

## DRAFT - Conservation Advice for *Euastacus urospinosus* (Maleny crayfish)



*Euastacus urospinosus* (Maleny crayfish) © Copyright, Jason Coughran.

### Conservation status

*Euastacus urospinosus* (Maleny crayfish) is proposed to be listed in the Endangered category of the threatened species list under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwth) (EPBC Act).

*Euastacus urospinosus* was assessed to be eligible for listing as Endangered under Criterion 2. The assessment is at Attachment A. The assessment of the species' eligibility against each of the listing criteria is:

- Criterion 1: Insufficient data
- Criterion 2: B1ab(iii,v)+2ab(iii,v): Endangered
- Criterion 3: Insufficient data
- Criterion 4: D2 Vulnerable
- Criterion 5: Insufficient data

The main factors that make the species eligible for listing in the Endangered category are the impacts of climate change (extreme weather events, increased temperature, increased intensity/frequency of bushfire), which will very likely lead to a continuing decline in the area, extent, and quality of habitat and number of mature individuals.

Species can also be listed as threatened under state and territory legislation. For information on the current listing status of this species, see the [Species Profile and Threat Database](#).

## Species information

### Taxonomy

Conventionally accepted as *Euastacus urospinosus* Riek, 1956 (Family: Parastacidae). Phylogenetic analyses by Shull et al. (2005), Hurry et al. (2015) and Austin et al. (2022) have confirmed *E. urospinosus* as a distinct and valid taxon. Hurry et al. (2015) and Austin et al. (2022) indicate that the Conondale National Park (labelled as *E. cf. urospinosus*) may be home to a cryptic lineage. Further phylogenetic analysis is warranted but this lineage is treated as a distinct taxon.

### Description

The Maleny crayfish is a poorly spinose species of *Euastacus* (Coughran 2008) with a maximum occipital carapace length (OCL: Morgan 1997) of 54.1 mm (Borsboom 1998). The body is dark red-brown dorsally, bluish or green on the sides and bright blue and cream coloured ventrally (Morgan 1988). The adult claws are dorsally dark brown with a lighter, brighter blue ventrally (Morgan 1988).

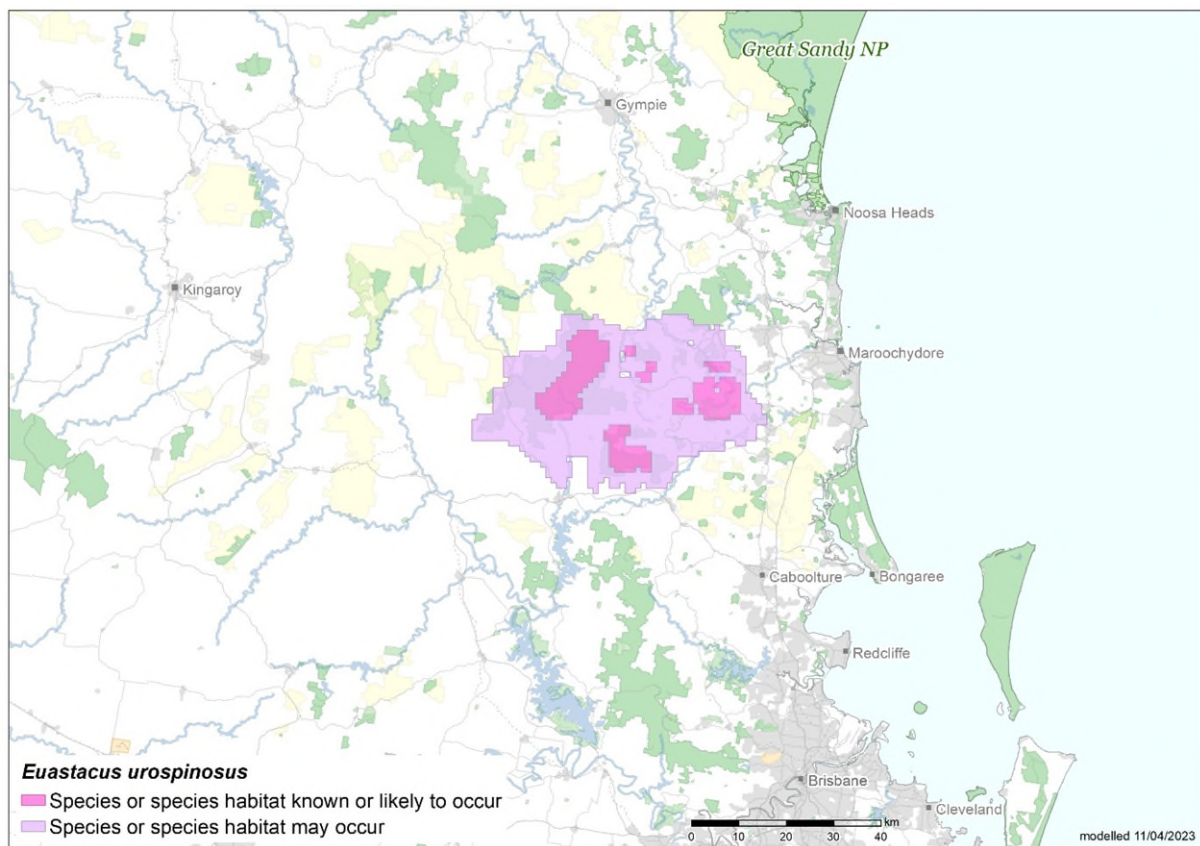
The morphological characteristics used to identify individual species of the small and poorly spinose *Euastacus* are subtle, with the differences often a few spines, and/or the presence of a groove. For example, Maleny crayfish can be distinguished from *Euastacus setotus* (Mount Glorious spiny crayfish) on the basis of its spination (Morgan 1988). This means that accurate and reliable identification is challenging and requires technical terminology to describe the morphological features separating the species. Detailed descriptions can be found in papers by Riek (1956) and Morgan (1988).

### Distribution

The Maleny crayfish is endemic to the Brisbane and Mary River basins in southeast Queensland, where it is found in the tributaries of the Obi Obi Creek (west of Nambour) and numerous creeks in the southern Conondale Range (Booloumba Creek, east and west of Kilcoy Creek, Bundaroo Creek, and Mary Smokes Creek) (Morgan 1988; Borsboom 1998; McCormack & van der Werf 2013; Hurry et al. 2015). Records from East Kilcoy Creek (Brisbane River Basin) and Summer Creek (Mary River Basin), all located within northern Conondale National Park may represent a divergent lineage (see Taxonomy section: Hurry et al. 2015; Austin et al. 2022) but further phylogenetic analysis is required to establish if this lineage is a distinct taxon.

Part of the range of this species is afforded a degree of protection by being contained within protected areas, including Conondale, Bellthorpe, Kondalilla and Maleny national parks, Bellthorpe State Forest and Mary Cairncross Scenic Reserve and Curramore Sanctuary Nature Refuge.

## Map 1 Modelled distribution of Maleny crayfish



Source: Base map Geoscience Australia; species distribution data [Species of National Environmental Significance](#) database.

Caveat: The information presented in this map has been provided by a range of groups and agencies. While every effort has been made to ensure accuracy and completeness, no guarantee is given, nor responsibility taken by the Commonwealth for errors or omissions, and the Commonwealth does not accept responsibility in respect of any information or advice given in relation to, or as a consequence of, anything contained herein. Due to limited survey effort and information available, *Euastacus urospinosus*, and its habitat, may occur in areas where it has not yet been recorded, and the modelled distribution (Map1) should be considered as indicative only.

Species distribution mapping: The species distribution mapping categories are indicative only and aim to capture (a) the habitat or geographic feature that represents to recent observed locations of the species (known to occur) or habitat occurring in close proximity to these locations (likely to occur); and (b) the broad environmental envelope or geographic region that encompasses all areas that could provide habitat for the species (may occur). These presence categories are created using an extensive database of species observations records, national and regional-scale environmental data, environmental modelling techniques and documented scientific research.

## Cultural and community significance

The cultural, customary and spiritual significance of species and the ecological communities they form are diverse and varied for the many First Nations peoples that live in the area and care for Country. Such knowledge may be only held by Indigenous groups and individuals who are the custodians of this knowledge and have the rights to decide how this knowledge is shared and used. This section describes some examples of this significance.

The Maleny crayfish occurs on the lands of the Gubbi Gubbi (also known as Kabi Kabi) and Wakka Wakka people (AIATSIS 2022). The Wakka Wakka people won the native title claim for their traditional land in April 2022 (NNTT 2022) and the Gubbi Gubbi people won a claim to native title in 2019 (NNTT 2019) and this claim was extended in 2024. The native title of the Gubbi Gubbi people covers Maleny National Park and parts of Conondale National Park (NNTT

2019). In 2024, the Gubbi Gubbi people won a further native title claim, increasing the extent of the determination area to cover approximately 10,280 km<sup>2</sup> from southern Bribie Island, Sandstone Point and Elimbah Creek catchment area to Coolool National Park, Curra State Forest, Mary River and Isis Rivers, and west to the Brisbane Range, the Burnett Range and Coast Range. The Blackall Range (situated within Kondalilla National Park) holds spiritual significance for many Aboriginal people in the region (DES 2022).

While it is not known if this species was hunted for food by Indigenous groups, it is large enough to be eaten and there is evidence that other crayfish, including other *Euastacus* species, were traditionally collected for food (Smith 1982; Horwitz & Knott 1995; Gilligan et al. 2007).

## Relevant biology and ecology

It is recognised that the *Euastacus* have a suite of common biological characteristics, and many of these characteristics will apply to the Maleny crayfish (Furse & Coughran 2011). Various studies have established that some *Euastacus* are slow-growing (growth increments of a few mm OCL yr<sup>-1</sup>) and long-lived and can take many decades (35–50 years) to reach the adult sizes that are recorded for some species (Honan & Mitchell 1995a; Turvey & Merrick 1997a; Morey 1998; Furse & Wild 2004; Coughran 2011, 2013). However, the biology and ecology of the Maleny crayfish is not well understood.

