

## *Galaxias fuscus* Barred Galaxias

### Taxonomy

*Galaxias fuscus* Mack, 1936

Part of the *Galaxias olidus* complex (Raadik 2014).

### Current conservation status

Listed as Endangered under the *Environment Protection and Biodiversity Conservation Act 1999*.

Listed as threatened under the *Flora and Fauna Guarantee Act 1988* as *Galaxias olidus* var. *fuscus* (SAC 1991a).

Categorised as Critically endangered in the 2013 Advisory list of threatened vertebrate fauna in Victoria (DSE 2013).

### Proposed conservation status

Critically Endangered in Australia

Criteria A2abce+3bce+4abce

### Species Information

#### Description and Life History

The taxon is confined to freshwater and are non-migratory. Gonad development commences as early as January, while spawning occurs during late winter to early spring (Raadik et al. 2010, Stoessel et al. 2012, DELWP 2015). Fecundity is low (~500 eggs), and on extrusion, eggs are adhesive and relatively large (~2.2 mm in diameter) (Raadik et al. 1996, Shirley and Raadik 1997, Stoessel et al. 2012, DELWP 2015). Eggs are laid on the underside of large rocks and hatch after about a month (Stoessel et al. 2012). Newly hatched larvae are small (about 9 mm in length), growth rates are slow, and adults live to about 15 years of age (Raadik et al. 2010, Stoessel et al. 2012). Sexual maturity occurs at approximately 2 years of age in males and 3-4 years of age in females (Raadik unpublished data).

#### Generation Length

The generation length of Barred Galaxias is estimated to be 8 years. This is based on longevity (up to 15 years) (Raadik et al. 2010) and age of maturity (2 years - males; 3-4 years- females) (survey data and observations). Generation length is calculated as  $((\text{max age} - \text{age maturity})/2 + \text{age maturity})$ , i.e.  $(15-2)/2 + 2 = 8.5$ .

#### Distribution

The Barred Galaxias is endemic to the Goulburn River system, Victoria. It is currently only found in upper reaches of headwater tributary streams, in forested catchments above 400 metres in elevation. There are 11 known extant populations, including several that are fragmented into sub-populations in nearby headwater catchments. Populations are highly fragmented and isolated from each other. The present distribution represents an estimated decline of over 95% of the taxon's range, and fragmentation of a much wider and continuous distribution, which likely extended upstream from 300 metres in elevation in the south eastern portion of the Goulburn River system (Raadik et al. 2010; DELWP 2015).

## Habitat

Barred Galaxias occur in upland creeks and rivers which are in small to medium-sized (0.7-11.0 m average width), moderately to fast flowing, steep gradient, shallow (0.1-0.4 m average depth), all typically cool to cold, well-shaded and well-oxygenated. Previously the species occupied larger, deeper and more moderate gradient/flowing river systems at lower altitudes (down to about 300 m elevation), with a coarser substrate and larger accumulations of timber debris. The preferred instream habitat of adults includes slower, deep pools adjacent to areas of faster flow, whilst juveniles (<50 mm in length) are usually found in shallow water along the banks. Stream substrate consists of a heterogeneous combination of bedrock, boulder, cobble, with smaller amounts of pebble, gravel and sand, and streams are usually well shaded by dense overhanging riparian vegetation. Water salinity is very low (<0.01 g/L) and water temperature is usually less than 15°C during summer, falling to 1-2°C during winter/early spring. Instream habitat usually consists of accumulations of large and small timber debris, rocks and tree roots in undercut banks, with minimal aquatic vegetation usually consisting of submerged marginal terrestrial vegetation, or small patches of bryophytes (Raadik unpublished data; Raadik et al. 2010; Raadik 2014; DELWP 2015).

## Threats

This taxon is one of a group of endemic galaxiids occurring in Victoria's eastern foothills and mountains. These taxa share ecological and habitat similarities that lead to a common suite of actual or potential threats. These taxa occur typically in small, isolated populations with limited geneflow. This may limit their adaptability to changing conditions associated with climate change.

