Freshwater fish monitoring in the Eastern Mount Lofty Ranges: environmental water requirements and tributary condition reporting for 2008 and 2009






Michael Hammer
Aquasave Consultants, Adelaide

June 2009

Government of South Australia
South Australian Murray-Darling Basin Natural Resources Management Board

Citation

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, Adelaide. 160 pp.

Correspondence in relation to this report contact

Dr Michael Hammer
Aquasave Consultants
Tel: +61 429 098 920
Email: michael@bold.net.au

Disclaimer

Executive summary

Tributary streams of the Eastern Mount Lofty Ranges (EMLR) provide important habitat for a range of freshwater fishes. Understanding and provision of environmental water requirements (EWR) for different fish functional groups provides a solid base for sound catchment management, ecosystem protection and biodiversity conservation. A long-running fish monitoring program aims to provide empirical knowledge in support of EWR initiatives being undertaken by the SA MDB Natural Resource Management Board and Department for Water, Land and Biodiversity Conservation.

Fish monitoring of varying forms has occurred at least annually in the EMLR since 2001. In 2007 existing monitoring programs and data were reviewed within a EWR framework to assess the condition of fish populations and communities for different stream reaches. This was expanded further in spring 2008 to include all annual autumn sampling sites in an aim to provide a better understanding of the status of threatened populations in response to rapid change in the local environment. This report presents 2008 and 2009 monitoring data for around 60 sites from 10 stream catchments, and also draws on previous data to provide context for recent results (overall 2001-2009 data includes >550 spatially or temporally replicated sites).

Monitoring targets include community composition, population extent, demographic data (i.e. recruitment and survivorship) and other population processes (i.e. spawning, migration, recolonisation, habitat use, and fish condition/behaviour). A range of standardised sampling techniques is utilised including backpack electrofishing, fyke nets, seine netting, traps, and visual observations, supported with various environmental descriptors.

In total some 45,000 fish were recorded in 2008 and 2009 including 17 native and six alien species. This included key data on three threatened freshwater specialists, namely river blackfish, southern pygmy perch and mountain galaxias; two diadromous species (common galaxias and congolli); potamodromous Murray-Darling golden perch; two threatened wetland specialists (Yarra pygmy perch and Murray hardyhead); and a range of other generalist or euryhaline species (e.g. smelt, hardyheads, gudgeons and gobies).

The interplay of drought conditions and significant water use across the Eastern Mount Lofty Ranges and the broader Murray-Darling Basin has had serious impacts to fish communities and ecological assets in the last two years, with many failures in native fish indicators. The terminal wetland reach type has been most impacted, being virtually eliminated from the region. In other reach types there is a mix of severe degradation or loss of refuges and ecological assets, and the more positive persistence of habitat types and species. Only the Tookayerta Creek Catchment performed well across all reach types upstream of its terminal wetland.

The performance of fish indicators relating to environmental objectives are detailed by individual catchment and reach in the text, but notable patterns include:

- Marne River – loss of fish at all upland monitoring sites, marginal condition of key river blackfish refuge, and dry terminal wetland.
- Saunders – poor condition of lowland refuges.
- Reedy Creek – persistence of a single mountain galaxias refuge and isolated dwarf flathead gudgeon, and demise of diverse lowland fish community and terminal wetland.
- Rocky Gully Creek – severe change in terminal wetland habitat and fish community.
- Bremer River – extirpation of native species in the Harrogate region, persistence of mountain galaxias in Mt Barker Creek, the need to artificially maintain the last pool of river blackfish on Rodwell Creek, and decline in lowland and terminal wetland fish communities.
- Angas River – strong persistence of mountain galaxias in the upper catchment, mixed (but overall positive) persistence of southern pygmy perch in the mid-catchment, warning signs of decline for river blackfish in the lowland channel, and demise of terminal wetland.

- Finniss River – improvement in native fish community in Meadows Creek despite critical drying (intermediate disturbance affected predatory alien species), large declines (loss?) in southern pygmy perch sites in mid-reaches, moderate lowland fish community, and poor terminal wetland.
- Tookayerta Creek – a stand out catchment with strong persistence of freshwater specialists in areas upstream of a desiccated terminal wetland.
- Currency Creek – marginal upland habitats, strongly performing mid-catchment refuges, lowland fish community shifting towards dominance by euryhaline species, and demise of terminal wetland.
- Inman River –population of southern pygmy perch in Back Valley remains strong in this honorary EMLR catchment.

The dry period currently being experienced clearly highlights that the persistence of refuge pools and habitat heterogeneity over summer and autumn (hence fish related ecological assets) is the critical process in the flow regime. Protecting surface and ground water inputs to base flow, and minimising the period of cease to flow, should thus be a strong target of both environmental water protection and provisions. Close monitoring and targeted actions may also be required to allow ecological assets to persist through any extension of critically dry conditions, and once again act as indicator species with the onset of more favourable conditions.

As some of the last freshwater refuge in the Lower Murray, Eastern Mount Lofty Range streams deserve close attention within management, monitoring, and restoration programs that aim to preserve regional biota.

Contents

Abbreviations

EMLR = Eastern Mount Lofty Ranges
MDB = Murray-Darling Basin
EWR = Environmental Water Requirements
SAMDBNRMB = South Australian MDB Natural Resources Management Board
DEH = Department for Environment and Heritage, South Australian Government
DWLBC = Department for Water, Land and Biodiversity Conservation
MREFTP = Marne River Environmental Flows Technical Panel
EPBC Act 1999 = Commonwealth Environment Protection and Biodiversity Conservation Act

1.0 Introduction

The Eastern Mount Lofty Ranges (EMLR) is a distinct and outlying section of the Murray-Darling Basin (MDB) intimately linked with the lower River Murray and Lakes Alexandrina (Figure 1). The EMLR offer diverse stream and swamp habitat, as well as linking habitats between lake and riverine environments (e.g. lowland stream reaches, stream terminal wetlands). An array of aquatic habitat supports a rich and unique freshwater fish fauna with conservation significance at the local, State, Murray-Darling Basin and national scale (Table 1.0.1: Hammer 2004). Being reliant on aquatic habitat, these fishes are an integral component of processes to both protect and enhance habitat and water resources in the EMLR and Lower Murray, and efforts to conserve species and genetic diversity (i.e. biodiversity) (e.g. Hammer 2002a; Hammer 2002b; Hammer 2008).

This report is principally concerned with catchment management to protect ecological assets in the region, specifically by providing input to the large scale issue of environmental water requirements (EWR) i.e. "the amount of water required to maintain aquatic systems, with a minimum risk of degradation" (SKM *et al.* 2002). The linkage between ecological data and management follow that (1) flow regimes are considered the primary driver to riverine ecosystems (Bunn and Arthington 2002) and hence self-sustaining populations of freshwater fishes in the region (e.g. Hammer 2004, 2005, 2007d; McNeil and Hammer 2007), and (2) there are current initiatives by the SA MDB Natural Resource Management Board (SAMDBNRMB) and Department for Water, Land and Biodiversity Conservation (DWLBC) to determine EWR, and later water provisions, for stream catchments of the EMLR (Mount Lofty Ranges Environmental Water Requirements Expert Panel in preparation).

The importance of EWR initiatives is heightened by the severe decline in the extent and quality of wetted habitat in the EMLR over the last 10 years, especially in the last two years. Impacts have occurred due to the loss of baseflow and protracted no flow conditions (e.g. delayed onset of seasonal flows). The changes are due to a relatively dry climatic period and the rapid acceleration of water resource development from dams, watercourse diversions, and groundwater extractions (e.g. Savadamuthu 2002, 2003), which is predicted to become more acute under climate change scenarios (Bardsley 2006; McInnes *et al.* 2003).

Fish monitoring of varying forms has occurred regularly in the EMLR since around 2001. In 2007 existing monitoring programs and data were reviewed within an EWR framework to assess the condition of fish populations and communities for different stream reaches and to be representative of different EMLR catchments (Hammer 2007d). The resultant monitoring program focuses on around 60 sites from 10 catchments. It is undertaken annually in autumn, although some sites are sampled periodically depending on the information required for a particular ecological asset (Hammer 2007d). In addition to annual autumn data, sampling at targeted sites was undertaken in spring 2007 in order to gain additional information on species biology and site performance (part of the SAMDBNRMB EMLR Flows Program). This was expanded further in spring 2008 to include all annual autumn sampling sites in an aim to provide a better understanding of the status of threatened populations in response to rapid change in the local environment.

Hence this report presents field data covering the 2007/08 and 2008/09 flow years (i.e. between winter 2007 to autumn 2009), and aims to provide initial assessments of fish indicators for EWR performance in different catchments. The assessment is more advanced for the Marne Catchment owing to the completion of an EWR report for that system (Marne River Environmental Flows Technical Panel 2003), being still under development for other catchments (Mount Lofty Ranges Environmental Water Requirements Expert Panel in preparation). Context for recent results is provided by comparison with previous research in the region (Conallin and Hammer 2003; Hammer 2001, 2002b, 2004, 2005, 2007c; Wedderburn and Hammer 2003).

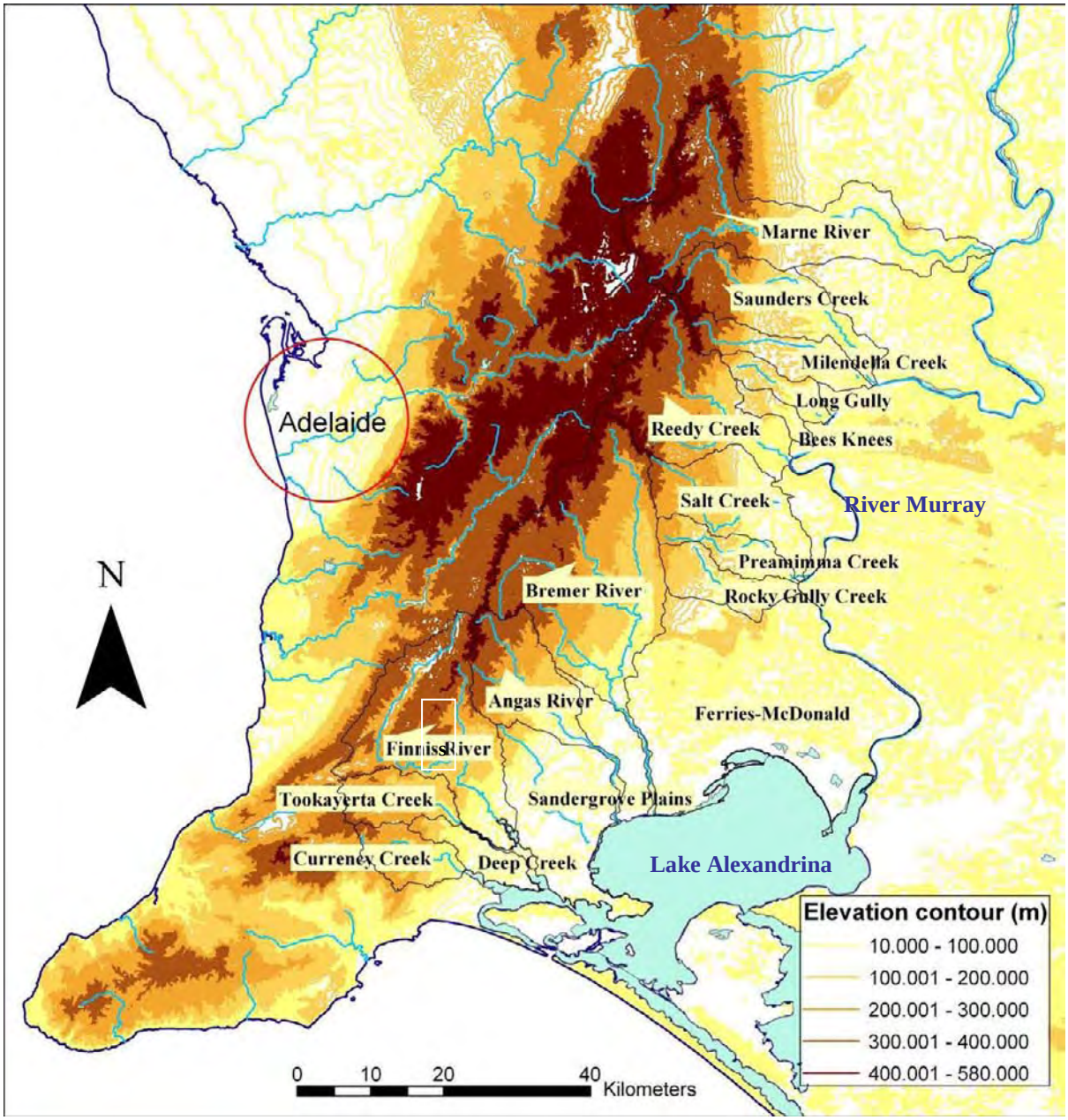


Figure 1.0.1. Catchments of the Eastern Mount Lofty Ranges.

Table 1.0.1. List of fish species recorded in the Eastern Mount Lofty Ranges.

Functional Group: D = Diadromous; Fs = Obligate freshwater, specialists stream, Fw = Obligate freshwater, specialists wetland; Fg = Obligate freshwater, generalist, Fp = Obligate freshwater, generalist which is Potamodromous; Ex = Exotic.

Conservation status: National: VU=Vulnerable *(EPBC Act 1999*); State: P = protected (*Fisheries Management Act 2007*), E = Endangered, V = Vulnerable, R = Rare (DEH 2003).

