

Fighting against extinction - the conservation of four small-bodied threatened freshwater fish species in the Lower Lakes

Sylvia Zukowski¹, Nick Whiterod²

¹ Nature Glenelg Trust, Victor Harbor, SA 5211. Email: sylvia.zukowski@ngt.org.au

² Goyder Institute for Water Research, CLLMM Research Centre, Goolwa, SA 5214. Email: nick.whiterod@goyderinstitute.org

Key Points

- Millennium drought profoundly impacted small-bodied native freshwater fish across the lower reaches of the Murray-Darling Basin.
- There is limited capacity for natural post drought recovery in the four fish species.
- Establishment and maintenance of long-term backup populations has safeguarded the fish species, raised awareness and provided capacity for reintroductions.
- Reintroductions, supported by water management, have played a crucial role in the recovery of small-bodied native freshwater fishes across the region, but further efforts are required.

Abstract

Freshwater native fish species are increasingly becoming threatened globally and in Australia. The impacts of river regulation, climate change, alien species and water extraction are leading to reductions in abundance and distribution, pushing many toward extinction (with some already lost). A diverse range of aquatic habitats such as tributary streams, wetlands, and lakes Alexandrina and Albert at the terminal end of the Murray-Darling Basin, support more than half of the Basin's small-bodied fish species. This includes the 'Big Little Four' - the nationally (under Australia's Environment Protection and Biodiversity Conservation Act) Endangered Murray hardyhead *Craterocephalus fluviatilis*, nationally Endangered Yarra pygmy perch *Nannoperca obscura*, nationally Vulnerable Southern pygmy perch *Nannoperca australis* (MDB lineage), and the South Australian Critically Endangered Southern purple-spotted gudgeon *Mogurnda adspersa* (which is currently under EPBC Act assessment). During the period of critical water shortage at the height of the Millennium Drought, these threatened fish species were placed under extreme threat. Indeed, three of the four threatened small-bodied fish species were extirpated from the region during this period. Fortunately, through the passion, hard work and strong collaboration undertaken over the past decade, each of the four native freshwater fish species are mounting a comeback. The establishment and maintenance of backup populations, through surrogate refuge wetlands and school breeding programs, is providing the basis of enabling recovery through reintroduction of these fish into their former habitats. Strong collaboration between community and landowners, schools, managers and ecologists, has been critical to this story of recovery. This paper will highlight the journey, collaborations, and conservation of the Big Little Four, and outline what is required as we face a future that will present further risks to these species.

Keywords

Threatened fish
Backup populations
Conservation
EPBC listed
Extinction
Collaboration
Engagement

Introduction

Many species have experienced population declines in range and abundance, and are at risk of extinction globally ([Dudgeon 2014](#); [Pimm et al. 2014](#)). Freshwater fishes appear disproportionately at risk, with almost one-third of assessed species deemed extinct or at risk of extinction ([Darwall and Freyhof 2016](#)). Many threats have been imposed on freshwater fishes including habitat loss and degradation, invasive species, over-exploitation and water abstraction and flow alteration ([Dudgeon et al. 2006](#); [Arthington et al. 2016](#)). Small-bodied fishes – those obtaining a maximum total length (TL) of less than 150 mm – typically possess traits such as limited dispersal, short longevity and small ranges that make them inherently at risk, with the risk exacerbated when species decline to small, fragmented populations ([Kopf et al. 2017](#); [Liu et al. 2017](#); [Olden et al. 2007](#)). Additionally, small fishes are often overlooked or neglected in management as they are often of little economic value ([Closs et al. 2016](#); [Olden et al. 2007](#)). This is indeed true of small fish species in the Murray Darling Basin (MDB).

