



Consultation Document on Listing Eligibility and Conservation Actions

***Prototroctes maraena* (Australian Grayling)**

You are invited to provide your views and supporting reasons related to:

- 1) the eligibility of *Prototroctes maraena* (Australian grayling) for inclusion on the EPBC Act threatened species list in the **Vulnerable** category; and
- 2) the necessary conservation actions for the above species.

Evidence provided by experts, stakeholders and the general public are welcome. Responses can be provided by any interested person.

Anyone may nominate a native species, ecological community or threatening process for listing under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or for a transfer of an item already on the list to a new listing category. The Threatened Species Scientific Committee (the Committee) undertakes the assessment of species to determine eligibility for inclusion in the list of threatened species and provides its recommendation to the Australian Government Minister for the Environment.

Responses are to be provided in writing either by email to:
species.consultation@environment.gov.au

or by mail to:

The Director
Marine and Freshwater Species Conservation Section
Biodiversity Conservation Division
Department of Agriculture, Water and the Environment
PO Box 787
Canberra ACT 2601

Contents of this information package	Page
General background information about listing threatened species	2
Information about this consultation process	3
Draft information about the common name and its eligibility for listing	4–17
Conservation actions for the species	18–19
Collective list of questions – your views	20–22
References cited	23–29

General background information about listing threatened species

The Australian Government helps protect species at risk of extinction by listing them as threatened under Part 13 of the EPBC Act. Once listed under the EPBC Act, the species becomes a Matter of National Environmental Significance (MNES) and must be protected from significant impacts through the assessment and approval provisions of the EPBC Act. More information about threatened species is available on the department's website at: <http://www.environment.gov.au/biodiversity/threatened/index.html>.

Public nominations to list threatened species under the EPBC Act are received annually by the department. In order to determine if a species is eligible for listing as threatened under the EPBC Act, the Threatened Species Scientific Committee (the Committee) undertakes a rigorous scientific assessment of its status to determine if the species is eligible for listing against a set of criteria. These criteria are available on the Department's website at: <http://www.environment.gov.au/system/files/pages/d72dfd1a-f0d8-4699-8d43-5d95bbb02428/files/tssc-guidelines-assessing-species-2018.pdf>.

As part of the assessment process, the Committee consults with the public and stakeholders to obtain specific details about the species, as well as advice on what conservation actions might be appropriate. Information provided through the consultation process is considered by the Committee in its assessment. The Committee provides its advice on the assessment (together with comments received) to the Minister regarding the eligibility of the species for listing under a particular category and what conservation actions might be appropriate. The Minister decides to add, or not to add, the species to the list of threatened species under the EPBC Act. More detailed information about the listing process is at: <http://www.environment.gov.au/biodiversity/threatened/nominations.html>.

To promote the recovery of listed threatened species and ecological communities, conservation advices and where required, recovery plans are made or adopted in accordance with Part 13 of the EPBC Act. Conservation advices provide guidance at the time of listing on known threats and priority recovery actions that can be undertaken at a local and regional level. Recovery plans describe key threats and identify specific recovery actions that can be undertaken to enable recovery activities to occur within a planned and logical national framework. Information about recovery plans is available on the department's website at: <http://www.environment.gov.au/biodiversity/threatened/recovery.html>.

Privacy notice

The Department will collect, use, store and disclose the personal information you provide in a manner consistent with the Department's obligations under the Privacy Act 1988 (Cth) and the Department's Privacy Policy.

Any personal information that you provide within, or in addition to, your comments in the threatened species assessment process may be used by the Department for the purposes of its functions relating to threatened species assessments, including contacting you if we have any questions about your comments in the future.

Further, the Commonwealth, State and Territory governments have agreed to share threatened species assessment documentation (including comments) to ensure that all States and Territories have access to the same documentation when making a decision on the status of a potentially threatened species. This is also known as the '[common assessment method](#)'. As a result, any personal information that you have provided in connection with your comments may be shared between Commonwealth, State or Territory government entities to assist with their assessment processes.

The Department's Privacy Policy contains details about how respondents may access and make corrections to personal information that the Department holds about the respondent, how respondents may make a complaint about a breach of an Australian Privacy Principle, and how the Department will deal with that complaint. A copy of the Department's Privacy Policy is available at: <http://environment.gov.au/privacy-policy>

Information about this consultation process

Responses to this consultation can be provided electronically or in hard copy to the contact addresses provided on Page 1. All responses received will be provided in full to the Committee and then to the Australian Government Minister for the Environment.

In providing comments, please provide references to published data where possible. Should the Committee use the information you provide in formulating its advice, the information will be attributed to you and referenced as a 'personal communication' unless you provide references or otherwise attribute this information (please specify if your organisation requires that this information is attributed to your organisation instead of yourself). The final advice by the Committee will be published on the department's website following the listing decision by the Minister.

Information provided through consultation may be subject to freedom of information legislation and court processes. It is also important to note that under the EPBC Act, the deliberations and recommendations of the Committee are confidential until the Minister has made a final decision on the nomination, unless otherwise determined by the Minister.

Prototroctes maraena

Australian Grayling

Taxonomy

Conventionally accepted as *Prototroctes maraena* Günther 1864.

Common names: Cucumber Herring, Cucumber Mullet, Cucumber Fish, Yarra Herring (Backhouse et al. 2008b; NSW DPI 2015a; Gomon & Bray 2017; VFA 2018).

Species/Sub-species Information

Description

Prototroctes maraena (Australian Grayling) is a small to medium sized slender fish with soft clear fins (Backhouse et al. 2008b). Reaching a maximum length of about 330 mm (more commonly between 170–190 mm) and 0.5 kg, the Australian Grayling is generally greyish-bronze to olive in colour on its back with a silvery belly (McDowall 1980a; Allen et al. 2002; Backhouse et al. 2008b). It has a small cone-like head, large eyes and its lower jaw is shorter than its upper jaw (McDowall 1980a; Allen et al. 2002; Backhouse et al. 2008b). Australian Grayling do not possess a lateral line or scales on its head however, its most distinguishable feature is that it extrudes a “cucumber-like” odour when freshly caught, hence commonly called “Cucumber Herring” or “Cucumber Mullet” (McDowall 1980a; Allen et al. 2002; Backhouse et al. 2008b; NSW DPI 2015a; VFA 2018).

Juvenile Australian Grayling are similar in appearance to smelts, mullets and hardyheads, they are often found together in schools forming what is known in Australia as “whitebait runs” (McDowall 1980a; Allen et al. 2002; Gomon & Bray 2017).

Distribution

Australian Grayling were historically known to occur in coastal catchments <200 m above sea level (a.s.l), generally in the freshwater, estuarine and marine reaches of south-eastern Australia along New South Wales (NSW), Victoria, Tasmania and South Australia (SA)—including waterways on King Island in the Bass Strait (Backhouse et al. 2008b; Jenkins et al. 2009; NSW FSC 2015; DoEE 2019). Nationally, there are no reliable population estimates for Australian Grayling (NSW DPI 2015a; DoEE 2019). Due to their high fecundity, it has been suggested that the Australian Grayling population undergoes large fluctuations (DoEE 2019). Berra (1982) suggested that following a decline in population, the Australian Grayling could exhibit an increase in abundance over a period of 14–17 years.

New South Wales

The historical distribution of Australian Grayling in NSW occurred on the eastern and southern flanks of the Great Dividing Ranges from the Hunter region catchment southwards to the Victorian border (Miles 2005, 2007; NSW FSC 2015). The majority of past observations have been from the NSW south coast, from the Shoalhaven River catchment to the Victorian border (Bell et al. 1980; Bishop & Bell 1978; Miles 2005; NSW DPI 2015a; NSW FSC 2015; DoEE 2019; Walsh pers. comms. in NSW Fisheries 2020). The Faragher (1995) threatened fish species survey (cited in Miles 2005) has the most comprehensive report on abundance/status of Australian Grayling in NSW. Since then all other NSW surveys have only recorded Australian Grayling at low abundances (Miles 2005). Furthermore, it has been suggested that the highest recorded NSW abundances occur in the Deua River (Kaminskas pers. comms. in DoEE 2019), emphasising the importance of this river system to the conservation of the species.

Victoria

Australian Grayling were considered extinct in Victoria in the years leading up to the 1970s due to the low numbers observed by recreational fishers targeting the species (VFA 2018). However,

a survey post-1970, recorded Australian Grayling present in almost all coastal rivers east of, and including the Hopkins River catchment near Warrnambool (Backhouse et al. 2008b; VFA 2018; DoEE 2019; SWIFFT 2019). Historically, the strongest abundances of Australian Grayling were found in the Tambo, Mitchell, Tarwin and Yarra catchments in central and eastern Victoria (Berra 1982; DoEE 2019; VFA 2018; SWIFFT 2019).

Australian Grayling occurs within the *Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria* ecological community. The Conservation Advice lists priority research and conservation actions to mitigate the risk of extinction of assemblages of species associated with this ecological community.

