/policy-programs-action> Accessed 17 May 2021.

495. Victorian Catchment Management Authorities 2020, 'Actions and achievements report 2019–20', Melbourne, Victoria.

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The Commonwealth Government has allocated \$57 million over five years (2018–2023) to support biodiversity conservation projects through Regional Land Partnerships with catchment management authorities and Landcare groups. The five-year targets are:

- herbivore control: 216,678 hectares
- pest predator control: 299,257 hectares
- weed control: 34,955 hectares
- revegetation: 2,188 hectares
- private land permanently protected: 1,330 hectares
- land management agreements: 44,059 hectares.

Case study: paddock trees

Paddock trees are an iconic feature of Australia's rural landscapes and represent remnants of past vegetation cover. They play an important role in supporting farm productivity by providing pest control (roosts for insectivorous bats and birds), sheltering crops and livestock, adding nutrients to the soil and potentially supplying seeds for regeneration projects. They are also significant habitat and shelter for wildlife, a source of food and a connector across the landscape.

Paddock trees are in decline due to their old age and the lack of replacements, from clearing to increase the efficiency of intensified agriculture, as well as bushfires, insect damage, the use of fertilisers and herbicides, and soil compaction by stock.

There are a number of Landcare networks and groups across Victoria that are involved in the conservation of paddock trees, including the:

- Greta Valley Landcare Group's Protecting Scattered Paddock Trees for our Woodland Birds and Bats Project, which aims to protect 20 paddock tree sites (can be single or multiple trees) and plant 200 paddock trees⁴⁹⁶
- Upper Goulburn Landcare Network, which received funding from the Australian Government to pay farmers for the cost of fencing and the purchase of plants for revegetation. The project protected 60 paddock trees that included red stringybark, grey, red and yellow box, candlebark and river red gum, along with many small to medium trees⁴⁹⁷
- Gecko Clan Landcare Network's Goomalibee Landcare Group, which is involved in the Goulburn Broken CMA's Paddock Tree Guard project. The group is installing tree guards to reduce pressure on the trees from cattle⁴⁹⁸
- Crowlands Landcare Group's Shelter Belts for Habitat, Paddock Trees and Erosion Control Project⁴⁹⁹
- Edi Black Range Catchment Group's Establishing Paddock Trees as Stepping Stones Through Nature Project.⁵⁰⁰

496. Greta Valley Landcare Group, 'Protecting scattered paddock trees for our woodland birds and bats', Wangaratta, Victoria <https://gretalandcare.org.au/projects/protecting-scattered-paddock-trees-for-our-woodland-birds-and-bats/> Accessed 17 May 2021.

497. Upper Goulburn Landcare Network, 'UGLN Paddock Tree Project', Yea, Victoria <https://ugln.net/ugln-paddock-tree-project/> Accessed 17 May 2021.

498. Goulburn Broken Catchment Management Authority, 'Guarding the next generation of precious paddock trees', Shepparton, Victoria https://www.gbcma.vic.gov.au/news_events/guarding-the-next-generation-of-precious-paddock-trees.html Accessed 17 May 2021.

499. DELWP, 'Victorian Landcare grants 2018–19: successful applicants', East Melbourne, Victoria <https://www.environment.vic.gov.au/landcare/victorian-landcare-grants-2018-19-successful-applicants> Accessed 17 May 2021.

500. Ibid

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Indicator B:08 The conservation and management of Victorian ecosystems on public land

Region Statewide	Indicator Performance:	2018 Status	2018 Trend	2018 Data
Measures Victorian conservation categories, area in hectares and the number of threatened species in conservation areas	2018 & 2021: Unable to be assessed due to Fair status			
Data Custodian DELWP; Parks Victoria	Why this indicator? Native vegetation is a key indicator for the overall state of terrestrial biodiversity. Many ecosystems and conservation areas in eastern Victoria were impacted by the bushfires.	2021 Status	2021 Trend	2021 Data

Potential thresholds for status in the SoE 2023 report

Good: A well-managed and well-resourced comprehensive, adequate and representative parks estate

Fair: A park estate with some shortfalls in funding and management and identified gaps that need filling before it can be a comprehensive, adequate and representative parks estate

Poor: Poorly resourced and managed parks estate well short of being comprehensive, adequate and representative

Why this assessment in 2021?

Status: Except for the increased protection given to 2,500 hectares of the Kuark Forest by its addition to the Errinundra National Park, there has been little spatial change in the conservation estate since the SoE 2018 Report. Gaps in the estate prevent it from being comprehensive, adequate and representative. Recent Victorian Government proposals for three new national parks and other reserves covering more than 50,000 hectares, if approved by the Victorian Parliament, will fill some of these gaps.

Trend: There has been little change in the area of the conservation estate. However, fires burnt large areas in eastern Victoria and impacted park condition. State Forests were also severely impacted.

Data Confidence: There are good spatial data on protected areas.

Should this indicator be used in the SoE 2023 report?

Yes.

Summary of SoE 2018 Report assessment

- In the parks managed by Parks Victoria, the top three conservation category types with the greatest area were national parks, wilderness parks and state parks. The top three endangered ecological vegetation divisions were high-altitude alpine sphagnum bogs and associated fens, closed forest and damp scrub.
- The three Victorian bioregions with the poorest representation of EVCs in protected areas were the Strzelecki Ranges, Gippsland Plain and Central Victorian Uplands.

The 2019–20 bushfires: Impacts and responses

More than 90% of the fire extent of the 2019–20 bushfires occurred on public land,⁵⁰¹ with Victoria's conservation estate severely impacted. Thirty national parks and reserves had 81–100% of their area burnt, another seven between 40% and 80%. Alfred, Lind and Burrowa-Pine Mountain national parks had 100% of their area burnt, Croajingolong National Park had 87% and the Snowy River National Park had 76%. Across Victoria, 482,094 hectares of national parks and nature conservation reserves (12.4% of their areas in the state) were inside the fire extent, with 285,462 hectares of that area (7.3% of the state's parks and reserves) affected by high-severity fire.

501. Inspector-General of Emergency Management 2020, 'Inquiry into the 2019–20 Victorian fire season, phase 1 Community and sector preparedness for and response to the 2019–20 fire season', Melbourne, Victoria.

Threatened species and communities

The fire extent covered a larger area in State Forests. A spatial analysis by the Victorian National Parks Association found that 839,184 hectares (or 55%) of State Forests in the East Gippsland, North-east and Tambo fire management areas in eastern Victoria were within the fire extent.⁵⁰² The analysis also estimated that within the fire extent there were:

- 202,302 hectares (or 52%) of the Special Protection Zones in the State Forests (24% was impacted by high-severity fire)

- 67,133 hectares (or 92%) of the Immediate Protection Areas established in 2019 and found within the three fire management areas (46% was impacted by high-severity fire)
- 446,803 hectares (or 46%) of parks and reserves (22% was impacted by high-severity fires).

Table 41 lists threatened communities impacted by the 2019-20 bushfires, with percentage estimates of their area within the fire extent. The Warm Temperate Rainforest communities, which are rarely ever burnt, had from 70% to above 90% of their coverage affected.

Table 41: Fire impacts on listed threatened communities.⁵⁰³

Community	% Within Fire Extent
On the EPBC list	
Alpine Sphagnum Bogs and Associated Fens Ecological Community [^]	11%
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	15% (7% high severity)
Natural Temperate Grassland of the South Eastern Highlands	Adjacent but not within fire extent
Silurian Limestone Pomaderris Shrubland of the South East Corner and Australian Alps Bioregions	Adjacent to but not within fire extent
White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Grassland Ecological Community	5%
On the Flora and Fauna Guarantee Act list	
Cool Temperate Mixed Forest Community	~40%
Dry Rainforest (Limestone)	44%
Limestone Grassy Woodland	>90%
Warm Temperate Rainforest (Coastal East Gippsland)	>80%
Warm Temperate Rainforest (East Gippsland Alluvial Terraces)	~90%
Warm Temperate Rainforest (Far East Gippsland)	>70%
Warm Temperate Rainforest (Cool Temperate Overlap, Howe Range) Community	>90%
Cool Temperate Rainforest	8%

The bushfires also damaged two major ecotourism initiatives in eastern Victoria. Eighty percent of The Sea to Summit multi-day hiking trail stretching 120 kilometres from Bemm River/Cape Conran Coastal

Park to Mount Ellery in Errinundra National Park was burnt. The section of the Wilderness Coast Walk from Point Hicks to Mallacoota was completely burnt out.⁵⁰⁴

502. Victorian National Parks Association 2021, 'After the fires: protecting our forest refuges', Carlton, Victoria.

503. DELWP 2020, 'Victoria's bushfire emergency: biodiversity response and recovery, Version 2', East Melbourne, Victoria.

504. Information supplied by Parks Victoria.

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A federally funded bushfire recovery project of relevance to the assessment of this indicator is 'Building capacity for resilience and recovery of threatened ecological communities.' It is being delivered by the University of NSW at sites from Victoria to south-east Queensland and aims to develop adaptive fire management strategies to improve prospects for eight priority ecological communities and seven animal species. It will do this by integrating remote sensing, ground survey and citizen science with management. Another funded project will assess impacts of the recent bushfires on freshwater biodiversity and 14 Priority Matters across south-eastern Australia using eDNA sampling. This project will enable the identification of species and areas in urgent need of management.

SoE Biodiversity Update 2021 Report assessment

Victoria has almost 18% of its land protected within the national parks and conservation reserves managed by Parks Victoria. Table 42 identifies the park types and their number and area, while Figure 36 maps their locations. Each of the parks is also classified under the IUCN category system with Category Ia Strict Nature Reserve offering the highest level of protection and Category VI Protected area with sustainable use of natural resources offering the lowest. Table 43 identifies the area of parks managed by Parks Victoria and designated one of six of the IUCN's seven categories (there are no parks or reserves classified as IUCN Category V in Victoria). Category II National Park

covers the largest area and Category IV Habitat/Species Management Area is designated to the largest number of parks.

Table 42 focuses on those area of parks and reserves that are managed by Parks Victoria. There are various other reserves for conservation that are managed by DELWP or under DELWP's delegation (e.g. committees of management). Committees of management manage many nature conservation reserves, bushland reserves, scenic reserves, streamside reserves and lake reserves that are designated with IUCN categories from Ia to VI and deemed protected areas. DELWP, Melbourne Water, the Phillip Island Nature Park Management Committee and the Ballarat Environment Network are some of the organisations that manage protected areas. The total coverage of these protected areas not under Parks Victoria management is 17,824 hectares.⁵⁰⁵

There are also reserves that are not managed by Parks Victoria and, although not protected areas, can contain biodiversity. These include forest parks, regional parks, historic reserves and coastal reserves that can be managed by DELWP, committees of management, water authorities or other government agencies. In total they cover an area of 81,531 hectares.⁵⁰⁶

With limited information available about the reserves not managed by Parks Victoria, the following analysis focuses on the parks and reserves the agency does manage and the findings of its 2018 State of the Parks report.

Table 42: Terrestrial parks and reserves by type.⁵⁰⁷

Park Type	Number of Parks	Total Area (ha)	Percentage of Area All Parks (ha)
Conservation Reserve	2,766	543,636	13.6
National Parks Act	94	3,347,290	83.8
Urban and Other	86	105,463	2.6
Total	2,946	4,117,552	100

505. DELWP 2021, 'Parks and reserves' <https://discover.data.vic.gov.au/dataset/parks-and-conservation-reserves-parkres> Accessed 4 September 2021.

506. Ibid

507. Parks Victoria 2020, 'State of the Parks 2018', Melbourne, Victoria.

Threatened species and communities

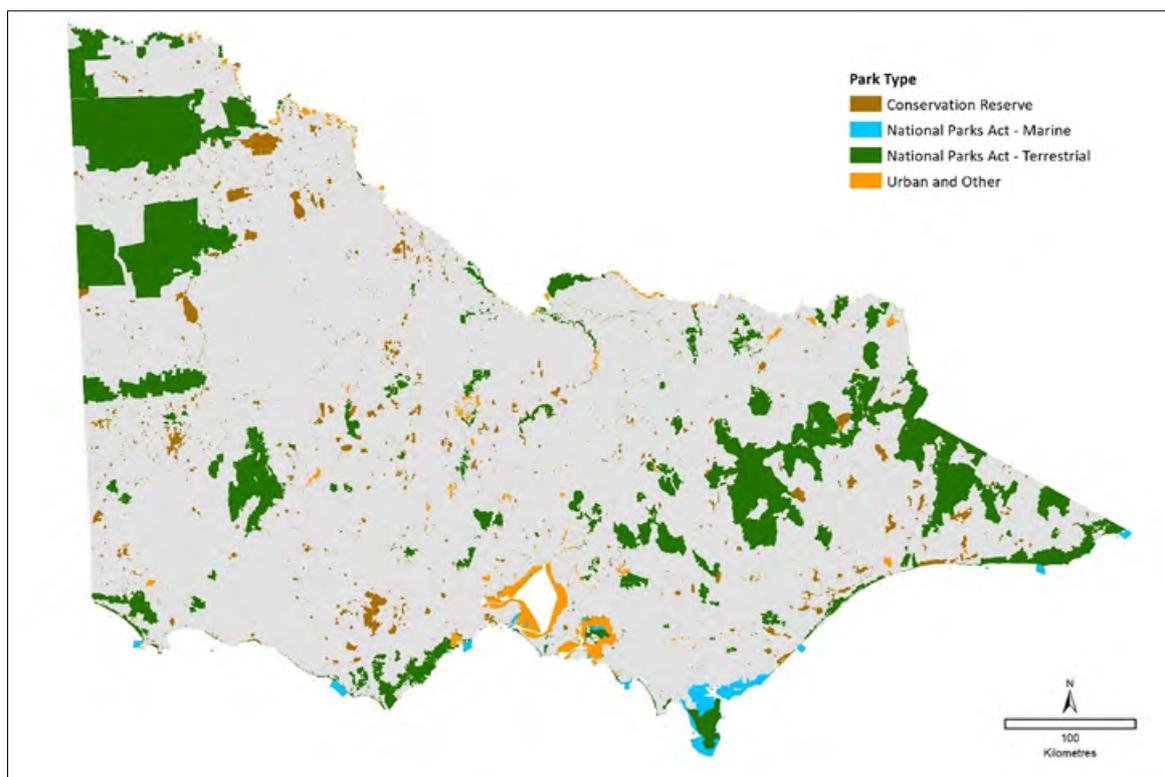


Figure 36: Victoria's parks and reserves by type.⁵⁰⁸

Table 43: Area and number of parks by IUCN Protected Area Management Category.⁵⁰⁹

IUCN Protected Area Management Category	Number of Parks	Percentage of Total Parks	Total Area (ha)	Percentage of Total Estate Area
Ia Strict Nature Reserve	466	15.6	262,637	6.2
Ib Wilderness Area	3	0.1	200,700	4.7
II National Park	84	2.8	3,128,052	73.3
III Natural Monument or Feature	334	11.2	66,143	1.6
IV Habitat/Species Management Area	1,479	49.7	45,787	1.1
V Protected Landscape/Seascape	0	0	0	0
VI Protected Area with Sustainable Use of Natural Resources	252	8.5	169,556	4.0
Total Protected Area	2,618	87.9	3,872,876	90.8

There were approximately 6,500 hectares added to the park estate from 2013 to 2018, with the Anglesea Heathlands representing 6,357 hectares of that area when absorbed into the Great Otway National Park. In 2020, national park protection was also given to 2,500 hectares of the Kuark Forest in East Gippsland.

⁵⁰⁸. Ibid
⁵⁰⁹. Ibid

Threatened species and communities

Analysis⁵¹⁰ of the habitat importance of 638 selected parks and reserves found that they protected the habitats of 1,581 species (see Table 44). Of those, 516 had at least 80% of their habitat protected in the parks. The national parks with 80–100% of suitable habitat for the highest number of species are the Alpine, Grampians and Murray-Sunset national parks. In addition, 40 of the 41 threatened flora and fauna communities are found within the

park estate.⁵¹¹ For example, the Cool Temperate Rainforest Community is found in 13, the Northern Plains Grassland Community in 11, the Victorian Temperate-Woodland Bird Community in 1,358 and the Victorian Mallee Bird Community in 23. Finally, of the 37 Key Biodiversity Areas (most important sites for conservation worldwide) that occur in Victoria, 36 are inside the park estate, with 14 having more than 80% of their area protected.⁵¹²

Table 44: Number of species for which national parks and nature conservation reserves provide best habitat.⁵¹³

Habitat Importance in Selected Parks	Threatened Species Category					Total Number of Species
	Critically Endangered	Endangered	Rare	Vulnerable	Not Specified	
80%-100% of best habitat	17	75	241	181	2	516
60%-80% of best habitat	4	34	158	59	2	257
40%-60% of best habitat	7	39	149	72	1	268
20%-40% of best habitat	7	58	152	96	1	314
20%-0% of best habitat	12	51	92	70	1	226
Total	47	257	792	478	7	1,581

The most common threats to the park estate, according to park managers surveyed for the State of the Parks 2018 report, were weeds and pest animals. Figure 37 and Figure 38 map the severity of these two threats across the park estate. Park managers were also asked about the impact of fire on conservation values in the park estate. Although Figure 39 was mapped before the 2019–20 bushfires, a number of parks were experiencing an increasing impact from fire. Park managers were also asked about the condition of terrestrial systems in the park estate and rated it as good or very good in 54% of the parks.

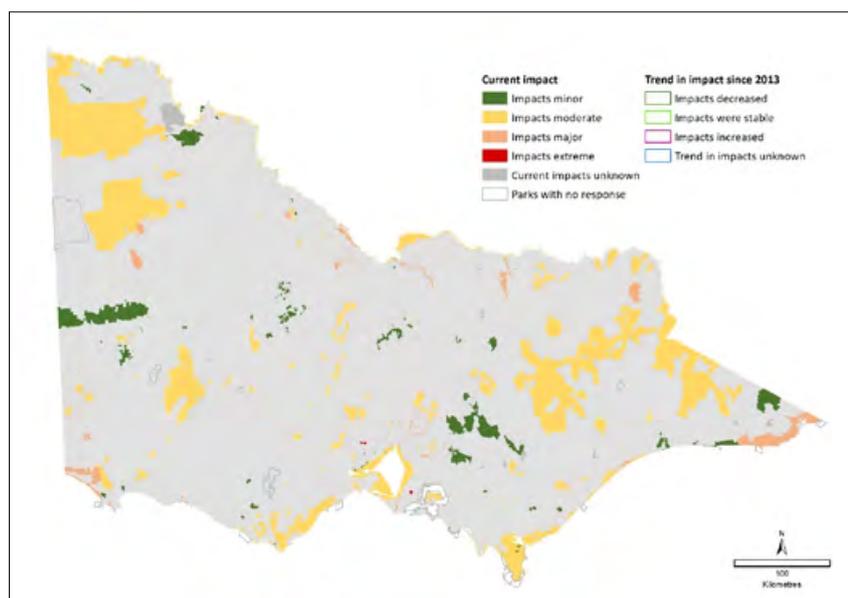


Figure 37: Impact of weeds on the park estate.⁵¹⁴

510. Ibid
511. Ibid
512. Ibid
513. Ibid
514. Ibid

Threatened species and communities

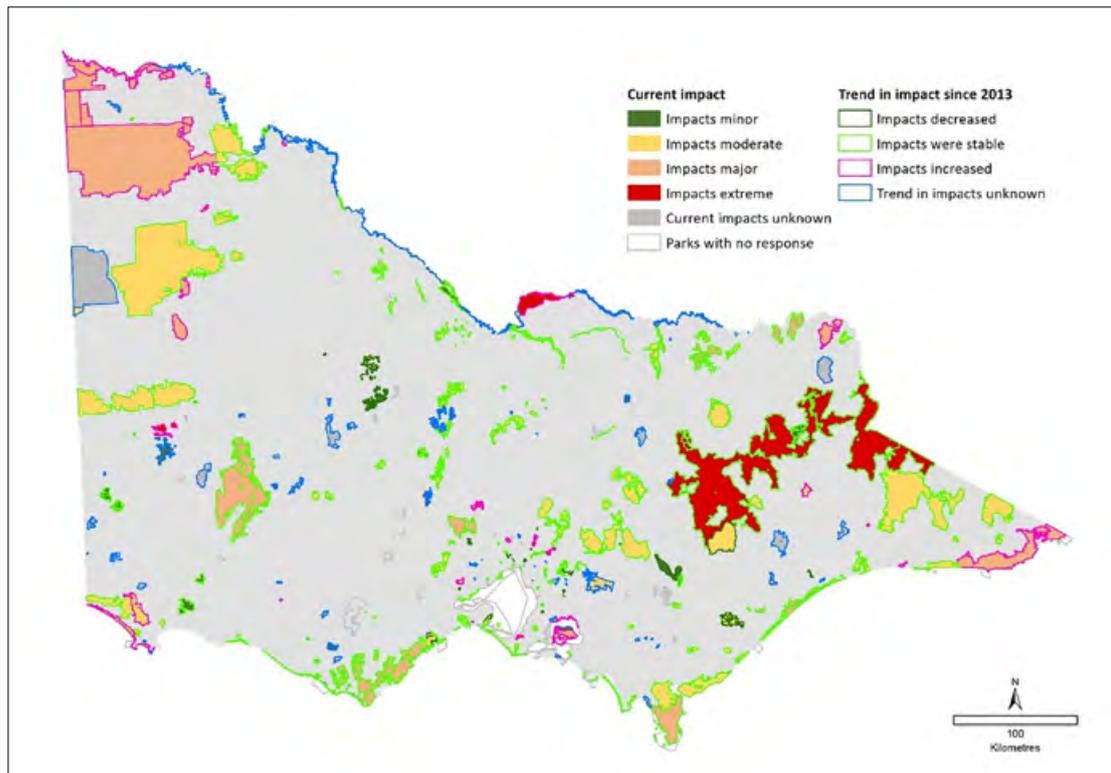


Figure 38: Impact of pest animals on the park estate.⁵¹⁵

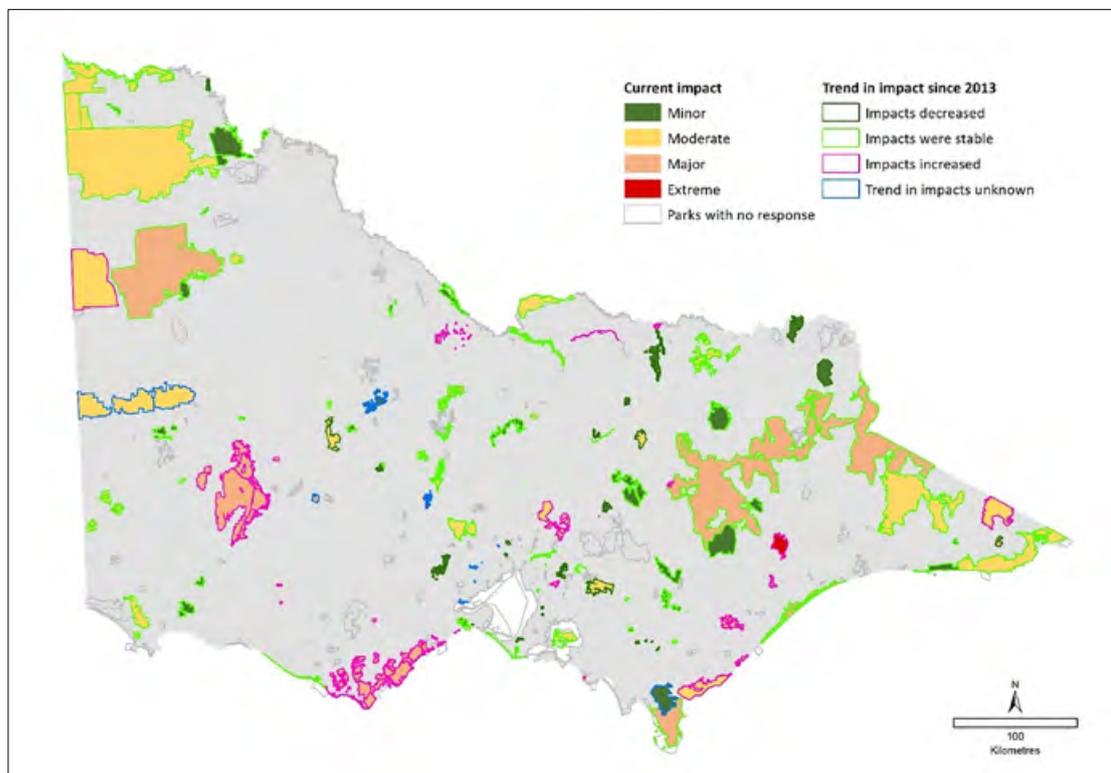


Figure 39: Impact of fire on conservation values in the park estate.⁵¹⁶

⁵¹⁵. Ibid
⁵⁶⁴. Ibid

Threatened species and communities

Table 45: Parks Victoria responses to some key findings in the State of the Parks 2018 report.⁵¹⁷

State of the Parks 2018 Finding	Response Since 2018 State of the Parks Assessment
Extent objectives met for weeds, pest animals, non-compliance and visitor impacts has declined.	<p>Priority parks (e.g. Mallee, Grampians, Alps) have implemented well-planned, resourced and monitored weed, pest animal and habitat restoration initiatives (e.g. Semi-arid woodland total grazing management and revegetation, implementation of grazer controls in Grampians, and weed and grazer controls for Alpine peatlands).</p> <p>Targeted compliance programs (e.g. illegal firewood removal).</p>
Extent objectives met for nature conservation of terrestrial parks has declined.	<p>Progressive development of Conservation Action Plans for each of 18 landscape units across the state is identifying conservation assets and threats, setting conservation objectives and prioritising required actions and resourcing.</p> <p>Since 2018, Conservation Action Plans have been released for the Mallee, Wimmera and River Red Gum Landscapes.</p>
50% of the streams in the River Red Gum and Western Port and Port Phillip landscapes are in poor or very poor condition (2010 ISC results).	<p>Parks Victoria has appointed a dedicated Program Lead (Ecological Water) in its Environment and Science Division.</p> <p>Consequently, Parks Victoria is increasingly collaborating and coordinating with Catchment Management Authorities in developing Seasonal Watering Plans for priority locations, in delivering works that increase the area of water-dependent ecosystems that can receive floodwater or environmental water, and in establishing water quality monitoring with EPA and community groups.</p> <p>This collaboration and coordination were recently recognised as improving in the recent Auditor-General's audit of effective management of Victoria's Ramsar wetlands.</p> <p>Collaboration with Melbourne Water is also delivering improvements in streamside vegetation within urban and peri-urban parks.</p>
Extent objectives met for nature conservation of conservation reserves and <i>National Park Act</i> terrestrial parks has declined.	<p>Conservation programs that commenced in 2018 under Biodiversity 2037 funding through the Biodiversity Response Funding initiative (BRP) are delivering cost-effective reduction of threats to high priority conservation values which largely occur on the parks estate.</p>
<p>Asset condition (considering all assets within a park) has declined</p> <p>The extent to which relevant parks met objectives for visitor opportunities, asset management, park servicing, visitor facilities and visitor safety has declined.</p>	<p>Continued roll out of the Visitor Experience Framework (VEF) to assist prioritisation.</p> <p>Infrastructure improvements at a range of priority parks and sites.</p> <p>Great Victorian Outdoors funding secured from the state government to create 30 new campgrounds, upgrade 30 campgrounds, upgrade four-wheel-drive tracks and develop new walking trails.</p> <p>Appointment of 53 Strengthening Parks Victoria (SPV) rangers across the state.</p>

517. Parks Victoria, 'Summary of relevant Parks Victoria and governmental initiatives developed since the 2017-2018 State of the Parks assessment', Melbourne, Victoria <https://www.parks.vic.gov.au/get-into-nature/conservation-and-science/science-and-research/state-of-the-parks/fourth-edition> Accessed 15 May 2021.

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Table 45: Parks Victoria responses to some key findings in the State of the Parks 2018 report cont'd.

<p>Adequate opportunities for learning about nature or heritage were provided in 44% of relevant parks.</p>	<p>Implementation of the Learning in Nature plan including:</p> <ul style="list-style-type: none"> • expansion of junior ranger program both on line and face-to-face • launch of bush kinder handbook; 16 new bush kinders established (77 active bush kinder groups) • collaborated with EarthWatch to establish 15 ClimateWatch trails across the State on PV sites • new learning in nature website • new education programs • volunteer guide interpretation program developed • on-site interpretation projects developed at key parks
<p>25% of National Park Act parks have a management plan older than 15 years.</p>	<p>Four new management plans, covering 20 parks managed under the National Parks Act 1975 have been developed and released.</p> <p>A further two plans (covering four National Park Act parks) are currently in development.</p>

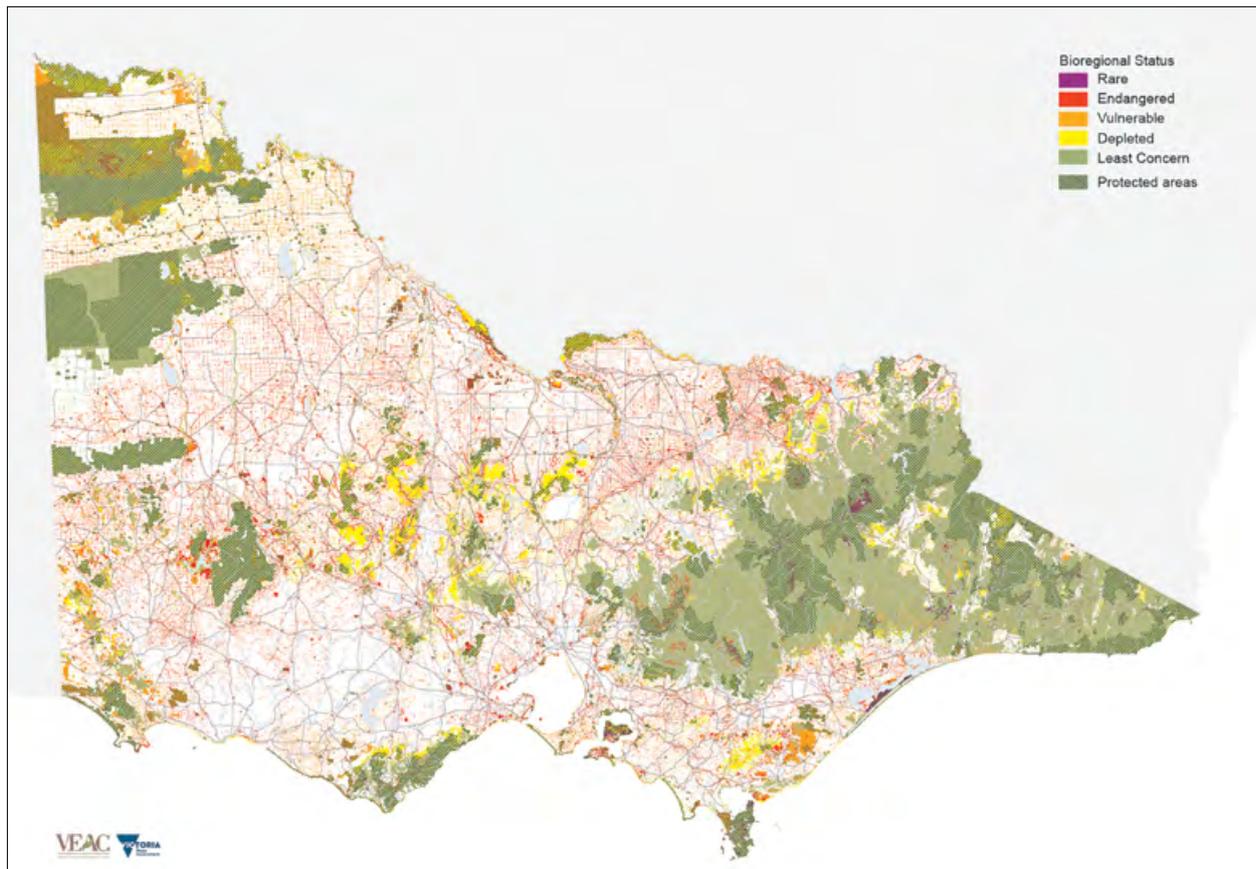


Figure 40: Terrestrial bioregional conservation status on public land.⁵¹⁸

518. Victorian Environmental Assessment Council 2016, 'Map D: terrestrial bioregional conservation status – public land', in 'Statewide assessment of public land, discussion paper', Melbourne, Victoria.

Threatened species and communities

In 2016 The Victorian Environmental Assessment Council identified three clusters (see Figure 40) where there were shortfalls in the representation of their EVCs in protected areas:

- South west cluster: Glenelg Plain and Dundas Tablelands bioregions and the western part of the Wimmera bioregion
- Strzelecki Ranges and Gippsland Plain bioregions cluster
- Central Victorian Uplands bioregion cluster.

In its submission to the Victorian Legislative Council's Inquiry into Ecosystem Decline in Victoria, the Royal Botanic Gardens Victoria observed that: 'Despite current efforts, Victorian ecosystems continue to decline at an unprecedented rate. The legacy of 200 years of European impact upon the land is of great concern to those organisations, scientists and individuals charged with protecting it. To reverse this decline, we need new ways of thinking and new models of investment, as well as new tactics and strategies in terms of land management.'⁵¹⁹

The submission also observed that although there had been some legislative reform: 'A critical flaw in the current legislative framework is that biodiversity and ecosystem protection is often the last part of the planning process. Furthermore, the environment is generally undervalued and so any cost-benefit analysis is often biased towards direct economic gain. Bringing the environment to the front of planning processes and recognising the benefits that biodiversity and natural ecosystems provide is crucial if we want to reverse ecosystem decline. Approaches such as penalties for failing to refer projects, making binding recommendations for the protection of biodiversity in EES, and mandatory requirements for all projects to avoid impacts rather than offset impacts are required urgently.'

In February 2021, a team of Australian scientists warned of the collapse of 19 Australian ecosystems, which included sub-alpine forests, Murray-Darling Basin waterways and mountain ash forests that occur in Victoria.⁵²⁰

To help prevent ecosystem collapse, they recommended a new framework dubbed the 3As Pathway:

- Awareness of ecosystem values and where the protection of biodiversity and ecosystem services is needed
- Anticipation of pressures and the identification of their risks to ecosystems
- Action to reduce pressures and plan for future change.

In June 2021, the Victorian Government announced, in response to recommendations by the Victorian Environmental Assessment Council in 2019, that it would create 65,106 hectares of new national parks and reserves in the central west of Victoria. The new national parks would be the Wombat-Lerderberg National Park of 44,000 hectares, the Pyrenees National Park of 15,000 hectares and the Mount Buangor National Park of 5,282 hectares. In addition, the area of conservation parks would be increased by 5,246 hectares, existing nature and bushland reserves by 7,560 hectares, and regional parks by 27,735 hectares.

Case study: wildlife refuges

The 2019–20 bushfires razed many large areas of native vegetation in eastern Victoria. However, there are unburnt patches among the devastation and these will be crucial for the recovery of native plants and animals.

Scientists and local experts from Parks Victoria and DELWP completed a post-fire aerial survey of fire-affected parts of the state and uploaded a video to the Parks Victoria website: 'While much of the impacted area had been severely damaged by fire, there were pockets of green vegetation providing areas of refuge for plants and animals. These intact areas are becoming the focus of our attention.'⁵²¹

Collins et al. (2019) found that the 'increased severity of fire weather and increased drought conditions, both predicted under future climate scenarios, are likely to lead to a reduction of wildfire refugia across the forests of southern Australia.

519. Royal Botanic Gardens Victoria 2020, Submission to the Legislative Council Environment and Planning Committee Inquiry into Ecosystem Decline in Victoria', Parliament of Victoria, Melbourne, Victoria.

520. Bergstrom D, Wienecke B and van den Hoff J 2021, 'Combating ecosystem collapse from the tropics to the Antarctic', *Global Change Biology*, 27(9), pp. 1692-1703.

521. Parks Victoria, 'Bushfire impacts on Victoria's environment', Melbourne, Victoria <https://www.parks.vic.gov.au/news/2020/02/13/22/21/bushfire-impacts-on-the-victorian-environment> Accessed 9 May 2021.

Threatened species and communities

Protection of topographic areas able to provide long-term fire refugia will be an important step towards maintaining the ecological integrity of forests under future climate change.⁵²²

The DELWP Biodiversity Division is currently working on an analysis of the distribution of long-term refuges from fire across Victoria. This considers plant flammability, fire weather and landscape context to identify locations that are more or less fire prone. DELWP is also working on a second product that uses satellite imagery since 1970 to identify areas of realised refuge, where there is habitat that is relatively undisturbed by fire over the past 50 years. These products will be

incorporated into decision-support tools, such as Strategic Management Prospects, to help inform investment decisions about conservation actions.

The Victorian National Parks Association analysed 10 unburnt or less-severely burnt patches from the 2019–20 bushfires in the East Gippsland, North-eastern and Tambo forest management areas (see Figure 41 for their location and Table 46 for their values). They include mixed species wet and damp forests, lowland coastal forests and higher elevation forests, as well as alpine environments. The results of the analysis were released in January 2021 in the Association's 'After the fires: protecting our forest refuges' report.

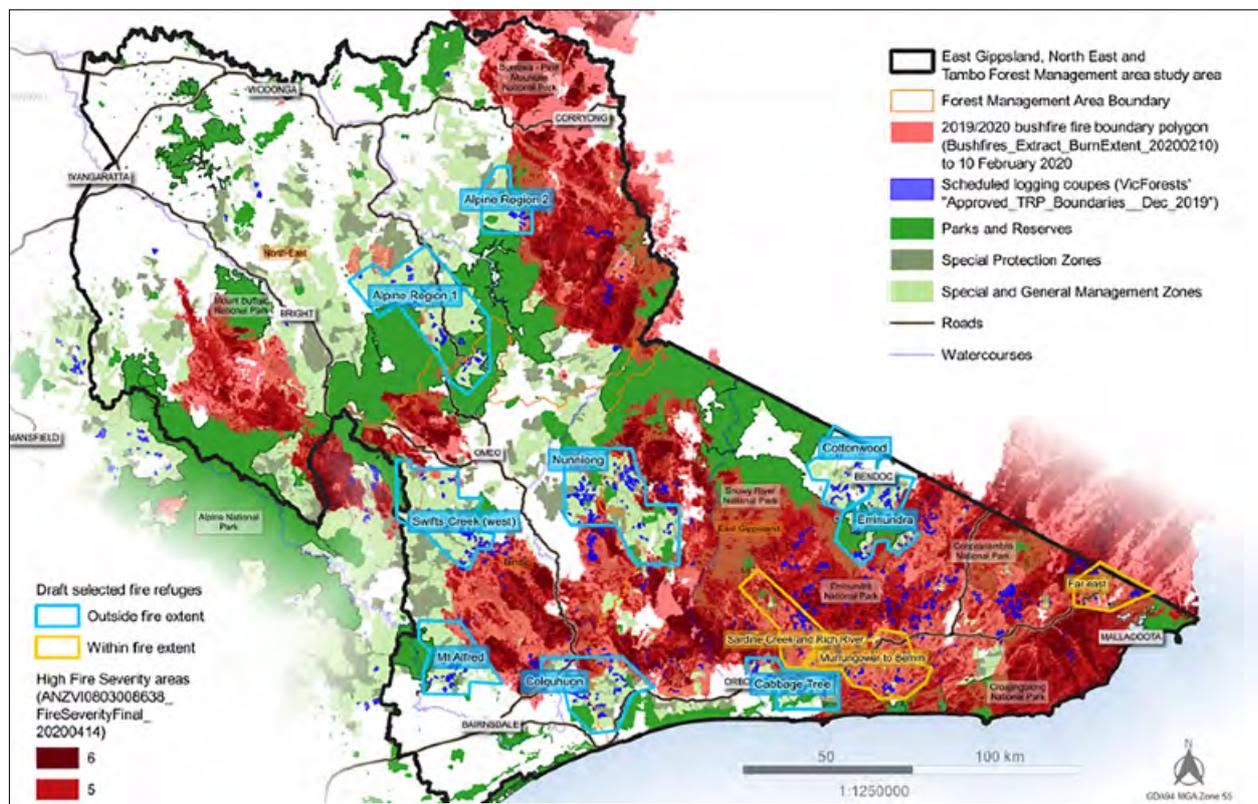


Figure 41: Extent of 2019–20 bushfires in East Gippsland, Tambo and North-east forest management areas and identified refuge areas.⁵²⁴

522. Collins L, Bennett A, Leonard S and Penman T 2019, 'Wildfire refugia in forests: severe fire weather and drought mute the influence of topography and fuel age', *Global Change Biology*, 25(11), pp. 3829–3843.

524. Ibid

Threatened species and communities

Table 47 uses data from the analysis and reveals that:

- 92% of the spatial extent of the Immediate Protection Areas (within the three fire management areas) declared in 2019 was burnt
- 55% of all state forests in the study area were burnt, with 24% burnt by high-severity fires
- 52% of the special protection zones (free from logging) in state forests were burnt, with 24% experiencing high-severity fires.

- 46% of parks and reserves were within the fire extent, with 24% subjected to high-severity fires.

The analysis also found that of the 585,000 hectares of State Forests in the East Gippsland Forest Management Area, 112,000 hectares were outside the 2019–20 fire extent and 90,000 hectares of that remains unprotected.⁵²³

Table 46: Ten unburnt refuges in the East Gippsland, North-eastern and Tambo fire management areas.⁵²⁵

Refuge Area	Values
Errinundra	Mature mixed species wet and damp forests, important habitat for the greater glider, long-footed potoroo, and large forest owls. HIM analysis shows around 37% of glider habitat is unburnt across the East Gippsland, Tambo and North East FMAs.
Cottonwood	Higher elevation mixed species wet and damp forests, critical habitat for the greater glider, spot-tailed quoll, and large forest owls. More than 30% of the quoll's protected habitat across the three fire-affected FMAs has burnt.
Colquhoun	Lowland coastal forests, only known records of Colquhoun grevillea, and critical habitat for glossy black cockatoo and masked owl. Around 80% of habitat deemed important for the Masked Owl was impacted by the bushfires. Around 10% of the important habitat areas are unburnt and protected.
Cabbage Tree	Some of the last remaining unburnt lowlands coastal forests providing important habitat for the lace monitor and contains rare warm temperate rainforest species and banksia woodlands. Over 60% of the lace monitor's most important modelled habitat in the East Gippsland FMA was impacted by fire.
Sardine Creek	Large areas impacted by fire with extensive corridors containing lower severity fire. One of the last intact tracts of forest extending from higher elevation alpine forests to the coast and critical habitat for the long-footed potoroo. The long-footed potoroo was seriously impacted by the fires, with over 80% of its modelled habitat affected.
to Bemm	Forests less severely impacted by fire supporting endemic plant species usually only found in NSW, and critical habitat for the glossy black cockatoo and giant burrowing frog. Of the glossy black cockatoo's unburnt modelled habitat, around 52% is open to logging.
Far East	Higher elevation forests dominated by Alpine Ash, some of the last fragments of intact forest in heavily logged areas provide critical habitat for forest owls and gliders. According to VNPA analysis, around 63% of the powerful owl's unburnt habitat in the Tambo FMA is available for logging.
Nunniong	Mature tracts of wet forests are ideal habitat for greater glider, and sooty and powerful owls. Alpine ash forests have been heavily impacted by fire and logging. Analysis shows that of the remaining unburnt habitat for the sooty owl in the Tambo FMA where Swifts Creek is located, more than half is available for logging.
Swifts Creek	Lowlands and herb-rich forests, critical habitat for fragmented populations of greater glider and giant burrowing frog. More than 80% of the habitat deemed important for the frog is within the fire extent. Around 17% of the frog's habitat within the Tambo area is unburnt and protected, 31% is unburnt and available for logging.
Mt Alfred	Area contains sensitive alpine vegetation and large stands of alpine ash, vulnerable to higher frequency fire regimes. Logging is scheduled inside the Mt Wills Historic Area.
Alpine Region	Area contains sensitive alpine vegetation and large stands of alpine ash, vulnerable to higher frequency fire regimes. Logging is scheduled inside the Mt Wills Historic Area.

523. Victorian National Parks Association 2021, 'After the fires: protecting our forest refuges', Carlton, Victoria.

525. Ibid

Threatened species and communities

Table 47: Impact of fire on land tenures in East Gippsland, North-east and Tambo forest management areas.⁵²⁶

Tenure	Area Within Fire Extent	% Within Fire Extent	% Impacted by High-Severity Fire
State Forests (All Zones)	839,184	55	26
State Forests Special Protection Zones	202,302	52	24
Parks and Reserves	446,803	46	22
Immediate Protection Areas (2019)	67,133	92	46

Figure 42 maps the extent of the 2019–20 bushfires in one of the 10 study areas, the Errinundra National Park and adjacent areas within the East Gippsland Fire Management Area. Fifty percent of the park was burnt during the fires. Figure 42 also maps the location of records of the threatened greater glider and long-footed potoroo (for which the national park is a stronghold), rare and threatened flora and fauna, and scheduled logging coupes. Based on the map, many of the greater glider records are within the coupes scheduled for timber harvesting, as are a number of long-footed potoroo records. The analysis estimated that 37% of the glider habitat remains unburnt across the three fire management areas, while a little more than half of that is available for timber harvesting.

In its report, the Victorian National Parks Association recommended that the Government:

- protect each of the key refuges identified in its report and any other remaining unburnt forests from current and future logging to ensure the survival and persistence of flora and fauna species that rely on those forests to survive
- commit to not logging any identified habitat remaining in Victoria for each threatened species significantly affected by the 2019–20 bushfires, particularly those species listed in its report
- bring forward the 2030 transition out of native forest logging.

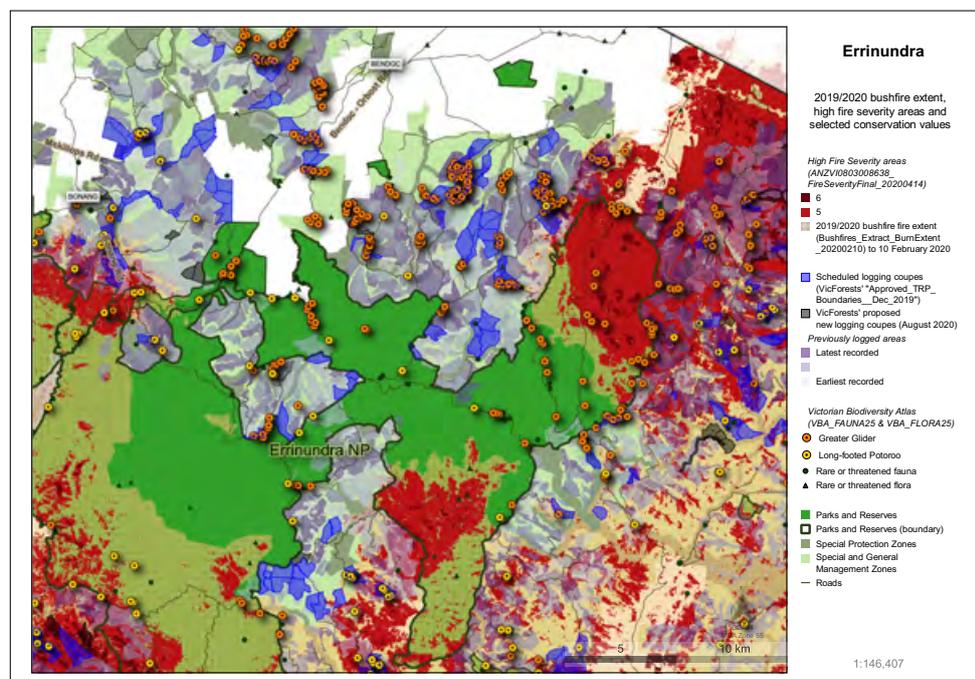


Figure 42: Errinundra National Park and surrounds with 2019-20 fire extent and threatened species locations.⁵²⁷

526. Ibid
527. Ibid

Wetlands and rivers

Background

Thousands of wetlands are scattered across Victoria and vary in shape, size and type: swamps, lakes, peatland bogs, springs, marshes and intertidal areas. Most are natural but many are artificial.

