GOVERNMENT OF WESTERN AUSTRALIA

Department of **Biodiversity, Conservation and Attractions**

Threatened species nomination

For nominations to the WA Threatened Species Scientific Committee (and the Minister for Environment) to amend threatened species listings under the WA *Wildlife Conservation Act 1950* or their assigned IUCN Red List threat status ranking.

Cover Page *(Office use only)*

Species name (scientific and common name)**:**	***Galaxias truttaceus* (Western Australian population)** **(western spotted galaxias, western trout minnow)**
Nomination for (addition, deletion, change)**:**	**Change (taxonomy and criteria)**
Nominated conservation category and criteria:	**Endangered B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)**

Scientific committee assessment of eligibility against the criteria:		
A.	Population size reduction	•
B.	Geographic range	•
C.	Small population size and decline	•
D.	Very small or restricted population	•
E.	Quantitative analysis	•

Outcome*:*			
Scientific committee meeting date:			
Scientific committee comments:			
Recommendation:			
Ministerial approval:		*Government Gazettal/ Legislative effect:*	

Nomination summary *(to be completed by nominator)*

Current conservation status			
Scientific name:	*Galaxias truttaceus* (Western Australian population) (currently listed as *Galaxias truttaceus hesperius*)		
Common name:	western spotted galaxias, western trout minnow		
Family name:	Galaxiidae	Fauna ☒	Flora ☐
Nomination for:	Listing ☐	Change of status ☒	Delisting ☐

1. *Is the species currently on any conservation list, either in a State or Territory, Australia or Internationally?* 2. *Is it present in an Australian jurisdiction, but not listed?*	*Provide details of the occurrence and listing status for each jurisdiction in the following table*

Jurisdiction	**List or Act name**	**Date listed or assessed (or N/A)**	**Listing category i.e. critically endangered or 'none'**	**Listing criteria i.e. B1ab(iii)+2ab(iii)**
International	IUCN Red List			
National	EPBC Act	19/08/2006	Critically Endangered (as *Galaxias truttaceus hesperius*)	Criterion 2 (equivalent to B2ab(iii,iv))
	Australian Society for Fish Biology (using IUCN categories and criteria)	December 2016	Critically Endangered (as *Galaxias truttaceus hesperius*)	N/A
State of WA	Threatened list	08/02/2005	Endangered (as *Galaxias truttaceus hesperius*)	C2
		10/4/2018 TSSC	Endangered As *Galaxias truttaceus* (Western Australian population)	B1ab(i,ii,iii,iv,v)+ 2ab(i,ii,iii,iv,v)
	Priority list		1 ☐ 2 ☐ 3 ☐ 4 ☐	
Other State / Territory				

Nominated conservation status: category and criteria (including recommended categories for deleted species)					
Critically endangered (CR) ☐	**Endangered (EN)** ☒	Vulnerable (VU) ☐	Presumed extinct (EX) ☐		
Other Specially Protected	Priority 1 ☐	Priority 2 ☐	Priority 3 ☐	Priority 4 ☐	None ☐

(Conservation Dependent) ☐		
What criteria support the conservation status category above? *Refer to Appendix A table 'Summary of the five criteria (A-E)' and the check version that can be completed to indicate all criteria options*		**B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)**
Eligibility against the criteria		
*Provide justification for the nominated conservation status; is the species eligible or ineligible for listing against the five criteria. For **delisting**, provide details for why the species no longer meets the requirements of the current conservation status.*		
A.	Population size reduction *(evidence of decline)*	• The Goodga and Angove Rivers have water extracted for domestic, industrial and agricultural purposes and the Kent River has been identified as a potential future water supply. In 2001, the extraction volume from the Angove River was removing 67-82 % of the river's mean annual flow. • Climate change in southwest WA has resulted in 10-15 % reduction in average annual rainfall and an associated 50 % reduction in river surface flow. Climate change will also lead to an increase to instream temperatures and as temperature affects the aerobic scope of fish, impact to growth, swimming performance, migratory capacity and population viability is expected (Beatty *et al.* 2014, CSIRO 2009, Morrongiello *et al.* 2011, Ogston *et al.* 2016). • Globally, water extraction and climate change are predicted to cause a loss of up to 75 % of freshwater fish diversity by 2070 (Beatty *et al.* 2014, Ogston *et al.* 2016). • Potamodromous fish have been identified as being some of the most vulnerable freshwater fish to climate change in the southwest. Regarding the life history of *Galaxias truttaceus*, the Western Australian population of the species is likely to be highly sensitive to any change in the timing and/or magnitude of water flow during migration, spawning and recruitment. Any change is expected to reduce reproductive and recruitment success. Flow reduction will also reduce the connectivity and amount of habitat available (Beatty *et al.* 2014). • Various introduced species have been identified as having a medium-high impact on the species into the future. • **Insufficient information to assess**
B.	Geographic range *(EOO and AOO, number of locations and evidence of decline)*	• (B1) EOO = 700 km^2 (using the Minimum Convex Polygon method) • (B2) AOO = 48 km^2 (using the 2 km x 2 km grid method) • (a) Population is severely fragmented and occurs in 3 locations • Major past, current and future threats to the species include flow reduction (due to climate change and water extraction), presence of instream barriers, water quality decline (due to salinisation and increased stream temperatures) and various introduced species. These threats have and will continue to lead to a reduction in habitat availability and connectivity, including refugia, an increase in mortality, and a reduction in reproductive and recruitment success. Therefore, it is observed, inferred and projected that there will be (b) continuing decline in (i) EOO, (ii) AOO, (iii) area, extent

		and/or quality of habitat, (iv) number of locations/subpopulations and (v) number of mature individuals. • (c) The species is migratory and this leads to a fluctuation in the species' spatial distribution within a catchment during the year, but this is not an overall fluctuation in EOO, AOO, number of locations/subpopulations or number of individuals. • **Meets criteria for Endangered B1ab(i,ii,iii,iv,v) and B2ab(i,ii,iii,iv,v)**
C.	Small population size and decline *(population size, distribution and evidence of decline)*	• No population size estimates are available. However, a total of 3574 individuals (including juveniles) were captured in WA surveys between 2013 and 2015. • **Insufficient information to assess**
D.	Very small or restricted population *(population size)*	• (D) No population size estimates are available. However, a total of 3574 individuals (including juveniles) were captured in WA surveys between 2013 and 2015. • (D2) AOO = 48 km^2 (i.e. > 20 km^2) but only found at 3 locations. Due to climate change, it is projected that there will be a 4-month increase in the period of no-flow in the Kent River. Similar flow reductions in the Angove and Goodga rivers are also likely and exacerbated by water extraction. Further reductions in rainfall and ongoing water extraction could potentially drive the species to CR or EX in a short period of time, particularly if the timing and magnitude of water flow changes during migration, spawning and recruitment. • **Meets criteria for Vulnerable D2**
E.	Quantitative analysis *(statistical probability of extinction)*	• **No information to assess**

Reasons for change of status

Genuine change ☐ New knowledge ☒ Taxonomic change ☒ Previous mistake ☐ Other ☐

Provide details:

CURRENT CONSERVATION STATUS: The Western Australian subspecies *Galaxias truttaceus hesperius* was assessed as Endangered and listed in Western Australia in 2005 based on the species' occurrence only being within the Goodga and Angove Rivers and no longer present within the King and Kalgan Rivers, and the calculation of area of occupancy not using the 2 km x 2 km grid square method. The subspecies was listed by the Commonwealth as Critically Endangered in 2006.

TAXONOMIC REVIEW: Morgan *et al.* (2016) provided evidence that the Western Australian subpopulation of *Galaxias truttaceus* does not represent a subspecies (*Galaxias truttaceus hesperius*), but determined that there is a genetic divergence between the western and eastern Australian subpopulations sufficient to warrant recognition of evolutionary significant units (ESU). Morgan *et al.* (2016) recommended listing the Western Australian ESU as Critically Endangered due to the restricted distribution, past decline and present and future threats, however did not include any quantitative information to demonstrate eligibility against the criteria.

NEW KNOWLEDGE: At the time of listing, the Western Australian population was only known from the Goodga River catchment (including Angove River). The species has since been found in Kent River catchment resulting in a range extension. Results from 2013-2015 targeted freshwater fish surveys conducted in all rivers and several lakes between Bow River and Angove River has provided up to date information on the species' distribution, life history, population dynamics, habitat and threats.

This new information, the taxonomic review and conservation status recommendation by Morgan *et al.* (2016), and

the discrepancy between State and Commonwealth threat category, warranted a complete review of the conservation status of the Western Australian ESU of *Galaxias truttaceus.*

Summary of assessment information *(detailed information to be provided in the relevant sections of the form)*

EOO	700 km^2	AOO	48 km^2	Generation length	2-3 years

No. locations	3	Severely fragmented	Yes ☒ No ☐ Unknown ☐
No. subpopulations	3 (within the WA ESU)	No. mature individuals	Unknown. A total of 3574 individuals (including juveniles) were captured in WA between 2013 and 2015

Percentage global population within WA	100 % of the Western Australian ESU is within WA.
Percentage global population within Australia	100 %
Percentage population decline over 10 years or 3 generations	Unknown

Summary of Western Australian population information *(detailed information to be provided in the relevant sections of the form)*						
Subpopulation location *(include coordinates)*	Land tenure	Survey information: Date of survey and No. mature individuals	Area of subpopulation	Site / habitat Condition	Threats *(note if past, present or future)*	Specific management actions
Kent River, including two of its tributaries (Styx River and Kentdale Creek) and Owingup Swamp	National Park, Timber Reserve, Unallocated Crown Land, Crown Reserve (Water Resources), Private Property	2013-2015: 56	23 km stretch of river (area of available habitat: ~0.023 km^2)	Habitat where species is found is in very good condition, water quality is excellent, tannin stained.	Flow reduction: past, present and future Water quality decline – salinisation and increased instream temperatures: past, present and future Water quality decline – increased instream temperatures: future Riparian degradation: past, present and future Introduced species – *Gambusia holbrooki* (eastern gambusia, mosquito fish): past, present and future Introduced species – *Cherax destructor, Ligula intestinalis,* aquatic plants: future Bushfire and inappropriate fire regimes: future	Manage any future water extraction so that it does not impact negatively on the species, particularly during migration, spawning and recruitment. Continue to implement actions to reduce salinity. Work with private landowners to install fencing so that cattle cannot access the river and its riparian vegetation. Consider conducting fishouts to remove *Gambusia holbrooki* and *Cherax destructor* from the river and continue to implement education campaigns regarding introduced species. Ensure prescribed burns are undertaken during a time that will not negatively impact on the species, particularly during migration, spawning and recruitment.
Goodga River and Moates Lake	Nature Reserve, Crown Reserve	2013-2015: 3215	4 km stretch of river (area of	Habitat where species is found	Flow reduction: past, present and future	Manage any water extraction so that it does not impact