Tasmania

Australian Grayling has been recorded in catchments draining to the north, west and east of Tasmania, but has not yet been recorded in the south-west—potentially due to a lack of surveys (McDowall 1976; Backhouse et al. 2008b; TSS 2019). Historically, Australian Grayling have been found on King Island in the Bass Strait (Backhouse et al. 2008b; DoEE 2019).

South Australia

Whilst considered rare, Australian Grayling may still be found in SA, with a historical verified report at Ewens Ponds in 1982 and an unverified report at Piccaninnie Ponds (Hammer 2002; Backhouse et al. 2008b; Hammer et al. 2009; NSW DPI 2015a; DoEE 2019). Other recordings of the species remain unverified (Hammer et al. 2009). It is suggested that SA never held established local populations and individuals recorded were likely vagrant fish which travelled to South Australian catchments from resident local populations based in Victoria (Hammer 2002; Hammer et al. 2009).

Cultural Significance

The Australian Grayling is a native fish species which may hold significant values to Indigenous people as a valued food resource (Humphries & Walker 2013).

Australian Grayling were once a popular target sport fish for recreational fishers, especially with fly fishers, given the species readily “takes to” a fly (the specialised, light-weight, artificial fly lure used in this method) (Bishop & Bell 1978; Backhouse et al. 2008a).

Relevant Biology/Ecology

The Australian Grayling is a diadromous species that spends its larval stages in marine water and its adult life mainly in freshwater (Backhouse et al. 2008b). Berra (1982) suggested that the species also exhibited an amphidromous life history, as juveniles will spend time in brackish waters. This suggestion was supported by a later study (Crook et al. 2006).

Australian Grayling have a maximum life expectancy of up to five years, but many rarely live past an age of three years (Bishop & Bell 1978; Berra 1982; NSW DPI 2015a). Males are sexually mature at one year of age, and females at two years of age, but most won't spawn until after two years. As a result, most individuals would only spawn once in their lifetime as most typically die after spawning (Bishop & Bell 1978; Berra 1982; Backhouse et al. 2008b; NSW DPI 2015a).

Australian Grayling migrate to brackish waters to spawn and larvae are swept into marine waters, where they spend approximately six months or reach ~45–65 mm long before returning to freshwater (Backhouse et al. 2008b; NSW DPI 2015a). Spawning typically occurs from late summer to winter, however this period varies with location and local environmental factors such as varying water temperatures, water flow events and other variables (McDowall 1976; Backhouse et al. 2008b; DoEE 2019). For instance, Hall & Harrington (1989), concluded that spawning in the Barwon River (Victoria) occurs in mid- to late-May coinciding with temperatures between 12–13.5°C and salinities of 1.5 ppt. However, it appears that spawning is triggered by a

combination of water flow events and decreases in water temperatures (Bakehouse et al. 2008b; DoEE 2019).

Fecundity of Australian Grayling varies between 25 000–68 000 eggs, producing an average of 47 000 eggs (Backhouse et al. 2008b; NSW DPI 2015a; VFA 2018). Eggs are less than 1 mm in diameter and demersal, settling on a variety of substrates (gravel, granite, muddy and silted) (McDowall 1976; Jackson 1980; Backhouse et al. 2008b; DoEE 2019). Spawning behaviour and site selection are currently unknown, which could account for the variety of substrates in which eggs settle (Backhouse et al. 2008b). Eggs hatch between 10–20 days after being laid. Larvae emerge at 6.5 mm in length, and while they are free swimming, they are typically swept downstream into marine habitats by river flow (Berra 1982; Backhouse et al. 2008b).

The Australian Grayling is an omnivorous feeder, feeding on crustaceans, aquatic insects (and their larvae), their own larvae, aquatic plants (including macrophytes and algae) as well as terrestrial insects that fall into the water (Jackson 1976; Backhouse et al. 2008b). The presence of plant material in their stomach contents may be a result of incidental digestion when predated on insects as Jackson (1976) suggested that this species is at least a predatory insectivore.

A lack of genetic diversity between Australian Grayling collected from coastal rivers in Victoria suggested that a single population occurs in Victoria, as larvae are most likely dispersed during the marine stage of their life cycle (Schmidt et al. 2011). Genetic studies for populations occurring in NSW and Tasmania have not been undertaken.

Threats

Table 1: Threats impacting the Australian Grayling in approximate order of severity of risk, based on available evidence.

Number	Threat factor	Threat type and status	Evidence base
1.0	Habitat loss and fragmentation		
1.1	Fish passage barriers	Known past and current	<p>Australian Grayling rely on passages free from barriers for their spawning movements up- and downstream in coastal catchments. The installation of weirs, dams, locks and barrages are known to affect fish movement by creating barriers and preventing fish access to key habitat areas. This has led to declines and localised extinctions from above and below these barriers (Crook et al. 2006; Humphries & Walker 2013; Dawson & Koster 2018). For instance, Australian Grayling are now extinct upstream of Tallowa Dam in the Shoalhaven River (Gehrke et al. 2001). Many of the other coastal catchments in south-eastern Australia contain barriers which similarly restrict lineal fish movements along river and stream channels (Humphries & Walker 2013).</p> <p>Bice et al. (2018) suggested that low-level tidal barriers can prevent spawning movements to the sea for diadromous species. As a result, the connectivity between larvae flowing into the sea and juveniles returning into the rivers are likely prevented through these structures.</p>

1.2	Hydrology	Known past and current	<p>Australian Grayling are reliant on natural water flows to trigger a migratory response for spawning (Koster et al. 2013, 2018). Flow event duration is also critical as it needs to be of a length of time that allows for larvae to drift to coastal waters and for juveniles to swim back into freshwater (Koster et al. 2017; Dawson & Koster 2018).</p> <p>In the absence of natural water flows, effective management of environmental flow releases can promote migration and spawning of the species (Amtstaetter et al. 2016; Shenton et al. 2011, 2014). O'Connor & Mahoney (2004) demonstrated that Australian Grayling will not release eggs if no or less than expected river flow occurs during their expected spawning season.</p> <p>It is noted that Australian Grayling was previously thought to have always migrated to brackish waters to spawn (Koster et al. 2013). However, recent studies (Amtstaetter et al. 2015, 2016) demonstrated that Australian Grayling may select spawning sites based on water velocity and temperature. Therefore, the Australian Grayling's daily habitat may also be the site in which they choose to spawn.</p>
1.3	Habitat degradation	Suspected past and known current	<p>Anthropogenic events lead to the depletion of key riparian zones required by the Australian Grayling (Miles 2007). The species is susceptible to the following activities: vegetation and tree clearing (including riparian), which increases siltation, and; earthworks (for agricultural and urban development) which can damage/destroy riverine habitats (TSS 2019). These activities lead to erosion and poor water quality by effecting levels of water temperature, eutrophication and chemistry (Berra 1982; TSS 2019).</p> <p>Bushfires can cause direct and indirect effects on aquatic ecosystems (Lyon & O'Connor 2008). Direct effects include increases in water temperatures and changes in water chemistry (Lyon & O'Connor 2008). While indirect effects are compounded from the fires impact on the surrounding landscape, the biggest indirect impact is post-fire rainfall leading to sediment runoff or "sediment slugs" into waterways (Lyon & O'Connor 2008; Alexandra & Finlayson 2020). Sediment slugs causes toxic algal blooms which deoxygenates the water, leading to fish kills</p>

			<p>(Alexandra & Finlayson 2020). Additionally, sediment slugs were found to cause impacts to the aquatic ecosystem up to 80 km downstream of the fire impacted area (Lyon & O'Connor 2008).</p> <p>While impacts of bushfires on Australian Grayling is not known, the 2019/20 bushfires in NSW and Victoria have prompted investigations. The species is suspected to be susceptible to sediment slugs changing water chemistry and potentially also through increased sediment covering important spawning habitats (Backhouse et al. 2008a).</p>
1.4	Coastal morphology	Suspected past, present and future	<p>It has been suggested that changes in coastal morphology (i.e. the river mouth and its connectivity with the sea) can cause disruptions to migration pathways (Crook et al. 2006). Gillanders et al. (2011) has indicated that closures of estuarine mouths will have a direct impact on diadromous fish migration.</p>
2.0	Invasive species		
2.1	Introduced fish species	Suspected past and current	<p>Introduced fish species are present in areas inhabited by Australian Grayling. These include:</p> <p>Brown Trout (<i>Salmo trutta</i>) and Rainbow Trout (<i>Oncorhynchus mykiss</i>) were introduced to Australia for angling reasons and are known to cause detrimental effects to native fish populations (Jackson et al. 2004; Humphries & Walker 2013). Trout compete with Australian Grayling for resources and are known to prey on smaller Australian Grayling individuals (including larvae and juveniles) (Backhouse et al. 2008a). Knott (1973) attributes the near extinction of Australian Grayling in Tasmania from the presence of Trout.</p> <p>Redfin (<i>Perca fluviatilis</i>) is another fish which was introduced for angling reasons (Arthington & McKenzie 1997; Humphries & Walker 2013). While no direct studies have demonstrated any interaction between Redfin and the Australian Grayling (Arthington & McKenzie 1997), Redfin is a voracious predator of other native fish species (McDowall 1980b; Backhouse et al. 2008a; Humphries & Walker 2013), therefore it is highly likely to impact Australian Grayling when the two species co-occur.</p> <p>European Carp (<i>Cyprinus carpio</i>) including ornamental variant Koi Carp and Goldfish</p>

