Threatened Species Assessment

Prototroctes maraena
Australian Grayling

Taxonomy

Prototroctes maraena Gunther, 1864

The Australian Grayling belongs to the family Retropinnidae (smelts and graylings), subfamily Prototroctinae (southern graylings), which contains only two species: *P. maraena* and the New Zealand Grayling *Prototroctes oxyrhynchus*, a species endemic to New Zealand, not seen since the mid-1920s and now believed extinct (McDowall 1978; 1996b). Other names include: Cucumber Mullet, Cucumber Herring.

Current conservation status

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

Listed as threatened under the *Flora and Fauna Guarantee Act 1988* (SAC 1991).

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

Proposed conservation status

Endangered in Victoria

Criterion B2b(ii,iii,v)c(i,ii,iv)

The eastern Victorian subpopulations have been impacted by the bushfires of 2019/2020. Although the degree of damage is yet to be determined, such a loss of habitat may have resulted in a decline in population.

Species Information

Description and Life History

The Australian Grayling is a small to medium sized, slender, laterally compressed fish, with soft-rayed fins lacking any spines. The short-based dorsal fin (9-13 rays) is situated well back on the body, just in front of a small adipose fin. The caudal fin is forked. The anal fin (16-20 rays) is short-based, ending below the adipose fin. The pelvic fins (6 rays) are abdominal and inserted in front of the origin of the dorsal fin. The small pectoral fins (12-14 rays) are inserted just behind the gill plates. The head is small and conical, the snout somewhat rounded and blunt. The mouth is small and slightly oblique, the gape extending back to beneath the eye. The lower jaw is shorter than the upper jaw, and tapers to a fine, soft point. Teeth in the upper jaw are rather blunt and form a uniform comb-like row that bites on a narrow, tough shelf in the lower jaw. The body is covered with small, thin, cycloid, easily dislodged scales (the head is scale-less), with a scale count of 68-84 along the body; there is no lateral line. There is a low, horny, abdominal keel present in front of the vent. When freshly caught, this species has a distinct cucumber like odour, giving rise to an historical name of 'cucumber herring'.

The Australian Grayling reaches a maximum size of about 330 mm and 0.5 kg, but is usually smaller, more commonly to 170-190 mm. The species is sexually dimorphic. During the breeding season, mature males develop numerous small nuptial tubercles on each scale and on rays of the pectoral, pelvic, dorsal and anal fins.

The Australian Grayling is a diadromous species that migrates between freshwater and the sea. Most of its life is spent in freshwater, but the larval/juvenile stages are spent in coastal seas (Crook et al. 2006; Schmidt et al. 2010). An autumn downstream spawning migration is initiated by an increase in flow and decreasing water temperature or day length. In the absence of an increase in flow mature fish may undergo ovarian involution (O'Connor and Mahoney 2004). Adult fish undertake long and rapid (up to 25 km/day) downstream movements to the lower

reaches of rivers and streams where they form spawning aggregations. Spawning occurs above the estuary (Amtstaetter et al. 2012; O'Connor et al. 2012; Koster et al. 2013), although a small amount of spawning may occur in the upstream freshwater reaches of some streams. Most adult fish return upstream after spawning and some fish undertake this movement in consecutive years Only localised movement (less than 5 km) has been recorded for adults of the species during the non-spawning period.

Spawning occurs in freshwater from late summer to winter (exact timing being dependant on location and annual conditions). Different rivers at different latitudes with varying temperature regimes or other environmental influences produce different spawning seasons. Spawning initiation appears to be caused by an increase in river flows from seasonal rains, possibly coupled with a drop in water temperatures.

In the Tambo River (Victoria) population, juvenile fish less than 12 months old return to fresh water in about November. They attain 73 - 142 mm in length at one year, 113 - 200 mm in length after two years and 183 - 234 mm in length after three years. However, most fish die after their second year, probably soon after spawning, although a small proportion may reach four or five years of age. Some males may spawn in their first year, but most males and females do not spawn until their second year. This means that most individuals probably spawn only once before dying.

Recent estimates state that most die after their second year, probably soon after spawning, however a small proportion reach five years of age. Longevity of individuals in the Shoalhaven River was about three years and heaviest adult mortality appeared to occur after spawning at two years of age. The males mature sexually at 1-2 years of age and at a length of 15 cm and females appear to mature after 2 years. Males were found to be fertile more than two months earlier than females. The species may reach a stage of maturity close to spawning, but do not spawn until conditions are suitable.

Australian Grayling are omnivorous, feeding on a variety of small aquatic organisms, including crustaceans (such as cladocerans), insects and their larvae and algae. Non-aquatic insects have also been taken from the water surface by this species. The diet of the Tambo River (Victoria) population consists of immature aquatic insects, gastropods and, most commonly, plant material (diatom/organic matrix). The teeth of Australian Grayling are well adapted for combing filamentous algae with specimens observed to nibble on filamentous algae growing on the downstream side of rocks.

Generation Length

The generation length of the Australian Grayling is estimated to be 2 to 5 years. The taxon's longevity is based on otolith dating, and the generation length is approximately at a slightly older age than the mean of the taxon's longevity.

