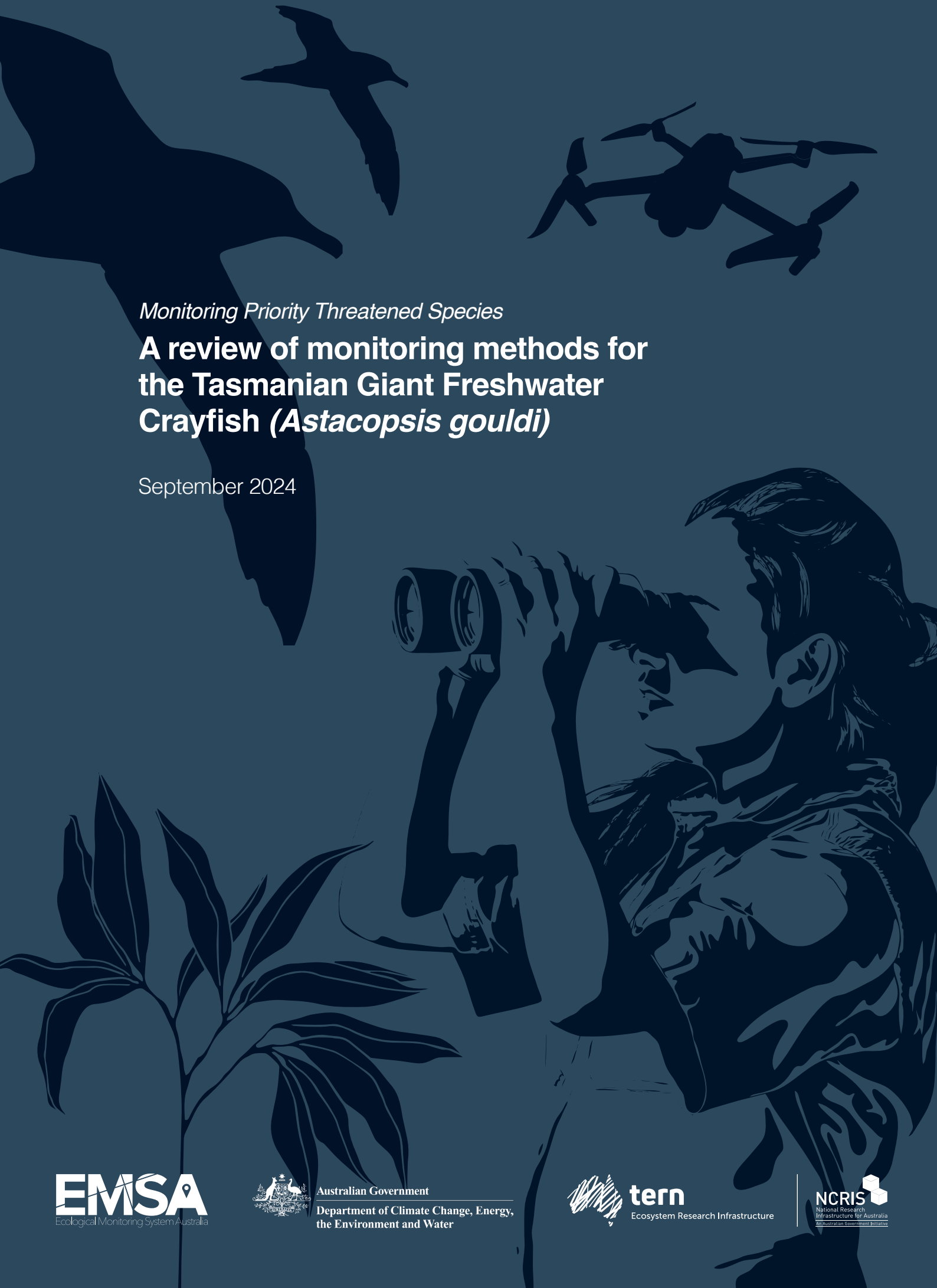

Monitoring Priority Threatened Species

A review of monitoring methods for the Tasmanian Giant Freshwater Crayfish *(Astacopsis gouldi)*

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Acknowledgement of Country

We acknowledge the Traditional Custodians of Australia and their continuing connection to land and sea, waters, environment and community. We pay our respects to the Traditional Custodians of the lands we live and work on, their culture, and their Elders past and present.

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About

This literature review collates information on one of the 110 priority threatened species identified in the *Threatened Species Action Plan 2022-2032* and has been reviewed by invited practitioners experienced in monitoring the species.