	(Water Resources)		available habitat: ~0.008 km^2)	is in very good condition, water quality is excellent, tannin stained. However the Goodga catchment is modified. Instream barriers exist. Water flow regulated by weirs or gauging stations which impact fish movement upstream, limiting available habitat. A fishway has been installed to allow fish movements upstream.	Water quality decline – increased instream temperatures: future Riparian degradation: past, present and future Introduced species – *Gambusia holbrooki*, *Cherax destructor*, *Ligula intestinalis, Typha orientalis*: past, present and future Instream barriers from existing weirs and dams: past Bushfire and inappropriate fire regimes: future	negatively on the species, particularly during migration, spawning and recruitment. Monitor salinity and implement actions as required if secondary salinisation becomes a threat. Work with private landowners to install fencing so that cattle cannot access the river and its riparian vegetation. Consider conducting fishouts to remove *Gambusia holbrooki* and *Cherax destructor* from the river and continue to implement education campaigns regarding introduced species. Continue to improve on the design of the fishway installed at the weir. Ensure prescribed burns are undertaken during a time that will not negatively impact on the species, particularly during migration, spawning and recruitment.
Angove River and Angove Lake	Nature Reserve, Crown Reserve (Water Resources)	2013-2015: 303	2 km stretch of river (area of available habitat: ~0.004 km^2)	Habitats in very good condition, water quality is excellent, tannin stained. Instream barriers exist. Water flow	Flow reduction: past, present and future Water quality decline – increased instream temperatures: future Riparian degradation: past, present and future	Manage any water extraction so that it does not impact negatively on the species, particularly during migration, spawning and recruitment. Monitor salinity and implement actions as required if secondary salinisation

				regulated by weirs or gauging stations which impact fish movement upstream, limiting available habitat.	Introduced species – *Gambusia holbrooki*, *Ligula intestinalis*: past, present and future Introduced species – *Cherax destructor*, aquatic plants: future Instream barriers from existing weirs and dams: past, present and future Bushfire and inappropriate fire regimes: future	becomes a threat. Work with private landowners to install fencing so that cattle cannot access the river and its riparian vegetation. Consider conducting fishouts to remove *Gambusia holbrooki* and *Cherax destructor* from the river and continue to implement education campaigns regarding introduced species. Install a fishway at the weir. Ensure prescribed burns are undertaken during a time that will not negatively impact on the species, particularly during migration, spawning and recruitment.

Nomination detail

Please refer to the Departments guidelines on nominating species for amendment of the Western Australian threatened species lists at http://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/Threatened_Species_Nomination_Guidelines_2014.pdf

For technical information on terminology used in this form, and the intent of information requirements, as they relate to an assessment of this nomination against the IUCN Red List criteria, refer to the 2001 *IUCN Red List Categories and Criteria. Version 3.1 Second Edition* http://s3.amazonaws.com/iucnredlist-newcms/staging/public/attachments/3192/redlist_cats_crit_en.pdf

and *Guidelines for Using the IUCN Red List Categories and Criteria Version 11* (February 2014) http://cmsdocs.s3.amazonaws.com/RedListGuidelines.pdf

Section 1: Taxonomy

1.1 Current taxonomy		
Species name and Author:	*Galaxias truttaceus* Valenciennes, 1846	
Subspecies name(s) and Author:	N/A	
Is the species/subspecies conventionally accepted?		Yes ☒ No ☐
Is there any controversy about the taxonomy?		Yes ☒ No ☐
If not conventionally accepted and/or if there is any controversy; provide details:	The species is taxonomically accepted at the species level but there has been controversy about the validity of all the subspecies, including *Galaxias truttaceus hesperius* Whitley 1944 (western trout minnow). McDowall and Frankenberg (1981) reviewed the species and suggested that the subspecies was not valid, and that the subpopulations from Western Australia, South Australia, Tasmania and Victoria were not taxonomically distinct from each other. Morgan *et al.* (2016) provided additional evidence that the subspecies is not valid but the Western Australian subpopulation should be considered as an evolutionary significant unit (ESU).	
Has the species/subspecies been formally named?		Yes ☒ No ☐
Has the species/subspecies been recently described?		Yes ☐ No ☒
If the species has not been formally named or described; is it in the process of being described? Is there an anticipated date for the publication of the description? Has a type specimen been deposited? And if so provide the registration number and where deposited.	N/A	
If there are any closely related taxa provide details and include key distinguishing features:	There are several other *Galaxias* species found in southwestern Australia. Refer to Morgan *et al.* (2011) for identification information.	
1.2 Taxonomic history		
Are there recent synonyms for the species?		Yes ☒ No ☐
If Yes; provide details of synonyms:	Currently listed as *Galaxias truttaceus hesperius* (western trout minnow). At species level, it is commonly known as the spotted mountain trout in eastern Australia.	

Have there been recent changes in the taxonomy or nomenclature?	Yes ☒ No ☐
If Yes; provide details of changes:	Morgan *et al.* (2016) resolved the taxonomy of *Galaxias truttaceus* and have found that *Galaxias truttaceus hesperius* is not a valid subspecies.

1.3 Hybridisation

Is there any known hybridism with other species in the wild?	Yes ☐ No ☒ Unknown ☐
If Yes; Where does this occur and how frequently?	N/A

Section 2: Species information

2.1 Morphology / physical description

Insert photograph(s) of species or provide as an attachment:

Adult *Galaxias truttaceus* (Photo: David Morgan)

Video of *Galaxias truttaceus* from the Freshwater Fish Group, Murdoch University.

Species description:	"A large, deep-bodied galaxiid with a distinctive trout-like appearance and unmistakable pattern of dark spots (bars in juveniles) on the sides, including a short diagonal stripe below the eye. Colour is olive to tan-brown overall; fins are reddish-orange, usually with dark edges. The largest galaxiid in the state [WA], reaching a maximum size of 200 mm, but more commonly 120-140 mm." (Morgan *et al.* 2011)

2.2 Biology *(provide details)*

Galaxias truttaceus have a migratory life history. Adults move upstream to spawn in the autumn. In Western Australia, the hatched larvae drift downstream into coastal lakes, as opposed to out to sea as occurs in some locations in eastern Australia. The larvae remain at the surface of the lakes for several months and return to the river as juveniles in the spring-early summer.

Juveniles reach maturity at two years or older. Individuals generally live for less than five years, but the maximum recorded age is seven years. In the Goodga river, the majority of fish are under three years of age. Fish aged four to seven years contribute to less than 4 % of the entire population.

Population structures and juvenile recruitment differ between the different rivers in southwestern Australia. There is

negligible body growth of individuals during the warmer months.

2.3 Ecology *(provide details)*

In Western Australia, *Galaxias truttaceus* is a land-locked potamodromous fish, completing its life-cycle entirely within near-coastal freshwater environments. It inhabits streams and lakes in flowing or still waters. Seasonal and daily water flows appear to act as a trigger for spawning. Studies have found that the species is able to climb and jump hydraulic and physical barriers during upstream migration.

Larval fish feed on surface plankton. Juvenile and adult fish feed predominantly on terrestrial insects on the water surface.

Section 3: Habitat

3.1 Habitat *(provide details in response to the question below)*			
Described the habitat suitable for the species (biological and non-biological). Include descriptions of specific purpose habitat (e.g. foraging, breeding, roosting, seasonal migration, different life stages).	*Galaxias truttaceus* is only found in Australia and is confined to cooler climatic regions within Western Australia, South Australia, Tasmania and Victoria. Most commonly found in shallow and relatively narrow stream habitats in lower elevations close to the coast. In Western Australia, *Galaxias truttaceus* is found on the south coast in near-coastal freshwater rivers and their tributaries and associated downstream lakes. The species is tolerant of tannin-stained acidic waters. Mean water temperatures on the Goodga River follow a seasonal pattern from a minimum of 11.7°C in winter to a maximum of 23°C in summer. Adults move upstream to spawn and the hatched larvae drift downstream into the river's associated coastal freshwater lake where they develop into juveniles.		
If the species occurs in a variety of habitats, is there a preferred habitat?	N/A		
Does the species use refugia? *(include what is it and when is it used)*	Yes. Permanently watered freshwater habitats are required for the species to survive the dry and hot summer months.		
Is the habitat restricted in extent or number of locations?		Yes ☒ No ☐ Unknown ☐	
If Yes, provide details:	The Western Australian ESU is restricted to near-coastal, land-locked freshwater river catchments and their associated lakes/wetlands in the cooler climates of south-western WA. Only known to be present in three catchments on the south coast.		
Is this species reliant on a threatened or priority species or ecological community?		Yes ☐ No ☒ Unknown ☐	
If Yes, provide details:	N/A		
Are there any other species (sympatric species) that may affect the conservation status of the nominated species?		Yes ☒ No ☐ Unknown ☐	
If Yes, provide details:	The introduced *Gambusia holbrooki* (eastern gambusia, mosquito fish), *Cherax destructor* (common yabbie) and *Ligula intestinalis* (a cestode, parasitic worm) have been recorded within the species' distribution in WA. Competition, predation and infection from these species are known to be affecting the species. Various birds found in the area are known to predate upon the species. This was		

	recorded as an issue when a weir in the Goodga River prevented the fish from migrating upstream and they congregated below the weir, increasing their risk of predation. The introduced aquatic plant *Typha orientalis* is present in parts of the species' distribution and may impact on water levels, food availability and the movement of the species. Livestock have access to the some parts of the rivers within the species' distribution and cause considerable damage to riparian habitat and therefore affects refuges and food resources for instream biota. There are several other native fish species found within the same river systems, including *Galaxiella munda* (mud minnow, western dwarf galaxias), *Galaxiella nigrostriata* (black-stripe minnow, black-striped dwarf galaxias), *Nannatherina balstoni* (Balston's pygmy perch) and *Nannoperca pygmaea* (little pygmy perch). Conservation efforts to recover these Threatened species would likely also benefit *Galaxiella truttaceus*.
What is the area, extent, abundance of habitat?	The Western Australian ESU is currently known from a 23 km stretch in the Kent River catchment (area of available habitat: 0.023 km^2), a 4 km stretch of the Goodga River catchment (area of available habitat: ~0.008 km^2), and a 2 km stretch of the Angove River catchment (area of available habitat: ~0.004 km^2).
What is the quality of habitat?	Generally good quality water and habitats excellent; but some barriers exist, i.e. weirs, gauging stations and fishway. Both Angove and Goodga Rivers have weirs installed which are inhibiting movements upstream. The Goodga River had a fishway installed in 2003 which has increased the habitat used by the species from a 2 km to 4 km stretch of the river. It is likely that the species used to occur along a larger stretch of the Angove River prior to the installation of the weir.
Is there a decline in habitat area, extent or quality?	Yes ☒ No ☐ Unknown ☐
If there is a decline, is the decline continuing?	Yes ☒ No ☐ Unknown ☐
Provide details:	Major past, current and future threats to the species includes flow reduction (due to climate change and water extraction), presence of instream barriers, and water quality decline (due to salinisation and increased stream temperatures). Cattle are also able to access parts of the rivers, leading to riparian habitat degradation. These threats have and will continue to lead to a reduction in habitat quality, availability and connectivity, including refugia.
What is the critical habitat or habitat important for the survival of the species?	All locations where the Western Australian ESU is known to currently occur and locations with similar habitat where the species was known to occur in the past.