Functional Group	Species	Scientific name	National.	State
D	Pouched lamprey	*Geotria australis*		EN
D	Shortheaded lamprey	*Mordacia mordax*		EN
D	Shortfinned eel	*Anguilla australis*		R
Fw	Freshwater catfish	*Tandanus tandanus*		P, V
Fg	Bony herring	*Nematalosa erebi*		
Fg	Smelt	*Retropinna semoni*		
D	Climbing galaxias	*Galaxias brevipinnis*		V
D	Common galaxias	*Galaxias maculatus*		
Fs	Mountain galaxias 1	*Galaxias olidus*		R
Fs	Mountain galaxias 2	*Galaxias* sp. 1		R
Fg	Murray rainbowfish	*Melanotaenia fluviatilis*		R
Fg	Smallmouthed hardyhead	*Atherinosoma microstoma*		
Fw	Murray hardyhead	*Craterocephalus fluviatilis*	VU	E
Fg	Unspecked hardyhead	*Craterocephalus stercusmuscarum fulvus*		R
Fw	Chanda perch	*Ambassis agassizii*		P, E
Fs	River blackfish	*Gadopsis marmoratus*		P, E
Fg	Murray cod	*Maccullochella peelii peelii*	VU	R
Fp	Murray-Darling golden perch	*Macquaria ambigua ambigua*		
Fs	Southern pygmy perch	*Nannoperca australis*		P, E
Fw	Yarra pygmy perch	*Nannoperca obscura*	VU	P, E
Fg	Silver perch	*Bidyanus bidyanus*		P, V
D	Congolli	*Pseudaphritis urvillii*		R
Fg	Midgley's carp gudgeon	*Hypseleotris* sp. 1		
Fg	Murray-Darling carp gudgeon	*Hypseleotris* sp. 3		R
Fg	Hybrid forms	*Hypseleotris* spp.		
Fw	Southern purple-spotted gudgeon	*Mogurnda adspersa*		P, E
Fg	Flathead gudgeon	*Philypnodon grandiceps*		
Fg	Dwarf flathead gudgeon	*Philypnodon* sp. 1		R
Fg	Western bluespot goby	*Pseudogobius olorum*		
Fg	Lagoon goby	*Tasmanogobius lasti*		
Ex	Goldfish	*Carassius auratus*		
Ex	Common carp	*Cyprinus carpio*		
Ex	Tench	*Tinca tinca*		
Ex	Rainbow trout	*Oncorhynchus mykiss*		
Ex	Brown trout	*Salmo trutta*		
Ex	Brook trout	*Salvelinus fontinalis*		
Ex	Gambusia	*Gambusia holbrooki*		
Ex	Redfin	*Perca fluviatilis*		

2.0 Assessment framework

2.1 Background to Environmental Water Requirements

The best available guide to assessing EWR is currently the FLOWS method (SKM *et al.* 2002). The FLOWS method has been previously adapted in South Australia for the Onkaparinga River (SKM 2002) and Marne River Catchment (Marne River Environmental Flows Technical Panel 2003), the latter with the explicit purpose of acting as a model assessment for other EMLR streams (i.e. a technically-robust method for quantifying EWR in intermittent streams connected to the River Murray). Hence the process used in the Marne River forms the basis for provisional EWR and relevant monitoring methods in EMLR stream sections as detailed in the recent fish review (Hammer 2007d). Information in the fish review has since been incorporated into a technical panel approach to defining EWR for all biological components of the Mount Lofty Ranges (Mount Lofty Ranges Environmental Water Requirements Expert Panel in preparation). A basic summary of the EWR process includes the five key steps below, but readers are directed to the above references for more detailed background:

- Information collation (catchment descriptions).
- Reach delineation.
- Identification of ecological assets per reach.
- Develop conceptual model linking ecological drivers to assets.
- Define environmental objectives for ecological assets, and the water requirements to meet these objectives.

2.2 Functional groups

To address conceptual models and defining environmental objectives, natural groupings of fish species (ecological assets) are made under ecologically meaningful categories, or functional groups. These were first presented in Hammer (2007b) and have been refined through the MLR EWR program to encompass five groups as follows:

Resident Freshwater species

1. **Obligate freshwater, specialised (stream)**. Species that reside in freshwater habitats permanently (i.e. obligate), and that have particular stream habitat or environmental requirements. Are often found as the only species in a reach, but are restricted to specific habitats. Includes southern pygmy perch, mountain galaxias and river blackfish.
2. **Obligate freshwater, specialised (wetland)**. Species that require particular habitats or environments for survival. Are often found as rare species in diverse fish assemblages, being restricted to specific habitats within lowland or terminal stream reaches. Includes Yarra pygmy perch, Murray hardyhead, and southern purple-spotted gudgeon.
3. **Freshwater, generalists.** Have more generalised habitat or environmental requirements, being mostly found in association with other species and occupy multiple habitats within a reach. The community composition and structure (and therefore the water requirements) is determined by the types of habitats present. Includes gudgeon species, numerous species from terminal wetlands and euryhaline species like gobies.

Migratory Freshwater Species

4. **Diadromous species** – species that require migration to and from the sea or estuary. Includes congolli, common galaxias and lampreys.
5. **Potamodromous species** - species known to make determined movements within freshwater systems for particular lifecycle stages (Murray-Darling golden perch).

The functional group of each EMLR fish species is shown in Table 1.0.1. While some habitats and landscape positions may only have one or two species, broad groupings of fish species with similar water requirements can also be made on the basis of habitat and reach types:

- Groundwater dependent habitat fish community.
- Lowland stream and floodplain habitat fish community.
- Terminal Wetland habitat fish community.
- Fleurieu Swamp habitat fish community.

2.3 EWR tables

Environmental water requirements for EMLR fishes are described in a series of species or community specific tables (Tables 2.3.1-2.3.9) that detail: (1) the processes required to support environmental objectives, (2) the parts of the water regime linked to those processes, and (3) the monitoring approach and indicators used to assess whether these processes are being supported. Note several of the objectives or water requirements implicate monitoring of environmental variables and habitat condition; fish specific techniques only are mentioned but relevant environmental data is routinely collected (e.g. water quality, pool depth, habitat availability) with some techniques specific to assessment for other functional groups (e.g. indicators for vegetation health).

Table 2.3.1. Mountain galaxias

Working environmental water requirements and relevant monitoring methods for mountain galaxias in Eastern Mount Lofty Ranges stream sections.

Environmental Objective: **Maintain or restore self-sustaining populations of mountain galaxias**	**Water Requirements:**	**Fish Monitoring at key nodes within river reaches:** **Method (with indicator in brackets)**
Habitat Processes: • Habitat availability	Persistence of water in pools throughout the Low Flow Season (base flow ideal). Freshes during the Low Flow Season that refill pools are important. Maintain smaller habitats and tributaries especially when exotic predators occur.	Mapping distribution at key nodes during low flow seasons (population extent).
• Water quality	Freshes during the Low Flow Season that refresh water quality.	Assessing survivorship through a snapshot of demographic structure (length data).
• Deep pool structure	Bankfull channel forming flows that occur at a frequency and duration to maintain channel form. Prevent vegetation encroachment.	Mapping distribution at key nodes during low flow seasons (population extent).
• Clean substrate for egg deposition following spawning	Freshes during the Low Flow Season.	Assessing recruitment through a snapshot of demographic structure (length data), with studies of fish biology (larvae).
Biodiversity Processes: • Recolonisation of vacant habitats and mixing of extant populations	Sustained low-high flows that allow movement between pools over relatively long distances.	Mapping distribution at key nodes in river reaches during low flow seasons (population extent) over time (temporal monitoring). Studies of fish biology (movement).
• Successful spawning	Increase in flows over transitional period between Low and High Flow Season in June/July triggers spawning, oxygenates riffles and allows access to new habitats (spawning sites).	Assessing recruitment through a snapshot of demographic structure (length data). Studies of fish biology (spawning and larvae).
• Habitat complexity and resistance to the impacts of exotic fishes	Low flows and base flow to maintain shallower sub-optimal habitats and pool margins when exotic predatory fishes (trout and redfin) occur.	Mapping distribution at key nodes in reaches during low flow seasons (population extent) over time (temporal monitoring).
• Riparian and edge vegetation (macroinvertebrate food resources, shading, cover)	Low flows and overbank flow to maintain shallow margins and banks to encourage emergent and riparian species (e.g. sedges, amphibious woody species, gums).	Standardised environmental measures.
• Suppression of exotic species	Variable flows and zero flows discourage colonisation by exotic fish and favour natives. High flow disturbances can flush exotics like Gambusia.	Assessing fish community composition (species inventory/presence), snapshot of demographic structure for exotic species (length data).

Table 2.3.2. River blackfish
Working environmental water requirements and relevant monitoring methods for river blackfish in the Eastern Mount Lofty Ranges.

Environmental Objective: **Maintain or restore self-sustaining populations of river blackfish**	**Water Requirements:**	**Fish Monitoring at key nodes within river reaches:** **Method (with indicator in brackets)**
Habitat Processes: • Habitat availability and quality	Permanent water in pools throughout the year (via baseflow). Maintain shallow pool margins or shelves for juvenile and young fish.	Determining that fish remain in the reach (presence), assessing survivorship through a snapshot of demographic structure (length data). Studies of fish biology (spawning and health).
• Water quality	Cool and well oxygenated conditions (extended low flows or permanent baseflow).	Determining that fish remain in the reach (presence), assessing survivorship through a snapshot of demographic structure (length data). Studies of fish biology (spawning and health).
• Deep pool structure	High channel forming flows that occur at a frequency and duration to maintain channel form.	Mapping distribution during low flow seasons (population extent).
• Minimal siltation of underwater surfaces to allow feeding and successful egg hatching	Freshes during the Low Flow Season.	Assessing survivorship through a snapshot of demographic structure (length data). Studies of fish biology (spawning & larvae).
Biodiversity Processes: • Recolonisation of vacant habitats and mixing of extant populations	Low flows or occasional freshes that allow movement between pools over relatively short distances.	Mapping distribution during low flow seasons (population extent) over time (temporal monitoring). Studies of fish biology (movement).
• Spawning success	Spawning and recruitment require maintenance of shallows (larval habitat) during spring and sustained into early summer (low flows and raised pool levels); probably also below a salinity threshold (<4000uS) required for successful recruitment (i.e. Freshes). Spawning occurs in hollows or cavities with a long incubation time. Freshes and sustained flows in late spring will assist recruitment.	Assessing recruitment through a snapshot of demographic structure (length data). Studies of fish biology (spawning and larvae).

Table 2.3.3. Southern pygmy perch

Working environmental water requirements and relevant monitoring methods for southern pygmy perch in Eastern Mount Lofty Ranges stream habitats.

Environmental Objective: **Maintain or restore self-sustaining populations of southern pygmy perch**	**Water Requirements:**	**Fish Monitoring at key nodes within river reaches:** **Method (with indicator in brackets)**
Habitat Processes: • Habitat availability.	• Persistence of water in pools throughout the Low Flow Season (baseflow ideal, also early on-set of seasonal flows). Freshes during the Low Flow Season that refill pools are important. • Appropriate flow regime for maintaining submerged aquatic macrophytes and riparian vegetation	• Mapping distribution at key nodes during low flow seasons (population extent). • Assessing recruitment through a snapshot of demographic structure (length data), with studies of fish biology (larvae/spawning sites /eggs).
• Water quality.	• Freshes during the Low Flow Season that refresh water quality but that follow naturally occurring local patterns.	• Assessing survivorship through a snapshot of demographic structure (length data).
• Deep pool structure.	• Bankfull channel forming flows that occur at a frequency and duration to maintain channel form.	• Mapping distribution at key nodes during low flow seasons (population extent).
Biodiversity Processes: • Recolonisation of vacant habitats and mixing of extant populations.	• Sustained low flows that allow movement between pools in local areas (the species has a limited dispersal ability).	• Mapping distribution at key nodes reaches during low flow seasons (population extent) over time (temporal monitoring). Studies of fish biology (movement).
• Spawning success.	• Spawning and recruitment linked to lateral connectivity and access to edge vegetation during spring; extended period of flows at the end of the Low Flow season to raise and maintain pool level in emergent and edge vegetation. Promote successful spawning of southern pygmy perch to improve population resilience to exotics.	• Assessing recruitment through a snapshot of demographic structure (length data). Studies of fish biology (spawning and larvae).
• Habitat complexity resistance to the impacts of exotic fishes.	• Low flows and base flow maintain shallower sub-optimal habitats and pool margins when exotic predatory fishes occur (trout and redfin).	• Mapping distribution at key nodes in river reaches during low flow seasons (population extent) over time (temporal monitoring).
• Suppression of exotics	• Variable flows and zero flows discourage colonisation by exotic fish and favour natives. Larger disturbances can flush exotics, especially Gambusia.	• Assessing fish community composition (species inventory/presence).

Table 2.3.4. Freshwater generalists

Working environmental water requirements and relevant monitoring methods for generalists in Eastern Mount Lofty Ranges stream habitats (includes the gudgeon species from the genera *Hypseleotris* and *Philypnodon*, numerous species from terminal wetlands, and euryhaline species).

Environmental Objective: **Maintain or restore self-sustaining populations of gudgeons**	**Water Requirements:**	**Fish Monitoring at key nodes within river reaches:** **Method (with indicator in brackets)**
Habitat Processes: • Habitat availability.	• Persistence of water in pools throughout the Low Flow Season (base flow ideal). Freshes during the Low Flow Season that refill pools are important.	• Mapping distribution at key nodes during low flow seasons (population extent).
• Water quality.	• Freshes during the Low Flow Season that refresh water quality.	• Assessing survivorship through a snapshot of demographic structure (length data).
• Deep pool structure.	• Bankfull channel forming flows that occur at a frequency and duration to maintain channel form.	• Mapping distribution at key nodes during low flow seasons (population extent).
Biodiversity Processes: • Recolonisation of vacant habitats and mixing of extant populations.	• Sustained low-high flows that allow movement between pools over relatively long distances.	• Mapping distribution at key nodes in river reaches during low flow seasons (population extent) over time (temporal monitoring). Studies of fish biology (movement).
• Spawning success.	• Low flows and warmer temperatures during the Low Flow season, low flows to stabilise water levels.	• Assessing recruitment through a snapshot of demographic structure (length data). Studies of fish biology (spawning and larvae).
• Habitat complexity and resistance to the impacts of exotic fishes.	• Low flows and base flow maintain shallower habitats and pool margins when exotic predatory fishes (trout and redfin) occur.	• Mapping distribution at key nodes in river reaches during low flow seasons (population extent) over time (temporal monitoring).
• Discourage colonisation and establishment of exotic species (negative impacts of predation, competition and disease)	• Variable flows and zero flows discourage colonisation by exotic fish and favour natives. Larger disturbances can flush exotics.	• Assessing fish community composition (species inventory) or specific investigation for species of concern (presence), snapshot of demographic structure for exotic species (length data)

Table 2.3.5. Diadromous and potamodromous species

Working environmental water requirements and relevant monitoring methods for diadromous species (e.g. lampreys, shortfinned eel, common galaxias, congolli) and migratory species (e.g. potamodromous Murray-Darling golden perch) in Eastern Mount Lofty Ranges stream habitats.

