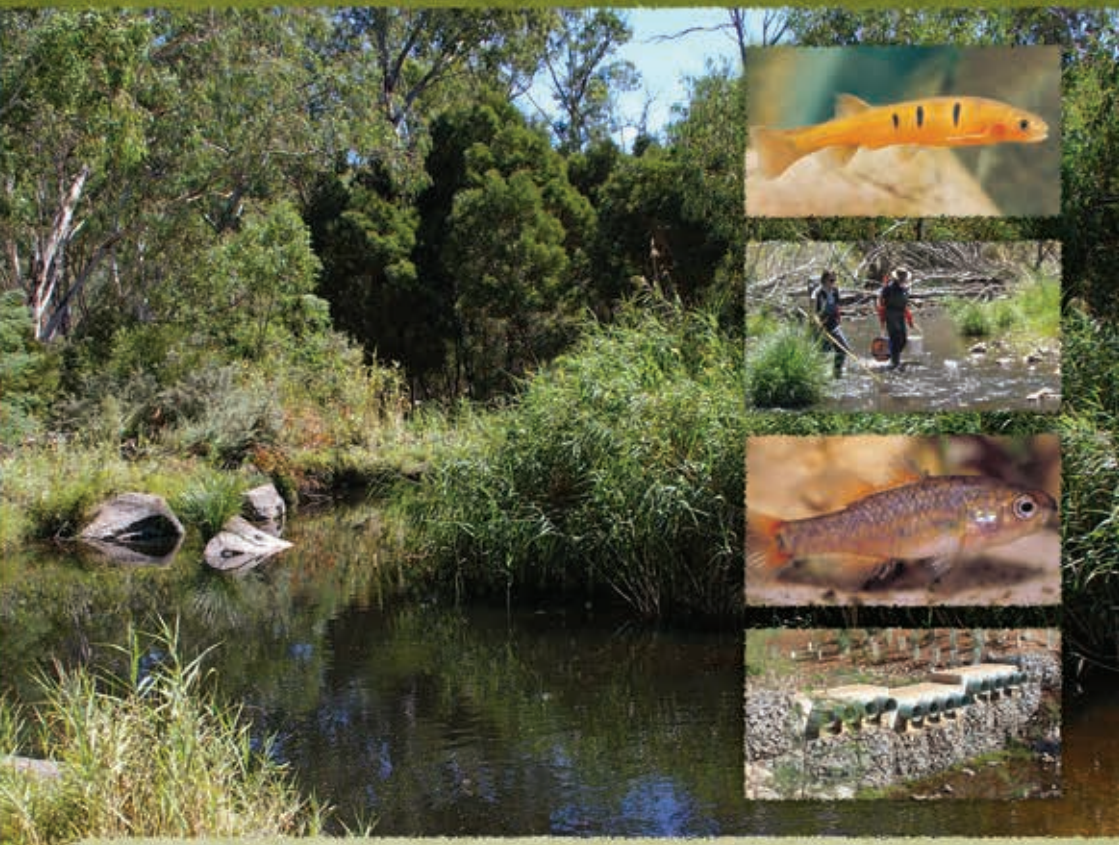
Fishes of the Goulburn Broken Catchment



GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

State Government Victoria
Department of Sustainability and Environment

A guide to the native and alien fish species of the Goulburn Broken Catchment

First printed in 2010

Disclaimer

Author

All fish information by Mark Lintermans.

Acknowledgments

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We would also like to acknowledge the Murray-Darling Basin Authority for allowing us to produce a booklet specific to the Goulburn Broken Catchment using information and text taken directly from their book *Fishes of the Murray-Darling Basin: An introductory guide*.

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Neil Armstrong - Broad finned galaxias, Brown trout, Two-Spined blackfish, Rainbow trout

Michael Hammer - Short-Headed lamprey, Southern pygmy perch

Arthur Mostead - Goldfish

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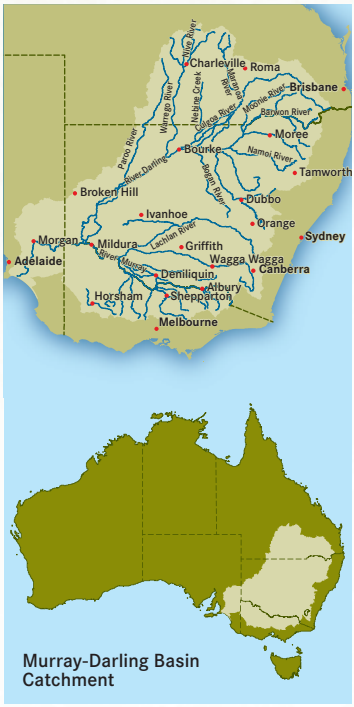


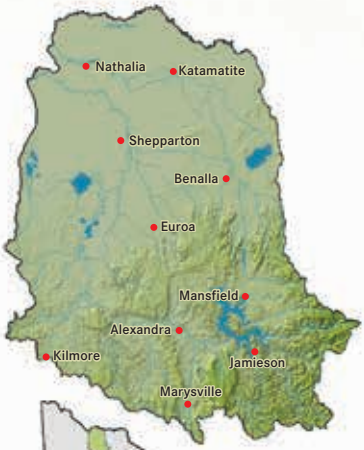
Mark Lintermans
Murray-Darling Basin Authority

The Murray-Darling Basin covers more than a million square kilometres, equivalent to 14% of Australia's total area. It is one of the largest catchments in the world (the river system flows some 3,750 km from its headwaters to the sea) and one of the driest. Nearly two million people depend on the Basin's resources and the value of its agricultural produce exceeds $10 billion each year. The three major rivers of the Basin are the Murray (2,530 km length), the Darling (2,740 km length) and the Murrumbidgee (1,690 km length), the longest rivers in Australia, and there are a further 21 major rivers in the Basin. Although the Basin is bounded by the Great Dividing Range, the majority of fish habitats and streams are in the lowlands (below 200 m altitude). Lowland rivers are generally meandering, slow-flowing and turbid, often surrounded by extensive floodplains containing billabongs, swamps and River Red Gum forests. Fallen trees, logs and branches form major fish habitats in these rivers, providing cover from predatory birds and other fish, feeding and breeding locations, as well as shade and refuge from the current. In the arid west and north of the Basin, rivers may dry to a series of waterholes in low-rainfall years.

The upland streams are often rocky-bottomed, swift-flowing and clear, with limited or no floodplains or billabongs. Boulders and bedrock may replace fallen wood as major fish habitats, and the streams often contain a series of alternating riffles, pools and runs, in contrast to the predominantly pool habitat of lowland rivers.

One of the features of the Australian climate is its low and variable rainfall, and the Basin is no exception. Consequently, river flows are also highly variable from one year to another. River regulation has reduced this natural variability, with small floods now much less frequent than previously. The majority of the Basin's runoff comes from a relatively small proportion of the total catchment. The Darling River catchment, while comprising 10.0% of the Basin's area, contributes only 0.4% of its mean annual runoff. By contrast, the upper Murray catchment occupies only 1.4% of the Basin's area, but contributes 17.3% of mean annual runoff.

The Goulburn Broken Catchment



Goulburn Broken Catchment Region.

Some facts about the Goulburn Broken Catchment

Area: 2.4 million hectares.

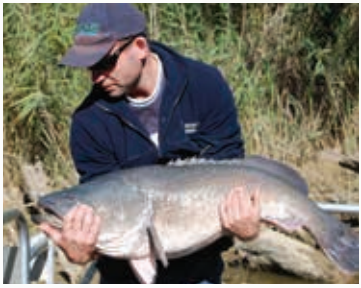
Population: 189,500

Major River Basins: Goulburn River and Broken River.

Priority Streams: Goulburn River, King Parrot Creek, Rubicon River, Big River, Howqua and Jamieson Rivers, Seven Creeks, Broken River, Broken Creek, Hollands Creek.

Major Towns: Shepparton, Mooroopna, Numurkah, Euroa, Benalla, Seymour, Kyabram, Tatura, Yarrawonga, Cobram, Alexandra, Mansfield, Yea and Kilmore

Wayne Tennant
Goulburn Broken Catchment Management Authority



The Goulburn Broken Catchment is home to 189,500 people and covers 2.4 million ha or 10.5 per cent of Victoria. It is part of the Murray-Darling Basin and comprises the Goulburn and Broken River catchments and part of the Murray Valley.

The Catchment stretches from the Murray River in the north through to the outskirts of Melbourne in the south taking in the cities and towns of Kyabram, Tatura, Mooroopna, Shepparton, Numurkah, Cobram, Yarrawonga, Euroa, Benalla, Mansfield, Alexandra, Yea, and Kilmore.

The Catchment, while comprising only 2% of the Murray-Darling Basin's land area, generates 11% of the basin's water resources

The mountainous upper catchment area is renowned for its beauty, history and recreational opportunities that draw increasingly large numbers of visitors and permanent residents to the region.

The lower foothills and plains through the middle of the Catchment support cropping, grazing, vineyards and horse studs, while irrigated dairy and horticultural enterprises and food processing industries dominate the Shepparton Irrigation Region (SIR).

The region is blessed with an array of assets – soil, water, land and biodiverity. The Regional River Health Strategy identifies rivers as having many assets – social, economic and environmental. One of the high priority assets include the native fish which inhabit the waters of the region.

While fish are highly valued, many species have either suffered a significant decline in distribution, and are now found only in restricted areas.

The intent of this booklet is to profile fishes of the region, encourage their protection, and present ways in which communities are and can protect one of the region's valued assets – our fishes.

Threatened fish species in the Goulburn Broken Catchment

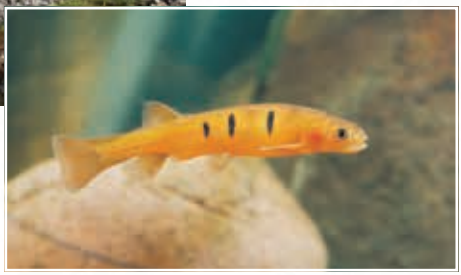
The threatened fish species that occur in the waterways of the Goulburn Broken Catchment are detailed in Table 1. Action Statements for many of the species Listed under the *Flora and Fauna Guarantee Act 1988* are available from the Department of Sustainability web site (www.dse.vic.gov.au). There are a number of other useful web sites listed on page 63 of this booklet.

Table 1. Threatened fish species in the Goulburn Broken Catchment, according to State and National Listings

	State	National[1]
Barred galaxias	Listed (Critically endangered)	Endangered
Macquarie perch	Listed (Endangered)	Endangered
Golden perch	(Vulnerable)	
Murray cod	Listed (Endangered)	Vulnerable
Trout cod	Listed (Critically endangered)	Endangered
Freshwater catfish	Listed (Vulnerable)	
Silver perch	Listed (Critically endangered)	
Murray hardyhead	Listed (Endangered)	
Unspecked hardyhead	Listed	
Murray-Darling rainbowfish	Listed	Vulnerable

Key: **Listed** = listed under the *Victorian Flora and Fauna Guarantee Act 1988*
[1] National status under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC)

▲ **Trout barriers to prevent trout moving upstream into Barred galaxias habitat in Marysville.**



▼ **Barred galaxias.**

Why have fish species declined in the Goulburn Broken Catchment?

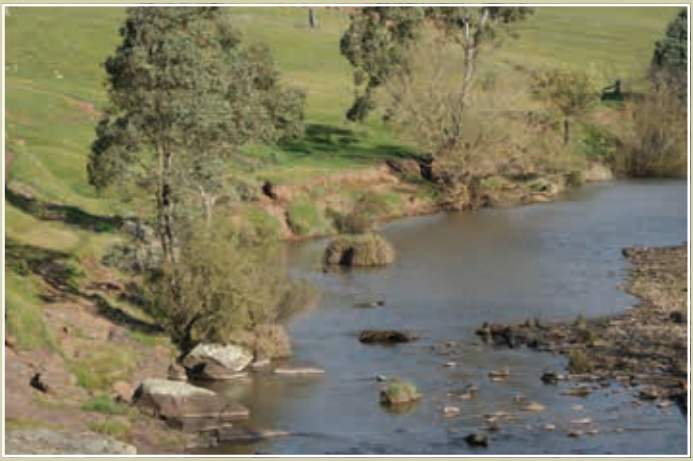
Various factors have contributed to the decline in native fish numbers over the period of European settlement. The eight major threats to native fish in the Goulburn Broken Catchment are summarised in Table 2.

Table 2. Major threats to native fish in the Goulburn Broken Catchment.

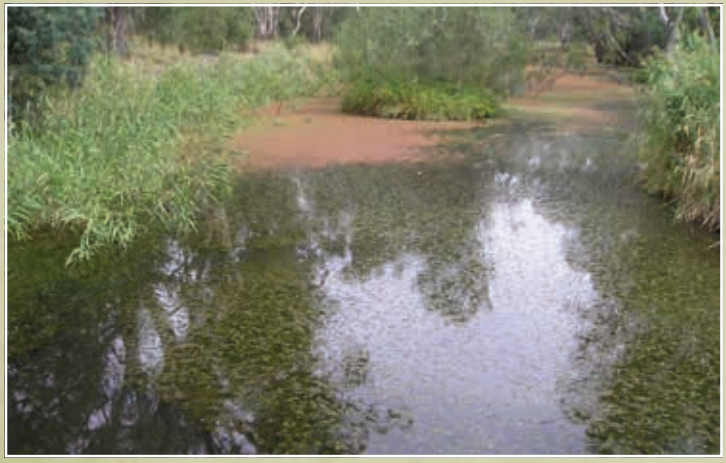
Threat	Threatening process
Flow regulation	Loss of water to other uses; critical low flows; loss of flow variation, flow seasonality and low to medium floods; permanent flooding and high water; increased periods of no flow.
Habitat degradation	Damage to riparian zones; removal of in-stream habitats (including “snags”); sedimentation
Lowered water quality	Increased nutrients, turbidity, sedimentation and salinity; artificial changes in water temperature; pesticides and other contaminants
Barriers	Impediments to fish passage resulting from the construction and operation of dams, weirs, levees, culverts, etc.; non-physical barriers such as increased velocities, reduced habitats, water quality and thermal pollution (changes in water temperature)
Alien species	Competition and/or predation by Carp, Eastern gambusia, Oriental weatherloach, Redfin perch and trout. Infestation by introduced aquatic plant species.
Diseases	Outbreak and spread of Epizootic Haematopoietic ecrosis Virus (EHNV) and other viruses, diseases and parasites
Exploitation	Recreational and commercial fishing pressure on depleted stocks; illegal fishing
Translocation and stocking	Loss of genetic integrity and fitness caused by inappropriate translocation and stocking of native species

Source: MDB Native Fish Strategy 2003–2013.

◀ Habitat degradation - infestation by willows



Habitat degradation - unrestricted stock access ▶



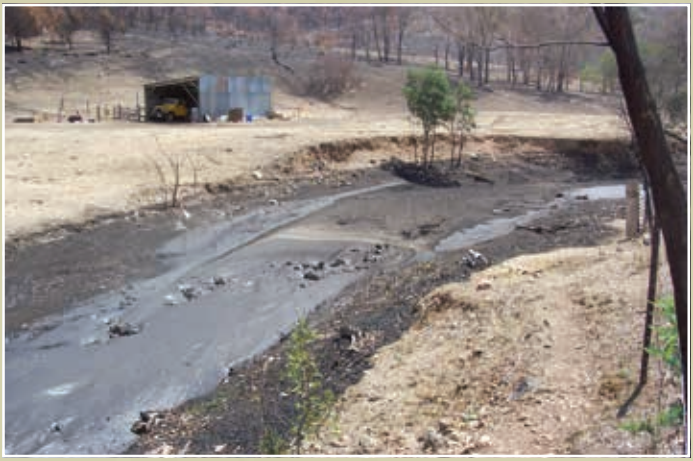
◀ Aquatic weed infestation.

◀ Alien species - carp

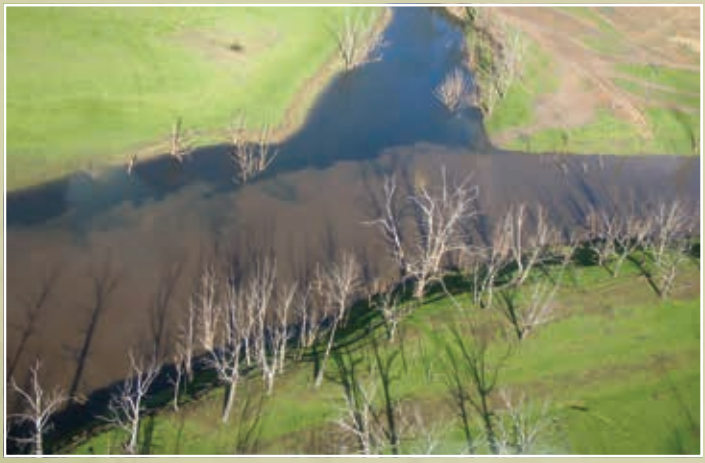
Lowered water quality - ▶
Blue Green Algae blooms

◀ Barriers - man made structures impeding fish migration

◀ Lowered water quality - erosion and associated sedimentation



Lowered water quality - sediment and ash in waterways following wild fire ▶



◀ Lowered water quality - sediment in waterways

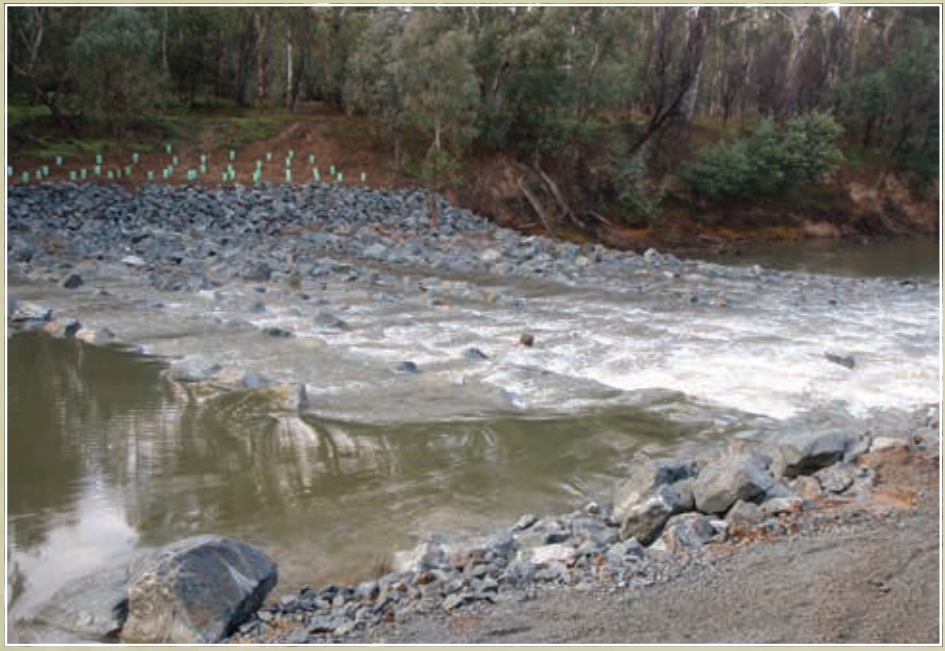
What are we doing to help native fish in the Goulburn Broken Catchment?

