Action statement No.257

Flora and Fauna Guarantee Act 1988

Australian Grayling *Prototroctes maraena*

Department of Environment, Land, Water & Planning

State Government Victoria

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Australian Grayling *Prototroctes maraena*

Description

The Australian Grayling (*Prototroctes maraena* Gunther, 1864) 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'.

Colour is generally greyish bronze, slightly darker on the dorsal surface, fading to silvery white below; each scale has a darker outline, and the operculum is silvery. Occasionally there is a steely blue sheen along the body and operculum. Fins are translucent and yellowish-grey, the adipose fin matching the dorsal surface. The body may sometimes bear a wedge shaped black mark at the base of the caudal fin, and three or more wide, chevron shaped bands along the sides between the operculum and dorsal fin; these may appear bolder when the fish is stressed.

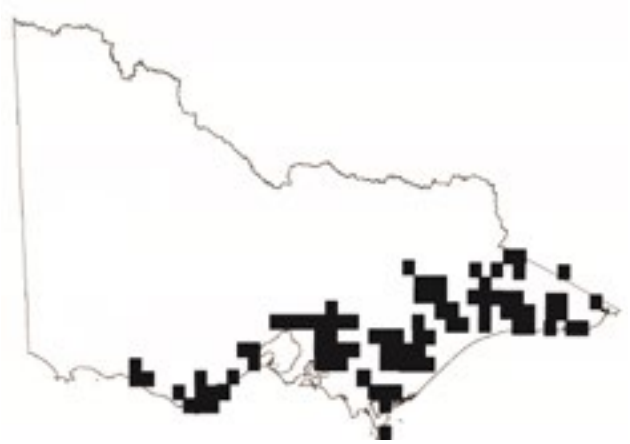
The Australian Grayling reaches a maximum size of about 330 mm and 0.5 kg, but is usually smaller, more commonly to 170-190 mm. The species is sexually dimorphic. During the breeding season, mature males develop numerous small nuptial tubercles on each scale and on rays of the pectoral, pelvic, dorsal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

The Australian Grayling 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).

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). In Tasmania, it occurs on King Island in Bass Strait, and around much of the coast, but has not been recorded in the the south-west (although this is probably due to lack of surveys in the region). There is a single record from near Port MacDonnell in the far south-east of South Australia (Kuiter 1983), where it is considered either extremely rare or locally extinct (Hammer 2001), and the record is most likely of a vagrant fish.

Australian Grayling (Alexis Beckett)



Distribution in Victoria (DELWP, 2015)

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 can penetrate well inland, and has been reported over 300 km upstream from the sea (Koster and Raadik 2010). Larvae and juveniles inhabit coastal seas in an obligatory marine stage (Crook *et al.*, 2006), although their precise marine habitat requirements are not known.

Life History and Ecology

Aspects of the biology and ecology of the Australian Grayling have been described in several publications (McDowall 1974, 1976, 1996a; Jackson 1976; Bishop and Bell 1978 a & b; Berra 1982, 1987; Berra *et al.* 1987; Jackson and Koehn 1988; Bacher and O'Brien 1989; Hall and Harrington 1989; O'Connor and Mahoney 2004; Crook *et al.* 2006; Schmidt *et al.* 2011; O'Connor *et al.* 2012; Koster *et al.* 2013). 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 (O'Connor *et al.* 2012; Koster *et al.* 2013). 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 (O'Connor *et al.* 2012; Koster *et al.* 2013). 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 (Koster *et al.* 2013). Most adult fish return upstream after spawning (O'Connor *et al.* 2012; Koster *et al.* 2013) and some fish undertake this movement in consecutive years (O'Connor *et al.* 2012). Only localised movement (less than 5 km) has been recorded for adults of the species during the non-spawning period (O'Connor *et al.* 2012; Koster 2013).