Section 4: Survey

4.1 Survey methods *(Provide details)*	
What survey methods are applicable to the species?	Double-winged fyke nets (set overnight) and seine nets are highly effective equipment for capture freshwater fish in south-western Australian lentic and lotic system. Larvae can be captured using plankton nets and light trap at night, and eggs can be collected using dip nets.

	Mature fish can be tracked by attaching PIT tags.
Are there preferred or recommended survey methods that yield better results for the species?	Fyke netting is now standard for surveying and monitoring fish communities, but seine netting is still appropriate, particularly in refuge pools with low levels of instream structure. Colours fade rapidly in freshly caught or preserved fish. A photograph of a live fish is a more accurate method of capturing the true colours of the fish. Photographs of live specimens are also a useful non-destructive method to confirm identification. Catchability is highest in spring and autumn, during recruitment of juveniles and increased adult activity.
Are there special requirements, techniques, expertise or other considerations that are necessary when surveying for this species?	Personnel should have experience conducting freshwater fish surveys and be able to differentiate between freshwater fish species. When fyke netting, personnel must ensure air hatches are created to prevent air-breathing bycatch (e.g. turtles) from drowning. Fyke netting requires exemption permits from Department of Primary Industries and Regional Development (Fisheries).
Are there reasons why the species may not be detected during surveys?	Larvae can be difficult to survey because of the large size of the lakes where they are found. Eggs are difficult to collect due to the gaps of knowledge regarding spawning habitats.

Can the species be identified in the field?	Yes ☒ No ☐
Provide details:	Refer to Morgan *et al.* (2011) for identification information.
Can the species be easily confused within similar species in the field?	Yes ☐ No ☒ Unknown ☐
Provide details:	There are several other *Galaxias* species within the distribution of *Galaxias truttaceus.* Refer to Morgan *et al.* (2011) for identification information.

List any published survey guidelines, guidance statements, protocols, standard operating procedures or other documents that are relevant to conducting surveys for this species.

Morgan, D., Beatty, S., Klunzinger, M., Allen, M. and Burnham, Q. (2011). *A field guide to freshwater fishes, crayfishes and mussels of south-western Australia.* Beckenham, WA: SERCUL.

Beatty, S., Close, P., Morgan, D., Allen, M and Lawrence, C. (2015). *Conserving freshwater fish in south-west Western Australia: A summary of distribution, migration, critical habitats and threats to the region's most endangered freshwater fishes.* A report for the State Natural Resource Management Officer, Project No. 12035. Perth, WA: Murdoch University.

Allen, G., Midgley, S. and Allen, M. (2002). *Field guide to the freshwater fishes of Australia.* Perth, WA: Western Australian Museum/CSIRO Publishing.

Hardie, S., Barmuta, L. and White, R. (2006). Comparison of day and night fyke netting, electrofishing and snorkelling for monitoring a population of the threatened golden galaxias (*Galaxias auratus*). *Hydrobiologia* 560: 145-158.

Department of Sustainability, Environment, Water, Population and Communities (2011). Survey guidelines for Australia's threatened fish: Guidelines for detecting fish listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999*. Commonwealth of Australia. Retrieved from : http://www.environment.gov.au/resource/survey-guidelines-australias-threatened-fish-guidelines-detecting-fish-listed-threatened

4.2 Survey effort		
Has the species been well surveyed?	Yes ☒	No ☐
Have targeted surveys been conducted for the species?	Yes ☒	No ☐
Provide details of the successful and unsuccessful surveys undertaken for the species:	Surveys for the species conducted between 1996-1999, 2003-2005 and 2009. 2013-2015 targeted fish (and larval) sampling conducted in all rivers and several lakes between Bow River and Angove River, plus several additional rivers to the west of Bow River. A total of > 150 sites were sampled.	

4.3 Research *(Provide details)*				
Has the species been well researched?	Yes ☒	No ☐	Partially ☐	Unknown ☐
What research has been or is being conducted?	• Various research projects into eastern states subpopulations' morphology, genetics, distribution, threats. • McDowall and Frankenberg (1981): morphology and biology • Beatty *et al.* (2014): impact of climate change • Beatty *et al.* (2015): distribution, migration, critical habitat, threats • Close *et al* (2014): migratory movements and behaviour of juvenile fish • McAleer (2005): larval development, diet • Morgan (2003): distribution, impact of parasitism • Morgan and Beatty (2006): vertical-slot fishway to aid migration • Morgan *et al.* (2004), Beatty and Morgan (2013), Beatty *et al*. (2005): impacts of introduced freshwater fish and introduced crayfish • Morgan *et al.* (2016): taxonomy, range and ecology • Rowland *et al.* (2017): larval development • Beatty *et al* (2016), Beatty *et al* (2017): impacts and possibilities of fire water points			
What are the knowledge gaps for the species?	• Spawning biology • Population-size structures • Magnitude and timing of juvenile recruitment • Level of tolerance to salinity			
Research recommendations:	• Research to understand population structure and recruitment differences between locations. • Investigate alternative fishway designs • Determine level of impact of cestode (parasitic worm) infection. • Determine physiological tolerances to salinity			

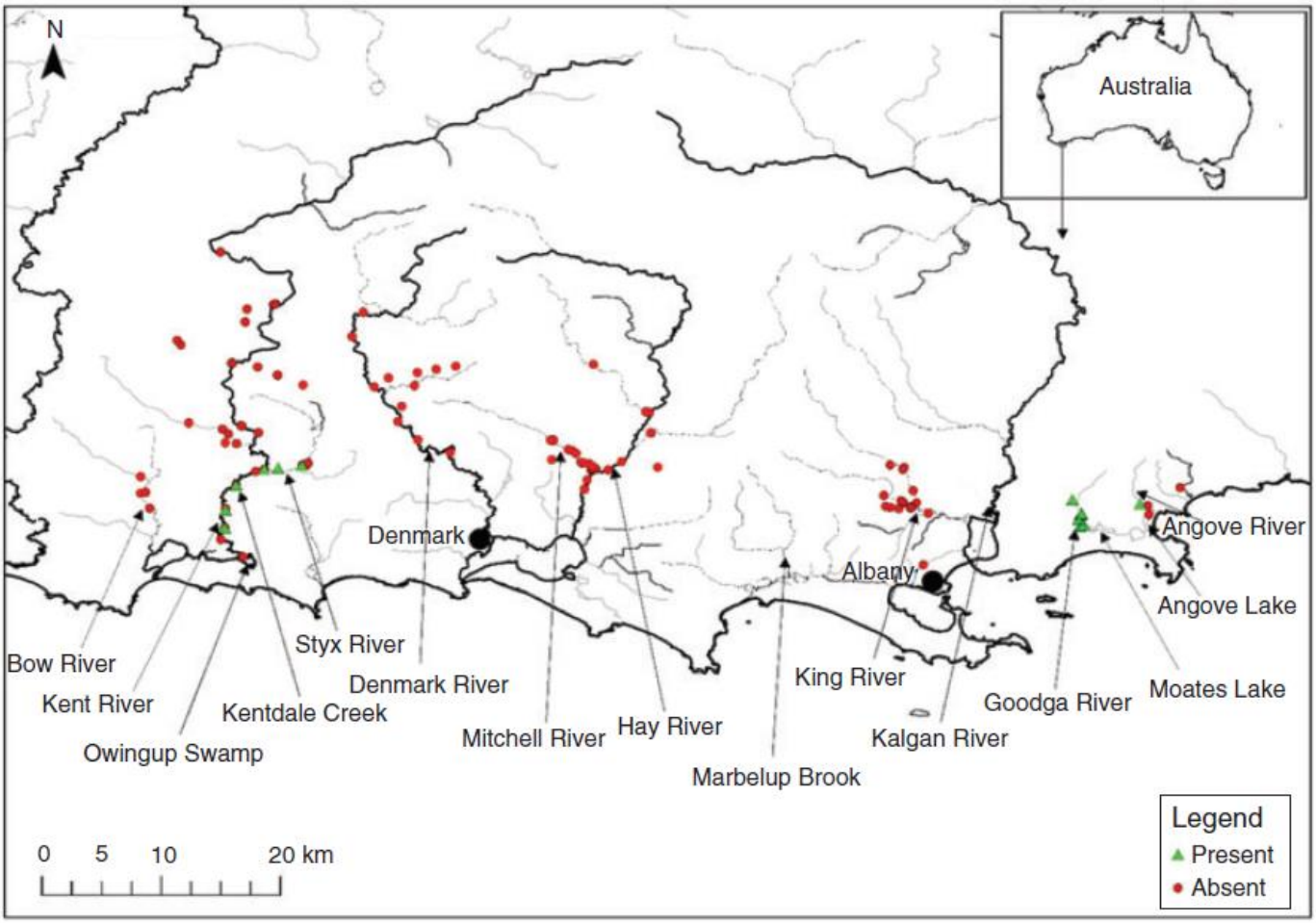
4.4 Monitoring *(Provide details)*	
Is the species being monitored, either directly (targeted) or indirectly (general monitoring)?	• Freshwater fish surveys and monitoring have been conducted within the southwest since the early 1990s by Murdoch Uni and UWA researchers (Morgan *et al.* 1998). • Department of Water and Environmental Regulation (Water section) conducts water monitoring at sites across the southwest (South West Index of River Condition http://www.water.wa.gov.au/water-topics/waterways/assessing-waterway-health/south-west-index-of-river-condition).

What methods are used for monitoring?	See Section 4.1 Survey methods
Monitoring recommendations:	• Continue monitoring all known locations of the species. • Monitor the impact of the known and potential threats to the species.