Through the region's river health program and many community initiatives within the catchment a number of actions are being implemented to reduce the threat to native fish within the region. Some of these initiatives are summarised in Table 3.

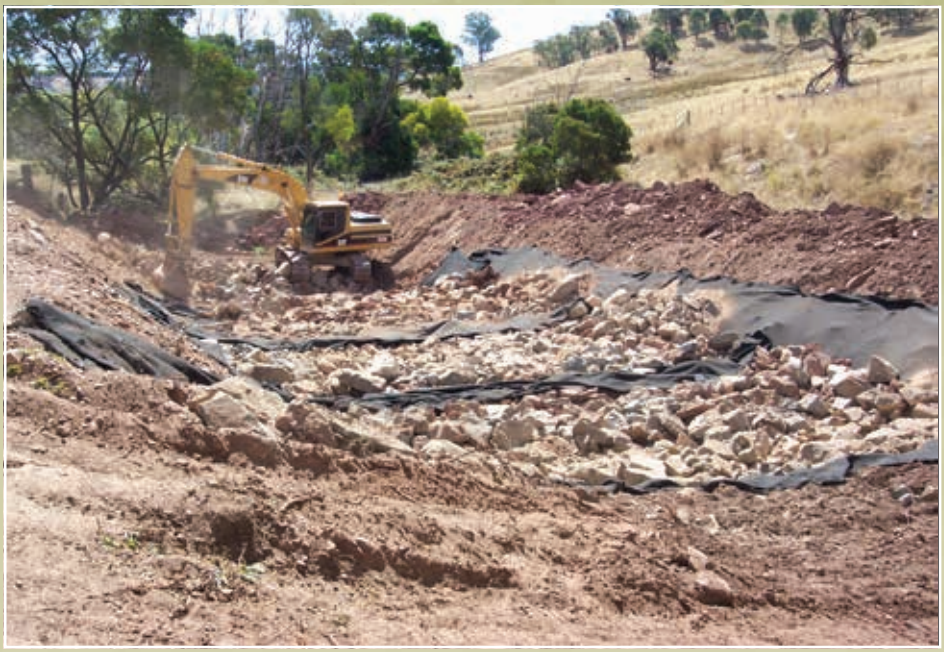
Table 3. Actions taken within the Goulburn Broken Catchment to reduce the threat to native fish within the region

Threat	Examples of actions undertaken by the Goulburn Broken Catchment Management Authority and their partners (including the community) to reduce or eliminate threats to native fish in the region
Flow regulation	Completion of environmental flow studies for key waterways (Broken River, upper Broken Creek, and Goulburn River) and wetlands (Moodies Swamp, Kinnaird's Wetland, Barmah Wetland and Reedy Swamp). Delivery of environmental water to key assets.
Habitat degradation	Reinstatement of Large Woody Debris (Snags) into waterways (Goulburn River, Broken River, Boosey and Broken Creeks, Hollands Creek); Incentives for Riparian fencing (throughout the catchment, with a focus on priority waterways); revegetation with indigenous species; provision of off stream water points for stock; aquatic weed control (Goulburn River, Broken River and Broken Creek); and removal of Exotic woody weeds (including priority willows and other Weeds of National Significance).
Water quality	Erosion control projects (within priority catchments, and on major waterways), including alignment training, rock beaching and gully stabilisation; gross pollutant traps on storm water outlets (Goulburn River, Broken Creek, Broken River); reuse systems on irrigated properties; outfall structures; water quality monitoring, macro invertebrate surveys.
Barriers	Vertical slot fish ways and other "fish ladders" on major weirs, fish-friendly rock chutes to replace minor weirs and allow fish passage; removal of moderate barriers.
Alien species	Trout barriers to protect Barred galaxias from predation (upper Goulburn River tributaries)
Exploitation	Signage to raise awareness of community on high priority waterways; Increased media.
Translocation and stocking	Many waterways within the Goulburn Broken Catchment are stocked with native fish species; some native fish species in waterways that were under threat from turbidity from ash due to the 2009 fires were removed from the waterways and reintroduced once the threat had passed.

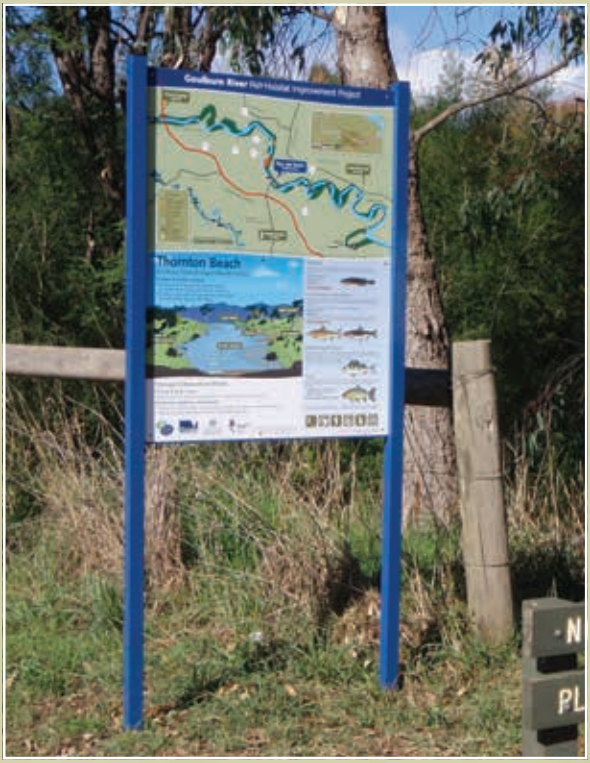
▲ Riparian fencing and revegetation.



▲ Fishway constructed to replace the Shepparton weir.

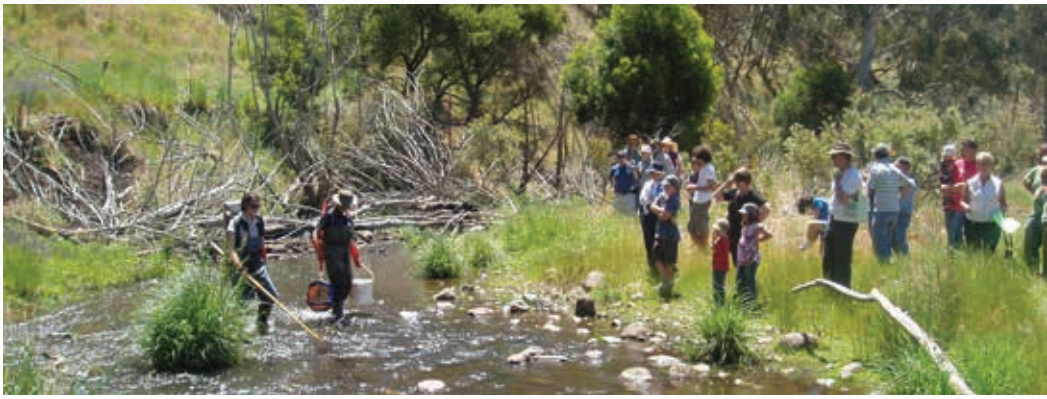


▲ Erosion control works underway.



◀ Signage that educates the public about native fish or fishing regulations.

How can you help protect native fish?



There are a number of ways you can help to protect native fish in the Goulburn Broken Catchment. A few examples of how you can help are listed below.

- ☑ Find out about your local fish populations
- ☑ Ensure any in-stream infrastructure is fish friendly
- ☑ Protect and manage buffer areas by fencing and re-establishing native riparian vegetation
- ☑ Maintain and enhance stream-side reserves
- ☑ Protect water quality
- ☑ Get involved with local groups working on fish-friendly projects (eg. Conservation Management Networks, Rivercare groups, Waterwatch, Landcare groups & recreational angling groups)
- ☑ Support water saving initiatives
- ☑ Get involved with and encourage participation in fish and river health education programs
- ☑ Observe fishing regulations
- ☑ Care for the frontage and floodplain (not just the river or stream)

See page 44 for more detailed information and refer to the list of useful contacts on Page 63.

Native fish species found in the Goulburn Broken Catchment

Author
MARK LINTERMANS, © MDBA

Australian smelt

Retropinna semoni

Distribution and Abundance

The Australian smelt is one of the most widespread and abundant species at lower and mid altitudes in south-eastern Australia. It is not generally found in upland headwater streams with fast flows in the southern Basin, but occurs in these habitats in the northern parts of its range.

Habitat

Typically, smelt are a pelagic species in the southern Basin, usually recorded from slow moving or still water in a variety of habitats (e.g. river channels, wetlands, lakes) where they can be found in large numbers (thousands of fish). They are at their highest abundance in lakes or non-flowing environments.

Diet

Smelt are carnivorous and the diet consists primarily of terrestrial insects and microcrustaceans, although a variety of small aquatic insects are also consumed.

Potential Threats

None known, but barriers to fish passage may be fragmenting populations.

Common Name: Australian smelt (Smelt)
Scientific Name: *Retropinna semoni* (Weber, 1895)
Size: Maximum length 100 mm; commonly 40-60 mm

General References

Baumgartner 2003; Hammer *et al*. 2007; Humphries *et al*. 2002; Leigh 2002; Llewellyn 1971; McDowall 1996a; Milton & Arthington 1985; Mallen-Cooper 1994; Moffat & Voller 2002; Pusey *et al*. 2004; Wedderburn & Hammer 2003.

Picture

Bony herring

Nematalosa erebi

Common Name: Bony herring (Bony bream, Hairback herring, Pyberry)
Scientific Name: *Nematalosa erebi* (GÜnther, 1868)
Size: Maximum size 470 mm; usually 120-200 mm

Distribution and Abundance

Widespread and abundant, Bony herring vie with Spangled perch for the distinction of being the most widespread of Australia's native freshwater fish species.

Most common in lowland river systems generally, in the Basin they are known from the majority of lowland rivers, where they are often the most abundant native species.

Habitat

Bony herring are a hardy fish, tolerating high temperatures (up to 38°C), high turbidity, high salinity (up to at least 39 ppt) and low dissolved oxygen. However, they are not tolerant of low water temperatures and, hence, are considered susceptible to the effects of cold-water pollution. Low water temperatures are thought to depress the immune response, allowing increased infection by protozoan parasites and fungi.

Diet

The species feeds predominantly during daylight hours. It is an algal detritivore, consuming large quantities of detritus, microalgae and microcrustaceans. The amount of algae consumed varies widely between studies. Microcrustaceans were more significant in the diet of juveniles than adults from the Murray River.

Bony herring are consumed by other fish such as Murray cod and Golden perch, and also form a significant part of the diet of waterbirds such as cormorants and Pelicans.

Potential Threats

River regulation (barriers to fish passage, cold-water pollution) has reduced the abundance of the species and it is now in low abundance in the Murrumbidgee and Murray rivers below Burrinjuck and Hume Dams.

General References

Baumgartner 2003; Bishop *et al*. 2001; Briggs & McDowall 1996; Medeiros 2004; Puckridge & Walker 1990; Pusey *et al*. 2004.

Picture

Murray-Darling rainbowfish

Melanotaenia fluviatilis

Distribution and Abundance

Formerly widespread across the Basin, the Murray-Darling rainbowfish has declined in the Murray region, but is still patchily recorded from the middle and lower sections of the Murray, Murrumbidgee and Macquarie rivers, and parts of the Gwydir, Namoi and Bogan rivers in NSW. In Victoria, cold winter temperatures limit it to the Murray and its tributaries such as the Goulburn and Broken rivers.

Habitat

Rainbowfish are a tropical to sub-tropical group, and Murray-Darling rainbowfish is the southern-most species in the group. The species is generally found in the lowland parts of the Basin, and prefers slow-flowing rivers, wetlands and billabongs.

Diet

The species is carnivorous, consuming aquatic invertebrates as well as terrestrial invertebrates that fall on the water surface. Some filamentous algae is also consumed.

Potential Threats

Predation of adults by Redfin perch and larvae by Eastern gambusia are considered potential threats, as are loss of aquatic vegetation (spawning sites and cover) and cold-water pollution.

Common Name: Murray-Darling rainbowfish (crimson-spotted rainbowfish, Murray river rainbowfish)
Scientific Name: *Melanotaenia fluviatilis* (Castelnau, 1878)
Size: Maximum length 90 mm, commonly less than 70 mm
Conservation Status: Uncommon

General References

Backhouse & Frusher 1980; Baumgartner 2003; Cadwallader & Backhouse 1983; Humphries *et al.* 2002; Koehn & O'Connor 1990; Lloyd & Walker 1986; McGuigan *et al.* 2000; Milton & Arthington 1984; Moffat & Voller 2002; Wedderburn & Hammer 2003.

Picture

Flat-headed gudgeon

Philypnodon grandiceps

Common Name: Flat-headed gudgeon (Flathead gudgeon, Big-headed gudgeon)
Scientific Name: *Philypnodon grandiceps* (Krefft, 1864)
Size: Maximum size 115 mm, usually 80 mm

Distribution and Abundance

The Flat-headed gudgeon is largely absent from upland areas of the Basin. Previously, it was considered to be a widespread and common inhabitant of the slope and lowlands in Vic, NSW and SA.

Habitat

This benthic species prefers slow-flowing areas of lowland streams or lakes and dams and is often found in weedy or muddy areas with abundant cover in the form or rocks or logs.

Diet

It is a carnivorous ambush predator of aquatic insects, molluscs, tadpoles, crustaceans and small fish.

Potential Threats

None known.

General References

Cadwallader & Backhouse 1983; Harris & Gehrke 1997; Higham *et al.* 2005; Humphries *et al.* 2002; Lintermans & Phillips 2004; Koehn & O'Connor 1990; Larson & Hoese 1996a: Llewellyn 1971; Lloyd & Walker 1986; Pollard 1973; Pusey *et al.* 2004.

Picture

Freshwater catfish

Tandanus tandanus

Common Name: Freshwater catfish (Jewfish, Eeltail catfish
Scientific Name: *Tandanus tandanus* Mitchell, 1838
Size: Maximum length 900 mm and maximum size 6.8 kg; usually < 500 mm and < 2 kg
Conservation Status: Declining

Distribution and Abundance

This catfish is widespread throughout the Murray-Darling Basin, but generally in the lower, slow-flowing rivers. It has been stocked into some farm dams and lakes where it can establish breeding populations.

Most riverine populations have declined significantly since the late 1970s/early 1980s, and the species is no longer common in many areas where it was formerly abundant.

Habitat

Freshwater catfish is a benthic species that prefer slow-flowing streams and lake habitats.

The Freshwater catfish is a relatively sedentary species and adults show very limited movement compared to cod and perch; most individuals move less than 5 km.

Diet

This catfish is predominantly an opportunistic carnivore and the adult diet consists mainly of shrimps, freshwater prawns and yabbies, with aquatic insects, snails and small fishes also important. Aquatic insects are more important in the diet of juvenile fish. Adults are mostly active at dusk and in the early evening.

Potential Threats

Numerous threats have contributed to the decline in this species. Concern has been expressed about the potential impacts of Carp and Redfin perch on riverine populations. Cold-water pollution below dams, barriers to movement, changes to natural flow regimes and elevated salinity levels (juveniles have much lower salinity tolerance than adults), are also suspected as causes of declining local populations. The lack of formal recognition as a threatened species has hampered conservation efforts.

General References

Clunie & Koehn 2001a,b; Davis 1977a,b,c; Pollard *et al*. 1996; Pusey *et al*. 2004; Morris *et al*. 2001; Reynolds 1983.

Picture

Short-headed lamprey

Mordacia mordax

Common Name: Short-headed lamprey
Scientific Name: *Mordacia mordax* (Richardson, 1846)
Size: Adults are commonly 300–440 mm long in freshwater situations (maximum size ~500 mm)

Distribution and Abundance

Generally restricted to the lower to mid Murray River in the Basin but occasionally recorded as far upstream as Yarrawonga and even Narrandera on the Murrumbidgee. Otherwise found in coastal rivers in Victoria, NSW, SA and Tasmania.

Habitat

Most of the adult life is spent at sea or in estuaries. Young adults migrate upstream from the sea in spring and summer to breed in rivers. The spawning run lasts for about a year, before they spawn the following spring, from August–November.

