National Recovery Plan for the Australian Grayling *Prototroctes maraena*

Australian Government

Department of Sustainability and Environment

Inland Fisheries Service

Victoria The Place To Be

Prepared by Gary Backhouse, Justin O'Connor (Department of Sustainability and Environment, Victoria) and Dr Jean Jackson (Department of Primary Industries, Water and Environment, Tasmania).

Published by the Victorian Government Department of Sustainability and Environment (DSE) Melbourne, 2008.

Authorised by the Victorian Government, 8 Nicholson Street, East Melbourne.

ISBN 1 74152 434 2 (html)

This is a Recovery Plan prepared under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999, with the assistance of funding provided by the Australian Government.

This Recovery Plan has been developed with the involvement and cooperation of a range of stakeholders, but individual stakeholders have not necessarily committed to undertaking specific actions. The attainment of objectives and the provision of funds may be subject to budgetary and other constraints affecting the parties involved. Proposed actions may be subject to modification over the life of the plan due to changes in knowledge.

An electronic version of this document is available on the Department of the Environment, Water, Heritage and the Arts website www.environment.gov.au

For more information contact the DSE Customer Service Centre 136 186

Citation: Backhouse, G., Jackson, J. and O'Connor, J. 2008a. National Recovery Plan for the Australian Grayling *Prototroctes maraena*. Department of Sustainability and Environment, Melbourne.

Cover photograph: Australian Grayling *Prototroctes maraena* by Gary Backhouse.

Table of Contents

Summary 3

Species Information 3

Distribution 3

Population Information 4

Habitat 5

Decline and Threats 5

Areas and Populations Under Threat 8

Recovery Information 9

Strategy for Recovery 9

Program Implementation 9

Program Evaluation 9

Recovery Objectives 9

Recovery Objectives, Performance Criteria and Actions - Summary 10

Affected interests 12

Cost of the Recovery Plan 12

Role and interests of indigenous people 13

Benefits to other species/ecological communities 13

Social and economic impacts 13

Management Practices 13

Acknowledgments 14

References 14

Figures and Tables

Figure 1. Distribution of the Australian Grayling in south-eastern Australia 3

Table 1. Important Rivers for Australian Grayling 4

Table 2. Organisations with an interest in conservation of the Australian Grayling including responsibility for management of Australian Grayling habitat' 12

Abbreviations

ARI Arthur Rylah Institute for Environmental Research (DSE, Victoria)
CMA Catchment Management Authority
DPIW Department of Primary Industries and Water
DPI Department of Primary Industries
DSE Department of Sustainability and Environment (Victoria)
IFS Inland Fisheries Service (Tasmania)
IUCN International Union for the Conservation of Nature
MDBC Murray Darling Basin Commission
PV Parks Victoria

Summary

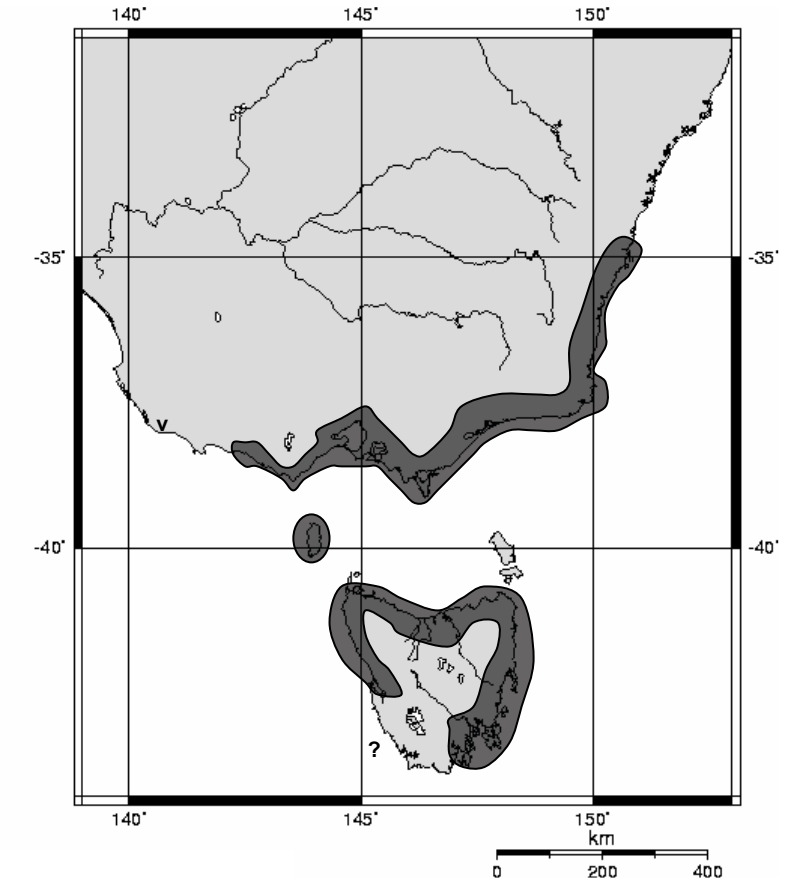
The Australian Grayling *Prototroctes maraena* is a small to medium-sized, slender, silvery fish with soft-rayed fins lacking any spines. It is endemic to south-eastern Australia, including Victoria, Tasmania and New South Wales, and is a migratory species that inhabits estuarine waters and coastal seas as larvae/juveniles, and freshwater rivers and streams as adults. The Australian Grayling is considered threatened due to declines in abundance throughout most of its range, and has been listed as Vulnerable under the Australian Government *Environment Protection and Biodiversity Conservation Act 1999*. This national Recovery Plan for the Australian Grayling is the first recovery plan prepared for the species. The Plan details the species' distribution and biology, conservation status, threats, and recovery objectives and actions necessary to ensure the long-term survival of the Australian Grayling.

