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.

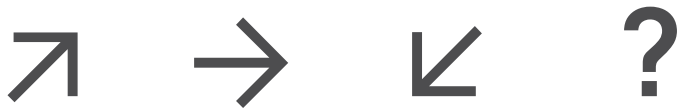
Summary of 2021 indicator assessments for Status, Trend and Data Confidence

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	○	○	○	○	N	?	○	○	○	●
B:21 Area of management in priority locations **Data Custodian** DELWP	○	○	○	○	N	?	○	○	○	●
B:22 Victorians value nature **Data Custodian** DELWP	○	○	○	○	N	?	○	○	○	●
B:23 Number of Victorian government organisations that manage environmental assets that contribute to environmental economic accounting **Data Custodian** DELWP	○	○	○	●	○	?	○	○	○	●

Summary of status assessments

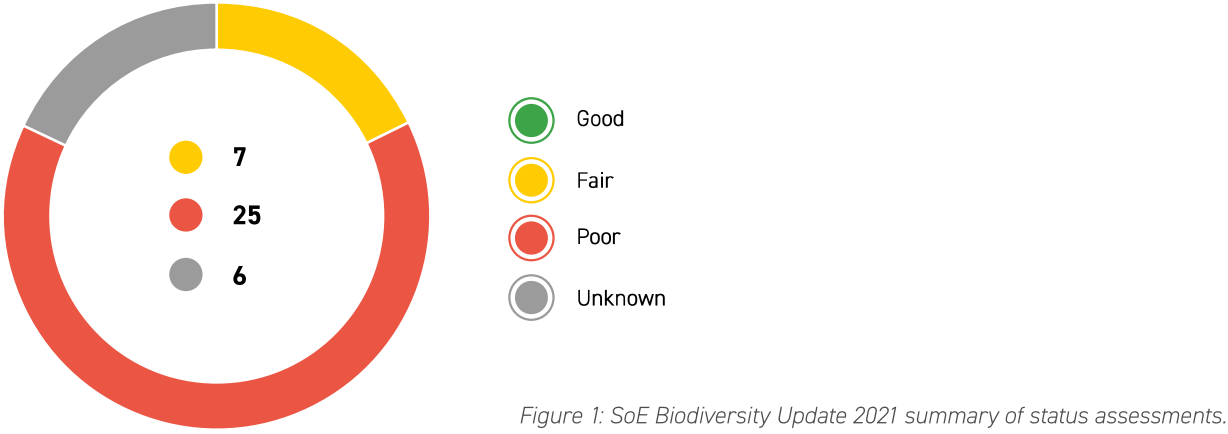


Figure 1: SoE Biodiversity Update 2021 summary of status assessments.

