Fisheries Scientific Committee

Final determination

Swollen crayfish (*Euastacus guruhgi*)

Assessment outcome CRITICALLY ENDANGERED
IUCN Category B1ab(iii,v)

The Fisheries Scientific Committee, established under Part 7A of the New South Wales *Fisheries Management Act 1994* (the FM Act), has assessed ***Euastacus guruhgi* (swollen crayfish)** under the FM Act and the Common Assessment Method and has determined that it is eligible to be listed as a **CRITICALLY ENDANGERED SPECIES**.

The Fisheries Scientific Committee, with reference to the criteria relevant to this species, prescribed by Part 14 of the Fisheries Management (General) Regulation 2019 has assessed and determined that:

- The listing of CRITICALLY ENDANGERED is provided for by Part 7A, Division 2 of the FM Act.
- The species is facing an extremely high risk of extinction in New South Wales in the immediate future and in the opinion of the Fisheries Scientific Committee it meets the criteria specified for CRITICALLY ENDANGERED. The species is proposed to be added to Part 1of Schedule 4A in the FM Act.
- The assessment has been determined in accordance with the national Common Assessment Method (CAM), which provides a nationally consistent approach to the assessing and listing of threatened species in Australia.
- The assessment documentation below indicates the eligibility of the species for listing under both FM Act requirements and IUCN criteria as prescribed by the CAM.

- For more information about the CAM, visit Common Assessment Method – —DCCEEW

- This assessment was submitted as a public nomination to the Commonwealth for listing under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). This nomination was provided to the Fisheries Scientific Committee and the Department of Primary Industries and Regional Development in accordance with the Memorandum of Understanding on the CAM with the Commonwealth on national threatened species assessments.

Assessment against Fisheries Management (General) Regulation 2019 criteria

In its assessment of the nomination the Fisheries Scientific Committee has had regard to Regulation Clause 237 *Criteria—reduction in abundance, geographic distribution or genetic diversity* and Regulation Clause 238 *Criteria—threatening processes.*

237 Criteria—reduction in abundance, geographic distribution or genetic diversity

(1) It is observed, estimated, inferred or reasonably suspected that the species has undergone, or is likely to undergo, within a time frame appropriate to the life cycle and habitat characteristics of the taxon—

(a) for ***critically endangered species***—an extremely large reduction in 1 or more of the following—
(i) an index of abundance appropriate to the taxon,
(ii) geographic distribution,
(iii) genetic diversity
The information to support this assessment is in Attachment A.

238 Criteria—threatening processes

(1) For ***critically endangered***, ***endangered*** and ***vulnerable species***, there is, or there is observed, estimated, inferred or reasonably suspected to be, a historical, current or potential threatening process, or threatening processes affecting the species.

(2) The Fisheries Scientific Committee must have regard to the following in determining the relevant extent of the effect of the threatening process or processes—

(a) the number and nature of the threatening processes,
(b) the potential for synergistic effects between threatening processes,
(c) the extent of the threatening processes relative to the geographic distribution of the species,
(d) the impact of the threatening processes on the diversity and quality of the species' habitat,
(e) the level of protection offered to the species within existing reserve systems, other forms of refuge or by current management strategies.
The information to support this assessment is provided in the Threats section below.

Conservation Advice for *Euastacus guruhgi* (swollen crayfish)

This document combines a conservation advice and listing assessment for the species. It provides a foundation for conservation actions and further planning.

Acknowledgements

This listing assessment and Conservation Advice was initiated and developed by World Wide Fund for Nature Australia (WWF) as a public nomination under the Environment Protection and Biodiversity Conservation Act (EPBC 1999) and was subsequently revised by the NSW Fisheries Scientific Committee under the Common Assessment Method Memorandum of Understanding. The following experts contributed to listing assessment and the Conservation Advice: Maiko Lutz (NGT), James M. Furse (Griffith University), Nick Whiterod (NGT) and Jason Coughran (Sheridan Institute of Higher Education).

Euastacus guruhgi in a captive setting. Image does not depict the species' natural habitat © Copyright, Rob McCormack

Conservation status

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

Euastacus guruhgi was assessed to be eligible for listing as Critically 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): Critically Endangered
- Criterion 3: Insufficient data
- Criterion 4: Insufficient data

- Criterion 5: Insufficient data

The main factors that make the species eligible for listing in the Critically Endangered category are the impacts of climate change (extreme weather events, increased temperature, increased severity and frequency of bushfire) on its highly restricted distribution, 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 under relevant state or territory legislation, see the Species Profile and Threat Database.

