fish of the lake eyre catchment of central australia

Rob Wager & Peter J. Unmack

Department of Primary Industries
Queensland Fisheries Service

LAKE EYRE ZONAL ADVISORY COMMITTEE

In recognition of the decentralised nature of fishing activities in Queensland, ten regionally based Zonal Advisory Committees (ZAC) were set up to advise the Queensland Fisheries Management Authority (QFMA) on local issues relating to fisheries management and fish habitats.

The Lake Eyre ZAC was established by the QFMA to provide: a forum for discussion on regional fisheries and fisheries habitat issues; a vital two-way information flow between fisheries mangers and the community.

ZAC membership is diverse, representing fisher groups and associations, conservation groups, tourism, fish stocking groups, local government, other government agencies, and other bodies with an interest in fisheries management and fish habitat issues.

Disclaimer

This document has been prepared by the authors on behalf of the Queensland Fisheries Lake Eyre Zonal Advisory Committee. Opinions expressed are those of the authors.

Acknowledgments for the photographs provided by G. E. Schmida and Ross Felix.

NOTE: The management arrangements described in this document were accurate at the time of publication. Changes in these management arrangements may occur from time to time. Persons with any questions regarding fisheries management should contact the local office of the Queensland Boating and Fisheries Patrol or the Queensland Fisheries Management Authority or their relevant state authority.

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introduction

Rarely do people associate fishes with deserts. Despite the defining quality of a desert being a lack of water, it does indeed exist, albeit in small quantities. These scant water resources maintain much of the wildlife found in deserts, especially the aquatic wildlife, much of which cannot survive without permanent water. Over time, plants and animals have adapted to extreme environments on earth, and the aquatic wildlife living in deserts is no exception to this. Most deserts of the world contain a surprising diversity of aquatic habitats, and Australia is no exception. Australia is the second driest continent (after Antarctica) with around 70% being considered arid. Drainage from these desert areas never reaches the sea under the present climatic conditions.

Australia's arid areas can be broadly separated into two regions based on its fishes. The western portion includes the inland drainages from west of the Finke River near Alice Springs to the edge of the Pilbara in Western Australia. This massive area is largely unexplored for fishes partially because of its remoteness and very scant water resources. One species, spangled perch has been recorded here from five localities. The eastern portion extends from the Finke River east to the Bulloo River at Quilpie, and from Mt Isa in the north to Broken Hill in the south (fig. x). We have termed this eastern portion the Lake Eyre Region, since most waterbodies have, or had connections to Lake Eyre. Furthermore, this region contains a characteristic grouping of fish (33 native species in all). The fishes from this Lake Eyre Region are the focus of this publication.

The fishes are presented in order according to currently accepted evolutionary relationships of the family groups. At the beginning of the fish section a key is provided to allow fish to be identified to their family. A page number directs readers to the section on each family. Within each family, species are listed alphabetically, according to their scientific names (by genus and species). Readers may be challenged when trying to distinguish species within a family. To alleviate this difficulty, unique identifying features are noted for each species. Unfortunately, easily recognisable features do not always exist, and closer study using a magnifying lens, or even dissection, may be necessary to get a positive identification. Fish distribution, habitat information and colour photographs will enable readers to more easily identify some species. A glossary is provided at the end to assist readers with the definitions of unusual words.

>>> Information on habitat requirements and breeding biology is provided for those species for which it is known. This information is often based on studies conducted outside the Lake Eyre Region as little research has been conducted on central Australian fishes. However, some species are surprisingly well known. Most references pertaining to fishes from this region are presented in the bibliography, and will allow the reader to obtain additional information if they wish.

Compared to the world's arid areas, Lake Eyre Region fish communities are in remarkably good condition. Anglers can still catch any of the eight largest species, all of which provide good sport and most of which are good eating. Naturalists and aquarists can still observe small fish in their natural habitats. To date, the Lake Eyre Region has largely avoided two of the greatest threats to desert aquatic ecosystems: over-exploitation of water resources and the introduction of many exotic species (either from overseas or other regions of Australia).

There have been proposals to build dams, divert flows or extract water in the Lake Eyre Region. Although these proposals may be conducive to the region's economic prosperity, such water resource developments, if not managed properly, can adversely affect fish communities to the point of their extinction.

Two introduced fish are present in the Lake Eyre Region: goldfish and gambusia. Most people would be unaware of their presence. Goldfish are so much a part of Australian culture that many people do not realise they are not native. To date, its presence has not caused any known problems in the Lake Eyre Region but, as with carp in the Murray–Darling Basin, that could change very quickly if it becomes more abundant. Gambusia is well known for its worldwide impact on native fishes, but to what extent it affects some species in the Lake Eyre Region remains uncertain. It continues to spread throughout the Lake Eyre Region and has been implicated in the decline of at least two central Australian fish; red-finned blue-eye and Edgbaston goby.

Carp are present in the Murray–Darling Basin adjacent to the Lake Eyre Region. There have been some recent 'carp scares', with live fish or frames being found in the Lake Eyre Region. Like all introduced fishes, carp are impossible to eradicate from a river system once introduced. The introduction of native fishes from outside the Lake Eyre Region can also have a dramatic effect on local fish communities.

Major gaps exist in our knowledge of many central Australian fishes. Several species are yet to be described, and little is known of the biology and ecology of most species.

Lake Eyre Region fishes have evolved in association with the climate, landforms, and other fauna and flora. Understanding the environment's natural components can help us to maintain the unique fish fauna and aquatic habitats.

Climate

The Lake Eyre Region is semiarid to arid, experiencing low humidity and rainfall. Average daily summer temperatures are typically 37–39ºC. Occasionally, temperatures may rise to the low 50s. Average daily winter temperatures range between 16–24ºC. In winter, night-time temperatures rarely drop below -2 or -3ºC.

Droughts are normal in central Australia; rainfall is sporadic. Annual average rainfall varies from 110 mm around Lake Eyre itself to 300–450 mm on the margins of the region. However, localised falls can be extremely heavy. For instance, in 1974, 300 mm fell in an overnight storm at Merty Merty near Innamincka homestead. Annual evaporation varies between 2400 and 4400 mm, which dramatically exceeds the average rainfall.

Central Australia does not have well-defined wet and dry seasons. Storms tend to be more common in summer and are associated with the monsoon trough or the occasional remnants of tropical cyclones. As a result of storm activity, late spring and summer rainfall averages are marginally higher than in winter.

Landscapes

The Lake Eyre Region consists of ancient landforms that have changed little over the last 65 million years. The largest mountain range, the MacDonnell Ranges, was formed about 600 million years ago. The only ‘recent’ significant mountain uplift occurred in the Flinders Ranges 65 million years ago. As a result of its stability over vast time periods, the Lake Eyre Region is mostly flat. Individual catchments are vast and each watercourse often consists of many widely separated channels. Watersheds between catchments are often nothing more than gently rolling hills.

Some ranges are little more than a series of low, flat-topped hills. Nevertheless, these are fascinating features, exhibiting the layering of sediments that created the Lake Eyre Region. Some apparent ranges are not hills at all, but are ‘jump-ups’ that consist of a steep and craggy wall rising from a flat plain and leading to another expanse of flat country. Mountains are rare, with less than 30% of the Lake Eyre Region being higher than 250 m above sea level.

The region’s highest point is Mount Zeil (1531 m), which is part of the MacDonnell Ranges in the Northern Territory and marks the headwaters of what is perhaps one of the world’s oldest rivers. Parts of the Finke River are thought to have followed the same course for at least 65 million years and possibly up to 350 million years.

Great Artesian Basin

The Great Artesian Basin (GAB) is a vast geological formation spanning 1.76 million km^2 or 22% of Australia's surface area. It is one of the world's largest artesian basins and its importance lies in the reserves of water collected within its sedimentary layers. The GAB began to form about 200 million years ago when subsidence of inland areas began. Over millions of years sediments were deposited and compressed in successive layers as the sea entered and left the landscape several times (the last time being 95 million years ago). It is the sequential deposition of these different sedimentary rocks that produced the layers that consist of porous rocks (usually sandstones) through which water flows, and the non-porous rocks (usually siltstones and shales) which confine the water to specific layers. Hence, the GAB actually consists of several partially interconnected aquifers.

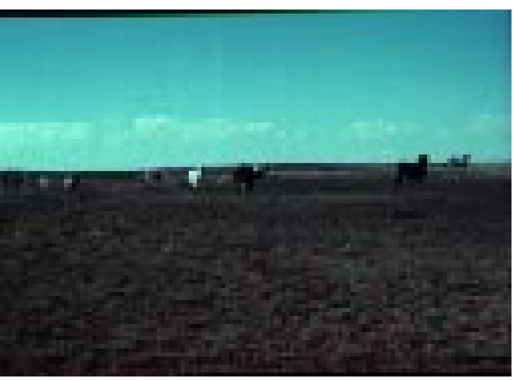
Subsidence in central parts of the GAB and uplift in parts of the margins resulted in these layers being exposed at the surface in several places, including the Simpson Desert and the western slopes of the Great Dividing Range. These exposed porous sandstones allow rainfall to percolate into the aquifer, and are referred to as the recharge zones. Water flows through the permeable beds and cannot rise to the surface because of the overlying impermeable layers. Because the recharge areas are higher than most of the basin, the underground water is under considerable pressure.

If there is a natural fault or weakness in the overlying rocks, or if a bore is drilled, water flows to the surface, resulting in a natural spring or an artesian bore. Rainfall on the Great Dividing Range (the main recharge area) may take tens to hundreds of thousands, even millions of years before it comes to the surface again, as it only travels an average of 2–5 m per year through the aquifer.

Mitchell grass plains (*Rob Wager*)

Vegetation and land use

The Lake Eyre Region's dominant feature is the Mitchell grass plains (or open tussock grasslands), which covers about one-third of the region. Other common vegetation communities include sparse open herbfields (mostly herbaceous plants of the Family Chenopodiaceae); tall, open shrubland (dominated by mulga and other acacia species); low open woodland (dominated by acacia or eucalypt species); and low woodland.



Cattle grazing on herb land (*Rob Wager*)

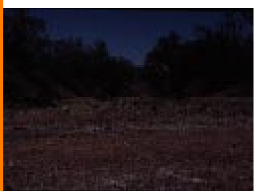
Domestic grazing is the dominant land use and occurs on about 90% of all lands in the Lake Eyre Region. Grazing of cattle is widespread, while sheep grazing is primarily restricted to areas east of the dingo fence. Kangaroos are the most common native herbivore, being more abundant today than at the time of European settlement. Feral animals are frequently common and include rabbits, goats, pigs, donkeys, camels and horses. Cropping and irrigation are almost non-existent, as are the associated water developments such as impoundments (dams) and water-harvesting schemes.

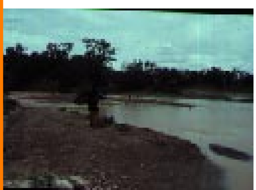
Some form of land degradation affects much of the grazing area, but a few areas are severely degraded. Many soils throughout the region are naturally unstable, and run-off has caused widespread sheet erosion and gully erosion in some areas. Flood damage is a natural occurrence, and creek-bed and stream-bank erosion is evident. Feral and domestic animals often make this worse. Woody weeds are a common problem, especially in the eastern areas. Prickly-acacia, parkinsonia, mesquite, mimosa, rubbervine, turkey bush cassias, sandalwood, gidgee and lignum are plants that have invaded various parts of the basin.

A kangaroo drinks at a spring before the storm breaks (*Steve Brooks*)

Rivers and creeks

No rivers in central Australia have permanently flowing water. Rivers and creeks flow only after rainfall. In small catchments, flows are of short duration, perhaps a few hours to a few days. At any one site on a larger river a flow typically lasts for a few days to a few weeks. Flows lasting longer than a month are rare. Because of the low gradients water tends to travel slowly along the length of a river. The larger rivers have gradients of 1.7–5.7 cm/km. Consequently, water in the upper reaches may take up to two months to get to the lower reaches. Once flows cease, the rivers recede to a series of waterholes, most of which disappear after a year or two if there is no further rain. Indeed, most waterholes throughout the basin are known to have dried at least once since European settlement.





The same road crossing over the Diamantina River, one day apart (*Rob Wager*)

When in flood, rivers such as Cooper Creek may spread as wide as 50 km or more in parts, owing mainly to the flatness of the landscape, which causes the river to spread out into many channels. This is how the Channel Country in south-western Queensland acquired this name. In this region, a road crossing over a major river consists not only of a bridge over the main channel but a series of bridges or culverts spanning many overflow channels.

Waterholes are the main wetland feature in central Australia. Given the length of river between waterholes, larger more permanent ones are considered uncommon. Waterholes are formed through the erosive action of water. This process results in different types of waterholes in different places. In the inland ranges, waterholes form in gorges. The gorge walls concentrate the flow, increasing its erosive power and tending to carve out a hole.

The Diamantina River channel country (*Rob Wager*)

In some places, waterholes are associated with bedrock in the river channel. Water flowing over the bedrock causes scouring. Typically, these waterholes have a sandy bottom. In other areas, waterholes may form where water flow becomes concentrated, such as where two channels come together. In areas like the channel country, clays dominate the upper soils to a depth of about 2 m. If a river can erode through the clay, it hits a sandy layer, which is far more easily eroded. When flow ceases some clay settles out and seals the bottom.

The banks of waterholes are often steep or undercut. Roots of trees help to hold the banks and provide cover for fishes. In parts of the Lake Eyre Region where sandy stream bottoms are rare, the water is exceptionally muddy. This muddiness is caused by fine clay particles chemically suspended in the water. The water will not clear even if left in a bucket for a month, although treatment with alum can clear the water overnight.

The Old Cork waterhole, Diamantina River (*Rob Wager*)

An annual water temperature range of 13–34ºC has been recorded in the lower Cooper Creek. No doubt this is more extreme in shallow waterholes. During warmer months, waterholes may undergo thermal layering. The top layer of water may be very warm, with a much cooler layer below. For example, in Aramac Creek in November, the temperature of the top layer was 36ºC at midday, while the lower layers were between 29 and 31ºC. In addition, the salinity or the salt content of the water is variable, but usually is less than one part per thousand (that is, one gram of salt per litre of water), except in areas around Lake Eyre.

In flooding rivers, the flow often spills into tributaries, overflow channels and gullies before continuing downstream. This flow dispersal can make a flooded river difficult to navigate, because it is not obvious which is the main channel and whether the flow is leading downstream or back up a tributary. Initially, floodwaters tend to be very muddy and are often several degrees cooler than the waterholes into which they flow.

The Lake Eyre Region consists of several separate drainage areas that are described below. Following that, a summary of the major habitat types is provided.

Lake Eyre Drainage

The Lake Eyre Drainage is about 1.3 million km^2 in area and has an average annual run-off of 4457 m^3. Lake Eyre is the terminus for all the drainage.

Despite the relatively long and apparent large size of the rivers, permanent water is limited in extent. For example, the Neales River is reported to have only two permanent waterholes. The Macumba, Todd and Hale Rivers and all of the Frome System have no permanent waterholes, while the Plenty and Hay rivers have only a couple of tiny spring-fed pools that may not be permanent either. Only seven waterholes in the Finke River are considered permanent. The Georgina River has only one waterhole that has not dried since European settlement, although it has many waterholes that usually contain some water. The Diamantina River has a number of permanent waterholes, while Cooper Creek has the greatest number of waterholes and, not surprisingly, the highest number of fish species. This may also in part be due to its occurring in the least arid part of the Lake Eyre Catchment. It is important to remember that the term permanent is used loosely here. While a given waterhole may not dry up completely, its suitability for fishes may be limited by the water becoming saline, too shallow or to hot or cold.

A waterhole in Cooper Creek near Windorah (*Rob Wager*)

Despite maps showing that most of the larger rivers connect to Lake Eyre, the lake appears to act as a physical barrier to dispersal for some fish species and to Krefft's river turtle (*Emydura krefftii*). Most of the rivers that contribute water to Lake Eyre have a distinctive fish fauna. For instance, several fish species are endemic to Cooper Creek; the Diamantina River has no endemic species; and the Georgina River has some species that also occur in the Gulf of Carpentaria rivers.

Both Cooper Creek and the Diamantina River occasionally flow into Lake Eyre at the same time. There are no obvious reasons why at least some of the Cooper Creek endemic fish could not survive in the Diamantina River today. Although information is sparse on which fishes live in Lake Eyre, most species can access the lake during floods. Moreover, the lake habitat is not too different from some of their usual habitats. Possibly, circumstances may be more complicated than are presently understood.

Bulloo–Bancannia Drainage

The Bulloo–Bancannia Drainage is about 100 570 km^2 in area and has an average annual run-off of about 400 m^3. It has two main catchments; the Bulloo River system that terminates in Bulloo Lake, which is a series of large ephemeral swamps on the Queensland–New South Wales border (see Figure 2); and the Bancannia (or Yanncannia) system which consists of a series of small, isolated creeks and lakes. Both catchments remain poorly studied and most fishes are known only from a few specimens.

