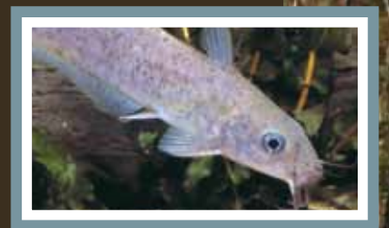
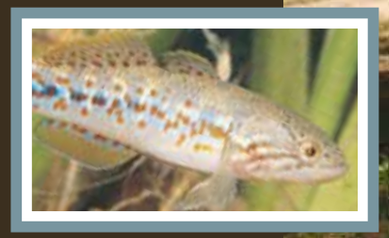
Murray-Darling rainbowfish

Redfin perch



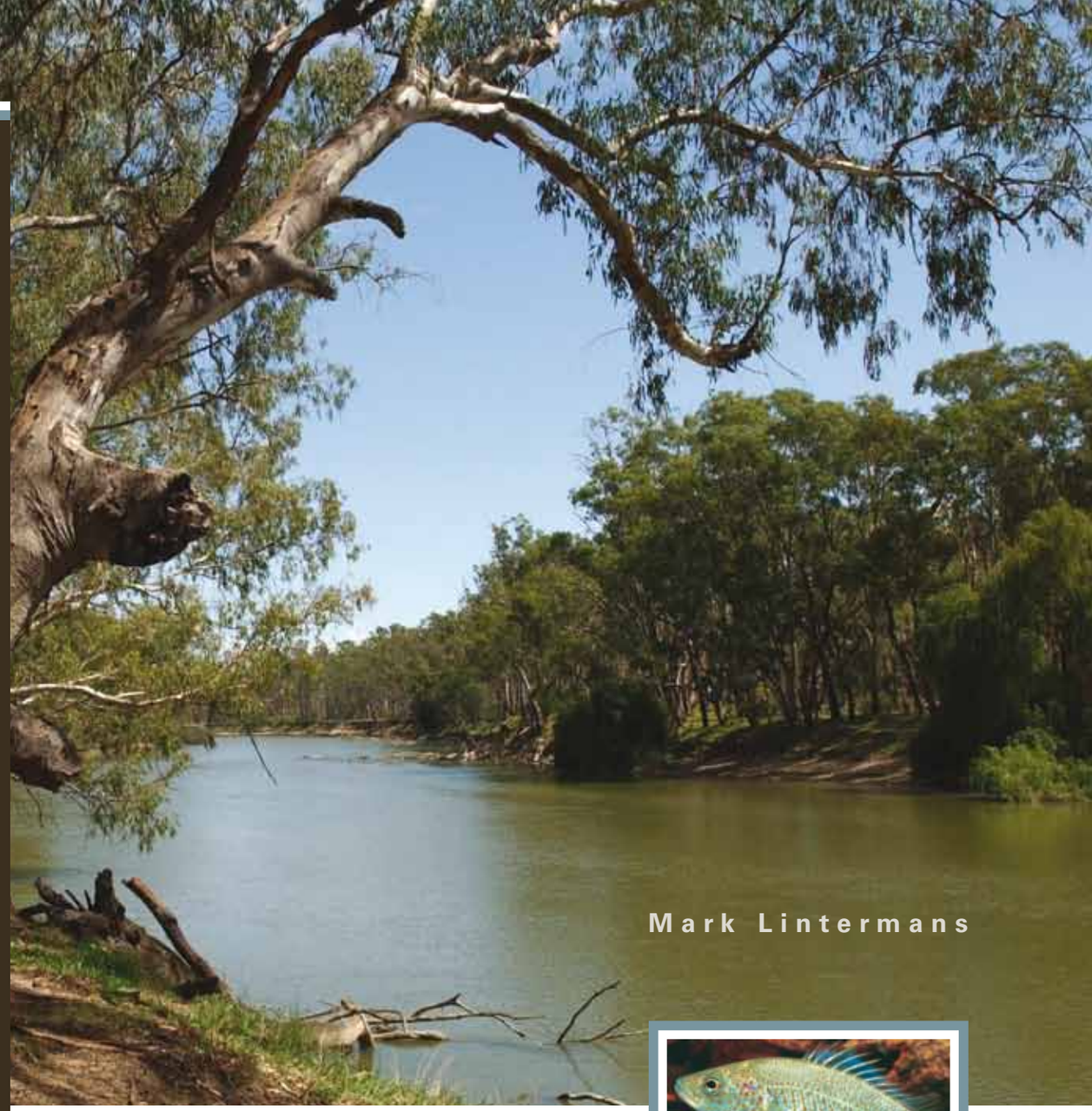
Freshwater catfish



Southern purple-spotted gudgeon

Fishes of the Murray-Darling Basin An introductory guide

Mark Lintermans



Mark Lintermans

FISHES of the Murray-Darling Basin

AN INTRODUCTORY GUIDE

Australian Government

MURRAY–DARLING BASIN AUTHORITY

Fishes of the Murray-Darling Basin: An introductory guide **is the first book devoted exclusively to the fishes of Australia's largest river system. It contains information on the identification, habitats, biology and distribution of the 57 species of freshwater fish found in the Murray-Darling Basin, as well as background information on the threats to fish and aquatic ecosystems. An extensive reference list is also provided.**

This book will be an invaluable guide for naturalists, students, fishermen, scientists and anyone else interested in the life within our rivers. Learn about the iconic Murray cod (Australia's largest freshwater fish), and the smaller species such as galaxias, gudgeons, hardyheads and pygmy perch that inhabit the Basin's waterways.

Mark Lintermans

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Foreword

Native fish populations in the Murray–Darling Basin are estimated to be 10% of their pre-European-settlement levels, and alien species, such as carp, dominate the fish population in many places.

The Murray–Darling Basin Authority's Native Fish Strategy has a goal of restoring native fish populations to 60% of pre-European-settlement levels by 2050. In recent years, significant progress has been made towards this goal.

A big success has been the Sea to Hume Dam fishways program, selected in 2009 as one of the top 25 Australasian ecological restoration projects by a panel set up by the journal *Ecological Management & Restoration*. Under the program, many fishways have been built at weirs and locks, allowing fish to swim freely along the Murray River. In another major initiative, snags (such as logs from dead trees) are being placed back in the river. They provide new habitat where fish can spawn, feed, and avoid predators.

However, there is still much to be done, and an important part of the rehabilitation effort is to provide information about the Basin's fish species. Only a few species, such as the iconic Murray cod, golden perch, silver perch and freshwater catfish, are widely recognised. Populations of these species have declined in recent decades, as have those of the trout cod and Macquarie perch, previously popular targets for anglers. The smaller fish species, such as galaxiids, gudgeons and hardyheads, are less well known, but the populations of these species have also declined.

Fishes of the Murray–Darling Basin: an introductory guide is the first book to focus solely on the Basin's fish. Originally published in 2007, it is now being reprinted to meet continuing demand.

In addition to providing a wealth of information, the book also identifies areas where there are information gaps. As readers of this book, you can not only get to know the Basin's fish better, but you may be able to provide vital information to fill some of these gaps, and to help restore our native fish populations (see page 15). Many exciting discoveries remain to be made.

Rob Freeman

Chief Executive

Murray–Darling Basin Authority

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Acknowledgements

Thanks to the many colleagues who provided unpublished data or comments on individual species accounts, particularly Paul Brown, Brendan Ebner, Dean Gilligan, Michael Hammer, Paul Humphries, Michael Hutchison, Mark Kennard, Alison King, John Koehn, Leighton Llewellyn, David Moffatt, Tarmo Raadik and Peter Unmack. Of course, any errors or omissions are entirely the fault of the author.

Various MDBC staff contributed to the production of this book: Sheridan Lockerbie facilitated the collection of the photos, and Dean Ansell, Jim Barrett, and Craig Boys all provided assistance in preparing or sourcing illustrations, commenting on text and generally massaging the process to ensure this book was produced. Thanks also to Richard Allan and Kris Kleeman for assistance with mapping. Special thanks to my family, particularly Lucy, who once again tolerated me locking myself away at nights and on weekends to write.

The photographs of the fish are worth a thousand words—thanks to Gunther Schmida, Neil Armstrong, and Michael Hammer for their stunning images.

About the author

Mark Lintermans has more than 20 years experience as a fisheries ecologist and has written over 100 papers and reports. His major interests are the ecology and management of threatened species, and the interaction of native and alien fish species. Mark completed a Master's degree at The Australian National University on the ecology of the Two-spined Blackfish and has carried out extensive surveys and ecological studies on fish of the high country. He has worked as a fisheries scientist for the ACT Government, the Cooperative Research Centre for Freshwater Ecology, the Invasive Animals Cooperative Research Centre, and the Murray-Darling Basin Commission. He is currently the President of the Australian Society for Fish Biology. Mark grew up in Melbourne, is a passionate supporter of the Collingwood Football Club, and hopes he will live long enough to see them win back-to-back premierships. This is his second book, the first being a field guide to aquatic fauna of the high country and southern tablelands.

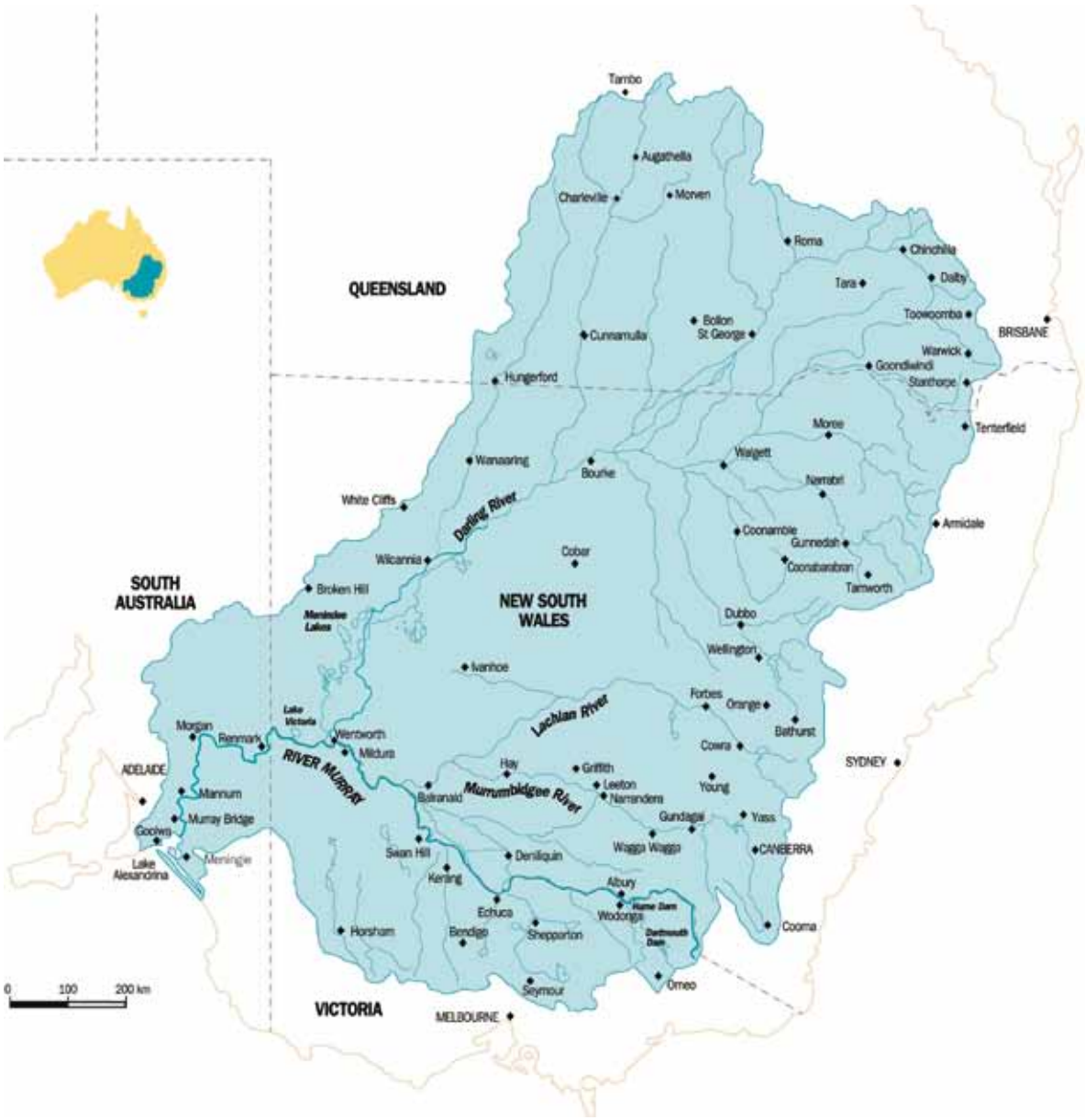
About this book

This is the first book devoted solely to the fish of the Murray-Darling Basin (MDB). Other books have included information on Murray-Darling Basin fish communities in broader regional (southeast Australia) or national compilations, but many of these are out of print and difficult to obtain. There are some excellent regional field guides available (see page 14), but nothing that covers the entire fish fauna of the MDB. When you consider that the MDB contains the three longest rivers in Australia (Murray, Darling and Murrumbidgee) (Fig 1), covers more than 1 million km^2 (14 per cent of the country's total area), and that in 1983–84 it accounted for almost 60 per cent of the nations water use, it is surprising that a book on MDB fish has not appeared sooner.

Hopefully, this book will provide information to anglers, naturalists, students, scientists and managers on the diversity, distribution and ecology of the native and alien fish of the Basin. The main text describes each freshwater species that occurs in the Basin, its common and scientific name (and alternative common names in brackets), where it occurs, how to identify it, what habitats it utilises, and aspects of its ecology. For native species, the threats to its survival are listed and for alien species, the impacts on native species are outlined. For each species, a list of references for further information is provided, although due to limitations on space, this is not exhaustive. A glossary of terms used in the text is also provided.

The distribution maps for each species show the boundaries of the 23 river valleys (as defined in the Sustainable Rivers Audit), and where confirmed records exist for each fish species. Records were sourced from State and Territory fisheries agencies, museums, scientific papers and the MDBC. There is often a considerable delay in entering data into government databases, so the records displayed on the maps may not include recently collected data. Species occurrence records collected before 1980 are distinguishable from later records, to give an indication of how the distribution of a species has changed since that date. The shaded areas on the distribution maps indicate the river valleys and altitudinal zones where the species has been collected. Each river valley has two to four altitudinal zones, as defined in the fish theme of the Sustainable Rivers Audit. These zones are lowland (<200 m altitude), slopes (200–400 m altitude), upland (400–700 m altitude) and montane (>700 m altitude). Not all zones occur in a river valley, with the montane zone not distinguished where it occupies less than 7.5 per cent of the valleys stream network. Where a species occurs in a valley zone as a result of a translocation (possibly followed by natural spread from the translocation site), a different colour of shading is used.

Occasionally vagrant individuals are recorded outside their normal distribution range (e.g. in a flood year), and the valley zones for these vagrant records have not been shaded in this book. For some valleys (e.g. the Castlereagh), there is almost no information in State agencies or museums on the fish fauna. Consequently, there are gaps in the shaded distributional range for many species in such valleys. Hopefully such data gaps will stimulate further investigation into the fish fauna of these valleys.

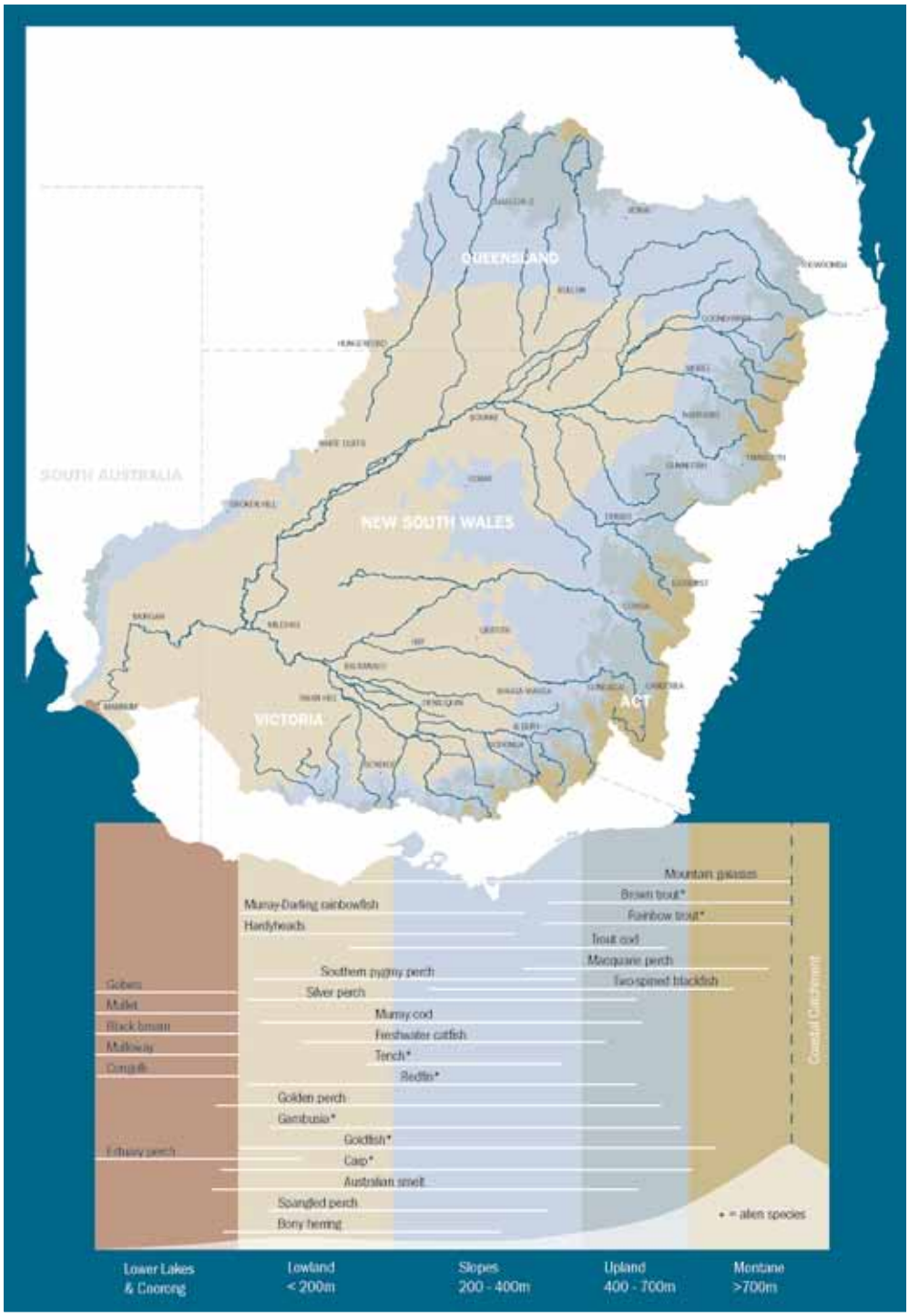

Tambo
Augathella
Charleville
Morven
Roma
Chinchilla
Tara
Dalby
Toowoomba
BRISBANE
Bollon
St George
Cunnamulla
Warwick
Goondiwindi
Stanthorpe
Hungerford
QUEENSLAND
Moree
Terrerfield
Wanaaring
Bourke
Walgett
Narrabri
White Cliffs
Darling River
Armidale
Coonamble
Gunnedah
Wilcannia
Cobar
Coonabarabran
Tamworth
SOUTH AUSTRALIA
Broken Hill
NEW SOUTH WALES
Menindee Lakes
Dubbo
Wellington
Ivanhoe
Forbes
Orange
Lachlan River
Lake Victoria
Morgan
Renmark
Wentworth
Bathurst
Cowra
RIVER MURRAY
Mildura
SYDNEY
ADELAIDE
Hay
Griffith
Leeton
Young
Mannum
Balranald
Murrumbidgee River
Narrandera
Murray Bridge
Gundagai
Yass
Goolwa
Swan Hill
Deniliquin
Wagga Wagga
CANBERRA
Meningie
Lake Alexandrina
Kerang
Albury
Echuca
Hume Dam
Wodonga
Horsham
Bendigo
Shepparton
Dartmouth Dam
Cooma
Seymour
Orneo
0
100
200 km
VICTORIA
MELBOURNE

The Murray-Darling Basin

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 kilometres 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 redgum 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 per cent of the Basin's area, contributes only 0.4 per cent of its mean annual runoff. By contrast, the upper Murray catchment occupies only 1.4 per cent of the Basin's area, but contributes 17.3 per cent of mean annual runoff.



Approximate altitudinal distribution of a number of fish species in the Murray-Darling Basin.

Introduction

Fish are the most diverse vertebrate group, with more than 30,000 species known worldwide. Australia only has about 300 species of freshwater fish—a very small number for such a large continent. By comparison, the much smaller countries of New Guinea and Japan have more than 300 and 120 species of freshwater fish, respectively. Hence, the Australian freshwater fish fauna is often described as depauperate or impoverished. The longest river system in Australia, the Murray-Darling, has only 46 or so native fish species, whereas the Mississippi-Missouri system has more than 370 native species and the Amazon Basin some 1,300 species described so far. The relatively low number of Australian freshwater fish species is related to this country's long isolation from other continents, low rainfall and high proportion of arid areas (e.g. deserts). Although no Australian freshwater fish species has become extinct since European settlement, approximately 40 per cent of the Australian freshwater fish fauna is now considered of conservation concern. Many species have either suffered a significant decline in distribution, or are now found only in restricted areas.

The Murray-Darling system has a high proportion of alien species—12 of the 57 fish species are alien or translocated. Alien fish now make up about 70 per cent of the numbers and 80–90 per cent of the biomass of fish in many rivers.

Genetic studies are now recognising a number of previously undescribed fish species in the Basin. For instance, the Mountain galaxias and Australian smelt are now known to contain a number of previously undescribed species (four of which occur in the MDB). Similarly, increasing survey effort has recently documented the presence of species not previously known from the Basin (e.g. Rendahl's tandan, Desert rainbowfish and the Yarra pygmy perch). Consequently, the number of species known from the Basin is expected to rise in future years.

The fish species presently known from the Murray-Darling Basin are listed in Table 1. Some of the fish species in the Basin are both native to the Basin and translocated, meaning that some of the catchments they occur in are not part of their natural distribution. Examples include the Common galaxias, which has been introduced to the Wimmera catchment in Victoria through transfers of irrigation water from coastal streams, and the Freshwater catfish, which has been stocked in a number of lakes outside their normal range.

In this book, the carp gudgeons are treated as a group. Recent genetic studies have shown that there are at least four species present, as well as a range of hybrids. Similarly, Mountain galaxias are treated as a single species even though two new species (Riffle galaxias and Obscure galaxias) are likely to be described in the near future.

Not all species occur at all sites: some are restricted to the warmer northern waters (e.g. Spangled perch, Hyrtl's tandan) and others to southern locations with access to the sea (e.g. Common galaxias, Congolli, lampreys). Fish communities also change with altitude: some fish are upland species (trout, Two-spined blackfish), some lowland (Golden perch, Freshwater catfish), and others occupy a range of altitudes (see figure opposite). Generally, the higher the altitude, the less fish species are present. This is because there is lower habitat diversity at high altitudes (e.g. no large floodplains or billabongs) and species with marine phases in their lifecycle are usually not present.

Table 1. Fishes of the Murray-Darling Basin (N = native; T = translocated; A = alien).

Family	Scientific name	Common name	Origin
Mordaciidae	*Mordacia mordax*	Short-headed lamprey	N
Geotriidae	*Geotria australis*	Pouched lamprey	N
Anguillidae	*Anguilla australis*	Short-finned eel	N/T
Anguillidae	*Anguilla reinhardtii*	Long-finned eel	N/T
Clupeidae	*Nematalosa erebi*	Bony herring	N
Galaxiidae	*Galaxias brevipinnis*	Climbing galaxias	N/T
Galaxiidae	*Galaxias fuscus*	Barred galaxias	N
Galaxiidae	*Galaxias olidus*	Mountain galaxias	N
Galaxiidae	*Galaxias sp.1*	Obscure galaxias	N
Galaxiidae	*Galaxias sp. 2*	Riffle galaxias	N
Galaxiidae	*Galaxias maculatus*	Common galaxias	N/T
Galaxiidae	*Galaxias rostratus*	Flat-headed galaxias	N
Galaxiidae	*Galaxias truttaceus*	Spotted galaxias	N/T?
Retropinnidae	*Retropinna semoni*	Australian smelt	N
Plotosidae	*Porochilus rendahli*	Rendahl's tandan	N
Plotosidae	*Neosilurus hyrtlii*	Hyrtl's tandan	N
Plotosidae	*Tandanus tandanus*	Freshwater catfish	N/T
Atherinidae	*Craterocephalus amniculus*	Darling River hardyhead	N
Atherinidae	*Craterocephalus fluviatilis*	Murray hardyhead	N
Atherinidae	*Craterocephalus stercusmuscarum fulvus*	Un-specked hardyhead	N
Atherinidae	*Atherinosoma microstoma*	Small-mouthed hardyhead	N
Melanotaeniidae	*Melanotaenia fluviatilis*	Murray-Darling rainbowfish	N
Melanotaeniidae	*Melanotaenia splendida tatei*	Desert rainbowfish	N
Ambassidae	*Ambassis agassizii*	Olive perchlet	N
Percichthyidae	*Macquaria ambigua ambigua*	Golden perch	N
Percichthyidae	*Macquaria australasica*	Macquarie perch	N
Percichthyidae	*Macquaria colonorum*	Estuary perch	N
Percichthyidae	*Maccullochella macquariensis*	Trout cod/Bluenose cod	N
Percichthyidae	*Maccullochella peelii peelii*	Murray cod	N

Family	Scientific name	Common name	Origin
Terapontidae	*Bidyanus bidyanus*	Silver perch	N
Terapontidae	*Leiopotherapon unicolor*	Spangled perch	N
Nannopercidae	*Nannoperca australis*	Southern pygmy perch	N
Nannopercidae	*Nannoperca obscura*	Yarra pygmy perch	N
Gadopsidae	*Gadopsis bispinosus*	Two-spined blackfish	N
Gadopsidae	*Gadopsis marmoratus*	River blackfish	N
Bovichtidae	*Pseudaphritis urvillii*	Congolli	N
Eleotridae	*Philypnodon grandiceps*	Flat-headed gudgeon	N
Eleotridae	*Philypnodon macrostomus*	Dwarf flat-headed gudgeon	N
Eleotridae	*Mogurnda adspersa*	Southern purple-spotted gudgeon	N
Eleotridae	*Hypseleotris klunzingeri*	Western carp gudgeon	N
Eleotridae	*Hypseleotris sp.*	Midgley's carp gudgeon	N
Eleotridae	*Hypseleotris sp.*	Lake's carp gudgeon	N
Eleotridae	*Hypseleotris sp.*	Murray-Darling carp gudgeon	N
Gobiidae	*Pseudogobius olorum*	Western blue-spot goby	N
Gobiidae	*Afurcagobius tamarensis*	Tamar goby	N
Gobiidae	*Tasmanogobius lasti*	Lagoon goby	N
Salmonidae	*Salmo trutta*	Brown trout	A
Salmonidae	*Salmo salar*	Atlantic salmon	A
Salmonidae	*Salvelinus fontinalis*	Brook char	A
Salmonidae	*Oncorhynchus mykiss*	Rainbow trout	A
Cyprinidae	*Cyprinus carpio*	Carp	A
Cyprinidae	*Carassius auratus*	Goldfish	A
Cyprinidae	*Tinca tinca*	Tench	A
Cyprinidae	*Rutilus rutilus*	Roach	A
Cobitidae	*Misgurnus anguillicaudatus*	Oriental weatherloach	A
Poecilidae	*Gambusia holbrooki*	Eastern gambusia	A
Percidae	*Perca fluviatilis*	Redfin perch	A

Current state of fish populations

In the past 50 years, populations of native fish species in the Murray-Darling Basin have suffered serious declines in both distribution and abundance. These declines reflect the poor state of the river system and the impacts of human use. A group of expert fisheries and riverine ecologists estimated the fish communities currently in the Basin to be about 10 per cent of their levels before European settlement. Without intervention, they predicted this is likely to fall to near 5 per cent in the coming 40 to 50 years. The types of recent information that the group could draw upon to produce this assessment included:

- the 93 per cent and 74 per cent decline between 1940 and 1990 in the numbers of Silver perch and Golden perch respectively passing through Euston Weir;
- the fact that more than half of the Basin's native fish species are now listed as threatened or of conservation concern (Table 2);
- the decline in the commercial catch of Murray cod in NSW from approximately 74 tonnes/year in the late 1940s to 9.5 tonnes/year in the early 1990s;
- the presence of 11 alien species which comprise 80–90 per cent of fish biomass at many sites in several rivers;
- rapid decline in the conservation status of 'flagship' species such as Silver perch, Freshwater catfish and Murray cod across the Basin; and
- localised extinction of some native fish species.

Conservation status

Twenty-six of the 46 native species in the Basin are recognised as either rare or threatened on State, Territory or National listings (Table 2). No fish species has become extinct in the Basin, (indeed no freshwater fish species has become extinct in Australia), but localized extinctions have occurred. The increasing number of cryptic species currently being described from genetic investigations means it is almost certain that some species will have been lost before they have been described, a sobering thought in a country that has a relatively depauperate freshwater fish community. A number of Basin fish communities are also listed as threatened. In NSW, three aquatic ecological communities are listed as endangered (the lower Murray, lower Darling, and lower Lachlan), and in Victoria the Lowland Riverine Fish Community of the Southern Murray-Darling Basin is listed as threatened.

Table 2. Threatened fish species in the Basin, according to State, Territory and National listings.

Common name	ACT	NSW	Vic	SA	Qld	National[1]
Mountain galaxias				[R]		
Barred galaxias			L {CE}			EN
Spotted galaxias				[R]		
Two-spined blackfish	VU					
Northern river blackfish				PROT [EN]		
Estuary perch				[EN]		
Macquarie perch	EN	VU (EN[2])	L {EN}	[EN]		EN
Golden perch			{VU}			
Murray cod			L {EN}	[R]		VU
Trout cod	EN	EN	L {CE}	PROT [EN]		EN
Freshwater catfish			L {VU}	PROT [V]		
Silver perch	EN	VU	L {CE}	PROT [V]		
Short-finned eel				[R]		
Short-headed lamprey				[EN]	EX	
Pouched lamprey				[EN]		
Congolli				[R]		
Dwarf flat-headed gudgeon				[R]		
Western carp gudgeon				[R]		
Murray-Darling carp gudgeon				[R]		
Southern purple-spotted gudgeon		EN POP (EN[2])	L {EX}	PROT [EN]		
Olive perchlet		EN POP	L {EX}	PROT [EN]		
Southern pygmy perch		VU (EN[2])		PROT [EN]		
Yarra pygmy perch			L			VU
Murray hardyhead		EN (CE[2])	L {EN}	[EN]		VU
Un-specked hardyhead			L	[R]		
Murray-Darling rainbowfish			L	[R]		

Key: CE = critically endangered; EN = endangered; EN POP = endangered population; EX = extinct in the wild; V = vulnerable; R = rare

L = listed under the *Victorian Flora & Fauna Guarantee Act 1988*; {xx} = conservation status under 2003 advisory listing in Victoria.

PROT = protected under *SA Fisheries Act 1982*; [xx] = status proposed in SA under the *Department of Environment & Heritage 2003 Discussion Paper*.

1 National status under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC).

2 Proposed status in NSW as at May 2007

Why have fish populations declined in the Basin?

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 Basin are summarised in Table 3.

Table 3. Major threats to native fish in the Basin.

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; 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
Diseases	Outbreak and spread of Epizootic Haematopoietic Necrosis 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.

Flow regulation

The regulation of almost all of the Basin's rivers to provide water for irrigation and other purposes has greatly affected native fish populations. Damming, storage, extraction and regulated flow procedures:

- severely reduce available water;
- alter and sometimes reverse the normal seasonal flow pattern;
- result in periods of unnaturally constant flow;
- reduce the occurrence of small to medium sized floods;
- reduce the size, rate of rise and duration of flood events;
- reduce the occurrence of low flows due to unseasonal irrigation releases;
- convert open-flowing riverine environments to a sequence of pools because of the construction of weirs; and
- cause parts of wetlands and floodplains to be continually saturated (waterlogged) rather than experiencing a wetting and drying period.

These conditions affect water quality and change the flow-related triggers for fish movement, recolonisation and spawning. They also reduce habitat diversity and the flows necessary for fish breeding, recruitment and occupancy. As a result, native fish species diversity and abundance has decreased in rivers. In addition, evidence is emerging that substantial numbers of larval and small fish are removed from waterways with water extracted or diverted by pumps and irrigation canals. These fish usually end up in unsuitable habits and are effectively lost from the river.

Habitat degradation

There are many different types of aquatic systems in the Basin, such as floodplains, upland and lowland rivers, wetlands, billabongs and lakes. Each of these systems contains many habitats such as weed beds, undercut banks, rocks, logs and bank vegetation, and it is these habitats that provide essential shelter, resting areas, spawning sites and food sources for fish.

These habitats and the fish populations they support have been greatly affected by the removal of snags and riverside vegetation, realignment or reconstruction of river banks, invasion of alien plants such as willows and other pest aquatic plants, and greater input of sediment from eroding streams. All of these human-related processes degrade important fish habitats: increased sediment smothers spawning sites and reduces food abundance; removal of snags and undercut banks means loss of shade and shelter from predators and the river current; loss of bank vegetation results in less shade, lowered nutrient input for fish-food production and warming of the water. Even if all the alien fish species could be magically removed, and normal flow patterns reinstated, many habitats could not revert to their pre-European condition. If native fish populations are to recover, instream and riparian habitats must be actively rehabilitated.

Lowered water quality

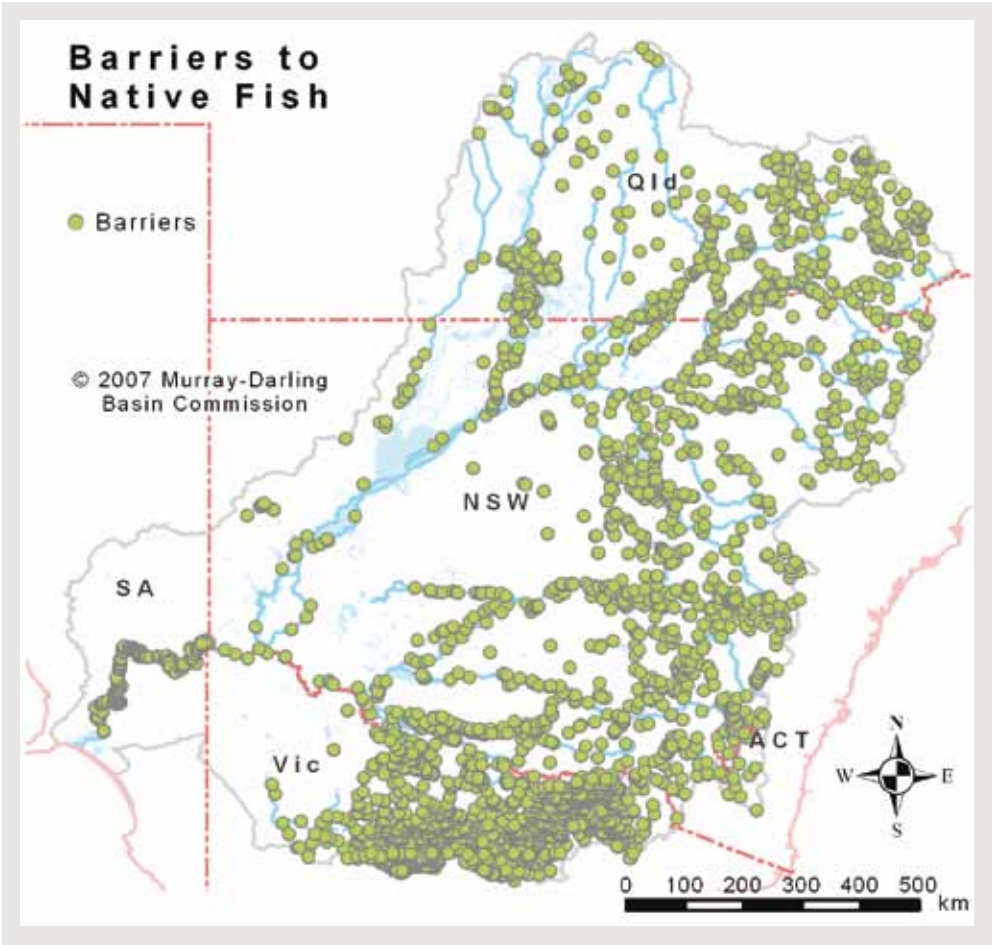
Many factors have contributed to the decline of water quality in the Murray-Darling Basin. Significant changes to water quality include increasing salinity levels, agricultural chemicals, and discharges from industries and sewage treatment works. Whilst many adult fish are tolerant of increased salinity, eggs or larvae have been shown to be highly susceptible, resulting in greatly lowered survival of these early life stages. The latest threat is the addition of endocrine-disrupting chemicals to waterways. These chemicals either disrupt normal hormone function, or mimic hormones to give an unnatural response. One group of endocrine disruptors is the environmental oestrogens, which can mimic the female hormone, oestrogen. Major sources of environmental oestrogens are pesticides, detergents and prescription drugs such as antibiotics and the contraceptive pill. These chemicals flow into waterways via runoff from agriculture or discharge of treated sewage effluent. Overseas research indicates that exposure to environmental estrogens can alter sex ratios or feminise aquatic species, particularly fish. Potentially, this has a severe impact on the ability of the species to reproduce successfully.

