

# Australian Government Bushfire Recovery Package for Wildlife and their Habitat

## Provisional list of priority invertebrate species requiring urgent management intervention or on-ground assessment

The 2019-20 fires of eastern and southern Australia have had severe impacts on many Australian animals and plants. Because there are far more invertebrate species than there are vertebrate or plant species, and many invertebrate species have very localised ranges, it is likely that the fires will have severely affected many more invertebrate than plant or vertebrate species. However, for invertebrate species, the severity of this impact can be challenging to assess, because distributional information is typically limited, there are few monitoring programs for invertebrates, there is limited information on the susceptibility of most invertebrates to fire, invertebrates are poorly represented on threatened species lists, and the conservation status of most invertebrate species is unknown.

In order to help guide conservation responses, this report identifies 191 invertebrate species known or presumed to have been severely affected by the 2019-20 fires. This prioritisation is based mostly on spatial analysis of the extent of overlap between species' distributional range and fire, with such analysis considering the following groups of Australian invertebrate species:

- approximately 700 invertebrate species listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* or equivalent state and territory legislation or on the global IUCN Red List of Threatened Species
- invertebrate species considered to be of concern by state and territory agencies and by some experts, because of fire impacts
- some taxonomic groups likely to contain many fire-affected species.

The analysis considered potential impacts from fires in southern and eastern Australian between 1 July 2019 and 24 February 2020 identified in the [National Indicative Aggregated Fire Extent Dataset](#). Susceptibility of invertebrate species to fire was considered where available, notably for a set of Kangaroo Island invertebrate species. Comparable information was not readily available for most invertebrate species.

The main criterion for inclusion here is that the fires affected at least 30 per cent of the range of invertebrate species listed as threatened by any jurisdiction or the IUCN or 50 per cent of the range of species not presently listed. In some cases, all known locations for a species were burnt in the 2019-20 fires. With more information, many additional species are likely to meet these thresholds, so the provisional priorities identified here should not be regarded as comprehensive.

A further 147 species are included as they are considered likely to have met these thresholds but the available information is insufficient to make a robust assessment. Many additional invertebrate species are likely to have suffered conservation detriment due to these fires, but not to the extent of these threshold values.

Broad management actions likely to assist the recovery of invertebrate species severely affected by the 2019-20 fires are described. Two priority actions are likely to be required for all high priority species:

(1) rapid on-ground surveys to establish the extent of population loss and provide a baseline for ongoing monitoring; and (2) protecting unburnt areas (within or adjacent to recently burnt ground, or in suitable habitat away from the burnt areas) that provide refuge. For most invertebrate species substantially affected by the 2019-20 fires, recovery may also be contingent upon longer-term management that reduces the likelihood of future comparable fires.

More specific recovery actions will also be required for individual fire-affected invertebrate species. For example, almost all of the Kangaroo Island range and habitat of the Green Carpenter Bee *Xylocarpa aerata* was burnt in the 2019-20 fires, and its recovery may need to consider translocations and provision of artificial nest sites. In contrast, priority management actions for the Kangaroo Island Micro-Trapdoor Spider *Moggdridgea rainbowi* relate more to the control of weeds and erosion in severely-burnt sites. For many other fire-affected invertebrate species, priority recovery management actions may not yet be well resolved, and additional research may be needed to provide a robust evidence base to guide recovery.

## INTRODUCTION

The 2019-20 fires in eastern and southern Australia had a devastating impact on many plant and animal species and ecosystems. Many threatened species lost large proportions of their already reduced populations, rendering them appreciably more imperiled. Many species not previously considered threatened also experienced major losses. Many of these severely affected species now require targeted management to support recovery: in some cases, this conservation management needs to be applied urgently in order to avert extinction.

On 11 February 2020, the Australian Government released a provisional list of 113 animal species considered to be high priorities for urgent management intervention due to the significant impacts of the fires. With the exception of a set of spiny crayfish (*Euastacus* species: Family Parastacidae), and a small set of other invertebrates listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBCA), that list comprised vertebrate species (fish, frogs, reptiles, birds and mammals). The list of priority animal species was amended on 24 March, and now comprises 119 animal species, including 92 vertebrate species, 22 spiny crayfish and five other (EPBCA-listed) invertebrate species (<https://www.environment.gov.au/biodiversity/bushfire-recovery/priority-animals>).

The identification of priority species is a mechanism to help address the Wildlife and Threatened Species Bushfire Recovery Expert Panel objectives, to:

- prevent extinction and limit decline of native species
- maximise the chances for long term recovery of native species and communities.

Spiny crayfish were included in this initial prioritisation because there were recent comprehensive accounts of their distribution, ecology and conservation status, and many spiny crayfish species clearly required rapid post-fire management intervention in order to prevent extinction.

Relevant information for most other invertebrate groups is far more limited than for spiny crayfish or vertebrates, making it more challenging to identify those species likely to have been most affected by the 2019-20 fires. For most of Australia's approximately 320,000 invertebrate species (Chapman 2009), there is little available information on distribution, susceptibility to fire, potential for recovery, conservation status, threats, or management needs; and many invertebrate species remain

undescribed. Further complicating the assessment of impacts of the 2019-20 fires on invertebrate species is that many invertebrate groups have distinct life stages, each with different susceptibilities to fire.

However, many invertebrate species are likely to have been severely impacted by the 2019-20 fires, and will require urgent and/or sustained management response. For example, many invertebrate species have very small distributional ranges (Harvey *et al.* 2011; Taylor *et al.* 2018) and, in some cases, the entire extent of their distribution may have been burnt in the 2019-20 fires. Invertebrates span a vast range of ecologies, and species will have been affected by fire in very different ways. Some species are entirely dependent on ecological features occurring only in long-unburnt habitats (such as decaying logs or a dense layer of fallen leaves); others have tight ecological associations with other individual animal species or plants (such as obligate pollinators); others live entirely or partly in water and may be affected by marked reductions in water quality following fire when rain washes heavy loads of ash into watercourses.

Based on assessments described below, 191 invertebrate species are recognised to be priorities for post-fire management (see Table 1 below), and a further 147 species are recognised as priorities for further assessment because of concern about possible fire impact (see Table 2 below). This prioritisation should be seen as preliminary. It is highly likely that many fire-affected invertebrate species are not included in this invertebrate priority list; some of these may be added subsequently as more information becomes available.

## **ASSESSMENT APPROACH**

Several complementary approaches were used to derive the priority list of fire-affected invertebrate species, with these approaches generally consistent with the approaches adopted for comparable prioritisations for vertebrates and plants.

### **Groups of species considered**

(1) On the basis that impacts of fire may be of most concern for species already considered threatened, an initial assessment of fire overlap was undertaken for all Australian invertebrate species (other than marine species, those endemic to Australia's offshore territories, extinct species, and spiny crayfish which were already considered) that are listed as threatened under the EPBC Act or equivalent state and territory legislation or by the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species. Note that this includes but substantially extends the previous consideration of EPBC Act listed invertebrate species (an assessment at 24 March 2020 that led to inclusion of five threatened invertebrate species in the previously published priority list of 119 species (<https://www.environment.gov.au/biodiversity/bushfire-recovery/priority-animals>)).

Although an initial consideration of threatened invertebrate species is justified, there is a marked bias in most threatened species lists against invertebrates (Walsh *et al.* 2012), and many highly imperiled invertebrate species are not formally listed as threatened.

(2) For two locations – Kangaroo Island (South Australia) and Stirling Range National Park (Western Australia) – where extensive fires coincided with known concentrations of short-range endemic invertebrates (Harvey *et al.* 2011), lists of invertebrate species that were most likely to have been fire-

affected were compiled, in consultation with relevant experts (see Contributors section below for lists of experts consulted).

(3) Where state/territory agencies have already developed lists of priority fire-affected invertebrates, species in these lists were considered for inclusion in the priority listing here after assessment of the species' national extent.