Curiously, the Bulloo River's fish stocks are far less abundant than expected compared with other central Australian rivers. This may be because the water in the Bulloo River, compared with other central Australian rivers, is much muddier. It has been suggested that the Bulloo River is, or was, part of the Murray–Darling Drainage Division. However, the present topography indicates that the most likely direction for historical drainage to occur is towards Lake Frome. The fish fauna of the Bulloo River most closely resembles that of Cooper Creek, which also had past connections to Lake Frome.

Barkley Tablelands Drainage

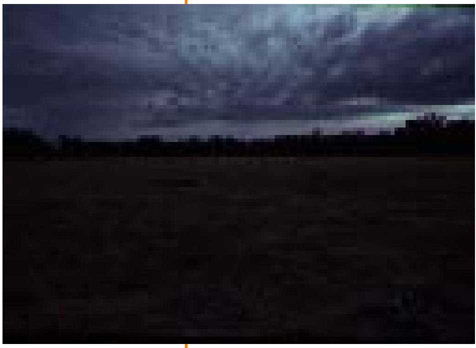
The Barkley Tablelands Drainage is approximately 230 000 km^2 in area. Annual run-off is not specifically known, but is a small amount. Two main catchments exist; those creeks that drain into Lake Sylvestor and nearby associated lakes, and those that drain into Lake Woods. The entire drainage is very flat except in the south in the Davenport Ranges. Most creeks are short and permanent waterholes are scarce. Little research of any type has been conducted in this drainage. It is likely to have once been connected to Lake Eyre Drainage on its eastern margin where the drainage divide between it and the Georgina River is virtually non-existent.

Lakes

Most lakes in central Australia provide only a temporary and irregular habitat for fishes. Small isolated bodies of water throughout the Lake Eyre Region are invariably known as waterholes, although several local names such as lakes, billabongs, lagoons, oxbow lakes, clay or salt pans, flood-outs or melon holes may be used.

The term ‘waterhole’ (as applied to rivers) describes some isolated water bodies that might otherwise be considered lakes. Indeed some, if not most, lakes in central Australia are part of a watercourse and have an inflow and outflow, as do waterholes on larger rivers. Whether a waterhole is called a waterhole or a lake depends largely on its size or, more likely, on what it has been called in the past.

Common features of these isolated lakes and waterholes are that they are shallow depressions, usually without vertical or undercut banks, that fill during floods when rivers overflow. However, some clay pans have a closed catchment area and are filled only by rainfall. Although these small lakes may contain water for a few weeks to several years, finding one that is permanent is unusual. The water is usually muddy, although in some instances it is clearer than nearby riverine waterholes. Such lakes may have only one or two fish species, or as many species as nearby riverine waterholes.



Coorabulka Lakes near Boulia, the grassy area fills after rain (*Rob Wager*)

Larger lakes are usually found in the lower reaches of catchment areas. Despite the great size of these lakes, seeing them full of water is still unusual. As with smaller lakes, they generally have gently sloping banks and rarely are more than 2 m deep. When partially or completely full, the large lakes (such as Eyre and Frome) contain massive, although short-lived fish populations that die as the salinity level rises owing to evaporation. As they dry up, many lakes become much saltier than seawater.

Some lakes in the Lake Eyre Region, (for example Woods Lake and Coongie Lake) are as close to permanent as is possible for lakes in this area. Woods Lake is in the Barkley Drainage and its water quality and wildlife are poorly known. Coongie Lakes in the Cooper Creek system are a series of interconnected lakes less than 2 m deep. Coongie Lakes have been a centre for intensive study in recent years.

Lake Eyre

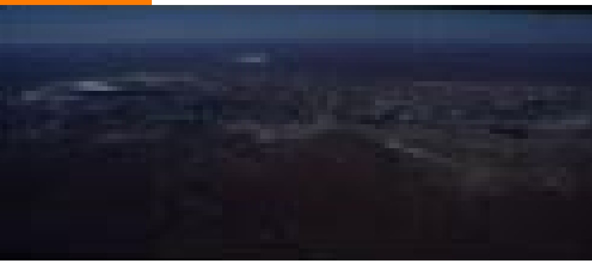
In 1840, Edward John Eyre became the first European to see the lakes of central Australia. He thought that what are now known as Lake Eyre, Lake Torrens and Lake Frome was a single massive salt lake. Although not as large as Eyre thought, Lake Eyre, when full, is still the largest inland body of water in Australia. Usually Lake Eyre is a 9000 km^2 desert of salt and clay, with small areas of mud and saline water. After unusually wet seasons, which occur about five times a century, Lake Eyre fills. During the record 1974 floods, the lake peaked at an estimated 32.5 million megalitres, or 26 million acre feet. After some minor inflows in the intervening years, it was virtually dry again by 1979–80. While the lake is rarely completely dry, it probably does not contain resident fish stocks because of its extremely high salinity levels.

Lake Eyre lies 15.2 m below sea level and is the lowest point on the Australian continent. Its geological history is long and complex and many aspects are poorly known (such as when it last had connections to the sea). It has been landlocked for some time, perhaps two million years or more. During the last 20 million years, a combination of continental forces and the deposition of sediments has caused the lake bed to sink and at times large to massive freshwater lakes formed, depending upon climatic conditions. Lake Eyre began to take on its present-day arid condition only over the last 1 million years or so, marking the time when severe aridity began in central Australia.

Springs

Most springs in central Australia are natural outlets of the Great Artesian Basin. There are about 600 known outlets. However, one outlet may represent between 1 and 400 individual springs; consequently, the number of springs is considerably higher. All the springs occur in 11 'supergroups' (see the Great Artesian Basin map). Most springs are relatively small, with a discharge of less than 1 litre a second (L/s). Only 11 springs have a discharge rate between 5–138 L/s; all are located within the Dalhousie Springs Supergroup. Many springs have a distinctive mound and are often referred to as mound springs, although the size and composition of mounds vary between springs. Springs that do not form mounds are often referred to as artesian springs, boggomosses or soaks. Water from most springs is at least suitable for watering stock and may be suitable for human consumption.

Some springs have an unusual concentration of biological diversity. The groups of springs described below contain fishes, plants and other wildlife that are found nowhere else in the world. Many of these springs have not been studied to any great extent, and many new animal and plant species are likely to be found. Sadly, most springs have been damaged or degraded and, consequently, some unique and special animals and plants may have been lost already.



Dalhousie Springs

Dalhousie Springs contains about 100 individual spring outlets, of which about 80 are still active. The springs occur over about 70 km^2. Dalhousie Springs accounts for 41% of the natural water discharge from the Great Artesian Basin. It is the only major group of springs that produces warm-water outflows, with many springs having temperatures between 30ºC and 46ºC.

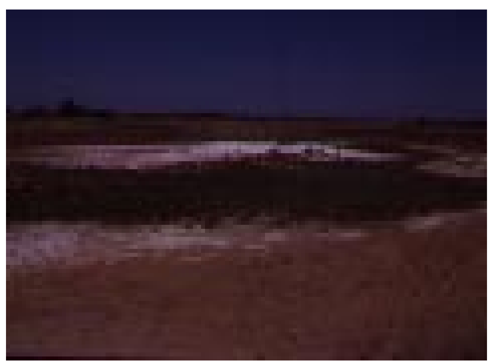
These springs have the most diverse fauna of any of the Great Artesian Basin springs, with six fishes, five of which are endemic; at least six endemic snails; and several small endemic crustaceans, including a blind amphipod. Isn addition, a crayfish and a frog are also possibly endemic. There are no introduced aquatic animals, including fishes, in any of the springs, which have undergone little modification except for the introduction of date palms (*Phoenix dactylifera*).

In 1985, the South Australian Government bought the property containing Dalhousie Springs, to form Witjira National Park, making Dalhousie Springs the first complete spring group to be protected within Australia.

Springs in the Lake Eyre Supergroup

This is the largest spring supergroup in terms of the number of individual springs, which occur in a band about 400 km long by 20 km wide around Lake Eyre. About 100 named groups of springs are present within the Lake Eyre Supergroup, although there are perhaps several thousand individual springs. Most of these are small. The water emerging from springs in the south-west of the Great Artesian Basin is thought to have been underground for about one million years.

Several species of fish have been found in these springs. For example, desert goby have been recorded in 30 springs; Lake Eyre hardyhead and spangled perch are recorded occasionally; and one exotic fish, gambusia, is found in a few springs.



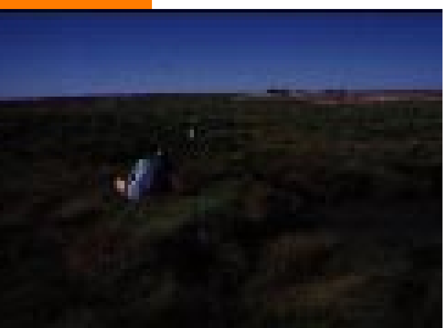
Edgbaston Springs, habitat of red-finned blue-eyed and Edgbaston goby (*Rob Wager*)

Endemic invertebrates include 10 species of snails, several small crustaceans (ostracods, amphipods and an isopod) and a flat worm.

Edgbaston Springs

Edgbaston Springs is part of the Springsure Supergroup. At least 44 springs have been identified at Edgbaston Springs, most of which are small, shallow and marshy; none form mounds. Some are little more than moist areas with remnant vegetation. Three fishes (namely red-finned blue-eye, Edgbaston goby and a hardyhead) occur here. They are known only from these springs and have the smallest natural ranges of any Australian fishes. Occasionally, spangled perch are recorded from some springs. Unfortunately, the exotic gambusia also is present in many springs.

Edgbaston Springs also exhibits some of the harshest freshwater environmental conditions found anywhere in the world; for example, over a few hours, temperatures may vary by more than 20ºC. Despite the small size of Edgbaston Springs, it contains a surprisingly diverse and endemic fauna, rivaling that of Dalhousie Springs. This fauna includes at least seven endemic species of snails, six of which occur together in some springs, and undescribed endemic ostracods, amphipods and other invertebrates.



Elizabeth Springs

Elizabeth Springs is a part of the Springvale Supergroup and consists of about 40 individual springs, with a total area of about 6.5 ha. Several springs in the Springvale Supergroup were active before water extraction. Elizabeth Springs, which once was probably the second or third-largest spring in the Great Artesian Basin, is the only extant spring group. Today, it flows at less than 5% of its original rate. One endemic fish, the Elizabeth Springs goby, and one endemic snail are found in Elizabeth Springs.

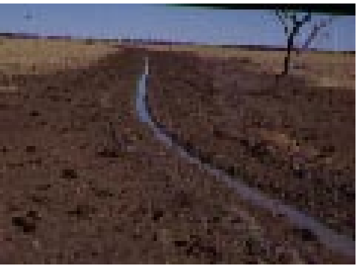
Artificial habitats – flowing bores, farm dams and impoundments

Artesian bores are artificial outlets of the Great Artesian Basin. Major drilling of bores began in central Australia during the late 1870s. Since then, many bore holes have been sunk into the water-bearing layers of the basin. Water is forced up the bore and flows out onto the ground. Such a bore is called a free-flowing bore. Often networks of drains were constructed, taking water from the bore to distant parts of properties. These drains have become known as bore drains.

In many instances, the artesian water is allowed to enter a natural gully or creek so that the creek becomes permanent for much of its length. Often the bore does not flow very far, but instead forms a waterhole or wetland. Artesian bores have transformed many areas of central Australia, allowing pastoral industries to expand into previously inhospitable areas. Further, bore drains have provided habitat for fishes and other wetland flora and fauna.

A free-flowing (uncontrolled) bore (*Rob Wager*)

Unfortunately, free-flowing bores and bore drains may have detrimental impacts. They are a waste of extremely precious water and, by reducing water pressure over large areas of the Great Artesian Basin, have caused the extinction of many natural springs. Over-exploitation has meant that many bores have stopped flowing. This problem has been recognised and governments are now assisting landowners and managers to cap and pipe free-flowing bores. A valve is placed on the bore outlet so that the flow can be regulated and then piped to stock troughs. This process conserves water by reducing evaporation and seepage, thereby ensuring that only as much as is needed is used.

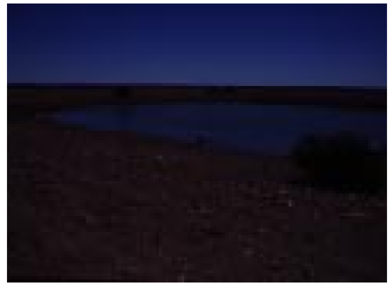


A bore drain. Habitat of gambusia and rarely of the Edgbaston goby(*Rob Wager*)

Free-flowing bores have allowed an exotic fish and some weeds to proliferate. The introduced fish, gambusia is often abundant in bore drains. The warm, shallow, permanent water allows large populations to survive, even during dry times when nearby waterholes dry. Because of this, they have become locally known as bore-drain fish. Gambusia can also be found in riverine waterholes, but rarely in large numbers. They have spread throughout the Cooper Creek Basin and are invading the Diamantina Basin. This dispersal is assisted by the presence of bore drains that provide many individuals that can spread during floods to colonise new areas. It is unlikely that this species could survive as well as it does in central Australia without bore drains.

Isisford Weir on the Barcoo River (*Rob Wager*)

Farm dams also have become fish and wildlife habitats throughout much of central Australia. Earthen dams are constructed across a gully to catch run-off. Alternatively, an earthen wall is constructed around an excavated hole. This type of dam is usually called a ring tank or a turkey nest. Water is pumped into ring tanks either from underground or during floods from nearby waterholes.



A ring tank or turkey nest (*Rob Wager*)

Fishes and crayfish have an uncanny ability to find their way into ring tanks and bore drains. This may be explained by the incredible dispersal ability of some species, especially during floods. Some species undoubtedly are pumped into ring tanks either as eggs or larvae. Birds may be responsible for introducing eggs, although this has never been documented. Local lore has it that ‘the postman’, wanting a feed of crayfish or spangled perch at an overnight camp, often introduces them.

The only impoundments in the Lake Eyre Region are small weirs used for supplying the domestic water needs of many towns. These are not much different to waterholes in terms of habitat, water quality and fish communities. They may be more permanent, but many still dry completely.

Fact or fiction?

Apart from stories about the ones that got away, several tales are regularly told about unusual fish or unusual happenings involving fishes. For some reason, these are heard mostly in outback areas-perhaps isolation generates a better storyteller or perhaps the stronger association with the land creates a greater perception? Either way, and despite the conviction with which they are told, most are hard to believe.

Rains of fishes

Many stories are told about people finding fishes in unusual places. The usual explanation is that they must have ‘come from the sky.’ However, in most cases, it is impossible to rule out the possibility that they swam there. Lake Eyre fishes have a remarkable capacity to disperse. Spangled perch have been recorded swimming up to 16.6 km in 6 hours along a wheel rut. They stopped only because the water dried up. After the briefest of showers, introduced gambusia have been found on clay pans near bore drains in 5 mm of water.

Dispersal does not explain how fishes came to be found in a house water tank on a station, near Winton in central western Queensland. After a heavy but brief downpour, fishes and tadpoles were observed on the ground around the station. It was explained simply as ‘one of them rains of fishes’ and given little more thought. About a week later, the tap of the tank became blocked and stopped flowing. Closer inspection revealed that a small fish was stuck in the inlet to the tap and that others were living in the water tank. Most rains of fishes probably do not originate from the sky.

Fish living underground

Another story relates to the presence of fishes in or around newly drilled bore-holes. The common aspect of these stories is the presence of pinkish fishes (like cooked prawns) around the base of the drilling rig. They are invariably dead. The inference is that they have come from below ground.

Some fishes do live below ground. Australia has two such species. However, these live in caves near the surface rather than in aquifers hundreds of metres below ground. Such species have adaptations such as well-developed lateral lines and also lack eyes; they certainly cannot tolerate water temperature much over 35ºC.

It is not known if the water around the drilling operations comes from below ground or if it is trucked to the site for cooling or cleaning purposes. The ‘bore hole fish’ may have arrived with the cooling water. The high temperatures around the drill probably killed them. Fishes may be found around drilling sites, but it is unlikely that they come from below ground.

Hibernation, aestivation or just living in mud

There is no scientific evidence that any fishes in the Lake Eyre Region are able to aestivate or hibernate. None produce eggs that are able to survive when dried. Live spangled perch or catfish are often found in the mud of a drying waterhole. They have a remarkable ability to survive these adverse conditions, but they die if rain or flooding does not fill the waterhole. Again, the mystery appearance of fishes in a remote waterhole is most likely the result of their ability to travel after rain.

Apart from fishes, a variety of plants and animals inhabit central Australian wetlands. The long isolation from the rest of the world has allowed the evolution of many unique and endemic plant and animal species.

Common reed (*Phragmites australis*) and Cumbungi (*Typha* species) in a bore drain (*Rob Wager*)

Aquatic plants

Submerged aquatic plants are uncommon in the Lake Eyre Region because there is so little clear water. Aquatic plants are unable to grow in muddy water, because they cannot get enough light. Where the water is clear, such as in creeks fed by flowing bores, many plants will grow, including the common water milfoil (*Myriophyllum* species) and pondweed (*Potamogeton* species).

