Small-Bodied Native Fish Conservation for the Drought Action Plan

Summary of monitoring in 2008/09

June 2009

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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 part of the South Australian 'Drought Action Plan (DAP) for small-bodied threatened fish', significant sites for threatened fish species (i.e. river blackfish, southern purple-spotted gudgeon, southern pygmy perch, Yarra pygmy perch and Murray hardyhead) within the South Australian Murray-Darling Basin were monitored between winter 2008 and autumn 2009. Fish populations were sampled in spring 2008 and autumn 2009 to monitor changes in abundance and assess recruitment, whilst site assessments to track habitat quality were also carried out during these periods and additionally in winter 2008 and summer 2009. This monitoring allows the identification of populations that are at greatest risk and hence in most need of management intervention. Table 1 presents a summary of the sites (i.e. name, number), fish population monitoring (i.e. abundances, evidence of recruitment), the status of water level (i.e. rising, falling, stable, dry) and brief notes on the habitat conditions at each site. By combining the information gathered, a level of risk (low, medium, high or population lost) was determined for each population. Levels of risk are defined as follows,

- Low risk (green) – considerable abundance in autumn 2009, evidence of recent recruitment and stable habitat conditions.
- Moderate risk (orange) – stable abundance, lack of recruitment (river blackfish) and/or diminished habitat quality.
- High risk (red) – significant declines in abundance (between spring 2008 and autumn 2009), lack of recruitment (pygmy perch species' and Murray hardyhead), severely diminished habitat quality.
- Population 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	Species	Abundance spring 2008	Abundance 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.
Rodwell Creek	2.1.1	River blackfish	6	11	N	Falling	Pool being maintained by watering
Marne	2.2.1	River blackfish	3	1	N	Rising	Pool in poor condition
Angas Gauge	2.3.1	River blackfish	17	26	N	Rising	Pool in reasonable condition but salinity rising
Willowburn Road	2.4.1a	River blackfish	8	7	Yes	Falling	Pools in good condition
	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
	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	Dry
	4.1.1a	Yarra pygmy perch	0	0	-	Falling	Dry
	5.1.1a	Murray hardyhead	58	1	Yes	Falling	Dry
Eastick	3.2.1b	Southern pygmy perch	0	Not sampled	-	Falling	Dry
	4.1.1b	Yarra pygmy perch	0	Not sampled	-	Falling	Dry
	5.1.1b	Murray hardyhead	0	Not sampled	-	Falling	Dry
Steamer Drain	3.2.1c	Southern pygmy perch	Not sampled	Not sampled	-	Dry	Dry
	4.1.1c	Yarra pygmy perch	Not sampled	Not sampled	-	Dry	Dry
	5.1.1c	Murray hardyhead	Not sampled	Not sampled	-	Dry	Dry
Black Swamp	3.2.2a	Southern pygmy perch	Not sampled	Not sampled	-	Dry	Dry
	4.1.3	Yarra pygmy perch	Not sampled	Not sampled	-	Dry	Dry

Table 1 continued.

Site Name	DAP Site Number	Species	Abundance spring 2008	Abundance 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	Dry
Turvey's Drain	3.2.3	Southern pygmy perch	81	5	Yes	Stable	Water secured for filling
	5.1.3a	Murray hardyhead	8	7	Yes	Stable	As above
Meadows	3.3.1	Southern pygmy perch	2	38	Yes	Falling	Pools very low
Waterfalls	3.3.3	Southern pygmy perch	35	1	No	Falling	Pools very low, major loss of fish
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
	-	Murray hardyhead	11	Not sampled	No	Dry	Dry
Finniss River Confluence	4.1.2	Yarra pygmy perch	0	Not sampled	-	Dry	Dry
	-	Murray hardyhead	2	Not sampled	No	Dry	Dry
Boggy Creek	5.1.1d	Murray hardyhead	587	Not sampled	-	Was dry (now refilled)	Unknown??
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	53	Yes	Falling	Very high abundance of gambusia may be impacting population
Berri	5.2.1	Murray hardyhead	37	84	Yes	Falling	Salinity decreasing, with an associated increase in non salt-tolerant species that may compete with Murray hardyhead

2. INTRODUCTION

In the Lower Murray region of South Australia there are currently five species of threatened small-bodied fish. These include 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 Act 1982.*

Persistent drought conditions being experienced across south-eastern Australia, combined with a history over extraction of water, 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 2008/09, as part of the South Australian 'Drought Action Plan for small-bodied threatened species', significant sites for these species in the South Australian MDB were monitored to determine the status of populations and habitat quality. In spring (October-November 2008) and autumn (March-May 2009) fish populations were quantitatively sampled and in winter (August 2008) and summer (February 2009) site checks were conducted to assess site condition.

The following document presents the results of fish sampling in spring and autumn with a summary of site condition throughout 2008/09. These data provide insight on the trajectory of fish 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 and therefore in need of management intervention.

3. METHODS

3.1. Sites

A total of 26 sites were deemed to be significant for at least one of the five threatened species and thus in need of monitoring. 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 (

Figure 1a-b). Not all sites were sampled and assessed throughout 2008/09, either due to a continued absence of threatened fish or if the site had completely dried.

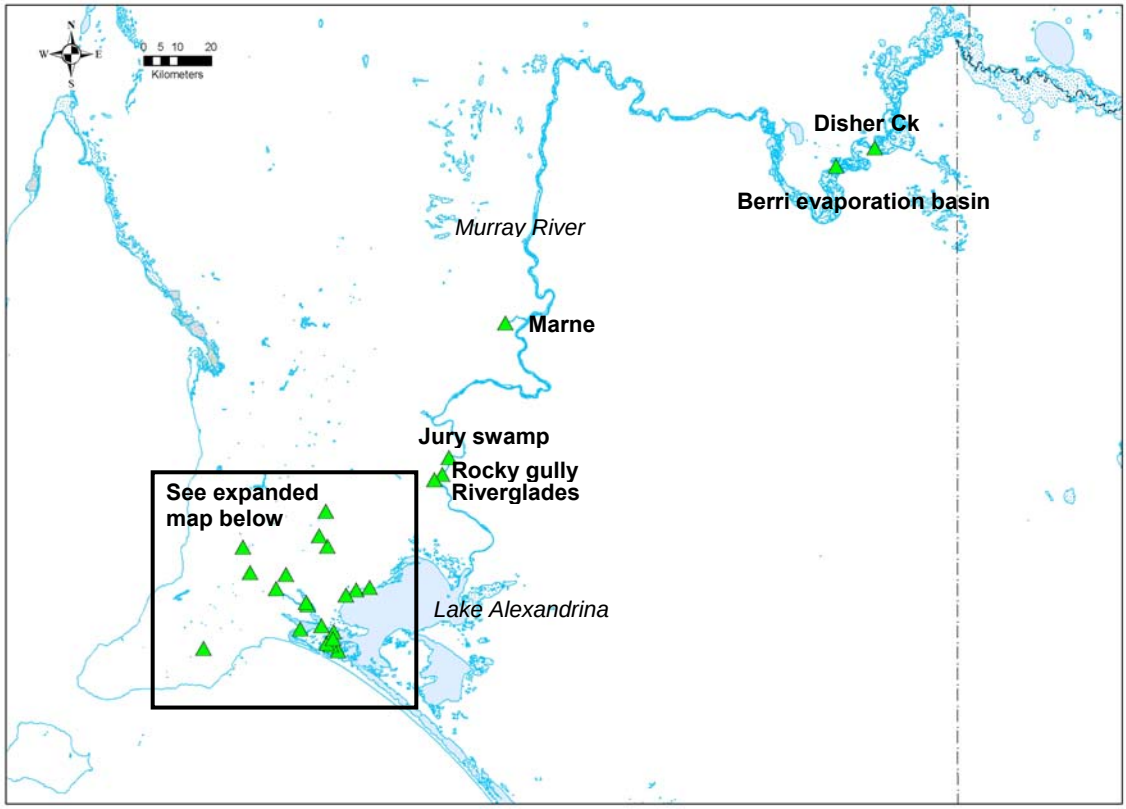


Figure 1a. Map of the SA MDB showing Drought Action Plan monitoring sites. The western Lower Lakes and Mount Lofty Ranges region is expanded below.

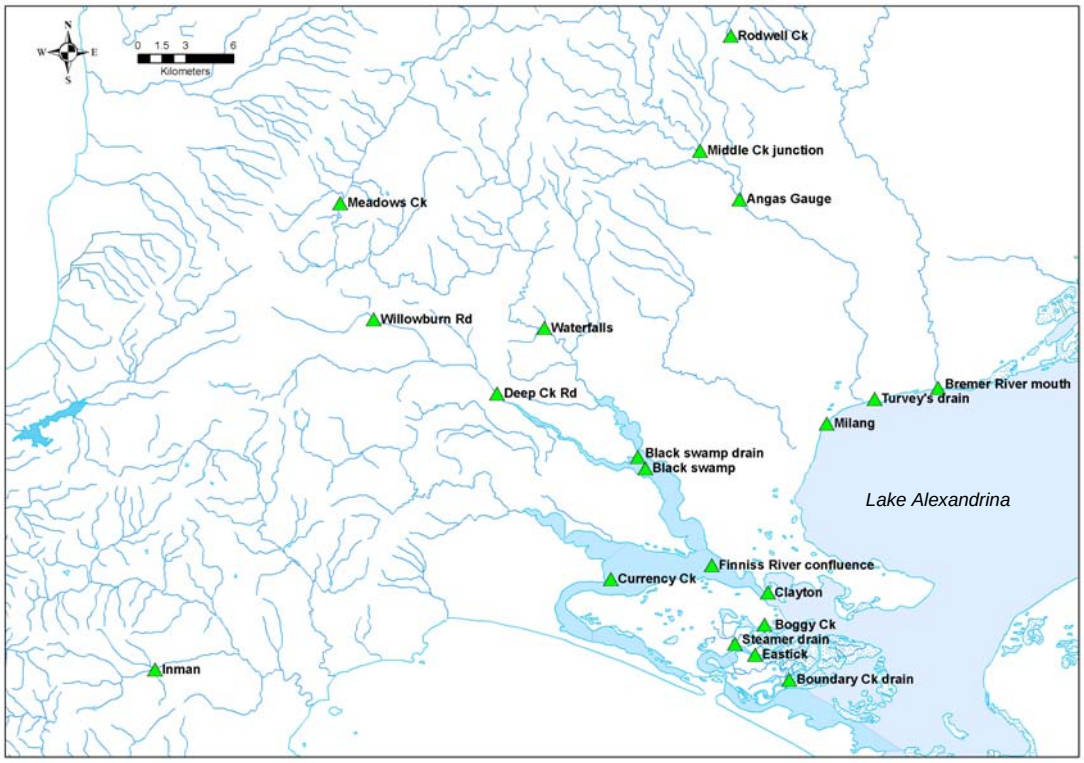


Figure 1b. Expanded map of sites in the western Lower Lakes and Mount Lofty Ranges region.

Table 2. Drought Action Plan sites, species originally present and seasons sampled.

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	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

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	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	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

3.2. Fish sampling

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

- Backpack electro-fishing
- Fyke netting (3 mm mesh, 3-6 m wing length)
- Seine netting (6 mm mesh, 4 m length)
- Box trapping (1 mm mesh, 400 x 240 x 240 mm size, 70 mm opening)

The specific gear types used is indicated in individual site summaries. At each site, where possible, sampling methods were kept consistent across seasons.

3.3. Site assessments

Site assessments were carried out in winter and summer, and also during sampling trips in spring and autumn. This primarily involved taking photo points and describing the characteristics of each site using the following parameters,

- water physico-chemistry
    - Conductivity ($\mu S.cm^{-1}$)
    - pH
    - Dissolved oxygen concentration (ppm)
    - Temperature (°C)
    - Turbidity (Secchi depth, m)
    - All measurement except secchi depth taken with a TPS 90-FLT water quality meter.
- Physical habitat
    - Percentage (%) cover of submerged and emergent aquatic vegetation and physical cover (e.g. woody debris). Determined by visual estimation.
- Water depth and level
    - Max water depth (m) was measured at each site
    - Depth stakes were placed at each site to monitor changes in water level. Depth was also measured at these stakes.

    - Where possible a dumpy level was taken as a back up technique to assess water level changes

All of the mentioned habitat parameters are presented in tabulated format in the following site sub-sections.

4. RESULTS

4.1. Jury Swamp (DAP site 1.1.1 River Murray)

Winter 2008


Spring 2008


Summer 2009


Autumn 2009


Figure 2. Photopoints of Jury swamp from winter 2008, spring 2008, summer 2009 and autumn 2009.

Sampling effort

Spring 2008

- 10 baited box traps set overnight within Jury Swamp.
- 10 baited box traps and 3 fyke nets 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 and fyke nets could not be set in the River Murray

Environmental conditions

Table 3. Water quality parameters measured at Jury Swamp during each site visit.

Water Quality	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

Table 4. Habitat variables measured at Jury Swamp during each site visit.