Environmental Objective: **Maintain or restore populations of diadromous species**	**Water Requirements:**	**Fish Monitoring at key nodes within river reaches:** **Method (with indicator in brackets)**
Habitat Processes: • Habitat availability.	• Persistence of water in pools throughout the Low Flow Season (base flow ideal). Maintenance of permanent water in slow flow areas (larval lampreys). Encourage diversity of habitat types.	• Mapping distribution at key nodes during low flow seasons (population extent).
• Water quality.	• Freshes during the Low Flow Season that refresh water quality, particularly around partial barriers to dispersal that can act as population bottlenecks (e.g. high concentrations of fish).	• Assessing survivorship through a snapshot of demographic structure (length data). Studies of fish biology (movement and tolerances – in situ and experimental)
• Deep pool structure.	• Bankfull channel forming flows that occur at a frequency and duration to maintain channel form.	• Mapping distribution at key nodes during low flow seasons (population extent).
• Connectivity.	• Large flows to provide physical disturbance and improve pool connectivity along the stream corridor to the River Murray/ Lake Alexandrina (e.g. dislodge debris).	• Mapping distribution at key nodes during low flow seasons (population extent).
Biodiversity Processes: • Movement.	• Attractant flows. • Sustained low-high flows that allow movement in and out of stream habitat, and dispersal between pools over relatively long distances. Requires appropriate timing and duration for different species.	• Mapping distribution at key nodes in river reaches during low flow seasons (population extent) over time (temporal monitoring). Studies of fish biology (movement). • Assessing barriers to dispersal.
• Spawning success.	• Raises in water levels to allow access to emergent vegetation (e.g. common galaxias spawning lower stream reaches), appropriate water quality, permanence and access where species congregate.	• Assessing recruitment through a snapshot of demographic structure (length data). Studies of fish biology (spawning and larvae).
• Habitat complexity and resistance to the impacts of exotic fishes.	• Low flows and base flow maintain shallower habitats and pool margins when exotic predatory fishes (trout and redfin) occur.	• Mapping distribution at key nodes in river reaches during low flow seasons (population extent) over time (temporal monitoring).
• Suppress exotics	• Variable flows and zero flows (if natural part of flow regime) to discourage colonisation by exotic fish and favour natives. Larger disturbances can flush (high flow) or suppress (no flow) exotics.	• Assessing fish community composition (species inventory) or species presence, snapshot of demographic structure for exotic species, studies of fish biology.

Table 2.3.6. Groundwater dependent habitat (fish community)
Working environmental water requirements for fish communities in groundwater dependent habitats in Eastern Mount Lofty Ranges streams (mainly stream specialists, but also generalists and diadromous functional groups).

Environmental Objectives: **• Maintain or restore diversity and composition of fish community (important refuges or core habitat).**	**Water Requirements:**	**Fish Monitoring at key nodes within river reaches:** **Method (with indicator in brackets)**
Habitat Processes: • Habitat availability.	• Permanent water in pools throughout the year. There should be a minimum pool number and a diversity of pool or habitat types include deeper and shallower areas to provide adequate security and resilience.	• Assessing fish community composition (species inventory), determining that species diversity is maintained in a reach (presence), mapping distributions during low flow seasons (population extent).
• Water quality.	• Cool and well oxygenated conditions (extended low flows or permanent baseflow). Minimise salinity impacts on the tolerance (lethal and sub-lethal) of adult or juveniles stages of native fish – freshes and flushing flows.	• Determining that fish remain in the reach (presence), assessing survivorship through a snapshot of demographic structure (length data). Studies of fish biology (spawning and health).
• Habitat diversity (prevent encroachment of vegetation).	• High flows that occur at a frequency and duration to prevent vegetation encroachment.	• Mapping distribution during low flow seasons (population extent), assessing survivorship through a snapshot of demographic structure (length data).
• Deep pool structure.	• High channel forming flows that occur at a frequency and duration to maintain channel form.	• Assessing fish community composition (species inventory)
Biodiversity Processes: • Recolonisation of vacant habitats and mixing of extant populations.	• Low flows or occasional freshes that allow movement between pools over relatively short distances.	• Mapping distribution during low flow seasons (population extent) over time (temporal monitoring). Studies of fish biology (movement).
• Suppress exotic species	• Variable flows and continuous flowing cool water discourage exotic fish and favour natives, larger flows dislodge/flush exotics.	Assessing fish community composition (species inventory), assessing survivorship through a snapshot of demographic structure (length data). Studies of fish biology (habitat use).

Table 2.3.7. Lowland stream and floodplain habitat (fish community)

Working environmental water requirements for fish communities in lowland stream sections with floodplains of the Eastern Mount Lofty Ranges (generalist, diadromous, potamodromous and wetland specialist functional groups).

Environmental Objectives: **• Maintain or restore diversity and composition of fish community.**	**Water Requirements:**	**Fish Monitoring at key nodes within river reaches:** **Method (with indicator in brackets)**
Habitat Processes: • Habitat availability	• Permanent water in channel, anabranches and refuges (e.g. billabongs) throughout the year.	• Assessing fish community composition across habitat types (species inventory), determining that species diversity is maintained in a reach (presence), mapping distributions during low flow seasons (population extent).
• Water quality.	• Cool and well oxygenated conditions (extended low flows or permanent baseflow). Minimise salinity impacts on the tolerance (lethal and sub-lethal) of adult or juveniles stages of native fish – freshes and flushing flows.	• Determining that fish remain in the reach (presence), assessing survivorship through a snapshot of demographic structure (length data). Studies of fish biology (spawning and health).
• Habitat diversity (prevent encroachment of emergent vegetation, maintain submerged vegetation)	• High flows that occur at a frequency and duration to prevent vegetation encroachment, shape channels, and provide water quality and flow requirements for plant species.	• Mapping distribution during low flow seasons (population extent), assessing survivorship through a snapshot of demographic structure (length data).
• Deep pool structure and availability of off channel habitats	• High channel forming flows that occur at a frequency and duration to maintain form and diversity of channel and off-channel habitats	• Assessing fish community composition (species inventory)
Biodiversity Processes: • Provide spatial and temporal variability	• Flow related disturbance to provide a variety in the types of habitats present (mosaic) to allow species co-existence or cater for the requirements of multiple species (including purple-spotted gudgeon). Provision of contrasting habitat to that of wetlands associated with the River Murray and Lower Lakes	• Assessing fish community composition (species inventory), determining that species diversity is maintained in a reach (presence), mapping distributions during low flow seasons (population extent).
• Attractant flows for diadromous/ migratory fish species from the River Murray.	• High flows at natural time of year (winter-spring) for diadromous/migratory fish.	Assessing fish community composition (species inventory), with studies of fish biology (movement).
• Suppress exotic species	• Variable flows and continuous flowing cool water discourage exotic fish and favour natives, larger flows dislodge/flush exotics.	Assessing fish community composition (species inventory), assessing survivorship through a snapshot of demographic structure (length data). Studies of fish biology (habitat use).

Table 2.3.8. Terminal wetland habitat (fish community)
Working environmental water requirements for fish communities in terminal wetlands of Eastern Mount Lofty Ranges streams (includes stream specialist, generalist, diadromous, wetland specialist and potamodromous functional groups).

Environmental Objectives: **• Maintain and restore diversity and composition of fish community.**	**Water Requirements:**	**Fish Monitoring at key nodes within river reaches:** **Method (with indicator in brackets)**
Habitat Processes: • Habitat availability.	• Permanent water in wetlands throughout the year.	• Assessing fish community composition (species inventory), determining that species diversity is maintained in a reach (presence), mapping distributions during low flow seasons (population extent).
• Habitat diversity (prevent encroachment of emergent vegetation, maintain submerged vegetation).	• High flows that occur at a frequency and duration to prevent vegetation encroachment, provide water quality and flow requirements for plant species.	• Mapping distribution during low flow seasons (population extent), assessing survivorship through a snapshot of demographic structure (length data).
• Deep pool structure.	• High channel forming flows that occur at a frequency and duration to maintain channel form.	• Assessing fish community composition (species inventory)
Biodiversity Processes: • Provide spatial and temporal variability	• Flow related disturbance to provide a variety in the types of habitats present (mosaic) to allow species co-existence or cater for the requirements of multiple species. Tannin-rich, clearer river waters for example provide habitat for Yarra pygmy perch in the Lower Murray.	• Assessing fish community composition (species inventory), determining that species diversity is maintained in a reach (presence), mapping distributions during low flow seasons (population extent).
• Attractant flows for diadromous/ migratory fish species from the River Murray.	• High flows at natural time of year (winter-spring) for diadromous/migratory fish.	Assessing fish community composition (species inventory), with studies of fish biology (movement).
• Suppress exotic species	• Variable flows and continuous flowing cool water discourage exotic fish and favour natives, larger flows dislodge/flush exotics.	Assessing fish community composition (species inventory), assessing survivorship through a snapshot of demographic structure (length data). Studies of fish biology (habitat use).

Table 2.3.9. Fleurieu Swamps (fish community)
Working environmental water requirements for fish communities in Fleurieu Swamps of Eastern Mount Lofty Ranges catchments (includes stream specialists).

Environmental Objectives: **• Maintain and restore diversity and composition of swamp fish communities.**	**Water Requirements:**	**Fish Monitoring at key nodes within river reaches:** **Method (with indicator in brackets)**
Habitat Processes: • Habitat availability.	• Permanent water in swamps throughout the year (spring feeding or inflow), of a sufficient depth and quality for species requirements (e.g. >20cm depth for southern pygmy perch, baseflow for river blackfish). Not necessarily open water, but areas with interstitial space.	• Assessing fish community composition (species inventory), determining that species diversity is maintained in a particular feature (presence).
• Water quality.	• Freshes during the Low Flow Season that refresh water quality but that follow naturally occurring local patterns.	• Assessing fish community composition (species inventory), determining that species diversity is maintained in a particular feature (presence).
• Habitat diversity (prevent encroachment of vegetation).	• High flows or high water levels that occur at a frequency and duration to prevent vegetation encroachment.	• Mapping distribution during low flow seasons (population extent), assessing survivorship through a snapshot of demographic structure (length data).
Biodiversity Processes: • Recolonisation of vacant habitats and mixing of extant populations.	• Low flows or occasional freshes between swamps (where applicable) that allow movement between over relatively short distances.	• Mapping distribution during low flow seasons (population extent) over time (temporal monitoring). Studies of fish biology (movement).
• Provide spatial and temporal variability.	• Flow related disturbance to provide a variety in the types of habitats present (mosaic) to allow species co-existence or cater for the requirements of multiple species (where applicable).	• Assessing fish community composition (species inventory), determining that species diversity is maintained in a reach (presence), mapping distributions during low flow seasons (population extent).
• Successful spawning	• Lateral connections for accessing new habitat and food resources for adult conditioning, spawning sites and larval habitat.	Assessing survivorship through a snapshot of demographic structure (length data). Studies of fish biology (larvae).
• Suppress exotic species	• Variable flows and continuous flowing cool water discourage exotic fish and favour natives, larger flows dislodge/flush exotics.	• Assessing fish community composition (species inventory), assessing survivorship through a snapshot of demographic structure (length data). Studies of fish biology (habitat use).

2.4. Fish monitoring targets

Fish monitoring for EWR is based around assessing the condition, trend or occurrence of processes that support Environmental Objectives (Hammer 2007d). The tables in Section 2.3 detail suggested fish monitoring to assess Environmental Objectives for different functional groups, and a summary including specific sampling methods is provided in Table 2.4.1. There are five specific targets for monitoring, namely:

- Species inventory.
- Presence.
- Population extent.
- Demographic data to assess Recruitment and Survivorship.
- Studies of fish biology to assess Movement, Habitat use, and Spawning success.

Each target has different requirements for intensity, timing and frequency as well as general gear to be employed. Further a strong requirement for the sampling methodology includes minimal impact to populations and habitat whilst gathering meaningful and repeatable data, such that the application of the various gear types will vary depending on the extent and type of habitat, and sensitivity of habitats and species to capture and disturbance (see Hammer 2004, 2005, 2006c). A key component of data interpretation relies on tracking indicators through time (Temporal Monitoring) and trying to associate changes with environmental conditions. Hence the aim of sampling should not be to collect every individual present, but rather to be sampling in a consistent manner to reveal information about populations or communities.

Sampling methods for EMLR streams include seine netting (top), fyke nets (middle) and back-pack electrofishing (lower)

Table 2.4.1. Monitoring framework for fishes in the EMLR - matched to Tables in Section 2.3.

