Fish monitoring for the 'Drought Action Plan for South Australian Murray-Darling Basin threatened freshwater fish populations':

Summary for 2008/09




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Cover: (clockwise from top left) southern pygmy perch (*Nannoperca australis*), river blackfish (*Gadopsis marmoratus*), southern purple-spotted gudgeon (*Mogurnda adspersa*), and Murray hardyhead (*Craterocephalus fluviatilis*).

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1. EXECUTIVE SUMMARY

As a result of the combined affect of the over-extraction of water in the Murray-Darling Basin (MDB) and persistent drought conditions in south-eastern Australia, inflows in the South Australian MDB have been below average for several years. Consequently, water levels in many freshwater habitats, particularly below Lock 1, have receded since 2006. There are currently five species of small-bodied freshwater fish of national or state conservation significance in the South Australian MDB (i.e. river blackfish (*Gadopsis marmoratus*), southern purple-spotted gudgeon (*Mogurnda adspersa*), southern pygmy perch (*Nannoperca australis*), Yarra pygmy perch (*Nannoperca obscura*) and Murray hardyhead (*Craterocephalus fluviatilis*)) and all are under threat from the current conditions. Therefore, the South Australian Department for Environment and Heritage initiated the 'Drought Action Plan (DAP) for South Australian MDB threatened freshwater fish populations' with the aim of providing a framework for the management and conservation of these populations during current unfavourable conditions.

As part of the South Australian DAP for threatened fish, 26 significant sites for these species within the South Australian MDB were monitored in 2008/2009. Fish populations were sampled, using a variety of techniques (i.e. electro-fishing, fyke netting, box traps) in spring 2008 and autumn 2009 to monitor changes in abundance and assess recruitment. Site condition assessments (i.e. water levels, water quality and vegetation cover) were also carried out in spring 2008 and autumn 2009, with additional site condition assessments in winter 2008 and summer 2009. This monitoring assesses site trends (e.g. declining water levels) and identifies sites and populations that are at greatest risk and hence in need of immediate management intervention.

A summary of monitoring results is presented in Table 1, including site information (i.e. name, number, species originally present), fish population monitoring (i.e. abundances, evidence of recruitment), the status of water level (i.e. rising, falling, stable, dry) and brief comments on the site/population. By combining the information gathered, a level of risk (low, medium, high or population lost) was determined for each population. The risk of species loss was determined using the following criteria,

- Low risk (green) – moderate abundance in autumn 2009, evidence of recent recruitment and stable habitat conditions.
- Moderate risk (orange) – moderate abundance, lack of recruitment (river blackfish) and/or diminished habitat quality.

- High risk (red) – substantial declines in abundance (between spring 2008 and autumn 2009), lack of recruitment (Pygmy perch species' and Murray hardyhead), extended lack of recruitment (i.e. >3 years, river blackfish) and/or severely diminished habitat quality.
- Population likely to be lost (purple)

Table 1. The population status of threatened fish (abundance, recruitment and site conditions) at each site monitored under the drought action plan and associated risk level to the persistence of the population (colours: green – low risk, orange – medium risk, red – high risk, purple – population lost).

Site Name	DAP Site Number	Target Species	No. caught spring 2008	No. caught autumn 2009	Recruitment within the last 12 months (Y/N)	Water level summer-autumn (Rising, stable, falling, dry)	Site comments
Jury Swamp	1.1.1	Southern purple spotted gudgeon	1	1	No	Falling	Likely further habitat degradation through decreasing water level.
Rodwell Creek	2.1.1	River blackfish	6	11	No	Falling	Pool being maintained by watering. Recruitment within last 3 years.
Marne	2.2.1	River blackfish	3	1	No	Rising	No recruitment within last 3 years Pool in poor condition (i.e. presence of unknown white plume on bottom of pool)
Angas Gauge	2.3.1	River blackfish	17	26	No	Rising	Pool in reasonable condition but salinity rising. Recruitment within last 3 years
Willowburn Road	2.4.1a	River blackfish	8	7	Yes	Falling	Pools in good condition (i.e. consistent cool base flow)
	3.4.1a	Southern pygmy perch	7	24	Yes	Falling	As above
Deep Creek Road	2.4.1b	River blackfish	3	5	Yes	Stable	Pool in good condition (i.e. consistent cool base flow)
	3.4.1b	Southern pygmy perch	21	13	Yes	Stable	As above
Middle Creek Junction	3.1.1	Southern pygmy perch	35	53	Yes	Falling	Low water level in pool
Boundary Creek Drain	3.2.1a	Southern pygmy perch	0	0	-	Falling	Low water levels, population likely lost
	4.1.1a	Yarra pygmy perch	0	0	-	Falling	Low water levels, population likely lost
	5.1.1a	Murray hardyhead	58	1	Yes	Falling	Low water levels, low numbers still present
Eastick	3.2.1b	Southern pygmy perch	0	Not sampled	-	Falling	Low water level, high salinity – population likely lost
	4.1.1b	Yarra pygmy perch	0	Not sampled	-	Falling	Low water level, high salinity – population likely lost
	5.1.1b	Murray hardyhead	0	Not sampled	-	Falling	Low water level, high salinity – population likely lost
Steamer Drain	3.2.1c	Southern pygmy perch	Not sampled	Not sampled	-	Dry	Dry – population lost
	4.1.1c	Yarra pygmy perch	Not sampled	Not sampled	-	Dry	Dry – population lost
	5.1.1c	Murray hardyhead	Not sampled	Not sampled	-	Dry	Dry – population lost
Black Swamp	3.2.2a	Southern pygmy perch	Not sampled	Not sampled	-	Dry	Dry – population lost
	4.1.3	Yarra pygmy perch	Not sampled	Not sampled	-	Dry	Dry – population lost

Table 1 continued.

Site Name	DAP Site Number	Target species	No. caught spring 2008	No. caught autumn 2009	Recruitment within the last 12 months (Y/N)	Water level summer-autumn (Rising, stable, falling, dry)	Site comments
Black Swamp Drain	3.2.2	Southern pygmy perch	0	Not sampled	-	Dry	Low water level, population potentially lost
Turvey's Drain	3.2.3	Southern pygmy perch	81	5	Yes	Stable	Environmental water secured for filling
	5.1.3a	Murray hardyhead	8	7	Yes	Stable	Environmental water secured for filling
Meadows	3.3.1	Southern pygmy perch	2	38	Yes	Falling	Very low water level
Waterfalls	3.3.3	Southern pygmy perch	35	1	No	Falling	Very low water level
Inman	3.5.1	Southern pygmy perch	12	101	Yes	Falling	Low water levels in pools, low DO
Currency Creek	4.1.2A	Yarra pygmy perch	0	Not sampled	-	Dry	Dry – population lost
	-	Murray hardyhead	11	Not sampled	No	Dry	Dry – population lost
Finniss River Confluence	4.1.2	Yarra pygmy perch	0	Not sampled	-	Dry	Dry – population lost
	-	Murray hardyhead	2	Not sampled	No	Dry	Dry – population lost
Boggy Creek	5.1.1d	Murray hardyhead	587	Not sampled	-	Was dry (now refilled)	Unknown since re-filling
Clayton	5.1.2	Murray hardyhead	8	1	Yes	Falling	No off-channel habitat remains, water level continues to recede
Milang Jetty	5.1.3b	Murray hardyhead	5	0	No	Falling	Very low water levels, probably dry in certain wind conditions
Bremer River Mouth	5.1.3c	Murray hardyhead	9	Not sampled	No	Dry	Dry
Rocky Gully	5.1.4	Murray hardyhead	760	3	Yes	Stable	Habitat was in critical condition but has now been watered
Riverglades	5.1.5	Murray hardyhead	0	Not sampled	-	Dry	Dry
Disher Creek	5.2.1	Murray hardyhead	3	174	Yes	Falling	Very high abundance of gambusia may be impacting Murray hardyhead
Berri	5.2.1	Murray hardyhead	37	84	Yes	Falling	Salinity decreasing Increase in non salt-tolerant species that may compete with Murray hardyhead

2. INTRODUCTION

In the Lower Murray River region of South Australia there are currently threatened populations of five species of small-bodied freshwater fish of national or state conservation significance. These are Yarra pygmy perch (*Nannoperca obscura*) and Murray hardyhead (*Craterocephalus fluviatilis*), nationally listed as 'Vulnerable' under the Commonwealth *EPBC Act* (*1999*) and southern pygmy perch (*Nannoperca australis*), southern purple-spotted gudgeon (*Mogurnda adspersa*) and river blackfish (*Gadopsis marmoratus*) considered endangered in the region and 'Protected' under the *Fisheries Management Act 2007*. Each of these species is now present in the South Australian Murray-Darling Basin (MDB) in only a limited number of populations and several species have undergone severe declines in abundance in recent years (see Hammer 2007a; Hammer 2007b).

Persistent drought conditions across south-eastern Australia in the last decade, combined with a history of over-extraction of water (Kingsford 2000), have led to reduced inflows in the Murray-Darling Basin (MDB) and receding water levels in many freshwater habitats. These conditions are profoundly impacting threatened fish populations in the South Australian MDB (Bice *et al.* 2008; Hammer 2008). Consequently, the South Australian Department for Environment and Heritage has developed the 'Drought Action Plan (DAP) for South Australian MDB threatened freshwater fish populations' (Hall *et al.* 2009) to manage and conserve these populations. The DAP identifies sites or populations of significance, summarizes information on past and current population status and threats to these populations but most importantly, provides a framework for determining management actions needed to conserve, rescue and recover populations. A total of 26 sites were initially included in the DAP based on the presence of at least one of the species of concern (Hall *et al.* 2009).

As a component of the DAP, all sites were monitored through 2008/09 and will continue to be monitored through 2009/2010. In spring 2008 (October-November) and autumn 2009 (March-May) fish populations were sampled and site condition assessments (e.g. measurements of water quality) were conducted. Additional site checks were conducted in winter 2008 (August) and summer 2009 (February) to assess site condition. These data provide insight on the presence/absence of threatened species, the trajectory of populations (e.g. declining/increasing abundance, successfully recruiting) and site condition (e.g. receding/rising water levels) and facilitate in identifying populations at greatest risk of loss and therefore in need of management intervention.

The following document presents the results of fish sampling in spring 2008 and autumn 2009 with a summary of site condition assessments throughout 2008/09. It aims to support the DAP by providing a 'report card' on the status of each population and identifying those in need of management. This document does not provide a comprehensive summary of management actions undertaken to date (see Hall *et al.* 2009) or provide thorough suggestions on potential management actions but simply aims to highlight the current status of populations and thus facilitate discussion of potential management options by the DAP team (i.e. DEH, SARDI Aquatic Sciences, Aquasave Consultants and South Australian Murray-Darling Basin Natural Resource Management Board (SA MDB NRMB)).

3. METHODS

3.1. Sites

A total of 26 sites were selected for monitoring based on the previous presence of at least one of the five threatened species. Sites range in location from Disher Creek and Berri evaporation basin near the Victorian border to Eastick Creek and Steamer drain near the mouth of the River Murray (Figure1a-b) and cover three broad habitat types – wetlands associated with the River Murray Channel; fringing wetlands of western Lake Alexandrina; and stream tributaries of the Eastern Mount Lofty Ranges. Not all sites were sampled and assessed throughout 2008/09, either due to complete drying, lack of access or continued absence of threatened species (i.e. throughout this project and previous monitoring programs). Table 2 presents the sites, the species originally present at each site and the seasons in which they were monitored.

Adelaide University also conducted 'condition monitoring' of threatened fish populations in the Lower Lakes in 2008/09 as part of the Murray-Darling Basin Authorities' (MDBA), *The Living Murray* program (funded by the SA MDB NRMB) (Wedderburn and Barnes 2009). Due to the current precarious status of fish populations in this region and their potential susceptibility to interference, a data sharing agreement was made between the two projects to avoid excessive sampling of populations. Sampling events were coordinated to occur at the same time. Sites monitored by Adelaide University are indicated in Table 2.

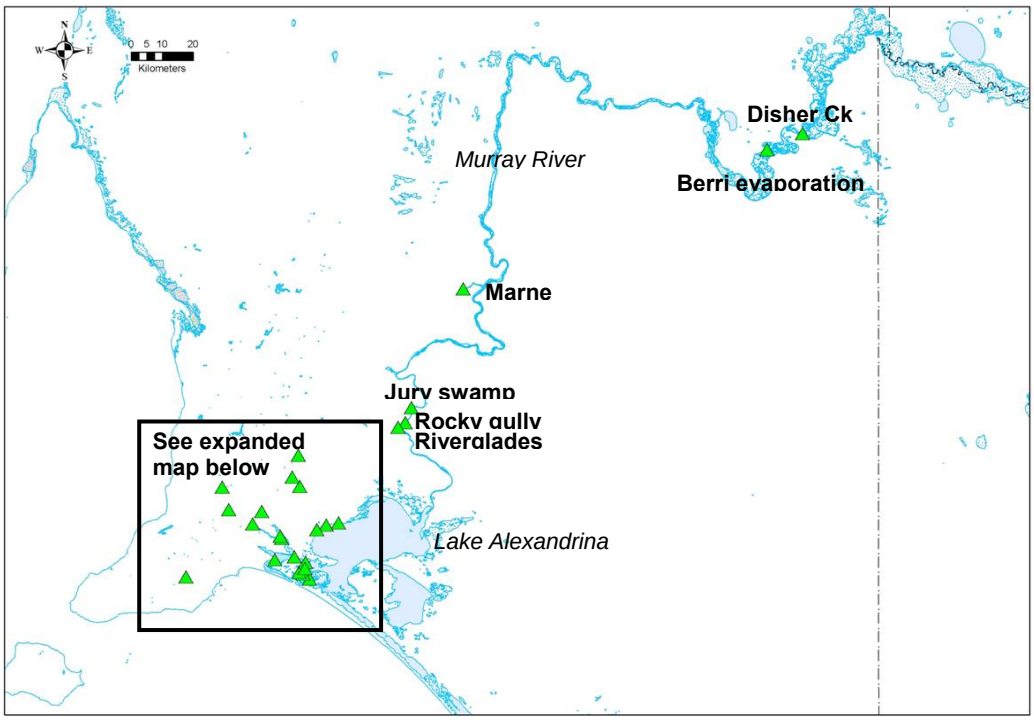

Figure 1a. Map of the SA MDB showing Drought Action Plan monitoring sites.

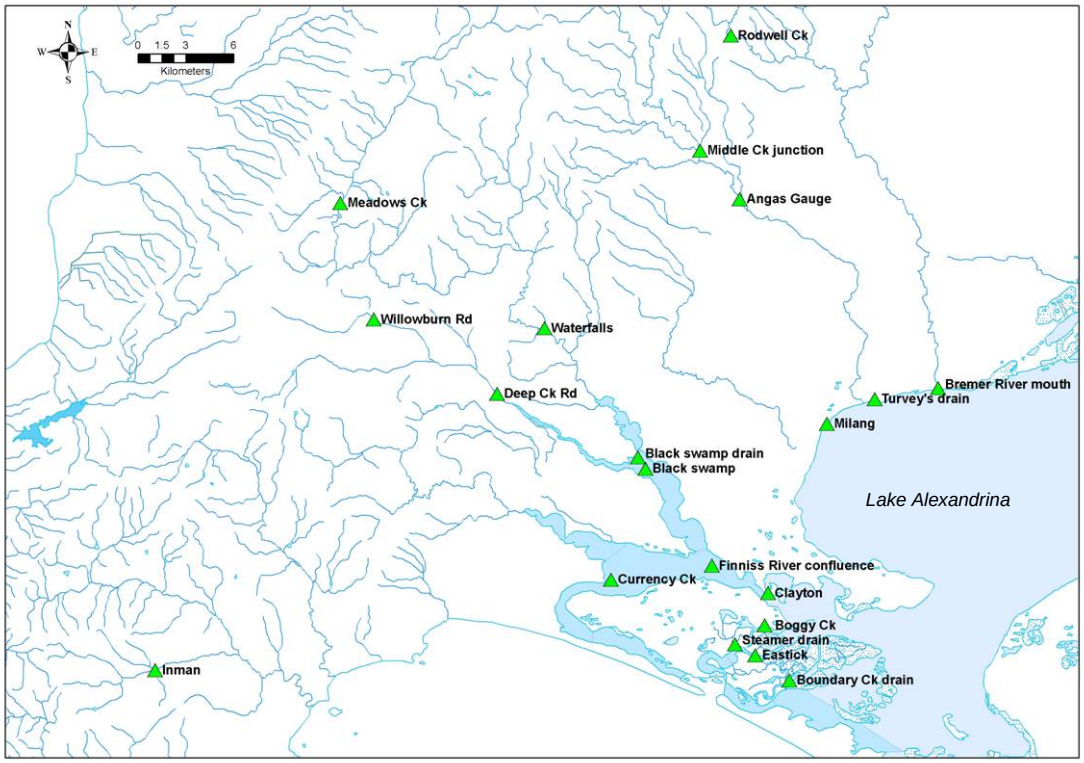

Figure 1b. Expanded map of sites in the western Lower Lakes and Eastern Mount Lofty Ranges region.

Table 2. Drought Action Plan monitoring sites, threatened species present and seasons when monitoring was conducted (winter and summer trips involved site condition assessments, whilst spring and autumn trips involved fish sampling and site condition assessments).

Site Name	DAP Site Number	Species	Monitoring season (Yes/No)			
			Winter 08	Spring 08	Summer 09	Autumn 09
Jury Swamp	1.1.1	Southern purple spotted gudgeon	Yes	Yes	Yes	Yes
Rodwell Creek	2.1.1	River blackfish	Yes	Yes	Yes	Yes
Marne River	2.2.1	River blackfish	Yes	Yes	Yes	Yes
Angas Gauge	2.3.1	River blackfish	Yes	Yes	Yes	Yes
Willowburn Road	2.4.1	River blackfish, southern pygmy perch	Yes	Yes	Yes	Yes
Deep Creek Road	2.4.1	River blackfish, southern pygmy perch	Yes	Yes	Yes	Yes
Middle Creek Junction	3.1.1	Southern pygmy perch	Yes	Yes	Yes	Yes
Boundary Creek Drain*	3.2.1a, 4.1.1a, 5.1.1a	Southern pygmy perch, Yarra pygmy perch, Murray hardyhead	Yes	Yes	No	Yes
Eastick	3.2.1b, 4.1.1b, 5.1.1b	Southern pygmy perch, Yarra pygmy perch, Murray hardyhead	Yes	Yes	No	No

*Denotes sites sampled by Adelaide University

Table 2 continued

Site Name	DAP Site Number	Species	Monitoring season (Yes/No)			
			Winter 08	Spring 08	Summer 09	Autumn 09
Steamer Drain	3.2.1c, 4.1.1c, 5.1.1c	Southern pygmy perch, Yarra pygmy perch, Murray hardyhead	Yes	No	No	No
Black Swamp	3.2.2a, 4.1.3	Southern pygmy perch, Yarra pygmy perch	Yes	No	No	No
Black Swamp Drain	3.2.2b	Southern pygmy perch	Yes	Yes	No	No
Turvey's Drain	3.2.3, 5.1.3a	Southern pygmy perch, Murray hardyhead	Yes	Yes	Yes	Yes
Meadows Creek	3.3.1	Southern pygmy perch	Yes	Yes	Yes	Yes
Waterfalls	3.3.3	Southern pygmy perch	Yes	Yes	Yes	Yes
Inman	3.5.1	Southern pygmy perch	Yes	Yes	Yes	Yes
Currency Creek Confluence	4.1.2a	Yarra pygmy perch, Murray hardyhead	Yes	Yes	No	No
Finniss River Confluence	4.1.2b	Yarra pygmy perch, Murray hardyhead	Yes	Yes	No	No
Boggy Creek*	5.1.1d	Murray hardyhead				
Clayton	5.1.2	Murray hardyhead	Yes	Yes	Yes	Yes
Milang Jetty	5.1.3b	Murray hardyhead	Yes	Yes	Yes	Yes
Bremer River Mouth	5.1.3c	Murray hardyhead	Yes	Yes	Yes	No
Rocky Gully	5.1.4	Murray hardyhead	Yes	Yes	Yes	Yes
Riverglades	5.1.5	Murray hardyhead	Yes	Yes	No	No
Disher Creek	5.2.1	Murray hardyhead	Yes	Yes	Yes	Yes
Berri Evaporation Basin	5.2.2	Murray hardyhead	Yes	Yes	Yes	Yes

*Denotes sites sampled by Adelaide University

3.2. Fish sampling

Various methods were used to sample fish populations. Depending on the characteristics of individual sites, one or a combination of the following methods were used,

- Backpack electro-fishing
    - A Smith-Root model LR-24 backpack electrofisher was used to sample all microhabitats (e.g. snags, vegetation, open water) represented within a site. 'On time' of electro-fishing differs between sites due to differences in available habitat area.
- Fyke netting (3 mm mesh, 3-6 m wing length)
    - Fyke nets are set perpendicular to the bank where possible. The number of fyke nets used at each site varies based upon the size of the sampling site
- Seine netting (6 mm mesh, 4 m length, 1.5 m depth)

  - Seine hauls are made of *c.* 10 m in length
- Box trapping (1 mm mesh, 400 x 240 x 240 mm size, 30-70 mm opening)

The specific sampling gear types and effort used at each site are indicated in individual site summaries (see results section). As many of these populations and habitats are highly restricted and thus vulnerable to interference, sampling effort was often low and tailored to minimize impact on fish populations. This is most notable for river blackfish populations at Rodwell Creek and the Marne River. At each site, where possible, sampling methods were kept consistent across seasons to allow for robust comparison of catch data over time. This is often difficult, particularly at sites in the Eastern Mount Lofty Ranges where backpack electro-fishing is used; these streams often have highly variable water levels and consequently the area that is able to be sampled also fluctuates resulting in lesser or greater effort.

All fish captured were identified to species, counted and length measurements (total length TL mm) taken for all threatened species. Sampling was conducted under a *Section 115 permit* in accordance with the *Fisheries Act 2007* and PIRSA Animal Ethics Committee standards.

3.3. Site condition assessments

Site assessments were carried out in winter 2008 and summer 2009, and also during fish sampling trips in spring 2008 and autumn 2009. This involved taking photos from an established photo point (when possible), estimating physical habitat, determining changes in water levels and measuring the physico-chemical characteristics of the water at each site.

Physical habitat cover was described (visual estimation) as the proportion of aquatic habitat area (i.e. below the water surface) comprised of emergent and submerged vegetation, other physical structure (i.e. woody debris, rock) and open water. Water level and depth were measured in a number of ways to provide a confident measure of changes in water levels (i.e. rising or falling). Maximum depth (m) was measured at each site and graduated depth stakes were installed to monitor changes in water level (depth was also measured at these stakes). Where possible, elevation readings were taken with a ‘dumpy’ level as another technique to assess changes in water level. Specifically, an elevation reading is taken from the site photo point and from the current water level, which provides a measure of the ‘difference’ between these elevations. Variation in the ‘difference’ between these elevation reference points over time signifies rises or falls in water levels.

