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Fish distribution, status and threats in the rivers and springs of the Queensland Lake Eyre Basin

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Introduction

Even a cursory glance at a map of central Australian waterways tells the story: there aren't many, and there are really only three big rivers (Fig. 3.1). The Cooper, the Diamantina and the Georgina Rivers are the collective engine-room of Australian arid-zone aquatic ecosystems, and run-off from unpredictable monsoon rains is their fuel. The study of fish ecology in the Lake Eyre Basin is patchy. Despite the fact that most permanent waters are within Queensland (Silcock 2009), both the earliest fish surveys (Glover and Sim 1978; Glover 1979) and ecological studies (Puckridge 1999) were in South Australia. Sites from the upper and mid-reaches of the three big rivers in Queensland have only been sampled since 2000 (Bailey and Long 2001; Costelloe *et al.* 2004), with the Cooper consistently receiving most attention (Arthington *et al.* 2005; Balcombe *et al.* 2007; Balcombe and Arthington 2009). Long-term repeated sampling of multiple riverine sites throughout all three major rivers of the Queensland Lake Eyre Basin occurred between 2006 and 2010 (Fig. 3.1; Kerezsy 2010; Kerezsy 2011) and then from 2010 onwards through the implementation of the Lake Eyre Basin Rivers Assessment, administered by a combination of natural resource agencies based in Queensland, South Australia and the Northern Territory. No fish species present in the rivers of the Queensland Lake Eyre Basin is currently listed under either state or federal endangered species legislation, and none is a species on the international Red List of Threatened Species (International Union for the Conservation of Nature 2016).

Though far smaller in area, the Great Artesian Basin spring complexes in Queensland – the Barcaldine group in the north-east, the centrally located Springvale group and the Mulligan group on the eastern edge of the Simpson Desert – have received comparatively more attention over a longer time than the riverine environments (Fig. 3.1). This disparity has been due largely to the notable numbers of endemic plants, invertebrates and fish within these springs (Ponder and Clark 1990; Fairfax *et al.* 2007; Fensham *et al.* 2011; Kerezsy and Fensham 2013). Spring complexes – or groups – are characterised by multiple shallow, groundwater-fed ponded and/or damp areas. All are associated with faulting, and it is the presence of faults that has enabled water from the Great Artesian Basin to reach the surface over a prolonged period. Most native fish species present in Great Artesian Basin spring complexes in Queensland are listed as vulnerable, endangered or critically endangered under relevant Australian legislation (*Nature Conservation Act 1992*; *Environment Protection and*