## Habitat

The Maleny crayfish is a cool water adapted species that is restricted to higher altitudes within its range. It inhabits clear, cool, fast flowing headwater streams in rainforested areas at altitudes from ~250 to over 600 m above sea level (ASL) (Horwitz 1990; Borsboom 1998; Coughran & Furse 2010). Maleny crayfish were recorded in creek riffles, runs, glides and shallow reaches of pools where there were instream structures (i.e., stones, rocks and logs) (Borsboom 1998). Adults may build deep, multichambered burrows that are unconnected to creeks (but reach the water table), while juvenile crayfish build relatively simple burrows under rocks or other structures (Horwitz 1990; Borsboom 1998). Burrows of adult crayfish may be located near small gullies that may be ephemeral (following heavy rains) (McCormack & van der Werf 2013). Burrows are often located near *Archontophoenix cunninghamiana* (bungalow palm) (McCormack & van der Werf 2013) and may be permanently occupied by adults (Borsboom 1998). In Conondale National Park, water temperatures in creeks inhabited by Maleny crayfish were <20 °C for most of the year and maximum water temperatures observed were just a couple of degrees above that (22.0–22.5 °C) (Borsboom 1998). Lower areas with higher water temperatures are likely unsuitable habitat and a barrier to movement between subpopulations. Many higher altitude species of *Euastacus* are already restricted to what is presumed to be refuge habitat from warmer and drier conditions at lower altitudes within their ranges (Ponniah & Hughes 2006). While specimens have been observed in creeks running through dairy farm pastures, these sites do not likely represent ideal environmental conditions for the species (Hurry et al. 2015).

## Reproductive Ecology

Reproductive studies show that many *Euastacus* are typically late maturing and have slow reproductive cycles with females only reaching reproductive maturity after 5–10 years (e.g. Honan & Mitchell 1995a; Turvey & Merrick 1997a; Borsboom 1998; Furse & Wild 2004; Coughran 2013). Females in this species are thought to reach sexual maturity at > 32 mm OCL

and at approximately six years old (Borsboom 1998). Mean length estimates for 1 to 3 year old Maleny crayfish ranges from 13.7 mm, ~18–19 mm and ~22–24 mm OCL for each year class respectively (Borsboom 1998). The actual growth rates, population sizes and generation lengths of the Maleny crayfish are not known.

Many species of *Euastacus* are winter brooders (mating in late summer/autumn with females carrying eggs over winter) and brooding periods may be long (6–10 months is typical). Some species only breed biennially and pleopodal egg fecundity (number of fertilised eggs attached to underside of a gravid female) varies considerably between species, typically ranging from 20–1,500 eggs per female (Clark 1937; Barker 1992; Honan & Mitchell 1995b; Turvey & Merrick 1997b; Borsboom 1998; Honan 1998; Morey 1998; Furse & Wild 2004; Coughran 2006, 2013; McCormack et al. 2010). Fecundity of female Maleny crayfish is lower than other similarly-sized species of *Euastacus* but appears to increase with the size of the individual (Borsboom 1998). Borsboom (1998) reported Maleny crayfish breed annually, with mating reported in April, and females carrying eggs from May and June. The brooding period was reported as 4–5 months with juveniles being released in December (Borsboom 1998). The mean number of eggs carries by females when first captured during a breeding season was 51 (n=25; range 3–119) (Borsboom 1998). Males have been observed travelling >20m to visit the burrows of females during the mating period (Borsboom 1998).

### Diet

The diet of the Maleny crayfish is not well understood, but the species is likely omnivorous, as with many species of spiny crayfish (McCormack 2012).

### Co-occurring species

The Maleny crayfish co-occurs with *Euastacus hystricosus* (Conondale spiny crayfish; Endangered on the IUCN Red List, Furse & Coughran 2010; Endangered in Queensland, Queensland Government 2021) and *Cherax depressus* (orange fingered yabby), *Cherax dispar* (slender yabby; Least Concern on the IUCN Red List, Austin 2010) (Borsboom 1998, 2001; Hurry 2016).

### Threats

Established threats (habitat destruction, invasive species, human exploitation and climate change) and potential threats (disease, *Aphanomyces astaci* [crayfish plague]; Panteleit et al. 2017) may put nearly all species of *Euastacus* at serious risk of population declines, or extinction in less than a decade (Wells et al. 1983; Coughran 2007; Furse & Coughran 2011b; Furse 2014; Richman et al. 2015). Climate change is a key threat to the Maleny crayfish, with the species having limited capacity to relocate to higher, cooler altitudes, or overland to other nearby suitably cool habitat which are already occupied by other species of *Euastacus* (Ponniah & Hughes 2006; Furse et al. 2012a). While the species was not directly impacted by the 2019–20 megafires, rainforest habitat surrounding its known distribution was burnt (DAWE 2020). Little uncleared highland rainforest habitat remains besides small sections within protected areas (Morgan 1988). The restricted distribution of this species puts all individuals in the population at considerable risk of extirpation by a single stochastic event (e.g., natural disaster, or disease) impacting the species across its range (Furse & Coughran 2011b).



**Table 1 Threats**

Threats in Table 1 are noted in approximate order of highest to lowest impact, based on available evidence.

Threat	Status and severity	Evidence
Climate change and extreme weather impacts		
Increased average temperature	<ul style="list-style-type: none"> <li>• Timing: current/future</li> <li>• Confidence: inferred</li> <li>• Likelihood: almost certain</li> <li>• Consequence: major</li> <li>• Trend: increasing</li> <li>• Extent: across the entire range</li> </ul>	<p><i>Euastacus</i> species are highly vulnerable to the effects of climate change as they tend to be sensitive to changes in temperatures, tend to be highly specialist and most are short-range endemics (Harvey 2002; Richman et al. 2015; Hossain et al. 2018). Furthermore, many <i>Euastacus</i> species have already been restricted to cooler upland areas as “climate refugees” due to changes to Australia’s climate over the last few million years (Ponniah &amp; Hughes 2004; Bone et al. 2014).</p> <p>Increased average temperature is a direct, on-going, and persistent long-term impact of climate change. Unlike short-term heatwaves, this is a steady long-term increase in average temperature. Most of the years between 2019 and 2028 are projected to be amongst the top 10 warmest years globally with more than 99% probability (Arguez et al. 2020).</p> <p>Minimum, maximum and average temperatures in South East Queensland are projected to continue to rise with an annual average warming of 0.6 to 1.3 °C above the climate from 1986-2005 by 2030 (DES 2019). By 2070, mean annual temperature is expected to increase by 1.1–2.2 °C (Representative Concentration Pathway (RCP) 4.5) to 1.9–3.6 °C (RCP 8.5) in the southeast of Queensland compared to the baseline period between 1986 and 2005 (DES 2019, Syktus et al. 2020).</p> <p><i>Euastacus</i> are sensitive to increasing temperatures, and it is unlikely that the Maleny crayfish, which inhabits cooler waters in headwater streams (above 250 m ASL), has the capacity to physiologically adapt to warmer conditions or relocate to cooler habitats as temperatures increase (Lowe et al. 2010; Bone et al. 2015, 2017). This will probably lead to altitudinal compression of habitat as movement between waterways will likely be blocked by the warmer intervening lowlands (Ponniah &amp; Hughes 2004; Furse et al. 2012a; Bone et al. 2014). In the Maleny area, migration to other areas of suitable habitat may be unlikely as much of the rainforest habitat where this species occurs has been cleared for agriculture (Morgan 1988). Thus, increased temperatures could severely impact Maleny crayfish. Again, because of Maleny crayfish’s highly restricted distribution, any impact on one part of the population is likely to influence the entire species distribution, and greatly increase extinction risk.</p> <p>Projected increases in mean annual temperature in the region have the capacity to impact this species across its range and places the species at a significant risk of extinction. Borsboom (1998) reported water temperature in the species habitat was generally below 20 °C for most of the year. The thermal limit of this species remains unknown, however, given the species association with cooler temperatures, and based on the work of Bone et al. (2014) environmental temperatures may only be a few degrees away from temperatures that may cause thermal stress in this species.</p>

Threat	Status and severity	Evidence
		<p>Increasing average temperature associated with climate change will also interact with the other threats:</p> <ul style="list-style-type: none"> <li>- Fire regimes that cause declines in biodiversity</li> <li>- Extreme weather events</li> <li>- Alterations to hydrological regimes</li> </ul>
Extreme weather events	<ul style="list-style-type: none"> <li>• Timing: current/future</li> <li>• Confidence: observed</li> <li>• Likelihood: likely</li> <li>• Consequence: major</li> <li>• Trend: increasing</li> <li>• Extent: across the entire range</li> </ul>	<p>Increased intensity and frequency of extreme weather events (heatwaves, storms, cyclones, droughts (and fires – discussed below)) are broad geographic scale threats associated with climate change. These events are not persistent, and may be relatively short-term in duration (i.e., hours to weeks). Extreme weather events have the capacity to seriously impact the population, leading to a decline or extirpation of the species (Coughran &amp; Furse 2010).</p> <p>Climate change modelling projects increased length and duration of droughts, longer periods of consecutive wet days, and longer and more frequent heatwaves for the region where this species is found (Syktus et al. 2020). By 2060–79, southeast Queensland is expected to have ~5–11 additional hot days (&gt;35 °C) annually compared to the period 1986–2005 (Syktus et al. 2020).</p> <p>Bone et al. (2014) reported that when exposed to chronic, steadily increasing temperature, similarly-sized, small specimens of the larger <i>Euastacus sulcatus</i> (Lamington spiny crayfish) became sluggish at ~23 °C and was effectively incapacitated at ~27 °C. The Lamington spiny crayfish typically inhabits waters that rarely exceed 21 °C (Bone et al. 2014). The Maleny crayfish is a cool water species that inhabits creeks that remained below 20 °C for most of the year (Borsboom 1998). Extreme hot weather events, which have already been observed within its range, could raise water temperatures to lethal levels for this species. The thermal limit of this species remains unknown, however based on the work of Bone et al. (2014) environmental temperatures may only be a few degrees away from temperatures that may cause thermal stress in this species. A single heatwave event could potentially lead to water temperatures reaching the upper thermal tolerance threshold, and result in physiological impacts, or even mortalities.</p> <p>More frequent severe drought periods could lead to lower water table levels or completely dry out water within stream banks where adult Maleny crayfish have their burrows (A. Borsboom 2022 unpub.). While adults may inhabit burrows that are unconnected to creeks, they are often found in chambers that are filled with water and are connected to the water table. Seventy bank burrows that were dug out all had at least one waterfilled chamber used by crayfish (Borsboom 1998).</p> <p>The projected increase of extreme weather events may have very serious implications for freshwater crayfish, especially for range restricted species such as the Maleny crayfish. For example, high rainfall events can cause flash floods that scour streams and can be deadly to any <i>Euastacus</i> that seek refuge under temporary shelter, such as loose rocks and logs. Mass mortality was recorded in <i>Euastacus valentulus</i> (powerful crayfish) in the Numinbah Valley (Qld), when an intense rainfall event and flash flood killed hundreds, and possibly thousands, of crayfish (Furse et al. 2012b). Many of the crayfish killed in that event were</p>