Various physico-chemical parameters were measured at each site. Turbidity was measured as secchi depth (m) using a secchi disk, whilst the following parameters were measured using a TPS 90-FLT water quality meter,

- Conductivity ($\mu S.cm^{-1}$)
- pH
- Dissolved oxygen concentration (ppm)
  - At sites where low dissolved oxygen levels are a concern, both surface and bottom readings are taken
- Temperature (°C)

Data from site condition assessments is presented in tabulated format in the following site sub-sections.

4. RESULTS

4.1. Jury Swamp (River Murray: Southern purple-spotted gudgeon)

Winter 2008


Spring 2008


Summer 2009


Autumn 2009


Figure 2. Photo point images of Jury swamp from winter 2008, spring 2008, summer 2009 and autumn 2009.

Environmental conditions

Table 3. Habitat cover measured at Jury Swamp during each site visit. Habitat cover is measured as the proportion (percentage cover) of aquatic habitat area comprised of submerged and emergent macrophytes, physical structure or open water.

Season	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	0	20 (willows, *Cotula*)	10 (snags)	70
Spring 2008	0	35 (willows)	30 (snags)	35
Summer 2009	0	0	20	80
Autumn 2009	0	30	20	50

Table 4. Water depth at reference stake at Jury Swamp during each site visit and the overall change in water level between winter 2008 and autumn 2009.

Water surface level and water depth	Winter 2008	Spring 2008	Summer 2009	Autumn 2009	Total difference (m)
Depth at reference stake (m)	0.6	0.35	0.14	0.05	-0.55
Difference in water level (winter 2008 – autumn 2009, m)	-	-0.20	-0.47	-0.11	-0.78

Table 5. Water quality parameters measured at Jury Swamp during each site visit.

Season	Temp (ºC)	pH	Conductivity ($\mu S.cm^{-1}$)	DO (ppm)	Secchi (m)	Max depth (m)	Time
Winter 2008	13.1	8.6	600	10.0	0.60	-	1445
Spring 2008	20.6	8.4	633	-	0.52	1.5	-
Summer 2009	24.0	8.2	835	7.2	0.30	1	1230
Autumn 2009	19.4	8.0	700	6.2	0.45	0.5	0900

Fish sampling effort

Spring 2008

- 10 baited box traps set overnight within Jury Swamp.
- 10 baited box traps and 3 fyke nets set overnight in the River Murray around the mouth of Jury Swamp.

Autumn 2009

- 10 baited box traps set overnight in the River Murray.
- As a result of reduced water levels box traps could not be set within the wetland (Jury Swamp) and fyke nets could not be set in the River Murray

Catch summary and length-frequency analysis

A single purple-spotted gudgeon (Figure 3) was captured during each sampling occasion (Table 6). Both individuals were sampled in the River Murray, among willow roots near the mouth of Jury swamp. Both were adult fish (>70 mm TL (total length))

and as such, no recent recruitment has been observed in this population (Figure 4Figure 4a-b). Other species sampled and their abundances are also presented in Table 6.

Figure 3. Southern purple-spotted gudgeon sampled from the Murray River adjacent Jury swamp in autumn 2009.

Table 6. Total numbers of fish species collected from Jury Swamp in spring 2008 and autumn 2009.

Species		**Sampling trip**	
Common name	**Scientific name**	**Spring 2008**	**Autumn 2009**
Southern purple-spotted gudgeon	*Mogurnda adspersa*	**1**	**1**
Flat-headed gudgeon	*Philypnodon grandiceps*	52	4
Dwarf flat-headed gudgeon	*Philypnodon macrostomus*	7	
Carp gudgeon complex	*Hypseleotris spp.*	386	6
Unspecked hardyhead	*Craterocephalus stercusmucarum fulvus*	108	
Murray rainbowfish	*Melanotania fluviatilis*	31	
Australian smelt	*Retropinna semoni*	36	
Common galaxias	*Galaxias maculatus*	2	
Bony herring	*Nematalosa erebi*	1	
Golden perch	*Macquaria ambigua*	1	
Carp	*Cyprinus carpio*	1	

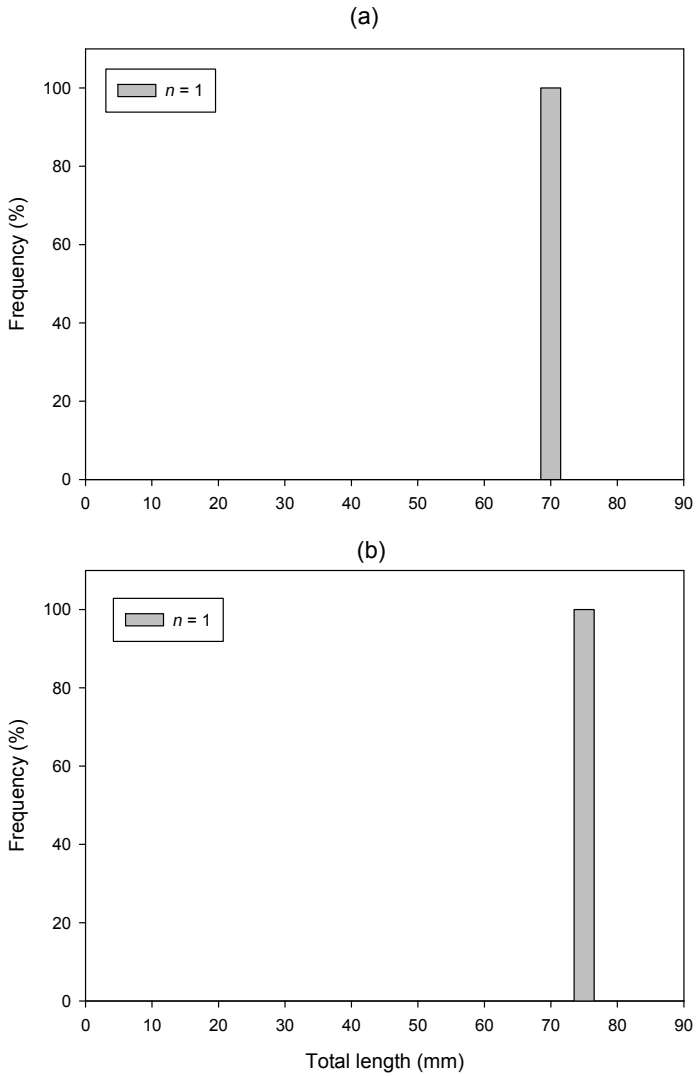

Figure 4a-b. Length-frequency distribution (5 mm increments) of southern purple-spotted gudgeon collected from Jury Swamp in (a) spring 2008 and (b) autumn 2009.

Site summary

Purple-spotted gudgeon are still present at this site, albeit in low abundance. Fish were captured in structurally complex habitat at the base of willows, outside of Jury Swamp, as preferred habitat in the swamp where this species was formerly found (Hammer 2007b) is now dry. As river levels continue to fall, the area of 'willow root' habitat will decrease and would likely be lost at river levels < -1.0 m AHD (Australian height datum).

4.2. Rodwell Creek (Bremer River: river blackfish)

Winter 2008

Spring 2008

Summer 2009

Autumn 2009

Figure 5. Photo point images of Rodwell Creek from winter 2008, spring 2008, summer 2009 and autumn 2009.

Environmental conditions

Table 7. Habitat cover measured at Rodwell Creek during each site visit. Habitat cover is measured as the proportion (percentage cover) of aquatic habitat area comprised of submerged and emergent macrophytes, physical structure or open water.

Season	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	0	30 (*Typha*)	5 (snags)	65
Spring 2008	5 (Algae)	40 (*Triglochin, Typha*)	5 (rock)	50
Summer 2009	0	40 (*Typha*)	10 (rock)	50
Autumn 2009	10 (*Chara*)	20 (*Typha*)	20 (snag, rock)	50

Table 8. Water depth at reference stake at Rodwell Creek during each site visit and the overall change in water level between winter 2008 and autumn 2009.

Water surface level and water depth	Winter 2008	Spring 2008	Summer 2009	Autumn 2009	Total difference (m)
Depth at reference stake (m)	1.38	1.08	0.89	0.85	-0.53
Difference in water level (winter 2008 – autumn 2009, m)	-	-0.30	-0.19	-0.04	-0.53

Table 9. Water quality parameters measured at Rodwell Creek during each site visit.

Season	Temp (ºC)	pH	Conductivity ($\mu S.cm^{-1}$)	DO (ppm) surface	DO (ppm) bottom	Secchi (m)	Max depth (m)	Time
Winter 2008	7.6	7.4	3900	5.0	0.5	0.8	-	1015
Spring 2008	17.2	7.4	6510	7.0	4.1	0.7	-	-
Summer 2009	16.6	7.7	5230	4.0	2.2	1.0	1.5	1000
Autumn 2009	14.8	7.6	4280	6.6	5.4	0.2	0.8	-

Fish sampling effort

Spring 2008 & autumn 2009

- 10 baited (yabbie) box traps set for 1.5 hours on dusk.
- Opportunistic observation of fish with a spotlight

Sampling effort at this site is minimal for several reasons. Firstly, blackfish are nocturnal and thus are most active on dusk and secondly, trapping time is limited to 1.5 hours to limit the risk of fish death due to localised low dissolved oxygen concentrations often recorded at this site (Table 9).

Catch summary and length-frequency analysis

River blackfish were caught in both seasons, with greater numbers in autumn than in spring (Table 10; Figure 6). The difference in abundance is likely due to more efficient sampling potential as a result of greater fish activity (movement) in autumn.

No other fish species were collected in spring but carp gudgeon and gambusia were both collected in autumn (Table 10).

In spring river blackfish ranged from 126-169 mm TL (Figure 7a) and 161-226 mm TL in autumn (Figure 7b) suggesting no recent recruitment. Although no recent recruits were collected in traps, two likely one year old fish (1+) were observed with a spotlight in autumn. Thus recruitment may have occurred in the last two years.

Table 10. Total numbers of fish species collected from Rodwell Creek in spring 2008 and autumn 2009.

Species		**Sampling trip**	
Common name	**Scientific name**	**Spring 2008**	**Autumn 2009**
River blackfish	*Gadopsis marmoratus*	**6**	**11 (+ 3 obs)**
Carp gudgeon complex	*Hypseleotris spp.*		2
Gambusia	*Gambusia holbrooki*		3

Figure 6. Adult river blackfish sampled from Rodwell Creek in autumn 2009.

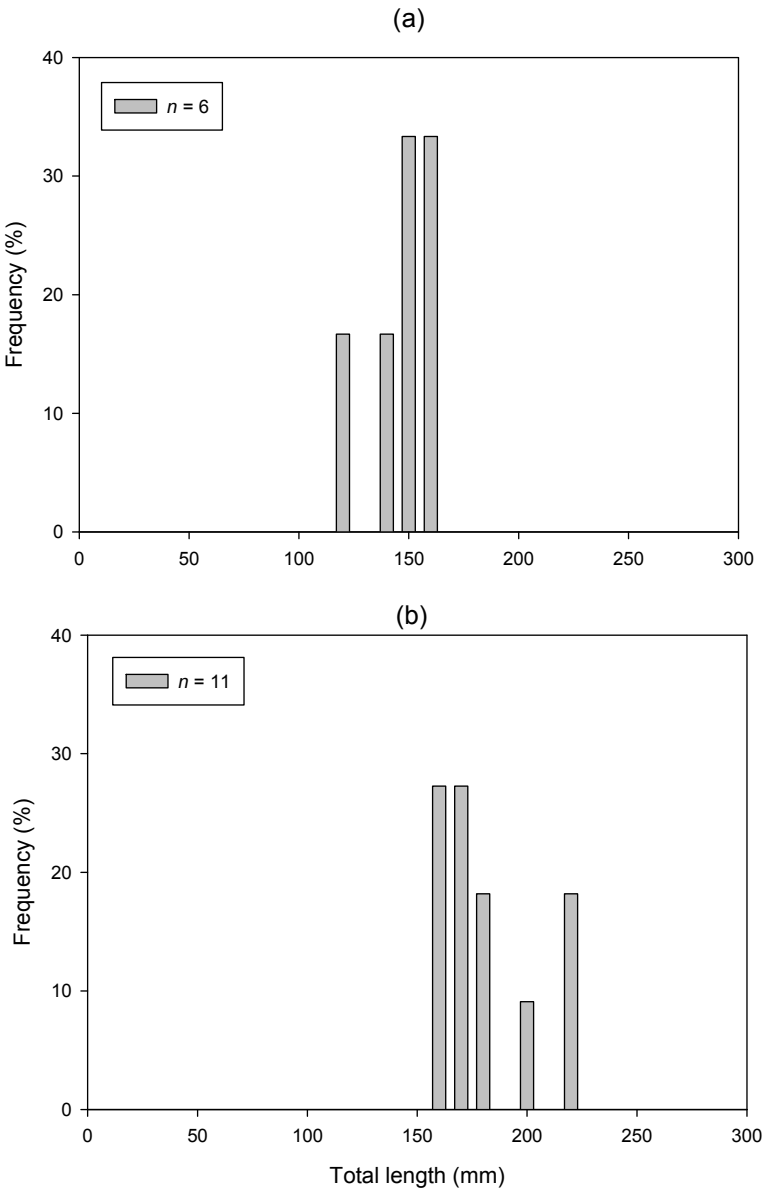

Figure 7a-b. Length-frequency distribution (10 mm increments) of river blackfish collected from Rodwell Creek in (a) spring 2008 and (b) autumn 2009.

Site summary

River blackfish are persisting at this site but recent recruitment has not been detected. Due to low water levels in autumn 2008 and the risk this posed to the population, this site was supplied with environmental water, which was trucked onto site. This occurred multiple times when required and this management intervention may be facilitating the persistence of adult fish at this site.

4.3. Marne (Marne River: river blackfish)

Winter 2008

Spring 2008

Summer 2009

Autumn 2009

Figure 8. Photo point images of the Marne River site from winter 2008, spring 2008, summer 2009 and autumn 2009.

Environmental conditions

Table 11. Habitat cover measured at the Marne River site during each site visit. Habitat cover is measured as the proportion (percentage cover) of aquatic habitat area comprised of submerged and emergent macrophytes, physical structure or open water.

Season	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	20 (*Chara*)	20 (*Typha, Phragmites*)	0	60
Spring 2008	0	40 (*Typha, Phragmites*)	5	55
Summer 2009	20 (Algae and *Chara*)	30 (*Typha, Phragmites*)	10	40
Autumn 2009	5 (Algae)	40 (*Typha, Phragmites*)	1	54

Table 12. Water depth at reference stake at the Marne River site during each site visit and the overall change in water level between winter 2008 and autumn 2009.

Water surface level and water depth	Winter 2008	Spring 2008	Summer 2009	Autumn 2009	Total difference (m)
Depth at reference stake (m)	1.02	0.97	0.88	0.90	-0.12
Difference in water level (winter 2008 – autumn 2009, m)	-	-0.05	-0.09	+0.05	-0.09

Table 13. Water quality parameters measured at the Marne River site during each site visit.

Season	Temp (ºC)	pH	Conductivity ($\mu S.cm^{-1}$)	DO (ppm) surface	DO (ppm) bottom	Secchi (m)	Max depth (m)	Time
Winter 2008	12.5	7.5	5200	7.95	-	>depth	1.2	1615
Spring 2008	18.6	5.5	5633	6.1	6.1	>depth	1.2	-
Summer 2009	16.9	7.3	5440	5.5	4.39	>depth	1.2	1510
Autumn 2009	17.1	7.5	5640	6.8	0.69	>depth	1.2	-

Fish sampling effort

Spring 2008

- 10 baited (yabbie) box traps set for 1 hour at dusk.
- Opportunistic observation of fish with a spotlight.

Autumn 2009

- 6 baited (yabbie) box traps set for 1 hour at dusk
- Opportunistic observation of fish with a spotlight.

Sampling effort at this site is minimal for several reasons. Firstly, blackfish are nocturnal and thus are most active on dusk and secondly, trapping time is limited to one hour to limit the risk of fish death due to localised low dissolved oxygen concentrations often recorded at this site. A white plume of unknown composition has

been observed at the bottom of the pool on several occasions, which appears to be producing anoxic conditions in its vicinity.

Catch summary and length-frequency analysis

Similar numbers of river blackfish were captured and observed during both sampling occasions (Table 14). Carp gudgeon and mountain galaxias also sampled in spring, whilst carp gudgeon and gambusia were sampled in autumn (Table 14).

No recent recruitment was detected for this blackfish population (Figure 9a-b). All individuals sampled and observed at the Marne River site (both seasons) were large adults (> 200 mm TL; Figure 9a-b) and therefore recruitment is unlikely to have occurred for several years.

Table 14. Total numbers of fish species collected from the Marne River site in spring 2008 and autumn 2009.

Species		**Sampling trip**	
Common name	**Scientific name**	**Spring 2008**	**Autumn 2009**
River blackfish	*Gadopsis marmoratus*	**3 (+3 observed)**	**1 (+4 observed)**
Carp gudgeon complex	*Hypseleotris spp.*	3	1
Mountain galaxias	*Galaxias olidus*	4	
Gambusia	*Gambusia holbrooki*		1

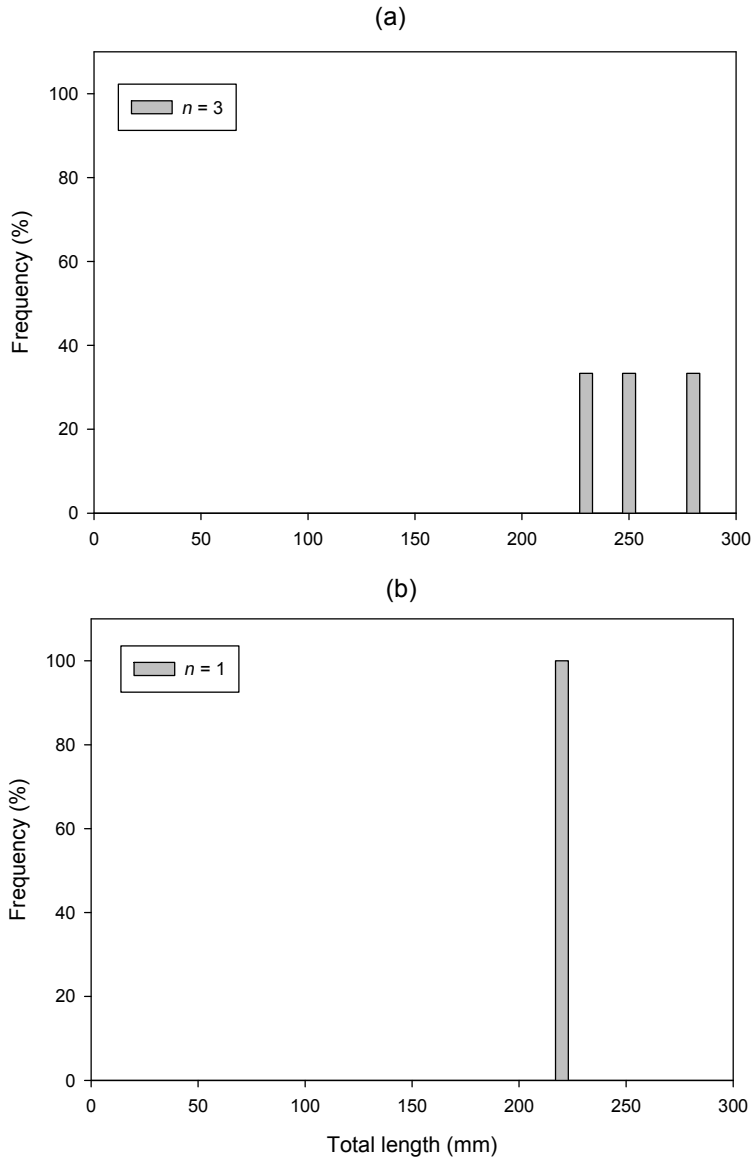

Figure 9a-b. Length-frequency distribution (10 mm increments) of river blackfish collected from the Marne River site in (a) spring 2008 and (b) autumn 2009.

Site summary

River blackfish are still present at this site but based on the absence of fish < 200 mm TL, it is unlikely that recruitment has occurred for several years, representing a significant threat to the persistence of this population. An anoxic white plume has been observed several times at the bottom of the pool and fish appear to be avoiding this area, which may be reducing available habitat and feeding area. Samples of this plume have recently been collected for analysis to determine its composition and identify any possible management options to mitigate its impact on the blackfish population.

4.4. Angas Gauge Site (Angas River: river blackfish)

Winter 2008

Spring 2008

Summer 2009

Autumn 2009

Figure 10. Photo point images of the Angas River gauge site from winter 2008, spring 2008, summer 2009 and autumn 2009.

Environmental conditions

Table 15. Habitat cover measured at the Angas River gauge site during each site visit. Habitat cover is measured as the proportion (percentage cover) of aquatic habitat area comprised of submerged and emergent macrophytes, physical structure or open water.

Season	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	20 (Algae)	20 (*Typha*)	0	60
Spring 2008	20 (Algae)	20 (*Typha*)	0	60
Summer 2009	5 (Algae)	10 (*Typha*)	20	65
Autumn 2009	5 (Algae)	10 (*Typha*)	20	65

Table 16. Water depth at reference stake at the Angas River gauge site during each site visit and the overall change in water level between winter 2008 and autumn 2009.

Water surface level and water depth	Winter 2008	Spring 2008	Summer 2009	Autumn 2009	Total difference (m)
Depth at reference stake (m)	0.45	0.28	0.30	0.25	-
Difference in water level (winter 2008 – autumn 2009, m)	-	-0.18	0	+0.05	-0.13

Table 17. Water quality parameters measured at the Angas River gauge site during each site visit.

Season	Temp (ºC)	pH	Conductivity ($\mu S.cm^{-1}$)	DO (ppm)	Secchi (m)	Max depth (m)	Time
Winter 2008	11.3	7.2	1650	8.9	0.9	>2	1140
Spring 2008	22.5	7.6	5227	7.3	> 2.0	2	1600
Summer 2009	19.6	7.8	7757	5.0	1.5	2	1000
Autumn 2009	19.6	8.0	8640	5.6	1.0	1.5	1000

Fish sampling effort

Spring 2008 & Autumn 2009

- 3 fyke nets set overnight

Catch summary and length-frequency analysis

River blackfish were caught in similar numbers in both seasons but were slightly more abundant in autumn (Table 18). Other species sampled were carp gudgeon, flat-headed gudgeon, dwarf flat-headed gudgeon, mountain galaxias and tench (Table 18).