The *Survey Guidelines for Monitoring Threatened Species* project, a collaboration of the Department of Climate Change, Energy, the Environment, and Water (DCCEEW) and the Terrestrial Ecosystem Research Network (TERN), aims to improve our knowledge of threatened species by enhancing accessibility and sharing of quality scientific threatened species data. By developing best practice field survey guidelines and recommendations, practitioners will be better equipped to conduct standardised, repeatable surveys.

By identifying the monitoring methods typically implemented by practitioners, documenting and assessing the techniques known to work, and identifying opportunities to standardise the methods, we can move towards ensuring all monitoring is species-appropriate, comparable between practitioners and populations, and repeatable over time. Further, together with consistent terminology, guidelines, instructions, and data collection, we can refine efforts and resources to measure and share information. Data collected using robust, standardised methods will improve our knowledge of threatened species and underpin threatened species recovery at scale. This project is essential to establishing monitoring protocols and data repositories to enhance the accessibility and sharing of threatened species data.

TERN has prepared the literature reviews for the Department of Climate Change, Energy, the Environment, and Water. For further information, please visit the EMSA Threatened Species Survey Guidelines website. Additional information, particularly monitoring methods and techniques not included that should be considered, can be brought to the author's attention by emailing tern@adelaide.edu.au for consideration for future updates.

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1 Background

1.1 Species name

Tasmanian Giant Freshwater Crayfish (*Astacopsis gouldi*) (Clark, 1936), herein referred to as the Giant Freshwater Crayfish. The genus *Astacopsis* only occurs in Tasmania, and the Giant Freshwater Crayfish is one of three *Astacopsis* species (Cradle Coast NRM 2022). There have been several revisions of nomenclature since *Astacopsis gouldi* was first described, with all Tasmanian in-stream freshwater crayfish wrongly classified as a single species under the name *A. franklinii* until the early 1900's (Mulhern 2018).

The recorded English transliteration of the purported Aboriginal name for the Giant Freshwater Crayfish is 'loe.ter.er.le.pe.en.ne' (Cape Portland tribe of the north-east, recorded by G. A. Robinson in the 1830's) (Plomley 1976 p.262). In recent times, it has been common to use 'tayatea' as the Aboriginal name for Giant Freshwater Crayfish. However, the historical records suggest this refers to the smaller *Astacopsis* species from Tasmania's south-east. The palawa kani Language Program of the Tasmanian Aboriginal Centre has revived 'lutaralipina' (pronounced: lu-tar-rah-lee-pee-nah) as the appropriate Tasmanian Aboriginal term for the Giant Freshwater Crayfish (Mulhern 2018).

1.2 Conservation status

The Tasmanian Giant Freshwater Crayfish is listed as Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) The species is also listed as Vulnerable in Tasmania under the *Threatened Species Protection Act 1995* (Tas) and is listed as a 'protected fish' under the Tasmanian *Inland Fisheries Act 1995* (Tas). It is illegal to fish or collect this species without a permit.

The Giant Freshwater Crayfish is the world's largest freshwater invertebrate and one of six threatened crayfish species in northern Tasmania (DPIPWE 2020). Giant Freshwater Crayfish is one of 11 priority invertebrates identified in the *Threatened Species Action Plan 2022-2032* (DCCEEW 2022).

Table 1. National, international and state conservation status for the Giant Freshwater Crayfish

Jurisdiction	Conservation status	Legislation
Commonwealth	Vulnerable	*Environment Protection and Biodiversity Conservation Act 1999*
Tasmania	Vulnerable	*Threatened Species Protection Act 1995*
IUCN	Endangered	IUCN Red List of Threatened Species