(4) Based on expert advice, fire overlap was analysed for several invertebrate groups – butterflies, landsnails and some beetle groups – selected on the basis that there was reasonable distributional information for these groups (e.g., Stanisic *et al.* 2010; Braby 2016; Stanisic *et al.* 2017), and they include species known to be susceptible to fire (e.g., Braby *et al.* 2011). Note that although informative, assessments of these groups are not representative of all invertebrate biodiversity. For example, if comparable distributional information was readily available for all termites or earthworms, a very different set of priority species may have been derived.

(5) An unusually extensive pre-fire (historic) baseline sampling of some invertebrate groups (notably terrestrial beetles, spiders, ants and hemipterans) across some fire-affected regions of New South Wales by Gerry Cassis and colleagues from the Australian Museum (Ferrier *et al.* 1999) allowed for a sample-based quantitative assessment of extent of range (proportion of occupied sites) burnt. For the purposes of the preliminary prioritisation of fire-affected species reported here, this analysis contextualised overlap of fire with species' ranges across the surveyed area with reference to the entire known range of species, and considered only those taxa that have been formally described.

(6) At least 30 experts were consulted, seeking justified examples of any additional fire-affected invertebrate species for which they had particular concerns.

### **Distributional data and assessment of fire overlap**

Assessment of fire impact on invertebrate species is largely based on spatial analysis comparing the areas within the extent of the 2019-20 fires with the distributions of individual invertebrate species. The fire-affected area considered includes bioregions in south-west Western Australia, southern South Australia, Victoria, southern and eastern New South Wales, south-eastern Queensland and Tasmania. A map of this Preliminary Analysis Area is available on the [Department's website](#). Analyses were undertaken on mapping of the fire extent as at 24 February 2020.

Distributional data for invertebrate species were generally taken from the Department of Agriculture, Water and the Environment's Species Observation System (SOS) and the Atlas of Living Australia. Analyses mostly used a filtered subset of records, to include only those records post-dating 1995, and those with a precision of ca. 1 km (2 decimal places of latitude and longitude). Distributional records were gridded (to 1 km x 1 km cells), and analysis calculated the percentage of these cells that had been at least 50 per cent burnt in the 2019-20 fires. Some parallel analyses were also conducted with these filters relaxed, especially for species for which there were few filtered records. For analyses of some groups (as described subsequently), additional distributional databases were considered: many distributional records for some invertebrate groups are not yet collated into national electronic databases.

Modelled distributions were available for some EPBC Act listed species (for which 'known and likely' distributions were included); and alpha hulls (polygons derived from connecting outlying distributional

records) were calculated where possible. A distance measure of 2.5 was applied for the calculation of all alpha hulls. For modelled distributions and alpha hulls, overlap with fire was expressed as a percentage.

Note that disparate fire-overlap values for the same species may eventuate depending upon whether filtered or unfiltered records, or modelled distributions, were used: in such cases, the most plausible value was selected.

Following the procedure used for assessment of fire impact on spiny crayfish and fish, for (some) aquatic invertebrate species, an additional analysis considered the extent of fire in the upstream catchment, because impacts on aquatic species may be realised through catchment-wide flow of ash from burnt areas to watercourses, with subsequent reduction in water quality.

For many (probably the majority of) invertebrate species, there are too few available records to provide a robust assessment of the extent of overlap with fire.

Accordingly, for species considered in the analyses described above, results were grouped broadly to:

- threatened species with at least 10 acceptable distributional records, for which analysis (and/or expert opinion) indicated that at least 30 per cent of the distribution was burnt [group A1: high confidence of extensive fire overlap]
- species not currently listed as threatened with at least 10 acceptable distributional records, for which analysis (and/or expert opinion) indicated that at least 50 per cent of the distribution was burnt [group A1: high confidence of extensive fire overlap]
- threatened species with fewer than 10 acceptable distributional records for which analysis (and/or expert opinion) indicated that at least 30 per cent of the distribution was burnt [group A2: lower confidence, but likely extensive fire overlap]
- species not currently listed as threatened with fewer than 10 acceptable distributional records for which analysis (and/or expert opinion) indicated that at least 50 per cent of the distribution was burnt [group A2: lower confidence, but likely extensive fire overlap]
- species with no or very few readily accessible and acceptable distributional records, but potentially severely fire-affected [group F: more information (e.g. on-ground survey) required]
- all other species.

Species considered priorities here for recovery efforts were those in groups A1 and A2, with group F considered priorities for further assessment (through on-ground survey, aggregation of further distributional records, and/or more precise mapping of fire severity) and precautionary management.

For some species with very few records but known to occur in or near burnt areas, available information is currently inadequate to determine the proportion of occurrences within burnt areas (e.g., some Queensland species known to be endemic to Bulburin or Cooloola): these species are categorised here as group F, indicating that fire impact is unknown but may be substantial.

Note that some species considered here to be priorities have not yet been formally described, but are recognised as specifically distinct by appropriate authorities and are typically linked to a numbered specimen held in a museum collection.

## Susceptibility

Invertebrate species vary in ecology, life history and other traits, and these characteristics render some species more likely than others to suffer high rates of mortality during fire, and to determine which species recover most rapidly after fire (from survivors at the burnt site or from emigration to the site). In the initial lists of priority animals (<https://www.environment.gov.au/biodiversity/bushfire-recovery/priority-animals>), information about traits that influenced species' susceptibility to fire was used as an element in the prioritisation. Comparable information was not readily available for most invertebrate species. An exception was for a set of Kangaroo Island invertebrate species, for which trait information was considered.

A project coordinated through Taxonomy Australia is currently compiling relevant trait information at the level of invertebrate families, and such information will be useful to help further resolve fire impacts and help guide recovery management actions (K. Thiele *pers. comm.*).

## RESULTS

### Currently listed threatened invertebrate species

Of nearly 700 non-marine invertebrate species (or, in some cases, subspecies) that are listed as threatened under the EPBCA, by states and territories, or by the IUCN Red List, about 100 have had some of their distributional extent burnt by the 2019-20 fires. Forty-nine of these species are considered here to be substantially fire-affected (i.e. at least 30 per cent of the known distribution of these threatened species overlaps with the 2019-20 fires) (Table 1). Although distributional information is sparse in many cases, spatial analysis or expert opinion indicates that five of these species have had all of their known range burnt and another four species have had 80-99 per cent of their range burnt: most of these species are narrow range endemics restricted to the Stirling Range National Park in Western Australia.

The 49 threatened invertebrates that are most substantially fire-affected span an extensive taxonomic range, including freshwater mussels, shrimps, burrowing crayfish, land snails, spiders, millipedes, bees, dragonflies, caddisflies, mayflies, hemipterans (bugs) and butterflies. These fire-affected threatened species occur in Queensland, New South Wales, Victoria, South Australia and Western Australia. An additional five threatened invertebrates are suspected to be substantially fire-affected but the available information on their distribution is too sparse to reliably estimate the extent of their overlap with fire (Table 2): on-ground survey or other precautionary action is required for these species.

Note that the species included in Tables 1 and 2 includes the five EPBCA-listed species previously included in the priority list of fire-affected animal species (<https://www.environment.gov.au/biodiversity/bushfire-recovery/priority-animals>): *Pseudococcus markharveyi* (Banksia montana mealybug), *Bertmainius colonus* (Eastern Stirling Range Pygmy Trapdoor Spider), *Trioza barrettiae* (*Banksia brownii* Plant Louse) and *Thaumatoperla alpina* (Alpine Stonefly) and the Bathurst Copper Butterfly (Purple Copper Butterfly) *Paralucia spinifera*. Note that the spatial analysis indicates that latter species falls marginally below the threshold of 30 per cent of range burnt, but is included here for precautionary reasons.