Species Information

Distribution

The Australian Grayling occurs in south-eastern Australia, in coastal rivers and streams in New South Wales, Victoria and Tasmania (Cadwallader & Backhouse 1983; Fulton 1990; McDowall 1996a) (Fig 1). 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 from 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.

Figure 1. Distribution of the Australian Grayling in south-eastern Australia



distribution indicated by shaded area. v = vagrant ? = presence uncertain

Population Information

The Australian Grayling has been recorded from many rivers across its range (listed in Table 1). Important populations, that will be high priority for recovery actions to ensure their long-term survival, are those at the limits of the species range, and those known to contain large breeding populations or occur in areas with extensive spawning habitat. Such populations are likely to act as 'source' populations for other areas containing less suitable habitat for the species. Identification of additional important populations, such as any that are genetically distinct, will be undertaken as a recovery action. Important populations necessary to the long term survival and recovery of the Australian Grayling occur in the following locations:

Table 1. Important Rivers for Australian Grayling

River	Bioregion*
New South Wales	
Shoalhaven River	Sydney Basin
Bega River	South East Corner
Clyde River	South East Corner
Victoria	
Genoa River	South East Corner
Wingan River	South East Corner
Thurra River	South East Corner
Cann River system	South East Corner
Bemm River	South East Corner
Snowy River system (incl. Buchan River)	South East Corner
Tambo River	South East Corner, South East Highlands
Mitchell River system	South East Corner, South East Highlands
Avon River system	South East Corner, South East Highlands
Thomson River (incl. lower Latrobe River)	South East Highlands
Agnes River	South East Coastal Plain, South East Highlands
Albert River	South East Coastal Plain, South East Highlands
Franklin River	South East Coastal Plain, South East Highlands
Tarra River	South East Coastal Plain, South East Highlands
Merrimans Creek	South East Coastal Plain
Roaring Meg Creek	South East Coastal Plain, South East Highlands
Tarwin River	South East Coastal Plain
Lang Lang River	South East Coastal Plain, South East Highlands
Cardinia Creek	South East Coastal Plain, South East Highlands
Bunyip River	South East Coastal Plain, South East Highlands
Yarra River system	South East Coastal Plain, South East Highlands
Barwon River	South east Coastal Plain, Victorian Volcanic Plain, South East Highlands
Calder River	South East Coastal Plain, South East Highlands
Cumberland River	South East Coastal Plain, South East Highlands
Carisbrook Creek	South East Coastal Plain, South East Highlands
Aire River	South East Coastal Plain, South East Highlands
Barham River	South East Coastal Plain, South East Highlands
Skenes Creek	South East Coastal Plain, South East Highlands
Erskine River	South East Coastal Plain, South East Highlands
St Georges River	South East Coastal Plain, South East Highlands
Wild Dog Creek	South East Coastal Plain, South East Highlands
Wye River	South East Coastal Plain, South East Highlands
Gellibrand River	South East Coastal Plain, South East Highlands
Curdies River	South East Coastal Plain
Hopkins River	South East Coastal Plain
Tasmania	
Gordon River	Tasmanian West
Pieman River	Tasmanian West
Arthur River	Tasmanian West
Ettrick River	King

