# InverTraits Team

Project: 8.3.1

**Fire-affected invertebrates: Priority species and management response**

Project Leaders: John Woinarski



**The Guardian**

**Environmental investigations**

# 'Overlooked': 14,000 invertebrate species lost habitat in Black Summer bushfires, study finds

Scientists say the animals are vital to ecosystem and true number affected is probably far higher

# What we learnt?

*Data on invertebrate species (occurrence, traits, fire response, etc.) is sparse - not available, not been collated and/or not easily accessible.*

- Fire impact ≠ fire overlap
- Species vary in their responses to fire
- Expand our assessments to more species

# Project objectives

- Develop robust assessment approach to estimate likely impacts of fire on Australian invertebrates
- Build a curated and standardised database of invertebrate traits data
- List of priority taxa (at-risk, data-deficient, etc.) and associated conservation actions
- Open-access data, tools, and workflows to ensure reproducibility

## Traits-based assessment framework to estimate fire-susceptibility of Australian invertebrates

- Conceptual framework
- Traits selection & definitions
- Analyses outputs & workflows

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### Work Package 1:
*AusInverTraits* database

- Database design
- Traits selection & definitions
- Trait data extraction & repeatable workflow
- Working taxonomic checklist
- Database construction
- First (private) release
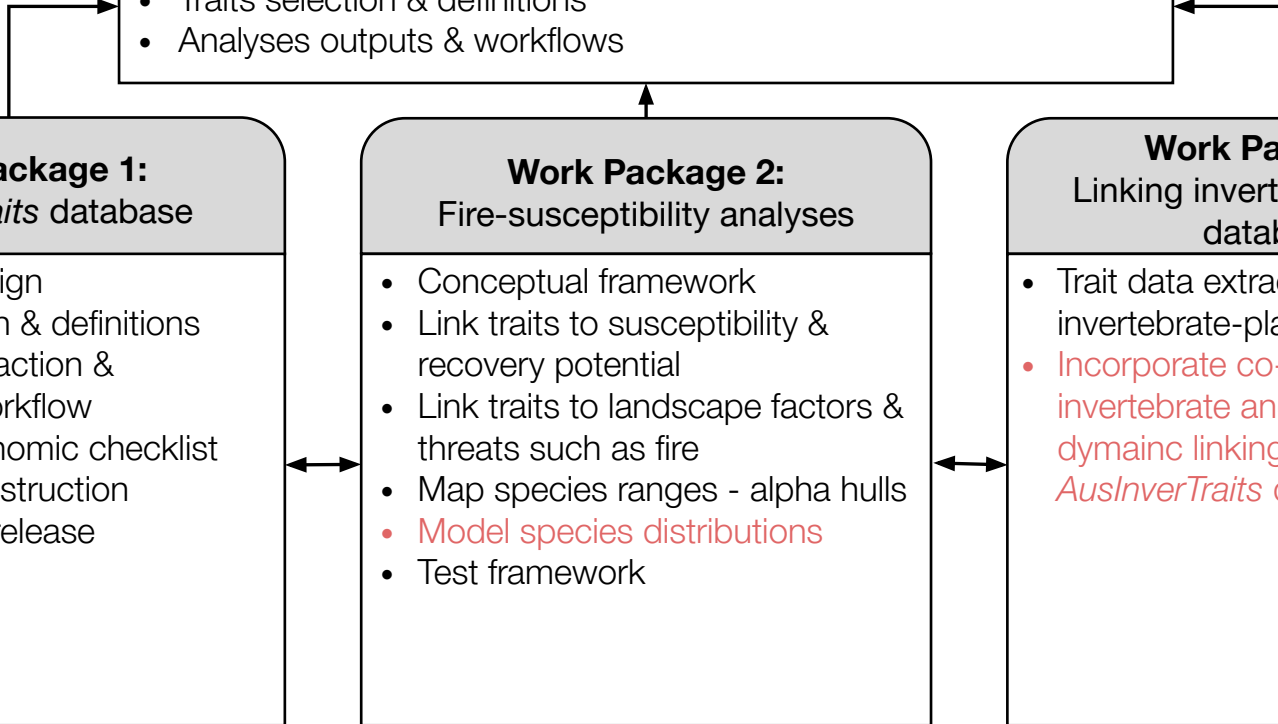
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### Work Package 2:
Fire-susceptibility analyses

- Conceptual framework
- Link traits to susceptibility & recovery potential
- Link traits to landscape factors & threats such as fire
- Map species ranges - alpha hulls
- Model species distributions
- Test framework

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### Work Package 3:
Linking invertebrate & plant databases

- Trait data extraction for invertebrate-plant interactions
- Incorporate co-susceptibility of invertebrate and plant species - dymainc linking of *AusTraits* & *AusInverTraits* databases

# Project outcomes

# *AusInverTraits* database

- Published on Zenodo, DOI: [10.5281/zenodo.10023667](10.5281/zenodo.10023667)
- A living database with a standard structure (potential to link to others)
- Currently contains data on:
  - 160 studies
  - 53 traits (ecological & life history)
  - 188 invertebrate families
  - 2,638 species + 2,016 morphospecies = 4,654 taxa
  - 25,681 taxa-trait combinations

Published October 20, 2023 | Version 0.0.0.9000          Dataset   🚫 Restricted

## InverTraits: a curated trait database for Australian invertebrates

Bal, Payal[1, 2] ⓘ; Ogilvie, Jane[2] ⓘ; Foon, Junn Kitt[3, 4, 2] ⓘ; Elizabeth, Wenk[5] ⓘ; Yang, Sophie[6] ⓘ;
Marsh, Jessica[7, 8, 9, 2] ⓘ                                                                    Show affiliations

The InverTraits database is a curated and standardised database of traits data for Australia's invertebrate taxa gathered from
hundreds of primary sources. It is developed in collaboration with AusTraits.

