# Fish monitoring for the 'Drought Action Plan for South Australian Murray-Darling Basin threatened freshwater fish populations': Summary for 2009/10



**C. Bice, M. Hammer, S. Leigh and B. Zampatti**

**SARDI Publication No. F2010/000647-1**
**SARDI Research Report Series No. 484**

**SARDI Aquatic Sciences**
**PO Box 120 Henley Beach SA 5022**

**August 2010**

AQUASAVE CONSULTANTS

Government of South Australia
Department of Environment and Natural Resources

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

# Fish monitoring for the 'Drought Action Plan for South Australian Murray-Darling Basin threatened freshwater fish populations': Summary for 2009/10

**C. Bice, M. Hammer, S. Leigh and B. Zampatti**

**SARDI Publication No. F2010/000647-1**
**SARDI Research Report Series No. 484**

**August 2010**

This publication may be cited as:
Bice, C., Hammer, M., Leigh, S. and Zampatti, B (2010). Fish monitoring for the 'Drought Action Plan for South Australian Murray-Darling Basin threatened freshwater fish populations': Summary for 2009/10. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2010/000647-1. SARDI Research Report Series No. 484. 156 pp.

Cover: (Clockwise from top left) Meadows Creek, Murray hardyhead (*Craterocephalus fluviatilis*), Berri Evaporation Basin and a net of river blackfish (*Gadopsis marmoratus*) and southern pygmy perch (*Nannoperca australis*).

**South Australian Research and Development Institute**
SARDI Aquatic Sciences
2 Hamra Avenue
West Beach SA 5024

Telephone: (08) 8207 5400
Facsimile: (08) 8207 5406
http://www.sardi.sa.gov.au

**DISCLAIMER**

The authors warrant that they have taken all reasonable care in producing this report. The report has been through the SARDI Aquatic Sciences internal review process, and has been formally approved for release by the Chief, Aquatic Sciences. Although all reasonable efforts have been made to ensure quality, SARDI Aquatic Sciences does not warrant that the information in this report is free from errors or omissions. SARDI Aquatic Sciences does not accept any liability for the contents of this report or for any consequences arising from its use or any reliance placed upon it.



Printed in Adelaide: September 2010

SARDI Publication No. F2010/000647-1
SARDI Research Report Series No. 484

| | |
|---|---|
| Author(s): | C. Bice, M. Hammer, S. Leigh and B. Zampatti |
| Reviewer(s): | S. Gehrig and R. Ward |
| Approved by: | Dr Q. Ye<br>Program Leader – Inland Waters & Catchment Ecology |
| Signed: |  |
| Date: | 14 September 2010 |
| Distribution: | SA Department of Environment and Natural Resources (DENR), SAASC Library and University of Adelaide Library |
| Circulation: | Public Domain |

## TABLE OF CONTENTS

## LIST OF FIGURES

## LIST OF TABLES

## ACKNOWLEDGEMENTS

This research was funded by the Department of Environment and Natural Resources (DENR) as part of the 'Drought Action Plan (DAP) for South Australian Murray-Darling Basin threatened freshwater fish populations' and was managed by Arkellah Hall. Thanks go to Jason Higham (DENR) for assistance in the early development of this project. Thanks also to Scotte Wedderburn, Tom Barnes, Karl Hillyard (Adelaide University), and Adrienne Frears (SA MDB NRMB) for collecting and sharing data from several sites sampled in 'Condition Monitoring' under *The Living Murray'* program. Dylan Sortino and Mel Tucker provided general field assistance, whilst Todd Goodman and Ian Ellis (MDFRC) provided field assistance at the Riverland sites. Finally, the various landholders that have provided access to sites on their properties are gratefully acknowledged.

## 1. EXECUTIVE SUMMARY

As a result of the combined affect of the over-abstraction of water from the Murray-Darling Basin (MDB) and persistent drought conditions in south-eastern Australia, inflows in the South Australian MDB have been below average for over five years. Consequently, water levels in many freshwater habitats, particularly below Lock 1, have receded since 2006. There are currently five species of small-bodied freshwater fish of national or state conservation significance in the South Australian MDB; namely Yarra pygmy perch (*Nannoperca obscura*) and Murray hardyhead (*Craterocephalus fluviatilis*), both listed as *vulnerable* under the *EPBC Act* (1999), and river blackfish (*Gadopsis marmoratus*), southern purple-spotted gudgeon (*Mogurnda adspersa*) and southern pygmy perch (*Nannoperca australis*), all protected under the state *Fisheries Management Act* (2007). All five species are under threat from current conditions. The South Australian Department of Environment and Natural Resources (DENR; formerly DEH) initiated the 'Drought Action Plan (DAP) for South Australian MDB threatened freshwater fish populations' with the aim of providing a framework for the management and conservation of these populations during the current unfavourable conditions.

As part of the DAP for threatened fish, 28 significant sites for these species within the South Australian MDB were monitored in 2008/2009 and/or 2009/10. Fish populations were sampled, using a variety of techniques (i.e. electro-fishing, fyke nets, seine nets and/or box traps) in the spring and autumn of each year to monitor changes in abundance and assess recruitment. Site condition assessments (i.e. water levels, water quality and habitat cover) were undertaken in conjunction with fish sampling in spring and autumn, with additional assessments undertaken in winter and summer. Fish sampling and condition assessments allow temporal variation in population dynamics and site trends (e.g. declining water levels) to be investigated, thus identifying populations and sites that are at greatest risk and hence in need of immediate management intervention.

A summary of monitoring results is presented in Table 1, including site information (i.e. name, number, species originally present), fish population monitoring (i.e. abundances, evidence of recruitment), the status of water level (i.e. rising, falling, stable, dry) and brief comments on the site/population. This information was used to

determine the level of risk (low, medium, high or population lost) for each population. The risk of species loss from a site was determined using the following criteria,

- Low risk (green) – moderate abundance in 2009/10, evidence of recent recruitment and stable habitat conditions.
- Moderate risk (orange) – moderate abundance in 2009/10, lack of recruitment (river blackfish) and/or diminished habitat quality.
- High risk (red) – substantial declines in abundance (between spring 2009 and autumn 2010 or relative to 2008/09), lack of recruitment (pygmy perch species, southern purple-spotted gudgeon and Murray hardyhead), extended lack of recruitment (i.e. >3 years, river blackfish) and/or severely diminished habitat quality.
- Population likely to be lost (purple)

**Table 1.** The population status of threatened fish species (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). NS = not sampled.

| Site Name | DAP Site Number | Target species | No. caught spring 2009 | No. caught autumn 2010 | Recruitment within the last 12 months (Y/N) | Water level (Rising, stable, falling, dry) | Site comments |
|---|---|---|---|---|---|---|---|
| Jury Swamp | 1.1.1 | Southern purple spotted gudgeon | 1 | 0 | Yes | Rising | If still present abundance probably very low |
| Rodwell Creek | 2.1.1 | River blackfish | 4 | 4 | No | Variable (pumping) | Pool being maintained by watering. Very limited or no recruitment within last 3 years. Population dominated by adult fish |
| Marne | 2.2.1 | River blackfish | 5 | 4 | No | Stable | No recruitment within last 3 years. Pool in poor condition (i.e. presence of unknown white plume on bottom of pool) |
| Angas Gauge | 2.3.1 | River blackfish | 27 | 28 | Yes | Seasonally variable | Pool in good condition, consistent abundances and recent recruitment evident. Elevated salinity may be an issue but is seasonally variable |
| Willowburn Road | 2.4.1a | River blackfish | 13 | 11 | Yes | Seasonally variable | Pools in good condition (i.e. consistent cool base flow). Consistent abundance and recent recruitment |
| | 3.4.1a | Southern pygmy perch | 24 | 21 | Yes | Seasonally variable | As above |
| Deep Creek Road | 2.4.1b | River blackfish | 4 | 16 | Yes | Seasonally variable | Pool in good condition (i.e. consistent cool base flow). Increase in abundance with significant recruitment |
| | 3.4.1b | Southern pygmy perch | 15 | 5 | Yes | Seasonally variable | Decrease in abundance from 2008/09. Recruitment evident in 2009/10 |
| Middle Creek Junction | 3.1.1 | Southern pygmy perch | 2 | 9 | Yes | Falling | Decrease in abundance from 2008/09 |
| Boundary Creek Drain | 3.2.1a | Southern pygmy perch | NS | NS | - | Dry | Low water levels, population probably lost |
| | 4.1.1a | Yarra pygmy perch | NS | NS | - | Dry | Low water levels, population probably lost |
| | 5.1.1a | Murray hardyhead | NS | NS | - | Dry | Low water levels, population probably lost |
| Eastick | 3.2.1b | Southern pygmy perch | 0 | 0 | - | Rising | Low water level, high salinity – population probably lost |
| | 4.1.1b | Yarra pygmy perch | 0 | 0 | - | Rising | Low water level, high salinity – population probably lost |
| | 5.1.1b | Murray hardyhead | 0 | 1 | - | Rising | Single individual sampled in autumn 2010, population probably small |
| Steamer Drain | 3.2.1c | Southern pygmy perch | NS | NS | - | Dry | Dry – population lost |
| | 4.1.1c | Yarra pygmy perch | NS | NS | - | Dry | Dry – population lost |
| | 5.1.1c | Murray hardyhead | NS | NS | - | Dry | Dry – population lost |

**Table 1 continued.**

| Site Name | DAP Site Number | Target species | No. caught spring 2008 | No. caught autumn 2009 | Recruitment within the last 12 months (Y/N) | Water level summer-autumn (Rising, stable, falling, dry) | Site comments |
|---|---|---|---|---|---|---|---|
| Black Swamp | 3.2.2a | Southern pygmy perch | 7 | 0 | No | Variable (dependent on Goolwa Channel level) | Population likely to be small. No recruitment detected in autumn 2010. Conditions in the area may be favourable for this species with higher water levels due to the *GWLMP* |
| | 4.1.3 | Yarra pygmy perch | 0 | 0 | - | Variable (dependent on Goolwa Channel level) | Population probably lost |
| Black Swamp Drain | 3.2.2 | Southern pygmy perch | 0 | 2 | Yes | Variable (dependent on Goolwa Channel level) | Population likely small. Conditions in the area may be favourable for this species with higher water levels due to the *GWLMP* |
| Turvey's Drain | 3.2.3 | Southern pygmy perch | 10 | 1 | Yes | Stable (pumping) | Despite environmental watering, marked decrease in abundance from 2008/09 and no recruitment detected |
| | 5.1.3a | Murray hardyhead | 11 | 0 | Yes | Stable (pumping) | Despite environmental watering, marked decrease in abundance from 2008/09 and no recruitment detected |
| Meadows | 3.3.1 | Southern pygmy perch | 3 | 24 | Yes | Seasonally variable | Consistent numbers and significant recruitment, albeit restricted distribution within the site (i.e. two pools) |
| Waterfalls | 3.3.3 | Southern pygmy perch | 1 | 1 | No | Seasonally variable | Very low abundance and significant decline from spring 2008 and previous years. Recruitment not detected for >2 years |
| Inman | 3.5.1 | Southern pygmy perch | 8 | 19 | Yes | Seasonally variable | Slight decrease in abundance from 2008/09. Low water levels in pools, low DO |
| Currency Creek | 4.1.2A | Yarra pygmy perch | 0 | 0 | - | Variable (dependent on Goolwa Channel level) | Population probably lost |
| | - | Murray hardyhead | 11 | 0 | No | Variable (dependent on Goolwa Channel level) | Population likely in low abundance. Conditions at this site may now be favourable for this species with higher water levels due to the *GWLMP*. Several individuals were sampled from a nearby site in autumn 2010 by Wedderburn and Hillyard (In Prep) |
| Finniss River Confluence | 4.1.2 | Yarra pygmy perch | 0 | 0 | - | Variable (dependent on Goolwa Channel level) | Population probably lost |
| | - | Murray hardyhead | 0 | 0 | No | Variable (dependent on Goolwa Channel level) | Whilst not sampled in 2009/10, 10 individuals were sampled in the area (within ~1 km) in autumn 2010 by Bice *et al.* (2010). Conditions at this site may now be favourable for this species with higher water levels due to the *GWLMP*. |
| Boggy Creek | 5.1.1d | Murray hardyhead | 16 | 98 | Yes | Stable (pumping) | Moderate numbers and significant recruitment in autumn 2010. Water level will remain an issue at this site without management |
| Mundoo Drain West | | Murray hardyhead | 14 | 0 | No | Dry | Either present in low numbers or potentially lost |
| | | Southern pygmy perch | 4 | 0 | No | Dry | Population probably lost |

**Table 1 continued.**

| Site Name | DAP Site Number | Target species | No. caught spring 2008 | No. caught autumn 2009 | Recruitment within the last 12 months (Y/N) | Water level summer-autumn (Rising, stable, falling, dry) | Site comments |
|---|---|---|---|---|---|---|---|
| Mundoo Drain East | | Murray hardyhead | 162 | 0 | No | Dry | Population likely lost. Pools dried or very shallow, with electrical conductivity >90,000 µS.cm$^{-1}$ |
| Clayton | 5.1.2 | Murray hardyhead | 0 | 0 | No | Rising | Not sampled since autumn 2009, population likely lost. However, water levels have recently risen slightly and the lagoon has begun to fill. As such conditions may be favourable for Murray hardyhead after filling and the species may re-colonise the site if an appropriate source population exists |
| Milang Jetty | 5.1.3b | Murray hardyhead | 0 | 0 | No | Rising | Not sampled since spring 2010, population likely lost. However, water levels have recently risen slightly. As such conditions may become favourable for Murray hardyhead and the species may re-colonise the site if an appropriate source population exists |
| Bremer River Mouth | 5.1.3c | Murray hardyhead | 0 | 0 | No | Dry | Dry – population lost |
| Rocky Gully | 5.1.4 | Murray hardyhead | 0 | 103 | Yes | Stable (pumping) | This population has improved from 2009, matching management interventions (i.e. watering), with moderate abundance and recent recruitment evident. However population reliant on continued management to ensure adequate water level and salinity |
| Riverglades | 5.1.5 | Murray hardyhead | NS | NS | - | Dry | Dry – population lost |
| Disher Creek | 5.2.1 | Murray hardyhead | 52 | 4 | Yes (limited) | Stable | Diminished abundance in autumn 2010. Very high abundance of gambusia may be impacting Murray hardyhead |
| Berri | 5.2.1 | Murray hardyhead | 16 | 41 | Yes (limited) | Stable | Salinity continues to decrease. Level of recruitment limited in autumn 2010 relative to autumn 2009. Increase in non salt-tolerant species that may compete with Murray hardyhead |

## 2. INTRODUCTION

In the Lower Murray River region of South Australia there are currently five key species of small-bodied freshwater fish of national or state conservation significance, with populations under threat of loss. These are Yarra pygmy perch (*Nannoperca obscura*) and Murray hardyhead (*Craterocephalus fluviatilis*), nationally listed as 'Vulnerable' under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and southern pygmy perch (*Nannoperca australis*), southern purple-spotted gudgeon (*Mogurnda adspersa*) and river blackfish (*Gadopsis marmoratus*), considered endangered in the region and 'Protected' under the *Fisheries Management Act 2007*. Each of these species now exist in the South Australian Murray-Darling Basin (MDB) in a limited number of small isolated populations and several species have undergone severe declines in abundance in recent years (Hammer *et al.* 2009).

Persistent drought conditions across south-eastern Australia in the last decade (Murphy and Timbal 2007), combined with a history of over-extraction of water (Kingsford 2000), have led to reduced inflows in the Murray-Darling Basin (MDB) and receding water levels in many freshwater habitats. These conditions are profoundly impacting threatened fish populations in the South Australian MDB (Hammer 2007; Bice *et al.* 2008; Hammer *et al.* 2009). Consequently, the South Australian Department of Environment and Natural Resources (DENR; formerly the Department for Environment and Heritage (DEH)) developed the 'Drought Action Plan (DAP) for South Australian MDB threatened freshwater fish populations' (Hall *et al.* 2009) to manage and conserve these populations. The DAP identifies sites or populations of significance, summarizes information on past and current population status and threats to these populations and most importantly, provides a framework for determining management actions needed to conserve, rescue and recover populations. A total of 26 sites were initially included in the DAP based on the presence of at least one of the species of concern (Bice *et al.* 2009; Hall *et al.* 2009); however this number has risen with the subsequent discovery of further sites.

A major component of the DAP involves regular monitoring of the identified populations and monitoring of habitat quality at these sites in order to determine the ongoing status of these populations and identify any need for management. Sites have been monitored under the current program since mid-2008. In spring (October-

November) and autumn (March-May) of each year, fish populations were sampled and site condition assessments (i.e. habitat and water quality) were conducted. Additional site checks were conducted in winter (August) and summer (February) each year, to assess site condition. These data provide insight on the presence/absence of threatened species, the status of populations (e.g. declining/increasing abundance, recruitment success) and site condition (e.g. decreasing/increasing water levels or salinity) and facilitate in the identification of populations at greatest risk of loss and therefore in need of management intervention.

The following document presents the results of fish sampling in spring 2009 and autumn 2010 with reference to results from 2008/09 (see Bice *et al.* 2009) and a summary of site condition assessments throughout 2009/10. It aims to support the DAP by providing a 'report card' on the status of each population and identifies those in need of management. This document does not provide a comprehensive summary of management actions undertaken to date or provide thorough suggestions on potential management actions, but simply aims to highlight the current status of populations and thus facilitate discussion of potential management options by the DAP team (i.e. DENR, SARDI Aquatic Sciences, Aquasave Consultants, the South Australian Murray-Darling Basin Natural Resource Management Board (SA MDB NRMB), Primary Industries and Resources South Australia (PIRSA) and the Department for Water (DFW)).

# 3. METHODS

## 3.1. Sites

A total of 28 sites were selected for monitoring based on the previous presence of at least one of the five threatened species (Table 2). Sites range in location from Disher Creek and Berri evaporation basin in the Riverland near the Victorian border to Dunn's Lagoon (Clayton) and Currency Creek near the terminus of the MDB and cover three broad habitat types – wetlands associated with the River Murray Channel; fringing wetlands of western Lake Alexandrina; and stream tributaries of the Eastern Mount Lofty Ranges (Figure 1a & b).

Whilst monitoring has occurred since 2008, not all sites were sampled and assessed throughout the project, either due to complete drying, lack of access or continued absence of threatened species (i.e. during this project and previous monitoring programs). Several sites were not monitored in 2009/10 and thus site summaries are not included in this report (see Bice *et al.* 2009). Table 2 presents the sites, the species originally present at each site and the seasons in which they were monitored.

Adelaide University also conducted 'condition monitoring' of threatened fish populations in the Lower Lakes in 2008/09 and 2009/10 as part of the Murray-Darling Basin Authorities' (MDBA) *The Living Murray* program (funded by the SA MDB NRMB) (Wedderburn and Barnes 2009; Wedderburn and Hillyard In Prep). Due to the current precarious status of threatened fish populations in this region and their potential susceptibility to interference, a data sharing agreement was made between the two projects to avoid excessive sampling of populations. Sampling events were coordinated to occur on similar dates. Sites monitored by Adelaide University are indicated in Table 2.

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

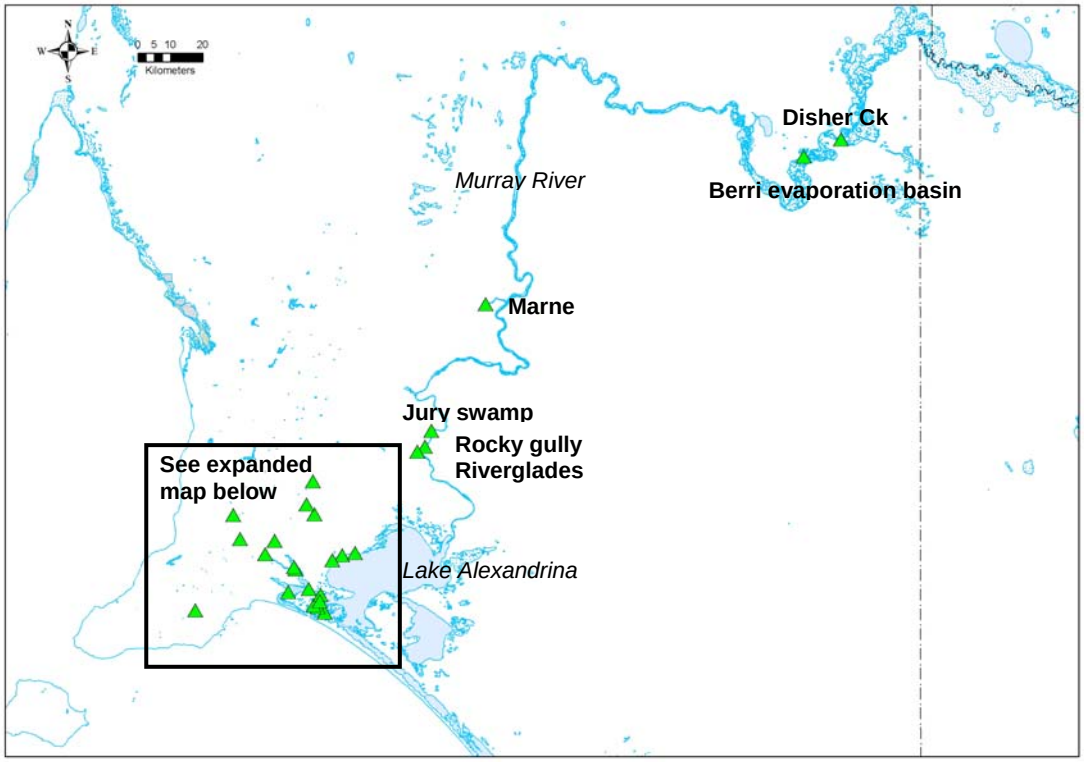
| Site Name | DAP Site Number | Species | Monitoring season (Yes/No) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Win 08 | Spr 08 | Sum 09 | Aut 09 | Win 09 | Spr 09 | Sum 10 | Aut 10 |
| Jury Swamp | 1.1.1 | Southern purple spotted gudgeon | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Rodwell Creek | 2.1.1 | River blackfish | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Marne | 2.2.1 | River blackfish | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Angas Gauge | 2.3.1 | River blackfish | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Willowburn Road | 2.4.1 | River blackfish, southern pygmy perch | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Deep Creek Road | 2.4.1 | River blackfish, southern pygmy perch | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Middle Creek Junction | 3.1.1 | Southern pygmy perch | Yes | Yes | Yes | Yes | 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 | No | No | No | No |
| Eastick Creek | 3.2.1b, 4.1.1b, 5.1.1b | Southern pygmy perch, Yarra pygmy perch, Murray hardyhead | Yes | Yes | No | No | No | No | No | No |
| Steamer Drain | 3.2.1c, 4.1.1c, 5.1.1c | Southern pygmy perch, Yarra pygmy perch, Murray hardyhead | Yes | No | No | No | No | No | No | No |
| Black Swamp | 3.2.2a, 4.1.3 | Southern pygmy perch, Yarra pygmy perch | Yes | No | No | No | No | Yes | Yes | Yes |
| Black Swamp Drain | 3.2.2b | Southern pygmy perch | Yes | Yes | No | No | No | Yes | Yes | Yes |
| Turvey's Drain | 3.2.3, 5.1.3a | Southern pygmy perch, Murray hardyhead | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

**Table 2 continued.**

| Site Name | DAP Site Number | Species | Monitoring season (Yes/No) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Win 08 | Spr 08 | Sum 09 | Aut 09 | Win 09 | Spr 09 | Sum 10 | Aut 10 |
| Meadows | 3.3.1 | Southern pygmy perch | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Waterfalls | 3.3.3 | Southern pygmy perch | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Inman | 3.5.1 | Southern pygmy perch | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Currency Creek | 4.1.2a | Yarra pygmy perch, Murray hardyhead | Yes | Yes | No | No | Yes | Yes | Yes | Yes |
| Finniss River Confluence | 4.1.2b | Yarra pygmy perch, Murray hardyhead | Yes | Yes | No | No | No | Yes | Yes | Yes |
| Boggy Creek* | 5.1.1d | Murray hardyhead | Yes | No | Yes | No | Yes | Yes | Yes | Yes |
| Mundoo Drain West* | | Murray hardyhead, southern pygmy perch | Yes | No | Yes | No | Yes | Yes | Yes | Yes |
| Mundoo Drain East* | | Murray hardyhead | Yes | No | Yes | No | Yes | Yes | Yes | Yes |
| Clayton | 5.1.2 | Murray hardyhead | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Milang Jetty | 5.1.3b | Murray hardyhead | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Bremer River Mouth | 5.1.3c | Murray hardyhead | Yes | Yes | Yes | No | Yes | Yes | Yes | No |
| Rocky Gully | 5.1.4 | Murray hardyhead | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Riverglades | 5.1.5 | Murray hardyhead | Yes | Yes | No | No | No | No | No | No |
| Disher Creek | 5.2.1 | Murray hardyhead | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Berri Evaporation Basin | 5.2.2 | Murray hardyhead | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

* denotes sites sampled by Adelaide University (Wedderburn and Barnes 2009; Wedderburn and Hillyard In Prep)

a)




b)

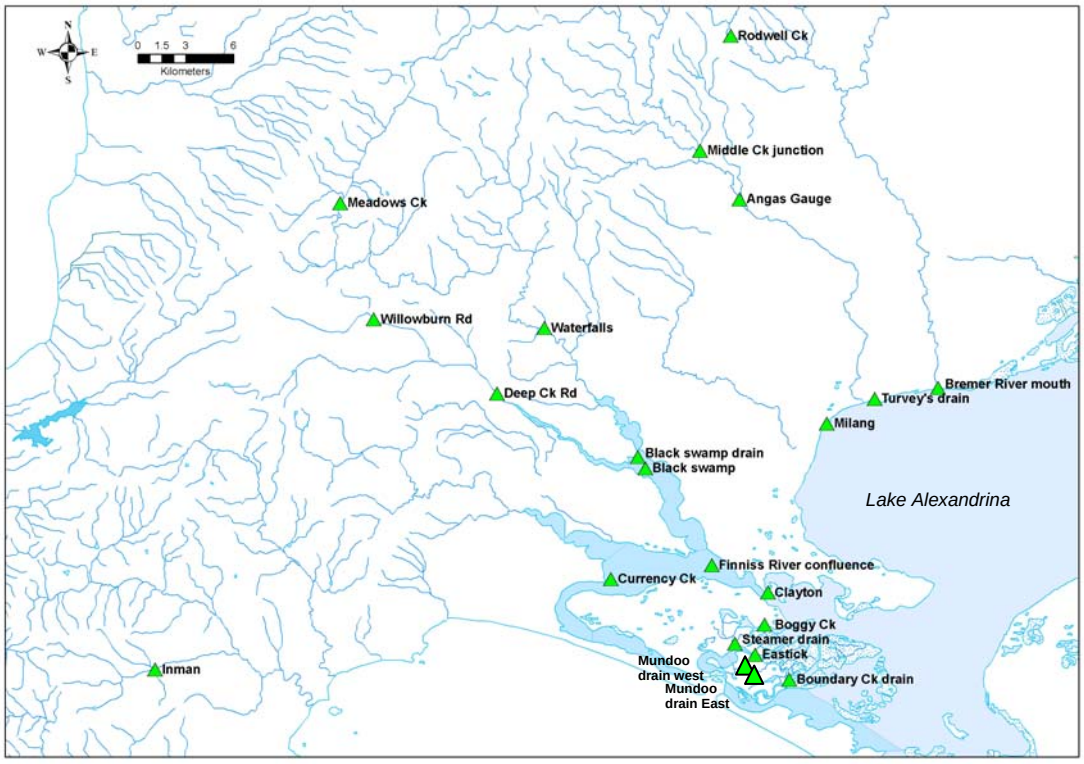



**Figure 1.** a) Map of the SA MDB showing Drought Action Plan Monitoring Sites and b) expanded map of sites in the western Lower Lakes and Eastern Mount Lofty Ranges region.

### 3.2. Fish sampling

Various methods were used to sample fish populations at different sites, depending on individual site characteristics. At each site one or a combination of the following methods were used,

- Backpack electro-fishing
    - A Smith-Root model LR-24 backpack electrofisher was used to sample all microhabitats (e.g. snags, vegetation, open water) represented within a site. 'On time' of electro-fishing differs between sites and at sites between seasons due to differences in available habitat area (e.g. changes in water level). However, a standard reach of stream is sampled on each occasion and abundance data is standardised for electrofishing 'on time' (e.g. number of fish.100 $s^{-1}$) to account for differences in sampling effort between seasons
- Fyke netting (3-6 m wing length, 0.6 m entry diameter, 0.003 m mesh)
    - Fyke nets are set perpendicular to the bank where possible. The number of fyke nets used at each site varies based upon the areal extent of the sampling site
- Seine netting (4 m length, 1.5 m depth, 6 mm mesh)
    - Seine hauls are *c.* 10 m in length and the number of hauls is based upon the areal extent of the site/habitat.
- Box trapping (0.4 x 0.24 x 0.24 m (L x W x H), 0.03 – 0.07 m opening, 0.001 m mesh)
    - The number of box traps used at each site varies based upon the areal extent of the sampling site

The specific sampling gear types and effort used at each site are indicated in individual site summaries (see results section). As many of these populations and sites are highly restricted and thus vulnerable to interference, sampling effort was often low and tailored to provide representative data yet minimize impact on fish populations. This is most notable for river blackfish populations at Rodwell Creek and the Marne River.

At each site, where possible, sampling methods were kept consistent across seasons to allow for robust comparison of catch data over time. This is often difficult,

particularly at sites in the Eastern Mount Lofty Ranges where backpack electro-fishing is used; these streams often have highly variable water levels and consequently the area that may be effectively sampled also fluctuates resulting in lesser/greater effort or lesser/greater fishing efficiency.

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

#### *Assessing recruitment*

Southern purple-spotted gudgeon, Yarra pygmy perch, southern pygmy perch and Murray hardyhead are all short-lived species (i.e. 1-4 years) and thus annual recruitment is highly important to support self-sustaining populations. River blackfish are 'longer lived' than the aforementioned species and thus annual recruitment success is not critical for supporting self-sustaining populations. Recruitment within these populations was determined by investigating length-frequency distributions.

Recruitment is largely assessed by the presence of young-of-year (YOY) cohorts in autumn sampling (although newly recruited YOY cohorts are often present in spring). Southern purple-spotted gudgeon, Yarra pygmy perch, southern pygmy perch and Murray hardyhead all typically spawn during spring/summer and thus YOY cohorts are usually detectable in autumn. The size range that differentiates YOY from older fish was largely determined from previous monitoring of these populations (see Wedderburn and Hammer 2003; Hammer 2004; Hammer 2005; Bice and Ye 2006; Bice and Ye 2007; Bice *et al.* 2008; Hammer 2009) and knowledge of the species' lifecycle. For example, southern pygmy perch <40 mm TL sampled in autumn are likely YOY individuals spawned the previous spring/summer (see Hammer 2009).

### 3.3. Site condition assessments

Site condition assessments were carried out in winter and summer, and also during fish sampling trips in spring and autumn. This involved taking photos from established photo points (when possible), estimating biological and physical habitat,

determining changes in water levels and measuring water physico-chemical characteristics at each site.

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

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

- Conductivity ($\mu S.cm^{-1}$)
- pH
- Dissolved oxygen concentration (ppm)
    - Surface reading at depth of ~0.2 m and at sites where depth is >1.5 m bottom measurements are also taken
- Temperature (°C)

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

# 4. RESULTS

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

Jury Swamp is an off-channel wetland located in the gorge section of the Murray River below Lock and Weir 1 (Blanchetown) (Figure 2). Southern purple-spotted gudgeon were believed to be extinct in South Australia until 2004 when this species was rediscovered at this site. Genetic analysis proved this population to be a remnant wild population (Hammer 2008a). This species was moderately abundant at this site until April 2007 (Hammer 2007).

With severely diminished inflows into South Australia and dramatically receding water levels below Lock 1, the water level within Jury Swamp began receding in late 2006 and eventually dried completely in April 2007 (the wetland disconnected at a river height of ~0.3 m AHD). Prior to drying, a number of southern purple-spotted gudgeon were removed from this site for captive maintenance (Hammer 2007). The River Murray channel at the entrance to Jury Swamp continues to be monitored for the presence of this species.

### Fish sampling effort

*Spring 2008*

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

*Autumn 2009, spring 2009 and autumn 2010*

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

## 2009/10 Photo-point images

**Winter 2009**

**Spring 2009**

**Summer 2010**

**Autumn 2010**

**Figure 2.** Photo-point images of the Jury Swamp site from winter 2009, spring 2009, summer 2010 and autumn 2010.

## Environmental conditions

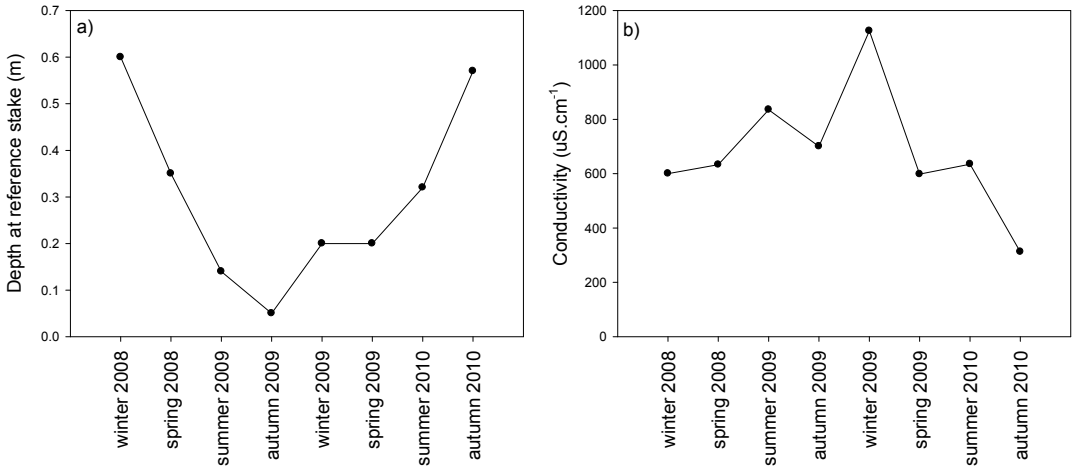



**Figure 3.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (μS.cm$^{-1}$) at the Jury Swamp site between winter 2008 and autumn 2010. Note this data relates to the River Murray channel adjacent Jury Swamp and the wetland remains dry.

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

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | 0 | 10 (willow) | 5 (snag) | 85 |
| Spring 2009 | 0 | 20 (willow) | 40 (snag) | 40 |
| Summer 2010 | 0 | 10 (willow) | 20 (snag) | 70 |
| Autumn 2010 | 0 | 20 (willow) | 30 (snag) | 50 |

**Table 4.** Water quality parameters measured at Jury Swamp during each site visit.

| Season | Temp (ºC) | pH | DO (ppm) | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|
| Winter 2009 | 15.4 | 7.7 | 9.0 | 0.45 | 1 |
| Spring 2009 | 21.8 | 8.05 | 3.06 | 0.55 | 1 |
| Summer 2010 | 25.4 | 8.7 | 5.16 | 0.5 | 1 |
| Autumn 2010 | 18.2 | 7.83 | 4.93 | 0.05 | 1.5 |

## Catch summary and length-frequency analysis

A single purple-spotted gudgeon was collected in spring 2009, as was the case for spring 2008 and autumn 2009, but none were sampled in autumn 2010 (Table 5). All individuals were captured from the River Murray, among willow roots near the mouth of Jury swamp. Both fish sampled in 2008/09 were medium-sized adult fish (>70 mm

TL (total length)) (Figure 4a & b) but the individual sampled in spring 2009 (TL = 52 mm) was likely to have been spawned the previous spring/summer (Figure 4c and Figure 5). Other species sampled and their respective abundances are also presented in Table 5.