Threat	Status and severity	Evidence
		<p>in the same size range as adult Maleny crayfish (30–40 mm OCL) (Borsboom 1998; Furse et al. 2012b). The extreme rainfall that occurred across areas of southeastern Queensland from 22 February to 1 March 2022 was some of the most significant on record, causing flash floods and banks of creeks to break (BoM 2022). Juvenile Maleny crayfish are often found in simple burrows under rocks and other structures (Horwitz 1990; Borsboom 1998), making them susceptible to effects of flash floods. In addition, entrances to bank burrows might be covered and filled by sediment and flood debris following major flood events potentially trapping adult crayfish in their burrows (A. Borsboom 2022 unpub.). A single severe rainfall event may lead to other localised natural disasters (e.g., tree falls, landslides, and sedimentation events) (Furse et al. 2012b).</p>
Alterations to hydrological regimes	<ul style="list-style-type: none"> <li>• Timing: current/future</li> <li>• Confidence: observed</li> <li>• Likelihood: almost certain</li> <li>• Consequence: major</li> <li>• Trend: increasing</li> <li>• Extent: across the entire range</li> </ul>	<p>Changes in moisture availability and increased ephemerality of hydrological systems due to global climate change, will likely impact the species itself, but also floral and faunal assemblages, across the species' range. <i>Euastacus</i> are known to be sensitive to effects of drought, but also effects of flooding (Furse et al. 2012a). Moisture deficits and excesses are threats that put this restricted range species at high risk of population declines, or extirpation.</p> <p>Changes to rainfall patterns in the South East Queensland region are complex to project accurately, however heavy rainfall events are likely to increase (DES 2019). Rainfall patterns in the region occupied by the Maleny crayfish are projected to change as a result of climate change, with annual rainfalls potentially declining and annual mean number of consecutive wet days increasing by 2060–2079 (Syktus et al. 2020). Furthermore, the duration and frequency of droughts are projected to rise by 2060–2079 throughout the catchments where this species is found (Syktus et al. 2020). Shifting precipitation patterns coupled with projected increases in temperature may lower the local water table and increase seasonality of streams in which Maleny crayfish is resident. Changes to water availability might significantly impact this species.</p>
Fire regimes that cause declines in biodiversity	<ul style="list-style-type: none"> <li>• Timing: current/future</li> <li>• Confidence: observed</li> <li>• Likelihood: likely</li> <li>• Consequence: major</li> <li>• Trend: increasing</li> <li>• Extent: part or across entire range</li> </ul>	<p>Bushfire frequency and severity as well as length of the bushfire season in Queensland have increased over the last few decades (BoM 2019). For example, the annual accumulated Forest Fire Danger Index (FFDI), a measure of level of fire danger, for the South East Coast region has increased by 51 % between 1950 and 2018 (BoM 2019). Bushfire season was also declared early in 2018 in Queensland when nearly 750 000 hectares were burned by late November (Lewis et al. 2020). The FFDI in November 2018 was the highest on record for many areas across the state (Lewis et al. 2020). Above average high temperatures and below average seasonal rainfall were identified as key contributing factors making the extreme fire conditions 4.5 times and 1.5 times more likely to occur respectively (Lewis et al. 2020; Mackey et al. 2021).</p> <p>The processes by which fire impacts freshwater habitats are complex and depend on the characteristics of the fire event, condition of the contributing catchment and hydrological cycle pre- and post-fire (Silva et al. 2020; Gomez Isaza et al. 2022). Impacts may be immediate (habitat loss) or delayed (siltation and deoxygenation of habitat following a fire, change of stream temperature and light regimes due to canopy loss).</p>



Threat	Status and severity	Evidence
		<p>Fires may increase the occurrence of weed species in the habitat. Various highly invasive non-native species of vegetation are known to exist in the region (e.g., lantana [<i>Lantana camara</i>], mist flower [<i>Ageratina riparia</i>]) including in this species habitat (Borsboom, 1998). In the subtropical rainforests of SE Queensland, dense stands of lantana quickly establish in the exposed areas created by tree falls and landslides. They can quickly smother habitat and may increase the chance and severity of bushfires (Hines et al. 2020).</p> <p>Fire management burns to reduce the risk of high intensity fires are known to be undertaken in Bellthorpe, Conondale and Kondalilla National Parks (as outlined in the draft conservation assessment for Conondale spiny crayfish in Queensland Borsboom 2022). Some chemical retardants used in firefighting may be toxic to, and adversely affect freshwater species (Anderson and Prosser 2023).</p> <p>The Maleny crayfish did not occur within the footprint of the 2019–20 bushfires, although rainforest less than 10 km from known sites was burnt (DAWE 2020). A single bushfire has the capacity to impact much of the population of this short-range species, potentially leading to a population decline across its range, or extirpation of the species.</p>
Habitat loss, disturbance or modification		
Livestock farming & ranching	<ul style="list-style-type: none"> <li>• Timing: historical/current</li> <li>• Confidence: observed</li> <li>• Likelihood: almost certain</li> <li>• Consequence: major</li> <li>• Trend: unknown</li> <li>• Extent: across part of its range</li> </ul>	The Maleny crayfish is typically absent from creek banks in cleared pasture lands just outside reserves where it is found (Borsboom 2001). This suggests that the species is sensitive to the combined effects of riparian forest clearing and grazing (Borsboom 2014). There has been significant land clearing in the Maleny region in the past, and Maleny National Park was used for grazing by adjacent property holders (DNPRSR 2013a; Borsboom 2022). However, grazing leases have expired and current regulation have reduced the level of the threat from grazing (DNPRSR 2013a; Borsboom 2022).
Timber harvesting	<ul style="list-style-type: none"> <li>• Timing: historical</li> <li>• Confidence: suspected</li> <li>• Likelihood: possible</li> <li>• Consequence: moderate</li> <li>• Trend: n/a</li> <li>• Extent: across part of its range</li> </ul>	The availability of suitable Maleny crayfish habitat outside protected areas is limited as much of the rainforest throughout its range has been logged to some extent (Morgan 1988). Timber harvestings is known to have occurred in Bellthorpe and Conondale National Parks, but levels of past timber harvesting are unknown (DNPRSR 2013b, c). Bellthorpe National Park was a state forest until 2003, and its vegetation has been changed significantly through forestry, grazing and horticultural activities (DNPRSR 2013b). Additional impacts associated with past timber harvesting are sedimentation from disused roads and tracks, invasion of weeds and soil compaction (DNPRSR 2013b, c). Timber harvesting might have impacted on the Maleny crayfish through a decline in the quality (e.g., increased water temperature through loss of shading, sedimentation and weed invasion) of its habitat.
Invasive species		
Invasive fauna	<ul style="list-style-type: none"> <li>• Timing: current/future</li> <li>• Confidence: inferred</li> <li>• Likelihood: possible</li> </ul>	Feral pigs ( <i>Sus scrofa</i> ) are found in Bellthorpe and Conondale National Parks (DNPRSR 2013b, c). Whilst direct impacts to the Maleny crayfish have not been observed, it is