Floating plants are more common, but true waterlilies are rarely found. Pink flowering waterlilies (*Nymphaea gigantea*), or a similar species, are present in some of the more lasting waterholes and some ring tanks. More often, a waterlily-like plant known as water snowflake or marshwort (*Nymphoides crenata*) is present. This plant has small, floating leaves and a small, feathery, yellow flower. Water primrose or ludwigia (*Ludwigia peploides*) is common in waterholes, lakes and dams; it grows in mud and extends long runners from the shore into deeper water. It also has yellow flowers. This species is suspected of causing gastroenteritis in cattle.

Emergent plants (that is, plants that grow in water but have their stems, leaves and flowers above water) are more common and include such widespread species as cumbungi or bulrushes (*Typha domingensis*), common reeds (*Phragmites australis*) and several kinds of sedges and rushes. Such plants are common in springs and flowing bores.

'Tall' and 'short' Salt Pipewort (*Eriocaulon* species) in artesian springs (*Rob Wager*)

A species of *Myriophyllum* from an artesian spring (*Rob Wager*)

Many plants occur in artesian springs but nowhere else. For example, salt pipewort (*Eriocaulon carsonii*) and another closely related but undescribed species that look like small aquatic cacti grow in shallow water or are totally submerged. Because of the degradation of so many springs, some of these plants are in danger of extinction.

Nardoo (*Marsilea* spp.) is the most famous plant of wetlands in the Lake Eyre Region. It is a small, clover-like fern that grows rapidly in damp situations. After flooding, spores germinate and old, apparently dead plants may produce shoots. Before the pastoral industry was established, this plant formed vast meadows about 30 cm high. Aborigines were able to collect sufficient spores to make a type of flour. When mixed with water, the nardoo flour can be

Crayfish or Yabby (*Cherax destructor*)
(*Rob Wager*)

made into a paste and baked to form small nardoo cakes. Nardoo was made famous by members of the Burke and Wills Expedition to Cooper Creek. The explorers persisted for a time on nardoo cakes, which the local Aborigines taught them to make.

Following the establishment of pastoral activities in the Lake Eyre Region, nardoo and many other water plants appear to have become less common. Many emergent and aquatic plants are very palatable to stock. Cattle wade in wither-deep water to get to waterlilies, and feral pigs uproot plants to get to their bulbs.

Invertebrates

Many invertebrates (animals without backbones) occur in waterholes. The crayfish or yabby (*Cherax destructor*) and the freshwater prawn or shrimp (*Macrobrachium australiense*) are widespread and abundant. Both are good to eat.

The eggs of the unusual shield shrimp or tadpole shrimp (*Triops australiensis*) may lie dormant in dry gullies or claypans for many years. After rain, the eggs hatch and female shield shrimp emerge. The females mature and lay eggs that produce more females. This enables large populations to quickly build up, since the females do not need to wait for males to fertilise their eggs. When the claypan starts to dry, males are produced. Males and females mate and produce a type of egg that can survive in the dry sediments. These eggs will not hatch unless they undergo a period of drying. This feature prevents eggs hatching in the last remnants of mud. These eggs are very light and can be dispersed by wind and dust storms to new habitats. Fairy shrimps (Family Anostraca) are another unusual Lake Eyre crustacean that has a similar life cycle to tadpole shrimps.

Freshwater mussels live buried in the sediments at the margins of waterholes. They move by anchoring their large fleshy foot into the surrounding mud and drawing themselves to it. Mussels feed by filtering water drawn into their bodies through an extended tube. Once organic material has been collected, the water is expelled through another tube. Mussels appear to survive the drying of waterholes by burying themselves deep in the mud and waiting for the next flood. Aboriginal people ate mussels and used their shells for cutting and scraping, and for decorative purposes. Several species of snails occur in the Lake Eyre Region, some of which are important food sources for fishes and other animals. Little is known about the life histories of these species.

Frogs and reptiles

About 22 species of frogs live in the Lake Eyre Region. Most also occur in other areas of Australia, but some are restricted to arid regions. The desert spade-foot toad (*Notaden nichollsi*) is a burrowing frog that lives in sandy areas. It is found only after rain, when it comes to the surface to breed in clay pans. Most frogs are active after rain, and the chorus of calling males around a waterhole or spring can be deafening. Cane toads (*Bufo marinus*) also have invaded the Lake Eyre Region from eastern and northern areas.

Krefft's river turtle (*Emydura kreffti*) is the only turtle recorded from the Lake Eyre Region. It is common in the Cooper Creek Catchment, but whether it occurs further west is unknown.

Krefft's River Turtle
(*Gunther Schmida*)

In the early 1990s, a 1.85 m freshwater crocodile (*Crocodylus johnstoni*) was caught near Windorah. Crocodiles are not a typical part of the Cooper Creek fauna, and it is not known how this particular crocodile happened to be more than 1000 km from home. Perhaps, it had some human assistance!

Water birds

Birds are one of the most obvious types of wildlife at waterholes and lakes. Some 250 species of birds have been recorded from the Lake Eyre Region and many of these are associated with wetlands. Most waterfowl and many other birds are highly nomadic. Within days of a waterhole filling, hundreds or even thousands of birds may turn up, including ducks, geese, swans, cormorants, pelicans and even seagulls and terns. Many wetlands in central Australia are important resting and feeding areas for migratory birds.

Fishes

Few fishes occur in the desert regions of Australia. Only 33 native species from 11 families have been recorded. Many do not occur elsewhere and most have extraordinary adaptations for desert existence. Within the Lake Eyre Region, fishes can be separated into two groups: those that rely on the permanent and relatively stable environments of artesian springs, and those that live in waterholes.

Despite the lack of permanent water, fishes are able to persist in central Australia for two reasons. Firstly, rarely do all the waterholes in a particular system go dry at the same time, and, secondly, flooding provides a means by which they can disperse widely. During flooding, virtually every water body upstream of the point where flow ceases will be connected. This situation is ensured by low gradients that allow floodwaters to persist for long periods. Fish distributions are fairly uniform within each river system, and most waterholes typically contain 80–100% of the total riverine fish fauna. Many species produce huge numbers of eggs, often in response to flooding.

Most central Australian fishes have broad environmental tolerances. All species can tolerate temperatures between 15 and 35ºC; most can tolerate 7–37ºC; and a few, such as desert goby and spangled perch, will survive from 4–42ºC, for short periods. Almost all Lake Eyre Region fishes will survive a period in 50% seawater. Generally, most can survive in relatively low oxygen concentrations. The survival of juveniles of most species is linked to flooding. Several species can spawn independently of flooding, but significant juvenile survival occurs only after floods.

Most species spawn when the water temperatures are greater than 20ºC, although some require temperatures in excess of 25ºC. Most of the smaller species, especially hardyheads, rainbowfish, smelt and glass perchlet, lay a few eggs daily during the warmer months. Larger species, such as catfishes, grunters and perch, lay large numbers of small eggs during floods. Gobies and gudgeons attach eggs onto hard surfaces; the male guards the eggs until hatching, after which no further parental care occurs.

The key below allows any fish likely to be found in the Lake Eyre Region to be identified. To use the key, start at number one and carefully read the statements. For any fish, one statement will be correct and the other incorrect. After each statement, there is either the next key number, or a Family name with a picture and a page number. Follow the key until a Family name is reached. Turn to the page indicated. The colour photographs and information in the first two paragraphs (distribution and unique features) of each species in that Family will usually enable them to be identified. Avoid using colour alone for identification, as colour is variable and can be misleading. Colour patterns are often of greater importance. Any technical terms used are shown in Figure x and/or defined in the glossary.

1a. The second dorsal fin, caudal fin and anal fin form a single continuous fin; barbels present around the mouth. Plotosidae page 23.
1b. Separate dorsal, caudal and anal fins. 2.

2a. Adipose fin present. Retropinnidae, page 22.
2b. No adipose fin present. 3.

3a. Single dorsal fin with no obvious low point in the middle. 4.
3b. ‘Single’ dorsal fin with distinctive low point in middle or two dorsal fins. 6.

4a. Beginning of dorsal fin contains a single spine. Cyprinidae, page 42.
4b. No obvious spine at beginning of dorsal fin. 5.

5a. Last ray of the dorsal fin has a long thread-like filament, which extends almost to the tail; it is readily observed by extending and spreading the dorsal fin forward; caudal fin forked. anal fin unmodified. Clupeidae, page 21.
5b. No extended last dorsal fin ray; caudal fin rounded; males have a unique modified anal fin (called a gonopodium). Poeciliidae, page 41.

6a. Obvious sharp spines in the dorsal, anal and pelvic fins; weak in small fish. 7.

6b. No obvious sharp spines on fins. 9.

7a. Usually less then 60 mm. Ambassidae, page 31.
7b. Usually larger then 60 mm. 8.

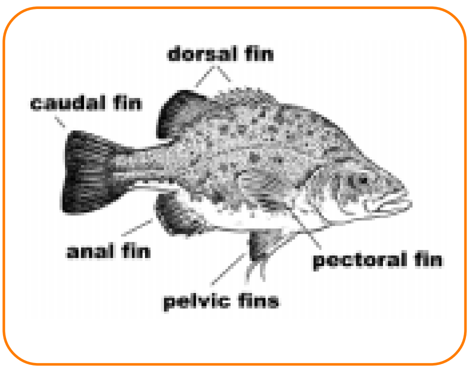
8a. Pelvic fin origin below or in front of the pectoral fin base. Percichthyidae, page 31.
8b. Pelvic fin origin distinctly behind pectoral fin base. Terapontidae, page 33.

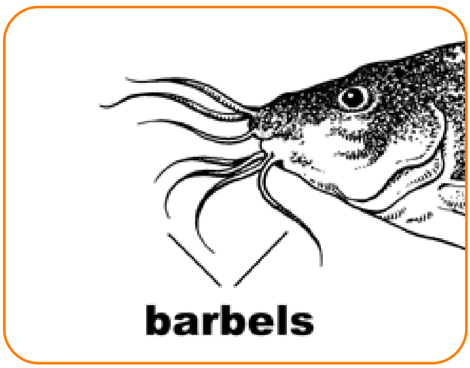
9a. Pelvic fin origin below or in front of pectoral fin base. 10.
9b. Pelvic fin origin distinctly behind pectoral fin base. 11.

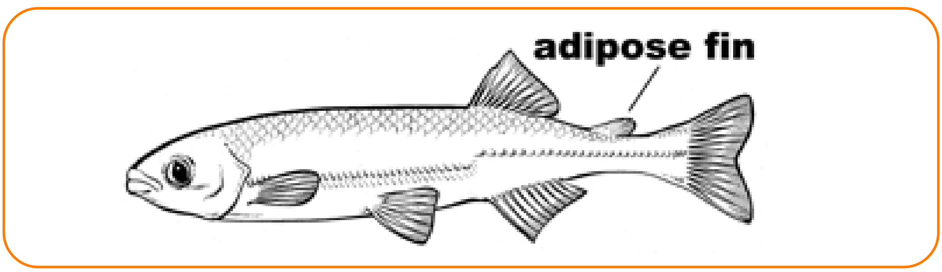
10a. Pelvic fins joined to form a single fin. Gobiidae, page 38.
10b. Pelvic fins separate. Eleotridae, page 35.

11a. Caudal fin rounded ; no larger than 30 mm. Pseudomugillidae, page29.
11b. Caudal fin forked ; may be smaller or larger than 30 mm. 12.

12a. Body thick and rounded (pencil-like); thin iridescent line down centre of body; no speckles on any fins. Atherinidae, page 26.
12b. Body clear thin, much deeper than wide; no thin iridescent line down centre of







Family Clupeidae – herrings

Bony bream

Nematalosa erebi (Gunther, 1868)

Description. In the Murray River, bony bream grow to 470 mm. Commonly, in the Lake Eyre Region they reach 300 mm. They are silver with a greenish or grey tinge on their backs, becoming whitish on the sides and belly; fins are clear. Mature fish may have a reddish tinge on the snout and belly. Bony bream have a single dorsal fin with no spines; the last ray of the dorsal fin consisting of a long filament that extends almost to the caudal fin. It is readily observed by extending and spreading the dorsal fin forward. The snout is blunt, fleshy and overhangs a small toothless mouth. The scales form a serrated keel along the belly.

Habitat. Large schools of bony bream often are found in waterholes. They are most common in the larger creeks, rivers and lakes, and are also found in ring tanks and larger bore drains.

Biology. Bony bream spawn in spring and summer, independently of flooding. Apparently, Cooper Creek bony bream have a longer spawning period compared with bony bream in the Murray–Darling System and in rivers further east. Bony bream produce up to several hundred thousand buoyant eggs of about 1 mm diameter. Details of spawning behaviour and early development are known only from the Murray–Darling System. Their breeding biology is likely to be slightly different in the Lake Eyre Region. Growth records in the Murray River indicate lengths of 67, 120, 240, 340 and 390 mm are achieved in years one to five, respectively. Individuals may be mature at 70 mm. Adults are herbivorous, detrital feeders while juveniles may be omnivorous eating algae, aquatic plants, small crustaceans and insects. During winter, mass mortality of bony bream is common. These kills have been attributed to several causes such as fungal or parasitic infections and low water temperatures. Bony bream often are used as bait for angling and fish traps. It is likely that bony bream are an important forage species for larger fish and birds.

Distribution. After spangled perch, bony bream is the equal second most widespread fish in Australia (Hyrtl's catfish being the other). They are abundant throughout northern and inland Australia, and occur in all major Lake Eyre Region rivers.

(*Gunther Schmida*)

Family Retropinnidae – smelts

Australian smelt

Retropinna semoni (Weber, 1895)

Description. Australian smelt appear to be a little smaller in Cooper Creek than elsewhere. The largest recorded size is about 80 mm, although they are more commonly 40–50 mm. They are long, slender fish with single dorsal and anal fins set well back on their bodies. The anal fin is located more posteriorly than the dorsal fin. A small adipose fin is present. Australian smelt have a prominent eye and a forked tail. In muddy water, they are translucent, except for a silvery body cavity lining, opaque head and vertebral column. Their back is yellowish tan above, becoming lighter on the sides. In coastal populations, Australian smelt in spawning condition become vivid orange to red, with an orange to red mid-lateral stripe, often terminating with a black spot on the caudal peduncle. The fins are transparent.

Habitat. Australian smelt occur in waterholes and lakes where they frequently form large schools. Often during floods, they are found congregating in turbulent flows below crossings and other places that form barriers.

Biology. No information is available on the breeding biology of Australian smelt in the Lake Eyre Region. Information derived from other parts of its range shows that spawning occurs from late winter to early summer at water temperatures of 15ºC or above. Aquarium observations indicate that several individuals may become involved in a single spawning. In the wild, spawning occurs at the shallow margins of pools over sandy substrates or aquatic vegetation. Females lay up to 200 eggs each slightly less than 1 mm in diameter. The eggs are sticky and settle on the substrate. They hatch in 9–10 days at temperatures of 15–18ºC. Newly-hatched larva are 4.6 mm long and drift for 2–3 days. Fish from Cooper Creek are thought to mature at a smaller size than the 40 mm recorded elsewhere. They probably mature at 6–12 months of age. Australian smelt feed on small invertebrates and algae. They are likely to be an important forage species for larger fish and birds. They can be maintained in aquaria by experienced aquarists.

Distribution. Within the Lake Eyre Region, Australian smelt are known only from Cooper Creek where they are abundant. They also occur in south-eastern coastal drainages and in the Murray–Darling Basin. Smelt from the Lake Eyre Region appear to differ from those from elsewhere (for example they have larger eyes) and may prove to belong to a different species.

(*Gunther Schmida*)

Family Plotosidae – eel-tailed catfishes

Hyrtl's catfish, moony or moonfish

Neosilurus hyrtlii (Steindachner, 1867)

Description. Commonly grow to about 200 mm and may reach 350 mm; colour varies, depending on the time of day, season or location. The back and upper sides may be dark to light brown, golden to silver, or dark to light grey; sides are lighter and the belly is whitish, creamy or silvery. The fins may be grey-brown or yellow, often with a black margin. Hyrtl's catfish are not easily distinguished from other Neosilurus species. Their caudo–dorsal fin typically is less than 20% of their standard length. They have a slightly convex profile, from their dorsal fin over their head, and a moderately stocky body with a distinctly rounded tail.

Habitat. Mainly in waterholes, though they may also be found in lakes and ring tanks. Spawning is associated with flooding and probably occurs during even minor floods at any time of year. Adults may migrate upstream and congregations often are found below obstructions to the main flow. Upstream migration may compensate for downstream displacement of eggs or larvae.

Biology. While specific observations have not been made on Lake Eyre Region populations of Hyrtl's catfish, observations made in the Ross River, near Townsville, indicated that spawning occurs over gravel or sand substrates. A male closely follows a female, then repeatedly darts ahead and arches his body around the female.