**Table 5.** Total numbers of fish species collected from Jury Swamp between spring 2008 and autumn 2010.

| **Species** | | **Sampling trip** | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **Southern purple-spotted gudgeon** | ***Mogurnda adspersa*** | **1** | **1** | **1** | **0** |
| Flat-headed gudgeon | *Philypnodon grandiceps* | 52 | 4 | 18 | 0 |
| Dwarf flat-headed gudgeon | *Philypnodon macrostomus* | 7 | 0 | 1 | 0 |
| Carp gudgeon complex | *Hypseleotris spp.* | 386 | 6 | 26 | 13 |
| Unspecked hardyhead | *Craterocephalus stercusmucarum fulvus* | 108 | 0 | 0 | 2 |
| Murray rainbowfish | *Melanotania fluviatilis* | 31 | 0 | 0 | 1 |
| Australian smelt | *Retropinna semoni* | 36 | 0 | 0 | 0 |
| Common galaxias | *Galaxias maculatus* | 2 | 0 | 1 | 0 |
| Bony herring | *Nematalosa erebi* | 1 | 0 | 0 | 0 |
| Golden perch | *Macquaria ambigua* | 1 | 0 | 0 | 0 |
| Carp | *Cyprinus carpio* | 1 | 0 | 0 | 0 |

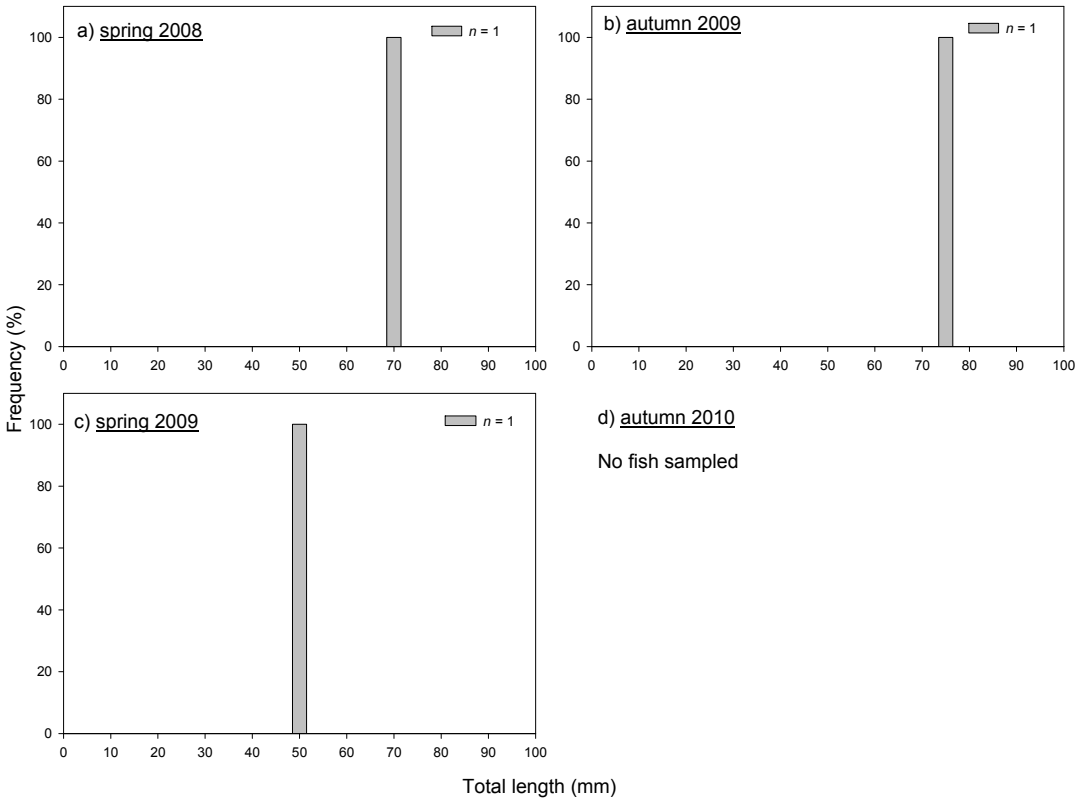



**Figure 4.** Length frequency distribution of southern purple-spotted gudgeon from Jury Swamp in a) spring 2008, b) autumn 2009, c) spring 2009 and d) autumn 2010.


**Figure 5.** Southern purple-spotted gudgeon sampled from the Murray River adjacent Jury swamp in spring 2009.

**Site summary**

Despite not being sampled in autumn 2010, southern purple-spotted gudgeon may still be present at this site, although likely in very low abundances. The capture of an individual in spring 2009 that was likely spawned in spring/summer 2008/09, indicates that some level of recruitment had recently occurred. Water levels in the River Murray below Lock 1 have risen in early 2010 and as such water level at this site is now similar to that in winter 2008 after reaching a low point in autumn 2009 (Figure 3a). Nevertheless, this population remains at high risk of loss.

Individuals from this population are currently part of a captive breeding program being undertaken by Aquasave and Native Fish Australia (NFA) with support from Alberton Primary School and Urrbrae Agricultural College. A number of juvenile southern purple-spotted gudgeon, produced in captivity, were released into a restored 'wild' refuge at the Paiwalla wetland near Jury Swamp in March 2010. It is hoped that this action will result in a self-sustaining population.

### 4.2. Rodwell Creek (Bremer River: river blackfish)

Rodwell Creek is a tributary of the Bremer River in the Eastern Mount Lofty Ranges (EMLR) (Figure 6). Based on anecdotal evidence, river blackfish were present historically, however, their presence was confirmed at this location in 2004 (Hammer 2004). This population has been monitored henceforth (Hammer 2009). Originally more broadly distributed in the Bremer River catchment (Hammer 2004) this species is now known from just one pool (~ 20 m length x 5 m width) in Rodwell Creek.

Whilst historically the stream section was likely perennial (owing to springs), pools now receive only intermittent surface water flow (Hammer 2009). In fact, there were no surface water flows in 2007 and 2008, and subsequently receding water levels over summer and autumn seasonally threatened this river blackfish population. Whilst lower water levels resulted in decreased habitat area and disconnection of water from emergent vegetation, the lack of significant inflows has lead to diminished dissolved oxygen concentrations. Furthermore, when flows have occurred, 'built up' organic matter has been deposited in the pool, exacerbating concerns over low dissolved oxygen concentrations. This site is intensely managed and is being provided with environmental water, transported to the site, on a regular basis, in order to mitigate the impact of reduced water levels and reduced dissolved oxygen concentrations.

#### Fish sampling effort

*Spring 2008, autumn 2009, spring 2009 and autumn 2010*

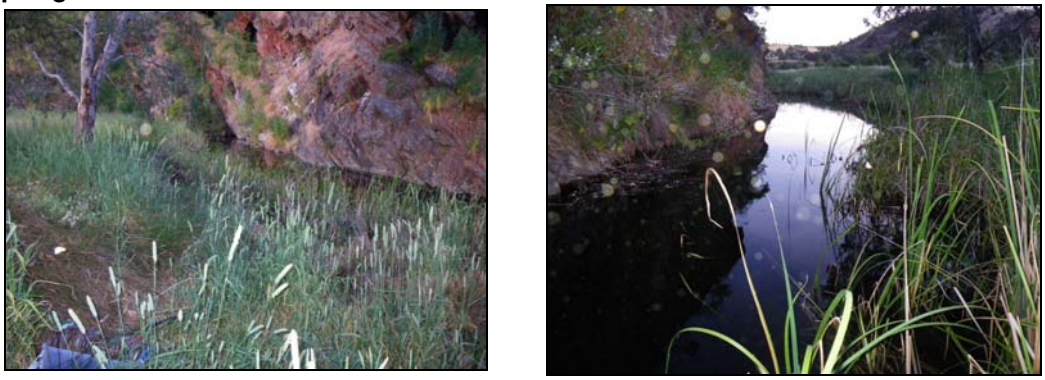
- 10 baited box traps set for 1.5 hours on dusk

Sampling effort at this site is minimal for several reasons. Firstly, blackfish are nocturnal and are most active on dusk and hence the sampling method targets peak activity and thus sampling efficiency. Secondly, trapping time is limited to 1.5 hours to limit the risk of fish death due to localised low dissolved oxygen concentrations often recorded at this site (Table 7).

## 2009/10 Photo-point images

**Winter 2009**

**Spring 2009**



**Summer 2010**

**Autumn 2010**

**Figure 6.** Photo-point images of the Rodwell Creek site from winter 2009, spring 2009, summer 2010 and autumn 2010.

## Environmental conditions

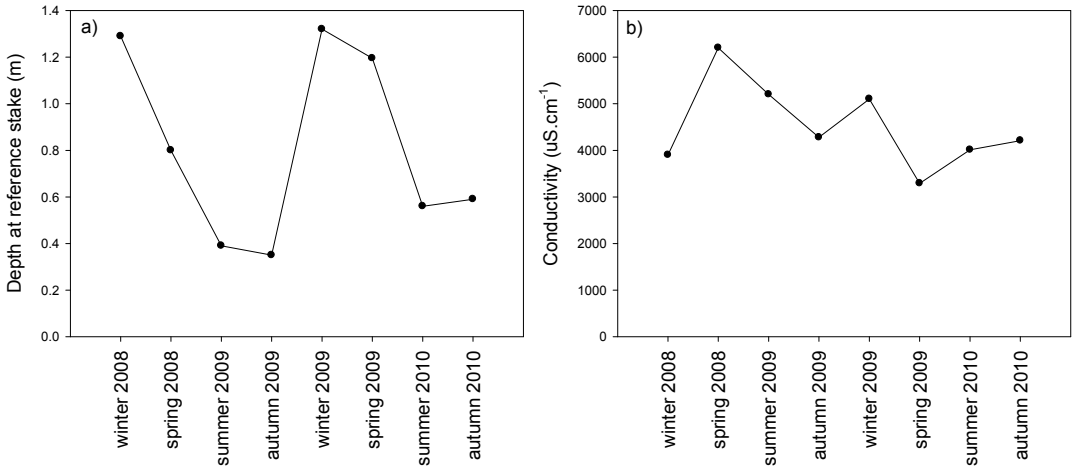



**Figure 7.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (µS.cm$^{-1}$) at the Rodwell Creek site between winter 2008 and autumn 2010.

**Table 6.** Habitat cover measured at Rodwell Creek during each site visit. Habitat cover is measured as the proportion (percent (%) cover) of aquatic habitat area comprised of submerged and emergent vegetation, physical structure or open water.

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | 0 | 40 (*Typha*) | 10 (rock) | 50 |
| Spring 2009 | 10 (algae) | 40 (*Typha*) | 10 (rock) | 40 |
| Summer 2010 | 20 (algae) | 30 (*Typha*) | 10 (rock) | 40 |
| Autumn 2010 | 10 (algae) | 30 (*Typha*) | 10 (rock) | 50 |

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

| Season | Temp (ºC) | pH | DO (ppm) surface | DO (ppm) bottom | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|---|
| Winter 2009 | 11 | 6.9 | 7.4 | 5.1 | 1.2 | 2 |
| Spring 2009 | 23.5 | 7.62 | 4.15 | 0.38 | 0.65 | 2 |
| Summer 2010 | 21.6 | 8.04 | 3.67 | 1.05 | >1.1 | 1.1 |
| Autumn 2010 | 15.4 | 7.53 | 6.13 | 4.79 | >1.5 | 1.5 |

## Catch summary and length-frequency analysis

River blackfish were sampled in consistently low numbers in 2009/10, albeit slightly lower than 2008/09 (Table 8). Individuals ranged from 126 – 169 mm and 161 – 226 mm TL in spring 2008 and autumn 2009 and 170 – 232 mm and 185 – 234 mm TL in

spring 2009 and autumn 2010 (Figure 8a-d). As such, growth of resident fish was evident but there was no evidence of recent recruitment. Carp gudgeon and eastern gambusia have also been sampled at this site.

**Table 8.** Total numbers of fish species collected from Rodwell Creek between spring 2008 and autumn 2010.

| **Species** | | **Sampling trip** | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **River blackfish** | ***Gadopsis marmoratus*** | **6** | **11 (+ 3 obs)** | **4** | **4 (+ 1 obs)** |
| Carp gudgeon complex | *Hypseleotris spp.* | 0 | 2 | 0 | 30 |
| Gambusia | *Gambusia holbrooki* | 0 | 3 | 2 | 0 |

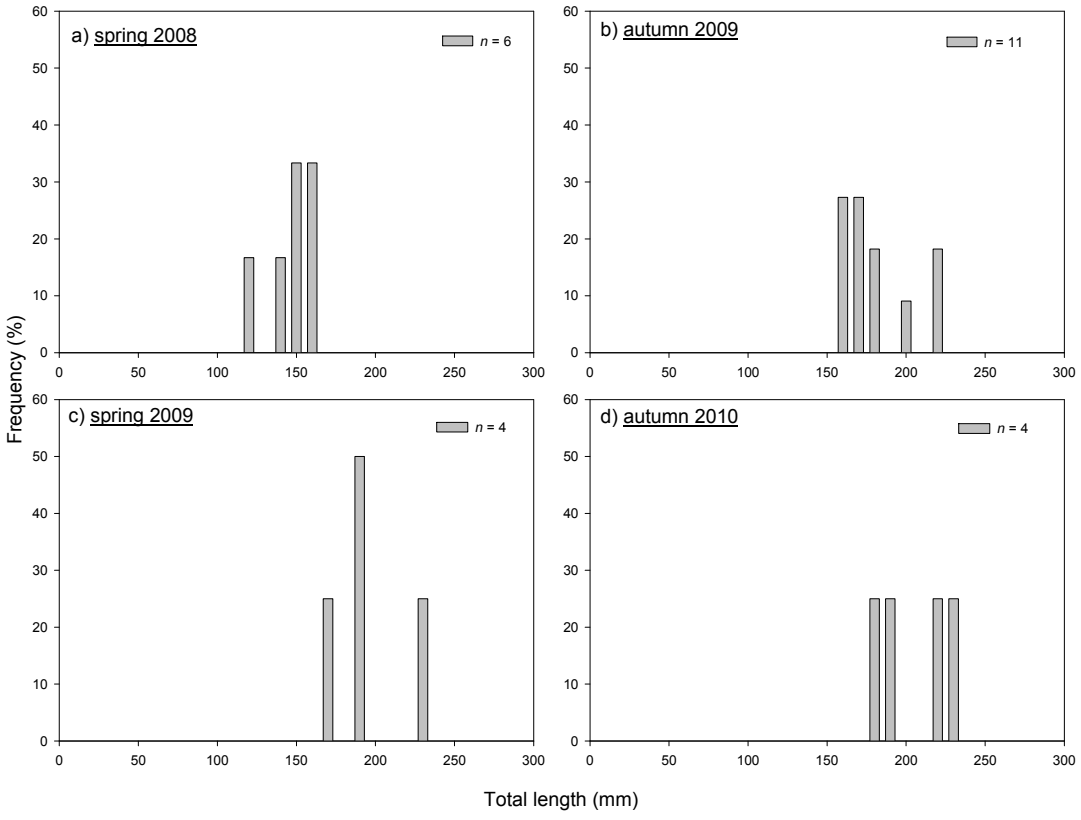



**Figure 8.** Length frequency distribution of river blackfish from Rodwell Creek in a) spring 2008, b) autumn 2009, c) spring 2009 and d) autumn 2010.

**Site summary**

River blackfish are persisting at this site in low numbers but recent recruitment was not detected. This site has been intensely managed for the past 2 years due to the risk posed by low water levels and low dissolved oxygen concentrations (DO, ppm) (Table 7). This has involved trucking environmental water to the site during times of low water level and low DO (i.e. < 3 ppm), which aims to maintain water level above a height of 0.3 m at the reference stake and thus supplement local rainfall runoff and occasional stream flow (Figure 7). Furthermore, an aerator has been installed to provide further oxygen to the pool and appears to be maintaining slightly higher DO concentrations (Table 7) than in 2008/09 (see Bice *et al.* 2009). A captive breeding trial is being undertaken, with adult fish from this population, by SARDI Aquatic Sciences, which aims to develop propagation techniques and allow for a captive breeding program (Westergaard and Ye 2010). Nonetheless, this population remains at significant risk of loss.

### 4.3. Marne River (Marne River: river blackfish)

The Marne River flows in an easterly direction from the EMLR before entering the River Murray below Lock 1. This site is on the Lower Marne River and habitat consists of a series of perennially ground-fed, cool, clear-water pools with abundant emergent vegetation (Figure 9) (Hammer 2009). Surface water inflows have been minimal since 2005 (Hammer 2009).

Sampling at this site has been conducted since 2002, with river blackfish consistently sampled in low numbers (Hammer 2009). Importantly, recruitment has not been observed since 2002 (Hammer 2009).

#### Fish sampling effort

*Spring 2008, spring 2009 and autumn 2010*

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

*Autumn 2009*

- 6 baited (yabbie) box traps set for 1 hour at dusk.

Sampling effort at this site is minimal for several reasons. Firstly, blackfish are nocturnal and are most active on dusk, and hence the sampling method targets peak activity and thus sampling efficiency. Secondly, trapping time is limited to 1 hour to limit the risk of fish death due to localised low dissolved oxygen concentrations often recorded at this site (Table 10). A white plume of unknown composition has been observed at the bottom to lower half of the pool on several occasions, which appears to be producing anoxic conditions in its vicinity.

## 2009/10 Photo-point images

**Winter 2009**


**Spring 2009**


**Summer 2010**


**Autumn 2010**


**Figure 9.** Photo-point images of the Marne River site from winter 2009, spring 2009, summer 2010 and autumn 2010.

## Environmental conditions

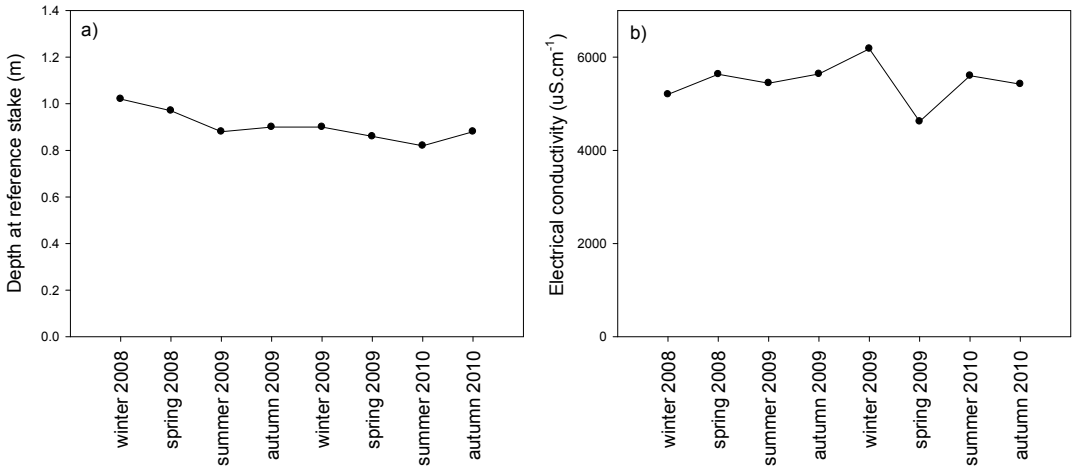



**Figure 10.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (µS.cm$^{-1}$) at the Marne River site between winter 2008 and autumn 2010.

**Table 9.** Habitat cover measured at the Marne River site during each site visit. Habitat cover is measured as the proportion (percent (%) cover) of aquatic habitat area comprised of submerged and emergent vegetation, physical structure or open water.

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | 0 | 40 (*Typha, Phragmites*) | 0 | 60 |
| Spring 2009 | 5 (algae) | 40 (*Typha, Phragmites*) | 0 | 55 |
| Summer 2010 | 0 | 40 (*Typha, Phragmites*) | 5 (leaf litter) | 55 |
| Autumn 2010 | 1 (algae) | 20 (*Typha, Phragmites*) | 5 (leaf litter) | 74 |

**Table 10.** Water quality parameters measured at the Marne River site during each site visit.

| Season | Temp (ºC) | pH | DO (ppm) surface | DO (ppm) bottom | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|---|
| Winter 2009 | 13.9 | 7.5 | 6.42 | 2.2 | >1.4 | 1.4 |
| Spring 2009 | 19.8 | 7.27 | 4.32 | 0.77 | >1.3 | 1.3 |
| Summer 2010 | 22.3 | 7.6 | 3.97 | 0.73 | >1.2 | 1.2 |
| Autumn 2010 | 14.2 | 7.44 | 5.54 | 1.5 | >1.2 | 1.2 |

## Catch summary and length-frequency analysis

Consistently low numbers of river blackfish were sampled across 2008/09 and 2009/10 (Table 11). Carp, gudgeon, mountain galaxias and eastern gambusia have also been sampled at the site (Table 11). All river blackfish sampled at this site

throughout the project have been large adult fish (>200 mm TL) and thus no recent recruitment has been detected (Figure 11a-d).

**Table 11.** Total numbers of fish species collected from the Marne River between spring 2008 and autumn 2010.

| **Species** | | **Sampling trip** | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **River blackfish** | ***Gadopsis marmoratus*** | **3 (+3 observed)** | **1 (+4 observed)** | **5** | **4** |
| Carp gudgeon complex | *Hypseleotris spp.* | 3 | 1 | 1 | 0 |
| Mountain galaxias | *Galaxias olidus* | 4 | 0 | 0 | 1 |
| Gambusia | *Gambusia holbrooki* | 0 | 1 | 3 | 17 |

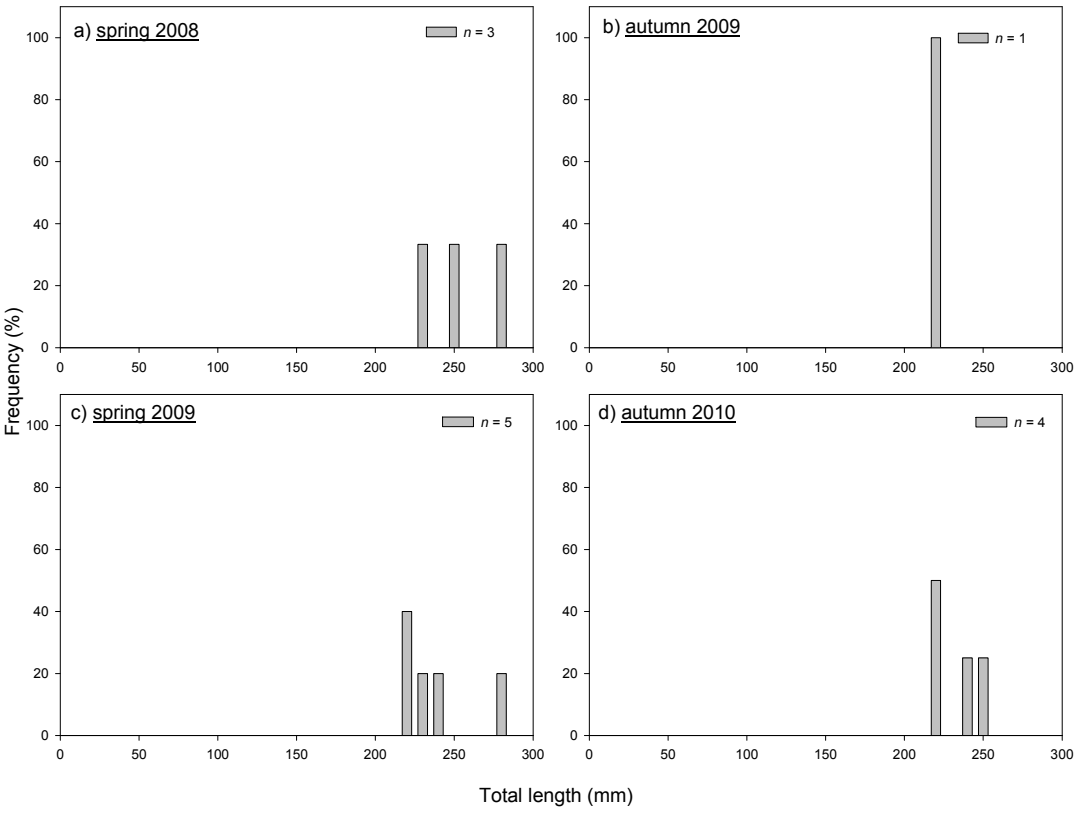



**Figure 11.** Length frequency distribution of river blackfish from the Marne River in a) spring 2008, b) autumn 2009, c) spring 2009 and d) autumn 2010.

## Site summary

River blackfish are still present in the Marne River but the continued lack of recruitment represents a significant risk to this population. Previous data suggest that recruitment has now not occurred for ≥ eight years (Hammer 2009). Artificial spawning tubes (PVC pipes of different diameters) have been installed at this site and in spring 2009 eggs were found attached to the inner surface of a spawning tube (Figure 12a). Thus, it appears attempts to spawn are being made and recruitment is not occurring due either to limited fertilisation or egg/larval survival.

An anoxic white plume was observed several times through 2008/09 and again in 2009/10 at the bottom of the pool and fish appear to be avoiding this area (pers obs), which may be reducing available habitat and feeding area (Figure 12b). The composition of this plume remains unknown.

a) b)

**Figure 12.** a) River blackfish eggs within an artificial spawning tube installed in the Marne River and b) underwater image of an anoxic white plume regularly observed at this site.

### 4.4. Angas Gauge site (Angas River: river blackfish)

This site is on the Angas River, which drains part of the EMLR before discharging into Lake Alexandrina near Milang. The reach of the Angas River where this site is located is dominated by a series of large, deep, bedrock-based clear-water pools separated by small waterfalls (Figure 13) (Hammer 2009). Fringing emergent vegetation (i.e. *Typha domingensis* and *Phragmites australis*) is abundant. Flow through this reach is largely permanent with significant ground-water base flows (Hammer 2009).

This site has been sampled since 2004. Whilst river blackfish were most abundant in 2004 they have typically been sampled in moderate – high numbers in subsequent years (Hammer 2009).

#### Fish sampling effort

*Spring 2008, autumn 2009, spring 2009 and autumn 2010*

- 3 fyke nets set overnight

## 2009/10 Photo-point images

**Winter 2009**


**Spring 2009**


**Summer 2010**


**Autumn 2010**


**Figure 13.** Photo-point images of the Angas Gauge site from winter 2009, spring 2009, summer 2010 and autumn 2010.

## Environmental conditions

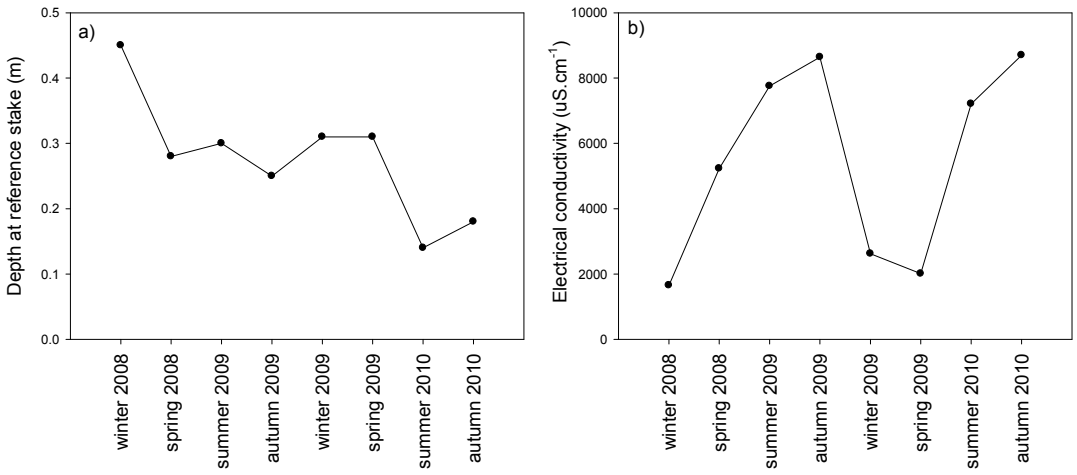



**Figure 14.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (µS.cm$^{-1}$) at the Angas River Gauge site between winter 2008 and autumn 2010.

**Table 12.** Habitat cover measured at the Angas River Gauge site during each site visit. Habitat cover is measured as the proportion (percent (%) cover) of aquatic habitat area comprised of submerged and emergent vegetation, physical structure or open water.

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | 5 (algae) | 10 (*Typha, Phragmites*) | 20 (rock) | 65 |
| Spring 2009 | 20 (algae) | 10 (*Typha, Phragmites*) | 10 (rock) | 60 |
| Summer 2010 | 5 (algae) | 20 (*Typha, Phragmites*) | 20 (rock) | 55 |
| Autumn 2010 | 10 (algae) | 5 (*Typha, Phragmites, Triglochin*) | 20 (rock) | 65 |

**Table 13.** Water quality parameters measured at the Angas River Gauge site during each site visit.

| Season | Temp (ºC) | pH | DO (ppm) surface | DO (ppm) bottom | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|---|
| Winter 2009 | 14.3 | 7.9 | 8.32 | - | >2.5 | 2.5 |
| Spring 2009 | 24.6 | 7.86 | 6.47 | 5.24 | 0.72 | 2.5 |
| Summer 2010 | 25.3 | 7.87 | 5.83 | 4.96 | >2 | 2 |
| Autumn 2010 | 19.8 | 8.16 | 7.23 | 4.4 | >2 | 2 |

## Catch summary and length-frequency analysis

River blackfish were sampled in moderate numbers in both spring 2009 and autumn 2010 as in 2008/09 (Table 14). Other species sampled include carp gudgeon, flat-headed gudgeon, dwarf flat-headed gudgeon, mountain galaxias and tench (Table 14).

**Table 14.** Total numbers of fish species collected from the Angas River Gauge site between spring 2008 and autumn 2010.

| **Species** | | **Sampling trip** | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **River blackfish** | ***Gadopsis marmoratus*** | **17** | **26** | **27** | **28** |
| Carp gudgeon complex | *Hypseleotris spp.* | 20 | 36 | 41 | 20 |
| Flat-headed gudgeon | *Philypnodon grandiceps* | 12 | 14 | 14 | 32 |
| Dwarf flat-headed gudgeon | *Philypnodon macrostomus* | 8 | 2 | 1 | 7 |
| Mountain galaxias | *Galaxias olidus* | 1 | 0 | 2 | 10 |
| Tench | *Tinca tinca* | 1 | 9 | 4 | 0 |

River blackfish exhibited broad length distributions in 2008/09 with fish ranging 105 – 265 mm TL in spring 2008 and 118 – 228 mm TL in autumn 2009 (Figure 15a & b). Similarly in spring 2009, fish ranged 95 – 237 mm TL and 120 – 239 mm TL (Figure 15c & d). As such separate recruitment events have been observed at this site in 2008/09 and 2009/10.

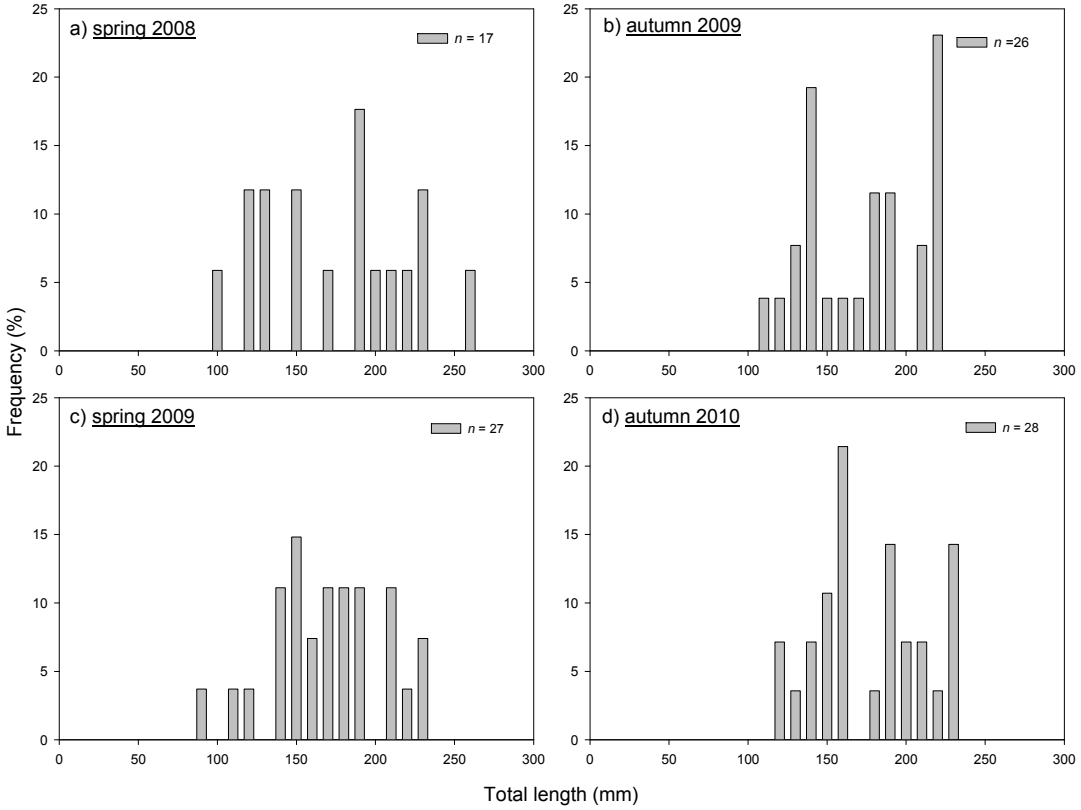



**Figure 15.** Length frequency distribution of river blackfish from the Angas River Gauge site in a) spring 2008, b) autumn 2009, c) spring 2009 and d) autumn 2010.

## Site summary

The river blackfish population at this site appears stable, as evidenced by recent recruitment observed in both 2008/09 and 2009/10 and a range of different aged (length) fish in the population. Electrical conductivity at this site reached ~8000 $\mu S.cm^{-1}$ in autumn each year and has been steadily increasing since 2004 (Hammer 2009), which is likely to be unfavourable for river blackfish. However, increased salinity appears to be offset by a seasonal trend of decreasing conductivity (~2000 $\mu S.cm^{-1}$) upon winter flows.

### 4.5. Willoburn Road, Nangkita Creek (Tookayerta Creek: river blackfish and southern pygmy perch)

This site is on Nangkita Creek, a tributary of Tookayerta Creek, which flows out of the southern EMLR before meeting the Finniss River and flowing into the Goolwa Channel on the south-western side of Lake Alexandrina. This catchment has highly contrasting geomorphology and hydrology to other catchments of the EMLR (Hammer 2009). There are significant ground-water interactions and subsequently perennial lotic habitats are present in some reaches. Habitat at this site is comprised of a mosaic of braided lotic channels, deep pools and riffles with complex structure (i.e. debris, willow roots and emergent vegetation) (Figure 16) and low salinity (typically <500 $\mu S.cm^{-1}$).

This site has been monitored since 2001 (see Hammer 2004; Hammer 2009). Both river blackfish and southern pygmy perch have been regularly captured in consistent numbers over time at this site.

#### Fish sampling effort

*Spring 2008*

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

*Autumn 2009*

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

*Spring 2009*

- Backpack electrofishing (807 seconds, 75 Hz, 220 v, 10% DC)

*Autumn 2010*

- Backpack electrofishing (637 seconds, 75 Hz, 220 v, 10% DC)

## 2009/10 Photo-point images

**Winter 2009**

**Spring 2009**

**Summer 2010**

**Autumn 2010**

**Figure 16.** Photo-point images of the Willowburn Rd Nangkita Creek site from winter 2009, spring 2009, summer 2010 and autumn 2010.