In the technical sense, wetlands are defined as 'surface waters, whether natural, modified or artificial, subject to permanent, periodic or intermittent inundation, which hold static or very slow-moving water and support biota adapted to inundation and the aquatic environment.'⁵²⁸

Table 48 lists the type, number and area of Victoria's wetlands. Marine and coastal wetlands are included, although they are not the subject of this SoE Biodiversity Update 2021 Report, which focuses on freshwater wetlands.⁵²⁹

Figure 43 maps all wetlands in Victoria including natural wetlands as well as major water storages, irrigation areas and some farm dams. It is estimated that there are 35,429 wetlands in Victoria covering an area of 784,205 hectares (Table 48). The most numerous are of 'Unknown' type, which also occupy the largest area. They are followed by 'Temporary marshes and meadows', which number 7,383 and cover 95,107 hectares. Approximately two-thirds of Victoria's wetlands are on private land.⁵³⁰ Among the thousands of wetlands there are 12 that have been recognised as having international significance under the Ramsar Convention.

Victoria's rivers and streams flow along an estimated 85,000 kilometres,⁵³¹ sustaining floodplains, lakes, wetlands and estuaries that support diverse ecosystems with more than 100 waterbird species, 50 freshwater fish, 38 frog species, 40 crayfish species⁵³² and more than 800 vascular plants. Some crayfish and galaxiid fish have high levels of endemism in Victoria and close to half or more of Victoria's frogs, freshwater fish and freshwater crayfish are threatened.

Victoria's wetlands and rivers face a number of threats that are causing their poor condition and include:

- habitat fragmentation and loss that is leading to reduced connectivity
- drought, water regulation and extractions altering volumes and flow regimes
- bushfire damage to riparian vegetation and post-fire runoff leading to sedimentation
- cropping, grazing and drainage
- climate change
- catchment development and peri-urban expansion (small dams; loss of vegetation, although there is some revegetation; removal of wetlands)
- water pollution
- alien fish stocking impacting native fish and frogs
- invasive aquatic and riparian weeds and invasive pest animal species.

528. DELWP 2016, 'The Victorian wetland classification framework 2014', East Melbourne, Victoria.

529. Marine and coastal wetlands will be reported on periodically through the Victorian State of the Marine and Coastal Environment Report to be prepared by the Commissioner for Environmental Sustainability, commencing with the inaugural report in late 2021.

530. Casanova M and Casanova A 2016, 'Current and future risks of cropping wetlands in Victoria, technical report', DELWP, East Melbourne, Victoria.

531. DELWP, 'Regional riparian action plan 2015–2020', East Melbourne, Victoria.

532. Victorian National Parks Association 2020, 'Submission to the Legislative Council Environment and Planning Committee Inquiry into Ecosystem Decline in Victoria', Parliament of Victoria, Melbourne, Victoria.

Wetlands and rivers

Table 48: Wetland types, number and area in Victoria.⁵³³

Wetland Type	Number of Wetlands	Approximate % Number of Wetlands	Area of Wetlands (ha)	Approximate % Area of Wetlands
Coastal saltmarsh	314	<1%	53,733	7%
Estuary	27	<1%	4,213	<1%
High country peatlands	3,183	9%	4,476	<1%
Intertidal flats	5	<1%	72,790	9%
Permanent freshwater lakes	1,016	3%	95,596	12%
Permanent freshwater marshes and meadows	33	<1%	2,241	<1%
Permanent freshwater swamps	192	<1%	897	<1%
Permanent freshwater swamps/marshes/meadows	2	<1%	52	<1%
Permanent saline lakes	101	<1%	65,998	8%
Permanent saline marshes and meadows	11	<1%	2,887	<1%
Permanent saline swamps	3	<1%	319	<1%
Permanent saline swamps/marshes/meadows	2,542	7%	58,314	7%
Temporary freshwater lakes	1	<1%	45	<1%
Temporary freshwater marshes and meadows	7,383	21%	95,107	12%
Temporary freshwater swamps	5,976	17%	103,669	13%
Temporary freshwater swamps/marshes/meadows	37	<1%	1,016	<1%
Temporary saline lakes	564	2%	36,704	5%
Temporary saline marshes and meadows	122	<1%	8,536	1%
Temporary saline swamps	87	<1%	5,430	<1%
Temporary saline swamps/marshes/meadows	15	<1%	1,125	<1%
Unknown	13,815	39%	170,877	22%
Total	35,429		784,025	

533. DELWP 2016, 'The Victorian wetland classification framework 2014', East Melbourne, Victoria.

Wetlands and rivers

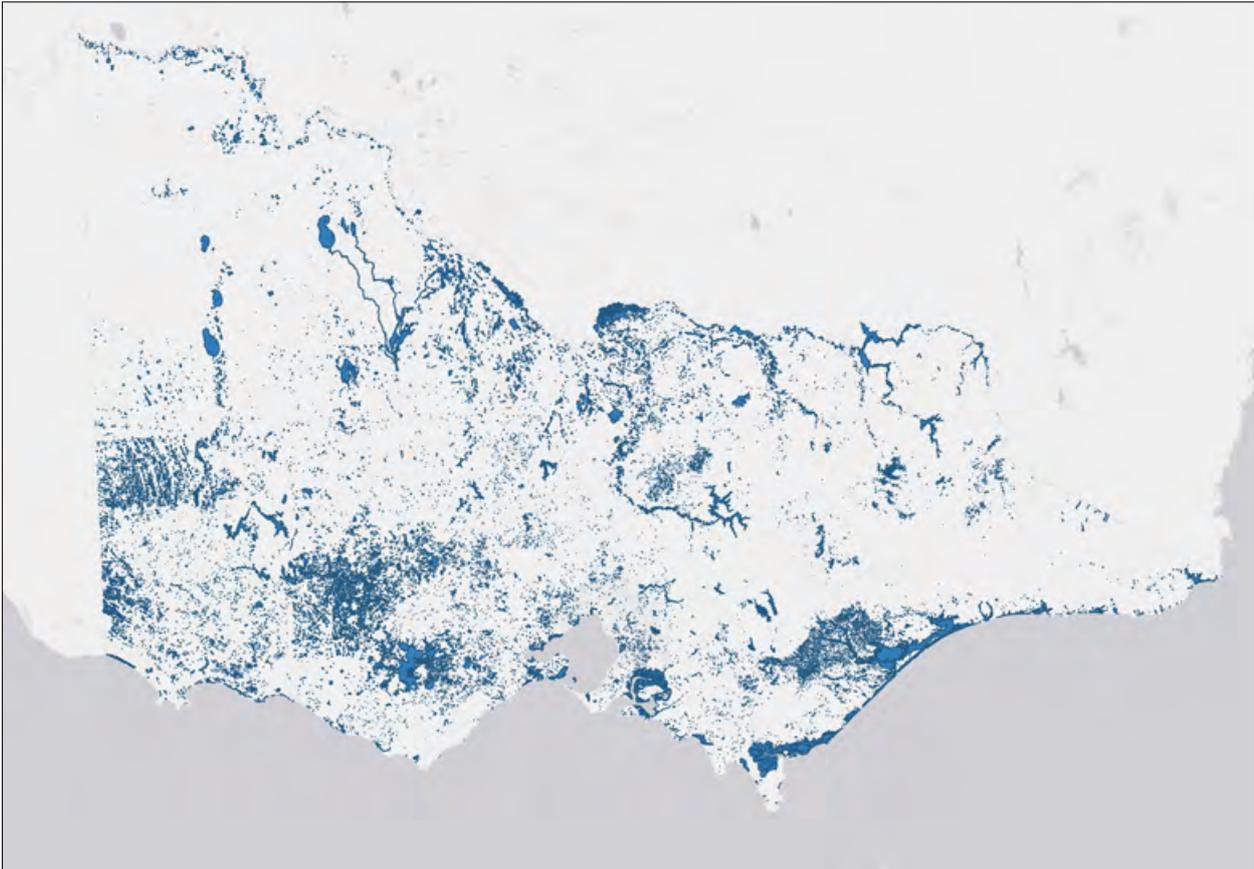


Figure 43: The distribution of naturally occurring wetlands in Victoria.⁵³⁴

Population growth and urban and agricultural development (especially farm irrigation) have led to large increases in the demand for water. In response, governments have constructed instream dams and off-stream water storages. Up to 80% of the water in the Goulburn River can be extracted for irrigation and 90% in the Moorabool River can be diverted for urban and agricultural use.⁵³⁵ In 2018–19, water was supplied to 5,800 farms across Victoria, with an estimated 1.9 million ML of water used for irrigated agriculture, including 1.7 million ML on crops and pastures.⁵³⁶

Instream dams alter flow regimes and create barriers to the movement of native fish. The proliferation of small dams in expanding peri-urban areas is reducing water flows to streams and rivers. Cold-water releases from dams can harm native fish, such as the Murray cod, and favour alien fish, such as brown and rainbow trouts. Pivot irrigation has led to the loss of paddock trees, which can be critical habitat for many native animals, and has also increased the use of groundwater.

Climate change has been impacting the flow regimes of Victoria's rivers and will continue to do so in the future. Figure 44 projects significant reductions in runoff by 2065 in all areas of the state under medium climate change, with the highest percentage reductions in the rivers of western Victoria.

534. Map downloaded from Data Vic https://discoverdata.vic.gov.au/dataset?sort=score+desc%2C+metadata_modified+desc&q=&organization=&org_ups=satial-data&res_format Accessed 13 October 2021.

535. Environment Victoria, 'Threats to river health', Carlton, Victoria <https://environmentvictoria.org.au/our-campaigns/healthy-rivers/about-healthy-rivers/rivers-trouble/threats-river-health/> Accessed 10 May 2021.

536. Agriculture Victoria 2020, 'An overview of Victoria's agriculture factsheet September Quarter 2020', Melbourne, Victoria.

Wetlands and rivers

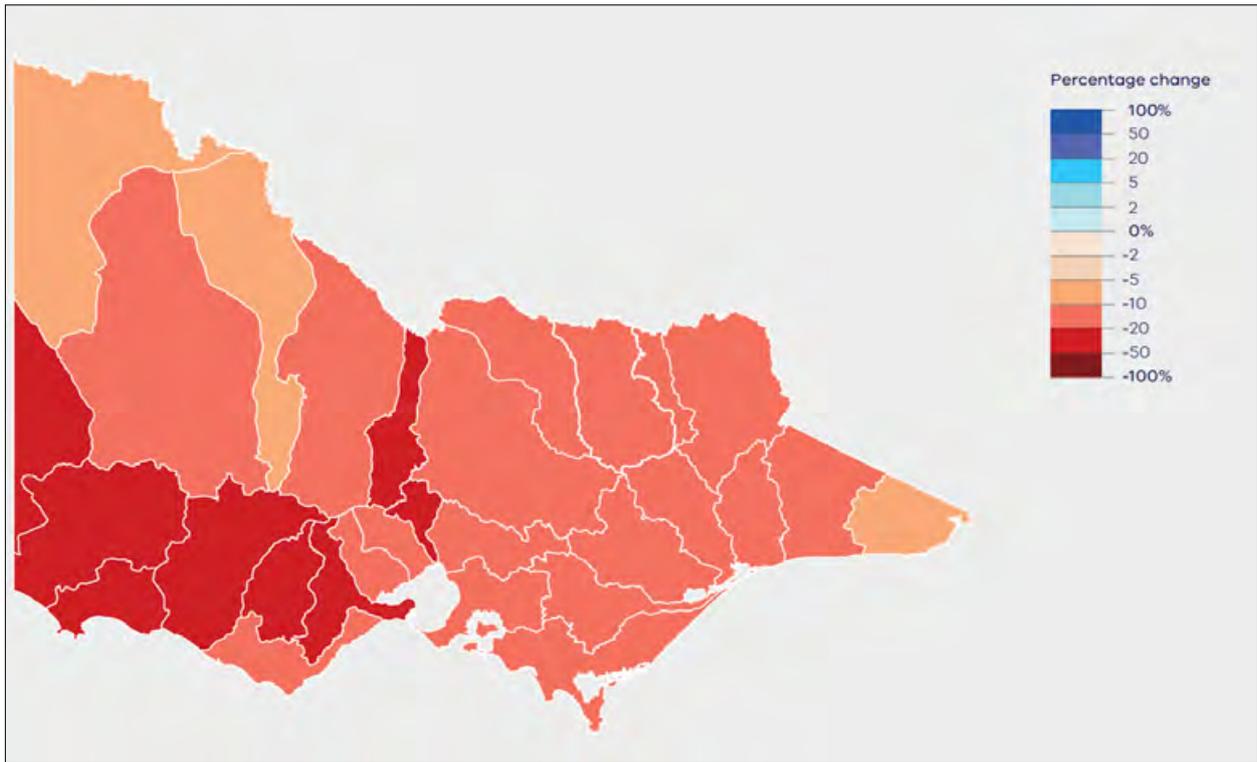


Figure 44: Projected changes in runoff for 2065 under medium climate change.⁵³⁷

A 2020 submission by the Interim Inspector-General of Murray-Darling Basin Water Resources⁵³⁸ reported that for the basin, 'the median annual inflow over the past 20 years is approximately half that of the preceding century. More significantly, the frequency of drier years is also much greater.'

Figure 45 'illustrates that more than half of the driest 10% of years in the historical record have occurred in the past two decades. The pattern of such dry years occurring back-to-back is also not observable to the same extent at any other time prior to 2000.'⁵³⁹

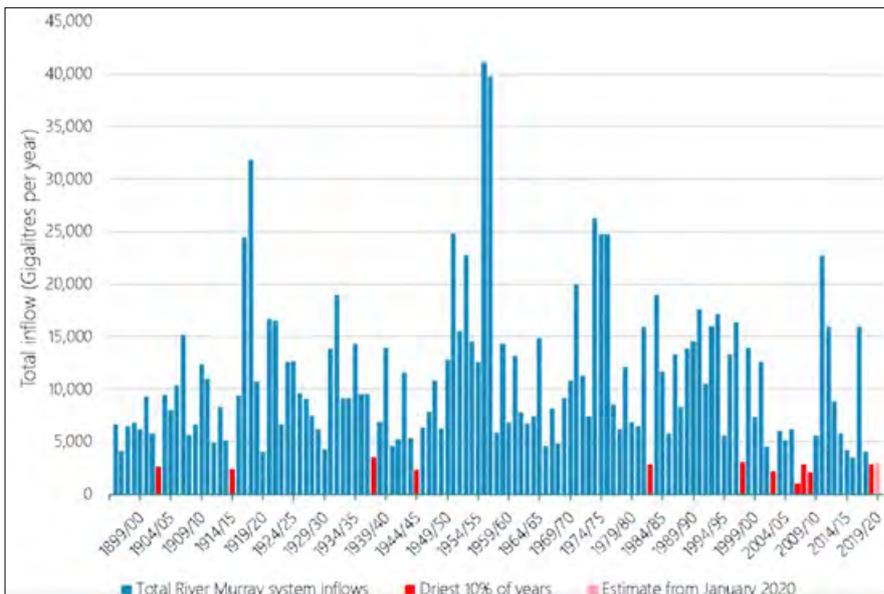


Figure 45: Total River Murray system inflows, 1895-2020.⁵⁴⁰

537. DELWP 2016, 'Water for Victoria: water plan', East Melbourne, Victoria.
 538. Interim Inspector-General of Murray-Darling Basin Water Resources 2020, 'Impact of lower inflows on state shares under the Murray-Darling Basin Agreement', Canberra, CC BY 4.0.
 539. Ibid.
 540. Ibid.

Wetlands and rivers

Bushfires can severely impact rivers, their catchments and the water resources they provide for the environment, biodiversity and human consumption. Impacts include:

- ash, debris and nutrients flowing in after rain and held as sediment slugs, which greatly simplify aquatic habitats and gradually move down river systems
- increased nutrient inflow leading to algal blooms
- the loss of riparian vegetation
- changes in river hydrology due to changes in the vegetation cover of catchments. This leads to initial increases in runoff and then later reductions as forests regrow
- aquatic animals suffering from reduced levels of dissolved oxygen levels and suffocating through the clogging of gills and other breathing structures
- increased turbidity that reduces light penetration and photosynthesis in aquatic plants
- sediment coating the cobbles and other rocks on the stream bed and eliminating the habitat for some invertebrates, reducing algal growth and potentially limiting fish breeding success
- increased treatment costs of water for human consumption.

The Victorian Government, catchment management authorities, DELWP, Parks Victoria, other agencies and the community are investing in various projects to improve the condition of the state's wetlands and rivers. A series of these is part of the government's 36 Flagship Waterways Projects, which comprise three to four landscape-scale restoration projects on priority waterways in each of Victoria's 10 CMA regions. All of the projects have projected 30-year environmental outcomes, while some have 30-year economic, social, cultural and monitoring outcomes.⁵⁴¹

Policies and legislative settings

The *Water Act 1989* provides the legal framework for managing Victoria's water resources. Its main purpose is to:

- promote the equitable and efficient use of water resources
- make sure water resources are conserved and properly managed for the benefit of all Victorians
- increase community involvement in conserving and managing water resources.

Water for Victoria: Water Plan⁵⁴² is a strategic plan for the sustainable management of Victoria's water resources and was released in 2016. It contains actions for the better integration and more efficient use of water resources, improved infrastructure and environmental flow management. The Victorian Government allocated \$222 million to the plan, which is due for review in 2023.

The aim of the State Environment Protection Policy (Waters)⁵⁴³ was to protect and improve the state's surface and groundwater resources and contained environmental quality objectives to guide water management. State Environment Protection Policies have now been replaced by Environmental Reference Standards for ambient air, sound, land, surface water and groundwater. Each standard identifies an environmental value with indicators and objectives to assess whether the value is being met. Decision makers should use the standard when assessing proposals or activities e.g. Environment Protection Authority licence applications, planning permits and environmental audits.⁵⁴⁴

The Regional Riparian Action Plan 2015–2020 (2015)⁵⁴⁵ outlined riparian management outcomes and aspirational targets that were to be achieved across regional Victoria over the five-year period 2015–16 to 2019–20 through an accelerated program of riparian management activities.

541. DELWP, 'Flagship waterways', East Melbourne, Victoria <https://www.water.vic.gov.au/waterways-and-catchments/flagship-waterways> Accessed 9 May 2021.

542. DELWP 2016, 'Water for Victoria: water plan', East Melbourne, Victoria.

543. DELWP 2018, 'State Environment Protection Policy (Waters)', East Melbourne, Victoria.

544. Environment Protection Authority, 'The environment reference standard', Melbourne, Victoria <https://www.epa.vic.gov.au/about-epa/laws/epa-tools-and-powers/environment-reference-standard> Accessed 27 July 2021.

545. DELWP 2015, 'Regional riparian action plan: working in partnership to improve riparian land in regional Victoria', East Melbourne, Victoria.

Wetlands and rivers

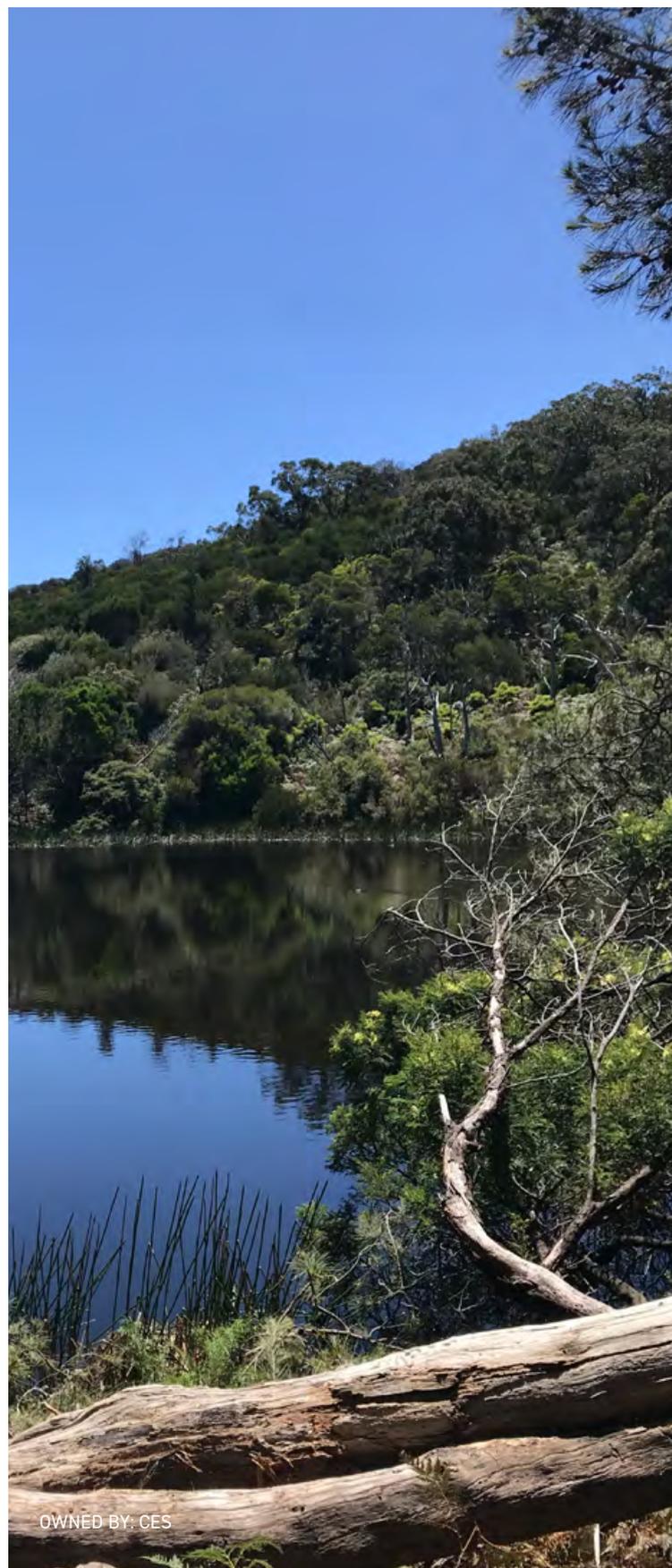
Each CMA must prepare and implement a five-yearly Regional Catchment Strategy that seeks to achieve sustainable land, water and biodiversity management through partnerships with government, landholders and the community.

The annual Seasonal Watering Plan is released by the Victorian Environmental Water Holder to outline the location and volume of environmental watering in the state. The 2020–21 plan details the water volumes and environmental watering objectives for each of four regions: Gippsland (four river systems); Central (six river systems); Western (two river systems and the Wimmera-Mallee Wetlands); and Northern (six river systems).

The Victorian Waterway Management Strategy is an eight-year program released in 2013 that provides the framework for government, in partnership with the community, to maintain or improve the condition of rivers, estuaries and wetlands so that they can continue to provide environmental, social, cultural and economic values for all Victorians.

Regional Waterway Strategies are single planning documents for river, estuary and wetland management in each region and drive implementation of the management approach outlined in the Victorian Waterway Management Strategy. They were developed by waterway managers in partnership with other regional agencies, authorities and boards involved in natural resource management, plus Traditional Owners, regional communities and other key stakeholders. For coastal regions, the Regional Waterway Strategies include the management of estuary health, highlighting the importance of estuaries as the link between catchments, coasts and the marine environment.

The Living Murray Program has four icon sites in Victoria: Barmah Forest, Hattah Lakes, Gunbower Forest and Lindsay, Mulcra and Walpolla Islands. Each of these is also a Ramsar site.



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Wetlands and rivers

Indicator B:09 River health

Region Statewide Measures Percentage of major rivers that remain in a near pristine or largely unmodified state; Assessment of freshwater biodiversity information; Area of management in priority locations; Restoration of habitat Data Custodian DELWP; Catchment management authorities; Melbourne Water	Indicator Performance:		2018 Status	2018 Trend	2018 Data	
	2018:	2021:		→		
	Why this indicator? River health is important for the environment and also many cultural, social and economic values.			2021 Status	2021 Trend	2021 Data
				→		

Potential thresholds for status in the SoE 2023 report

- Good:** >75% to 100% of rivers in good to excellent condition
- Fair:** >50 to <75% in good to excellent condition
- Poor:** <50% in good to excellent condition

Why this assessment in 2021?

Status: There are many projects aiming to improve river health, however they will require long-term resourcing and commitments from government, agencies and the community to improve the status of river health. Some river stretches will also take years to recover from the bushfires in eastern Victoria.

Trend: The trend remains stable. However, in the long-term, climate change could cause it to move downwards as river flows further decline. There will also be increasing demands for urban and rural water consumption from population growth and the continuing intensification of agriculture.

Data Confidence: The Long-term Water Resource Assessment for the river basins of southern Victoria has provided new data on river flows.

Should this indicator be used in the SoE 2023 report?

Yes.

Summary of SoE 2018 Report assessment

- The National Assessment of River Condition was compiled in 2001. It found that 79% of Victorian river lengths had been moderately or substantially modified, while 335 had damage to macroinvertebrate communities.
- Victoria’s River Monitoring and Assessment Program (RiverMAP) found that Victorian river health was influenced by grazing, land clearing for agriculture, timber production and urban development, which led to increased sedimentation, runoff, nutrient and pollutant loads, removal and/or reductions of riparian vegetation and the loss of in-stream habitat for aquatic biota. RiverMap ceased in 2016.

The 2019–20 bushfires: Impacts and responses

Burnt soil repels water, while ash-enriched soils are highly erodible, sending ash, debris and sediments into rivers and streams when rains come after fires. Nutrient levels in rivers and streams can increase 100-fold after fires, stay in the system for several years,⁵⁴⁶ and lead to algal blooms that affect waters downstream. Erosion and sedimentation will vary across the landscape and be influenced by slope, soil type, aridity, rainfall regime and fire severity.

North-eastern Victoria covers 2% of the Murray-Darling Basin, however it provides 38% of the water inflows.⁵⁴⁷ More than 20% of the region was burnt by the 2019–20 bushfires. Although there will be an increase in water flows after the fires, young trees will use more water as the forests regrow. The long-term impact on future water resources is as yet unclear.

⁵⁴⁶ Interim Inspector-General of Murray–Darling Basin Water Resources 2020, ‘Impact of lower inflows on state shares under the Murray–Darling Basin Agreement’, Canberra, CC BY 4.0.

Wetlands and rivers

Post-fire research^{548, 549} by CSIRO in the upper catchments of the Murray and Mitta Mitta rivers found that subsequent heavy rainfall and runoff led to high sediment and nutrient loads, increased turbidity, reduced water quality and fish kills (caused by the smothering of fish gills, not by reduced dissolved oxygen levels). Water samples collected from the catchment in January and February 2020 had turbidity levels 30 times higher than normal and metals such as zinc, arsenic chromium, nickel, copper and lead at concentrations above what is considered healthy for waterways. Laboratory experiments showed that water samples reduced growth rates of duckweed, impaired reproduction of water fleas and caused the death of freshwater snails. The researchers also predicted that increased nutrient flows could lead to algal blooms and elevated metals could harm aquatic organisms.

Victoria's Environment Protection Authority conducted water quality monitoring in 17 fire-affected waterways in the north-east (six waterways) and East Gippsland (11 waterways) in February and March 2020.

The monitoring was focused on the reaches of streams where recreational activities could be occurring, rather than a broader geographical sweep. The research found that: 'Although water quality generally improved between February and March, measurements of turbidity, total phosphorus and total nitrogen at several freshwater sites, still exceeded the State Environment Protection Policy (SEPP) (Waters) environmental quality objectives for these indicators. Dissolved oxygen levels were generally good, except for Corryong Creek in February and at Lake Tyers (both dates). Polyaromatic hydrocarbons were below reporting limits and surfactants, where detected, occurred at very low concentrations in February 2020. Metals were below drinking water guidelines.'⁵⁵⁰

Table 49 provides data on the extent of the 2019–20 bushfires in 13 water supply catchments in the Shire of East Gippsland. Five of the catchments had between 90 and 100% of their area burnt; only one was unaffected. Emergency extractions of threatened freshwater fish and invertebrate species were conducted after the fires in a number of these catchments.

Table 49: 2019-20 fire extent in proclaimed water supply catchments, Shire of East Gippsland.⁵⁵¹

Water Supply Catchment	Area (ha)	Total Burnt Area (ha)	Unburnt Area (ha)	% of Catchments Burnt
Bemm River	93,259	84,414	8,846	91%
Betka River	11,563	11,563	0	100%
Boggy Creek (Nowa Nowa)	26,688	18,025	8,663	68%
Brodribb River (Orbost)	93,601	88,109	5,493	94%
Buchan River (Buchan)	81,609	42,390	39,219	52%
Cann River	62,298	59,264	3,034	95%
Lake Hume	300,231	78,624	221,607	26%
Lake Hume Northern Section	3,747	1,571	2,048	42%
Mitchell River	73,508	11,950	61,558	16%
Nicholson River	47,672	45,964	1,708	96%
Rocky River	2,273	2,008	266	88%
Tambo River	270,411	116,645	153,766	43%
Upper Kiewa	516	0	516	0%
Total	1,067,377	560,526	506,723	53%

547. McInerney P, Rees G and Joehnk K 2020, 'The sweet relief of rain after bushfires threatens disaster for our rivers', *The Conversation*, 13 January 2020.

548. Joehnk K, Biswas T, Karim F, Kumar A et al. 2020, 'Water quality responses and mitigation options for post 2019–20 bushfires floods in south eastern Australia: a catchment scale analysis', technical report for the CSIRO Strategic Bushfire Project 2020, Australia.

549. McInerney P, Kumar A, Rees G, Joehnk K et al. 2020, 'How bushfires and rain turned our waterways into "cake mix", and what we can do about it', *The Conversation*, 14 September 2020.

550. Environment Protection Authority 2020, 'Water quality in waterways affected by bushfires in eastern Victoria: summary of results for February and March 2020', EPA water quality report February–March 2020, Carlton, Victoria.

551. Bushfire Recovery Victoria 2020, 'East Gippsland Fires 2019–20 natural recovery sub-plan', Melbourne, Victoria.

Wetlands and rivers

Monitoring of the impacts of the 2003 bushfires by Victoria's Environment Protection Authority can provide further insight into how fire affects river health. The Authority conducted research at 60 sites across the six catchments affected by the fires: Ovens, Kiewa, Mitchell, Tambo, Upper Murray and Snowy. Many of the streams were negatively affected by the fires, however more than half experienced no change in condition (it was suggested that they have evolved to cope with such short-term disturbances).⁵⁵² Before the fires, 65% of the sites were assessed as being in good condition, whereas a year after the fires this declined to 40%. The percentage of streams with poor condition rose from 16% to 30% after the fires. Although 35% of all sites recorded declines in condition after the fires, a larger 70% of rivers that experienced a sediment slug declined in condition. Sediment slugs were viewed as the main driver of any declines in river condition and could influence it for many years after their formation.

After the 2003 fires, a large slug of sediment, ash and debris slowly moved from the upland waters of the Ovens River catchment down along 200 kilometres of the system.⁵⁵³ Research showed that fish abundance fell by 95–100% at four impacted sites in the river due to reduced levels of dissolved oxygen. The fish population failed to show signs of recovery for two years after the fires but later recovered.

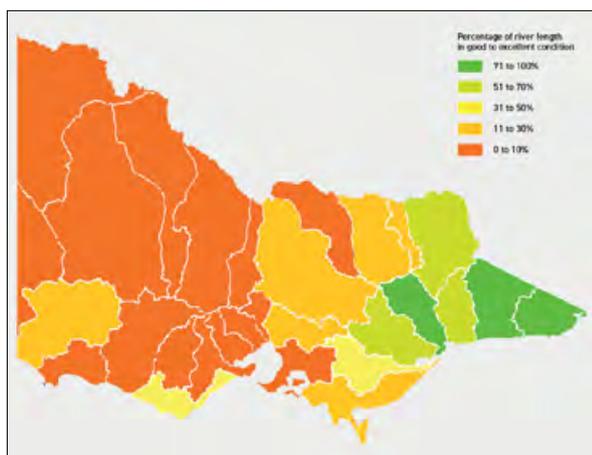


Figure 46: Waterway health in Victoria.⁵⁵⁶

SoE Biodiversity Update 2021 Report assessment

The third Index of Stream Condition released in 2013, and using data up to 2010, reported that 32% of streams were in poor to very poor condition, 43% in moderate condition and 23% in good to excellent condition. Rivers in the east of the state were in better condition than those in the west of the state,⁵⁵⁴ largely due to the retention of native vegetation in their catchments.

Figure 46 maps the percentage of river length in good to excellent condition across Victoria and shows that western Victorian rivers are in poor condition and East Gippsland rivers in good to excellent condition. Most of the rivers in western Victoria have 0–10% of their river lengths in good to excellent condition. One of those is the Werribee River, which flows through expanding urban areas and discharges into the western side of Port Phillip Bay. Water quality data was gathered and analysed for the Werribee River Association and showed that electrical conductivity, turbidity, dissolved oxygen, nitrogen, nitrates and phosphorous exceeded either Victorian SEPP (Waters) or the Australian and New Zealand Guidelines for Fresh and Marine Water Quality at many or all sites.⁵⁵⁵ The exception was the Lerderderg River, which has a heavily forested catchment containing the Wombat Forest Park.

Sparrow et al. (2019) assessed the changes in waterway health in southern Victoria⁵⁵⁷ using water-quality data – generally monthly observations between 1990 and 2018 – from 80 sites in 17 river basins. The quantitative assessment of trends in waterway health was conducted for the Long-term Water Resource Assessment. The data included measurements of electrical conductivity, dissolved oxygen, total NO₂/NO₃, total phosphorous, total suspended solids, turbidity, macroinvertebrates, fish, and five hydrology measures (mean discharge, maximum discharge, days of no flow, days since end of last flow and baseflow index).

552. Environment Protection Authority 2004, 'River health: a snapshot of the effects of the 2003 bushfires', Melbourne, Victoria.

553. Lyon J and O'Connor J 2008, 'Smoke on the water: can riverine fish populations recover following a catastrophic fire-related sediment slug?' *Austral Ecology*, 33(6), pp. 794–806.

554. Department of Environment and Primary Industries 2010, 'Index of stream condition: the third benchmark of Victorian river condition', East Melbourne, Victoria.

555. Mackintosh T 2018, 'Our Werribee River: a water quality analysis report', report for the Werribee River Association, Aqua Terra Ecology, Maidstone, Victoria.

556. DELWP 2016, 'Water for Victoria: water plan', East Melbourne, Victoria.

557. Sparrow A, Molone, P, McKendrick S, Crowther D et al. 2019, 'Assessment of change in waterway health in Victoria: a quantitative trend analysis for the long-term water resources assessment', unpublished client report for the Water and Catchments Group, DELWP, Arthur Rylah Institute, Heidelberg, Victoria.

Wetlands and rivers

The scientists found:

'During the period 1990-2005, there was deterioration with respect to all or most water quality indicators in most basins.

During the last half of the Millennium Drought (2006-2010) ... the macroinvertebrate indicators show deterioration in most river basins.

During 2011-2018 ... there is substantial variation in the water quality responses between river basins. In some basins, water quality improves according to most indicators, whilst in other basins no trend was detected in most indicators. Macroinvertebrate indicators show improvement in most river basins during 2011-2018.

There are some instances of continuing deterioration in waterway health since the Millennium Drought ended in 2011. Most of these relate to nutrient load and thus potential on-going eutrophication e.g. in the East Gippsland and Snowy River Basins (nitrogen) and the Thomson River Basin (phosphorus).⁵⁵⁸

The Long-term Water Resource Assessment was released in 2020, the result of research in the 18 river basins in southern Victoria,⁵⁵⁹ found that:

'Long-term surface water availability across southern Victoria has declined by up to 21% due to drier conditions. Contributing factors could be the upstream interception of water for storage in domestic and stock

dams and plantations. The likelihood for these contributing factors was highest in the Glenelg, Barwon, Otway Coast, Hopkins, South Gippsland and Latrobe basins, whereas they were unlikely to affect water availability in the East Gippsland, Mitchell, Tambo, Thomson, Yarra, Snowy and Lake Corangamite basins.'

'Water availability for consumptive uses declined in most of southern Victoria. The percentage decline varied from 1% to 13%.'

'Water availability for the environment declined in all basins except the Otway Coast.

'Bushfires, historical forestry management, urbanisation and the change in catchment responses to rainfall can affect surface water availability, however it was not possible to separate their effects.'

Figure 47 illustrates the differences in environmental water availability across southern Victoria's 18 river basins. This indicates that those basins nearest to Melbourne have either:

- experienced declines in in water available for the environment, and those declines would have been greater without changes to water sharing
- there has been no change in water available for the environment, but that would not have been the case without changes to water sharing.

There was no change in those basins to the far east and far west of Melbourne.

Figure 48 illustrates changes in trend for eight river health indicators across 18 river basins in southern Victoria over three time periods: 1990-2005, 2006-10 and 2011-18 in relation to river flow.⁵⁶¹ These diagrams show mixed results within and across basins – not all indicators are necessarily following the same trends. They also show a lack of data or no significant statistical trend for the fish and macroinvertebrates indicators. In the last period there has been a reversal in the negative trends for the turbidity, suspended solids and phosphorus indicators.

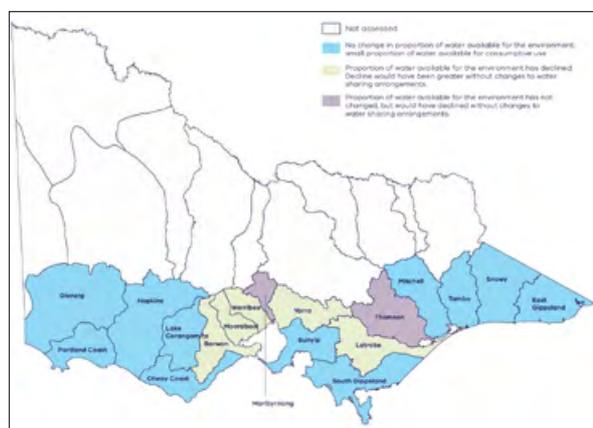


Figure 47: Changes in proportions of water available for the environment and for consumptive uses, by basin.⁵⁶⁰

558. Ibid

559. The long-term water resource assessment for northern Victoria will begin in 2024.

560. DELWP 2020, 'Long term water resource assessment for southern Victoria. Overview report', East Melbourne, Victoria.

561. Ibid

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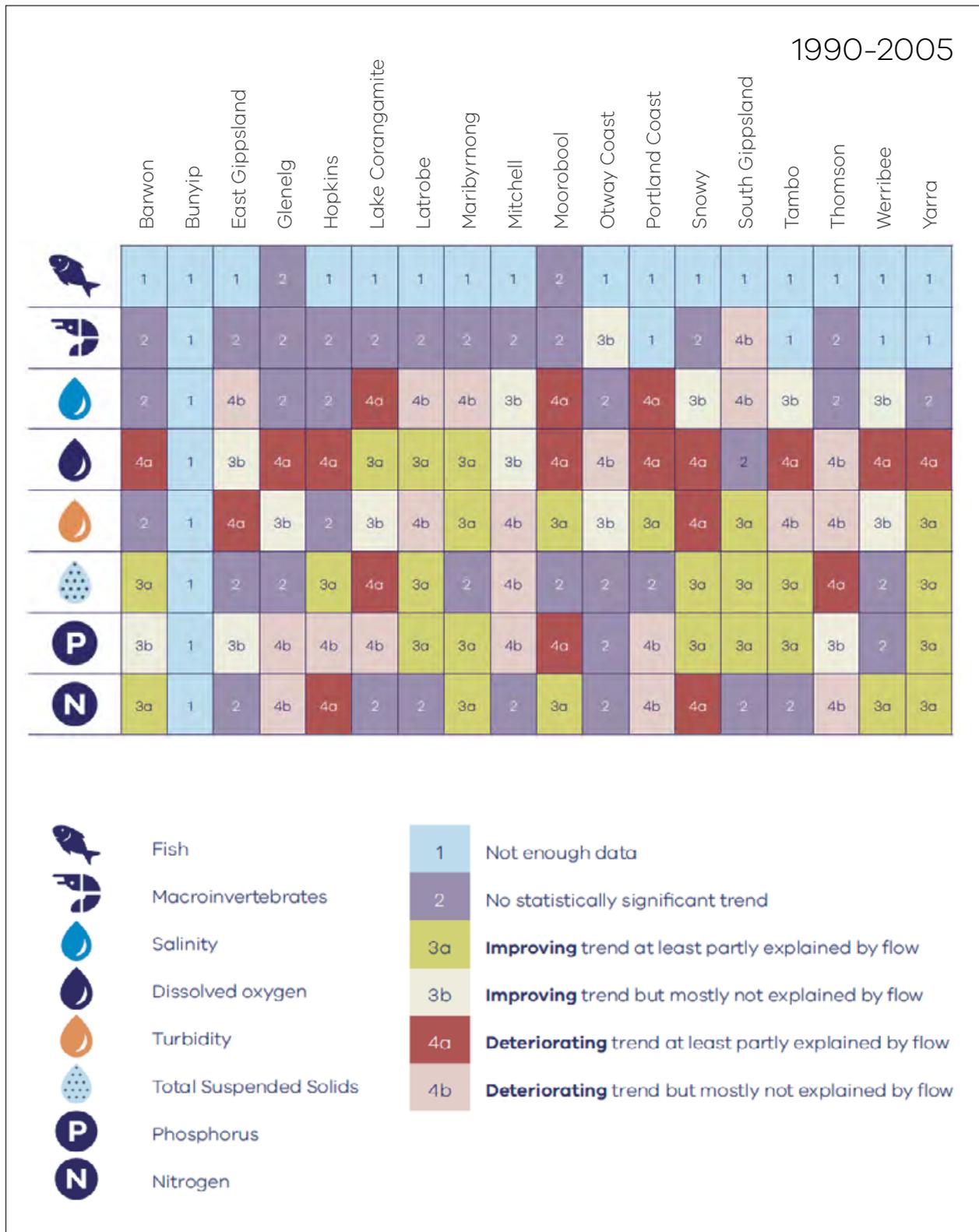


Figure 48: Changes in waterway health related to flow in southern Victoria: (a) 1990-2005; (b) 2006-10; (c) 2011-18.⁵⁶²

562. Ibid

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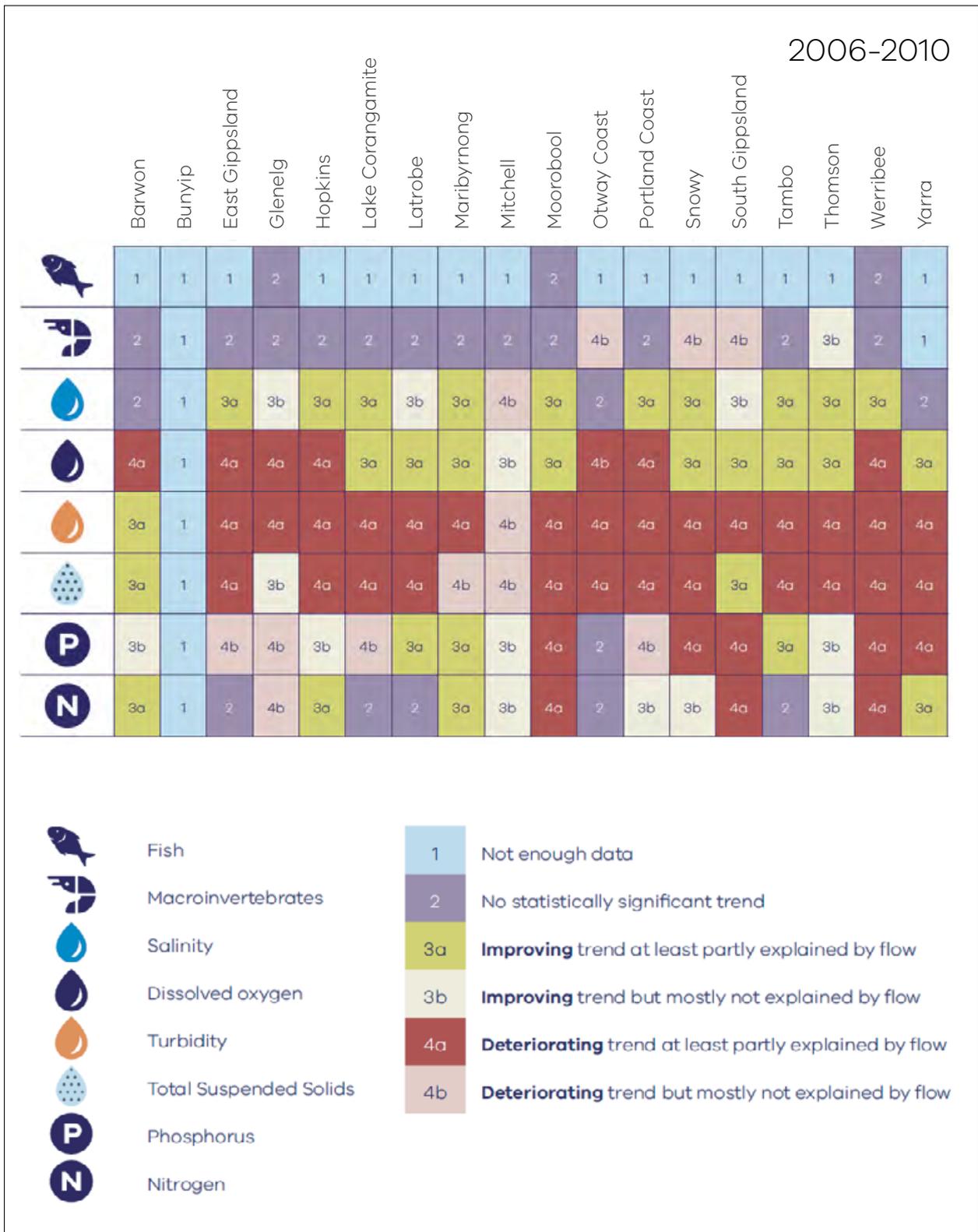


Figure 48: Changes in waterway health related to flow in southern Victoria: (a) 1990-2005; (b) 2006-10; (c) 2011-18 cont'd.