Diet

Lampreys are toothless, feeding on algae, detritus and micro-organisms filtered from the water. After metamorphosis to adulthood, they become parasitic on other fish, rasping a hole in the side and feeding on blood and/or muscle. Adults cease feeding prior to their spawning migration.

Potential Threats

Barriers to fish movement can interfere with spawning migrations, although the species can climb wet vertical surfaces.

General References

Allen *et al.* 2002; Cadwallader & Backhouse 1983; Gilligan 2005a,b; Hughes & Potter 1968; Koehn & O'Connor 1990; Potter 1970, 1996a; Wedderburn & Hammer 2003.

Picture

Silver perch

Bidyanus bidyanus

Common Name: Silver perch (Black bream, Silver bream, Bidyan)
Scientific Name: *Bidyanus bidyanus* (Mitchell, 1838)
Size: Maximum length ~500 mm and maximum weight 8 kg; usually 350 mm and 2 kg
Conservation Status: Threatened

Distribution and Abundance

Formerly widespread over much of the Murray-Darling Basin excluding the most upper reaches, Silver perch has declined over most of its range. The first 2 sampling rounds of the Sustainable Rivers Audit has so far only recorded a total of 20 Silver perch whilst surveying 351 randomly selected sites covering 16 river valleys.

The species is still patchily abundant in the mid-Murray.

Habitat

Silver perch are found in similar habitats to Murray cod and Golden perch, i.e. lowland, turbid and slow-flowing rivers. This species is bred artificially in a number of government and commercial hatcheries and widely stocked into farm dams and reservoirs. It has been the subject of considerable interest for its potential as an aquaculture species.

Diet

Silver perch are omnivorous. The diet contains aquatic plants, snails, shrimps and aquatic insect larvae. Reports that the species becomes mainly herbivorous once it reaches lengths of 250 mm are incorrect, at least for lake populations, as diet in Googong Reservoir near Canberra shows little change with fish size.

Potential Threats

River regulation has severely affected this species through disruption of migration and reproductive behaviour. Thermal pollution and interactions with alien species (Carp and Redfin perch) are also suspected to be a threat.

General References

Baumgartner 2003; Clunie & Koehn 2001c,d; Kibria *et al.* 1998; King *et al.* 2005; Mallen-Cooper 1993; Mallen-Cooper & Stuart 2003; Mallen-Cooper *et al.* 1995; Merrick 1996; Tonkin *et al.* 2007.

Picture

Southern pygmy Perch

Nannoperca australis

Common Name: Southern pygmy perch (Swamp perch)
Scientific Name: *Nannoperca australis* Günther, 1861
Size: maximum size 85 mm; usually less than 65 mm
Conservation Status: Threatened

Distribution and Abundance

Formerly found in the Murray and lower Murrumbidgee catchments, the Southern pygmy perch has now disappeared from most locations in NSW and has only been recorded from a handful of sites in the last 25 years. New populations are occasionally discovered, most recently in the Lachlan drainage north of Yass. In NSW only two other populations are currently known, from near Holbrook and Albury. The species is still present in the Mount Lofty Ranges, the Lower Lakes and the lower Murray in SA, where it is highly threatened. It is still common in southern (coastal) Vic, but is patchily distributed along Vic tributaries of the Murray, where it is still known from the Broken, Ovens, Campaspe, Goulburn, Kiewa, Mitta Mitta, Loddon and Wimmera basins.

Habitat

The Southern pygmy perch prefers slow flowing or still waters, usually with dense aquatic vegetation and plenty of cover. It has been recorded from small streams, well-vegetated lakes (or wetlands within), billabongs and irrigation channels.

Diet

Southern pygmy perch are carnivorous, eating cladocerans, copepods, ostracods and small insect larvae such as chironomids, mayflies, mosquito larvae and water bugs.

Potential Threats

Predation by alien species such as trout, Redfin perch and possibly Eastern gambusia is thought to have played a role in the decline of this species. Habitat alteration such as loss of aquatic vegetation, floodplain alienation, cold-water pollution and seasonal flow changes/reductions is also likely to be involved.

General References

Hammer 2002a; Higham *et al*. 2005; Humphries 1995; Kuiter *et al*. 1996; Lintermans & Osborne 2002; Llewellyn 1974, 1980; Lloyd & Walker 1986; Morris *et al*. 2001; Unmack 1992; Woodward & Malone 2002.

Picture

Unspecked hardyhead

Cretarocephalus stercusmuscarum fulvus

Distribution and Abundance

The Unspecked hardyhead is generally now found only in the lowland areas of the Basin, but more common in the northern Basin. It was formerly abundant but has suffered a significant reduction in distribution and is now considered rare in the southern part of its range, though still common in the north.

Habitat

The Unspecked hardyhead is found around the margins of large, slow-flowing, lowland rivers, and in lakes, backwaters and billabongs. It prefers slow-flowing or still habitats with aquatic vegetation and sand, gravel or mud substrates.

The Unspecked hardyhead is usually found in schools and little is known of its movements. However, recent research in the Murray and Murrumbidgee rivers has recorded it attempting to move upstream through fishways, with most movement in the afternoon or dusk periods.

Diet

This species is carnivorous, eating small insects such as mosquito larvae, and microcrustaceans. In turn, it is probably eaten by birds and larger fish such as Golden perch.

Common Name: Unspecked hardyhead (Freshwater hardyhead, Fly-specked hardyhead, non-speckled hardyhead)
Scientific Name: *Craterocephalus stercusmuscarum fulvus* Ivantsoff, Crowley & Allen, 1987
Size: Maximum size 78 mm; usually 50-60 mm
Conservation Status: Threatened

Potential Threats

The precise reasons for the species' decline are not definitely known, but suspected to include increased salinisation (which affects macroinvertebrate and aquatic vegetation structure), habitat degradation, cold-water pollution, and impacts of alien species such as Eastern gambusia and Redfin perch.

General References

Allen *et al*. 2002; Baumgartner 2003; Cadwallader & Backhouse 1983; Harris & Gehrke 1997; Higham *et al*. 2005; Ivantsoff & Crowley 1996; Llewellyn 1979; McCulloch 1913; MDBC 2004b; Wedderburn & Hammer 2003; (T. Raadik unpubl. data); (G. Wilson unpubl. data).

Picture

Western carp gudgeon

Hypseleotris klunzingeri

Common Name: Carp gudgeons
Scientific Name: *Hypseleotris* spp.
Size: Maximum length 70 mm; usually around 40 mm
Conservation Status: Declining

Identification

There is considerable confusion over the identification of 'carp gudgeons' in south-eastern Australia. Recent genetic studies have shown that at least four taxa are present, as well as a range of hybrids. In this book, carp gudgeons are treated as a group.

Habitat

This group of species is found in slow-flowing or still waters, normally associated with macrophyte beds or other aquatic vegetation. Two to four species of carp gudgeon often occur sympatrically.

Diet

The Western carp gudgeon is the only form present in Lake Burley Griffin in the ACT and is primarily a mid-water carnivore although some benthic feeding also occurs. At this site important dietary items include copepods, aquatic insects, cladocerans and ostracods, and chironomids are the most frequently consumed aquatic insect.

Potential Threats

The group is widespread and abundant. However, in the ACT, significant kills of Western carp gudgeon have occurred as a result of infestation with the introduced tapeworm *Bothriocephalus acheilognathi*.

General References

Balcombe & Closs 2000, 2004; Baumgartner 2003; Bertozzi *et al*. 2000; Dove 1998; Dove *et al*. 1997; Larson & Hoese 1996a; MDBC 2004b; Stoffels & Humphries 2003; Thacker & Unmack 2005; Unmack 2000.

Picture

Barred galaxias

Galaxias fuscus

Common Name: Barred galaxias
Scientific Name: *Galaxias fuscus* Mack, 1936
Size: Maximum size 160 mm; commonly 70–90 mm
Conservation Status: Threatened

Distribution and Abundance

The Barred galaxias is only found in the headwaters (above 400 m altitude) of the Goulburn River catchment. There are approximately 20 known populations of this species still extant, and at least five previous populations are now extinct. It is possible that additional small populations may be discovered in inaccessible areas of the upper Goulburn catchment, but this is unlikely to affect the highly threatened status of the species.

Habitat

The Barred galaxias occurs in cool, clear, upland streams with stony or sandy substrates. Little is known of its ecology due to its highly threatened status and small population size. The preferred habitat is thought to be slow-flowing deep pools adjacent to riffles and cascades.

Diet

The diet consists of drifting and benthic aquatic invertebrates taken at the upstream end of pools. The species is relatively long-lived for a small fish–individuals up to 13 years old have been recorded.

Potential Threats

Interaction with Rainbow and Brown trout (largely predation) is the major threat to the Barred galaxias. Following the invasion of trout, the species has been eliminated from streams where it was formerly abundant. It has been recorded in gut samples of trout captured in Barred galaxias habitat, and juvenile galaxias are the most severely impacted by predation. Competition between larger Barred galaxias and trout may be a secondary threat. As a result of the small, fragmented distribution of the species, local habitat modifications and degradation could also threaten populations. The effects of the invading Climbing galaxias on natural galaxiid populations are unknown, but competition or displacement is possible.

Barred galaxias now exist only in trout-free streams, with physical barriers to exclude upstream invasion by trout an essential part of their management (see page 4).

General References

Allen *et al.* 2002; DSE 2006; Lintermans & Raadik 2003; Morris *et al.* 2001; Raadik 1995a, 2000; Raadik *et al.* 1996; Shirley & Raadik 1997.

Picture

Climbing galaxias

(Broad-finned galaxias)
Galaxias brevipinnis

Habitat

The Climbing galaxias is normally a fish of coastal streams, but it has been transferred to the upper Murray drainage in water from the Snowy River, via the Snowy Mountains Scheme. It is among the several coastal galaxiids that can survive and reproduce as landlocked populations. The species is renowned for its ability to climb vertical waterfalls and rock faces, using its broad pectoral and pelvic fins.

Diet

The diet consists mainly of aquatic invertebrates such as mayflies, caddisflies dipterans and small crustaceans.

Potential Threats

Where it is a translocated species, the Climbing galaxias may pose a threat to other native fish species, such as galaxiids or blackfish, through competition for food or space. In its natural habitats, it is threatened by predation and displacement by introduced trout species, and habitat loss through deforestation.

Common Name: Climbing galaxias (Broad-finned galaxias) Translocated/Native
Scientific Name: *Galaxias brevipinnis* GŸnther, 1866
Size: Maximum size 278 mm; usually 150–180 mm
Conservation Status: Translocated/native

General References

Glova & Sagar 1989; Hammer 2004; McDowall & Fulton 1996; Merrick & Schmida 1984; Morison & Anderson 1991; O'Connor & Koehn 1998; Waters *et al.* 2002.

Picture

Flat-headed galaxias

Galaxias rostratus

Habitat

Little is known of the ecology of Flat-headed galaxias other than aspects of its reproduction. Historically, it was collected from a variety of habitats including billabongs, lakes, swamps and rivers, usually in still or slow-flowing waters. It is a schooling species that congregates in mid-water.

Diet

The diet is predominantly aquatic insects with some microcrustaceans.

Potential Threats

Possibly competition or predation from introduced species such as Redfin perch, trout and Eastern gambusia. River regulation (cold-water pollution and altered flow regimes) may also impact this species. The effects of the Climbing galaxias–which has been transferred to inland waters via the Snowy Mountains Scheme–on natural galaxiid populations is unknown, but competition or displacement of the remnant Albury population is possible.

Common Name: Flat-headed galaxias (Murray jollytail)
Scientific Name: *Galaxias rostratus* Klunzinger, 1872
Size: Maximum size 146 mm; rarely exceeds 100 mm
Conservation Status: Declining

General References

Allen *et al*. 2002; Kennard *et al*. 2001; Koehn & O'Connor 1990; Lintermans & Osborne 2002; Llewellyn 1971, 2005; McDowall & Fulton 1996; Merrick & Schmida 1984; Morris *et al*. 2001.

Picture

Mountain galaxias

Galaxias olidus

Habitat

Mountain galaxias are found in a variety of habitats from small creeks to large rivers. They are often observed in schools in slower flowing or pool habitats, but in situations where trout are abundant they may be restricted to very shallow edge habitats or riffles. They occur at a variety of altitudes within the Murray-Darling Basin, and are the only native fish that is found in the alpine zone above the snowline during winter.

Diet

The diet consists mainly of aquatic insect larvae, but terrestrial insects that fall onto the water from overhanging vegetation may form a substantial part of the diet.

Potential Threats

Continued spread of alien species, particularly trout, threatens local galaxiid populations. The effects of the Climbing galaxias–which have been transferred to inland waters via the Snowy Mountains Scheme–on natural galaxiid populations is unknown, but competition or displacement is possible. Infection with the alien parasitic copepod *Lernaea* has been shown to cause significant mortality.

Common Name: Mountain galaxias (ornate mountain galaxias)
Scientific Name: *Galaxias olidus* GŸnther, 1866
Size: Maximum size 140 mm; average 70–80 mm
Conservation Status: Declining

General References

Berra 1973; Bond 2004; Cadwallader *et al.* 1980; Green 1979; Lintermans 2000, 2002; McDowall 2006; McDowall & Fulton 1996; O'Connor & Koehn 1991; Raadik 2001.

Picture

Spotted galaxias

Galaxias truttaceus

Common Name: Spotted galaxias (Spotted mountain trout, Trout minnow)
Scientific Name: *Galaxias truttaceus* Valenciennes, 1846
Size: Maximum size 200 mm + ; commonly 120-140 mm

Distribution and Abundance

Normally a species of coastal streams of Vic, Tas and southwest WA, in the Basin the Spotted galaxias is present in the upper Campaspe and Loddon drainages, where it is thought to have been transferred from coastal Victorian streams through its use for bait, or to represent a remnant population of a historically wider distribution. A single recent record of a whitebait of this species is also known from the Lower Murray near Wentworth.

Habitat

In its natural lowland coastal habitats, the Spotted galaxias favours cover such as logs, boulders and overhung banks on the edges of pools. Coastal populations spawn in autumn–winter, and the larvae have a marine phase of several months before returning to estuaries as 45–65 mm whitebait in spring.

Diet

Spotted galaxias are carnivorous–adults eat aquatic insect larvae and terrestrial insects that fall onto the water surface. They take much of their food in the drift in mid-water, particularly caddisflies and mayflies. The larvae feed mainly on microcrustaceans (copepods) for the first 2–3 months of life.

Potential Threats

Predation and displacement by introduced trout species, and habitat loss through deforestation are threats. When translocated, the Spotted galaxias may itself pose a threat to other native fish species through competition for food or space.

General References

Allen *et al*. 2002; Cadwallader & Backhouse 1983; McDowall & Fulton 1996; Gilligan 2005b; Humphries 1989, 1990; Humphries & Lake 2000; Littlejohn 2000; Morgan 2003.

Picture

Golden perch

Macquaria ambigua

Common Name: Golden Perch (yellowbelly, callop, Murray perch)
Scientific Name: *Macquaria ambigua* ambigua (Richardson, 1845)
Size: Maximum weight 23 kg and maximum length 760 mm; usually less than 400 mm and 4 kg.

Distribution and Abundance

The Golden perch is widespread throughout the Murray-Darling Basin, where it is widespread in the lower and mid reaches, but has declined in some areas.

Habitat

Golden perch are predominantly found in the lowland, warmer, turbid, slow flowing rivers. In the Broken River they have been shown to prefer deep, slow flowing pool habitats and were often associated with snags and other cover. The species is long-lived, with the maximum validated age for an individual of 26 years, although most individuals live less than 10–12 years.

Adult and immature fish are migratory and extensive upstream movements of more than 1000 kilometres have been recorded for some adult fish, although movements of this scale are not common. Outside the breeding season, individuals occupy home ranges of about 100 m for weeks or months before relocating to another site where a new home range is established. Upstream movements by both immature and adult fish are stimulated by small rises in streamflow and most movement in the Murray occurs between October and April. Recent research in the Murray River has also suggested that some fish may move downstream to spawn.

Diet

The species is an opportunistic carnivore. The diet of adult fish consists mainly of shrimps, yabbies, small fish and benthic aquatic insect larvae. Juvenile fish consume more of the smaller items such as aquatic insect larvae and microcrustaceans.

Potential Threats

River regulation has disrupted migrations and spawning behaviour, and cold-water pollution has eliminated some populations below large dams. Barriers to migration and recolonisation posed by weirs and dams are also threats.

General References

Anderson *et al.* 1992; Baumgartner *et al.* 2006; Crook 2004; Crook *et al.* 2001; Harris & Rowland 1996; King *et al.* 2005; Koehn & Harington 2005; Mallen-Cooper & Stuart 2003; O'Connor *et al.* 2005; Phillips 2003; Reynolds 1983; Ye 2005.

Picture

Macquarie perch

Macquaria australasica

Common Name: Macquarie perch (White eye, Mountain perch, Black bream)
Scientific Name: *Macquaria australasica* Cuvier, 1830
Size: Maximum length 465 mm and maximum weight 3.5 kg; usually less than 350 mm and 1 kg.
Conservation Status: Threatened

Distribution and Abundance

It is thought that there may be at least two forms contained within Macquarie perch, one of which occurs in the western rivers (the Murray-Darling form) and one in eastern or coastal rivers (the Shoalhaven and Hawkesbury-Nepean systems) (the coastal form).

In Victoria, it is still known to exist in the Goulburn, Broken, Ovens and Mitta Mitta catchments.

The populations of Macquarie perch in Dartmouth Reservoir and Lake Burrinjuck initially supported significant recreational fisheries but both have declined dramatically, with the species now virtually absent from the latter. Most of the remaining populations are relatively small and isolated, although populations in the upper Murrumbidgee and Goulburn river systems are locally abundant.