## Environmental conditions

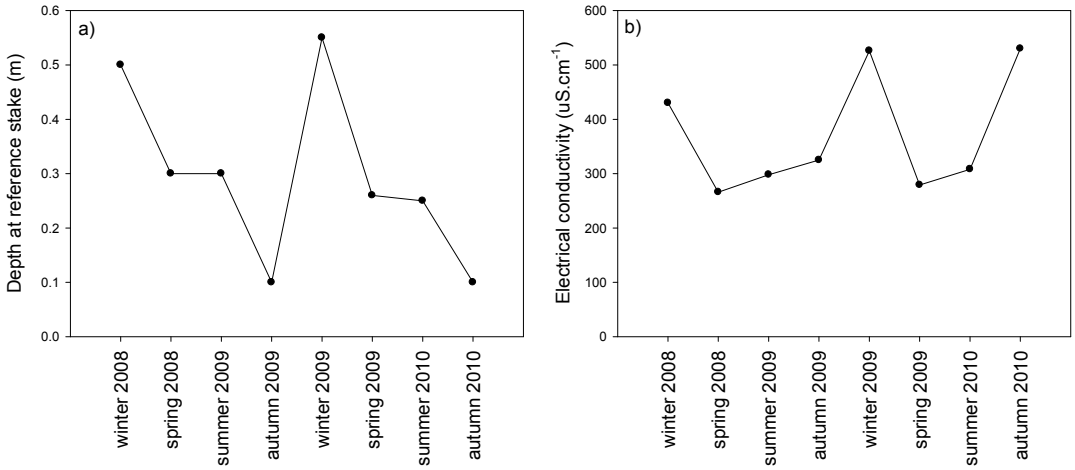



**Figure 17.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (µS.cm$^{-1}$) at the Willowburn Road site between winter 2008 and autumn 2010.

**Table 15.** Habitat cover measured at Willowburn Road during each site visit. Habitat cover is measured as the proportion (percent (%) cover) of aquatic habitat area comprised of submerged and emergent vegetation, physical structure or open water.

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | 0 | 40 (Willow, *Persicaria, Callatriche*) | 5 (snag) | 55 |
| Spring 2009 | 0 | 30 (Willow, *Persicaria, Callatriche*) | 30 (snag) | 40 |
| Summer 2010 | 30 (*Azolla*) | 10 (Willow, *Persicaria, Callatriche*) | 10 (snag) | 50 |
| Autumn 2010 | 0 | 20 (Willow, *Callatriche*) | 40 (snag) | 40 |

**Table 16.** Water quality parameters measured at Willowburn Road during each site visit.

| Season | Temp (ºC) | pH | DO (ppm) surface | DO (ppm) bottom | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|---|
| Winter 2009 | 13.8 | 6.8 | 9 | 4.4 | 0.45 | 1.02 |
| Spring 2009 | 16.6 | 7.53 | 5.19 | 2.76 | 0.5 | 1.3 |
| Summer 2010 | 19.9 | 7.52 | 6.28 | - | 0.7 | 1 |
| Autumn 2010 | 15.4 | 7.23 | 8.29 | 6.1 | >1 | 1 |

## Catch summary and length-frequency analysis

River blackfish and southern pygmy perch were sampled in consistent numbers across all sampling events in 2008/09 and 2009/10 (Table 17). Mountain galaxias was the only other species sampled in 2008/09, whilst mountain galaxias together with the non-native eastern gambusia and rainbow trout were sampled in 2009/10 (Table 17).

**Table 17.** Total numbers and abundance (in bracket; number of fish.100 seconds of e-fishing$^{-1}$) of fish species collected from the Willowburn Road site between spring 2008 and autumn 2010.

| **Species** | | **Sampling trip** | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **River blackfish** | ***Gadopsis marmoratus*** | **8 (1.22)** | **7 (0.74)** | **13 (1.61)** | **11 (1.73)** |
| **Southern pygmy perch** | ***Nannoperca australis*** | **7 (1.02)** | **24 (2.54)** | **24 (2.97)** | **21 (3.30)** |
| Mountain galaxias | *Galaxias olidus* | 7 (1.02) | 153 (16.19) | 19 (2.35) | 35 (5.49) |
| Eastern gambusia | *Gambusia holbrooki* | 0 | 0 | 1 (0.12) | 0 |
| Rainbow trout | *Onchorrychus myskiss* | 0 | 0 | 1 (0.12) | 0 |

Juvenile river blackfish, 62 – 82 mm TL dominated the population in spring 2008 (Figure 18a). Data from autumn 2009 shows the growth of this cohort and the presence of a young-of-year individual (43 mm TL) (Figure 18b). Length-distribution in spring 2009 was broad with fish ranging 73 – 185 mm TL (Figure 18c). Growth of these individuals was evident by autumn 2010 with fish exhibiting a similarly broad but larger length range (97 – 195 mm TL) (Figure 18d).

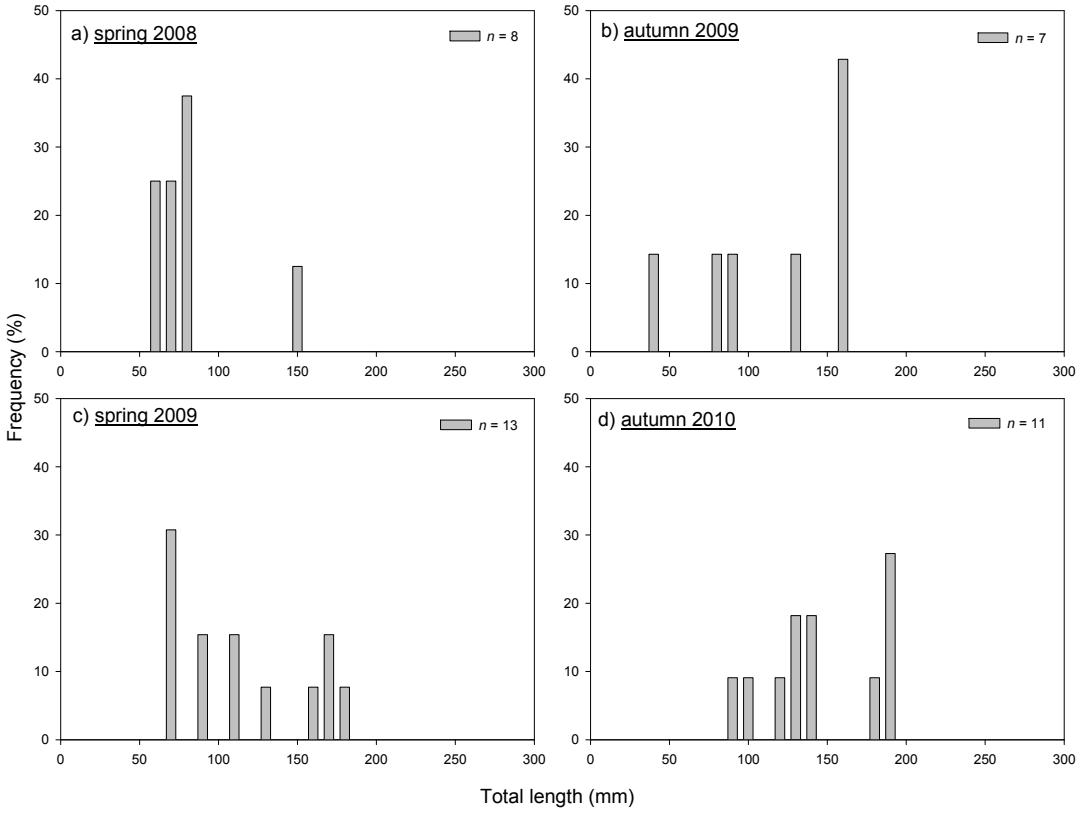



**Figure 18.** Length frequency distribution of river blackfish from the Willowburn Road site in a) spring 2008, b) autumn 2009, c) spring 2009 and d) autumn 2010.

In spring 2008 the southern pygmy perch population was dominated by adult fish (> 40 mm TL) (Figure 19a) but significant recruitment was observed in autumn 2009 with > 45% of the population comprised of YOY individuals (Figure 19b). Similarly in spring 2009 the population was dominated by adult fish >40 mm TL (Figure 19c). However, in autumn 2010 recruitment is not as clear, nonetheless fish <45 mm TL may represent YOY individuals (Figure 19d)

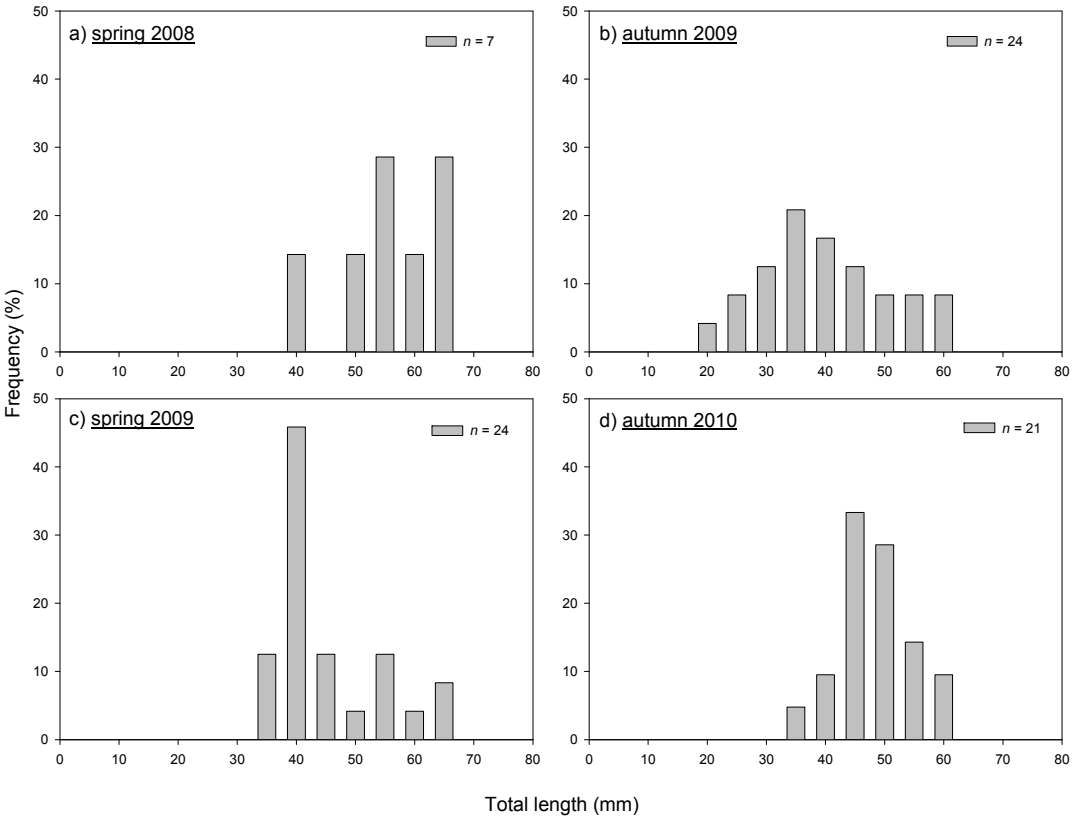



**Figure 19.** Length frequency distribution of southern pygmy perch from the Willowburn Road site in a) spring 2008, b) autumn 2009, c) spring 2009 and d) autumn 2010.

## Site summary

Both river blackfish and southern pygmy perch populations appear stable. Both populations have exhibited recent recruitment and have diverse population structures (i.e. broad size ranges). Furthermore, habitat conditions also appear stable and favourable for the persistence of these species. Sedimentation has been observed at this site, which may account for reduced depth at the reference stake rather than decreased flow/water levels (Figure 17a).

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

This site is on the lowland channel section of Tookayerta Creek, which flows out of the southern EMLR before meeting the Finniss River and flowing into the Goolwa Channel on the south-western side of Lake Alexandrina. This reach consists of large, deep pools dominated by fringing emergent vegetation (e.g. *Phragmites australis, Typha domingensis, Triglochin striatum*), interspersed with sections of swamp (Figure 20) (Hammer 2009).

Monitoring has occurred at this site since 2001 (see Hammer 2004; Hammer 2009). Southern pygmy perch were formerly sampled in moderate – high numbers, whilst river blackfish have been consistently sampled in low numbers, with occasional spikes in the abundance of YOY in autumn.

#### Fish sampling effort

*Spring 2008*

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

*Autumn 2009*

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

*Spring 2009*

- Backpack electrofishing (parameters not recorded)

*Autumn 2010*

- Backpack electrofishing (553 seconds, 75 Hz, 250 v, 10% DC)

## 2009/10 Photo-point images

**Winter 2009**

**Spring 2009**

**Summer 2010**

**Autumn 2010**

**Figure 20.** Photo-point images of the Deep Creek Rd site from winter 2009, spring 2009, summer 2010 and autumn 2010.

## Environmental conditions

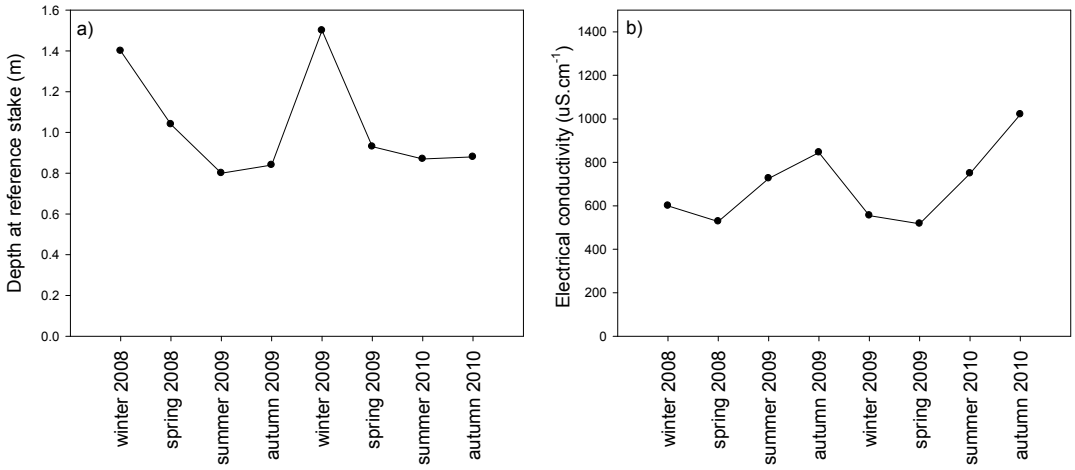



**Figure 21.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (µS.cm$^{-1}$) at the Deep Creek Road site between winter 2008 and autumn 2010.

**Table 18.** Habitat cover measured at Deep Creek Road during each site visit. Habitat cover is measured as the proportion (percent (%) cover) of aquatic habitat area comprised of submerged and emergent vegetation, physical structure or open water.

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | 0 | 50 (*Typha, Phragmites*) | 0 | 50 |
| Spring 2009 | 0 | 70 (*Typha, Phragmites, Triglochin, Callitriche*) | 0 | 30 |
| Summer 2010 | 0 | 80 (*Typha, Phragmites, Triglochin*) | 0 | 20 |
| Autumn 2010 | 0 | 80 (*Typha, Phragmites, Triglochin*) | 0 | 20 |

**Table 19.** Water quality parameters measured at Deep Creek Road during each site visit.

| Season | Temp (ºC) | pH | DO (ppm) surface | DO (ppm) bottom | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|---|
| Winter 2009 | 13.1 | 7.59 | 10.46 | | 0.5 | 2.2 |
| Spring 2009 | 19.6 | 7.09 | 5.08 | | 0.7 | 1.7 |
| Summer 2010 | 21.7 | 7.92 | 6.12 | 3.55 | 0.6 | 0.92 |
| Autumn 2010 | 17 | 6.88 | 9.93 | 8.99 | 0.9 | 1.6 |

## Catch summary and length-frequency analysis

River blackfish were present in consistent numbers in spring 2008, autumn 2009 and spring 2009 but were more abundant in autumn 2010 (Figure 22a & b; Table 20).

Conversely, southern pygmy perch were present in consistent numbers in spring 2008, autumn 2009 and spring 2009 but were less abundant in autumn 2010 (Figure 22a; Table 20). Mountain galaxias was the only other species sampled (Table 20).

a) b)

**Figure 22.** a) a mixed catch of southern pygmy perch and adult and juvenile river blackfish sampled in autumn 2010 and b) a young-of-year river blackfish (37 mm TL) also sampled in autumn 2010.

**Table 20.** Total numbers of fish species collected from the Deep Creek Road site between spring 2008 and autumn 2010.

| Species | | Sampling trip | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **River blackfish** | ***Gadopsis marmoratus*** | **3 (0.38)** | **5 (0.83)** | **4** | **16 (2.89)** |
| **Southern pygmy perch** | ***Nannoperca australis*** | **21 (2.65)** | **13 (2.17)** | **15** | **5 (0.9)** |
| Mountain galaxias | *Galaxias olidus* | 1 (0.13) | 0 | 0 | 0 |

In spring 2008 river blackfish ranged from 80-98 mm TL (Figure 23a), most likely representing recruits from the previous spring. This cohort was present in autumn 2009 but had grown to *c.* 120 mm TL, whilst a new cohort of young-of-year individuals was also present (39-51 mm TL; Figure 23b) suggesting recent recruitment. One large adult (212 mm TL) was also present (Figure 23b). Growth of this YOY cohort was evident in spring 2009 with a cohort ranging 117 – 129 mm TL (Figure 23c). In autumn 2010, 16 individuals were sampled and three distinct cohorts (age classes) were evident (Figure 23d). Adult fish were present at 142 – 169 mm TL, whilst there were two juvenile cohorts; one ranging 81-98 mm TL and the other 37 – 58 mm TL, indicating that spawning occurred during the previous spring (Figure 23d).

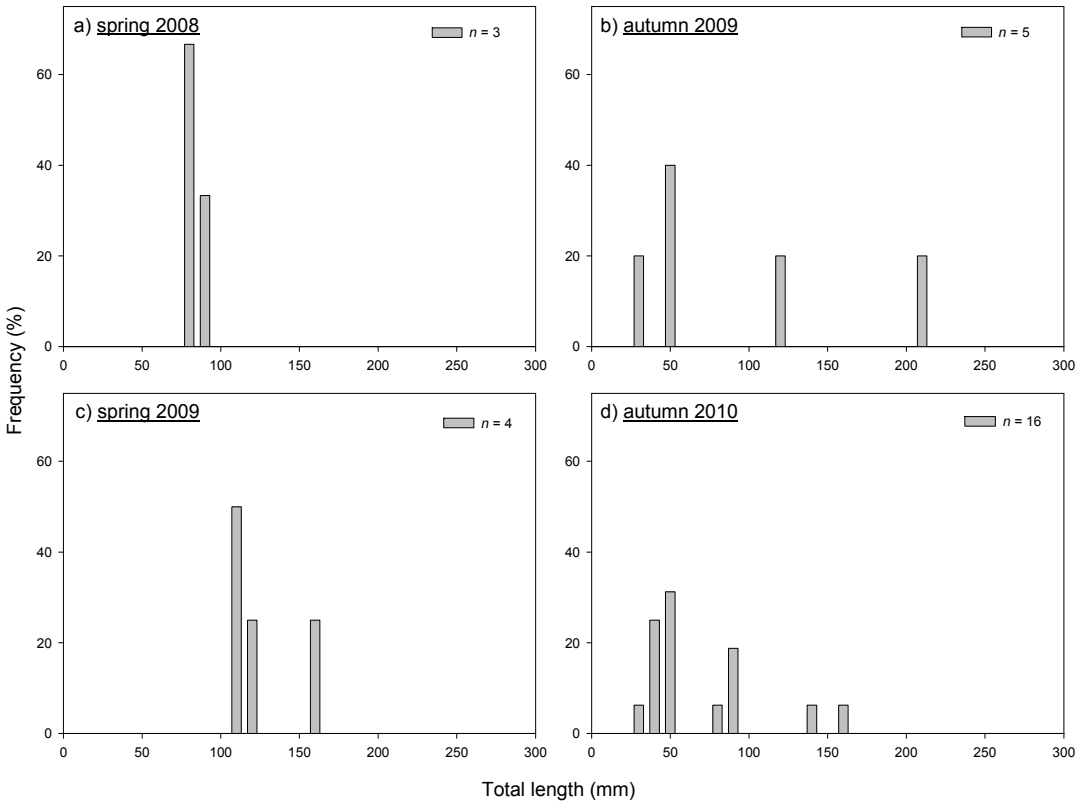



**Figure 23.** Length frequency distribution of river blackfish from the Deep Creek Road site in a) spring 2008, b) autumn 2009, c) spring 2009 and d) autumn 2010.

In spring 2008 *c.* 40% of southern pygmy perch individuals were < 35 mm TL and are likely to be recruits from late in the previous spawning season based upon similar length frequency distributions from this site in previous years (Hammer 2009) (Figure 24a). In autumn 2009, the population exhibited a very broad length distribution, with a cohort of YOY (10-35 mm TL) likely spawned in spring/summer (Figure b). Large adult fish (>60 mm TL) were also present (Figure 24b). Growth of this YOY cohort was evident in spring 2009 and the length-frequency distribution appears similar to spring 2008 (Figure 24a & c). Nonetheless, in autumn 2010, length-frequency distribution is dissimilar to the previous, although just 5 individuals were sampled (Figure 24d). The cohort centred around 30 mm TL is likely to represent YOY from spring/summer spawning but no recently recruited individuals were present as in autumn 2009.

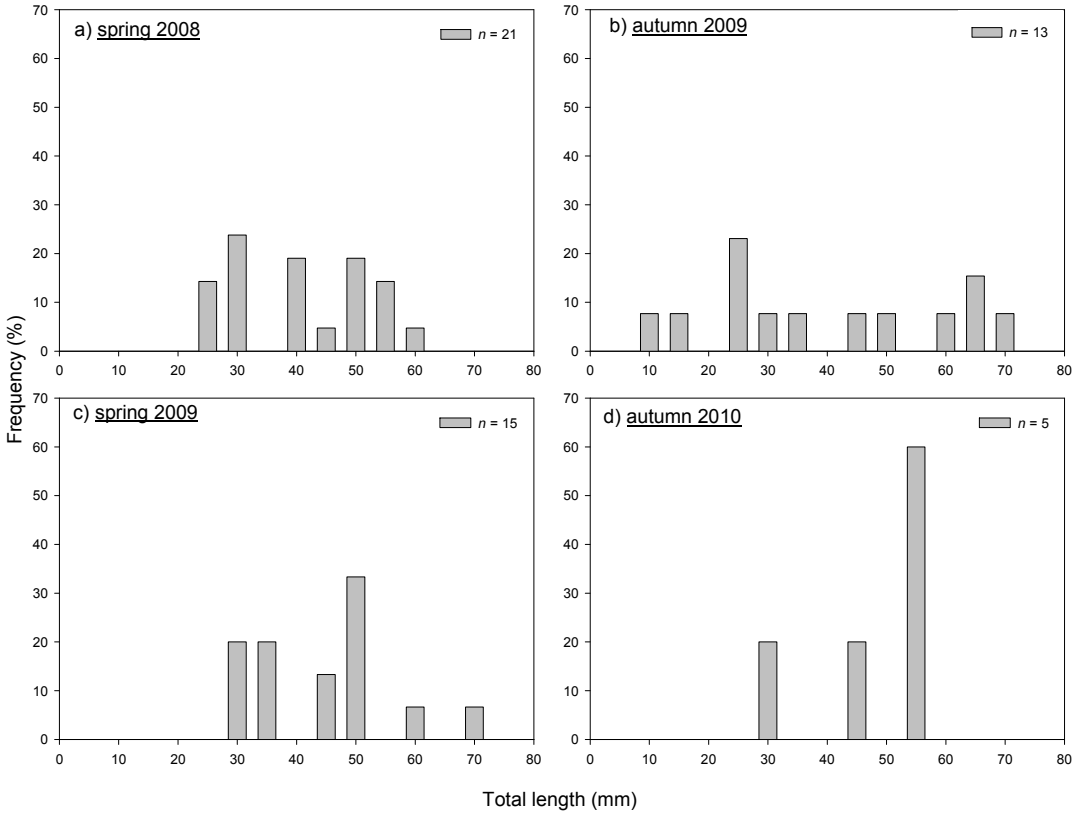



**Figure 24.** Length frequency distribution of southern pygmy perch from the Deep Creek Road site in a) spring 2008, b) autumn 2009, c) spring 2009 and d) autumn 2010.

## Site summary

The River blackfish population is likely to be stable with a slight increase in abundance in autumn 2010 after substantial recent recruitment. Furthermore the population possesses a diverse age structure (i.e. broad size range). Southern pygmy perch have slightly decreased in abundance since 2008/09 but exhibited a greater decline when compared to previous sampling at this site pre-2008 (Hammer 2009). Nevertheless, there has been recent recruitment and this population is likely to be performing satisfactorily.

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

Middle Creek is a tributary of the Angas River, flowing into the Angas River near Strathalbyn. The Angas River flows south-east from here before discharging into Lake Alexandrina near the township of Milang. This site could be characterised as a narrow creek reach and habitat is dominated by abundant emergent (*Phragmites australis, Typha domingensis, Schoenoplectus validus*) and submerged (*Potamogetan tricarinatus*) vegetation (Figure 25). Southern pygmy perch have been consistently sampled in low – moderate numbers at this site since 1999 (Hammer 2005; Hammer 2009).

#### Fish sampling effort

*Spring 2008, autumn 2009, spring 2009 and autumn 2010*

- 1 fyke net set overnight

## 2009/10 Photo-point images

**Winter 2009**


**Spring 2009**


**Summer 2010**


**Autumn 2010**


**Figure 25.** Photo-point images of the Middle Creek Junction site from winter 2009, spring 2009, summer 2010 and autumn 2010.

## Environmental conditions

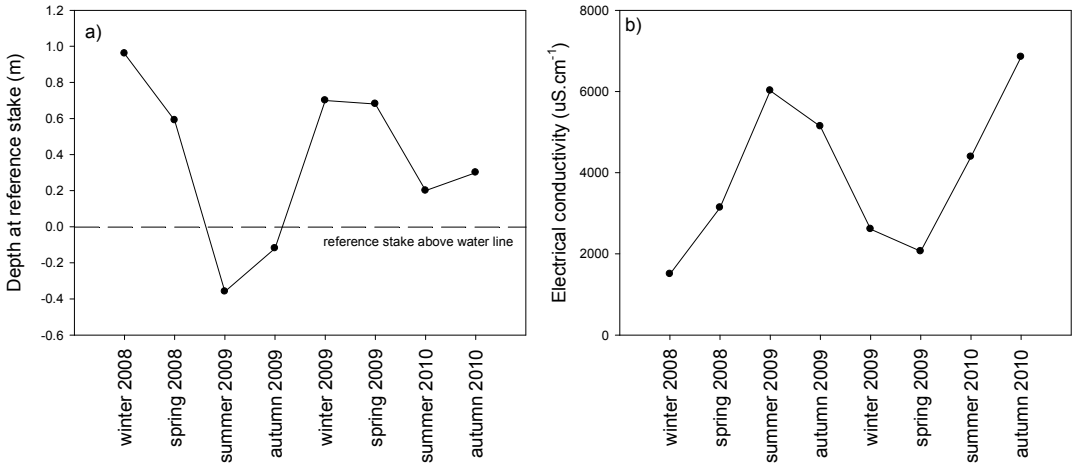



**Figure 26.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (µS.cm$^{-1}$) at the Middle Creek Junction site between winter 2008 and autumn 2010.

**Table 21.** Habitat cover measured at Middle Creek Junction during each site visit. Habitat cover is measured as the proportion (percent (%) cover) of aquatic habitat area comprised of submerged and emergent vegetation, physical structure or open water.

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | 10 (*Potamogeton*) | 70 (*Typha, Phragmites*) | 0 | 20 |
| Spring 2009 | 20 (*Potamogeton*) | 60 (*Typha, Phragmites*) | 0 | 20 |
| Summer 2010 | 0 | 90 (*Typha, Phragmites, Triglochin*) | 0 | 10 |
| Autumn 2010 | 50 (*Potamogeton*) | 30 (*Typha, Phragmites*) | 0 | 20 |

**Table 22.** Water quality parameters measured at Middle Creek Junction during each site visit.

| Season | Temp (ºC) | pH | DO (ppm) | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|
| Winter 2009 | 13.5 | 7.83 | 8 | >1.4 | 1.4 |
| Spring 2009 | 24.4 | 7.57 | 5.23 | 1.2 | 1.4 |
| Summer 2010 | 15.9 | 7.15 | 1.1 | 0.6 | 1 |
| Autumn 2010 | 13.3 | 7.04 | 5.2 | 0.3 | 1 |

## Catch summary and length-frequency analysis

Southern pygmy perch were captured in lower numbers in 2009/10 compared to 2008/09 (Table 23). Low numbers in spring 2009 were in part due to the capture of an eastern long-neck turtle (*Chelodina longicollis*), which may have impacted fish numbers.

In spring 2008, southern pygmy perch ranged from 34-66 mm TL (Figure 27a). A large proportion of individuals (*c.* 85%) were of a similar size in autumn 2009, however, a cohort of YOY (<24 mm TL) was also present, indicating recent recruitment (Figure 27b). The single individual captured in spring 2009 was a large adult (>50 mm TL; Figure 27 c). However, in autumn 2010, the population exhibited a broad range of lengths with a large proportion (50%) of likely YOY (< 35 mm TL) (Figure 27d)

**Table 23.** Total numbers of fish species collected from the Middle Creek Junction site between spring 2008 and autumn 2010.

| **Species** | | **Sampling trip** | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **Southern pygmy perch** | ***Nannoperca australis*** | **35** | **53** | **2** | **9** |
| Carp gudgeon complex | *Hypseleotris spp.* | 21 | 11 | 0 | 5 |
| Flat-headed gudgeon | *Philypnodon grandiceps* | 4 | 0 | 0 | 0 |
| Mountain galaxias | *Galaxias olidus* | 4 | 4 | 2 | 5 |

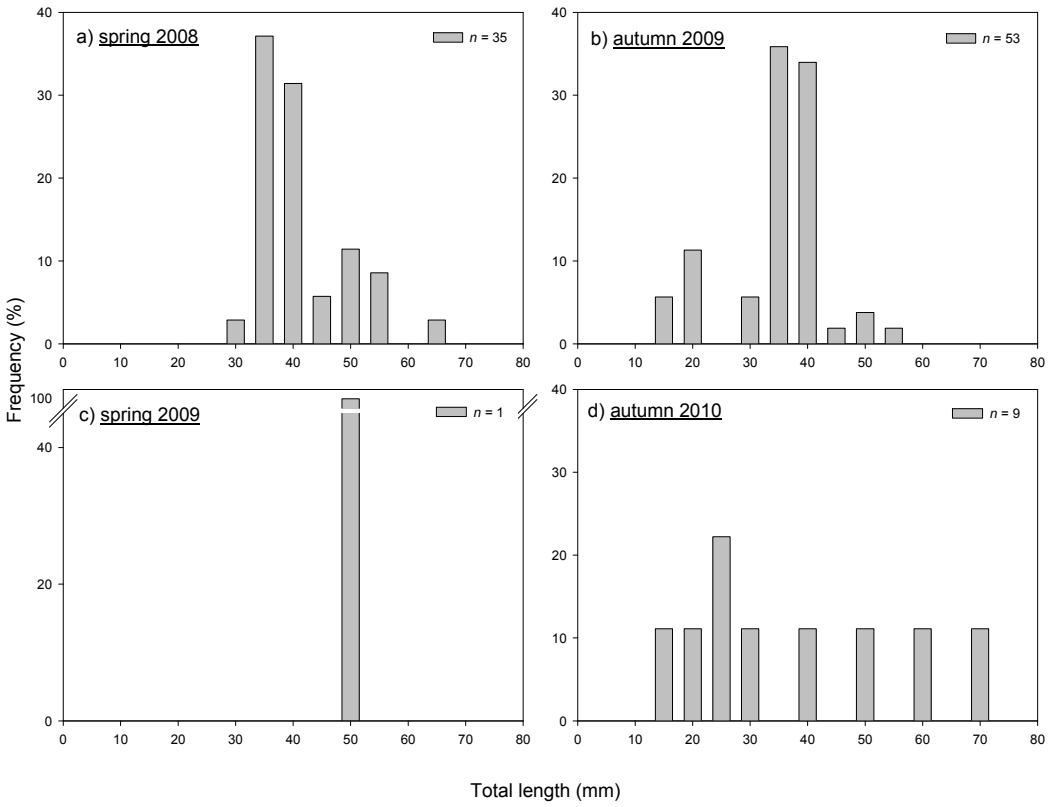



**Figure 27.** Length frequency distribution of southern pygmy perch from the Middle Creek Junction site in a) spring 2008, b) autumn 2009, c) spring 2009 and d) autumn 2010.

**Site summary**

Southern pygmy perch are persisting at this site in low numbers with moderate recruitment in autumn 2010. Water levels remained higher this year (Figure 26a) inferring greater security of habitat and thus this population remains steady.

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

Eastick Creek is on Hindmarsh Island in Lake Alexandrina and discharges into Holmes Creek (Figure 28). This site was formerly a sheltered edge habitat with abundant emergent (i.e. *Typha domingensis, Phragmites australis* and *Schoenoplectus validus*) and submerged vegetation (i.e. *Myriophyllum* spp.), but has been impacted by diminished water levels in the Lower Lakes. Submerged vegetation has vanished and fringing emergent vegetation has been largely disconnected from the water. There has also been a concurrent rise in salinity. Data for this site from autumn 2010 was collected by SARDI Aquatic Sciences as part of a DENR funded project which aimed to investigate the response of fish species to the *Goolwa Water Level Management Plan* (SA Water 2009; Bice *et al.* 2010)

This site, together with several other sites in the vicinity, has been sampled since 2003 (Wedderburn and Hammer 2003; Higham *et al.* 2005; Bice and Ye 2006; Bice and Ye 2007; Bice *et al.* 2008) and was a rescue location for several Yarra pygmy perch included in the captive breeding program being undertaken by Aquasave (last records in February 2008; Hammer 2008b). Yarra pygmy perch, southern pygmy perch and Murray hardyhead were typically sampled in low abundances.

#### Fish sampling effort

*Spring 2008 and autumn 2010*

- 4 fyke nets set overnight

*Autumn 2009 and spring 2009*

- Not sampled

## 2009/10 Photopoint images

**Winter 2009**

Not monitored

**Spring 2009**

Not monitored

**Summer 2010**

**Autumn 2010**

**Figure 28.** Photo-point images of the Eastick Creek mouth site from winter 2009, spring 2009, summer 2010 and autumn 2010.

## Environmental conditions

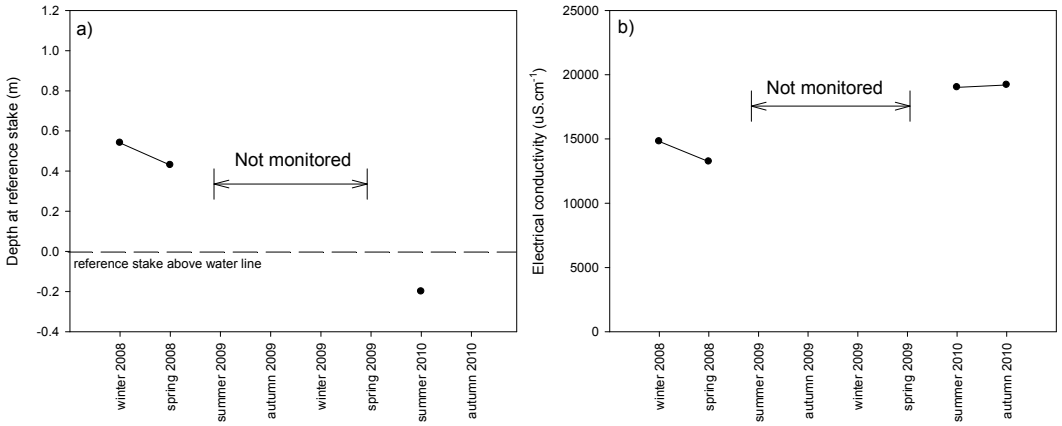



**Figure 29.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (μS.cm$^{-1}$) at the Eastick Creek mouth site between winter 2008 and autumn 2010.

**Table 24.** Habitat cover measured at Eastick Creek mouth during each site visit. Habitat cover is measured as the proportion (percent (%) cover) of aquatic habitat area comprised of submerged and emergent vegetation, physical structure or open water.

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | Not monitored | | | |
| Spring 2009 | Not monitored | | | |
| Summer 2010 | 0 | 0 | 5 (polychaete mounds) | 95 |
| Autumn 2010 | 0 | 10 | 2 (polychaete mounds) | 88 |

**Table 25.** Water quality parameters measured at Eastick Creek mouth during each site visit.

| Season | Temp (ºC) | pH | DO (ppm) | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|
| Winter 2009 | Not monitored | | | | |
| Spring 2009 | Not monitored | | | | |
| Summer 2010 | 29.9 | 9.48 | 7.88 | 0.4 | 1 |
| Autumn 2010 | 20.4 | 8.97 | 7.93 | 0.2 | |

## Catch summary and length-frequency analysis

No southern pygmy perch or Yarra pygmy perch were captured at this site throughout the project. Murray hardyhead were not collected throughout 2008/09 but one individual was recently collected in autumn 2010 (Table 26). A total of 12 other species have been sampled at this site (Table 26).