Monitoring Objectives (with indicator):	**Technique:**	**Method notes:**
• Assessing fish community composition (species inventory).	• Inventory using a variety of complementary gear types suited to sampling different habitats and species –can incorporate requirements for other objectives (e.g. by standardising method, measuring portions of a catch).	• Requires targeted sampling for distinct regions/reaches and potentially species that are harder to census. Method/s will vary according to fish community and conditions (e.g. structure, sediment, depth, water clarity, water conductivity): seine net (smaller/shallow areas), fyke net (deeper areas), bait trap (high structure), dip net (edge/shallows), electrofishing (wadeable habitat w. lower conductivity).
• Determining that a species remains in a reach (presence).	• Targeted sampling for a particular taxa at a particular monitoring site. Can be obtained from 'species inventory'.	• Methods vary according to target species as qualitative observations, but can be more comprehensive to incorporate species inventory targets. Often with threatened species method needs to have minimal impact and can thus be quite specific (e.g. torchlight, baited traps). Some larger species may require specialised techniques such as large fyke and boat electrofishing.
• Mapping distributions during low flow seasons (population extent).	• Targeted sampling (presence) for particular taxa across available habitat in a particular stream section (~1km).	• Methods vary according to target species, but incorporate 'species inventory' as qualitative observations (i.e. a rapid assessment of presence across an area). Dip net/bait traps often most practical, efishing efficient but only with lower EC values.
• Snapshot of demographic structure (length data) for (a) assessing presence of *recruits* and (b) assessing longer-term *survivorship* through presence of older size classes.	• Length frequency measurements, and may need to incorporate weight data and/or aging to help separate cohorts. Ideally requires temporal data to examine trends though time.	• Method suited to habitat and species specific. A need for sampling to be standardised and also to minimise environmental impact which may restrict gear types and effort. Hence a balance -with the ultimate aim to provide a reasonable snap-shot of the population present.
• Studies of fish biology (a): movement.	• Specific targeted monitoring to detect linear or lateral movement.	• Method suited to species and often event based (i.e. flow). Options include directional fyke nets and microhabitat sampling (e.g. freshly inundated or connecting habitat).
• Studies of fish biology (b): habitat use.	• Specific targeted monitoring to detect fish – habitat relationships.	• Various methods suited to sampling different habitats (e.g. electrofishing, bait traps, dip net). Will vary with conditions but should be replicated in space and time. *In situ* observations also useful (snorkel, video, torch light, polaroids)
• Studies of fish biology (c): spawning and larvae.	• Specific targeted monitoring to detect: spawning activity, spawning sites (physical examination) and larvae (specific sampling).	• Could range from casual observations of behaviour, inspection of fish condition (e.g. running ripe), upturning/inspection of spawning media (where appropriate) to dedicated larval studies (fyke or light traps).
• Temporal monitoring (all of the above).	• Incorporates any of the above, but relates specifically to population trends, especially with recolonisation (annual or periodic checking).	• Helps to track variability in data, and can affirm trends (multiple years of data). Frequency depends on species life history characteristics and level of info required.

2.5. Biological models

To better understand self-sustaining populations, information on aspects relating to recruitment and survivorship needs to be based on an understanding of local species ecology. Representative models for the three key EMLR obligate freshwater species, the main focus for demographic data, have been previously developed to help interpret annual data (Hammer 2005, 2006c, 2007a, b) and are shown in Figures. 2.5.1-2.5.4). These should be used to help interpret patterns in demographic data for sites, noting that site and inter-annual variability may shift the relative position of breaks, and that further research is required to more accurately validate these models (e.g. ageing studies).

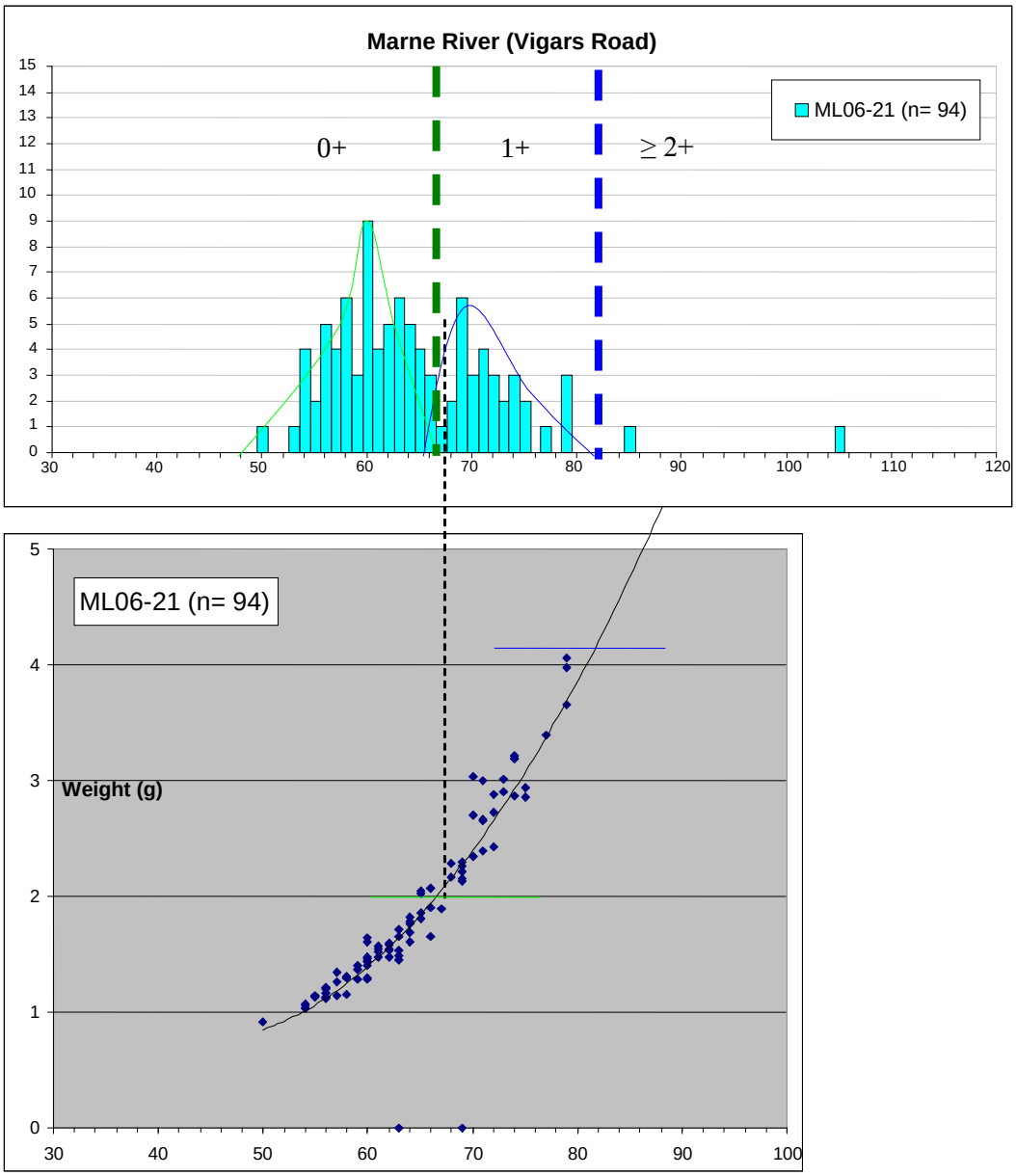


Figure 2.5.1. Representative autumn population model for mountain galaxias (*Galaxias* sp. 1) (note weights for two larger fish not shown), see also Hammer (2007b). Data collected on this form of mountain galaxias is best represented by smaller fish in the 45-65mm range and subsequent peaks. Hence an overall proposed general autumn population model is: 0+ fish reach a size of up to 65mm (<2g); 1+ fish 60-80mm (2-4g); 2+ and older fish >80mm (>4g) (3+ fish may represent individuals larger than 100mm TL).

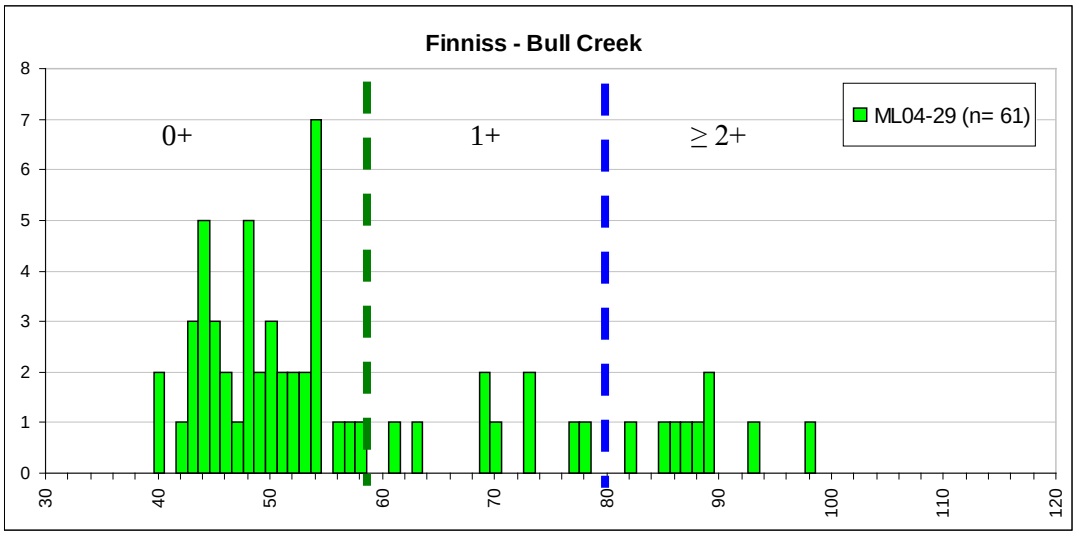


Figure 2.5.2. Representative autumn population model for mountain galaxias form occurring in the Finniss and Tookayerta catchments (true *Galaxias olidus*), see also Hammer (2007b). Data collected on this form of Mountain Galaxias is heavily dominated by smaller fish in the 40-60mm range with a relatively clear indication of a strong 0+ cohort <60mm and 2g across most sites. Interpreting subsequent potential cohorts is difficult due to low numbers of larger fish without defined peaks, but nevertheless predicted breaks in length data for cohorts are tentatively 60-80mm and 3.5g for 1+ fish and >80mm for ≥2+ fish.

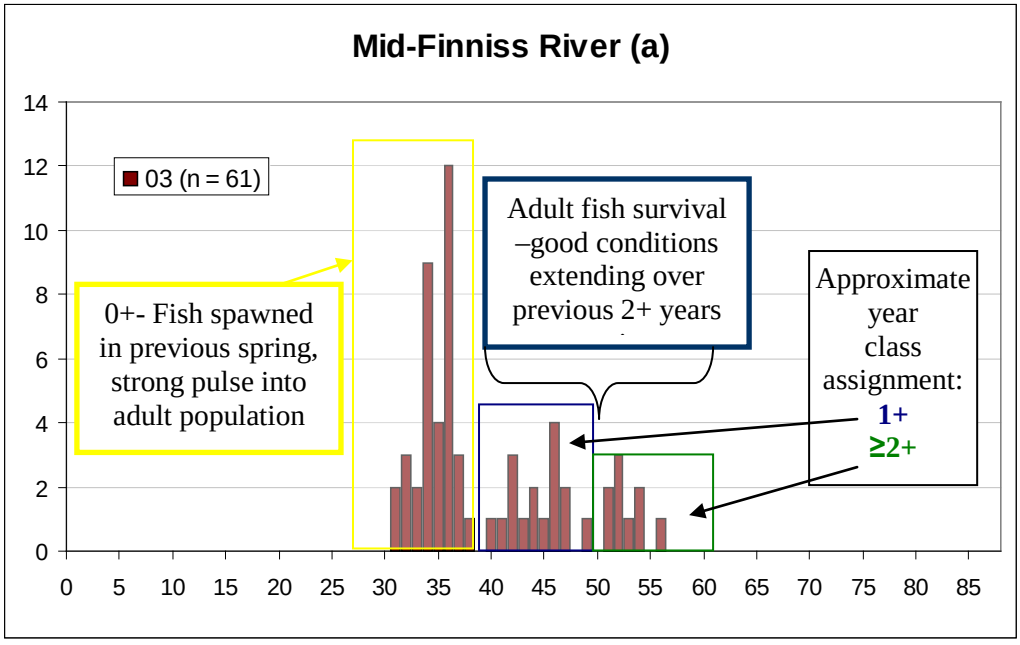


Figure 2.5.3. Representative autumn population model for southern pygmy perch in the Eastern Mount Lofty Ranges, see also Hammer (2005). Samples are often dominated by smaller with an indicative 0+ peak between 30-45mm, 1+ fish 40-55mm and ≥2+ >50mm.

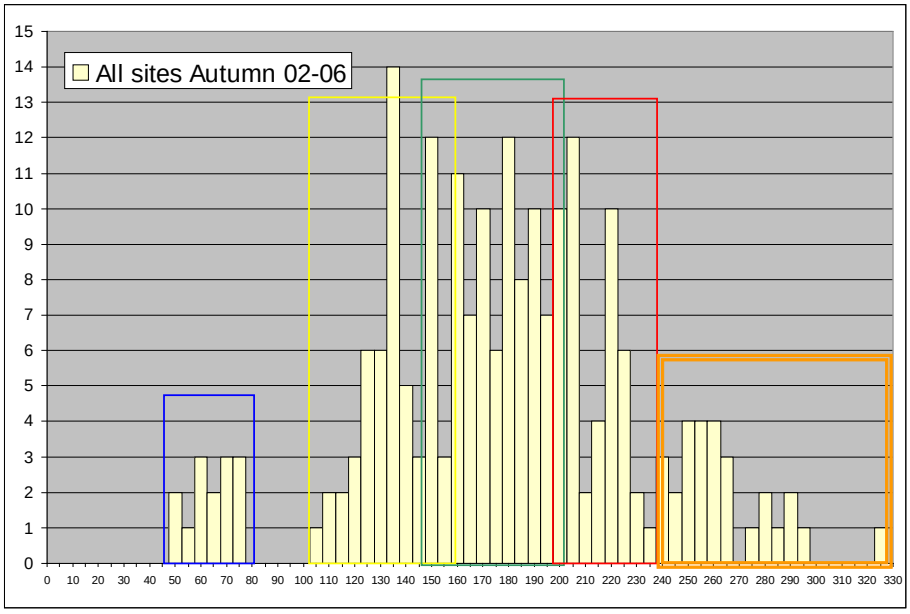


Figure 2.5.4. Representative age-class structure for river blackfish in the Eastern Mount Lofty Ranges, see also Hammer (2006c). The first two size classes are fairly clear, with later sizes showing a high degree of variability between and within sites. Consecutive potential age-classes are shown with different colours and correspond to the below ranges:

Age class	Size range (mm) EMLR	Notes
0+	45-80	Spawned in previous spring
1+	110-160	Grow ~70mm
2+	150-200	Grow ~40mm
3+	190-240	Grow ~40mm
≥4	>250	Max 330mm, longevity?

