

Australian Government Department of the Environment and Energy



Recovery Plan for the Giant Freshwater Crayfish (Astacopsis gouldi)



April 2017

The Species Profile and Threats Database page linked to this recovery plan is obtainable from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

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Table of Contents

Recovery Plan for the Giant Freshwater Crayfish (Astacopsis gouldi)	1
Table of Contents	3
Tables and figures	4
Acronyms	4
1 Summary	6
Giant Freshwater Crayfish (Astacopsis gouldi)	6
Habitat critical for survival:	6
Recovery plan objectives:	7
Recovery team:	7
Recovery strategies:	7
Criteria for success:	7
Criteria for failure:	8
2 Introduction	8
2.1 Conservation Status	10
2.2 Crayfish Recovery Team	11
3 Background	11
3.1 Species description and distribution in Australia	11
3.2 Population trends	11
3.3 Biology and ecology	12
3.4 Habitat critical to the survival of the giant freshwater crayfish	13
3.5 Indigenous knowledge, role and interest	14
4 Threats	18
4.1 Historical causes of decline	18
4.2 Current threatening processes	18
4.2.1 Habitat loss/disturbance and sedimentation of waterways	18
4.2.2 Modifications to water flow	20
4.2.3 Illegal fishing	21
4.2.4 Climate change	21
4.2.5 Management approaches to managing threatening processes	22
5 Current management practices	22
6 Populations under particular pressure	24
7 Objectives and strategies	24
8 Actions to achieve the specific objectives	24
Strategy 1 – Conduct population trend monitoring and research to assess the current status of species and evaluate the effectiveness of recovery actions	the 25
Strategy 2 – Mitigate key threats impacting upon giant freshwater crayfish habitat	27

Strategy 3 – Increase the reservation status and improve the quality of key habitat for the gia freshwater crayfish	nt 31
Strategy 4 – Prevent illegal fishing of the giant freshwater crayfish.	32
Strategy 5 – Engage with the general public, local government and NGOs in developing / del conservation measures.	ivering 33
9 Duration and cost of the recovery process	36
10 Effects on other native species and biodiversity benefits	37
11 Social and economic considerations	37
12 Affected interests	37
13 Consultation	38
14 Organisations/persons involved in evaluating the performance of the plan	38
15 References	39

Tables and figures

Table 1: Progress made against the objectives of the 2006 Recovery Plan8No table of figures entries found.

Acronyms

CBS	Clearfell, burn and sow
CNFN	Central North Field Naturalist
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Commonwealth)
DoEE	Department of the Environment and Energy (Commonwealth)
DPIPWE	Department of Primary Industries, Parks, Water and Environment (Tasmania)
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)
FLAG	Friends of Lapoinya Action Group
FLG	Friends of the Leven Group
FPA	Forest Practices Authority
FPP	Forest Practices Plan
FT	Forestry Tasmania
IMCRA	Integrated Marine and Coastal Regionalisation of Australia
IUCN	International Union for Conservation of Nature
LMRM Act	Living Marine Resources Management Act 1995 (Tasmania)
LRT	Crayfish Recovery Team
MNES	Matter of National Environmental Significance
NGO	Non-government organisation
NVA	Natural Values Atlas (Tasmania)

REDMAP	Range Extension Database and Mapping Project
SAC	Scientific Advisory Committee (Tasmania)
SPRAT	Species Profile and Threats Database (Commonwealth)
TFGA	Tasmanian Farmers and Graziers Association
TSP Act	Threatened Species Protection Act 1995 (Tasmania)
TSSC	Threatened Species Scientific Committee (Commonwealth)
UTAS	University of Tasmania

1 Summary

Giant Freshwater Crayfish (Astacopsis gouldi)

Family:	Parastacidae
IBRA Bioregion (ver. 7.0):	Known: King; Furneaux; Tasmanian Northern Slopes; Ben Lomond
	Translocated populations: Ben Lomond; Tasmanian South East
	Possible: Tasmanian West; Tasmanian Northern Midlands; Tasmanian Central Highlands: Tasmanian South East
Current status of taxon:	Environment Protection and Biodiversity Conservation Act 1999 (C'th): Vulnerable
	Threatened Species Protection Act 1995 (Tasmania): Vulnerable
	IUCN Red List of Threatened Species: Endangered
Distribution and habitat:	The giant freshwater crayfish is endemic to rivers of northern Tasmania. This species requires well-shaded streams that have good water quality, low sediment levels, snags, pools and undercut banks (Growns 1995; Hamr 1990a, b; Lynch 1967). The giant freshwater crayfish requires a stable thermal regime of relatively low water temperature (TSS 2006).

Habitat critical for survival:

Habitat critical to the survival of the giant freshwater crayfish is defined as:

- Habitat within the known/likely distribution of the species that:
 - is known to be of high priority for the maintenance of breeding populations throughout the species' range;

AND

• the conversion of which to an alternative land-use is considered likely to result in a long-term negative impact on breeding populations of the species.

Habitat, as defined above, includes streams, river reaches and associated riparian vegetation.

Known/likely distribution, as defined above, can be derived from the 'species likely to occur' category shown in Figure 1 and subsequently ground-truthed using appropriate methodology agreed by the Threatened Species Section of Department of Primary Industries, Parks, Water and Environment (DPIPWE) in consultation with species' specialists.

Note: For the purpose of forestry operations that are conducted in accordance with the Forest Practices Act 1985, the above definition of 'habitat critical for survival' should be considered to be consistent with the generic description of 'significant habitat' and the definition of giant freshwater crayfish 'potential habitat', as outlined by the Forest Practices Authority (FPA) in the <u>Threatened</u> fauna species range boundaries and habitat descriptions.

Recovery plan objectives:

The objectives of this recovery plan are to:

- Identify, conserve and manage key locations to support increasing populations of the giant freshwater crayfish, with a healthy demographic structure.
- Address threats and improve habitat quality across the species' range.

Recovery team:

Recovery teams provide advice and assist in coordinating actions described in recovery plans. They include representatives from organisations with a direct interest in the recovery of the species, including those involved in funding and those participating in actions that support the recovery of the species. The Crayfish Recovery Team (CRT) has the responsibility of providing advice on the implementation of the recovery actions outlined in this recovery plan. The membership of the CRT may include individuals with relevant responsibility and expertise from Department of the Environment and Energy (DoEE) and DPIPWE, as well as experts from research institutions and consultancies, and private researchers; membership may change over time.

Recovery strategies:

The strategies to achieve the plans' objectives are to:

- Conduct population trend monitoring and research to assess the current status of the species and evaluate the effectiveness of recovery actions.
- Mitigate key threats impacting upon giant freshwater crayfish habitat.
- Increase the reservation status and improve the quality of identified key locations for the giant freshwater crayfish.
- Reduce the pressures of illegal fishing on the giant freshwater crayfish.
- Engage with the general public, local government and non-government organisations (NGOs) in developing and delivering conservation measures.

Criteria for success:

This recovery plan will be deemed successful if, within 10 years, all the following have been achieved:

- Population densities are increasing and have a healthy demographic structure.
- Key locations are identified and monitored annually, and population trends are assessed.
- Illegal fishing has been reduced to a point that it no longer threatens the species' survival.
- Appropriate measures have been put in place to manage key threats affecting habitat.
- Habitat quality has been maintained or improved in key locations.
- Reservation status has been improved, or habitat protections increased, in key locations.
- Community awareness of, and participation in, giant freshwater crayfish conservation has increased.

Criteria for failure:

This recovery plan will be deemed to have failed if; within 10 years any of the following have occurred:

- Regular monitoring has not been conducted and population trends have not been assessed.
- The species has become locally extinct from key locations in the wild, or populations at these locations do not display a healthy demographic structure.
- Recruitment of juveniles has not been recorded, and a healthy demographic structure is lacking, at locations identified as key to the survival of the giant freshwater crayfish.
- Illegal fishing pressure has not been reduced across the species' range.
- Actions have not been undertaken to address key threats limiting population growth and recovery.
- Habitat quality has declined in key locations.

2 Introduction

This document constitutes the 'National Recovery Plan for the Giant Freshwater Crayfish *(Astacopsis gouldi)*'. The recovery plan considers the conservation requirements of the species across its range and identifies the actions to be taken to ensure the species' long-term viability in nature, and the parties that will undertake those actions.

This recovery plan is a revision of the Giant Freshwater Lobster (*Astacopsis gouldi*) Recovery Plan 2006-2010 (TSS 2006). The 2006 recovery plan was reviewed in 2015 by an expert panel that included representatives from DoEE, DPIPWE, CSIRO, the University of Tasmania (UTAS), FPA, Hydro Tasmania and independent researchers and species experts. This review acknowledged that while considerable progress had been made on implementing the 2006 recovery plan, continued efforts were required to secure the future of the species. In particular a more targeted approach was needed with a focus on building upon the actions already undertaken and identifying the actions that would be likely to be the most effective in improving the species' conservation status. Furthermore, the review concluded that a new recovery plan should be developed for the species that included actions such as the identification of key habitat that may benefit from greater protection and a shift in fisheries compliance activities to focus on illegal poaching, including greater collaboration with police. The 2006 recovery plan and the 2015 review of the recovery plan are available from:

http://www.environment.gov.au/resource/giant-freshwater-crayfish-astacopsis-gouldi-recovery-plan-2006-2010.