The single Murray hardyhead sampled in autumn 2010 was likely a newly recruited YOY (43 mm TL) (Figure 30).

**Table 26.** Total numbers of fish species collected from the Eastick Creek mouth between spring 2008 and autumn 2010. NS = not sampled.

| Species | | Sampling trip | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **Murray hardyhead** | ***Craterocephalus fluviatilis*** | **0** | **NS** | **NS** | **1** |
| Flat-headed gudgeon | *Philypnodon grandiceps* | 25 | NS | NS | 734 |
| Carp gudgeon | *Hypseleotris spp.* | 0 | NS | NS | 13 |
| Australian smelt | *Retropinna semoni* | 156 | NS | NS | 112 |
| Bony herring | *Nematalosa erebi* | 5 | NS | NS | 163 |
| Common galaxias | *Galaxias maculatus* | 19 | NS | NS | 15 |
| Congolli | *Pseudaphritus urvillii* | 1 | NS | NS | |
| Small-mouthed hardyhead | *Atherinosoma microstoma* | 2745 | NS | NS | 2190 |
| Lagoon | *Tasmanogobius lasti* | 66 | NS | NS | 158 |
| Tamar River goby | *Afurcagobius tamarensis* | 59 | NS | NS | 47 |
| Blue-spot goby | *Pseudogobius olorum* | 47 | NS | NS | 103 |
| Bridled goby | *Arenogobius bifrenatus* | 5 | NS | NS | 49 |
| Redfin perch | *Perca fluviatilis* | 5 | NS | NS | 3 |

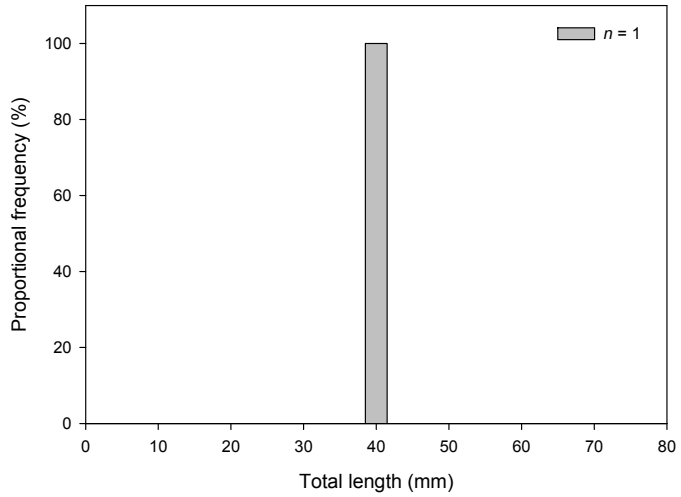



**Figure 30.** Length-frequency distribution of Murray hardyhead from the Eastick Creek mouth site in autumn 2010.

**Site summary**

Threatened species had not been recorded from this site since February 2008 (Hammer 2008b). This site has been impacted by low water levels in Lake Alexandrina, with fringing emergent vegetation disconnected from the water, diminished submerged vegetation and rising salinity. Water level has recently begun to rise at this site with slightly increased water levels in Lake Alexandrina. An individual YOY Murray hardyhead was sampled at this site, indicating the population in this area is likely small; however, recent recruitment had occurred. Yarra pygmy perch from this site were included in the captive breeding program being undertaken by Aquasave and Cleland Wildlife Park.

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

Black Swamp is in the lower Finniss River, where it meets the Tookayerta Creek (Figure 31). This area was once characterised by low-land wetlands with diverse submerged and emergent plant communities. Water level is influenced by water level in Lake Alexandrina and consequently has undergone complete drying and now re-inundation with the initiation of the *Goolwa Channel Water Level Management Plan* (SA Water 2009).

Both Yarra pygmy perch and southern pygmy perch were sampled in low numbers at this site in 2003 (Wedderburn and Hammer 2003) and a single Yarra pygmy perch was sampled from this site in spring 2007 (Bice *et al.* 2008), prior to drying.

#### Fish sampling effort

*Spring 2008 and autumn 2009*

- not sampled

*Spring 2009 and autumn 2010*

- 6 fyke nets set overnight

## 2009/10 Photo-point images

### Winter 2009

**Not monitored**

### Spring 2009

### Summer 2010

### Autumn 2010

**Figure 31.** Photo-point images of the Black Swamp site from winter 2009, spring 2009, summer 2010 and autumn 2010**.**

## Environmental conditions

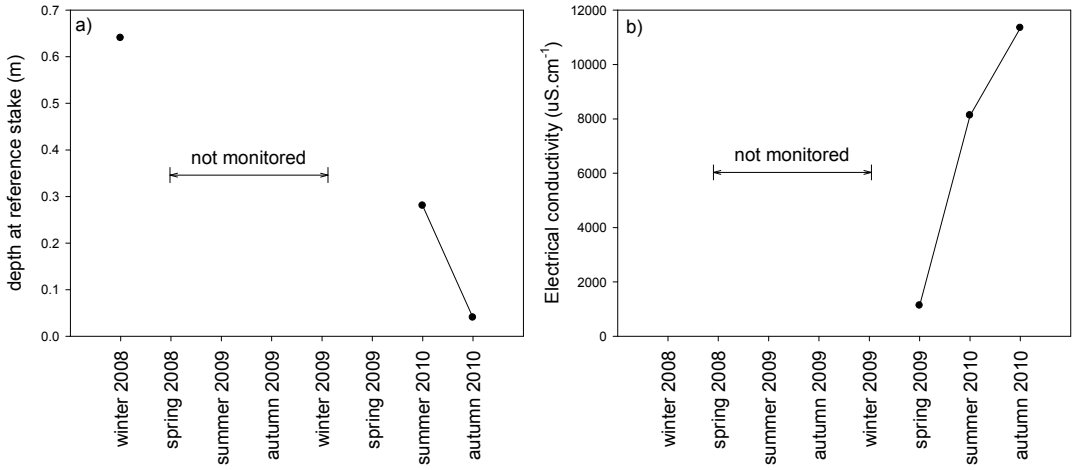



**Figure 32.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (µS.cm$^{-1}$) at the Black Swamp site between winter 2008 and autumn 2010.

**Table 27.** Habitat cover measured at Black Swamp during each site visit. Habitat cover is measured as the proportion (percent (%) cover) of aquatic habitat area comprised of submerged and emergent vegetation, physical structure or open water.

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | Not monitored (dry) | | | |
| Spring 2009 | 1 (*Myriophyllum*) | 35 (*Phragmites, Baumea, Gahnia*) | 0 | 64 |
| Summer 2010 | 1 (*Myriophyllum*) | 25 (*Phragmites, Baumea, Cladium*) | 0 | 74 |
| Autumn 2010 | 0 | 40 (*Phragmites, Typha, Schoenoplectus*) | 5 (snag) | 55 |

**Table 28.** Water quality parameters measured at Black Swamp during each site visit.

| Season | Temp (ºC) | pH | DO (ppm) | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|
| Winter 2009 | Not monitored (dry) | | | | |
| Spring 2009 | 16.8 | 6.69 | 0.75 | 0.2 | - |
| Summer 2010 | 27.4 | 8.09 | 5.5 | 0.4 | 1 |
| Autumn 2010 | 21.2 | 5.28 | 7.49 | >0.7 | 0.7 |

## Catch summary and length-frequency analysis

This site was not sampled in spring 2008 or autumn 2009 as it was dry and inaccessible. However, in spring 2009, southern pygmy perch (Figure 33) were detected at the site, together with significant numbers of juvenile common carp (Table 29). All fish sampled were large adults (>40 mm TL) (Figure 34). No southern

pygmy perch were sampled in autumn 2010 but a diverse range of 14 other species were sampled (Table 29).


**Figure 33.** Adult southern pygmy perch sampled in spring 2009.

**Table 29.** Total numbers of fish species collected from Black Swamp between spring 2008 and autumn 2010. NS = not sampled.

| **Species** | | **Sampling trip** | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **Southern pygmy perch** | ***Nannoperca australis*** | **NS (dry)** | **NS (dry)** | **7** | **0** |
| Flat-headed gudgeon | *Philypnodon grandiceps* | NS | NS | 2 | 585 |
| Dwarf flat-headed gudgeon | *Philypnodon macrostomus* | NS | NS | 0 | 2 |
| Carp gudgeon | *Hypseleotris spp.* | NS | NS | 0 | 60 |
| Australian smelt | *Retropinna semoni* | NS | NS | 0 | 3 |
| Bony herring | *Nematalosa erebi* | NS | NS | 0 | 260 |
| Common galaxias | *Galaxias maculatus* | NS | NS | 0 | 3 |
| Unspecked hardyhead | *Craterocephalus stercusmuscarum fulvus* | NS | NS | 0 | 2 |
| Small-mouthed hardyhead | *Atherinosoma microstoma* | NS | NS | 0 | 71 |
| Tamar River goby | *Afurcagobius tamarensis* | NS | NS | 0 | 11 |
| Blue-spot goby | *Pseudogobius olorum* | NS | NS | 0 | 4 |
| Bridled goby | *Arenogobius bifrenatus* | NS | NS | 0 | 3 |
| Common carp | *Cyprinus carpio* | NS | NS | 176 | 401 |
| Goldfish | *Carrasius auratus* | NS | NS | 0 | 11 |
| Eastern gambusia | *Gambusia holbrooki* | NS | NS | 0 | 102 |

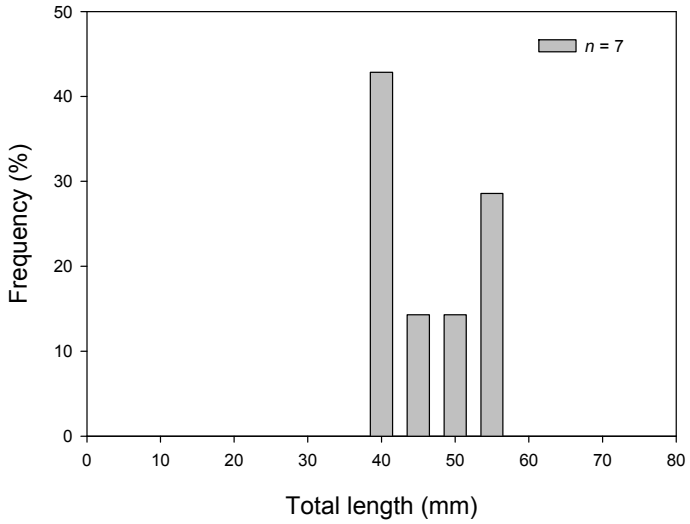



**Figure 34.** Length frequency distribution of southern pygmy perch from the Black Swamp site in spring 2009.

## Site summary

This site dried in spring 2008 and remained dry until spring 2009 when water levels were influenced by raised water levels within the Goolwa Channel as part of the *Goolwa Channel Water Level Management Plan*. As such, the site was re-inundated and water returned to levels similar to pre-2007. Whilst no southern pygmy perch or Yarra pygmy perch were detected in autumn 2010, the maintenance of higher water levels in this area, tributary inflow and re-establishment of aquatic vegetation may see conditions favourable for re-colonisation.

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

Black Swamp drain is located in the lower Finniss River immediately upstream of Black Swamp. The drain channels water that flows into the top of Black Swamp from Tookayerta Creek and diverts it into the Finniss Channel. Water in the drain was typically tannin stained and habitat was dominated by abundant submerged (e.g. *Myriophyllum* spp.) and emergent (e.g. *Phragmites australis, Typha domingensis, Baumea* spp.) vegetation (Figure 35). Southern pygmy perch were located at this site during a 'search' for Yarra pygmy perch by Hammer (2008b), for the current captive breeding program.

#### Fish sampling effort

*Spring 2008, spring 2009 and autumn 2010*

- 4 fyke nets set overnight

*Autumn 2009*

- not sampled

## 2009/10 Photo-point images

**Winter 2009**

**Not monitored**

**Spring 2009**

**Summer 2010**

**Autumn 2010**

**Figure 35.** Photo-point images of the Black Swamp Drain site from winter 2009, spring 2009, summer 2010 and autumn 2010.

## Environmental conditions

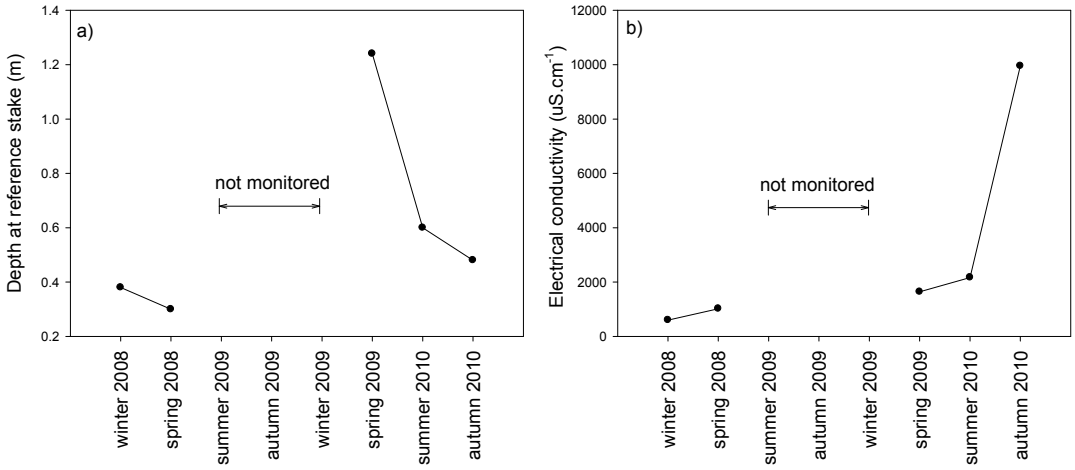



**Figure 36.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (µS.cm$^{-1}$) at the Black Swamp Drain site between winter 2008 and autumn 2010.

**Table 30.** Habitat cover measured at Black Swamp Drain during each site visit. Habitat cover is measured as the proportion (percent (%) cover) of aquatic habitat area comprised of submerged and emergent vegetation, physical structure or open water.

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | Not monitored (dry) | | | |
| Spring 2009 | 1 (*Myriophyllum*) | 40 (*Typha, Phragmites. Baumea, Gahnia, Leptospermum*) | 0 | 59 |
| Summer 2010 | 0 | 50 (*Typha, Phragmites. Cladium, Leptospermum*) | 0 | 50 |
| Autumn 2010 | 0 | 50 (*Typha, Phragmites, Leptospermum*) | 5 (snag) | 45 |

**Table 31.** Water quality parameters measured at Black Swamp Drain during each site visit.

| Season | Temp (ºC) | pH | DO (ppm) | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|
| Winter 2009 | Not monitored (dry) | | | | |
| Spring 2009 | 18.1 | 6.73 | 1.16 | 0.15 | 2.1 |
| Summer 2010 | 20.6 | 7.19 | 0.24 | 0.4 | 1 |
| Autumn 2010 | 19.8 | 5.28 | 3.11 | >0.8 | 0.8 |

### Catch summary and length-frequency analysis

No southern pygmy perch were sampled in 2008/08 or spring 2009 but two individuals were sampled in autumn 2010 (Table 32). One individual was a large adult (55 mm TL), whilst the other was a likely YOY (35 mm TL) (Figure 37). A diverse range of 11 other species were sampled including large abundances of juvenile carp (Table 32; Figure 38).

**Table 32.**Total numbers of fish species collected from the Black Swamp Drain site between spring 2008 and autumn 2010. NS = not sampled.

| **Species** | | **Sampling trip** | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **Southern pygmy perch** | ***Nannoperca australis*** | **0** | **NS (dry)** | **0** | **2** |
| Flat-headed gudgeon | *Philypnodon grandiceps* | 0 | NS | 0 | 800 |
| Dwarf flat-headed gudgeon | *Philypnodon macrostomus* | 0 | NS | 0 | 5 |
| Carp gudgeon | *Hypseleotris spp.* | 1 | NS | 0 | 450 |
| Australian smelt | *Retropinna semoni* | 0 | NS | 0 | 10 |
| Bony herring | *Nematalosa erebi* | 0 | NS | 0 | 99 |
| Common galaxias | *Galaxias maculatus* | 9 | NS | 0 | 9 |
| Small-mouthed hardyhead | *Atherinosoma microstoma* | 0 | NS | 0 | 3 |
| Blue-spot goby | *Pseudogobius olorum* | 0 | NS | 0 | 1 |
| Common carp | *Cyprinus carpio* | 0 | NS | 2 | 1115 |
| Goldfish | *Carrasius auratus* | 0 | NS | 0 | 14 |
| Eastern gambusia | *Gambusia holbrooki* | 0 | NS | 0 | 106 |

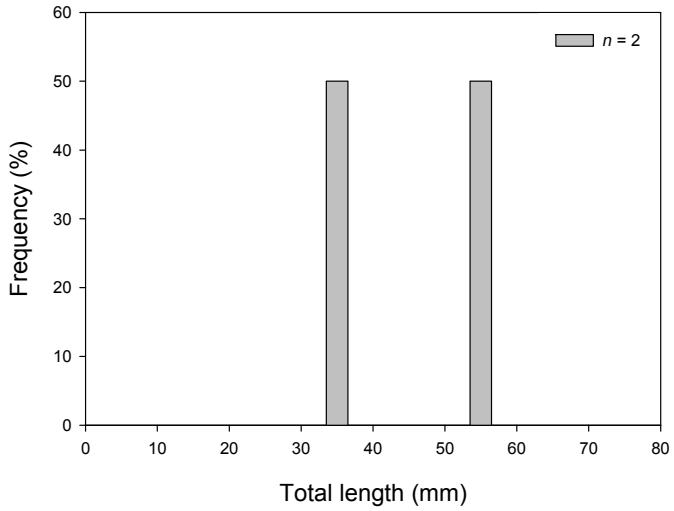



**Figure 37.** Length frequency distribution of southern pygmy perch from the Black Swamp Drain site in autumn 2010.

**Figure 38.** Juvenile common carp together with common native freshwater species (i.e. bony herring, flat-headed gudgeon and carp gudgeon).

## Site summary

Southern pygmy perch were not collected at this site in the current project until autumn 2010. As water levels have risen as part of the *Goolwa Channel Water Level Management Plan,* habitat quality at this site has likely improved. Thus, similar to the Black Swamp site, the maintenance of higher water levels in this area, tributary inflow and re-establishment of aquatic vegetation may see a return of favourable conditions for southern pygmy perch. Nonetheless, common carp exhibited a large spawning and recruitment event following water level rise within the Goolwa Channel (Bice *et al.* 2010) and were subsequently abundant at this site. These individuals would likely compete with southern pygmy perch for space and resources.

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

Turvey's Drain is an irrigation channel on the western side of Lake Alexandrina near Milang (Figure 39). Water levels at this site were traditionally dictated by levels in Lake Alexandrina. However, since 2008, the lower end of this drain has been disconnected from Lake Alexandrina and water levels have been maintained at a higher level than the lake through pumping for irrigation and environmental water delivery.

Monitoring has occurred at this site since 2001 with southern pygmy perch abundant from 2003 – 2006 (Wedderburn and Hammer 2003; Hammer 2009), however, Murray hardyhead have only recently been present at this site. No Yarra pygmy perch have been detected at the site over the last 10 years.

#### Fish sampling effort

*Spring 2008, autumn 2009, spring 2009 and autumn 2010*

- 4 fyke nets set overnight

## 2009/10 Photo-point images

**Winter 2009**


**Spring 2009**


**Summer 2010**

**No photo**

**Autumn 2010**


**Figure 39.** Photo-point images of the Turvey's Drain site from winter 2009, spring 2009, summer 2010 and autumn 2010.

## Environmental conditions

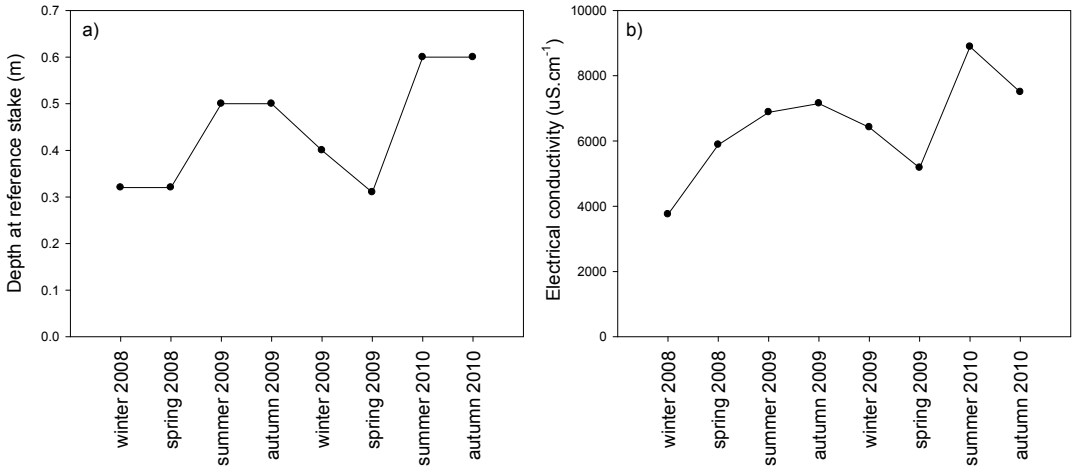



**Figure 40.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (µS.cm$^{-1}$) at the Turvey's Drain site between winter 2008 and autumn 2010.

**Table 33.** Habitat cover measured at Turvey's Drain during each site visit. Habitat cover is measured as the proportion (percent (%) cover) of aquatic habitat area comprised of submerged and emergent vegetation, physical structure or open water.

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | 40 (*Myriophyllum, Ceratophyllum, algae*) | 40 (*Typha, Phragmites)* | 0 | 20 |
| Spring 2009 | 10 (*Myriophyllum, Ceratophyllum*) | 50 (*Typha, Phragmites)* | 0 | 40 |
| Summer 2010 | 5 (*Myriophyllum, Ceratophyllum*) | 70 (*Typha, Phragmites)* | 0 | 25 |
| Autumn 2010 | 10 (*Myriophyllum, Ceratophyllum*) | 40 (*Typha, Phragmites)* | 1 (debris) | 49 |

**Table 34.** Water quality parameters measured at Turvey's Drain during each site visit.

| Season | Temp (ºC) | pH | DO (ppm) | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|
| Winter 2009 | 13.9 | 7.73 | 8.8 | >1 | 1 |
| Spring 2009 | 16.6 | 7.66 | 2.23 | 0.35 | 0.8 |
| Summer 2010 | 23 | 7.88 | 7.1 | 0.45 | 1 |
| Autumn 2010 | 20.3 | 7.44 | 6.52 | 0.3 | 1.1 |

## Catch summary and length-frequency analysis

Southern pygmy perch have been collected during every sampling event but in declining numbers (Figure 41a; Table 35). Murray hardyhead were sampled in consistently low numbers in spring 2008, autumn 2009 and spring 2009 but were absent in autumn 2010 (Figure 41b; Table 35).

a) b)


**Figure 41.** Adult a) southern pygmy perch and b) Murray hardyhead sampled from Turvey's Drain in spring 2009

**Table 35.** Total numbers of fish species collected from Turvey's Drain between spring 2008 and autumn 2010.

| Species | | Sampling trip | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **Southern pygmy perch** | ***Nannoperca australis*** | **81** | **5** | **10** | **1** |
| **Murray hardyhead** | ***Craterocephalus fluviatilis*** | **8** | **7** | **11** | **0** |
| Flat-headed gudgeon | *Philypnodon grandiceps* | 44 | 8 | 321 | 67 |
| Dwarf flat-headed gudgeon | *Philypnodon macrostomus* | 4 | 0 | 28 | 1 |
| Carp gudgeon | *Hypseleotris spp.* | 0 | 0 | 0 | 1 |
| Australian smelt | *Retropinna semoni* | 0 | 0 | 2 | |
| Small-mouthed hardyhead | *Atherinosoma microstoma* | 1 | 0 | 1 | 3 |
| Common galaxias | *Galaxias maculatus* | 11 | 0 | 1 | 0 |
| Tamar goby | *Afurcagobius tamarensis* | 1 | 0 | 0 | 0 |
| Blue-spot goby | *Pseudogobius olorum* | 34 | 0 | 12 | 2 |
| Lagoon goby | *Tasmanogobius lasti* | 0 | 0 | 1 | 0 |
| Goldfish | *Carrasius auratus* | 2 | 0 | 0 | 0 |
| Gambusia | *Gambusia holbrooki* | 157 | 390 | 1338 | 326 |
| Common carp | *Cyprinus carpio* | 0 | 0 | 2 | 0 |

In spring 2008, all Murray hardyhead sampled were large adult fish (>50 mm TL; Figure 42a). In autumn 2009, this adult cohort was not observed, however, a YOY cohort (30-37 mm TL) was captured signifying recent recruitment between sampling events (Figure 42 b). Subsequently, in spring 2009, Murray hardyhead exhibited a

broad length distribution (Figure 42c). Suspected Murray hardyhead were observed in autumn 2010 but no individuals were sampled in fyke nets.

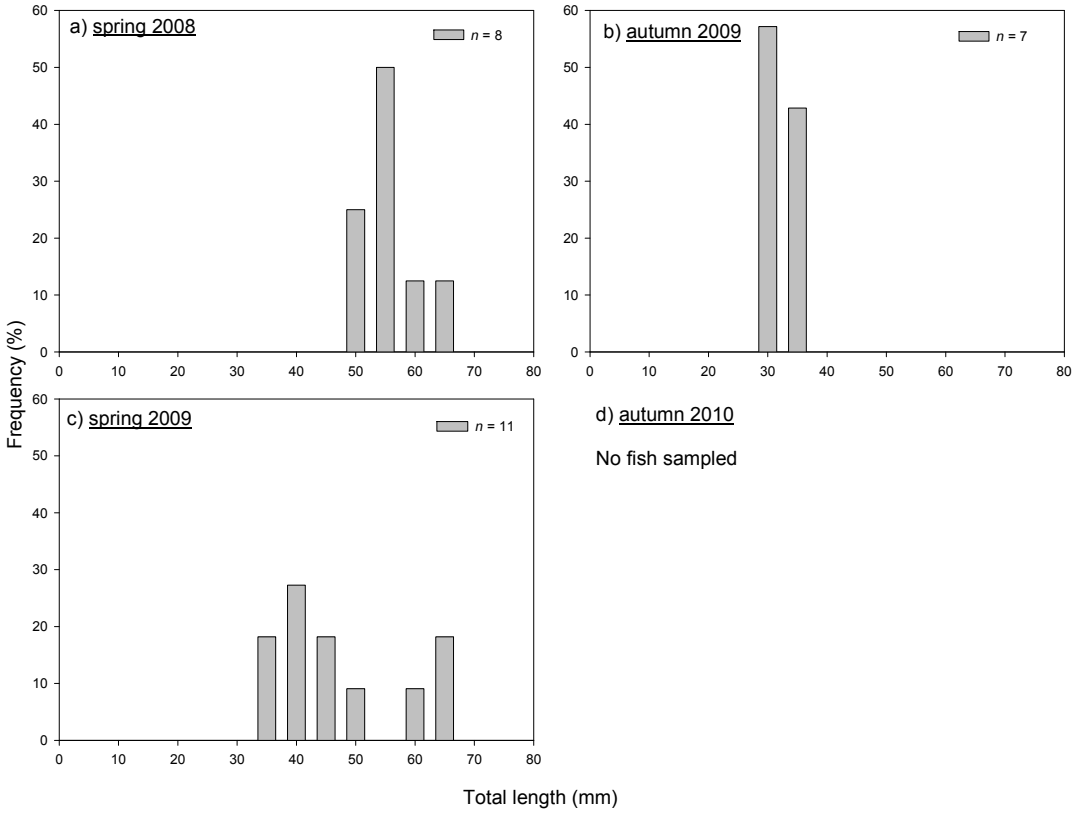



**Figure 42.** Length frequency distribution of Murray hardyhead from Turvey's Drain in a) spring 2008, b) autumn 2009, c) spring 2009 and d) autumn 2010.

There were two distinct cohorts of southern pygmy perch in spring 2008 with adult fish >50 mm TL and YOY fish ranging from 19-28 mm TL (Figure 43a). In autumn 2009 this adult cohort (>50 mm TL) was not sampled and YOY fish from spring had grown to >40 mm TL (Figure 43b). In spring 2009 this cohort had grown further to 51-64 mm TL but no YOY were present as in the previous year (Figure 43c). The one individual sampled in autumn 2010 was a large adult (58 mm TL) and as such no recruitment was detected (Figure 43d).

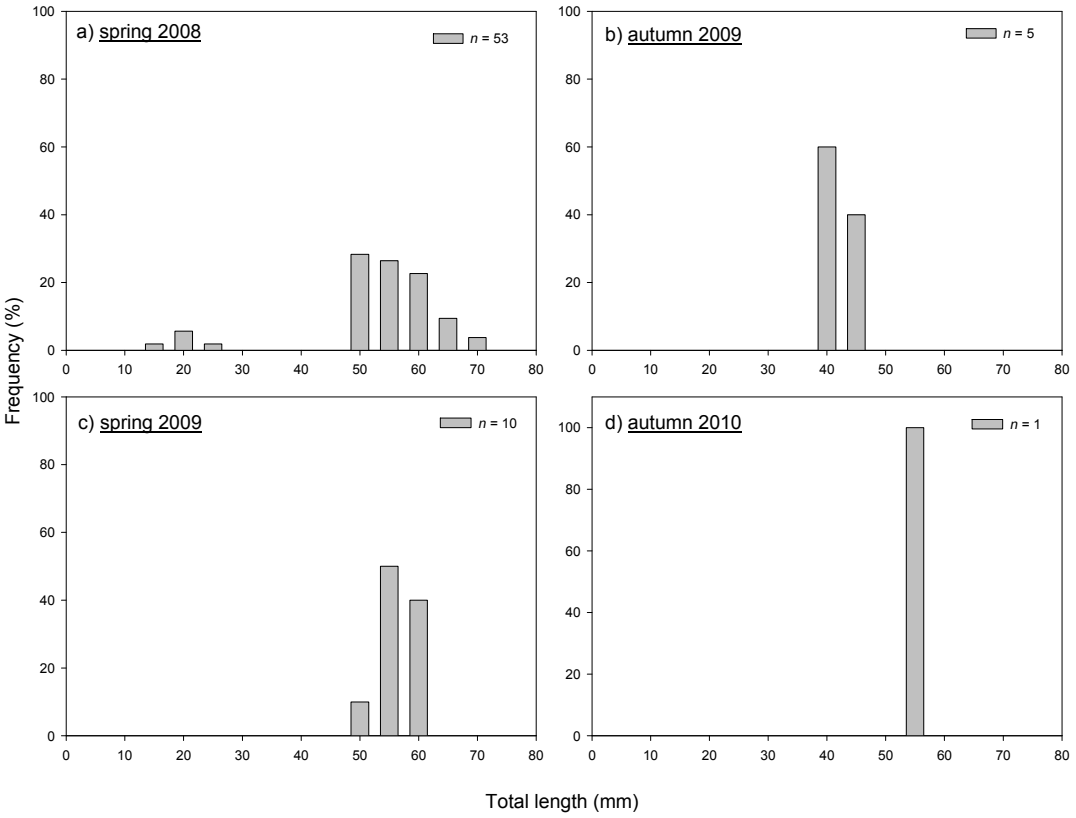



**Figure 43.** Length frequency distribution of southern pygmy perch from Turvey's Drain in a) spring 2008, b) autumn 2009, c) spring 2009 and d) autumn 2010.

## Site summary

Murray hardyhead were not detected in autumn 2010 and southern pygmy perch have been sampled in declining numbers. Furthermore, there was no evidence of recent recruitment of southern pygmy perch in autumn 2010. Thus, Murray hardyhead and southern pygmy perch are likely at high risk of loss from this site.

This site has received considerable management intervention over the past two years. Initially, the landholder inadvertently managed the site to the benefit of fish, by installing a blocking bank, disconnecting the drain and maintaining higher water levels than in Lake Alexandrina, for the purpose of irrigation. Furthermore, environmental water allocations have now accompanied landholder management to maintain higher water levels when needed and infrastructure (i.e. a pipeline) to ensure greater water security and quality is in development.

### 4.12. Meadows Creek (Finniss River: southern pygmy perch)

Meadows Creek is an upper catchment tributary of the Finniss River. Meadows Creek is a small to medium alluvial stream with intermittent pools and patchy emergent vegetation (Figure 44). Sampling has occurred regularly at this site since 2001 (Hammer 2005; Hammer 2009). Southern pygmy perch abundance is variable with typically low numbers sampled interspersed with irregular higher catch rates.

#### Fish sampling effort

*Spring 2008*

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

*Autumn 2009*

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

*Spring 2009*

- Backpack electrofishing (2308 seconds, 75 Hz, 220 v, 10% DC)

*Autumn 2010*

- Backpack electrofishing (2003 seconds, 75 Hz, 220 v, 10% DC)

## 2009/10 Photo-point images

**Winter 2009**

**Spring 2009**

**Summer 2010**

**Autumn 2010**

**Figure 44.** Photo-point images of the Meadows Creek site from winter 2009, spring 2009, summer 2010 and autumn 2010.

## Environmental conditions

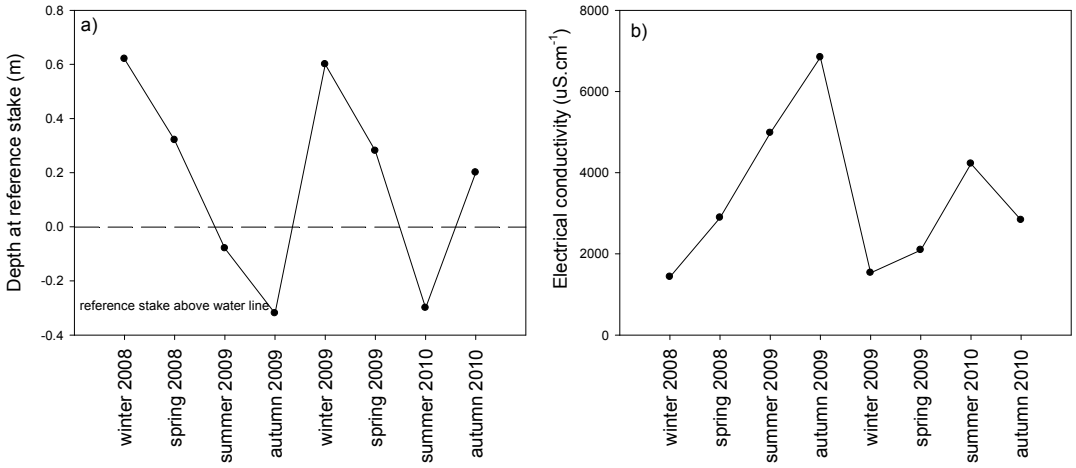



**Figure 45.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (µS.cm$^{-1}$) at the Meadows Creek site between winter 2008 and autumn 2010.

**Table 36.** Habitat cover measured at Meadows Creek during each site visit. Habitat cover is measured as the proportion (percent (%) cover) of aquatic habitat area comprised of submerged and emergent vegetation, physical structure or open water.