Many native fish species use increasing water temperature as a cue to commence spawning. The quality of water released from dams may be a problem if drawn from lower levels in the reservoir where it is usually much colder than the surface waters. The release of cold water during the breeding season can inhibit migration or spawning of native fish, and if releases of cold water are regular and persistent, native fish may not breed at all. Similarly cold-water pollution can slow the growth of juvenile fish, which exposes them to higher predation risk for a greater period of their life.

Barriers to fish movement

Many fish use different parts of a river system at different stages in their life cycle. The presence of dams, weirs and other barriers on rivers or floodplains stops fish moving from one part of a stream to another. Such movements may be necessary for feeding, breeding or other reasons. For example, Macquarie perch can live and feed in still waters such as lakes and reservoirs, but must move into flowing waters to breed. If access to flowing waters is not available, the population will die out. Barriers also prevent recolonisation of streams by fish after local 'catastrophes' or depletion. Barriers such as regulators in lowland forests have been shown to restrict movement of fish between floodplains and rivers, and structures such as levee banks also isolate floodplains from their rivers.

Approximately 4,000 barriers are documented across the Basin. Fishways of different kinds exist on about 55 of the barriers, but many are poorly designed and offer only limited fish passage.



There are approximately 4,000 barriers to fish passage in the Basin.

The impacts of structures on downstream movement of fish have also recently been recognized as an issue in the Basin. There is evidence that adult fish actively avoid going over weirs and that weir pools and dams may not provide optimal habitat for larval fish, which drift downstream. Recent research has shown that mortality of fish larvae is higher for some weir types than others. More study is required of the requirements of fish for downstream movement.

Alien species

The Basin already contains at least 11 alien fish species and 1 translocated species, some considered pests and others providing valuable recreational fisheries. The abundance and attributes of certain alien fish continue to cause damage to habitats and populations of native species. The risk of further introductions into the Basin—especially from aquariums and nearby rivers outside the Basin—also needs to be considered.

There is growing evidence of the detrimental impact of Carp on native fish species and the aquatic environment. In the 40 years since their illegal release into Lake Hawthorn, near Mildura, Carp are now estimated to account for 70–90 per cent of fish numbers in some rivers of Murray-Darling Basin. However Carp are not the only problem species. Redfin perch, trout and Eastern gambusia all have significant impacts on native fish through competition, predation or introduction of diseases and parasites.

The focus of all management of alien fish species should be on reducing their impacts on native species rather than on complete eradication of numbers. The best approach to reducing such impacts is an integrated one that combines a range of techniques. For example, an alien fish control program could include rehabilitating the wetting and drying cycles for floodplain wetlands, commercial exploitation, preventing access to spawning areas, and the installation of screens to prevent spread into uninfested areas. There is unlikely to be one 'silver bullet' that can solve any single alien species problem. Control of alien species needs to be part of an overall river rehabilitation process.

Diseases

The introduction of alien species has also brought a number of pathogens and diseases that affect native fish. Both exotic and endemic disease outbreaks have potentially devastating effects on native fish populations. Our knowledge of fish diseases and parasites is far from complete.

Redfin perch are the main host for Epizootic Haematopoietic Necrosis Virus (EHNV). This virus, unique to Australia, was first isolated in 1985 on Redfin perch. The virus also affects trout

Secondary bacterial infection of *Lernaea* attachment sites.

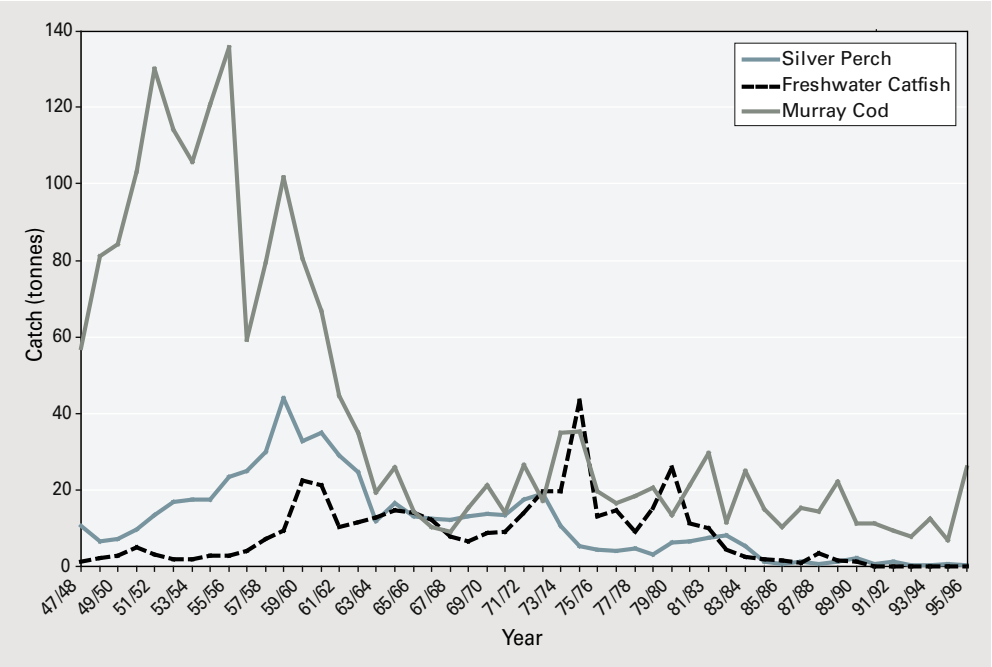
species, which can act as vectors to spread the disease. Experimental work has demonstrated that a number of native fish species (including Macquarie perch, Silver perch and Mountain galaxias) are extremely susceptible to the disease, but many native fish species have not been tested. Once EHNV has been recorded in a water body it is considered impossible to eradicate.

Carp or Redfin perch is suspected of introducing the parasitic Anchor worm (*Lernaea* sp). This parasite has been recorded on introduced trout species, Carp and Goldfish in the Basin, as well as many native fish species, including Murray cod, Golden perch, Silver perch, Macquarie perch, River blackfish, Freshwater catfish, Southern pygmy perch and Mountain galaxias. Similarly, Carp or Eastern gambusia are considered the source of the Asian fish tapeworm *Bothriocephalus acheilognathi* which has recently been recorded from carp gudgeons in the Canberra region. This is the first Australian record of this parasite, which is known to cause high levels of mortality in juvenile fish overseas, and may have similar effects on local native species.

Exploitation

Long before European settlement, native fish species provided an important source of food for Aboriginal people. Large quantities were harvested and some of the fish traps used are still to be seen along the Darling River. Large quantities were also harvested by European settlers in the early to mid-19th century, but there was a rapid decline in the catch through the latter part of the last century and the early years of this century. In 2003, commercial fishing for native species ceased in the Basin's rivers, although there is still a commercial fishery in the Lower Lakes near the Murray mouth.

Aboriginal fish traps in the Barwon River at Brewarrina.



Decline in commercial catches of Murray cod, Freshwater catfish and Silver perch in NSW between 1947 and 1996 (Source: Reid *et al*. 1997).

Commercial and recreational fishing have contributed to the decline of several freshwater native fish species, such as Trout cod, Macquarie perch, Murray cod and blackfish. Overfishing is not always the primary reason for the decline of a species, but it may prevent populations of threatened fish from recovering. Closed seasons, bag, size and gear limits are designed to prevent overfishing, but illegal fishing is still a significant threat to some species. Overfishing is generally not involved in the decline of smaller species, although the harvesting of some small fish as bait may lead to localised declines.

Translocation and stocking

Fish stocking (the release of hatchery-bred fish) plays an important role in managing recreational fisheries. Stocking enables the development of fish populations in habitats that cannot naturally sustain such populations, for example, in man-made lakes without spawning streams, or in rivers upstream of barriers such as weirs or dams. The composition and evolution of native fish communities can be threatened by the liberation of native and alien fish outside their natural range or from hatcheries. To minimise this risk, appropriate guidelines and codes of practice are being developed. However, while some States do have guidelines in place, it is very difficult to verify whether the guidelines are being followed.

Natural populations of native fish are also at risk from the potential release of genetically restricted individuals from native fish aquaculture operations using limited numbers of brood stock. The release of these individuals has potential to reduce the genetic fitness and hence viability of fish populations. Aquaculture is a rapidly developing industry throughout the Murray-Darling Basin. Measures to protect native fish from adverse impacts need to keep pace with this development.

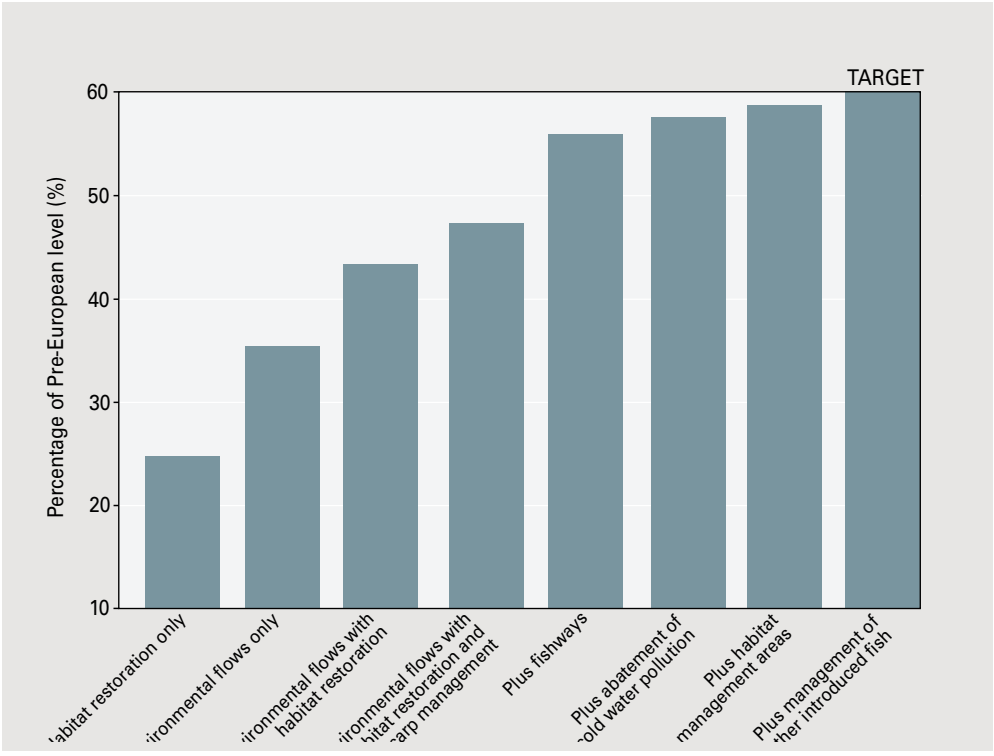
What is being done to help native fish in the Basin?

In 2002 the Murray-Darling Basin Commission instigated the Native Fish Strategy (NFS). The overall goal of the NFS is to rehabilitate native fish communities in the Murray-Darling Basin back to 60 per cent or better of their estimated pre-European settlement levels after 50 years of implementation.

The Strategy seeks to achieve its goal by implementing six driving actions that include management, research and investigation, and community engagement interventions. These are:

- rehabilitating fish habitat;
- protecting fish habitat;
- managing riverine structures;
- controlling alien fish species;
- protecting threatened native fish species; and
- managing fish translocation and stocking.

Experts believe that if only one strategic intervention were to occur, such as allocation of environmental flows, this may help to recover native fish populations to about 25 per cent of their estimated pre-European settlement levels. The actions will also assist (at least in part) with the restoration of listed threatened fish and fish communities. If a number of interventions are implemented—such as allocation of environmental flows, habitat rehabilitation, abatement of cold-water pollution, improved land-use management practices, provision of fish passage, and management of alien fish—in an integrated way, then it is believed that the goal of this Strategy is achievable.



While single interventions, such as environmental flow and habitat restorations will improve fish communities, the most significant positive impact will occur through a combination of interventions which address a range of problems

Other activities, such as the Sustainable Rivers Audit (SRA), are providing a clearer picture of the health of our rivers, their fish populations, and how they are responding to management activities. Every three years the SRA will sample fish populations in each of the Basin's 23 river valleys, greatly improving knowledge of the distribution and relative abundance. This information on fish (along with other environmental indicators such as aquatic macroinvertebrates and hydrology) will be used as part of a standardised assessment to compare river health across the Basin.

Also, as part of the MDBC Native Fish Strategy and Living Murray initiatives, a program has commenced to construct fishways at major barriers on the Murray River between Lake Hume and the sea.

Fishway at Torrumbarry Weir on the Murray River

Where to get more information

Fisheries or conservation agencies in each State and Territory offer a variety of information on their fish resources, threats, and research and management activities underway. The Murray-Darling Basin Commission also publishes information on the fish resources of the Basin. A list of relevant web sites is provided in Appendix 1. There are several local or regional field guides or reports available on fish in the Basin, and these provide information on local issues and status. Such guides exist for:

Queensland

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

ACT and Southern Tablelands

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

New South Wales

NSW Department of Primary Industries 2007. *What fish is this? A guide to freshwater fish in NSW*. NSW Department of Primary Industries, Wollongbar, NSW.

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.

South Australia

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.

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.

Victoria

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

Raadik, T.A. and Backhouse, G. (in press). *Field Guide to the Freshwater Fishes and Decapod Crustaceans of Victoria*.

What can you do to help?

Protection of the riparian zone helps to maintain a healthy aquatic environment. Riparian zones provide shade, instream 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 fertilizers before they enter the stream. So, if you are camping or picnicking beside a stream, leave logs on the floodplain for fish to use 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, minimizing runoff of agricultural chemicals such as herbicides and fertilizers, controlling invasive weeds and protecting wetland habitats. Get involved in local catchment and environmental activities such as Landcare.

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 Basin 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.

Further reading

General

Cadwallader 1978; Harris & Gehrke 1997; McDowall 1996d; MDBC 2004a; Morris *et al.* 2001; Treadwell & Hardwick 2003; Young 2001.

Flow regulation

Baumgartner *et al.* 2007; Gehrke *et al.* 1995; Kingsford 2000; Lloyd *et al.* 2003; Todd *et al.* 2002; Walker & Thoms 1993.

Habitat degradation

Lintermans *et al.* 2005; Nicol *et al.* 2001, 2004; Pusey & Arthington 2003; Rutherfurd *et al.* 2000; Scott 2001.

Lowered water quality

Astles *et al.* 2003; James *et al.* 2003; Phillips 2001; Ryan *et al.* 2003; Scott 2001; Todd *et al.* 2005.

Barriers to fish movement

Baumgartner *et al.* 2006; Lintermans & Phillips 2004; Mallen-Cooper *et al.* 1995; Stuart *et al.* 2005; Thorncraft & Harris 2000.

Alien species

Koehn *et al.* 2000; Koehn & McKenzie 2004; Jackson *et al.* 2004; Karolak 2006; Lintermans 2004; McDowall 2003, 2006.

Diseases

Bond 2004; Dove 1998; Dove *et al.* 1997; Langdon 1989.

Exploitation

Henry & Lyle 2003; Reid *et al.* 1997; Rowland 1989.

Stocking and translocation

Gillanders *et al.* 2006; Lintermans 2004; NSW Fisheries 2003; Phillips 2003; Todd *et al.* 2002.

How fish are grouped and named

Fish, like all known living things, are given a scientific name, which consists of two parts (three if it is a subspecies) and is usually written in italics (see Table 1). The first part is the generic name or genus to which a species belongs, and the second part is the specific or species name. For example the Macquarie perch *Macquaria australasica* belongs to the genus *Macquaria*, and is the species *australasica*. The generic name always begins with a capital letter, and the specific name starts with a lowercase letter.

Species that are closely related are placed in the same genus. For example, Macquarie perch and Golden perch are in the genus *Macquaria*. Closely related genera are placed in the same family, so that the similar perch (*Macquaria*) and freshwater cods (*Maccullochella*) are in the same family, the Percichthyidae. Family names always end in '-idae'. Closely related families are grouped into orders, orders are then grouped into classes, and classes are grouped into Phylums. For example all fish, mammals, reptiles, birds and frogs are in the Phylum Chordata, but fish are in the class Osteichthyes, the birds in Aves, reptiles in Reptilia, frogs in Amphibia and mammals in Mammalia. Consequently, the full classification for Macquarie Perch is:

- Phylum: Chordata (animals with a spinal chord)
- Class: Osteichthyes (bony fishes)
- Order: Perciformes (most marine and freshwater fishes)
- Family: Percichthyidae (freshwater perch, cod and bass)
- Genus: *Macquaria* (Australian freshwater perch and bass)
- Species: *australasica* (Macquarie perch)

Most species have a common name as well as a scientific name, but common names are not standardised, which can cause confusion. For example Golden perch is also known as 'Yellowbelly', or, in South Australia, 'Callop'. Species found in several countries or continents—such as alien fish or migratory birds—often have many different common names, but always the same scientific name.

Scientific names are often followed by the names of the authors who first formally described the species and the year that the species was described. For example, *Macquaria australasica* Cuvier, 1830, means that the ichthyologist Cuvier first described Macquarie perch as a species in 1830. Sometimes the name and the year are enclosed in brackets, e.g. Trout cod *Maccullochella macquariensis* (Cuvier, 1829). This means that whilst Cuvier first described Trout cod in 1829, its scientific name has changed since he described it (he originally described it as *Gristes macquariensis*). Sometimes a species does not yet have a valid scientific species name because it has not been formally described, and if this is the case there is no name or year after the scientific name. An example was the Dwarf flat-headed gudgeon, *Philypnodon macrostomus*. This species was recognised for more than 25 years but has only recently been described, with many books listing it as *Philypnodon* sp. The 'sp.' is an abbreviation for 'species' and simply identifies that it was an unnamed species belonging to the genus *Phylipnodon.*

Similarly, a species may not have a specific name where there is confusion about the correct taxonomy. An example is the carp gudgeons *Hypseleotris* where there are thought to multiple species and hybrids present.

What do the scientific names mean?

Scientific names usually have a recognizable meaning, often based on Latin. For example, in *Gadopsis bispinosus* (Two-spined blackfish), *Gadopsis* means 'cod-like' (from the Latin name *Gadus*, the European cod) and *bispinosus* means 'two spined', referring to the usual number of spines in the dorsal fin, a distinguishing characteristic of the species. Sometimes the scientific name honours a person, place, or object. For example, the Murray cod is in the genus *Maccullochella*, named after the Australian fish biologist A. R. McCulloch, and its specific name is *peelii*, after the Peel River where the species was first collected.

Occasionally the meaning of old scientific names is not known, or there may be conflicting interpretations. The genus *Galaxias* is thought to refer to the abundance of spots on the fish, like a galaxy of stars, but some authors have proposed that it alludes to the abundance of the species.

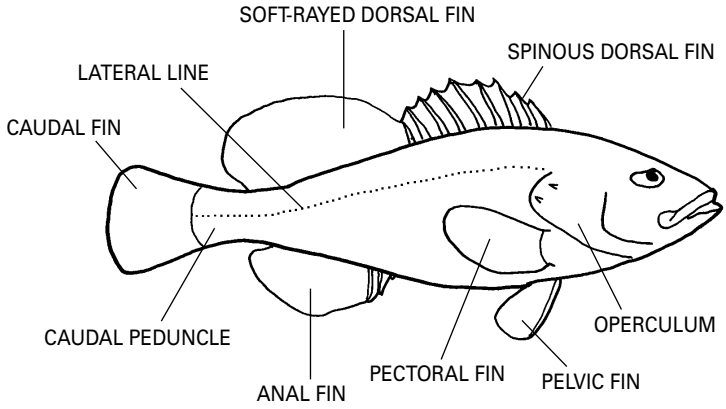
Scientific name	Meaning of generic name	Meaning of specific name
Ambassis agassizii	Small amount of French coinage (2 sous)—refers to its low worth as human food	After Jean Louis Rodolphe Agassiz, a Swiss ichthyologist
Anguilla australis	Eel	Southern
Anguilla reinhardtii		After Johann Reinhardt
Craterocephalus stercusmuscarum fulvus	Strong, sturdy or hard-headed	Fly spotted, yellow
Craterocephalus fluviatilis		From a river
Craterocephalus amniculus		Small creek or stream
Hypseleotris klunzingeri	A deep or tall gudgeon	After Carl Benjamin. Klunzinger, a German fish taxonomist
Mogurnda adspersa	Aboriginal name	Dotted
Philypnodon grandiceps	Toothed allied genus. Alternatively, *Philypnodon* means 'not a Philypnus' (Philypnus is an allied genus of goby)	Large headed
Philypnodon macrostomus		Large mouthed
Pseudaphritis urvillii	False allied genus	After Commander J.S.C. Dumont d'Urville, French explorer
Nematalosa erebi	Thread shad (a type of herring)	After the ship *HMS Erebus*
Gadopsis marmoratus	Cod-like	Marbled—refers to patterning
Gadopsis bispinosus		Two spined—refers to number of spines in the dorsal fin

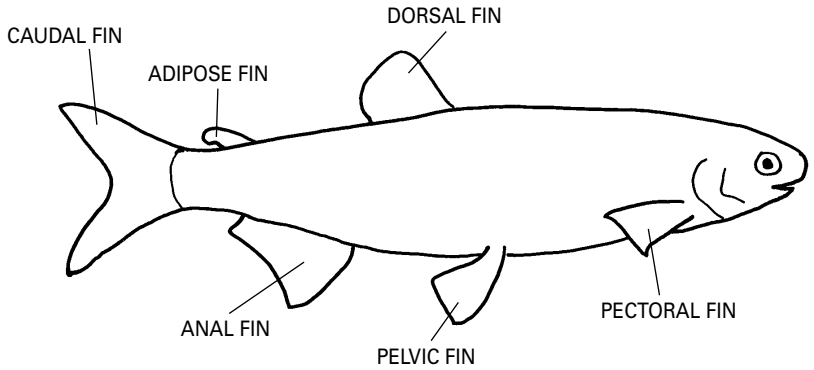
Scientific name	Meaning of generic name	Meaning of specific name
Galaxias rostratus	Galaxy—refers to markings on fish, which is often milky or strewn with dots of colour like tiny stars	Long nosed
Galaxias olidus		Emitting an odour, strong smelling
Galaxias brevipinnis		Short-finned
Galaxias truttaceus		Trout-like
Galaxias fuscus		Brown
Galaxias maculatus		Spotted
Geotria australis	Unknown	Southern
Nannoperca australis	Dwarf perch	Southern
Nannoperca obscura		Dark or indistinct (obscure)
Melanotaenia fluviatilis	Black band or ribbon—refers to markings on fish	From a river
Mordacia mordax	biting	Voracious
Maccullochella peelii peelii	After Allan Riverstone McCulloch, Australian icthyologist	After Peel River, NSW
Maccullochella macquariensis		After Macquarie River, NSW
Macquaria ambigua	After Governor Lachlan Macquarie	Doubtful
Macquaria australasica		After Australia
Macquaria colonorum		Relating to the colonies
Tandanus tandanus	Aboriginal name noted by explorer Thomas Mitchell	
Neosilurus hyrtlii	New catfish	After Joseph Hyrtl, Austrian anatomist
Porochilus rendahli	Holed lip—refers to position of the nostrils	After ichthyologist H. Rendahl who originally described the species
Retropinna semoni	Backward fin—refers to position of dorsal fin, far behind the ventral (pelvic) fins	After German naturalist Richard Semon
Bidyanus bidyanus	Aboriginal name noted by explorer Thomas Mitchell	
Leiopotherapon unicolor	Smooth shouldered teraponid—refers to lack of the typical prominent hump of grunters	One coloured

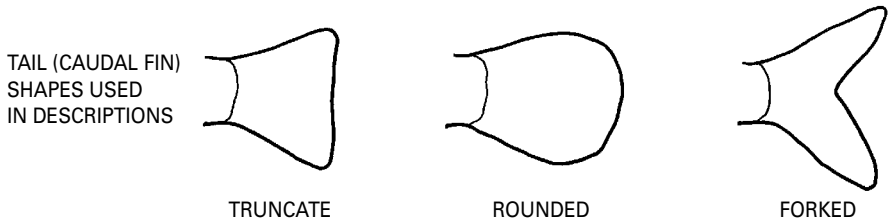
Scientific name	Meaning of generic name	Meaning of specific name
Atherinosoma microstoma	A small bony fish	Small mouthed
Afurcagobius tamarensis	Forkless goby	After the Tamar River, Tasmania
Pseudogobius olorum	False goby	Swan, referring to the Swan River, WA
Tasmanogobius lasti	Tasman goby	After Australian fish biologist Peter Last
Perca fluviatilis	Perch	From a river
Cyprinus carpio	Ancient name of the carp, probably derived from Cyprus, abode of Venus (highly fertile)	Carp
Carassius auratus	From the common name Karass, the European crucian carp	Golden or gilded
Tinca tinca	Tench	Tench
Rutilus rutilus	Red	Red
Gambusia holbrooki	Nothing, of little worth	After US naturalist John Holbrook
Salmo trutta	Salmon	Trout
Oncorhynchus mykiss	Hooked snout	*Mykiss* is presumably a derivative of *mikizha* or *mykz*, the Kamchatkan word for trout
Salmo salar	Salmon	Old name, from 'salio', to leap.
Salvelinus fontinalis	An old name for char	Living in springs
Misgurnus anguillicaudatus	Unknown	Eel tailed

Identifying fish

The fish included in this field guide can be readily identified by their body shape, colour and patterning, fin shape and fin positions. The illustrations below show the positions and names of the fins and other body parts mentioned in the species descriptions, as well as the shapes of the caudal fin as described in the text.







Key to fish species in the Murray-Darling Basin

To use this dichotomous key, start at number 1 and work down through using a process of elimination. For example, if your fish has neither jaws nor paired fins go to number 2; then, if it has no eyes go to number 4 and decide whether it is either a larval Short-headed lamprey or a Pouched lamprey.

1 No jaws or paired fins 2
Jaws and paired fins present 5

2 Eyes present 3
Eyes absent 4

3 Two large tricuspid teeth on oral disc above mouth; few teeth on oral disc; teeth sharp and in radial rows; eyes dorsolateral; fimbriae not present around oral disc . . . . . Short-headed lamprey (adult) . . . . Pg 28
One tooth on oral disc above mouth; numerous teeth on disc in blunt and in irregular spirals; eyes distinctly lateral; fimbriae present around oral disc . . . . . Pouched lamprey (adult) . . . . Pg 30

4 Snout to anterior margin of vent 83% or more of total length . . . . . Short-headed lamprey (ammocete) . . . . Pg 28
Snout to anterior margin of vent < 80% or more of total length . . . . . Pouched lamprey (ammocete) . . . . Pg 30

5 Dorsal, caudal and anal fins or caudal and anal fins continuous 6
Dorsal, caudal and anal fins separate 10

6 Fish very elongate and slender; no barbels around mouth 7
Fish not elongate and slender; barbells present 8

7 Dorsal fin commences just in front of anal fin; uniform colour without obvious markings . . . . . Short-finned eel . . . . Pg 32

Dorsal fin commences well in front of anal fin; colour distinctly blotched or mottled . . . . . Long-finned eel . . . . Pg 34

8 Eel-like tail fin extends along back at least 25% of body length . . . Freshwater catfish . . . . Pg 56
Eel-like tail fin restricted mostly to underside of body 9

9 Nasal barbel extending to, or behind back of head . . . . . Rendahl's tandan . . . . Pg 52
Nasal barbel barely reaching beyond eye . . . . . Hyrtl's tandan . . . Pg 54

10 Adipose fin present (may be very small) 11
Adipose fin absent 15

11 Dorsal fin origin in front of pelvic fin bases; body not semitransparent 12
Dorsal fin origin well behind pelvic fin bases; small, semitransparent body . . . . . Australian smelt . . . Pg 50

12 Leading edge of pectoral, anal and pelvic fins white with contrasting black line behind; body dark with paler spots or markings . . . . . Brook char . . . Pg 114
Leading edge of pectoral, anal and pelvic fins without distinctive markings; body pale with darker markings 13

13 Dark spots numerous and obvious on tail; usually a pink or red flush along head and side . . . . . Rainbow trout . . . Pg 116
No or few spots on tail; no pink or red flush along sides 14

14 Dark spots on body usually surrounded by paler halos; often pale or reddish-orange spots on side; orange or red anterior margin on adipose fin; short and stout caudal peduncle (anal fin may reach tail base when pressed against caudal peduncle) . . . . . Brown trout . . . Pg 110
Dark spots on body not surrounded by pale halo; no pale or reddish-orange spots on side; no orange or red anterior margin on adipose fin; long and slender caudal peduncle (anal fin does not reach tail base when pressed against caudal peduncle) . . . . . Atlantic salmon . . . Pg 112

15 Ventral surface of abdomen serrated due to presence of scaly scutes . . . . Bony herring . . . . Pg 36
Ventral surface not serrated 16

16 Jaws toothless 17
Jaws toothed (teeth may be very small) 21

17 Barbels present at corners of mouth 18
No barbels present at corners of mouth 20

18 Single short-based dorsal fin midway down body; small scales 19
Single long-based dorsal fin midway down body; large scales . . . . . Carp . . . Pg 118

19 Fish elongate and sinuous;
5 pairs of conspicuous barbells around mouth . . . . . Oriental weatherloach . . . Pg 126
Fish not elongate and sinuous;
1 small barbel at each corner of mouth . . . . . Tench . . . Pg 122

20 Long-based dorsal fin, (14–20 rays); 26–34 scales along lateral line . . . . Goldfish . . . Pg 120
Short-based dorsal fin (9–11 rays); 40–42 scales along lateral line . . . . . Roach . . . Pg 124

21 Pelvic fins reduced to a single indistinct spine; slender, divided ray located under the throat 22
Pelvic fins with 2 or more rays 23

22 1–3 (usually 2) small spines at front of dorsal fin . . . . . Two-spined blackfish . . . . Pg 90
6–13 spines at front of dorsal fin . . . . . River blackfish . . . . Pg 92

23 Single short dorsal fin with no obvious low point in middle . . . Eastern gambusia . . . Pg 128
Single dorsal fin with obvious low point; or two dorsal fins 24

24 Scales present 25
Scales absent 49

25 Pelvic fins joined to form a small cup 26
Pelvic fins separate, not forming a cup 28

26 Body largely without scales; first dorsal fin with 6–8 spines . . . . . Lagoon goby . . . Pg 106
Body fully scaled; first dorsal fin with 6 spines 27

27 Head without scales, none before first dorsal fin;
head distinctly depressed . . . . . Tamar goby . . . Pg 108
Head scaled on top and sides; head rounded . . . . . Western blue-spot goby . . . Pg 104

28 Two dorsal fins with distinct gap between fin bases 29
Single dorsal fin, may be notched in middle 40

29 Anal fin long-based, containing 17 or more rays 30
Anal fin not long-based, containing 13 or fewer rays 32

30 Elongated, tubular body; tail truncate; lateral line present . . . . . Congolli . . . . Pg 94
Body laterally compressed not elongated; tail forked;
lateral line absent 31

31 Operculum with pink to reddish spot; fins without
yellow and green chequered pattern . . . . . Murray-Darling rainbowfish . . . . Pg 66
Operculum without pink to reddish spot; fins
with yellow and green chequered pattern . . . . . Desert rainbowfish . . . . Pg 68

32 Deep-bodied with large head; red anal, pelvic and caudal fins;
6 or more vertical dark bands on the body;
adult generally > 150 mm total length . . . . . Redfin perch . . . Pg 130
Small (always < 150 mm) and elongate;
without red fins or dark vertical bands 33

33 Sturdy with non-protrusible mouth and truncate or rounded tail 34
Delicate, silvery-bellied, with protrusible mouth and forked tail 37

34 Head distinctly dorsventrally flattened; mouth large
(reaching to behind middle of eye) 35
Head rounded not flattened;
mouth small (not reaching to middle of eye) 36

35 Gill openings large, reaching forward to below eye;
pectoral rays usually 18–19;
commonly > 50 mm total length, reaching 110 mm . . . . . Flat-headed gudgeon . . . . Pg 96
Gill openings narrow, not reaching to below eye;
pectoral rays usually 15–16;
not exceeding 50 mm total length . . . . . Dwarf flat-headed gudgeon . . . . Pg 98

36 Robust, not laterally compressed, reaches 152 mm total length;
numerous brick-red spots on dorsal, anal and caudal fins;
tail rounded . . . . . Southern purple-spotted gudgeon . . . Pg 100
Small, laterally compressed, < 60 mm total length;
no brick-red spots on fins; tail truncate . . . . . carp gudgeons . . . Pg 102

37 Gill raker length more than half the diameter of the pupil;
anal fin with 7–12 rays;
only found in lower Murray . . . . . Small-mouthed hardyhead . . . . Pg 64
Gill raker length less than half the diameter of the pupil;
anal fin with 9 or less rays 38

38 Midlateral scale count > 37; transverse scale count 14–18;
if present, scales on top of head small, circular,
never large or irregular in shape . . . . . Darling River hardyhead . . . . Pg 58
Midlateral scale count rarely more than 38;
transverse scale count > 7;
scales on top of head always present, large and irregular in shape 39

39 Transverse scale count > 9 . . . . . Murray hardyhead . . . . Pg 60
Transverse scale count < 9 . . . . . Un-specked hardyhead . . . . Pg 62

40 Oval, laterally compressed; partly transparent body;
very large eye and forked tail; maximum fish length 76 mm . . . . . Olive perchlet . . . . Pg 70
Not as above 41

41 Lateral line discontinuous 42
Lateral line continuous 43

42 Lower, free edge of preorbital bone straight, edge strongly serrated;
body colour dusky brown-grey, paler on the belly; dark spots or
blotches along the midline; pelvic fins black in breeding males;
only found in Lake Alexandrina in lower Murray . . . . . Yarra pygmy perch . . . . Pg 88
Lower edge of preorbital bone hidden under skin, curved,
edge smooth; body colour creamish to green-brown,
paler on the belly; blotches on side but not in a row along
the midline; dorsal, anal and inner caudal fins bright red
in breeding males . . . . . Southern pygmy perch . . . . Pg 86

43 Pelvic fin origin distinctly behind the pectoral fin base; mouth small 44
Pelvic fin origin below or in front of pectoral fin base;
mouth large, reaching behind front margin of eye 45

44 Scales small, 70–90 along lateral line; head small;
mouth small, not reaching to front margin of eye;
silvery grey body with reticulated appearance but no spots or blotches;
tail weakly forked . . . . . Silver perch . . . . Pg 82
Scales medium size, 44–53 along lateral line; mouth large, reaching
back to anterior margin of eye; brown to steely blue body colour
with characteristic brownish red spots; tail truncate . . . . . Spangled perch . . . . Pg 84

45 Caudal fin very slightly forked; dorsal head profile concave; outer rays of pelvic fin grayish; only found in lower Murray ..... Estuary perch .... Pg 76
Caudal fin rounded; dorsal head profile deeply concave in adult fish 46

46 Head broad and dorsoventrally flattened; mouth very large; no conspicuous open pores on lower jaw; 63–82 scales in lateral line 47
Head deep and laterally compressed; mouth large; conspicuous open pores on lower jaw; 42–63 scales in lateral line 48

47 Lateral head profile straight; upper jaw overhangs lower; dark stripe through eye; body colour blue-grey with fine dark grey-black spotting ..... Trout cod .... Pg 78
Lateral head profile concave; jaws equal or lower jaw protruding; black eye-stripe may be present in juveniles, but not adults; body colour yellowish-green with coarser olive-green mottling ..... Murray cod .... Pg 80

48 Lower and upper jaw equal; large white eye; body colour almost black to dark bluish-grey, white on the belly; mouth extends to front margin of eye ..... Macquarie perch .... Pg 74
Lower jaw protruding; smaller, yellow eye; body colour olive green to lightish grey, belly lighter or golden yellow; mouth extends to middle of eye ..... Golden perch .... Pg 72

49 A distinct diagonal dark stripe extending from bottom of eye; body pattern with distinct, round, large, purplish spots ..... Spotted galaxias .... Pg 48
No distinct diagonal eye-stripe; no large, round purplish body spots 50

50 Large, distinct bluish-black blotch above base of pectoral fin; large pectoral fins positioned low on the body ..... Climbing galaxias .... Pg 38
No distinct, large bluish-black blotch above base of pectoral fin; pectoral fins not as above 51

51 Head bluntly rounded; anal fin usually originates behind middle of dorsal fin 52
Head flattened or bluntly pointed; anal fin originates directly below dorsal fin 53

52 Body an orange-yellow colour and always un-mottled; 1–10 complete or partial, vertical, ovoid black bars on the sides between the gill cover and just behind the pelvic fin origin; belly creamy yellow ..... Barred galaxias .... Pg 40
Body yellowish-green to brown; dorsal and lateral surfaces marked with grey-olive speckling, mottling or striping, from top of head to tip of caudal peduncle; belly silvery white ..... Mountain galaxias .... Pg 44

53 Head flattened; large mouth reaching to well below eyes; jaws equal or lower protruding ..... Flat-headed galaxias .... Pg 46
Head bluntly pointed, not flattened on top; small mouth reaching to front of eye; upper and lower jaws equal ..... Common galaxias .... Pg 42