Summary of trend assessments

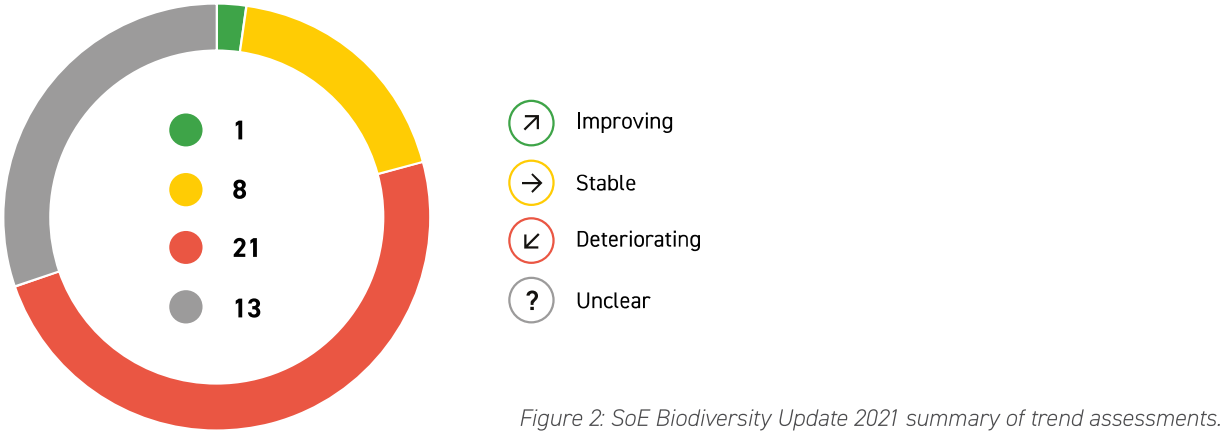


Figure 2: SoE Biodiversity Update 2021 summary of trend assessments.

Summary of data confidence

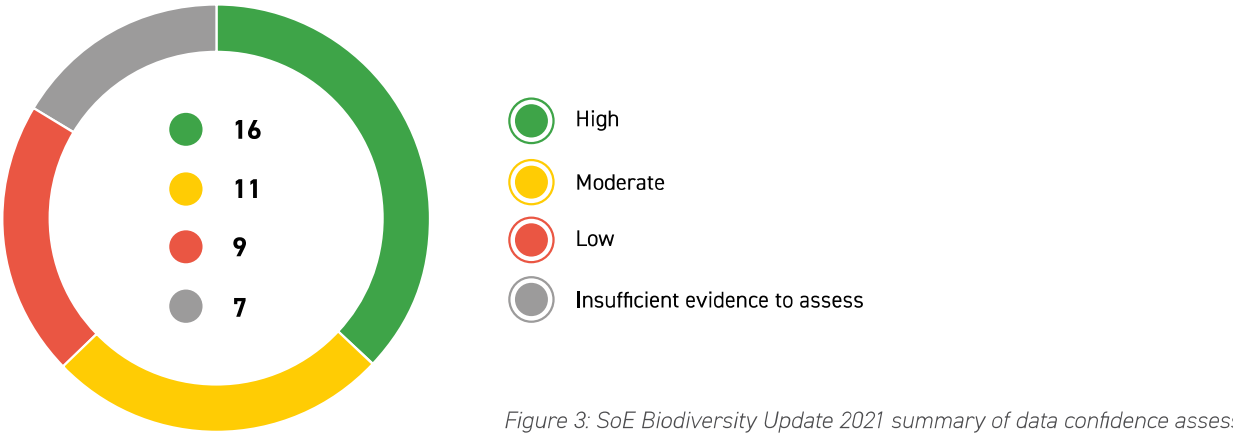


Figure 3: SoE Biodiversity Update 2021 summary of data confidence assessments.

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 2018[1] 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.

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 remined 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.
- N **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 **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 	?	

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

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

Region Statewide

Measures Number, abundance and distribution; Threatening processes impacting on native freshwater plants and animals

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**
	?	

B:01A European carp

Region Statewide

Measures Abundance and distribution

Data Custodian DELWP; Catchment management authorities

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

B:02 Invasive terrestrial plant species

Region Statewide

Measures Number, abundance and distribution

Data Custodian DELWP; DJPR

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

B:03 Invasive terrestrial animal species

Region Statewide

Measures Number, abundance and distribution

Data Custodian DELWP; DJPR; Parks Victoria

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

B:03A Feral deer species

Region Statewide

Measures Number, abundance and distribution

Data Custodian DELWP; DJPR

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

B:03B Feral horses

Region Statewide

Measures Abundance and distribution

Data Custodian DELWP; Parks Victoria

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

THEME: Threatened species and communities

B:19 Landscape-scale change

Region Statewide

Measures Native vegetation extent and land use from 1987–2020

Data Custodian DELWP

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).

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

B:04 Threatened freshwater species in the wild

Region Statewide

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

Data Custodian DELWP

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

B:04 Trout cod

Region Ovens River; Murray River; Goulburn River; Seven Creeks

Measures Abundance and distribution

Data Custodian DELWP

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

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

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

B:04C Murray crayfish

Region Southern Murray-Darling

Measures Abundance and distribution

Data Custodian DELWP

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).

