Section 2 Species Recovery Outlines

A conservation status reflects a level of extinction risk for a species. In this document, extinction risk relates to the continued survival of the species in South Australia. Status is thus assigned independently of social, management and political implications (status can however, influence these and other factors depending on how such a list is used). The current list of threatened freshwater fishes was instigated by a need to raise awareness of the overall plight of freshwater native fish in South Australia and to enable comparisons across vertebrate groups of the State. The list also provides the basis for developing Recovery Outlines for threatened species which document:

- Conservation status – includes South Australia Action Plan status (criteria are in brackets and match Appendix 4), Protected species (*Fisheries Management Act 2007*), and other national and interstate listings.
- Taxonomy and identification – includes a description of the species and key characters (see Figure 5) for distinguishing between similar species (as a guide only).
- Former distribution – description of historic records (i.e. prior to 1990). Note that the historic and current distribution of many species has not been specifically assessed.
- Current distribution – records after 1990 summarising documented declines and also listing any habitats where the species may be expected to occur.
- Brief overview of species biology and habitat to outline the level of available information for aspects useful for management.
- An assessment of potential reasons for species decline and threats.
- Land tenure and conservation.
- Recovery objectives.
- Details of conservation actions already initiated.
- Required conservation actions to help meet recovery objectives.
- A list of organisations responsible for conservation of the species.
- A list of those already having some involvement with the conservation/management of the species or its habitat.

The information, recovery objectives and required conservation actions contained in Recovery Outlines should be fed into management, community activity, resource allocation and other plans. It is best to define a species as 'Threatened' and refer to recovery objectives and actions rather than prioritising purely on species status. It is also dangerous to rely solely on threatened species lists to limit the use of the natural environment (e.g. development applications). The greater value assigned to an area based on the presence of threatened species is meaningful, but should not be the only consideration as impacts to local ecosystems and genetic diversity for example may be overlooked.

Reactive conservation efforts are often complex, difficult and expensive. Preventative measure for protecting species and ecosystems before they reach a higher category of threat will often be more effective, more cost effective, and have long lived benefits. Hence while the conservation list provided here is an indication of some immediate priorities, a broader purpose of this Action Plan is to provide a holistic idea of what can be done to better protect all species of fish and their habitat in South Australia (i.e. today's common species could be tomorrow's threatened species if preventative measures are not taken).

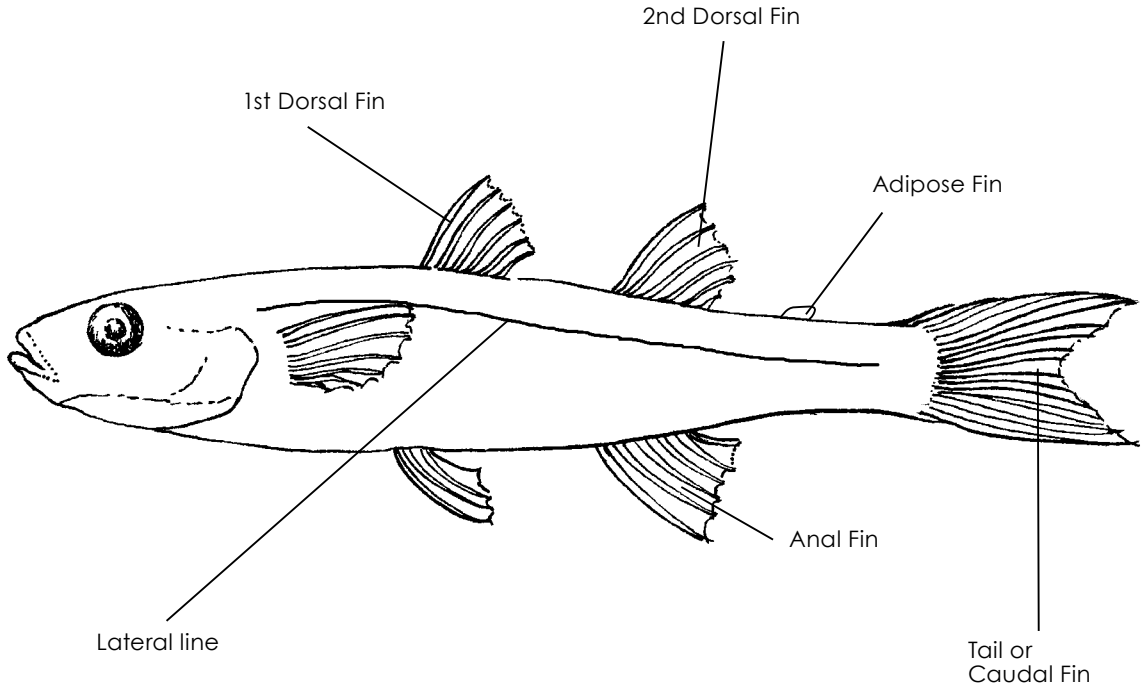


Figure 5. A generic fish with some key features used for identification.

2.1. **EXTINCT IN SA**

> no reasonable doubt that the last individual has died, following exhaustive surveys


Tarmo Raadik

Flathead Galaxias *(Galaxias rostratus)*

Other common names: Murray Galaxias or Murray Jollytail

Conservation status *South Australia:* Extinct in SA (EX)
National & interstate: listed as Threatened in Victoria (Vulnerable) and recommended Vulnerable in NSW74 (also Vulnerable on IUCN Red List[6]).

Taxonomy and identification The Flathead Galaxias is a long slender fish, reaching a length of around 10cm. It is most similar to Common Galaxias, but has large eyes, a flatter head, longer snout and a mouth reaching well below the eyes (compared to the front of the eye), and is similar to some forms of Mountain Galaxias, but is more slender (v. stocky and rounded body) and the origin of both dorsal and anal fins align.

Former distribution The Flathead Galaxias is endemic to the southern MDB, and known in SA from a few early records on the lower River Murray – Frederick von Müeller (a prominent botanist) collected specimens from near Murray Bridge in 1868 and 1869 and sent them to a museum in Germany. It probably occurred more widely in floodplain, swamp and billabong habitat along the SA River Murray, but the species and its preferred habitat were not targeted in historic surveys.

Current distribution There have been no further records since the 1800s. Recent surveys in potential habitat have not recorded the species, and in general, suitable floodplain and billabong habitat has severely diminished with an altered River Murray flow regime. Most recent records elsewhere in the species range are from the Ovens and Goulbourn river systems (~600km upstream from the SA border).

Biology and habitat The distribution, biology and habitat of this species is poorly understood (no information for SA). However it generally occurs in floodplain areas (lakes, lagoons, billabongs) amongst structure such as submerged logs (snags) and leaf litter, with an unknown lifespan or diet (probably lives for 2-3 years as an opportunistic feeder), and spawns in late winter to spring[75,76,77].

Reasons for decline and threats Presumed Extinct in SA, likely a reflection of a limited historic distribution and abundance coupled with a drastically altered River Murray environment, especially the reduction in overbank flows and flow variability important in establishing and maintaining a mosaic of different floodplain habitats. Predation by Redfin and interaction with Gambusia may be a threat in isolated and concentrated floodplain habitat.

Land tenure and conservation

- Previously River Murray corridor.

Recovery objectives

- Continue to monitor for presence in SA.
- Restore floodplain water regime to aid recolonisation (flow volume and patterns).

Conservation actions already initiated

- SAMDB NRM Board has instigated baseline surveys of a number of wetlands and encourages community monitoring[69,70,78,79].
- The Living Murray Initiative aims to restore flow regimes to key ecological assets including the Chowilla region which may provide improved conditions (e.g. flooding) for Flathead Galaxias.

Required conservation actions

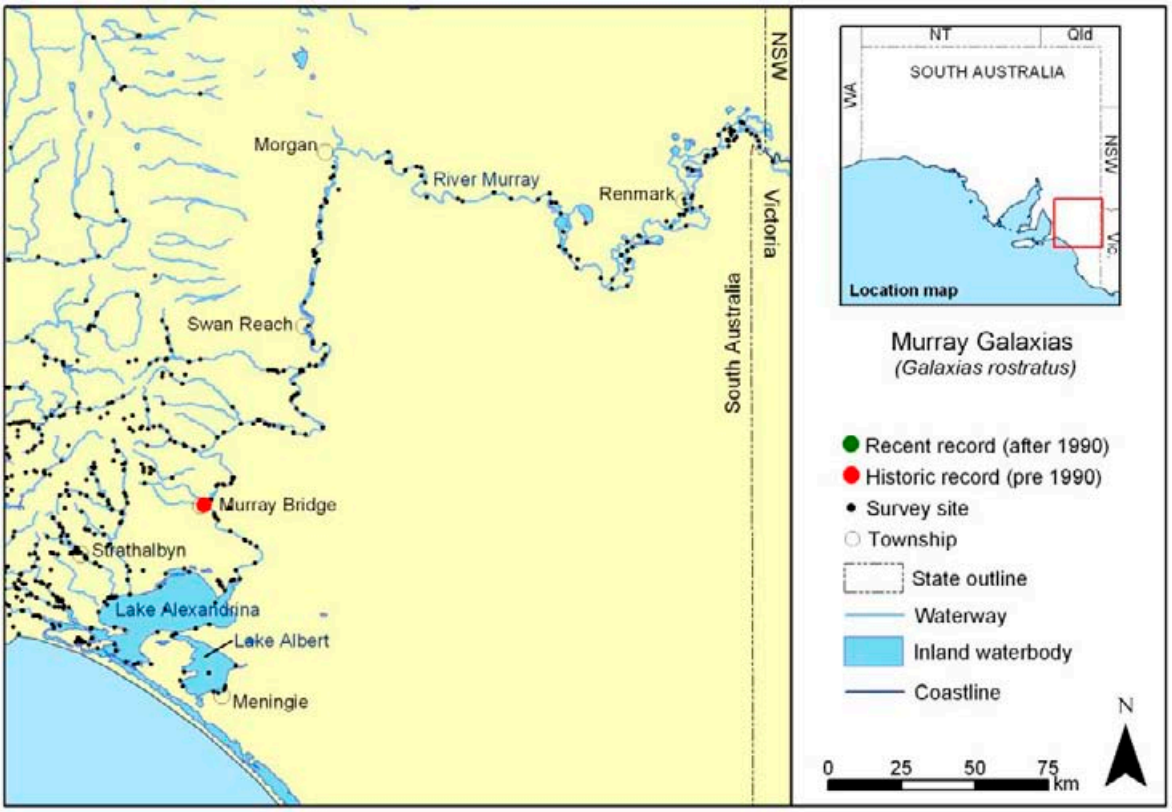
- Targeted surveys in floodplain habitat.
- Appropriate verification of suspected records.
- Longer-term monitoring as part of environmental flow programs.

Organisations responsible for conservation of species

DEH, PIRSA, SAMDB NRM Board, MDBA.

Organisations or individuals involved

Not currently applicable.



Top. Murray Cod
Bottom. Trout Cod

Trout Cod *(Maccullochella macquariensis)*

Other common names: Rock Cod (SA name) and Bluenose Cod

Conservation status *South Australia:* Extinct in SA (EX); Protected (*Fisheries Management Act 2007*). *National:* Endangered (*EPBC Act*). *Interstate:* Threatened in Victoria (Critically Endangered) and Endangered in NSW and ACT.

Taxonomy and identification A medium to large growing species up to ~80cm, but more commonly 30-50cm. Often and historically confused with Murray Cod, a formal separation occurred in 1972, although numerous sources identified the presence of two distinct 'cod' species before this time[80,81]. Distinguishable from the Murray Cod by its undercut lower jaw, speckled rather than marbled body markings (markings absent from gill cover) and a black stripe through the eye which is not clearly visible in adult Murray Cod.

Former distribution The historic distribution and abundance in the SA section of the River Murray is difficult to determine due to taxonomic confusion, limited reporting and no specific investigations on the species. As 'cod' are a prized table fish very few (five) specimens were lodged at the SA Museum, but one of these is a juvenile Trout Cod - collected at Purnong in January 1932. This record follows a reasonably large flood in 1931 and hence may have been displaced from interstate populations. However, local anecdotal information suggests that the species was once a rare inhabitant of the region (e.g. newspaper article from 1892[82]). Unpublished SA Museum notes by T.D. Scott states "evidence taken from fisherman, May-June 1935, ...all still insist that there are 2 species of cod. They call the 'Tout Cod' the Rock Cod from No. 6 Lock down." A later publication suggests Trout Cod was formerly more widespread, but rarely taken in SA by the 1970s[44], and there has since only been one unverified record from Chowilla in the 1980s[83]. An historic presence in SA could also be implied from the documented occurrence in adjoining river sections in Victoria prior to the 1930s[81,84].

Current distribution Presumed Extinct in SA. There is one remaining self-sustaining natural population on the Murray River between Yarrawonga and Tocumwal (>500km upstream of the SA border), and there are other translocated populations (few self-sustaining) in Ovens, Goulbourn and Murrumbidgee catchments (Vic/NSW/ACT)[11,85].

Biology and habitat Unknown in SA. Its remaining range interstate has a strong bias towards cooler, mid-upland river habitats, with an association for deeper flowing areas with instream structure such as hollow logs and boulders, but it clearly occurred under varied conditions prior to major MDB wide declines. Trout Cod is a long-lived predatory species preying on fish, yabbies, freshwater shrimp and larger macroinvertebrates. Spawning occurs in spring within hollows or caves, with larvae free swimming. Movement studies suggest fish tend to remain at the one site and have small home ranges, although exploratory movements of 20-60km have been recorded[11,86,87,88,89].

Reasons for decline and threats The Trout Cod has for several decades been considered an endangered species because of its highly restricted distribution, habitat degradation (e.g. de-snagging, flow regulation), small populations, and threat from angling[11,90]. The primary threats or reasons for decline in SA are likely to be altered flow regimes and habitat from a 2/3 flow reduction of the River Murray, regulated local conditions (i.e. transformation from flowing river to a series of weir pools in the SAMDB), and snag removal.

Land tenure and conservation
Formerly River Murray corridor.

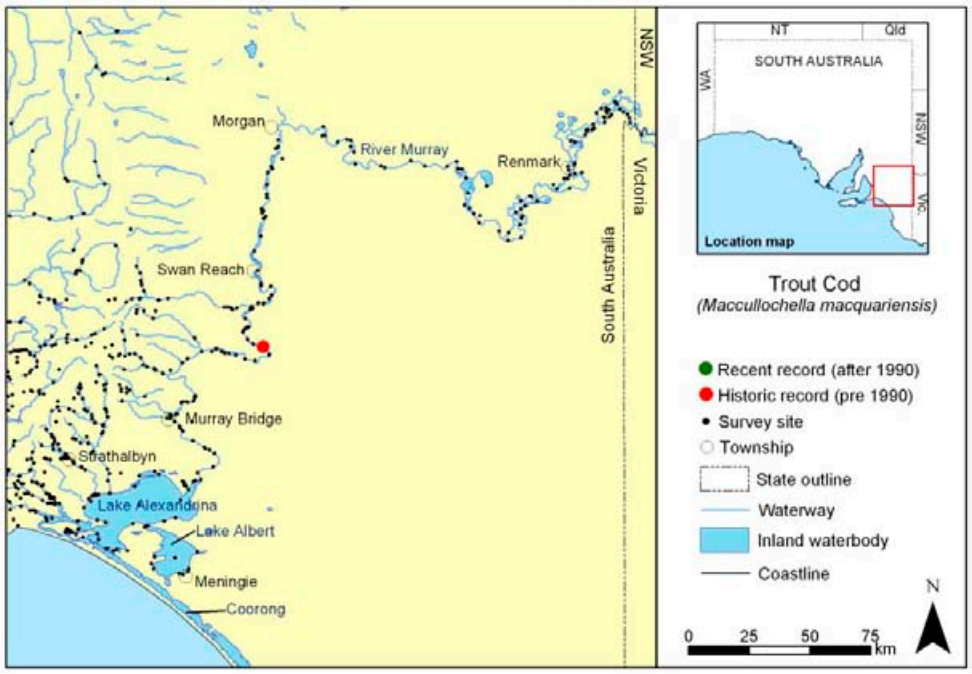
Recovery objectives No immediate recovery objectives can be made as Trout Cod is likely extinct in SA. However some flowing anabranch sections (e.g. around Chowilla) may be suitable habitat, and a better understanding of historic distribution and habitat in SA would be useful for efforts of national recovery (e.g. an objective of the National Trout Cod Recovery Plan is 'To increase the species' distribution by re-establishing populations of suitable size and density within available habitat areas within its former range in the Murray and Murrumbidgee systems').

Conservation actions already initiated
- Protected from fishing pressure (*Fisheries Management Act 2007*).
- A National Recovery Plan has been prepared and considerable research into habitat, ecology and restocking has and is occurring interstate[11,91].
- SARDI Aquatic Sciences have been monitoring Murray Cod in the lower River Murray over recent years, but have not yet found Trout Cod.

Required conservation actions
- Undertake an oral history program within the community and especially commercial fishers or fishing families to collate any available historic information on distribution, frequency of encounters and habitat conditions.
- The lack of information regarding the Trout Cod means that the general public can help by reporting any past or present sightings (www.nativefishsa.asn.au).
- Determine if populations remain in SA through targeted surveys.
- Ensure routine verification of cod species (especially juveniles) occurs in research.
- The current highly altered environment of the River Murray in SA is unlikely to be suitable for the re-establishment of Trout Cod, but research could be focused to identify any areas for habitat restoration to restore the species extent of occurrence and link to the National Recovery Plan (collaborative research).

Organisations responsible for conservation of species
DEH, PIRSA Fisheries, DEWHA, SAMDB NRM Board.

Organisations or individuals involved
SARDI Aquatic Sciences, SAMDB NRM Board, MDBA.



Macquarie Perch *(Macquaria australasica)*

Other common names: Murray Perch, Silver Eye, Black Bream

Conservation status *South Australia:* Extinct in SA (EX).
National: Endangered (*EPBC Act 1999*). I*nterstate:* listed as Threatened in Victoria (Endangered) and Endangered in New South Wales and the ACT.

Taxonomy and identification A medium sized species reaching 50cm but commonly smaller. Variable in colour from green/grey to nearly golden, having a blunt snout and large eyes. They can be distinguished from Murray-Darling Golden Perch by a small mouth with equal lower and upper jaws (lower jaw protrudes in Golden Perch, more so in adults) and by having much fewer scales in a line transverse between the first dorsal and anal fins (max 33 v. min 40). Juveniles could be confused with pygmy perches, but they have protruding and more visible spines on the dorsal fin. Macquarie Perch may be a species complex with two distinct forms east and west of the Great Dividing Range, including a single species in the MDB, with some indication of spatial genetic structure[88].

Former distribution There are two SA Museum specimens (both large, adult fish) listed from an unspecified location of the "River Murray, South Australia" from 1917 and 1918. Note that no systematic surveys were conducted for the species, and it was a table fish, so lodging of specimens may not have been a priority. The two SA specimens appear to have been noted at markets in Adelaide from the River Fishery so they likely came from the Morgan or Renmark areas. The collection dates coincide with three high flow years between 1916-1918, including a large flood in 1917. Hence the fish may have been washed or moved downstream. The species was known to inhabit the main stem of the Murray upstream of the SA border between Swan Hill and Yarrawonga (prior to the 1950s) and 56 fish were captured migrating upstream through a fish ladder at Euston (only 150km upstream but above the Darling River junction) between 1938-1942[84,92]. This supports downstream dispersal or even an extension of a main stream population into SA, but it is unknown whether any local reproduction also occurred.

Current distribution No further SA records since 1918 (presumed extinct), and the species has contracted significantly in the MDB to now only occur in forested upland areas of Murray, Murrumbidgee and Lachlan river tributaries in Victoria, ACT and New South Wales.

Biology and habitat Unknown in SA. Remaining habitat of Macquarie Perch interstate is characterised by flowing stream habitat with clear water and low silt loads, however, the species occurred historically over a broader range of habitats including lowland rivers (these had very different flow regimes and habitat conditions than now). This fish is a schooling species which feeds on insects, crustaceans and molluscs and which is moderately long lived (10 or more years). Documented to make spawning movements and was a component of fish caught moving through fish ladder on the mid Murray River at Euston in 1938-1942[88,92].

Reasons for decline and threats Broader change in the MDB has impacted the likelihood of this species moving to SA where habitat conditions themselves are no longer suitable (e.g. reduced flows, lack of free-to-flow river sections, high turbidity and high temperatures). Some general reasons for the broader decline are presumed to include flow reduction (loss), seasonal flow reversal, cold water pollution, increased siltation, habitat loss, interaction with introduced Redfin and trout, susceptibility to disease such as the Epizootic Haematopoietic Necrosis Virus (EHNV), and overfishing[12,92,93].

Land tenure and conservation

- Formerly River Murray corridor.

Recovery objectives Broader declines and unsuitable habitats mean there is an extremely low chance that Macquarie Perch could occur or be restocked into SA. Hence evaluating the potential recovery options for the species should be done once ecosystem recovery has been noted.

Conservation actions already initiated

- Not relevant as the species is presumed long extinct in SA.

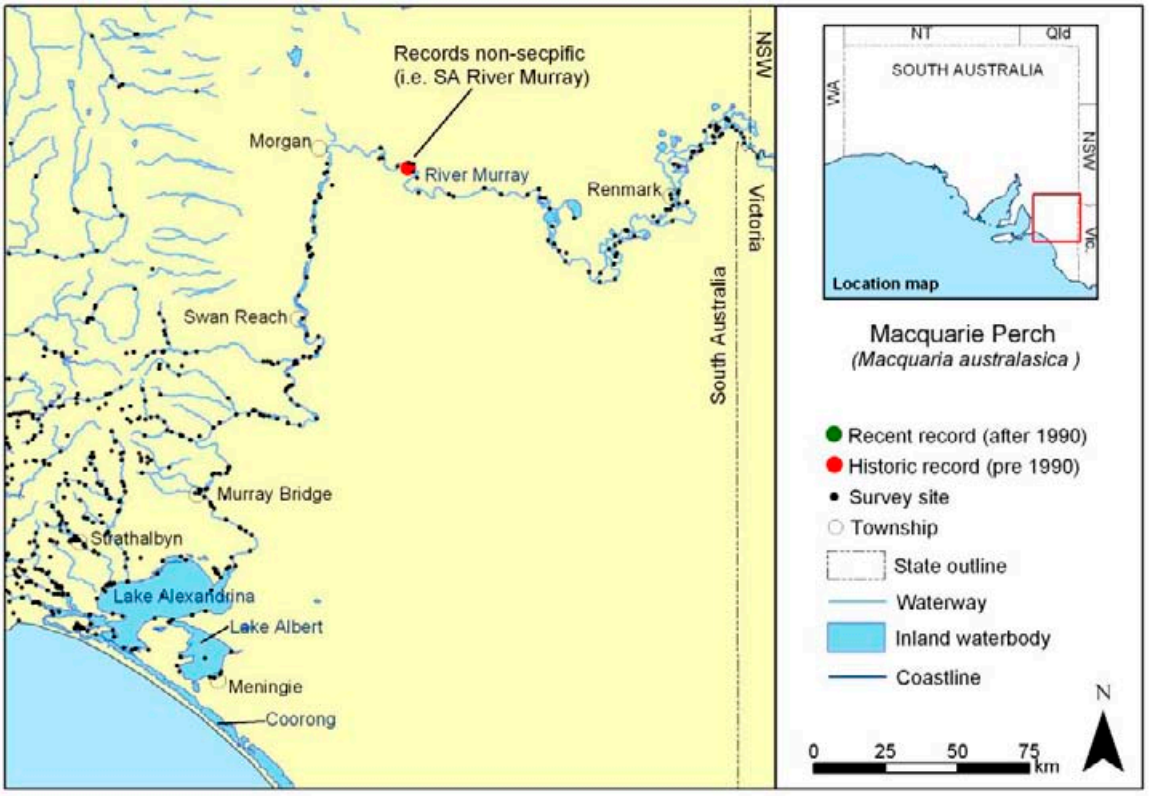
Required conservation actions Broader ecosystems restoration is required to once again provide suitable habitat (e.g. significant return of flow regime). An oral/local history program may help to assess if the species occurred at other times or more permanently in SA, especially prior to construction of the Locks and Weirs.

Organisations responsible for conservation of species

For historic range – DEH, SAMDB NRM Board, DEWHA.

Organisations or individuals involved

There are numerous stakeholders such as Fisheries agencies involved in research and recovery efforts interstate.



2.2. **CRITICALLY ENDANGERED**

> considered to be facing an extremely high risk of extinction in the wild

Australian Mudfish *(Neochanna cleaveri)*

Other common names: Tasmanian Mudfish, Mud Galaxias

Conservation status *South Australia:* Critically Endangered (CR B1ab(iii)).
National: not listed. *Interstate:* listed as Threatened in Victoria (Critically Endangered).

Taxonomy and identification A small slender fish reaching 8cm in length. Generally similar to some other galaxias (such as Mountain Galaxias), but has smaller eyes, an anal fin origin set well behind the origin of the dorsal fin and a distinctly rounded tail (caudal) fin. Isolated fish in SA may be a genetically distinct species to interstate populations. The juvenile 'whitebait' stage can be distinguished by the offset fin orientation, speckled head, generally smaller size and a black band on the tail.

Former distribution Unknown; previously known from a single SA Museum specimen from the Bool Lagoon outlet regulator in 1974. Historically, prior to drainage, extensive areas of landlocked wetland occurred in the region surrounding Bool Lagoon and SE SA in general, hence the species may have been more widespread. The construction of Drain M (completed in the early 1970s) created a dispersal route from the coast, and the record may have been based on migration to the area by juvenile fish. However no other diadromous species have been recorded at Bool Lagoon which is 80km inland, and the nearest known Australian Mudfish population is found 350km further around the coast at Cape Otway in Victoria.

Current distribution Intensive sampling from 2000-2006 failed to locate the species[23,55], however a few individuals have recently been discovered near the end of the Drain M (connected to Bool Lagoon)[94]. Habitat is thus likely to include Bool Lagoon to Lake George and smaller connected drains and wetlands (CR B1a).

Biology and habitat The Australian Mudfish can have dual lifecycles – either as (a) a migratory species (most commonly reported) whereby larvae are swept to sea soon after hatching in autumn and winter and return to freshwater as transparent juveniles with other galaxias in spring (collectively known as whitebait) or (b) complete their lifecycle landlocked in freshwater swamps (some Tasmanian populations and related species in New Zealand). Adults are found in small creeks, freshwater wetlands, drains and swamps where they are benthic (living in or close to bottom mud and vegetation), have cryptic and nocturnal habits, and probably feed on small aquatic invertebrates. Lifespan is probably 2-3 years and individuals can sometimes survive periods (dry seasons) without surface water by burrowing into the mud[76,94,95,96,97,98,99].

Reasons for decline and threats The rarity of Australian Mudfish in SA may be a result of its specific habitat requirements, which make it susceptible to habitat changes – extensive loss of wetland and swamp habitat has occurred in SE SA following drainage and agricultural pursuits. Hydrological change is especially evident, in that previous habitat at Bool Lagoon has been dry for most of the last 10 years (e.g. outlet regulates water levels, possible changes in groundwater hydrology, and drains remove general water from the local landscape)(CR B1b(iii)).

Land tenure and conservation Bool Lagoon is a Game Reserve and interlinked with the Hack Lagoon Conservation Park (combined representing a Ramsar site). Drain M is managed by the SEWCDB. There are a few swamps and wetlands surrounding Bool Lagoon and Drain M on private land and Forestry SA land.

Recovery objectives

- Urgently map the range and habitat of Australian Mudfish in South Australia.
- Determine local biology and potential threats.
- Protect and restore potential habitat in the area of known distribution.
- Determine taxonomic position of SA populations relevant to those in Victoria and Tasmania.

Conservation actions already initiated

- Broad baseline survey of aquatic habitats[23], rediscovered during threatened species monitoring[94].
- A project has been initiated which aims to integrate surface water management in the Mosquito Creek Catchment/Bool Lagoon (SE NRM Board, DEH and other project partners).
- Public awareness about Australian Mudfish has been generated through community presentations and media.

Required conservation actions

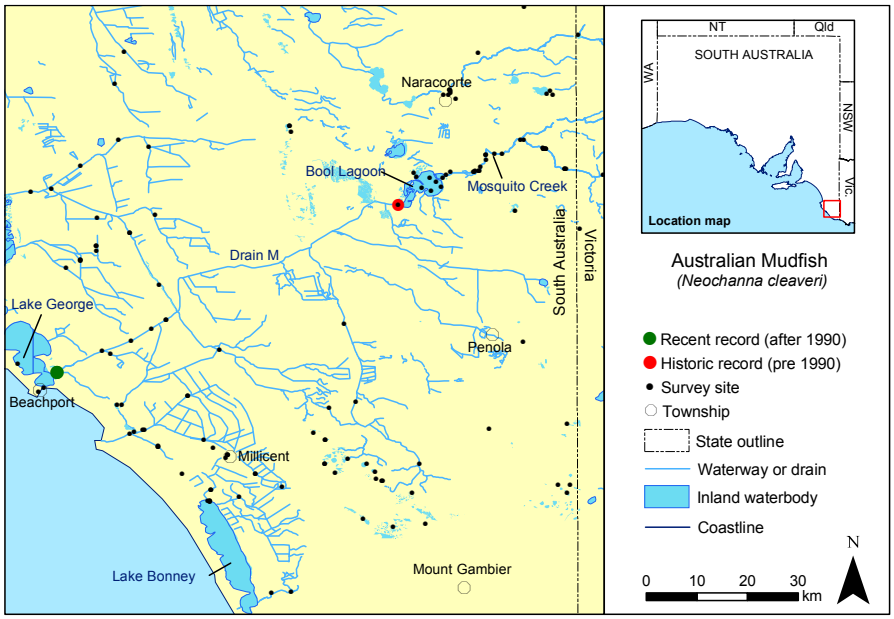
- Targeted and seasonally repeated surveys to determine status in SA, including regular monitoring at Bool Lagoon when surface water is present.
- Targeted habitat restoration in small drain habitat near Lake George.
- Morphological and genetic studies to assess the taxonomic position of SA populations.

Organisations responsible for conservation of species

DEH, SE NRM Board, DWLBC.

Organisations or individuals involved

Native Fish Australia (SA), DEH, community stakeholders, Waterwatch.



Murray Hardyhead *(Craterocephalus fluviatilis)*

Conservation status *South Australia:* Endangered (CR A2c,B1ab(ii,iii,iv)).
National: Vulnerable (*EPBC Act 1999*). *Interstate:* listed as Threatened in Victoria (Critically Endangered) and Critically Endangered in New South Wales.

Taxonomy and identification The Murray Hardyhead is a small silvery fish commonly reaching 3-5cm. There has been a long history of confusion between different hardyheads in southern Australia due to taxonomic uncertainty (now resolved) and the general similar appearance of different species. The Murray Hardyhead is most similar to the Lake Eyre Hardyhead which is endemic to SA from the LEB and Lake Torrens Catchment but is distinguished by non-overlapping geographic range, molecular markers and the characteristics of scales such as shape[100]. Within the SA Murray-Darling Basin it can be distinguished from (a) Smallmouthed Hardyhead on greater body depth and length of gill rakers (<than half diameter of pupil) and (b) from Unspecked Hardyhead based on greater body depth (most easily assessed through the number of transverse scales = 10 or 11 v. 7-8), patterns of scales (irregular v. uniform) and general body colouration (e.g. black lips often apparent in Unspecked Hardyhead).

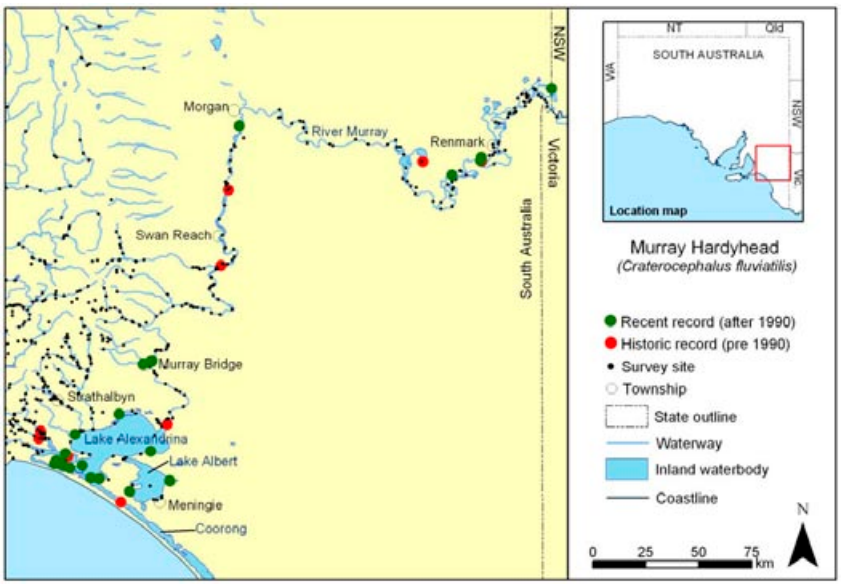
Former distribution Historic distribution is not well documented, but the species appears to have occupied lowland wetland habitats throughout the SA Murray-Darling Basin. It has had a long-term presence in the Lower Lakes (Lakes Alexandrina and Albert), with records dating back to the late 1800s[101], and occurred patchily in the Lower Lakes and River Murray corridor during the 1960-70s[101] and 1980s[35].

Current distribution A reasonable level of suitable sampling has occurred in the SA Murray-Darling Basin in the last five years. Data suggests the species is severely fragmented (CR B1a) with three larger isolated populations: (a&b) Disher Creek and Berri Salt Evaporation Basins near Berri and Renmark, and (c) the Lower Lakes, with the most records and highest abundances in channel habitat on the eastern end of Hindmarsh Island, and scattered records from sheltered edges of Lake Alexandrina and Lake Albert. Other infrequent records of small populations have been detected at a handful of locations along the River Murray corridor including: Lake Littra Inlet (near the SA-NSW border), Scott Creek (a backwater near Morgan), and Riverglades and Rocky Gully wetlands at Murray Bridge. While historic records are few, Murray Hardyhead no longer appear to occur at many places where they were recorded in the 1960-80s. For example, they have apparently disappeared from wetlands in the upper Finniss River arm of Lake Alexandrina, as well as other habitats along the River Murray between Mannum and Berri (e.g. Marne River Mouth, Kroehns Landing, Swan Reach and Lake Bonney). While there are occasional records from the Coorong (a single individual from Long Point, 1984, and irregular captures on the salt water side of the Barrages around Hindmarsh Island), this habitat under current marine conditions, where Smallmouthed Hardyhead is abundant, appears unsuitable[24,58,59,63,70,101]. Further to this broad decline, acute contraction in abundance and area of occupancy has been witnessed in the last two years including loss from the main part of Disher Creek, Riverglades, and much of previous habitat in the Lower Lakes (CR A2c,B1b(ii,iii,iv)[102].

Biology and habitat In SA the Murray Hardyhead is found primarily in wetland and sheltered lake edge habitat, often in areas with high densities of submerged aquatic plants including Milfoil *(Myriophyllum* spp.*)*, Foxtail *(Ceratophyllum)* and Eel Grass *(Ruppia* spp.*)*. Conditions where the species has been detected are often slightly to highly saline (i.e. 1,500-50,000µS or 1,000-35,000ppm), suggesting a physiological and/or competitive advantage in these habitats[24,35,59,63,70,103]. The Murray Hardyhead is a mobile schooling species which is thought to be omnivorous with a diet consisting mainly of zooplankton, insect larvae, detritus and algae[39]. It spawns in spring and summer, with larval abundance peaking in Victorian lake populations during early November[104]. Studies in Victoria suggest the species is primarily an annual species (i.e. most fish reach maturity, spawn and die within a year)[104], with preliminary demographic data from Hindmarsh Island supporting this pattern[58]. Hence any failure in recruitment could be catastrophic for a population. There is some evidence for small-scale movements as fish have been observed to colonise freshly inundated habitat on Hindmarsh Island[50].