In both seasons the blackfish population exhibited a broad range of lengths (i.e. spring: 105-265 mm TL, autumn: 118-228 mm TL; Figure 11a-b). Low levels of recruitment have likely occurred in the last two years with fish *c.* 100-150 mm TL likely to be newly recruited individuals.

Table 18. Total numbers of fish species collected from the Angas River gauge site in spring 2008 and autumn 2009.

Species		**Sampling trip**	
Common name	**Scientific name**	**Spring 2008**	**Autumn 2009**
River blackfish	*Gadopsis marmoratus*	**17**	**26**
Carp gudgeon complex	*Hypseleotris spp.*	20	36
Flat-headed gudgeon	*Philypnodon grandiceps*	12	14
Dwarf flat-headed gudgeon	*Philypnodon macrostomus*	8	2
Mountain galaxias	*Galaxias olidus*	1	
Tench	*Tinca tinca*	1	9

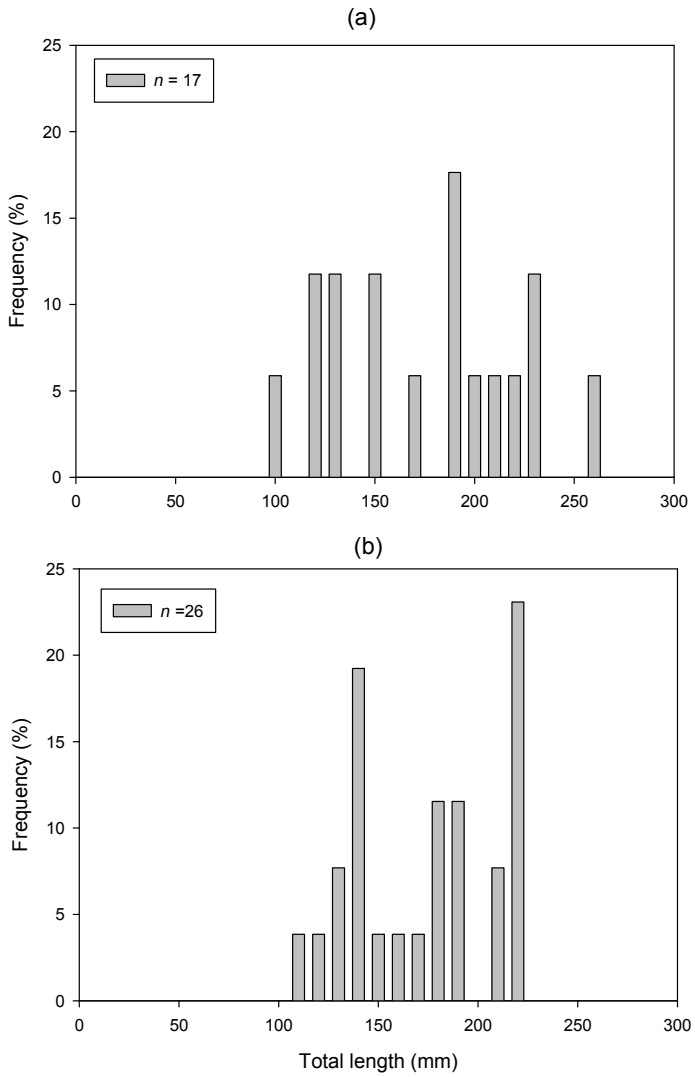

Figure 11a-b. Length-frequency distribution (10 mm increments) of river blackfish collected from the Angas River gauge site in (a) spring 2008 and (b) autumn 2009.

Site summary

The river blackfish population at this site appears to be stable, with recruitment having occurred in the last two years and a range of different aged (length) fish in the population. Conductivity has risen from 1650 to 8640 $\mu S.cm^{-1}$ during the course of monitoring and thus, raised water salinity may pose a threat to this population in the future. Nevertheless, this variation in conductivity may be seasonal with winter flows potentially reducing conductivity to original levels.

4.5. Willowburn Road Nangkita (Tookayerta Creek: river blackfish and southern pygmy perch)

Winter 2008


Spring 2008


Summer 2009


Autumn 2009


Figure 12. Photo point images of the Willowburn Rd Nangkita site from winter 2008, spring 2008, summer 2009 and autumn 2009.

Environmental conditions

Table 19. Habitat cover measured at the Willowburn Road Nangkita site during each site visit. Habitat cover is measured as the proportion (percentage cover) of aquatic habitat area comprised of submerged and emergent macrophytes, physical structure or open water.

Season	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	0	5 (*Juncus, Callitriche*)	30 (Snags)	65
Spring 2008	0	40 (*Callitriche*)	30 (Snags)	30
Summer 2009	20 (*Azolla*)	20 (*Callitriche*)	20 (Snags)	40
Autumn 2009	0	10 (*Callitriche*)	40 (Snags)	50

Table 20. Water depth at reference stake at the Willowburn Road Nangkita site during each site visit and the overall change in water level between winter 2008 and autumn 2009.

Water surface level and water depth	Winter 2008	Spring 2008	Summer 2009	Autumn 2009	Total difference (m)
Depth at reference stake (m)	0.5	0.3	0.3	0.1	-0.4
Difference in water level (winter 2008 – autumn 2009, m)	-	-0.2	0	-0.05	-0.25

Table 21. Water quality parameters measured at the Willowburn Road Nangkita site during each site visit.

Season	Temp (ºC)	pH	Conductivity ($\mu S.cm^{-1}$)	DO (ppm)	Secchi (m)	Max depth (m)	Time
Winter 2008	10.7	8.2	430	13.8	0.6	1.2	1350
Spring 2008	16.2	7.1	266	5.6	0.4	1.2	1300
Summer 2009	16.6	7.1	298	3.2	0.4	0.8	1530
Autumn 2009	17.5	7.3	325	7.5	0.5	0.5	1300

Fish sampling effort

Spring 2008

- Backpack electrofishing (685 seconds, 75 Hz, 250 v, 8% DC)

Autumn 2009

- Backpack electrofishing (945 seconds, 75 Hz, 300 v, 10% DC)

Catch summary and length-frequency analysis

River blackfish numbers were consistent between spring and autumn, whilst southern pygmy perch were present in both seasons but were sampled in the greatest numbers in autumn (Table 22). Mountain galaxias was the only other species sampled at this site (Table 22).

Table 22. Total numbers of fish species collected from the Willowburn Rd Nangkita site in spring 2008 and autumn 2009.

Species		Sampling trip	
Common name	**Scientific name**	**Spring 2008**	**Autumn 2009**
River blackfish	*Gadopsis marmoratus*	**8**	**7**
Southern pygmy perch	*Nannoperca australis*	**7**	**24**
Mountain galaxias	*Galaxias olidus*	7	153

The majority of blackfish (*n* = 7) sampled in spring ranged from 62-82 mm TL, suggesting likely recruitment from the previous spawning season (i.e. they are likely 1+ individuals; Figure 13a). Data from autumn sampling suggests the growth of this cohort, with several fish *c.* 80-100 mm TL (Figure 13b). There was also one young-of-year (hereafter YOY or 0+) sampled in autumn (43 mm TL; Figure 13b) suggesting there had been a recent spawning event. Several larger, adult fish were also sampled in autumn (>150 mm TL; Figure 13b).

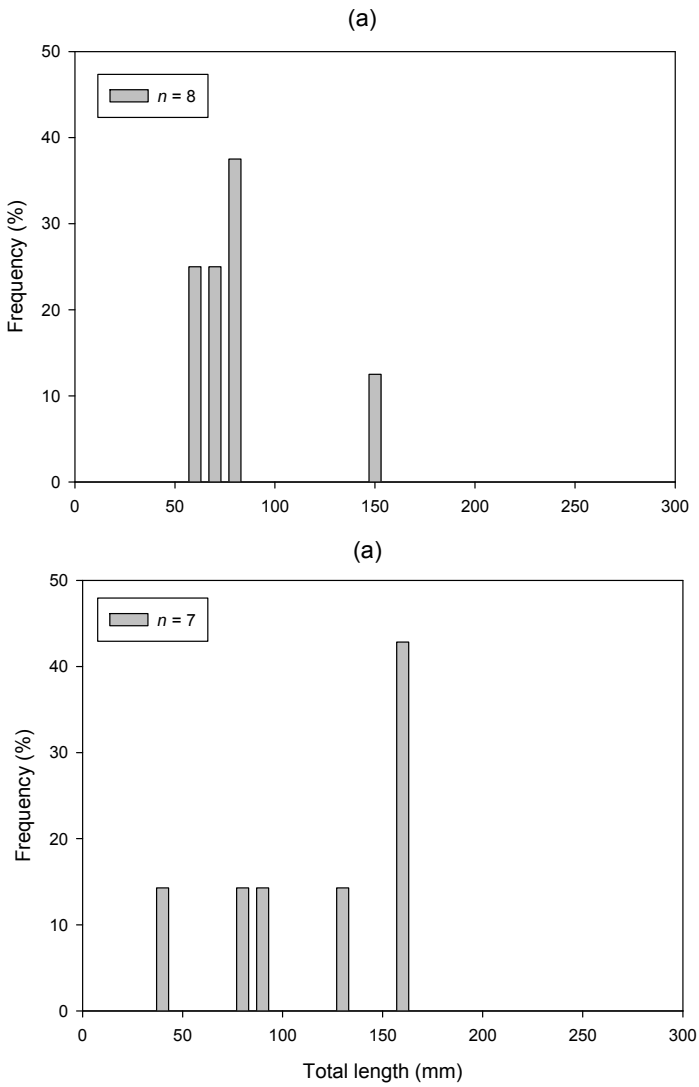

Figure 13a-b. Length-frequency distribution (10 mm increments) of river blackfish collected from the Willowburn Rd Nangkita site in (a) spring 2008 and (b) autumn 2009.

In spring the southern pygmy perch population was dominated by adult fish (> 40 mm TL) but significant recruitment was noted in autumn with > 45% of the population comprised of YOY individuals (< 40 mm TL; Figure 14a-b).

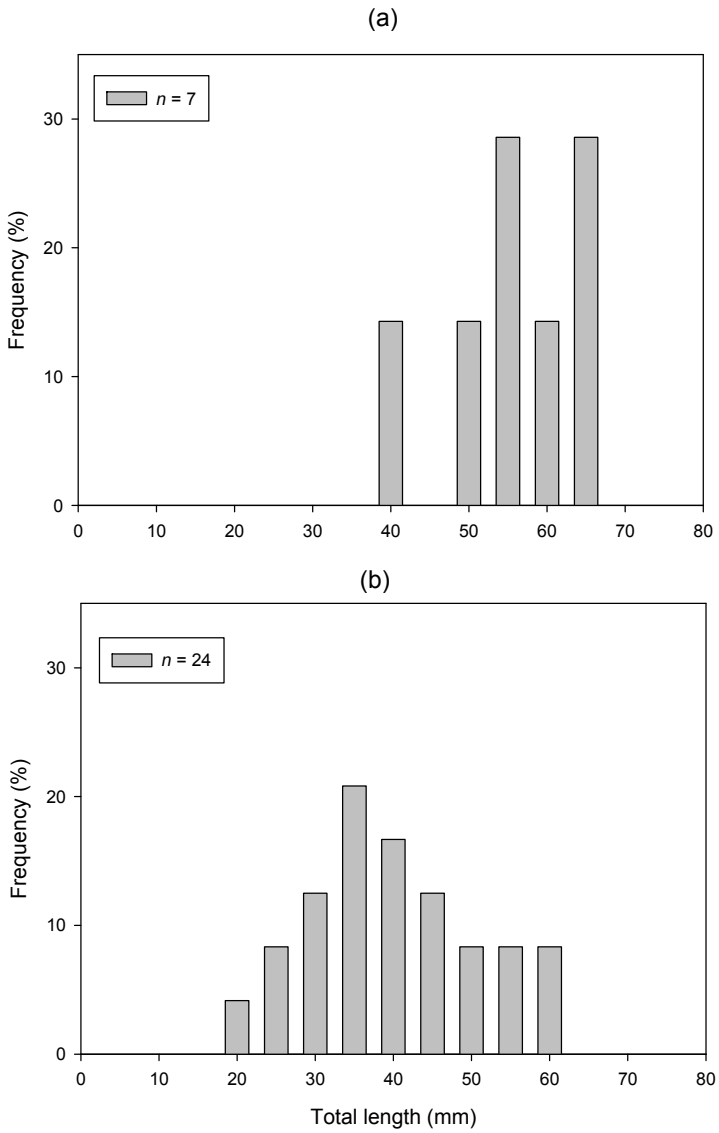

Figure 14a-b. Length-frequency distribution (5 mm increments) of southern pygmy perch collected from the Willowburn Rd Nangkita site in (a) spring 2008 and (b) autumn 2009.

Site summary

Both river blackfish and southern pygmy perch populations appear stable. Both populations exhibited recent recruitment and have diverse population structures (i.e. broad size ranges). Low flows through summer likely resulted in siltation at this site and a corresponding decrease in depth but higher winter flows may scour this sediment and return the site to the same condition as winter 2008.

4.6. Deep Creek Road (Tookayerta Creek: river blackfish and southern pygmy perch)

Winter 2008

Spring 2008

Summer 2009

Autumn 2009

Figure 15. Photo point images of the Deep Creek Road site from winter 2008, spring 2008, summer 2009 and autumn 2009.

Environmental conditions

Table 23. Habitat cover measured at the Deep Creek Road Tookayerta site during each site visit. Habitat cover is measured as the proportion (percentage cover) of aquatic habitat area comprised of submerged and emergent macrophytes, physical structure or open water.

Season	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	0	60 (*Phragmites, Typha*)	-	40
Spring 2008	0	70 (*Phragmites, Typha*)	5	25
Summer 2009	0	60 (*Phragmites, Typha*)	10	30
Autumn 2009	10 (Algae)	70 (*Phragmites, Typha*)	-	20

Table 24. Water depth at reference stake at the Deep Creek Road site during each site visit and the overall change in water level between winter 2008 and autumn 2009.

Water surface level and water depth	Winter 2008	Spring 2008	Summer 2009	Autumn 2009	Total difference (m)
Depth at reference stake (m)	1.4	1.04	0.8	0.84	-0.60
Difference in water level (winter 2008 – autumn 2009, m)	-	-0.36	-0.24	+0.01	-0.59

Table 25. Water quality parameters measured at the Deep Creek Road site during each site visit.

Season	Temp (ºC)	pH	Conductivity ($\mu S.cm^{-1}$)	DO (ppm)	Secchi (m)	Max Depth (m)	Time
Winter 2008	10.9	7.7	600	10.1	0.4	1.4	1620
Spring 2008	16.0	6.9	528	7.3	0.8	1.5	1130
Summer 2009	17.0	7.1	726	7.8	0.45	1.5	1600
Autumn 2009	15.5	7.2	845	8.3	0.9	1.2	1400

Fish sampling effort

Spring 2008

- Backpack electrofishing (800 seconds, 75 Hz, 250 v, 8% DC)

Autumn 2009

- Backpack electrofishing (600 seconds, 75 Hz, 250 v, 10% DC)

Catch summary and length-frequency analysis

River blackfish were present in consistent numbers in both seasons, whilst southern pygmy perch, also present in both seasons, were more abundant in spring (Table 26). The only other species sampled at this site was mountain galaxias (Table 26).

Table 26. Total numbers of fish species collected from the Deep Creek Road site in spring 2008 and autumn 2009.

Species		**Sampling trip**	
Common name	**Scientific name**	**Spring 2008**	**Autumn 2009**
River blackfish	*Gadopsis marmoratus*	**3**	**5**
Southern pygmy perch	*Nannoperca australis*	**21**	**13**
Mountain galaxias	*Galaxias olidus*	1	

In spring blackfish ranged from 80-98 mm TL (Figure 16a) and these fish likely represent recruits from the previous spring. This cohort is present in autumn but has grown to *c.* 120 mm TL, whilst a new cohort of young-of-year individuals is also present (39-51 mm TL; Figure 16b & Figure 17), suggesting recent recruitment. One large adult (212 mm TL) was also present (Figure 16b).

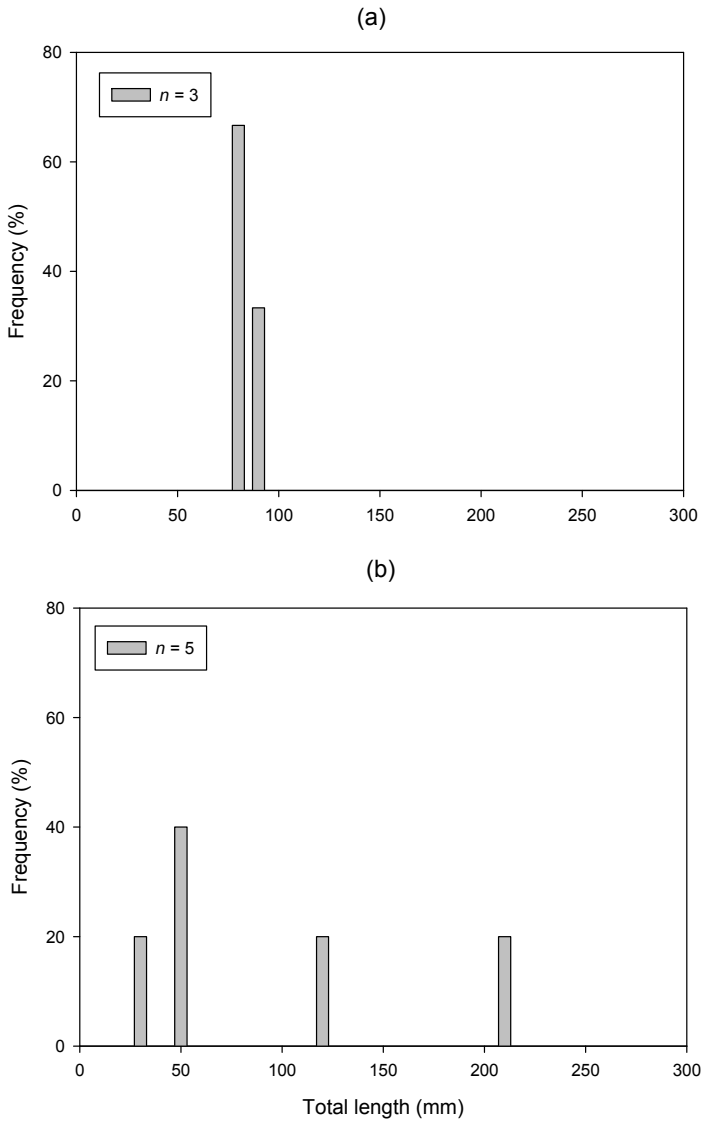

Figure 16a-b. Length-frequency distribution (10 mm increments) of river blackfish collected from the Deep Creek Road site in (a) spring 2008 and (b) autumn 2009.

Figure 17. A YOY river blackfish sampled from the Deep Creek Road site in autumn 2009.

In spring *c.* 40% of southern pygmy perch individuals were < 35 mm TL and are likely to be recruits from late in the previous spawning season based upon similar length frequency distributions from this site in previous years (unpublished data, M. Hammer; Figure 18a). In autumn, a new cohort of smaller (10-35 mm TL), more recently recruited individuals from spring/summer spawning is apparent (Figure 18b). Large adult fish (>60 mm TL) were also present (Figure 18b & Figure 19)

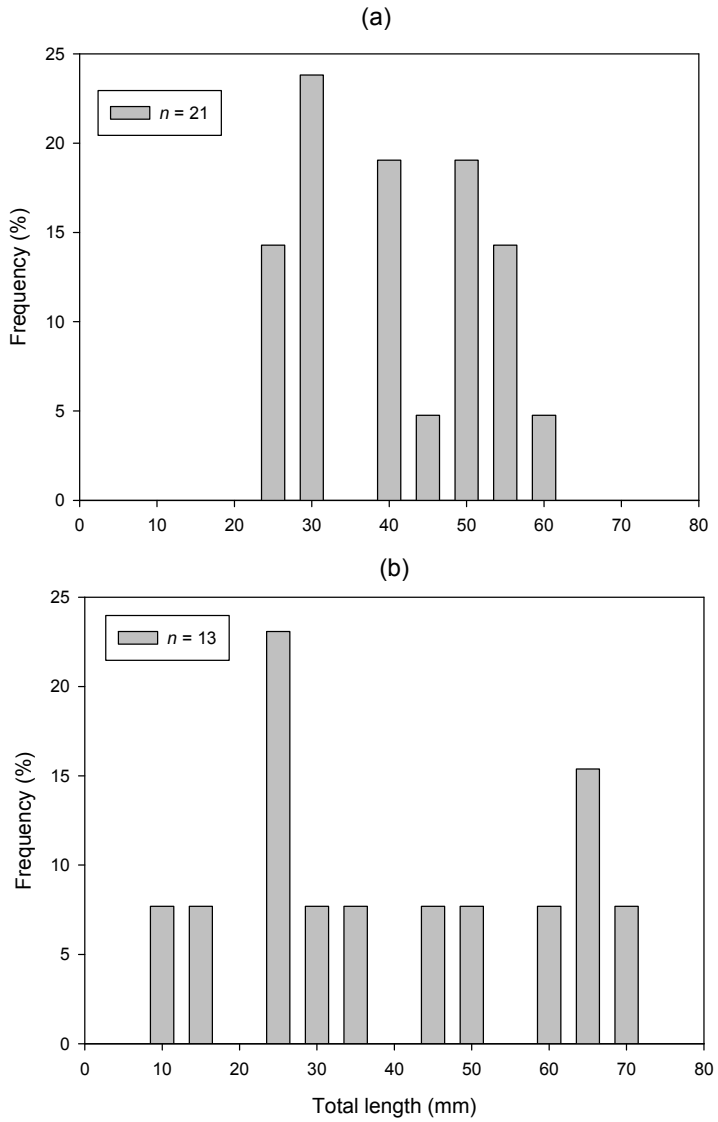

Figure 18a-b. Length-frequency distribution (5 mm increments) of southern pygmy perch collected from the Deep Creek Road site in (a) spring 2008 and (b) autumn 2009.

Figure 19. An adult southern pygmy perch sampled at Deep Creek Road in autumn 2009.

Site summary

The River blackfish and southern pygmy perch populations are likely to be stable with consistent abundances, recent recruitment and a diverse population structure (i.e. broad size range). Water level has dropped substantially but is likely to increase again through winter.

4.7. Middle Creek Junction (Angas River: southern pygmy perch)

Winter 2008

Spring 2008

Summer 2009

Autumn 2009

Figure 20. Photo point images of the Middle Creek junction site from winter 2008, spring 2008, summer 2009 and autumn 2009.