## **Kangaroo Island (SA) and Stirling Range NP (WA)**

Experts developed a list of 15 invertebrate species of concern that are endemic (or mainly so) to Kangaroo Island, noting that there are probably many additional endemic invertebrate species that could be considered. Three of these 15 species were already listed as threatened and were included in the analysis of threatened species considered in the preceding paragraph. Of the remaining 12 species, seven have had at least 50 per cent of their distributional extent burnt, including at least one species, the Kangaroo Island assassin spider *Zephyrarchaea austini* for which all known locations have been burnt. These species are included in Table 1.

The Stirling Range National Park area is a significant area of endemism for many plant and invertebrate species, and much was burnt in the 2019-20 fires. Experts developed a list of 46 endemic invertebrate species of concern, of which 16 are already listed as threatened (mostly under Western Australian legislation) and hence were considered in the preceding analysis of threatened invertebrate species. Of the remaining 30 species, available information indicates that 10 have had all or much of their limited range burnt, and information is not yet adequate to resolve the extent of fire overlap for the remaining 20 species. The former set are included in Table 1 and the latter in Table 2. Note that many of these species were also affected by fires in 2018-19 and in other recent years.

## **Invertebrates recognised as priority fire-affected species from other states and territories**

The ACT Department of Environment, Planning and Sustainable Development reported six invertebrate species of concern, with one of these species (Key's Matchstick Grasshopper *Keyacris scurra*) listed as threatened and considered in the analysis of threatened species above (with analysis indicating that 10-30 per cent of its range burnt, so not included in the priority list here), and three of these considered in the butterfly analysis below. The two remaining species (both dragonflies: *Austroaeschna atrata* and *Austroaeschna inermis*) are not endemic to the ACT, but analysis indicates that 30-50 per cent of their range is likely to have been fire-affected – a substantial impact, but not sufficiently so to meet the threshold for inclusion in Table 1 here.

The Queensland Department of Environment and Science (with advice from experts at the Queensland Museum) identified concerns for sets of narrow range endemic invertebrate species from the Gondwanan World Heritage Area, Bulburin, and Cooloola-Fraser Island, but there has not yet been a robust assessment of the extent to which the limited distributional information for these species overlaps with burnt areas. As such, these 52 species are listed here in Table 2, as priorities for further survey and assessment.

The Victorian Department of Environment, Land, Water and Planning, in collaboration with experts from the Victorian Museum and other institutions, reported a large set of invertebrate species that are known or thought to have had substantial parts of their range (at least, their Victorian range) affected by fire. This set comprises 78 species, as well as higher taxonomic levels (families, genera). Of the 78 species, 38 are considered here under the threatened species assessment (see above under the Currently listed threatened invertebrate species section), or under national assessments of butterflies and land snails (see below); 20 are priorities for further assessment and survey (Table 2), there is sufficient information to consider three as substantially fire-affected at national scale (Table 1), and national level analysis indicates, with varying levels of reliability, that the fire overlap for the remaining 17 species is less than 30 per cent of their distributional extent. Not included in the analyses here are invertebrate taxa at

levels higher than species. The Victorian assessment also recognised concern for groups of beetles (*Simsonia* spp., *Kingolus* spp., *Lancetes* spp., *Hydraena* spp., *Berosus* spp., *Notohydrus* spp., *Necterosoma* spp., and species in the family Eucinetidae), dragonflies (*Garinjuga* spp., *Ulmerophlebia* spp., *Tasmanocoenis* spp., *Diphlebia* spp., *Hemigomphus* spp., *Notoaeschna* spp., *Eusynthemis* spp., and *Austroaeschna* spp.), flies (*Forcipomyia* spp., *Austrosimullum* spp., species in the families Simuliidae, Tabanidae and Athericidae, and in the subfamily Tanyopidinae and tribe Chironomini), caddisflies (*Koetonga* spp., *Tasiogma* spp., *Tasimia* spp., *Matasia* spp., *Hudsonema* spp., *Micronecta* spp., 'Genus P' (Odontoceridae) spp., *Apsilichorema* spp., *Ethochorema* spp., *Psyllobetina* spp., *Ptychobiosis* spp., *Taschorema* spp., *Ulmerochorema* spp., *Agapetus* spp., *Chimarra* spp., *Hydrobiosella* spp., *Asmicridea* spp., *Smicrophylax* spp., *Coenoria* spp., *Conoesucus* spp., *Costora* spp., *Helicopsyche* spp., *Tamasia* spp., *Austrheithrus* spp., *Anisocentropus* spp., *Notalina* spp., *Triplectides* spp., *Cheumatopsyche* spp., and *Diplectrona* spp.), dobsonflies (*Archichauliodes* spp.), mayflies (*Hellyethira* spp., *Hydroptila* spp., and *Oxyethira* spp.), stoneflies (*Austrocercella* spp., *Cosmioperla* spp., *Dinotoperla* spp., *Leptoperla* spp., *Illiesoperla* spp., *Eunotoperla* spp., *Riekoperla* spp., and *Trinotoperla* spp.), and grasshoppers (*Monistria* spp.). This considerable list of higher-order invertebrate groups indicates the magnitude of the impacts on invertebrates generally, and the challenge of considering impacts on individual species where the information base is limited.

The Tasmanian Department of Primary Industries, Parks, Water & Environment indicated that, on the limited available evidence, no Tasmanian invertebrate species had been significantly affected by fires in that state in 2019-20.

The New South Wales Department of Environment, Energy and Science recognised fire impacts on three state-listed threatened invertebrate species, with analysis here indicating that fire overlap for only one of these species was >30 per cent (the giant dragonfly *Petalura gigantea*). The NSW state agency also helped collate information from the Australian Museum on many other NSW invertebrate species of potential concern.

### **NSW baseline invertebrate monitoring sites**

From the matrix of invertebrate species by sites, data-holders determined the relative proportion of known sites that were burnt in the 2019-20 fires (G. Cassis, S. Laffan and C. Reid: Australian Museum and University of New South Wales). With further consideration of species' broader range beyond the sampled area, 24 species from these surveys are considered to have had 50 per cent or more of their range burnt (Table 1).

### **Assessments of diverse taxonomic groups**

The extent of fire impact was estimated for a diverse set of invertebrate groups, included to broadly exemplify a wide range of invertebrate ecologies and distributional characteristics.

#### **Butterflies**

A list of non-threatened butterflies and moths of potential concern was developed by experts (principally Michael Braby), and fire overlap considered by reference to reliable distribution maps in relevant publications (e.g., Braby 2016). Of 27 taxa considered (including subspecies), spatial analysis indicates fire overlaps of at least 50 per cent for 14 taxa (Table 1), there is insufficient information to



assess fire overlap for one taxon (Table 2), with the other considered taxa most likely have fire overlap values of <30 per cent.

### **Landsnails**

Of about 1500 landsnail species in Australia, spatial analysis indicates some concern for fire overlap for about 150 species, including eight species listed as threatened (with the threatened landsnails considered above). Although there are very few records for many species, there is 100 per cent overlap of the known distributions of 17 species with fire, and 39 species have 50-99 per cent of their distributions overlapping with fire (Table 1). A further 59 species have 30-50 per cent of their range overlapping with fire: these are not listed as priorities here. Another 16 species have too few records for analysis, but are listed in Table 2 as priorities for survey or more detailed consideration. Note that some of the landsnail species with extensive overlap with fire may have escaped some of the impacts of such fire because they occur in rugged rocky areas that may have provided some immediate shelter from fire effects.

### **Beetles**

Analysis here included sections of the beetle families Buprestidae (jewel beetles), Scarabaeidae (dung beetles) and Lucanidae (stag beetles), with spatial analysis also from the Australian Museum and additional expert opinion. The analyses were less comprehensive than for butterflies and land snails, but indicated that the 2019-20 fires overlapped at least 50 per cent of the range of at least 32 beetle species (Table 1) and another 29 species may well have comparable overlaps but distributional information is inadequate to assess (Table 2).

### **Flies**

Based on information from D. Yeates (Australian National Insect Collection, CSIRO), the 2019-20 fires overlapped at least 50 per cent of the range of at least eight dipteran species (Table 1), with a further 13 species having potentially comparable overlap, but too few records to allow for a robust assessment.