Reasons for decline and threats The recent loss of known localities infers a decline in the extent and quality of habitat which is projected to continue with existing and potential threats including:

- Salinity – populations isolated in salt evaporation basins are potentially susceptible to high and rapidly fluctuating salinities (e.g. rapid loss of a population from Elizabeth Lake in Victoria[105]).
- Changes in management - the SA evaporation basins are currently experiencing changing hydrology due to improved irrigation efficiency meaning less runoff (loss of water) from surrounding irrigation, which has meant that salinities have gradually increased in these core populations over the last five years (see Figure 6). At other locations structures have been installed to improve freshwater flow and may be problematic for Murray Hardyhead by reducing salinity or altering local conditions (Riverglades, Scott Creek, Waltowa Swamp). Localities in the Lower Lakes are susceptible to changes in management of water levels and low river inflow.
- Low water levels – reduced River Murray flow and irrigation may cause levels in the Lower Lakes to reach critical lows during summer with drying of sheltered edge habitat and greater exposure to predators.
- Alien species – interaction with predatory Redfin needs to be assessed as they may limit populations and be a biological barrier to movement. Aggressive interactions from Gambusia in shallow habitat may also be a threat under some conditions.
- Broader threats may include: river regulation providing constantly fresh conditions, little temporal variability in flows and reduced floodplain inundation/connectivity, reducing habitat suitability and opportunities for colonisation/movement. The currently fragmented nature of populations means there is a high chance of population losses and longer-term problems with gene flow.



Top. Unspecked Hardyhead
Middle. Smallmouthed Hardyhead
Bottom. Murray Hardyhead
Photo. Ben Smith

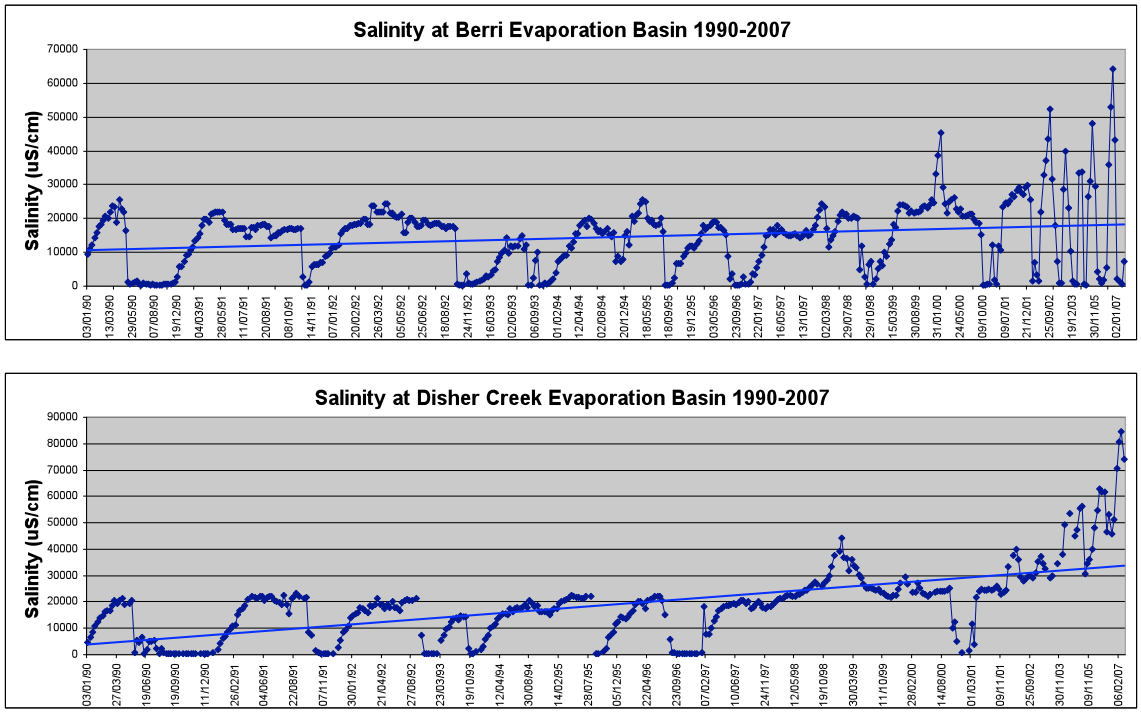


Figure 6. Recent salinity records at two core SA Murray Hardyhead habitats (DWLBC).

Land tenure and conservation Murray Hardyhead occurs within the State Reserve system at Wyndgate on Hindmarsh Island (the Lower Lakes in general are also part of a Ramsar site), Chowilla Game Reserve (Lake Littra) and in a section of the Murray River National Park (Disher Creek). Disher Creek and Berri Evaporation basins are salinity management areas. Remaining localities are connected to public waterways with access through private and public land (e.g. Council Reserves at Clayton and Murray Bridge) where landuse is mostly recreational and with some areas of stock grazing (e.g. Hindmarsh Island).

Recovery objectives

- Secure core populations by appropriate local habitat management and research (may require urgent conservation measures).
- Develop a sound understanding of distribution and biology including identifying the extent and connectivity between different management units, and the effects of potential threats.
- Establish and monitor relationships to environmental conditions, especially with any changes in management and/or conditions.
- Ensure that all key stakeholders are aware of populations and potential threats.

Conservation actions already initiated

- Genetic and morphological studies have resolved taxonomic issues and field researchers are now taking more care with identification.
- A National Recovery Plan is in the final stages of development.
- Habitat on Hindmarsh Island was recently added to the State Reserve system.
- An ecological investigation examining distribution and physiology has been initiated[62,63].
- Population monitoring for threatened fishes is being undertaken on Hindmarsh Island[58].
- SAMDB NRM Board has instigated baseline surveys of a number of wetlands and encourages community monitoring[69,70,78,79].

- 'Habitat restoration' programs are being undertaken at known Murray Hardyhead sites, but the effects of these to this particular species may or may not be beneficial.
- Living Murray Initiative - the Lower Lakes is a key target for environmental flows restoration.
- Colour data sheet with ID tips for Murray fishes are available from NFA(SA)[106].

Required actions

- Continued surveys to determine locations of extant populations, targeting saline habitats.
- Monitor distribution and recruitment at core populations linked with environmental conditions.
- Conduct studies to better understand biology, fine scale habitat requirements, potential threats (especially predators in the Lower Lakes) and dispersal capacity/requirements.
- Urgent conservation measures: access environmental water to maintain salinity at moderate levels and prevent drying, investigate and implement where necessary captive breeding as a backup to catastrophe from severe environmental conditions (e.g. habitat drying at core populations), and carefully monitoring of population trends.
- Ensure that ecological restoration programs include: (a) prior assessment for presence, (b) careful planning encompassing an assessment of potential threats from any proposed changes to habitat and flow conditions, (c) provision for appropriate design suited to the species (may mean no change to current conditions) and (d) monitoring of the population to ensure management can be changed adaptively if declines are noted.
- Investigate new and ongoing management options for the SA salt evaporation basins in the face of change.
- Undertake genetic studies to evaluate diversity and historic gene flow between currently fragmented populations.
- Establish programs to improve awareness of Murray Hardyhead identification, habitat requirements and conservation amongst researchers, managers, planners and the community (e.g. provide identification keys, education material and a system where trained professionals verifying survey records).

Organisations responsible for conservation of species

DEH, DWLBC, DEWHA, local councils (Alexandrina, Murray Bridge), SAMDB NRM Board.

Organisations or individuals involved

SARDI Aquatic Sciences, NFA(SA), University of Adelaide, SAMDB NRM Board, DWLBC, MDBA, DEH, various Landcare and Community groups (Hindmarsh Island, Riverglades, Clayton Environmental) and Goolwa to Wellington LAP.

Agassiz's Glassfish *(Ambassis agassizii)*

Other common names: Olive Perchlet, Chanda Perch, Glassfish

Conservation status *South Australia:* Critically Endangered (CR B1ab(i,iii,iv)); Protected (*Fisheries Management Act 2007*).
National: not listed. *Interstate:* Endangered in New South Wales (MDB population) and listed as Threatened in Victoria (Regionally Extinct).

Taxonomy and identification A short, deep bodied fish attaining a length of 4-5cm. It has large eyes and a semi-transparent to olive body. Agassiz's Glassfish is somewhat similar to pygmy perches and juvenile Murray-Darling Golden Perch, but can be distinguished by having a forked tail, silvery gill cover and larger scales.

Former distribution Historical records indicate this species was apparently always rare. Records are patchy and mostly from the 1960s and 1970s from wetlands along the River Murray including Tailem Bend, Murray Bridge, Kroehn's Landing, Big Bend, Portee Station, Hart Island, Renmark, and extending into Lake Alexandrina (e.g. Finniss River arm)[101]. The last verified record was from the mouth of the Marne River (near Walker Flat) in 1983[39].

Current distribution There have been no verified records of Agassiz's Glassfish in the past 20 years, despite a reasonable level of suitable (but non-targeted) sampling that has occurred in the SAMDB in the last five years. Hence there has been a noted decline (disappearance) in the extent of occurrence and number of localities from the mid 1970s (CR B1ab(i,iii,iv)) and the species may be extinct in SA. A translocated population (sourced from Queensland fish) may exist in artificial habitat near Murray Bridge[36].

Biology and habitat Agassiz's Glassfish is poorly known in SA due to a lack of overall records and observations, although it was a naturally rare and patchy species[107,108]. There is some indication that it was associated with submerged aquatic vegetation such as Ribbonweed *(Vallisneria)* and Foxtail *(Ceratophyllum)*, and clearer water in wetland habitats. It remains common only in the Queensland section of the MDB where it is reported to occur in still or slow flowing habitats with high levels of submerged and emergent vegetation, or structure such as snags. Agassiz's Glassfish is an opportunistic nocturnal micro-carnivore, which spawns in late spring and summer amongst aquatic vegetation. Its lifespan is reported to be up to four years[109,110,111].

Reasons for decline and threats These are largely unknown but could include a combination of factors such as the impacts of river regulation reducing the frequency and duration of River Murray and wetland flooding, and constantly high turbidity from altered flow patterns. There is a casual link between the arrival of Carp and the disappearance of Agassiz's Glassfish (i.e. potential loss of aquatic vegetation or transmission of disease). Ill-planned reintroductions could cause genetic problems for any remnant, but as yet undetected local populations.

Land tenure and conservation

- Previous records from public waterways (sometimes accessed through private property).

Recovery objectives

- Accurately determine the status of Agassiz's Glassfish in SA through targeted surveys.
- If populations are discovered initiate research on the species requirements to assist with conservation and recovery planning.
- Restore a more natural flow regime and preferred micro-habitats.
- Establish the genetic relationship between SA and interstate MDB populations.

Conservation actions already initiated

- Several recent surveys have been undertaken within the range of Agassiz's Glassfish[24,69,70,78].
- An attempt to establish a refuge population in artificial habitat using fish from the Queensland MDB has been made (unknown if successful)[36].
- The Living Murray Initiative aims to restore flow regimes to key ecological assets including the Chowilla region which may provide improved conditions (e.g. flooding) for Agassiz's Glassfish.

Required conservation actions

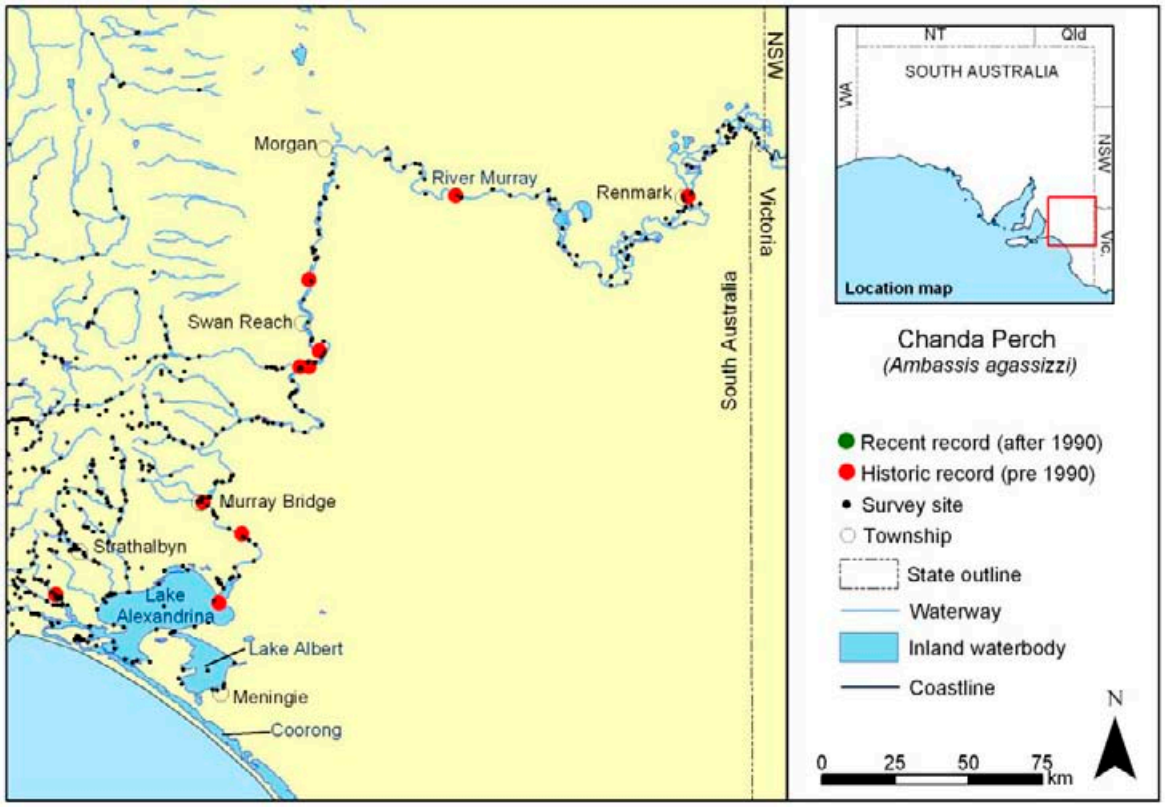
- There is a possibility that populations will be uncovered if comprehensive targeted surveys were conducted, focusing on historic survey locations.
- The lack of information regarding the Agassiz's Glassfish means that the general public can help by reporting any past or present sightings (www.nativefishsa.asn.au).
- Undertake a genetic study using historic museum specimens to determine the suitability of interstate populations for translocation and reintroduction.

Organisations responsible for conservation of species

DEH, PIRSA Fisheries, SAMDB NRM Board.

Organisations or individuals involved

NFA(SA), DEH, SARDI Aquatic Sciences, SAMDB NRM Board.



Yarra Pygmy Perch *(Nannoperca obscura)*

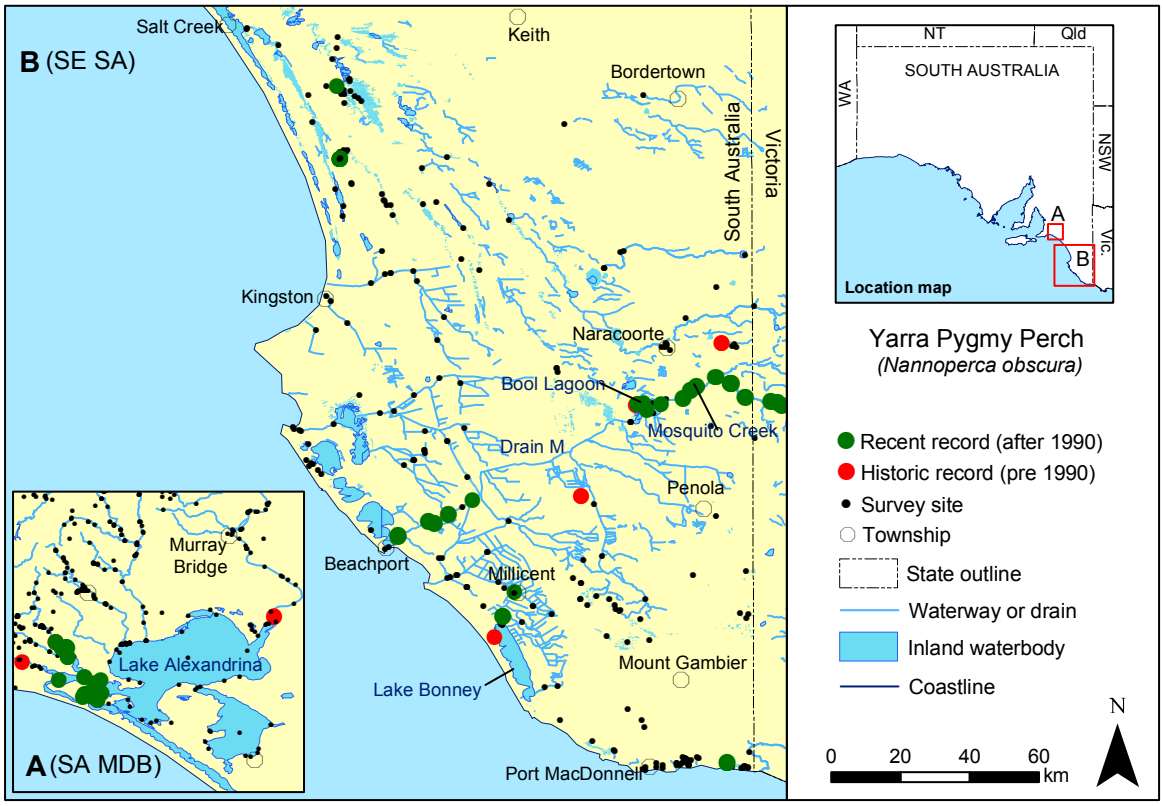
Conservation status *South Australia:* Critically Endangered (CR A2ac); Protected (*Fisheries Management Act 2007*).
National: Vulnerable (*EPBC Act 1999*). *Interstate:* listed as Threatened in Victoria (Near Threatened).

Taxonomy and identification A small trim fish with a short deep body which reaches a length of 8cm, commonly 4-5cm. In the past, this species and the Southern Pygmy Perch have been confused and grouped together. Distinguished from other SA pygmy perches by a small mouth not reaching below the eye, high dorsal fin and irregular shaped eye pupil (not round) (also has a free lower edge to pre-orbital bone when viewed under the microscope). Recent genetic research through the SA Museum and the University of Adelaide indicates that populations in the SAMDB are distinct from those in the SE and comprise separate Management Units[55].

Former distribution Very little historic data was available prior to the review of SA Museum specimens as part of Phase 1 of the Action Plan. The often cited western limit of the species was considered to be Bool Lagoon. However from the review and with additional research[13] we now know the western range (SA) included (a) permanent habitats throughout the South East with documented localities included Crescent Pond (west of Piccaninnie Ponds), Mosquito Creek/Bool Lagoon system, the Lake Bonney area (1913), Bakers Range Watercourse as far north as Mandina Marshes (parallel with the southern Coorong) and Henry Creek[23,101,112] and (b) the lower section of the SAMDB with records from the Lower Murray, Lake Alexandrina and wetlands on connected tributary stream arms of the Lake (records date back to 1915 and 1928). A record from Piccaninnie Ponds proper[44] cannot be verified as the specimen is missing from the labelled jar at the SA Museum.

Current distribution Prior to 2007 remaining known localities were highly fragmented and included for the South East region: Mosquito Creek system (including Bool, Little Bool and Hacks lagoons (when wet!), Dead Man Swamp and occasional records from Drain M), Picks Swamp, the Lake Bonney/Millicent Region (SE); and for the MDB: eastern Hindmarsh Island, vegetated edges of the Goolwa channel, and the upper Finniss River arm of Lake Alexandrina[23,24,50,55,59,113]. There have been major recent declines in both the area of occurrence and local abundance of Yarra pygmy perch, and also a possible major reduction in extent of occurrence. Most recently severe drought has exacerbated existing threats with large declines in local abundance and area of occupancy noted. A rapid fall in Lake Alexandrina water level since late 2006 has virtually eliminated all required Yarra Pygmy Perch habitat with the species feared regionally extinct[102,114,115]. In the South East five remaining populations are under critical threat: confirmed extinct at Henry Creek; feared extinct at Lake Bonny; in low abundance at Crescent Pond; highly restricted in the lower Drain M area; and in sharp decline at Mosquito Creek – a 75% reduction in relative abundance and 40% reduction in area of occupancy was noted between spring 2006 and 2008[94] (CR A2ac).

Biology and habitat In South Australia the Yarra Pygmy Perch occurs in permanent environments including slow flowing streams, lakes, sinkholes (pond habitat) and wetlands. Associated with emergent and submerged aquatic vegetation including Milfoil *(Myriophyllum)*, Foxtail *(Ceratophyllum)*, Club Rush *(Schoenoplectus)*, Water Ribbons *(Triglochin)* and Cumbungi or Bulrushes *(Typha)* and water transparency at most recorded sites is limited due to natural tannin colouring. The biology of the species is little known, but fish in spawning condition have been found during September-November and fish probably live for less than 4 years, with most fish in a population being 1-2 years old[23,24,55,59,112]. Data from Victoria indicates food items include macroinvertebrates common on submerged surfaces such as insect larvae and copepods[116] and suggests that when occurring together Yarra and Southern pygmy perch compete for similar micro-habitats, potentially forcing Yarra Pygmy Perch to use deeper areas (and thus be more susceptible to Redfin predation)[117]. The species is not known to undertake migratory movements.



Reasons for decline and threats Historic declines appear be related to habitat alteration such as loss of permanent wetlands through drainage of much of the South East and levees which isolated and removed swamps along the River Murray between Wellington and Mannum. More recently the drying of habitat on Mosquito Creek/Bool Lagoon and Lake Alexandrina due to altered hydrology is the critical threat to survival[94,113,118]. Any impacts to specific habitat components such as emergent vegetation or submerged vegetation would be detrimental due to loss of habitat, food resources and cover from predators (e.g. from stock damage, constructive works, aquatic vegetation control, low water levels, sedimentation, altered water transparency, destruction by Carp). For example Yarra Pygmy Perch abundance at a site on the Finniss River declined annually in line with a decreasing amount of submerged vegetation (Milfoil) and an increase in Redfin[113]. The general role of predation from Redfin and competitive interactions with Gambusia are likely to be significant but need confirmation. Forced interaction between Yarra and Southern pygmy perch through reduced flows, pool/lake levels or habitat loss (e.g. damage to riparian vegetation) may add further competitive pressure between the two species and predation from introduced species, especially for small, restricted populations of Yarra Pygmy Perch (e.g. Henry Creek). Rising salinity is a threat to at least one population where recruitment has failed (in combination with reduced flow and pool levels)[112].

Land tenure and conservation Known from the Naracoorte Caves NP, Bool Lagoon GR, Hacks Lagoon CP, on land owned by DEH for conservation at Picks Swamp (SE) and Wyndgate, Hindmarsh Island (the Lower Lakes is also a Ramsar site). Some private land at Henry Creek and Mosquito Creek has been fenced and is being managed for conservation. Wetlands in the Finniss River arm of Lake Alexandrina have a mix of stock grazing and areas used for recreation or that are inaccessible to stock.

Recovery objectives

- Ensure that the two genetically distinct populations are conserved (SAMDB and SE) with secure habitat for multiple populations in each.
- Establish and monitor relationships to environmental conditions, especially with any changes in management and/or conditions.
- Improve understanding of species life history, habitat dynamics and potential threats.
- Ensure that all key stakeholders are aware of populations and potential threats (improve awareness, particularly regarding species identification).

Conservation actions already initiated

- Habitat based conservation measures to try and secure populations have been attempted or underway for SE populations[119,120].
- Captive maintenance has been initiated as part of urgent conservation measures for fish in the SAMDB and SE in response to major habitat drying[113,120].
- Annual flow related monitoring has been initiated at Mosquito Creek and a project has been initiated which aims to integrate surface water management in the Mosquito Creek Catchment (SE NRM Board and DEH together with several other project partners).
- Securing of physical habitat at Picks Swamp (DEH) and habitat restoration is in progress to improve water quality at Lake Bonney.
- Initial moves to secure water requirements in the SAMDB (e.g. Environmental Flows Program for EMLR, Living Murray Initiative), although critical lows have not been prevented.
- Population monitoring occurs on Hindmarsh Island and the Finniss River[58,113].
- Data sheet produced for the SE to aid awareness and identification[121].
- A national Recovery Plan is in preparation (currently at a draft stage).

Required conservation actions

- Secure and protect surface and groundwater water supply (hydrology) for core populations through studies and management programs.
- Support and expand captive maintenance as a last resort backup in the face of critical threats to populations.
- Document life history and relationships to changes in water levels and vegetation through continued monitoring of populations and expand the network to include more locations in Lake Alexandrina and the SE.
- Determine the water quality requirements of adults and eggs/larvae.
- Undertake studies of aquatic plant biology and dynamics in the Lower Lakes directed towards protection and enhancement of core habitat.
- Establish long-term government and community support structures to promote the Yarra Pygmy Perch within regional planning and management, restoration and education programs.

Organisations responsible for conservation of species

DEH, PIRSA Fisheries, DEWHA, DWLBC, SAMDB & SE NRM boards, SEWCDB & USE Program, Alexandrina & Millicent councils.

Organisations or individuals involved

DEH, NFA(SA), Aquasave, SARDI Aquatic Sciences, SAMDB NRM Board, USE Program, DEWHA, Pembroke High School, local landholders.

Variegated Pygmy Perch *(Nannoperca variegata)*

Other common names: Ewens Pygmy Perch

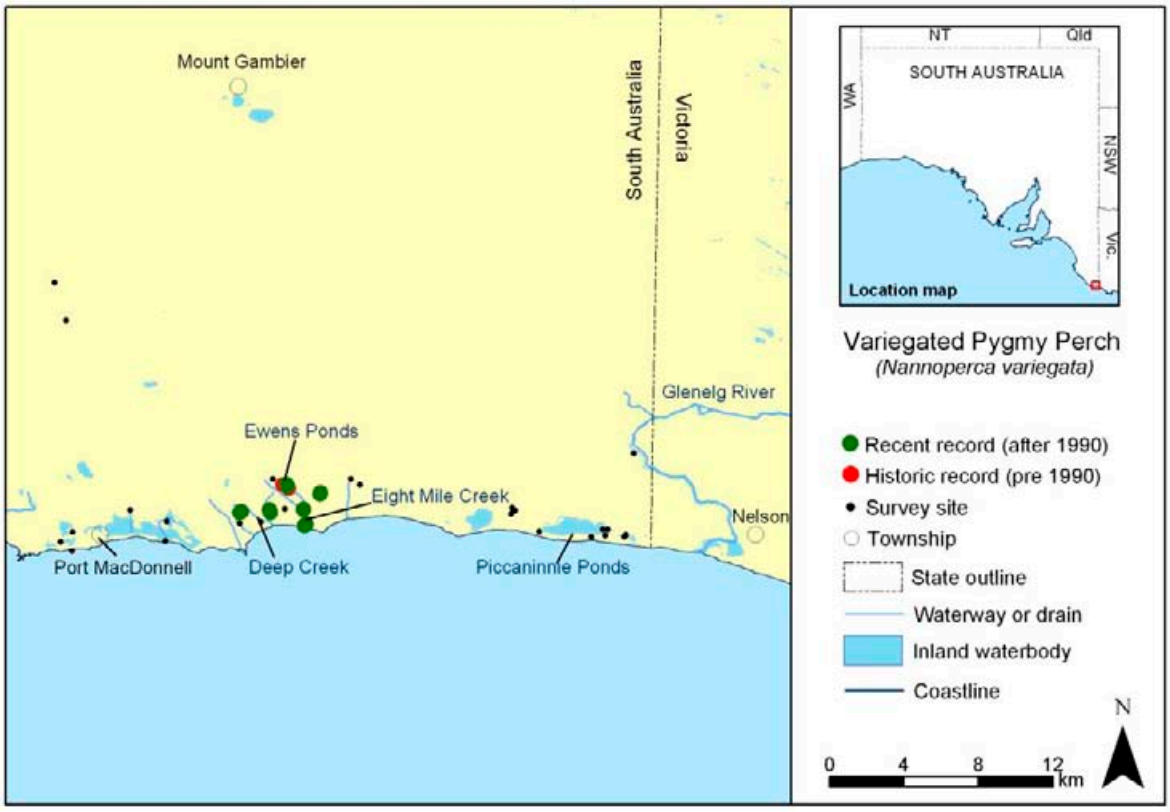
Conservation status *South Australia:* Critically Endangered (CRB2ab(i,iii)); Protected (*Fisheries Management Act 2007*).
National: Vulnerable (*EPBC Act 1999*). *Interstate:* listed as Threatened in Victoria (Endangered).

Taxonomy and identification A small, deep-bodied fish reaching a maximum length of ~6.5cm (commonly 3-5cm). The variegated body patterning is most obvious in juveniles and females, with males having a yellow-green body especially during spawning. It co-occurs with Southern Pygmy Perch in SA, but can be distinguished by a lack of scales on the top off the head and a second dorsal spine shorter than the third. Body patterning and a distinct black dot at the base of the tail is also a good guide.

Former distribution Only discovered and formally described in the 1980s[122], with limited information prior to this (e.g. retrospective identifications of museum specimens). The species range in SA includes a small section of habitat in the Lower South East (also known from the adjacent Glenelg River system in Victoria). Verified records in SA are known from Ewens Ponds (where the species was first found) and other parts of the Eight Mile Creek system upstream and downstream of the Ponds and in Spencer Pond. Also occurs in the Deep Creek system (formerly connected to Eight Mile Creek before an artificial mouth was cut to the sea) including upper Deep Creek, Stratmans Pond and 54 Foot Pond. It may have also occurred in the Piccaninnie System between Eight Mile Creek and the Glenelg River, but records from here cannot be verified[23,123,124].

Current distribution Has a highly restricted area of occupancy (<4km^2) in what is essentially one location fragmented into two parts due to channel alteration (CRB2a). Has declined slightly in extent of occurrence due to drying and loss of habitat above Ewens Ponds (CRB2b(i)), and there has been a decline and now overall low abundance in the Deep Creek system. The quality of habitat across its SA range has been observed to decline through loss of flow, increased nutrients and habitat alterations, as described below (CRB2b(iii))[94,125].

Biology and habitat The regional habitat supporting the Variegated Pygmy Perch is comprised of a landscape of limestone containing rising springs that form ponds with fast flowing outflow creeks. It is most common in areas with fast flow, clear water, lush submerged aquatic vegetation and good emergent and riparian (edge) cover. Also occurs in low numbers amongst submerged vegetation in pond habitat and still shallows, but Southern Pygmy Perch is more common in this habitat. Biology is little known, with indications that it spawns in spring and has a short lifecycle (~2-4 years), and diet likely includes small aquatic invertebrates picked from underwater surfaces. Movements have been speculated but do not appear necessary for spawning[122,123,124].



Reasons for decline and threats Given the flow reliance of the Variegated Pygmy Perch, the primary threat is reduced flow due to declining spring discharge (assumed to be largely supplied by the regional unconfined aquifer). Changes in stream flow (spring discharge) occur as a result of a reduction in the water table level and aquifer pressure due to groundwater extractions, especially in dry periods where water demand for irrigation increases and thus represents a higher use compared to aquifer recharge rates[126]. There has been a rapid proliferation in intense irrigation pumping of groundwater in the immediate vicinity of Variegated Pygmy Perch habitat since the 1990s (Figure 7), that is exacerbated by below average recharge to the aquifer from a protracted low rainfall period, and that is predicted to worsen for the future under climate change scenarios. Flow has decreased at Eight Mile Creek by 20-30% since 1990[126,127] and local groundwater levels have declined alarmingly in the same period[128]. Groundwater extraction also creates the additional risk of salt water intrusion (elevated salinity), and increased nutrient infiltration into shallow aquifers combined with reduced flow creates a potential for increased algal growth smothering underwater surfaces. Most of Eight Mile Creek and Deep Creek are currently managed as artificial habitat (drains) and consequently have poorly developed riparian habitat and unstable edges, thus affecting the quality of edge habitat for the species. Regular dredging also creates intense disturbance to in-stream habitat[57]. Predatory alien fish are a potential threat to the species. A general lack of awareness of the presence and requirements of Variegated Pygmy Perch and the subsequent failure for inclusion in management and planning, is also a threat to the species.

Land tenure and conservation Occurs in the Ewens Ponds CP and on drainage reserves abutting dairy properties, with some public access from roadways.

Recovery objectives

- Urgently secure water requirements and habitat of Variegated Pygmy Perch.
- Monitor population trends and link to environmental conditions.
- Restore habitat of the Variegated Pygmy Perch (longer-term).
- Increase awareness and knowledge of the species.

Conservation actions already initiated

- Recognised and described as a distinct species.

- Initial distribution and habitat surveys have been undertaken.
- Review and assessment of groundwater extraction scenarios and a recent review of water use undertaken. Review of water allocation planning in progress.
- Information sheets with information on identification and for raising awareness[121].
- 'Protected' from exploitation under the *Fisheries Management Act 2007.*
- Recent level of publicity over concern for decline in flows and health of Ewens Ponds[127].
- Dredging of Eight Mile Creek is now seen as damaging and alternatives are being sought.

Required conservation actions

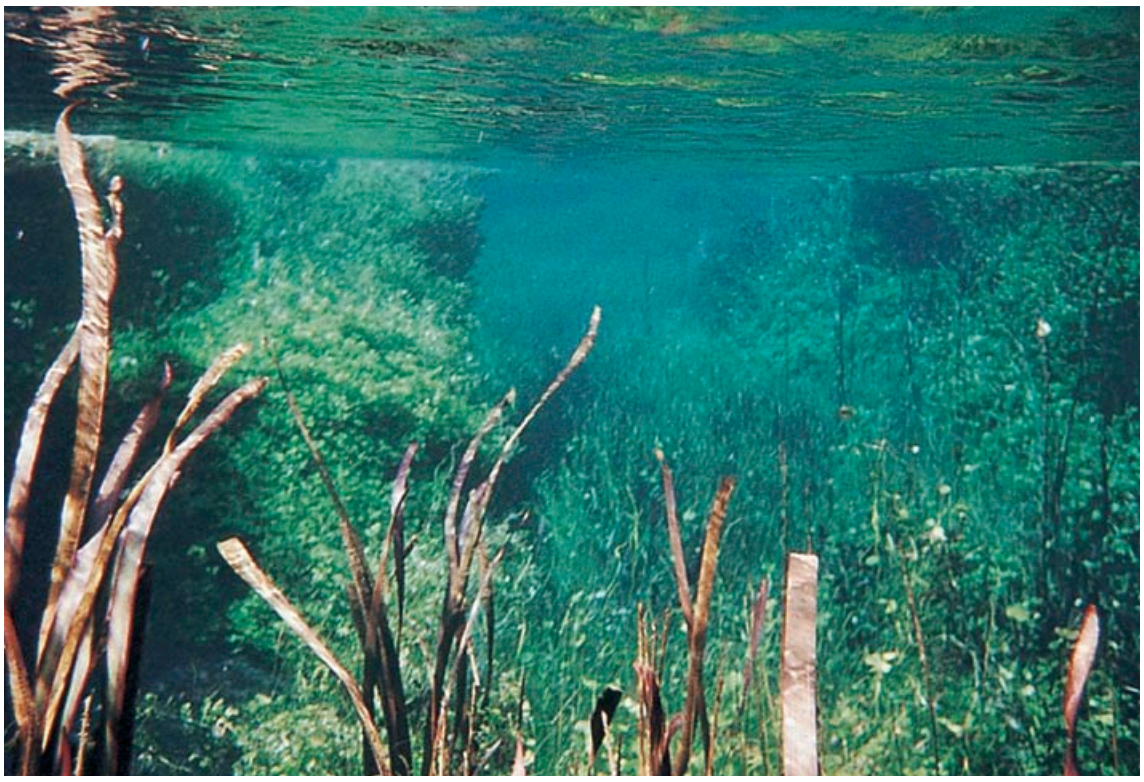
- Review local hydrological models at the appropriate scale, and water use and loss of stream flow (including climate change scenarios) in the Eight Mile Creek and Deep Creek systems.
- Protect environmental requirements through appropriate water allocation.
- Undertake adaptive management incorporating environmental monitoring data to improve habitat conditions in the Eight Mile Creek and Deep Creek systems (e.g. dredging and riparian vegetation management initiatives).
- Establish long-term government and community support structures to promote the Variegated Pygmy Perch within regional planning and management, and aquatic protection, restoration and education programs.
- Regular field monitoring of the distribution and abundance of Variegated Pygmy Perch to detect any responses or declines to changing conditions as a key indicator species for the health of the Ewens Ponds and Eight Mile Creek system.