# *AusInverTraits* structure

## traits table

| dataset_id | taxon_name | observation_id | trait_name | value |
|---|---|---|---|---|
| Driscoll_2020 | Acantholophus crenaticollis | 001 | functional_role | herbivore |
| Driscoll_2020 | Acantholophus crenaticollis | 001 | microhabitat_activity | bark vegetation_understorey |
| Driscoll_2020 | Acantholophus crenaticollis | 001 | wing_development | wingless |
| Driscoll_2020 | Acantholophus franklinensis | 002 | body_length | 19 |
| Driscoll_2020 | Acantholophus franklinensis | 002 | functional_role | herbivore |
| Driscoll_2020 | Acantholophus franklinensis | 002 | microhabitat_activity | bark vegetation_understorey |
| Driscoll_2020 | Acantholophus franklinensis | 002 | wing_development | wingless |
| Driscoll_2020 | Acantholophus gravicollis | 003 | body_length | 20 |
| Driscoll_2020 | Acantholophus gravicollis | 003 | functional_role | herbivore |
| Driscoll_2020 | Acantholophus gravicollis | 003 | microhabitat_activity | bark vegetation_understorey |
| Driscoll_2020 | Acantholophus gravicollis | 003 | wing_development | wingless |

## methods

| dataset_id | trait_name | methods | method_id |
|---|---|---|---|
| Driscoll_2020 | wing_development | We sampled beetles from 23 transect and seven grid ... | 01 |
| Driscoll_2020 | functional_role | Trophic group was allocated based on expert knowle... | 01 |
| Driscoll_2020 | microhabitat_activity | Microhabitat position was based on Tom Weir's (CSIR... | 01 |
| Driscoll_2020 | body_length | Once collected, beetle sizes were based on medians o... | 01 |
| Dunn_2019 | microhabitat_activity | unknown | 01 |

## contexts (incl. plant-invert interactions)

| dataset_id | context_property | category | value |
|---|---|---|---|
| Driscoll_2020 | sex | entity_context | unreported |
| Driscoll_2020 | taxon specific life stage | entity_context | unreported |
| Driscoll_2020 | taxon specific life stage | entity_context | larva |
| Driscoll_2020 | associated plant taxa | entity_context | Eucalyptus |
| Driscoll_2020 | plant association | entity_context | folivore (herbivore) |

## locations (incl. fire impact)

| dataset_id | location_id | location_name | location_property |
|---|---|---|---|
| Driscoll_2020 | 01 | Eyre Peninsula, South Australia | description |
| Driscoll_2020 | 01 | Eyre Peninsula, South Australia | latitude (deg) |
| Driscoll_2020 | 01 | Eyre Peninsula, South Australia | longitude (deg) |
| Driscoll_2020 | 01 | Eyre Peninsula, South Australia | fire impact |
| Driscoll_2020 | 01 | Eyre Peninsula, South Australia | precipitation, mean annual (mm) |

## taxa

| taxonomic_reference | taxon_name | taxon_id | scientific_name_authorship | taxon_rank |
|---|---|---|---|---|
| AFD | Acantholophus crenaticollis | NA | NA | species |
| AFD | Acantholophus franklinensis | NA | NA | species |
| AFD | Acantholophus gravicollis | NA | NA | species |
| AFD | Acantholophus tribulus | NA | NA | species |
| AFD | Acherres granulatus | NA | NA | species |

# Trait-based assessment framework

INVERTEBRATES AUSTRALIA

landscape characteristics:
native veg, drought, fire,
fragmentation, protected
areas, proximity to roads