Wetlands and rivers

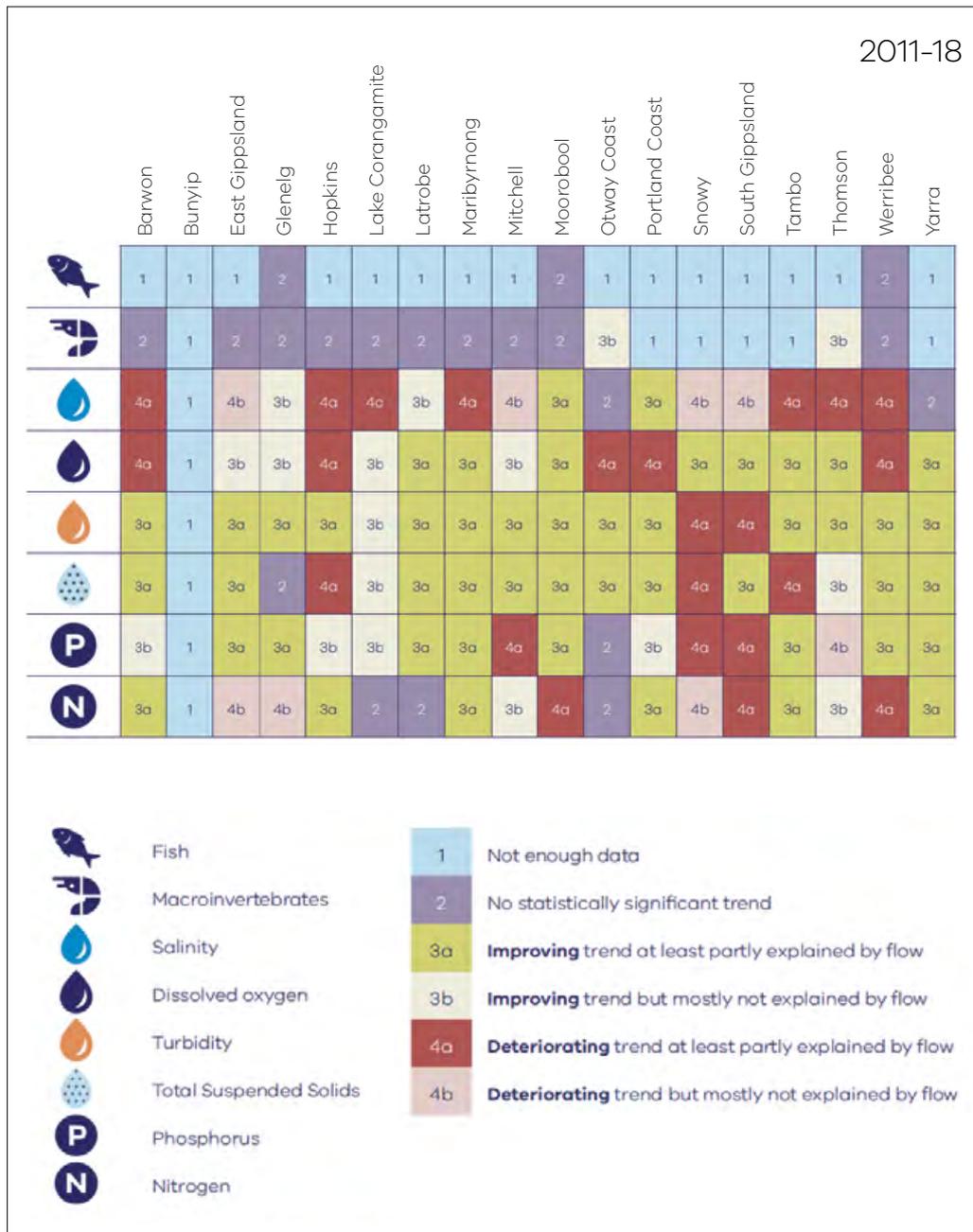


Figure 48: Changes in waterway health related to flow in southern Victoria: (a) 1990-2005; (b) 2006-10; (c) 2011-18 cont'd.

Melbourne Water has been working to improve river health in the Melbourne metropolitan area. The health of Little Stringybark Creek in the Dandenong Ranges had suffered because of agricultural, urban and industrial development in its catchment. To improve the creek's health, the University of Melbourne has been working with Melbourne Water on what they describe as a world-first, catchment-scale, water-sensitive design project. The focus has been on the use of stormwater control measures,

such as rainwater tanks and raingardens, to improve the creek's hydrology, water quality and ecological function: 'Nearly one third of properties in the catchment took part in the experiment, installing various SCMs [stormwater control measures] to treat and use stormwater runoff from their land. Council also installed 88 stormwater treatment systems on public land, including 15 large precinct raingardens, and 62 streetscape raingardens and underground infiltration systems.' Potable water

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has been saved, groundwater recharged and water quality and hydrology improved through the project.⁵⁶³

The aquatic biodiversity of Melbourne waterways is also being monitored by Melbourne Water using eDNA technology.⁵⁶⁴ This is extracting the DNA of aquatic animals such as platypus, fish, frogs, birds and invertebrates from water samples at 300 sites across Melbourne.

The Victorian Government has invested \$222 million into improving the health of the Victoria's waterways and catchments. The Water for Victoria Action Status Report released in July 2020 indicated that for waterway and catchment health:

- there were 19 regional projects being delivered to strengthen integrated catchment management
- 10 large scale Flagship waterways projects had been established
- investment had been made in environmental works for priority waterways
- there was improved monitoring and reporting on the benefits of environmental watering
- support for waterway citizen science programs across Victoria was continuing.⁵⁶⁵

The investment includes funds for the Living Murray initiative, which uses water infrastructure to recover water for use on six iconic sites. Four of which – Barmah Forest, Gunbower Forest, Hattah Lakes and Lindsay-Wallpolla Islands – are in Victoria. Since the project began, the health of the rivers, wetlands and floodplains have improved.⁵⁶⁶

DELWP's 2019–20 Annual Report states that: 'On-ground works and watering programs were undertaken at 356 river reaches and wetlands to maintain or improve their environmental condition in 2019–20. This included 10,635 hectares of vegetation works such as tree planting, weed control and fencing alongside waterways, and delivery of water for the environment to 146 wetlands and river reaches across the state. These works delivered significant recreational, cultural and economic benefits for Victorian communities and improved habitat for platypus, fish and other aquatic wildlife.'⁵⁶⁷

Table 50 summarises the condition of waterways and biodiversity as assessed by each of Victoria's 10 catchment management authorities, based on their 2019–20 annual reports. Four of the 10 catchment management authorities rated waterway condition as Concerned, three as Neutral, one as Satisfactory and two as Positive. For biodiversity, three were Neutral, five Concerned, one Poor and one Neutral on threatened species and 'Positive' on terrestrial habitat.

Reasons given by the catchment management authorities for their concern about waterway condition included drought, reduced stream flows, the impact of the 2019–20 bushfires, including fish kills, and the loss of wetlands to cropping. For those that rated waterway condition as neutral or positive, the reasons given were environmental watering, removal of stock grazing in riparian vegetation, tree planting, threat mitigation and investment in waterway health.

More concerns were expressed by the catchment management authorities about the condition of biodiversity in their region. The reasons for their 'concerned' and 'highly concerned' ratings included:

- land clearing, changing land use, urban development pressures, invasive species, drought and climate change
- 2019–20 bushfires
- wetlands and grasslands modified for agriculture
- small net increase in vegetation insufficient to sustain ecological function
- river regulation and water pollution
- declining populations of native fish, crayfish, frogs and waterbirds
- cat and fox control effective locally but not carried out at a catchment scale.

Reasons for positive and neutral ratings for biodiversity condition included protection and restoration works, increased populations of threatened species, threat mitigation, priority restoration and improved habitat condition.

564. Melbourne Water, 'Monitoring waterway diversity using environmental DNA', Melbourne, Victoria <https://www.melbournewater.com.au/water-data-and-education/news/research-and-innovation/monitoring-waterway-diversity-using> Accessed 9 May 2021.

565. DELWP 2020, 'Water for Victoria action status report July 2020', East Melbourne, Victoria.

566. Murray-Darling Basin Authority 2018, 'The living Murray: icon site condition report', Canberra, Australia.

567. DELWP 2020, 'Annual report 2020', East Melbourne, Victoria.

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Table 50: Condition reporting by Victoria's 10 Catchment Management Authorities.⁵⁶⁸

Catchment Management Authority	Waterways Condition	Biodiversity Condition
Corangamite	Neutral (past 3 years)	Concerned (past 3 years)
East Gippsland	Concerned	Highly concerned
Glenelg Hopkins	Concerned (as past 3 years)	Concerned (Neutral previous 2 years)
Goulburn Broken	Satisfactory	Poor
Mallee	Positive	Threatened species: Neutral (past 3 years) Terrestrial habitat: Positive (past 3 years)
North East	Positive to Concerned in 3 years	Concerned to Highly Concerned in 1 year
North Central	Neutral (long-term Positive)	Neutral (long-term Concerned)
Port Phillip and Westernport	Neutral (as for past year)	Highly concerned
West Gippsland	Positive (as past 3 years)	Neutral (past 3 years)
Wimmera	Positive to Concerned in 3 years	Neutral (past 3 years)

Biodiversity restoration and threatened species recovery projects are a key focus for catchment management authorities and their development of partnerships with local communities, community groups and volunteers, Victorian and federal government departments, Traditional Owners and Aboriginal communities, water corporations, landowners, agricultural industries, and universities and research institutions. Actions that involve

partnerships include weed and pest animal control, revegetation, fencing, livestock grazing control, partnership establishment and maintenance, and events. Table 51 presents data on these actions along with their achievements in 2018–19 and 2019–20. The targets for each are in brackets and, with the exception of partnerships in 2018–19, all targets in the two years were exceeded.

Table 51: Selected actions and achievements of Victorian catchment management authorities 2018–19 and 2019–20.^{571,572}

Actions	2018–19 (Target)	2019–20 (Target)
Weed control (ha)	262,981 (140,161)	140,580 (126,451)
Pest animal control (ha)	630,273 (525,671)	829,072 (618,362)
Vegetation planting (ha)	2,854 (2,409)	3,508 (2,000)
Fencing (km)	639 (525)	568 (354)
Livestock grazing control (ha)	3,873 (2,436)	3,946 (2,712)
Threatened species response (No.)	19 (7)	29 (14)
Partnerships established or maintained (No.)	1,310 (1,496)	1,464 (1,262)
Participants at events (No.)	76,859 (41,848)	67,281 (31,205)

568. 2019–20 annual reports for each catchment management authority.

571. Victorian Catchment Management Authorities 2019, 'Actions and achievements report 2018–19', Melbourne, Victoria.

572. Victorian Catchment Management Authorities 2020, 'Actions and achievements report 2019–20', Melbourne, Victoria.

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Table 52 lists various threatened species and habitat and landscape restoration projects coordinated by Victoria's catchment management authorities. Weed and pest animal control, revegetation, fencing, livestock grazing control and partnerships are key elements of these.

Catchment management authorities and their communities have been working to improve river health in their regions, in some cases through the Demonstration Reach project developed by the Murray-Darling Basin Authority under its Native Fish Strategy.

The Ovens River was one such project, running from 2008 to 2014 and including the following rehabilitation works:

- 305 habitat snags inserted
- 25 fish hotels placed in river
- 18 kilometres of willows removed
- 6 kilometres of fencing installed
- new fishway constructed (Wangaratta)
- 250 kilograms of European carp removed
- 10,000 Macquarie perch stocked in 2014.⁵⁶⁹

The works contributed to a 450% increase in the Murray cod population and a 270% increase in trout cod numbers. Similar restoration work was carried out in the Hollands Creek Demonstration Reach project, which reported a 1,200% increase in Macquarie perch, a 1,500% increase in two-spined blackfish and a 400% increase in river blackfish.⁵⁷⁰

Table 52: Catchment Management Authority habitat restoration and threatened species recovery projects.⁵⁷³

Catchment Management Authority	
Corangamite	Dewing Creek restoration works · Willow removal at Barwon River (Birregurra) · Willow removal in the Gellibrand River (Charley Creek) · Wild Otways (pig and deer eradication; fox and cat management; Phytophthora management) · Protecting the Victorian Volcanic Plains · Ramsar wetlands · Adapting to climate change (Woody Yaloak, Leigh and Moorabool River catchments and Western District Lakes) · Linear reserves project · Cultural burning · Grassy eucalypt woodlands stewardship project · Connecting landholders to biodiversity on the Victorian Volcanic Plain · The Living Moorabool · Wild Otways (Small mammal conservation; Rewilding threatened species) · Orange-bellied parrot recovery · Threatened fish recovery · eDNA monitoring · Curdies Perch Search
East Gippsland	Protecting the best (weed and pest control) · Red Gum Plains · Highlands Down (alpine peatlands) · Waterway health projects (Combenbar; Snowy; Dargo; Buchan; Tambo; Lower Mitchell) · Protecting Traditional Owner Country of the Gippsland Lakes Outer Barrier · Lake Wellington and fringing wetlands program · Understanding and improving aquatic habitats and ecosystems · Priority actions for the Gippsland Lakes Ramsar Site
Glenelg Hopkins	Glenelg River Restoration Project (including Wannon River and Konongwootong, Den Hills and Wennicott creeks) · Walker Swamp Australasian Bittern · Budj Bim Connections (Flagship Waterway) · Catchments for communities (sustainability and integrated catchment management) · Coastal Connections (habitat protection and restoration) · Coastal works program (estuary management) · Grange Burn restoration project · Hopkins Wetlands restoration project · Merri River restoration · Mt Emu Creek · Permanent protection of Long Swamp · Protecting red-tailed black cockatoo feed habitat · Protecting the hooded plover · Victorian Volcanic Plains recovery project · Wetland defence program
Goulburn Broken	Bogies and beyond (citizen science water monitoring and climate change) · Year of the paddock tree · Linking landscapes and communities (improve condition of grey box grassy woodlands and grasslands) · Tree storey (citizen science project) · 3Bs: Bores of the bogies and beyond · Macquarie perch · Seven Creeks (fish habitat) · Strathbogie Streams (riparian improvements along Seven Creeks and Hughes, Merton, Brankeet and other creeks) · Ribbons of blue, sashes of green (box woodlands and ironbark forests) · iSpy catchment creatures identification app

569. Department of Environment and Primary Industries 2014, 'Ovens cod love river rehabilitation', East Melbourne, Victoria.

570. Department of Environment and Primary Industries 2014, 'Victoria demonstrates that river rehabilitation works for native fish', East Melbourne, Victoria.

573. Catchment management authority annual reports and websites.

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Table 52: Catchment Management Authority habitat restoration and threatened species recovery projects cont'd

Catchment Management Authority	
Mallee	Merbein Common (fish hotels) and Nyah Recreational Reserve (revegetation invasive control) · Birchip region (plains-wanderer habitat)
North Central	Current flows (environmental watering) · Caring for the Campaspe · Coliban River flows · Guttrum and Benwell · Forests Birch's Creek · Gunbower (forest, creek and Ramsar wetlands – flows and invasives control) · Koondrook Fishway · Loddon Murray Wetlands Wimmera-Mallee Wetlands · Bringing back the bittern · Plains for wanderer · Native fish recovery plan (Gunbower Creek and lower Loddon River) ·
North East	Uncovering the Ovens (improving biodiversity and recreational values) · Mountain pygmy-possum recovery plan · Bushfire recovery program · Helping landowners help our endangered birds (regent honeyeater and swift parrot) · Protecting alpine peatlands · Lower Ovens floodplain (improving connectivity) · Creating a safe haven for native fish in the Mitta Mitta River
Port Phillip and Westernport	Grow West (landscape restoration) · Greens Bush to Arthurs Seat Biolink · The great heho escape Yarra Valley (helmeted honeyeater habitat restoration) · Yarra4Life · Living Links (urban nature) · Greening the Maribyrnong · Restoring the natural glory of Jacksons Creek · Deepening connections (Deep Creek and Konagaderra Creek habitats) Feral Cat Free French Island · Peaks to plains (threatened species protection in the You Yangs and on Werribee Plains) · Two great Ramsar wetlands
West Gippsland	Headwater willow control program · Protecting our ponds · Thomson River Fishway 2017-19 · Corner Inlet connections · Heart Morass · River blackfish (translocation) · Silcocks Hill (improve water quality of runoff to Corner Inlet) · Alpine peatlands · Red gum grassy woodlands · Coastal saltmarsh protection project · Lake Wellington land and water management plan
Wimmera	South-eastern red-tailed black cockatoo · The Ranch Billabong (environmental water) · Bird monitoring program
Melbourne Water	Cockatoo Swamp rehabilitation project · Creating the Grasmere Creek · Wetland Improving Police Road Wetland · Lillydale Lake Wetland upgrade · Mosquito monitoring and control at Seaford Wetlands · Improving the Little Yarra River · Improving the Lower Yarra River, Kew · Protecting the Watts River catchment · Spartina management in Western Port estuaries · Chain of Ponds Collaboration · Chinamans Creek earthen levee · Cockatoo Swamp rehabilitation project · Creating the Grasmere Creek Wetland · Enhancing our Dandenong Creek · Hadfield Park Naturalisation · Improving access to the Yarra River at Westerfolds Park · Improving the Little Yarra River · Improving the Lower Yarra River, Kew · Reimagining Your Creek program · Reimagining your Moonee Ponds Creek · Upper Stony Creek transformation · Lower Yarra billabong · Environmental water releases to Tarago, Bunyip, Yarra and Werribee rivers

A major feature of recent river restoration projects is the re-snagging or installation of instream woody habitat. Research had shown that although the habitat was in poor condition across the state, it was of critical importance to native species.

The then Department of Environment and Primary Industries in 2013 mapped instream woody habitat in 38,000 river reaches along 27,700 kilometres of rivers across Victoria. The analysis found 53% or ~17,000 kilometres had severely or highly depleted

densities, with 30% more than 80% below natural levels⁵⁷⁴ (see Figure 49). Instream woody habitat was in very poor condition in the South Western Floodplains and the Glenelg and North Central Floodplain river regions, whereas the Alpine, North East Uplands and East Gippsland Uplands river regions were at natural densities.

574. Department of Environment and Primary Industries 2013, 'Instream woody habitat assessment', East Melbourne, Victoria.

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In a study that included more than 300 sites across eight Victorian waterways, Tonkin et al. (2020) found positive relationships between instream woody habitat and the abundance of fish, especially the Murray cod.⁵⁷⁵ The modelling used by the authors predicted a fourfold increase in the abundance of Murray cod if the density of instream woody habitat was increased from low levels to natural levels. According to the authors, the results were further evidence that the loss of instream woody habitat had had 'major adverse impacts on the

health of south-eastern Australian fish populations.' The results also suggested that 'restoring IWH is likely to lead to more pronounced changes in fish abundance in reaches that are more degraded, both in terms of historical IWH removal, and the population status of the native fish community.'⁵⁷⁶ In conclusion, the authors urged that instream woody habitat not be carried out in isolation from other threats and constraints, and should also include other restoration actions such as riparian revegetation, removal of barriers to fish movement and the fencing out of livestock.

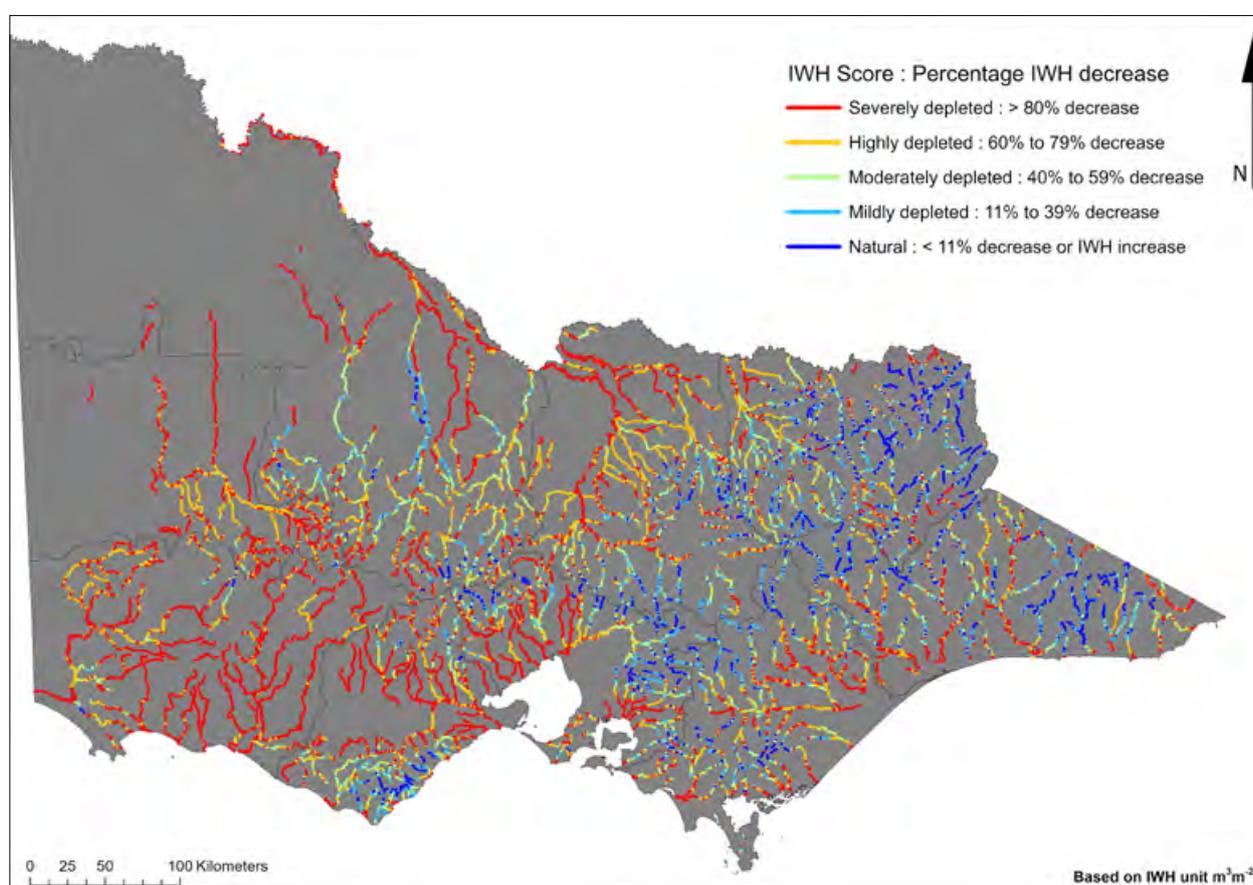


Figure 49: Instream Woody Habitat (IWH): Percentage IWH decrease.⁵⁷⁷

Case study: Small farm dams

Victoria has 450,000 dams that store 13,400 GL.⁵⁷⁸ Other than a few large dams and impoundments, most are very small farm dams. Table 53

summarises the storage capacity of licensed (for irrigation) and unlicensed (domestic and livestock use) small dams in each river basin. The Loddon, South Gippsland and Bunyip basins have the largest volume of storage in small dams.

575. Tonkin Z, Kitchingman A, Fanson B, Lyon J et al. 2020, 'Quantifying links between instream woody habitat and freshwater fish species in south-eastern Australia to inform waterway restoration', *Aquatic Conservation*, 30(7), pp. 1385–1396.

576. Ibid

577. Department of Environment and Primary Industries 2013, 'Instream woody habitat assessment', East Melbourne, Victoria.

578. DELWP, 'Dams', East Melbourne, Victoria <https://www.water.vic.gov.au/managing-dams-and-water-emergencies/dams> Accessed 10 May 2021.

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Table 53: Water storage in small dams by river basins in Victoria.⁵⁷⁹

River Basin	Licensed Small Farm Dams Capacity (ML)+	Unlicensed Small Farm Dams Capacity (ML)*
Murray	4,123	12,142
Kiewa	4,519	6,406
Ovens	10,935	26,401
Broken	8,796	16,857
Goulburn	22,645	51,197
Campaspe	6,522	29,715
Loddon	16,978	42,665
East Gippsland	176	1,094
Snowy	1,590	2,840
Tambo	1,357	4,933
Mitchell	2,912	3,957
Thomson	3,175	5,396
Latrobe	16,147	15,362
South Gippsland	13,983	31,815
Bunyip	23,668	23,583
Yarra	9,477	17,935
Maribyrnong	1,790	10,262
Werribee	936	9,033
Moorabool	7,259	13,067
Barwon	9,849	24,060
Corangamite	3,851	9,864
Otway Coast	10,014	13,676
Hopkins	8,146	27,942
Portland Coast	497	6,594
Glenelg	3,084	32,525
Millicent Coast	5,071	4,656
Wimmera	7,436	29,535
Mallee		
Avoca	5,183	9,483
Total	210,119	482,995

+Registered/licensed commercial and irrigation *Domestic and stock not licensed

579. Victorian Water Register, 'Victorian water accounts 2018-19', DELWP, East Melbourne, Victoria.

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The Long-term Water Resource Assessment mapped the location of small domestic and stock supply dams in Victoria's southern river basins (see Figure 50). The relative contribution of the increased interception by these dams to the total long-term decline in available surface water is mapped in Figure 51. There is a strong correlation between the density of farm dams shown in Figure 50 and the level of interception in Figure 51. The farm dams in the Barwon, Yarra and Bunyip river basins have a high likelihood of contribution to a decline in surface water. On the other hand, farm dams in basins in the far west and far east of the state have little to no likelihood.

SKM (2007) investigated the impact of small farm dams on water resources in the Murray-Darling Basin and estimated that by 2030 the storage within them would increase by 228 GL and reduce runoff by 180 GL.⁵⁸⁰ In Victoria, the Campaspe and Loddon-Avoca systems would experience 1.66% and 0.65% reductions in runoff respectively. There was little change predicted for western Victoria, where runoff was insufficient to support many more dams.

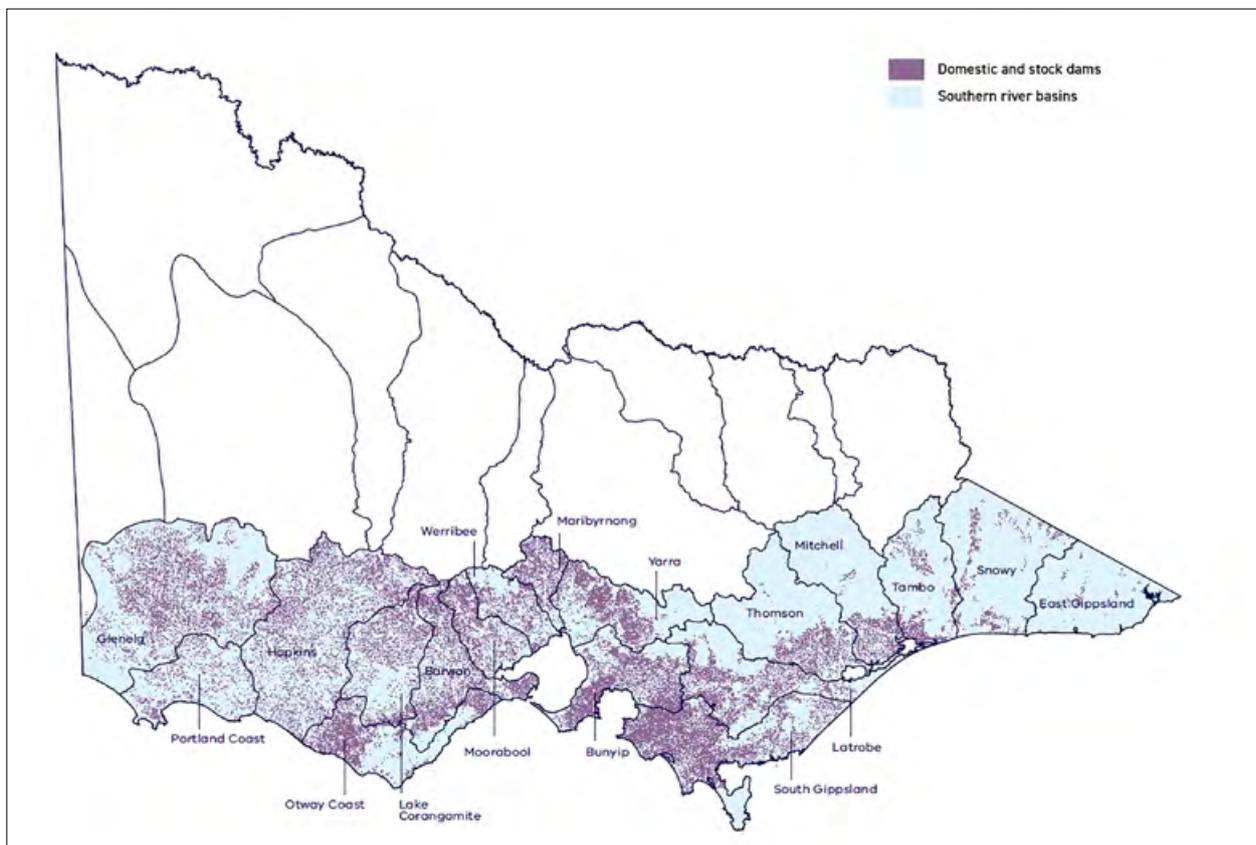


Figure 50: The location of farm dams for domestic and stock water supply.⁵⁸¹

580. Sinclair Knight Merz 2007, 'Projections of effect of future farm dam development to the year 2030 on run-off', unpublished report to the CSIRO Murray-Darling Basin Sustainable Yields Project.

581. DELWP 2020, 'Long term water resource assessment for southern Victoria. Overview report', East Melbourne, Victoria.

Wetlands and rivers

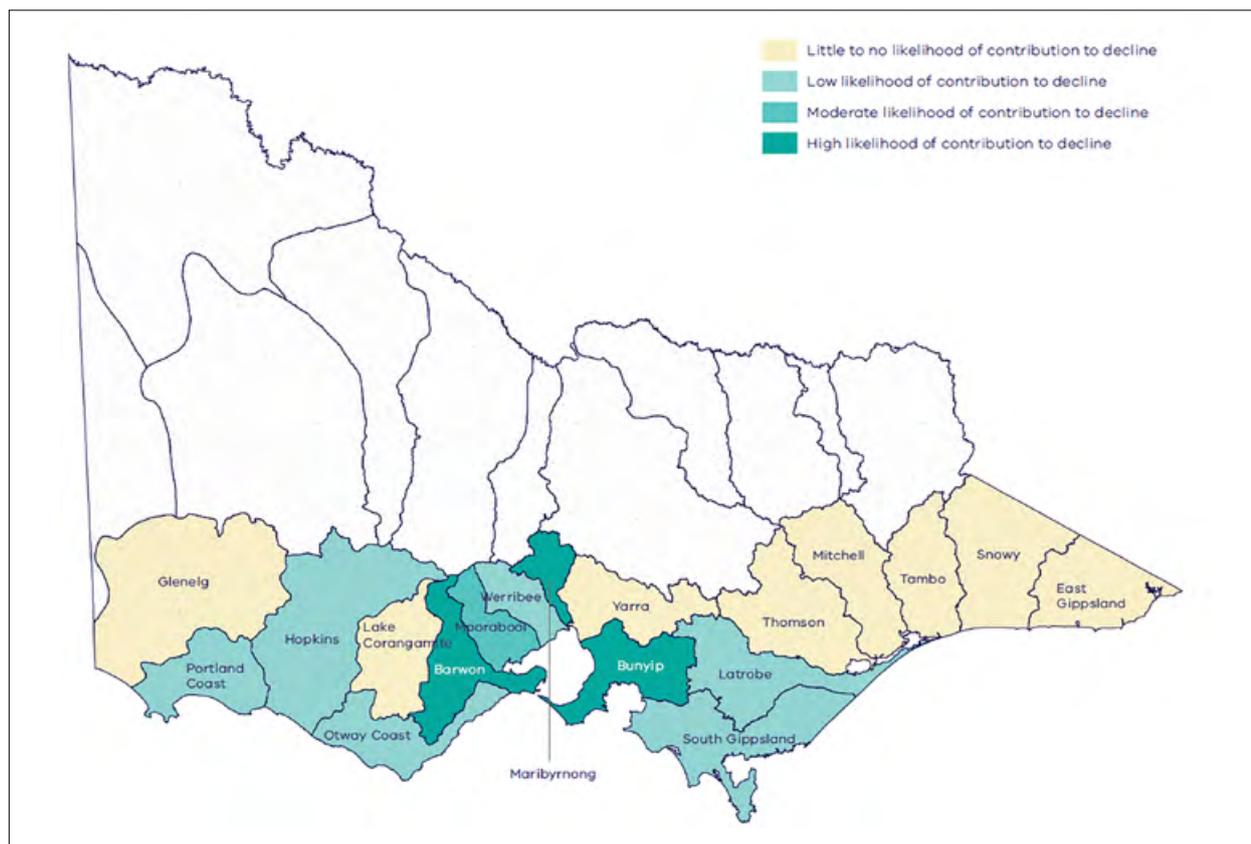


Figure 51: Relative contribution of the increase in interception by domestic and stock water supply dams to the total long-term decline in available surface water.⁵⁸²

Lett et al. (2009) reviewed the impacts of climate change and farm dams on water flows in the basin of the Campaspe River.⁵⁸³ They based their analysis on the climate change projection CSIRO Scenario B: Warmer and drier climate in which the daily temperature time series increases by 2°C, daily rainfall time series decreases by 10% compared with historical climate, and the mean annual flow decreases by 20–30%.⁵⁸⁴ The analysis indicated that inflows to Lake Eppalock could decline by 31% in 2055, and possibly by 72%, if low inflows continued. The authors also simulated the impact of farm dams on inflows to Lake Eppalock under historic climate and two climate change scenarios.

The model indicated that farm dams would magnify climate change impacts by capturing up to 25% of all inflows to the lake, compared with only 8% of all inflows under historic climate data.

In an analysis of farm dams in the Strathbogrie Tableland,⁵⁸⁵ Lobert (2020) found 864 dams in the 15,300 hectares of the Seven Creeks catchment above Polly McQuinn's. These are mapped in Figure 52, with small dams in blue, medium dams in yellow and large dams in pink. Of the 864 dams, 811 were small (<2 ML), 21 medium (2–5 ML) and 32 large (>5 ML). Their combined storage capacity was estimated at 1,006 ML.

582. Ibid

583. Lett R, Morden R, McKay C, Sheedy T et al. 2009, 'Farm dam interception in the Campaspe Basin under climate change', Conference paper at the 32nd Hydrology and Water Resources Symposium, Newcastle: Adapting to Change, 1 January 2009.

584. Zhang L, Zheng H, Teng J, Chiew F et al. 2020, 'Plausible hydroclimate futures for the Murray-Darling Basin', A report for the Murray-Darling Basin Authority, CSIRO, Australia.

585. Lobert B 2020, 'Farm dams on the Strathbogrie Tableland', Bogies and Beyond Groundwater Monitoring Project, Strathbogrie Ranges – Nature View, 20 August 2020 <https://strathbogierangesnatureview.wordpress.com/2020/08/20/farm-dams-on-the-strathbogrie-tableland/> Accessed 8 May 2021.

Wetlands and rivers

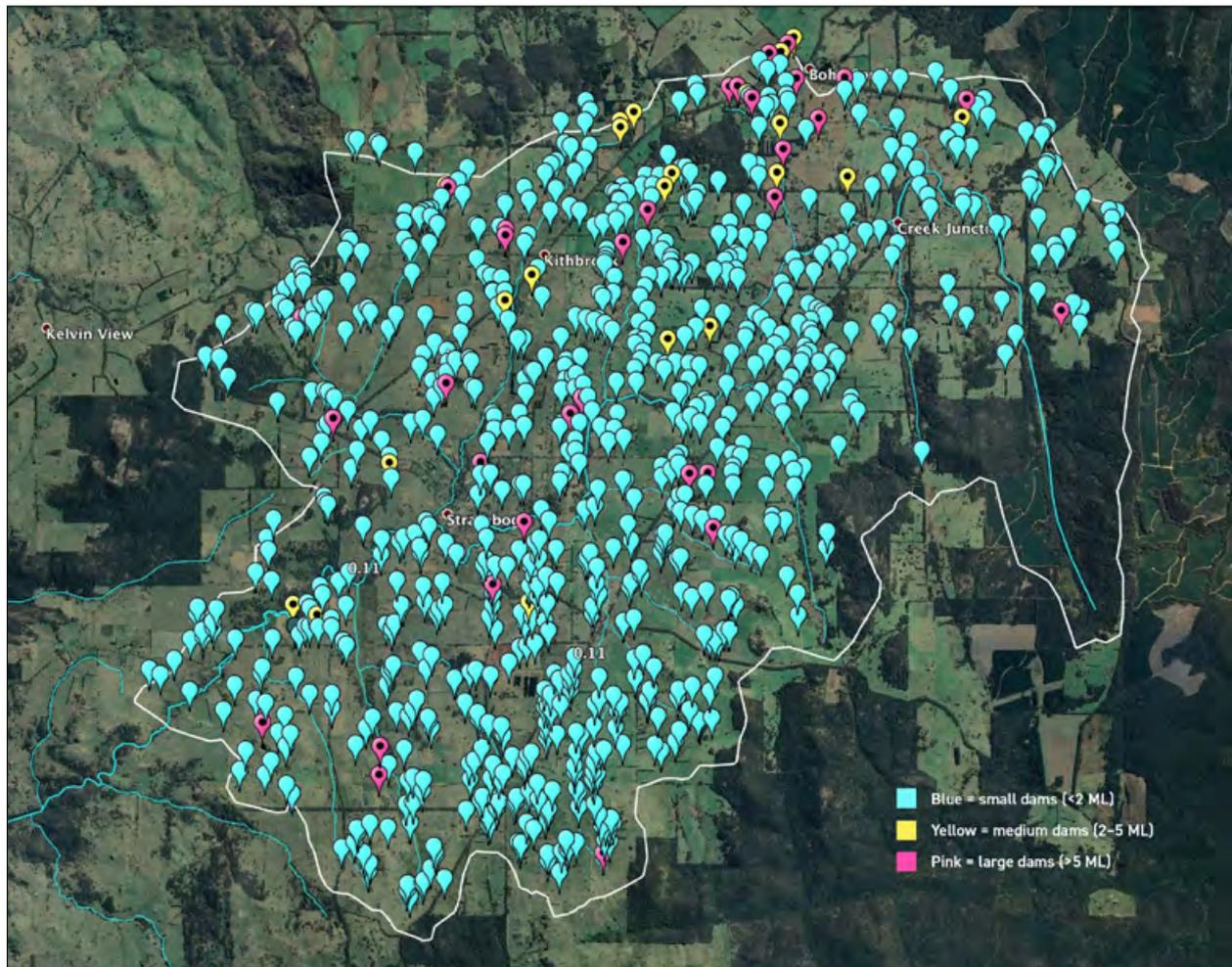


Figure 52: Farm dams in the Seven Creeks catchment above Polly McQuinn's Weir.⁵⁸⁷

Lobert concluded that the 'impact on stream-flow during the drier months is likely to be high because these dams can intercept runoff that would otherwise provide freshening flows in summer (when base-flow is at its lowest)' ... and ... 'Demand for reliable, good quality water is high and will only increase as rainfall patterns change and the catchment becomes drier' ... and... 'The sheer number of farm dams on the Strathbog Tableland, along with the amount of water they divert away from surface flow, suggests they may already be having a significant impact.'⁵⁸⁶

586. Ibid

Wetlands and rivers

Indicator B:10 Riparian vegetation habitat extent

Region Statewide	Indicator Performance:	2018 Status	2018 Trend	2018 Data
Measures Riparian vegetation cover and extent	2018: Unable to be assessed due to Unknown Trend and Low Data Confidence			
Data Custodian DELWP; Catchment management authorities; Melbourne Water	2021:	2021 Status	2021 Trend	2021 Data
	Why this indicator? Removal of riparian vegetation impacts terrestrial and aquatic food webs.			

Potential thresholds for status in the SoE 2023 report

Good: >75% to 100% of river lengths with intact or restored riparian vegetation

Fair: >50% to <75% of river lengths with intact or restored riparian vegetation

Poor: 50% of river lengths with intact or restored riparian

Why this assessment in 2021?

Status: Although catchment management authorities and the community are working well on restoring local areas of riparian vegetation, they are starting from a low bar in some places. There are thousands of kilometres of degraded or absent riparian vegetation, any improvement in Status will require a long-term, well-resourced and comprehensive program of action.

Trend: The three Index of Stream Condition assessments, and recent LiDAR collection in 2018–19 from a subset of rivers, suggests the Trend is stable for cover and extent on a statewide basis. In localised sections of rivers there has been an improving Trend.

Data Confidence: DELWP reports that Victoria has the most comprehensive and detailed data on riparian cover and extent of any state. The 2010 Index of Stream Condition data remain relevant for contemporary broad-scale assessments such as this one. The Riparian Intervention Monitoring Program evaluates management effectiveness in relation to changes in vegetation cover and extent.

Summary of SoE 2018 Report assessment

- Results of the SoE Report 2013 had highlighted that 21 of 29 river basins had less than 50% of assessed river length with riparian vegetation in good condition.
- Riparian zone removal and degradation in Victoria is due to channelisation of drainage and agricultural activity alongside rivers.
- The loss of riparian vegetation exposes the water surface to more sunlight, encouraging the growth of algae and potentially of algal blooms.
- Management actions under the Riparian Intervention Monitoring Program established in 2014 at 12 sites led to improved vegetation cover, increased species richness, decreased weed cover and increased woody vegetation.

The 2019–20 bushfires: Impacts and responses

Table 54 shows the change in vegetation cover and sediment delivery before and after the 2019–20 bushfires in 13 sub-catchments of the Cudgewa Creek (catchment area 797 km²) in the North East CMA region (the fire extent covered 22% of the region⁵⁸⁸). Of the 13 sub-catchments, 10 experienced reductions in vegetation cover and increased sediment delivery. Estimated sediment flows from simulations were very high in the first year after the fire but at reduced levels in the second year for most of the sub-catchments.

588. Joehnk K, Bisweas T, Karim F, Kumar A et al. 2020, 'Water quality responses and mitigation options for post 2019–20 bushfires floods in south eastern Australia: a catchment scale analysis', technical report for the CSIRO Strategic Bushfire Project 2020, Australia.

Wetlands and rivers

Table 54: Pre- and post-fire vegetation cover in the 3 sub-catchments of Cudgewa Creek, Upper Murray.⁵⁸⁹

Catchment	Area (ha)	Vegetation Cover (%)			Sediment Delivery (Tonne/ha)			Slope (%)
		11/2019	2/2020	3/2020	PRE-FIRE	POST-FIRE YEAR 1	POST-FIRE YEAR 2	
1	5,193	94.1	85.7	89.7	0.77	2.50	0.93	2.95
2	9,398	95.6	95.0	96.3	0.74	0.74	0.74	4.15
3	4,219	96.4	95.8	96.1	1.14	1.57	1.19	3.40
4	4,762	93.8	92.5	94.6	0.62	0.72	0.64	2.09
5	6,976	93.7	88.0	92.4	2.58	5.13	3.52	0.96
6	7,285	95.6	76.3	84.6	1.67	19.86	2.96	5.14
7	6,469	97.2	87.9	91.6	1.94	9.21	2.93	1.83
8	3,155	96.1	86.0	89.4	1.89	9.51	3.08	2.25
9	5,395	94.3	78.6	85.0	3.05	17.31	4.82	1.13
10	8,599	94.8	77.3	85.9	1.68	9.98	2.30	0.43
11	5,864	94.1	77.6	86.8	1.17	6.95	1.68	0.37
12	7,317	91.0	76.8	81.0	2.07	7.69	2.38	0.27
13	5,091	95.2	75.8	84.3	1.65	13.96	2.57	2.67

The 2019-20 bushfires impacted more than 430,000 hectares or 22% of the North East CMA's region in the Upper Murray. In response, the Authority's bushfire recovery program is focussing 'on restoring sites of prior CMA investment, helping address threats to public infrastructure and the recovery of fish populations in severely impacted waterways. Activities funded by the program include fencing, revegetation, woody weed control, bank stabilisation and targeted in-stream habitat structures.'⁵⁹⁰

Projects in Cudgewa Creek and Nariel Creek include the construction of log jams and boulder beds to simulate natural conditions, initiating scour and improving water flow and habitat. A large fishway is also being built on the Cudgewa Creek to enhance movements of the Murray cod. The Cudgewa project is a partnership between the Authority, OzFish and the Corryong Angling Club and also includes revegetation, weed control, fencing and barrier removal.

Challenges that have been faced by the North East CMA during bushfire recovery include:⁵⁹¹

- the long-term nature of bushfire recovery (at least five years) in contrast to the short-term funding. Longer-term funding is required to ensure initial on-ground works (in the first two years) are maintained and to respond to calls for assistance from landholders (the bushfires shocked landholders because their living memory is one of reliable rainfall and no bushfires (not since 1939)
- difficulty in obtaining a supply of climate-ready seeds for restoration
- although riparian vegetation along Nariel Creek has, through Authority programs, increased from 10% to 60%, some Upper Murray landholders are reluctant to fence and revegetate because they rely on streams for their stock to access water (there are few dams and limited water reticulation).

589. Ibid

590. North East Catchment Management Authority 2021, 'Bushfire recovery summary update May 2021', Wodonga, Victoria.

591. Information supplied by the North East Catchment Management Authority.

SoE Biodiversity Update 2021 Report assessment

Riparian vegetation adjoining freshwater rivers, streams and wetlands is critical habitat for many native plants and animals and can also reduce the impact of floods. However, along many waterways, riparian vegetation has been removed or is degraded by weeds and stock access. Uncontrolled grazing leads to destabilised banks and erosion, the introduction of weeds, soil compaction and excessive nutrients. Weeds such as willow and blackberry outcompete native species, while habitat fragmentation reduces connectivity and species dispersal.

The five-year Regional Riparian Action Plan 2015–20 accelerated on-ground works to improve riparian vegetation and was underpinned by the Riparian Intervention Monitoring Program, a partnership between DELWP with the Arthur Rylah Institute, catchment management authorities and Melbourne Water. The program's second progress report was released in 2020.

The Riparian Intervention Monitoring Program has instituted changes in riparian management monitoring sites – livestock exclusion, revegetation and woody weed control – in each CMA region.⁵⁹² For each intervention site there is a control site where there has been no change in management. The results from the monitoring sites, including increases in vegetation cover and native species richness, and decreases in woody weed abundance, are summarised in Table 55 and show improvements in each feature at the sites where management has been changed and the improvements exceed or are the reverse of changes at the control sites.

The Regional Riparian Action Plan 2015–2020 involved catchment management authorities working with more than 1,500 landholders and approximately 600 Traditional Owner, Landcare, angling, school and community groups.

Outcomes of the plan included the protection and improvement of nearly 3,500 kilometres of riparian land (140% of the five-year action plan target) and more than 53,000 hectares of riparian land (190% of the five-year target).⁵⁹³ The Regional Riparian Action Plan has been replaced by the Rivers and Riparian Action Plan 2021,⁵⁹⁴ which will run until 2024 and aim to continue improvements in the health of rivers and riparian lands through the implementation of eight initiatives:

- Flagship Waterway projects - Nine new flagship waterway projects commencing in 2021 will focus on improving riparian and aquatic habitats of nine additional key waterways with an emphasis on partnerships with Traditional Owners and community engagement.
- Gippsland Lakes - support the Gippsland Lakes Coordinating Committee, on-ground works by the East and West Gippsland catchment management authorities and the Gunaikurnai Land and Waters Aboriginal Corporation, implementation of the Gippsland Lakes Ramsar Management Plan and the Gunaikurnai Whole-of-Country Plan for Tatungalong Country, and the Gippsland Lakes Priority Plan.
- Ramsar wetlands - undertake management activities from Ramsar management plans such as pest plant and animal control, revegetation, and other wetland restoration activities, and monitoring to track ecological character.
- Major environmental water works in northern Victoria - construction of projects to support native fish and high-value wetlands in the regions of the North East, North Central, Goulburn Broken and Mallee catchment management authorities.
- Iconic urban waterways - continue to improve management of the Yarra, Barwon, Maribyrnong and Werribee rivers and other urban waterways in the west of Melbourne.
- Bushfire Recovery - restoration of waterway and catchment assets damaged by the 2019–20 bushfires.
- Water for the environment - to maintain the health of rivers, estuaries and wetlands.
- CMA water statutory functions.

592. Mole B, Morris K, Moloney P, Sparrow A et al. 2020, 'Riparian intervention monitoring program, second progress report', unpublished client report for Water and Catchments, DELWP, Arthur Rylah Institute, Heidelberg, Victoria.

593. DELWP 2015, 'Regional riparian action plan 2015–2020', East Melbourne, Victoria <https://www.water.vic.gov.au/waterways-and-catchments/riparian-land/riparian-land/how-is-riparian-land-managed/regional-riparian-action-plan> Accessed 8 May 2021.