With river regulation and water abstraction across the MDB, altered flows and less water have diminished the extent and quality of habitat available to freshwater fishes, including wetland specialists. Specifically, in the SA MDB region, floodplain wetlands are now either permanently inundated or infrequently flooded. For example, in the SA MDB region, floodplain wetlands are now either permanently inundated or infrequently flooded, while Mount Lofty tributary streams experience less flow resulting in the disconnection and deterioration of habitats and in the Lower Lakes, less productive fringing habitat now occurs with stable water levels (VanLaarhoven and van der Wielen 2009). Each of the target four small-bodied freshwater species discussed in this paper – the nationally (under Australia’s Environment Protection and Biodiversity Conservation Act) Endangered Murray hardyhead *Craterocephalus fluviatilis*, nationally Endangered Yarra pygmy perch *Nannoperca obscura*, nationally Vulnerable Southern pygmy perch *Nannoperca australis* (MDB lineage), and the South Australian Critically Endangered Southern purple-spotted gudgeon *Mogurnda adspersa* (which is currently under EPBC Act assessment) – are short-lived (<5 years) and dispersal limited wetland ecological specialists. These species were historically more abundant and widespread (Hammer et al. 2009; MDBC 2004; Wedderburn et al. 2017), as extensive and diverse habitats would have prevailed under natural flow regimes across the SA MDB region (Mallen-Cooper and Zampatti 2018; Robinson et al. 2015). Other threats such as alien species and habitat modification have also impacted freshwater fishes across the region. Combined, these threats act to simplify the regional fish assemblage by favouring generalist and alien species, whilst ecological specialists such as the four target species have declined to threatened, small and fragmented populations (Table 1).

These historical declines were further compounded more recently by the prolonged and extreme millennium drought (2001–09). The SA MDB region – representing a hotspot for small fishes – was profoundly impacted by the drought, with the significant deterioration and loss of aquatic habitat. The four target species were significantly impacted, with the latter two species believed to have become regionally extinct. The foresight of certain researchers and managers to rescue fish from deteriorating habitats at this time, and ongoing work to build up fish numbers at surrogate dams and through school breeding programs over the past 15 years has allowed translocations aimed at returning fish to former wild habitats. Translocations have been warranted given the impact of the millennium drought on already threatened species and limited post-drought recovery. In reality, translocations, along with other conservation actions such as improved water management, will be necessary to reestablish resilient, connected populations to help secure the long-term survival of the four target species in the SA MDB region. Without these conservation efforts, the four species of fish may well have been lost from the region. This paper will highlight the journey, collaborations, and conservation of the Big Little Four, and outline what is required as we face a future that will present further risks to these species.

Table 1. Summary of the targeted threatened small-bodied freshwater fish species in the SA Murray-Darling Basin region. Conservation status is coded as Critically Endangered (CR); Endangered (EN); Vulnerable (VU); Rare (R); and Protected (P) at national (Environment Protection and Biodiversity Conservation Act 1999), state (Fisheries Management Act 2007) and SA Action Plan 2009 (Hammer et al. 2009).

Species	Conservation status				SA MDB significance
	International (IUCN)	National (EPBC Act)	State Fisheries	Action Plan 09	
Murray hardyhead	CR	EN	-	CR	Few fragmented populations remain across two genetically distinct populations (i.e. Lower Murray and mid-Murray)
Southern purple-spotted gudgeon	-	-	P	CR	Only known southern MDB population present in the Lower Murray
Southern pygmy perch	-	VU (MDB lineage)	P	EN	SA MDB fish are genetically distinct populations observed across Lake Alexandrina and separate catchments of the Eastern Mount Lofty Ranges
Yarra pygmy perch	EN	EN	P	CR	The genetically distinct MDB population is only known from Lake Alexandrina (and terminal wetlands of EMLR)

Fish rescues

Yarra pygmy perch is a small (~75mm) temperate species with a geographic range extending from Western Victoria, through South Eastern South Australia to the SA MDB region, where the only MDB population occurs. Throughout its range, the species occurs in patchy and fragmented habitats. It prefers lower flow habitats within drainage channels and wetlands, preferably with an abundance of submerged aquatic vegetation. The MDB population, restricted to fringing habitats of Lake Alexandrina, was only formally recognised within the MDB in 2001 and has subsequently been shown to be genetically distinct from others across the range of the species (Brauer *et al.* 2013; Hammer *et al.* 2010). This population is restricted to the fringing habitats of Lake Alexandrina, the lower reaches of the Mount Lofty Ranges tributary streams and waterways of Hindmarsh Island (Hammer 2004; Hammer *et al.* 2002; Wedderburn and Hammer 2003). Yarra pygmy perch were first detected at Hindmarsh Island in 2002, but have been known to inhabit areas of south-eastern Australia since their discovery in the late 19th century. During the period of critical water shortages associated with the Millennium Drought, there were dramatic declines in the availability and condition of their habitats and the species experienced declines in range and abundance (Hammer 2007a; Hammer 2008b; Wedderburn *et al.* 2012). In 2007, a total of 200 wild Yarra pygmy perch were rescued from drying habitats at three sites to enable captive maintenance, breeding and surrogate sites. The species was last detected in the wild in February 2008 (Holmes Creek at Estick Creek mouth: Hammer 2008b), after which time it was considered to have become regionally extinct.