Physical habitat (%cover)	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 5. 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	0.005	-
Difference in elevation (winter 2008 – autumn 2009, m)	-	-0.20	-0.47	-0.11	-0.78

Catch summary and length-frequency analysis

A single purple-spotted gudgeon (Figure 3) was captured during each sampling occasion (Table 6). Both individuals were captured in the River Murray, among willow roots near the mouth of Jury swamp. Both individuals were adult fish and as such, no recent recruitment has been witnessed in this population (Figure 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 different 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	

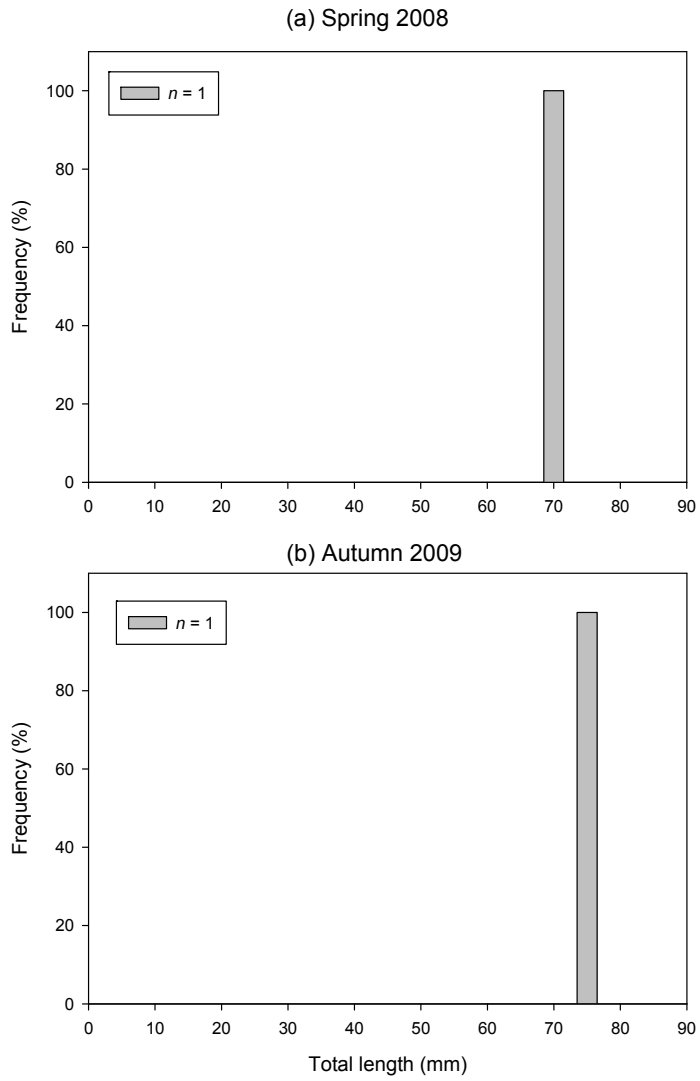


Figure 4a-b. Length-frequency distribution (mm) of southern purple-spotted gudgeon collected from Jury Swamp in (a) spring 2008 and (b) autumn 2009.

Site summary

Purple-spotted gudgeon are still present at this site, albeit in low abundance. Fish are confined to structurally complex habitat at the base of willows, outside of Jury Swamp, as preferred habitat in the swamp is now dry. As river levels continue to fall, the area of 'willow root' habitat will decrease.

4.2. Rodwell Creek (DAP site 2.1.1 Bremer R)

Winter 2008

Spring 2008

Summer 2009

Autumn 2009

Figure 5. Photopoints of Rodwell Creek from winter 2008, spring 2008, summer 2009 and autumn 2009.

Sampling effort

Spring 2008 & Autumn 2009

- 10 baited box traps set for 1.5 hours on dusk.

Environmental conditions

Table 7. Water quality parameters measured at Rodwell Creek during each site visit.

Water Quality	Temp (ºC)	pH	Conductivity (µS.cm^{-1})	DO (ppm)	Secchi (m)	Max depth (m)	Time
Winter 2008	7.6	7.4	3900	5.0	0.8	-	1015
Spring 2008	17.2	7.4	6510	7.0	0.7	-	-
Summer 2009	16.6	7.7	5230	4.0	1.0	1.5	1000
Autumn 2009	14.8	7.6	4280	6.6	0.2	0.8	-

Table 8. Habitat variables measured at Rodwell Creek during each site visit.

Physical habitat (% cover)	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 9. 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)	0.39	0.8*	1.19	0.55	-
Difference in elevation (winter 2008 – autumn 2009, m)	-	-0.47	+0.39	-0.72	-0.80

* A new reference stake was installed and therefore has no relevance to the original measurement in winter 2008

Catch summary and length-frequency analysis

River blackfish were caught in greater numbers in autumn than in spring (Table 10; Figure 6). This slight increase in abundance was likely not due to recruitment or immigration of individuals from upstream or downstream as pools have been disconnected for the length of the project. Rather, greater numbers of fish were likely sampled due to more efficient sampling. Other species sampled and their abundances are also presented in Table 10.

Table 10. Total numbers of different 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.

No recent recruitment was detected at Rodwell Creek (Figure 7a-b). However, the population exhibited substantial growth; in spring fish ranged from 126-169 mm TL (total length; Figure 7a) and 161-226 mm TL in autumn (Figure 7b).

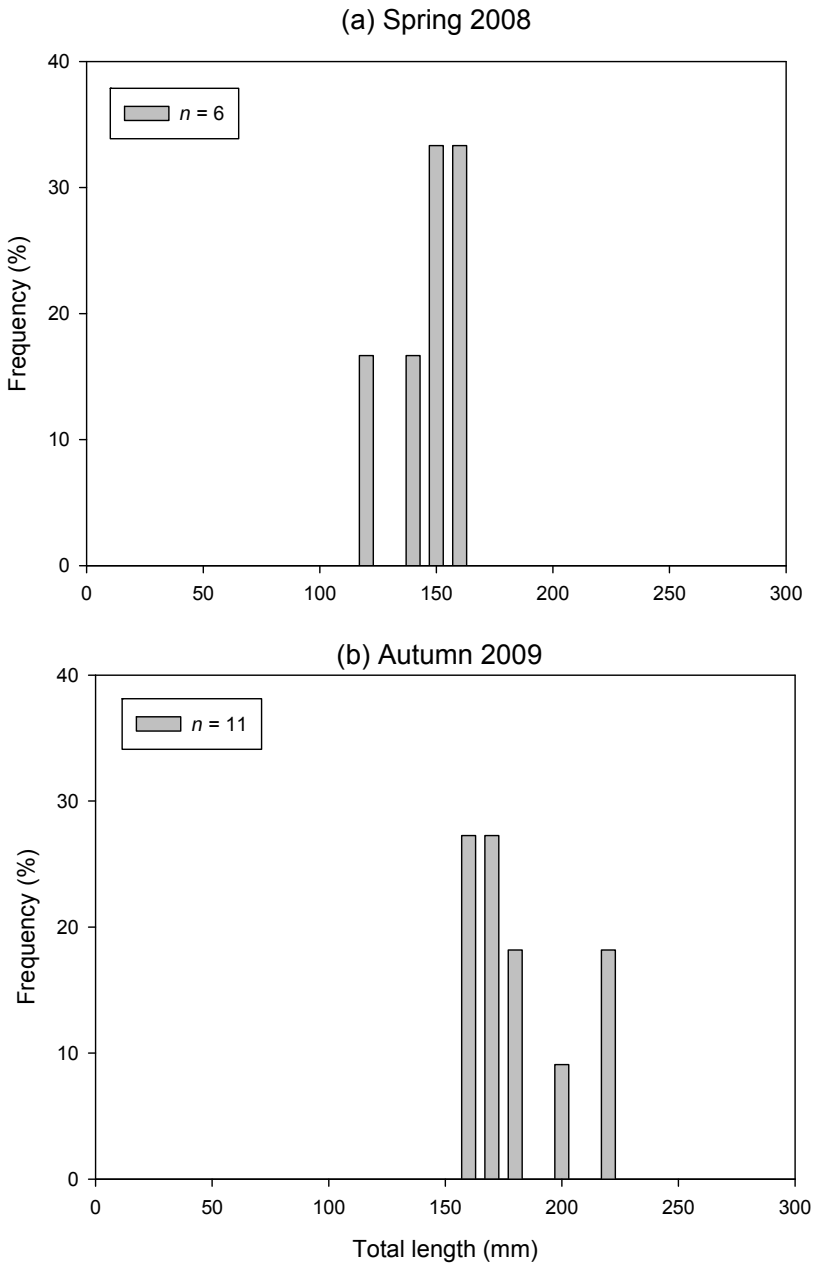


Figure 7a-b. Length-frequency distribution (mm) of river blackfish collected from Rodwell Creek in (a) spring 2008 and (b) autumn 2009.

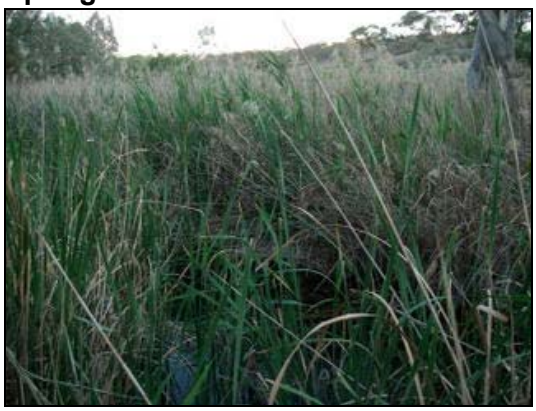
Site summary

River blackfish are persisting within the pool but recent recruitment has not been detected. Rodwell Creek continues to be filled when required and this management intervention appears to be facilitating the persistent of adult fish at this site. Low dissolved oxygen concentration (ppm) at the bottom of the pool remains a concern.

4.3. Marne (DAP Site 2.2.1 Marne R)

Winter 2008


Spring 2008




Summer 2009


Autumn 2009


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

Sampling effort

Spring 2008

- 10 baited box traps set for 1 hour at dusk.

Autumn 2009

- 6 baited box traps set for 1 hour at dusk

Environmental conditions

Table 11. Water quality parameters measured at the Marne River site during each site visit.

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

Table 12. Habitat variables measured at the Marne River site during each site visit.

Physical habitat (% cover)	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 13. 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	-
Difference in elevation (winter 2008 – autumn 2009, m)	-	-0.05	-0.09	+0.05	-0.09

Catch summary and length-frequency analysis

Similar numbers of river blackfish were captured and observed during both sampling occasions (Table 14). Other species sampled and their abundances are also presented in Table 14.

Table 14. Total numbers of different 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

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

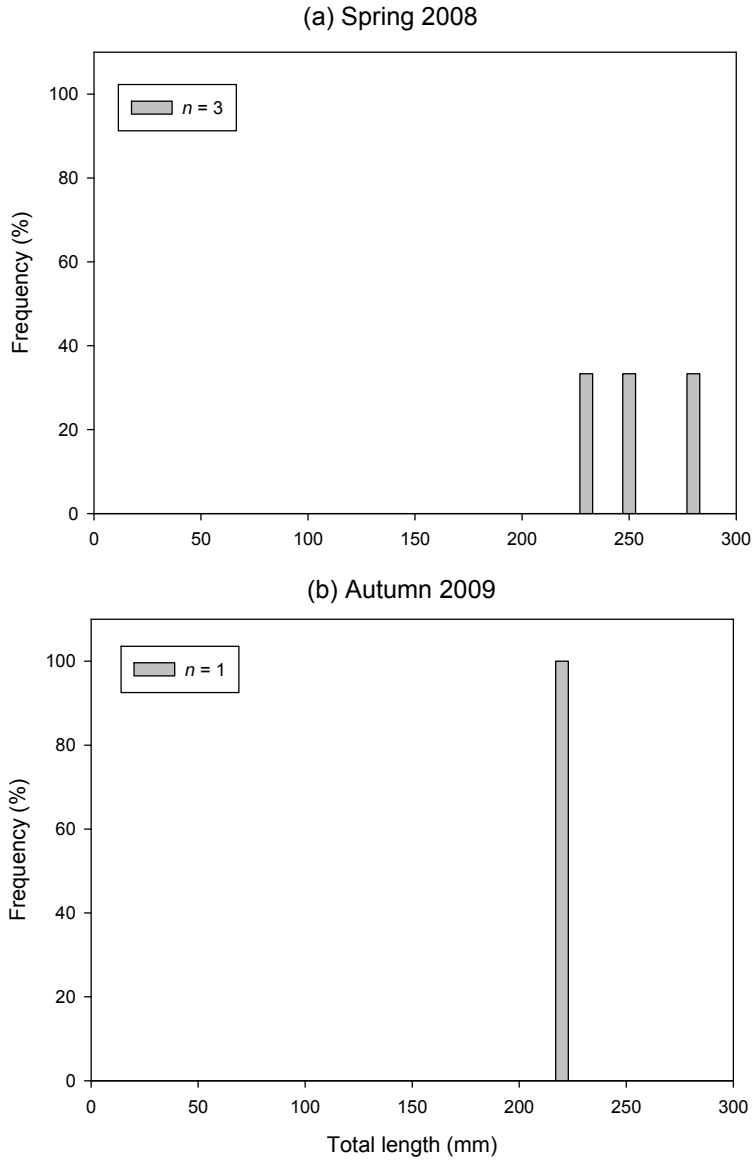


Figure 9a-b. Length-frequency distribution (mm) of river blackfish collected from the Marne River site in (a) spring 2008 and (b) autumn 2009.

Site summary

River blackfish are still present at this site but there has been no sign of recruitment for several years, representing a significant threat to the persistence of this population. An acidic plume has been observed several times at the bottom of the pool and fish appear to be avoiding this area.

4.4. Angas Gauge Site (DAP site 2.3.1 Angas R)

Winter 2008

Spring 2008

Summer 2009

Autumn 2009

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

Sampling effort

Spring 2008 & Autumn 2009

- 3 fyke nets set overnight

Environmental conditions

Table 15. Water quality parameters measured at the Angas River gauge site during each site visit.

Water Quality	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	> water depth	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

Table 16. Habitat variables measured at the Angas River gauge site during each site visit.

Physical habitat (% cover)	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	5 (Algae)	10 (Typha)	20	65

Table 17. 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	-	-
Difference in elevation (winter 2008 – autumn 2009, m)	-	-0.18	0	+0.05	-0.13

Catch summary and length-frequency analysis

River blackfish were caught in considerable numbers in both seasons but were most abundant in autumn (Table 18). Other species sampled and their abundances are also presented in Table 18.

Table 18. Total numbers of different 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

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). Recruitment is likely to have occurred in the last two years with fish *c.* 100-150 mm TL likely to be newly recruited individuals.