2006 Recovery Plan Objectives	Actions undertaken and progress against recovery objectives	
Reduce and eliminate fishing pressure.	Reductions in recreational fishing have been significant. Nevertheless, fishing is still an issue in terms of small numbers of people engaged in significant poaching activity that may have a large impact. Fishing pressure has not been eliminated, thus bans need to be maintained, even if the species conservation trajectory were to improve significantly.	
	Some covenants have been enacted for protection of the species on private land. More funding would be beneficial to continue this initiative. A number of mechanisms have been developed to mitigate the impacts	
Prevent and ameliorate habitat degradation.	of forestry activities, including the establishment of streamside reserves, and restoration of streamside reserves in previously cleared areas now utilised for wood production. However, there is still scope to incorporate uture research into ongoing forestry management. Mechanisms have been slower to improve in other sectors/tenures such as agriculture and dam constructions.	
	Community awareness programs were very effective in the early days of the plan, however due to funding restrictions scope was limited.	
Monitor and assess <i>A</i> . <i>Gouldi</i> populations and habitats.	Good baseline monitoring was conducted, and regularly occurring, when the plan was implemented. Though funding restraints limited ongoing monitoring. An increase in the size of adults has been documented. However, ongoing monitoring is needed to assess population trends.	
Increase understanding of <i>A. gouldi</i> biology and conservation requirements to improve management.	Some knowledge of movement has been gained but further genetic studies would aid understanding of relationships between populations and meta-population movements. Considerable research has been conducted by the FPA on potential impacts associated with forestry activities, and management prescriptions have been regularly updated in response. Further research is needed to improve understanding of impacts to environmental flows and water temperatures.	
Coordinate implementation of the recovery program.	Recovery plan implementation progressed well, given funding constraints. Implementation and financing of some actions was largely undertaken by Cradle Coast Natural Resource Management Group, DPIPWE and the FPA.	

Table 1: A summary of the progress made against the objectives of the 2006 recovery plan

Threats to the giant freshwater crayfish include illegal fishing pressure, large-scale habitat disturbance or loss, siltation of waterways, drought and climate change. However, at the workshop to review the 2006 recovery plan, land clearing and habitat disturbance were identified as potentially the most significant threat currently impacting upon the species. In particular, any form of land clearing or habitat disturbance that resulted in increased siltation of waterways, including in-stream erosion, bank destabilisation, slope run-off and clearing in upstream reaches of catchments supporting giant freshwater crayfish populations, was considered high risk. Such activities can affect the ability of giant freshwater crayfish to transpire oxygen through the gills (Eastman & Eastman 2007), and have a considerable impact on the life cycle of giant freshwater crayfish, particularly affecting the species' juvenile life stage.

This recovery plan sets out the research and management actions necessary to stop the decline, and support the recovery, of the giant freshwater crayfish in Australia. The overarching objectives of this recovery plan are to:

- Identify, conserve and manage key locations to support increasing populations of the giant freshwater crayfish, with a healthy demographic structure.
- Address threats and improve habitat quality across the species' range.

To achieve these objectives a range of strategies will be employed, including: reducing the impacts of habitat degradation and illegal fishing; improving habitat quality and increasing habitat protection; increasing understanding of the species biology and ecology, and its ability to recover from past threats; and promoting the giant freshwater crayfish as a flagship species for healthy catchment management. In particular, it is believed that the species has a high probability of recovery if the following three goals are achieved:

- Habitat protection is increased in key locations;
- Upstream land use activities are appropriately managed to prevent impacts on key downstream locations; and
- Fishing ban enforcement activities are focussed on tackling poaching.

An accompanying Species Profile and Threats Database (SPRAT) page provides background information on the biology, population status and threats to the giant freshwater crayfish. The SPRAT page is available from: <u>http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl</u>.

2.1 Conservation Status

The giant freshwater crayfish is listed as threatened under both the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Tasmanian *Threatened Species Protection Act 1995* (refer to Table 1).

The giant freshwater crayfish was transferred from the *Endangered Species Protection Act 1992* (ESP Act) to the Vulnerable list of the EPBC Act when it came into force in July 2000. For a species to be considered as Vulnerable under the ESP Act, the Minister must have been satisfied that the species was likely to become endangered within the next 25 years. Recommendations for listing species under the ESP Act were made to the Minister by the then Endangered Species Advisory Committee.

Legislation	Conservation Status
Environment Protection and Biodiversity Conservation Act 1999 (C'th)	Vulnerable
Threatened Species Protection Act 1995 (Tas)	Vulnerable
IUCN Red List of Threatened Species (International)	Endangered

Table 2: Conservation status of the giant freshwater crayfish.

2.2 Crayfish Recovery Team

The recovery program for the giant freshwater crayfish will be coordinated by the Crayfish Recovery Team (CRT) which was formed in 2015. The membership of the CRT may include individuals with relevant expertise from DoEE and DPIPWE, as well as experts from research institutions, consultancies and individuals with relevant expertise; membership may change over time. The CRT will provide advice on the implementation of the recovery actions outlined in this recovery plan.

3 Background

3.1 Species description and distribution in Australia

The giant freshwater crayfish is the world's largest freshwater crustacean. The species has been reported to attain weights of up to 6 kg, however in recent years the majority of the larger specimens recorded weigh between 2-3 kg. The species is slow-growing and long-lived. Colour varies considerably among individuals, with adults ranging from dark brown-green to black or blue. The species is spiny and has large distinct chelae (front pincers), walking legs, carapace and abdomen ending in a tail fan. Males have larger pincers than females. *Astacopsis gouldi* is the largest of the three *Astacopsis* species. Juvenile *A. gouldi* can be differentiated from the other two species (*A. franklinii* and *A. tricornis*) by the presence of a raised ridge in the middle of its forehead (rostrum).

The Tasmanian giant freshwater crayfish is endemic to rivers, lakes and streams of northern Tasmania. Formerly, the species was distributed from the Arthur River in the west and eastwards across northern Tasmania, where it was found in all rivers flowing into Bass Strait, except for those of the Tamar catchment (Horwitz 1994). Presently, the species distribution is more disjunct. Localised extinctions, or large declines in numbers, are thought to have occurred in the Welcome, Montagu, Rubicon, Don, Brid, Boobyalla, Pipers, Ringarooma, Duck, Little and Great Forester Rivers and Claytons Rivulet (Horwitz 1990, 1991, 1994; TSS 2006). The species has also been introduced into two catchments: the North Esk catchment (St Patricks River); and the Derwent catchment (Clyde River) (IFS unpub. Data, cited in TSS 2006), and populations have become established. The species naturally occurs at altitudes below 400 m, with most caught below 200 m (Horwitz 1991, 1994). The estimated extent of occurrence of the giant freshwater crayfish, based on catchments where the species is known to occur and historical reports of species presence, is approximately 10 700 km² (TSS 2006). Approximately 19 percent of the streams in which the species habitat is predicted to occur were protected in either formal or informal reserves at the time of development of the previous recovery plan (TSS 2006). Since this time a large proportion of additional habitat has been incorporated into formal and informal reserves, however current figures on the total amount of giant freshwater crayfish habitat within a protected area were not available at the time of writing this plan.

3.2 Population trends

No data on population numbers are available for the giant freshwater crayfish, however reports, largely based on anecdotal evidence, of localised extinctions and large declines in numbers due to fishing and/or habitat degradation were relatively common in the 1990s (e.g. Hamr 1990a; Horwitz 1991, 1994; Maxwell et al. 1997). The structure of populations studied during this period indicated an absence of large individuals, particularly males, with very few giant freshwater crayfish of a size indicating sexual maturity being found (Growns 1995; Hamr 1996; Lynch & Blühdorn 1997). However, in recent years ongoing monitoring efforts have recorded larger specimens with increasing regularity (Doran & Richardson 2008). Whilst earlier records of the species had individuals weighing in at five kilograms or greater, by the late 1990s individuals weighing two or three kilograms were considered large (Doran & Richardson 2008). In January 1998, a fishing ban was imposed for the species, and

there is some evidence to suggest that population demographics have been improving since this time, with records of individuals weighing four kilograms and recaptures of marked individuals becoming increasingly common (Doran & Richardson 2008).

3.3 Biology and ecology

The giant freshwater crayfish is a slow-growing crustacean, with females reaching sexual maturity at a carapace length of approximately 119 mm and weight of approximately 550 g, around 14 years, and males reaching sexual maturity at a carapace length of approximately 76 mm and weight of approximately 300 g, thought to be around nine years (Hamr 1996). The species also has relatively low fecundity (TSS 2006), with females mating and spawning biennially in autumn, after a summer moult (Hamr 1990a, 1992, 1996). Gestation takes about nine months, with females carrying the eggs on their tail through winter (TSS 2006). The number of eggs produced by a female is proportional to its size, and egg counts range from 224–1300 per female (Hamr 1996). After hatching in mid-summer, young giant freshwater crayfish stay attached to the female until autumn (Hamr 1996). The species is long-lived and has been known to live up to 60 years of age (Bryant & Jackson 1999).

