

Victoria's bushfire emergency: biodiversity response and recovery

Version 2

August 2020



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Image: Yellow-bellied Water Skink. Credit: Mark Antos

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Preamble

This report covers the 2019/2020 fires across the whole of Victoria, with a particular emphasis on Eastern Victoria due to the size and impact of these fires.

Eastern Victoria, in the south-east corner of mainland Australia, is renowned for its wildlife and plant diversity being of global conservation significance. It is recognised as an example of a megadiverse region of Australia possessing four key ecological attributes that make Eastern Victoria's biodiversity so critical, particularly in a time of climate change.

Three major bioregions in one: The area is situated at the convergence of southern ancient cool temperate forests that are a living record of the former super-continent known as Gondwana, warm temperate rainforests and coastal heathlands extending along the eastern seaboard, and up into Australia's unique alpine ecosystems and species.

Unique habitat continuity from summit to sea: Almost 85% of the land area remains in public ownership and extends from iconic alpine ecosystems through to marine national parks. Virtually all the area remains clothed in native vegetation. Limited land clearing, low human population densities and complex topography result in landscapes and water catchments that are continuous. It is the only place on mainland Australia where such continuity of natural ecosystems remains and provides for unparalleled habitat connectivity for wildlife and capacity for climate change resilience through animal migrations and adaptations.

With climate change, south is best: A major feature of climate change is the poleward migration of plants and animals, migrating away from increasing heat and drought. For Australia's native plants and animals, southerly animal emigrations have the best chance of survival at the cooler/wetter end of historical distributions. As such, protected nature areas at the southern end of species ranges are the highest priority candidates for climate change refuges and adaptation.

Diversity counts: Approximately 3,000 plant species grow here, and there are nearly 500 species of terrestrial vertebrate animals, several hundred species of fish in the rivers, lakes and estuaries, and vast invertebrate fauna (as yet uncounted) populations. Many of the species found in the area are suffering extreme conservation impacts elsewhere, such as koalas, platypus, bandicoots, large owls, carnivorous marsupials (like quolls), flying foxes and gliding possums. For some threatened species, this region encompasses much of the world-wide distribution, such as for the Long-footed Potoroo, many native fish species, unique burrowing crayfishes and extremely localised flowering plants. The region also represents critical strongholds for wider-ranging species such as Glossy Black-Cockatoos, Eastern Bristlebirds and the Ground Parrot.

Introduction

The 2019/2020 bushfires in Victoria were exceptional in size and impact. Existing Department of Environment, Land, Water and Planning (DELWP) fire recovery processes are well underway, and biodiversity is an important part of this work. However, it is recognised that under climate change we are entering a new world in terms of the scale and complexity of managing fire impacts on biodiversity. Multiple large-scale active fires and the increasing proportion of areas that have been burnt multiple times since 2000, has expanded the context in which mitigation needs to be framed. For example, there is a need to consider the status of species in neighbouring states and mitigation will increasingly include options beyond the fire areas.

Report purpose

This report is an update of the *Victoria's bushfire emergency – Biodiversity response and recovery Preliminary Report Version 1* released on 23 January 2020. This report documents the results of the initial impact analysis of the 2019/2020 fire season on biodiversity. The report is the start of planning for biodiversity response and recovery, so sound and timely decisions on government priorities and investment can be made and Country outcomes (biodiversity conservation and cultural outcomes) are maximised.

Impacts are assessed using the proportions of modelled habitat for the species within Victoria or Victorian distribution of vegetation types that are within the fire extent. This will be periodically updated as revised fire extent and intensity mapping and information from the on-ground species reconnaissance becomes available. Existing data supplemented by expert opinion on the vulnerability of species to fire impacts is also used to prioritise responses. It is important to acknowledge that while many species impacted in Victoria by fire will also have been impacted by fire in other states (e.g. NSW), this report focuses only on the impacts of the Victorian fires.

Emergency responses are being considered in terms of nested timeframes:

- emergency actions (while the fire is still active) - (not the subject of this report as they fall within the responsibility of the Incident Management Teams) – actions completed
- immediate and short-term actions (up to 1 year) – actions are currently underway
- medium-term actions (1 – 3 years) – design and prioritisation of actions is underway
- long-term actions (beyond 3 years)

The current focus is on the “immediate and short-term actions (as soon as able to operate in the fire area)” phase but all the timeframes are part of the overall emergency response. The Victorian Government has provided \$17.5 million in initial funding as part of the Bushfire Biodiversity Response and Recovery program to fund immediate actions over the first-year post-bushfire (until December 2020). Planning for medium-term actions has commenced. The responsibility for delivering these actions must be undertaken by the relevant land managers and partner organisations with coordination of the response and recovery (including allocation of funding) and oversight by DELWP.

Priorities are being assessed for each species of concern based on structured estimates of the level of relative impact, the level of relative improvement in regional persistence as a result of relevant actions and the cost and feasibility (technical and social) of actions. The report can be used for broader investment decisions from governments at all levels, non-government organisations and the broader community including volunteers. Once investors have made initial investment portfolio decisions, then more specific project-scale planning can be undertaken that considers the needs of specific projects, as well as the needs and priorities of the project's investors.

Summary of key changes since previous report

Version 2 of this preliminary report is based on the current fire extent as of 20th April 2020. This report has been updated from Version 1 (published 23rd January 2020). The key changes or additions include:

- Updated spatial mapping to reflect final fire extent (as at 20th April). The extent of the fire area increased by approximately 200,000 hectares to over 1.5 million hectares across the state. Key areas impacted since the last report include Cape Howe and Errinundra Plateau
- Removal of the potential impact area analysis as fires are now controlled
- Impacts by high severity fire on species and key areas for biodiversity
- Further data quality assurance to support improved assessment of impacts on species' habitats
- Analysis of the impacts on invertebrate species (where data is available)
- Further information provided by species experts, land managers and other jurisdictions on vulnerability and impacts on important species populations or locations
- Changes to impacts on species and groups based on the updated data and analyses
- Refinement of some Habitat Distribution Models to better reflect known distributions
- Information on actions to date

Key results of the updated biodiversity impacts analysis include:

- There are 244 species with more than 50% of their modelled habitat within the burnt area, including 215 rare or threatened species.
- 43 species had more than 50% of their modelled habitat impacted by high severity fire, including 42 rare or threatened species
- Nine ecological vegetation classes (EVCs) had more than 50% of their extent burnt

Based on the updated data and analysis there have been changes to our understanding of impacts on species and groups, including:

- Flora with 50% or more of the modelled habitat in the burnt area went from 168 species to 224 species, and fauna with 50% or more of the modelled habitat in the burnt area increased from 17 to 20 species
- Some species, like the Brush-tailed Rock-wallaby and the Guthega Skink, were not as impacted as first predicted as the fire did not reach key populations. Other species appear at least initially to be showing some resilience to the fires, such as Yellow-bellied Water Skink.
- The initial lists of flora and fauna of most concern have been refined and added to, reflecting the increased extent of the fires, species impacted by high severity fires and increased understanding of the vulnerability of species to these impacts. As a result, the number of flora of concern increased from 38 species to 154 species as a result of both the increased fire extent, as well as due to advice from species experts. The number of vertebrate fauna species of concern decreased from 80 species to 67 species, due to freshwater invertebrates being moved to the invertebrate section in the report. Four vertebrate fauna species were added to the list based on expert advice, and seven other species were removed as the analysis now indicated no impact of the fire.

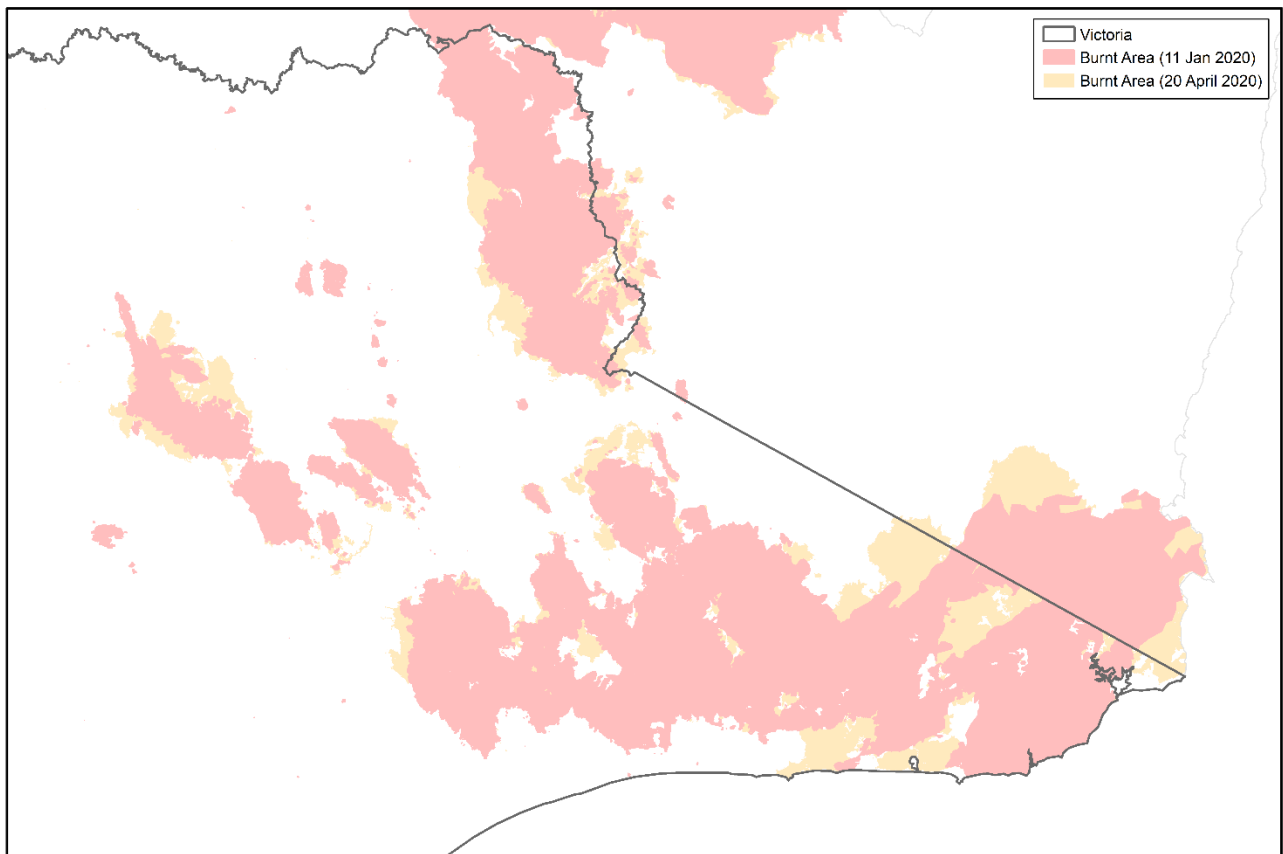


Figure 1: Map of change in fire extent since the analysis (11th January 2020) for Version 1 of this report (20th April 2020). The change in indicated by the yellow shading.

Report development and methodology

This report is a living document and will continue to be updated as the bushfire situation in Victoria changes and as more data and information becomes available. The next update will be undertaken following delivery of Phase 1 – immediate and short-term actions.

Multiple methods have been used to collect information, including a desktop analysis, consultation with key agencies and the expert workshops to support Victoria's Biodiversity Bushfire Response.

The DELWP desktop analysis assessed the impact of the fires on Victoria's biodiversity and potential emergency responses. This included an assessment of the extent of impact to protected areas, biodiversity values including rare or threatened species. The desktop analysis was completed using a range of data and decision support tools (see below). A range of experts and key partner agency staff were also consulted in the development of this report through a series of formal workshops as well as direct informal communication. Consultation was sought to provide advice and help inform particular aspects of the report (see Appendix 3).

The first Biodiversity Bushfire Response Workshop was held on the 10th January 2020 and brought together interagency, non-government organisation and University conservation experts and managers. The workshop participants identified high priority species and ecological communities and developed actions and conservation strategies required for their recovery. Further detail on the workshop methodology is included in Appendix Four. An internal DELWP workshop was also held with staff across Biodiversity Division, the Arthur Rylah Institute and Forest Fire and Regions (including the Natural Environment Program) as an extension of the first Biodiversity Bushfire Response workshop to allow greater participation with a wider range of DELWP staff.

The second Biodiversity Bushfire Response Workshop was held on the 20th February 2020, once again bringing together interagency, non-government organisation and University conservation experts and managers. The workshop participants used species scenarios to explore approaches to maximising biodiversity resilience in a climate of intensifying fire. The principles that were drawn from this discussion will be used to inform prioritisation approaches. These will be applied to population management, particularly direct interventions involving emergency extraction, genetic mixing and translocating between populations, as well as broader level landscape-scale actions.

Version 1 of the report was based on the impacts of the fire as of 11th January 2020. The current Version (Version 2) has been updated to include impacts of the fire as of 20th April 2020 (after the fires had been contained), as well as fire severity information, early results from reconnaissance surveys and information on local impacts on species populations where available.

Information will continue to be gathered from key partner agencies, stakeholders and experts to supplement the initial findings of the desktop analysis and workshops. This may result in the inclusion of additional information and data, particularly as information from on-ground reconnaissance is gathered. Currently, DELWP is facilitating a program of work to identify key species and recovery actions that are required to assist post-fire recovery of biodiversity and maximise the resilience of species to future disturbance events.

Data used in this report

Current fire extent and severity

The current and projected fire extent was used to assess the impact of the Victorian bushfires on biodiversity.

The analyses in this report have been conducted using the current fire extent, which is the state-wide extent of the Victorian bushfires as of 20th April 2020.

There are 5 fire severity classes in the data used in this report, which have been derived from Sentinel 2 imagery. They are: no data, non-woody vegetation (unclassified), unburnt, low canopy scorch (<20% canopy scorch), medium canopy scorch (20%-80% canopy scorch), high canopy scorch (>80% canopy scorch) and canopy burnt. For the analysis in this report we have focused on the two highest fire severity classes that highlight where the vegetation canopy has been either completely burnt or scorched leaving very little green foliage (high canopy scorch and canopy burnt). An overview of the methodology used is provided in *Collins, L., Griffioen, P., Newell, G., & Mellor, A. (2018). The utility of Random Forests for wildfire severity mapping. Remote Sensing of Environment, 216, 374-384.*

A fire severity classification algorithm was developed using satellite imagery as it came available, to rapidly generate accurate fire severity maps using machine learning trained with previous bushfires across Victoria. Within this dataset there may still be areas classified as unburnt due to smoke or cloud cover obscuring the image.

The final fire severity map used in this analysis can be accessed publicly at data.vic.gov.au.

Strategic Biodiversity Values

Strategic Biodiversity Values (SBV v4) is one of DELWP Biodiversity Division's decision-support products. It combines information on areas important for threatened flora and fauna, and vegetation types and condition to provide a view of relative biodiversity importance of all parts of the Victorian landscape. The objective of this analysis was to rank all locations across Victoria for their ability to represent threatened (VROT) vertebrate fauna, vascular flora, and the full range of Victoria's native vegetation. It is based on efficient and effective spatial coverage of these biodiversity values. This integrated information is important because decision-makers need access to an objective, comprehensive and spatially explicit view of the rank of biodiversity assets to enable comparison of locations across Victoria. For more information on the methodology used to develop Strategic Biodiversity Values and where to obtain the data, read the [DELWP fact sheet](#).

Habitat Distribution Models

DELWP currently has Habitat Distribution Models (HDMs) for over 4000 taxa that predict the distribution and relative likelihood of suitable habitat for each species across Victoria. This covers all terrestrial vertebrate fauna and most vascular plants. HDMs are built using species occurrence records from the Victorian Biodiversity Atlas (VBA) and relating that data to environmental variables, such as soil, prevailing climate and topography to make predictions about the likely distribution of habitat for individual species across Victoria. For more information on how DELWP's HDMs are built, read the [fact sheet](#). For a subset of species that DELWP does not have continuous modelled distributions for, polygons of expert delineated habitat extent are used (e.g. Galaxiids, Crayfish).

Decision-support tools and metrics

Outlined below are decision-support tools and metrics that have been used to conduct this initial desktop analysis or will be employed in the future to further refine priorities.

Genetic Risk Index

The Genetic Risk Index is a new metric developed for Victoria that can provide a preliminary assessment of the genetic risk of impacted species. The Index combines available genetic and demographic metrics that have the potential to contribute to or influence overall genetic risk for a given species and is communicated as "Very High", "High", "Medium" or "Low" risk. Currently, 1,100 species of flora and fauna found in Victoria have genetic risk assessments, although some have limited data or information available for them, so are classified as "Uncertain". Species not yet assessed using the process have been marked as "Unknown".

Strategic Management Prospects

Strategic Management Prospects (SMP) integrates and simultaneously compares information on biodiversity values, threats, effectiveness of management actions and indicative direct costs of management actions for biodiversity across Victoria using a spatially explicit approach to prioritise conservation actions state-wide. It is the key decision-support tool used by the Victorian government to guide investment in on-ground actions for biodiversity. For more information, read the [fact sheet](#).

Fire Analysis Module for Ecological values (FAME)

The Fire Analysis Module for Ecological Values ([FAME](#)) has been developed by DELWP to predict the impact of individual fires and fire history on the relative abundance of a range of vertebrate fauna. It uses a combination of HDMs, tolerable fire intervals for vegetation, expert judgment and field data on species' response to fire.

Specific Needs Assessments

Specific Needs Assessments is the approach used by the Victorian government to assess the relative cost-effectiveness of conservation actions that have not been modelled spatially and incorporated in the full Strategic Management Prospects analysis. It builds on the Project Prioritisation Protocol (Joseph, L.N., Maloney, R.F. and Possingham, H.P., 2009. *Optimal allocation of resources among threatened species: a project prioritization protocol*. *Conservation Biology*, 23(2), pp.328-338) approach to simultaneously consider the cost-effectiveness of actions between species' populations and across a range of species. For more information visit the website.

Change in Suitable Habitat

Change in Suitable Habitat (CSH) is the spatially explicit, species-specific measure that the Victorian government uses under Biodiversity 2037 to quantify the benefit of conservation actions using local-scale estimates of species persistence under action and no-action scenarios. It is based on a large dataset of expert judgement of species' response to management actions and then modelled spatially to create maps of the relative benefit of management actions. The measure can be interrogated at the species-level but also summed across a collection of species (e.g. a particular taxon group, or all biodiversity). For more information, including on how expert judgement was quantified and collated, [visit the website](#).

Zonation

Zonation is a spatially explicit prioritisation tool for conservation planning that ranks cells according to their contribution to a conservation objective (Moilanen, A., Kujala, H. and Leathwick, J.R., 2009. *The Zonation framework and software for conservation prioritization*. In *Spatial conservation prioritization* (pp. 196-210). Oxford University Press). It explicitly incorporates complementarity principles to ensure that a given prioritisation adequately represents the range of biodiversity values being modelled, while also balancing potential costs and threats to biodiversity in those cells. In this report, Zonation was used to provide an indication of the change in biodiversity value as a result of the bushfires through the Integrated Biodiversity Values Model. It is also a key tool used in the development of Strategic Management Prospects.

Data availability

Most of the data and decision-support tools featured in this report are available publicly through the [NatureKit portal](#). This includes Strategic Biodiversity Values, Habitat Distribution Models and Strategic Management Prospects. Fire history and severity mapping will be available on the Victorian Government's DataVic website as it is finalised following the completion of the fire season.

Analyses methods

Overall Biodiversity Impact

To calculate the broad impacts on Victoria's biodiversity values, we calculated the proportion of the state-wide extent of each biodiversity class (Strategic Biodiversity Values v4) that had been impacted by fire.

General Species Impacts

To understand the current impacts of the 2019/2020 fires on Victorian species, we calculated the percentage of each individual species state-wide modelled distribution that:

- Has been impacted state-wide within the current fire extent and
- Has been impacted by the highest severity burn (>80% canopy scorch).

The modelled distribution for each species was determined using DELWP's Habitat Distribution Models. This provides an indication of the level of impact of the fire on each species. To calculate the impact of the fires on each species, the analysis considered used both the amount of area the HDM indicated, as well as the suitability of the habitat for the species within that area (see Appendix Six for detailed methods). This approach was used to more heavily weight the better value habitat for a species, compared with lower value habitat. The number of species listed under the *Flora and Fauna Guarantee (FFG) Act 1988*, the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* and DELWP Advisory listed species for each taxon group that have had at least 10%, 30%, 50%, 80% or 95% of their Victorian modelled habitat distribution impacted by fire was then calculated, as well as the same with their Victorian modelled habitat distribution impacted by the highest severity burn.

The impact of the fire on species was also considered using Victorian Biodiversity Atlas records to determine the percentage of species' records in Victoria within the current fire extent. This was determined by the proportion of 'VBA pixels' for each species that fall within the current fire extent, where a 'VBA pixel' is a 225 m pixel that contains at least one VBA record since 1980 (see Appendix Size for detailed methods). The results produced using VBA records were generally similar to the extent of modelled habitat determined by the HDM analysis, with 78% of species having less than 10% difference between the burnt extent estimated by the HDM and VBA records. This suggests that our impact analysis method using HDMs appropriately reflects where species have been recorded, as well as accounting for fire impacts in under-surveyed areas or high suitability habitat, which analyses using records alone are not able to account for. Higher differences generally occurred for species with limited records, and this detail was captured through discussions with experts, and presented for species of concern in the "localised impacts" column. The results for flora and fauna of concern species are presented in Appendix 5.

Identification of species of most concern

For Version 1 of the report, species of most immediate concern were initially identified based on the per cent of their modelled habitat distribution in Victoria within the current fire extent (above 40%), as well as per cent decline in species abundance (over 25%; modelled using the Fire Analysis Module for Ecological Values). These lists were then refined and amended based on conservation expert and managers' advice collected at the First Biodiversity Bushfire Response Workshop 2020 and the internal DELWP workshop. In addition to this, the list of flora species was refined using a combination of extent of modelled habitat in the current fire extent, as well as previous information regarding their life history response to fire, genetic risk and previous impact of fire.

For the Version 2 of the report, the same analysis has been conducted using updated data, along with further refinement and local information to produce list of flora and fauna of concern. The fauna and flora species of most concern tables include the updated proportion of modelled habitat in current fire extent, and proportion of modelled habitat impacted by high severity fire. Where known, localised impacts (i.e. if local populations were known to be within or outside the current fire extent due to regional intel) were included in both the flora and fauna species of most concern tables.

The flora species of most concern was amended to include additional species where the percentage modelled habitat within the current fire extent exceed 75% and the species was categorised as vulnerable due to information regarding their life history response to fire, genetic risk and previous impact of fire. Flora were also added according to advice received from conservation experts and managers, including species identified by RBGV to be of high priority for seed/cutting collection due to the impact of the bushfires. Overall, flora species of concern are generally not resilient to fire.

Invertebrates potentially impacted have also been included, based on (limited) available information and expert advice.

Impact on vegetation communities

The impact of the 2019/2020 Victorian bushfires on vegetation communities was assessed through analyses of the current fire extent on EPBC listed communities, FFG listed communities and Ecological Vegetation Classes (EVCs).

Multiple repeat fires within a short time period can have significant impacts on some ecosystems, resulting in regeneration failure. Analysis was conducted to determine the state-wide area (in hectares) impacted by bushfires multiple (two, three or four) times since 2000 prior to and following the Victorian 2019/2020 fires.

Identification of immediate and short-term response actions

At the first Biodiversity Bushfire Response Workshop conservation experts and managers were brought together to identify high priority species and develop actions and conservation strategies required for the recovery of these species and ecological communities following the 2019/2020 Victorian fire season.

Experts initially considered the current and projected fire extent, as at 9:00am, 10th January 2020. This expected impact area was then split into two broad regions:

- North East (comprising the Corryong and Alps fires); and
- East Gippsland (comprising the Mallacoota, Buchan and Snowy River complex fires).

Using a structured expert elicitation approach, in groups based on taxonomic expertise (arboreal mammals, other mammals, birds, reptiles, amphibians, freshwater species, rainforest flora, and other flora), experts were asked to identify the actions and species that required immediate attention (i.e. in the first 6 months post-fire).

This work was supplemented with a second workshop held at the Arthur Rylah Institute for Environmental Research with DELWP staff using a similar format. The information from these workshops was checked against species attribute databases already available within DELWP to identify the species that are vulnerable to fire and the subsequent outcomes of large bushfires (e.g. loss of critical habitat, loss of food source, predation by foxes and cats in the post-fire landscape) and the actions that are most urgent. Further refinement will occur as more information on the species impacts and feasibility of actions becomes available.

Reports prepared through Bushfire Rapid Risk Assessment Team deployments across the fire grounds have also be used to identify any additional potential immediate and short-term response actions.

Impacts on biodiversity as of 20th April 2020

Current fire extent and severity

There is approximately 1,511,000 ha within the current Victorian fire extent, the majority of which is in eastern Victoria (hashed area in Figure 2 and 3). Figure 4 shows the fire severity across North East Victoria and East Gippsland.

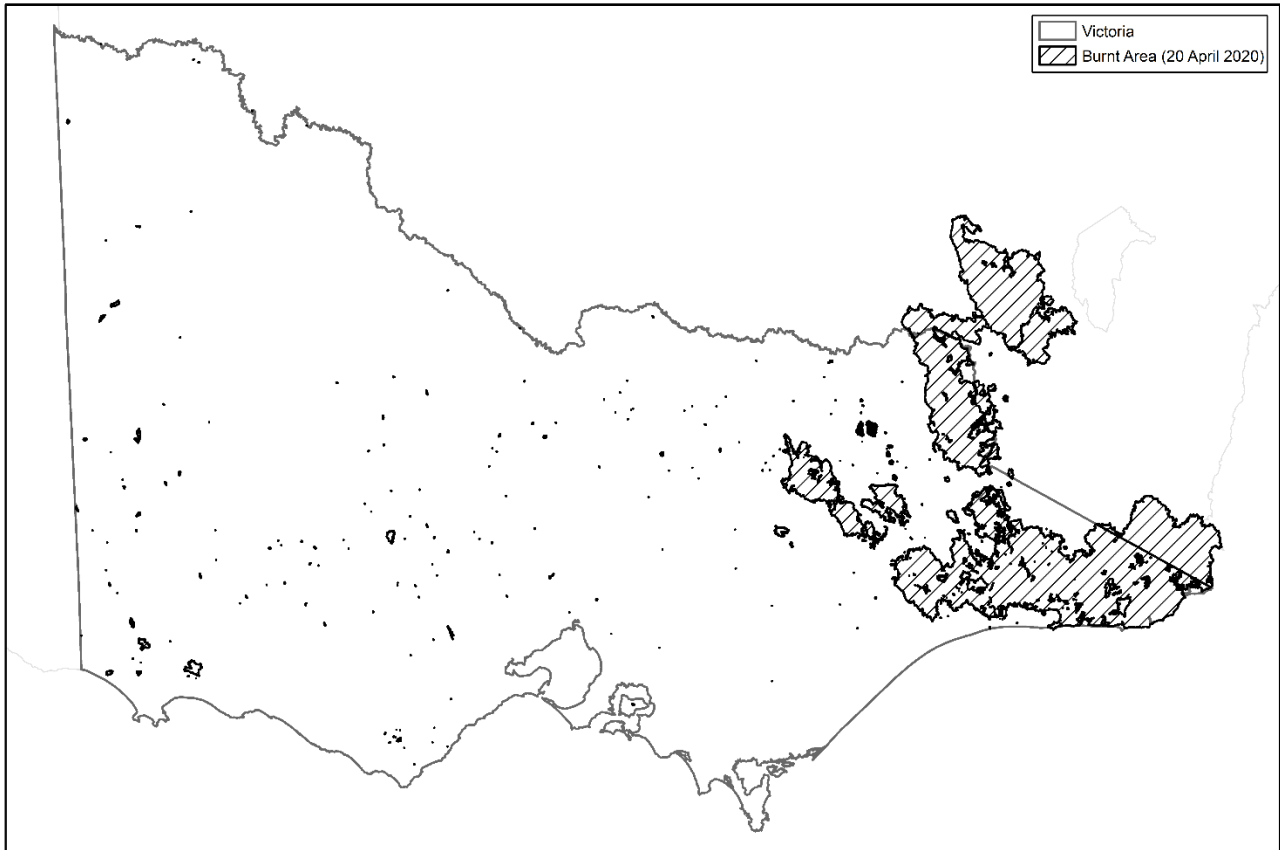


Figure 2: Map of fire extent across Victoria (20th April 2020)

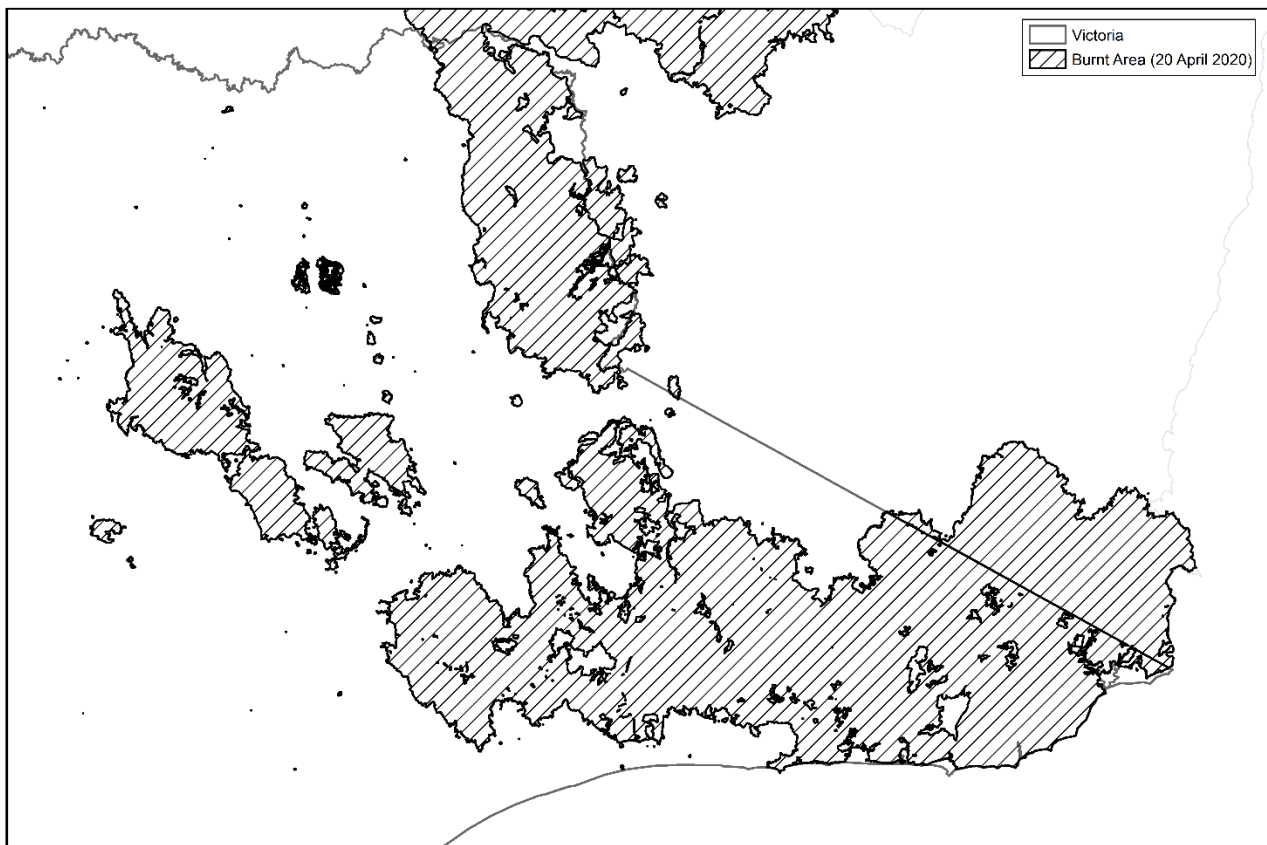


Figure 3: Map of fire extent in Eastern Victoria (20th April 2020)

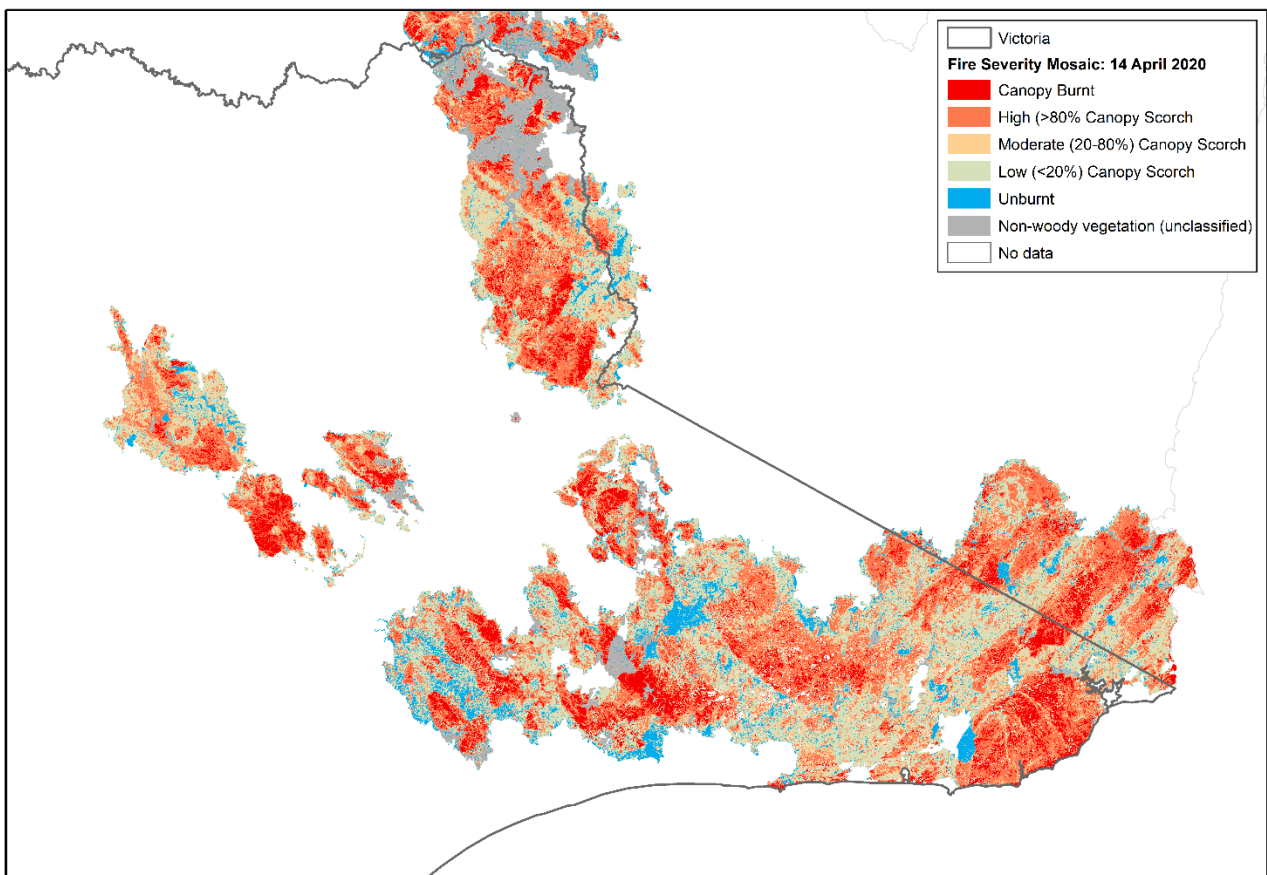


Figure 4: Map of fire severity across Eastern Victoria

Impacts on areas within the CAR Reserve System

The bushfires have impacted on a large part of the Comprehensive, Adequate and Representative (CAR) Reserve System and other components of the reserve system in eastern Victoria. This includes 25 national parks and nature conservation reserves that have between 90-100% of their land within the current fire extent and the impact by high severity fire (Table 1 and Table 2). High severity fire includes class 4 and 5, which is high canopy scorch (>80% canopy scorch) and Canopy Burnt. Key affected national parks in the current fire extent include:

- Alfred National Park - 100% (3,021 ha of 3,021 ha)
- Burrowa - Pine Mountain National Park - 100% (18,867 ha of 18,963 ha)
- Lind National Park - 100% (1,359 ha of 1,359 ha)
- Mt Mitta Mitta Regional Park - 100% (3,927 ha of 3,929 ha)
- Tara Range Park - 99% (7,540 ha of 7,618 ha)
- Mt Elizabeth Nature Conservation Reserve - 99% (5,169 ha of 5,231 ha)
- Croajingolong National Park - 87% (76,952 ha of 88,512 ha)
- Snowy River National Park - 76% (87,003 ha of 114,674 ha)
- Errinundra National Park - 66% (26,426 ha of 40,089 ha)
- Crawford River Regional Park - 58% (1,394 ha of 2,421 ha)

Table 1: Impacts on the National Parks, Conservation Reserves and State Forests

	Percent of reserve in current fire extent			
	40 – 60%	61 – 80%	81-90%	91-100%
National parks and nature conservation reserves (per National Parks Act)	3 reserves	4 reserves	5 reserves	25 reserves
Other conservation reserves (non-protected areas, such as regional parks, lake parks and historical reserves)	3 reserves	5 reserves	1 reserve	36 reserves
State Forests	6 reserves	6 reserves	9 reserves	30 reserves

Table 2: Impacts on the CAR Reserve System and related components by type of protection. The prescriptions relate to the modelled exclusion and rainforest prescriptions outlined in the Management Standards and Procedures for timber harvesting operations in Victoria's State forests. The Immediate Protection Area figures refer only to the new, additional areas identified in the Greater Glider Action Statement No. 267. Prescriptions and the Immediate Protection Area are not part of the CAR reserve system, but they are considered related components for the purposes of this report only.