Species information

Taxonomy

Conventionally accepted as *Euastacus guruhgi* Coughran, 2005 (Family: Parastacidae). Phylogenetic results have confirmed *E. guruhgi* as a distinct and valid taxon (Austin et al. 2022).

Description

The swollen crayfish is a poorly spinose species of *Euastacus* (Coughran 2008) with a maximum occipital carapace length (OCL; Morgan 1997) of 32 mm (Coughran 2005). The body is brown to green-brown above (dorsally), laterally lighter, often rich golden-brown and pink and cream below (ventrally) with blue-grey walking legs (Coughran 2005). 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. The swollen crayfish is similar in appearance to *Euastacus girurmulayn* (smooth crayfish) with distinction based on several morphological features (Coughran 2005). 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 Coughran (2005, 2006).

Distribution

Current distribution

The swollen crayfish is a short-range endemic (Harvey 2002) occurring in the Tweed River Basin in north-eastern New South Wales, where it is restricted to a small area within Wollumbin National Park and surrounds (Coughran 2005, 2007; Furse & Coughran 2010). The species has been recorded from Korrumbyn and Palmer creeks, plus two unnamed adjacent gullies (Coughran 2005, 2007). More recent unpublished collection records include additional specimens collected from a tributary of Byrill Creek (R.B. McCormack 2022 unpub.), which have been verified by Austin et al. (2022). All sites of record are within the Oxley River drainage area. It has only been recorded from creeks and gullies on the Wollumbin (Mount Warning) volcanic plug (Coughran 2005, 2007).

Additional areas of potential habitat exist in the Wollumbin National Park and the surrounds. However, these areas are either already occupied by one or more of the other 13 species of *Euastacus* known to occur in the region (Coughran 2005, 2007; Coughran & Furse 2010; Furse et al. 2012b; Furse et al. 2013), and/or the swollen crayfish has not been detected in those areas, indicating that the species is likely not found far outside of its currently known distribution.

The region occupied by this crayfish is an area of extremely high annual average rainfall – typically exceeding 2,000 mm per annum (BOM 2022). Mean annual temperature in the region ranges between 15 and 25 °C (BOM 2022).