Environmental conditions

Table 27. Habitat cover measured at the Middle Creek junction site during each site visit. Habitat cover is measured as the proportion (percentage cover) of aquatic habitat area comprised of submerged and emergent macrophytes, physical structure or open water.

Season	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	0	80 (*Phragmites, Typha*)	0	20
Spring 2008	5 (*Potamogeton*)	80 (*Phragmites, Typha*)	0	15
Summer 2009	30 (*Potamogeton*)	50 (*Phragmites, Typha*)	0	20
Autumn 2009	30 (*Potamogeton*)	50 (*Phragmites, Typha*)	0	20

Table 28. Water depth at reference stake at the Middle Creek junction site during each site visit and the change in water level between seasons.

Water surface level and water depth	Winter 2008	Spring 2008	Summer 2009	Autumn 2009	Total difference
Depth at reference stake (m)	0.96	0.59	-0.36 (out of water)	-0.12 (out of water)	-
Difference in water level (winter 2008 – autumn 2009, m)	-	-0.23	-0.58	-0.23	-1.04

Table 29. Water quality parameters measured at the Middle Creek junction site during each site visit.

Season	Temp (ºC)	pH	Conductivity ($\mu S.cm^{-1}$)	DO (ppm)	Secchi (m)	Max depth (m)	Time
Winter 2008	9.8	6.9	1500	10.2	0.6	1.6	1015
Spring 2008	20.3	7.8	3135	6.0	> 1.2	1.2	-
Summer 2009	15.2	7.2	6020	3.2	0.4	0.7	0920
Autumn 2009	14.5	7.7	5140	2.9	0.4	0.5	0830

Fish sampling effort

Spring 2008 & autumn 2009

- 1 fyke net set overnight

The pool that is sampled at this site is very small and only allows for one fyke net to be set.

Catch summary and length-frequency analysis

Southern pygmy perch were abundant at this site in both seasons but were collected in greatest abundance in autumn (Table 30). Carp gudgeon, flat-headed gudgeon and mountain galaxias were also collected at this site (Table 30).

In spring, southern pygmy perch ranged from 34-66 mm TL (Figure 21a). A large proportion of individuals (*c.* 85%) are of a similar size in autumn, however, a cohort of YOY (<24 mm TL) is also present, indicating recent recruitment (Figure 21b).

Table 30. Total numbers of different fish species collected from the Middle Creek junction site in spring 2008 and autumn 2009.

Species		**Sampling trip**	
Common name	**Scientific name**	**Spring 2008**	**Autumn 2009**
Southern pygmy perch	*Nannoperca australis*	**35**	**53**
Carp gudgeon complex	*Hypseleotris spp.*	21	11
Flat-headed gudgeon	*Philypnodon grandiceps*	4	
Mountain galaxias	*Galaxias olidus*	4	4

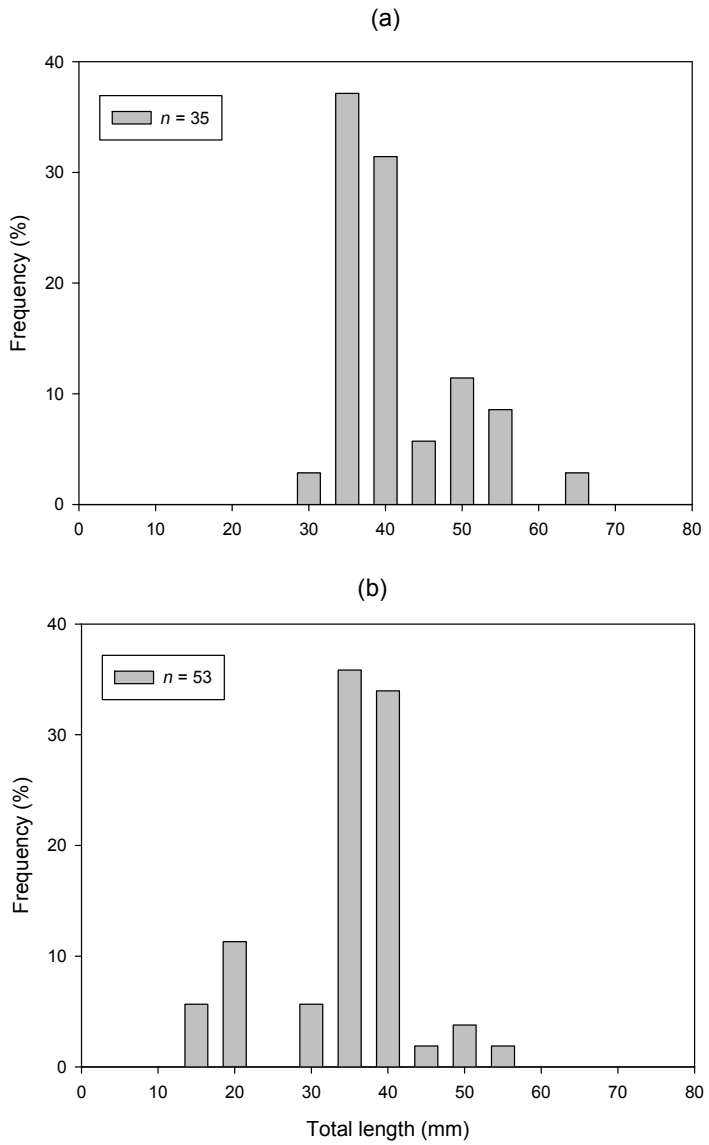

Figure 21a-b. Length-frequency distribution (5 mm increments) of southern pygmy perch collected from the Middle Creek junction site in (a) spring 2008 and (b) autumn 2009.

Site summary

Southern pygmy perch are persisting at this site in consistent numbers and have recently recruited. Available habitat became increasingly restricted with decreases in water level and depth and increased growth of emergent vegetation at this site by autumn 2009 but winter flows will likely increase depth.

4.8. Boundary Creek Drain, Mundoo Island (Lake Alexandrina: Yarra pygmy perch, southern pygmy perch and Murray hardyhead)

Winter 2008

Spring 2008

Summer 2009

Not monitored

Autumn 2009

No photo

Figure 22. Photo point images of the Boundary Creek drain site from winter 2008, spring 2008 and autumn 2009.

Environmental conditions

Table 31. Habitat cover measured at the Boundary Creek drain site during each site visit. Habitat cover is measured as the proportion (percentage cover) of aquatic habitat area comprised of submerged and emergent macrophytes, physical structure or open water.

Season	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Spring 2008	0	0	0	100
Autumn 2009	30	0	25	45

Table 32. Water quality parameters measured at the Boundary Creek drain site during each site visit.

Season	Temp (ºC)	pH	Conductivity ($\mu S.cm^{-1}$)	DO (ppm)	Secchi (m)	Max depth (m)	Time
Spring 2008	20.5	7.7	9700	2.5	> 0.2	0.2	-
Autumn 2009	18.5	7.6	12830	2.9	>0.14	0.14	-

Fish sampling effort

Spring 2008 & autumn 2009

- 3 fyke nets set overnight
- 3 x 10m seine net hauls

This site was sampled by Adelaide University and did not include winter and summer site condition assessments. These assessments will be made in the future.

Catch summary and length-frequency analysis

Yarra pygmy perch and southern pygmy perch, both previously present, were not collected from this site and there was a decline in the abundance of Murray hardyhead at this site between sampling events (Table 33). The abundance of all other native species also declined between spring and autumn, whilst the exotic gambusia increased in abundance (Table 33).

In spring, Murray hardyhead ranged from 38-66 mm TL (Figure 23a). In autumn only one individual was sampled (29 mm TL) and is likely to be a new recruit (0+; Figure 23b) given Murray hardyhead have a largely annual lifecycle (Ellis 2005).

Table 33. Total numbers of fish species collected from the Boundary Creek drain site in spring 2008 and autumn 2009.

Species		Sampling trip	
Common name	**Scientific name**	**Spring 2008**	**Autumn 2009**
Murray hardyhead	*Craterocephalus fluviatilis*	**58**	**1**
Small-mouthed hardyhead	*Atherinosoma microstoma*	10	
Tamar goby	*Afurcagobius tamarensis*	9	
Blue-spot goby	*Pseudogobius olorum*	51	1
Lagoon goby	*Tasmanogobius lasti*	1	
Carp gudgeon complex	*Hypseleotris spp.*	2	
Flat-headed gudgeon	*Philypnodon grandiceps*	5	
Gambusia	*Gambusia holbrooki*	84	285

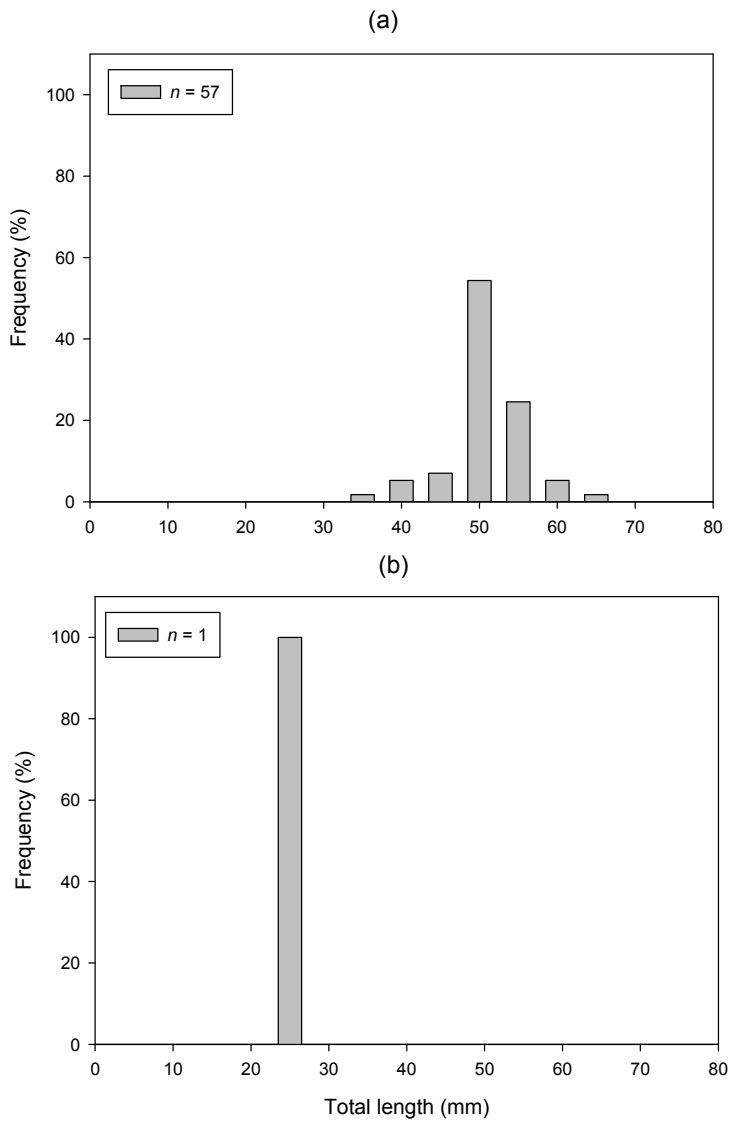

Figure 23a-b. Length-frequency distribution (5 mm increments) of southern pygmy perch collected from the Middle Creek junction site in (a) spring 2008 and (b) autumn 2009.

Site summary

Yarra pygmy perch and southern pygmy perch have likely been lost from this site. Murray hardyhead are still present, however, they have undergone a severe decrease in abundance. A different site on Mundoo Island, sampled in spring 2008 and autumn 2009 by Wedderburn and Barnes (2009), yielded substantial numbers of Murray hardyhead (n = 48 & n = 273) and significant recruitment was evident. Therefore this site will be incorporated in the DAP in the future. Similarly, southern pygmy perch were collected (n = 6 (spring) & n = 22 (autumn)) from another drain on Mundoo Island by Wedderburn and Barnes (2009) and this site will also be incorporated in the DAP in the future.

4.9. Eastick Creek mouth, Hindmarsh Island (Lake Alexandrina: Yarra pygmy perch, southern pygmy perch and Murray hardyhead)

Winter 2008

Spring 2008

Summer 2009
Not monitored
Autumn 2009
Not monitored

Figure 24. Photo point images of the Eastick Creek mouth site from winter 2008 and spring 2008.

Environmental conditions

Table 34. Habitat cover measured at the Eastick Creek mouth site during each site visit. Habitat cover is measured as the proportion (percentage cover) of aquatic habitat area comprised of submerged and emergent macrophytes, physical structure or open water.

Season	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	0	2	5	93
Spring 2008	1	1	5	94

Table 35. Water depth at reference stake at the Eastick Creek mouth site during each site visit and the overall change in water level between winter 2008 and spring 2008.

Water surface level and water depth	Winter 2008	Spring 2008	Total difference (m)
Depth at reference stake (m)	0.54	0.43	-
Difference in elevation (winter 2008 – spring 2008, m)	-	-0.09	-0.09

Table 36. Water quality parameters measured at the Eastick Creek mouth site during each site visit.

Season	Temp (ºC)	pH	Conductivity ($\mu S.cm^{-1}$)	DO (ppm)	Secchi (m)	Max depth (m)	Time
Winter 2008	11.9	7.1	14800	17.0	0.4	-	1140
Spring 2008	25.6	8.9	13233	10.7	0.25	-	1500

Fish sampling effort

Spring 2008

- 4 fyke nets set overnight

Autumn 2009

- Not sampled due to diminished water level and continued absence of threatened species

Catch summary

No threatened species were collected from this site in spring and it was not sampled in autumn. A total of 11 other species were sampled at this site including small-mouthed hardyhead which were highly abundant (Table 37).

Table 37. Total numbers of fish species collected from the Eastick Creek site in spring 2008.

Species		Sampling trip
Common name	**Scientific name**	**Spring 2008**
Small-mouthed hardyhead	*Atherinosoma microstoma*	2745
Tamar goby	*Afurcagobius tamarensis*	59
Blue-spot goby	*Pseudogobius olorum*	47
Lagoon goby	*Tasmanogobius lasti*	66
Bridled goby	*Arenogobius bifrenatus*	5
Common galaxias	*Galaxias maculatus*	19
Congolli	*Pseudaphritus urvillii*	1
Bony herring	*Nematalosa erebi*	5
Australian smelt	*Retropinna semoni*	136
Flat-headed gudgeon	*Philypnodon grandiceps*	25
Redfin perch	*Perca fluviatilis*	5

Site summary

Murray hardyhead and both pygmy perch species have not been collected from or in the vicinity of this site for at least two years (Bice and Ye 2007; Bice *et al.* 2008; Hammer 2008), and have probably been lost from this site due to a number of factors resulting from decreased water level including a loss of vegetated habitats and increased salinity.

4.10. Steamer Drain, Hindmarsh Island (Lake Alexandrina: Yarra pygmy perch, southern pygmy perch and Murray hardyhead)

Winter 2008

Spring 2008

Summer 2009
Not monitored
Autumn 2009
Not monitored

Figure 25. Photo point images of Steamer drain from winter 2008 and spring 2008.

Fish sampling effort

Spring 2008 & autumn 2009

- Not sampled due to diminished water level (dry).

Site summary

This site was effectively dry at the commencement of this project and thus Yarra pygmy perch, southern pygmy perch and Murray hardyhead have been lost.

4.11. Black Swamp (Finniss River: Yarra pygmy perch and southern pygmy perch)

Winter 2008

Spring 2008
Not sampled
Summer 2009
Not sampled
Autumn 2009
Not sampled

Figure 26. Photopoints of Black Swamp from winter 2008.

Fish sampling effort

Spring 2008 & autumn 2009

- Not sampled due to diminished water level (dry).

Site summary

Black Swamp was dry by spring 2008 and was inaccessible. Yarra pygmy perch was last collected in spring 2007 (Bice *et al.* 2008) and the species is likely to have disappeared from this site along with southern pygmy perch which was last collected in the general area in summer 2007 (Hammer 2008).

4.12. Black Swamp Drain (Finniss River: southern pygmy perch)

Winter 2008

Spring 2008

Summer 2009
Not monitored
Autumn 2009
Not monitored

Figure 27. Photo point images of the Black Swamp drain site from winter 2008 and spring 2008.

Environmental conditions

Table 38. Habitat cover measured at the Black Swamp drain site during each site visit. Habitat cover is measured as the proportion (percentage cover) of aquatic habitat area comprised of submerged and emergent macrophytes, physical structure or open water.

Season	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	5 (*Myriophyllum*)	50 (*Phragmites, Typha, Baumea, Gahnia*)	5	40
Spring 2008	5 (*Myriophyllum*)	25 (*Phragmites, Typha, Baumea, Gahnia*)	5	65

Table 39. Water depth at reference stake at the Black Swamp drain site during each site visit and the overall change in water level between winter 2008 and spring 2008.

Water surface level and water depth	Winter 2008	Spring 2008	Total difference (m)
Depth at reference stake (m)	0.38	0.30	-
Difference in water level (winter 2008 – spring 2008, m)	-	-0.08	-0.08

Table 40. Water quality parameters measured at the Black Swamp drain site during each site visit.

Season	Temp (ºC)	pH	Conductivity ($\mu S.cm^{-1}$)	DO (ppm)	Secchi (m)	Max depth (m)	Time
Winter 2008	9.2	6.5	600	7.5	1.0	-	1500
Spring 2008	13.8	6.2	1020	2.2	0.05	-	-

Fish sampling effort

Spring 2008

- 4 fyke nets set overnight

Autumn 2009

- Not sampled due to diminished water level and inaccessibility

Catch summary

No southern pygmy perch were collected from this site in spring (Table 41). Common galaxias and carp gudgeon were the only species sampled at this site (Table 41).

Table 41. Total numbers of fish species collected from the Black Swamp drain site in spring 2008.

Species		Sampling trip
Common name	**Scientific name**	**Spring 2008**
Common galaxias	*Galaxias maculatus*	9
Carp gudgeon complex	*Hypseleotris spp.*	1

Site summary

Southern pygmy perch were not collected at this site in spring and it was not sampled in autumn as it was inaccessible. The species may have been lost from this site due to diminished water levels but further sampling is required to confirm this.

4.13. Turvey's Drain, Milang (Lake Alexandrina: Yarra pygmy perch, southern pygmy perch and Murray hardyhead)

Winter 2008

Spring 2008

Summer 2009

Autumn 2009

Figure 28. Photopoint images of Turvey's drain from winter 2008, spring 2008, summer 2009 and autumn 2009.

Environmental conditions

Table 42. Habitat cover measured at Turvey's drain during each site visit. Habitat cover is measured as the proportion (percentage cover) of aquatic habitat area comprised of submerged and emergent macrophytes, physical structure or open water.

Season	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	30 (*Myriophyllum, Ceratophyllum*, algae)	10 (*Typha*)	-	60
Spring 2008	60 (*Myriophyllum, Ceratophyllum*, algae)	20 (*Typha*)	0	20
Summer 2009	20 (*Myriophyllum, Ceratophyllum*, algae)	40 (*Typha*)	0	40
Autumn 2009	20 (*Myriophyllum, Ceratophyllum*, algae)	50 (*Typha*)	0	30

Table 43. Water depth at reference stake at Turvey's drain during each site visit and the overall change in water level between winter 2008 and autumn 2009.

Water surface level and water depth	Winter 2008	Spring 2008	Summer 2009	Autumn 2009	Total difference (m)
Depth at reference stake (m)	0.32	0.32	0.5	0.5	+0.22
Difference in water level (winter 2008 – autumn 2009, m)	-	-0.15	+0.40	-0.05	+0.2

Table 44. Water quality parameters measured at Turvey's drain during each site visit.

Season	Temp (ºC)	pH	Conductivity ($\mu S.cm^{-1}$)	DO (ppm)	Secchi (m)	Max depth (m)	Time
Winter 2008	13.4	8.0	3750	16.6	>1.0	1.0	1320
Spring 2008	23.2	8.9	5883	16.7	0.6	1.0	-
Summer 2009	17.0	7.3	6880	5.0	0.55	1.0	1110
Autumn 2009	19.6	7.6	7150	4.8	0.35	1.0	1000

Fish sampling effort

Spring 2008 & autumn 2009

- 4 fyke nets set overnight

Catch summary and length-frequency analysis

Considerable numbers of southern pygmy perch were collected from Turvey's drain in spring but a substantial decline in abundance was observed in autumn (Table 45; Figure 29a). Murray hardyhead were collected in consistently low numbers in both seasons (Table 45; Figure 29b). Yarra pygmy perch were not detected at this site. The exotic gambusia showed a marked increase in abundance between spring and autumn whilst several native species collected in spring were absent in autumn (Table 45).

Table 45. Total numbers of fish species collected from Turvey's drain in spring 2008 and autumn 2009.

Species		Sampling trip	
Common name	**Scientific name**	**Spring 2008**	**Autumn 2009**
Southern pygmy perch	*Nannoperca australis*	**81**	**5**
Murray hardyhead	*Craterocephalus fluviatilis*	**8**	**7**
Flat-headed gudgeon	*Philypnodon grandiceps*	44	8
Dwarf flat-headed gudgeon	*Philypnodon macrostomus*	4	
Small-mouthed hardyhead	*Atherinosoma microstoma*	1	
Common galaxias	*Galaxias maculatus*	11	
Tamar goby	*Afurcagobius tamarensis*	1	
Blue-spot goby	*Pseudogobius olorum*	34	
Goldfish	*Carrasius auratus*	2	
Gambusia	*Gambusia holbrooki*	157	390

(a)

(b)

Figure 29a-b. A southern pygmy perch (a) and Murray hardyhead (b) collected from Turvey's drain in autumn 2009.

There were two distinct cohorts of southern pygmy perch in spring with adult fish >50 mm TL and YOY fish ranging from 19-28 mm TL (Figure 30a). In autumn this adult cohort (>50 mm TL) was not sampled and YOY fish from spring had grown to >40 mm TL (Figure 30b).