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | 0 | 10 (*Typha, Triglochin,Crassula,* grasses) | 10 (rock) | 80 |
| Spring 2009 | 10 (algae, *Chara*) | 30 (*Typha, Triglochin,Crassula,* grasses) | 10 (rock) | 50 |
| Summer 2010 | 20 (algae) | 10 (*Typha, Triglochin,Crassula*) | 20 (rock, snag) | 50 |
| Autumn 2010 | 1 (algae) | 30 (*Crassula, Ranunculus, Mimulus*) | 10 (rock, snag) | 59 |

**Table 37.** Water quality parameters measured at Meadows Creek during each site visit.

| Season | Temp (ºC) | pH | DO (ppm) | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|
| Winter 2009 | 10.9 | 10.9 | 12.39 | 0.6 | 1.2 |
| Spring 2009 | 20.6 | 8.19 | 7.94 | >0.8 | 0.8 |
| Summer 2010 | 20.2 | 8.7 | 3.81 | >0.4 | 0.4 |
| Autumn 2010 | 18.6 | 6.59 | 5.09 | >0.6 | 0.6 |

## Catch summary and length-frequency analysis

Just two southern pygmy perch were sampled in spring 2008 but the population exhibited a considerable increase in abundance in autumn 2009 (Table 38). This

pattern was also apparent in 2009/10 with low abundance in spring 2009 and increased abundance in autumn 2010 (Table 38). It appears greater numbers are typically sampled in autumn due to greater sampling efficiency as a result of increased concentration (i.e. density) of fish following water level decreases in summer/autumn.

**Table 38.** Total numbers of fish species collected from Meadows Creek between spring 2008 and autumn 2010.

| **Species** | | **Sampling trip** | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **Southern pygmy perch** | ***Nannoperca australis*** | **2 (0.07)** | **38 (2.53)** | **3 (0.13)** | **24 (1.2)** |
| Mountain galaxias | *Galaxias olidus* | 4 (0.14) | 62 (4.13) | 74 (3.21) | 5 (0.25) |
| Flat-headed gudgeon | *Philypnodon grandiceps* | 6 (0.21) | 170 (11.33) | 0 | 52 (2.6) |
| Gambusia | *Gambusia holbrooki* | 2 (0.07) | 100 (6.67) | 12 (0.52) | 11 (0.55) |

Both southern pygmy perch collected in spring 2008 were large adult fish (>50 mm TL) (Figure 46a). However, in autumn 2009, >60% of the population represented newly recruited YOY fish (<35 mm TL) (Figure 46b). Similarly, in spring 2009, the few individuals sampled were large adults (>50 mm TL) (Figure 46c). Nevertheless, substantial recruitment had occurred by autumn 2010 with ~95% of the population comprised of YOY (<30 mm TL) (Figure 46d & Figure 47).

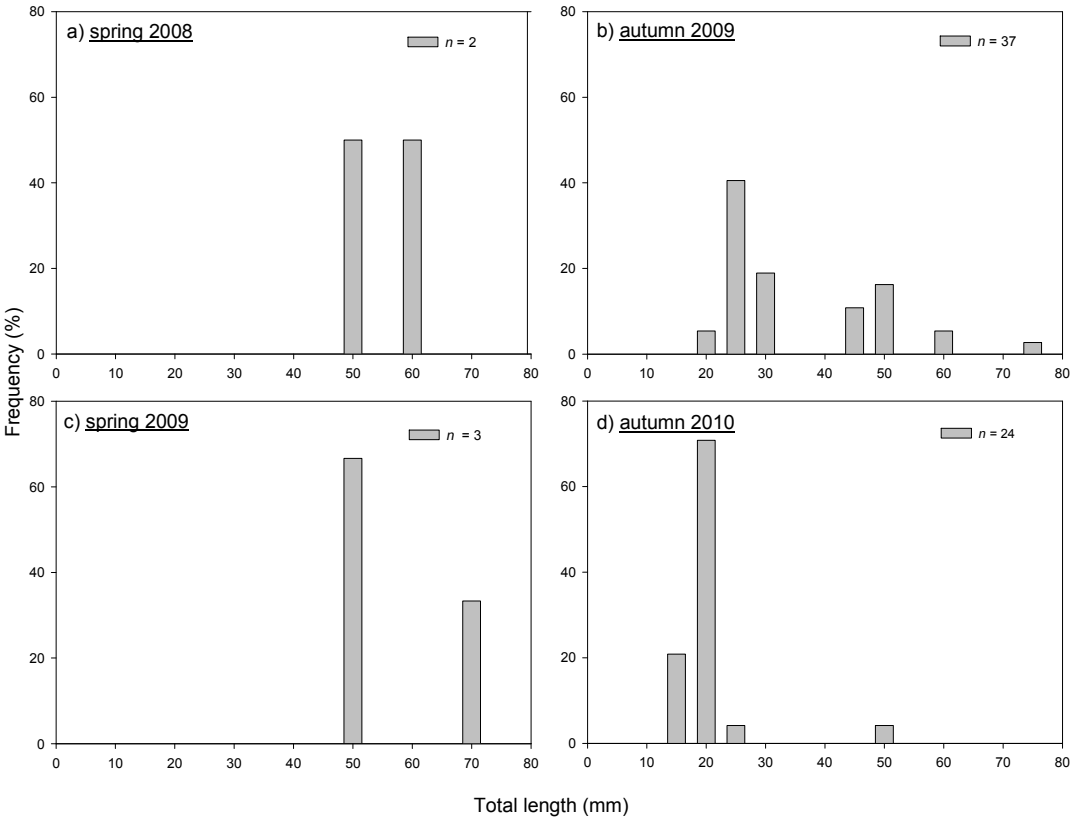



**Figure 46.** Length frequency distribution of southern pygmy perch from Meadows Creek in a) spring 2008, b) autumn 2009, c) spring 2009 and d) autumn 2010.

**Figure 47.** An adult and two YOY southern pygmy perch sampled from Meadows in autumn 2010.

**Site summary**

Variation in abundance of southern pygmy perch between spring and autumn appears cyclic with greater numbers encountered in autumn when water levels are lowest and fish are concentrated. Southern pygmy perch are persisting in moderate numbers and exhibited significant recruitment in autumn 2010, albeit in a highly restricted area (i.e. two pools). Thus, this population remains steady.

### 4.13. Waterfalls (Finniss River: southern pygmy perch)

The Waterfalls site is on the main channel of the mid-Finniss River. This reach is characterised by shallow rocky pools and riffles, with some emergent vegetation (i.e. *Typha domingensis, Triglochin procerum*) and is influenced by ground-water baseflows (Figure 48) (Hammer 2009). This site has been sampled since 2001 with the abundance of southern pygmy perch typically high to very high (Hammer 2005; Hammer 2009). Furthermore, strong recruitment was often evident.

#### Fish sampling effort

*Spring 2008*

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

*Autumn 2009*

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

*Spring 2009*

- Backpack electrofishing (1157 seconds, 75 Hz, 250 v, 10% DC)

*Autumn 2010*

- Backpack electrofishing (1037 seconds, 75 Hz, 250 v, 10% DC)

## 2009/10 Photo-point images

**Winter 2009**


**Spring 2009**


**Summer 2010**


**Autumn 2010**


**Figure 48.** Photo-point images of the Waterfalls site from winter 2009, spring 2009, summer 2010 and autumn 2010.

## Environmental conditions

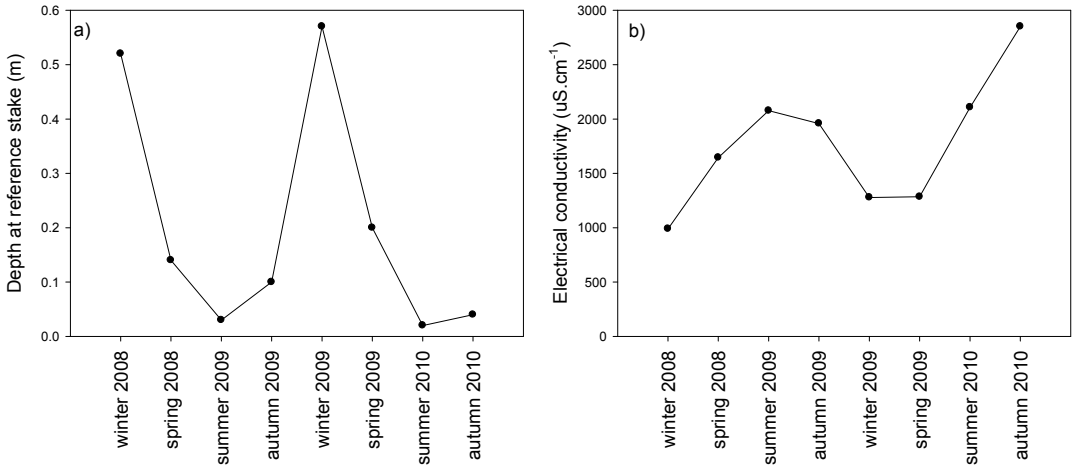



**Figure 49.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (µS.cm$^{-1}$) at the Waterfalls site between winter 2008 and autumn 2010.

**Table 39.** Habitat cover measured at Waterfalls during each site visit. Habitat cover is measured as the proportion (percent (%) cover) of aquatic habitat area comprised of submerged and emergent vegetation, physical structure or open water.

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | 0 | 10 | 30 (rock) | 60 |
| Spring 2009 | 5 (algae) | 10 (*Typha, Triglochin, Melaleuca*) | 20 (rock, snag) | 65 |
| Summer 2010 | 5 (algae) | 5 (*Typha*) | 10 (rock) | 80 |
| Autumn 2010 | 20 (algae) | 10 (*Typha*) | 20 (rock, snag) | 50 |

**Table 40.** Water quality parameters measured at Waterfalls during each site visit.

| Season | Temp (ºC) | pH | DO (ppm) | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|
| Winter 2009 | 14.5 | 8.28 | 8.3 | 0.8 | 1.4 |
| Spring 2009 | 21.6 | 8.11 | 6.34 | >1 | 1 |
| Summer 2010 | 21 | 7.77 | 4.58 | >0.9 | 0.9 |
| Autumn 2010 | 19.4 | 7.04 | 5.7 | >0.95 | 0.95 |

## Catch summary and length-frequency analysis

Southern pygmy perch were sampled in considerable abundance in spring 2008 but exhibited a considerable decline in autumn 2009 (Table 41). Furthermore, in spring 2009 and autumn 2009, just one individual was sampled during each event.

**Table 41.** Total numbers of fish species collected from the Waterfalls site between spring 2008 and autumn 2010.

| Species | | Sampling trip | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **Southern pygmy perch** | ***Nannoperca australis*** | **35 (2.69)** | **1 (0.08)** | **1 (0.09)** | **1 (0.1)** |
| Mountain galaxias | *Galaxias olidus* | 11 (0.85) | 15 (1.25) | 76 (6.57) | 18 (1.74) |
| Common galaxias | *Galaxias maculatus* | 0 | 0 | 0 | 8 (0.77) |
| Flat-headed gudgeon | *Philypnodon grandiceps* | 7 (0.54) | 0 | 1 (0.09) | 1 (0.1) |
| Carp gudgeon complex | *Hypseleotris spp.* | 3 (0.23) | 0 | 0 | 31 (2.99) |

Southern pygmy perch ranged from 42-63 mm TL in spring 2008 (Figure 50a) and there was no evidence of recent recruitment. The one individual collected in autumn 2009 was a large adult fish (59 mm TL) (Figure 50b) and thus no recruitment was detected 2008/09. Individual fish collected in both spring 2009 and autumn 2010 were very large adult fish (>70 mm TL) (Figure 51) and thus no recruitment was detected in 2009/10 (Figure 50c & d).

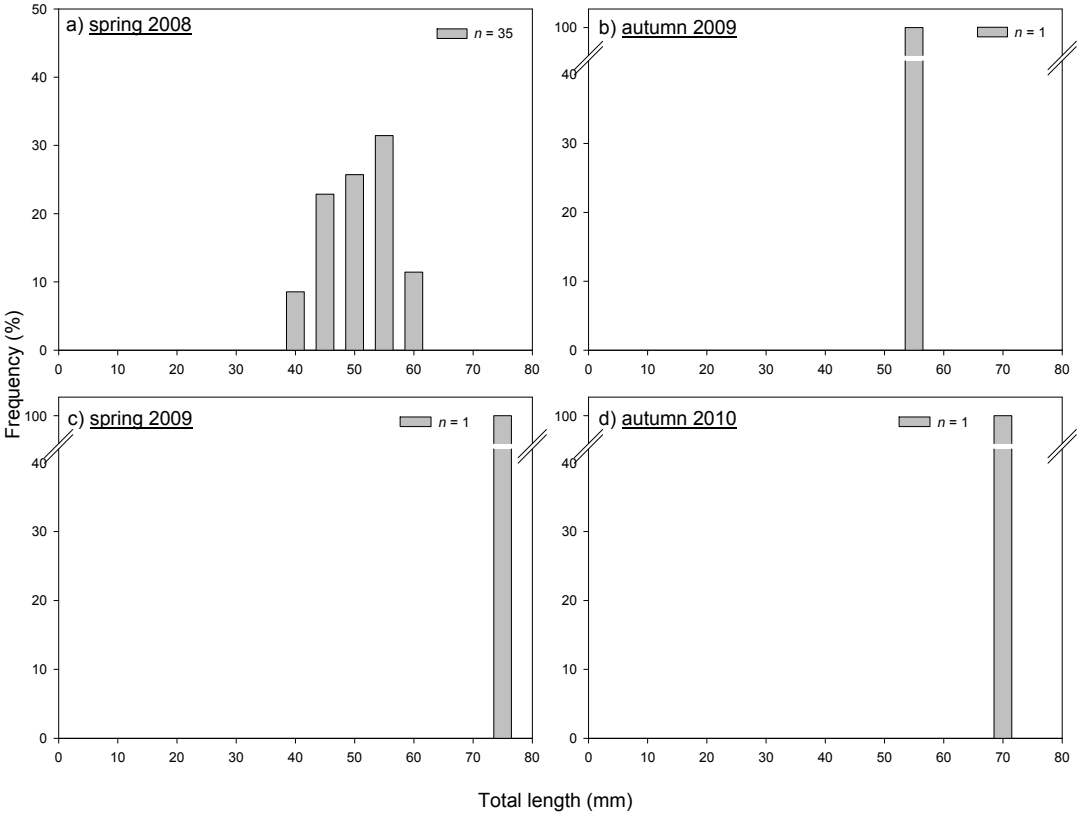



**Figure 50.** Length frequency distribution of southern pygmy perch from Waterfalls in a) spring 2008, b) autumn 2009, c) spring 2009 and d) autumn 2010.

**Figure 51.** Very large southern pygmy perch (75 mm TL) sampled at the Waterfalls site in spring 2009.

## Site summary

In summer 2009, the usually perennial groundwater baseflow ceased from January – February and subsequently water levels receded dramatically, resulting in extensive habitat desiccation, with remaining aquatic habitat in poor condition. Concurrently, southern pygmy perch have undergone a substantial decline in abundance through 2009/10, with the species formerly abundant at this site prior to 2008 (Hammer 2005; Hammer 2009). Furthermore, there has been no evidence of recruitment for 2 years, with all individuals sampled since autumn 2009 being large adult fish. Thus the population of southern pygmy perch at this site is showing limited signs of recovery and is at high risk of loss.

### 4.14. Inman (Inman River: southern pygmy perch)

This site is on Back Valley Creek, a tributary of the Inman River on the southern Fleurieu Peninsula, which drains into the Southern Ocean near the town of Victor Harbour. The site is characterised by shallow stream and swamp habitat interspersed with deeper pools and fringing emergent vegetation (i.e. *Typha domingensis, Phargmites australis, Triglochin procerum*) (Figure 52). This site has been monitored since 2001, with abundance of southern pygmy perch typically variable (low abundance interspersed with irregular high catch rates) (Hammer 2009).

#### Fish sampling effort

*Spring 2008*

- 5 baited box traps set for 1.5 hours

*Autumn 2009, spring 2009 and autumn 2010*

- 10 baited box traps set for 1.5 hours

## 2009/10 Photo-point images

**Winter 2009**

**Spring 2009**

**Summer 2010**

**Autumn 2010**

**Figure 52.** Photo-point images of the Inman River site from winter 2009, spring 2009, summer 2010 and autumn 2010.

## Environmental conditions

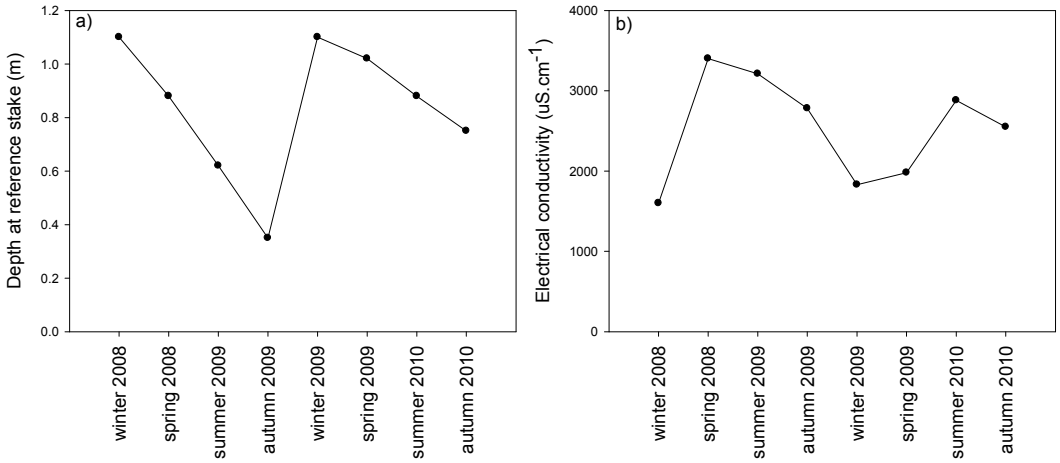



**Figure 53.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (µS.cm$^{-1}$) at the Inman River site between winter 2008 and autumn 2010.

**Table 42.** Habitat cover measured at Inman River during each site visit. Habitat cover is measured as the proportion (percent (%) cover) of aquatic habitat area comprised of submerged and emergent vegetation, physical structure or open water.

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | 0 | 20 (*Typha, Phragmites, Triglochin*) | 5 (snag) | 75 |
| Spring 2009 | 0 | 40 (*Typha, Phragmites, Triglochin*) | 5 | 55 |
| Summer 2010 | 0 | 30 (*Typha, Phragmites*) | 0 | 70 |
| Autumn 2010 | 0 | 30 (*Typha, Phragmites, Triglochin*) | 5 (snag) | 65 |

**Table 43.** Water quality parameters measured at Inman River during each site visit.

| Season | Temp (ºC) | pH | DO (ppm) | | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|---|
| Winter 2009 | 13.9 | 7.75 | 9 | 7.44 | 0.2 | 1.2 |
| Spring 2009 | 23.5 | 7.96 | 1.58 | 0.47 | 0.35 | 1.2 |
| Summer 2010 | 19.6 | 7.29 | 1.62 | 0.3 | 0.2 | 0.9 |
| Autumn 2010 | 15.7 | 7.24 | 2.4 | 1.4 | 0.4 | 1.0 |

## Catch summary and length-frequency analysis

Southern pygmy perch were captured in low numbers in spring 2008 but in high abundance in autumn 2009 (Table 44). Again in spring 2009 they were sampled in low numbers before a slight increase in autumn 2010 (Table 44). Carp gudgeon were the only other species captured throughout the project (Table 44).

Recent recruitment was evident in spring with likely YOY individuals <25 mm TL and adult fish 34-41 mm TL both present in the catch (Figure 54a). Southern pygmy perch ranged 23-62 mm TL in autumn with recent recruitment also evident in this season (Figure 54b). Length-frequency distribution in spring 2009 differed from that of the previous year with the population dominated by adult fish (>40 mm TL) (Figure 54c). Nonetheless in autumn 2010 southern pygmy perch exhibited a broad range of lengths from 34-60 mm TL with recent recruitment evident (Figure 54d).

**Table 44.** Total numbers of fish species collected from the Inman River site between spring 2008 and autumn 2010.

| **Species** | | **Sampling trip** | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **Southern pygmy perch** | ***Nannoperca australis*** | **12** | **101** | **8** | **19** |
| Carp gudgeon complex | *Hypseleotris spp.* | 2 | 8 | 6 | 3 |

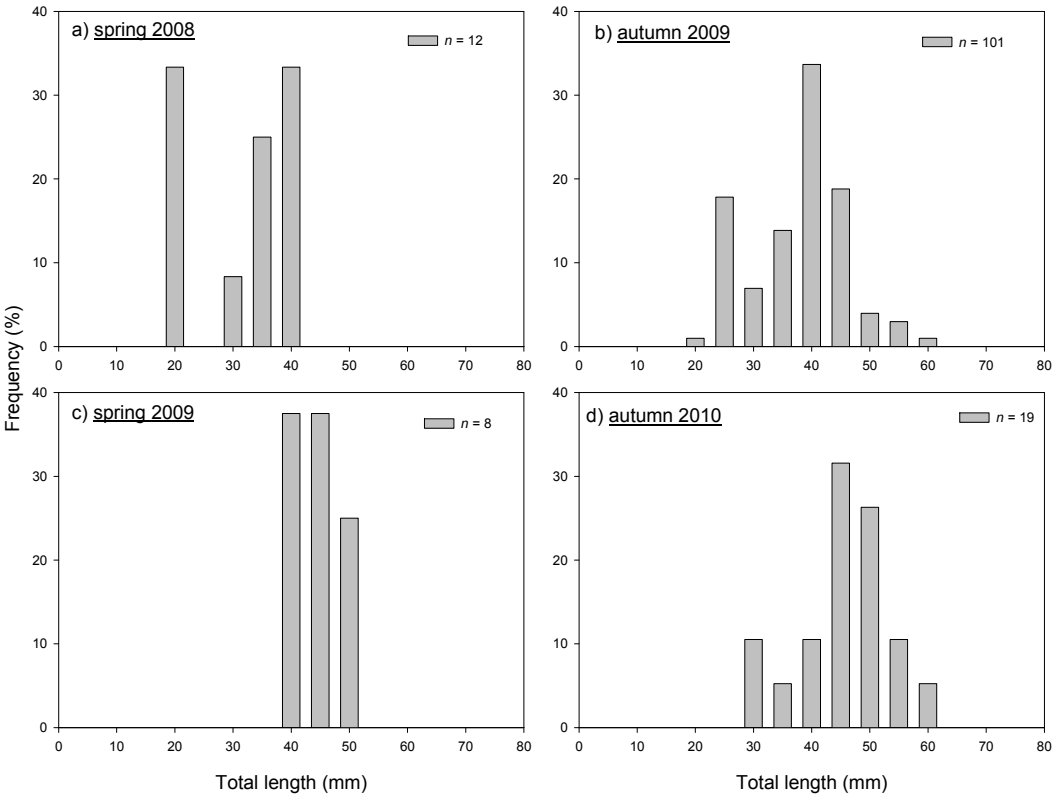



**Figure 54.** Length frequency distribution of southern pygmy perch from the Inman site in a) spring 2008, b) autumn 2009, c) spring 2009 and d) autumn 2010.

**Site summary**

Considerable numbers of southern pygmy perch were sampled in autumn 2009 but declines were noted in 2009/10. However, the species is persisting at the site and there were signs of recent recruitment. This site is still under threat from decreased water levels (Figure 53a) and consistently low dissolved oxygen concentrations (Table 43).

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

This site is located in Lake Alexandrina, at the junction of Currency Creek with the Goolwa Channel in the game reserve near the town of Goolwa (Figure 55). It could be considered a sheltered lake edge/terminal wetland habitat and was typically characterised by abundant emergent (i.e. *Phragmites australis, Typha domingensis* and *Schoenoplectus validus*) and submerged vegetation (i.e. *Myriophyllum* spp). This site completely dried in summer 2008/09 due to receding water levels in Lake Alexandrina. However, due to the *Goolwa Channel Water Level Management Plan* and the raising of water levels within the Goolwa Channel, this site has been re-inundated. Yarra pygmy perch and Murray hardyhead were recorded in 2007 and 2008 respectively (Hammer 2008b; Hammer 2009).

#### Fish sampling effort

*Spring 2008, spring 2008 and autumn 2010*

- 4 fyke nets set overnight

*Autumn 2009*

- Not sampled as site had completely dried

## 2009/10 Photo-point images

**Winter 2009**


**Spring 2009**


**Summer 2010**


**Autumn 2010**


**Figure 55.** Photo-point images of the Currency Creek site from winter 2009, spring 2009, summer 2010 and autumn 2010.

## Environmental conditions

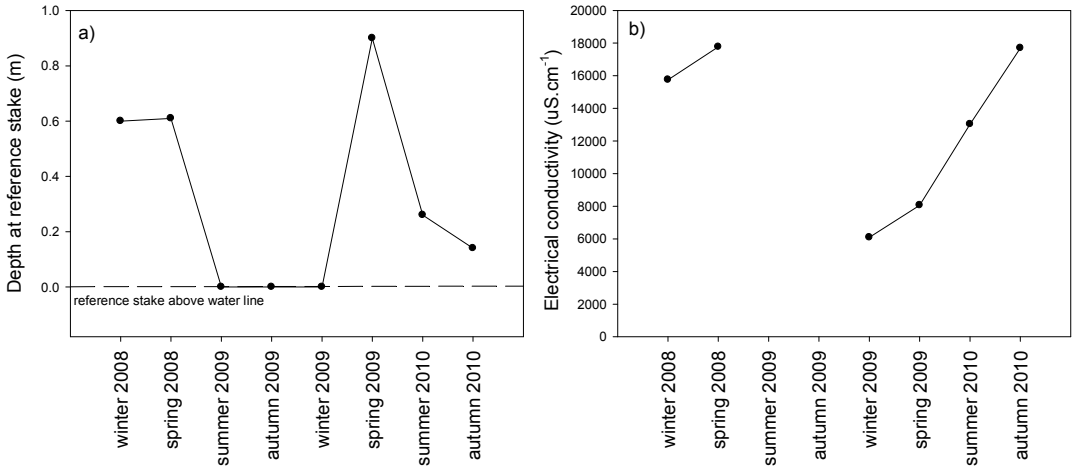



**Figure 56.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (µS.cm$^{-1}$) at the Currency Creek site between winter 2008 and autumn 2010.

**Table 45.** Habitat cover measured at Currency Creek during each site visit. Habitat cover is measured as the proportion (percent (%) cover) of aquatic habitat area comprised of submerged and emergent vegetation, physical structure or open water.

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | 0 | 35 (*Typha, Phragmites, Schoenoplectus*) | 5 (snag, polychaete mounds) | 65 |
| Spring 2009 | 0 | 60 (*Typha, Phragmites, Schoenoplectus*, various terrestrial) | 0 | 40 |
| Summer 2010 | 20 (algae, *Myriophyllum, Ruppia*) | 20 (*Typha, Phragmites, Schoenoplectus*) | 0 | 60 |
| Autumn 2010 | 50 (*Myriophyllum, Ruppia*) | 5 (*Schoenoplectus*, grasses) | 1 (snag, polychaete mounds) | 44 |

**Table 46.** Water quality parameters measured at Currency Creek during each site visit.

| Season | Temp (ºC) | pH | DO (ppm) | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|
| Winter 2009 | - | 9.44 | - | >0.38 | 0.38 |
| Spring 2009 | 17.1 | 8.32 | 7.09 | 0.4 | 1 |
| Summer 2010 | 26 | 8.52 | 7.75 | 0.7 | 0.8 |
| Autumn 2010 | 19.4 | 8.66 | 8.79 | 0.6 | 0.7 |

## Catch summary and length-frequency analysis

No Yarra pygmy perch have been sampled throughout the project. Murray hardyhead were present in spring 2008 but the site was completely dry in autumn 2009 and thus

no fish were sampled (Table 47). Eleven individuals were sampled in spring 2009 after water levels within the Goolwa Channel were raised; however, no individuals were sampled in autumn 2010. A diverse assemblage is typically present at this site with a total of 15 other species having been collected (Table 47). Similar to other sites within the Goolwa Channel, large numbers of common carp were sampled following the raising of water levels.

**Table 47.** Total numbers of fish species collected from the Currency Creek site between spring 2008 and autumn 2010. NS = not sampled.

| **Species** | | **Sampling trip** | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **Murray hardyhead** | ***Craterocephalus fluviatilis*** | **11** | **NS (dry)** | **11** | **0** |
| Flat-headed gudgeon | *Philypnodon grandiceps* | 76 | NS | 2 | 238 |
| Dwarf flat-headed gudgeon | *Philypnodon macrostomus* | 3 | NS | 1 | 2 |
| Carp gudgeon | *Hypseleotris spp.* | 0 | NS | 3 | 2 |
| Bony herring | *Nematalosa erebi* | 0 | NS | 2 | 41 |
| Australian smelt | *Retropinna semoni* | 44 | NS | 2 | 0 |
| Common galaxias | *Galaxias maculatus* | 2 | NS | 2 | 16 |
| Small-mouthed hardyhead | *Atherinosoma microstoma* | 5875 | NS | 2635 | 88 |
| Tamar goby | *Afurcagobius tamarensis* | 137 | NS | 0 | 46 |
| Blue-spot goby | *Pseudogobius olorum* | 398 | NS | 1 | 65 |
| Lagoon goby | *Tasmanogobius lasti* | 16 | NS | 13 | 0 |
| Bridled goby | *Arenigobius bifrenatus* | 22 | NS | 1 | 60 |
| Redfin perch | *Perca fluviatilis* | 3 | NS | 0 | 0 |
| Common carp | *Cyprinus carpio* | 0 | NS | 106 | 1008 |
| Goldfish | *Carrasius auratus* | 0 | NS | 0 | 4 |
| Gambusia | *Gambusia holbrooki* | 24 | NS | 1 | 63 |

The population of Murray hardyhead was dominated by large adult fish (48-69 mm TL) in spring 2008 (Figure 57a). Similarly, the population was dominated by adult fish in spring 2009 (Figure 57c), however, the range of lengths was smaller (i.e. 38-60 mm TL).

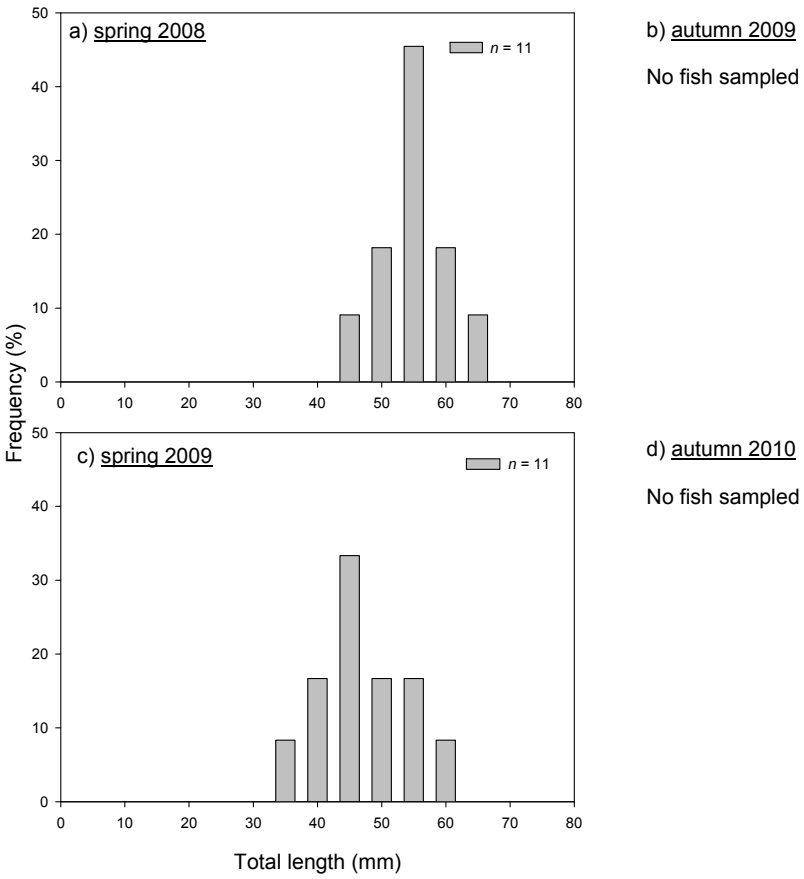



**Figure 57.** Length frequency distribution of Murray hardyhead from the Currency Creek site in a) spring 2008, b) autumn 2009, c) spring 2009 and d) autumn 2010.

## Site summary

Yarra pygmy perch have not been sampled throughout the project and have likely been lost from the site. Murray hardyhead, however, re-colonised this site and were captured in low numbers in spring 2009 following water level rise within the Goolwa Channel. Thus, there is likely a population of Murray hardyhead more broadly in the Goolwa Channel from which these individuals came. Nonetheless, Murray hardyhead were absent in autumn 2010. Due to the *Goolwa Channel Water Level Management Plan*, water levels should be greater and more secure at this site than in 2008/09. Furthermore, conditions within the Goolwa Channel may benefit Murray hardyhead and future monitoring of this site will determine this. Yarra pygmy perch from this site have been included in the captive breeding program being undertaken by Aquasave and Cleland Wildlife Park.

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

This site is located in Lake Alexandrina, at the junction of the Finniss River with the Goolwa Channel (Figure 58). It represents sheltered lake edge habitat and was typically characterised by abundant emergent (i.e. *Phragmites australis, Typha domingensis* and *Schoenoplectus validus*) and submerged vegetation (i.e. *Myriophyllum* spp and *Vallisneria australis*). This site completely dried in summer 2008/09 due to receding water levels in Lake Alexandrina. However, due to the *Goolwa Channel Water Level Management Plan* and the raising of water levels within the Goolwa Channel, this site has been re-inundated. Yarra pygmy perch and Murray hardyhead were typically caught in low numbers at this site (Hammer 2008b)

#### Fish sampling effort

*Spring 2008*

- 6 seine net hauls

*Autumn 2009*

- Not sampled as site had completely dried

*Spring 2009 and autumn 2010*

- 4 fyke nets set overnight.

## 2009/10 Photo-point images

**Winter 2009**

**Not monitored**

**Spring 2009**


**Summer 2010**


**Autumn 2010**


**Figure 58.** Photo-point images of the Finniss River Confluence site from winter 2009, spring 2009, summer 2010 and autumn 2010.

## Environmental conditions

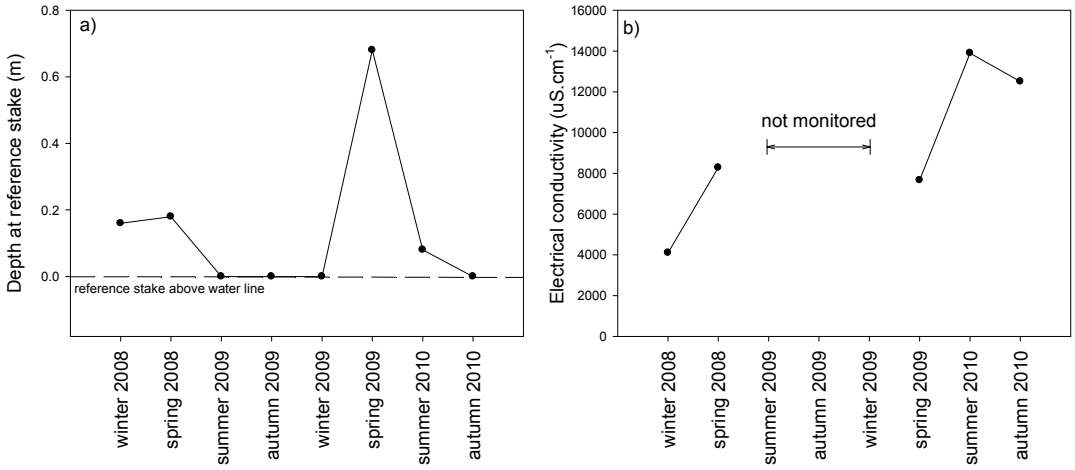



**Figure 59.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (µS.cm$^{-1}$) at the Finniss River Confluence between winter 2008 and autumn 2010.

**Table 48.** Habitat cover measured at the Finniss River Confluence during each site visit. Habitat cover is measured as the proportion (percent (%) cover) of aquatic habitat area comprised of submerged and emergent vegetation, physical structure or open water.