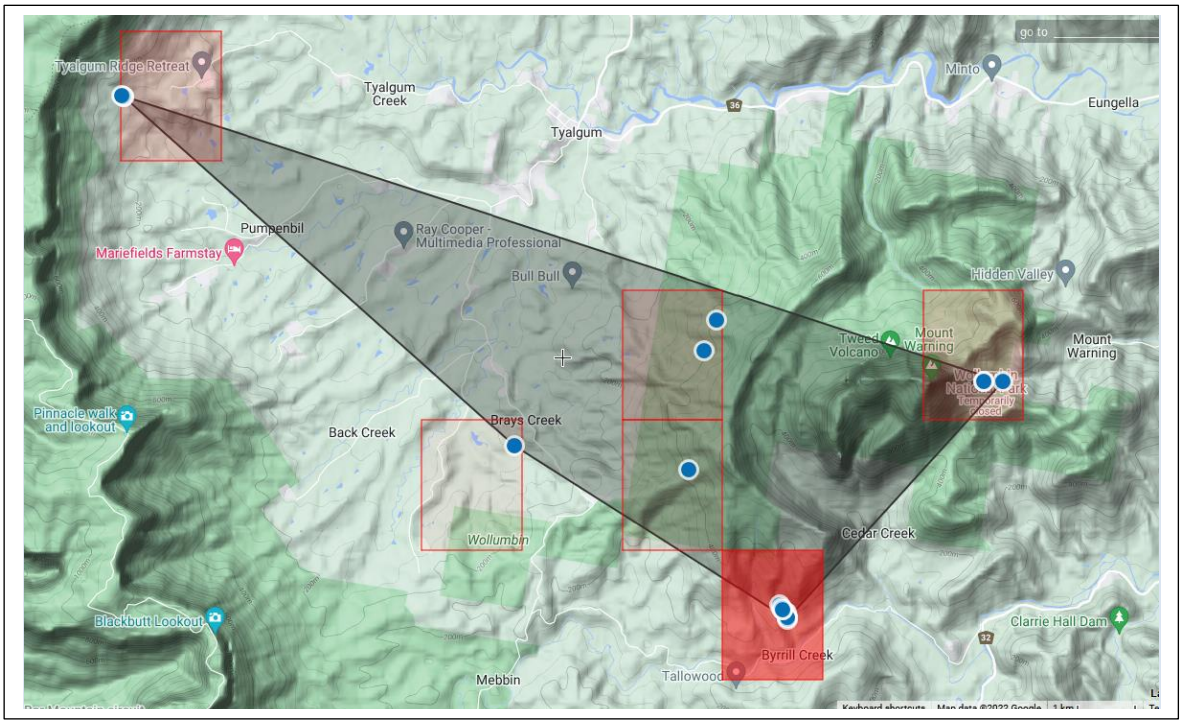

Figure 1. Distribution of swollen crayfish, blue dots denote sites where the species has been recorded. Source: Coughran (2005, 2007) and R.B. McCormack (2022 unpub.). Map prepared and Extent of Occurrence (EOO) and Area of Occupancy (AOO) estimated using the Geospatial Conservation Assessment Tool (GeoCAT, https://geocat.iucnredlist.org/; Bachman et al. 2011).

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 Indigenous peoples that live in the area and care for Country. This section describes some examples of this significance but is not intended to be comprehensive or applicable to, or speak for, Indigenous peoples. 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.

The swollen crayfish occurs on the lands of the Bundjalung people (AIATSIS 2022). The Wollumbin area is of great cultural value to many Indigenous groups (NPWS 2022). The Wollumbin Consultative Group represents the interests of Indigenous groups in the management of Wollumbin National Park (NPWS 2022). The cultural significance of the swollen crayfish is currently unknown. However, given the acknowledged importance to Aboriginal peoples of Connection to Country and the widespread importance of Caring for Country (which includes biodiversity, 'place', custom and totemic elements) it is considered likely that the species has or is associated with some cultural and/or community significance. The species name is derived from the Bundjalung Aboriginal word *guruhgi* meaning swollen (Coughran 2005).

Relevant biology and ecology

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

Habitat

The swollen crayfish inhabits rainforest gullies and streams at altitudes between 320–440 m above sea level (ASL) (Coughran 2005, 2007; Coughran & Furse 2010). It is often found under rocks and debris as well as in complex burrow systems (Coughran 2005, 2007). In April and September of 2002 water temperature in the species habitat was documented as ~20.5 ˚C (Coughran 2007). As the species has a naturally small range, it is considered a short-range endemic species (Harvey 2002).

Reproductive Ecology

Reproductive studies show that *Euastacus* species are typically late maturing and have slow reproductive cycles with females only reaching reproductive maturity after 5–10 years (e.g., Honan & Mitchell 1995; Turvey & Merrick 1997; Borsboom 1998; Furse & Wild 2004; Coughran 2013). Females in this species are thought to reach sexual maturity at ~25 mm OCL (Coughran 2005). The actual growth rates, population sizes and generation lengths of the swollen crayfish are not known. The species is likely to be a poor disperser, with slow growth and low fecundity (Harvey 2002).

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). Pleopodal egg fecundity (number of fertilised eggs attached to underside of a gravid female) varies considerably between species; for the similar sized *Euastacus mirangudjin* (orange-bellied crayfish) fecundity ranges between 16–80 eggs depending on the female body size (McCormack et al. 2010; Coughran 2011). Little is known about the reproductive ecology of the swollen crayfish.

Diet

The diet of the swollen crayfish is not well understood, but the species is likely omnivorous as with many other *Euastacus* species (McCormack 2012).

Co-occurring species

The swollen crayfish has been collected with *Euastcus sulcatus* (mountain crayfish) (Coughran 2005).

Threats and level of risk to the species

Assessment of threatening processes (under clause 238 of the Fisheries Management (General) Regulation 2019)

Established threats (habitat destruction, invasive species, human exploitation and climate change) and potential threats (disease such as *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 2011; Furse 2014; Richman et al. 2015). Climate change is a key threat to the swollen crayfish, with the species having limited capacity to relocate to other nearby suitable habitat. While the species was not directly impacted by the 2019–20 megafires, forest within 5 km of Wollumbin National Park was burnt (DAWE 2020). The highly 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 2011).