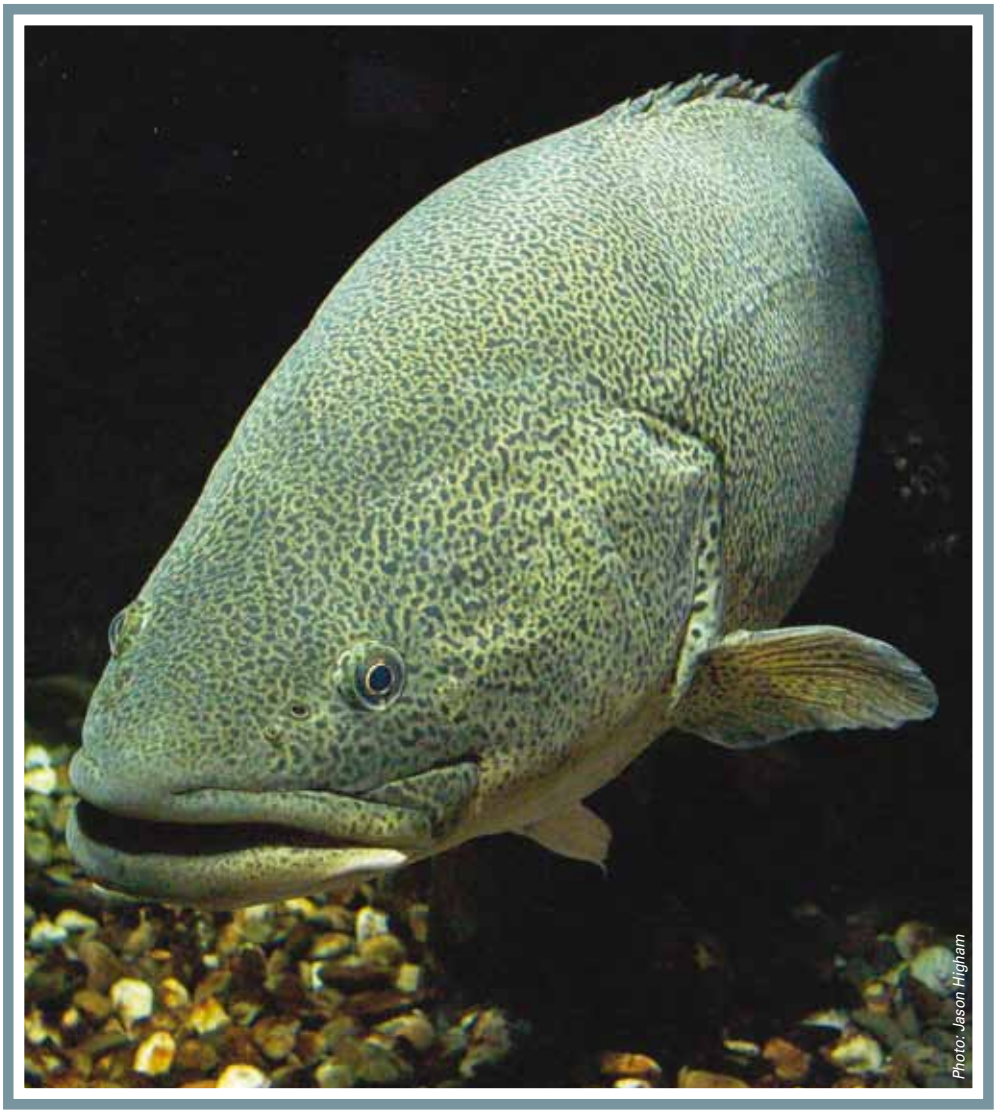


Photo: Jason Higham

Common Name Short-headed lamprey

Scientific Name *Mordacia mordax* (Richardson, 1846)

Photo: Michael Hammer

Photo: Michael Hammer

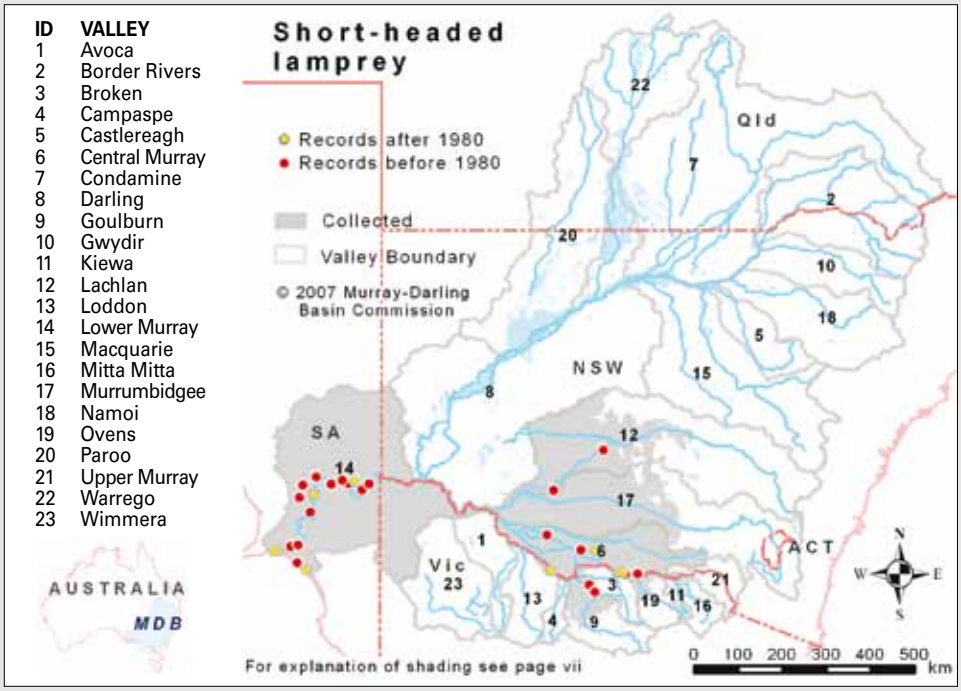
Identification

Small to medium sized, slender and elongated, with a scaleless, eel-like body. Adults are commonly 300–440 mm long in freshwater situations (maximum size ~500 mm). Two low dorsal fins are situated well back on the body near the rounded caudal fin, and paired pectoral and pelvic fins are absent. Lampreys lack jaws; instead adults have a well-developed suctorial oral disc with sharp, radially arranged tooth plates. There are two large tricuspid teeth on the oral disc above the mouth and no fimbriae (fringing filaments) surrounding the oral disc. In mature adults, the radial toothplates disappear. The eyes of adults are dorsolateral, and both adults and ammocetes have seven small oval gill apertures on each side of the body behind the head. Adults are bluish-grey dorsally just before and after their marine phase; during their spawning migration they are a duller grey.

The larval juvenile life phase (ammocete) is usually less than 140 mm long, worm-like, lacks eyes and tooth plates, and the dorsal fins are very low, not extending far above the body surface. A large, hood-like upper lip overhangs the small mouth. Brownish in colour, ammocetes are darker on the dorsal surface and reddish around the gills because of the underlying blood vessels. They can be distinguished from ammocetes of the Pouched lamprey by the position of the vent, which is below a point about halfway along the length of the second dorsal fin.

Biology and 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. During the spawning run, individuals are usually active nocturnally, and burrow into the substrate during the day. Females have 3,800–13,400 small eggs, (0.3–0.5 mm diameter), which are deposited in a shallow nest (small depression) in the substrate, often in shallow, relatively fast water. Adults die shortly after spawning. Ammocetes are sedentary and live in slow-flowing streams, burrowing in silt or mud, for about three years before metamorphosing (at around 100–140 mm length) and migrating down to the sea, usually in spring.

The ammocetes 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.

Distribution and Abundance

Generally restricted to the lower to mid Murray River in the Basin (occasionally recorded as far upstream as Yarrawonga and even Narrandera on the Murrumbidgee), but otherwise found in coastal rivers in Vic, NSW, SA and Tas. In recent times adults are rarely seen, but formerly they could be seen in large numbers in the lower Murray on their spawning run at migration barriers such as weirs. There are recent records of this species from below the Goolwa Barrage. Ammocetes are reasonably common in suitable silty habitats.

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.

Common Name Pouched lamprey

Rare

Scientific Name *Geotria australis* Gray, 1851

Photo: Neil Armstrong

Photo: Michael Hammer

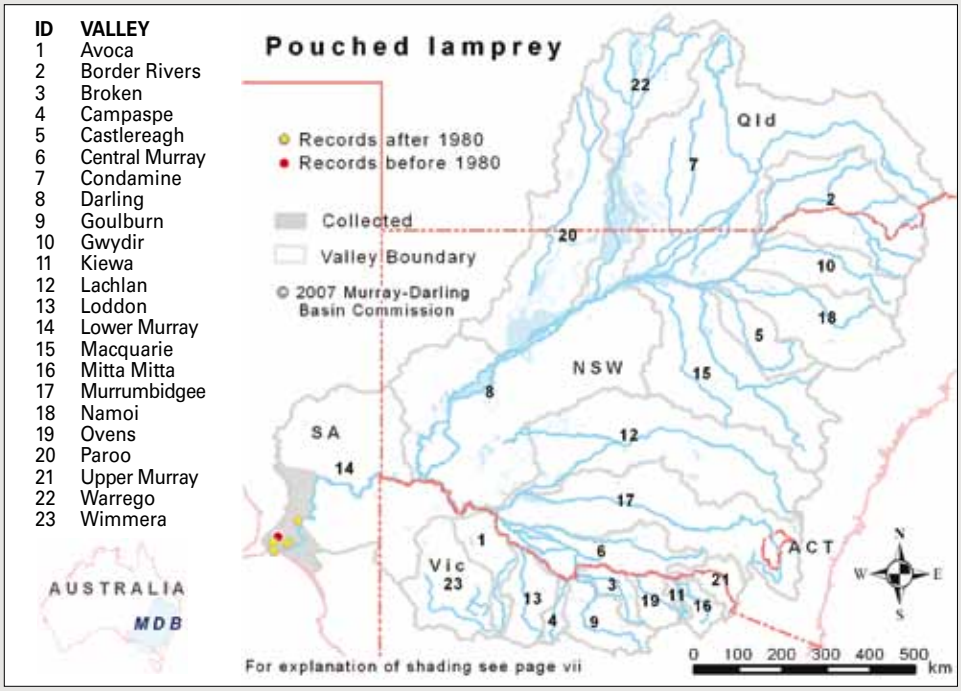
Identification

Medium sized, slender and elongated, with a scaleless, eel-like body. Adults are commonly 500–700 mm long in freshwater situations (larger than the Short-headed lamprey). Two, low dorsal fins are situated well back on the body near the rounded caudal fin, and paired pectoral and pelvic fins are absent. Lampreys lack jaws; instead adults have a well-developed suctorial oral disc with blunt teeth in irregular spirals. Fimbriae (fringing filaments) are present surrounding the oral disc (absent in Short-headed lamprey), and the eyes of adults are lateral in position (rather than dorsolateral in Short-headed lamprey). Adults and ammocetes both have seven small oval gill apertures on each side of the body behind the head. During the spawning run, adult males develop a large pouch below the head. Newly metamorphosed young adults are bright silvery with blue bands along the back. The bands persist throughout the marine phase and early in the return to freshwaters, before fading and disappearing, leaving the adults a muddy grey-brown.

The larval juvenile life phase (ammocete) is usually less than 120 mm long, worm-like, lacks eyes and tooth plates, and the dorsal fins are very low, not extending very far above the body surface. Sandy-brown to blue in colour, these ammocetes are darker on the dorsal surface. They can be distinguished from ammocetes of the Short-headed lamprey by the position of the vent, which is below the start of the second dorsal fin.

Biology and Habitat

Little is known of the species' ecology in the Basin, so information below is drawn from studies in Western Australia. Most of the adult life is spent at sea. Young adults



migrate upstream from the sea, usually in mid-winter, to breed. The spawning run can involve distances of hundreds of kilometres, and like the Short-headed lamprey is thought to be mainly by nocturnal movements. The spawning run lasts for about 15–16 months, before spawning the following spring. Ammocetes are sedentary, and live in soft substrates (mud and silt) for about 4.25 years, before metamorphosing (at around 80–120 mm length) and migrating down to the sea, usually in late winter. Details of spawning are not known but spawning probably occurs in headwater streams and adults probably die after spawning. Females lay on average 58,000 eggs, which are small (~1.1 mm diameter).

The ammocetes are toothless, probably 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.

Distribution and Abundance

Generally restricted to the lower Murray River in the Basin, but otherwise found in coastal rivers in Vic, SA, Tas and WA. This species is now rarely recorded in the Basin because of its cryptic habits, but could formerly be seen in large numbers on spawning runs in the lower Murray at migration barriers such as weirs. There are recent records of this species in SA from below the Goolwa Barrage and in the Lower Lakes.

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; Hammer 2004; Hardisty *et al.* 1986; Koehn & O'Connor 1990; Potter 1996b; Potter *et al.* 1996; Wedderburn & Hammer 2003.

Common Name Short-finned eel (Silver eel)

Scientific Name *Anguilla australis* Richardson, 1841

Identification

A large, elongate and cylindrical eel. Maximum length is 1100 mm and maximum weight is 3.2 kg, but most individuals are <700 mm long and weigh less than 400 g.

The dorsal, anal and caudal fins are joined, with the dorsal fin commencing just in front of, or level with the anal fin. Usually coloured a uniform olive-green to golden-brown dorsally, with a whitish or sometimes silvery-white belly. The mouth is large with distinct and numerous teeth. The mouth is large, but unlike that of the Long-finned eel, does not extend well behind the eye, instead finishing below the eye.

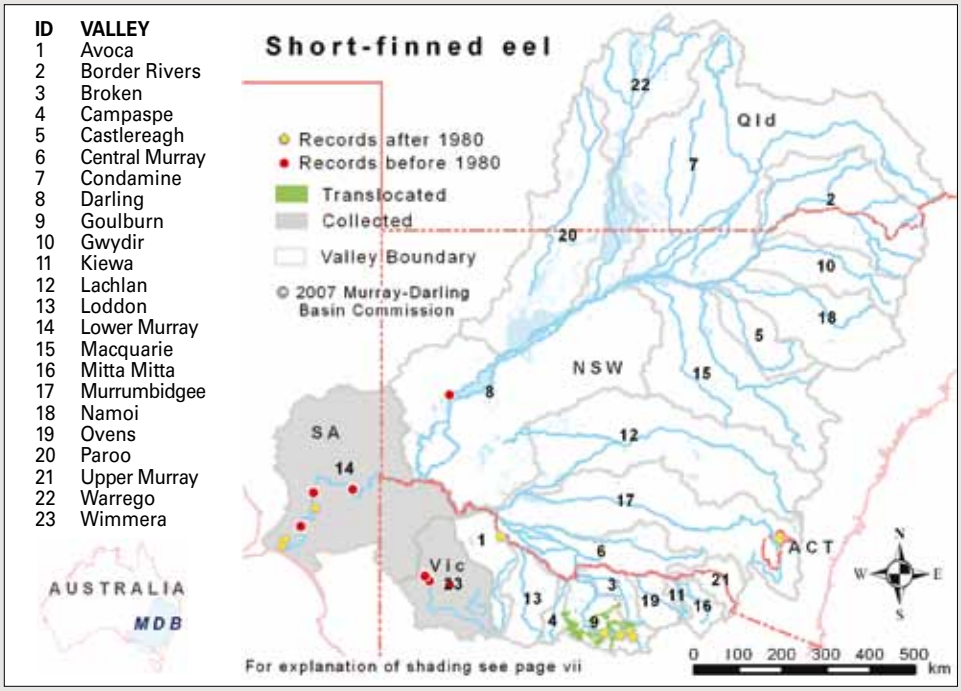
Biology and Habitat

This species lives in a variety of habitats including rivers, lakes and swamps, generally with low or no flow. It migrates to sea to spawn, with the spawning location being the Coral Sea near New Caledonia. The larval eels are washed down the east Australian coast by sea currents. The larvae then metamorphose and attain the typical eel shape before entering fresh water in spring–summer and migrating upstream to the upper reaches of rivers. Adults occupy a well-defined home range of about 400 m. Females dominate the catch in freshwater environments and males are more abundant in downstream, estuarine areas. Males are sexually mature at 14 years and females at 18–24 years. Adults may remain in fresh waters for 20 years or more before migrating to the sea to breed and then die.

A voracious nocturnal predator, the Short-finned eel eats a variety of fish, crustaceans, molluscs and insects.

Distribution and Abundance

Primarily a fish of coastal streams outside the Basin, there are occasional records from inland streams. Most inland records are assumed to be of fish translocated from coastal streams by anglers, but some represent natural dispersal events. There are occasional records in the Basin from the upper Murrumbidgee River (possibly translocated via the Snowy Mountains Scheme) and historic and recent records from the lower



Murray in SA. The species has also been introduced into the Wimmera River Basin in Vic via water transfer from the Glenelg Basin.

Potential Threats

None known in MDB, but in coastal systems barriers to downstream migration of adults, particularly hydroelectricity schemes and associated turbines are cause cause for concern. Overharvesting of larval eels for aquaculture and adult eels are also potential threats.

General References

Allen *et al.* 2002; Beumer 1979a, 1996; Koehn & O'Connor 1990; McKinnon 2002; Sloane 1984a,b.

Common Name Long-finned eel (Spotted eel)

Scientific Name *Anguilla reinhardtii* Steindachner, 1867

Identification

A large, elongate, cylindrical eel. Maximum size 1650 mm and 22 kg, but typically about 1000 mm and 1–2 kg. The mouth is large, extending back well past the eye. The back and sides of the body are distinctly blotched or mottled with dark brownish spots or patches. Like the Short-finned eel, the dorsal, anal and caudal fins are joined. Readily differentiated from the Short-finned eel by the spotted body pattern and length of the dorsal fin, which commences well in front of the anal fin.

Biology and Habitat

Similar to the Short-finned eel but more commonly recorded in rivers than lakes. Preferred habitats include undercut banks and areas with snags. The larvae of Long-finned eels (glass eels, ~58 mm length) enter estuaries and migrate upstream to freshwater habitats where they may remain for up to 52 years before returning to the ocean to spawn and die. Long-finned eels in freshwater habitats generally have a restricted home range of 300 m or less, although larger movements are recorded when the eels return to the sea to spawn. Size and age range in coastal Australian rivers varies between the sexes with females generally larger and older (up to 52 years of age) than males. Size at sexual differentiation and migration also varies between the sexes: males differentiate at 42–60 cm and migrate at 44–62 cm and females at 50–76 cm and 74–142 cm, respectively. The majority of males are found in the tidal zones whilst females dominate abundance (up to 97% of individuals) in freshwater habitats.

Like the Short-finned eel, the Long-finned eel is a nocturnal predator of fish, crustaceans, molluscs and insects, and the occasional juvenile waterfowl.

Distribution and Abundance

Eels are generally only recorded from coastal streams outside the Basin. This species is more commonly found in lowland sections of coastal streams although it is occasionally recorded from upland sections as well. However, it is far less abundant in upland

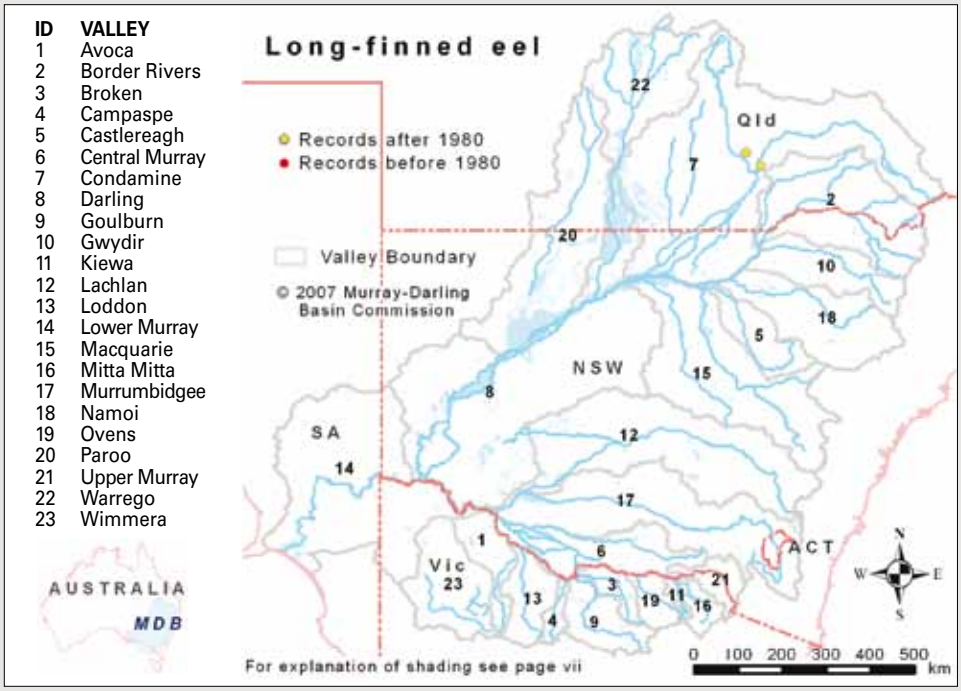



Photo: Neil Armstrong

habitats than the Short-finned eel. The only known records from the Murray-Darling Basin are in the Condamine-Balonne drainage in southern Qld and the Lower Lakes of the Murray in SA.

Potential Threats

None known in MDB, but in coastal systems barriers to downstream migration of adults, particularly hydroelectricity schemes and associated turbines are cause cause for concern. Overharvesting of larval eels for aquaculture and adult eels are also potential threats.

General References

Beumer 1979a, 1996; Koehn & O'Connor 1990; McKinnon 2002; Moffat & Voller 2002; Pease *et al.* 2003; Sloane 1984a,b; Walsh *et al.* 2003, 2004.

Common Name Bony herring (Bony bream, Hairback herring, Pyberry)

Scientific Name *Nematalosa erebi* (Günther, 1868)

Identification

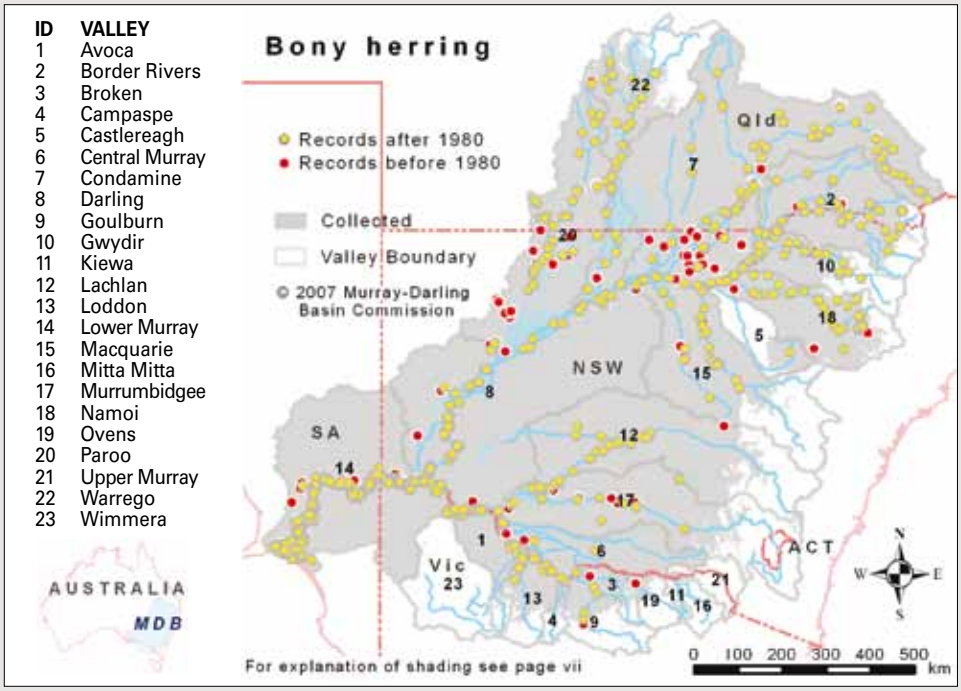
A medium sized, laterally compressed, deep-bodied fish with a small head and mouth, large eyes and blunt snout. Maximum size ~470 mm; commonly 120–200 mm. The tail is large and deeply forked. The single dorsal fin is short-based and, in larger individuals, has a greatly elongated last ray that sometimes extends to the base of the tail. The pectoral fins are small; the pelvic fins are approximately midway along the belly, below the dorsal fin; and the anal fin is long-based. Scales form a serrated ridge on the belly. The back is greenish, the sides bright-silvery iridescent and the belly silvery white; there is no lateral line.

Biology and 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.

In the lower Murray, males mature at 1–2 years and females at 2 years. Fecundity is high, with 33,000–880,000 eggs produced, depending on fish size. The small eggs (0.83 mm diameter) are released in the still waters of shallow, sandy bays in October–February. Daytime upstream movements have been recorded for juveniles and adults in the Murray and Murrumbidgee Rivers, and individuals as small as 22 mm have been recorded migrating. These movements are possibly related to the colonisation of new habitats by juveniles, as well as reproductive movements by adults.

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.

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. They were the most and second-most abundant native fish species in the Pilot Sustainable Rivers Audit and the NSW Rivers survey, respectively. They are commercially fished in Lake Alexandrina, SA. In the Basin, they are largely absent from upland habitats, probably due to low water temperatures.

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.

Common Name Climbing galaxias (Broad-finned galaxias)

Translocated/ Native

Scientific Name *Galaxias brevipinnis* Günther, 1866

Identification

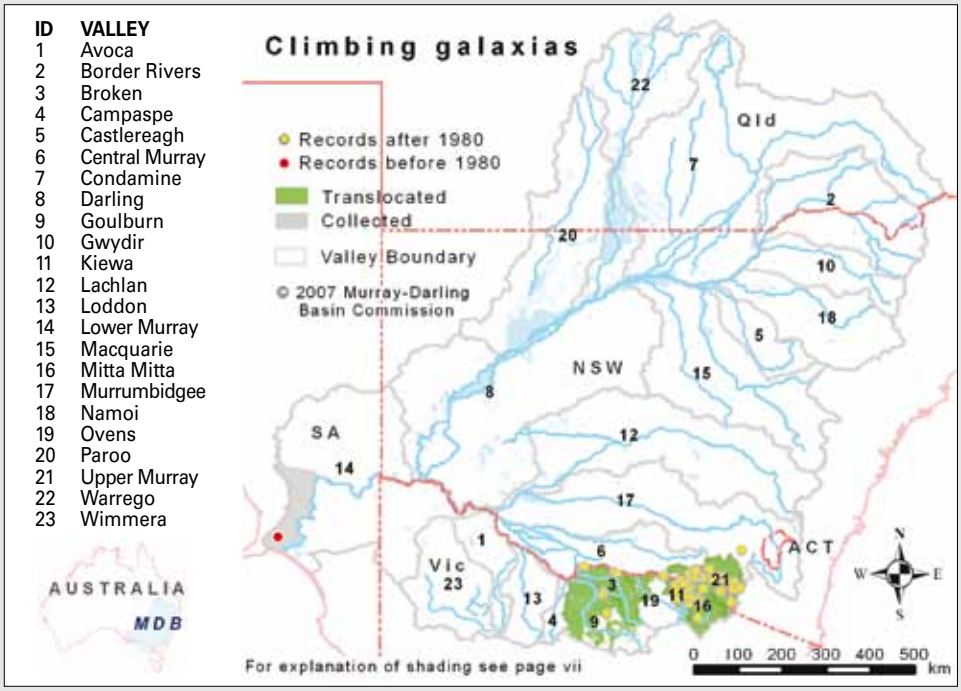
A relatively large galaxiid with a large, dorsoventrally flattened head and a large mouth reaching to below the eyes. Maximum size 278 mm; usually 150–180 mm. Adults are sturdy and almost tubular, and usually have a blue-black blotch above the base of the pectoral fins. The tail is truncate and the pectoral fins are large, low and downward facing, hence its alternative common name of Broad-finned galaxias. The body is scaleless and greyish brown to olive, often patterned with bold chevron stripes on the dorsal and lateral surfaces, and the belly is a dull silvery olive.

Biology and 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. In coastal streams it breeds during autumn and winter, scattering its eggs amongst vegetation on the stream edge above the normal flow level, presumably when streams are in flood. In these sea run populations the eggs are deposited in flooded riparian areas, usually within 1 m but up to 7 m from the water's edge. Fecundity is high: up to 23,676 eggs have been reported, and an average of 7,000 per individual. The eggs are round, adhesive and 1.8–2.1 mm diameter. They develop out of water in these damp habitats for days or weeks and hatch with the next flood. The larvae are thought to be swept downstream to the sea, where they remain for 5–6 months before migrating back into estuarine and freshwater habitats.

The reproductive ecology in the landlocked population of the Basin is unknown, but in similar situations in Tasmania large lakes replace the marine larval stage. There has been little investigation into the species' ecology in the Basin, but in the upper Murray spawning is thought to occur in late April or early May.

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



is renowned for its ability to climb vertical waterfalls and rock faces, using its broad pectoral and pelvic fins.

Distribution and Abundance

This widespread species is found in coastal streams of south-eastern Australia and New Zealand. Although it can be predominantly considered as occurring in the Basin as a result of translocation, there is an historical record from the Lower Murray in SA where it probably had a small population in the Mt Lofty Ranges, which adjoins coastal populations (e.g. the species is common on the nearby southern Fleurieu Peninsula). In the Basin, it is largely restricted to the upper Murray and its tributaries such as the Kiewa, Geehi, Swampy Plains, and Tooma rivers although recent records from the lower Goulburn and Broken rivers indicate it is spreading downstream. A recent record of the species from the Tumut catchment (presumably via the Snowy Mountains Scheme) is the first record for the Murrumbidgee drainage.

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.

General References

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

Common Name Barred galaxias

Threatened

Scientific Name *Galaxias fuscus* Mack, 1936

Identification

A small and, strikingly coloured fish. Maximum size 160 mm; commonly 70–90 mm. Scales are absent, the tail is truncate to weakly forked, and the anal fin originates behind the middle of the dorsal fin. The head is short and bulbous and the caudal peduncle is thick compared to that of the Mountain galaxias. The body is an unmottled orange-yellow colour with 1–10 complete or partial vertical ovoid black bars on the sides between the gill cover and just behind the origin of the pelvic fin.

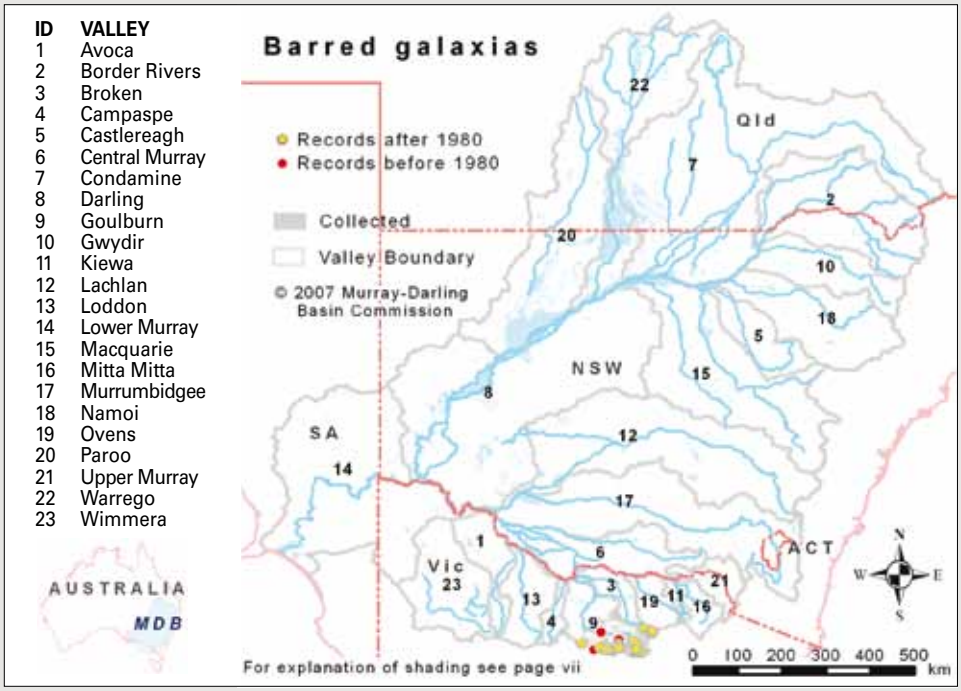
Biology and Habitat

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. Spawning is triggered by an increase in day-length and water temperature in August–September. Average fecundity is about 500 eggs, which are large (unshed eggs are ~ 2.2 mm diameter) and demersal. The eggs are laid under large boulders when water temperatures are around 2–3° C. Time to hatching and size of larvae at hatching are unknown, but 12 mm long larvae are present in streams by December. Movement requirements are unknown, but the species is thought to be non-migratory and relatively sedentary, judging by recolonisation rates of streams where trout have been removed.

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.

Distribution and Abundance

The Barred galaxias is only found in the headwaters (above 400 m altitude) of the Goulburn River catchment in the central highlands of Vic, in the southern Murray-Darling Basin. 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.

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.

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.

Common Name Common galaxias (Common jollytail)

Scientific Name *Galaxias maculatus* (Jenyns, 1842)

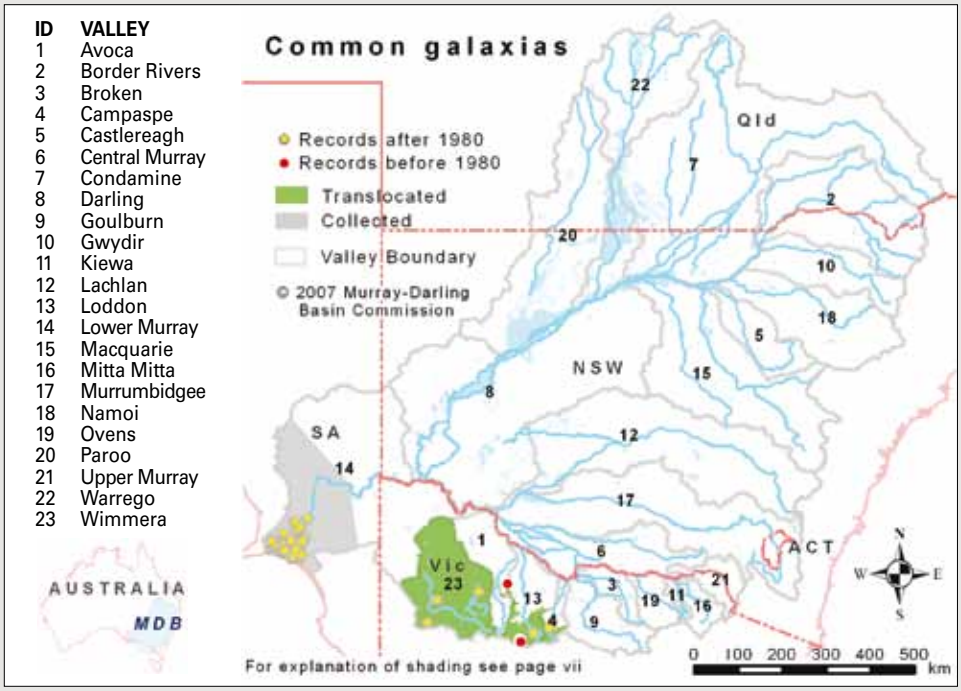
Whitebait stage

Identification

A small, slender fish with a slender caudal peduncle. Maximum size 190 mm; usually < 100 mm. Scales are absent, the tail is slightly forked, and the anal fin originates directly below the dorsal fin. The head is small and bluntly pointed and the mouth is small, only reaching back to the front of the eyes. The jaws are equal in length. Overall translucent grey-olive to amber in colour, with the back and sides irregularly blotched or spotted greenish grey. The belly, eyes and gill covers are bright silvery to white. The fins are largely translucent.

Biology and Habitat

This species is commonly found in coastal habitats, in still or slow-flowing streams and the margins of lagoons and lakes. Coastal stream populations breed in autumn, with adults migrating downstream to brackish areas to spawn. The larvae disperse to sea for six months before returning to streams the following spring. In landlocked populations in lakes, breeding occurs in late winter-early spring on rising water levels, with adults making a short migration into tributaries to spawn. The larvae are washed down into lakes to spend several months amongst the shallow shoreline vegetation. Individuals are mature at the end of their first year, (~ 90 mm length), although some do not breed until their second year. Very few survive until the end of their third year and a substantial proportion of adult fish die after spawning. Each female produces several thousand eggs (up to 13,500). The spawning site is in terrestrial vegetation



above the normal water line, either in flooded shallow margins of streams or above the normal tideline in estuaries. The adhesive eggs (~ 1 mm diameter) develop in these moist environments over about 14 days and hatching is stimulated by the next high tide or flood. Eggs are able to survive without immersion for up to 8 weeks. Newly hatched larvae are approximately 7 mm long.

The species is carnivorous and takes food from the bottom, mid-water or the surface. The diet of landlocked populations consists mainly of amphipods, chironomid larvae and microcrustaceans; stream-dwelling individuals consume more insects.

Distribution and Abundance

The Common galaxias is a common fish of lowland coastal streams, from SA to southern Qld and Tas. In the Murray-Darling Basin it is known from the Lower Lakes (Alexandrina and Albert), extending up to approximately Mannum on the Lower Murray and streams of the Mt Lofty Ranges in SA. Its abundance in the lower Basin is likely to have been affected by the barrages below the Lower Lakes, which act as a barrier to prevent the larval whitebait stage returning from the sea. However, the species is still widespread and abundant in the Lower Lakes, where it may be recruiting as a landlocked population without access to marine environments. It is also known from the Wimmera, Loddon and Campaspe catchments in Vic, where it is considered a translocated species, probably introduced through water diversions from coastal streams or in bait-buckets.

Potential Threats

The barrages on the Lower Lakes may be depressing larval whitebait returns and reduced flows may be reducing spawning opportunities for landlocked recruitment and migration.