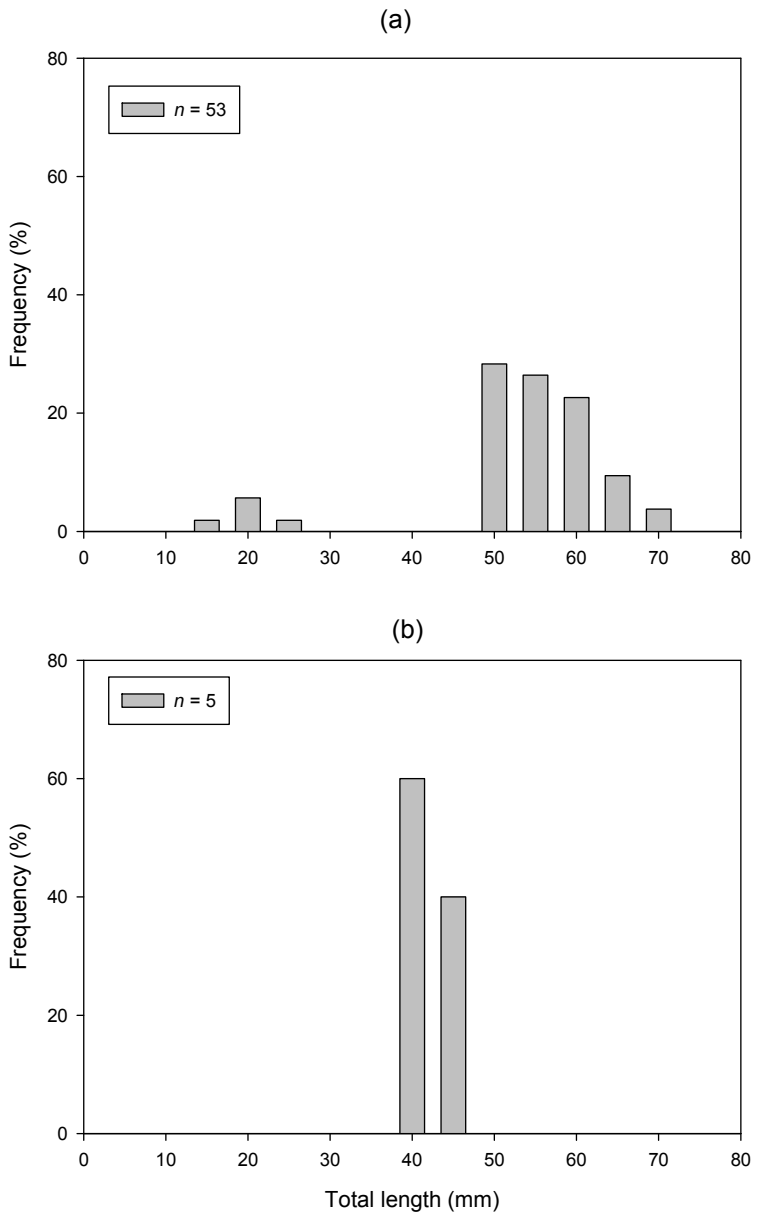

Figure 30a-b. Length-frequency distribution (5 mm increments) of southern pygmy perch collected from Turvey's drain in (a) spring 2008 and (b) autumn 2009.

In spring, all Murray hardyhead sampled were large adult fish (>50 mm TL; Figure 31a). In autumn, this adult cohort was not observed, however, a YOY cohort (30-37 mm TL) was captured signifying recent recruitment between sampling events (Figure 31b).

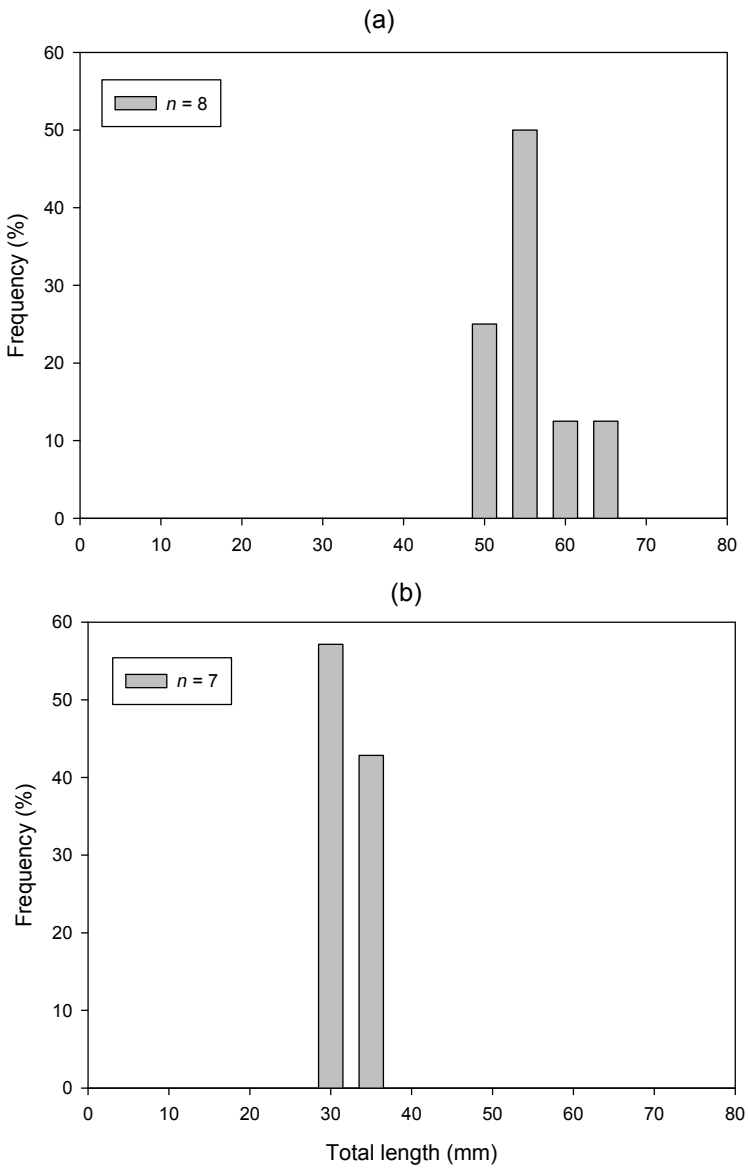

Figure 31a-b. Length-frequency distribution (5 mm increments) of Murray hardyhead collected from Turvey's drain in (a) spring 2008 and (b) autumn 2009.

Site summary

Both southern pygmy perch and Murray hardyhead showed signs of recruitment but were present in low abundances, whilst Yarra pygmy perch were not detected and may have been lost from the site. A water allocation has been procured to maintain water levels at this site and may facilitate the persistence of the southern pygmy perch and Murray hardyhead populations.

4.14. Meadows Creek (Finniss River: southern pygmy perch)

Winter 2008


Spring 2008


Summer 2009


Autumn 2009


Figure 32. Photo point images of Meadows from winter 2008, spring 2008, summer 2009 and autumn 2009.

Environmental conditions

Table 46. Habitat cover measured at Meadows Creek during each site visit. Habitat cover is measured as the proportion (percentage cover) of aquatic habitat area comprised of submerged and emergent macrophytes, physical structure or open water.

Season	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	0	10	20	70
Spring 2008	10	20	20	50
Summer 2009	10	5	30	55
Autumn 2009	5 (Algae)	20 (*Typha*)	20 (rock, snag)	55

Table 47. Water depth at reference stake at Meadows Creek during each site visit and the overall change in water level between winter 2008 and autumn 2009.

Water surface level and water depth	Winter 2008	Spring 2008	Summer 2009	Autumn 2009	Total difference (m)
Depth at reference stake (m)	0.62	0.32	Out of water	Out of water	-
Difference in water level (winter 2008 – autumn 2009, m)	-	-0.31	-0.40	-0.24	-0.95

Table 48. Water quality parameters measured at Meadows Creek during each site visit.

Season	Temp (ºC)	pH	Conductivity ($\mu S.cm^{-1}$)	DO (ppm)	Secchi (m)	Max depth (m)	Time
Winter 2008	10.2	7.5	1430	13.0	0.6	1.5	1500
Spring 2008	17.9	7.1	2887	7.2	> water depth	1.5	1300
Summer 2009	19.9	7.6	4977	2.3	> water depth	0.8	0905
Autumn 2009	12.1	7.8	6840	7.3	>water depth	0.5	1300

Fish sampling effort

Spring 2008

- Backpack electrofishing (2909 seconds, 70 Hz, 220 v, 7% DC)

Autumn 2009

- Backpack electrofishing (1500 seconds, 75 Hz, 250 v, 10% DC)

Sampling effort was markedly different between seasons as the water level had fallen and the area of habitat available for effective sampling had decreased dramatically.

Catch summary and length-frequency analysis

Just two southern pygmy perch were sampled in spring but the population exhibited a considerable increase in abundance in autumn (Figure 33; Table 49). Mountain galaxias, flat-headed gudgeon and gambusia were also caught at this site in both seasons but in greatest numbers in autumn (Table 49). Greater numbers of all species in autumn relative to spring may be due to greater sampling efficiency as a result of increased concentration (i.e. density) of fish following water level decreases in summer/autumn 2009.

Both southern pygmy perch collected in spring were large adult fish (>50 mm TL; Figure 34a). However, in autumn, >60% of the population represented newly recruited YOY fish (<35 mm TL; Figure 34b). The large fish recorded in spring are likely to be represented by a cohort >60 mm TL in autumn (Figure 34a-b). The presence of fish between 45-50 mm TL in autumn indicates that fish <50 mm TL were likely present in spring but were not sampled (Figure 34a-b).

Figure 33. Adult southern pygmy perch sampled from Meadows in autumn 2009

Table 49. Total numbers of fish species collected from Meadows in spring 2008 and autumn 2009.

Species		**Sampling trip**	
Common name	**Scientific name**	**Spring 2008**	**Autumn 2009**
Southern pygmy perch	*Nannoperca australis*	**2**	**38**
Mountain galaxias	*Galaxias olidus*	4	62
Flat-headed gudgeon	*Philypnodon grandiceps*	6	170
Gambusia	*Gambusia holbrooki*	2	100

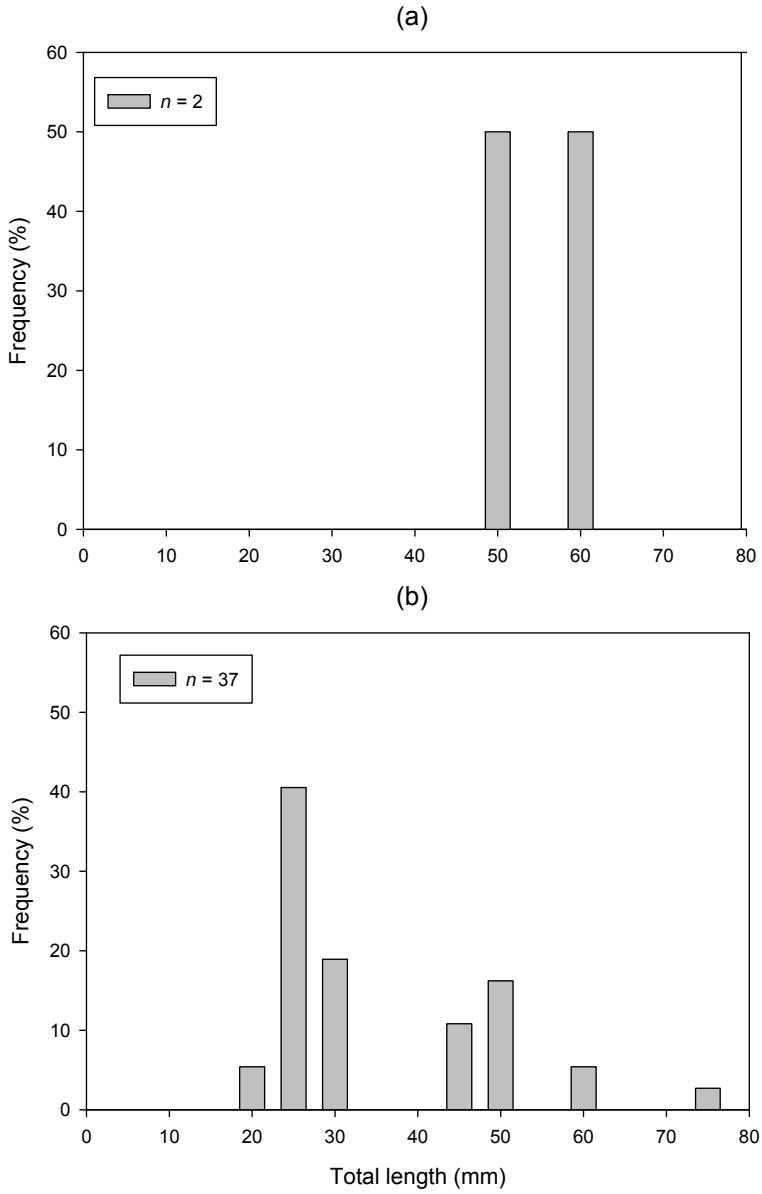

Figure 34a-b. Length-frequency distribution (5 mm increments) of southern pygmy perch collected from Meadows in (a) spring 2008 and (b) autumn 2009.

Site summary

Southern pygmy perch are persisting in moderate numbers and had successful recent recruitment. Nevertheless, critical low water levels and water depths are a concern at this site with many fish sampled from very small shallow pools. Unfortunately there is no scope for managing water levels at this site.

4.15. Waterfalls, Finniss River (Finniss River: southern pygmy perch)

Winter 2008


Spring 2008


Summer 2009


Autumn 2009


Figure 35. Photo point images of the Waterfalls site from winter 2008, spring 2008, summer 2009 and autumn 2009.

Environmental conditions

Table 50. Habitat cover measured at the Waterfalls site during each site visit. Habitat cover is measured as the proportion (percentage cover) of aquatic habitat area comprised of submerged and emergent macrophytes, physical structure or open water.

Season	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	0	15 (*Typha*)	40 (rock)	45
Spring 2008	30 (Algae and moss)	5 (*Typha*)	40 (rock)	25
Summer 2009	10 (Algae)	5 (*Typha*)	30 (rock)	55
Autumn 2009	1 (Algae and moss)	10 (*Typha*)	20 (rock)	69

Table 51. Water depth at reference stake at the Waterfalls site during each site visit and the overall change in water level between winter 2008 and autumn 2009.

Water surface level and water depth	Winter 2008	Spring 2008	Summer 2009	Autumn 2009	Total difference (m)
Depth at reference stake (m)	0.52	0.14	0.03	0.1	-0.42
Difference in water level (winter 2008 – autumn 2009, m)	-	-0.43	-0.06	-	> - 0.5

Table 52. Water quality parameters measured at the Waterfalls site during each site visit.

Season	Temp (ºC)	pH	Conductivity ($\mu S.cm^{-1}$))	DO (ppm)	Secchi (m)	Max depth (m)	Time
Winter 2008	11.4	7.9	990	16.4	0.5	1.2	1615
Spring 2008	18.0	7.0	1645	10.7	> water depth	1.2	1700
Summer 2009	21.8	7.4	2077	4.1	0.8	1.2	1100
Autumn 2009	16.2	7.6	1958	4.0	> water depth	0.8	1200

Fish sampling effort

Spring 2008

- Backpack electrofishing (1300 seconds, 70 Hz, 220 v, 7% DC)

Autumn 2009

- Backpack electrofishing (1200 seconds, 75 Hz, 250 v, 10% DC)

Catch summary and length-frequency analysis

Southern pygmy perch were captured in moderate numbers in spring but showed a significant decline in autumn (Table 53). Mountain galaxias, flat-headed gudgeon and carp gudgeon were also sampled at this site and their abundances are also presented in Table 53.

Southern pygmy perch ranged from 42-63 mm TL in spring (Figure 36a) and there was no evidence of recent recruitment. The one individual collected in autumn was a large adult fish (59 mm TL; Figure 36b & Figure 37) and thus no recruitment was detected between spring and autumn.

Table 53. Total numbers of fish species collected from Meadows in spring 2008 and autumn 2009.

Species		**Sampling trip**	
Common name	**Scientific name**	**Spring 2008**	**Autumn 2009**
Southern pygmy perch	*Nannoperca australis*	**35**	**1**
Mountain galaxias	*Galaxias maculatus*	11	15
Flat-headed gudgeon	*Philypnodon grandiceps*	7	
Carp gudgeon complex	*Hypseleotris spp.*	3	

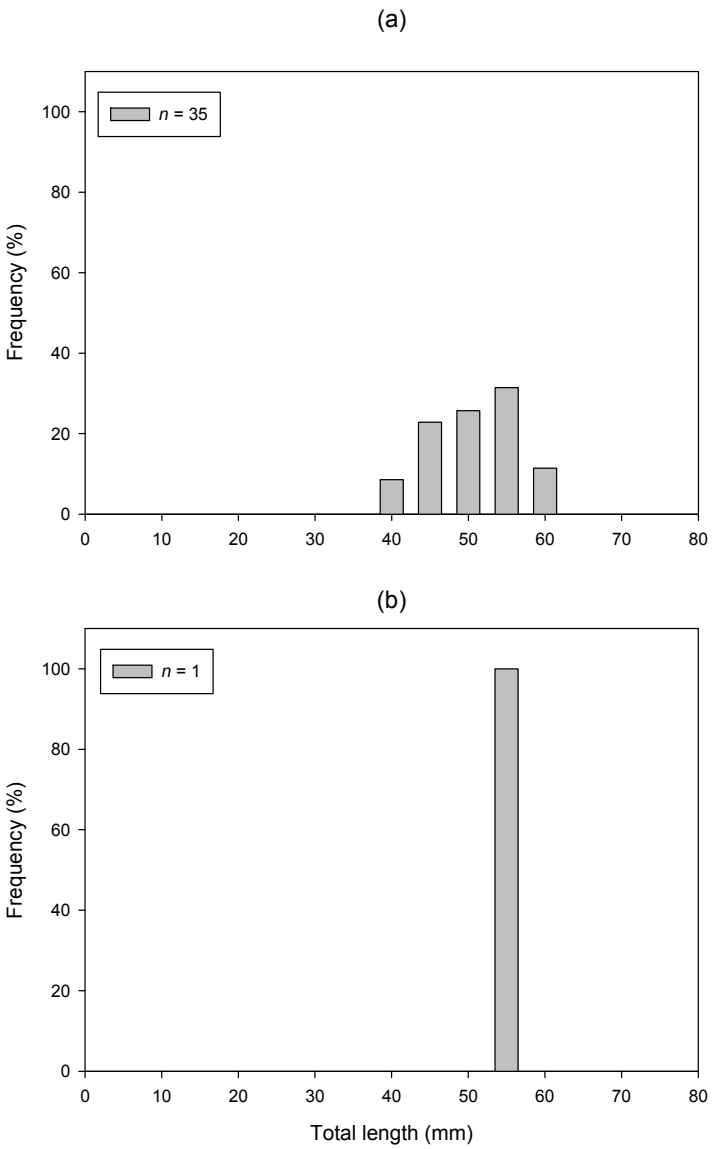

Figure 36a-b. Length-frequency distribution (5 mm increments) of southern pygmy perch collected from the Waterfalls site in (a) spring 2008 and (b) autumn 2009.

Figure 37. A large adult southern pygmy perch sampled at the Waterfalls site in autumn 2009.

Site summary

Southern pygmy perch have decreased in abundance and no recent recruitment was detected in spring or autumn. Additionally, in February (between site visits), water level at this site dropped by *c.* 1 m in one week and water quality was severely diminished (dissolved oxygen concentration of 0.04 ppm; Figure 38). These poor conditions are likely to have resulted in the decrease in abundance and recruitment failure of southern pygmy perch at this site. During the rapid water decline in February, 57 southern pygmy perch were rescued from drying pools and transferred to a more secure pool within the site, however, there were limited signs of success for this re-location in subsequent autumn sampling. Therefore, this population is under serious threat.

Figure 38. The Finniss Waterfalls site in February 2009, following a rapid drop in water level.

4.16. Inman River (Inman River: southern pygmy perch)

Winter 2008

Spring 2008

Summer 2009

Autumn 2009

Figure 39. Photo point images of the Inman River site from winter 2008, spring 2008, summer 2009 and autumn 2009.

Environmental conditions

Table 54. Habitat cover measured at the Inman River site during each site visit. Habitat cover is measured as the proportion (percentage cover) of aquatic habitat area comprised of submerged and emergent macrophytes, physical structure or open water.

Season	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	0	40	-	60
Spring 2008	0	40	1	59
Summer 2009	5	30	10	55
Autumn 2009	0	30 (*Phragmites, Typha*)	5 (snags)	65

Table 55. Water depth at reference stake at the Inman River site during each site visit and the overall change in water level between winter 2008 and autumn 2009.

Water surface level and water depth	Winter 2008	Spring 2008	Summer 2009	Autumn 2009	Total difference (m)
Depth at reference stake (m)	1.1	0.88	0.62	0.35	-
Difference in water level (winter 2008 – autumn 2009, m)	-	-0.22	-0.26	-0.27	-0.75

Table 56. Water quality parameters measured at the Inman River site during each site visit.

Season	Temp (ºC)	pH	Conductivity ($\mu S.cm^{-1}$)	DO (ppm)	Secchi (m)	Max depth (m)	Time
Winter 2008	12.8	7.3	1600	8.8	0.15	-	1730
Spring 2008	19.4	7.0	3400	2.6	0.50	1.0	-
Summer 2009	16.4	7.0	3210	1.2	0.30	1.0	1430
Autumn 2009	13.9	7.1	2780	1.9	0.20	0.8	-

Fish sampling effort

Spring 2008

- 5 baited box traps set for 1.5 hours

August 2009

- 10 baited box traps set for 1.5 hours

Catch summary and length-frequency analysis

Southern pygmy perch were sampled in both seasons but in greater numbers in autumn (Table 57). Sampling effort was greater in autumn and may have resulted in greater numbers of Southern pygmy perch. Carp gudgeon was the only other species sampled at this site (Table 57).

Recent recruitment was evident in spring with likely YOY individuals <25 mm TL and adult fish 34-41 mm TL both present in the catch (Figure 40a). Southern pygmy perch ranged 23-62 mm TL in autumn with recent recruitment also evident in this season (Figure 40b).

Table 57. Total numbers of fish species collected from the Inman River site in spring 2008 and autumn 2009.