Landscape
risk factors

Fire
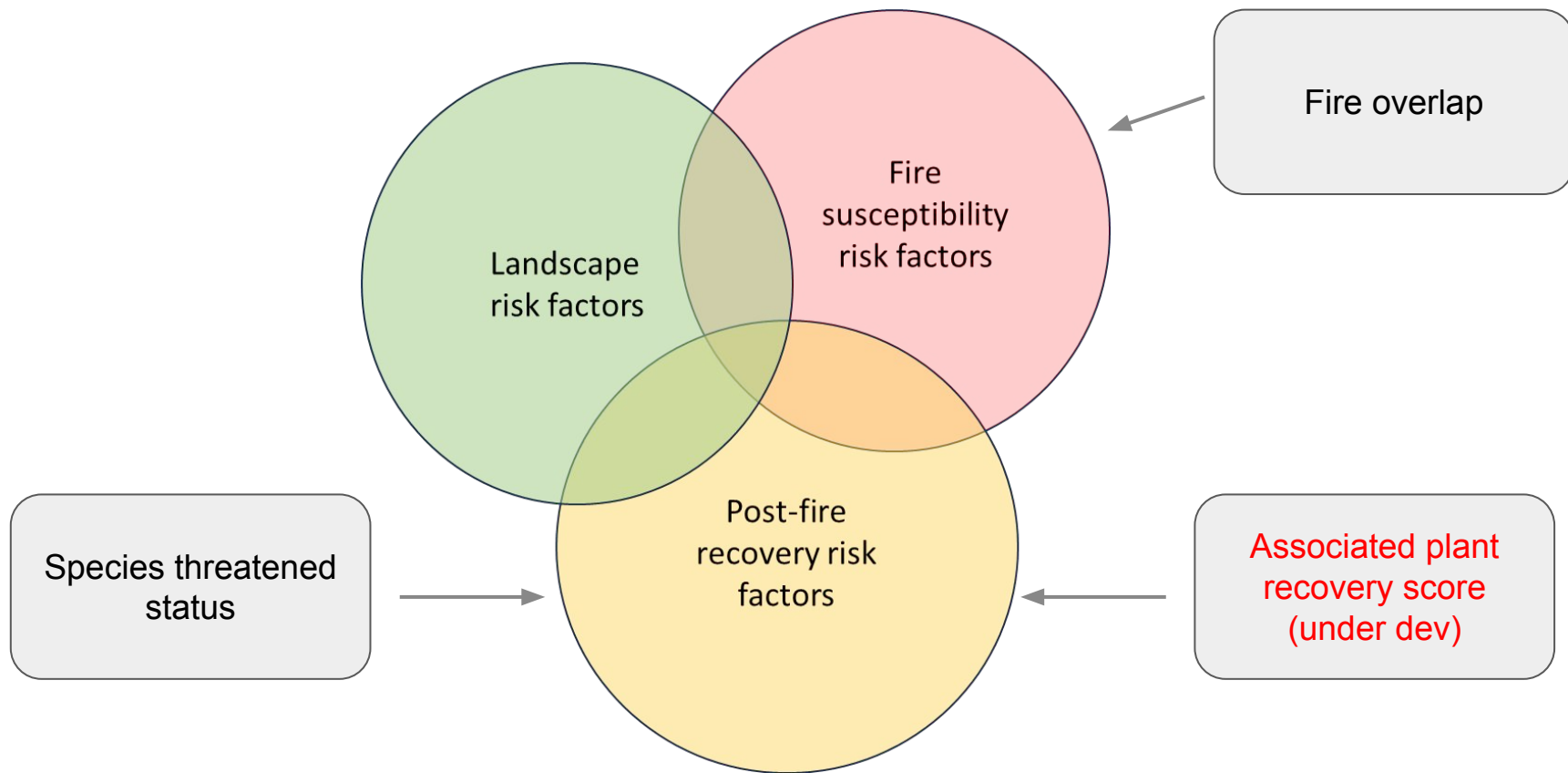susceptibility
risk factors

factors related to:
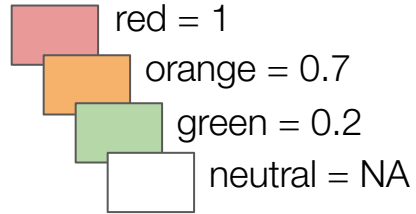microhabitat (activity,
shelter, nesting)

Post-fire
recovery risk
factors

traits related to:
morphology, physiology, life
history, demography,
movement, ecology, fire
response, range and
connectivity

# Trait-based assessment framework

**Flag scores**

red = 1
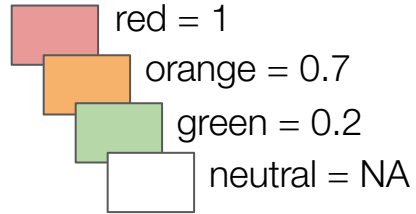orange = 0.7
green = 0.2
neutral = NA

Post-fire recovery risk factors

| Trait category | Trait name | Trait value | Risk flag |
|---|---|---|---|
| Life history & demography | degree_of_fecundity | high | green |
| | | very_high | green |
| | | moderate | orange |
| | | low | red |
| | life_span_categories | days | green |
| | | weeks | green |
| | | months | neutral |
| | | years_few | orange |
| | | years_many | red |
| Movement | dispersal_potential | high | green |
| | | moderately_high | neutral |
| | | moderately_low | orange |
| | | low | red |
| | dispersal_syndrome | active_flight | green |
| | | swimming | neutral |
| | | aerial_passive | neutral |
| | | aquatic_flow | neutral |
| | | phoretic | orange |
| | | terrestrial_movement | orange |
| Range & connectivity | species_range_categories | broad | green |
| | | restricted | orange |
| | | likely_sre | red |
| | | sre | red |

## Flag scores

red = 1
orange = 0.7
green = 0.2
neutral = NA

Landscape risk factors

| Landscape factor | Data categories | Risk flag |
|---|---|---|
| NVIS | native | green |
| | non-native | red |
| Protected areas | high protection | green |
| | moderate protection | green |
| | neutral protection | neutral |
| Distance to roads | >5 km | green |
| | 1 -5 km | orange |
| | 0-1 km | red |
| Drought | low absolute severity | green |
| | moderate-low | neutral |
| | high-moderate | orange |
| | high absolute severity | red |
| Fire severity | no data | neutral |
| | unburnt | green |
| | low and moderate | orange |
| | high | red |
| | Very high | red |
| Landsape frag / disturbance | low | green |
| | low-moderate | orange |
| | moderate-high | red |
| | high | red |

# Susceptibility analyses examples

Species A:

- FSI - Lives in deep burrow in the ground
- RRI - Dispersive, habitat generalist
- LFI - Connected landscape, large amount of habitat occurs in protected areas

**Low risk**

Species B:

- FSI - Lives in leaf litter
- RRI - Short range endemic, low dispersal capacity
- LFI - Highly fragmented landscape

**High risk**

# Susceptibility analyses examples

| Taxon name | LFI | FSI | RRI |
|---|---|---|---|
| Bembidion (Sloanephila) jacksoniense | 0.48 | 0.01 | |
| Euastacus clarkae | 0.45 | 0.26 | 0.74 |
| Euastacus guwinus | 0.43 | 0.71 | 0.72 |
| Kirkaldyella rugosa | 0.40 | 0.00 | 0.35 |
| Leoglymmius lignarius | 0.49 | 0.02 | |
| Percolestus blackburni | 0.44 | 0.01 | 1.00 |
| Pommerhelix duralensis | 0.49 | 0.05 | 0.59 |
| Eritingis trivirgata | | | 0.40 |
| Eucalyptolyma pollicaris | | | 0.70 |
| Trioza barrettae | | | 0.79 |
| Zephyrarchaea austini | | | 0.84 |

**LFI** = Landscape factor index

**FSI** = Fire susceptibility index

**RRI** = Risk recovery index

# Susceptibility analyses examples

| Taxon name | LFI | FSI | RRI | Species threatened status-score | Asssociated plant threat status-score |
|---|---|---|---|---|---|
| Bembidion (Sloanephila) jacksoniense | 0.48 | 0.01 | | | |
| Euastacus clarkae | 0.45 | 0.26 | 0.74 | EN | |
| Euastacus guwinus | 0.43 | 0.71 | 0.72 | CR | |
| Kirkaldyella rugosa | 0.40 | 0.00 | 0.35 | | |
| Leoglymmius lignarius | 0.49 | 0.02 | | | |
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| Eritingis trivirgata | | | 0.40 | | |
| Eucalyptolyma pollicaris | | | 0.70 | | EN |
| Trioza barrettae | | | 0.79 | CR | CR |
| Zephyrarchaea austini | | | 0.84 | CR | |