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		
Extreme weather events	Timing: current/future Confidence: observed Likelihood: likely Consequence: major Trend: increasing Extent: across the entire range	Increased severity and frequency of extreme weather events (heatwaves, storms, cyclones, droughts (and fires as discussed below)) are broad geographic scale threats associated with climate change. Extreme weather events have the capacity to seriously impact the population, leading to a decline or extirpation of the species. These events are not persistent, and may be relatively short-term in duration (i.e., hours to weeks) (Coughran & Furse 2010). By 2060–79, the north coast region of NSW is projected to have 5–10 more hot days (over 35 °C) annually compared to 1990–2009 (NSW OEH 2014). Bone et al. (2014) reported that when exposed to chronic, steadily increasing temperature, similarly-sized, small specimens of the co-occurring mountain crayfish became sluggish ~23 °C and were effectively incapacitated at ~27 °C (Bone et al. 2014). Acute exposure to temperatures above the upper thermal tolerance limit could cause sublethal physiological impacts (such as reduced reproductive capacity, or compromised immune health) or direct mortalities could drive population reductions. Short-term extreme weather heatwaves are distinct from long-termincrease in average temperature. The projected increase of extreme weather events may have very serious implications for freshwater crayfish, especially for range restricted species such as the swollen crayfish. For example, high rainfall events can cause flash floods that scour streams and can be deadly to any *Euastacus* that seek refuge under temporary shelter, such as loose rocks and logs. Mass mortality was recorded in *E. valentulus* (powerful crayfish) in the nearby 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 in the same size range as adult swollen crayfish (30–40 mm OCL) (Furse

		et al. 2012b). A single severe rainfall event may lead to other localised natural disasters (e.g., tree falls, landslides, and sedimentation events) (Furse et al. 2012b). Soils in the subtropical rainforests of the Qld-NSW border region are poor, unstable and susceptible to landslides and erosion in the steep terrain where high rainfall is typical. This commonly leads to sediment influxes to streams and gullies in high relief montane areas occupied by this species (Ravindran et al. 2019) which is likely to interact with and negatively affect the species physiological tolerance of other environmental stressors (Cramp et al. 2021).
Increased average temperature	Timing: current/future Confidence: inferred Likelihood: almost certain Consequence: major Trend: increasing Extent: across the entire range	Increased average temperature is a direct, ongoing, and persistent long-term impact of climate change. Unlike short-term heatwaves, this is a steady, long-term increase in temperature. Mean annual temperature is prjoected to increase in the north coast region of NSW by 0.7 °C in the near future (2020–39) and 2 °C longer term (2060–79) (NSW OEH 2014). *Euastacus* are sensitive to increasing temperatures, with the swollen crayfish likely lacking the capacity to physiologically adapt 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 there is limited scope for up-slope migration of this species and overland dispersal to other suitably cool habitats is blocked by the warm lowlands (Ponniah & Hughes 2004; Furse et al. 2012a; Bone et al. 2014). Projected increases in temperature in the region have the capacity to impact this species across its range and places the species at a very high risk of extinction. Coughran (2007) reported water temperature in the species habitat was around 20.5 °C. The upper thermal limit of this species remains unknown, however, projected increases in temperature in the region will likely impact this species across its range and puts the species at a very high risk of extinction. Other potential impacts of the projected increases in temperature may be a lowering of the local water table (particularly in winter; NSW OEH 2014). This may result in a decrease of available habitat for this species. Increasing average temperature associated with climate change will also interact with the other threats: - Fire regimes that cause declines in biodiversity - Extreme weather events - Alterations to hydrological regimes
Alterations to hydrological regimes	• Timing: current/future • Confidence: observed • Likelihood: almost certain • Consequence: major • Trend: increasing • Extent: across the entire range	Changes in moisture availability, due to global climate change, will impact the species itself, but also floral and faunal assemblages, across the species' range. *Euastacus* are known to be sensitive to effects of drought, but also effects of flooding (Furse et al. 2012b). Moisture deficits and excesses are threats that put this restricted range species at high risk of population declines, or extirpation. Rainfall patterns across the distribution of the swollen crayfish are projected to change as a result of climate change, with rainfall declining in spring, and increasing in autumn and summer across the north coast region in the long-term (2060–2079) (NSW OEH 2014). Shifting precipitation patterns coupled with projected increases in temperature may lower the local water table and increase seasonality of streams in which swollen crayfish is resident. Changes to water availability would significantly impact this species.

