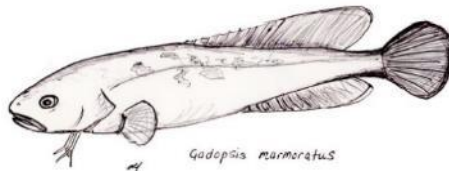


AQUASAVE - NatureGlenelgTrust



Ecology, Monitoring, Conservation

# The 2022 Action Plan for priority 2019–20 bushfire- impacted species from Australia's endemic freshwater crayfish genus *Euastacus* (Parastacidae)

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Many photos in this report show crayfish in captive settings and do not depict the species’ natural habitat. The photographer is Rob McCormack.

*Disclaimer*

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### *Acknowledgement of the Traditional Owners of Australia*

We respectfully acknowledge the Traditional Owners of the lands on which this work took place, their Elders past, present and emerging, the First Nations of Australia, and their cultural, social, environmental, spiritual, and economic connections to their lands and water.

### *A note on common names*

Common names are, at times, ambiguously assigned for species of *Euastacus*, and the scientific name should be used as the definitive identifier for all species. Most species were formally described without designation of a common name, and several common names have been subsequently assigned for some species. The various common names either derive from the literature or may reflect regional or local names currently used by some stakeholders. In acknowledging this confusion, we have adopted the currently used common name.

## EXECUTIVE SUMMARY

The endemic Australian freshwater crayfish genus *Euastacus* is considered one of the most threatened genus of freshwater crayfish in the world, with its members facing an uncertain future. In providing an up-to-date conservation assessment, this Action Plan affirms the threatened status of the bushfire-impacted priority species of *Euastacus*. In total, five species were assessed as Critically Endangered and 13 species as Endangered (with conservation assessment not currently possible for three of the priority species). Importantly, this up-to-date assessment outlined in this Action Plan is contributing to the proposed formal listing of 17 species of *Euastacus* under the Australian *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*.

To assist with management and conservation, the Action Plan compiles existing knowledge on taxonomy, conservation status, description, cultural significance, distribution and habitat, biology and ecology as well as threats, conservation priorities and knowledge gaps for each priority *Euastacus*. Furthermore, the Action Plan outlines nine priorities for the conservation and management of bushfire-impacted priority species of *Euastacus*, which are equally relevant to all members of the genus. The priorities are to:

- Undertake formal national assessment for all *Euastacus* and develop recovery plan(s);
- Mitigate threats and implement conservation actions;
- Incorporate and include *Euastacus* into management strategies and actions at multiple scales;
- Define species' range boundaries and implement ongoing population monitoring programs;
- Resolve taxonomic uncertainty and formally describe putative species;
- Redress previously identified critical biological and ecological knowledge gaps;
- Explore species-specific conservation translocations;
- Engage stakeholders in management and conservation; and
- Raise the profile of the *Euastacus* within governments, NGOs and funding bodies.

It is hoped that this Action Plan will establish a platform for the genus-level conservation and management species of *Euastacus*, which are a critically important and vulnerable component of Australia's distinctive inland aquatic biodiversity.

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## 1. BACKGROUND

### 1.1 Freshwater crayfish conservation

Freshwater crayfish are a diverse taxonomic group, with currently more than 590 currently described species across four families worldwide (Parastacidae, Cambaridae, Cambaroididae and Astacidae) found in a wide range of aquatic habitats ([Ahyong 2014](#); [Crandall and De Grave 2017](#); [Richman et al. 2015](#)). In many parts of the world freshwater crayfish are under threat with at least one-third of all species considered at risk of extinction ([Richman et al. 2015](#)). The endemic Australian freshwater crayfish genus *Euastacus* is considered the most threatened genus of freshwater crayfish in the world, with 80% of its current described species listed under International Union for Conservation of Nature (IUCN) threat categories ([Furse and Coughran 2011b](#); [Richman et al. 2015](#)).

Freshwater crayfish are primarily threatened by over-exploitation, fragmentation of habitats and climate change ([Collen et al. 2014](#); [Hossain et al. 2018](#); [Richman et al. 2015](#)). Although not immediately obvious, the complex and dynamic impacts of bushfires, which are predominately realised with post-fire runoff events ([Gomez Isaza et al. 2022](#)), have emerged as a key threatening process for *Euastacus* ([Legge et al. 2021](#)). Indeed, the 2019–20 Australian megafires that burned over 10 million hectares of the Australian continent ([Bowman et al. 2020](#); [Ward et al. 2020](#)) were predicted to have impacted 40% of the known species of *Euastacus* ([Legge et al. 2022](#); [Legge et al. 2021](#)). Extinction risk in freshwater crayfish is significantly linked to range size, body size and habitat specialisation ([Bland 2017](#)). For species of *Euastacus*, distinctive life history traits including limited dispersal, slow growth, late maturity, slow population turnover (high longevity) and low egg production (fecundity), are anticipated to further heighten their vulnerability to environmental perturbations such as bushfires.

Urgent conservation actions are necessary for freshwater crayfish, especially for species of *Euastacus*. To this end, the ‘Saving the Spiny: urgent actions to conserve the *Euastacus* freshwater crayfish’ project, funded by the Australian Government’s Bushfire Wildlife and Habitat Recovery Program, addressed recovery actions for bushfire-impacted priority species of *Euastacus* (but with broader focus on the entire genus). This multi-faceted project incorporated field surveys and specimen collection, taxonomic identification, evaluation of

the feasibility of conservation translocations and conservation assessments (against Australian *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) criteria) along with the collection of molecular genetic data to support taxonomic analyses and the application of environmental DNA (eDNA) methodology to assist range determination. This report combines the outcomes of multiple components of the project into species accounts intended to inform, assist with and guide future conservation and management initiatives.

## 1.2 Conservation status of species of *Euastacus*

*Euastacus* is a member of Australia's diverse and distinctive endemic freshwater crayfish fauna. The genus currently includes 53 described species distributed from southern mainland Australia to far north Queensland ([Clark 1936](#); [Clark 1941](#); [Coughran 2002](#); [Coughran 2005](#); [Coughran and Leckie 2007](#); [Coughran and McCormack 2011](#); [Furse et al. 2013](#); [Heller 1865](#); [McCormack and Ahyong 2017](#); [McCormack and Coughran 2008](#); [McCoy 1867](#); [McCulloch 1917](#); [Milne Edwards 1837](#); [Morgan 1986](#); [Morgan 1988](#); [Morgan 1997](#); [Riek 1951](#); [Riek 1956](#); [Riek 1969](#); [Short and Davie 1993](#); [Smith 1912](#); [von Martens 1866](#); [Watson 1935](#)). In total, 42 species of *Euastacus* are listed under IUCN threat categories, with 19 species listed as Critically Endangered, 18 species listed as Endangered and five species listed as Vulnerable ([Furse and Coughran 2011b](#); [Richman et al. 2015](#)). However, only three species are currently listed under the EPBC Act, these being the Critically Endangered *Euastacus bindal*, the Critically Endangered *Euastacus dharawalus* and the Endangered *Euastacus bispinosus*. All priority species of *Euastacus* believed to be most impacted by the 2019–20 Australian megafires ([Legge et al. 2022](#); [Legge et al. 2021](#)), are listed (or preliminarily assessed) as threatened under IUCN, but none are listed under the EPBC Act.

The Saving the Spinys project focused on redressing this underrepresentation by undertaking species nominations (including listing assessment and conservation advice) for all bushfire-impacted priority species. Where the listing assessment for each species is supported by the Threatened Species Scientific Committee and the Minister for Environment, listing under the EPBC Act will result.

### 1.3 *Insight from molecular taxonomic analyses*

Accurate and complete understanding of species delineation and range boundaries forms the fundamental basis to assess the conservation status and long-term trends of species. To improve our incomplete understanding in this area, the most comprehensive molecular taxonomic analyses ever conducted for *Euastacus* (and speciose genera of freshwater crayfish) – accounting for major populations of all known 53 species as well as the three priority undescribed species – were implemented through the Saving the Spinys project ([Austin et al. 2022](#)). The analyses provide support for the distinctiveness of all described species of *Euastacus* (except the undescribed *Euastacus* sp. 2 as well as the taxonomic uncertainty of *Euastacus gumar* and *Euastacus pilosus*) and revealed a very high and unanticipated level of unrealised diversity. Taken together, these analyses provided a molecular taxonomic basis for the presence of up to 82 putative species within *Euastacus*, with as many as 27 being new species (with full evaluation requiring additional lines of evidence); this represents an approximately 50% increase in the number of species within the genus. Importantly, the findings of Austin et al. ([2022](#)) confirm, and improve our understanding on the range boundaries of many species of *Euastacus*. Nevertheless, some uncertainty as to the completeness of the taxonomic framework for the genus remains, which precluded listing assessment for some species – ongoing population surveys and research on taxonomic and genetic variation within *Euastacus* is required.

### 1.4 *Species action plans*

Species action plans aim to assess the extinction risk status of groups of Australian biodiversity and to help ensure national lists of threatened species are as accurate and up-to-date as possible. Australia has action plans for a variety of taxa including *The Action Plan for Australian Birds 2010* ([Garnett et al. 2011](#)), *The Action Plan for Australian Mammals 2012* ([Woinarski et al. 2014](#)), *The Action Plan for Australian Lizards and Snakes 2017* ([Chapple et al. 2019](#)), and *The Action Plan for Australian Sharks and Rays 2021* ([Kyne et al. 2021](#)), but there has been an absence of an action planning for most Australia for freshwater species (see [Tyler 1997](#); [Wager and Jackson 1993](#)), including the crayfish of genus *Euastacus*. The present report partially rectifies this deficiency by providing an action plan for priority 2019–20 bushfire impacted species of *Euastacus*.



### 1.5 Action plan objectives

The objective of this Action Plan is to provide a comprehensive and standardised assessment of the status of the 21 recognised bushfire-impacted priority species of *Euastacus*. It draws on existing and newly gained knowledge to provide up-to-date conservation assessment, identification of threats and provide species-specific recommendations to help guide management for their conservation. Similar to other action plans for taxon groups in Australia (cf. [Chapple et al. 2019](#); [Garnett et al. 2011](#); [Kyne et al. 2021](#); [Woinarski et al. 2014](#)), the aims of *The 2022 Action Plan for priority 2019–20 bushfire-impacted species from Australia’s endemic freshwater crayfish genus Euastacus* are to:

- summarise current listing assessments to provide an overview of the conservation status of all priority species of *Euastacus* against EPBC Act criteria;
- identify those priority species most urgently requiring conservation management attention;
- identify threats to the endemic Australian *Euastacus* and to recommend priority actions to ameliorate those threats;
- outline previously identified, and identify additional critical information gaps that substantially compromise, or preclude, status assessment and conservation responses; and
- act to raise the profile and highlight conservation needs of *Euastacus*.

This Action Plan will contribute to the conservation of a subset of *Euastacus*; it is hoped that it will form the basis of future genus-level action planning.

## 2. METHODS

In this Action Plan, the conservation status of each priority species of *Euastacus* was assessed at a whole-of-range, national level (under the EPBC Act) in accordance with IUCN Red List Categories and Criteria ([Version 3.1: IUCN 2012](#)). Under the EPBC Act, the following IUCN Red List Threat Categories are relevant:

- **Extinct (EX)**: ‘there is no reasonable doubt that the last individual has died’;
- **Extinct in the Wild (EW)**: a species ‘is known only to survive in cultivation, in captivity or as a naturalised population (or populations) well outside the past range’;
- **Critically Endangered (CR)**: a species ‘is facing an *extremely high* risk of extinction in the wild’;
- **Endangered (EN)**: a species ‘is facing a *very high* risk of extinction in the wild’; and
- **Vulnerable (VU)**: a species ‘is facing a *high* risk of extinction in the wild’.

IUCN Red List non-Threat Categories of Near Threatened (NT), Least Concern (LC) or Data Deficient (DD) are not applied under the EPBC Act.

The IUCN Red List Categories and Criteria utilise a series of thresholds to evaluate extinction risk based on population size reduction (Criterion A), geographic range (Criterion B), population size (Criteria C and D), or the probability of extinction (Criterion E) (Table 2-1). Each assessment considered all available information on a species’ taxonomy, distribution, population status, habitat and ecology, major threats, use and trade, and conservation measures. The IUCN Red List Categories and Criteria ([Version 3.1: IUCN 2012](#)) were applied following the version 15 of the *Guidelines for Using the IUCN Red List Categories and Criteria* ([IUCN Standards and Petitions Committee 2022](#)).

For each species, existing knowledge was compiled with historical and contemporary records (obtained from field surveys and molecular taxonomic analyses as part of the Saving the Spiny project) utilised to define range (i.e., extent of occurrence (EOO), area of occupancy (AOO)). This information allowed for assessment against the IUCN criteria in accordance with listing assessment and conservation advice process under the EPBC Act; the conservation advice for each species details conservation and recovery actions to guide management and will become publicly available once the species is listed. The species accounts in this Action Plan provide a summary of outcomes of the listing assessment and conservation advice process.

Table 2-1. Summary of the five criteria (A–E) used to evaluate if a taxon belongs in an IUCN Red List Threatened Category ([IUCN 2012](#)) and Guidelines for Using the IUCN Red List Categories and Criteria ([IUCN Standards and Petitions Committee 2022](#)).

Threat category	CRITICALLY ENDANGERED	ENDANGERED	VULNERABLE
<b>A. Population size reduction measured over the longer of 10 years or 3 generations) based on any of A1–A4</b>			
A1	≥90%	≥70%	≥50%
A2, A3 & A4	≥80%	≥50%	≥30%
<b>A1.</b> Population reduction observed, estimated, inferred or suspected in the past where the causes of the reduction are clearly reversible AND understood AND ceased, based on and specifying any of the following: (a) direct observation; (b) an index of abundance appropriate to the taxon; (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat; (d) actual or potential levels of exploitation; (e) effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites			
<b>A2.</b> Population reduction observed, estimated, inferred or suspected in the past where the causes of the reduction may not have ceased OR may not be understood OR may not be reversible, based on any of (a) to (e) under A1			
<b>A3.</b> Population reduction projected or suspected to be met in the future (up to a maximum of 100 years) based on any of (b) to (e) under A1			
<b>A4.</b> An observed, estimated, inferred, projected or suspected population reduction where the time period must include both the past and the future (up to a maximum of 100 years in future), and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible, based on any of (a) to (e) under A1			
<b>B. Geographic range in the form of either B1 (extent of occurrence) AND/OR B2 (area of occupancy)</b>			
<b>B1.</b> Extent of Occurrence (EOO)	<100km <sup>2</sup>	<5000km <sup>2</sup>	<20,000km <sup>2</sup>
<b>B2.</b> Area of Occupancy (AOO)	<10km <sup>2</sup>	<500km <sup>2</sup>	<2000km <sup>2</sup>
AND at least 2 of the following 3 conditions:			
(a) Severely fragmented OR number of locations	=1	≤5	≤10
(b) Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals			
(c) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals			
<b>C. Small population size and decline</b>			
Number of mature individuals	<250	<2500	<10,000
AND at least one of C1 or C2:			
<b>C1.</b> An observed, estimated or projected continuing decline of at least (up to a maximum of 100 years in future):	25% in 3 years or 1 generation (whichever is longer)	20% in 5 years or 2 generations (whichever is longer)	10% in 10 years or 3 generations (whichever is longer)
<b>C2.</b> An observed, estimated, projected or inferred continuing decline AND at least 1 of the following 3 conditions			
(a) (i) Number of mature individuals in each subpopulation	≤50	≤250	≤1000
(a) (ii) % mature individuals in 1 subpopulation =	90–100%	95–100%	100%
(b) Extreme fluctuations in the number of mature individuals			
<b>D. Very small or restricted population</b>			
<b>D1.</b> Number of mature individuals	<50	<250	<1000
<b>D2.</b> Restricted area of occupancy (AOO) or number of locations	-	-	Typically: AOO <20km <sup>2</sup> or number of locations ≤5
<b>E. Quantitative analysis</b>			
Indicating the probability of extinction in the to be	≥50% in 10 years or 3 generations, whichever is longer (100 years maximum)	≥20% in 20 years or 5 generations, whichever is longer (100 years maximum)	≥10% in 100 years

### 3. CONSERVATION STATUS

The assessment of the conservation status confirmed the high level of extinction risk amongst priority species of *Euastacus* (Table 3-1). In summary, seven species were provisionally assessed as Critically Endangered, implying they face an extremely high risk of extinction, and 12 species provisionally as Endangered, which indicate they face a high risk of extinction. Assessment was not possible for three species due to uncertainty relating to taxonomy and clarity on range boundaries ([Austin et al. 2022](#)). For the 34 species of *Euastacus* that were not specific priorities for this study (Table 3-2), there are 24 species that are already listed as threatened under IUCN (with others as Least Concern or Data Deficient), but only three are listed under the EPBC Act. It is noted that seven further currently subject of national assessment following state-led nomination (provisionally Critically Endangered or Endangered).