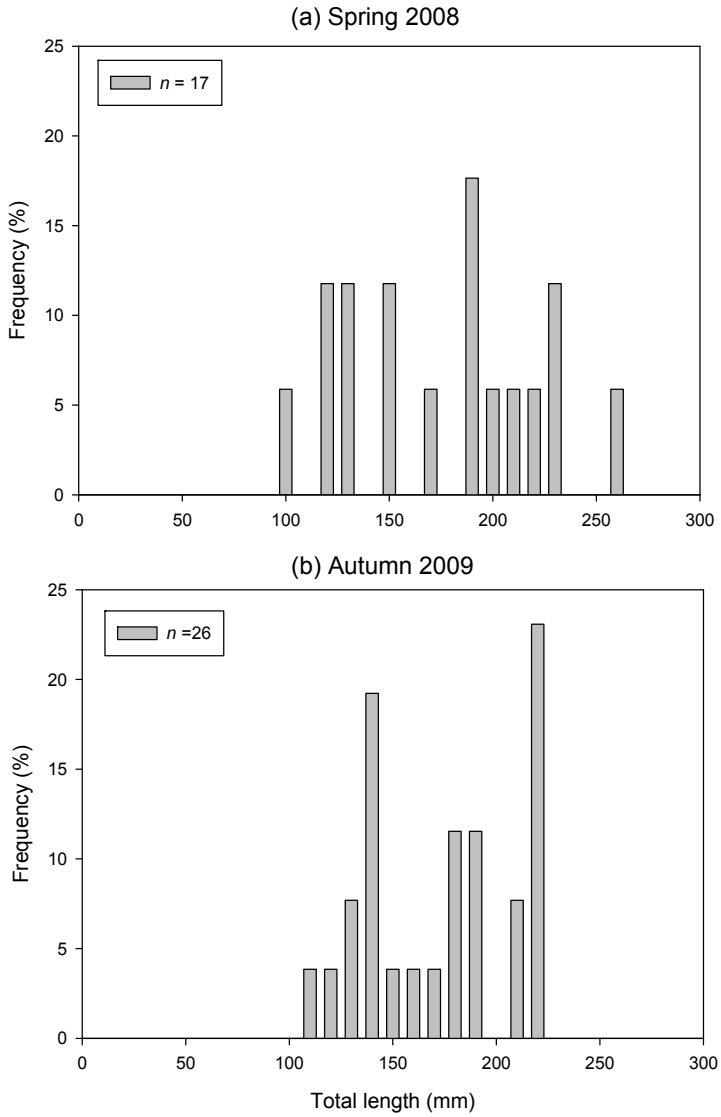


Figure 11a-b. Length-frequency distribution (mm) of river blackfish collected from the Angas River gauge site in (a) spring 2008 and (b) autumn 2009.

Site summary

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

4.5. Willowburn Road Nangkita (DAP site 2.4.1 & 3.4.1 Tookayerta)

Winter 2008

Spring 2008

Summer 2009

Autumn 2009

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

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)

Environmental conditions

Table 19. Water quality parameters measured at the Willowburn Rd Nangkita site during each site visit.

Water Quality	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

Table 20. Habitat variables measured at the Willowburn Rd Nangkita site during each site visit.

Physical habitat (% cover)	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	0	5 (Juncus, challitriche)	30 (Snags)	65
Spring 2008	0	40 (Challitriche)	30 (Snags)	30
Summer 2008	20 (Azola)	20 (Challitriche)	20 (Snags)	40

Table 21. Water depth at reference stake at the Willowburn Rd 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	-
Difference in elevation (winter 2008 – autumn 2009, m)	-	-0.2	0	-0.05	-0.25

Catch summary and length-frequency analysis

River blackfish numbers were consistent between spring and autumn, whilst southern pygmy perch exhibited increased abundance (Table 22). Mountain galaxias was the only other species sampled at this site (Table 22).

Table 22. Total numbers of different 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 were young-of-year (0+, 62-82 mm TL; Figure 13a). The growth of this cohort was evident in autumn with these fish now *c.* 80-100 mm TL (Figure 13b). There was also one individual from a more recent spawning event (43 mm TL) and several larger, adult fish (>150 mm TL; Figure 13b).

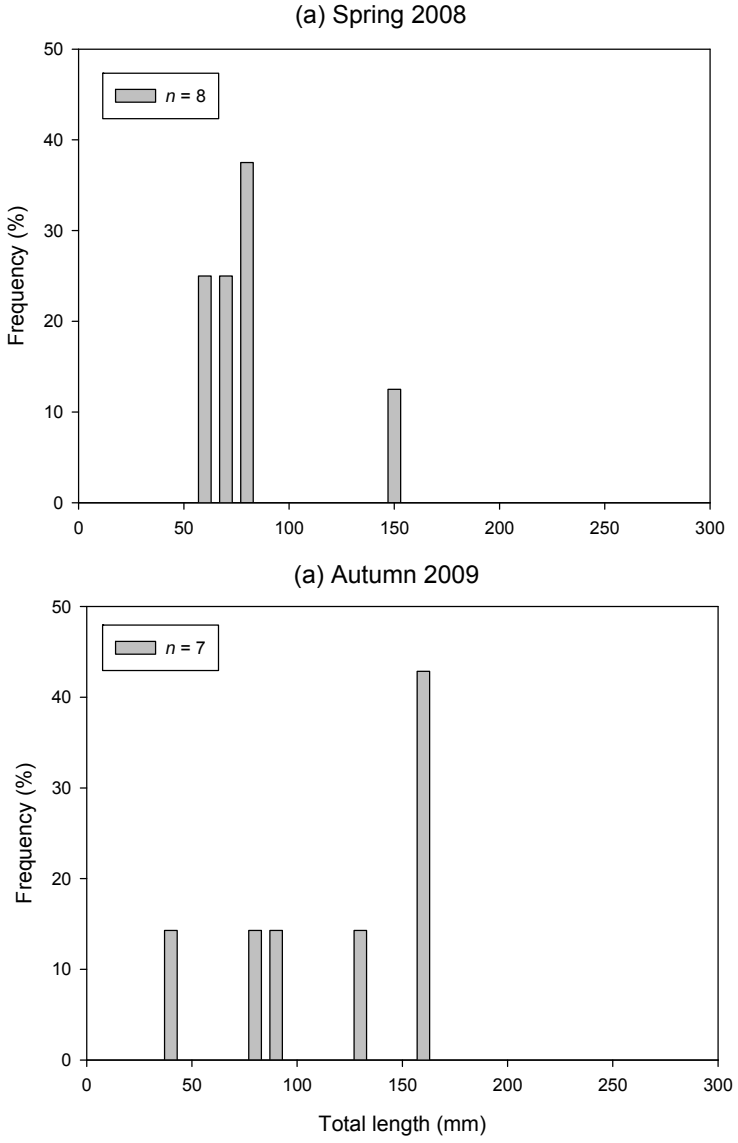


Figure 13a-b. Length-frequency distribution (mm) of river blackfish collected from the Willowburn Rd Nangkita site in (a) spring 2008 and (b) autumn 2009.

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

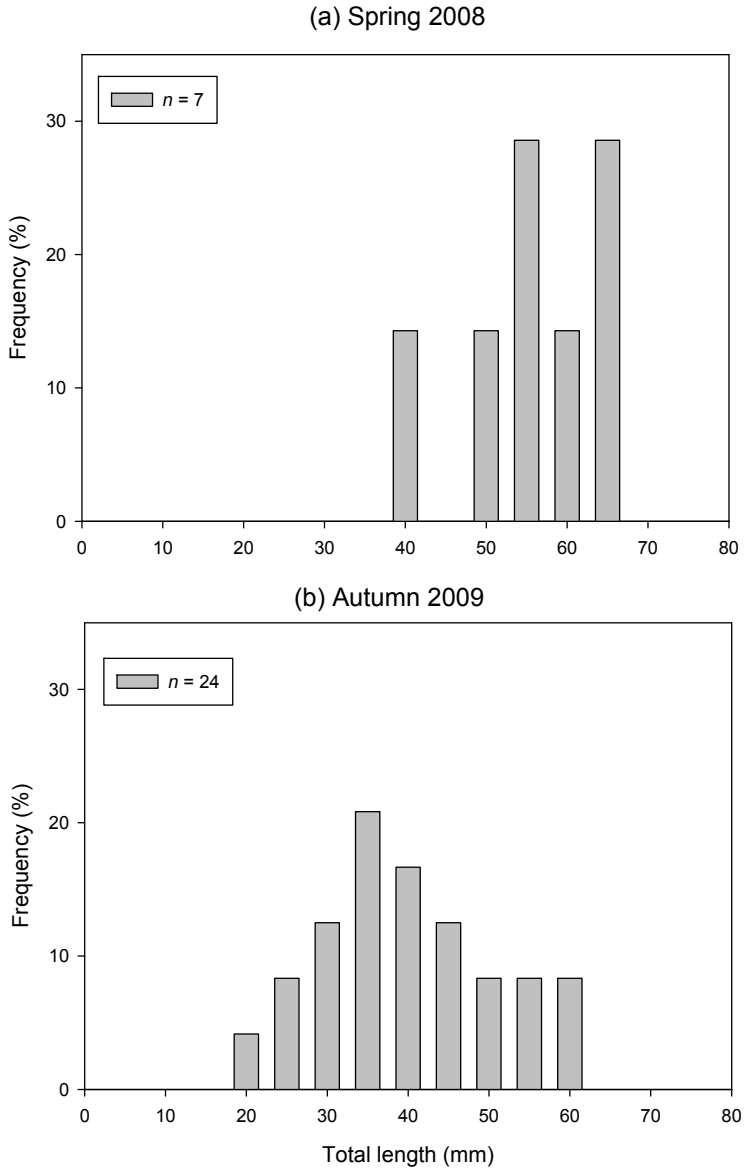


Figure 14a-b. Length-frequency distribution (mm) of southern pygmy perch collected from the Willowburn Rd Nangkita site in (a) spring 2008 and (b) autumn 2009.

Site summary

Both the river blackfish and southern pygmy perch populations appear stable with both species present in considerable numbers and exhibiting recent recruitment. Nevertheless, low flows have resulted in siltation at this site and a corresponding decrease in depth. However, high winter flows may scour this sediment and return the site to the same condition as spring 2008.

4.6. Deep Creek Road, Tookayerta (DAP site 2.4.1, 3.4.1)

Winter 2008

Spring 2008

Summer 2009

Autumn 2009

Figure 15. Photopoints of the Deep Creek Rd Tookayerta site from winter 2008, spring 2008, summer 2009 and autumn 2009.

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)

Environmental conditions

Table 23. Water quality parameters measured at the Deep Creek Rd Tookayerta site during each site visit.

Water Quality	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

Table 24. Habitat variables measured at the Deep Creek Rd Tookayerta site during each site visit.

Physical habitat (% cover)	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 25. Water depth at reference stake at the Deep Creek Rd Tookayerta 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	-
Difference in elevation (winter 2008 – autumn 2009, m)	-	-0.36	-0.24	+0.01	-0.59

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 different fish species collected from the Deep Creek Rd Tookayerta 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 represented recruits from the previous year. 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), signifying recent recruitment. One large adult (212 mm TL) was also present (Figure 16b).

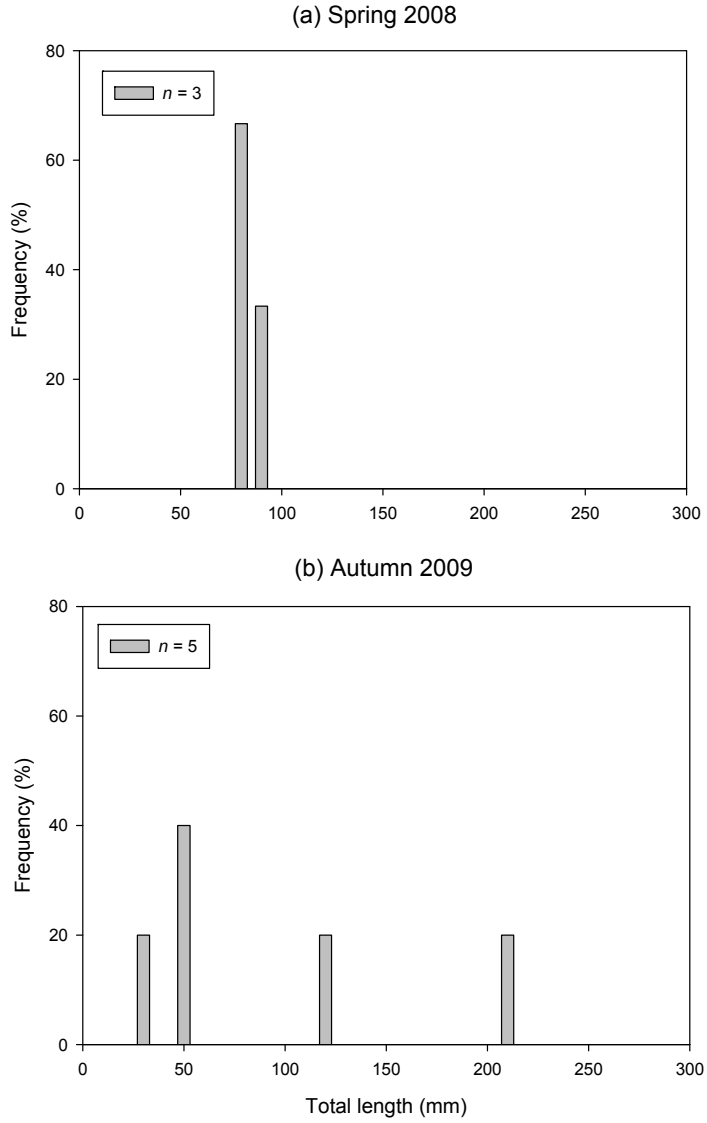


Figure 16a-b. Length-frequency distribution (mm) of river blackfish collected from the Deep Creek Rd Tookayerta site in (a) spring 2008 and (b) autumn 2009.

Figure 17. A YOY river blackfish sampled from the Deep Creek Rd Tookayerta site inautumn 2009.