Southern purple-spotted gudgeon is a benthic, and sedentary wetland specialist (maximum total length <150 mm; typically 60–120 mm), with a strong preference for dense cover of physical features (woody structure and rocks) and aquatic vegetation (Hammer *et al.* 2015; Lintermans 2007). It was historically patchily distributed across the MDB, and was once widespread and common in wetland and fringing river habitats in the lower sections of the SA MDB. The species declined profoundly due to intensive flow regulation and diversions resulting in habitat alteration and loss. In the SA MDB, the species was declared regionally extinct in the early 1990s; following the last verified record of them in 1973. However, in 2002, the species was recorded from a single wetland, near Murray Bridge, signaling its rediscovery after 30 years (Hammer *et al.* 2015). Just as the species was rediscovered, flows and water availability began to decline, driven by the Millennium Drought. As conditions deteriorated, fish were rescued into three captive breeding facilities, with the view of establishing surrogate populations to help safeguard the species (Hammer 2007b).

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By spring 2009, the wetland had completely dried, with presumed local, and regional extinction of the species (Hammer *et al.* 2015).

Murray hardyhead is a small (<80mm) and short-lived species that is endemic to the lowland floodplains of the Murray and Murrumbidgee rivers where it was historically common (Ellis *et al.* 2013; Lintermans 2007). The species has experienced rapid and ongoing decline, attributed to multiple, compounding threats (DELWP 2017; Ellis *et al.* 2013; Hammer *et al.* 2013). Many of these threats relate to the deterioration and loss of the shallow saline, and vegetated (namely submerged *Myriophyllum spp.* and *Ruppia spp.*) wetland habitats preferred by Murray hardyhead (Wedderburn *et al.* 2007). These habitats have been impacted by river regulation for decades, but more recently, habitat degradation increased during critical water shortages exacerbated by the Millennium Drought. In fact, populations at many sites became extinct during the drought, while others experienced dramatic declines in abundance (DELWP 2017). In 2007, during the Millennium Drought, emergency captive maintenance, breeding and surrogate populations were prioritised and undertaken with Murray hardyhead sourced from nine sites across four of the regional populations (Ellis *et al.* 2013; Hammer *et al.* 2013).

Southern pygmy perch are a small freshwater perch attaining a maximum size of ~100 mm. In the SA MDB region, Southern pygmy perch once occurred more broadly across Lower Murray floodplain wetlands, the fringing habitats of the Lower Lakes, and tributary streams of the eastern Mount Lofty Ranges (EMLR) (Hammer *et al.* 2009). The species has now contracted to four genetically distinct subpopulations across the study region (Cole *et al.* 2016; Hammer 2008a). During the Millennium Drought, wild fish were collected from Lake Alexandrina and the surrounding subpopulation (Turvey's Drain and Mundoo Island) and held in a private hatchery before being used as brood stock to initiate captive breeding and surrogate sites.

Fish breeding program

Since the Millennium Drought, conservation translocations have been a critical aspect of the management of the four target species (Hammer *et al.* 2013; Whiterod 2019; Zukowski *et al.* 2021). Initially, to establish captive maintenance and breeding, as well as surrogate populations, small numbers of each species were removed from known locations. This method is a form of *assisted colonisation* with individuals moved to isolated surrogate waterbodies to provide a safeguard for the species and a safe breeding space for fish.

Surrogate wetlands on private landholder properties at developments such as Beyond at Harborough, and at stormwater treatment council areas such as Oaklands Wetland, have been instrumental to the continued successful conservation of the four species. Surrogate wetlands provide back-up havens for populations, breeding surrogates, and reduce the extinction risk. Two-stage site suitability criteria is used to assess each potential surrogate site. Desktop investigations, stakeholder consultation and on ground assessments are undertaken to determine factors such as site management, hydrology, location, isolation, habitat suitability, water quality (water temperature, pH, dissolved oxygen concentration, electrical conductivity and water transparency), presence of existing fish including alien fish, and food resources (macroinvertebrate diversity and abundance). These factors are assessed against the differential requirements of each target fish species.