Duck River	King
Detention River	King
Franklin Rivulet	Tasmanian Northern Slopes
Inglis River	Tasmanian Northern Slopes
Cam River	Tasmanian Northern Slopes
Blythe River	Tasmanian Northern Slopes
Sulphur Creek	Tasmanian Northern Slopes
Leven River	Tasmanian Northern Slopes
Forth River	Tasmanian Northern Slopes
Don River	Tasmanian Northern Slopes
Mersey River	Tasmanian Northern Slopes
Rubicon River	Tasmanian Northern Slopes
North Esk River	Ben Lomond
Great Forester River	Flinders
Ansons River	Flinders
George River	Flinders
Scamander River	Flinders
Little Swanport River	Tasmanian South East
Douglas River	Tasmanian South East
Apsley River	Tasmanian South East
Lisdillon River	Tasmanian South East
Meredith River	Tasmanian South East
Prosser River	Tasmanian South East
Derwent River	Tasmanian South East
Huon River	Tasmanian Southern Ranges
North West Bay River	Tasmanian South East

*** IBRA Bioregions *sensu* DEH (2000)**

Habitat

The Australian Grayling is a diadromous species, migrating between rivers, their estuaries and coastal seas, so relies on free access to a range of freshwater, estuarine and marine habitats for its survival. Australian Grayling spend most of their lives in freshwater, inhabiting rivers and streams, usually in cool, clear waters with a gravel substrate and alternating pool and riffle zones (Bishop & Bell 1978b; Berra 1982) but can also occur in turbid water (Jackson & Koehn 1988). The species can penetrate well inland, and has been reported from over 100 km upstream from the sea (Jackson & Koehn 1988). Larvae and juveniles inhabit estuaries and coastal seas, and there appears to be an obligatory marine stage (Crook *et al.* in prep.), although their precise habitat requirements are not known.

Given the wide distribution and range of habitats used by the species throughout its life, it is not practical to specify habitat that is critical to survival as all habitat where Australian Grayling potentially occur. However, some habitats such as spawning, refuge and juvenile habitats are likely to be limited in distribution, yet crucial to the grayling's life cycle. Proposed recovery actions include identification of habitats used at critical stages of the grayling's life cycle.

Detailed distribution information on the Australian Grayling is available from:
Victoria: Department of Sustainability and Environment (www.dse.vic.gov.au)
Tasmania: Department of Primary Industries, Water and Environment (www.dpiwe.tas.gov.au)
New South Wales: Department of Primary Industries (www.dpi.nsw.gov.au)

Decline and Threats

The Australian Grayling was once abundant throughout its range, but it has declined in many areas since European settlement of Australia, and is now generally patchily distributed, although it can still be locally common in some rivers (Bell *et al.* 1980; Berra 1982; Jackson and Koehn 1988; McDowall 1996a). It is uncertain if the extent of occurrence has declined. There is an old (1895) record from the Glenelg River in south-western Victoria but, despite numerous surveys in the Glenelg River over several decades, the species has not been recorded there since (DSE-ARI unpubl. data).

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

Threatening Processes

Barriers to Movements

Barriers to fish movements include instream dams, weirs, culverts, levee banks, areas of unsuitable habitat including dewatered areas, and high flow or turbulence. Barriers have been recognised as a major threatening process operating in many waterways in south-eastern Australia, affecting the movements of many migratory species including Australian Grayling. Many rivers within the natural range of the Australian Grayling have been affected by barriers (DSE unpubl., IFS 2003a). As the Australian Grayling needs to move between rivers and coastal seas to complete its life cycle, barriers block upstream migration, and can interfere with downstream migration, and can cause local extinction in the section of river upstream from the barrier. If barriers block access to breeding habitat, then reproductive output is reduced, placing pressure on the population. Barriers also limit the ability to colonise or recolonise suitable habitat, and can reduce gene flow by fragmenting populations. Migrating fish, especially juveniles, congregating below barriers because their upstream passage is blocked, are much more vulnerable to predation by larger fish and birds, and capture by humans (angling and whitebaiting).