Distribution

The Australian Grayling occurs in south-eastern Australia, in coastal rivers and streams in New South Wales, Victoria and Tasmania (Cadwallader and Backhouse 1983; Fulton 1990; McDowall 1996a). On the mainland it occurs from the Shoalhaven River (NSW) south and west to the Hopkins River system (Vic).

DoE (2018): Currently, the species occurs in streams and rivers on the eastern and southern flanks of the Great Dividing Range, from Sydney, southwards to the Otway Ranges of Victoria and in Tasmania. It is absent from the inland Murray-Darling system. In Victoria in the 1980s, this species had been most frequently collected in the Tambo, Barwon, Mitchell and Tarwin River systems.

Historically, the Australian Grayling occurred in coastal streams from the Grose River, west of Sydney, southwards through NSW and Victoria. They were common in the Yarra River catchment in Victoria however, in the 1940s, a rock weir was constructed at Dights Falls (and subsequently upgraded in the 1960s) which would have prevented upstream migration of the species except during high flow events. A rock ramp fishway was constructed at Dights Falls in 1993 and subsequently modified in 1994. Anecdotal evidence from angler captures indicated that recolonising upstream of the structure may have been occurring post fishway construction. The species has more recently been confirmed in several locations in the Yarra River including below Dights Falls (Barnham 1998).

Habitat

The Australian Grayling is a diadromous species which exhibits an amphidromous life history (Crook et al. 2006). The species migrates within freshwater as adult fish, including annual movements downstream towards the top of

the estuary to spawn before returning upstream, and between freshwater and the sea as juveniles (Crook et al. 2006; O'Connor et al. 2012; Koster et al. 2013) and therefore relies on uninhibited access between freshwater and the sea for its survival. The Australian Grayling spends most of its life in freshwater, inhabiting rivers and streams, usually in cool, clear waters with a gravel substrate and alternating pool and riffle zones (Bishop and Bell 1978b; Berra 1982) but it can also occur in turbid water (Jackson and Koehn 1988; Hall and Harrington 1989). The species has also been associated with clear, gravel-bottomed habitats in the Mitchell and Wonnangatta Rivers (Victoria) and in a muddy-bottomed, heavily silted habitat in the Tarwin River (Victoria). The taxon can penetrate well inland, and has been reported over 300 km upstream from the sea. Larvae and juveniles inhabit coastal seas in an obligatory marine stage, although their precise marine habitat requirements are not known.

During January-November 1979 in the Tambo River, Victoria, water temperatures ranged from 5-26 degrees C and the pH was approximately 8 (Berra 1982). Hall and Harrington (1989) located a population of adult Australian Grayling in consecutive years in an urban area of the lower reaches of the highly turbid Barwon River, with a salinity of approximately 1.5 parts per thousand.

Threats

Precise causes of the decline of Australian Grayling are not known, but likely factors contributing to decline include habitat degradation caused by farming, forestry and water extraction, barriers (such as dams and weirs) to migration in coastal rivers, changes to rivers including altered flow and temperature regimes and increased nutrient and sediment loads, and perhaps competition and predation from introduced fish species such as trout. With its relatively short life span, most individuals spawn only once before they die, so populations are especially vulnerable to any disruption of spawning or recruitment. The species appears to be able to recolonise rivers from which it has been excluded. For example, installation of a fishway to provide passage above the weir at Dights Falls in the Yarra River (Victoria) has enabled grayling to move upstream into areas from which the species had been absent for many decades (J. O'Connor ARI; unpubl. data).

Current threatening processes include barriers to movements; river regulation; poor water quality; siltation; impact of introduced fish e.g. Common Carp *Cuprinus carpio,* Goldfish *Carrasius auratus,* Redfin Perch *Perca fluviatilis,* Eastern Gambusia *Gambusia holbrooki,* Oriental Weatherloach *Misgurnis anguillicaudatus,* Brown Trout *Salmo trutta* and Rainbow Trout *Oncorhynchus mykiss.*

A major impact of climate change in south-eastern Australia will be a predicted decline in overall rainfall with subsequent increasing dryness (Pittock 2003; Pook 2001). Decreased rainfall is expected to result in reduced river flows and higher demand for water use, further increasing pressures on stressed rivers. For the Australian Grayling, reduced flows mean reduced habitat, reduced spawning opportunities and interference with upstream migration. Reduced flows may also mean increased blockage of river mouths by sand bars, which prevent both upstream migration and movement of larvae and juveniles to the sea, decreasing chances of recolonisation and possibly causing local extinction of populations.

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%

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

A2 Population reduction observed, estimated, inferred or suspected in the past where the causes of the reduction may not have ceased OR may not be understood OR may not be reversible.

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

A4 An observed, estimated, inferred, projected or suspected population reduction where the time period must include both the past and the future (up to a max. of 100 years in future), and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible.

based on any of the following:

(a) direct observation [*except A3*]

(b) an index of abundance appropriate to the taxon

(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat

(d) actual or potential levels of exploitation

(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites

Evidence:

Eligible under Criterion A3 as Vulnerable

The population reduction over the next 6 to 15 years is projected to be 30%, based on (c) above.