Habitat

The Macquarie perch is a riverine, schooling species. It prefers deep, rocky holes with lots of cover. Spawning occurs just above riffles (shallow running water). Populations may survive in impoundments if able to access suitable spawning sites (Wager & Jackson 1993).

Diet

A quiet and docile species, Macquarie perch feed on shrimps and small benthic aquatic insect larvae, particularly mayflies, caddisflies and midges, but in lakes cladocerans can also be a significant dietary item.

Potential Threats

Threats include interactions with alien species such as trout and Redfin perch, exposure to Epizootic Haematopoietic Necrosis Virus (carried by Redfin perch), and habitat modification such as sedimentation, clearing of riparian vegetation, construction of dams and weirs which act as barriers to migration and recolonisation, and cold-water discharges from dams which prevent successful breeding.

General References

Cadwallader 1977, 1981; Cadwallader & Eden 1979; Cadwallader & Rogan 1977; Douglas 2002; Douglas *et al.* 2002; Harris & Rowland 1996; Ingram *et al.* 2000; Koehn *et al.* 1995; Lintermans 2002, 2006; McKeown 1934; Wharton 1973.

Picture

Murray cod

Maccullochella peelii peelii

Common Name: Murray cod (Cod, Goodoo)
Scientific Name: *Maccullochella peelii peelii* (Mitchell, 1838)
Size: The largest Australian freshwater fish, reaching 113.6 kg and 1800 mm length
Conservation Status: Threatened

Distribution and Abundance

The Murray cod was formerly widespread and abundant in the lower and mid-altitude reaches of the Murray-Darling Basin. Commercial fisheries data indicate that natural populations declined in the 1920s and then again dramatically in the 1950s. The species now has a patchy distribution and abundance across its historic range and was listed as nationally threatened in 2003.

Identification

Easily identified by its large mouth, cream to white belly and green mottled pattern on the body and head. Murray cod is a long-lived species: average weights for fish from rivers aged 5, 10, 15, 20 and 30 years is approximately 5, 10, 15, 20 and 36 kg respectively. The oldest cod that has been accurately aged was 48 years old, 1280 mm long and weighed 32.5 kg, but younger fish may be larger, e.g. one was 29 years and 34 kg.

Habitat

The Murray cod is an icon of the Basin and forms the basis of a popular recreational fishery in south-eastern Australia where it is often stocked into dams and lakes. The species is important in Aboriginal mythology: a huge Murray cod is responsible for forming the Murray River and all its fishes.

Generally associated with deep holes in rivers, the Murray cod prefers habitats with instream cover such as rocks, stumps, fallen trees or undercut banks.

It has only recently been discovered that Murray cod make an upstream migration to spawn. This movement can be up to 120 km and generally occurs in late winter/early spring when river levels are high. After spawning the fish move downstream again, returning to the same area they occupied before the migration, usually to exactly the same snag.

Diet

A 'sit and wait' predator, its diet contains fish, crayfish and frogs.

Potential Threats

Threats include: overfishing, particularly during the breeding season when fish are aggressive and easily caught; habitat destruction through sedimentation; and, in the lower reaches of the Murray-Darling system, river regulation (altered flows and thermal pollution) and removal of structural woody habitat (snags).

General References

Baumgartner *et al.* 2006, 2007; Ebner 2006; Harris & Rowland 1996; Humphries 2005; Kearney & Kildea 2001; Koehn 1997; Koehn 2006; Koehn & Harrington 2005, 2006; Lintermans & Phillips 2004, 2005; Rowland 1989, 1992, 1998a,b; Todd *et al.* 2005.

Picture

Trout cod

Maccullochella macquariensis

Common Name: Trout cod (Blue-nose cod)
Scientific Name: *Maccullochella macquariensis*
Size: Maximum size 16 kg and 850 mm; usually < 5 kg
Conservation Status: Threatened

Distribution and Abundance

There are now only three self-sustaining populations of Trout cod remaining in the wild. The largest is in the Murray River between Yarrawonga and Barmah (approximately 200 km of river), the others are small translocated populations present in Cataract Dam, and in about 15 km of the upper reaches of Sevens Creek near Euroa in Vic. Because of early confusion regarding the identification of Trout cod, information on the historic distribution of the species is unclear.

Identification

The overhanging upper jaw and a speckled body pattern which is blue-grey rather than yellow-green, distinguishes this species from the otherwise similarly-shaped Murray cod.

Most individuals have a dark stripe through the eye, although this feature is also present in young Murray cod.

Habitat

The species is usually associated with deeper water (pools) and instream cover such as logs and boulders. In the Murray River, where it is found with Murray cod, it occupies slightly faster-flowing locations. Recent research in the lowlands of the Murrumbidgee River has demonstrated that adults occupy small areas of less than 500m^2 centred on a 'home snag', and occasionally undertake exploratory movements of 20–60 km involving a return to their home.

Diet

The diet includes fish, yabbies, mudeyes, aquatic insect larvae, shrimps and freshwater prawns.

Potential Threats

Threats include interactions with alien species such as trout and Redfin perch, and habitat modification such as desnagging, sedimentation, clearing of riparian vegetation, river regulation and cold-water pollution from dams. Overfishing of remnant populations has also contributed to declines and needs to be carefully managed if reintroductions are to be successful.

General References

Berra & Weatherley 1972; Cadwallader & Gooley 1984; Douglas *et al.* 1994; Ebner *et al.* 2006; Harris & Rowland 1996; Ingram & Rimmer 1992; King *et al.* 2005; Koehn & Harrington 2006; Lintermans *et al.* 1988, 2005; Morris *et al.* 2001.

Picture

Northern River blackfish

Gadopsis marmoratus

Common Name: Northern river blackfish (river blackfish, Slippery, Slimy, Muddy, Greasy)
Scientific Name: *Gadopsis marmoratus* Richardson 1848
Size: Maximum around 350 mm, commonly 200–250 mm long and about 100 g
Conservation Status: Threatened

Habitat

The Northern river blackfish is found in a diverse range of stream types, from upland and lowland small creeks to large rivers. It prefers habitats with good instream cover such as woody debris, aquatic vegetation or boulders. Most aspects of its ecology are similar to that of the Two-spined blackfish, which often replaces this species in montane habitats.

Diet

An opportunistic carnivore, the Northern river blackfish consumes aquatic insect larvae, crustaceans, terrestrial insects that fall on the water surface, and occasionally other fish.

Potential Threats

Major threats include the smothering of eggs and spawning sites by sediment, interactions with alien species such as trout and Redfin perch, particularly predation and competition for food. Habitat modifications such as cold-water pollution, desnagging and altered flows through river regulation are also likely to impact on this species.

General References

Hammer 2004; Harris & Gehrke 1997; Jackson 1978a,b; Jackson *et al*. 1996; Khan 2003; Khan *et al*. 2004a,b; Lintermans & Osborne 2002; Lloyd and Walker 1986; Miller *et al*. 2004; Moffat & Voller 2002; Morris *et al*. 2001.

Picture

Two-spined blackfish

Gadopsis bispinosus

Habitat

The Two-spined blackfish is restricted to cool, clear upland or montane medium to large streams with abundant instream cover, usually in the form of boulders and cobble. It is found more where there is greater water depth and lower stream velocity, and is not found in the smallest headwater streams. It is usually found in forested catchments, where there is little sediment input to the stream from erosion or agriculture.

Diet

Its diet is dominated by aquatic insect larvae, particularly mayflies, caddisflies and midges, and occasionally fish and crayfish.

Potential Threats

Major threats include cold-water pollution, smothering of eggs and spawning sites by sediment and interactions with trout, particularly predation and competition for food.

Common Name: Two-spined blackfish (Slippery, Slimy, Greasy)
Scientific Name: *Gadopsis bispinosus* Sanger, 1984
Size: Maximum length ~350 mm and ~200 g; usually < 200 mm and 50 g
Conservation Status: Threatened

General References

Jackson *et al.* 1996; Kalish *et al.* 1998; Koehn 1990; Lintermans 1998, 2002; Lintermans & Osborne 2002; Morris *et al.* 2001; Sanger 1990.

Picture

Alien fish species found in the Goulburn Broken Catchment

Author
MARK LINTERMANS, © MDBA

Brown trout

Salmo trutta

Common Name: Brown trout
Scientific Name: *Salmo trutta* Linnaeus, 1758
Size: Maximum weight 20 kg; commonly 1-4 kg

Distribution and Abundance

Brown trout is native to Europe and western Asia and was first introduced to Australia in 1864. Fisheries agencies in the Basin have substantial stocking programs for this and other trout species. Vic and NSW fisheries agencies release approximately five million salmonids each year; and private hatcheries also make releases. Brown trout is widely distributed in the cooler upland streams of Vic, NSW and the ACT, as well as a small number of streams in SA. It is not present in Qld. There is a tendency for Brown trout to become the dominant species in lakes and dams where both Rainbow and Brown trout are present.

Biology and Habitat

Brown trout is found in cool upland streams and lakes.

Brown trout is often found with the parasitic copepod *Lernaea* sp. attached, particularly around the fins. It is generally a longer-lived species than Rainbow trout, often surviving to six years of age, although individuals have been recorded in excess of 25 years of age overseas.

Brown trout form the basis of important recreational fisheries in southeastern Australia and is widely stocked. However, in light of its serious impact on a number of threatened native fish, particularly galaxiid species, it is no longer stocked in a number of streams and dams where threatened species are known to be present.

Diet

The diet contains a wide variety of freshwater insect larvae, snails and wind-blown terrestrial arthropods, aquatic crustaceans, and small fish.

Impacts on Native Fish

As with Rainbow trout, Brown trout has had a serious impact on the distribution and abundance of south-east Australia's native galaxiids, such as Mountain galaxias and Barred galaxias. Brown trout is suspected of having deleterious impacts on Trout cod and Macquarie perch and a number of other threatened native species. Trout species are also thought to impact on a number of threatened frogs, such as the Spotted tree frog (*Litoria spenceri*).

General References

Cadwallader 1996; Clements 1988; Davies & McDowall 1996; Jackson *et al.* 2004; Jackson & Williams 1980; McDowall 2003, 2006; Tilzey 1976.

Picture

Carp

Cyprinus carpio

Common Name: Carp (European carp, Common carp, Koi carp)
Scientific Name: *Cyprinus carpio* Linnaeus, 1758
Size: Maximum 1200 mm and 60 kg; usually 4-5 kg

Distribution and Abundance

Carp are native to central Asia. They were first introduced into Australia in the mid 1800s, but remained in two relatively confined locations, Sydney and the Murrumbidgee Irrigation Area. These two populations were different strains of the one species and showed no signs of spreading. In the early 1960s, a fish farmer illegally introduced a new strain, Boolarra, and it has rapidly colonised watercourses throughout Australia. A recent genetic study of Carp in Australia has identified a fourth strain. Koi, which is present in the wild in the ACT and Tas. The feral Koi strain lacks the bright orange, black or white colouration seen in aquarium Koi.

Carp are present in the majority of slopes and lowland rivers and creeks, and in upland streams as well. They often comprise between 70 and 90% of the fish biomass in lakes and streams.

Habitat

The Carp is usually associated with warm, slow-flowing lowland rivers or lakes, and is rarely found in clear, cool fast-flowing streams. It is tolerant of a wide range of environmental conditions and able to survive extremely low levels of dissolved oxygen.

Diet

Carp feed by 'mumbling' in the sediment on the bottom or banks of water bodies. This involves sucking in sediment, sorting the edible items from the inedible sediment, and expelling the sediment through the gill openings. Dietary items include zooplankton, freshwater insect larvae, crustaceans, molluscs and to a lesser extent plant material. Carp carry the parasitic copepod Anchorworm (*Lernaea* sp.), which infests a range of native and alien fish species. When Carp are seen apparently gasping at the water surface, they are not taking in oxygen, but rather feeding on zooplankton.

Impacts on Native Fish

The impacts of Carp are not clear but their feeding behaviour has led to considerable concern that they may be increasing turbidity levels in waterways and undermining riverbanks. They may also be altering zooplankton levels, exacerbating algal blooms, and their high abundance in many streams and lakes indicates they are probably competing with native fish for food and space.

General References

Brown *et al.* 2005; Brumley 1996; Crook 2004; Davis *et al.* 1998; Driver *et al.* 2005; Harris & Gehrke 1997; Koehn 2004; Koehn *et al.* 2000; Nicol *et al.* 2004; Stuart & Jones 2002, 2006.

Picture

Eastern gambusia

Gambusia holbrooki

Common Name: Eastern gambusia (Gambusia, Mosquitofish, top minnow, Plague minnow)
Scientific Name: *Gambusia holbrooki* (Girard, 1859)
Size: Maximum length 60 mm

Distribution and Abundance

Native to rivers draining to the Gulf of Mexico, Eastern gambusia was introduced into Australia in 1925. Health authorities made further introductions in the 1930s and the species was distributed to many military camps during the Second World War. Now widely distributed throughout Australia, it is commonly found in farm dams, slow-flowing waters and shallow wetlands, and is widespread and abundant across the Basin.

Habitat

The Eastern gambusia is commonly found in lakes or still or slow-flowing streams, mostly around the edges or amongst freshwater plants. Maturity can be reached after only two months, at about 25 mm long.

The Eastern gambusia is not known to migrate. It tolerates of a wide range of water temperatures, oxygen levels, salinities and turbidities. Because of its ability to breed rapidly, it has assumed plague proportions in many habitats.

Often referred to as Mosquitofish, it was introduced into Australia for mosquito control in the 1920s, but unfortunately mosquito larvae do not figure prominently in its diet. Consequently, Mosquitofish should not be used as the common name as it implies some environmental or social benefit, which is largely incorrect.

Diet

Gambusia are primarily carnivorous and the diet contains a range of small freshwater invertebrates and wind-blown terrestrial insects.

Impacts on Native Fish

An aggressive species, Eastern gambusia chase and fin-nip fish much larger than themselves. They also prey on the eggs of native fish and frogs and larval native fish, and significantly reduce growth rates of small native fish. Gambusia are implicated in the decline of more than 30 fish species world-wide, at least nine of which occur in Australia. It has recently been listed as a key threatening process for frog populations in NSW, and is implicated in the decline of more than 10 species of frogs in Australia.

General References

Aarn & Ivantsoff 2001; Arthington & Marshall 1999; Howe *et al.* 1997; Ivantsoff & Aarn 1999; Lloyd *et al.* 1986; McDowall 1996b; NSW NPWS 2003; Pen & Potter 1991; Stoffels & Humphries 2003.

Picture

Goldfish

Carassius auratus

Common Name: Goldfish
Scientific Name: *Carassius auratus* Linnaeus, 1758
Size: Maximum of 400 mm; usually less than 200 mm

Distribution and Abundance

Goldfish are native to eastern Asia and were first introduced into Australia in the 1860s when they were imported as an ornamental fish. Widespread in the Murray-Darling Basin, they are often present in substantial numbers in the early years following construction of impoundments. Their abundance in such lakes usually declines after the stocking of predatory species such as Murray cod, Golden perch and trout, which consume large numbers of Goldfish.

Identification

Easily distinguished from Carp by the absence of barbels around the mouth.

Biology and Habitat

The Goldfish is usually associated with warm, slow-flowing lowland rivers or lakes, although it is also known from weedbeds and slower-flowing areas of upland rivers. It is often found in association with submerged or emergent freshwater plants such as Ribbon-weed (*Vallisneria*), Bullrush (*Typha*) and Common reed (*Phragmites*).

Diet

Its diet includes small crustaceans, freshwater insect larvae, plant material and detritus. It is often heavily infested with the parasitic copepod Anchorworm (*Lernaea* sp.).

Impacts on Native Fish

A consignment of Goldfish from Japan to Victoria is believed to be responsible for introducing to Australia the disease 'Goldfish ulcer', which also affects salmonid species such as trout. Apart from the introduction of this disease, the species is generally regarded as a 'benign' introduction to Australia and New Zealand, with few or no adverse impacts documented.

General References

Allen *et al.* 2002; Brumley 1996; Clements 1988; Lintermans & Osborne 2002; Merrick & Schmida 1984; Moffat & Voller 2002.

Picture

Oriental weatherloach

Misgurnus anguillicaudatus

Common Name: Oriental weatherloach (Japanese weatherloach, Weatherfish)
Scientific Name: *Misgurnus anguillicaudatus* (Cantor, 1842)
Size: Maximum length 250 mm; usually less than 190 mm

Distribution and Abundance

Oriental weatherloach are native to Asia and have established feral populations in the mainland states of the USA as well as Hawaii, Palau, the Philippines, Italy and Germany. In Australia, the species is now established in the ACT, NSW and Vic, and there have been isolated records from Qld and SA. Formerly present near Brisbane, that population has been successfully eradicated. Although it has been recorded from the Murray River and tributaries as far downstream as the Barmah-Gunbower area, it has not yet established in SA, but it is only a matter of time. Illegal use as live bait by anglers is thought to be a significant factor in its spread between drainage systems in south-eastern Australia.

Habitat

The Oriental weatherloach is a benthic fish, native to eastern and central Asia. It was imported into Australia in the 1960s and became a popular aquarium fish. It was first detected as a breeding population in the wild in Australia in 1984 (Victoria) and, consequently, its importation was banned in 1986.

The weatherloach is commonly found in slow-flowing or still water with sand, mud or detritus substrates into which it can burrow to escape predation or hibernate. It is so named because it was thought to be able to predict the weather, becoming restless in response to changing barometric pressure.

The species can occur in a range of habitats, from degraded urban and rural streams and ponds to relatively pristine headwater streams. It can utilise atmospheric oxygen by 'gulping' air and passing it through a highly vascularised hindgut. It is eurythermal, tolerates water temperatures of 2–30°C and has even been recorded in thermal springs at temperatures up to 42°C.