# Susceptibility analyses examples



INVERTEBRATES AUSTRALIA

| Taxon name | LFI | FSI | RRI |
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| Trioza barrettae | | | 0.79 |
| Zephyrarchaea austini | | | 0.84 |

Freshwater Crayfish or Yabby

© RB McCormack

Critically endangered

# What next?

- Assessment of other threats: climate change, invasive species, change in land use
- Short-range endemics
- Comprehensive taxonomic checklist for Australian invertebrates
- Quantifying uncertainty
- Inferences based on higher level taxonomy - for which taxonomic groups can you reliably infer ecology based on higher level taxonomy?
- Development of a standardised terminology around invertebrate traits

# Thank you

*References*

- Marsh, J. R. et al. (2021). Assessment of the impacts of the 2019-20 wildfires of southern and eastern Australia on invertebrate species Final Report.
- Marsh, J. R. et al. (2022). Accounting for the neglected: Invertebrate species and the 2019–2020 Australian megafires. *Global Ecology and Biogeography* 31:2120–2130
- https://www.theguardian.com/australia-news/2021/oct/20/overlooked-14000-invertebrate-species-lost-habitat-in-black-summer-bushfires-study-finds
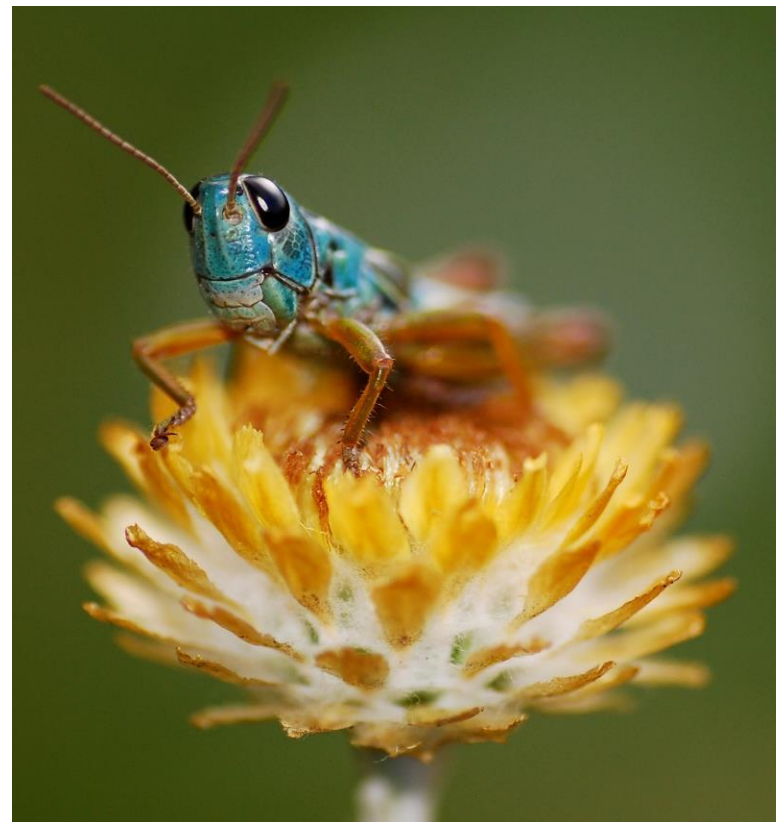
*Contacts*

- jessmarsh@invertsau.org
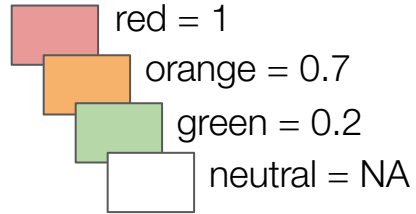- payal.bal@unimelb.edu.au

*Websites*

- Database release: https://zenodo.org/doi/10.5281/zenodo.10023666
- Database build: https://github.com/traitecoevo/ausinvertraits.build
- IA: https://invertebratesaustralia.org/