Non-adhesive eggs are scattered over the substrate, where they collect in spaces between rocks and other objects. Eggs are 2–3 mm in diameter and hatch in 2–3 days. Larvae are about 6 mm long at hatching, and 6-week-old fish are about 30–40 mm long. Females are 186–267 mm long and have 1600–15 300 eggs. Diet includes aquatic insects, crustaceans, molluscs and worms, usually taken from or near the substrate. Hyrtl's catfish primarily are nocturnal, especially in clear water. In muddy conditions, they are active throughout the day. They are taken regularly by anglers, and larger individuals are good eating. They are suitable for keeping in aquariums.

Distribution. Hyrtl's catfish is the equal second most widespread fish (the other being bony bream) in Australia; usually it is abundant in Cooper Creek and the Diamantina, Georgina and Finke catchments. Some individuals found sympatrically in the Diamantina River may represent a closely related but undescribed species; these individuals differ from Hyrtl's catfish in colour, barbel length and position, head profile and fin ray counts.

(*Gunther Schmida*)

Dalhousie catfish

Neosilurus gloveri (Allen & Feinberg, 1998)

Description. Maximum size in the wild is 120 mm; captive specimens grow to 180 mm. Dalhousie catfish are dark brown, with a lighter belly and fins. They are not distinguished easily from other Neosilurus species. They have small black eyes and a much shorter dorsal fin than other eel-tailed catfish. Their caudo-dorsal fin typically is greater than 20% of their standard length. The restricted distribution and habitat are likely to be sufficient to distinguish this species from other catfishes as no others occur at Dalhousie Springs.

Habitat. Dalhousie catfish occur in pools and spring outflows where the water is warm and very clear. Typically, they inhabit springs where water temperatures vary between 26ºC and 40ºC, although they will feed and show no sign of distress at 16(C, once acclimatised. Dalhousie catfish will voluntarily enter spring outflows where the water temperature is as high as 40ºC, although water of 41.8ºC elicits a rapid escape response.

Biology. The smallest mature female found was 44 mm. The number of eggs varies from 136–1197 for fish 72–120 mm long. It is not known if spawning is seasonal or occurs all year round. Aquarium observations suggest that eggs are scattered over the substrate. They are about 1 mm in diameter and non-adhesive. The diet of Dalhousie catfish includes various invertebrates, fishes and plant matter. They are primarily nocturnal. This species is an ideal aquarium fish.

Distribution. The Dalhousie catfish has been recorded in only 14 springs at Dalhousie Springs. It is typically abundant, but, because of its restricted distribution, is listed as 'potentially threatened' by the Australian Society for Fish Biology. Because they occur in a national park they cannot be collected without appropriate permits.

(*Ross Felix*)

Bulloo false-spined catfish

Neosilurus

Description. Known to grow to 350 mm. It is usually dark on the back and sides and may have grey mottling on the sides. The underside is whitish to grey and the fins are mainly black. Bulloo false-spined catfish are the only central Australian catfish with flexible spines in the first dorsal and pectoral fins; these spines are cartilaginous, not bony.

Habitat. False-spined catfish have been taken only in muddy waterholes.

Biology. Nothing is known of the biology of this species.

Distribution. The Bulloo false-spined catfish is known only by two specimens collected from the Bulloo River in 1974. It remains undescribed as there are insufficient specimens to determine if they are different from the other two false-spined catfish species in northern and eastern Australia. It appears to be extremely rare in the Bulloo River.

Cooper Creek catfish

Neosilurides cooperensis (Allen & Feinberg, 1998)

Description. Cooper Creek catfish grow to 600 mm. When taken from muddy water, they are light brown or tan on their backs and sides, with lighter and darker mottling. They have a creamy-coloured belly. In aquaria, colour can vary from steel-grey to bluish-black. The Cooper Creek catfish has no close relatives (being the only species in its genus), and even its relationships to other catfish genera is obscure. However, it may still be confused with other eel-tailed catfish. It has a uniquely rounded head profile, with a small distinctively underslung mouth and small eyes. These features, together with its stout body, larger size and distribution may assist in its identification.

Habitat. It is found only in large, more permanent waterholes in rivers. It has not been collected in small ephemeral waterholes, lakes or ring tanks.

Biology. Very little is known of the biology of this recently described species. As with all eel-tailed catfishes, the shape of the urogenital papilla distinguishes the sexes; that of the female is short and stubby, whereas that of the male is slender and long. This species has the largest egg size and lowest number of eggs per unit length of any fish in the Lake Eyre Region or of any other Australian freshwater eel-tailed catfishes. A female 450 mm long was found to contain about 1000 eggs.

The gut contents of the few wild fish examined contained mostly snails. Individuals kept in aquaria eat snails, shrimps, fish flesh, earthworms and fish pellets. They are extremely aggressive and have been known to eat the scales or eyes of other aquarium inhabitants. Like most eel-tailed catfishes, this species is nocturnal, although in muddy water they may remain active during daytime. Because of its relatively large size, it is a worthwhile angling species. It is also good eating.

Distribution. The Cooper Creek catfish is little known occurring only in the Cooper Creek River system, where it is widespread and common, though rarely abundant.

Silver tandan

Porochilus argenteus (Zeitz, 1896)

Description. Silver tandans grow to 300 mm. In muddy water, the colouration is silvery-white, silvery-grey or golden, with lighter under parts. The fins are translucent white to golden. In clear water (for example ring tanks), the overall colouration becomes more greenish. Within the Lake Eyre Region, silver tandans may be confused with other eel-tailed catfishes. They have a slender body with a concave profile between the dorsal fin and mouth. The small eyes are set low on the head, and the caudal fin is pointed (the caudal fin is slightly rounded in *Neosilurus* species). They also tend to have longer barbels than *Neosilurus* species. Silver tandans often have red markings on its body and/or fins as a result of injury. Their caudo-dorsal fin is typically less than 10% of their standard length.

Habitat. Silver tandans may be found in any waterway within the known distribution. They have been collected from waterholes, flooding rivers, lakes, ring tanks, flowing bores and pools associated with artesian springs.

Biology. Silver tandans probably spawn during floods. They are thought to undertake substantial migrations, and often congregate downstream of road culverts and other barriers. During minor flooding, juveniles 15–20 mm long have been collected from the Thomson and Alice rivers and Torrens Creek in December and from the Diamantina River in October. Silver tandans are ideal aquarium inhabitants. The are taken occasionally by anglers.

Distribution. Silver tandans are abundant in all of the Queensland Lake Eyre Region rivers and Barkley Tableland drainages in the Northern Territory. They are also present, though apparently less common, in the Macumba River in South Australia. Past records for the Finke River are based on misidentifications, they have never been found there. This species has also been identified from several Gulf of Carpentaria rivers in Queensland and the Northern Territory.

Family Atherinidae – hardyheads

Finke hardyhead

Craterocephalus centralis (Crowley & Ivantsoff, 1990)

Description. Finke hardyhead grow to about 65 mm. They have a silvery body with a distinctive, greenish mid-lateral stripe. They may get a golden hue on the sides, which may be associated with breeding activity. Upper body scales and some scales below the mid-lateral stripe have dark margins. This species is not easily distinguished from other hardyheads. However, it is the only hardyhead in the Finke River and is not found elsewhere.

Habitat. During dry periods, Finke hardyhead persist in pools in the gorges of the Finke River and other semi-permanent waterholes.

Biology. Nothing is known of their breeding biology, although it is likely to be similar to that of other hardyheads, with adhesive eggs being scattered over vegetation or on the substrate. They probably lay a few eggs each day and spawn continuously over a protracted period during the warmer months. The diet probably consists of small invertebrates and plant material. They can be kept easily in aquaria.

Distribution. The Finke hardyhead is a poorly known, recently described species. It only occurs in the Finke River in the Northern Territory and possibly in the South Australian portion of that drainage when water is present. It is widespread and usually abundant. They are listed as 'restricted' by the Australian Society for Fish Biology due to their limited range.

Dalhousie hardyhead

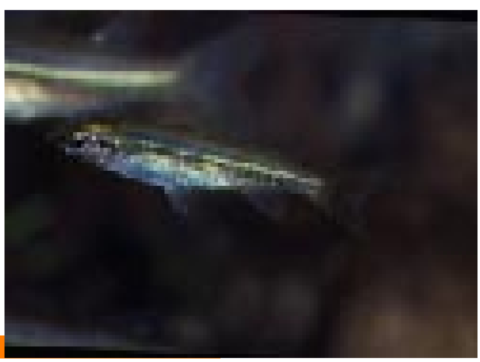
Craterocephalus dalhousiensis (Ivantsoff & Glover, 1974)

Description. The Dalhousie hardyhead grows to 80 mm. It is brownish with a distinctive greenish or dark mid-lateral stripe usually with a single band of spots above the mid-lateral stripe and three bands below it. It is the only member of the genus Craterocephalus considered to exhibit obvious sexual differences, although these differences are only evident in mature fish. The female has a sloping concave dorsal profile from the snout to the first dorsal fin and its underside is flat from the gills to the pelvic fins. In contrast, the male has a dorsal profile that is almost straight, while its underside is gently arched.

Habitat. Dalhousie hardyhead occur in moderate to large springs with warm outflows (temperature at the spring sources of 35–40ºC). They are found in both pools and outflows, and prefer those parts of the spring outflows where the water temperature remains above 20ºC. Dalhousie hardyhead have the highest recorded voluntary temperature tolerance of any Australian fish; they can live in water at 40ºC and make very brief voluntary excursions into water of 41.8ºC.

Biology. Nothing is known of their breeding biology in the wild. In aquaria, they lay a few eggs a day when temperatures are maintained over 24ºC. The sticky eggs are scattered over vegetation or the substratum. Under natural conditions, it is not known whether they reproduce throughout the year or seasonally. Their diet consists of green filamentous algae and small aquatic invertebrates. They are suitable aquarium inhabitants. Because they occur in a national park, they cannot be collected without appropriate permits.

Distribution. The Dalhousie hardyhead is restricted to about seven springs at Dalhousie Springs where it is abundant. It is regarded as 'potentially threatened' by the Australian Society for Fish Biology because of its highly restricted distribution.



Lake Eyre hardyhead

Craterocephalus eyresii (Steindachner, 1883)

Description. Lake Eyre hardyhead grows to 100 mm. They have a silvery body with a distinctive greenish mid-lateral stripe. They may get a golden hue on their sides, which may be associated with breeding activity. Upper body scales and some scales below the mid-lateral stripe have dark margins. This species is not easily distinguished from other hardyheads.

Habitat. Lake Eyre hardyhead have been found in fresh and saline waterholes, lakes, springs and bore drains. In most places where they occur, there is no permanent water. They appear to persist between floods in semi-permanent refuge waterholes. Even in permanent springs, their presence is unpredictable. After inland lakes flood and fill, Lake Eyre hardyhead numbers increase dramatically, only to fall equally dramatically with evaporating water and increasing salinity. In 1975, an estimated 20 million Lake Eyre hardyhead died in Lake Eyre as water levels fell and salinity levels rose to lethal levels before to the lake dried.

Biology. Lake Eyre hardyhead have the highest and widest salinity tolerance of any Australian fish. They can tolerate salinities between 0 and 110 parts per thousand. The salinity of seawater is about 35 parts per thousand. Their breeding biology is unknown, but it is probably similar to that of Finke hardyhead. They are suitable aquarium inhabitants. They are an important food resource for birds when the large inland lakes fill.

Distribution. Lake Eyre hardyhead are found in South Australia. Three isolated populations exist: in the Neales River and other waterholes and springs to the west, south and east of Lake Eyre; in the Northern Flinders Ranges in tributaries to Lake Frome; and in Lake Torrens–Willochra Creek. The Lake Torrens–Willochra Creek System is not part of the Lake Eyre Regionand this population has never been closely compared to Lake Eyre populations, hence its inclusion as Lake Eyre hardyhead is tentative. Additional study is needed to establish its correct identification. The abundance and distribution of Lake Eyre hardyhead fluctuates widely. Occasionally, they may be found in the lower reaches of Cooper Creek and the Diamantina River. However, these populations are probably ephemeral. Lake Eyre hardyhead were once thought to also occur in the Finke River and Murray-Darling Basin, however these populations were re-identified and described as new species.

Glover's hardyhead

Craterocephalus gloveri (Crowley & Ivantsoff, 1990)

Description. Glover's hardyhead grows to 50 mm. They are light brownish, with a distinctive greenish or dark mid-lateral stripe. Typically, they lack the spotting pattern above and below the mid-lateral stripe, apparent in other species. Morphologically, they are similar to Dalhousie hardyhead, making them difficult to distinguish.

Habitat. Glover's hardyhead inhabit pools and outflows of moderate to large springs with slightly cooler water (temperature at the spring sources of 32-35ºC) than those in which Dalhousie hardyhead occur. Glover's hardyhead and Dalhousie hardyhead occur together in one spring system.

Biology. Nothing is known of their breeding biology in the wild. In aquaria, Glover's hardyhead lay a few eggs each day and spawn at slightly lower temperatures than Dalhousie hardyhead. The sticky eggs are scattered over vegetation and the substrate. In the wild, it is not known whether they reproduce all year round or seasonally. The diet consists of green filamentous algae and probably small invertebrates. They are suitable aquarium inhabitants.

Distribution. Glover's hardyhead is known from only three springs at Dalhousie Springs, where it is typically abundant. It is regarded as 'potentially threatened' by the Australian Society for Fish Biology because of its highly restricted distribution. Since they occur in a national park, they cannot be collected without appropriate permits.

Aramac Springs hardyhead

Craterocephalus

Description.

Habitat. Aramac Springs hardyhead occur in a single large pool, about 150 m long and 30 m wide. The pool is part of a larger, ephemeral wetland that is fed by artesian springs. The pool appears to be permanent. The maximum water depth throughout the pool is about 0.6 m, except for an area at one end that is about 1.4 m deep. The vegetation in the pool mainly comprises sedges (*Cyperaceae*) and cumbungi (*Typha domingensis*). Two endangered plants, pipewort (*Eriocaulon sp.*) and spring grass (*Sporobolus pamelae*), are present.

Biology. Little is known of the life history of Aramac Springs hardyhead. Schools of juveniles or sub-adults (about 15–20 mm long) have been observed around the margins of the pool in June. They exist with several other native fishes. The introduced gambusia is present, but not abundant.

The Aramac Springs hardyhead appears closely related to non-speckled hardyhead (*Craterocephalus stercusmuscarum fulvus*), a subspecies primarily found in the Murray–Darling Basin. Its specific taxonomic status is yet to be fully determined. It may prove the same species as the non-speckled hardyhead.

Distribution. The Aramac Springs hardyhead was discovered in 1994. Its discovery marked the first record of a hardyhead in the upper Cooper Creek System. To date, it has been found only in a single large pool near the Edgbaston Spring group.

Family Melanotaeniidae – rainbowfishes

Desert rainbowfish

Melanotaenia splendida tatei (Zietz, 1896)

Description. Desert rainbowfish grow to 80 mm. Colouration is variable, depending on the river system and habitat, but most have a slight chequered pattern on the fins, pale stripes along the sides, and an iridescent sheen to the scales. Two colour forms are common: a purplish one from the Georgina River westward around Lake Eyre and a blue-green one from rivers east of and including the Diamantina. When taken from muddy water, the typically bright colours are greatly subdued. Desert rainbowfish usually are paler above and silvery below, with pale fins. Specimens from clear water are much brighter and have more intense colour in the body and fins. When spawning, their bellies may be pinkish. Desert rainbowfish have two dorsal fins, the first being short and the second long. The anal fin originates below the first dorsal fin and extends as far back as the second dorsal fin.

Habitat. Desert rainbowfish are found in most habitats, including waterholes, lakes, ring tanks and flowing bores.

Biology. Courtship and spawning behaviour has been observed in a small, clear waterhole associated with a flowing bore near Lake Dunn during late autumn, when the water temperature was 25ºC. Males were observed to court females under a stand of water snowflake (*Nymphoides crenata*) near the steeply sloping banks. Eggs appeared to be deposited over the exposed roots of riparian vegetation (mostly black tea tree) or around the stems of water snowflake. A school of rainbowfish and western chanda perch was observed scavenging below the spawning groups.

In aquaria, desert rainbowfish lay 20–100 eggs, often daily, whenever temperatures are higher than about 20ºC. The eggs are 0.8–0.95 mm in diameter and have sticky tendrils. The eggs hatch after 7 days at 24ºC. Newly hatched fry are about 4–5 mm, and begin to feed after 1 to 3 days. In the wild, desert rainbowfish eat filamentous algae and small invertebrates. They appear to be mature at 30–35 mm long. Desert rainbowfish are ideal aquarium inhabitants. They are used as live bait and probably are valuable forage fish for larger species.

Distribution. The desert rainbowfish is widespread and abundant in all the larger rivers in the Lake Eyre Region. Related subspecies occur throughout northern Australia, from the Pilbara in Western Australia to just south of Rockhampton in Queensland, and also in southern New Guinea.