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

B:04D Spotted tree frog

Region Ovens River; Murray River; Goulburn River; Seven Creeks

Measures Abundance and distribution

Data Custodian DELWP

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

THEME: Threatened species and communities (cont'd)

B:04E Booroolong tree frog

Region North-eastern Victoria

Measures Abundance and distribution

Data Custodian DELWP

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

B:04F Baw Baw frog

Region Mt Baw Baw Plateau and escarpment

Measures Abundance and distribution

Data Custodian DELWP

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 km^2) on the Baw Baw Plateau and escarpment, and the spread of the infectious disease, chytridiomycosis.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

B:05 Threatened wetland-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 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.

2018 Status	2018 Trend	2018 Data
	?	
2021 Status	**2021 Trend**	**2021 Data**
	?	

B:06 Threatened terrestrial 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

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

THEME: Threatened species and communities (cont'd)

B:06A 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

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

B:06B Terrestrial vertebrate species

Region Statewide

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

Data Custodian DELWP

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

B:06C Terrestrial invertebrate 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

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

B:07 The conservation and management of biodiversity on private land

Region Statewide

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

Data Custodian DELWP; Trust for Nature; Catchment management authorities

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

THEME: Threatened species and communities (cont'd)

B:08 The conservation and management of Victorian ecosystems on public land

Region Statewide

Measures Victorian conservation categories, area in hectares and the number of threatened species in conservation areas

Data Custodian DELWP; Parks Victoria

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

THEME: Wetlands and rivers

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

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

B:10 Riparian vegetation habitat extent

Region Statewide

Measures Riparian vegetation cover and extent

Data Custodian DELWP; Catchment management authorities; Melbourne Water

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

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

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

B:12 Threatened native frog species

Region Statewide

Measures Number, abundance and distribution

Data Custodian DELWP

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

THEME: Wetlands and rivers (cont'd)

B:13 Threatened native fish species

Region Statewide

Measures Number, abundance and distribution

Data Custodian DELWP

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

B:14 Waterbird species in the Murray-Darling Basin

Region Murray-Darling basin

Measures Number, abundance and distribution

Data Custodian DELWP

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

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

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

B:16 Wetland extent and condition

Region Statewide

Measures Extent and condition of wetlands

Data Custodian DELWP

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

B:17 Health and status of Ramsar wetlands in Victoria

Region Statewide

Measures Ecological condition of Ramsar wetlands

Data Custodian DELWP

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

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**
		

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

THEME: Victoria's biodiversity targets

B:18 Net gain in extent and condition of native vegetation

Region Statewide

Measures Estimates of the overall rate of change in extent and quality of native vegetation on public and private land in Victoria

Data Custodian DELWP

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).

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

B:20 Change in suitable habitat for threatened native species

Region Statewide

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

Data Custodian DELWP

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

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

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

B:22 Victorians value nature

Region Statewide

Measures Number of Victorians connecting with nature; Number of Victorians acting to protect the natural environment

Data Custodian DELWP

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

B:23 Number of Victorian government organisations that manage environmental assets that contribute to environmental economic accounting

Region Statewide

Measures Measures: % of natural resource management organisations that manage environmental assets that contribute to environmental economic accounting

Data Custodian DELWP

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.

2018 Status	2018 Trend	2018 Data
		
2021 Status	**2021 Trend**	**2021 Data**
		

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.

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 Inquiry[6] 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 Convention[9] 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 2001.
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 2019–2030[12] 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 Rangelands[13] 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 Strategy[15] 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 2017–2027[16] '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 2017–2027[17] '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 Statement[18] 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.