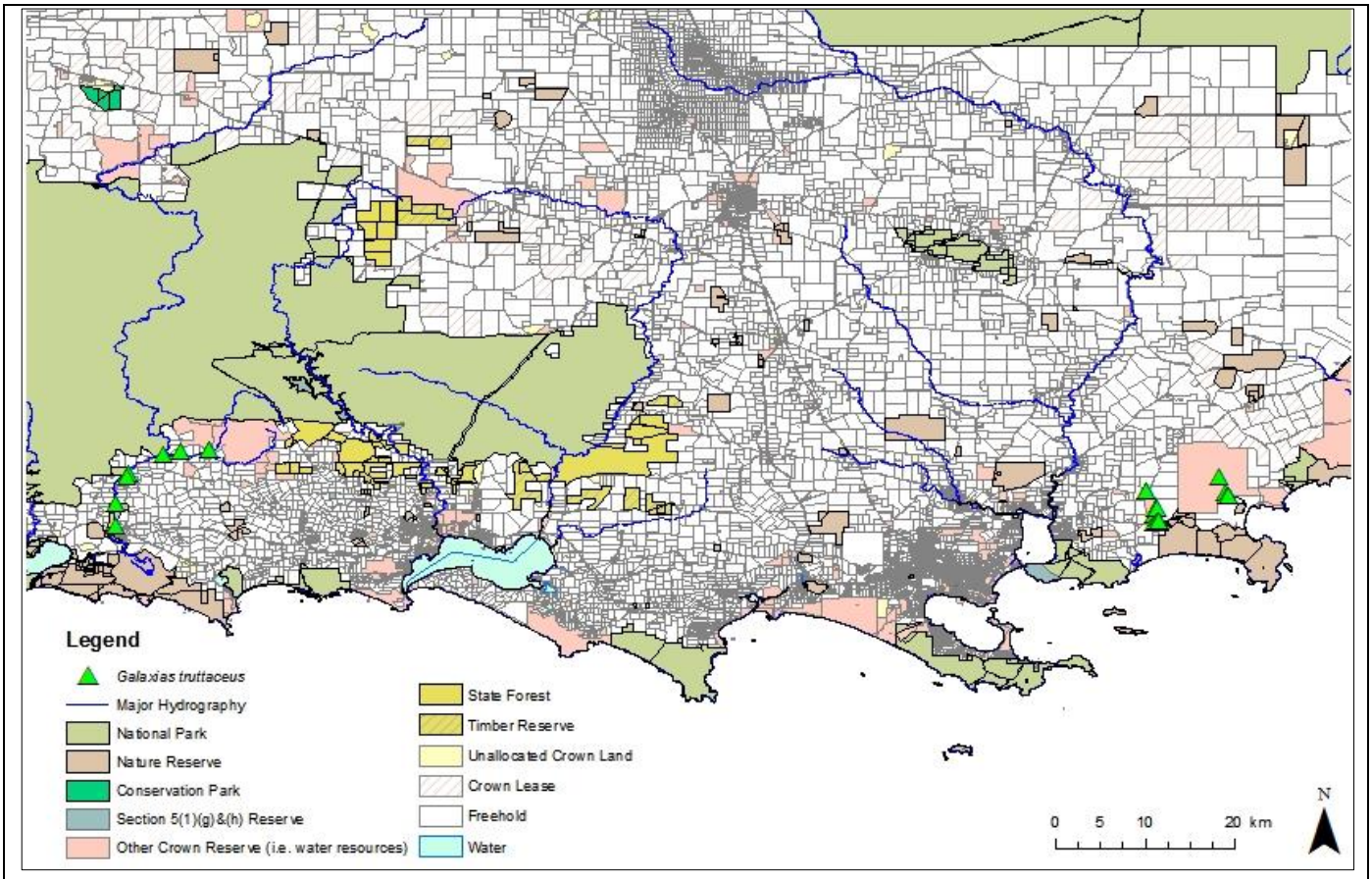
Section 5: Geographic range

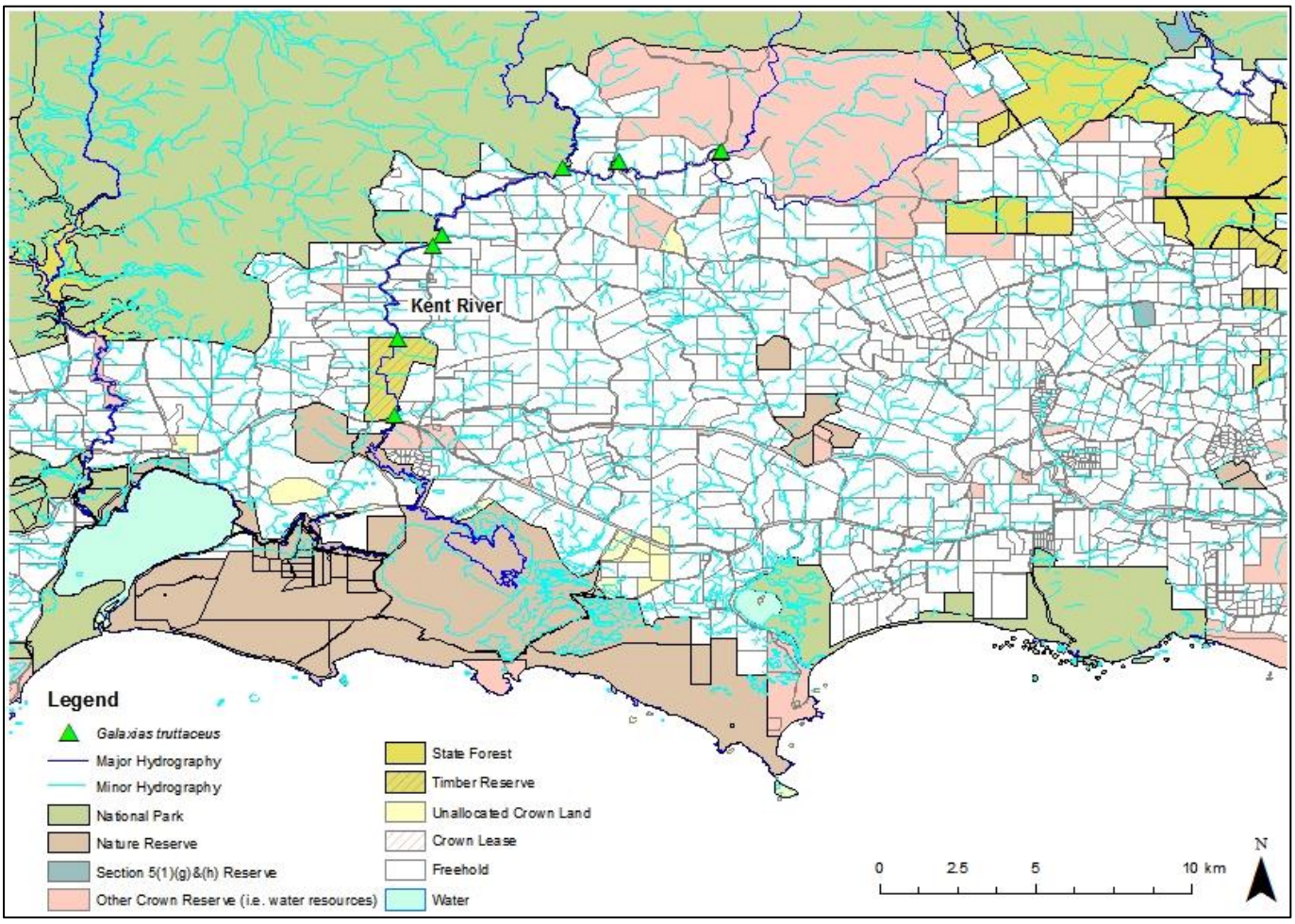
5.1 Distribution

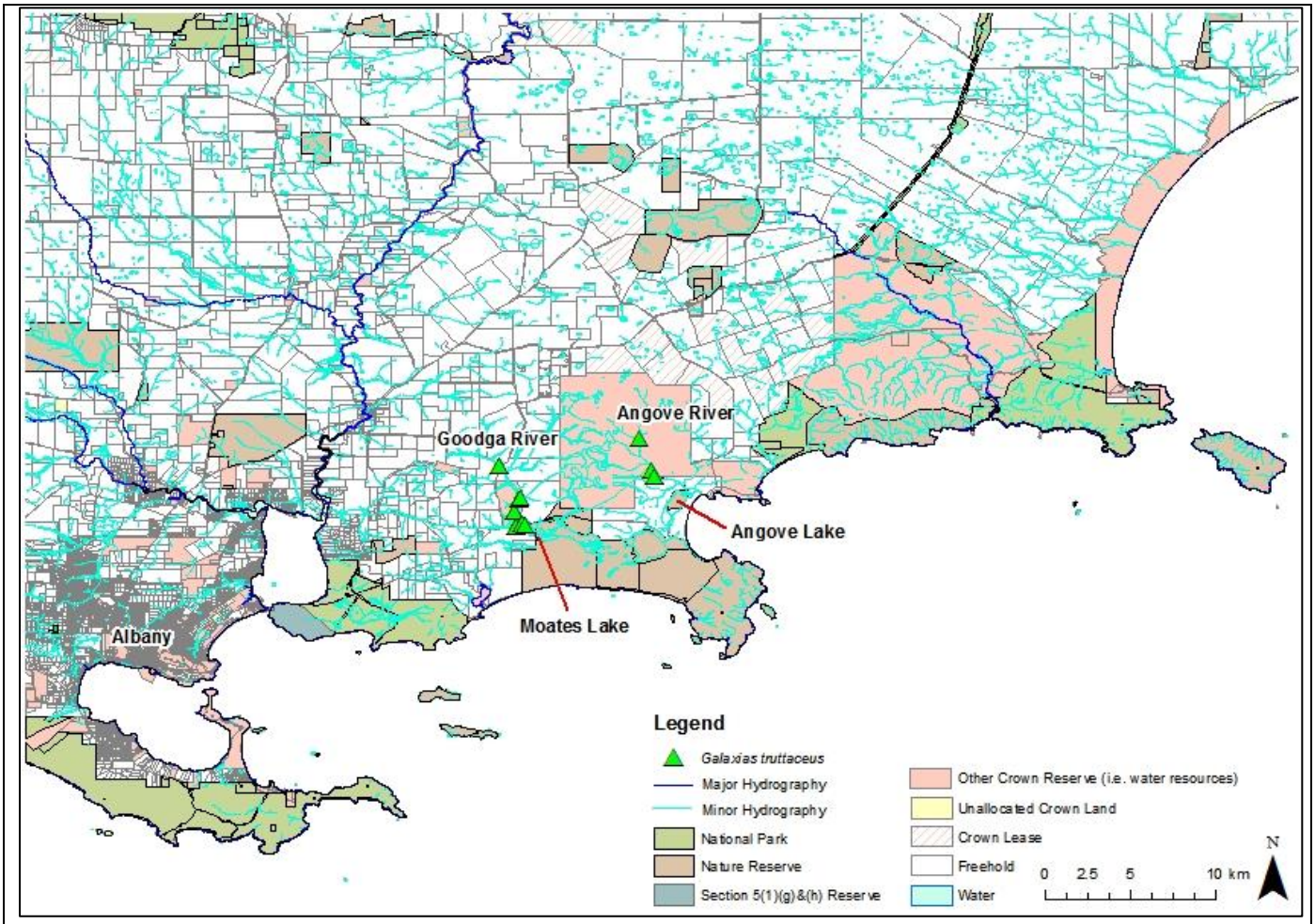
Insert map(s) of the species distribution, or provide as an attachment:



Map of sampling locations where the species has been recorded as present or absent (from Morgan *et al.* 2016).


Legend
Galaxias truttaceus
Major Hydrography
National Park
Nature Reserve
Conservation Park
Section 5(1)(g)&(h) Reserve
Other Crown Reserve (i.e. water resources)
State Forest
Timber Reserve
Unallocated Crown Land
Crown Lease
Freehold
Water
0 5 10 20 km
N


Kent River
Legend
Galaxias truttaceus
Major Hydrography
Minor Hydrography
National Park
Nature Reserve
Section 5(1)(g)&(h) Reserve
Other Crown Reserve (i.e. water resources)
State Forest
Timber Reserve
Unallocated Crown Land
Crown Lease
Freehold
Water
0 2.5 5 10 km
N



What is the current distribution of the species within Western Australia?	The species is currently found in three catchments: • Kent River, two of its tributaries (Styx River and Kentdale Creek) and Owingup Swamp • Goodga River and Moates Lake • Angove River and Angove Lake
What percentage of the species distribution is within WA?	Unknown for the species, but 100 % of the Western Australian ESU is located within WA.
What is the current distribution of the species within the other Australian States and Territories?	The species is also found in South Australia, Tasmania (including King, Flinders and Clarke Islands in the Bass Strait) and Victoria. Conservation agencies from South Australia, Victoria and Tasmania have advised that the species is not under threat in their states, and hence the Western Australian ESU is being considered as a distinct population for the purpose of listing, with the support of the other states.
Does the species occur outside of Australia?	Yes ☐ No ☒
If Yes, what percentage of the species distribution is within Australia, or what is the significance of the occurrence in Australia?	N/A
What is the current international trend for the species? (if known)	N/A
5.2 Migration *(fauna only)*	
Is the species migratory?	Yes ☒ No ☐ Unknown ☐

Is the migration within WA or within Australia or international? (include details of migration routes if known)	Migration occurs only within each river catchment.