Species		**Sampling trip**	
Common name	**Scientific name**	**Spring 2008**	**Autumn 2009**
Southern pygmy perch	*Nannoperca australis*	**12**	**101**
Carp gudgeon complex	*Hypseleotris spp.*	2	8

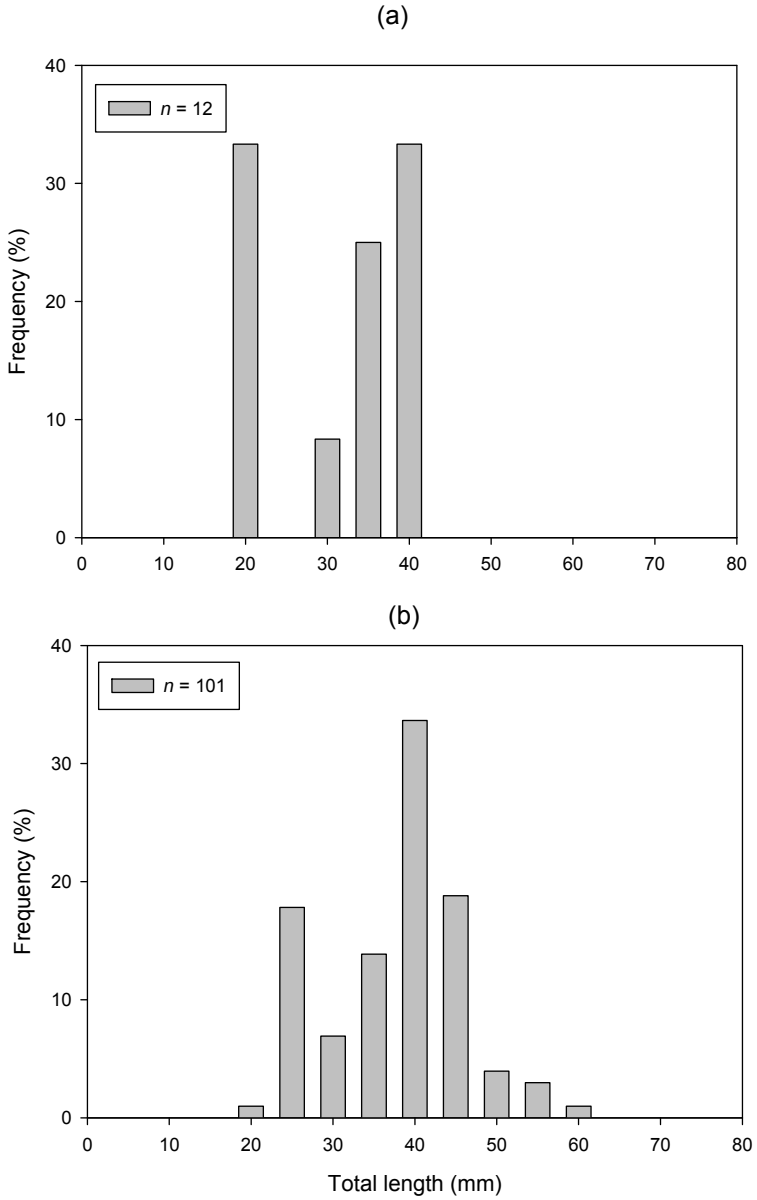

Figure 40a-b. Length-frequency distribution (5 mm increments) of southern pygmy perch collected from the Inman River site in (a) spring 2008 and (b) autumn 2009.

Site summary

Southern pygmy perch are persisting at this site in considerable numbers and have shown signs of recent recruitment in both sampling seasons. However, this population is still under threat from decreased water levels (this pool has dropped by *c.* 0.75 m since last winter) and consistently low dissolved oxygen concentrations.

4.17. Currency Creek (Lake Alexandrina: Yarra pygmy perch and Murray hardyhead)

Winter 2008

Spring 2008

Summer 2009

Autumn 2009
Not monitored

Figure 41. Photo point images of the Currency Creek site from winter 2008, spring 2008 and summer 2009.

Environmental conditions

Table 58. Habitat cover measured at the Currency Creek site during each site visit. Habitat cover is measured as the proportion (percentage cover) of aquatic habitat area comprised of submerged and emergent macrophytes, physical structure or open water.

Season	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	1 (Algae)	10 (*Phragmites, Schoenoplectus*)	0	89
Spring 2008	1 (Algae)	10 (*Phragmites, Schoenoplectus*)	0	89

Table 59. Water depth at reference stake at the Currency Creek site during each site visit and the overall change in water level between winter 2008 and spring 2008.

Water surface level and water depth	Winter 2008	Spring 2008	Total difference (m)
Depth at reference stake (m)	0.61	0.50	-
Difference in water level (winter 2008 – autumn 2009, m)	-	-0.11	-0.11

Table 60. Water quality parameters measured at the Currency Creek site during each site visit.

Season	Temp (ºC)	pH	Conductivity ($\mu S.cm^{-1}$)	DO (ppm)	Secchi (m)	Max depth (m)	Time
Winter 2008	11.4	8.1	15750	13.7	0.8	-	1000
Spring 2008	22.8	8.7	17773	9.3	> water depth	-	-

Fish sampling effort

Spring 2008

- 4 fyke nets set overnight

Autumn 2009

- Not sampled due to diminished water level (dry)

Catch summary and length-frequency analysis

No Yarra pygmy perch were collected from this site but Murray hardyhead were collected in spring (Table 61). Eleven other species were also collected from this site, including several euryhaline estuarine species (i.e. small-mouthed hardyhead and blue-spot goby) that were highly abundant (Table 61).

The population of Murray hardyhead detected at this site was comprised solely of large adult fish (48-69 mm TL; Figure 42). There was no evidence of recruitment (i.e. no YOY cohort).

Table 61. Total numbers of fish species collected from the Currency Creek site in spring 2008.

Species		Sampling trip
Common name	**Scientific name**	**Spring 2008**
Murray hardyhead	*Craterocephalus fluviatilis*	**11**
Flat-headed gudgeon	*Philypnodon grandiceps*	76
Dwarf flat-headed gudgeon	*Philypnodon macrostomus*	3
Australian smelt	*Retropinna semoni*	44
Common galaxias	*Galaxias maculatus*	2
Small-mouthed hardyhead	*Atherinosoma microstoma*	5875
Tamar goby	*Afurcagobius tamarensis*	137
Blue-spot goby	*Pseudogobius olorum*	398
Lagoon goby	*Tasmanogobius lasti*	16
Bridled goby	*Arenogobius bifrenatus*	22
Redfin perch	*Perca fluviatilis*	3
Gambusia	*Gambusia holbrooki*	24

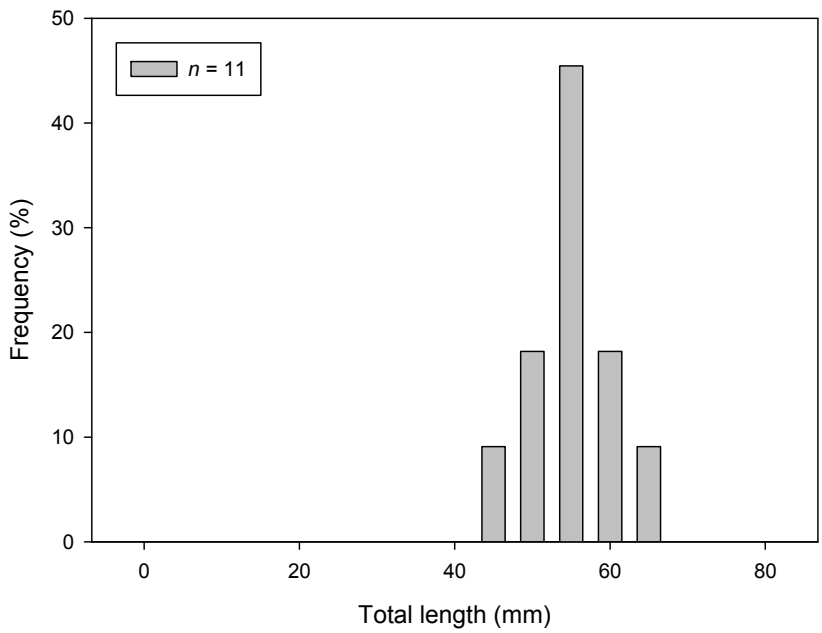

Figure 42. Length-frequency distribution (5 mm increments) of Murray hardyhead collected from the Currency Creek site in spring 2008.

Site summary

This site is now dry and therefore Yarra pygmy perch and Murray hardyhead have been lost from this location.

4.18. Finniss River Confluence (Lake Alexandrina: Yarra pygmy perch and Murray hardyhead)

Winter 2008

Spring 2008

Summer 2009

Not monitored

Autumn 2009

Not monitored

Figure 43. Photo point images of the Finniss River confluence site from winter 2008, spring 2008 and summer 2009 (red dot indicates sampling location (dry)).

Environmental conditions

Table 62. Habitat cover measured at the Finniss River confluence site during each site visit. Habitat cover is measured as the proportion (percentage cover) of aquatic habitat area comprised of submerged and emergent macrophytes, physical structure or open water.

Season	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	0	10 (*Phragmites, Schoenoplectus*)	0	90
Spring 2008	1	30 (*Phragmites, Schoenoplectus*)	0	69

Table 63. Water depth at reference stake at the Finniss River confluence site during each site visit and the overall change in water level between winter 2008 and spring 2008.

Water surface level and water depth	Winter 2008	Spring 2008	Total difference (m)
Depth at reference stake (m)	0.16	0.18	-
Difference in water level (winter 2008 – autumn 2009, m)	-	+0.02	+0.02

Table 64. Water quality parameters measured at the Finniss River confluence site during each site visit.

Season	Temp (ºC)	pH	Conductivity ($\mu S.cm^{-1}$)	DO (ppm)	Secchi (m)	Max depth (m)	Time
Winter 2008	13.7	8.4	4100	10.6	0.15	-	1115
Spring 2008	18.3	8.8	8277	10.8	-	-	-

Fish sampling effort

Spring 2008

- 6 seine net hauls.

Autumn 2009

- Not sampled due to diminished water level (dry)

Catch summary and length-frequency analysis

No Yarra pygmy perch were sampled at this site and only low numbers of Murray hardyhead were collected in spring (Table 65). Both Murray hardyhead sampled in spring were adults (>45 mm TL) with no YOY present (Figure 44). Several other species were sampled at this site in spring and their abundances are also presented in Table 65.

Table 65. Total numbers of fish species collected from the Finniss River confluence site in spring 2008.

Species		Sampling trip
Common name	**Scientific name**	**Spring 2008**
Murray hardyhead	*Craterocephalus fluviatilis*	**2**
Australian smelt	*Retropinna semoni*	5
Small-mouthed hardyhead	*Atherinosoma microstoma*	47
Tamar goby	*Afurcagobius tamarensis*	1
Blue-spot goby	*Pseudogobius olorum*	5
Lagoon goby	*Tasmanogobius lasti*	3

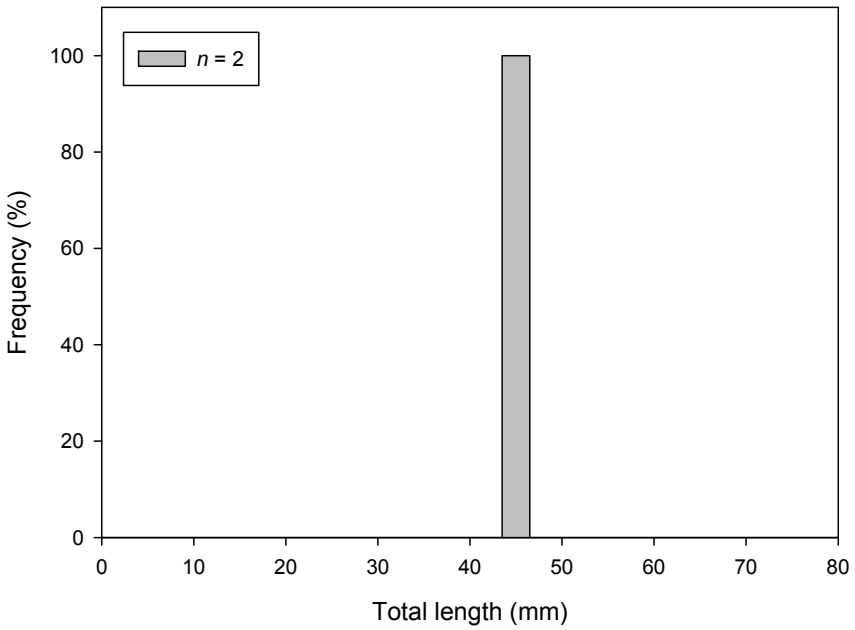

Figure 44. Length-frequency distribution (5 mm increments) of Murray hardyhead collected from the Finniss River confluence site in spring 2008.

Site summary

Whilst not presented in the data, as a summer site assessment was not undertaken, water level fell by *c.* 0.4 m between spring 2008 and summer 2009 and consequently the site dried. Thus, Yarra pygmy perch and Murray hardyhead have been lost from this site.

4.19. Boggy Creek, Hindmarsh Island (Lake Alexandrina: Murray hardyhead)

Winter 2008
Not monitored
Spring 2008
No photo
Summer 2009
Not monitored
Autumn 2009

Not monitored

Figure 45. Photo point image of Boggy Creek from autumn 2009.

Environmental conditions

Table 66. Habitat cover measured at Boggy Creek during each site visit. Habitat cover is measured as the proportion (percentage cover) of aquatic habitat area comprised of submerged and emergent macrophytes, physical structure or open water.

Season	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	35	50	-	15
Spring 2008	-	-	-	-

Table 67. Water quality parameters measured at Boggy Creek during each site visit.

Season	Temp (ºC)	pH	Conductivity ($\mu S.cm^{-1}$)	DO (ppm)	Secchi (m)	Max depth (m)	Time
Winter 2008	24.1	8.28	16460	7.4	0.14	-	-
Spring 2008	-	-	-	-	-	-	-

Fish sampling effort

Spring 2008

- 3 fyke nets set overnight.

Autumn 2009

- Not sampled due to diminished water level (dry)

This site was sampled by Adelaide University and did not include winter and summer site condition assessments. These assessments will be made in the future.

Catch summary and length-frequency analysis

Large numbers of Murray hardyhead were sampled in spring (Table 68). Several non-threatened species were also sampled and their abundances are presented in Table 68.

In spring Murray hardyhead ranged from 30-73 mm TL (Figure 46). This size distribution suggests that significant recruitment occurred in spring/summer 2007.

Table 68. Total numbers of fish species collected from the Finniss River confluence site in spring 2008.

Species		**Sampling trip**
Common name	**Scientific name**	**Spring 2008**
Murray hardyhead	*Craterocephalus fluviatilis*	**587**
Common galaxias	*Galaxias maculatus*	1
Flat-headed gudgeon	*Philypnodon grandiceps*	18
Dwarf flat-headed gudgeon	*Philypnodon macrostomus*	1
Carp gudgeon complex	*Hypseleotris spp.*	207
Blue-spot goby	*Pseudogobius olorum*	170
Gambusia	*Gambusia holbrooki*	6

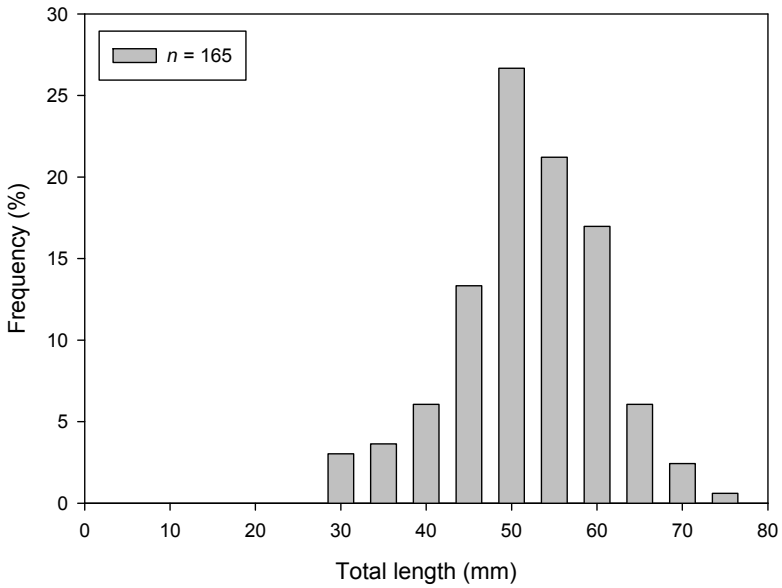

Figure 46. Length-frequency distribution (5 mm increments) of Murray hardyhead collected from Boggy Creek in spring 2008.

Site summary

Murray hardyhead were present in significant numbers in spring 2008 but the site had severely diminished water levels in autumn and was not sampled. An allocation of water has now been provided to this site but the current status of fish is still to be determined.

4.20. Clayton/Dunns Lagoon (Lake Alexandrina: Murray hardyhead)

Winter 2008

Spring 2008

Summer 2009

Autumn 2009

Figure 47. Photo point images of Clayton from winter 2008, spring 2008, summer 2009 and autumn 2009.

Environmental conditions

Table 69. Habitat cover measured at Clayton during each site visit. Habitat cover is measured as the proportion (percentage cover) of aquatic habitat area comprised of submerged and emergent macrophytes, physical structure or open water.

Season	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	<1	1	-	98
Spring 2008	1	0	1	98
Summer 2009	0	0	0	100
Autumn 2009	0	0	1	99

Table 70. Water depth at reference stake at Clayton during each site visit and the overall change in water level between winter 2008 and autumn 2009.

Water surface level and water depth	Winter 2008	Spring 2008	Summer 2009	Autumn 2009	Total difference (m)
Depth at reference stake (m)	0.48	0.46	Out of water	-0.2 (out of water)	-
Difference in water level (winter 2008 – autumn 2009, m)	-	-0.05	-0.44	> -0.2	> -0.75

Table 71. Water quality parameters measured at Clayton during each site visit.

Season	Temp (ºC)	pH	Conductivity ($\mu S.cm^{-1}$)	DO (ppm)	Secchi (m)	Max depth (m)	Time
Winter 2008	15.2	8.2	8000	13.1	0.12	-	1500
Spring 2008	19.9	8.7	7687	9.9	0.10	0.6	-
Summer 2009	16.4	7.0	12587	11.7	0.40	0.4	1225
Autumn 2009	23.1	8.6	15060	10.57	0.25	0.3	1500

Fish sampling effort

Spring 2008 & autumn 2009

- 6 seine net hauls.

Catch summary and length-frequency analysis

Murray hardyhead were collected in low numbers in spring and had decreased further by autumn (Table 72). A total of nine non-threatened species were also sampled at this site (Table 72).

All Murray hardyhead sampled in spring were adults with length ranging from 36-54 mm TL (Figure 48a). Most individuals were likely to have been spawned in the previous spawning season (spring/summer 07/08). Only one individual was captured in autumn and was a new recruit from the most recent spawning season (spring/summer 08/09; Figure 48b).

Table 72. Total numbers of fish species collected from Clayton in spring 2008 and autumn 2009.

Species		Sampling trip	
Common name	**Scientific name**	**Spring 2008**	**Autumn 2009**
Murray hardyhead	*Craterocephalus fluviatilis*	**8**	**1**
Australian smelt	*Retropinna semoni*	32	45
Bony herring	*Nematalosa erebi*	1	1
Flat-headed gudgeon	*Philypnodon grandiceps*		80
Common galaxias	*Galaxias maculatus*	2	1
Small-mouthed hardyhead	*Atherinosoma microstoma*	71	90
Lagoon goby	*Tasmanogobius lasti*	5	30
Tamar goby	*Afurcagobius tamarensis*	9	123
blue-spot goby	*Pseudogobius olorum*	2	1
Redfin perch	*Perca fluviatilis*		1

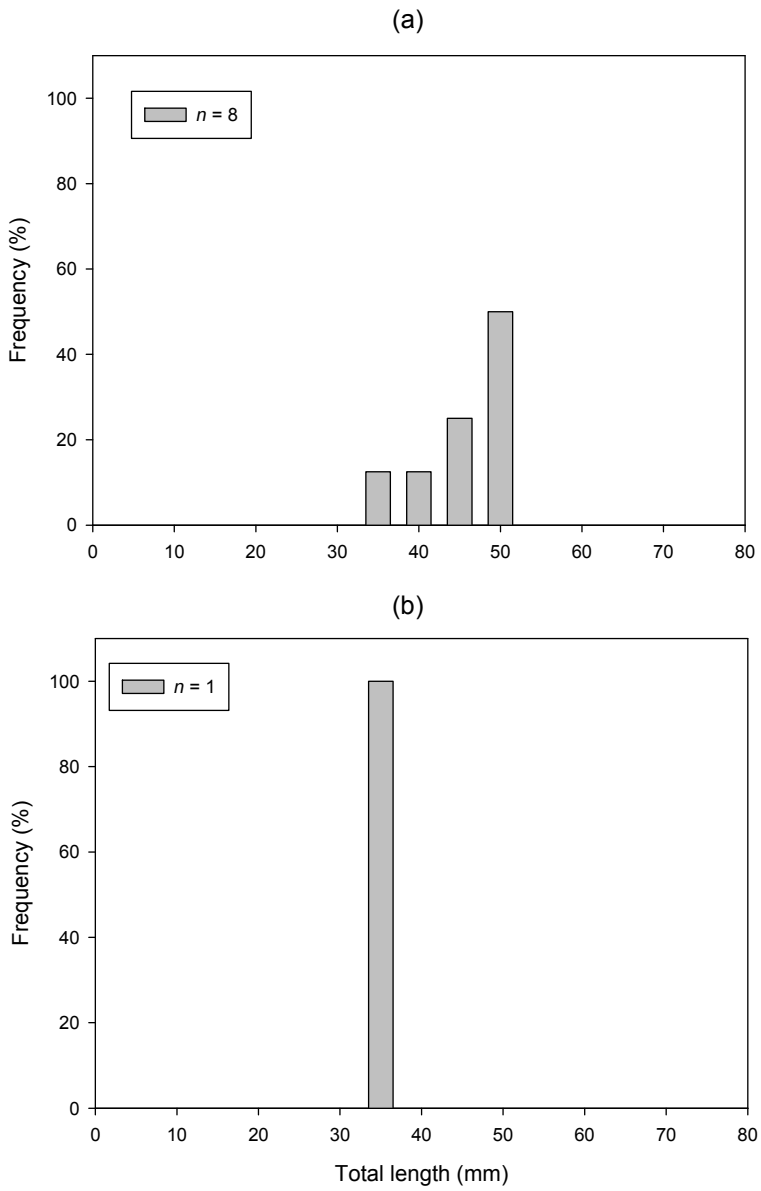

Figure 48a-b. Length-frequency distribution (5 mm increments) of Murray hardyhead collected from Clayton in (a) spring 2008 and (b) autumn 2009.

Site summary

Murray hardyhead were captured in low abundance in both spring and autumn, however, only a single new recruit was detected in autumn 09. Furthermore, non-related sampling in the area by SARDI Aquatic Sciences after autumn 2009, failed to detect any Murray hardyhead (SARDI Unpublished data). Water level has dropped by >0.75 m over the course of monitoring such that Dunn's lagoon is completely dry and the habitat quality in the Goolwa channel outside of Dunn's lagoon is severely diminished. Murray hardyhead may have been lost from this site but further monitoring is needed to confirm this.

4.21. Milang Jetty (Lake Alexandrina: Murray hardyhead)

Winter 2008

Spring 2008

Summer 2009

Autumn 2009

Figure 49. Photo point images of the Milang jetty site from winter 2008, spring 2008, summer 2009 and autumn 2009.

Environmental conditions

Table 73. Habitat cover measured at Milang during each site visit. Habitat cover is measured as the proportion (percentage cover) of aquatic habitat area comprised of submerged and emergent macrophytes, physical structure or open water.

Season	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	5	1	-	94
Spring 2008	0	0	0	100
Summer 2009	0	0	5	95
Autumn 2009	0	0	0	100

Table 74. Water depth at reference stake at Milang during each site visit and the overall change in water level between winter 2008 and autumn 2009.