Fecundity varies from 25,000 to 68,000 eggs per female (Berra 1982). The fertilized eggs are small, spherical (approximately 1.1 mm in diameter), non-adhesive and demersal (Bacher and O'Brien 1989). Eggs sink and settle in the interstices of the substrate. The eggs hatch after 10 - 20 days; larvae are about 6.5 mm long, slender, buoyant and swim actively to the water surface. They have a small yolk sac that is soon absorbed. The larvae are swept to the sea (Berra 1982; Crook *et al.* 2006), where they remain between 6-10 months before returning to freshwater (Bishop and Bell 1978b; Berra 1982). Schmidt *et al.* (2010) estimated the level of population genetic structure among Victorian coastal populations using microsatellite and mitochondrial DNA (mtDNA) markers and concluded that there is a single stock of Australian Grayling within Victoria mediated by the dispersal of larvae and juveniles during the marine phase of the life cycle. In the Tambo River (Victoria), 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 (Bishop and Bell 1978a), probably soon after spawning (McDowall 1976), 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 (Berra 1982). This means that most individuals probably spawn only once before dying.

The Australian Grayling is omnivorous, feeding on a wide variety of small aquatic organisms, including crustaceans such as cladocerans, insects and their larvae, and algae. They also take terrestrial insects that fall on to the water surface (Jackson 1976; Berra *et al.* 1987).

Conservation status

National conservation status

Australian Grayling (*Prototroctes maraena*) has been listed as vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

Victorian conservation status

Australian Grayling (*Prototroctes maraena*) has been listed as threatened under the *Flora and Fauna Guarantee Act 1988*.

Australian Grayling (*Prototroctes maraena*) is considered vulnerable in Victoria according to the Department of Environment, Land, Water and Planning (DELWP)'s *Advisory List of Threatened Vertebrate Fauna in Victoria* (DSE 2013).

Threats

The Australian Grayling is a migratory species which undertakes annual downstream migrations towards the top of the estuary to spawn before returning upstream. These adult migrations are initiated by increases in flow. Upon hatching larvae are washed out to sea and return to freshwater habitats about 6-10 months later. These return juvenile migrations are also thought to be associated with increases in flow (Amtstaetter *et al.* 2012; O'Connor *et al.* 2012; Koster *et al.* 2013). Consequently, two of the major threats to this species include modifications to the natural flow regimes and the construction of dams and weirs which block access to upstream habitats. Climate change, which will cause a decrease in rainfall, is also expected to impact upon this species through changes to stream flow regimes.

Standard threat	Source of threat	Explanation
Habitat fragmentation	Waterways – in stream barriers (including dams)	Australian Grayling is a migratory species which is severely impacted by barriers to migration (such as dams, weirs, culverts, levee banks). Many rivers within the natural range of the Australian Grayling have been impacted by barriers (McGucken and Bennet 1999) which block migration. Decreased connectivity can cause local extinction in the section of river upstream from the barrier by limiting the ability to colonise or recolonise suitable habitat.
Habitat damage or loss	Vegetation clearance	Damage to riparian habitats can lead to poor water quality and sedimentation. Heavy rainfall can cause sediment run-off from areas laid bare from over-grazing, vegetation clearance, drought and wild fires. Nutrient run-off from urban and agricultural areas can cause increased growth of phytoplankton and filamentous algae, initiating plankton blooms and reducing oxygen levels. Fish kills can result from these conditions, and species such as the Australian Grayling may avoid or not recolonise areas of sustained poor water quality due to riparian vegetation clearance.
Surface water - quality	Waterways - sedimentation or siltation	Increased siltation of rivers can result from catchment disturbance through vegetation clearing, degradation of riparian zones, burning and road construction. Increased siltation reduces water quality, can promote plankton blooms and smother river substrate used by Australian Grayling for feeding and spawning. High turbidity resulting from suspended sediment can erode fish gills and has been shown to affect feeding in riverine fish species (Rowe *et al.* 2002).