### **Other invertebrate groups for which experts have expressed concern**

Many other invertebrate groups are likely to have been severely affected by the 2019-20 fires, although comprehensive assessment of all potentially affected species groups has not yet been attempted. One group considered of concern is the many minute moths, *Pseliastis* spp. (Lepidoptera: Heliozelidae), that have critical ecological roles as obligatory pollinators for several genera of Rutaceae (e.g., *Boronia*, *Zieria*, *Phebalium* spp. etc). These moths are known to pollinate threatened *Boronia* spp. in several states and are likely to be very vulnerable to extinction from broad-scale fires (Don Sands, *pers. comm.*). Additional to the beetle groups considered above, experts have suggested that the beetle family Cerambycidae (especially the subfamily Prioninae) is also likely to have had many species severely affected by fire, at least in part because many are dependent on decomposing timber, an ecological feature typically associated with long periods without fire (Roger De Keyser *pers. comm.*). Assessment of the impacts of the 2019-20 fires on Gondwanan relict taxa is also not yet substantially advanced, with the following groups considered to be of potential concern: the spider families Cyatholipidae, Anapidae (especially the genus *Maxanapis*), Migiidae (the genera *Migas* and *Heteromigas*) and Idiopidae (genus *Cataxia*) (M. Rix, *pers. comm.*), the king crickets (family Stenpelmidae) and further ground beetles (Carabiidae) and dung beetles (Scarabaeidae) (Chris Burwell *pers. comm.*).

## WHAT IS IN THE LIST?

The provisional list includes 191 species considered to be priorities for management response because of demonstrated or probable high fire overlap (Table 1) and a further 147 species for priority assessment because much of their distributional extent has been burnt, but the available information is inadequate to allow confident assessment (Table 2).

Of the 191 priority species for management response, 141 occur in New South Wales, 43 in Victoria, 25 in Western Australia, 17 in South Australia, 30 in Queensland and 10 in the Australian Capital Territory (noting that many of the 191 species occur in more than one jurisdiction).

Note that this priority list is not definitive. Additional information may readily show further invertebrate species have been substantially fire-affected and require urgent management response. Also, additional information (e.g., from refined fire severity mapping, inclusion of additional distributional records, or on-ground survey) may show that some species considered here to be priorities have not been as affected by fires as current concern indicates.

## WHAT IS IN THE TABLE BELOW?

The table lists species by taxonomic group, and includes the following columns:

**Scientific Name** is the formal name for the species accepted by the Australian Faunal Directory. In some cases, the species has not yet been formally described, but is denoted by a reference museum collection number or label given by a stated authority.

**Common Name** is the plain language name(s) used for the species: note that some species have no accepted common name.

**Threatened status** is the category listed under the EPBC Act, by the IUCN, or by states/territories. Codes for conservation status: REX=regionally extinct; CR=Critically Endangered; EN=Endangered; VU=Vulnerable. For species listed as threatened in Victoria, their advisory list status is indicated, or the species is coded as THR=threatened.

**States and territories** are the states and territories that the species may occur in. The fires may not have affected each species in all states and territories where it occurs. Note that distributional information is sparse for many invertebrate species, and the state/territory occurrence given in these Tables is indicative only.

## NEXT STEPS FOR IMPROVING UNDERSTANDING OF FIRE IMPACTS

This analysis here of invertebrate species considered to be substantially fire-affected is inevitably incomplete; also, it may include some species for which further analysis or survey demonstrates that impacts are less than currently recognised.

A range of mechanisms can be used to improve knowledge of fire impacts on Australian invertebrate species. These include:

- (1) more refined and finer-scale fire mapping, incorporating assessments of fire severity. Most species are likely to be much more affected by high intensity and extensive fires than by low

intensity and patchy fires, but the analyses conducted here to date have not incorporated consideration of fire severity.

- (2) more information on distributions of invertebrate species. There are no or few readily available distributional records for many invertebrate species, rendering it almost impossible to provide reliable estimates of fire impact. For some species, there are some records that are not yet included in distributional databases, and addition of such records would allow for more robust assessment of fire overlap. In some cases, modelling of species distributions may also provide a useful advance beyond the small set of distributional records.
- (3) more information from on-ground surveys and assessments. The extent to which species' populations may have survived in burnt areas (or in unburnt patches within largely burnt landscapes) is currently unknown for most invertebrate species.
- (4) more information on species' life history, ecological and other traits. Invertebrate species will vary in their susceptibility to fire and their capacity to recover from it. For example, most individuals in populations of some species may have been living in deep burrows during fires, and consequently may have suffered little direct mortality; whereas populations of other species live on the ground in leaf litter and all of the population in burnt areas may have been killed by fire. recovery may also be much more rapid for species that can disperse over larger distances from unburnt refuge patches to recolonise burnt areas. Such information on traits can be used to further refine estimates of impacts of the 2019-20 fires and the likelihood of recovery. However, information about traits will be limited for many species.
- (5) focused assessment across taxonomic groups additional to those considered here. The assessments considered here indicate that about 10 per cent of the complement of Australian land snails have been substantially affected by the 2019-20 fires. It is likely that similar proportions of other taxonomic groups, especially those with many narrow range endemic species, will also have been affected, but comparable analyses have not yet been conducted for most groups. Such an exercise represents a formidable challenge.

Assessment of the impacts of the 2019-20 fires on Australian invertebrates is also constrained by the absence or limited extent of monitoring of Australian invertebrates, with little monitoring even for most threatened invertebrate species (Legge *et al.* 2018). In the absence of such monitoring, it is difficult to evaluate the extent of loss, or progress to recovery, of most invertebrate species.

To some extent, the priority species listed here are representative of concerns for the invertebrate fauna more generally, and especially so for invertebrate species even less well known than those noted here. A characteristic of this assessment is that the distributions of many listed species are broadly coincident to a small set of locations where extensive and high severity fires have occurred in areas with high endemism. The most notable of these areas are the Stirling Range (Western Australia), Kangaroo Island (South Australia), Australian Alps (Victoria, New South Wales and the ACT), Blue Mountains (New South Wales), and the Gondwanan Rainforest World Heritage Area (New South Wales, Queensland), with more diffuse endemism in the foothill and mountain forests, and coastal heathlands, from eastern Victoria to north-eastern New South Wales. Survey and management for the priority species listed here should be implemented to also consider and benefit the many other fire-affected invertebrate species likely to co-occur with the priority species listed here.

## WHAT ACTIONS ARE NEEDED FOR HIGH PRIORITY SPECIES?

The previously published listing of priority animal species included some consideration of broad management actions that may be needed to support recovery. Again, such information is generally not readily available for most invertebrate species. An exception is for a set of Kangaroo Island invertebrate species: in this case major post-fire threats and, consequently, priorities for management response were identified.

Across the gamut of fire-affected invertebrates, management actions that can help prevent extinction and support recovery will vary considerably among different species. However, actions most likely to be needed will include:

- rapid survey to assess extent of loss, locate any important remaining populations and unburnt habitat patches, and help to determine post-fire management priorities. In some cases, surveys may be most efficient if they can sample many fire-affected species within a locality with many narrow range endemic species and extensive occurrence of fire; in such cases, sampling such as undertaken by BushBlitz may be appropriate (Preece *et al.* 2015)
- salvage (rescue) for species whose critical surviving populations may be particularly susceptible to post-fire threats. For example, the Victorian Department of Environment Land Water and the Environment salvaged populations of some spiny crayfish in the period after wildfire but before subsequent rainfall washed ash into their highly localised freshwater habitat
- establishment of *ex situ* populations as insurance or to translocate to unburnt patches or recovering habitat to increase the number of wild populations
- establishment or continuation of monitoring programs that can chart extent of population loss from fires, extent and pace of recovery, and effectiveness of management actions
- provision of habitat features for some highly specialised fire-affected invertebrate species. For example, artificial nest sites have been provided for Green Carpenter Bees *Xylocarpa aerata* on Kangaroo Island
- control of herbivores (introduced and sometimes native), where these may otherwise hinder vegetation recovery
- control of competitors and predators (such as honey bees or European wasps)
- control of weeds that would otherwise reduce habitat suitability or hinder recovery
- more targeted management of fire to reduce the likelihood of future conflagrations and increase the diversity (mix of fire ages) of habitats across an area, and help retain an adequate proportion of long-unburnt habitat
- recognition of sites supporting critical populations of imperiled invertebrates in management plans and other policy documents.