The dispersal patterns and migratory activities of the giant freshwater crayfish are largely unknown; however, the species generally appears to have two patterns in their movement and behaviour:

- residential periods, during which time animals may be inactive, or undertake small-scale movements, usually returning to a specific "home site"; and
- less common large-scale movements, after which the animal takes up residence in a new "home site" or pool, or returns to its initial "home site" (Webb & Richardson 2004).

A study involving radio telemetry tracking of eight giant freshwater crayfish showed periods of inactivity lasting from 1-10 days, interspersed with movements involving travel over relatively large distances, including one giant freshwater crayfish moving over 700 m in a single night and a total distance of 2.2 km recorded for one giant freshwater crayfish over the five month study period (Webb & Richardson 2004). This species is also known to walk over land (Horwitz 1991).

The main food of the giant freshwater crayfish is decaying wood and its associated microbes, though its diet varies with age, and they also eat leaves and animal flesh, including small fish, when available (Forteath 1987; Hamr 1996; Lynch 1967).

Giant freshwater crayfish display differences in habitat preferences at different life stages. A study by Davies et al. (2005) found juvenile giant freshwater crayfish in streams at elevations ranging from 18-250 m ASL, channels ranging from 1-20 m bankfull width and catchments areas ranging in size from 0.4-240 km². However, the study noted that densities were greatest in streams in catchments of intermediate size (typically 2-30 km²) within channels of 1-3 m wetted widths at base flow (Davies et al. 2005). Furthermore, juvenile abundance responded positively to lower levels of silt substrate (< 2 %) and higher proportions of moss cover (> 10 % stream bed area) and boulder substrate (10-30 % stream bed area), while no juveniles were detected in streams with channel slopes > 10 %, silt substrate levels > 5 % and baseflow conductivities > 160 µS/cm (Davies et al. 2005). Optimal habitat for juvenile giant freshwater crayfish may be considered to include shallow areas of streams with minimal silt substrate, high proportions of moss and boulder cover, and meso-habitat features including large rocks, cavities and in-stream logs, while class 4 streams with substantial, sustained groundwater input may also provide suitable habitat conditions (Davies et al. 2005). Class 4 streams (catchment size < 50 ha) are defined within the Forest Practices Code as watercourses carrying water for part or all of the year for most years, they are differentiated from a drainage depression by: having a gravelly, pebbly, rocky or sandy bed; and/or an obvious gully; and/or a short steep section of stream bank adjacent to the watercourse bed (FPA 2015), Conversely, preferred habitat for adult giant

freshwater crayfish includes larger streams with deeper pools often associated with snags (Webb 2001).

While small headwater streams have been found to contain suitable habitat for juvenile giant freshwater crayfish, the species has typically been detected in lower densities in these streams compared to larger, higher-order streams within the same drainage (Davies et al. 2005). However, there are some examples of high densities of juveniles being found in smaller headwater streams, such as Coopers Creek which has a catchment area of 40 ha (Davies et al. 2005), and streams with sources rising adjacent to basalt-sedimentary geological contacts (Davies & Cook, unpublished data, cited in Davies et al. 2005). Streams within the Flowerdale-Hebe River catchment provide an example of areas where juvenile giant freshwater crayfish can be found in high densities (Walsh, pers. comm. cited in Davies et al. 2005). Furthermore, densities of juvenile giant freshwater crayfish are also likely to be lower within extensively cleared and intensively managed areas typically found in the lower area of catchments compared to less modified areas within the same catchment (Davies et al. 2005).

3.4 Habitat critical to the survival of the giant freshwater crayfish

Habitat critical to the survival of the giant freshwater crayfish is defined as:

- Habitat within the known/likely distribution of the species that:
 - is known to be of high priority for the maintenance of breeding populations throughout the species' range (this may include areas that do not currently support breeding populations of the species but that need to be maintained to ensure the long-term future of the species);

AND

 the conversion of which to an alternative land-use is considered likely to result in a longterm negative impact on breeding populations of the species (this may include landconversion activities in areas upstream of known populations that may have negative impacts on downstream habitat).

Habitat, as defined above, includes streams, river reaches and associated riparian vegetation. Habitat may be characterised by a combination of well-shaded flowing and still waters, deep pools, decaying logs and undercut banks. Riparian vegetation needs to be native and predominantly intact to provide shade, nutrient, energy and structural inputs into streams. Smaller juveniles inhabit shallow fast-flowing streams favouring habitats 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. Perennial headwater streams have substantially higher juvenile densities than non-perennial headwater streams.

Known/likely distribution, as defined above, can be derived from the 'species likely to occur' category shown in figure 1 and subsequently ground-truthed using appropriate methodology agreed by the Threatened Species Section of DPIPWE in consultation with species' specialists.

Note: For the purpose of forestry operations that are conducted in accordance with the Forest Practices Act 1985, the above definition of 'habitat critical for survival' should be considered to be consistent with the generic description of 'significant habitat' and the definition of giant freshwater crayfish 'potential habitat', as outlined by the FPA in the <u>Threatened fauna species range boundaries</u> and habitat descriptions.

3.5 Indigenous knowledge, role and interest

There are multiple Indigenous Groups represented across the distribution of the giant freshwater crayfish, also known by the Indigenous name of '*tayatea*'. The Australian Government recognises that Indigenous Australians have social, cultural and economic interests for their lands that both compete with and complement biodiversity values. Opportunities may exist through Australian Government programmes to engage with Traditional Owners on biodiversity issues relating to the giant freshwater crayfish. These programmes give landowners a chance to balance economic objectives through sustainable, low impact activities with land stewardship responsibilities through managing land for conservation.

Table 3: Current distribution of the giant freshwater crayfish, showing major land-use tenures in each catchment/sub-catchment and any significant areas that are protected under a conservation/reservation mechanism. (*Note: Data has been sourced from the Lands Tasmania's Land Tenure dataset which is generated, using an automated process, from the following LIST spatial layers: Cadastral Parcels, Public Land Classification, FPPF, Private Reserves and Local Government Act Reserves*).

	Catchment	Major land-use tenures (i.e. > 10 % of catchment area)	Major areas under protection (i.e. > 10 % of catchment area)
	Black/Dip Sub-catchment	Permanent Timber Production Zone, Private Freehold, Future Potential Production Forest (Crown)	Regional Reserve
	Detention Sub-catchment	Private Freehold, Future Potential Production Forest (Crown)	Regional Reserve
	Arthur Sub-catchment	Permanent Timber Production Zone, Future Potential Production Forest (Crown)	Regional Reserve
	Frankland Sub-catchment	Future Potential Production Forest (Crown)	Conservation Area, Nature Recreation Area
	Inglis Sub-catchment	Private Freehold, Permanent Timber Production Zone	N/A
Known	Flowerdale Sub-catchment	Private Freehold, Future Potential Production Forest (Crown), Permanent Timber Production Zone	Regional Reserve
to occur*	Duck Catchment	Private Freehold, Permanent Timber Production Zone	N/A
	Cam Catchment	Private Freehold	N/A
AND	Emu Catchment	Private Freehold	N/A
	Blythe Catchment	Private Freehold, Permanent Timber Production Zone	N/A
Likely to occur**	Leven Catchment	Private Freehold, Future Potential Production Forest (Crown), Permanent Timber Production Zone	N/A
	Forth Catchment	Private Freehold, Permanent Timber Production Zone	National Park
	Mersey Catchment	Private Freehold, Permanent Timber Production Zone	National Park, Conservation Area
	Rubicon Catchment	Private Freehold, Permanent Timber Production Zone	N/A
	Pipers Catchment	Private Freehold, Permanent Timber Production Zone	N/A
	Little Forester Catchment	Private Freehold, Permanent Timber Production Zone	N/A
	Great Forester-Brid Catchment	Private Freehold, Permanent Timber Production Zone	Regional Reserve

	Catchment	Major land-use tenures (i.e. > 10 % of catchment area)	Major areas under protection (i.e. > 10 % of catchment area)
Known to occur*	Boobyalla Sub-catchment	Private Freehold, Permanent Timber Production Zone, Future Potential Production Forest (Crown)	Regional Reserve
	Tomahawk Sub-catchment	Private Freehold, Permanent Timber Production Zone	Regional Reserve
AND	Priva Ringarooma Catchment Priva Pote	Private Freehold, Permanent Timber Production Zone, Future Potential Production Forest (Crown)	Regional Reserve
Likely to occur**	Welcome Catchment	Private Freehold, Permanent Timber Production Zone	N/A
	Montagu Catchment	Permanent Timber Production Zone, Private Freehold	Regional Reserve
May occur***	Musselroe Catchment	Permanent Timber Production Zone, Future Potential Production Forest (Crown)	Regional Reserve
Trans- located pops****	St. Patricks Catchment	Private Freehold, Permanent Timber Production Zone, Future Potential Production Forest (Crown)	N/A
	Clyde Catchment	Private Freehold	N/A

* **Known to occur** = all locations where the species has been sighted since 1990, including biologically important areas where the species is known to breed, feed or forage. This category is primarily associated with high quality habitat, characterized by low to no sedimentation, no flow modifications and intact riparian vegetation which can allow for recruitment of in-stream woody debris. Note: 'known to occur' and 'likely to occur' categories have been amalgamated in Figure 1 to protect the location of known sites from potential illegal fishing.