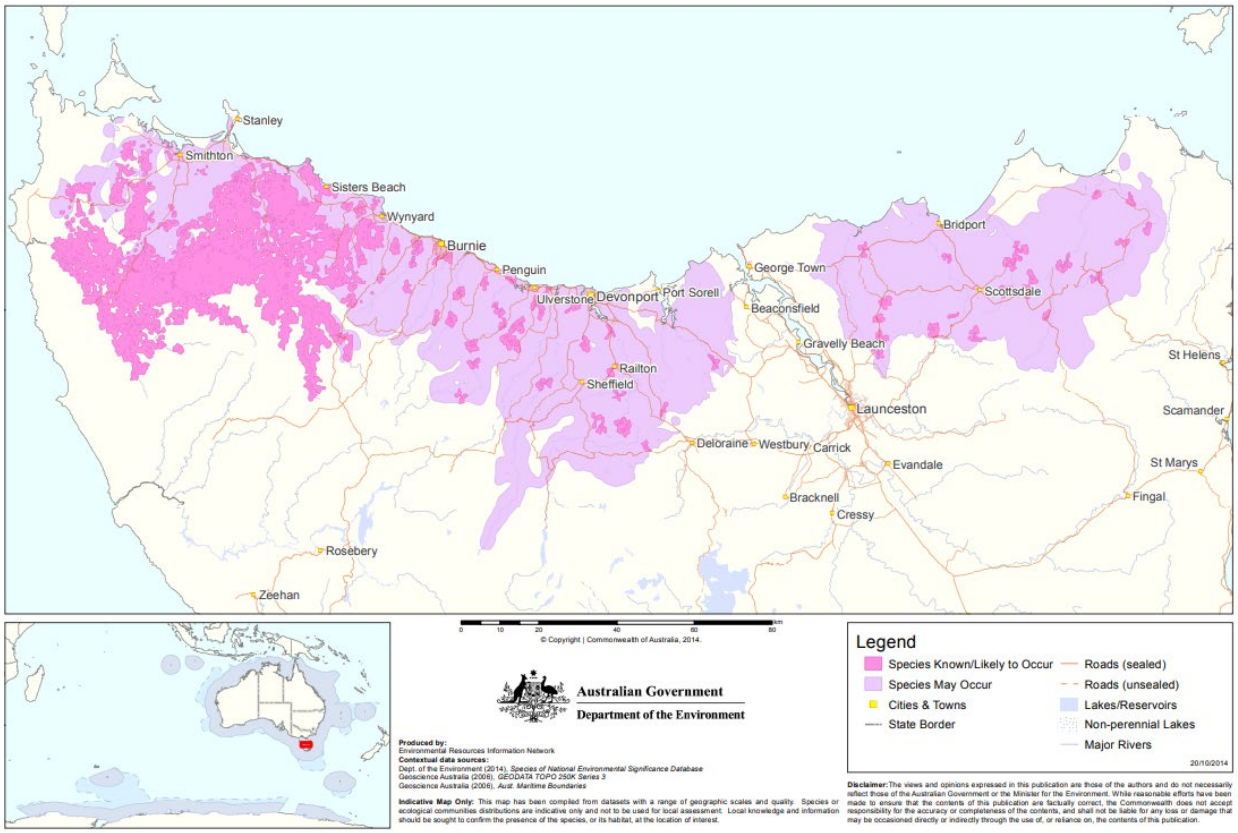
1.3 Summary of data held in the Threatened Species Index

The Threatened Species Index (TSX) provides reliable and robust measures of change in the relative abundance of Australia's threatened and near-threatened species at national, state and regional levels. Understanding these changes in species populations is crucial for monitoring Australia's conservation progress and allows users to measure and report on the benefits of conservation investments, and to justify and design targeted management responses. Currently, the index is restricted to birds, plants and mammals, with new groups to be added in the near future. Therefore, the TSX does not currently hold data on the Giant Freshwater Crayfish. More information on the TSX, including how to contribute threatened species monitoring data to the index, can be found on the TSX website.

1.4 Distribution and abundance

The Giant Freshwater Crayfish is endemic to rivers of northern Tasmania. Historically, the species was found in all rivers flowing into Bass Strait from the Arthur River and east across northern Tasmania, but not those of the Tamar catchment. Its current distribution is more disjunct, with declines and localised extinction in several river systems attributed to fishing pressure and large-scale habitat disturbance. The species has successfully been introduced into the North Esk and Derwent catchments (DOE 2023). In 2006, the estimated extent of occurrence of the Giant Freshwater Crayfish was estimated at 10,700 km², with approximately 19 % of the streams in which the species habitat was predicted to occur protected in either formal or informal reserves (Threatened Species Section 2006). Since then, some additional habitat has been incorporated into formal and informal reserves (Commonwealth of Australia 2017). There is no data available on population numbers (DOE 2023).

Figure 1. Distribution of the Tasmanian Giant Freshwater Crayfish



Source: DCCEEW

1.5 Habitat requirements

The Giant Freshwater Crayfish occurs in streams of various sizes, in both flowing and still waters, that are well-shaded, have good water quality, low sediment levels, snags, pools and undercut banks (DOE, 2023), and consistently low water temperature (6-19°C) (T. Walsh 2024, personal communication, 6 March). The species naturally occurs at altitudes below 400 m, with most caught below 200 m (Horwitz 1994).

Typically, adults are found in still, deep pools beneath decaying logs and undercut banks and move through shallow riffle zones. Juveniles utilise shallow, fast-flowing streams, with rocks or logs that are large enough to be stable but not embedded in finer substrates but overlie coarser substrates and/or have a distinct cavity underneath (Commonwealth of Australia 2017; DOE 2023).