	Hectares in current fire extent	Hectares impacted by high severity fire	Total Area across the state
National parks and nature conservation reserves	482,094 ha	285,462 ha	3,900,480 ha
Permanent protection on private land	404 ha	130 ha	49,025 ha
Special protection zone (SPZs) areas	203,758 ha	127,966 ha	765,900 ha
Prescriptions (modelled exclusions and rainforest, per <i>Management Standards and Procedures for timber harvesting operations in Victoria's State forests</i>)	193,375 ha	123,59 ha	629,120 ha
Immediate protection areas (additional new protected areas, as identified in the Greater Glider Action Statement No. 267)	44,169 ha	31,255 ha	95,107 ha

Impacts on Heritage listed areas

There are two heritage listed reserves within the current fire extent: Budj Bim Cultural Landscape and Australian Alps National Parks and Reserves (Table 3). Recently listed World Heritage (and National Heritage) area, Budj Bim Cultural Landscape, has been significantly impacted with over 60% of the northern component in the current fire extent. Although there is no fire severity data available for the Budj Bim Cultural Landscape, the fires have impacted a significant proportion of the area. *Budj Bim Cultural Landscape* in South-Western Victoria has been listed for the lava flows which were utilised to create one of the world's most extensive and oldest aquaculture systems. Known impacts in *Budj Bim*, debris flows from the fires may impact freshwater aquatic species within the area. In addition, 26% (224,445 Ha) of the Victorian extent of the Australian Alps National Parks and Reserves National Heritage area is in the current fire extent.

Table 3: Heritage listed areas

		Hectares in current fire extent	Per cent of listed area within current fire extent
World heritage listing	Budj Bim Cultural Landscape (Budj Bim Northern Component) (also on the National Heritage List).	5,179 Ha	64%
National Heritage listing	Victorian extent of the Australian Alps National Parks and Reserves	224,445 Ha	26%

Impacts on Indigenous Protected Areas

The Lake Condah Indigenous Protected Area, part of the World Heritage Budj Bim Cultural Landscape has been significantly affected by the bushfires. Over 80% of the Indigenous Protected Area has been burnt (Table 4).

Table 4: Indigenous protected areas

	Hectares in current fire extent	Per cent of listed area within current fire extent
Lake Condah Indigenous Protected Area	1,389 ha	81%

Overall impacts on biodiversity values

To date the fire has burnt in mostly high biodiversity value areas, impacting over 10% of each of the state's highest three Strategic Biodiversity Value (SBV) classes (Class 1, 2 & 3), and 9% of the next highest SBV classes (Table 5). The areas of highest severity also impacted mostly high biodiversity values, impacting 8% of the top three SBV Classes.

Table 5: Overall impacts on Strategic Biodiversity Values (SBV) classes

SBV class	Class ranking	Hectares in current fire extent	Hectares impacted by high severity fire	Proportion of state-wide area of SBV class within the current fire extent	Proportion of state-wide area of SBV class impacted by high severity fire
Class 1	90-100	283,799	146,570	13%	6%
Class 2	80-90	263,285	132,713	12%	6%
Class 3	60-80	572,837	280,903	13%	6%
Class 4	40-60	381,561	170,318	8%	4%
Class 5	20-40	32,846	3,260	1%	0%
Class 6	1-20	7,391	3,559	0%	0%

Changes in biodiversity value

To understand the potential changes in biodiversity value, in terms of state-wide conservation, as a result of the immediate impacts of the 2019/2020 bushfires, Zonation was used to rank areas across all of Victoria by biodiversity value before and after the fires.

The changes in biodiversity value from before to after the fires provide an indication of where habitat has increased or decreased in its current contribution to supporting state-wide conservation goals (i.e. supporting a range of habitat for threatened species) as a result of the 2019/2020 bushfires. Decreases in relative value are greatest where there is habitat for a larger number of species impacted by high severity fire (see Figure 4). Increases in relative value are highest where there is unburnt habitat for a larger number of species that have had other parts of their range impacted by high severity fire.

Figure 5 (fauna) and Figure 6 (flora) show the areas across Victoria that may have had short-term increases or decreases in biodiversity value as a result of the fires. To interpret the figures, areas where rankings have increased (blue) may indicate unburnt habitats for fire impacted species, which may be important as short or long-term refuges. It should be noted, however, an increase in the value of habitat in a particular location does not necessarily indicate the area is now high value. Instead, these areas are driven by impacted species which have a range that extends beyond the fire extent. Areas where rankings have decreased (red), indicate areas of severely burnt habitat that was previously important for fire-affected species.

This analysis is preliminary and will be added to over time. As this approach considers only the effect of fire severity on changes in relative habitat value, the results should be interpreted as short-term changes in value. Knowledge of fire impacts on species and monitoring of fire recovery progress will provide additional information on potential medium and long-term changes in habitat value. This analysis only considered all fauna species and only flora on the DELWP Advisory List that had habitat distribution models available. This analysis used the fire severity mapping from early February 2020, due to the computation time required to assess the change in biodiversity values. This earlier severity mapping will have still captured the areas of highest severity burn accurately (with updates from future severity mapping clarifying areas of low severity burns or unburnt areas). To address similar questions regarding the impacts of the 2019/2020 fires on long-term habitat value for 51 forest dependent species, the Integrated Biodiversity Values Model v2 has been developed (Hauser et al. 2020) using a similar approach but focusing on the effects of the fires on species accounting for forest age. Future analyses could incorporate more up to date severity information as well as information on where conservation actions should be prioritised post-fire assisted and natural recovery of biodiversity values post-fire.

Hauser, C., White, M., Thomson, J. and Newell, G. (2020). An integrated biodiversity values model: updated and extended Stage 1 biodiversity datasets. Unpublished Report for the Forest, Fire and Regions Group, DELWP. Arthur Rylah Institute for Environmental Research, Department of Environment, Land, Water and Planning, Heidelberg, Victoria.

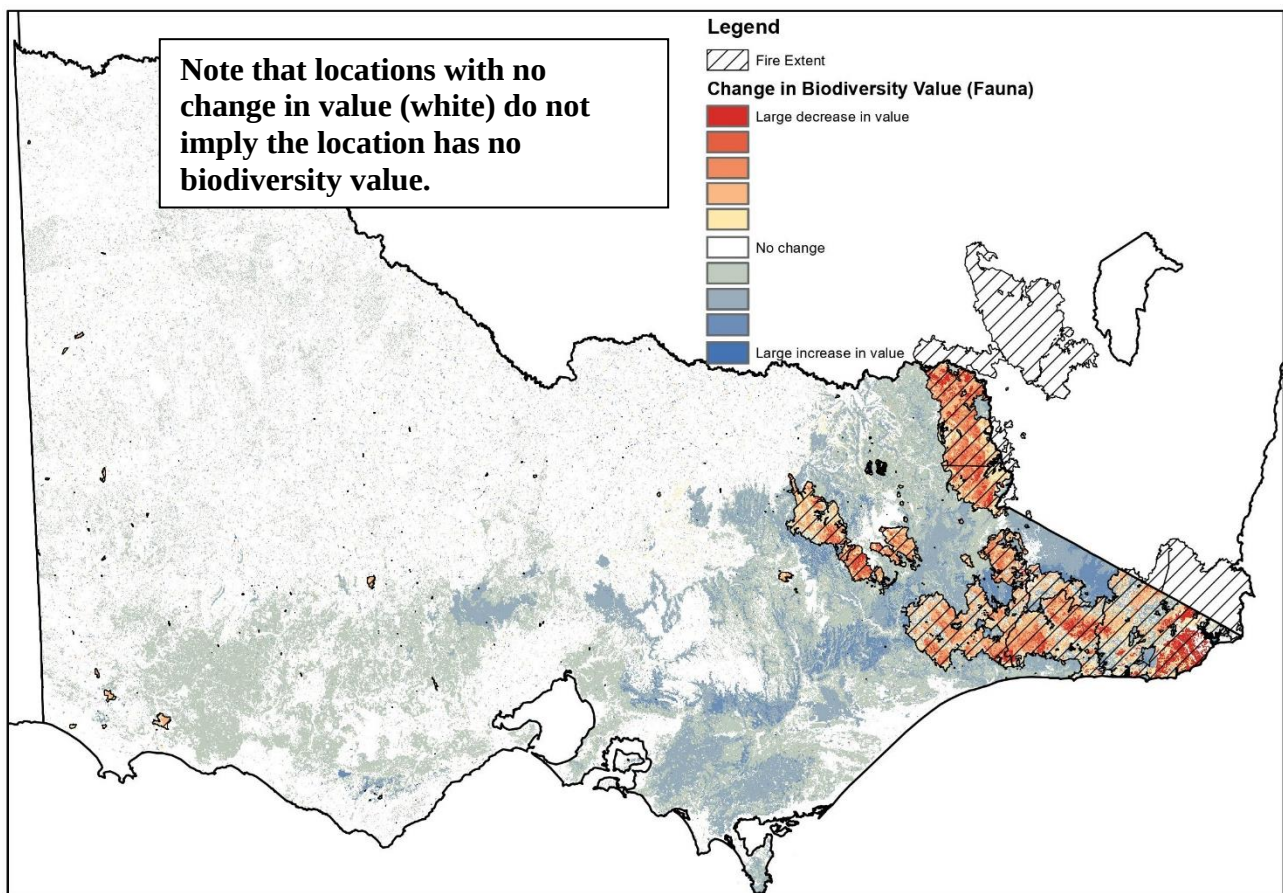


Figure 5: Map of the indicative change in relative biodiversity values for rare and threatened terrestrial vertebrate fauna species across eastern Victoria with current fire extent as at 20th April 2020. Red coloured areas indicate decreases in relative value and blue coloured areas indicate increases in relative value. Note that locations with no change in value (white) do not imply the location has no biodiversity value, just that there has been no change.

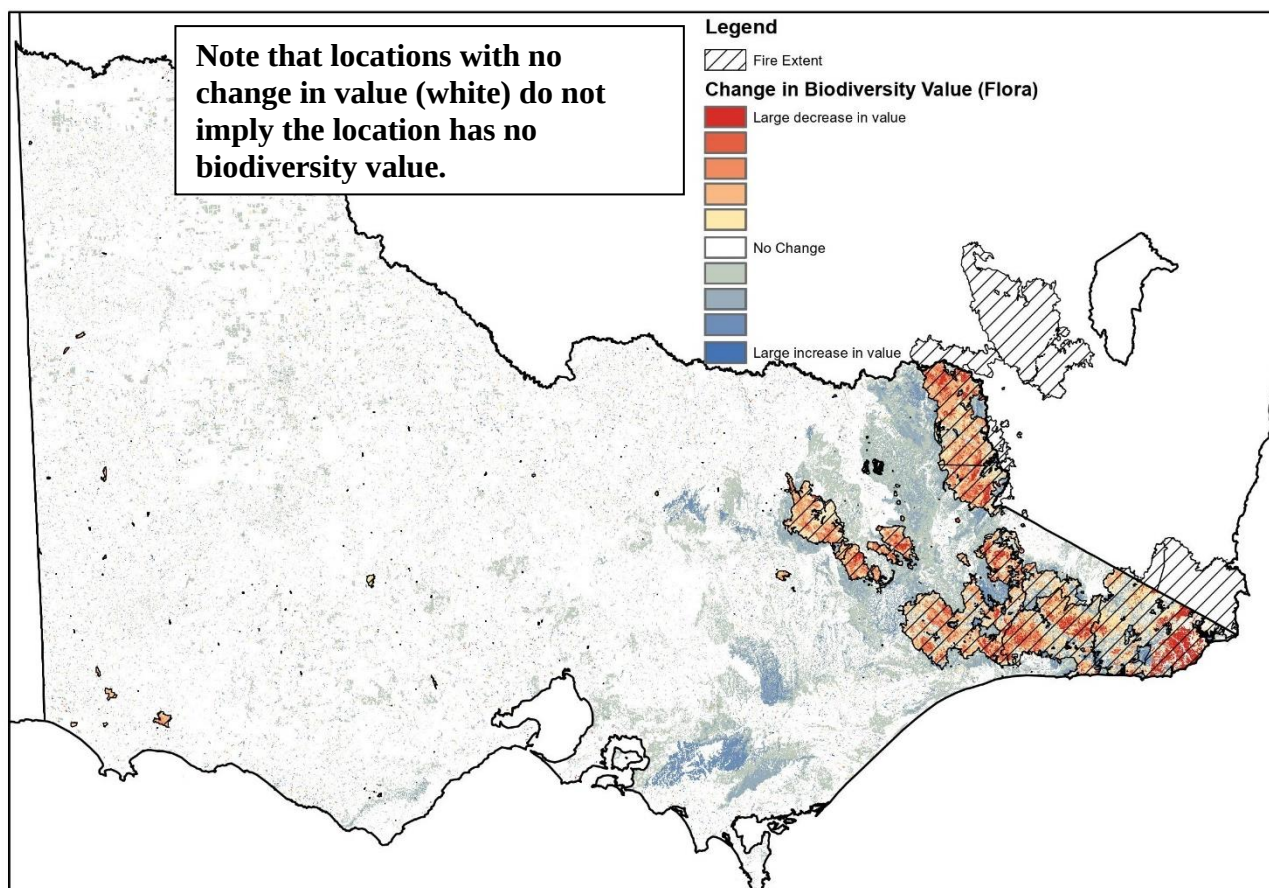


Figure 6: Map of indicative change in biodiversity values for rare or threatened flora species across eastern Victoria with current fire extent as at 20th April 2020. Red coloured areas indicate decreases in relative value and blue coloured areas indicate increases in relative value. Note that locations with no change in value (white) do not imply the location has no biodiversity value, just that there has been no change.

General species impacts

The number of fauna (excluding invertebrates) and flora with 95%, 80%, 50%, 30% and 10% or more of their state-wide modelled distribution within the current fire extent are shown in Table 6. Further detail of the impact on each taxon group is provided in Appendix One.

Table 6: General species impacts in the current fire extent.

% of modelled habitat in the current fire extent	Total species	Listed under the EPBC Act*^	Listed under the FFG Act*	Listed under the DELWP Advisory List*
Fauna (excluding invertebrates)				
Over 95%	3 species	0 species	3 species	3 species
80% to 95%	4 species	0 species	2 species	3 species
50% to 80%	13 species	2 species	7 species	9 species
30% to 50%	40 species	0 species	10 species	12 species
10% to 30%	127 species	4 species	16 species	21 species
Flora				
Over 95%	13 species	0 species	1 species	13 species
80% to 95%	93 species	1 species	13 species	93 species
50% to 80%	118 species	1 species	10 species	94 species
30% to 50%	242 species	4 species	14 species	114 species
10% to 30%	926 species	7 species	26 species	214 species

* the same species may be included under one or more of these statutory listing processes

^ this list includes species currently under assessment

The number of fauna and flora with 95%, 80%, 50%, 30% and 10% or more of their state-wide modelled distribution impacted by high severity fire are shown in Table 7. This includes severity Classes 4 and 5, which is high canopy scorch (>80% canopy scorch) and Canopy Burnt.

Table 7: General species impacts by high severity fire

% of modelled impacted by high severity fire	Total species	Listed under the EPBC Act*^	Listed under the FFG Act*	Listed under the DELWP Advisory List*
Fauna				
Over 95%	0 species	0 species	0 species	0 species
80% to 95%	0 species	0 species	0 species	0 species
50% to 80%	2 species	0 species	0 species	1 species
30% to 50%	8 species	2 species	5 species	5 species
10% to 30%	85 species	4 species	22 species	28 species
Flora				
Over 95%	0 species	0 species	0 species	0 species
80% to 95%	2 species	0 species	1 species	2 species
50% to 80%	39 species	1 species	5 species	39 species
30% to 50%	131 species	1 species	15 species	126 species
10% to 30%	731 species	8 species	30 species	283 species

* the same species may be included under one or more of these statutory listing processes

^ this list includes species currently under assessment

Fauna species (excluding invertebrates) of most concern

There is a high risk of immediate mortality and impact of short-term threats (e.g. predation) for fauna species. Therefore, fauna species are a strong focus for immediate response. Listed below are 67 fauna species, split via taxa, that are of most concern due to the impact of the 2019/2020 Victorian Bushfires (Table 8).

This includes species such as EPBC listed Giant Burrowing Frog and Long-footed Potoroo (see Figures 7 and 8 for the modelled distribution of these species overlaid with current fire extent).

The original list of 80 species of most immediate concern included in Version 1 of the report was reviewed and refined based on updated information and on-ground assessments. For example, initial advice from regional staff and aerial reconnaissance determined that the key Brush-tailed Rock-wallaby site in Little River Gorge was not impacted yet but, may be suffering from increased predation. The original list included some freshwater invertebrates. These are now included in the invertebrate section in the report. Four fauna species were added to the list based on expert advice received after the publication of the initial report, if they met the criteria (see methods).

Seven species which were identified as most immediate concern in Version 1 of the report have been removed as the analysis now indicated no impact of the fire (very minimal proportion Victorian habitat in fire extent). These species are: Barred Galaxias, Shaw Galaxias, Regent Honeyeater, Swift Parrot, Water Rat, New Holland Mouse and Guthega Skink.

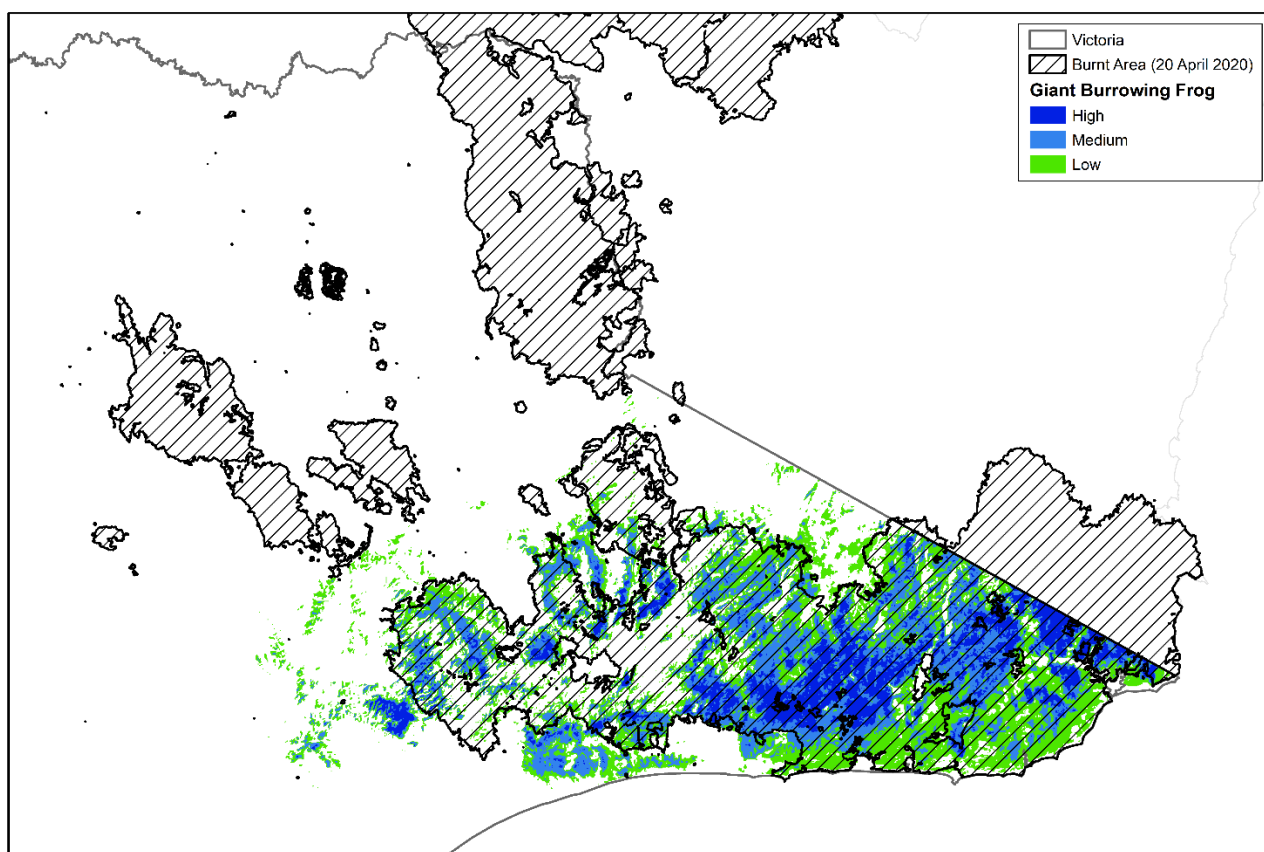


Figure 7: Modelled distribution of Giant Burrowing Frog for south eastern Australia and current fire extent as at 20th April 2020. At least 75% of the Victorian modelled distribution of Giant Burrowing Frog habitat has been burnt.

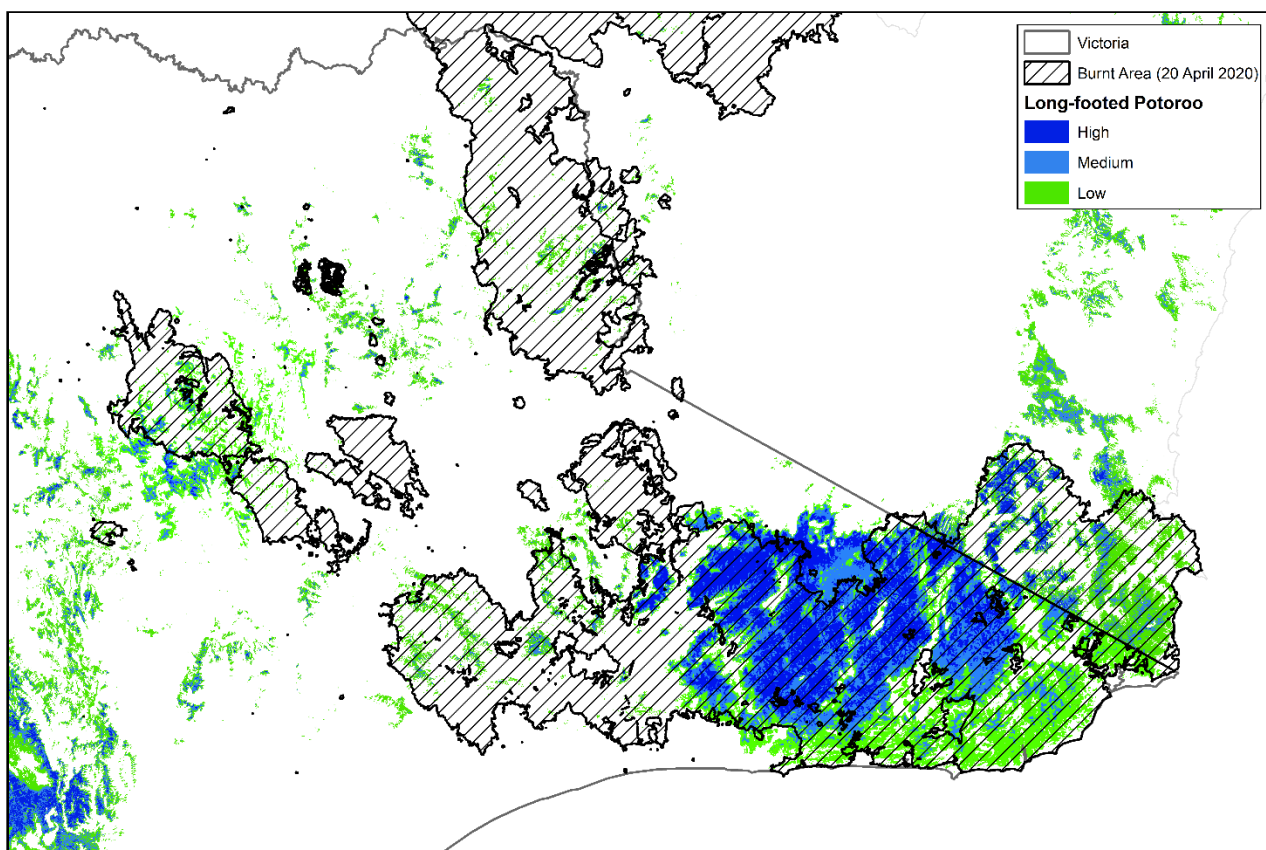


Figure 8: Modelled distribution of Long-footed Potoroo for south eastern Australia and current fire extent as at 20th April 2020. At least 79% of the Victorian modelled distribution of Long-footed Potoroo has been burnt.

Table 8: Fauna species of most concern. Includes % of modelled habitat in the current fire extent, % of modelled habitat impacted by high severity fire, genetic risk rating and localised impacts. Localised impacts were gathered through consultation with species experts, regional DELWP staff and other regional biodiversity experts from partner agencies. No thresholds or criteria were used to determine these localised impacts, other than seeking advice primarily on species that had large proportions of their habitat impacted by the fires or if advice was that they were especially vulnerable to wildfire. Green shading is EPBC and italics is DELWP Advisory List listed species (a species listed on both lists is bold and italics). Species marked with an asterisk (*) are Priority Species under the Australian Government's Threatened Species Strategy. Species marked with a caret (^) are currently being reviewed under the EPBC Act. Species marked with a hash (#) are migratory species with a smaller impact in their Victorian extent, but which have had their habitat impacted in other states.

Common Name	Scientific Name	% of modelled habitat in Victoria within the current fire extent	% of modelled habitat in Victoria impacted by high severity fire	Genetic Risk	Localised impacts
Amphibians					
Alpine Tree Frog	<i>Litoria verreauxii alpina</i>	15%	8%	High	
Blue Mountains Tree Frog	<i>Litoria citropa</i>	66%	32%	High	
Booroolong Tree Frog [^]	<i>Litoria booroolongensis</i>	39%	13%	Very high	Two of three Victorian populations impacted
Dendy's Toadlet	<i>Pseudophryne dendyi</i>	46%	23%	High	
Giant Burrowing Frog [^]	<i>Heleioporus australiacus</i>	75%	38%	Very high	
Green and Golden Bell Frog	<i>Litoria aurea</i>	53%	24%	High	Populations around Mallacoota may be impacted. Some individuals observed in Cape Conran National Park since fires
Keferstein's Tree Frog	<i>Litoria dentata</i>	84%	53%	High	
Large Brown Tree Frog [^]	<i>Litoria littlejohni</i>	88%	47%	Very high	All known populations may be impacted
Leaf Green Tree Frog	<i>Litoria nudigita</i>	66%	34%	High	
Martin's Toadlet	<i>Uperoleia martini</i>	31%	13%	Very high	Over 30% of Gippsland populations may be impacted
Southern Barred Frog	<i>Mixophyes balbus</i>	96%	Currently unknown	Very high	No confirmed records in Victoria since 1982. All known (pre 1982) sites have been impacted.
Spotted Tree Frog [^]	<i>Litoria spenceri</i>	22%	13%	Very high	Four significant populations impacted by high severity fire
Aquatic fauna					
Australian Grayling [^]	<i>Prototroctes maraena</i>	Currently unknown	Currently unknown	Low	Eastern Victorian populations may be impacted
Burrnan Dolphin	<i>Tursiops australis</i>	Currently unknown	Currently unknown	Moderate	
'Cann' Galaxias	<i>Galaxias</i> sp. 17	Currently unknown	Currently unknown	Very high	Almost all populations impacted in sediment event. Individuals extracted. No more located within known range.
Dargo Galaxias [^]	<i>Galaxias mungadhan</i>	16%	Currently unknown	High	All populations impacted. Individuals extracted.
East Gippsland Galaxias [^]	<i>Galaxias aequipinnis</i>	100%	Currently unknown	High	All populations may be impacted
Flatheaded Galaxias	<i>Galaxias rostratus</i>	~25%	Currently unknown	Very high	Impacts unknown due to difficulty in sampling.