** Likely to occur = areas where the species or species' habitat is likely to occur, such as locations adjacent to known distribution polygons or locations where the species has been previously sighted (i.e. pre-1990). Habitat may exhibit a reduction in quality of riparian vegetation and an increase in sedimentation impacts, and densities are expected to be lower.

*** May occur = areas where the species or species' habitat may occur, including locations of anecdotal sightings. Habitat may be significantly compromised.

**** **Translocated populations** = individuals have been introduced into these catchments and have subsequently established populations; these catchments are not a part of the species historic 'natural' range.



Figure 1: Modelled distribution of the giant freshwater crayfish (Astacopsis gouldi).

4 Threats

4.1 Historical causes of decline

The principal threats affecting giant freshwater crayfish in past decades were fishing pressure and habitat disturbance (Lynch 1967; Hamr 1990b; Horwitz 1994; Growns 1995; Lynch & Blühdorn 1997), with relatively common reports of localised extinctions and large declines in numbers attributed to these threatening processes (Hamr 1990a; Horwitz 1991, 1994; Maxwell et al. 1997). Many of the streams inhabited by the species have been subject to disturbance from agricultural, forestry and urban activities and much of the floodplain riparian area within its range has been heavily modified (Jackson & Blühdorn 1999). With expansion of road construction, primarily a result of forestry activities, many of the species' upland refuges have become more easily accessed for fishing (TSS 2006).

The recolonisation of impacted streams appears to be very slow (e.g. Maxwell et al. 1997), indicating that dispersal is naturally slow or that the animals available for such migrations may no longer be plentiful. The species' slow growth and relatively low fecundity compounds the problems facing recruitment into impacted areas (TSS 2006).

4.2 Current threatening processes

Current, ongoing threats to the species include illegal fishing pressure (the species is easily caught), and habitat disturbance, including siltation of waterways and modifications to flow regimes, as well as the effects of drought, flooding and climate change.

4.2.1 Habitat loss/disturbance and sedimentation of waterways

Habitat loss/disturbance includes the removal or destruction of riparian vegetation, bank erosion, removal of snags, channelisation, siltation, nutrification, toxic chemical inputs, instream barriers to movement such as culverts and farm dams, and alterations to stream flow and thermal regime (TSS 2006).

Sedimentation of waterways, particularly in the headwaters of occupied river reaches, poses a threat to the survival of giant freshwater crayfish. Headwaters have been recognised as important sources of downstream sediment, nutrient, carbon and water budgets, and, as they can constitute a significant portion of a catchment (up to 70 %), appropriate management of these areas can help to control downstream impacts (Davies et al. 2016). Channel morphology, riparian structure and in-stream macro-invertebrate community composition can all display signs of modification in response to increases in sediment transported from headwater tributaries (Gregory et al. 1991; Gomi et al. 2002). Increased sediment levels arising from agricultural and forestry related land-uses have also been correlated with decreased abundances of giant freshwater crayfish (Walsh & Nash 2002). It is has also been found that increased siltation and turbidity places increased stress on the giant freshwater crayfish's ability to transpire oxygen through the gills (Eastman & Eastman 2007). Conversely, observational evidence from a survey conducted by Pracejus (2016) suggested that adult giant freshwater crayfish may display a moderate level of tolerance to increases in sedimentation if refugia, such as submerged logs or undercut banks, are present in the landscape. However, the ability of juvenile giant freshwater crayfish to withstand increasing levels of sedimentation could not be qualified from this study.

Forestry

In forestry areas, riparian and aquatic habitats are affected by activities such as road construction, logging and the establishment and subsequent harvesting of plantation timber (TSS 2006). Effects include loss of canopy cover, increased runoff, sedimentation, and changes in hydrology (TSS 2006). In situations where streamside vegetation is removed within clear-cutting forestry operations impacts can include changes to stream flows, geomorphology, nutrient dynamics, carbon budgets and impacts to in-stream habitat (Thompson et al. 2009). These threats were known to occur in Tasmanian catchments (Jackson & Blühdorn 1999). Impacts on stream condition can vary in relation to the location, extent and duration of forestry operations within a catchment (Smith et al. 2009; Johnson & Host 2010), in addition to the nature of the forestry operations being undertaken. The giant freshwater crayfish is known to occur in streams in both plantations and native forest areas subject to production forestry activities (Pracejus 2016)

A recent study by Davies et al. (2016) examined the relationship between upstream forest management and the condition of mid-catchment streams in the north west of Tasmania. It aimed to investigate whether historical forestry operations (native forest harvesting and plantation management) in upper catchment areas have downstream effects on stream biota, including benthic macroinvertebrates, and threatened fauna (specifically giant freshwater crayfish). The study found that when > 40 % of the upstream catchment area had been harvested under clearfell, burn and sow (CBS) operations, levels of fine benthic sediments increased and the proportion of sensitive aquatic insect taxa decreased in relation to the proportion of upstream (headwater) land area under CBS. Increases in fine sediment loads were largely attributable to historic CBS operations, though increases in the area of unsealed roads in upstream CBS operations were also positively correlated with increases in fine sediment loads in downstream reaches. In catchments with non-basaltic geologies these impacts could extend up to 10 km downstream to mid-catchment regions. Fewer giant freshwater crayfish were found in catchments with a greater proportion of land harvested by CBS, however the results were only marginally statistically significant due to the small sample size (Davies et al. 2016). Furthermore, it was not possible to distinguish whether the impacts recorded were the result of current CBS operations or legacy impacts from historic CBS operations. Thus the extent to which forestry operations impact on juvenile giant freshwater crayfish habitat, and the effectiveness of current management actions to reduce impacts, remains unclear.

The work by Davies et al. (2016) also suggests that plantation forestry (hardwood *Eucalyptus nitens*) in Tasmania within predominantly basaltic catchments in north-west Tasmania appear significantly more benign in terms of downstream impacts on stream biota than CBS forestry operations and associated road construction occurring in other geological contexts. Nevertheless, harvest of plantation forests that were established on steep land prior to the implementation of the Forestry Practices Code (i.e. pre-1987), with no regard for streamside reserves, has affected the condition of Class 2 to Class 4 streams, particularly after heavy rainfall (McIntosh 2016; McIntosh et al. 2007, 2014). The FPA has recommended that eucalypt forest streamside reserves be established adjacent to all streams in steep plantation country to stabilise streams and riparian zones (FPA 2011; McIntosh 2016).

Over the past decade several improvements have been made to the Forest Practices Code in order to reduce the impact clearfell forest operations have on streams and stream biota, including the giant freshwater crayfish, particularly in relation to provisions for headwater (Class 3 and 4) streams (see Section 9). Furthermore, land clearing and plantation conversion activities have decreased significantly in Tasmania in recent years, with these activities now significantly constrained by the State's <u>Permanent Native Forest Policy</u>.

Davies et al. (2016) recommend a number of further management actions that could be implemented to reduce the impacts associated with CBS forestry operations and the associated increases in fine sediment loads, including:

- Enhancing mitigation measures to reduce run-off of fine sediments associated with the construction of roads.
- Controlling the extent and intensity of hot regeneration burns implemented after harvesting.
- Including upper area operational thresholds for CBS operations in catchment plans.
- Expanding the focus on estate-level forest management in Tasmania.

Assessing whether current forest management practices are effective at mitigating impacts to giant freshwater crayfish, or whether additional measures (such as those proposed by Davies et al. 2016) are required, should be a priority recovery action for the species.

Agriculture

In agricultural areas, giant freshwater crayfish populations may be affected by general stream degradation caused by the clearing of riparian vegetation, removal of snags, extensive modification of stream channels (including dam construction), access by stock, water abstraction and inflows of agricultural chemicals and nutrients. The clearance of riparian vegetation can result in elevated sediment loads entering waterways as vegetation removal often causes the destabilisation of stream-banks, while bank erosion can result in the direct loss of burrowing habitat (Horwitz 1994). The clearance of riparian vegetation can also result in increased water temperatures as canopy shading is reduced allowing more light to reach the water (Horwitz 1994). Pesticide use resulting from agricultural activities, and point-source increases in effluent and nutrient discharge, may also impact water quality (Horwitz 1994).The overall result of these practices has been probable local extinctions of crayfish from some river reaches, especially in floodplain and estuarine areas (Horwitz 1994).