Family Pseudomugilidae – blue-eyes

Red-finned blue-eye

Scaturiginichthys vermeilipinnis Ivantsoff (Unmack, Saeed & Crowley, 1991)

Description. The red-finned blue-eye grows to a maximum length of 30 mm. The body is golden to silver. The rear half is translucent and the body cavity lining can be seen. A series of iridescent spangles occur along the middle of the sides. In males, the outer margins of all fins, except the pectoral and caudal fins, are red. The caudal fin has horizontal red bars, dorsally and ventrally. Females generally do not have red on the fins. Both sexes have a brilliant sky-blue ring around the eye. Young fish up to about 12 mm are distinctly coloured. Viewed from above, the posterior part of the body is yellow and the anterior part is metallic blue. Red-finned blue-eye can be confused with the introduced gambusia but are distinguished by two dorsal fins whereas gambusia only have one.

Habitat. Red-finned blue-eye are generally found in shallow water (less than 100 mm and down to 5 mm) where emergent vegetation is abundant. During spring, summer and autumn, and in winter during the day, red-finned blue-eye may be distributed throughout a spring. During cold winter nights individuals congregate around the warm outflow of the spring. Adults occur in depths greater than 10–15 mm, while newly hatched fry and young fish (less than 12 mm long) usually are found in areas less than 15 mm deep. When approached by people, red-finned blue-eye form loose schools that may comprise several hundred fish. This schooling behaviour may be a predator avoidance response. Gradually, the schools of fish disperse into smaller groups, which begin feeding and displaying.

Biology. Mature males do not defend fixed territories, but instead defend a 'space' that is, in part, defined by the patchy nature of the habitat. A given male will defend a small, open-water area (usually defined by clumps of the emergent vegetation). If, as a result of chasing another male, the first male moves to another small open-water area, he will defend that area for a variable period. Generally, smaller individuals give way to larger individuals. Aggressive display may last several tens of seconds between equally matched males. Males will display and attempt to spawn with any mature females they encounter within their defended space.

Courtship activities occur throughout the day. Courtship displays are of variable duration and involve the male swimming around the female with outspread fins. If the female is receptive, the pair will align side by side. At this time, the male can be observed shimmying. This is probably the time of egg release and fertilisation. Eggs may be released over the substrate or onto submerged vegetation. Displays have been observed in all months. Developing eggs have occasionally been found on the substrate and newly hatched fry have been observed in all months, but are more common during the warmer months. During the warmer months, juveniles of about 6–12 mm congregate in shallow areas of the spring away from the source area. In the cooler months, juveniles are usually found on the margins of the source area.

The diet of red-finned blue-eye is unknown. Individuals have been observed taking a mouthful of substrate, expelling matter from the mouth and then picking particles from the expelled cloud. Individuals have also been observed picking particles directly from the substrate, from the surface of submerged vegetation and from the water column. It is suspected that red-finned blue-eye are opportunistic omnivores.

In captivity, spawning occurs at temperatures above 20ºC. Females produce up to 20 eggs a week. Eggs are spherical and opaque, 1.2–1.4 mm in diameter, and have filaments that attach to vegetation or substrate. At 28ºC, hatching occurs in 7–10 days. Fry are 4–5 mm and begin feeding 1 day after hatching. Both sexes mature at about 15 mm total length. Individuals may reach 15 mm in 6–10 weeks.

Red-finned blue-eye make interesting and attractive aquarium inhabitants, although they should not be kept with other species. Some early difficulty occurred in establishing captive populations, although recent efforts are promising.

Distribution. The red-finned blue-eye was discovered in 1989. It is known only from springs in the Edgbaston Group where its abundance and distribution varies. At the time of discovery, six populations were found in five springs. By July 1991, two populations had become extinct so that red-finned blue-eye were known from only four springs. In September 1991, another population was discovered, but this became extinct by December 1992. During August 1993, another population was discovered at Edgbaston.

Only five distinct, naturally occurring populations in five springs are known. This species is regarded as 'endangered' by the Australian Society for Fish Biology. This status is based on the apparent extinction of populations from three springs and the threats posed by: the presence of gambusia; habitat damage caused by stock and feral animals; the potential for habitat destruction because of the limited size of the habitat; and the threat of collection for the aquarium trade. The presence of gambusia and habitat damage from domestic and feral animals have proved to be the most significant threats.

Family Ambassidae – glassfishes

Western chanda perch

Ambassis mulleri (Klunzinger, 1880)

Description. Western chanda perch can grow to at least 60 mm. They are generally translucent, but often with a greenish-silver tint. The body cavity lining and backbone can be seen. The edges of the scales are often darker, resulting in a netting pattern. The dorsal fin may have a black leading edge and the pelvic and anal fins a white leading edge. Otherwise, the fins are clear. The western chanda perch is laterally compressed and, has relatively large scales, a large eye and an upward directed mouth.

Habitat. Western chanda perch may occur in any environment, but appear to be most common in clearer habitats such as some lakes and ring tanks and outflows of flowing bores.

Biology. Little is known of its biology. Like other members of the genus, it probably scatters small (less than 0.5 mm in diameter) adhesive eggs over the substrate or onto vegetation. These are likely to hatch in 12–36 hours. Breeding does not appear to be linked to flooding, although this species appears to be able to take advantage of floodwaters for dispersal. Large numbers of juveniles have been found below road crossings during minor flows. The western chanda perch is primarily carnivorous and eats small crustaceans (cladocerans, ostracods and copepods), and aquatic and terrestrial insects. It is likely to also take small fishes. It is a suitable aquarium fish, but is usually overlooked in favour of more colourful species. It is likely to be an important forage species for larger fish.

Distribution. The western chanda perch is widespread in the larger rivers, although its abundance fluctuates greatly. It also occurs across much of northern Australia. All previous records of *Ambassis castelnaui* for central Australia are now applicable to western chanda perch.

Family Percichthyidae – cods and perches

Lake Eyre golden perch, yellowbelly or callop

Macquaria species A

Description. This is the largest fish found in central Australia. It grows to about 600 mm and a weight of 5.6 kg; in comparison the Murray–Darling golden perch reaches 760 mm and 23 kg. Lake Eyre golden perch are usually yellowish tan on the back, becoming lighter on the sides to a creamy yellow on the belly. In clear water, they may be more greenish to greyish. They can be recognised by the small, laterally compressed head, protruding lower jaw with conspicuous pores underneath (much larger than those of the Murray–Darling species), filaments on the pelvic fins and a large, rounded tail.

Habitat. Lake Eyre golden perch are mostly found in rivers and larger creeks. At times, they are also abundant in lakes.

Biology. The following paragraph is primarily (but not solely) based on data from Murray–Darling golden perch which is a similar species and is likely to have similar biology. Spawning typically occurs during the first flooding of the season. Limited recruitment may also occur on later floods during the same season. Water temperatures over 23.5ºC are probably necessary for spawning. Specific stimuli for spawning, while unknown, may be related to chemicals released from flooding previously dry soil. Adult fish move upstream during higher flows, presumably for reproduction and/or to allow for downstream displacement of eggs and larvae. A 2.5 kg female may produce 500 000 semi-buoyant eggs. Once water hardened, the eggs average 3.9 mm. The eggs hatch in 33–34 hours at 24–25ºC. The newly hatched larvae average 3.2 mm TL. The egg yolk is absorbed in 5-6 days at which stage post larva are between 5.5 mm TL and 4.7–4.9 mm TL. Size varies between 150 mm, and 100 and 300 mm TL at one year of age.

All life stages are carnivorous. Adults are known to eat fish, shrimps and crayfish.

This species is a major angling species, and a small commercial fishery also exists in the lower Cooper Creek in South Australia. Hatchery-bred fingerlings have been stocked into the Thomson River catchment (for example, Lake Dunn). Stocking is probably unnecessary given the abundance and dispersal ability of this species and the relatively unregulated nature of the rivers in this region.

Distribution. Golden perch is widespread and abundant in the Cooper Creek, Diamantina and Georgina catchments. This species was recently recognised as distinct from the Murray–Darling golden perch (*Macquaria ambigua ambigua*), although it has not yet been scientifically described.

Family Percichthyidae – cods and perches

Bulloo golden perch or yellowbelly

Macquaria species A, subsp. A

The Bulloo golden perch is considered to be common throughout the Bulloo River. It is recognised as being separate to the Murray–Darling golden perch and more closely related to the Lake Eyre golden perch. The biology of this species is probably similar to that of the Lake Eyre golden perch.

Family Percichthyidae – cods and perches

Murray-Darling golden perch, yellowbelly or callop

Macquaria ambigua ambigua (Richardson, 1845)

This is a translocated species. Murray–Darling golden perch have been stocked twice in the Hay–Plenty River Drainage, once in Whistleduck Creek on the Barkley Tablelands and once into Clayton Bore, which flows towards Lake Eyre. It has probably been introduced elsewhere, because it is a popular angling and eating fish and fingerlings are readily available. It is unknown whether this species will hybridise with other related golden perch species.

Murray cod

Maccullochella peelii peelii (Mitchell, 1838)

This is a translocated species, which was stocked into the Cooper Creek Catchment in 1989 and 1990. Specimens have been captured, although it is not known if they will establish a self-maintaining population. Murray cod may been introduced elsewhere, because it is a popular angling and eating fish, and fingerlings are readily available.

Family Terapontidae – grunters

Banded grunter

Amniataba percoides (Gunther, 1864)

Description. Banded grunter reach 200 mm. It is usually light brown, bronze or golden on the back, becoming lighter on the sides and belly. There are five to eight faint to distinct vertical black or brown bars on their sides, each bar being about two to four scales wide; bars become less distinct in larger individuals or from those taken in muddy water. The banded grunter can be recognised by the vertical barring and a small mouth, which clearly does not extend back to the front edge of the eye.

Habitat. In central Australia it occurs in rivers. Loose schools or colonies usually occur around fallen timber or rocky outcrops in areas with coarse sand, gravel or cobble substrates.

Biology. Nothing is known of banded grunter breeding biology in the Lake Eyre Region. All information presented here is based on populations elsewhere. Spawning occurs at night when water temperature is 26–33C. It is not known how often individuals spawn, but spawning may occur independently of flooding. Fish between 70 and 90 grams produce 40 000–77 000 non-adhesive eggs, which sink and collect in the substrate. Water-hardened eggs are 0.6–0.85 mm in diameter. The eggs hatch in 48-60 hours at temperatures between 23–27.5ºC. Larvae actively feed when 2 days old. In a hatchery, banded grunter grow to 35–40 mm in 6 to 7 weeks.

Adults are omnivorous, but mainly eat small crustaceans (shrimps) and aquatic insects. This species may also scavenge and has been observed eating the carcass of a tortoise. Banded grunter is often captured on a variety of baits and is excellent eating, although the small size limits its acceptability to anglers. It is a good aquarium fish, but should be kept only in groups and with fish larger than itself, because they can be aggressive. They will eat frozen and prepared foods.

Distribution. Banded grunter has a patchy distribution in the Lake Eyre Region. They occur in the Georgina, Finke and Frew rivers, where they are usually common. A single record exists for the Neales River. The banded grunter is also common throughout much of western, northern and eastern Australia.

Silver perch

Bidyanus bidyanus (Mitchell, 1838)

This is a translocated species from the Murray–Darling System. Silver perch have been stocked into Clayton Bore, which leads into Lake Eyre and Whistleduck Creek on the Barkley Tableland. It has probably been introduced elsewhere, because it is a popular angling and eating fish and fingerlings are readily available. It is unknown whether this species will hybridise with Welch's grunter.

Welch's grunter or black bream

Bidyanus welchi (McCulloch & Waite, 1917)

Description. Length 250 mm and about 300 g, although some have been recorded as large as 375 mm and 1.5 kg. Body colouration silvery-grey, with lighter sides and belly. Welch's grunter are difficult to distinguish from Barcoo grunter, especially at smaller sizes. The body of a Welch's grunter is more than three times as long as deep and lacks black spots. The body of Barcoo grunter is two-and-a-half times as long as deep, and large irregular black spots are often present along their sides (although these may not be present in muddy conditions).

Habitat. Welch's grunter is usually found in waterholes. Schools congregate near fallen timber or other cover.

Biology. Spawning occurs during the warmer months and it is likely that flooding is necessary for spawning. No details of spawning behaviour have been published. Hormone-induced spawning is possible and egg development is similar to that of the silver perch. Buoyant, non-adhesive eggs hatch after 30 hours at 24ºC. Larvae begin feeding 5 days after spawning. In the wild, eggs are thought to float downstream with floodwaters.

There is no information on growth rates. Laboratory studies suggest that males less than 240 mm are immature and females of 280 mm may produce 100 000 eggs. Several males of 180–200 mm caught in early summer have been running ripe. This suggests that spawning may occur at much smaller sizes. Sexual dimorphism is not apparent.

Welch's grunter is carnivorous. Gut contents have included shrimps and small fishes. Individuals maintained in aquariums will also accept earthworms, fish and animal flesh, insect and beetle adults and larvae, wet food preparations including vegetable matter, and dry pellets. They are readily angled with smaller hooks and meaty baits.

Distribution. Welch's grunter is widespread and abundant, from the Georgina River east to the Bulloo River.

Spangled perch or bobby cod

Leiopotherapon unicolor (Gunther, 1859)

Description. Length 150 mm occasionally 300 mm. In muddy conditions largely silvery with a few bluey-brown speckles present on their sides. In clearer water speckles more prominent.

They can be difficult to distinguish from Welch's grunter. Spangled perch have a square to very slightly forked tail, whereas Welch's grunter has a tail that is clearly forked.

Habitat. Spangled perch live in almost any wet habitat. They have been recorded from rivers, lakes, bore drains, ring tanks, springs and even wells, water troughs and wheel ruts. In clear water, small schools of similarly sized fish may be seen cruising the shoreline. It is unusual not to find several in a given habitat.

Biology. Based on studies conducted in the Murray–Darling system spangled perch spawn at temperatures over 20-26ºC. Flooding is unnecessary, although it will often trigger spawning. Pairs or small groups congregate in shallow areas, usually at night. Small, sinking non-adhesive eggs (0.65–0.85 mm diameter) are scattered over the substrate. The eggs hatch in 50 hours at 23–26.5C. Larvae begin feeding 2 days later. Growth rates are not known, but females mature at 78 mm and males at 58 mm. Fish 24 g and 65 g contained 24 000 and 113 200 eggs, respectively.

Spangled perch is the most commonly reported fish found during 'rains of fishes.' It has also been proposed that this species can aestivate, either as eggs or adults. These reports usually follow finding fish in an unusual location; for example, in a recently sunk well or outside the front door after a downpour. In most situations, it cannot be proven that they have not migrated through overland flow.

This species has remarkable dispersal abilities and a particularly good ability to rapidly colonise new water bodies. In 1947, a Mr Bruce Shipway noted hundreds of young spangled perch swimming 10 miles in 6 hours along a single wheel rut. It is this behaviour that has enabled them to colonise so many bore drains. Spangled perch have an excellent flavour and provide exceptional angling for its size; unfortunately, they do not grow very large. They may be kept as aquarium fish, but should only be kept in groups and with larger fishes, because they can be aggressive. They readily eat frozen and prepared foods.

Distribution. The spangled perch is the most widespread fish in Australia where it occurs almost everywhere except the southern drainages. It is known from all parts of the Lake Eyre Region.

Barcoo grunter or black bream

Scortum barcoo (McCulloch & Waite, 1917)

Description. Commonly reach 200 mm; specimens larger than this are occasionally found. Body colouration is silvery grey, becoming lighter on the sides and belly. A few large irregular spots may be present on one side or both sides of the fish, although in muddy water these tend not to be present. Barcoo grunter is difficult to distinguish from Welch's grunter.

Habitat. Barcoo grunter is usually found in waterholes. Schools congregate near fallen timber or other cover.

Biology. Spawning occurs during the warmer months and it is likely that flooding is necessary for spawning. No studies have been undertaken on their breeding biology or ecology. They can be angled if small hooks are used with meaty baits. Their eating qualities are unknown, but a closely related species is often referred to as leathery grunters for good reason! They can be an attractive aquarium fish, if housed singly in large aquaria, but they are rarely available.

Distribution. Barcoo grunter is widespread from the Georgina River east to the Bulloo River. They may be locally abundant at times. However, they are typically uncommon. They are also found in rivers draining into the Gulf of Carpentaria in Queensland and the Northern Territory.

Family Eleotridae – gudgeons

Western carp gudgeon

Hypseleotris klunzingeri (Ogilby, 1898)

Description. Western carp gudgeon grow to 60 mm. It is usually a light tan colour with silvery bellies. Scales along the mid-lateral region of their bodies from the head to the tail have a dark pattern around the margins. During the spawning season, males develop blood-red dorsal, pelvic, tail and anal fins, often with a thin, bright white margin. Females develop a yellow stomach, but lack fin colouration. These are difficult to identify relative to the other carp gudgeon species.

Habitat. Western carp gudgeon typically inhabit rivers and smaller creeks.

Biology. The only studies undertaken on this species were on Murray–Darling Basin populations that are likely to differ a little to the Lake Eyre Region populations. They usually spawn in spring and early summer, during flooding, at temperatures of more than 20ºC, although flooding may not be a prerequisite. Females mature at about 30 mm and deposit between 1 000 and 2 000 eggs, which are attached to a hard object near the water surface. Eggs are about 0.5 mm in diameter and are elongate. Males guard the eggs until fry hatch in 50 hours, after which there is no further parental care. Larvae are about 2 mm. They reach spawning size after one year and may possibly live as long as 2–3 years. They are an attractive though little known aquarium fish and are likely to be a valuable forage fish for larger species.