594. DELWP 2021, 'Rivers and riparian action plan 2021', East Melbourne, Victoria.

Wetlands and rivers

Catchment management authorities have worked with anglers in the four-year Angler Riparian Partnerships Program 2017–20. The program, also part of the Regional Riparian Action Plan 2015–2020, involved 156 angling clubs and community groups and 1,045

people, planted 41,555 native trees and shrubs, carried out 39 projects on 30 waterways, controlled weeds on 174 hectares, constructed 12 kilometres of fencing, improved 70 kilometres of riparian land and removed four truckloads of rubbish.⁵⁹⁵

Table 55: Riparian Intervention Monitoring Program site responses.⁵⁹⁶

Feature	Intervention Site Response	Control Site Response
Bare ground	Decreased proportionally by ~41%	Increased proportionally by ~61%
Organic litter	~78% increase	~31% increase
Native vegetation cover	~37% increase	~14% increase
Density of native woody recruits	Increased proportionally by over 1,600%	Decreased proportionally by ~66%
Native vegetation cover	~6% decrease, likely due to removal of woody weeds	Remained constant
Stem density of native tree or woody shrubs	Increased proportionally by over 600%	Decreased proportionally by ~42%
Number of native taxa	Increased proportionally by ~76%	Relatively unchanged

Table 56 lists the stock exclusion actions in the East Gippsland CMA's Waterway Goal 2014–2022.⁵⁹⁷ Targets for 2022 for fencing and stock exclusion in far East Gippsland and the Gippsland Lakes and Snowy River are almost met.

Table 56: Stock exclusion in the East Gippsland Catchment Management Authority waterway goal 2014–2022.⁵⁹⁸

Waterway Goal	Total Length (km)	Goal Achieved (%)
The Mitchell River above Glenaladale Bridge will have an additional 50km completed	50	50
The Nicholson River will be excluded from grazing stock	64	64
The Tambo River, below Ramrod will have an additional 40km of fencing constructed	40	16
The Mitchell River estuary below Picnic Point will be excluded from grazing stock	36	77
Freehold sections of the Buchan and Brodribb Rivers will be fenced	92	91
All rivers in the Far East catchment will be excluded from stock	90	93
Five priority wetlands fringing the Gippsland Lakes or Snowy River will be excluded from stock (No.)	5	100

595. DELWP 2020, 'Angler riparian partnerships program: statewide achievements in 2019/20 and program finale', East Melbourne, Victoria.

596. Mole B, Morris K, Moloney P, Sparrow A et al. 2020, 'Riparian intervention monitoring program, second progress report', unpublished client report for Water and Catchments, DELWP, Arthur Rylah Institute, Heidelberg, Victoria.

597. East Gippsland Catchment Management Authority 2020, 'Annual report 2019–2020', Bairnsdale, Victoria.

598. Ibid

Wetlands and rivers

As part of its Target One Million program to increase the number of recreational fishers in the state, the Victorian Government amended the *Land Act 1958* to allow camping on Crown land that has grazing licences and licensed river frontage. This was to deliver a 2018 Victorian election commitment to encourage families and their friends to spend more time outdoors. Draft regulations to manage this access were open to public consultation in March and April 2021 and have been in place since 1 September 2021.

Water frontages to rivers, creeks, stream, watercourses, lakes, lagoons, swamps and marshes are found on both private and Crown land in Victoria. The Crown land component, to which the new regulations apply, represents about 18% of Victoria's 170,000 kilometres of water frontages, and is a mix of management by Parks Victoria, DELWP, local councils and committees of management. Some water frontages are licensed to adjoining landholders under more than 10,000 Crown Water

Frontage Licences for agricultural, riparian and conservation management. Table 57 summarises the number of Crown Water Frontage Licences as at July 2018, with most licences and the largest area in the agriculture primary productive category. However, riparian management licences cover more than 8,000 hectares.

The Victorian Farmers Federation expressed concerns that the 'proposed regulations pose an unacceptable risk to landholder privacy and safety, to farm biosecurity and to the environment' and urged changes that would protect farmer privacy and safety, and the environment, biosecurity and emergency access.⁵⁹⁹ The Victorian National Parks Association argued that camping 'access should be the exception and not the norm' and 'avoids significant and sensitive habitats, and that is also practical and avoids conflict' and only occurs 'in areas which have had a proper boundary survey and assessment for ecological impact.'⁶⁰⁰

Table 57: Crown water frontage licences as at July 2018.⁴⁰¹

Crown Water Frontage Licences	Number	Area Grazed (ha)	Area Cropped (ha)	Area Non-Productive or Conservation (ha)	Total Area (ha)
Agricultural – primary productive	8,818	36,855	360	10,745	47,992
Agricultural: non-productive	152	135	0	547	682
Riparian Management Licence	1,112	0	7	6,362	8,439
Conservation Licence	123	0	0	749	749
Total	10,205	39,055	367	18,403	57,862

599. Victorian Farmers Federation, 'Protecting your rights: fair river camping rules', Melbourne, Victoria <https://www.vff.org.au/contact/>, Accessed 14 May 2021.

600. Victorian National Parks Association 2021, 'Submission to public consultation on Victoria's Land (Regulated Watercourse Land) Regulations', Carlton, Victoria.

601. Ibid

Wetlands and rivers

Indicator B:11 Area of functional floodplain

Region Statewide Measures Change to floodplain area as a natural approach to mitigate, and reduce the risk, of flood and drought impacts and provide refuge to plants and animals during extreme weather events Data Custodian DELWP; Catchment management authorities; Victorian Environment Water Holder	Indicator Performance: 2018: Unable to be assessed due to Unknown Status and Trend and Low Data Confidence 2021: Not assessed Why this indicator? Strengthening the capacity of ecosystems to deal with climate extremes is a key management strategy for minimising the adverse effects of climate change on flora and fauna.	2018 Status	2018 Trend	2018 Data
		2021 Status	2021 Trend	2021 Data

Potential thresholds for status in the SoE 2023 report

Good: Regulation, supporting and cultural functions returned to >75 to 100% of floodplains

Fair: Regulation, supporting and cultural functions returned to >50 to <75% of floodplains

Poor: Regulation, supporting and cultural functions returned to <50% of floodplains

OR

Good: >75 to 100% of floodplains are flooded in natural cycle time frames that mirror natural cycles

Fair: >50 to <75% of floodplains are flooded in natural cycle time frames that mirror natural cycles

Poor: <50% of floodplains are flooded in natural cycle time frames that mirror natural cycles

Why this assessment in 2021?

Status: Floodplains, like their river channels, have been degraded over many years and, although there are efforts to restore parts of some of them, it will require a long-term and comprehensive program of action to begin to improve their Status. However, difficulties in interpreting this indicator and its measures have led to an 'Unknown' status.

Trend: Unknown.

Data Confidence: There was a lack of data for this indicator's assessment in the SoE 2018 Report. Data at state-scale is still unavailable to determine floodplain functionality.

Should this indicator be used in the SoE 2023 report?

Not in its current form. It is an indicator that is difficult to interpret. There are no data other than environmental water delivery, which does not target floodplains i.e. overbanking flows are not the objective. Floodplains contain wetland and riparian biodiversity, so this cuts across existing indicators (B:09, B:10; B:14; B:16; B:17). Consideration could be given to dropping this from the Biodiversity chapter of the SoE 2023 report and merging its narratives with the assessments of other river and wetland indicators. Alternatively, it could be retitled and become focussed on 'Trends in biodiversity outcomes from environmental water delivery'.

Summary of SoE 2018 Report assessment

- Future predictions under climate change suggest an increasing intensity and frequency of floods and drought.
- Floodplains are potential drought refuges as they are cooler and have localised microclimates and greater water availability through groundwater and flooding. Frequently flooded sites had healthier vegetation
- Floodplains with high vegetation productivity have greater resistance to climate change impacts such as drought.

The 2019–20 bushfires: Impacts and responses

The heat from fires can increase water temperatures in rivers and wetlands and impact fish and other aquatic life, while ash, sediment and debris in runoff from post-fire rain reduces water quality, smothers aquatic habitats and reduces food sources. After the 2019–20 fires, a freshening flow of environmental water was released into the Buffalo River by the North East CMA and Goulburn-Murray Water to improve water quality, move sediment and scour biofilm from rocks and timber.⁶⁰²

⁶⁰² Victorian Environmental Water Holder, 'Reflections: water for the environment in Victoria 2019–20', Melbourne, Victoria.

SoE Biodiversity Update 2021 Report assessment

Floodplains serve many functions that include:

- Regulation functions: Flood storage and conveyance; groundwater recharge; water filtration; soil formation; soil retention; buffer protection; micro-climate regulation; greenhouse gas regulation; water treatment
- Supporting functions: Bird habitat; fish habitat; frog habitat; floodplain vegetation
- Cultural functions: heritage; aesthetics; recreation.⁶⁰³

The functionality of floodplains has been dramatically impacted by the regulation of rivers – dams, weirs and irrigation infrastructure – to supply water for expanding urban, agricultural and industrial uses. This has degraded aquatic habitats, increased sedimentation of wetlands, encouraged blackwater and cold-water pollution, increased salinity and nutrients and reduced the volume of water flowing through the system.

Floodplains have been shown to be drought refuges for native flora and fauna because they are cooler, with localised microclimates and larger volumes of water available when compared with adjoining land. Research by Selwood et al. (2015) found that during drought, fewer bird species declined in floodplain zones compared to non-floodplain zones.⁶⁰⁴

The focus of governments when improving floodplain functionality has been the adjustment of water allocations and the introduction of water-saving measures to make water available for environmental flows. These are aimed at helping restore degraded aquatic habitats by restoring more natural watering cycles.

At the end of each year the Victorian Environmental Water Holder releases its seasonal watering plan to outline where and how much environmental water is to be delivered in the coming year.

At the end of 2019–20, the achievements⁶⁰⁵ included:

- delivery of about 890,227 ML of environmental water (includes 596,308 ML of water made available by the Commonwealth Environmental Water Holder and 38,428 megalitres by the Living Murray program)
- delivery of water for the environment to 168 river reaches and wetlands in Victoria
- of the top 50 Victorian recreational fishing reaches, 27 of the 28 that can receive environmental flows did receive water
- 82% of environmental flows delivered in northern Victoria were re-used to meet downstream environmental water needs
- at least 70 species benefitted from watering events and 28 vulnerable or threatened species were supported by environmental flow deliveries
- of the six Ramsar sites that can receive water for the environment, five were watered
- at least 11 environmental watering activities were delivered and/ or monitored in partnership with Traditional Owners.

DELWP released a 2020 report card on progress implementing the Murray-Darling Basin Plan in Victoria's northern wetlands and rivers. The focus of the report card was on the benefits of environmental watering, although complementary measures such as the control of stock grazing, feral animals and weeds, and the installation of fishways were also important actions. The environmental watering program can only be conducted in the rivers that are regulated. Figure 53 shows the location of these northern rivers and the biodiversity monitored – fish, waterbirds, frogs and other fauna and vegetation – at several sites along each. It should be noted that these sites are not part of an ongoing monitoring program and for 2021-24 and beyond they may change depending on the projects and the knowledge that is needed. Table 58 summarises some of the reported results of environmental watering for fish, waterbirds, frogs, other fauna and vegetation. Although there are several exceptions, the results reported were generally positive.

603. Peters G 2016, 'Identifying and valuing the functions of floodplains', 2016 Floodplain Management Association National Conference, Nowra, Floodplain Management Australia, Sydney, NSW.

604. Setwood K, Thomson J, Clarke R, McGeoch M et al. 2015, 'Resistance and resilience of terrestrial birds in drying climates: do floodplains provide drought refugia?' *Global Ecology and Biogeography*, 24, pp. 838–848.

605. Victorian Environmental Water Holder, 'Reflections: water for the environment in Victoria 2019–20', Melbourne, Victoria.

Wetlands and rivers

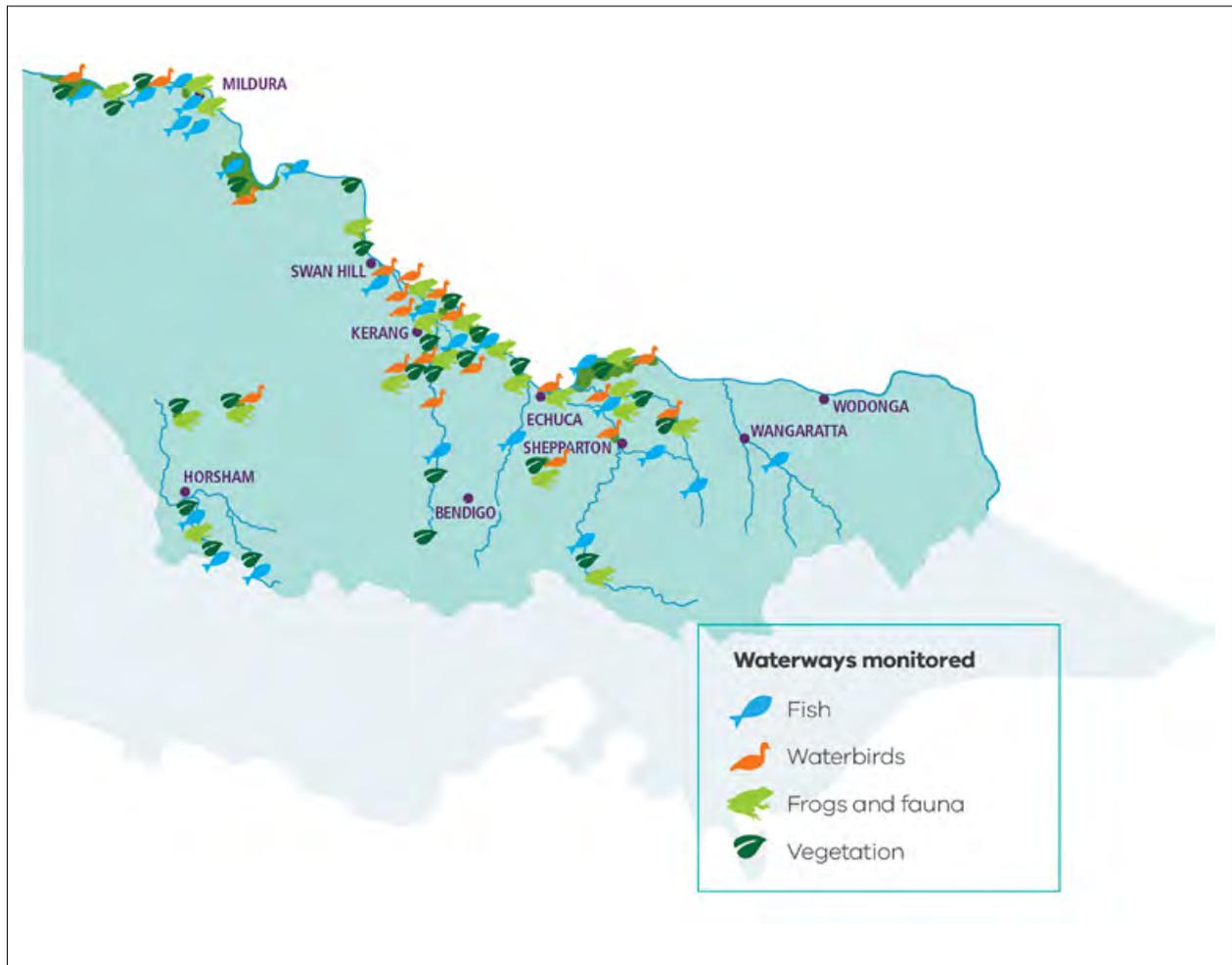


Figure 53: Northern wetlands and rivers monitored.⁶⁰⁶

606. DELWP 2020, 'Victoria's basin plan report card 2020', East Melbourne, Victoria.

Wetlands and rivers

Table 58: Selected results of environmental watering in Victoria's northern rivers.⁶⁰⁷

Biodiversity	Results	Objective Protected or Restored	Objective not Achieved or Mixed Result
Fish	Improved abundance of native fish Enhanced fish species richness Enable fish movement Improved spawning and recruitment of native fish	Campaspe River: Native fish abundance increased Gunbower Creek: Evidence of recruitment of five native fish species	Cardross Lake and Lake Hawthorn: Colonised by Murray hardyhead before Millennium Drought but none have been captured in recent sampling
Waterbirds	Increasing waterbird abundance, diversity, habitat and breeding Internationally important wetlands and migratory birds	Hattah Lakes: Breeding improved Barmah Forest: Increased numbers of cormorants breeding	McDonalds Swamp: Although high waterbird abundance and diversity, waterbird habitat not in the best condition
Frogs and other fauna	Frog abundance and diversity maintained or recovering Turtle habitat maintained and breeding stimulated	Wimmera River: Platypus expanded distribution Barmah Forest: Increased turtle populations	Carapugna Wetland: Received environmental water in spring 2018 and 2019 but it was insufficient to support large numbers or a diversity of frogs
Vegetation	Wetland vegetation condition improved Condition of black box, river red gum, shrub and lignum communities improved Riparian vegetation condition	Hattah Lakes: Improvement in floodplain vegetation	Lindsay, Mulcra and Wallpolla Islands: Extent and condition of water- dependent vegetation declined across the site

A more detailed account of the benefits of environmental watering in Victoria's northern rivers accompanied the report card.⁶⁰⁸ The environmental watering program has six key objectives that are listed in Table 59, which also includes data on indicator trends and data quality. The status of objectives is represented by four categories – Improved; Maintained; Declined; Unknown – that is based on four categories of data: Not enough; Limited; Adequate; High quality. For this report, the various indicators from the assessment have been grouped into seven categories:

- Fish: abundance; distribution; diversity; dispersal; recruitment; habitat; spawning; reproduction; native fish
- Frogs: abundance; breeding; diversity
- Trees: condition; survival; recruitment
- Vegetation: cover; diversity; recruitment; growth and survival; lignum condition; black box condition
- Vegetation: fringing; emergent; instream; herbaceous; riparian; riparian seed dispersal

- Waterbirds: habitat; breeding; diversity; abundance; threatened
- Flow management: delivery of environmental water.

Table 59 summarises the indicator assessments and the quality of their data in relation to the six key objectives. Under each of the objectives, fish indicators generally showed improvement or were maintained, while data ranged from limited to adequate. 'Unknown' was the main result for the frog indicators, for which there were insufficient or limited data. Tree condition had mixed results and had to rely on limited data and expert opinion. Vegetation cover was largely maintained or improved, with data quality ranging from limited to high-quality. Riparian and instream vegetation was either improved or maintained, based on data of mostly high quality. The majority of waterbird indicators showed improvement or maintenance, although the data ranged from limited to adequate. As would be expected, waterflow management (delivery of environmental water) was improved and with high data quality in each of the 47 waterways monitored under the mitigation objective.

⁶⁰⁷. Ibid

⁶⁰⁸. DELWP 2020, 'Achievement of environmental outcomes in northern Victoria's waterways', report to meet Murray-Darling Basin Plan Schedule 12 Matter 8 obligations, East Melbourne, Victoria.

Wetlands and rivers

Table 59: Objectives, indicators and data quality in the Long-term Water Resource Assessment.⁶⁰⁹

Objective	Indicator Trend				Data Quality			
	Improved	Maintained	Declined	Unknown	1	2	3	4
To protect and restore biodiversity dependent on Basin water resources, including ecosystems supporting threatened species or communities, their life cycles, and representative populations and communities of native biota.								
Fish	13	5			1	6	9	2
Frogs	4	12	4	18	17	16	5	
Vegetation	13	15	2			25	4	1
Vegetation: riparian and instream	15	6	3				3	21
Waterbirds	19	9	3	2	5	22	5	1
To protect refugia in order to support the long-term survival and resilience of water-dependent populations of native flora and fauna.								
Fish	7	1	1	1	2	5	3	
Frogs			1	22	22	1		
Tree		8	2			10		
Vegetation	7	5	1			10	2	1
Vegetation: riparian and instream	15	6				1	1	19
Waterbirds	2	1					3	
To protect and restore in-stream and floodplain processes including flow components and inundation and recession events that meet ecological requirements (e.g. habitat diversity, recruitment, regeneration, dispersal, movement, migration, food webs).								
Fish	13	7			3	4	11	2
Frogs	1	2				1	2	
Tree	3	10	7			20		
Vegetation	3	3					1	5
Vegetation: riparian and instream	2						1	1
Waterbird	1	5			1	1	1	3
To protect and restore connectivity within and between water-dependent ecosystems – longitudinally along watercourses, laterally between watercourses, floodplains and wetlands, and vertically between surface and subsurface.								
Fish	6	4			2	1	6	1
To mitigate human-induced threats such as impacts of alien species, water management activities and degraded water quality								
Fish	4	1	2			4	3	
Vegetation	12	7				8	5	6
Waterbirds	2					2		
Water flow management	47							47
To protect and restore water-dependent ecosystems that support species listed under JAMBA, CAMBA, ROKAMBA, Bonn Convention.								
Migratory shorebirds	1	2			1	2		
Waterbird diversity	2	1	1			3	1	

Data quality: 1. Not enough data available to make an assessment; 2. Limited evidence and expert opinion-based assessments; 3. Adequate data to make a qualitative assessment; 4. High-quality data able to make a quantitative assessment.

Wetlands and rivers

The delivery of environmental water is focussed on the river channel and associated wetlands. Any overbank flows on to the floodplain are unintentional, except in the case of one release, with the landowner's consent, to a small, privately owned wetland along the Loddon River.⁶¹⁰ Examples of connecting floodplains are mostly via works or pumps, such as at Mulcra Island, where flows are delivered through an anabranch and with a regulator to back flows up onto the floodplain, a similar approach to weir raising on the Murray River.

Fitzsimons et al. (2011) found that there were at least 110 EVCs, 124 rare or threatened plant species and 62 threatened vertebrate species taxa (excluding fish) dependent on flooding⁶¹¹ of the Murray, Goulburn, Ovens and King rivers in northern Victoria. For approximately 30 classes, a flood every two years was critical.

There were variable responses from floodplain plants in the semi-arid Hattah-Kulkyne National Park to an environmental flow. The aim of the flow was to replicate a one-in-eight-year flood event. Moxham et al. (2018) found that '52.9% of terrestrial damp plant taxa showed a short-term increase in occurrence in response to the environmental flow, which translated into similar responses in some functional groups. However, nearly half of the plant taxa that increased then demonstrated a decline by 18 months after the flow event.'⁶¹²

An analysis by Williams and Grafton (2019) of expected return flows from government-subsidised infrastructure for increasing irrigation efficiency found that it may have 'resulted in smaller increases in net stream and river flows than is estimated by the Australian Government, and may even have reduced net stream and river flows.'⁶¹³

The Wentworth Group of Concerned Scientists compared observed river flows with expected river flows at 27 key sites under the Murray-Darling Basin Plan for the period 2012–19.⁶¹⁴ The analysis, released in August 2020, found that after accounting for dry and drought periods, flows at 24 of the 27 sites were lower than expected, and that 20% of the water expected did not flow past the sites. The analysis also compared the expected and observed flows upstream of Ramsar-listed wetlands. In Victoria it was estimated that the river upstream of the Hattah-Kulkyne Lakes received 77% of expected flows, Gunbower Forest 75% and Lake Albacutya 41%. However, under the analysis, the Kerang Wetlands received 128% of expected flows and Barmah Forest 92%. Possible reasons for the shortfall included higher than expected evaporation, upstream environmental water extraction, diversion into upstream dams and floodplain harvesting, and the expected yield of environmental water being lower in reality.

Another analysis⁶¹⁵ by Chen et al. (2020) compared the Commonwealth Environmental Water Office (CEWO) environmental flows from 2014–15 to 2018–19 with expected vegetation outcomes in the Basin-wide Environmental Watering Strategy. The analysis found that:

- 20% of water releases were as floods, 80% were delivered as in-channel flows
- just 12% of river gums forests received their expected floodwaters, and half of the flows were unlikely to provide ecological benefits
- only the low-lying parts of the floodplain were being watered, with vegetation like black box woodland (which grows on higher ground) not receiving any water.

610. Information supplied by DELWP Waterways Division.

611. Fitzsimons J, Peake P, Frood D, Mitchell M et al. 2011, 'Flooding requirements for biodiversity values along the Victorian floodplain of the Murray Valley', *The Victorian Naturalist*, 128, pp. 48–85.

612. Moxham C, Kenny S, Beesley L and Gwinn D 2019, 'Large-scale environmental flow results in mixed outcomes with short-term benefits for a semi-arid floodplain plant community', *Freshwater Biology*, 64(1), pp. 24–36.

613. Williams J and Grafton Q 2019, 'Missing in action: possible effects of water recovery on stream and river flows in the Murray–Darling Basin, Australia', *Australasian Journal of Water Resources*, 23(2), pp. 78–87.

614. Wentworth Group of Concerned Scientists 2020, 'Assessment of river flows in the Murray-Darling Basin: observed versus expected flows under the Basin Plan 2012-2019', Sydney, NSW.

615. Chen Y, Colloff M, Lukasiewicz and Pittock J 2020, 'A trickle, not a flood: environmental watering in the Murray–Darling Basin, Australia', *Marine and Freshwater Research*, 71, DOI: 10.1071/MF20172.

616. Information from DELWP Waterways Division.

617. Baumgartner L, Gell P, Thiem J, Finalyson C et al. 2020, 'Ten complementary measures to assist with environmental watering programs in the Murray–Darling river system', *River Research and Applications*, 36, pp. 645–655.

Wetlands and rivers

The authors concluded that: 'Environmental water delivery has not supported floods of the magnitude, duration and extent required to maintain or improve the condition of wetlands [including floodplains] and their woody vegetation communities.'

However, Sustainable Diversion Limits only came into effect in July 2019 when the full amount of basin plan water was not yet available, and operational constraints continue to limit the ability to deliver overbank flows. Even with constraints lifted to targeted levels, there will still be extensive areas of floodplain that cannot be watered through managed events.⁶¹⁶

Baumgartner et al. (2020) argue that although returning water to floodplains will have positive outcomes, on its own the intervention will 'not be enough to deliver the desired environmental benefits of the reform given the significantly altered state of the catchment.'⁶¹⁷ They proposed 10 complementary measures to integrate recovery actions and enhance water reform, and these are:

Measure 1: Integrated aquatic pest control

Measure 2: Sustainable agricultural infrastructure

Measure 3: Habitat restoration

Measure 4: Addressing cold water pollution

Measure 5: Enhancing fish passage

Measure 6: Enhancing nutrient cycles

Measure 7: Improving sediment transport

Measure 8: Addressing salinity

Measure 9: Re-establishing threatened species

Measure 10: Integrating complementary measures into basin scale flow delivery strategies.

Wetlands and rivers

Indicator B:12 Threatened native frog species

Region Statewide Measures Number, abundance and distribution Data Custodian DELWP	Indicator Performance: 2018: 2021:	2018 Status 2018 Trend 2018 Data
	Why this indicator? There have been declines in the populations of native frog species (threatened and nonthreatened species) over the past few decades. Three frog species have been the priority in bushfire response and recovery projects.	2021 Status 2021 Trend 2021 Data

Potential thresholds for status in the SoE 2023 report

Good: Significant increasing trend in the abundance and distribution of threatened native frog species, and threats are being monitored, reported and mitigated

Fair: Stable or small increasing trend in the abundance and distribution of threatened native frog species, and threats are in part being monitored, reported and mitigated

Poor: Significant declining trend in the abundance and distribution of threatened native frog species, and threats are not being monitored, reported or mitigated

Why this assessment in 2021?

Status: Frogs across Australia are in peril and their status remains Poor.

Trend: The Trend of frog populations is continuing to deteriorate.

Data Confidence: Frog populations are the focus of considerable research.

Should this indicator be used in the SoE 2023 report?

Yes, however, consideration could be given to merging it with the indicators for individual frog species (B:04D, E and F).

Summary of SoE 2018 Report assessment

- There had been declines in the abundance of native frog species (threatened and non-threatened species) over the past few decades.
- There were 37 amphibian species in Victoria, with 17 frog species listed as threatened.
- In the last 20 years, the number of threatened frog species on the Flora and Fauna Guarantee Act List doubled.
- Although fires, predation, climate change and habitat loss are all factors in frog decline, the main driver is the chytrid fungus, which was introduced to Australia in the 1970s.

The 2019–20 bushfires: Impacts and responses

Frog populations in eastern and north-eastern Victoria were impacted by the 2019–20 bushfires. An estimated 96% of the southern barred frog's modelled habitat was inside the fire extent, although the frog has not been seen since 1982. The large brown tree frog had 88% of its modelled habitat inside the fire extent, with 47% subjected to high-severity fire. The giant burrowing frog had 78% of its modelled habitat inside the fire extent and 38% subjected to high-severity fire. Figure 54 maps the modelled habitat distribution of the giant burrowing frog and the fire extent, with the darker colours indicating areas of relatively higher habitat suitability compared to the lighter colours.

Wetlands and rivers

Table 60 lists each of the frog species impacted by the bushfires. The table presents data on the percentage of their modelled habitat inside the fire extent, the percentage of that habitat impacted by high-severity fire, and information about localised impacts. For example, all known populations of the large brown tree frog were inside the fire extent.

Research by the Australian Museum, using the observations of thousands of citizen scientists in NSW, indicates that many frog species might have survived the 2019–20 bushfires. Before the fires there were 2,655 observations of 66 species, compared to 632 observations of 45 frog species after the fires.⁶¹⁸ The researchers saw this result as a positive, however they added that ‘the population-level and longer-term consequences of the fires remain unknown, as does the ability of frogs to persist with the changing fire regimes predicted as a consequence of global climate change.’⁶¹⁹

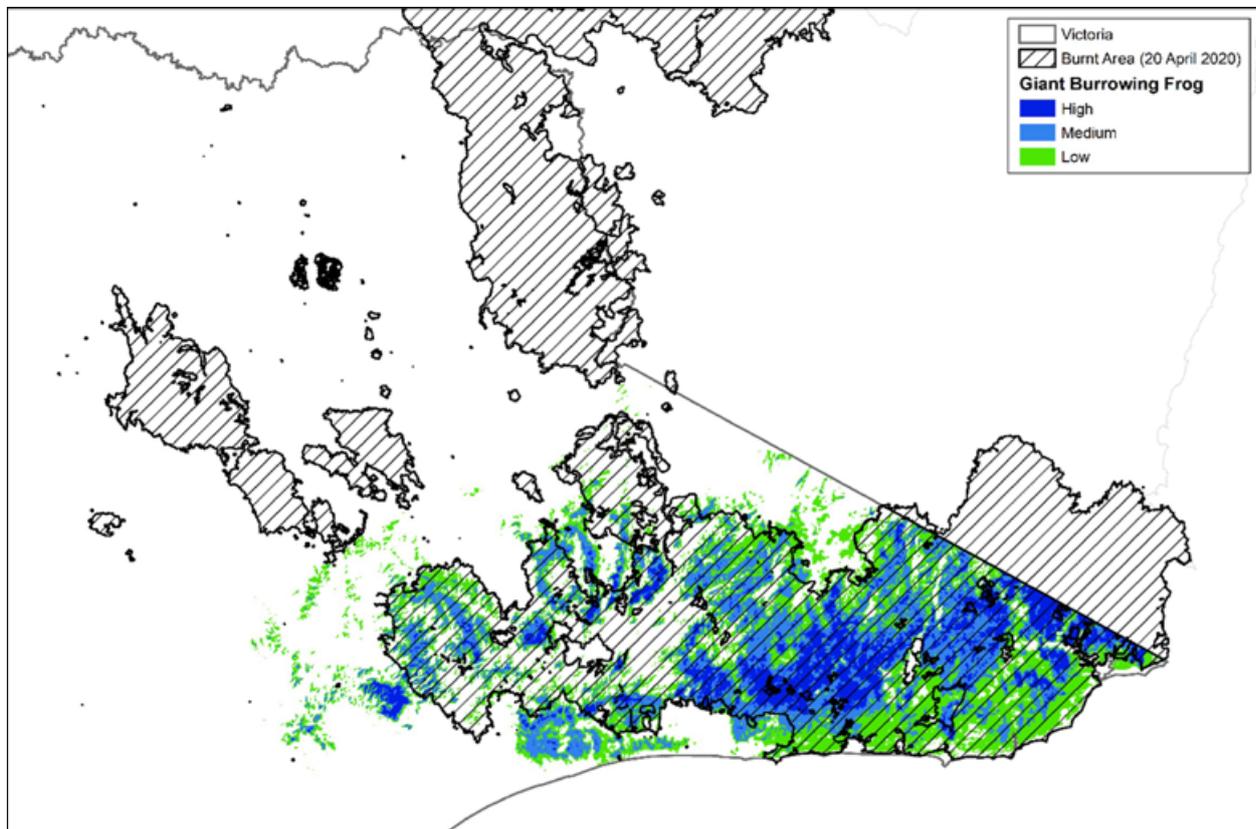


Figure 54: Modelled distribution of giant burrowing frog for south eastern Australia and current fire extent as at 20th April 2020.⁶²⁰

⁶¹⁸ Rowley J, Callaghan C and Cornwell W 2020, 'Widespread short-term persistence of frog species after the 2019–20 bushfires in eastern Australia revealed by citizen science', *Conservation Science and Practice*, 2(11), doi:10.1111/csp2.287.

⁶¹⁹ Ibid

⁶²⁰ DELWP 2020, 'Victoria's bushfire emergency: biodiversity response and recovery, version 2', East Melbourne, Victoria.

Wetlands and rivers

Table 60: Amphibian species of most concern impacted by the 2019–20 fires.⁶²¹

Species Impacted by Fire	% Modelled Habitat in Fire Extent	% Modelled Habitat Impacted by High Severity Fire	Localised Impact
Alpine tree frog	15	8	
Blue mountains tree frog	66	32	
Booroolong tree frog	39	13	2 of 3 populations impacted
Dendy's toadlet	46	23	
Giant burrowing frog	75	38	
Green and Golden Bell Frog	53	24	Populations around Mallacoota may be impacted. Some individuals observed in Cape Conran National Park since fires.
Keferstein's tree frog	84	53	
Large brown tree frog	88	47	All known populations may be impacted
Leaf green tree frog	66	34	
Martin's toadlet	31	13	Over 30% of Gippsland populations may be impacted
Southern barred frog	96	Unknown	No confirmed records in Victoria since 1982. All known (pre-1982) sites have been impacted.
Spotted tree frog	22	13	Four significant populations impacted by high severity fire

SoE Biodiversity Update 2021 Report assessment

Chytrid fungus is the prime driver of the decline in 43 Australian frog species, including a possible seven extinctions.⁶²² According to the Ecological Society of Australia, 'Preventing further extinctions requires improved biosecurity and the development of effective mitigation. Potential strategies include

increasing an individual's capacity to withstand infection (e.g. probiotics), reducing environmental suitability for chytrid fungus (e.g. altering water salinity), or reducing other threats (e.g. increase breeding and survival to outweigh deaths caused by the disease).⁶²³

621. Ibid

622. Ecological Society of Australia, 'Amphibian chytrid fungus: impacts on Australian frogs and ongoing conservation challenges', Canberra, Australia <https://www.ecolsoc.org.au/?hottopic-entry=amphibian-chytrid-fungus-impacts-on-australian-frogs-and-ongoing-conservation-challenges> Accessed 8 May 2021.

623. Ibid

Wetlands and rivers

Skerratt et al. (2016) identified seven frog species that, due to the chytrid fungus, faced a high risk of extinction. They included two in Victoria, the Baw Baw frog *Philoria frosti* and the spotted tree frog *Litoria spenceri*. Another 22 species were viewed as having a moderate to low risk of extinction. They urged funding to implement the following management actions:

- surveying to determine the entire species distribution and conservation status
- monitoring the species to detect any change in conservation status
- assessing the threat of chytridiomycosis to the conservation of the species
- developing husbandry protocols and establishing assurance colonies
- reintroducing and/or translocating individuals
- adequately supporting and resourcing a recovery program.⁶²⁴

Geyle et al. (2021) used expert elicitation to assess the probability of extinction by 2040 for 26 Critically Endangered and Endangered Australian frogs.⁶²⁵ The Baw Baw frog was assessed as having a 65% chance of extinction, while the spotted tree frog was assessed as having a 36% chance. For the frogs in general, the

scientists concluded that: 'Increased resourcing and management intervention are urgently needed to avert future extinctions of Australia's frogs.' One of the key priorities listed was 'establishing or extending in-situ population refuges to alleviate the impacts of disease and climate change.'

The Arthur Rylah Institute has been monitoring frog populations in the WetMAP program. In 2018–19, the Institute monitored frogs at 16 wetlands varying from near permanent to ephemeral in four CMA regions. More than 6,300 records were logged for eight species, with three to six species per wetland. The most frequently recorded were the spotted marsh frog *Limnodynastes tasmaniensis* (every wetland) and Peron's tree frog *Litoria peronii* (all but one wetland). The least common were the growling grass frog *Litoria raniformis* and painted burrowing frog *Neobatrachus pictus*, which were found in only one wetland each.⁶²⁶

Recent research by Bell et al. (2020) along rainforest streams in the wet tropics of Queensland found that maintaining habitat connectivity between frog populations, which would allow in-migration to rebuild populations, the maintenance of refugia, and the use of translocations are important management actions to support the persistence of populations and their recovery from chytridiomycosis.⁶²⁷

624. Skerratt L, Berger L, Clemann N, Hunter D et al. 2016, 'Priorities for management of chytridiomycosis in Australia: saving frogs from extinction', *Wildlife Research*, 42(3), April 2016.

625. Geyle H, Hoskin C, Bower, Catullo R et al. 2021, 'Red hot frogs: identifying the Australian frogs most at risk of extinction', *Pacific Conservation Biology* <https://doi.org/10.1071/PC21019>.

626. DELWP 2019, 'WetMAP: Victoria's wetland monitoring and assessment program for environmental water, project update – 2019 frog theme', East Melbourne, Victoria.

627. Bell S, Heard G, Berger L and Skerratt L 2020, 'Connectivity over a disease risk gradient enables recovery of rainforest frogs', *Ecological Applications*, 30(7), e02152.

Wetlands and rivers

Indicator B:13 Threatened native fish species

Region Statewide Measures Number, abundance and distribution Data Custodian DELWP	Indicator Performance: 2018:	2018 Status	2018 Trend	2018 Data
	2021: Unable to be assessed due to Moderate Data Confidence Why this indicator? This is a general indicator of fish biodiversity. A number of threatened fish species have been impacted by the bushfires in eastern Victoria.	2021 Status	2021 Trend	2021 Data

Potential thresholds for status in the SoE 2023 report

Good: Significant increasing trend in the abundance and distribution of threatened native fish species, and threats are being monitored, reported and mitigated

Fair: Stable or small increasing trend in the abundance and distribution of threatened native fish species, and threats are in part being monitored, reported and mitigated

Poor: Significant declining trend in the abundance and distribution of threatened native fish species, and threats are not being monitored, reported or mitigated

Why this assessment in 2021?

Status: Many agencies and communities are working to improve fish habitats and numbers but are starting from a low bar.

Trend: Agencies and communities are working to improve fish habitat, and the abundance of fish species, however the 2019–20 bushfires have severely impacted small-bodied fish such as the galaxiids. Even so, to determine any attributions of statewide trends, more data through time are required.

Data Confidence: Native Fish Report Cards and other research are improving data on native fish. However, there is no formal analysis of fish status and environmental data. The Native Fish Report Cards for 2020 have not been released.

Should this indicator be used in the SoE 2023 report?

Yes, however, not in its current form. Consideration should be given to splitting into two, with one for large-bodied fish and the other for small-bodied fish. The indicators for Macquarie perch and trout cod could be merged with the large-bodied fish indicator.

Summary of SoE 2018 Report assessment

- The Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP) monitors nine regulated rivers that include both northern and coastal rivers.
- Stage 5 VEFMAP monitoring (until 2016) reported 45 fish species across Victoria, of which 28 were native species that regularly inhabit inland aquatic ecosystems. The dominant native fish species were Australian smelt and flathead gudgeon, but fish biomass was dominated by the European carp.
- Stage 6 surveys in 2016–17 (these continued until 2020) investigated species population immigration, dispersal and distribution and recruitment across the regulated rivers. Stage 6 data suggest a general increase in abundance and distribution for most priority native species in rivers that received environmental flows since the millennium drought (1996–2010).

Results highlighted that improved flow conditions – including environmental water – potentially facilitated this recovery.

The 2019–20 bushfires: Impacts and responses

Thologolong is a small Victorian farming community located on the Murray river Road between Jingelic and Talmalmo. On 21 January 2020 there were reports of thousands of fish killed including cod, carp, redfin and small fish, as well as Murray crayfish and shrimp. Some of the Murray cod killed were more than a metre in length and weighed 40 kg.⁶²⁸

DELWP's biodiversity response and recovery report revealed that: 'Native freshwater fish such as Victoria's highly range-restricted galaxiid species, are highly sensitive to the impact fires can have on immediate reductions of dissolved oxygen and water quality in streams due to debris flow moving down

⁶²⁸ Thomson B 2020, '40kg Murray cod among thousands of fish killed in Upper Murray', *Canberra Times*, 24 January 2020.

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waterways after rain events. This has resulted in fish death events in some areas for example in the Cudgewa and Corryong Creeks and Tambo River,⁶²⁹ which flows into the Gippsland Lakes.

Table 61 lists the freshwater fish impacted by the 2019–20 bushfires and includes the percentage of their modelled habitat in the fire extent, the local impacts on their populations and the number of individuals extracted. Figure 55 maps the location of the 10 galaxiid species in eastern Victoria and the

extent of the 2019–20 fires. The habitat of six of the 10 species were within the fire extent.

The Victorian Fisheries Authority prepared a bushfire fish response plan that involved working with partner agencies and recreational fishing interests to assess the feasibility of fish extraction and the prioritisation of fish stocking where fish kills had occurred. By July 2020, the Authority reported encouraging signs of fish recovery and determined to conduct a fish population survey and trial fish stocking of Corryong/Nariel Creek, Cudgewa Creek and Thowgla Creek.⁶³⁰

Table 61: Fish species impacted by the 2019–20 bushfires.^{631,632}

Species Impacted by Fire	% Modelled Habitat in Fire Extent	Localised Impacts	No. Extracted	No. Returned
Australian grayling	Currently unknown	Eastern Victorian populations may be impacted		15
Australian bass	Currently unknown	Immediate translocation from Brodribb River to Snowy River due to debris flow	5	
Cann galaxias	Currently unknown	Almost all populations impacted in sediment event. Individuals extracted. No more located within known range.	24	19
Dargo galaxias	16%	All populations impacted. Individuals extracted.	210	199
East Gippsland galaxias	100%	All populations may be impacted	100	77
Flat-headed galaxias	~25%	Impacts unknown due to difficulty in sampling		
Galaxias olidus complex (15 species)	Currently unknown	Key population in south of range may be impacted (~85% of populations occur within current fire extent).		
Gippsland blackfish	Currently unknown	Key populations in East Gippsland may be impacted	11	9
Macquarie perch	20%	Population in Lake Dartmouth and Buffalo River impacted. Individuals extracted.	15	
McDowall's Galaxias	77% (All pops may be impacted)	All populations may be impacted. Individuals extracted.	120	106
Moroka galaxias	Currently unknown	Only known population outside of fire footprint.		
Mountain galaxias	Currently unknown	Key populations in south of range may be impacted		
Roundsnout galaxias	97%	Entire Victorian population may be impacted. No access possible for extraction due to fires.		
Yalmy galaxias	94% (All populations impacted by sedimentation post fire)	Entire population impacted in major sediment event post-fire. Individuals extracted. No more located within known range	7	1

630. Victorian Fisheries Authority, 'Bushfire fish response plan', Melbourne, Victoria <https://vfa.vic.gov.au/recreational-fishing/bushfire-fish-response-plan> Accessed 8 May 2021.

631. DELWP 2020, 'Victoria's bushfire emergency: biodiversity response and recovery, version 2', East Melbourne, Victoria.

632. Raadik T 2021, personal communication.

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In the wake of the 2019–20 fires, Silva et al. (2020) used media reports and agency and field observations across Queensland, NSW and Victoria to document fish kills in the fire-affected areas and downstream. In Victoria, the analysis covered the Murray River upstream, Cudgewa and Corryong creeks and Tambo and Buffalo rivers. Murray cod,

trout cod, Murray crayfish golden perch, Australian smelt, river blackfish and freshwater prawns and eels were the native species found dead along fire-affected rivers in numbers that ranged from 1-10 and up to hundreds e.g. trout cod along the Murray River between Jingelic and Talmalmo.

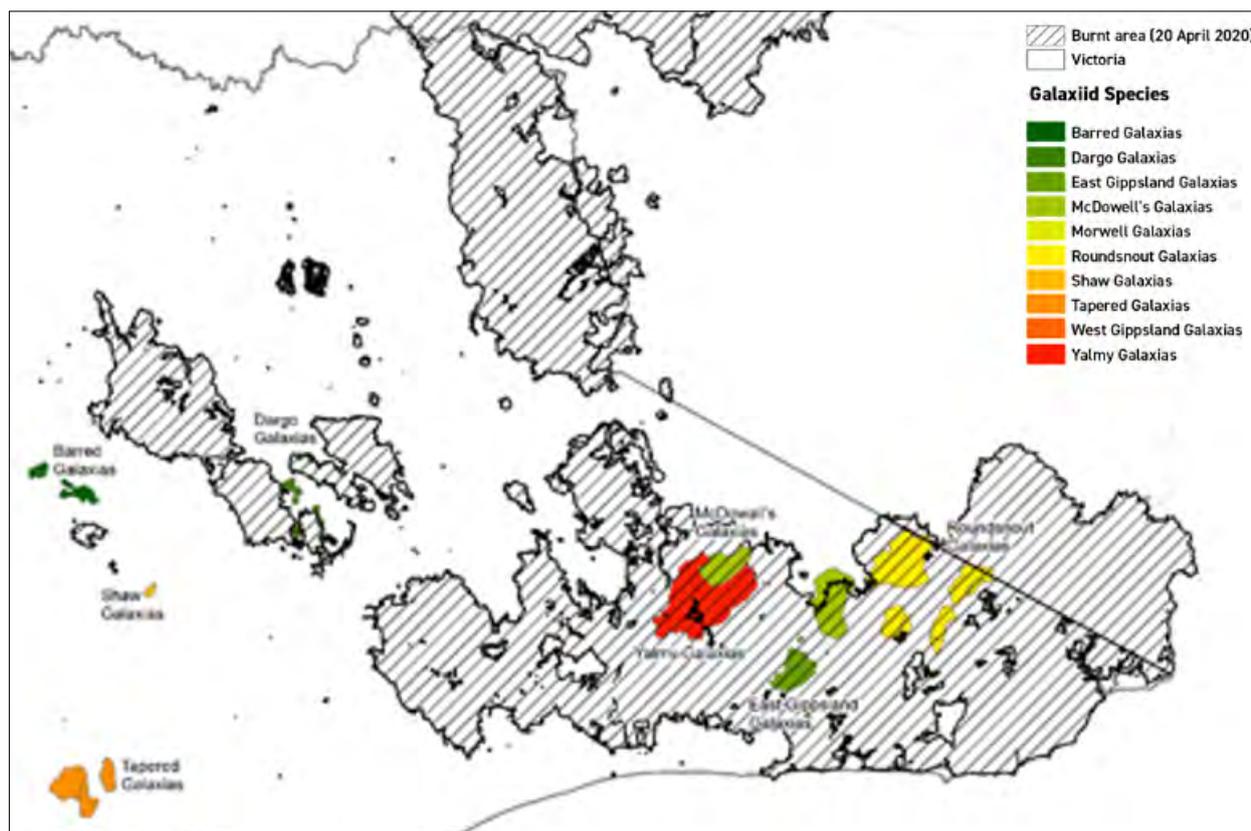


Figure 55: Likely habitat extent for endemic freshwater galaxiid species across Eastern Victoria.⁶³³

The scientists noted that the combination of fire severity, high elevation and steep slopes in the affected areas, followed by rainfall immediately after the fire, likely increased runoff and washed sediment, ash and debris to waterways.⁶³⁴ Invasive species also succumbed to the fires, including redfin perch, European carp, and rainbow trout. They also observed that 'freshwater ecosystems are recognized as the most threatened globally, yet fire impacts are rarely acknowledged as a threat in the scientific literature and in water management policies.' They urged that bushfire plans '(a) identify immediate and long-term actions to mitigate impacts and (b) develop medium and long-term research plans based on sound science to

advance knowledge aimed at enhancing freshwater ecosystem resilience.'