*Photo credits*

- Kate Umbers, Tanya Latty, Jess Marsh

## Flag scores



red = 1
orange = 0.7
green = 0.2
neutral = NA

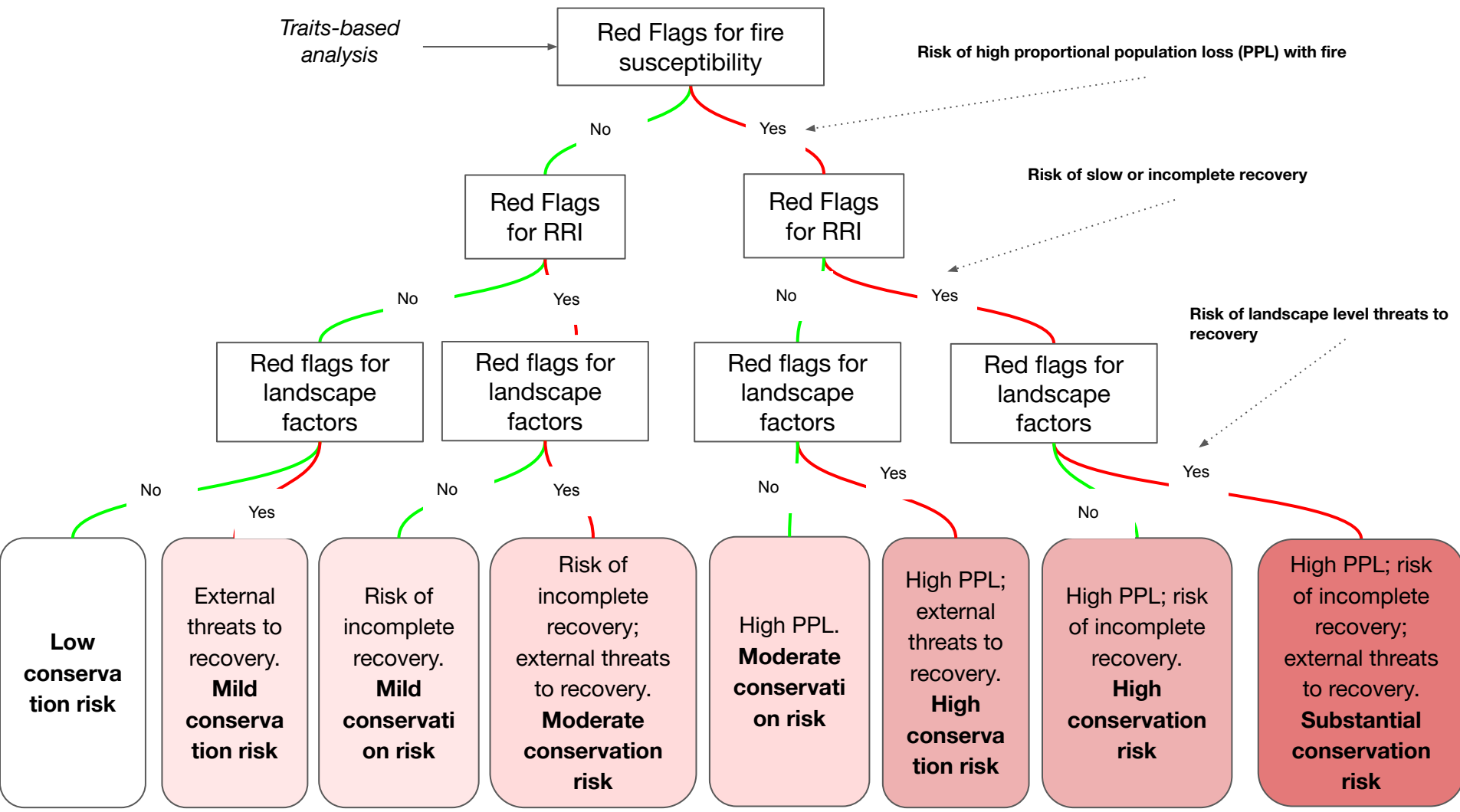| Trait category | Trait name | Unit | Trait value: MIN | Trait value: MAX | Risk flag |
|---|---|---|---|---|---|
| Range & connectivity | AOO | km2 | 0 | 500 | red |
| | | | 500.01 | 2000 | orange |
| | | | 2000.01 | Inf | green |
| | EOO | km2 | 0 | 5000 | red |
| | | | 5000.01 | 20000 | orange |
| | | | 20000.01 | Inf | green |
| Life history & demography | fecundity | eggs or offspring per year | 0 | 10 | red |
| | | | 10.01 | 100 | orange |
| | | | 100.01 | 1000 | neutral |
| | | | 1000.01 | Inf | green |
| | life_span | years | 0 | 365 | green |
| | | | 365.01 | 1825 | orange |
| | | | 1825.01 | Inf | red |
| | time_to_maturity | years | 0 | 182.5 | green |
| | | | 182.51 | 365 | neutral |
| | | | 365.01 | 730 | orange |
| | | | 730.01 | Inf | red |

# What next?

- …same as next slide on open questions?
- …something about looking for funding because look at all this other cool stuff we want to do/build on from this project
- … who is benefitting from this work already (collabs, project offshoots - **Jess can you provide some ideas from IA work?**
- …who will benefit from the planned work/what we propose next
- Involvement of JM in Biodiversity Council - this work gives us a stronger footing in providing comment/advice on key conservation issues …
- …anything else?

THE END.
Content after could possibly be included.

1. Risks of high fire susceptibility, low recovery capacity and landscape risk factors
2. Risks of high fire susceptibility & low recovery capacity.
3. Risks of high fire susceptibility & landscape risk factors.
4. Risks of low recovery capacity and landscape risk factors
5. Risks of high fire susceptibility
6. Risks of low recovery capacity
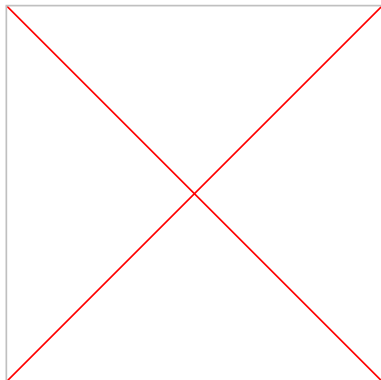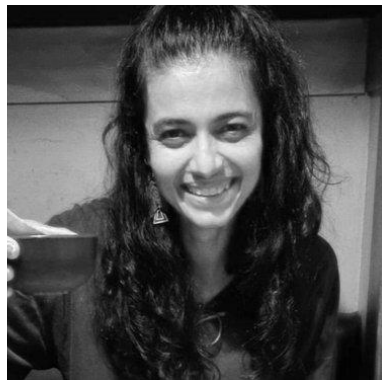7. Landscape risk factors
8. No red flags

# InverTraits:

## Invertebrate traits and fire susceptibility



INVERTEBRATES AUSTRALIA

# InverTraits Team

**Project: 8.3.1**

**Fire-affected invertebrates: Priority species and management response**

Project Leaders: John Woinarski

**Environmental investigations**

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Scientists say the animals are vital to ecosystem and true number affected is probably far higher

# What we learnt?

*Data on invertebrate species (occurrence, traits, fire response, etc.) is sparse - not available, not been collated and/or not easily accessible.*

- Fire impact ≠ fire overlap
- Species vary in their responses to fire
- Expand our assessments to more species

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- Develop robust assessment approach to estimate likely impacts of fire on Australian invertebrates
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- Open-access data, tools, and workflows to ensure reproducibility