2.6. Reporting

An ideal way to summarise annual fish monitoring is to develop a basic report card based on key indicators, with supporting presentation and interpretation of raw data. Table 2.6.1 represents a simple tick or cross reference against indicators for environmental objectives relating to water requirements developed for the Marne Catchment for 2006 (Hammer 2006b, 2007a). A report card is for a flow year, essentially from the onset of seasonal flow one year to just before this point the next year (i.e. "2009" means winter 2008 to autumn 2009).

Table 5.1.2. Example report card for environmental water requirements. Summary of performance against fish indicators assessed with field data. Blank indicators were not assessed or not relevant. For exotic species ticks indicate the desirable result was observed (i.e. not detected, low abundance or invasion was not detected) and crosses indicate a negative result (i.e. present, abundance had not been suppressed or invasions occurred). *Recolonisation = invasion for exotic species. Yellow highlight show changes from the last assessment.

Asset	***Environmental Objective***	***Indicator***							
		Presence	Population extent	Recolonisation*	Recruitment	Survivorship	Spawning/larvae	Movement/habitat	Low exotic abundance
Reach 2 – Upper Marne pool/riffle channel									
Mountain galaxias (upper reach)	• Maintain or Restore a self-sustaining population.	✓	✓	✓	✓	✓			
Mountain galaxias (lower reach)	• Maintain or Restore a self-sustaining population.	✓	✓		✓	✓			
Exotic species	• Discourage colonisation and establishment.	✓		✓					
Reach 4 – North Rhine main channel									
Mountain galaxias (longer term objective)	• Restore self-sustaining population.	✓	✗	✓	✗				
Reach 5 – Marne Gorge									
Mountain galaxias	• Maintain or Restore a self-sustaining population.	✓	✓	✓	✓	✗			
Exotic species	• Discourage colonisation and establishment.	✓		✓					
Reach 8 – Lower Marne under spring influence									
River Blackfish	• Maintain a self-sustaining population.	✓			✗	✓			
	• Restore a self-sustaining population (to springs in Reach that have dried).	✗		✗					
Lower Marne fish community	• Maintain diversity, demographics and composition of native fish community.	✓			✓	✓			
Exotic species	• Suppress exotics.	✗							✓
Reach 9 – Marne under Murray influence									
Lower Marne/Murray backwater fish community	• Maintain diversity and composition of fish community.								
	• Restore community of diadromous and rare species.								
Exotic species	• Discourage colonisation and establishment.								

3.0 Sampling summary

3.1 Fish sampling

A total of 188 sites spread across the Currency-Marne catchments were sampled over the four seasonal snapshots covering spring 2007 (18 sites), autumn 2008 (53 sites), spring 2008 (55 sites) and autumn 2009 (62 sites) (Fig. 3.1.1). The focus was on demographic data for indicator species or fish community structure depending on relevant ecological objectives. Note this represents a combined data set of sites funded by the SAMBDNRM Board, SA DEH Drought Action Plan monitoring and rescue activities (collected by a combined SARDI and Aquasave field team), and other miscellaneous projects. Methods included electrofishing, bait traps, fyke netting, night observations and dip netting depending on target species and habitat. A summary of autumn 2009 survey effort is provided as a site specific guide (Appendix 1).

In total some 45,000 fish were recorded including 17 native and six alien species. Summaries of sites and catch are provided for each seasonal sampling (Tables 3.1.1-3.1.4), with specific data discussed by catchment in Section 4. Comparative data for 2001-2007 is presented in Appendix 2-11 (total sampling sites is >550).

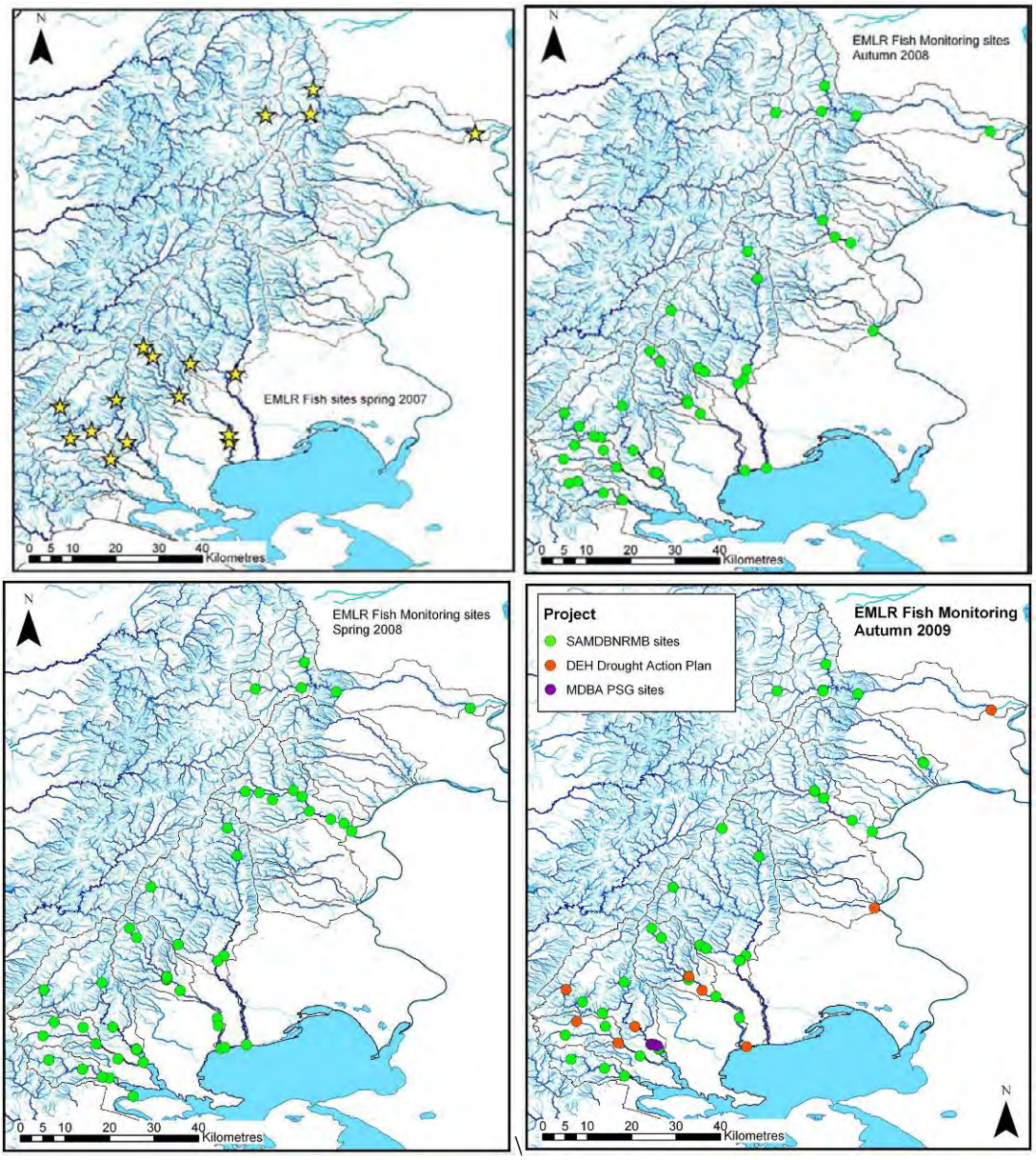


Figure 3.1.1 Sites sampled in EMLR fish monitoring spring 2007-autumn 2009.

Table 3.1.1. Summary of sampling data for spring 2007.

Site Code	Date	River System	Waterway	Location	Carp gudgeons	Common galaxias	Dwarf flathead gudgeon	Flathead gudgeon	Mountain galaxias	River blackfish	Southern pygmy perch	No fish	Brown trout	Carp	Gambusia	Goldfish	Redfin
ML07-56	11/11/07	Tookayerta Creek	Tookayerta Ck	Deep Creek Road						1	26						
ML07-57	17/09/07	Bremer River	Rodwell Creek	Highland Valley (a)						1					50		
ML07-58	17/09/07	Bremer River	Bremer River	Hartley flow gauge station		50		80						18	1	1	
ML07-59	25/08/07	Marne River	Marne River	Black Hill Springs (b)					1	3							
ML07-60	29/10/07	Finniss River	Finniss River	Upstream waterfalls			2		16		27						
ML07-61	29/10/07	Finniss River	Bull Creek	Mcharg Creek Road Bridge					48								
ML07-62	01/11/07	Angas River	Angas River	Bush Care site ds North Pde	40			10			7						
ML07-63	17/11/07	Marne River	Marne River	Off Vigars Rd					154								
ML07-64	17/11/07	Marne River	Marne River	Jutland Road					157								
ML07-65	17/11/07	Marne River	North Rhine R	Netherby Pine Hutt Rd								x					
ML07-66	17/01/07	Marne River	Marne River	Black Hill Springs (b)					3	1							
ML07-67	13/11/07	Finniss River	Finniss River	Cole Crossing				10	35				1				4
ML07-68	13/11/07	Tookayerta Creek	Nangkita Creek	us Willowburn Rd							15						
ML07-69	13/11/07	Finniss River	Meadows Creek	Thorn Dairy -between fords				5	100				2				1
ML07-70	23/11/07	Angas River	Angas River	Watson Park Rd					2								
ML07-71	23/11/07	Angas River	Angas River	Searle Street					78								
ML07-72	23/11/07	Angas River	Angas River	Davidson Rd					9								
ML07-73	23/11/07	Angas River	Angas River	Quarry Road					25								

Table 3.1.2. Summary of sampling data for autumn 2008.

Site Code	Date	River System	Waterway	Location	Bony herring	Carp gudgeons	Common galaxias	Congolli	Dwarf flathead gudgeon	Flathead gudgeon	Lagoon goby	Mountain galaxias	Murray hardyhead	Murray-Darling golden perch	River blackfish	Smallmouthed hardyhead	Smelt	Southern pygmy perch	Tamar River goby	Unspecked hardyhead	Western bluespot goby	No fish	Brown trout	Carp	Gambusia	Redfin	Tench	Goldfish
ML08-03	11/03/08	Bremer River	Rodwell Creek	'Highland Valley' (a)		30									8										200			
ML08-04	11/03/08	Bremer River	Rodwell Creek	'Highland Valley' (b)		2						4													100			
ML08-05*	22/03/08	Bremer River	Rodwell Creek	'Highland Valley' (a)		10						1			10										10			
ML08-06*	20/03/08	Bremer River	Rodwell Creek	'Highland Valley' (a)		40									10										200			
ML08-07	31/03/08	Bremer River	Rodwell Creek	James property (Stone End)		1065						6													462			
ML08-08*	31/03/08	Finniss River	Medows Creek	Thorn Dairy						108		104						22					1		150	8		
ML08-09	01/04/08	Marne River	Marne River	Vigars Road																		x						
ML08-10	01/04/08	Marne River	Marne River	off Jutland Road																		x						
ML08-11	01/04/08	Marne River	North Rhine River	Pine Hutt Road																		x						
ML08-12	01/04/08	Marne River	Marne River	Gorge pool								23																
ML08-14	04/04/08	Tookayerta Creek	Tookayerta Creek	Deep Creek Road											7			36							2			
ML08-15	04/04/08	Tookayerta Creek	Nangkita Creek	us Willoburn Road								24			9			52										
ML08-16	07/04/08	Finniss River	Bull Creek	McHarg Creek Road								300																
ML08-17	07/04/08	Tookayerta Creek	Swampy Creek	Brawleys Swamp (causway)														28										
ML08-18	07/04/08	Tookayerta Creek	Tookayerta Creek	Compass Cabins								13			4			6										
ML08-19	07/04/08	Currency Creek	Currency Creek	Kilchoan								1													400			
ML08-20	08/04/08	Angas River	Angas River	Quarry Road								11																
ML08-21	08/04/08	Angas River	Angas River	Searle Street, Macclesfield								93																
ML08-22a*	08/04/08	Angas River	Angas River	Middle Ck junction		100												86										
ML08-22b	08/04/08	Angas River	Angas River	1st weir ds of Nth Parade		149				39		1						12										
ML08-23	08/04/08	Angas River	Angas River	Walkway in Strathalbyn		1042			7	152		2						33										
ML08-24*	09/04/08	Lakes Alexandrina & Albert	Bremer River	Mouth below bridge	546		24			20			3			8					2				1	26		
ML08-25*	09/04/08	Lakes Alexandrina & Albert	Lake Alexandrina	Turveys Drain			7			22	1		60		28			3		2	3				2220			
ML08-26*	09/04/08	Angas River	Angas River	us Nth Parade, large pool next to wetland						3																19		
ML08-27	10/04/08	Angas River	Angas River	Strathalbyn (old Swimming pool and main weir)		54				104														5		7	1	
ML08-28	10/04/08	Angas River	Angas River	us and ds of walkway, Strathalbyn						6																19		
ML08-29	10/04/08	Angas River	Angas River	Gurney Property		73			2	19					25										1		1	
ML08-30	15/04/08	Bremer River	Bremer River	Flow gauge site						50														10	200	1		
ML08-31	15/04/08	Bremer River	Bremer River	Military Road		6																						
ML08-32	15/04/08	Bremer River	Bremer River	Harrogate at main road bridge																		x						
ML08-33	20/04/08	Inman River	Inman River	Kirk Property		20												32										
ML08-34a	20/04/08	Inman River	Back Valley Creek	Kirk Road		9												71										
ML08-34b	20/04/08	Inman River	Back Valley Creek	Robertson Property		7	3											63										
ML08-35	22/04/08	Finniss River	Finniss River	300m ds of Winery Road ford		5		1	3	33															1	1		
ML08-36	22/04/08	Finniss River	Finniss River	500m ds of Winery Rd ford		3	4		4	43																		
ML08-37	22/04/08	Finniss River	Finniss River	Where channel meets paddocks			1		9	8										4				2	500			
ML08-38	17/04/08	Currency Creek	Currency Creek	Lions Park			10	1		7																20		
ML08-39	17/04/08	Currency Creek	Currency Creek	ds Goolwa Road	3		137	8	1	252						3					21			5	155	11		6
ML08-40	23/04/08	Reedy Creek	Reedy Creek	Below water fall		15	4			449															2			
ML08-41	23/04/08	Reedy Creek	Reedy Creek	'Abraham' property					4																150			
ML08-42	23/04/08	Reedy Creek	Reedy Creek	Palmer Road					71																			
ML08-43	24/04/08	Bremer River	Bremer River	100m us of Rodwell Ck jn		1	3							1												25		
ML08-44	24/04/08	Bremer River	Bremer River	South Bremer Road		27			26	34														7	73			
ML08-45	27/04/08	Marne River	Marne River	Black Hill Springs (b)		20			10			2			9										30			
ML08-46	18/04/08	Finniss River	Finniss River	ds Coles Crossing						287		67						19					2		165	4		
ML08-47	16/04/08	Currency Creek	Currency Creek	Stuarts bridge						3		23													1			
ML08-48	16/04/08	Currency Creek	Currency Creek	Kiloran, us of powerlines																					2000			
ML08-49	22/04/08	Finniss River	Finniss River	us of Coles Crossing @ CP						9		50											3		6	1		
ML08-50	12/04/08	Finniss River	Blackfellows Creek	JVW Pty Ltd (opp. CP)								15											3					
ML08-51	24/04/08	Angas River	Angas River	Macclesfield at footbridge								24																
ML08-52	24/04/08	Bremer River	Mt Barker Creek	Foot-bridge near bowls club								4													8			
ML08-53*	31/03/08	Finniss River	Finniss River	us of waterfall			5					220						73										
RM08-06*	17/03/08	River Murray	Rocky Gully wetland	At road bridge on outlet channel												30												