River regulation

River regulation occurs where natural flows are altered through the retention or diversion of water in dams and weirs, and extraction of water from the river. This has the effect of reducing the frequency and extent of natural flooding in winter and spring, and often increasing flows in summer, when stored water is released for irrigation. Management for hydro power generation may result in short term fluctuations in flows or sustained low or flood level flows. Australian Grayling appear to be dependent upon flooding to spawn, requiring a rise in water levels, possibly coupled with a decrease in water temperatures, to initiate spawning. When flooding does not occur during the spawning season, females resorb their ovaries and do not spawn (O'Connor & Mahoney 2004). Bishop and Bell (1978a) recorded the death of many Australian Grayling below Tallowa Dam (Shoalhaven River, NSW) due to sudden cessation of flows. Some migratory species such as freshwater eels cue in on freshwater flows to the sea during their migration from marine to fresh water, so flooding may also be important in facilitating migration of larval and juvenile grayling from coastal seas into rivers. Reducing and altering the seasonality of river flow, through retention in dams and weirs, diversions and direct pumping, can directly affect adults as well as reducing reproductive potential and recruitment. Missing a spawning season could have major consequences for a species that may spawn only once or twice in its entire life. Where a river does have a dam or weir to regulate river flow, the same dams and weirs also act as barriers to migration, so the total effect of these structures on Australian Grayling can be severe.

Poor water quality

There are many different types and causes of poor water quality, including altered temperature regime (thermal pollution), reduced dissolved oxygen, increased nutrients and toxins. Causes include reduced flows due to water diversion, impoundment or sustained dry periods. Heavy rainfall can cause sediment and ash run-off from areas laid bare from over-grazing, vegetation clearance, drought and wild fires (see Siltation). 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 Australian Grayling may avoid or not recolonise areas of sustained poor water quality. Fish kills can also result from direct input of toxins into waterways, and oversaturation with oxygen below turbulent dam outflows.

Siltation

Increased siltation of rivers can result from catchment disturbance including vegetation clearing, degradation of riparian zones, burning and roading. Increased siltation reduces water quality, can promote plankton blooms and smother river substrate used by grayling for feeding and spawning. High turbidity from suspended sediment erodes fish gills and has been shown to affect feeding in riverine fish species (Rowe *et al.* 2002). Sediments can remain deep in river substrates for several years and altered flows may reduce sediment removal. Whilst subsequent flooding would usually flush excessive siltation downstream, reduced flooding (eg. from drought, river regulation) possibly means less effective flushing of sediment from gravel beds. The extensive wildfires in south-eastern Australia in January and February 2003 burnt through the upper catchments of two of the most important rivers for Australian Grayling in Victoria, the Tambo and Snowy River systems. The impact of this is not known, but is currently being investigated. However, runoff from the wildfire affected area in north-eastern Victoria caused an extensive fish kill in the Ovens River in February 2003 (DSE-ARI unpubl.). Australian Grayling are likely to be highly susceptible to siltation through covering gravel required for spawning habitat. Even though subsequent flooding may gradually mobilise sediments and shift them downstream, several missed breeding seasons in short succession can have severe consequences for population conservation.

Impact of Introduced Fish

A number of introduced fish species, including Common Carp *Cyprinus carpio*, Goldfish *Carrasius auratus*, Redfin Perch *Perca fluviatilis*, Eastern Gambusia *Gambusia holbrooki*, Oriental Weatherloach *Misgurnis anguillicaudatus*, Brown Trout *Salmo trutta* and Rainbow Trout *Oncorhynchus mykiss* occur within the distribution of Australian Grayling. Introduced species can pose a threat to native fish species and their habitats through predation, competition, disease transmission and other effects such as physical habitat degradation, often through the very high densities some introduced fish species may reach. Trout are known to prey on small grayling (T. Raadik DSE-ARI pers. comm.) and are also likely to compete for habitat, especially as grayling and trout occur in similar habitats (Jackson & Koehn 1988). Larvae and juveniles may be highly susceptible to predation by trout (and other piscivorous species), especially during their migration from marine waters through estuaries and then upstream to the adult habitats, where they may need to pass through areas occupied by trout. Barriers and areas of low flow may also exacerbate susceptibility to predation, causing large aggregations of migrating fish to gather at blockages. Adults may be at less risk of predation due to their larger size, but may be at risk of competition for habitat. However, there is little definitive evidence of the impact of trout on Australian Grayling, despite the implication of trout as a contributing factor in the extinction of the New Zealand Grayling (McDowall 1976). In a major review of the impact of introduced salmonids on Australian native fauna, Cadwallader (1996) considered it imperative that the impact of trout on Australian Grayling be investigated. Because of their feeding habits, Oriental Weatherloach are likely to be predators of grayling eggs (which are laid in the substrate), and weatherloach have been implicated in the demise of the Mountain Galaxias *Galaxias olidus* (M. Lintermans Environment ACT. pers. comm.), a small species of upland streams that also spawns over gravel beds.

Climate change

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

Disease

Mass mortalities of Australian Grayling were reported in the 1880s (Saville-Kent 1888, cited in Cadwallader 1996), which coincided with the introduction of trout to Tasmania. Dead and dying grayling were seen ‘floating down the rivers in thousands, covered…with a cottony fungoid growth’, and Saville-Kent suggested that a disease fatal to grayling may have been brought in with trout. A copepod parasite probably originating on Common Carp and Redfin Perch has been found on Australian Grayling in Victoria (Hall 1983), although its effects are not known.