Diet

The species is omnivorous and senses food using a combination of chemical and tactile cues. Its diet contains freshwater insect larvae, rotifers, algae, gastropods, molluscs, micro-crustaceans and detritus.

Impacts on Native Fish

Little is known of the impacts of Oriental weatherloach, but significant dietary overlap has been recorded with the native Mountain galaxias. It may also be a predator of the eggs of native species, particularly those such as galaxiids with demersal adhesive eggs. The weatherloach also carries a range of parasites not previously recorded from Australia. Laboratory experiments indicate that the species can significantly depress macroinvertebrate numbers, as well as increasing turbidity and nitrogen levels.

General References

Dove & Ernst 1998; Koster *et al*. 2002; Lintermans 2004; Lintermans & Burchmore 1996; Lintermans *et al*. 1990a,b; McMahon & Burggren 1987; Raadik *et al*. 2005.

Picture

Rainbow trout

Oncorhynchus mykiss

Common Name: Rainbow trout (Steelhead)
Scientific Name: *Oncorhynchus mykiss* Walbaum, 1792
Size: Maximum weight 10 kg; usually 1-4 kg

Distribution and Abundance

Rainbow trout are native to the western coastal drainages of North America and were first introduced to Australia in 1894, from New Zealand where the species had been introduced from California. The species is usually found throughout the montane catchments in which it occurs, and can occupy even the smallest headwater streams. Rainbow trout are widely distributed in the cooler upland streams of the Basin in Vic, NSW and the ACT, as well as a small number of streams in SA and the Condamine-Balonne in Qld. Fisheries agencies in the Basin have substantial stocking programs for this and other trout species, as they are a valued recreational angling target. Vic and NSW fisheries agencies release approximately five million salmonids each year; private hatcheries also make releases. Rainbow trout are more 'catchable' than Brown trout, making them popular in stocking programs.

Habitat

The Rainbow trout prefers cool, upland streams and lakes. It has a slightly higher thermal tolerance than Brown trout and water temperatures above about 27°C cause high mortality. Other aspects of the species' ecology are very similar to Brown trout.

Rainbow trout are popular targets for recreational angling, although anglers seem to prefer the more elusive Brown trout.

Rainbow trout (and Brown trout) are often found with the parasitic copepod Lernaea sp. attached, particularly around the fins. During times of heat stress, the species is prone to heavy infestation from this parasite, with large red sores from secondary infection obvious.

Diet

The diet contains freshwater insect larvae, crustaceans, snails, small fish and wind-blown terrestrial insects. There is a tendency for Rainbow trout to feed at the water surface more than Brown trout.

Impacts on Native Fish

As with Brown trout, Rainbow trout have had a serious impact on the distribution and abundance of the native galaxiid species in south-eastern Australia such as Mountain galaxias and Barred galaxias. Trout species are also thought to impact on a number of threatened frog species such as the Spotted tree frog (Litoria spenceri).

General References

Cadwallader 1996; Clements 1988; Davies & McDowall 1996; Jackson *et al.* 2004; Jackson & Williams 1980; Lintermans 2000; McDowall 2003, 2006; Tilzey 1976.

Picture

Redfin perch

Perca fluviatilis

Common Name: Redfin perch (Redfin, English perch, European perch)
Scientific Name: *Perca fluviatilis* Linnaeus, 1758
Size: Maximum length 600 mm and weight 10 kg; commonly 400 mm and 1-2 kg

Distribution and Abundance

The Redfin perch is native to the cool-temperate waters of the Northern Hemisphere. It was first introduced to Tas between 1858 and 1862 and to Vic in 1861. The species is widely distributed throughout the temperate portion of the Murray-Darling Basin, but is absent from the colder headwaters and the hotter reaches of the Darling drainage. It is not present in Qld. It survives in water temperatures of up to about 31°C, which largely explains its distribution.

The species is occasionally moved illegally by anglers and, once established, can increase rapidly in numbers. In Lake Burley Griffin, Canberra, within six years of establishing it formed 58% of the total catch. However, these numbers declined dramatically after an outbreak of EHNV in the early to mid 1990s, and the species now comprises around 10–15% of the catch. The perch is a popular angling species, particularly in Vic.

Biology and Habitat

Redfin perch mainly occur in slow-flowing or still water habitats, such as lakes, billabongs and swamps, especially where freshwater plants are abundant. Individuals are generally mature after 2–3 years, but males may mature at the end of the first year. A characteristic of the species is the propensity to 'stunt' under conditions of poor food availability or overcrowding, when individuals can mature at a very small size (approx. 120 mm length).

Diet

The Redfin perch is a pelagic carnivore with a diet that includes crustaceans (shrimps, yabbies and other freshwater crayfish), zooplankton and small fish such as Western carp gudgeon, galaxiids and Eastern gambusia. It is known to prey heavily on newly stocked trout.

Impacts on Native Fish

The Redfin perch is the main host for Epizootic Haematopoietic Necrosis Virus (EHNV). This virus, unique to Australia, was first isolated in 1985 on Redfin perch and is characterised by sudden high mortalities of fish. Laboratory trials have demonstrated that Macquarie perch, Silver perch, trout and Mountain galaxias are among several species found to be extremely susceptible to the disease, but the impacts in the wild are as yet unknown. EHNV has now been recorded from NSW, ACT, and Victoria.

The perch is a voracious predator, with large and small individuals in the Basin consuming small native species such as carp gudgeons and the young of Murray cod, Golden perch and trout.

General References

Langdon 1989; Lintermans *et al*. 1990b; McDowall 1996c; Morgan *et al*. 2002, 2005; Pen & Potter 1992; Weatherley 1963, 1977; Whittington *et al*. 1996.

Picture

Tench

Tinca tinca

Common Name: Tench (Doctor fish)
Scientific Name: *Tinca tinca* (Linnaeus, 1758)
Size: Maximum 700 mm and nearly 9 kg; usually 100-300 mm

Distribution and Abundance

The Tench is native to Europe, but was introduced to Australia in 1876. The species was originally widely distributed in Vic by acclimatisation societies and is still highly sought after by 'coarse fish' enthusiasts. In the Murray-Darling Basin, it is primarily restricted to Vic. It is rarely recorded in NSW, but was formerly present in the Murray, lower Murrumbidgee and lower Lachlan rivers. Since the arrival of Carp, Tench has become rare in the Basin in SA and rare or absent in NSW, and is not present in the ACT and Qld.

Biology and Habitat

The Tench avoids fast water and is typically found in slow-flowing or still waters, often with a muddy bottom and abundant aquatic plants. It is often abundant in off-channel habitats, such as backwaters and lagoons, and in deep, sheltered holes.

Diet

Adult Tench are predominantly benthic carnivores and their diet consists mainly of aquatic insects (commonly chironomids, mudeyes, mayflies) and microcrustaceans (cladocera, ostracods, amphipods, copepods), with some molluscs, worms and plant material. Small Tench feed largely on microcrustaceans and small chironomids. Fry feed on plankton and small insect larvae and crustaceans.

Impacts on Native Fish

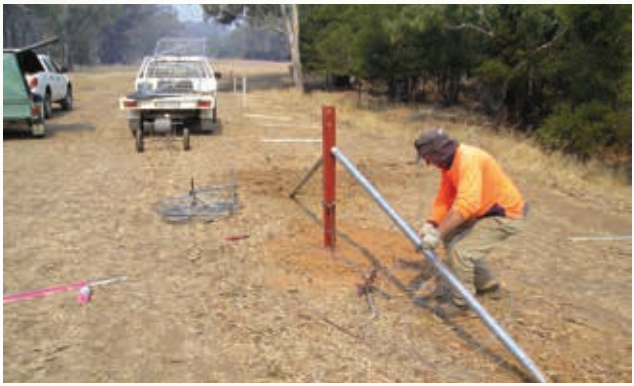
Little is known of the impacts of Tench on native fish species, but they are not thought to be significant.

General References

Brumley 1996; Cadwallader & Backhouse 1983; Clements 1988; Merrick & Schmida 1984; Weatherley 1959, 1962; Weatherley & Lake 1967.

Picture

What can land managers do to help protect native fish?



Protection of the riparian zone helps to maintain a healthy aquatic environment. Riparian zones provide shade, in stream cover (logs and branches) and the food source for aquatic invertebrates that in turn provide food for fish. A well-vegetated riparian zone also filters out sediment and chemicals such as fertilisers before they enter the stream. So, if you are camping or picnicking beside a stream, leave logs on the floodplain and don't cut down trees for firewood.

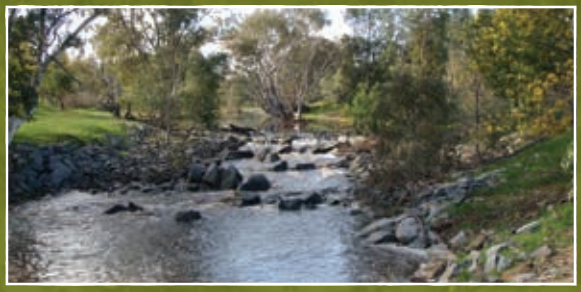
If you own a property that contains or fronts onto a waterway, actions that will assist fish populations include restricting stock access to the riparian zone, preventing runoff of agricultural chemicals such as herbicides and fertilizers, controlling invasive weeds and protecting wetland habitats. Get involved in local catchment and environmental groups such as Conservation Management Networks and Landcare groups.

Fishing is a great way to spend time along a river, but be aware of the local fishing regulations, return threatened species to the water, and don't keep more fish than you need. The use of live fish as bait can assist in the spread of unwanted alien species, so don't use live fish as bait. Report fish kills and illegal fishing activity to your local fisheries department. This will assist in ensuring there are fish for our kids to catch as well.

Keeping aquarium fish is a popular hobby, but release of unwanted fish into waterways is a threat to native fish populations. Dispose of unwanted aquarium fish by returning them to a pet shop.

If you think you have found a fish species in the Catchment that is not in this book, or if you have found a species outside the geographical range indicated, take a photo if possible, and please contact your local fisheries authority. There are still many exciting discoveries to be made on the fish of the Basin, and you can provide vital information to enable better protection of native species, or early action to control alien species.

Six ways you can help to protect our native fish species.



1 Find out about your local fish populations

Diverse and abundant native fish populations are an excellent indicator of healthy waterways which provide many benefits to local communities. However, in many areas, communities do not know what fish are in their local river or creek.

Together the iconic species, such as Murray cod and Golden perch, and the largely unrecognised, smaller species, such as gudgeons and galaxiids, can tell us a lot about the health of local waterways.

You can help protect our native fish by getting involved in the following activities:

- Learn about the species, distribution and status of native fish in the local region.
- Discover if there are introduced species in local waterways.
- Help establish a fish monitoring program to collect data to support management decisions.
- Adopt a native fish species to represent your local rivers and creeks and use it to engage with the local community.

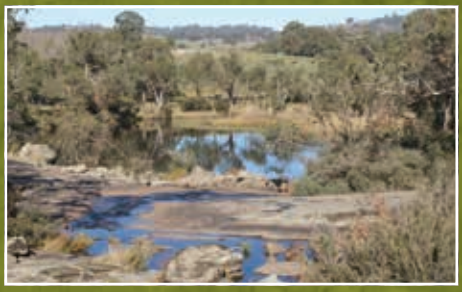
2 Ensure any in-stream infrastructure is fish friendly

Being able to move freely upstream and downstream is critical to the survival of native fish. Different species of fish move at different times to find food and shelter, to avoid predators and to reach breeding sites. Unfortunately, thousands of structures, including dams, regulators, weirs and road crossings, have been constructed throughout Australian river systems.

These structures impede fish passage and reduce water quality, change natural flows and accumulate sediment in upstream pools. These structures may also be unsafe and unreliable for residents, especially when rivers rise. There are a range of options available for anyone who wants to address these structures and restore fish passage.

You can help protect our native fish by:

- Obtain advice from the Goulburn Broken Catchment Management Authority on fish passage requirements and permits.
- Remove redundant weirs and road crossings.
- Modify structures that are barriers to allow fish passage.
- Include a fishway or otherwise allow for fish passage in new structures.
- Ensure flood mitigation infrastructure is fish-friendly.



3 Protect and manage buffer areas by fencing and re-establishing native vegetation

Indigenous trees, shrubs and grasses on riverbanks and areas adjacent to wetlands are vital. This riparian vegetation buffer helps stabilise riverbanks and reduce erosion and subsequent siltation. The vegetation contributes food, such as organic matter and insects, for fish.

The buffer strip will also help filter nutrients and sediments from run-off, reducing the likelihood of algal blooms. Well-developed riparian vegetation also provides a greater diversity of in-stream habitat for fish and shade for the creek. These areas help protect biodiversity by providing wildlife corridors that enable animals and birds to move freely. Buffer areas also provide open space and community recreation opportunities.

Setbacks of 50-100 metres for key fish habitat are recommended to ensure the water quality and habitat are adequately protected from adjoining developments.

You can help protect our native fish by:

- Fencing and revegetating waterways – contact the Goulburn Broken Catchment Management Authority for advice and assistance.
- Recognise the value of riparian and aquatic habitat and ensure new dwellings or infrastructure have appropriate setbacks.
- Manage and maintain existing buffer areas for river health and biodiversity.

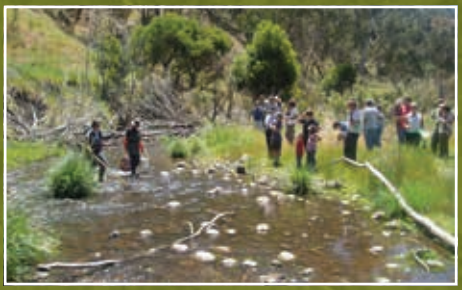
4 Maintain and enhance public reserves for river health

Public parks and reserves are important areas for community recreation and leisure. These areas are often of natural, cultural and economic value and frequently have rivers or creeks flowing through them, which provide additional passive recreation opportunities such as fishing, swimming and kayaking.

Maintaining and enhancing these areas provides social and economic benefits and helps keep waterways healthy.

You can help protect our native fish by:

- Identify reserves that are adjacent to key fish habitat and review their management.
- Establish a bush regeneration team or a “friends of” group.
- Get involved with community groups to improve riparian zones.
- Encourage others to plant trees and shrubs that are native to your area.
- Encourage the control of willows and other invasive weeds.
- Encourage and assist with the establishment of access points to reduce erosion of riverbanks.



5 Get involved with local groups working on fish-friendly projects (eg. Conservation Management Networks, Rivercare groups, Landcare groups & recreational angling groups).

Community groups often provide valuable services, some of which may not be widely recognised.

These groups involve people of all ages who have immense enthusiasm for protecting the environment. They also have great knowledge in local issues, plant regeneration, fauna and flora identification and fish habitat requirements.

By working with these groups you can help achieve beneficial outcomes.

- Become involved local groups and assist with waterways protection and enhancement projects.
- Develop collaborative projects, which can often bring more funding to your community.
- Work together with government agencies to achieve shared goals.
- Help create new groups in your local area if none exist.

6 Get involved with and encourage participation in fish and river health education programs

A growing amount of high quality information on native fish, river health and rehabilitation initiatives is readily and often freely available from sources such as government departments, Catchment Management Authorities, natural resource management agencies and the Murray-Darling Basin Authority.

- Encourage and assist local schools to establish a school native fish and river health education program.
- Help organise and run community events, such as a river-side tree planting day.
- Arrange for materials on native fish and river health to be distributed through visitor information centres and other local businesses.

References

Aarn and Ivantsoff, W. 2001. Predation on native fishes by Gambusia holbrooki in the Orara River, New South Wales. *Fishes of Sahul* 15 (1): 726–732.

Allen, G.R., Midgley, S.H. and Allen, M. 2002. *Field Guide to the Freshwater Fishes of Australia*. Western Australian Museum, Perth.

Anderson, J.R., Morison, A.K. and Ray, D.J. 1992. Validation of the use of thin-sectioned otoliths for determining the age and growth of golden perch *Macquaria ambigua* (Perciformes: Percichthyidae) in the lower Murray-Darling Basin, Australia. *Australian Journal of Marine and Freshwater Research* 43(5): 1103–1128.

Arthington, A.H. and Marshall, C.J. 1999. Diet of the exotic mosquitofish, *Gambusia holbrooki*, in an Australian lake and potential for competition with indigenous fish species. *Asian Fisheries Science* 12: 1–16.

Backhouse, G.N. and Frusher, D.J. 1980. The crimson-spotted rainbowfish, *Melanotaenia fluviatilis* (Castelnau 1878). *Victorian Naturalist* 97: 144–148.

Balcombe, S.R. and Closs, G.P. 2000. Variation in carp gudgeon (*Hypseleotris* spp.) catch rate in dense macrophytes. *Journal of Freshwater Ecology* 15(3): 389–395.

Balcombe, S.R. and Closs, G.P. 2004. Spatial relationships and temporal variability in a littoral macrophyte fish assemblage. *Marine and Freshwater Research* 55: 609–617.

Baumgartner, L.J. 2003. *Fish Passage through a Deelder Lock on the Murrumbidgee River, Australia.* NSW Fisheries Final Report Series No. 57. NSW Fisheries, Narrandera.

Baumgartner, L.J., Reynoldson, N. and Gilligan, D.M. 2006. Mortality of larval Murray cod *(Maccullochella peelii peelii)* and golden perch *(Maquaria ambigua)* associated with passage through two types of low-head weirs. *Marine and Freshwater Research* 57: 187–191.

Baumgartner L.J., Reynoldson N.K., Cameron L. and Stanger J. 2007 *The Effects of Irrigation Practices on Fish of the Murray-Darling Basin.* NSW Department of Primary Industries, Cronulla, Sydney.

Berra, T.M. and Weatherley, A.H. 1972. A systematic study of the Australian freshwater serranid fish genus *Maccullochella*. *Copeia* 1972(1): 53–64.