## CONTRIBUTORS

This draft listing builds on information and assessments contributed by many experts and agencies, including Shane Ah Yong (Australian Museum), Rachael Alderman (Tasmanian Department of Primary Industries, Parks, Water & Environment), Ethan Beaver, Sally Box (Department of Agriculture, Water and the Environment), Michael Braby (Australian National University), Renee Brawata (ACT Department of Environment, Planning and Sustainable Development), Matt Bruce (Victorian Department of Environment, Land, Water and Planning), Anne Buchan (Victorian Department of Environment, Land,

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#### **FURTHER INFORMATION**

Bushfire recovery package for wildlife and their habitat:

<http://www.environment.gov.au/biodiversity/bushfire-recovery>

Table 1. Preliminary list of priority fire-affected invertebrate species. This table includes currently listed threatened species known or presumed to have at least 30 per cent of their distributions overlapping with the 2019-20 fires, and unlisted species known or presumed to have at least 50 per cent of their distributions overlapping with the 2019-20 fires.

Scientific name	Common name	Threatened status	Jurisdictions
<b>Freshwater mussels</b>			
<i>Hyridella depressa</i>	Depressed Mussel; Knife-shaped Mussel		NSW, QLD, VIC
<i>Hyridella glenelgensis</i>	Glenelg Freshwater Mussel	EPBCA (CR); IUCN (CR); VIC (CR)	VIC
<b>Land snails</b>			
aff. Helicarionidae `sp. WAM S71330` (per M. Harvey)			WA
<i>Austrochloritis abbotti</i>	Yessabah Caves Bristle Snail		NSW
<i>Austrochloritis abrotonus</i>	Bermagui Bristle Snail		NSW
<i>Austrochloritis kanangra</i>	Jenolan Caves Bristle Snail		NSW
<i>Austrochloritis kaputarensis</i>	Mount Kaputar Bristle Snail		NSW
<i>Austrochloritis kippara</i>	Kippara Forest Bristle Snail		NSW
<i>Austrochloritis kosciuszkoensis</i>	Kosciuszko Bristle Snail		NSW, VIC, ACT
<i>Austrochloritis marksandersi</i>	Mount Sebastapol Bristle Snail		NSW
<i>Austrochloritis paucisetosa</i>	Macksville Bristle Snail		NSW
<i>Austrochloritis seaviewensis</i>	Mount Seaview Bristle Snail		NSW
<i>Austrochloritis wollemiensis</i>	Wollemi Bristle Snail		NSW
<i>Austropyrgus wombeyanensis</i> = <i>Cumberlandica wombeyanensis</i>			NSW
<i>Austrorhytida glaciamans</i>	Kosciuszko Carnivorous Snail		NSW, VIC, ACT
<i>Austrorhytida nandewarensis</i>	Nandewar Carnivorous Snail		NSW
<i>Bothriembryon glauerti</i>	Stirling Ranges Tapered Snail		WA
<i>Brevisentis kaputarensis</i>	Mount Kaputar Glass-snail		NSW
<i>Coenocharopa yessabahensis</i>	Yessabah Pinwheel Snail		NSW
<i>Coricudgia wollemiana</i>	Coricudgy Pinwheel Snail		NSW
<i>Cupedora tomsetti</i>	Tomsett's Shrubland Snail		SA
<i>Diphyoropa illustra</i>	Lakes Entrance Pinwheel Snail		NSW, VIC
<i>Diphyoropa macleayana</i>	Kempsey Copper Pinwheel Snail		NSW
<i>Discocharopa expandivolva</i>	Flared White Pinwheel Snail		NSW
<i>Egilodonta bendethera</i>	Bendathera Pinwheel Snail		NSW
<i>Egilodonta wyanbenensis</i>	Wyanbene Pinwheel Snail		NSW

<i>Egilomen sebastopol</i>	Sebastopol Pinwheel Snail		NSW
<i>Elsiothera kyliestumkatae</i>	Mount Seaview Pinwheel Snail		NSW
<i>Galadistes akubra</i>	Macleay Valley Woodland Snail		NSW
<i>Glyptorhagada bordaensis</i>	Cape Borda Corrugated Snail	IUCN (VU)	SA
<i>Gyrocochlea gibraltar</i>	Gibraltar Range Pinwheel Snail		NSW
<i>Gyrocochlea janetwaterhouseae</i>	Macleay Valley Pinwheel Snail		NSW
<i>Gyrocochlea planorbis</i>	Port Stephens Pinwheel Snail		NSW
<i>Gyrocochlea wauchope</i>	Wauchope Pinwheel Snail		NSW
<i>Hedleyropa yarrangobillyensis</i>	Yarrangobilly Pinwheel Snail		NSW
<i>Hyaloropa brazenori</i>	Brazenor's Pinwheel Snail		VIC
<i>Kaputaresta nandewarensis</i>	Nandewar Pinhead Snail		NSW
<i>Letomola contortus</i>	Contorted Pinwheel Snail		NSW
<i>Letomola lanalittleae</i>	Sunburst Pinwheel Snail		NSW
<i>Luturopa macleayensis</i>	Macleay Waxy Pinwheel Snail		NSW
<i>Macleayropa boonanghi</i>	Boonanghi Pinwheel Snail		NSW
<i>Macleayropa carraiensis</i>	Carrai Pinwheel Snail		NSW
<i>Macleayropa kookaburra</i>	Kookaburra Pinwheel Snail		NSW
<i>Macrophallikoropa stenoumbilicata</i>	Wolllemi Pinwheel Snail		NSW
<i>Marilyniropa jenolanensis</i>	Jenolan Pinwheel Snail		NSW
<i>Meridolum jervisensis</i>	Jervis Bay Forest Snail		NSW
<i>Mysticarion porrectus</i> = <i>Helicarion porrectus</i>		IUCN (VU)	NSW
<i>Paralaoma annabelli</i>	Prickle Pinhead Snail		NSW, SA, VIC, ACT
<i>Pommerhelix depressa</i>	Jenolan Caves Woodland Snail	IUCN (VU)	NSW
<i>Pommerhelix mastersi</i>	Merimbula Woodland Snail		NSW, VIC
<i>Pommerhelix monacha</i>	Blue Mountains Woodland Snail		NSW
<i>Rhophodon kempseyensis</i>	Lustrous Pinwheel Snail		NSW
<i>Rhophodon mcgradyorum</i>	McGrady's Pinwheel Snail		NSW
<i>Rhophodon palethorpei</i>	Palethorpe's Pinwheel Snail		NSW
<i>Rhophodon silvaticus</i>	Thumb Creek Pinwheel Snail		NSW
<i>Scelidoropa nandewar</i>	Nandewar Range Pinwheel Snail		NSW
<i>Vitellidelos dorrigoensis</i>	Dorrigo Carnivorous Snail		NSW
<i>Vitellidelos kaputarensis</i>	Mount Kaputar Carnivorous Snail		NSW