Surface water - quantity/regime	Water - level/flow changes	Changes to the natural flow regime through river regulation, resulting in changes in the timing, duration and magnitude of the natural flow regime are a major threat to Australian Grayling. Flow changes can impact upon the spawning of Australian Grayling which is associated with increases in flow (Amtstaetter *et al.* 2012; O'Connor *et al.* 2012; Koster *et al.* 2013). Reduction in flow can also lead to decreased river connectivity particularly in shallow riffle areas or cascading rocky outcrops, and produce increased blockage of river mouths by sand bars. This prevents both migration upstream and movement of larvae and juveniles to the sea. Climate change in south-eastern Australia, which is likely to cause a decline in overall rainfall, followed by increasing dryness (Pook 2001; Pittock 2003) will also impact upon key flow events that Australian Grayling rely upon for spawning and dispersal. Decreased rainfall is expected to result in reduced river flows and higher demand for water use, further increasing pressures on stressed rivers. River regulation can also affect water quality.
Competition	Animals - other species	Introduced fish species including Brown Trout (*Salmo trutta*), Rainbow Trout (*Oncorhynchus mykiss*) Common Carp (*Cyprinus carpio*), Goldfish (*Carrasius auratus*), Redfin Perch (*Perca fluviatilis*), Eastern Gambusia (*Gambusia holbrooki*), Oriental Weatherloach (*Misgurnis anguillicaudatus*) and translocated populations of Murray cod (*Maccullochella peelii*) and Macquarie perch (*Macquaria australasica*) (in the Yarra River system) occur in areas where Australian Grayling are distributed. These species can pose a threat through competition for food and habitat.
Carnivory	Animals - other species	Introduced fish species, including Brown Trout (*Salmo trutta*), Rainbow Trout (*Oncorhynchus mykiss*) Common Carp (*Cyprinus carpio*), Redfin Perch (*Perca fluviatilis*) and translocated populations of Murray cod (*Maccullochella peelii*) and Macquarie perch (*Macquaria australasica*) (in the Yarra River system) occur within the distribution of Australian Grayling. These species can pose a threat to Australian Grayling through predation. Trout are known to prey on small Australian Grayling. Larvae and juveniles may be highly susceptible to predation by trout (and other piscivorous species).

Important locations

Catchment	Location name	Land manager	Bioregion
CORANGAMITE	Aire River	Corangamite CMA	Otway Ranges
	Barham River	Corangamite CMA	Otway Ranges
	Barwon River	Corangamite CMA	Victorian Volcanic Plain

CORANGAMITE	Calder River, Otway Ranges	Corangamite CMA	Otway Plain
	Curdies River	Corangamite CMA	Warrnambool Plain
	Gellibrand River	Corangamite CMA	Otway Plain
EAST GIPPSLAND	Bemm River	East Gippsland CMA	East Gippsland Lowlands and Uplands
	Cann River	East Gippsland CMA	East Gippsland Lowlands and Uplands
	Genoa River	East Gippsland CMA	East Gippsland Lowlands and Uplands
	Mitchell River	East Gippsland CMA	Gippsland Plain
	Snowy River	East Gippsland CMA	East Gippsland Lowlands and Uplands
	Tambo River	East Gippsland CMA	East Gippsland Lowlands and Uplands
	Thurra River	East Gippsland CMA	East Gippsland Lowlands and Uplands
	Wingan River	East Gippsland CMA	East Gippsland Lowlands
GLENELG HOPKINS	Hopkins River	Glenelg Hopkins CMA	Victorian Volcanic Plain, Warrnambool Plain
PORT PHILLIP AND WESTERNPORT	Bunyip River	Melbourne Water	Gippsland Plain
	Yarra River	Melbourne Water	Highlands - Southern Fall, Gippsland Plain
WEST GIPPSLAND	Agnes River	West Gippsland CMA	Strzelecki Ranges
	Albert River	West Gippsland CMA	Gippsland Plain
	Avon River	West Gippsland CMA	Gippsland Plain
	Franklin River	West Gippsland CMA	Gippsland Plain
	Rainbow Creek - Thomson River	West Gippsland CMA	Gippsland Plain
	Tarwin River	West Gippsland CMA	Strzelecki Ranges
	Thomson River	West Gippsland CMA	Gippsland Plain