The suitable habitat is typically surrounded by native riparian vegetation, which provides the required shade, nutrients, energy and structural inputs into streams (Commonwealth of Australia 2017; Walsh & Haller 2012). The species has also been recorded in streams surrounded by non-native riparian vegetation, without riparian vegetation, and in farm dams (DOE 2023).

Adults dig burrows in stream banks and underneath logs and boulders in the streambed. Complicated burrows have been observed, with up to 10 crayfish residing in a 10 m stretch of riverbank wall (T Walsh unpublished data)(Walsh & Haller 2012).

1.6 Biology and ecology

Giant Freshwater Crayfish are reported to grow up to 6 kg (outstretched length of more than a metre). However, animals weighing 2-3 kg are considered large. Typical weights for females are 660 g (carapace length of 11.5 cm) and males around 680 g (carapace length of 10.9 cm) (T. Walsh 2024, personal communication, 6 March). They are slow-growing and live for up to 60 years, not reaching sexual maturity until around 14 years for females and 9 years for males). They have slow colonising abilities (e.g. recolonisation of impacted areas appears to be very slow) and relatively low fecundity (DOE 2023; TSSC 2017).

The diet of Giant Freshwater Crayfish varies with age, consisting of decaying wood and its associated microbes, leaves, animal flesh, and small fish (DOE 2023; Walsh & Haller 2012).

Females mate and spawn biennially in autumn, after a summer moult. Gestation takes about nine months, with females carrying the eggs on the tail through winter. After hatching in mid-summer, young crayfish stay attached to the female until autumn (DOE 2023; Walsh & Haller 2012). The structure of populations has been impacted by fishing pressure, with studies showing an absence of large breeding-sized individuals, particularly sexually mature males, and few small juveniles present (DOE 2023).

The dispersal and migration of the Giant Freshwater Crayfish is largely unknown. There is the opportunity for the species to disperse through drainage systems. They are less restricted than other burrowing species, given their relative independence of wet soils. Based on mark-recapture studies, the species has been shown to have a high degree of site fidelity, returning to their home site after movement. Individuals have been found to reside in a similar stretch of stream for at least a 7-8 year period, and more probably for life once they reach adulthood (Walsh & Haller 2012). A radio-tracking study of eight Giant Freshwater Crayfish showed periods of inactivity lasting from 1-10 days, interspersed with movements, including one crayfish moving over 700 m in a single night and a total recorded movement of 2.2 km for one crayfish over the five month study period. Tracked animals often returned to the same refuge after excursions. The species can also walk over land (DOE 2023; Webb & Richardson 2004).

1.7 Threats

Threatening processes for the species include:

- past legal, and current illegal fishing pressure (a fishing ban was imposed for the species in 1998).
- habitat disturbance and modification, including the removal or destruction of riparian vegetation, bank erosion, removal of snags, channelisation, siltation, nutrification, toxic chemical inputs, instream barriers to crayfish movement such as culverts and farm dams, and alterations to stream flow and thermal regime.

- intensification of forestry activities impacting on riparian and aquatic habitats (e.g. roads, logging, plantations), which may also result in increased access and associated fishing pressure on previously undisturbed populations.
- drought, with significant crayfish deaths in the north-west and north-east of Tasmania occurring in 2006–2007 as a result of low environmental flows.
- Flooding, significant crayfish deaths occurred in the north-west of Tasmania after flooding in 2016.
- climate change may result in altered stream flows, altered stream temperatures, and changes to catchment vegetation, which could affect the entire local crayfish population (Commonwealth of Australia 2017; DOE 2023).

2 Existing monitoring

2.1 Overview of monitoring methods

Giant Freshwater Crayfish are shy and secretive (Cradle Coast NRM 2022), and there are no obvious indicators of their presence in a catchment. The location of known records and the quality of habitat can be used to guide survey efforts. The Giant Freshwater Crayfish can be distinguished from other Tasmanian crayfish by the raised ridge running down the middle of the rostrum (the pointed structure on the forehead, between the eyes) (Cradle Coast NRM 2022; Threatened Species Section 2023).

Key population monitoring measures for Giant Freshwater Crayfish include:

- population abundance (trend)
- population demographic structure (e.g. sex, weight, carapace length, eggs present)
- population density
- distribution/area of occupancy
- habitat condition

A key objective for the recovery of the Giant Freshwater Crayfish is to assess the current status of the species and evaluate the effectiveness of recovery actions. Key achievement measures include:

- an increase in population densities and healthy demographic structure
- key locations identified and monitored annually, and population trends assessed
- habitat quality maintained or improved in key locations (Commonwealth of Australia 2017).