Threat	Status and severity	Evidence
	<ul style="list-style-type: none"> <li>Consequence: moderate</li> <li>Trend: static to increasing</li> <li>Extent: across part of its range</li> </ul>	<p>possible that feral pigs still be contributing to declines in its distribution and/or abundance (Coughran &amp; Furse 2010).</p> <p>Feral pigs eat crayfish (J. Coughran 2021 unpub) and are a serious threat to burrowing crayfish species in particular (e.g., <i>Engaeus martigener</i> (Furneaux burrowing crayfish)) both through predation and their rooting and wallowing behaviour causing damage to creek lines (DNPRSR 2013c; DEH 2017). Adult Maleny crayfish inhabit burrows along streamside edges, where pigs churn up leaf litter and surface soil. While the burrows of the adults are deep and pigs are unlikely to be able to reach these crayfish within their burrows, feral pig disturbance to burrow entrances has been observed (A. Borsboom 2022 unpub.). Consequently, trapped crayfish have to establish new entrances to their burrow systems. This might be especially problematic during the mating period as females are soft from moulting and their capability to re-establish burrow entrances to allow males access might be limited (A. Borsboom 2022 unpub.).</p> <p>Furthermore, feral pigs are known to feed on palm tree seeds and destroy seedlings and smaller saplings through browsing and soil disturbance thereby affecting palm tree recruitment (DNPRSR 2013; Borsboom 2022). Such damage to palm trees might lead to long-term changes in the vegetation composition and structure in the riparian zone (Borsboom 2022). Furthermore, the removal or thinning of palms in the riparian zone might reduce shading over watercourses leading to increased water temperatures (Borsboom 2022). Feral pigs are likely to have reduced the recruitment of bangalow palms within the riparian zone in areas where the Maleny crayfish is found (A. Borsboom 2022 unpub.).</p>
Problematic native species	<ul style="list-style-type: none"> <li>Timing: current/future</li> <li>Confidence: inferred</li> <li>Likelihood: possible</li> <li>Consequence: moderate</li> <li>Trend: static to increasing</li> <li>Extent: across part of its range</li> </ul>	<p>It has been suggested that Maleny crayfish may be absent if <i>Cherax</i> sp. also occupy streams (McCormack &amp; van der Werf 2013). The common yabby (<i>Cherax destructor</i>) was detected in the Mary River drainage outside of its natural distribution (McCormack &amp; van der Werf 2013). The common yabby is known to cause injuries to other species of crayfish and is thought to potentially outcompete other native species of crayfish (Coughran et al. 2009). O’Hea Miller et al. (2023a, 2023b, 2024) found that <i>C. destructor</i> exert competitive pressure on <i>E. dharawalus</i> (Fitzroy Falls spiny crayfish), impacting behaviour and diet in the Critically Endangered <i>Euastacus</i>. It is likely that the aggressive competitor <i>C. destructor</i> affects similar-sized <i>Euastacus</i> throughout its range, potentially including <i>E. urospinosus</i>.</p> <p>In Mary Cairncross Scenic Reserve, some orange-fingered yabby (<i>Cherax depressus</i>) was observed in a dam across Friers Creek upstream of the reserve and in Friers Creek, where juvenile Maleny crayfish occur (Borsboom 2001). Potential impacts of this yabby on Maleny crayfish are unknown.</p>
Invasive flora	<ul style="list-style-type: none"> <li>Timing: current/future</li> <li>Confidence: inferred</li> <li>Likelihood: possible</li> <li>Consequence: moderate</li> <li>Trend: unknown</li> </ul>	<p>Various highly invasive non-native species of vegetation are known to exist in the region (e.g., lantana [<i>Lantana camara</i>], mist flower [<i>Ageratina riparia</i>], silver-leaf desmodium [<i>Desmodium uncinatum</i>], Dutchmans pipe [<i>Aristolochia</i> sp.], cat’s claw creeper [<i>Macfadyena unguis-cati</i>] and asparagus fern [<i>Protasparagus</i> sp.]) including in this species habitat (Borsboom, 1998; DNPRSR 2013a, b, c).</p>

Threat	Status and severity	Evidence
	<ul style="list-style-type: none"> <li>Extent: across part of its range</li> </ul>	Mistflower has been found to grow along creeks and gullies in Conondale and Bellthorpe National Parks, changing creek line vegetation and potentially impacting species dependent on freshwater ecosystems such as crayfish (DNPRSR 2013b, c). The invasion of these weeds will likely suppress forest regeneration thereby restricting the amount of tree cover that provides shading for creeks. This might cause increased water temperatures that are unsuitable for the persistence of this species. Cat's claw has also been found to change soil chemistry (Business Queensland 2021a). The direct impacts of weed invasion on the Maleny crayfish are unknown and need further investigation.
Illegal collection		
Illegal take	<ul style="list-style-type: none"> <li>Timing: current</li> <li>Confidence: inferred</li> <li>Likelihood: possible</li> <li>Consequence: moderate</li> <li>Trend: unknown</li> <li>Extent: across part of its range</li> </ul>	<p>Illegal collectors specifically target rare species of <i>Euastacus</i> for personal collections and the aquarium trade (Coughran 2007; Coughran &amp; Furse 2012; J. Furse 2021 unpub.). Their targets include species in national parks (see Coughran &amp; Furse 2012) and extremely remote areas (J. Furse 2021 unpub.).</p> <p>A series of these activities are known to have occurred and continue throughout eastern Australia, with illegally collected crayfish intercepted (outbound) at Australian international airports (J. Furse 2021 unpub.). Illegal harvesting was identified as a threat to the Conondale spiny crayfish, a species that co-occurs with the Maleny crayfish (Smith et al. 1998).</p> <p>Any collection of slow-growing and short-range endemic species, such as the Maleny crayfish, has the capacity to lead to negative population-scale impacts. Specifically, removal of reproductive animals from a population, particularly females that may require &gt;5 years to reach sexual maturity, is likely to seriously impact species' recruitment. Illegal collectors can also act as a vector for diseases/pathogens between catchments, waterways, and into isolated areas of habitat.</p>
Disease		
Crayfish plague ( <i>Aphanomyces astaci</i> )	<ul style="list-style-type: none"> <li>Timing: future</li> <li>Confidence: projected</li> <li>Likelihood: possible</li> <li>Consequence: catastrophic</li> <li>Trend: n/a</li> <li>Extent: across entire range</li> </ul>	<p><i>Aphanomyces astaci</i> (crayfish plague) is a highly contagious fungal disease that is uniformly fatal (100 % mortality) to susceptible species (Panteleit et al. 2017), and it is considered one of the world's worst invasive species (Lowe et al. 2000). Crayfish plague, introduced from North America, has devastated populations of native species of freshwater crayfish in Europe and Asia (Panteleit et al. 2017). In Scandinavia, national declines in crayfish populations were up to 80% and some lakes where crayfish were eliminated became choked with aquatic plants (Abrahamsson 1966).</p> <p>Many strains of the disease prefer cooler temperatures, which is characteristic of the Maleny crayfish habitat. Crayfish plague is not currently known in Australia but is documented as fatal to Australian freshwater crayfish (Unestam 1975), and it is listed on Australia's National List of Reportable Diseases of Aquatic Animals (Animal Health Committee 2020). It poses an extremely high risk to native freshwater crayfish species in the event of it reaching Australian rivers and streams (DAWE 2019).</p> <p>The vector for the disease's movement outside of its native range has been translocation of North American crayfish, in particular, signal crayfish (<i>Pacifastacus leniusculus</i>) and red</p>

Threat	Status and severity	Evidence
		<p>swamp crayfish (<i>Procambarus clarkii</i>). Infected crayfish from the Americas are resistant carriers, and are largely unaffected by the disease (DAWE 2019). Illegally imported specimens of red swamp crayfish have been seized in multiple Australian states (Department of Primary Industries &amp; Regional Development 2021; Business Queensland 2021b), but not known to be infected.</p> <p>A single, illegally-imported crayfish, infected with crayfish plague has the capacity, via an unlicensed/illegal collector vector (or aquarium discard), to devastate the entire Australian crayfish fauna.</p>

<sup>a</sup>Timing—identifies the temporal nature of the threat

Confidence—identifies the nature of the evidence about the impact of the threat on the species

Likelihood—identifies the likelihood of the threat impacting on the whole population or extent of the species

Consequence—identifies the severity of the threat

Trend—identifies the extent to which it will continue to operate on the species

Extent—identifies its spatial context in terms of the range of the species

**Categories for likelihood are defined as follows:**

Almost certain – expected to occur every year

Likely – expected to occur at least once every five years

Possible – might occur at some time

Unlikely –known to have occurred only a few times

Unknown – currently unknown how often the threat will occur

**Categories for consequences are defined as follows:**

Not significant – no long-term effect on individuals or populations

Minor – individuals are adversely affected but no effect at population level

Moderate – population recovery stable or declining

Major – population decline is ongoing

Catastrophic – population trajectory close to extinction

Each threat has been described in Table 1 in terms of the extent that it is operating on the species. The risk matrix (Table 2) provides a visual depiction of the level of risk being imposed by a threat and supports the prioritisation of subsequent management and conservation actions. In preparing a risk matrix, several factors have been taken into consideration, they are: the life stage they affect; the duration of the impact; the spatial extent, and the efficacy of current management regimes, assuming that management will continue to be applied appropriately. The risk matrix and ranking of threats has been developed in consultation with experts and using available literature.

**Table 2 Risk Matrix**

Likelihood	Consequences				
	Not significant	Minor	Moderate	Major	Catastrophic
<b>Almost certain</b>				<ul style="list-style-type: none"> <li>– Increased average temperature</li> <li>– Alterations to hydrological regimes</li> <li>– Livestock farming &amp; ranching</li> </ul>	–
<b>Likely</b>				<ul style="list-style-type: none"> <li>– Fire regimes that cause declines in biodiversity</li> <li>– Extreme weather events</li> </ul>	
<b>Possible</b>			<ul style="list-style-type: none"> <li>– Timber harvesting</li> <li>– Invasive fauna</li> <li>– Problematic native species</li> <li>– Invasive flora</li> <li>– Illegal collection</li> </ul>		Disease: <ul style="list-style-type: none"> <li>– Crayfish plague (<i>Aphanomyces astaci</i>)</li> </ul>
<b>Unlikely</b>					
<b>Unknown</b>					

Risk Matrix legend/Risk rating:

Low Risk	Moderate Risk	High Risk	Very High Risk
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## Conservation and recovery actions

### Primary conservation objective

- Ensure the AOO and EOO of the Maleny crayfish are stable or increasing, and major threats are effectively managed, and resilience to climate change impacts is maximised.

### Conservation and management priorities

#### Climate change and extreme weather impacts

- Investigate feasibility and, if appropriate, plan and establish facilities for potential ex situ short-term, active conservation intervention(s), including:
  - Establish a capacity to maintain a captive population of this species over a short-term, in response to an extreme weather event, for subsequent re-release to natural habitat.



- Establish an environmental monitoring system in the species' habitat, to provide alerts of dangerous environmental conditions.
- Develop or access local weather and climate models to project when extreme weather events might require moving animals to ex situ facilities.
- Determine how any relatively 'cool' pockets of micro-habitat could potentially aid conservation as temporary refuges.

**Increased temperature**

- Determine if the species natural habitat features any relatively "cool" pockets of micro-habitat that may act as temporary refuges.