SoE Biodiversity Update 2021 Report assessment

Koehn, Raymond, Stuart et al. (2020) reviewed 600 publications and held 27 expert workshops to compile a knowledge compendium and identify knowledge gaps on nine priority native freshwater species in the Murray-Darling Basin. Although they found a growing but varied knowledge base, they identified knowledge gaps in 'early life stage requirements, survival, recruitment, growth rates, condition and movements,' and listed key

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threats, including 'reduced longitudinal and lateral connectivity, altered flows, loss of refugia, reductions in both flowing (lotic) and slackwater riverine habitats, degradation of wetland habitats, alien species interactions and loss of aquatic vegetation.'⁶³⁵

Threats were scored from 1 (lowest) to 5 (highest). Numbers in cells indicate median scores, and colours reflect these scores.

Figure 56 presents a summary of their threat assessments for eight of the nine species (the olive perchlet is now extinct in Victoria). The threat scores are 1 for lowest and 5 for highest, the cell

numbers are median scores, the colour green is the lowest level of threat and the colour red the highest. 'S' refers to the southern basin and 'N' the northern basin. The golden perch and silver perch are heavily impacted by barriers to connectivity and flow-related impacts, and the southern pygmy perch to the loss of aquatic vegetation and wetlands. Decreased water quality and in-stream structures and riverine habitats are significant threats for the Murray cod, while for trout cod they are altered flow seasonality, loss of riverine habitats, recreational fishing and decreased in-stream structure.

Threats	Murray cod		trout cod		golden perch		silver perch		Macquarie perch		freshwater catfish		southern pygmy perch		Murray hardyhead		olive perchlet	
	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N
Flow-related threats																		
Decreased overbank flooding	3.0	3.0	3.0		4.0	4.0	3.5	3.5	1.0		3.0	2.0	3.0		4.0		3.0	3.0
Decreased in-channel flows	3.0	3.0	3.0		4.0	3.5	4.0	3.0	3.0		2.0	2.0	2.0		2.0		2.0	2.0
Altered flow seasonality	3.0	3.0	4.0		4.0	3.0	3.0	3.0	4.0		3.0	2.0	3.0		3.0		3.0	3.0
Reduced spawning cues	2.0	2.0	2.0		4.0	4.5	4.0	4.0	4.0		1.5	1.0	1.0		2.0		1.0	1.0
Reduced movement cues	2.0	2.0	2.0		4.0	3.5	4.0	3.5	4.0		2.0	2.0	1.0		2.0		1.0	2.0
Reduced movement pathways	3.0	3.0	2.0		4.0	5.0	4.0	5.0	4.0		3.0	3.0	3.0		3.0		2.0	3.0
Loss of lentic habitats	1.0	1.0	1.0		3.0	3.0	3.0	3.0	2.0		4.0	4.0	4.0		4.0		4.0	4.0
Loss of riverine lotic habitats	4.0	3.5	4.0		4.0	4.0	4.0	4.0	4.0		2.0	2.0	1.0		1.0		2.0	2.0
Loss of refugia	2.0	4.0	2.0		2.0	4.0	2.0	4.0	3.0		3.0	4.0	4.0		4.0		2.0	4.0
Non-flow-related threats																		
Loss to pumps	2.0	3.0	1.0		2.0	3.0	2.5	3.0	1.0		2.0	3.0	1.0		1.0		2.0	2.0
Loss into irrigation channels	3.0	2.0	2.5		3.0	2.0	3.0	2.0	1.0		2.0	2.0	1.0		1.0		2.0	2.0
Cold-water pollution	3.0	3.5	3.5		3.0	3.0	3.0	3.5	3.0		3.0	2.0	2.0		1.0		2.0	2.0
Decreased in-stream structure	4.0	4.0	4.0		3.0	3.0	2.5	2.0	2.0		3.0	2.0	2.0		1.0		2.0	2.0
Decreased aquatic vegetation	2.0	2.0	2.0		2.0	2.0	3.0	2.0	3.0		4.0	3.0	5.0		5.0		5.0	5.0
Decreased wetlands	1.0	1.0	1.0		3.0	3.0	2.5	3.0	1.0		4.0	4.0	5.0		5.0		5.0	5.0
Barriers to longitudinal connectivity	3.0	3.0	3.0		5.0	5.0	5.0	5.0	4.0		3.0	3.0	2.0		2.0		3.0	3.0
Barriers to lateral connectivity	2.0	2.0	2.5		4.0	4.0	3.0	4.0	3.0		4.0	3.0	4.0		3.5		4.0	3.0
Sedimentation	3.0	3.0	3.0		2.0	2.0	2.0	2.0	4.0		4.0	4.0	3.0		2.0		4.0	4.0
Decreased water quality	4.0	4.0	3.5		3.0	3.0	3.0	3.5	3.0		3.0	4.0	3.0		3.0		4.0	4.0
Alien species impacts	3.0	2.5	3.0		3.0	2.0	3.0	3.0	4.0		5.0	5.0	5.0		4.0		4.0	4.0
Recreational fishing	3.0	3.5	4.0		3.0	3.0	2.0	2.0	3.0		3.0	3.0	1.0		1.0		1.0	1.0

Figure 56: Assessment of flow-related and non-flow-related threats to each species.⁶³⁶

635. Koehn JD, Raymond SM, Stuart I, Todd CR, et al. 2020. 'A compendium of ecological knowledge for restoration of freshwater fishes in Australia's Murray-Darling Basin', Marine and Freshwater Research, 71, pp. 1391-1463.

636. Ibid

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In a separate paper, Koehn, Balcombe, Baumgartner et al. (2020) detailed 30 priority actions they believed were urgently needed to drive the long-term recovery of native fish in the Murray-Darling Basin.⁶³⁷ The components included flow management, water infrastructure, restoration and engagement. A selection of the actions is listed in Table 62.

In a 2019 update⁶³⁸ of their 2014 paper on the first Native Fish Strategy for the Murray-Darling Basin, Koehn, Lintermans and Copeland (2019) listed its

benefits to include 100 separate research projects e.g. Sea to Hume fishway project, improved knowledge of fish responses to environmental water allocations, new techniques for controlling alien fish, and the rehabilitation of fish habitats. However, funding for the strategy ceased in 2013–14 and, since then, the scientists believed that there had been a loss of integrated and coordinated action. They argued that there was a need for a revised fish strategy, especially with the major changes that had occurred in the basin, including fish kills.

Table 62: Components and actions needed to restore native fishes in the Murray-Darling Basin.⁶³⁹

Component	Actions
Flow management: key flow components needed to be restored	<p>Design, implement and manage coordinated, optimised flow regimes (multiyear or decadal) for all water (environmental water, stock and domestic, irrigation deliveries, protection of natural flows) that permanently support native fishes and ecosystem processes at the appropriate scales</p> <p>Allow overbank flows to restore and support riverine productivity and food webs, connect floodplain habitats, including fish nursery areas, and maintain temporary, seasonal and perennial wetlands through relaxation of 'constraints'</p> <p>Develop and implement preventative strategies to minimise fish kills and poor water quality</p> <p>As a minimum, maintain adequate base flows across the year in perennial rivers to support existing populations, recent recruits and connectivity between rivers (source to sea), floodplains and wetlands</p>
Water infrastructure: needs improvement to reduce its effects on fish including:	<p>Provide effective fish passage for all life stages (upstream, downstream and laterally to floodplain channels and wetlands) at priority barriers and remove redundant structures</p> <p>Prevent the large-scale loss of fish (especially early life stages and small species) through pumps and irrigation diversion infrastructure</p> <p>Assess whether planned new infrastructure is needed</p>
Other restoration actions to complement flow management and infrastructure	<p>Protect existing threatened species populations and create additional populations through translocations or hatchery stocking</p> <p>Increase instream structural woody habitats at priority sites</p> <p>Eliminate stock access and control terrestrial animal (feral and stock) effects</p> <p>Protect and restore macrophyte habitats and riparian vegetation</p> <p>Undertake sustained, strategic control of alien fishes.</p> <p>Adequately fund and implement the NFRS for the MDB</p>
Support and engagement: ensure the public are champions for the restoration of MDB fishes	<p>Build public support for the restoration of MDB fishes from relevant stakeholder groups</p> <p>Ensure fish are prioritised equally compared with terrestrial flora and fauna</p> <p>Ensure that the concerns and values of First Nations People are represented in all plans and policies that relate to water use, flows, fish and conservation management.</p>

637. Koehn J, Balcombe S, Baumgartner L, Bice C et al. 2020, 'What is needed to restore native fishes in Australia's Murray-Darling Basin?' *Marine and Freshwater Research*, 71, pp. 1464–1468.

638. Koehn J, Lintermans M and Copeland C 2019, 'Recovering Murray-Darling Basin fishes by revitalizing a native fish strategy, update of EMR feature', *Ecological Management and Restoration*, 13 September 2019.

639. Koehn J, Balcombe S, Baumgartner L, Bice C et al. 2020, 'What is needed to restore native fishes in Australia's Murray-Darling Basin?' *Marine and Freshwater Research*, 71, pp. 1464–1468.

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Support and engagement: ensure the public are champions for the restoration of MDB fishes
Build public support for the restoration of MDB fishes from relevant stakeholder groups

Ensure fish are prioritised equally compared with terrestrial flora and fauna

Ensure that the concerns and values of First Nations People are represented in all plans and policies that relate to water use, flows, fish and conservation management.

In 2020, the Murray-Darling Basin Authority released its new Native Fish Recovery Strategy with a vision to recover native fish for future generations. The strategy contains four outcomes and a number of foundational actions and investment areas. The investment areas include research, community capacity building, continuing with rehabilitation, the improvement of connectivity, the management of introduced fish, and adaptation to climate change.

The four outcomes are:

- recovery and persistence of native fish
- threats to native fish are identified and mitigated
- communities are actively involved in native fish recovery
- recovery actions are informed by best available knowledge.⁶⁴⁰

The results of Stage 6 of VEFMAP were reported by Tonkin, Jones, Clunie et al. (2020).⁶⁴¹ Monitoring of aquatic and riverbank vegetation was conducted along the Campaspe, Glenelg, Wannon, Thompson, Macalister, Wimmera, Yarra and Watts rivers. For the fish theme, the researchers asked four key questions about the effects of environmental flows. Table 63 lists those questions and provides some of the answers which indicated significant benefits to fish dispersal, distribution, recruitment and migration.

Table 63: Key environment questions and answers in VEFMAP fish and vegetation themes.⁶⁴²

Questions and Answers for Fish Theme
<p>Q: Can environmental flows promote immigration by diadromous fishes in Victorian coastal rivers? A: Positive association between spring river discharge and catches of juvenile diadromous fishes Water is best used to enhance the dispersal and survival of recruits during the summer following a dry spring</p>
<p>Q: Do environmental flows enhance dispersal, distribution and recruitment of diadromous fishes in Victorian coastal rivers? A: Upstream dispersal increased significantly in response to environmental flow releases during summer and early autumn across multiple systems Fresh releases should be used in the lower reaches of rivers where there are no restrictions to fish passage and where sufficient flows exist to maintain suitable water quality and habitat for survival and maturation through summer. Fresh releases provide the greatest population level benefits in years when the abundance of new recruits is relatively high.</p>
<p>Q: Do environmental flows support immigration of native fish into, and dispersal throughout, northern Victorian rivers? A: Environmental flows play an important role in enhancing both immigration and dispersal in flow stressed regulated rivers Upstream movement of both large- and small-bodied species increased substantially during environmental flow releases in comparison to low baseflow conditions.</p>
<p>Q: Does environmental flow management used for large-bodied species enhance: (i) survival and recruitment, (ii) abundance and (iii) distribution throughout northern Victorian rivers? A: Links between attributes of river flows and Murray cod (<i>Maccullochella peelii</i>) recruitment and population dynamics. Links between river flows and abundance and biomass of golden perch (<i>Macquaria ambigua</i>), silver perch and trout cod (<i>Maccullochella macquariensis</i>). Contribution of environmental water appears to be river, species and process specific.</p>

640. Murray-Darling Basin Authority 2020, 'Native fish recovery strategy 2020', Canberra, Australia.

641. Tonkin Z, Jones C, Clunie P, Vivian L et al. 2020, 'Victorian environmental flows monitoring and assessment program, stage 6 synthesis report 2016–2020', technical report series no. 316, Arthur Rylah Institute, Heidelberg, Victoria.

642. Ibid

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In a 10-year study, Stuart et al. (2019)⁶⁴³ found that perennial environmental flows in the Gunbower Creek, a tributary of the Murray River, increased juvenile Murray cod abundance and aided the species' recovery by improving the survival of eggs, larvae and juveniles. The researchers dismissed immigration as a likely cause of the increased abundance and, although the creek was stocked each year with between 20,000 and 120,000 Murray cod fingerlings between 2001 and 2018, the research found that 'recruitment was very poor without an environmental flow regime.'

The Native Fish Report Card program, established in 2016 by DELWP and the Victorian Fisheries Authority, monitors the status of 10 native species from a waterway in each of the 10 CMA regions (the cards do not analyse the interactions between the species and their environment). The mix of species includes some that are targeted by recreational fishers. Table 64 presents report card data from 2019 (the 2020 cards are yet to be released) on fish/kilometre, the level of stocking and three key health indicators, namely:

- recent recruitment – were small fish (presumed less than 1 year old) present, indicating fish are breeding (or being stocked)
- multiple size classes – were there fish from a variety of sizes, an indicator of a healthy population
- mature fish present – were mature fish (capable of reproduction) caught.⁶⁴⁴

With the exception of the Macquarie perch outside of the Melbourne Water area, non-targeted fish species were not restocked.

The Flora and Fauna Guarantee Threatened List identifies the conservation status for silver perch, trout cod, Murray cod, Macquarie perch, Australian grayling and freshwater catfish as Endangered. Although there are instances where some or good recruitment is occurring, there is generally little to no recruitment for the fish species across the various rivers. This is also the case for some fish species where stocking has occurred.

Table 64: Native fish report cards 2017-2019.⁶⁴⁵

Species and Waterway	Fish/km			Stocking	Recruitment, Size Classes and Maturity/% Legal Length
	2017	2018	2019	2019	
Australian bass*					
Mitchell	25.52	39.5	72.78	190,000	Recent recruitment, multiple size classes, and mature fish in all years. Only 5-11% of legal size.
Thomson and Macalister	20.24	4.22	5.78	54,500	Recent recruitment in 2017, some in 2018 and none in 2019. Multiple size classes and mature fish in all years. 23-36% legal size.
Australian grayling					
Gellibrand	2.15	0.62	0.62	Nil	Rarely found in Gellibrand. No recent recruitment, multiple size classes (some 2018). Some mature fish in 2017 and 2019.
Mitchell	0.55	n/a	0.12	Nil	6 found across three years. No recent recruitment, multiple size classes, Some mature fish in 2017 and 2019).
Thomson and Macalister	7.48	1.04	n/a	Nil	14 found across 3 years. No recent recruitment, multiple size classes or mature fish present (yes in 2017 and 2018).
Yarra	n/a	0.79	0.6	Nil	5 found across 3 years. No recent recruitment, some multiple size classes in 2018 and some mature fish in 2018.

*Recreational fishing target +Recreational fishing target in Melbourne Water area only.

643. Stuart I, Sharpe C, Stanislawski K, Parker A et al. 2019, 'From an irrigation system to an ecological asset: adding environmental flows establishes recovery of a threatened fish species', *Marine and Freshwater Research*, 70, pp. 1295-1306.

644. DELWP 2018, 'Native fish report cards: project overview', East Melbourne, Victoria.
645. DELWP and Victorian Fisheries Authority, 'Native fish report card', Melbourne, Victoria <https://www.nativefishreportcard.org.au> Accessed 9 May 2021.

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Table 64: Native fish report cards 2017-2019 cont'd.

Species and Waterway	Fish/km			Stocking	Recruitment, Size Classes and Maturity/% Legal Length
	2017	2018	2019	2019	
Estuary perch*					
Glenelg	10.2	7.41	7.47	Nil	Some recent recruitment in 2018 and multiple size classes and mature fish in all years. Estuary conditions supporting survival and spawning supporting 34-51% legal length.
Freshwater catfish*					
Wimmera	0.04	0.07	0.16	Nil	Some recent recruitment, some multiple size classes in 2019 and some mature fish in 2018 and 2019.
Golden perch*					
Goulburn	6.71	4.56	5.98	213,000	No recent recruitment but multiple size classes and mature fish in all years. 70% stocked fish. 77-94% legal size.
Gunbower Creek	2.28	1.21	1.31	330,500	Some recruitment in 2019. Multiple size classes and mature fish in all years but 50% fewer fish caught in 2018 and 2019. Fish might have moved out due to low water levels. 47-94% legal size.
Lindsay and Mullaroo	7.88	8.09	4.78	Nil	Some recruitment in 2017 but none in following years. Multiple size classes and mature fish in all years. Conditions have not supported breeding. 74-98% legal size.
Ovens	0.17	0.64	0.90	131,000	No recruitment. Some multiple size classes in 2018 and 2019, and mature fish in 2018 and some in 2017 and 2019. First golden perch found in Ovens and likely due to stocking. % legal size n/a.
Wimmera	2.64	3.01	3.34	318,000	Some recruitment in 2018 and 2019. Multiple size classes and mature fish in all years. 79-88% legal size.
Macquarie perch+					
Ovens	13.55	11.74	7.34	37,200 plus 675 translocated fish	Decline in abundance over the three years. Recruitment in 2017 and 2019 and some in 2018. Multiple size classes across all years and some mature fish only in 2018.
Yarra	10.68	14.25	8.94	Nil	Some recruitment in 2017 and 2018, multiple size classes across all years, and some mature fish in 2018. 0-2% legal size. Only one legal size fish found and may suggest high fishing pressure.
Murray cod*					
Goulburn	12.44	5.21	9.2	267,000	Recruitment, multiple size classes and mature fish across all years. 6-11% legal size. Natural breeding occurring.
Gunbower Creek	4.36	4.27	6.73	225,000	Recruitment in 2017 and 2019 and some in 2018, multiple size classes and mature fish in all years. 5-14% legal size. Stocking and new flow regime could explain healthy population.
Lindsay and Mullaroo	0.15	3.46	13.8	Nil	Abundance decline following 2016 blackwater event but population now recovering. Recruitment in 2019 and some in 2018, multiple size classes in 2018 and 2019, and some mature fish in 2018 and 2019. 1-9% legal size.

*Recreational fishing target +Recreational fishing target in Melbourne Water area only.

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Table 64: Native fish report cards 2017-2019 cont'd.

Species and Waterway	Fish/km			Stocking	Recruitment, Size Classes and Maturity/% Legal Length
	2017	2018	2019		
Ovens	41.69	36.83	53.28	Nil	Recruitment, multiple size classes and mature fish in all years. 8-11% legal size. Conditions supporting survival throughout lifecycle.
Yarra	6.99	3.42	6.06	Nil	Recruitment in 2017 and some in 2018, multiple size classes in all years, and mature fish in 2019 and some in 2017 and 2018. 0-12% legal size. May indicate high fishing pressure.
River blackfish*					
Gellibrand	49.39	10.36	17.74	Nil	Recruitment in 2017 and some in 2018 and 2019. Multiple size classes and mature fish in all years. 61-82% legal size. Young of year only found in tributaries, indicating conditions in main channel not supporting recruitment.
Silver perch					
Goulburn	1.43	0.41	0.32	Nil	No recruitment in any year, multiples size classes in 2017 and 2018 and some in 2019, some mature fish in all years. Abundance low in all years.
Gunbower Creek	0.87	0.31	0.18	Nil	No recruitment in any year, multiple size classes in 2017, some in 2018 and none in 2019, and mature fish in 2017 and 2018 and some in 2019. Low abundance and no breeding.
Lindsay and Mullaroo	0.12	0.18	0.15	Nil	No recruitment of multiple size class and only some mature fish in 2018 and 2019. Abundance low in all years.
Trout cod					
Goulburn	2.99	1.32	2.49	Nil	No recruitment in 2017 but some in 2018 and 2019. Multiple size classes in all years, mature fish in 2019 and some in 2017 and 2018. Trout cod breeding and surviving.
Gunbower Creek	0.27	n/a	0.06	Nil	No recruitment, multiple size classes only in 2017 and no mature fish in any year. Four fish found over three years. Few historical records of this fish in Gunbower.
Ovens	11.81	12.11	8.88	Nil	Recruitment of 2019 and some in 2017 and 2018, multiple fish classes and mature fish in all years. River conditions supporting fish through lifecycle.

*Recreational fishing target +Recreational fishing target in Melbourne Water area only.

Lyon et al. (2019) conducted a seven-year investigation into the value of re-snagging along 110 kilometres of the Murray River. They installed 4,450 snags, mostly large pieces of wood, and gathered annual catch, effort, length and tagging data for Murray cod and golden perch. In the re-snagged areas, the scientists reported three-fold and two-fold population increases in Murray cod and golden perch respectively compared with the control areas, which showed fluctuating or declining populations.⁶⁴⁶ The authors suggested that such large-scale studies could also be used for

other restoration strategies such as restoring fish passage or environmental flows.

River regulation impacts native fish abundance in Australia by changing the timing, volume and duration of river flows. It has also led to the construction of barriers to fish movement – there are 10,000 barriers to fish passage in the Murray-Darling

⁶⁴⁶ Lyon J, Bird T, Kearns J, Nicol S et al. 2019, 'Increased population size of fish in a lowland river following restoration of structural habitat', *Ecological Applications*, 29(4), e01882.

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Basin.⁶⁴⁷ To help recover fish populations and restore ecological functions, water management agencies have in recent years released water from storages to augment river flows with 'environmental water'.

To determine the impact of such flows on Victorian native fish, Amtstaetter (2020) used field work and long-term fish monitoring data for the Australian grayling, tui whiting and common galaxias in the Thomson and Glenelg rivers.⁶⁴⁸ The results showed that tui whiting and common galaxias numbers had increased in the Glenelg River after increases in the summer to early autumn flows. However, the analysis of Australian grayling in the Thomson River was less certain, possibly explained by the end of the Millennium Drought and the absence of flow pulses. Other fish found in the Thomson River included the native species of short-finned eel, river blackfish, southern pygmy perch and Australia smelt, along with the exotic species of European carp, gambusia and brown trout. Gambusia and carp were also found in the Glenelg, although in far fewer numbers than the native species of river blackfish, tui whiting, common galaxias and the variegated pygmy perch.

Fish condition monitoring has been conducted at 21 sites in the Barmah-Millewa Forest by Arthur Rylah Institute scientists since 2007, gathering data for indices of community (abundance, biomass and native fish species) and population (recruitment, expectedness, size structure and distribution of native fish).⁶⁴⁹ The findings of the monitoring include:

- The overall condition of the fish community in 2019–20 was scored as 'Fair', with most indices declining since 2018 and not meeting the 75% targets for nativeness (percentage of native species) and expectedness (native fish species observed as percentage of what was expected to be observed).
- Recruitment, expectedness and nativeness indices for native fish across years and strata were 'Fair' to 'Good'.
- Large-bodied native fish species (Murray cod, trout cod and golden perch) were in similar numbers from 2016 to 2020, and in comparatively higher numbers, relative to sample years prior to this period.
- Native fish recruitment in riverine and off-channel habitats was high and stable across sample years.

- Community and population indices generally indicate native fish stability within the riverine strata across years and were more stable than in non-river habitats.

The Forest Protection Survey Program was established in 2018 to gather data in the State Forests of eastern Victoria to improve the protection of terrestrial and aquatic biodiversity from the impacts of timber harvesting.⁶⁵⁰ Eight species of freshwater spiny crayfish (genus *Euastacus*), three species of threatened burrowing crayfish (genus *Engaeus*) and 11 species of threatened galaxiids (genus *Galaxias*) are a focus for the program, which will run until the end of 2021.

A 2019 survey of fish by the Arthur Rylah Institute discovered the threatened barred galaxias at a new location in the Central Highlands (it is only found in small numbers in 12 isolated locations). Under the Code of Practice for Timber Harvesting, the discovery meant that the habitat had to be protected with the establishment of streamside buffers.⁶⁵¹

Government agencies, catchment management authorities and the community have been working to improve fish habitat and water use. Measures include improving habitat, managing invasive species, environmental water releases, fishways, the removal of barriers, fencing and off-stream water for livestock. The Victorian Fish Habitat and Flows Alliance is a partnership between government, anglers and the broader community that aims to coordinate partnerships, educate the community and build capacity to enhance fish habitat and recreational fisheries.⁶⁵² It does this through holding roundtables, supporting the Angler Riparian Partnerships Program, information displays and working with the Arthur Rylah Institute on various projects including fish translocation and improving woody habitat.

647. Baumgartner L, Zampatti B, Jones M, Stuart I et al. 2014, 'Fish passage in the Murray-Darling Basin, Australia: not just an upstream battle', *Ecological Management and Restoration*, 15(S1), pp. 28-39.

648. Amtstaetter F 2020, 'Long term monitoring of diadromous fishes in the Thomson and Glenelg rivers and 2020 survey results', unpublished client report for the Water and Catchments Group, Arthur Rylah Institute, Heidelberg, Victoria.

649. Raymond S, Duncan M, Tonkin Z and Robinson W 2020, 'Barmah-Millewa fish condition monitoring: 2020', unpublished client report for the Murray-Darling Basin Authority, Arthur Rylah Institute, Heidelberg, Victoria.

650. DELWP 2019, 'Threatened fish and crayfish in proposed Victorian timber harvesting coupes: forest protection survey program - improving threatened species management and protection, 2018-2021', East Melbourne, Victoria.

651. DELWP 2019, 'Threatened fish discovered at new Central Highlands location', East Melbourne, Victoria <https://www.forestsandreserves.vic.gov.au/media-releases/threatened-fish-discovered-at-new-central-highlands-location> Accessed 9 May 2021.

652. Ayres R 2020, 'Victorian fish habitat and flows alliance project 2019/2020, project report', unpublished client report for DELWP Water and Catchments, Victorian Environmental Water Holder and Victorian Fisheries Authority, Arthur Rylah Institute, Heidelberg, Victoria.

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The Fish in Supplementary Habitats (FISH) program is a partnership between the Arthur Rylah Institute, the Murray-Darling Basin Authority, Goulburn Broken CMA, local community groups and landowners working to establish refuge populations of the threatened southern pygmy perch in small farm dams.⁶⁵³ To date, 486 perch have been translocated from Castle Creek, Hughes Creek and Seven Creeks, and one private property, to four farm dams. Another 60 perch were translocated to three wetlands at Tahbilk and Mitchelstown.

In a major review⁶⁵⁴ of Australia's threatened freshwater fish by Lintermans et al. (2020), 22 were identified as having a high risk of extinction, with nine only occurring in eastern Victoria and one in south-west Victoria. The review found that:

- those fish with a >70% likelihood of extinction were Shaw galaxias (highest risk); West Gippsland galaxias (second-highest risk); tapered galaxias; Dargo galaxias; Morwell galaxias
- those fish with a 50–70% likelihood of extinction were McDowall's galaxias; Yalmy galaxias; East Gippsland galaxias; Moroka galaxias; SW Victoria river blackfish.

The scientists cited the small ranges of the fish, drought, climate change, increasing fire frequency and introduced predatory fish, such as trout, as the biggest threats.

Case study: Victoria's galaxiids

Eight galaxiids in Victoria are listed as Critically Endangered in the Flora and Fauna Guarantee Threatened List, two are listed as Endangered and one Vulnerable (the Morwell, Yalmy and Moroka galaxiids were not assessed as they are yet to be formally described).⁶⁵⁵ The Shaw galaxias, the most imperilled species, is known from only one population of 80 individuals living above a waterfall that prevents the arrival of predatory trout. Although the Lintermans et al. (2020) analysis was conducted before the 2019–20 bushfires, the small range of the Shaw galaxias – from 4–36 km² – makes the species especially at risk from catastrophic events. The population of the Yalmy galaxias before the 2019–20 bushfires was estimated to be 2,500, however post-fire monitoring found only two individuals, a male and a female in separate areas.⁶⁵⁶

Table 65 lists the threatened galaxiid species that are either endemic to Victoria or found in Victoria along with other states. The table also comments on their distribution, abundance and the threats they face. Habitat loss and degradation and predation by trout are drivers of declines in galaxiid abundance and range and remain ongoing threats, along with major causes of increased fire frequency, climate change and altered flows.

The taxonomy of galaxiid species is still evolving. Raadik (2014) published a comprehensive revision of galaxiid species in Australia, identified 15 separate species in what had been referred to as the *Galaxias olidus* complex, redescribing three species and describing 12 new species. Raadik concluded that: 'This study demonstrates the degree of salmonid impact on biodiversity in Australian non-migratory galaxiids has been seriously under-estimated due to the lack of taxonomic resolution in the *Galaxias olidus* complex. Significantly, trout are implicated in the decline and/or fragmentation in range of 10 of the 15 species within the complex (with at least regional/localised impacts documented/predicted in the remaining five), all of which occur in habitats which are now considered to have highly modified biotas which reflect relictual distributions as a result of recent and local extirpations. Significantly this is often in otherwise pristine or little modified upland habitat. Surviving populations of many of these new species are small and found above instream barriers that have prevented the upstream colonisation of trout (e.g. *Galaxias gunaikurnai* sp. nov., *Galaxias mcdowalli* sp. nov., *Galaxias mungadhan* sp. nov. and *Galaxias tantangara* sp. nov.). These are at high risk of extinction from the genetic consequences of reduced population size and stochastic events such as drought (dewatering) or floods (extensive post-fire sedimentation or facilitation of further salmonid expansion) and the general effects of catchment and climate change (increasing water temperature, altered seasonality of flows, salinity etc.). Other species occur in multiple rivers but occupy specific habitat niches in streams with predators (e.g. *Galaxias arcanus* sp.

653. Raymond S 2020, 'Landholders providing new homes for southern pygmy perch in Victoria', Finterest, 22 January 2020.

654. Lintermans M, Geyle H, Beatty S, Brown C et al. 2020, 'Big trouble for little fish: identifying Australian freshwater fishes in imminent risk of extinction', *Pacific Conservation Biology*, 26(4), pp. 365–377.

655. DELWP 2019, 'Conservation of endemic and threatened Victorian galaxiid species', East Melbourne, Victoria.

656. Costa J 2020, 'Shaw galaxias freshwater fish species in "dire straits" and on brink of extinction, study finds', ABC Gippsland, 24 August 2020.

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nov., *Galaxias terenasus sp. nov.*), and loss of genetic diversity within these, and more widespread species (e.g. *Galaxias olidus*, *Galaxias oliros sp. nov.*), may be occurring through reduction or elimination of local populations by salmonids singly or in concert with other threatening processes such as flow regulation and riparian habitat loss.⁶⁵⁷

Five years after Raadik's study, DELWP reported that: 'The main threat to the survival of the threatened galaxiids, above all else, is predation by introduced trout' ... and ... 'Preventing trout from moving upstream over the barriers protecting the galaxiids, or removing them immediately if they have done so, is critical to galaxiid survival.'⁶⁵⁸

Table 65: Features, threats and conservation status of galaxiid species in Victoria.⁶⁵⁹

Common Name	Species Name	Features	Threats	FFG List
Barred galaxias	<i>Galaxias fuscus</i>	Restricted range in Goulburn River system in Victoria in 12 separate populations. 25% decline in 25 years. 95% decline from historical numbers. 55-70% decline in three enations (6 years each) if no management	Trout, drought, fire, and erosion, all exacerbated by climate change	Critically Endangered
Shaw galaxias	<i>Galaxias gunaikurnai</i>	Reduced distribution to 30 metre reach in Shaw Creek, a tributary of Caledonia River in Gippsland. One small population. Invasion by trout would result in extinction	Trout, reduced quantity and quality of habitat	Critically Endangered
Tapered galaxias	<i>Galaxias lanceolatus</i>	Reduced distribution to now one population in 10 km reach of Stoney Creek in Thomson River system, West Gippsland. Invasion by trout would result in extinction	Trout, reduced quantity and quality of habitat	Critically Endangered
West Gippsland galaxias	<i>Galaxias longifundus</i>	One population of 25-75 in a 5.5km reach of the Rintoul Creek, a tributary of the La Trobe River. Invasion by trout would result in extinction.	Trout, reduced quantity and quality of habitat; increasing fire frequency; drying catchment	Critically Endangered
McDowall's galaxias	<i>Galaxias mcdowalli</i>	Distribution reduced due to trout predation. Numbers reduced by 20-40% in past 10 years. One population in the Rodger River in the Snowy River system, East Gippsland	Trout, reduced quantity and quality of habitat; increasing fire frequency (sedimentation; toxic retardants; increased water temperatures); climate change; erosion moving natural barriers to trout invasion	Critically Endangered
Dargo galaxias	<i>Galaxias mungadhan</i>	Reduced distribution now in one population along 3.3km reach in the Lightbound Creek/Upper Dargo River system	Trout, reduced quantity and quality of habitat; fire and drought	Critically Endangered
Flat-headed galaxias	<i>Galaxias rostratus</i>	Significant decline in distribution and 80% population decline since 2009. Goulburn, Ovens, Kiewa and upper-Murray catchments in Victoria	Competition with trout, redfin perch and gambusia. Loss of aquatic vegetation due to carp and habitat degradation.	Critically Endangered

657. Raadik T 2014, 'Fifteen from one: a revision of the *Galaxias olidus* Günther, 1866 complex (Teleostei, Galaxiidae) in south-eastern Australia recognises three previously described taxa and describes 12 new species', *Zootaxa*, 3898(1), pp. 001-198.

658. DELWP 2019, 'Conservation of endemic and threatened Victorian galaxiid species', East Melbourne, Victoria.

659. UCN red list assessments <https://www.iucnredlist.org>

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Table 65: Features, threats and conservation status of galaxiid species in Victoria cont'd

Common Name	Species Name	Features	Threats	FFG List
'Moroka' galaxias	<i>Galaxias sp. nov. 'Moroka'</i>	10-20% population decline in the Moroka River, a tributary of the Wonnangatta River. One population above waterfall. Invasion by trout would result in extinction.	Trout, reduced quantity and quality of habitat; increasing fire frequency; climate change.	Not yet described
'Morwell' galaxias	<i>Galaxias sp. nov. 'Morwell'</i>	Population declined by 65-80%. Three sub-populations in the Morwell River. Barrier prevents access by trout but unintentional translocation could occur.	Trout; reduced quantity and quality of habitat; increasing fire frequency; climate change.	Not yet described
'Yalmy' Galaxias	<i>Galaxias sp. nov. 'Yalmy'</i>	Significant reduction in population size (50-70%) and restricted to Yalmy River, Serpentine Creek and the lower Rodger River in Gippsland.	Trout; reduced quantity and quality of habitat; increasing fire frequency; climate change.	Not yet described
Roundsnout galaxias	<i>Galaxias terenusus</i>	South-east corner of southern New South Wales and East Gippsland (Snowy, Cann and Genoa rivers). Population decline.	Trout; reduced quantity and quality of habitat; drought; increasing fire frequency; climate change; loss of barriers.	Critically Endangered
Dwarf galaxias	<i>Galaxiella pusilla</i>	Patchy distribution of populations in southern Victoria and northern Tasmania.	Wetland drainage, water extraction and altered flows; reduced quantity and quality of habitat; climate change; predation by redfin perch; carp damage to aquatic vegetation; competition with gambusia.	Endangered
Little galaxias	<i>Galaxiella toourtkoourt</i>	Restricted distribution between the Barwon River and south-eastern South Australia. Expected decline in populations.	Wetland drainage, water extraction and altered flows; reduced quantity and quality of habitat; climate change; competition with gambusia.	Endangered

Wetlands and rivers

Indicator B:14 Waterbird species in the Murray-Darling Basin

Region Murray-Darling basin	Indicator Performance:	2018 Status	2018 Trend	2018 Data
Measures Number, abundance and distribution	2018: Unable to be assessed due to Moderate Data Confidence			
Data Custodian DELWP	2021:	2021 Status	2021 Trend	2021 Data
	Why this indicator? The Eastern Australian Waterbird survey is a large-scale biodiversity dataset that monitors waterbirds, including threatened species, and the health of rivers and wetlands.			

Potential thresholds for status in the SoE 2023 report

Good: Long-term population recovery and expanding distribution

Fair: Variable annual populations but signs of population recovery and expanding distribution

Poor: Long-term population decline and shrinking distribution

OR

Good: Significant increasing trend in the abundance and distribution of waterbird species, and threats are being monitored, reported and mitigated

Fair: Stable or a small increasing trend in the abundance and distribution of waterbird species, and threats are in part being monitored, reported and mitigated

Poor: Significant declining trend in the abundance and distribution of waterbird species, and threats are not being monitored, reported or mitigated

Why this assessment in 2021?

Status: There is clear evidence of the long-term and ongoing decline in a number of species surveyed each year since 1983.

Trend: The declining trend is well established and likely to continue due to reduced river flows.

Data Confidence: The Eastern Australian Waterbird survey is a good and robust source of longitudinal data.

Should this indicator be used in the SoE 2023 report?

Yes.

Summary of SoE 2018 Report assessment

- The Eastern Australian Waterbird survey has each year, since 1983, collected and analysed data on waterbird species across the Murray-Darling Basin.
- A reduction in water flow has contributed to a long-term decline in the total abundance of waterbirds.
- Floods trigger breeding in many species, and wetland systems flooded after a dry period support large numbers of waterbirds compared to permanently flooded sites.

The 2019–20 bushfires: Impacts and responses

Although largely removed from the fire-affected areas, the Murray-Darling Basin above the Hume Dam, and the upper Murrumbidgee River and Mitta Mitta River were affected by bushfires. However, this represents a small percentage of the region that this indicator covers. How this has affected the Murray-Darling Basin downstream of the fire-affected areas is unclear, as is the effect on waterbirds.

SoE Biodiversity Update 2021 Report assessment

The Murray-Darling is Australia's most developed river basin, with 240 dams that can store 29,893 GL. This water resource management has reduced flows and, according to Kingsford, Bino, Porter (2016), caused long-term ecological impacts for freshwater fauna.

Wetlands and rivers

In their research they 'identified significant long-term declines in total abundances, functional response groups (e.g. piscivores (fish-eating birds)) and individual species of waterbird, associated with reductions in cumulative annual flow. These trends indicated ecosystem level changes.'⁶⁶¹

Between 1983 and 2020, the annual Eastern Australian Waterbird survey has surveyed the distribution and abundance of up to 96 waterbird species that include herons, egrets, large and small waders, migratory shorebirds, ducks and terns.⁶⁶² Between 1983 and 2015 the surveys showed a 72% decline in waterbird abundance across the Murray-Darling Basin.

Kingsford, Bino, Porter (2017) 'identified significant long-term declines in total abundances, functional response groups (e.g. piscivores) and individual species of waterbird (n=50), associated with reductions in cumulative annual flow.' These trends indicated ecosystem level changes. The scientists also modelled the effects of the Australian Government buying up water rights and returning the water to the riverine environment. They explained that the cost of this purchase was greater than \$3.1 billion (Australian dollars) and were projected to partly (18% improvement) restore waterbird abundances. However, 'projected climate change effects could reduce these benefits considerably to only a 1% or 4% improvement, with respective annual recovery of environmental flows of 2,800 GL or 3,200 GL.'⁶⁶³

Since the release of the SoE 2018 Report there have been a further three annual waterbird surveys, which again show a continuing decline in waterbird abundance.

The 2018 survey⁶⁶⁴ reported that Victoria had experienced its eighth driest year and its warmest year on record, and drought had intensified. Declines from the previous year were recorded for each of the major indices – total abundance, breeding index, number of species breeding and wetland area index – monitored by the survey. Long-term declines had set in for total abundance, wetland area and breeding species richness.

The survey conducted in 2019⁶⁶⁵ also reported a very dry year, with the basin experiencing its worst 2–3-year drought in 120 years. Victoria recorded its hottest day on record during the year. The wetland area index was at its lowest since the surveys began in 1983, with birds concentrated in a small number of wetlands.

The most recent survey in 2020,⁶⁶⁶ a year in which Victoria received its average rainfall, found a

continuation of the long-term trend of decline in total abundance, breeding index, number of species breeding and the wetland area index.

Across these three survey years, each of the functional bird groups – ducks, herbivores, large wading birds, piscivores and shorebirds – all declined in abundance. Five of the bird species subjected to hunting – black duck, Australasian shoveler, grey teal, Australian shelduck and Australian wood duck – have experienced long-term declines, while another three hunting targets, the hardhead, chestnut teal and pink-eared duck, have shown no trend.

The hunting of the above eight ducks is allowed in Victoria, one of the three states where it continues. In 2020 there were 60,400 ducks shot in Victoria, about a quarter of the number in 2019 due to COVID-19, the bushfires and reduced duck numbers.⁶⁶⁷ The 2021 season was reduced from three months to 20 days. A 2020 report by the DJPR revealed that the gross economic contribution of duck hunting was \$65 million, however, that had declined by 28% since 2013.⁶⁶⁸

Conservation groups argue that duck hunting should be banned, as it is in Western Australia, NSW and Queensland because of the:

- steep decline in duck populations, which will continue as climate change reduces wetlands
- wounding, death and disturbance of non-target birds, some of which are threatened
- damage to wetlands.

Menkhorst (2019) assessed the susceptibility of 39 waterbird species to disturbance from hunting.⁶⁶⁹

Those with the highest susceptibility included herons, egrets, bitterns, gulls and terns, and sandpipers and their relatives. Menkhorst believes that 'susceptibility ranking, combined with the recommendations of significant population numbers, provide a clearer and more defensible basis for decisions about the need for further management interventions at individual wetlands.'⁶⁷⁰

661. Ibid

662. Kingsford R, Porter J, Brandis K and Ryall S 2020, 'Aerial surveys of waterbirds in Australia', Scientific Data, 7, Article 172, Supplementary information.

663. Kingsford R, Bino G and Porter J, 2017, 'Continental impacts of water development on waterbirds, contrasting two Australian river basins: global implications for sustainable water use', *Global Change Biology*, pp. 1–12.

664. Porter J, Kingsford R and Brandis K 2018, 'Aerial survey of wetland birds in eastern Australia: October 2018 annual summary report', Centre for Ecosystem Science, Sydney, NSW.

665. Ibid

666. Porter J, Kingsford R, Francis R and Brandis K 2020, 'Aerial survey of wetland birds in eastern Australia: October 2020 annual summary report', Centre for Ecosystem Science, Sydney, NSW.

667. ABC News 2021, 'Shortened Victorian duck hunt set to go ahead in May, angering animal activists and the Opposition', *ABC News*, 23 February 2021.

668. DJPR 2020, 'Economic contribution of recreational hunting in Victoria, final report', prepared by RMCg, Melbourne, Victoria.

669. Menkhorst P 2019, 'Assessing waterbird susceptibility to disturbance by duck hunters in Victoria', technical report series no. 305, Arthur Rylah Institute, Heidelberg, Victoria.

670. Ibid

Wetlands and rivers

Indicator B:15 Freshwater macroinvertebrate species

B:15 Freshwater macroinvertebrate species Region Statewide Measures Total macroinvertebrate richness; Total Ephemeropter (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies); Stream Invertebrate Grade Number Average Level (SIGNAL2); Australian River Assessment System observed/expected index (AUSRIVAS O/E) Data Custodian Nil	Indicator Performance:	2018 Status	2018 Trend	2018 Data
	2018: Unable to be assessed due to Fair Status and Data			
	2021: Not assessed	2021 Status	2021 Trend	2021 Data
	Why this indicator? Inland aquatic macroinvertebrates are widely used as a proxy for aquatic health assessment of ecosystem condition.			

Potential thresholds for status in the SoE 2023 report

Good: Significant increasing trend in the abundance and distribution of threatened freshwater macroinvertebrate species, and threats are being monitored, reported and mitigated

Fair: Stable or small increasing trend in the abundance and distribution of threatened freshwater macroinvertebrate species, and threats are in part being monitored, reported and mitigated

Poor: Significant declining trend in the abundance and distribution of threatened freshwater macroinvertebrate species, and threats are not being monitored, reported or mitigated

Why this assessment in 2021?

Status: Status cannot be determined due to the data used in SoE 2018 no longer being collected. That data was not a measure of abundance and distribution.

Trend: Not assessed.

Data Confidence: Data insufficient.

Should this indicator be used in the SoE 2023 report?

Not in its current form. The data referred to in the measures are no longer being collected and were not targeting abundance and distribution. Instead, they were used as a proxy for river health. Consideration could be given to including the collection of macroinvertebrate data in the indices for estuary, stream and wetland condition. Consideration could also be given to replacing this indicator with one focusing on the freshwater mega-macroinvertebrates e.g. mussel and crayfish species and merge this indicator with B:04C (Murray crayfish). However, data on mega macroinvertebrates are also currently limited.

Summary of SoE 2018 Report assessment

- The RiverMAP Long Term Sites Project provided trends in aquatic macroinvertebrate biodiversity across 66 sampling sites (RiverMAP has since ended).
- The overall condition of inland aquatic macroinvertebrates across Victoria's 66 long-term monitoring sites was stable. However, the Cleared Hills and Coastal Plains and Murray and Western Plains bioregions had low numbers of sensitive taxonomic macroinvertebrate groups indicating poor stream health compared to Highlands and Forests A and B. Streamflow and land use were factors leading to this difference.

The 2019–20 bushfires: Impacts and responses

There are no data available on the impacts of the 2019–20 bushfires on freshwater macroinvertebrates. However, monitoring by the Environment Protection Authority before and after the 2003 bushfires can provide some insight. The Authority reported on the impact of the bushfires on aquatic macroinvertebrate fauna monitored at five stream sites in the year after the fires.⁶⁷¹ The results varied across the sites. The Tambo River site was showing no recovery, the Snowy Creek was returning quickly to pre-fire condition and the other three sites varied between these extremes.

⁶⁷¹ Environment Protection Authority 2005, 'An assessment of the condition of the aquatic macroinvertebrate fauna at five stream sites affected by the 2003 Victorian bushfires', Melbourne, Victoria.

Wetlands and rivers

SoE Biodiversity Update 2021 Report assessment

This indicator in the SoE 2018 Report used data from the RiverMAP and Index of Stream Condition programs. The measure used for Index of Stream Condition was a family-based index of aquatic biota condition i.e. Stream Invertebrate Grade Number Average Level (SIGNAL), often used also as a proxy for water and habitat quality. The RiverMAP

program was not designed to provide a statewide assessment or 'abundance and distribution' of aquatic macroinvertebrates. The program largely aimed to provide a modelled view of aquatic macroinvertebrates across the state – filling the gaps at unsampled locations was the goal and the sites were sampled to validate these models. The modelling framework, the report and underlying data exist and will be updated as needed for input into a future statewide assessment.⁶⁷²

Indicator B:16 Wetland extent and condition

Region Statewide	Indicator Performance:	2018 Status	2018 Trend	2018 Data
Measures Extent and condition of wetlands	2018 & 2021: Unable to be assessed due to Unknown Status and Trend and Low Data Confidence		?	
Data Custodian DELWP	Why this indicator? Wetlands provide important ecosystem services to the environment and the community.	2021 Status	2021 Trend	2021 Data
			?	

Potential thresholds for status in the SoE 2023 report

Good: Wetland extent and condition improving significantly

Fair: No or small improvement in wetland extent and condition

Poor: Significantly declining wetland extent and condition

Why this assessment in 2021?

Status: The Murray-Darling Basin waterbird survey indicates that the extent of some wetlands is in decline. However, environmental watering is being used to help recover the health of some wetlands and the synthesis of the WetMAP program has shown that this can benefit the receiving wetlands.

Trend: Unknown.

Data Confidence: Research on wetlands is ad hoc and largely focussed on iconic wetlands. However, the WetMAP program has broadened the geographical scope of data gathering.

Should this indicator be used in the SoE 2023 report?

Yes, however it will require data collection beyond the iconic sites and include wetlands on private land.