Fishing: Angling and whitebaiting
The Australian Grayling was known as a sporting fish for anglers when the species was more common, especially before the introduction and widespread distribution of salmonids, and was one of very few native fish to be taken by flyfishing. Although no longer targeted by anglers, anecdotal reports and observations indicate that accidental catches can be quite high at times, especially where aggregations of grayling occur below instream barriers. In addition, juveniles are known to occur amongst *Galaxias* and *Lovettia* species in the upstream-migrating whitebait runs in Tasmania. Surveys conducted in the late 1980s found that juveniles were regularly recorded from a number of rivers in various parts of the State; the amount of grayling bycatch is not well documented but creel surveys of fishers indicate it is likely to be small (IFS unpublished data). There is a limited legal recreational fishery for whitebait in Tasmania, with the season open for one month only and a limited number of rivers open for fishing. Therefore fishing is considered unlikely to be a major threat to the species or populations.

Areas and Populations Under Threat

It is likely that some threats are operating in many, if not most, waters where Australian Grayling occur. Few catchments would have escaped some vegetation clearing, impoundment or diversion of water, and installation of structures acting as barriers to migration. There are few locations where Australian Grayling occur that are free of introduced fish, with at least one, and sometimes several, introduced fish species present. South-western Tasmania is currently free of trout, although trout are gradually spreading around the coast (IFS unpubl. data.) Although there are no records of Australian Grayling from the region, this is almost certainly due to lack of targeted surveys rather than any real absence.

However, with the installation of fish ladders and other devices to allow fish passage past barriers, increases in environmental flows to some rivers, and improved catchment management such as protection and revegetation of riparian zones, it is expected that the impact of some threatening processes on Australian Grayling will be substantially reduced over time. However, these improvements may be at least in part offset by decreasing rainfall, increasing dryness and subsequent reduced river flows due to climate change, and possibly by the continuing spread of some introduced freshwater fish. The impacts of sediment and ash run-off into rivers where Australia Grayling occur following the extensive wildfires in south-eastern Australia in 2003 may also be felt for many years, until the excess sediment has shifted downstream.

Human Activities with the potential to have detrimental impact on the Australian Grayling

- Constructing barriers to fish movement/migration – barriers include culverts, weirs, dams, barrages, areas of unsuitable habitat (eg. excessive turbulence, artificially raised water temperatures).
- Reduction in/alteration of river flows (especially winter flows), through abstraction of more water from the system, building new dams/weirs, retention in dams etc.
- Removal/degradation of riparian vegetation/habitat.
- Removal of snags, woody debris, rocks from potential habitat. Where this is unavoidable (eg. for protection of assets such as bridges), alternative suitable habitat should be created as a compensation or offset.
- Events leading to increased siltation or sedimentation, such as works on riverbank and floodplain.
- Release of potential predators/competitors (such as stocking for recreational angling) in areas where important populations occur or where habitat works are occurring to increase population size and security.
- Pesticide and fertiliser run-off changing nutrient regimes leading to algae blooms, reduction in dissolved oxygen, increasing sedimentation rates etc.

Recovery Information

Strategy for Recovery

The Australian Grayling is ideally placed to benefit from integrated catchment management, including maintaining or restoring environmental flows, and protection and revegetation of riparian zones to increase streamside cover and reduce erosion and sediment input into waterways. Many such programs are already occurring in catchments where Australian Grayling occur. The species is a potential major beneficiary of the Snowy River restoration program, through increased flows and habitat, and improved water quality. Programs to restore fish passage past barriers will also be of major benefit to the Australian Grayling. Monitoring the ecological response of Australian Grayling to these measures will be a key factor in managing the recovery of this species.

Program Implementation

The Recovery Plan will run for five years from the time of adoption and will be managed largely by the Department of Sustainability and Environment (Victoria), the Department of Primary Industries, Water and Environment (Tasmania) and the Department of Primary Industries (NSW). Implementation of individual actions will remain the responsibility of the relevant agencies and organisations identified in the Recovery Plan (subject to available resources), who will be responsible for preparing work plans and monitoring progress toward recovery within their own jurisdiction. A Recovery Team will be formed consisting of staff with relevant technical, scientific and habitat management skills, to coordinate recovery actions and circulate information.