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- Conceptual framework
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Fire-susceptibility analyses

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**Work Package 3:**
Linking invertebrate & plant databases

- Trait data extraction for invertebrate-plant interactions
- Incorporate co-susceptibility of invertebrate and plant species - dynamic linking of *AusTraits* & *AusInverTraits* databases

# Project outcomes

# *AusInverTraits* database

- Published on Zenodo, DOI: 10.5281/zenodo.10023667
- A living database with a standard structure (potential to link to others)
- Currently contains data on:
  - 160 studies
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  - 25,681 taxa-trait combinations

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Published October 20, 2023 | Version 0.0.0.9000                    **Dataset**   🚫 **Restricted**

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Marsh, Jessica[7, 8, 9, 2] (iD)                                                                              [ Show affiliations ]

The InverTraits database is a curated and standardised database of traits data for Australia's invertebrate taxa gathered from hundreds of primary sources. It is developed in collaboration with AusTraits.

# *AusInverTraits* structure

## traits table

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| Driscoll_2020 | Acantholophus franklinensis | 002 | body_length | 19 |
| Driscoll_2020 | Acantholophus franklinensis | 002 | functional_role | herbivore |
| Driscoll_2020 | Acantholophus franklinensis | 002 | microhabitat_activity | bark vegetation_understorey |
| Driscoll_2020 | Acantholophus franklinensis | 002 | wing_development | wingless |
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## methods

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| Driscoll_2020 | body_length | Once collected, beetle sizes were based on medians o… | 01 |
| Dunn_2019 | microhabitat_activity | unknown | 01 |

## contexts (incl. plant-invert interactions)

| dataset_id | context_property | category | value |
|---|---|---|---|
| Driscoll_2020 | sex | entity_context | unreported |
| Driscoll_2020 | taxon specific life stage | entity_context | unreported |
| Driscoll_2020 | taxon specific life stage | entity_context | larva |
| Driscoll_2020 | associated plant taxa | entity_context | Eucalyptus |
| Driscoll_2020 | plant association | entity_context | folivore (herbivore) |

## locations (incl. fire impact)

| dataset_id | location_id | location_name | location_property |
|---|---|---|---|
| Driscoll_2020 | 01 | Eyre Peninsula, South Australia | description |
| Driscoll_2020 | 01 | Eyre Peninsula, South Australia | latitude (deg) |
| Driscoll_2020 | 01 | Eyre Peninsula, South Australia | longitude (deg) |
| Driscoll_2020 | 01 | Eyre Peninsula, South Australia | fire impact |
| Driscoll_2020 | 01 | Eyre Peninsula, South Australia | precipitation, mean annual (mm) |

## taxa

| taxonomic_reference | taxon_name | taxon_id | scientific_name_authorship | taxon_rank |
|---|---|---|---|---|
| AFD | Acantholophus crenaticollis | NA | NA | species |
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| AFD | Acantholophus tribulus | NA | NA | species |
| AFD | Acherres granulatus | NA | NA | species |

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# Trait-based assessment framework

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landscape characteristics:
native veg, drought, fire,
fragmentation, protected
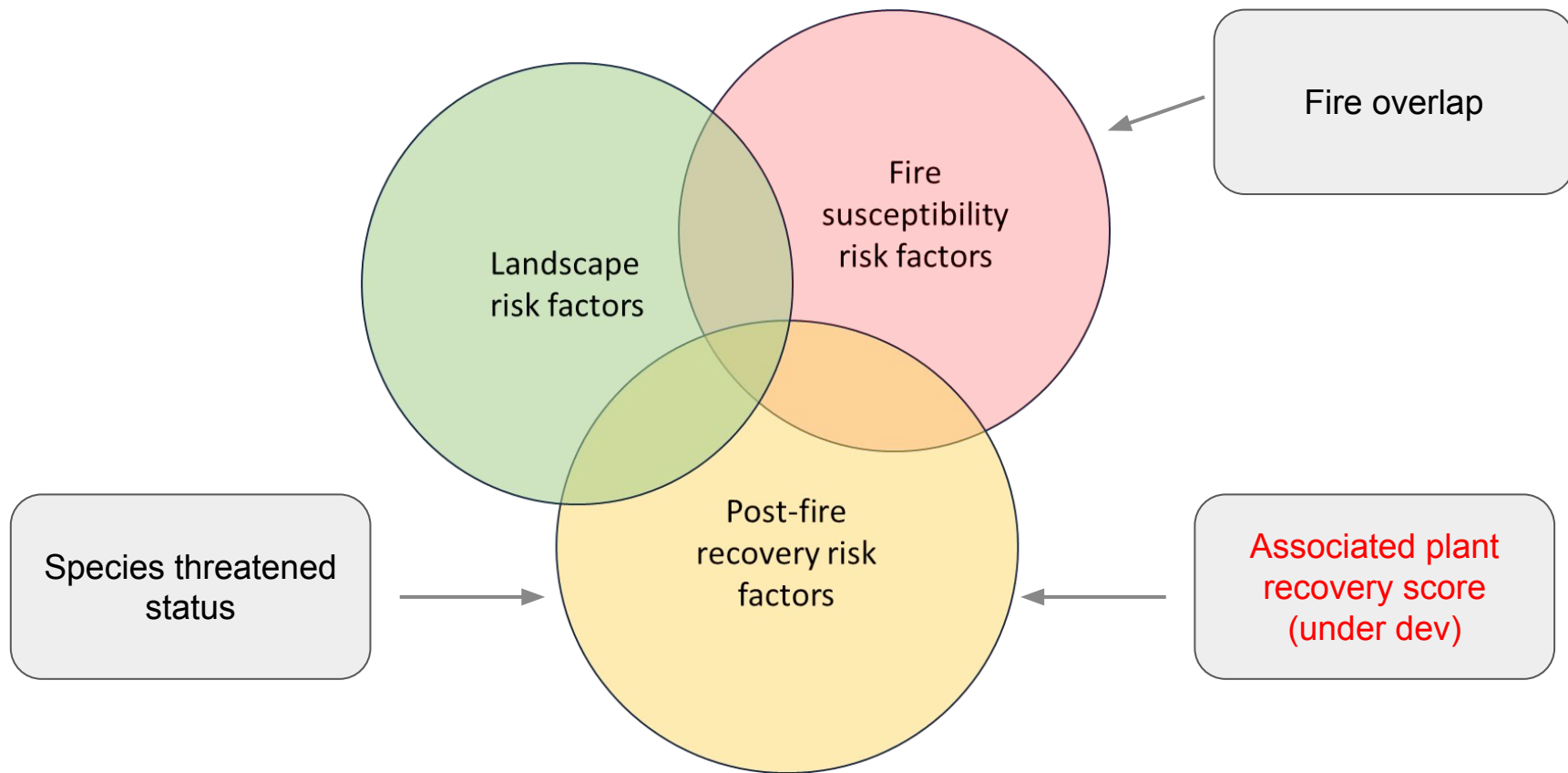areas, proximity to roads