For surrogate sites, the location can be outside the natural range of the species, but it must be deemed isolated from the catchment. Importantly, prevailing fish species are evaluated through targeted fish sampling, using appropriate sampling gear (e.g. fyke and seine netting) with a specific focus on the presence of large-bodied predators (such as Redfin Perch *Perca fluviatilis*) and small-bodied competitors (e.g. Eastern Gambusia *Gambusia holbrooki*) that would act to lessen the likelihood of establishment of the target species.

In combination, these criteria are evaluated against the species-specific tolerances and habitat preferences to provide the final assessment of overall site suitability. At this stage, a site can be recommended or rejected as a translocation site, but also identified as requiring potential management actions (e.g. habitat improvement, alien fish management) to improve site suitability.

In addition to surrogate sites, ten South Australian schools are involved in the Southern Purple-spotted Gudgeon breeding program. This species breeds well in aquaria at temperatures above 22 degrees and are an

excellent fish for schools to use in their curriculum to help educate students about conservation and to assist the recovery of this species (Zukowski 2023). Indeed, each year a collaborative and highly successful wild release event is held each year where schools release the fish they have bred during that year.

Wild releases

Following the Millennium Drought, as conditions improved following the return of flows and water availability over 2010–11, reintroductions and subsequent reinforcement of the four fish species from the surrogate populations commenced. During the Critical Fish Habitat (CFH) project (2011-2014), 15,840 fish from the four target species were released at ten locations (Bice *et al.* 2012; Bice *et al.* 2013; Bice *et al.* 2014). Over 2014–2019, conservation actions focused on maintaining and securing captive breeding facilities and surrogate refuges, and a further 22,293 fish were released (Table 2).

Ongoing monitoring has shown that Southern pygmy perch and Murray hardyhead are now persisting, albeit in low numbers, in wild release sites. Yarra pygmy perch and Southern purple-spotted gudgeon have been absent at wild sites, despite ongoing translocations. Recent translocation efforts (2020–2024) have included the use of soft release structures (Figure 1) which are submerged in the river to allow the fish to acclimatize to new conditions for 2 weeks before being opened and the fish fully released into the wild river site.

Most recently, during December 2023 and January 2024, approximately 9,000 Yarra pygmy perch were released into the Murray River at three sites near Hindmarsh Island (Figure 2) and approximately 2000 Murray Hardyhead were released into Lake Albert in an attempt to re-establish the species back into the wild. During post reintroduction targeted monitoring in early February, late February and March 2024, 16, 14 and 8 Yarra pygmy perch were sampled, respectively, at wild reintroduction sites. In November 2023, 500 southern purple-spotted gudgeon were released into the River Torrens, upstream from the newly re-invigorated Breakout Creek section (Figure 3). It was a momentous occasion as these threatened fish hadn’t been seen in the wild in the Adelaide Plains region for over 100 years. Ongoing monitoring will determine the long-term survival and detection of this species at the wild sites. Further wild reintroductions are planned for December and January 2024/2025 for the four species.

Table 2. Summary of total number of fish released and number of locations over two post-drought periods for the four target small-bodied freshwater fishes in the SA MDB region.

Species	Time period		Number of release locations
	2011–2014	2014–2019	
Murray Hardyhead	7520	16,350	7
Southern Pygmy Perch	1350	0	3
Southern Purple-spotted Gudgeon	1120	5043	2
Yarra Pygmy Perch	5850	900	6
TOTAL NUMBER	15,840	22,2938	18 locations



Figure 1. Soft wild release sites at Hindmarsh Island. (Picture credit Connor Gervais).



Figure 2. Yarra Pygmy Perch released at wild sites



Figure 3. Southern purple-spotted Gudgeon released at wild sites

Conclusions

The active conservation of threatened fish species is now critical to secure their long-term survival. Here, we report on a 15-year long tri state collaborative conservation project which has thus far successfully prevented the local extinction of four small bodied threatened fish species. Along with surrogates, breeding programs and wild reintroductions, habitat rehabilitation, environmental flows, climate change mitigation and alien fish management all need continued research and prioritization.

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11ASM Full Paper

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