Program Evaluation

The Recovery Team will be responsible for annual assessments of progress towards recovery. Within five years from adoption as a national recovery plan, an external evaluator will be appointed to undertake a formal review and evaluation of the recovery program.

Recovery Objectives

The **overall objective** of recovery is to minimise the probability of extinction of the Australian Grayling in the wild, and to increase the probability of important populations becoming self-sustaining in the long term.

Within the life span of this Recovery Plan, the **Specific Objectives** of recovery of the Australian Grayling are to:

1. Identify important populations of Australian Grayling.
2. Protect and restore habitat for Australian Grayling.
3. Investigate important life history attributes to acquire targeted information for management.
4. Investigate and manage threats to populations and habitats.
5. Increase awareness of Australian Grayling with resource managers and the public.

Note: A summary of the recovery plan actions is provided here. Detailed implementation information can be found in the supporting document 'Background and Implementation Information for the Australian Grayling Prototroctes maraena *National Recovery Plan' available at www.environment.gov.au*

Recovery Objectives, Performance Criteria and Actions - Summary

Objective	Performance Criteria	Actions
1. Identify important populations of Australian Grayling.	Important populations across the range, and threats to their survival, are identified and documented. *Timeframe: by Year Five*	1.1 Collate existing data on distribution, abundance and population parameters. 1.2 Determine gaps in distribution data and undertake surveys to determine presence and significance of grayling populations in areas poorly surveyed. 1.3 Undertake a genetic assessment of population structure throughout range. 1.4 Identify populations and locations for long-term monitoring, especially to determine population trends and responses in locations where recovery actions are occurring (eg. fishway installation, catchment protection). 1.5 Acquire baseline data on selected populations by conducting surveys including (a) identification of the area and extent of populations; (b) estimates of the size and structure of populations; (c) inference or estimation of population change and (d) habitat quality.
2. Protect and restore habitat for Australian Grayling.	Revegetation of riparian zones in important catchments continues, and there is an increase in length of rivers available for Australian Grayling through facilitation of fish passage past barriers. *Timeframe: by Year Five*	2.1 Identify and map important habitat (rivers/locations), particularly for recruitment and as potential drought refuge habitat. 2.2 Identify rivers where flow regulation or water abstraction potentially impacts on important populations and habitats of Australian Grayling, and ensure conservation requirements are included in river management processes. 2.3 Ensure Australian Grayling conservation requirements are included in fishway programs. 2.4 Protect and restore riparian habitat in catchments supporting Australian Grayling populations, with priority to those catchments supporting important habitat/populations.

Objective	Performance Criteria	Actions
3. Investigate important life history attributes to acquire targeted information for management.	Key life history attributes are identified and information supplied to management for population and habitat protection. *Timeframe: by Year Three*	3.1 Investigate spawning cues, particularly the influence of river flows. 3.2 Investigate larval and juvenile distribution, habitat and movements. 3.3 Investigate adult distribution, habitat and movements.
4. Investigate and manage threats to populations and habitats.	Important populations are secure from controllable threats. *Timeframe: by Year Five*	4.1 Investigate the potential for predation on larvae/juveniles in estuarine environments. 4.2 Investigate the impact of trout on Australian Grayling. 4.3 Ensure important populations and locations are protected from stocking of trout. 4.4 Investigate the impact of increased sedimentation on Australian Grayling and habitats in catchments affected by wildfires in 2003.
5. Increase awareness of Australian Grayling conservation with resource managers and the public.	Knowledge of Australian Grayling increases with managers and the public, and conservation requirements included in NRM plans and projects. *Timeframe: by Year Five*	5.1 Ensure research findings are publicised and incorporated into catchment management and river health programs where appropriate. 5.2 Promote angler awareness of conservation of Australian Grayling where incidental capture is likely to be an issue.

Cost of the Recovery Plan

The estimated cost of the recovery program is $1.4 million over five years.

	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Totals	**$237,000**	**$264,000**	**$330,000**	**$309,000**	**$259,000**	**$1,399,000**

Affected interests

The Australian Grayling occurs across a variety of water/land tenures and management, including public waters, parks, reserves, state forest, heritage rivers and private land/water. Consequently, management is the responsibility of a range of agencies, organisations and individuals (Table 2). This Recovery Plan has the support of State government agencies and land/water managers in the range States.