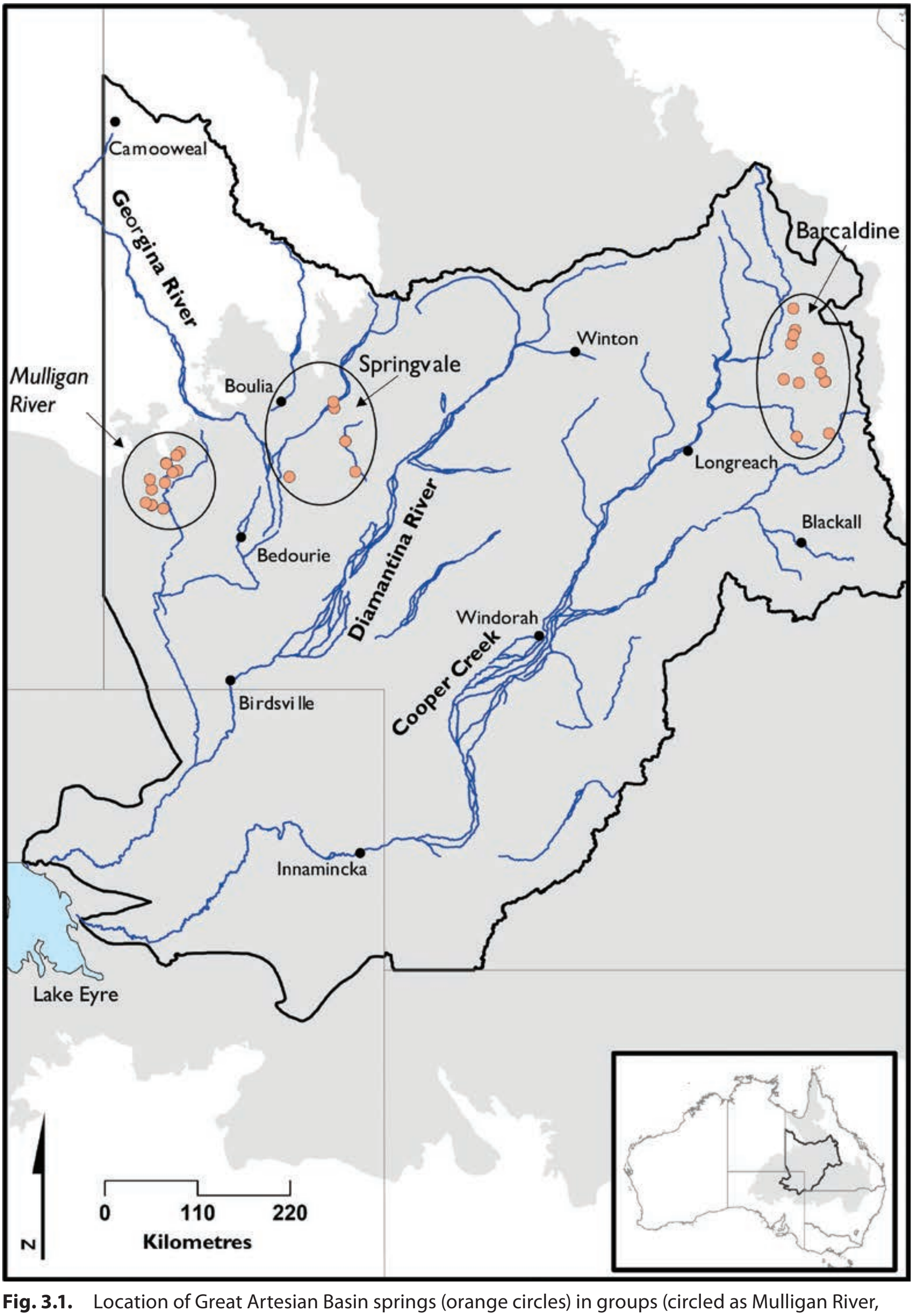

Fig. 3.1. Location of Great Artesian Basin springs (orange circles) in groups (circled as Mulligan River, Springvale and Barcaldine) in the Queensland Lake Eyre Basin (black outline) and within the Great Artesian Basin (grey shading). Mapping courtesy Jen Silcock.

Biodiversity Conservation Act 1999) and also on the Red List of Threatened Species (International Union for the Conservation of Nature 2016).

Widespread fish species

Despite the comparative paucity of studies of fish within Queensland's western rivers, some general patterns have been observed. Some species occur across all catchments, from the Bulloo River in the east to the highly temporary Mulligan River on the edge of the Simpson Desert, in permanent and ephemeral waterholes and across a wide range of habitats (Table 3.1). This group includes the algivore/detritivore bony bream, the carnivore spangled perch, two species of catfish, the silver tandan and the larger Hyrtl's tandan, and two small-bodied species, the desert rainbowfish and glassfish (Table 3.1). Most can move at least 300 km into ephemeral habitats following flooding. Many also continuously recruit, maintaining populations in both dry and wet periods. Large-bodied species such as Barcoo grunter, Welch's grunter and yellowbelly possess similar adaptations to living in the Australian arid zone, but tend not to move as far into temporary desert habitats, probably due to their longevity (around 10 years) and adult size (at least 300 mm).

Fish species confined to particular rivers

The waterholes and reaches of the Cooper catchment (the Barcoo, Thomson and Wilson Rivers, Kyabra Creek and many more headwater subcatchments; Fig. 3.1) provide habitat for three species that do not live in the western rivers of the Lake Eyre Basin: carp gudgeon, Australian smelt and the endemic Cooper Creek catfish (Table 3.1).

Carp gudgeon are widespread in all catchments east of and including the Cooper, although their origin remains unclear (P. Unmack, pers. comm.). The similarly located Australian smelt reflects a more traceable story. It is more closely related to southern cousins in the South Australian Murray–Darling Basin than to eastern populations in Queensland and New South Wales (Hammer *et al.* 2007), suggesting it may have colonised the Lake Eyre Basin from the south, when the continent was wetter.

The Lake Eyre Basin's most curious aquatic inhabitant is arguably the Cooper Creek catfish (Fig. 3.2). This large bottom-dwelling species is probably older or more ancestral than the other widespread catfish species (P. Unmack, pers. comm.). It is the only endemic riverine fish species from the Cooper, found in the Thomson and Barcoo Rivers and downstream in Cooper Creek, but nowhere else. Cooper Creek catfish produce relatively few large eggs (~1000, 3–4 mm diameter; Unmack 1996). It is possible that they may guard their eggs, or make shallow nests in the substrate in a similar fashion to freshwater catfish from southern Australia (e.g. *Tandanus tandanus* from the Murray–Darling Basin). However, the life history of Cooper Creek catfish is yet to be studied in detail.