			<p>(<i>Carassius auratus</i>) are successful invaders of freshwater waterways (Koehn 2004). European Carp are now the most abundant large freshwater fish in south-eastern Australia (Koehn 2004; Driver et al. 2005). Whilst no direct interaction has been observed between European Carp and Australian Grayling, the European Carp's ability to degrade aquatic habitats is suspected as the main contributing factor to the declines of many native fish populations (Arthington & McKenzie 1997; Koehn 2004; Driver et al. 2005). The Australian Grayling population is likely to be impacted by the presence of European Carp.</p> <p>Eastern Gambusia (<i>Gambusia holbrooki</i>) is a small fish introduced via the aquarium industry and has been implicated in the decline of more than 30 fish species worldwide, including nine from Australia (Lintermans 2007; Humphries & Walker 2013). It predated on the eggs and larvae of native fish, even fin-nipping at much larger fishes (Lintermans 2007; Humphries & Walker 2013).</p>
3.0	Disease		
3.1	Pathogens and parasites	Suspected, past, current and future	<p>The only known parasites to have directly affected the Australian Grayling are the Anchor Worm (<i>Lernaea cyprinacea</i>) and Trematodes (of the Family <i>Opecoelidae</i>) (Hall 1983; Berra 1987). Anchor Worms are thought to have been introduced through European Carp and Redfin (Lintermans 2007; Diggles 2011; Humphries & Walker 2013). While the parasite doesn't cause direct mortality to the host, an infestation can cause indirect mortality through poor health and growth as it affects the feeding behaviour of its host (Read et al. 2007).</p> <p>Trematodes are a type of flatworm parasite that is exclusively found in freshwater and marine fish (Bray et al. 2016). A study into the diet of Australian Grayling by Berra (1987) found that 87% of samples collected were infested with Trematodes.</p> <p>In the 1800s, mass mortalities of Australian Grayling covered in a cotton-like growth were observed in Tasmanian Rivers (Saville-Kent 1888; Examiner 1931). The suspected cause was the <i>Saprolegnia</i> fungus (cotton mould), coinciding with the introduction of Brown trout (known carriers of the fungus) to Tasmania (Saville-Kent 1888; Backhouse et al. 2008a). However, the cause of the mass</p>

		<p>mortalities by <i>Saprolegnia</i> was never confirmed (McDowall 1976; Berra 1982).</p> <p>While risk of infection is low and no studies have demonstrated the interaction between Australian Grayling and the following pathogens and parasites, they do inhabit the same areas:</p> <p><i>Bothriocephalus acheilognathi</i> (Asian Fish Tapeworm). The European Carp is a known definitive Asian Fish Tapeworm host species and is thought to have introduced it to Australia (Henderson 2009). It causes reduced growth and death in fish and infection has been observed in the following native and introduced species: <i>Hypseleotris</i> spp. (native Carp Gudgeons); <i>Retropinna semoni</i> (Australian Smelt); Eastern Gambusia and Goldfish (Dove & Fletcher 2000; Henderson 2009).</p> <p>Epizootic haematopoietic necrosis virus (EHNV) is an Australian endemic iridovirus (<i>Ranavirus</i>) affecting many native and introduced freshwater fish (OIE 2018). While the Australian Grayling have not been observed as naturally susceptible to EHNV (OIE 2018), the geographical distribution of EHNV overlaps that of Australian Grayling—natural infections occurring in Redfin and Rainbow Trout (Whittington et al. 2010). However, EHNV has not been detected in Australia (last detected in Victoria) since 2012 (AHA 2018).</p> <p>Infection with <i>Aeromonas salmonicida</i> – atypical strain (goldfish ulcer disease) is a bacterium that was introduced into Australia in the 1970s via the ornamental fish trade (Humphrey & Ashburner 1993). All salmonids, as well as many non-salmonids are believed to be susceptible. Australian Grayling is not known to be naturally susceptible and to date, there have been no infectivity trials (DAFF 2012). The bacterium is capable of survival outside its host in freshwater, brackish and marine environments and is currently known to occur in Qld, NSW, Vic, Tas and SA. However, it has not been detected since 2007 (DAFF 2012; AHA 2018).</p>
4.0	Climate change	

		Suspected current and future	<p>Lin et al. (2017) modelled the effects of climate change on the habitat of Australian Grayling and demonstrated that the biggest challenge for the species is the disconnection between habitats (barriers to movement) required to complete their life cycle. Climate change is expected to cause localised extinctions in both freshwater and marine habitats of Australian Grayling.</p> <p>Shenton et al. (2011) modelled climate change scenarios on Australian Grayling spawning in the Latrobe River. The modelling indicated that by 2050 or 2070 there will no longer be any sustaining populations in the Latrobe River due to reduced water flows and increasing water temperatures too high to trigger spawning.</p>
5.0	Fishing		
	Recreational fishing	Known past and current	<p>A once popular angling species, Australian Grayling was often taken during the early period following European settlement (Bishop & Bell 1978; Bakehouse et al. 2008a). Australian Grayling are now protected from all targeted fishing in NSW, Tasmania and Victoria. However, the species is being caught incidentally by recreational fishers targeting salmonids using fly-fishing methods (Bakehouse et al. 2008a). Australian Grayling are a delicate fish that is extremely prone to handling stress (Koster et al. 2013; Dawson & Koster 2018).</p> <p>Juvenile Australian Grayling in Tasmania are known to occur alongside <i>Galaxias</i> spp. and <i>Lovettia</i> spp. during upstream whitebait migration (Bakehouse et al. 2008a). The whitebait season occurs for one month between spring and summer each year alternating between rivers (Bakehouse et al. 2008a; IFS TAS 2019). Australian Grayling juveniles can still be harvested in Tasmania as part of the whitebait fishing season (IFS TAS 2019).</p>

Assessment of available information in relation to the EPBC Act Criteria and Regulations

Criterion 1. Population size reduction (reduction in total numbers)			
Population reduction (measured over the longer of 10 years or 3 generations) based on any of A1 to A4			
	Critically Endangered Very severe reduction	Endangered Severe reduction	Vulnerable Substantial reduction
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>(a) direct observation [except A3]</p> <p>(b) an index of abundance appropriate to the taxon</p> <p>(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat</p> <p>(d) actual or potential levels of exploitation</p> <p>(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites</p> <p><i>based on any of the following</i></p>		

The three-generation time period for this species (~7.5 years), is less than 10 years. The assessment period against this Criterion spans 2009–2019.

Evidence:

New South Wales

NSW populations of Australian Grayling are historically known to occur in coastal river catchments from the Minnamurra River (north of Kiama) south to Bruces Creek (Wallagaraugh River catchment near the NSW/Vic border) (NSW DPI 2015b). However, many historical observations have been recorded in the south coast region (NSW FSC 2015). Between 2008–2012, Fisheries NSW conducted surveys from sites based off the Faragher 1993–1995 NSW fisheries annual survey reports. The surveys failed to detect any Australian Grayling from seven sites surveyed in 2008–2009 and 20 sites in 2011–2012. In 2010–2011, one animal was caught from 81 sites (<200 m a.s.l.) surveyed (NSW FSC 2015).

In 2009–2010, Miles & West (2011) conducted surveys in the Shoalhaven region for the NSW Recreational Fishing Trust Fund. The survey investigated the recreational fishing effort within the region. While recognising that recreational fishers were unlikely targeting any Australian Grayling, the species was not reported in the survey. Between 2009–2013, a survey by NSW Department of Primary Industries (NSW DPI) evaluating the effectiveness of the Tallowa Dam Fishway (Shoalhaven River) also detected no Australian Grayling (Walsh et al. 2014).

The results from the Miles & West (2011) and NSW DPI (Walsh et al. 2014) surveys are not unexpected given that since the construction of the Tallowa Dam in 1976, only one Australian Grayling individual has been detected downstream of the dam (in 1997) and none upstream (Gehrke et al. 2001). In 2011, a single Australian Grayling individual was detected by NSW DPI Fisheries in the Yowaka River (ALA 2019). A single individual was also detected in 2019 in the Brogo River (Gilligan pers. comms. in NSW DPI Fisheries 2020). One Australian Grayling was observed and two captured by NSW DPI Fisheries in the freshwater reach of the Clyde River in

February 2020 during post-bushfire recovery monitoring (Walsh pers. comms. in NSW DPI Fisheries 2020).