Distribution. Western carp gudgeon is widespread and are usually abundant in Cooper Creek and the Bulloo River. They are also found throughout the Murray–Darling System and in some east-coast drainages.

Midgley's carp gudgeon

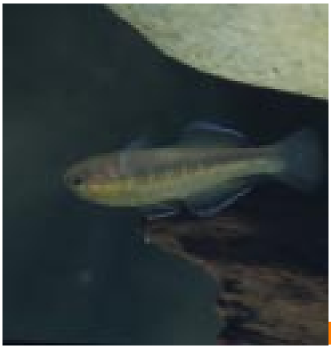
Hypseleotris species A

Description. Midgley's carp gudgeon commonly reach 40 mm. They are usually an olive colour with lighter bellies. Males can change their body colour from olive to dusky black, in minutes. They have up to four coloured bands on their anal and dorsal fins. They have a broad dusky band on the lower half of the fin, followed by a thinner orange-red band and then an even thinner white band. Occasionally, there is an even thinner outer orange band. The white band can appear blue, although this is rare. Females develop a golden coloured stomach, but lack fin colouration. These are difficult to distinguish from the other carp gudgeon species. The primary differences are fin colouration, female spawning colouration and the lack of distinctive mid-lateral scale markings present in western carp gudgeon.

Habitat. Midgley's carp gudgeon typically inhabit rivers and smaller creeks.

Biology. No field studies have been undertaken. In aquaria, populations outside the Lake Eyre Region spawn in spring and early summer at temperatures between 20 and 24ºC. Flooding is not necessary to induce spawning. Females mature at about 25 mm. About 200–400 eggs are laid on a hard object on or near the substrate (not near the surface as in western carp gudgeon). Eggs are about 1 mm in diameter. The male guards the eggs until hatching occurs in 7–8 days. Larvae are 3–4 mm. They reach spawning size after one year and may possibly live as long as 2–3 years. They are an attractive though little-known aquarium fish. They are likely to be a valuable forage fish for larger species.

Distribution. Midgley's carp gudgeon is widespread and often common in Cooper Creek and the Bulloo River. They are also found throughout the Murray–Darling System and in some east-coast drainages.



Lake's carp gudgeon

Hypseleotris species B

Description. Lake's carp gudgeon commonly reach 40 mm. Its body is an olive colour with lighter bellies. Body colouration can change from olive to dusky black in minutes in males, depending upon their mood. They have three bands on their anal and dorsal fins. They have a dusky band on the lower portion of the fin, followed by an outer thinner orange band bordered by a thinner white band. Females develop a golden coloured stomach, which changes to bright pink close to spawning. Females have clear fins. Lake's carp gudgeon are difficult to identify relative to the other carp gudgeon species. The primary differences are fin colouration, female spawning colouration, a lack of distinctive scale markings (unlike in western carp gudgeon) and a lack of scales between their head and the first dorsal fin and on their lower belly.

Habitat. Typically inhabit rivers and smaller creeks.

Biology. No field studies have been undertaken. In aquaria, Murray–Darling Basin populations appear to be basically identical in their biology to Midgley's carp gudgeon. They are an attractive though little-known aquarium fish. They are likely to be a valuable forage fish for larger species.

Distribution. Lake's carp gudgeon are known from the upper reaches of the Barcoo and Thomson rivers. They are neither widespread nor common. They are also found throughout the Murray–Darling System.

Frew mogurnda or purple-spotted gudgeon

Mogurnda species

The following mogurnda species have all been combined into one account since they are all very similar in their biology. Only a specialist could identify them to species. However, none coexist so they can be identified based on locality.

Description. Length 150 mm. The dorsal surface tends to be darker coloured, while the belly region is very light. The sides of the body have a series of round spots that are typically dark red and light blue. Along the sides are a series of 10 or more, light-yellowish vertical irregular bands. The cheeks have a series of red stripes. All fins except the pectorals are brightly marked with reddish, blue and other colours, with an outer white band on the anal fin and second dorsal. They have a reasonably large mouth for their size and a stocky, thick cigar-shaped body. The various species listed here presently are difficult to distinguish, but are unlikely to be confused with other Lake Eyre Region species.

Habitat. Mogurndas occur in a variety of habitats including large thermal springs, large waterholes in gorges and smaller creeks.

Biology. No field studies have been undertaken on Lake Eyre Region populations. The breeding biology of all Australian mogurndas is similar. In nature, they will probably spawn throughout the warmer months of the year. In aquaria, they spawn at temperatures of more than 20ºC. Females lay between 200 and 800 eggs, usually on the underside of a hard object such as a pipe. Eggs are about 3 mm long and are elongate in shape. The male guards the eggs until fry hatch in about 7 days. Larvae are about 5–6 mm long.

In aquaria, they can grow to about 50 mm in 3 months. Maturity is reached at 60 mm. Spawnings are generally repeated in aquaria as long as temperatures are maintained above 20ºC. These species are some of the few for which any life history information is available based upon central Australian individuals, albeit based on aquarium observations. Mogurndas are considered to be carnivorous and probably eat invertebrates and small fish.

Despite their attractive colouration and interesting breeding behaviour, they are not exceptionally common in the aquarium trade. They make excellent pets, but need to be kept with robust fish as they can be aggressive towards their tank mates, especially when spawning and guarding eggs.

Distribution. Each species occurs within a limited range, none of which overlap. The Flinders Ranges, Barcoo, or Bulloo mogurnda, occurs in a very limited area in the Gammon Ranges and upper Barcoo River, with a single specimen known from the Bulloo River collected in 1955 which has been identified tentatively as this species. Finke mogurnda are found only in the Finke system, while Dalhousie mogurnda are restricted to Dalhousie Springs. Another isolated population of unknown affinity occurs in the Frew River–Whistleduck Creek System on the Barkley Tablelands. The Flinders mogurnda is listed as 'vulnerable' by the Australian Society for Fish Biology, owing to its restricted range and small population size. The other mogurnda populations qualify for listing as 'restricted.' However, they were only recently described as new species, hence their conservation status has not yet been designated.

Family Eleotridae – gudgeons

Dalhousie mogurnda or purple spotted gudgeon

Mogurnda thermophila (Allen & Jenkins, 1999)

Family Eleotridae – gudgeons

Flinders Ranges, Barcoo, or Bulloo mogurnda or purple spotted gudgeon

Mogurnda clivicola (Allen & Jenkins, 1999)

Family Eleotridae – gudgeons

Finke mogurnda or purple spotted gudgeon

Mogurnda larapintae (Zeitz, 1896)

Family Gobiidae – gobies

Desert goby

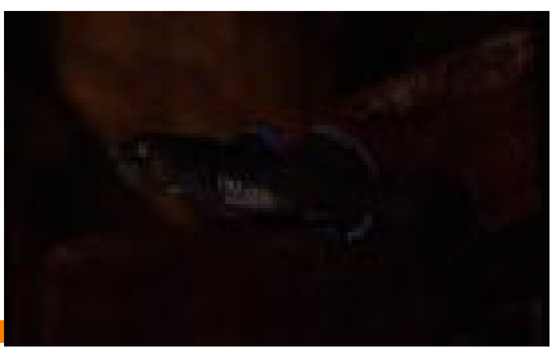
Chlamydogobius eremius (Zietz, 1896)

Description. Reach 60 mm in length. Body colour ranges from solid tan-brown to an irregular lighter-coloured barring pattern over their bodies. Their belly region tends to be light. Males, especially when feeding, guarding a territory or eggs, or mating, may go very dark. Often during breeding, their whole body turns golden yellow.

Females typically have clear fins, with the exception of a small blue spot at the back of their first dorsal fin just above the fin base. Males have intensely coloured fins, with two colour forms, one a bright blue and the other a pale yellow. The first dorsal fin of the blue form has the same blue spot as the female, although it is larger and brighter. The outer edge of the fin has a broad, brilliant yellow band, and the remainder of the fin is dusky. The second dorsal fin and the anal fin are dark with an obvious blue hue. The margins have a thin, bright, yellow stripe bordered by a white band on the fin's edge. The tail and pectoral fins tend to be dark with a white margin. The yellow form is basically the same as the blue, except that the anal and second dorsal fins have yellow instead of blue. Desert goby have very large mouths for their size. Their limited range and habitats, and the lack of coexisting species with which they could be confused make them relatively easy to identify. Gobies can easily be distinguished from most other fishes by their fused pelvic fins

Habitat. Desert goby are typically found in rivers, springs and bore drains.

Biology. This is the only species in central Australia that has undergone extensive field study. It is known to spawn from November through March. In aquaria, successful spawning can occur at anytime of the year if temperatures are above 26ºC. Desert goby will spawn at cooler temperatures although the eggs may not hatch. Females typically lay 50–250 eggs on the ceiling of a cave. Eggs are about 3 mm long and are elongate in shape. Males guard the eggs until hatching, which typically occurs in 10 days. Larvae are about 5–6 mm long. They rarely seem to live longer than one year in captivity. They can tolerate temperatures between 5 and at least 40ºC and salinities as high as 60 ppt, and they have been collected at oxygen concentrations as low as 0.8 mg/L. Dietary items include various invertebrates and algae. With their comical behaviour and ease of keeping and breeding, they make excellent aquarium fish.



Distribution. The desert goby is widespread and often abundant in the Neales River, southwards around Lake Eyre to Clayton Bore.

Elizabeth Springs goby

Chlamydogobius micropterus (Larson, 1995)

Description. Growing to a maximum size of 62 mm, they are a greyish colour overall, with little difference between males and females. Males get just a hint of darkness on their anal dorsal fins and have a faint blue spot on the rear bottom corner of their first dorsal fins. They can be distinguished from other *Chlamydogobius* species by their very small fins, especially the first dorsal and pelvic fins.

Habitat. Restricted to the larger springs at Elizabeth Springs where they live in the small outflow channels. Total population size is estimated to be between 1000 and 2000 individuals.

Biology. Spawning details are basically the same as for desert goby, at least under aquarium conditions, and their biology is probably similar to that of desert goby. They are suitable aquarium inhabitants but are generally ignored in favour of the more colourful desert goby. As they are present in a national park, they cannot be collected without appropriate permits.

Distribution. The Elizabeth Springs goby is restricted to Elizabeth Springs in western Queensland. It is listed as 'endangered' by the Australian Society for Fish Biology, owing to its extremely limited range, decreasing spring flows and cattle trampling.

Dalhousie goby

Chlamydogobius gloveri (Larson, 1996)

Description. Grows to about 40 mm. Greyish overall with a paler stomach. They have the blue spot on their first dorsal fin, like other *Chlamydogobius* species. Males tend to get darker fins than females, though not nearly as colourfully as desert gobies. They are not easily distinguished from other *Chlamydogobius* species. However, their limited geographic range makes confusion unlikely.

Biology. No biological studies have been undertaken in the wild. Their biology is probably similar to that of desert gobies. They are suitable aquarium inhabitants, although they are generally ignored in favour of the more colourful desert goby. As they are present in a national park, they cannot be collected without appropriate permits.

Distribution/Habitat. The Dalhousie goby is restricted to about 28 springs at Dalhousie Springs, where it is usually common. Owing to its limited range, it is listed as 'restricted' by the Australian Society for Fish Biology.

Edgbaston goby

Chlamydogobius squamigenus (Larson, 1995)

Description. Length 60 mm. They look almost identical to desert gobies (see the colour description of desert gobies). Males in breeding condition become quite colourful. The body colour grades from olive on the back to golden-yellow on the belly, with a chequered pattern of dark blotches on the back and sides. The fins are varying shades and patterns of blue to black and have a greyish white margin. The top of the first dorsal fin has a yellow flash. They are not easily distinguished from other *Chlamydogobius* species. However, their limited geographic range makes confusion unlikely.

Habitat. Shallow, clear water bodies free of larger fishes. Recent specimens have usually been collected from shallow artesian springs among emergent vegetation or from artesian bore drains. During the day, adult gobies shelter among emergent vegetation. At night, they can be observed some distance from cover and are apparently foraging. Juveniles are usually found in shallower areas than the adults are.

Biology. Reproduction is known only from captive populations. Spawning occurs at temperatures above 20ºC. The male selects a spawning site, such as a cave beneath a rock, which he defends. The male guides the females, attracted by his display, to the site. Spawning usually occurs at night and lasts about an hour. The male guards about 40-100 eggs, which are attached to the ceiling of the cave. Elongate water-hardened eggs are between 2.5 and 3.0 mm long and about 0.8–1.0 mm in diameter. Hatching begins after 10 days and may extend over several days. Newly hatched larvae are between 5 and 6 mm. Once the young are hatched, the male will attempt to attract another female. Spawning sites have not been identified in the wild. Mature males in spawning colouration are often found in or near the burrows of the common crayfish (*Cherax destructor*) or near the undercut clumps of spring grass. Juveniles may be found year round, but appear to be less common during winter. A long coiled intestine suggests that they are mainly herbivorous. Diet comprises various types of algae and small invertebrates. They are suitable aquarium inhabitants but are generally not kept, owing to their limited distribution and conservation status.

Distribution. Occurs in small numbers in artesian springs of the Edgbaston Springs Group. A small population exists in a bore drain between Longreach and Muttaburra. It is listed as 'vulnerable' by the Australian Society for Fish Biology. The main threats to this species include the presence of gambusia, and cattle and sheep trampling the habitat and fouling the water.

Finke goby

Chlamydogobius japalpa (Larson, 1995)

Description/Biology. Its description and breeding biology are probably similar to other desert gobies. No specific studies of this species have been undertaken. They have good potential as aquarium subjects, although their habitat's remoteness and the widespread presence of national parks make collection difficult.

Distribution/Habitat. Generally restricted to the upper Finke River. It may be common though typically not abundant. Owing to its limited range, it is listed as 'restricted' by the Australian Society for Fish Biology.

Golden goby

Glossogobius aureus (Akihito & Meguro, 1975)

Description. Length 200 mm. They are a brown colour, being darker on their upper bodies and lighter on their bellies. About five dark blotches are present along their sides. Large mouths and fused pelvic fins make their identification easy.

Biology. No work has been undertaken on Lake Eyre Region populations and little is known of their biology in Australia in general. Coastal populations may have a marine larval stage. For obvious reasons, this would be difficult in central Australia. Owing to its drab colour, this species is rarely kept in aquaria. They need to be kept with larger species because they will readily eat surprisingly large fish for their size.

Distribution. In the Lake Eyre Region, it is found only in the Georgina River, where it appears to be common. The golden goby is widespread throughout northern Australia and the Indo-Pacific region.

Family Poeciliidae – livebearers

Gambusia, mosquitofish

Gambusia holbrooki (Girard, 1859)

Description. Gambusia grow to 60 mm, although only females reach this size. Males commonly attain 35 mm. They are olive, tan or grey above, with a bluish sheen along the sides and silvery bellies. Their bodies may have fine black spots and these may continue onto the fins, which are otherwise clear. They may have a large, bluish black spot above the vent (usually only females). Gambusia have protrusible, upturned mouths; single, rounded dorsal fins without spines; and relatively large scales. The anal fins of males have the third, fourth and fifth rays thickened and extended to form elongate, pointed tubes. The anal fins of females are rounded.

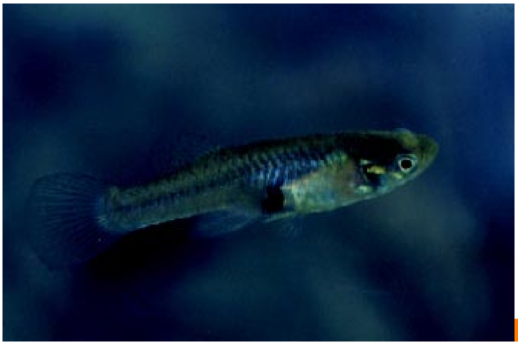
Biology. Gambusia have broad tolerance of salinity and oxygen content, and can tolerate water temperatures from 6–37ºC. They prefer shallow, slowly flowing or still clear water with abundant aquatic vegetation. In these habitats, they can form large populations and can exclude native species. Gambusia don't usually form large populations in muddy waterholes, possibly due to their reliance on sight to find food, or due to the ephermeral nature of these habitats and the large floods they experience. Gambusia tend to occur around the margins of waterholes in shallow areas probably in part to avoid predators, but also for feeding. Gambusia primarily rely on sight to avoid predators. Gambusia is unusual among fishes in its reproductive biology. Fertilisation occurs inside the female. The male's modified anal fin is used to transfer bundles of sperm to the female's genital opening. The young develop for 21–28 days inside the female before being released, completely developed. A large female may produce up to 375 fry. The young are about 4–5 mm long and reach maturity in as little as 6 weeks. In the Lake Eyre Region, gambusia breed in all months, except winter. In bore drains and springs with warm outflows, they breed year round.