Organisations responsible for conservation of species

DEH, PIRSA Fisheries, DEWHA, SEWCDB, DWLBC, SE NRM Board.

Organisations or individuals involved

NFA(SA), DEH, DWLBC SE NRM Board, SEWCDB, Australian and New Guinea Fishes Association.



Variegated Pygmy Perch habitat at Ewens Ponds

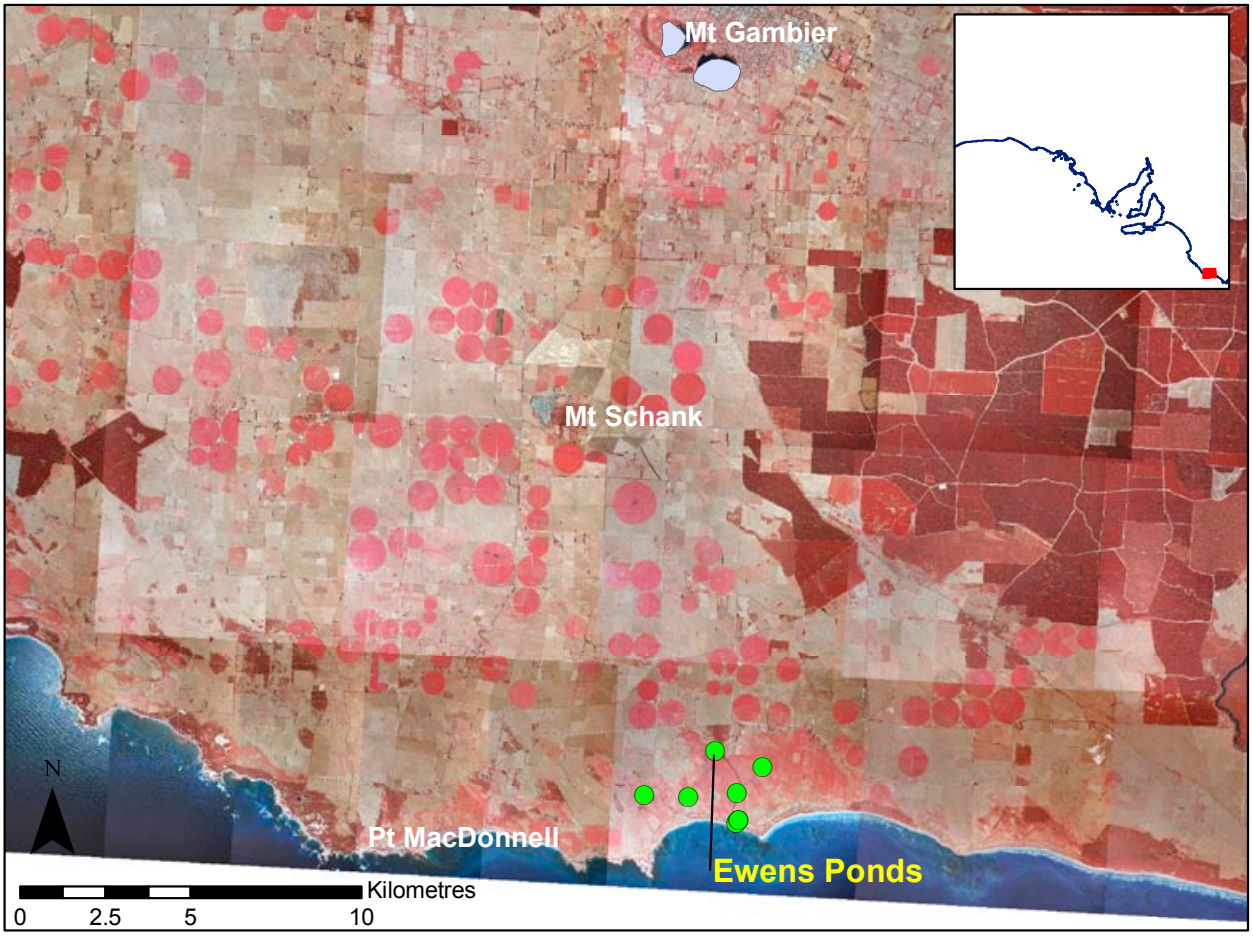


Figure 7. Aerial view (2003) of irrigation surrounding Variegated Pygmy Perch habitat (shown with green dots). Irrigation is indicated by the widespread red circles and other similarly coloured red areas surrounding Ewens Ponds (Orthoimagery supplied by DEH, Environmental Information)

Southern Purple-spotted Gudgeon *(Mogurnda adspersa)*

Other common names: Chequered Gudgeon, Purplestriped Gudgeon, Krefftius, and Mogurnda

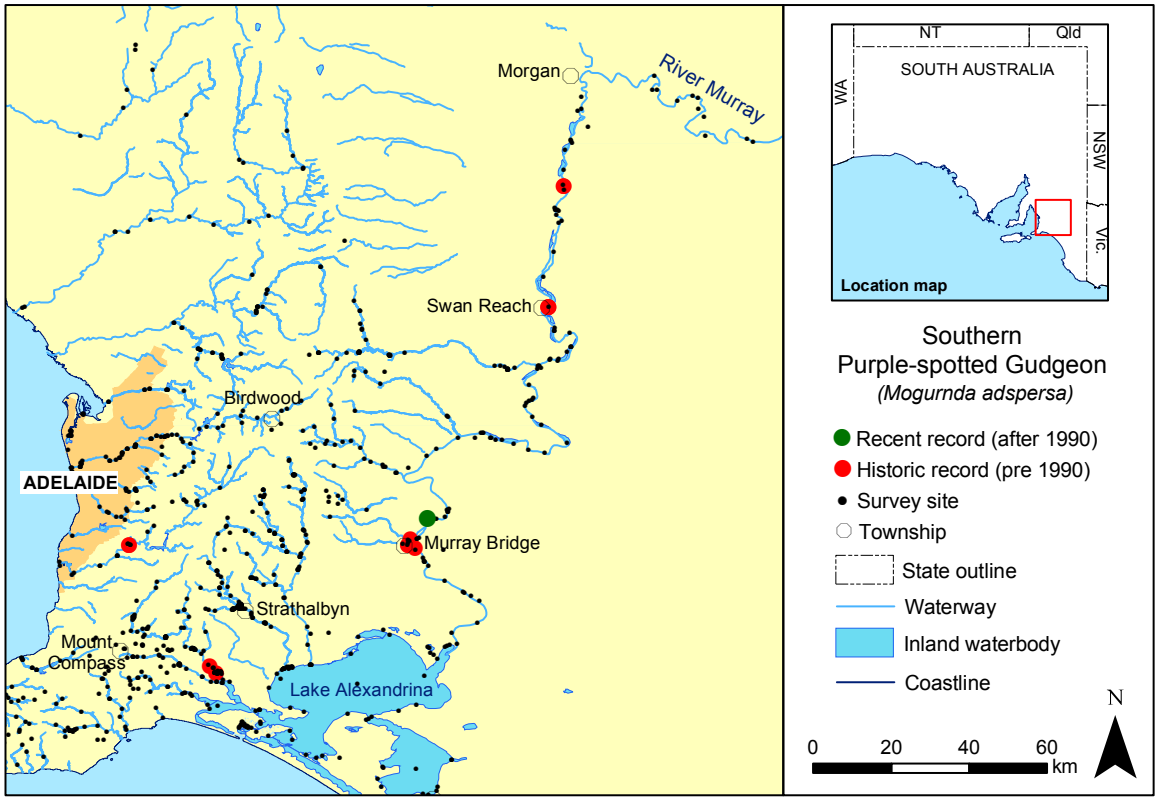
Conservation status *South Australia:* Critically Endangered (CRB1ab(i,ii,iii,v)); Protected (*Fisheries Management Act 2007*)
National: not listed. *Interstate:* listed as Endangered in New South Wales and Threatened in Victoria (Regionally Extinct).

Taxonomy and identification A small robust fish reaching around 12cm in length, but more commonly 4-7cm. The taxonomic status and genetic distinctness of fish from the Adelaide region compared to the remaining range remains to be determined. Distinguished from other gudgeons (e.g. Dwarf Flathead Gudgeon) by purple stripes on the gill cover and brick red body spots. There is a subtle difference between related species of Purple-spotted Gudgeon including presence of darker vertical bars and differences in lateral scale counts.

Former distribution The Southern Purple-spotted Gudgeon was previously widespread and common in patches throughout the lower section of the River Murray in South Australian with records from Lower Finniss River, Murray Bridge, Swan Reach and Blanchetown (between 1888 and the 1970s), and also being present (but little known) in the Torrens and Onkaparinga rivers (Adelaide Region, verified records prior to 1920)[17,18,101,107]. The Southern Purple-spotted Gudgeon was once common enough to be used by anglers as live bait for Murray Cod, Golden Perch and Redfin[17,36]. There is an unusual Australian Museum specimen with details "Moonta SA" (1933), an area with no natural waterbodies (the top of Yorke Peninsula, falls distantly between the Broughton and Wakefield rivers).

Current distribution Declared regionally extinct in SA in the early 1990s[36] with no verified records in the past 30 years from the River Murray and Adelaide regions despite a reasonable level of suitable sampling (although this has not necessarily been targeted to potential habitat of Southern Purple-spotted Gudgeon). Hence a decline (disappearance) in the extent of occurrence and number of localities has been noted from the mid 1970s (CRB1ab(i,ii,iii)). The species was however rediscovered in the Lower Murray from one location between Blanchetown and Wellington in 2004[129]. Genetic data indicate this population to be native, and quite different to a translocated population sourced from fish in the Queensland MDB[36] established near Murray Bridge[130,131]. The continued lowering of River levels has caused drying of the only known wetland (Figure 8), with a related crash in local abundance (CRB1b(v)), and is likely to result in the loss of this remaining population in South Australia and hence the southern Murray-Darling Basin[129].

Biology and habitat Information on historic habitat in South Australia suggests the species occurred in areas of dense submerged or emergent vegetation such as Ribbon Weed *(Vallisneria)*, Foxtail *(Ceratophyllum)* and Bullrush *(Typha)* in lowland river edges, wetlands and swampy drains[17,18,42,108]. The recently discovered site also had high levels of edge cover and submerged vegetation[129]. Other specific information on biology comes from interstate suggesting the species is carnivorous feeding on small fish and macroinvertebrates such as Glass Shrimp and small Yabbies, maturing at around 4-5cm and utilising hard substrate for spawning during summer[109,132,133].



Reasons for decline and threats The reasons for the considerable decline of the Southern Purple-spotted Gudgeon are little known but is likely due to progressive decline in the suitability of local habitats from a combination of reduced flows, increases in turbidity along the River Murray, decreased water quality, and loss of submerged and emergent macrophytes. Interaction with introduced fishes is also likely to be significant, especially Redfin predation (e.g. Adelaide Region), and aggressive interactions, competition and predation of fry by Gambusia, an often cited potential threat elsewhere[74,132,134]. There is a casual link between the arrival of Carp in the River Murray and the disappearance of Southern Purple-spotted Gudgeon (i.e. potential habitat modification through loss of aquatic vegetation or transmission of disease). Disease incidence was high just prior to wetland drying of the last known wild site[129]. Exploitation is a threat to small populations. Ill-planned reintroductions could cause genetic problems.

Land tenure and conservation

- River Murray corridor and formerly in the City of Adelaide, possibly Onkaparinga River NP.

Recovery objectives

- Ongoing assessment of status in the wild (known and potential habitat).
- Secure core habitat with flow and habitat protection.
- Further research species requirements to assist recovery planning.
- Look to expand population range to provide greater population security through a captive breeding and reintroduction program.

Conservation actions already initiated

- Protected from exploitation (*Fisheries Management Act 2007*).
- Several recent surveys have been undertaken within the species range[24,25,28,69,70,78].
- Previous trials have shown that refuge populations can be established in artificial habitat[36].
- Emergency captive maintenance has been initiated due to severe habitat loss at the remaining known site, included the rescue of around 50 individuals[129].
- A Reintroduction Plan is in preparation and links to a current SA DEH Drought Action Plan.

Required conservation actions

- There is a possibility that more populations will be discovered through comprehensive targeted surveys focusing on historic survey locations and suitable habitat.
- Better document information on species' biology and historic habitat including an oral history program and potential collaboration with interstate researchers.
- The lack of information regarding the Southern Purple-spotted Gudgeon means that the general public can help by reporting any past or present sightings (www.nativefishsa.asn.au).
- Continue support of urgent conservation measures (captive maintenance, habitat monitoring).
- Develop a strategy and actions to expand the species range to more natural and artificial habitats (captive breeding, habitat restoration, environmental water provisions).
- Undertake a genetic study using historic museum specimens to assess relationships between different SA and interstate populations, and to evaluate diversity within wild and captive fish.

Organisations responsible for conservation of species

DEH, PIRSA Fisheries, DWLBC, AMLR & SAMDB NRM boards.

Organisations or individuals involved

DEH, PIRSA, MDBA, SAMDB NRM Board, NFA(SA), Aquasave, SARDI Aquatic Sciences, SAMA.

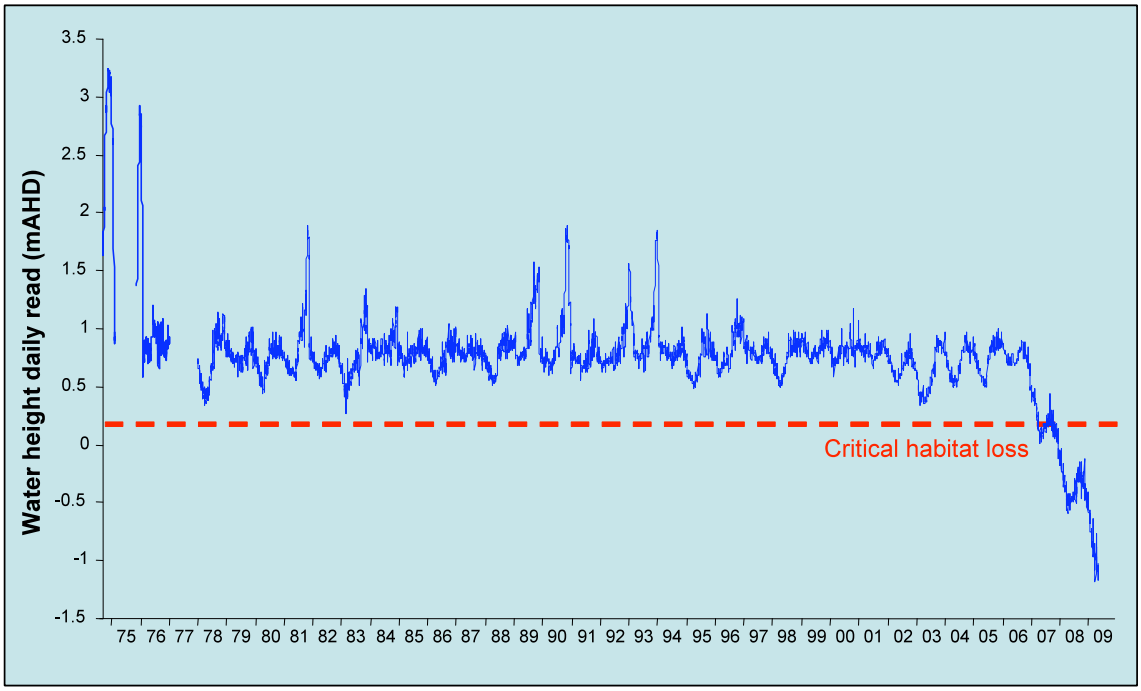


Figure 8. Indicative long-term record of water height at the recently discovered Southern Purple-spotted Gudgeon habitat on the Lower River Murray (metresAHD, observed at Mannum recorder A4261067)[135]. Critically low levels after 2007 are clearly highlighted, with the level in 2009 more than one metre below average sea level. The dashed line indicates the point where the wetland dried.

Flinders Ranges Purple-spotted Gudgeon *(Mogurnda clivicola)*

Other common names: Flinders Mogurnda

Conservation status *South Australia:* Critically Endangered (CRB2ac(ii,iv)); Protected (*Fisheries Management Act 2007*).
National: Vulnerable (*EPBC Act 1999*).

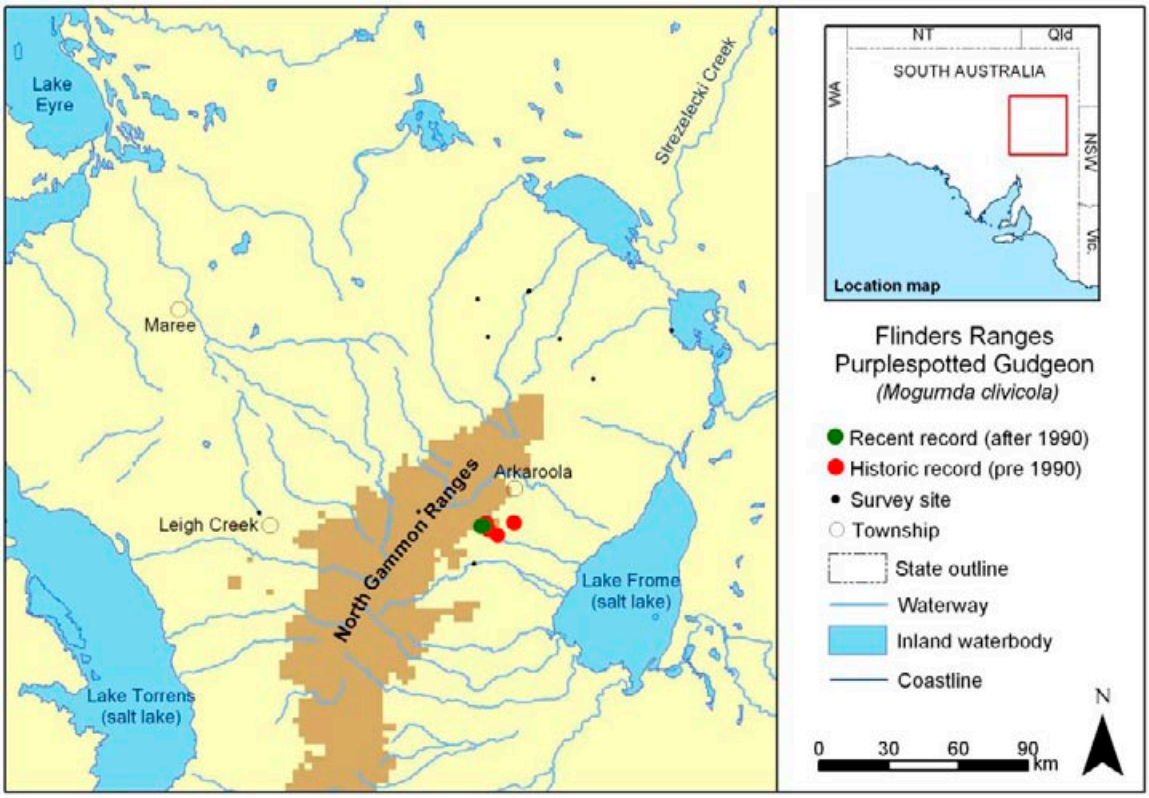
Taxonomy and identification A small robust fish reaching a size of ~15cm, more commonly 5-8cm. Recently described as a distinct species[136], some taxonomic issues remain to determine relationships between other populations thought to be this species in the upper Cooper Creek (Barcoo River) and Bulloo River systems. There is little chance of confusion between other species in the region it is found, but reports of Flinders Ranges Purple-spotted Gudgeon often turn out to be of Spangled Grunter which does have pale body speckling (but orange as opposed to the brick red spots of the gudgeon) and has a single dorsal fin and square to slightly forked tail (v. two dorsal fins and rounded tail for the gudgeon). There are subtle differences between this and other related species of purple-spotted gudgeon including the lack of darker vertical bars and differences in lateral scale counts.

Former distribution Known only from a 12km section of Balcanoona Creek, a small stream (<10m wide) in the Flinders Ranges (North Gammon Ranges) draining toward Lake Frome[107,137.] Flinders Ranges Purple-spotted Gudgeon has reportedly been translocated to other streams and artificial habitat in the area[31,32].

Current distribution Recent detailed monitoring has not been undertaken, but opportunistic records and observations suggest that area of occupancy remains at much less than 10km^2 due to dry recent conditions (CR B2a). The population in Balcanoona Creek is thought to contract considerably in dry periods (CR B2c(ii,iv)), possibly as low as 150 individuals in a few pools associated with two small springs[137]. A translocated population appears established at Nepouie Springs, but another in a large rainwater tank at the local National Park Headquarters appears to have been lost. There is a minor possibility that the species occurs naturally in other small refuges in the Flinders Ranges[55,101].

Biology and habitat The Flinders Ranges Purple-spotted gudgeon is found in rocky stream habitat in the lower foothills of a deep-sided gorge. This habitat is maintained by springs thought to be sourced from local rock aquifers, with occasional expansion of habitat following local rainfall and increased surface water flows. Habitat comprises small pools with high levels of physical cover of rock and snag, leaf litter and bark from River Redgums fringing the stream, and some submerged and emergent vegetation. A reasonable level of biological information is available from a study into the natural history of the species in the mid 1980s[137] and other opportunistic observations[32]. Spawning occurs in spring and summer, and possibly later if flood events occur during the warmer months, with a peak (or mass spawning) noted following an influx of underwater structure and thus spawning sites when Redgums shed their bark in

December. Spawning occurs on solid surfaces whereby males guard and fan the eggs. Schools of juveniles occur in surface waters before becoming more cryptic and territorial after maturation at 6-7cm, with most individuals in the population 1-2 years old and a few larger adults up to around five years old. Adults are opportunistic feeders on adult stages of aquatic macroinvertebrates (e.g. dragonflies), small fish, frogs and tadpoles, and other small terrestrial vertebrates. The Balcanoona Creek population does not co-exist with other fish species. Movement is restricted by limited habitat. Flinders Ranges Purple-spotted Gudgeon is affected by a nematode which appears to regrade the condition of adults under high density and thus regulate population density. Melanomas have also reportedly been detected on the species[138].



Reasons for decline and threats The single known population is small, isolated and fluctuates in occupied area and abundance making it highly susceptible to natural chance events and local and global human related impacts such as:

- Climate change – a reduction in the amount of rain received and an increase in the frequency of large storm disturbances (e.g. floods) may impact water availability and springs.
- Water abstraction – given the small habitat reliant on spring flows, any major water extractions in the region (e.g. mineral exploitation) pose a serious potential threat of extinction in a short time frame.
- Cancer – the influence of increased ultraviolet radiation is suggested to cause increased mortality in the Flinders Ranges Purple-spotted Gudgeon[138].
- Water quality - related species are sensitive to water contamination with uranium[139].
- Alien fishes – the small area of habitat increases the likelihood of interactions with introduced species, especially aggressive Gambusia.
- Introduced terrestrial vertebrates - feral goats frequenting stream habitat were suspected to cause water quality problems (e.g. algal blooms and deoxygenation) prior to pest control programs[32].
- Major habitat impacts – a proposal to mine within the Balcanoona Gorge (Figure 1) could have had devastating impacts to the species' habitat and water supply.
- Over harvest – illegal collecting of the species has been reported[32], and such removal could inhibit recovery or survival when the population is critically restricted during dry times.

- Any research needs to be careful not to cause disturbance to habitat, species ecology and ensure equipment is free from biological or chemical contaminants.

Land tenure and conservation

- Occurs within the Gammon Ranges National Park which was established in 1982 (formerly Balcanoona Station).

Recovery objectives

- Maintain and protect habitat, discourage fish introductions.
- Re-establish artificial refugia (sourced during times of greater wild abundance).
- Specifically investigate potential impact of climate change.
- Increase awareness within local natural resource management of species requirements and threats.

Conservation actions already initiated

- A vertebrate pest control program has been initiated and maintained in the region (i.e. feral goats).
- Scientific Expedition Group has been monitoring water quality, macroinvertebrates and rainfall in and around Balcanoona Gorge for over a decade.
- A SARDI Aquatic Sciences Stock Assessment Program was initiated in the 1990s[138,140], however this information is not available.

Required conservation actions

- Initiate regular monitoring to assess habitat extent and quality, estimate population status (numbers and health) and to ensure Gambusia and other alien species are not present.
- Develop contingency plans for extreme conditions or new threats (e.g. refuge drying, control of fish introductions) and investigate sites and methods for establishing artificial refugia.
- Continue terrestrial vertebrate pest control program.
- Undertake systematic regional surveys for other potential populations.
- Determine taxonomic relations with populations in the Cooper and Bulloo systems.

Organisations responsible for conservation of species

DEH, PIRSA Fisheries, DEWHA, Arid Areas NRM Board.

Organisations or individuals involved

DEH (National Parks), SARDI Aquatic Sciences, SEG, SA Sporting Shooters Association, traditional owners.

Habitat of the Flinders Ranges Purple-spotted Gudgeon at Balcanoona Creek

2.3. **ENDANGERED**

> considered to be facing a very high risk of extinction in the wild

Pouched Lamprey *(Geotria australis)*

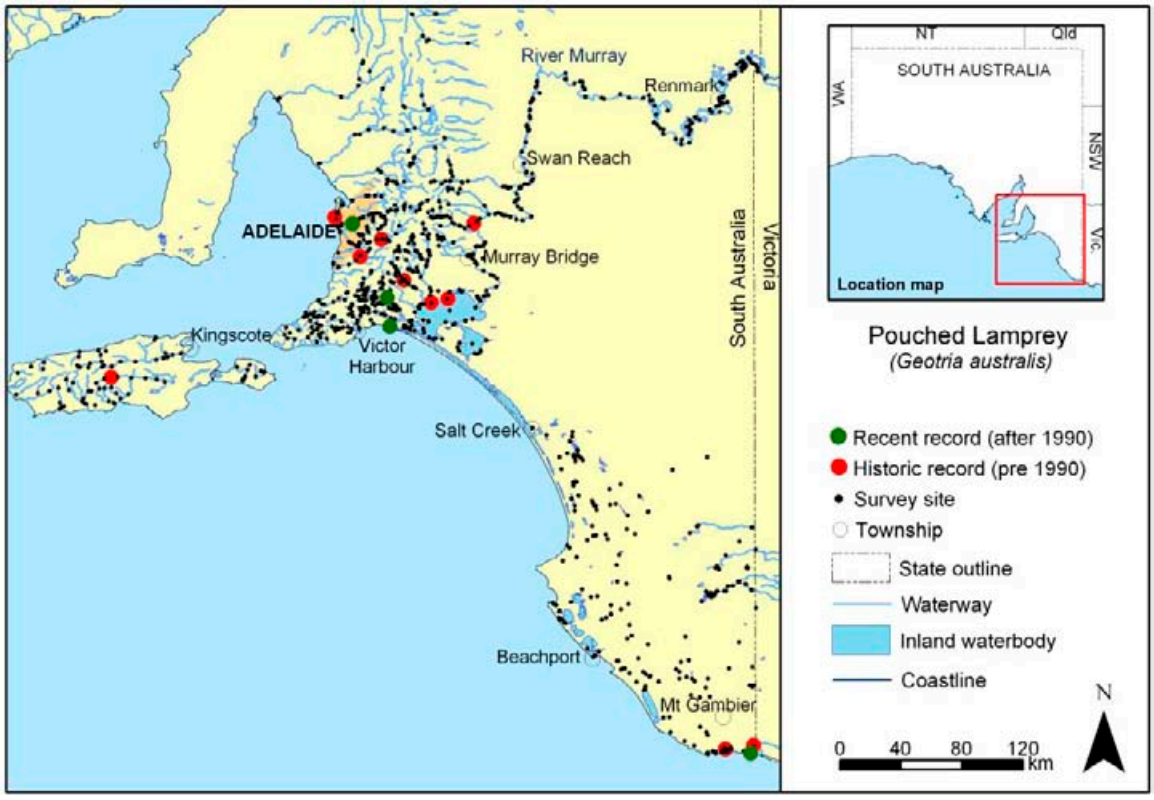
Conservation status *South Australia:* Endangered (EN A2c).
National & interstate: not listed.

Taxonomy and identification An eel like fish reaching 70cm; adults have a unique jawless, suction cap like mouth (oral disk). Pouched Lamprey can be distinguished easily from other freshwater fishes by a series of circular openings on the head (gills), the oral disk, and two distinct dorsal fins (eels have a long singular fin). They are similar in appearance to (and are often confused with) Shorthead Lamprey, but have eyes positioned to the side of the body (laterally) and circles of finer teeth on the outer oral disk. Pouched Lamprey are also generally lighter in colour and adults returning to freshwater are larger in size. Note that only males develop a pouch behind the head, and only when they are ready to spawn, hence this character is not reliable for identification. The worm like juveniles (ammocetes) can be distinguished by the alignment of the cloaca (akin to an anus) which is close to the front edge of the dorsal fin.

Former distribution Due to the unusual appearance of lampreys there is a reasonable level of opportunistic historic records held at the SA Museum (comparative to other species), mostly prior to the 1930s, with a few more recent records (>1980) helping to fill in the known distribution. However there is no indication or study relating to their former abundance. Pouched Lamprey has been recorded from four main freshwater areas: (1) in the Adelaide region within and near the larger streams - Torrens from as early as 1886 and Onkaparinga (1901 & 1906) including a record of a sub-adult high up in the catchment at Cox Creek, Bridgwater (1879), (2) the SAMDB (by far the largest are of habitat available) including Coorong/Lower Lakes, tributary streams (Bremer, Angas and Finniss rivers) and lower River Murray (records as far upstream as Mannum in 1932), (3) Kangaroo Island (ammocetes found in a well from a non specific location in 1928), and (4) Lower South East - SA section of the Glenelg River (1928) and from Ewens Ponds (1982). Pouched Lamprey spend part of their lives at sea.

Current distribution The current distribution and abundance of Pouched Lamprey is difficult to ascertain without targeted investigations using suitable gear types as the species is cryptic as both adults and juveniles. However, opportunistic records have diminished and reasonable levels of sampling have occurred within historic habitat including electrofishing and fyke netting in Adelaide Hills catchments, the EMLR, southern Fleurieu Peninsula, Kangaroo Island with no or few records[26,27,28,141], suggesting the area of occupancy in SA is limited and declining. Current records include observations of low numbers of upstream migrating adults at the Torrens River city weir in the middle of Adelaide in 1992, 1998 and 2001[28,101] and Murray Barrages (2002 and 2007)[101,142], with two individuals recently collected from the Piccaninnie Ponds fishway[55].

Biology and habitat The Pouched Lamprey has a multi-staged lifecycle switching between fresh and marine habitat via determined migrations (a diadromous species). The general lifecycle model and biology is reasonably well established for populations interstate (SW Western Australia) but details remain to be confirmed in SA. Adult Pouched Lamprey spend two years at sea where they use their oral disk to latch onto a host fish and feed parasitically. They migrate into freshwater streams and rivers during winter and spring and are able to negotiate small barriers with the aid of their suction cap like oral disc. Spawning occurs the following spring (site poorly known, but likely to be in flowing upper stream sections). Adults don't eat while in freshwater and are generally found amongst structure such as rocks and snags, they die after spawning. Juveniles (ammocetes) are worm like and live in the stream bed, in silty areas with shade and slow permanent flow, a habitat type generally occupying only a small proportion of available river and stream habitat (although again this is poorly known, especially in SA). The ammocetes are filter feeders, consuming algae and zooplankton. Juveniles grow until metamorphosis (change in body form) after around 4.5 years whereby they migrate downstream to the sea during high winter flows[87,143,144,145]. The overall dispersal ability of Pouched Lamprey is unknown, for example whether individuals could disperse to different catchments from adjoining areas or interstate.



Reasons for decline and threats The primary threats to Pouched Lamprey appear to be the interplay of major catchment modifications to hydrology, habitat and fish movement. Reduced stream and River Murray flows (e.g. via extensive farm dam development and water storages in the MLR, massive upstream diversion and storage in the MDB) are predicted to have led to a decrease both in the amount of wetted habitat available, the quality of remaining habitat (e.g. reduced dissolved oxygen and increased temperatures with flow loss) and reduced connectivity into and within catchments for migration (e.g. no access though the barrages since 2007). Broad habitat change from land clearance causes changes in stream flow and morphology, and combined with local impacts such as trampling and removal of edge vegetation by stock, the suitability of streams for larval lampreys is diminished (e.g. loss of shade, disruption of stream bed). Other processes such as dredging (e.g. extensive modification of Eight Mile Creek[57]), drain maintenance, road works or development also represent potential threats to larval and adult habitat. Numerous larger barriers to fish movement exist in the known range of Pouched Lamprey, particularly in the River Murray system (major barriers at the Barrages, Locks and Weirs) and in the Adelaide region through major reservoirs such as Mt Bold and numerous weirs and reservoirs along the Torrens[146]. Such barriers act to restrict access to suitable spawning habitat in parts of catchments or act as partial barriers

reducing adult numbers through exposure to conditions or predators[145]. Introduced animals including trout and Marron (Kangaroo Island) may prey on eggs and juvenile lampreys[147,148].

While there is not direct observational data on decline of Pouched Lamprey, the recent low incidence of detection and a significant decline in the available area and quality of freshwater habitat critical for the species' lifecycle indicates the species is susceptible to loss or extreme fluctuations within catchments and the State. Ongoing reductions in the abundance of individuals in freshwater habitat (both growing ammocetes and returning adults) is also suspected, especially with recent increasing levels of hydrological development[149,150] in stream habitats (e.g. loss of pools and perennial flow), particularly degradation and blocked access through the barrages in the Lower Murray[151] (EN A2c). Specific assessment of available and suitable freshwater habitat may reveal Pouched Lamprey to be more threatened than currently realised. Being cryptic they could equally decline without being noted.

Land tenure and conservation Known to occur in or move through the Ewens Ponds CP, Piccaninnie Ponds CP, Lower Glenelg NP, Coorong NP and Onkaparinga River NP. Other land is managed by councils (e.g. Adelaide City Council), private land (MLR streams) or has public access (e.g. Lower Lakes and River Murray).

Recovery objectives

- Improve knowledge of Pouched Lamprey: (a) distribution and abundance in SA, (b) habitat requirements and tolerances, especially for ammocetes, and (c) migration ability.
- Improve catchment management to assist recovery of Pouched Lamprey by: (a) maintaining or restoring natural flow regimes (habitat availability and condition), (b) re-establishing natural pathways
- for migration (flows and fishways), and (c) restoring suitable freshwater habitats to enable growth and survival of ammocetes.
- Improve awareness on the biological requirements and uniqueness of the Pouched Lamprey.

Conservation actions already initiated

- Initial assessments of distribution undertaken opportunistically from surveys occurring throughout much of the known range of Pouched Lamprey.
- Fishways have been installed at the Barrages and some Locks and Weirs as part of a large MDBA project aiming to restore fish passage between the sea and Hume Weir. Detailed study has been initiated at these fishways[142].
- A fishway has recently been installed at the mouth of the River Torrens (AMLR NRM Board).
- Dredging of Eight Mile Creek is now seen as damaging and alternatives are being sought.

Required conservation actions

- Targeted temporally repeated monitoring to detect the distribution, habitat and behaviour of adult and juvenile Pouched Lamprey, plus other research into dispersal ability at broad and local scales.
- Undertake environmental flow assessment and restoration programs to ensure sustainable surface water and groundwater supplies, including provision for climate change scenarios (especially MLR, plus broader improved management of water resources in the MDB).
- Assess and prioritise barriers potentially impacting migration, investigate fishway options, including studies to test their effectiveness.
- Undertake projects to protect and restore larval habitat, and monitor their effectiveness.
- The lack of information regarding the Pouched Lamprey means that the general public can help by reporting any past or present sightings (www.nativefishsa.asn.au).
- The unique form, complex biology and threatened status of the Pouched Lamprey make them a good icon for the sustainable use and improvement of waterways in SA, especially the Adelaide region. This needs to be fostered through improved education and natural resource management within government and community groups.

Organisations responsible for conservation of species

DEH, PIRSA Fisheries, DWLBC and the KI, AMLR, SAMDB & SE NRM Boards.