Table 3-1. Summary of the state (where species occurs) and international (IUCN) conservation status of the priority species of *Euastacus* along with their proposed national (EPBC) status. Threat categories are: Critically Endangered (CR); Endangered (EN) and Vulnerable (VU) with not assessed (NA) or not listed (-) species also indicated.

Species name		Existing status		Range		Proposed EPBC	
Scientific	Common	IUCN	State/territory	EOO (km <sup>2</sup> )	AOO (km <sup>2</sup> )	Category	Criteria
<i>Euastacus bidawalus</i>	East Gippsland Spiny Crayfish	EN	NSW: - VIC: VU	2609	248	EN	B1ab(i,ii,iii) + 2ab(i,ii,iii)
<i>Euastacus clarkae</i>	Clark's Crayfish	EN	NSW: -	207	72	EN	B1ab(iii,v) + 2ab(iii,v)
<i>Euastacus claytoni</i>	Clayton's Crayfish	EN	NSW: - VIC: EN	-	-	NA	
<i>Euastacus crassus</i>	Alpine Crayfish	EN	ACT: -			NA	
<i>Euastacus dalagarbe</i>	Mud Gully Crayfish	CR	NSW: - QLD: -	67	36	CR	B1ab(iii,v)
<i>Euastacus diversus</i>	Orbost Spiny Crayfish	EN	VIC: EN	1850	260	EN	B1ab(iii) + 2ab(iii)
<i>Euastacus gamilaroi</i>	Gamilaroi Crayfish	CR	NSW: -	210	68	EN	B1ab(iii)
<i>Euastacus girurmulayn</i>	Smooth Crayfish	CR	NSW: -	121	36	EN	B1ab(iii,v) + 2ab(iii,v)
<i>Euastacus gumar</i>	Blood Crayfish	EN	NSW: -	1686	64	EN	B1ab(iii,v) + 2ab(iii,v)
<i>Euastacus guwinus</i>	Tianjara Crayfish	CR	NSW: -	16	16	CR	B1ab(iii,v)
<i>Euastacus jagabar</i>	Blue-Black Crayfish	CR	NSW: -	8	8	CR	B1ab(iii) + 2ab(iii)
<i>Euastacus jagara</i>	Jagara Hairy Crayfish	CR	QLD: CR	28	28	CR	B1ab(iii)
<i>Euastacus morgani</i>	Morgan's Crayfish	NA	NSW: -	4	4	CR	B1ab(iii,v) + 2ab(iii,v)
<i>Euastacus pilosus</i>	Hairy Cataract Crayfish	EN	NSW: -	459	52	EN	B1ab(iii) + 2ab(iii)
<i>Euastacus polysetosus</i>	Many-bristled Crayfish	EN	NSW: -	637	88	EN	B1ab(iii) + 2ab(iii)
<i>Euastacus rieki</i>	Riek's Crayfish	EN	ACT: - NSW: -	4476	180	EN	B1ab(i,ii,iii,v) + 2ab(i,ii,iii,v)
<i>Euastacus simplex</i>	Simple Crayfish	VU	NSW: -	297	36	EN	B1ab(iii,iv) + 2ab(iii,iv)
<i>Euastacus spinichelatus</i>	Small Crayfish	EN	NSW: -	295	44	EN	B1ab(iii,iv) + 2ab(iii,iv)
<i>Euastacus suttoni</i>	Sutton's Crayfish	VU	NSW: - QLD: -	2719	84	EN	B1ab(iii,v) + 2ab(iii,v)
<i>Euastacus</i> sp. nov. 1 ( <i>Euastacus coughrani</i> )	Coughran's Crayfish	NA	VIC: -	250	44	EN	B1ab(iii) + 2ab(iii)
<i>Euastacus</i> sp. 2	-	Validity not supported ( <a href="#">Austin et al. 2022</a> )					
<i>Euastacus</i> sp. nov. 3	West Snowy Spiny Crayfish	NA	VIC: -	12	12	NA	

Table 3-2. Summary of the international (IUCN) and national (EPBC) status of the non-priority bushfire-related species of *Euastacus* (conservation status is **CR** = Critically Endangered; **EN** = Endangered; and **VU** = Vulnerable). Species that are currently subject of national assessment following state-led nomination are indicated with their provisional EPBC status.

Species name		Species authority	Status	
Scientific	Common		Global (IUCN)	National (EPBC)
<i>Euastacus angustus</i>	Narrow Crayfish	Coughran & Dawkins, 2013	CR	-
<i>Euastacus armatus</i>	Murray Crayfish	(von Martens, 1866)	DD	-
<i>Euastacus australasiensis</i>	Australian Crayfish	(Milne Edwards, 1837)	LC	-
<i>Euastacus balanensis</i>	Balan Spiny Crayfish	Morgan, 1988	EN	-
<i>Euastacus bindal</i>	Mount Elliot Crayfish	Morgan, 1989	CR	CR
<i>Euastacus binzayedii</i>	Embezee's Crayfish	Coughran & Furse, 2013	CR	CR
<i>Euastacus bispinosus</i>	Glenelg Spiny Crayfish	Clark, 1936	VU	EN
<i>Euastacus brachythorax</i>	Short Thorax Crayfish	Riek, 1969	EN	-
<i>Euastacus dangadi</i>	Small Spiny Crayfish	Morgan, 1997	LC	-
<i>Euastacus dharawalus</i>	Fitzroy Falls Spiny Crayfish	Morgan, 1997	CR	CR
<i>Euastacus eungella</i>	Eungella Crayfish	Morgan, 1988	CR	CR
<i>Euastacus fleckeri</i>	Flecker's Crayfish	Watson, 1935	EN	-
<i>Euastacus guruhgi</i>	Swollen Crayfish	Coughran, 2005	CR	-
<i>Euastacus hirsutus</i>	Hairy Crayfish	(McCulloch, 1917)	EN	-
<i>Euastacus hystricosus</i>	Conondale Spiny Crayfish	Riek, 1951	EN	EN
<i>Euastacus kershawi</i>	Gippsland Spiny Crayfish	Smith, 1912	LC	-
<i>Euastacus maccai</i>	Terrestrial Crayfish	McCormack & Coughran, 2008	EN	-
<i>Euastacus maidae</i>	Hinterland Crayfish	Riek, 1956	CR	CR
<i>Euastacus mirangudjin</i>	Orange-bellied Crayfish	Coughran, 2002	CR	-
<i>Euastacus monteithorum</i>	Monteith's Crayfish	Morgan, 1989	CR	EN
<i>Euastacus neodiversus</i>	South Gippsland Spiny Crayfish	Riek, 1969	EN	-
<i>Euastacus neohirsutus</i>	New Hairy Crayfish	Riek, 1956	LC	-
<i>Euastacus reductus</i>	Remote Crayfish	Riek, 1969	LC	-
<i>Euastacus robertsi</i>	Robert's crayfish	Monroe, 1977	CR	EN
<i>Euastacus setosus</i>	Mount Glorious Spiny Crayfish	(Riek, 1956)	CR	-
<i>Euastacus spinifer</i>	Sydney Crayfish	(Heller, 1865)	LC	-
<i>Euastacus sulcatus</i>	Mountain Crayfish	Riek, 1951	VU	-
<i>Euastacus urospinosus</i>	Maleny Crayfish	Riek, 1956	EN	-
<i>Euastacus valentulus</i>	Powerful Crayfish	Riek, 1951	LC	-
<i>Euastacus vesper</i>	Cudgegong Giant Spiny Crayfish	McCormack & Ahyong, 2017	CR	CR
<i>Euastacus woiwuru</i>	Central Highlands Spiny Crayfish	Morgan, 1986	NT	-
<i>Euastacus yanga</i>	Variable Spiny Crayfish	Morgan, 1997	LC	-
<i>Euastacus yarraensis</i>	Yarra Crayfish	(McCoy, 1888)	VU	-
<i>Euastacus yigara</i>	Cardwell Hairy Crayfish	Short & Davie, 1993	CR	-

## 4. SPECIES ACCOUNTS

This section presents the conservation accounts of all recognised priority bushfire-impacted species of *Euastacus*. Each account compiles existing knowledge on taxonomy, conservation status, description, cultural significance, distribution (noting range (in green) is indicative) and habitat, biology and ecology as well as threats, conservation priorities and knowledge gaps. Further details on each species are provided in listing assessments and conservation advices, which will become publicly available as part of the EPBC Act listing process. The accounts are arranged alphabetically by scientific name.

## *Euastacus bidawalus* (Morgan, 1986)

Common name: East Gippsland Spiny Crayfish

### Taxonomy

The species was formally described by Morgan [1]; the molecular taxonomic analyses of Austin et al. [2] confirmed its validity as a distinct taxon, whilst identifying two divergent lineages (*E. cf. bidawalus 1* and *E. cf. bidawalus 2*).

### Conservation status

IUCN Red List Category: Endangered [3]



State: NSW: not listed VIC: not listed

EPBC (proposed): Endangered

Justification: B1ab(i,ii,iii)+2ab(i,ii,iii)

**Rationale:** The species is known only from a restricted distribution and  $\leq 5$  locations. The extent of occurrence (EOO), area of occupancy (AOO), and area, extent and/or quality of its habitat are anticipated to decline due to the impacts of climate change. The species occurs in a bushfire prone area, with the megafires in 2019–20 overlapping with almost all of its range [4]. Whilst it is a deep burrowing species, and was recently recorded at heavily burnt stream sites [5], it is likely that the cumulative effects of increasing bushfire frequency and intensity on top of other threats (such as changing hydrology and habitat degradation) will lead to declines in the population of this species.

### Description

This is a spiny crayfish [6] with a maximum recorded occipital carapace length (OCL, defined by [1] throughout this Action Plan) of 53 mm and a dark green to brown upper body [1, 5].

### Cultural significance

The species occurs on the lands of the Bidwell and Kurnai people, but cultural significance is currently unknown.



### Distribution and habitat

Recorded from streams and tributaries of the East Gippsland Basin in eastern Victoria and south-eastern NSW at elevations from 28 to 796 m above sea level (asl) [1, 5, 6]. It may build long, deep, complex Type 2 burrows along the margins of permanent or temporary streams and swampy areas [6]. Generally, inhabits dry sclerophyll forest and heath vegetated ridges above streams [1], but is also found in streams where vegetation has been cleared as long as some riparian vegetation remains [5].

Geographic range: EOO: 2609 km<sup>2</sup> AOO: 248 km<sup>2</sup>



### Biology and ecology

The biology and ecology are not well understood. Females are thought to reach maturity at  $\geq 40$  mm OCL, with egg fecundity in the range of  $\sim 100$  eggs [5, 7]. It may occur with a number of other crayfish in the region including, *Euastacus yanga*, *Engaeus orientalis*, and *Engaeus laevis* [8].



## Threats

Threat	Consequence
<b>Climate change</b>	
Extreme weather events	Catastrophic
Increasing temperature	Catastrophic
Increased intensity / frequency of bushfire	Catastrophic
Alterations to hydrological regimes	Catastrophic
<b>Disease</b>	
Crayfish plague	Catastrophic
<b>Invasive species</b>	
Problematic native fauna	Moderate
Invasive fauna	Moderate
<b>Habitat loss and fragmentation</b>	
Land clearing and domestic stock grazing.	Catastrophic
Stochastic events	Moderate
<b>Exploitation</b>	
Illegal collection	Major

## Conservation priorities

### Primary conservation outcome:

- Ensure the species continues as a secure, viable population and prepare management strategy for species.

### Climate change and hydrology:

- Plan and establish facilities for potential ex-situ short-term, active conservation interventions.
- Identify any 'cool' pockets of refuge habitat.
- Ensure that changes to hydrology account for the species' habitat requirements.

## Supporting information

1. Morgan G. J. (1986). Freshwater crayfish of the genus *Euastacus* Clark (Decapoda: Parastacidae) from Victoria. *Memoirs of the Museum of Victoria* 47(1), 1–57.
2. Austin C. M., Whiterod N. S., McCormack R., Raadik T. A., Ahyong S. T., Lintermans M., Furse J. M., Grandjean F. (2022). 'Molecular taxonomy of Australia's endemic freshwater crayfish genus *Euastacus* (Parastacidae), with reference to priority 2019–20 bushfire-impacted species – 2022 update.' Deakin University and Aquasave-NGT, Victor Harbor, Australia.
3. Furse J., Coughran J., Lawler S. (2010). '*Euastacus bidawalus*. The IUCN Red List of Threatened Species 2010: e.T153720A4536402.' <https://dx.doi.org/10.2305/IUCN.UK.2010-3.RLTS.T153720A4536402.en>. Accessed on 14 March 2022.
4. Legge S. M., Woinarski J. C., Garnett S. T., Geyle H. M., Lintermans M., Nimmo D. G., Rumpff L., Scheele B. C., Southwell D., Ward M., Whiterod N. S. et al. (2021). 'Estimates of the impacts of the 2019–20 fires on populations of native animal species'. NESP Threatened Species Recovery Hub. Project 8.3.2 report. Brisbane, Australia.
5. McCormack R. B. (2021). '*Euastacus bidawalus* surveys within eastern Victoria & south-eastern New South Wales.' Field survey report to Aquasave-NGT for the Saving the Spyns project. Australian Aquatic Biological P/L, Port Stephens.
6. Coughran J. (2008). Distinct groups in the genus *Euastacus*? *Freshwater Crayfish* 16, 125-132.
7. McCormack R. B. (2012). 'A Guide to Australia's Spiny Freshwater Crayfish.' CSIRO Publishing. Collingwood, Victoria.
8. O'Brien M. B. (2007). Freshwater and terrestrial crayfish (Decapoda, Parastacidae) of Victoria: status, conservation, threatening processes and bibliography. *The Victorian Naturalist* 124(4), 210–229.
9. Furse J. M., Coughran J. (2011). An assessment of the distribution, biology, threatening processes and conservation status of the freshwater crayfish, genus *Euastacus* (Decapoda: Parastacidae) in continental Australia. III. Case studies and recommendations. *Crustaceana Monographs: New Frontiers in Crustacean Biology* 15, 265-274.

## Stakeholder and community engagement:

### Invasive species and disease:

- Review and revise existing fire management plans, and hazard reduction practices, and mitigate bushfire impacts.
- Active participation of national park managers and traditional owners in management.
- Control invasive species and minimise potential disease vectors entering species habitat.

### Illegal collection:

- Monitor online crayfish sales and assess compliance of any recreational fishers with fisheries regulations.

### Survey and monitoring priorities:

- Establish and monitor the population size and trajectory through time.

## Knowledge gaps:

The cultural significance and values of the species needs to be determined. There is a need to address previously identified critical knowledge gaps on the biology, ecology, life history, habitat requirements and thermal tolerance as well as determining contemporary geographic range, population status over time, and resilience of species and habitat to impacts of climate change [9] as well as resolving status of two divergent lineages [2].

## *Euastacus clarkae* (Morgan, 1997)

Common name: Clark’s Crayfish

### Taxonomy

The species was formally described by Morgan [1]; the molecular taxonomic analyses of Austin et al. [2] confirmed its validity as a distinct taxon.

### Conservation status

IUCN Red List Category: Endangered [3]



State: NSW: not listed

EPBC (proposed): Endangered

Justification: B1ab(iii,v)+2ab(iii,v)

**Rationale:** The species is known from a highly restricted area, with the species known to occur across a small range in two river basins the mountains of the Mid North Coast region of NSW. The area, extent, and quality of habitat are anticipated to decline due to impacts of climate change. The species occurs in a bushfire prone area, with the megafires in 2019–20 overlapping with the majority of its range [4]. Due to its highly restricted distribution, the population is also threatened by highly localised events such as accidents, natural disasters and invasive species. It is projected that there will be an altitudinal compression of its habitat with increasing temperatures as this species lacks the capacity to physiologically adapt to warmer conditions or relocate to cooler habitats [5, 6, 7].

### Description

This is a spinose crayfish [8] with an OCL of ~50 mm and a deep green-brown body, with variously shaded orange spines [1, 9].

### Cultural significance

The species occurs on the lands of the Biripi people, but cultural significance is currently unknown.



### Distribution and habitat

This species is endemic to headwater streams in the Hastings and Macleay River basins of mid North Coast region of NSW at elevations between 670 and 1100 m asl [1, 2, 8, 9]. It constructs and occupies Type 1 burrows that extend from the water’s edge into the stream banks and is closely associated well-shaded and cool highland streams with riparian rainforest or sclerophyllous forest [1, 9, 10].

Geographic range: EOO: 207 km<sup>2</sup> AOO: 72 km<sup>2</sup>



### Biology and ecology

Some information on biology and ecology compared to other *Euastacus*, but knowledge gaps remain. Females are thought to reach maturity at approximately 30 mm OCL, with pleopodal egg fecundity recorded between 5–288 eggs [1, 3, 9]. It occurs in sympatry with *Euastacus spinifer* and *Euastacus reductus* [1, 9, 10].