Barred Galaxias occur as 11 isolated and fragmented global populations, including several that are fragmented into sub-populations in nearby headwater catchments. The present distribution represents an estimated decline of over 95% of the taxon's range, and fragmentation of a much wider and continuous distribution. There is a low abundance of mature individuals and low population genetic variability and structure.

The main threat to this taxon is invasion by Brown Trout (*Salmo trutta*) and Rainbow Trout (*Oncorhynchus mykiss*). Trout predation and competition are extreme risks and are likely to rapidly extirpate the entire population.

Other threats include fire (sedimentation, post-fire debris flow during high intensity rainfall events), severe weather events (droughts, floods), fire suppression impacts such as the use of fire retardant and increased sedimentation following disturbance from machinery, climate change and reduced water flows, and other forest management operations including road and firebreak construction and maintenance, especially at stream crossings.

Habitat loss or degradation occurs as a result of loss of riverbank vegetation, siltation, reduced stream flow, poor water quality, and input of chemicals (DELWP 2015). Genetic diversity within populations is low and gene flow is highly constrained between all extant populations, causing populations inbred and potential loss of fitness, adaptability and resilience (Ayres et al. 2012).

Forestry operations continue in parts of the range of this taxon. Spatial analysis of catchments occupied by the Barred Galaxias across all land tenures indicates that 32% occurs within the Comprehensive, Adequate and Representative (CAR) reserve system, including parks, reserves and special protection zones in State forest. Species-specific protections for the Barred Galaxias are included in the Victorian Code of Practice for Timber Production 2014. Other more general prescriptions such as protection and buffering of waterways also provide protection from timber harvesting. In recent years, modified harvesting and forest regeneration practices have been implemented in native forest to further mitigate the potential threat from forestry operations to threatened species and their habitats.

### IUCN Criteria

Criterion A. Population size reduction. Population reduction (measured over the longer of 10 years or 3 generations) based on any of A1 to A4			
	Critically Endangered	Endangered	Vulnerable
A1	≥ 90%	≥ 70%	≥ 50%
A2, A3, A4	≥ 80%	≥ 50%	≥ 30%
<p>A1 Population reduction observed, estimated, inferred or suspected in the past and the causes of the reduction are clearly reversible AND understood AND ceased.</p> <p>A2 Population reduction observed, estimated, inferred or suspected in the past where the causes of the reduction may not have ceased OR may not be understood OR may not be reversible.</p> <p>A3 Population reduction, projected or suspected to be met in the future (up to a maximum of 100 years) [(a) cannot be used for A3]</p> <p>A4 An observed, estimated, inferred, projected or suspected population reduction where the time period must include both the past and the future (up to a max. of 100 years in future), and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible.</p> <p style="text-align: center;"><i>based on any of the following:</i></p> <ul style="list-style-type: none"> <li>(a) direct observation [except A3]</li> <li>(b) an index of abundance appropriate to the taxon</li> <li>(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat</li> <li>(d) actual or potential levels of exploitation</li> <li>(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites</li> </ul>			

### Evidence:

#### Eligible under Criterion A2 as Critically Endangered

The population reduction over the past 24 years is estimated to be 50 to 80%, based on (a), (b), (c) and (e) above.

This is based on observations and measurements during extensive fieldwork over the range of the taxon, and observation of the impacts from the known threats.

The causes of the reduction may not have ceased, be understood or be reversible.

#### Eligible under Criterion A3 as Critically Endangered

The population reduction over the next 24 years is suspected to be 80 to 100%, based on (b), (c) and (e) above.

This is based on the assumption that the known threats will continue to impact the taxon, and the remaining populations are small, isolated and fragmented.

#### Eligible under Criterion A4 as Critically Endangered

The population reduction over any 24 year period, including both past and future, is estimated to be 50 to 100%, based on (a), (b), (c) and (e) above. The causes of reduction may not have ceased, be understood or be reversible.