Organisations or individuals involved

NFA (SA), SARDI Aquatic Sciences, AMLR NRM Board, SA Water, DWLBC, MDBA.

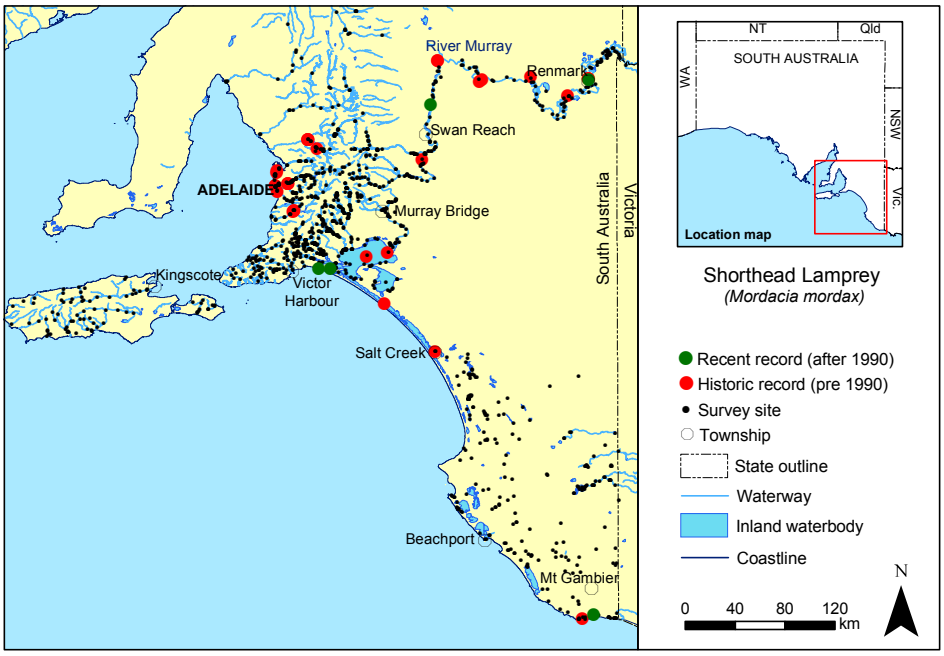
Shorthead Lamprey *(Mordacia mordax)*

Conservation status *South Australia:* Endangered (EN A2c).
National & interstate: not listed.

Taxonomy and identification An eel like fish reaching 50cm, adults have a unique jawless suction cap like mouth (oral disc). Shorthead Lamprey can be distinguished easily from other freshwater fishes by a series of circular openings on the head (gills), the oral disk, and two distinct dorsal fins (eels have a long singular fin). They are similar in appearance to Pouched Lamprey (and are often confused with them) but have eyes positioned towards the top of the body (dorsally) and ridged teeth on the outer oral disk. Shorthead Lamprey are also generally darker blue in colour and returning to freshwater smaller in size than their Pouched Lamprey counterparts. The worm like juveniles (ammocetes) can be distinguished by the alignment of the cloaca (akin to an anus) with the middle of the dorsal fin.

Former distribution Due to the unusual appearance of lampreys there is a reasonable level of opportunistic historic records held at the SA Museum (comparative to other species), with reasonably continuous records of Shorthead Lamprey through to the 1970s[101] from two main freshwater areas: (1) the Adelaide region including the Gawler Catchment (Gawler River and South Para River prior to 1928), Port River estuary (1941 & 1960), Torrens River (1877-1932), Patawalonga Creek, Glenelg (1920) and Onkaparinga River (1880 & 1928), and (2) the River Murray system including the Coorong including Salt Creek (1877-2006), Lake Alexandrina (1938 & 1972) and along the main channel and occasional wetlands of the River Murray including at Waikerie, Overland Corner, Morgan, Berri and Renmark[101]. There are unverified (anecdotal) reports from rivers in the SW of Kangaroo Island and a single record from marine habitat in the SE (both areas have potential habitat). While no investigations were undertaken the species appears to have been reasonably common in the River Murray - large aggregations have been reported clinging to Lock 1 in the past (~1960s). The Shorthead Lamprey was reported to be very common in the River Torrens prior to the construction of the weir at the river mouth in 1937[152], with "many specimens" reported near the Torrens outlet (1951)[153] (note both accounts may have included Pouched Lamprey as there are verified records of both in the system[101]).

Current distribution The current distribution and abundance of Shorthead Lamprey is difficult to ascertain without targeted investigations using suitable gear types as the species is cryptic as both adults and juveniles. However opportunistic records have diminished since the 1970s and despite increased levels of scientific sampling including electrofishing and fyke netting in Adelaide Hills catchments, the EMLR, southern Fleurieu Peninsula, Kangaroo Island and the SE which did not yield any records[25,26,27,28,141]. A few records have come from near to the Murray Mouth with recent intensive and temporally repeated sampling (e.g. Goolwa Barrage, Hunters Creek, Denver Creek on Hindmarsh Island[59,101,142,154]) and two single individuals were recorded along the River Murray channel[155]. Hence combined data suggests the area of occupancy in SA is limited.



Biology and habitat The Shorthead Lamprey has a multi-staged lifecycle switching between fresh and marine habitat via determined migrations (a diadromous species). The general lifecycle model and biology is reasonably well established for populations interstate (Victoria) but details remain to be confirmed in SA. Adult Shorthead Lamprey spend time at sea and in large estuaries where they use their oral disk to latch onto a host fish and feed parasitically. They migrate into freshwater streams and rivers during late winter and spring, being able to negotiate small barriers with the aid of their oral disc. Spawning occurs the following spring (site poorly known, but likely in flowing upper stream sections) with adults not eating while in freshwater and generally being found amongst structure such as rocks and snags. Juveniles (ammocetes) are worm like and burrow into silt, especially along protected banks in shallow slow flowing areas. They probably require permanent flow and shade (they are rarely found in stagnant or highly eutrophic waters). SA juveniles have been recorded near Walkers Flat, River Murray (1960) and in flowing habitat below Lock 1 at Blanchetown (2002). Ammocetes are filter feeders, consuming algae and zooplankton. Juveniles grow until metamorphosis (change in body form) after around 3.5 years whereby they migrate downstream to the sea during high winter flows[87,143,144,148]. The overall dispersal ability of Shorthead Lamprey is unknown, for example whether individuals could disperse to different catchments from adjoining areas or interstate.

Reasons for decline and threats The primary threat to both lamprey species occurring in SA appears to be the interplay of major catchment modifications to hydrology, habitat and fish movement. Reduced stream and River Murray flows (e.g. via extensive farm dam development and water storages in the MLR, massive upstream diversion and storage in the MDB) are predicted to have led to a decrease both in the amount of wetted habitat available, the quality of remaining habitat (e.g. reduced dissolved oxygen and increased temperatures with flow loss) and connectivity into and within catchments for migration (e.g. extended period of no flow). Access through the Murray barrages has been blocked since 2007 owing to very low water availability completing a major decline in predicted population size[151] and quality of the largest section of the species habitat (EN B2c). Broad habitat change from land clearance causes changes in stream flow and morphology, and combined with local impacts such as trampling and removal of edge vegetation by stock, the suitability of streams for larval lampreys is diminished (e.g. loss of shade, disruption of stream bed). Other processes such as dredging (e.g. extensive modification of Eight Mile Creek[57]), drain maintenance, road works or development also represent potential threats to larval and adult habitat. Numerous larger barriers to fish movement exist in the known range of Shorthead Lamprey, particularly in the River Murray system (major barriers at the Barrages, Locks and Weirs) and in the Adelaide region through major reservoirs such as Mt Bold and numerous weirs and reservoirs along the Torrens[146]. Such barriers act to restrict access to suitable spawning habitat in parts of

catchments or acts as partial barriers reducing adult numbers through exposure to adverse conditions or predators. Introduced animals including trout and potentially Marron (Kangaroo Island) may prey on eggs and juvenile lampreys[147,148].

While there is not direct observational data on decline of Shorthead Lamprey, the recent low incidence of detection including a lack of records from the Adelaide region, and a significant decline in the available area and quality of freshwater habitat critical for the species' lifecycle indicates the species is susceptible to loss from extreme fluctuations from catchments within the State. Ongoing reductions in the abundance of individuals in freshwater habitat (both growing ammocetes and returning adults) is also suspected, especially with recent increasing levels of hydrological development[149,150] in stream habitats (e.g. loss of pools and perennial flow). Specific assessment of available and suitable freshwater habitat may reveal Shorthead Lamprey to be more threatened than currently realised, especially regarding deterioration in their main habitat, the River Murray (e.g. lack of access for prolonged periods with low water availability).

Land tenure and conservation Shorthead Lamprey occurs or moves through several conservation reserves along the River Murray corridor (Coorong NP, land managed for conservation at Wyndgate, Ngaut Ngaut CP, Roonka CP, Morgan CP, Murray River NP), as well as numerous council reserves and public riverfront access. Also likely to occur in private lands in stream catchments of the MLR.

Recovery objectives

- Recovery objectives and conservation actions match those for the Pouched Lamprey, except with a stronger emphasis on conservation of the River Murray, and could easily be combined:
- Improve knowledge of Shorthead Lamprey: (a) distribution and abundance in SA, (b) habitat requirements and tolerances, especially for ammocetes, and (c) migration ability.
- Improve catchment management to assist recovery of Shorthead Lamprey by: (a) maintaining or restoring natural flow regimes, (b) re-establishing natural pathways for migration, and (c) restoring suitable freshwater habitats to enable growth and survival of ammocetes.
- Improve awareness on the biological requirements and uniqueness of the Shorthead Lamprey.

Conservation actions already initiated

- Initial assessments of distribution undertaken opportunistically from surveys occurring throughout much of the known range of Shorthead Lamprey.
- Fishways have been installed at the Barrages as part of a large MDBA project to restore fish passage between the sea and Hume Weir. Research has been initiated at these fishways[142].
- A fishway has recently been installed at the mouth of the River Torrens (AMLR NRM Board).
- Dredging of Eight Mile Creek is now seen as damaging and alternatives are being sought.

Required conservation actions

- Targeted temporally repeated monitoring to detect the distribution, habitat and behaviour of adult and juveniles, plus other research into dispersal ability at broad and local scales.
- Undertake environmental flow assessment and restoration programs to ensure sustainable surface water and groundwater supplies, including provision for climate change scenarios.
- Assess and prioritise barriers potentially impacting migration, investigate fishway options, including studies to test their effectiveness.
- Undertake projects to protect and restore known or potential larval habitat, and monitor their effectiveness (also for sites with threatening processes).
- A lack of information means that the general public can help by reporting sightings.
- The Shorthead Lamprey is a suitable icon for the sustainable use and improvement of waterways, especially the River Murray.

Organisations responsible for conservation of species

DEH, PIRSA Fisheries, DWLBC and the KI, AMLR, SAMDB & SE NRM Boards.

Organisations or individuals involved

NFA (SA), SARDI Aquatic Sciences, AMLR NRM Board, SA Water, DWLBC, MDBA.

Freshwater Catfish *(Tandanus tandanus)*

Other common names: Murray Catfish/Tandan, Catfish, Eel-tailed Catfish and Pomeri (Ngarrindjeri)

Conservation status *South Australia:* Endangered (EN A2bc); Protected (*Fisheries Management Act 2007*). *National:* not listed. *Interstate:* listed as Threatened in Victoria (Endangered) also recommended Vulnerable in NSW[74].

Taxonomy and identification Freshwater Catfish is a stout fish reaching a maximum length of 90cm, but more commonly attaining 30-50cm. It has a distinctive appearance due to four pairs of barbells around the mouth and a tapering eel-tail forming part of the body. This fish can be distinguished from other catfishes such as Cooper Catfish and Hyrtl's Catfish by the length of the second dorsal fin which extends to the mid body of the fish from the tail. Sharp spines are present on the dorsal and pectoral fins. There are taxonomic problems with Freshwater Catfish as studies indicate multiple species within the current species description. However only a single inland species is presumed for the MDB and SA[156,157]

Former distribution As with many of the larger edible fishes, verified records such as museum specimens are limited, and no detailed historic assessments of status were conducted. However, general reports indicate it was common throughout the SA section of the River Murray until around the mid 1960s, occurring in the main channel, billabongs[152], wetlands (including channels at Murray Bridge in the 1920s[41]), Lower Lakes and the lower reaches of tributary streams in the EMLR (Finniss River).

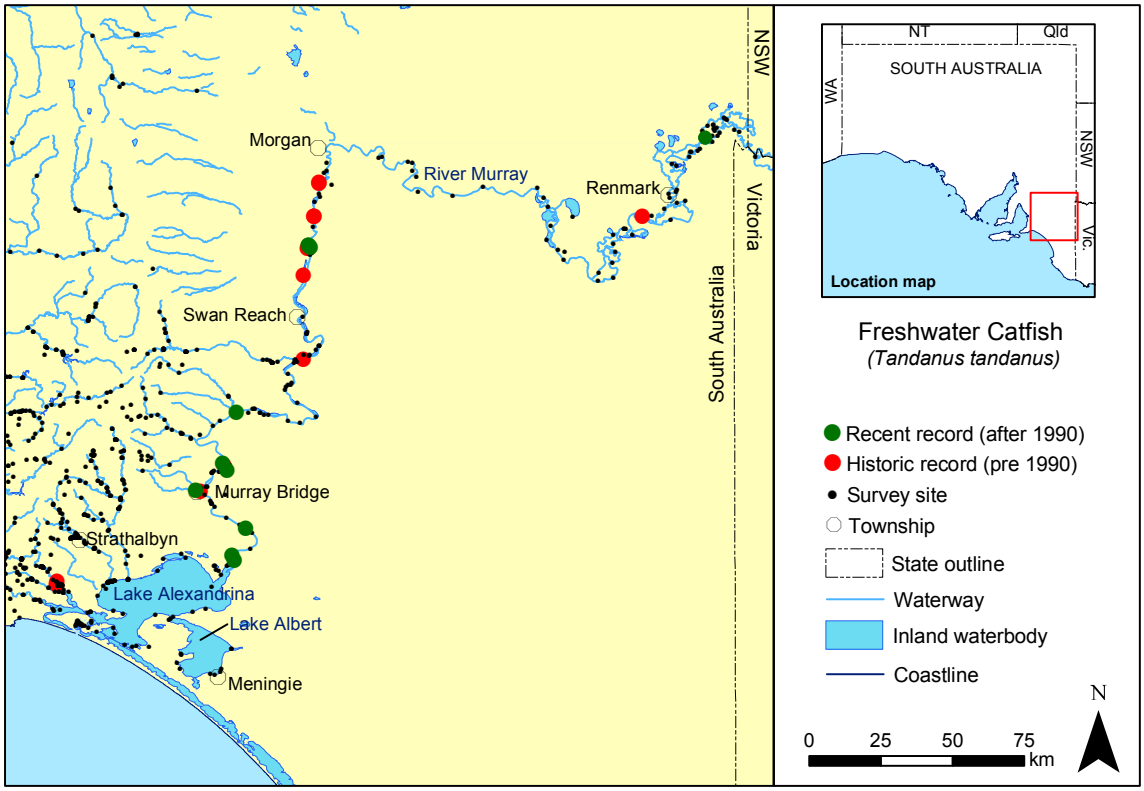
Current distribution The current distribution of Freshwater Catfish is patchy. Recent records are limited to a handful of locations from wetlands and the main Murray channel including juveniles from wetland habitat at Chowilla, Blanchetown, Mypolonga, Murray Bridge, Tailem Bend and Wellington [55,69,70,158,159,160]. Populations established in the WMLR through translocation are known from the Torrens, Wakefield and Field river catchments[28,53,55,65].

Biology and habitat The biology of Freshwater Catfish has not been studied in detail in SA, hence information is largely drawn from interstate studies and from translocated populations in WMLR. Freshwater Catfish prefer slow flowing habitat such as rivers and wetlands with reasonable levels of structure including snags, undercut banks and aquatic plants. They are common over gravel and rock habitat and submerged aquatic vegetation in the Torrens and Wakefield Rivers in sections which receive seasonal flushing flows. Freshwater Catfish are carnivorous feeding on fish, shrimps, freshwater prawns, Yabbies, and other macroinvertebrates which are mostly taken from the river bottom. Reproduction occurs in spring and summer with warmer water temperatures trigger distinctive behaviour as the male builds a large circular nest comprised of various material including rocks, course sand and gravel, which he guards actively. The larvae hatch and disperse away from the nest. Fish mature from 2-5 years of age and probably can live for 12 or more years[87,161]. Freshwater Catfish do not appear to undergo long-distance movements in South Australia[162].

Reasons for decline and threats Anecdotal information indicates that Freshwater Catfish almost disappeared from the River Murray after the 1960s, prior to this they were considered to be in high abundance. Trends in commercial fishing catch, as an approximate index of population size, illustrate the decline with catches progressively diminished to very low levels by 1980 which have not recovered (Figure 9). The reduction in catch plus limited current research records suggests a conservative estimate of decline over the last three generations (assume generation time of 10 years) of at least 50% (EN A2b) presumably due to declining environmental conditions or a failure to deliver suitable conditions or flows for recovery (EN A2c).

The reasons for a significant decline of Freshwater Catfish and current threats limiting population recovery remain poorly understood. Long periods of low flow and subsequent settlement and build up of silt is likely to interfere with their bottom feeding behaviour (smother productive surfaces), nesting requirements (coarse particles being covered with fine silts), and general habitat requirements (loss of structure and aquatic vegetation). Hence significant river regulation and loss of flow volume (only one third or less of the natural flow now reaches SA) and flushing flows/floods on the River Murray are likely to be a long term threat. Alien species may also be contributing to the decline of Freshwater Catfish. There is overlap in the diet and habitat of both juvenile and adult Freshwater Catfish and Carp in the River Murray implying the potential for competition or direct interaction (e.g. disturbance of nests) between the two species, especially considering the high abundance Carp in lowland river reaches including the SA River Murray[134,163,164]. Freshwater Catfish numbers appear to have declined before the arrival of Carp, but subsequent invasion and proliferation of Carp may have limited any potential recovery (Figure 9).

Land tenure and conservation Occurs along the River Murray corridor which incorporates several State Reserves (e.g. Chowilla GR, Murray River NP, Morgan CP, Roonka CP, Ngaut Ngaut CP) as well as numerous council reserves (specifically including Rocky Gully Wetland Council Reserve) and public riverfront access (introduced population occurs along the Torrens Linear Park).



Recovery objectives

- Restore environmental conditions to improve habitat quality and promote a self-sustaining population.
- Protect an adequate spawning population of adult Freshwater Catfish.
- Better define species biology in SA (e.g. recruitment, flow and habitat requirements).
- Develop an appropriate index to track population status.

Conservation actions already initiated

- Freshwater Catfish are protected from exploitation through fisheries legislation (generally well accepted by the community).
- The Living Murray Initiative aims to restore flow regimes to key ecological assets including the River Murray channel important for Freshwater Catfish recovery.
- A Recovery Plan has been prepared for Freshwater Catfish across its range (MDB) and this serves as an additional guide to recovery principles and actions for SA[164].

Required conservation actions

- Environmental flow programs to provide appropriate conditions for breeding and recruitment (monitored for effectiveness).
- Obtain fisheries independent monitoring data on Freshwater Catfish habitat use, important spawning sites or regions, abundance and demography to more fully explore status and population trends, especially in relation to environmental conditions. Disseminate research findings to the public.
- Continue education and enforcement of Protected status, encourage reporting of incidental captures (e.g. location and fish length) to help improve knowledge on status.
- Undertake study of the introduced populations in the Torrens to better understand conservation requirements in natural habitat.

Organisations responsible for conservation of species

PIRSA Fisheries, DEH, SAMDBNRM Board, DWLBC.

Organisations or individuals involved

SARDI Aquatic Sciences, PIRSA Fisheries, MDBA, DWLBC.

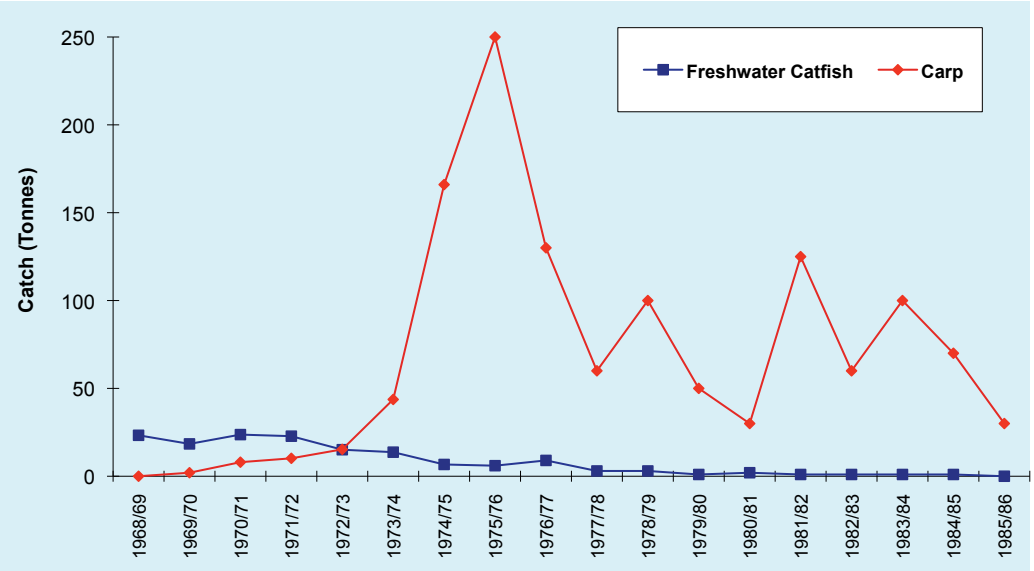


Figure 9. Catch data for Freshwater Catfish (compared to Carp) from the SA River Murray Commercial Fishery between 1968-1986 based on SA Fisheries Statistics[165].

Rudie Kuiter

Australian Grayling *(Prototroctes maraena)*

Other common names: Cucumber Mullet

Conservation status *South Australia:* Endangered (EN B2ab(ii,iii)).
National: Vulnerable (*EPBC Act 1999*). *Interstate:* listed as Threatened in Victoria (Vulnerable) and Tasmania and is Protected in New South Wales.

Taxonomy and identification A slender silvery fish reaching a size of 30cm, but commonly 15-18cm; has a distinctive cucumber odour when freshly caught. This species can be confused with various species of mullet which occur in freshwater, but it has a distinctive adipose fin (small fleshy fin) between the dorsal fin and tail, and the pectoral fin sits below rather than at the upper edge of the gill cover. Migrating juveniles are similar to juvenile galaxias (but have an adipose fin) and very similar to Smelt (but there are slight differences in fin and head shape).

Former distribution Lower South East SA is the very western limit of the species distribution. One verified (photographic) record from Ewens Ponds (part of the Eight Mile Creek system) in 1982[48] and other anecdotal reports from a similar time period in nearby Stratmans Pond (Deep Creek system) (EN B2a). Piccaninnie Ponds is also mentioned as recorded habitat, but without verification[166].

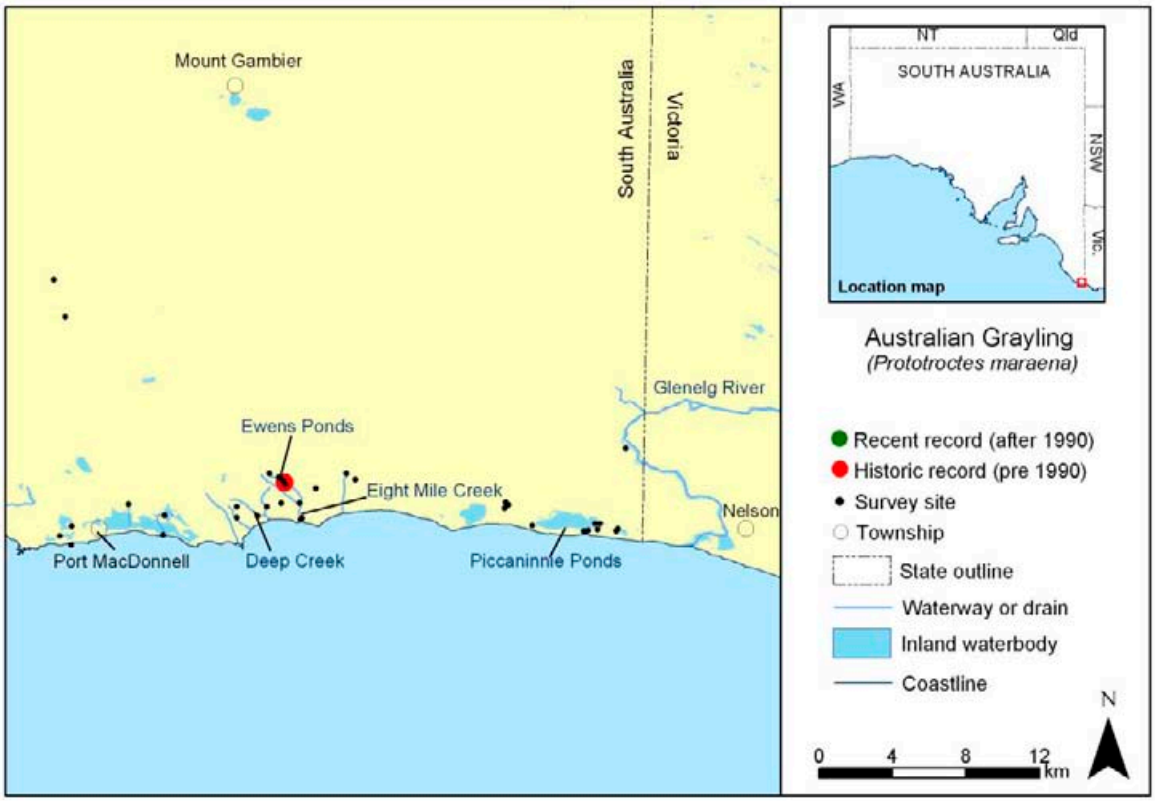
Current distribution No recent records despite a reasonable level of sampling in historic habitat[23,55,] potential habitat includes streams with coastal access in the LSE. It is unknown whether the Australian Grayling was a permanent inhabitant (sustaining population) in SA, and/or whether it had, and could again have, occasional individuals in the State due to migration of juveniles from nearby source habitat in Victoria.

Biology and habitat Unknown in South Australia. It is diadromous, with spawning in Victoria taking place during autumn whereby larvae are swept to sea. The young return to freshwater in spring. Habitat interstate is reported as deep pools and clear streams with moderate flow (i.e. matching rising spring habitat of the Lower South East well). A schooling species reported to be quite shy, fleeing when disturbed. The Australian Grayling lives for three to five years, with most fish reaching two years of age. It feeds opportunistically on algae, and aquatic and terrestrial insects[87,167.]

Reasons for decline and threats Threats to the presence of Australian Grayling in South Australia are likely to be linked to those interstate (i.e. source fish) and the suitability of habitat for adults. A reduction in habitat condition and suitability may have occurred from continual stream modifications (e.g. dredging on Eight Mile Creek), human activity and disturbance to a shy species (e.g. heavy recreational use of Ewens Ponds) and reducing stream discharge noted in the Lower South East springs (EN B2b(ii,iii)). Other general threats include the construction of migration barriers without adequate fish passage and the potential for predation from introduced trout (not currently present in the LSE).

Land tenure and conservation

- Ewens Ponds Conservation Park and other land managed by the SEWCDB.



Recovery objectives

- Improve conditions at potential habitat.
- Continual monitoring for presence and assess status in the wild.
- Gain a better understanding of biology and habitat in South Australia (if species is recorded).
- Increase awareness and reporting on the species presence.

Conservation actions already initiated

- Surveys in historic habitat.
- Review of dredging procedure for Eight Mile Creek.
- Hydrological and groundwater investigations initiated.
- A fish ladder has been installed on a weir at Piccaninnie Ponds.

Required conservation actions

- Protect and restore groundwater discharge to rising springs of the Lower South East.
- Undertake riparian habitat restoration along Eight Mile Creek and Deep Creek to improve stream side shelter and bank stability.
- Determine if the species remain in SA through ongoing surveys and movement studies to detect if juvenile migration is occurring (and hence recruitment to adult habitat is an issue).
- The lack of information regarding the Australian Grayling means that the general public can help by reporting any past or present sightings (www.nativefishsa.asn.au).

Organisations responsible for conservation of species

DEH, DEWHA, SENRM Board, DWLBC, SEWCDB.

Organisations or individuals involved

NFA(SA), DEH, SEWCDB,SENRMB, DWLBC.

Spotted Galaxias *(Galaxias truttaceaus)*

Other common names: Muddies, Mountain Trout or Trout Minnow

Conservation status *South Australia:* Endangered (EN B2ab(ii,iii)).
National & interstate: not listed (however a related subspecies from SW Western Australia is Critically Endangered (*EPBC Act 1999*) and Protected in WA).

Taxonomy and identification A long stout fish, reaching 24cm but more commonly 14-18cm. Adults are easily distinguished from other galaxias by uniform dark body spots (e.g. Common Galaxias can be speckled). This species is sometimes confused with the alien species Brown Trout, but Spotted Galaxias lack scales and an adipose fin (small fleshy fin between the dorsal and tail fin). Whitebait juveniles can be distinguished by a black band on the tail and a lack of speckling on the head.

Former distribution Historic data is lacking for this species, but it has likely always been restricted to specific cool flowing habitats of the Lower South East in the Port MacDonnell area. The first verified record was from Eight Mile Creek in 1979[101], with anecdotal reports the species was common in the same location in the 1950s[55].

Current distribution Cool groundwater fed habitats (spring pools and flowing creeks) of a small section of the Lower South East including the Eight Mile Creek and Deep Creek systems (i.e. Ewens, Stratmans and 54 Foot ponds)[124] with recent (2006 & 2007) records from the outflow from Piccaninnie Ponds[55] (the Ponds formerly drained toward the Glenelg River, but an artificial outlet was constructed in the 1930s) (ENB2a).

Biology and habitat Occurs in cool flowing habitat and spring pools amongst dense edge submerged or emergent vegetation, and is secretive and active during low light conditions[23,55]. Biology in South Australia is little known but spawning was recently documented at Piccaninnie Ponds in June[55]. In coastal Victoria and Tasmania the species is diadromous with adults spawning in autumn-winter with a possible downstream spawning migration. Larvae are swept to sea and return to freshwater habitat in spring to summer as transparent juveniles (one of the species collectively known as whitebait). Food includes aquatic and terrestrial invertebrates[76]. It is unknown whether recruitment of juveniles and hence adult occupation of the Lower South East occurs from local spawning and/or migration from nearby populations in Victoria.

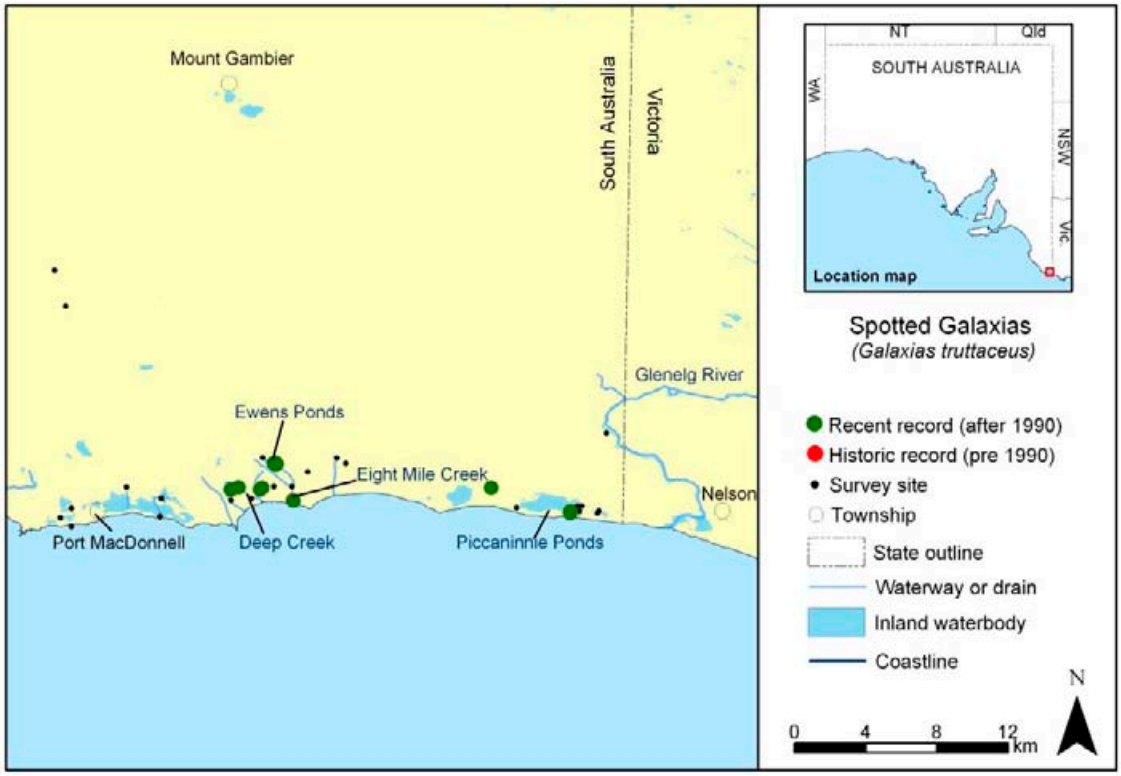
Reasons for decline and threats Degradation of stream and pond edge habitat (e.g. through drainage practices and stock access) and reduction in spring discharge are considered primary, ongoing threats (EN B2b(ii,iii))[94,125]. Any new barriers to fish passage should be strongly avoided due to the migratory nature of this species. A Tasmanian study provides strong evidence that Brown Trout adversely affect Spotted Galaxias[168] and hence illegal introductions of salmonids into habitat such as Eight Mile Creek could have negative consequences. The shy nature of the species may mean it is sensitive to human use of aquatic habitats (e.g. Ewens Ponds).

Land tenure and conservation

- Occurs in the Ewens Ponds CP, Piccaninnie Ponds CP and on land managed by the SEWCDB.

Recovery objectives

- Secure and restore core adult habitat.
- Monitor species abundance and recruitment to assess population trends.
- Increase awareness and reporting on the species presence.



Conservation actions already initiated

- Baseline surveys to detect presence and distribution have been undertaken.
- A fish ladder has been included and constructed within a weir designed to restore the natural pool level of the Piccaninnie Ponds region (the species has been shown to utilise the ladder)[169].
- Fish identification sheets have been developed[121] to help assist divers and the community with recognising and reporting the species (e.g. due to its larger size and appearance it is sometimes confused with trout and may be the target of well-meaning control for the alien species).

Required conservation actions

- Develop a monitoring program for adults (low impact or remote survey) and juveniles (i.e. targeted movement study) to assess population trends and recruitment.
- Protect and restore groundwater discharge to rising springs of the Lower South East.
- Undertake riparian habitat restoration along Eight Mile Creek and Deep Creek to improve stream side shelter and bank stability.
- The lack of information regarding the Spotted Galaxias means that the general public can help by reporting any past or present sightings (www.nativefishsa.asn.au).

Organisations responsible for conservation of species

DEH, SENRM Board, DWLBC, SEWCDB.

Organisations or individuals involved

NFA (SA), DEH, SENRM Board.