## Threats

Threat	Consequence
<b>Climate change</b>	
Extreme weather events	Catastrophic
Increasing temperature	Catastrophic
Increased intensity / frequency of bushfire	Catastrophic
Alterations to hydrological regimes	Catastrophic
<b>Disease</b>	
Crayfish plague	Catastrophic
<b>Invasive species</b>	
Invasive fauna	Moderate
<b>Habitat loss and fragmentation</b>	
Stochastic events	Moderate
<b>Illegal collection</b>	
Illegal take	Moderate

## Conservation priorities

### Primary conservation outcome:

- Ensure the species continues as a secure, viable population.

### Climate change:

- Investigate the feasibility of and plan for ex-situ conservation measures.
- Identify any 'cool' pockets of refuge habitat.
- Review and revise existing fire management plans, and hazard reduction practices, and mitigate bushfire impacts.

## Supporting information

1. Morgan G. J. (1997). Freshwater crayfish of the genus *Euastacus* Clark (Decapoda: Parastacidae) from New South Wales, with a key to all species of the genus. *Records of the Australian Museum* 23, 1–110.
2. Austin C. M., Whiterod N. S., McCormack R., Raadik T. A., Ah Yong S. T., Lintermans M., Furse J. M., Grandjean F. (2022). 'Molecular taxonomy of Australia's endemic freshwater crayfish genus *Euastacus* (Parastacidae), with reference to priority 2019–20 bushfire-impacted species – 2022 update.' Deakin University and Aquasave-NGT, Victor Harbor, Australia.
3. McCormack R. B. (2015). '*Euastacus clarkae*. The IUCN Red List of Threatened Species 2015: e.T153666A79360699.' <https://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T153666A79360699.en>. Accessed on 22 March 2022.
4. Legge S. M., Woinarski J. C., Garnett S. T., Geyle H. M., Lintermans M., Nimmo D. G., Rumpff L., Scheele B. C., Southwell D., Ward M., Whiterod N. S. et al. (2021). 'Estimates of the impacts of the 2019–20 fires on populations of native animal species'. NESP Threatened Species Recovery Hub. Project 8.3.2 report. Brisbane, Australia.
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8. McCormack R. B. (2015). Conservation of Imperilled Crayfish - *Euastacus clarkae* Morgan, 1997 (Decapoda: Parastacidae), a highland crayfish from the Gondwana Rainforests of Australia's World Heritage Area. *Journal of Crustacean Biology* 35(2), 282–291.
9. McCormack R. B. (2022). '*Euastacus clarkae* surveys within upper Hastings and Macleay rivers NSW.' Field survey report to Aquasave-NGT for the Saving the Spiny project. Australian Aquatic Biological P/L, Port Stephens.
10. Furse J. M., Coughran J. (2011). An assessment of the distribution, biology, threatening processes and conservation status of the freshwater crayfish, genus *Euastacus* (Decapoda: Parastacidae) in continental Australia. III. Case studies and recommendations. *Crustaceana Monographs: New Frontiers in Crustacean Biology* 15, 265–274.

### Stakeholder and community engagement:

- Active participation of national park managers and traditional owners in management.

### Habitat loss:

- Appropriate management and maintenance of habitat quality, including in national parks, where the species is found.

### Invasive species and disease:

- Control invasive species and minimise potential disease vectors entering species habitat.

### Illegal collection:

- Monitor online crayfish sales and assess compliance of any recreational fishers with fisheries regulations.

### Survey and monitoring priorities:

- Further survey to define contemporary range.
- Establish and monitor the population size and trajectory through time.

## Knowledge gaps

The cultural significance and values of the species needs to be determined. There is a need to address previously identified critical knowledge gaps on the biology, ecology and life history, habitat requirements and thermal tolerance, as well as determining its population status over time, and resilience of the species and habitat to impacts of climate change [10].

## *Euastacus claytoni* (Riek, 1969)

Common name: Clayton's Crayfish

### Taxonomy

The species was formally described by Riek [1]; the molecular taxonomic analyses of Austin et al. [2] confirmed its validity as a distinct taxon, whilst identifying a divergent lineage (*E. cf. claytoni*).

### Conservation status

IUCN Red List Category: Endangered [3]



State: NSW: not listed; VIC: not listed

EPBC (proposed): not assessed

### Summary

The species was thought to occur in the Snowy River, Tuross River, upper Murrumbidgee River and Shoalhaven River basins across southern NSW [1], but the molecular taxonomic analyses of Austin et al. [2] and field surveys [4] identified *E. claytoni* from the southern extent (i.e., Snowy River and East Gippsland basins) and the divergent lineage occurring across the northern extent of the range (i.e. upper Murrumbidgee River and Shoalhaven River basins). Better understanding of the north-south demarcation and the distribution of the species in the inland upper Murrumbidgee drainage is required before the conservation status of both lineages can be assessed.



### Supporting information

1. Riek, E. F. (1969). The Australian freshwater crayfish (Crustacea; Decapoda; Parastacidae) with description of new species. *Australian Journal of Zoology* 17: 855–918.
2. Austin C. M., Whiterod N. S., McCormack R., Raadik T. A., Ah Yong S. T., Lintermans M., Furse J. M., Grandjean F. (2022). 'Molecular taxonomy of Australia's endemic freshwater crayfish genus *Euastacus* (Parastacidae), with reference to priority 2019–20 bushfire-impacted species – 2022 update.' Deakin University and Aquasave-NGT, Victor Harbor, Australia.
3. Furse, J. & Coughran, J. 2010. *Euastacus claytoni*. The IUCN Red List of Threatened Species 2010: e.T153718A4536039. <https://dx.doi.org/10.2305/IUCN.UK.2010-3.RLTS.T153718A4536039.en>. Accessed on 19 January 2022.
4. McCormack, R. B. (2022). *Euastacus claytoni* surveys within eastern Victoria & south-eastern New South Wales. Port Stephens, Field survey report to Aquasave-NGT for the Saving the Spinys project. Australian Aquatic Biological Pty. Ltd, Port Stephens.

## *Euastacus crassus* (Riek, 1951)

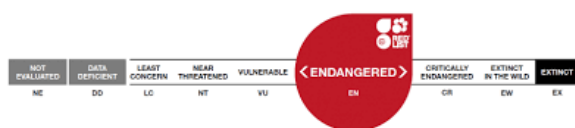
Common name: Alpine Crayfish

### Taxonomy

The species was formally described by Riek [1]; the molecular taxonomic analyses of Austin et al. [2] confirmed its validity as a distinct taxon, whilst identifying a divergent lineage (*E. cf. crassus*).

### Conservation status

IUCN Red List Category: Endangered [3]



State: ACT: not listed

EPBC (proposed): not assessed

### Summary

A small highland species thought to occur across a relatively broad range across southern NSW, northern Victoria and the Australian Capital Territory (ACT) [1], with the molecular taxonomic analyses from a very limited number of samples of Austin et al. [2] only confirming its range in the northern ACT, with the divergent lineage occurring across southern NSW [2,4, 5]. Previous records from the upper Molonglo River and upper Queanbeyan River Catchment in NSW in the upper Murrumbidgee River Basin have now been confirmed as *E. cf. claytoni* [2, 4, 5]. Clarification of the contemporary range and associated threats along with biology and ecology is necessary before assessing the conservation status of the species.



### Supporting information

1. Riek, E. F. (1951). The freshwater crayfish (family Parastacidae) of Queensland. Records of the Australian Museum 22, 368–388.
2. Austin C. M., Whiterod N. S., McCormack R., Raadik T. A., Ah Yong S. T., Lintermans M., Furse J. M., Grandjean F. (2022). 'Molecular taxonomy of Australia's endemic freshwater crayfish genus *Euastacus* (Parastacidae), with reference to priority 2019–20 bushfire-impacted species – 2022 update.' Deakin University and Aquasave-NGT, Victor Harbor, Australia.
3. Furse, J., Coughran, J. & Lawler, S. 2010. *Euastacus crassus*. The IUCN Red List of Threatened Species 2010: e.T8148A12892235. <https://dx.doi.org/10.2305/IUCN.UK.2010-3.RLTS.T8148A12892235.en>. Accessed on 19 January 2022.
4. Lintermans M. (2021). 'Post-bushfire survey of *Euastacus crassus* and *Euastacus rieki* in the High Country of NSW.' Field survey report to Aquasave-NGT for Project: 100086 Saving the spinys: urgent actions to conserve the *Euastacus* freshwater crayfish. Centre for Applied Water Science, University of Canberra, Canberra.
5. Hammer, M. and M. Beitzel (2019). Australian Capital Territory region Bush Blitz Fishes and Crayfish, Report submitted to Director of National Parks, Department of Agriculture, Water and the Environment, Canberra. Available at <https://bushblitz.org.au/wp-content/uploads/2020/10/Fishes-and-crayfish.pdf>

## *Euastacus dalagarbe* (Coughran, 2005)

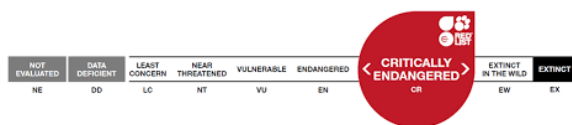
Common name: Mud Gully Crayfish

### Taxonomy

The species was formally described by Coughran [1]; the molecular taxonomic analyses of Austin et al. [2] confirmed its validity as a distinct taxon, whilst identifying a divergent lineage (*E. cf. dalagarbe*).

### Conservation status

IUCN Red List Category: Critically Endangered [3]



State: NSW: not listed; QLD: not listed

EPBC (proposed): Critically Endangered

Justification: B1ab(iii,v)

**Rationale:** The species is known only from five creeks within a single, small location and the area, extent and quality of its habitat are anticipated to decline due to the impacts of climate change. Temperature increase due to climate change is projected to lead to altitudinal compression of the species' habitat, as there is no scope for up-slope migration. Additionally, climate change may result in the upper extremities of the species' montane habitats becoming drier, thereby lowering the superficial water tables upon which the species appears to rely [3, 4].

### Description

This is a small and poorly spinose crayfish [5] with a maximum recorded OCL of 37.2 mm. The body is green-brown or brown from above, and tan or orange from below [1].

### Cultural significance

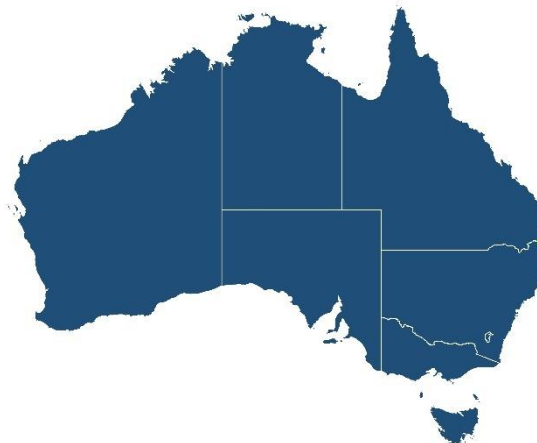
The species occurs on the lands of the Yugambeh-Bundjalung and Githabul people, but cultural significance is currently unknown.



### Distribution and habitat

This species is restricted to elevations from ~570 m to ~1000 m asl in the Border Ranges National Park in north-eastern NSW and southern Lamington National Park in southeastern Qld [1, 2, 4, 6, 7]. The divergent lineage appears to co-occur with the species [2]. *E. dalagarbe* generally inhabits complex burrows but can also be found under rocks and vegetative debris. It does not depend on flowing water and has been recorded from sites where surface water is either absent or negligible for much of the year [4, 6].

Geographic range: EOO: 67 km<sup>2</sup> AOO: 36 km<sup>2</sup>



### Biology and ecology

The biology and ecology are not well understood. Females reach maturity at ~30 mm OCL, with pleopodal egg fecundity likely in the range of 20–70 eggs [1, 9, 10]. It occurs in sympatry with *Euastacus sulcatus* and *Euastacus angustus* [1].

## Threats

Threat	Consequence
<b>Climate change</b>	
Extreme weather events	Catastrophic
Increasing temperature	Catastrophic
Increased intensity / frequency of bushfire	Major
<b>Disease</b>	
Crayfish plague	Catastrophic
<b>Invasive species</b>	
Invasive fauna	Moderate
<b>Exploitation</b>	
Illegal collection	Major

## Conservation priorities

### Primary conservation outcome:

- Ensure the species continues as a secure, viable population.

### Climate change:

- Plan and establish facilities for potential ex-situ short-term, active conservation interventions.
- Identify any 'cool' pockets of refuge habitat.
- Review and revise existing fire management plans, and hazard reduction practices, and mitigate bushfire impacts.

## Supporting information

1. Coughran J (2005). New crayfishes (Decapoda: Parastacidae: *Euastacus*) from northeastern New South Wales, Australia. Records of the Australian Museum 57(3), 361–374.
2. Austin C. M., Whiterod N. S., McCormack R., Raadik T. A., Ah Yong S. T., Lintermans M., Furse J. M., Grandjean F. (2022). 'Molecular taxonomy of Australia's endemic freshwater crayfish genus *Euastacus* (Parastacidae), with reference to priority 2019–20 bushfire-impacted species – 2022 update.' Deakin University and Aquasave-NGT, Victor Harbor, Australia.
3. Coughran J., Furse, J. (2010). '*Euastacus dalagarbe*. The IUCN Red List of Threatened Species 2010: e.T153601A4518770.' <https://dx.doi.org/10.2305/IUCN.UK.2010-3.RLTS.T153601A4518770.en>. Accessed on 17 March 2022.
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5. Coughran J. (2008). Distinct groups in the genus *Euastacus*? *Freshwater Crayfish* 16, 125–132.
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9. Furse J. M., Coughran J. (2011). An assessment of the distribution, biology, threatening processes and conservation status of the freshwater crayfish, genus *Euastacus* (Decapoda: Parastacidae) in continental Australia. III. Case studies and recommendations. *Crustaceana Monographs: New Frontiers in Crustacean Biology* 15, 265–274.

### Illegal collection:

- Restrict publicity on the species so as to not facilitate illegal collection and monitor online crayfish sales.

### Invasive species and disease:

- Develop and implement long-term strategies, including monitoring and removal, to control introduced predators and weeds.
- Take steps to minimise frequency of potential disease vectors entering the species' habitat.

### Stakeholder and community engagement:

- Active participation of national park managers and traditional owners in management.

### Survey and monitoring priorities:

- Establish and monitor the population size and trajectory through time.

### Knowledge gaps

The cultural significance and values of the species needs to be determined. There is a need to address previously identified critical knowledge gaps on the biology, ecology, life history, habitat requirements and thermal tolerance as well as resilience of species and habitat to impacts of climate change, invasive species, and disease [9] as well as resolving status of two divergent lineages [2].

## *Euastacus diversus* (Riek, 1969)

Common name: Orbost Spiny Crayfish

### Taxonomy

The species was formally described by Riek [1]; the molecular taxonomic analyses of Austin et al. [2] confirmed its validity as a distinct taxon.

### Conservation status

IUCN Red List Category: Endangered [3]



State: VIC: Endangered [4]

EPBC (proposed): Endangered

Justification: B1ab(iii)+2ab(iii)

**Rationale:** The species is known only from a restricted distribution and  $\leq 5$  locations. The area, extent and quality of its habitat are anticipated to decline due to the impacts of climate change and land clearance. The 2019–20 megafires overlapped the range of the species [4] but additional investigation is required. It is likely that the cumulative effects of increasing bushfire frequency and intensity together with other threats will cause a significant decline in the population of this species [5].

### Description

This is a spiny crayfish [6] with a maximum recorded OCL of 44.5 mm [7, 8]. Viewed from above and the side it may be dark brown to dark olive green, with a range of varying colours adorning the small spines and appendages [8].

### Cultural significance

The species occurs on the lands of the Bidwell and Kurnai people, but cultural significance is currently unknown.



### Distribution and habitat

This species is restricted to elevations from 350–950 m asl in East Gippsland, Victoria [8]. It is found in tributaries in the mid and upper Brodrigg River, the upper tributaries of the Bonang River, and the upper tributaries of the Rodger and Yalmy rivers [8]. The species generally inhabits complex burrows at or below water level along densely vegetated streams, but can also be found sheltering under rocks and vegetative debris [8, 9].

Geographic range: EOO: 1850 km<sup>2</sup> AOO: 260 km<sup>2</sup>



### Biology and ecology

The biology and ecology are not well understood. Females are thought to reach maturity at  $\geq 35$  mm OCL, with pleopodal egg fecundity likely  $< 30$  eggs [7]. It may occur in sympatry with *E. bidawalus*, the larger *Euastacus kershawi* and *Engaeus orientalis* [8, 10, 11].



## Threats

Threat	Consequence
<b>Climate change</b>	
Extreme weather events	Catastrophic
Alterations to hydrological regimes	Catastrophic
Increasing temperature	Catastrophic
Increased bushfires	Catastrophic
<b>Agriculture and aquaculture</b>	
Wood and pulp plantations	Moderate
<b>Transportation and service corridors</b>	
Roads and railroads	Catastrophic
<b>Disease</b>	
Crayfish plague	Catastrophic
<b>Invasive species</b>	
Invasive fauna	Moderate
Common yabby	Moderate
<b>Exploitation</b>	
Illegal collection	Moderate

## Conservation priorities

### Primary conservation outcome:

- Ensure the species continues as a secure, viable population.