Fire regimes that cause declines in biodiversity	Timing: current/future Confidence: observed Likelihood: likely Consequence: major Trend: increasing Extent: part or across entire range	The frequency, severity and magnitude of bushfires is projected to increase under climate change (Di Virgilio et al. 2019; DAWE 2022). For the north coast region of NSW, average fire weather and severe fire weather days are projected to increase during summer and spring (NSW OEH 2014). 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 (sedimentation and deoxygenation of habitat following a fire, possible changes of water temperature and light regimes due to canopy loss). Crayfish from restricted distributions and cooler climates (e.g. at altitude) are at an increased risk of decline as bushfires change aquatic thermal and oxygen regimes (Cramp et al. 2021). 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 [*Lantana camara*]) (NPWS 2004). Dense stands of lantana quickly establish in the exposed areas created by habitat disturbances (e.g., tree falls and landslides) (Stock 2004). They can quickly smother habitat (Stock 2004) and may increase the chance and severity of bushfires (Hines et al. 2020). The swollen crayfish did not occur within the footprint of the 2019–20 bushfires, however forest within 5 km of Wollumbin National Park was burnt (DAWE 2020). A single bushfire has the capacity to impact the entire population of this short-range endemic species, potentially leading to a population decline across the species' range, or extirpation of the species.
Invasive species		
Invasive fauna	Timing: current/future Confidence: inferred Likelihood: possible Consequence: moderate Trend: static to increasing Extent: across the entire range	Feral pigs (*Sus scrofa*) have not been recorded within Wollumbin National Park (DPI 2023) but occur within the range of this species and surrounding areas (Coughran & Furse 2010; DECCW 2010). Pigs eat crayfish (J. Coughran 2021 unpub.) and are a serious threat to crayfish in general, but species of burrowing crayfish (such as *E. guruhgi*) in particular both through predation and their rooting and wallowing behaviour, as has been seen in *Engaeus martigener* (DEH 2017).
Illegal collection		
Illegal take	Timing: current Confidence: inferred Likelihood: likely Consequence: moderate Trend: increasing Extent: across the entire range	Illegal collectors specifically target rare species of *Euastacus* for personal collections and the aquarium trade (Coughran 2007; Coughran & Furse 2012; J. Furse 2021 unpub.). Their targets include species in national parks (see Coughran & Furse 2012) and extremely remote areas (J. Furse 2021 unpub.). 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.). Any collection of slow-growing and short-range endemic species, such as the swollen crayfish, has the capacity to lead to negative population-scale impacts. Specifically, removal of reproductive animals from a population, particularly females that may require >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.
Disease		
Crayfish plague	Timing: future Confidence: projected Likelihood: possible Consequence: catastrophic Trend: unknown Extent: across entire range	*Aphanomyces astaci* (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). Many strains of the disease prefer cooler temperatures, which is characteristic of the swollen 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 when it reaches Australia (DAWE 2019). The vector for the disease's movement outside of its native range has been translocation of North American crayfish, in particular, *Pacifastacus leniusculus* (signal crayfish) and *Procambarus clarkii* (red swamp crayfish). 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 & Regional Development 2021; Business Queensland 2021), but not known to be infected. 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.

[a]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
Almost certain				Climate change: – Increased average temperature – Alterations to hydrological regimes	
Likely			Illegal take	Climate change: – Extreme weather events – Fire regimes that cause declines in biodiversity Illegal take	
Possible			Invasive fauna		Disease: – Crayfish plague
Unlikely					
Unknown					

Risk Matrix legend/Risk rating:

Low Risk	Moderate Risk	High Risk	Very High Risk

Priority actions have then been developed to manage the threats, particularly where the risk was deemed to be 'very high' (red shading) or 'high' (orange shading). For those threats with an unknown or low risk (blue and green shading respectively) research and monitoring actions have been developed to understand and evaluate the impact of the threats, where appropriate

Conservation and recovery actions

Primary conservation objective

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

Conservation and management priorities

Extreme weather events

- 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, when the species physiological tolerances are known.
- Develop or access local weather and climate models to project when extreme weather events might require moving animals to ex situ facilities.

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, 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

- Ensure that the habitat quality remains high through management actions (e.g., weed removal, fire suppression, etc.) in national parks where the species is found.

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 that could become a threat to the species, ensuring any possible disturbance/overspray does not adversely impact the swollen crayfish.

Illegal collection

- Regularly carry out surveillance of species habitats, websites, forums, collectors' groups, etc. to detect if illegal collection is occurring and if this species is being offered for sale, and then take action against the sellers where appropriate.
- Assess compliance of any recreational fishers with State fisheries regulations.