Bertozzi, T., Adams, M. and Walker, K.F. 2000. Species boundaries in carp gudgeons (Eleotridae: Hypseleotris) from the River Murray, South Australia: evidence for multiple species and extensive hybridization. *Marine and Freshwater Research* 51: 805–815.

Bishop, K.A., Allen, S.A., Pollard, D.A. and Cook, M.G. 2001. *Ecological Studies on Freshwater Fishes of the Alligator Rivers Region, Northern Territory: Autecology.* Office of the Supervising Scientist Report 145, Supervising Scientist, Darwin.

Bond, N.R. 2004. Observations on the effects of the introduced parasite Lernaea cyprinacea on a lowland population of a small native Australian fish, Mountain Galaxias *Galaxias olidus*. *Victorian Naturalist* 121(5): 194-198.

Briggs, I.C. and McDowall, R.M. 1996. Family Clupeidae: Herrings. Pp. 44–47 in: McDowall, R.M. (ed.) *Freshwater Fishes of South-eastern Australia*. Second edition. Reed Books, Sydney.

Brown, P., Sivakumaran, K.P., Stoessel, D. and Giles, A. 2005. Population biology of carp (*Cyprinnus carpio* L.) in the mid-Murray River and Barmah Forest Wetland, Australia. *Marine and Freshwater Research* 56: 1151–1164.

Brumley, A.R. 1996. Family Cyprinidae: carps, minnows, etc. Pp. 99–106 in: McDowall, R.M. (ed.) *Freshwater Fishes of South-eastern Australia*. Second edition. Reed Books. Sydney.

Cadwallader, P.L. 1977. J.O. *Langtry's 1949–50 Murray River Investigations*. Fisheries and Wildlife Paper No. 13. Fisheries and Wildlife Division, Victoria. Cadwallader, P.L. 1981. Past and present distributions and translocations of Macquarie perch *Macquaria australasica* (Pisces: Percichthyidae), with particular reference to Victoria. *Proceedings of the Royal Society of Victoria* 93: 23–30.

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 Freshwater Fish of Victoria*. Victorian Government Printing Office, Melbourne.

Cadwallader, P.L. and Eden, A.K. 1979. Observations on the food of Macquarie perch, *Macquaria australasica* (Pisces: Percichthyidae) in Victoria. *Australian Journal of Marine and Freshwater Research* 30: 401–409.

Cadwallader, P.L., Eden, A.K. and Hook, R.A. 1980. The role of streamside vegetation as a food source for *Galaxias olidus* Gunther (Pisces: Galaxiidae). *Australian Journal of Marine and Freshwater Research* 31: 257–262.

Cadwallader, P.L. and Gooley, G.J. 1984. Past and present distributions and translocations of Murray cod *Maccullochella peeli* and trout cod M. *macquariensis* (Pisces: Percichthyidae), in Victoria. *Proceedings of the Royal Society of Victoria* 96 (1): 33–43.

Cadwallader, P.L. and Rogan, P.L. 1977. The Macquarie perch *Macquaria australasica* (Pisces: Percichthyidae), of Lake Eildon, Victoria. *Australian Journal of Ecology* 2: 409–418.

Clements, J. 1988. Salmon at the Antipodes. *A History and Review of the Trout, Salmon and Char*, and Introduced Coarse Fish in Australia. John Clements, Ballarat.

Clunie, P. and Koehn, J. 2001a. *Freshwater Catfish: A Recovery Plan*. Final report to the Murray-Darling Basin Commission, Canberra.

Clunie, P. and Koehn, J. 2001b. *Freshwater Catfish: A Resource Document*. Final report to the Murray-Darling Basin Commission, Canberra.

Clunie, P. and Koehn, J. 2001c. *Silver Perch: A Recovery Plan.* Final report to the Murray-Darling Basin Commission, Canberra.

Clunie, P. and Koehn, J. 2001d. *Silver Perch: A Resource Document.* Final report to the Murray-Darling Basin Commission, Canberra.

Crook, D.A. 2004. Is the home range concept compatible with the movements of two species of lowland river fish? *Journal of Animal Ecology* 73: 353–366.

Crook, D.A., Robertson, A.I., King, A.J., and Humphries, P. 2001. The influence of spatial scale and habitat arrangement on diel patterns of habitat use by two lowland river fishes. *Oecologia* 129: 525–533.

Davies, P.E. and McDowall, R.M. 1996. Family Salmonidae: salmons, trouts and chars. Pp. 81–91 in: McDowall, R.M. (ed.) *Freshwater Fishes of South-eastern Australia.* Second edition. Reed Books, Sydney.

Davis, K.M., Dixon, P.I. and Harris, J.H. 1998. Allozyme and mitochondrial DNA analysis of carp, *Cyprinus carpio* L., from south-eastern Australia. *Marine and Freshwater Research* 50 (3): 243–260.

Davis, T.L.O. 1977a. Age determination and growth of the freshwater catfish *Tandanus tandanus* Mitchell, in the Gwydir River, Australia. *Australian Journal of Marine and Freshwater Research* 28 (2): 119–137.

Davis, T.L.O. 1977b. Food habits of the freshwater catfish *Tandanus tandanus* Mitchell, in the Gwydir River, Australia and effects associated with impoundment of this river by the Copeton Dam. *Australian Journal of Marine and Freshwater Research* 28 (4): 455–465.

Davis, T.L.O. 1977c. Reproductive biology of the freshwater catfish *Tandanus tandanus* Mitchell, in the Gwydir River, Australia. II. Gonadal cycle and fecundity. *Australian Journal of Marine and Freshwater Research* 28 (2): 159–169.

Douglas, J. 2002. *Observations on Aspects of Macquarie Perch Macquaria australasica (Cuvier) Spawning, Natural Recruitment and Selected Population Attributes in Lake Dartmouth and the Mitta Mitta River between 1994 and 1998.* Marine and Freshwater Resources Institute Freshwater Fisheries Report No. 02/07, Marine and Freshwater Resources Institute, Department of Natural Resources and Environment, Victoria.

Douglas, J., Giles, A. and Strongman, R. 2002. *Lake Dartmouth Multi-species Fishery Assessment.* Marine and Freshwater Resources Institute Freshwater Fisheries Report No. 02/2. Marine and Freshwater Resources Institute Department of Natural Resources and Environment, Victoria.

Douglas, J.W., Gooley, G.J. and Ingram, B.A. 1994. *Trout Cod,* Maccullochella macquariensis (*Cuvier*) (*Pisces: Percichthyidae*), *Resource Handbook and Research and Recovery Plan*. Department of Conservation and Natural Resources, Victoria.

Dove, A.D.M. 1998. A silent tragedy: parasites and the exotic fishes of Australia. *Proceedings of the Royal Society of Queensland* 107: 109–113.

Dove, A.D.M., Cribb, T.H., Mockler, S.P. and Lintermans, M. 1997. The Asian fish tapeworm, *Bothriocephalus acheilognathi*, in Australian freshwater fishes. *Marine and Freshwater Research* 48: 181–183.

Dove, A.D.M. and Ernst, I. 1998. Concurrent invaders–four exotic species of Monogenea now established on exotic freshwater fishes in Australia. *International Journal for Parasitology* 28: 1755–1764.

Driver, P.D., Harris, J.H., Closs, G.P. and Koen, T.B. 2005. Effects of flow regulation on carp (*Cyprinus carpio* L.) recruitment in the Murray-Darling Basin, Australia. *River Research and Applications* 21: 327–335.

DSE 2006. *Barred Galaxias Fact Sheet*. Department of Sustainability and Environment, Victoria. http://www.dse.vic.gov.au/DSE/nrenpa.nsf/LinkView/ 5E88C2D5696B0C244A256808007DCC1BE7A24BB36FF60A144A256DEA00244294 (accessed 21/4/06).

Ebner, B. 2006 Murray cod an apex predator in the Murray River, Australia. *Ecology of Freshwater Fish* 15: 510–520.

Ebner, B., Thiem, J., Lintermans, M. and Gilligan, D. 2006. *An Ecological Approach to Reestablishing Australian Freshwater Cod Populations: An Application to Trout Cod in the Murrumbidgee Catchment.* Final report to the Fisheries Research and Development Corporation for Project 2003/034. Environment ACT, Canberra.

Gilligan, D. 2005a. *Fish Communities of the Murrumbidgee Catchment: Status and Trends.* Fisheries Final Report Series No. 75. NSW Department of Primary Industries, Narrandera.138 pp.

Gilligan, D. 2005b. *Fish Communities of the Lower Murray-Darling Catchment: Status and Trends.* Fisheries Final Report Series No. 83. NSW Department of Primary Industries, Narrandera.106 pp.

Glova, G.J. and Sagar, P.M. 1989. Feeding in a nocturnally active fish *Galaxias brevipinnis*, in a New Zealand stream. *Australian Journal of Marine and Freshwater Research* 40: 231–240.

Green, K. 1979. Observations on rock climbing by the fish *Galaxias brevipinnis*. *Victorian Naturalist* 96: 230–231.

Hammer, M. 2002a. *Recovery Outline for the Southern Pygmy Perch in the Mount Lofty Ranges, South Australia*. Department of Environmental Biology, University of Adelaide, and Native Fish Australia (SA) Inc.

Hammer, M. 2004. *The Eastern Mt Lofty Ranges Fish Inventory: Distribution and Conservation of freshwater Fishes of Tributaries to the Lower Murray River, South Australia.* Native Fish Australia (SA) Inc. and River Murray Catchment Eater Management Board.

Hammer, M.P. Adams, M., Unmack, P.J. and Walker, K.F. 2007. A rethink on *Retropinna*: conservation implications of new taxa and significant genetic substructure in Australian smelts (Pisces: Retropinnidae). *Marine and Freshwater Research* 58(4): 327–341.

Harris, J.H. and Gehrke, P.C. (eds) 1997. *Fish and Rivers in Stress: The NSW Rivers Survey.* New South Wales Fisheries and the Cooperative Research Centre for Freshwater Ecology.

Harris, J.H. and Rowland, S.J. 1996. Family Percichthyidae: Australian freshwater cods and basses. Pp. 150–163 in: McDowall, R.M. (ed.) *Freshwater Fishes of South-eastern Australia*. Second edition. Reed Books, Sydney.

Henry, G.W. and Lyle, J.M. (eds) 2003. *The National Recreational and Indigenous Fishing Survey.* NSW Fisheries Final Report Series No. 48. NSW Fisheries.

Higham, J., Ye, Q. and Smith, B. 2005. *Murray-Darling Basin Drought Monitoring: Monitoring Small-bodied Fish in the Lower Murray During and After Drought Conditions in 2003–2004.* SARDI Research Report Series No. 73. SARDI Aquatic Sciences, Adelaide.

Howe, E.H., Howe, C., Lim, R. and Burchett, M. 1997. Impact of the introduced poeciliid *Gambusia holbrooki* (Girard, 1859) on the growth and reproduction of *Pseudomugil signifer* (Kner, 1865) in Australia. *Marine and Freshwater Research* 48: 425–434.

Hughes, R.L. and Potter, I.C. 1968. Studies on gametogenesis and fecundity in the lampreys *Mordacia praecox* and *M. mordax* (Petromyzontidae). *Australian Journal of Zoology* 17: 447–464.

Humphries, P. 1989. Variation in the life history of diadromous and landlocked populations of the spotted galaxias, *Galaxias truttaceus* Valenciennes, in Tasmania. *Australian Journal of Marine and Freshwater Research* 40: 501–518.

Humphries, P. 1990. Morphological variation in diadromous and landlocked populations of the spotted galaxias, Galaxias truttaceus, in Tasmania, south-eastern Australia. *Environmental Biology of Fishes* 27(1): 97–105.

Humphries, P. 1995. Life history, food and habitat of the southern pygmy perch, *Nannoperca australis*, in the Macquarie River, Tasmania. *Marine and Freshwater Research* 46: 1156–1169.

Humphries, P. 2005. Spawning time and early life history of Murray cod, *Maccullochella peelii peelii* (Mitchell) in an Australian river. *Environmental Biology of Fishes* 72: 393–407.

Humphries, P. and Lake, P.S. 2000. Fish larvae and the management of regulated rivers. *Regulated Rivers: Research and Management* 16: 421–432.

Humphries, P. and Potter, I.C. 1993. Relationship between the habitat and diet of three species of atherinids and three species of gobies in a temperate Australian estuary. *Marine Biology* 116: 193–204.

Humphries, P., Serafini, L.G. and King, A.J. 2002. River regulation and fish larvae: variation through space and time. *Freshwater Biology* 47: 1307–1331.

Ingram, B.A., Douglas, J.W. and Lintermans, M. 2000. Threatened fishes of the world: *Macquaria australasica* Cuvier, 1830 (Percichthyidae). *Environmental Biology of Fishes* 59: 68.

Ingram B.A. and Rimmer, M.A. 1992. Induced breeding and larval rearing of the endangered Australian freshwater fish trout cod, *Maccullochella macquariensis* (Cuvier)(Percichthyidae). *Aquaculture and Fisheries Management* 24: 7–17.

Ivantsoff, W. and Crowley, L.E.L.M. 1996. Family Atherinidae, Silversides or Hardyheads. Pp. 123–133 in: McDowall, R.M. (ed.) *Freshwater Fishes of South-eastern Australia.* Second edition. Reed Books, Sydney.

Ivantsoff, W. and Aarn 1999. Detection of predation on Australian native fishes by *Gambusia holbrooki. Australian Journal of Marine and Freshwater Research* 50: 467–468.

Jackson, J.E., Raadik, T.A., Lintermans, M. and Hammer, M. 2004. Alien salmonids in Australia: Impediments to effective impact management, and future directions. *New Zealand Journal of Marine and Freshwater Research* 38: 447–455.

Jackson, P.D. 1978a. Spawning and early development of the river blackfish, *Gadopsis marmoratus* Richardson (Gadopsiformes: Gadopsidae), in the McKenzie River, Victoria. *Australian Journal of Marine and Freshwater Research* 29: 293–298.

Jackson, P.D. 1978b. Benthic invertebrate fauna and feeding relationships of brown trout, *Salmo trutta* Linnaeus, and river blackfish, *Gadopsis marmoratus* Richardson, in the Aberfeldy River, Victoria. *Australian Journal of Marine and Freshwater Research* 29: 725–742.

Jackson, P.D., Koehn, J.D., Lintermans, M. and Sanger, A.C. 1996. Family Gadopsidae: Freshwater blackfishes. Pp. 186–190 in: McDowall, R.M. (ed.) *Freshwater Fishes of Southeastern Australia.* Second edition. Reed Books, Sydney.

Jackson, P.D. and Williams, W.D. 1980. Effects of brown trout, *Salmo trutta* L., on the distribution of some native fishes in three areas of southern Victoria. *Australian Journal of Marine and Freshwater Research* 31: 61–67.

Kalish, J.M., Lintermans, M. and Neira F.J. 1998. Family Gadopsidae; Freshwater blackfishes. Pp. 223–225 in: Neira, F.J., Miskiewicz, T.G. and Trnski, T. (eds) *Larvae of Temperate Australian fishes.* University of Western Australia Press.

Kearney, R.E. and Kildea, M.A. 2001. *The Status of Murray Cod in the Murray-Darling Basin.* Report to Environment Australia. Applied Ecology Research Group, University of Canberra. 66 pp.

Kennard, M.J., Pusey, B.J. and Arthington, A.H. 2001. Trophic Ecology of Freshwater Fishes in Australia. Summary Report, CRC for Freshwater Ecology Scoping Study ScD6. Centre for Catchment and In–Stream Research, Griffith University, Brisbane.

Khan, M.T. 2003. *Ecology and Habitat use of River Blackfish* (Gadopsis marmoratus R.) *in Victorian Streams.* Unpubl. PhD Thesis, University of Ballarat.

Khan, M.T., Khan, T.A. and Wilson, M.E. 2004a. Habitat use and movement of river blackfish (*Gadopsis marmoratus* R.) in a highly modified Victorian stream. *Ecology of Freshwater Fish* 13: 285–293.

Khan, M.T., Khan, T.A. and Wilson, M.E. 2004b. Movement and habitat use of added hollows by river blackfish *Gadopsis marmoratus* R. in an agricultural catchment stream. *Victorian Naturalist* 121(6): 244–253.

Kibria, G., Nugegoda, D., Fairclough, R. and Lam, P. 1998. Biology and aquaculture of silver perch, Bidyanus bidyanus (Mitchell 1838) (Terapontidae): A review. Victorian Naturalist 115(2): 56–62.

King, A.J., Crook, D.A., Koster, W.M., Mahoney, J. and Tonkin, Z. 2005. Comparison of larval fish drift in the Lower Goulburn and mid-Murray Rivers. *Ecological Management and Restoration* 6(2): 136–138.

Koehn, J.D. 1990. Distribution and conservation status of the two-spined blackfish, *Gadopsis bispinosus*, in Victoria. *Proceedings of the Royal Society of Victoria* 102(2): 97–103.

Koehn, J.D. 1997. Habitats and movements of freshwater fish in the Murray-Darling Basin. Pp. 27–37 in: Banens, R.J. and Lehane, R. (eds) *Proceedings of the 1995 Riverine Environment Research Forum*. Murray-Darling Basin Commission, Canberra.

Koehn, J.D. 2004. Carp (*Cyprinus carpio*) as a powerful invader in Australian waterways. *Freshwater Biology* 49: 882–894.

Koehn, J.D. 2006. The ecology and conservation management of Murray cod *Maccullochella peelii peelii*. PhD. Thesis. University of Melbourne, Australia.

Koehn, J.D., Doeg, T.J., Harrington, D.J. and Milledge, G.A., 1995. *The Effects of Dartmouth Dam on the Aquatic Fauna of the Mitta Mitta River*. Unpublished report to the Murray-Darling Basin Commission. Department of Conservation and Natural Resources, Melbourne.