Victoria

Australian Grayling are expected to occur in all Victorian coastal catchments from the Hopkins River eastwards to the NSW/Vic border. The greatest number of records for the species are from the Tambo, Barwon, Mitchell and Tarwin river systems in the central to east of the state (SWIFFT 2019). Local populations of Australian Grayling occurring in each of the Victorian Catchment Management Authorities (CMAs) are given below:

East Gippsland CMA

The major catchments of the East Gippsland CMA are Genoa, Cann, Bemm, Snowy, Tambo, Nicholson and Mitchell rivers (EGCMA 2019).

Between 2009–2019, 30 Australian Grayling were detected in the Mitchell River catchment, which included its tributaries, the Dargo and Wonnangatta rivers. (ALA 2019; NFRC 2019). Abundance varied yearly with seven recorded in 2009, four recorded in 2010, 13 recorded in 2015, five recorded in 2017 and one recorded in 2019. Zero were recorded in 2011–2014, 2016 and 2018.

Other records of Australian Grayling from the East Gippsland CMA included nine from the Bemm River in 2011 and some juveniles (~140 mm) were caught and released on shallow sandflats in the Thurra River in 2013.

The Snowy River priority native assessment report detected only one Australian Grayling individual (97 mm) from surveys in 2014 (Stoessel 2014).

West Gippsland CMA

The West Gippsland CMA consists of the Thomson, Latrobe and South Gippsland river catchments.

Amtstaetter et al. (2015) and (2016) surveyed the Thomson and Latrobe rivers between 2012–2014. In the 2015 study, 923 Australian Grayling eggs were collected in the Thomson River. In the 2016 study sampling occurred upstream from the confluence of the Thomson and Latrobe rivers, 38 adults were collected between 2012–2013 while 1198 eggs were collected between 2013–2014.

Other surveys in the Thomson River include; Koster et al. (2017) who collected 1117 eggs between 2013–2014 and Webb et al. (2018) who collected 98 young-of-the-year (YOY) animals over an 11-year period between 2005–2015. Abundance varied yearly, with the lowest record of zero in 2013 and highest of 34 in 2007.

The Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP) monitors and assesses priority rivers across Victoria. One of the priorities of VEFMAP is to evaluate the importance of environmental flows on the immigration, dispersal and subsequent recruitment of diadromous fish in Southern Victorian Rivers—the Thomson River is part of this program. In 2016, 18 Australian Grayling were detected in the Thomson River, 11 in 2018 and in 2019, the sampling detected animals between 80–220 mm, as well as six YOY fish (DELWP 2017, 2018; NFRC 2019).

The Native Fish Report Card Program aims to provide real time data to recreational fishers from scientific fish surveys at priority rivers in Victoria. Since 2017, 14 Australian Grayling have been detected in the Thomson River—nine in 2017, five in 2018 and none in 2019.

In 2010, three Australian Grayling were detected in the Latrobe River at Sand Banks Reserve (ALA 2019). A 2015 survey following an environmental water release in the Latrobe River

detected Australian Grayling eggs and larvae. This was the species' first recorded successful breeding event in the Latrobe River catchment (VEWH 2016a).

In 2012, a survey targeting threatened upland galaxiids was conducted in the Thomson and Latrobe river catchments. While the objective of the survey was to detect upland galaxiids, the study also recorded all other aquatic species surveyed. The Australian Grayling has been recorded in the sampling area of this survey, however, no individuals were detected (Raadik & Nicol 2013).

A survey in 2018 by Aquatica Environmental for VicRoads targeting for the presence of Australian Grayling at the Tarwin River detected three animals. The largest, an adult fish, measured 144 mm, while the other two were YOY at 89 mm (Aquatica Environmental 2018).

Port Phillip and Westernport CMA

In the Yarra River between 2009–2019, surveys for Australian Grayling detected 340 eggs and larvae, 50 YOY and 123 individuals (Borg et al. 2014; O'Connor et al. 2015; Koster et al. 2017; NFRC 2019; ALA 2019). Abundance varied yearly, and detections of Australian Grayling occurred across multiple sites along the Yarra River including; Dights Falls, Yarra Bend Park, Yering Gorge Bushland Reserve, Finns Reserve, Pound Bend Reserve and adjacent to the suburbs of Eltham and Healesville. Borg et al. (2014) detected 30 individuals at Dights Falls between 2012–2014. O'Connor et al. (2015) detected 50 YOY between 2013–2014, also at Dights Falls. The surveys by Borg et al. (2014) and O'Connor et al. (2015) were evaluating the performance of various fishways and fish passages in Victorian rivers. Those studies were able to detect Australian Grayling above and below the fishways and passages. Koster et al. (2017) collected 120 eggs via drift nets at one site in the Yarra River. In 2013, four eggs were collected using four drift nets while 116 eggs were collected using six drifts at the same site in 2014. Detections recorded in the Atlas of Living Australia varied yearly between 2009–2015. No detections occurred in 2011 while other detections varied yearly between larvae, eggs and individuals recorded. The Native Fish Report Card detected four individuals in 2018 and one in 2019.

In the Bunyip and Tarago River catchments, surveys for Australian Grayling between 2009–2015 detected 11 846 eggs, 1245 larvae and 143 adults (length ranging from 160–240 mm) (Koster et al. 2013, 2017, 2018). Eggs and larvae were collected every year except 2012 where no sampling occurred. Melbourne Water also detected Australian Grayling—eggs, larvae and adults—following water releases in 2016 (VEWH 2016b).

Other detections of Australian Grayling within this CMA occurred at the Lang Lang River (2011) and the Maribyrnong River (2015). Two eggs/larvae and one individual (unknown size) were detected at the Lang Lang River while one individual was detected at the Maribyrnong River.

Corangamite CMA

Within the Corangamite CMA, Australian Grayling has been detected in the Gellibrand, Barham and Barwon river catchments. The Native Fish Report Card detected the species in the Gellibrand River between 2017–2019. Other detections within this river system was an observation in 2010 and the capture of a juvenile in 2011 (The Standard 2011).

Studies by O'Connor et al. (2015) and Jones & O'Connor (2017) detected the species in the Barham and Barwon river catchments. In the Barwon River, O'Connor et al. (2015) detected 50 YOY fish. Jones and O'Connor (2017) detected 93 animals (unknown size) in the Barwon River and 72 animals (unknown size) in the Barham River.

A single Australian Grayling was detected in the Barwon River (in 2013) at Reedy Lake (ALA 2019).

Glenelg Hopkins CMA

A single Australian Grayling was detected in 2019 at the Glenelg River (ALA 2019; NFRC 2019). The only other detection of the species was recorded 122 years prior.

Tasmania

In Tasmania, surveys detected juvenile Australian Grayling in the Emu, Tamar, Pieman Gordon river catchments, and within the Tarkine Region in 2013. All other surveys monitoring the aquatic fauna in response to various constructions and earthworks detected no Australian Grayling (Parliament Tas 2009; Northbarker 2009; Hydro TAS 2013; Hardie 2015). Other recent detections of Australian Grayling have been observations at: Ringarooma River (2012; 2013); South Esk River (2016), and; Frankland River (2017) (NVA TAS 2019).

Conclusion

The data presented above appear to be insufficient to demonstrate if the species is eligible for listing under this criterion. While Australian Grayling was detected in their expected geographical range of NSW, Victoria and Tasmania, with detections occurring every year since 2009. The type of detections varied each year with no consistent population trend emerging. Detections of eggs and larvae from Victorian catchments suggests that there are mature adults present, however, as female Australian Grayling are highly fecund, (25 000–68 000 eggs) the recorded detections suggest that recruitment may be less than expected and/or the number of mature adults have fluctuated between years and catchments. In NSW, surveys from the past 10 years were unable to detect any eggs or larvae with only six individuals being detected in 2010, 2011, 2019 and 2020. These records suggest that the species may not be recruiting, and/or their geographic range has reduced significantly. In Tasmania sporadic observations suggests that the species is still present, but there is a lack of data on whether mature adults are present or if recruitment has occurred.

While it is likely that the population of Australian Grayling has experienced decline in the past 10 years as indicated by the varying detections from surveys across its geographical range, there are no reliable population estimates from which to infer whether there is ongoing decline and there are no data to suggest extreme fluctuations in distribution, number of locations or subpopulations.

Furthermore, at the time of writing, the full extent of impact of the 2019/20 bushfires in NSW and Victoria on this species is unknown.