**Fire impacts**

- Review and revise existing fire management plans, including hazard reduction and fire suppression practices, to ensure they are appropriate for the distribution and habitat requirements of this species. These can include:
  - Actively protect fire sensitive rainforest areas (e.g., maintain adequate fire breaks), and manage surrounding areas.
  - Reduce the prevalence of fire-prone lantana where infestations have established.
  - Avoid using chemical fire suppressants near to sites where the species occurs.
- Monitor and, if necessary, manage impacts from any upstream fires on the species habitat, including riparian erosion and siltation.

**Habitat loss, disturbance and modifications impacts**

- Ensure that the habitat quality remains high through management actions (e.g., weed removal, fire management, etc.) where the species is found.
- Ensure land managers are aware of the species' occurrence and provide protection measures against key and potential threats.
- Monitor and control damage to riparian areas by domestic animals; fence sites, where feasible. This may require a collaborative strategy with surrounding landholders and local government authorities to limit domestic animals in the area.

**Illegal collection**

- Regularly carry out surveillance of species habitats, websites, forums, collectors' groups, etc. to detect if illegal collection is occurring and if Maleny crayfish are offered for sale, and then take action where appropriate.
- Educate recreational fishers about their obligations under fisheries regulations.

**Invasive species (including threats from grazing, trampling, predation)**

- Develop and implement long-term strategies to control introduced predators by implementing eradication programs where feasible.
- Undertake weed control in the local area and identify and remove weeds or undertake weed control in the local area that could become a threat to the species, ensuring any possible disturbance/overspray does not adversely impact the Maleny crayfish.

**Disease impacts**

- Ensure authorised collectors are aware of required hygiene protocols

- Take steps (i.e. potentially limit publicity) to minimise frequency of potential disease vectors entering the species habitat. For example, not facilitating illegal collectors, or members of the public, identifying and visiting the species habitat.
- Ensure that appropriate guidelines for mitigating spread of disease is communicated to relevant stakeholders (including biosecurity). Develop agreed protocols for responding to incursions or reports of non-Australian crayfish (responsibilities, rapid response, reporting).

### **Breeding, propagation and other ex situ recovery action**

- Investigate feasibility and plan for potential short and long-term, active conservation intervention(s), including ex situ initiatives such as:
  - Establishing captive husbandry methods and protocols for the species.
  - Establishing a capacity to maintain captive populations over the short-term (i.e. in response to extreme weather events or natural disasters), for subsequent re-release to natural habitat.
  - Establishing captive breeding populations as a source of animals to augment the wild population, if required.
  - Investigate feasibility of translocations to assist conservation of the species.

### **Stakeholder engagement/community engagement**

- Prepare a management and engagement strategy for Maleny crayfish and other similar crayfish species in the region with input from crayfish experts, national park managers, and other identified stakeholders.
- Support Traditional Owners in the conservation of the species and its habitat.
- Limit publicity for this species due to risks from illegal collection and disease. Information should be restricted until key knowledge-gaps have been addressed, and thus full community engagement may not be beneficial to the species.
- Noting the requirement to limit publicity, adopt best practice for effective threat management through an adaptive management approach based on partnerships around co-design, co-implementation and social learning. Promote wide acceptance and capacity building, including explicit use of local knowledge in planning, management actions and monitoring.

### **Survey and monitoring priorities**

- Establish, and then monitor the population size and trajectory of this species through time.
- Determine the contemporary geographic distribution of the Maleny crayfish.
- Use population genetics to provide an indirect estimate of effective population size, heterozygosity, and structure among the various subpopulations, which can also form a baseline for ongoing monitoring.

### **Information and research priorities**

- Address the previously identified critical knowledge gaps on the biology, ecology and life history of the Maleny crayfish.
- Investigate the species' habitat requirements (including any moisture environmental temperature, dissolved oxygen and shelter/refuge requirements requirements).

- Investigate the potential influence of climate change on the long-term survival prospects of the species, due to altered temperatures, rainfall patterns, bushfires, environmental stressors and diseases. This includes:
  - Assess the thermal tolerance of the Maleny crayfish (using non-lethal methods if required) to ascertain its physiological limits, sensitivity and vulnerability. Thermal tolerances are likely to be similar between closely related species occupying similar environments (Cramp et al. 2021). So use of a more common *Euastacus* species which is physiologically and ecologically similar could be used to inform likely impacts to this threatened species.
  - Establish what are the species' moisture requirements and how these may be affected via changes in precipitation and increased temperature.
  - Establish the impacts of climate change on the species' habitat (vegetation assemblages, water availability, water and air temperatures).
- Investigate the threats and impacts of invasive species and diseases on Maleny crayfish.

## Links to relevant implementation documents

DAWE (Department of Agriculture Water and the Environment) (2019) *Australian aquatic veterinary emergency plan (AQUAVETPLAN) for crayfish plague (version 2.0)*. Commonwealth of Australia, Canberra, ACT, Australia. Viewed 22 June 2021. Available at: <https://www.agriculture.gov.au/sites/default/files/documents/aquavetplan-crayfish-plague.pdf>.

## Conservation Advice and Listing Assessment references

- Abrahamsson SAA (1966) Dynamics of an isolated population of the crayfish *Astacus astacus* Linne. *Oikos* 17, 96-107.
- Anderson J & Prosser RS (2023) Potential risk to aquatic biota from aerial application of firefighting water additives. *Environmental Pollution*. 316. <https://doi.org/10.1016/j.envpol.2022.120651>
- AIATSIS (Australian Institute of Aboriginal and Torres Strait Islander Studies) (2022) *Map of Indigenous Australia*. <https://aiatsis.gov.au/explore/map-indigenous-australia>. Accessed 12/07/2022.
- Arguez A, Hurley S, Inamdar A, Mahoney L, Sanchez-Lugo A, Yang L, Arguez A, Hurley S, Inamdar A, Mahoney L, Sanchez-Lugo A and Yang L (2020) Should we expect each year in the next decade (2019-2028) to be ranked among the top 10 warmest years globally? *Bulletin of the American Meteorological Society*, BAMS-D-19-0215.1.
- Austin CM (2010) *Cherax dispar*. *The IUCN Red List of Threatened Species 2010: e.T153619A4521306*. <https://dx.doi.org/10.2305/IUCN.UK.2010-3.RLTS.T153619A4521306.en>. Accessed on 18 September 2022.
- Austin CM, Whiterod NS, McCormack R, Raadik TA, Ah Yong ST, Lintermans M, Furse JM & 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.
- Bachman S, Moat J, Hill A, J de la Torre & Scott B (2011) Supporting Red List threat assessments with GeoCAT: geospatial conservation assessment tool. *Zookeys* 150, 117-126.

- Barker J (1992) *The spiny freshwater crayfish monitoring program, 1990*. Fisheries management report. No 44, Inland Fisheries Management Branch, Fisheries Management Division, Department of Conservation and Environment. Victoria, Australia.
- BoM (Bureau of Meteorology) (2019) *Annual climate statement 2019*. Viewed 20 May 2021. Available at: <http://www.bom.gov.au/climate/current/annual/aus/2019/#tabs=Rainfall>.
- BoM (Bureau of Meteorology) (2022) *Special Climate Statement 76 – Extreme rainfall and flooding in south-eastern Queensland and eastern New South Wales*. Australian Government. 25 May 2022.
- Bone JW, Wild CH & Furse JM (2014) Thermal limit of *Euastacus sulcatus* (Decapoda: Parastacidae), a freshwater crayfish from the highlands of central eastern Australia. *Marine and Freshwater Research* 65(7), 645-651.
- Bone JWP, Renshaw GMC, Furse JM & Wild CH (2015) Using biochemical markers to assess the effects of imposed temperature stress on freshwater decapod crustaceans: *Cherax quadricarinatus* as a test case. *Journal of Comparative Physiology B: Biochemical, Systems, and Environmental Physiology* 185(3), 291-301.
- Bone JWP, Renshaw GMC & Wild CH (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.
- Borsboom A (1998) Aspects of the biology and ecology of the Australian freshwater crayfish, *Euastacus urospinosus* (Decapoda: Parastacidae). *Proceedings of The Linnean Society of New South Wales* 119, 87-100.
- Borsboom A (2001) *Crayfish Assessment and Management Recommendations for Mary Cairncross Scenic Reserve, Maleny*. Queensland Department of Natural Resources.
- Borsboom A (2014) Preliminary riparian habitat assessment and crayfish survey along Obi Obi Creek and associated drainage lines on the Maleny Community Precinct site. Unpublished report.
- Borsboom AC (2022) *Nomination to change the conservation class of Euastacus hystricosus under the Commonwealth EPBC Act 1999*. Department of Environment and Science, Brisbane.
- Borsboom AC (2022) Unpublished data on threats to *Euastacus* species. In possession of author.
- Business Queensland (2021a) *Cat's claw creeper*. Viewed 03 March 2023, Available at: <https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/biosecurity/plants/invasive/restricted/cats-claw-creeper>.
- Business Queensland (2021b) *Red swamp crayfish*. Viewed 27 July 2022, Available at: <https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/land-management/health-pests-weeds-diseases/pests/invasive-animals/prohibited/red-swamp-crayfish>.
- Clark E (1937) The life history of the Gippsland crayfish. *The Australian Museum Magazine* 6, 186-192.
- Coughran J (2006) *Field guide to the freshwater crayfishes of Northeastern New South Wales*. Natureview Publishing, Bangalow, NSW.
- Coughran J (2007) Distribution, habitat and conservation status of the freshwater crayfishes, *Euastacus* sp. nov. 1, *E. girurmulayn*, *E. guruhgi*, *E. jagabar* and *E. mirangudjin*. *Australian Zoologist* 34(2), 222-227.