Table 2. Organisations with an interest in conservation of the Australian Grayling including responsibility for management of Australian Grayling habitat'

Organisation	Type
Victoria	
Department of Sustainability and Environment	State Government
Parks Victoria	State Government
East Gippsland Catchment Management Authority	Regional Authority
West Gippsland Catchment Management Authority	Regional Authority
Port Phillip & Western Port Catchment Management Authority	Regional Authority
Corangamite Catchment Management Authority	Regional Authority
Glenelg Hopkins Catchment Management Authority	Regional Authority
Melbourne Water	Regional Authority
Tasmania	
Inland Fisheries Service	State Government
Parks and Wildlife Service (Dept of Tourism, Parks, Heritage and the Arts)	State Government
Resource Management and Conservation Division (Dept of Primary Industries and Water)	State Government
Water Resources Division (DPIW)	State Government
Forestry Tasmania	State Government
Forest Practices Board	State Government
Hydro Tasmania	Govt Business Enterprise
New South Wales	
Department of Primary Industries	State Government

Role and interests of indigenous people

Indigenous communities on whose traditional lands and waters the Australian Grayling occurs will be advised, through the relevant regional Indigenous Facilitator, of the preparation of this Recovery Plan. Opportunities to involve indigenous communities in the implementation of the Recovery Plan will be explored once it is finalised.

Benefits to other species/ecological communities

The Recovery Plan includes a number of potential biodiversity benefits for other species and ecological communities inhabiting coastal rivers in south-eastern Australia. Principally, this will be through the protection, management and rehabilitation of riverine and riparian habitat. The adoption of broad-scale habitat management techniques and collection of baseline data will also benefit other aquatic species occurring in association with the Australian Grayling, particularly those species with similar habitat requirements and life histories, such as diadromous species including eels, galaxiids and lampreys.

The Recovery Plan will also provide an important public education role as threatened fish have the potential to act as 'flagship' species for highlighting broader nature conservation issues in aquatic habitats, such as habitat degradation, barriers to migration and invasive species.

Social and economic impacts

The implementation of this Recovery Plan is unlikely to cause significant adverse social and economic impacts. The Australian Grayling could substantially benefit from broad programs aimed at restoring the environmental health of catchments and rivers. Many such programs are already in place or planned. Cessation of desnagging rivers (except where infrastructure needs to be protected), resnagging rivers, rehabilitation of riparian zones and restoring environmental flows are recognised as being of major social and economic benefits as well as direct environmental benefit. Many waterway rehabilitation projects are already being undertaken by community groups. There are also large-scale programs aimed at catchment rehabilitation to improve water quality, such as in the Gippsland Lakes catchment in Victoria, 'fishway' programs in New South Wales, Victoria and Tasmania aimed at facilitating fish passage over barriers, and restoration of the Snowy River, by increasing flows and rehabilitating in-stream habitat. All of these have substantial potential to contribute to recovery of the Australian Grayling.

While many broad-scale environmental restoration programs that could benefit Australian Grayling are already underway or planned, additional work such as such as research and monitoring targeted specifically at Australian Grayling is required. Aside from seeking appropriate funding sources to facilitate these actions, this work will not have any substantial economic impact.

The main social impact of this Recovery Plan relates to the continuation of the protected status of Australian Grayling, and therefore lack of opportunity for anglers to legally take this species. Anglers occasionally unintentionally catch this species, and although fish are usually too small to keep they are not robust and may not survive capture and release. Information on its protected status will continue to be published in recreational fishing guides. Continuation of protection will have no additional social impact above that already occurring.

Management Practices

The Australian Grayling is a potential major beneficiary of efforts to maintain or restore ecological processes in rivers, including increasing environmental flows in the Snowy River, installation of fishways facilitating fish passage past barriers, and improved catchment management. A range of management practices planned or underway in many locations throughout its range may be of substantial benefit to the species. However, it needs to be recognised that there are some management practices that may be detrimental to the Australian Grayling, especially if they impact on important populations or locations (eg. spawning habitat), and thus jeopardise recovery of the species. For some activities, such as forest harvesting, plans and prescriptions (eg. FPB 2000, 2002; NRE 1996) are in place to minimise or eliminate the potential impact and protect threatened species and habitats.

Management practices required for conservation of Australian Grayling

- Maintenance or restoration of flow regimes (especially winter flows) in coastal rivers to meet the habitat and spawning requirements of Australian Grayling.
- Removal of artificial barriers or provision of fish passage (of a type suitable for negotiation by Australian Grayling) past barriers on coastal rivers and streams.
- Maintenance and restoration of river channel structure and instream habitat quality.
- Maintenance or restoration of quality and width of riparian vegetation at levels necessary to maintain stream temperature and light regimes, maintain input of organic materials, and filter surface runoff under heavy rainfall conditions.
- Management of catchment vegetation clearing and planting (eg. of pine or eucalypt plantations) to avoid negative effects on catchment water yields and flow patterns, in catchments where Australian Grayling occur.
- Manage water quality where Australian Grayling occurs to maintain waters free of significant levels of nutrient, sediment, pesticide and other pollutants, consistent with the ANZECC guidelines for water quality (ANZECC 2000).
- Continuing to prohibit fishing for the species, through education, regulation and enforcement, at least until there is recovery to sustainable levels.
- Management of fish stockings to avoid any potential impacts on Australian Grayling.
- Continue to limit the Tasmanian recreational whitebaiting season to selected rivers for a short open season.