In spring *c.* 40% of individuals were <35 mm TL and were likely a mixture of recruits from late in the previous spawning season and early in the current spawning season (based on previous unpublished data, M. Hammer; Figure 18a). In autumn, a cohort of similar length is present as well as a new cohort of smaller (<20 mm TL), more recently recruited individuals (Figure 18b). Large adult fish (>60 mm TL) are also present (Figure 18b & Figure 19)

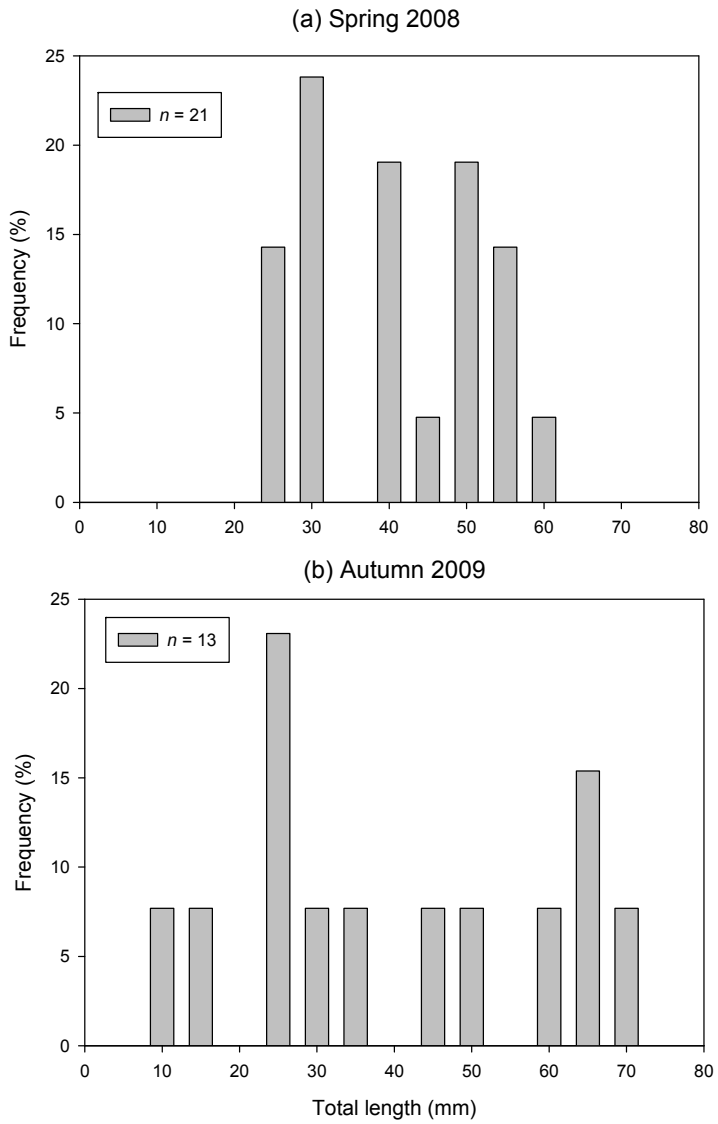


Figure 18a-b. Length-frequency distribution (mm) of southern pygmy perch collected from the Deep Creek Rd Tookayerta site in (a) spring 2008 and (b) autumn 2009.

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 stable with considerable numbers sampled and recent recruitment detected. Water level has dropped substantially but may increase again through winter.

4.7. Middle Creek Junction, Angas River (DAP site 3.1.1, Angas R)

Winter 2008


Spring 2008


Summer 2009


Autumn 2009


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

Sampling effort

Spring 2008 & autumn 2009

- 1 fyke net set overnight

Environmental conditions

Table 27. Water quality parameters measured at the Middle Creek junction site during each site visit.

Water Quality	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

Table 28. Habitat variables measured at the Middle Creek junction site during each site visit.

Physical habitat (% cover)	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	0	80 (Phragmites, Typha)	0	20
Spring 2008	5 (Potamogetan)	80 (Phragmites, Typha)	0	15
Summer 2009	30 (Potamogetan)	50 (Phragmites, Typha)	0	20
Autumn 2009	30 (Potamogetan)	50 (Phragmites, Typha)	0	20

Table 29. 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 elevation (winter 2008 – autumn 2009, m)	-	-0.23	-0.58	-0.23	-1.04

Catch summary and length-frequency analysis

Southern pygmy perch were collected in considerable numbers from this site in both seasons but were more abundant in autumn (Table 30). Other species sampled and their abundances are also presented in Table 30.

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

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).

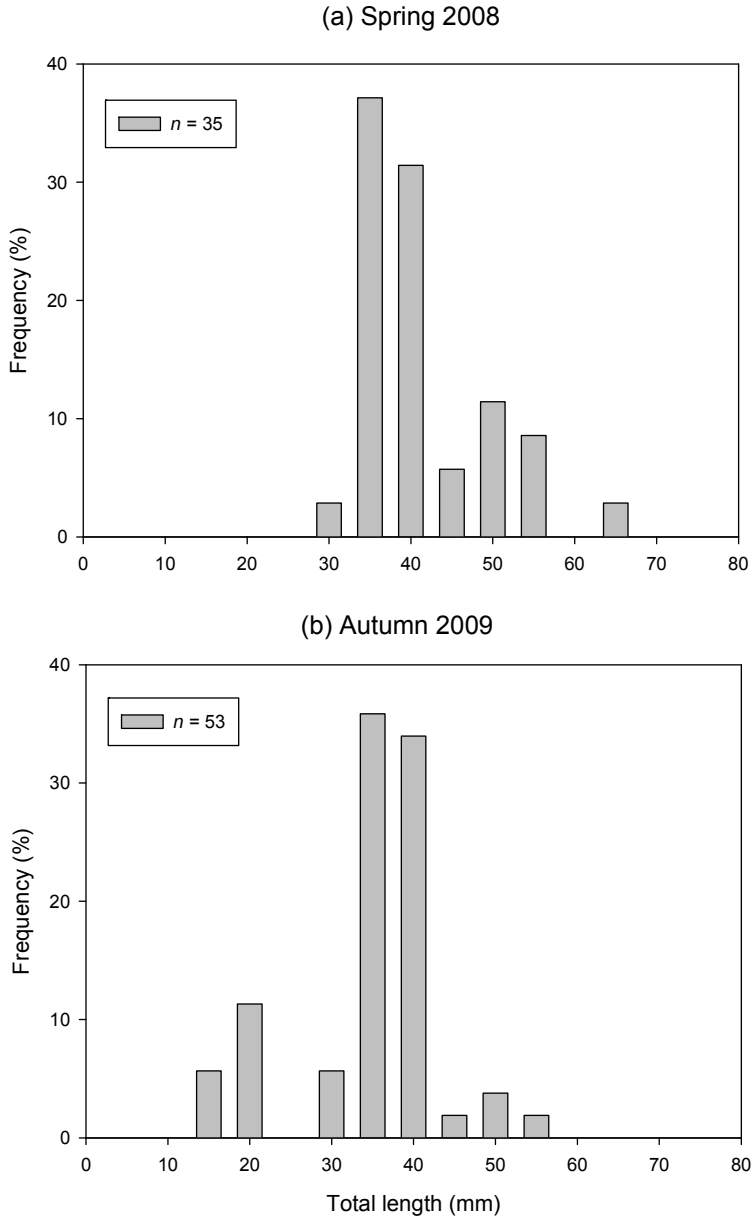


Figure 21a-b. Length-frequency distribution (mm) of southern pygmy perch collected from the Middle Creek junction site in (a) spring 2008 and (b) autumn 2009.

Site summary

Southern pygmy perch are persisting at this site in considerable numbers and have recently recruited. Nevertheless, water level at this site has fallen substantially with a corresponding decrease in water depth.

4.8. Boundary Creek Drain (Grundy's Property) (DAP site 3.2.1, 4.1.1, 5.1.1)

Winter 2008

Spring 2008

Summer 2009

NOT SAMPLED

Autumn 2009

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

Sampling effort

Spring 2008 & autumn 2009

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

Environmental conditions

Table 31. Water quality parameters measured at the Boundary Creek drain site during each site visit.

Water Quality	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	-

Table 32. Habitat variables measured at the Boundary Creek drain site during each site visit.

Physical habitat (% cover)	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Spring 2008	0	0	0	100
Autumn 2009	30	0	25	45

Catch summary and length-frequency analysis

No southern pygmy perch were collected from this site and there has been a drastic decline in the abundance of Murray hardyhead at this site between spring and autumn (Table 33). All other native species also declined between spring and autumn, whilst the exotic gambusia increased in abundance (Table 33).

Table 33. Total numbers of different 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

In spring, fish ranged from 38-66 mm TL (Figure 23a). In autumn only one individual was sampled (29 mm TL) but this individual was likely a new recruit (0+; Figure 23b).

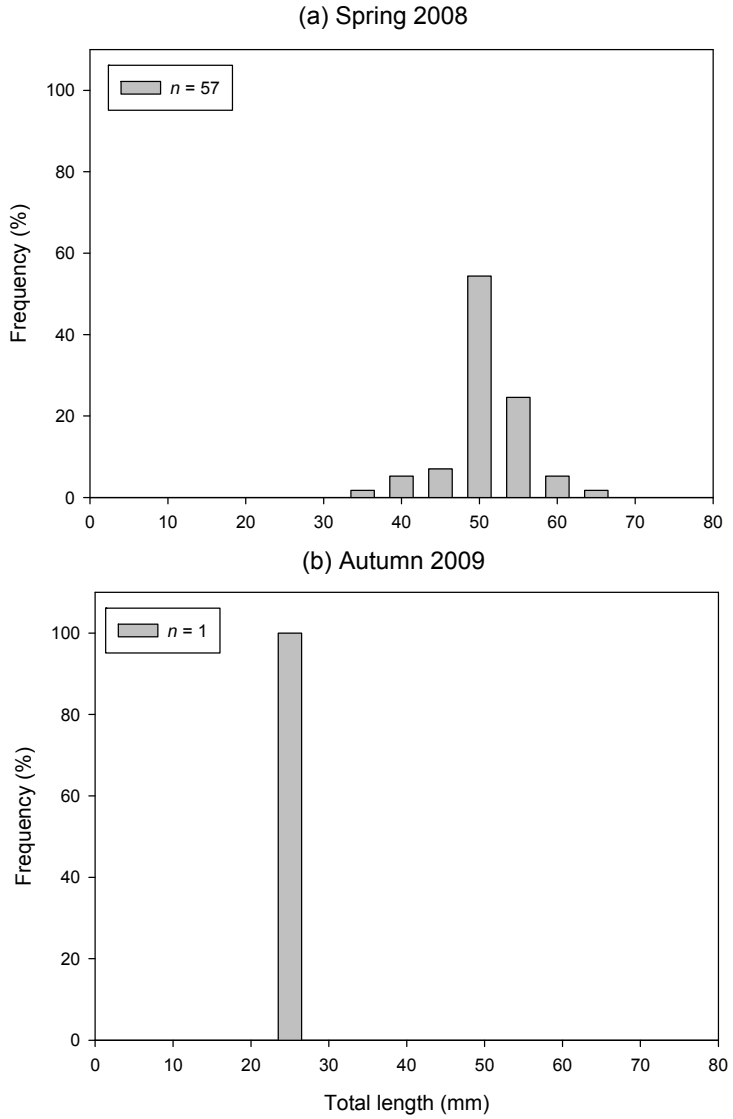


Figure 23a-b. Length-frequency distribution (mm) of southern pygmy perch collected from the Middle Creek junction site in (a) spring 2008 and (b) autumn 2009.

Site summary

Murray hardyhead are still present at this site but have undergone a severe decrease in abundance. However, a different site on Mundoo Island, sampled by Adelaide University (Scotte Wedderburn and Tom Barnes) yielded substantial numbers of Murray hardyhead (*n* = 273), with recent recruitment evident. Therefore it may be beneficial to either incorporate this site in the DAP or replace the Boundary Creek site. Similarly, southern pygmy perch were collected (*n* = 22) from another stock channel on Mundoo Island.

4.9. Eastick, Hindmarsh Island (DAP site 3.2.1, 4.1.1, 5.1.1)

Winter 2008

Spring 2008

Summer 2009
NOT SAMPLED
Autumn 2009
NOT SAMPLED

Figure 24. Photopoints of the Eastick Creek site from winter 2008 and spring 2008.

Sampling effort

Spring 2008

- 4 fyke nets set overnight

Autumn 2009

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

Environmental conditions

Table 34. Water quality parameters measured at the Eastick Creek site during each site visit.

Water Quality	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

Table 35. Habitat variables measured at the Eastick Creek site during each site visit.

Physical habitat (% cover)	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	0	2	5	93
Spring 2008	1	1	5	94

Table 36. Water depth at reference stake at the Eastick 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)	0.54	0.43	-
Difference in elevation (winter 2008 – spring 2008, m)	-	-0.09	-0.09

Catch summary

No threatened species were collected from this site in spring and it was not sampled in autumn. Other species sampled at this site and their abundances are presented in Table 37.

Table 37. Total numbers of different fish species collected from the Eastick Creek site in spring 2008 and autumn 2009.

Species		Sampling trip	
Common name	**Scientific name**	**Spring 2008**	**Autumn 2009**
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 have not been collected for approximately three years and have probably been lost from this site.

4.10. Steamer Drain, Hindmarsh Island (DAP site 3.2.1, 4.1.1, 5.1.1)

Winter 2008

Spring 2008

Summer 2009
NOT SAMPLED
Autumn 2009
NOT SAMPLED

Figure 25. Photopoints of Steamer drain from winter 2008 and spring 2008.

Sampling effort

Spring 2008 & autumn 2009

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

Site summary

All fish have been lost from this site.

4.11. Black Swamp (DAP site 3.2.2 Black Swamp, 4.1.3 Lower Finniss)

Winter 2008

Spring 2008
NOT SAMPLED
Summer 2009
NOT SAMPLED
Autumn 2009
NOT SAMPLED

Figure 26. Photopoints of Black Swamp from winter 2008.

Sampling effort

Spring 2008 & autumn 2009

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

Site summary

Black Swamp is now dry and inaccessible. Yarra pygmy perch were last collected in 2007 and the species has likely been lost from this site.

4.12. Black Swamp Drain (DAP site 3.2.2 Black Swamp)

Winter 2008

Spring 2008

Summer 2009
NOT SAMPLED
Autumn 2009
NOT SAMPLED

Figure 27. Photopoints of the Black Swamp drain site from winter 2008 and spring 2008.

Sampling effort

Spring 2008

- 4 fyke nets set overnight

Autumn 2009

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

Environmental conditions

Table 38. Water quality parameters measured at the Black Swamp drain site during each site visit.

Water Quality	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	-	-

Table 39. Habitat variables measured at the Black Swamp drain site during each site visit.

Physical habitat (% cover)	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	5 (Myriophyllum)	50 (Phragmites, Typha, Baumea, Garina)	5	40
Spring 2008	5 (Myriophyllum)	25 (Phragmites, Typha, Baumea, Garina)	5	65

Table 40. 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 elevation (winter 2008 – spring 2008, m)	-	-0.08	-0.08

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 different fish species collected from the Black Swamp drain site in spring 2008 and autumn 2009.

Species		Sampling trip	
Common name	**Scientific name**	**Spring 2008**	**Autumn 2009**
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 further. The species has likely been lost from this site.

4.13. Turvey's Drain, Milang (DAP site 3.2.3, 5.1.3a)

Winter 2008

Spring 2008

Summer 2009

Autumn 2009

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

Sampling effort

Spring 2008 & autumn 2009

- 4 fyke nets set overnight

Environmental conditions

Table 42. Water quality parameters measured at Turvey's drain during each site visit.

Water Quality	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	>water depth	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

Table 43. Habitat variables measured at Turvey's drain during each site visit.