Koehn, J.D., Gehrke, P.C. and Brumley, A.R. 2000. *Managing the Impacts of Carp*. Bureau of Rural Sciences, Canberra.

Koehn, J.D. and Harrington, D.J. 2005. Collection and distribution of the early life stages of the Murray cod (*Maccullochella peelii peelii*) in a regulated river. Australian Journal of Zoology 53: 137–144.

Koehn, J.D. and Harrington, D.J. 2006. Environmental conditions and timing for the spawning of Murray cod (*Maccullochella peelii peelii*) and the endangered trout cod (*M. macquariensis*) in southeastern Australian rivers. *River Research and Applications* 22: 327– 342.

Koehn, J.D. and McKenzie, R. F. 2004. Priority management actions for alien freshwater fish species in Australia. *New Zealand Journal of Marine and Freshwater Research* 38: 457–472.

Koehn, J.D. and O'Connor, W.G. 1990. *Biological Information for Management of Native Freshwater Fish in Victoria.* Department of Conservation and Environment, Victoria.

Koster, W.M., Raadik, T.A. and Clunie, P. 2002. *Scoping Study of the Potential Spread and Impact of the Exotic Fish Oriental Weatherloach in the Murray-Darling Basin, Australia: A Resource Document.* Report to Agriculture, Fisheries, Forestry, Australia under Murray-Darling 2001 FishRehab Program. Victoria, Freshwater Ecology, Arthur Rylah Institute for Environmental Research.

Kuiter, R.H., Humphries, P.A. and Arthington, A.H. 1996. Family Nannopercidae: Pygmy Perches. Pp. 168–175 in: McDowall, R.M. (ed.) *Freshwater Fishes of South-eastern Australia.* Second edition. Reed Books. Sydney.

Langdon, J.S. 1989. Experimental transmission and pathogenicity of epizootic haematopoietic necrosis virus (EHNV) in redfin perch *Perca fluviatilis* L., and 11 other teleosts. *Journal of Fish Diseases* 12: 295–310.

Larson, H.K. and Hoese, D.F. 1996a. Family Gobiidae, subfamilies Eleotridinae and Butinae: Gudgeons. Pp. 200–219 in: McDowall, R.M. (ed.) *Freshwater Fishes of South-eastern Australia.* Second edition. Reed Books, Sydney.

Leigh, S.J. 2002. *Aspects of the Life-History and Population Biology of the Australian Smelt,* Retropinna semoni (*Weber 1895*) (*Salmoniformes: Retropinnidae*) *for a Lower Murray River Population.* Unpubl. B Sc (Hons) thesis, University of Adelaide.

Lintermans, M. 1998 *The Ecology of the Two-spined Blackfish* Gadopsis bispinosus (*Pisces: Gadopsidae*). Unpublished M Sc thesis, Division of Botany and Zoology, Australian National University, Canberra.

Lintermans, M. 2000. Recolonisation by the mountain galaxias *Galaxias olidus* of a montane stream after the eradication of rainbow trout *Oncorhynchus mykiss. Marine and Freshwater Research* 51: 799–804.

Lintermans, M. 2002. *Fish in the Upper Murrumbidgee Catchment: A Review of Current Knowledge.* Environment ACT, Canberra. 92 pp.

Lintermans, M. 2004. Human-assisted dispersal of alien freshwater fish in Australia. *New Zealand Journal of Marine and Freshwater Research* 38: 481–501.

Lintermans, M. 2006. The Re-establishment of the Endangered Macquarie perch, *Macquaria australasica*, in the Queanbeyan River, New South Wales, with an Examination of Dietary Overlap with Alien Trout. CRC for Freshwater Ecology Technical Report. 34pp.

Lintermans, M. and Burchmore, J. 1996. Family Cobitidae: Loaches. Pp. 114–115 in: McDowall, R.M. (ed.) *Freshwater Fishes of South-eastern Australia.* Second edition. Reed Books. Sydney.

Lintermans, M., Cottingham, P. and O'Connor, R. (eds) 2005. *Native Fish Habitat Rehabilitation and Management in the Murray-Darling Basin: Statement, Recommendations and Supporting Papers.* Proceedings of a workshop held in Albury, NSW, 10–11 February 2004. Murray-Darling Basin Commission, and Cooperative Research Centre for Freshwater Ecology. Canberra. 101 pp.

Lintermans, M. Kukolic, K. and Rutzou, T. 1988. The Status of the trout cod, *Maccullochella macquariensis* in the Australian Capital Territory. *Victorian Naturalist* 105:205–207.

Lintermans, M. and Osborne, W.S. 2002. *Wet & Wild: A Field Guide to the Freshwater Animals of the Southern Tablelands and High Country of the ACT and NSW.* Environment ACT, Canberra. 262 pp.

Lintermans, M. and Phillips, B. (eds) 2004. *Downstream Movement of Fish in the Murray-Darling Basin. Statement, Recommendations and Supporting Papers.* Proceedings of a workshop held in Canberra, ACT, 3–4 June 2003. Murray-Darling Basin Commission, Canberra. 104 pp.

Lintermans, M. and Phillips, B. (eds) 2005. *Management of Murray Cod in the Murray-Darling Basin: Statement, Recommendations and Supporting Papers.* Proceedings of a workshop held in Canberra, 3–4 June 2004. Murray-Darling Basin Commission, Canberra. 128pp.

Lintermans, M. and Raadik, T. 2003. Local eradication of trout from streams using rotenone: the Australian experience. Pp. 95–11 in: *Managing invasive freshwater fish in New Zealand.* Proceedings of a workshop hosted by Department of Conservation, 10–12 May 2001, Hamilton, New Zealand. Department of Conservation, Wellington.

Lintermans, M., Rowland, S.J., Koehn, J., Butler, G., Simpson, R. and Wooden, I. 2005. The status, threats and management of freshwater cod species in Australia. Pp. 15–29 in: Lintermans, M. and Phillips, B. (eds) 2005. *Management of Murray Cod in the Murray-Darling Basin.* Proceeding of a workshop held in Canberra, ACT, 3–4 June 2004: Statement, recommendations and supporting papers. Murray-Darling Basin Commission, Canberra.

Lintermans, M., Rutzou, T. and Kukolic, K. 1990a. *The Status, Distribution and Possible Impacts of the Oriental Weatherloach Misgurnus anguillicaudatus in the Ginninderra Creek Catchment.* Research Report 2, ACT Parks and Conservation Service, Canberra.

Lintermans, M., Rutzou, T. and Kukolic, K. 1990b. Introduced fish of the Canberra region: recent range expansions. Pp. 50–60 in: Pollard, D. (ed.) Australian Society for Fish Biology Workshop: *Introduced and Translocated Fishes and Their Ecological Effects.* Bureau of Rural Resources Proceedings No. 8, Australian Government Publishing Service, Canberra.

Littlejohn, P. 2000. A fish called wander. *ANGFA News* No. 2, April 2000: 1.

Llewellyn, L.C. 1971. Breeding studies on the freshwater forage fish of the Murray-Darling River system. *The Fisherman* (NSW) 3 (13): 1–12.

Llewellyn, L.C. 1974. Spawning, development and distribution of the southern pigmy perch *Nannoperca australis australis* Gunther from inland waters in eastern Australia. *Australian Journal of Marine and Freshwater Research* 25: 121–149.

Llewellyn, L.C. 1979. Some observations on the spawning and development of the Mitchellian freshwater hardyhead *Craterocephalus fluviatilis* McCulloch from inland waters in New South Wales. *Australian Zoologist* 20(2): 269–288.

Llewellyn, L.C. 1980. Family Kuhliidae: Pigmy Perches. Pp. 153–155 in: McDowall, R.M. (ed.) *Freshwater Fishes of South-eastern Australia.* First edition. Reed Books. Sydney.

Llewellyn, L.C. 2005. Breeding biology, and egg and alarval development of *Galaxias rostratus* Klunzinger, the Murray jollytail from inland New South Wales. *Australian Zoologist* 33 (2): 141–165.

Lloyd, L.N., Arthington, A.H. and Milton, D.A. 1986. The mosquitofish–a valuable mosquito control agent or a pest. Pp. 7–25 in: Kitching, R.L. (ed.) *The Ecology of Exotic Animals and Plants: Some Case Histories.* Wiley, Brisbane.

Lloyd, L.N. and Walker, K.F. 1986. Distribution and conservation status of small freshwater fishes in the River Murray, South Australia. *Transactions of the Royal Society of South Australia* 110: 40–57.

Mallen-Cooper, M. 1993. Habitat changes and declines of freshwater fish in Australia: what is the evidence and do we need more? Pp. 118–123 in: Hancock, D. (ed.) *Australian Society for Fish Biology Workshop on Sustaining Fisheries Through Sustaining Habitat.* Australian Government Publishing Service, Canberra.

Mallen-Cooper, M. 1994. How high can a fish jump? *New Scientist* 142 (1921): 32–37.

Mallen-Cooper, M. and Stuart, I.G. 2003. Age, growth and non-flood recruitment of two potamodromous fishes in a large semi-arid/temperate river system. *River Research and Applications* 19: 697–719.

Mallen-Cooper, M., Stuart, I.G., Hides-Pearson, F. and Harris, J.H. 1995. *Fish Migration in the Murray River and Assessment of the Torrumbarry Fishway.* Final report to the Murray-Darling Basin Commission, Natural Resources Management Strategy Project N002, NSW Fisheries.

McCulloch, A.R. 1913. Notes on some Australian Atherinidae. *Proceedings of the Royal Society of Queensland* 24: 47–54.

McDowall, R.M. 1996a. Family Retropinnidae: Southern Smelts. Pp. 92–95 in: McDowall, R.M. (ed.) *Freshwater Fishes of South-eastern Australia.* Second edition. Reed Books, Sydney.

McDowall, R.M. 1996b. Family Poecilidae: Livebearers. Pp. 116–122 in: McDowall, R.M. (ed.) *Freshwater Fishes of South-eastern Australia.* Second edition. Reed Books, Sydney.

McDowall, R.M. 1996c. Family Percidae: Freshwater perches. Pp. 183–185 in: McDowall, R.M. (ed.) *Freshwater Fishes of South-eastern Australia.* Second edition. Reed Books, Sydney.

McDowall, R.M. 2003. Impacts of introduced salmonids on native galaxiids in New Zealand upland streams: A new look at an old problem. *Transactions of the American Fisheries Society* 132: 229–238.

McDowall, R.M. 2006. Crying wolf, crying foul, or crying shame: alien salmonids and a biodiversity crisis in the southern cool-temperate galaxioid fishes? *Reviews in Fish Biology and Fisheries* 16: 233–422.

McDowall, R.M. and Fulton, W. 1996. Family Galaxiidae. Pp. 52–77 in: McDowall, R.M. (ed.) *Freshwater Fishes of South-eastern Australia.* Second edition. Reed Books, Sydney.

McGuigan, K., Zhu, D., Allen, G.R. and Moritz, C. 2000. Phylogenetic relationships and historical biogeography of melanotaeniid fishes in Australia and New Guinea. *Marine and Freshwater Research* 51: 713–723.

McKeown, K.C. 1934. Notes on the food of trout and Macquarie Perch in Australia. Records of the Australian Museum 19: 141–152.

McMahon, B.R. and Burggren, W.W. 1987. Respiratory physiology of the intestinal breathing in the teleost fish *Misgurnus anguillicaudatus*. *Journal of Experimental Biology* 133: 371–393.

MDBC 2004a. *Native Fish Strategy for the Murray-Darling Basin 2003–2013*. Murray-Darling Basin Commission, Canberra.

MDBC 2004b. *Fish Theme Pilot Audit Technical Report – Sustainable Rivers Audit*. Murray-Darling Basin Commission, Canberra. 166 pp.

Medeiros, E.S.F. 2004. *Trophic ecology and energy sources for fish on the floodplain of a regulated dryland river: Macintyre River, Australia.* Unpubl. PhD thesis, Faculty of Environmental Sciences, Griffith University, Brisbane.

Merrick, J.R. 1996. Family Terapontidae: Freshwater grunters or perches. Pp. 164–167 in: McDowall, R.M. (ed.) *Freshwater Fishes of South-eastern Australia*. Second edition. Reed Books, Sydney.

Merrick, J.R. and Schmida, G.E. 1984. *Australian Freshwater Fishes: Biology and Management.* J. Merrick, North Ryde, New South Wales.

Miller, A.D., Waggy, G., Ryan, S.G. and Austin, C.M. 2004. Mitochondrial 12S rRNA sequences support the existence of a third species of freshwater blackfish (Percichthyidae: *Gadopsis*) from south-eastern Australia. *Memoirs of the Museum of Victoria* 61(2): 121–127.

Milton, D.A. and Arthington, A.H. 1985. Reproductive strategy and growth of the Australian smelt, *Retropinna semoni* (Weber) (Pisces: Retropinnidae), and the olive perchlet, *Ambassis nigripinnis* (De Vis) (Pisces: Ambassidae), in Brisbane, south-eastern Queensland. *Australian Journal of Marine and Freshwater Research* 36(3): 329–341.

Milton, D.A. and Arthington, A.H. 1984. Reproductive strategy and growth of the crimson-spotted rainbowfish, *Melanotaenia splendida fluviatilis* (Castelnau) (Pisces: Melanotaeniidae) in south-eastern Queensland. *Australian Journal of Marine and Freshwater Research* 35: 75–83.

Moffat, D., and Voller, J. 2002. *Fish and Fish Habitat of the Queensland Murray-Darling Basin.* Department of Primary Industries, Queensland.

Morgan, D.L. 2003. Distribution and biology of *Galaxias truttaceus* (Galaxiidae) in southwestern Australia, including first evidence of parasitism of fishes in Western Australia by *Ligula intestinalis* (Cestoda). *Environmental Biology of Fishes* 66: 155–167.

Morgan, D.L., Hambleton, S.J., Gill, H.S. and Beatty, S.J. 2002. Distribution, biology and likely impacts of the introduced redfin perch (*Perca fluviatilis*) (Percidae) in Western Australia. *Marine and Freshwater Research* 53: 1211–1221.

Morgan, D., Lintermans, M. and Raadik, T.A. 2005. Shame file: alien creature feature No. 2, Redfin perch *Perca fluviatilis* Linnaeus, 1758 (Pisces: Percidae). *Australian Society for Fish Biology Newsletter* 35(2): 82–87.

Morison, A.K. and Anderson, J.R. 1991. *Galaxias brevipinnis* Gunther (Pisces: Galaxiidae) in north-eastern Victoria: first records for the Murray-Darling drainage basin. *Proceedings of the Royal Society of Victoria* 103: 17–28.

Morris, S.A., Pollard, D.A., Gehrke, P.C. and Pogonoski, J.J. 2001. *Threatened and Potentially Threatened Freshwater Fishes of Coastal New South Wales and the Murray-Darling Basin.* Report to Fisheries Action Program and World Wide Fund for Nature. NSW Fisheries Final Report Series No. 33.

Nicol, S.J., Lieschke, J.A., Lyon. J.P. and Koehn, J.D. 2004. Observations on the distribution and abundance of carp and native fish, and their response to a habitat restoration trial in the Murray River, Australia. *New Zealand Journal of Marine and Freshwater Research* 38: 541–551.

NSW Fisheries 2003. *Environmental Impact Statement on Freshwater Fish Stocking in NSW. Public Consultation Document.* NSW Fisheries, Cronulla. 3 vols.

NSW NPWS 2003. *NSW Threat Abatement Plan. Predation by Gambusia holbrooki – the Plague Minnow.* NSW National Parks and Wildlife Service, Hurstville, NSW.

O'Connor, W.G. and Koehn, J.D. 1991. Spawning of the mountain galaxias *Galaxias olidus* Gunther, in Bruces Creek, Victoria. *Proceedings of the Royal Society of Victoria* 103(2): 113– 123.

O'Connor, W.G. and Koehn, J.D. 1998. Spawning of the broad-finned galaxias, *Galaxias brevipinnis* Gunther (Pisces: Galaxiidae) in coastal streams of southeastern Australia. *Ecology of Freshwater Fish* 7: 95–100.

O'Connor, J.P., O'Mahony, D.J. and O'Mahony, J.M. 2005. Movements of *Macquaria ambigua,* in the Murray River, south-eastern Australia. *Journal of Fish Biology* 66: 392–403.

Pen, L.J. and Potter, I.C. 1991. Reproduction, growth and diet of *Gambusia holbrooki* (Girard) in a temperate Australian river. *Aquatic Conservation: Marine and Freshwater Ecosystems* 1: 159–172.

Pen, L.J. and Potter, I.C. 1992. Seasonal and size-related changes in the diet of perch, *Perca fluviatilis* L., in the shallows of an Australian River, and their implications for the conservation of indigenous teleosts. *Aquatic Conservation: Marine and Freshwater Ecosystems* 2: 243–253.

Phillips, B. 2003 (ed.) *Managing Fish Translocation and Stocking in the Murray-Darling Basin: Statement, Recommendations and Supporting Papers.* Proceedings of a workshop held in Canberra, 25–26 September 2002. WWF Australia. 107 pp.

Pollard, D.A. 1973. The biology of a landlocked form of the normally catadromous salmoniform fish *Galaxias maculatus* (Jenyns).V. Composition of the diet. *Australian Journal of Marine and Freshwater Research* 24: 281–295.

Pollard, D.A., Davis, T.L.O. and Llewellyn, L.C. 1996. Family Plotosidae: Eel-tailed catfishes. Pp. 109–113 in: McDowall, R.M. (ed.) *Freshwater Fishes of South-eastern Australia*. Second edition. Reed Books, Sydney.