- Coughran J (2010) *Cherax leckii*. *The IUCN Red List of Threatened Species 2010*: e.T184424A8274399. <https://dx.doi.org/10.2305/IUCN.UK.2010-3.RLTS.T184424A8274399.en>. Accessed on 18 September 2022.
- 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.
- Coughran J (2021) Unpublished data on threats to *Euastacus* species. In possession of author.
- 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.
- Coughran J & Furse J (2010) *Euastacus urospinosus*. *The IUCN Red List of Threatened Species 2010*: e.T8147A12891980. <https://dx.doi.org/10.2305/IUCN.UK.2010-3.RLTS.T8147A12891980.en>. Accessed on 06 July 2022.
- Coughran J, McCormack R & Daly G (2009) Translocation of the Yabby *Cherax destructor* into eastern drainages of New South Wales, Australia. *Australian Zoologist* 35(1), 100–103.
- Coughran J, McCormack RB & Fetzner Jr JW (2015) Re-Description of the Orbost Spiny Crayfish, *Euastacus diversus* Riek 1969 (Decapoda: Parastacidae), in Eastern Victoria, Australia. *Freshwater Crayfish* 21, 185-197.
- DAWE (Department of Agriculture, Water and Environment, Australia) (2020) *National Indicative Aggregated Fire Extent Datasets*. <https://www.environment.gov.au/fed/catalog/search/resource/details.page?uuid=%7B9ACDCB09-0364-4FE8-9459-2A56C792C743%7D>.
- DEH (Department of Environment and Heritage) (2017) *Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs*. Department of Environment and Heritage, Commonwealth of Australia. Canberra, Australia. Viewed 22 June 2021. Available at: <https://www.environment.gov.au/system/files/resources/b022ba00-ceb9-4d0b-9b9a-54f9700e7ec9/files/tap-feral-pigs-2017.pdf>.
- DES (Department of Environment and Science, Queensland) (2019) Climate change in the South East Queensland region. Version 1. Queensland Department of Environment and Science. [https://www.qld.gov.au/data/assets/pdf\\_file/0023/67631/seq-climate-change-impact-summary.pdf](https://www.qld.gov.au/data/assets/pdf_file/0023/67631/seq-climate-change-impact-summary.pdf)
- DNPRSR (Department of National Parks, Recreation, Sport & Racing) (2013a) *Maleny National Park Management Statement 2013*. Queensland Government.
- DNPRSR (Department of National Parks, Recreation, Sport & Racing) (2013b) *Bellthorpe National Park Management Statement 2013*. Queensland Government.
- DNPRSR (Department of National Parks, Recreation, Sport & Racing) (2013c) *Conondale National Park Management Statement 2013*. Queensland Government.
- Department of Primary Industries & Regional Development (2021) *Red swamp crayfish seized (Wednesday 21 July 2021)*. Viewed 27 July 2021, Available at: <http://www.fish.wa.gov.au/About-Us/News/Pages/red-swamp-crayfish-seized.aspx>.
- DES (Department of Environment and Science, Queensland) (2022) *Kondalilla National Park: Nature, culture and history*. <https://parks.des.qld.gov.au/parks/kondalilla/about/culture>. Accessed 11/07/2022.
- Douglas on behalf of the Kabi Kabi First Nation Traditional Owners Native Title Claim Group v State of Queensland (No 5) [2024] FCA 645.



- Furse JM (2014) The freshwater crayfish fauna of Australia: update on conservation status and threats. *Crustaceana Monographs* 19 (Advances in freshwater decapod systematics and biology), 273-296.
- Furse J (2021) Unpublished data on threats to *Euastacus* species. In possession of author.
- Furse J & Coughran J (2010) *Euastacus hystriocosus*. *The IUCN Red List of Threatened Species* 2010: e.T8141A12890633. <https://dx.doi.org/10.2305/IUCN.UK.2010-3.RLTS.T8141A12890633.en>. Accessed on 18 September 2022.
- Furse JM & 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. I. Biological background and current status. *New Frontiers in Crustacean Biology* 1, 241-252.
- Furse JM & Wild CH (2004) Laboratory moult increment, frequency, and growth in *Euastacus sulcatus*. *Freshwater Crayfish* 14, 205-211.
- Furse JM, Bone JWP, Appleton SD, Leland JC & Coughran J (2012a) Conservation of Imperilled Crayfish - *Euastacus bindal* (Decapoda: Parastacidae), a Highland Crayfish from Far North Queensland, Australia. *Journal of Crustacean Biology* 32(4), 677-683.
- Furse JM, Coughran J & Wild CH (2012b) Report of a mass mortality of *Euastacus valentulus* (Decapoda: Parastacidae) in southeast Queensland, Australia, with a discussion of the potential impacts of climate change induced severe weather events on freshwater crayfish species. *Crustacean Research Special Number* 7, 15-24.
- Gilligan D, Rolls R, Merrick J, Lintermans M, Duncan P & Kohen J (2007) *Scoping the knowledge requirements for Murray crayfish* (*Euastacus armatus*). MDBC Project No. 05/1066, April 2007, NSW Department of Primary Industries – Fisheries Final Report Series No. 89 ISSN 1449-9967.
- Gomez Isaza DF, Cramp RL & Franklin CE (2022) Fire and rain: A systematic review of the impacts of wildfire and associated runoff on aquatic fauna. *Global Change Biology* 28, 2578-2595.
- Harvey MS (2002) Short-range endemism amongst the Australian fauna: some examples from non-marine environments. *Invertebrate Systematics* 16(4), 555-570.
- Hines HB, Brook M, Wilson J, McDonald WJ & Hargreaves J (2020) The extent and severity of the Mackay Highlands 2018 wildfires and the potential impact on natural values, particularly in the mesic forests of the Eungella-Crediton area. *Proceedings of the Royal Society of Queensland* 125, 139-157.
- Honan JA (1998) Egg and juvenile development of the Australian freshwater crayfish, *Euastacus bispinosus* Clark (Decapoda: Parastacidae). *Proceedings of the Linnean Society of New South Wales* 119, 37-54.
- Honan JA & Mitchell BD (1995a) Growth of the large freshwater crayfish *Euastacus bispinosus* Clark (Decapoda: Parastacidae) *Freshwater Crayfish* 10, 118-131.
- Honan JA & Mitchell BD (1995b) Reproduction of *Euastacus bispinosus* Clark (Decapoda: Parastacidae), and trends in the reproductive characteristics of freshwater crayfish. *Marine and Freshwater Research* 46, 485-499.
- Horwitz P (1990) *The conservation status of Australian freshwater crustacea with a provisional list of threatened species, habitats and potentially threatening processes*. pp. 121. Report series number 14. Australian National Parks and Wildlife Service. Canberra.
- Horwitz P & Knott B (1995) The distribution and spread of the yabby *Cherax destructor* complex in Australia: speculations, hypotheses and the need for research. *Freshwater Crayfish* 10, 81-91.

- Hossain MA, Lahoz-Monfort JJ, Burgman MA, Böhm M, Kujala H and Bland LM (2018) Assessing the vulnerability of freshwater crayfish to climate change. *Diversity and Distributions* 24(12), 1830–1843.
- Hurry CR, Schmidt DJ & Hughes JM (2015) Phylogeography and limited distribution of the endangered freshwater crayfish, *Euastacus urospinosus*. *Australian Journal of Zoology* 63(4), 236-244.
- Hurry CR (2016) *Comparative phylogeography and the population genetics of three endangered freshwater Euastacus spp. crayfish and the commensal Temnosewellia flatworms; from mountaintops in Queensland, Australia*. PhD thesis, Griffith University, Queensland, Australia.
- Hutchings RW (1979) A native predator of the cane toad (*Bufo marinus*). *North Queensland Naturalist* 45 (174), 4-5.
- IUCN Standards and Petitions Committee (2024). 'Guidelines for Using the IUCN Red List Categories and Criteria. Version 16. Prepared by the Standards and Petitions Committee. Downloadable from <https://www.iucnredlist.org/documents/RedListGuidelines.pdf>.
- Lewis SC, Blake SA, Trewin B, Black MT, Dowdy AJ, Perkins-Kirkpatrick SE, King AD & Sharples JJ (2020) Deconstructing factors contributing to the 2018 fire weather in Queensland, Australia. *Bulletin of the American Meteorological Society* 101, 115-121.
- Lowe K, FitzGibbon S, Seebacher F & Wilson RS (2010) Physiological and behavioural responses to seasonal changes in environmental temperature in the Australian spiny crayfish *Euastacus sulcatus*. *Journal of Comparative Physiology B: Biochemical, Systems, and Environmental Physiology* 180(5), 653-660.
- Lowe S, Browne M, Boudjelas S & De-Poorter M (2000) 100 of the world's worst invasive alien species. A selection from the global invasive species database. *Aliens* 12, 1-12.
- Mackey B, Gould S, Lindenmayer D, Norman P & Taylor C (2021) *How does climate affect bushfire risks in the native forests of south-eastern Australia? Bushfire Recovery Project Report No.1*. Griffith University and The Australian National University, <https://www.bushfirefacts.org/>.
- McCormack RB (2012) *A guide to Australia's spiny freshwater crayfish*. CSIRO Publishing, Collingwood, Australia.
- McCormack RB, Coughran J, Furse JM & Van-der-Werf P (2010) Conservation of Imperiled Crayfish - *Euastacus jagara* (Decapoda: Parastacidae), a highland crayfish from the Main Range, South-Eastern Queensland, Australia. *Journal of Crustacean Biology* 30(3), 531-535.
- McCormack RB & van der Werf P (2013) The distribution, ecology and conservation status of *Euastacus urospinosus* Riek, 1956 (Crustacea: Decapoda: Parastacidae), a dwarf freshwater crayfish from the Mary and Brisbane River drainages, south-eastern Queensland. *Memoirs of the Queensland Museum* 56(2), 639-646.
- Morey JL (1998) Growth, catch rates and notes on the biology of the Gippsland Spiny Freshwater Crayfish, *Euastacus kershawi* (Decapoda: Parastacidae), in West Gippsland, Victoria. *Proceedings of the Linnean Society of New South Wales* 119, 55-69.
- Morgan GJ (1988) Freshwater crayfish of the genus *Euastacus* Clark (Decapoda: Parastacidae) from Queensland. *Memoirs of the Museum of Victoria* 49(1), 1-49.
- Morgan GJ (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.