Fire
susceptibility
risk factors

Landscape
risk factors

factors related to:
microhabitat (activity,
shelter, nesting)

Post-fire
recovery risk
factors
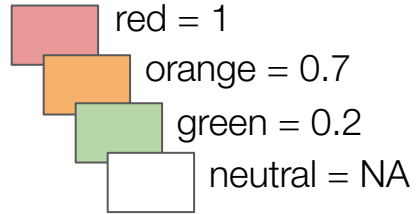
traits related to:
morphology, physiology, life
history, demography,
movement, ecology, fire
response, range and
connectivity

# Trait-based assessment framework

**Flag scores**

red = 1
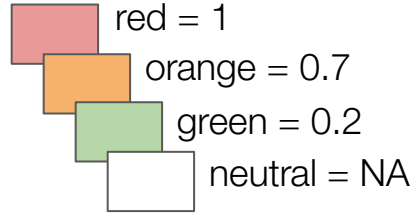orange = 0.7
green = 0.2
neutral = NA

Post-fire recovery
risk factors

| Trait category | Trait name | Trait value | Risk flag |
|---|---|---|---|
| Life history & demography | degree_of_fecundity | high | green |
| | | very_high | green |
| | | moderate | orange |
| | | low | red |
| | life_span_categories | days | green |
| | | weeks | green |
| | | months | neutral |
| | | years_few | orange |
| | | years_many | red |
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| | | moderately_high | neutral |
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| | | aerial_passive | neutral |
| | | aquatic_flow | neutral |
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**Flag scores**

red = 1
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|---|---|---|
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| | non-native | red |
| Protected areas | high protection | green |
| | moderate protection | green |
| | neutral protection | neutral |
| Distance to roads | >5 km | green |
| | 1 -5 km | orange |
| | 0-1 km | red |
| Drought | low absolute severity | green |
| | moderate-low | neutral |
| | high-moderate | orange |
| | high absolute severity | red |
| Fire severity | no data | neutral |
| | unburnt | green |
| | low and moderate | orange |
| | high | red |
| | Very high | red |
| Landsape frag / disturbance | low | green |
| | low-moderate | orange |
| | moderate-high | red |
| | high | red |

# Susceptibility analyses examples

Species A:

- FSI - Lives in deep burrow in the ground
- RRI - Dispersive, habitat generalist
- LFI - Connected landscape, large amount of habitat occurs in protected areas

**Low risk**

Species B:

- FSI - Lives in leaf litter
- RRI - Short range endemic, low dispersal capacity
- LFI - Highly fragmented landscape

**High risk**

# Susceptibility analyses examples

| Taxon name | LFI | FSI | RRI |
|---|---|---|---|
| Bembidion (Sloanephila) jacksoniense | 0.48 | 0.01 | |
| Euastacus clarkae | 0.45 | 0.26 | 0.74 |
| Euastacus guwinus | 0.43 | 0.71 | 0.72 |
| Kirkaldyella rugosa | 0.40 | 0.00 | 0.35 |
| Leoglymmius lignarius | 0.49 | 0.02 | |
| Percolestus blackburni | 0.44 | 0.01 | 1.00 |
| Pommerhelix duralensis | 0.49 | 0.05 | 0.59 |
| Eritingis trivirgata | | | 0.40 |
| Eucalyptolyma pollicaris | | | 0.70 |
| Trioza barrettae | | | 0.79 |
| Zephyrarchaea austini | | | 0.84 |

**LFI** = Landscape factor index

**FSI** = Fire susceptibility index

**RRI** = Risk recovery index

# Susceptibility analyses examples

| Taxon name | LFI | FSI | RRI | | Species threatened status-score | Asssociated plant threat status-score |
|---|---|---|---|---|---|---|
| Bembidion (Sloanephila) jacksoniense | 0.48 | 0.01 | | | | |
| Euastacus clarkae | 0.45 | 0.26 | 0.74 | | EN | |
| Euastacus guwinus | 0.43 | 0.71 | 0.72 | | CR | |
| Kirkaldyella rugosa | 0.40 | 0.00 | 0.35 | | | |
| Leoglymmius lignarius | 0.49 | 0.02 | | | | |
| Percolestus blackburni | 0.44 | 0.01 | 1.00 | | | |
| Pommerhelix duralensis | 0.49 | 0.05 | 0.59 | | EN | |
| Eritingis trivirgata | | | 0.40 | | | |
| Eucalyptolyma pollicaris | | | 0.70 | | | EN |
| Trioza barrettae | | | 0.79 | | CR | CR |
| Zephyrarchaea austini | | | 0.84 | | CR | |

# Susceptibility analyses examples


INVERTEBRATES AUSTRALIA

| Taxon name | LFI | FSI | RRI |
|---|---|---|---|
| Bembidion (Sloanephila) jacksoniense | 0.48 | 0.01 | |
| Euastacus clarkae | 0.45 | 0.26 | 0.74 |
| Euastacus guwinus | 0.43 | 0.71 | 0.72 |
| Kirkaldyella rugosa | 0.40 | 0.00 | 0.35 |
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| Trioza barrettae | | | 0.79 |
| Zephyrarchaea austini | | | 0.84 |