River Blackfish *(Gadopsis marmoratus)*

Other common names: Slipperies, Slimies, Black Perch and Freshwater Blackfish

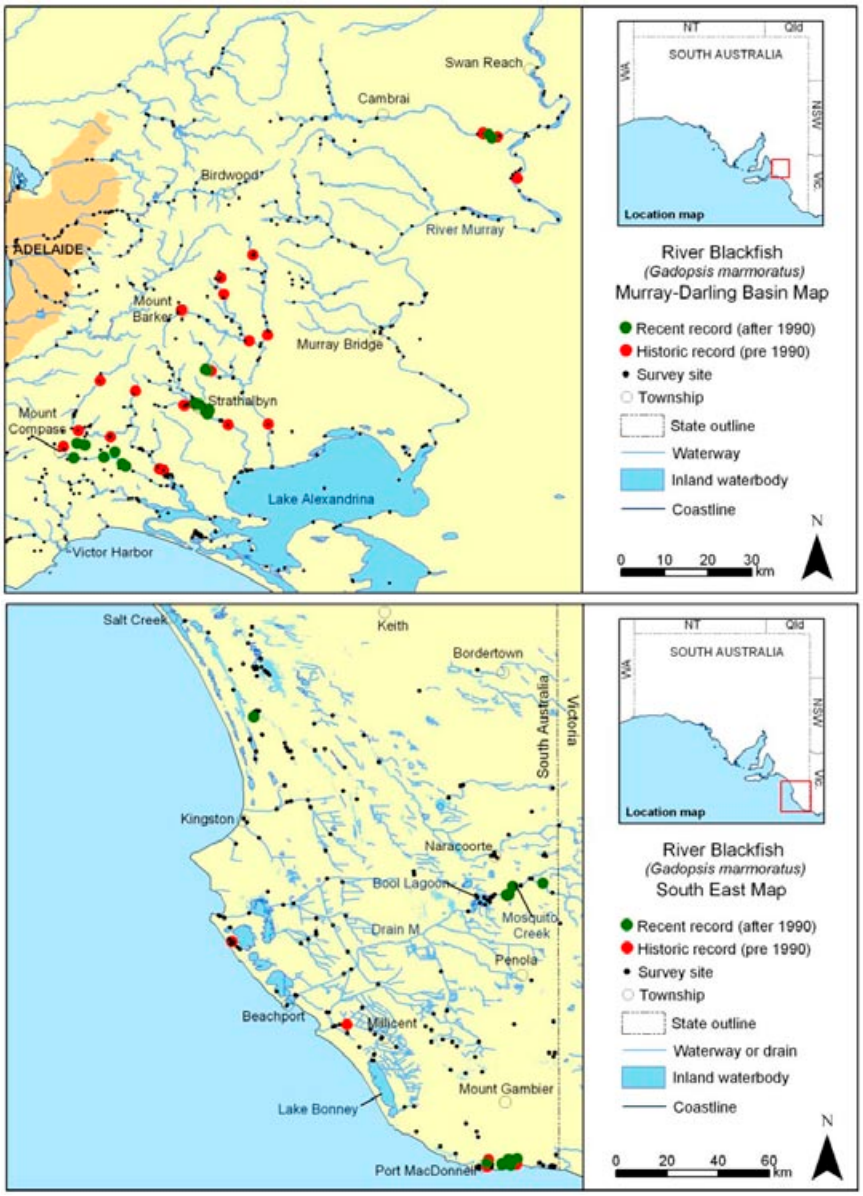
Conservation status *South Australia:* Endangered (EN B2ab(i,ii,iii,v)); Protected (Fisheries Management Act 2007).
National & interstate: not listed.

Taxonomy and identification A medium sized, elongate and slender species reaching a size of 35cm (commonly15-20cm) in South Australia. Most often confused with Climbing Galaxias (both are slippery, dark in colour and similar in size as adults), however there are numerous features for distinguishing the two – River Blackfish have small scales present, a long dorsal fin (> half body length) and unique modified pelvic fins which have single branched rays (finger-like). Two forms of River Blackfish occur in Australia essentially in systems north and south of the Great Dividing Range – a 'northern' form occurs patchily in the MDB and SESA/Glenelg River system, and a 'southern' form is found in the remainder of coastal Victorian catchments and northern Tasmania. There is genetic and morphological evidence to suggest that the two forms are distinctive at the species level, and two valid species should eventually be recognised[130,170,171].

Former distribution Occurred widely in the SAMDB in tributary streams with records from the Tookayerta, Finniss (including Meadows Creek and Bull Creek), Angas (including Dawson Creek), Bremer and Marne catchments[25], and the main channel and anabranches of the River Murray[44,101]. In the SE, records are patchy and from widespread locations including Henry Creek (USE, 2001), Robe Lakes (1903), near Millicent at Rendelsham (1944), Mosquito Creek and several locations in the Lower South East around Ewens Ponds and Eight Mile Creek (it is likely they had a more continuous distribution in the SE but historic data is limited). There is a single enigmatic record from Kangaroo Island in 1987, with no specific collection details[101]. Reports from the Torrens and Onkaparinga rivers were made in the early 1900s which came from an authoritative source but without verified records[28,172], and their presence here remains to be confirmed.

Current distribution The River Blackfish has undergone a significant and continuing decline. Its area of occupancy is now well less than 500km^2, with only six fragmented locations remaining (EN B2ab(i,ii,iv)). In the SAMDB there have been no verified records from the River Murray for at least 50 years, but four small populations remain in restricted refuges of the Eastern Mount Lofty Ranges – the Tookayerta Creek Catchment (~20km^2); a ~2km section of the Angas River; a single pool on Rodwell Creek (Bremer Catchment); and a <1km section of the lower Marne River. The species appears to have disappeared from the Finniss Catchment. Habitat in the EMLR has contracted considerably since the mid 1990s with the demise of groundwater fed springs[25]. In the South East, recent local extinction has occurred at Henry Creek[112], and at Mosquito Creek River Blackfish has experienced significant habitat change with pool drying and loss of spring flow during the last 10 years,

reducing the population to individuals only in 2008, a 90% reduction from 2006 data[94]. Reasonable populations remain in the Ewens Ponds region, however decline in groundwater flow and habitat deterioration has also been noted here recently[23,55,94,173]. The species is presumed extinct from Kangaroo Island and the Upper River Torrens after extensive sampling failed to locate the species[26,28].



Biology and habitat Remaining habitat for River Blackfish in SA comprises large, deep, spring fed pools or flowing stream sections, with an abundance of emergent (fringing) vegetation (e.g. Reeds) or snags. All habitats have some form of linkage to groundwater to secure water supply (historically at least). River Blackfish is a nocturnal predator consuming larger macroinvertebrates such as shrimp and caddis fly larvae and the occasional small fish. Spawning is thought to occur in late spring in hollows or within undercut banks[39,55]. The species probably lives for 4-5 years and is not known to move large distances, instead occupying relatively small home ranges for most of the time[174]. Larvae and first year juveniles (0+) have a heavy dependence on cover such as leaf litter or emergent and riparian vegetation[55,175].

Reasons for decline and threats The recent loss of known localities relates to a decline in the extent and quality of habitat which is projected to continue with existing and potential threats (EN B2b(iii)). The primary reason for recent decline and the principal threat to remaining populations is the loss of permanent flow to stream sections as a result of water abstraction and extraction. This has been exacerbated by recent dry climatic conditions and could conceivably become worse with predictions of climate change. Other factors likely stressing remaining populations include reduced water quality (e.g.

stormwater and other pollution and increasing salinity), interaction with the alien predatory fishes Redfin, Brown Trout and Rainbow Trout (i.e. predation, competition and disease), habitat loss limiting available cover, sedimentation (infilling pools and habitat), and channel alterations and disturbance (e.g. from ongoing dredging of Eight Mile Creek[57]). Some historic reasons for decline are less tangible but may include flow regulation on the River Murray eliminating suitable habitat (e.g. weir pools instead of flowing river and high turbidity), initial interactions with alien fishes, widespread use of toxic pesticides following WWII[25,176,] fishing pressure, and general habitat degradation or pollution from land clearance or mining (e.g. Mt Barker and Dawesley creeks)[25].

Land tenure and conservation All known localities in the SAMDB are on private land and most are managed for conservation except for a strip of Council Reserves in Strathalbyn. In the South East the species has been recorded in the Naracoorte Caves Conservation Park and private land on Mosquito Creek (which includes at least one section fenced from stock). In the Lower South East the species occurs in Ewens Ponds Conservation Park and on Drainage Reserves, road crossings and private land.

Recovery objectives

- Secure required environmental conditions (especially permanent flow) at remaining populations.
- Establish and monitor relationships to environmental conditions, especially with any changes in management and environmental conditions.
- Urgently increase the area of occupancy in critical areas by protecting and restoring habitat.
- Ensure that all key stakeholders are aware of populations and potential threats (awareness).

Conservation actions already initiated

- Remaining and historic range relatively well established (including survey and oral history).
- Initial local biological investigations undertaken.
- The water resources of the Marne River Catchment have been prescribed and an environmental flow study undertaken[177] with other EMLR catchments to follow.
- A project has been initiated which aims to integrate surface water management in the Mosquito Creek Catchment.
- Protected from fishing pressure under the *Fisheries Management Act 2007.*
- Recent drought related response has included artificial watering at Rodwell Creek, and captive maintenance programs for fish from Rodwell Creek and Mosquito Creek[120,178].

Required conservation actions

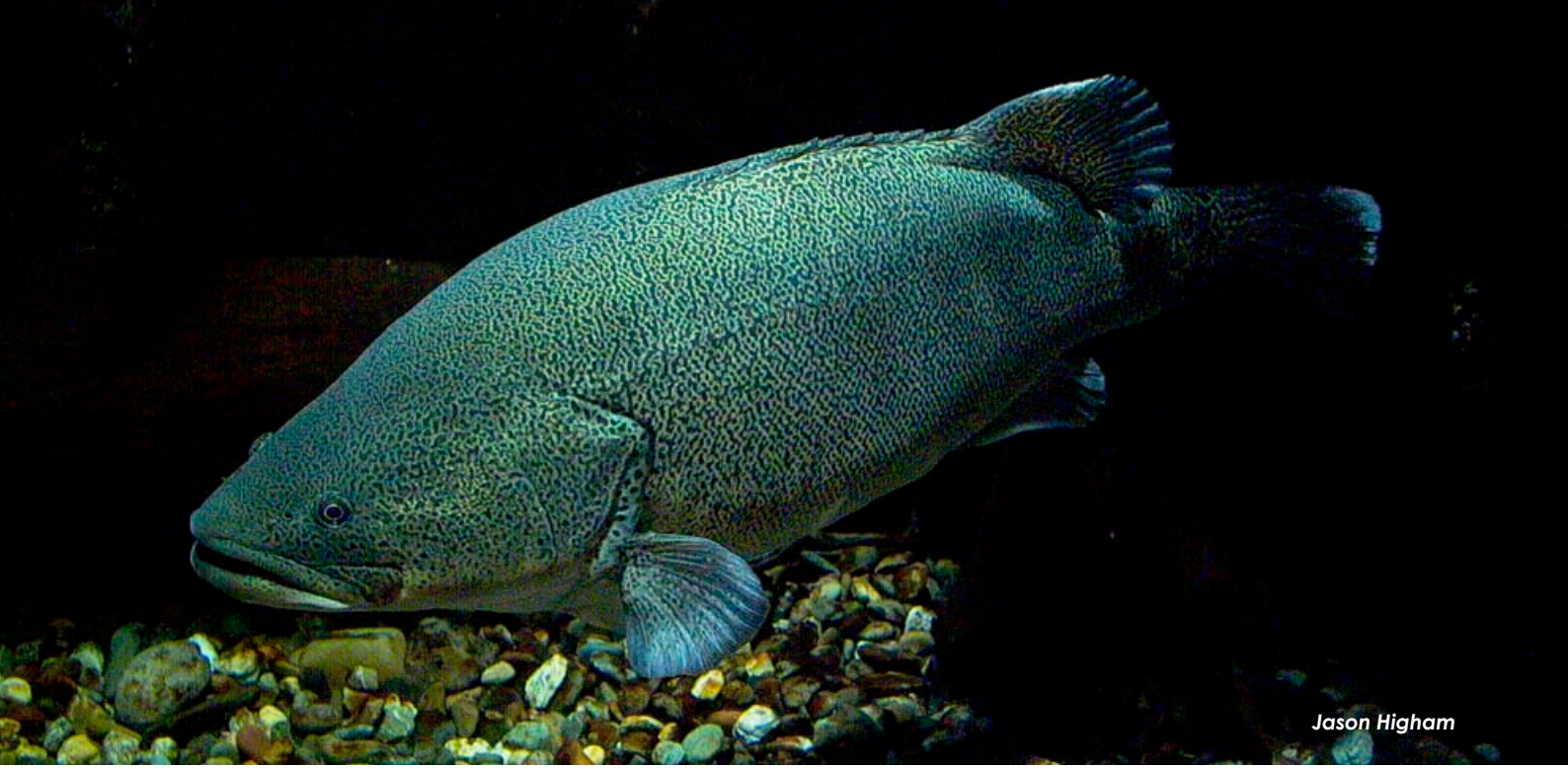
- Secure groundwater sources in key areas, including surface water management (i.e. recharge) and establish contingency plans for critically threatened populations.
- Continue and initiate urgent conservation measures in response to critical threats (e.g. artificial watering of habitat, captive maintenance).
- Develop sound understanding of hydrology surrounding remaining populations as part of Environmental Water Requirement Studies.
- Continue population monitoring and research, especially EMLR[179] and Mosquito Creek (SE).
- Manage physical (e.g. nutrients, stormwater) and biological (alien fishes) pollutants.
- Establish long-term government and community support structures to promote the River Blackfish within regional planning, management, restoration and education.
- Ensure that restoration programs in the known range of River Blackfish include a prior assessment for presence and consider species requirements carefully as in some cases the species relies on altered conditions (e.g. shade and structure from willows).

Organisations responsible for conservation of species

DEH, PIRSA Fisheries, SAMDB & SE NRM boards, SEWCDB, USE Program, Alexandrina Council.

Organisations or individuals involved

NFA(SA), SAMDB & SE NRM boards, DEH, SEWCDB and various Landcare/Catchment groups.


Jason Higham

Murray Cod *(Maccullochella peelii peelii)*

Other common names: Cod and Ponde (Ngarrindjeri)

Conservation status *South Australia:* Endangered (EN A2bcd).
National: Vulnerable (*EPBC Act 1999*). *Interstate:* listed as Threatened in Victoria (Endangered).

Taxonomy and identification Murray Cod is Australia's largest freshwater fish attaining lengths of to 1.8m, but more commonly 0.3-1.2m. Quite distinctive in appearance but sometimes confused with the similar Trout Cod from which it is distinguished by its equal length jaws and marbled body markings extending onto the gill covers.

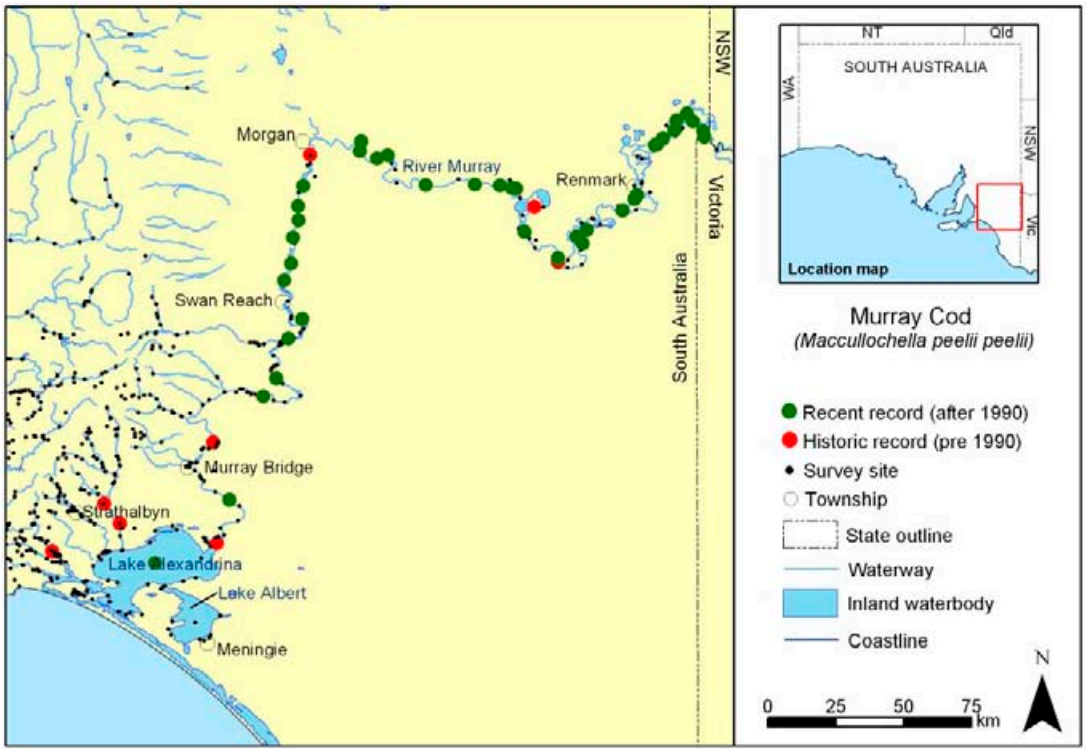
Former distribution The number of verified specimens is limited and mainly relies on oral history and fisheries records for this distinctive, well-known species (some records may have been confused with Trout Cod). Murray Cod was common along the length of the SA River Murray and connected anabranches, as well as the Lower Lakes and the lower sections of streams draining from the Mount Lofty Ranges (especially Bremer River[25]). Possibly present naturally in Burra Creek[52]. Early records (1920s) indicated juveniles were common in some wetland habitat (drains) along the Lower Murray at Murray Bridge[41].

Current distribution The current area of occupancy of Murray Cod remains similar, but it is now more commonly recorded upstream of Swan Reach, with a general decline noted in the River Murray below Mannum, Lower Lakes and Mount Lofty Ranges region (e.g. local extinctions in lower reaches of Mount Lofty Ranges streams[25]). The species has been translocated into various dam and stream habitats in the western Mount Lofty Ranges and the Cooper Creek[1,180] (probably from fish sourced from interstate hatcheries rather than SAMDB stock). Juvenile fish have not been recorded in recent wetland sampling[35,69,70,181].

Biology and habitat Most biological study on Murray Cod has occurred interstate and hence SA research is still required to confirm patterns observed elsewhere[182]. Both juvenile and adult Murray Cod are predators, consuming larger prey including Yabbies, shrimp and fish. Adult Murray Cod generally occur in river channels or larger flowing anabranches in or near deep holes with cover in the form of rocks, fallen timber or tree stumps. Spawning occurs in spring and early summer when water temperature reach 15-20°C. The eggs are attached to solid objects such as hollow logs, rocks and cavities in clay banks and the male guards and fans the eggs until larvae hatch[88]. Adult condition and recruitment appears to benefit from flooding (especially sequential flood years in SA[182]), with and important small breeding areas at the Chowilla anabranch system where there is in-channel flow[160]. Fish mature after around 4 years (variable in size) and the species is long lived with fish aged 20-50 years old recorded[183,184]. Individual Murray Cod often have a defined local home range or territory, however long distance migrations have been noted at certain times especially around the spawning period and high flow which is thought to relate to upstream migration to spawn followed by a return to their home range[162].

Reasons for decline and threats The decline of Murray Cod as a common River Murray fish likely relates to numerous historic changes such as extensive snag removal (i.e. fallen trees) to aid navigation and recreation, general habitat transformation, and movement barriers from Locks and Weirs, large early catches representing overfishing, and the introduction of fishes which compete for food or modify habitat conditions (i.e. Redfin and Carp). An overarching and continuing threat however, is reduced and altered flow patterns from massive upstream regulation and abstraction (Figure 10) which appears to interfere directly in Murray Cod ecology or impact ecological processes (e.g. food resources and appropriate habitat for juveniles). The River Murray now receives on average only a third of natural flow volumes and the frequency, magnitude and timing of floods have been dramatically altered[185,186]. Reduced flows and related poor water quality may also lead to fish kills as seen interstate recently.

Trends in commercial fishing catch, as an approximate index of population size, indicate a significant reduction (decline) since the 1950s of at least 30% over the last three generations, assuming a generation time of 20 years (Figure 10). Declines were dramatic during the 1960s, and catches remained very low through to the 1980s, resulting in a prohibition from fishing in the early 1990s. Slight increases in catch occurred in 2000-2002 following a successful recruitment event[182], but further declines are likely through if poor flow and related habitat conditions continue to limit recruiment[187] (EN A2bc). The low number of mainly large individuals from a few specific cohorts (i.e. individuals from a particular spawning event) are susceptible to exploitation by legal and illegal recreational fisheries (EN A2d)[182,187]. Stocking of hatchery reared Murray Cod is an additional threat to SA stocks (e.g. genetic pollution and reduced genetic diversity[188]).



Land tenure and conservation Occurs along the River Murray corridor which incorporates several State Reserves (Chowilla GR, Murray River NP, Morgan CP, Roonka CP, Ngaut Ngaut CP) as well as numerous council reserves and public riverfront access.

Recovery objectives

- Restore environmental conditions to promote a self-sustaining population.
- Protect an adequate spawning biomass of adult Murray Cod[182].
- Better define biology in South Australia (recruitment, habitat requirements, migration).
- Develop an appropriate index to track population status.
- Maintain and enhance the high profile of Murray Cod as a tool for conservation.

Conservation actions already initiated

- SARDI Inland Waters have been monitoring Murray Cod in the SA River Murray over recent years, including recruitment[187].
- The Living Murray Initiative aims to restore flow regimes to key ecological assets including the Chowilla region which is important for Murray Cod recovery[83].
- Fishways have and continue to be constructed and monitored on major barriers to fish movement on the River Murray.
- A habitat restoration pilot study involving returning large snags to the River Murray has been initiated at Mypolonga to improve habitat and provide spawning sites for species such as Murray Cod.
- A National Recovery Plan is being prepared, with a vision for future recovery being: 'Self-sustaining Murray Cod populations managed for conservation, fishing and culture'. This will contain more detailed Recovery Objectives and Actions applicable to SA.
- Fisheries regulations to protect breeding stock including moratoriums.

Required conservation actions

- Environmental flow programs to provide appropriate conditions for breeding and recruitment.
- Establish more habitat protection and restoration areas (Cod need snags!).
- Obtain fisheries independent monitoring data on Murray Cod abundance and demography to more fully explore status and population trends, especially in relation to environmental conditions. Disseminate research findings to the public.
- Manage the recreational fishery for Murray Cod in a sustainable manner while recognising the social, economic and recreational value of the fishery. Potentially provide fishing free refuges to protect breeding stock and promote safe handling of large fish (anglers and researchers).
- Involve the community in the conservation and management of Murray Cod to increase education on threats and requirements. Document the significance of Murray Cod in the community and harness
- aspects in conservation initiatives and education.

Organisations responsible for conservation of species

DEH, PIRSA Fisheries, DEWHA, SAMDB NRM Board, DWLBC.

Organisations or individuals involved

SARDI Aquatic Sciences, PIRSA Fisheries, SAMDB NRM Board, DEWHA, Greening Australia (SA), Mannum to Wellington LAP.

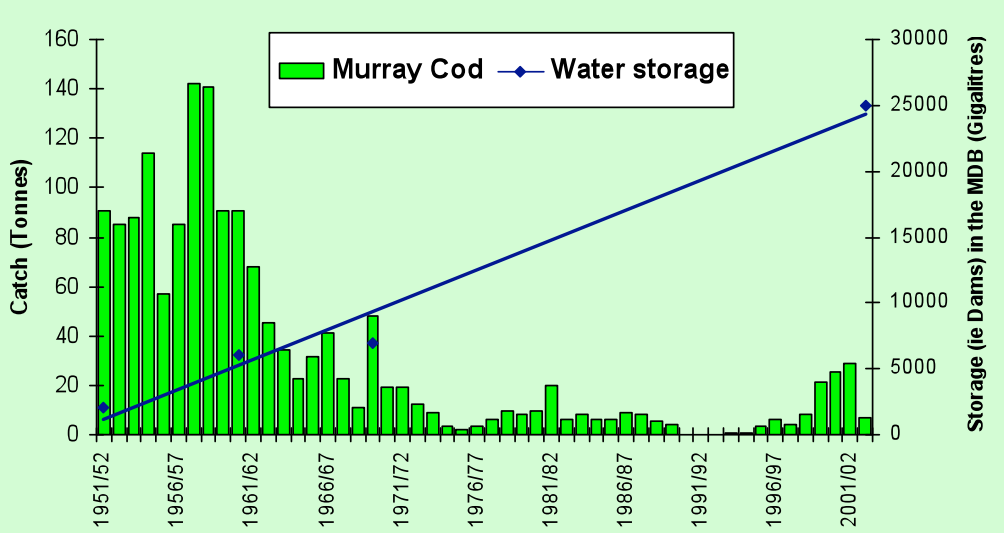


Figure 10. Catch data for Murray Cod from the SA River Murray Commercial Fishery (between 1951-2003) based on SA Fisheries Statistics[83,163,165,182,189,] with comparison of water storage capacity[83] in the Murray-Darling Basin (i.e. the potential holdings of large dams and reservoirs).

Estuary Perch *(Macquaria colonorum)*

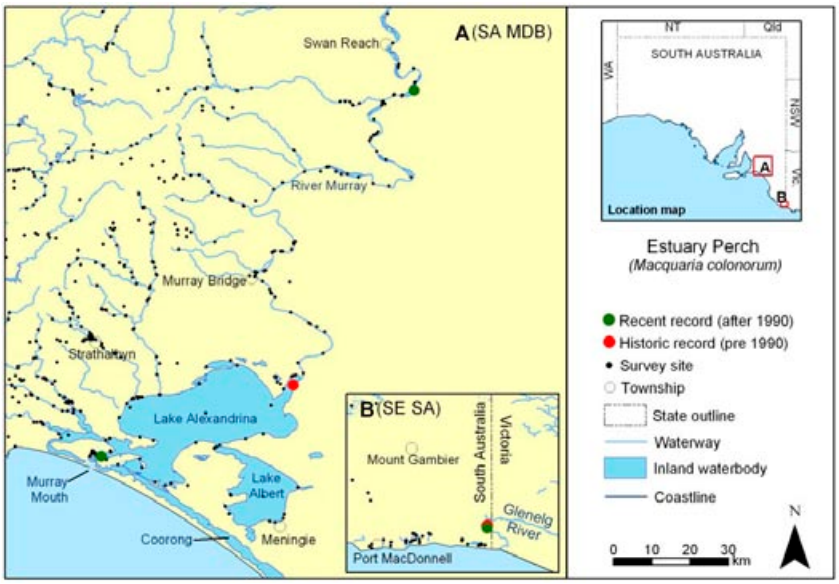
Other common names: Salt Water Perch and Taralgi (Ngarrindjeri)

Conservation status *South Australia:* Endangered (EN B1ab(iii,v)).
National & interstate: not listed.

Taxonomy and identification A medium sized species, up to 75cm in length but more commonly 30-40cm. In the River Murray system it was and can be mistaken for a colour variety of Murray-Darling Golden Perch (Callop)[44], however it can be distinguished from Callop and juvenile pygmy perches by its forked tail fin, and it has a much larger mouth than pygmy perches and Silver Perch.

Former distribution The Estuary Perch has been recorded from the small section of the Glenelg River (specimens from 1932 and 1986) which flows through SE SA, and the lower reaches of the SAMDB. It was apparently rare in the Lower River Murray channel (SA Museum specimens taken in 1932 and 1963). Professional fisherman reported it to be more common around Lake Alexandrina and especially within a few kilometres of the Murray Mouth prior to the construction of the Barrages (late 1930s). Estuary Perch was thought to be reasonably abundant prior to European settlement as it was well known by the Ngarrindjeri people[190].

Current distribution Remains restricted to two locations (EN B1a), and has declined significantly at one of these, the SAMDB (EN B1b(iii,v), where adult fish have only been taken occasionally in recent years (e.g. Mundoo Channel (freshwater) in 1990 and River Murray at Nildotte near Swan Reach in 2002[101]). Confirmation has been made of the presence of Estuary Perch in the Glenelg River recently[55] including occasional records from anglers, however abundance here is unknown.



Biology and habitat The Estuary Perch is associated with estuaries with freshwater influence, occurring in brackish or lower freshwater reaches of rivers and lakes in or upstream of tidal influence (SA). Juveniles have been recorded over rocky and sheltered habitats in the Glenelg River SA in summer in half strength sea water[55]. Biology in SA, especially the SAMDB, is unreported, but fish recorded near the Murray Mouth may have been congregating for spawning or were within their preferred habitat. Interstate, the species is known to feed on crustaceans and fish. Adults mature after 2-3 years and migrate downstream to near the mouth of estuaries to spawn (diadromous) during winter to spring before moving back to their preferred habitat which includes areas with structure (e.g. snags). Eggs and larvae are thought to be swept to sea or lower estuaries[88,191]. It is unknown whether populations in the SAMDB were self-sustaining or relied on migration from other populations to the south east in Victoria.

Reasons for decline and threats Given that the Estuary Perch prefers estuarine environments and has a need to move to spawning habitat in lower river reaches, the primary reason for its decline in the SAMDB relates to a continuing decline in the area and quality of suitable habitat (EN B1b(iii)) due the Barrages combined with a 2/3 reduction in River Murray flow. The Barrages have acted as a physical barrier to dispersal between freshwater and the sea, and with reduced flow to the Coorong the habitat on the seaward side of the barrages is often purely marine (almost exclusively so in the last 10 years), and purely fresh on the upstream side, providing no area of true estuarine conditions. The species probably suffers from competition and predation with high numbers of Redfin in the Lower Lakes and lower River Murray, and is also susceptible to fishing pressure across its range when they congregate in areas for spawning.

Land tenure and conservation The Murray Mouth region falls in the Coorong NP and the Lower Lakes and Coorong (a Ramsar site). Remaining distribution is in public waters with access through public and private lands. The SA section of the Glenelg River is in the Lower Glenelg River CP with a small area of public land at Donovans Landing.

Recovery objectives

- Better determine the status in the wild.
- Research to gain a better understanding of biology and habitat in SA.
- Increase awareness to encourage reporting of the species.
- Improve species status through environmental restoration (restore a more natural flow regime).

Conservation actions already initiated

- Construction of fishways and improved operational procedures at the Barrages and environmental flow release into the Coorong could improve habitat conditions for the species.
- Fish diversity and movement at and around Murray fishways is being monitored[142,154].

Required conservation actions

- Targeted surveys to assess status (SAMDB and SE).
- Undertake an assessment of the biology and status of fish in the Glenelg River (collaborative with Victorian agencies), and develop relationships with commercial fishers of the SAMDB to report sightings or oral history.
- Limits on recreation and commercial fishing interstate are likely to benefit SA populations (e.g. protecting the number of spawning adults) and a State and cross-jurisdictional review of sustainable harvest should be undertaken.
- Public awareness campaign to help improve recognition, reporting and protection.
- Establish the genetic relationship between SA and interstate populations, which could include understanding the potential for coastal migration into the SAMDB.

Organisations responsible for conservation of species

DEH, PIRSA Fisheries, SAMDB and SE NRM boards.

Organisations or individuals involved

SARDI Aquatic Sciences, MDBA, SA Water, DWLBC.

Southern Pygmy Perch *(Nannoperca australis)*

Other common names: Swamp Perch

Conservation status *South Australia:* Endangered (EN B1ab(i,ii,iii,v)); Protected (*Fisheries Management Act 2007*).
National: not listed. *Interstate:* Endangered in New South Wales.

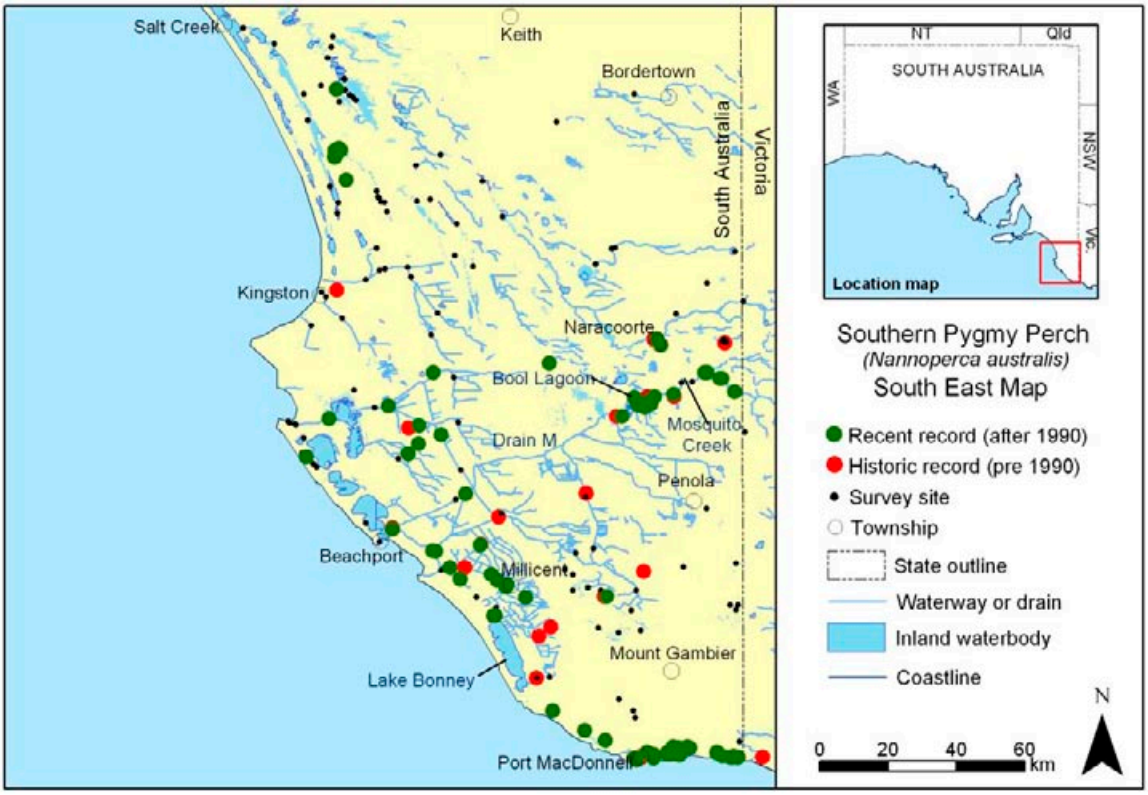
Taxonomy and identification A small, deep-bodied species reaching a maximum 10cm in length (commonly 3-5cm). It is characterised by a large eye and has brilliant red fins during spawning (males). Southern Pygmy Perch can be distinguished from Yarra Pygmy Perch by a larger mouth reaching below the eye and a regular (round) eye pupil; from Variegated Pygmy Perch by having scales on the top of its head and its second dorsal spine longer than its third; and from Agassiz's Glassfish by having a rounded rather than forked tail. Southern Pygmy Perch is sometimes confused with juvenile Redfin (an exotic species), however Redfin has a mouth which is much larger and can be opened right out, has two distinct dorsal (top) fins, and has vertical black stripes which develop after fish reach about 5cm.

A recent genetic study identified that the 'Southern Pygmy Perch' actually comprises two distinct species with an Eastern species in Gippsland (Vic), Flinders Island and NE Tasmania, and a Western species occurring coastally west of Wilsons Promontory and in the MDB[13,22]. The Western species has two distinct genetic lineages divided by the Great Dividing Range (i.e. coastal v. Murray-Darling) that warrant recognition at the sub-species level. Hence there are two distinct units of Management in SA: (a) Murray lineage and (b) SE lineage.

Former distribution There are numerous records of Southern Pygmy Perch from the SE, although most are after 1970; two earlier records were from swamps at Kalangadoo (1912) and Kingston (1928)[101]. Records after the 1970s (post drainage) are from across the region and the species was undoubtedly widespread under historic conditions of extensive wetland habitat. In the SAMDB, the species was widespread in the fringing swamps and tributary streams of the lower River Murray and Lake Alexandrina (e.g. historically plentiful in the smaller backwaters and swampy lowlands of the Finniss River[18]), and it is also likely to have been commonly found in areas associated with the River Murray through to Victoria (e.g. recorded from the Renmark region in the 1970s[192] and 1980s[83]). A new population slightly to the west of the Murray Drainage on the Southern Fleurieu Peninsula (Inman Catchment) was first documented in 2001, and a subsequent review provided oral history of its long-term presence[13,51].