Common Name	Scientific Name	% of modelled habitat in Victoria within the current fire extent	% of modelled habitat in Victoria impacted by high severity fire	Genetic Risk	Localised impacts
Galaxis olidus complex	<i>Galaxis olidus complex</i>	Currently unknown	Currently unknown	Moderate	Key population in south of range may be impacted (~85% of populations occur within current fire extent).
Gippsland Blackfish	<i>Gadopsis sp.</i>	Currently unknown	Currently unknown	Very high	Key populations in East Gippsland may be impacted.
Macquarie Perch	<i>Macquaria australasica</i>	~20%	Currently unknown	High	Population in Lake Dartmouth and Buffalo River impacted. Individuals extracted.
McDowall's Galaxias^	<i>Galaxias mcdowalli</i>	77%	Currently unknown	High	All populations may be impacted. Individuals extracted.
'Moroka' Galaxias	<i>Galaxias sp. 16</i>	Currently unknown	Currently unknown	Very high	Only known population outside of fire footprint.
Mountain Galaxias	<i>Galaxias olidus</i>	Currently unknown	Currently unknown	Moderate	Key populations in south of range may be impacted
Roundsnout Galaxias	<i>Galaxias terenasus</i>	97%	Currently unknown	Very high	Entire Victorian population may be impacted. No access possible for extraction due to fires.
'Yalmy' Galaxias	<i>Galaxias sp. 14</i>	94%	Currently unknown	Very high	Entire population impacted in major sediment event post-fire. Individuals extracted. No more located within known range
Birds					
Brown Gerygone	<i>Gerygone mouki</i>	52%	26%	Moderate	Impact on East Gippsland population linked to extent of Warm Temperate Rainforest and Riparian Forest burnt.
Eastern Bristlebird*	<i>Dasyornis brachypterus</i>	58%	39%	Very high	Fire boundaries very close to key sites. Individuals extracted and returned. The population in adjacent Nadgee Nature Reserve has been severely impacted.
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>	64%	26%	Moderate	Most of the population in East Gippsland has been impacted; effect of fire on food (Casuarina seeds) likely to be severe. Has since been observed eating other sheoak species
Ground Parrot	<i>Pezoporus wallicus</i>	33%	21%	Very high	Most of the population in East Gippsland has been impacted. Species may have been in decline across Victorian Range before fires.
Lewin's Honeyeater	<i>Meliphaga lewinii</i>	39%	20%	Moderate	
Masked Owl	<i>Tyto novaehollandiae</i>	54%	26%	High	Area burnt includes best habitat in Victoria and covers most of the recent records.
Powerful Owl	<i>Ninox strenua</i>	26%	13%	Moderate	
Red-browed Treecreeper	<i>Climacteris erythrops</i>	31%	16%	High	
Sooty Owl	<i>Tyto tenebricosa</i>	47%	24%	High	Likely impacted by fire, impact on species depends on fire severity

Common Name	Scientific Name	% of modelled habitat in Victoria within the current fire extent	% of modelled habitat in Victoria impacted by high severity fire	Genetic Risk	Localised impacts
Spotted Quail-thrush	<i>Cinclosoma punctatum</i>	29%	14%	High	
Mammals					
Broad-toothed Rat	<i>Mastacomys fuscus mordicus</i>	23%	14%	Very High (mainland)	Populations in sub-alpine areas may be impacted
Brush-tailed Rock-wallaby*	<i>Petrogale penicillata</i>	43%	26%	Very high	Wild Little River Gorge population not directly impacted
Eastern Bent-wing Bat	<i>Miniopterus schreibersii oceanensis</i>	21%	10%	Moderate	Most important Gippsland cave site is outside burnt area
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	26%	13%	Moderate	
Eastern Horseshoe Bat	<i>Rhinolophus megaphyllus megaphyllus</i>	39%	18%	High	Some cave sites within burnt area
Eastern Pygmy-possum	<i>Cercartetus nanus</i>	25%	13%	High	High proportion of best habitat in East Gippsland has been burnt; some tableland sites have been impacted. Most highest density sites in EG (on tableland near Bendoc) not burnt.
Feathertail Glider	<i>Acrobates pygmaeus</i>	22%	11%	High	
Greater Glider	<i>Petauroides volans</i>	32%	16%	High	Populations on foothill sites may be impacted
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	23%	11%	Low	Major population in Mallacoota may be impacted.
Koala	<i>Phascolarctos cinereus</i>	13%	6%	Moderate	
Long-footed Potoroo^	<i>Potorous longipes</i>	79%	41%	Very high	Populations may be impacted. Very high proportion of East Gippsland distribution burnt. Evidence of individuals in recently burnt areas
Long-nosed Bandicoot	<i>Perameles nasuta</i>	35%	17%	High	
Long-nosed Potoroo	<i>Potorous tridactylus tridactylus</i>	45%	22%	Very high	Very high proportion of East Gippsland distribution has been burnt. Recent (pre fire) detections of this species have been few; high priority to assess status
Mountain Pygmy-possum*	<i>Burramys parvus</i>	7%	4%	Very high	
Platypus	<i>Ornithorhynchus anatinus</i>	14%	6%	Moderate	
Smoky Mouse^	<i>Pseudomys fumeus</i>	20%	11%	High	
Southern Brown Bandicoot	<i>Isodon obesulus obesulus</i>	28%	14%	High	Very high proportion of East Gippsland distribution has been burnt.
Spot-tailed Quoll^	<i>Dasyurus maculatus maculatus</i>	36%	19%	Very High	Most Upper Snowy sites (north of Gelantipy) were not in the current fire extent

Common Name	Scientific Name	% of modelled habitat in Victoria within the current fire extent	% of modelled habitat in Victoria impacted by high severity fire	Genetic Risk	Localised impacts
White-footed Dunnart	<i>Sminthopsis leucopus</i>	36%	18%	High	
Yellow-bellied Glider	<i>Petaurus australis</i>	35%	18%	High	Populations on foothill sites may be impacted
Reptiles					
Alpine Bog Skink	<i>Pseudomoia cryodroma</i>	14%	9%	Very high	Some populations may be impacted
Alpine She-oak Skink	<i>Cyclodomorphus praealtus</i>	5%	2%	Very high	Minor impacts on southern edge of Bogong High Plains population. Extensive impacts in NSW and from previous bushfires
Alpine Water Skink	<i>Eulamprus kosciuskoi</i>	22%	14%	High	Likely > 50% of populations may be impacted
Copper-tailed Skink	<i>Ctenotus teniolatus</i>	19%	9%	Moderate	Preference for rocky habitat which may be less impacted by fires
Diamond Python	<i>Morelia spilota spilota</i>	86%	45%	High	Most of the population may be impacted. Likely to be individuals on Howe Flat
Eastern She-oak Skink	<i>Cyclodomorphus michaeli</i>	55%	Currently unknown	High	Majority of populations may be impacted. Likely to be individuals on Howe Flat
Gippsland Water Dragon	<i>Intellagama lesueurii howittii</i>	42%	20%	High	Some individuals observed but numbers severely reduced in some areas. Oviposition sites in some areas impacted by stream sediment
Lace Monitor	<i>Varanus varius</i>	16%	8%	High	High proportion of East Gipps distribution has been burnt.
Red-throated Skink	<i>Acritoscincus platynotus</i>	36%	22%	Very High	Likely all populations may be impacted
Swamp Skink	<i>Lissolepis coventryi</i>	17%	7%	High	Much of its range in East Gippsland (population stronghold) has been impacted. Few individuals observed at each site (in burrows)
Yellow-bellied Water Skink	<i>Eulamprus heatwolei</i>	39%	20%	High	Numerous sightings since fire, appears to be a resilient species

Invertebrate species potentially impacted

The major hazards to invertebrate groups include immediate mortality due to fire (due to lack of mobility), loss of critical habitat features (leaf litter, logs etc) and dependant flora, increased trampling from introduced herbivores, predators, loss of water quality and the long-term impacts of small population size in remnant patches caused by the fire.

The major limitation for determining invertebrate species of concern is the lack of data, particularly regarding species records, conservation status and vulnerability to fire. An Invertebrate Fire Response and Recovery-meeting was held with a number of Victorian invertebrate experts on the 4th of March to help understand the impacts of the bushfires and to determine actions for recovery.

Within these constraints, Table 9 describes invertebrates potentially impacted by the bushfires. This is a preliminary list which will need to be refined as more information becomes available. Invertebrate species are typically highly variable between locations and can exist as localised morphospecies. As a result, many narrow range endemic populations are likely affected within the current fire extent.

Table 9: Invertebrate species of concern. Species groups are written in bold. Green shading is EPBC and italics is DELWP Advisory List listed taxon. Includes genetic risk (if known) and known fire impacts within range. Impact assessment is based on aerial surveys of fire severity overlayed with acceptable species records from the Atlas of Living Australia and DELWP records. Species deemed particularly vulnerable to fire are non-flying or have low mobility, are litter and/or log dwelling and/or are aquatic-dependent in at least one life stage.

Common name(s)	Scientific name	Genetic risk	Highly vulnerable to fire	Known fire impact
Bees				
Metallic Green Carpenter Bee	<i>Xylocopa aeratus</i>	Currently unknown	N	Partial area of known range in current fire extent
Beetles				
	fam. <i>Elmidae</i> gen. <i>Simsonia</i>			
	fam. <i>Elmidae</i> gen. <i>Kingolus</i>	Currently unknown	Y	Partial area of known range in current fire extent
	fam. <i>Dytiscidae</i> gen. <i>Lancetes</i>			
Minute Moss Beetle	fam. <i>Hydraenidae</i> gen. <i>Hydraena</i>	Currently unknown	Y	Partial area of known range in current fire extent
Plate-thigh beetles	<i>Eucinetidae</i> spp.	Currently unknown	Y	Partial area of known range in current fire extent
Rove Beetle	supf. <i>Staphylinodea</i> fam. <i>Staphylinidae</i>	Currently unknown	Y	Partial area of known range in current fire extent
Water Beetle	fam. <i>Dytiscidae</i> gen. <i>Necterosoma</i>	Currently unknown	Y	Partial area of known range in current fire extent
Water Scavenger Beetle	fam. <i>Hydrophilidae</i> gen. <i>Berosus</i>	Currently unknown	Y	Partial area of known range in current fire extent
	fam. <i>Hydrophilidae</i> gen. <i>Notohydrus</i>			
Butterflies and Moths				
Alpine Silver Xenica/Small Alpine Xenica/Mount Buffalo Xenica	<i>Oreixenica latialis/ Oreixenica theddora</i>	High	N	Partial area of known range in current fire extent
Australian Hairstreak/Orange Tit/Silky Hairstreak/Victorian Hairstreak	<i>Pseudalmenus chlorinda fisheri/zephyrus</i>	Currently unknown	N	Partial area of known range in current fire extent
Bronze Flat	<i>Netrocoryne repanda</i>	Currently unknown	N	Partial area of known range in current fire extent
Brown Azure/Western Dark Azure/Small Brown Azure	<i>Ogyris otaes (otanes)</i>	Currently unknown	N	Partial area of known range in current fire extent
Chequered Sedge-skipper	<i>Hesperilla mastersi</i>	Currently unknown	N	Partial area of known range in current fire extent

Common name(s)	Scientific name	Genetic risk	Highly vulnerable to fire	Known fire impact
Common Pencilled-blue	<i>Candalides absimilis/ Candalides edwardsi</i>	Currently unknown	N	Partial area of known range in current fire extent
Copper Ant-blue	<i>Acrodipsas cuprea</i>	Currently unknown	N	Partial area of known range in current fire extent
Golden Ant-blue	<i>Acrodipsas aurata</i>	Currently unknown	N	Partial area of known range in current fire extent
Large Ant Blue Butterfly/Bronze Ant-blue	<i>Acrodipsas brisbanensis</i>	High	N	Partial area of known range in current fire extent
Orange Ringlet Butterfly	<i>Hypocysta adiante</i>	Currently unknown	N	Partial area of known range in current fire extent
Silver-studded Ochre	<i>Trapezites iacchoides</i>	Currently unknown	N	Partial area of known range in current fire extent
Painted Sedge-skipper	<i>Hesperilla picta</i>	Currently unknown	N	Partial area of known range in current fire extent
Small Orange-spotted Sun-moth	<i>Synemon discalis</i>	Currently unknown	N	Partial area of known range in current fire extent
Southern Sedge-darter Butterfly/ Dingy Darter	<i>Telicota eurychlora</i>	Currently unknown	Y	Majority area of known range in Victoria in current fire extent
Tasmanica Skipper/Two-spotted Skipper/Grass-skipper	<i>Pasma tasmanica</i>	Currently unknown	N	Partial area of known range in current fire extent
Wonder Brown	<i>Heteronympha mirifica</i>	Currently unknown	N	Partial area of known range in current fire extent
Yellow Ochre Butterfly	<i>Trapezites luteus</i>	Very high	N	Partial area of known range in current fire extent
Crayfish and other Crustaceans				
Alpine Spiny Crayfish	<i>Euastacus crassus</i>	High	Y	Majority of known range in current fire extent, southern population primarily impacted
Arte Spiny Crayfish	<i>Euastacus sp. 1</i>	Very high	Y	Majority of known range in current fire extent. Individuals extracted
Cann Spiny Crayfish	<i>Euastacus sp. 2</i>	Very high	Y	Majority of known range in current fire extent. Seeking to extract individuals
Claytons Spiny Crayfish	<i>Euastacus claytoni</i>	High	Y	Partial area of known range in current fire extent

Common name(s)	Scientific name	Genetic risk	Highly vulnerable to fire	Known fire impact
East Gippsland Spiny Crayfish	<i>Euastacus bidawalus</i>	Uncertain	Y	Entire known Victorian range in current fire extent. Individuals extracted.
Harpactacoid Copepod	<i>Canthocamptus longipes</i>	Currently unknown	Y	Entire known range in current fire extent
Mallacoota Burrowing Crayfish	<i>Engaeus mallacoota</i>	Very high	Y	Entire known Victorian range in current fire extent.
Orbost Spiny Crayfish	<i>Euastacus diversus</i>	Very high	Y	Majority of known range in current fire extent. Individuals extracted
Phreatoicid isopod	<i>Colubotelson joyneri</i>	Currently unknown	Y	Majority of known range in current fire extent
Riffle Shrimp/Eastern Freshwater Shrimp	<i>Australatya striolata</i>	Moderate	Y	Majority of known range in current fire extent
Variable Spiny Crayfish	<i>Euastacus yanga</i>	Moderate	Y	Entire known Victorian range in current fire extent. Young individuals extracted, no adults located.
West Snowy Spiny Crayfish	<i>Euastacus</i> sp. 3	Uncertain	Y	Entire known range in current fire extent
Dragonflies				
	fam. Leptophlebiidae gen. <i>Garinjuga</i> fam. Leptophlebiidae gen. <i>Ulmerophlebia</i> fam. Caenidae gen. <i>Tasmanocoenis</i> fam. Diphlebiidae gen. <i>Diphlebia</i> fam. Gomphidae gen. <i>Hemigomphus</i> fam. Telephlebiidae gen. <i>Notoaeschna</i> fam. Synthemistidae gen. <i>Eusynthemis</i>	Currently unknown	Y	Partial area of known range in current fire extent
Alpine Darner Dragonfly	<i>Austroaeschna</i> (<i>Austroaeschna</i>) <i>flavomaculata</i>	Currently unknown	Y	Partial area of known range in current fire extent
Darner Dragonfly	<i>Austroaeschna</i> spp.	Currently unknown	Y	Partial area of known range in current fire extent
Waterfall Redspot	<i>Austropetalia patricia</i>	Currently unknown	Y	Partial area of known range in current fire extent

Common name(s)	Scientific name	Genetic risk	Highly vulnerable to fire	Known fire impact
Flies				
Alpine Stonefly	<i>Thaumatoperla alpina</i>	Very high	Y	Partial area of known range in current fire extent
Biting Midge	fam. Ceratopogonidae gen. <i>Forcipomyia</i>	Currently unknown	Y	Partial area of known range in current fire extent
	<i>Ceratopogonidae</i> sp. 1, 8 (DNRE), 12, 20, 32 (EPA)			
Black Fly	<i>Austrosimulium</i> spp. <i>Simuliidae</i> spp.	Currently unknown	Y	Partial area of known range in current fire extent
Caddisfly	fam. Hydrobiosidae gen. <i>Koetonga</i>	Currently unknown	Y	Partial area of known range in current fire extent
	fam. Ecnomidae gen. <i>Ecnomina</i> E group			
	fam. Tasimiidae gen. <i>Tasiagma</i>			
	fam. Tasimiidae gen. <i>Tasimia</i>			
	fam. Conoesucidae gen. <i>Matasia</i>			
	<i>Aphilorheithrus stepheni</i>			
	fam. Leptoceridae gen. <i>Hudsonema</i>			
	fam. Micronectidae gen. <i>Micronecta</i>			
	fam. Odontoceridae gen. Genus P			
	<i>Hydrobiosidae</i> spp. <i>Conoesucidae</i>			
	spp. <i>Apsilochorema</i> spp.			
	<i>Ethochorema</i> spp. <i>Psyllobetina</i> spp.			
	<i>Ptychobiosis</i> spp. <i>Taschorema</i> spp.			
	<i>Ulmerochorema</i> spp. <i>Agapetus</i> spp.			
	<i>Chimarra</i> spp. <i>Hydrobiosella</i> spp.			
	<i>Asmicridea</i> spp. <i>Smicrophylax</i> spp.			
	<i>Coenoria</i> spp. <i>Conoesucus</i> spp.			
	<i>Costora</i> spp. <i>Helicopsyche</i> spp.			
	<i>Tamasia</i> spp. <i>Austrheithrus</i> spp.			
	<i>Kosrheithrus</i> spp.			

Common name(s)	Scientific name	Genetic risk	Highly vulnerable to fire	Known fire impact
	<i>Anisocentropus</i> spp. <i>Notalina</i> spp. <i>Triplectides</i> spp. <i>Archaeophylax canarus</i>			
	<i>Ecnomus nevoissi</i>			Majority of known range in current fire extent
	<i>Ecnomus nibbor</i>			Partial area of known range in current fire extent
	<i>Ramiheithrus virgatus</i>			Majority of known range in current fire extent
	<i>Triaenodes cuspidosa</i>			Majority of known range in current fire extent
	<i>Triaenodes uvida</i>			Majority of known range in current fire extent
Crane Fly	<i>Tipulidae</i> sp. 1, 7-9, 13, 29 (EPA) <i>Tipulidae</i> sp. 4, 5, 17-19, 25, 28, 33 (SRV)	Currently unknown	Y	Partial area of known range in current fire extent
Dobsonfly	<i>Archichauliodes</i> spp.	Currently unknown	Y	Partial area of known range in current fire extent
Lacewing	<i>Kempyninae</i> sp. 1	Currently unknown	Y	Partial area of known range in current fire extent
Large Blue Lake Mayfly	<i>Tasmanophlebi lacuscoerulei</i>	Currently unknown	Y	Partial area of known range in current fire extent
Large Riverdamselfly	<i>Caliagrion billinghursti</i>	Currently unknown	Y	Partial area of known range in current fire extent
March/Horse Flies	<i>Tabanidae</i> spp.	Currently unknown	Y	Partial area of known range in current fire extent
Mayfly	<i>Coloburiscoides</i> spp. <i>Leptophlebiidae</i> spp. <i>Atalophlebia</i> spp. <i>Austrophlebioides</i> spp. <i>Mirawara</i> spp. <i>Nousia</i> spp.	Currently unknown	Y	Partial area of known range in current fire extent
Microcaddisfly	supf. <i>Hydroptiloidea</i> fam. <i>Hydroptilidae</i> fam. <i>Hydroptilidae</i> gen. <i>Hellyethira</i> fam. <i>Hydroptilidae</i> gen. <i>Hydroptila</i> fam. <i>Hydroptilidae</i> gen. <i>Oxyethira</i>	Currently unknown	Y	Partial area of known range in current fire extent

Common name(s)	Scientific name	Genetic risk	Highly vulnerable to fire	Known fire impact
Netspinning Caddisfly	<i>Cheumatopsyche</i> spp. <i>Diplectrona</i> spp.	Currently unknown	Y	Partial area of known range in current fire extent
Non-biting Midge	<i>Tanypodinae</i> spp. <i>Chironomini</i> spp.	Currently unknown	Y	Partial area of known range in current fire extent
Stonefly	fam. <i>Notonemouridae</i> gen. <i>Austrocercella</i> , <i>Gripopterygidae</i> spp. <i>Cosmioperla</i> spp. <i>Dinotoperla</i> spp. <i>Leptoperla</i> spp. <i>Illiesoperla</i> spp. <i>Eunotoperla</i> spp. <i>Riekoperla</i> spp. <i>Trinotoperla</i> spp.	Currently unknown	Y	Partial area of known range in current fire extent
Water Snipe-flies	<i>Athericidae</i> spp.	Currently unknown	Y	Partial area of known range in current fire extent
Grasshoppers				
Alpine Yellow-Bellied Grasshopper	<i>Praxibulus uncinatus</i>	Currently unknown	Y	Partial area of known range in current fire extent
Brown Kosciuscola	<i>Kosciuscola cuneatus</i>	Currently unknown	Y	Partial area of known range in current fire extent
Chameleon Grasshopper	<i>Kosciuscola tristis</i>	Currently unknown	Y	Partial area of known range in current fire extent
Common Montane Grasshopper	<i>Kosciuscola cognatus</i>	Currently unknown	Y	Partial area of known range in current fire extent
<i>Key's Matchstick Grasshopper</i>	<i>Keyacris scurra</i>	Currently unknown	Y	Partial area of known range in current fire extent
Pyrgomorph Grasshopper	fam. <i>Pyrgomorphidae</i> gen. <i>Monistria</i>	Currently unknown	Y	Partial area of known range in current fire extent
Land snails				
Kosciuszko Carnivorous Snail	<i>Austrothyrida glaciamans</i>	Currently unknown	Y	Partial area of known range in current fire extent
Snowy Mountains Carnivorous Snail	<i>Vitellidelos helmsiana</i>	Currently unknown	Y	Partial area of known range in current fire extent
Kershaw's Panda-snail	<i>Pygmipanda kershawi</i>	Currently unknown	Y	Partial area of known range in current fire extent
Snowy Mountains Pinhead Snail	<i>Paralaoma gelida</i>	Currently unknown	Y	Partial area of known range in current fire extent
Bairnsdale Pinwheel Snail	<i>Egilodonta bairnsdalensis</i>	Currently unknown	Y	Partial area of known range in current fire extent
Lakes Entrance Pinwheel Snail	<i>Diphyoropa illustra</i>	Currently unknown	Y	Partial area of known range in current fire extent
Snowy River Pinwheel Snail	<i>Banjoropa snowyensis</i>	Currently unknown	Y	Partial area of known range in current fire extent

Common name(s)	Scientific name	Genetic risk	Highly vulnerable to fire	Known fire impact
Mount Feathertop Pinwheel Snail	<i>Alpiniropa okeana</i>	Currently unknown	Y	Partial area of known range in current fire extent
Bell's Pinwheel Snail	<i>Macrophallikoropa belli</i>	Currently unknown	Y	Partial area of known range in current fire extent
Kosciuszko Bristle Snail	<i>Austrochloritis kosciuszkoensis</i>	Currently unknown	Y	Partial area of known range in current fire extent
Merimbula Woodland Snail	<i>Pommerhelix mastersi</i>	Currently unknown	Y	Partial area of known range in current fire extent
Molluscs				
Austral Mussel	<i>Hyridella (Hyridella) australis</i>	High	Y	Entire known Victorian range in current fire extent. No individuals could be located for extraction
Depressed Mussel	<i>Hyridella (Hyridella) depressa</i>	High	Y	Entire known Victorian range in current fire extent. Individuals extracted from 2 populations
Glenelg Freshwater Mussel	<i>Hyridella glenelgensis</i>	High	Y	Partial area of known range in current fire extent. Fire impacted upstream of main population
Gunn's Screw Shell	<i>Gazameda gunnii</i>	Currently unknown	Y	Partial area of known range in current fire extent
Spiders				
Peacock Spider	<i>Maratus rainbowi</i> , <i>Maratus pavonis</i>	Currently unknown	Y	Partial area of known range in current fire extent
Worms and other invertebrates				
Giant Gippsland Earthworm	<i>Megascolides australis</i>	Very High	N	Partial area of known range in current fire extent
Mt Buffalo glow-worm	<i>Arachnocampa</i> sp. = <i>Arachnocampa lucifera buffaloensis</i>	Currently unknown	N	Partial area of known range in current fire extent
Planarian	<i>Planarian</i> sp. 3, 4 (RSC)	Currently unknown	Y	Partial area of known range in current fire extent
Velvet Worm	fam. <i>Onychophora</i> gen. <i>Peripatopsidae</i> , <i>Ooperipatellus duwilensis</i> , <i>Ooperipitas pulchellus</i> , <i>Planipapillus biacinaces</i>	Currently unknown	Y	Partial area of known range in current fire extent

Flora species of most concern

Plant responses to fire are complex but can be broadly split into those species that regenerate from seed or those that can re-sprout. Seed-regeneration may occur from soil-stored seed while others rely on seed migration from unburnt populations. Regardless of which survival strategy is used, most plants are very susceptible to drought stress and browsing by animals in the post-fire environment and mortality may be high in populations that survive fire. Long-term survival also depends on fire regimes, since repeated fires may exhaust seedbanks and rootstocks.

Table 10 outlines the flora species of most concern (see explanation of criteria in analyses methods). This is the top 154 species of most concern (for example *Callistemon kenmorrissonii* Figure 9). This list has increased from the 38 species initially highlighted in Version 1 of the report due to an increase in fire extent, and further information becoming available of species vulnerability to fire. This list will continue to be added to and refined as more information becomes available.

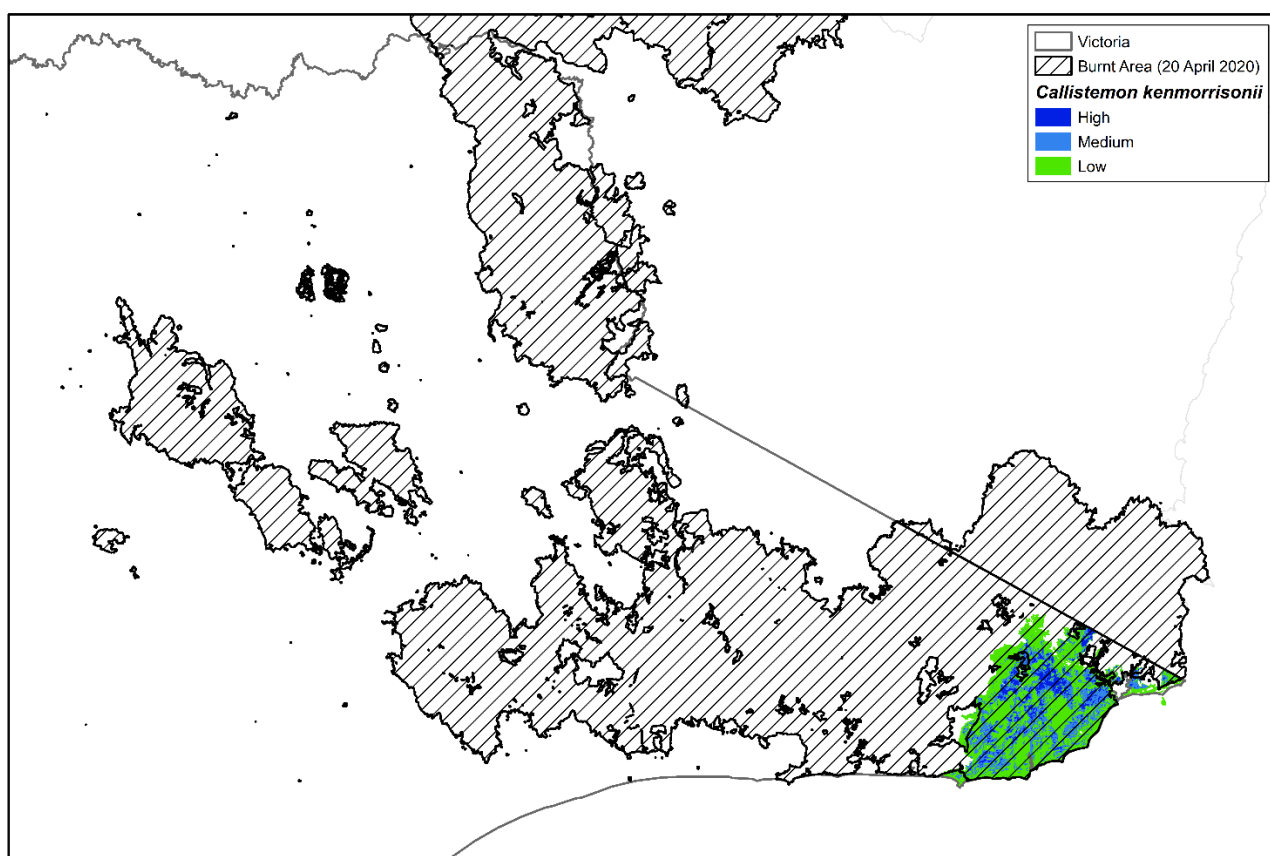


Figure 9: Modelled habitat distribution of *Callistemon kenmorrissonii* in Victoria and the burn extent as at 20th April 2020. At least 93% of the Victorian modelled distribution of *Callistemon kenmorrissonii* has been burnt.

Table 10: Flora species of most concern. Includes % of modelled habitat in the current fire extent, % of modelled habitat impacted by high severity fire, genetic risk rating and localised impacts. Localised impacts were gathered through consultation with species experts, regional DELWP staff and other regional biodiversity experts from partner agencies. No thresholds or criteria were used to determine these localised impacts, other than seeking advice primarily on species that had large proportions of their habitat impacted by the fires or if advice was that they were especially vulnerable to wildfire. Green shading is EPBC and italicised rows are DELWP Advisory List. Note: this table will be updated as new analyses and advice arises.

<i>Scientific Name</i>	<i>Common Name</i>	<i>% of modelled habitat in Victoria within the current fire extent</i>	<i>% of modelled habitat in Victoria impacted by high severity fire</i>	<i>Genetic Risk</i>	<i>Localised impacts</i>
Conifers					
<i>Podocarpus aff. lawrencei</i> (Goonmirk Rocks)	<i>Errinundra Plum-pine</i>	8%	1%	Moderate	
Dicotyledons					
<i>Acacia caerulescens</i>	<i>Limestone Blue Wattle</i>	23%	9%	Very high	Confined to the largely cleared limestones of the Buchan-Nowa Nowa area
<i>Acacia dawsonii</i>	<i>Poverty Wattle</i>	21%	9%	Currently unknown	
<i>Acacia irrorata</i> subsp. <i>irrorata</i>	<i>Green Wattle</i>	96%	61%	Currently unknown	Restricted to two populations in Victoria, both impacted
<i>Acacia maidenii</i>	<i>Maiden's Wattle</i>	23%	6%	High	Only Victorian site, southernmost occurrence/end of range
<i>Acacia subtilinervis</i>	<i>Net-veined Wattle</i>	82%	37%	Currently unknown	Restricted to two populations in Victoria, both entirely impacted
<i>Acacia ureniae</i>		100%	Currently unknown	Currently unknown	Single population which was impacted. Plant material extracted.
<i>Aciphylla glacialis</i>	<i>Snow Aciphyll</i>	13%	9%	Uncertain	
<i>Actinotus forsythii</i>	<i>Ridge Flannel-flower</i>	56%	41%	Uncertain	Restricted in Victoria to single population which was entirely impacted
<i>Alectryon subcinereus</i>	<i>Native Quince</i>	92%	39%	Currently unknown	Restricted in Victoria to single population which was entirely impacted
<i>Allocasuarina nana</i>	<i>Stunted Sheoak</i>	95%	32%	Very high	Restricted in Victoria to single population which was likely impacted
<i>Androcalva rossii</i>	<i>Native Hemp</i>	96%	54%	Currently unknown	Some, but probably not all populations, likely impacted
<i>Angophora floribunda</i>	<i>Rough-barked Apple</i>	92%	59%	Currently unknown	
<i>Astrotricha crassifolia</i>	<i>Thick-leaf Star-hair</i>	41%	18%	Currently unknown	Only known Victorian occurrence
<i>Banksia canei</i>	<i>Mountain Banksia</i>	33%	16%	Currently unknown	Population at Burrowa Pine Mountain impacted

Scientific Name	Common Name	% of modelled habitat in Victoria within the current fire extent	% of modelled habitat in Victoria impacted by high severity fire	Genetic Risk	Localised impacts
<i>Banksia croajingolensis</i>	Gippsland Banksia	65%	45%	Very high	Restricted to a single population in Croajingolong National Park, impacted by fire. Ongoing persistence depends on fire severity.
<i>Bertya findlayi</i>	Mountain Bertya	59%	28%	Currently unknown	All of Victorian population impacted by fire
<i>Boronia ledifolia</i>	Showy Boronia	69%	35%	Currently unknown	
<i>Boronia</i> sp.		Currently unknown	Currently unknown	Currently unknown	An unnamed species apparently confined to Mt Typo
<i>Brachyscome riparia</i>	Snowy River Daisy	34%	14%	Currently unknown	
<i>Brachyscome salkiniae</i>	Elegant Daisy	93%	52%	Very high	
<i>Brunoniella pumilio</i>	Dwarf Brunoniella	93%	69%	Currently unknown	Restricted in Victoria to single population which was entirely impacted
<i>Callistemon forresterae</i>	Forrester's Bottlebrush	88%	45%	Very high	Restricted to six small populations in Gippsland, majority likely impacted
<i>Callistemon kenmorrisonii</i>	Betka Bottlebrush	93%	71%	Very high	Restricted to two populations in Gippsland, both impacted
<i>Callistemon subulatus</i>	Dwarf Bottlebrush	92%	48%	Very high	
<i>Cassinia maritima</i>	Coast Cassinia	86%	49%	Very high	
<i>Cassinia venusta</i>	Elegant Cassinia	69%	45%	Very high	
<i>Commersonia dasyphylla</i>	Kerrawang	99%	86%	Currently unknown	Single population only, not seen recently, but likely impacted
<i>Conospermum taxifolium</i>	Variable Smoke-bush	86%	58%	Currently unknown	
<i>Cooperookia barbata</i>	Purple Cooperookia	93%	51%	Currently unknown	
<i>Correa lawrenceana</i> var. <i>cordifolia</i>	Pink Mountain-correa	93%	37%	Currently unknown	Restricted in Victoria to single population which was entirely impacted. Also likely impacted in NSW.
<i>Correa lawrenceana</i> var. <i>genoensis</i>	Genoa River Correa	86%	33%	Currently unknown	Restricted in Victoria to a few small populations which were impacted
<i>Corymbia gummifera</i>	Red Bloodwood	92%	65%	Currently unknown	
<i>Craspedia</i> sp. 1	Mountain Forest Billy-buttons	0%	Currently unknown	Currently unknown	Identified as high priority for emergency extraction of seed/cuttings.
<i>Daviesia wyattiana</i>	Long-leaf Bitter-pea	96%	44%	Currently unknown	Restricted in Victoria to single population

Scientific Name	Common Name	% of modelled habitat in Victoria within the current fire extent	% of modelled habitat in Victoria impacted by high severity fire	Genetic Risk	Localised impacts
					<i>which was entirely impacted</i>
<i>Dendrophthoe vitellina</i>	Long-flower Mistletoe	86%	46%	Moderate	Rainforest species restricted to areas around Mallacoota, likely impacted.
<i>Discaria nitida</i>	Shining Anchor Plant	42%	20%	Currently unknown	
<i>Dodonaea rhombifolia</i>	Broad-leaf Hop-bush	70%	37%	Uncertain	Snowy River Gorge and Pine Mountain populations likely impacted by fire
<i>Dodonaea truncatiales</i>	Angular Hop-bush	90%	36%	Currently unknown	Restricted in Victoria to single population which was impacted
<i>Epacris microphylla</i> s.s.	Coast Coral Heath	77%	51%	Currently unknown	All of Victorian population impacted by fire
<i>Eucalyptus agglomerata</i>	Blue-leaf Stringybark	96%	48%	Currently unknown	
<i>Eucalyptus delegatensis</i> subsp. <i>delegatensis</i>	Alpine Ash	24%	14%	Moderate	Although species is not of a concern overall, some areas have been impacted by multiple burns over the last 20 years (see below). Because of vulnerability of this species to multiple burns, areas of where this is the dominant tree species are of concern.
<i>Eucalyptus denticulata</i>	Errinundra Shining Gum	42%	21%	Moderate	This is a keystone species of the Errinundra subalpine forests, and only a small, single seed lot is held at RBGV. Significant numbers of seed will be required if any kind of regenerative work is to be carried out in the area in future.
<i>Eucalyptus elaeophloia</i>	Olive Mallee	52%	38%	Currently unknown	Restricted in Victoria to single population which was entirely impacted
<i>Eucalyptus forresterae</i>	Brumby Sallee	50%	36%	Currently unknown	Restricted in Victoria to single population which was entirely impacted
<i>Eucalyptus mitchelliana</i>	Buffalo Sallee	23%	10%	Currently unknown	Buffalo endemic, collections required, at risk of repeated burns
<i>Eucalyptus perriniana</i>	Spinning Gum	26%	17%	Moderate	
<i>Eucalyptus regnans</i>	Mountain Ash	8%	4%	Moderate	Impact is isolated to easternmost areas. Although species is not of a concern overall, because of vulnerability of this species to multiple burns, areas of where this is the dominant tree species are of concern.