General References

Allen *et al.* 2002; Becker *et al.* 2005; McDowall & Fulton 1996; Pollard 1971, 1972, 1973; Stuart *et al.* 2005; Wedderburn & Hammer 2003.

Common Name Mountain galaxias (Ornate mountain galaxias) **Declining**

Scientific Name *Galaxias olidus* Günther, 1866

Identification

A small, elongate, tubular fish. Maximum size 140 mm; average 70–80 mm. The body patterning is variable, with stripes, blotches or no markings present. The back is usually brownish to yellowish-green, and the belly is olive to silvery white. Scales are absent, the tail is truncate to weakly forked, and the anal fin originates at or behind the middle of the dorsal fin.

The Mountain galaxias is quite a variable small fish, with several former species of *Galaxias* subsumed into *Galaxias olidus* in the early 1980s. However, it is likely that some of these species may be reinstated in the near future, and new ones, such as the Riffle galaxias and Obscure galaxias, described.

Biology and 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.

Individuals mature at the end of their first year or in their second year. Spawning occurs mainly in spring and early summer although a small proportion of fish may spawn in autumn. Between 50 and 400 eggs are laid on the underside of stones at the head of pools and in riffles. Eggs are approximately 2.5 mm in diameter and hatch in about three weeks. Larvae are about 10 mm long at hatching.

The species is thought not to migrate, and to have a relatively small home range of around 19 m. It has been recorded basking on damp rocks in alpine areas. 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.

Distribution and Abundance

Mountain galaxias are widely distributed throughout south-eastern Australia, from

ID	VALLEY
1	Avoca
2	Border Rivers
3	Broken
4	Campaspe
5	Castlereagh
6	Central Murray
7	Condamine
8	Darling
9	Goulburn
10	Gwydir
11	Kiewa
12	Lachlan
13	Loddon
14	Lower Murray
15	Macquarie
16	Mitta Mitta
17	Murrumbidgee
18	Namoi
19	Ovens
20	Paroo
21	Upper Murray
22	Warrego
23	Wimmera

southern Qld through to SA. They are not restricted to the mountains, being found in lowland habitats as well. However, other galaxiids such as the Common galaxias are more abundant and widespread in lowland rivers in the Basin.

As with other galaxiid species, where trout are present the abundance of Mountain galaxias is greatly reduced in lowland streams and eliminated from many upland streams. In such situations galaxiids are only found above waterfalls or swamps that prevent trout access. An experiment to remove Rainbow trout from a section of Lees Creek in the ACT has resulted in the recolonisation by galaxiids of the trout-free section of stream.

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.

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.

Common Name Flat-headed galaxias (Murray jollytail) **Declining**

Scientific Name *Galaxias rostratus* Klunzinger, 1872

Identification

A small fish with a forked tail and small pectoral fins. Maximum size 146 mm; rarely exceeds 100 mm. The anal fin originates directly below the dorsal fin. The back and sides are olive-green and the belly silvery. The fins are colourless but pigment spots are often present at the base of the fin rays. The dorsal fin originates almost directly above the anal fin, but the anal fin has a longer base than the dorsal. The top of the head is flattened and the jaws are equal or the lower jaw is slightly protruding, and the gill covers are silvery. The mouth is very large with the gape extending to well below the eye.

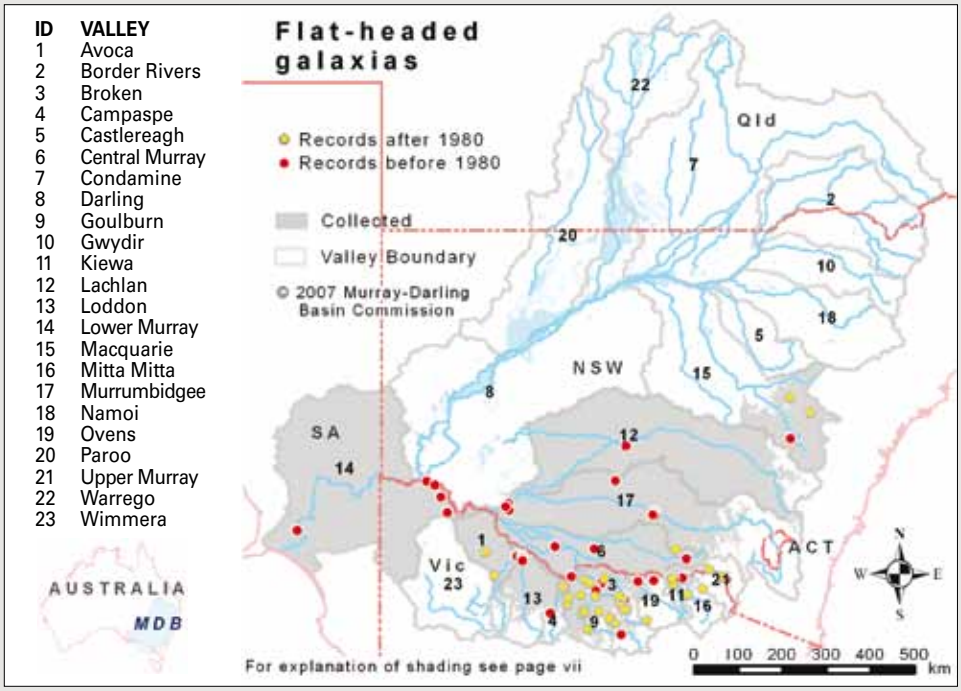
Biology and Habitat

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. It spawns August–September when water temperatures are above 10.5°C. Fecundity increases with increasing fish length: an 86 mm fish has 2,300 eggs and a 136 mm fish 7,000 eggs. The eggs are round, demersal and slightly adhesive, with egg diameters between 1.3 and 1.6 mm. Eggs are spawned randomly and settle on the bottom, hatching in 8–9 days. At hatching, the larvae are 5.7–8.1 mm in length. Individuals probably mature in their first year, at lengths around 80 mm. The reproductive organs of ripe individuals are large, and can make up about 20–40 % of total body weight.

The diet is predominantly aquatic insects with some microcrustaceans. Movement requirements are unknown, but there is a suggestion they may school and move upstream in November–December.

Distribution and Abundance

The Flat-headed galaxias is only known from the southern Murray-Darling Basin where it has been recorded patchily. It is known in NSW from the billabongs and main channel of the upper Murray (near Albury)



and a variety of habitats in the mid to lower Murrumbidgee River. There is also an isolated record from a lagoon near Bathurst. The species was not collected during the NSW Rivers Survey of 80 sites across the State between 1994 and 1996 and has recently been proposed for listing as a threatened species. There is an old record from the Lower Murray in SA and the species is known from the Goulburn, Loddon, and Murray catchments in Vic. Even at sites where it was known to be common historically, it was a difficult fish to adequately sample, but there is little doubt that it has declined across its range. It does not occur in the ACT or Qld.

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.

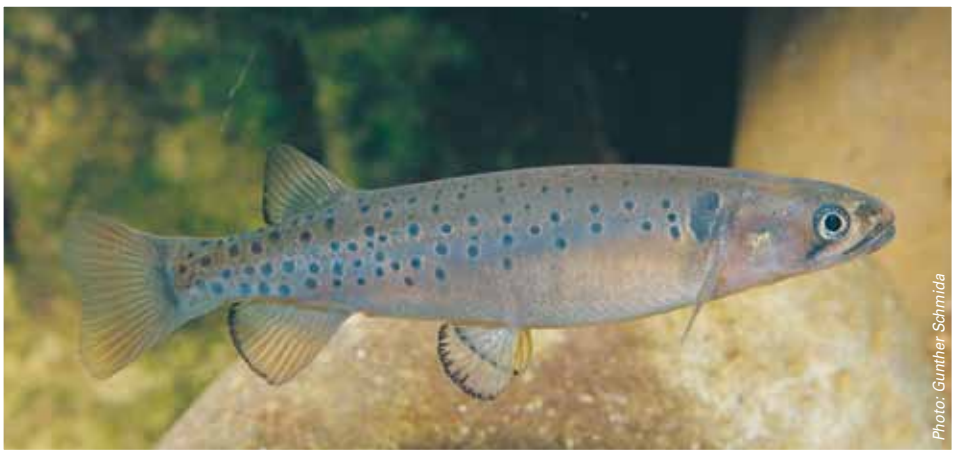
General References

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.

Common Name Spotted galaxias
(Spotted mountain trout, Trout minnow)

Translocated or remnant?

Scientific Name *Galaxias truttaceus* Valenciennes, 1846



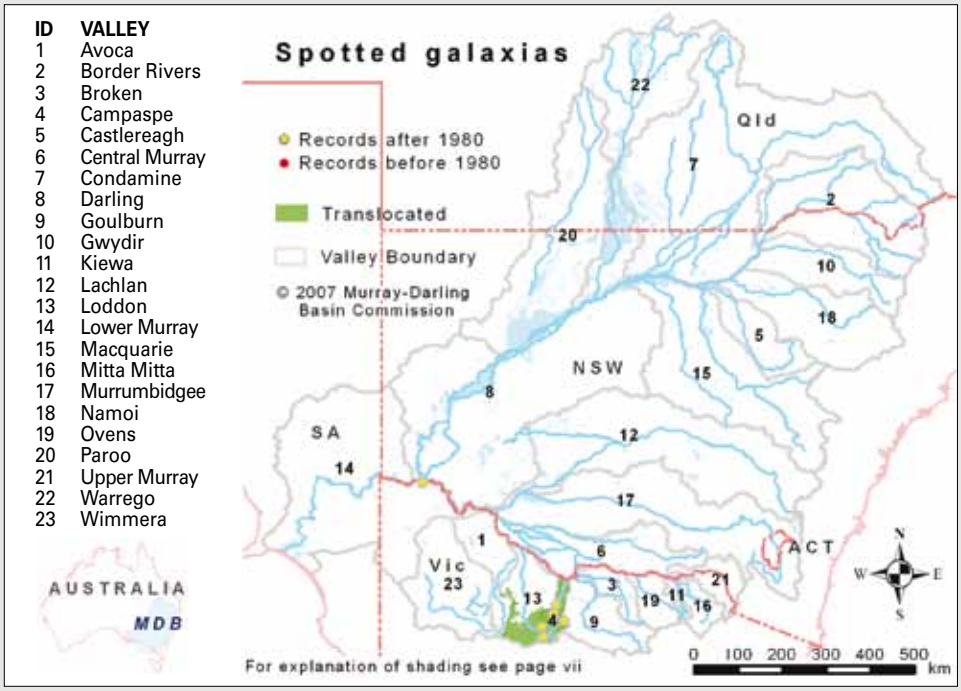
Identification

A large, stout-bodied, scaleless fish with a longish head and large mouth reaching back to below the front of the eyes. Maximum size > 200 mm; usually 120–140 mm. The anal fin is positioned directly below or slightly behind the dorsal fin, and the tail is slightly forked. The dorsal, anal and caudal fins are golden to orange, with a dark rear fringe. The back is a brownish to deep-olive, fading to brownish-grey on the sides and silvery on the belly. Large, round purplish spots are present on the upper sides and back, each surrounded by a lighter halo. There is a distinct dark diagonal stripe extending down from the bottom of the eye.

Biology and 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. In landlocked populations spawning occurs in spring after an upstream migration into feeder streams, and the larvae fulfilling their pelagic phase in downstream lakes. Fecundity is moderate to high: 1000–16,000 eggs deposited amongst instream aquatic vegetation. The eggs are small (~1.0–1.3 mm diameter) and take about four weeks to hatch, and the larvae are about 6.5–9.0 mm long at hatching.

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. There are significant differences in the ecology of the coastal and landlocked populations of this species in Tasmania, including different timing of the breeding season and the presence of more young fish in coastal populations. There are also significant differences between landlocked Tasmanian and landlocked Western Australian populations: the Tasmanian fish mature



later, live longer, grow larger and have larger eggs and larvae. The WA population has the late-autumn spawning season of the coastal Tasmanian fish. Little is known of the species' ecology in the Basin, but it must be assumed that the Basin populations are landlocked given the large numbers of migration barriers between the Campaspe and marine waters.

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.

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.

Common Name Australian smelt (Smelt)

Scientific Name *Retropinna semoni* (Weber, 1895)

Identification

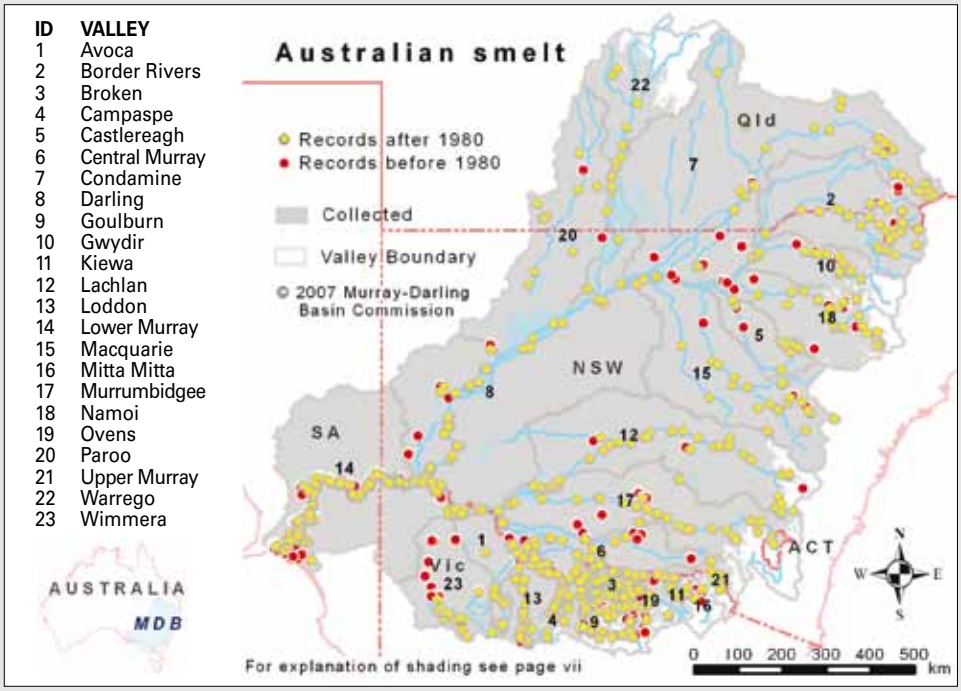
A small, elongate, laterally compressed fish. Maximum length 100 mm; commonly 40–60 mm. Slender, silvery and largely transparent apart from a prominent silver-orange to bluish lateral band. The eyes are large, the opercula are silvery and the tail is moderately forked. A small adipose fin is present. The pectoral and pelvic fins of males are larger than in females. Nuptial tubercles are present on the body and head, and are larger in males. A cucumber-like odour is apparent in freshly caught individuals.

Biology and Habitat

Two species of smelt are currently recognised, but recent genetic investigations suggest that there are as many as five species present in Australia; only one occurs in the Murray-Darling Basin. Consequently, some of the information summarised below is likely to refer to a number of closely related species.

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 channel, 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. However, in Queensland smelt is commonly encountered in riffles or along shorelines in association with fringing vegetation. In Murray River tributaries, larval smelt were collected from a range of habitats, but prefer deeper billabongs. Upstream migrations of juvenile and adults have been recorded during daylight hours in the Murray and Murrumbidgee rivers, with fish as small as 21 mm migrating. Migration rates in the Murrumbidgee tended to peak in the afternoon.

Both sexes mature towards the end of their first year and may live for two or more years, although most only live for a year. Fecundity ranges from 100 to 1000 eggs depending on fish size. Spawning occurs when water temperatures reach about 11–15°C, generally in spring and early summer in the Basin, but for up to 9 months of the year in the Campaspe River. In the Lower Murray, smelt



are multiple batch spawners, and females produce discrete batches of eggs every 3–4 days. The eggs are about 1 mm diameter, demersal and adhesive; they sink and adhere to aquatic vegetation, sediment or debris. Hatching occurs in 9–10 days and the larvae are <5 mm long.

Smelt are carnivorous and the diet consists primarily of terrestrial insects and microcrustaceans, although a variety of small aquatic insects are also consumed. Smelt does not tolerate handling well, and considerable care is required if mortality is to be avoided.

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. In the Murrumbidgee catchment it is rarely recorded above 600 m asl. In the Basin, it has been recorded from most lowland streams and is also common in coastal streams from central Qld through to the Murray mouth in SA.

Potential Threats

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

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.

Common Name Rendahl's tandan (Rendahl's catfish) **Rare**

Scientific Name *Porochilus rendahli* (Whitley, 1928)

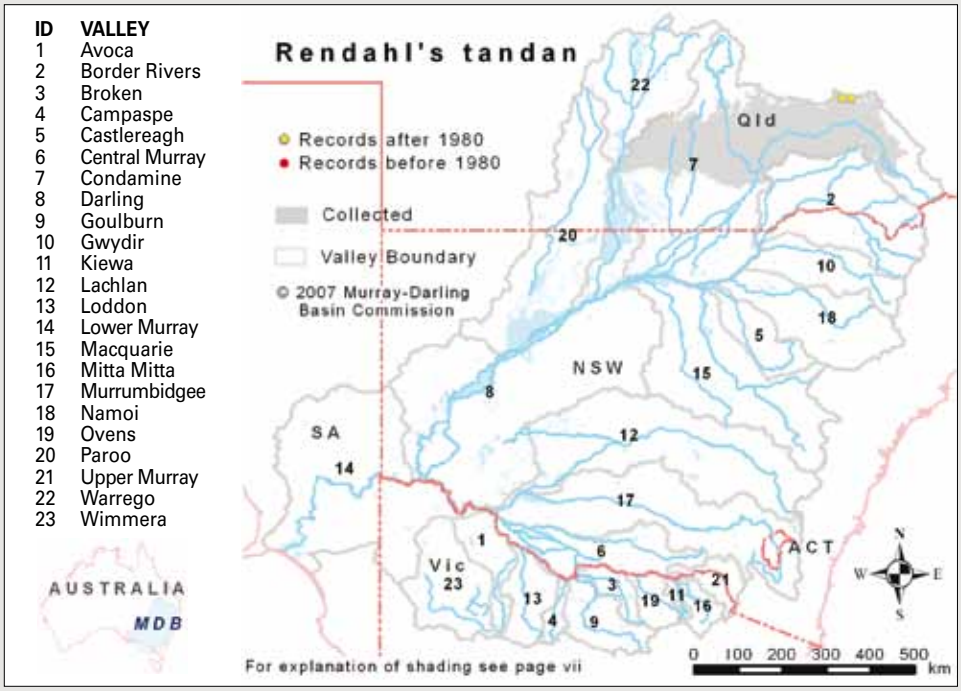
Identification

A small catfish with a relatively short first dorsal fin and the classic tandan feature of conjoined caudal and anal fins. Maximum size ~240 mm; usually less than 150 mm. The skin is smooth, with no scales. The body is slender with a roundly pointed tail. The head and nape profile is concave and the eyes are close to the snout. The longish nasal barbel extends to, or behind back of head, with other barbels reaching to or beyond the base of the pectoral fin. Colour ranges from light grey to almost black, sometimes mottled, or pale yellow-brown, generally with a golden sheen. A white form is also known. The individuals collected from the Basin differ slightly morphologically to other populations, and it is possible that genetic research may show that there are cryptic species within *P. rendahli*.

Biology and Habitat

Virtually nothing is known of this tandan's ecology in the Basin, but elsewhere it is a benthic feeder, consuming relatively small items such as insect larvae, (predominantly chironomids and mayflies), microcrustaceans (ostracods or cladocerans) and detritus. In the Alligator Rivers region of the Northern Territory males mature at approximately 100 mm total length and females at 110 mm, and breeding occurs early in the wet season (~November–December). In this locality spawning occurs in muddy lowland lagoons. Average fecundity is about 900 eggs, but up to 3465 has been recorded. Mean egg diameter is 1.3 mm. Little is known of movement requirements other than that there is a migration into lowland lagoons to spawn, and an upstream movement to refuge habitats early in the dry season.

In the Alligator Rivers region, Rendahl's tandan was recorded at surface water temperatures of from 26–38°C. It is found in both riverine and off-channel habitats, but is commonly recorded in lagoons. A benthic species, this tandan is found in greatest abundance in slow-flowing areas with dense submerged vegetation, indicating that it is tolerant of low dissolved oxygen levels.



Distribution and Abundance

The species has only recently been recorded from the Basin. A number of individuals were captured from upstream reaches of Dogwood and Charlie's Creeks in the Condamine drainage of southern Qld during sampling for the Pilot Sustainable Rivers Audit. Subsequently, specimens have been collected from the Balonne catchment near St George. Outside the Basin it has a patchy distribution in northern Australia in the Kimberleys, Cape York, the Burdekin and coastal streams of the NT. Its northern Australian distribution indicates that is a warm water species and is unlikely to be widely distributed in the Basin.

Potential Threats

Almost nothing is known of this species in the Basin, so it is difficult to identify threats. However wetland degradation and alienation may be issues to consider.

General References

Allen *et al.* 2002; Bishop *et al.* 2001; Larson & Martin 1989; MDBC 2004b; Pusey *et al.* 2004.

Common Name Hyrtl's tandan (Hyrtl's catfish, Yellow-finned catfish)

Scientific Name *Neosilurus hyrtlii* Steindachner, 1867

Identification

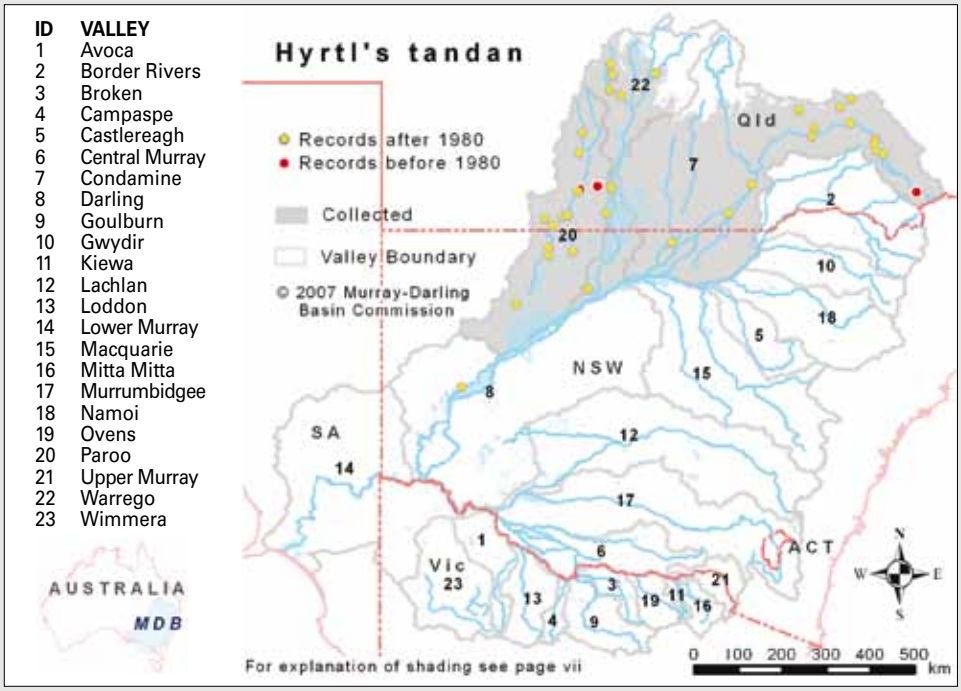
A medium sized catfish with a small, moderately high first dorsal fin and the classic tandan feature of conjoined caudal and anal fins. Maximum size > 400 mm and 2 kg; usually less than 280 mm. The skin is smooth, with no scales. The body is slender and the tail roundly pointed. The head and nape profile is straight and the eyes are further back along the head than in Rendahl's tandan. The nasal barbel barely reaches beyond the eye, and the other barbels reach to the gill opening. Colour ranges from dark brown-grey to a pale yellowish brown dorsally, paling on the sides to whitish on the belly. Small specimens may be silver on the sides with yellow fins. Breeding individuals are bright silvery-white on the sides with bright yellow fins. Individuals from very turbid waters are dull grey.

Biology and Habitat

Virtually nothing is known of the ecology of Hyrtl's tandan in the Basin, and the following information is drawn from studies elsewhere.

The species occurs in a variety of habitats, including flowing waters or still areas such as billabongs and lagoons. Individuals may mature in their first year, (~135 mm length), but most females probably mature in their second year. Longevity is unknown, but it is thought that fish may live for up to 5 years. Spawning occurs during the summer wet season in northern populations, and is thought to be stimulated by increasing water levels and possibly temperature. Details of the spawning site are unknown, but may be in sandy areas in the upper reaches of streams. Fecundity is little known, however, a 205 mm female had 3,630 eggs of ~1.3 mm diameter. The eggs are non-adhesive, demersal and 2.6 mm in diameter when water hardened. Hatching occurs after about 60 hours at 26–27°C.

The species appears to be tolerant of low dissolved oxygen and high turbidity, but probably not of low temperatures, with water temperatures below 8–12°C not being conducive to survival in this species. It is a nocturnal, benthic carnivore, consuming



small prey items such as aquatic insects, (chironomids, caddisflies, mayflies), microcrustaceans, molluscs (small bivalves) and some detritus. Movement patterns of Basin populations are unknown, but in coastal Queensland it has been recorded in spring/summer moving upstream through tidal barrages, mainly at night. Upstream migration by adults to small tributary streams is presumably associated with spawning.

Distribution and Abundance

The species is widespread in northern and central Australia in WA, the NT and Qld, but occurs in the Murray-Darling Basin only in the north, having been recorded from the Paroo, Warrego and Condamine rivers in northern NSW and Qld, and also the Menindee Lakes.

Potential Threats

Evidence from outside the Basin suggests that barriers to movement may be detrimental to this species.

General References

Allen *et al.* 2002; Beumer 1980; Bishop *et al.* 2001;Brown 1992; Gehrke *et al.* 1999; Larson & Martin 1989; Orr & Milward 1984; Pollard *et al.* 1996; Pusey *et al.* 2004.

Common Name Freshwater catfish (Jewfish, Eeltail catfish) **Declining**

Scientific Name *Tandanus tandanus* Mitchell, 1838

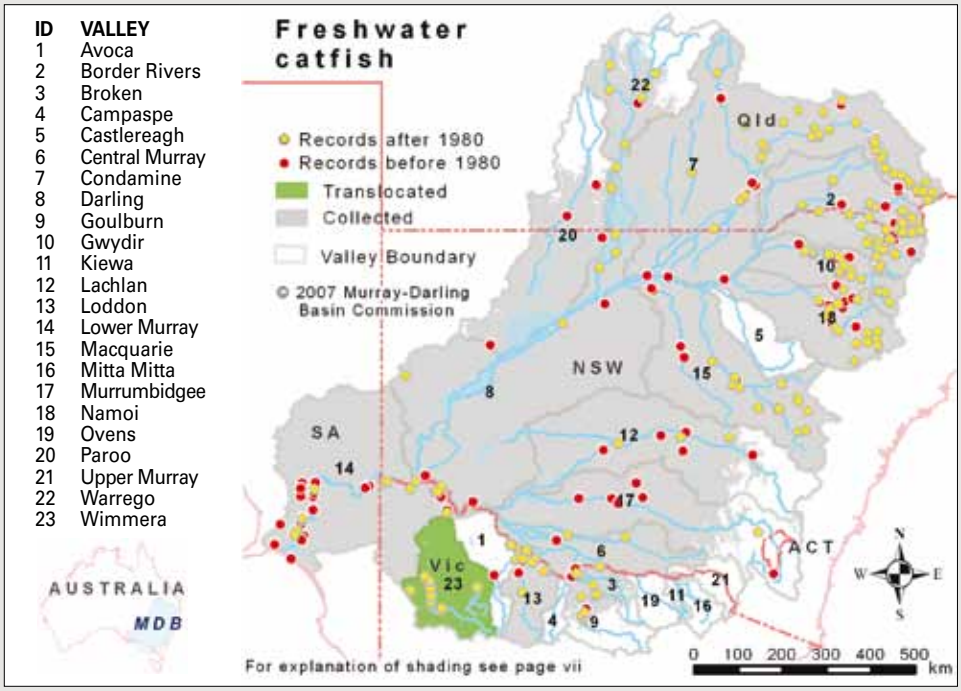
Identification

A medium sized species with a laterally compressed rear portion of the body. Maximum length 900 mm and maximum size 6.8 kg; usually < 500 mm and < 2 kg. The head is large and four pairs of barbels surround the large mouth, with its thick fleshy lips. The first dorsal fin is short but high, just behind the head, and has a stout, serrated spine at the front of the fin. The second dorsal fin is continuous with the caudal and anal fins, hence the species' alternative common name of Eel-tailed catfish. The skin is smooth, with no scales. The back of adults is usually olive-green to brown, and the belly whitish. Juveniles tend to be grey-brown, mottled with darker blotches.

Biology and Habitat

Freshwater catfish is a benthic species that prefer slow-flowing streams and lake habitats. Individuals are sexually mature at 3–5 years of age and spawn in spring and summer when water temperatures are 20–24°C. The nest is a circular to oval depression, 0.6–2.0 m in diameter, constructed from pebbles and gravel, with coarser material in the centre. The eggs are large (~3 mm), non-adhesive, settle into the interstices of the coarse substrate, and take up to seven days to hatch. The male fish remains with the nest to fan, clean and guard the eggs. It has been suggested that there may be multiple spawnings in a single nest in a season, either sequentially or concurrently. Larvae are about 7 mm long at hatching.

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. 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.



Distribution and Abundance

This catfish is widespread throughout the Murray-Darling Basin, but generally in the lower, slow-flowing rivers. It (and a number of suspected cryptic species) is also found in coastal rivers from southern NSW to northern Qld. 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. Some populations in impoundments seem to be faring better. The species was relatively abundant in the Qld portion of the Basin until recently. It is still common in the upper Condamine River but has disappeared from the Paroo and is now in relatively low numbers in the lower Condamine and Warrego rivers.

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.

Common Name Darling River hardyhead

Scientific Name *Craterocephalus amniculus* Crowley & Ivantsoff, 1990

Identification

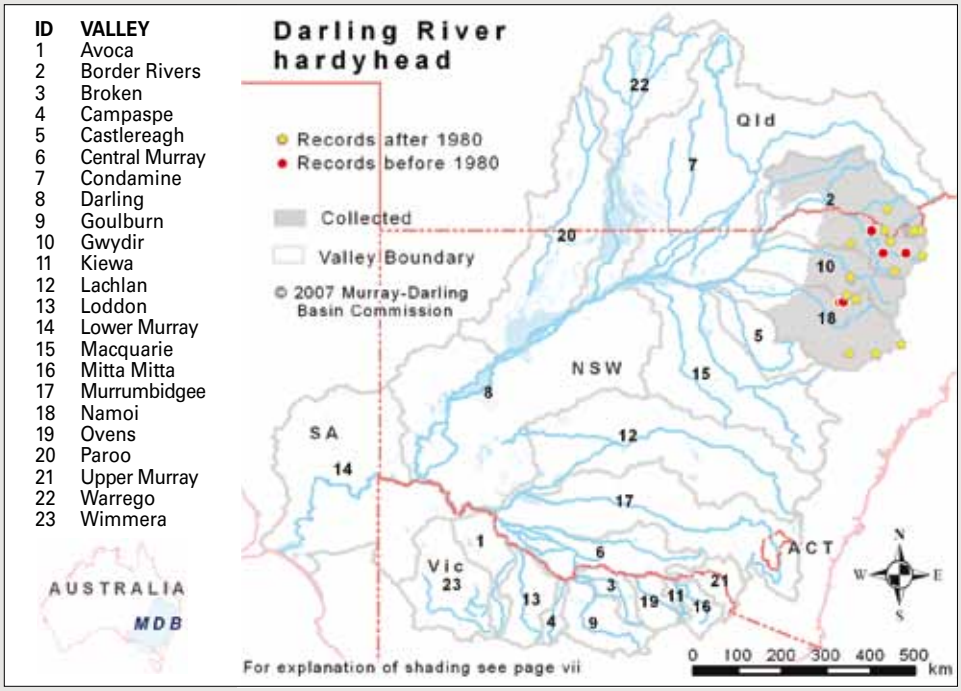
A small, laterally compressed fish with a small protrusible mouth, thin lips, large silvery eye and moderately short, blunt gill rakers. Maximum size 55 mm. There are two small, short-based dorsal fins, with the second directly above the anal fin. The tail is forked, the pectoral fins are positioned high on the body and the anal fin has 5–8 rays. The scales are small and rarely overlap; the midlateral scale count is 37–38 and the transverse count 14–18. There are usually no scales on top of head, but if present they are small and circular. The back is dusky gold, the midlateral stripe is dark and silvery with silvery gold below, and the ventral surface is always paler, with a silvery sheen. The opercula are bright silver.

Biology and Habitat

The Darling River hardyhead is found in slow-flowing, clear, shallow waters or in aquatic vegetation at the edge of such waters. It has also been recorded from the edges of faster-flowing habitats, such as runs at the head of pools. Almost nothing is known of its life history. Small subadult specimens have been collected in September, but the breeding details are unknown. It can be found singly or in small or large schools (50+ fish). In the Macintyre River, spawning appears to span at least September to February.

Distribution and Abundance

This hardyhead is found in the northern Murray-Darling Basin in the upper tributaries of the Darling River near the Qld–NSW border. It is also known from the headwaters of the Hunter system in coastal NSW. In the Basin it is patchily distributed, and known from the Condamine, Peel, Namoi, Macintyre and Cockburn rivers and Boiling Down and Warialda Creeks. It is reportedly relatively common in these locations. Recent fish sampling in the upper Dumaresq, Mole and Severn rivers in northern NSW found Un-specked hardyheads in abundance and a concomitant absence of *C. amniculus*, while the reverse was true for the upper Macintyre River. Although abundant at sites where riparian cover is moderate to good



in the Macintyre, it is not known whether hardyheads also occur further upstream where the riparian cover is either poor or dominated by willows and other exotic species. The NSW Rivers Survey failed to record any individuals. The Pilot Sustainable Rivers Audit also failed to record any individuals at the 'best available' sites in the northern Basin and at the assessment sites in the Condamine drainage. In the first two sampling rounds of the Audit, a total of 39 individuals were recorded: 1 from the Border Rivers and 38 from 3 sites in the Namoi. In NSW the species has been recorded between about 250–900 m altitude.

Potential Threats

The relatively recent recognition of this species means that any declines have not been documented. Water abstraction may be an issue in the smaller creeks that it occupies. Other hardyheads are potentially threatened by habitat degradation, altered flow regimes and impacts of alien species such as Eastern gambusia.

General References

Crowley & Ivantsoff 1990; Ivantsoff & Crowley 1996; Morris *et al.* 2001; Harris & Gehrke 1997; Gehrke & Harris 2004; (P. Unmack unpubl. data) (G. Wilson unpubl. data).

Common Name Murray hardyhead

Threatened

Scientific Name *Craterocephalus fluviatilis* McCulloch, 1913

Identification

A small, laterally compressed fish with a small protrusible mouth, large silvery eye and short, blunt gill rakers. Maximum size 76 mm, commonly 40–65 mm. The two dorsal fins are small and short-based, and the second is directly above the anal fin. The tail is forked and the pectoral fins are positioned high on the body. The midlateral scale count is 31–35 and the transverse scale count is 10–12. The scales on top of the head are large and irregular in shape. The back is silver to golden, and the ventral surface is always paler with a silvery sheen. There is a silvery-black stripe midlaterally, and the opercula are bright silver. The scale margins on the back are darker, giving a reticulated appearance.

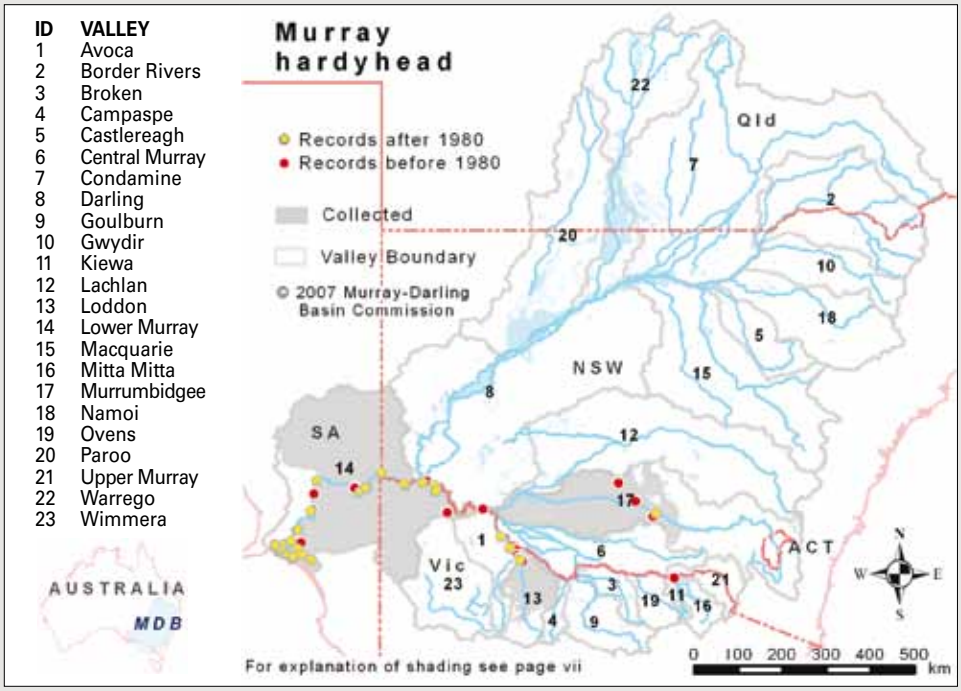
Biology and Habitat

Found around the margins of lakes, wetlands, backwaters and billabongs, the Murray hardyhead prefers open water, shallow, slow-flowing or still habitats, with sand or silt substrates, but can also be found in deeper habitats with dense aquatic vegetation.