### Habitat loss and disturbance:

- Ensure that the habitat quality remains high and that any human-mediated changes to surface and groundwater hydrology account for the species' habitat requirements.

### Climate change:

- Plan and establish facilities for potential ex-situ short-term, active conservation interventions.
- Review and revise existing fire management plans, and hazard reduction practices, and mitigate bushfire impacts.

### Invasive species and disease:

- Develop and implement long-term strategies to control introduced predators and competitors.
- Take steps to minimise frequency of potential disease vectors entering the species' habitat.

### Stakeholder and community engagement:

- Active participation of national park managers and traditional owners in management.

### Survey and monitoring priorities:

- Establish and monitor the population size and trajectory through time.

## Knowledge gaps

The cultural significance and values of the species needs to be determined. There is a need to address previously identified critical knowledge gaps on the biology, ecology, life history, habitat requirements and thermal tolerance as well as resilience of species and habitat to impacts of climate change, invasive/exotic species, and disease [12].

## Supporting information

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## *Euastacus gamilaroi* (Morgan, 1997)

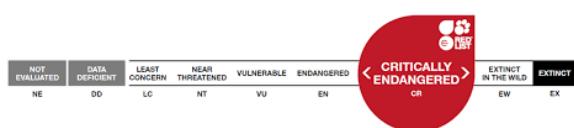
Common name: Gamilaroi Crayfish

### Taxonomy

The species was formally described by Morgan [1]; the molecular taxonomic analyses of Austin et al. [2] confirmed its validity as a distinct taxon.

### Conservation status

IUCN Red List Category: Critically Endangered [3]



State: NSW: not listed

EPBC (proposed): Endangered

Justification: B1ab(iii)

**Rationale:** This species has a restricted distribution in north-eastern NSW. The area, extent, and quality of habitat are anticipated to decline due to the impacts of climate change. The species occurs in a bushfire prone area, with the megafires in 2019–20 overlapping with most of its range [4]. Due to its highly restricted distribution, the population is also threatened by highly localised events such as land clearing, accidents and illegal collecting, as well as natural disasters (floods, bushfire) and invasive species. It is projected that there will be an altitudinal compression of its habitat with increasing temperatures as this species lacks the capacity to physiologically adapt to warmer conditions or relocate to cooler habitats [5, 6, 7].

### Description

This species is a spiny crayfish [8] with blue highlights around its eye sockets, abdominal skirt and carapace, a maximum recorded OCL of 47 mm [1, 9].

### Cultural significance

The species occurs on the lands of the Kamilaroi people, but cultural significance is currently unknown.



### Distribution and habitat

This species is endemic to the headwater reaches of highland streams above 950 m asl in the Namoi River and Manning River basins [1,2, 7]. It is known to excavate burrows in the stream bed or bank and the burrows may typically intersect the water table [9].

Geographic range: EOO: 210km<sup>2</sup> AOO: 68 km<sup>2</sup>



### Biology and ecology

The biology and ecology are not well understood. Females are thought to reach maturity at >34 mm OCL, with pleopodal egg fecundity recorded in the range of 20–87 eggs [1, 9, 10]. It shares part of its distribution with *Euastacus maccai*, *E. spinifer*, and *Cherax destructor*.

## Threats

Threat	Consequence
<b>Climate change</b>	
Extreme weather events	Catastrophic
Increasing temperature	Catastrophic
Increased intensity / frequency of bushfire	Castastrophic
<b>Disease</b>	
Crayfish plague	Catastrophic
<b>Invasive species</b>	
Invasive fauna and weeds	Moderate
<b>Habitat loss and fragmentation</b>	
Stochastic events	Moderate
Vegetation clearance	Moderate
<b>Illegal collection</b>	
Illegal take	Major

## Conservation priorities

### Primary conservation outcome:

- Ensure the species continues as a secure, viable population and protect the two known streams occupied by the species.
- Investigate the feasibility and plan for ex-situ conservation measures.

### Illegal collection:

- Restrict publicity on the species so as to not facilitate illegal collection and monitor online crayfish sales.

## Supporting information

1. Morgan G. J. (1997). Freshwater crayfish of the genus *Euastacus* Clark (Decapoda: Parastacidae) from New South Wales, with a key to all species of the genus. *Records of the Australian Museum* 23, 1–110.
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3. Furse J., Coughran, J. (2010). '*Euastacus gamilaroi*. The IUCN Red List of Threatened Species 2010: e.T153613A4520298.' <https://dx.doi.org/10.2305/IUCN.UK.2010-3.RLTS.T153613A4520298.en>. Accessed on 23 March 2022.
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11. Coughran J. (2011). Aspects of the biology and ecology of the Orange-Bellied Crayfish, *Euastacus mirangudjin* Coughran 2002, from northeastern New South Wales. *Australian Zoologist* 35(3), 750–756.

## Climate change:

- Identify any 'cool' pockets of refuge habitat.
- Review and revise existing fire management plans, and hazard reduction practices, and mitigate bushfire impacts.

## Stakeholder and community engagement:

- Active participation of national park managers and traditional owners in management.

## Survey and monitoring priorities:

- Establish and monitor the population size and trajectory through time.

## Invasive species and disease:

- Control invasive predator and undertake weed control.
- Minimise potential disease vectors entering species' habitat.

## Knowledge gaps

The cultural significance and values of the species needs to be determined. There is a need to address previously identified critical knowledge gaps on the biology, ecology and life history, habitat requirements and thermal tolerance, as well as determining population status over time, and resilience of species and habitat to impacts of climate change, invasive species and disease [11].

## *Euastacus girurmulayn* (Coughran, 2005)

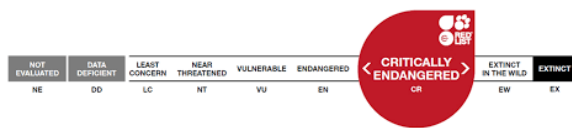
Common name: Smooth Crayfish

### Taxonomy

The species was formally described by Coughran [1]; the molecular taxonomic analyses of Austin et al. [2] confirmed its validity as a distinct taxon.

### Conservation status

IUCN Red List Category: Critically Endangered [3]



State: NSW: not listed

EPBC (proposed): Endangered

Justification: B1ab(iii,v)+2ab(iii,v)

**Rationale:** This species has a highly restricted distribution in north-eastern NSW and the area, extent and quality of its habitat are anticipated to decline due to the impacts of climate change. The species occurs in a bushfire prone area, with the megafires in 2019–20 overlapping with the majority of its range [4]. Due to its highly restricted distribution, the population is also threatened by highly localised events such as accidents and illegal collecting, as well as natural disasters and invasive species. It is projected that there will be an altitudinal compression of its habitat with increasing temperatures as this species lacks the capacity to physiologically adapt to warmer conditions or relocate to cooler habitats [5, 6, 7].

### Description

This is a small, poorly spinose crayfish [8] with an occipital carapace length (OCL) of 34 mm [1]. Its body typically appears as brown from above with a cream underside, and varied colours on its legs and claws [1].

### Cultural significance

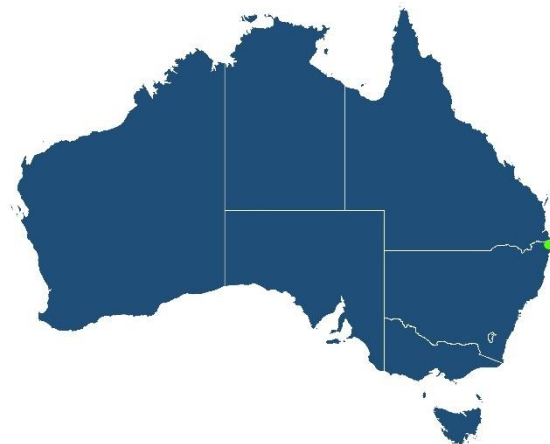
The species occurs on the lands of the Bundjalung Nation and Widjaba people, but cultural significance is currently unknown.



### Distribution and habitat

This species is known from small areas of highland rainforest contained in Whian Whian, Nightcap, 121in northeast NSW [1, 7]. It is closely associated with well-shaded and cool highland streams at ~110 m to ~720 m asl [1, 7, 9].

Geographic range: EOO: 121 km<sup>2</sup> AOO: 36km<sup>2</sup>



### Biology and ecology

The biology and ecology are not well understood. Female maturity recorded above 30 mm OCL, breeding commences May-June with release juveniles December. Fecundity is low with females having been recorded with 21–24 large eggs. This species occurs at very low abundance and within this highly restricted distribution, it occurs in sympatry with *E. sulcatus* [1, 9, 10].

## Threats

Threat	Consequence
<b>Climate change</b>	
Extreme weather events	Catastrophic
Increasing temperature	Catastrophic
Increased intensity / frequency of bushfire	Major
<b>Disease</b>	
Crayfish plague	Catastrophic
<b>Invasive species</b>	
Invasive fauna	Moderate
<b>Habitat loss and fragmentation</b>	
Stochastic events	Moderate
<b>Illegal collection</b>	
Illegal take	Moderate

## Conservation priorities

### Primary conservation outcome:

- Ensure the species continues as a secure, viable population.

### Climate change:

- Investigate the feasibility and plan for ex-situ conservation measures.
- Identify any 'cool' pockets of refuge habitat.
- Review and revise existing fire management plans, and hazard reduction practices, and mitigate bushfire impacts.

## Supporting information

1. Coughran J. (2005). New crayfishes (Decapoda: Parastacidae: *Euastacus*) from northeastern New South Wales, Australia. *Records of the Australian Museum* 57(3), 361–374.
2. Austin C. M., Whiterod N. S., McCormack R., Raadik T. A., Ah Yong S. T., Lintermans M., Furse J. M., Grandjean F. (2022). 'Molecular taxonomy of Australia's endemic freshwater crayfish genus *Euastacus* (Parastacidae), with reference to priority 2019–20 bushfire-impacted species – 2022 update.' Deakin University and Aquasave-NGT, Victor Harbor, Australia.
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4. Legge S. M., Woinarski J. C., Garnett S. T., Geyle H. M., Lintermans M., Nimmo D. G., Rumpff L., Scheele B. C., Southwell D., Ward M., Whiterod N. S. et al. (2021). 'Estimates of the impacts of the 2019–20 fires on populations of native animal species'. NESP Threatened Species Recovery Hub. Project 8.3.2 report. Brisbane, Australia.
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6. Bone J. W. P., Renshaw G. M. C., Wild C. H. (2017). Physiological and biochemical responses to elevated temperature in a threatened freshwater crayfish, *Euastacus sulcatus* (Decapoda: Parastacidae). *Marine and Freshwater Research* 68(10), 1845–1854.
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10. Coughran J., Furse J. M. (2010). 'An assessment of genus *Euastacus* (49 species) versus IUCN Red List criteria. A report prepared for the global species conservation assessment of crayfishes for the IUCN Red List of Threatened Species.' The International Association of Astacology. Auburn, Alabama, USA. ISBN: 978-0-9805452-1-0.
11. Furse J. M., Coughran J. (2011). An assessment of the distribution, biology, threatening processes and conservation status of the freshwater crayfish, genus *Euastacus* (Decapoda: Parastacidae) in continental Australia. III. Case studies and recommendations. *Crustaceana Monographs: New Frontiers in Crustacean Biology* 15, 265–274

## Stakeholder and community engagement:

- Active participation of national park managers and traditional owners in management.

## Illegal collection:

Restrict publicity on the species so as to not facilitate illegal collection and monitor online crayfish sales.

## Invasive species and disease:

- Control invasive species and weeds, and minimise potential disease vectors entering species habitat.

## Survey and monitoring priorities:

- Establish and monitor the population size and trajectory through time.

## Knowledge gaps

The cultural significance and values of the species needs to be determined. There is a need to address previously identified critical knowledge gaps on the biology, ecology and life history, habitat requirements and thermal tolerance, as well as determining resilience of species and habitat to impacts of climate change, invasive species, and disease [11].

## *Euastacus gumar* (Morgan, 1997)

Common name: Blood Crayfish

### Taxonomy

The species was formally described by Morgan [1]; Austin et al. [2] confirmed its validity as a distinct taxon using molecular taxonomic analyses, but also found low genetic divergence between the *E. gumar* and *E. pilosus*.

### Conservation status

IUCN Red List Category: Endangered [3]



State: NSW: not listed

EPBC (proposed): Endangered

Justification: B1ab(iii,v)+2ab(iii,v)

**Rationale:** The species is known only from a single, small location and the area, extent and quality of its habitat are anticipated to decline due to the impacts of climate change. Mean annual temperatures are predicted to increase in north-eastern NSW [4] and this is likely to lead to altitudinal compression of the species' habitat, as there is limited scope for up slope migration by this species. Due to its restricted distribution, the population is also threatened by highly localised events such as accidents (chemical spills from surrounding roads or campgrounds) and illegal collecting, as well as natural disasters (floods, bushfire) and invasive species.

### Description

This is a not heavily spinose species [5] with an OCL of 44 mm (1, 6). It may appear as a dark green with an orange underside; the appendages tend to be red or orange [6].

### Cultural significance

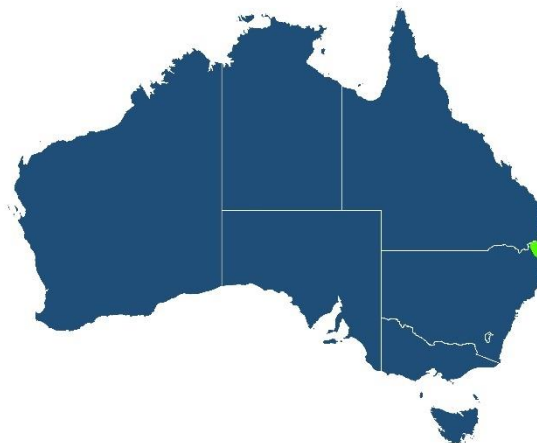
The species occurs on the lands of the Bundjalung Nation and Githabul people, but cultural significance is currently unknown.



### Distribution and habitat

This species is endemic to north-eastern NSW where it occupies rainforested gullies and streams, typically at altitudes above ~200 m asl [3, 7, 8]. It may occupy simple shallow excavations under rocks and vegetative debris, and less commonly is known to excavate multi-chambered burrows in the stream-bed and banks, where burrows are more abundant in areas of clay substrate [6].

Geographic range: EOO: 1686 km<sup>2</sup> AOO: 64 km<sup>2</sup>



### Biology and ecology

The biology and ecology are not well understood. It is slow-growing, growth increments between 0.8 to 2.3 mm OCL yr<sup>-1</sup>, and like other species of *Euastacus* is probably long-lived [6]. Pleopodal egg fecundity varies according to female body size and is known to range between 20–150 eggs [6].

## Threats

Threat	Consequence
<b>Climate change</b>	
Extreme weather events	Catastrophic
Increasing temperature	Catastrophic
Increased intensity / frequency of bushfire	Major
<b>Disease</b>	
Crayfish plague	Catastrophic
<b>Invasive species</b>	
Invasive fauna	Moderate
<b>Habitat loss and fragmentation</b>	
Stochastic events	Moderate
<b>Illegal collection</b>	
Illegal take	Moderate

## Conservation priorities

### Primary conservation outcome:

- Ensure the species continues as a secure, viable population and protect known sites.

### Climate change:

- Investigate the feasibility and plan for ex-situ conservation measures.
- Identify any 'cool' pockets of refuge habitat.
- Review and revise existing fire management plans, and hazard reduction practices, and mitigate bushfire impacts.

## Supporting information

1. Morgan G. J. (1997). Freshwater crayfish of the genus *Euastacus* Clark (Decapoda: Parastacidae) from New South Wales, with a key to all species of the genus. *Records of the Australian Museum Supplement* 23, 110.
2. Austin C. M., Whiterod N. S., McCormack R., Raadik T. A., Ahyong S. T., Lintermans M., Furse J. M., Grandjean F. (2022). 'Molecular taxonomy of Australia's endemic freshwater crayfish genus *Euastacus* (Parastacidae), with reference to priority 2019–20 bushfire-impacted species – 2022 update.' Deakin University and Aquasave-NGT, Victor Harbor, Australia.
3. Furse J., Coughran J. (2010). '*Euastacus gumar*. The IUCN Red List of Threatened Species 2010: e.T153609A4519793.' <https://dx.doi.org/10.2305/IUCN.UK.2010-3.RLTS.T153609A4519793.en>. Accessed on 30 March 2022.
4. NSW OEH (2014). 'New South Wales Climate change snapshot.' Office of Environment and Heritage. Government of New South Wales, Sydney South, New South Wales.
5. Coughran J. (2008). Distinct groups in the genus *Euastacus*? *Freshwater Crayfish* 16, 125-132.
6. Coughran J. (2011). Biology of the Blood Crayfish, *Euastacus gumar* Morgan 1997, a small freshwater crayfish from the Richmond Range, northeastern New South Wales. *Australian Zoologist* 35(3), 685-697.
7. Coughran J. (2005). New crayfishes (Decapoda: Parastacidae: *Euastacus*) from northeastern New South Wales, Australia. *Records of the Australian Museum* 57(3), 361-374.
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9. Furse J. M., Coughran J. (2011). An assessment of the distribution, biology, threatening processes and conservation status of the freshwater crayfish, genus *Euastacus* (Decapoda: Parastacidae) in continental Australia. III. Case studies and recommendations. *Crustaceana Monographs: New Frontiers in Crustacean Biology* 15, 265-274.