Scientific Name	Common Name	% of modelled habitat in Victoria within the current fire extent	% of modelled habitat in Victoria impacted by high severity fire	Genetic Risk	Localised impacts
<i>Eucalyptus saxatilis</i>	Rock Mallee	15%	7%	Currently unknown	
<i>Eucryphia moorei</i>	Eastern Leatherwood	77%	19%	Very high	Only known Victorian population impacted at Howe Range, population has likely been impacted.
<i>Euphrasia scabra</i>	Rough Eyebright	28%	16%	Currently unknown	
<i>Eupomatia laurina</i>	Bolwarra	93%	50%	Currently unknown	
<i>Ficus coronata</i>	Sandpaper Fig	89%	52%	Moderate	
<i>Gingidia algida</i>		Currently unknown	Currently unknown	Currently unknown	Only location for Victoria, currently known only by photograph, 1 site E of Mt Hotham
<i>Goodenia bellidifolia</i> subsp. <i>bellidifolia</i>	Daisy Goodenia	93%	51%	Currently unknown	
<i>Grevillea alpivaga</i>	Buffalo Grevillea	30%	12%	Currently unknown	Buffalo endemic; Grevillea is particularly fire-susceptible
<i>Grevillea celata</i>	Colquhoun Grevillea	56%	24%	Very high	Majority if not all populations impacted
<i>Grevillea jephcottii</i>	Green Grevillea	50%	35%	Currently unknown	All Victoria populations impacted by fire.
<i>Grevillea pachylostyla</i>	Buchan River Grevillea	51%	27%	Currently unknown	Not currently in seed collectoin, 2 localities only; susceptible to successive fires
<i>Grevillea parvula</i>	Genoa Grevillea	92%	45%	Currently unknown	
<i>Grevillea polychroma</i>	Tullach Ard Grevillea	74%	38%	Currently unknown	
<i>Grevillea ramosissima</i> subsp. <i>hypargyrea</i>	Fan Grevillea	58%	31%	Currently unknown	Population at Burrowa Pine Mountain impacted by fire.
<i>Hakea dactyloides</i>	Finger Hakea	93%	49%	Currently unknown	
<i>Hakea macraeana</i>	Willow Needlewood	93%	35%	Moderate	
<i>Hibbertia dentata</i>	Trailing Guinea-flower	93%	50%	Currently unknown	
<i>Hovea purpurea</i>	Tall Hovea	94%	34%	Currently unknown	Restricted in Victoria to single population which was likely impacted
<i>Irenepharsus magicus</i>	Elusive Cress	54%	28%	Currently unknown	Limited occurrence in Victoria
<i>Kelleria bogongensis</i>	Snow Daphne	4%	2%	High	Extreme range restriction, threatened by horses
<i>Korthalsella rubra</i> subsp. <i>rubra</i>	Jointed Mistletoe	22%	12%	Currently unknown	

Scientific Name	Common Name	% of modelled habitat in Victoria within the current fire extent	% of modelled habitat in Victoria impacted by high severity fire	Genetic Risk	Localised impacts
<i>Lasiopetalum ferrugineum</i>	Rusty Velvet-bush	86%	44%	Currently unknown	
<i>Lepidium aschersonii</i>	Spiny Peppercress	1%	0%	Currently unknown	Extraordinary eastern outlying occurrence at Lake Omeo. Almost certainly distinct genetic races (or cryptic taxa) of this across its range
<i>Leptomeria acida</i> s.s.	Sour Currant-bush	91%	58%	Currently unknown	
<i>Leptospermum glabrescens</i> s.s.	Smooth Tea-tree	98%	88%	Currently unknown	
<i>Leptospermum trinervium</i>	Paperbark Tea-tree	91%	47%	Currently unknown	
<i>Leptostigma breviflorum</i>	Mountain Nertera	10%	5%	Moderate	
<i>Lobelia dentata</i>	Toothed Lobelia	90%	51%	Currently unknown	
<i>Marsdenia flavescens</i>	Yellow Milk-vine	73%	40%	Currently unknown	Thought to be the only site left in Victoria
<i>Mirbelia pungens</i>	Prickly Mirbelia	96%	43%	Currently unknown	Restricted in Victoria to single population which was entirely impacted.
<i>Mirbelia rubiifolia</i>	Heathy Mirbelia	88%	53%	Currently unknown	Restricted in Victoria to single population which was entirely impacted
<i>Monotoca rotundifolia</i>	Trailing Monotoca	53%	38%	Currently unknown	Restricted in Victoria to single population which was entirely impacted
<i>Muehlenbeckia gracillima</i>	Slender Lignum	83%	41%	Very high	Restricted to two populations, both potentially impacted
<i>Muellerina celastroides</i>	Coast Mistletoe	10%	5%	Uncertain	Both this and its common host, <i>Banksia serrata</i> , susceptible to fire with no obvious recruitment strategy post-fire
<i>Myoporum floribundum</i>	Slender Myoporum	16%	7%	Very high	Extremely rare in nature despite being common in horticulture
<i>Nematolepis frondosa</i>	Leafy Nematolepis	45%	20%	Uncertain	Restricted in Victoria to single population which was entirely impacted
<i>Notothixos subaureus</i>	Golden Mistletoe	89%	61%	Moderate	
<i>Olax stricta</i>	Olax	95%	36%	Moderate	
<i>Olearia astroloba</i>	Marble Daisy-bush	22%	12%	High	Only population in Victoria not currently impacted by fire.
<i>Olearia iodochroa</i>	Violet Daisy-bush	42%	22%	Very high	
<i>Olearia tomentosa</i>	Toothed Daisy-bush	80%	20%	Very high	

Scientific Name	Common Name	% of modelled habitat in Victoria within the current fire extent	% of modelled habitat in Victoria impacted by high severity fire	Genetic Risk	Localised impacts
<i>Ozothamnus adnatus</i>	Winged Everlasting	27%	13%	Very high	
<i>Ozothamnus argophyllus</i>	Spicy Everlasting	86%	50%	Very high	
<i>Persoonia levis</i>	Smooth Geebung	92%	48%	High	
<i>Persoonia silvatica</i>	Forest Geebung	54%	28%	Moderate	Majority of populations impacted, recovery will depend on fire severity.
<i>Philotheca myoporoides</i> subsp. <i>brevipedunculata</i>	Suggan Buggan Wax-flower	4%	1%	Currently unknown	Only known Victorian occurrence
<i>Philotheca virgata</i>	Tasmanian Wax-flower	90%	49%	Currently unknown	
<i>Picris angustifolia</i> subsp. <i>merxmuelleri</i>	Highland Picris	20%	10%	Currently unknown	
<i>Pittosporum revolutum</i>	Rough-fruit Pittosporum	84%	39%	Currently unknown	Disjunct westerly outlier on Mt Nowa Nowa
<i>Podolobium ilicifolium</i>	Prickly Podolobium	93%	49%	Currently unknown	
<i>Polyscias murrayi</i>	Pencil Cedar	79%	19%	Currently unknown	Restricted in Victoria to single population which was entirely impacted. Also likely impacted in NSW.
<i>Pomaderris brunnea</i>	Rufous Pomaderris	84%	30%	Currently unknown	Key population impacted by fire, likely all populations impacted and possibly twice burnt in the last six years.
<i>Pomaderris costata</i>	Veined Pomaderris	92%	45%	Currently unknown	
<i>Pomaderris sericea</i>	Bent Pomaderris	89%	37%	Currently unknown	Restricted in Victoria to single population which was impacted
<i>Pomaderris virgata</i>	Upright Pomaderris	88%	54%	Very high	Restricted in Victoria to single small population which was entirely impacted
<i>Poranthera corymbosa</i>	Clustered Poranthera	95%	79%	Currently unknown	
<i>Prostanthera incisa</i>	Cut-leaf Mint-bush	83%	35%	Very high	Majority if not all populations impacted
<i>Prostanthera monticola</i>	Buffalo Mint-bush	24%	14%	High	
<i>Prostanthera walteri</i>	Monkey Mint-bush	66%	31%	Very high	Only population in Victoria impacted by fire, NSW populations also likely impacted
<i>Santalum obtusifolium</i>	Blunt Sandalwood	93%	37%	High	Restricted to small colonies around Mallacoota Inlet and Genoa River upstream of Princes Highway, which have mostly been impacted.

Scientific Name	Common Name	% of modelled habitat in Victoria within the current fire extent	% of modelled habitat in Victoria impacted by high severity fire	Genetic Risk	Localised impacts
<i>Scutellaria mollis</i>	Soft Skullcap	90%	48%	Currently unknown	
<i>Solanum silvestre</i>	Violet Nightshade	94%	69%	Currently unknown	
<i>Spyridium cinereum</i>	Tiny Spyridium	58%	40%	Currently unknown	Restricted to two populations in Victoria, one of which burnt
<i>Stylidium laricifolium</i>	Giant Triggerplant	96%	76%	Currently unknown	
<i>Symplocos thwaitesii</i>	Buff Hazelwood	47%	30%	Currently unknown	Restricted in Victoria to single population which was entirely impacted
<i>Tetratheca thymifolia</i>	Thyme Pink-bells	92%	40%	Currently unknown	Restricted to two populations in Victoria, both impacted
<i>Viola improcera</i>	Dwarf Violet	45%	32%	Currently unknown	Known only from 3 localities in Australia, one at Brumby Point
<i>Wahlenbergia gloriosa</i>	Royal Bluebell	28%	17%	Currently unknown	
Westringia cremnophila	Snowy River Westringia	68%	31%	Very high	Restricted in Victoria to single population which was entirely impacted
Zieria citriodora	Lemon-scented Zieria	70%	29%	NA	Restricted in Victoria to single population which was entirely impacted
Fern and allies					
<i>Adiantum formosum</i>	Black Stem	95%	46%	Currently unknown	Both populations likely impacted by fire
<i>Botrychium lunaria</i>	Grassy Moonwort	45%	31%	Very high	
<i>Cyathea leichhardtiana</i>	Prickly Tree-fern	93%	60%	Currently unknown	
<i>Gleichenia rupestris</i>	Rock Coral-fern	70%	51%		Both populations likely impacted by fire
<i>Lastreopsis microsora</i> subsp. <i>microsora</i>	Creeping Shield-fern	93%	57%	Currently unknown	Majority of populations likely impacted
<i>Polystichum formosum</i>	Broad Shield-fern	59%	31%	Very high	
<i>Pteris vittata</i>	Chinese Brake	84%	49%	High	Majority of populations likely impacted
<i>Sticherus flabellatus</i> var. <i>flabellatus</i>	Shiny Fan-fern	93%	62%	High	
Monocotyledons					
<i>Caladenia ancylosa</i>	Genoa Spider-orchid	79%	48%	Currently unknown	
<i>Carex jackiana</i>	Carpet Sedge	20%	13%	Currently unknown	
<i>Cryptostylis erecta</i>	Bonnet Orchid	80%	49%	Very high	

<i>Scientific Name</i>	<i>Common Name</i>	<i>% of modelled habitat in Victoria within the current fire extent</i>	<i>% of modelled habitat in Victoria impacted by high severity fire</i>	<i>Genetic Risk</i>	<i>Localised impacts</i>
<i>Cryptostylis hunteriana</i>	<i>Leafless Tongue-orchid</i>	79%	34%	Very high	<i>Restricted to two populations, both potentially impacted</i>
<i>Cyathochaeta diandra</i>	<i>Sheath Sedge</i>	94%	73%	Currently unknown	
<i>Dendrobium speciosum</i> var. <i>speciosum</i>	<i>Rock Orchid</i>	94%	63%	Very	<i>Some populations impacted and species is susceptible to fire.</i>
<i>Deyeuxia crassiuscula</i>	<i>Thick Bent-grass</i>	21%	13%	Currently unknown	
<i>Deyeuxia decipiens</i>	<i>Devious Bent-grass</i>	82%	37%	Currently unknown	<i>Restricted to two populations in Victoria, both impacted</i>
<i>Deyeuxia frigida</i>	<i>Forest Bent-grass</i>	21%	10%	Currently unknown	
<i>Deyeuxia pungens</i>	<i>Narrow-leaf Bent-grass</i>	3%	1%	Uncertain	<i>Only 2 known Victorian occurrences, both in this region</i>
<i>Dipodium interaneum</i> [hamiltonianum]	<i>Yellow Hyacinth-orchid</i>	18%	9%	Currently unknown	<i>Extremely rare in Victoria, Beechworth population not sited in decades, possibly restricted to McKillops Rd sites within the state</i>
<i>Echinopogon caespitosus</i> var. <i>caespitosus</i>	<i>Bushy Hedgehog-grass</i>	8%	3%	Currently unknown	
<i>Hookerchloa eriopoda</i>	<i>Snow Fescue</i>	44%	25%	Currently unknown	<i>Grass of restricted occurrence, thought to be preferentially grazed by horses</i>
<i>Livistona australis</i>	<i>Cabbage Fan-palm</i>	62%	21%	High	<i>Iconic, only Victorian site and southernmost locality for the species.</i>
<i>Patersonia sericea</i> var. <i>longifolia</i>	<i>Dwarf Purple-flag</i>	97%	34%	Currently unknown	
<i>Plectorrhiza tridentata</i>	<i>Tangle Orchid</i>	93%	49%	High	
<i>Plinthanthesis paradoxa</i>	<i>Wiry Wallaby-grass</i>	91%	60%	Currently unknown	
<i>Prasophyllum uvidulum</i>	<i>Summer Leek-orchid</i>	55%	29%	Currently unknown	<i>Species only known from one small area, 100% of the known population was impacted by fire.</i>
<i>Pseudoraphis paradoxa</i>	<i>Slender Mud-grass</i>	0%	0%	Currently unknown	<i>Known from few sites in Victoria, more or less centred on Colquhoun Forest</i>
<i>Pterostylis acuminata</i>	<i>Pointed Greenhood</i>	94%	78%	Currently unknown	<i>Restricted in Victoria to single population which was impacted by fire. Also likely impacted in NSW.</i>
<i>Pterostylis oreophila</i>	<i>Blue-tongue Greenhood</i>	52%	29%	Very high	
<i>Pterostylis reflexa</i>	<i>Small Autumn Greenhood</i>	94%	44%	Currently unknown	

<i>Scientific Name</i>	<i>Common Name</i>	<i>% of modelled habitat in Victoria within the current fire extent</i>	<i>% of modelled habitat in Victoria impacted by high severity fire</i>	<i>Genetic Risk</i>	<i>Localised impacts</i>
<i>Pterostylis sp. aff. alveata (Montane)</i>	<i>Hill Greenhood</i>	96%	45%	Currently unknown	
<i>Ripogonum album</i>	<i>White Supplejack</i>	90%	48%	Currently unknown	
<i>Sarcochilus falcatus</i>	<i>Orange-blossom Orchid</i>	88%	28%	High	
<i>Schelhammera undulata</i>	<i>Lilac Lily</i>	93%	50%	Currently unknown	
<i>Schoenus melanostachys</i>	<i>Black Bog-sedge</i>	93%	49%	Currently unknown	
<i>Xyris juncea</i>	<i>Dwarf Yellow-eye</i>	26%	15%	Currently unknown	All of Victorian population impacted by fire

Algal and bryophyte species potentially impacted

Other taxa have limited data in terms of species distributions, population sizes, genetic vulnerability and conservation status. This lack of knowledge restricts our capacity to measure the impacts of fire for those groups. In the case of algae and bryophytes, experts have begun collaborating and collecting information to create a working assessment of fire impacts and preliminary list of affected species. These are detailed in Appendix 7 (Table 25) and Appendix 8 (Table 26).

Impacted vegetation communities

EPBC listed communities

There are five EPBC listed communities within the fire boundary (Table 11) and currently there is limited direct impact on these communities by fire. However, these areas are at high risk of the future indirect bushfire impacts such as from soil erosion, increased exposure and elevated levels of feral herbivore browsing.

FFG listed communities

There are eight FFG listed communities impacted by the fires (Table 12). Rainforest in Victoria develops in the long-term absence of severe disturbance such as fire, and there are significant areas of rainforest within the current fire extent (Figure 10). In addition to the bushfires, these sites are at high risk of the future indirect impacts of bushfire such as soil erosion, exposure, weed invasion, eucalypt invasion and encroachment and elevated levels of feral herbivore browsing. The impact of fire severity for these communities requires further assessment.

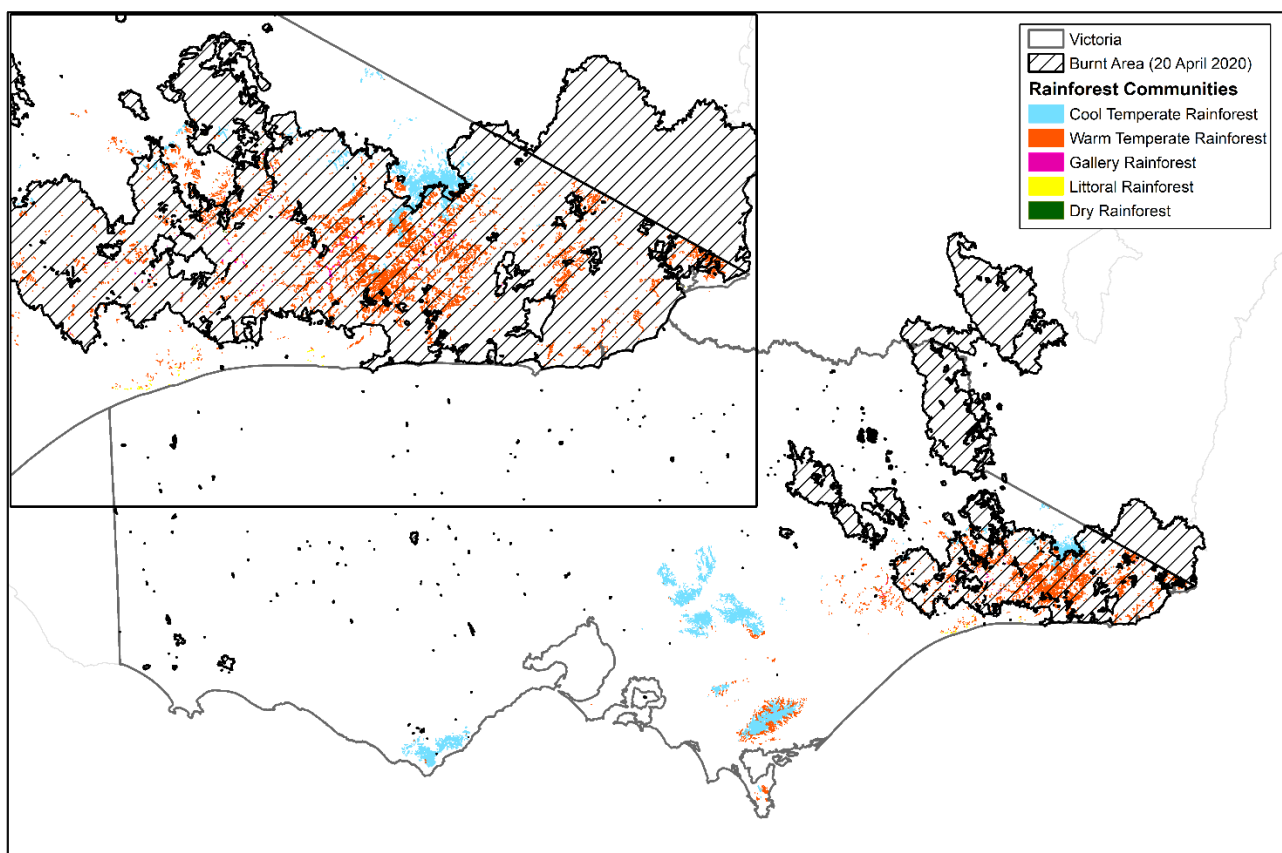


Figure 10: Overlay of current fire extent as of 20th April 2020 and mapped rainforest communities in Victoria. Note that there is a 0.05 pt border used on the rainforest extent map to aid visual interpretation.

Table 11: Impacts on EPBC listed communities

Community	Extent in Victoria	Impact of fire	% of community within current fire extent	% of community impacted by high severity fire
Alpine Sphagnum Bogs and Associated Fens ecological community [^]	Less than 4,300 hectares is extant in Victoria.	Direct and severe impacts to this community will be likely given the protracted period of low rainfall leading up to the fires. In several places across the projected impact area, this community has been subject to repeat fires. Impacts included destruction associated with peat ignition, altered hydrology, and mass movement of soils and siltation. The community is at risk of the future indirect impacts of bushfire such as feral herbivore browsing, trampling and wallowing.	11%	Unknown
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	The extent of this rainforest community in Victoria is limited – likely to be less than 100 hectares - and comprised of small fragmented remnants typically less than 1 hectare in size	The community is at risk of the future indirect impacts of bushfire such as soil erosion, exposure, weed encroachment and feral herbivore browsing.	15%	7%
Natural Temperate Grassland of the South Eastern Highlands	Remnants in Victoria are very small in area likely to be less than 10,000 hectares and within the small extent of the Monaro Tablelands that extends into Victoria.	While the community is 'tolerant of fire', the impact of hot summer fire combined with drought is unknown.	Adjacent to but not within current fire extent	
Silurian Limestone Pomaderris Shrubland of the South East Corner and Australian Alps Bioregions	The only known population occurs at Marble Gully Nature Conservation Reserve, near Bindi in the Tambo valley north-east of Swifts Creek, East Gippsland.	This site was completely burnt in 2003 and is in recovery from this event. The impact of repeated burning is potentially a problem for many of the constituent species whose fire response is relatively poorly known.	Adjacent to but not within current fire extent	
White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Grassland ecological community	Significant areas of this community are extant in the rain-shadow areas of the middle reaches of the Snowy River Catchment (~32,000 ha)	This community was severely impacted by the 2003 fires. There is a risk of the ongoing loss of the fire sensitive White Native Pine, a keystone species in this community.	5%	0%

[^]Also listed under FFG Act

Table 12: Impacts on FFG listed communities

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

Ecological Vegetation Classes (EVC)

Based on the current fire extent, the entire modelled area of Montane Grassy Shrubland and over 80% of Gallery Rainforest and Banksia Woodland are within the fire extent, and 9 EVCs have over 50% of their modelled area within the current fire extent (Table 13). A list of EVCs with significant impacts is provided in Table 14. Some EVCs are more or less resilient than others in responding to fire depending on a range of factors including impacts of multiple fires on seedbanks and germination.

Table 13: Summary of Ecological Vegetation Classes and the proportion of their extent impacted by fire

	% of modelled EVC in the current fire extent	% of modelled EVC impacted by high severity fire
Over 95%	1 EVC	0 EVC
80% to 95%	2 EVC	0 EVC
50% to 80%	6 EVC	5 EVC
30% to 50%	9 EVC	5 EVC
10% of more	28 EVC	18 EVC

Table 14: Ecological Vegetation Classes and the proportion of their extent impacted by fire

Ecological Vegetation Class	Area within current fire extent (Ha)	Area impacted by high severity fire (Ha)	Total extent of EVC (Ha)	% total EVC area within current fire extent	% of EVC impacted by high severity fire
Montane Grassy Shrubland	85	42	85	100%	49%
Foothill Box Ironbark Forest	526	310	584	90%	53%
Gallery Rainforest	310	146	348	89%	42%
Banksia Woodland	33107	16159	39,413	84%	41%
Sub-alpine Wet Heathland/Sub-alpine Grassland Mosaic	128	60	158	81%	38%
Warm Temperate Rainforest	12997	5499	16,663	78%	33%
Gallery Rainforest - former niche	532	262	709	75%	37%
Cut-tail Forest	34051	17946	46,015	74%	39%
Warm Temperate Rainforest - former niche	18786	8610	26,092	72%	33%
Coastal Sand Heathland	483	412	710	68%	58%
Clay Heathland	1869	709	3,222	58%	22%
Blackthorn Scrub	7137	4716	12,745	56%	37%
Dry Rainforest	24	8	54	44%	14%
Riparian Scrub/Swampy Riparian Forest Mosaic	12720	5621	29,582	43%	19%
Damp Forest	242561	109730	577,526	42%	19%
Dry Rainforest - former niche	59	22	144	41%	15%
Lowland Forest	216438	91986	541,094	40%	17%
Montane Herb-rich Woodland	8983	6798	24,278	37%	28%
Shrubby Dry Forest	294303	143174	795,413	37%	18%
Montane Grassy Woodland	17517	9245	48,659	36%	19%
Shrubby Damp Forest	24585	10244	68,293	36%	15%
Wet Heathland	8970	4051	28,936	31%	14%

Ecological Vegetation Class	Area within current fire extent (Ha)	Area impacted by high severity fire (Ha)	Total extent of EVC (Ha)	% total EVC area within current fire extent	% of EVC impacted by high severity fire
Montane Dry Woodland	100046	53358	333,486	30%	16%
Coastal Lagoon Wetland	253	54	902	28%	6%
Montane Damp Forest	48251	26806	178,706	27%	15%
Riverine Escarpment Scrub	2608	1605	10,031	26%	16%
Dry Valley Forest	5122	1707	21,342	24%	8%
Coast Banksia Woodland	1554	906	6,473	24%	14%
Littoral Rainforest - former niche	108	63	450	24%	14%
Granitic Hills Woodland	9895	7646	44,976	22%	17%
Alpine Crag Complex	118	48	536	22%	9%
Sub-alpine Woodland	24180	14968	115,141	21%	13%
Riparian Forest/Swampy Riparian Woodland Mosaic	1577	601	7,510	21%	8%

Impact of multiple fires since 2000

In some ecosystems, multiple bushfires within a short time period (e.g. 20 years) can result in regeneration failure for obligate seeders. Multiple large-scale bushfires across Victoria over the last 20 years have resulted in an increasing proportion of area that has been impacted multiple times since 2000.

Preliminary analyses on the current fire extent has shown a large increase in the area of Victoria that has had been impacted by multiple bushfires (up to four fires) since 2000 as a result of this year's fire season (Figure 11,12 and 13).

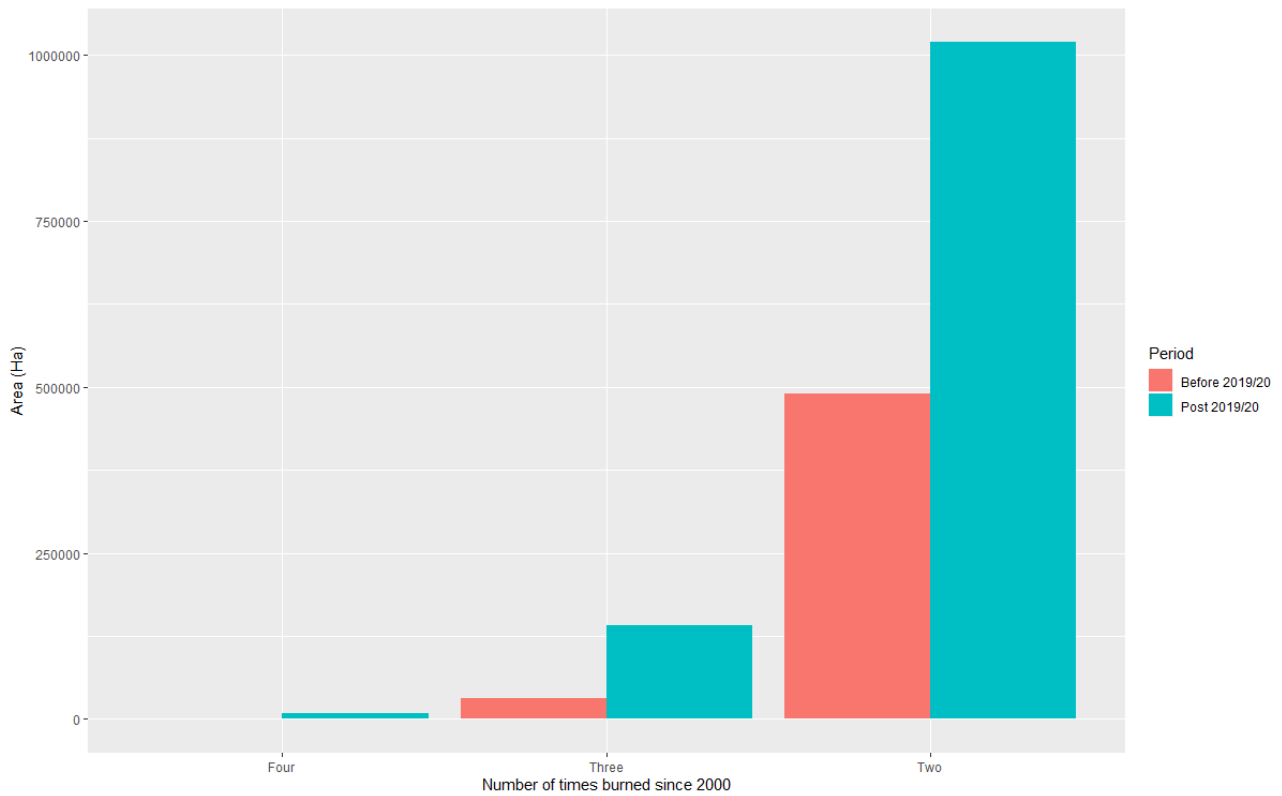


Figure 11: Area of Victoria that has been impacted by multiple bushfires since 2000 before this fire season (red) and after this fire season (blue).