<i>Fluvidona petterdi</i>		IUCN (CR)	NSW
<i>Georissa laseroni</i>	Macleay Valley Microturban	IUCN (VU)	NSW
<i>Pleuropoma jana</i>	Macleay Valley Droplet-snail		NSW
<i>Rhytidid</i> sp. (WAM# 2295-69)	Stirling Range Rhytidid Snail	WA (CR)	WA
<b>Velvet worms</b>			
<i>Kumbadjena toolbrunupensis</i>	Toolbrunup velvet worm		WA
<b>Copepods</b>			
<i>Canthocamptus longipes</i>	harpactacoid copepod	IUCN (VU)	VIC
<b>Branchiopods</b>			
<i>Rhynchochydorus australiensis</i>	Water Flea	IUCN (VU)	NSW
<b>Decapods</b>			
<i>Australatya striolata</i>	Eastern Freshwater Shrimp	VIC (VU)	NSW, QLD, VIC
<i>Cherax leckii</i>		IUCN (CR)	NSW, QLD, VIC
<i>Engaeus mallacoota</i>	Mallacoota Burrowing Crayfish	IUCN (CR); VIC (VU)	VIC
<b>Isopods</b>			
<i>Colubotelson joyneri</i>	phreatoicid isopod	VIC (VU)	VIC
<b>Spiders, harvestmen and pseudoscorpions</b>			
<i>Asteron grayi</i>			NSW, QLD, VIC
<i>Bertmainius colonus</i>	Eastern Stirling Range Pygmy Trapdoor Spider	EPBCA (VU); WA (VU)	WA
<i>Bertmainius pandus</i>	Toolbrunup pygmy trapdoor spider	WA (CR)	WA
<i>Cataxia colesi</i>			WA
<i>Graycassis bruxner</i>			NSW, QLD
<i>Graycassis dorrigo</i>			NSW, QLD
<i>Karaops toolbrunup</i>			WA
<i>Lampona fife</i>			NSW
<i>Maratus sarahae</i>	Sarah's peacock spider, Bluff Knoll peacock spider	WA (CR)	WA
<i>Moggdridgea rainbowi</i>	Kangaroo Island Micro-trapdoor spider		SA
<i>Molycria grayi</i>			NSW, QLD
<i>Molycria mammosa</i>			NSW, QLD
<i>Nosterella nadgee</i> = <i>Nostera nadgee</i>			NSW, QLD
<i>Storenosoma terraneum</i>			NSW, QLD, VIC, ACT
<i>Teyl</i> `MYG636` (per M. Harvey)			WA
<i>Venatrix australiensis</i>			NSW, QLD
<i>Zephyrarchaea austini</i>	Kangaroo Island Assassin spider		SA
<i>Zephyrarchaea melindae</i>	Toolbrunup Assassin Spider	WA (VU)	WA



<i>Zephyrarchaea robinsi</i>	Eastern Massif Assassin Spider	WA (VU)	WA
<i>Nunciella kangarooensis</i>	Western Kangaroo Island Harvestman		SA
<i>Pseudotyrannochthonius</i> `Harms sp. Stirling Range 1` (per M. Harvey)			WA
<i>Pseudotyrannochthonius</i> `Harms sp. Stirling Range 3` (per M. Harvey)			WA
<i>Synsphyronus apimelus</i>	Toolbrunup Pseudoscorpion		WA
<b>Millipedes</b>			
<i>Atelomastix anancita</i>	millipede	WA (VU)	WA
<i>Atelomastix danksi</i>	Toolbrunup atelomastix millipede	WA (VU)	WA
<i>Atelomastix poustiei</i>	Wedge Hill atelomastix millipede	WA (VU)	WA
<i>Atelomastix tigrina</i>	striped atelomastix millipede	WA (VU)	WA
<i>Atelomastix tumula</i>	Bluff Knoll atelomastix millipede	WA (VU)	WA
`Hesperisiphon` `peckorum` (per M. Harvey)			WA
<i>Australeuma</i> `sp.` (per M. Harvey)			WA
<b>Dragonflies</b>			
<i>Acanthaeschna victoria</i>	Thylacine Darner	IUCN (EN)	NSW, QLD, VIC
<i>Austroaeschna cooloola</i>	Wallum Darner	IUCN (EN)	QLD
<i>Austroaeschna flavomaculata</i>	Alpine Darner	VIC (VU)	NSW, VIC
<i>Austropetalia patricia</i>	Waterfall Redspot	IUCN (VU)	NSW, VIC
<i>Caliagrion billinghursti</i>	Large Riverdamsel	IUCN (VU); VIC (EN)	NSW, QLD, VIC
<i>Cordulephya divergens</i>	Clubbed Shutwing	IUCN (VU)	NSW
<i>Petalura gigantea</i>	Giant Dragonfly	NSW (EN)	NSW
<b>Caddisflies</b>			
<i>Ecnomus nevoissi</i>	caddisfly	VIC (VU)	NSW, QLD, VIC
<i>Ecnomus nibbor</i>	caddisfly	VIC (VU)	NSW, VIC
<i>Ramiheithrus virgatus</i>	caddisfly	VIC (VU)	NSW, VIC
<i>Triaenodes cuspiosa</i>	caddisfly	VIC (VU)	NSW, VIC
<i>Triaenodes uvida</i>	caddisfly	VIC (VU)	VIC
<b>Mayflies</b>			
<i>Tasmanophlebi lacuscoerulei</i>	Large Blue Lake Mayfly	IUCN (EN)	NSW, VIC
<b>Stoneflies</b>			
<i>Leptoperla cacuminis</i>	Mount Kosciusko Wingless Stonefly	IUCN (VU)	NSW

<i>Thaumatoperla alpina</i>	Alpine Stonefly	EPBCA (EN); VIC (VU)	VIC
<b>Grasshoppers and crickets</b>			
<i>Apteronomus bordaensis</i>	Raspy Cricket		SA
<i>Apteronomus tepperi</i>	Raspy Cricket		SA
<i>Metaballus mesopterus</i>	Kangaroo Island Marauding Katydid		SA
<i>Psacadonotus insulanus</i>	Kangaroo Island Robust Fan-winged Katydid	IUCN (EN)	SA
<b>Hemiptera (bugs)</b>			
<i>Acizzia mccarthyi</i>	McCarthy's Plant Louse	IUCN (EN); WA (VU)	WA
<i>Epimixia vulturna</i>			NSW
<i>Eritingis trivirgata</i>			NSW
<i>Kirkaldyella rugosa</i>			NSW
<i>Kirkaldyella schuhi</i>			NSW
<i>Myrmecoroides grossi</i>			NSW
<i>Pseudococcus markharveyi</i>	<i>Banksia montana</i> mealybug	EPBCA (CR); IUCN (CR); WA (CR)	WA
<i>Setocoris</i> sp. ms <i>binataphila</i> (per G. Cassis)			NSW
<i>Trioza barrettiae</i>	<i>Banksia brownii</i> Plant Louse, Barrett's Plant-louse	EPBCA (EN); IUCN (CR); WA (EN)	WA
<i>Wallabioris helichrysi</i>			NSW
<i>Woodwardiola</i> sp. ms <i>lomandrae</i> (per G. Cassis)			NSW
<b>Beetles</b>			
<i>Cardiothorax femoratus</i>			NSW, QLD
<i>Cardiothorax iridipes</i>			NSW
<i>Coripera morleyana</i>			NSW, QLD
<i>Ceratognathus flabellatus</i>			NSW
<i>Ceratognathus macrognathus</i>			NSW, VIC
<i>Figulus trilobus</i>			NSW
<i>Lissapterus grammicus</i>			NSW
<i>Lissapterus hopsoni</i>			NSW
<i>Mitophyllus ocularis</i>			NSW, VIC
<i>Safrina dekeyzeri</i>			NSW, QLD
<i>Aulacopris reichei</i>			NSW, VIC
<i>Diorygopyx duplodentatus</i>			NSW
<i>Diorygopyx incrassatus</i>			NSW
<i>Lepanus</i> nr <i>pisoniae</i> (per C. Reid)			NSW