- NNTT (National Native Title Tribunal) (2019) *Native Title Determination Details: QC2018/007 - Kabi Kabi First Nation Traditional Owners Native Title Claim Group*.  
[http://www.nntt.gov.au/searchRegApps/NativeTitleRegisters/Pages/RNTC\\_details.aspx?NNTT\\_Fileno=QC2018/007](http://www.nntt.gov.au/searchRegApps/NativeTitleRegisters/Pages/RNTC_details.aspx?NNTT_Fileno=QC2018/007). Accessed 19/07/2022.
- NNTT (National Native Title Tribunal) (2022) *Native Title Determination Details: QCD2022/003 - Wakka Wakka People #3 - Part A & B*.  
[http://www.nntt.gov.au/SearchRegApps/NativeTitleClaims/Pages/Determination\\_details.aspx?NNTT\\_Fileno=QCD2022/003](http://www.nntt.gov.au/SearchRegApps/NativeTitleClaims/Pages/Determination_details.aspx?NNTT_Fileno=QCD2022/003). Accessed 11/07/2022.
- O'Hea Miller SB, Wong MYL, Mazumder D, Gray R & Davis, AR. (2023a). Will the experimental population control of an invasive crayfish influence the diet and trophic position of a native crayfish? An assessment using stable isotopes. *Marine and Freshwater Research*. 74. 10.1071/MF23157.
- O'Hea Miller SB, Davis AR & Wong MYL. (2023b) Further Insights into Invasion: Field Observations of Behavioural Interactions between an Invasive and Critically Endangered Freshwater Crayfish Using Baited Remote Underwater Video (BRUV). *Biology*. 12(1):18. <https://doi.org/10.3390/biology12010018>
- O'Hea Miller SB, Davis AR & Broadhurst B & Wong, MYL. (2024). Activity, movement and habitat-use patterns of a critically endangered endemic Australian freshwater crayfish. *Austral Ecology*. 49. 10.1111/aec.13526.
- Panteleit J, Keller NS, Kokko H, Jussila J, Makkonen J, Theissinger K & Schrimpf A (2017) Investigation of ornamental crayfish reveals new carrier species of the crayfish plague pathogen (*Aphanomyces astaci*). *Aquatic Invasions* 12(1), 77-83.
- Ponniah M & Hughes JM (2004) The evolution of Queensland spiny mountain crayfish of the genus *Euastacus*. I. Testing vicariance and dispersal with intraspecific mitochondrial DNA. *Evolution* 58(5), 1073-1085.
- Ponniah M & Hughes JM (2006) The evolution of Queensland spiny mountain crayfish of the genus *Euastacus*. II. Investigating simultaneous vicariance with intraspecific genetic data. *Marine and Freshwater Research* 57(3), 349-362.
- Queensland Government (2021) *Listing and changing the conservation status of QLD species: Changes made to wildlife categories 29 April 2021*.  
<https://www.qld.gov.au/environment/plants-animals/conservation/threatened-wildlife/threatened-species/conservation-status/categories-changes-2021>. Accessed 19/09/2022.
- Richman NI, Böhm M, Adams SB, Alvarez F, Bergey EA, Bunn JJ, Burnham Q, Cordeiro J, Coughran J, Crandall KA & Dawkins KL (2015) Multiple drivers of decline in the global status of freshwater crayfish (Decapoda: Astacidea). *Philosophical Transactions of the Royal Society B: Biological Sciences* 370, 20140060.
- Riek EF (1956) Additions to the Australian freshwater crayfish. *Records of the Australian Museum* 24, 1-6.
- Riek EF (1969) The Australian freshwater crayfish (Crustacea: Decapoda: Parastacidae), with descriptions of a new species. *Australian Journal of Zoology* 17(5), 855-918.
- Shull HC, Pérez-Losada M, Blair D, Sewell K, Sinclair EA, Lawler S, Ponniah M & Crandall KA (2005) Phylogeny and biogeography of the freshwater crayfish *Euastacus* (Decapoda: Parastacidae) based on nuclear and mitochondrial DNA. *Molecular Phylogenetics and Evolution* 37(1), 249-263.

- Silva LGM, Doyle KE, Duffy D, Humphries P, Horta A & Baumgartner LJ (2020) Mortality events resulting from Australia's catastrophic fires threaten aquatic biota. *Global Change Biology* 15282, 5345–5350.
- Smith GC, Borsboom A, Lloyd R, Lees N & Kehl J (1998) Habitat Changes, Growth and Abundance of Juvenile Giant Spiny Crayfish, *Euastacus hystricosus* (Decapoda: Parastacidae), in the Conondale Ranges, South-east Queensland. *Proceedings of the Linnean Society of New South Wales* 119, 71-86.
- Smith MA (1982) Devon Downs reconsidered: changes in site use at a lower Murray River rock shelter. *Archaeology in Oceania* 17, 109–116.
- Syktus J, Trancoso R, Ahrens D, Toombs N & Wong K (2020) *Queensland Future Climate Dashboard: Downscaled CMIP5 climate projections for Queensland*. Accessed from <https://www.longpaddock.qld.gov.au/qld-future-climate/>.
- Turvey P & Merrick JR (1997a) Growth with age in the freshwater crayfish, *Euastacus spinifer* (Decapoda: Parastacidae), from the Sydney region, Australia. *Proceedings of the Linnean Society of New South Wales* 118, 205-215.
- Turvey P & Merrick JR (1997b) Reproductive biology of the freshwater crayfish, *Euastacus spinifer* (Decapoda: Parastacidae), from the Sydney region, Australia. *Proceedings of the Linnean Society of New South Wales* 118, 131-155.
- Wells SM, Pyle RM & Collins NM (1983) *The IUCN Invertebrate Red Data Book*. 1st edition, The IUCN, Gland, Switzerland.

## Attachment A: Listing Assessment for *Euastacus urospinosus*

### Reason for assessment

This public nomination was initiated by the World Wide Fund for Nature Australia (WWF). The species was prioritised due to its IUCN conservation status and its proximity to the Border Ranges WWF fire-impacted landscape.

### Assessment of eligibility for listing

This assessment uses the criteria set out in the [EPBC Regulations](#). The thresholds used correspond with those in the [IUCN Red List criteria](#) except where noted in criterion 4, sub-criterion D2. The IUCN criteria are used by Australian jurisdictions to achieve consistent listing assessments through the Common Assessment Method (CAM).

### Key assessment parameters

Table 3 includes the key assessment parameters used in the assessment of eligibility for listing against the criteria. The definition of each of the parameters follows the [Guidelines for Using the IUCN Red List Categories and Criteria](#).

**Table 3 Key assessment parameters**

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Number of mature individuals	Unknown	Unknown	Unknown	Not known for this species.
Trend	n/a			
Generation time (years)	Unknown	Unknown	Unknown	The longevity, fecundity, and age of sexual maturity in females is presently unknown for the Maleny crayfish. In addition, there is little information available from other species of <i>Euastacus</i> . Therefore, generation length cannot be estimated.
Extent of occurrence	648 km <sup>2</sup>			Based on published, and known survey and collection records from Borsboom (various dates), McCormack & van der Werf (2013) and Hurry et al. (2015). Calculated using the Geospatial Conservation Assessment Tool (GeoCAT; Bachman et al. 2011).
Trend	Unknown			The species is not known outside of the current EOO, and its habitat outside of protected areas has been heavily impacted by deforestation (Morgan 1988; McCormack & van der Werf 2013; Hurry et al. 2015).



Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Area of Occupancy	148 km <sup>2</sup>			Based on published, and known survey and collection records from Borsboom (various dates), McCormack & van der Werf (2013) and Hurry et al. (2015). Calculated using the Geospatial Conservation Assessment Tool (GeoCAT; Bachman et al. 2011).
AOO is a standardised spatial measure of the risk of extinction, that represents the area of suitable habitat known, inferred or projected to be currently occupied by the taxon. It is estimated using a 2 x 2 km grid to enable comparison with the criteria thresholds. The resolution (grid size) that maximizes the correlation between AOO and extinction risk is determined more by the spatial scale of threats than by the spatial scale at which AOO is estimated or shape of the taxon's distribution. It is not a fine-scale estimate of the actual area occupied. In some cases, AOO is the smallest area essential at any stage to the survival of existing populations of a taxon (e.g. breeding sites for migratory species).				
Trend	Unknown			The species is not known outside of the current AOO, and its habitat outside of protected areas has been heavily impacted by deforestation (Morgan 1988; McCormack & van der Werf 2013; Hurry et al. 2015).
Number of subpopulations	4			Hurry et al. (2015) identified four genetically distinct upland regions (Bellthorpe, Maleny, Conondale and Curramore) and proposed that these should be treated as separate conservation units.
Trend	Unknown			
Basis of assessment of subpopulation number	Hurry et al. (2015) identified four genetically distinct upland regions (Bellthorpe, Maleny, Conondale and Curramore) and proposed that these should be treated as separate conservation units. Given these four genetically distinct groups are also geographically distinct, and it is considered unlikely that there is genetic exchange of more than one migrant individual/gamete per year between them, the four groups are considered separate subpopulations in this assessment (IUCN Standards and Petitions Committee 2024)			
No. locations	≤5	1	5	This is a restricted range species that is exposed to a range of threats such as climate change, habitat degradation, exotic species and bushfire throughout most of its range. While it is found at a number of localities, it is possible that almost all subpopulations are affected by extreme weather event driven by climate change (e.g. severe heatwave, flood, fire) which could plausible lead to loss of the entire population in a single event .
Trend	Unknown			The species is not known outside of its current range, and its habitat outside of protected areas has been heavily impacted by deforestation (Morgan 1988; McCormack & van der Werf 2013; Hurry et al. 2015).