The species appears to thrive in ephemeral deflation basin lakes and can survive in highly saline environments.

Mature males have been recorded at 27–34 mm caudal fork length and females at 41–43 mm, with fish maturing in their first year of life. Spawning occurs over an extended breeding season (September–April) but breeding usually occurs in late spring–early summer. The species is a batch spawner, with ovarian eggs at various stages of development. Details of the reproductive ecology and spawning site are currently being studied and are probably similar to other hardyhead species, which lay adhesive eggs amongst aquatic vegetation.

The Murray hardyhead is considered to be a largely annual species, although some individuals survive into their second year. It is omnivorous, eating primarily microcrustaceans but also some aquatic insects and algae. It is usually found in schools of distinct size classes—juveniles found throughout lakes (in open waters and associated with edge structure) and adults



observed over shallow habitats including open sand banks and in association with emergent macrophytes.

Little is known of its movements.

Distribution and Abundance

The Murray hardyhead is found only in the lowland areas of the southern Basin: in the mid to lower Murray as far upstream as Yarrawonga, and lower to mid Murrumbidgee drainages. Formerly abundant, it has suffered a significant reduction in distribution and is now a nationally threatened species. It is probably now extinct in the Murrumbidgee in NSW, and since 2000 only a single individual has been collected in NSW despite extensive surveys. Intermittently abundant at some locations, it is still present in a number of lakes near Swan Hill and Mildura in Vic, a few wetlands/saline basins along the Lower Murray, and the Lower Lakes in SA.

Potential Threats

The precise reasons for its dramatic decline are not known, but suspected to include increased salinisation, habitat degradation, altered flow regimes (decreasing connectivity with floodplain lakes), and impacts of alien species such as Eastern gambusia. The complete drying of some wetlands due to flow modification, coupled with the loss of connectivity with mainstream sites, has recently caused the extinction of two of the five remaining populations in Victoria.

General References

Crowley & Ivantsoff 1990; Ebner *et al.* 2003; Ellis 2005; Gilligan 2005a; Higham *et al.* 2005; Ivantsoff & Crowley 1996; Lyon & Ryan 2005; McCulloch 1913; Morris *et al.* 2001; Raadik & Harrington 1996; Wedderburn & Hammer 2003; (T. Raadik unpubl. data).

Common Name Un-specked hardyhead
(Fly-specked hardyhead, Non-speckled hardyhead)

Threatened

Scientific Name *Craterocephalus stercusmuscarum fulvus* Ivantsoff, Crowley & Allen, 1987

Identification

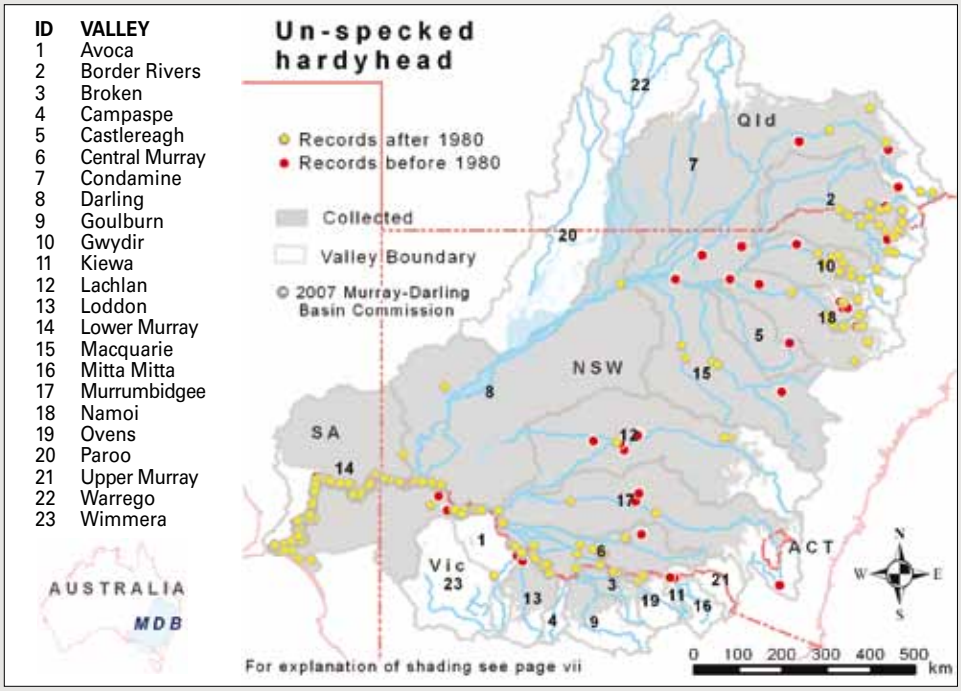
A small, slender fish with moderately thick lips, a small protrusible mouth and short, blunt gill rakers. Maximum size 78 mm; usually 50–60 mm. The two small dorsal fins are short-based and the second is directly above the anal fin. The tail is forked, the pectoral fins are positioned high on the body and the anal fin has 6–9 rays. The midlateral scale count is generally 32–35 and the transverse scale count is 7–7.5. The scales on top of the head are large and irregular in shape. Body colour varies between localities. There is a dusky stripe from the snout, through the eye and operculum, extending to the base of the caudal fin, although along the body this stripe may be black, golden or silvery. Males are a bright golden yellow during the spawning season.

This species is often referred to as the Fly-specked hardyhead. However, this name is not applicable to the subspecies that occurs in the Murray-Darling Basin, which lacks the dark spots of the northern, coastal subspecies.

Biology and Habitat

The Un-specked 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. It spawns from October to February, with a peak in spring when water temperatures are above 24°C, and is capable of multiple spawnings. Fecundity is low, with only 20–107 eggs laid. The eggs are transparent and demersal, with filamentous adhesive strands, and approximately 1.3–1.5 mm diameter. Larvae are 3–5 mm on hatching, after 4–7 days incubation.

The Un-specked 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. 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.

Distribution and Abundance

The Un-specked 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. In the south, populations are still present in the Lower Lakes (Alexandrina and Albert) and Lower Murray wetlands and main channel in SA, the central Murray and lower Murrumbidgee in NSW and extending upstream in the Murray to near Howlong, though restricted or absent from most tributaries in Vic. Pre 1913 collections of 'hardyheads' by David Stead from upland sites (~780 m; the Cudegong above Rawden; the Murrumbidgee near Cooma) may also have been of this species, but no specimens were retained.

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).

Common Name Small-mouthed hardyhead

Restricted

Scientific Name *Atherinosoma microstoma* (Günther, 1861)

Identification

A small, semi-transparent, slender fish with a small, barely protrusible mouth, thin lips, large silvery eye and long gill rakers (> half the diameter of the pupil). Maximum size 107 mm; commonly < 80 mm. The two small dorsal fins are short-based, with the second above or slightly behind the origin of the anal fin. The tail is forked, the pectoral fins are positioned high on the body and the anal fin has 7–12 rays. The midlateral scale count is 36–41 and the transverse scale count is 7. Body colour is normally silver but can be green or green-brown above the midlateral stripe, and light green, yellow, white or silvery below. The opercula are bright silver. Males develop intense, bright-orange lateral stripes during the spawning season.

Biology and Habitat

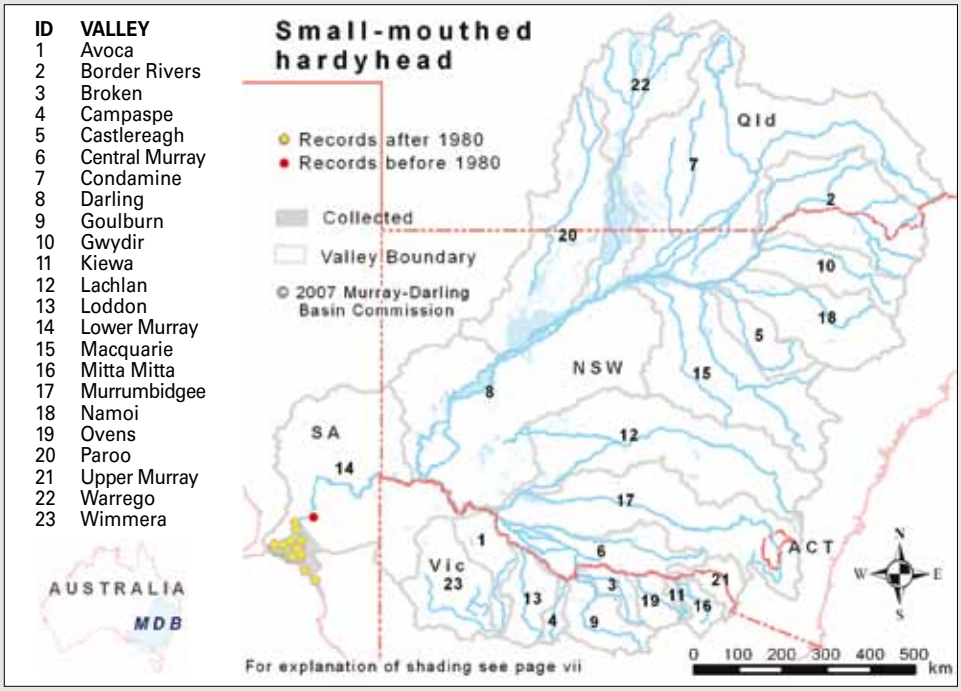
The Small-mouthed hardyhead is a flexible species that normally occurs in estuaries but has a very wide salinity tolerance and is thus capable of living in inland habitats such as lakes and the lower end of freshwater rivers. It is normally found in brackish lakes, lagoons and estuaries in still or slow flowing habitats, and adjacent marine habitats. It is common in estuarine eel-grass habitats. In the Lower Lakes (Alexandrina and Albert) it occurs in edge habitats (e.g. near reeds) or those with aquatic vegetation. It is largely an annual species, breeding in spring and early summer. The diet includes microcrustaceans and insects.

Distribution and Abundance

The Small-mouthed hardyhead is a common and widespread species in coastal streams of southeast Australia. In the Basin, it is only known from the Lower Lakes of SA and a small distance upstream along the main channel of the Murray and associated wetlands, where it exists as largely landlocked populations.

Potential Threats

None known.



Small-mouthed hardyhead and Murray hardyhead habitat, Hindmarsh Island

General References

Allen *et al.* 2002; Cadwallader & Backhouse 1983; Higham *et al.* 2005; Ivantsoff & Crowley 1996; Molsher *et al.* 1994; Potter *et al.* 1986; Stuart *et al.* 2005; Wedderburn & Hammer 2003.

Common Name Murray-Darling rainbowfish
(Crimson-spotted rainbowfish, Murray River rainbowfish)

Uncommon

Scientific Name *Melanotaenia fluviatilis* (Castelnau, 1878)

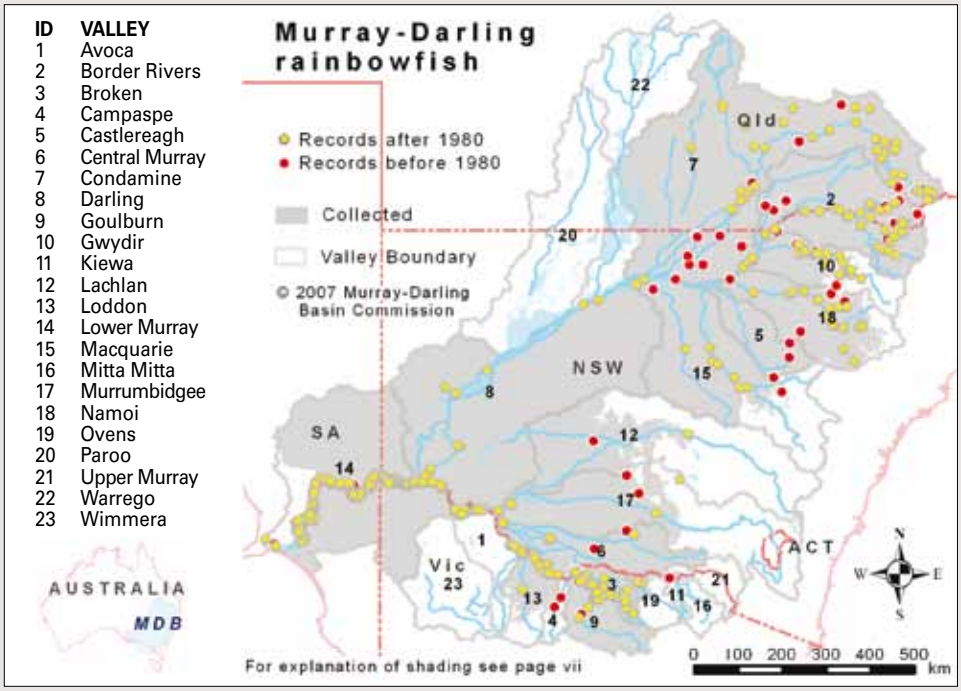
Male in breeding colouration

Identification

A small, strongly laterally compressed fish, the adults of which have a relatively deep body. Maximum length 90 mm, commonly less than 70 mm. The eyes are large and positioned towards the top of the head, and the mouth is moderately large, oblique and upturned, with several rows of small, conical teeth. There are two dorsal fins separated by a small gap, with the first short-based and the second long-based. There is a long-based anal fin and the tail is moderately forked. There is no lateral line and the scales are relatively large. Colouration varies with sex, age and habitat, but is generally silvery with a greenish iridescence and whitish on the lower head and belly. Younger individuals are translucent. The majority of scales have a brownish margin. There is a pink to-reddish spot on the operculum. Males have red spots on the dorsal, caudal and anal fins, and the fins of breeding males have a blackish margin. Females and immatures have clear fins.

Biology and 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. It is a schooling species—schools of 30 or more are commonly seen swimming just below the water surface. Breeding is seasonal, generally spring-summer when water temperature exceeds 20°C, and males perform an elaborate courtship display. Fecundity is low (average 130 eggs, range 35–333) with females laying 5–20 eggs per batch, in 3–4 batches per day for several days. The eggs sink and lodge amongst aquatic plants, where they attach via adhesive threads. Eggs are 1.3–1.8 mm diameter, and hatch after about 1 week, with the larvae ~2.0–3.7 mm long. Individuals mature at 10–12 months old. Until recently it was not known that this species migrated, but individuals as small as 21 mm have been recorded moving through a fishway on the Murrumbidgee River, most commonly in the afternoon and dusk.



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

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 Vic, cold winter temperatures limit it to the Murray and its tributaries such as the Goulburn and Broken rivers. The species is not present in the relatively upland ACT, and appears to have disappeared from the Lower Lakes in SA. It is still common but localised/patchy in wetlands and vegetated edges of the main channel of the Lower Murray River in SA and the lower Victorian section below the Darling junction. It appears to be common in the Qld portion of the Basin, but may be confused with the Desert rainbowfish.

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.

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.

Common Name Desert rainbowfish

Rare

Scientific Name *Melanotaenia splendida* tatei (Zietz, 1896)

Male in breeding colouration

Identification

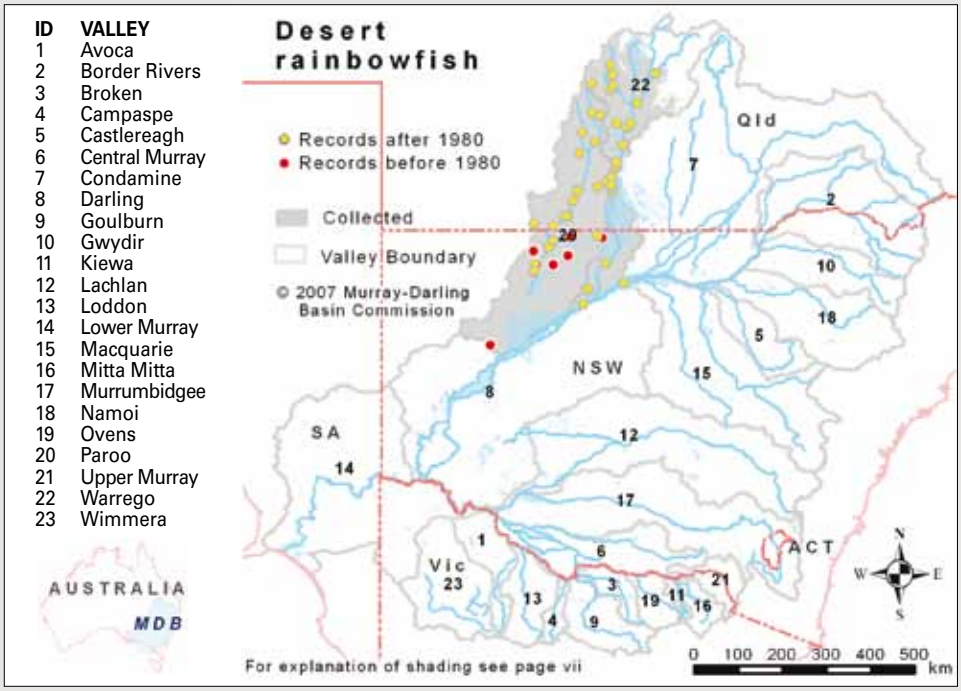
A small, strongly laterally compressed fish reaching approximately 90 mm in length. The eyes are large and positioned towards the top of the head, and the mouth is moderately large, oblique and upturned. There are two dorsal fins separated by a small gap, with the first short-based and the second long-based. There is a long-based anal fin and the tail is moderately forked. There is no lateral line. Colouration varies with sex, age and habitat, but is generally silvery and iridescent, with a yellow and green chequered pattern on the unpaired fins and pale stripes along the sides. Unlike Murray-Darling rainbowfish, there is no pink to reddish spot on the operculum, but otherwise the two species are very similar in scale counts, number of fin rays etc. The easiest way to distinguish them is by colour.

Currently, three subspecies of *M. splendida* are recognised, but morphological differences are slight and colour patterns are highly variable, making identification in the field difficult. Recent genetic investigations have identified hybrids between the Desert rainbowfish and the Murray-Darling rainbowfish, further confounding the identification of these species in some areas.

Biology and Habitat

As its name suggests, Desert rainbowfish is an arid-adapted species, found in a variety of slow-flowing and still habitats, including ephemeral rivers, waterholes, lakes, flowing bores and stock dams. These habitats are often quite turbid and highly variable in terms of permanence.

Like other rainbowfish, the Desert rainbowfish is a schooling species and commonly seen swimming just below the water surface. Breeding is probably dependant on local conditions, occurring when water temperatures are above about 20°C and after good rains. Adults mature at about 30–35 mm length and males perform a courtship display among aquatic vegetation. The eggs are laid amongst aquatic plants or on the exposed roots of riparian vegetation (although aquatic plants and roots are not very common where this species occurs, compared to the



other subspecies). In aquaria, females lay 80–100 small eggs (0.8–0.95 mm diameter), often in daily batches, and the eggs hatch after 7 days at 24°C. The newly hatched larvae are 4–5 mm long.

The species is omnivorous, consuming small aquatic invertebrates as well as filamentous algae.

Distribution and Abundance

The Desert rainbowfish is widespread and abundant in the larger rivers of the Lake Eyre Basin and the Western Plateau of the NT. This species has only recently been identified from the Murray-Darling Basin, where it is recorded from the arid rivers in the north-western Basin. It is found only in the Paroo and Warrego rivers, and hybrids with Murray-Darling rainbowfish have been identified in the lowermost Warrego River and the Darling River from around the Bogan River down to at least Menindee. Any rainbowfish captured in or near the Darling River need to be carefully examined, as confusion or hybridisation with Murray-Darling rainbowfish is likely.

Potential Threats

None known. Interactions with Eastern gambusia may be a threat as numbers of Desert rainbowfish at some localities appeared to decline significantly after flooding in the early 1990s facilitated the spread of gambusia.

General References

Larson and Martin 1989; Leggett and Merrick 1987; McGuigan *et al.* 2000; Pusey *et al.* 2004; Wager and Unmack 2000; (P. Unmack unpubl. data).

Common Name Olive perchlet (Agassiz's glassfish, Glass perchlet, Western chanda perch)

Threatened

Scientific Name *Ambassis agassizii* Steindachner 1866

Identification

A small, oval fish with a laterally compressed body, moderately large oblique mouth and gape reaching just past the front of the very large eye. Maximum size 76 mm; commonly < 50 mm. The tail is forked and the single dorsal fin is deeply notched between the spinous front section and the rayed rear section. The anal fin is directly below the rayed rear section of the dorsal fin. The body is olive to semitransparent and the scales have brownish margins, giving it a reticulated appearance. The fins are clear.

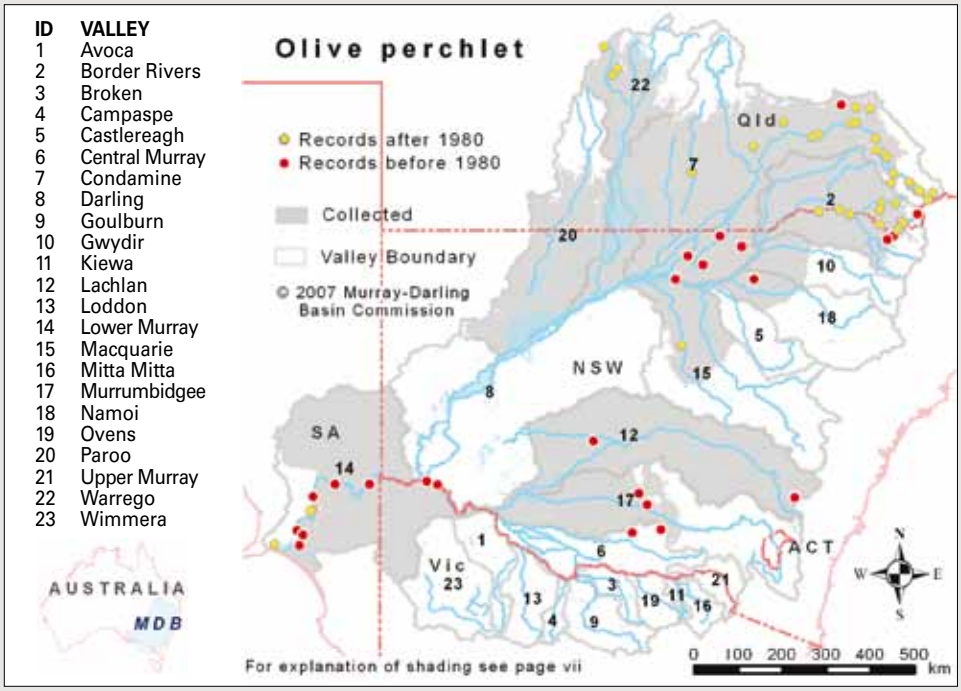
Biology and Habitat

The Olive perchlet inhabits the vegetated edges of lakes, creeks, swamps, wetlands and rivers, where it is often associated with woody habitat and aquatic vegetation in areas with little or no flow, particularly backwaters. It forms almost stationary, small schools during daylight hours in areas close to instream cover, which disperse during darkness. Both males and females are mature at 1 year of age, and live for 2–4 years, and females live longer than males. Spawning occurs from October to December, when water temperature reaches 22–23°C. Fecundity is usually 200–700 eggs, although a 49 mm long female has been reported to contain 2350 eggs. The eggs are small (0.7 mm diameter), adhesive and attach to aquatic plants and rocks on the streambed. Hatching occurs in 5–7 days at 22°C, and larvae are approximately 3 mm long at hatching.

Olive perchlets are carnivorous, eating a range of microcrustaceans (copepods and cladocera), aquatic and terrestrial insects including mosquito wrigglers and small arachnids and, occasionally, small fish. This species feeds mainly during daylight hours. Little is known of its movement patterns in the Basin, but in coastal streams migration through tidal barrage fishways has been recorded.

Distribution and Abundance

This species is still present in coastal streams from northern NSW to north Qld, but has undergone a significant decline in most of the Basin. It is now naturally extinct in SA,



where it is present only as a single translocated population, and extinct in Vic. In NSW it is known from only a few localities in the Darling drainage upstream of Bourke, but is still locally abundant in the Border Rivers and Condamine-Balonne system and present in the Nebine and Warrego catchments in Qld. Formerly, it was widespread in the lower Murrumbidgee, Lachlan and lower Murray rivers and throughout the Darling drainage in NSW. The species historic range only just extended to Vic where it was formerly present in an irrigation channel near Mildura, where it was last recorded in 1922. The last confirmed record from the Basin drainage in SA was in 1983.

Potential Threats

The precise reasons for the decline of this species are unknown, but predation by alien species (particularly Eastern gambusia and Redfin perch), cold-water pollution that restricts spawning, habitat degradation, river regulation and related decline in wetland condition (e.g. loss of macrophyte beds in SA) are thought to be significant.

General References

Allen 1996; Allen & Burgess 1990; Cadwallader & Backhouse 1983; Lloyd & Walker 1986; Medeiros 2004; Milton & Arthington 1985; Moffat & Voller 2002; Morris *et al*. 2001.

Common Name Golden perch (Yellowbelly, Callop, Murray perch)

Scientific Name *Macquaria ambigua ambigua* (Richardson, 1845)

Identification

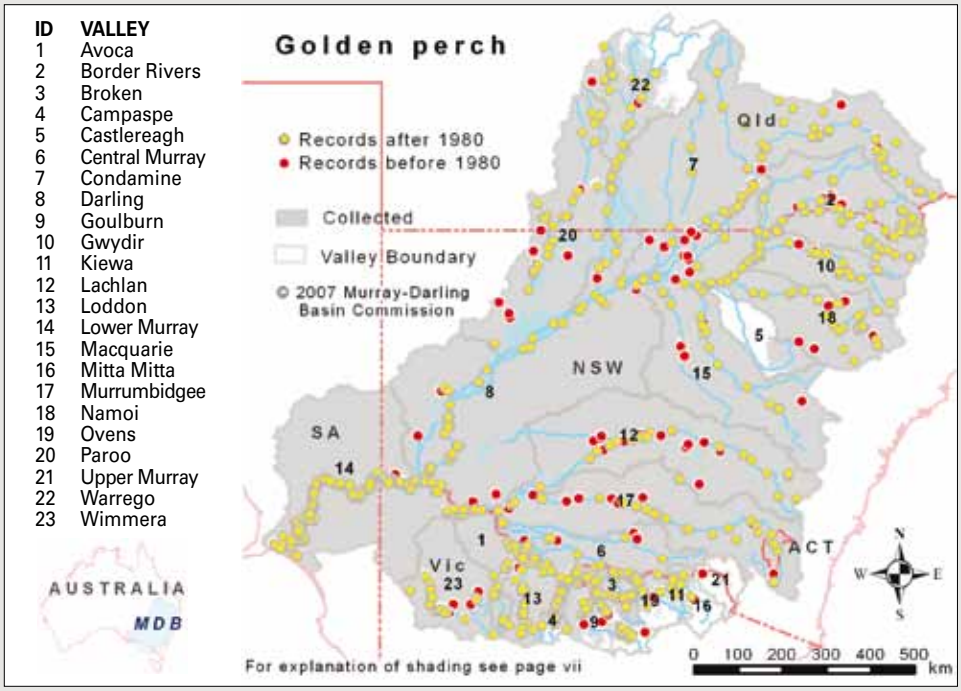
A medium to large fish with a deep, laterally compressed body. Maximum weight 23 kg and maximum length 760 mm; usually less than 400 mm and 4 kg. The body colour being generally olive-green with a yellow or cream belly. The mouth is large with the lower jaw protruding slightly. The tail is rounded.

Biology and 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. Males are reproductively mature at 2 years and females at 4 years, and are generally thought to spawn in floods during spring and summer when water temperature exceeds about 20°C. However, recent evidence from the Murray River suggests that this species is able to spawn during relatively stable, bankfull irrigation flows. Spawning was significantly increased during the 2005 environmental water release in the mid-Murray.

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.

Golden perch are highly fecund, with a 2.3 kg female holding up to 500,000 eggs. Water-hardened eggs are large (~3–4 mm diameter), semi-buoyant and drift downstream. Hatching occurs after 1–2 days and newly hatched larvae are about 3.5 mm long.



Regular breeding has been recorded in some lakes in the Canberra region (Googong, Lake Burley Griffin), but these events are usually small-scale and insufficient to support viable fisheries.

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.

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. For example, in the Canberra region the species had effectively disappeared from the upper Murrumbidgee catchment above Lake Burrinjuck and has only re-established after successful lake stockings commencing in the early 1970s. The species is widely stocked in farm dams, lakes and streams in some States and forms the basis for popular recreational fisheries.

A closely related but genetically distinct species has been identified from the Lake Eyre and Bulloo drainages in central Australia.

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.

Common Name Macquarie perch (White eye, Mountain perch, Black bream)

Threatened

Scientific Name *Macquaria australasica* Cuvier, 1830

Identification

A medium sized fish with a deep, laterally compressed body. Maximum length 465 mm and maximum weight 3.5 kg; usually less than 350 mm and 1 kg. The body colour is generally black-grey or bluish grey, and some individuals are distinctly mottled, particularly small juveniles. The tail is rounded, the eye is large and white, and there are prominent pores on the snout and around the eyes. The mouth is large and the jaws equal in length.

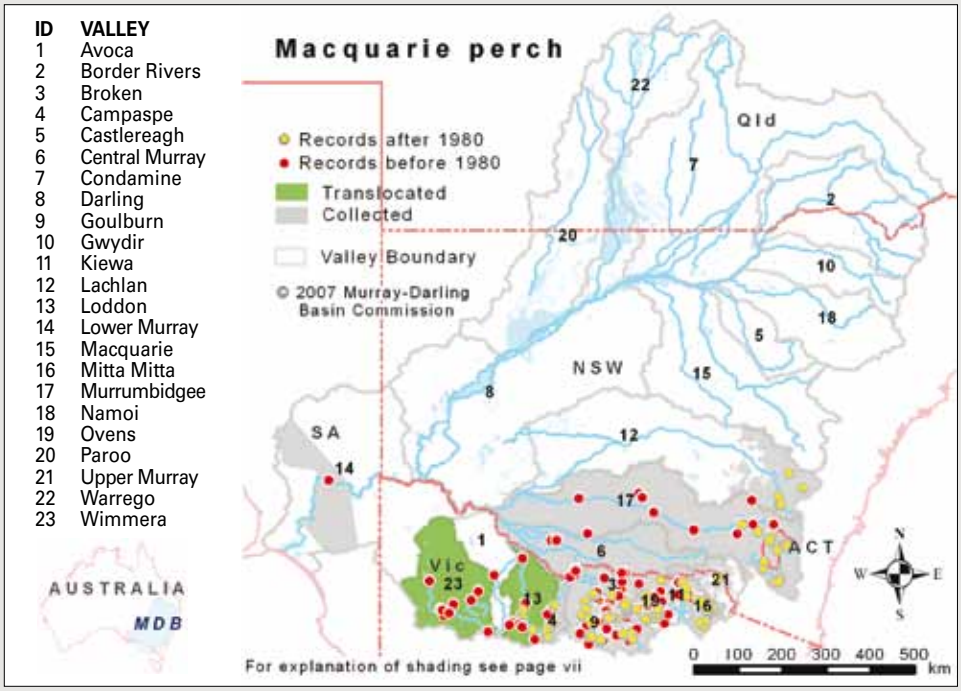
Biology and Habitat

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). More is known of the ecology of the Murray-Darling form than the coastal form, although many aspects of their ecology are similar. Males are reported to reach sexual maturity at 2 years of age and approximately 210 mm total length, and females at 3 years and 300 mm. In the Cotter River, ACT, males mature at about 140–150 mm and in Lake Dartmouth ripe males have been recorded down to lengths of 117 mm. Spawning occurs from October to December, with fish from lakes moving into tributaries to spawn. The spawning sites are located at the foot of pools and the eggs drift downstream and lodge amongst gravel and cobble in riffles. Hatching usually occurs after 10–11 days at water temperatures of 15–17°C and the newly hatched larvae being about 7 mm long. Radio-tracking studies have shown that adult and sub-adult fish are largely crepuscular and nocturnal, and occupy well-defined home-sites during the day.

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.

Distribution and Abundance

The Murray-Darling form is typically found in the cool, upper reaches of the Murray-



Darling River system in Vic, NSW and the ACT. It is still known to exist in the upper reaches of the Murrumbidgee, Lachlan and Murray catchments in NSW; the Goulburn, Broken, Ovens and Mitta Mitta catchments in Vic; and the Paddys, Cotter and Murrumbidgee rivers in the ACT. The species has been stocked or translocated into a number of reservoirs including Talbingo, Cataract, Khancoban and Coliban reservoirs, and translocated into streams including the Yarra, Mongarlowe and Wannon rivers, and Sevens Creek. 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.

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.

Common Name Estuary perch (Estuarine perch) **Rare**

Scientific Name *Macquaria colonorum* (Günther, 1863)

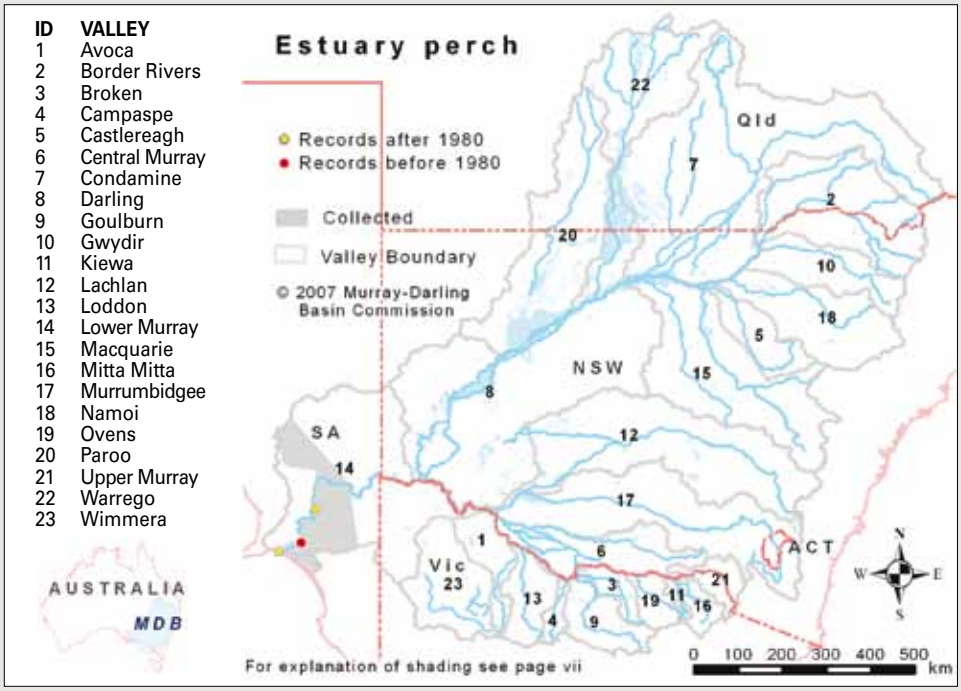
Identification

A medium sized fish with a deep, laterally compressed body. Maximum length 750 mm, maximum weight 10 kg; usually less than 1.5 kg. There is a single dorsal fin with a moderately deep notch between the spinous and soft-rayed portions. The pelvic fins are inserted behind the origin of the pectoral fins. The back is generally dark grey and silvery, paling to whitish on the lower sides. The tail is forked, the eye is moderately large and the mouth is of moderate size with a protruding lower jaw. The dorsal head profile is slightly concave.

Biology and Habitat

The Estuary perch predominantly lives in tidal or estuarine waters, but will penetrate significant distances upstream into fresh waters. It breeds in seawater at the entrance of estuaries in winter when water temperatures are from 14 to 19°C. Males mature at 220 mm length and females at 280 mm. Fecundity is high and increases with fish length: a 34 cm fish has 182,000 eggs and a 40 cm fish 540,000. The eggs are 1.3–2.4 mm in diameter, round, non-adhesive and semi-buoyant. They hatch in 2–3 days and the newly hatched larvae are about 2.2 mm long.

The species is an opportunistic carnivore, favouring mid-water prey such as shrimp and fish. The composition of the diet from freshwater environments in the Basin is unknown. However, a study of diet in both freshwater and estuarine habitats of the Hopkins River found that both large (> 250 mm) and small (< 250 mm) fish consumed mostly caddisfly larvae, and shrimp (*Paratya*) were the next most common item. In the estuary, large fish (> 300 mm) fed mainly on fish, amphipods and shrimp, in descending order of importance, whereas small fish (< 250 m) fed mainly on shrimp and then amphipods. The diet varied seasonally, with terrestrial insects becoming prominent in November. Apart from the adult migration downstream to estuaries to breed, little is known of movements.



Distribution and Abundance

Essentially a fish of coastal drainages from the Murray mouth in SA to Northern NSW, Estuary perch is rare in the Basin, and recorded only from the Lower Murray, Lower Lakes (Alexandrina and Albert) and the Coorong. Specimens have been recorded in recent years from as far up the Murray as Swan Reach.

Potential Threats

Since the construction of the barrages and decline in river flows, the abundance of this species has fallen significantly in the Lower Lakes (Alexandrina and Albert).

General References

Allen *et al.* 2002; Harris & Rowland 1996; Howell *et al.* 2004; Koehn & O'Connor 1990; McCarragher & McKenzie 1986; Merrick & Schmida 1984; Sim *et al.* 2000; Wedderburn & Hammer 2003.