<i>Matthewsius illawarrensensis</i>			NSW
<i>Matthewsius rossi</i>			NSW
<i>Buburra jeanae</i>	leaf beetle		VIC
<i>Castiarina</i> cf. <i>alecgemmelli</i> (Wollemi) (per A. Sundholm)	jewel beetle		NSW
<i>Castiarina flavoviridis</i>	jewel beetle		NSW, VIC, ACT
<i>Castiarina kershawi</i>	jewel beetle		NSW, VIC
<i>Castiarina klugii</i>	jewel beetle		NSW, VIC
<i>Castiarina luteocincta</i>	jewel beetle		NSW, QLD
<i>Castiarina maculipennis</i>	jewel beetle		NSW, QLD
<i>Castiarina montigena</i>	jewel beetle		NSW, VIC, ACT
<i>Castiarina terminalis</i> (Wollemi form) (per A. Sundholm)	jewel beetle		NSW
<i>Stigmodera jacquini</i>	jewel beetle		NSW
<i>Temognatha</i> cf. <i>mitchellii</i> (Blue Mountains) (per A. Sundholm)	jewel beetle		NSW
<i>Temognatha grandis</i>	jewel beetle		NSW
<i>Temognatha limbata</i>	jewel beetle		NSW
<i>Temognatha mitchelli</i> (' <i>karratae</i> ') (per A. Sundholm)	jewel beetle		SA
<i>Temognatha rufocyanea</i>	jewel beetle		NSW
<i>Temognatha sexmaculata</i>	jewel beetle		NSW
<b>Flies</b>			
<i>Edwardsina gigantea</i>	Giant Torrent Midge	IUCN (EN)	NSW
<i>Exeretonevra angustifrons</i>			NSW
<i>Pelecorhynchus distinctus</i>			NSW
<i>Pelecorhynchus flavipennis</i>			NSW
<i>Pelecorhynchus lineatus</i>			NSW
<i>Pelecorhynchus nebulosus</i>			NSW
<i>Pelecorhynchus niger</i>			NSW
<i>Pelecorhynchus rubidus</i>			NSW
<i>Trichophthalma bivitta</i>			NSW
<b>Butterflies and moths</b>			
<i>Abantiades</i> sp. n. Kangaroo Island (per E. Beaver)			SA
<i>Aenetus tindalei</i>			SA
<i>Oxycanus incanus</i>			NSW
<i>Oxycanus</i> sp. n. ' <i>Kartus</i> ' (per E. Beaver)			SA
<i>Telicota eurychlora</i>	Dingy Darter, Sedge Darter, Southern Sedge Darter	VIC (VU)	NSW, QLD, VIC
<i>Anisynta cynone anomala</i>	Mottled Grass-skipper		NSW
<i>Antipodia chaostola chaostola</i>			NSW

<i>Candalides absimilis edwardsi</i>	Glistening Pencil-blue; Common Pencilled-blue		NSW, VIC
<i>Cyprotides</i> sp. aff. <i>cyprotus</i> (per M. Braby)			NSW, ACT
<i>Hesperilla hopsoni</i>	Golden Sedge-skipper		NSW
<i>Mesodina aeluropis</i>	Montane Iris-skipper; Aeluropis Skipper		NSW
<i>Ogyris halmaturia</i>	Eastern Brown Azure	VIC (REX)	SA, VIC
<i>Ogyris otanes otanes</i>	Small Brown Azure	VIC (CR)	SA, VIC
<i>Oreixenica correae</i>	Orange Alpine Xenica; Correa Brown		NSW, VIC, ACT
<i>Oreixenica latialis latialis</i>	Small Alpine Xenica		NSW, VIC, ACT
<i>Oreixenica latialis theddora</i>	Alpine Silver Xenica, Mount Buffalo Xenica	VIC (EN)	VIC
<i>Oreixenica orichora orichora</i>	Spotted Alpine Xenica		NSW, VIC, ACT
<i>Paralucia spinifera</i>	Bathurst Copper Butterfly, Purple Copper Butterfly	EPBCA (VU), IUCN (EN), NSW (EN)	NSW
<i>Pseudalmenus barringtonensis</i>	Flame Hairstreak		NSW
<b>Ants, wasps and bees</b>			
<i>Tetramorium confusum</i>			NSW
<i>Xylocopa aeratus</i>	Green Carpenter Bee, Metallic Green Carpenter Bee, Southern Green Carpenter Bee	VIC (REX)	NSW, QLD, SA, VIC

Table 2. List of priority invertebrate species for further assessment – considered of concern because of possible substantial fire overlap but for which distributional information that is currently readily available precludes confident assessment.

Species name	Common name	Threatened status	Jurisdictions
<b>Planarians</b>			
Planarian sp. 3 (RSC) (per. Vic DELWP)	a planarian		VIC
Planarian sp. 4 (RSC) (per. Vic DELWP)	a planarian		VIC
<b>Land snails</b>			
<i>Alpiniropa okeana</i>	Mount Feathertop Pinwheel Snail		VIC
<i>Banjiropa snowyensis</i>	Snowy River Pinwheel Snail		VIC
<i>Bothriembryon decreasensis</i>	Kangaroo Island Tapered Snail		SA
<i>Diphyoropa jonesi</i>	Goomeri Copper Pinwheel Snail		QLD
<i>Egilomen cochlidium</i>	Armoured Pinwheel Snail		NSW, QLD
<i>Gouldiropa carlessi</i>	Yarramanbully Pinwheel Snail		NSW
<i>Gyrocochlea conjuncta</i>	Byron Bay Pinwheel Snail		NSW
<i>Hildapina subpolita</i>	Byron Bay Chrysalis-snail		NSW, QLD
<i>Hyaloropa brazenori</i>	Brazenor's Pinwheel Snail		VIC
<i>Kaputaresta nandewarensis</i>	Nandewar Pinhead Snail		NSW
<i>Koreelahropa paucicostata</i>	Bold-ribbed Pinwheel Snail		NSW, QLD
<i>Kosciuskoropa nivea</i>	Alpine Pinwheel Snail		NSW, VIC
<i>Lacuropa colliveri</i>	Colliver's Pinwheel Snail		VIC
<i>Letomola lanalittleae</i>	Sunburst Pinwheel Snail		NSW
<i>Marilyniropa jenolanensis</i>	Jenolan Pinwheel Snail		NSW
<i>Scelidoropa altior</i>	Snowy Mountains Pinwheel Snail		NSW, VIC
<i>Sphaerospira bencarlessi</i>			QLD
<i>Triboniophorus</i> sp. nov. 'Kaputar' (per IUCN)	Kaputar Pink Slug	IUCN (EN)	NSW
<b>Velvet worms</b>			
<i>Kumbadjena</i> `ONY04` (per M. Harvey)			WA
<i>Ooperipatellus duwilensis</i>	velvet worm		VIC
<i>Ooperipatellus pulchellus</i>	velvet worm		VIC
<i>Planipapillus biacinaces</i>	velvet worm		VIC
<b>Spiders, harvestmen and pseudoscorpions</b>			
<i>Austrarchaea dianneae</i>			QLD

<i>Austrarchaea nodosa</i>			QLD
<i>Cryptoforis</i> sp. 'montana' (per M. Rix)			QLD
<i>Migas variapalpus</i>			QLD
<i>Bymainiella monteithi</i>			QLD
<i>Bymainiella terraereginae</i>			QLD
<i>Paraembolides cannoni</i>			QLD
<i>Tarlina woodwardi</i>			QLD
<i>Austrarchaea aleenae</i>			QLD
<i>Austrarchaea cunninghami</i>			QLD
<i>Austrarchaea</i> sp. nov. (Mt Ballow, per M. Page)			QLD
<i>Baiami</i> `sp. nov.` (per M. Harvey)			WA
<i>Baiami stirlingi</i>			WA
<i>Bertmainius monachus</i>	Talyuberlup pygmy trapdoor spider	WA (EN)	WA
<i>Birrana bulburin</i>			Qld
<i>Calcarsynotaxus benrobertsi</i>			WA
<i>Cataxia barrettae</i>			WA
<i>Cataxia sandsorum</i>			WA
<i>Cataxia stirlingi</i>			WA
<i>Cryptoforis cooloola</i>			QLD
<i>Desognaphosa bulburin</i>			QLD
<i>Heteropoda bulburin</i>			QLD
<i>Heteropoda cooloola</i>			QLD
<i>Molycria bulburin</i>			QLD
<i>Namea calcaria</i>			QLD
<i>Namea callemonda</i>			QLD
<i>Ozicrypta cooloola</i>			QLD
<i>Perissopmeros darwini</i>			WA
<i>Stanwellia</i> `MYG420` (per M. Harvey)			WA
<i>Stanwellia</i> `MYG634` (per M. Harvey)			WA
<i>Wugigarra bulburin</i>			QLD
<i>Zephyrarchaea barrettae</i>	Talyuberlup Assassin Spider	WA (VU)	WA
<i>Megalopsalis epizephyros</i>			WA
<i>Pseudotyrannochthonius</i> `Harms sp. Stirling Range 2` (per M. Harvey)			WA
<i>Pseudotyrannochthonius</i> `Harms sp. Stirling Range 4` (per M. Harvey)			WA