* Sites sampled by a combine Aquasave and SARDI field team as part of the DEH Drought Action Plan

Table 3.1.3. Summary of sampling data for spring 2008.

Site Code	Date	River System	Waterway	Location	Bony herring	Bridled goby	Carp gudgeons	Common galaxias	Congolli	Dwarf flathead gudgeon	Flathead gudgeon	Lagoon goby	Mountain galaxias	Murray hardyhead	River blackfish	Smallmouthed hardyhead	Smelt	Southern pygmy perch	Tamar River goby	Unspecked hardyhead	Western bluespot goby	No fish	Carp	Gambusia	Goldfish	Redfin	Tench
ML08-59	18/09/08	Angas River	Angas River	100m us from lake entrance				202			6	19				1150	104										
ML08-60	18/09/08	Finniss River	Finniss River	ds of Winery Road ford			2	1		2	4						9			1				9		2	
ML08-61	18/09/08	Currency Creek	Currency Creek	Rotary Park				6	1		2															2	
ML08-62	24/10/08	Currency Creek	Currency Creek	Rotary club and us to railway bridge				6	6		7															17	
ML08-63	24/10/08	Currency Creek	Currency Creek	ds of Goolwa Road bridge				10	6	2	251					261	21		4		5					1	
ML08-64	24/10/08	Currency Creek	Currency Creek	Entrance to Lake Alexandrina						2	146					2					36			1			
ML08-65	24/10/08	Finniss River	Finniss River	400m ds of Winery Road ford			24			12	37					4	13			3						4	
ML08-66	25/10/08	Finniss River	Finniss River	Below natural barrier to lake						1	3					2	80							100		2	
ML08-67	25/10/08	Finniss River	Finniss River	500m ds from Winery Road ford				2	1	14	51					6	8							19		6	
ML08-68	29/10/08	Angas River	Angas River	Quarry Rd									4														
ML08-69	29/10/08	Angas River	Angas River	Searle Street									40														
ML08-70	29/10/08	Angas River	Angas River	Old swimming pool, Strathalbyn			73			1	168							1									
ML08-71	30/10/08	Bremer River	Bremer River	Flow gauge station			1			1	84												19				
ML08-72	30/10/08	Bremer River	Bremer River	us Rodwell Creek junction							3															166	
ML08-73	31/10/08	Bremer River	Bremer River	us of Millitary Road																		x					
ML08-74	30/10/08	Angas River	Angas River	Watson Park Road							1		22														
ML08-75	30/10/08	Angas River	Angas River	Davidson Rd bridge									2														
ML08-76	30/10/08	Angas River	Angas River	Foot bridge in Strathalbyn			216			2	55		3					12									
ML08-77	30/10/08	Angas River	Angas River	First weir, Strathalbyn			358			4	27							74									
ML08-78	30/10/08	Angas River	Angas River	Cliff pool, new development							1							2								1	
ML08-79	31/10/08	Bremer River	Bremer River	Harrogate Road bridge																		x					
ML08-80	03/11/08	Reedy Creek	Reedy Creek	ds of waterfalls																		x					
ML08-81	03/11/08	Reedy Creek	Reedy Creek	Off Abrahams Rd, near train crossing																				50			
ML08-82	03/11/08	Reedy Creek	Reedy Creek	Palmer Rd bridge						126			21														
ML08-83	03/11/08	Reedy Creek	Reedy Creek	Reedy Creek wetland			18				3						20										
ML08-84	05/11/08	Currency Creek	Currency Creek	Stuarts Bridge							68		248											3			
ML08-85	05/11/08	Tookayerta Creek	Tookayerta Creek	ds of railway bridge, Currency Creek Winery									184		1			306								1	
ML08-86	06/11/08	Reedy Creek	Dairy Creek	Collins Rd bridge																		x					
ML08-87	06/11/08	Reedy Creek	Dairy Creek	cnr Hoad Rd and Brinkworths Rd																		x					
ML08-88	06/11/08	Reedy Creek	Talbot Creek	ds Hoads Fire Track																		x					
ML08-89	12/11/08	Bremer River	Mt Barker Creek	Linear park foot bridge									17											5		2	
ML08-90	13/11/08	Currency Creek	Currency Creek	Kilchoan									56											46			
ML08-91	13/11/08	Tookayerta Creek	Nangkita Creek tributary	Brawley Swamp									2					21									
ML08-92	13/11/08	Tookayerta Creek	Tookayerta Creek	Compass Country Cabins									9		3			1									
ML08-93	25/11/08	Marne River	Marne River	Vigars Road																		x					
ML08-94	25/11/08	Marne River	Marne River	off Jutland Rd									12														
ML08-95	25/11/08	Marne River	North Rhine River	Pine Hutt Rd																		x					
ML08-96	25/11/08	Marne River	Marne River	Gauge pool									10														
ML08-97	27/11/08	Finniss River	Bull Creek	McHargs Creek Road bridge									111														
ML08-98*	28/10/08	Finniss River	Meadows Creek	Thorn Dairy									50					2									
ML08-99*	28/10/08	Finniss River	Finniss River	us waterfall			3				7		56					35									
ML08-100*	29/10/08	Tookayerta Creek	Tookayerta Creek	Deep Creek Rd									1		3			21									
ML08-101*	29/10/08	Tookayerta Creek	Nangkita Creek	us Willowburn Rd									7		8			7									
ML08-102*	03/11/08	Tookayerta Creek	Black Swamp	Drain off Finniss channel			1	9																			
ML08-103*	04/11/08	Bremer River	Bremer River	Bremer Mouth	114		1	238	1		61			9		42	7		1		3		1			4	2
ML08-104*	04/11/08	Lakes Alexandrina & Albert	Lake Alexandrina Drain	Turveys Drain				11		44	44			8		1		81	1		34			157	2		
ML08-105*	05/11/08	Angas River	Angas River	Flow gauge site			20			8	12		1		17												1
ML08-106*	05/11/08	Angas River	Angas River	Middle Creek junction			21				4		4					35									
ML08-107*	05/11/08	Lakes Alexandrina & Albert	Goolwa Channel	at Currency Creek channel (Laffin Point)		22		2		3	76	16		11		5875	44		137		398			24		3	
ML08-108*	06/11/08	Inman River	Back Valley Creek	Kirk Road			2											12									
ML08-109*	10/11/08	Marne River	Marne River	Black Hill Springs (b)			3						4		6												
ML08-110*	12/11/08	Bremer River	Rodwell Creek	'Highland Valley' (a)											6												
ML08-111	23/12/08	Reedy Creek	Reedy Creek	Track in swamp																				15			
ML08-112	23/12/08	Reedy Creek	Baker Creek	us Reedy Ck junction (Mine Shaft Waterhole)						105			106														
ML08-113	23/12/08	Reedy Creek	Reedy Creek	Off Camel Hump Rd									16														

* Sites sampled by a combine Aquasave and SARDI field team as part of the DEH Drought Action Plan

Table 3.0.4. Summary of sampling data for autumn 2009.

Site Code	Date	River System	Waterway	Location	Carp gudgeons	Common galaxias	Congolli	Dwarf flathead gudgeon	Flathead gudgeon	Mountain galaxias	Murray hardyhead	Philypnodon hybrid	River blackfish	Smallmouthed hardyhead	Smelt	Southern pygmy perch	Tamar River goby	Unspecked hardyhead	Western bluespot goby	No fish	Brown trout	Carp	Gambusia	Goldfish	Redfin	Tench
ML09-01*	06/02/09	Finniss River	Finniss River	Waterfalls	1	6		3	32	63						57										
ML09-02	11/02/09	Bremer River	Rodwell Creek	'Stone End'	1380																		630			
ML09-03	21/03/09	Finniss River	Blackfellows Creek	JVW Pty Ltd						7											1		0			
ML09-04*	23/03/09	Finniss River	Meadows Creek	Thorn Dairy					170	62						38							100			
ML09-05*	24/03/09	Finniss River	Finniss River	us of waterfall												1										
ML09-06*	29/03/09	Tookayerta Creek	Tookayerta Creek	Deep Creek Rd									6			16										
ML09-07*	24/03/09	Angas River	Angas River	Middle Creek junction	11					4						53										
ML09-08*	24/03/09	Angas River	Angas River	Flow gauge site	36			2	14				26													9
ML09-09*	25/03/09	Tookayerta Creek	Nangkita Creek	us Willowburn Rd						153			7			32										
ML09-10*	26/03/09	Lakes Alexandrina & Albert	Lake Alexandrina Drain	Turveys Drain					8		7					5							390			
ML09-11*	30/03/09	River Murray	Rocky Gully Wetland	Channel at Road Bridge							2			2									40			
ML09-12	01/04/09	Currency Creek	Currency Creek	'Kilchoan'						6													116			
ML09-13	01/04/09	Tookayerta Creek	Tookayerta Creek	Compass Cabins						18			6			7									1	
ML09-14	01/04/09	Tookayerta Creek	Swampy Creek	Brawley Swamp																x						
ML09-15	01/04/09	Finniss River	Bull Creek	McHarg Creek Road						214																
ML09-16	02/04/09	Angas River	Angas River	Quarry Road						36																
ML09-17	02/04/09	Angas River	Angas River	ds of Searle Street, Macclesfield						8																
ML09-18	02/04/09	Angas River	Angas River	New development, cliff pool	2				26	9						5						1			5	
ML09-19	02/04/09	Angas River	Angas River	Walkway at Colman Terrace	50			1	21							3										
ML09-20	02/04/09	Angas River	Angas River	First weir ds of Nth Parade	221			8	175	6						40										
ML09-21	02/04/09	Angas River	Angas River	'Belvidere' parking bay	36			2	41	47													199			
ML09-22*	26/03/09	Marne River	Marne River	Black Hill Springs (b)	1								5										1			
ML09-23	03/04/09	Angas River	Angas River	War memorial park, Strathalbyn	6				104																6	3
ML09-24	03/04/09	Angas River	Angas River	Davidson Rd ford																x						
ML09-26	03/04/09	Bremer River	Bremer River	Gauge station					8													44	30			
ML09-27	03/04/09	Angas River	Angas River	Old swimming pool, Strathalbyn	68			2	356							2										1
ML09-28	08/04/09	Currency Creek	Currency Creek	Lions Park		94	5	4	41														12		3	
ML09-29	08/04/09	Currency Creek	Currency Creek	ds of Goolwa to Strathalbyn road			2	1	114					2			1		4				20		1	
ML09-30	09/04/09	Finniss River	Finniss River	ds Winery Road, below barrier to Lake				1	5		1			2	4			1				1	290	2		
ML09-31	09/04/09	Finniss River	Finniss River	500m ds of Winery Road	3	11	4	3	44					4	2										5	
ML09-32	09/04/09	Finniss River	Finniss River	300m ds of Winery Road	6			4	68						8			25								
ML09-33	14/04/09	Currency Creek	Currency Creek	'Stuarts Bridge'					11	167													2			
ML09-34	14/04/09	Marne River	Marne River	Vigars Road																x						
ML09-35	14/04/09	Marne River	Marne River	off Jutland Rd																x						
ML09-36	14/04/09	Marne River	Marne River	Jutland Water Reserve						2																
ML09-37	14/04/09	Marne River	North Rhine River	Pine Hutt Rd																x						
ML09-38	14/04/09	Marne River	Marne River	Marne George																x						
ML09-39	15/04/09	Tookayerta Creek	Tookayerta Creek	Tonkins Winery		1			7	2			1												2	
ML09-40	16/04/09	Bremer River	Bremer River	100m us of Rodwell Creek					8														3		29	
ML09-41	16/04/09	Bremer River	Bremer River	Pump station					1																7	
ML09-42	16/04/09	Bremer River	Bremer River	Military Road																x						
ML09-43	16/04/09	Bremer River	Bremer River	Main Road, Harrogate																x						
ML09-44	16/04/09	Finniss River	Finniss River	ds of Coles Crossing					155	44													15		77	
ML09-45	17/04/09	Bremer River	Mt Barker Creek	ds of foot bridge, Mt Barker						5													11			
ML09-46	17/04/09	Bremer River	Rodwell Creek	'Highland Valley' (b)																			148			
ML09-47	17/04/09	Bremer River	Rodwell Creek	'Highland Valley' (a)	2								14										3			
ML09-48	19/04/09	Inman River	Back Valley Creek	Kirk Property	100											23										
ML09-49	19/04/09	Inman River	Back Valley Creek	Kirk Road	8											101										
ML09-50	19/04/09	Inman River	Back Valley Creek	Robertson Property	3											121										
ML09-51	21/04/09	Finniss River	Finniss River	Railway Bridge 'Dunreath'		8	2	36	6			1										1	7		2	
ML09-52	21/04/09	Finniss River	Finniss River	ds of railway bridge, Vallis pool		9		5	8			1			7								21			
ML09-53	23/04/09	Saunders Creek	Saunders Creek	ds of road junction (Lenger Reserve)																			80			
ML09-54	23/04/09	Saunders Creek	Saunders Creek	us of Springs Rd (circular pool)	20																	1	1000			
ML09-55	23/04/09	Reedy Creek	Baker Creek	Baker Creek Gorge				305		29																
ML09-56	23/04/09	Reedy Creek	Reedy Creek	Reedy Creek Swamp																x						
ML09-57	24/04/09	Reedy Creek	Reedy Creek	300m us of fence line																x						
ML09-58	24/04/09	Reedy Creek	Reedy Creek	ds of Mannum Waterfalls					25													1	4			
ML09-59	24/04/09	Reedy Creek	Reedy Creek	Palmer Rd				100															200			
ML09-60	07/05/09	Finniss River	Finniss River	us of ford on eastern arm				10							20							1				
ML09-61	07/05/09	Finniss River	Finniss River	us of Winery Rd, east channel		6																	41	5		
ML09-62	05/05/09	Bremer River	Rodwell Creek	'Stone End' dam	4600																		2050			
RM09-03*	26/03/09	River Murray	Rocky Gully Wetland	Bridge on channel							3												65			