### Stakeholder and community engagement:

- Active participation of national park managers and traditional owners in management.

### Invasive species and disease:

- Control invasive species and minimise potential disease vectors entering species habitat.

### Illegal collection:

- Restrict publicity on the species so as to not facilitate illegal collection.
- Monitor online crayfish sales and assess compliance of any recreational fishers with State fisheries regulations.

### Survey and monitoring priorities:

- Establish and monitor the population size and trajectory through time.

### Knowledge gaps

The cultural significance and values of the species needs to be determined. There is a need to address previously identified priority knowledge gaps on the biology, ecology and life history, habitat requirements and thermal tolerance, as well as determining its taxonomic status, population status over time, and resilience of species and habitat to impacts of climate change [9].

## *Euastacus guwinus* (Morgan, 1997)

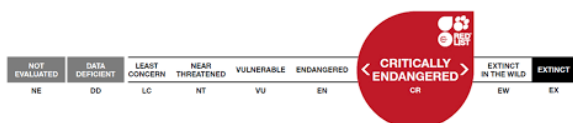
Common name: Tianjara Crayfish

### Taxonomy

The species was formally described by Morgan (1); the molecular taxonomic analyses of Austin et al. [2] confirmed its validity as a distinct taxon.

### Conservation status

IUCN Red List Category: Critically Endangered [3]



State: NSW: not listed

EPBC (proposed): Critically Endangered

Justification: B1ab(iii,v)

**Rationale:** The species is known only from a highly restricted area, with the species known to occur within a single small location. The area, extent and quality of its habitat are anticipated to decline due to the impacts of climate change. Additionally, a decline in the number of mature individuals due to impacts from extreme weather events such as heatwaves and bushfires is projected. The entirety of the range of this species was significantly impacted by extensive bushfires in 2019–20 [4]. Field surveys in 2021 indicate the species persisted at bushfire impacted sites [5], but bushfire remains a very serious and increasing threat under climate change.

### Description

This is a small spiny crayfish [6] with a maximum recorded OCL of 55 mm [1, 5, 7]. Viewed from above it is chocolate brown in colour with a green tinge, and orange to red from below [1, 7].

### Cultural significance

The species occurs on the lands of the Dharawal (or Tharawal) people, but cultural significance is currently unknown.

### Distribution and habitat

This species is restricted to above Tianjara Falls in Morton National Park >460 m asl in southern NSW [5]. It is known to occupy burrows or live under large boulders below water level at sites with clear, permanent water [1, 5].

Geographic range: EOO: 16 km<sup>2</sup> AOO: 16 km<sup>2</sup>



### Biology and ecology

The biology and ecology of this species are not well understood. Females are thought to reach maturity at approximately 34.5 mm OCL [7]. Moderate fecundity (20-120 eggs). It shares part of its distribution with the widespread *E. yanga* [1, 5].



## Threats

Threat	Consequence
<b>Climate change</b>	
Extreme weather events	Catastrophic
Increasing temperature	Catastrophic
Alterations to hydrological regimes	Catastrophic
Increased intensity / frequency of bushfire	Major
<b>Disease</b>	
Crayfish plague	Catastrophic
<b>Invasive species</b>	
Common yabby	Moderate
Invasive fauna	Moderate
<b>Habitat loss and fragmentation</b>	
Stochastic events	Moderate
<b>Illegal collection</b>	
Illegal take	Major

## Conservation priorities

### Primary conservation outcome:

- Ensure the species continues as a secure, viable population.

### Climate change:

- Investigate the feasibility and plan for ex-situ conservation measures.
- Identify any 'cool' pockets of refuge habitat.

- Review and revise existing fire management plans, and hazard reduction practices, and mitigate bushfire impacts.

### Stakeholder and community engagement:

- Active participation of national park managers and traditional owners in management.

### Invasive species and disease:

- Control invasive species and minimise potential disease vectors entering species habitat.

### Illegal collection:

- Restrict publicity on the species so as to not facilitate illegal collection
- Monitor online crayfish sales and assess compliance of any recreational fishers with State fisheries regulations.

### Survey and monitoring priorities:

- Establish and monitor the population size and trajectory through time.

## Knowledge gaps

The cultural significance and values of the species needs to be determined. There is a need to address previously identified critical knowledge gaps on the biology, ecology and life history, habitat requirements and thermal tolerance, as well as determining contemporary geographic range, population status over time, and resilience of species and habitat to impacts of climate change [8]

## Supporting information

1. Morgan G. J. (1997). Freshwater crayfish of the Genus *Euastacus* Clark (Decapoda: Parastacidae) from New South Wales, with a key to all species of the genus. *Records of the Australian Museum Supplement* 23, 1–110.
2. Austin C. M., Whiterod N. S., McCormack R., Raadik T. A., Ahyong S. T., Lintermans M., Furse J. M., Grandjean F. (2022). 'Molecular taxonomy of Australia's endemic freshwater crayfish genus *Euastacus* (Parastacidae), with reference to priority 2019–20 bushfire-impacted species – 2022 update.' Deakin University and Aquasave-NGT, Victor Harbor, Australia.
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8. Furse J. M., Coughran J. (2011). An assessment of the distribution, biology, threatening processes and conservation status of the freshwater crayfish, genus *Euastacus* (Decapoda: Parastacidae) in continental Australia. III. Case studies and recommendations. *Crustaceana Monographs: New Frontiers in Crustacean Biology* 15, 265-274.

## *Euastacus jagabar* (Coughran, 2005)

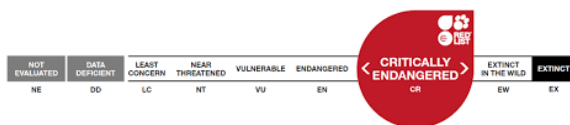
Common name: Blue-black Crayfish

### Taxonomy

The species was formally described by Coughran [1]; the molecular taxonomy analyses of Austin et al. [2] confirmed its validity as a distinct taxon.

### Conservation status

IUCN Red List Category: Critically Endangered [3]



State: NSW: not listed

EPBC (proposed): Critically Endangered

Justification: B1ab(iii)+2ab(iii)

**Rationale:** The species is known only from five sites within a single, small location and the area, extent and quality of its habitat are anticipated to decline due to the impacts of climate change. Field surveys of the species in 2007 and 2020 uncovered evidence that may suggest a species under some stress, as evidenced by limited observations of possible reduced reproduction in females [4, 5]. It is found at very low abundance [4, 5] and is considered exceedingly rare [6].

### Description

This is a small and poorly spinose species of *Euastacus* [7] that is endemic to the montane rainforests of northern NSW [4, 5]. The top of the body of the species is rich tan-brown to dark blue-black and tends to deep green-brown, green-blue or blue on the head [1]. The species has a maximum recorded OCL of 36 mm and maximum recorded wet weight of 22 g [4, 8].

### Cultural significance

The species occurs on the lands of the Bundjalung people, but cultural significance is currently unknown.



### Distribution and habitat

This species has been recorded at five proximate sites, in a small section of a creek and one of its tributaries in the Richmond River Basin [4, 5]. It inhabits shallow stream margin habitat in subtropical rainforest at altitudes between 330 m and 430 m asl [6].

Geographic range: EOO: 8 km<sup>2</sup> AOO: 8 km<sup>2</sup>



### Biology and ecology

The biology and ecology are not well understood. Females are thought to reach maturity at approximately 30 mm OCL, with pleopodal egg fecundity likely in the range of 20–40 eggs. This species co-occurs with the larger *E. sulcatus*.

## Threats

Threat	Consequence
<b>Climate change</b>	
Extreme weather events	Major
Increasing temperature	Major
Increased intensity / frequency of bushfire	Major
<b>Disease</b>	
Crayfish plague	Catastrophic
<b>Invasive species</b>	
Invasive weeds and weed incursion	Moderate
Invasive fauna	Moderate
<b>Habitat loss and fragmentation</b>	
Stochastic events	Moderate
<b>Illegal collection</b>	
Illegal take	Moderate

## Conservation priorities

### Primary conservation outcome:

- Ensure the species continues as a secure, viable population and prepare management strategy for species.

### Climate change:

- Investigate the feasibility and plan for ex-situ conservation measures.
- Identify any 'cool' pockets of refuge habitat.
- Investigate and establish ex-situ capacity to minimise impact of extreme weather events.

- Review and revise existing fire management plans, and hazard reduction practices, and mitigate bushfire impacts.

### Stakeholder and community engagement:

- Active participation of national park managers and traditional owners in management.
- Limit publicity

### Invasive species and disease:

- Control invasive species and minimise potential disease vectors entering species habitat.

### Illegal collection:

- Restrict publicity on the species so as to not facilitate illegal collection
- Monitor online crayfish sales and assess compliance of any recreational fishers with State fisheries regulations.

### Survey and monitoring priorities:

- Establish and monitor the population size and trajectory through time.

## Knowledge gaps

The cultural significance and values of the species needs to be determined. There is a need to address previously identified critical knowledge gaps on the biology, ecology and life history, habitat requirements and thermal tolerance, as well as determining contemporary geographic range, population status over time, and resilience of species and habitat to impacts of climate change [9].

## Supporting information

1. Coughran J. (2005). New crayfishes (Decapoda: Parastacidae: *Euastacus*) from northeastern New South Wales, Australia. *Records of the Australian Museum* 57(3), 361–374.
2. Austin C. M., Whiterod N. S., McCormack R., Raadik T. A., Ahyong S. T., Lintermans M., Furse J. M., Grandjean F. (2022). 'Molecular taxonomy of Australia's endemic freshwater crayfish genus *Euastacus* (Parastacidae), with reference to priority 2019–20 bushfire-impacted species – 2022 update.' Deakin University and Aquasave-NGT, Victor Harbor, Australia.
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8. Morgan G. J. (1997). Freshwater crayfish of the genus *Euastacus* Clark (Decapoda: Parastacidae) from New South Wales, with a key to all species of the genus. *Records of the Australian Museum* 23, 1–110.
9. Furse J. M., Coughran J. (2011). An assessment of the distribution, biology, threatening processes and conservation status of the freshwater crayfish, genus *Euastacus* (Decapoda: Parastacidae) in continental Australia. III. Case studies and recommendations. *Crustaceana Monographs: New Frontiers in Crustacean Biology* 15, 265–274.

## *Euastacus jagara* (Morgan, 1988)

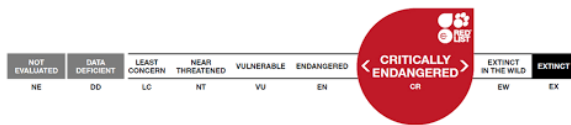
Common name: Jagara Hairy Crayfish

### Taxonomy

The species was formally described by Morgan [1]; the molecular taxonomic analyses of Austin et al. [2] confirmed its validity as a distinct taxon.

### Conservation status

IUCN Red List Category: Critically Endangered [3]



State: QLD: Critically Endangered

EPBC (nominated): Critically Endangered

Justification: B1ab(iii)

**Rationale:** The species is only known from a very small distribution and is restricted to a single location with a continuing decline in the area, extent and/or quality of the habitat due to bushfires, climate change and feral predators. It was identified as a priority species due to almost 50% of its highly restricted range estimated to have been impacted by the 2019–20 megafires [4].

### Description

This is a range restricted species with a maximum OCL of 50 mm and a maximum wet weight of 53 g [5]. It is dark green or green-blue to orange-brown from above and has a blue tint on the underside [6, 7].

### Cultural significance

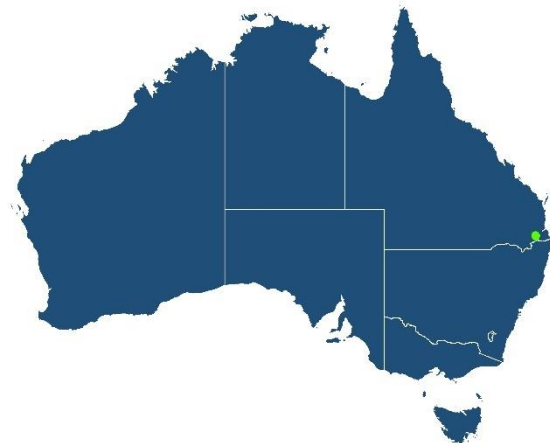
The species occurs on the lands of the Yuggera (Jagara) people, but cultural significance is currently unknown.



### Distribution and habitat

The species has a highly restricted range in the Main Range National Park in Queensland. Presently, it is only known from five small permanently flowing and well-shaded headwater creeks in highland rainforest at elevations above 700 m asl [5, 6, 7].

Geographic range: EOO: 28 km<sup>2</sup> AOO: 28 km<sup>2</sup>



### Biology and ecology

The biology and ecology are not well understood. Females are thought to reach maturity at  $\geq 39$  mm OCL and each clutch consists of approximately 50–70 pleopodal eggs [6]. Despite its restricted range it may occur in some abundance where it is found, especially at elevations above 920 m asl [5]. It is not known to occur with any other species of crayfish [5, 6].

## Threats

Threat	Consequence
<b>Climate change</b>	
Increased intensity / frequency of bushfire	Catastrophic
Increasing temperature	Catastrophic
Alterations to hydrological regimes	Major
Extreme weather events	Major
<b>Exploitation</b>	
Illegal collection	Moderate
<b>Invasive species</b>	
Invasive fauna (feral pigs and cane toads)	Major

## Conservation priorities

### Primary conservation outcome:

- Ensure the species continues as a secure, viable population and prepare management strategy for species.
- Investigate any impacts of the 2019–20 bushfires on this species and its habitat.

### Climate change:

- Review and revise existing fire management plans, and hazard reduction practices, and mitigate bushfire impacts.

### Invasive species:

- Current pig management activities (incidental pig trapping) may need to increase, especially if the crayfish populations suffered badly in the bushfires.

### Illegal collection:

- Restrict publicity on the species so as to not facilitate illegal collection
- Monitor online crayfish sales and assess compliance of any recreational fishers with fisheries regulations.

### Survey and monitoring priorities:

- Establish and monitor the population size and trajectory through time.

## Knowledge gaps

The cultural significance and values of the species needs to be determined. There is a need to address previously identified critical knowledge gaps on the biology, ecology, life history, habitat requirements, population assessment and monitoring, and resilience to invasive species [7]. There is a need to define contemporary range of the species. Any impacts of the 2019–20 bushfires on this species need to be investigated and its recovery and vulnerability to future events need to be assessed.

## Supporting information

1. Morgan G. J. (1988). Freshwater crayfish of the genus *Euastacus* Clark (Decapoda: Parastacidae) from Queensland. *Memoirs of the National Museum of Victoria* 49(1), 1–49.
2. Austin C. M., Whiterod N. S., McCormack R., Raadik T. A., Ahyong S. T., Lintermans M., Furse J. M., Grandjean F. (2022). 'Molecular taxonomy of Australia's endemic freshwater crayfish genus *Euastacus* (Parastacidae), with reference to priority 2019–20 bushfire-impacted species – 2022 update.' Deakin University and Aquasave-NGT, Victor Harbor, Australia.
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4. Legge S. M., Woinarski J. C., Garnett S. T., Geyle H. M., Lintermans M., Nimmo D. G., Rumpff L., Scheele B. C., Southwell D., Ward M., Whiterod N. S. et al. (2021). 'Estimates of the impacts of the 2019–20 fires on populations of native animal species'. NESP Threatened Species Recovery Hub. Project 8.3.2 report. Brisbane, Australia.
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7. Furse J. M., Coughran J. (2011). An assessment of the distribution, biology, threatening processes and conservation status of the freshwater crayfish, genus *Euastacus* (Decapoda: Parastacidae) in continental Australia. III. Case studies and recommendations. *Crustaceana Monographs: New Frontiers in Crustacean Biology* 15, 265–274.

## *Euastacus morgani* (Coughran & McCormack, 2011)

Common name: Morgan's Crayfish

### Taxonomy

The species was formally described by Coughran and McCormack [1]; the molecular taxonomic analyses of Austin et al. [2] confirmed its validity as a distinct taxon, whilst identifying a divergent lineage (*E. cf. morgani*).

### Conservation status

IUCN Red List Category: Not assessed

State: NSW: not listed

EPBC (proposed): Critically Endangered

Justification: B1ab(iii,v)+2ab(iii,v)

**Rationale:** The species is known only from a single, small location and the area, extent and quality of its habitat are anticipated to decline due to the impacts of climate change. Due to its highly restricted distribution, the population is also threatened by highly localised events such as accidents (oil, or chemical spills from major State and other roads adjacent the species habitat) and illegal collecting, as well as natural disasters (floods, bushfire) and invasive species. It is projected that there will be an altitudinal compression of its habitat with increasing temperatures as this species lacks the capacity to physiologically adapt to warmer conditions or relocate to cooler habitats [3, 4, 5].