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 Framework[19] 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 2021–2031[21] 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 Strategy[24] 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	Code of Practice for Bushfire Management on Public Land 2015 Joint Fuel Management Program Safer Together Strategic bushfire management plans
Climate change	*Climate Change Act 2017* Victoria's Climate Change Adaptation Plan 2017-2020 Take 2 Victoria's Climate Change Strategy 2021
Invasive plants and animals	*Catchment and Land Protection Act 1994* 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
Threatened species and communities	*Aboriginal Heritage Act 2006* *Alpine Resorts (Management) Act 1997* *Catchment and Land Protection Act 1994* *Climate Change Act 2017* *Conservation, Forests and Land Act 1987* *Crown Land (Reserves) Act 1978* *Emergency Management Act 2013* *Environment Protection Act 2017* *Flora and Fauna Guarantee Act 1988* *Flora and Fauna Guarantee Amendment Act 2019* *Forests Act 1958* *Guidelines for the removal, destruction or lopping of native vegetation* *Heritage Rivers Act 1992* *Land Act 1958* *Marine and Coastal Act 2018* *Melbourne Strategic Assessment (Environment Mitigation Levy) Act 2020* *National Parks Act 1975* *Parks Victoria Act 2018* Parks Victoria Conservation Action Plans Parks Victoria Landscape Management Plans Parks Victoria Nature Conservation Strategy *Planning and Environment Act 1987* Procedure for the removal, destruction or lopping of native vegetation on Crown land Protection of Large Trees Policy *Sustainable Forests (Timber) Act 2004* *Traditional Owner Settlement Act 2010, Victorian Conservation Trust Act 1972* *Victorian Conservation Trust Act 1972* *Victorian Environmental Assessment Council Act 2001* *Water Act 1989* *Wildlife Act 1975*

Public policy context

Indicator Theme	Statutes, Policies, Strategies and Plans
Wetlands and rivers	*Water Act 1989* 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
Forests	Code of Practice for Timber Production 2014 Forest Management Plans *Forests Act 1958* Regional Forest Agreements *Sustainable Forests (Timber) Act 2004* The Timber Release Plan The Victorian Forest Monitoring Program Timber Utilisation Plan Victorian Forestry Plan
Victoria's Biodiversity Targets	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

TITLE: Brisbane Ranges National Park
CREDIT: Parks Victoria

TITLE: Ovens River
CREDIT: Visit Victoria

Commissioner *for* Environmental Sustainability Victoria

Part II – Scientific assessments

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 report[28] in August 2020 identified Victoria's[29] 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 forest[31] – 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.

N **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 **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.

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.