Disease impacts

- Ensure authorised collectors are aware of required hygiene protocols, and assess compliance.
- 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.
- Biosecurity at international borders should be reviewed and updated as may be appropriate to limit opportunities for incidental importation of disease (including on infected crayfish)

- 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.

Stakeholder engagement/community engagement

- Prepare a management and engagement strategy for this and other similar species of crayfish in the region with input from *bona fide* crayfish experts, national park managers, and other identified stakeholders.
- Actively engage Traditional Owners in the conservation of the species and its habitat and work with them to divulge any traditional knowledge associated with the species, ensuring the practices to record, store and share this knowledge are mutually supported.
- 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.
- 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 supported by cost-effectiveness and risk based collective decision making.

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 swollen 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 swollen crayfish (see ‘Relevant biology and ecology’ above).
- Investigate the species’ habitat requirements.

- Investigate the potential influence of climate change on environmental stressors (altered temperatures, rainfall patterns, bushfires) and diseases and how these impact the long-term survival prospects of the species, . This includes:
    - Assess the thermal tolerance of the swollen crayfish (using non-lethal methods) 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 would be affected via increased temperature.
    - Establish the impacts of climate change on the species' habitat (vegetation assemblages, water availability, water and air temperatures).
- Understand the threats and impacts of invasive species and diseases on the swollen crayfish.
- Establish laboratory research protocols as well as protocols for crayfish releases to source after use in laboratory research (such as check for diseases).

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

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Attachment A: Listing Assessment for *Euastacus guruhgi*

Assessment under the NSW *Fisheries Management Act 1994* (FM Act)

Assessment of the species reduction in abundance, geographic distribution or genetic diversity (under clause 271 of the Fisheries Management (General) Regulation 2019)

In 2015 the NSW Government signed an Intergovernmental Memorandum of Understanding on the Agreement on a Common Assessment Method for listing of threatened species and threatened ecological communities (the CAM). The CAM provides a nationally consistent approach to assessing and listing threatened species in Australia, using the IUCN Redlist Categories and Criteria (Version 3.1). To ensure that this Proposed Final Determination meets the requirements under the CAM, an assessment against the IUCN Redlist Categories and Criteria (Version 3.1) has been included. This assessment also reflects the requirements for listing species provided under clause 271 of the Fisheries Management (General) Regulation 2019. For more information on the CAM please visit http://www.environment.gov.au/biodiversity/threatened/cam

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).

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.

237 Criteria—reduction in abundance, geographic distribution or genetic diversity

(1) It is observed, estimated, inferred or reasonably suspected that the species has undergone, or is likely to undergo, within a time frame appropriate to the life cycle and habitat characteristics of the taxon—

(a) for **critically endangered** species—an extremely large reduction in 1 or more of the following—

(i) an index of abundance appropriate to the taxon,

(ii) geographic distribution,

(iii) genetic diversity

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			Not known for this species.
Trend	n/a			
Generation time (years)	unknown			The longevity, fecundity, and age of sexual maturity in females is presently unknown for the swollen crayfish. In addition, there is little information available from other species of *Euastacus*. Therefore, generation length cannot be estimated.
Extent of occurrence	46 km^2			Based on published, and known survey and collection records from Coughran (2005, 2007) and RB McCormack (2022 unpub.). Calculated using the Geospatial Conservation Assessment Tool (GeoCAT; Bachman et al. 2011).
Trend	unknown			The species is not known outside of the current EOO. Field surveys are needed to confirm its presence at historic sites (Coughran 2005). It was not recorded from other highland sites in similar nearby habitat (Coughran 2007).
Area of Occupancy	24 km^2			Based on published, and/or known survey and collection records from Coughran (2005, 2007) and RB McCormack (2022 unpub.). 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).				

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Trend	unknown			The species is not known outside of the current range. Field surveys are needed to confirm its presence at historic sites (Coughran 2005). It was not recorded from other highland sites in similar nearby habitats (Coughran 2007).
Number of subpopulations	unknown			No population data is available for this species.
Trend	n/a			
Basis of assessment of subpopulation number	n/a			
No. locations	1	1	1	This is a restricted range species that is exposed to a range of threats such as climate change, bushfire, illegal collection and invasive species throughout its range. While it is found at a number of localities, it is possible that all subpopulations are affected by some of the major threats identified for this species at the same time.
Trend	unknown			The species is not known outside of the current range. Field surveys are needed to confirm its presence at historic sites (Coughran 2005). It was not recorded from other highland sites in similar nearby habitats (Coughran 2007).
Basis of assessment of location number	All known sites for the species are adjacent each other within a small geographic range, with common threats (such as climate change) over that range, and therefore are considered a single location.			
Fragmentation	It is not known if the subpopulations can be considered to be severely fragmented.			
Fluctuations	Not known to be subject to extreme fluctuations in EOO, AOO, number of subpopulations, locations or mature individuals.			