However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered as tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 2. Geographic distribution as indicators for either extent of occurrence AND/OR area of occupancy			
	Critically Endangered Very restricted	Endangered Restricted	Vulnerable Limited
B1. Extent of occurrence (EOO)	< 100 km ²	< 5,000 km ²	< 20,000 km ²
B2. Area of occupancy (AOO)	< 10 km ²	< 500 km ²	< 2,000 km ²
AND at least 2 of the following 3 conditions indicating distribution is precarious for survival:			
(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:

The extent of occurrence (EOO) is estimated to be 266 000 km² and the area of occupancy (AOO) is estimated at 312 km² which has been calculated from mapping data between 1999 and 2015 (no records available post 2015). The varying detections under Criterion 1 suggests that there is continuing decline in area, extent and/or quality of habitat and number of subpopulations.

The 2019/20 bushfires affecting the south coast of NSW and eastern Victoria have potentially reduced known locations (IUCN 2019) of the species. The extent of impact in NSW has affected the south coast, an area historically known to contain the greatest number Australian Grayling detections. Fires have affected the Morton, Monga, Deua, Wadbilliga and South Forest National Parks (NSW SEED) and the species is likely to be threatened by sediment slug runoff. The detection of only six individuals from the past 10 years suggests that the NSW population has seen a severe decline in number of locations and the potential impacts from these fires may compound this decline. Locations in NSW are suspected to be as low as one or two (defined from the Guidelines for Using the IUCN Red List Categories and Criteria ver. 14, August 2019). In Victoria, the extent of impact includes the East and North Gippsland region (DELWP 2020). The catchments in the East Gippsland region has known Australian Grayling populations. In the past 10 years detections of the species has occurred in the following East Gippsland rivers; Mitchell, Bemm, Thurra and Snowy. Furthermore, sediment slug from the North Gippsland region may impact known locations 80 km downstream of the burnt area. Therefore, the suspected number of locations in Victoria is between 1–3. The extent of bushfire impacts overlapping in NSW and Victoria suggests that number of locations for Australian Grayling have been limited. Accounting for the Tasmanian population and the affected populations in NSW and Victoria, the total number of locations for the species is suspected to be as low as 5, but it is likely to be ≤ 10.

The evidence presented above appear to demonstrate that the species is **eligible for listing as Vulnerable** under this criterion as it meets the criteria for **B2ab (ii, iii, iv)**. However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered as tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 3. Population size and decline			
	Critically Endangered Very low	Endangered Low	Vulnerable Limited
Estimated number of mature individuals	< 250	< 2,500	< 10,000
AND either (C1) or (C2) is true			
C1 An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future)	Very high rate 25% in 3 years or 1 generation (whichever is longer)	High rate 20% in 5 years or 2 generation (whichever is longer)	Substantial rate 10% in 10 years or 3 generations (whichever is longer)
C2 An observed, estimated, projected or inferred continuing decline AND its geographic distribution is precarious for its survival based on at least 1 of the following 3 conditions:			
(a) (i) Number of mature individuals in each subpopulation	≤ 50	≤ 250	≤ 1,000
(a) (ii) % of mature individuals in one subpopulation =	90 – 100%	95 – 100%	100%
(b) Extreme fluctuations in the number of mature individuals			

Evidence:

As described above under Criterion 1, the data presented above appear to be insufficient to demonstrate if the species is eligible for listing under this criterion as there are no reliable population estimates for the Australian Grayling. However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered as tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 4. Number of mature individuals			
	Critically Endangered Extremely low	Endangered Very Low	Vulnerable Low
Number of mature individuals	< 50	< 250	< 1,000

Evidence:

As described above under Criterion 3, the data presented above appear to be insufficient to demonstrate if the species is eligible for listing under this criterion, as no estimates can be inferred on the number of mature individuals. However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered as tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 5. Quantitative Analysis			
	Critically Endangered Immediate future	Endangered Near future	Vulnerable Medium-term future
Indicating the probability of extinction in the wild to be:	≥ 50% in 10 years or 3 generations, whichever is longer (100 years max.)	≥ 20% in 20 years or 5 generations, whichever is longer (100 years max.)	≥ 10% in 100 years

Evidence:

No published population viability analysis has been undertaken, therefore there are insufficient data to demonstrate if the species is eligible for listing under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered as tentative at this stage, as it may be changed as a result of responses to this consultation process.



Conservation Actions

Recovery Plan

A National Recovery Plan for the Australian Grayling was adopted under to the EPBC Act from 2008.

Primary Conservation Actions

Primary conservation action is to mitigate extinction risk, and to ensure that current and known populations become self-sustaining in the wild to increase their Area of Occupancy and Extent of Occurrence.

Conservation Actions

Conservation and Management priorities

- Habitat protection and rehabilitation
 - Assess fish passage barriers (weirs, dams, locks and barrages), targeting areas where Australian Grayling occur or known to occur and implement management and engineering solutions to fish passage barriers to improve river connectivity.
 - Identify rivers where flow regulation or water abstraction potentially impacts on important populations and habitats of Australian Grayling and ensure conservation requirements (such as promoting/triggering spawning migration) are included in river management processes.
 - Protect key habitat areas used by Australian Grayling from activities, such as vegetation and tree clearing and earthworks that degrade riverine and estuarine habitats.
- Invasive species eradication and control
 - Implement, or supplement existing programs to include a targeted control program for introduced fish species, including Trout (Family Salmonidae), Redfin (*Perca fluviatilis*), European Carp (*Cyprinus carpio*) and Eastern Gambusia (*Gambusia holbrooki*), in areas known to contain Australian Grayling.
 - Protect important Australian Grayling populations and locations from stocking of trout. Current stocking programs are occurring in areas known to contain Australian Grayling, making them highly vulnerable to predation. Trout stocking programs will need to be reassessed to ensure that they are not impacting Australian Grayling populations.
- Community and stakeholder liaison, awareness and education
 - Increase public awareness on Australian Grayling fishing impacts. Reiterate the “no-take” status and non-targeting of the species in NSW, Victoria and Tasmania.
 - Increase recreational fisher awareness on the incidental capture of Australian Grayling as the species is prone to handling stress and may recover poorly from hooking/de-hooking.
 - Ensure research findings are publicised and incorporated into catchment management and river health programs where appropriate.

- Enhance, modify and implement National Resource Management planning processes to minimise adverse impacts on Australian Grayling.

Survey, Monitoring and Mapping priorities

- Implement a targeted monitoring program for Australian Grayling across their known distribution, to assess the current extent of occurrence and area of occupancy. Monitoring should initially target areas where there are known gaps in distribution of data—this could include the use of eDNA surveying.
- Implement surveys to determine reliable population estimates—this includes data on size and structure of populations.
- Once populations have been identified, establish ongoing monitoring to gain an understanding of population distribution and changes as well as habitat quality. This will provide data for reliable estimates on the population cycle of Australian Grayling and is especially important for locations where recovery actions are occurring (e.g. fishway installation, catchment rehabilitation).

Information and Research priorities

- Investigate spawning cues, site selection and the influence of water flow parameters for triggering a spawning response in Australian Grayling.
- Investigate the impact of estuary/coastal morphology on the migration of Australian Grayling during the larval and juvenile phase. This will fill major gaps on larval and juvenile distribution, habitat and movement and lead into investigating the marine phase of Australian Grayling.
- Investigate the direct and indirect impact of invasive species (other than Trout (Family Salmonidae)) Redfin (*Perca fluviatilis*), European Carp (*Cyprinus carpio*) and Eastern Gambusia (*Gambusia holbrooki*), in areas known to contain Australian Grayling.
- Investigate Australian Grayling's susceptibility to parasites and pathogens endemic to the areas where Australian Grayling occurs or known to occur.
- Identify populations of Australian Grayling that occur during Tasmania's whitebait fishery and whether the fishery is having a detrimental effect on recruitment in Tasmanian Rivers.
- Undertake genetic assessment of Australian Grayling populations in NSW and Tasmania (the Victorian population has already been assessed).
- Investigate the impact of increased sedimentation on Australian Grayling and habitats in catchments affected by wildfires.



Collective list of questions for Australian Grayling (*Prototroctes maraena*) – your views

SECTION A GENERAL

1. Provide a general summary of your views of the assessment finding of Australian Grayling across its entire national extent as Vulnerable in the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) threatened species list. If you consider the species to be eligible for threatened species listing other than Vulnerable, provide detailed evidence against the listing criteria for its entire national extent.
2. Can you provide any other additional data or information relevant to the assessment, especially any collected in the past 10 years (since 2009) for the species?

PART 1 – INFORMATION TO ASSIST LISTING ASSESSMENT

SECTION B DO YOU HAVE ADDITION INFORMATION ON THE ECOLOGY OR BIOLOGY OF THE SPECIES?

Biological and taxonomic information

3. Are you able to provide any further information on the taxonomy of the Australian Grayling?
4. Can you provide any additional or alternative information or estimates for the Australian Grayling's longevity (3+ years), age-at-maturity (1 year for males and 2 years for females) and generation length (~2.5 years) with supporting references?
5. Do you have any additional information regarding the ecology or biology of the species not in the current assessment?

SECTION C ARE YOU AWARE OF THE STATUS OF THE TOTAL POPULATION OF THE SPECIES?