Past reduction is based on observations and measurements during extensive fieldwork over the range of the taxon, and observation of the impacts from known threats. Future reduction is based on the assumption the known threats will continue and the remaining populations are small, isolated and fragmented.

Criterion B. Geographic range in the form of either B1 (extent of occurrence) and/or B2 (area of occupancy)			
	Critically Endangered Very restricted	Endangered Restricted	Vulnerable Limited
B1. Extent of occurrence (EOO)	< 100 km <sup>2</sup>	< 5,000 km <sup>2</sup>	< 20,000 km <sup>2</sup>
B2. Area of occupancy (AOO)	< 10 km <sup>2</sup>	< 500 km <sup>2</sup>	< 2,000 km <sup>2</sup>
AND at least 2 of the following 3 conditions:			
(a) Severely fragmented OR Number of locations	= 1	≤ 5	≤ 10
(b) Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals			
(c) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals			

### Evidence:

#### Eligible under Criterion B as Endangered

The Extent of Occurrence (EoO) is estimated to be 2,708 km<sup>2</sup>, based on accepted, post-1970 records in the Victorian Biodiversity Atlas (VBA).

The Area of Occupancy (AoO) is estimated to be 156 km<sup>2</sup>, based on 2 x 2 km grids derived from accepted, post-1970 records in the VBA.

All remnant populations are highly fragmented and isolated from each other (DELWP 2015). All populations represent the severe fragmentation of a previously larger range, and are considered important to the survival of the taxon. All subpopulations are small and isolated, and are at risk from the identified threats, such that there is increased extinction risk and little or no probability of recolonisation should subpopulations become extinct.

The main identified threats to the taxon (i.e. trout predation and competition, climate change, reduced stream flows, fire impacts, instream sedimentation, low genetic variability) have a non-reversible impact on the individuals of the taxon and occur in a stochastic manner, but have the potential over time to threaten the majority (and any) of the individuals in the geographic area. There are considered to be two such areas, so there are considered to be two locations. Fire and drought may impact half or more of the populations at any one time.

It has a continuing decline in (i), (ii), (iii), (iv) and (v) above, based on the assumption that the known threats will continue to impact populations unless remedial measures are taken, and threats may intensify in the longer term. The remaining populations are small, isolated and fragmented. They have low genetic variability and are subject to inbreeding.

Criterion C. Small Population size and decline		Critically Endangered	Endangered	Vulnerable
Number of mature individuals		< 250	< 2,500	< 10,000
AND at least one of C1 or C2				
C1	An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future):	25% in 3 years or 1 generation (whichever is longer)	20% in 5 years or 2 generations (whichever is longer)	10% in 10 years or 3 generations (whichever is longer)
C2	An observed, estimated, projected or inferred continuing decline AND least 1 of the following 3 conditions:			
(a)	(i) Number of mature individuals in each subpopulation	≤ 50	≤ 250	≤ 1,000
	(ii) % of mature individuals in one subpopulation =	90 – 100%	95 – 100%	100%
(b)	Extreme fluctuations in the number of mature individuals			

### Evidence:

#### Eligible under Criterion C1 as Vulnerable

It is estimated that there are 300 to 2,000 mature individuals. This is based on extrapolation from monitoring point data.

There is estimated to be a continuing decline of 80 to 100% within three generations.

Criterion D. Very small or restricted populations		Critically Endangered	Endangered	Vulnerable
Number of mature individuals (observed or estimated)		< 50	< 250	< 1,000
D2. Only applies to the VU category Restricted area of occupancy or number of locations with a plausible future threat that could drive the species to critically endangered or Extinct in a very short time.		-	-	D2. Typically: AoO < 20 km <sup>2</sup> or number of locations ≤ 5

### Evidence:

#### Eligible under criterion D as Vulnerable

It is estimated that there are 300 to 2,000 individuals, and the taxon is estimated to be very restricted.

Criterion E (Quantitative Analysis) was not addressed as the taxon does not have a detailed Population Viability Analysis.

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