Water surface level and water depth	Winter 2008	Spring 2008	Summer 2009	Autumn 2009	Total difference (m)
Depth at reference stake (m)	0.24	-	-	-	-
Difference in water level (winter 2008 – autumn 2009, m)	-	+0.46	-0.93	> -0.5	> -1.0

Table 75. Water quality parameters measured at the Milang jetty site during each site visit.

Season	Temp (ºC)	pH	Conductivity ($\mu S.cm^{-1}$)	DO (ppm)	Secchi (m)	Max depth (m)	Time
Winter 2008	14.1	8.6	4200	12.8	0.20	-	1410
Spring 2008	20.9	8.8	4933	10.4	0.25	0.4	1330
Summer 2009	16.6	8.1	6450	11.5	0.15	-	1145
Autumn 2009	23.5	9.15	6870	10.1	0.2	0.3	1100

Fish sampling effort

Spring 2008 & autumn 2009

- 6 seine net hauls.

Catch summary and length-frequency analysis

A small number of Murray hardyhead were sampled in spring and no Murray hardyhead were sampled in autumn (Table 76). A total of 10 non-threatened species were also sampled at this site (Table 76).

All Murray hardyhead sampled in spring were large adult fish (46-51 mm TL; Figure 50). As no fish were captured in autumn no recruitment was observed.

Table 76. Total numbers of fish species collected from the Milang jetty site in spring 2008 and autumn 2009.

Species		Sampling trip	
Common name	**Scientific name**	**Spring 2008**	**Autumn 2009**
Murray hardyhead	*Craterocephalus fluviatilis*	**5**	
Australian smelt	*Retropinna semoni*	120	32
Bony herring	*Nematalosa erebi*	16	2
Flat-headed gudgeon	*Philypnodon grandiceps*		10
Common galaxias	*Galaxias maculatus*	1	
Small-mouthed hardyhead	*Atherinosoma microstoma*	15	
Lagoon goby	*Tasmanogobius lasti*	3	15
Tamar goby	*Afurcagobius tamarensis*		1
blue-spot goby	*Pseudogobius olorum*		1
Gambusia	*Gambusia holbrooki*		1
Redfin perch	*Perca fluviatilis*	3	1

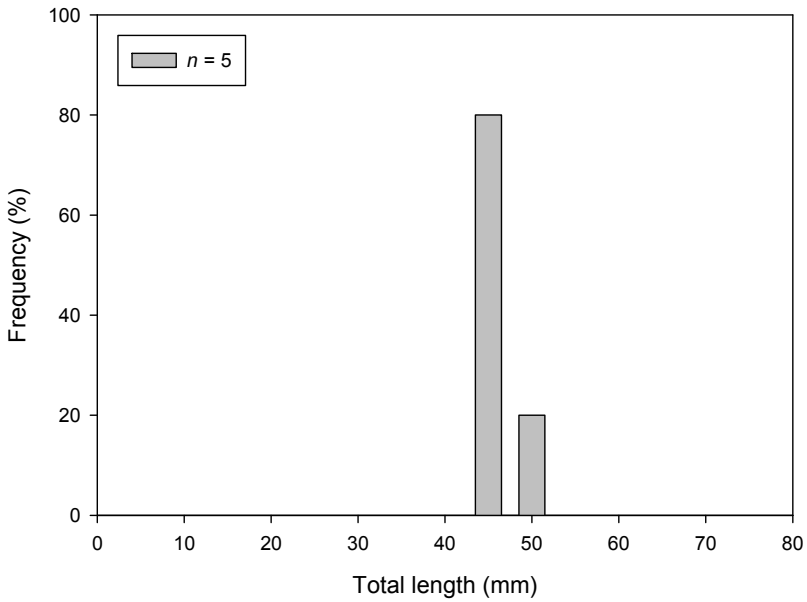

Figure 50. Length-frequency distribution (mm) of Murray hardyhead collected from the Milang jetty site in spring 2008.

Site summary

Murray hardyhead have potentially been lost from this site. The water level has dropped by >1.0 m since winter 2008 and the quality of the remaining habitat is poor. This site is highly influenced by wind driven water level fluctuations and in conjunction with current low lake levels, may therefore undergo periods of total drying. The value of the site as a sheltered habitat area for Murray hardyhead has thus been diminished.

4.22. Bremer River Mouth (Bremer River: Murray hardyhead)

Winter 2008


Spring 2008


Summer 2009


Autumn 2009


Figure 51. Photo point images of the Bremer River mouth from winter 2008, spring 2008, summer 2009 and autumn 2009.

Environmental conditions

Table 77. Habitat cover measured at the Bremer River Mouth during each site visit. Habitat cover is measured as the proportion (percentage cover) of aquatic habitat area comprised of submerged and emergent macrophytes, physical structure or open water.

Season	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	10	10	-	80
Spring 2008	5	20	0	75
Summer 2009	0	5	20	75

Table 78. Water depth at reference stake at the Bremer River Mouth during each site visit and the overall change in water level between winter 2008 and autumn 2009.

Water surface level and water depth	Winter 2008	Spring 2008	Summer 2009	Autumn 2009	Total difference (m)
Depth at reference stake (m)	0.48	0.45	0.40	0 (dry)	-
Difference in water level (winter 2008 – autumn 2009, m)	-	-	-	-	> -0.5

Table 79. Water quality parameters measured at the Bremer River Mouth during each site visit.

Season	Temp (ºC)	pH	Conductivity ($\mu S.cm^{-1}$)	DO (ppm)	Secchi (m)	Max depth (m)	Time
Winter 2008	14.1	7.4	3800	8.8	> water depth		1245
Spring 2008	22.8	8.6	5807	13.1	0.3		-
Summer 2009	16.0	7.8	9770	5.8	> 0.5		1045

Fish sampling effort

Spring 2008

- 4 fyke nets set overnight.

Autumn 2009

- Not sampled due to diminished water levels (dry).

Catch summary and length-frequency analysis

A small number of Murray hardyhead were sampled in spring (Table 80) but this site was not sampled in autumn after it had dried out. A total of 12 non-threatened species were also sampled at this site in spring (Table 80).

All Murray hardyhead sampled in spring were large adults (50-64 mm TL; Figure 52 & Figure 53). As this site was dry in autumn, no recruitment was detected.

Table 80. Total numbers of fish species collected from the Bremer River mouth in spring 2008.

Species		**Sampling trip**
Common name	**Scientific name**	**Spring 2008**
Murray hardyhead	*Craterocephalus fluviatilis*	**9**
Australian smelt	*Retropinna semoni*	7
Carp gudgeon complex	*Hypseleotris spp.*	1
Flat-headed gudgeon	*Philypnodon grandiceps*	61
Bony herring	*Nematalosa erebi*	114
Common galaxias	*Galaxias maculatus*	238
Congolli	*Pseudaphritus urvillii*	1
Small-mouthed hardyhead	*Atherinosoma microstoma*	42
Tamar goby	*Afurcagobius tamarensis*	1
Blue-spot goby	*Pseudogobius olorum*	3
Carp	*Cyprinus carpio*	1
Tench	*Tinca tinca*	2
Redfin perch	*Perca fluviatilis*	4

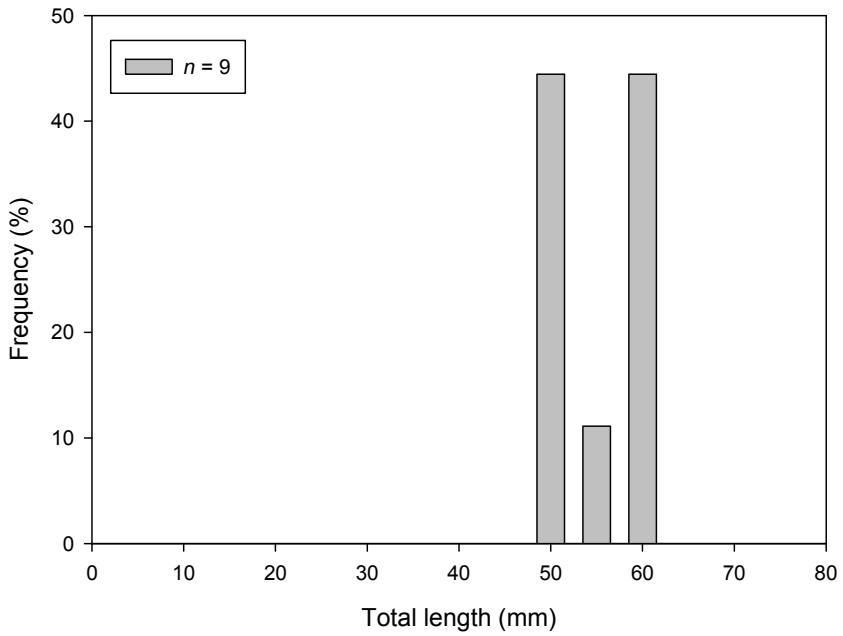

Figure 52. Length-frequency distribution (5 mm increments) of Murray hardyhead collected from the Bremer River mouth in spring 2008.

Figure 53. Adult Murray hardyhead sampled at the Bremer River mouth in spring 2008.

Site summary

Murray hardyhead have been lost from this site as it has completely dried.

4.23. Rocky Gully (River Murray: Murray hardyhead)

Winter 2008

Spring 2008

Summer 2009

Autumn 2009

Figure 54. Photo point images of Rocky Gully from winter 2008, spring 2008, summer 2009 and autumn 2009.

Environmental conditions

Table 81. Habitat cover measured at Rocky Gully during each site visit. Habitat cover is measured as the proportion (parentage cover) of aquatic habitat area comprised of submerged and emergent macrophytes, physical structure or open water.

Season	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	20	5	2	73
Spring 2008	5	5	0	90
Summer 2009	0	1	10	89
Autumn 2009	2 (algae)	2 (*Phragmites*, grass)	5 (rock)	91

Table 82. Water depth at reference stake at Rocky Gully during each site visit and the overall change in water level between winter 2008 and autumn 2009.

Water surface level and water depth	Winter 2008	Spring 2008	Summer 2009	Autumn 2009	Total difference (m)
Depth at reference stake (m)	0.84	0.72	0.40	0.49	-0.35
Difference in water level (winter 2008 – autumn 2009, m)	-	-0.12	-	-	-0.34

Table 83. Water quality parameters measured at Rocky Gully during each site visit.

Season	Temp (ºC)	pH	Conductivity ($\mu S.cm^{-1}$)	DO (ppm)	Secchi (m)	Max depth (m)	Time
Winter 2008	13.1	8.2	22750	15.9	0.5	-	1300
Spring 2008	27.6	8.9	33933	13.2	0.3	-	-
Summer 2009	20.2	8.2	49967	7.4	0.1	1.2	1105
Autumn 2009	23	8.62	57700	15.2	0.15	-	1000

Fish sampling effort

Spring 2008 & autumn 2009

- 4 fyke nets set overnight.

Catch summary and length-frequency analysis

A substantial number (*n* = 760) of Murray hardyhead were sampled from this site in spring, however, the population had declined significantly (*n* = 3) by autumn (Table 84; Figure 55). Several non-threatened species were sampled in spring, all of which were not sampled in autumn, apart from the exotic gambusia (Table 84).

All Murray hardyhead sampled in spring appear to be adults (>30 mm TL; Figure 56a). The fish collected in autumn are likely to be recruits from the previous spawning season (spring/summer 2008; Figure 56b), which is supported by observations of juvenile hardyhead during the summer site assessment.

Table 84. Total numbers of fish species collected from Rocky Gully in spring 2008 and autumn 2009.

Species		Sampling trip	
Common name	**Scientific name**	**Spring 2008**	**Autumn 2009**
Murray hardyhead	*Craterocephalus fluviatilis*	**760**	**3**
Small-mouthed hardyhead	*Atherinosoma microstoma*	7606	
Lagoon goby	*Tasmanogobius lasti*	29	
blue-spot goby	*Pseudogobius olorum*	314	
Gambusia	*Gambusia holbrooki*	38	65

Figure 55. One of just three Murray hardyhead sampled at Rocky Gully in autumn 2009.

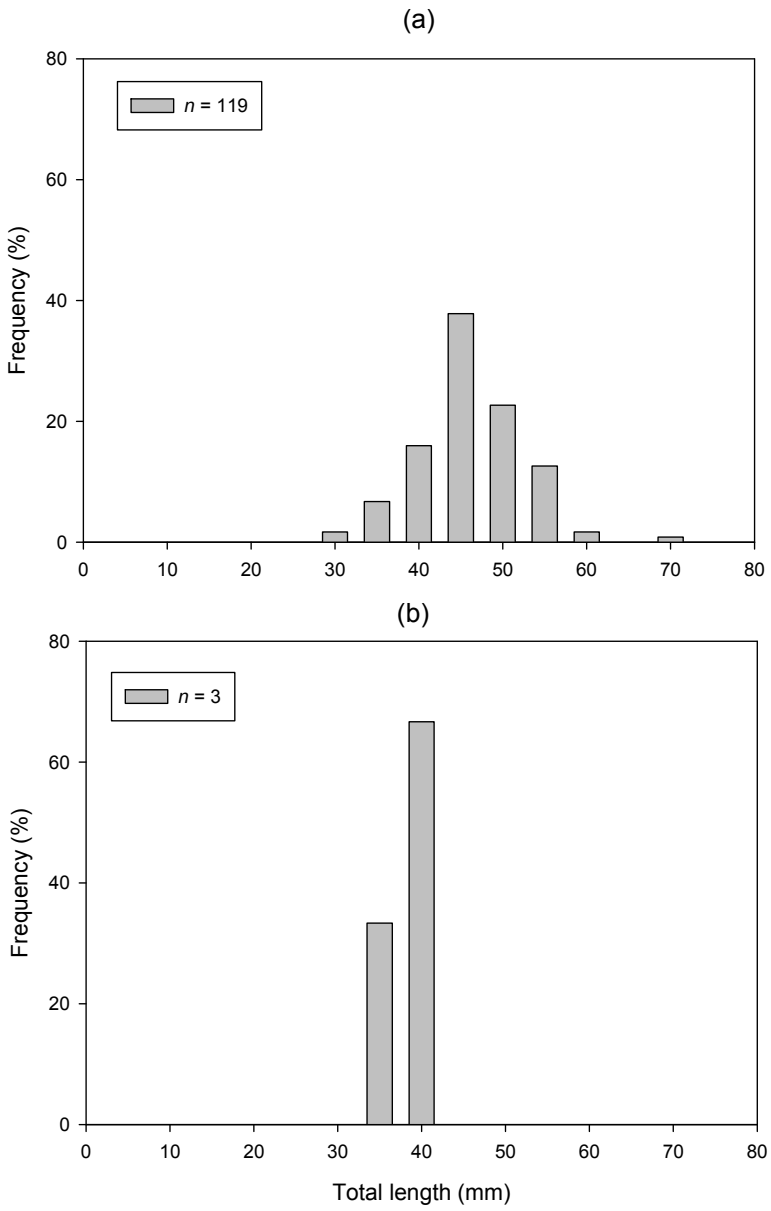

Figure 56a-b. Length-frequency distribution (5 mm increments) of Murray hardyhead collected from Rocky Gully in (a) spring 2008 and (b) autumn 2009.

Site summary

Murray hardyhead have undergone a severe decline in abundance at this site. Salinity has consistently increased and at the time of autumn sampling, had a value similar to sea water and there was a concurrent algal bloom. Further sampling at this site, after autumn 2009, in an attempt to rescue fish for captive maintenance yielded just two individuals. An environmental water allocation has now been provided to this site but follow up sampling to determine the current status of Murray hardyhead has not yet been conducted.

4.24. Riverglades (River Murray: Murray hardyhead)

Winter 2008

Spring 2008

Summer 2009
Not monitored
Autumn 2009
Not monitored

Figure 57. Photo point images of Riverglades from winter 2008 and spring 2008.

Environmental conditions

Table 85. Habitat cover measured at Riverglades during each site visit. Habitat cover is measured as the proportion (percentage cover) of aquatic habitat area comprised of submerged and emergent macrophytes, physical structure or open water.

Season	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	20	5	2	73
Spring 2008	5	5	0	90
Summer 2009	0	1	10	89
Autumn 2009	2 (algae)	2 (*Phragmites*, grass)	5 (rock)	91

Table 86. Water depth at reference stake at Riverglades during each site visit and the overall change in water level between winter 2008 and spring 2009.

Water surface level and water depth	Winter 2008	Spring 2008	Total difference (m)
Depth at reference stake (m)	0.2	0.05	-
Difference in water level (winter 2008 – autumn 2009, m)	-	-0.15	-0.15

Table 87. Water quality parameters measured at Riverglades during each site visit.

Season	Temp (ºC)	pH	Conductivity ($\mu S.cm^{-1}$)	DO (ppm)	Secchi (m)	Max depth (m)	Time
Winter 2008	13.1	5.5	550	11.0	0.7		1210
Spring 2008	23.6	4.1	433	11.7	0.5	0.3	-

Fish sampling effort

Spring 2008

- 5 seine net hauls.

Autumn 2009

- Not sampled due to diminished water levels (drying of the actual wetland) and absence of Murray hardyhead in spring sampling.

Catch summary and length-frequency analysis

No Murray hardyhead were sampled at this site. Nevertheless five other native species were collected (Table 88).

Table 88. Total numbers of fish species collected from Riverglades in spring 2008 and autumn 2009.

Species		Sampling trip
Common name	**Scientific name**	**Spring 2008**
Carp gudgeon complex	*Hypseleotris spp.*	9
Flat-headed gudgeon	*Philypnodon grandiceps*	21
Dwarf flat-headed gudgeon	*Philypnodon macrostomus*	1
Australian smelt	*Retropinna semoni*	29
Unspecked hardyhead	*Craterocephalus stercusmuscarum fulvus*	4

Site summary

Murray hardyhead were previously present at this site in 2004/2005 (Wedderburn *et al.* 2007) but it is now completely dry and the species has been lost.

4.25. Disher Creek (River Murray: Murray hardyhead)

Winter 2008
Not monitored
Spring 2008


Summer 2009


Autumn 2009


Figure 58. Photo point images of Disher Creek from winter 2008, spring 2008, summer 2009 and autumn 2009.

Environmental conditions

Table 89. Habitat cover measured at Disher Creek during each site visit. Habitat cover is measured as the proportion (percentage cover) of aquatic habitat area comprised of submerged and emergent macrophytes, physical structure or open water.

Season	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Spring 2008	30	10	5	65
Summer 2009	20	5	20	55
Autumn 2009	60	5	2	33

Table 90. Water depth at reference stake at Disher Creek during each site visit and the overall change in water level between winter 2008 and autumn 2009.

Water surface level and water depth	Winter 2008	Spring 2008	Summer 2009	Autumn 2009	Total difference (m)
Depth at reference stake (m)	-	0.48	0.52	0.4	-
Difference in water level (winter 2008 – autumn 2009, m)	-	-	+0.05	-0.13	-0.08

Table 91. Water quality parameters measured at Disher Creek during each site visit.

Season	Temp (ºC)	pH	Conductivity ($\mu S.cm^{-1}$)	DO (ppm)	Secchi (m)	Max depth (m)	Time
Spring 2008	21.3	6.1	30100	13.7	> 0.6	0.6	1200
Summer 2009	17.6	8.2	26200	11.5	> 0.6	0.6	1000
Autumn 2009	14.9	8.15	30100	9.56	>0.6	0.6	0930

Fish sampling effort

Spring 2008 & autumn 2009

- 4 fyke nets set overnight.

Catch summary and length-frequency analysis

Murray hardyhead were sampled at Disher Creek during both seasons but in greatest numbers in autumn (Table 92). The only other species present was gambusia, which were collected in very high abundances in both seasons (Table 92).

All Murray hardyhead sampled in spring were large adult fish (56-72 mm TL; Figure 59a). Although not represented in Figure 59a, many juvenile Murray hardyhead (*c.* 15-25 mm TL) were observed and opportunistically sampled (i.e. with a dip net) at the exit of the irrigation drain in Disher Creek in spring. This is consistent with the significant recruitment observed in autumn 2009 with the majority of the population likely to be YOY individuals (Figure 59b & Figure 60). Older and larger fish (≥60 mm TL) were absent from the population in autumn (Figure 59b).

Table 92. Total numbers of fish species collected from Disher Creek in spring 2008 and autumn 2009.

Species		Sampling trip	
Common name	**Scientific name**	**Spring 2008**	**Autumn 2009**
Murray hardyhead	*Craterocephalus fluviatilis*	**3**	**174**
Gambusia	*Gambusia holbrooki*	2650	9687

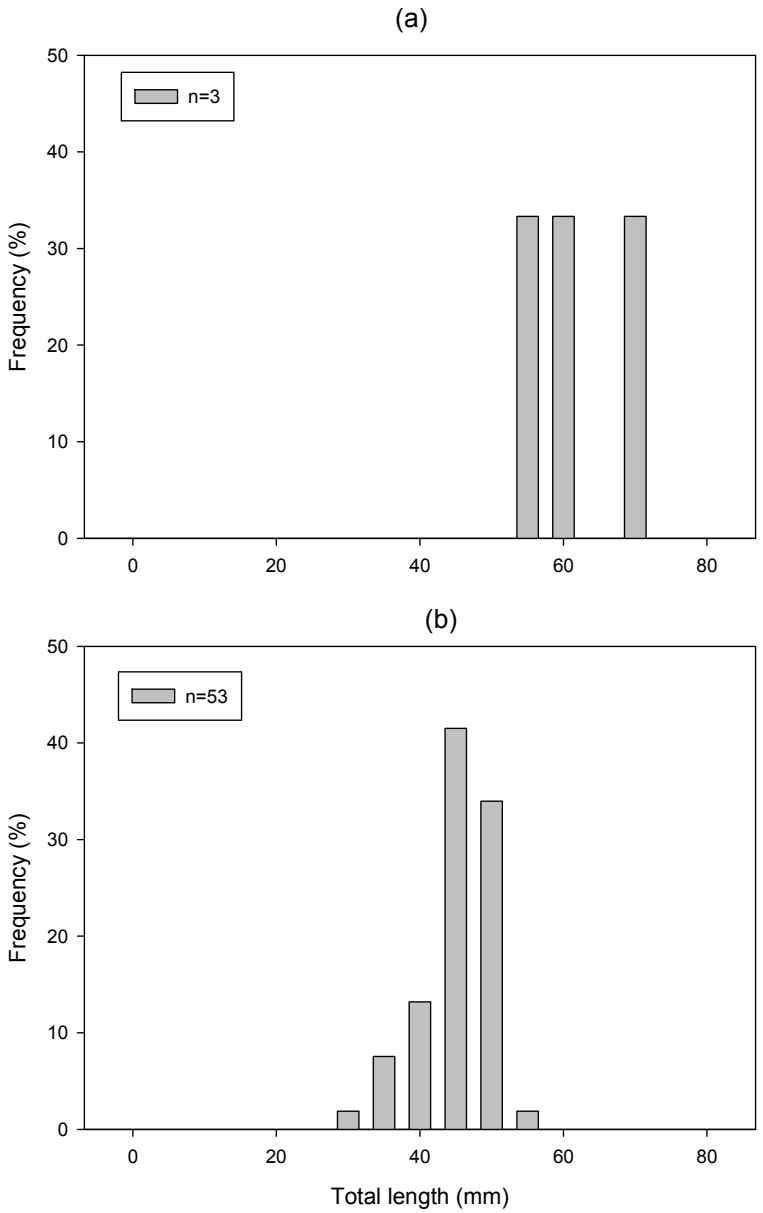

Figure 59a-b. Length-frequency distribution (5 mm increments) of Murray hardyhead collected from Disher Creek in (a) spring 2008 and (b) autumn 2009.