Current distribution In the South East, available habitat is much reduced due to extensive drainage and there are several presumed local extinctions (Kingston, Kalangadoo, Benara Creek, swamps near Mosquito Creek). In recent periods this lineage has remained relatively widespread and common[23], however rising salinity and drying of habitats in the Upper South East and Mosquito Creek is projected to cause further declines (EN B1b(iii))[94]. The range, abundance and area of occupancy of the Murray lineage has, and continues, to decline[21,22,51], especially in the last two years (EN B1b(i,ii,iii,v))[102,115]. Genetic evaluation of the remaining populations of the Murray lineage indicates five genetically distinct sub-populations separated by land barriers only 10km or less in some areas, all of which have contracted in their extent of occurrence and number of sites in the last 10 years. The remaining populations include (1) a patchy distribution in swampy edges and drains around Lake Alexandrina, but which has declined dramatically since 2007 with lowered Lake Alexandrina levels (previous core populations on eastern Hindmarsh Island, Black Swamp and near Milang, presumed extinct along the River Murray proper), and four stream catchments: (2) Inman River – two disjunct populations, both extremely small and with one suffering from stream drying, (3) Tookayerta Creek where populations are reasonably continuous and more secure in slow-flowing or Fleurieu Swamp sections, but an overall small catchment, (4) Finniss River, in a few highly restricted sites and recent possible local extinctions, and (5) Angas River, where they remain in a small stretch of stream, with recent loss of fish from two tributary streams (Dawson and Middle creeks). Populations within individual streams are severely fragmented, especially those contained in the Inman, Finniss and Angas catchments (EN B1a). Habitat conditions continue to deteriorate (e.g. Angas Catchment) or have a high potential for deterioration with habitat drying (e.g. during critical low water levels as experienced in Lake Alexandrina in 2007 and beyond).

Biology and habitat Remaining habitat is varied across and within different regions, but generally comprises smaller pools, swamps and wetlands (plus some artificial refuges including drains) with dense structure. Structure can include either physical components such as rock and snags or submerged plants such as algae and Pond Weeds (*Potamogeton* spp), but most often emergent or overhanging edge vegetation such as grasses, Water Ribbons (*Triglochin*), Club Rush (*Schoenoplectus)* and Cumbungi (*Typha*). Preferred habitat can include large pools with edge cover where large predatory fish are absent and often comprises areas with cooler temperatures due to shade or spring flows, reaching the highest densities in the MLR in fenced or ungrazed areas. Southern Pygmy Perch also benefit from the seasonal inundation (winter/spring) of edge and emergent vegetation as this provides prime habitat and cover for juveniles and shelter for adults during high flows. There are likely to be some biological differences between the two lineages in SA, and fish in the MLR do seem more sensitive to habitat and flow changes. In both regions individuals in spawning condition have been noted in spring and occasionally through summer in areas with permanent cool flow. They have a diet of small invertebrates which they pick from underwater surfaces, and are short lived (~4 years) with only a small percent of most populations older than 1 or 2 years (they reach sexual maturity within a year). Movement is fairly limited, especially in the streams of the MLR, with dispersal occurring across inundated shallows rather than against flow[21,22,23,25,39,51,55].


Salt Creek
Keith
Bordertown
South Australia
Victoria
Kingston
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Bool Lagoon
Mosquito Creek
Drain M
Penola
Beachport
Millicent
Mount Gambier
Lake Bonney
Port MacDonnell
NT
Qld
SOUTH AUSTRALIA
WA
NSW
Vic.
Location map
Southern Pygmy Perch
(Nannoperca australis)
South East Map
Recent record (after 1990)
Historic record (pre 1990)
Survey site
Township
State outline
Waterway or drain
Inland waterbody
Coastline
N
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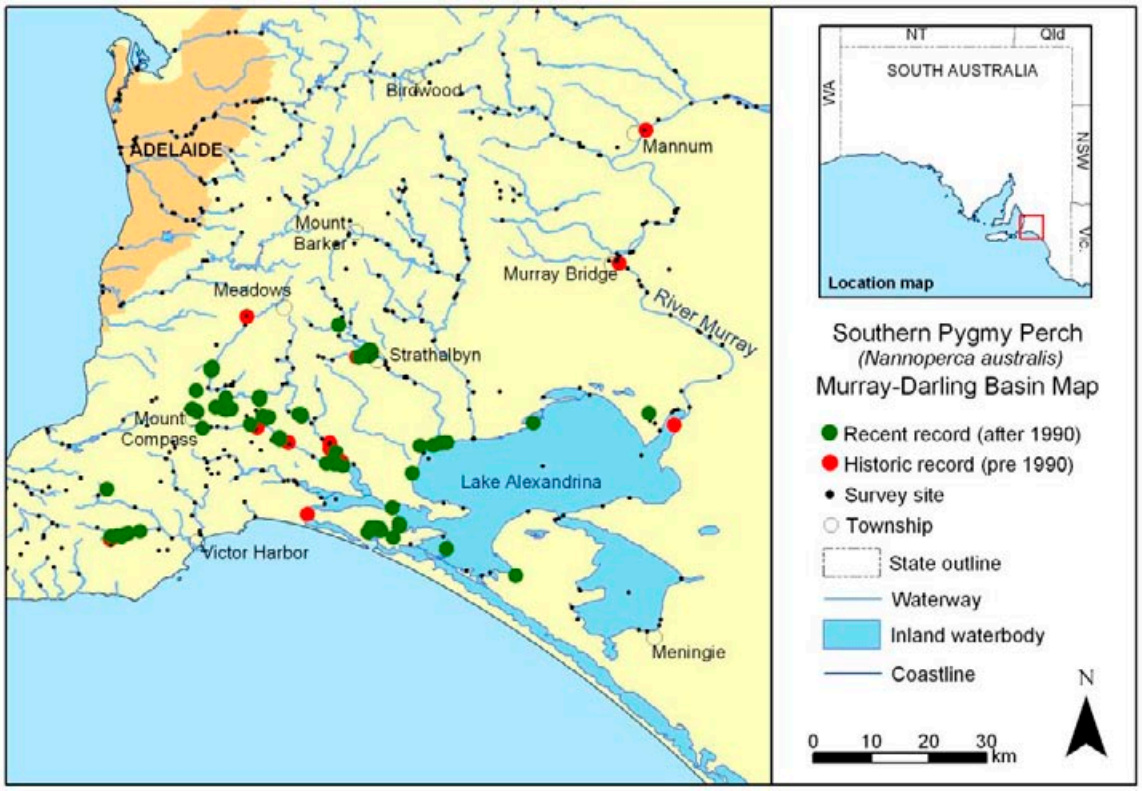

Birdwood
ADELAIDE
Mannum
Mount Barker
Murray Bridge
River Murray
Meadows
Strathalbyn
Mount Compass
Lake Alexandrina
Victor Harbor
Meningie
NT
Qld
SOUTH AUSTRALIA
WA
NSW
Vic.
Location map
Southern Pygmy Perch
(Nannoperca australis)
Murray-Darling Basin Map
Recent record (after 1990)
Historic record (pre 1990)
Survey site
Township
State outline
Waterway
Inland waterbody
Coastline
N
0 10 20 30 km

Springfed habitat of Southern Pygmy Perch in the Finniss River, Eastern Mount Lofty Ranges

Reasons for decline and threats The main reason for historic decline appears to be habitat alteration and loss such as drainage or reclamation of swamps (e.g. much of the SE, levees that have isolated and removed swamps along the River Murray between Wellington and Mannum, clearance and drainage of Fleurieu Swamps), which are now compounded by (a) altered flow regimes, (b) ongoing habitat change, (c) alien species, and (d) a lack of awareness:

- The general nature of remaining habitat, often highly restricted distribution and their presumed poor dispersal ability leaves Southern Pygmy Perch (especially SAMDB lineage) susceptible to unnatural cycles of drying. Water abstraction (e.g. farm dams), extraction (e.g. groundwater pumping) and drainage have lead to the loss of numerous once permanent refuge habitats (as above), and would be affecting the flow requirements of the species (e.g. lateral connections to riparian areas).
- Habitat loss through stock damage to stream edge vegetation and banks (e.g. shallowing and silting pools), plus other impacts from altered landuse (e.g. increased nutrients, illegal instream works) have been highlighted as issues to the sustainability of the species in the Mount Lofty Ranges[21,51].
- Predation by Redfin and trout (e.g. they have mutually exclusive distributions[25,27,51]), and competition with the Gambusia (e.g. laboratory experiments suggesting dietary overlap[39] and observations for related Pygmy Perches[193,194]) are believed to be contributing to declines.
- Artificial refuges have so far been hard to sustain in the longer term as dams in close range to remnant populations lack the right mix of natural conditions.
- A general lack of awareness surrounding the existence and conservation requirements of native fish in the MLR by the wider community and government agencies (management and planning) is an immediate concern[21,22].

Land tenure and conservation South East: occurs in the Ewens Ponds CP, Piccaninnie Ponds CP, Naracoorte Caves NP, Bool Lagoon GP, Hacks Lagoon CP and Little Dip CP, also in numerous council and drainage reserves and private land. Mount Lofty Ranges streams: close to Cox Scrub CP and Finniss CP, other locations on private land managed for conservation (e.g. Meadows Creek, Lower Finniss River, Swampy Creek), a few populations still with stock access, and the remaining core pool in the Angas River is surrounded by a new housing development. Lake Alexandrina: occurs in Land Managed for Conservation at Wyndgate and on Mud Islands Game Reserve, some fenced properties or areas inaccessible to stock, and a few grazing areas and artificial drains used for water pumping (pumping provides slow flow and prevents stagnation).

Recovery objectives

- Secure the species in each region of SA, with a priority for urgent species recovery in the MLR and Lake Alexandrina. Previously recognised recovery objectives[22] include:
- Improve the status of the Southern Pygmy Perch by increasing the security and extent (range and density) of populations in each of the five occupied drainage areas, and by increasing the amount and quality of stream and swamp habitats (e.g. minimise threatening processes, secure core populations, provide artificial refuges, feral fish control, further biological research, water quality monitoring).
- Establish long-term government and community support structures to promote Southern Pygmy Perch (subsequently native fish in general) within regional planning and management as well as aquatic protection, restoration and education programs (e.g. environmental flow programs, education, recognition in planning and management, formal conservation status).
- These objectives remain valid, however, dedicated actions regarding further research, monitoring, education and critical habitat management would greatly improve the local viability of sub populations, and could be applied more broadly to the SE lineage also.

Conservation actions already initiated

- Currently one of the most well-known of South Australia's threatened fishes due to recent research and education programs, however conservation actions have been slow to initiate and new and existing threats continue. Actions relating to objectives are already being perused through various programs

(provided in detail elsewhere[21]) and a summary (mostly related SAMDB) includes:

- An initial detailed research program, ongoing monitoring and detailed range mapping[13,21,24,25,27,50,51,58,59,69,70,195].
- Maintained fencing at some core sites, plus attempts to establish refuge populations.
- Initial moves to secure water requirements (e.g. Environmental Flows Program for EMLR, Living Murray Initiative).
- Detailed Recovery Outline and review of performance produced and disseminated.
- Positive progress on education and awareness (e.g. chocolate pygmy perch, involvement of Fleurieu Schools, signage, media articles).
- Alien fish-outs (e.g. to remove Redfin) have occurred in some areas (Angas Catchment), and trout stocking has been formally discontinued by PIRSA Fisheries from the Inman, Tookayerta, Angas and Mosquito Creek catchments (but continues in the Finniss River Catchment).

Required conservation actions

- The species is suffering large declines, however, there is a good potential for conservation and securing the local viability of genetic forms unique to SA. Localised community programs will be effective, but must be underpinned by broader catchment management, particularly the provision and enhancement of environmental flows (especially to maintain permanent pools, springs in stream habitat and Lake Alexandrina freshwater levels). Other specific actions include:
- Continue to work on the objectives and actions previously outlined, especially continuing to ensure that core populations are carefully managed and prevented from further habitat changes (including checking for species presence before constructive or restoration works in the known range).
- Continue to monitor adaptive responses to improved or declining environmental conditions such as habitat and flow.
- Further research and implement control (with monitoring) of alien fish species.
- Conduct a taxonomic review to confirm species and subspecies of Southern Pygmy Perch.

Organisations responsible for conservation of species

DEH, PIRSA Fisheries, AMLR, SAMDB & SE NRM Boards, SEWCDB, Alexandrina Council.

Organisations or individuals involved

A long list of stakeholders have so far been involved (see 'Recovery Progress report[21]'), but major organisations include NFA(SA), SAMDB NRM Board, Goolwa to Wellington LAP, SARDI Aquatic Sciences, DWLBC and community groups, especially Angas River and Inman catchment groups.

Silver Perch *(Bidyanus bidyanus)*

Other common names: Bream, Black Bream and Tcheri (Ngarrindjeri)

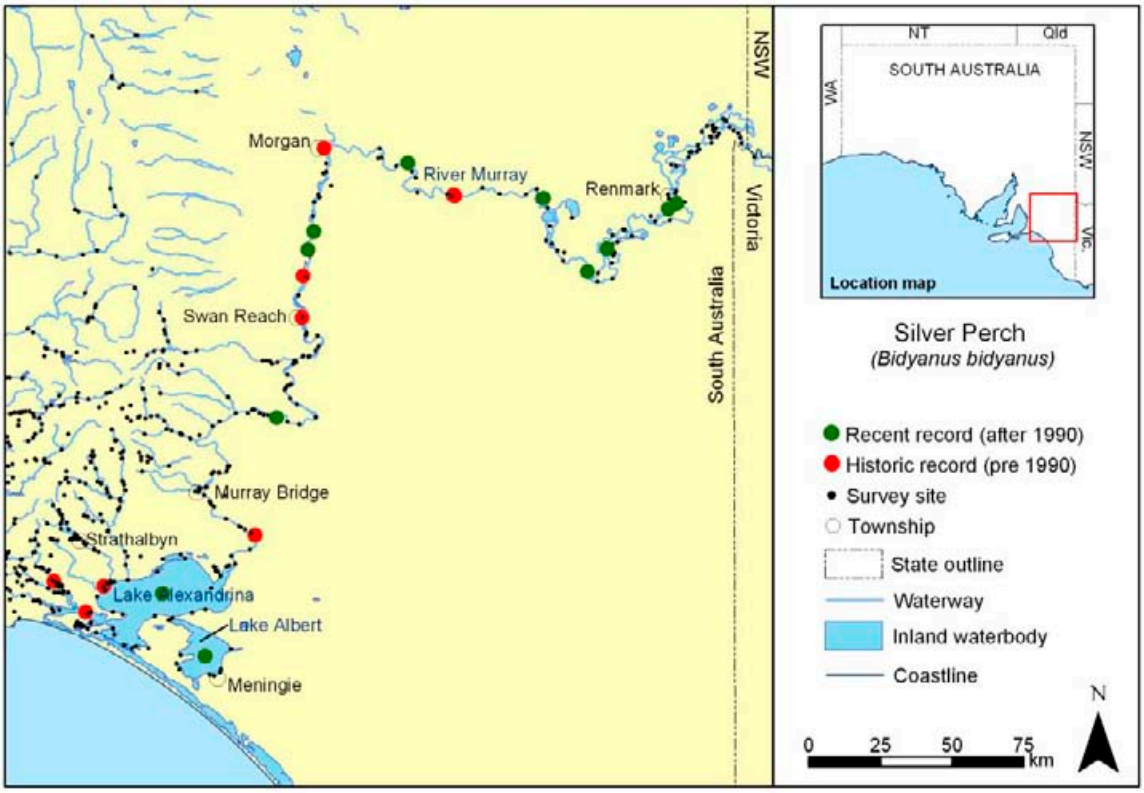
Conservation status *South Australia:* Endangered (EN A2bc); Protected *(Fisheries Management Act 2007).*
National: not listed. *Interstate:* listed as Threatened in Victoria (Critically Endangered) and Endangered in NSW and ACT.

Taxonomy and identification A medium to large sized fish up to 60cm in length, more commonly 25-40cm. Silver Perch is actually a species of grunter and can be distinguished from perches in the MDB by its small mouth and/or a flat edged to forked rather than round tail. The Silver Perch is very similar in appearance to Welch's Grunter which occurs in the LEB (e.g. Cooper Creek) with taxonomic keys distinguishing them on body depth and the number of lateral scales.

Former distribution As with many of the larger edible fishes, verified records such as museum specimens are limited, and no detailed historic assessments of status were conducted. Anecdotal evidence and commercial fishery catches suggest that Silver Perch was common throughout lowland river habitat in the SAMDB including the main river channel, Lower Lakes (e.g. Milang, Clayton, Hindmarsh Island) and lower sections of eastern Mt Lofty Ranges streams (Finniss and Bremer rivers)[25,152,176]. For example it was considered one of the most abundant species in the River Murray system in the 1960s[153].

Current distribution Silver Perch has declined considerably from its historic abundance in SA to the point that species is rarely seen and its distribution is now patchy. Recent records from fishway sampling, wetland studies and the commercial fishery (1995-2000) are mainly of a few individuals from limited localities[69,70,155], although juveniles (15-30cm) have been recorded from the main channel in areas such as Blanchetown[158]. The species has likely been translocated into various dam and stream habitats in the Mount Lofty Ranges and other areas of the State including Clayton Bore in the LEB[31] but fish were probably sourced from interstate hatcheries rather than SAMDB stock.

Biology and habitat Little research has occurred on Silver Perch in SA and hence most data is from interstate. Silver Perch is reported as a schooling fish which occurs across a variety of climatic types and environmental conditions, but generally in flowing river habitat. It is omnivorous, consuming aquatic plants, snails, shrimps and macroinvertebrates. Spawning occurs in spring and early summer involving large numbers of small semi-buoyant eggs shed into the water column, and requiring a trigger of water level rise or flooding. It has been reported that little or no spawning occurs in drought years. Upstream spawning migrations have been documented (including SA[162]) and adults and juveniles display active movement outside the spawning period, possibly stimulated by river flows. Silver Perch are long-lived with fish maturing at 3-5 years old and reaching a maximum age of at least 27 years[84,196,197].



Reasons for decline and threats Silver Perch appear to be particularly sensitive to flow regulation[198] as they are a species with biological requirements dependent of flows and flooding for biology. Habitat degradation, overfishing, and impacts from alien fish have also been suggested as causes for decline across the range of Silver Perch in the MDB[134]. These factors could all apply to SA, especially the progressive alteration (reduction) in flow to SA and the dramatic loss of smaller and medium sized flood events[185,186]. Additional threats to the species in SA include competition with Carp for similar food resources, numerous barriers to upstream movement during low flow conditions (this is currently being addressed) and stocking of hatchery reared Silver Perch is a threat to local stocks (e.g. genetic pollution, reduced genetic diversity and disease[188]).

Anecdotal information heralded a heavy decline of Silver Perch from the River Murray after the 1960s. Trends in commercial fishing catch, as an approximate index of population size, capture these low levels in the 1970s, indicating a slight recovery during the mid 1980s before a collapse of the fishery which failed to recover (Figure 11). While populations of this species may fluctuate naturally and data is limited, the reduction in catch (which targeted mature adults) plus few current records suggests a conservative estimate of decline over the last 3 generations (assume generation time of 10 years) of at least 50% (EN A2b). This apparent trend is likely to be due to declining environmental conditions from a highly regulated flow regime especially with recent protracted low flow conditions on the River Murray cumulating in serious drought in 2006/2007 (EN A2c).

Land tenure and conservation Occurs along the River Murray corridor which incorporates several State Reserves (Chowilla GR, Murray River NP, Morgan CP, Roonka CP, Ngaut Ngaut CP) as well as numerous council reserves and public riverfront access.

Recovery objectives

- Restore environmental conditions to promote a self-sustaining population.
- Protect an adequate spawning biomass of adult Silver Perch.
- Better define biology in SA (recruitment, flow and habitat requirements, migration).
- Develop an appropriate index to track population status.

Conservation actions already initiated

- Silver Perch is protected from exploitation through fisheries legislation (generally well accepted by the community).
- The Living Murray Initiative aims to restore flow regimes to key ecological assets including the River Murray channel important for Silver Perch recovery.
- Fishways have and continue to be constructed on major barriers to fish movement on the River Murray (mainly locks and weirs). Monitoring of the effectiveness of fishways is being undertaken by SARDI in conjunction with other interstate agencies and the MDBA.
- A Recovery Plan has been prepared for Silver Perch across its range (MDB) and this serves as an additional guide to recovery principles and actions for SA[199].

Required conservation actions

- Environmental flow programs to provide appropriate conditions for breeding and recruitment (monitored for effectiveness).
- Obtain fisheries independent monitoring data on Silver Perch habitat use, trends in abundance, and demography to more fully explore status, especially in relation to environmental conditions. Disseminate research findings to the public.
- Continue education and enforcement of Protected status, encourage reporting of incidental captures (e.g. location and fish length) to help improve knowledge on status.

Organisations responsible for conservation of species

PIRSA Fisheries, DEH, SAMDBNRM Board, DWLBC.

Organisations or individuals involved

SARDI Aquatic Sciences, SAMDBNRM Board, PIRSA Fisheries, MDBA, DWLBC.

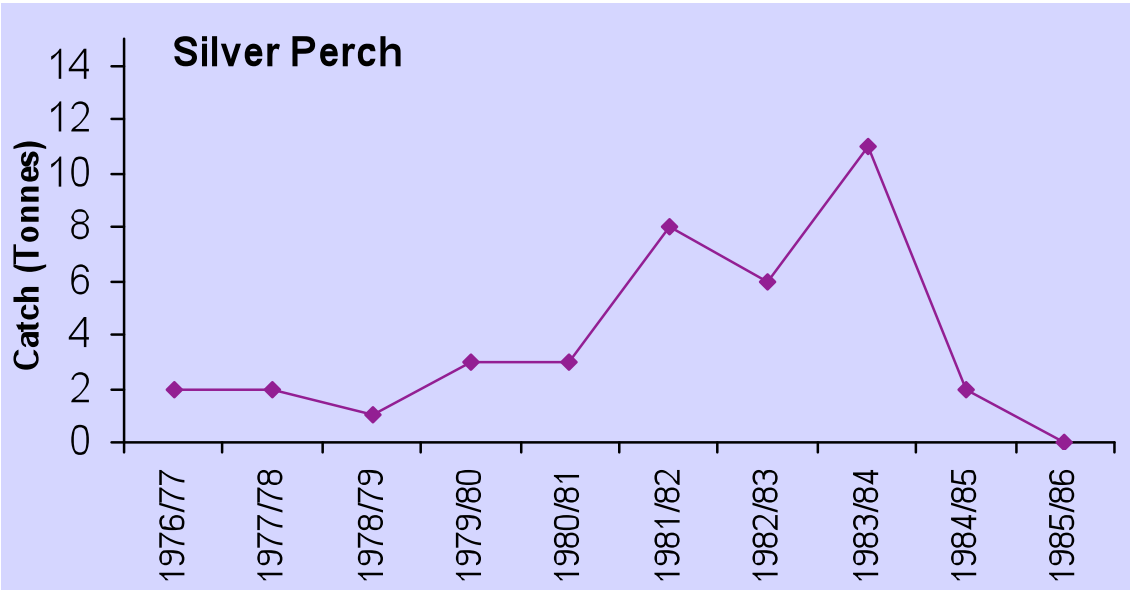


Figure 11. Catch data for Silver Perch from the SA River Murray Commercial Fishery between 1976-1986 based on SA Fisheries Statistics[165].

2.4. **VULNERABLE**

> considered to be facing
> a high risk of extinction
> in the wild

Mountain Galaxias *(Galaxias olidus)*

Other common names: Minnows, Muddies or Slipperies.

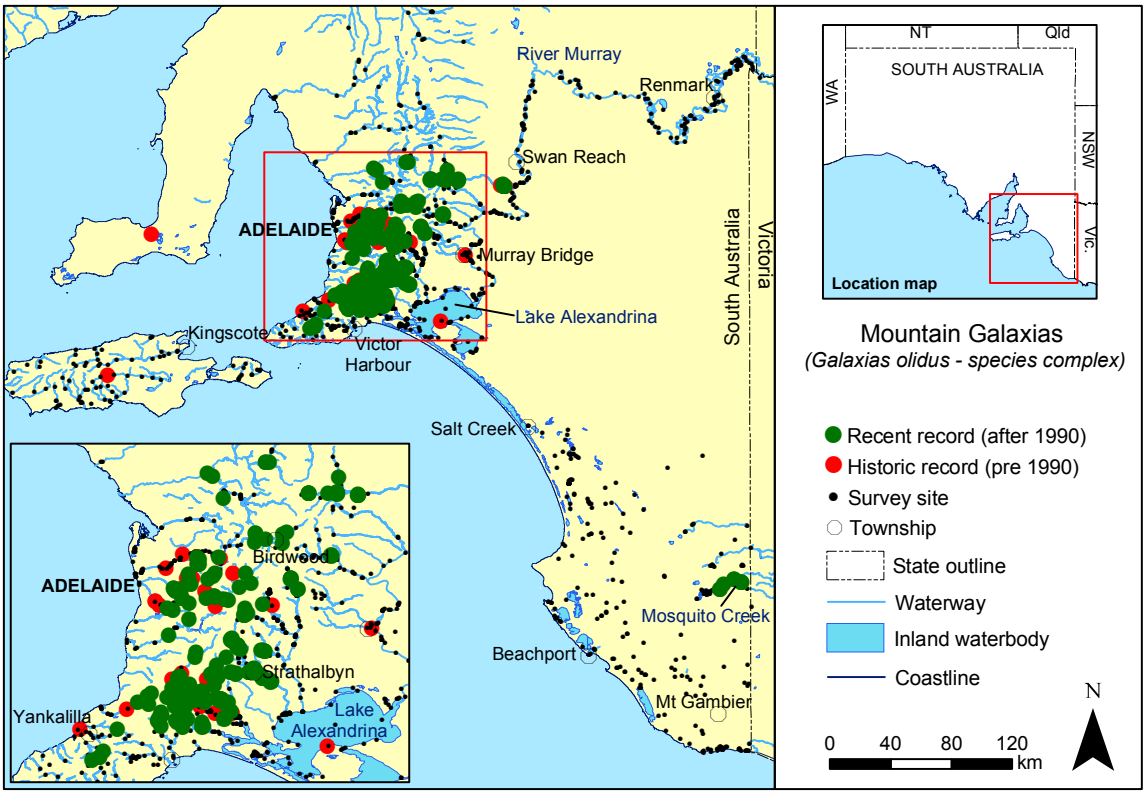
Conservation status South Australia: Vulnerable (VU B1ab(ii,iii)).
National & interstate: not listed (but certain forms are under consideration in Victoria - Data Deficient).

Taxonomy and identification A long slender fish to 14cm; more commonly 4-8cm. Mountain Galaxias can be distinguished from other galaxias by: (a) origin of the anal fin which is set behind the origin of the dorsal fin (used to distinguish between Common Galaxias – fins aligned, or Dwarf Galaxias – dorsal fin slightly in front of the anal fin), and (b) small pectoral and anal fins, equal length jaws and lack of a large black spot behind the gill cover (used to distinguish from Climbing Galaxias). Mountain Galaxias across southeastern Australia is currently under systematic review[15] with initial indications of multiple species including two distinct species in South Australia. Currently molecular (genetic) markers are used to separate the two species, with general differences in body shape and colouration (e.g. eastern form more robust and marbled[25,27]), with taxonomic keys still to be developed along with formal descriptions.

Former distribution A reasonable number of historic SA Museum records suggest that the Mountain Galaxias was once a widespread and common species in southern SA inland (cooler) freshwaters. It was predominantly known in the MLR (recorded catchments include: Gawler, Little Para, Torrens, Patawalonga (Sturt and Brownhill), Onkaparinga, Myponga, Carrickalinga, Bungala, Yankalilla, Hindmarsh and Inman (WMLR); Marne, Reedy, Bremer, Angas, Finniss, Tookayerta and Currency (EMLR)) with outlying records including swamps of the lower River Murray at Murray Bridge (during or prior to 1928) and at Lake Alexandrina (Point McLeay 1886). A distinct sub-section of habitat is known from the SE (records from Mosquito Creek) and there are unverified records from (a) Kangaroo Island - a single individual specimen from 1883 with no specific collection location, and (b) southern Yorke Peninsula, also based on a single record from 1934, although there is no remaining specimen to verify its identify (and it may well represent a record of Common Galaxias).

Current distribution The two species of Mountain Galaxias in SA have discrete ranges, with an approximate separation following the east-west divide of catchments in the Mount Lofty Ranges. Recent research sampling within the known range of Mountain Galaxias has been reasonably comprehensive. There has been a decline in the area of occupancy as it was not located in the historic catchment areas/regions of (a) Bungala River and Inman River (southern Fleurieu Peninsula[27]), (b) Scott Creek (Bremer Catchment), Murray Bridge and Lake Alexandrina (SAMDB[24,25,69,70]), and (c) Kangaroo Island[26]. Mountain Galaxias distribution is severely fragmented at broad (catchment) and local (stream reach) scales (VU B1a). This has been largely due to continuing declines in area of occupancy and abundance of isolated populations, especially with habitat change and the presence of alien predators in the Adelaide region (Torrens, Sturt and Onkaparinga catchments)[28], extensive recent pool drying, habitat degradation and introduced predators in the EMLR[25], and general habitat change on the southern Fleurieu[27]. Abundance and occupied area has also decreased at Mosquito Creek (SE) in the last five years due to pool drying and loss of flow[94,118] (VU B1bii,iii).

Biology and habitat While the presence of two distinct species of Mountain Galaxias in SA is recognised, there is as yet no differentiation of biological information for each, and hence a general account is provided. As the name implies, Mountain Galaxias occurs most commonly in areas with higher elevation including streams and swamps across a variety of environmental conditions, most commonly in areas with shallow flowing areas and moderate levels of instream cover. Cooler temperatures are preferred provided by stream flow and/or shade from edge riparian and terrestrial vegetation (this vegetation is also thought to provide habitat for invertebrates as an important source of food for Mountain Galaxias). Lowland areas are occupied where permanent springs occur (e.g. lower Marne and Angas rivers) and large pools can be habitat if alien predatory fish are absent; Brown Trout, Rainbow Trout and Redfin appear to restrict the distribution of Mountain Galaxias at microhabitat or stream reach scales when these larger growing alien predators are present. Fish in reproductive condition have been found in autumn through to spring. Mountain Galaxias does appear to undertake small scale movements within



stream sections for population expansion and recolonisation with the return of suitable conditions (if source populations remain)[23,25,27,28,200]. More detailed biology has not been investigated in distinct SA habitat, with interstate studies suggesting that: (a) diet includes a variety of terrestrial and aquatic insects and macroinvertebrates, (b) spawning occurs under solid objects such as rocks in flowing areas (riffles), and (c) longevity is unknown but most fish in a population are less than 2 years old, with sexual maturity reached within around a year[76].

Reasons for decline and threats The major threat to Mountain Galaxias in SA involves altered hydrology. Stream flow in upland areas of the MLR is heavily influenced by increasing levels of abstraction from water captured in farm dams and other storages, especially during naturally dry periods (potentially worsened with climate change). Abstraction impacts the presence and permanency of stream pools (thus determining the extent of Mountain Galaxias habitat) and causes changes to the nature and timing of flows, especially the loss of low flows or delayed onset of seasonal flows, both critical for maintaining water quality (e.g. oxygenation, reducing salt loads) and potential links to species biology (e.g. maintaining spawning habitat and eggs)[149,150,177]. The influences on vertical water sources (i.e. springs) is less obvious but groundwater extractions are likely to influence the availability of critical base flows. Cumulative to water stress, the reduction in the quality of stream banks and vegetation (e.g. stock grazing, urban development) is a threat to the quality of Mountain Galaxias habitat such as reduced shade, instream structure and increased silt loads. Introduced predatory fishes can reach larger sizes than native species and eliminate them from otherwise suitable habitat at local or regional scales, particularly in structurally and hydrologically simple systems (hence predation and competition from introduced fishes is a threat in its own right, potentially compounded by habitat change and water resource development)[25,27,28].

Land tenure and conservation Mountain Galaxias is known from numerous lands in the State Reserve system including: Montacute CP, Blackhill CP, Morialta CP, Cleland CP, Brownhill Creek RP, Belair NP, Sturt Gorge RP, Onkaparinga River NP, Scott Creek CP (Adelaide Hills), Myponga CP and Naracoorte Caves CP. Numerous stream sections on private property have been fenced and managed for conservation, others are linear reserves (e.g. Stirling), with populations also known from land managed by councils (e.g. Mt Barker, Strathalbyn) and SA Water.

Recovery objectives

- Secure and enhance existing populations by: (a) protecting and improving environmental flows, (b) protecting and restoring stream side habitat, and (c) reduce predatory and competitive effects of alien trout and Redfin.
- Promote research and monitoring on biology and environmental relationships.
- Improve awareness of the public, management and planning on the presence and requirements of Mountain Galaxias.

Conservation actions already initiated

- Broad baseline studies into distribution and status undertaken.
- Initial genetic investigations underway.
- Water resource allocation reviews are underway in key habitats (Marne and EMLR, Adelaide Hills (WMLR) and Mosquito Creek (SE).
- Environmental flows programs considering Mountain Galaxias requirements have been established in the lower Torrens and Onkaparinga catchments.
- Data sheets with pictures, identification keys and summary of biology are available[106,121,201].

Required conservation actions

- Determine taxonomic status and the genetic uniqueness of SA populations to inform management of distinct conservation units and priorities.
- Undertake environmental flow and water allocation processes across the range of Mountain Galaxias to ensure sustainable surface water and groundwater supplies, including provision for climate change scenarios.

- Further map the range of Mountain Galaxias, with specific reference to environmental conditions and the local influence of predatory fishes.
- Undertake research on local biology to better inform management, especially: (a) flow relationships for spawning and recruitment, (b) juvenile and adult tolerances, (c) age and growth, and (d) biological interactions with predatory fishes.
- Establish strategic riparian restoration zones at and near key populations, with before and after monitoring to quantify and document benefits. Disseminate findings and best practice guidelines to groups involved with on ground works.
- Assess and priorities sections where the control of introduced fishes will have benefits to biodiversity protection and expansion of important populations.

Organisations responsible for conservation of species

DEH, PIRSA Fisheries, AMLR, SAMDB & SE NRM boards, DWLBC , SA Water, local councils.

Organisations or individuals involved

NFA (SA), SARDI Aquatic Sciences, AMLR, SAMDB & SE NRM boards, DWLBC, DEH, SA Water, numerous Catchment and Landcare groups (especially Upper River Torrens and Sixth Creek Landcare groups and Friends of Scott Creek CP).

Dwarf Galaxias *(Galaxiella pusilla)*

Other common names: Eastern Little Galaxias

Conservation status *South Australia:* Vulnerable (VU B1b(i,ii,iii)c(i,ii)).
National: Vulnerable (*EPBC Act 1999*). *Interstate:* listed as Threatened in Victoria (Vulnerable) and Tasmania.

Taxonomy and identification A tiny, bullet shaped species reaching a maximum size of only 4.8cm, commonly 2-3cm. Distinguished from juveniles of other species by a lack of scales (e.g. compared to Gambusia) and faint to iridescent body stripes and a small single dorsal fin with origin slightly in front of the anal fin (e.g. compared to Mountain Galaxias). Males have orange to red lateral body stripes during the spawning season, while females develop purple flanks.