2.2 Monitoring resources

The National Recovery Plan for the Giant Freshwater Crayfish was approved in 2017 (Commonwealth of Australia 2017), after the revision of the 2006 version (TSS 2006). Priority research and on-ground actions are identified in the plan and are summarised in **Error! Reference source not found.**.

The Draft EPBC Act referral guidelines for the Giant Freshwater Crayfish (Commonwealth of Australia 2015) provides a recommended guide to conducting surveys in suitable habitat.

There are a range of resources (scientific papers, workshop notes, web-based information, and field survey reports) that provide information about survey methods and analysis (e.g. Pracejus 2016; Tasmanian Crayfish Workshop 2010; Trujillo-Gonzalez et al. 2021; Walsh & Haller 2012). DCCEEW's Species Profile and Threats database (SPRAT) provides information on how to survey using trapping for non-juvenile crayfish, and visual searches/netting for juvenile crayfish (DOE 2023). Proceedings from the Tasmanian Crayfish Workshop (2010) provide monitoring information. Trujillo-Gonzalez et al. (2021) define how to collect and analyse water samples for Giant Freshwater Crayfish DNA. Irrigation Tasmania has developed a protocol for Giant Freshwater Crayfish translocation (Tasmanian Irrigation 2017). Monitoring approaches for other freshwater crayfish species may also have relevance (e.g. Zimmerman & Palo 2011).

2.3 Survey methods

Population monitoring has been undertaken (in some form) since 1998 (Commonwealth of Australia 2017). Key monitoring methods for Tasmanian Giant Freshwater Crayfish are trapping (mark-recapture), visual search, habitat assessment, and eDNA.

Trapping methods are recommended for larger crayfish (sub-adults and adults), whereas visual surveys are recommended for juvenile crayfish. A combined approach is generally used to determine population structure and reduce the risk of a false absence being recorded (Commonwealth of Australia 2015; DOE 2023). Monitoring to determine demographics requires three separate surveys at least three weeks apart, ideally conducted across three seasons (i.e., spring, summer and autumn) (Commonwealth of Australia 2015; DOE 2023; Tasmanian Crayfish Workshop 2010). Surveys can be conducted year-round however surveys conducted in autumn spring and summer are recommended as winter water is too cold and consistently high flows may affect crayfish numbers (T. Walsh 2024, personal communication, 6 March). Smaller crayfish (less than 1 kg) are generally sampled better in the warmer months such as during summer and larger individuals better sampled in cooler months during autumn (Commonwealth of Australia 2015; DOE 2023; Tasmanian Crayfish Workshop 2010).

Monitoring should be carried out at selected comparable sites across the species' geographical and habitat range (stream size and altitude) and include disturbed and undisturbed areas. Regular, ongoing monitoring is required to assess trends in population abundance, age structure and recruitment, and to understand the reproductive ecology, life history and habitat use of recovering crayfish populations. It is recommended that surveys are repeated at five-year intervals to assess population trends. The slow growth, low fecundity and age at maturity for the species mean that a long time is required to observe trends in population recovery from recent impacts (TSS 2006).

More information about these and other potential monitoring methods is provided below.

2.3.1 Trapping – non-juvenile crayfish

Giant Freshwater Crayfish are easily caught (DOE 2023). They are a robust species, able to tolerate being out of water for considerable periods, especially during cooler months (Tasmanian Irrigation 2017). Adults can be spotted in clear waters and captured by hand, behind the claws. Other trapping methods include searching under rocks and logs, baited lines, ring nets (Threatened Species Section 2023), and baited box traps with platypus escape hatches (DOE 2023; TSS 2023; Walsh 2020).

The number of traps used to survey is site specific and based on the habitat in a survey area as well as the perceived or actual population density. Within a search area, traps should be placed in the most suitable habitat (deep pools, near large woody debris and overhangs) (DOE 2023; Tasmanian Crayfish Workshop 2010). Traps may be set and checked after 90 minutes and then reset or moved to an adjacent area. Relatively frequent monitoring of the traps is required to reduce the risk of platypus capture and to reduce stress caused to any captured animal. Sampling may occur in the one location for around 4 hours (with more frequent trap checks).

As part of baseline monitoring before habitat rehabilitation works, Walsh (2020) used baited box traps to capture crayfish from priority areas, with repeat trapping undertaken at the end of the project to help identify changes or improvements (Cradle Coast NRM 2022).