Potter, I.C. 1970. The life cycles and ecology of Australian lampreys of the genus *Mordacia*. *Journal of Zoology* (London) 161: 487–511.

Potter, I.C. 1996a. Family Mordaciidae, Shortheaded Lampreys. Pp. 32–35 in: McDowall, R.M. (ed.) *Freshwater Fishes of South-eastern Australia.* Second edition. Reed Books, Sydney.

Puckridge, J.T. and Walker, K.F. 1990. Reproduction biology and larval development of a Gizzard Shad, *Nematolosa erebi* (Günther) (Dorasomatinae: Teleostei), in the River Murray, South Australia. *Australian Journal of Marine and Freshwater Research* 41: 695–712.

Pusey, B.J., Kennard, M.J. and Arthington, A.H. 2004. *Freshwater Fishes of North-Eastern Australia.* CSIRO Publishing, Collingwood, Victoria.

Raadik, T.A. 1995a. A research recovery plan for the Barred galaxias in south-eastern Australia. *Flora and Fauna Technical Report* No. 141. Department of Conservation and Natural Resources, Victoria.

Raadik, T.A. 2000. *Barred Galaxias Recovery Project - Final Report.* Endangered Species Program Project Number 6092. Report to Environment Australia, Canberra. Freshwater Ecology, Arthur Rylah Institute, Victoria. 34 pp.

Raadik, T.A. 2001. When is a mountain galaxias not a mountain galaxias? *Fishes of Sahul* 15 (4): 785–789.

Raadik, T.A., Koster, W. and Lintermans, M. 2005. Shame file: alien creature feature No. 1, Oriental weatherloach Misgurnus *anguillicaudatus* (Cantor, 1842) (Pisces: Cobitidae). *Australian Society for Fish Biology Newsletter* 35(1): 55–8.

Raadik, T.A., Saddlier, S.R. and Koehn, J.D. 1996. Threatened fishes of the world: *Galaxias fuscus* Mack, 1936 (Galaxiidae). *Environmental Biology of Fishes* 47: 108.

Reynolds, L.M. 1983. Migration patterns of five fish species in the Murray-Darling River system. *Australian Journal of Marine and Freshwater Research* 34: 857–871.

Rowland, S.J. 1989. Aspects of the history and fishery of the Murray cod *Maccullochella peeli* (Mitchell) (Percichthyidae). *Proceedings of the Linnaean Society of New South Wales* 111: 201–213.

Rowland, S.J. 1992. Diet and feding of Murray cod (*Maccullochella peelii*) larvae. *Proceedings of the Linnaean Society of New South Wales* 113: 193–201.

Rowland, S.J. 1998a. Aspects of the reproductive biology of Murray cod, *Maccullochella peelii peelii. Proceedings of the Linnaean Society of New South Wales* 120: 147–162.

Rowland, S.J. 1998b. Age and growth of the Australian freshwater fish Murray Cod, *Maccullochella peelii peelii. Proceedings of the Linnaean Society of New South Wales* 120: 163–180.

Rutherfurd, I.D., Jerie, K. and Marsh, N. 2000. *Rehabilitation Manual for Australian Streams*. LWRRDC and the CRC for Catchment Hydrology, Canberra.

Sanger, A.C. 1990. Aspects of the life history of the two-spined blackfish, *Gadopsis bispinosus*, in King Parrot Creek, Victoria. *Proceedings of the Royal Society of Victoria* 102(2): 89–96.

Shirley, M.J. and Raadik, T.A. 1997. Aspects of the ecology and breeding biology of *Galaxias fuscus* Mack, in the Goulburn River system, Victoria. *Proceedings of the Royal Society of Victoria* 109 (2): 157–166.

Stoffels, R.J. and Humphries, P. 2003. Ontogenetic variation in the diurnal food and habitat associations of an endemic and an exotic fish in floodplain ponds: consequences for niche partitioning. *Environmental Biology of Fishes* 66: 293–305.

Stuart, I. and Jones, M. 2002. *Ecology and Management of Common Carp in the Barmah-Millewa Forest*. Final report to Agriculture, Fisheries and Forestry Australia. Arthur Rylah Institute for Environmental Research, Victoria.

Stuart, I.G. and Jones, M. 2006. Large, regulated forest floodplain is an ideal recruitment zone for non-native common carp (*Cyprinus carpio* L.). *Marine and Freshwater Research* 57: 333–347.

Thacker, C. and Unmack, P.J. 2005. Phylogeny and biogeography of the Eleotrid genus *Hypseleotris* (Teleostei: Gobioidei: Eleotridae), with redescription of *H. cyprinoides. Records of the Australian Museum* 57: 1–13.

Tilzey, R.D.J. 1976. Observations on interactions between indigenous Galaxiidae and introduced Salmonidae in the Lake Eucumbene catchment, New South Wales. *Australian Journal of Marine and Freshwater Research* 27: 551–564.

Todd, C.R., Ryan, T.,Nicol, S.J. and Bearlin, A.R. 2005. The impact of cold water releases on the critical period of post-spawning survival and its implications for Murray cod (*Maccullochella peelii peelii*): a case study of the Mitta Mitta River, southeastern Australia. *River Research and Applications* 21: 1035–1052.

Tonkin, Z., King, A., Mahoney, J. and Morrongiello, J. 2007. Diel and spatial drifting patterns of silver perch *Bidyanus bidyanus* eggs in an Australian lowland river. *Journal of Fish Biology* 70: 313–317.

Unmack, P.J. 1992. Victorian pygmy perches. *Fishes of Sahul* 7 (3): 321–323.

Unmack, P.J. 2000. The genus Hypseleotris of southeastern Australia: its identification and breeding biology. Fishes of Sahul 14 (1): 645–657.

Wager, R. and Jackson, P (1993). The Action Plan For Australian Freshwater Fishes. Canberra, ACT: Australian Nature Conservation Agency.

Waters, J.M., Shirley, M. and Closs, G.P. 2002. Hydroelectric development and translocation of *Galaxias brevipinnis*: a cloud at the end of the tunnel? *Canadian Journal of Fisheries and Aquatic Sciences* 59: 49–56.

Weatherley, A.H. 1959. Some features of the biology of the tench, *Tinca tinca* (Linnaeus) in Tasmania. *Journal of Animal Ecology* 28: 73–87.

Weatherley, A.H. 1962. Notes on distribution, taxonomy and behaviour of Tench *Tinca tinca* (Linnaeus) in Tasmania. *Annals and Magazine of Natural History* 13 (4): 713–719.

Weatherley, A.H. 1963. Zoogeography of *Perca fluviatilis* Linnaeus and *Perca flavescens* Mitchill, with special reference to the effects of high temperature. *Proceedings of the Zoological Society of London* 141: 557–576.

Weatherley, A.H. 1977. *Perca fluviatilis* in Australia: zoogeographical expression of a life cycle in relation to environment. *Journal of the Fisheries Research Board of Canada* 34: 1464–1466.

Weatherley, A.H. and Lake, J.S. 1967. Introduced fish species in Australian inland waters. Pp. 217–239 in: Weatherley, A.H. (ed.) *Australian Inland Waters and their Fauna: Eleven Studies.* Australian National University, Canberra.

Wedderburn, S. and Hammer, M. 2003. *The Lower Lakes Fish Inventory: Distribution and Conservation of Freshwater Fishes of the Ramsar Convention Wetland at the Terminus of the Murray-Darling Basin, South Australia.* Native Fish Australia (SA) Inc., Adelaide. 38 pp.

Wharton, J.C.F. 1973. Spawning induction, artificial fertilisation and pond culture of the Macquarie perch (*Macquaria australasica* [Cuvier, 1830]). *Australian Society for Limnology Bulletin* 5: 43–65.

Whittington, R.J., Kearns, C., Hyatt, A.D., Hengstberger, S. and Rutzou, T. 1996. Spread of epizootic haematopoietic necrosis virus in southern Australia. *Australian Veterinary Journal* 73 (3): 112–114.

Woodward, G.M.A, and Malone, B.S. 2002. Patterns of abundance and habitat use by *Nannoperca obscura* (Yarra pygmy perch) and *Nannoperca australis* (Southern pygmy perch). *Proceedings of the Royal Society of Victoria* 114 (1/2): 61–72.

Ye, Q. 2005. *Golden perch* (*Macquaria ambigua*). Fishery assessment report to PIRSA Fisheries for the Inland Inland Fishery Management Committee. SARDI Research Report Series No. 71. 75 pp.

Glossary and abbreviations

Adipose fin	a small fin on trout and smelt, between the dorsal and caudal fins
Alien	species not native to Australia
Alpine	above the treeline (~1500 m)
Ammocete	larval juvenile life phase of lampreys
Anal fin	a single fin on a fish just behind the anus
Aquatic	associated with water
Barbel	slender, fleshy, finger-like appendage ('whisker') usually around the mouth of fish, used in detecting food
Benthic	associated with the bottom of rivers or lakes
Billabong	a cutoff river meander that is isolated from the river channel except in floods
Biomass	the weight of living organisms in an area
Carnivore	an animal that eats other animals
Cascade	section of stream or habitat with turbulent, broken water including small waterfalls
Catchment	the land drained by a stream
Caudal fin	the tail of a fish
Caudal peduncle	the thin, hind-part of the body of a fish, between the back of the anal fin and the start of the tail
Chironomid Bloodworms	the aquatic larvae of non-biting midges
Cladoceran	small, free-swimming crustacean ('water flea')
Copepods	a group of small, planktonic crustaceans which lack walking legs and are usually free swimming; one species (Lernaea sp.) is a relatively large external parasite on fish
Crepuscular	active at dawn and dusk
Crustacean	animals with a hard exoskeleton. Highly variable body form, but containing two pairs of antennae (Yabbies, prawns, shrimps crayfish, water fleas, copepods)
Cryptic	Camouflaged, in relation to colour; hidden or obscure, in relation to species
Cumbungi	rushes of the genus Typha, bullrushes
Declining	decreasing in numbers/abundance and/or range
Demersal	sinking, in relation to fish eggs

Detritivore	an animal that eats detritus from the bottom of streams or lakes
Detritus	dead or decaying organic matter
Diurnal	active during daylight
Dorsal	dorsum relating to the top surface of an animal, its back
Dorsal fin(s)	fin(s) located on the top of a fish
Dorsolateral	located towards the top of the body
Dorso-ventrally compressed	flattened from top to bottom, like a flounder
Ecosystem	an interdependent biological system involving interactions and linkages between living organisms and their physical , chemical and biological components
EHNV	Epizootic Haematopoietic Necrosis Virus
Emergent	protruding out of the water, not floating or submerged
Endangered	a formal category for animals recognised as being in danger of extinction in the near term future
Ephemeral	transient or temporary, not permanent
Eurythermal	lives in a wide range of water temperatures
Family	a group of similar genera
Fecundity	the number of eggs per female. A measure of reproductive capacity
Fimbrae	fringing filaments
Fishway	a man-made structure to enable fish to move over a physical barrier such as a weir
Fossorial	burrowing
Genus	(plural: genera) a group of similar species
Gill rakers	stout protuberances of the gill arch which function to retain food organisms.
Gonadopodium	a specialised part of the anal fin in some male fish used to transfer sperm to the female.
Habitat	where an animal lives, grows and breeds (includes physical and biological components)
Headwaters	the small streams at the top of a catchment or drainage system
Herbivore	an animal that eats plants
Ichthyology	the study of fishes
Interstice, interstitial space	the gaps between substrate particles (boulders, cobbles, pebbles), often used for shelter or spawning by smaller fish species

Invertebrates	animals without backbones such as insects, spiders, crayfish, worms, etc.
Lacustrine	associated with lakes or reservoirs. (compare with riverine)
Larvae	the life-history stage of a fish immediately after hatching and before development into a juvenile
Lateral	relating to the sides of an animal, or to movement (e.g. onto the floodplain as opposed to upstream or downstream)
Lateral line	a canal (usually with pores) running along the side of the body that functions as a sensory organ
Laterally compressed	flattened from side to side, like a knife blade
Lernaea	a large (~8–12 mm) threadlike external parasitic copepod often found attached to softer body parts of fish (fins etc).
Macroinvertebrates	invertebrates that can be seen with the naked eye (with a length > 1 mm)
Macrophytes	literally 'big plants', usually used to describe water plants other than microscopic algae
MDBC	Murray-Darling Basin Commission
Microcrustacean	small crustaceans such as water fleas (Cladocera), copepods and ostracods
Migratory	has a regular pattern of movements, can be seasonal, altitudinal, international
Molluscs	animals with a hard outer shell
Montane	mountainous environments
Nape	the dorsal part of the head behind the occiput, the back of the neck
Native indigenous;	occurring naturally
Nocturnal	active at night
NFS	Native Fish Strategy
Nuptial	associated with breeding
Oblique	at an angle
Omnivore	an animal that eats both plants and animals
Opercula	the hard bony covers of the gills; plural of operculum
Oral disc	the disc-like, tooth-bearing apparatus around the mouth of lampreys that attaches them to their prey
Ostracod	small (0.5–2 mm) crustaceans sometimes referred to as seed shrimps
Otolith	middle ear bones, made from calcium carbonate, part of the balance system of fish, often used to estimate fish age
Parr marks	dark transverse bands or blotches on a young salmon or trout

Pectoral fins	a pair of fins on a fish, usually just behind the gill openings
Pelagic	lives in the upper part of the water column, not benthic
Pelvic fins	a pair of fins on a fish, usually below and behind the pectoral fins
Planktivore	an animal that eats plankton
Plankton	microscopic animals and plants that float or drift in the water
Pool	section of stream or habitat with still or slow flow, usually deep
Protrusible	can be extended to form a tube (often refers to mouthparts, e.g. as in Goldfish)
Rare	scarce
Rays	the flexible rod-like supporting parts of the fin
Redd	fish nest: a hollow scooped out in the sand or gravel by trouts and salmons for spawning
Remnant	remainder of a much more widespread population
Reticulated (in appearance)	marked with lines that form a network
Riffle	section of stream or habitat with shallow, fast-flowing, broken water, usually over rocks or stones
Riparian vegetation	growing beside a river, often water dependent
Riverine	associated with rivers (compare with lacustrine)
Run	section of stream with fast-flow but an unbroken water surface, usually deep
Scute	an enlarged scale or external bony plate
Sedimentation	the process of silt and sediment addition to waterbodies
Serrated	notched along the edge, like the cutting edge of a saw
Snag	a fallen tree or log in the river
Spawning	shedding of eggs and sperm for breeding
Species	a group of animals that can breed and produce fertile offspring
SRA	Sustainable Rivers Audit (an MDBC program)
Sub-alpine	the ecological zone immediately above the winter snowline (~1000 m) but below the treeline (~1500 m on the mainland of Australia)
Submerged	under the water (compare with emergent)
Substrate	the base, or material on the bottom of a waterbody (rocks, pebbles, sand, silt, etc.)
Suctorial	adapted for sucking (as in mouthparts of lampreys)
Sympatric	overlapping in geographic distribution

Taxonomy	how organisms are grouped, classified and named
Threatened	a general term encompassing the formal categories of endangered and vulnerable. Also in danger of extinction unless the processes threatening its existence are ameliorated
Translocated	moved outside of the normal range by direct or indirect human intervention (applies to both native and alien fish)
Tricuspid	with 3 cusps (on teeth)
Tubercle	horny lump, (found on breeding male goldfish and smelt)
Turbidity	a measure of the transparency or muddiness of water
Truncate	square-ended (shape of tail in fish)
Uncommon	infrequent
Vent	anus
Ventral	relating to the under-side of an animal, its belly
Vertebrates	animals with backbones (birds, fish, fogs, reptiles, mammals, etc.)
Zooplankton	animal plankton (as opposed to phytoplankton)
<	less than
>	greater than
kg	kilogram(s)
g	gram(s)
mm	millimeter(s)
~	approximately

Where to find more information

General

Native Fish Australia
Phone: (03) 9848 2285 | www.nativefish.asn.au/

Australia New Guinea Fishes Association
www.angfa.org.au/

Murray-Darling Basin Authority, Native Fish Strategy
Phone: (02) 6279 0100
www.mdba.gov.au/programs/nativefishstrategy

Department of the Environment and Water Resources threatened species
Phone: (02) 6274 1111
www.environment.gov.au/biodiversity/threatened/

Victoria

Goulburn Broken Catchment Management Authority
Phone: (03) 5820 1100 | www.gbcma.vic.gov.au

Department of Sustainability and Environment (including information on Conservation Management Networks)
Phone: 136 186 | www.dse.vic.gov.au

Department of Primary Industries
Phone: 136 186 | www.dpi.vic.gov.au/dpi/index.htm

Arthur Rylah Institute
Phone: 136 186
www.dse.vic.gov.au/dse/nrenari.nsf/Home+Page/DSE+ARI~Home+Page?open

New South Wales

Department of Primary Industries
Phone: 1300 550 474 | www.dpi.nsw.gov.au/fisheries

Australian Capital Territory

Department of the Environment, Climate Change, Energy and Water
Phone: 13 22 81 | www.environment.act.gov.au

Department of Territory and Municipal Services
Phone: 13 22 81 | www.tams.act.gov.au

South Australia

South Australian Research and Development Institute
Phone: (08) 8303 9400 | www.sardi.sa.gov.au/

PIRSA Fisheries
Phone: (08) 8463 3000 | www.pir.sa.gov.au

Native Fish Australia SA Inc
www.nativefishsa.asn.au/

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Who are the Goulburn Broken Catchment Management Authority

The Goulburn Broken Catchment Management Authority was established in 1997 as the peak natural resource management body in the catchment to develop and oversee the implementation of the Regional Catchment Strategy.

The GB CMA is working to ensure land and water resources are protected and enhanced as well as improving the region's social wellbeing, environmental quality and productive capacity in a sustainable manner. It is one of ten such CMA's established around the State.