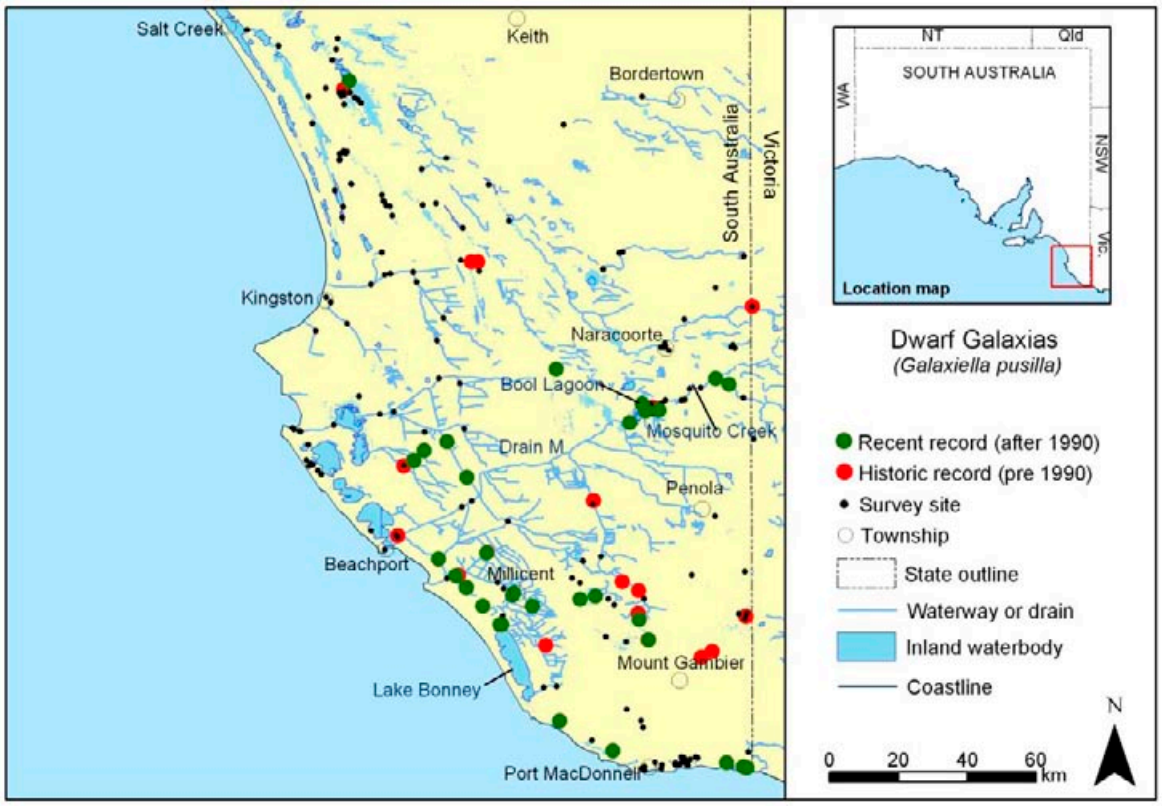
Former distribution Widespread in swamp and wetland habitat throughout SE SA including the Naracoorte Creek system (Mullinger Swamp), Mosquito Creek/Bool Lagoon system, Bakers Range Watercourse through to Cortina Lakes, Dismal Swamp Corridor through to Mt Burr, the Millicent/ Lake Bonney area, and the Lower South East[23,40,101]. Due to its small size and lack of specific searches the species presence was not recognised until the 1970s (e.g. records from Bool Lagoon in 1974), but subsequent publications revealed earlier records (Mingbool area near Mount Gambier)[202].

Current distribution A reasonably comprehensive survey in 2001-2002 revealed the species to still be widespread in the region, but reasonably patchy and with limited natural (secure) habitat[23]. Strongholds appear to be in the areas of Bool Lagoon, coastal springs of the Lower South East, Millicent/Mt Burr area and Drain L system, with patchy records in the Bakers Range and Upper South East. The species was not located in the Mingbool area, Naracoorte Creek system or Deep Swamp system (east of Kingston) where there had been previous records. Recent assessment (2008) indicates further decline, with potential loss from the Upper South East[94] (VU B1b(i,ii)).

Biology and habitat Occurs in shallow swampy habitat amongst emergent and submerged aquatic vegetation, primarily in swamp and wetland habitat, but also in numerous artificial drains which represent the only available habitat in some areas, and with some records in stream habitat (Mosquito Creek) and flooded lake edges (Lake Bonney)[23]. The species has been documented to occur in seasonal habitats, surviving swamp drying by seeking refuge in Swamp Yabby (Geocharax spp.) burrows for periods of up to five months[202] but survival at a regional context is likely best provided within a network of populations (metapopulation) where core refuges exist for recolonisation. Recolonisation is aided by a strong ability to navigate shallow surface water connections between habitats[55,202]. This species appears to be short-lived (longevity 1-2 years) and hence successive failures in habitat condition could lead to local extinctions. They spawn during cooler conditions in aquatic vegetation from around April to November. Adults are known to eat small crustaceans and vegetative matter[202].

Reasons for decline and threats Habitat loss from cumulative and progressive effects of widespread drainage of wetland and low-lying areas is likely to have had, and continue to have, a great impact on this species (e.g. loss of 90% of SE wetland habitats and alteration of most others[23,203,204])(VU B1b(iii)). A short lifecycle, altered regional hydrology and shallow occupied habitats leaves the species susceptible to extreme fluctuations in area of occupancy during climatically dry period. In addition, such adverse conditions may become more frequent and severe with climate change. This species is concurrently exposed to threatening processes which reduce quality of refuges may affect their ability to recover from such periods of stress (VU B1c(i,ii)). Other threatening processes are likely to include:

- Localised habitat damage from stock trampling wetland edges and seasonally dry habitats[202].
- Altered groundwater hydrology (e.g. from irrigation and plantations) lowering water tables potentially influencing the water holding ability of surface habitat and the ability of Dwarf Galaxias to reach refuge in Swamp Yabby burrows.
- Altered surface water connections by creating artificial barriers to Dwarf Galaxias movement may inhibit dispersal and recolonisation. Barriers do not need to be large structures given the small size of the fish (e.g. elevated roads, culverts, and drain spoilings may be significant dispersal barriers).
- Alien species: while the distribution of introduced species in the SE is currently restricted, future spread of species, primarily competition and aggression from Gambusia, is a concern based on experience interstate.
- Chemical pollutants: population losses were noted in the 1960s in the Mingbool region following application of pesticide (Lindane)[202]. Investigation is required into the impacts of other pesticides and herbicides employed in agriculture and local management (e.g. weed spraying).



Land tenure and conservation Occurs at Piccaninnie Ponds CP, Bool Lagoon GR, Hacks Lagoon CP, Reedy Creek CP, on land owned by DEH for conservation at Picks Swamp, other private lands managed for conservation (e.g. Ellis Swamp north of Lake Bonney), Forestry SA land (e.g. Mt Burr and Mingbool regions), drains in the Millicent region and Drain L system managed by the SEWCDB, and other private land with stock access (e.g. Mosquito Creek, coastal swamps).

Recovery objectives

- Secure core populations and regional metapopulations.
- Establish monitoring to develop an understanding of relationships to environmental conditions and hydrology, especially with any changes in management and/or conditions.
- Ensure that all key stakeholders are aware of populations and potential threats and improve awareness, particularly regarding species presence and ability to occur in seasonally dry habitats.

Conservation actions already initiated

- Initial broad scale distributional surveys and habitat assessment undertaken[23].
- Published ecological account provides significant information for management[202].
- Fencing on selected habitats (Picks Swamp, Ellis Swamp[205], parts of Mosquito Creek).

Required conservation actions

- Continue to identify then protect or undertake restoration at core dry period refuges.
- Protect and restore other known habitats.
- Protect and restore corridors for dispersal (e.g. fencing, reviewing road infrastructure).
- Temporal monitoring programs at current and historic sites to help determine population dynamics under different environmental and seasonal conditions. Urgent priority to assess the impacts of landscape drying from a prolonged period of below average rainfall since 2005.
- Improve habitat conditions to assist long term persistence at drain sites through adaptive habitat management (e.g. section fencing, hydrological alterations).
- Active management to prevent new pest fish introductions to Dwarf Galaxias habitat.
- Establish long-term government and community support structures (e.g. plans, educative materials) to promote the Dwarf Galaxias within regional planning and management, and aquatic protection and restoration programs.

Organisations responsible for conservation of species

DEH, DEWHA, SENRM Board, SEWCDB, USE Program, Forestry SA, regional Councils.

Organisations or individuals involved

NFA (SA), DEH, private landholders.

Flyspecked Hardyhead *(Craterocephalus stercusmuscarum stercusmuscarum)*

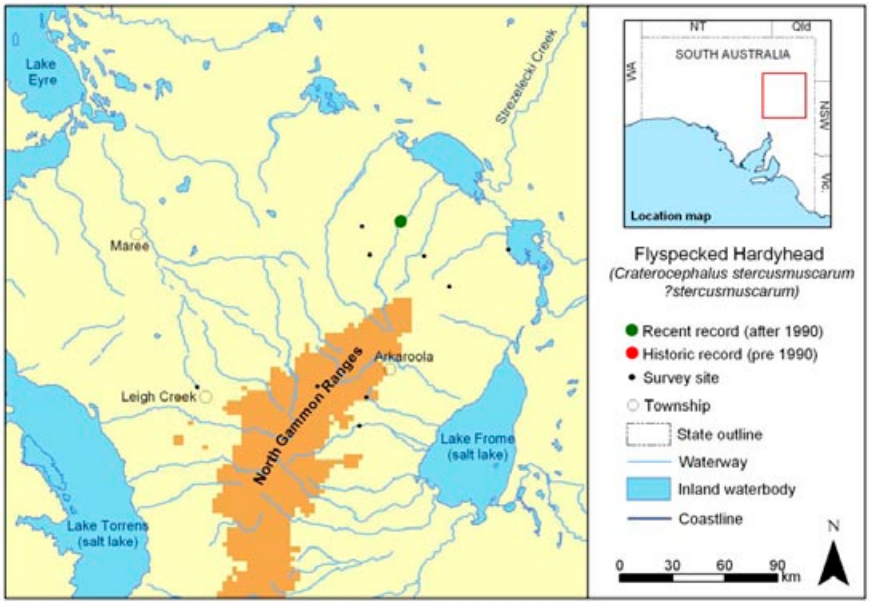
Conservation status *South Australia:* Vulnerable (VU D2).
National & interstate: not listed (the related subspecies Unspecked Hardyhead is listed as Threatened in Victoria and recommended Vulnerable in NSW[74]).

Taxonomy and identification A slender, silvery-gold coloured fish with thin black body stripes visible under certain conditions, maximum size is around 11cm, but is commonly 4-6cm. Occurs in the same region as Lake Eyre Hardyhead but is distinguished by being more elongated, having less transverse body scale rows (7-8 v. 1-14) and a faint black stripe through the head and mouth. The species is very similar to Glovers Hardyhead and Unspecked Hardyhead which occur in isolated habitats. There is currently taxonomic confusion surrounding the different subspecies in the 'Craterocephalus stercusmuscarum' group and hence the current identity of the South Australian population is tentative - initial genetic research indicates this form is distinct from those in the Murray (i.e. Unspecked Hardyhead) and is most closely related to fish in NE Queensland[206] but further research may prove the SA population to be an endemic subspecies.

Former distribution This species is known positively from MacDonnell Creek flowing from the northern Flinders Ranges. There have been historic reports from other locations in the SA Lake Eyre Basin[207,208], however these appear to be based on misidentifications or taxonomic confusion with Lake Eyre Hardyhead and Glovers Hardyhead as there are no verified records within extensive historic samples at the SA Museum[1].

Current distribution Recent records from large pool habitat on ~2km of MacDonnell Creek (1994-95 & 2003[55,101]) (VU D2). Could occur in other locations but appears to prefer habitats without Lake Eyre Hardyhead, a species which is common and widespread throughout most inland waters in the SA LEB (except perhaps for the Cooper Creek).

Biology and habitat Occurs in large deep pools fringed with emergent vegetation of Reeds (*Typha* and *Phragmites*), commonly in the edges or shallow areas of rock, algae or Pond Weed (*Potamogeton crispus*)[55]. The series of pools it occupies on MacDonnell Creek appear to be fed from local groundwater (not the Great Artesian Basin) which is relatively fresh (<1000µS, but this requires longer term quantification) compared to other more saline waters commonly encountered in the LEB which are occupied by Lake Eyre Hardyhead. There is no biological information currently known for the South Australian population. Data from NE Australia (tropical habitat) indicates the species to have a primarily carnivorous diet of aquatic insects and micro-organisms with occasional ingestion of vegetative matter (e.g. algae). The same data has found that spawning occurs on submerged and edge vegetation opportunistically over an extended period depending on temperatures and rainfall; that fish mature quickly and are relatively short lived (2 or more years); and that they are mobile within sections of stream systems[209].



Reasons for decline and threats There is no long-term data to assess population trends for the species, but its limited distribution, extreme isolation in desert habitat, and specific known habitat makes it susceptible to local losses – its status could quickly shift from the 'Vulnerable' to 'Critically Endangered' category if any indication or observed, inferred or projected decline or fluctuation in the habitat or population were observed. The hydrology of unique local freshwater habitat requires further investigation to ensure long-term sustainability and presence, with any major water extractions in the region a likely serious potential threat (e.g. mineral exploitation). Other local issues could include the introduction of alien fishes, both exotic (e.g. competition, disease and aggressive behaviour from Gambusia) and translocated Australian native species which do not naturally occur in the region (e.g. predation and disease from larger angling species). Additionally, high levels of stock grazing may be detrimental to water quality and edge habitat condition.

Land tenure and conservation

- Occurs on private land.

Recovery objectives

- Secure the known population through (a) improved knowledge and (b) acting to protect important aspects of population sustainability (especially water security).
- Further determine distribution in the SA LEB.

Conservation actions already initiated

- Genetic studies to determine species status (i.e. SA endemic) initiated.
- Current presence of species confirmed through research sampling.

Required conservation actions

- Undertake temporally replicated research into habitat dynamics, biology and potential threats at known habitat.
- Work closely with local land managers to provide water security and on-ground protective measures within a framework of existing landuse.
- Build broader awareness within planning and management of the importance of the local water resource (spring feeding).
- Undertake baseline sampling throughout the SA LEB.

Organisations responsible for conservation of species

DEH, SAAL NRM Board, DWLBC.

Organisations or individuals involved

NFA (SA), SA Museum, SAAL NRM Board.

Congolli *(Pseudaphritis urvillii)*

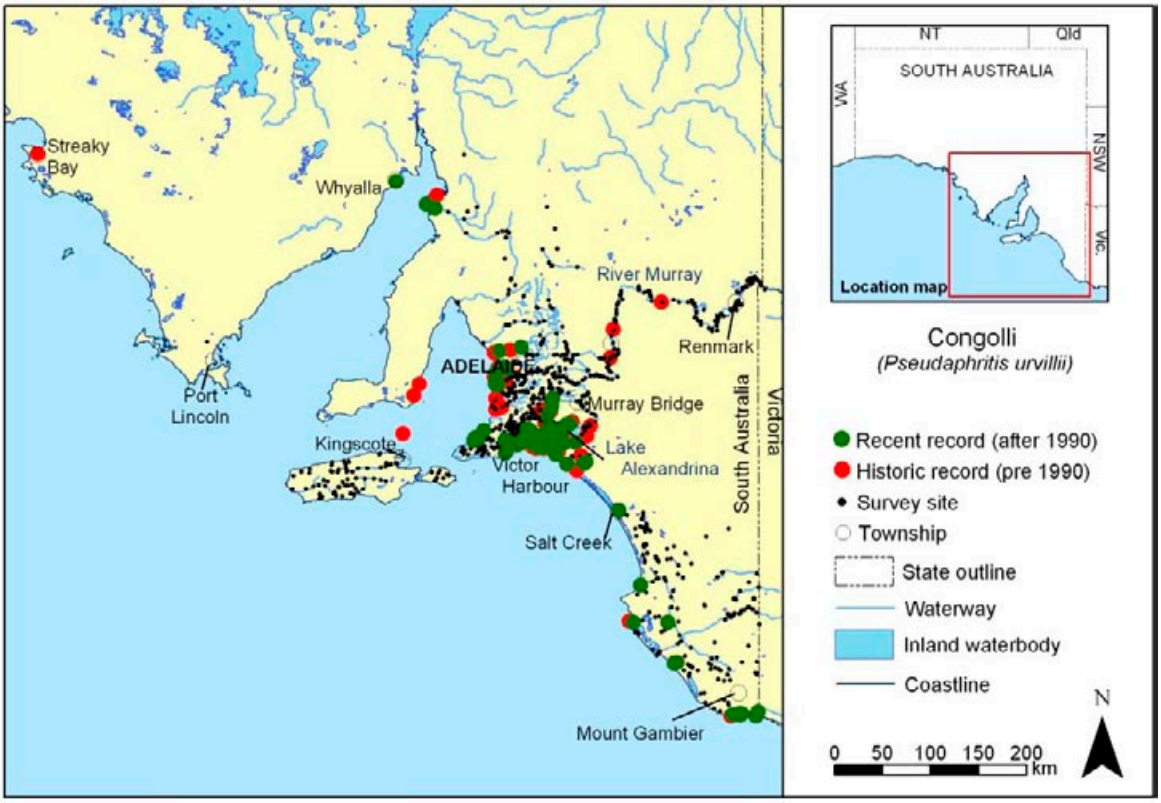
Other common names: Freshwater Flathead, Sandy and Tupong

Conservation status *South Australia:* Vulnerable (EN A2ac).
National & interstate: not listed.

Taxonomy and identification A small-medium sized species, highly variable in colour and reaching a maximum size of 35cm (females), more commonly 10-20cm. The Congolli is similar in appearance to gudgeons but can be distinguished by the very long second dorsal and anal fins.

Former distribution Relatively widespread in freshwater systems with coastal access and in estuaries stretching along the SA coast, although known records are quite patchy in the west of the State - limited to an old record from Streaky Bay (1903), Upper Spencer Gulf near to the outlet of the Broughton River (1988-2004) and from the foot of Yorke Peninsula (1931 & 1969). Core distributional records come from: (a) streams and estuaries in the Adelaide region (Gawler to Onkaparinga rivers), (b) the southern Fleurieu (e.g. Myponga, Bungala, Inman, Hindmarsh and Middleton catchments), (c) Lower River Murray region including the Coorong, Lower Lakes, EMLR and with intermittent records stretching upstream along the River Murray to the SA border, and (d) a coastal fringe of freshwater habitat in SE SA. Surprisingly no records have come from streams and estuaries on Kangaroo Island despite reasonable searches there over time. Congolli was formerly reported as abundant in the River Torrens near Adelaide[172], and a commercial fishery existed for the species in the Lower Lakes[176].

Current distribution Recent records have been made throughout core habitat in the Adelaide region, southern Fleurieu, Lower Lakes and coastal habitats of SE SA[23,24,25,27,28,67,141,210,211], with no recent records despite suitable sampling in wetlands and the main channel of the River Murray[69,70,155,212] and on Kangaroo Island[26]. An early disappearance was noted from the River Torrens[28] although they have recently returned to lower freshwater sections due to the installation of fish ladders. Similarly the distribution in lowland streams of the EMLR and north of Adelaide has declined (range and abundance) with loss of previously permanent pools and reduced flow connecting to the Lower Lakes (e.g. Bremer and Angas rivers[25,67]). The status of Congolli in the west of the SA requires further investigation with the only recent records being from Port Davies and Whyalla[55,66].



Biology and habitat Some details of Congolli biology have been documented for SA, however a general life history model is still to be developed with the species appearing to exhibit complex and varying behaviour across its range. Congolli appears to occur in a variety of habitats from purely marine to the mid sections of lowland streams (and it has the ability to tolerate a direct transfer from marine to freshwater[213]), but often occurs in or near areas of freshwater discharge and reaches its highest adult abundance at the interface of fresh and salt water. This species occupies habitat with soft silt or sand (especially lakes and estuaries) in which it can bury itself, or in stream situations with reasonable levels of instream cover (rocks and snags) and edge vegetation such as Bullrush. The congolli is an ambush predator, with diet from the Lower Lakes found to include fish, fish eggs, molluscs, crustaceans and aquatic vegetation. There appears to be pronounced size differences between males and females, with larger individuals invariably reported as females. Reproduction occurs from May to September in the lower River Murray, and likely takes place in freshwater - large congregations of females in roe (presumably spawning) were historically netted from around Reed islands in Lake Alexandrina. Its longevity is unknown but it probably lives for 4-5 years. Congolli has traditionally been known as a diadromous species (i.e. its lifecycle involves movement between fresh and salt water for different life stages), but such movements appear flexible and need to be better understood in SA[24,25,27,142,176,214,215].

Reasons for decline and threats Threatening processes for Congolli require greater documentation, however the species seems most susceptible to hydrological change and instream barriers to dispersal (e.g. Barrages, numerous weirs in the Adelaide region) blocking access to freshwater habitat. Reduced river discharge such as the 2/3 loss of flow of the River Murray leads to reduced available area of habitat, weakens connections for upstream and downstream movement, and results in an overall deterioration in the quality of habitat and food webs (e.g. reduced water quality, decreases in edge vegetation). Habitat loss through land clearance (e.g. changes to stream channel shape, loss of snag input) and local changes (e.g. stock damage, development of stream banks) could reduce the suitability of lowland stream habitats, and industrial/stormwater pollution to some estuaries may be significant. Netting of spawning aggregations in the Lower Lakes may also have contributed to regional declines.

While the species remains reasonably widely distributed there is evidence to suggest a significant decline in abundance across its range. Most significant is the major recent changes to habitat in the lower Murray, the largest and likely core population in South Australia. Access to freshwater habitat in the SAMDB has been blocked since 2007 denying a migration pathway in or out (a 96% decline in congolli juveniles was observed between 2006/07 and 2007/08[151]), and major water level lowering has greatly reduced vegetated edge and off-channel habitats with matching declines in records[102]. This decline is predicted to continue if environmental conditions degrade further (EN A2ac).

Land tenure and conservation There are known records of Congolli from the following State Reserves: Lower Glenelg River CP, Piccaninnie Ponds CP, Ewens Ponds CP, Lake Frome CP, Coorong NP, land managed for conservation at Wyndgate, Tolderol GR, Onkaparinga NP and Port River/Barker Inlet Aquatic Reserve. Also occurs on a variety of public and private land including managed habitat in drains and Lake George in the SE.

Recovery objectives

- Improve understanding of Congolli (a) biology under different SA conditions, and (b) potential threats.
- Secure and restore environmental flows, and the general condition of lowland and estuarine habitats including unimpeded access for fish movement.

Conservation actions already initiated

- Distributional surveys within most of the known range of Congolli have been undertaken.
- An environmental flow program has been developed for significant habitat on the lower Onkaparinga
- River (reservoir releases), with initial moves to secure water requirements in the EMLR. The Living Murray Initiative also aims to restore flow regimes to key ecological assets including the Lower Lakes and Coorong.
- Fishways have and continue to be constructed and monitored on major barriers to fish movement on the River Murray.
- A new fishway has been installed at the mouth of the River Torrens.
- An initial pilot biological study on Congolli in SA has been undertaken[215].

Required conservation actions

- Initiate long-term biological studies across various habitat types and regions of SA to monitor the status of populations, and concomitantly investigate movement, spawning behaviour/biology, recruitment and habitat use across different life stages, and link this to required environmental conditions.
- Specifically undertake environmental flow assessment and restoration programs to ensure sustainable surface water and groundwater supplies, including provision for climate change scenarios (especially MLR, plus broader improved management of water resources in the MDB).
- Assess and prioritise barriers potentially impacting migration, then investigate fishway options including studies to test their effectiveness.
- Undertake projects to protect and restore lowland stream reaches (and monitor their effectiveness).
- Investigate the status of Congolli in the western portion of SA through targeted surveys at known historic habitat and likely estuaries.

Organisations responsible for conservation of species

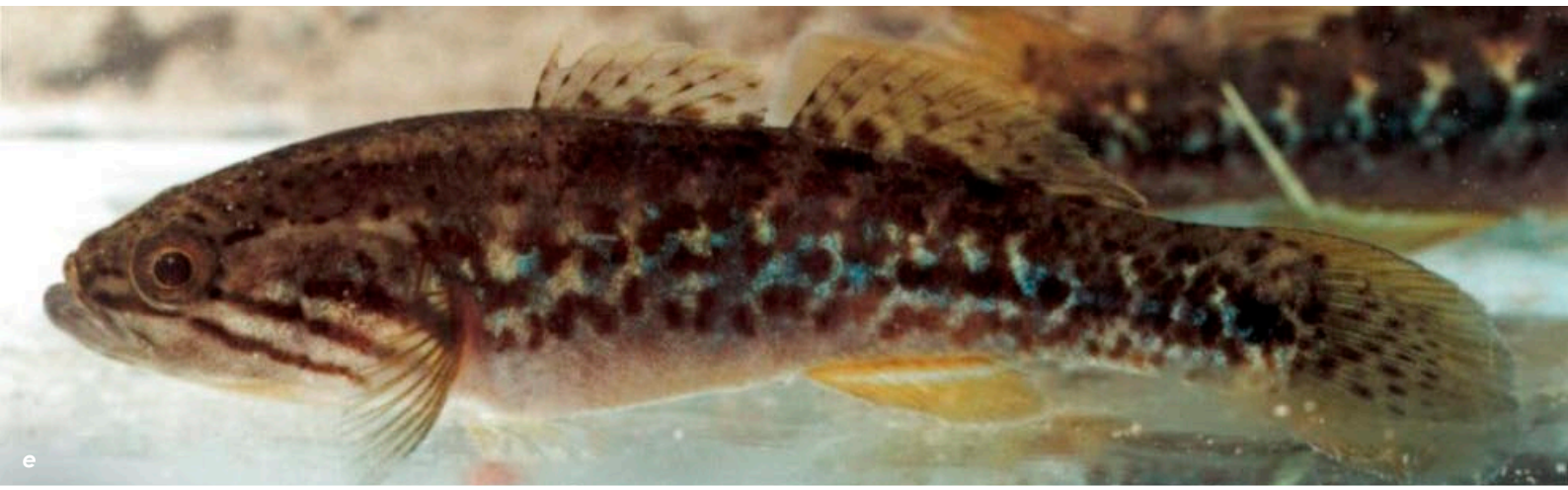
DEH, PIRSA Fisheries, DWLBC, SEWCDB and the SE, SAMDB, AMLR, NY & EP NRM boards.

Organisations or individuals involved

NFA(SA), DEH, SARDI Aquatic Sciences, the SE, SAMDB and AMLR NRM boards, MDBA, DWLBC, SA Water, Goolwa to Wellington LAP.







a Dalhousie Catfish (*Neosilurus gloveri*) ***b*** Dalhousie Goby (*Chlamydogobius gloveri*)
c Glover's Hardyhead (*Craterocephalus gloveri*) ***d*** Dalhousie Hardyhead (*Craterocephalus dalhousiensis*)
e Dalhousie Purple-spotted Gudgeon (*Mogurnda thermophila*)

Dalhousie Springs Endemic Fishes

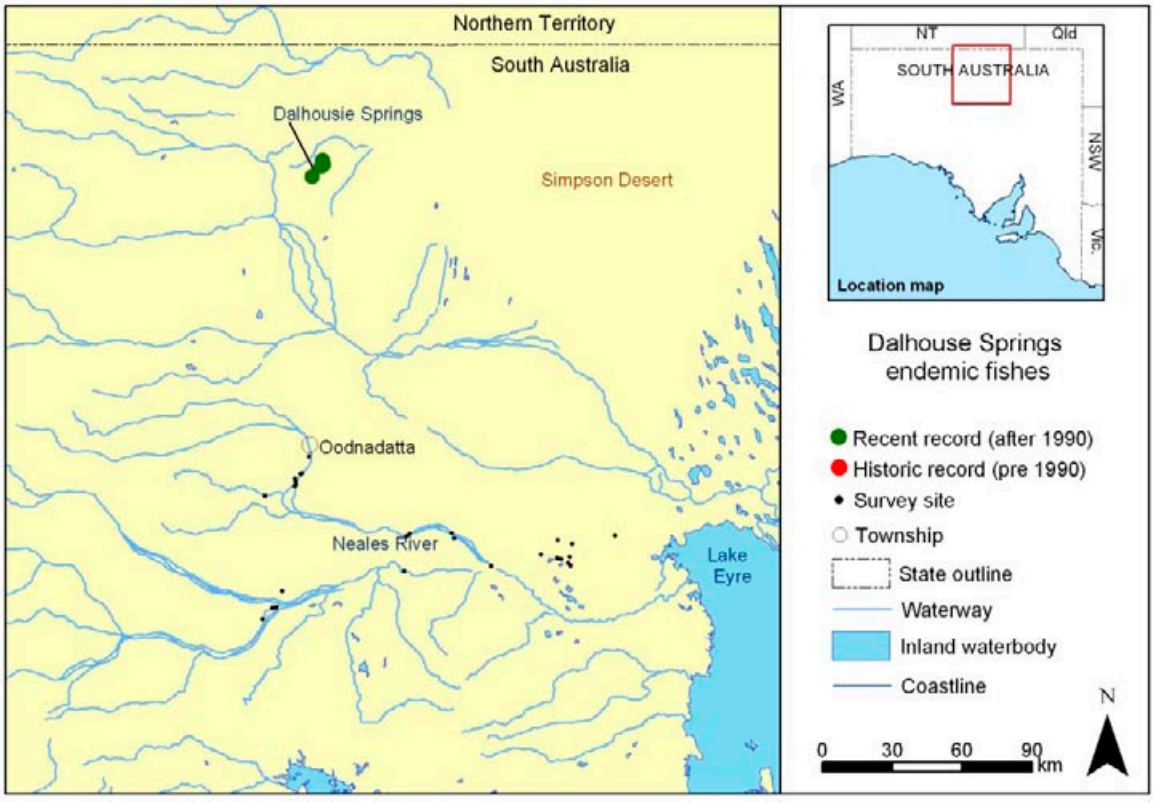
Conservation status *South Australia:* Vulnerable (VU D2), the Dalhousie Purple-spotted Gudgeon is also Protected (*Fisheries Management Act 2007*).
National: individual species are not listed but fall within the 'community of native species dependent on natural discharge of groundwater from the Great Artesian Basin' listed as an Endangered Ecological Community (*EPBC Act 1999*) (three species are considered Vulnerable on the IUCN Red List[6]).

Taxonomy and identification All five of the Dalhousie Springs endemic fishes are small reaching a size no larger than 15cm. Each species group exhibits major differences in body form (e.g. streamlined hardyheads, eel-tail of catfish, cupped pelvic fin of goby and robust spotted form of the gudgeon: see photos). The two species of hardyhead are difficult to identify and require further investigation into species boundaries. The five endemic species have been distinguished and described in the last 30 years and in addition to geographic isolation, other keys are available to distinguish them from similar species elsewhere[31,136,216,217,218,219,220].

Former distribution The Dalhousie Springs complex is situated in northern SA occupying a relatively small area with an extent around 70km^2. Fish were reported from Dalhousie Springs as early as 1894-95, but it was not until 1968 that they became known in scientific circles (mainly from a major spring group). The first study across the various spring groups was completed in 1985[30] forming the best available historic data on occurrence at a fine scale. The study found fishes at about half of the 80 active springs which occur as isolated springs or as small clusters or groupings of springs. The Dalhousie Goby was the most widespread species (30 springs) followed by Dalhousie Purple-spotted Gudgeon (11 springs), Dalhousie Catfish (5 springs), Dalhousie Hardyhead (7 springs) and Glover's Hardyhead (4 springs).

Current distribution A second major study on the fishes of Dalhousie Springs was undertaken in 1991 documenting 77 populations of fish, distributed among 28 isolated springs[49]. Data was similar to patterns observed in the 1980s with only minor loss of populations due to drying of one spring in what appeared to be natural cycling. The study also recorded additional sites for Dalhousie Catfish and Dalhousie Purple-spotted Gudgeon due to more comprehensive sampling (14 and 19 sites total respectively)[221], but hardyheads were not identified to species level in this study. A more recent assessment of species distributions was undertaken by the same researchers in 2003[222]. The latest study identifies major changes in the fish community in recent times, especially the loss of twelve of 30 (40%) occurrences of Dalhousie Goby sites (VU A2ac), due to a change in local grazing regime (feral animal control) leading to proliferation of Common Reed (*Phragmites australis*) subsequently encroaching and reducing shallow aquatic habitat.

Biology and habitat Dalhousie Springs represents a restricted and isolated ecosystem that has been in existence for several million years[220], fed by water rising from the Great Artesian Basin. Hence, the primary habitat requirement for Dalhousie endemic fishes is water to maintain highly isolated refuges in an otherwise inhospitable habitat. The endemic fishes show clear patterns of spring occupancy – each species appears to occupy a particular distribution among different sized springs or microhabitats (i.e. gudgeon and goby generally in shallow edges and spring tails; catfish and hardyhead in deeper habitat). Distributions may be influenced by the only other fish species recorded at Dalhousie, Spangled Perch (native) which occupies larger and deeper springs[49]. While no detailed studies have been undertaken, opportunistic observations on diet, behaviour and biology have been compiled for the different fish species at Dalhousie Springs[30,31]. Of note is the high thermal tolerance of many species allowing them to occur in warm groundwater at the source of discharge in many springs; nocturnal behaviour in Dalhousie Catfish; wide variation in diet within and between species; and difference in basic spawning modes between species (e.g. broadcast spawning of eggs over the bottom (catfish), scattered on vegetation (hardyheads) and fixed to solid objects and guarded by the male (gudgeon and goby). Other information on spawning periods, lifespan and dispersal remain to be studied.



Reasons for decline and threats A limited extent of occurrence, extreme isolation in desert surrounds, and specific known habitat makes the community of Dalhousie endemic fishes susceptible to local losses (VU D2). The primary potential threat is hydrological change and spring drying due to aquifer water drawdown and/or reduced artesian pressure. Recent observations of fish declines associated with habitat change and vegetation dynamics (Reed and Date Palms *Hoenix dactylifera*), indicates altering grazing and habitat management may also be a key threatening process. Other potential threats include habitat damage associated with tourism which needs further quantification of long-term influence. The introduction of fishes, especially Gambusia, poses potential competition, aggressive interaction and disease introduction. Wildlife research poses a minor threat, mainly for the potential introduction of disease with via contaminated equipment.

Land tenure and conservation

- Dalhousie Springs occurs within the Witjira National Park (established 1985).

Recovery objectives

- Undertake proactive efforts to protect the high conservation values of Dalhousie Springs including (a) ensuring the long term sustainability of source aquifer water, (b) providing appropriate fish related habitat management, and (c) controlling other human impacts such as physical and biological pollution (e.g. fish introductions).

Conservation actions already initiated

- Establishment of a National Park incorporating Dalhousie Springs.
- Initial biological investigations undertaken and documented, more detailed investigations of fish distribution have occurred and have been repeated through time.
- Date Palm control is currently been undertaken with aquatic monitoring associated with the removal (but not directly targeting changes in fish communities).
- Improved facilities to minimise the impacts of tourism have been installed (e.g. restricted access for vehicles and camping).
- Terrestrial feral animal control is being undertaken to aid terrestrial vegetation. Resultant changes to aquatic habitat need careful monitoring and potential alternate disturbance to protect fish habitat.

Required conservation actions

- The exact dynamics of the Great Artesian Basin water source needs to be better understood. The potential impact and lag times of water extraction should be assessed and built into proactive water resource management (e.g. creation of mineral exclusion zones, bore capping).
- Establish regular long-term monitoring points to help build biological information (recruitment and demography) linked to changes in environmental conditions, especially to help adaptive habitat management. Investigating the role of fire and fire management on fish habitat condition and availability would also be beneficial.
- Research into the genetic structure of species across different spring groups would be useful to assess if multiple conservation units are present which need individual management.
- Unlike many desert springs elsewhere in the world, Dalhousie Springs contain no introduced fishes. To maintain this status awareness within management and active local vigilance is required.
- Increased awareness of the uniqueness and importance of Dalhousie Springs may help long term conservation of the area and resource allocation, but needs to be balanced against the related increase in potential for visitation and deliberate acts. Improved awareness of presence of unique fishes may encourage an increase in such activity.
- All fish and aquatic research equipment must be sterilised before arrival at Dalhousie and between usage in different spring groups.

Organisations responsible for conservation of species

DEH, SAALNRM Board, PIRSA Fisheries, DEWHA.

Organisations or individuals involved

DEH, SAALNRM Board, SA Museum, traditional owners.

One of the many thermal pools at Dalhousie Springs, North East SA

2.5. **RARE**

> taxa that are in decline or that naturally have a limited presence in South Australia

James Doube

Shortfinned Eel *(Anguilla australis australis)*

Conservation status *South Australia:* Rare (RA d(ii)).
National & interstate: not listed.