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**
A1	≥ 90%	≥ 70%	≥ 50%
A2, A3, A4	≥ 80%	≥ 50%	≥ 30%

A1 Population reduction observed, estimated, inferred or suspected in the past and the causes of the reduction are clearly reversible AND understood AND ceased.

A2 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.

A3 Population reduction, projected or suspected to be met in the future (up to a maximum of 100 years) [(*a) cannot be used for A3*]

A4 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

The generation length of the swollen crayfish is unknown and there are **insufficient data** to determine eligibility for listing under Criterion 1.

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
B1.	Extent of occurrence (EOO)	**< 100 km²**	**< 5,000 km²**	**< 20,000 km²**
B2.	Area of occupancy (AOO)	**< 10 km²**	**< 500 km²**	**< 2,000 km²**
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			

Criterion 2 evidence

Eligible under Criterion 2 B1ab(iii, v) for listing as Critically Endangered.

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

The swollen crayfish is endemic to gullies and headwater streams in Wollumbin National Park, New South Wales. On the basis of field surveys (Coughran 2005, 2007; RB McCormack 2022 unpub.), the EOO is estimated at 46 km² and AOO is estimated at 24 km² calculated using the IUCN standard convex polygon and 2-km 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 estimates meets the threshold for listing as Critically Endangered under Criterion B1.

Number of locations

The small range of the species means that all sites are in close proximity, and are exposed to similar environmental stressors over time. Therefore, increased exposure to extreme weather events associated with climate change (e.g., heatwaves, severe storms/cyclones, droughts and fires) is the major threat to this species. Given the spatial distribution of the species and the scale of these threats, exposure to any of these extreme weather events is likely to be experienced in a uniform fashion across all known sites and could plausibly lead to rapid reduction of the population. It is therefore assessed that the species is restricted to one threat defined location (IUCN Standards and Petitions Committee 2024), meeting the threshold for listing as Critically Endangered under subcriterion (a).

Continuing decline

It is inferred 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 including fire) satisfying subcriterion (b)(iii). Mean annual temperature is projected to increase along the north coast region of NSW by 0.7 °C in the near term (i.e. within 20 years), and by 2 °C later in the century (NSW OEH 2014). This is likely to lead to altitudinal compression of the species' habitat**.** Additionally, a decline in the number of mature individuals due to impacts from extreme weather events such as heatwaves, plus more frequent and intense fires is projected, also satisfying subcriterion (b)(v).

Conclusion

The above data indicate the swollen crayfish is eligible for listing as **Critically Endangered B1ab(iii, v)** under this criterion.

Criterion 3 Population size and decline

		Critically Endangered Very low	Endangered Low	Vulnerable Limited
Estimated number of mature individuals		< 250	< 2,500	< 10,000
AND either (C1) or (C2) is true				
C1. An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future)		Very high rate 25% in 3 years or 1 generation (whichever is longer)	High rate 20% in 5 years or 2 generation (whichever is longer)	Substantial rate 10% in 10 years or 3 generations (whichever is longer)
C2. 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
	(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 swollen 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

	Critically Endangered Extremely low	Endangered Very Low	Vulnerable Low
D. Number of mature individuals	< 50	< 250	< 1,000
D2.[1] *Only applies to the Vulnerable category* 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 km² or number of locations ≤ 5

[1] 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

Insufficient data to determine eligibility

The number of mature individuals of the swollen crayfish is not known.

Although only one location was identified (see Criterion 2), there are **insufficient data** to demonstrate if the species is eligible for listing under subcriterion D2. Population demographics have not been investigated for this species, and the extent to which the species has been impacted by significant threats has not been ascertained. Therefore, it is uncertain whether a plausible future threat could drive the species towards extinction in a very short time.

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

Criterion 5 Quantitative analysis

	Critically Endangered Immediate future	Endangered Near future	Vulnerable Medium-term future
Indicating the probability of extinction in the wild to be:	≥ 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.