Physical habitat (% cover)	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 44. 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	-
Difference in water level (winter 2008 – autumn 2009, m)	-	-0.15	+0.40	-0.05	+0.2

Catch summary and length-frequency analysis

Considerable numbers of southern pygmy perch were collected from Turvey's drain in spring but exhibited a substantial decline in abundance in autumn (Table 45; Figure 29a). Murray hardyhead were collected in similar numbers in both seasons (Table 45; Figure 29b). Other species sampled at this site and their abundances are also presented in Table 45.

Table 45. Total numbers of different 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 none of this adult cohort remained (>50 mm TL) and YOY fish from spring had grown to >40 mm TL (Figure 30b).

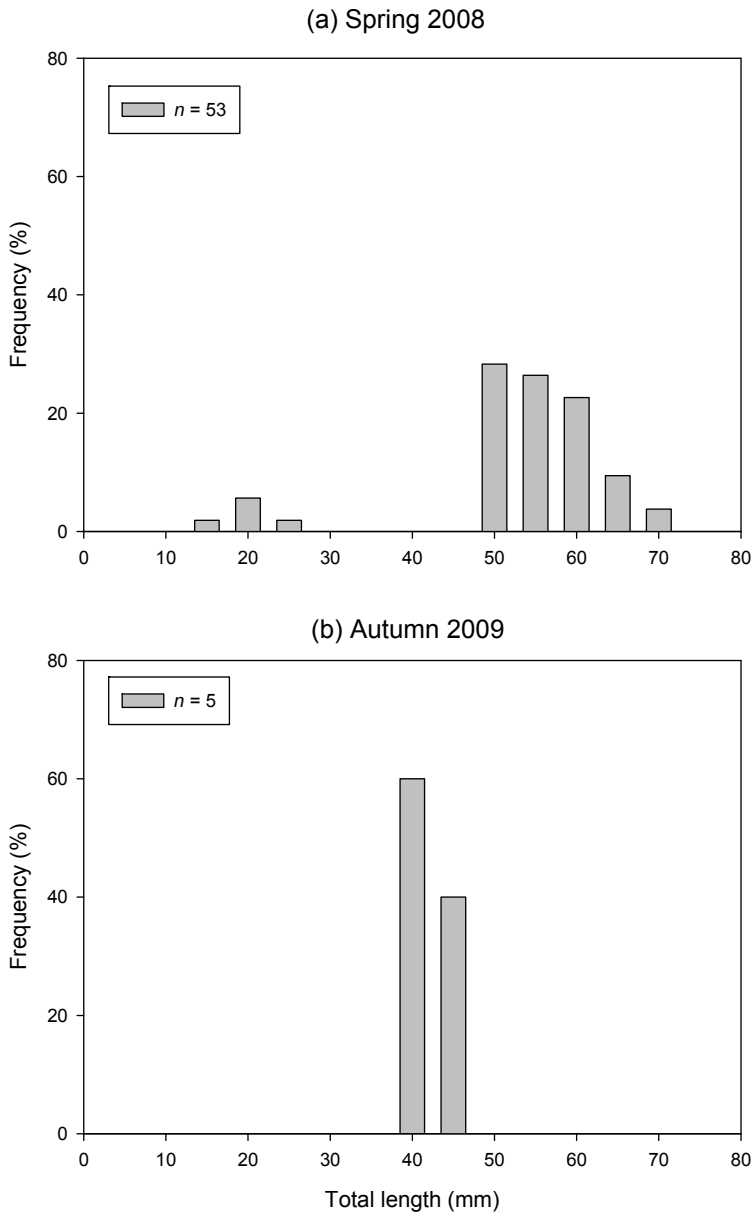


Figure 30a-b. Length-frequency distribution (mm) of southern pygmy perch collected from Turvey's drain in (a) spring 2008 and (b) autumn 2009.

In spring, all Murray hardyhead sampled were large adult fish (>50 mm TL; Figure 31a). In autumn, none of this adult cohort remained but rather all fish represented a YOY cohort (30-37 mm TL), signifying recent recruitment (Figure 31b).

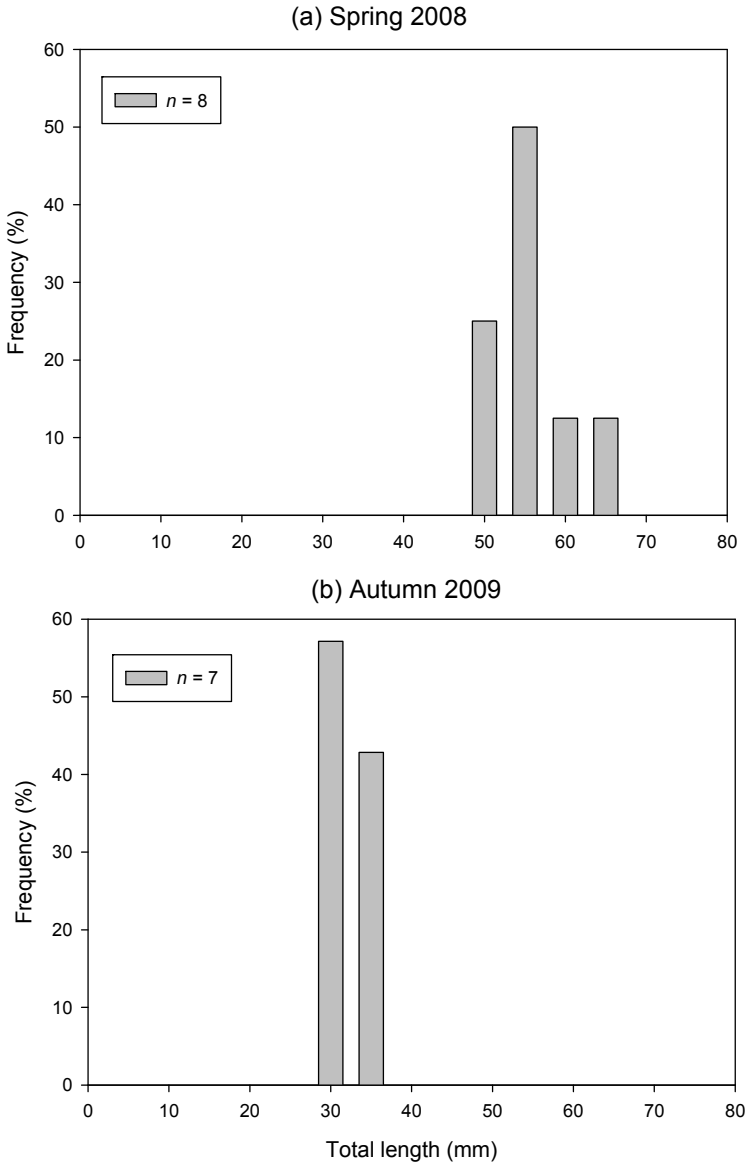


Figure 31a-b. Length-frequency distribution (mm) of Murray hardyhead collected from Turvey's drain in (a) spring 2008 and (b) autumn 2009.

Site summary

Both Southern pygmy perch and Murray hardyhead showed signs of recruitment but are present in low abundances. A water allocation has been procured to maintain water levels at this site. Conductivity has steadily risen at this site and given the allocated water is to be sourced from Lake Alexandrina, it is likely to continue rising. This could become a threat for the pygmy perch population.

4.14. Meadows Creek (DAP site 3.3.1)

Winter 2008


Spring 2008


Summer 2009


Autumn 2009


Figure 32. Photopoints of Meadows from winter 2008, spring 2008, summer 2009 and autumn 2009.

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)

Environmental conditions

Table 46. Water quality parameters measured at Meadows during each site visit.

Water Quality	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

Table 47. Habitat variables measured at Meadows during each site visit.

Physical habitat (% cover)	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 48. Water depth at reference stake at Meadows 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

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). Other species sampled at this site and their abundances are also presented in Table 49.

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

Table 49. Total numbers of different 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

Both individuals 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 fish recorded in spring are likely represented by cohorts >60 mm TL in autumn (Figure 34a-b). The presence of fish between 45-50 mm TL in autumn likely indicates that fish <50 mm TL were present in spring but were not sampled (Figure 34a-b).

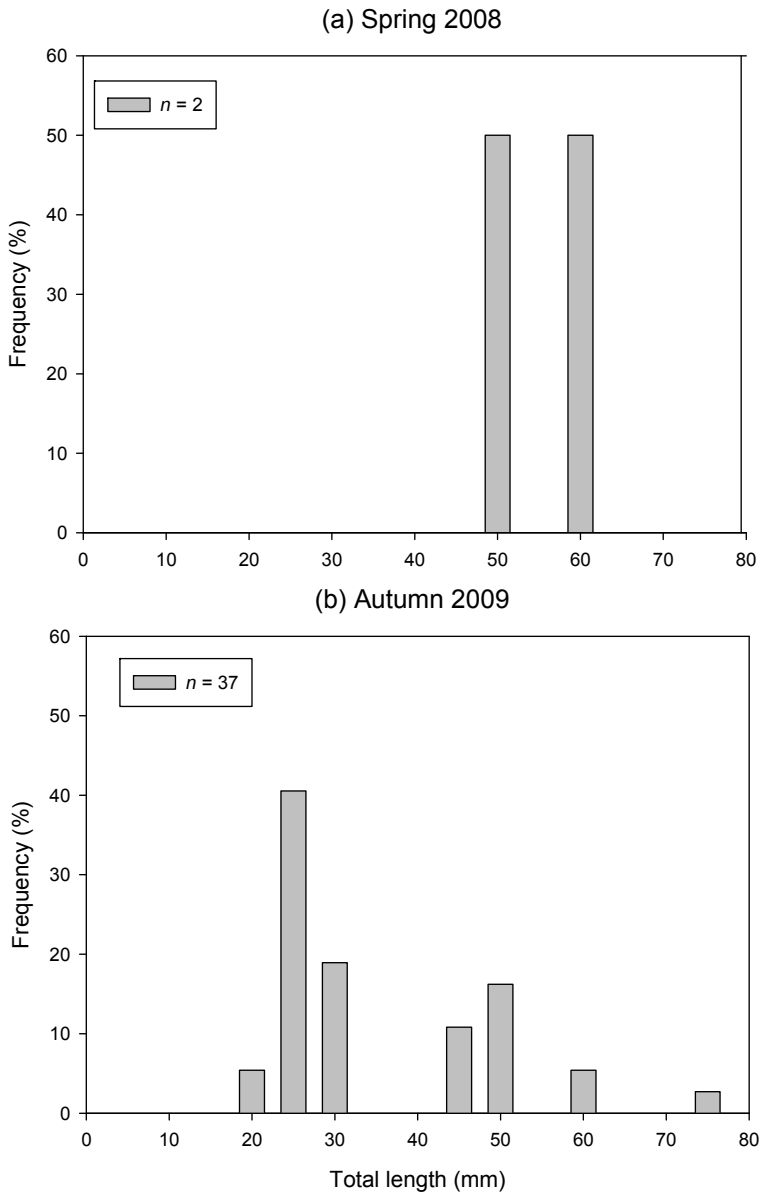


Figure 34a-b. Length-frequency distribution (mm) of southern pygmy perch collected from Meadows in (a) spring 2008 and (b) autumn 2009.

Site summary

Southern pygmy perch are persisting in considerable numbers and had successful recent recruitment. Nevertheless, decreasing water levels and water depths are a concern at this site with many fish sampled from very small pools.

4.15. Waterfalls (Finniss River) (DAP site 3.3.3 Waterfalls)

Winter 2008


Spring 2008


Summer 2009


Autumn 2009


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

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)

Environmental conditions

Table 50. Water quality parameters measured at the Waterfalls site during each site visit.

Water Quality	Temp (ºC)	pH	Conductivity (µS.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

Table 51. Habitat variables measured at the Waterfalls site during each site visit.

Physical habitat (% cover)	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 52. 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	-
Difference in water level (winter 2008 – autumn 2009, m)	-	-0.43	-0.06	-	-0.05???

Catch summary and length-frequency analysis

Southern pygmy perch were captured in considerable numbers in spring but showed a drastic decline in autumn (Table 53). Other species sampled at this site and their abundances are also presented in Table 53.

Table 53. Total numbers of different 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	

Fish length 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 also a large adult fish (59 mm TL; Figure 36b & Figure 37) and thus no recruitment was detected between spring and autumn.

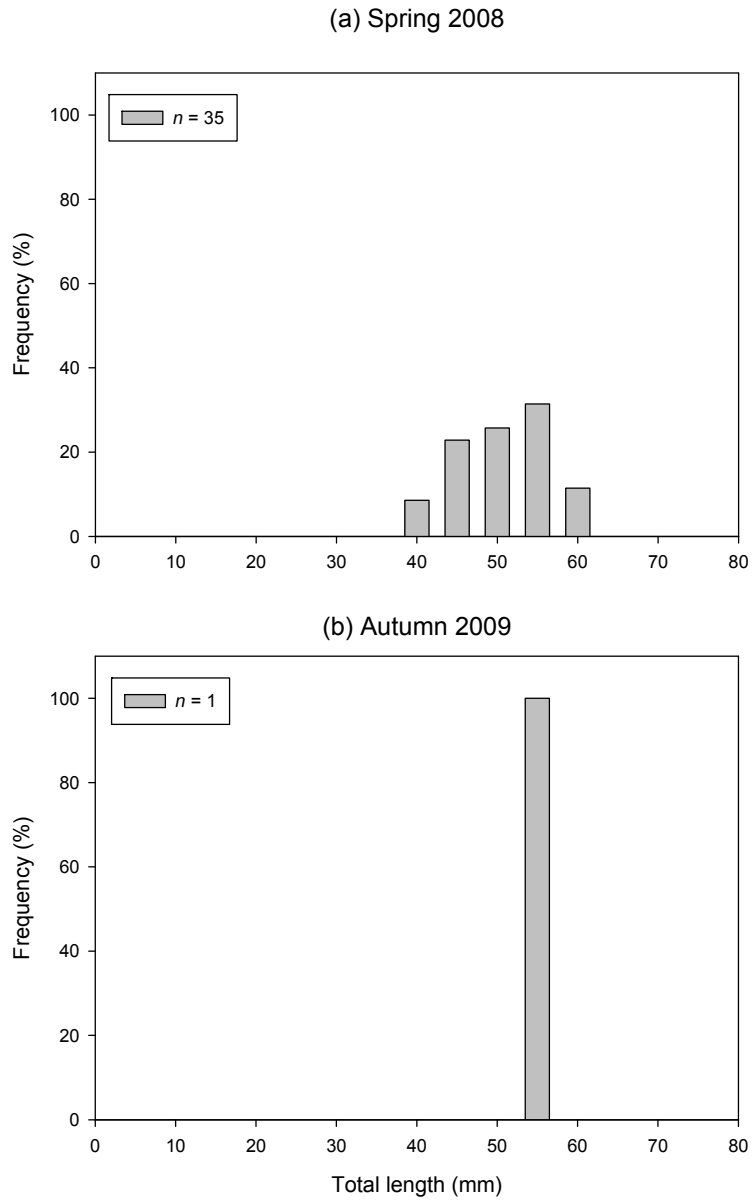


Figure 36a-b. Length-frequency distribution (mm) of southern pygmy perch collected from the Waterfalls site in (a) spring 2008 and (b) autumn 2009.