* Sites sampled by a combine Aquasave and SARDI field team as part of the DEH Drought Action Plan

3.2 Regional flow trends

This report is intended to present data summaries for later application within holistic EWR analysis (i.e. other functional groups) and by more in-depth assessments using hydrological models. Nevertheless implications of changing water availability and flow events are discussed when evident in the data, providing perspective on the performance of fish based EWR indicators in different reaches (again note the fish indicators observed in autumn of a particular year is a response to the flow conditions of the preceding year). Some general patterns in climate and flow events during the sampling period are presented as background information.

The first useful hydrological perspective is the broad lowering of water across the Lower Murray below Blanchetown and the Lower Lakes as result of heavy abstraction and drought severely reducing inflows. Water levels have fallen over 1.5m over a short period since January 2007 (Figure 3.2.1). Local rainfall has been low over an extended period including the 2007 and 2008 flow seasons, and combined with abstraction to have the result of often extended periods of no flow and related critically low autumnal water availability in pools (e.g. indicative hydrographs of Figure 3.2.2-3.2.4).

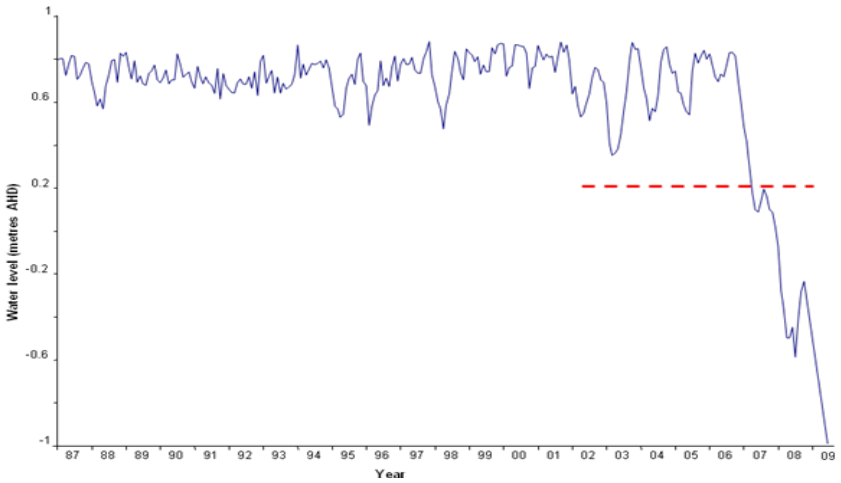


Figure 3.2.1. Recent water level declines in the Lower Murray region, dashed line indicates the point where most off-channel and edge habitat dried, including terminal wetlands (DWLBC 2009).

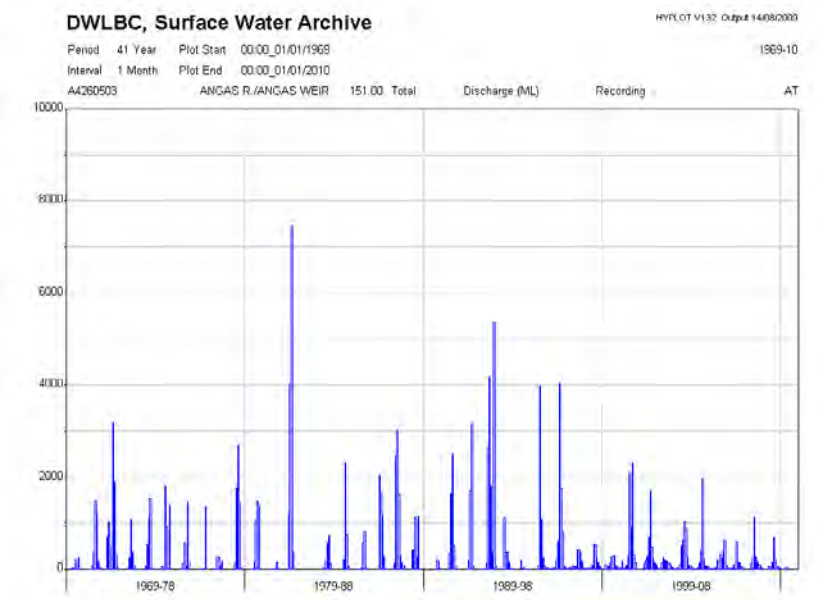
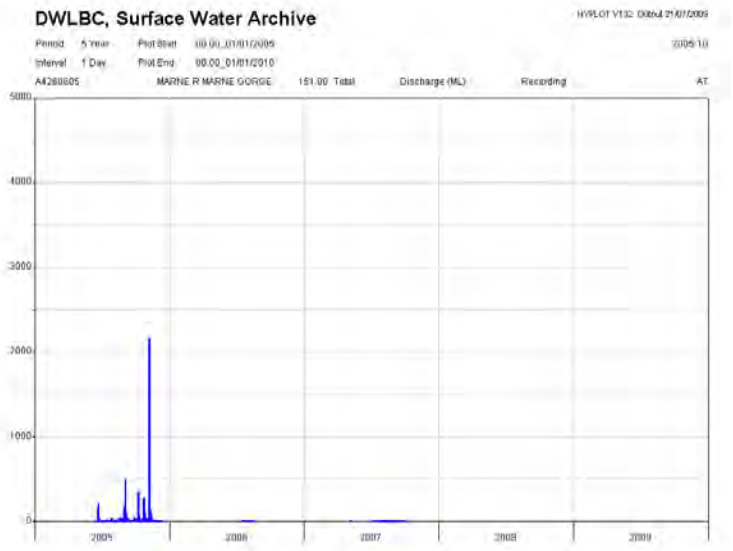
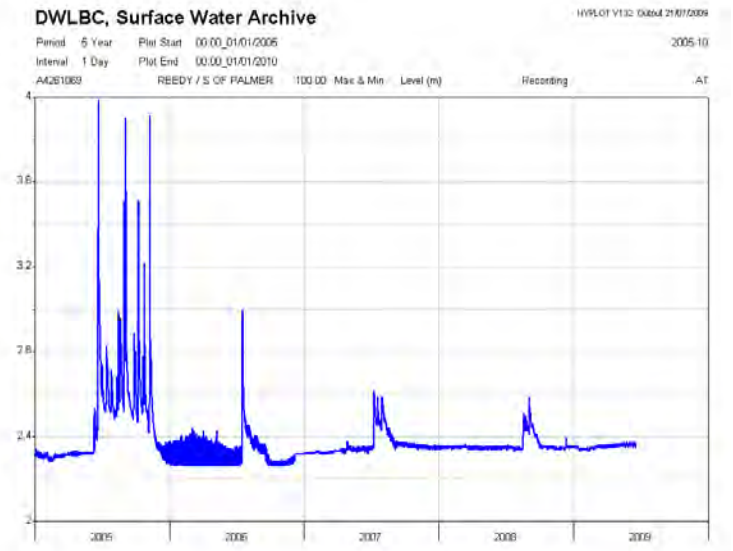


Figure 3.2.2. Long term flow record from the Angas River gauging station north of Strathalbyn as indication of EMLR flow patterns including a period of generally low flows since the late 1990s (DWLBC 2009).

(a) Marne Gorge



(b) Reedy Creek mid-channel



(c) Bremer at Hartley

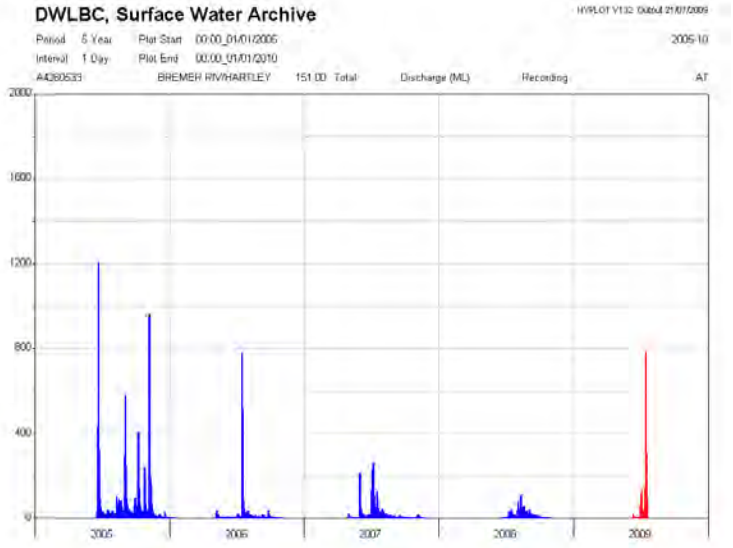
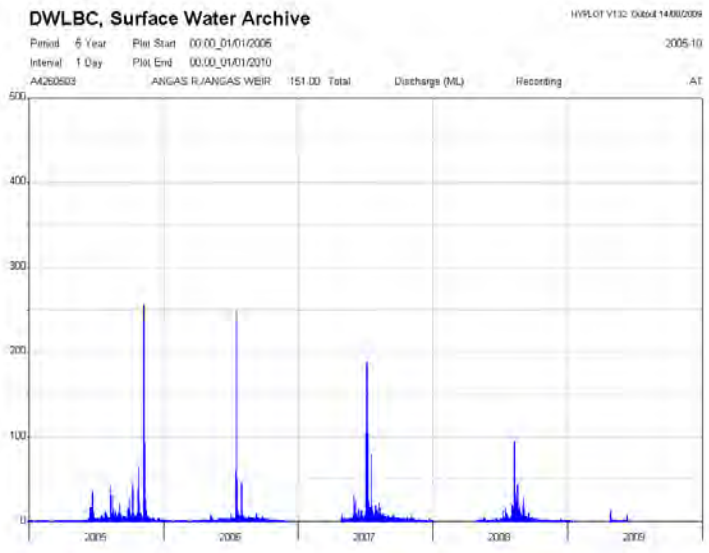
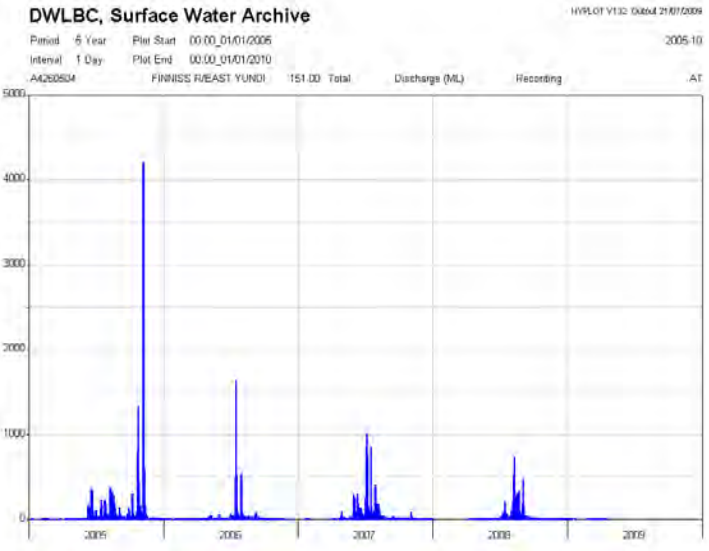


Figure 3.2.3. Indicative five years hydrographs for different catchments for the Marne, Reedy and Bremer Catchments (DWLBC 2009), accessed June 2009.