Summary of SoE 2018 Report assessment

- More than a quarter of Victoria's wetlands have been lost since European settlement.
- Of the 149 wetland EVCs, nearly all are threatened in at least one Victorian bioregion and over 75% of all wetland EVCs across Gippsland Plain, Glenelg Plain, Otway Plain, Victorian Riverina, Victorian Volcanic Plain and Warrnambool Plain are considered Endangered or Vulnerable.

- The Index of Wetland Condition indicates that cropping in wetlands is reasonably common and that certain types of wetlands are more vulnerable than others to the impacts from cropping.

The 2019–20 bushfires: Impacts and responses

The main wetlands in eastern Victoria, where the 2019–20 fires were concentrated, are the coastal lagoons and estuaries e.g. Gippsland Lakes. Previous research by Sinclair Knight Mertz (2008)

⁶⁷². Information from DELWP Waterways Division.

Wetlands and rivers

indicated that bushfires in the summers of 2003 and 2006–07 led to large increases in loads of suspended sediment, nitrogen and phosphorus compared to background levels in the lakes.⁶⁷³ In January 2020, there were media reports of ash and sediment damage in the Tambo River and concerns about the potential impact on the Gippsland Lakes. However, there have been no subsequent reports.

SoE Biodiversity Update 2021 Report assessment

The Index of Wetland Condition is one of the measures used for this indicator's assessment. From the SoE 2018 Report: 'These assessments confirmed that while the IWC provides condition data for individual wetlands, the resources available for undertaking IWC assessments restrict its use to a small percentage of Victoria's 25,000 naturally occurring wetlands (e.g. approximately 3% in 2009–11).' In using results from a subset of wetlands, the Index of Wetland Condition cannot be extrapolated to obtain a statewide snapshot of condition. DELWP is using Landsat data to assess changes to water regimes.⁶⁷⁴

WetMAP was a statewide monitoring program designed to assess the ecological responses of vegetation, waterbirds, frogs and fish to the delivery of water for the environment in Victorian wetlands. Monitoring for WetMAP (2016–20) was coordinated by the Arthur Rylah Institute and funded through the Victorian Government's four-year and \$222 million investment to improve catchment and waterway health.

The WetMAP 2016–2020 synthesis report⁶⁷⁵ released in 2021 summarises the responses of four target groups – vegetation, birds, frogs and fish – to the delivery of environmental water to wetlands. In all, 66 sites (two near Geelong and the remainder along the Murray River and its tributaries in the north of the state) were monitored for the four target groups: 22 for vegetation, 30 for frogs, 25 for birds and 15 for fish. The Arthur Rylah Institute scientists involved in the monitoring framed a number of key evaluation questions. These and their answers are summarised (with their responses) in Table 66. The response to environmental watering was positive for each of the four target groups.

Table 66: Key evaluation questions and their outcomes among the four biota themes.⁶⁷⁶

Key Evaluation Question	Was a Response to Watering Events Detected?
Vegetation	
Do environmental water events:	
increase native wetland plant species richness?	Yes. There were significantly more wetland species in the inundated and drawdown treatments than in the dry treatment
increase the cover of native wetland plant species?	Yes. There was significantly higher cover in the inundated and drawdown treatments than in the dry treatment.
reduce the cover of terrestrial plant species in wetlands?	Yes. There was significantly lower cover of terrestrial species in the inundated and drawdown treatments than in the dry treatment.
improve the condition of lignum in wetlands?	No. There was no significant difference in lignum condition between drawdown treatments and the dry treatment. However, lignum condition was already high in the dry treatment (likely a response to antecedent conditions).
lead to growth and flowering of mature wetland tree species?	Tip growth – yes. Flowering – no. The survey time frame was likely too short to detect effects that are more likely to be influenced by antecedent hydrology.
Did environmental watering over the Stage 3 monitoring period support the survival of mature trees?	Indeterminate. Survivorship was high, though mortality was observed in some wetlands – especially from overwatering.

673. Sinclair Knight Mertz 2008, 'Bushfire impacts on water quality in the Gippsland Lakes', Armadale, Victoria.

674. Data supplied by DELWP.

675. Papas P, Hale R, Amtstaetter F, Clunie P et al. 2021, 'Wetland monitoring and assessment program for environmental water: stage 3 final report', technical report series no. 322. Arthur Rylah Institute, Heidelberg, Victoria.

676. Ibid

Wetlands and rivers

Table 66: Key evaluation questions and their outcomes among the four biota themes cont'd.

Key Evaluation Question	Was a Response to Watering Events Detected?
Frogs	
Do environmental water events:	
increase the abundance of frog species in wetlands?	Yes. Abundances of all species were higher at watered than dry wetlands.
increase the species richness of frogs in wetlands?	Yes. More species were observed at watered than dry wetlands.
precipitate breeding by frogs in wetlands?	Yes. Breeding records were relatively rare, but all breeding was observed at watered wetlands.
Birds	
Do environmental water events:	
increase abundance and richness of waterbirds?	Yes. Abundance and species richness of all waterbirds and individual guilds, were higher following watering.
result in waterbird breeding?	Yes. While breeding records were relatively rare, most breeding was recorded at watered sites.
increase suitable habitat for waterbirds?	Yes. Watering increased the availability of several habitat types.
increase the abundance and richness of woodland birds?	No. Richness and abundance of woodland bird species were not significantly increased following watering.
Fish	
Is seasonal fish production (increase in the number of fish from late winter to summer) greater in wetlands that receive environmental water than in wetlands that do not?	Yes. Early findings support our conceptual model that greater inundation from environmental watering results in more fish.
Does watering regime influence native fish species richness and abundance in wetlands?	Perhaps. Greater native fish density was observed in naturally flooded wetlands and greater native species richness was observed in wetlands with long-term connections to the Murray River. However, these results were not statistically significant, and more data are required.
Do environmental water events provide opportunities for fish to move between wetlands and rivers?	Yes. There was directional movement of fish in wetland channels when environmental watering events provided connections with wetlands.
Do Murray Hardyhead (<i>Craterocephalus fluviatilis</i>) persist in saline wetlands where environmental water is effectively used to maintain wetland salinity levels within the range required for successful spawning and recruitment?	Yes. Relatively high abundances of Murray Hardyhead were only observed in wetlands and years when salinity was within the range required for successful spawning.

Wetlands and rivers

The focus of the Murray-Darling Basin Authority's Living Murray Program is to meet the ecological objectives at its icon sites through a combination of environmental water delivery and works. Monitoring tracks progress towards objectives, however it does not in itself improve the health of the icon sites. Four of the icon sites are in Victoria: Barmah Forest,

Gunbower Forest, Hattah Lakes and Lindsay, Mulcra and Wallpolla Islands. They have been chosen as icon sites due to their high ecological values and cultural significance. The report cards for each icon site are summarised in Table 67, which indicates that their health ratings range from B to A.⁶⁷⁷

Table 67: Health of Victorian icon sites 2018-2019.⁶⁷⁸

Wetland	Score	Comments	Vegetation	Water Delivered/Used	Waterbirds	Fish	Other
Barmah-Millewa	B	Dry conditions and reduced opportunities to deliver water for the environment saw a small decline in the overall health	B	172.2GL/57.7GL	A	B	C
Gunbower Forest	A	Water for the environment is helping improve the condition of the forest and the wetlands despite the dry landscape, providing an important refuge for waterbirds and fish	A	42.7GL/3.8GL	A	B	n/a
Hattah Lakes	B	Following five consecutive years of water for the environment delivery, together with natural flooding in 2016, the lakes went through a drying phase this year. Combined with record summer temperatures and low rainfall the condition of Hattah Lakes Icon Site slightly declined	B	0.3GL/0.3GL	A	A	n/a
Lindsay, Mulcra and Wallpolla Wetlands	B	Water for the environment is helping to maintain the health of Lindsay, Mulcra and Wallpolla Wetlands after natural flooding in 2016-17, however continued hot and dry conditions will see the health of the site decline. Note that only a very small area of this icon site can be actively watered (around 5%)	B	0.7GL/0.7GL	B	B	n/a

677. Murray-Darling Basin Authority, 'Progress and outcomes', Canberra, Australia <https://www.mdba.gov.au/issues-murray-darling-basin/water-for-environment/progress-outcomes> Accessed 9 May 2021.

678. Ibid

Wetlands and rivers

Melbourne Water and Ecology Australia (2020) released a report on the Index of Wetland Condition for 28 wetlands in the Melbourne metropolitan area,⁶⁷⁹ including 11 seasonal herbaceous wetlands, four billabongs, three saline wetlands and 11 other wetlands. The conditions assessment used six sub-indices: biota, wetland catchment; water properties; hydrology; physical; form; and soils. The results of their condition assessments were as follows:

- 11 seasonal herbaceous wetlands: eight in 'Good' condition
- Four billabongs: two in the upper Yarra were in 'Good' condition, two in the lower Yarra 'Moderate'
- Three saline wetlands: one 'Excellent' and two 'Good'
- 11 other wetlands: three 'Excellent' and eight 'Good'.

In western Victoria a blue gum plantation on the Wannon River floodplain has been transformed into a wetland by ecologists from the NatureGlenelgTrust. The land, originally a wetland, was drained in the 1950s for grazing, suffered further water diversions in the 1970s and became a blue gum plantation in the early 2000s. As water returned to the wetland, brolga, growling grass frog, long-neck turtle and freshwater fish returned.⁶⁸⁰

The Nature Conservancy, the Murray Darling Wetlands Working Group and Kilter Rural have partnered to establish the Murray-Darling Basin Balanced Water Fund, which invests in permanent water rights and allocates these to either the environment or irrigation depending on water availability. By mid-2020, the outcomes of the fund had been:

- the donation of 1,294 ML of water (complemented 2,613 ML provided by the Commonwealth Water Holder) to 23 wetlands in the basin
- three wetlands in Victoria – Yambuna Lagoon, O'Kane's Swamp and The Plain Paddock – received 562 ML from the fund

- support for 14 threatened species of birds, frogs and fish
- an estimated area for improved biodiversity outcomes of 4,600 hectares
- an average increase in bird diversity of 212% and in bird abundance of 282% from the watering events.⁶⁸¹

The Victorian Environmental Water Holder provides funding to catchment management authorities to undertake management interventions at the priority wetland sites identified in their Regional Water Strategies. These cover more than just 'iconic' wetlands. In some places there is too much water e.g. increased urban stormwater runoff, or permanent inundation due to river regulation.

The Waterways Division of DELWP is planning to have statewide data on wetland condition to prepare statewide condition snapshots for applications such as State of Environment reporting. This will incorporate statewide information on the status of other threats to wetland condition.⁶⁸² It will also use a metric that indicates the degree of impact to water regimes based on the recent analysis of inundation using Landsat Imagery for the last 30 years. The Division is currently working with a team of hydrologists from the University of Melbourne, along with input from wetland policy experts, ecologists and on-ground managers to:

- determine how the water regimes of wetlands have been affected across the state over the last 30 years
- identify drivers for any identified hydrological trends
- identify level of threat to wetlands at local, regional and statewide scales and inform risk assessments
- provide statewide knowledge of water regimes and improve wetland tools (e.g. wetland inventory)

679. Melbourne Water and Ecology Australia 2020, 'Index of wetland condition and monitoring round 2 report', Melbourne, Victoria.

680. Bissland E 2021, 'Ecologists buy 1000-acre blue gum plantation and transform it into wetland it once was', *ABC South West Vic*, 7 February 2021.

681. The Nature Conservancy, 'Environmental Water Trust: environmental impact summary fund to date (2015–June 2020)', Carlton, Victoria.

682. DELWP Waterways Division personal communication.

683. Casanova M and Casanova A 2016, 'Current and future risks of cropping wetlands in Victoria', technical report, DELWP, East Melbourne, Victoria.

Wetlands and rivers

Case study: Cropping in wetlands

Cropping is an increasing threat to wetlands in Victoria. It mainly occurs in wetlands that are dry, shallow and fresh to brackish⁶⁸³ and usually on plains. Cropping of wetlands can:

- reduce plant germination and diversity
- impact invertebrate diversity and abundance
- reduce food supply for amphibians, reptiles and mammals through chemical and physical disturbances
- reduce their support for waterbird breeding and feeding fragment the wetland landscape and reduce resilience.

Casanova and Casanova (2016) investigated the impacts of wetland cropping in the South East Grampians and West Wimmera. They found that between 2010 and 2016, the number of wetlands cropped increased from 2% to 46%, whereas in West Wimmera it had remained stable at 20%. They recommended management guidelines for unimpacted wetlands, buffers between crops and wetlands, the preservation of connectivity and the prioritising of wetlands and wetland mosaics for restoration. The scientists concluded that the rapid rate of change detected made it necessary to implement conservation measures as soon as possible.

A more recent analysis of cropping in the South East Grampians Cluster by Farrington et al. (2020) for the Nature Glenelg Trust investigated 2,247 wetlands. It found that 55% were cropped to some extent, 21% entirely cropped, 16% cropped at the edge and across areas of the bed, and 18% along the edge only. In terms of wetland area, 60% (24,000 hectares) had been cropped to some extent, with 10% (3,784 hectares) cropped entirely. The cropped area had increased since 2016, although at a slower rate than between 2010 and 2016.

⁶⁸⁴. Farrington L, Cranswick R, Elotrovic Z and Kerr G 2020, 'Wetlands spatial analysis', report for the Glenelg Hopkins Catchment Management Authority by Nature Glenelg Trust, Mount Gambier, South Australia.

Wetlands and rivers

Indicator B:17 Health and status of Ramsar wetlands in Victoria

B:17 Health and status of Ramsar wetlands in Victoria

Region Statewide

Measures Ecological condition of Ramsar wetlands

Data Custodian DELWP

Indicator Performance:

2018: Unable to be assessed due to Unknown Status and Trend and Low Data Confidence

2021: Unable to be assessed due to Fair Status and Moderate Data Confidence

Why this indicator? As part of the Ramsar Convention, management agencies are to maintain the ecological character description for each site.

2018 Status 2018 Trend 2018 Data



2021 Status 2021 Trend 2021 Data



Potential thresholds for status in the SoE 2023 report

Good: The Ecological Condition of all sites has been maintained or improved

Fair: The Ecological Condition of most sites has been maintained or improved

Poor: The Ecological Condition of most sites is in decline

Why this assessment in 2021?

Status: There is now a clearer picture of the ecological condition of Victoria's Ramsar sites, with only three of the 12 potentially experiencing a decline. Environmental watering programs have been positive for sites on regulated rivers.

Trend: Except for a potential decline in the ecological character of three sites, most sites are stable in their condition and there have been improvements in governance, monitoring and management.

Data Confidence: Monitoring and data collection have improved since the audit by the Victorian Auditor-General's Office in 2016. This is acknowledged by a change in Data Confidence from Low to Moderate.

Should this indicator be used in the SoE 2023 report?

Yes.

Summary of SoE 2018 Report assessment

- Victoria had 11 Ramsar sites (now 12, with the Glenelg River and Discovery Bay site listed in 2018), of which 6 were inland and covered 98,623 hectares.
- In 2016, the Victorian Auditor-General's Office found limited evidence that ecological character descriptions for each site were being maintained.
- Where information was available, it showed that some Ramsar sites were not being effectively managed and protected from ecological decline. For these sites, the declines were attributed to changed water regimes, water quality, recreational use, agricultural use, invasive species and climate change
- Due to limited data, the SoE 2018 Report could not determine the health status of the sites.

The 2019–20 bushfires: Impacts and responses

The catchments of the Gippsland Lakes and Barmah Forest Ramsar sites were impacted by the 2019–20 bushfires. However, there are no reports available on bushfire impacts for either site.

SoE Biodiversity Update 2021 Report assessment

Victoria has 12 Ramsar sites (Figure 57), of which six are inland and cover 98,623 hectares. As part of the Ramsar Convention, Victorian management agencies are responsible for maintaining the ecological character description for each site.

In 2016, the Victorian Auditor-General's audit of Ramsar wetlands⁶⁸⁶ was critical of site management and monitoring and concluded that improvements in governance, coordination and oversight were

⁶⁸⁶ Victorian Auditor-General's Office 2016, 'Meeting obligations to protect Ramsar wetlands', Melbourne, Victoria.

Wetlands and rivers

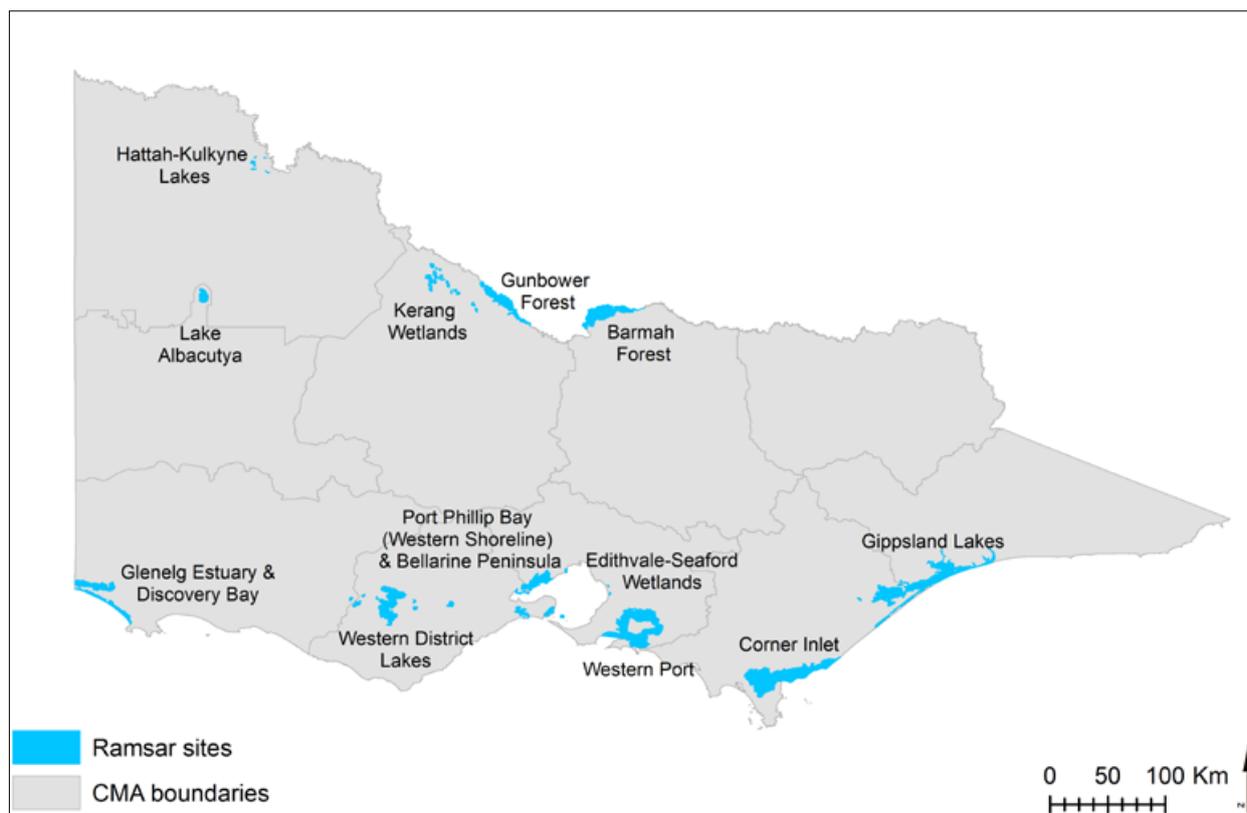


Figure 57: Victoria's Ramsar sites.⁶⁸⁵

required. There was also evidence of potential negative change in the ecological condition of some sites. The Auditor-General also found that Ecological Character Descriptions and Ramsar Information Sheets were out of date, funding was inadequate and management plans failed to meet Australian guidelines. DELWP and other managers accepted

the findings and recommendations of the audit and have, in response, improved the governance arrangements by developing a management framework and establishing a statewide inter-agency governance group and 12 individual site coordinating committees. Table 68 summarises the recommendations and the government response.

Table 68: Government response to the recommendations of the Auditor-General's audit of Ramsar site management.⁶⁸⁷

Victorian Auditor-General's Recommendation	Government Response
<p>Recommendation 1</p> <p>Improve Ramsar governance and agency accountability</p> <p>Set out timeframes and resourcing for Ramsar management plan actions</p>	<p>Establishment of statewide Inter-agency Governance Group</p> <p>Establishment of 12 individual Ramsar site coordinating committees</p>
<p>Recommendation 2</p> <p>Finalise outstanding Ramsar site management plans</p> <p>Prioritise resources to target high priority threats</p> <p>Improve oversight of implementation of Ramsar management plans</p>	<p>Development of framework to implement Ramsar site management plans (annual action plan development and review, and six-monthly investment reporting)</p> <p>Development of an online management tool for tracking implementation of plans and status of ecological character</p> <p>Plans for Port Phillip Bay and Western Port Ramsar sites finalised</p>
<p>Recommendation 3</p> <p>Develop a Ramsar monitoring, evaluation, reporting and improvement framework</p>	<p>Development of statewide MERI framework and individual MERI plans for each Ramsar site</p>

685. Public Accounts and Estimates Committee 2020, 'Inquiry into Auditor-General's report no. 202: meeting obligations to protect Ramsar wetlands 2016', Parliament of Victoria, Melbourne, Victoria.

687. DELWP 2020, 'Submission to the Public Accounts and Estimates Committee 2020 Inquiry into Auditor-General's report no. 202: meeting obligations to protect Ramsar wetlands 2016', Parliament of Victoria, Melbourne, Victoria.

Wetlands and rivers

A 2020 Victorian Parliamentary inquiry⁶⁸⁸ into the effectiveness of Ramsar site management acknowledged the improvements made to the governance arrangements by DELWP, which resulted in a better understanding of agency roles. The inquiry by the Public Accounts and Estimates Committee also found that DELWP had established a framework to strengthen site management, finalise management plans and prepare annual action plans, which target site threats. The Committee's report also noted the establishment of a MERI Framework, an online

Ramsar Management System and the collection of more data to support the development of the Limits of Acceptable Change for all critical components.

Table 69 shows the new roles for each of the agencies involved in the management of Ramsar sites. DELWP is the statewide coordinator, catchment management authorities convene the site coordinating committees in their regions, Parks Victoria is the site manager for 11 sites and Melbourne Water the site coordinator and manager for one site.

Table 69: New roles or agencies responsible for Ramsar sites in Victoria.⁶⁸⁹

Agency	Role	Responsibility (Summary)
DELWP	Ramsar statewide coordinator	Oversees implementation of Ramsar Convention obligations in Victoria Reports to Commonwealth Department of Environment and Energy Updates Ramsar site documentation Convenes Ramsar Inter-Agency Governance Group
Catchment Management Authorities	Ramsar site coordinator	Responsible for convening Ramsar site coordinating committees which oversee the implementation of Ramsar site management plans and MERI plan, and develop annual action plans Report to the statewide coordinator
Parks Victoria	Ramsar site manager (for 11 sites)	Take part in site coordinating committees Implement agreed actions from management plan Notify the site coordinator of any indication of a potential change in ecological character
Melbourne Water	Ramsar site manager and site coordinator	Ramsar site manager and site coordinator for Edithvale-Seafood Wetlands

Although the Public Accounts and Estimates Committee noted that most site management plans had not been updated since the Victorian Auditor-General's Office audit, recent reports indicate progress. All 12 Ramsar sites now have up-to-date management plans that meet the Australian Ramsar Management Principles under the EPBC Act. Five sites have standalone plans published on the DELWP website. Interim Ramsar site

management plans were developed for six sites (Gunbower Forest, Kerang Lakes, Barmah Forest, Western District Lakes, Corner Inlet and Hattah-Kulkyne Lakes) to fill gaps identified by the audit of the Victorian Auditor-General's Office, followed by an analysis of these plans against the Australian Ramsar Management Principles. The Lake Albacutya Ramsar Site Management Plan was found to meet all requirements of the Australian Ramsar Management

688. DJPR 2020, 'Economic contribution of recreational hunting in Victoria, final report', prepared by RMCG, Melbourne, Victoria.

689. Menkhorst P 2019, 'Assessing waterbird susceptibility to disturbance by duck hunters in Victoria', technical report series no. 305, Arthur Rylah Institute, Heidelberg, Victoria.

Wetlands and rivers

Principles and did not require an interim Ramsar management plan. These interim plans complement the Ramsar site management plans embedded in regional waterway strategies. Table 70 lists some of the values, threats, actions and outcomes for five of the Ramsar sites in Victoria.

However, in evidence given to the Public Accounts and Estimates Committee inquiry, DELWP reported that three Ramsar sites faced potential threats to their ecological character:

- Barmah Forest: Experiencing a decline in moira grass due to grazing pressure, drought and unseasonal operational water delivery
- Western District Lakes: The Limits of Acceptable Change for salinity and hydrology being exceeded in two of the lakes, potentially due to climate change

- Gippsland Lakes: The Limits of Acceptable Change for salinity was exceeded in Lake Wellington due to rising sea levels and reduced inflows of freshwater.

Since the Parliamentary Inquiry, there has been progress in the updating of ecological character descriptions. Four sites now have addenda to their ecological character descriptions published on the DELWP website and include ecological character status. Three additional sites – Port Phillip Bay and Bellarine Peninsula; Glenelg River and Discovery Bay; Hattah-Kulkyne Lakes – did not require an update to the ecological character descriptions, although analysis indicated there had been no change. The addendum for the Gunbower Forest site is in the late draft stage, with analysis showing no change in ecological character, while the Lake Albacutya site will be assessed when the results of long-term monitoring become available.⁶⁹⁰

Table 70: Values, threats, actions and outcomes for five Ramsar sites in Victoria.⁶⁹¹

Values	Threats	Actions	Outcomes
Glenelg Estuary and Discovery Bay			
Nationally listed saltmarsh and eight nationally listed threatened species Supports threatened Australasian bittern, great knot, eastern curlew, fairy tern, hooded plover, Yarra pygmy perch and growling grass frogs 24 international migratory species	Pest plants and animals Changed hydrology Climate change (drying conditions, sea level rise, more frequent storms)	Long Swamp restoration with the installation of weir to block an artificial outlet to the sea Revegetation Fencing to exclude stock Removal of fish barriers and habitat creation Pest plant and animal control	70 ha inundated to increase connectivity and availability of aquatic habitats Improved wetland condition; movement of juvenile tupong between estuary and Long Swamp; increased habitat for greenling
Gunbower Forest			
Second-largest river red gum forest in Murray-Darling Basin Breeding site for 48 bird and 3 species of turtle Supports 5 nationally listed threatened species Provides migratory routes for native fish	Pest plants and animals Drought Altered water regimes (decreased inundation) Off-road vehicle use	Installation of wetland regulators and the Hipwood Channel Delivery of environmental water Pest plant and animal control including carp	Watering of almost 5,000 ha Supported breeding of many birds Improved conditions for native fish and their recovery Healthy population of Murray cod Aquatic plants flourished after removal of 1,170 kg of carp in 2017

690. Data supplied by DELWP.

691. DELWP 2020, 'Transcript and PowerPoint of presentation to Public Accounts and Estimates Committee Inquiry into the Auditor-General's report no. 202, meeting obligations to protect Ramsar wetlands (2016)', Parliament of Victoria, Melbourne, Victoria.

Wetlands and rivers

Table 70: Values, threats, actions and outcomes for five Ramsar sites in Victoria cont'd

Values	Threats	Actions	Outcomes
Gippsland Lakes			
<p>Supports over 20,000 waterbirds</p> <p>Supports ecologically significant coastal saltmarsh and seagrass</p> <p>Supports nationally listed threatened species: 9 fauna, 3 flora</p> <p>Supports >1% of chestnut teal, little tern, and fairy tern populations</p> <p>Supports one of only two known populations of Burrunan dolphin</p>	<p>Increased salinity levels</p> <p>Potential change in ecological character due to rising sea levels, reduced freshwater inflows and climate change</p> <p>Pest plants and animals</p> <p>Nutrient runoff from catchment (algal blooms)</p>	<p>Beach sand renourishment of bird-breeding sites with dredged spoil from channel maintenance</p> <p>Pest plant and animal control</p> <p>Wetland protection and enhancement</p> <p>Delivery of environmental water</p>	<p>Resident and migratory birds using renourished sites</p>
Barmah Forest			
<p>Important site and drought refuge for waterbirds, frogs, native fish and turtles</p> <p>Supports 533 native species of flora and 273 fauna</p> <p>Supports 7 nationally listed threatened species</p> <p>Supports breeding of waterbirds, frogs, native fish and turtles</p>	<p>Pest plants and animals</p> <p>Drought</p> <p>Altered water regimes (decreased inundation)</p>	<p>Delivery of environmental water</p> <p>Fencing</p> <p>Pest plant and animal control</p>	<p>Growth of threatened plants e.g. moira grass</p> <p>Native fish breeding</p> <p>Waterbird breeding</p> <p>Exclusion of feral pigs and horses leading to growth of native vegetation</p>
Hattah-Kulkyne Lakes			
<p>Largest series of floodplain lakes along the Murray River</p> <p>3 threatened species - Australian painted snipe, regent parrot, winged peppergrass</p> <p>12 international migratory waders</p> <p>70 species of waterbird (34 breed at the site)</p> <p>Small bodied native fish breeding habitat</p>	<p>Pest plants and animals</p> <p>Changes to hydrology</p> <p>Climate change Decreased rainfall</p>	<p>Delivery of environmental water</p> <p>Installation of a pump station, four regulators and three levies</p> <p>Pest plant and animal control</p>	<p>Recovery of wetland vegetation with significant increases in threatened plants</p> <p>Feeding habitat for waterbirds</p> <p>Breeding of some birds</p> <p>Inundation of 6,000 ha, including the lakes</p>

Wetlands and rivers

Parks Victoria is the site manager for 11 of Victoria's 12 Ramsar sites (Melbourne Water manages the Edithvale-Seaford Wetlands) and many other wetlands on public land. However, 11 of the sites also include private land. Although the proportion that is private land within Ramsar sites is very small, according to the Trust for Nature 'there are no explicit management guidelines or policy mechanisms applied to that private land portion of these Ramsar wetlands to ensure that their ecological values are maintained.'⁶⁹² The Trust recommends formal protection, such as an in-perpetuity conservation covenant, as well as policies and guidelines for the use of private land that adjoins Ramsar sites and an incentive program to assist landholders.

In its submission to the Victorian Parliamentary Inquiry by the Public Accounts and Estimates Committee, the Victorian National Parks Association⁶⁹³ recommended that:

- land use planning schemes should be required to contain wetland overlays to prohibit destruction or modification of high-value wetlands, as identified by catchment management authorities, and including all Ramsar sites
- the *Flora and Fauna Guarantee Act* be used to protect high-value wetlands that provide habitat for threatened species by declaring them as critical habitat and, where they are under imminent threat, by issuing interim conservation orders
- all public land in Ramsar wetland sites be protected within the parks estate.

Hansen et al. (2021) analysed data on shorebird numbers at 22 Ramsar sites around Australia and New Zealand to determine whether there had been potential changes in their ecological character.

The authors analysed the data against three metrics: whether the data showed that the Limits of Acceptable Change were exceeded (Yes or No or Unknown); whether the abundance of a species fell below the 1% threshold (Yes or No or Unknown); and whether the Australian Bird Index Trend was Decreasing, Increasing or Unknown.⁶⁹⁴ Six of the sites were in Victoria and three are summarised in Table 71.

Data for the Port Phillip Bay, Western Port and Corner Inlet sites showed that with only a few exceptions, there is little known about the exceedance of the Limits of Acceptable Change. At Port Phillip Bay and Corner Inlet three and two species respectively had not exceeded the limits, whereas one species at Port Phillip Bay and two at Corner Inlet had done so. Where data was available on abundance and the 1% threshold, 12 species had not fallen below that threshold, while three had. Of the 17 species reported for Port Phillip Bay, 12 had suffered a decline in numbers (four had increased). For Western Port, two had declined and one had increased, and at Corner Inlet three had declined and one had increased.

Hansen et al. (2021) concluded that long-term shorebird monitoring was providing limited insight into ecological character and was unlikely to capture trends in other waterbirds. They argued that the 'value of these data would be greatly enhanced through complementary monitoring of other ecological characters at sites, particularly where shorebird populations provide early warning signs of potential deterioration. The main impediment to achieving a good understanding of how Ramsar sites are changing in Australasia appears to be a lack of analysis and centralised system for data and analytics, rather than a lack of monitoring data.'

⁶⁹². Trust for Nature 2020, 'Submission to the Public Accounts and Estimates Committee Inquiry into the Auditor-General's report no. 202, meeting obligations to protect Ramsar wetlands 2016', Parliament of Victoria, Melbourne, Victoria.

⁶⁹³. Victorian National Parks Association 2020, 'Submission to the Public Accounts and Estimates Committee Inquiry into the Auditor-General's report no. 202, meeting obligations to protect Ramsar wetlands 2016', Parliament of Victoria, Melbourne, Victoria.

⁶⁹⁴. Hansen B, Szabo J, Fuller R, Clemens R et al. 2021, 'Insights from long-term shorebird monitoring for tracking change in ecological character of Australasian Ramsar sites', *Biological Conservation*, 260, 109189.

Wetlands and rivers

Table 71: Limits of Acceptable Change (LAC), species abundance and Australian Bird Index Trend for selected bird species at three Victorian Ramsar sites.⁶⁹⁵

Species	Port Phillip Bay	Western Port	Corner Inlet
Migratory birds			
Bar-tailed godwit	??↑		NN?
Common greenshank	??↓		
Curlew sandpiper	YN↓	?Y↓	YY↓
Double-banded plover	NN?	?N?	
Eastern curlew	??↓	?N↓	YN↓
Great knot	??↓		
Grey plover	??↓		
Grey-tailed tattler	??↓		
Latham's snipe	??↓		
Pacific golden plover	??↓		
Red knot	??↓		?N↓
Red-necked stint	NN↓	?N?	?N?
Ruddy turnstone	??↓		
Sharp-tailed sandpiper	NN↓		
Non-migratory birds			
Banded stilt	??↑		
Pied oystercatcher		?N↑	
Red-capped plover	??↑		
Sooty oystercatcher			??↑
Red-necked avocet	??↑		

LAC Exceedance: Yes (Y) or No (N) or Unknown (?); Abundance below 1% threshold Yes (Y) or No (N) or Unknown (?); Australian Bird Index Trend Decreasing (↑) or Increasing (↓) or Unknown (?).

695. Ibid

Forests

Background

Victoria's forests cover almost 35% of the state (Figure 58) providing clean air and drinking water, places for recreation and research, and habitat for many threatened plants and animals. The forests are a mix of:

- box, ironbark and gun-barked eucalypts in central Victoria
- medium and tall damp sclerophyll forests across much of Victoria
- tall wet sclerophyll forests in the eastern side of the state
- dry sclerophyll forests in the east, central and south-west of the state
- rainforests
- mallee forests in north-western Victoria.

Eucalypts dominate the forests and include red and brown stringybarks, narrow-leaved peppermint, messmate stringybark, mountain ash, alpine ash and river red gum. Victoria's forests have many environmental, cultural, social and economic values that include:

- providing food, shelter and habitat for wildlife
- protecting threatened species
- protecting soil and catchment water quality
- storing carbon and helping to mitigate climate change
- spiritual and cultural significance for Aboriginal communities
- popular locations for recreation, education and tourism
- forests and wood products.

The main threats to Victoria's forests are fire, invasive plants and animals, climate change, timber harvesting, habitat loss and fragmentation.

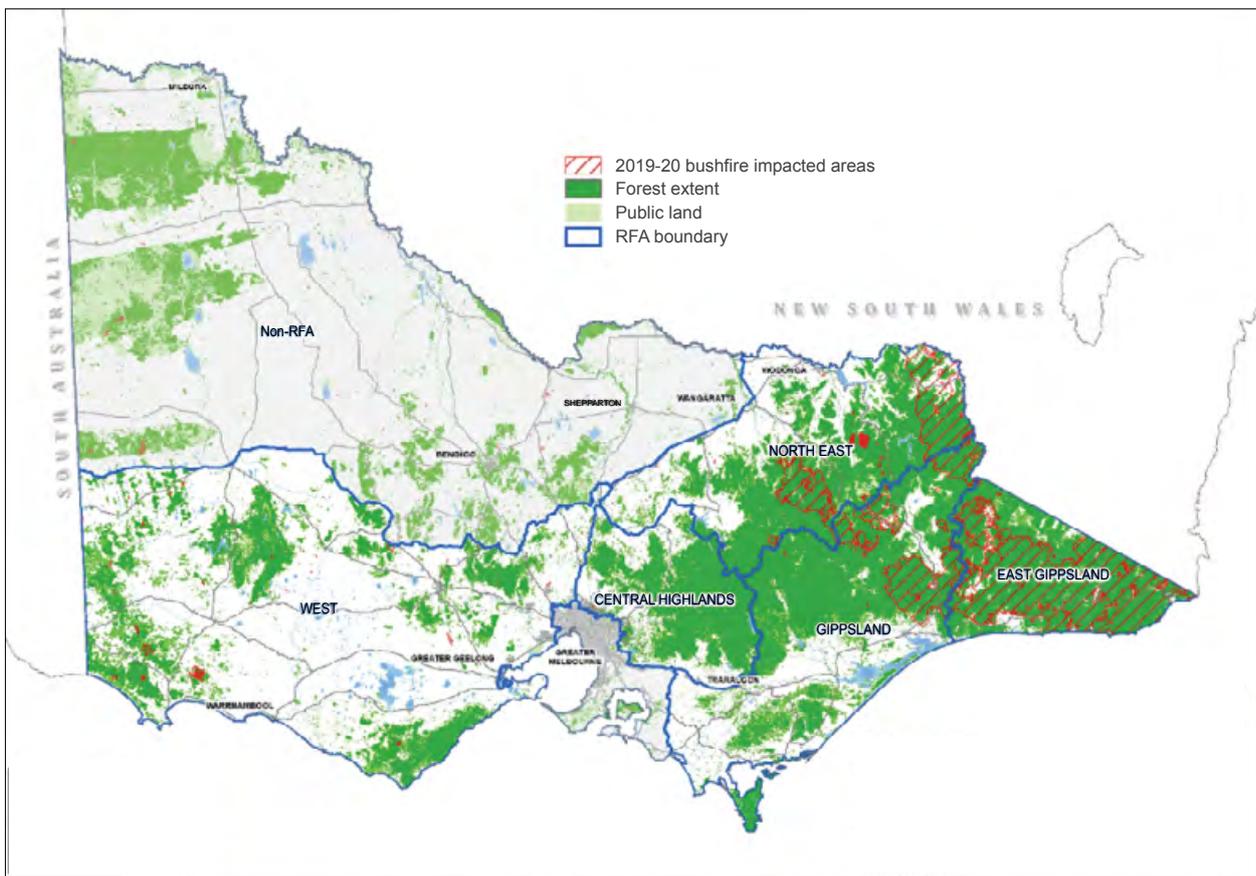


Figure 58: Victorian forest cover and the extent of the 2019–20 bushfires in the state's five Regional Forest Agreement areas.⁶⁹⁶

⁶⁹⁶ Department of Agriculture, Water and the Environment 2021, 'Victorian regional forest agreements major event review of the 2019-20 bushfires: summary report: information and data to inform public consultation', Canberra, Australia.

Policy and legislative setting

Victoria's forests are managed in accordance with Victorian legislation, including the *National Parks Act 1975*, *Forests Act 1958*, *Conservation, Forests and Land Act 1987*, *Flora and Fauna Guarantee Act 1988*, *Crown Land (Reserves) Act 1978*, *Land Act 1958* and the *Sustainable Forests (Timber) Act 2004*, along with related regulations, codes of practice, management plans and policy initiatives.

In 2017, the Victorian Environmental Assessment Council recommended that within five years State Forests should be administered under one Act. It also recommended a new public land act to replace the current *Land Act 1958*, the *Crown Land (Reserves) Act 1978* and the *Forests Act 1958*.⁶⁹⁷ The Victorian Government accepted both recommendations.

The *Forests Act 1958* is used to support the management and use of Victoria's State Forests and includes provisions for firewood collection, fire management, forest park establishment and licensing of various uses such as grazing.

The object of the *Conservation, Forests and Lands Act 1987* is 'to be an effective conservator of the State's lands, waters, flora and fauna; and to make provision for the productive, educational and recreational use of the State's lands, waters, flora and fauna in ways which are environmentally sound, socially just and economically efficient.'⁶⁹⁸ It details administrative arrangements, powers and functions and includes provisions for codes of practice, land management cooperative agreements, Traditional Owner land management boards and joint management plans.

The *Sustainable Forests (Timber) Act 2004* includes provisions for the allocation of timber to VicForests through issuance of an Allocation Order, compliance with the Code of Practice for Timber Production, the preparation and implementation of the Timber Release Plan, and the framework for state of the forests reporting.

The Victorian Forestry Plan⁶⁹⁹ was released by the Victorian Government in November 2019. It is being used to assist the timber industry transition from native forest harvesting to a plantation-based timber supply. At the same time, the Government gave immediate protection from timber harvesting to 90,000 hectares of old-growth forests and released the Greater Glider Action Statement,⁷⁰⁰ which was supported by a further 96,000 hectares of State Forests exempted from timber harvesting by the establishment of Immediate Protection Areas.

The purpose of the Code of Practice for Timber Production 2014⁷⁰¹ is to provide direction to timber harvesting managers, harvesting entities and operators to deliver sound environmental performance when planning for and conducting commercial timber harvesting operations in a way that:

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

In Victoria, 20 mammal species, 14 birds, 6 reptiles, 6 amphibians, 14 fish, 10 crustaceans, 2 terrestrial invertebrates and 315 plant species are protected by 'prescriptions' that guard against timber harvesting impacts under the Code.

When revising Victoria's RFAs⁷⁰² in 2019, the Australian and Victorian governments said that they are a 'means of balancing environmental, economic and social uses and values of key native forest regions across Australia.'⁷⁰³

697. Victorian Environmental Assessment Council 2017, 'Statewide assessment of public land, final report', Melbourne, Victoria.

698. Government of Victoria, 'Conservation, Forests and Lands Act 1987', Melbourne, Victoria.

699. DJPR 2019, 'Victorian forestry plan 2019', Melbourne, Victoria <https://djprvic.gov.au/forestry/forestry-plan> Accessed 9 May 2021.

700. DELWP 2019, 'Action statement no. 267 greater glider (*Petauroides volans subsp. volans*)', East Melbourne, Victoria.

701. Department of Environment and Primary Industries 2014, 'Code of practice for timber production 2014', East Melbourne, Victoria.

702. State of Victoria and Commonwealth of Australia 2019, 'Victoria's regional forest agreements: assessment of matters pertaining to the modernisation of Victoria's regional forest agreements', Australia.

703. Ibid

Forests

The Victorian Forest Monitoring Program⁷⁰⁴ was established in 2011 'to provide baseline data for long term trend detection and prediction of type and severity of future changes, so that management options can be developed and evaluated in time to be effective. It provides a platform to meet statutory reporting obligations, support forest policy and management decisions and assess Victoria's performance towards sustainable forest management.'⁷⁰⁵ The program has more than 600 monitoring sites across Victoria's forested bioregions. Although approximately 90 were burnt by the 2019–20 bushfires, they continue to be monitored.

The Timber Release Plan⁷⁰⁶ identifies the forestry coupes that are available for timber harvesting in the future. The coupes are found within a larger area covered by the Allocation Order, which is released by the Minister for Agriculture and gives VicForests access to State Forests. The Timber Utilisation Plan⁷⁰⁷ applies to areas outside the boundary defined in the Allocation Order and which are largely in the Western RFA.

Forest management plans⁷⁰⁸ were developed in the 1990s and early 2000s, zone Victoria's forests and establish objectives for conservation, land management and uses that include timber harvesting. There are eight plans covering forest management areas that include East Gippsland, the Central Highlands, the North East and Midlands.

The plans identify the location of forest management zones:

- General Management Zone: managed for a range of uses, but timber production has a high priority
- Special Management Zone: managed to conserve specific features, while catering for timber production under certain conditions
- Special Protection Zone: managed for conservation and where timber harvesting is excluded. Planned burning and grazing may be allowed if compatible with maintaining the area's values.

The Statewide Protection for Large Trees Policy 2019 requires that in all coupes where timber harvesting is conducted, VicForests must retain and protect all large trees from the direct impacts of timber harvesting and regeneration burning, including by ensuring that slash and bark accumulation is cleared from within three metres of the base of retained trees.

The Forest Protection Survey Program aims to protect animals and plants that are either threatened or of high conservation value where they occur in areas (or coupes) of State Forests scheduled for harvesting. This survey work is taking place in State Forests in eastern Victoria in Gippsland, the Central Highlands and North-East regions. The aim of the program is to survey at least 80% of coupes planned for harvest each year. VicForests is also required to undertake its own assessment of biodiversity values on coupes prior to harvesting.

Large areas of forest were impacted by the 2019–20 bushfires (Figure 58).

704. DELWP, 'Victorian forest monitoring program', East Melbourne, Victoria <https://www.forestsandreserves.vic.gov.au/forest-management/victorian-forest-monitoring-program> Accessed 9 May 2021.

705. DELWP 2015, 'Victorian forest monitoring program = installed', East Melbourne, Victoria.

706. VicForests, 'Timber release plan', Melbourne, Victoria <https://www.vicforests.com.au/planning-1/timber-release-plan-1/approved-timber-release-plan> Accessed 9 May 2021.

707. Ibid

708. DELWP, 'Forest management plans', East Melbourne, Victoria <https://www.forestsandreserves.vic.gov.au/forest-management/forest-management-plans> Accessed 9 May 2021.

Forests

Indicator Fo:03 Area of forest types by growth stage distribution in protected areas

Region Statewide	Indicator Performance:	2018 Status	2018 Trend	2018 Data
Measures IUCN-defined protected areas; Implications of changes in protected areas for threatened species	2018 & 2021: Unable to be assessed due to Moderate Data Confidence			
Data Custodian DELWP; Parks Victoria	Why this indicator? The protection of biodiversity to sustain forest ecosystems and the species that inhabit them is part of Victoria's approach to forest conservation and management.	2021 Status	2021 Trend	2021 Data

Potential thresholds for status in the SoE 2023 report

Good: All forest types are protected in a comprehensive, adequate and representative parks estate

Fair: Gaps remain in the protection of forest types in a comprehensive, adequate and representative parks estate

Poor: Forest types are becoming less protected and the parks estate is well short of being comprehensive, adequate and representative

Why this assessment in 2021?

Status: Gaps remain in the parks estate and prevent it from being comprehensive, adequate and representative.

Trend: There has been only a small addition to the forest types protected in the parks estate since the SoE 2018 Report.

Data Confidence: The quality of data remains Fair.

Should this indicator be used in the SoE 2023 report?

Yes.

Summary of SoE 2018 Report assessment

- Victoria's forest management aims to conserve biodiversity, heritage and cultural values, while at the same time developing an internationally competitive forest products industry based on native forests managed sustainably. This includes a commitment to a comprehensive, adequate and representative (CAR) reserve system and protection of old-growth forests.
- The proportion of Victorian land assigned formal protection status has risen from less than 1% in the 1950s to 17% in 2016.
- There was an increase of about 13% in IUCN protected areas overall between 2004 and 2016, largely in IUCN Category V Protected Landscape/Seascape and IUCN Category VI Protected area with sustainable use of natural resources. Areas of IUCN category Ia Strict Nature Reserve increased gradually.

The 2019–20 bushfires: Impacts and responses

Almost all of the fire extent of the 2019–20 bushfires was in the forests of north-eastern and far-eastern Victoria (Figure 58). The largest fire in western Victoria was between Warrnambool and Portland in the Budj Bim Cultural Landscape World Heritage Area and burnt across more than 7,000 hectares.