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | Not monitored (dry) | | | |
| Spring 2009 | 0.1 (*Myriophyllum*) | 45 (*Phragmites, Schoenoplectus,* cereal rye) | 0 | 55 |
| Summer 2010 | 20 (*Myriophyllum, Vallisneria, Ruppia,* algae) | 20 (*Schoenoplectus*) | 0 | 60 |
| Autumn 2010 | 10 (*Myriophyllum,* algae) | 10 (*Schoenoplectus*) | 5 (polychaete mounds) | 75 |

**Table 49.** Water quality parameters measured at the Finniss River Confluence during each site visit.

| Season | Temp (ºC) | pH | DO (ppm) | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|
| Winter 2009 | Not monitored (dry) | | | | |
| Spring 2009 | 18.9 | 7.86 | 8.15 | 0.25 | 0.8 |
| Summer 2010 | 25.2 | 8.7 | 7.52 | >0.8 | 0.8 |
| Autumn 2010 | 18.5 | 8.25 | 8.52 | >0.4 | 0.4 |

## Catch summary and length-frequency analysis

No Yarra pygmy perch have been detected throughout the project. Murray hardyhead were sampled in spring 2008, the site was dry in autumn 2009 and no Murray hardyhead were detected in 2009/10 (Table 50). A total of 13 other fish species have been collected at this site (Table 50). Both Murray hardyhead sampled in spring 2008 were adult fish (Figure 60).

**Table 50.** Total numbers of fish species collected from the Finniss River Confluence between spring 2008 and autumn 2010. NS = not sampled

| Species | | Sampling trip | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **Murray hardyhead** | ***Craterocephalus fluviatilis*** | **2** | **NS (dry)** | **0** | **0** |
| Australian smelt | *Retropinna semoni* | 5 | NS | 17 | 51 |
| Bony herring | *Nematalosa erebi* | 0 | NS | 6 | 0 |
| Flat-headed gudgeon | *Philypnodon grandiceps* | 0 | NS | 8 | 4 |
| Carp gudgeon | *Hypseleotris spp.* | 0 | NS | 5 | 0 |
| Common galaxias | *Galaxias maculatus* | 0 | NS | 3 | 1 |
| Congolli | *Pseudaphritis urvillii* | 0 | NS | 1 | 0 |
| Small-mouthed hardyhead | *Atherinosoma microstoma* | 47 | NS | 3240 | 691 |
| Tamar goby | *Afurcagobius tamarensis* | 1 | NS | 2 | 20 |
| Blue-spot goby | *Pseudogobius olorum* | 5 | NS | 1 | 0 |
| Lagoon goby | *Tasmanogobius lasti* | 3 | NS | 23 | 10 |
| Bridled goby | *Arenigobius bifrenatus* | 0 | NS | 2 | 13 |
| Common carp | *Cyprinus carpio* | 0 | NS | 223 | 36 |
| Eastern gambusia | *Gambusia holbrooki* | 0 | NS | 0 | 14 |

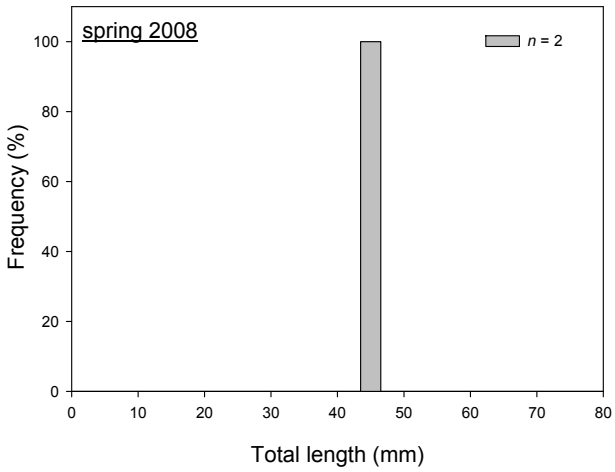



**Figure 60.** Length frequency distribution of Murray hardyhead from the Finniss River Confluence spring 2008.

**Site summary**

No Yarra pygmy perch have been sampled at this site throughout the project and have likely been lost. No Murray hardyhead have been sampled since spring 2008. Nevertheless, fish monitoring for a different project (Bice *et al.* 2010) sampled 10 Murray hardyhead ~1 km upstream from this site in the Finniss River arm. Thus, Murray hardyhead are likely not lost from the area but are rather in low abundance. Conditions at this site may be favourable for the residence of Murray hardyhead in the short-term future with water levels being maintained at a higher level than 2008/09 under the *Goolwa Channel Water Level Management Plan.* Yarra pygmy perch from this site have been included in the captive breeding program being undertaken by Aquasave and Cleland Wildlife Park.

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

Boggy Creek is a small stream/wetland located on Hindmarsh Island in Lake Alexandrina (Figure 61). Yarra pygmy perch were collected from this site in 2002 (Hammer unpublished). Post drought, a population of Murray Hardyhead at this site was sampled in spring 2008 by researchers from Adelaide University (Wedderburn and Barnes 2009), data from which is presented in this report. Whilst not sampled, Murray hardyhead were likely present at this site historically.

The site is characterised by shallow off-channel stream/wetland habitat with abundant emergent vegetation (i.e. *Typha domingensis, Phragmites australis*). Water is also slightly saline. Furthermore, this site has received regular management intervention with environmental water provided on several occasions.

#### Fish sampling effort

*Spring 2008, spring 2009 and autumn 2010*

- 3 fyke nets set overnight

*Autumn 2009*

- Not sampled as site had dried

## 2009/10 Photo-point images

**Winter 2009**

**Spring 2009**

**Summer 2010**

**Autumn 2010**

**Figure 61.** Photo-point images of the Boggy Creek site from winter 2009, spring 2009, summer 2010 and autumn 2010.

## Environmental conditions

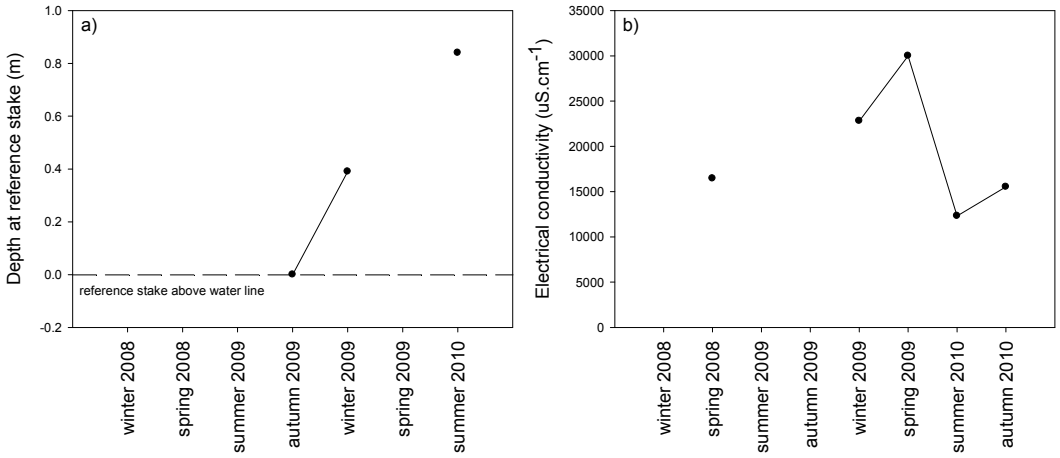



**Figure 62.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (µS.cm$^{-1}$) at the Boggy Creek site between winter 2008 and autumn 2010.

**Table 51.** Habitat cover measured at Boggy Creek during each site visit. Habitat cover is measured as the proportion (percent (%) cover) of aquatic habitat area comprised of submerged and emergent vegetation, physical structure or open water.

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | 10 | 30 (*Typha, Phragmites,* grasses) | 0 | 60 |
| Spring 2009 | 45 % total aquatic plant cover | | | 55 |
| Summer 2010 | 0 | 50 (*Typha, Phragmites,* grasses) | 0 | 50 |
| Autumn 2010 | 40 % total aquatic plant cover | | | 60 |

**Table 52.** Water quality parameters measured at Boggy Creek during each site visit.

| Season | Temp (ºC) | pH | DO (ppm) | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|
| Winter 2009 | 17.6 | 8.56 | - | >0.4 | 0.4 |
| Spring 2009 | 23.7 | 8.24 | - | >0.22 | 0.22 |
| Summer 2010 | 28 | 7.68 | 2.54 | >0.9 | 0.9 |
| Autumn 2010 | 16.1 | 7.43 | - | >0.25 | - |

## Catch summary and length-frequency analysis

A large number of Murray hardyhead were sampled from Boggy Creek, together with six other species, in spring 2008 (Table 53). Water level decreased dramatically over summer/autumn 2008/09 and subsequently, the site was not sampled in autumn 2009. Low numbers of Murray hardyhead were sampled in spring 2009 but they

exhibited an increase in abundance in autumn 2010, following the provision of environmental water (Table 53).

**Table 53.** Total numbers of fish species collected from Boggy Creek between spring 2008 and autumn 2010. NS = not sampled.

| **Species** | | **Sampling trip** | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **Murray hardyhead** | ***Craterocephalus fluviatilis*** | **587** | **NS (dry)** | **16** | **98** |
| Common galaxias | *Galaxias maculatus* | 1 | NS | 0 | 0 |
| Flat-headed gudgeon | *Philypnodon grandiceps* | 18 | NS | 0 | 0 |
| Dwarf flat-headed gudgeon | *Philypnodon macrostomus* | 1 | NS | 0 | 0 |
| Carp gudgeon complex | *Hypseleotris spp.* | 207 | NS | 0 | 0 |
| Blue-spot goby | *Pseudogobius olorum* | 170 | NS | 39 | 1 |
| Gambusia | *Gambusia holbrooki* | 6 | NS | 7 | 334 |

In spring 2008, Murray hardyhead had a broad length distribution from 30-73 mm TL (Figure 63a). This site was dry in autumn 2009 and was not sampled. In spring 2009, the population was dominated by a new YOY cohort (10-14 mm TL) (Figure 63c). In autumn 2010 significant recruitment was evident with the population exhibiting a broad length distribution, ranging 24-61 mm TL (Figure 63d). As such, recent recruitment had occurred over summer 2009/10.

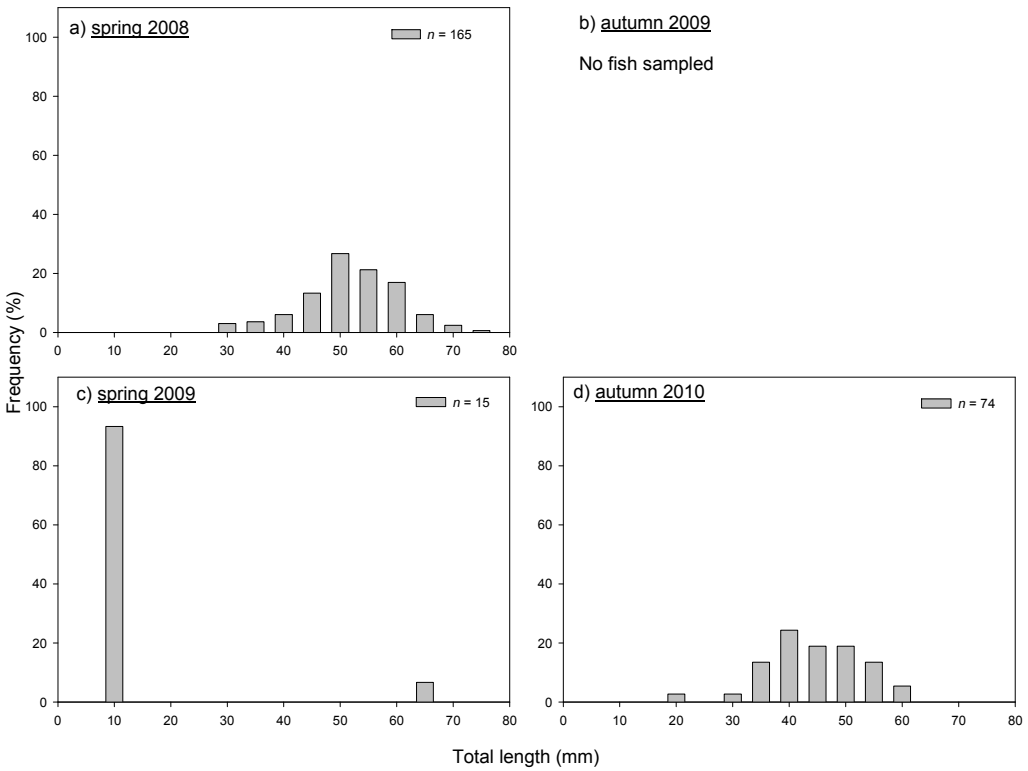



**Figure 63.** Length frequency distribution of Murray hardyhead from the Boggy Creek in a) spring 2008, b) autumn 2009, c) spring 2009 and d) autumn 2010.

## Site summary

Murray hardyhead were sampled in considerable numbers at this site in spring 2008 and in autumn 2010 and significant recent recruitment had been detected. This site is managed jointly by the South Australian Murray-Darling Basin Natural Resource Management Board (SA MDB NRMB) and DENR and has been provided with environmental water on several occasions. This action appeared to facilitate spawning and recruitment in Murray hardyhead in 2009/10 and has likely ensured the persistence of the species at this site.

Individuals from this site have been included in a captive breeding program for Murray hardyhead being undertaken by the Murray-Darling Basin Freshwater Research Centre (MDFRC), Mildura lab. Spawning and rearing of juveniles was successful and progeny have been released into a surrogate refuge dam in the Adelaide Hills, with the aim of establishing a self-sustaining population for re-introduction upon the re-establishment of favourable 'wild' conditions.

### 4.18. Mundoo Drain West, Mundoo Island (Lake Alexandrina: Murray hardyhead, Yarra pygmy perch and southern pygmy perch)

This site is located on Mundoo Island in Lake Alexandrina. It is an irrigation channel that commonly had a high proportion of emergent vegetation (i.e. *Typha domingensis*) and submerged vegetation (Figure 64). Yarra pygmy perch and southern pygmy perch were opportunistically sampled from this site in summer 2007/08 (SARDI unpublished data) and Murray hardyhead were detected by Wedderburn and Barnes (2009) in spring 2008.

#### Fish sampling effort

*Spring 2008, autumn 2009, spring 2009* and *autumn 2010*

- 3 fyke nets set overnight

## 2009/10 Photo-point images

**Winter 2009**

**Spring 2009**

**Summer 2010**

**Autumn 2010**

**Figure 64.** Photo-point images of the Mundoo Drain West site from winter 2009, spring 2009, summer 2010 and autumn 2010.

## Environmental conditions

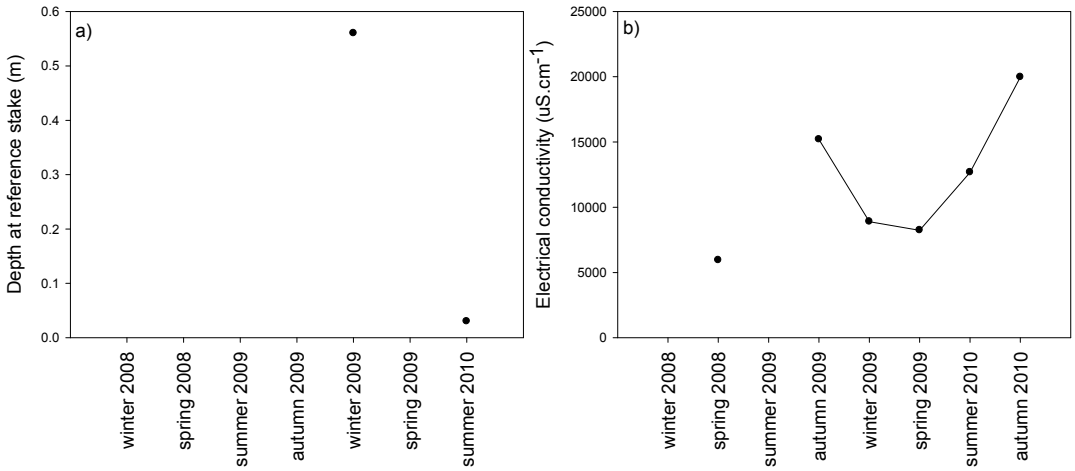



**Figure 65.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (µS.cm$^{-1}$) at Mundoo Drain west between winter 2008 and autumn 2010.

**Table 54.** Habitat cover measured at Mundoo Drain west during each site visit. Habitat cover is measured as the proportion (percent (%) cover) of aquatic habitat area comprised of submerged and emergent vegetation, physical structure or open water.

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | 0 | 40 (*Typha*) | 0 | 60 |
| Spring 2009 | 70 % total aquatic plant cover | | | 30 |
| Summer 2010 | 0 | 20 (*Typha*) | 0 | 80 |
| Autumn 2010 | 60 % total aquatic plant cover | | | 40 |

**Table 55.** Water quality parameters measured at Mundoo Drain west during each site visit.

| Season | Temp (ºC) | pH | DO (ppm) | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|
| Winter 2009 | 15.1 | 8.15 | 10.25 | 0.5 | 0.7 |
| Spring 2009 | 14.5 | 7.85 | - | >0.34 | 0.34 |
| Summer 2010 | 32.1 | 8.41 | 7.14 | >0.1 | 0.1 |
| Autumn 2010 | 12.9 | 8.28 | - | >0.2 | 0.2 |

## Catch summary and length-frequency analysis

Low numbers of southern pygmy perch were sampled in spring 2008, autumn 2009 and spring 2009 but none were sampled in autumn 2010 (Table 56). Murray hardyhead were detected in spring 2009 but not in autumn 2010 (Table 56). Eight other species have been sampled at this site but only eastern gambusia were sampled in autumn 2010 and were abundant (Table 56).

**Table 56.** Total numbers of fish species collected from the Mundoo Drain west between spring 2008 and autumn 2010.

| Species | | Sampling trip | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **Murray hardyhead** | ***Craterocephalus fluviatilis*** | **0** | **0** | **14** | **0** |
| **Southern pygmy perch** | ***Nannoperca australis*** | **6** | **22** | **4** | **0** |
| Flat-headed gudgeon | *Philypnodon grandiceps* | 40 | 49 | 23 | 0 |
| Dwarf flat-headed gudgeon | *Philypnodon macrostomus* | 9 | 3 | 9 | 0 |
| Carp gudgeon complex | *Hypseleotris spp.* | 460 | 332 | 114 | 0 |
| Common galaxias | *Galaxias maculatus* | 3 | 7 | 1 | 0 |
| Congolli | *Pseudaphritus urvillii* | 1 | 0 | | 0 |
| Eastern gambusia | *Gambusia holbrooki* | 14 | 68 | 41 | 354 |
| Goldfish | *Carrasius auratus* | 29 | 0 | 1 | 0 |

All southern pygmy perch sampled in spring 2008 were adults (>45 mm TL) (Figure 66a), however, significant recruitment had been detected in autumn 2009 (Figure 66b). Southern pygmy perch sampled in spring 2009 were again dominated by adult fish (>50 mm TL) (Figure 66c) and no fish were sampled in autumn 2010.

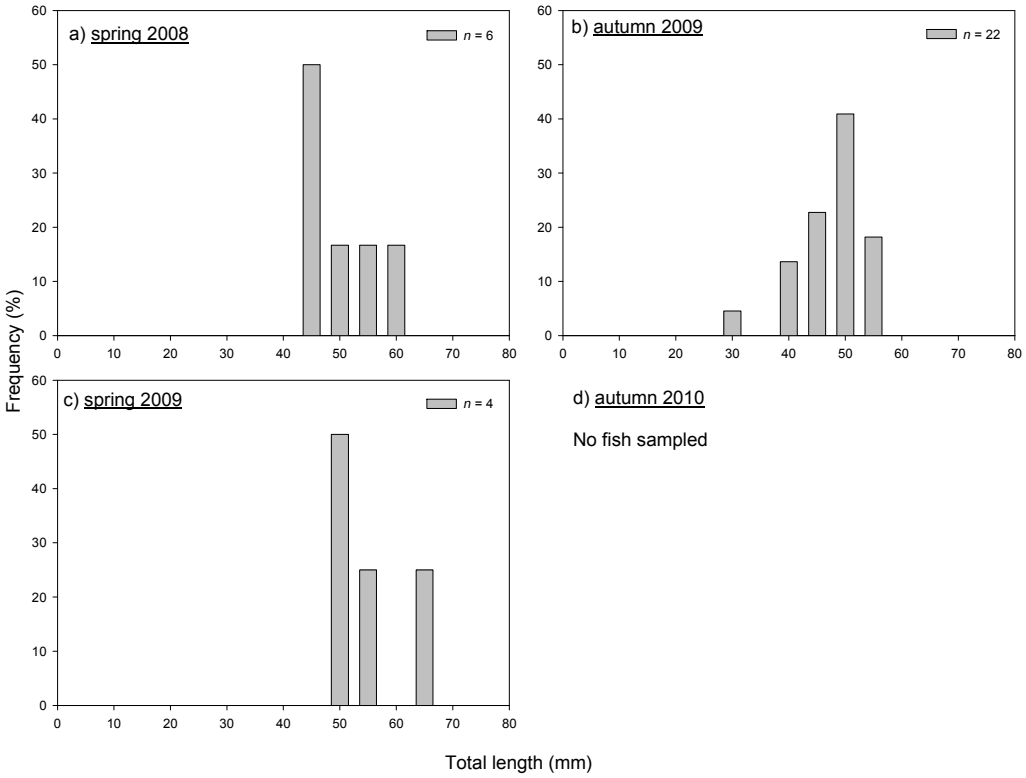



**Figure 66.** Length frequency distribution of southern pygmy perch from Mundoo Drain west in a) spring 2008, b) autumn 2009, c) spring 2009 and d) autumn 2010.

Murray hardyhead sampled in spring 2009 were dominated by large adult fish (>50 mm TL) (Figure 67). No individuals were sampled in autumn 2010.

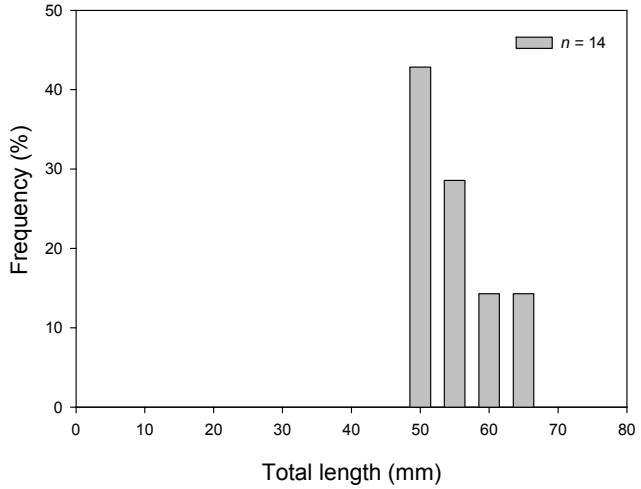



**Figure 67.** Length frequency distribution of Murray hardyhead from Mundoo Drain west in spring 2009.

## Site summary

Water level at this site receded rapidly in summer/autumn 2010 and there was a concurrent increase in salinity (Figure 65a & b). Thus, the quality of remaining habitat was poor. Post sampling in autumn 2010, efforts were made to rescue any remaining southern pygmy perch from this site but none were present. As such, Yarra and southern pygmy perch and Murray hardyhead have been lost from this site. Yarra pygmy perch from this site have been included in the captive breeding program being undertaken by Aquasave and Cleland Wildlife Park. Furthermore, a small number of southern pygmy perch from this site are being maintained at SARDI Aquatic Sciences for a potential captive breeding program.

### 4.19. Mundoo Drain East, Mundoo Island (Lake Alexandrina: Murray hardyhead)

This site is located on Mundoo Island in Lake Alexandrina. It is an irrigation channel that commonly had a high proportion of emergent vegetation (i.e. *Typha domingensis*) and submerged vegetation (Figure 68). Murray hardyhead were detected at this site by Wedderburn and Barnes (2009) in spring 2008.

#### Fish sampling effort

*Spring 2008, autumn 2009, spring 2009* and a*utumn 2010*

- 3 fyke nets set overnight
- 3 seine net hauls (~2 m length).

## 2009/10 Photo-point images

**Winter 2009**

**Spring 2009**

**Summer 2010**

**Autumn 2010**

**Figure 68.** Photo-point images of the Mundoo Drain East site from winter 2009, spring 2009, summer 2010 and autumn 2010.

## Environmental conditions

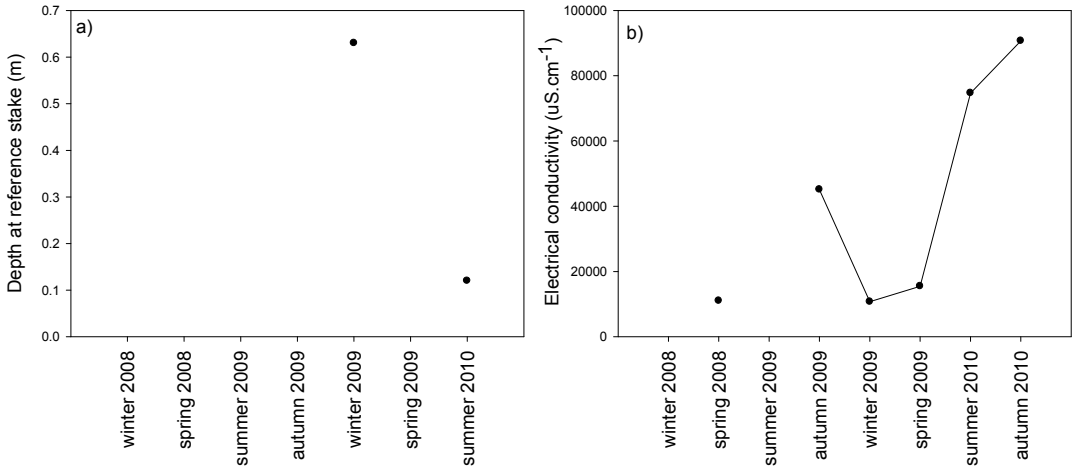



**Figure 69.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (µS.cm$^{-1}$) at Mundoo Drain east between winter 2008 and autumn 2010.

**Table 57.** Habitat cover measured at Mundoo Drain east during each site visit. Habitat cover is measured as the proportion (percent (%) cover) of aquatic habitat area comprised of submerged and emergent vegetation, physical structure or open water.

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | 40 (*Chara*) | 5 | 0 | 55 |
| Spring 2009 | 70% total aquatic plant cover | | | 30 |
| Summer 2010 | 80 (*Chara*) | 0 | 0 | 20 |
| Autumn 2010 | 60% total aquatic plant cover | | | 40 |

**Table 58.** Water quality parameters measured at Mundoo Drain east during each site visit.

| Season | Temp (ºC) | pH | DO (ppm) | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|
| Winter 2009 | 17.2 | 9 | 13.09 | >0.9 | 0.9 |
| Spring 2009 | 18 | 9.32 | - | >0.69 | 0.69 |
| Summer 2010 | 33.2 | 8.27 | 5.6 | >0.1 | 0.1 |
| Autumn 2010 | 26.8 | 7.81 | - | >0.26 | 0.26 |

## Catch summary and length-frequency analysis

Murray hardyhead were sampled in considerable numbers in spring 2008, autumn 2009 and spring 2009 but were absent in autumn 2010 (Table 59). A total of 6 other species have been sampled from the site (Table 59).

**Table 59.** Total numbers of fish species collected from the Mundoo Drain east between spring 2008 and autumn 2010.

| Species | | Sampling trip | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **Murray hardyhead** | ***Craterocephalus fluviatilis*** | **48** | **273** | **162** | **0** |
| Small-mouthed hardyhead | *Atherinosoma microstoma* | 6 | 301 | 785 | 0 |
| Flat-headed gudgeon | *Philypnodon grandiceps* | 1 | 2 | 0 | 0 |
| Carp gudgeon complex | *Hypseleotris spp.* | 0 | 1 | 0 | 0 |
| Common galaxias | *Galaxias maculatus* | 0 | 0 | 1 | 0 |
| Blue-spot goby | *Pseudogobius olorum* | 9 | 32 | 20 | 0 |
| Eastern gambusia | *Gambusia holbrooki* | 40 | 145 | 29 | 0 |

In spring 2008, the Murray hardyhead population was comprised of two cohorts, with an adult cohort >40 mm TL and a cohort of recently recruited YOY (<29 mm TL) (Figure 70a). In autumn, growth of the YOY cohort was evident with lengths ranging 29-63 mm TL (Figure 70b). The length-frequency distribution of the population in spring 2009 was different to the previous year with no YOY cohort present (Figure 70a&c). No fish were sampled in autumn 2010.

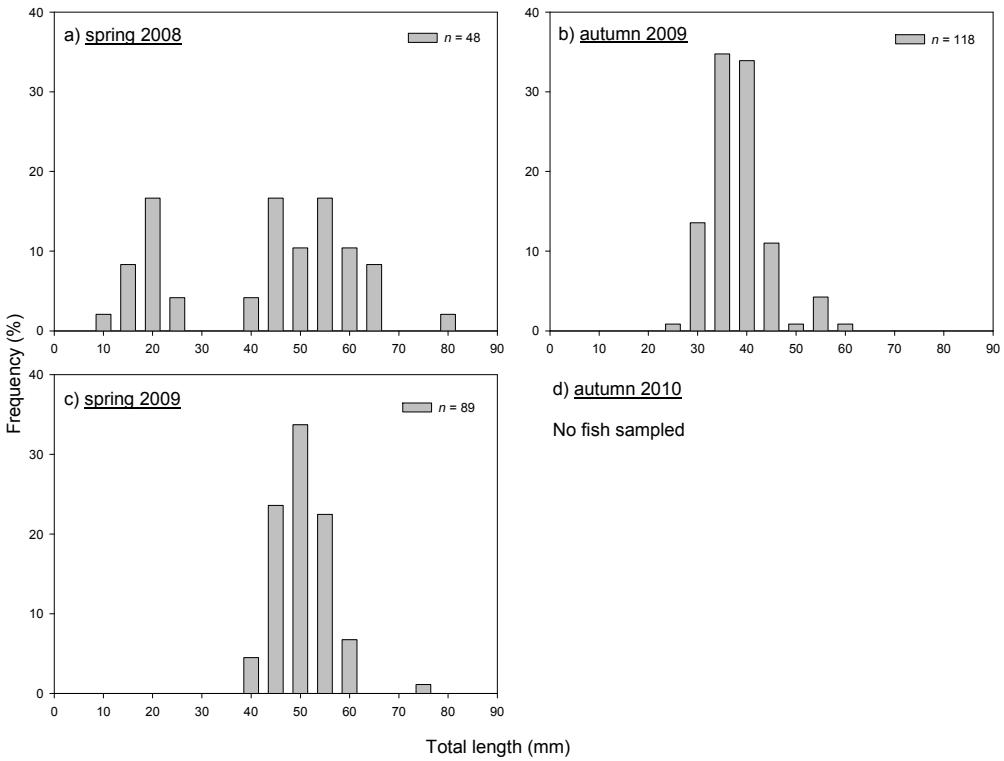



**Figure 70.** Length frequency distribution of Murray hardyhead from Mundoo Drain east in a) spring 2008, b) autumn 2009, c) spring 2009 and d) autumn 2010.

**Site summary**

Water level receded rapidly at this site in summer/autumn 2010 and there was a concurrent increase in salinity, with electrical conductivity reaching ~90,000 µS.cm$^{-1}$ (Figure 69a & b). It is likely that Murray hardyhead have been lost from this site.

### 4.20. Clayton/Dunn's Lagoon (Lake Alexandrina: Murray hardyhead)

Dunn's Lagoon is located near the township of Clayton in the south-west of Lake Alexandrina. It is a large wetland and was typically characterised by abundant emergent (i.e. *Phragmites australis, Typha domingensis* and *Schoenoplectus validus*) and submerged vegetation (i.e. *Myriophyllum* spp) (Holt *et al.* 2005). This site completely dried in summer 2008/09 and vegetation was lost, owing to receding water levels in Lake Alexandrina; however, water level in Lake Alexandrina had increased slightly in early 2010 and subsequently water had again begun to enter Dunn's Lagoon (Figure 71).

Fish monitoring has occurred at this site since 2003 (Wedderburn and Hammer 2003). Low numbers of Murray hardyhead have consistently been sampled from Dunn's Lagoon (Wedderburn and Hammer 2003; Higham *et al.* 2005; Bice and Ye 2006; Bice and Ye 2007; Bice *et al.* 2008) along with a single Yarra pygmy perch in 2004 (Holt *et al.* 2005).

#### Fish sampling effort

*Spring 2008, autumn 2009, spring 2009*

- 6 seine net hauls

*Autumn 2009*

- 4 fyke nets set overnight within Dunn's Lagoon

## 2009/10 Photo-point images

**Winter 2009**


**Spring 2009**


**Summer 2010**


**Autumn 2010**


**Figure 71.** Photo-point images of the Clayton/Dunn's Lagoon site from winter 2009, spring 2009, summer 2010 and autumn 2010.

## Environmental conditions

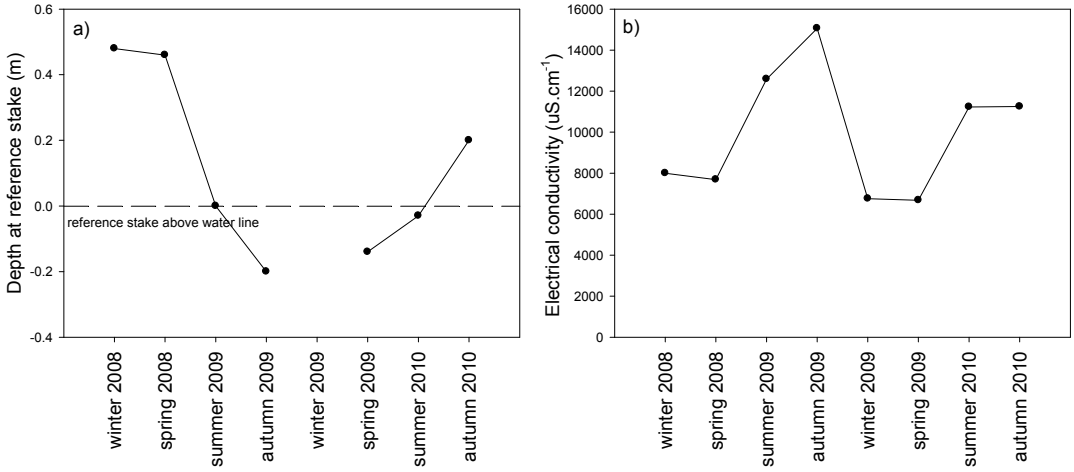



**Figure 72.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (µS.cm$^{-1}$) at Clayton/Dunn's Lagoon between winter 2008 and autumn 2010.

**Table 60.** Habitat cover measured at Clayton/Dunn's Lagoon during each site visit. Habitat cover is measured as the proportion (percent (%) cover) of aquatic habitat area comprised of submerged and emergent vegetation, physical structure or open water.

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | 0 | 0 | 1 (Polychaete mounds, dead muscles) | 99 |
| Spring 2009 | 0 | 0 | 2 (Polychaete mounds, dead muscles) | 98 |
| Summer 2010 | 0 | 0 | 1 (Polychaete mounds, dead muscles) | 99 |
| Autumn 2010 | 1 (algae) | 30 (*Cotula*) | 0 | 69 |

**Table 61.** Water quality parameters measured at Clayton/Dunn's Lagoon during each site visit.

| Season | Temp (ºC) | pH | DO (ppm) | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|
| Winter 2009 | 16 | 8.48 | 13.01 | 0.3 | - |
| Spring 2009 | 20.7 | 8.6 | 8.14 | 0.15 | 1 |
| Summer 2010 | 27.7 | 9.42 | 7.72 | 0.2 | 1 |
| Autumn 2010 | 22.7 | 9.05 | 10.68 | 0.1 | 0.4 |

## Catch summary and length-frequency analysis

Low numbers of Murray hardyhead were sampled in 2008/09 and no individuals were sampled in 2009/10 (Table 62). A total of 12 other species have been sampled at this site (Table 62).

All Murray hardyhead sampled in spring 2008 were adults with length ranging from 36-54 mm TL (Figure 73a). Only one individual was captured in autumn 2009 and was a new recruit from the most recent spawning season (Figure 73b).