Lower catch rates occur in winter (i.e. colder temperatures) and may occur after consistent rainfall events during the sampling season, with crayfish being well-fed due to the large volume of food entering the creeks (Walsh 2020). Care should be taken to minimise the disturbance of habitats during surveys. The species can suffer from shock when water temperatures decrease about 10 °C as a result of cold weather changes, so trapping should be avoided during or after such weather events (Commonwealth of Australia 2015).

Mark-recapture / micro-chip tagging

Mark-recapture is used to monitor individual growth and local population dynamics. The recapture of marked individuals has become increasingly common since fishing bans were imposed

(Commonwealth of Australia 2017; Walsh & Haller 2012). By 2012, almost 2000 specimens at more than 100 sites had been catalogued (Walsh & Haller 2012). In 2017, over 500 tagged crayfish were present (Commonwealth of Australia 2017), with additional tagging undertaken since this time.

Adult captures are checked for a microchip, to determine if they are new individuals (not previously captured) or recaptures. Each captured crayfish is weighed, sexed, and the carapace length is measured. New individuals (larger specimens) are fitted with a microchip inserted at the base of the upper back leg (second leg from bottom) on the left side (looking down) so as to avoid the sperm sac in males (Walsh & Haller 2012). Notes are recorded about each individual's condition, particularly regarding missing claws, scars, and parasite load. Future monitoring could trial in-stream microchip readers to monitor the movement of tagged adults (Cradle Coast NRM 2022).

2.3.2 Visual search – juvenile crayfish

A standardised visual search of habitat is undertaken to obtain estimates of juvenile crayfish abundance (TSS 2006). Visual searches involve turning all rocks in riffle/rocky substrate zones and boulder/cobble areas, with a hand-net held downstream. All rocks that are turned should be slowly returned to their original position, being careful not to crush any organisms which may be underneath. The effort required can be determined by search area (minimum 250 m river stretch) or time (minimum 4 hours of survey). (Commonwealth of Australia 2015; DOE 2023; Tasmanian Crayfish Workshop 2010).

Juveniles are difficult to detect or catch in smaller tributaries (Commonwealth of Australia 2015). Searches for juveniles should avoid periods of high or turbid flows, as the crayfish will be harder to see. Searches should also avoid periods when the water temperature is very low, as the juveniles are less active (DOE 2023).

Juvenile crayfish are measured (length of carapace), sexed if possible and the weight estimated (e.g. <15 g). They cannot be microchipped so there is the possibility of undetected recapture if a site is re-surveyed.

2.3.3 Opportune observations

Adult crayfish can sometimes be spotted when the waters are relatively clear. The Tasmanian Government requests that new records be reported to the Natural Values Atlas or that the information be provided directly to the Threatened Species Section (TSS 2023). Poaching activities should be reported to the Inland Fisheries Service.

2.3.4 Habitat survey and assessment

The characteristics and condition of instream and riparian habitats significantly impact the suitability of a site for the Giant Freshwater Crayfish and should be considered when evaluating the likelihood of the species' presence (Walsh & Haller 2012). Typically, sites cleared of riparian vegetation, with large amounts or increased levels of instream sedimentation and a lack of instream woody debris, are unsuitable (Walsh & Haller 2012). Habitat attributes should be recorded at each site with population monitoring (TSS 2006). Important instream measures include water temperature, oxygen content, salinity, and suspended sediment (Walsh & Haller 2012).

AusRivAS (Australian River Assessment System) sampling has been undertaken in association with baseline population monitoring of Giant Freshwater Crayfish before habitat rehabilitation works (Walsh 2020). This method uses aquatic macroinvertebrates as biological indicators of river health. AUSRIVAS also provides a means to measure changes in water quality over time (Cradle Coast NRM 2022). Citizen scientists can potentially help collect macroinvertebrates samples during annual surveys (see Waterbug.net).

NRM North ran a project for citizen scientists to help identify priority habitats (see NRM North project).

2.3.5 eDNA

Environmental DNA (eDNA) has successfully been used to detect the presence and absence of Giant Freshwater Crayfish in the wild, validating its use as a non-invasive monitoring method. The method is highly sensitive, with detection possible from minute traces of eDNA present in water samples (Trujillo-Gonzalez et al. 2021).

Environmental DNA monitoring could help identify key locations that warrant protection, monitor potential home range shifts, constrictions or expansions, and indicate how effective recovery efforts have been (Trujillo-Gonzalez et al. 2021).