### Description

This is a weakly spinose species, with an OCL of ~40 mm [1, 6]. Its body is typically brown or green-brown overall, with varied colours on the underside, legs, and claws [1].

### Cultural significance

The species occurs on the lands of the Gumbaynggirr people, but cultural significance is currently unknown.



### Distribution and habitat

This species is endemic to two rainforest streams at a single highland site at Bindarri National Park in the Coastal Mountains of the Mid North Coast of NSW [1, 7]. It constructs and occupies burrows that extend from the water's edge into the stream banks at altitudes above 557 m asl [1].

Geographic range: EOO: 4 km<sup>2</sup> AOO: 4 km<sup>2</sup>



### Biology and ecology

The biology and ecology are not well understood. Females are thought to reach maturity at approximately 40 mm OCL, with pleopodal egg fecundity likely in the range of 50 through to the low 100s of eggs [1, 8]. It occurs in sympatry with *Euastacus dangadi* and *Euastacus neohirsutus* [1].

## Threats

Threat	Consequence
<b>Climate change</b>	
Extreme weather events	Catastrophic
Increasing temperature	Catastrophic
Increased intensity / frequency of bushfire	Major
<b>Disease</b>	
Crayfish plague	Catastrophic
<b>Invasive species</b>	
Invasive fauna	Moderate
<b>Habitat loss and fragmentation</b>	
Stochastic events	Moderate
<b>Illegal collection</b>	
Illegal take	Moderate

## Conservation priorities

### Primary conservation outcome:

- Ensure the species continues as a secure, viable population and protect the two known streams occupied by the species.

### Climate change:

- Investigate the feasibility and plan for ex-situ conservation measures.
- Identify any 'cool' pockets of refuge habitat.
- Review and revise existing fire management plans, and hazard reduction practices, and mitigate bushfire impacts.

### Stakeholder and community engagement:

- Active participation of national park managers and traditional owners in management.

### Invasive species and disease:

- Control invasive species and minimise potential disease vectors entering species habitat.

### Illegal collection:

- Restrict publicity on the species so as to not facilitate illegal collection
- Monitor online crayfish sales and assess compliance of any recreational fishers with fisheries regulations.

### Survey and monitoring priorities:

- Establish and monitor the population size and trajectory through time.

## Knowledge gaps

The cultural significance and values of the species needs to be determined. There is a need to address previously identified critical knowledge gaps on the biology, ecology and life history, habitat requirements and thermal tolerance, as well as determining contemporary geographic range, population status over time, and resilience of species and habitat to impacts of climate change [8] as well as further study of the relationships within and between *E. morgani* and *E. neohirsutus* and a review of morphological variation are required [2].

## Supporting information

1. Coughran J., McCormack R. B. (2011). *Euastacus morgani* sp. n., a new spiny crayfish (Crustacea, Decapoda, Parastacidae) from the highland rainforests of eastern New South Wales, Australia. *Zookeys* 85, 17–26.
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## *Euastacus pilosus* (Coughran & Leckie, 2007)

Common name: Hairy Cataract Crayfish

### Taxonomy

The species was formally described by Coughran and Leckie [1]; the molecular taxonomic analyses of Austin et al. [2] confirmed its validity but also found low genetic divergence between the species and *E. gumar*. Given established morphological differences [1], *E. pilosus* will remain a valid species but further study is required to better characterise its molecular distinctions from *E. gumar*.

### Conservation status

IUCN Red List Category: Endangered [3]



State: NSW: not listed

EPBC (proposed): Endangered

Justification: B1ab(iii)+2ab(iii)

**Rationale:** The species occurs at a limited number of fragmented sites and the area, extent and quality of habitat are anticipated to decline due to impacts of climate change. Due to its restricted range, the species is susceptible to localised threats including habitat destruction and loss through bushfires, drought, and forest management practices, and exploitation (illegal harvest) by collectors. The impacts of climate change, including increasing air and water temperature, alteration of hydrological regimes, increased frequency of extreme weather events, and increased frequency and severity of bushfires are anticipated to threaten the species [4].

### Description

This is a small, moderately spinose species with a maximum OCL of 42 mm [1]. The upper side of the body of is dark brown, tending to light brown with orange, yellow and cream speckles along the sides [1].



### Cultural significance

The species occurs on the lands of the lands of the Bundjalung Nation and Githabul people but cultural significance is currently unknown.

### Distribution and habitat

This species occurs across the upper Clarence River Basin, northern NSW [1]. It excavates extensive deep burrows usually connected to subsurface groundwater at altitudes between 330 m and 850 m asl [4].

Geographic range: EOO: 459 km<sup>2</sup> AOO: 52 km<sup>2</sup>



### Biology and ecology

The biology and ecology are not well understood. Females are thought to reach maturity at approximately 25 mm OCL, with pleopodal egg fecundity likely up to 100 burgundy-coloured eggs [1, 5]. While its range overlaps with that of *Euastacus suttoni*, the two species are not known to co-exist at the same sites [1].



## Threats

Threat	Consequence
<b>Climate change</b>	
Extreme weather events	Catastrophic
Increasing temperature	Catastrophic
Increased intensity / frequency of bushfire	Catastrophic
<b>Disease</b>	
Crayfish plague	Catastrophic
<b>Invasive species</b>	
Invasive fauna	Moderate
<b>Habitat loss and fragmentation</b>	
Stochastic events	Major
<b>Illegal collection</b>	
Illegal take	Moderate

## Conservation priorities

### Primary conservation outcome:

- Ensure the species continues as a secure, viable population.

### Climate change:

- Investigate the feasibility and plan for ex-situ conservation measures.
- Review and revise existing fire management plans, and hazard reduction practices, and mitigate bushfire impacts.

## Supporting information

1. Coughran J., Leckie S. (2007). *Euastacus pilosus* n. sp., a new crayfish from the highland forests of northern New South Wales, Australia. *Fishes of Sahul* 21(1), 309–316.
2. Austin C. M., Whiterod N. S., McCormack R., Raadik T. A., Ahyong S. T., Lintermans M., Furse J. M., Grandjean F. (2022). 'Molecular taxonomy of Australia's endemic freshwater crayfish genus *Euastacus* (Parastacidae), with reference to priority 2019–20 bushfire-impacted species – 2022 update.' Deakin University and Aquasave-NGT, Victor Harbor, Australia.
3. Coughran J., Furse, J. (2010). '*Euastacus pilosus*. The IUCN Red List of Threatened Species 2010: e.T153736A4538303.' <https://dx.doi.org/10.2305/IUCN.UK.2010-3.RLTS.T153736A4538303.en>. Accessed on 30 March 2022.
4. Coughran J., Furse J. (2010). 'An assessment of genus *Euastacus* (49 species) versus IUCN Red List criteria. A report prepared for the global species conservation assessment of crayfishes for the IUCN Red List of Threatened Species.' The International Association of Astacology. ISBN: 978-0-9805452-1-0. Auburn, Alabama, USA.
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6. Furse J. M., Coughran J. (2011). An assessment of the distribution, biology, threatening processes and conservation status of the freshwater crayfish, genus *Euastacus* (Decapoda: Parastacidae) in continental Australia. III. Case studies and recommendations. *Crustaceana Monographs: New Frontiers in Crustacean Biology* 15, 265-274.

### Stakeholder and community engagement:

- Active participation of national park managers and traditional owners in management.

### Invasive species and disease:

- Control invasive species and minimise potential disease vectors entering species habitat.

### Illegal collection:

- Restrict publicity on the species so as to not facilitate illegal collection
- Monitor online crayfish sales and assess compliance of any recreational fishers with fisheries regulations.

### Survey and monitoring priorities:

- Establish and monitor the population size and trajectory through time.

### Knowledge gaps

The cultural significance and values of the species needs to be determined. There is a need to address previously identified critical knowledge gaps on the biology, ecology and life history, and habitat requirements as well as determining its taxonomic status, population status over time, and resilience of species and habitat to impacts of climate change [6] and further study is required to better characterise its molecular distinctions from *E. gumar* [2].

## *Euastacus polysetosus* (Riek, 1951)

Common name: Many-bristled Crayfish

### Taxonomy

The species was formally described by Riek (1); the molecular taxonomic analyses of Austin et al. [2] confirmed its validity as a distinct taxon.

### Conservation status

IUCN Red List Category: Endangered [3]



State: NSW: not listed

EPBC (proposed): Endangered

Justification: B1ab(iii)+2ab(iii)

**Rationale:** The species has a highly restricted distribution, being found at  $\leq 5$  locations. The area, extent, and quality of habitat are anticipated to decline due to impacts of climate change. It is unclear if the species persists in the western part of its distribution, and additional surveys are required to clarify. Due to its restricted range, the population is also threatened by highly localised events such as accidents (chemical spills from surrounding roads) and illegal collecting, as well as natural disasters (floods, bushfire), and invasive species. It is a high-altitude species that may rely on cool conditions and permanently flowing streams [4]. Increased temperature and drought associated with climate change likely to further reduce this species' available habitat.

### Description

This is a small, poorly spinose crayfish with an occipital carapace length (OCL) of 56 mm [5]. Its body is typically dark greenish to black from above and lighter below [1].

### Cultural significance

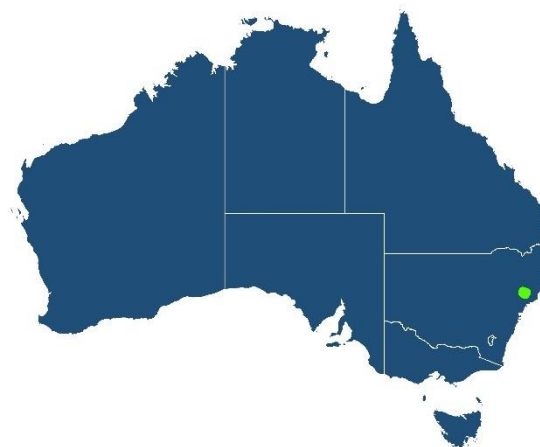
The species occurs on the lands of the Geawegal people, but cultural significance is currently unknown.



### Distribution and habitat

This species inhabits permanently flowing headwaters in the Hunter River and Manning River drainages, Mt Royal Ranges, NSW [1, 4]. It is a cold water species that is typically found in streams  $>900$  m asl that are vegetated by dry sclerophyll forests and other types of vegetation [1, 4].

Geographic range: EOO: 637 km<sup>2</sup> AOO: 88 km<sup>2</sup>



### Biology and ecology

The biology and ecology are not well understood. Females are thought to reach maturity at approximately 32.5 mm OCL, with pleopodal egg fecundity likely in the range of 30–60 eggs [1, 6].

## Threats

Threat	Consequence
<b>Climate change</b>	
Extreme weather events	Catastrophic
Increasing temperature	Catastrophic
Alterations to hydrological regimes	Catastrophic
Increased intensity / frequency of bushfire	Major
<b>Disease</b>	
Crayfish plague	Catastrophic
<b>Invasive species</b>	
Invasive fauna	Moderate
<b>Habitat loss and fragmentation</b>	
Stochastic events	Moderate
<b>Agriculture and aquaculture</b>	
Livestock farming and ranching	Minor
<b>Illegal collection</b>	
Illegal take	Moderate

## Conservation priorities

### Primary conservation outcome:

- Ensure the species continues as a secure, viable population and protect remaining sites.

### Climate change:

- Investigate the feasibility and plan for ex-situ conservation measures.
- Identify any 'cool' pockets of refuge habitat.
- Review and revise existing fire management plans, and hazard reduction practices, and mitigate bushfire impacts.

## Supporting information

1. Riek E. F. (1956). Additions to the Australian freshwater crayfish. *Records of the Australian Museum* 24, 1–6.
2. Austin C. M., Whiterod N. S., McCormack R., Raadik T. A., Ahyong S. T., Lintermans M., Furse J. M., Grandjean F. (2022). 'Molecular taxonomy of Australia's endemic freshwater crayfish genus *Euastacus* (Parastacidae), with reference to priority 2019–20 bushfire-impacted species – 2022 update.' Deakin University and Aquasave-NGT, Victor Harbor, Australia.
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5. Coughran J. (2008). Distinct groups in the genus *Euastacus*? *Freshwater Crayfish* 16, 125–132.
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7. Furse J. M., Coughran J. (2011). An assessment of the distribution, biology, threatening processes and conservation status of the freshwater crayfish, genus *Euastacus* (Decapoda: Parastacidae) in continental Australia. III. Case studies and recommendations. *Crustaceana Monographs: New Frontiers in Crustacean Biology* 15, 265-274.

### Stakeholder and community engagement:

- Active participation of national park managers and traditional owners in management.

### Invasive species and disease:

- Control invasive species and minimise potential disease vectors entering species habitat.

### Illegal collection:

- Restrict publicity on the species so as to not facilitate illegal collection
- Monitor online crayfish sales and assess compliance of any recreational fishers with fisheries regulations.

### Survey and monitoring priorities:

- Establish and monitor the population size and trajectory through time.

## Knowledge gaps

The cultural significance and values of the species needs to be determined. There is a need to address previously identified critical knowledge gaps on the biology, ecology and life history, habitat requirements and thermal tolerance, as well as determining contemporary geographic range, population status over time, and resilience of species and habitat to impacts of climate change [7].

## *Euastacus rieki* (Morgan, 1997)

Common name: Riek's Crayfish

### Taxonomy

The species was formally described by Morgan [1]; the molecular taxonomic analyses of Austin et al. [2] confirmed its validity as a distinct taxon whilst identifying a divergent lineage (*E. cf. rieki*).

### Conservation status

IUCN Red List Category: Endangered [3]



State: NSW: not listed

EPBC (proposed): Endangered

Justification: B1ab(i,ii,iii,v)+2ab(i,ii,iii,v)

**Rationale:** This species is known from a highly restricted area ( $\leq 5$  locations) confined to the high country of western and southern ACT and southern NSW [1, 2]. The range, habitat and populations are anticipated to decline due to impacts of climate change, such as increased temperatures, alteration of hydrological regimes, increased frequency of extreme weather events, and increased frequency and severity of bushfires, as well as the documented impacts of feral horses on stream habitat over the majority of its range [4]. Potential threats to water quality from road use and management within its range (use of de-icing salts, pollution from tire wear) are also of concern due to its restricted distribution.

### Description

This is a small and spinose crayfish with an maximum OCL of 53 mm [1]. The body is typically chocolate brownish to olive green on top and a paler brown on the sides and below [1].

### Cultural significance

The species occurs on the lands of the Ngarigo and Ngunnawal people, but cultural significance is currently unknown.



### Distribution and habitat

This species is endemic to the high country (typically above 1000 m asl) of the ACT and southern NSW [1, 4, 5, 6]. A divergent lineage (*E. cf. rieki*) has been revealed to occur across northern Victoria [2]. *Euastacus rieki* is restricted to small to moderate sized streams and stream margins, often fringed by snow gums, tussock grasses and heath, as well as bog habitats often containing rushes, sedges and sphagnum [1, 4]. This species may create deep and complex burrows at the edge of creeks that extend down to the water table but can also reportedly extend horizontally below the fringing heath and tussock grass.

Geographic range: EOO: 4476 km<sup>2</sup> AOO: 180 km<sup>2</sup>



### Biology and ecology

The biology and ecology are not well understood. Females are thought to reach maturity at approximately 42 mm OCL, with pleopodal egg fecundity likely in the range of 70–100 eggs [4].

## Threats

Threat	Consequence
<b>Climate change</b>	
Extreme weather events	Catastrophic
Increasing temperature	Catastrophic
Increased intensity / frequency of bushfire	Major
Drought	Moderate
<b>Disease</b>	
Crayfish plague	Catastrophic
<b>Invasive species</b>	
Invasive fauna	Major
<b>Habitat loss and fragmentation</b>	
Stochastic events	Moderate
<b>Pollution</b>	
Tyre road wear particles and de-icing salts	Minor
<b>Residential and commercial development</b>	
Tourism and recreation areas	Minor

## Conservation priorities

### Primary conservation outcome:

- Ensure the species continues with secure, viable populations. Population.
- Prepare translocation or salvage/rescue plans in response to future climatic-induced events.

### Climate change:

- Investigate the feasibility and plan for ex-situ conservation measures.
- Identify any 'cool' pockets of refuge habitat.
- Review and revise existing fire management plans, and hazard reduction practices, and mitigate bushfire impacts.

## Supporting information

1. Morgan G. J. (1997). Freshwater crayfish of the genus *Euastacus* Clark (Decapoda: Parastacidae) from New South Wales, with a key to all species of the genus. Records of the Australian Museum 23, 1–110.
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6. Hammer, M. and M. Beitzel (2019). Australian Capital Territory region Bush Blitz Fishes and Crayfish, Report submitted to Director of National Parks, Department of Agriculture, Water and the Environment, Canberra.
7. Furse J. M., Coughran J. (2011). An assessment of the distribution, biology, threatening processes and conservation status of the freshwater crayfish, genus *Euastacus* (Decapoda: Parastacidae) in continental Australia. III. Case studies and recommendations. *Crustaceana Monographs: New Frontiers in Crustacean Biology* 15, 265-274.