5.3 Extent of Occurrence (EOO) within Australia

What is the current EOO?	700 km^2
How has this been calculated?	Minimum convex polygon using records from the past 10 years
What is the historical EOO?	Unknown. There are limited records and information on the species past-distribution. Historically it was also recorded at Taylor Inlet, Nanarup, King River and Kalgan River.
What is the current EOO trend?	Decreasing ☒ Increasing ☐ Stable ☐ Unknown ☐
Provide details on the current trend – quantify if possible	It is inferred that the species was previously found in other land-locked freshwater rivers along the south coast of WA and therefore the historical EOO was likely larger than the current EOO.
If there has been a change in EOO when did this change occur?	In the past
Was the change observed, estimated, inferred or projected?	Inferred
If the EOO is decreasing / declining, is it continuing?	Yes ☒ No ☐ Unknown ☐ N/A ☐
Is the continuing decline observed, estimated, inferred or projected?	It is projected that the EOO will continue to decrease due to the major threat of flow reduction (due to climate change and water extraction).
Is there extreme fluctuation in EOO?	Yes ☐ No ☒ Unknown ☐
If Yes, provide details:	N/A

5.4 Area of Subpopulations within Australia *(if not known, go to section 5.5)*

What is the current area of the known subpopulations or occupied habitat?	Western Australian population (ESU): Kent subpopulation: found along a 23 km stretch of river from Styx River, along the upper Kent River and into Owingup Swamp. Area of available habitat: ~0.023 km^2. Previously, when first nominated and listed in 2005, the area of available habitat was calculated as 0.001 km^2 (being a 1 km stretch of river x 1 m in width) based on the species records known at that time. The recalculated figure is using the length of river that the 2013-2015 species captures were recorded along and the same river width. Goodga subpopulation: restricted to a 4 km stretch of the Goodga River and Moates Lake (area of available habitat: ~0.008 km^2) Angove subpopulation: restricted to a 2 km stretch of the Angove River downstream of a weir and Angove Lake (area of available habitat: ~0.004 km^2)
How has this been calculated?	The length of the river where the species has been recorded multiplied by the average width of the river
What is the historical area of	Unknown. The species possibly would have been found in other south

subpopulations?	coast land-locked freshwater river catchments.
What is the current area of subpopulations trend?	Decreasing ☒ Increasing ☐ Stable ☐ Unknown ☒
Provide details on the current trend – quantify if possible	Both Angove and Goodga Rivers have weirs installed which are inhibiting migratory movements upstream. The Goodga River had a fishway installed in 2003 which has increased the habitat used by the species from a 2km to 4km stretch of the river. It is likely that the species previously occurred along a larger stretch of the Angove River prior to the installation of the weir. Climate change has led to a 10-15 % reduction in average annual rainfall in the southwest, leading to 50 % reduction in the rivers' surface flows (Beatty *et al.* 2014, CSIRO 2009, Ogston *et al.* 2016). It is projected that there will be a 4-month increase in the period of no-flow in the Kent River (Morgan *et al.* 2016). The Kent River was previously freshwater but salinity exceeded > 500 mg/L Total Dissolved Solids (TDS) in the 1960s.
If there has been a change in the area of subpopulations when did this change occur?	Past, present and future
Was the change observed, estimated, inferred or projected? Give details.	Observed and inferred
If the area of subpopulations is decreasing / declining, is it continuing?	Yes ☒ No ☐ Unknown ☐ N/A ☐
Is the continuing decline observed, estimated, inferred or projected? Give details.	Salinisation and water flow reduction (climate change) will likely continue to reduce the amount of habitat available to the species.
Is there extreme fluctuation in the area of subpopulations?	Yes ☐ No ☒ Unknown ☐
If Yes, provide details:	The species is migratory and therefore the location of the subpopulation along the catchment naturally fluctuates. However the scale of fluctuation is not considered to be 'extreme'.
5.5 Area of Occupancy (AOO) within Australia	
What is the current AOO (estimated using the 2x2km grid method specified in the IUCN guidelines)?	48 km^2 (using records from the past 10 years)
What is the historical AOO?	72 km^2 (using all records). There are limited records and information on the species past-distribution and it was likely located in other south coast land-locked freshwater rivers. Therefore this historical AOO is likely an underestimate.
What is the current AOO trend?	Decreasing ☒ Increasing ☐ Stable ☐ Unknown ☐
Provide details on the current trend – quantify if possible	Historical records of the species at Taylor Inlet, Nanarup, King River and Kalgan River. Both Angove and Goodga Rivers have weirs installed which are inhibiting migratory movements upstream. The Goodga River had a fishway

	installed in 2003 which has increased the habitat used by the species from a 2 km to 4 km stretch of the river. It is likely that the species used to occur along a larger stretch of the Angove River prior to the installation of the weir. Water surface flow reductions and salinity have impacted on suitable habitat, and climate change is projected to further decrease the area of suitable habitat.
If there has been a change in AOO when did this change occur?	Past, present and future
Was the change observed, estimated, inferred or projected? Give details.	Observed. Recent surveys between the Bow River and Angove River, with additional surveys of several rivers to the west of Bow River, including locations of historical records, have not located the species anywhere except in the Kent, Goodga and Angove catchments.
If the AOO is decreasing / declining, is it continuing?	Yes ☒ No ☐ Unknown ☐ N/A ☐
Is the continuing decline observed, estimated, inferred or projected? Give details.	Projected Climate change has led to a 10-15 % reduction in average annual rainfall in the southwest, leading to 50 % reduction in the rivers' surface flows (Beatty *et al.* 2014, CSIRO 2009, Ogston *et al.* 2016). It is projected that there will be a 4-month increase in the period of no-flow in the Kent River (Morgan *et al.* 2016). The Kent River was previously freshwater but salinity exceeded > 500 mg/L TDS in the 1960s.
Is there extreme fluctuation in AOO?	Yes ☐ No ☒ Unknown ☐
If Yes, provide details:	The species is migratory and therefore the area occupied by the species along the catchment naturally fluctuates. However the scale of fluctuation is not considered to be 'extreme'.
5.6 Number of Locations	
'Locations' are defined as a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present. The size of the location depends on the area covered by the threatening event and may include part of one or many subpopulations. Where a taxon is affected by more than one threatening event, location should be defined by considering the most serious plausible threat. (IUCN 2001).	
At how many locations does the species occur?	3
Has there been a change in the number of locations?	Decrease ☒ Increase ☐ No change ☐ Unknown ☐
If there has been a change, when did this change occur?	Historical records of the species at Taylor Inlet, Nanarup, King River and Kalgan River.
Was the change observed, estimated, inferred or projected? Give details.	Observed. Recent surveys of all rivers between Bow River and Angove River, including locations of historical records, did not find the species in any catchments except for the Kent, Angove and Goodga rivers.
If the number of locations is decreasing / declining, is it continuing?	Yes ☒ No ☐ Unknown ☐ N/A ☐
Is the continuing decline observed,	Projected. Potamodromous fishes are likely to continue to be impacted by

estimated, inferred or projected? Give details.	flow reductions (climate change and water extraction) with serious implications for population dynamics and viability, which is project to result in losses of individuals, and possibly subpopulations and locations.
Is there extreme fluctuation in the number of locations?	Yes ☐ No ☒ Unknown ☐
If Yes, provide details:	N/A
Does this species occur on any off-shore islands?	Yes ☐ No ☒
If Yes, provide details:	It occurs only on off-shore islands in the Bass Strait (i.e. not the Western Australia ESU).
5.7 Fragmentation	
Is the distribution fragmented?	Yes ☒ No ☐ Unknown ☐
The phrase '**severely fragmented**' refers to the situation in which increased extinction risks to the taxon results from the fact that most of its individuals are found in small and relatively isolated subpopulations (in certain circumstances this may be inferred from habitat information). These small subpopulations may go extinct, with a reduced probability of recolonization.	
Is the distribution severely fragmented?	Yes ☐ No ☒ Unknown ☐
If Yes, provide details:	Not severely fragmented as per IUCN definition, however, the three subpopulations in Western Australia are found in three separate land-locked and isolated catchments. Recolonisation can only occur from sources within the particular catchment, and therefore there is a significant risk of each subpopulation going locally extinct.
5.8 Land tenure	
Is the species known to occur on lands managed primarily for nature conservation? i.e. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation	Yes ☒ No ☐
If Yes; provide details:	Sections of the all three rivers flow through/are within conservation lands, including National Parks and Nature Reserves. However the river sections where the species has been captured is predominantly not within conservation lands.
Is the species known to occur on lands that are under threat? i.e. mining tenement, zoned for development	Yes ☒ No ☐
If Yes; provide details:	All three catchments are used or are planned to be used for water resources (Crown Reserves for catchment purposes). A section of one river is within a Timber Reserve.
Provide details of other land tenures where the species occurs as this relates to the species conservation status	Private property and Unallocated Crown Land

Section 6: Population

'Population' is used in a specific sense in the Red List Criteria that is different to its common biological usage. Population is here defined as the total number of mature individuals of the taxon. In the case of taxa obligately dependent on other taxa for all or part of their life cycles, biologically appropriate values for the host taxon should be used. (IUCN 2001)

'Subpopulations' are defined as geographically or otherwise distinct groups in the population between which there is little demographic or genetic exchange (typically one successful migrant individual or gamete per year or less).