Freshwater Crayfish or Yabby
© RB McCormack

Critically endangered

# What next?

- Assessment of other threats: climate change, invasive species, change in land use
- Short-range endemics
- Comprehensive taxonomic checklist for Australian invertebrates
- Quantifying uncertainty
- Inferences based on higher level taxonomy - for which taxonomic groups can you reliably infer ecology based on higher level taxonomy?
- Development of a standardised terminology around invertebrate traits

# Thank you

*References*

- Marsh, J. R. et al. (2021). Assessment of the impacts of the 2019-20 wildfires of southern and eastern Australia on invertebrate species Final Report.
- Marsh, J. R. et al. (2022). Accounting for the neglected: Invertebrate species and the 2019–2020 Australian megafires. *Global Ecology and Biogeography* 31:2120–2130
- https://www.theguardian.com/australia-news/2021/oct/20/overlooked-14000-invertebrate-species-lost-habitat-in-black-summer-bushfires-study-finds
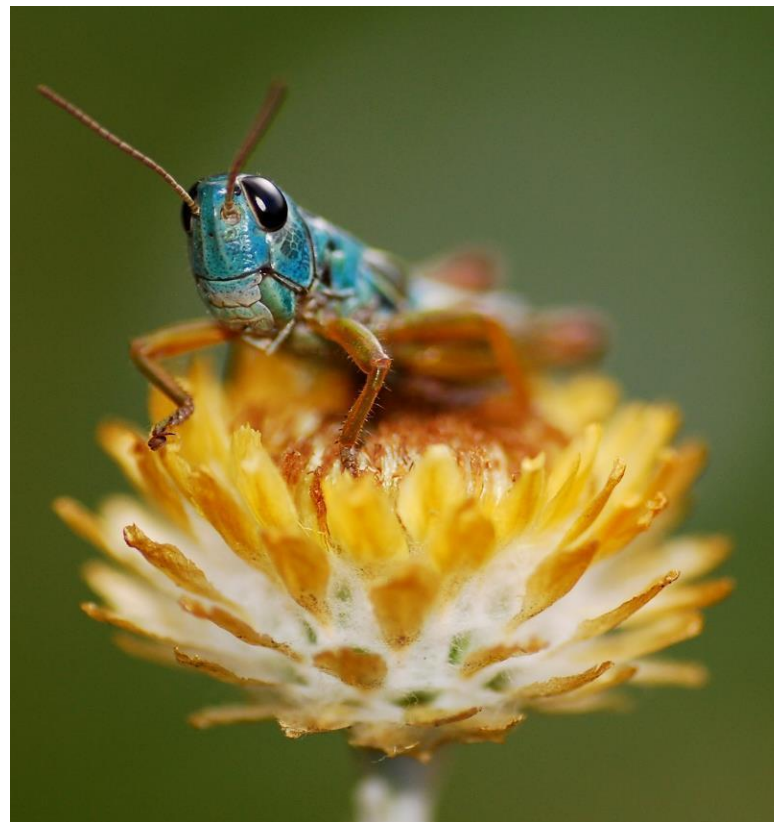
*Contacts*

- jessmarsh@invertsau.org
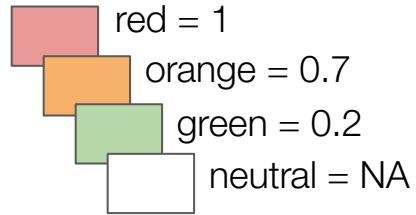- payal.bal@unimelb.edu.au

*Websites*

- Database release: https://zenodo.org/doi/10.5281/zenodo.10023666
- Database build: https://github.com/traitecoevo/ausinvertraits.build
- IA: https://invertebratesaustralia.org/

*Photo credits*

- Kate Umbers, Tanya Latty, Jess Marsh

## Flag scores

red = 1
orange = 0.7
green = 0.2
neutral = NA

| Trait category | Trait name | Unit | Trait value: MIN | Trait value: MAX | Risk flag |
|---|---|---|---|---|---|
| Range & connectivity | AOO | km2 | 0 | 500 | red |
| | | | 500.01 | 2000 | orange |
| | | | 2000.01 | Inf | green |
| | EOO | km2 | 0 | 5000 | red |
| | | | 5000.01 | 20000 | orange |
| | | | 20000.01 | Inf | green |
| Life history & demography | fecundity | eggs or offspring per year | 0 | 10 | red |
| | | | 10.01 | 100 | orange |
| | | | 100.01 | 1000 | neutral |
| | | | 1000.01 | Inf | green |
| | life_span | years | 0 | 365 | green |
| | | | 365.01 | 1825 | orange |
| | | | 1825.01 | Inf | red |
| | time_to_maturity | years | 0 | 182.5 | green |
| | | | 182.51 | 365 | neutral |
| | | | 365.01 | 730 | orange |
| | | | 730.01 | Inf | red |

# What next?

- …same as next slide on open questions?
- …something about looking for funding because look at all this other cool stuff we want to do/build on from this project
- … who is benefitting from this work already (collabs, project offshoots - **Jess can you provide some ideas from IA work?**
- …who will benefit from the planned work/what we propose next
- Involvement of JM in Biodiversity Council - this work gives us a stronger footing in providing comment/advice on key conservation issues …
- …anything else?

THE END.
Content after could possibly be included.

1. Risks of high fire susceptibility, low recovery capacity and landscape risk factors
2. Risks of high fire susceptibility & low recovery capacity.
3. Risks of high fire susceptibility & landscape risk factors.
4. Risks of low recovery capacity and landscape risk factors
5. Risks of high fire susceptibility
6. Risks of low recovery capacity
7. Landscape risk factors
8. No red flags