Table 72 shows that Victoria's forested areas cover 8.222 million hectares, with 7.622 million hectares in native forest, 415,000 hectares in plantations and 162,000 hectares in 'Other forests.' The 2019–20 bushfires burnt through 1.457 million hectares of Victoria's forests, almost all of which were covered in native forest.

Forests

Table 72: Area of Victoria's forests, and the area and proportion in the fire extent area of the 2019–20 bushfires as at 28 April 2020, by forest category.⁷⁰⁹

Total Forest Area, by Forest Category ('000 Hectares)				Total Area Burnt, by Forest Category ('000 Hectares)				Proportion of Total Forest Area Burnt, by Forest Category (%)			
Native Forest	Commercial Plantation	Other Forest	Total Forest	Native Forest	Commercial Plantation	Other Forest	Total Forest	Native Forest	Commercial Plantation	Other Forest	Total Forest
7,645	415	162	8,222	1,444	10	3	1,457	19	2.4	2.0	18

Table 73 presents data on the extent of the bushfires across Victoria's six forest tenure categories.⁷¹⁰

- Multiple-use public forest: Crown land managed for a range of values including wood harvesting, water supply, conservation, recreation and environmental protection. Significant proportions of multiple-use forests are informal reserves where wood harvesting is not permitted (within State Forests in Victoria and management is overseen by DELWP)
- Nature conservation reserve: Crown land formally reserved for environmental, conservation and recreational purposes, including national parks and nature reserves (managed by Parks Victoria)
- Other Crown land: Crown land held for a variety of purposes, including utilities, mining, water catchments and use by Indigenous communities (DELWP oversight management of this tenure category)
- Private forest: forest on privately owned land, including Indigenous owned land
- Leasehold forest: forest which is privately managed on leased Crown land and is generally used for grazing
- Unresolved tenure: forest for which ownership status has not been determined.

The main tenure categories by area in Victoria are multiple-use public forest (State Forests) and nature conservation reserve e.g. national parks, and these are also the two forest tenure categories most affected by the 2019–20 bushfires, as shown in Table 73.

Table 73: Area of Victoria's native forest and the area and proportion in the fire extent area of the 2019–20 bushfires as at 28 April 2020, by forest tenure.⁷¹¹

Forest Tenure	Total Forest Area
Native Forest Area ('000 Hectares)	
Leasehold Forest	0
Multiple-Use Public Forest	3,052
Nature Conservation Reserve	3,367
Other Crown Land	241
Private Forest	984
Unresolved Tenure	0
Total Native Forest	7,645
Native Forest in Burnt Area ('000 Hectares)	
Leasehold Forest	0
Multiple-Use Public Forest	878
Nature Conservation Reserve	496
Other Crown Land	13
Private Forest	57
Unresolved Tenure	0
Total Native Forest in Burnt Area	1,444
Proportion of Native Forest in Burnt Area (%)	
Leasehold Forest	0
Multiple-Use Public Forest	29
Nature Conservation Reserve	15
Other Crown Land	5.3
Private Forest	5.8
Unresolved Tenure	13
Total	19

709. Department of Agriculture, Water and the Environment 2020, 'Forest fire area data for the 2019–20 summer bushfire season in southern and eastern Australia', Canberra, Australia.

710. Department of Agriculture, Water and the Environment, 'Australia's forests', Canberra, Australia <https://www.agriculture.gov.au/forestry/australias-forests> Accessed 9 May 2021.

711. Department of Agriculture, Water and the Environment 2020, 'Forest fire area data for the 2019–20 summer bushfire season in southern and eastern Australia', Canberra, Australia.

Forests

In the wake of the 2019–20 bushfires, the Victorian and Commonwealth governments agreed to establish a Major Event Review on the impacts the bushfires on the implementation of Victoria's five RFAs. Since the signing of the modernised RFAs for Victoria, the Victorian Commissioner for Environmental Sustainability is one of three panel members for any Major Event Review as well as the regular, five-yearly review of the RFAs. Figure 58 maps Victoria's five RFAs and the extent of the 2019–20 bushfires. The Major Event Review Scoping Agreement is assessing the impacts of the 2019–20 bushfires on the:

- operation of the RFAs
- Ecologically Sustainable Forest Management
- the CAR Reserve System⁷¹²
- effective management and protection of Matters of National Environmental Significance
- timber harvest levels
- the long-term stability of forests and forest industries.

The CAR Reserve System is a key element of the National Forest Policy Statement and the RFAs.

It comprises four components:

- **Dedicated Reserves:** Reserves established through legislation for conservation purposes such as National Parks, State Parks and Flora and Fauna Reserves.
- **Informal Reserves:** Elements of the Special Protection Zone in State Forests and other areas of Public Land.
- **Values protected by Prescription:** Elements of General Management Zone or Special Management Zone protected by regional prescriptions, including stream buffers and Rainforest.
- **Private Land mechanisms** which ensure protection, such as covenants on freehold land.

Table 74 presents data on the coverage of the four components in Victoria's five RFAs, and the spatial impact of the 2019–20 bushfires (NB: DELWP, the source of this data, states that the Prescriptions and the Immediate Protection Areas are not part of the CAR Reserve System but are considered to be related components). Dedicated Reserves, the largest area in the CAR Reserve system, was the most affected by the fire extent and high-severity fires. Table 75 provides further details on the impacts of the 2019–20 bushfires. It reveals that 133 reserves had between 40% and 100% of their area within the fire extent, including 91 where 91-100% of their area was within the fire extent.

Table 74: Impacts of 2019-20 bushfire season on the Regional Forest Agreements CAR Reserve system.⁷¹³

CAR Reserve System Component	Current Fire Extent (ha)	High Severity Fire (ha)	Total Area Across State (ha)
Dedicated Reserves: National parks and nature conservation reserves	482,094	285,462	3,900,480
Permanent protection on private land	404	130	49,025
Informal Reserves: Special Protection Zones	203,758	127,966	765,900
Prescriptions (modelled exclusions and rainforest, per Management Standards and Procedures for timber harvesting operations in Victoria's State forests)	193,375	12,359	629,120
Immediate Protection Areas (additional new protected areas, as identified in the Greater Glider Action Statement No. 267)	44,169	31,255	95,107

712. CAR = Comprehensive, Adequate and Representative reserve system for forests in Australia.

713. DELWP 2020, Victoria's bushfire emergency: biodiversity response and recovery, August 2020, DELWP, Melbourne.

Forests

Table 75: Fire impacts on Reserves and State Forests.⁷¹⁴

Reserves and State Forests	% of reserve or State Forests in Fire Extent			
	40-60%	61-80%	81-90%	91-100%
National parks and nature conservation reserves (per National Parks Act)	3 reserves	4 reserves	5 reserves	25 reserves
Other conservation reserves (non-protected areas, such as regional parks, lake parks and historical reserves)	3 reserves	5 reserves	1 reserve	36 reserves
State Forests	6 reserves	6 reserves	9 reserves	30 reserve

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Table 76 shows the changes in the area of formal protection (and IUCN categories) and informal protection between 2004 that were included in the SoE 2018 Report. The largest areas under formal protection are in IUCN Categories Ia Strict Nature Reserve, Ib Wilderness Area and II National Park. Forests represent a high percentage of cover in each of those – the higher the category number i.e. from categories III to VI, the lower the percentage of forest cover.

In June 2021, the Victorian Government announced, in response to recommendations by the Victorian

Environmental Assessment Council in 2019, that it would create 65,106 hectares of new national parks and reserves in the central west of Victoria. The new national parks would be the Wombat-Lerderderg National Park of 44,000 hectares, the Pyrenees National Park of 15,000 hectares and the Mount Buangor National Park of 5,282 hectares. In addition, the area of conservation parks would be increased by 5,246 hectares, existing nature and bushland reserves by 7,560 hectares, and regional parks by 27,735 hectares. Each of the proposed national parks contain forests. Whether the new parks fill some of the gaps in the parks estate will

Table 76: Victorian protected areas by IUCN category and informal Special Protection Zones 2004–16 in hectares.⁷¹⁵

Formal Protection IUCN Category	2004	2006	2008	2010	2012	2014	2016	Proportion of Forest Cover (%)*
Ia Strict Nature Reserve	356,300	366,200	381,900	380,700	388,600	421,600	421,500	83.37
Ib Wilderness Area	815,500	815,300	815,700	815,700	815,500	740,900	740,900	78.50
II National Park	2,128,600	2,182,400	2,224,200	2,309,700	2,371,300	2,374,400	2,373,700	83.89
III Natural Monument or feature	55,000	48,900	49,500	51,300	78,000	75,500	75,600	73.68
IV Habitat/Species Management Area	48,000	44,900	43,800	43,700	47,400	47,500	47,500	54.74
V Protected Landscape/Seascape	58,500	57,800	56,600	49,200	26,800	135,200	135,200	58.58
VI Protected area with sustainable use of natural resources	91,100	89,200	94,500	85,100	130,600	208,300	206,200	23.13
All IUCN Protected Areas	3,553,000	3,604,700	3,666,200	3,735,400	3,858,200	4,003,400	4,000,600	
Special Protection Zone (SPZ)	828,100	828,100	783,100	783,100	753,100	747,300	761,100	97.19
Total	4,381,100	4,432,800	4,449,300	4,518,500	4,611,300	4,750,700	4,761,700	81.44

*Proportion of forest cover refers to the proportion of this reserve class under forest. Source: SoE 2018 Report.

715. Ibid

716. Commissioner for Environmental Sustainability 2018, 'State of the Environment 2018 Report', Melbourne, Victoria.

Forests

According to the Department of Agriculture, Water and Environment website: 'Regional Forest Agreements (RFAs) safeguard biodiversity, old-growth forests, wilderness and other natural and cultural values. They achieve this through the Comprehensive Adequate and Representative (CAR) reserve system and through ecologically sustainable forest management outside of reserves.' The website also states that the 'CAR reserve system is based on three principles:

- including the full range of vegetation communities (comprehensive)
- ensuring the level of reservation is large enough to maintain species diversity (adequate)
- conserving the diversity within each vegetation community, including genetic diversity (representative)'.⁷¹⁷

However, the CAR Reserve System is not the same as the National Reserve System. The 2009–2030 strategy for the National Reserve System states that: 'Only those areas that fall within the IUCN definition of a protected area form part of the National Reserve System. According to the IUCN, a protected area is: "A clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values."⁷¹⁸

The only reserves in the CAR Reserve System of Victoria's RFAs to satisfy the National Reserve System definition are the Dedicated Reserves, which have been established in state decision-making processes separate and unrelated to the Regional Forests Agreements. The informal reserves (Special Protection Zones in the forest management system overseen by DELWP) and the Prescriptions are insecure protections that can be changed by the Secretary of DELWP.

During the process of modernising the Regional Forests Agreements, reports for advice were commissioned by the Commonwealth and Victorian governments from William Jackson, an independent consultant, and the RFAs Scientific Advisory Panel.⁷¹⁹

In relation to the CAR Reserve system, Jackson (2019)⁷¹⁹ recommended that: 'To conserve forest biodiversity and maintain ecosystem health, the modernised RFAs should include a range of conservation strategies, including changes to the formal and informal CAR reserve system, restoration of EVCs, improving connectivity between fragmented EVCs, and working with private landholders to conserve under-represented EVCs.'

The Scientific Advisory Panel also made recommendations on the CAR reserve system:

- Review the Nationally Agreed Criteria for the Establishment of a Comprehensive, Adequate and Representative Reserve System for Forests in Australia (JANIS criteria). This would be timely given advances in forest conservation science over the past 20 years.
- Review the spatial extent and configuration of the CAR reserve system:
- Assess the representation, adequacy and comprehensiveness of the areal representation of habitats and vegetation communities, based on the JANIS criteria.
- Evaluate the utility of other spatial measures of the entire forest estate including the CAR reserve system such as levels of forest fragmentation, and the extent of edge effects and other spatial metrics of disturbance by human activities and wildfire.
- Require the development and implementation of new management plans for the CAR reserve system in each RFA region
- Undertake sensitivity analyses of the adequacy of the CAR reserve system and management plans under a range of climate change scenarios.

717. Natural Resource Management Ministerial Council 2009, Australia's strategy for the national reserve system 2009-2030, Natural Resource Management Ministerial Council, Canberra.

718. Regional Forest Agreements Scientific Advisory Panel 2019, 'Scientific advice to support regional forest agreement negotiations'.

719. Jackson W 2019, 'Independent consultation paper: modernisation of the Victorian regional forest agreements'.

Forests

With the release of the Victorian Forestry Plan in 2019, the Victorian Government announced that '90,000 hectares of Victoria's remaining rare and precious old growth forest – aged up to 600 years old – will be protected immediately.' The Forestry Plan also placed 96,000 hectares of forest in Immediate Protection Areas free of timber harvesting. These 186,000 hectares are not considered part of the National Reserve System because they are not given formal legislative protection.

A DELWP fact sheet⁷²⁰ states that 'old-growth forests contain a significant number of older trees in the latter stages of their growth, with distinctive crowns, minimal regrowth and little, if any, sign of disturbance. These ecologically mature forests provide a wide range of habitats for plants, insects and animals, and are a vital part of the water and carbon cycles, which we depend on for clean water and other ecological and economic benefits.'

However, before an area is given protection from timber harvesting, it needs an assessment to determine whether it is old-growth forest. To assist the process, the Conservation Regulator Victoria released an assessment procedure.⁷²¹ It determined that old-growth 'must have a minimum area of one hectare, and that regrowth trees must comprise less than 15%, and senescent (old and declining) trees more than 10%, of the upper stratum trees.' The assessment, if required, is carried out by VicForests or its contractors.

The assessment procedure defines three growth stages for ash-type and mixed species forests as Regrowth (<120 years); Mature (120-250 years); Senescent (>250 years). If regrowth is <15% and Senescent is >10%, a logging coupe being assessed would be deemed to have old-growth present. However, if Regrowth is >15% and Senescent is <10%, old growth is deemed to be absent. The assessment process excludes timber harvesting from old-growth patches larger than one hectare (it was previously five hectares).

Research by Lindenmayer and Taylor (2020) identified approximately 833,445 hectares of Modelled Old Growth Forest and Woodland occurring in Victoria between 1994 and 2000. They found that 638,253 hectares were disturbed by wildfire, logging or both between 1995 and 2019-20, with 28% disturbed twice or more (98% by wildfire). Taylor and Lindenmayer also identified that 564,588 hectares of Modelled Old Growth Forest had been declassified as no longer old growth after a Victorian Government review 'to reflect disturbances by logging operations and wildfires.'⁷²² This, they argued, meant that old-growth forest was now much rarer and in need of greater protection.

Lindenmayer and Taylor (2020) viewed the age ranges for the three growth stages as weakening protection for large old trees that are less than 250 years old (typically 150–170 plus years) and which provide hollows for threatened arboreal animals, such as Leadbeater's possum and the southern greater glider. They recommended that the age definition for old-growth in ash-type forests be reduced to 120 plus years, and that the minimum size of old growth patches to be given protection be 'reduced from 1 ha to a scale of an individual large old tree (defined as any stem that is 120 years or older).'

720. DELWP 2019, 'Fact sheet 3: old growth forests', East Melbourne, Victoria.

721. Conservation Regulator Victoria 2020, 'Old growth forest identification assessment tool', East Melbourne, Victoria.

722. Lindenmayer D and Taylor C 2020, 'Extensive recent wildfires demand more stringent protection of critical old growth forest', *Pacific Conservation Biology*, 26, pp. 384–394.

Forests

Indicator Fo:06 Threatened forest-dependent species

Region Statewide Measures Number, abundance and distribution Data Custodian DELWP	Indicator Performance: 2018 & 2021: Unable to be assessed due to Fair Status Why this indicator? Changes in the number, abundance and distribution of these species can be used to assess the effectiveness of biodiversity management and species recovery programs.	2018 Status 	2018 Trend 	2018 Data 
		2021 Status 	2021 Trend 	2021 Data 

Potential thresholds for status in the SoE 2023 report

Good: Significant recovery in abundance and distribution and/or significant reductions in the number of threatened forest-dependent species

Fair: Little or no recovery or small decline in the abundance and distribution and/or small increase in the number of threatened forest-dependent species

Poor: Significant reductions in abundance and distribution and/or significant increases in the number of threatened forest-dependent species
OR

Good: Significant increasing trend in the abundance and distribution of threatened forest-dependent species, and threats are being monitored, reported and mitigated

Fair: Stable or a small increasing trend in the abundance and distribution of threatened forest-dependent species, and threats are in part being monitored, reported and mitigated

Poor: Significant declining trend in the abundance and distribution of threatened forest-dependent species, and threats are not being monitored, reported or mitigated

Why this assessment in 2021?

Status: The use of more rigorous criteria in preparing the new Flora and Fauna Guarantee Threatened List has led to the conservation status of some threatened species of threatened forest-dependent flora and fauna being upgraded e.g. from Vulnerable to Critically Endangered (some have also remained the same or been downgraded). Although the on-ground situation e.g. population size and habitat for the forest-dependent species might not have changed since its last assessment, the new conservation status gives greater public recognition of their plight.

Trend: The Deteriorating Trend is continuing. With forest the main habitat impacted by the 2019-20 bushfires, there is increased pressure on forest-dependent species.

Data Confidence: Threatened forest-dependent are the focus of considerable research.

Should this indicator be used in the SoE 2023 report?

Yes, however it will need agreement on a set of forest-dependent species to monitor.

Summary of SoE 2018 Report assessment

- Identifying the conservation status of forest-dependent species at risk is an important initial step to developing action plans for their successful protection.
- The 2018 report relied on threatened species lists that were updated in 2013 and 2014. Based on those lists, the conservation status of vascular plants and amphibians had not changed but that of mammals was of concern.
- A deterioration of the conservation status of species in the Central Highlands had been observed.
- A DELWP analysis of Victoria's state forests identified 79 forest-dependent species, 35 of which could be adversely affected by native-timber harvesting.

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The 2019–20 bushfires: Impacts and responses

The Victorian Environmental Assessment Council identified 84 forest-dependent fauna and flora species in its 2017 report on the conservation values of state forests.⁷²³ DELWP's bushfire response and recovery report from August 2020 has been used to identify those from the Council's list that have been impacted during the 2019–20 bushfires. Of the 84 species listed by the Council, 75 appear as valid species on the Flora and Fauna Guarantee Threatened List. These 75 listed forest-dependent threatened species (see Table 77) were impacted by the bushfires to varying degrees or, in some cases, not at all. DELWP's August 2020 report on the bushfires and the biodiversity response and recovery⁷²⁴ identified the species of most concern, those impacted by having proportions of their

modelled habitat within the fire extent or affected by high-severity fires. A comparison of DELWP's species of most concern with the Council's forest-dependent species list reveals that 10 of 15 mammal species on the Council's list were identified as species of most concern. Further, there were:

- four of 15 listed bird species were of most concern
- five of eight listed frog species
- four of five listed reptile species
- three of nine listed fish species
- none of one listed spiny crayfish species
- six of 22 listed plant species.

The species of most concern are marked with an asterisk in Table 79.

Table 77: Seventy-seven forest-dependent fauna and flora species.⁷²⁵

Scientific Name	Common Name	Conservation Status 2021	Conservation Status 2013-14
Mammals			
<i>Antechinus minimus</i>	Swamp antechinus	VU	Near Threatened
<i>Dasyurus maculatus*</i>	Spot-tailed quoll	EN	EN
<i>Gymnobelideus leadbeateri</i>	Leadbeater's possum	CR	EN
<i>Mastacomys fuscus*</i>	Broad-toothed rat	VU	EN
<i>Petauroides volans*</i>	Greater glider	VU	VU
<i>Petaurus norfolcensis</i>	Squirrel glider	VU	EN
<i>Petrogale penicillate*</i>	Brush-tailed rock wallaby	CR	CR
<i>Phascogale tapoatafa</i>	Brush-tailed phascogale	VU	VU
<i>Potorous longipes*</i>	Long-footed potoroo	EN	VU
<i>Potorous tridactylus*</i>	Long-nosed potoroo	VU	Near Threatened
<i>Pseudomys fumeus*</i>	Smoky mouse	EN	EN
<i>Pteropus poliocephalus*</i>	Grey-headed flying-fox	VU	VU
<i>Rhinolopus megaphyllus*</i>	Eastern horseshoe bat	EN	VU
<i>Saccolaimus flaviventris</i>	Yellow-bellied sheath-tail bat	VU	Data Deficient
<i>Sminthopsis leucopus*</i>	White-footed dunnart	VU	Near Threatened

723. Victorian Environmental Assessment Council 2017, 'Conservation values of state forests', Melbourne, Victoria.

724. DELWP 2020, Victoria's bushfire emergency: biodiversity response and recovery, August 2020, DELWP, Melbourne.

725. Victorian Environmental Assessment Council 2017, 'Conservation values of state forests', Melbourne, Victoria.

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Table 77: Seventy-seven forest-dependent fauna and flora species cont'd.

Scientific Name	Common Name	Conservation Status 2021	Conservation Status 2013-14
Birds			
<i>Accipiter novaehollandiae</i>	Grey goshawk	EN	VU
<i>Anthochaera phrygia</i>	Regent honeyeater	CR	CR
<i>Calamanthus pyrrhopygius</i>	Chestnut-rumped heathwren	VU	VU
<i>Calyptorhynchus lathami</i> *	Glossy black-cockatoo	CR	VU
<i>Climacteris picumnus victoriae</i>	Brown treecreeper	EN	VU
<i>Haliaeetus leucogaster</i>	White-bellied sea-eagle	EN	VU
<i>Lathamus discolor</i>	Swift parrot	CR	EN
<i>Lichenostomus melanops cassidix</i>	Helmeted honeyeater	CR	CR
<i>Lophoictinia isura</i>	Square-tailed kite	VU	VU
<i>Melanodryas cucullata</i>	Hooded robin	VU	Near Threatened
<i>Neophema pulchella</i>	Turquoise parrot	VU	Near Threatened
<i>Ninox connivens</i>	Barking owl	CR	EN
<i>Ninox strenua</i> *	Powerful owl	VU	VU
<i>Tyto novaehollandiae</i> *	Masked owl	CR	EN
<i>Tyto tenebricosa</i> *	Sooty owl	EN	VU
Amphibians			
<i>Heleioporus australiacus</i> *	Giant burrowing frog	CR	CR
<i>Litoria booroolongensis</i> *	Booroolong tree frog	CR	CR
<i>Litoria littlejohni</i> *	Large brown tree frog	CR	EN
<i>Litoria spenceri</i> *	Spotted tree frog	CR	CR
<i>Phyllorhynchus frosti</i>	Baw Baw frog	CR	CR
<i>Pseudophryne bibronii</i>	Brown toadlet	EN	EN
<i>Pseudophryne semimarmorata</i>	Southern toadlet	EN	VU
<i>Uperoleia martini</i> *	Martin's toadlet	CR	CR
Reptiles			
<i>Cyclodomorphus michaeli</i> *	Eastern she-oak skink	CR	Near Threatened
<i>Lissolepis coventryi</i> *	Swamp skink	EN	VU
<i>Pseudemoia cryodroma</i> *	Alpine bog skink	EN	EN
<i>Varanus rosenbergi</i>	Rosenberg's goanna	CR	EN
<i>Varanus varius</i> *	Lace monitor	EN	EN
<i>Varanus varius</i> *	Lace monitor	EN	EN

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Table 77: Seventy-seven forest-dependent fauna and flora species cont'd.

Scientific Name	Common Name	Conservation Status 2021	Conservation Status 2013-14
Fish			
<i>Galaxias fuscus</i>	Barred galaxias	CR	CR
<i>Galaxias rostratus*</i>	Flat-headed galaxias	VU	VU
<i>Galaxiella pusilla</i>	Dwarf galaxias	EN	EN
<i>Gobiomorphus coxii</i>	Cox's gudgeon	EN	EN
<i>Hypseleotris compressa</i>	Empire gudgeon	CR	VU
<i>Maccullochella macquariensis</i>	Trout cod	EN	CR
<i>Maccullochella peelii</i>	Murray cod	EN	VU
<i>Macquaria australasica*</i>	Macquarie perch	EN	EN
<i>Prototroctes maraena*</i>	Australian grayling	EN	VU
<i>Euastacus diversus</i>	Orbost spiny cray	EN	EN
Flora			
Dicotyledons			
<i>Brachyscome salkiniae*</i>	Elegant daisy	VU	VU
<i>Eucalyptus mackintii</i>	Gippsland stringybark	VU	VU
<i>Grevillea barklyana</i>	Gully grevillea	CR	R
<i>Grevillea celata*</i>	Colquhoun grevillea	CR	VU
<i>Grevillea miqueliana subsp. miqueliana</i>	Oval-leaf grevillea	EN	VU
<i>Hibbertia hermanniifolia subsp. recondita</i>	Outcrop guinea-flower	VU	R
<i>Hibbertia rufa</i>	Brown guinea-flower	VU	R
<i>Leionema bilobum subsp. bilobum</i>	Truncate leionema	VU	R
<i>Persoonia arborea</i>	Tree geebung	EN	R
<i>Persoonia levis*</i>	Smooth geebung	EN	R
<i>Persoonia sylvatica*</i>	Forest geebung	EN	R
<i>Persoonia subvelutina</i>	Velvety geebung	EN	R
<i>Phebalium squamulosum squamulosum</i>	Forest phebalium	EN	R
<i>Philotheca virgate*</i>	Tasmanian wax-flower	EN	R
<i>Pomaderris costata*</i>	Veined pomaderris	EN	VU
<i>Pomaderris discolor</i>	Eastern pomaderris	EN	VU
<i>Pomaderris virgate*</i>	Upright pomaderris	CR	VU
<i>Richea Victoriana</i>	Serpent heath	EN	EX
<i>Tetratheca subaphylla</i>	Leafless pink-bells	VU	R
Monocotyledons			
<i>Astelia Australiana</i>	Tall astelia	EN	VU
<i>Carex Alsophila</i>	Forest sedge	EN	R
Ferns and allies			
<i>Cyathea cunninghamii</i>	Slender tree-fern	CR	VU

DELWP is responsible for the removal of hazardous trees on public or Crown land that are damaged by bushfires and pose an immediate safety risk along roads, tracks and public sites. DELWP's 2019–20 Annual Report revealed that its fire management activities included the removal of hazardous trees from along 81 kilometres of forest roads and tracks and undertaking roadside vegetation management along 1,398 kilometres of roads and tracks in our forest and parks, creating firebreaks across the landscape that are used in fire response operations.⁷²⁶

The Conservation Regulator had written to VicForests in February 2020 stating that 'the scale of the damage [in East Gippsland] meant that it was justified to stop commercial logging until there was more information that reduced scientific uncertainty about the risk of permanent damage.'⁷²⁷ A return to timber harvesting in East Gippsland was eventually approved in June after 'VicForests had decided to apply "important precautionary measures" including restricting harvesting to fire-killed stands of ash species, retaining all green patches, and all live trees and dead large hollow trees where safe to do so.'⁷²⁸ Such a move into unburnt areas could impact potential refuges for threatened species affected by the fires.

Due to the reduction in timber availability due to the 2019–20 bushfires, VicForests had used the 'salvage logging' of burnt areas and along roads e.g. Princes Highway to provide regional work for timber contractors and their employees. In commenting on the post-fire salvage logging, Lindenmayer (2020) argued that that scientific research showed that 'so-called post-fire "salvage logging" is the most damaging form of logging in native forests. Its impacts can last for decades or centuries and seriously impair the recovery of animal, bird and insect populations.'⁷²⁹ According to Lindenmayer, salvage logging operations can kill animals directly, expose soils to erosion, destroy old and dead hollow-bearing trees crucial for mammals and birds, crush plants that would normally germinate in ash beds after fire, simplify forest structure and hinder the recovery of species and habitats.

In a study of disturbance impacts after the 2009 bushfires in mountain ash forests, Banks et al. (2016) found that: 'Fern and midstory trees decreased significantly in frequency of occurrence across the gradient. Ferns (excluding bracken) decreased from 34% of plants in undisturbed forest to 3% on salvage logged sites.'⁷³⁰

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The conservation status of the Victorian Environmental Assessment Council's 84 forest-dependent species in has been compared with the new Flora and Fauna Guarantee Threatened List, which includes the status of species from the Advisory list of threatened vertebrate fauna (2013) and the Advisory list of rare and threatened flora (2014). Of the 84 species, 75 appear on the new list and include 15 mammals, 15 birds, eight amphibians, five reptiles, nine fish, one crayfish, 19 dicotyledons, two monocotyledons and one from ferns and allies.

Table 78 lists the conservation status by category of the 75 in both 2013-14 and 2021, while Table 80 lists each species and its conservations status for 2021 and 2013-2014. Note that the 'Rare' category used in 2013-14 is not used in the Flora and Fauna Guarantee Threatened List. Of the 75 species, four had their conservation status downgraded e.g. Endangered to Vulnerable, 27 had no change and 44 had their conservation status upgraded e.g. Vulnerable to Critically Endangered.

Three factors are primarily responsible for the trend towards the upgrading of threatened species: new evidence and perspectives, including inferences about the likely future impacts of climate change; the application of the Critically Endangered category (not used previously for plants and fungi), which replaced the 'Rare' category; and the more rigorous CAM. Although caution is needed when interpreting the upgrading (and any downgrading or no change), and the on-ground situation e.g. population size and habitat for the species might not have changed since their last assessment, the new conservation status gives greater public recognition of their plight.

726. DELWP 2020, 'Annual report 2020', East Melbourne, Victoria.

727. Morton A 2020, VicForests allowed to resume logging despite risk of 'irreversible damage' in fire-hit Gippsland, *The Guardian*, 8 December 2020.

728. Ibid

729. Lindenmayer D 2020, 'Post-bushfire logging makes a bad situation even worse, but the industry is ignoring the science', *ABC News*, 29 January 2020.

730. Blair D, McBurney L, Blanchard W, Banks S et al. 2016, 'Disturbance gradient shows logging affects plant functional groups more than fire', *Ecological Applications*, 26(7), pp. 2280–2301.

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Table 78: Change in conservation status of 84 threatened forest-dependent species from 2013 to 2020.⁷³¹

Conservation Status Category	2020	2013-14
Extinct	0	1
Critically Endangered	22	10
Endangered	32	17
Vulnerable	21	28
Near threatened	0	6
Rare	0	12
Data Deficient	0	1
Total	75	75

The Victorian Government in 2019 released the Greater Glider Action Statement to address the threats to the animal's survival that include the loss and fragmentation of habitat due to bushfires, planned burning, drought and timber harvesting.⁷³² The southern greater glider is dependent on hollow-bearing trees in the moist forests found in the Great Dividing Range and the Strathbogie and Strzelecki ranges. To assist in the glider's conservation, the State Government established 96,000 hectares of Immediate Protection Areas in those forests. At the same time, it excluded timber harvesting from 90,000 hectares of old-growth forests. The two objectives of the Greater Glider Action Statement are:

1. To address specific knowledge gaps in the biology and ecology of the Greater Glider to support ecologically sustainable management regimes. Actions to achieve this objective include targeted research programs to improve knowledge of the glider's distribution, abundance and population genetics and correlate this with habitat features, fire history, timber harvesting and climate change, and research to identify potential refugia.
2. To secure populations or habitat from potentially incompatible land use or catastrophic loss. Actions to achieve this objective include the establishment of the Immediate Protection Areas, timber harvesting prescriptions, avoiding greater glider populations and habitat during bushfire management and suppression, and research to identify potential areas for protection in parks and reserves.

Research⁷³³ in the alpine and mountain ash forests of the Central Highlands RFA has shown that over the past 20 years there have been significant declines in all arboreal marsupials, almost half the species of native birds, the populations of hollow-bearing trees and the extent of old-growth forest. There have also been declines in site occupancy of 50% for the Critically Endangered Leadbeater's possum and 80% for the Vulnerable southern greater glider, and the mountain ash ecosystem has been listed as Critically Endangered on the IUCN Red list. The main driver of the decline is the cumulative impact of bushfires, timber harvesting, post-fire salvage logging and climate change.⁷³⁴

Timber harvesting operations under RFAs are exempt from seeking environmental approval under Part 3 of the EPBC Act, presuming that a comprehensive regional assessment has been conducted into the environmental, economic and social impacts of timber harvesting. However, a federal court judgement on 27 May 2020 found that VicForests had breached national threatened species laws. The court action was brought by the Friends of Leadbeater's Possum, who argued that VicForests had breached the code of practice for logging operations in the Central Highlands RFA in habitat areas of the Leadbeater's possum and southern greater glider.

731. Flora and Fauna Guarantee Threatened List.

732. DELWP 2019, 'Action statement no. 267 greater glider (*Petauroides volans subsp. volans*)', East Melbourne, Victoria.

733. Lindenmayer D 2020, 'Submission to the Legislative Council Environment and Planning Committee Inquiry into Ecosystem Decline in Victoria', Parliament of Victoria, Melbourne, Victoria.

734. Ibid

Justice Mortimer found that logging in 26 coupes had not complied with the Central Highlands RFA and that logging yet to proceed in a further 41 coupes was not likely to be in accordance with the agreement. On 21 August 2020, Justice Mortimer handed down orders banning logging in the 67 coupes.⁷³⁵ In response to the court decision, the Victorian Government in July 2020 commissioned a 'broad-ranging review' of the Code of Practice for Timber Production 2014 to:

- minimise the risk to short-term supply obligations arising from third-party litigation
- ensure it remains fit for purpose and facilitates the implementation of the Victorian Forestry Plan
- strengthen the regulatory powers available to the Conservation Regulator
- identify regulatory reforms informed by the 2019–20 bushfires.⁷³⁶

VicForests successfully appealed the Justice Mortimer decision. A Federal Court judgement handed down on 10 May 2021 held that logging companies do not lose their exemption from federal environmental laws even though they may be in breach of state laws. However, the judgement 'upheld all initial findings of the Federal Court, including that VicForests had not been complying with the precautionary principle – a requirement of state law which says actions should be taken to avoid environmental harm, even when it is not certain that harm would occur. It also agreed with the original judge's finding that VicForests was destroying habitat critical to the survival of the greater glider and the Leadbeater's possum.'⁷³⁷ On 5 July 2021, the Friends of the Leadbeater's possum lodged a Notice of Filing to appeal with the High Court.

Taylor and Lindenmayer (2019) analysed Victoria's formal reserve system in relation to its adequacy in protecting vegetation communities (EVCs) and forest-dependent plants and animals.⁷³⁸

They found that:

some EVC groups were poorly protected and others, such as the Wet and Damp Forest EVC Group, having been subject to extensive disturbance such as through clearfell logging

areas previously targeted for logging and those proposed for logging under the Timber Release Plan in that EVC Group support forests of significantly higher value for threatened forest-dependent species than unallocated forest for logging in the same EVC Group.

ongoing human disturbance generated by logging will likely further exacerbate existing declines in threatened species.

The scientists recommended that areas of the Wet and Damp EVC Group should be among those targeted for addition to the existing dedicated protected area network to promote the conservation of forest-dependent threatened species. They concluded that: 'First, past analyses in the Central Highlands region have shown that the current reserve system is inadequate for a suite of forest-dependent taxa, including critically endangered Leadbeater's Possum and the vulnerable Greater Glider'... and 'Second, off-reserve management is currently not providing a sufficient complementary contribution to the reserve system for these species.'

Case study: Leadbeater's possum and small mammals of the Otway Ranges

The Critically Endangered Leadbeater's possum is endemic to Victoria and one of the state's faunal emblems. Fossil records indicate its distribution was much broader, however it is now restricted to an area 70 kilometres in width and 95 kilometres in length.⁷³⁹

The results of research reported by the Leadbeater's Possum Advisory Group in 2015 identified four key issues for the species: fire, timber harvesting, a decline in habitat quality and population fragmentation.⁷⁴⁰ The advisory group estimated that the size of the possum's population ranged between 3,945 and 10,960 individuals. Modelling showed a population crash after the 1939 bushfires, and then recovery, and another crash after the 2009 bushfires. The modelling also predicted a continuing population decline to very low levels during the next 70 years.

735. Ibid

736. D'Ambrosio L 2020, 'Review to protect Victoria's forests, jobs and timber industry', Ministerial media release, Government of Victoria, 22 July 2020.

737. Slezak M 2021, 'Federal Court finds in favour of VicForests in battle over destruction of Leadbeater's possum habitat', ABC News, 10 May 2021.

738. Taylor C and Lindenmayer D 2019, 'The adequacy of Victoria's protected areas for conserving its forest-dependent fauna', *Austral Ecology*, 44, pp. 1076–1091.

739. Zoos Victoria 2021, 'Leadbeater's possum: summary of conservation trends', Zoos Victoria, Parkville, Victoria.

740. Leadbeater's possum advisory group 2014, 'Technical report', Melbourne, Victoria.

Forests

However, additional research reported by the Advisory Group suggested that the decline could be less, and new and higher population estimates could provide opportunities for recovery of the species if actions were taken.

More recently, research by Zoos Victoria in the Yellingbo Nature Conservation Reserve (lowland population) and Lake Mountain (highland population) and reported by Zoos Victoria (2021) has charted the population decline of the Leadbeater's possum and the key threats that it faces. For the lowland population, the key threats are habitat clearance and degradation, inbreeding and a small population size, while for the highland population they are the loss of hollow-bearing trees, bushfires, timber harvesting and fragmentation of the population. Figures 57 and 58 graph the changes in the possum's lowland populations and the Lake Mountain component of its highland populations since 2001 and 2006 respectively. The lowland population has declined by 70% since 2003, while the highland population in subalpine woodland at Lake Mountain was devastated by the 2009 Black Saturday bushfires (it was not affected by the 2019–20 bushfires). The majority (96%) of the highland population, however, occurs within montane ash forest where the species is more common.⁷⁴¹ Part of this area (34%) was burnt in 2009, with recent surveys indicating populations are now recovering, albeit the scarcity of old trees with hollows will continue to limit populations.⁷⁴²

The exclusion of timber harvesting from some areas, the provision of nest boxes, increased monitoring, translocation and captive breeding are conservation strategies currently underway. However, Zoos Victoria (2021) also recommends an expansion of the reserve system, the updating of the possum's action statement, an earlier phase-out of native timber harvesting (currently scheduled by the Victorian Government for 2030), an expansion of den provisioning (nest boxes and chainsaw hollows), restoration of lowland swamp forests in the Yarra Valley (part of the lowland populations historic range) and translocations.

The Otway Ranges in south-west Victoria support a number of major vegetation communities including

heathy woodland, heathy lowland forest, sandy heathland, coastal headland scrub, coastal scrub and estuarine woodland. Wilson and Garkaklis (2020) reported on the results of the long-term monitoring (live trapping over 20 to 42 years) of small-mammal populations at 30 sites across these communities in the eastern ranges.⁷⁴³ They found changes in occurrence and abundance. In total, 67% of sites exhibited large to severe decreases in abundance and only 3% of sites had more than four species, compared to 27% in earlier decades. Declines occurred following wildfire and drought, with drivers likely to be multifactorial. While regional declines were significant, higher mammal abundance (two- to six-fold) and native species richness were recorded at coastal dune sites, indicating that this community provides important mammal refuges. The scientists recommended the identification of refuges across the landscape, with protection from inappropriate fire and predators as management priorities.

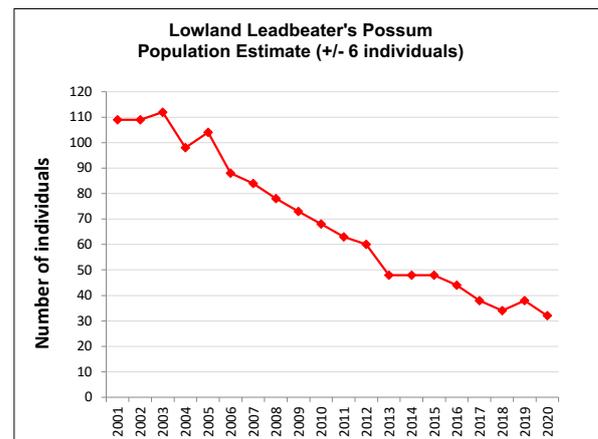


Figure 59: Leadbeater's possum population trends based on estimates of the number of individuals 'Known to be Alive' (KTBA) from long-term nest box monitoring and camera trapping at Yellingbo Nature Conservation Reserve.⁷⁴⁴

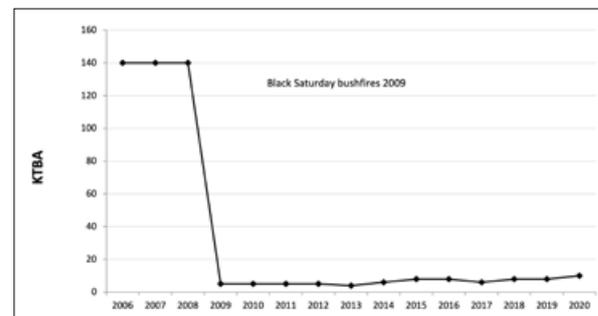


Figure 60: Leadbeater's possum population trends based on estimates of the number of individuals 'Known to be Alive' (KTBA) from long-term nest box monitoring and camera trapping at Lake Mountain.⁷⁴⁵

741. Ibid

742. Information supplied by the Arthur Rylah Institute.

743. Wilson B and Garkaklis M 2020, 'Patterns of decline of small mammal assemblages in vegetation communities of coastal south-east Australia: identification of habitat refuges', *Australian Mammalogy*, 43(2), pp. 203-220.

744. Zoos Victoria 2021, 'Leadbeater's possum: summary of conservation trends', Zoos Victoria, Parkville, Victoria.

745. Ibid

Victoria's biodiversity targets

Background

Despite understanding the importance of our natural environment, not enough has been done to protect it from harm. Victoria's biodiversity is in decline. More than half of the state's native vegetation has been cleared since European settlement, and many native plant and animal species are at risk from a range of pressures, including the impacts of climate change.⁷⁴⁶

Released in April 2017, Protecting Victoria's Environment – Biodiversity 2037⁷⁴⁷ (Biodiversity 2037) is the Victorian Government's policy response to addressing the decline in the state's biodiversity. It presents a long-term vision for Victoria's biodiversity supported by two goals: 'Victorians value nature', and 'Victoria's natural environment is healthy.' Biodiversity 2037 sets statewide targets and contributing targets for both goals, with contributing targets reviewed and updated every five years.

The statewide targets for Biodiversity 2037 are:

- (on average) 100% Change in Suitable Habitat expected over 50 years from sustained improved management for threatened species
- a net improvement in the outlook across all species as measured by all species having a positive % Change in Suitable Habitat expected over 50 years from sustained improved management
- no Vulnerable or Near Threatened species will have become Endangered
- that all Critically Endangered and Endangered species will have at least one option available for being conserved ex-situ or re-established in the wild (where feasible under climate change) should they need it
- a net gain of the overall extent and condition of habitats across terrestrial, waterway and marine environments.

The statewide targets associated with Victorian's value nature are:

- All Victorians connecting with nature
- Five million Victorians acting to protect the natural environment.

Along with these targets, Biodiversity 2037 has a Biodiversity 2037 Monitoring, Evaluating, Reporting and Improvements Framework⁷⁴⁸ with targets, actions and key performance indicators. The Biodiversity Knowledge Framework is a major element of the Framework and supports the identification of knowledge gaps to more effectively target investment in biodiversity research, monitoring and data collection.

Biodiversity 2037 has also been developed to ensure that Victoria's biodiversity policies and actions are consistent with national biodiversity strategies and complement the UN Sustainable Development Goals and Aichi Biodiversity Targets. The first of the five-yearly evaluations of the implementation of Biodiversity 2037 is currently underway. The evaluation of progress will look across the sector and at organisational arrangements, strategic planning and processes, and mechanisms for coordinating efforts.

The Victorian Government committed \$86.3 million to implement Biodiversity 2037 over the four years to 2021. Included within that allocation was \$34.77 million for Biodiversity Response Planning projects. Biodiversity Response Planning 'is a new area-based planning approach to biodiversity conservation in Victoria. It is designed to strengthen alignment, collaboration and participation between government agencies, Traditional Owners, non-government agencies (NGOs) and the community.'⁷⁴⁹ Victoria was divided into 11 areas, each with its own working group with up to 15 stakeholders to identify on-ground projects for funding. These were then evaluated against a set of published criteria. Achieving Biodiversity 2037 targets relies on a range of funding and programs in addition to the direct investment referred to above. These include the Weeds and Pests on Public Land program, the Icon Species program and Commonwealth Government programs.

746. DELWP 2017, 'Minister's foreword' in 'Protecting Victoria's environment: biodiversity 2037', East Melbourne, Victoria.

747. Ibid.

748. DELWP 2017, 'Biodiversity 2037 Monitoring, Evaluation, Reporting and Improvements Framework (MERF)', East Melbourne, Victoria.

749. DELWP, 'Biodiversity response planning: working together for biodiversity', East Melbourne, Victoria <https://www.environment.vic.gov.au/biodiversity/biodiversity-response-planning> Accessed 9 May 2021.

Victoria's biodiversity targets

Three-year funding was allocated to 89 biodiversity response planning projects that began in 2018–19 and which have now been completed. In 2018–19, DELWP reported that volunteers contributed 14,500 hours, delivery organisations numbered 79, and there were 257 partnerships and 58 Traditional Owner partnerships. In that same year, 951,000 hectares of pest herbivore and predator control, 164,000 hectares of weed control, 1,100 hectares of revegetation and 1,100 hectares of wetland restoration were carried out. In 2019–20 the results from 85 on-ground projects were: 16,500 hours of volunteer contributions, 127 new partnerships and 15 new Traditional Owner partnerships formed, along with 1,377,000 of pest herbivore and predator control, 180,000 hectares of weed control, 3,300 hectares of revegetation and 1,200 hectares of wetland restoration. Other achievements included:

Parks Victoria removed 125 deer from 47,000 hectares of the Grampians National Park

- Greening Australia planted 17,140 desert stringybark seedlings in the Wimmera and Glenelg areas to increase food supply for the endangered south-eastern red-tailed black cockatoo
- a camera monitoring program for deer was installed over 50,000 hectares of the Lake Tyers area through a partnership between Gunaikurnai Land and Waters Corporation, the Moogji Aboriginal Council and DELWP.

Victorians Volunteering for Nature was released by the Victorian Government in 2018, aiming to harness the efforts of the environmental volunteer sector to help achieve the goals and targets of Biodiversity 2037.



TITLE: Great Otway National Park
OWNED BY: Great Ocean Road Marketing
CREDIT: Robert Blackburn

Victoria's biodiversity targets

Indicator B:18 Net gain in the extent and condition of native vegetation

Region Statewide	Indicator Performance:	2018 Status	2018 Trend	2018 Data
Measures Estimates of the overall rate of change in extent and quality of native vegetation on public and private land in Victoria	2018:  2021: 			
Data Custodian DELWP	Why this indicator? This is a Biodiversity 2037 indicator.	2021 Status	2021 Trend	2021 Data
				

Potential thresholds for status in the SoE 2023 report

Good: There is a net gain in the extent and condition of native vegetation

Fair: There is no net gain in the extent and condition of native vegetation

Poor: There is a net loss in the extent and condition of native vegetation

Why this assessment in 2021?

Status: Based on most recent data, the Status remains Poor. However, this will be reassessed at the end of the first five-year milestone target period and in the SoE 2023 report.

Trend: There is an ongoing net loss in native vegetation. However, the Trend will be reassessed at the end of the first five-year milestone target period and in the SoE 2023 report.

Data Confidence: The data are sourced from DELWP reports and submissions. It will be reassessed at the end of the first five-year milestone target period and in the SoE 2023 report.

Should this indicator be used in the SoE 2023 report?

Yes.

Summary of SoE 2018 Report assessment

- There had been a loss in native vegetation on public and private land between 2008 and 2014.
- Controlled management of public land e.g. planned burns was recorded as a loss when it resulted in native vegetation being below the tolerable fire interval.
- The largest contributors to net loss in native vegetation on private and freehold land were entitled uses (e.g. grazing and removal of trees and fallen logs for personal use), unmanaged threats beyond legislative obligations (e.g. environmental weeds) and clearing that was exempt from requiring a permit (e.g. fences and fire protection).