Common Name Trout cod (Blue-nose cod) **Threatened**

Scientific Name *Maccullochella macquariensis* (Cuvier, 1829)

Identification

A large, deep-bodied fish with a large mouth reaching to below the back of the eye. Maximum size 16 kg and 850 mm; usually < 5kg. The head profile is straight, and the upper jaw overhangs the lower. The tail is rounded and the pelvic fins are located below the pectorals. 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.

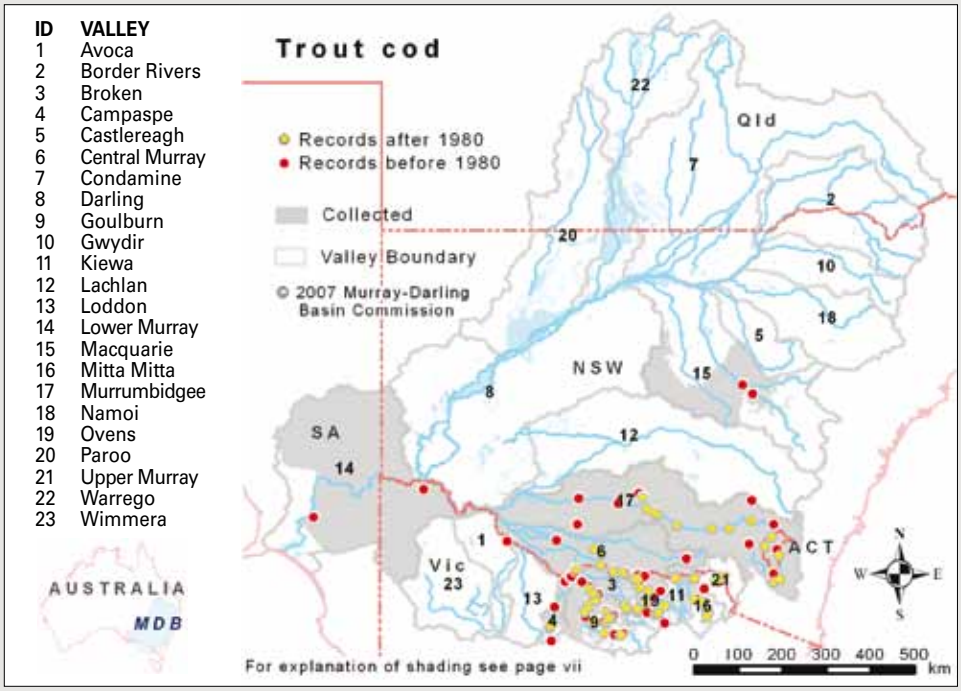
Biology and Habitat

Only formally recognised as a separate species from Murray cod in 1972, some aspects of the biology of Trout cod are poorly known. 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. Sexual maturity is reached at 3–5 years of age when fish are 0.75–1.5 kg and spawning occurs in late spring (mid-October–mid-November). Fecundity is ~1200–11,000 eggs per female. The eggs are large (2.5–3.6 mm diameter), adhesive, and probably deposited on hard substrates such as logs and rocks. After 5–10 days, larvae of about 6–9 mm length hatch.

The diet includes fish, yabbies, mudeyes, aquatic insect larvae, shrimps and freshwater prawns. Recent research in the lowlands of the Murrumbidgee River has demonstrated that adults occupy small areas of less than 500 m centred on a 'home snag', and occasionally undertake exploratory movements of 20–60 km involving a return to their home.

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.

Trout cod was originally described from the Macquarie River, where it has not been recorded since the 1820s, other than a single unconfirmed record from the Turon River in the 1970s. It was not known from the Darling River. Formerly widespread in the southern Murray-Darling Basin (Murray, Murrumbidgee and Macquarie rivers, NSW/ACT; Ovens, Goulburn, Campaspe, King, Buffalo, Mitta Mitta rivers, Vic; Murray River, SA), the species declined significantly in the 1970s. A long-term stocking program since the late 1980s has reintroduced Trout cod to a number of locations in the Basin including sites on the Murrumbidgee, Macquarie, Ovens, Goulburn, Tumut and upper Murray drainages. The species has also been stocked in Bendora Reservoir, ACT, and Talbingo Reservoir, NSW. Unfortunately, these reintroductions have not resulted in the establishment of viable populations, although breeding has been recorded in the Goulburn and Cotter rivers and is suspected in the mid-Murrumbidgee River.

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.

Common Name Murray cod (Cod, Goodoo) **Threatened**

Scientific Name *Maccullochella peelii peelii* (Mitchell, 1838)

Identification

The largest Australian freshwater fish, reaching 113.6 kg and 1800 mm length. Easily identified by its large mouth, cream to white belly and green mottled pattern on the body and head. Adults have a broad head with a concave profile. The spiny front portion of the long, single dorsal fin is lower than the softer rear portion. The tail is rounded.

Biology and Habitat

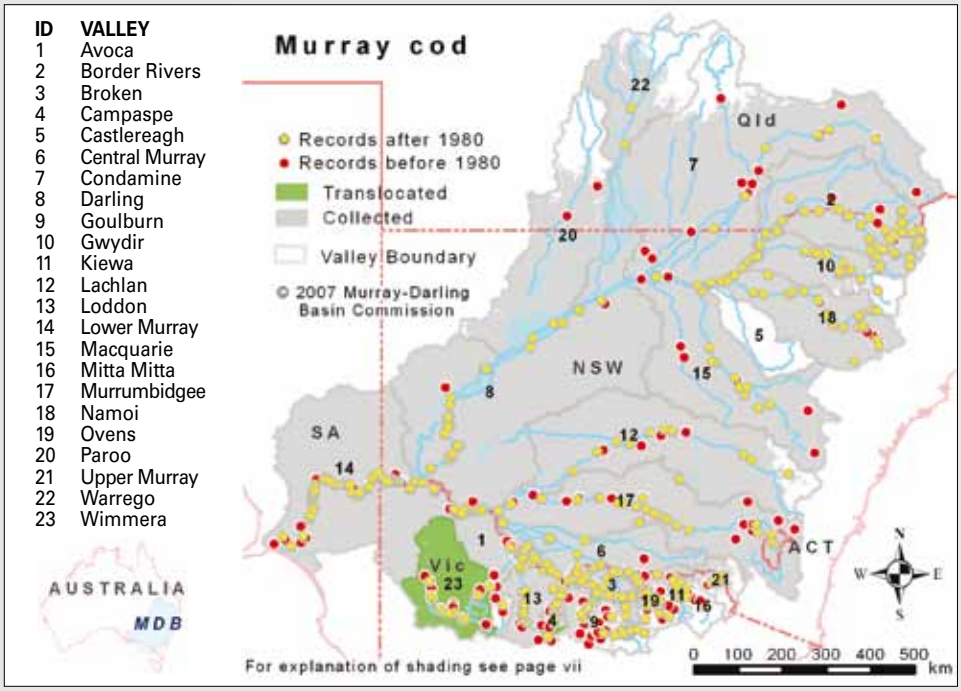
The Murray cod is an icon of the Basin and forms the basis of a popular recreational fishery in south-eastern Australia where it is often stocked into dams and lakes. The species is important in Aboriginal mythology: a huge Murray cod is responsible for forming the Murray River and all its fishes.

Generally associated with deep holes in rivers, the Murray cod prefers habitats with instream cover such as rocks, stumps, fallen trees or undercut banks. A 'sit and wait' predator, its diet contains fish, crayfish and frogs.

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.

The species matures at 4–5 years of age and 500–600 mm total length, and spawns in spring and early summer when water temperatures exceed about 15°C. Eggs are large (3–3.5 mm diameter), adhesive and usually deposited onto a hard surface such as logs, rocks or clay banks. The male guards the eggs during incubation and they hatch after 5–13 days. The larvae are about 5–8 mm long at hatching and have a large yolk sac. Larvae drift downstream for 5–7 days, particularly by night in spring and summer (late-October–mid-January, peaking from mid-November–mid-December).

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.

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.

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.

Common Name Silver perch (Black bream, Silver bream, Bidyan) **Threatened**

Scientific Name *Bidyanus bidyanus* (Mitchell, 1838)

Identification

A medium to large, fish with a body that becomes deeper and more laterally compressed with age. Maximum length ~500 mm and maximum weight 8 kg; usually 350 mm and 2 kg. The single dorsal fin has a higher, spinous anterior section and a lower, rayed section at the rear. The body colour is grey to grey-brown with a lighter belly. The scales are much smaller than those on Golden or Macquarie perch, and the head and mouth are small. The tail is weakly forked.

Biology and Habitat

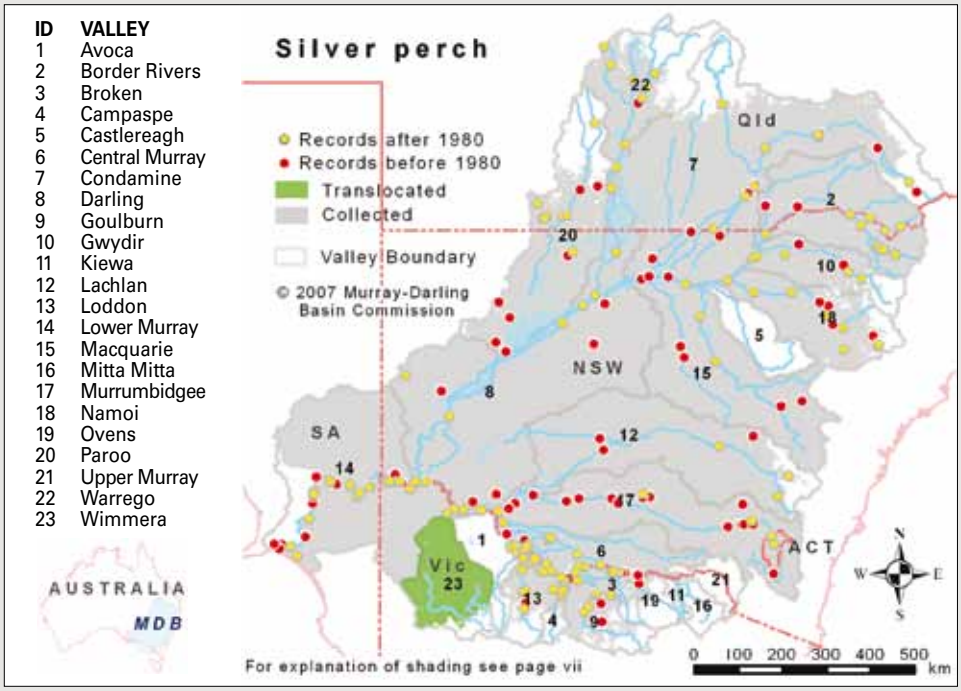
Silver perch are found in similar habitats to Murray cod and Golden perch, i.e. lowland, turbid and slow-flowing rivers. This species is bred artificially in a number of government and commercial hatcheries and widely stocked into farm dams and reservoirs. It has been the subject of considerable interest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

Individuals mature at 3–5 years—males earlier than females. They spawn in spring and summer after an upstream migration, when large schools often form. Spawning possibly occurs at night, just after dusk. Whilst spawning can occur during non-flood conditions, spawning activity was significantly increased during a flood and environmental water release in 2005 in the mid-Murray River. Immature individuals have been recorded moving through fishways in the Murray and Murrumbidgee rivers. Murrumbidgee fish moved during afternoon and dusk periods, and fish as small as 68 mm were involved.

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.

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. Numbers moving through a fishway at Euston Weir on the Murray River declined by 93% between 1940 and 1990. Only nine Silver perch were recorded in a two-year survey of 40 randomly selected sites in the NSW portion of the Basin in the mid 1990s. Similarly, 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. The ACT probably represented the upstream limit of distribution in the Murrumbidgee catchment, although the large spawning run of fish that occurred in summer from Lake Burrinjuck is unfortunately a thing of the past.

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.

Common Name Spangled perch (Spangled grunter, Jewel perch)

Scientific Name *Leiopotherapon unicolor* (Günther, 1859)

Identification

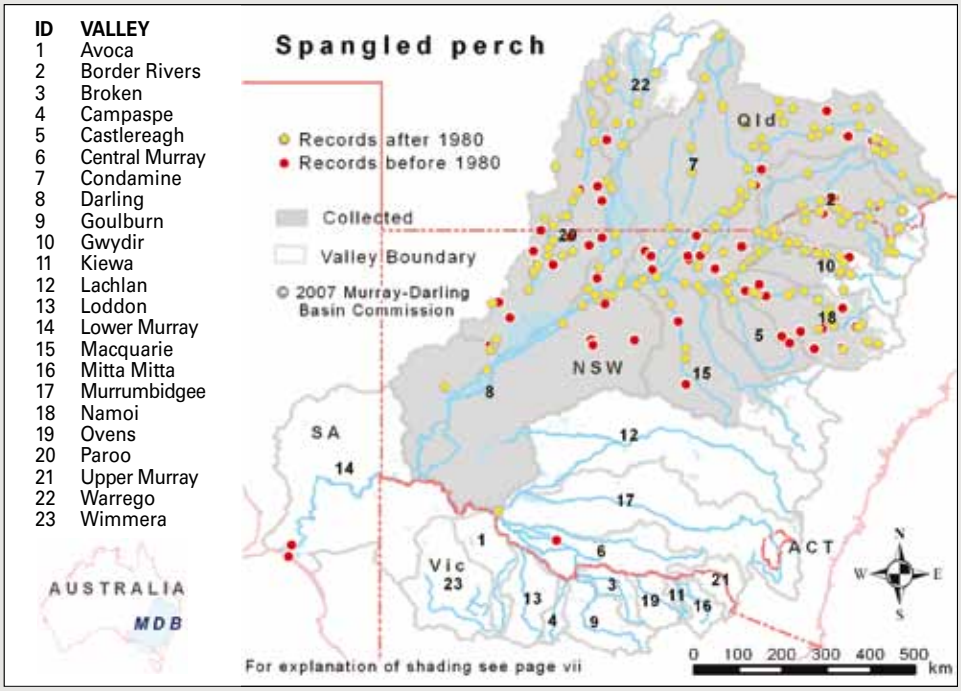
A small to medium sized, laterally compressed fish with a relatively slender body for a grunter. Maximum size 330 mm; rarely 250 mm and 560 g; commonly 150 mm. The single dorsal fin has a moderately sized notch between the spinous and soft-rayed portions. The pelvic fins are inserted behind the origin of the pectoral fins. The anal and pelvic fins are white. The back is generally brown to steely-blue and the sides silvery-grey with numerous bronze to rusty-brown spots. The tail is slightly forked, the eye is small to moderate, and the mouth is of moderate size with equal jaws.

Biology and Habitat

The Spangled perch is a hardy species that is well adapted to surviving in diverse environments such as rivers, billabongs, lakes, isolated dams, bore-drains, wells and waterholes in intermittent streams. It can survive temperatures up to 40°C, but doesn't like the cold, with a lower lethal limit of around 4.1°C and markedly lower survival below 7.2°C. It has admirable dispersal abilities which allows it to rapidly colonise habitats not readily accessible to other fish species. During heavy rain it has been observed swimming across flooded paddocks and along wheel ruts on tracks.

Individuals mature in their first year, males at about 58 mm length and females at 78 mm. Breeding occurs from November to February and fecundity is high and size-dependant, with between 24,000 and 113,200 eggs per female. Spawning occurs when water temperatures are above 20–22°C and a rise in water level is not essential as the species will breed in impoundments. However, flooding maximises recruitment. Spawning occurs at night, in shallow areas such as backwaters or still pools and eggs are spread randomly over the bottom. The eggs are small (0.7 mm), round, demersal and non-adhesive and hatch in 45–55 hrs at 23–26°C.

Movement can be associated with spawning or dispersal, and fish move rapidly upstream, downstream or laterally in flooded environments. The Spangled perch feeds



mainly during daylight hours and is primarily a carnivore, although it consumes some plant material (~10 % of diet). Aquatic insects, shrimps and prawns, microcrustaceans and fish are important components of the diet, with the relative importance varying between studies and locations.

Distribution and Abundance

The Spangled perch is Australia's most widespread native freshwater fish, occurring across most of northern Australia. In the Murray-Darling Basin it occurs on the north and western portions, essentially north of Condoblin. It is rare in southern waters of the Basin (down to the Murray), and is recorded in such areas only after extensive flooding in northern rivers. It is not known from the ACT or Vic. Cold winter water temperatures are thought to limit its distribution. This perch can be very abundant, especially after flooding, but this varies with seasonal conditions.

Potential Threats

Spangled perch has lower abundance in regulated rivers, with aspects of river regulation such as cold-water pollution, barriers to fish movement, reduced flooding and access to floodplains likely to disadvantage it.

General References

Allen *et al.* 2002; Beumer 1979b,c; Bishop *et al.* 2001; Bostock *et al.* 2006; Harris & Gehrke 1997; Llewellyn 1973; Medeiros 2004; Merrick 1996; Merrick & Schmida 1984; Pusey *et al.* 2004.

Common Name Southern pygmy perch (Swamp perch) **Threatened**

Scientific Name *Nannoperca australis* Günther, 1861

Identification

A small, laterally compressed fish with a deeply notched single dorsal fin. Maximum size 85 mm; usually less than 65 mm. The tail is squarish to slightly rounded, and the mouth is small, reaching to just below the front of the eye. The lower edge of the preorbital bone is hidden under skin, and is curved with a smooth (non-serrate) edge (compare with Yarra pygmy perch). The lateral line is discontinuous. Body colour varies from cream to gold-orange to a greenish-brown, darker on the dorsal surface, and almost white on the belly, with a series of dark blotches on the side. Males in the breeding season have bright red dorsal, anal and inner caudal fins. Breeding males also have prominent black colouration on the pelvic and anal fins and around the vent.

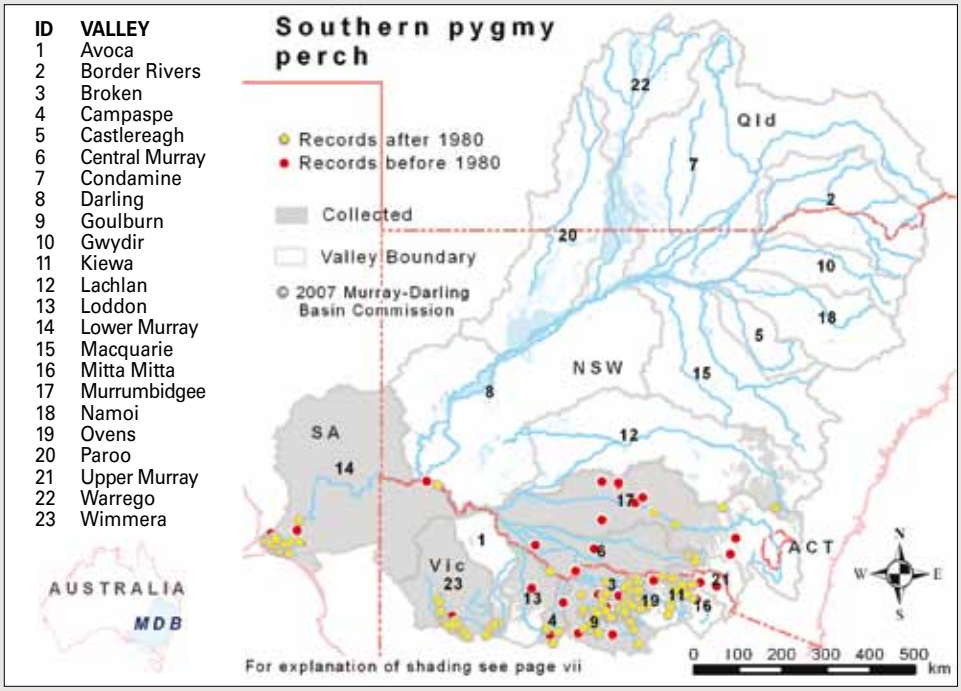
Biology and Habitat

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. Fish can live for 5 years or more although most individuals in a population are less than 3 years old. Females grow larger than males and both sexes mature in their first year at 30–33 mm. Spawning usually occurs between September and January when water temperatures exceed 16°C, and males are territorial when breeding. Depending on their size, females produce 100–4,200 round, transparent and non-adhesive eggs. The eggs are scattered over the bottom or aquatic vegetation and hatch in 2–4 days, with the larvae about 3–4 mm long.

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

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.

Recent genetic studies have shown that there are two species within the Southern pygmy perch: an eastern coastal species and a species in the Basin and western coastal streams. The Basin form likely represents a separate sub-species and is never particularly abundant in any location, having suffered severe declines and fragmentation of populations since the 1970s.

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.

Common Name Yarra pygmy perch

Restricted

Scientific Name *Nannoperca obscura* (Klunzinger, 1872)

Photo: Gunther Schmida

Identification

A small, laterally compressed fish with a deeply notched single dorsal fin. Maximum size 75 mm; usually less than 65 mm. The tail is slightly rounded, and the mouth is small, reaching to just below the front of the eye. The lateral line is discontinuous. The lower, free edge of preorbital bone is straight, with the edge strongly serrated (compare with Southern pygmy perch). The body colour is gold to dusky brown-grey, paler on the belly, with dark spots or blotches in a row along the midline. The pelvic fins turn black in breeding males. The black pupil of the eye forms an imperfect circle (slightly notched compared with circular in Southern pygmy perch).

Biology and Habitat

In the Basin the Yarra pygmy perch is restricted to the Lake Alexandrina region in slow-flowing waters, wetland or drainage channel habitats with abundant submerged aquatic vegetation. It is found in small groups, often mixed with Southern pygmy perch.

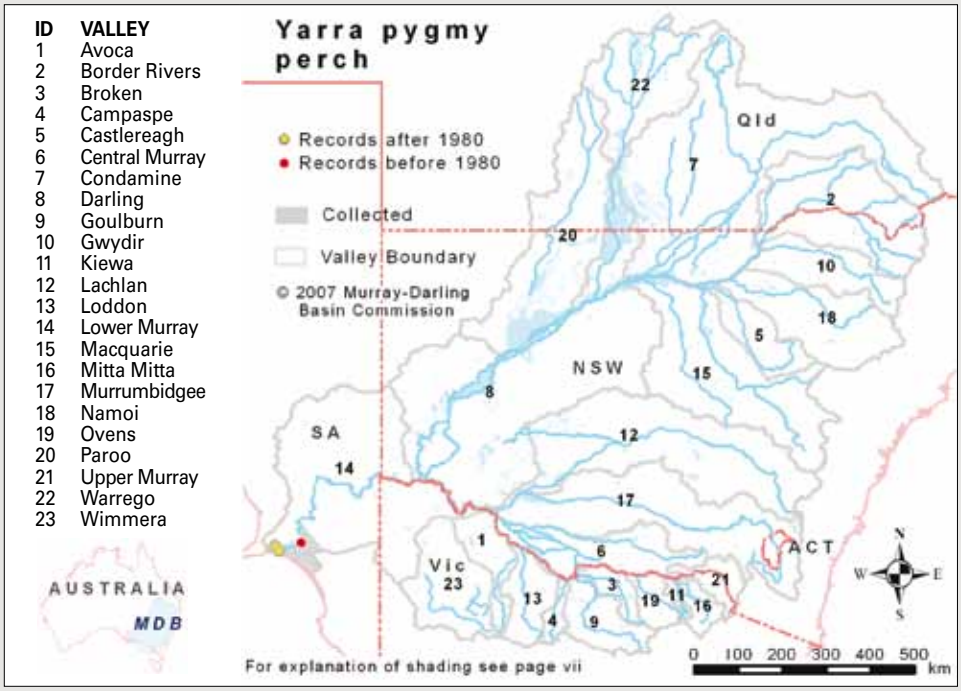
It breeds in spring, at water temperatures between 16 and 24°C. The diet includes microcrustaceans, molluscs and aquatic insects, such as mosquito larvae.

Distribution and Abundance

In the Basin, the Yarra pygmy perch is found only in Lake Alexandrina in the lower Murray. It is also found in coastal streams in western Vic and patchily throughout southeast SA, and it is locally common within suitable habitats in Lake Alexandrina.

Potential Threats

Predation by alien species such as Redfin perch and possibly Eastern gambusia may threaten the Basin populations. Habitat alteration such as loss of aquatic vegetation in irrigation channel/drain habitats or alienation of wetland habitats may also impact on the extremely localised populations of this species in the Basin.



Yarra pygmy perch habitat, Finnis River

General References

Allen *et al.* 2002; Cadwallader & Backhouse 1983; Hammer 2002b; Higham *et al.* 2005; Wedderburn & Hammer 2003; Woodward & Malone 2002.

Common Name Two-spined blackfish (Slippery, Slimy, Greasy) **Threatened**

Scientific Name *Gadopsis bispinosus* Sanger, 1984

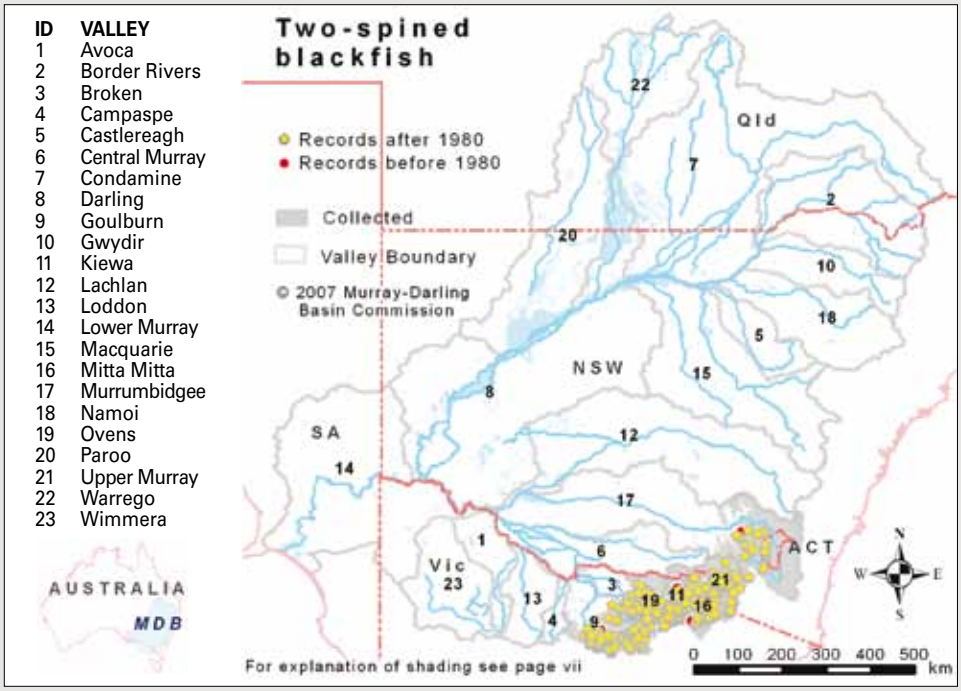
Identification

A small to medium sized fish with a yellowish-brown to olive green back and sides, often spectacularly mottled ('giraffe' spots), and a creamy or light grey belly. Maximum length ~350 mm and ~200 g; usually < 200 mm and 50 g. The pelvic fins have been reduced to a pair of fine, white, divided filaments located under the throat. The dorsal fin is low and long, reaching almost to the tail. The mouth is large. The dorsal fin has 1–3, usually 2, spines. The body is covered in very small scales with a thick mucous coating. Readily distinguished from the Northern river blackfish by its possession of 1–3 spines in the dorsal fin.

Biology and Habitat

The Two-spined blackfish is restricted to cool, clear upland or montane streams with abundant instream cover, usually in the form of boulders and cobble. It is found more in the medium to large streams 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. Its diet is dominated by aquatic insect larvae, particularly mayflies, caddisflies and midges, and occasionally fish and crayfish. Young-of-year and juvenile blackfish eat proportionally more mayfly and midge larvae than adult fish, which consume larger items such as caddisfly larvae and terrestrial invertebrates.

The Two-spined blackfish is benthic and nocturnal. Its movement is extremely limited—the home range of adults is estimated at ~15 m. Fecundity increases with length and spawning occurs in November–December. 80–420 eggs are laid in a single mass. Larger individuals spawn earlier in the season than small individuals and females commence breeding in their second or third year (at > ~120 mm length). The spawning site is usually in the gaps between cobbles or boulders where the eggs are attached to the upper surface of a rock. The eggs are large (~3.5 mm diameter), yolky and adhesive and



are fanned and guarded by the male fish until the larvae have almost fully utilised the yolk reserves and are free-swimming. Hatching occurs after approximately 16 days at a water temperature of 15°C. After approximately three weeks both the male parent and the larvae leave the spawning site.

Distribution and Abundance

This species is only known from the Murray-Darling Basin, where it has been recorded from north-east Vic, the ACT and south-east NSW. In Vic it is present in the upper sections of the Goulburn, Broken, Ovens, Mitta Mitta and upper Murray catchments. In the ACT it is only currently present in the Cotter catchment, although it was previously present in the Murrumbidgee and Paddys rivers, and possibly the Naas/Gudgenby system. In NSW it is known from the Goodradigbee, upper Murray above Lake Hume, Tumut and Goobarragandra catchments. A small remnant population is still present in the Murrumbidgee River above Cooma. When it is present, the species is often abundant, but it has declined in a number of catchments in the ACT and NSW.

Potential Threats

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

General References

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

Common Name Northern river blackfish (River blackfish, Slippery, Slimy, Muddy, Greasy)

Threatened

Scientific Name *Gadopsis marmoratus* Richardson 1848

Identification

A pale olive-green or brown to almost black fish, often with a diffuse marbled pattern. Maximum size of the northern form is about 350 mm, but it is commonly 200–250 mm long and about 100 g. The pelvic fins are reduced to a pair of fine, white, divided filaments located under the throat. The dorsal fin is low and long, reaching almost to the tail. The mouth is large. The dorsal fin has 6–13 spines. The body is covered in very small scales with a thick mucous coating. The northern form is readily distinguished from the Two-spined blackfish by its possession of more than three spines in the dorsal fin.

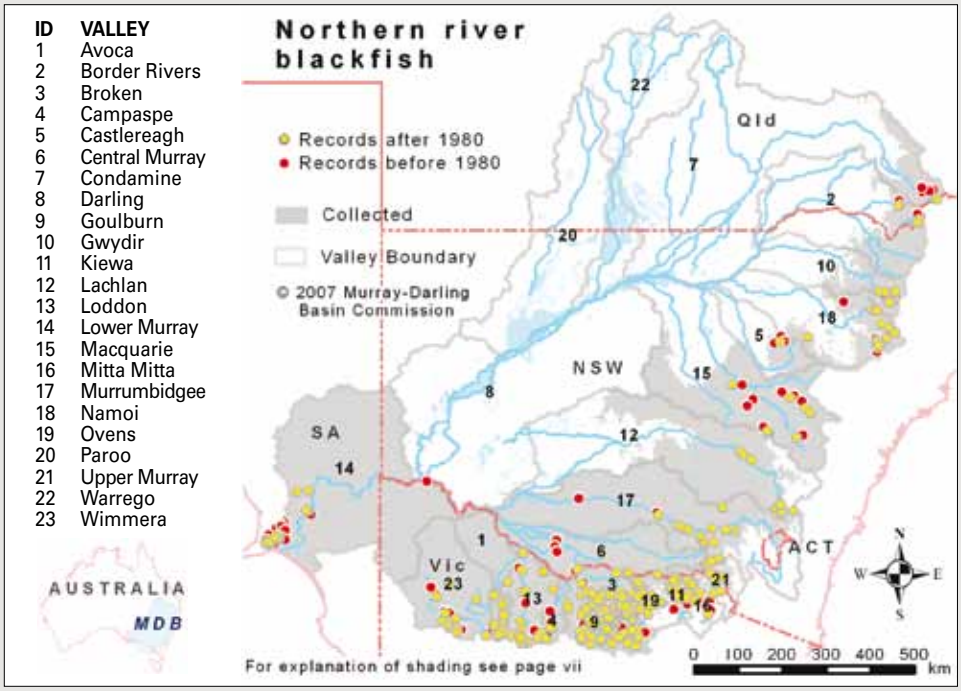
There is an undescribed species complex within *Gadopsis marmoratus* consisting of two species (northern and southern) which differ mainly in maximum size attained. Only the northern form occurs in the Basin.

Biology and 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.

Spawning occurs from October–January when water temperatures exceed ~16°C. The spawning site is usually inside hollow logs, although rocks and undercut banks may also be used. Fecundity is low (generally ~200–500 eggs) and increases with fish length. The eggs are large (~4 mm diameter), demersal, adhesive and hatch after 14 days at 15°C with the larvae about 6–8 mm long. The male guards and fans the eggs and rarely leaves the spawning site. The larvae remain at the spawning site for about 3 weeks after hatching.

An opportunistic carnivore, the Northern river blackfish consumes aquatic insect larvae, crustaceans, terrestrial insects that fall on the water surface, and occasionally other fish. Its movements are restricted—home range is estimated at 10–26 m. It is benthic and



nocturnal. However, in a highly modified, small rural stream, it has been shown to use different habitats between day and night: undercut banks during the day, and open water at night.

Distribution and Abundance

The Northern river blackfish is known from the Murray and the mid to upper reaches of the Murrumbidgee, Macquarie, Lachlan, Gwydir and Namoi drainages in NSW. It is locally common in the Condamine-Balonne and present in the Border rivers drainage in Qld, the northernmost extent of any of the blackfish species. In SA it has disappeared from the Murray and is now confined to small localised populations in the Easterm Mt Lofty streams. In Vic it is known from all the major tributaries of the Murray. Once considered to be highly threatened across the Basin, its numbers and distribution have declined. However, its abundance in some locations seems to fluctuate considerably from year to year, although SA populations are precarious and threatened.

Potential Threats

Major threats are smothering of eggs and spawning sites by sediment, and 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.

Common Name Congolli (Tupong, Sandy)

Scientific Name *Pseudaphritis urvillii* (Valenciennes, 1831)

Identification

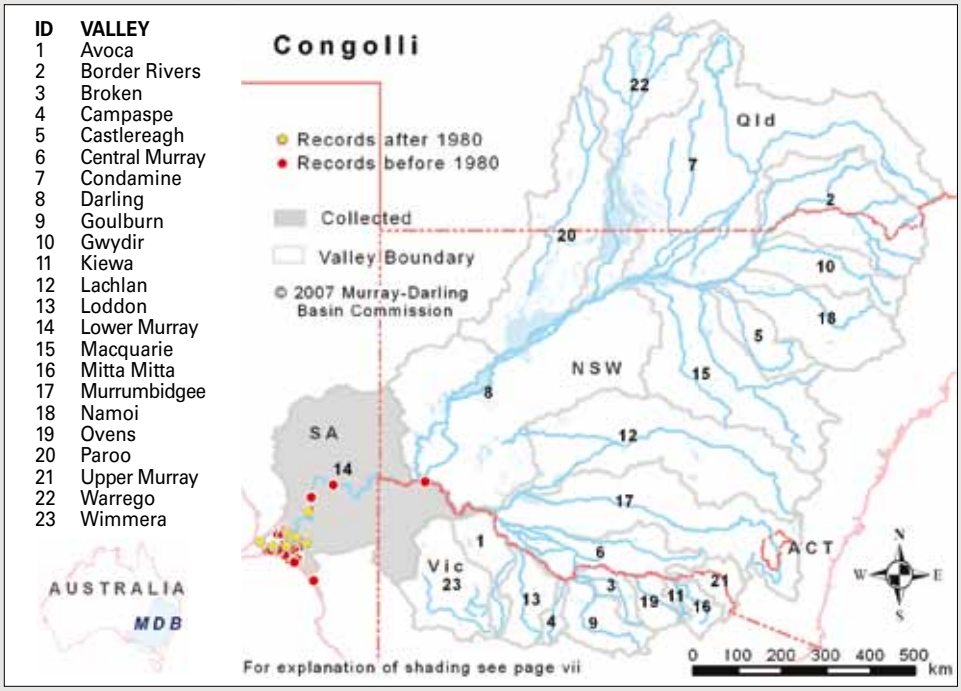
An elongate, small to medium sized, slender fish with an almost cylindrical body. Maximum size ~330 mm; commonly 150–200 mm. The head is flattened on top and the eyes are small and set high on the head. The mouth is large, extending to below the front of the pupil, and the lower jaw protrudes. The first dorsal fin is short-based and rounded, and the second long-based and straight-edged. The caudal fin is truncate to rounded, and the anal fin is long-based and straight-edged, slightly longer than the second dorsal, and almost opposite in position. Body colour varies with habitat, but is mostly light brown on the back and yellowish-white ventrally, with a series of irregular dark brown blotches on the sides.

Biology and Habitat

Little is known of the Congolli's ecology in the Basin. It is primarily an estuarine species, but can comfortably live in freshwater or the sea. It is known to migrate substantial distances upstream in coastal rivers and in the Lower Murray has been recorded 215 km upstream of the river mouth. In the Lower Murray it occurs in terminal wetlands and a few lowland stream habitats where it is often found partially buried in leaf litter or sand, or associated with cover such as logs, rocks or overhanging banks.

Knowledge of reproduction in this species is limited, but spawning is thought to occur in autumn and winter, with adult fish moving downstream from freshwater habitats to estuaries.

The Congolli is predominantly an opportunistic benthic carnivore. It can also behave as an ambush predator, burying itself in the substrate and taking small fish. The diet from Tasmanian streams comprises mostly small prey items such as aquatic insect larvae, (chironomids, caddisflies, mayflies), small crustaceans (shrimp and amphipods), snails and worms. Some plant material is also consumed. As individuals grow, the importance of shrimps, caddisflies and snails increases and chironomids and mayflies decreases.