Figure 60. Murray hardyhead sampled at Disher Creek in autumn 2009.

Site summary

Conditions at this site have remained relatively stable over the course of sampling and Murray hardyhead exhibited a significant recruitment event between spring and autumn. However, gambusia are very abundant at this site and may be impacting the Murray hardyhead population through competition. Salinity remains moderate-high but appears satisfactory for maintaining the population at present.

4.26. Berri Evaporation Basin (River Murray: Murray hardyhead)

Winter 2008


Spring 2008


Summer 2009


Autumn 2009


Figure 61. Photo point images of the Berri evaporation site from winter 2008, spring 2008, summer 2009 and Autumn 2009.

Environmental conditions

Table 93. Habitat cover measured at the Berri evaporation basin site during each site visit. Habitat cover is measured as the proportion (percentage cover) of aquatic habitat area comprised of submerged and emergent macrophytes, physical structure or open water.

Season	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	2	10	-	88
Spring 2008	5	10	1	79
Summer 2009	0	10	5	85
Autumn 2009	0	30	5	65

Table 94. Water depth at reference stake at the Berri evaporation basin site during each site visit and the overall change in water level between winter 2008 and autumn 2009.

Water surface level and water depth	Winter 2008	Spring 2008	Summer 2009	Autumn 2009	Difference (m)
Depth at reference stake (m)	-	0.35	0.05	0.35	-
Difference in water level (winter 2008 – autumn 2009, m)	-	-0.06	-0.17	+0.23	0

Table 95. Water quality parameters measured at the Berri evaporation basin site during each site visit.

Season	Temp (ºC)	pH	Conductivity ($\mu S.cm^{-1}$)	DO (ppm)	Secchi (m)	Max depth (m)	Time
Winter 2008	8.5	8.1	4190	10.5	> 0.4	-	1030
Spring 2008	20.3	6.0	6597	6.0	> water depth	0.6	0900
Summer 2009	20.3	9.1	1705	5.3	0.2	0.6	1030
Autumn 2009	16.3	8.6	505	10.55	>0.6	0.6	1630

Fish sampling effort

Spring 2008 & autumn 2009

- 8 fyke nets set overnight.

Catch summary and length-frequency analysis

Murray hardyhead were sampled from the Berri evaporation basin in both seasons but were more abundant in autumn (Table 96; Figure 62). Several non-threatened species were also sampled in both seasons, with carp gudgeon and gambusia highly abundant (Table 96).

Two distinct cohorts of Murray hardyhead were present in spring 2008, representing adults (45-65 mm TL) likely spawned in 2007 and YOY (21-25 mm TL; Figure 63a) likely from recent spawning in 2008. This YOY cohort had progressed in length and

successfully recruited and represents the majority of the population in autumn (Figure 63b).

Table 96. Total numbers of fish species collected from the Berri evaporation basin site in spring 2008 and autumn 2009.

Species		**Sampling trip**	
Common name	**Scientific name**	**Spring 2008**	**Autumn 2008**
Murray hardyhead	*Craterocephalus fluviatilis*	**37**	**84**
Australian smelt	*Retropinna semoni*	39	91
Carp gudgeon complex	*Hypseleotris spp.*	4585	3146
Flat-headed gudgeon	*Philypnodon grandiceps*	518	355
Dwarf flat-headed gudgeon	*Philypnodon macrostomus*	24	32
Gambusia	*Gambusia holbrooki*	860	4284

Figure 62. Murray hardyhead sampled from the Berri evaporation basin in spring 2008.

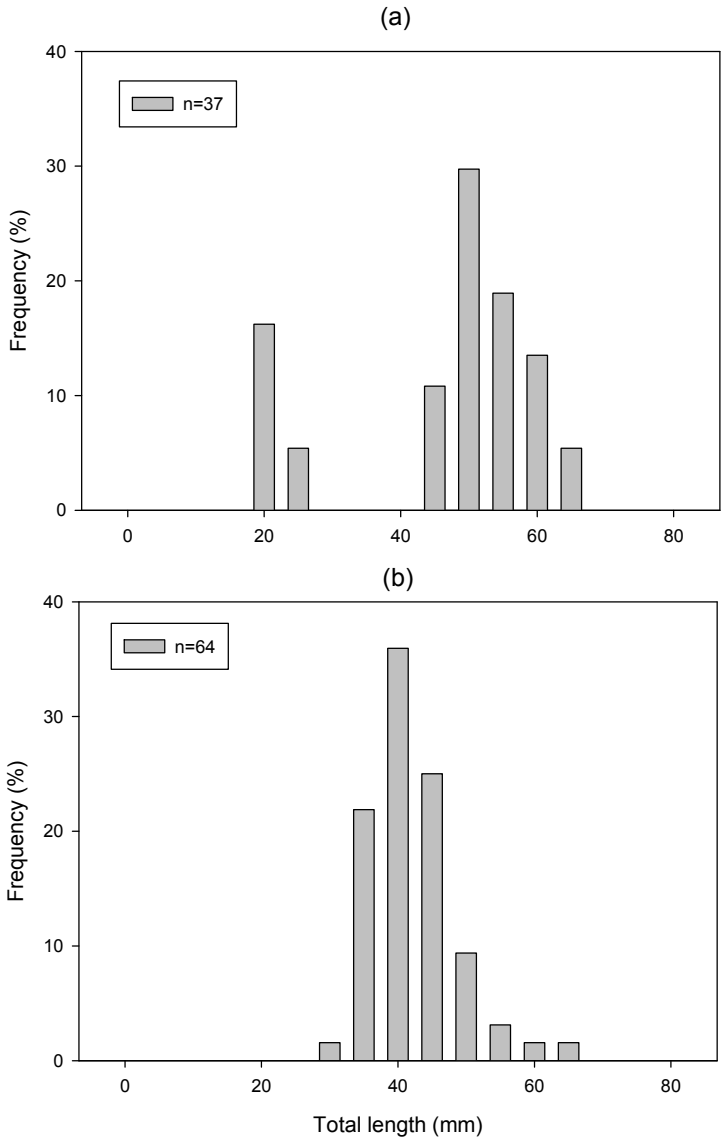

Figure 63a-b. Length-frequency distribution (mm) of Murray hardyhead collected from the Berri evaporation basin site in (a) spring 2008 and (b) autumn 2009.

Site summary

Murray hardyhead are present at this site in moderate abundance and have recently recruited successfully. Nonetheless, the Murray hardyhead population may still be under threat from reduced salinity (salinity at this site has decreased substantially over the last year). Murray hardyhead are highly tolerant of saline conditions relative to other freshwater species and the recent decrease in salinity may favour other species, leading to increased competition with Murray hardyhead (Wedderburn *et al.* 2008). Thus, common non-threatened species such as Australian smelt and gudgeon species may eventually out-compete Murray hardyhead at this site.

5. SUMMARY

The sites and populations of small-bodied threatened fish being monitored exhibited differential responses to drought conditions over 2008/2009. Only a small number of populations were considered to be in a satisfactory condition, and thus have a lower risk of population loss (i.e. Tookayerta Creek sites). Tookayerta Creek is ground water fed and, unlike other catchments sampled in this project, flows year round, providing the habitats within this catchment with relatively stable water levels. Most populations, however, declined considerably over the year (e.g. Rocky Gully, Boggy Creek, Finniss River waterfalls), remained in a critical state (e.g. Rodwell Creek, Marne River) or are now feared lost (e.g. Bremer River Mouth, Finniss River confluence and Currency Creek). This was primarily due to further decreases in water levels resulting in the complete drying of some sites but also potentially due to a loss of vegetated habitat and increased salinity at some sites (e.g. Rocky Gully).

The data presented in this report are used to summarize the status of each population and site (i.e. abundance, recruitment, water level) and develop risk factors for the loss of each of these populations (Table 97). A 'traffic light' system was applied to visually represent the risk to each population. Levels of risk are defined as follows,

- Low risk (green) – moderate abundance in autumn 2009, evidence of recent recruitment and stable habitat conditions.
- Moderate risk (orange) – moderate abundance, lack of recent recruitment (river blackfish) and/or diminished habitat quality.
- High risk (red) – substantial declines in abundance (between spring 2008 and autumn 2009), lack of recent recruitment (southern purple-spotted gudgeon, pygmy perch species' and Murray hardyhead), extended lack of recruitment (i.e. >3 years, river blackfish) and/or severely diminished habitat quality.
- Population likely to be lost (purple)

Only one site is monitored for Southern purple-spotted gudgeon and this population is at high risk of loss. There is currently a captive breeding program for this population being undertaken by Aquasave Consultants and the Murray-Darling Basin Authority (MDBA) and a recovery plan is in preparation with the primary goal of identifying surrogate refuges for the introduction of fish spawned in captive (Hall *et al.* 2009).

River blackfish are still present at all five monitoring sites for this species. Both populations within the Tookayerta catchment (i.e. Willowburn road and Deep Creek road) are performing satisfactorily and are at low risk of loss. Conversely, the remaining three populations were deemed to be under medium (i.e. Rodwell Creek and Angas River gauge site) and high risk (i.e. the Marne River) of loss. In response to low water levels and low dissolved oxygen concentrations in autumn 2008, Rodwell Creek has been filled with environmental water on several occasions and it is hoped this intervention will facilitate the persistence of this population. The population in the Marne River is dominated by large adult fish and has not exhibited successful recruitment for several years. Consequently this is the most 'at risk' population of river blackfish.

A total of 12 sites are monitored for southern pygmy perch, including seven where this species is present together with other threatened species. Southern pygmy perch are found at both Tookayerta catchment sites together with river blackfish and similarly these populations are performing satisfactorily and are at low risk of loss. Four populations remain that can be considered at medium risk of loss (i.e. Middle Creek junction, Turvey's Drain, Meadows and the Inman River) and one of these sites, namely Turvey's Drain, has now received an environmental water allocation which may facilitate the persistence of this population. The Waterfalls site on the Finniss River was the only site considered to be at a high risk of loss due to the marked decrease in abundance observed and recruitment was not detected. The remaining five populations have potentially been lost. These sites are within the Lower Lakes and have completely dried or become severely degraded (e.g. increased salinity, lack of vegetated habitat) as a result of reduced water levels.

Yarra pygmy perch were not collected from any of the six sites sampled for this species. All of these sites are in the Lower Lakes and have completely dried or become severely degraded (e.g. increased salinity, lack of vegetated habitat) as a result of reduced water levels. Additionally, no Yarra pygmy perch were collected by Wedderburn and Barnes (2009) from a broader survey of sites in the Lower Lakes in 2008/2009. Yarra pygmy perch were last collected in the region in February 2008 near the mouth of Eastick Creek (Hammer 2008) and it is possible that this species has now been extirpated from the region. Nevertheless, in 2007/2008 *c*. 150 fish were collected from the wild to become part of a captive breeding program being undertaken by DEH and Aquasave Consultants (see Hammer 2008). Offspring from these wild caught fish have been released into two privately owned 'surrogate dams'

with the aim of establishing source populations for later reintroduction upon the return of favourable conditions in the Lower Lakes.

Murray hardyhead populations remain at seven of 14 sites sampled for this species. Murray hardyhead is the most widely yet patchily distributed species under investigation and can be found in three sub-regions in the South Australian MDB - wetlands, irrigation drains and sheltered lake edges in the Lower Lakes; off-channel wetlands below Lock 1; and off-channel evaporation basins in the upper reaches of the South Australian MDB. Similar to both pygmy perch species, which Murray hardyhead commonly occurred with in sympatry in the Lower Lakes; several sites in this region have been lost due to drying. Murray hardyhead are likely still present at both Boggy Creek and Turvey's Drain and both sites have now been supplied with environmental water which may facilitate the persistence of these populations. Approximately 100 Murray hardyhead from Boggy Creek have been transferred to the Murray-Darling Basin Freshwater Research Centre (MDFRC) Lower Basin Laboratory (Mildura) as part of an already existing captive breeding program for this species. Additionally, Wedderburn and Barnes (2009) identified another significant population of Murray hardyhead at a site on Mundoo Island, which will be included in future DAP monitoring.

Of the two off-channel wetlands below Lock 1, the Riverglades population has been lost due to the drying of the wetland and the Rocky Gully population was deemed to be at high risk of loss as indicated by significant reductions in abundance and raised salinities at this site. An environmental water allocation has also been provided for this site and future monitoring will determine the current status of this population.

Murray hardyhead were collected in moderate abundances at both Disher Creek and Berri evaporation basin in the upper reaches of the South Australian MDB but both populations were determined to be at medium risk of loss. Salinity at Disher Creek is relatively high and the high abundance of the exotic gambusia may lead to increased competition with Murray hardyhead. Nevertheless, significant recruitment was detected in autumn 2009. Salinity may also pose a threat to the Berri evaporation basin population but due to decreasing rather than increasing salinity. Murray hardyhead are tolerant of saline conditions relative to other freshwater species and the decrease in conductivity observed at this site (from 6597 $\mu S.cm^{-1}$ in spring 2008 to 505 $\mu S.cm^{-1}$ in autumn 2009) may favour other species, leading to increased competition with Murray hardyhead (Wedderburn *et al.* 2008). Due to the risk posed to these populations, a number of Murray hardyhead have been collected from both sites (Disher Creek n = 80+, Berri evaporation basin n = 15+) as part of the captive

breeding program being undertaken the MDFRC Lower Basin Laboratory. Additionally, there have been preliminary discussions on changes to the management of these two sites to secure greater amounts of environmental water.

Ongoing monitoring as a component of the 'DAP for threatened fish populations in the South Australian MDB' (Hall *et al.* 2009) is essential to highlight populations and sites most at risk of loss and to inform actions to secure these populations. Monitoring will continue through 2009/2010 following the same time frames as 2008/09. This will provide greater insight on the trajectory of these populations and sites, and the potential success or failure of management interventions already undertaken to conserve certain populations (e.g. Murray hardyhead at Rocky Gully). Additionally, the continuation of monitoring is critically important as current drought conditions and low system inflows are not expected to alleviate in the short-term. Instead water levels and water quality in the Lower Murray and Lower Lakes are predicted to decline further over the next year. This increases the importance of having a rigorous management framework to conserve these species and a corresponding monitoring program to inform management decisions.

Table 97. The population status of threatened fish (abundance, recruitment and site conditions) at each site monitored under the drought action plan and associated risk level to the persistence of the population (colours: green – low risk, orange – medium risk, red – high risk, purple – population lost).

Site Name	DAP Site Number	Target species	No. caught spring 2008	No. caught autumn 2009	Recruitment within the last 12 months (Y/N)	Water level summer-autumn (Rising, stable, falling, dry)	Site comments
Jury Swamp	1.1.1	Southern purple spotted gudgeon	1	1	N	Falling	Likely further habitat degradation through decreasing water level.
Rodwell Creek	2.1.1	River blackfish	6	11	N	Falling	Pool being maintained by watering. Recruitment within last 3 years.
Marne	2.2.1	River blackfish	3	1	N	Rising	No recruitment within last 3 years Pool in poor condition (i.e. presence of unknown white plume on bottom of pool)
Angas Gauge	2.3.1	River blackfish	17	26	N	Rising	Pool in reasonable condition but salinity rising. Recruitment within last 3 years
Willowburn Road	2.4.1a	River blackfish	8	7	Yes	Falling	Pools in good condition (i.e. consistent cool base flow)
	3.4.1a	Southern pygmy perch	7	24	Yes	Falling	As above
Deep Creek Road	2.4.1b	River blackfish	3	5	Yes	Stable	Pool in good condition (i.e. consistent cool base flow)
	3.4.1b	Southern pygmy perch	21	13	Yes	Stable	As above
Middle Creek Junction	3.1.1	Southern pygmy perch	35	53	Yes	Falling	Low water level in pool
Boundary Creek Drain	3.2.1a	Southern pygmy perch	0	0	-	Falling	Low water levels, population likely lost
	4.1.1a	Yarra pygmy perch	0	0	-	Falling	Low water levels, population likely lost
	5.1.1a	Murray hardyhead	58	1	Yes	Falling	Low water levels, low numbers still present
Eastick	3.2.1b	Southern pygmy perch	0	Not sampled	-	Falling	Low water level, high salinity – population likely lost
	4.1.1b	Yarra pygmy perch	0	Not sampled	-	Falling	Low water level, high salinity – population likely lost
	5.1.1b	Murray hardyhead	0	Not sampled	-	Falling	Low water level, high salinity – population likely lost
Steamer Drain	3.2.1c	Southern pygmy perch	Not sampled	Not sampled	-	Dry	Dry – population lost
	4.1.1c	Yarra pygmy perch	Not sampled	Not sampled	-	Dry	Dry – population lost
	5.1.1c	Murray hardyhead	Not sampled	Not sampled	-	Dry	Dry – population lost
Black Swamp	3.2.2a	Southern pygmy perch	Not sampled	Not sampled	-	Dry	Dry – population lost
	4.1.3	Yarra pygmy perch	Not sampled	Not sampled	-	Dry	Dry – population lost

Table 97 continued.

Site Name	DAP Site Number	Target species	No. caught spring 2008	No. caught autumn 2009	Recruitment within the last 12 months (Y/N)	Water level summer-autumn (Rising, stable, falling, dry)	Site comments
Black Swamp Drain	3.2.2	Southern pygmy perch	0	Not sampled	-	Dry	Low water level, population potentially lost
Turvey's Drain	3.2.3	Southern pygmy perch	81	5	Yes	Stable	Environmental water secured for filling
	5.1.3a	Murray hardyhead	8	7	Yes	Stable	Environmental water secured for filling
Meadows	3.3.1	Southern pygmy perch	2	38	Yes	Falling	Very low water level
Waterfalls	3.3.3	Southern pygmy perch	35	1	No	Falling	Very low water level
Inman	3.5.1	Southern pygmy perch	12	101	Yes	Falling	Low water levels in pools, low DO
Currency Creek	4.1.2A	Yarra pygmy perch	0	Not sampled	-	Dry	Dry – population lost
	-	Murray hardyhead	11	Not sampled	No	Dry	Dry – population lost
Finniss River Confluence	4.1.2	Yarra pygmy perch	0	Not sampled	-	Dry	Dry – population lost
	-	Murray hardyhead	2	Not sampled	No	Dry	Dry – population lost
Boggy Creek	5.1.1d	Murray hardyhead	587	Not sampled	-	Was dry (now refilled)	Unknown since re-filling
Clayton	5.1.2	Murray hardyhead	8	1	Yes	Falling	No off-channel habitat remains, water level continues to recede
Milang Jetty	5.1.3b	Murray hardyhead	5	0	No	Falling	Very low water levels, probably dry in certain wind conditions
Bremer River Mouth	5.1.3c	Murray hardyhead	9	Not sampled	No	Dry	Dry
Rocky Gully	5.1.4	Murray hardyhead	760	3	Yes	Rising?	Habitat was in critical condition but has now been watered
Riverglades	5.1.5	Murray hardyhead	0	Not sampled	-	Dry	Dry
Disher Creek	5.2.1	Murray hardyhead	3	174	Yes	Falling	Very high abundance of gambusia may be impacting Murray hardyhead
Berri	5.2.1	Murray hardyhead	37	84	Yes	Falling	Salinity decreasing Increase in non salt-tolerant species that may compete with Murray hardyhead

6. REFERENCES

Bice C, Wilson P and Ye Q (2008) 'Threatened fish populations in the Lower Lakes of the River Murray in spring 2007 and summer 2008.' South Australian Research and Developement Institute (Aquatic Sciences), Adelaide. 32pp. SARDI Publication number F2008/000801-1.

Bice CM and Ye Q (2007) 'Monitoring threatened fish communities on Hindmarsh Island, in the Lower Lakes of the River Murray, South Australia, in the summers of 2006 and 2007 with reference to baseline data from 2005.' South Australian Research and Developement Institute (Aquatic Sciences), Adelaide, 47pp. SARDI Publication Number F2007/000551-2.

Ellis I (2005) 'Ecology and breeding seasonality of the Murray hardyhead *Craterocephalus fluviatilis* (McCulloch), Family Atherinidae, in two lakes near Mildura, Victoria.' Murray-Darling Freshwater Research Centre, Lower Basin Laboratory, Mildura.

Hall A, Higham J, Hammer M, Bice C and Zampatti B (2009) 'Drought Action Plan for South Australian Murray-Darling Basin threatened freshwater fish populations 2009-2010; Rescue to Recovery'.' South Australian Department for Environment and Heritage, Adelaide.

Hammer M (2007a) 'Distribution, status and urgent conservation measures for Yarra Pygmy Perch in the Murray-Darling Basin.' Aquasave consultants, Adelaide.

Hammer M (2007b) 'Report on urgent conservation measures and monitoring of southern purple-spotted gudgeon on the River Murray, South Australia. Report to the South Australian Murray-Darling Basin Natural Resource Management Board.' Aquasave Consultants.

Hammer M (2008) 'Status review of wild and captive populations of Yarra pygmy perch in the Murray-Darling Basin.' Aquasave Consultants, Adelaide.

Kingsford RT (2000) Ecological impacts of dams, water diversions and river management on floodplain wetlands in Australia. *Austral Ecology* **25**, 109-127.

Wedderburn S and Barnes T (2009) 'Condition monitoring of threatened fish species at Lake Alexandrina and Lake Albert (2008-2009). Report to the Murray-Darling Basin Authority and the South Australian Murray-Darling Basin Natural Resources Management Board.' Adelaide Unniversity, Adelaide.

Wedderburn SD, Walker KF and Zampatti BP (2007) Habitat separation of *Craterocephalus* (Atherinidae) species and populations in off-channel areas of the lower River Murray, Australia. *Ecology of Freshwater Fish* **16**, 442-449.

Wedderburn SD, Walker KF and Zampatti BP (2008) Salinity may cause fragmentation of hardyhead (Teleostei: Atherinidae) populations in the River Murray, Australia. *Marine and Freshwater Research* **59**, 254-258.