The 2019–20 bushfires: Impacts and responses

The spatial extent of bushfires is not included in DELWP's calculation of the net loss or gain of native vegetation in Victoria as the department expects the vegetation to regenerate.

SoE Biodiversity Update 2021 Report assessment

DELWP its submission⁷⁵⁰ to the Legislative Council Environment and Planning Committee Inquiry into Ecosystem Decline in Victoria reported that: 'Victoria has a legacy of loss, degradation and fragmentation of habitats that is evident across the state. The effects of this legacy are continuing, creating more pressure on species and increasing their vulnerability to other threats. Although the rate of land clearing has slowed since the introduction of Victoria's native vegetation clearing regulations in 1989, the quality and extent of native vegetation continues to shrink by about 4,000 habitat hectares each year.⁷⁵¹ This trajectory is largely the result of activities and unmanaged threats that are outside the regulatory framework,

750. DELWP 2020, 'Submission to the Legislative Council Environment and Planning Committee Inquiry into Ecosystem Decline in Victoria', Parliament of Victoria, Melbourne, Victoria.

751. Habitat hectares is a method for assessing native vegetation, in terms of both quality and extent. Quality is assessed by scoring habitat attributes at a site in comparison to a reference point (benchmark) for the relevant vegetation type – this provides a 'habitat score'. The habitat score is multiplied by the area of vegetation to determine the amount of habitat hectares. For example, 10 hectares with a habitat score of 60/100 is 6 habitat hectares.

Victoria's biodiversity targets

such as the exempted removal of native vegetation from fence lines and roadsides (resulting in loss of extent of native vegetation) together with insufficient management of threats, such as introduced weeds and pest herbivores or inappropriate fire regimes (resulting in loss of quality).⁷⁵²

DELWP's 2020 report on implementation of Biodiversity 2037 revealed that there was a net annual loss of 8,200 habitat hectares of native vegetation in Victoria in the previous year.⁷⁵³ This is 4,200 hectares more than the average annual loss reported by DELWP in the above quote and which was based on data in 'Protecting Victoria's environment – Biodiversity 2037.'

Indicator B:20 Change in Suitable Habitat for threatened native species

Region Statewide	Indicator Performance:	2018 Status	2018 Trend	2018 Data
Measures Estimating net improvement in suitable habitat and the most effective options for improving the future of threatened native species across the state under climate change	2018: Unable to be assessed due to only Fair Status			
	2021: Not assessed	2021 Status	2021 Trend	2021 Data
Data Custodian DELWP	Why this indicator? It is one of the Key Performance Indicators through which progress towards the Biodiversity 2037 targets is measured.			

Potential thresholds for status in the SoE 2023 report

Good: >75% of the five-yearly milestone target for Change in Suitable Habitat is met

Fair: > 50% to <75% of the five-yearly milestone target for Change in Suitable Habitat is met

Poor: <50% of the five-yearly milestone target for Change in Suitable Habitat is met

Why this assessment in 2021?

Status: This will be assessed at the end of the first five-year milestone target period and in the SoE 2023 report.

Trend: This will be assessed at the end of the first five-year milestone target period and in the SoE 2023 report.

Data Confidence: This will be assessed at the end of the first five-year milestone target period and in the SoE 2023 report.

Should this indicator be used in the SoE 2023 report?

Yes.

Summary of SoE 2018 Report assessment

- This indicator is a practical measure for estimating net improvement in suitable habitat achieved by implemented actions compared with a 'no action' scenario, and the most effective options for improving the future of native species across the state under climate change.
- The indicator target is for a 100% net positive change (on average) in suitable habitat for threatened species in 50 years.
- According to Biodiversity 2037, achieving the 100% change (on average) in suitable habitat target will require the establishment and maintenance of management actions (e.g. weed and feral predator removal) and undertaking the most cost-effective actions identified in the Strategic Management Prospects tool.

752. DELWP 2020, 'Submission to the Legislative Council Environment and Planning Committee Inquiry into Ecosystem Decline in Victoria', Parliament of Victoria, Melbourne, Victoria.

753. DELWP, 'Implementing Biodiversity 2037' <https://www.environment.vic.gov.au/biodiversity/Implementing-Biodiversity-2037> Accessed 13 September 2021.

Victoria's biodiversity targets

The 2019–20 bushfires: Impacts and responses

Change in Suitable Habitat measures the increase in the likelihood that a species will persist at a priority location at a future time (for example, in 50 years) in response to sustained management of relevant threats, compared with the likelihood of persistence in 50 years under no action i.e. the change between two different futures (action and no action). The Change in Suitable Habitat is not measured between two dates i.e. pre and post-fire. It is expressed as the proportional increase (percentage) in hectares of suitable habitat a species has received under a sustained management regime, compared with no management.

In 2020, DELWP released data on the benefits to threatened flora and fauna (Change in Suitable Habitat) from the emergency response aerial shooting operation conducted after the 2019–20 bushfires. The main target of the operation were feral deer species, however any other pest herbivores found were also culled.⁷⁵⁴ Table 79 summarises the Change in Suitable Habitat expected from sustained long-term herbivore control across the management area, although this was not a deer eradication or long-term control program. The Victorian species lists referred to in Change in suitable habitat expected from sustained long-term herbivore control across the management area. i.e. Flora and Fauna Guarantee Act List and Advisory Lists, have now been replaced by the Flora and Fauna Guarantee Threatened List.

The Change in Suitable Habitat figures in Table 80 incorporate consideration of the 2019–20 bushfires by reducing the persistence of the threatened species in the fire extent if there was no action. This could have had the effect of increasing the modelled benefit of particular actions and therefore an increase in Change in Suitable Habitat for some species within that fire extent.

Table 80 indicates that for post-fire pest herbivore control, 1,235 native species have very low percentages of Change in Suitable Habitat, as do 661 threatened species listed under the now superseded advisory lists. However, there were examples of key animal and plant species of most concern with higher percentages of Change in Suitable Habitat:

'Key fauna species of most concern due to the 2019–20 bushfires that are expected to increase in probability of local persistence (Change in Suitable Habitat) under sustained long-term herbivore control include:

- brush-tailed rock wallaby (*Petrogale penicilliate*): Change in Suitable Habitat of 35%
- alpine she-oak skink (*Cyclodomorphus praealtus*): Change in Suitable Habitat of 30.7%
- eastern bristlebird (*Dasyornis brachypterus*): Change in Suitable Habitat of 13.4%
- alpine water skink (*Eulamprus kosciuskoi*): Change in Suitable Habitat of 12.8%.

'Key flora species of most concern due to the 2019–20 bushfires that are expected to increase in probability of local persistence (Change in Suitable Habitat) under sustained long-term herbivore control include:

- Snowy River westringia (*Westringia cremnophila*): Change in Suitable Habitat of 18%
- summer leek-orchid (*Prasophyllum uvidulum*): Change in Suitable Habitat of 17.3%
- green grevillea (*Grevillea jephcottii*): Change in Suitable Habitat of 14.1%
- Suggan Buggan wax-flower (*Philotheca myoporoides subsp. brevipedunculata*): Change in Suitable Habitat of 12%.'

These percentage estimates are based on 'sustained long-term herbivore control'. The post-fire aerial shooting operation was a short-term operation in targeted locations and was not designed as a long-term management action.

⁷⁵⁴ DELWP 2020, 'Emergency response aerial shooting operation: summary report', East Melbourne, Victoria.

Victoria's biodiversity targets

Table 79: Change in suitable habitat expected from sustained long-term herbivore control across the management area.⁷⁵⁵

Change in Suitable Habitat	Total Species	Listed under EPBC Act	Listed under FFG Act	Listed under DELWP Advisory List
>30%	3 species	2 species	2 species	3 species
20% to 30%	2 species	1 species	1 species	2 species
10% to 20%	37 species	3 species	10 species	34 species
5% to 10%	105 species	6 species	14 species	102 species
1% to 5%	544 species	20 species	37 species	260 species
Total >1%	691 species	32 species	64 species	401 species

SoE Biodiversity Update 2021 Report assessment

For this indicator, the Biodiversity 2037 target is: (On average) a 100% net positive Change in Suitable Habitat in 50 years for threatened species. Change in Suitable Habitat is the Victorian Government's key performance indicator through which it will measure progress toward the targets in Protecting Victoria's Environment: Biodiversity 2037. It is a spatially explicit outcome measure that allows comparisons to be made between many combinations of species, places, threats and actions. It is based on forward-looking estimates in order to allow consideration of the likely effects of climate change.

Change in Suitable Habitat is the increase in the likelihood that a species will persist at a location at a future time (e.g. 50 years) in response to the sustained management of relevant threats, such as invasive animals and plants. It is expressed as the proportional increase (percentage) in hectares of Suitable Habitat that a species has received under a sustained management regime, compared with no management. The calculation is:

Change in Suitable Habitat (for a species) = $(\text{action1} - \text{action0}) / \text{action0}$

Where:

action0 is the likelihood of persistence of the species with no action in the analysis

action1 is the likelihood of persistence of the species with actions, adjusted based on the standard and coverage of the set of actions applied.

Biodiversity 2037 states that achieving the target of an (on average) 100% Change in Suitable Habitat will require the establishment and maintenance of the appropriate type and amount of actions at priority locations as identified by a Strategic Management Prospects analysis of the most cost-effective options.

Biodiversity 2037 also set some contributing targets to provide guidance on the type and amount of the most common landscape-scale actions, and an intermediate outcome indicator based on these is also being reported (see B:21 Hectares of management action in priority locations). The better aligned actions are to the priority locations, and the sooner these actions are delivered over the 20-year life of Biodiversity 2037, the more likely it is that the statewide outcome targets will be achieved.

Threatened species are defined as Critically Endangered, Endangered and Vulnerable species per the new CAM project (data are unavailable for the average percentages for each conservation status category). The average percent Change in Suitable Habitat in 50 years for threatened species is 11.4%, based on the actions undertaken (see Table 80).

⁷⁵⁵. Ibid

Victoria's biodiversity targets

Table 80: Percentage net change in suitable habitat in 50 years for five taxon groups.⁷⁵⁶

Taxon Group	(On Average) % Net Change in Suitable Habitat in 50 Years SoE 2018 Report*	(On Average) % Net Change in Suitable Habitat in 50 Years
Threatened species	5.24	11.4
Birds	2.56	15.4
Frogs	3.45	30.2
Mammals	27.11	31.4
Plants	4.33	10.4
Reptiles	19.02	13.7
Average Change in Suitable Habitat	5.3	11.4

*based on data for from the years 2015-16 and 2017-18

The percentage of all species that had a net improvement (2% to >50%) in Change in Suitable Habitat was 80.6% (see Table 81). For some species, the percent Change in Suitable Habitat was much higher than the average. For example, 414 threatened species (664 for all species) had a

Change in Suitable Habitat greater than 10%. The achievement of these figures is reliant on sustained, well-resourced and effective management actions and, for more than 50% of all species, and almost 50% of threatened species, there was no improvement or only a 2-5% Change in Suitable Habitat.

Table 81: Threatened species and their percentage ranges of Change in Suitable Habitat 2019-20.⁷⁵⁷

Change in Suitable Habitat Value Range	Proportion of Threatened (CAM Status)* Species (Total = 1,347)	Proportion of All Species (Total= 3,942)
No net improvement	24.7%	19.4%
2-5%	24.8%	39.9%
5-10%	19.7%	23.9%
10-50%	28.1%	15.7%
>50%	2.7%	1.1%

*CAM Status species are those assessed using the CAM in the preparation of the Flora and Fauna Guarantee Threatened List.

A key assumption of these calculations is that the actions are continued for the next 50 years at the best-practice standard. The relatively low predicted (on average) % net Change in Suitable Habitat in 50 years for all species may be due to a number of factors, including:

- a lack of alignment of key management actions with priority locations, either due to lack of familiarity with new cost-effectiveness information for biodiversity outcomes, or because the actions are focused on other/multiple outcomes (see B:21 Hectares of management action in priority locations)

⁷⁵⁶. Data supplied by DELWP.

⁷⁵⁷. Ibid

Victoria's biodiversity targets

- only partial achievement of biodiversity benefits due to a lack of fully integrated management. For example, predators will prey on herbivores, so control of one without appropriate control of the other can limit the overall outcome. Notably, a relatively large number (>100) of flora species are likely to be receiving negative benefits from predator control management actions, due to the increase of overall grazing pressure e.g. by rabbits caused by reductions in their predators without the corresponding pest herbivore control
- missing spatial data regarding actions already being undertaken that may impact on Change in Suitable Habitat. For example, actions implemented by community groups and volunteers that have not been recorded digitally and/or incorporated in DELWP datasets
- the need for further management action through increased investment.

To achieve the Biodiversity 2037 targets will rely on an accelerated and targeted level of effort. To assist with planning this investment and reporting on progress, DELWP has established five-yearly milestone targets for both the outcome target and the contributing targets. Figure 61 and Figure 62 present five-yearly milestone targets for 'Change in Suitable Habitat across threatened species' and 'Species with at least one option available for being conserved ex-situ or re-established in the wild.' These measure progress from on-ground management actions in achieving Biodiversity 2037 targets by comparing the current state with the desired target trend. The first measure is close to equal with the desired target trend for 2019–20, the second well below (DEWP reports that a basely is being established for this second target).⁷⁵⁸ Both will need to increase significantly to meet the five-yearly milestone target in 2022–23.

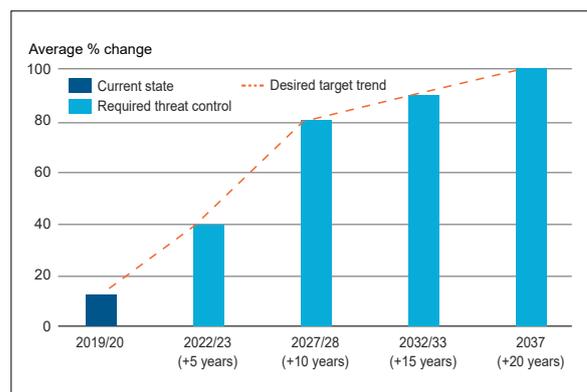


Figure 61: Change in suitable habitat across threatened species.⁷⁵⁹

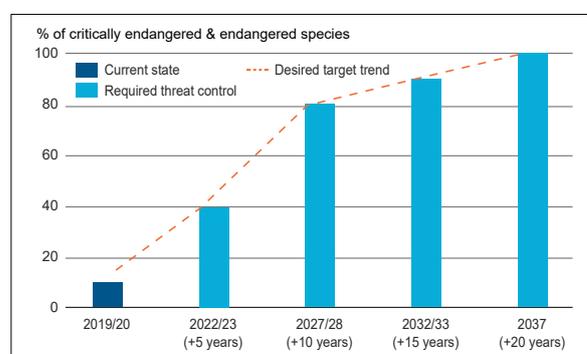


Figure 62: Species with at least one option available for being conserved ex-situ or re-established in the wild.⁷⁶⁰

Caveats and assumptions

- Net improvement in suitable habitat is defined as a positive change in suitable habitat greater than 2%. This threshold was chosen to limit the effect that benefits in marginal/edge of range/low suitability modelled habitat for species may have on the overall reporting results.
- The benefit and area data are calculated on the assumption that an action is undertaken across the full extent of the polygons reported, and therefore may be overestimated in some cases. Efforts were made to refine polygons where better information was available.

⁷⁵⁸ DELWP, 'Implementing Biodiversity 2037' <https://www.environment.vic.gov.au/biodiversity/implementing-biodiversity-2037> Accessed 13 September 2021.

⁷⁵⁹ Data supplied by DELWP.

⁷⁶⁰ Ibid

Victoria's biodiversity targets

- The values provided here assume that the reported actions were done to best practice, and that they will be sustained for 50 years. Any estimated benefits do not apply if an action is not sustained for the 50-year time horizon. Therefore, when calculating benefits, actions will be counted for an area if they are current (either newly established or continuing from previous years) but not if they have lapsed within 2 years.
- In some instances, some polygons of reported actions did not intersect with the action benefit models in the Strategic Management Prospects tool. This is mostly due to some threat models in Strategic Management Prospects not adequately reflecting the true distribution of a threat, and therefore the places where action is required. Therefore, in some instances, the Change in Suitable Habitat values may be an underestimate.
- The figures detailed here apply to the information provided by the current Strategic Management Prospects (SMP V2) analysis. As the Strategic Management Prospects tool develops and improves over time, and more accurate data is provided for effective treatment area and standard of works, the figures reported here may vary. However, it will be possible in the future to back-cast the Strategic Management Prospects models and data to provide trend information through time.
- Some Specific Needs actions provided very large benefits that are likely unrealistic e.g. >500% improvements in Change in Suitable Habitat. Where this has occurred, benefits have been truncated to a maximum percent Change in Suitable Habitat of 300%.

Climate change will likely impact the future distribution and amount of suitable habitat across Victoria. It will also influence the benefit achieved by particular conservation actions, both in terms of magnitude and where that benefit can be achieved. DELWP is currently working on better ways to consider that in the analyses for future reporting.

Victoria's biodiversity targets

Indicator B:21 Area of management in priority locations

Region Statewide Measures Achieving targets for hectares of management in priority locations, including weed and animal pest predator and herbivore control, revegetation on public and private land, and permanent protection on private land Data Custodian DELWP	Indicator Performance: 2018: Unable to be assessed due to Fair Status and Moderate Data Confidence 2021: Not assessed Why this indicator? This is a Biodiversity 2037 indicator. It allows a comparison of management options, or the effectiveness of individual management actions in different places. When the output deliveries are large, the Change in Suitable Habitat will also be large.	2018 Status 	2018 Trend 	2018 Data 
		2021 Status 	2021 Trend 	2021 Data 

Potential thresholds for status in the SoE 2023 report

Good: >75% of the five-yearly milestone target for each of the five management actions in priority locations is met

Fair: >50% to <75% of the five-yearly milestone target for each of the five management actions in priority locations is met

Poor: <50% of the five-yearly milestone target for each of the five management actions in priority locations is met

Why this assessment in 2021?

Status: The combination of five disparate management actions and the early point in the five-yearly milestone target time frame, prevent an assessment of Status.

Trend: Data over a longer time period is required to determine Trend. That will be available for the SoE 2023 report.

Data Confidence: Data are only available for the initial part of the milestone time frame. Data Confidence will be reviewed in the SoE 2023 report.

Should this indicator be used in the SoE 2023 report?

Not in its current form. Consideration should be given to splitting this into five: weed control; predator control; herbivore control; revegetation; permanent protection on private land.

Summary of SoE 2018 Report assessment

- This indicator sets out targets for hectares of management in priority locations, including restoration of habitat
- A priority location refers to areas identified within the top 20% cost-effective actions in the Strategic Management Prospects, which help to integrate and compare information on the expected benefits and indicative costs of conservation actions across species and locations. It allows a comparison of management options or the effectiveness of individual management actions in different places.

The 2019–20 bushfires: Impacts and responses

The response to the 2019-20 bushfires has included significant actions to reduce the impact of invasive predators, herbivores and plants. These have been documented in the indicators for Theme 3: Invasive plant and animals, and in B:20 Change in Suitable Habitat.

SoE Biodiversity Update 2021 Report assessment

This indicator has been disaggregated by DELWP⁷⁶¹ and is now hectares of conservation management action in priority locations with the Biodiversity 2037 contributing targets being:

- 4 million hectares of pest herbivore control in priority locations by 2037
- 1.5 million hectares of pest predator control in priority locations by 2037
- 1.5 million hectares of weed control in priority locations by 2037
- 200,000 hectares of revegetation in priority areas for connectivity between habitats by 2037
- 200,000 hectares of new protected areas on private land by 2037.

⁷⁶¹ DELWP, 'Healthy, resilient and biodiverse environment', East Melbourne, Victoria <https://www.delwp.vic.gov.au/corporate-plan/healthy-resilient-and-biodiverse-environment> Accessed 9 May 2021.

Victoria's biodiversity targets

A priority location refers to areas identified within the top 20% of cost-effective actions in the Strategic Management Prospects, now a key process for DELWP. Strategic Management Prospects help to integrate and compare information on the expected benefits and indicative costs of conservation actions across species and locations.

Contributing targets identify the area of management in priority locations that needs to be achieved, as soon as possible, and maintained over the 20-year life of Biodiversity 2037. If effort slows or stops, in some cases even for a short time, the gains made

over the preceding years of effort could be lost.

The better aligned actions are to those identified in priority locations, and the sooner these actions are commenced, the more likely it is that the statewide outcome targets will be achieved. The contributing targets will be reviewed every five years to ensure they reflect the right actions to help achieve the statewide outcome targets. Table 82 demonstrates that there is alignment of some key management actions with priority locations. However, revegetation and private land protection are well behind as key management actions with priority locations.

Table 82: Indicative progress towards contributing targets in Biodiversity 2037.⁷⁶²

Action	Total Hectares of Action Statewide (Priority and Non-Priority Locations)	Hectares of Action in Non-Priority Locations	Hectares of Action in Priority Locations	Target Hectares of Actions in Priority Locations by 2037	Percentage of Total Intervention in Priority Locations
Pest herbivore control	1,674,138	785,810	888,757	4,000,000	53%
Pest predator control	2,105,220	1,239,892	865,328	1,500,000	41%
Weed control	584,622	382,765	201,857	1,500,000	35%
Revegetation for habitat connectivity	9,135	9,061	74	200,000	1%
Hectares of newly protected area on private land since 2017	5,373	5,373	priority locations do not apply	200,000	n/a

Activity data was included in the analysis if it met the Biodiversity 2037 activity data requirements. In the case of historical data, management was assumed to be still current up to two years for predator and herbivore control, and five years for weed control. All revegetation and permanent protection data are included.

Figure 63, Figure 64 and Figure 65 map the location of predator, herbivore and weed control activities respectively. The detail in the shaded areas reflects a more nuanced approach to data reporting by

DELWP. Previously a broad brush was applied when mapping the activity areas. This new presentation provides a clearer picture of the control activities and their location. East Gippsland, Wilsons Promontory, the Otway Ranges, Gariwerd National Park and far western Victoria are areas of focus predator control. The distribution of weed control is different, with a focus on the north-western Victoria, the Otway Ranges and parts of the Great Dividing Range. Herbivore control is largely in north-eastern and north-western Victoria, with scattered areas across the state and in coastal ranges.

Victoria's biodiversity targets

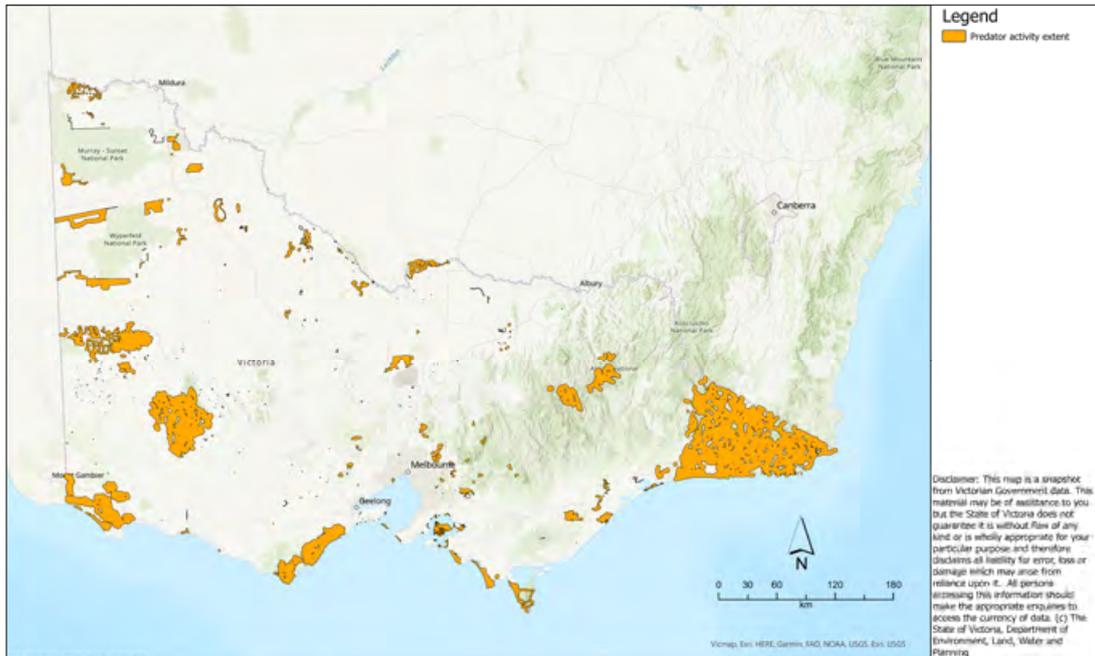


Figure 63: Reported predator control across Victoria.⁷⁶³

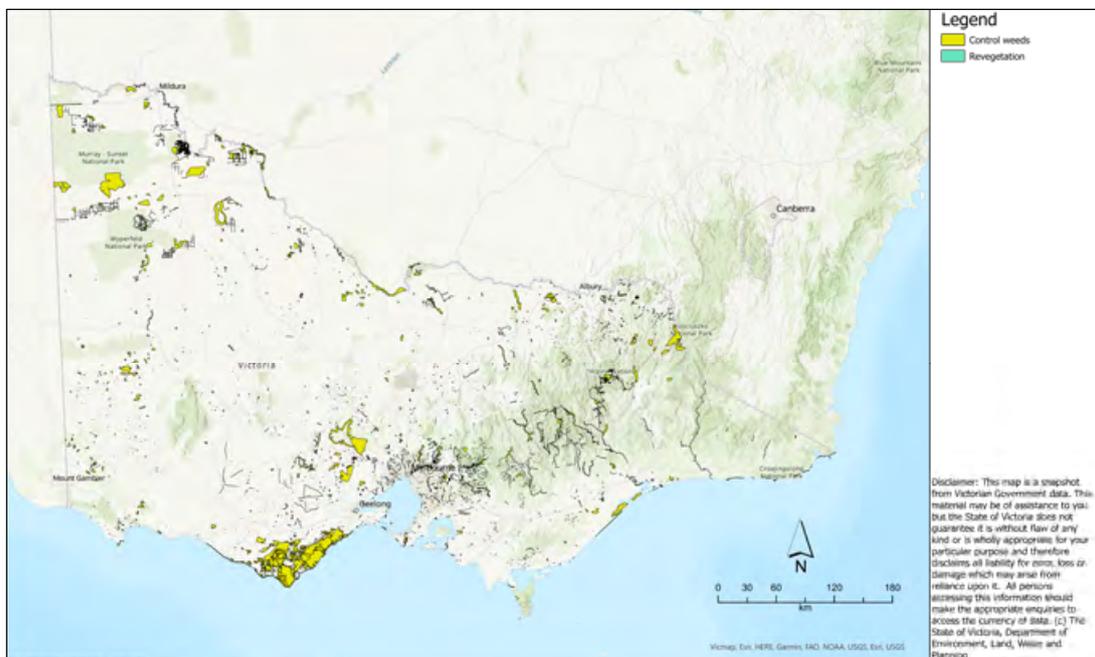


Figure 64: Reported weed control across Victoria.⁷⁶⁴

763. Ibid

764. Ibid

Victoria's biodiversity targets

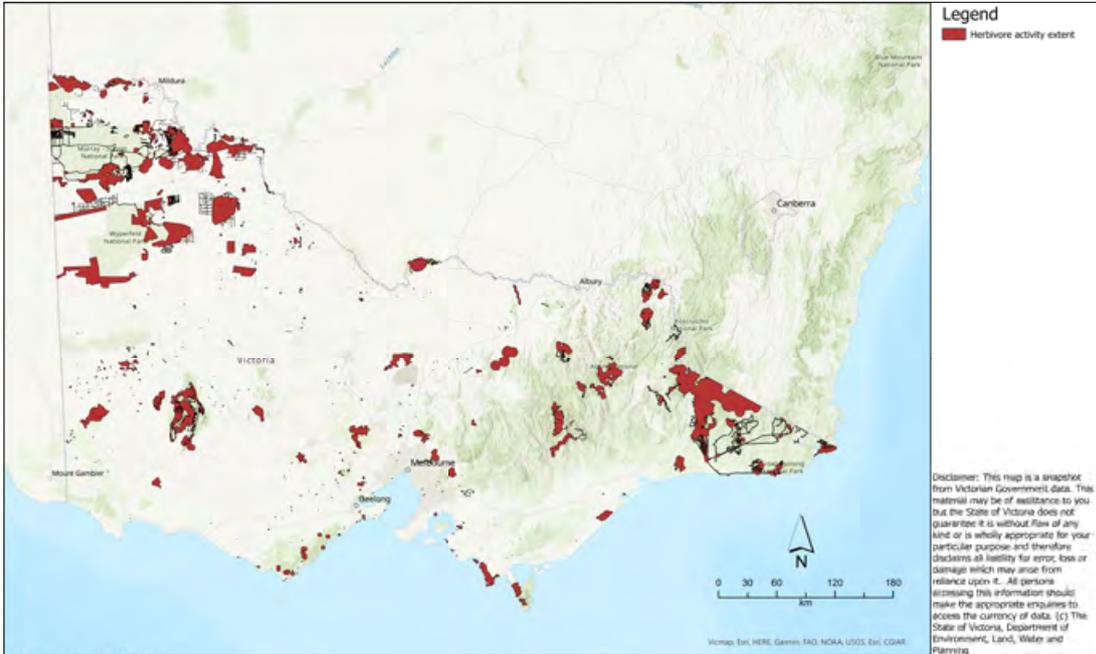


Figure 65: Reported herbivore control across Victoria.⁷⁶⁵

Figure 66 to Figure 70 present milestone targets for newly protected areas on private land, pest predator, herbivore and weed control, and revegetation, in priority locations. These measure progress from on-ground management actions in achieving Biodiversity 2037 targets by comparing the current state (2019-20) with the desired trend. Currently protected areas on private land and

revegetation in priority locations are well below their targets. Pest predator and herbivore control are ahead, and weed control is equal to the target. The graphs also show the trajectories required to meet the five-yearly milestone targets in the coming years. They indicate that except for pest predator control, which is already ahead of the 2022-23 target, the management actions will require significant increases in coverage to meet their milestone targets.

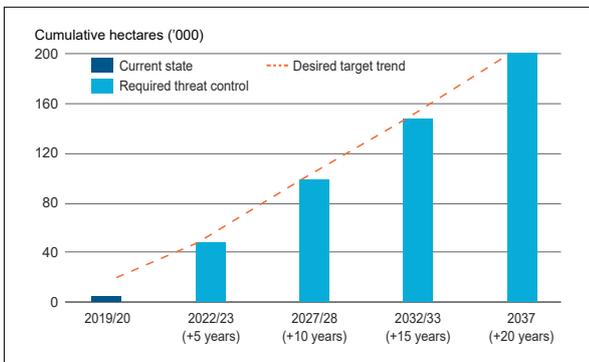


Figure 66: Newly protected area on private land.⁷⁶⁶

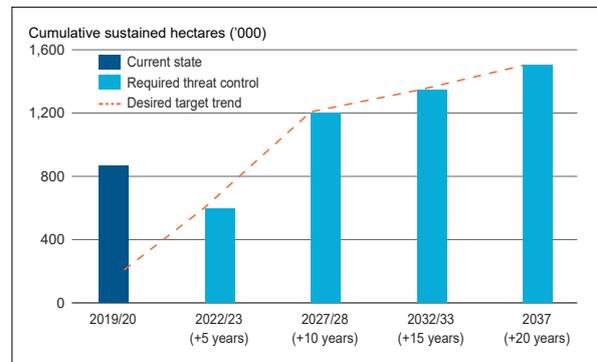


Figure 67: Pest predator control in priority locations.⁷⁶⁷

764. Ibid
 765. Ibid
 766. Ibid

767. Data supplied by DELWP. Note: Current numbers above the target trend do not indicate too much pest predator control, as action is required to be maintained up to and beyond 2037.

Victoria's biodiversity targets

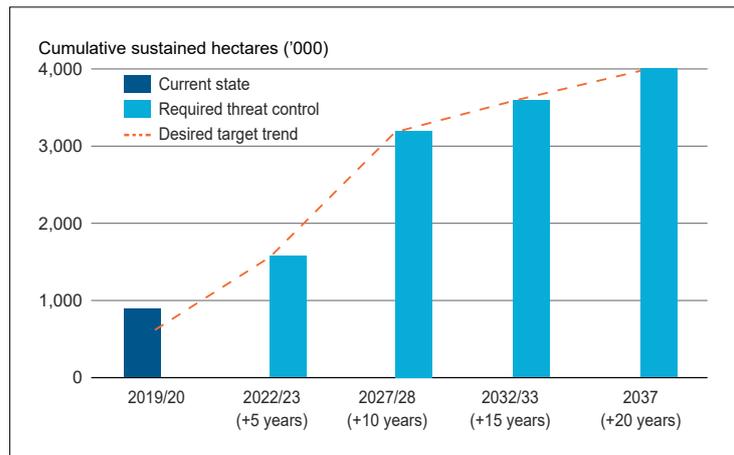


Figure 68: Herbivore control in priority locations.⁷⁶⁸

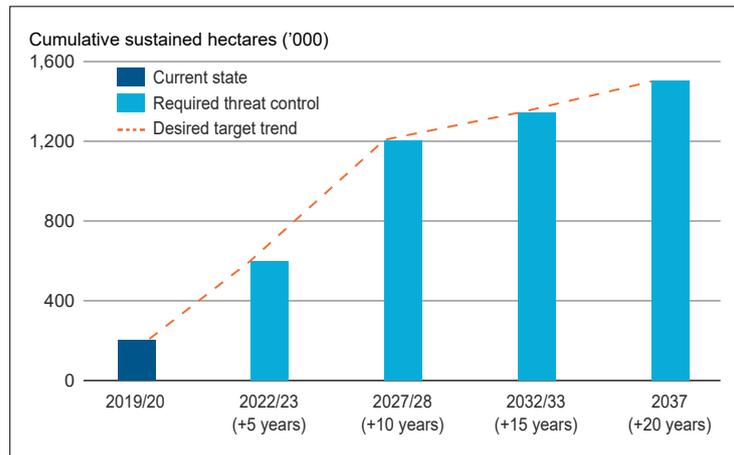


Figure 69: Weed control in priority locations.⁷⁶⁹

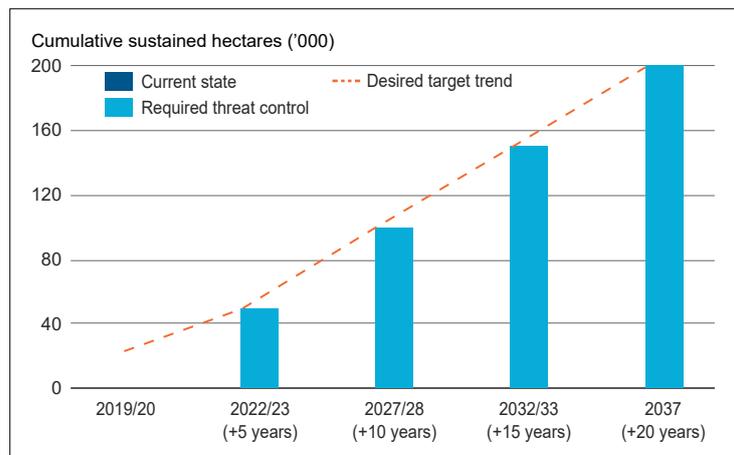


Figure 70: Revegetation in priority locations for habitat connectivity.⁷⁷⁰

768. Ibid
769. Ibid
770. Ibid

Victoria's biodiversity targets

Indicator B:22 Victorians value nature

Region Statewide	Indicator Performance:	2018 Status	2018 Trend	2018 Data
Measures Number of Victorians connecting with nature; Number of Victorians acting to protect the natural environment	2018: Unable to be assessed due to Unknown Status and Trend and Low Data Confidence			
Data Custodian DELWP	2021: Not assessed	2021 Status	2021 Trend	2021 Data
	Why this indicator? The 2019–20 bushfires raised community awareness and concerns about biodiversity			

Potential thresholds for status in the SoE 2023 report

Connecting with nature

Good: 4 million to 5 million Victorians are connecting with nature

Fair: >2.5 million to <4 million Victorians are connecting with nature

Poor: <2.5 million Victorians are connecting with nature

Acting to protect nature

Good: >75 to 100% of all Victorians are acting to protect the environment

Fair: >50% to <75% of all Victorians are acting to protect the environment

Poor: <50% of all Victorians are acting to protect the environment

Why this assessment in 2021?

Status: The Potential Thresholds for Status are based on 2019–20 targets which, if sustained, would not meet the overall targets of 100% of Victorians connecting with nature and 5 million Victorians acting to protect the natural environment. The potential threshold numbers will need adjustment once targets and actual results become clearer. Preparation for the SoE 2023 report will have more data to use to better assess this indicator.

Trend: There is an insufficient time period to identify Trend.

Data Confidence: Data are limited due to time period involved in its collection.

Should this indicator be used in the SoE 2023 report?

Yes.

Summary of SoE 2018 Report assessment

- There is an estimated 100,000 Victorians participating in environmental volunteering each year across diverse volunteer groups and mostly structured programs. These include citizen science programs, marine and coastal volunteers, water programs, Landcare, 'Friends' groups, parks volunteers, outdoor enthusiast groups, Zoos Victoria, climate change and sustainability networks, gardening, wildlife programs, corporate volunteering, not-for-profits, and local government and government agency programs.

The 2019–20 bushfires: Impacts and responses

The closures to parks due to bushfires and COVID-19 impacted park visitor numbers in 2019–20. It also meant that planned face-to-face DELWP and Parks Victoria activities were suspended or replaced by online flora.

Theme 7 in Victoria's bushfire response and recovery projects aims to support people's recovery from the fires by facilitating their engagement in activities to assist the recovery of nature.

Victoria's biodiversity targets

Key actions include:

- providing grants to support community-led, place-based, small projects
- providing access to scientist/expertise to assist understanding and opportunity
- supporting meaningful citizen science and volunteering projects
- encouraging people to notice nature recovery
- sharing stories of recovery.

SoE Biodiversity Update 2021 Report assessment

Volunteering Naturally 2020 is the first of planned annual snapshots by DELWP of Victoria's environmental volunteer groups⁷⁷¹ It reported that in 2020 there were:

- 186,508 volunteers (63% mostly promoting sustainable living and 15% caring for landscapes)
- 2,166 groups (63% caring for landscapes and 21% promoting sustainable living) 2,429,484 hours volunteered (38% citizen science and 16% wildlife rescue and rehabilitation)

The economic contribution of volunteers in 2020 was estimated to be \$101.36 million.

Much of the work thus far on the Victorians valuing nature goal has been foundational, with surveys and behavioural research rather than broad activities and data collection. The Victorians Value Nature Foundations Survey conducted in 2018 received 3,090 responses and found that:

- 64% felt connected or very connected with nature
- 86% supported pro-environmental values
- 91% of parents believed it important that their children spend time in nature
- 84% engaged in actions or behaviours to help Victoria's natural environment once or more over the past year

- 48% had volunteered time for the environment at least once in the past year
- 80% chose native plants over non-native plants (at least once in the past year)
- 89% believed biodiversity is important for a healthy environment
- 77% understood that land clearing, foreign plants and animals, climate change and household waste are threats to a healthy environment
- 86% spent time in nature at least once a month.

A survey by Biddle and Gray (2020) found that 65.9% of respondents had stopped volunteering or other unpaid work due to COVID-19.⁷⁷² The pandemic's impact on the community's connection with nature was analysed by the community group, Remember the Wild, after conducting an online survey that received 359 responses.⁷⁷³ The key findings were that although people were valuing nature more, there were some who found that access to nature had been reduced. For those who were valuing nature more:

- 47% of people were spending more time in nature
- 75% of people were thinking about nature more
- 29% were consuming more nature-related content
- at least 38% of people were appreciating nature more
- 82% of people were using nature more to manage their mental health.

For those who had less access to nature:

- 28% of people were spending less time in nature
- 81% of people were craving nature more than before
- at least 21% of people could not access nature in ways they would like
- local parks and walking trails were overcrowded.

A survey of 1,009 Melburnians by the Victorian National Parks Association explored people's attitudes towards national parks and conservation areas,⁷⁷⁴ and in particular COVID-19 restrictions.

771. DELWP 2020, 'Volunteering naturally 2020', East Melbourne, Victoria.

772. Biddle N and Gray M 2020, 'The experience of volunteers during the early stages of the COVID-19 pandemic', ANU Centre for Social Research and Methods, Canberra, Australia.

773. Remember the Wild 2020, 'Report: COVID and nature connection, August 2020', Northcote, Victoria.

774. Victorian National Parks Association 2020, 'VNPA polling 2020, a survey conducted by Lonergan for the VNPA', Carlton, Victoria.

Victoria's biodiversity targets

It found that:

- 56% said the COVID-19 restrictions had made them value access to natural areas across Victoria more
- 54% of those stood down due to COVID-19 were more likely than average to value access to natural areas across Victoria much more
- 46% said the COVID restrictions made them visit bushland and parks in their local area
- 81% supported expanding national parks in Victoria
- 86% supported Victoria having a comprehensive network of national parks and conservation areas
- 67% said walking tracks and trails would make Melbournians visit national parks more often
- 58% believed the best use for Victoria's 3 million hectares of publicly owned state forests is for the protection of wildlife, trees and nature, with 2% supporting native forest logging.

Parks Victoria reported that for 2019–20: 'A large array of passionate and enthusiastic volunteers from over 110 different volunteer groups ranging from Friends groups, community organisations, Landcare, research and recreational user groups as well as individuals, made a very significant contribution to the management of many areas under the Act during the year. They contributed 62,116 volunteer hours across 77 parks under the Act. This outstanding volunteer contribution is valued at just under \$2.5 million dollars of in kind support this year.'⁷⁷⁵ The annual report also noted that: 'Face-to-face interpretation and education activities were delivered to 13,956 adults and children in 45 parks under the Act. This included engagement with 6,120 school students (+838 teachers) across 23 parks.'⁷⁷⁶

The Future of our Forests survey⁷⁷⁷ conducted by DELWP between December 2018 and March 2019 found community support for an end to timber harvesting in Victoria's native forests.

Some of the survey results were as follows:

- 'How can we protect and improve our forests for all Victorians?': 52% said by 'Protecting native forest from timber harvesting;' 42% by 'Protecting and restoring biodiversity to the forests.'
- 'What benefits do you want future generations to gain or enjoy from Victoria's forests?': 40% said 'Purity of nature' and 37% 'Maintaining healthy fauna and flora habitats.' The Top three answers to 'What should our forests be managed for?': 'Conserving plants and animals'; 'Maintaining water and catchment health'; 'Maintaining natural landscapes.'
- The Top three answers to 'What could be done to alleviate your concerns and improve the things you most value about our forests?': 'Stronger focus on biodiversity conservation;' 'Stronger focus on health and structure of our forests;' 'Improved protection of ecosystem services.'

The Royal Botanic Gardens of Victoria has also conducted surveys and focus groups on how people can connect with nature.⁷⁷⁸ The key findings were:

- nature experiences are important at all stages of the life course (childhood, adolescence, adulthood, and old age)
- nature experiences are extensively shaped by other people
- what is meant by 'acting for nature' is poorly understood
- a shift in focus toward developing and understanding the impact of curated nature experiences is valuable
- there is relevance and value in adopting a life course approach
- focus group participants described 'everyday' (local) nature experiences as important in their lives
- botanic gardens, and gardens in general, are considered to be 'special places' offering uniquely influential nature experiences
- nature connectedness, physical activity levels and action for nature are correlated.

⁷⁷⁵ Parks Victoria, 'National Parks Act annual report 2019–2020', Melbourne, Victoria.

⁷⁷⁶ Ibid

⁷⁷⁷ DELWP 2019, 'Future of our forests, feedback report: phase 1 engagement December 2018–March 2019', East Melbourne, Victoria.

⁷⁷⁸ Veale G and Kendal D 2020, 'Connecting people, nature and special places', Royal Botanic Gardens, Melbourne, Victoria.

Victoria's biodiversity targets

Victoria Nature Festival

The Victoria Nature Festival aimed to collaboratively produce a range of events to help increase the number of Victorians who connect with and act for nature and build awareness of the aims of Protecting Victoria's Environment - Biodiversity 2037 throughout the general community. This Statewide Nature Festival was designed by agencies across the Minister for Environment portfolio to produce an event aimed to help deliver several key objectives within the Victorian Government's Protecting Victoria's Environment – Biodiversity 2037 plan.

'Health and Wellbeing' and 'A new way to access nature close to you' were the festival themes selected to support Victorians at home whilst under pandemic restrictions. It aimed to embrace the leadership of Traditional Owners in Caring for Country and be supported by social and behavioural research. The festival's activities were influenced and shaped by priorities identified through Department of Environment, Land, Water and Planning (DELWP) research on target audiences, behaviours and messaging, in relation to Victorians valuing nature.

Festival achievements

The inaugural Victoria Nature Festival occurred in September 2020.

The festival developed a heightened awareness of the aims of Protecting Victoria's Environment - Biodiversity 2037 throughout the general community.

Coordinated by DELWP, representatives from the Vic Environments Forum worked together to curate over one hundred virtual on-line events over a two-week period from September 28 October to 11 October 2020. Content highlighting Traditional Owners and their leadership in Connecting to Country enhanced the Nature Festival.

A virtual festival 'Hub' was built on an existing government website – vic.gov.au/ournature – while communication efforts across participating agencies helped to promote and lift visibility of the festival. This was primarily done through social media.

A social media campaign helped to direct users to the festival's diverse array of nature-based content. The campaign received: 6.97M Impressions, 134K+ Engagements, 13K Link clicks, and 1.12M+ Video views. This engagement ranks as the highest ever for a Victorian nature-based digital campaign.

A new 'Pin My Nature' map provided an opportunity for festival community engagement and for people to share their favourite places in nature. The map received 474 'pins' during the festival.

The Victoria Nature Festival 2020 provided a tangible and important opportunity for VEF partners to achieve substantial collective impact and progress our shared goals for Victorians connecting with and acting for nature.

View the Victoria Nature Festival 2020 in the video wrap-up here - <https://www.youtube.com/watch?v=d0QVfoOLdVQ3>

VEF will deliver the Victoria Nature Festival again in 2021 and hope to have a stronger physical presence on Country and in nature.

To explore the digital nature content, visit the 'It's in our Nature' website www.vic.gov.au/victoria-its-our-nature.

Victoria's biodiversity targets

Indicator B:23 Number of Victorian government organisations that manage environmental assets that contribute to environmental economic accounting

Region	Indicator Performance:	2018 Status	2018 Trend	2018 Data
Statewide	<p>Measures Measures: % of natural resource management organisations that manage environmental assets that contribute to environmental economic accounting</p> <p>Data Custodian DELWP</p> <p>2018: Unable to be assessed due to Unknown Trend and Low Data Confidence</p> <p>2021: Not assessed</p> <p>Why this indicator? This indicator's target is to have 100% of Victorian Government organisations that manage environmental assets contributing to DELWP Standard Output Data.</p>		?	
		2021 Status	2021 Trend	2021 Data
			?	

Potential thresholds for status in the SoE 2023 report

Good: >75% of organisations contributing output data and species records

Fair: >50 to <75% of organisations contributing output data and species records

Poor: <50% of organisations contributing output data and species records

Why this assessment in 2021?

Status: Not assessed due to lack of data

Trend: Not assessed due to lack of data

Data Confidence: Not assessed due to lack of data

Should this indicator be used in the SoE 2023 report?

Only if data is available to assess.

Summary of SoE 2018 Report assessment

- This indicator's target is to have 100% of Victorian Government organisations that manage environmental assets contributing to environmental economic accounting.
- 12% of Victorian Government organisations who manage Victoria's natural assets had contributed some data. In most cases the data was incomplete and did not reflect all on-ground works those organisations had delivered or funded.

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