Distribution and Abundance

The Congolli is found predominantly in coastal rivers in Tas, Vic, SA, and southern NSW. In the Murray-Darling Basin it only occurs in the Lower Murray drainage, where it has been recorded in the Murray River up to Echuca, streams of the Mt Lofty Ranges and the Lower Lakes (Alexandrina and Albert). It is never abundant in the Basin today, but once formed huge migrations in the lower Murray, and is usually now recorded in low numbers at a site.

Potential Threats

Evidence from outside the Basin suggests that barriers to movement may be detrimental to this species, and declining river flows may also be a threat.

General References

Allen *et al.* 2002; Andrews 1996; Fulton 1990; Hortle & White 1980; Kuiter 1993; Lloyd & Walker 1986; Morris *et al.* 2001; Scott *et al.* 1974; Stuart *et al.* 2005.

Common Name Flat-headed gudgeon (Flathead gudgeon, Big-headed gudgeon)

Scientific Name *Philypnodon grandiceps* (Krefft, 1864)

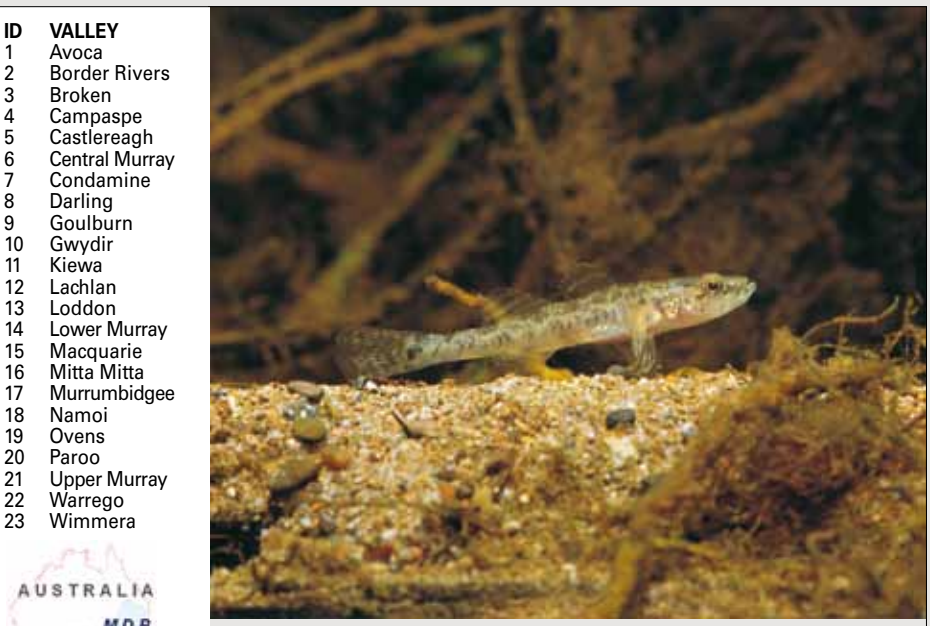
Identification

A small, fish with a broad, flat head and large mouth. Maximum size 115 mm; usually 80 mm. The eyes are positioned close together, high on the head. The gill openings are broad, extending forward to, or below the eye. There are two separate dorsal fins and a rounded tail. The dorsal colour is variable: it may be grey, brown, black, yellowish or reddish brown, often with a series of darker blotches on the back, sides and below the dorsal fins. The belly is usually lighter and may be yellowish. The anal and dorsal fins often have a series of faint, grey stripes with orange areas in between. There is often a black blotch at the base of the caudal fin. The mouth in males is larger, extending to at least below the pupil, whereas in the female it extends to below the front of the eye. Distinguished from the Dwarf flat-headed gudgeon by its larger size; the presence of gill openings on the underside of the head that extend forward to, or below the eye; and the larger number of pectoral fin rays (16–20, usually 18–19).

Biology and 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. It matures at 42–50 mm length and breeds in spring and summer when water temperatures are between 18 and 27°C. Fecundity ranges from 500–900 eggs which are attached to solid objects such as rocks and wood and guarded by the male, which fans the eggs with its pectoral fins. The eggs are elongate, 1.5–2.2 mm long and 0.7–0.9 mm wide, and pointed at one end. They hatch after 4–6 days and the newly hatched larvae are about 3.8 mm long. This species comprised 96% of the drifting larval fish fauna in the Campaspe River between 1995 and 2001, with the majority of this downstream drift occurring in late spring/early summer. Flow regime appears to play little part in breeding, and the species does not routinely utilise the floodplain for larval development. It is a carnivorous ambush predator of aquatic insects, molluscs, tadpoles, crustaceans and small fish.

ID	VALLEY
1	Avoca
2	Border Rivers
3	Broken
4	Campaspe
5	Castlereagh
6	Central Murray
7	Condamine
8	Darling
9	Goulburn
10	Gwydir
11	Kiewa
12	Lachlan
13	Loddon
14	Lower Murray
15	Macquarie
16	Mitta Mitta
17	Murrumbidgee
18	Namoi
19	Ovens
20	Paroo
21	Upper Murray
22	Warrego
23	Wimmera



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. However, the NSW Rivers Survey only recorded the species at 3 out of 40 sites in the Basin, indicating that the current distribution is patchy. Similarly, the Pilot Sustainable Rivers Audit only recorded 4, 2, and 40 individuals from 26, 21 and 24 sites on the Lachlan, Ovens and Lower Murray drainages, respectively. It appears to have declined in NSW, although it is reasonably common in wetlands and tributaries of the Lower Murray and along the edges of the Lower Lakes in SA. It is not present in the ACT or Qld portions of the Basin, but is in the upper Murrumbidgee just downstream of the ACT. It is also present in coastal streams in Vic, NSW, SA and Qld.

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.

Common Name Dwarf flat-headed gudgeon **Uncommon**

Scientific Name *Philypnodon macrostomus* Hoese & Reader 2006

Male in breeding colouration

Identification

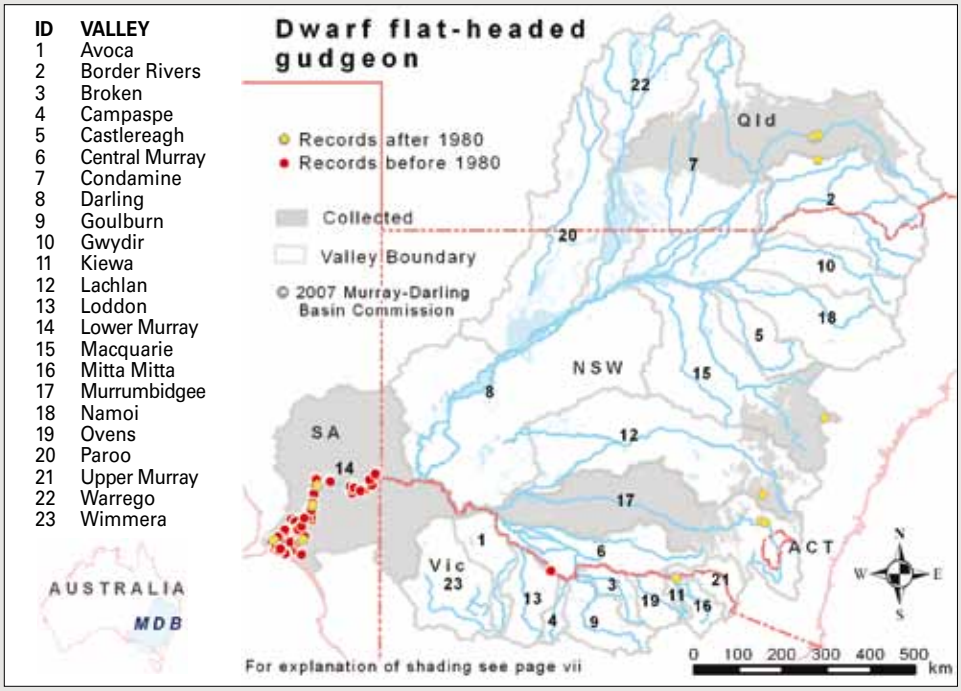
A small, fish with a truncate to rounded tail. Maximum length 65 mm; rarely more than 40 mm. The head is broad and flat with a large mouth. Males have a larger mouth, extending beyond the rear margin of the eye, whereas in females it extends to below the middle of the eye. The gill openings on the underside of the head are narrow, extending forward to below the posterior portion of the gill covers, ending well behind the eye. It has two separate dorsal fins. The upper head and body is brown to black with irregular blotches, and a vertical black bar on the base of the caudal fin. Two black oblique bands extend backwards from the eye. The first dorsal fin has two black bands interspersed with orange or whitish areas. The second dorsal fin has 3–4 black stripes, also interspersed with orange or whitish areas. The caudal fin has orange spotting.

This species can be easily confused with small individuals of Flat-headed gudgeon but can be distinguished by: the narrower gill openings which do not extend to, or below the eye; the smaller number of pectoral fin rays (15–16); and the black bar at the base of the tail.

This recently described species is variable in morphology across its range, with some Murray-Darling populations differing in body patterning and pre-dorsal scalation to the taxon described from coastal drainages near Coffs Harbour. Further taxonomic work is required. Dwarf flat-headed gudgeon has also been confused with *Philypnodon grandiceps*, and some references to *P. grandiceps* prior to 1980 probably refer to Dwarf flat-headed gudgeon.

Biology and Habitat

Dwarf flat-headed gudgeon reportedly prefer relatively calm waters and occur over mud and rock substrates or in weedy areas. However, recent information from coastal populations in southeastern Queensland indicates that this species occurs over coarser substrates such as gravel and cobbles, close to submerged cover such as leaf-litter accumulations, woody habitat and aquatic vegetation. Nothing is



known of the reproductive biology in the wild, and little is known of its general ecology in the Basin. In aquaria it has been recorded breeding at temperatures of 19–22°C. The eggs are transparent and teardrop shaped, and hatch in 4–5 days. The male fish guards the egg mass, fanning them regularly and driving away other fish.

The Dwarf flat-headed gudgeon is a benthic carnivore, feeding mainly on aquatic insects and their larvae such as chironomids, mayflies and caddisflies.

Distribution and Abundance

Dwarf flat-headed gudgeons are relatively common in coastal streams from southern Qld to Wilsons Promontory in Vic, and there are some outlying coastal populations near Adelaide in eastern SA. They occur also in the inland MDB but are patchily distributed and have only been recorded from a few localities. It is known from the Macquarie drainage near Bathurst, the Murrumbidgee near Canberra, the Boorowa River near Boorowa, the upper Murray near Albury, the Condamine near Condamine and Chinchilla, and the Lower Lakes and Mount Lofty Ranges in SA. It has also been reported from wetlands and edges of the lower Murray River up to Torrumbarry weir. In the first two sampling rounds of the Sustainable Rivers Audit covering 16 river valleys encompassing 351sampling sites, only 9 individuals were captured, all from the Lower Murray. The species has not been recorded from the ACT.

Potential Threats

None known. Predation (larval and adult) by alien fishes and interaction with the aggressive Eastern gambusia may be threats.

General References

Allen *et al.* 2002; Fletcher 1997; Hammer 2004; Higham *et al.* 2005; Hoese & Reader 2006; Koehn & O'Connor 1990; Larson & Hoese 1996a; Lintermans & Osborne 2002; Lloyd & Walker 1986; Merrick & Schmida 1984; Pusey *et al.* 2004; Wedderburn & Hammer 2003.

Common Name Southern purple-spotted gudgeon (Purple-spotted gudgeon)

Threatened

Scientific Name *Mogurnda adspersa* (Castelnau, 1878)

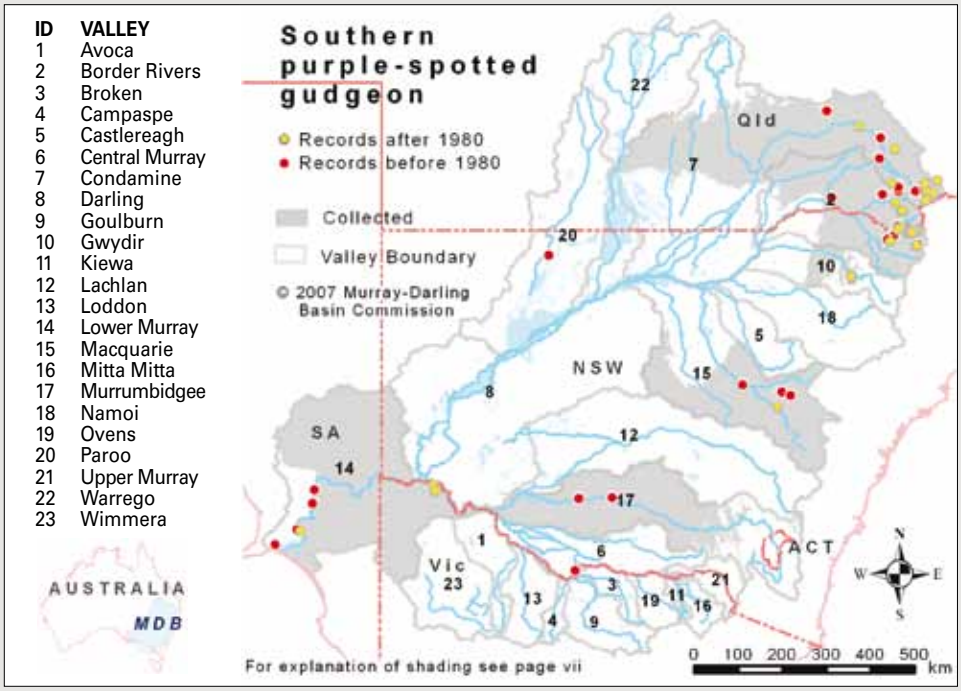
Identification

An attractive, small, robust fish with a rounded head, small mouth, and gape that extends to the anterior margin of the eye. Maximum size 152 mm; commonly 60–120 mm. The tail is rounded, and there are two dorsal fins, the first short-based and lower than the longer and taller second dorsal. The back is dark brownish to yellowish brown (but can be iridescent blue in general with a series of blue blotches towards the tail), fading to lighter brown or cream on the belly. A row of darkish blotches are present on the sides from the start of the second dorsal fin to the start of the caudal fin, surrounded by numerous red and white spots. Males have 3–4 brown-to-purple facial stripes extending from behind the eye to the back of the operculum. Females generally have two stripes, which are less prominent. There are numerous red spots on the dorsal, anal and caudal fins.

Biology and Habitat

The Southern purple-spotted gudgeon is a slow-moving ambush predator, consuming small fish and aquatic macroinvertebrates and also worms and tadpoles. It is a benthic species, usually associated with good cover such as cobble and rocks in the Queensland parts of its range, or aquatic vegetation in its southern range. It is found in slow moving or still waters of creeks, rivers, wetlands and billabongs, and prefers slower flowing, deeper habitats.

Males mature at 45 mm and females at 49 mm. The male has an elaborate courtship display and pairing and spawning occurs in summer when water temperature exceeds 20°C. Females can spawn several times during a spawning season. The eggs are adhesive and 280–1300 are deposited in a single batch on a rock, log or aquatic plants. The eggs are elongate, pointed at both ends, transparent and 1.0–1.3 mm wide and 2.0–3.8 mm long. The male stays to guard and fan the eggs, which hatch after 3–9 days depending on water temperature. Newly hatched larvae are approximately 4 mm long.



Purple-spotted gudgeons are carnivorous, obtaining food from the benthos, the water column and the water surface.

Distribution and Abundance

This gudgeon is present in coastal streams of northern NSW and Qld as well as the Murray-Darling Basin. In the Basin it has undergone a significant decline and is now presumed extinct in SA (where a single translocated population occurs) and Vic. It is patchily distributed and rare in northern NSW, but still locally abundant in the Border Rivers, Moonie River and Condamine-Balonne system in Qld. A new population was recently discovered in the Macquarie catchment in NSW. It was formerly patchily distributed in the Murrumbidgee, Lachlan and Murray rivers and tributaries of the Darling in NSW; and tributaries of the Murray and Wimmera rivers in Vic. Records in the mid 1990s from the Cardross Lakes near Mildura were the first from Vic in more than 50 years, but recent surveys of this lake system have failed to relocate the species.

Potential Threats

The precise reasons for the decline of this species are unknown, but interactions with alien species (particularly Eastern gambusia and Redfin perch), and fluctuations in water levels with river regulation, are thought to be significant.

General References

Boxall *et al.* 2002; Cadwallader & Backhouse 1983; Hamlyn-Harris 1931; Hansen 1988; Larson & Hoese 1996a; Merrick & Schmida 1984; Moffat & Voller 2002; Morris *et al.* 2001; Raadik 1995; Raadik & Harrington 1996.

Common Name Carp gudgeons

Scientific Name *Hypseleotris spp.*

Murray-Darling carp gudgeon, male

Identification

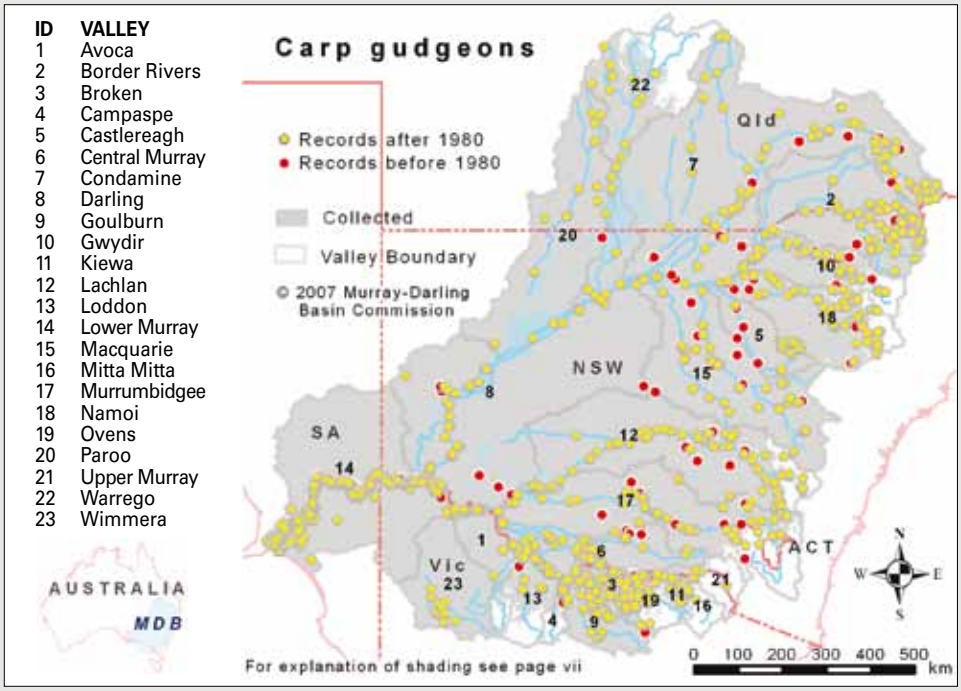
There is considerable confusion over the identification of 'carp gudgeons' in south-eastern Australia. Recent genetic studies have shown that at least four taxa are present, as well as a range of hybrids. In this book, carp gudgeons are treated as a group.

All carp gudgeons are small and laterally compressed, with a truncate to slightly rounded tail. Maximum length 70 mm; usually around 40 mm. They have two separate and distinct dorsal fins. The upper portion of their dorsal fins often develops and orange-red colour, bordered by a bluish-white stripe, which is particularly noticeable in breeding males. The back is yellowish-grey to greenish-brown and the scales of the upper sides and back have darker edges, giving a slightly reticulated appearance. The bluntness of the head profile, subtle colour variations, and presence of scales on the head and belly vary between the taxa.

Biology and 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. Early studies of reproduction in an unknown species of carp gudgeons recorded that spawning occurred when water temperature exceeded 22.5°C. Females may lay up to 2,000 small, (0.5 mm diameter), adhesive eggs. Spawning occurs in shallow water and the eggs are deposited on submerged aquatic vegetation or twigs. The male guards and fans the eggs. Hatching occurs after about 50 hours, and newly hatched larvae are 1.8–2.1 mm long.

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. Western carp gudgeon is abundant in the Canberra



region, in the urban lakes and Googong Reservoir, where it can form a substantial portion of the diet of Golden perch, Redfin perch and Brown trout.

Originally thought to be a relatively sedentary species, recent investigations have demonstrated that large numbers of carp gudgeons attempt to move through fishways on the Murrumbidgee and Murray rivers. Whether these attempted movements reflect local dispersal or foraging movements is unknown.

Distribution and Abundance

As a group, carp gudgeons are widespread and common at mid to lower altitudes in the central and southern Basin, and up to 1000 m elevation in the northern Basin. They are also found in coastal streams from central NSW to central Qld. The relative abundance of the various forms differs across the Basin. The Western carp gudgeon is now apparently rare in SA, but abundant and the only form found in the upper Murrumbidgee. However, they are not found in the Murrumbidgee River upstream of the ACT and in cold headwater streams generally. During the NSW Rivers Survey, carp gudgeons were the most and third most abundant native species recorded in the Darling and Murray catchments, respectively.

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.

Common Name Western blue-spot goby (Swan River goby) **Restricted**

Scientific Name *Pseudogobius olorum* (Sauvage, 1880)

Identification

A small, cylindrical fish with a rounded head, bulbous cheeks and a small mouth. Maximum size ~60 mm, commonly <45 mm. The gape extends to just past the anterior margin of the eye in females, and to mid-eye or further back in males. There are two dorsal fins, the caudal fin is oval, and the pelvic fins are joined to form a disc-shape. Scales are present on the nape and opercula. The head and body is light brownish to yellowish brown or grey, fading to white on the ventral surface. A series, usually of 5–6 dark, roughly rectangular blotches are present on the back from the nape to the caudal peduncle, and there is another series of midlateral blotches on the sides. The anal fin may have a blue edge, the dorsal fins are barred and the first dorsal fin may have a blue spot.

Biology and Habitat

The Western blue-spot goby is really a marginal freshwater/estuarine species and occupies brackish estuaries and associated freshwater streams and lakes. It is benthic, burrowing and usually recorded over mud or rock substrates, occasionally in weedy areas. It spawns about 150 eggs in dense aquatic vegetation in spring in the upper reaches of estuaries, and the male guards and fans the eggs. In an estuary in Western Australia, the species consumed benthic crustaceans and algae.

Distribution and Abundance

This goby is a common and widespread estuarine species in coastal streams of SA and WA. In the Basin it is known only from the Lower Lakes (Alexandrina and Albert) and associated wetlands, where it exists as largely landlocked populations.

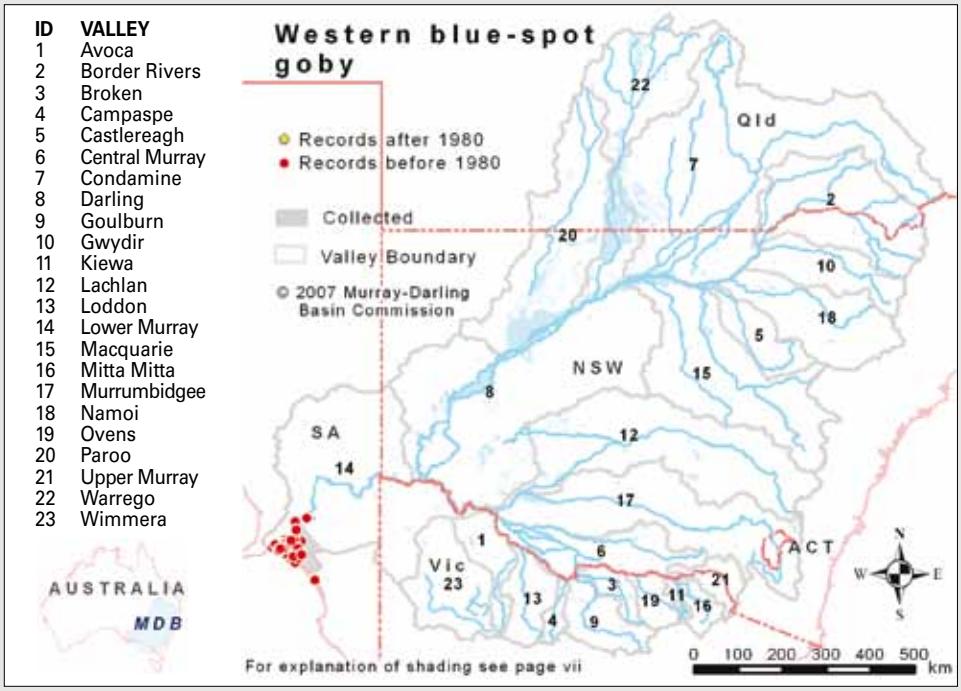
Potential Threats

None known.

General References

Allen *et al*. 2002; Cadwallader & Backhouse 1983; DPI 2006; Gill & Potter 1993; Humphries & Potter 1993; Larson & Hoese 1996b; Wedderburn & Hammer 2003.

ID	VALLEY
1	Avoca
2	Border Rivers
3	Broken
4	Campaspe
5	Castlereagh
6	Central Murray
7	Condamine
8	Darling
9	Goulburn
10	Gwydir
11	Kiewa
12	Lachlan
13	Loddon
14	Lower Murray
15	Macquarie
16	Mitta Mitta
17	Murrumbidgee
18	Namoi
19	Ovens
20	Paroo
21	Upper Murray
22	Warrego
23	Wimmera



Western blue-spot goby habitat, Lake Alexandrina

Common Name Lagoon goby (Scary's Tasman goby)

Restricted

Scientific Name *Tasmanogobius lasti* Hoese, 1991

Identification

A small, slender fish with a medium sized head and mouth, and a gape that extends to below the middle of the eye. Maximum size 55 mm. There are two dorsal fins, almost joined together, with the second dorsal fin long-based like the anal fin. The caudal fin is rounded, and the pelvic fins are joined to form a cup-shaped disc. There are no scales on the head or nape in front of the first dorsal fin. The head and body is tan to pale brown or grey/white, with scattered small dark brown blotches. There is a thin vertical black bar from each eye to the end of the gape. Five or six small brown blotches are present along the sides, often connected with white dashes. There is sometimes a black to blue spot apparent at the base of the first dorsal fin.

Biology and Habitat

This is really an estuarine species in areas of freshwater discharge, but is also found and can complete its lifecycle in freshwater streams and lakes. It is usually recorded in still or slow-flowing habitats with mud or silty sand substrates. It is a benthic, burrowing species.

Distribution and Abundance

The Lagoon goby is a common and widespread estuarine species in coastal streams of Vic, SA and Tas. In the Basin it is known only from the Lower Lakes (Alexandrina and Albert) and Coorong, where it is widely distributed but not abundant. Its distribution extends a small distance upstream into the main channel and wetlands of the Lower Murray.

Potential Threats

None known.

General References

DPI 2006; Higham *et al.* 2005; Hoese 1991; Wedderburn & Hammer 2003;

ID	VALLEY
1	Avoca
2	Border Rivers
3	Broken
4	Campaspe
5	Castlereagh
6	Central Murray
7	Condamine
8	Darling
9	Goulburn
10	Gwydir
11	Kiewa
12	Lachlan
13	Loddon
14	Lower Murray
15	Macquarie
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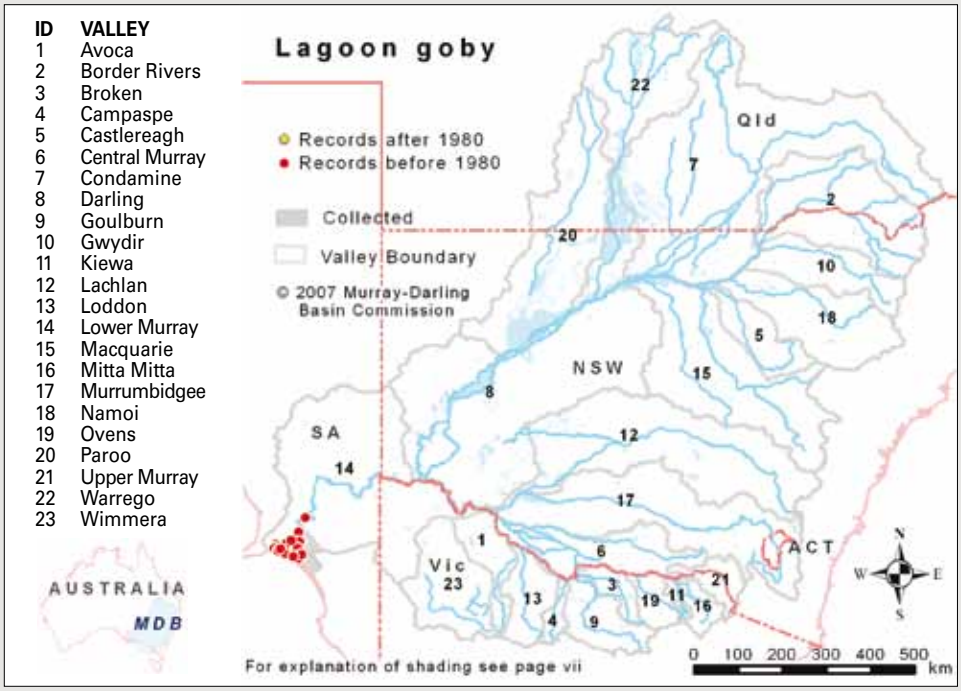

Lagoon goby habitat, Lake Alexandrina

Common Name Tamar goby (Tamar River goby) **Restricted**

Scientific Name *Afurcagobius tamarensis* Johnston, 1883

Identification

A small fish with a flattened head, bulbous cheeks and an oblique, moderate to large mouth. Maximum size ~110 mm; commonly 80 mm. The gape extends to below the middle of the eye (females), or to well beyond the eye (males). There are two dorsal fins, the caudal fin is rounded, and the pelvic fins are joined to form a large cup-shaped disc. There are no scales on the head or nape in front of the first dorsal fin. The head and body is pale grey to brown, fading to cream on the ventral surface. The head is mottled. A series of 3–5 dark brown saddle-shaped blotches are present on the back, with a row of 6–9 midlateral brown blotches on the sides.

Biology and Habitat

An estuarine species, the Tamar goby is also found in adjacent freshwater streams and lakes. It is usually recorded in still or slow-flowing habitats with mud or silt substrates and abundant cover from rocks, logs or aquatic vegetation. Benthic and burrowing, it constructs its own burrow or uses a vacated one. It spawns in spring and the male performs a 'hopping' courtship display to entice the female to the burrow.

Distribution and Abundance

The Tamar goby is common and widespread in estuaries of Vic, NSW, eastern SA and northern Tas. In the Basin, it is known only from the Lower Lakes (Alexandrina and Albert) where it is patchily distributed and unknown whether it forms reproductively viable populations. It is common in the Coorong.

Potential Threats

None known.

General References

Allen *et al.* 2002; Cadwallader & Backhouse 1983; Larson & Hoese 1996b; Higham *et al.* 2005; Wedderburn & Hammer 2003.

ID	VALLEY
1	Avoca
2	Border Rivers
3	Broken
4	Campaspe
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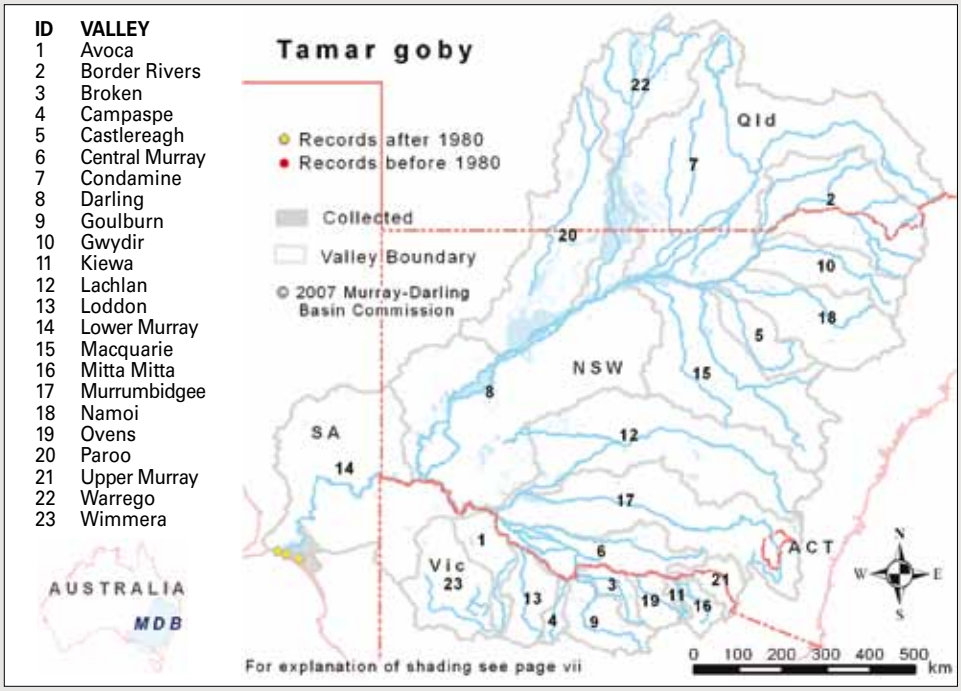
8	Darling
9	Goulburn
10	Gwydir
11	Kiewa
12	Lachlan
13	Loddon
14	Lower Murray
15	Macquarie
16	Mitta Mitta
17	Murrumbidgee
18	Namoi
19	Ovens
20	Paroo
21	Upper Murray
22	Warrego
23	Wimmera



Tamar goby habitat, Boundary Creek below barrage

Common Name Brown trout

Scientific Name *Salmo trutta* Linnaeus, 1758

Identification

A medium sized, fish, similar in body shape to the Rainbow trout, but lacking the fine, black spotting on the tail and the pink stripe on the sides. Maximum weight 20 kg; commonly 1–4 kg. Often have large spots on the back and sides, but none on the tail, and usually have an orange rear-edge to the adipose fin. The spots on the back are usually dark and those on the sides are either dark or reddish-orange surrounded by a light halo.

Biology and Habitat

Brown trout is found in cool upland streams and lakes. The diet contains a wide variety of freshwater insect larvae, snails and wind-blown terrestrial arthropods, aquatic crustaceans, and small fish.

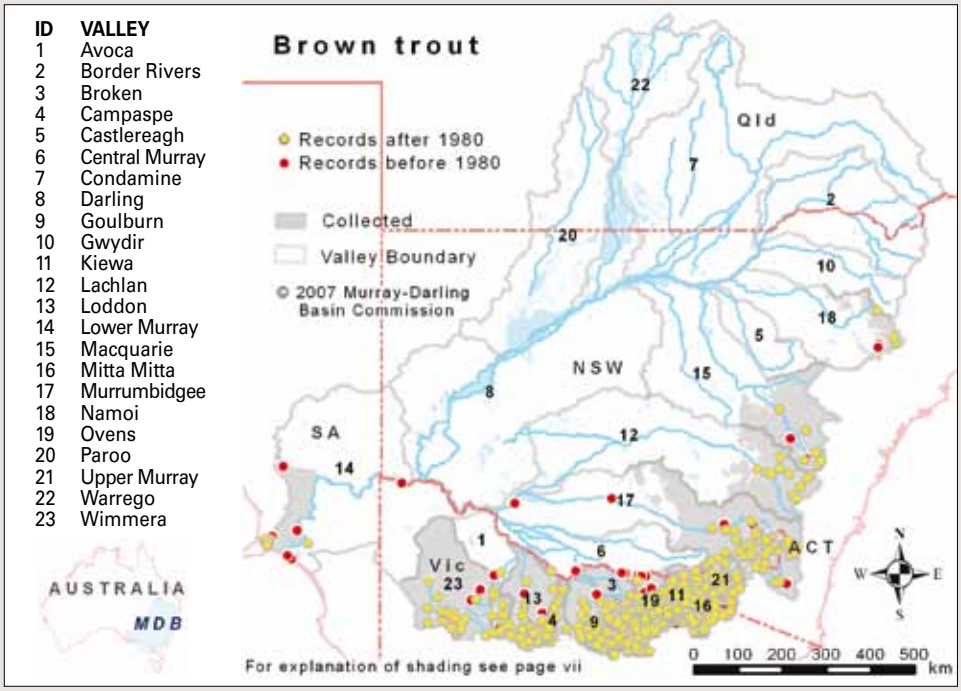
Brown trout spawn between April and August, earlier than Rainbow trout. As in Rainbow trout, the eggs are deposited in a gravel nest ('redd') constructed by the female in flowing water. The eggs are large (4–5 mm diameter) and hatch in 6–20 weeks depending on water temperature. Brown trout is slightly less tolerant than Rainbow trout of warm water, preferring temperatures below 25°C.

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.

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*).

Distribution and Abundance

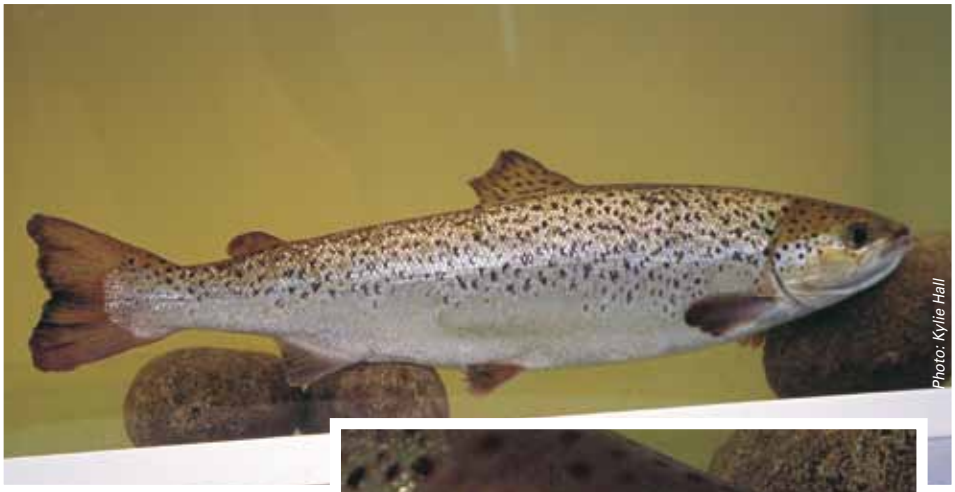
Brown trout is native to Europe and western Asia and was first introduced to Australia in 1864. Fisheries agencies in the Basin have substantial stocking programs for this and other trout species. Vic and NSW fisheries agencies release approximately five million salmonids each year; and private hatcheries 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.