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
<b>Basis of assessment of location number</b>	This is a restricted range species that is exposed to a range of threats such as climate change, habitat degradation, exotic species and bushfire throughout most of its range. While it is found at a number of localities, it is possible that almost all subpopulations are affected by some of the major threats identified for this species, especially impacts from climate change such as extreme weather events. The number of locations is based on the impacts of climate change and the geographic proximity of inhabited sites (i.e., the likelihood of crayfish across sites experiencing the same changed conditions under climate change and being impacted by severe climate change impacts).			
<b>Fragmentation</b>	It is not known if the subpopulations can be considered to be severely fragmented.			
<b>Fluctuations</b>	Not known to be subject to extreme fluctuations in EOO, AOO, number of subpopulations, locations or mature individuals. No parameter has been shown to have changed by an order of magnitude by the 2019–20 bushfire.			

### Criterion 1 Population size reduction

Reduction in total numbers (measured over the longer of 10 years or 3 generations) based on any of A1 to A4			
	Critically Endangered Very severe reduction	Endangered Severe reduction	Vulnerable Substantial reduction
<b>A1</b>	≥ 90%	≥ 70%	≥ 50%
<b>A2, A3, A4</b>	≥ 80%	≥ 50%	≥ 30%
<b>A1</b> Population reduction observed, estimated, inferred or suspected in the past and the causes of the reduction are clearly reversible AND understood AND ceased. <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. <b>A3</b> Population reduction, projected or suspected to be met in the future (up to a maximum of 100 years) [(a) cannot be used for A3] <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 max. 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 the following (a) direct observation [except A3] (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) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites		

### Criterion 1 evidence

#### Insufficient data to determine eligibility

There is insufficient data to determine eligibility of Maleny crayfish for listing under Criterion 1. The population has not been specifically monitored since its original description. However, a series of collection records from published and unpublished surveys are known in the region (e.g., Borsboom various dates; McCormack & van der Werf 2013; Hurry et al. 2015).

It is projected that there will be a future reduction in population size of Maleny crayfish due to the impacts of climate change. This species, and other likely cool-adapted species of crayfish, do

not have the capacity to adapt to the current or projected rates of warming (Bone et al. 2014) (see Threats Table 1 above). A decline in Area of Occupancy (AOO), Extent of Occupancy (EOO) and quality of habitat is anticipated due to climate change as increasing temperatures and reduced moisture availability, especially in the soil, displaces flora and fauna upslope, including the rainforest in which the species is found.

The species' highly restricted distribution, at fewer than five locations, leaves it vulnerable to extinction from events such as extreme flooding or disease, fires, or other threats (see Criterion 2 below). However, there are no population data to support such an assessment at the present time, with the population size of the species unknown, making it difficult to quantify any previous or likely future changes in the population.

There is insufficient information to determine the eligibility of the species for listing in any category under this criterion.

### Criterion 2 Geographic distribution as indicators for either extent of occurrence AND/OR area of occupancy

	Critically Endangered Very restricted	Endangered Restricted	Vulnerable Limited
<b>B1.</b> Extent of occurrence (EOO)	< 100 km <sup>2</sup>	< 5,000 km <sup>2</sup>	< 20,000 km <sup>2</sup>
<b>B2.</b> Area of occupancy (AOO)	< 10 km <sup>2</sup>	< 500 km <sup>2</sup>	< 2,000 km <sup>2</sup>
<b>AND at least 2 of the following 3 conditions:</b>			
(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			

### Criterion 2 evidence

#### Eligible under Criterion 2 B1ab(iii,v)+2ab(iii,v) for listing as Endangered

#### Extent of occurrence (EOO) and area of occupancy (AOO)

Maleny crayfish is endemic to the Brisbane and Mary River catchments in southeast Queensland, where it inhabits clear, cool, fast flowing headwater streams in rainforested areas (Morgan 1988; Horwitz 1990; Borsboom 1998; McCormack & van der Werf 2013; Hurry et al. 2015). On the basis of surveys and records from 1982 to 2020, the EOO is estimated at 576 km<sup>2</sup> and the AOO at 148 km<sup>2</sup>, calculated using the IUCN standard convex polygon and 2 x 2-km grid method respectively (IUCN Standards and Petitions Committee 2024) with the Geospatial Conservation Assessment Tool (GeoCAT: Bachman et al. 2011). The EOO and AOO estimates meet the threshold for listing as Endangered under Criteria B1 and B2.

### Number of locations

Maleny crayfish is known from numerous sites, which are assessed to be to  $\leq 5$  threat defined locations (IUCN Standards and Petitions Committee 2024), meeting the threshold for listing as Endangered under subcriterion (a). The small range of this species means that all sites are in close proximity and are exposed to similar environmental stressors over time. Therefore, extreme weather events associated with climate change (such as heatwaves, storms, droughts or fires) is the major threat to the species and likely to be experienced in a relatively uniform fashion across all or most sites, with the likelihood of any habitat providing refuge from adverse conditions reduced. Some species of *Euastacus* have been identified as having limited tolerance to abiotic changes (Lowe et al. 2010; Bone et al. 2014; Bone et al. 2017) and are susceptible to ongoing declines in habitat through climate change (Bruna 2004).

### Continuing decline

By 2070, mean annual temperature is expected to increase by 1.1–2.2 °C (RCP 4.5) to 2.0–3.6 °C (RCP 8.5) in the southeast of Queensland (DES 2019; Syktus et al. 2020). *Euastacus* are sensitive to increasing temperatures, and it is unlikely the Maleny crayfish has the capacity to physiologically adapt or relocate to cooler habitats as temperatures increase (Lowe et al. 2010; Bone et al. 2015, 2017). There are no higher altitude areas with suitable habitat beyond the current range of this species for it to extend into under climate change conditions (Borsboom 2022). Furthermore, climate change is projected to increase bushfire risk making rainforest habitat more prone to burning (as was the case during the 2019–20 bushfire season) thereby reducing the availability of suitable habitat. It is projected that there will be a decline in area, extent and/or quality of habitat due to impacts of climate change (principally increasing temperature, reduced moisture availability and extreme weather events) and fire satisfying subcriterion (b)(iii). Additionally, a decline in the number of mature individuals due to impacts from intense weather events such as heatwaves, plus more frequent and intense fires is projected, also satisfying subcriterion (b)(v).

### Conclusion

The species' Extent of Occurrence (EOO) and Area of Occupancy (AOO) are highly restricted, the species occurs at fewer than five locations, and a continuing decline is projected in the area, extent and/or quality of habitat and number of mature individuals. Therefore, the species has met the relevant elements of Criterion 2 to make it eligible for listing as **Endangered**.

**Criterion 3 Population size and decline**

	<b>Critically Endangered Very low</b>	<b>Endangered Low</b>	<b>Vulnerable Limited</b>
Estimated number of mature individuals	< 250	< 2,500	< 10,000
AND either (C1) or (C2) is true			
<b>C1.</b> An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future)	<b>Very high rate 25% in 3 years or 1 generation (whichever is longer)</b>	<b>High rate 20% in 5 years or 2 generation (whichever is longer)</b>	<b>Substantial rate 10% in 10 years or 3 generations (whichever is longer)</b>
<b>C2.</b> An observed, estimated, projected or inferred continuing decline AND its geographic distribution is precarious for its survival based on at least 1 of the following 3 conditions:			
(a) (i) Number of mature individuals in each subpopulation	≤ 50	≤ 250	≤ 1,000
(a) (ii) % of mature individuals in one subpopulation =	90 – 100%	95 – 100%	100%
(b) Extreme fluctuations in the number of mature individuals			

**Criterion 3 evidence****Insufficient data to determine eligibility**

There are no estimates of numbers of mature individuals or any population-decline data that will allow assessment of the Maleny crayfish for eligibility for listing under Criterion 3.

The data presented suggest that there are **insufficient data** to demonstrate if the species is eligible for listing under this criterion.



**Criterion 4 Number of mature individuals**

	<b>Critically Endangered Extremely low</b>	<b>Endangered Very Low</b>	<b>Vulnerable Low</b>
<b>D. Number of mature individuals</b>	< 50	< 250	< 1,000
<b>D2.<sup>1</sup> Only applies to the Vulnerable category</b> Restricted area of occupancy or number of locations with a plausible future threat that could drive the species to Critically Endangered or Extinct in a very short time			D2. Typically: area of occupancy < 20 km <sup>2</sup> or number of locations ≤ 5

<sup>1</sup> The IUCN Red List Criterion D allows for species to be listed as Vulnerable under Criterion D2. The corresponding Criterion 4 in the EPBC Regulations does not currently include the provision for listing a species under D2. As such, a species cannot currently be listed under the EPBC Act under Criterion D2 only. However, assessments may include information relevant to D2.

**Criterion 4 evidence****Eligible under Criterion 4 D2 for listing as Vulnerable.**

There are insufficient data to assess Maleny crayfish against the thresholds for listing under Criterion D1 as there is little information available to determine a robust estimate of the number of mature individuals. However, the species does qualify under Criterion D2 as Vulnerable (VU). This is because it is found in ≤ 5 locations, and the combined threats of enhanced climate change, bushfires and feral predators could drive the species towards extinction in a short timeframe. The isolation of this species to the headwaters of streams at high altitudes (>250 m ASL) increases the risk of extirpation of any individual subpopulations through environmental and demographic stochasticity (Bruna 2004; De Castro & Bolker 2005). Therefore, current and future threats could potentially rapidly eliminate all individuals in the taxon.

**Criterion 5 Quantitative analysis**

	<b>Critically Endangered Immediate future</b>	<b>Endangered Near future</b>	<b>Vulnerable Medium-term future</b>
<b>Indicating the probability of extinction in the wild to be:</b>	≥ 50% in 10 years or 3 generations, whichever is longer (100 years max.)	≥ 20% in 20 years or 5 generations, whichever is longer (100 years max.)	≥ 10% in 100 years

## Criterion 5 evidence

### Insufficient data to determine eligibility

Population viability analysis has not been undertaken. Therefore, there is **insufficient information** to determine the eligibility of the species for listing in any category under this criterion.

### Adequacy of survey

The survey effort for this assessment is appropriate (see sources for EOO and AOO estimates) and there is sufficient published scientific evidence to support this assessment.

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