Further research is required to investigate:

- how different DNA extraction, preservation and sampling methods can maximise DNA recovery
- how DNA shedding rates are affected by environmental conditions to understand population size and abundance better
- suitable eDNA sampling regimes for improved detection probability
- seasonality and reproductive activity of the species to identify potentially important seasons to survey using eDNA-based methods (Trujillo-Gonzalez et al. 2021)

2.3.6 Other methods

Additional methods that may have future or specific applications include:

- DNA genetic studies would aid in understanding the relationships between populations and meta-population movements (Commonwealth of Australia 2017).
- Baited remote underwater stereo-video systems (stereo-BRUVs) are a robust, cost-effective and non-invasive method for surveying distribution (presence/absence), relative abundance, and body size structure of demersal fish, with its use growing rapidly across the world (Langlois et al. 2020). Its potential application for monitoring marine lobsters is recognised, with a study showing BRUV outperformed nets and traps regarding sampling effort. It may be worth trialling the method's suitability for monitoring crayfish in freshwater systems. The technique requires clear water for visibility, does not require disturbance or handling of crayfish, and is platypus-safe.
- Camera trapping has been used to monitor human activity at sites where poaching has been identified (compliance rather than population monitoring) (Cradle Coast NRM, 2022).
- Radio-tracking has been used to study the movements of Giant Freshwater Crayfish (Commonwealth of Australia 2017; Webb & Richardson 2004).

3 Key agencies and organisations involved in the species research and recovery

Key agencies, organisations or individuals identified as having been previously or currently involved in monitoring Giant Freshwater Crayfish include:

- Todd Walsh, Kanunnah Pty Ltd
- Kym Blechynden, NRM North, Tasmania
- Fiona Marshall, Cradle Coast NRM, Tasmania
- Iona Flett, Cradle Coast NRM, Tasmania
- Huon Aquaculture, Tasmania
- Alejandro Trujillo-Gonzalez, University of Canberra
- Alastair Richardson, University of Tasmania,
- Bookend Trust
- Niall Doran, University of Tasmania, Environmental Consulting Options Tasmania (Ecotas)
- Ryan Francis, Pinion Advisory
- Leon Barmuta, University of Tasmania
- Tasmanian Giant Freshwater Crayfish Reference Group, chaired by NRM North and Cradle Coast NRM, comprising members from NRET, FPA, IFS, Tas Irrigation, Launceston City Council, UTAS, STT, Tasmanian Land Conservancy and ecological consultants.

4 Key survey guideline recommendations gathered from the literature

This literature review of monitoring methods for the Giant Freshwater Crayfish has identified some key points that must be addressed when developing species-specific survey guidelines. These points include:

- The core monitoring methods are trapping, measuring and marking adults and subadults, and standardised visual search of habitat for juveniles to inform estimates of population abundance and demographics (TSS 2006).
- Example data fields for Giant Freshwater Crayfish field survey can be found in (Walsh 2020).
- Surveying Giant Freshwater Crayfish using traditional methods can be challenging and time-consuming and need to be conducted by suitably qualified persons with demonstrated skill in freshwater crayfish surveys (Commonwealth of Australia 2015).
- eDNA-based monitoring provides a non-invasive way to detect occupancy and can be used to complement other survey techniques.
- Permits are required to conduct surveys for Giant Freshwater Crayfish; refer to the Tasmanian Department of Natural Resources and Environment and the Inland Fisheries Service. Under the *Tasmanian Threatened Species Protection Act 1995*, a permit is required to 'take' (which includes kill, injure, catch, damage, destroy and collect), keep, trade-in or process any specimen or products of a listed species (TSS 2023).
- The impact (direct or indirect) on Giant Freshwater Crayfish and other species must be considered for any monitoring actions. Traps should only be used with measures to avoid capture or entanglement of platypus (DOE 2023). Any action likely to have a significant impact requires referral under the EPBC Act (Commonwealth of Australia 2015).

5 References

Commonwealth of Australia 2015, Draft EPBC act referral guidelines for the vulnerable Tasmanian giant freshwater lobster (Astacopsis gouldi), Department of the Environment, Canberra, ACT.

Commonwealth of Australia 2017, Recovery plan for the giant freshwater crayfish (Astacopsis gouldi).

Cradle Coast NRM 2022, 'Giant freshwater crayfish recovery project', no. 3, p. 8, <https://issuu.com/cradlecoast01/docs/gfc_newsletter_-_june_2022>.

DCCEEW 2022, *Threatened Species Strategy Action Plan 2022–2032*, Department of Climate Change, Energy, the Environment and Water, Canberra, ACT, <www.dcceew.gov.au/environment/biodiversity/threatened/publications/action-plan-2022-2032>.