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

Site summary

Southern pygmy perch have dramatically decreased in abundance and no recruitment has been detected. Therefore this population is under serious threat. In February (between site visits), water level at this site dropped by >1 m in a week and water quality was severely diminished (dissolved oxygen concentration of 0.04 ppm). These poor conditions likely resulted in the decrease in abundance and recruitment failure. However, a number of fish were rescued from this site for captive maintenance.

4.16. Inman River (DAP site 3.5.1)

Winter 2008

Spring 2008

Summer 2009

Autumn 2009

Figure 38. Photopoints of the Inman River site from winter 2008, spring 2008, summer 2009 and autumn 2009.

Sampling effort

Spring 2008

- 5 baited box traps set for 1.5 hours

August 2009

- 10 baited box traps set for 1.5 hours

Environmental conditions

Table 54. Water quality parameters measured at the Inman River site during each site visit.

Water Quality	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	-

Table 55. Habitat variables measured at the Inman River site during each site visit.

Physical habitat (% cover)	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 56. 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

Catch summary and length-frequency analysis

Southern pygmy perch were sampled in considerable numbers in both seasons but were much more abundant in autumn (Table 57). Carp gudgeon was the only other species sampled at this site (Table 57).

Table 57. Total numbers of different 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

This population appears to have had some level of recent recruitment in spring with likely YOY individuals <25 mm TL and adult fish 34-41 mm TL (Figure 39a). The adult fish appear to have grown by autumn, whilst there is evidence of further recent recruitment with many fish <30 mm TL (Figure 39b).

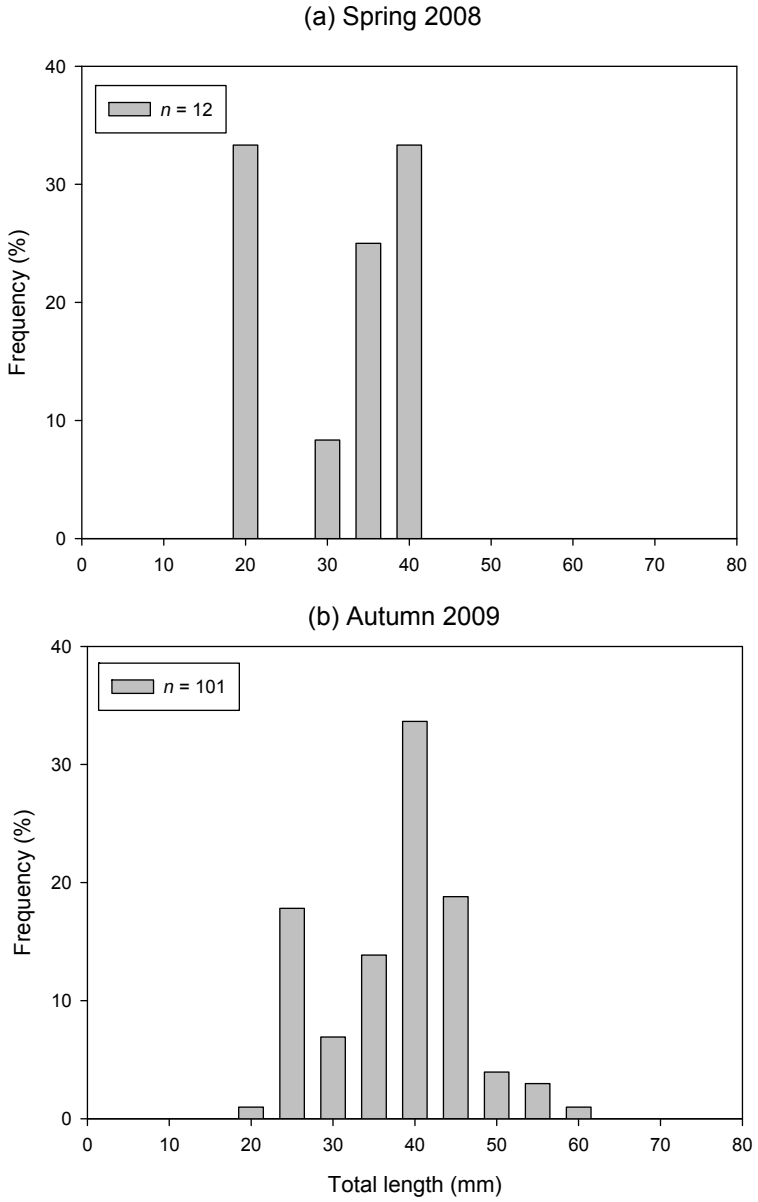


Figure 39a-b. Length-frequency distribution (mm) of southern pygmy perch collected from the Inman River site in (a) spring 2008 and (b) autumn 2009.

Site summary

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

4.17. Currency Creek (DAP site 4.1.2 Goolwa Channel)

Winter 2008

Spring 2008

Summer 2009

Autumn 2009
Not sampled

Figure 40. Photopoints of the Currency Creek site from winter 2008, spring 2008 and summer 2009.

Sampling effort

Spring 2008

- 4 fyke nets set overnight

Autumn 2009

- Not sampled due to diminished water level (dry)

Environmental conditions

Table 58. Water quality parameters measured at the Currency Creek site during each site visit.

Water Quality	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	-	-

Table 59. Habitat variables measured at the Currency Creek site during each site visit.

Physical habitat (% cover)	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 60. 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

Catch summary and length-frequency analysis

No Yarra pygmy perch were collected from this site, however, Murray hardyhead were collected (Table 61). Eleven other species were also collected from this site (Table 61).

Table 61. Total numbers of different 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

The population of Murray hardyhead detected at this site was solely comprised of large adult fish (48-69 mm TL; Figure 41). There was no evidence of recruitment.

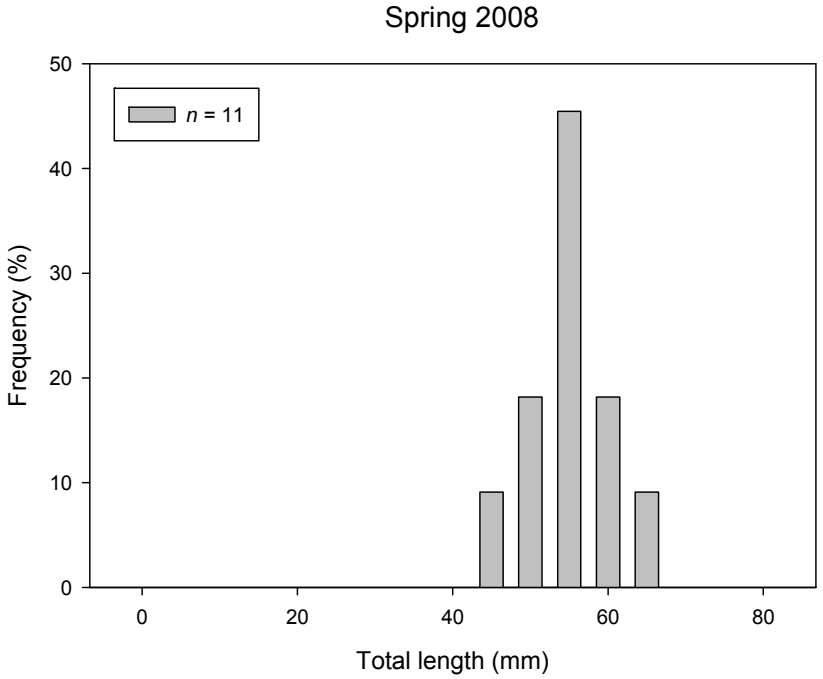


Figure 41. Length-frequency distribution (mm) of Murray hardyhead collected from the Currency Creek site in spring 2008.

Site summary

This site is now dry and threatened species have been lost.

4.18. Finniss River Confluence (DAP site 4.1.2 Goolwa Channel)

Winter 2008

Spring 2008

Summer 2009

Not sampled

Autumn 2009
Not sampled

Figure 42. Photopoints of the Finniss River confluence site from winter 2008, spring 2008 and summer 2009.

Sampling effort

Spring 2008

- 6 seine net hauls.

Autumn 2009

- Not sampled due to diminished water level (dry)

Environmental conditions

Table 62. Water quality parameters measured at the Finniss River confluence site during each site visit.

Water Quality	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	-	-	-

Table 63. Habitat variables measured at the Finniss River confluence site during each site visit.

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

Table 64. 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

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). No other threatened species were collected at this site. Other species sampled at this site and their abundances are also presented in Table 65.

Table 65. Total numbers of different 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

Both fish collected in spring were adults (>45 mm TL; Figure 43).

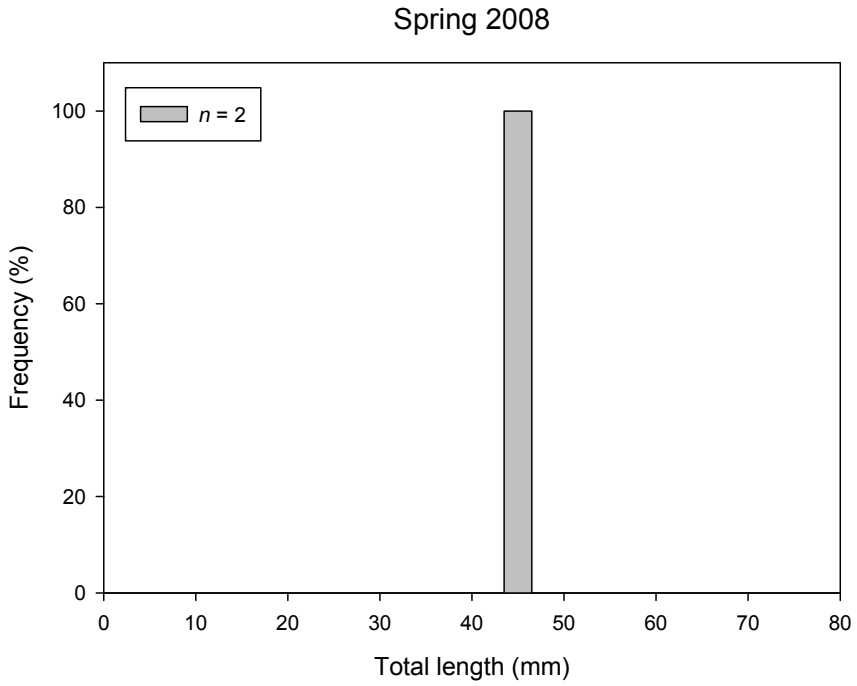


Figure 43. Length-frequency distribution (mm) of Murray hardyhead collected from the Finniss River confluence site in spring 2008.

Site summary

This site is now dry and threatened species have been lost.

4.19. Boggy Creek (DAP site 5.1.1d Hindmarsh Island)

Winter 2008

Spring 2008

Summer 2009
Not sampled
Autumn 2009

Not sampled

Figure 44. Photopoints of Boggy Creek from winter 2008, spring 2008 and summer 2009.

Sampling effort

Spring 2008

- 3 fyke nets set overnight.

Autumn 2009

- Not sampled due to diminished water level (dry)

Environmental conditions

Table 66. Water quality parameters measured at the Finniss River confluence site during each site visit.

Water Quality	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	-	-	-	-	-	-	-

Table 67. Habitat variables measured at the Finniss River confluence site during each site visit.

Physical habitat (% cover)	Submergent macrophytes	Emergent macrophytes	Physical	Open water
Winter 2008	35	50	-	15
Spring 2008	-	-	-	-

Catch summary and length-frequency analysis

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

Table 68. Total numbers of different 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

In spring Murray hardyhead ranged from 30-73 mm TL (Figure 45). Thus recruitment occurred in the previous summer but there is no evidence of recent recruitment.

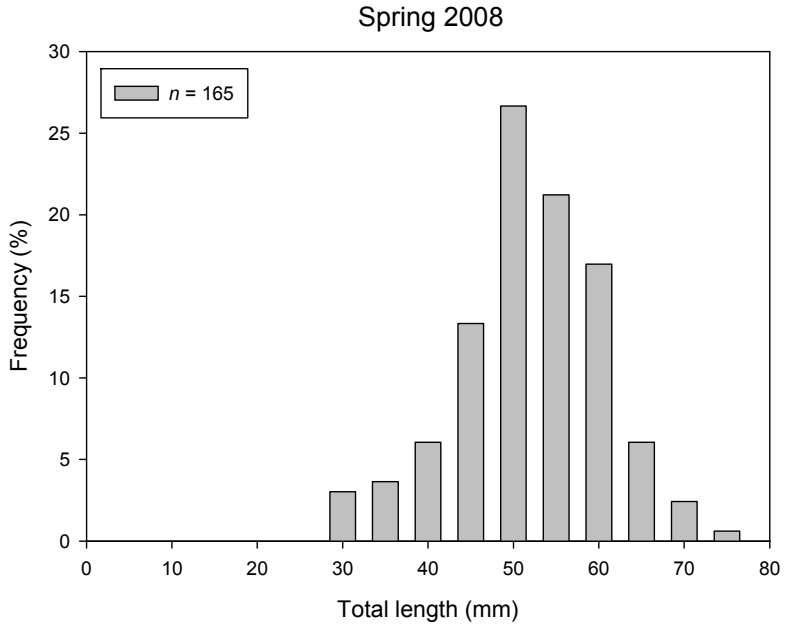


Figure 45. Length-frequency distribution (mm) of Murray hardyhead collected from Boggy Creek in spring 2008.

Site summary

Murray hardyhead were present in very significant numbers in spring but the site was dry in autumn and was not sampled. An allocation of water has now been procured for the site but the current up-to-date status of fish at this site is unknown.