**Table 62.** Total numbers of fish species collected from Clayton/Dunn's Lagoon between spring 2008 and autumn 2010.

| **Species** | | **Sampling trip** | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **Murray hardyhead** | ***Craterocephalus fluviatilis*** | **8** | **1** | **0** | **0** |
| Australian smelt | *Retropinna semoni* | 32 | 45 | 86 | 61 |
| Bony herring | *Nematalosa erebi* | 1 | 1 | 0 | 49 |
| Flat-headed gudgeon | *Philypnodon grandiceps* | 0 | 80 | 0 | 129 |
| Carp gudgeon | *Hypseleotris spp* | 0 | 0 | 0 | 0 |
| Common galaxias | *Galaxias maculatus* | 2 | 1 | 0 | 0 |
| Small-mouthed hardyhead | *Atherinosoma microstoma* | 71 | 90 | 7 | 57 |
| Lagoon goby | *Tasmanogobius lasti* | 5 | 30 | 38 | 43 |
| Tamar goby | *Afurcagobius tamarensis* | 9 | 123 | 365 | 12 |
| Blue-spot goby | *Pseudogobius olorum* | 2 | 1 | 1 | 22 |
| Bridled goby | *Arenogobius bifrenatus* | 0 | 0 | 0 | 5 |
| Redfin perch | *Perca fluviatilis* | 0 | 1 | 5 | 1 |
| Common carp | *Cyprinus carpio* | 0 | 0 | 0 | 5 |

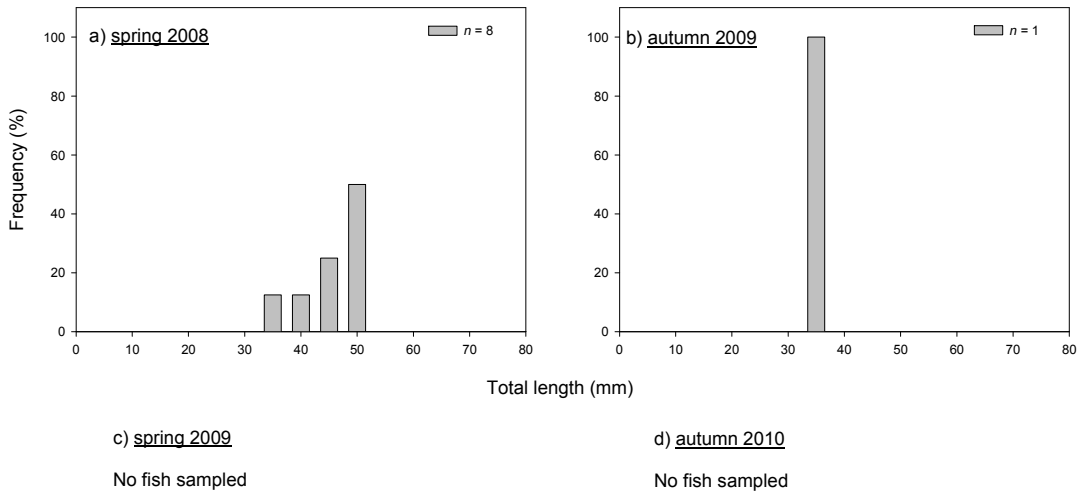



**Figure 73.** Length frequency distribution of Murray hardyhead from Clayton/Dunn's Lagoon in a) spring 2008, b) autumn 2009, c) spring 2009 and d) autumn 2010.

## Site summary

Murray hardyhead were caught in low numbers in 2008/09 but were absent in 2009/10. As water refills Dunn's Lagoon, conditions favourable for Murray hardyhead are likely to return. Given re-colonisation observed at the Currency Creek site, it is possible that re-colonisation will also occur at this site if there is a source of individuals.

### 4.21. Milang Jetty (Lake Alexandrina: Murray hardyhead)

This site is a sheltered lake edge located near the township of Milang. Habitat at this site could be characterised as a shallow, sheltered bay with fringing emergent vegetation (Figure 74). Murray hardyhead were sampled at this site in 2003 (Wedderburn and Hammer 2003) and re-sampled in autumn 2008 as part of site selection for the current project (unpublished data).

#### Fish sampling effort

*Spring 2008, autumn 2009, spring 2009 and autumn 2010*

- 6 seine net hauls

## 2009/10 Photo-point images

**Winter 2009**

**Spring 2009**

**Summer 2010**

**Autumn 2010**

**Figure 74.** Photo-point images of the Milang Jetty site from winter 2009, spring 2009, summer 2010 and autumn 2010.

## Environmental conditions

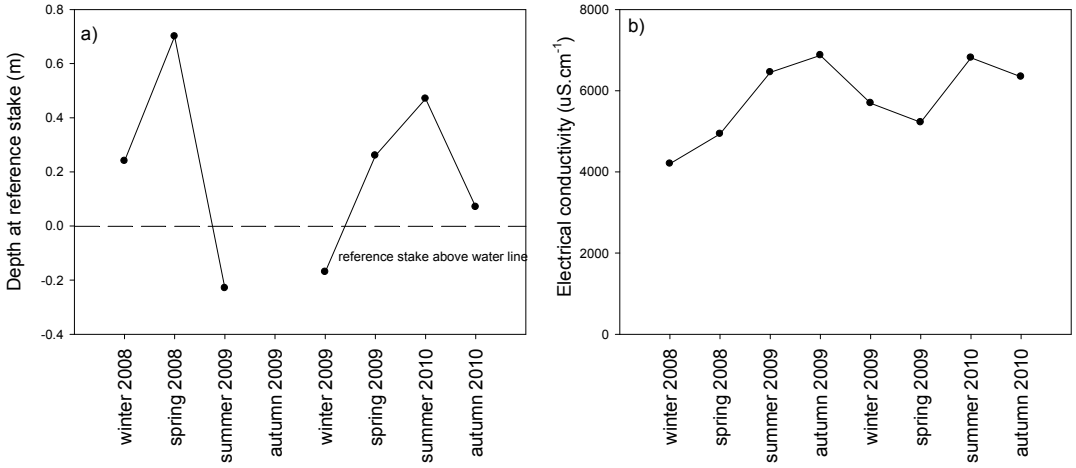



**Figure 75.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (µS.cm$^{-1}$) at Milang between winter 2008 and autumn 2010.

**Table 63.** Habitat cover measured at Milang during each site visit. Habitat cover is measured as the proportion (percent (%) cover) of aquatic habitat area comprised of submerged and emergent vegetation, physical structure or open water.

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | 0 | 2 | 0 | 98 |
| Spring 2009 | - | - | - | - |
| Summer 2010 | 0.1 (Chara) | 1 (grasses) | 0 | 99 |
| Autumn 2010 | 0 | 30 (*Cotula,* grasses) | 0 | 70 |

**Table 64.** Water quality parameters measured at Milang during each site visit.

| Season | Temp (ºC) | pH | DO (ppm) | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|
| Winter 2009 | 15 | 8.63 | 11.94 | 0.15 | 0.4 |
| Spring 2009 | 21.3 | 8.65 | 9.01 | 0.075 | |
| Summer 2010 | 26.9 | 9.05 | 7.5 | 0.2 | 0.4 |
| Autumn 2010 | 23.7 | 9.14 | 10.39 | 0.15 | 0.4 |

## Catch summary and length-frequency analysis

Low numbers of Murray hardyhead were sampled at Milang in spring 2008 but fish were absent in autumn 2009 (Table 65). No Murray hardyhead were sampled throughout 2009/10. Eleven other species have been sampled at this site over the project (Table 65).

All Murray hardyhead sampled at this site in spring 2008 were large adults (>45 mm TL) (Figure 76).

**Table 65.** Total numbers of fish species collected from Milang between spring 2008 and autumn 2010.

| Species | | Sampling trip | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **Murray hardyhead** | ***Craterocephalus fluviatilis*** | **5** | **0** | **0** | **0** |
| Australian smelt | *Retropinna semoni* | 120 | 32 | 26 | 12 |
| Bony herring | *Nematalosa erebi* | 16 | 2 | 1 | 23 |
| Flat-headed gudgeon | *Philypnodon grandiceps* | 0 | 10 | 22 | 8 |
| Common galaxias | *Galaxias maculatus* | 1 | 0 | 4 | 0 |
| Small-mouthed hardyhead | *Atherinosoma microstoma* | 15 | 0 | 0 | 9 |
| Lagoon goby | *Tasmanogobius lasti* | 3 | 15 | 3 | 2 |
| Tamar goby | *Afurcagobius tamarensis* | 0 | 1 | 0 | 3 |
| blue-spot goby | *Pseudogobius olorum* | 0 | 1 | 0 | 0 |
| Common carp | *Cyprinus carpio* | 0 | 0 | 38 | 0 |
| Gambusia | *Gambusia holbrooki* | 0 | 1 | 0 | 0 |
| Redfin perch | *Perca fluviatilis* | 3 | 1 | 0 | 0 |

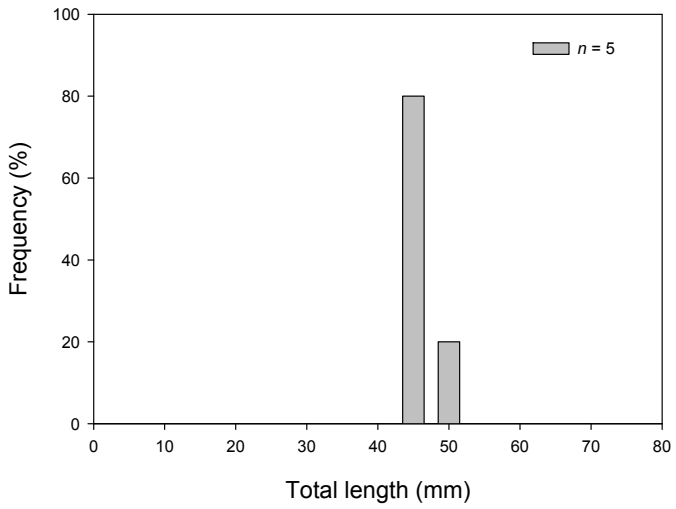



**Figure 76.** Length frequency distribution of Murray hardyhead from Milang in spring 2008.

### Site summary

Murray hardyhead have potentially been lost from this site. This site has been heavily impacted by receding water levels in Lake Alexandrina. Remaining habitat is very shallow and poor quality, with little emergent or submerged vegetation (Table 63). Nevertheless, water level has recently increased in Lake Alexandrina and thus conditions at this site may improve.

### 4.22. Bremer Mouth (Lake Alexandrina: Murray hardyhead)

This site is at the mouth of the Bremer River, which flows from the EMLR and discharges into Lake Alexandrina near the town of Milang. Murray hardyhead were first sampled at this site in summer 2008 (Bice *et al.* 2008) and have typically been detected in low abundances. Habitat is similar to that of an irrigation drain with abundant emergent (e.g. *Typha domingensis, Phragmites australis, Triglochin procerum*) and submerged vegetation (e.g. *Myriophyllum* spp.) (Figure 77).

#### Fish sampling effort

*Spring 2008 and spring 2009*

- 4 fyke nets set overnight

*Autumn 2009 and autumn 2010*

- not sampled as site had completely dried

## 2009/10 Photo-point images

**Winter 2009**


**Spring 2009**

**Summer 2010**


**Autumn 2010**


**Figure 77.** Photo-point images of the Bremer Mouth site from winter 2009, spring 2009, summer 2010 and autumn 2010.

## Environmental conditions

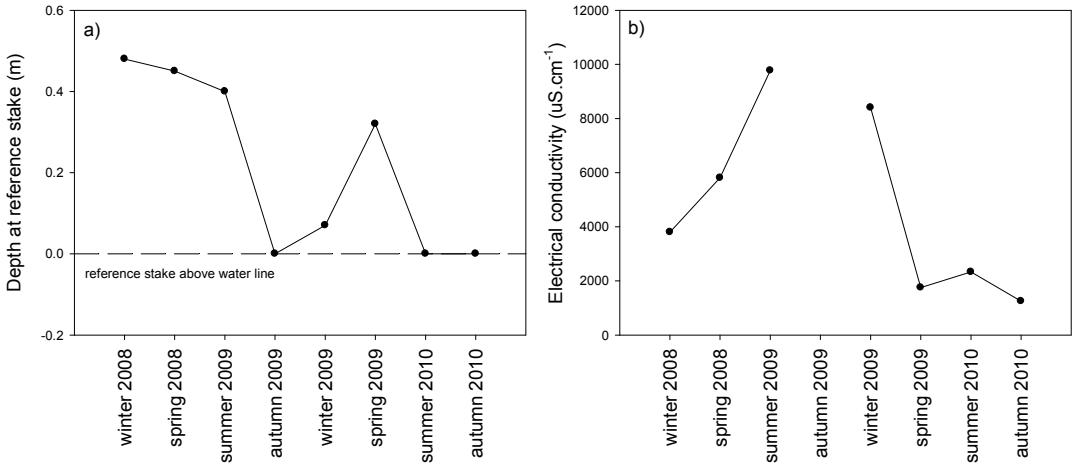



**Figure 78.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (µS.cm$^{-1}$) at the Bremer Mouth between winter 2008 and autumn 2010.

**Table 66.** Habitat cover measured at the Bremer Mouth during each site visit. Habitat cover is measured as the proportion (percent (%) cover) of aquatic habitat area comprised of submerged and emergent vegetation, physical structure or open water.

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | 0 | 60 (*Typha, Phragmites, Cotula, Triglochin, Rumex, Lignum,* grasses) | 0 | 40 |
| Spring 2009 | 0 | 60 (*Typha, Phragmites, Cotula, Triglochin, Rumex, Lignum,* grasses) | 0 | 40 |
| Summer 2010 | 1 (*Myriophyllum*) | 50 (*Typha, Phragmites, Cotula, Triglochin, Lignum*) | 0 | 49 |
| Autumn 2010 | 0 | 20 (*Typha*) | 0 | 80 |

**Table 67.** Water quality parameters measured at the Bremer Mouth during each site visit.

| Season | Temp (ºC) | pH | DO (ppm) | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|
| Winter 2009 | 14.2 | 7.2 | 8.3 | >1 | 1 |
| Spring 2009 | 20.4 | 7.7 | 3.42 | 0.18 | 0.6 |
| Summer 2010 | 26.6 | 8.34 | 7.16 | 0.05 | 0.4 |
| Autumn 2010 | 21 | 7.75 | 7.59 | >0.1 | 0.1 |

## Catch summary and length-frequency analysis

Murray hardyhead were sampled in low numbers in spring 2008 (Figure 79; Table 68). The site dried in autumn 2009 and subsequently no individuals were collected throughout 2009/10 (Table 68). Thirteen other species were sampled at this site (Table 68). All Murray hardyhead sampled in spring 2009 were large adult fish (>50 mm TL) (Figure 80).


**Figure 79.** An adult Murray hardyhead sampled from the Bremer River site in spring 2008.

**Table 68.** Total numbers of fish species collected from the Finniss River Confluence between spring 2008 and autumn 2010. NS = not sampled.

| **Species** | | **Sampling trip** | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **Murray hardyhead** | ***Craterocephalus fluviatilis*** | **9** | **NS (dry)** | **0** | **NS (dry)** |
| Australian smelt | *Retropinna semoni* | 7 | NS | 1 | NS |
| Carp gudgeon complex | *Hypseleotris spp.* | 1 | NS | 1 | NS |
| Flat-headed gudgeon | *Philypnodon grandiceps* | 61 | NS | 2 | NS |
| Bony herring | *Nematalosa erebi* | 114 | NS | 0 | NS |
| Common galaxias | *Galaxias maculatus* | 238 | NS | 908 | NS |
| Congolli | *Pseudaphritus urvillii* | 1 | NS | 0 | NS |
| Small-mouthed hardyhead | *Atherinosoma microstoma* | 42 | NS | 0 | NS |
| Tamar goby | *Afurcagobius tamarensis* | 1 | NS | 0 | NS |
| Blue-spot goby | *Pseudogobius olorum* | 3 | NS | 0 | NS |
| Carp | *Cyprinus carpio* | 1 | NS | 28 | NS |
| Goldfish | *Carrasius auratus* | 0 | NS | 1 | NS |
| Tench | *Tinca tinca* | 2 | NS | 0 | NS |
| Redfin perch | *Perca fluviatilis* | 4 | NS | 0 | NS |

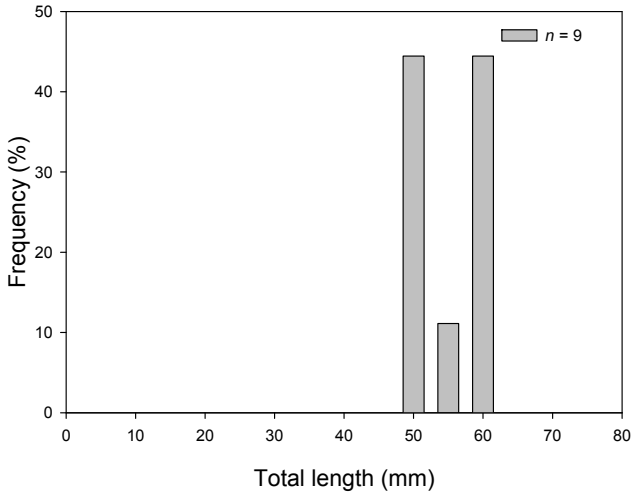



**Figure 80.** Length frequency distribution of Murray hardyhead from the Bremer Mouth in spring 2008.

## Site summary

Murray hardyhead have likely been lost from this site as it has completely dried out on two occasions as it became disconnected from Lake Alexandrina at low lake levels.

### 4.23. Rocky Gully (River Murray: Murray hardyhead)

Rocky Gully is an off-channel wetland of the River Murray near the town of Murray Bridge below Lock 1 (Figure 81). Rocky Gully is a medium sized wetland and is currently disconnected from the river, with a cement structure holding water at this site whilst River Murray levels are below ~0.3 m AHD. Habitat is dominated by algae and fringing terrestrial grasses. Salinity is typically elevated but variable.

Smith (2006) sampled a diverse assemblage of 16 species in 2005, including Murray hardyhead. Decreased water levels below Lock 1 since 2007 resulted in disconnection and increasing salinity. Subsequently, this site has received management attention with environmental water provided on several occasions due to poor water quality (i.e. rising salinity, algal bloom) and low levels.

#### Fish sampling effort

*Spring 2008, autumn 2009, spring 2009 and autumn 2010*

- 4 fyke nets set overnight

## 2009/10 Photo-point images

**Winter 2009**


**Spring 2009**


**Summer 2010**


**Autumn 2010**


**Figure 81.** Photo-point images of Rocky Gully from winter 2009, spring 2009, summer 2010 and autumn 2010.

## Environmental conditions

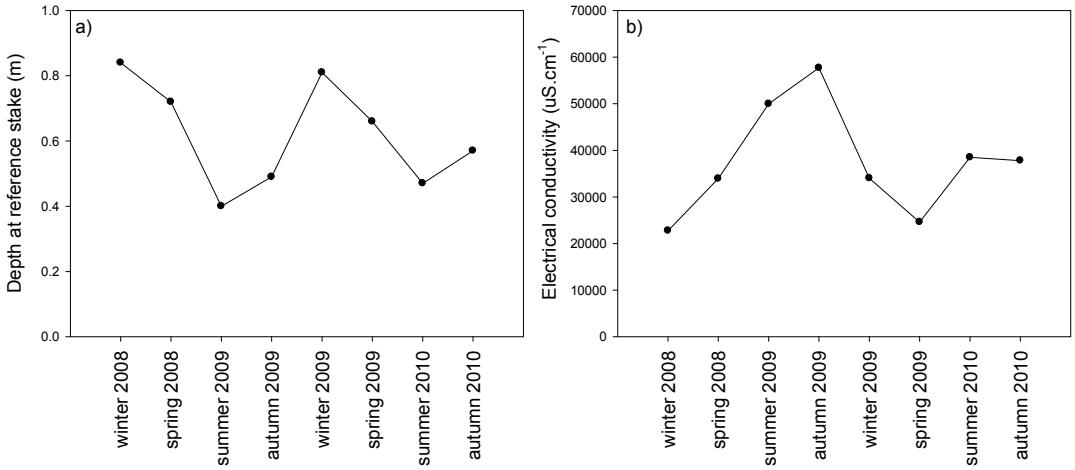



**Figure 82.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (µS.cm$^{-1}$) at Rocky Gully between winter 2008 and autumn 2010.

**Table 69.** Habitat cover measured at Rocky Gully during each site visit. Habitat cover is measured as the proportion (percent (%) cover) of aquatic habitat area comprised of submerged and emergent vegetation, physical structure or open water.

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | 0 | 10 (grasses, *Bolboschoenus*) | 0 | 90 |
| Spring 2009 | 35 (algae) | 5 (grasses, *Bolboschoenus*) | 0 | 60 |
| Summer 2010 | 35 (algae) | 5 (grasses, *Bolboschoenus*) | 0 | 60 |
| Autumn 2010 | 25 (algae) | 5 (grasses, *Bolboschoenus*) | 0 | 70 |

**Table 70.** Water quality parameters measured at Rocky Gully during each site visit.

| Season | Temp (ºC) | pH | DO (ppm) surface | DO (ppm) bottom | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|---|
| Winter 2009 | 16.7 | 8.82 | 13.3 | 7.6 | 0.33 | - |
| Spring 2009 | 27 | 9.01 | 10.85 | 6.21 | >1.5 | 1.5 |
| Summer 2010 | 25.9 | 8.79 | 4.34 | 2.1 | 0.5 | 1 |
| Autumn 2010 | 15.9 | 8.57 | 8.01 | 6.38 | 0.46 | 1.5 |

## Catch summary and length-frequency analysis

Murray hardyhead were sampled in large numbers in spring 2009 (Table 71). However in autumn 2009 they had shown a significant decrease in abundance and subsequently were not detected in spring 2009 (Table 71). In autumn 2010, Murray hardyhead were again detected in considerable abundance (Figure 83; Table 71). A

total of seven other species have been sampled at this site throughout the project (Table 71).

**Table 71.** Total numbers of fish species collected from Rocky Gully between spring 2008 and autumn 2010.

| Species | | Sampling trip | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **Murray hardyhead** | ***Craterocephalus fluviatilis*** | **760** | **3** | **0** | **103** |
| Small-mouthed hardyhead | *Atherinosoma microstoma* | 7606 | 0 | 7 | 612 |
| Flat-headed gudgeon | *Philypnodon grandiceps* | 0 | 0 | 73 | 179 |
| Dwarf flat-headed gudgeon | *Philypnodon macrostomus* | 0 | 0 | 5 | 2 |
| Carp gudgeon complex | *Hypseleotris spp* | 0 | 0 | 1 | 0 |
| Lagoon goby | *Tasmanogobius lasti* | 29 | 0 | 0 | 0 |
| blue-spot goby | *Pseudogobius olorum* | 314 | 0 | 0 | 0 |
| Gambusia | *Gambusia holbrooki* | 38 | 65 | 20 | 151 |

**Figure 83.** Adult Murray hardyhead sampled at Rocky Gully in autumn 2010.

All Murray hardyhead sampled in spring 2008 appeared to be adults from the previous spawning season (i.e. spring/summer 2007/08; >30 mm TL) (Figure 84a). The fish collected in autumn 2009 were likely to be recruits from spawning in spring/summer 2008 (Figure 84b). Whilst no fish were sampled in spring 2009, juvenile Murray hardyhead were observed (pers. obs.). In autumn 2010, Murray

hardyhead exhibited a broad length distribution with fish ranging 35-69 mm TL and recent recruitment evident (Figure 84d).

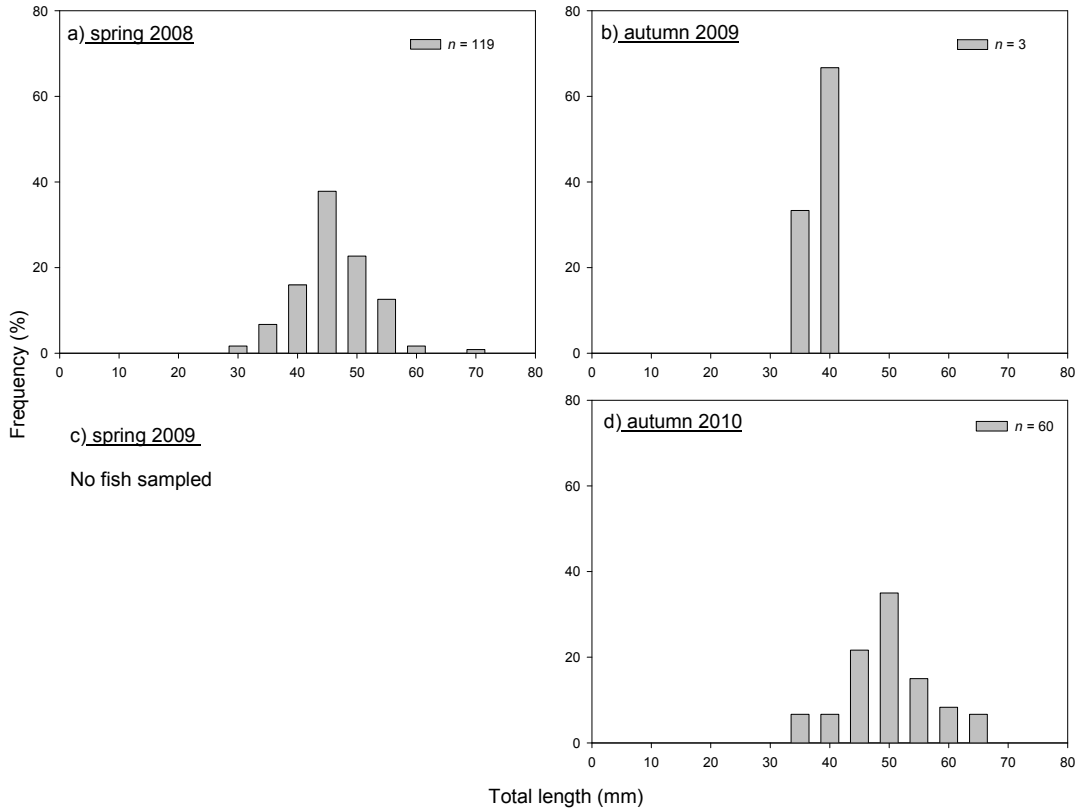



**Figure 84.** Length frequency distribution of Murray hardyhead from Rocky Gully in a) spring 2008, b) autumn 2009, c) spring 2009 and d) autumn 2010.

## Site summary

Murray hardyhead underwent a severe decline in abundance in 2008/09. This was likely due to the combination of a severe algal bloom and elevated salinity, which reached ~55,000 µS.cm$^{-1}$ in autumn 2009 (Figure 82b). Further sampling at this site, after autumn 2009, in an attempt to rescue fish for captive maintenance yielded just two individuals. An environmental water allocation was provided to this site in winter 2009. This action appears to have been favourable for Murray hardyhead with an increase in abundance and recent recruitment detected in autumn 2010.

### 4.24. Disher Creek (River Murray: Murray hardyhead)

Disher creek is a saline water disposal basin near the town of Renmark in the Riverland. This wetland is fed by water from the Renmark Area Drainage Disposal Scheme (RAADS). The site is shallow and often has abundant submerged vegetation (i.e. *Lepilaena*) and elevated salinities (Figure 85).

This site traditionally harboured a large population of Murray hardyhead across the whole wetland (Lloyd and Walker 1986; Wedderburn 2000). However, lack of flooding and decreased volumes of 'drainage disposal' flows has led to increased salinities throughout much of the wetland. As such the distribution of Murray hardyhead within the wetland has significantly contracted and the species is now confined to the immediate area around the drainage disposal outflow (DAP site selection, Wilson and Wedderburn unpublished data).

#### Fish sampling effort

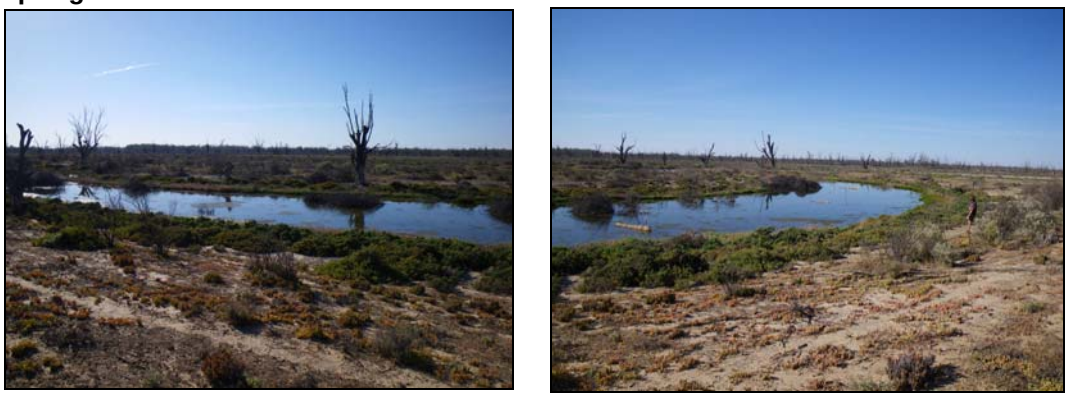
*Spring 2008, autumn 2009, spring 2009 and autumn 2010*

- 4 fyke nets set overnight

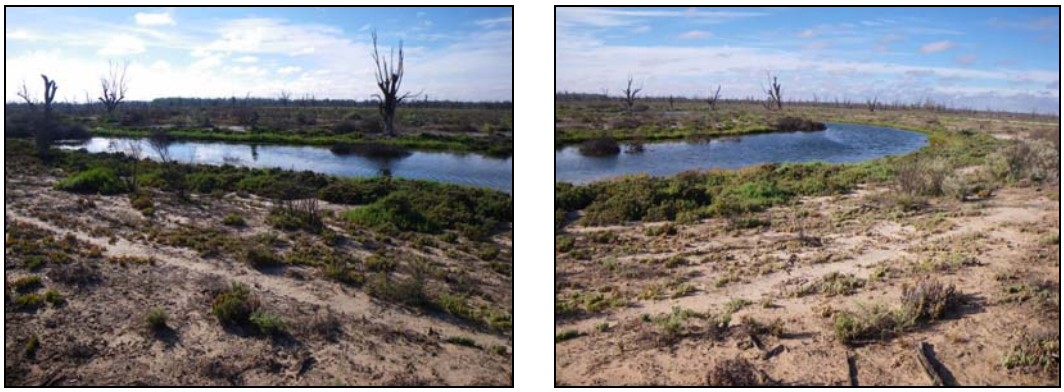
## 2009/10 Photo-point images

**Winter 2009**

**Spring 2009**



**Summer 2010**



**Autumn 2010**

**Figure 85.** Photo-point images of Disher Creek from winter 2009, spring 2009, summer 2010 and autumn 2010.

## Environmental conditions

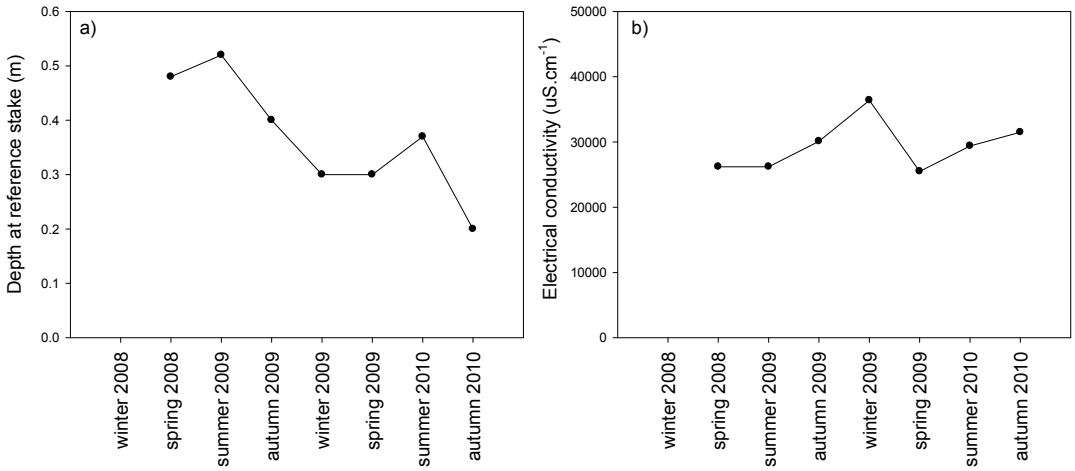



**Figure 86.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (µS.cm$^{-1}$) at Disher Creek between winter 2008 and autumn 2010.

**Table 72.** Habitat cover measured at Disher Creek during each site visit. Habitat cover is measured as the proportion (percent (%) cover) of aquatic habitat area comprised of submerged and emergent vegetation, physical structure or open water.

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | 5 (*Lepilaena*, algae) | 5 (*Lignum,* samphire, grasses) | 0 | 90 |
| Spring 2009 | 40 (*Lepilaena*, algae) | 10 (*Lignum,* samphire) | 0 | 50 |
| Summer 2010 | 20 (*Lepilaena*, algae) | 10 (*Lignum, Triglochin striatum*, samphire) | 0 | 70 |
| Autumn 2010 | 30 (*Lepilaena*, *Chara*) | 10 (*Lignum, Triglochin striatum*, samphire) | 0 | 60 |

**Table 73.** Water quality parameters measured at Disher Creek during each site visit.

| Season | Temp (ºC) | pH | DO (ppm) | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|
| Winter 2009 | 12 | 7.8 | 7.4 | >0.5 | 0.5 |
| Spring 2009 | 21.1 | 8 | 5 | >depth | - |
| Summer 2010 | 21.7 | 7.93 | 5.69 | >0.5 | 0.5 |
| Autumn 2010 | 13 | 7.92 | 10.24 | >0.45 | 0.45 |

## Catch summary and length-frequency analysis

Murray hardyhead were sampled in low numbers in spring 2008 but exhibited an increase in abundance in autumn 2009 (Table 74). Considerable numbers were also sampled in spring 2009 (Figure 87) but a substantial decline was evident in autumn 2010 (Table 74). Eastern gambusia is the only other species sampled at this site and is highly abundant (Table 74).

**Table 74.** Total numbers of fish species collected from Disher Creek between spring 2008 and autumn 2010.

| **Species** | | **Sampling trip** | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **Murray hardyhead** | *Craterocephalus fluviatilis* | **3** | **174** | **52** | **4** |
| Gambusia | *Gambusia holbrooki* | 2650 | 9687 | 3470 | 15490 |


**Figure 87.** Adult Murray hardyhead sampled from Disher Creek in spring 2009.

All Murray hardyhead sampled in spring 2008 were large adult fish (56-72 mm TL) (Figure 88a). Significant recruitment was observed in autumn 2009 with the majority of the population likely to be YOY individuals (Figure 88b). The population exhibited a broad range of lengths in spring 2009 (39-71 mm TL) but few individuals were sampled in autumn 2010 (Figure 88c & d). Nonetheless, fish <50 mm TL are likely to be YOY (Figure 88d).

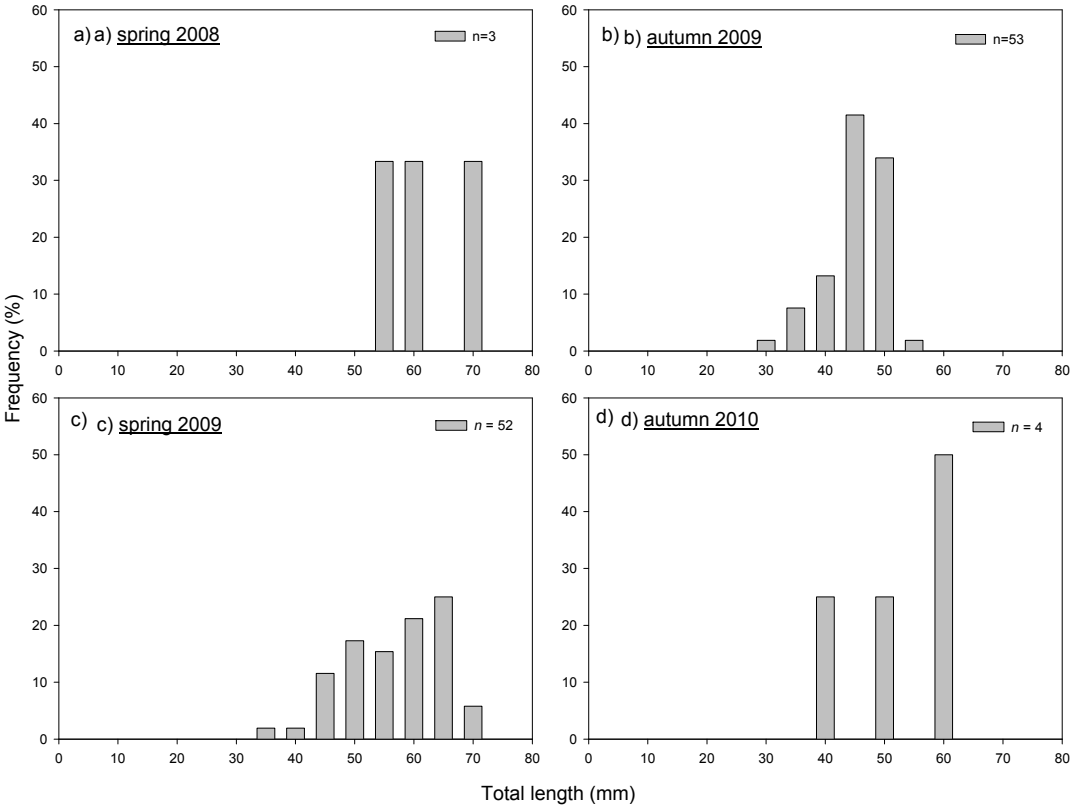



**Figure 88.** Length frequency distribution of Murray hardyhead from Disher Creek in a) spring 2008, b) autumn 2009, c) spring 2009 and d) autumn 2010.