Restoration of agricultural areas in key locations for giant freshwater crayfish, particularly through rehabilitation and protection of riparian areas and reintroduction of course woody debris into streams, should be a high priority for the conservation of the species. Funding opportunities for such activities may be available through a range of <u>Commonwealth programmes</u> or local NRM grant schemes.

4.2.2 Modifications to water flow

A study by Pracejus (2016) found that the presence of giant freshwater crayfish appeared to be linked to the amount of water in a river. The author theorised that while crayfish may be able to tolerate intermittent water flows to some extent, higher abundances of crayfish would be expected in permanent streams (Pracejus 2016).

In forestry areas, hydrology and flow dynamics within streams immediately downstream of forestry (clearfelling) activities typically showed signs of modification (Davies & Nelson 1994; Growns & Davis 1994). Impacts of forestry operations on hydrological processes can include reductions in base flows and increases in high flows and flow flashiness, all of which can affect bank stability, channel morphology and stream heterogeneity (McIntosh 2004).

In agricultural areas, land conversion and crop intensification coupled with rising temperatures have led to increased water extraction rates for irrigation purposes in some areas. Such practices exacerbate impacts already faced by aquatic species, including giant freshwater crayfish, as development may also result in a loss of connectivity between areas of suitable habitat (Richman et al. 2015).

A report by the National Water Commission (2012), which assessed water stress in Australian catchments and aquifers, found that while Tasmanian river basins are generally less impacted than other catchments across Australia, some river basins (such as the Mersey and Pipers–Ringarooma river basins) are heavily impacted by hydro-electric schemes and, to a lesser degree, by water extraction for irrigated agriculture and urban water use (NWC 2012).

The giant freshwater crayfish is also threatened by reduced flows in streams and rivers associated with drought conditions (DoEE 2015), as well as excessive flows associated with extreme weather events. Anecdotal reports indicate that low environmental flows caused the death of giant freshwater crayfish in several catchments in the north-west and north-east of Tasmania in 2006–2007 (DoEE 2015). Of particular concern is a lack of contingency planning by authorities in preparation for reduced environmental flows in areas utilised by land owners for irrigation of crops (Eastman & Eastman 2007).

4.2.3 Illegal fishing

Fishing of the giant freshwater crayfish was prohibited, through an amendment to the *Inland Fisheries Act (1995),* on 1 January 1998; however, the impacts of ongoing illegal fishing continue to threaten the species. The full implications of fishing on the population dynamics of the species are not well understood, although population surveys indicate that past fishing pressure has had a significant impact on crayfish populations (TSS 2006). Fishing pressure targets mainly adult and large sub-adult members of the population. Given the slow growth rate of the species, and the significant time lags in the reappearance of full sized adults following past recreational fishing pressure, illegal fishing has the potential to significantly threaten crayfish populations,

A degree of fishing activity is known to be continuing despite now being illegal. This is evidenced by prosecutions, the presence of bait lines and anecdotal reports. Annual reports from the Inland Fisheries Service (IFS) provide details on the compliance activities undertaken jointly by the IFS, Tasmanian Police and the Tasmanian Parks and Wildlife Service in relation to illegal fishing activities (IFS 2016). Investigations and/or prosecutions relating to offences involving giant freshwater crayfish are occurring on a regular basis, with most convictions relating to the take of a protected fish or possession of the giant freshwater crayfish, and penalties generally involving the issuing of fines (IFS 2016). Reports indicate that compliance activities often occur in remote areas and many prosecutions are associated with joint charges being laid for offences involving firearms, ammunitions, drugs and drug-related materials (IFS 2016). The amount of illegal fishing that may be going undetected is currently unknown. However, anecdotal reports suggest that illegal fishing may be having a more significant impact than suggested by the number of prosecutions occurring, with one citizen report suggesting that an entire crayfish population may have been targeted by poachers in the Lower Beulah sub catchment and several reports of bait lines having been found abandoned in many catchments containing crayfish.

4.2.4 Climate change

Climate change is a significant overarching threat that may result in altered stream flows, stream temperatures and changes to catchment vegetation (DoEE 2015). Extreme weather events which are predicted to increase with climate change may significantly impact a large proportion of the population within a catchment, or sub-catchment. Such habitat disturbance may have significant effects on entire local crayfish populations, not just large individuals (TSS 2006). For example, extensive flooding that occurred in north-west Tasmania in June 2016 resulted in more than 100 crayfish being found dead, washed up on a single property (Gibson 2016). Within Australia climate-mediated threats, including impacts on water temperature and availability, are putting the conservation status of two-thirds of all freshwater crayfish species at risk (Richman et al. 2015).

4.2.5 Management approaches to managing threatening processes

Given the nature of the threats that are impacting upon crayfish survival, researchers are increasingly identifying the need for catchment-level management approaches to address both direct and indirect (e.g. downstream) impacts. Davies et al. (2005) highlight the need to consider catchment-scale management to secure the future of the species, with an emphasis on the protection of crayfish in higher order streams to address the cumulative impacts of modified land-use (including forestry and agriculture), point source pollution and illegal fishing. Minimising the impacts of land-use activities on downstream reaches that support optimal habitat for both juvenile and adult crayfish is of particular importance (Davies et al. 2005). Research indicates that optimal habitat includes, but is not limited to, class 4 streams such as Coopers Creek, where groundwater inputs strongly supplement base flows (Davies et al. 2005). Davies et al. (2016) also recommend a holistic approach to river and catchment management to address the relationship between catchment-wide activities and localised impacts, including the potential for upper catchment disturbances to result in flow-on effect to downstream habitats. Barmuta (2011), in relation to forest practices in particular, also discusses the need for management of freshwater systems to incorporate both broad landscape-scale and fine-scale planning in order conserve these ecosystems and the values they support.

5 Current management practices

As the giant freshwater crayfish is protected under the EPBC Act, it is an offence to kill, injure, take, trade, keep, or move any individual without a permit in Commonwealth areas and Commonwealth waters. In addition, all listed threatened species are considered matters of national environmental significance (MNES), and any action that may have an impact on MNES must be referred to the Minister of the Environment for approval. The Department of the Environment and Energy, as the Australian Government Department responsible for administering the EPBC Act, maintains a suite of interactive tools that allow users to search, find and generate reports on information and data describing MNES, including the giant freshwater crayfish.

The giant freshwater crayfish is also protected across its range in Tasmania. Under the Tasmanian *Threatened Species Protection Act 1995* it is an offence to knowingly take, trade in, keep or process any listed species without a permit. Management of the giant freshwater crayfish is primarily the responsibility of the Inland Fisheries Service (Tasmania) under the provisions of the *Inland Fisheries Act 1995*, and the Department of Primary Industries, Parks, Water and Environment (Tasmania) under the *Threatened Species Protection Act 1995*. Since January 1998 giant freshwater crayfish have been a 'protected fish' under the *Inland Fisheries Act 1995*, prohibiting fishing for the species. Previous fisheries regulations allowed a recreational fishery for the giant freshwater crayfish during the angling season, with original regulation allowing a bag limit of 12 giant freshwater crayfish a day, a minimum size of 130 mm carapace length, and no taking of females in berry (Hamr 1990b). From the 1993-94 season, the taking of all females was prohibited and a bag limit of three males per day applied. Six catchments, including the Hellyer, Inglis, Duck, Emu, Mersey and Great Forester were closed to the taking of freshwater crayfish (Inland Fisheries Commission 1993a, b). In addition, taking of any giant freshwater crayfish (i.e. including the two other species of *Astacopsis*) was prohibited under Inland Fisheries regulations in 2000.

Management of the species in relation to forest practices is also subject to a number of provisions under the Forest Practices Code (FPA 2015). The giant freshwater crayfish is a 'priority species requiring consideration' under the Tasmanian Regional Forest Agreement 1997 (RFA). The RFA requires that priority species be protected through the Comprehensive, Adequate Representative (CAR) Reserve System, and/or by applying relevant management prescriptions (Clause 68) which are adequate for the species protection and have a sound scientific basis (Clause 96). The RFA states

that management prescriptions and actions identified in jointly prepared and agreed recovery plans are to be implemented as a matter of priority (Clause 70).

The Tasmanian Forest Practices Code (2015) requires that threatened species listed under both the Tasmanian *Threatened Species Protection Act 1995* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* be taken into account in the preparation of Forest Practices Plans (FPPs) both on Crown land and on private land. Mechanisms for mitigating impacts include the establishment of streamside reserves in moderate and high suitability habitat, determined from mapping and on ground habitat surveys, and restoration of streamside reserves in previously cleared agricultural/plantation areas now utilised for wood production. A Forest Practices Plan (FPP) must be prepared for any forest practices (as defined under the Forest Practices Act, 1985) on non-vulnerable land that is in excess of one hectare or 100 tonnes of timber per year upon any one property, even if no commercial wood is produced (FPB 2002). On vulnerable land, a FPP is required for any forest practice, unless it meets specific circumstances outlined in the <u>Forest Practices Regulations</u>.