Past management actions

Action	Result explanation
Prepare/revise Recovery Plan	National Recovery Plan completed (Backhouse *et al.*. 2008 a, b)
Provide fishways	Programs to facilitate fish passage over barriers in Victoria include fishways that have been installed in the Thomson, Yarra, Tarwin and Barwon rivers and in other coastal rivers and streams within the Australian Graylings range, facilitating access to over 3,000 km of rivers previously blocked (Arthur Rylah Institute unpubl. data).
Provide adequate environmental flows	Environmental flow releases to facilitate Australian Grayling spawning have been undertaken in the Snowy, Thomson, Tarago-Bunyip and Yarra river catchments which contain important populations of Australian Grayling.
Restore habitat	General river improvement programs, including river health strategies, stream flow management plans and restoration of riparian vegetation for many rivers within the range of the Australian Grayling.
Conduct survey to determine abundance/ extent	A number of targeted and opportunistic surveys have been undertaken for the Australian Grayling including sampling in the Mitchell, Thomson, Avon, Yarra, Franklin, Albert, Agnes, Tarwin and Gellibrand rivers.
Identify and document specific measures to mitigate a threatening process.	Stocking of trout has ceased in the Barwon River, because of the presence of several threatened fish species including the Australian Grayling. Instigation of a major catchment management program for improved water quality in the Gippsland Lakes (Victoria).
Conduct priority research projects as specified	A number of studies that consider the conservation status, biology and ecology of Australian Grayling have been undertaken: Bishop and Bell (1978a, b); Bell *et al.*. (1980) Berra (1982); Berra and Cadwallader (1983); Berra (1987); Jackson and Koehn (1988); Bacher and O'Brien (1989); Hall and Harrington (1989); O'Connor and Mahoney (2004); Backhouse *et al.*. (2008a, b); Koster *et al.* 2013. The most recent research includes: • Crook *et al.* (2006) used otolith chemistry to determine that larval Australian Grayling spend their juvenile marine phase in open sea water rather than in an estuary. • Schmidt *et al.* (2010) estimated the level of population genetic structure among Victorian coastal populations of Australian Grayling using microsatellite and mitochondrial DNA (mtDNA) markers and concluded there was an absence of population structure among the coastal rivers sampled indicating that there is a single stock of Australian Grayling within Victoria mediated by the dispersal of larvae and juveniles during the marine phase of the life cycle.

	• O'Connor *et al.* (2012), in a movement study using PIT tags, found that Australian Grayling usually undertook limited movement (less than 5 km) but during autumn on increased flow fish undertook long (10-35 km) and rapid (up to 25 km/day) downstream movements to the lower reaches of the Tarwin River before returning upstream. Some fish undertook this movement in consecutive years. This downstream migration was associated with an increase in flow. These movements were suspected of being spawning related. • Koster *et al.* (2013) demonstrated that Australian Grayling usually undertake fairly limited movement but during autumn on increased flow fish undertook long (10-35 km) downstream spawning migrations to the lower reaches of the Bunyip River before returning upstream. Large numbers of Australian Grayling eggs were collected in these lower reaches of the river shortly after fish were observed moving downstream. There was also a clear association between in-creased flow and downstream migration. • Amtstaetter *et al.* (2013; 2014) observed Australian Grayling spawning over two years (through the collection of eggs) during environmental flow releases in the Thomson River with most of the eggs collected during the peak period of the environmental flow release.

Conservation objectives

Long term objective

To ensure that the Australian Grayling can survive, flourish and retain its potential for evolutionary development in the wild.

Objectives of this Action Statement

- To maintain or increase the extent of habitat
- To secure populations or habitat from potentially incompatible land use or catastrophic loss
- To increase knowledge of biology, ecology or management requirements

Intended management actions

The intended management actions listed below are further elaborated in DELWP's Actions for Biodiversity Conservation (ABC) system. Detailed information about the actions and locations, including priorities, is held in this system and will be provided annually to land managers and other authorities.