In waterholes, they appear to have caused few problems to native fish populations, probably because they tend not to be abundant. However, they are reported to have caused a decrease in fish populations inhabiting non-riverine habitats such as bores and springs, e.g. Edgbaston Springs and Clayton Bore. Gambusia do not contribute any positive values to the Lake Eyre Region and there are ample native fishes to control any mosquito problems.

Distribution. Gambusia are a pest. They are widespread and common in the Neales River and Cooper Creek. They are spreading throughout the Diamantina River. A few other populations exist around Lake Eyre and in isolated parts of the Bulloo-Bancannia catchment. Their range is expanding due to flooding, bore drains and people physically moving them.

Gambusia are native to eastern drainages of the United States of America. They were deliberately introduced to the Sydney area between 1925 and 1927 and to Brisbane in 1929. Large-scale introductions occurred throughout Australia during World War II, when the armed services released them to try and control the wrigglers of disease-carrying mosquitoes. Some local authorities continued to introduce gambusia until the late 1970s and misinformed people continue to put them into new areas.

DO NOT MOVE GAMBUSIA.



Family Poeciliidae – livebearers

One-spot livebearer

Phalloceros caudimaculatus (Hensel, 1868)

In the Lake Eyre Region the one-spot livebearer has only been recorded from the Todd River Catchment. It was reported from Trephina Creek in 1973, John Hayes Rockhole in 1977, and in ponds in Alice Springs during 1982. None have been reported subsequently, and none were found during a recent survey.

Family Poeciliidae – livebearers

Swordtail

Xiphophorus helleri (Heckel, 1848)

Swordtails were reported as being present in the Todd River in 1982. None have been reported since, and a recent survey failed to find any.

Family Cyprinidae - minnows

Goldfish

Carassius auratus (Linnaeus, 1758)

Description. Goldfish is known to grow to 400 mm long and 2 kg. In the Cooper Creek Catchment, they rarely reach 180 mm. The wild colouration of goldfish in Cooper Creek is silvery bronze on the back, becoming lighter on the sides and belly. The fins are the same colour as the body. Specimens with aquarium-variety colouration may be found. Goldfish have a single broad based dorsal fin with a strong spine at the front. The anal fin has a similar spine. The forked tail has rounded lobes. Goldfish are unlikely to be confused with other Lake Eyre fishes, except perhaps bony bream. They do not have a dorsal fin filament or scales that form a serrated keel along the belly. Goldfish can be distinguished from carp by a lack of barbels around the mouth.

Habitat. Goldfish are normally found in waterholes and are able to persist in shallow drying water. They are able to withstand low oxygen levels and a wide temperature range. They prefer temperatures between 16-32C, but can withstand 0-42C, if acclimatised.

Biology. Goldfish spawn in spring and summer at water temperatures between 17-23C. Females produce between 160 000 and 380 000 eggs, but these are not all shed at once. The eggs are between 1.0 and 1.5 mm in diameter. They are scattered over, and stick to, the substrate or vegetation. Hatching occurs after 3-10 days, depending on temperature. The fry feed on plankton. Growth is variable and fish may reach between 44 and 178 mm (excluding the tail) in the first year. In South Australia, a fish about 370 mm was thought to be ten years old. Goldfish may mature at between 50 and 200 mm and at 1 to 4 years of age. Goldfish are omnivores and feed on a variety of vegetative matter, algae, invertebrates and detritus. In the Murray–Darling System, golden perch and Murray cod eat goldfish. Goldfish are known to hybridise with carp. They are popular aquarium fish, because of their variety of colours and their hardiness. Anglers occasionally catch them, but they are considered neither good sport nor good eating. It is illegal to use goldfish as bait.

Distribution. Goldfish are becoming widespread in the Cooper Creek Catchment. They have been present in the upper reaches of the Barcoo River for many years. They are now also widespread in the Thomson River and its tributaries, where they could have been independently introduced. They have also been recently recorded from Coongie Lakes, where they were apparently first introduced in the 1970s. It is believed that the use of goldfish as live bait and escapes from outdoor fish ponds have aided their dispersal. They are common throughout south-eastern Australia.

Carp

Cyprinus carpio (Linnaeus, 1758)

Description. Carp grow to 1200 mm and 60 kg. In the Murray–Darling System, they commonly grow to over 4 kg. They display variable colouration and may be olive, yellow-green or golden on their backs and sides, becoming silvery yellow on their bellies. The fins are opaque and are slightly darker than the body colour. Ornamental carp exhibit a wide range of colours. Carp have a single, broad–based dorsal fin with a strong serrated spine at the front. The dorsal fin profile is concave at the front. The anal fin also has a serrated spine. Carp have four barbels: two long ones at the corners of the mouth and two short ones at the ends of the upper lip. The presence of barbels distinguishes carp from goldfish.

Habitat. Carp prefer still or slow-flowing habitats, preferably with a muddy bottom. They are able to tolerate very muddy low oxygenated water. They can tolerate salinity to about half the strength of seawater, and can tolerate water temperatures from 0–41ºC but prefer 15–32ºC. Carp are tolerant of pollutants and can survive poor water quality where other species cannot.

Biology. Carp may spawn throughout the year, with peaks during spring and autumn when water temperatures are between 17–25ºC. Up to 40% of the female's body weight may be eggs amounting to more than 3 million eggs, which are released over several weeks. The eggs are 1.0–1.5 mm in diameter and are attached to the substrate or vegetation. The eggs can hatch in two days at 30ºC, or longer at cooler temperatures. Newly hatched fish are about 4–6 mm long. Growth is variable; a one-year-old fish may be 300 mm long.

Carp are omnivorous and feed on a wide variety of plant and animal materials. They typically feed by sucking mud, filtering out digestible material and expelling the sediment, but may also feed in mid-water or at the surface. Carp are not highly regarded as food fish in Australia. However, they are the most widely cultivated food fish in the world. They are regarded as good sport on light tackle and are easy to hook. A commercial fishery in the Murray–Darling System supplies mostly pet meat and crayfish bait. A small quantity is sold for the consumption market and a speculative liquid fish-fertiliser industry.

Distribution. Carp do not appear to have invaded the Lake Eyre Region. They have been found in a tailings dam at Leigh Creek coal mine, a tributary to Frome Creek. The Inland Waters section of the South Australian Research and Development Institute treated the dam, and all the carp were removed. They are common throughout much of south-eastern Australia.

The Lake Eyre Region is largely free from many of the serious problems that are typical of aquatic ecosystems elsewhere. This probably results from central Australia's isolation, low population density and extensive rather than intensive agricultural practices. Despite this, the integrity of central Australia's unique aquatic ecosystems has many potential threats. Individuals, community groups and government have recognised the need to respond to and manage these issues to ensure that the land remains productive while retaining the unique flora, fauna and landscapes.

Fishing

The Lake Eyre Region provides some of the best freshwater fishing in Australia. Golden perch, grunters (often called black bream, which may refer to two or three species) and catfishes can be caught almost anywhere. The habitats have suffered only minor impacts; there are no introduced angling species with self-maintaining populations; and there are relatively few anglers for the amount of water. Most people do not think to pack fishing gear when visiting the desert. Of course, some areas fish better than others do. For example, the Thomson River at Longreach sees quite a few anglers, and legal-sized fish can be a bit hard to find. Yet the Darr River only 20 kilometers up the road usually produces a legal-sized keeper.

Try to find a waterhole a little out of the way. Remember to seek permission to access private property, if necessary. Look for deeper areas in the waterhole, preferably with a bit of cover such as a fallen log or rocky outcrop. As in most places, dawn and dusk are the best times, although fish will bite at any time.

Bait is the preferred method and live shrimps hooked through the tail will catch golden perch and all varieties of grunters. A dip net scooped through leaf litter in a shallow area is a quick way to catch bait. Small bait traps baited with dry dog food or cat food also work well. Goldfish and redclaw crayfish are exotic to the region and should never be used as bait. If you catch your bait where you fish, you will not get into any trouble. If you prefer perch, fish with a float so that the bait is off the bottom, although this is no guarantee that you will not catch a catfish. Jiggling the float may help fish to find your bait. Lure fishing can be difficult, owing to the muddy water. If you insist on fishing with lures, try something bright and noisy, although black also seems to work well. Otherwise, wait for the rare occasion when a waterhole clears. At these times, local anglers have reported the most exciting lure sportfishing that they have ever experienced. Some enthusiasts have even used flies!

Fishing regulations

Fishing regulations change from time to time, and it is best to seek up-to-date information from the relevant authority e.g. Queensland Fisheries Service or the Queensland Boating and Fisheries Patrol (there is an office in Longreach at the Department of Primary Industries complex), Primary Industries and Resources, South Australia, Northern Territory Department of

Primary Industry and Fisheries and New South Wales Fisheries Department. Each department produces a brochure advising on the types of gear to use, bait-collecting regulations, bag and size limits on certain fishes, and areas closed to fishing.

Illegal fishing

Capturing fish using methods other than prescribed by the Queensland Fisheries Management Authority is illegal. Illegal methods include gill or mesh nets, bait nets or dynamite. Some people use illegal methods to take commercial quantities of fish. These fish may be sold locally or transported to, and sold at, interstate markets. Unfortunately, the Lake Eyre Region's isolation allows illegal fishing to continue largely undetected. Owing to the small number of waterholes present during drought, removal of large quantities of fish can severely reduce year classes of fishes that are susceptible to capture in gill nets.

Illegal fishing activities should be reported to the Queensland Boating and Fisheries Patrol on free call 1800 017 116, Primary Industries and Resources, South Australia on 1800 065 522, Northern Territory Police Marine and Fisheries Enforcement Unit on 1800 891 136 and New South Wales Fisheries Department on 1800 043 536 seven days a week.

Research on fish

The Horn Expedition in 1896 was the first to document central Australian fishes. Its observations included the lack of evidence for aestivation by desert fishes and the importance of flooding for dispersal. Several new species were described and new localities were recorded for others. This expedition raised the number of species known in central Australia from three to ten, representing seven families.

Between 1894 and 1971, occasional collecting raised the total number of native fishes recorded to 26 species from nine families. During this time, three exotic fishes from two families were recorded. Detailed investigations really only began when John Glover, Curator of Ichthyology at the South Australian Museum, studied central Australian fishes from 1967 until his death in 1992. He conducted many expeditions throughout central Australia and made several new records and discoveries, including the fishes from Dalhousie Springs. In his last (1982) checklist of central Australian fishes, Glover recorded 26 native species from 10 families and four exotic fishes from three families. The number recognised today is 33 native and two exotic species.

Several other workers have made, or continue to make contributions to central Australian ichthyology. These include Hamar Midgley (consultant), Helen Larson (Curator of Ichthyology at the Museum and Art Galleries of Northern Territory), Jim Puckridge (University of Adelaide), Bryan Pierce (South Australian Research and Development Institute), Mark Adams (South Australian Museum, Evolutionary Biology Unit), Terry Sim (South Australian Museum, Ichthyology Department), Peter Long (Department of Primary Industries, Queensland), Peter Unmack (Arizona State University) and Rob Wager (Raintree Aquatics Pty Ltd).

Lucy Crowley and Walter Ivantsoff (Macquarie University) have published several taxonomic papers describing new species of hardyheads, as has Gerald Allen on catfishes and mogurndas and Helen Larson on gobies.

Research fishing often uses gill nets and other methods not usually permitted. Researchers should display a sign on their vehicle or on the creek bank stating that their activities are being carried out under a permit. Researchers will always be happy to explain what they are doing.

Noxious and translocated species

A total of eight exotic and translocated fishes have been recorded from the Lake Eyre Region. Exotic species are those that do not naturally occur in Australia. Translocated species are those that are native to Australia, but do not naturally occur in the Lake Eyre Region.

Three native fishes— Murray cod, Murray–Darling golden perch and silver perch — have been recently translocated to the region by either local landholders or government agencies. Five exotic species — goldfish, carp, gambusia, swordtail and one-spot livebearer — have been previously recorded. Only two exotic species, gambusia and goldfish, are still present. Goldfish have been a relatively benign introduction. Natural river regimes, characterised by irregular flow and lack of permanent habitats have meant that goldfish have survived, but have not become a serious pest.

Gambusia have proliferated in the artificial environments of bore drains and have also spread to natural springs where they appear to be causing local extinctions of endemic fishes. Gambusia are declared noxious in each of the states in the Lake Eyre Region, hence it is illegal to place or release them into waterways, or to have them in your possession alive.

Translocated native fishes have not been shown to have a harmful effect yet, but the potential for disaster through hybridisation with closely related species is considerable. Silver perch are closely related to Welch's grunter and Murray–Darling golden perch are closely related to Lake Eyre golden perch. Hybridisation between the local and translocated species could result in a fish unsuited to the conditions of Lake Eyre rivers. This could lead to a decrease in native fish populations and an irreplaceable genetic loss.

Two other species are capable of causing serious environmental harm in the Lake Eyre Region. Carp are widely recognised as a nuisance species in south-eastern Australia and have been declared noxious in all Australian states and territories except New South Wales. They were found in a tailings dam near Leigh Creek, from which they were successfully eradicated. A recent find of carp frames on the banks of Cooper Creek was attributed to left-over bait. It is only due to luck that carp have not yet become established.

DO NOT MOVE CARP ANYWHERE OR USE THEM AS BAIT — IT IS ILLEGAL AND IRRESPONSIBLE.

If translocated, redclaw crayfish could cause considerable environmental damage. Redclaw do not occur naturally in the Lake Eyre Region. They should be used only as an aquaculture species on farms from which they cannot escape. They should not be stocked on farm dams. It is illegal to stock farm dams with redclaw crayfish in the Queensland section of the Lake Eyre Drainage. After rainfall, they will walk away from the dam and into surrounding waterways. Redclaw may devastate stocks of local crayfish. Besides, why pay money for redclaw when the local crayfish is perfectly suited to dam environments and can be caught for free?

Fish stocking

In the Lake Eyre Region, fish stocking is necessary only in farm dams or ring tanks, which otherwise may not contain fish. Large-scale stocking of public waterways is unnecessary, given the reproductive and dispersal abilities of native fish. Taking only enough for immediate needs ensures that everyone can catch a fish, even at heavily fished sites.

Fingerlings for stocking into dams should be sourced from a hatchery that has Lake Eyre fish. The Department of Primary Industries can provide a list of suitable hatcheries. When stocking fish, it may be desirable to also stock feeder fish or shrimps. These can be captured, using bait traps, from local creeks or rivers. Be careful to avoid gambusia. Providing some shelter or cover from cormorants and pelicans is also beneficial, especially if the water is clear. Water plants or tree branches are ideal.

Commercial fishing

The Queensland Government generally has not allowed commercial fishing in freshwater areas (with some exceptions that are not applicable to the Lake Eyre Region).

Recently, a commercial fishery was established at Lake Hope on the lower Cooper Creek for Lake Eyre golden perch. The South Australian Government allowed this on the basis that it was a temporary lake/waterhole, which was isolated from the system and would inevitably dry out.

A key consideration is the role of temporary waterholes in sustaining fish populations in an exceptionally variable system. To what extent do fish populations rely on the rare recruitment opportunities provided by inundation of the outlying sites? What are the implications of harvesting the colonising populations in these outliers? Unfortunately, no biological studies have been completed to determine appropriate management procedures for commercial fisheries in the Lake Eyre Region.

Land management

The health of waterholes and other wetlands is related to land use in the surrounding catchment. Although erosion and sedimentation are natural and obvious processes in the Lake Eyre Region, both have increased since a pastoral industry was established in the late 1800s. Overstocking, poor fire and drought management, the introduction of feral animals and clearing of inappropriate land types have caused an overall reduction of vegetation leading to soil losses. These factors are often aggravated along flood plains and riparian zones because feral animals and domestic stock congregate near water in these areas. Fouling of waterholes through dead stock or excess animal wastes has also been reported. While no direct impacts relating to this have been reported in central Australia, it is likely to have caused some siltation in waterholes, erosion of riverbanks and changes to nutrient dynamics.

Landowners and managers have recognised these problems and are addressing them through schemes like Landcare. Sustainable stocking rates, increased herd management through fencing and supply of off-stream water points, reclamation of scalded and clay pan areas, and control of woody weeds and feral animals will ensure that wetland ecosystems can persist.

Water resource development

Weirs are common throughout the Lake Eyre Region. Almost every town on a river has a weir from which domestic water is pumped. Weirs have the potential to stop fish migrations and alter downstream flows, and have other deleterious impacts. These are well documented for east coast rivers. However, in the Lake Eyre Region, most weirs are small, and the habitat created upstream is similar to waterhole habitats. Small weirs are also quickly inundated during floods, allowing fishes to bypass them.

Probably, the greatest shield for Lake Eyre's riverine ecosystems has been the absence of major water developments such as large impoundments or water-harvesting schemes. This is primarily related to the lack of cropping and irrigation industries. There have been many proposals to dam several rivers and divert the water into the Murray–Darling System, where water is used mainly for irrigation. Dams have also been proposed for flood control on the Todd River above the township of Alice Springs. Cotton farms have been proposed for the Cooper Creek. To date all proposals have not proceeded. Large impoundments can stop fish migrations, alter downstream flows, change fish communities and provide strongholds for introduced species such as carp.