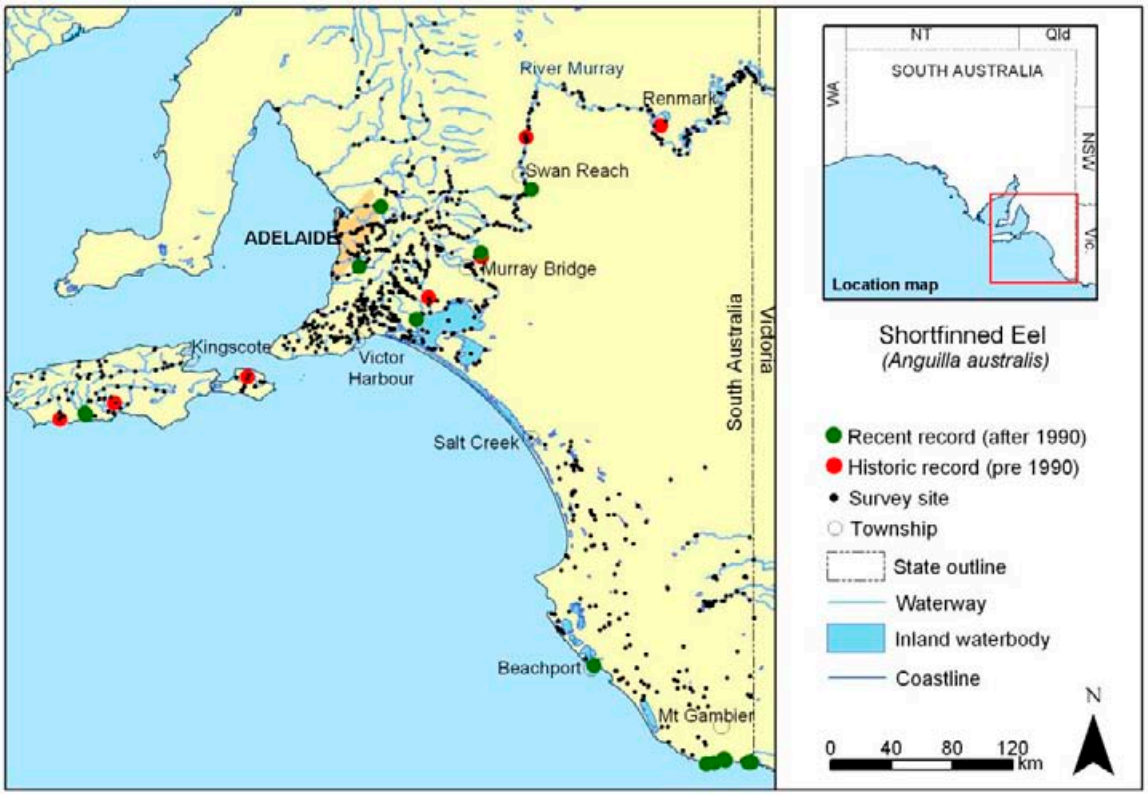
Taxonomy and identification The Shortfinned Eel has the characteristic elongated eel body shape, reaching a maximum size of around 1.2 metres, commonly 40-60cm. Shortfinned Eel can be distinguished from Longfinned Eel (a species from the east coast of Australia) and Conger Eel (a marine species) by the length of the dorsal fin which reaches only half way along the top of the body and is aligned with the origin of the anal fin.

Former distribution Early details of the distribution of Shortfinned Eel in South Australia are vague, but suggest the species was once common in SA freshwaters particularly prior to the construction of the Barrages on the Lower Murray[44,107,152]. A specimen (1.1m and 3 kg in weight) taken at Sunnyside on the River Murray in 1961 was the first documented record for some time, and there has been a slow trickle of reports since from coastal areas including southern catchments of Kangaroo Island (records from the Willson, Eleanor and South West River in the 1980s), SAMDB including main channel, wetlands, lower tributary streams and Lower Lakes (e.g. Blanchetown 1973, Barmera 1982, Bremer River 1988), and SE, particularly with more intensive sampling in streams using fyke nets in recent times. The species may have occurred in the Adelaide region (e.g. Torrens and Patawalonga catchments) but there are no verified records (but see current distribution)[28].

Current distribution Most recent records of Shortfinned Eel in SA have come from the SE which houses a reliable population concentrated in the area of groundwater discharge near Port MacDonnell (Eight Mile Creek and Piccaninnie Ponds areas[23,55]). There is a sprinkling of documented records further west in systems with coastal access (e.g. Lake George 2002[155]) including the Lower River Murray region (recent records from Milang 1996[101], Devon Downs 2003[59], Mypolonga[101], Goolwa[101]) and Kangaroo Island (two records from the Stunsail Boom River in 2005[26,101]). The first verified records of Shortfinned Eel have recently come from the Adelaide region (WMLR streams) including one found at the Salisbury Wetlands (interconnected with the Little Para River) by Waterwatch in 2005 and an adult from the Onkaparinga River in 2006[155]. Given the location close to urban areas it is unknown whether these are natural occurrences or translocations (e.g. discarded aquarium fish).

Biology and habitat The Shortfinned Eel is a diadromous species (i.e. it has different life stages in both marine and freshwater habitat). Juveniles grow to maturity for as long as 10-20 years in upper estuaries and freshwater habitat types such as streams and rivers, springs, wetlands, sinkholes. A predatory

species, diet interstate is known to include insects, molluscs, crustaceans and fish. Adults migrate out to sea on full moons in late winter with seasonally high discharge and undertake a long spawning migration to spawning grounds thought to occur somewhere NE of Australia in the Coral Sea (around 3000km!). Larvae (leptocephali) are carried back towards the coast on the East Australian Current where they metamorphose (change form) into the glass eel stage which move into freshwater in winter and spring[87,223](an upstream migrant was recorded in December 2006 at Eight Mile Creek in SE SA[55]). Recruitment (colonisation) of Shortfinned Eel into streams becomes less regular and reduced west of Cape Otway in Victoria as juveniles need to contend with opposing current directions across Bass Strait and along the SA coast in winter and spring[224,225]. Hence, as the western most distribution of the species, long distances and unfavourable conditions likely limit the abundance of the species in SA.
In addition, a late summer arrival will rarely coincide with significant discharge, further limiting penetration inland.



Reasons for decline and threats The species is threatened in SA as it is naturally rare in abundance and has a restricted and divided area of occupancy (RA d(ii)). However, other potential threats which may be ongoing might have caused declines from historic distribution and abundance. Changes in catchment hydrology, especially loss of perennial (permanent) flow and early cessation of seasonal flows (e.g. from farm dam abstraction, water storage in reservoirs and upstream regulation on the River Murray) would lead to limited opportunities for colonising freshwater habitat and a reduction in the availability and quality of suitable habitat. Migration barriers (such as large dams, the Barrages and smaller weirs) would act to limit the numbers of individuals accessing freshwater and cause bottlenecks exposing fish to predation and deleterious conditions. Loss of instream and riparian habitat would be significant in small streams (e.g. known habitats on Kangaroo Island) and general ecosystem change could influence required trophic linkages for populations[226]. The local and regional impacts of fishing are unknown. For example a small recreational fishery exists for Shortfinned Eel in the SE and larger numbers are harvested in eastern states. Reduced adult spawning biomass may for example, influence the numbers of juveniles available to migrate to SA.

Land tenure and conservation Shortfinned Eel is known from or moves through the following conservation reserves: Lower Glenelg River NP, Piccaninnie Ponds CP, Ewens Ponds CP, Kelly Hill CP, Coorong NP and Onkapringa River NP. It occurs on other private and public lands including drains managed by the SEWCDB.

Recovery objectives

- Gain a detailed understanding of status and biology in SA through targeted research.
- Improve access to freshwater habitat by addressing artificial barriers to fish movement and altered flow regimes.
- Undertake habitat restoration projects on strategic habitat areas.
- Link conservation of Shortfinned Eel in SA to broader management of interstate fisheries.

Conservation actions already initiated

- Initial assessments of distribution undertaken opportunistically from surveys occurring throughout much of the known range of Shortfinned Eel.
- Fishways have been installed at the Barrages and some Locks and Weirs as part of a large MDBA project aiming to restore fish passage between the sea and Hume Weir. Initial[227] and more detailed SARDI study has been initiated at these fishways.
- A fishway has recently been installed at the mouth of the River Torrens (AMLR NRM Board).
- Pilot movement studies have been undertaken in the SE[55] and at the Onkaparinga as part of an environmental flows project[155].

Required conservation actions

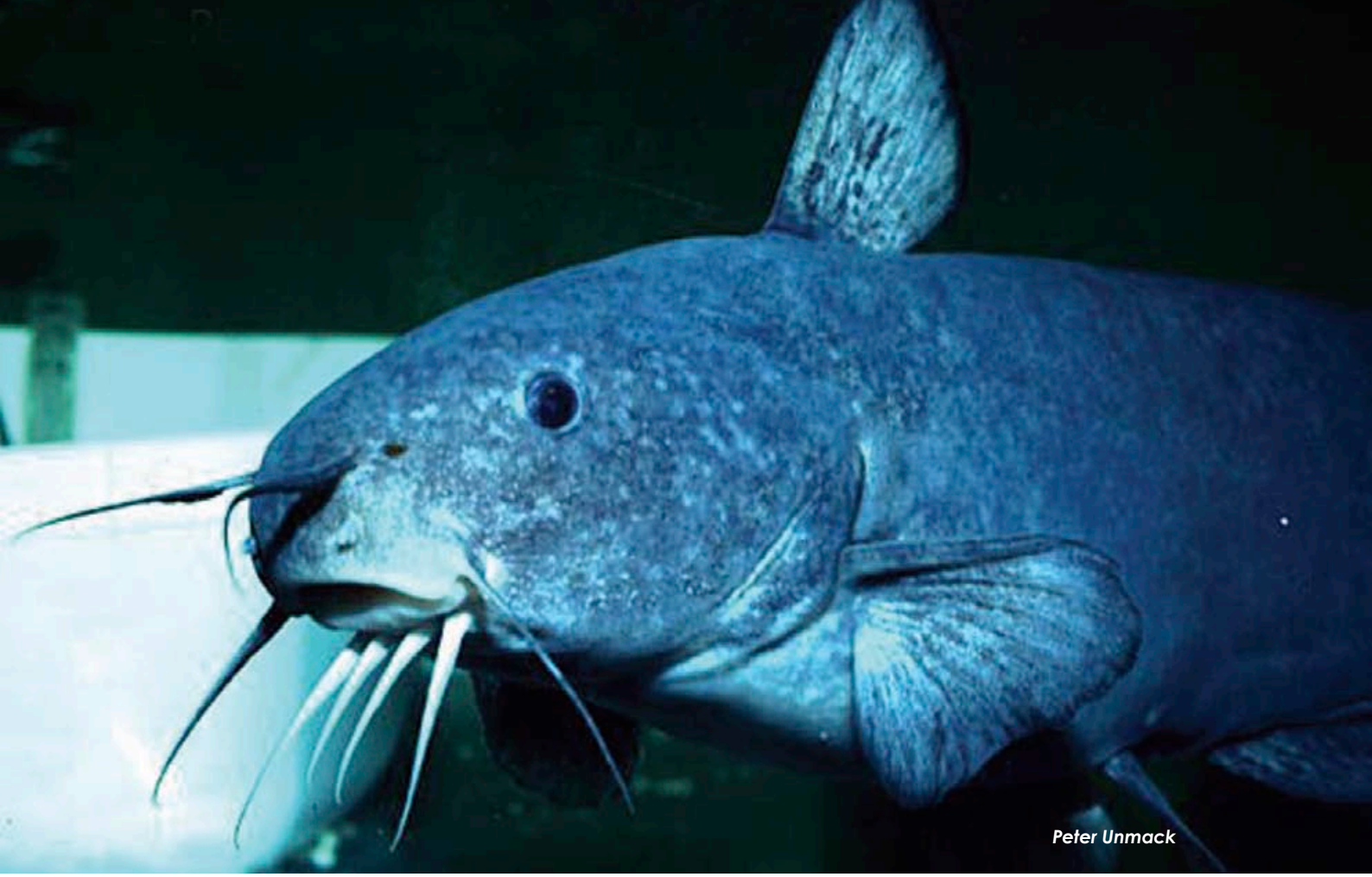
- Continue to monitor adult distribution with targeted surveys, and undertake long term movement studies at key habitats (e.g. Eight Mile Creek, Murray Mouth, SW Kangaroo Island, Onkaparinga River) to determine the scale and timing of juvenile upstream migration so that requirements for upstream colonisation can be catered for (e.g. environmental flow restoration programs).
- Assess and prioritise barriers potentially impacting migration, investigate fishway options, including studies to test their effectiveness[228].
- Undertake genetic and/or otolith studies to assess the origin of fish in the Adelaide region and whether any homing of juveniles to rearing grounds exists (and hence further identify the importance of protecting and enhancing local populations).

Organisations responsible for conservation of species

DEH, PIRSA Fisheries, DWLBC and the KI, AMLR, SAMDB & SE NRM boards.

Organisations or individuals involved

NFA(SA), SARDI Aquatic Sciences, DEH, AMLR & SAMDB NRM boards, KI Community Education, MDBA, SA Water.


Peter Unmack

Cooper Catfish *(Neosiluroides cooperensis)*

Other common names: Cooper Creek Catfish, Cooper Creek Tandan

Conservation status *South Australia:* Endangered (RA d(ii)).
National & interstate: not listed.

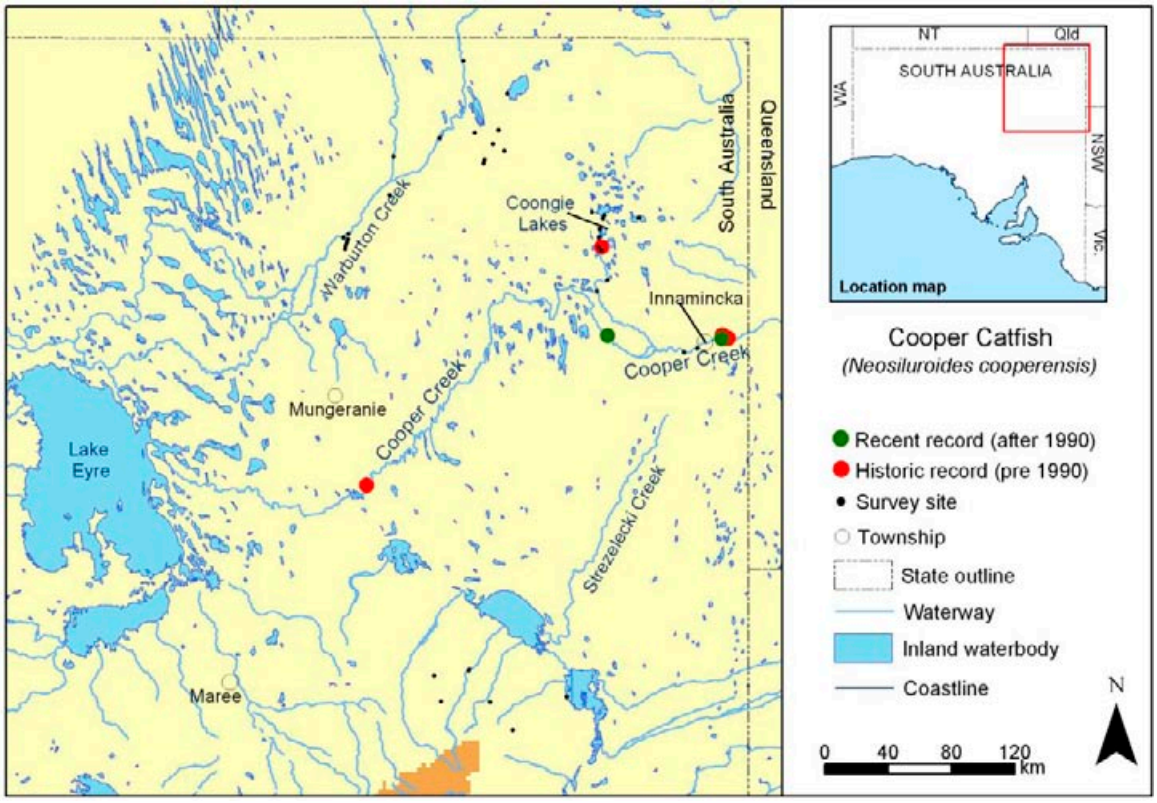
Taxonomy and identification The Cooper Catfish has a stout, tapered body and is large growing to around 60cm. Catfishes can easily be distinguished by the four pairs of barbells around their mouth and by the eel-like tail. The Cooper Catfish can be distinguished from Freshwater Catfish by the tail fin occurring only on the underside of the fish compared to extending along the dorsal surface (top) in Freshwater Catfish. It also has an underslung mouth, and a bulbous rounded head and small black eye when compared to Silver Catfish and Hyrtl's catfish.

Former distribution There are only a handful of documented records for the species in SA, and over its range which is limited to the Cooper Creek river system of the LEB. The Cooper Catfish has been historically overlooked due to rarity, a lack of research within its known range and by confusion with other co-occurring catfishes. It was first reported in the 1970s and not formally described until 1998[216,229] and hence there is little information from before this time. Most records are from Cullyamarra Waterhole, a large permanent pool on the Cooper Creek near Innamincka (1971-2003). Other records include Coongie Lakes (1988, location details may be inaccurate) and Lake Warrawarinna (1974).

Current distribution Remains poorly known, with only a few recent records from Coopers Creek – Cullyamarra Waterhole[64,230] and Embarka Waterhole[101,231]. Expected habitat includes any larger permanent waterholes along Cooper Creek proper and its North West branch which splits off and heads towards Coongie Lakes.

Biology and habitat The Cooper Creek Catfish is poorly known. The little available data suggests the species is restricted to permanent waterholes and does not disperse widely to areas inundated during flooding unlike many other species in the LEB. They are known to eat snails, and probably also prey upon other invertebrates, shrimps and fishes. No information is known on spawning times or habits, although they appear to produce a relatively low number of eggs. Juveniles have not been recorded to date and maximum age is unknown[31,64,232]

Reasons for decline and threats The current status and population trends for Cooper Catfish cannot be determined due to a current lack of information. They have a limited range which appears to include specific habitat which would become highly fragmented and contracted during the long periods without flow common to Central Australia (RA d(ii)). Cooper Creek is currently one of the very few unregulated (i.e. without major dams or extractions) river systems in SA, and any change from this status may threaten localised species like Cooper Catfish by reducing the permanency of pools and lengthening the duration between flow events. Similarly climate change may have serious implications. The potentially highly restricted and fragmented occupied habitat of Cooper Catfish leaves them susceptible to local losses and range contraction which may have occurred in the past or be occurring, but remains undetected. Potential threats include: (a) local habitat loss from pool pumping or instream works, (b) fishing pressure either direct or incidental, especially during dry periods, (c) deterioration in water quality due to pollution from human use or stock access, and (d) the introduction or establishment of alien species which may bring threats from disease, changes to aquatic food chains, competition and predation (for example Murray Cod have been reported[180] and Tilapia is an ever present threat).



Land tenure and conservation

- Most known records fall within the Innamincka Regional Reserve, with remaining sites on private grazing properties or public water reserves.

Recovery objectives

- Provide a significant increase in available knowledge of Cooper Catfish distribution and biology in SA.
- Use acquired knowledge to implement appropriate conservation initiatives as required.

Conservation actions already initiated

- Recent research sampling has occurred at several sites (potential habitat) on rivers in the SA LEB[64] although little published information exists for Cooper Creek directly.
- Recreational fishing restrictions have been introduced.

Required conservation actions

- Determine distribution through time at identified permanent pools via targeted sampling. Undertake concurrent biological studies as pilot for more in-depth investigations of spawning, recruitment and movement.
- Review information on recreational fishing catch and vulnerability to overharvest to inform fisheries management and species conservation (e.g. investigate moratoriums during drought).
- Initiate community driven programs to protect habitat at isolated populations and to help improve awareness of the presence and uniqueness of the Cooper Catfish plus threats to the species and related habitat.
- The lack of information regarding the Cooper Catfish means that the general public can help by reporting any past or present sightings (www.nativefishsa.asn.au).

Organisations responsible for conservation of species

DEH, PIRSA Fisheries, DWLBC, SAAL NRM Board.

Organisations or individuals involved

University of Adelaide, DWLBC, PIRSA Fisheries, traditional owners.

Cullyamarra Waterhole on Cooper Creek, a large desert refuge for Cooper Catfish (Photo Dylan Sortino)

Climbing Galaxias *(Galaxias brevipinnis)*

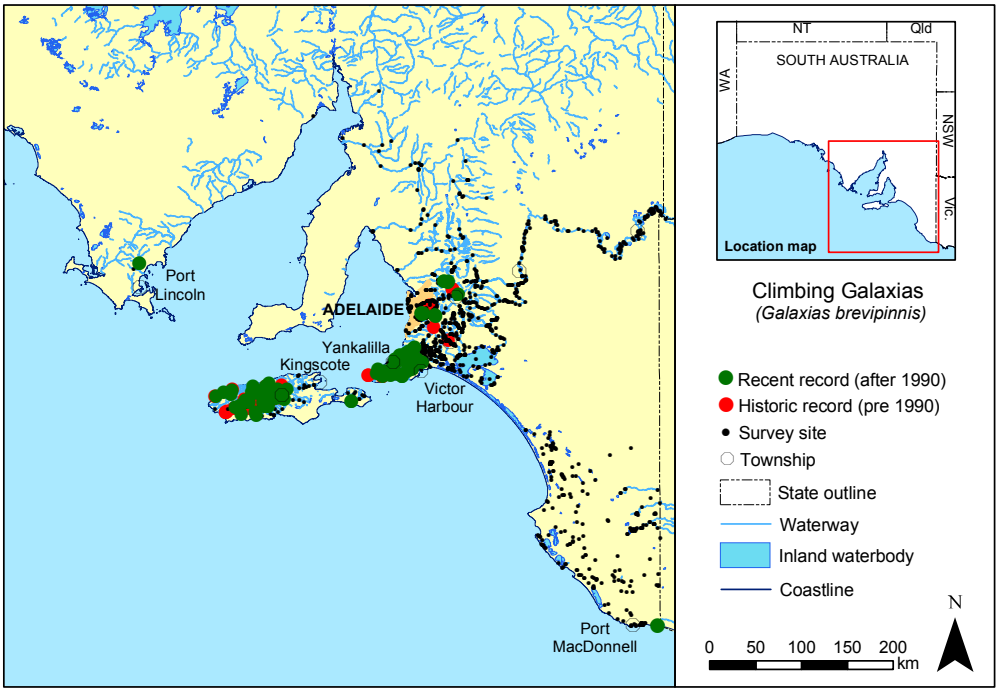
Other common names: Broadfinned Galaxias, Muddies and Slipperies.

Conservation status *South Australia:* Rare (RA b).
National & interstate: not listed.

Taxonomy and identification Climbing Galaxias is a stocky, scaleless fish reaching a maximum size of around 25cm, but is more commonly 10-18cm. Small individuals can be confused with Mountain Galaxias, but Climbing Galaxias have an undercut lower jaw, dark spot behind the gill cover, and larger pelvic and anal fins. Adults are similar to Spotted Galaxias which have jaws equal in length and uniform large spots on the body. Climbing Galaxias are often quite dark and could be confused with River Blackfish which have a long single dorsal fin and small finger-like pelvic fins. Transparent juveniles (whitebait) can be identified by the anal fin beginning behind the origin of the dorsal fin and the lack of a black band at the base of the tail.

Former distribution The historic distribution of the Climbing Galaxias is poorly documented with only sparse and patchy records held at the SA Museum. Early records include four distinct areas: (a) Adelaide region - Morialta Gully (Fourth Creek, prior to 1928), (b) Southern Fleurieu Peninsula - Myponga River and Deep Creek (1949), (c) Kangaroo Island - Cygnet River (1883, 1912) and Breakneck and Rocky rivers (1948-50), and (d) EMLR – Angas River, Strathalbyn (1914). Additional records between 1950 and the 1980s expanded known localities in three of the four regions listed above including: (a) Watts Gully (Gawler Catchment) and Jupiter Echunga Creek (Onkaparinga Catchment), (b) Cape Jervis and Hindmarsh River, and (c) the western half of Kangaroo Island including the Middle, Western, De Mole, Ravine des Casoars, South West, Stunsail Boom, Harriet and Eleanor rivers.

Current distribution Baseline sampling across much of the known range of Climbing Galaxias since the 1990s (mostly concentrated in the period 2001-2005) has revealed significant new information. A fifth distinct range section has been identified from the Tod River on Eyre Peninsula (1995)[101], with numerous new records or location confirmations from other regions: (a) Adelaide region – Victoria Creek (Gawler Catchment)[55,67,101], upper River Torrens[28], Brownhill Creek[28,101] and the Onkaparinga Catchment including Scott Creek and the main channel of the Onkaparinga River between the upper Gorge and above Mt Bold Reservoir[55,155,233], (b) most streams with permanent pools on the Southern Fleurieu[27], and (c) most streams on Western Kangaroo Island, plus another small population in Willson River (eastern KI)[26,27]. Distribution within known catchments is quite patchy, and with the exception of KI and some streams of the Southern Fleurieu, abundances are quite low (especially in the Adelaide region, with the current status on the Eyre Peninsula unknown). Although there are only a few historic records, at least two locations where the species was previously known appear to no longer support populations: Fourth Creek[28] and the EMLR, where despite extensive sampling no individuals have been found[25]. The species was likely to have been more commonly recorded in the EMLR prior to construction of the Barrages around the Murray Mouth and reductions in stream discharge. The first South East record was made in September 2007 during monitoring at the Piccaninnie Ponds fishway[169].



Biology and habitat Climbing Galaxias occur in mid to upper catchment sections in deeper, cool pools that are often spring fed and have high levels of instream cover (rock) and a good buffer of riparian (stream side) vegetation (shade, edge cover and source of food). They also move into flowing areas between pools (riffles) when this habitat is available. Environmental flows appear important in maintaining the cool and oxygenated required habitat, and also to aid dispersal of the species within systems. Climbing Galaxias is generally thought to be a diadromous species where, after spawning in autumn and winter (spawning site documented as streamside vegetation above the normal water levels in Victorian streams[234]), larvae are swept out to sea where they develop for several months before returning to freshwater in spring as small transparent juveniles (whitebait). This lifecycle has yet to be confirmed in SA, and may occur wholly within some stream catchments, especially for a few populations landlocked above reservoirs (e.g. Mt Bold, Middle River, above Kangaroo Creek Reservoir). Population demographics and age of Climbing Galaxias is little known, and diet from studies outside SA is known to be opportunistic including aquatic and terrestrial invertebrates. Their large downward facing pectoral and pelvic fins combined with a flattened body assist the Climbing Galaxias to move through streams and negotiate waterfalls and instream structures. Its distribution and abundance appears to be significantly negatively influenced by the presence of predatory Brown and Rainbow Trout as they share similar habitat requirements in small streams[26,27,28,76,87].

Reasons for decline and threats Climbing Galaxias are likely to be influenced by altered catchment hydrology affecting the permanency and quality of pools (e.g. loss of spring feeding and delayed onset of seasonal flows due to water abstraction, which is likely to become even more pronounced with climate change), and habitat change especially land clearing and loss of stream side vegetation through stock access. Major barriers or disruptions to dispersal such as reservoirs, vertical weirs, road culverts and dry lower stream reaches are likely to impede the colonisation of juveniles and cause aggregations which are then susceptible to other impacts like predation and exposure to poor conditions. Competition for space and food, plus predation from trout (and also possibly Redfin) is a known threat in SA. Some catchments in the Adelaide region have lost connectivity to the sea and Climbing Galaxias must now rely solely on variable conditions in reservoirs to survive (and hence may now be fragmented). Fish from eastern Australia translocated into the MDB are currently invading downstream[89] and may pose a risk of genetic pollution to SA stocks.

There is little evidence for recent declines of Climbing Galaxias in SA although this is likely to be masked by a lack of previous data. While a large portion of the species' extent of occurrence seems relatively secure in less modified streams of the Southern Fleurieu and Kangaroo Island, this situation could

easily change with increasing water resource development or changes in landuse. Indeed some smaller modified catchments and/or areas with trout have restricted distributions compared to that which would have naturally occurred. Further, based on: (a) a deterioration in the extent and quality of suitable adult habitat, (b) some presumed local extinctions from the few populations that were historically documented, and (c) the seemingly precarious position (low abundance and extent) of some populations especially in the Adelaide region and Eyre Peninsula, the abundance of Climbing Galaxias in >50% of known habitat is predicted to have declined significantly and both abundance and area of occupancy is predicted to continue declining from existing and potential threats (RA b).

Land tenure and conservation Known conservation reserves where Climbing Galaxias occurs include: Para Wirra RP, Morialta CP (historic record), Brownhill Creek RP, Scott Creek CP, Onkaparinga NP, Deep Creek CP, Western River WA, Ravine des Casoars WA, Flinders Chase NP, Kelly Hill CP and Seddon CP. The species also occurs on other land managed by SA Water and Forestry SA, council reserves (e.g. Cox Creek at Bridgewater, Hindmarsh Falls) and private property including some properties managed for conservation (e.g. Bungala and Carrickalinga creeks).

Recovery objectives

- Improve knowledge of Climbing Galaxias biology and fine scale distribution in SA.
- Protect and restore environmental conditions including water regimes for maintaining habitat, spawning and migration.
- Protect terrestrial vegetation buffers around known populations and undertake targeted stream side restoration projects extending from core habitats.
- Provide appropriate management and control of introduced fish species.
- Improve access into and within freshwater habitat by assessing and addressing where appropriate artificial barriers to fish movement

Conservation actions already initiated

- Baseline surveys conducted in a large portion of the known range of Climbing Galaxias, providing a significant increase in available knowledge on the species.
- Climbing Galaxias has a reasonable representation in the State Reserve system and on a few properties managed for conservation.
- Fishways have been installed at the Murray Mouth region and at the River Torrens mouth.

Required conservation actions

- Initiate long-term monitoring programs and specific biological studies to examine the life history of Climbing Galaxias across different regions and habitats, especially focused on spawning, recruitment and movement in relation to flow, introduced predators and climate change.
- There is a strong need for fine scale mapping of distribution to better understand the status of Climbing Galaxias in the Eyre Peninsula and Adelaide regions.
- Secure key populations with immediate conservation management such as habitat restoration, managing introduced fishes, addressing barriers to fish passage and implementing environmental flow programs (e.g. Brownhill Creek, upper River Torrens, Tod River, Willson River).
- The interesting anatomy and biology, requirement for good stream side vegetation, and threatened status of the Climbing Galaxias make the species a good icon for the protection and restoration of waterways in SA (e.g. Landcare Programs), especially the Southern Fleurieu and KI regions – this needs to be fostered through improved education and natural resource management within government and community groups.

Organisations responsible for conservation of species

DEH, PIRSA Fisheries, DWLBC, Forestry SA, and the EP, AMLR, KI & SAMDB NRM boards.

Organisations or individuals involved

NFA(SA), SARDI Aquatic Sciences, DWLBC, AMLR, KI & SAMDB NRM boards, KI Community Education, Bungala Restoration Committee, and Landcare groups from the Southern Fleurieu.

2.6. **NON LISTED SPECIES**

> should not necessarily be considered secure

The future of the 26 native fishes not included on the conservation list should not necessarily be considered secure. Some species may be in historic or recent decline but with trends masked by a common lack of information on distribution and abundance or other issues such as inadequate taxonomy where additional cryptic species could occur. Several 'near threatened' species which narrowly missed qualifying for the conservation list are prime candidates for proactive approaches to secure populations before they indeed become threatened (Table 2). The near threatened species include several from the River Murray system which are suspected to have declined (eg. Figure 12), and also some little known fishes from the Lake Eyre Basin. Species have also been considered based on the warning signs of similar members of their Family being threatened.

Left to right. Northwest Glassfish, Lagoon Goby and Murray Rainbowfish

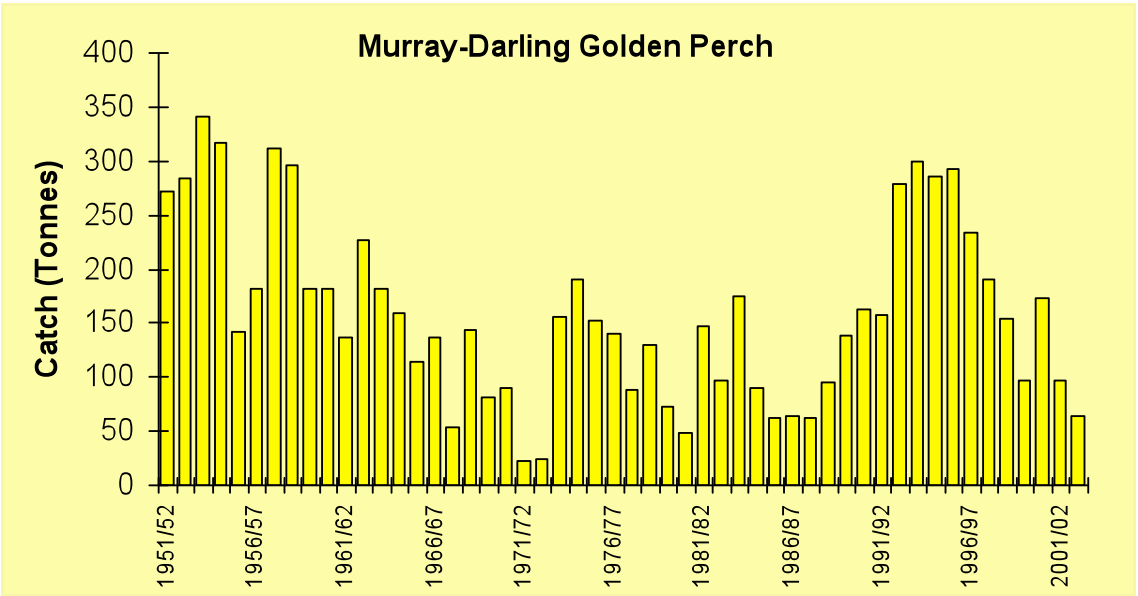


Figure 12. Catch data for Murray-Darling Golden Perch from the SA River Murray Commercial Fishery (between 1951-2003) based on SA Fisheries Statistics[163,165,189,235].

Table 2. List of 'near threatened' freshwater fishes (unofficial category) for South Australia.

Family	Species	Common name	Conservation concerns
Galaxiidae	*Galaxias maculates*	Common galaxias	Widespread in coastal systems, but potential to be listed due to due to blocked access and deterioration of the Lower Lakes.
Melanotaeniidae	*Melanotaenia fluviatilis*	Murray Rainbowfish	Patchy distribution, minor decrease in extent of occurrence (Finniss River), possibly subject to major fluctuations in abundance.
Atherinidae	*Craterocephalus stercusmuscarum fulvus*	Unspecked Hardyhead	Uncommon in 1980s, appears to have increased in recent years, but could fluctuate rapidly.
Ambassidae	*Ambassis* sp.	Northwest Glassfish	Poorly known species, with a limited distribution. Related species is presumed extinct in the SAMDB.
Percichthyidae	*Macquaria ambigua ambigua*	Murray-Darling Golden Perch	Populations fluctuate but seem secure (Fig. 10), however susceptible to further changes (degradation) in the condition of River Murray, especially reduced flooding and with loss of Lower Lakes habitat. Most other members of the Family are threatened.
	Macquaria sp.	Lake Eyre Golden Perch	Vulnerable to over harvest and habitat change depleting refuge populations in isolated pools during dry periods. Most other members of the Family are threatened.
Terapontidae	*Scortum barcoo*	Barcoo Grunter	Poorly known species, with a limited distribution. May be susceptible to over harvest and habitat change depleting refuge populations during dry periods.
Eleotridae	*Philypnodon macrostomus*	Dwarf Flathead Gudgeon	A patchy distribution, generally in low abundance. May have declined concurrent to altered conditions in the River Murray. Small populations in MLR streams susceptible to local extinction.
	Hypseleotris sp. 3	Murray-Darling Carp Gudgeon	Poorly known due to taxonomic confusion, initial SA Museum research suggest a patchy distribution that may be susceptible to further changes (degradation) in the condition of River Murray wetlands and EMLR streams.
	Hypseleotris klunzingeri	Western Carp Gudgeon	Poorly known due to taxonomic confusion. Initial SA Museum research suggests a patchy distribution that may be susceptible to further changes (degradation) in the condition of the River Murray.
Gobiidae	*Tasmanogobius lasti*	Lagoon Goby	Limited number of known locations within a limited area of occupancy.