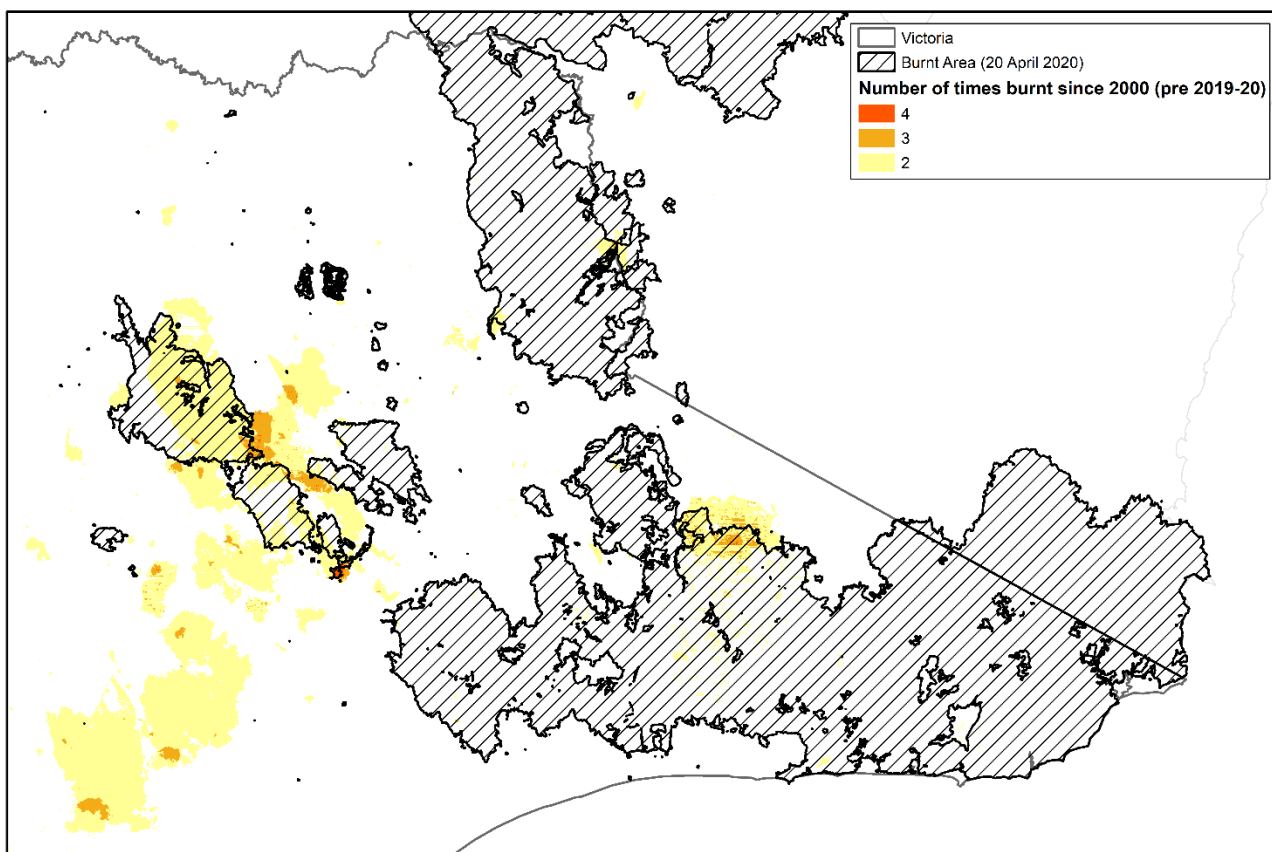


Figure 12: Areas that have impacted by multiple bushfires since 2000, up until but not including the current fire extent of the 2019/2020 fire season

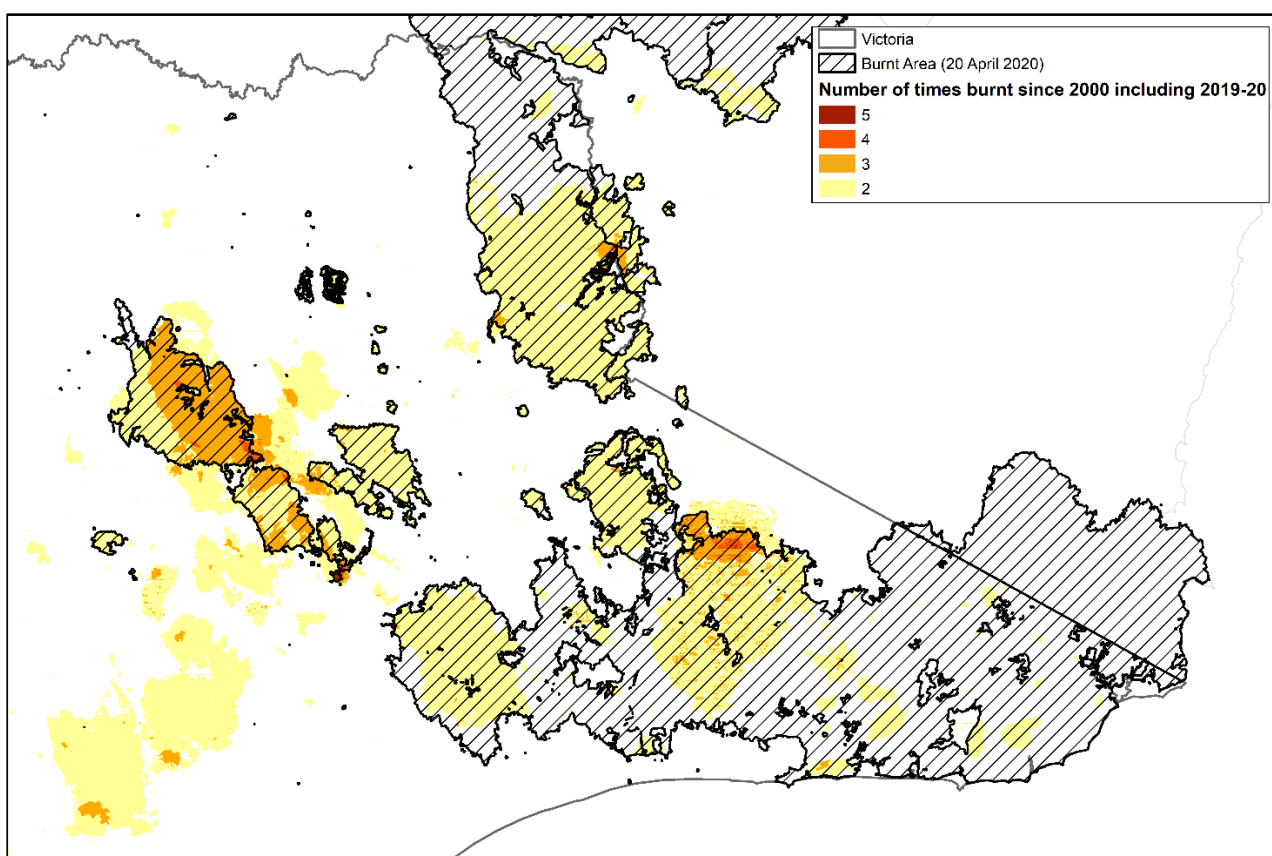


Figure 13: Areas that have been impacted by multiple bushfires since 2000, including the current fire extent of the 2019/2020 fire season.

There are over 50 EVCs (Table 15) which have been impacted by multiple bushfires over the last 20 years, which, for some EVCs has had a significant impact on their ability to regenerate naturally.

Table 15: Area of EVCs impacted by bushfires twice since 2000

Ecological vegetation class	Total hectares impacted by bushfires twice in last 20 years	Percentage area of total EVC extent
Montane Grassy Shrubland	84	99%
Foothill Box Ironbark Forest	454	78%
Herb-rich Heathy Forest	295	68%
Sub-alpine Grassland	79	68%
Alpine Crag Complex	333	62%
Shrubby Damp Forest	31,873	47%
Valley Slopes Dry Forest	825	42%
Montane Herb-rich Woodland	9,683	40%
Montane Dry Woodland	130,133	39%
Sub-alpine Woodland	44,070	38%
Montane Damp Forest	66,909	37%
Sub-alpine Dry Shrubland	201	36%
Montane Grassy Woodland	17,199	35%
Shrubby Dry Forest	260,679	33%
Riverine Escarpment Scrub	3,219	32%
Gallery Rainforest	100	29%
Sub-alpine Wet Heathland	431	28%
Dry Valley Forest	5,832	27%
Blackthorn Scrub	3,189	25%
Clay Heathland	762	24%
Sub-alpine Riparian Shrubland	3	24%
Damp Forest	135,817	24%
Montane Rocky Shrubland	988	20%
Alpine Damp Grassland	324	19%
Sub-alpine Shrubland	433	18%
Alpine Grassy Heathland	886	17%
Montane Wet Forest	12,100	17%
Sub-alpine Treeless Vegetation	1,183	17%
Dry Rainforest	9	17%
Montane Riparian Thicket	1,045	17%
Herb-rich Foothill Forest	130,975	16%
Alpine Fen	5	16%
Wet Heathland	4,322	15%
Riparian Shrubland	723	14%
Alpine Grassland	333	14%
Banksia Woodland	5,343	14%
Heathy Dry Forest	50,823	13%
Tableland Damp Forest	2,114	13%
Snowpatch Grassland	15	13%

Ecological vegetation class	Total hectares impacted by bushfires twice in last 20 years	Percentage area of total EVC extent
Floodplain Thicket	370	13%
Heathland Thicket	84	13%
Warm Temperate Rainforest	2,059	12%
Montane Riparian Woodland	823	11%
Wet Forest	29,533	11%
Shrubby Foothill Forest	14,953	10%
Riparian Forest	8,711	10%
Damp Heathy Woodland	929	10%

Impact of multiple fires since 2000 on ash forest

Alpine Ash (*Eucalyptus delegatensis*), and Mountain Ash (*Eucalyptus regnans*) (Figure 14) are of particular concern following the 2019/2020 bushfire season due to their fire sensitivity, and exposure to multiple burns since 2000. Young Ash (aged around 20 years or less) are particularly vulnerable to fire and at the most juvenile stages, are also susceptible to herbivory, exacerbated by the presence of pest species such as deer and goats. Initial indicative analyses suggest that at least 14,000 hectares of young Ash species forest within the current fire extent impacted by high severity fire (>80% crown scorch and/or full crown burn) may require active interventions (e.g. re-seeding) to support regeneration (Table 16). Aerial and field verification is underway to refine these numbers.

Table 16: Area of Ash forest across all tenures impacted by the 2019/2020 bushfires and 2019/2020 high severity fire

Category	Area (Ha)
Mountain Ash (<i>Eucalyptus regnans</i>)	
Total area of Mountain Ash impacted by 2019/2020 fires	4,286 ha
Total area of young Mountain Ash impacted by 2019/2020 fires	1,741 ha
Area of young Mountain Ash impacted by 2019/2020 high severity fire	1,277 ha
Alpine Ash (<i>Eucalyptus delegatensis</i>)	
Total area of Alpine Ash impacted by 2019/2020 fires	52,516 ha
Total area of young Alpine Ash impacted by 2019/2020 fires	20,460 ha
Area of young Alpine Ash impacted by 2019/2020 high severity fire	13,051 ha

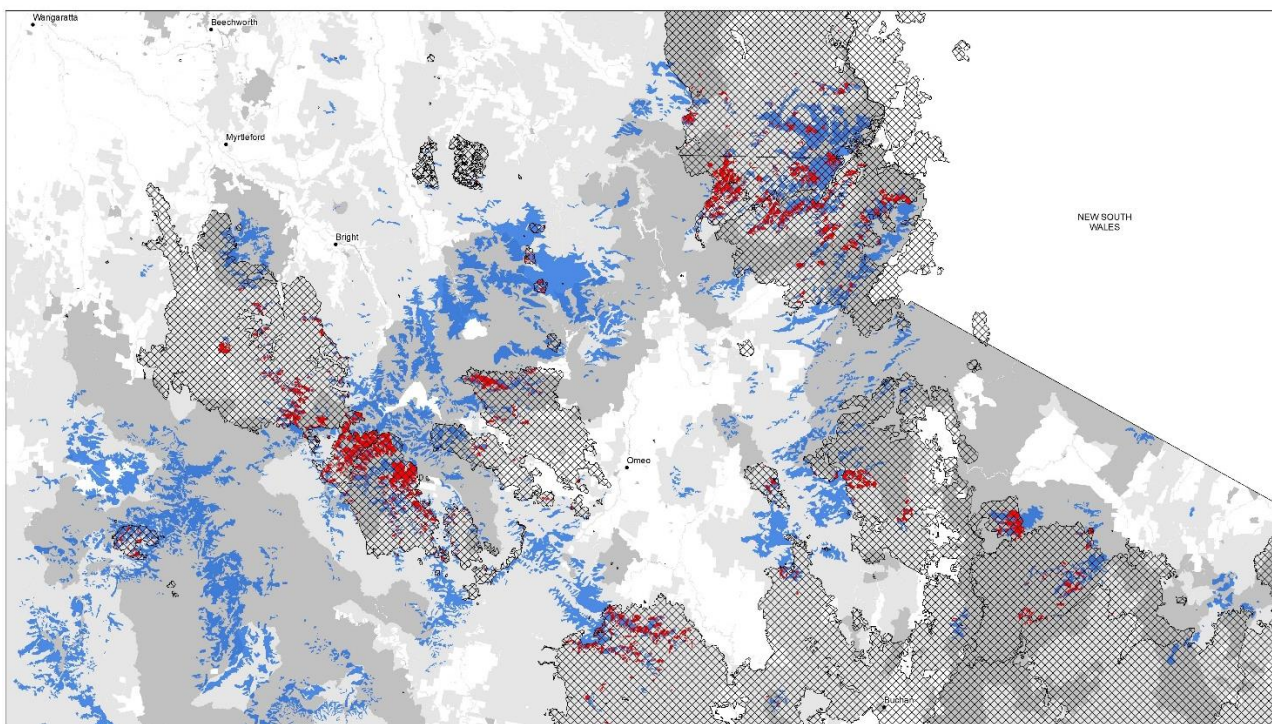


Figure 14: Indicative extent of young (less than 20 years of age) Alpine Ash (*Eucalyptus delegatensis*), and Mountain Ash (*Eucalyptus regnans*) forest impacted by 2019/2020 fires indicated by the red area. Blue areas indicate entire extent of Ash forest and fire extent is indicated by the hashed area.

Response and recovery plan

Strategic planning approach

An overarching strategic approach to the biodiversity response and recovery for Victoria's bushfire emergency is vital for the coordination between different emergency response recommendations and multiple funding sources. Funding for delivery of the response actions may come from different jurisdictions and sources (including external organisations). The responsibility for delivering actions must be undertaken by the relevant land managers and relevant natural resource management organisations with coordination of the response and recovery (including allocation of funding) and oversight through DELWP (Figure 15).

The overarching response considers that the current fires are exceptional in size and impact and recognises that under climate change we are entering a changing environment in terms of the scale and complexity of managing fire impacts on biodiversity. Multiple large-scale active fires and the increasing proportion of areas that have been burnt multiple times since 2000 has expanded the context in which mitigation needs to be framed. This means that for some species and actions mitigation, will need to include options beyond the fire areas.

The approach is steered by the Protecting Victoria's Environment - Biodiversity 2037 and ensure that existing processes (such as Biodiversity Response Planning, Forest & Fire Planning, Catchment Planning) are utilised to progressively engage key stakeholders and support them in recognising and responding to the challenge of climate change impacts, particularly the increased risk of future bushfire.

The initial focus of the response will be on the most urgent actions (i.e. Phase 1 Immediate and short-term actions - as soon as able to operate in the fire area) but all the timeframes are part of the overall emergency response.

Beyond the most urgent actions, DELWP needs to use this experience to rapidly improve preparedness for similar events in the future. Better provision of information is highly desirable and feasible before next fire season. This is also the time to expand our capability to plan for the broader range of future shocks that may be triggered through climate change.

Prioritisation

The level of impact, the range of species affected, the mix of fire effects and other existing threats, and the wide range of relevant actions (both within and beyond the current fire extent), means there are many considerations and candidates for conservation action. Prioritisation is essential due to limits in available time and resources, and broadly must address:

Urgency

- increased vulnerability of some biodiversity values post-fire
- post-fire windows of opportunity for some actions

Importance of biodiversity values

- conservation status of species, including any potential change to this from fires
- relative importance of populations/locations to the overall persistence of a species
- genetic fitness of important populations
- evolutionary distinctiveness of species

Functional state of ecosystems at locations

- existing chronic threats such as invasive species, fragmentation
- historical regimes of disturbance events such as fire, harvesting, droughts, floods etc (e.g. forest age classes due to previous events; current unburnt areas as immediate refuges)

Victoria's bushfire emergency:

Biodiversity response and recovery

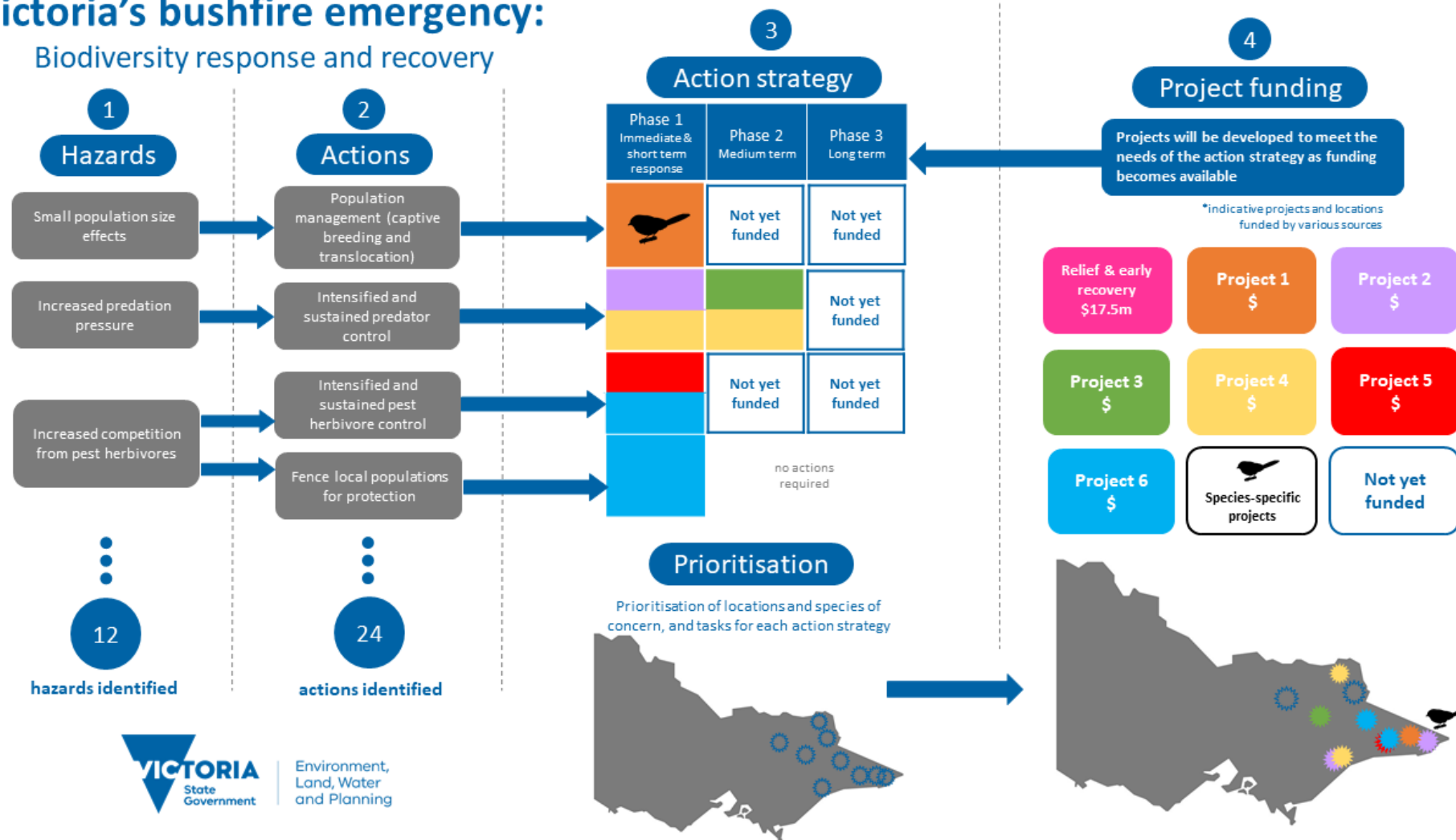


Figure 15: Response and recovery planning approach

- dynamic interactions of threats and disturbance events/regimes
- presence and contribution of key functional groups

Suitability and expected outcomes of actions

- relevance and feasibility of actions
- benefit of actions i.e. the difference in expected outcomes without and with action
- relative contribution of expected outcomes from one action/location compared to all other options

Risks to achieving outcomes

- direction and relative influence of future scenarios for disturbance events/regimes and shifting biophysical envelopes, given climate change
- spreading of risk across a range of geographic (*in situ*) and situational (*ex situ*) locations

Cost-effectiveness of actions

- combinations of the above factors need to be weighed against the cost of the relevant actions to enable programs to achieve the best outcomes for the available resources
- costs need to consider initiation, continuation and exit strategies for actions

These factors must be considered as an integrated set, noting they are not simply additive and sometimes inherent tensions could undermine the overall intent of the program. For example:

- early commitments are advantageous for urgent and important actions, but subsequently there may be insufficient availability of resources for less urgent but more important actions;
- the need for consequent actions must be considered e.g. can extracted/captive-bred individuals be returned to the wild and what options/resources are required to enable this? how intensive or invasive is the action?
- contrastingly, committing to a well-scoped but large and long-term project may narrow future options for other projects.

Prioritisation factors are described above according to the primary goal of maximising on-ground biodiversity outcomes but are also relevant inputs to enabling actions such as improvements in knowledge and community engagement/participation in these actions.

DELWP has datasets and decision-support tools for quantifying and integrating some of these factors for many species and environments. Where these datasets do not cover specific situations, these can be considered in a similar manner and compared to the broader datasets. Particularly, decision support tools Strategic Management Prospects and Specific Needs are used by DELWP to assess the benefit and cost-effectiveness of landscape scale and species-specific conservation actions respectively. DELWP is applying these existing datasets and tools to apply these above factors when prioritising actions.

Preliminary post-fire analysis using DELWP's spatial conservation action planning tool Strategic Management Prospects has revealed that a range of actions have increased in priority within the burnt area (Figure 16). The results from this prioritisation, and comparing these results to pre-fire priorities, show that controlling deer, weeds, predators (foxes and feral cats) and pigs have all substantially increased in priority within the burnt area. The analysis shows that undertaking these actions at the landscape scale (y-axis on the graph) within the burned extent will deliver the greatest benefit to biodiversity and aligns well with the current threat management actions already underway.

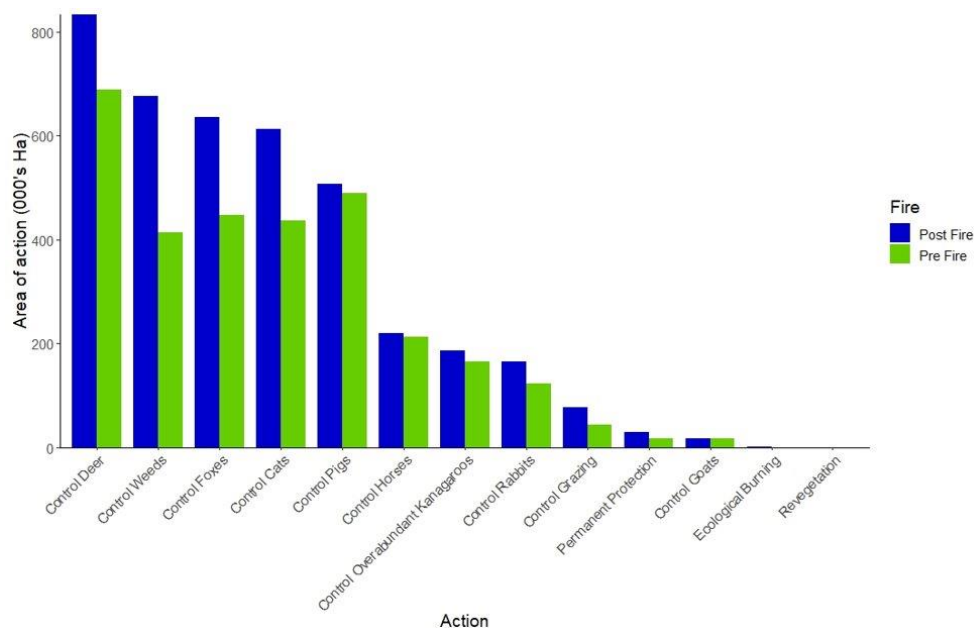


Figure 16: The area (hectares) of priority actions within the state-wide 2019/20 fire extent as identified using Strategic Management Prospects v2.0, in the pre-fire analysis (green) and post-fire analysis (blue). Actions that have had a large increase in area in the post fire analysis are of increased importance to undertake to assist biodiversity recovery.

Work is currently underway to improve the development and application of information and to better prepare for decision-making in the response to the bushfires, and to improve preparedness for the next fire season. This involves exploring the potential benefits of other post-fire recovery actions, as well as actions that could maximise resilience of species to future fires across Victoria and incorporating these into existing decision support tools.

Prioritisation has commenced with 11 taxon-specific workshops held virtually in May 2020, which developed shortlists of potential actions that assist recovery or maximise resilience to future disturbances, as well as key knowledge gaps, for each taxon group for further exploration. These actions are now being assessed for their benefit to species using Specific Needs, a process to determine the cost-effectiveness of specific conservation actions (that are not currently included in Strategic Management Prospects) for species. These results will be integrated with existing decision support tools to assist in prioritising actions across the state under the biodiversity bushfire response and recovery.

Timeframes for response

There are a wide range of potential responses and actions that can be undertaken to assist the recovery of biodiversity post-fire, and due to the criticality of time in an emergency response, they will be considered in terms of nested timeframes:

Emergency response actions (while the fire is still active)

Examples of activities implemented as part of the 2019/2020 fire response include:

- wildlife welfare coordination, including responding to animals already being brought to treatment locations, and preparation and delivery of expanded wildlife assessment activities and responses once the fire ground is declared safe to enter.

- advice on managing risks of biodiversity impacts from on-going fire suppression activities (e.g. where to restrict application of retardant or blacking out actions in refuges¹ for localised high value biodiversity assets such as narrow endemics or very fire-sensitive species/communities).
- providing supplementary food/water for threatened fauna or at-risk wildlife.
- extracting priority threatened species from habitat at risk of burning.

Phase 1 - Immediate and short-term actions (up to 1 year)

A number of risks require immediate action otherwise the opportunity to manage the risk will be lost. Some of these actions will require ground access, while others may be most effective if permission for air access prior to ground access is possible (e.g. it is critical to control cats quickly since they are known to travel long distances (25 km) and rapidly inhabit areas post-fire to prey on remaining native animals).

Coincidentally, the post-fire landscape provides a unique management opportunity to cost-effectively do this - short-term lack of vegetative cover and restricted public land access during the initial phase of recovery will enable aerial control of pest species. There are broader-scale risks that require timely actions otherwise the opportunity to manage the risk will be lost. For example, herbivore control in the burnt and adjacent areas is required because any remaining plants are more exposed to browsing, and seedling and re-sprouting plants are more vulnerable to damage.

There are some risks that do not need immediate action so there is an opportunity to plan more thoroughly on the basis of information collected in the first-year post-fire. This could include reconsidering the mix and priority of conservation actions more broadly across the state. For example, increased protection and/or management of other areas of habitat that have become more strategically important for key species as a result of the fires. Prioritisation of species and locations across the state is currently underway, considering existing issues and impact of the bushfires, to determine which areas and species may need increased management. This prioritisation will occur in Phase 1, and actions may begin now and continue into Phase 2 and 3. This may include creation of safer havens in key priority areas and direct management of species, potentially involving wild-to-wild translocation and genetic management.

Other actions include:

- on-ground assessment of the status of critical species to improve targeting of management actions
- continue to provide supplementary food/water, or artificial habitat
- extraction and temporary housing for priority threatened species prior to further deaths or environmental degradation (e.g. debris flows)
- surveillance and management weed infestations arising from the release of soil-stored seed

Phase 2 - Medium-term actions (1 – 3 years)

There is an important opportunity to review and build on the strengths of existing projects, and also to expand our thinking to trial novel management options. This phase will include implementation of priority conservation actions for increased protection and/or management of other areas of habitat or populations that have become more strategically important for key species as a result of the fires. This may include genetic management, wild to wild translocations to establish new populations, creation of safer havens etc.

Phase 3 - Longer-term actions (beyond 3 years)

As well as sustaining implementation of relevant short and medium-term actions, there are additional actions that will become necessary in the longer term. For example, restoring animals into previously burnt areas,

1. Refuges are places that promote species survival during times of stress. Refuges may reflect urgent and specific circumstances for protecting individual plants and animals, such as minimising further impact on residual or unburnt vegetation within or adjacent to the fire ground (immediate refuges). Refuges can also reflect longer-term and landscape-scale ecological circumstances for protecting and actively managing important populations across the range of each species (ecological refuges). Identifying ecological refuges requires consideration of protective topographic or environmental features (including surrounding land use), risk-spreading for future disturbance events, and shifting species distributions and dynamic interactions.

and implementing measures to reduce the occurrence and/or impact of future high severity fires in significant locations.

A summary of the potential response actions across time frames is shown in Table 17.

Table 17: Summary of potential response actions across time frames

Hazard	Actions	Phase 1 Immediate & short-term response	Phase 2 Medium term	Phase 3 Long term
Immediate impact of fire on survival of critical species	Emergency extraction of critical flora and terrestrial fauna and temporary housing for ongoing conservation			
	Provide strategic advice on managing risks of biodiversity impacts from on-going fire suppression activities			
	Improve biodiversity risk management during preparedness & suppression for next fire season, including better integration of local & state-wide spatial information and more suitable spatial outputs for rapid application			
Loss of food source	Supplementary feeding of critical fauna populations			
Immediate impact of debris flow following fire on survival of critical species	Provide off-stream temporary ponds for amphibians			
	Monitor water quality			
	Emergency extraction of critical aquatic species and temporary housing for ongoing conservation			
Loss of critical habitat features	Identify and design protections for key unburnt areas and populations within the current fire extent			
	Reconnaissance of critical fauna and flora species to inform status and management following fire			
	Traditional Owner reading country and reconnaissance of species of cultural significance (intangible heritage) to inform status and management following fire			
Increased predation pressure/ effectiveness	Intensified and sustained pest predator control within the current fire extent and adjacent areas			
Increased competition and grazing pressure from pest herbivores	Intensified and sustained pest herbivore (e.g. deer, pig, horse) control within the current fire extent and adjacent areas			
	Fence local populations for protection from pest herbivore species			
Multiple bushfires within 20 years	Collection of seed and ex situ seed banking for key species			
	Reseeding of flora and vegetation communities in key locations			
Increased competition from invasive plants	Intensified and sustained weed control within the current fire extent and adjacent areas			
Impacts on Traditional Owner ability to connect and heal Country	Healing Country by Traditional Owners through Traditional Knowledge			
Small population size effects (inbreeding depression, vulnerability to localised disturbances)	Population management – wild to wild translocation of critical fauna populations, sanctuaries, captive breeding to support population growth in priority wild populations			
Disease	Hygiene control in emergency response actions			
	Protection of key areas without disease			

Hazard	Actions	Phase 1 Immediate & short-term response	Phase 2 Medium term	Phase 3 Long term
Change in importance of other populations	Protect and manage key populations of species outside the current fire extent			
	Translocation of critical fauna populations			
	Initial identification of ecological refuges and climate change considerations			
	Creation of safer haven/ sanctuary network			
Poorly chosen actions leading to lower outcomes for biodiversity	Strategic approach to learning about the fire impacts and benefits of on-ground response for targeted species and/or threats (including Assessment of biodiversity response effectiveness monitoring options and targeted research to improve the most influential and uncertain actions (Biodiversity 2037 Knowledge Framework)			

Emergency actions implemented while fires were still active

There has been a range of emergency response actions that were completed under the emergency response to the 2019/2020 bushfires. These actions were implemented through the Victorian emergency management framework, overseen by the Level 2 State Controller – Wildlife. Some actions will be continued through the Bushfire Biodiversity Response and Recovery (BBRR) program.

The emergency response actions conducted during the 2019/2020 bushfires include:

- Appointment of the Level 2 State Controller - Wildlife
- Identification of important areas for biodiversity outside the current fire extent, but at risk of being burnt as the fire season continued. These were considered at a strategic level for immediate protection from being fire and suppression activities (e.g. mechanical fuel breaks; Figure 17).
- Intensive fire suppression efforts in at Howe Flat to protect important biodiversity values and habitat and initiated strategic use of retardant to protect biodiversity values such as adjacent to Mountain Pygmy-possum habitat
- Emergency supplementary feeding for wildlife welfare in key locations
- Emergency extraction of the Eastern Bristlebird. The only Victorian population of this high priority threatened species was at immediate risk of fires
- Commencement of aerial control of invasive herbivores (e.g. deer, goats, cattle) and predators (e.g. foxes, cats)
- Aerial reconnaissance flights with biodiversity experts for initial impact assessments
- Mapping of fire severity across the fire ground using remote sensing data

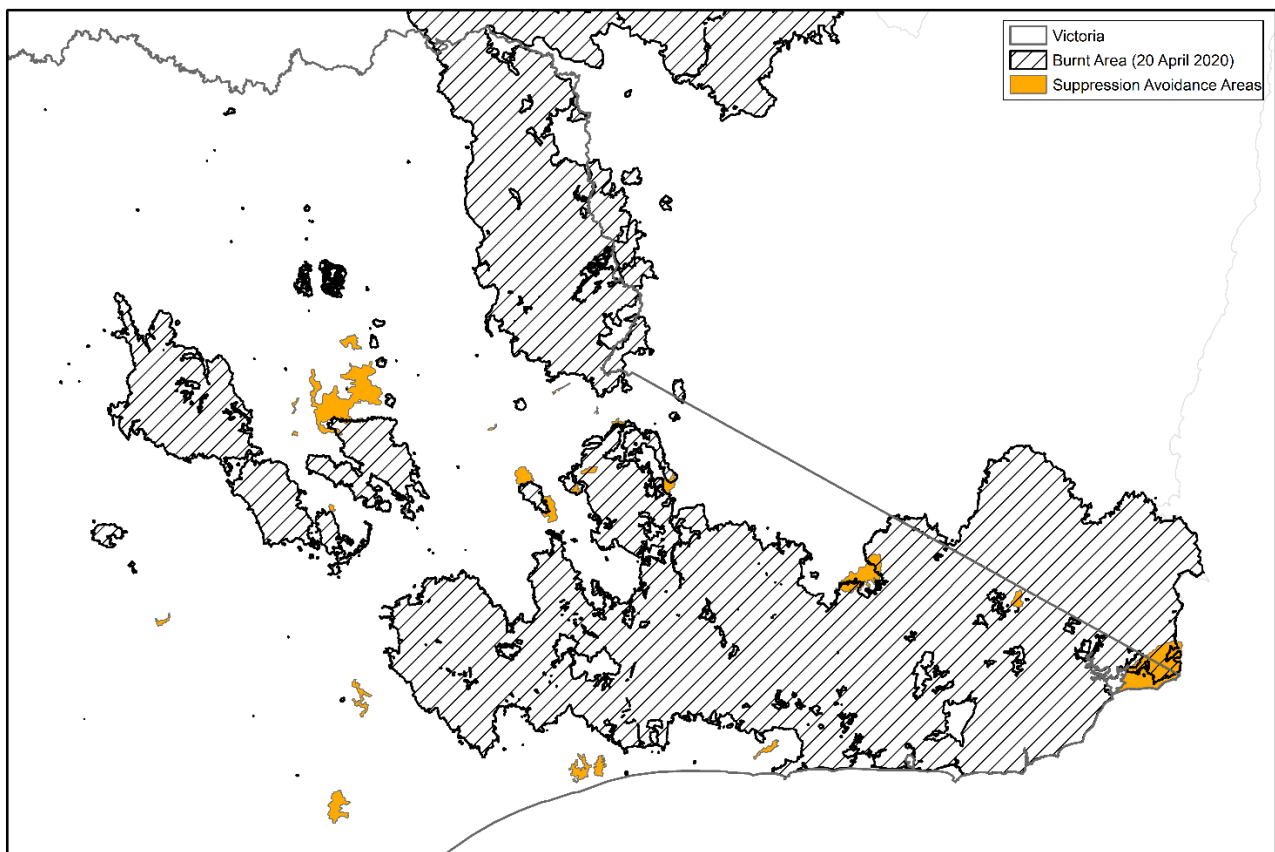


Figure 17: Initial key unburnt areas of high biodiversity value for immediate protection

Priority response actions for immediate and short-term implementation

Coinciding with Version 1 of the report, the Victorian Government is taking immediate action to support Victoria's bushfire impacted wildlife and biodiversity with a \$17.5 million funding package under the Bushfire Biodiversity Response and Recovery (BBRR) program.