General References

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

Common Name Atlantic salmon

Scientific Name *Salmo salar* Linnaeus 1758



Note the mouth does not extend behind the eye

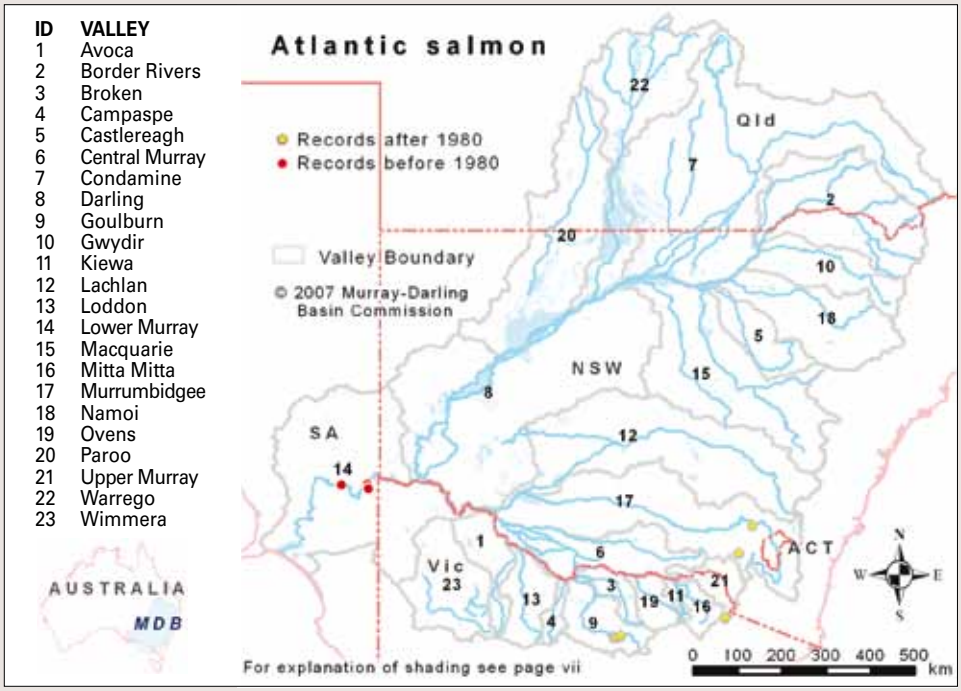
Identification

A medium sized fish that is very similar to the Brown trout, but with a smaller mouth that does not reach back past the eye. Maximum weight 38 kg in Europe; commonly 1–3 kg in Australia. Unlike Brown trout, it does not have an orange margin to its adipose fin. The tail is more deeply forked, and the caudal peduncle more slender.

Biology and Habitat

A fish of cool streams and lakes, the Atlantic salmon has not established significant populations in Australia. Its ecology is very similar to Brown trout and it is a popular species for aquaculture. It is stocked to provide recreational fisheries in NSW, but returns are marginal. Overseas the species is variable across its range in its freshwater habitat use, length of residence in streams, and age at maturity. In Canada, young, stream-dwelling Atlantic salmon feed mainly on aquatic insect larvae such as mayflies, caddisflies, chironomids and stoneflies.

Adult salmon on their spawning run do not feed. Adult salmon usually mature after 1–3 winters at sea, returning to streams to spawn from May–November, depending on the population. Average fecundity is around 10,000–20,000 eggs, depending on body size and population, with 1,300–2,000 eggs/kg of body weight common. The eggs are large (5–7 mm diameter) and are laid in a 'redd' excavated by the female, usually in a gravel-bottomed riffle. The young salmon parr remain in freshwaters for 2 or 3 years before migrating downstream to spend several



winters in the ocean before returning to spawn. Reproductive biology is variable and fish may spawn several times in a season, or for consecutive years. There is a large body of scientific literature on this species in its natural range, due to its declining status, but very little has been published on its habits in Australia.

Impacts on Native Fish

Due to its limited distribution within the Basin, little is known of the impacts of Atlantic salmon on native fish. However, as a large predatory species, it can be expected to consume small native fish such as galaxiids and small perch, as well as native crayfish.

Distribution and Abundance

The Atlantic salmon is native to rivers draining to the North Atlantic Ocean. It was was first introduced to Australia between 1864 and 1870 when it was released in Tas and Vic, but with little success. Eggs were imported from Canada in 1963 and the species was regularly stocked into Lake Burrinjuck and its tributary the Goodradigbee River until 2003, and is still stocked in Lake Jindabyne in NSW. No natural recruitment occurs in these locations and the species' continued presence in these water bodies is thought to depend completely on the stocking program.

General References

Cadwallader 1996; Clements 1988; Davies & McDowall 1996; Faragher 1986; Klemetsen *et al.* 2003; Scott & Crossman 1973.

Common Name Brook char (Brook trout)

Scientific Name *Salvelinus fontinalis* (Mitchill, 1815)

Identification

A medium sized fish that is similar to other trout in body shape, but with a very large mouth reaching much further back behind the eye. Maximum length 850 mm and maximum weight 6.5 kg. The colouring is distinctive: the body is dark olive-green with irregular mottling and paler markings; the sides are paler with red spots surrounded by bluish halos; and the dorsal fin and tail are olive-green with irregular patterning.

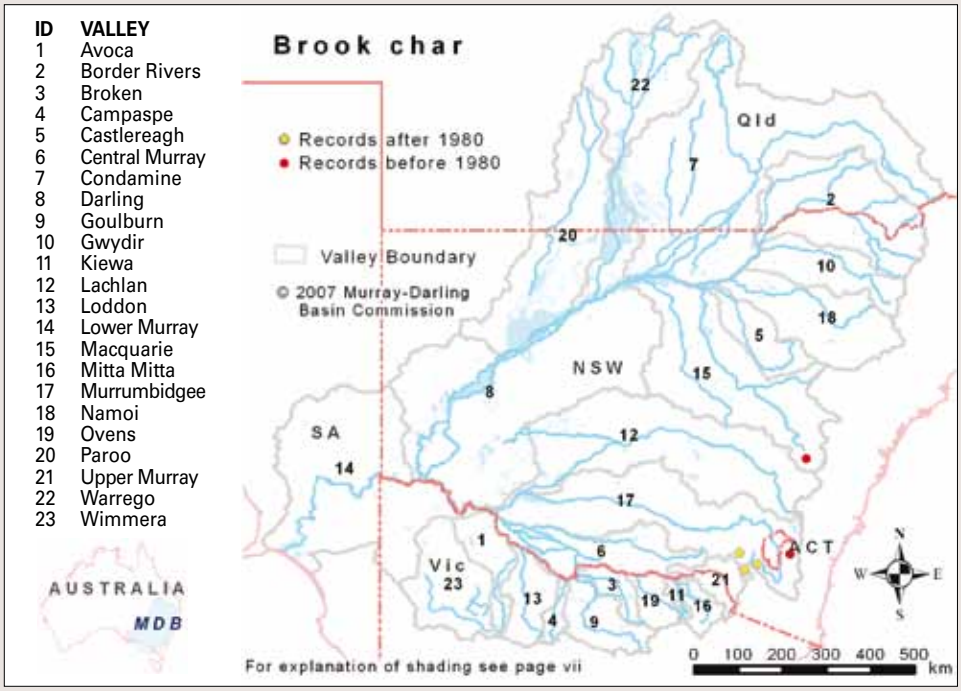
Biology and Habitat

Brook char is a cool water species of clear streams and lakes that does not coexist well with other salmonids such as Brown and Rainbow trout. Only two self-sustaining population are known on mainland Australia, one in the New England Tablelands, (although the current status of this population is unknown), and another in Ogilvies Creek in the upper Murray catchment. Self-sustaining populations are present in Tasmania.

It is occasionally stocked into lakes and streams in the Murray-Darling Basin on mainland Australia. Its breeding is similar to that of Brown trout. In their native North America they spawn in late summer or autumn. The large (3.5–5.0 mm diameter) eggs are deposited in a nest in gravelly areas in either streams or lakes. Fecundity is moderate and size-dependant, with between 100 and 5,000 eggs laid. Adults mature at 2–3 years, and are not as long-lived as Brown trout, with few individuals reaching 5 years, and none reaching 8 years of age. The diet contains freshwater insects, crustaceans, molluscs and terrestrial insects as well as small fish.

Impacts on Native Fish

Due to its limited distribution within the Basin, little is known of the impacts of the Brook char on native fish. However, as a large predatory species, it is expected that it would consume small native fish such as galaxiids and small perch, as well as native crayfish.



Distribution and Abundance

The Brook char is native to the east coast of North America and was introduced to Australia in the 1870s. It is not common in the Basin. It has been stocked into various streams and lakes but rarely establishes reproducing populations, hence its reputation on the mainland as 'soluble trout'—i.e. when added to water it is not seen again.

General References

Cadwallader 1996; Cadwallader & Backhouse 1983; Clements 1988; Davies & McDowall 1996; Faragher 1986; Fulton 1990; Lintermans & Osborne 2002; Merrick & Schmida 1984; Scott & Crossman 1973.

Common Name Rainbow trout (Steelhead)

Scientific Name *Oncorhynchus mykiss* Walbaum, 1792

Identification

A medium sized and laterally compressed fish with a slightly forked tail. Maximum weight 10 kg; usually 1–4 kg. Rainbow trout are very similar in body shape to Brown trout, but usually have a prominent pink stripe down the sides, and fine black spots on the body and tail (Brown trout don't have spots on the tail). The back is usually greenish or steely-blue and the belly white. Some individuals from lakes are silvery and lack the pink stripe. Juveniles can have prominent dark blotches on the sides (as can Brown trout), called 'parr marks', but these disappear as the fish get larger.

Biology and 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, with the diet containing 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.

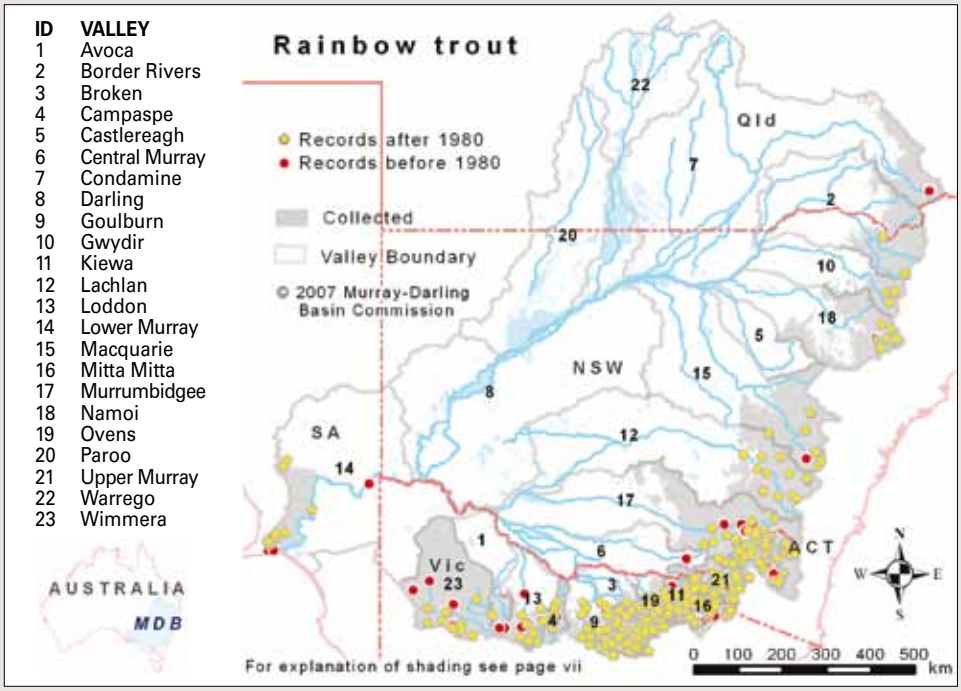
Individuals mature at 2–3 years of age and spawn from July to October. The female constructs a nest (a 'redd') in gravel, where the slightly adhesive, demersal eggs are deposited. The eggs are large (4–5 mm diameter) and hatch in 3–12 weeks, depending on water temperature.

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.

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*).

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.

General References

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

Common Name Carp (European carp, Common carp, Koi carp)

Scientific Name *Cyprinus carpio* Linnaeus, 1758

Identification

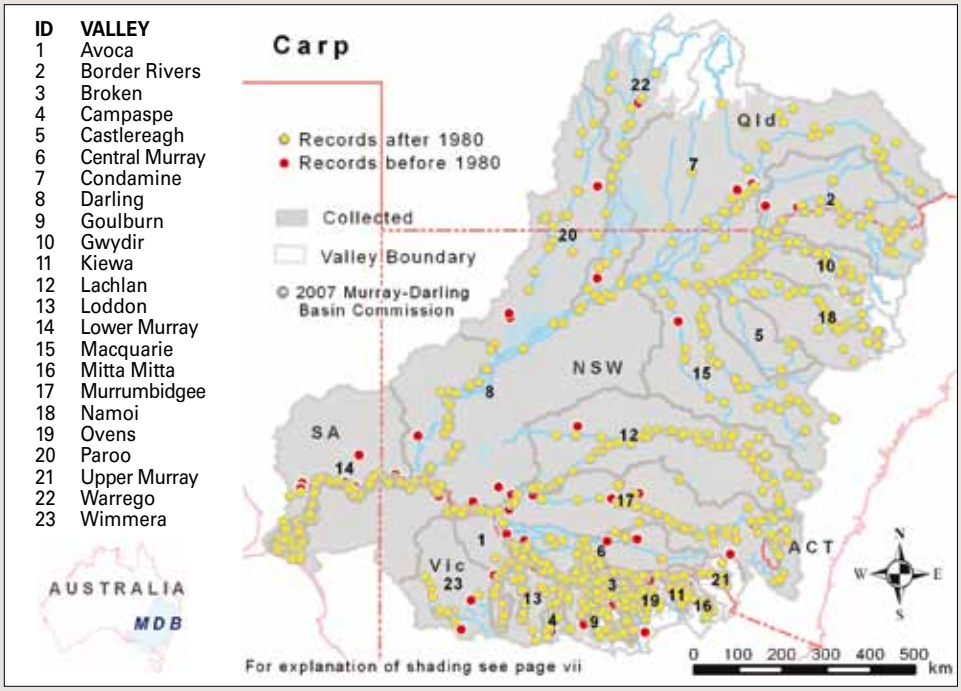
A medium sized fish with a forked tail. Maximum 1200 mm and 60 kg; usually up to 4–5 kg. The mouth is of moderate size, with thick fleshy lips and two pairs of barbels ('whiskers') at the corners. The single long, low dorsal fin has a stout serrated spine at the front. The scales are large and thick. Some individuals are only partly scaled, with very large scales in three or four rows ('mirror carp'), and some have no scales ('leather carp'). The back is usually olive-green, silvery-grey or brownish and the belly a creamy or silvery-yellow.

Biology and 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. When Carp are seen apparently gasping at the water surface, they are not taking in oxygen, but rather feeding on zooplankton. Males are sexually mature at 2–3 years (300 mm) and females at 3–4 years (350 mm).

Spawning usually occurs in spring and summer when water temperatures are 17–25°C. Spawning fish congregate in shallow water with egg-laying often accompanied by much chasing and splashing as fish break the water surface with their back and tail. Eggs are adhesive and laid in clumps on freshwater vegetation, logs and submerged grass. They are 0.5 mm in diameter and hatch in 2–6 days, depending on water temperature. Large wetland areas such as the Barmah-Millewa Forest and the Gwydir wetlands are thought to be significant 'hotspots' for Carp breeding.

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.

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.

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.

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.

Common Name Goldfish (Common carp)

Scientific Name *Carassius auratus* Linnaeus, 1758

Identification

A small, deep-bodied fish with a forked tail and a small, protrusible mouth that does not reach back to below the eye. Maximum size 400 mm; usually less than 200 mm. Easily distinguished from Carp by the absence of barbels around the mouth. Like Carp, it has 3–4 stout spines at the front of the dorsal fin, the largest one serrated on the trailing edge. The back is usually olive-bronze to golden, paling to silvery-white on the belly. Occasionally, the classic aquarium colour of orange-red is seen in wild specimens, as is the fan-tail. Individuals can be quite rotund when large, particularly females. Males have fine nuptial tubercles on the body, fins and opercula.

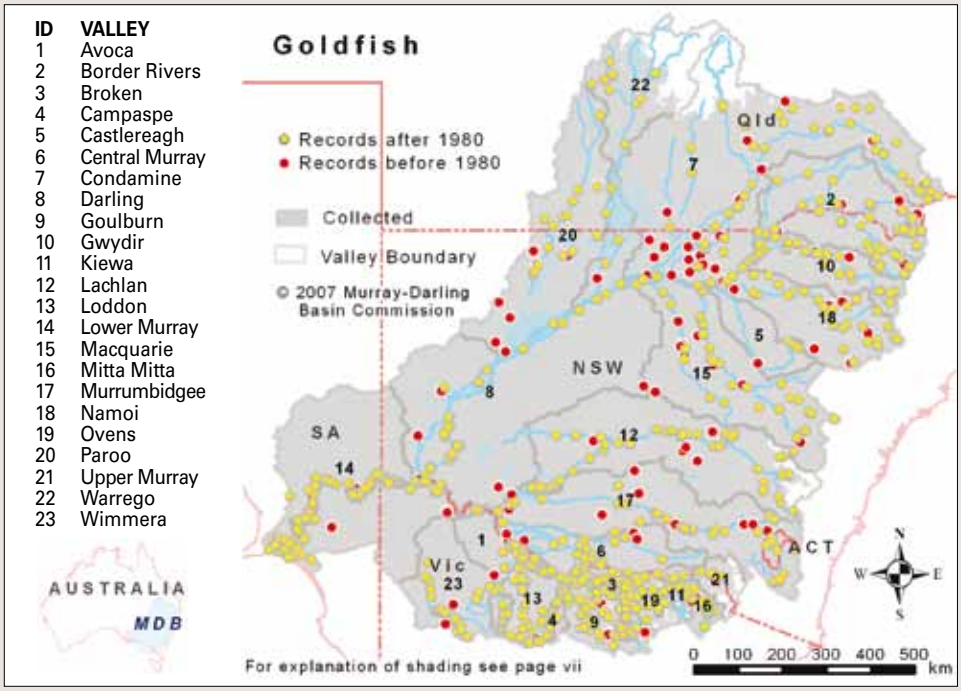
Biology and Habitat

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*). Individuals generally mature at 100–150 mm length, although they can be mature at 30–50 mm, and spawn during summer at water temperatures of 17–23°C. Eggs are laid amongst freshwater plants and hatch in about one week.

The Goldfish is not known to migrate. 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.



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.

General References

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

Common Name Tench (Doctor fish)

Scientific Name *Tinca tinca* (Linnaeus, 1758)

Identification

A medium sized and, thickset fish with a slightly-forked tail. Maximum 700 mm and nearly 9 kg; usually 100–300 mm. The head is large with a long, blunt snout and small, distinctively orange-red eyes. The mouth is small to moderate in size with a small barbel at each corner. The fins are rounded and thick. It has a single, short-based, high and rounded dorsal fin, located in about the middle of the back. The scales are very small, and covered with a heavy mucous. Usually, dark olive to pale golden or silvery in colour.

Biology and Habitat

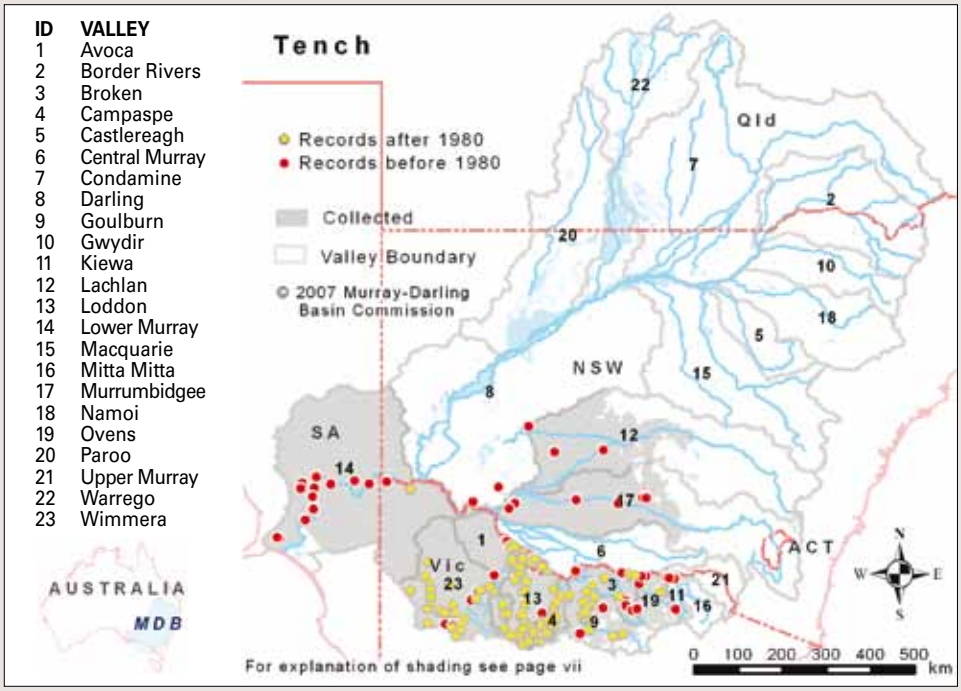
The Tench avoids fast water and is typically found in slow-flowing or still waters, often with a muddy bottom and abundant aquatic plants. It is often abundant in off-channel habitats, such as backwaters and lagoons, and in deep, sheltered holes. Adult Tench are predominantly benthic carnivores and their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

Tench may live for 20–30 years and reach maturity at 3–4 years. In rivers, growth is generally slow: fish from the Coal River in Tas reached lengths of approximately 29, 57, 93, 132, 172, 208, 239 and 261 mm at 1 to 8 years of age, respectively.

Spawning occurs in spring and summer. Females produce large numbers (300,000–900,000) of small eggs (0.8–1.0 mm diameter) in 3–4 batches, at intervals of about two weeks. The eggs are adhesive and laid in shallow water, usually on weeds. Hatching occurs after 3–6 days and hatchlings are about 4–5 mm in length.

Impacts on Native Fish

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



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.

General References

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

Common Name Roach

Scientific Name *Rutilus rutilus* (Linnaeus, 1758)

Identification

A relatively deep-bodied fish with a high arched back and a single, short-based dorsal fin placed about midway down the back. The dorsal fin is not rounded like in the Tench. Maximum size is 450 mm and two kg, but usually much smaller at 150–200 mm. The caudal peduncle is relatively slender and the tail is distinctly forked. There are no barbels and the mouth is small, with the gape not reaching to the front of the eye. The eye is small and bright red. There are small axillary processes at the base of the pelvic fins. The scales are of moderate-size. The back is usually an olive-green, the sides silvery and the belly whitish to pale golden or silvery.

Biology and Habitat

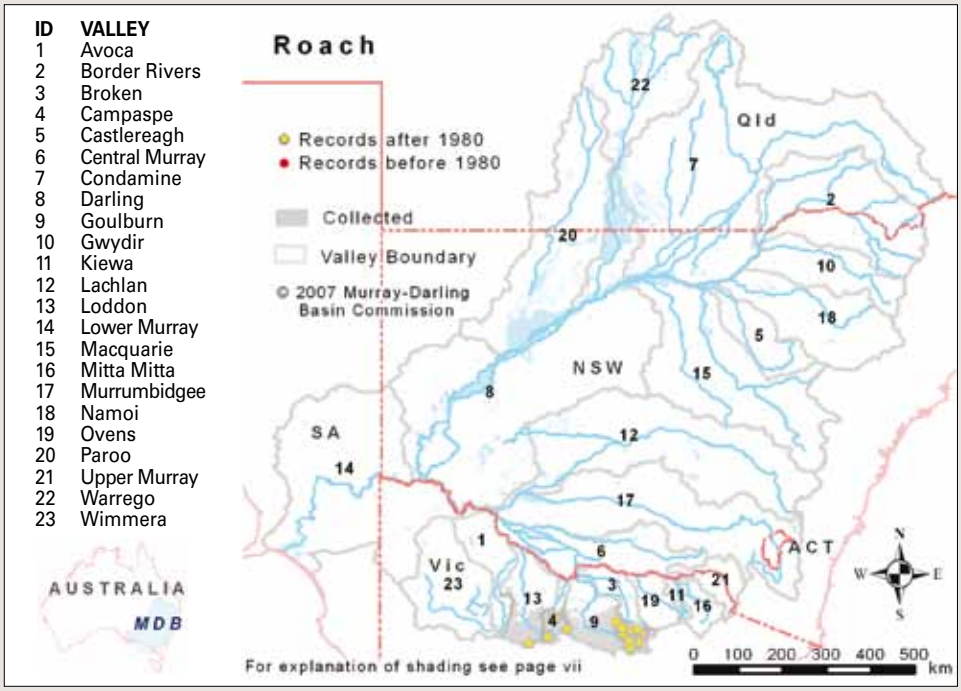
Little is known of the ecology of this species in Australia. In its natural habitats in Europe it swims in schools in ponds, lakes and slow-flowing rivers. It is often found in habitats with abundant aquatic plants and habitat usage patterns vary seasonally, possibly in response to food availability, temperature preferences or predator avoidance.

Roach may live for up to 12 years, with males maturing after 1–2 years and females at 2–3 years. They spawn in shallow water in spring and early summer, either amongst water plants or on a stony bottom. The eggs are small (~1–1.5 mm diameter), transparent and slightly adhesive. Fecundity ranges from 5,000 to 200,000. The eggs hatch in 4–10 days, depending on water temperature, and the newly hatched larvae are 5–6 mm long.

Juvenile Roach feed on plankton and adults eat a variety of animal and plant material. In lakes in Europe, Roach are known to be important planktivores. However, in Australian streams they are mainly benthic feeders, also taking terrestrial insects from the water surface. Roach are themselves probably eaten by native fish such as Golden perch and Murray cod.

Impacts on Native Fish

Little is known of the impacts of Roach on native fish species in Australia.



Distribution and Abundance

Roach are native to Europe and were introduced to Australia in the 1860s. The species is mainly confined to the coastal waters of Vic but is occasionally recorded in the Victorian waters of the Murray-Darling Basin, and very rarely from NSW. It is not known from the ACT, Qld or SA. The species was originally introduced by acclimatisation societies but is rarely fished for now.

General References

Baade & Frederich 1998; Bean & Winfield 1995; Brumley 1991, 1996; Cadwallader & Backhouse 1983; Clements 1988; Jepsen & Berg 2002; Merrick & Schmida 1984.

Common Name Oriental weatherloach (Japanese weatherloach, Weatherfish)

Scientific Name *Misgurnus anguillicaudatus* (Cantor, 1842)

Identification

A small, elongate, cylindrical fish with a rounded tail and small eyes. Maximum length 250 mm; usually < 190 mm. The single, short-based dorsal fin is positioned about half way down the body, and a prominent black spot is present at the base of the tail. The females are more solidly built than the males, and the pectoral fin of females is rounder than the more triangular or square-cut fin of males. Five pairs of barbels surround the small down-turned mouth. The mucous-covered body is very slippery, making the species difficult to handle.

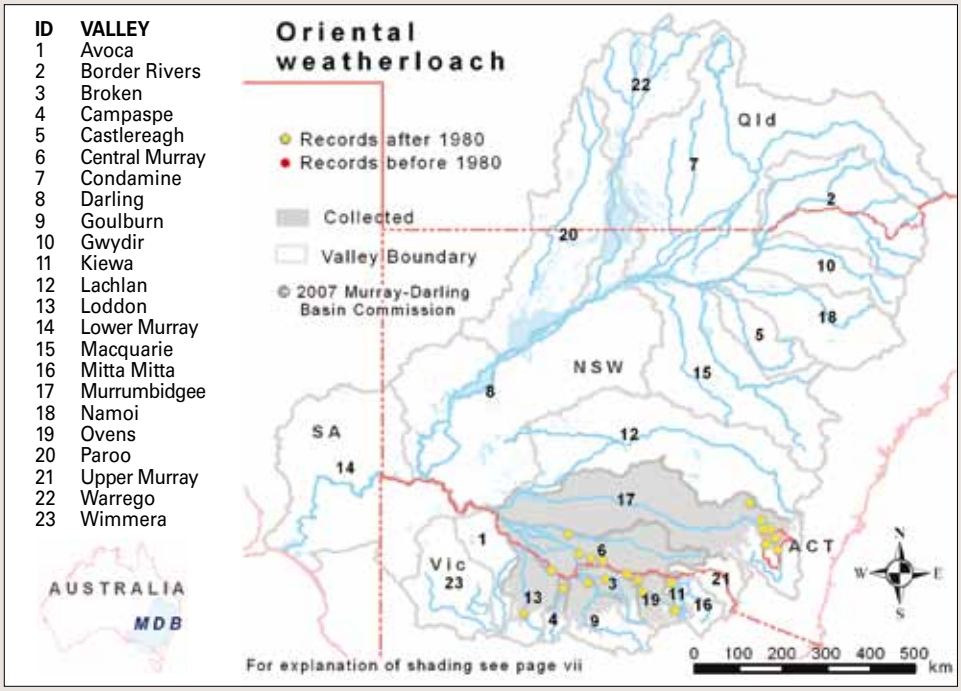
Biology and Habitat

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.

Individuals are mature at approximately 100 mm length and may live for up to 13 years. Spawing occurs in summer. A multiple spawner, the weatherloach lays 4,000–8,000 eggs of approximately 1.5 mm in diameter per spawning. The eggs are laid onto freshwater plants or mud and hatch after 2–3 days.



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.

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 River Murray 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.

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.

Common Name Eastern gambusia (Gambusia, Mosquitofish, Top minnow, Plague minnow)

Scientific Name *Gambusia holbrooki* (Girard, 1859)

Eastern gambusia female

Identification

A small fish with a rounded tail, distinctly flattened head and an upturned mouth. Maximum length 60 mm. The single high, soft-rayed dorsal fin originates well back on the body. Females are much larger than males and usually have a large, black blotch just above the vent. Males have the front rays of the anal fin elongated and modified to form the gonopodium, which is used in breeding. Usually, olive to brownish on the back, with bluish-grey sides and a silvery belly.

Biology and Habitat

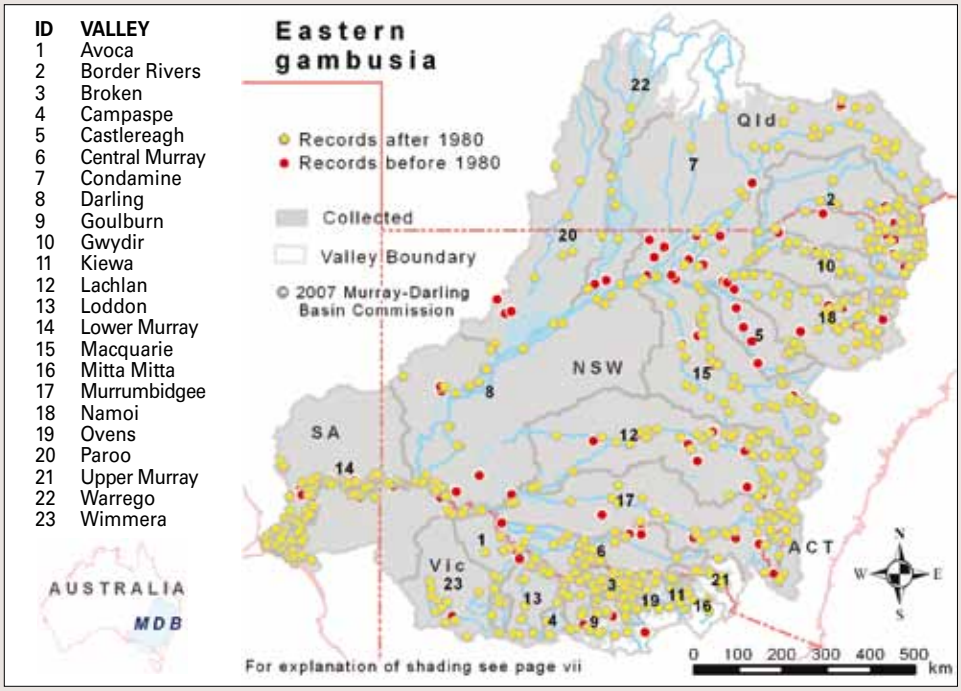
The Eastern gambusia is commonly found in lakes or still or slow-flowing streams, mostly around the edges or amongst freshwater plants. Maturity can be reached after only two months, at about 25 mm long. Breeding occurs during the warmer months and a female produces about 50 young in each batch, and up to nine batches per year. The species does not lay eggs, but produces live young. The fertilised eggs develop inside the female and the young are a few millimetres long when born.

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. 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.

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.

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.

Common Name Redfin perch (Redfin, English perch, European perch)

Scientific Name *Perca fluviatilis* Linnaeus, 1758

Identification

A medium sized and deep-bodied fish with a slightly forked tail, two separate dorsal fins and a large mouth which reaches to under the eye. Maximum length 600 mm and weight 10 kg; commonly 400 mm and 1–2 kg. The back is olive-green to grey, paling on the sides to white on the belly. There are usually around six black bands on the back, tapering on the sides. The pelvic and anal fins and margins of the tail are bright red or orange-red, which is the origin of the common name.

Biology and Habitat

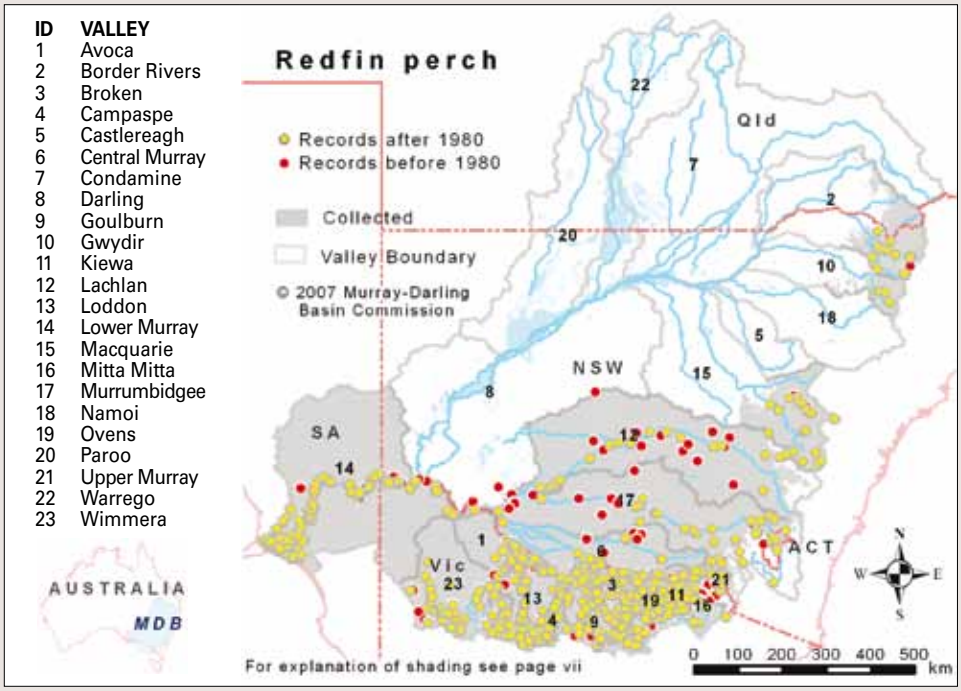
Redfin perch mainly occur in slow-flowing or still water habitats, such as lakes, billabongs and swamps, especially where freshwater plants are abundant. Individuals are generally mature after 2–3 years, but males may mature at the end of the first year. A characteristic of the species is the propensity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

Spawning occurs in spring when water temperature reaches 12°C. Thousands of eggs are laid as gelatinous ribbons amongst freshwater plants. The eggs are 2–3 mm in diameter and the larvae hatch in 1–2 weeks with juvenile fish forming large schools.

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.

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 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.

General References

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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

Appendix 1
Web sources of additional information on the fish of the Murray-Darling Basin

General

Native Fish Australia
http://www.nativefish.asn.au/

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

Murray-Darling Basin Commission, Native Fish Strategy
http://www.mdbc.gov.au/NFS

Department of the Environment and Water Resources threatened species
http://www.environment.gov.au/biodiversity/threatened/

Victoria

Department of Sustainability and Environment
http://www.dse.vic.gov.au/dse/index.htm

Department of Primary Industries
http://www.dpi.vic.gov.au/dpi/index.htm

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

New South Wales

Department of Primary Industries
http://www.dpi.nsw.gov.au/fisheries

Australian Capital Territory

Environment and Recreation
http://www.environment.act.gov.au/airandwater/water

South Australia

South Australian Research and Development Institute
http://www.sardi.sa.gov.au/

PIRSA Fisheries
http://www.pir.sa.gov.au/sector7.shtml

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

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