DOE 2023, *Astacopsis gouldi in species profile and threats database*, Department of the Environment, Canberra, ACT, viewed 6 March 2023, <www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64415>.

Horwitz, P 1994, 'Distribution and conservation status of the Tasmanian giant freshwater lobster *Astacopsis gouldi* (Decadopa: Parastacidae)', *Biological Conservation*, vol. 69, no. 2, pp. 199-206.

Mulhern, TD 2018, 'Correcting misconceptions about the names applied to Tasmania's giant freshwater crayfish *Astacopsis gouldi* (Decapoda: Parastacidae)', in *Papers and Proceedings of the Royal Society of Tasmania,* vol. 152, pp. 21-26.

Plomley, NJB 1976, *A word-list of the Tasmanian Aboriginal languages*, NJB Plomley in association with the Government of Tasmania, Launceston, Tasmania.

Pracejus, AM 2016, 'Improving study designs for assessing forestry impacts on the giant freshwater crayfish, *Astacopsis gouldi*', BSc Honours thesis, University of Tasmania, Hobart, Tasmania.

Tasmanian Crayfish Workshop 2010, 'Proceedings of the Tasmanian Crayfish Workshop', in *Tasmanian Crayfish Workshop,* Davenport, Tasmania.

Tasmanian Irrigation 2017, *Giant Freshwater Lobster Protocol May 2017*, Evandale, Tasmania, <http://epbcnotices.environment.gov.au/_entity/annotation/3b3cad06-d462-e711-93a7-005056ba00a7/a71d58ad-4cba-48b6-8dab-f3091fc31cd5?t=1567468800363>.

Threatened Species Section 2006, Giant Freshwater Lobster Astacopsis gouldi Recovery Plan 2006-2010. , Hobart.

Threatened Species Section 2023, *Species management profile: Astacopsis gouldi Lutaralipina or giant freshwater crayfish*, Department of Natural Resources and Environment, Hobart, Tasmania, viewed 04/09 2023, <www.threatenedspecieslink.tas.gov.au/Pages/Giant-Freshwater-Crayfish.aspx>.

Trujillo-Gonzalez, A, Hinlo, R, Godwin, S, Barmuta, LA, Watson, A, Turner, P, Koch, A & Gleeson, D 2021, 'Environmental DNA detection of the giant freshwater crayfish (*Astacopsis gouldi*)', *Environmental DNA*, vol. 3, no. 5, pp. 950-958.

Trujillo-Gonzalez, A, Hinlo, R, Godwin, S, Barmuta, LA, Watson, A, Turner, P, Koch, A & Gleeson, D 2021, 'Environmental DNA detection of the giant freshwater crayfish (*Astacopsis gouldi*)', *Environmental DNA*, vol. 3, no. 5, pp. 950-958.

TSS 2006, *Giant freshwater lobster Astacopsis gouldi recovery plan 2006-2010.*, Threatened Species Section, Department of Primary Industries and Water, DoPIaW Threatened Species Section, Hobart, Tasmania.

TSS 2023, Lutaralipina or giant freshwater Crayfish (Astacopsis gouldi): species management profile for Tasmania's threatened species Link, Threatened Species Section, Department of Natural Resources and Environment, Hobart, Tasmania, viewed 15/3/2023 2023, <www.threatenedspecieslink.tas.gov.au/Pages/Giant-Freshwater-Crayfish.aspx >.

TSSC 2017, *Conservation advice on Astacopsis gouldi (giant freshwater crayfish)*, Threatened Species Scientific Committee, Department of the Environment, Water, Heritage and the Arts, Canberra, ACT, <www.environment.gov.au/biodiversity/threatened/species/p-conspicillatus.html>.

Walsh, T 2020, *Project support and monitoring for giant freshwater crayfish recovery*, Report by Todd Walsh of Kanunnah Pty Ltd November 2020.

Walsh, T & Haller, B 2012, 'Biology of the giant Tasmanian freshwater lobster *Astacopsis gouldi* (Clark) and its conservation', *Crustacean Research*, vol. Special 2012, 01/01, pp. 95-104.

Webb, M & Richardson, AMM 2004, 'A radio telemetry study of movement in the giant Tasmanian freshwater crayfish, *Astacopsis gouldi*', *Freshwater Crayfish*, vol. 14, pp. 197-204.

Zimmerman, J & Palo, R 2011, 'Reliability of catch per unit effort (CPUE) for evaluation of reintroduction programs – A comparison of the mark-recapture method with standardized trapping', Knowledge and Management of Aquatic Ecosystems, vol. 401, 05/01, p. 07.

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