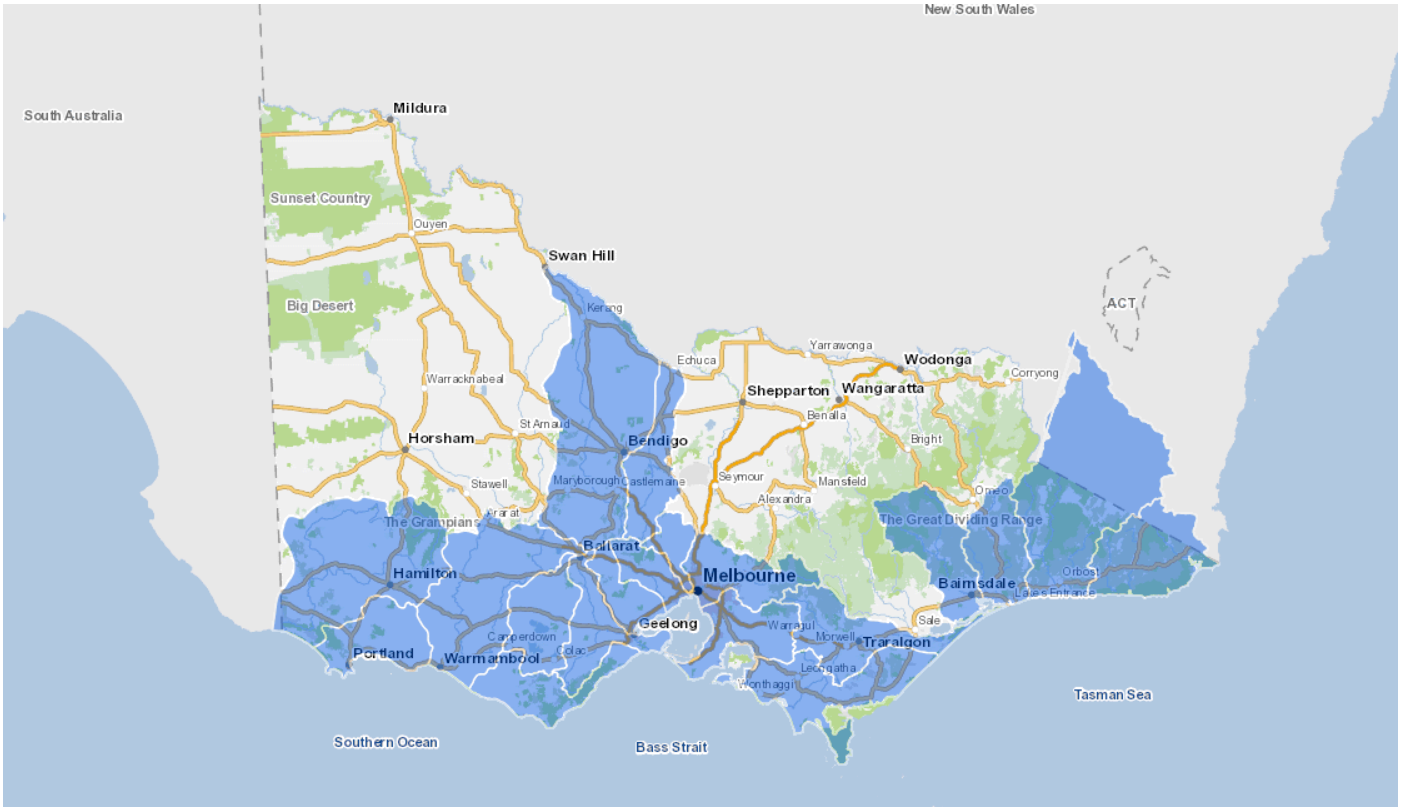
6.1 Subpopulations

Subpopulation location *(include coordinates)*	Land tenure	Survey information: Date of survey and No. mature individuals	Area of subpopulation	Site / habitat Condition
Kent River, including two of its tributaries (Styx River and Kentdale Creek) and Owingup Swamp	National Park, Nature Reserve, Timber Reserve, Unallocated Crown Land, Crown Reserve (Catchment/water resources), Private Property	2013-2015: 56	23 km stretch of river (area of available habitat: ~0.023 km^2)	The habitat is in very good condition; water quality is excellent, tannin stained
Goodga River and Moates Lake	Nature Reserve, Crown Reserve (Waterway), Private Property	2013-2015: 3215	4 km stretch of river (area of available habitat: ~0.008 km^2)	The habitat is generally in very good condition; water quality is excellent, tannin stained However Goodga catchment is modified.
Angove River and Angove Lake	Nature Reserve, Crown Reserve (Catchment/water resources)	2013-2015: 303	2 km stretch of river (area of available habitat: ~0.004 km^2)	The habitat is in very good condition; water quality is excellent, tannin stained

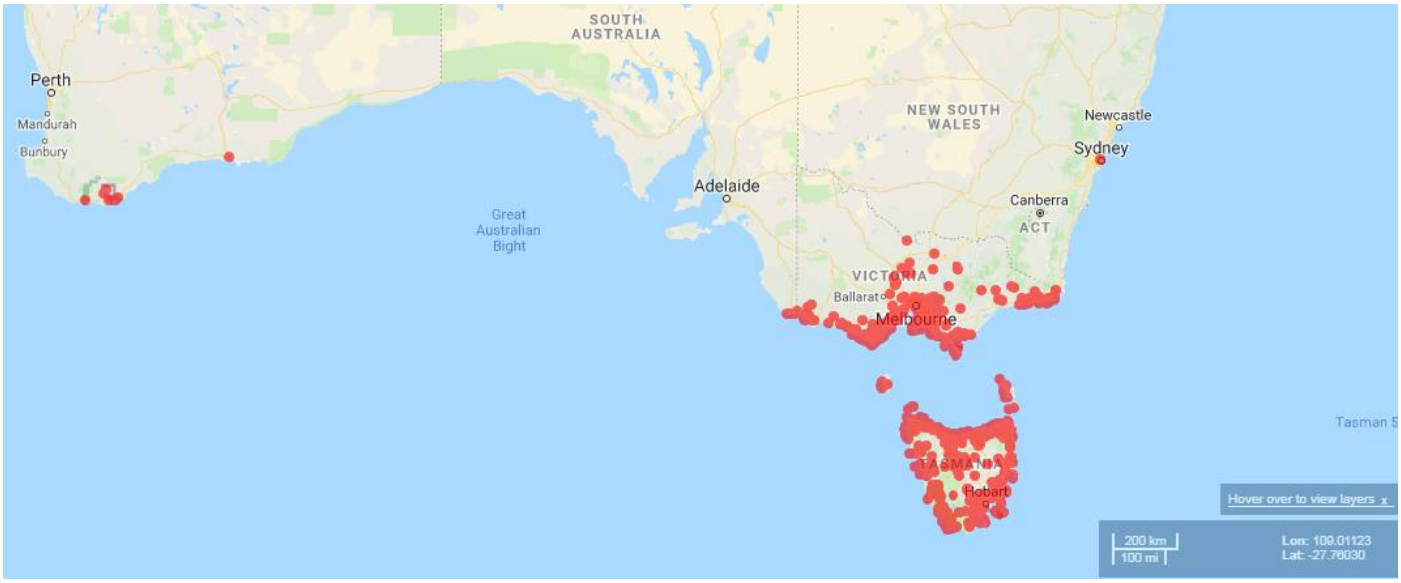
6.2 Population size (Australian context) *(include how numbers were determined/calculated)*

What is the total population size?	Unknown. The species subpopulations from Western Australia, South Australia, Tasmania and Victoria are not taxonomically distinct from each other but the Western Australian subpopulation should be considered as an evolutionary significant unit (ESU) (Morgan *et al.* 2016). The genetic analysis by Morgan *et al*. (2016) "confirmed the presence of genetically distinctive western and eastern subpopulations in *G. truttaceus*, but provided no evidence that these subpopulations reflect either different species or subspecies (congruent with morphological data), meeting only part of the genetic criteria for separate ESUs (*sensu* Moritz 1995). Nevertheless, they do merit recognition as discrete ESUs when the definition of an ESU is broadened to include ecological criteria (as argued by Crandall *et al.* 2000), namely, the unique ecology of western populations as a signal of evolutionary divergence and regional adaptation." <u>Western Australian population (ESU):</u> Total captures during 2013-2015 surveys of WA subpopulations(mature individuals and juveniles): • Kent: 56 captures • Goodga: 3215 captures

	• Angove: 303 captures Limited mark recapture has been done but should or could be done using photo-ID - spot matching (Morgan, D. pers. comm. 2018). <u>Eastern population (South Australia, Tasmania and Victoria):</u> Advice was sought from the Inter-State jurisdiction counterparts to request any species data, if they agree that the species does not meet eligibility for listing at species level and if they supported the WA proposal to list (retain) the Western Australian population (ESU) as nationally threatened. Responses received confirmed that the species is not of concern in their jurisdictions and supported the WA ESU level nomination. • South Australian Department for Environment and Water: "SA is on the edge of range of the eastern Australian population, so have very little bearing on the national status. The EOO within SA is less than 50 km^2 and the species has been provisionally assessed as Endangered: B1+B2a (< 5 locations), b(ii,iii), but only based on the SA portion of the species range. But it sounds like you already have enough to establish that it is not nationally threatened." • Tasmanian Department of Primary Industries, Parks, Water and Environment: "*Galaxias truttaceus* is common and widespread in Tasmania, occupying coastal streams as well as occurring in some land-locked waterbodies and the marine environment. There are over 1500 records for the species in Tasmania, and it is not one that we would consider for listing. On that basis we support the proposal to list (retain) the Western Australian population as nationally threatened." • Victorian Department of Environment, Land, Water and Planning: "This species is widespread in Victoria (see blue catchments on map) - there are 900+ records in Victoria for this species - it is not considered to be of conservation concern."



Galaxias truttaceus distribution (blue shaded catchments) within Victoria (DELWP pers. comm. 2018)



Galaxias truttaceus distribution from The Atlas of Living Australia (ALA), including historical records however majority of records are since 1980.

What is the number of subpopulations?	Unknown 3 subpopulations in the Western Australian ESU
What percentage of the population is within WA?	Unknown
What percentage of the population is within Australia?	100 %
6.3 Population dynamics (Australian context) *(include how numbers were determined/calculated)*	
What is the number of mature individuals?	Unknown

	A total of 3574 individuals (including juveniles) were captured in WA between 2013 and 2015.
What is the number of immature individuals?	Unknown
What is the number of senescing/past reproductive individuals?	Fish aged 4-7 years contribute to less than 4 % of the Goodga subpopulation (based on captures in 1996-1999).
What is the maximum number of mature individuals per subpopulation?	Unknown
What is the percentage of mature individuals in the largest subpopulation?	In the Goodga subpopulation, 47.2 % of individuals captured in the period 1996-1999 were in the 1-7 age classes and 12.8 % were in the 2-7 age classes.
What percentage of mature individuals is within WA?	Unknown
What percentage of global mature individuals is within Australia?	100 %
What is the age of sexual maturity?	1-2 years
What is the life expectancy?	5 years (maximum recorded: 7 years)
What is the generation length?	2-3 years
What is the reproductive capacity? (i.e. litter size, number of eggs or number of seeds)	Unknown
What is the reproductive success?	Unknown

6.4 Population trend

What is the current population trend (mature individuals)?	Decreasing ☒	Increasing ☐	Stable ☐	Unknown ☐
What is the percentage of the population change and over what time period?	Unknown. The population trend is assumed to be decreasing (past, present and future) based on knowledge of habitat decline, life history and threats.			
How has this been calculated?	N/A			
If the trend is decreasing; are the causes of the reduction understood?	Yes ☒	No ☐	Unknown ☐	
Have the causes of the reduction ceased?	Yes ☐	No ☒	Unknown ☐	
Are the causes of the reduction reversible?	Yes ☒	No ☒	Unknown ☐	
Is the reduction continuing (continuing decline)?	Yes ☒	No ☐	Unknown ☐	
Has the change been observed, estimated, inferred or is it suspected (direct observation, index of abundance appropriate to the species)? Give details	Decline has been observed and inferred based on water extraction rates and climate change modelling. Globally, water extraction and climate change are predicted to cause a loss of up to 75 % of freshwater fish diversity by 2070. Potamodromous fish are vulnerable to climate change. Any changes in flow are expected to reduce reproductive and recruitment success.			