Climate change and reduced river discharge is a growing threat, along with habitat degradation due to farming, forestry, etc. These are likely to accelerate declines in numbers.

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 km²	< 5,000 km²	< 20,000 km²
B2. Area of occupancy (AOO)	< 10 km²	< 500 km²	< 2,000 km²
AND at least 2 of the following 3 conditions:			
(a) Severely fragmented OR Number of locations	= 1	≤ 5	≤ 10
(b) Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals			
(c) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals			

Evidence:

Eligible under Criterion B2 as Endangered

The Area of Occupancy (AoO) across the taxon's range is estimated to be 340 km², based on 2 x 2 km grids derived from accepted, post-1990 records in the Victorian Biodiversity Atlas. (Records prior to 1990 were excluded.)

It is inferred to have a continuing decline in (ii), (iii) and (v) above, as a result of climate change and reduced river flow, along with habitat degradation caused by farming, forestry and water extraction,

It has extreme fluctuations in (i), (ii) and (iv) above, as spawning and dispersal is driven by (among other factors) river flow and is impacted by wet and dry years.

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:

Ineligible under Criterion C

It is inferred that there are 5,000 to 10,000 (midpoint 7,500) mature individuals, but this qualifier is too weak and other thresholds under this criterion have not been met.

Criterion D. Very small or restricted population			
	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 km2 or number of locations ≤·5

Evidence:

Ineligible under Criterion D

It is inferred that there are 5,000 to 10,000 (midpoint 7,500) mature individuals.

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

References

Amtstaetter, F., O'Connor, J. and Pickworth, A. (2012). *Thomson and Macalister rivers environmental flows monitoring and assessment program: 2012 survey results and migration of Australian Grayling (Prototroctes maraena).* Arthur Rylah Institute for Environmental Research. Department of Sustainability and Environment, Heidelberg, Victoria

Backhouse, G., Jackson, J., and O'Connor, J. (2008). *National Recovery Plan for Australian Grayling Prototroctes maraena.* Department of Sustainability and Environment, Melbourne. Available from: http://www.environment.gov.au/biodiversity/threatened/recovery-plans/national-recovery-plan-australian-grayling-prototroctes-maraena

Bishop, K. A., and Bell, J. D. (1978). Observations on the fish fauna below Tallowa Dam (Shoalhaven River, New South Wales) during river flow stoppages. *Marine and Freshwater Research*, *29*(4), 543-549.

Cadwallader, P. L., and Backhouse, G. N. (1983). *A guide to the freshwater fish of Victoria*. Government Printer, Melbourne.

Crook, D. A., Macdonald, J. I., O'Connor, J. P., and Barry, B. (2006). Use of otolith chemistry to examine patterns of diadromy in the threatened Australian grayling Prototroctes maraena. *Journal of Fish Biology*, *69*(5), 1330-1344.

DELWP (2015). Action Statement - Australian Grayling *Prototroctes maraena* (No. 257). Department of Environment, Land, Water and Planning. Retrieved from: https://www.environment.vic.gov.au/__data/assets/pdf_file/0013/33034/Australian-Grayling_action-statement.pdf

DSE (2013) *Advisory List of Threatened Vertebrate Fauna in Victoria 2013.* Department of Sustainability and Environment, East Melbourne. (Retrieved from https://www.environment.vic.gov.au/__data/assets/pdf_file/0014/50450/Advisory-List-of-Threatened-Vertebrate-Fauna_FINAL-2013.pdf)

DoE (2018). *Prototroctes maraena* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=26179

Fulton, W. (1990). *Tasmanian Freshwater Fishes. Fauna of Tasmania Handbook No. 7.* University of Tasmania, Hobart.

Hall, D.N. and Harrington, D.J. (1989). *Studies on the spawning and early life history of Australian grayling Prototroctes mareana Gunther, in the Barwon River, Victoria*. Arthur Rylah Institute for Environmental Research Technical Report Series No. 84, Department of Conservation, Forests and Lands, Melbourne.

Koster, W., Dawson, D., and Cook, D. (2013). Downstream spawning migration by the amphidromous Australian Grayling (*Prototroctes maraena)* in a coastal river in south eastern Australia. *Marine and Freshwater Research* 64, 31-34.

O'Connor, J., Raymond, S., and Dodd, L. (2012). Offsets for Conservation of the EPBC Act-listed Australian Grayling, *Prototroctes maraena. Arthur Rylah Institute for Environmental Research Technical Report Series No.* 233. Heidelberg, Victoria: Department of Sustainability and Environment.

Pittock, B. (2003). Climate change and Australia's natural resources: A review. In *Proceedings of the Conference on Climate Impacts on Australia's Natural Resources: Current and Future Challenges* (pp. 51-52).

Pook, M. (2001). Tasmania's Climate and Projections for the Century. Water Development Plan for Tasmania Project. Department of Primary Industries, Water and Environment, Tasmania (available on www.dpiwe.tas.gov.au).

SAC (1991). Flora and Fauna Guarantee Scientific Advisory Committee: Final Recommendation on a Nomination for Listing. Nomination No. 3 *Prototroctes maraena.*