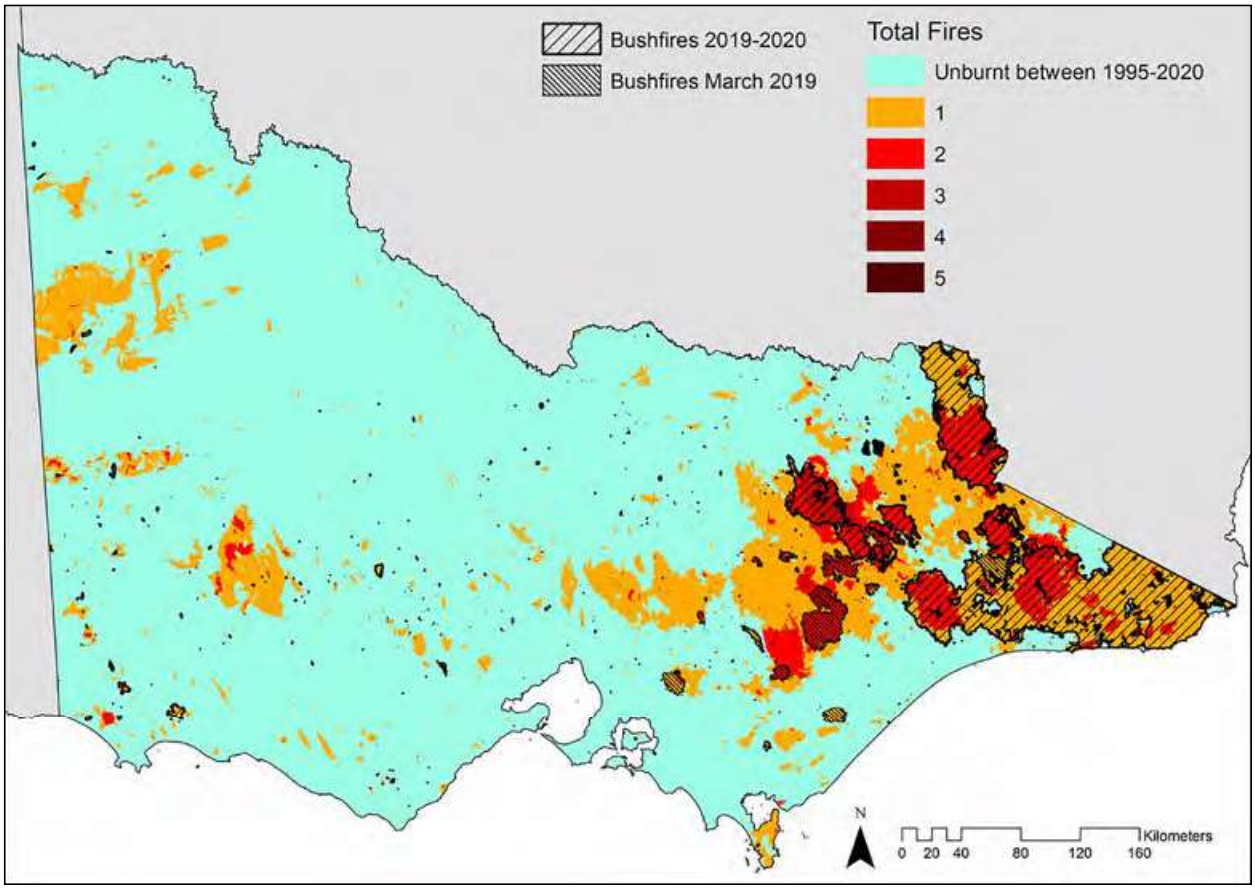


Figure 4: Number of bushfires in Victoria 1995-2020.[35]

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 Change[37] 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.

- 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

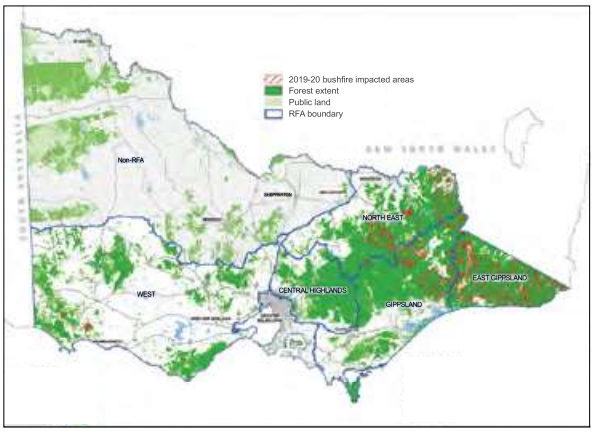


Figure 5: Fire extent of the 2019-20 bushfires in Victoria.[38]

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] 2007[41] 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 though 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 polices, 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

Measures Annual planned burn area; Annual total area affected by bushfires

Data Custodian DELWP

Indicator Performance:

2018:  2021: 

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

2018 Status	2018 Trend	2018 Data
		

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]