	The presence of weirs is known to increase the risk of predation, although this can be reversed by installing a fishway to allow migration. Introduced species (currently *Gambusia holbrooki, Cherax destructor* and *Ligula intestinalis*) are known to increase mortality (from competition, predation and disease/infection).
When was the reduction or is it anticipated to occur?	Past ☒ Present ☒ Future ☒
What is the period of time for the reduction (in years and generations)?	Unknown. There is no information to calculate population size reduction, but it is suspected, based on climate change modelling, that the species could potentially undergo a severe reduction, including both the past and the future (up to a maximum of 100 years).
Are there extreme fluctuations in population size?	Yes ☐ No ☒ Unknown ☐
If Yes, provide details:	N/A

6.5 Translocations and captive/enclosed subpopulations

Have there been translocations (introduction or re-introduction)?	Yes ☒ No ☐ Unknown ☐
Are there proposed translocations (introduction or re-introduction)?	Yes ☐ No ☒ Unknown ☐
Are there self-sustaining translocated subpopulations?	Yes ☐ No ☒ Unknown ☐
Are there translocated subpopulations that are not self-sustaining?	Yes ☒ No ☐ Unknown ☐
If Yes is the response to any of the four questions above, provide summary details:	In 2004, 25 individuals were collected from the Goodga River and translocated into a wetland on private property in the upper Goodga catchment. No *Galaxia truttaceus* were observed in the wetland during surveys in April 2008. It is assumed that the translocation was unsuccessful. The *Western Trout Minnow Recovery Plan* (DEC, 2008a) recommends investigating the potential for translocations.
Are there captive/enclosed/cultivated subpopulations?	Yes ☐ No ☒ Unknown ☐
Are there proposed captive/enclosed/cultivated subpopulations?	Yes ☐ No ☒ Unknown ☐
Are there self-sustaining captive/enclosed subpopulations?	Yes ☐ No ☒ Unknown ☐
Are there captive/enclosed subpopulations that are not self-sustaining?	Yes ☐ No ☒ Unknown ☐
If Yes is the response to any of the four questions above, provide summary details:	The *Western Trout Minnow Recovery Plan* (DEC, 2008a) recommends investigating the potential for a captive breeding/rearing program. The Department of Primary Industries and Regional Development (Fisheries) bred the species in captivity during the NRM project. No report is available, but it was successful (Morgan, D. pers. comm. 2018).
Other information on translocations and captive/enclosed subpopulations for the species (including failures):	N/A

6.6 Important subpopulations

Identify any subpopulations that are important or necessary for the long-term survival of the species and provide details for why they are considered as such (i.e. key breeding, edge or range, maintenance of genetic diversity):

All subpopulations are important and necessary for the long-term survival of the species. The remaining subpopulations are isolated and have relatively small population sizes, leaving them vulnerable to local extinctions through stochastic events.

Section 7: Threats

7.1 Threats *(detail how the species is being impacted, i.e. how severe, the extent, evidence of the impact)*				
Threat *(describe how the threat impacts on the species. Include abiotic and biotic causes, human related e.g. exploitation, and biological characteristics of the species e.g. low genetic diversity)*	Extent *(give details of impact on whole species or specific subpopulations)*	Impact *(what is the level of threat to the conservation of the species)*	Evidence	Time period *(past, present, future)*
Flow reduction – water abstraction and land use exacerbated by rainfall declines associated with climate change Any change in the timing and/or magnitude of water flow during migration, spawning and recruitment will reduce reproductive and recruitment success. Flow reduction reduces connectivity and quality of the species' habitats. Flow reduction will reduce spawning habitat availability and connectivity on both a temporal and spatial scale. Flow reduction may lead to a loss of permanently watered summer refugia, which the species relies on for survival over the summer period.	Entire	High	The Kent River has been recognised as a potential potable water supply for the future. The Goodga and Angove rivers are partially in a Water Catchment Reserve and are used for domestic, industrial and agricultural water supply. In 2001, the extraction volume from the Angove River was removing 67-82 % of the river's mean annual flow. There are blue gum plantations in the Goodga catchment that possibly alter the amount of groundwater recharge into aquatic systems, and increase soil runoff and deposition. Climate change in southwest WA has resulted in a 10-15 % reduction in average annual rainfall. There has been an associated 70 % decline in average surface discharge into major water supply dams this decade. There has also been a 50 % reduction in rivers' surface flows. It is projected that there will be a 4-month increase in the period of no-flow in the Kent River. Globally, reduction in river discharge due to water extraction and climate change is predicted to cause a loss of up to 75 % of freshwater fish diversity by 2070.	Past, present and future
Instream barriers from existing weirs and dams	Goodga and Angove River	High	The Goodga and Angove rivers are partially in a Water Catchment Reserve and are regulated by weirs.	Past (Goodga) Present and future

Instream barriers impedes migration leading to increased mortality and reduced recruitment. Barriers also reduce the amount of habitat available.			The Goodga River weir was found to be a significant threat to the sustainability of the subpopulation because it impeded movement up the river. It therefore reduced the amount of habitat to the fish, prevented migration upstream for spawning, and increase the risk of predation by birds due to the congregation of the fish downstream of the weir. A fishway was constructed at the Goodga River weir and it has been concluded as successful in increasing available habitat and allowing migratory movement.	(Angove)
Water quality decline – salinisation *Galaxias truttaceus* is only known from freshwater habitats. Any increase in salinity may exceed the species physiological tolerances, therefore leading to range and population size reductions.	Kent River	High	Extensive land clearing in the period 1950-1970 contributed to a rapid rise in the salinity of the upper Kent River. The Kent River water was previously fresh but salinity exceeded > 500 mg/L TDS in the 1960s and in 2007 was recorded as 1480 mg/L TDS. Current land clearing regulations have been in place since the late 1970s and the establishment of Tasmanian bluegum plantations has decreased the amount of cleared land in the upper catchment of the Kent River. Additional plans are in place with the aim of reducing salinity to 500 mg/L TDS. Increased secondary salinisation in the Kent River may result in increased mortality during baseflow. Other freshwater fishes have experienced large range reduction due to secondary salinity, and it is likely the species has been lost from other rivers in the area (e.g. King and Kalgan River) due to secondary salinisation.	Past, present and future
Water quality decline – increased instream temperature Climate change is leading to increases in instream temperatures. These temperatures may exceed the species physiological tolerances, therefore leading to range and population size	Entire	High	Average annual air temperatures in Australia have risen by 0.9 °C over the past 50 years. This air temperature rise, as well as reduced water flow, leads to increased instream temperatures. Successful spawning and recruitment for freshwater fish is unlikely in streams with low water levels, high water temperatures and associated reduced dissolved oxygen. Studies have found that other Australian	Future

reductions.			freshwater fish have a maximum sustained tolerance for temperatures 27-29 °C and that larval survival is very low at these temperatures.	
Introduced species – *Gambusia holbrooki* (eastern gambusia, mosquito fish) Competition, predation, aggression and disease from the introduced *Gambusia holbrooki.*	Entire	Medium-High	*Gambusia holbrooki* is prolific in the Kent River where it is known to have a severe impact on native fishes. It has recently been recorded in the Goodga and Angove Rivers. These new occurrences indicate that invasive species may represent an increased risk to *Galaxias truttaceus.* There is the potential for other fish to be introduced into the three river catchments by human activity or flooding from an artificial structure.	Past, present and future
Introduced species – *Cherax destructor* (common yabbie) Predation and disease from the introduced *Cherax destructor.*	Goodga River (currently), Entire (future)	Medium-High	*Cherax destructor* is widespread throughout the region and has recently been recorded in the Goodga River. These new occurrences indicate that invasive species may represent an increased risk to *Galaxias truttaceus.*	Present and future
Introduced species – *Ligula intestinalis* (a cestode, parasitic worm) Infection of the introduced cestode *Ligula intestinalis* affects the survival and reproductive potential of *Galaxias truttaceus.*	Goodga and Angove Rivers (currently), Entire (future)	Medium-High	*Ligula intestinalis* is known to occur in the Goodga River catchment and has recently been identified in fish in the Angove River. These new occurrences indicate that invasive species may represent an increased risk to *Galaxias truttaceus.* *L. intestinalis* found to occupy the body cavity of 7 % of juveniles in the Goodga River, with no infestation of fish > 80 mm TL, suggesting that mortality occurs in small infected fish. Infestation rates in the Angove River appear to be very low.	Past, present and future
Introduced species – *Typha orientalis* (an introduced aquatic plant) Introduced aquatic plants may impact	Goodga River (currently), Entire (future)	Unknown	*Typha orientalis* is present in the Goodga River and observations show that it is highly concentrated in areas below the weir.	Past, present and future

on water levels, food availability and the movement of the species by blocking water flows.			No quantitative studies have been conducted on the impact of the species. There is the potential for other aquatic plants to be introduced into the three river catchments by human activity.	
Riparian degradation from livestock and vegetation clearing. Riparian habitat provides refuges and food resources to various instream biota, including fish. Degradation/loss of this habitat will lead to reduced population sizes.	Private properties along the Kent, Goodga and Angove Rivers	High in areas where it is a threat.	Livestock can cause considerable damage to riparian habitat and increase erosion of banks. Private properties allow stock to access to the rivers. Private properties within the vicinity of the Kent, Angove and Goodga rivers have largely been cleared of vegetation for agricultural purposes. This past vegetation clearing and landuse change has negatively affected the quality of the riparian vegetation. The majority of the occurrences of the species are not located within private properties.	Past, present and future
Bushfire and inappropriate fire regimes Fires can impact on aquatic biota by causing increases in runoff, erosion of stream banks, suspended sediment and turbidity level and stream temperatures, and changes in water chemistry.	Entire	Unknown, potentially high.	The impact of fire on *Galaxias truttaceus* is unknown but could be significant due to the isolation and relatively small distribution of the subpopulations. It is predicted that climate change will increase the intensity and frequency of bushfires in southwest WA.	Future

Section 8: Management

8.1 Current management		
Is the species managed?	Yes, directly ☐ Yes, indirectly ☒ No ☐	
If Yes; provide details of current or past management actions:	• The Department of Water and Environmental Regulation manages waterways for economic, social and environmental benefits. The species benefits from the protection and management measures undertaken for rivers within its distribution. • There are rivers and wetlands in the south-west that fall within or are directly adjacent to Department-managed lands. The species therefore benefits from any habitat protection and management undertaken in these areas. • Fire programs within Department-managed lands consider riparian vegetation prior to conducting burns, and the Freshwater Fish Group at Murdoch University has recently assessed and made recommendations regarding the impact of fire water points on freshwater fish in the Warren Region. • The Freshwater Fish Group at Murdoch University and the South East Regional Centre for Urban Landcare have produced informational products, including a field guide. • The *WA Native Fish Strategy*, funded by the State NRM and undertaken by the WA Department of Fisheries and Department of Water, compiled survey data on native and feral fish into a database, reviewed management actions and developed a public website as an information source for the general public. The WA Department of Fisheries has also produced other educational products, including the *Aquatic Invaders Identification Guide: Freshwater*.	
Does the species benefit from the management of another species or ecological community?	Yes ☒ No ☐ Unknown ☐	
If Yes; provide details:	The species occurs within/near the following ecological communities: 'Banksia coccinea shrubland' and 'Banksia coccinea thicket.' *Galaxia truttaceus* would likely benefit from the management of these EPBC listed TECs.	