4.20. Clayton (DAP site 5.1.2 Clayton/Dunns Lagoon)

Winter 2008

Spring 2008

Summer 2009

Autumn 2009

Figure 46. Photopoints of Clayton from winter 2008, spring 2008, summer 2009 and Autumn 2009.

Sampling effort

Spring 2008 & autumn 2009

- 6 seine net hauls.

Environmental conditions

Table 69. Water quality parameters measured at Clayton during each site visit.

Water Quality	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

Table 70. Habitat variables measured at Clayton during each site visit

Physical habitat (% cover)	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 71. 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

Catch summary and length-frequency analysis

Murray hardyhead were collected in low numbers in spring and had declined further by autumn (Table 72). Several non-threatened species were also sampled at this site (Table 72).

Table 72. Total numbers of different 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

All Murray hardyhead sampled in spring were adults with length ranging from 36-54 mm TL (Figure 47a). Most individuals were likely 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 47b).

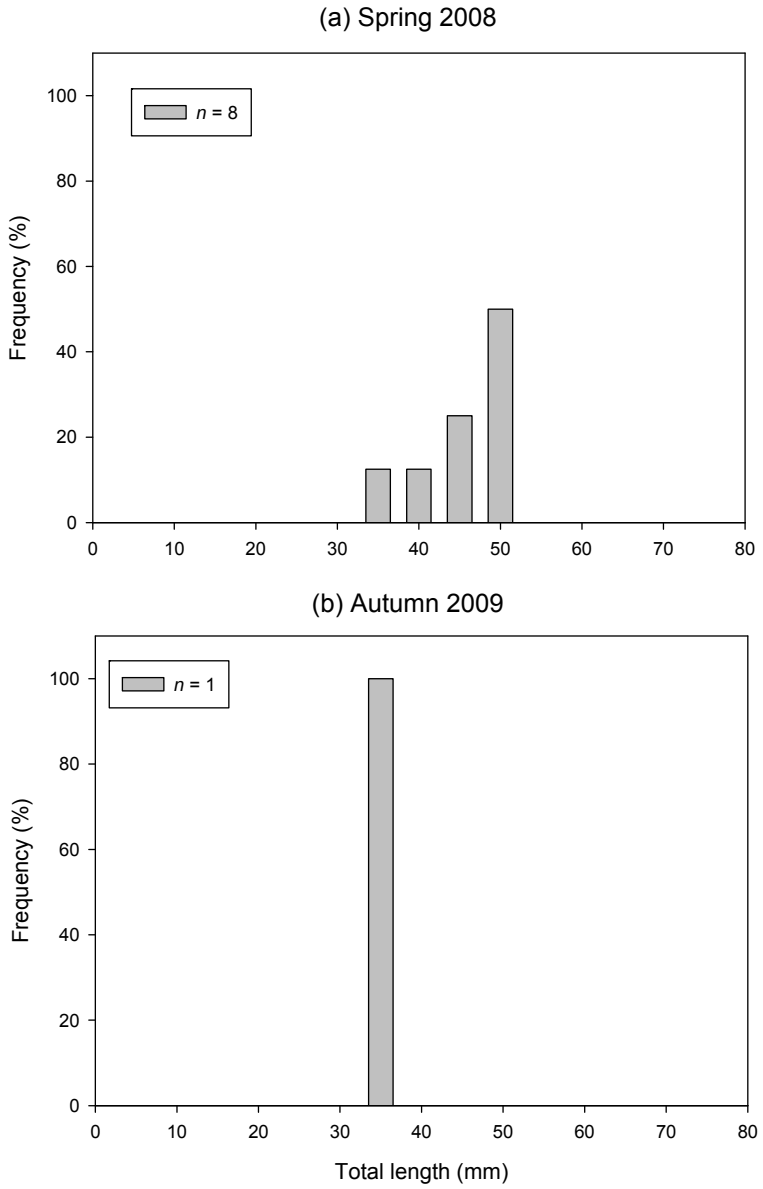


Figure 47a-b. Length-frequency distribution (mm) of Murray hardyhead collected from Clayton in (a) spring 2008 and (b) autumn 2009.

Site summary

Murray hardyhead have decreased in abundance at this site, although recruitment was noted. Later non-related sampling in the area by SARDI Aquatic Sciences failed to detect any Murray hardyhead. 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 is severely diminished. Therefore Murray hardyhead may have been lost from this site.

4.21. Milang Jetty (DAP site 5.1.3b)

Winter 2008

Spring 2008

Summer 2009

Autumn 2009

Figure 48. Photopoints of the Milang jetty site from winter 2008, spring 2008, summer 2009 and Autumn 2009.

Sampling effort

Spring 2008 & autumn 2009

- 6 seine net hauls.

Environmental conditions

Table 73. Water quality parameters measured at the Milang jetty site during each site visit.

Water Quality	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

Table 74. Habitat variables measured at the Milang jetty site during each site visit

Physical habitat (% cover)	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 75. 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)	0.24	-	-	-	-
Difference in water level (winter 2008 – autumn 2009, m)	-	+0.46	-0.93	> -0.5	> -1.0

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). Several non-threatened species were also sampled at this site (Table 76).

Table 76. Total numbers of different 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

All Murray hardyhead sampled in spring were large adult fish (46-51 mm TL; Figure 49). As such no recent recruitment was detected in spring.

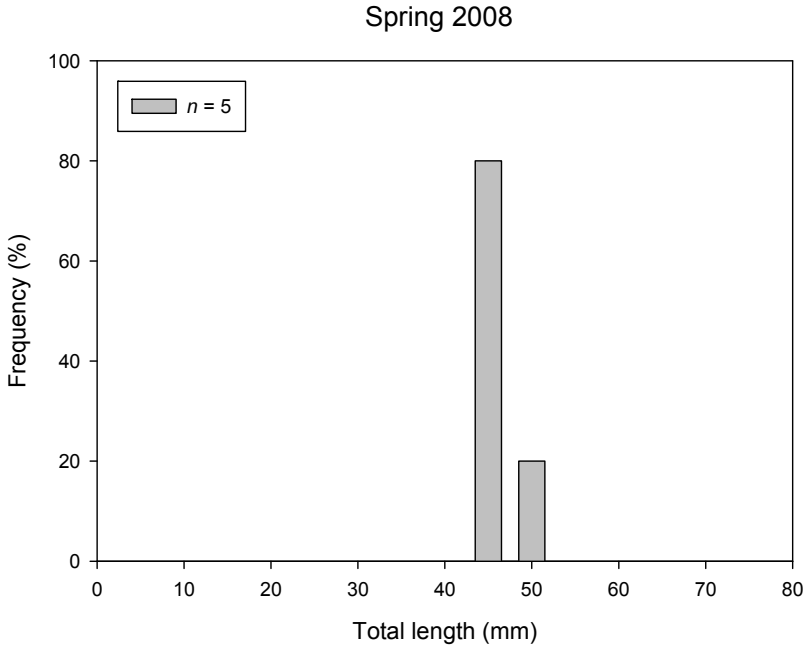


Figure 49. Length-frequency distribution (mm) of Murray hardyhead collected from the Milang jetty site in spring 2008.

Site summary

Murray hardyhead have potentially been lost from this site. 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 thus may undergo periods of total drying.

4.22. Bremer River Mouth (DAP site 5.1.3c)

Winter 2008


Spring 2008


Summer 2009


Autumn 2009


Figure 50. Photopoints of the Bremer River mouth from winter 2008, spring 2008, summer 2009 and Autumn 2009.

Sampling effort

Spring 2008

- 4 fyke nets set overnight.

Autumn 2009

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

Environmental conditions

Table 77. Water quality parameters measured at the Bremer River mouth during each site visit.

Water Quality	Temp (ºC)	pH	Conductivity (µS.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

Table 78. Habitat variables measured at the Bremer River mouth during each site visit

Physical habitat (% cover)	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 79. 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

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 dried. Several non-threatened species were also sampled at this site (Table 80).

Table 80. Total numbers of different 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

All Murray hardyhead sampled in spring were large adults (50-64 mm TL; Figure 51 & Figure 52) and thus recent recruitment was not detected.

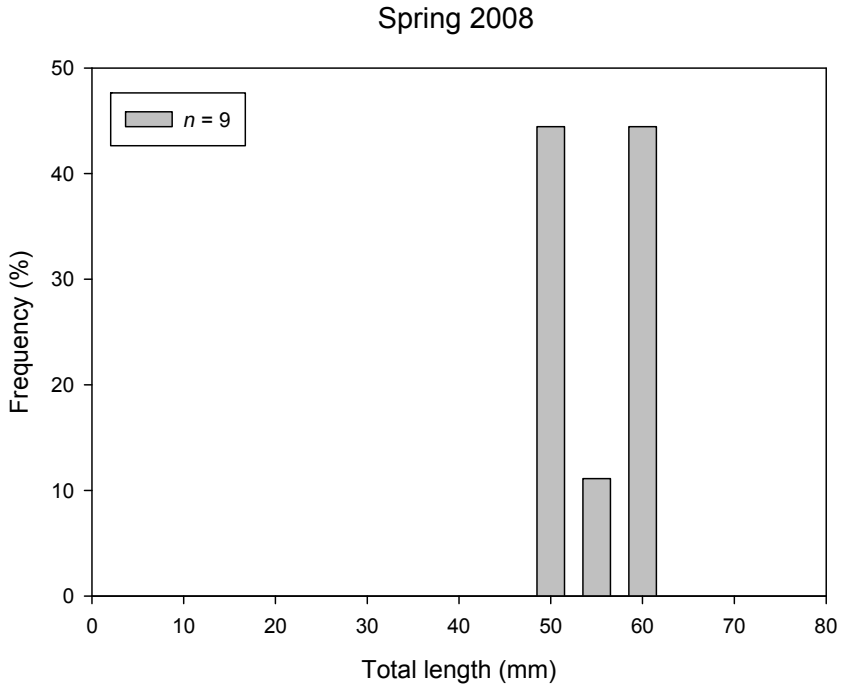


Figure 51. Length-frequency distribution (mm) of Murray hardyhead collected from the Bremer River mouth in spring 2008.

Figure 52. 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 (DAP site 5.1.4)

Winter 2008

Spring 2008

Summer 2009

Autumn 2009

Figure 53. Photopoints of Rocky Gully from winter 2008, spring 2008, summer 2009 and Autumn 2009.

Sampling effort

Spring 2008 & autumn 2009

- 4 fyke nets set overnight.

Environmental conditions

Table 81. Water quality parameters measured at Rocky Gully during each site visit.

Water Quality	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

Table 82. Habitat variables measured at Rocky Gully during each site visit.

Physical habitat (% cover)	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)	

Table 83. 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	-
Difference in water level (winter 2008 – autumn 2009, m)	-	-0.12	-	-	-0.34

Catch summary and length-frequency analysis

A substantial number of Murray hardyhead were sampled from this site in spring, however, the population has undergone a drastic decline with just three individuals collected in autumn (Table 84; Figure 54). Several non-threatened species were sampled in spring, all of which were lost from the site in autumn, apart from the exotic gambusia (Table 84).

Table 84. Total numbers of different 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*	**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 54. One of just three Murray hardyhead sampled at Rocky Gully in autumn 2009.

All fish sampled in spring appear to be adults (>30 mm TL; Figure 55a). The fish collected in autumn are likely recruits from the previous spawning season (Figure 55b). Juvenile fish were noted during the summer site assessment trip and thus spawning did occur and the fish detected in autumn may represent this cohort.

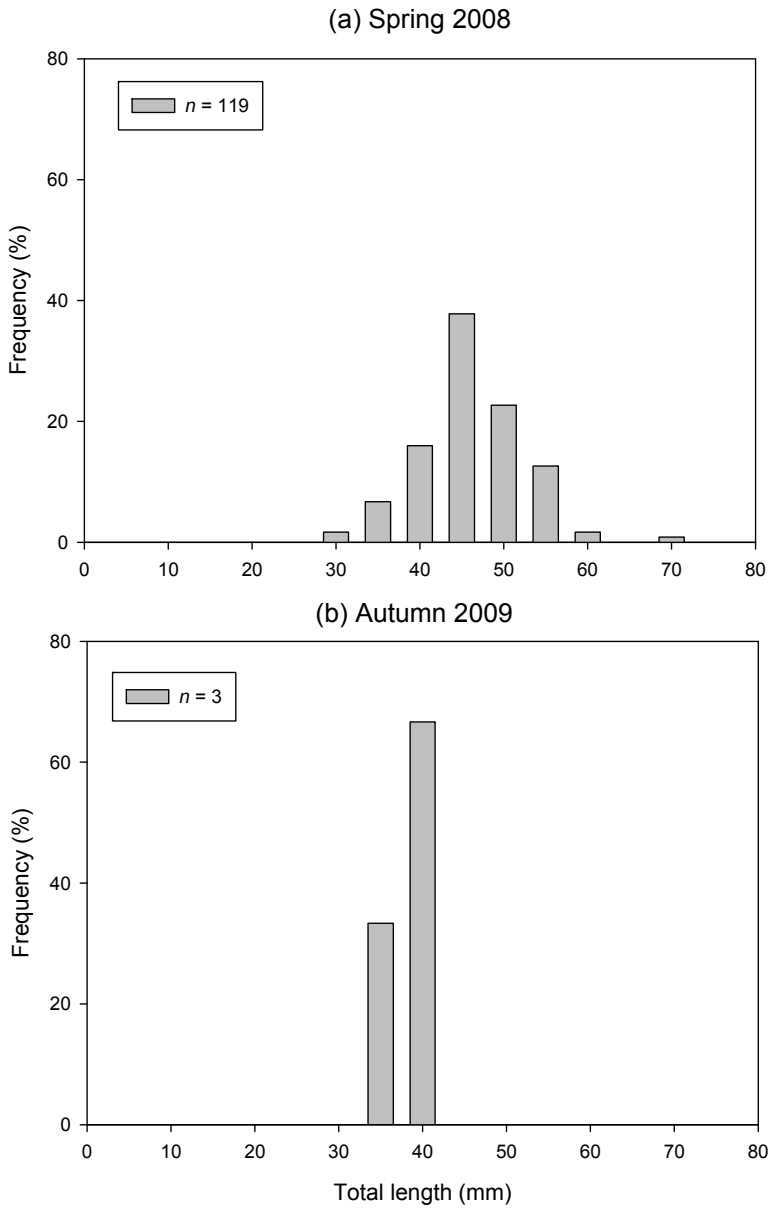


Figure 55a-b. Length-frequency distribution (mm) of Murray hardyhead collected from Rocky Gully in (a) spring 2008 and (b) autumn 2009.