The Diamantina and Georgina River catchments also provide habitat for species that have not been able to cross the catchment divide into the Cooper Creek catchment, or successfully colonise via Kati Thanda-Lake Eyre during wet periods. For example, the banded or barred grunter is widespread across northern Australia (Allen *et al.* 2002), with either an advance or ancient population living only in the Diamantina and Georgina River

Table 3.1. Names and some life history characteristics of fish species in the rivers and springs of the Queensland Lake Eyre Basin.

See Fig. 3.1 for the locations of springs and rivers.

Species	Common name	Distribution	Life history	References
Riverine native species				
Nematolosa erebi	Bony herring	All catchments	Extreme dispersal ability, continuous recruitment	Bailey and Long 2001; Arthington *et al.* 2005; Balcombe *et al.* 2007; Balcombe and Arthington 2009; see Chapter 4; Puckridge 1999; Wager and Unmack 2000; Kerezsy *et al.* 2011; Kerezsy and Fensham 2013; Kerezsy *et al.* 2014; Cockayne *et al.* 2015
Neosiluroides cooperensis	Cooper Creek catfish	Cooper Creek catchment	Poorly known benthic species, spring/summer spawning	
Neosiluris hyrtlii	Hyrtl's tandan	All catchments	Conservative dispersal to deep areas, flow-dependent recruitment	
Porochilus argenteus	Silver tandan	All catchments	Spring/summer recruitment, extreme dispersal ability	
Retropinna semoni	Australian smelt	Cooper Creek catchment	Winter recruitment	
Craterocephalus eyresii	Lake Eyre hardyhead	Georgina River catchment (Mulligan R.)	Extreme dispersal, colonises springs opportunistically	
Melanotaenia splendida tatei	Desert rainbowfish	All catchments	Extreme dispersal, continual recruitment, colonises springs opportunistically	
Ambassis sp.	Glassfish	All catchments	Extreme dispersal, continual recruitment, colonises springs opportunistically	
Macquaria sp.	Yellowbelly	All catchments	Conservative dispersal to deeper areas, flow and continuous recruitment	
Amniataba percoides	Barred grunter	Georgina River catchment	Extreme dispersal, continual recruitment, colonises springs opportunistically	
Bidyanus welchi	Welch's grunter	All catchments	Conservative dispersal to deep areas, flow-dependent recruitment	
Leiopotherapon unicolor	Spangled perch	All catchments	Extreme dispersal, continual recruitment, colonises springs opportunistically	
Scortum barcoo	Barcoo grunter	All catchments	Conservative dispersal to deep areas, flow-dependent recruitment.	
Glossogobius aureus	Golden goby	Diamantina–Georgina River catchments	Spring/summer recruitment, conservative dispersal ability	
Hypseleotris sp.	Carp gudgeon	Cooper Creek catchment	Continual recruitment	

Species	Common name	Distribution	Life history	References
Riverine translocated species				
Oxyeleotris lineolata	Sleepy cod	Cooper catchment	Benthic carnivore likely to threaten native species	Kerezsy 2011
Riverine alien species				
Gambusia holbrooki	Gambusia	Cooper catchment	Live-bearer, continuous recruitment, also present in springs (Edgbaston)	Kerezsy 2009
Carassius auratus	Goldfish	Cooper catchment	Widespread but potential effects unknown	
Species of the Great Artesian Basin springs				
Scaturiginichthys vermeilipinnis	Red-finned blue-eye	Barcaldine spring group (Cooper catchment)	Endangered. Present in one naturally occurring and six relocated populations at Edgbaston, threatened by gambusia	Fairfax *et al.* 2007; Fensham *et al.* 2011; Kerezsy and Fensham 2013; Kerezsy 2014; Kerezsy 2015
Chlamydogobius micropterus	Elizabeth Springs goby	Springvale spring group (Diamantina catchment)	Endangered. Small benthic species limited to the Elizabeth Springs complex	
Chlamydogobius squamigenus	Edgbaston goby	Barcaldine spring group (Cooper catchment)	Endangered. Small benthic species limited to springs and bore drains on Edgbaston, Myross and Ravenswood	

Fig. 3.2. The Cooper Creek catfish is known only from the Thomson and Barcoo Rivers and Cooper Creek (Fig. 3.1), and grows to 60 cm.

catchments. It is a common smaller cousin of the Barcoo and Welch's grunters. Similarly, the golden goby is a northern and Indo-Pacific species, but some populations survive in the few permanent waterholes of the Georgina River, and more recently were found in the Diamantina and Mulligan Rivers (Table 3.1).