If water developments are to be undertaken in the Lake Eyre Region, then considerable investigation into their sustainability and operational specifications will be required. The biological requirements of aquatic ecosystems will need to be identified. Water management arrangements will have to be established between States to ensure that downstream needs are met, especially environmental needs. Any use of water in the catchment will mean that less water will reach Lake Eyre or many of the waterholes that fish and other wildlife rely on.

Rare and threatened species and communities

Despite the Lake Eyre Region's overall good condition in terms of fish communities, some spots have suffered badly. The Australian Society for Fish Biology has a Threatened Fishes Committee that monitors the status of

Australian fish. Fish are listed according to the perceived likelihood of extinction. Several fish that occur in the Lake Eyre Region are listed by the Society. These are mostly found in artesian springs. Unfortunately, it is not just the fish in artesian springs that are threatened, but whole spring ecosystems.

Artesian Springs

A number of threats impact artesian springs. The continuing existence of the water on which they rely on is the greatest threat. The water in the Great Artesian Basin was first tapped in the late 1870s when the first bores or wells were sunk. This caused an initial period of draw down or loss of pressure in the aquifer, which resulted in a decline in spring discharge. This probably affected most springs within the Great Artesian Basin to some degree. Virtually all springs in the Bogan and Bourke supergroups are extinct or nearly so; many in the Eulo supergroup are extinct; and only Elizabeth Springs (which flows at less than 95% of its original rate) remains active in the Springvale Supergroup. Many of the Lake Eyre Supergroup springs are also reduced in flow, based on comparisons with the descriptions of early explorers.

Today, the Great Artesian Basin appears to be in equilibrium between recharge and discharge; that is, no further decrease in spring flow is expected providing no new developments occur. However, several new mining and smelting operations are proposed. Presumably, these will use artesian water.

Cattle, sheep or feral animals have impacted on virtually every artesian spring. Grazing ceased at Dalhousie Springs in 1985. A few of the Lake Eyre Springs were fenced between 1986–1988; Elizabeth Springs was re-fenced in 1994; two outlets were fenced at Edgbaston Springs in 1997; and a few springs are protected within Carnarvon Gorge National Park. Owing to the presence of water and fodder, livestock tend to congregate around springs. This results in considerable trampling of the surrounding area and disturbance to the spring itself. Faeces tend to pollute springs by causing high concentrations of nutrients and ammonia. Occasionally, livestock become trapped in soft mud and die, or they just happen to be in a spring when they die. In very small springs, this may lead to a devastating loss of fauna; in larger springs, a reduction in the animal biomass may occur.

Many smaller springs in Queensland have been excavated to improve stock accessibility to water. It is unknown whether the fauna is killed during excavation or whether it is unable to adapt to the new, deeper habitat that results. It is known that excavated springs tend to have only widespread and common plant and animal species.

Gambusia occur in a few springs in the Neales River and Frome Creek portions of the Lake Eyre Supergroup, and a few scattered Queensland springs. Gambusia are gradually expanding their range, primarily through bore drains and flood dispersal. They are a major problem at Edgbaston Springs, where they threaten red-finned blue-eye and Edgbaston goby. Physical removal of gambusia at Edgbaston has been unsuccessful in eliminating the species. Chemical eradication remains as an option. Fortunately, owing to its isolation, Dalhousie Springs remains free of exotic fishes. However, with increased tourist numbers, this could easily change. The large warm pools (32–38ºC) would make ideal environments for many exotic tropical fish species.

There is some debate as to whether fencing springs to prevent animal grazing is threatening or protecting them. The small number of Lake Eyre Supergroup springs that have been fenced have become overgrown with common reeds (*Phragmites australis*). This may result in a change to the plant and animal communities, although it is difficult to distinguish the effects of increasing plant growth from decreasing water supply. If the springs are not fenced, then they risk being destroyed by stock trampling and pollution.

There is also disagreement as to how much grazing occurred on the springs before European settlement. Have the springs had time to come into equilibrium with cattle grazing? Are springs dependent upon grazing to maintain aquatic habitats? Is it not known how the Aborigines managed the springs. It is thought that they may have used fire to maintain access to the springs or to catch game. These are challenging management questions, which hopefully ongoing research may be able to answer.

CONCLUSIONS

The Lake Eyre Region contains a fascinating assemblage of aquatic animals that live in a variety of habitats. These animals and their aquatic habitats are special in many different ways, whether it be for our angling pleasure, as aquarium fishes, curiosity, or just in their own right. They provide scientists with clues about historical changes that have occurred over thousands or millions of years, and possibly how they may change in the future. Or they can perhaps aid in the search for medicinal or dietry substances (desert goby make great anchovy substitutes on pizza!). Some have even suggested these desert creatures may provide clues that will assist us in colonising new harsh environments such as Mars! We enjoy studying and writing about these creatures and they have provided us with years of fascination. We are grateful our forefathers left the Lake Eyre Region to us in a mostly reasonable state (especially compared to the Murray–Darling system). We only hope our generation leaves it in similar, or better condition for the next.

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further **reading**

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glossary

abdomen (adj. abdominal) - that part of the body containing the digestive and reproductive organs; the lower part of the body in front of the vent.

adaptation - characteristics of a fish that assist it in living successfully in its habitat.

adipose fin - a small dorsal fin without fin rays posterior to the dorsal fin, usually fleshy.

aestivation (vb. aestivate) - a period of dormancy or inactivity during unsuitable periods.

anal fin - the unpaired fin just behind the vent and in front of the tail.

anterior - forwards, on or near the head.

barbel - slender, finger-like structures around the mouth or on the snout of some fish, provides sensory (usually taste) function.

benthic - occurring at or near the bottom of the water.

biota - the community of animals and plants that occupies a given habitat or area.

buoyant - capable of floating.

carnivore (adj. carnivorous) - pertaining to animals that feed on other live animals.

caudal fin - tail fin.

caudal peduncle - the posterior, slender section of the body behind the vent and before the caudal fin.

caudo-dorsal fin - the dorsal and caudal fin are joined to form a single, continuous fin (particularly in plotosid catfishes) which also, is usually continuous with the anal fin.

cladocerans - small aquatic crustaceans.

compressed - flattened from side to side.

concave - curved inwards.

copepod - small planktonic or benthic crustaceans of importance as fish food.

demersal - living on the bottom or sinking to it (eggs).

depressed - dorso-ventrally flattened.

detritus - organic material, derived from decomposing plants and animals, which some fishes feed on.

dimorphism - occurring in two distinct forms, shapes or colours; often related to the sexes, as in sexual dimorphism.

diversity - a measure of the number of species and the variety of life history and other adaptations present in an area.

dorsal - on or relating to the upper surface or back.

dorsal fin - any unpaired fin on the back.

endemic - native and restricted to a given area.

exotic - introduced or transplanted outside their native range.

family - one of the categories in animal and plant classification, contains at least one genus or several genera (pl).

fauna - the assemblage of animals inhabiting an area or habitat.

fecundity - the number of eggs produced by a fish.

filament (adj. filamentous) - slender or thread-like rays that extend beyond the main edge of a fin.

fingerling - a young fish.

fin ray - a flexible bone supporting a fin which is segmented along its length and consists of two branches.

fin spine - a slender tapering bone usually with a sharp point which is not segmented and not branched.

flora - the plants occurring in an area or habitat.

fry - newly hatched fish.

genus (pl. genera) - one of the categories in plant and animal classification; contains one or more related species.

habitat - a place where a species normally lives.

herbivore - a plant-eating animal.

hybrid - an individual (or stock of fish) that is the product of fertilisation of the ova from a female of one species by the spermatozoa of another species.

hydrology - the study of the behaviour of flowing waters.

introduced - describes a species transferred from its natural distribution into new areas where it was not previously present; such species are exotic (q.v.).

invertebrate - animals that do not have backbones, such as crustaceans, insects and worms.

isthmus - the area below the head, between the gill openings.

jugular - used to refer to the isthmus (q.v.); below the head between the gill openings.

keel - a ridge along the ventral surface of the abdomen, usually composed of scales.

larva (pl. larvae, adj. larval) - the youngest life history stage after hatching of the egg, usually with obvious shape and structural differences from the adult.

lateral - referring to the sides.

lateral line - a row of pored scales or pores in the skin along the sides of fish; the pores open into sensory canals along the sides.

laterally compressed - flattened from side to side.

nocturnal - active and usually feeding at night.

omnivore (adj. omnivorous) - animal that feeds on both plants and animals.

operculum - a group of bones that form the gill cover.

origin (applied to fins) - the anterior most point of the fin, normally where it joins the body.

ostracods - small aquatic crustaceans that have bivalve-like shells.

ova (sing. ovum) - eggs.

ovaries - female reproductive organs containing ova.

paired fins - fins that occur in pairs, pectoral and pelvic fins.

papilla (plural papillae) - a small usually fleshy part projecting from the body (similar to a pimple in appearance.

pectoral fins - paired fins just behind the gill openings.

pelagic - occurring in deep water away from land; free swimming, free-floating eggs.

pelvic fins - paired fins positioned on the ventral surface between the head and vent; jugular (q.v.), thoracic (q.v.) or abdominal (q.v.); often referred to as ventral fins.

piscivorous - fish-eating animal.

plankton - microscopic organisms that live near or at the surface of waterholes or lakes.

posterior - towards the tail.

ray - see fin ray.

riparian - referring to the zone along banks of rivers and lakes between the water and drier uplands.

sexual dimorphism - see dimorphism.

species - a group of actually or potentially interbreeding populations that is reproductively isolated from other populations; species are often, but not always distinct in appearance and behaviour.

spine - see fin spine.

standard length - the distance from the end of the snout to the hypural plate (the modified last vertebrae) (abbrev. SL).

territory - an area within which a fish may live and from which it may cause intruders, especially of its own species, to be excluded from.

testes - male reproductive organs.

thoracic - the area of the ventral surface below the pectoral fins bases, just behind the head; e.g., thoracic pelvic fins.

total length - the length from the end of the snout to the end of the caudal fin when both lobes are brought together. (abbrev. TL).

translocation - the movement of fish or distinct genetic stocks of fish to areas outside their natural distribution.

vent - the external opening of the alimentary canal, anus.

ventral - refers to the lower surface of the body.

ventral fins - see pelvic fins.

year class - all individuals of a population born in any given year.

	Basin	Bu	Ba	Co	Di	Ge	LE	Fr	Ne	Ma	Ds	Fi	To	PH
NATIVE SPECIES														
Nematolosa erebi	Bony Bream	✓	-	✓	✓	✓	✓	✓	✓	✓	-	✓	-	-
Retropinna semoni	Australian Smelt	-	-	✓	-	-	✓	-	-	-	-	-	-	-
Neosilurus hyrtlii	Hyrtl's Tandan	✓	-	✓	✓	✓	-	-	✓	-	-	✓	-	-
Neosilurus aff. hyrtlii	Tandan				✓									
Neosilurus gloveri	Dalhousie Catfish	-	-	-	-	-	-	-	-	-	✓	-	-	-
Neosilurus sp.	False-spined Catfish	✓	-	-	-	-	-	-	-	-	-	-	-	-
Neosilurus cooperensis	Cooper Creek Tandan	-	-	✓	-	-	-	-	-	-	-	-	-	-
Porochilus argenteus	Silver Tandan	✓	-	✓	✓	✓	-	-	-	✓	-	-	-	-
Craterocephalus centralis	Finke Hardyhead	-	-	-	-	-	-	-	-	-	-	✓	-	-
Craterocephalus dalhousiensis	Dalhousie Hardyhead	-	-	-	-	-	-	-	-	-	✓	-	-	-
Craterocephalus eyresii	Lake Eyre Hardyhead	-	-	✓	✓	-	✓	✓	✓	-	-	-	-	-
Craterocephalus gloveri	Clover's Hardyhead	-	-	-	-	-	-	-	-	-	✓	-	-	-
Craterocephalus n.sp	Edgbaston Spring Hardyhead	-	-	✓	-	-	-	-	-	-	-	-	-	-
Melanotaenia splendida tatei	Desert Rainbowfish	✓	-	✓	✓	✓	-	-	✓	✓	-	✓	-	-
Scaturiginichthyes vermeilipinnis	Red-finned Blue-eye	-	-	✓	-	-	-	-	-	-	-	-	-	-
Ambassis mulleri	Western Chanda Perchlet	-	-	✓	✓	✓	-	-	-	-	-	✓	-	-
Macquaria sp.	Lake Eyre Golden Perch	-	-	✓	✓	✓	-	-	-	-	-	✓	-	-
Macquaria sp.	Bullo River Golden Perch	✓	-	-	-	-	-	-	-	-	-	-	-	-
Amniataba percoides	Banded Grunter	-	-	-	-	✓	-	-	✓	-	-	✓	-	-
Bidyanus welchi	Welch's Grunter	✓	-	✓	✓	✓	-	-	-	-	-	-	-	-

Leiopotherapon unicolor	Spangled Perch	✔	-	✔	✔	✔	✔	✔	✔	✓	✓	✓	✓	✓
Scortum barcoo	Barcoo Grunter	✔	-	✔	✔	✔	-	-	-	-	-	-	-	-
Hypseleotris klunzingeri	Western Carp Gudgeon	✔	-	✔	-	-	-	-	-	-	-	-	-	-
Hypseleotris sp.A	Midgley's Carp Gudgeon	✔	-	✔	-	-	-	-	-	-	-	-	-	-
Hypseleotris sp.B	Lake's Carp Gudgeon	-	-	✔	-	-	-	-	-	-	-	-	-	-
Mogurnda adspersa	Dalhousie (Finke) Purple-spotted Gudgeon	-	-	-	-	-	-	-	-	-	✓	✓	-	-
Mogurnda adspersa	Barcoo (Flinders Range) Purple-spotted Gudgeon	?	-	v	-	-	-	✓	-	-	-	-	-	-
Mogurnda adspersa	Bulloo Purple-spotted Gudgeon	✓	-	-	-	-	-	-	-	-	-	-	-	-
Chlamydogobius eremius	Desert Goby	-	-	-	-	-	-	✓	✓	-	-	-	-	-
Chlamydogobius gloveri	Dalhousie Goby	-	-	-	-	-	-	-	-	-	✓	-	-	-
Chlamydogobius japala	Finke Goby	-	-	-	-	-	-	-	-	-	-	✓	-	-
Chlamydogobius micropterus	Elizabeth Springs Goby	-	-	-	✓	-	-	-	-	-	-	-	-	-
Chlamydogobius squamigenus	Edgbaston Goby	-	-	✓	-	-	-	-	-	-	-	-	-	-
Glossogobius aureus	Golden Goby	-	-	-	-	✓	-	-	-	-	-	-	-	-
INTRODUCED NATIVES														
Maccullochella peeli peeli	Murray Cod	-	-	✓	-	-	-	-	-	-	-	-	-	-
Macquaria ambigua	Murray River Golden Perch	-	-	-	-	-	-		-	-	-	-	-	✓
Bidyanus bidyanus	Silver Perch	-	-	-	-	-	-	✓	-	-	-	-	-	-
EXOTIC SPECIES														
Gambusia holbrooki	Gambusia	✓	-	✓	✓	-	-	✓	✓	-	-	-	-	-
Carassius auratus	Goldfish	-	-	✓	-	-	-	-	-	-	-	-	-	-
Cyprinus carpio	Carp	-	-	-	-	-	-	✓	-	-	-	-	-	-
	SPECIES PER BASIN (Introduced)	13(1)	0	20(3)	11(1)	11	4	5(3)	7(1)	4	7	10	1	1(1)

Rob Wager

Rob Wager has a life-long interest in Australian native freshwater fish. He studied geology, aquatic ecology and fisheries biology at the University of Queensland and has worked in the fields of limnology, aquaculture, fisheries research, and as an environmental consultant.

Rob worked in the Fisheries Section of the Department of Primary Industries, Queensland for eight years. During this time he worked on spawning Australian bass and barramundi, the biology and spawning of the endangered Mary River cod, the conservation of artesian spring fishes and the conservation and management of Queensland freshwater fishes. He also developed his fish farm during that time.

Rob's current pursuit is Raintree Aquatics Pty Ltd, an aquatic environment consulting business established in 1995. Raintree Aquatics undertakes work on artesian springs management, assessment, monitoring and managing natural and artificial freshwater ecosystems and preparing environmental management plans for developments and aquaculture. Rob and his family continue to operate their fish farm, breeding fish for mosquito control, recreation and ornamental uses.

Peter J. Unmack

Peter also has a strong and long interest in native fish species, particularly those that he collected or bred himself. He is also a keen angler. In the mid-eighties he became keenly interested in the conservation and biology of Australian native freshwater fish. Since then has collected fish extensively throughout the eastern half of Australia.

Peter's academic interests are broad and include desert spring conservation and ecology. In 1995 he attended the University of California, Davis for one year to complete an undergraduate degree as an exchange student. He recently finished a Masters Degree at Arizona State University on the biogeography of Australian freshwater fishes and is currently undertaking a PhD on the historical biogeography and systematics of Percichthyidae.