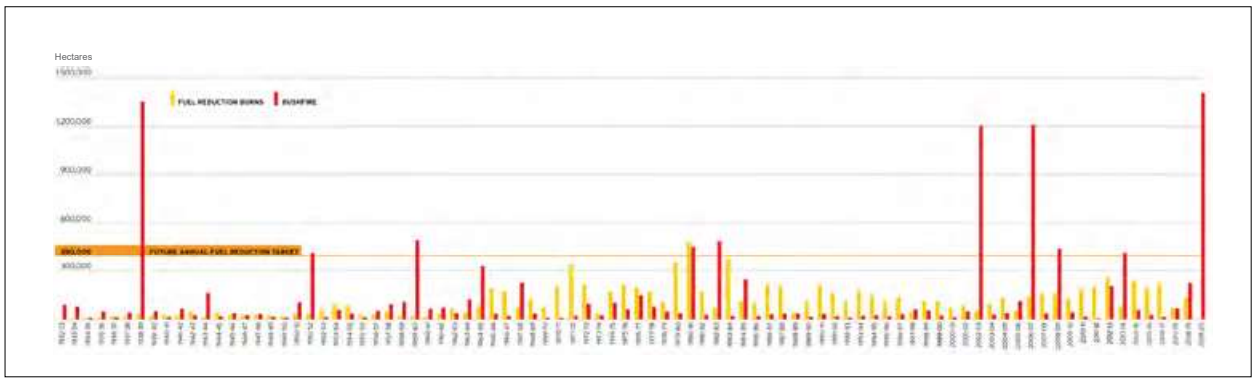


Figure 6: Area of fuel reduction burns and bushfires from 1932–33 to 2019–20.[48]

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 analysis[59] 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.'

Florec 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. Florec 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 20202, '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.

Fire

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.

The 2019–20 bushfires: Impacts and responses

The Inspector-General for Emergency Management's Phase 1 report[72] 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 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
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

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
Strathbogie	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 due 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. Purtill 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.

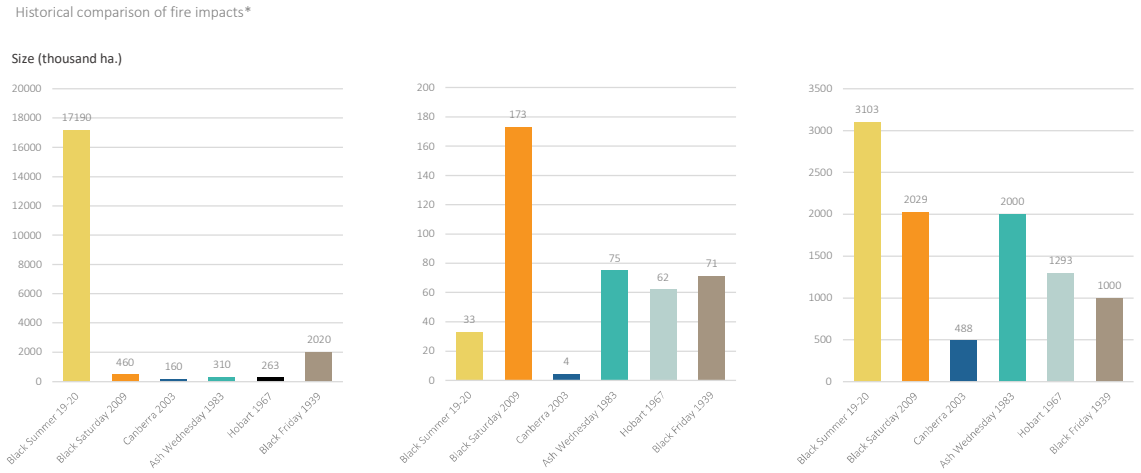

Figure 7: Areas burnt ('000s of hectares), number of lives lost, and number of homes lost in some significant fires between 1939 and 2019-20.[92]

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

Measures Tolerable Fire Interval (TFI) and Growth Stage Structure (GSS) distribution on public forests

Data Custodian DELWP

Indicator Performance:

2018: Unable to be assessed due to Low Data Confidence and Unknown Trend

2021:

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.