Our understanding of fish ecology in remote regions of the Lake Eyre Basin remains in its infancy. A good example is the detection of a small schooling species (Lake Eyre hardyhead) in the highly temporary Mulligan River during the wet years 2009–2012 (Kerezsy *et al.* 2013). This was over 300 km away from previous records in Goyder's Lagoon (Costelloe *et al.* 2004; R. Mathwin and D. Schmarr, pers. comm.), and the first time the species had been found in Queensland. These records suggest that this species, previously only recorded from South Australia, can migrate long distances following above-average rainfall and the inundation of usually dry channels.

Fish species of the springs

Three endemic species live in the springs of the Queensland section of the Great Artesian Basin (Fig. 3.1), and a further five fish species are found in Dalhousie Springs in northern South Australia. The Queensland species are listed as either endangered or vulnerable under both state and national legislation.

No endemic fish species are present in springs in the Mulligan group (Fig. 3.1), where desert rainbowfish, glassfish, Lake Eyre hardyhead and spangled perch colonise during floods which briefly connect the springs to the Mulligan River (M. Tischler and A. Kerezsy personal observations 2009–13; Table 3.1). At the Springvale group, south-east of Boulia in the Diamantina catchment, populations of the Elizabeth Springs goby are the only fish present

Fig. 3.3. Great Artesian Basin springs form isolated wetlands that provide habitat for the endangered red-finned blue-eye and Edgbaston goby. These species are significantly affected by competition with the invasive mosquito fish. Trampling by livestock and feral animals and drawdown from water extraction are more general threats to spring complexes (photo, A. Kerezsy).

and are comparatively secure as this spring complex is reserved as a national park and fenced to exclude stock. Cattle, pigs and camels all severely damage and deplete springs through pugging, wallowing and drinking (Fig. 3.3). In addition, the invasive fish species gambusia or mosquitofish has not been recorded in the Diamantina catchment in Queensland.

Two species of endangered and endemic fish occur at Edgbaston in the Barcaldine group (Fig. 3.3), the most ecologically diverse Great Artesian Basin spring complex in Australia. The Edgbaston goby (Fig. 3.4) is a close relative of the Elizabeth Springs goby and three other *Chlamydogobius* species from South Australia and the Northern Territory. All are morphologically similar and their speciation is an artefact of their prolonged isolation and subsequent evolution. The second species, the red-finned blue-eye, is far more curious. It is the only Pseudomugilid fish known from inland Australia; all other species in this family live in coastal-draining rivers in northern and eastern Australia and New Guinea. Discovered in 1990 by fish biogeographer and geneticist Peter Unmack, populations of the species had dwindled to occupy only four of the 40 habitable springs when the conservation not-for-profit organisation Bush Heritage Australia purchased the property in 2008. The red-finned blue-eye was identified by IUCN as among the world's 100 most endangered species of any animal or plant group, and is threatened by gambusia, feral and domestic stock, and aquifer drawdown.

Gambusia probably out-compete red-finned blue eye because the former give birth to live young, meaning new-born juveniles are comparatively large and self-sufficient. In contrast, red-finned blue-eye are egg-layers, and gambusia are known to predate the eggs of

Fig. 3.4. The endemic and endangered Edgbaston goby, with a global population existing in only nine springs at Edgbaston and at two locations on adjacent properties in the Aramac district in central western Queensland (photo, A. Kerezsy).

native Australian fish species. Since 2009, intensive management has focused on recovery of red-finned blue-eye using three control techniques: use of the piscicide rotenone to remove gambusia, relocation of red-finned blue-eye (using a founder populations of 20 individuals) to safe habitats where gambusia have been removed or do not occur, and the installation of barriers around some springs to prevent gambusia colonisation (Kerezsy and Fensham 2013; Kerezsy 2015).

Alien invasions

Unlike the neighbouring and similarly sized Murray–Darling Basin, the Lake Eyre Basin and its rivers remain unregulated, with relatively few alien aquatic species in relatively low numbers (see Chapter 4). Carp (*Cyprinus carpio*), redfin (*Perca fluviatilis*) and various salmonids (trouts and salmon) are absent from the Bulloo, Cooper, Diamantina and Georgina Rivers. Small populations of gambusia and goldfish live throughout Cooper Creek (Table 3.1), although their impacts are largely unknown (with the exception of impacts on the spring species mentioned above). However, several translocated native fish species have established in the Lake Eyre Basin rivers, and they were probably first introduced by government agencies and/or local fishing clubs for recreational fishers or aquaculture. The largest and most iconic Murray–Darling Basin fish, Murray cod (*Maccullochella peelii*) was introduced into the Thomson River at Longreach in the Cooper Creek catchment in the late 1980s and early 1990s; individuals still show up occasionally (A. Emmott, pers. comm.). This fish is a top order predator in rivers where it naturally occurs, and therefore has the potential to negatively impact populations of naïve prey species in rivers where it is translocated. From the 1980s to the early 2000s, far larger numbers of yellowbelly (*Macquaria*