## Site summary

Water level and salinity (Figure 86a & b) at this site have remained relatively stable over the course of sampling. However, Murray hardyhead exhibited a significant decline in abundance in autumn 2010 with just four individuals sampled. Eastern gambusia are very abundant at this site and may be impacting the Murray hardyhead population through competition.

Individuals from this site have been included in the captive breeding program being undertaken by the MDFRC Mildura lab. Furthermore, there are proposals for the management of this site with the aims of providing more secure water and decreasing salinity across the site, thus extending the available habitat area for Murray hardyhead.

### 4.25. Berri Evaporation Basin (River Murray: Murray hardyhead)

Berri Evaporation Basin is a saline water disposal basin near the town of Berri in the Riverland. The site could be described as a creek or billabong with abundant emergent vegetation (i.e. *Typha domingensis* and *Phragmites australis*) (Figure 89). Murray hardyhead were typically abundant at this site but have decreased in abundance in recent years (cf. Wedderburn *et al.* 2008; DAP site selection autumn 2008, Wilson and Wedderburn unpublished data). Salinity at this site has been gradually decreasing which may favour common small-bodied freshwater species at the expense of Murray hardyhead.

#### Fish sampling effort

*Spring 2008, autumn 2009, spring 2009* and *autumn 2010*

- 8 fyke nets set overnight

## 2009/10 Photo-point images

**Winter 2009**


**Spring 2009**


**Summer 2010**


**Autumn 2010**


**Figure 89.** Photo-point images of Berri evaporation basin from winter 2009, spring 2009, summer 2010 and autumn 2010.

## Environmental conditions

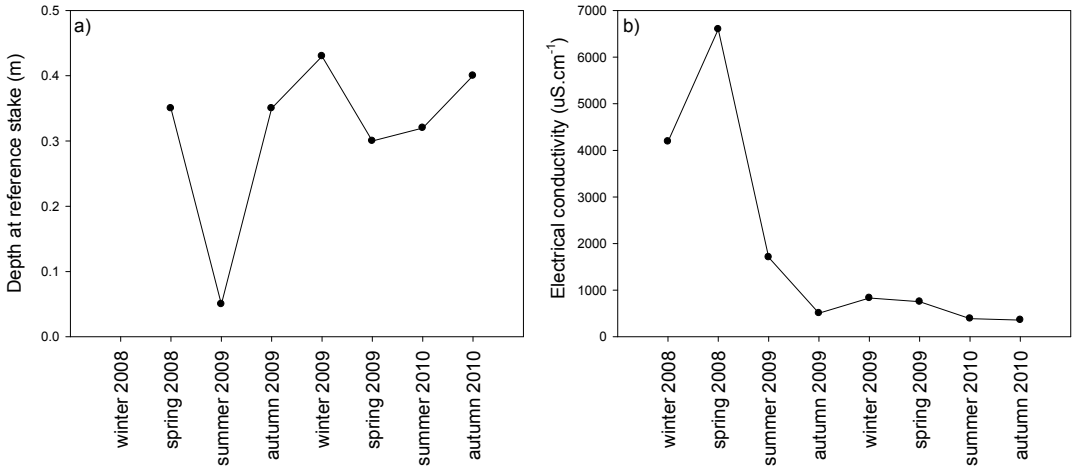



**Figure 90.** a) depth at reference stake (m, i.e. water level variability) and b) electrical conductivity (µS.cm$^{-1}$) at Berri evaporation basin between winter 2008 and autumn 2010.

**Table 75.** Habitat cover measured at Berri evaporation basin during each site visit. Habitat cover is measured as the proportion (percent (%) cover) of aquatic habitat area comprised of submerged and emergent vegetation, physical structure or open water.

| Season | Submergent vegetation | Emergent vegetation | Physical | Open water |
|---|---|---|---|---|
| Winter 2009 | 0 | 20 | 0 | 80 |
| Spring 2009 | 20 (algae) | 30 (*Typha, Phragmites*) | 1 (snag) | 49 |
| Summer 2010 | 20 (algae) | 20 (*Typha, Phragmites, Paspalum*) | 0 | 60 |
| Autumn 2010 | 10 (algae) | 40 (*Typha, Phragmites*) | 1 (snag) | 49 |

**Table 76.** Water quality parameters measured at Berri evaporation basin during each site visit.

| Season | Temp (ºC) | pH | DO (ppm) | Secchi (m) | Max depth (m) |
|---|---|---|---|---|---|
| Winter 2009 | 14.8 | 7.61 | 6.72 | >0.6 | 0.6 |
| Spring 2009 | 25.9 | 8.9 | 6.1 | >0.8 | 0.8 |
| Summer 2010 | 26.2 | 9.63 | 3.8 | >0.4 | 0.4 |
| Autumn 2010 | 16.5 | 7.92 | 3.29 | >0.5 | 0.5 |

## Catch summary and length-frequency analysis

Murray hardyhead have been collected in all seasons but were less abundant in spring 2009 and autumn 2010 relative to the previous year (Table 77). A total of six other species have been collected from this site with carp gudgeon highly abundant (Table 77).

**Table 77.** Total numbers of fish species collected from Berri Evaporation Basin between spring 2008 and autumn 2010.

| Species | | Sampling trip | | | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Spring 2008** | **Autumn 2009** | **Spring 2009** | **Autumn 2010** |
| **Murray hardyhead** | ***Craterocephalus fluviatilis*** | **37** | **84** | **16** | **41** |
| Australian smelt | *Retropinna semoni* | 39 | 91 | 9 | 10 |
| Carp gudgeon complex | *Hypseleotris spp.* | 4585 | 3146 | 3386 | 3869 |
| Flat-headed gudgeon | *Philypnodon grandiceps* | 518 | 355 | 214 | 374 |
| Dwarf flat-headed gudgeon | *Philypnodon macrostomus* | 24 | 32 | 11 | 38 |
| Goldfish | *Carrasius auratus* | 0 | 0 | 0 | 1 |
| Gambusia | *Gambusia holbrooki* | 860 | 4284 | 1619 | 472 |

Two distinct cohorts of Murray hardyhead were present in spring 2008, representing adults (45-65 mm TL) likely spawned in 2007 and YOY (21-25 mm TL) likely from recent spawning in 2008 (Figure 91a). This YOY cohort had progressed in length and successfully recruited, representing the majority of the population in autumn 2009 (Figure 91b). Again in spring 2009, the population was dominated by large (>45 mm TL) adult fish (Figure 91c) and the growth of this cohort was evident in autumn 2010 (Figure 91d). However the length-frequency distribution in autumn 2010 was dissimilar to the previous year, with what appears to be a comparatively lesser level of recruitment (Figure 91d).

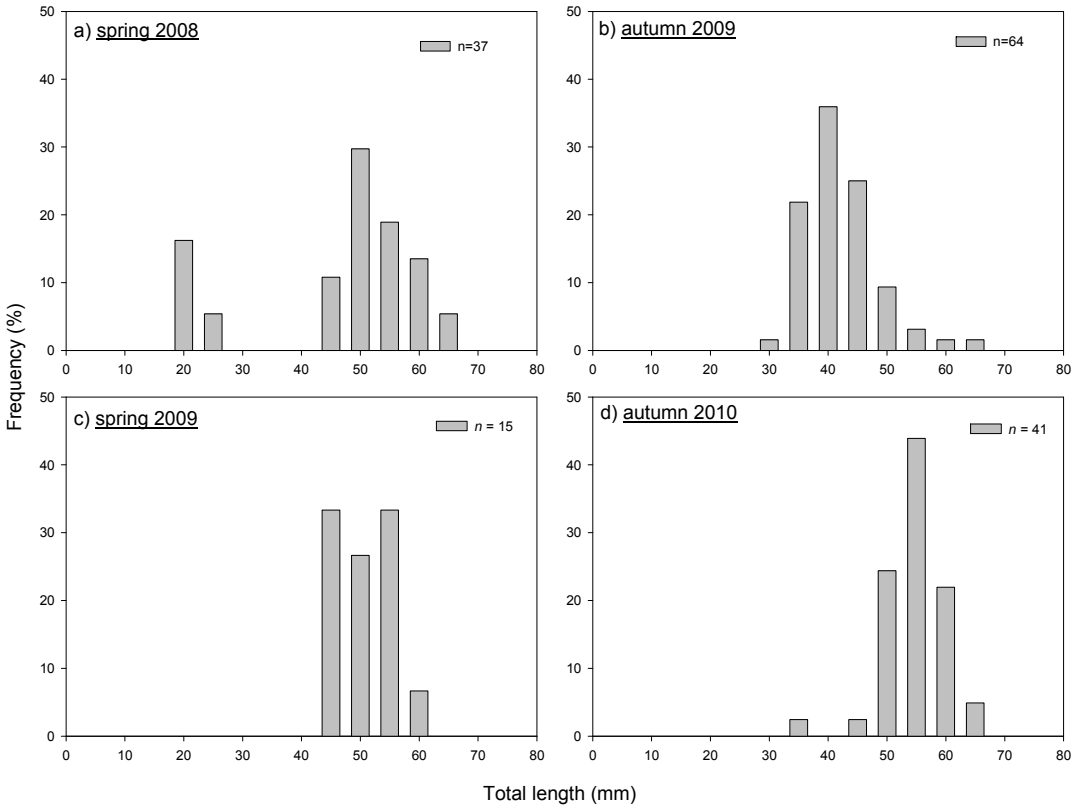



**Figure 91.** Length frequency distribution of Murray hardyhead from Berri evaporation basin in a) spring 2008, b) autumn 2009, c) spring 2009 and d) autumn 2010.

## Site summary

Murray hardyhead are still present at this site in moderate numbers but have undergone a slight decrease in abundance and recruitment in autumn 2010 was minimal. Salinity has been gradually decreasing at this site and as of autumn 2010 was ~400 μS.cm$^{-1}$ (Figure 90b). Murray hardyhead are highly tolerant of saline conditions relative to other freshwater species and the recent decrease in salinity may favour other species and infer additional energetic cost to Murray hardyhead due to osmoregulation, potentially leading to increased competition (Wedderburn *et al.* 2008). Furthermore, fish sampled from this site often appear to be in poor condition and are very susceptible to handling, potentially indicating that individuals are stressed due to the metabolic stress experienced at low salinities (pers obs). Thus, common non-threatened species such as Australian smelt and gudgeon species may eventually out-compete Murray hardyhead at this site.

Individuals from this site have also been included in the captive breeding program being undertaken by the MDFRC Mildura lab. Furthermore, there are proposals for

the management of this site with the aims of providing more secure water and increasing salinity across the site, thus extending the available habitat area for Murray hardyhead.

# 5. DISCUSSION

## 5.1. Species' 'wild' population status

The monitored sites and populations of small-bodied threatened fish exhibited different responses to conditions over 2009/2010. A small number of populations were considered to be in a satisfactory condition and thus have a lower risk of population loss (e.g. Tookayerta Creek sites); however, most populations declined considerably relative to 2008/09 (e.g. Finniss River waterfalls), remained in a critical state (e.g. Rodwell Creek, Marne River), or are now feared lost (e.g. Bremer River Mouth and Mundoo Drain East). This was primarily due to further decreases in water levels resulting in complete drying, loss of vegetated habitat and/or increased salinity at some sites (e.g. Mundoo Drain East). Nevertheless, some populations/sites were in better condition in autumn 2010 relative to 2008/09 primarily due to management intervention and the delivery of environmental water (e.g. Boggy Creek and Rocky Gully).

The data presented in this report are used to summarize the status of each population and site (i.e. abundance, recruitment, site condition) and to develop risk factors for the loss of each of these populations (Table 78). A 'traffic light' system was applied to visually represent the risk to each population. Levels of risk are defined as follows,

- Low risk (green) – moderate abundance in 2009/10, evidence of recent recruitment and stable habitat conditions.
- Moderate risk (orange) – moderate abundance in 2009/10, lack of recruitment in 2009/10 (river blackfish) and/or diminished habitat quality.
- High risk (red) – substantial declines in abundance (between spring 2009 and autumn 2010 or relative to 2008/09), lack of recruitment (pygmy perch species, southern purple-spotted gudgeon and Murray hardyhead), extended lack of recruitment (i.e. >3 years, river blackfish) and/or severely diminished habitat quality.
- Population likely to be lost (purple)

Jury Swamp, an off-channel wetland of the River Murray below Lock 1, is the only site monitored for southern purple-spotted gudgeon and this population remains at high risk of loss. The population at this site is likely to be small and functionally may

struggle to recover due to the demographic threats posed by small populations such as skewed sex ratios and loss of genetic diversity.

As of autumn 2010, river blackfish were present at all five monitoring sites for this species. Populations within the Tookayerta catchment (i.e. Willowburn road and Deep Creek road) and the population within the Angas River (i.e. Angas River Gauge site) were sampled in moderate abundances, with significant recent recruitment observed and are subsequently at low risk of loss. Conversely, the remaining two river blackfish populations (i.e. the Marne River and Rodwell Creek) are deemed to be at high risk of loss. Both of these populations are dominated by large adult fish and recruitment has not been observed for >2 years at Rodwell Creek and ≥8 years at the Marne River.

A total of 13 sites are monitored for southern pygmy perch, including eight where this species was present together with other threatened species. Southern pygmy perch are found at both Tookayerta catchment sites together with river blackfish and similar to river blackfish, the population at Willowburn Road is performing satisfactorily and is at low risk of loss. The population at Deep Creek Road, however, was deemed to be at moderate risk due to decreases in abundance relative to 2008/09. The Meadows Creek and the Inman River populations can also be considered at medium risk of loss. Five sites were deemed to be at high risk of loss. These include both Black Swamp and Black Swamp Drain, sites that were not sampled in autumn 2009, as they were dry, but low numbers of southern pygmy perch were detected in 2009/10 following water level rise in the Goolwa Channel as part of the *Goolwa Channel Water Level Management Plan*. Three other populations, namely Waterfalls, Turvey's Drain and Middle Creek Junction were deemed to be at high risk of loss as a result of diminished abundances relative to 2008/09. The remaining four populations have potentially been lost, which includes a population which was discovered in spring 2008 (i.e. Mundoo Drain West) (see Wedderburn and Barnes 2009). These sites are within the Lower Lakes and have completely dried or become severely degraded (e.g. increased salinity, lack of vegetated habitat) as a result of reduced water levels.

Yarra pygmy perch were not collected from any of the six sites sampled for this species in 2009/10. All of these sites are in the Lower Lakes and have completely dried or become severely degraded (e.g. increased salinity, lack of vegetated habitat) as a result of reduced water levels. Furthermore, no Yarra pygmy perch were

collected by Wedderburn and Barnes (2009) or Wedderburn and Hillyard (In Prep) from broader surveys of sites in the Lower Lakes in 2008/2009 and 2009/10 as part of *The Living Murray* 'condition monitoring'. Yarra pygmy perch were last collected in the region in February 2008 near the mouth of Eastick Creek (Hammer 2008b) and it is likely that this species has been extirpated from the region.

As of autumn 2010, Murray hardyhead were present at just five of 16 sites sampled for this species. Murray hardyhead is the most widely yet patchily distributed species under investigation and is represented by two separate conservation units: (a) the Lower Lakes unit, which is known from wetlands, irrigation drains and sheltered lake edges in the Lower Lakes and off-channel wetlands below Lock 1; (b) the Riverland unit, known from off-channel evaporation basins in the upper reaches of the South Australian MDB (Hammer *et al.* 2009). Most populations are tracking poorly (i.e. low or declining abundance), however, two Lower Lakes sites are represented by higher abundances, namely Rocky Gully and Boggy Creek, both subject to environmental watering. No Murray hardyhead were sampled from Turvey's Drain in autumn 2010 and further monitoring will determine if this population has been lost or was simply not detected by sampling in autumn 2010. Additionally, newly discovered populations in the Lower Lakes (i.e. Mundoo Drains East and West) have likely been lost due to drying and increased salinity. Other former Murray hardyhead habitat in the Lower Lakes and in off-channel wetlands below Lock 1 (i.e. Riverglades and Jury Swamp) remains dry.

Sporadic captures of Murray hardyhead have occurred in other fish monitoring programs in the Lower Lakes in 2009/10. This has primarily occurred in the Goolwa Channel, where fish have been detected in the Finniss River arm (Bice *et al.* 2010), in Goolwa Channel near the Hindmarsh Island Bridge (Wedderburn and Hillyard In Prep) and immediately upstream of the Goolwa Barrage (SARDI unpublished data). A single fish was also recorded downstream of Winery Road in the upper Finniss Arm of Lake Alexandrina in Autumn 2010 in 'SA MDB NRMB tributary monitoring' (Hammer unpublished data). Furthermore, whilst not sampled in autumn 2010, Murray hardyhead were detected at the Currency Creek site in spring 2009 after re-inundation of this site, which was completely dry in summer-autumn 2009. This suggests that there is a population of Murray hardyhead more broadly in the Goolwa Channel area that are capable of re-colonising sites upon the return of favourable water levels and habitat conditions. As such, the *Goolwa Channel Water Level Management Plan* may benefit Murray hardyhead by maintaining higher water levels

and facilitating vegetation growth (see Nicol and Gehrig 2010). Furthermore, it is widely accepted that Murray hardyhead prefer slightly to moderately saline waters (Wedderburn *et al.* 2008) and thus may be benefited by a freshwater-saline regime currently exhibited within the Goolwa Channel (DWLBC 2010).

The status of both Riverland populations of Murray hardyhead (i.e. Disher Creek and Berri evaporation basin) was upgraded from 'moderate risk of loss' to 'high risk of loss' between 2008/09 and 2009/10. Murray hardyhead exhibited a steep decline in numbers at Disher Creek between spring 2009 and autumn 2010 and recruitment was limited. Murray hardyhead were less abundant in 2009/10 than in 2008/09 at Berri Evaporation Basin. Recruitment appeared diminished relative to 2008/09 and decreasing salinity is likely to be impacting the population. Murray hardyhead are tolerant of saline conditions relative to other freshwater species and the decrease in conductivity observed at this site (from 6597 $\mu S.cm^{-1}$ in spring 2008 to 440 $\mu S.cm^{-1}$ in autumn 2010) may favour other species, leading to increased competition with Murray hardyhead (Wedderburn *et al.* 2008).

**Table 78.** The population status of threatened fish species (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). NS = not sampled.

| Site Name | DAP Site Number | Target species | No. caught spring 2009 | No. caught autumn 2010 | Recruitment within the last 12 months (Y/N) | Water level (Rising, stable, falling, dry) | Site comments |
|---|---|---|---|---|---|---|---|
| Jury Swamp | 1.1.1 | Southern purple spotted gudgeon | 1 | 0 | Yes | Rising | If still present abundance probably very low |
| Rodwell Creek | 2.1.1 | River blackfish | 4 | 4 | No | Variable (pumping) | Pool being maintained by watering. Very limited or no recruitment within last 3 years. Population dominated by adult fish |
| Marne | 2.2.1 | River blackfish | 5 | 4 | No | Stable | No recruitment within last 3 years. Pool in poor condition (i.e. presence of unknown white plume on bottom of pool) |
| Angas Gauge | 2.3.1 | River blackfish | 27 | 28 | Yes | Seasonally variable | Pool in good condition, consistent abundances and recent recruitment evident. Elevated salinity may be an issue but is seasonally variable |
| Willowburn Road | 2.4.1a | River blackfish | 13 | 11 | Yes | Seasonally variable | Pools in good condition (i.e. consistent cool base flow). Consistent abundance and recent recruitment |
| | 3.4.1a | Southern pygmy perch | 24 | 21 | Yes | Seasonally variable | As above |
| Deep Creek Road | 2.4.1b | River blackfish | 4 | 16 | Yes | Seasonally variable | Pool in good condition (i.e. consistent cool base flow). Increase in abundance with significant recruitment |
| | 3.4.1b | Southern pygmy perch | 15 | 5 | Yes | Seasonally variable | Decrease in abundance from 2008/09. Recruitment evident in 2009/10 |
| Middle Creek Junction | 3.1.1 | Southern pygmy perch | 2 | 9 | Yes | Falling | Decrease in abundance from 2008/09 |
| Boundary Creek Drain | 3.2.1a | Southern pygmy perch | NS | NS | - | Dry | Low water levels, population probably lost |
| | 4.1.1a | Yarra pygmy perch | NS | NS | - | Dry | Low water levels, population probably lost |
| | 5.1.1a | Murray hardyhead | NS | NS | - | Dry | Low water levels, population probably lost |
| Eastick | 3.2.1b | Southern pygmy perch | 0 | 0 | - | Rising | Low water level, high salinity – population probably lost |
| | 4.1.1b | Yarra pygmy perch | 0 | 0 | - | Rising | Low water level, high salinity – population probably lost |
| | 5.1.1b | Murray hardyhead | 0 | 1 | - | Rising | Single individual sampled in autumn 2010, population probably small |
| Steamer Drain | 3.2.1c | Southern pygmy perch | NS | NS | - | Dry | Dry – population lost |
| | 4.1.1c | Yarra pygmy perch | NS | NS | - | Dry | Dry – population lost |
| | 5.1.1c | Murray hardyhead | NS | NS | - | Dry | Dry – population lost |

**Table 78 continued.**

| Site Name | DAP Site Number | Target species | No. caught spring 2008 | No. caught autumn 2009 | Recruitment within the last 12 months (Y/N) | Water level summer-autumn (Rising, stable, falling, dry) | Site comments |
|---|---|---|---|---|---|---|---|
| Black Swamp | 3.2.2a | Southern pygmy perch | 7 | 0 | No | Variable (dependent on Goolwa Channel level) | Population likely to be small. No recruitment detected in autumn 2010. Conditions in the area may be favourable for this species with higher water levels due to the *GWLMP* |
| | 4.1.3 | Yarra pygmy perch | 0 | 0 | - | Variable (dependent on Goolwa Channel level) | Population probably lost |
| Black Swamp Drain | 3.2.2 | Southern pygmy perch | 0 | 2 | Yes | Variable (dependent on Goolwa Channel level) | Population likely small. Conditions in the area may be favourable for this species with higher water levels due to the *GWLMP* |
| Turvey's Drain | 3.2.3 | Southern pygmy perch | 10 | 1 | Yes | Stable (pumping) | Despite environmental watering, marked decrease in abundance from 2008/09 and no recruitment detected |
| | 5.1.3a | Murray hardyhead | 11 | 0 | Yes | Stable (pumping) | Despite environmental watering, marked decrease in abundance from 2008/09 and no recruitment detected |
| Meadows | 3.3.1 | Southern pygmy perch | 3 | 24 | Yes | Seasonally variable | Consistent numbers and significant recruitment, albeit restricted distribution within the site (i.e. two pools) |
| Waterfalls | 3.3.3 | Southern pygmy perch | 1 | 1 | No | Seasonally variable | Very low abundance and significant decline from spring 2008 and previous years. Recruitment not detected for >2 years |
| Inman | 3.5.1 | Southern pygmy perch | 8 | 19 | Yes | Seasonally variable | Slight decrease in abundance from 2008/09. Low water levels in pools, low DO |
| Currency Creek | 4.1.2A | Yarra pygmy perch | 0 | 0 | - | Variable (dependent on Goolwa Channel level) | Population probably lost |
| | - | Murray hardyhead | 11 | 0 | No | Variable (dependent on Goolwa Channel level) | Population likely in low abundance. Conditions at this site may now be favourable for this species with higher water levels due to the *GWLMP*. Several individuals were sampled from a nearby site in autumn 2010 by Wedderburn and Hillyard (In Prep) |
| Finniss River Confluence | 4.1.2 | Yarra pygmy perch | 0 | 0 | - | Variable (dependent on Goolwa Channel level) | Population probably lost |
| | - | Murray hardyhead | 0 | 0 | No | Variable (dependent on Goolwa Channel level) | Whilst not sampled in 2009/10, 10 individuals were sampled in the area (within ~1 km) in autumn 2010 by Bice *et al.* (2010). Conditions at this site may now be favourable for this species with higher water levels due to the *GWLMP*. |
| Boggy Creek | 5.1.1d | Murray hardyhead | 16 | 98 | Yes | Stable (pumping) | Moderate numbers and significant recruitment in autumn 2010. Water level will remain an issue at this site without management |
| Mundoo Drain West | | Murray hardyhead | 14 | 0 | No | Dry | Either present in low numbers or potentially lost |
| | | Southern pygmy perch | 4 | 0 | No | Dry | Population probably lost |

**Table 78 continued.**

| Site Name | DAP Site Number | Target species | No. caught spring 2008 | No. caught autumn 2009 | Recruitment within the last 12 months (Y/N) | Water level summer-autumn (Rising, stable, falling, dry) | Site comments |
|---|---|---|---|---|---|---|---|
| Mundoo Drain East | | Murray hardyhead | 162 | 0 | No | Dry | Population likely lost. Pools dried or very shallow, with electrical conductivity >90,000 µS.cm$^{-1}$ |
| Clayton | 5.1.2 | Murray hardyhead | 0 | 0 | No | Rising | Not sampled since autumn 2009, population likely lost. However, water levels have recently risen slightly and the lagoon has begun to fill. As such conditions may be favourable for Murray hardyhead after filling and the species may re-colonise the site if an appropriate source population exists |
| Milang Jetty | 5.1.3b | Murray hardyhead | 0 | 0 | No | Rising | Not sampled since spring 2010, population likely lost. However, water levels have recently risen slightly. As such conditions may become favourable for Murray hardyhead and the species may re-colonise the site if an appropriate source population exists |
| Bremer River Mouth | 5.1.3c | Murray hardyhead | 0 | 0 | No | Dry | Dry – population lost |
| Rocky Gully | 5.1.4 | Murray hardyhead | 0 | 103 | Yes | Stable (pumping) | This population has improved from 2009, matching management interventions (i.e. watering), with moderate abundance and recent recruitment evident. However population reliant on continued management to ensure adequate water level and salinity |
| Riverglades | 5.1.5 | Murray hardyhead | NS | NS | - | Dry | Dry – population lost |
| Disher Creek | 5.2.1 | Murray hardyhead | 52 | 4 | Yes (limited) | Stable | Diminished abundance in autumn 2010. Very high abundance of gambusia may be impacting Murray hardyhead |
| Berri | 5.2.1 | Murray hardyhead | 16 | 41 | Yes (limited) | Stable | Salinity continues to decrease. Level of recruitment limited in autumn 2010 relative to autumn 2009. Increase in non salt-tolerant species that may compete with Murray hardyhead |

### 5.2. In situ population maintenance

Several actions have been undertaken in attempts to protect wild habitats, primarily involving the delivery of environmental water. More specific information is provided in site summaries, but key highlights are included below.

In response to low water levels and low dissolved oxygen concentrations since autumn 2008, Rodwell Creek has been filled with environmental water on multiple occasions over summer and autumn and it is hoped this intervention will facilitate the persistence of the river blackfish population. Furthermore, an aerator has been installed to further raise dissolved oxygen concentrations at this site. It is likely the population would have been lost without this intervention.

The two best performing Murray hardyhead sites were both subject to in situ management. Murray hardyhead are present at Boggy Creek in considerable numbers and have recently exhibited significant recruitment. This population was nearly lost in autumn 2009, when the site dried (fish were rescued and temporarily housed), but was provided with environmental water on several occasions which appears to have facilitated the persistence of the species at the site. Likewise conditions at Rocky Gully were very poor in autumn 2009 (algae bloom, high salinity, ~55,000 $\mu S.cm^{-1}$) but the site and population of Murray hardyhead has responded well to environmental watering, at least in the short-term. Murray hardyhead were captured in substantial numbers in autumn 2010 following significant recruitment. Issues of low water levels and increasing salinity remain significant and it is likely further management intervention will be required.

Turvey's Drain initially received indirect management intervention through landholder actions to maintain irrigation which preserved habitat for fish (i.e. blocking bank to maintain original lake height in the channel) and more recently targeted measures through combined landholder and DENR management (maintaining water height for fish). Both southern pygmy perch and Murray hardyhead were recorded in 2009/10 albeit in limited numbers. Actions have provided important support for the species and aquatic vegetation (site would otherwise be dry), but additional intervention appears to be required to enhance fish response. A pipeline to provide fresher and controlled inflows is in development.

Similarly, there are proposals to change the management of both Riverland Murray hardyhead sites (i.e. Disher Creek and Berri Evaporation Basin), with the primary objectives of providing further water and subsequently providing more favourable salinity regimes and

increasing available habitat area. Conversely the Marne River and Finniss waterfalls sites have received minimal management intervention (aside from spawning tubes and a local rescue) and these are the sites likely to have the most 'at risk' populations remaining.

### 5.3. Captive breeding

There are currently captive breeding programs established through the DAP of at least one population for each of the five threatened species (involving multiple agencies, see site summaries for specifics). The primary goal of these programs is to spread risk from imperilled 'wild' populations (back up) and to then produce juveniles for introduction into surrogate refuges, and ultimately 'wild' sites.

A number of juvenile southern purple-spotted gudgeon have been released into a restored 'wild' refuge at the Paiwalla wetland near Jury Swamp. It is hoped that this action will result in a self-sustaining population. Yarra pygmy perch have been bred in captivity and released into two surrogate dams where they appear to have established. An initial release of Lower Lakes Murray hardyhead into a farm dam in the Mount Lofty Ranges has also been made, and juveniles from the Riverland conservation unit are also ready for release into a surrogate refuge. To date, limited breeding success has been made with river blackfish (Rodwell Creek stock) and southern pygmy perch (Lake Alexandrina and Angas River stocks).

### 5.4. Conclusion

Given continuing changes in population and habitat status, ongoing monitoring is essential to highlight populations and sites most at risk of loss and to inform actions to secure these populations. Monitoring as a component of the 'DAP for threatened fish populations in the South Australian MDB' (Hall *et al.* 2009) will continue through 2010/2011 following the same time frames as previous years. This will provide greater insight on the trajectory of these populations and sites, and the potential success or failure of management interventions already undertaken to conserve certain populations. Additionally, the continuation of monitoring is critically important as current drought conditions and low system inflows are not expected to alleviate in the short-term. This increases the importance of having a rigorous management framework to conserve these species and a corresponding monitoring program to inform management decisions. Importantly, monitoring may trigger swift and decisive management action when populations are deemed to be at high risk of loss.

## 6. REFERENCES

Bice C, Hammer M, Wilson P and Zampatti B (2009) 'Fish monitoring for the 'Drought Action Plan for South Australian Murray-Darling Basin threatened freshwater fish populations': Summary for 2008/09. Report to the South Australian Department for Environment and Heritage.' South Australian Research and Development Institute (Aquatic Sciences), Adelaide, 110pp. SARDI Publication No. F2009/000451-1.

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

Bice C and Ye Q (2006) 'Monitoring threatened fish communities on Hindmarsh Island, in the Lower Lakes of the River Murray, South Australia in 2005.' South Australian Research and Development Institute (Aquatic Sciences), Adelaide, SARDI Publication Number RD06/0004-1.

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

Bice C, Zampatti B and Short D (2010) 'Response of fish to the 'Goolwa Channel Water Level Management Plan' in 2009/10 ' South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2010/000703-1.

Corporation SW (2009) 'Goolwa Channel Water Level Management Project: Report to the Public Works Committee.' South Australian Water Corporation, Adelaide. 12525/08.

DWLBC (2010) 'DWLBC Unpublished Data. Department of Water Land and Biodiversity Conservation.'

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

Hammer M (2004) 'The Eastern Mount Lofty Ranges Fish Inventory: Distribution and Conservation of Freshwater Fishes of Tributaries to the Lower River Murray, South Australia.' Native Fish Australia (SA) Inc. and River Murray Catchment Water Management Board.

Hammer M (2005) 'Recovery monitoring for the Southern Pygmy Perch in the Mount Lofty Ranges, 2001-2005 review.' Native Fish Australia (SA) Inc, Adelaide.

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

Hammer M (2008a) A molecular genetic appraisal of biodiversity and conservation units in freshwater fishes from southern Australia. PhD Thesis. University of Adelaide.

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

Hammer M (2009) 'Freshwater fish monitoring in the Eastern Mount Lofty Ranges: environmental water requirement and tributary condition reporting for 2008 and 2009.' Report to the South Australian Murray-Darling Basin Natural Resources Management Board. Aquasave Consultants. 160pp.

Hammer M, Wedderburn S and van Weenen J (2009) 'Action Plan for South Australian Freshwater Fishes.' Native Fish Australia (SA).

Higham J, Ye Q and Smith B (2005) 'Murray Darling Basin Drought Monitoring: 'Monitoring small-bodied fish in the Lower Murray during and after drought conditions in 2003-2004.' Project Final Report to the Department of Water, Land and Biodiversity Conservation.

Holt M, Swingler K, O'Donnell E, Shirley M, Lake M, *et al.* (2005) 'River Murray Wetlands Baseline Survey.' River Murray Catchment Water Management Board, Berri, South Australia.

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

Lloyd LN and Walker KF (1986) Distribution and conservation status of small freshwater fish in the River Murray, South Australia. *Transactions of the Royal Society of South Australia* **110**, 49-57

Murphy BF and Timbal B (2007) A review of recent climate variability and climate change in southeastern Australia. *International Journal of Climatology* **28**, 859-879

Nicol J and Gehrig S (2010) 'Aquatic and littoral vegetation monitoring of Goolwa Channel 2009-10.' South Australian Research and Development Institute (Aquatic Sciences), Adelaide, 21 pp.

Smith BB (2006) 'Final report on the 'fish' component of the 2005 River Murray Wetlands Baseline Survey.' South Australian Research and Development Institute (Aquatic Sciences), Adelaide.

Wedderburn S (2000) Habitat and conservation status of small fish in the Lower River Murray, and a comparison of the western carp gudgeon (*Hypseleotris klunzingeri*) and gambusia (*Gambusia holbrooki*) as larval mosquito predators. . Honours Thesis (Bachelor of Science), Adelaide University.

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

Wedderburn S and Hammer M (2003) 'The Lower Lakes Fish Inventory: Distribution and Conservation of Freshwater Fishes of the Ramsar Convention Wetland at the Terminus of the Murray-Darling Basin, South Australia.' Native Fish Australia (SA) Inc., Adelaide.

Wedderburn S and Hillyard C (In Prep) 'Condition monitoring of threatened fish species at Lake Alexandrina and Lake Albert (2009-2010). Report to the Murray-Darling Basin Authority and the South Australian Murray-Darling Basin Natural Resources Management Board.' Adelaide University, Adelaide.

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

Westergaard S and Ye Q (2010) 'A captive spawning and rearing trial for river blackfish (*Gadopsis marmoratus*): Efforts towards saving local genetic assets with recognised conservation significance from the South Australian Murray-Darling Basin.' South Australian Research and Development Institute (Aquatic Sciences), Adelaide, 26pp. SARDI Publication Number F2010/000183-1. SARDI Research Report Series No. 471.