8.2 Recovery planning	
Is there an approved Recovery Plan (RP) or Interim Recovery Plan (IRP) for the species?	Yes ☒ No ☐

List all relevant recovery plans or interim recovery plans (including draft, in-preparation, out-of-date, national and other State/Territory plans, and plans for other species or ecological communities that may benefit or be relevant to the nominated species):

Department of Environment and Conservation (2008a). *Western trout minnow (Galaxias truttaceus hesperius) Recovery Plan: Western Australian Wildlife Management Program No. 47.* Perth, WA: Department of Environment and Conservation. Retrieved from: https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/recovery_plans/western-trout-minnow-recovery_plan_47.pdf

List other documents that may be relevant to the management of the species or the lands on which it occurs (i.e. area management plans, conservation advices, referral guidelines):

Department of the Environment, Water, Heritage and the Arts (2008). *Approved Conservation Advice for Galaxias truttaceus hesperius (Western Trout Minnow)*. Canberra, ACT: Department of the Environment, Water, Heritage and the Arts. Retrieved from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/81282-conservation-advice.pdf.

Beatty, S., Close, P., Morgan, D., Allen, M and Lawrence, C. (2015). *Conserving freshwater fish in south-west Western Australia: A summary of distribution, migration, critical habitats and threats to the region's most endangered freshwater fishes.* A report for the State Natural Resource Management Officer, Project No.

12035. Perth, WA: Murdoch University.

Department of Biodiversity, Conservation and Attractions (2017). Albany coast parks and reserves management plan 90, 2017. Department of Biodiversity, Conservation and Attractions, Perth. Retrieved from: https://www.dpaw.wa.gov.au/parks/management-plans/approved-management-plans

Department of Environment and Conservation (2008b). Walpole wilderness and adjacent parks and reserves management plan 61, 2008. Department of Environment and Conservation, Perth. Retrieved from: https://www.dpaw.wa.gov.au/parks/management-plans/approved-management-plans

8.3 Management recommendations

Conservation strategies should focus on the maintenance of natural flow variability and habitat connections, management of secondary salinisation and protection of nature stream-side vegetation.

Section 9: Nominator details

Nominator name(s):	Species and Communities Branch
Contact details:	
Date submitted:	31/01/2018

If the nomination has been refereed or reviewed by experts, please provide their names and contact details:

David Morgan

Murdoch University

Section 10: References

9.1 References

Allen, G., Midgley, S. and Allen, M. (2002). *Field guide to the freshwater fishes of Australia.* Perth, WA: Western Australian Museum/CSIRO Publishing.

Atlas of Living Australia (ALA). *Galaxias truttaceus* Valenciennes, 1846 - Trout Galaxias, webpage accessed 23 March 2018, https://www.ala.org.au/

Beatty, D., Morgan, D., Rashnavadi and Lymbery, A. (2011). Salinity tolerances of endemic freshwater fishes of south-western Australia: implications for conservation in a biodiversity hotspot. *Marine and Freshwater Research* 62(1): 91-100.

Beatty, S. and Morgan. D (2013). Introduced freshwater fishes in a global endemic hotspot and implications of habitat and climatic change. *BioInvasions Records* 2: 1-9.

Beatty, S. Morgan, D. and Gill, H. (2005). Role of life history strategy in the colonisation of Western Australian aquatic systems by the introduced crayfish Cherax destructor Clark, 1936. *Hydrobiologia* 549: 219-237.

Beatty, S., Close, P., Morgan, D., Allen, M and Lawrence, C. (2015). *Conserving freshwater fish in south-west Western Australia: A summary of distribution, migration, critical habitats and threats to the region's most endangered freshwater fishes.* A report for the State Natural Resource Management Officer, Project No. 12035. Perth, WA: Murdoch University.

Beatty, S., Morgan, D. and Lymbery, A. (2014). Implications of climate change for potamodromous fishes. *Global Change Biology* 20: 1794-1807.

Beatty S., Ryan T., Allen M., Close P. and Morgan D. (2016). *Aquatic fauna assessment of fire waterpoints in the Warren region, south-western WA*. Report to Department of Parks and Wildlife. Freshwater Fish Group and

Fish Health Unit, Murdoch University, Western Australian Museum, and CENRM, UWA Albany.

Beatty S., Ryan T., Allen M., Close P. and Morgan D. (2017). *Aquatic fauna assessment of fire waterpoints in the Frankland region, south-western WA*. Report to Department of Parks and Wildlife. Freshwater Fish Group and Fish Health Unit, Murdoch University, Western Australian Museum, and CENRM, UWA Albany.

Bray, D.J. & Gomon, M.F. (eds) Fishes of Australia. Museums Victoria and OzFishNet, accessed 2018, http://fishesofaustralia.net.au/

Close, P., Ryan, T., Morgan, D., Beatty, S and Lawrence, C. (2014). First record of climbing and jumping by juvenile *Galaxias truttaceus* Valenciennes, 1846 (Galaxiidae) from south-western Australia. *Australian Journal of Zoology* 62: 175-179

Crandall, K. A., Bininda-Emonds, O. R. P., Mace, G. M., and Wayne, R. K. (2000). Considering evolutionary processes in conservation biology. *Trends in Ecology & Evolution* 15, 290–295. doi:10.1016/S0169-5347 (00)01876-0

CSIRO (2009). Water yields and demands in south-west Western Australia. A report to the Australian Government from the CSIRO South-West Western Australia Sustainable Yields Project. CSIRO Water for a Healthy Country Flagship, Australia.

De Silva, J., Bari, M., Dixon, R., Coppolina, M., Boniecka, L. and Ward, B. (2007). *Salinity Situation Statement: Kent River. Report No. WRT 33.* Perth, WA: Department of Water. Retrieved from: https://www.water.wa.gov.au/__data/assets/pdf_file/0013/3334/45006.pdf

Department of Biodiversity, Conservation and Attractions (2017). Albany coast parks and reserves management plan 90, 2017. Department of Biodiversity, Conservation and Attractions, Perth. Retrieved from: https://www.dpaw.wa.gov.au/parks/management-plans/approved-management-plans

Department of Environment and Conservation (2008a). *Western trout minnow (Galaxias truttaceus hesperius) Recovery Plan: Western Australian Wildlife Management Program No. 47.* Perth, WA: Department of Environment and Conservation. Retrieved from: https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/recovery_plans/western-trout-minnow-recovery_plan_47.pdf

Department of Environment and Conservation (2008b). Walpole wilderness and adjacent parks and reserves management plan 61, 2008. Department of Environment and Conservation, Perth. Retrieved from: https://www.dpaw.wa.gov.au/parks/management-plans/approved-management-plans

Department of Primary Industries and Regional Development (Fisheries). Freshwater Fish Distribution in Western Australia: Trout Minnow, *Galaxias truttaceus* webpage accessed 2018, http://freshwater.fish.wa.gov.au/mapspecies.aspx?species_id=37

Department of Sustainability, Environment, Water, Population and Communities (2011). Survey guidelines for Australia's threatened fish: Guidelines for detecting fish listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999*. Commonwealth of Australia. Retrieved from : http://www.environment.gov.au/resource/survey-guidelines-australias-threatened-fish-guidelines-detecting-fish-listed-threatened

Department of the Environment, Water, Heritage and the Arts (2008). *Approved Conservation Advice for Galaxias truttaceus hesperius (Western Trout Minnow)*. Canberra, ACT: Department of the Environment, Water, Heritage and the Arts. Retrieved from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/81282-conservation-advice.pdf.

Hardie, S., Barmuta, L. and White, R. (2006). Comparison of day and night fyke netting, electrofishing and snorkelling for monitoring a population of the threatened golden galaxias (*Galaxias auratus*). *Hydrobiologia* 560: 145-158.

McAleer, F. J. (2005). Larval development and ontogenetic changes in the diet of Trout Minnow (Galaxias truttaceus, Valenciennes 1846) in South Western Western Australia (Honours Thesis). Perth, WA: Murdoch University.

McDowall, R. and Frankenberg, R. (1981). The galaxiid fishes of Australia (Pisces: Galaxiidae). *Records of the Australian Museum* 33: 443-605

Morgan, D. (2003). Distribution and biology of Galaxias truttaceus (Galaxiidae) in southwestern Australia, including first evidence of parasitism of fishes in Western Australia by Ligula intestinalis (Cestoda). *Environmental*

Biology of Fish 66: 155-167.

Morgan, D. and Beatty, S. (2006). Use of a vertical-slot fishway by galaxiids in Western Australia. *Ecology of Freshwater Fish* 15: 500-509

Morgan, D., Beatty, S., Close, P., Allen, M., Unmack, P., Hammer, M. and Adams, M. (2016). Resolving the taxonomy, range and ecology of biogeographically isolated and critically endangered populations of an Australian freshwater galaxiid Galaxias truttaceus. *Pacific Conservation Biology* 22(4): 350-359.

Morgan, D., Beatty, S., Klunzinger, M., Allen, M. and Burnham, Q. (2011). *A field guide to freshwater fishes, crayfishes and mussels of south-western Australia.* Beckenham, WA: SERCUL.

Morgan, D., Gill, H., Maddern, M., and Beatty, S. (2004). Distribution and impacts of introduced freshwater fishes in Western Australia. *New Zealand Journal of Marine and Freshwater Research* 38: 511-523.

Morgan, D. L., Gill, H. S., and Potter, I. C. (1998). Distribution, identification and biology of freshwater fishes in south-western Australia. *Records of the Western Australian Museum* 56(Suppl.), 1–97.

Moritz, C. (1995). Uses of molecular phylogenies for conservation. *Philosophical Transactions of the Royal Society of London. Series B. Biological Sciences* 349, 113–118. doi:10.1098/RSTB.1995.0097

Morrongiello, J., Beatty, S., Bennett,J., Crook, D., Ikedife, D., Kennard, M., Kerezy, A., Lintermans, M. McNeil, D., Pusey, B. and Rayner, T. (2011). Climate change and its implications for Australia's freshwater fish. *Marine and Freshwater Research* 62: 1082-1098.

Ogston, G., Beatty, S.J., Morgan, D.L., Pusey, B.J. and Lymbery, A.J. (2016). Living on burrowed time: Aestivating fishes in south-western Australia face extinction due to climate change. *Biological Conservation* 195: 235-244.

Rowland, F., Close, P., Beatty, S., Allen, M., Gill, H., Berkelaar, J. and Morgan, D. (2017). Larval development and dietary ontogeny of a critically endangered Australian galaxiid within a Mediterranean climatic zone of Australia. *Fishes in Mediterranean Environments* 001:1-14.

Threatened Species Scientific Committee (TSSC) (2006). *Commonwealth Listing Advice on Galaxias truttaceus hesperius*. Retrieved from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/galaxias-truttaceus-hesperius-listing.pdf.