The BBRR program is delivering across seven key themes. Further information about the delivery of actions is provided below.

- Immediate reconnaissance of critical fauna, flora, habitat and reading Country assessments (species and landscapes of cultural value) to inform future actions, and immediate targeted actions
- Wildlife welfare (not part of this report)
- Emergency extraction to prevent extinction and limit species decline
- Intensified and sustained management of threats (i.e. invasive species control)
- Maximising long-term resistance of biodiversity across the landscape including actions to heal Country using Traditional Knowledge
- Knowledge, data and preparedness
- Community-led nature recovery

Co-ordination is important for effective implementation of response actions, to streamline processes, encourage complimentary activities and avoid duplication. This will require critical information and knowledge exchange between the delivery agencies, investors, Regional Natural Environment Recovery sub-committees and Bushfire Recovery Victoria.

Complementary investment governments from all levels, non-government organisations and the broader community including volunteers is encouraged to support and expand these response and recovery actions both in the short-term and subsequent phases.

Immediate reconnaissance of critical species to inform status following fire

A selection of species of immediate concern were identified as requiring immediate reconnaissance of the status of key populations post-fire and inform management actions. This is particularly focused on species that have had all known populations have been impacted by the current fires and their current status is unknown (e.g. *Lastreopsis decomposita*), or species that have had key populations within the current fire extent (e.g. Long-footed Potoroo, Greater Glider (Figure 18), Glossy Black Cockatoo), but the actual impacts are unknown. In addition, fire sensitive vegetation communities such as rainforest forest will require immediate reconnaissance to determine their status and what actions may be feasible post-fire (e.g. regeneration activities).

The immediate reconnaissance approach includes:

- Site selection supported by distribution of species, fire severity and zonation analysis, combined with expert knowledge
- use of standard survey methods & approaches should be applied in a consistent way so that measures of abundance post-fire can be compared with existing data to assess impact.
- identification of complementarity and co-design opportunities with existing assessment programs such as Weeds and Pests on Public Land, State of the Forests monitoring, Ark & Eden projects, environmental non-government organisations, etc
- identification of complementarity of taxa for which similar methods can be used e.g. small mammals & remote cameras
- implementation of field reconnaissance (ground and where appropriate aerial), subject to relevant safety procedures and record data on:
 - current status of species/community (occurrence, relative abundance)
 - impact of fires on target species/community
 - status of key environmental attributes for the taxa, including distribution and magnitude of likely risks.

Reconnaissance activities completed or currently underway include:

- **Aquatic** surveys & risk assessment including threatened Galaxiids, blackfish, spiny and burrowing crays, mussels
- **Threatened reptiles and frogs** including alpine skinks, Spotted Tree Frog, Giant Burrowing Frog, Booroolong Frog and Large Brown Tree Frog. Phase 1 surveys and assessments have been completed. Assessments will be completed for locations for off-stream temporary ponds for Large Brown Tree Frog
- **Arboreal mammals and large forest owls** assessment including Southern Greater Glider, Yellow-bellied Glider, Masked Owl and Sooty Owl. Survey areas have been identified.
- **Cave-breeding Bats** assessment including karst / cave sites Nowa Nowa, Eastern Horseshoe Bat, Common Bent-wing Bat (Eastern subspecies)
- Field assessments complete for **Glossy Black-Cockatoo**. A highlight was that a number of individuals were found feeding on alternative species of Sheoak for the first time recorded
- Planned **Eastern Ground Parrot** surveys
- Planned **Spot-tailed Quoll** surveys in Alpine National Park, Snowy River National Park and the Upper Snowy River area
- Survey areas identified for **Long-footed Potoroo** and **Broad-toothed Rat** assessments
- Creating artificial habitat for **hollow using birds and mammals** in East Gippsland. Deployment of nest boxes is being carried out in partnership with Gunaikurnai Land and Waters Aboriginal Corporation
- Collation of data to support future **invertebrate** reconnaissance. A trait database has been developed for 150 priority species

- **Threatened flora, rainforest and bog community** assessments for Warm Temperate Rainforest, Littoral Rainforest, Cool Temperate Rainforest, alpine peatlands, key flora species
- Weed reconnaissance and strategic sampling to support ecological priorities

Initial survey results are provided in Tables 8 and 10. Further reconnaissance to understand the impacts of the bushfires is planned for Spring 2020, building on these surveys. It will target species which require spring or summer surveys and have a focus on reconnaissance for invertebrates and plants.

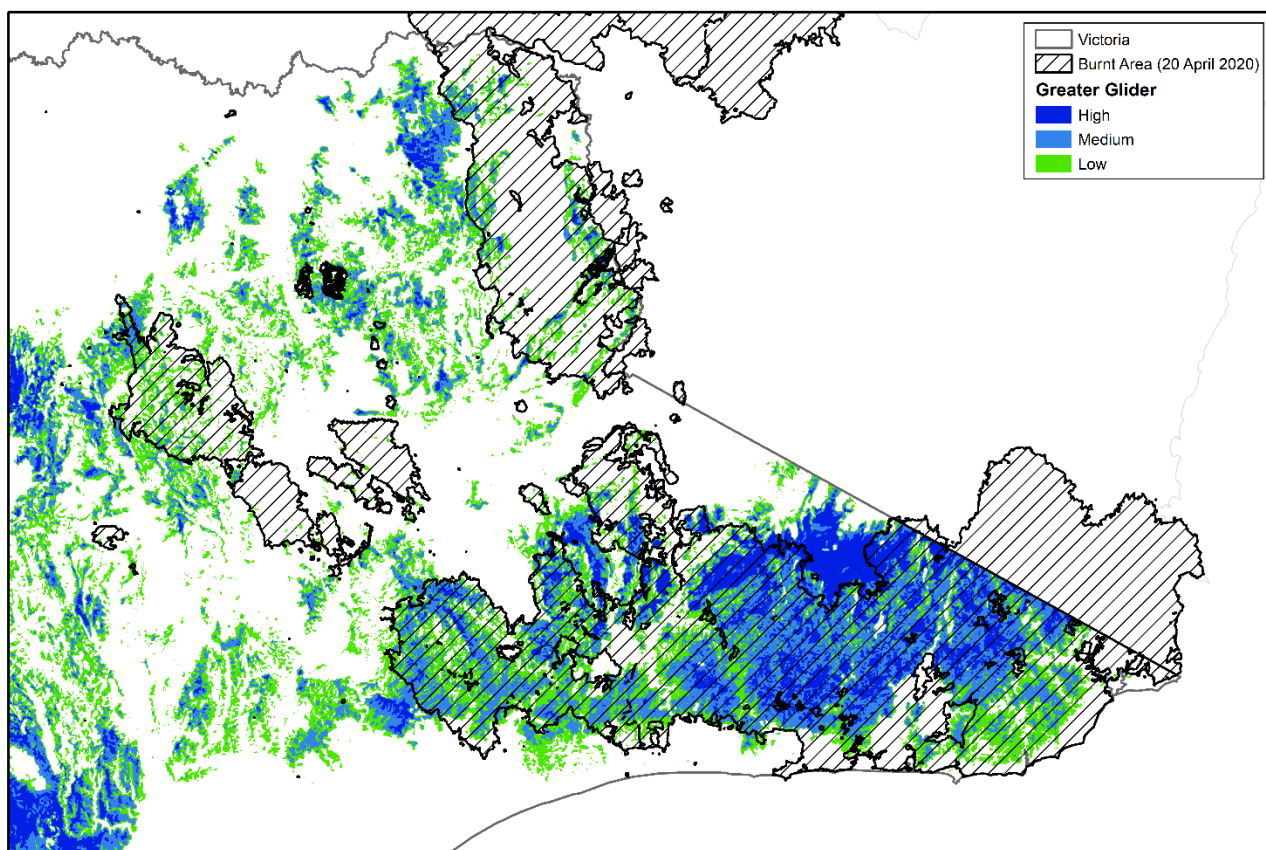


Figure 18: Modelled habitat distribution for Greater Glider in eastern Victoria. Darker colours indicate areas of relatively higher habitat suitability compared to lighter colours. This model will help guide on-ground survey and assessment to understand post-fire recovery of the species.

Reconnaissance case study: Long-footed Potoroos

For five weeks across April and May the Southern Ark team had cameras out at 82 sites where Long-footed Potoroos were detected just before the fires (in October-November 2019), 75 of which had been burnt during this summer's fires, with the other seven sites remaining unburnt.

Long-footed Potoroos were detected at 47 of the 82 sites, or around 57% of the sites that they were detected at pre-fire. They were detected at the seven sites that didn't get burnt, and 40 of the 75 sites that had been burnt by the bushfires. Equally as important, they were detected right across their known distribution in Far East Gippsland, which should make it easier for the species to re-populate the forest as it recovers, and the potoroo numbers increase.

Some cameras photographed multiple potoroos, and there was evidence of on-going breeding, with images of female potoroos with large pouch young. Potoroos only eat the sporocarps (truffles) of native underground fungi, which tend to survive fires well, so there was no shortage of food for potoroos immediately after the fire.

The cameras also recorded the presence of a range of other mammal and bird species. Mountain and Common Brushtail Possums were surprisingly detected at 82% of sites post-fire; Superb Lyrebirds were detected at 42% of the sites. Common Wombats and Swamp Wallabies were seen at around 47% of the cameras. Long-nosed Bandicoots, Lace Monitors, Bush Rats, Antechinus and Ringtail Possums also popped up from time to time.

Reconnaissance case study: Brush-tailed Rock-wallaby

There are a number of small, fire-impacted areas known to be occupied by Brush-tailed Rock-wallabies in Little River Gorge in the Snowy River National Park. The fires have opened up bush adjacent to the occupied areas, which has likely facilitated movement of predators, especially foxes. Camera monitoring of the population in autumn did not detect nine animals that previously detected at the 'West Gully' site. It is likely that predation was the cause for some of these missing animals. However, even with this loss the overall population has grown from 49 to 52 animals. Funds are supporting intensification of predator control through predator baiting and ground shooting operations to further reduce threats to this species.

Emergency extraction and temporary housing of critical flora and fauna species

Some species of immediate concern are particularly vulnerable to severe fire and the post-fire landscape, to the point where short-term survival of populations is highly uncertain. Mostly, this applies to species with small population sizes and restricted distributions (Figure 19). Therefore, immediate extraction or translocation of individuals out of the burnt area or potentially burnt area may be required to ensure the persistence of species in Victoria. This will also involve short-term holding of insurance populations for re-release once habitat has recovered or translocation out of burnt areas into unburnt areas of suitable habitat. These actions will be informed by models of the known distributions of species and expert advice on where key populations remain.

Native freshwater fish such as Victoria's highly range-restricted galaxiid species, are highly sensitive to the impact fires can have on immediate reductions of dissolved oxygen and water quality in streams due to debris flow moving down waterways after rain events. This has resulted in fish death events in some areas for example in the Cudgewa and Corryong Creeks and Tambo River.

Due to the highly restricted distribution of some species, and because fire has impacted the entire range of some species (e.g. East Gippsland Galaxias) there was a real and immediate risk that post-fire debris flow will lead to extinction. Temporary extraction of individuals into aquaria is therefore required to ensure the survival of some species. This process was achieved successfully following the 2009 Black Saturday fires and is a proven viable action.

Similar actions may be required for a range of critical flora and terrestrial fauna species that have had large proportions of their distribution impacted. Initially analysis suggested there may be a number of candidate fauna species that would benefit from this action, however further feasibility assessment and understanding of the fire impact has resulted in extraction of one bird species. Reconnaissance over the following months will inform the need for this action.

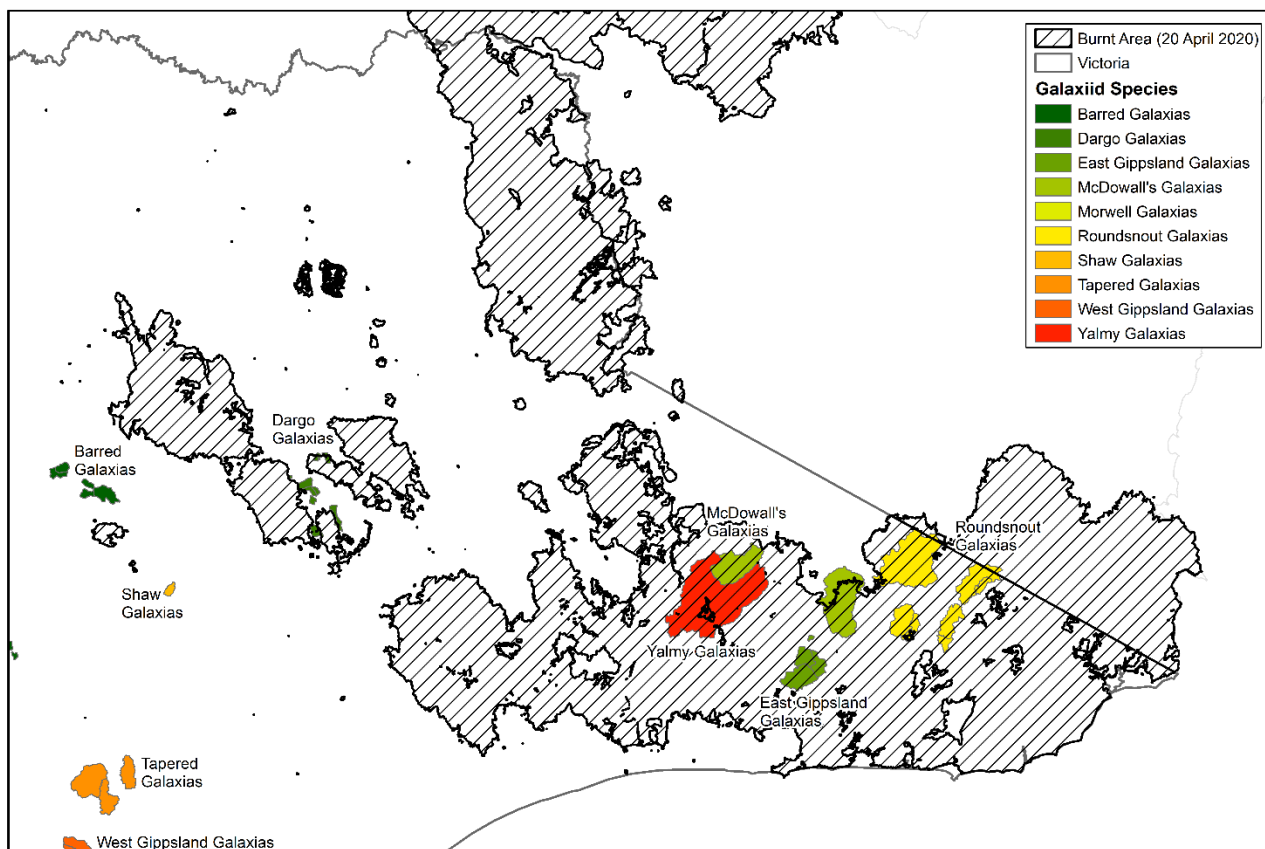


Figure 19: Likely habitat extent for endemic freshwater galaxiid species across Eastern Victoria. Each polygon shows the habitat extent of a different galaxiid species. Key galaxiid species within the burn extent that required immediate extraction include the Yalmy Galaxias, East Gippsland Galaxias, Roundsnout Galaxias and McDowall's Galaxias.

Seventeen fauna species were extracted from the fire area and are currently being held in temporary housing until it is possible to return them to the wild (Table 18).

Table 18: List of fauna species extracted from fire area to date

Species	Number of Individuals extracted	Estimated return
Cann Galaxias	25	Spring
Dargo Galaxias	200	Spring
East Gippsland Galaxias	100	Spring
Gippsland Blackfish	11	Spring
Macquarie Perch	15	Return in June
McDowall's Galaxias	100	Spring
Yalmy Galaxias	7	Spring
Arte Spiny Crayfish	3	Spring
East Gippsland Spiny Crayfish	40	Spring
Orbost Spiny Crayfish	30	Spring
Variable Spiny Crayfish	15	Spring
Depressed Freshwater Mussels	75	Spring
Glenelg Freshwater Mussels	30	Spring
Murray Cod	12	Immediate translocation 20km upstream (Ovens River) of potential source of debris

Species	Number of Individuals extracted	Estimated return
		flow
Australian Bass	5	Immediate translocation from Brodbribb River to Snowy River due to debris flow
Eastern Bristlebird	15	Returned in early April

Twelve flora species have been extracted (via collections of seeds and/or cuttings; Table 19). Detail on the amount and viability of seed is being determined. There are also plans to extract an additional 36 flora species from unburnt areas adjacent to the fire once current conditions allow safe access. These include six species which were not listed in the flora species of concern due to minimal impact from the fire according to the analysis but have still been prioritised for extraction due to small population size and limited seed currently in storage. They are: *Acacia boormanii* subsp. *gibba*, *Acacia linearifolia*, *Craspedia* sp. 1, *Grevillea callichlaena*, *Parsonsia eucalyptophylla* and *Tasmannia xerophylla* subsp. *Xerophila*

Table 19: List of flora species where seed or cutting have been extracted from fire area or adjacent to the fire area to date

Species
<i>Acacia ureniae</i>
<i>Picris angustifolia</i> subsp. <i>merxmuelleri</i>
<i>Aciphylla glacialis</i>
<i>Wahlenbergia gloriosa</i>
<i>Craspedia</i> sp. 1
<i>Carex jackiana</i>
<i>Tasmannia xerophylla</i> subsp. <i>xerophylla</i>
<i>Leptostigma breviflorum</i>
<i>Deyeuxia frigida</i>
<i>Deyeuxia crassiuscula</i>
<i>Eucalyptus delegatensis</i>
<i>Eucalyptus perriniana</i>

Intensified and sustained pest predator and herbivore control

Invasive predators such as the red fox and feral cat are capable of exploiting burnt habitat as it provides favourable hunting conditions due to the removal of vegetation cover that prey would normally hide in. A large number of fauna species that have been impacted by the fire (e.g. Long-footed Potoroo, Brush-tailed Rock Wallaby, Long-nosed Potoroo) will be at a greater risk of succumbing to predation by foxes and cats as a result. To address this, intensive predator control is required to reduce the heightened predation risk in the burnt area and adjacent unburnt refuges immediately post-fire as this is when prey are most vulnerable.

The DELWP decision support tool Strategic Management Prospects provides an initial overview of the likely areas where intensive pest predator control will provide the greatest return on investment by benefiting the full range of species that may be vulnerable to predation (Figure 20), and also shows that predator control has increased in priority within the burned area as a result of the fires (Figure 21). In addition, intensive predator control will be required at key local populations for species of immediate concern due to existing small population sizes (e.g. Brush-tailed Rock Wallaby, Eastern Bristlebird).

Threat management case study: Southern Ark — a landscape-scale fox control program in the East Gippsland burn extent — has been running for over a decade using regular ground baiting. Work has commenced to re-establish this program in the burn extent and around key refuges, and intensive fox baiting expanded into new areas also burnt this season. Three additional fixed term staff have been employed to support baiting programs and camera monitoring re-establishment. Over 80% of approximately 3,500 stations have been rebuilt and are currently providing effective fox control. Camera monitoring has highlighted the resilience of Long-footed Potoroo and the importance of landscape-scale predator control.

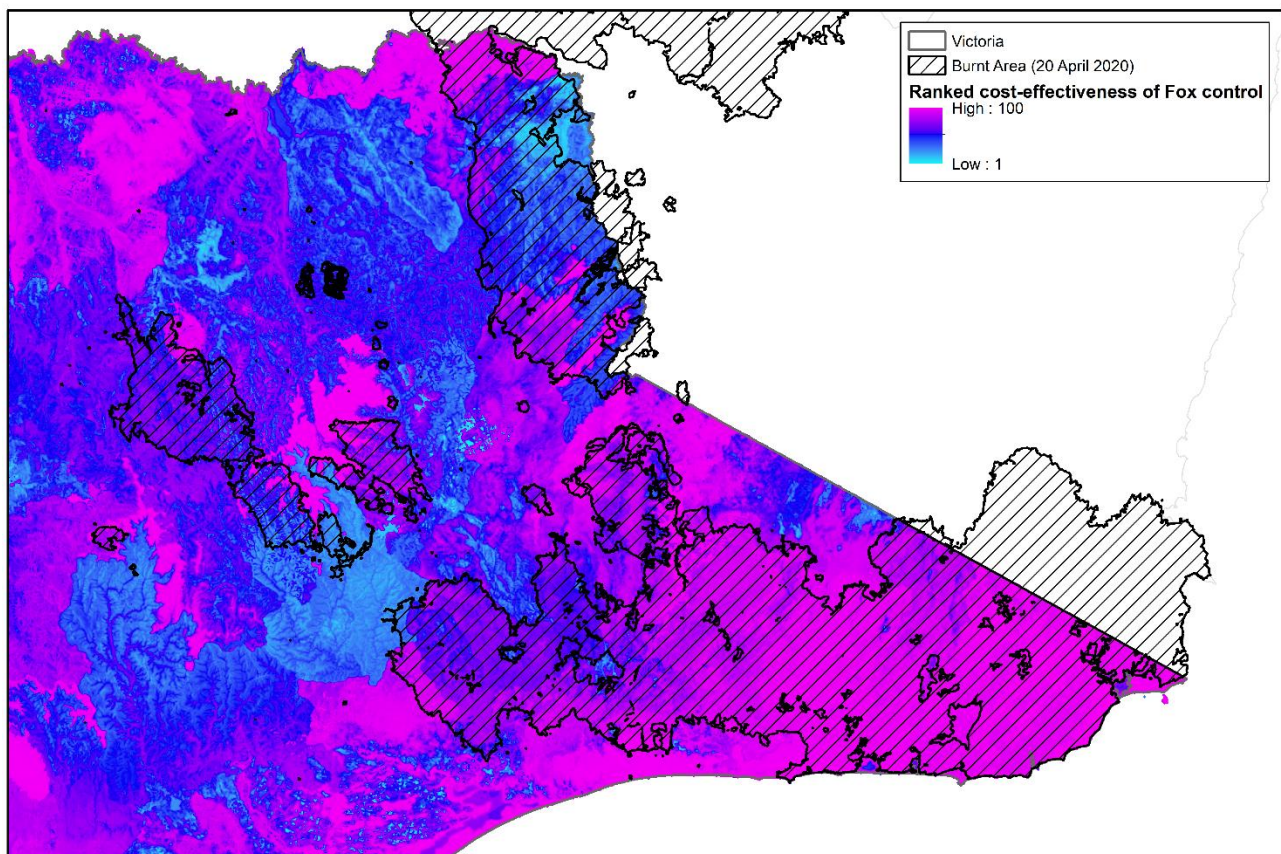


Figure 20: Indicative ranking of areas for implementing fox control according to relative cost-effectiveness. High values (100) indicate areas where fox control has a relatively higher return on investment compared with low values (0). Map output taken from Strategic Management Prospects v2.0 exposure draft.

Large invasive herbivores such as deer, goats, pigs and horses are key threats across the burnt area and adjacent areas. Their effects are intensified in the post-fire landscape as they selectively eat new, recovering plant growth. Normally, controlling these invasive species is difficult throughout this region as the most effective method (aerial shooting) is ineffective in forest landscapes. The burnt area therefore presents a new and time-limited opportunity to implement landscape-scale control for these species in areas where control was previously not possible. The DELWP decision support tool SMP provides an initial overview of the likely areas where intensive pest herbivore control will provide the greatest return on investment by benefiting the full range of species that may be vulnerable to herbivory (e.g. Figure 21), and has shown that herbivore control has increased in priority within the burned area as a result of the fires (Figure 22).

Intensive and sustained herbivore control within the burnt area and adjacent unburnt refugia has been identified as a key action for immediate implementation that would benefit fauna of concern species, as well as important vegetation communities such as rainforest and alpine bogs. Through the workshops, experts identified this action as key to the post-fire recovery for a range of species of immediate concern.

Threat management case study: Aerial shooting operations as part of the emergency response

Aerial shooting operations commenced on Monday 10 February 2020 and concluded on Friday 8 May 2020 after 11 weeks as part of the emergency response to the 2019-20 bushfires.

The aim of the aerial shooting operation was to reduce the impact of introduced animals - deer, feral goats, feral pigs, feral cattle, foxes and feral cats – on native species and habitat in priority fire-affected and adjacent public land in the North East and East Gippsland regions of Victoria (Figure 21). Feral horses were not a target species. Controlling introduced pest animals as soon as possible after fire is an important immediate action to ensure the survival of threatened native flora and fauna and their habitats at a time when they are most vulnerable.

Introduced large herbivores, such as deer and feral goats, reduce the ability of native plants to regrow after fire, spread weeds, compete with native animals for food and significantly damage native vegetation and critical habitat by grazing, trampling on vegetation, rubbing against trees and wallowing. Burnt landscapes provide less shelter for native animals, leaving them exposed and vulnerable to predation by foxes and feral cats, whose numbers have been shown to increase by five times the normal amount in fire-affected areas.

Aerial shooting was undertaken in areas of national park and state forest that were closed to the public due to the fires, namely:

- Mount Buffalo National Park
- Alpine National Park
- Snowy River National Park and Corridor
- Croajingolong National Park
- Coopracambra National Park
- Errinundra National Park
- Brodribb River Corridor
- Murrangowar State Forest
- Combienbar State Forest
- Burrowa-Pine Mountain National Park
- Mount Mittamatite Regional Park
- Wabba Wilderness Park
- Nunniong Plateau

A total of 260,000 hectares of high priority habitat were managed under the aerial shooting operation, which delivered 150 hours of shooting over 42 days of operation. Over 1500 target animals were controlled, including over 1400 Sambar deer. Foxes, Fallow deer, feral pigs, feral goats and feral cattle were also controlled in smaller numbers. The operation achieved a high level of efficiency, with 90% of target animals observed cleared from the treated areas, noting that animals were unable to be dispatched in or near water courses, walking tracks or roads, or in densely vegetated areas.

Introduced animal control will continue through the Bushfire Biodiversity Response and Recovery (BBRR) program. Introduced animal and weed control activities will be delivered in fire-affected areas of Victoria up to twelve months after the fires, by a range of organisations, including DELWP, Parks Victoria, Trust for Nature and the East Gippsland Catchment Management Authority. These activities will build on the immediate relief provided through the emergency response operation to help to ensure the ongoing survival and recovery of native plants and animals after the fires.

All objectives of the aerial shooting operation were successfully met, including the highest standards of safety and animal welfare, and reducing the post-fire impact of introduced pest animals on the survival and recovery of native species and habitat.

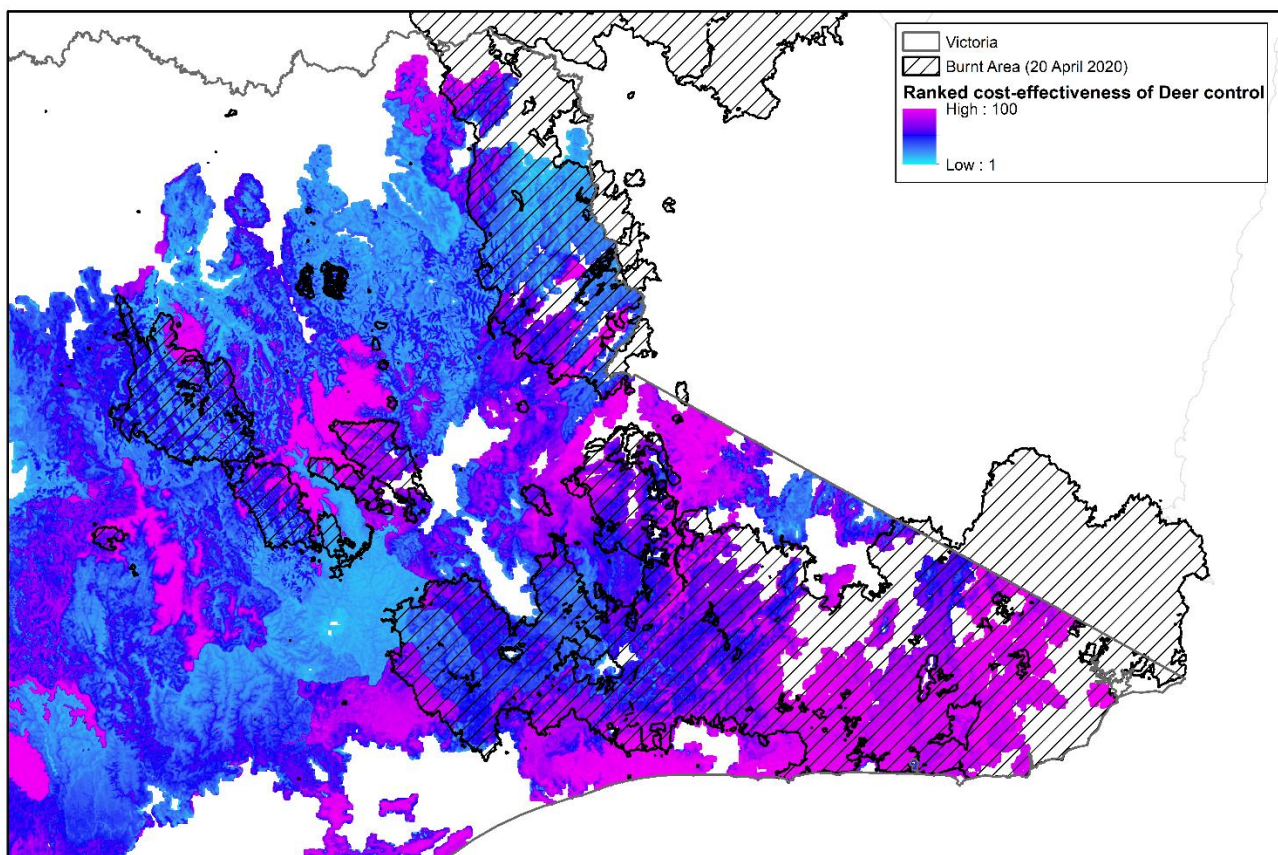


Figure 21: Indicative ranking of areas for implementing deer control according to relative cost-effectiveness. High values (100) indicate areas where deer control has a relatively higher return on investment compared with low values (0). Map output taken from Strategic Management Prospects v2.0 exposure draft.