Population size

6. Can you provide estimates of the current population size of mature adults for the 1.) national extent and 2.) individual jurisdictions (NSW, Victoria or Tasmania)? *Importantly, for the purposes of the assessment against the listing criteria, is it likely that the population size of mature adults is greater or less than 250 individuals? Please provide any supporting justification or other information.*
7. Are you able to provide any evidence that extreme fluctuations in the number of mature adults occurs in this species?

SECTION D ARE YOU AWARE OF TRENDS IN THE OVERALL POPULATION OF THE SPECIES?

Evidence of total population size change

8. Are you able to provide an estimate of decline in the Australian Grayling's total population size over the last 10 years (since 2009) for the:
 - a.) national extent and;
 - b.) individual jurisdictions (NSW, Victoria or Tasmania)? *Please provide justification and data for your response.*

If, because of uncertainty, you are unable to provide an estimate of decline, you may wish to provide an estimated range (see table below). If so, please choose one of the ranges suggested, and also choose the level of confidence you have in this estimated range.

Decline estimated to be in the range of:

1–30% 31–50% 51–80% 81–100% 90–100%

Level of your confidence in this estimated decline:

0–30% - low level of certainty/ a bit of a guess/ not much information to go on

31–50% - more than a guess, some level of supporting evidence

51–95% - reasonably certain, suggests this range of decline

95–100% - high level of certainty, information indicates a decline within this range

99–100% - very high level of certainty, data are accurate within this range

9. Please provide (if known) any additional evidence which shows any populations is stable, increasing or declining.

SECTION E ARE YOU AWARE OF INFORMATION ON THE TOTAL RANGE OF THE SPECIES

Current distribution/range/extent of occurrence, area of occupancy

10. Has the survey effort for the Australian Grayling been adequate to determine its natural distribution? *If not, please provide justification for your response.*
11. Do you agree with the estimates of the current extent of occurrence (EOO) and area of occupancy (AOO) in the advice (see Criterion 2, page 15–16)? *If not, please provide an alternative estimate with supporting information.*

SECTION F ARE YOU AWARE OF TRENDS IN THE TOTAL RANGE OF THE SPECIES?

12. Do you consider that the way the historical distribution of the Australian Grayling has been estimated is appropriate? Please provide justification for your response.
13. Can you provide estimates of historic EOO and AOO for Australian Grayling across its former range for the 1.) national extent and 2.) individual jurisdictions (NSW, Victoria or Tasmania)? *Please provide justification for your response.*

PART 2 – INFORMATION FOR CONSERVATION ADVICE ON THREATS AND CONSERVATION ACTIONS

SECTION G DO YOU HAVE INFORMATION ON THREATS TO THE SURVIVAL OF THE SPECIES?

14. Do you consider that all threats to Australian Grayling have been identified and described adequately?
- a. Habitat loss and fragmentation
 - i. Fish passage barriers
 - ii. Hydrology – flow regulation and water abstraction
 - iii. Habitat degradation
 - iv. Coastal morphology

- b. Invasive species
 - i. Trout (Family Salmonidae)
 - ii. Redfin (*Perca fluviatilis*)
 - iii. European Carp (*Cyprinus carpio*)
 - iv. Eastern Gambusia (*Gambusia holbrooki*)
- c. Disease
 - i. Anchor worm (*Lernaea cyprinacea*)
 - ii. Trematodes (Family Opecoelidae)
 - iii. Asian Fish Tapeworm (*Bothriocephalus acheilognathi*)
 - iv. Epizootic haematopoietic necrosis virus (EHNV)
 - v. Infection with *Aeromonas salmonicida* – atypical strain (goldfish ulcer disease)
- d. Climate change
- e. Fishing

15. Can you provide additional or alternative information on threats, past, current or potential that may adversely affect Australian Grayling at any stage of its life cycle, with supporting references?

SECTION H DO YOU HAVE INFORMATION ON CURRENT OR FUTURE MANAGEMENT FOR THE RECOVERY OF THE SPECIES?

16. a. What planning, management, and recovery actions are currently in place supporting protection and recovery of Australian Grayling.

b. To what extent have they been effective?

17. Can you recommend any additional or alternative specific threat abatement or conservation actions that would aid the protection and recovery of Australian Grayling?

SECTION I DO YOU HAVE INFORMATION ON STAKEHOLDERS IN THE RECOVERY OF THE SPECIES?

18. a. Are you aware of other knowledge (e.g. traditional ecological knowledge) or individuals/groups with knowledge that may help better understand population trends/fluctuations, or critical areas of habitat for Australian Grayling?

b. Are you aware of any cultural or social importance or use that Australian Grayling has?

19. What individuals or organisations are currently, or potentially could be, involved in the management and recovery of Australian Grayling?

20. How aware of the Australian Grayling are land managers where it is found?

PART 3 – ANY OTHER INFORMATION

21. Do you have comments on any other matters relevant to the assessment of Australian Grayling?

22. In recent events due to the 2019/20 bushfires in NSW and Victoria, are you able to provide any information on the extent of impact from fires on any known or potentially known populations of Australian Grayling.



References cited in the advice

- Allen GR, Midgley SH & Allen M (2002). Southern Graylings Family Prototroctidae, in Allen GR, Midgley SH & Allen M (Eds), *Field Guide to the Freshwater Fishes of Australia*. Western Australian Museum, Perth, Australia. pp. 89–90.
- AHA (Animal Health Australia) (Eds) (2018). Chapter 5 Aquatic animal health, in AHA (Eds), *Animal Health in Australia*. Animal Health Australia, Canberra, Australia.
- ALA (Atlas of Living Australia) (2019). Preserved Specimen of *Prototroctes maraena*, Australian grayling. Viewed: 29 October 2019.
Available at:
<https://biocache.ala.org.au/occurrences/search?taxa=Prototroctes+maraena>
- Alexandra J & Finlayson M (2020). Floods after bushfires: rapid responses for reducing impacts of sediment, ash, and nutrient slugs. *Australasian Journal of Water Resources*. DOI: 10.1080/13241583.2020.1717694
- Amtstaetter F, Dawson D & O'Connor J (2015). Improving our ability to collect eggs of the threatened Australian grayling, *Prototroctes maraena*. *Marine and Freshwater Research* 66, 1216–1219.
- Amtstaetter F, O'Connor J & Pickworth A (2016). Environmental flow releases trigger spawning migrations by Australian grayling *Prototroctes maraena*, a threatened, diadromous fish. *Aquatic Conservation: Marine and Freshwater Ecosystems* 26, 35–43.
- Aquatica Environmental (2018). *Australian grayling Prototroctes maraena targeted survey South Gippsland Highway Realignment Koonwarra, Victoria*. Report prepared for VicRoads. Aquatica Environmental, Lower Plenty, Australia.
- Arthington A & McKenzie F (1997). *Review of impacts of displaced/introduced fauna associated with inland waters*. Australia: State of the Environment Technical Paper Series (Inland Waters), Department of the Environment, Canberra, Australia.
- Backhouse G, Jackson J & O'Connor J (2008a). *National Recovery Plan for the Australian Grayling Prototroctes maraena*. Department of Sustainability and Environment, Melbourne, Australia.
- Backhouse G, Jackson J & O'Connor J (2008b). *Background and Implementation Information for the Australian Grayling Prototroctes maraena National Recovery Plan*. Department of Sustainability and Environment, Melbourne, Australia.
- Bice CM, Zampatti BP & Morrongiello JR (2018). Connectivity, migration and recruitment in a catadromous fish. *Marine and Freshwater Research* 69, 1733–1745.
- Bell JD, Berra TM, Jackson PD, Last PR & Sloane RD (1980). Recent records of Australian grayling *Prototroctes maraena* Günther (Pisces: Prototroctidae) with notes on its distribution. *Australian Zoologist* 20, 419–431.
- Berra TM (1982). Life History of the Australian Grayling, *Prototroctes maraena* (Salmoniformes: Prototroctes) in the Tambo River, Victoria. *Copeia* 1982, 4, 795–805.
- Berra TM, Campbell A & Jackson PD (1987). Diet of the Australian Grayling, *Prototroctes maraena* Günther (Salmoniformes: Prototroctidae), with notes on the Occurrence of a Trematode Parasite and Black Peritonium. *Australian Journal of Marine and Freshwater Research* 38, 661–669.