Acknowledgments

We thank the following colleagues who provided information or comments on the Plan:

DSE, Victoria: Dr David Crook, Paulo Lay, Bill O'Connor, Tarmo Raadik

NSW Fisheries: Andrew Bruce, Craig Copeland, Dean Gilligan, Allan Lugg, John Pursey, Adam Vey

References

ANZECC 2000. *An Introduction to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, October 2000.

Bell, J.D., Berra, T.M., Jackson, P.D., Last, P.R. and Sloane, R.D 1980. Recent records of the Australian grayling *Prototroctes maraena* Günther (Pisces: Prototroctidae) with notes on its distribution. *The Australian Zoologist* 20: 419-431.

Berra, T.M. 1982. Life history of the Australian grayling, *Prototroctes maraena* (Salmoniformes: Prototroctidae) in the Tambo River, Victoria. *Copeia* 1982: 795-805.

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

Bishop, K.A. and Bell, J.D. 1978b. Aspects of the biology of the Australian grayling *Prototroctes maraena* Günther (Pisces: Prototroctidae). *Australian Journal of Marine and Freshwater Research* 29: 743-761.

Cadwallader, P.L. 1996. *Overview of the Impacts of Introduced Salmonids on Australian Native Fauna*. Australian Nature Conservation Agency, Canberra.

Cadwallader, P.L. and Backhouse, G.N. 1983. *A Guide to the Freshwater Fish of Victoria*. Government Printer, Melbourne.

Crook, D.A., Macdonald, J.I., O'Connor, J. and Barry, B. In prep. Use of otolith chemical analysis to examine patterns of diadromy in Australian Grayling (*Prototroctes maraena*).

DEH 2000. *Revision of the Interim Biogeographic Regionalisation of Australia (IBRA) and the Development of Version 5.1. - Summary Report*. Department of the Environment and Heritage, Canberra.

FPB 2000. *Forest Practices Code.* Forest Practices Board, Hobart.

FPB 2002. *Threatened Fauna Advisor: An expert system to advise on threatened fauna management in production forests.* Forest Practices Board, Hobart, Tasmania. (See www.fpb.tas.gov.au Research and Advisory programs> Zoology> Planning Tools).

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

Hall, D.N. 1983. Occurrence of the copepod parasite *Lernia cyprinacea* L., on the Australian grayling *Prototroctes maraena* Günther. *Proceedings of the Royal Society of Victoria* 95: 273-274.

Hammer, M. 2001. Freshwater Fishes of south-eastern South Australia – Data sheet. Native Fish Australia (SA) Inc.

Jackson, P.D. and Koehn, J.D. 1988. A review of biological information, distribution and status of the Australian grayling (*Prototroctes maraena*) Günther in Victoria. Arthur Rylah Institute for Environmental Research Technical Report Series No. 52. Conservation Forests and Lands, Melbourne.

Kuiter, R. 1983. Mount Gambier Fishes. *The SCUBA Diver* 2 (4): 3-8.

McDowall, R.M. 1976. Fishes of the Family Prototroctidae. *Australian Journal of Marine and Freshwater Research* 27(4): 641-659.

McDowall, R.M. 1996a. Family Prototroctidae Southern graylings. Pp 96–98 in McDowall, R.M. (ed.). *Freshwater Fishes of South-eastern Australia*. Reed Books, Chatswood.

NRE 1996. Code of Forest Practices for Timber Production. Department of Natural Resources and Environment, Melbourne.

O'Connor, J. and Mahoney, J. 2004. Observations of ovarian involution in the Australian grayling (*Prototroctes mareana*). *Ecology of Freshwater Fish* 13: 70-73.

Pittock, B. (editor) 2003. Climate change: An Australian Guide to the Science and Potential Impacts. Australian Greenhouse Office, Canberra.

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

Rowe, D.K., Smith, J. and Williams, E. 2002. Effects of turbidity on the feeding of adult, riverine smelt (*Retropinna retropinna*) and inanga (*Galaxias maculatus*). *New Zealand Journal of Marine and Freshwater Research* 36: 143-150.