FPPs are subject to specific management prescriptions for threatened species, which are delivered via the *Threatened Fauna Adviser* decision support system (FPA 2014). The management prescriptions developed for the giant freshwater crayfish are based on recommended actions delivered through the *Threatened Fauna Adviser*, and any supplementary specialist advice, and are in addition to the general requirements of the soil and water provisions of the Forest Practices Code. Areas reserved for threatened species purposes become vulnerable land upon expiry of the FPP. Any proposed future clearing or harvesting on such vulnerable land retained for the conservation of threatened species, such as the giant freshwater crayfish, requires a Forest Practices Plan, and is therefore provided a measure of security into the future (*Forest Practices Act 1985*).

Over the past decade a number of improvements have been made to the Forest Practices Code in response to the outcomes of research into the impact of forestry on streams and stream biota, particularly in relation to provisions for headwater (Class 3 and 4) streams. The general provisions of the Forest Practices Code for the management of soil and water also contribute to the mitigation of forestry impacts to the habitat of threatened species. Improvements designed to mitigate impacts of forestry operations on streams and associated biota include:

- Introduction of statewide headwater stream protection (Class 4 stream guidelines) in 2004, to manage erosion risk and sedimentation (McIntosh 2004; McIntosh et al. 2005).
- Introduction of minimum 10 m reserves (on either side of stream) in 2002, for headwater streams with suitable habitat for giant freshwater crayfish (FPB 2002).
- Introduction of 30 m stream-side reserves (on either side of stream) in 2002, for headwater streams with a known locality for giant freshwater crayfish within two kilometres downstream (FPB 2002).
- Introduction of minimum 30 m reserves (on either side of stream) in 2010, for headwater streams with high suitable potential habitat of juvenile giant freshwater crayfish irrespective of a known locality being present (Davies et al. 2005, 2007; FPA 2013, 2014).
- Introduction of constraints on the maximum size of coupes on steep land to less than 51 ha.
- The dispersal of individual coupes (*Forest Practices Code 2000*), rather than dispersal of aggregates of coupes (*Forest Practices Code 1993*).
- Introduction of constraints on harvest area in sensitive catchments.

Guidelines are also available with recommended management practices for works in waterways (Gallagher 2003) and to protect and rehabilitate riparian zones on agricultural land (Munks 1996; Hamlet 2002).

6 **Populations under particular pressure**

The actions described in this recovery plan are designed to provide ongoing protection for the giant freshwater crayfish throughout its range.

Giant freshwater crayfish populations have a restricted distribution and have experienced reductions in the number of mature individuals within a three generation period, and also decreases in the extent of occurrence and area and quality of habitat (TSS 2006), all of which present significant challenges for their recovery and exert strong pressures on their survival in the wild. Giant freshwater crayfish may also be at increased survival risk as a result of future climate change scenarios. Given these challenges all populations of giant freshwater crayfish (as identified in the known/likely to occur distribution categories in Table 2 and Figure 1) require protective measures. These measures should be targeted to the local landscape context and the specific needs of the given population.

7 **Objectives and strategies**

The objectives of this recovery plan are to:

- Identify, conserve and manage key locations to support increasing populations of the giant freshwater crayfish, with a healthy demographic structure.
- Address threats and improve habitat quality across the species' range.

The strategies to achieve the plans' objectives are to:

- Conduct population trend monitoring and research to assess the current status of the species and evaluate the effectiveness of recovery actions.
- Mitigate key threats impacting upon giant freshwater crayfish habitat.
- Increase the reservation status and improve the quality of identified key locations for the giant freshwater crayfish.
- Reduce the impacts of illegal fishing on the giant freshwater crayfish.
- Engage with the general public, local government and NGOs in developing and delivering conservation measures.

8 Actions to achieve the specific objectives

Actions identified for the recovery of the giant freshwater crayfish are described below. It should be noted that some of the objectives are long-term and may not be achieved prior to the scheduled five-year review of the recovery plan. Priorities assigned to actions should be interpreted as follows:

Priority 1:	Taking prompt action is necessary to mitigate the key threats to the giant freshwater crayfish and also provide valuable information to help identify long-term population trends.
Priority 2:	Action would provide a more informed basis for the long-term management and recovery of the giant freshwater crayfish.
Priority 3:	Action is desirable, but not critical to the recovery of the giant freshwater crayfish or assessment of trends in that recovery.

Strategy 1 – Conduct population trend monitoring and research to assess the current status of the species and evaluate the effectiveness of recovery actions.

Research/information actions

Action	Description	Priority	Performance Criteria	Responsible Agencies and potential partners	Indicative Cost *priority 1 only
1a	Increase understanding of genetic connectivity between giant freshwater crayfish populations and develop effective population estimates.	1	 Genomic research to assess population structure and genetic relationships within and between populations, and increase understanding of movements within the meta-population is undertaken. Results are analysed to estimate effective population size and survivorship of young. Research is linked to the ongoing surveys of tagged individuals (as undertaken in Action 1c). Genetic studies are undertaken to determine whether or not the two known colour morphs for the species represent different subspecies. 	CSIRO Research community	\$75,000
1b	Collate and analyse existing population data to inform ongoing monitoring strategy.	1	 All existing population data is collated, standardised and analysed to assess population trends, where possible. Population demographics (e.g. age and size class structure, sex ratio etc.) representative of healthy populations are identified. Results of the data analysis are used to inform monitoring of the giant freshwater crayfish. 	DPIPWE Research community	\$20,000

On-ground actions

Action	Description	Priority	Performance Criteria	Responsible Agencies and potential partners	Indicative Cost *priority 1 only
10	Conduct regular, ongoing monitoring to assess population trends, including in response to extreme weather events and/or climate change, and determine the reproductive ecology and habitat use of recovering crayfish populations.	1	 Regular monitoring of long-term study populations occurs annually at key locations (identified under Action 3a) and a minimum of every three years at other locations, using a standardised surveying protocol and survey effort. A representative selection of additional sites are nominated for ongoing monitoring, minimum three yearly, with a focus on the inclusion of major catchments in the north-east. Population trends are monitored annually for key locations and, where possible, extrapolated from long-term data for other locations. Emergency response monitoring is conducted following extreme weather events that may impact upon crayfish, and population trend assessment investigates the impacts of events. Age and size classes, moult patterns, reproduction and growth dynamics are identified for all monitored populations. Understanding of the recovery trajectory of monitored populations, and responses to management interventions, is increased. The behaviour and ecological role, of crayfish in an un-fished population is assessed. The > 500 presently tagged animals are used to increase understanding of local population dynamics. Citizen scientists are engaged to assist with monitoring efforts where possible. 	partners DPIPWE NRM bodies Research community	only \$50,000 pa (for a minimum of five years)
1d	Maintain a database for	1	National Values Atlas (Tas) and Protected Matters Search Tool (C'th)	DPIPWE DoEE	Core government
	population, habitat and distributional		databases are maintained and updated on a regular basis.		business
	data.		Databases effectively capture		
			population, habitat and distributional information for the species.		

Strategy 2 – Mitigate key threats impacting upon giant freshwater crayfish habitat.

Research/information actions

Action	Description	Priority	Performance Criteria	Responsible Agencies and potential partners	Indicative Cost *priority 1 only
2a	Assess the effectiveness of current management provisions for giant freshwater crayfish conservation and use the outcomes to inform the development of catchment management plans that cover all land- uses across the species range.	1	 Current management provisions for the conservation of the giant freshwater crayfish are assessed to evaluate their effectiveness, including management relating to: Water planning Agricultural development Forestry operations Conservation covenants. Catchment management plans that incorporate all land-uses, including plantation and native forestry and agricultural areas, are developed for catchments across the species range. Catchment management plans are designed to provide a framework for the consistent management of crayfish habitat across sectors. Key habitat regulators and local government planning schemes implement catchment management plans are deal solver the species range. 	DPIPWE NRM bodies FPA Tasmanian Irrigation TFGA	\$30,000
2b	Develop information products, including voluntary Codes of Practice, to promote and encourage the conservation of giant freshwater crayfish habitat in agricultural communities.	1	 Voluntary Codes of Practice, such as that used by the dairy industry, are reviewed and, where appropriate, updated to incorporate best practice management of giant freshwater crayfish habitat across all agricultural sectors. Opportunities to link voluntary Codes of Practice to certification requirements are investigated. Informative material on giant freshwater crayfish, best practice management for their conservation and voluntary Codes of Practice is provided to agricultural communities within the species distribution. Efforts are focussed on promoting restoration of agricultural areas that historically contained high quality giant freshwater crayfish habitat, including such actions as the addition of course woody debris to streams, and avoiding further clearance of riparian vegetation 	DPIPWE TFGA NRM bodies	\$50,000

			in areas with potentially suitable habitat.		
		•	Positive engagement with local landholders results in improved management of giant freshwater crayfish habitat in key locations (as identified under Action 3a).		
2c Conduct research assess th impacts of increased sediment on giant freshwate crayfish a the effectiver of curren manager provision mitigating these imp and, if necessar update manager	Conduct research to assess the impacts of increased sedimentation on giant	1 •	Research is undertaken to assess the impacts of increased sedimentation on giant freshwater crayfish and determine whether current management of Class 4 streams is effective at minimising sediment input into lower stream reaches.	FPA DPIPWE Research community	\$100,000
	treshwater crayfish and the effectiveness of current management provisions for	• t	Methods for categorising the suitability of giant freshwater crayfish habitat are analysed to determine their effectiveness at protecting habitat upstream of key locations (identified under Action 3a).		
	mitigating these impacts, and, if necessary, update management provisions.	•	Options are investigated for increasing the habitat suitability rating in headwaters above key locations (as identified under Action 3a), including potential refinement of watercourse definitions, and a suitable method for conferring increased protection is identified.		
		•	The FPA's Threatened Fauna Adviser and Giant Freshwater Crayfish Habitat Suitability Map are updated to include the chosen method for improving upstream habitat management.		
		•	DPIPWE's formal advice on the management and maintenance of giant freshwater crayfish habitat is updated as required.		