### Stakeholder and community engagement:

- Active participation of national park managers and traditional owners in management.

### Habitat loss:

- Ensure that the habitat quality remains high through actions of the land managers where the species is found.

### Invasive species and disease:

- Investigate trampling, pugging and sediment impacts of feral horses.
- Control invasive species and minimise potential disease vectors entering species habitat.

### Illegal collection:

- Restrict publicity on specific population locations so as to not facilitate illegal collection.
- Monitor online crayfish sales and assess compliance of any recreational fishers with fisheries regulations.

### Survey and monitoring priorities:

- Establish and monitor the population size and trajectory through time.

## Knowledge gaps

The cultural significance and values of the species needs to be determined. There is a need to address previously identified critical knowledge gaps on the biology, ecology and life history, habitat requirements and thermal tolerance, as well as determining its population status over time, and resilience of the species and habitat to impacts of climate change and other identified threats [7].

## *Euastacus simplex* (Riek, 1956)

Common name: Simple Crayfish

### Taxonomy

The species was formally described by Riek [1]; the molecular taxonomic analyses of Austin et al. [2] confirmed its validity as a distinct taxon.

### Conservation status

IUCN Red List Category: Vulnerable [3]



State: NSW: not listed

EPBC (proposed): Endangered

Justification: B1ab(iii,iv)+B2ab(iii,iv)

**Rationale:** This species is known only from  $\leq 5$  locations and the area, extent and quality of its habitat are anticipated to decline due to the impacts of climate change. It has been suggested that the species may now be absent from a number of former sites of record including the type locality and further investigation is required to clarify this matter. Predicted temperature rises associated with climate change are likely to further reduce this species' available habitat thereby reducing its already small range [4].

### Description

This species has a maximum occipital carapace length (OCL) of 58 mm and maximum weight of 108 g [4].

### Cultural significance

The species occurs on the lands of the Gumbaynggirr people, but cultural significance is currently unknown.



### Distribution and habitat

This species is endemic to creeks in the uppermost parts of catchments southwest of Coffs Harbour, NSW [4]. It appears the species can occupy creeks in cleared land as long as the water temperature remains cool ( $< 20^{\circ}\text{C}$ ) [4]. *Euastacus simplex* generally constructs and occupies burrows that are along the stream edges at or below water level, and may be reliant on permanent groundwater [4]. It is also occupies temporary burrows under rocks or logs in the stream bed [4].

Geographic range: EOO: 297 km<sup>2</sup> AOO: 36 km<sup>2</sup>



### Biology and ecology

The biology and ecology are not well understood. Females are thought to reach maturity at approximately 39 mm OCL and in some females in the population, breeding commences between May-July [4].

## Threats

Threat	Consequence
<b>Climate change</b>	
Extreme weather events	Catastrophic
Increasing temperature	Catastrophic
Alterations to hydrological regimes	Catastrophic
Increased intensity / frequency of bushfire	Major
<b>Disease</b>	
Crayfish plague	Catastrophic
<b>Invasive species</b>	
Invasive fauna	Catastrophic
<b>Habitat loss and fragmentation</b>	
Land clearing	Major
Stochastic events	Moderate
<b>Illegal collection</b>	
Illegal take	Moderate

## Conservation priorities

### Primary conservation outcome:

- Ensure the species continues as a secure, viable population and protect the remaining populations.

### Climate change:

- Investigate the feasibility of and plan for ex-situ conservation measures.
- Identify any 'cool' pockets of refuge habitat.
- Review and revise existing fire management plans, and hazard reduction practices, and mitigate bushfire impacts.

## Supporting information

1. Riek E. F. (1956). Additions to the Australian freshwater crayfish. *Records of the Australian Museum* 24, 1–6.
2. Austin C. M., Whiterod N. S., McCormack R., Raadik T. A., Ah Yong S. T., Lintermans M., Furse J. M., Grandjean F. (2022). 'Molecular taxonomy of Australia's endemic freshwater crayfish genus *Euastacus* (Parastacidae), with reference to priority 2019–20 bushfire-impacted species – 2022 update.' Deakin University and Aquasave-NGT, Victor Harbor, Australia.
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4. McCormack R. B. (2022). '*Euastacus simplex* surveys within upper Nymboida & Macleay rivers, NSW.' Field survey report to Aquasave-NGT for the Saving the Spinys project. Australian Aquatic Biological P/L, Port Stephens.
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### Stakeholder and community engagement:

- Active participation of land managers and traditional owners in management.

### Invasive species and disease:

- Control invasive species and minimise potential disease vectors entering species habitat.

### Illegal collection:

- Restrict publicity on the species so as to not facilitate illegal collection.
- Monitor online crayfish sales and assess compliance of any recreational fishers with fisheries regulations.

### Survey and monitoring priorities:

- Establish and monitor the population size and trajectory through time.

## Knowledge gaps

The cultural significance and values of the species needs to be determined. There is a need to address previously identified critical knowledge gaps on the biology, ecology and life history, habitat requirements and thermal tolerance, as well as determining contemporary geographic range, population status over time, and resilience of species and habitat to impacts of climate change [5].

## *Euastacus spinichelatus* (Morgan, 1997)

Common name: Small Crayfish

### Taxonomy

The species was formally described by Morgan [1]; the molecular taxonomic analyses of Austin et al. [2] confirmed its validity as a distinct taxon, whilst identifying two divergent lineages (*E. cf. spinichelatus* 1 and *E. cf. spinichelatus* 2).

### Conservation status

IUCN Red List Category: Endangered [3]



State: NSW: not listed

EPBC (proposed): Endangered

Justification: B1ab(iii,iv)+2ab(iii,iv)

**Rationale:** This species is known only from  $\leq 5$  locations and the area, extent and quality of its habitat are anticipated to decline due to the impacts of climate change. It is unclear if the species still occupies former sites of record, and further investigation is required to clarify any possible reduction in contemporary range. Due to its highly restricted distribution, the population is also threatened by highly localised events such as natural disasters (floods, bushfire), illegal collecting, as well as invasive species. Large areas of the species' distribution were affected by the 2019–20 megafires [4]; the impacts of which are not currently understood.

### Description

This is a poorly spinose species with an occipital carapace length (OCL) of 40 mm [4]. It may be green-brown or green-blue from above [1].

### Cultural significance

The species occurs on the lands of the Biripi people, but cultural significance is currently unknown.



### Distribution and habitat

This species is known from the headwaters ( $>1000$  m asl) of the Hastings River, Macleay River, Manning River and Namoi River basins, with the two divergent lineages occurring at lower elevations of the Hastings River Basin [1, 2, 4]. It inhabits complex burrow systems in small streams with permanent subsurface flows but standing water may not be essential for this species [1, 4].

Geographic range: EOO: 295 km<sup>2</sup> AOO: 44 km<sup>2</sup>



### Biology and ecology

The biology and ecology are not well understood. Females are thought to reach maturity at  $\sim 26$ – $30$  mm OCL, with low pleopodal egg fecundity noted, potentially in the range of 16–69 eggs per female [1, 4]. It can co-occur with various other species of crayfish such as *E. spinifer* at lower elevations.



## Threats

Threat	Consequence
<b>Climate change</b>	
Extreme weather events	Catastrophic
Increasing temperature	Catastrophic
Alterations to hydrological regimes	Catastrophic
Increased intensity / frequency of bushfire	Major
<b>Disease</b>	
Crayfish plague	Catastrophic
<b>Invasive species</b>	
Invasive fauna	Moderate
<b>Illegal collection</b>	
Illegal take	Moderate
<b>Agriculture and aquaculture</b>	
Plantation forestry	Minor
Livestock farming and ranching	Major

## Conservation priorities

### Primary conservation outcome:

- Ensure the species continues as a secure, viable population, and define its current range.

### Climate change:

- Investigate the feasibility and plan for ex-situ conservation measures.
- Investigate translocations to restock populations at any former sites of record where the species is now believed to be absent.
- Review and revise existing fire management plans, and hazard reduction practices, and mitigate bushfire impacts.

## Supporting information

1. Morgan G. J. (1997). Freshwater crayfish of the genus *Euastacus* Clark (Decapoda: Parastacidae) from New South Wales, with a key to all species of the genus. *Records of the Australian Museum* 23, 1-110.
2. Austin C. M., Whiterod N. S., McCormack R., Raadik T. A., Ahyong S. T., Lintermans M., Furse J. M., Grandjean F. (2022). 'Molecular taxonomy of Australia's endemic freshwater crayfish genus *Euastacus* (Parastacidae), with reference to priority 2019–20 bushfire-impacted species – 2022 update.' Deakin University and Aquasave-NGT, Victor Harbor, Australia.
3. Coughran J., Furse J. (2010). '*Euastacus spinichelatus*. The IUCN Red List of Threatened Species 2010: e.T153673A4530582.' <https://dx.doi.org/10.2305/IUCN.JK.2010-3.RLTS.T153673A4530582.en>. Accessed on 24 March 2022.
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5. Furse J. M., Coughran J. (2011). An assessment of the distribution, biology, threatening processes and conservation status of the freshwater crayfish, genus *Euastacus* (Decapoda: Parastacidae) in continental Australia. III. Case studies and recommendations. *Crustaceana Monographs: New Frontiers in Crustacean Biology* 15, 265-274.

### Stakeholder and community engagement:

- Active participation of national park managers and traditional owners in management.

### Invasive species and disease:

- Control invasive species and minimise potential disease vectors entering species habitat.

### Illegal collection:

- Restrict publicity on the species so as to not facilitate illegal collection.
- Monitor online crayfish sales and assess compliance of any recreational fishers with fisheries regulations.

### Survey and monitoring priorities:

- Establish and monitor the population size and trajectory through time.
- Conduct genetic studies of all populations across the species' range.

## Knowledge gaps

The cultural significance and values of the species needs to be determined. There is a need to address previously identified critical knowledge gaps on the biology, ecology and life history, habitat requirements and thermal tolerance, as well as determining contemporary geographic range, population status over time, and resilience of species and habitat to impacts of climate change [5] as well as resolving status of two divergent lineages [2].

## *Euastacus suttoni* (Clark, 1941)

Common name: Sutton's Crayfish

### Taxonomy

The species was formally described by Clark [1]; the molecular taxonomic analyses of Austin et al. [2] confirmed its validity as a distinct taxon.

### Conservation status

IUCN Red List Category: Vulnerable [3]



State: NSW: not listed, QLD: not listed

EPBC (proposed): Endangered

Justification: B1ab(iii,v)+2ab(iii,v)

**Rationale:** This species is known only from one location and the area, extent and quality of its habitat and number of mature individuals are anticipated to decline due to impacts of climate change (i.e. increasing environmental temperature, more frequent and severe heatwaves, droughts and bushfires, land clearing). Furthermore, the species faces a series of additional, well-understood threats including natural disasters, accidents, disease, overharvesting, illegal collecting, and exotic species. Climate change is a key threat to this species as it may have limited capacity to relocate to higher, cooler altitudes, or overland to any other suitably cool habitats which may already be occupied by other species [4, 5].

### Description

This is a heavily spinose species with a maximum recorded occipital carapace length (OCL) of 86 mm [6]. It may typically appear as a very dark red, green-black, or blue-grey/green from above, red and/or orange, or orange-brown on the underside [6].

### Cultural significance

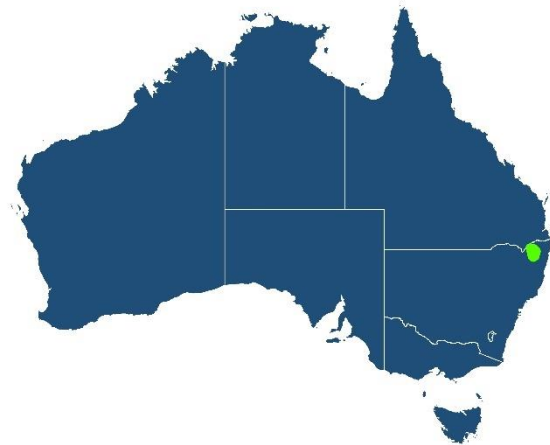
The species occurs on the lands of the Kambuwal, Bundjalung, Gumbaingirri, Jukambal and Ngarrabul peoples, but cultural significance is currently unknown.



### Distribution and habitat

This species is endemic to southern Qld and the northern region of NSW, and inhabits streams and other waterbodies at altitudes usually above 1000 m asl [6]. It is associated with highland habitats and cool conditions, some specific vegetation types, but not necessarily permanent water, all of which may reflect a requirement for cool conditions [7].

Geographic range: EOO: 2719 km<sup>2</sup> AOO: 84 km<sup>2</sup>



### Biology and ecology

The biology and ecology are not well understood. Females are thought to reach maturity at ~40–60 mm OCL, with fecundity likely between 50–100s of pleopodal eggs per female [6, 9]. It is not known to occur in sympatry with other *Euastacus*, but co-occurs with *C. destructor*.

## Threats

Threat	Consequence
<b>Climate change</b>	
Extreme weather events	Catastrophic
Increasing temperature	Catastrophic
Increased intensity / frequency of bushfire	Major
<b>Disease</b>	
Crayfish plague	Catastrophic
<b>Invasive species</b>	
Invasive fauna	Moderate
<b>Illegal collection</b>	
Illegal take	Moderate
<b>Habitat loss and fragmentation</b>	
Stochastic events	Moderate
<b>Agriculture and aquaculture</b>	
Wood and pulp plantations	Minor

## Conservation priorities

### Primary conservation outcome:

- Ensure the species continues as a secure, viable population.

### Climate change:

- Investigate the feasibility and plan for ex-situ conservation measures.
- Investigate translocations to restock populations at any former sites of record where the species is now believed to be absent.
- Review and revise existing fire management plans, and hazard reduction practices, and mitigate bushfire impacts.

## Supporting information

1. Clark E. (1941). Revision of the genus *Euastacus* (Crayfishes, Family Parastacidae), with notes on the distribution of certain species. *Memoirs of The National Museum of Victoria* 12, 7–30.
2. Austin C. M., Whiterod N. S., McCormack R., Raadik T. A., Ah Yong S. T., Lintermans M., Furse J. M., Grandjean F. (2022). 'Molecular taxonomy of Australia's endemic freshwater crayfish genus *Euastacus* (Parastacidae), with reference to priority 2019–20 bushfire-impacted species – 2022 update.' Deakin University and Aquasave-NGT, Victor Harbor, Australia.
3. Coughran J., Furse J. (2010). '*Euastacus suttoni*. The IUCN Red List of Threatened Species 2010: e.T153727A4537203.' <https://dx.doi.org/10.2305/IUCN.UK.2010-3.RLTS.T153727A4537203.en>. Accessed on 30 March 2022.
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5. Furse J. M., Bone J. W. P., Appleton S. D., Leland J. C., Coughran J. (2012). Conservation of imperilled crayfish - *Euastacus bindal* (Decapoda: Parastacidae), a highland crayfish from Far North Queensland, Australia. *Journal of Crustacean Biology* 32(4), 677–683.
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8. Coughran J. (2013). Biology of the Mountain Crayfish *Euastacus sulcatus* Riek, 1951 (Crustacea: Parastacidae), in New South Wales, Australia. *Journal of Threatened Taxa* 5(14), 4840–4853.
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10. Furse J. M., Coughran J. (2011). An assessment of the distribution, biology, threatening processes and conservation status of the freshwater crayfish, genus *Euastacus* (Decapoda: Parastacidae) in continental Australia. III. Case studies and recommendations. *Crustaceana Monographs: New Frontiers in Crustacean Biology* 15, 265-274.

### Stakeholder and community engagement:

- Active participation of national park managers and traditional owners in management.

### Invasive species and disease:

- Control invasive species and minimise potential disease vectors entering species habitat.

### Illegal collection:

- Restrict publicity on the species so as to not facilitate illegal collection
- Monitor online crayfish sales and assess compliance of any recreational fishers with State fisheries regulations.

### Survey and monitoring priorities:

- Establish and monitor the population size and trajectory through time.

## Knowledge gaps

The cultural significance and values of the species needs to be determined. There is a need to address previously identified critical knowledge gaps of the biology, ecology and life history, habitat requirements and thermal tolerance, as well as determining contemporary geographic range, population status over time, and resilience of species and habitat to impacts of climate change [10].

## **Euastacus sp. nov. 1** (McCormack & Fetzner, in prep)

**Common name:** Coughran's Crayfish

### **Taxonomy**

This species is being formally described by McCormack and Fetzner [1] and will be named *Euastacus coughrani*; the molecular taxonomic analyses of Austin et al. [2] confirmed its validity as a distinct taxon.