- Bishop KA & Bell JD (1978). Aspects of the Biology of the Australian Grayling *Prototroctes maraena* Günther (Pisces: Prototroctidae). *Australian Journal of Marine and Freshwater Research* 29, 743–761.
- Bray RA, Cribb TH, Timothy Littlewood DJ & Waeschenbach A (2016). The molecular phylogeny of the digenean family Opecoelidae Ozaki, 1925 and the value of morphological characters, with the erection of a new subfamily. *Folia Parasitologica* 63, doi: 10.14411/fp.2016.013.
- Borg D, O'Connor J & Jones M (2014). Evaluating the effectiveness of the Dights Falls fishway in the Yarra River, Melbourne, Australia, in Vietz G, Rutherford ID & Hughes R (Eds). *Proceedings of the 7th Australian Stream Management Conference*. Townsville, Australia. pp. 210-218.
- Crook DA, Macdonald JI, O'Connor JP & Barry B (2006). Use of otolith chemistry to examine patterns of diadromy in the threatened Australian Grayling *Prototroctes maraena*. *Journal of Fish Biology* 69, 1330–1344.
- DAFF (Department of Agriculture, Forestry and Fisheries) (2012). *Aquatic Animal Diseases Significant to Australia: Identification Field Guide 4th Edition*. Viewed: 28 August 2019. Available on the Internet at: <http://www.agriculture.gov.au/SiteCollectionDocuments/animal-plant/aquatic/field-guide/4th-edition/aquatic-animal-diseases-significant-aus-id-field-guide-4ed.pdf>
- Dawson DR & Koster WM (2018). Habitat use and movements of Australian grayling (*Prototroctes maraena*) in a Victorian coastal stream. *Marine and Freshwater Research* 69, 1259–1267.
- DELWP (Department of Environment, Land, Water and Planning) (2017). Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP) Stage 6, Fish study – Southern Victorian Rivers, project update. Viewed: 9 September 2019. Available on the Internet at: https://www.ari.vic.gov.au/_data/assets/pdf_file/0021/90345/VEFMAP-Stage-6-2017-Project-Update-Southern-Rivers-Fish.pdf
- DELWP (Department of Environment, Land, Water and Planning) (2018). Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP) Stage 6, Fish study – Southern Victorian Rivers, project update. Viewed: 9 September 2019. Available on the Internet at: https://www.ari.vic.gov.au/_data/assets/pdf_file/0034/398905/VEFMAP-Stage-6-Project-Update-2018-Southern-Rivers-fish.pdf
- DELWP (Department of Environment, Land, Water and Planning) (2020). Victoria's bushfire emergency: Biodiversity response and recovery Preliminary report – Version 1. Viewed: 4 February 2020. Available on the Internet at: https://www.wildlife.vic.gov.au/_data/assets/pdf_file/0034/449746/Victorias-bushfire-emergency-Biodiversity-response-and-recovery-Version-1-23-January-2020.pdf
- Diggles B (2011). Risk Analysis – *Aquatic Animal Diseases Associated with Domestic Bait Translocation*. DigsFish Services Pty Ltd, FRDC project no. 2009/072, Banksia Beach, Australia.
- DoEE (Department of the Environment and Energy) (2019). *Prototroctes maraena in Species Profile and Threats Database*, Department of the Environment and Energy, Canberra. Viewed: 15 August 2019. Available at: <http://www.environment.gov.au/sprat>
- Driver P, Stuart I, Closs G, Shirley M & Harris J (2005). *Carp (Cyprinus carpio L.) impacts and recruitment in Australian wetlands: strategies for management*. Native Fish and Wetlands in the Murray-Darlin Basin, Canberra, Australia.

- Dove ADM & Fletcher AS (2000). The distribution of the introduced tapeworm *Bothriocephalus acheilognathi* in Australian freshwater fishes. *Journal of Helminthology* 74, 121–127.
- EGCMA (East Gippsland Catchment Management Authority) (2019). Rivers. Viewed: 3 October 2019. Available at: <https://egcma.com.au/rivers/>
- Examiner (1931). Nature and Science: The Cucumber Herring. Examiner, Launceston, Tasmania.
- Gehrke PC, Gilligan DM & Barwick M (2001). *Fish communities and migration in the Shoalhaven River – Before construction of a fishway*. NSW Fisheries Office of Conservation, Taylors Beach, Australia.
- Gillanders BM, Elsdon TS, Halliday IA, Jenkins GP, Robins JB & Valesini FJ (2011). Potential effects of climate change on Australian estuaries and fish utilising estuaries: a review. *Marine and Freshwater Research* 62, 1115–1131.
- Gomon MF & Bray DJ (2017). *Prototroctes maraena* in *Fishes of Australia*. Viewed: 15 August 2019. Available at: <http://fishesofaustralia.net.au/home/species/3634>
- Hall DN (1983). Occurrence of the copepod parasite *Lernaea Cyprinacea* L., on the Australian grayling, *Prototroctes maraena* Günther. *Royal Society of Victoria Proceedings* 954, 273–274.
- Hall DN & Harrington DJ (1989). *Studies on the spawning and early life history of the Australian grayling, Prototroctes maraena Günther, in the Barwon River, Victoria*. Arthur Rylah Institute for Environmental Research. Technical Report Series No.84. Department of Conservation, Forests & Lands Victoria, Heidelberg, Australia.
- Hammer M (2002). The South East Fish Inventory: Distribution and Conservation of Freshwater Fishes of South East South Australia. Native Fish Australia (SA) Inc., Adelaide, Australia.
- Hammer M, Wedderburn S & van Weenen J (2009). *Action Plan for South Australian Freshwater Fishes*. Department of Environment and Natural Resources, Government of South Australia, Adelaide, Australia.
- Hardie S (2015). *A survey of the freshwater fish fauna of the Tarkine region, north-west Tasmania*. Department of Primary Industries, Parks, Water and Environment, Hobart, Australia.
- Humphrey JD & Ashburner LD (1993). Spread of the bacterial fish pathogen *Aeromonas salmonicida* after importation of infected goldfish, *Carassius auratus*, into Australia. *Australian Veterinary Journal* 70, 12, 453–454.
- Humphries P & Walker K (Eds) (2013). *Ecology of Australian Freshwater Fishes*. CSIRO Publishing, Victoria, Australia.
- Henderson WR (2009). *Pathogens in vertebrate pests in Australia*. Invasive Animals Cooperative Research Centre, Canberra, Australia.
- Hydro TAS (Hydro Tasmania) (2013). *Basslink Review Report 2006–12. Gordon River Basslink Monitoring Program*. Hydro Tasmania, Tasmania, Australia.
- IFS TAS (Inland Fisheries Services Tasmania) (2019). *Whitebait recreational fishery*. Viewed: 3 September 2019. Available at <https://www.ifs.tas.gov.au/whitebait-recreational-fishery>
- IUCN (The International Union for Conservation of Nature) (2019). Guidelines for Using the IUCN Red List Categories and Criteria. Version 14. Prepared by the Standards and Petitions Committee. Available on the internet at: <http://www.iucnredlist.org/documents/RedListGuidelines.pdf>

- Jackson PD (1976). A note on the food of the Australian Grayling *Prototroctes maraena* Günther (Galaxioidae: Prototroctidae). *Australian Journal of Marine and Freshwater Research* 27, 525–528.
- Jackson PD (1980). Survey of fishes in the west branch of the Tarwin River above Berrys Creek. *Victorian Naturalists* 97, 11–14.
- Jackson JE, Raadik TA, Lintermans M & Hammer M (2004). Alien salmonids in Australia: Impediments to effective impact management, and future directions, *New Zealand Journal of Marine and Freshwater Research* 38, 3, 447–455.
- Jenkins A, Kullander F. & Tan HH (2009). *Prototroctes maraena*. *The IUCN Red List of Threatened Species*: e.T18383A8184412. Viewed: 15 August 2019. Available at: <http://dx.doi.org/10.2305/IUCN.UK.2009-2.RLTS.T18383A8184412.en>
- Jones MJ & O'Connor JP (2017). *Monitoring the performance of fishways and fish passage works*. Arthur Rylah Institute for Environmental Research. Technical Report Series No. 257. Department of Environment, Land, Water and Planning, Heidelberg, Australia.
- Knott B (1973). What Tasmanian Trout eat now and what will they eat next? in Gilmour D (ed), *The Tasmania Trout*. Woolston, Launceston, Australia. pp 244–265.
- Koehn JD (2004). Carp (*Cyprinus carpio*) as a powerful invader in Australian waterways. *Freshwater Biology* 49, 882–834.
- Koster WM, Dawson DR & Crook DA (2013). Downstream spawning migration by the amphidromous Australian grayling (*Prototroctes maraena*) in a coastal river in south-eastern Australia. *Marine and Freshwater Research* 64, 31–41.
- Koster WM, Amtstaetter F, Dawson DR, Reich P & Morrongiello JR (2017). Provision of environmental flows promotes spawning of a nationally threatened diadromous fish. *Marine and Freshwater Research* 68, 159–166.
- Koster WM, Crook DA, Dawson DR Gaskill S & Morrongiello JR (2018). Predicting the Influence of Streamflow on Migration and Spawning of a Threatened Diadromous Fish, the Australian Grayling *Prototroctes Maraena*. *Environmental Management* 61, 443–453.
- Lin HY, Bush A, Linke S, Possingham HP & Brown CJ (2017). Climate change decouples marine and freshwater habitats of a threatened migratory fish. *Diversity and Distributions* 23, 7, 751–760.
- Lintermans M (2007). *Fishes of the Murray-Darling Basin: An introductory guide*. Murray-Darling Basin Authority, Canberra, Australia.
- Lyon JP & O'Connor JP (2008). Smoke on the water: Can riverine fish populations recover following a catastrophic fire-related sediment slug? *Austral Ecology* 33, 794–806.
- McDowall RM (1976). Fishes of the Family Prototroctidae (Salmoniformes). *Australian Journal of Marine and Freshwater Research* 27, 641–659.
- McDowall RM (1980a). Chapter 14 Family Prototroctidae Southern graylings, in McDowall RM (ed), *Freshwater Fishes of South-eastern Australia*. Reed Books, Sydney, Australia. pp. 96–98.
- McDowall RM (1980b). Chapter 30 Family Percidae Freshwater perches, in McDowall RM (ed), *Freshwater Fishes of South-eastern Australia*. Reed Books, Sydney, Australia. pp. 183–185.
- Miles NG (2005). *The distribution and abundance of Australian grayling in coastal catchments of southern New South Wales*. School of Earth and Environmental Sciences, University of Wollongong, Wollongong, Australia.