On-ground actions

Action	Description	Priority	Performance Criteria	Responsible Agencies and potential partners	Indicative Cost *priority 1 only
2d	Habitat managers and regulators work cooperatively to identify and implement methods for strengthening habitat protections, or reducing forestry impacts, in upstream reaches of key locations.	1	 Forestry management and practices continue to undergo a process of adaptive management to improve and refine measures designed to minimise downstream impacts in areas that support optimal habitat for both juvenile and adult giant freshwater crayfish. Options for increasing habitat protection, or reducing adverse impacts, in upstream reaches of key locations (as identified under Action 3a) are investigated. Habitat managers and regulators work together to identify the most effective method for increasing protections, or improving management, in upstream reaches of key locations (as identified under Action 3a). The identified method for increasing protections is incorporated into catchment by catchment strategic plans. The chosen method is implemented by regulators. 	DoEE DPIPWE FPA FT Research community	\$30,000 pa (for a minimum of five years)
2e	Undertake monitoring of forestry industry compliance with giant freshwater crayfish management prescriptions.	1	 Regular monitoring is continued to ensure management prescriptions for the protection of giant freshwater crayfish habitat are being correctly and effectively implemented. Compliance with management prescriptions is evaluated. Monitoring results are used to inform adaptive management of the prescriptions to improve implementation and incorporate any new recommendations/prescriptions. 	FPA FT	Core government business
2f	Investigate options for sediment control.	1	 The effectiveness of various methods of controlling erosion and reducing sediment inputs into streams are investigated for different habitat types. Appropriate erosion and sediment controls measures are implemented in priority sub-catchments. 	FPA DPIPWE FT Research community	\$50,000

2g	Ensure water management planning incorporates requirements of the giant freshwater crayfish.	1.	Water managers in catchments housing giant freshwater crayfish are aware of the water requirements of the species. The water requirements of giant freshwater crayfish are incorporated in water management planning processes and environmental flow assessments.	DPIPWE Tasmanian Irrigation	\$10,000 pa (for a minimum of five years)
		•	Appropriate mechanisms are in place to control illegal water extraction across the species range.		
		•	Appropriate mechanisms are in place to ensure that the impacts of dam construction on giant freshwater crayfish are minimised.		
			Positive engagement with water regulators results in improved management of giant freshwater crayfish habitat in key locations (as identified under Action 3a).		
2h	Ensure culvert designs allow for movement of giant freshwater crayfish	3•	Information on minimal-impact culvert designs, as described in the FPA Fauna Technical Note No.15, is disseminated to local councils, landholders and other relevant stakeholders within the giant freshwater crayfish's distribution.	DPIPWE FPA NRM bodies Local councils Private landholders	-
		•	Culvert designs which allow for the movement of giant freshwater crayfish are used for stream crossings within the species range.		
2i	Reduce the impacts of acid mine drainage on giant freshwater	Reduce the 2 • impacts of acid mine drainage on giant freshwater	Areas where acid mine drainage, arising as a legacy impact from disused mine sites, overlaps with giant freshwater crayfish habitat are identified.	DPIPWE Research community	-
	crayfish habitat.	habitat.	Technologies under development for the amelioration of acid mine drainage are investigated for potential use in habitat rehabilitation.		

Strategy 3 – Increase the reservation status and improve the quality of key habitat for the giant freshwater crayfish.

Research/information actions

Action	Description	Priority	Performance Criteria	Responsible Agencies and potential partners	Indicative Cost *priority 1 only
3a	Identify key locations that are a priority for improved habitat protection in order to support and maintain healthy giant freshwater crayfish populations.	1	 A scientifically-robust process is undertaken to identify specific sub- catchments which function as 'key locations' for the support and maintenance of healthy giant freshwater crayfish populations (i.e. areas of high-quality habitat with high giant freshwater crayfish densities). The process includes assessment and consideration of sub-catchments within the Arthur, Frankland, Black, Dip, Flowerdale and Leven River catchments, which have previously been nominated for protection. Sub-catchments are ranked in terms of population and habitat health, and key locations are prioritised for potential increased habitat protections. Where possible, key locations are selected to maximise genetic diversity. 	DoEE DPIPWE Research community	\$20,000

On-ground actions

Action	Description	Priority	Performance Criteria	Responsible Agencies and potential partners	Indicative Cost *priority 1 only
3b	Increase the total area of giant freshwater crayfish habitat that is reserved.	1	 All opportunities to incorporate key locations (identified under Action 3a), or portions thereof, into public or private reserve systems are explored. The total area of giant freshwater crayfish habitat that is protected under regional, State, National or private reserves systems increases (including in both formal and informal reserves). 	DOEE	\$300,000 (split over two annual investments of \$150,000)

3c	Implement mechanisms for protecting giant freshwater crayfish habitat on private land.	1 •	Mechanisms for protecting giant freshwater crayfish habitat and enhancing riparian restoration on private land, such as conservation covenants or other landholder incentives, are identified and promoted, particularly in key locations (identified under action 3a).	DPIPWE NRM bodies	\$300,000 (split over three annual investments of \$100,000)
		·	The establishment of streamside reserves, similar to those applied in forest terrain, is encouraged in agricultural areas.		
		•	Implementation of identified mechanisms focuses on increasing participation in the north-east.		

Strategy 4 – Prevent illegal fishing of the giant freshwater crayfish.

Research/administration actions

Action	Description	Priority	Performance Criteria	Responsible Agencies and potential partners	Indicative Cost *priority 1 only
4a	Increase awareness of the fishing ban, methods for identifying giant freshwater crayfish, and avenues for reporting breaches of the ban.	3	 The IFS website is updated to incorporate new information on the giant freshwater crayfish and provide links to other relevant websites. An education and awareness program is undertaken to inform the public about the fishing ban and encourage reporting of any fishing breaches to IFS or Bushwatch. Existing brochures detailing how to recognise giant freshwater crayfish and gain the evidence required to prosecute illegal fishers/poachers are reprinted and distributed to all staff involved with compliance and enforcement activities. Enforcement staff are informed of the benefits the fishing ban is having on giant freshwater crayfish populations to highlight the importance of enforcement. 	IFS DPIPWE PWS Tasmania Police Bushwatch	-
			enforcement.		

On-ground actions

Action Desc	cription	Priority	Performance Criteria	Responsible Agencies and potential partners	Indicative Cost *priority 1 only
4b Enfor ban c of gia fresh crayf	rce the full on fishing ant water ish.	2	 An appropriate level of enforcement of the fishing ban is undertaken, with a focus on: Joint collaboration between IFS and PWS compliance officers and Tasmanian police; Targeting poachers; Preventing illegal trade. Consideration is given to activities that would restrict, or deter, access to key locations for the giant freshwater crayfish, such as: The use of cameras at known sites or roads leading to them; Implementation of boom gates on roads leading to known sites; Identification of roads that can be closed and rehabilitated. 	IFS PWS DPIPWE Tasmania Police	-

Strategy 5 – Engage with the general public, local government and NGOs in developing / delivering conservation measures.