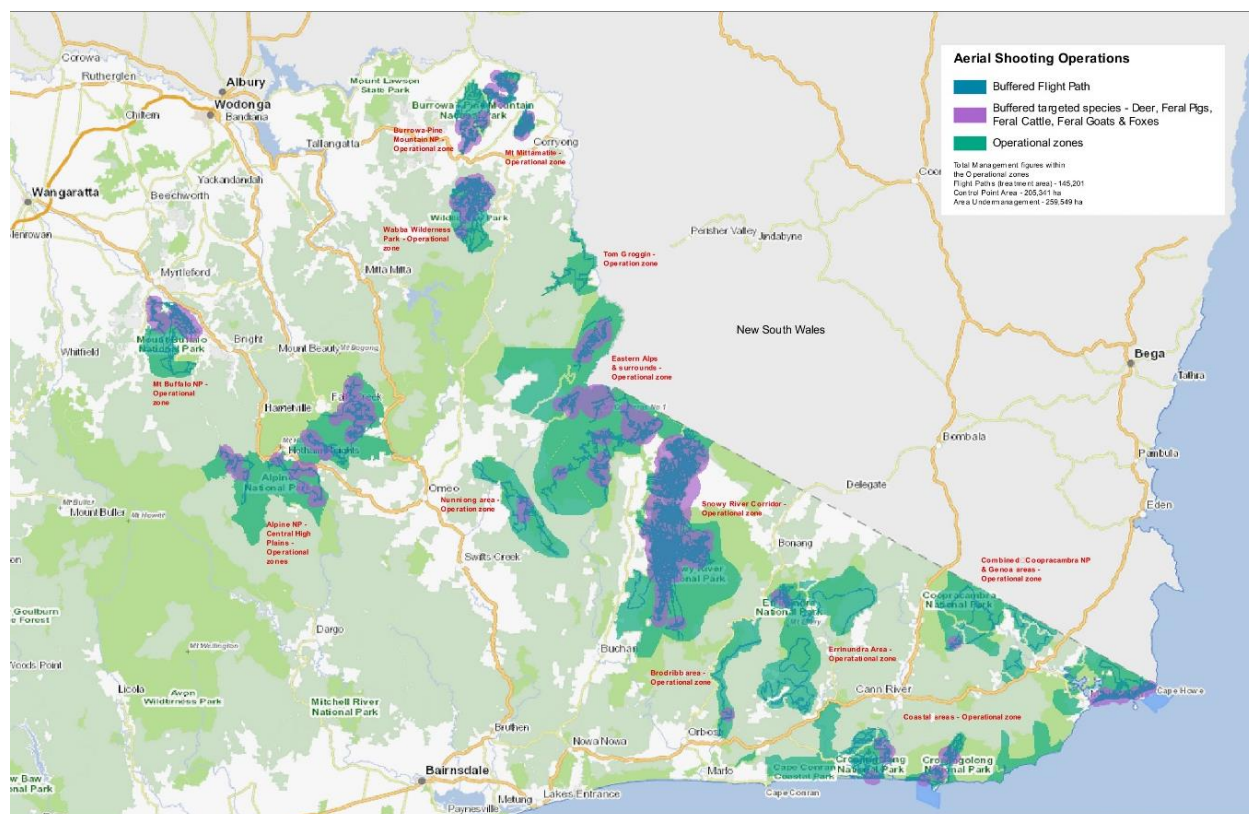


Figure 22: Emergency Response Aerial Shooting Operations map showing operational zones, buffered flight paths and targeted species for operations between February 10 and May 8, 2020.

Maximising resilience across the landscape

Protecting Victoria's Environment – Biodiversity 2037 outlines Victoria's plan to achieve overall biodiversity improvement over the next 20 years. Within this, the plan recognises the importance of being strategic when planning conservation objectives and recognises that there is a trade-off between multiple and single species actions. Under the game changing influence of climate change new types of interventions and projects that maintain a single species focus will still be needed, particularly for endangered and critically endangered species. These single species management actions will need to be balanced against landscape-scale multi-species approaches, to maximise the benefit to the most species.

The bushfire creates an episodic threat to a species, population(s) or individuals. These species and populations were already being impacted by a range of ongoing threats. There may also be ongoing or planned actions for these species.

In this context, it is important to build the long-term resilience (i.e. ability to recover) of species and ecological communities of greatest concern both within and beyond the fire areas. This differs from the immediate actions within the current fire extent in that it relates to the long-term, state-wide recovery of species and populations, with a vision of ensuring that populations are healthy and thriving well into the future.

To ensure resilience across the landscape it is also critical to enhance Traditional Owner Connection to Country and improve health of Country. This will include assessments and actions as determined by Traditional Owners to meet these aims, including actions to heal country and reading country assessments.

Building resilience will include protection and management of key populations of species at locations within and beyond the fire areas. Many of these populations have become significantly more important to the overall conservation of their species considering the impact of the fires on other key populations. This approach aims to ensure actions are undertaken across a species' entire range, to manage ongoing threats as well as threats from current and future disturbances in a way that builds long term resilience.

There are a number of high-level considerations for decision-makers and species managers when managing populations post-bushfire. This is particularly important for actions which may require more intensive management, including moving populations to new areas and mixing different populations to create genetic diversity, in order to build long-term resilience. These include:

- Where possible populations should be conserved *in situ*, or *ex situ* natural safer haven areas of suitable habitat. Ex situ captive conservation may occur where needed to prevent species extinction within the context of returning species to the wild
- Interventions should be as minimally intensive as possible to still meet the conservation objective
- Interventions should be designed to consider long term implications for the conservation of the species and to practice appropriate population management principles (including capturing or enhancing genetic diversity to minimise effects on adaptive resilience)
- Management of species should be coordinated (where appropriate) across species ranges and jurisdictions

Prioritisation processes are underway to rank the importance and urgency of species and projects for action. It will also include identification of important populations of highly ranked species, including those in areas outside the fire extent, which will require ongoing management and protection. Prioritisation of the cost-effectiveness of actions will continue to ensure actions have the greatest benefit to the most species.

Activities include:

- Healing Country and people through reading Country and enabling Traditional Owners to apply their ecological knowledge, focusing on culturally significant species and sites
- Management of key populations in priority locations across the species range
- In accordance with species conservation objectives, supplementing natural breeding regimes including through *in situ* and *ex situ* management such as wild to wild translocation to build critical mass and genetically robust gene pools of key species at the state-wide scale, seed-banking and captive breeding or plant nurseries where appropriate to support wild populations.
- Feasibility assessments and creation of a safe haven network of ecological refuges across the state
- Applying a cultural landscape lens to species renewal and resilience

Actions currently underway include:

- Reading and healing Country projects delivered by 8 Traditional Owner groups impacted by the fires
- Genetic testing to support identification and prioritisation of species based on a Genetic Risk Index and species risk analyses. These species include Spotted Tree Frog, New Holland Mouse, Smoky Mouse, Broad-toothed Rat and several plant species.
- Genetic management of Southern Brown Bandicoot across its Victorian range. The Southern Brown Bandicoot has been identified as a candidate species to demonstrate spreading the risk from population failures through genetic mixing to improve the fitness of populations. A state-wide strategy to improve the genetic fitness of Southern Brown Bandicoot is underway.
- Feasibility, cultural and social assessments of Wilsons Promontory and French Island as a safer haven and a potent location for translocation of species to create new populations.
- Feasibility and cultural assessments of Gunditj Mara Country to create a safer haven for Eastern Quoll and other species.
- Assessing the response of Alpine Ash when there is no reseeded post bushfire. This will be used as a guide to increase resilience of Alpine Ash in areas impacted by multiple fires through reseeded with different provenance and species.

Knowledge, data management and preparedness

The increasing size, impact and frequency of fires is threatening the futures of many species, as well as the broader function of underlying ecosystems. In the face of climate change, DELWP, agencies and partner organisations need to change expectations and be able to respond faster to natural emergencies. This means that more diverse and dynamic biodiversity circumstances and management options need to be considered, and this information needs to be provided in timely and accessible ways for biodiversity conservation decision-makers and stakeholders.

This project will create new fit-for-purpose data and synthesise current knowledge that enables emergency fire managers to avoid and minimise impacts to species and habitats from our future emergency fire response and to identify priority emergency actions needed and those responsible for these in the event of future fire across different Victorian landscapes.

This project will also include monitoring and analysis of the effectiveness of actions and projects delivered as part of the other five themes.

Synthesis of current knowledge and further analysis will inform the most cost-effective recovery actions for biodiversity under future phases following the 2019/2020 fires. We also require analyses for the reform of policy and strategy to make sure that we can act with more certainty and clarity during future fires, through pre-fire identification and decisions for emergency response options.

There are a number of discrete but linked components relating to knowledge and data management:

- Design & prioritisation of species & population management actions
- Knowledge acquisition & targeted research on management effectiveness
- Monitoring of biodiversity response to post-fire management actions
- Continuous improvement of biodiversity information & tools for better preparedness & response for future fire emergencies
- Improved systems & delivery options for biodiversity data flow between DELWP & agencies/stakeholders
- Strategic emergency response and climate ready biodiversity policy reform
- Identification of ecological refuges that may enhance the resistance of local biodiversity to threats and where intensified and targeted threat management is required

Actions currently underway include:

- Assessment of the relative effectiveness of potential biodiversity response monitoring options (utilising a National Environmental Science Program (NESP) monitoring simulation tool) to identify which monitoring methods are the most cost-effective (power to detect vs cost). This work will identify which species will be the best candidates for longer term monitoring efforts through the broader Bushfire Biodiversity Recovery Program.
- An analysis to identify ecological refuges and Climate Change Adaptation gradients to characterise parts of landscapes for their relative ability to provide refuge to increase the likelihood of future persistence given the biophysical and disturbance regime consequences of climate change. The approach will be to combine CSIRO climate change modelling and other available fire modelling with existing spatial datasets on environmental features and species distributions, and data on species traits.
- A knowledge gap analysis through expert-based causal models of benefits and the consequences of uncertainty. Priority problem-response scenarios (describing biodiversity management scenarios that may benefit from knowledge acquisition) for each taxon group will be identified and biodiversity bushfire response partners invited and funded to lead each analysis with relevant experts. This work may also align with Specific Needs assessments. A manual and training will be provided to each lead. For each priority problem-response scenario, group leads will work with experts to develop a best and worst-case scenario model and identify the links with greatest uncertainty and interpret into key research questions for prioritisation across problem-response scenarios.
- Expert elicitation of expected benefits of point-based scenarios as inputs to spatial extrapolation to expand the database of point-based estimates of Change in Suitable Habitat (or local persistence) that is used to analyse the cost-effectiveness of management options (Strategic Management Prospects). The focus will be on post-fire responses with and without management of landscape-scale threats. It is intended to integrate this task with other projects that are likely to be collecting similar data, for example considering post-harvesting scenarios for alternative harvesting methods.
- Verification & refinement of existing Genetic Risk Index using existing data (including updated species genetic risk assessments for fire-affected species)
- Development of a dataset of important populations with an integrated polygon-based view of important populations/locations based on combination of: existing regional datasets, VBA & SMP outputs, disturbance history datasets; new information on ecological refugia/ Climate Change adaptation and population genetics importance
- Improvements to systems and data management including facilitation of public access to the biodiversity knowledge base used to inform fire emergency response & recovery

Appendix One – General species impact in current fire extent

Table 20. General species impacts within the current fire extent (spilt via broad taxon).

Taxon Type	Over 95%	80% to 95%	50% to 80%	30% to 50%	10% to 30%
Amphibians	0	2	5	6	11
EPBC	0	0	1	0	0
FFG	0	1	1	2	2
DELWP Advisory List	0	0	1	0	0
Birds	0	1	6	17	62
EPBC	0	0	0	0	1
FFG	0	0	4	2	4
DELWP Advisory List	0	0	0	0	2
Mammals	0	0	1	11	31
EPBC	0	0	1	0	3
FFG	0	0	1	6	6
DELWP Advisory List	0	0	0	3	2
Plants	13	93	118	242	926
EPBC	0	1	1	4	7
FFG	1	13	10	14	26
DELWP Advisory List	1	26	19	23	39
Reptiles	0	1	0	6	22
EPBC	0	0	0	0	0
FFG	0	1	0	0	3
DELWP Advisory List	0	0	0	0	2
Aquatic Fauna	Unknown	Unknown	Unknown	Unknown	Unknown
EPBC	Unknown	Unknown	Unknown	Unknown	Unknown
FFG	Unknown	Unknown	Unknown	Unknown	Unknown
DELWP Advisory List	Unknown	Unknown	Unknown	Unknown	Unknown
Total	13	97	130	282	1052

Appendix Two – General species impacted by high severity fire

Table 21. General species impacted by high severity fire (spilt via broad taxon).

Taxon Type	Over 95%	80% to 95%	50% to 80%	30% to 50%	10% to 30%
Amphibians	0	0	1	4	10
EPBC	0	0	0	1	0
FFG	0	0	0	2	3
DELWP Advisory List	0	0	1	2	7
Birds	0	0	1	2	35
EPBC	0	0	0	0	1
FFG	0	0	0	1	7
DELWP Advisory List	0	0	0	1	8
Mammals	0	0	0	1	26
EPBC	0	0	0	1	3
FFG	0	0	0	1	11
DELWP Advisory List	0	0	0	1	12
Plants	0	2	39	131	731
EPBC	0	0	1	1	8
FFG	0	1	5	15	30
DELWP Advisory List	0	2	39	126	283
Reptiles	0	0	0	1	14
EPBC	0	0	0	0	0
FFG	0	0	0	1	1
DELWP Advisory List	0	0	0	1	1
Aquatic Fauna	Unknown	Unknown	Unknown	Unknown	Unknown
EPBC	Unknown	Unknown	Unknown	Unknown	Unknown
FFG	Unknown	Unknown	Unknown	Unknown	Unknown
DELWP Advisory List	Unknown	Unknown	Unknown	Unknown	Unknown

Appendix Three – Seeking expert advice

Throughout the development of this report, DELWP has consulted conservation experts and land managers to receive advice and help inform different aspects of the analysis and response. This information was sought formally through three separate Bushfire Response Workshops (see below), as well as informally through contacting content experts to comment on aspects of the report. For instance, for species of concern we contacted taxon experts, DELWP Regional staff and other regional biodiversity experts from partner agencies (e.g. CFA, Parks Victoria and Zoos Victoria) to advise on the localised impacts on species.

We acknowledge the wide range of individuals and organisations that contributed to the information and development of this report, and although we cannot provide the names of individuals due to privacy concerns, the organisations are listed below. These organisations contributed substantially to the state's bushfire response.

Australian Government Bushfire Expert Panel	Gunaikurnai Land and Water Aboriginal Corporation
Australian Wildlife Conservancy	Gunditj Mirring Traditional Owner Aboriginal Corporation
Birdlife Australia	La Trobe University
Charles Darwin University	Monash University
Charles Sturt University	Museums Victoria
Conservation Ecology Centre	North East Catchment Management Authority
Country Fire Authority	Office of the Commissioner for Environmental Sustainability
Deakin University	Parks Victoria
DELWP Arthur Rylah Institute	RMIT University
DELWP Biodiversity Division	Royal Botanic Gardens Victoria
DELWP Forest Fire and Regions	Taungurung Land & Waters Council
DELWP Gippsland Region	The University of Melbourne
DELWP Hume Region	Trust for Nature
Department of the Agriculture, Water and Energy	VicForests
Department of the Environment and Energy	Victorian National Parks Association
Department of Planning, Industry and Environment	DELWP Water and Catchments
Dja Dja Wurrung Clans Aboriginal Corporation	Zoos Victoria
East Gippsland Catchment Management Authority	

First Biodiversity Bushfire Response Workshop – 10th January 2020

On the 10th January 2020 the First Biodiversity Bushfire Response Workshop was held. The Workshop brought together conservation experts and managers to develop high priority species, actions and conservation strategies required for the recovery of species and ecological communities following the 2019/2020 Victorian fire season.

Experts initially considered the current and predicted fire impact zone, as at 9am 10th January 2020. This expected impact area was then split into two broad regions:

- North East (comprising the Corryong and Alps fires)
- East Gippsland (comprising the Mallacoota, Buchan and Snowy River complex fires)

Using a structured expert elicitation approach, in groups based on taxonomic expertise (Arboreal Mammals, Other Mammals, Birds, Reptiles, Amphibians, Freshwater species, Rainforest flora, and other flora), experts were asked to:

- Identify the key plants, animals and vegetation communities that are of immediate concern
- Identify the actions and overall response strategies required to assist the identified species recover post-fire, and for each action:

- Estimate the likelihood each species would persist if no recovery actions were taken
- Estimate the likelihood each species or entity would persist if each recovery action was undertaken
- Estimate the social feasibility and the technical feasibility of each action

The key actions identified as necessary for immediate implementation were:

- Identification and protection of key unburnt refuges within the fire extent
- Intensive predator (fox and cat) control within the burnt area and adjacent refuges
- Intensive herbivore (deer, goats, pigs, horses) control within the burnt area and adjacent refuges
- On-ground assessment of key species and populations to guide short and medium-term post-fire action
- Emergency extraction and/or translocation from the burnt area or projected burnt area for key species

Representatives from 21 organisations participated in the workshop. There were a number of other organisations which were unable to attend at short notice some of which have sent through additional notes or information. The following organisations were in attendance:

Australian Wildlife Conservancy
 Birdlife
 Charles Darwin University
 Charles Sturt University
 Country Fire Authority
 Deakin University
 Department of Environment, Land, Water and Planning
 DELWP Arthur Rylah Institute
 Department of the Environment and Energy
 La Trobe University
 Melbourne University
 Monash University
 NSW Department of Planning, Industry and Environment
 Parks Victoria
 RMIT University
 Royal Botanic Gardens Victoria
 Taungurung Land & Waters Council
 The University of Melbourne
 Trust for Nature
 Victorian National Parks Association
 Zoos Victoria

Internal DELWP Workshop – 15th January 2020

As an extension of the first workshop, to allow greater participation with a wider range of DELWP staff, an internal workshop was held on the 15th of January 2020. Using a structured expert elicitation approach, staff were grouped based on taxonomic expertise (Mammals, Birds, Reptiles and Amphibians, Aquatic species, Rainforest flora, and Other flora) and asked to:

- Identify species, species groupings or ecological communities likely to be impacted by the current (15/01/2020) or potential fire extent
- Determine a key action list for the first 6 months based on initial discussion

- Elaborate on actions required to promote recovery of specific biota. This included specific species which would benefit, time post-fire and the duration of activity, level of effort required, trigger for stopping, location relative to fire, minimum effective treatment area and limitations for implementation

In addition to supporting the key actions identified in the first workshop, the workshop highlighted the feasibility of some of the actions particularly ability to get on-ground access and more information on the fire impact.

It was held at the Arthur Rylah Institute and attended by staff from:

DELWP Biodiversity Division
 DELWP Hume Region
 DELWP Gippsland Region
 DELWP Forest Fire and Regions
 Arthur Rylah Institute
 Water and Catchments

Second Biodiversity Bushfire Response workshop – 20 February 2020

The focus for this second workshop was to look beyond the 6-month emergency response focus of the first workshop. Reflecting on the increased prevalence of fires and climate change, participants were asked to discuss risk management and new ways of thinking to maximise biodiversity resilience in a climate of intensifying fire.

A facilitated discussion occurred on the response to date, particularly calling on the Traditional Owners in the room to give their thoughts. They highlighted the need for Traditional Owner groups to work together, to facilitate collaboration across groups to perform healing ceremony on other's Country.

Attendees asked to participate in an activity in which they were required to allocate "effort" to maximising long term resilience for given risk management scenarios. As per the previous workshops, attendees were broken up into their taxa of speciality (Mammals, Birds, Aquatic species, Plants, Reptiles and Amphibians). Responses were species specific, but generally geared towards spreading risk and investing in the protection of remnant populations not impacted by bushfires. Groups were generally averse to *ex situ* (captive) strategies, except in the case of breeding populations or seed for eventual re-introduction or planting in new or recovering burnt areas.

Participants were asked when they look back in 5 years, what they would have liked to change about our response to this fire event. Key responses were:

- Be better prepared earlier, know what the best cause of action is so it can be enacted immediately
- Harness community engagement and enthusiasm
- Tackle the harder things earlier: horse control

The future was described as one with a completely new fire management strategy, focused around the knowledge of Traditional Owners and the community. Traditional Owners are on their own journey and are keen to have others join them.

Over 70 representatives from 22 organisations outside of DELWP participated in the workshop. There were a number of other organisations which were unable to attend, however DELWP will continue to work collaboratively with them, along with other experts and stakeholders. The following organisations were in attendance:

Birdlife Australia
 Charles Darwin University
 Charles Sturt University
 Conservation Ecology Centre
 Country Fire Authority

Deakin University
Department of Environment, Land, Water and Planning (DELWP)
Department of the Agriculture, Water and Energy
Dja Dja Wurrung Clans Aboriginal Corporation
East Gippsland CMA
Gunaikurnai Land and Water Aboriginal Corporation
La Trobe University
Museums Victoria
North East Catchment Management Authority
NSW Department of Planning, Industry and Environment
Office of the Commissioner for Environmental Sustainability
Parks Victoria
Royal Botanic Gardens Victoria
Taungurung Land & Waters Council
The University of Melbourne
VicForests
Victorian National Parks Association
Zoos Victoria

Appendix Four – Fauna of concern currently held in captivity

Table 22: Fauna of most concern currently held in captivity

Common name	Scientific name	FFG Act Status	EPBC Act Status	Captive status
Amphibians				
Booroolong Tree Frog	<i>Litoria booroolongensis</i>	Listed	Endangered	Housed in captivity
Green and Golden Bell Frog	<i>Litoria aurea</i>	Rejected	Vulnerable	Breeding in captivity
Spotted Tree Frog	<i>Litoria spenceri</i>	Listed	Endangered	Housed in captivity
Aquatic fauna				
Arte Spiny Crayfish	<i>Euastacus</i> sp. 1			Extracted due to 2019/2020 fires and currently held in temporary housing
'Cann' Galaxias	<i>Galaxias</i> sp. 17			Extracted due to 2019/2020 fires and currently held in temporary housing
Cann Spiny Crayfish	<i>Euastacus</i> sp. 2			Extracted due to 2019/2020 fires and currently held in temporary housing
Dargo Galaxias	<i>Galaxias mungadhan</i>	Listed		Extracted due to 2019/2020 fires and currently held in temporary housing
Depressed Mussel	<i>Hyridella (Hyridella) depressa</i>			Extracted due to 2019/2020 fires and currently held in temporary housing
East Gippsland Galaxias	<i>Galaxias aequipinnis</i>	Listed		Extracted due to 2019/2020 fires and currently held in temporary housing
East Gippsland Spiny Crayfish	<i>Euastacus bidawalus</i>			Extracted due to 2019/2020 fires and currently held in temporary housing
Glenelg Freshwater Mussel	<i>Hyridella glenelgensis</i>	Listed	Critically Endangered	Extracted due to 2019/2020 fires and currently held in temporary housing
Macquarie Perch	<i>Macquaria australasica</i>	Listed	Endangered	Extracted due to 2019/2020 fires and currently held in temporary housing. Breeding in captivity.
McDowall's Galaxias	<i>Galaxias mcdowalli</i>	Listed		Extracted due to 2019/2020 fires and currently held in temporary housing
Orbost Spiny Crayfish	<i>Euastacus diversus</i>	Listed		Extracted due to 2019/2020 and currently held in temporary housing

Common name	Scientific name	FFG Act Status	EPBC Act Status	Captive status
River Blackfish	<i>Gadopsis marmoratus</i>			Extracted due to 2019/2020 fires and currently held in temporary housing
Variable Spiny Crayfish	<i>Euastacus yanga</i>			Extracted due to 2019/2020 fires and currently held in temporary housing
'Yalmy' Galaxias	<i>Galaxias</i> sp. 14			Extracted due to 2019/2020 fires and currently held in temporary housing
Birds				
Eastern Bristlebird	<i>Dasyornis brachypterus</i>	Listed	Endangered	Extracted due to 2019/2020 fires and currently held in temporary housing
Glossy Black-Cockatoo	<i>Calyptorhynchus lathamii</i>	Listed		Breeding in captivity
Ground Parrot	<i>Pezoporus wallicus</i>	Listed		Housed in captivity
Masked Owl	<i>Tyto novaehollandiae</i>	Listed		Breeding in captivity
Powerful Owl	<i>Ninox strenua</i>	Listed		Housed in captivity
Sooty Owl	<i>Tyto tenebricosa</i>	Listed		Breeding in captivity
Mammals				
Brush-tailed Rock-wallaby	<i>Petrogale penicillata</i>	Listed	Vulnerable	Breeding in captivity
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	Listed	Vulnerable	Housed in captivity
Koala	<i>Phascolarctos cinereus</i>			Breeding in captivity
Long-nosed Potoroo	<i>Potorous tridactylus trisulcatus</i>	Listed	Vulnerable	Housed in captivity
Mountain Pygmy-possum	<i>Burramys parvus</i>	Listed	Endangered	Breeding in captivity
Southern Greater Glider	<i>Petauroides volans</i>	Listed	Vulnerable	Breeding in captivity
Southern Long-nosed Bandicoot	<i>Perameles nasuta</i>			Housed in captivity
Yellow-bellied Glider	<i>Petaurus australis</i>			Housed in captivity
Reptiles				
Alpine She-oak Skink	<i>Cyclodomorphus praealtus</i>	Listed	Endangered	Breeding in captivity
Diamond Python	<i>Morelia spilota spilota</i>	Listed		Housed in captivity
Gippsland Water Dragon	<i>Intellagama</i>			Housed in captivity

Common name	Scientific name	FFG Act Status	EPBC Act Status	Captive status
	<i>lesueurii howittii</i>			
Guthega Skink	<i>Liopholis guthega</i>	Listed	Endangered	Housed in captivity
Lace Monitor	<i>Varanus varius</i>			Breeding in captivity

Appendix Five – Proportion of habitat impacted using records for species of concern

Table 23: Fauna of concern percentage of habitat in the current fire extent using Habitat Distribution Models (HDMs) and Victorian Biodiversity Atlas (VBA) records. VBA record percentages were calculated by converting the VBA records to pixels (where each was a 225 pixel that contained at least one VBA record since 1980) and determining the percentage of pixels within the current fire extent.

Common Name	Scientific Name	% of modelled habitat in Victoria within the current fire extent using HDM	% of habitat in Victoria within the current fire extent using VBA records
Amphibians			
Alpine Tree Frog	<i>Litoria verreauxii alpina</i>	15%	5%
Blue Mountains Tree Frog	<i>Litoria citropa</i>	66%	97%
Booroolong Tree Frog	<i>Litoria booroolongensis</i>	39%	0%
Dendy's Toadlet	<i>Pseudophryne dendyi</i>	46%	64%
Giant Burrowing Frog	<i>Heleioporus australiacus</i>	75%	23%
Green and Golden Bell Frog	<i>Litoria aurea</i>	53%	17%
Keferstein's Tree Frog	<i>Litoria dentata</i>	84%	Currently unknown
Large Brown Tree Frog	<i>Litoria littlejohni</i>	88%	93%
Leaf Green Tree Frog	<i>Litoria nudidigita</i>	66%	77%
Martin's Toadlet	<i>Uperoleia martini</i>	31%	10%
Southern Barred Frog	<i>Mixophyes balbus</i>	96%	Currently unknown
Spotted Tree Frog	<i>Litoria spenceri</i>	22%	13%
Aquatic Fauna			
Australian Grayling	<i>Prototroctes maraena</i>		Currently unknown
Barred Galaxias	<i>Galaxias fuscus</i>	0%	Currently unknown
Burrnan Dolphin	<i>Tursiops australis</i>	Currently unknown	Currently unknown
'Cann' Galaxias	<i>Galaxias sp. 17</i>		Currently unknown
Dargo Galaxias	<i>Galaxias mungadhan</i>	16%	Currently unknown
East Gippsland Galaxias	<i>Galaxias aequipinnis</i>	100%	Currently unknown
Flatheaded Galaxias	<i>Galaxias rostratus</i>	~25%	Currently unknown
Galaxis olidus complex	<i>Galaxis olidus complex</i>	Currently unknown	Currently unknown
Macquarie Perch	<i>Macquaria australasica</i>	~20%	Currently unknown
McDowall's Galaxias	<i>Galaxias mcdowalli</i>	77%	Currently unknown
'Moroka' Galaxias	<i>Galaxias sp. 16</i>	Currently unknown	Currently unknown
Mountain Galaxias	<i>Galaxias olidus</i>	Currently unknown	Currently unknown
Gippsland Blackfish	<i>Gadopsis sp.</i>	Currently unknown	Currently unknown
Roundsnout Galaxias	<i>Galaxias terenasus</i>	97%	Currently unknown
Shaw Galaxias^	<i>Galaxias gunaikurnai</i>	0%	Currently unknown
'Yalmy' Galaxias	<i>Galaxias sp. 14</i>	94%	Currently unknown

Common Name	Scientific Name	% of modelled habitat in Victoria within the current fire extent using HDM	% of habitat in Victoria within the current fire extent using VBA records
Birds			
Brown Gerygone	<i>Gerygone mouki</i>	52%	66%
Eastern Bristlebird	<i>Dasyornis brachypterus</i>	58%	4%
Glossy Black-Cockatoo	<i>Calyptorhynchus lathamii</i>	64%	78%
Ground Parrot	<i>Pezoporus wallicus</i>	33%	65%
Lewin's Honeyeater	<i>Meliphaga lewinii</i>	39%	35%
Masked Owl	<i>Tyto novaehollandiae</i>	54%	35%
Powerful Owl	<i>Ninox strenua</i>	26%	11%
Red-browed Treecreeper	<i>Climacteris erythrops</i>	31%	31%
Regent Honeyeater	<i>Anthochaera phrygia</i>	<1%	0%
Sooty Owl	<i>Tyto tenebricosa</i>	47%	27%
Spotted Quail-thrush	<i>Cinclosoma punctatum</i>	29%	34%
Swift Parrot	<i>Lathamus discolor</i>	<1%	0%
Mammals			
Broad-toothed Rat	<i>Mastacomys fuscus mordicus</i>	23%	17%
Brush-tailed Rock-wallaby	<i>Petrogale penicillata</i>	43%	6%
Eastern Bent-wing Bat	<i>Miniopterus schreibersii oceanensis</i>	21%	4%
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	26%	25%
Eastern Horseshoe Bat	<i>Rhinolophus megaphyllus megaphyllus</i>	39%	9%
Eastern Pygmy-possum	<i>Cercartetus nanus</i>	25%	13%
Feathertail Glider	<i>Acrobates pygmaeus</i>	22%	12%
Greater Glider	<i>Petauroides volans</i>	32%	14%
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	23%	4%
Koala	<i>Phascolarctos cinereus</i>	13%	2%
Long-footed Potoroo^	<i>Potorous longipes</i>	79%	74%
Long-nosed Bandicoot	<i>Perameles nasuta</i>	35%	38%
Long-nosed Potoroo	<i>Potorous tridactylus tridactylus</i>	45%	54%
Mountain Pygmy-possum*	<i>Burramys parvus</i>	7%	0%
New Holland Mouse^	<i>Pseudomys novaehollandiae</i>	<1%	0%
Platypus	<i>Ornithorhynchus anatinus</i>	14%	2%
Smoky Mouse^	<i>Pseudomys fumeus</i>	20%	0%
Southern Brown Bandicoot	<i>Isodon obesulus obesulus</i>	28%	17%
Spot-tailed Quoll^	<i>Dasyurus maculatus maculatus</i>	36%	22%
Water Rat	<i>Hydromys chrysogaster</i>	5%	1%

Common Name	Scientific Name	% of modelled habitat in Victoria within the current fire extent using HDM	% of habitat in Victoria within the current fire extent using VBA records
White-footed Dunnart	<i>Sminthopsis leucopus</i>	36%	18%
Yellow-bellied Glider	<i>Petaurus australis</i>	35%	41%
Reptiles			
Alpine Bog Skink	<i>Pseudomoia cryodroma</i>	14%	4%
Alpine She-oak Skink	<i>Cyclodomorphus praealtus</i>	5%	0%
Alpine Water Skink	<i>Eulamprus kosciuskoi</i>	22%	15%
Copper-tailed Skink	<i>Ctenotus teniolatus</i>	19%	0%
Diamond Python	<i>Morelia spilota spilota</i>	86%	55%
Eastern She-oak Skink	<i>Cyclodomorphus michaeli</i>	55%	67%
Gippsland Water Dragon	<i>Intellagama lesueurii howittii</i>	42%	55%
Guthega Skink	<i>Liopholis guthega</i>	0%	0%
Lace Monitor	<i>Varanus varius</i>	16%	33%
Red-throated Skink	<i>Acritoscincus platynotus</i>	36%	25%
Swamp Skink	<i>Lissolepis coventryi</i>	17%	4%
Yellow-bellied Water Skink	<i>Eulamprus heatwolei</i>	39%	65%

Table 24: Flora of concern percentage of habitat in the current fire extent using Habitat Distribution Models (HDMs) and Victorian Biodiversity Atlas (VBA) records. VBA record percentages were calculated by converting the VBA records to pixels (where each was a 225 pixel that contained at least one VBA record since 1980) and determining the percentage of pixels within the current fire extent.