2018 Status	2018 Trend	2018 Data
		

2021 Status	2021 Trend	2021 Data
		

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.

The 2019–20 bushfires: Impacts and responses

DELWP reported[94] 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

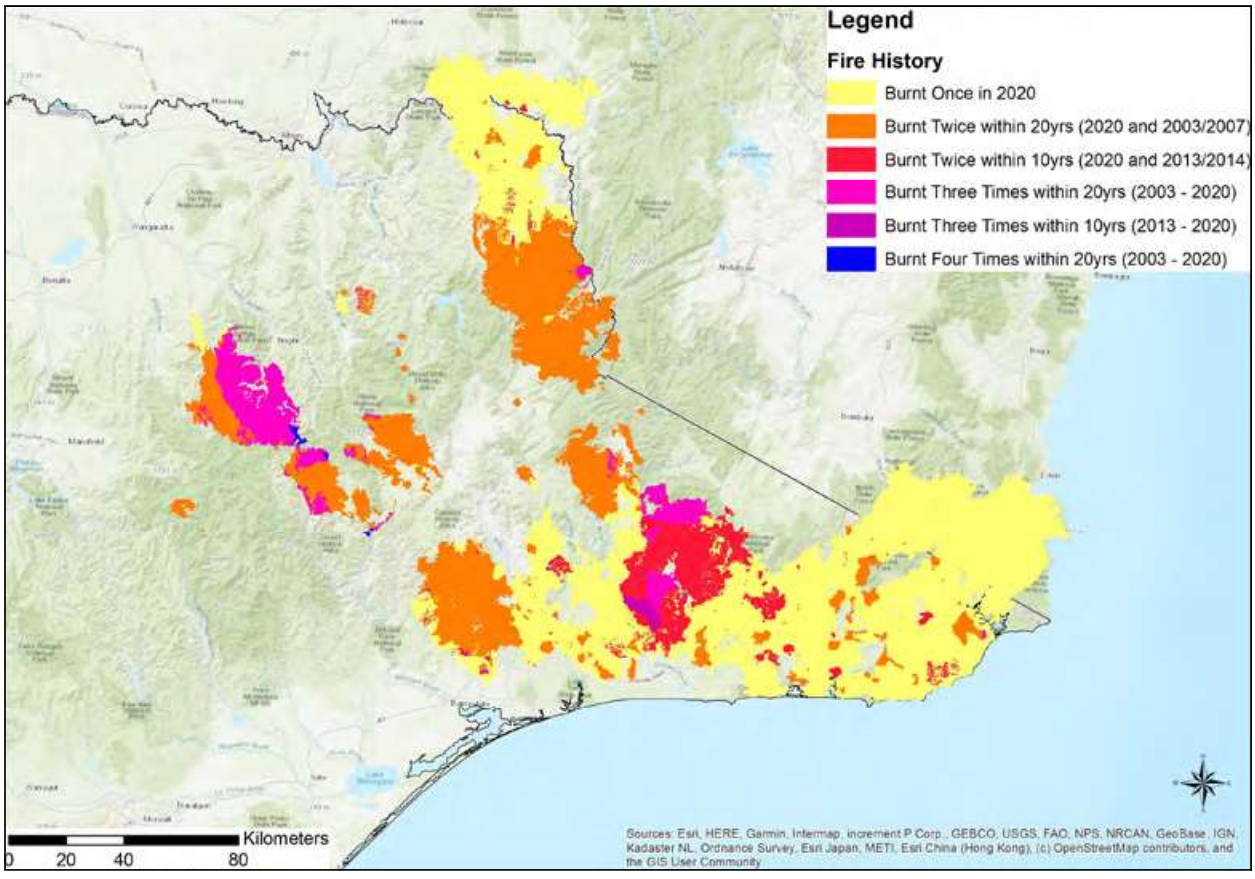

Figure 8: Fire history of eastern Victoria 2003 to 2020.[96]