Research/information actions

Action	Description	Priority	Performance Criteria	Responsible Agencies and potential partners	Indicative Cost *priority 1 only
5a	Apply a principle of adaptive management to all aspects of recovery plan implementation	1	• An overarching principal of adaptive management is used to guide recovery plan implementation and enable the identification of new threats, refocus priorities appropriately and recognise when certain actions are no longer relevant to the species recovery.	DPIPWE DoEE	Core government business

On-ground actions

Action	Description	Priority	Performance Criteria	Responsible Agencies and potential partners	Indicative Cost *priority 1 only							
5b Promote giant freshwate crayfish a flagship species f good catchmei manager	Promote the giant freshwater crayfish as a flagship species for good catchment management.	2	 Giant freshwater crayfish are the focus point for audio/visual material encouraging healthy catchment management across their range. Particular focus is given to promoting the giant freshwater crayfish as a flagship in the north-east. Informative material on giant freshwater crayfish ecology and conservation, including fact sheets, colour brochures, posters and stickers, is updated and distributed to schools, local land care groups and other relevant stakeholders (e.g. fishers, foresters, farmers, irrigators). 	NRM bodies DPIPWE Community groups	-							
											 The development of a website, or Facebook page, devoted to promoting the conservation of the giant freshwater crayfish is considered. 	
5c	Establish a demonstration site to display habitat rehabilitation in agricultural areas.	3	 A suitable location for establishing a demonstration site is identified. A demonstration site is established to showcase methods of rehabilitating /managing habitat for the conservation of the giant freshwater crayfish. 	NRM bodies	-							
5d	Investigate options to display giant freshwater crayfish to increase public awareness.	Investigate 2 options to display giant freshwater crayfish to	Opportunities to display giant freshwater crayfish in major accredited public institutions for the purpose of raising public awareness are investigated.	DPIPWE	-							
			• Opportunities to incorporate viewing of the giant freshwater crayfish into local eco-tourism operations, at specific sites, are investigated with eco-tourism operators educated and encouraged to promote the species' conservation.									
			• Policy is developed to inform any potential future display of giant freshwater crayfish, including consideration of the species sensitivity to light and temperature.									

5e	Options for reintroduction and translocation of giant freshwater crayfish are investigated and, where appropriate,	2 •	A translocation strategy, informed by the outcomes of strategy 5, which considers population distribution and genetic characteristics, is developed. Potential reintroductions and translocations of giant freshwater crayfish into areas where previous habitat impacts have been removed are considered.	DPIPWE - DoEE
	implemented.	•	Modelling is undertaken to determine the likely thermal and hydrological alterations to the species' range as a result of climate change, and the outcomes of this research are used to inform identification of potential translocation sites.	
		•	All reintroduction and translocation activities undertaken are compliant with IUCN, state and Commonwealth guidelines.	
5f	Investigate opportunities to work with local landcare groups, environmental NGOs and citizen scientists to implement recovery plan actions	2.	Agencies working on recovery plan implementation actively engage with local volunteers (both community groups and citizen scientists) to explore opportunities for collaboration. Strong partnerships are built between all levels of local, state and federal government agencies, NRM bodies and community groups interested in progressing conservation actions for the giant freshwater crayfish.	DPIPWE - NRM bodies Wynyard Landcare CNFN FLG FLAG

9 Duration and cost of the recovery process

It is anticipated that the recovery process will not be achieved prior to the scheduled five year review of the recovery plan. The *Recovery Plan for the Giant Freshwater Crayfish (Astacopsis gouldi)* (2016) will therefore remain in place until such time as the populations of the giant freshwater crayfish have improved to the point at which they no longer meet threatened species status under the EPBC Act.

It is expected that state and Commonwealth agencies will use this plan to prioritise actions to protect the species and enhance their recovery, and that projects will be undertaken according to agency priorities and available resources. In order to maximise the conservation outcomes and cost effectiveness of this plan, it is intended that the recovery actions proposed complement, where possible, those of other protected matters.

Table 3: Summary of high priority recovery actions and estimated costs in (\$000's) for the first five years of implementation (these estimated costs do not take into account inflation over time).

Action	Cost					
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Increase understanding of genetic connectivity and develop effective population estimates	-	75	-	-	-	75
Collate and analyse existing population data to inform ongoing monitoring strategy	20	-	-	-	-	20
Conduct regular monitoring at long-term study sites to determine the reproductive ecology and habitat use of recovering populations	50	50	50	50	50	250
Assess the effectiveness of current management provisions and develop catchment management plans that cover all land-uses	30					30
Develop information products to promote and encourage conservation in agricultural communities			50			50
Conduct research to assess the impacts of increased sedimentation on crayfish and the effectiveness of current management provisions	100					100
Habitat managers/regulators identify and implement methods for strengthening protections, or reducing impacts, upstream of key locations	30	30	30	30	30	150
Investigate options for sediment control		50				50
Ensure water management planning incorporates the water requirements of giant freshwater crayfish	10	10	10	10	10	50
Identify priority sub-catchments for improved habitat protection to support and maintain healthy giant freshwater crayfish populations	20	-	-	-	-	20
Increase the total area of giant freshwater crayfish habitat that is reserved	-	150	-	150	-	300
Implement mechanisms for protecting crayfish habitat on private land in priority areas	100	-	100	-	100	300
TOTAL	360	365	240	240	190	1395

10 Effects on other native species and biodiversity benefits

By managing northern Tasmanian freshwater ecosystems for the benefit of giant freshwater crayfish, many other native aquatic fauna will also benefit. Tasmania's <u>Natural Values Atlas</u> database lists a number of other threatened species that occur in giant freshwater crayfish habitats, including hydrobiid snails and four species of burrowing crayfish, in addition to non-threatened iconic species such as the platypus. Because of the linkages between riparian and in-stream ecosystems, the protection of riparian zones will benefit riparian and in-stream fauna. Functional, intact riparian zones are directly related to high in-stream biodiversity (Boulton & Brock 1999) and contribute to the floristic diversity of off-reserve areas. Benefits can be effectively achieved by measures to raise awareness of freshwater environments and their conservation management requirements, and by encouraging implementation of management through private and community projects, private land conservation agreements, and forest and agricultural industry management prescriptions and codes of practice.

11 Social and economic considerations

Habitat degradation threatens the giant freshwater crayfish and may largely exclude the species from areas, perhaps traditionally utilised for feeding or spawning, where they were historically much more abundant. Due to their distribution in rivers across northern Tasmania, often in close proximity to forestry or agricultural land uses, giant freshwater crayfish populations could be adversely affected by habitat degradation arising from anthropogenic activities in these regions. As habitats critical to the survival of the species are identified, there is potential for developments to be restricted under the EPBC Act assessment and approval process. Any measures to assist recovery of this species that involve restrictions on the use of riparian land may result in economic impacts to affected industries. Conversely, the positive engagement of the forestry sector with the actions and objectives outlined in this recovery plan may have a positive economic benefit in terms of increased likelihood of achieving certification through forestry industry certification bodies.

Increased protection of giant freshwater crayfish habitat is expected to result in significant improvements in water quality which are likely to be economically and socially advantageous. For example, improved water quality can significantly reduce the costs associated with water treatment processes and is also likely to convey positive social benefits in terms of increased recreational and aesthetic values. Increased public awareness of the giant freshwater crayfish and its undisturbed forest habitat may bring social and economic advantages through tourism.

12 Affected interests

Organisations with an interest in the actions proposed in this plan include Australian and state governments agencies, particularly those with environmental and fisheries concerns; forestry operators, forestry industry certification bodies; recreational fishers; local Indigenous communities; researchers; tourism operators; conservation groups; wildlife interest groups; and proponents of urban or other development in the vicinity of important crayfish habitat. This list, however, should not be considered exhaustive, as there may be other interest groups that would like to be included in the future or need to be considered when specialised tasks are required in the recovery process.

13 Consultation

The *Recovery Plan for the Giant Freshwater Crayfish (Astacopsis gouldi)* (2016) has been developed through ongoing consultation with a broad range of stakeholders. The consultation process commenced with a workshop in Tasmania that brought together key species experts, conservation managers and land managers, to categorize ongoing threats to the species and identify knowledge gaps and potential management options. Workshop participants included representatives from DoEE, DPIPWE, CSIRO, FPA, IFS, Hydro Tasmania, researchers from UTAS, other species experts and local community groups. These parties were engaged repeatedly throughout the development of the draft recovery plan, which was subsequently released for a three month public consultation period. Submissions were invited from any interested parties during this period. In the process of finalising the recovery plan DoEE continued to work closely with key stakeholders, including DPIPWE, FPA, FT and independent researchers.

14 Organisations/persons involved in evaluating the performance of the plan

This plan should be reviewed no later than five years from when it was endorsed and made publically available. The review will determine the performance of the plan and assess:

- whether the plan continues unchanged, is varied to remove completed actions, or varied to include new conservation priorities; and
- whether a recovery plan is no longer necessary for the species as either conservation advice will suffice, or the species is removed from the threatened species list.

As part of this review, the listing status of the species will be assessed against the EPBC Act species listing criteria.

The review will be coordinated by DoEE in association with relevant Australian and state government agencies and key stakeholder groups such as non-governmental organisations, local community groups and scientific research organisations.

Key stakeholders who may be involved in the review of the performance of the *Recovery Plan for the Giant Freshwater Crayfish (Astacopsis gouldi)*, include organisations likely to be affected by the actions proposed in this plan and are expected to include:

Australian Government

Department of the Environment and Energy Commonwealth Scientific and Industrial Research Organisation

State/territory governments

Department of Primary Industries, Parks, Water and Environment (Tas) Inland Fisheries Service (Tas) Forestry Tasmania (Tas) Forest Practices Authority (Tas) Hydro Tasmania (Tas) Tasmanian Irrigation (Tas) Local government across the species range

Non-government organisations

Natural resource management bodies across the species range Conservation groups Local communities Universities and other research organisations Recreational fishers and associations

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