- Miles NG (2007). *Biology and ecology of diadromous fishes in south eastern Australia*, PhD thesis. School of Earth and Environmental Sciences, University of Wollongong, Wollongong, Australia. Available on the Internet at: <https://ro.uow.edu.au/theses/727/>
- Miles NG and West RJ (2011). *Recreational fishing in the Shoalhaven Region, NSW, Australia: optimising survey methods and assessing sustainability*. Final Report for the NSW Recreational Fishing Trust. Australian National Centre for Ocean Resources and Security, University of Wollongong, Wollongong, Australia.
- NFRC (Native Fish Report Card) (2019). Native Fish Report Card. Viewed: 3 October 2019. Available at <https://www.nativefishreportcard.org.au/>
- Northbaker (Northbaker ecosystems services) (2009). *Tasmania Mines Ltd. – Tailings dam Kara Road, Hampshire*. Botanical survey and fauna habitat assessment for Pitt & Sherry. Hobart, Tasmania.
- NSW DPI (Department of Primary Industries) (2015a). *Primefact: Australian Grayling – *Prototroctes maraena**. Available on the Internet at: https://www.dpi.nsw.gov.au/_data/assets/pdf_file/0011/635348/australian-grayling-prototroctes-maraena.pdf
- NSW DPI (Department of Primary Industries) (2015b). *Dataset: Australian Grayling Indicative Distribution in NSW*. NSW Spatial Dataset Profile. Available on the Internet at: https://www.dpi.nsw.gov.au/_data/assets/pdf_file/0008/670337/Spatial-Dataset-Profile-Australian-Grayling.pdf
- NSW FSC (Fisheries Scientific Committee) (2015). *Prototroctes maraena – Australian Grayling as an Endangered Species*. Available on the Internet at: https://www.dpi.nsw.gov.au/_data/assets/pdf_file/0010/636490/australian-grayling-final-determination.pdf
- NSW SEED (The Central Resource for Sharing and Enabling Environmental Data in NSW) (2020). Google Earth Engine Burnt Area Map (GEEBAM). Viewed: 5 February 2020. Available at https://geo.seed.nsw.gov.au/Public_Viewers/index.html?viewer=Public_Viewers&locale=en-AU&runWorkflow=AppendLayerCatalog&CatalogLayer=SEED_Catalog.250.GEEBAM%20Burnt%20Area%20Class
- NVA TAS (Natural Values Atlas Tasmania) (2019). *Prototroctes maraena*. Tasmanian Government. Viewed: 10 September 2019 Available at: <https://www.naturalvaluesatlas.tas.gov.au/>
- O'Connor JP & Mahoney JC (2004). Observations of ovarian involution in the Australian grayling (*Prototroctes maraena*). *Ecology of Freshwater Fish* 13, 70–73.
- O'Connor J, Mallen-Cooper M & Stuart I (2015). *Performance, operation and maintenance guidelines for fishways and fish passage works*. Arthur Rylah Institute for Environmental Research Technical Report No. 262 for the Water and Catchments Group, Department of Environment, Land, Water and Planning. Arthur Rylah Institute for Environmental Research, Department of Environment, Land, Water and Planning, Heidelberg, Australia.
- OIE (World Organisation for Animal Health) (2018). *Chapter 2.3.1. Infection with Epizootic Haematopoietic Necrosis Virus*. Viewed: 28 August 2019. Available on the Internet at: https://www.oie.int/fileadmin/Home/eng/Health_standards/aahm/current/chapitre_ehn.pdf
- Parliament Tas (Parliament of Tasmania) (2009). East Tamar Highway, Dilston Bypass. Parliamentary Standing Committee on Public Works, Parliament of Tasmania.

- Raadik TA & Nicol MD (2013). *Searching for threatened upland galaxiids (Teleostei, Galaxiidae) in the Thomson and La Trobe river catchments, West Gippsland, Victoria*. Arthur Rylah Institute for Environmental Research Technical Report Series No. 248. Department of Environment and Primary Industries, Heidelberg, Australia.
- Read P, Landos M, Rowland SJ & Mifsud C (2007). *Diagnosis, Treatment & Prevention of the Diseases of the Australian Freshwater Fish Silver Perch (Bidyanus bidyanus)*. NSW Department of Primary Industries, Sydney, Australia.
- Saville-Kent W (1888). On the acclimatisation of the salmon (*Salmo salar*) in Tasmanian waters, and upon the reported salmon disease at the breeding establishment on the River Plenty. *Papers and Proceeding of the Royal Society of Tasmania* 1887, 54–66.
- Schmidt DJ, Crook DA, O'Connor JP & Hughes JM (2011). Genetic analysis of threatened Australian grayling *Prototroctes maraena* suggests recruitment to coastal rivers from an unstructured marine larval source population. *Journal of Fish Biology* 78, 1, 98–111.
- Shenton W, Hart B & Chan T (2011). Bayesian network models for environmental flow decision-making: 1. Latrobe River Australia. *River Research and Applications* 27, 283–296.
- Shenton W, Hart B & Chan T (2014). A Bayesian network approach to support environmental flow restoration decisions in the Yarra River, Australia. *Stochastic Environmental Research and Risk Assessment* 28, 57–65.
- Stoessel D (2014). *Snowy River priority native fish assessment*. Arthur Rylah Institute for Environmental Research. Unpublished Client Report for East Gippsland Catchment Management Authority, Department of Environment and Primary Industries, Heidelberg, Australia.
- SWIFFT (State Wide Integrated Flora and Fauna Teams) (2019). *Australian grayling*. Viewed 16 August 2019. Available at: https://www.swiff.net.au/cb_pages/sp_australian_grayling.php
- The Standard (2011). *Grayling signals rebirth of Gellibrand River*. Viewed: 10 September 2019 Available at: <https://www.standard.net.au/story/795017/grayling-signals-rebirth-of-gellibrand-river/>
- TSS (Threatened Species Section) (2019). *Prototroctes maraena (Australian Grayling): Species Management Profile for Tasmania's Threatened Species Link*. Department of Primary Industries, Parks, Water and Environment, Tasmania. Viewed: 22 August 2019 Available at: <https://www.threatenedspecieslink.tas.gov.au/Pages/Australian-Grayling.aspx>
- VEWH (Victorian Environment Water Holder) (2016a). *First recorded Australian grayling breeding in Latrobe*. Viewed: 10 September 2019 Available at: <http://www.vewh.vic.gov.au/news-and-publications/stories/latrobe-records-first-australian-grayling-breeding>
- VEWH (Victorian Environment Water Holder) (2016b). *Threatened fish baby boom*. Viewed: 10 September 2019 Available at: <http://www.vewh.vic.gov.au/news-and-publications/news/threatened-fish-baby-boom>
- VFA (Victorian Fisheries Authority) (2018). *Australian grayling*. Viewed: 15 August 2019. Available at: <https://vfa.vic.gov.au/education/fish-species/australian-grayling>
- Walsh W, Rodgers M, Robinson W & Gilligan D (2014). *Evaluation of the effectiveness of the Tallowa Dam Fishway*. NSW Department of Primary Industries, Fisheries Final Report Series No. 143. Batemans Bay Fisheries Centre, Batemans Bay, Australia.

- Webb JA, Koster WM, Stuart IG, Reich P & Stewardson MJ (2018). Make the Most of the Data You've Got: Bayesian Models and a Surrogate Species Approach to Assessing Benefits of Upstream Migration Flows for the Endangered Australian Grayling. *Environmental Management* 61, 398–407.
- Whittington RJ, Becker JA & Dennis MM (2010). Iridovirus infections in finfish – critical review with emphasis on ranavirus. *Journal of Fish Diseases* 33, 95–122.