Fig. 3.5. Sleepy cod, naturally occurring in Australia's tropical rivers, is a predator and was first detected in the Thomson River in 2008. The species is now well established throughout the Cooper Creek catchment (photo, A. Emmott).

ambigua) from the Murray–Darling Basin were also introduced across a wide area. The negative effects on local populations of yellowbelly (potentially a separate species) were never considered, and the fate of these stocked fish remains unknown (including potentially breeding with local yellowbelly).

In the 1990s, the large red claw crayfish (*Cherax quadricarinatus*) was also deliberately released, with considerable investment of resources. Red claw are native to north-eastern Australia but not the Lake Eyre Basin. They quickly established in the Cooper Creek, Diamantina and Georgina River catchments. It is assumed that individuals escaped from aquaculture populations and walked into the rivers. Dramatically, red claw exclude and out-compete the locally occurring blue claw yabbies (*Cherax destructor*) (Kerezsy 2010; B. Cockayne and D. Akers, personal communication).

Most recently, the large bottom-dwelling gudgeon, sleepy cod (*Oxyeleotris lineolate*; Fig. 3.5) – also from rivers in Australia's north-east – has become established in the Cooper Creek catchment. The source population of sleepy cod in the Cooper Creek catchment is likely to be specimens that escaped from dams close to Longreach during flooding. The species was first caught in 2008, near Stonehenge on the Thomson River (Kerezsy *et al.* 2014), and is becoming increasingly common during recent fish surveys in the Cooper Creek catchment (B. Cockayne, D. Sternberg personal communications). The concern is that this large (up to 450 mm) and carnivorous species may also have a negative effect on the local food webs within Cooper Creek, particularly as waterholes dry during summer.

Conclusion – now and the future

Our current knowledge of fish communities throughout the Queensland Lake Eyre Basin indicates that native fish populations are in good condition, especially compared to other inland systems regulated by dams and extractions (e.g. the rivers of the Murray–Darling Basin). In stark contrast, the endangered spring communities, particularly those in the easternmost Barcaldine group, are still threatened by alien species (primarily gambusia but also cane toads), spring destruction and degradation due to trampling and disruption by domestic and feral stock, and the threat of aquifer drawdown from extractive industries such as coal mining and coal seam gas.

Governments and communities have rarely attempted to contain or control the impacts of invasive aquatic species in the Queensland section of the Lake Eyre Basin. Exceptions include the concentrated rehabilitation of artesian springs and their fish at Edgbaston by controlling gambusia, and preventing the liberation of other aquatic invaders – a recent goal of government agencies and associated research institutions. The ecological effects of population booms of introduced species (e.g. red claw crayfish and sleepy cod) could be locally catastrophic during dry periods when all species – both native and introduced – concentrate in shrinking waterholes. Unfortunately, our ability to successfully control or mitigate such impacts in the extensive boom and bust systems of the Lake Eyre Basin is limited.

Avoidance of further invasions into catchments where non-native species do not occur should be the priority. This means preventing sleepy cod, Murray cod, goldfish and gambusia reaching the Diamantina and Georgina, and dedicated programs and policies (e.g. community education programs) to reduce the chances of other alien or translocated species entering Lake Eyre Basin watersheds. Carp and various *Tilapia* species, established in the rivers of the Murray–Darling and north-eastern Australia, are currently the biggest potential threats facing the riverine communities of far western Queensland, and every effort should be made to prevent their expansion into the Lake Eyre Basin rivers.

The Lake Eyre Basin rivers occupy an iconic place in Australia's cultural identity and history (Durack 1959; Bowen 1987; Murgatroyd 2002; see Chapters 1, 7 and 8), and are considered to comprise the healthiest and most intact arid-zone aquatic ecosystems worldwide (see Chapters 2, 4 and 7). There are legislative challenges associated with managing such a large area, especially as it is administered by multiple jurisdictions (Queensland, South Australia, Northern Territory and New South Wales), and there are considerable logistical and practical difficulties. Management and research in the Lake Eyre Basin must be approached collaboratively in order to assess threats and adequately monitor river health in these unique systems, because evidence-based policy and sound management of the Lake Eyre Basin rivers and springs are crucial for maintaining dependent biodiversity.

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