Standard objective	Objective explanation	
To maintain or increase the extent of habitat	Barriers to fish migration pose a major threat to this species through the construction of dams and weirs which block access to upstream habitats. Damaged riparian habitats also pose a threat to this species as they may lead to poor water quality and sedimentation.	
Standard action	**Details**	**Responsible agents**
Provide Fishways	Increase the habitat available to Australian Grayling by facilitating fish passage over barriers and ensure Australian Grayling management requirements are incorporated into design and location of proposed fishways, where relevant. Where important populations or habitats occur, the need for fishways is assessed to maximise access to habitat and facilitate upstream and downstream migration.	Corangamite CMA, West Gippsland, CMA, East Gippsland CMA, Melbourne Water, Glenelg Hopkins CMA , DELWP

Restore habitat	Protect and restore riparian habitat in catchments supporting Australian Grayling populations, with priority to those catchments with important habitat and/or populations. Protect and restore specific spawning habitat in catchments with important populations of Australian Grayling.	Corangamite CMA, West Gippsland CMA, East Gippsland CMA, Melbourne Water, Glenelg Hopkins CMA

Standard objective	Objective explanation	
To secure populations or habitat from potentially incompatible land use or catastrophic loss	Important life history stages of Australian Grayling, including spawning and dispersal, are associated with increases in flow. Poor water quality as a result of low flows can also impact upon this species. Consequently, modifications to the natural flow regimes of streams and rivers are a major threat to this species.	
Standard action	**Details**	**Responsible agents**
Provide adequate environmental flows	Sites which are highly regulated may not provide conditions which are required to initiate spawning and the associated flows necessary to carry larvae to sea. Furthermore, highly regulated sites may not provide adequate attraction flows for returning juveniles following their marine larval phase. Additionally, lack of flows through water abstraction may lead to a reduction in the period in which the rivers estuarine entrance is open to the sea. This may lead to the inability of larval Australian Grayling to access habitat necessary for their early development. Poor water quality, as a result of low flows, may also adversely impact this species, through increased water temperatures and low dissolved oxygen levels.	Corangamite CMA, West Gippsland CMA, East Gippsland CMA, Melbourne Water, Glenelg Hopkins CMA, DELWP
Develop, provide input to or implement park, reserve or land management plan.	Incorporate actions to conserve Australian Grayling into catchment management and river health programs where appropriate	Melbourne Water, Corangamite CMA, West Gippsland CMA, East Gippsland CMA, Port Phillip and Westernport CMA, Glenelg Hopkins CMA

Standard objective	Objective explanation	
To increase knowlede of biology, ecology or management requirements	There remain a number of knowledge gaps in the biology of the Australian Grayling. Increased knowledge will assist in the management of this species.	
Standard action	**Details**	**Responsible agents**
Identify research priorities and facilitate their implementation	Determine the timing and parameters (e.g. flow) around the return of juvenile Australian Grayling to freshwater habitats following their marine larval phase. Determine environmental flow requirements for specific river systems (both spawning and juvenile attraction flows) and develop detailed watering plan. Update the National Recovery Plan for Australian Grayling. Identify systems that may be acting as important source populations, as a result of good breeding habitat and locations that could serve as important drought refuges in periods of low flow.	DELWP
Conduct surveys to locate additional populations	Undertake surveys to determine presence and significance of Australian Grayling populations in areas poorly surveyed including in East Gippsland CMA, Corangamite CMA, and Glenelg Hopkins CMA.	Corangamite CMA, East Gippsland CMA, Glenelg Hopkins CMA, DELWP
Assess habitat characteristics and/or condition	Identify specific spawning reach location in rivers containing important populations of Australian Grayling	Corangamite CMA, West Gippsland CMA, East Gippsland CMA, Melbourne Water, Glenelg Hopkins CMA, DELWP
Undertake periodic surveillance monitoring of populations	Undertake periodic monitoring of known important populations of this species to gain a better understanding of population status and trends	Corangamite CMA, West Gippsland CMA, East Gippsland CMA, Melbourne Water, Glenelg Hopkins CMA, DELWP

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