<i>Pseudotyrannochthonius`Harms</i> sp. Stirling Range 5` (per M. Harvey)			WA
<b>Millipedes</b>			
<i>`Hesperisiphon` `diversus`</i> (per M. Harvey)			WA
<i>Antichiropus`DIP075`</i> (per M. Harvey)			WA
<i>Atelomastix montana</i>			WA
<i>Samichus`Eastern Stirling Ranges`</i> (per M. Harvey)			WA
<i>Samichus`Mt Talyuberlup`</i> (per M. Harvey)			WA
<i>Samichus`Mt Trio`</i> (per M. Harvey)			WA
<b>Dragonflies</b>			
<i>Austroaeschna (Austroaeschna)</i> <i>cooloola</i>			QLD
<i>Hemigomphus cooloola</i>			QLD
<b>Caddisflies</b>			
<i>Arcyphysa fraserensis</i>			QLD
<b>Cockroaches</b>			
<i>Dyakinodes fraserensis</i>			QLD
<i>Geoscaphus crenulatus fraserensis</i>			QLD
<i>Robshelfordia fraserensis</i>			QLD
<b>Grasshoppers and crickets</b>			
<i>Cooloola propator</i>			QLD
King cricket genus nov. sp nov. (Bulburin, per G. Monteith)			QLD
<i>Praxibulus uncinatus</i>	Alpine Yellow-Bellied Grasshopper	IUCN (VU)	VIC
<i>Tinzeda fraserensis</i>			QLD
<b>Hemiptera (bugs)</b>			
<i>Acizzia keithi</i>	Keith's Plant-louse		NSW
<i>Granulaptera remota</i>			QLD
<i>Neophloeobia bulburina</i>			QLD
<i>Olonia rubicunda = Eurybrachys</i> <i>rubicunda</i>			QLD
<i>Trioza banksiae</i>	Banksia plant-louse		NSW
<i>Hackeriella veitchi</i>			NSW, QLD
<i>Hackeriella echina</i>			NSW, QLD
<i>Hackeriella brachycephala</i>			NSW
<b>Lacewings</b>			
Kempyninae sp.1 (per Vic DELWP)	lacewing		VIC

Beetles			
<i>Castelnaudia</i> sp. nov. (Bulburin, per G. Monteith)			QLD
<i>Gnathoxys</i> sp. (Wollemi Region) (per A. Sundholm)			NSW
<i>Nurus knox</i>			QLD
<i>Serabilia monteithi</i>			QLD
<i>Serabilia amaroides</i>			QLD
<i>Ceratognathus froggatti</i>			NSW
<i>Ceratognathus gilesi</i>			NSW, VIC
<i>Serrogathus australicus</i>			NSW
<i>Anoplognathus debaari</i>			QLD
<i>Anoplognathus storeyi</i>			QLD
<i>Onthophagus beelarong</i>			QLD
<i>Onthophagus cooloola</i>			QLD
<i>Onthophagus yarrumba</i>			QLD
<i>Trichaulax kirbyi</i>			NSW
<i>Australobolbus masneri</i>			QLD
<i>Canobolas nobilis</i>	leaf beetle		NSW
<i>Canobolas tubrabucca</i>	leaf beetle		NSW
<i>Cheiloxena blackburni</i>	leaf beetle		NSW
<i>Castiarina carnabyi</i>	jewel beetle		WA
<i>Castiarina erasma</i>	jewel beetle		NSW, VIC, ACT
<i>Castiarina kanangara</i>	jewel beetle		NSW
<i>Castiarina maculifer</i>	jewel beetle		NSW
<i>Castiarina mima</i>	jewel beetle		NSW
<i>Castiarina rayclarkei</i>	jewel beetle		QLD
<i>Castiarina rubicunda</i>	jewel beetle		NSW, QLD
<i>Castiarina rutila</i>	jewel beetle		NSW, QLD
<i>Castiarina scintillata</i>	jewel beetle		NSW, QLD
<i>Castiarina variegata</i>	jewel beetle		NSW
<i>Sticholotis cooloola</i>			QLD
Strepsiptera			
<i>Triozocera cooloolaensis</i>			QLD
Flies			
<i>Exeretonevra tertia</i>			NSW
<i>Molophilus (Superbomolophilus) cooloola</i>			QLD
<i>Paralimnophila (Paralimnophila) cooloola</i>			QLD
<i>Pelecorhynchus deuqueti</i>			NSW



<i>Pelecorhynchus interruptus</i>			NSW
<i>Pelecorhynchus kippsi</i>			NSW
<i>Pelecorhynchus nero</i>			NSW
<i>Pelecorhynchus simplex</i>			NSW
<i>Pelecorhynchus simplissimus</i>			NSW
<i>Pelecorhynchus taeniatus</i>			NSW
<i>Pelecorhynchus tigris</i>			NSW
<i>Pelecorhynchus tillyardi</i>			NSW
<i>Tipulidae</i> sp. 1 (EPA) (per. Vic DELWP)	crane fly		VIC
<i>Tipulidae</i> sp. 13 (EPA) (per. Vic DELWP)	crane fly		VIC
<i>Tipulidae</i> sp. 17 (SRV) (per. Vic DELWP)	crane fly		VIC
<i>Tipulidae</i> sp. 18 (SRV) (per. Vic DELWP)	crane fly		VIC
<i>Tipulidae</i> sp. 19 (SRV) (per. Vic DELWP)	crane fly		VIC
<i>Tipulidae</i> sp. 25 (SRV) (per. Vic DELWP)	crane fly		VIC
<i>Tipulidae</i> sp. 28 (SRV) (per. Vic DELWP)	crane fly		VIC
<i>Tipulidae</i> sp. 29 (EPA) (per. Vic DELWP)	crane fly		VIC
<i>Tipulidae</i> sp. 33 (SRV) (per. Vic DELWP)	crane fly		VIC
<i>Tipulidae</i> sp. 4 (SRV) (per. Vic DELWP)	crane fly		VIC
<i>Tipulidae</i> sp. 5 (SRV) (per. Vic DELWP)	crane fly		VIC
<i>Tipulidae</i> sp. 7 (EPA) (per. Vic DELWP)	crane fly		VIC
<i>Tipulidae</i> sp. 8 (EPA) (per. Vic DELWP)	crane fly		VIC
<i>Tipulidae</i> sp. 9 (EPA) (per. Vic DELWP)	crane fly		VIC
<i>Trichophthalma lutea</i>			NSW, VIC
<i>Trichophthalma trilinealis</i>			NSW
<i>Trichophthalma waterhousei</i>			NSW
<b>Butterflies and moths</b>			
<i>Hesperilla crypsargyra binna</i>			QLD
<i>Pseudalmenus chlorinda fisheri</i> = <i>Pseudalmenus chlorinda zephyrus</i>	Australian Hairstreak, Orange Tit, Silky Hairstreak, Victorian Hairstreak	VIC (VU)	NSW, VIC

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