Site summary

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

4.24. Riverglades (DAP site 5.1.5)

Winter 2008

Spring 2008

Summer 2009
Not sampled
Autumn 2009
Not sampled

Figure 56. Photopoints of Riverglades from winter 2008 and spring 2008.

Sampling effort

Spring 2008

- 5 seine net hauls.

Autumn 2009

- not sampled due to diminished water levels (dry) and continued absence of threatened species

Environmental conditions

Table 85. Water quality parameters measured at Riverglades during each site visit.

Water Quality	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	-

Table 86. Habitat variables measured at Riverglades during each site visit.

Physical habitat (% cover)	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 87. 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

Catch summary and length-frequency analysis

No Murray hardyhead were sampled at this site. Nevertheless several non-threatened species were collected (Table 88).

Table 88. Total numbers of different 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

This site has completely dried and Murray hardyhead have been lost.

4.25. Disher Creek (DAP site 5.2.1)

Winter 2008
Not sampled
Spring 2008

Summer 2009

Autumn 2009

Figure 57. Photopoints of Disher Creek from winter 2008, spring 2008, summer 2009 and Autumn 2009.

Sampling effort

Spring 2008 & autumn 2009

- 4 fyke nets set overnight.

Environmental conditions

Table 89. Water quality parameters measured at Disher Creek during each site visit.

Water Quality	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

Table 90. Habitat variables measured at Disher Creek during each site visit.

Physical habitat (% cover)	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 91. 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

Catch summary and length-frequency analysis

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

Table 92. Total numbers of different 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

All Murray hardyhead sampled in spring were large adult fish (56-72 mm TL; Figure 58a). Although not represented in Figure 58a, many juvenile Murray hardyhead (*c.* 15-25 mm TL) were observed and opportunistically sampled at the exit of the irrigation drain in Disher Creek in spring. Significant recruitment then occurred between spring and autumn with the vast majority of the population likely to be YOY individuals (Figure 58b & Figure 59). Older and larger fish (≥60 mm TL) were absent from the population in autumn (Figure 58b).

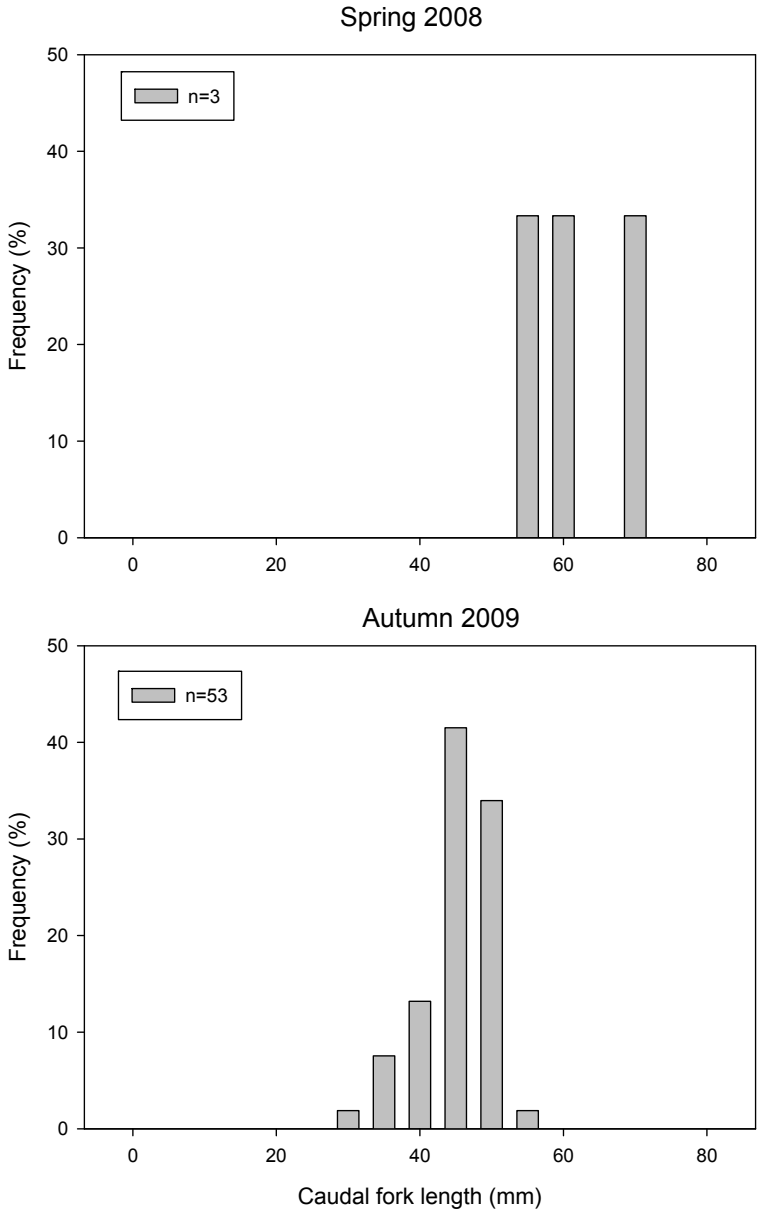


Figure 58a-b. Length-frequency distribution (mm) of Murray hardyhead collected from Disher Creek in (a) spring 2008 and (b) autumn 2009.

Figure 59. 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. Gambusia are very abundant at this site and may be impacting the Murray hardyhead population through competition. Salinity remains high at this site but plans are being put in place to secure water delivery to this site and allow more effective management.

4.26. Berri Evaporation Basin (DAP site 5.2.2)

Winter 2008

Spring 2008

Summer 2009

Autumn 2009

Figure 60. Photopoints of the Berri evaporation site from winter 2008, spring 2008, summer 2009 and Autumn 2009.

Sampling effort

Spring 2008 & autumn 2009

- 8 fyke nets set overnight.

Environmental conditions

Table 93. Water quality parameters measured at the Berri evaporation basin site during each site visit.

Water Quality	Temp (ºC)	pH	Conductivity (µS.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

Table 94. Habitat variables measured at the Berri evaporation basin site during each site visit

Physical habitat (% cover)	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 95. 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

Catch summary and length-frequency analysis

Murray hardyhead were sampled in considerable numbers from the Berri evaporation basin in both seasons but were most abundant in autumn (Table 96; Figure 61). Several non-threatened species were also sampled in both seasons (Table 96).

Table 96. Total numbers of different 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 61. Murray hardyhead sampled from the Berri evaporation basin in spring 2008.

Two distinct cohorts were present in spring, representing adults (45-65 mm TL) and YOY (21-25 mm TL; Figure 62a). This YOY cohort successfully recruited and represented the majority of the population in autumn (Figure 62b).

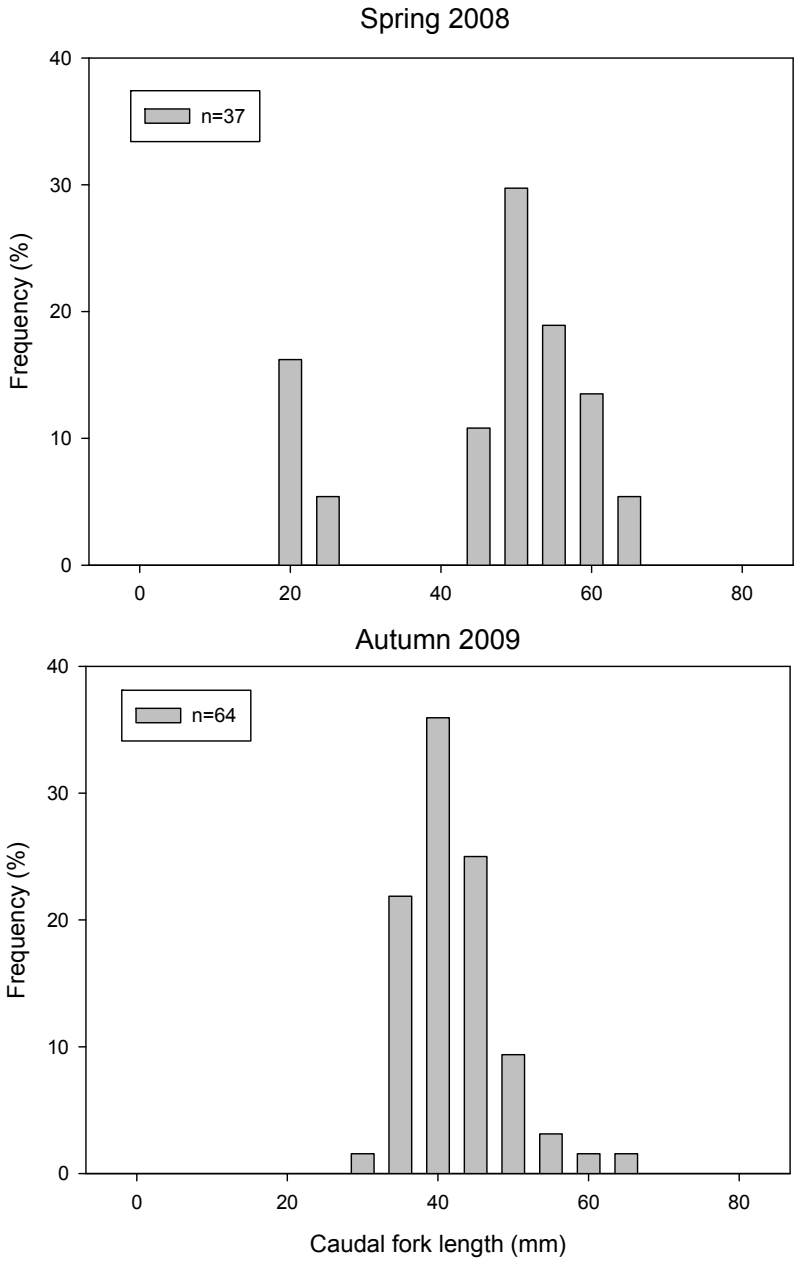


Figure 62a-b. Length-frequency distribution (mm) of Murray hardyhead collected from the Berri evaporation basin site in (a) spring 2008 and (b) autumn 2009.

Site summary

Murray hardyhead are present at this site in considerable numbers and have recently recruited successfully. Nonetheless, the Murray hardyhead population may still be under threat from reduced salinity (salinity at this site has fallen dramatically over the last year). Murray hardyhead are highly tolerant of saline conditions, relative to other freshwater species, and likely possess a competitive advantage over these species under such conditions (Wedderburn *et al.* 2008). However, under conditions of low salinity this competitive advantage is lost. Thus, common non-threatened species (e.g. Australian smelt and gudgeon species) may begin to out-compete Murray hardyhead at this site.

5. CONCLUSION

The different sites and populations of small-bodied threatened fish being monitored exhibited differential responses to drought conditions over the last year. Table 97 summarizes the status of each population (i.e. abundance, recruitment, water level) while also determining a risk factor for the loss of each of these populations. A 'traffic light' system was applied to visually represent the risk to each population. Levels of risk are defined as follows,

- Low risk (green) – considerable abundance in autumn 2009, evidence of recent recruitment and stable habitat conditions.
- Moderate risk (orange) – stable abundance, lack of recruitment (river blackfish) and/or diminished habitat quality.
- High risk (red) – significant declines in abundance (between spring 2008 and autumn 2009), lack of recruitment (Pygmy perch species' and Murray hardyhead), severely diminished habitat quality.
- Population lost (purple)

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	Species	Abundance spring 2008	Abundance 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.
Rodwell Creek	2.1.1	River blackfish	6	11	N	Falling	Pool being maintained by watering
Marne	2.2.1	River blackfish	3	1	N	Rising	Pool in poor condition
Angas Gauge	2.3.1	River blackfish	17	26	N	Rising	Pool in reasonable condition but salinity rising
Willowburn Road	2.4.1a	River blackfish	8	7	Yes	Falling	Pools in good condition
	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
	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	Dry
	4.1.1a	Yarra pygmy perch	0	0	-	Falling	Dry
	5.1.1a	Murray hardyhead	58	1	Yes	Falling	Dry
Eastick	3.2.1b	Southern pygmy perch	0	Not sampled	-	Falling	Dry
	4.1.1b	Yarra pygmy perch	0	Not sampled	-	Falling	Dry
	5.1.1b	Murray hardyhead	0	Not sampled	-	Falling	Dry
Steamer Drain	3.2.1c	Southern pygmy perch	Not sampled	Not sampled	-	Dry	Dry
	4.1.1c	Yarra pygmy perch	Not sampled	Not sampled	-	Dry	Dry
	5.1.1c	Murray hardyhead	Not sampled	Not sampled	-	Dry	Dry
Black Swamp	3.2.2a	Southern pygmy perch	Not sampled	Not sampled	-	Dry	Dry
	4.1.3	Yarra pygmy perch	Not sampled	Not sampled	-	Dry	Dry

Table 96 continued.

Site Name	DAP Site Number	Species	Abundance spring 2008	Abundance 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	Dry
Turvey's Drain	3.2.3	Southern pygmy perch	81	5	Yes	Stable	Water secured for filling
	5.1.3a	Murray hardyhead	8	7	Yes	Stable	As above
Meadows	3.3.1	Southern pygmy perch	2	38	Yes	Falling	Pools very low
Waterfalls	3.3.3	Southern pygmy perch	35	1	No	Falling	Pools very low, major loss of fish
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
	-	Murray hardyhead	11	Not sampled	No	Dry	Dry
Finniss River Confluence	4.1.2	Yarra pygmy perch	0	Not sampled	-	Dry	Dry
	-	Murray hardyhead	2	Not sampled	No	Dry	Dry
Boggy Creek	5.1.1d	Murray hardyhead	587	Not sampled	-	Was dry (now refilled)	Unknown??
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	53	Yes	Falling	Very high abundance of gambusia may be impacting population
Berri	5.2.1	Murray hardyhead	37	84	Yes	Falling	Salinity decreasing, with an associated increase in non salt-tolerant species that may compete with Murray hardyhead

5. REFERENCES

Wedderburn S, Walker K and Zampatti B (2008) Salinity may cause fragmentation of hardyhead (Teleostei: Atherinidae) populations in the River Murray, Australian. *Marine and Freshwater Research* **59**, 254-258.