### **Conservation status**

**IUCN Red List Category:** not listed

**State:** VIC: not listed

**EPBC (proposed):** Endangered

**Justification:** B1ab(iii)+2ab(iii)

**Rationale:** The species is known only from a single location and the area, extent and quality of its habitat are anticipated to decline due to the impacts of climate change. It likely prefers cooler conditions as it is restricted to forested headwater streams. As climate change causes ambient and water temperatures to rise the species' distribution may contract upstream [1]. The species only occurs in streams with permanent subsurface flow and is absent from deforested streams [1, 3]. Therefore, the actual area of habitat available is a small fraction of the calculated range. The species occurs in bushfire-prone areas, with the 2019–20 megafires potentially having some impact(s) on the species [3, 4].

### **Description**

This species is a medium sized, poorly spinose *Euastacus* with a maximum recorded occipital carapace length (OCL) of 52 mm [1, 3]. Its body is dark brown to olive green above, and tan to orange below [1].

### **Cultural significance**

The species occurs on the lands of the Kurnai people, but cultural significance is currently unknown.



### **Distribution and habitat**

This species is endemic to eastern Victoria, with the species' range occurring in the East Gippsland and Snowy River basins [1,2, 3]. It inhabits burrows in or connected to open or flowing water between the altitudes of 250–1050 m asl [1].

**Geographic range:** EOO: 250 km<sup>2</sup> AOO: 44 km<sup>2</sup>



### **Biology and ecology**

The biology and ecology are not well understood. On the basis of the single berried female recorded to date (which had 97 pleopodal eggs), females maturity occurs at <39 mm OCL [1, 3]. Within its highly restricted distribution, it occurs in sympatry with *E. kershawi* and *Engaeus orientalis* [1].

## Threats

Threat	Consequence
<b>Climate change</b>	
Extreme weather events	Catastrophic
Increasing temperature	Catastrophic
Alterations to hydrological regimes	Catastrophic
Increased intensity / frequency of bushfire	Major
<b>Disease</b>	
Crayfish plague	Catastrophic
<b>Agriculture and aquaculture</b>	
Wood and pulp plantations	Catastrophic
<b>Invasive species</b>	
Invasive fauna	Moderate
<b>Habitat loss and fragmentation</b>	
Stochastic events	Moderate
<b>Illegal collection</b>	
Illegal take	Moderate

## Conservation priorities

### Primary conservation outcome:

- Ensure the species continues as a secure, viable population.

### Climate change:

- Investigate the feasibility of and plan for ex-situ conservation measures.
- Identify any 'cool' pockets of refuge habitat.
- Review and revise existing fire management plans, and hazard reduction practices, and mitigate bushfire impacts.

## Supporting information

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### Stakeholder and community engagement:

- Active participation of national park managers and traditional owners in management.

### Invasive species and disease:

- Control invasive species and minimise potential disease vectors entering species habitat.

### Illegal collection:

- Restrict publicity on the species so as to not facilitate illegal collection
- Monitor online crayfish sales and assess compliance of any recreational fishers with fisheries regulations.

### Survey and monitoring priorities:

- Establish and monitor the population size and trajectory through time.

## Knowledge gaps

The cultural significance and values of the species needs to be determined. There is a need to address previously identified genus wide critical knowledge gaps on the biology, ecology and life history of this species. Additionally, habitat requirements, thermal tolerance, geographic range, population status through time, and resilience of species and habitat to impacts of climate change require investigation [5].

## ***Euastacus sp. nov. 3***

Common name: West Snowy Spiny Crayfish

### **Taxonomy**

This is an undescribed species for which the molecular taxonomic analyses of Austin et al. [1] confirmed its validity as a distinct taxon.

### **Conservation status**

IUCN Red List Category: not assessed

State: VIC: not listed

EPBC (proposed): not assessed

### **Summary**

This species is currently only known from a small area in the Snowy River Basin of eastern Victoria [1]. Its restricted range (i.e. EOO: 12 km<sup>2</sup> and AOO: 12 km<sup>2</sup>) across a single location and anticipated declines in area, extent and quality of its habitat due to the impacts of climate change indicate a Critically Endangered status. However, there is a need to formally describe the species and address priority knowledge gaps along with defining its range before conservation assessment can occur.



### **Supporting information**

1. Austin C. M., Whiterod N. S., McCormack R., Raadik T. A., Ah Yong S. T., Lintermans M., Furse J. M., Grandjean F. (2022). 'Molecular taxonomy of Australia's endemic freshwater crayfish genus *Euastacus* (Parastacidae), with reference to priority 2019–20 bushfire-impacted species – 2022 update.' Deakin University and Aquasave-NGT, Victor Harbor, Australia.

## 5. THE WAY FORWARD

### 5.1 Summary

This Action Plan provides timely assessment of the conservation status of bushfire-impacted priority species of *Euastacus*. All priority species were assigned to IUCN threat categories: five species (*E. dalagarbe*, *E. guwinus*, *E. jagabar*, *E. jagara*, *E. morgani*) as Critically Endangered and 13 species (*E. bidawalus*, *E. clarkae*, *E. diversus*, *E. gamilaroi*, *E. girurmulayn*, *E. gumar*, *E. pilosus*, *E. polysetosus*, *E. rieki*, *E. simplex*, *E. spinichelatus*, *E. suttoni* and *E. sp. nov. 1* (*'E. coughrani'*)) as Endangered (with conservation assessment not currently possible for three of the priority species). These outcomes are consistent with previous IUCN assessments ([Furse and Coughran 2011b](#); [Richman et al. 2015](#)), although there has been an escalation of the threat category for two species (*E. simplex* and *E. suttoni*) and a downgrading of the threat category for *E. gamilaroi* and *E. girurmulayn* with the outcomes of field surveys and the molecular taxonomic analysis contributing to range expansions.

This Action Plan affirms the highly threatened status of the bushfire-impacted priority species of *Euastacus*. It is now necessary to build on the momentum achieved by the Saving the Spinys project to address priorities for the conservation and management for all species in the genus.

### 5.2 The nine priorities for *Euastacus* conservation and management

This section outlines nine priorities for conservation and management of bushfire-impacted priority species of *Euastacus*, which are equally relevant to all members of the genus. The priorities are to:

- Undertake formal national assessment for all *Euastacus* and develop recovery plan(s);
- Mitigate threats and implement conservation actions;
- Incorporate and include *Euastacus* into management strategies and actions at multiple scales;
- Define species' range boundaries and implement ongoing population monitoring programs;
- Resolve taxonomic uncertainty and formally describe putative species;
- Redress previously identified critical biological and ecological knowledge gaps;
- Explore species-specific conservation translocations;
- Engage stakeholders in management and conservation; and
- Raise the profile of the *Euastacus* within governments, NGOs and funding bodies.

Each priority for conservation and management is discussed below.

### Undertake formal national assessment for all *Euastacus* and develop recovery plan(s)

Contrasting with the threat status revealed for bushfire-impacted priority species (and the genus overall), only three species (*E. bispinosus*, *E. bindal* and *E. dharawalus* – all non-priority species) are listed under the EPBC Act. Without appropriate national recognition, the conservation of some of the most at-risk species in Australia has been hampered. Fortunately, the nationally funded bushfire-focused Saving the Spinys project (from which this Action Plan is generated) and state- and NGO-led assessments have helped to redress this underrepresentation. As a result, national conservation assessment of 40 species is currently underway, but the national status of a further 15 species remain unassessed. Furthermore, it is likely that additional species may be identified in the genus ([see 'resolve taxonomic uncertainty and formally describe putative species': Austin et al. 2022](#)), which may require assessment against EPBC Act criteria in the future. Thus, it is recommended to continue the EPBC assessment process for remaining species of the genus.

Whilst the EPBC conservation advice for listed species provides guidance for management and recovery, it is recommended that national recovery planning (either single- or multi-species or for the genus as a whole) is initiated facilitate accountable and coordinated management of the *Euastacus*.

### Mitigate threats and implement conservation actions

Established (habitat destruction, pollution, invasive species, and human exploitation), emerging (climate change), and potential future threats (disease such as *Aphanomyces astaci* [crayfish plague]: [DAWE 2019](#); [Panteleit et al. 2017](#)) may put nearly all species of *Euastacus* at serious risk of population declines, or extinction, over sub-decadal timeframes ([Coughran 2007](#); [Furse 2014](#); [Furse and Coughran 2011b](#); [Richman et al. 2015](#)). Whilst the threatening processes vary between species, the myriad impacts of climate change, including more frequent and intense bushfires, represent a key threat for many species given their highly restricted distributions often associated with cool conditions. In reality, many species are at considerable risk of extirpation by a single stochastic event (e.g., accident, natural disaster, or disease), that have the potential to impact the entirety of the range of several species.

The development and implementation of strategies to mitigate these threats, where possible, is essential. This may involve active protection of the habitats at known sites, eradication



programs to control introduced species, revision of existing fire management plans and hazard reduction practices to ensure they are appropriate for the distribution and species' habitat requirements, implementing strategies to alleviate disease vectors and rapidly respond to disease incursions. Stakeholder ownership and sustainable investment will be necessary to mitigate threats to ensure each priority species continues as a secure, viable population.

### **Incorporate and include *Euastacus* into management strategies and actions at multiple scales**

The *Euastacus* have slipped through management cracks for decades. Presently, specific management actions are not articulated in national, state or regional management strategies for any species of *Euastacus*. This includes the national Threatened Species Strategy 2021–2031 ([DAWE 2021](#)). State-level strategies, such as the Protecting Victoria's Environment – Biodiversity 2037 ([DELWP 2017](#)), provide some guidance (e.g., stopping the overall decline of threatened species) but it remains unclear if any *Euastacus* will be prioritised. Furthermore, *Euastacus* are not well represented (or represented at all) in regional management strategies or thematic-focused strategies relating to fire, forestry and invasive species.

Whilst many of the priority species occur in protected areas (e.g., national parks), *Euastacus* are not specifically addressed in any associated management strategies or plans. For instance, the recent commitment to zero extinctions across the NSW national park estate by the NSW National Parks and Wildlife Service does not consider crayfish as they are not covered under the *Biodiversity Conservation Act 2016* ([NPWS 2021b](#)). Equally, *Euastacus* are not considered in park-level strategies, including in the plan of management for Kosciuszko National Park ([NPWS 2021a](#)) or in the Greater Alpine National Parks Management Plan, which covers the Snowy River and Errinundra national parks ([Parks Victoria 2016](#)).

There is a key recommendation to redress this lacuna evident at multiple scales so that the conservation and management needs of the *Euastacus* are incorporated into, and implemented through, relevant strategies and management plans.

## Define species range boundaries and implement ongoing population monitoring programs

The contemporary range has been incompletely resolved for most species of *Euastacus*. Fortunately, field surveys ([Lintermans 2021](#); [McCormack 2020a](#); [McCormack 2020b](#); [McCormack 2020c](#); [McCormack 2020d](#); [McCormack 2020e](#); [McCormack 2020f](#); [McCormack 2020g](#); [McCormack 2021a](#); [McCormack 2021b](#); [McCormack 2021c](#); [McCormack 2021d](#); [McCormack 2021e](#); [McCormack 2022a](#); [McCormack 2022b](#); [McCormack 2022c](#); [McCormack 2022d](#); [McCormack 2022e](#); [McCormack 2022f](#)) and molecular taxonomic analyses ([Austin et al. 2022](#)) as part of the Saving the Spinys project have provided additional insight into range boundaries for the bushfire-impacted species. This has resulted in refinement of the known range; for some described species, such as *E. dalagarbe* and *E. girurmulayn*, the known range has increased, but for others, including *E. claytoni* (and *E. cf. claytoni*) and *E. rieki* (and *E. cf. rieki*), the discovery of two divergent lineages of taxonomic significance has acted to split the former known range into two smaller ranges. Once thought to occur across three state and territories, *E. crassus* was only detected from the ACT. In some cases, new putative species were identified from areas where *Euastacus* had not previously been recorded ([Austin et al. 2022](#)).

Species boundary refinements have had important management implications in terms of conservations assessments, the prevailing threats, management responsibilities and the likely mitigation of future disturbances. More work is needed to continue to refine our knowledge on the contemporary distributions of species in this genus. This exploration of range boundaries should rely on not only traditional trapping or collection methods (e.g., hand picking, burrow digging) but also environmental DNA (eDNA) sampling. Stemming from the molecular taxonomic analyses of Austin et al. ([2022](#)), a comprehensive reference library of mitogenome primers has been established. This reference library, accounting for intraspecific variation across all described species and 27 putative species, will facilitate genus-wide metabarcoding to accurately identify species of *Euastacus* from field eDNA samples. As such, eDNA sampling represents a powerful tool to assist with the refinement of species range boundaries in the genus.

Rigorous, ongoing population monitoring will be critical to understanding future trajectories, in relation to disturbance and recovery, in the status of bushfire-impacted species of *Euastacus*. Yet, formal (i.e. governmental) monitoring strategies of sufficient spatial and

temporal scale, with appropriately species-specific sampling methodology have not been evident for any species of *Euastacus* ([hence the critical knowledge gaps: Furse and Coughran 2011a](#)). It is therefore recommended to commit to developing and implementing appropriate formal monitoring strategies.

### **Resolve taxonomic uncertainty and formally describe putative species**

Austin et al. ([2022](#)) provided the molecular taxonomic basis for the presence of up to 82 putative species within *Euastacus*, with as many as 27 being new species; this represents an approximately 50% increase in the number of species within the genus. Additional lines of evidence are necessary to confirm the validity of the potential new species. This will require comprehensive field surveys of new candidate species and further sequencing of additional tissue samples to resolve taxonomic uncertainties and species boundaries, analysis of nuclear data to support findings based on mitochondrial data, the characterisation of full geographic range, as well as examination of morphological and ecological characteristics of new candidate species. It will then be necessary to formally describe well-supported new putative species ([e.g., McCormack and Fetzner in prep](#)). The findings of Austin et al. ([2022](#)) must ensure that ongoing resources are allocated to fulfil the necessary taxonomic revisions for *Euastacus* supported with molecular genetic data.

### **Redress previously identified critical biological and ecological knowledge gaps**

Genus *Euastacus* has not been thoroughly studied and is not yet fully understood ([Furse and Coughran 2011c](#)). There is a need to address previously identified critical knowledge gaps relating to biology, ecology and life history, habitat requirements and thermal tolerance, as well as determining the resilience of species and habitats to impacts of the identified threats (e.g., climate change, invasive species, and disease). This basic knowledge will be key to informing the conservation and management of each species.

### **Explore species-specific conservation translocations**

Conservation translocations may, in some cases, represent a necessary, final and the only viable conservation action for some species of *Euastacus*. Translocations can be used for population restoration either through the intentional release of animals within the natural range to either enhance existing populations (reinforcement) or re-establish populations

from where they have disappeared (reintroduction). The feasibility of using conservation translocations will need to be assessed per species, and per site, and will depend on several critical factors including ability to source crayfish, availability of suitable release sites, genetics, biosecurity and disease, permitting, and long-term investment. As such, the feasibility assessment of Zukowski et al. (2021) provides a platform to guide the considerations for conservation translocation projects of *Euastacus* in Australia. Various species of *Euastacus* require comprehensive and sustained management actions which may include translocations, without which, they will be lost to extinction in the future. Conservation translocations must be a last resort, and accordingly require appropriate evaluation, planning and resourcing.

### Engage stakeholders in management and conservation

The conservation and management of the *Euastacus* requires a collaborative engagement of a wide range of stakeholders. The expertise and knowledge of diverse stakeholders will be critical to implement species- and habitat-relevant actions. Relevant stakeholders include all levels of government (federal, state, and local) and various government departments (relating to areas such as conservation, land use, biosecurity), Indigenous peoples, members of the general public (such as recreational fishers), other natural resource and land managers including in fisheries and forestry, landowners, and national and state parks staff. Engagement of and collaboration between these stakeholders will be necessary in the effective management and conservation of species of *Euastacus*.

### Raise the profile of the *Euastacus* within governments, NGOs and funding bodies

*Euastacus* may be declining largely out of sight and without concern. The Saving the Spinys project acted to promote the conservation of species impacted by the 2019–20 megafires. There is an obligation for stakeholders (such as government departments, NGOs, and researchers) to continue to seek out appropriate opportunities and explore novel partnerships to raise the profile of the *Euastacus* and required habitats. It is important to articulate the uniqueness and threatened nature of these species, the habitats they occupy and demonstrate the way forward for conservation and management. Such promotion of *Euastacus* may include limited awareness raising directed at the general public, but should primarily focus on influencing managers, policy makers and politicians.

### 5.3 Conclusions

The endemic Australian freshwater crayfish genus *Euastacus* is considered the most threatened genus of freshwater crayfish in the world. Conservation assessments detailed here, which are contributing to national listing assessment, affirm the highly threatened status of *Euastacus* priority species impacted by the 2019–20 bushfires. In response, this Action Plan articulates nine priorities that must be implemented to assist the conservation and management of members of the genus. In this way, it is hoped that this Action Plan will establish a platform for the genus-level conservation and management species of *Euastacus*.

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