Scientific Name	Common Name	% of modelled habitat in Victoria within the current fire extent using HDM	% of habitat in Victoria within the current fire extent using VBA records
Conifers			
<i>Podocarpus aff. lawrencei</i> (Goonmirk Rocks)	Errinundra Plum-pine	8%	0%
Dicotyledons			
<i>Acacia boormanii</i> subsp. <i>gibba</i>	Mount Typo Wattle	0%	Currently unknown
<i>Acacia caeruleascens</i>	Limestone Blue Wattle	23%	27%
<i>Acacia dawsonii</i>	Poverty Wattle	21%	15%
<i>Acacia irrorata</i> subsp. <i>irrorata</i>	Green Wattle	96%	100%
<i>Acacia linearifolia</i>	Stringybark Wattle	0%	Currently unknown
<i>Acacia maidenii</i>	Maiden's Wattle	23%	0%
<i>Acacia subtilinervis</i>	Net-veined Wattle	82%	0%
<i>Acacia ureniae</i>		100%	Currently unknown
<i>Aciphylla glacialis</i>	Snow Aciphyll	13%	4%
<i>Actinotus forsythii</i>	Ridge Flannel-flower	56%	100%
<i>Alectryon subcinereus</i>	Native Quince	92%	100%
<i>Allocasuarina nana</i>	Stunted Sheoak	95%	50%
<i>Androcalva rossii</i>	Native Hemp	96%	71%
<i>Angophora floribunda</i>	Rough-barked Apple	92%	88%

<i>Scientific Name</i>	<i>Common Name</i>	<i>% of modelled habitat in Victoria within the current fire extent using HDM</i>	<i>% of habitat in Victoria within the current fire extent using VBA records</i>
<i>Astrotricha crassifolia</i>	Thick-leaf Star-hair	41%	25%
<i>Banksia canei</i>	Mountain Banksia	33%	33%
<i>Banksia croajingolensis</i>	Gippsland Banksia	65%	100%
<i>Bertya findlayi</i>	Mountain Bertya	59%	50%
<i>Boronia ledifolia</i>	Showy Boronia	69%	91%
<i>Boronia</i> sp.		Currently unknown	Currently unknown
<i>Brachysome riparia</i>	Snowy River Daisy	34%	100%
<i>Brachyscome salkiniae</i>	Elegant Daisy	93%	91%
<i>Brunoniella pumilio</i>	Dwarf Brunoniella	93%	100%
<i>Callistemon forresterae</i>	Forrester's Bottlebrush	88%	100%
<i>Callistemon kenmorrisonii</i>	Betka Bottlebrush	93%	100%
<i>Callistemon subulatus</i>	Dwarf Bottlebrush	92%	100%
<i>Cassinia maritima</i>	Coast Cassinia	86%	43%
<i>Cassinia venusta</i>	Elegant Cassinia	69%	100%
<i>Commersonia dasyphylla</i>	Kerrawang	99%	Currently unknown
<i>Conospermum taxifolium</i>	Variable Smoke-bush	86%	13%
<i>Cooperhooia barbata</i>	Purple Cooperhooia	93%	94%
<i>Correa lawrenceana</i> var. <i>cordifolia</i>	Pink Mountain-correa	93%	Currently unknown
<i>Correa lawrenceana</i> var. <i>genoensis</i>	Genoa River Correa	86%	100%
<i>Corymbia gummiifera</i>	Red Bloodwood	92%	90%
<i>Craspedia</i> sp. 1	Mountain Forest Billy-buttons	0%	0%
<i>Daviesia wyattiana</i>	Long-leaf Bitter-pea	96%	100%
<i>Dendrophthoe vitellina</i>	Long-flower Mistletoe	86%	60%
<i>Discaria nitida</i>	Shining Anchor Plant	42%	56%
<i>Dodonaea rhombifolia</i>	Broad-leaf Hop-bush	70%	97%
<i>Dodonaea truncatiales</i>	Angular Hop-bush	90%	100%
<i>Epacris microphylla</i> s.s.	Coast Coral Heath	77%	Currently unknown
<i>Eucalyptus agglomerata</i>	Blue-leaf Stringybark	96%	98%
<i>Eucalyptus delegatensis</i> subsp. <i>delegatensis</i>	Alpine Ash	24%	19%
<i>Eucalyptus denticulata</i>	Errinundra Shining Gum	42%	42%
<i>Eucalyptus elaeophloia</i>	Olive Mallee	52%	50%
<i>Eucalyptus forresterae</i>	Brumby Sallee	50%	67%
<i>Eucalyptus mitchelliana</i>	Buffalo Sallee	23%	20%
<i>Eucalyptus perriniana</i>	Spinning Gum	26%	17%
<i>Eucalyptus regnans</i>	Mountain Ash	8%	2%
<i>Eucalyptus saxatilis</i>	Rock Mallee	15%	17%
<i>Eucryphia moorei</i>	Eastern Leatherwood	77%	53%
<i>Euphrasia scabra</i>	Rough Eyebright	28%	50%
<i>Eupomatia laurina</i>	Bolwarra	93%	83%
<i>Ficus coronata</i>	Sandpaper Fig	89%	91%

Scientific Name	Common Name	% of modelled habitat in Victoria within the current fire extent using HDM	% of habitat in Victoria within the current fire extent using VBA records
<i>Gingidia algida</i>		Currently unknown	Currently unknown
<i>Goodenia bellidifolia</i> subsp. <i>bellidifolia</i>	Daisy Goodenia	93%	86%
<i>Grevillea alpivaga</i>	Buffalo Grevillea	30%	29%
<i>Grevillea callichlaena</i>	Benambra Grevillea	0%	Currently unknown
<i>Grevillea celata</i>	Colquhoun Grevillea	56%	56%
<i>Grevillea jephcottii</i>	Green Grevillea	50%	95%
<i>Grevillea pachylostyla</i>	Buchan River Grevillea	51%	33%
<i>Grevillea parvula</i>	Genoa Grevillea	92%	100%
<i>Grevillea polychroma</i>	Tullach Ard Grevillea	74%	100%
<i>Grevillea ramosissima</i> subsp. <i>hypargyrea</i>	Fan Grevillea	58%	71%
<i>Hakea dactyloides</i>	Finger Hakea	93%	100%
<i>Hakea macraeana</i>	Willow Needlewood	93%	Currently unknown
<i>Hibbertia dentata</i>	Trailing Guinea-flower	93%	94%
<i>Hovea purpurea</i>	Tall Hovea	94%	Currently unknown
<i>Irenepharsus magicus</i>	Elusive Cress	54%	50%
<i>Kelleria bogongensis</i>	Snow Daphne	4%	0%
<i>Korthalsella rubra</i> subsp. <i>rubra</i>	Jointed Mistletoe	22%	20%
<i>Lasiopetalum ferrugineum</i>	Rusty Velvet-bush	86%	Currently unknown
<i>Lepidium aschersonii</i>	Spiny Peppercross	1%	2%
<i>Leptomeria acida</i> s.s.	Sour Currant-bush	91%	100%
<i>Leptospermum glabrescens</i> s.s.	Smooth Tea-tree	98%	100%
<i>Leptospermum trinervium</i>	Paperbark Tea-tree	91%	89%
<i>Leptostigma breviflorum</i>	Mountain Nertera	10%	0%
<i>Lobelia dentata</i>	Toothed Lobelia	90%	100%
<i>Marsdenia flavescens</i>	Yellow Milk-vine	73%	43%
<i>Mirbelia pungens</i>	Prickly Mirbelia	96%	100%
<i>Mirbelia rubiifolia</i>	Heathy Mirbelia	88%	100%
<i>Monotoca rotundifolia</i>	Trailing Monotoca	53%	100%
<i>Muehlenbeckia gracillima</i>	Slender Lignum	83%	75%
<i>Muellerina celastroides</i>	Coast Mistletoe	10%	0%
<i>Myoporum floribundum</i>	Slender Myoporum	16%	6%
<i>Nematolepis frondosa</i>	Leafy Nematolepis	45%	100%
<i>Notothixos subaureus</i>	Golden Mistletoe	89%	67%
<i>Olax stricta</i>	Olax	95%	100%
<i>Olearia astroloba</i>	Marble Daisy-bush	22%	0%
<i>Olearia iodochoa</i>	Violet Daisy-bush	42%	50%
<i>Olearia tomentosa</i>	Toothed Daisy-bush	80%	50%
<i>Ozothamnus adnatus</i>	Winged Everlasting	27%	0%
<i>Ozothamnus argophyllus</i>	Spicy Everlasting	86%	75%
<i>Parsonsia eucalyptophylla</i>	Gargaloo	0%	0%
<i>Persoonia levis</i>	Smooth Geebung	92%	95%

Scientific Name	Common Name	% of modelled habitat in Victoria within the current fire extent using HDM	% of habitat in Victoria within the current fire extent using VBA records
<i>Persoonia silvatica</i>	Forest Geebung	54%	52%
<i>Philotheca myoporoides</i> subsp. <i>brevipedunculata</i>	Suggan Buggan Wax-flower	4%	Currently unknown
<i>Philotheca virgata</i>	Tasmanian Wax-flower	90%	100%
<i>Picris angustifolia</i> subsp. <i>merxmuelieri</i>	Highland Picris	20%	17%
<i>Pittosporum revolutum</i>	Rough-fruit Pittosporum	84%	68%
<i>Podolobium ilicifolium</i>	Prickly Podolobium	93%	98%
<i>Polyscias murrayi</i>	Pencil Cedar	79%	0%
<i>Pomaderris brunnea</i>	Rufous Pomaderris	84%	100%
<i>Pomaderris costata</i>	Veined Pomaderris	92%	100%
<i>Pomaderris sericea</i>	Bent Pomaderris	89%	100%
<i>Pomaderris virgata</i>	Upright Pomaderris	88%	100%
<i>Poranthera corymbosa</i>	Clustered Poranthera	95%	88%
<i>Prostanthera incisa</i>	Cut-leaf Mint-bush	83%	38%
<i>Prostanthera monticola</i>	Buffalo Mint-bush	24%	8%
<i>Prostanthera walteri</i>	Monkey Mint-bush	66%	88%
<i>Santalum obtusifolium</i>	Blunt Sandalwood	93%	67%
<i>Scutellaria mollis</i>	Soft Skullcap	90%	88%
<i>Solanum silvestre</i>	Violet Nightshade	94%	100%
<i>Spyridium cinereum</i>	Tiny Spyridium	58%	46%
<i>Stylidium laricifolium</i>	Giant Triggerplant	96%	100%
<i>Symplocos thwaitesii</i>	Buff Hazelwood	47%	86%
<i>Tasmannia xerophila</i> subsp. <i>xerophila</i>	Alpine Pepper	0%	3%
<i>Tetradlea thymifolia</i>	Thyme Pink-bells	92%	Currently unknown
<i>Viola improcera</i>	Dwarf Violet	45%	100%
<i>Wahlenbergia gloriosa</i>	Royal Bluebell	28%	18%
<i>Westringia cremnophila</i>	Snowy River Westringia	68%	100%
<i>Zieria citriodora</i>	Lemon-scented Zieria	70%	100%
Fern and allies			
<i>Adiantum formosum</i>	Black Stem	95%	100%
<i>Botrychium lunaria</i>	Grassy Moonwort	45%	29%
<i>Cyathea leichhardtiana</i>	Prickly Tree-fern	93%	64%
<i>Gleichenia rupestris</i>	Rock Coral-fern	70%	25%
<i>Lastreopsis microsora</i> subsp. <i>microsora</i>	Creeping Shield-fern	93%	82%
<i>Polystichum formosum</i>	Broad Shield-fern	59%	40%
<i>Pteris vittata</i>	Chinese Brake	84%	100%
<i>Sticherus flabellatus</i> var. <i>flabellatus</i>	Shiny Fan-fern	93%	79%
Monocotyledons			
<i>Caladenia ancylosa</i>	Genoa Spider-orchid	79%	67%
<i>Carex jackiana</i>	Carpet Sedge	20%	7%
<i>Cryptostylis erecta</i>	Bonnet Orchid	80%	73%

<i>Scientific Name</i>	<i>Common Name</i>	<i>% of modelled habitat in Victoria within the current fire extent using HDM</i>	<i>% of habitat in Victoria within the current fire extent using VBA records</i>
<i>Cryptostylis hunteriana</i>	Leafless Tongue-orchid	79%	61%
<i>Cyathochaeta diandra</i>	Sheath Sedge	94%	97%
<i>Dendrobium speciosum</i> var. <i>speciosum</i>	Rock Orchid	94%	100%
<i>Deyeuxia crassiuscula</i>	Thick Bent-grass	21%	8%
<i>Deyeuxia decipiens</i>	Devious Bent-grass	82%	86%
<i>Deyeuxia frigida</i>	Forest Bent-grass	21%	14%
<i>Deyeuxia pungens</i>	Narrow-leaf Bent-grass	3%	0%
<i>Dipodium interaneum</i> [hamiltonianum]	Yellow Hyacinth-orchid	18%	11%
<i>Echinopogon caespitosus</i> var. <i>caespitosus</i>	Bushy Hedgehog-grass	8%	0%
<i>Hookerchloa eriopoda</i>	Snow Fescue	44%	47%
<i>Livistona australis</i>	Cabbage Fan-palm	62%	0%
<i>Patersonia sericea</i> var. <i>longifolia</i>	Dwarf Purple-flag	97%	Currently unknown
<i>Plectorrhiza tridentata</i>	Tangle Orchid	93%	86%
<i>Plinthanthesis paradoxa</i>	Wiry Wallaby-grass	91%	71%
<i>Prasophyllum uvidulum</i>	Summer Leek-orchid	55%	50%
<i>Pseudoraphis paradoxa</i>	Slender Mud-grass	0%	0%
<i>Pterostylis acuminata</i>	Pointed Greenhood	94%	100%
<i>Pterostylis oreophila</i>	Blue-tongue Greenhood	52%	33%
<i>Pterostylis reflexa</i>	Small Autumn Greenhood	94%	60%
<i>Pterostylis</i> sp. aff. <i>alveata</i> (Montane)	Hill Greenhood	96%	100%
<i>Ripogonum album</i>	White Supplejack	90%	73%
<i>Sarcochilus falcatus</i>	Orange-blossom Orchid	88%	20%
<i>Schelhammera undulata</i>	Lilac Lily	93%	95%
<i>Schoenus melanostachys</i>	Black Bog-sedge	93%	94%
<i>Xyris juncea</i>	Dwarf Yellow-eye	26%	Currently unknown

Appendix Six: Detailed methods for analysis of species impacts by fire

Data used

DELWP used a range of different datasets and analyses to understand the impacts of the fires on individual species. These analyses used three types of data to represent the distributions of species' habitat spatially:

- Habitat Distribution Models
- Species habitat envelope polygons (for a subset of species without HDMs)
- Victorian Biodiversity Atlas record distributions

And two datasets representing the fires:

- Fire extent map
- Fire severity map

Analyses

To calculate the proportion of species habitat that falls within the extent of the fire area, for each species we calculated the amount of suitable habitat both state- wide and within the extent of the fire. The proportion of species' habitat within the fire extent was then calculated by dividing the amount of suitable habitat within the fire extent by the amount of suitable habitat across the state. The same analysis was repeated for areas burnt just by high severity fire to provide an indication of species that have been heavily impacted by high severity fire.

For species with a Habitat Distribution Model, the area of suitable habitat for a species was calculated by considering both the amount of area the HDM covered, as well as the suitability of the habitat for the species within that area (i.e. the HDM value). The area of suitable habitat is calculated by totalling the area of species' distribution in each HDM value, then multiplying the area by the HDM value to give an 'amount' of suitable habitat for each HDM value. The total area of suitable habitat is then calculated by summing the 'amount' of suitable habitat across all HDM values. We use this calculation to represent the amount of suitable habitat for a species because it more heavily weights the better value habitat for a species, compared with lower value habitat. This provides a clearer picture of the impacts of fires, helping to discriminate between areas where fire has impacted mostly higher value habitat for one species, compared with mostly lower quality habitat for another species.

In instances where a species did not have a Habitat Distribution Model, we used species habitat envelope polygons. These represent the distribution of a species without considering habitat quality, and so the proportions represent true areas, rather than 'amounts' of suitable habitat.

Finally, to check for species that may have had their distribution overestimated by Habitat Distribution Models, we used mapped distributions created using the Victorian Biodiversity Atlas records. These mapped distributions break Victoria into 225m resolution cells and give a cell a value of 1 if the species has been recorded there since 1980, therefore providing a binary view of the distribution of records for each species. We use a binary representation of records, rather than total numbers of records as the former would bias results for species with pixels with many records, even if the records were over a short time period. For each species, we calculated the proportion of state-wide pixels with records that occurred within the fire extent. Results suggested that these values are in agreement with the results from the habitat distribution models for most species (Appendix Five). We use the habitat distribution model numbers as these make predictions about habitat value and help to provide information for under-surveyed areas and so provide a more comprehensive picture of a species' distribution than records alone.

Appendix Seven: Algal species potentially impacted

Algae exist in deep and shallow, still and flowing water-bodies, on the soil surface and on the surfaces of moist vegetation (such as tree-fern trunks). The major hazards to algal groups include immediate mortality due to desiccation and burning, loss of substrate (deeply burned soil surface, evaporation of temporary pools, burnt surfaces), increased trampling in bogs and mossy habitats from introduced herbivores, herbivory, loss of water quality and in-stream habitat due to runoff and sedimentation, and the loss of spore banks in temporary wetland soil.

The major limitation for determining algal species of concern is the lack of data, particularly regarding species records and conservation status. Because of their dependency on water for survival and reproduction it is likely that many are vulnerable to fire. Similarly, a lack of sampling throughout Australia (including the fire-grounds) means that the total biodiversity that might be (have been) present has not been documented.

Within these constraints, Table 25 lists algal taxa potentially impacted by the bushfires. This is a very short preliminary list which will need to be refined as more information becomes available. In general, species that are widespread and unlikely to go extinct, but occur in the fire-ground, have been left out of the table except where there have been thorough reviews of the group (Rhodophyceae and Charophyceae).

Table 25. Algal species of concern. Species groups are written in bold. Includes. Impact assessment is based on mapping of fire extent and species records from the Atlas of Living Australia published records and personal communications. Species deemed particularly vulnerable to fire are species of bogs and mossy habitats, species of temporary wetlands and shallow streams, species of pristine upland streams. Genetic risk is unknown for all species.

Scientific name	Common name(s)	Known distribution	Likely threatened	Comments
Rhodophyta	Freshwater Red Algae		Yes	This group was last comprehensively surveyed in 2007. In general, the species grow in clean, flowing freshwater. There are relatively few gatherings of most species described (Entwisle and Kraft 1984).
<i>Audouinella hermanii</i>		World-wide distribution	No	
<i>Batrachospermum antipodites</i>		Confined to the fire-ground.	Yes	Common in mountains of eastern Australia (Entwisle 1995; Entwisle et al. 2007)
<i>Batrachospermum atrum</i> = <i>Torularia atra</i> 2019		World-wide distribution	No	Common on the east coast of Australia (Entwisle et al. 2007)
<i>Nothocladus pseudogelatinosum</i>		World-wide distribution	No	Common on the east coast of Australia (Entwisle et al. 2007)

Scientific name	Common name(s)	Known distribution	Likely threatened	Comments
<i>Nothocladus lindaueri</i>		Main distribution is in the fire-ground.	Yes	Common in alpine areas, Gippsland; Entwisle et al. 2007)
<i>Nothocladus nodosum</i>		Main distribution is in the fire-ground, but in larger streams and rivers.	Yes	Common in alpine areas, Gippsland; Entwisle et al. 2007); at risk of sedimentation.
<i>Batrachospermum wattsii</i>		Only in fire ground	Yes	Endemic to Victoria (Entwisle et al. 2007).
<i>Batrachospermum kraftii</i>		Tasmania and Victoria	Yes	Victorian distribution is in fire-ground (Entwisle et al. 2007).
<i>Sirodotia suecica</i> probably var. <i>australica</i> endemic, rarely collected		Possibly endemic to Victoria	Yes	Recorded on the ALA as occurring in the fire-ground.
<i>Sirodotia goebelii</i>		Western Australia and Victoria	No	A single collection near Narbethong.
<i>Tuomeya fluviatilis</i>		North America and Victoria	No	Occurs in Victoria (Day et al. 1995). This determination needs verification.
<i>Compsopogon coeruleus</i>		World-wide distribution	No	
<i>Hildenbrandia rivularis</i>		World-wide distribution	No	
Bacillariophyceae	Diatoms			Numerous species of diatom have been recorded for the region, however the reliability of the determinations, and their conspecificity with cosmopolitan species has not been ascertained. Few endemic or endangered diatoms have been detected world-wide (Brodie et al. 2009), but pristine and remote Australian systems have not been comprehensively surveyed.

Species recorded from the fire ground: *Amphora mexicana*, *Bacteriastrum delicatulum*, *Chaetoceros coarctatus*, *Chaetoceros compressus*, *Chaetoceros convolutes*, *Chaetoceros difficilis*, *Chaetoceros lorenzianus*, *Chaetoceros secundus*, *Chaetoceros* sp., *Chaetoceros teres*, *Climacodium frauenfeldianum*, *Ditylum* sp., *Helicotheca tamesis*, *Leptocylindrus danicus*, *Mastogloia cribrosa*, *Mastogloia quinquecostata*, *Odontella sinensis*, *Proboscia alata*, *Rhizosolenia hebetata*, *Rhizosolenia styliformis*,

Scientific name	Common name(s)	Known distribution	Likely threatened	Comments
Vaucheriaceae	Water-moss			25 species of <i>Vaucheria</i> have been described from south eastern Australia (Entwisle 1988), of which one (<i>V. aversa</i>) is listed in the ALA as occurring in the fire-ground. Other species whose distribution is in the eastern Victorian fire-ground are also recorded here. The other 21 genera in Xanthophyceae recorded for Australia (<i>Botrydium</i> , <i>Charciopsis</i> , <i>Harpochytrium</i> , <i>Chlorellidium</i> , <i>Heterococcus</i> , <i>Phyllosiphon</i> , <i>Botrydiopsis</i> , <i>Chlorosloster</i> , <i>Ellipsoidon</i> , <i>Eustigmatos</i> , <i>Goniochloris</i> , <i>Istmochloron</i> , <i>Polydriella</i> , <i>Pseudostaurastrum</i> , <i>Teraddriella</i> , <i>Teraplectron</i> , <i>Centrirectus</i> , <i>Meringosphaera</i> , <i>Ophiocytium</i> , <i>Stipitococcus</i> , <i>Buillieria</i> , <i>Heterothrix</i> , <i>Tribonema</i>) are little known.
<i>Vaucheria aversa</i>	Water-moss	Cosmopolitan	No	Widespread (Entwisle 1988).
<i>Vaucheria gardneri</i>	Water-moss	Cosmopolitan	Yes	Only two collections known from Victoria (Entwisle 1988).
<i>Vaucheria geminata</i>	Water-moss	Cosmopolitan	Yes	All known collections (except one from Rocklands Reservoir) come from the area near Mt Beauty (Entwisle 1988).
<i>Vaucheria gynogyra</i>	Water-moss	Victoria	Yes	Recorded only from coastal eastern Victoria (Entwisle 1988).
<i>Vaucheria conifera</i>	Water-moss	South Australia and Victoria	Yes	Occurring in South Australia and recorded from coastal eastern Victoria (Entwisle 1988).
Charophyceae	Charophytes, Stoneworts			The following species have been recorded from the fire-ground in eastern Victoria. Charophytes are generally widespread in freshwaters world-wide, Australia has a high degree of endemism and many undescribed species.
<i>Chara australis</i>		Eastern Australia	No	Common
<i>Chara globularis</i>		Cosmopolitan	No	Common, 'cosmopolitan'
<i>Chara muelleri</i>		South-eastern Australia	No	Revised, now 4 species.

Scientific name	Common name(s)	Known distribution	Likely threatened	Comments
<i>Lamprothamnium capitatum</i>		Southern Australia	Yes	Fewer than 20 gatherings
<i>Lamprothamnium australicum</i>		Southern Australia	Yes	Fewer than 20 gatherings
<i>Nitella ambigua</i>		Yarra River, xxx river	Yes	Only two collections known
<i>Nitella arthroglochin</i>		Upland Eastern Australia	Yes	Fewer than 20 gatherings, all from altitude
<i>Nitella sonderi</i>		South east Australia	No	Common (ALA records for <i>N. pseudoflabellata</i> group).
<i>Nitella</i> sp. 38		South Eastern Australia	Yes	Undescribed, previously confused with <i>Nitella furcata</i> and <i>N. subtilissima</i> endemic to Australia
<i>Nitella</i> 'Wigan River'		Wigan River	Yes	(Unique clade from genetic analysis Ken Karol pers. com.)
<i>Nitella woodii</i>		Eastern Australia and New Zealand	Yes	Genetically groups with New Zealand species, only a few gatherings
Chlorophyceae	Freshwater Green Algae			This group contains a huge diversity of planktonic and filamentous families, genera and species, most of which are poorly known. Only a few 'charismatic' genera are ever recorded. A couple of groups (Oedogoniales, and Zygnemataceae) have been more comprehensively examined (Entwisle et al. 2007). The other groups (with the exception of Characeae and Desmidiaceae) contain hundreds of species and have rarely been examined.
<i>Klebsormidium</i> sp.		Cosmopolitan	Yes	Rarely collected basal chlorophyte
<i>Spirogyra rugulosa</i> prov.		Victoria	Yes	Apparently endemic to fire-ground (Entwisle et al. 2007).
<i>Zygogonium ericetorum</i> prov		Victoria	Yes	Only occurrence is the Mt Baw Baw summit (Entwisle et al. 2007).
Cyanobacteria	Blue-green algae			Blue-green algae are widespread in freshwater systems in Australia, no rare or endangered species have been recorded, but comprehensive surveys have not been undertaken.

Scientific name	Common name(s)	Known distribution	Likely threatened	Comments
<i>Nostoc pruniforme</i>	Mare's eggs, bullets	Eastern Australia	Yes	The only Victorian record is from near Cann River in the fire-grounds (Skinner and Entwisle 2001)
	Rare taxa			Cyanobacterial diversity is rarely recorded, but rare species and genera do exist. No comprehensive assessment has been made for the fire-grounds, but several taxa are listed in the ALA.
Protista	Other algal groups			Many planktonic and epiphytic species in the Chrysophyta, Cryptophyta, Dinophyta, Euglenophyta, Glaucophyta, Prymnesiophyta, Raphidophyta and Tribophyta occur in Australian waters, but their occurrence, rarity and threats are not well documented (Day et al . 1995).

Appendix Eight: Bryophyte species potentially impacted

Impacts to bryophytes have been assessed using available published information and expert opinion. Information about many of Victoria's rare or threatened bryophyte species is very limited in reports and databases. A workshop was held on the 12th of March to undertake a provisional assessment of impacts and recovery actions for threatened bryophytes known or likely to be impacted by the bushfires.

The assessment made of vulnerability to fire is largely based on the extent and vulnerability of habitat types, although it also considers dispersal and some other factors. For many rare species their response to fire is poorly understood. For some species, assumptions have been made based on what is known about other bryophyte species with similar traits, ecological roles or habitat types. Impacts have been assessed as either *impact uncertain* or *likely impacted*. Impacts for this assessment include medium- to long-term loss of populations or habitats.

The following is a working assessment. Planning is limited by data deficiencies for many species. The list of species and their attributes will be updated as more information becomes available.

Table 26: Bryophyte species of concern. All taxa are DELWP advisory listed with FFG Act listing in bold. Impact assessment is based on acceptable species records from the Atlas of Living Australia (including Victorian Biodiversity Atlas data) within the fire extent area.

Common name(s)	Scientific name	Highly vulnerable to fire	Localised impacts
Mosses			
Bogong Apple-moss	<i>Bartramia subsymmetrica</i>	Y	Few scattered sites on the Bogong High Plains. Impact uncertain.
Diaphanous Fork-moss	<i>Dicranoloma diaphanoneuron</i>	Y	Single collection at Mt Ellery. Likely impacted.
Shore Feather-moss	<i>Drepanocladus polygamus</i>	N	Four sites within fire extent. Likely impacted.
Prince-of-Wales Feather-moss	<i>Leptodon smithii</i>	Y	One site in East Gippsland where at southern end of Australian range. Likely impacted.
Garden Bristle-moss	<i>Orthotrichum hortense</i>	Y	Few sites near Falls Creek. Impact uncertain.
Screw Moss	<i>Syntrichia anderssonii</i>	N	Scattered in alpine areas. Impact uncertain.
Marsh Tree-moss	<i>Climacium dendroides</i>	Y	Scattered in alpine / sub-alpine riparian areas. Likely impacted.
Fine Fringe-moss	<i>Distichium capillaceum</i>	N	Two sites in East Gippsland. Likely impacted.

Common name(s)	Scientific name	Highly vulnerable to fire	Localised impacts
Tall Apple-moss	<i>Bartramia mossmaniana</i>	N	Scattered, mostly high elevation sites in Gippsland. Likely impacted.
Bogong Bristle-leaf Moss	<i>Brachydontium intermedium</i>	Y	Few sites around Falls Creek. Impact uncertain.
Crisped Mitre-moss	<i>Distichophyllum crispulum</i>	Y	Few sites in East Gippsland. Likely impacted.
Common Extinguisher-moss	<i>Encalypta vulgaris</i>	N	Scattered at several sites. Impact uncertain.
Nerveless Pocket-moss	<i>Fissidens dealbatus</i>	N	Scattered at several sites. Impact uncertain.
Arc Moss	<i>Hampeella pallens</i>	Y	East Gippsland at southern limit of distribution in Australia. Likely impacted.
Hump Moss	<i>Meesia muelleri</i>	Y	East Gippsland and alpine region at southern limit of distribution in Australia. Likely impacted.
Jungle Thyme-moss	<i>Mesochaete undulata</i>	Y	East Gippsland at southern limit of distribution in Australia. Likely impacted.
Granite Bristle-moss	<i>Orthotrichum rupestre</i>	N	At various sites around Falls Creek, Mt Hotham and elsewhere. Impact uncertain.
Thyme Moss	<i>Plagiomnium novae-zealandiae</i>		East Gippsland at southern limit of distribution in Australia. Likely impacted.
Eastern Weft-moss	<i>Thuidium cymbifolium</i>	Y	East Gippsland at southern end of distribution in Australia. Likely impacted.
Trachyloma	<i>Trachyloma planifolium</i>	Y	Scattered in Vic rainforest. Likely impact.
Dwarf Blindia	<i>Blindia magellanica</i>	Y	One site near Falls Creek. Impact uncertain.
Breutelia	<i>Breutelia pseudophilonotis</i>	Y	Two sites Falls Creek / Mt Buffalo. Impact uncertain.
Feather Moss	<i>Brachythecium latinervium</i>	Y	Two sites in alpine Vic, one Falls Creek. Impact uncertain.
Swan-neck Moss	<i>Campylopus fragilis</i>	Y	Two sites in Vic, one Cabbage Creek. Likely impacted.
Swan-neck Moss	<i>Campylopus incrassatus</i>	N	Scattered in eastern Vic. Impact uncertain.
Pincushion	<i>Dicranoweisia antarctica</i>	Y	One site at Falls Creek. Impact uncertain.

Common name(s)	Scientific name	Highly vulnerable to fire	Localised impacts
Pocket Moss	<i>Fissidens integerrimus</i>	N	Three sites in East Gippsland. Likely impacted.
Pimpled Pocket-moss	<i>Fissidens linearis</i> var. <i>linearis</i>	N	Scattered in Vic. Likely impacted.
Pincushion Moss	<i>Leptostomum erectum</i>	N	Two sites, one East Gippsland. Likely impacted.
Macromitrium	<i>Macromitrium hemitrichodes</i>	Y	East Gippsland at southern limit of distribution in Australia. Likely impacted.
Three-ranked Hump-moss	<i>Meesia triquetra</i>	Y	One site near Mt Wombargo. Likely impacted.
Earth Moss	<i>Pleuridium curvisetum</i>	N	Several sites around Falls Creek. Impact unknown.
Monaro Weft-moss	<i>Thuidium subglaucinum</i>	Y	Three of four Vic sites in East Gippsland. East Gippsland at southern limit of distribution in Australia. Likely impacted.
Pincushion Moss	<i>Ulota cochleata</i>	Y	Half of Vic records from north Errinundra. Likely impacted.
Liverworts			
Caducous Whipwort	<i>Bazzania hochstetteri</i>	Y	Two sites in East Gippsland. Likely impacted.
Lobed Veilwort	<i>Metzgeria saccata</i>	Y	One site near Falls Creek. Impact uncertain.
Black Rustwort	<i>Cephalomitrium aterrimum</i>	Y	Four sites in alps. Impact uncertain.
Twin-tooth Featherwort	<i>Adelanthus bisetulus</i>	Y	Scattered in Vic though few sites, two East Gippsland. Likely impacted.
Woodland Woollywort	<i>Trichocolea rigida</i>	Y	One site Dargo High Plains. Impact uncertain.
Frostwort	<i>Gymnomitrium incompletum</i>	Y	Several sites in alps. Impact uncertain.
Earwort	<i>Diplophyllum verrucosum</i>	Y	Two sites near Tom Groggin, location uncertain. Impact uncertain.
Rustwort	<i>Herzogobryum teres</i>	Y	Three sites near Fall Creek / Mt Buffalo. Impact uncertain.
Mountain Ribbonwort	<i>Pallavicinia xiphoides</i>	Y	Scattered in eastern Vic, from few sites. Impact uncertain.

Threadwort	<i>Telaranea tetradactyla</i>	Y	Three sites in Vic, one East Gippsland. Likely impacted.
Rustwort	<i>Nothogymnomitrium erosum</i>	Y	Scattered in alpine areas. Impact uncertain.
Scalewort	<i>Frullania victoriensis</i>	Y	One site Upper Ovens River. Impact uncertain.
Balantwort	<i>Balantiopsis tumida</i>	Y	Scattered in Vic. Likely impacted.
Fringed Veilwort	<i>Metzgeria fauriana</i>	Y	Three sites in Vic, one Martins Creek East Gippsland. Likely impacted.
Green-strap Star-liverwort	<i>Asterella tenera</i>	N	Four sites scattered in Vic, one near Lake Dartmouth. Impact uncertain.
Threadwort	<i>Andrewsianthus cuspidatus</i>	Y	One site in Cobberas. Impact uncertain.
Monaro Crestwort	<i>Chiloscyphus excisifolius</i>	Y	One site near Bendoc. Impact uncertain.