(d) Angas us of Strathalbyn



(e) Finniss at Yundi



(f) Currency Creek, south arm

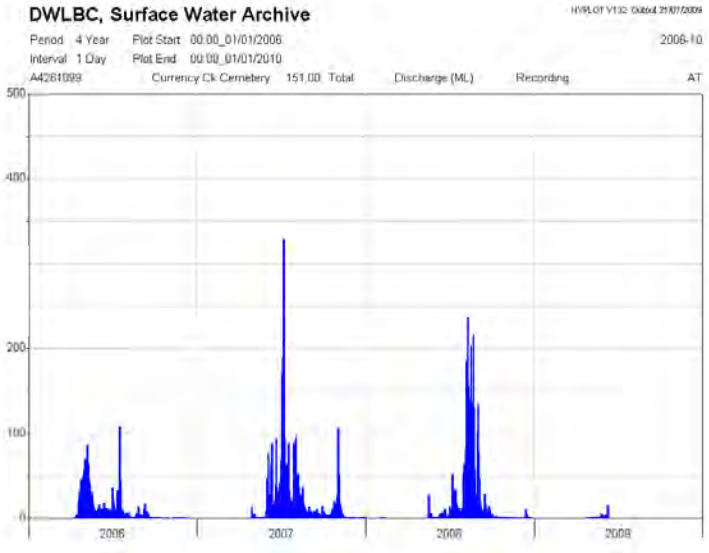


Figure 3.2.4. Indicative five year hydrographs for the Angas, Finniss and Currency catchments (DWLBC 2009), accessed June 2009.

4.0 EWR Assessments

4.1 Marne River Catchment

The Marne River Catchment covers ~500km^2 being a direct tributary to the River Murray, situated north east of Adelaide. Its headwaters originate in higher rainfall areas east of the apex of the Mount Lofty Ranges, with a catchment area spreading between Springton, Eden Valley and Keyneton, north east of Adelaide. The upland catchment area or "Hills Zone" spills through a confined gorge before exiting onto the "Plains Zone". The lower zone contains an ephemeral river red gum *Eucalyptus camaldulensis* lined channel through much drier lowland areas until it reaches the township of Black Hill. The stretch following here forms a unique ecological scenario, with harsh Mallee terrain sliced by a lush valley supported by a spring fed stream. Historically this stream stretch was continuous through to a deep clear wetland at the Marne Mouth near Wongulla (around 20km upstream of Mannum) before flowing into the River Murray. Surface water connection between the upper and lower sections is only facilitated by flows and flood spates with sufficient magnitude to traverse the ephemeral channel. Both Marne River flows and River Murray flooding can inundate the Marne Mouth wetland.

Overall nine distinct river reaches can be defined in the catchment based on distinction in geomorphic character (MREFTP 2003; Fig. 4.1.1), and these form the spatial basis of setting and measuring environmental flow related objectives.

Fish related ecological assets identified by Hammer (2002b) and summarised in MREFTP (2003) are shown in Table 4.1.1. These include mountain galaxias populations, a highly significant population of river blackish and other native fish communities.

Environmental objectives, water requirements and monitoring recommendations are shown in Tables 4.1.1 & 4.1.2, and these match fish related ecological assets identified in the Marne Catchment to the relevant EWR tables of Section 2.3.

In addition to the 2008 and 2009 flow season data, additional data from autumn 2007 is presented for this catchment linking with a previous 2006 assessment (Hammer 2007a). Five sites were sampled on most of the five occasions within four distinct Stream Reaches of the Marne Catchment (Appendix 2).

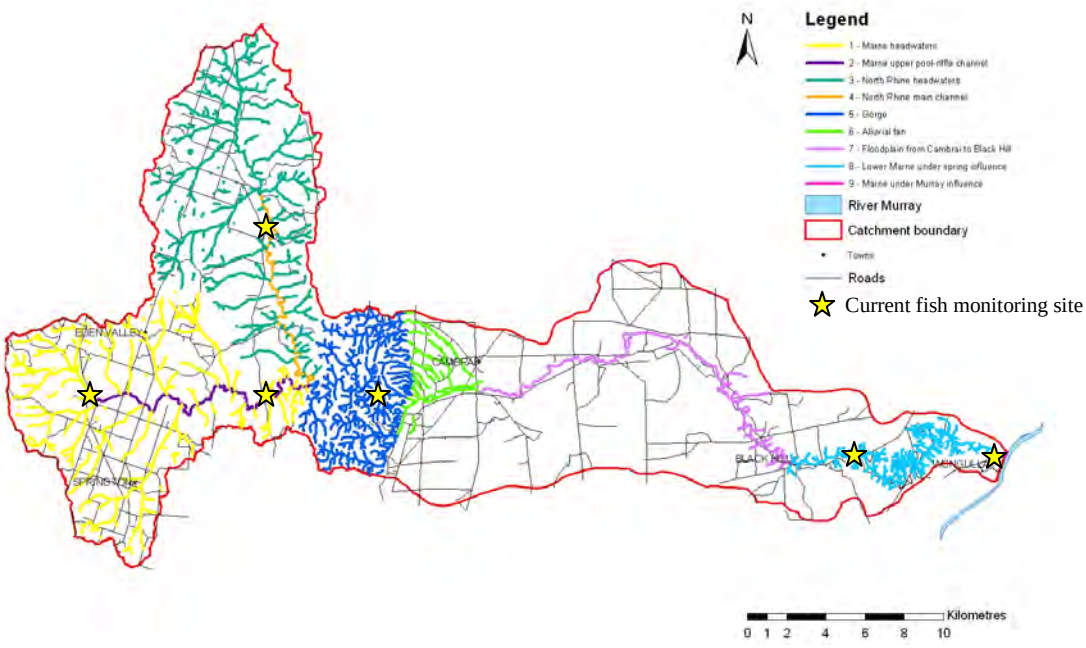


Fig 4.1.1. Map of the Marne River Catchment showing river reaches (MREFTP 2003).

Table 4.1.1. Distribution patterns and significant environmental assets in the Marne River Catchment relating to fish species and communities (adapted from MREFTP 2003).

Specific asset/pattern	Location	EWR Table
1) Mountain galaxias	• Reaches 2, 5	2.3.1
2) River blackfish (local extinctions due to some springs drying out)	• Reach 8	2.3.2 & 2.3.6
3) Lower Marne diverse fish community	• Reach 8	2.3.6
4) Lower Marne/Murray backwater diverse fish community	• Reach 9	2.3.8
5) Potential for diadromous fish species (Congolli, galaxias, lamprey) to colonise lower Marne River	• Reach 9	2.3.5 & 2.3.8
6) No permanent populations present due to lack of summer refuge, connectivity and water quality (but mountain galaxias occurs intermittently)	• Reach 4	2.3.1
7) No permanent fish communities due to lack of permanent water. Mountain galaxias may be opportunistically present washed in from upstream, but unlikely to be sustainable	• Reach 6	NA
8) Little aquatic habitat present. Unlikely to ever have sustainable populations	• Reaches 1, 3, 7	NA

Table 4.1.2. Summary of environmental objectives by reach for fish related ecological assets in the Marne Catchment (Hammer 2006b).

Asset	***Environmental Objective***
Reach 1, 3, 6, 7 – Marne & North Rhine headwaters, Alluvial Fan & Floodplain from Cambrai to Black Hill	
NA	
Reach 2 – Upper Marne pool/riffle channel (EWR Table 2.3.1)	
Mountain galaxias	• Maintain or Restore a self-sustaining population
Reach 4 – North Rhine main channel (EWR Table 2.3.1)	
Mountain galaxias (longer term objective)	• Restore self-sustaining population
Reach 5 – Marne Gorge (EWR Table 2.3.1)	
Mountain galaxias	• Maintain or Restore a self-sustaining population
Reach 8 – Lower Marne under spring influence (EWR Tables 2.3.2, 2.3.4 & 2.3.6)	
River Blackfish	• Maintain a self-sustaining population. • Restore a self-sustaining population (to springs in Reach that have dried out)
Lower Marne fish community	• Maintain diversity, demographics and composition of fish community
Reach 9 – Marne under Murray influence (EWR Tables 2.3.5 & 2.3.8)	
Lower Marne/Murray backwater fish community Rare/endangered chanda perch and diadromous congolli and common galaxias were historically recorded)	• Maintain diversity and composition of fish community • Restore community of diadromous/rare species

Reach 2 – Upper Marne River

Two sites are sampled for mountain galaxias in this reach, one in the upper reach (Vigars Rd), and one in the lower reach (Jutland Rd). A previous monitoring report provided a positive relationship between greater water availability and fish abundance and recruitment (2006). The opposite is true for the subsequent three years, with declining surface water and fish presence.

At Vigars Road autumn relative abundance declined from 96 fish in 2006 to 11 fish in 2007, with the habitat dry in both autumn 2008 and 2009, representing the first time the key upland refuge has been dry during the monitoring program (initiated 2002: Appendix 2). Successful regional spawning and recovery was observed as recolonisation of juvenile fish 30-65mm in Spring 2007, however this did not re-occur in the subsequent winter/spring flow season of 2008 (Fig 4.1.2a). The site represents the main refuge pool in the area, and searches failed to map any other pools or fish in the vicinity during autumn 2008 and 2009. Water quality and habitat have been relatively stable at this site over time, albeit with sharp recent increases with pool concentration (Appendix 2).

At the Jutland Road site relative abundance has been gradually declining since a strong recruitment event in 2005, having minimal 0+ recruits in autumn 2007 and culminating in an absence of the species due to pool drying (<10cm water remaining) in autumn 2008 and 2009. Recolonisation with large numbers of juveniles (30-60mm) was observed in spring 2007 and to a lesser extent in 2008 (Figure 4.1.1b). Searches confirmed remaining presence in the vicinity of the site, upstream at Jutland Water Reserve. Water quality was poor in 2009 (Appendix 2).

The dramatic decline suggests that the resilience of mountain galaxias in this reach (and catchment) will be tested by current drought and abstraction.

Autumn 2009:

Top – Vigars Road site, dry

Lower – Jutland Road site with only 0.1m water

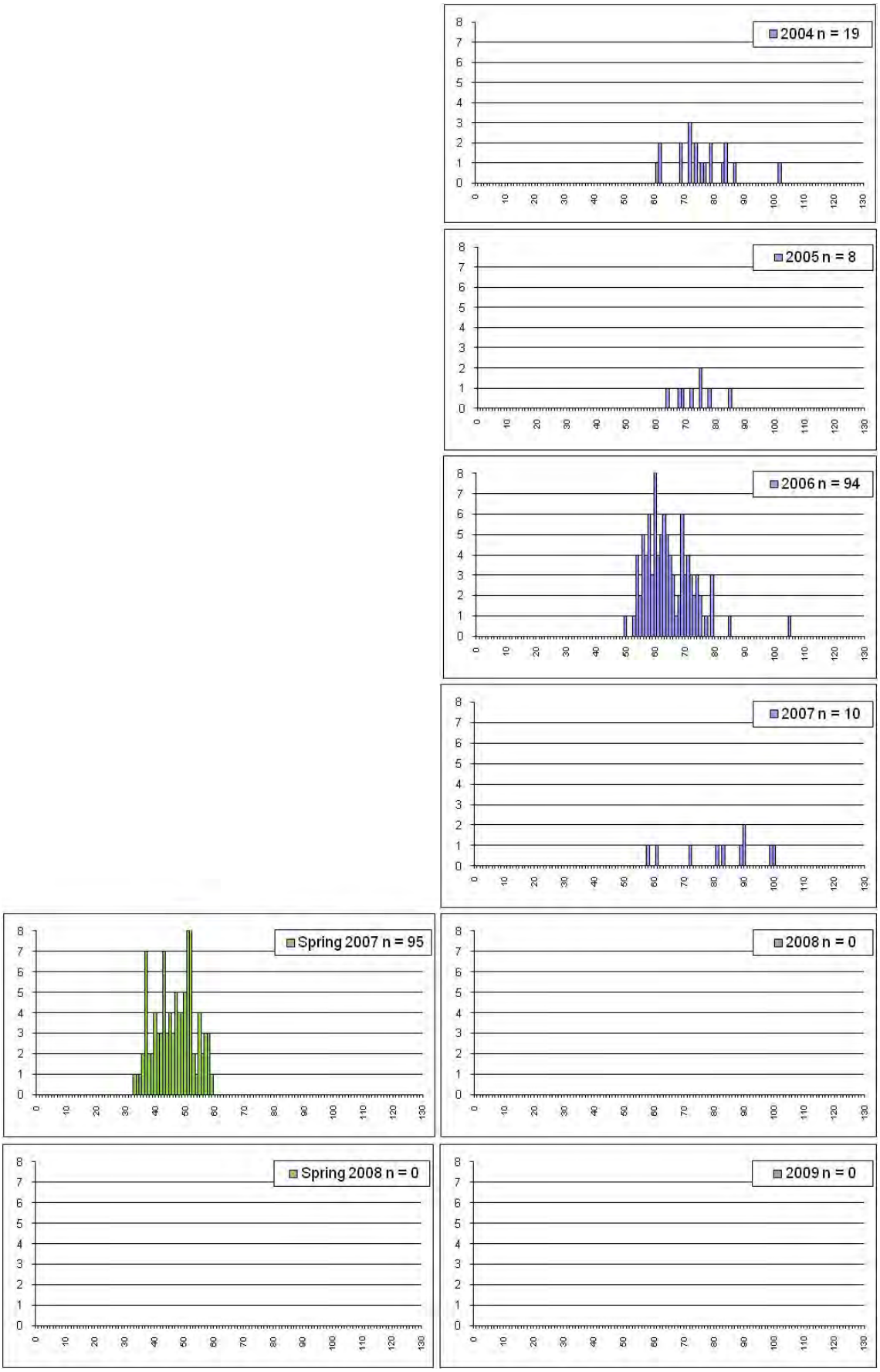


Figure 4.1.2a. Length frequency data for mountain galaxias at Vigars Road, Marne Catchment Upper Reach 2, over six years 2004-2009.

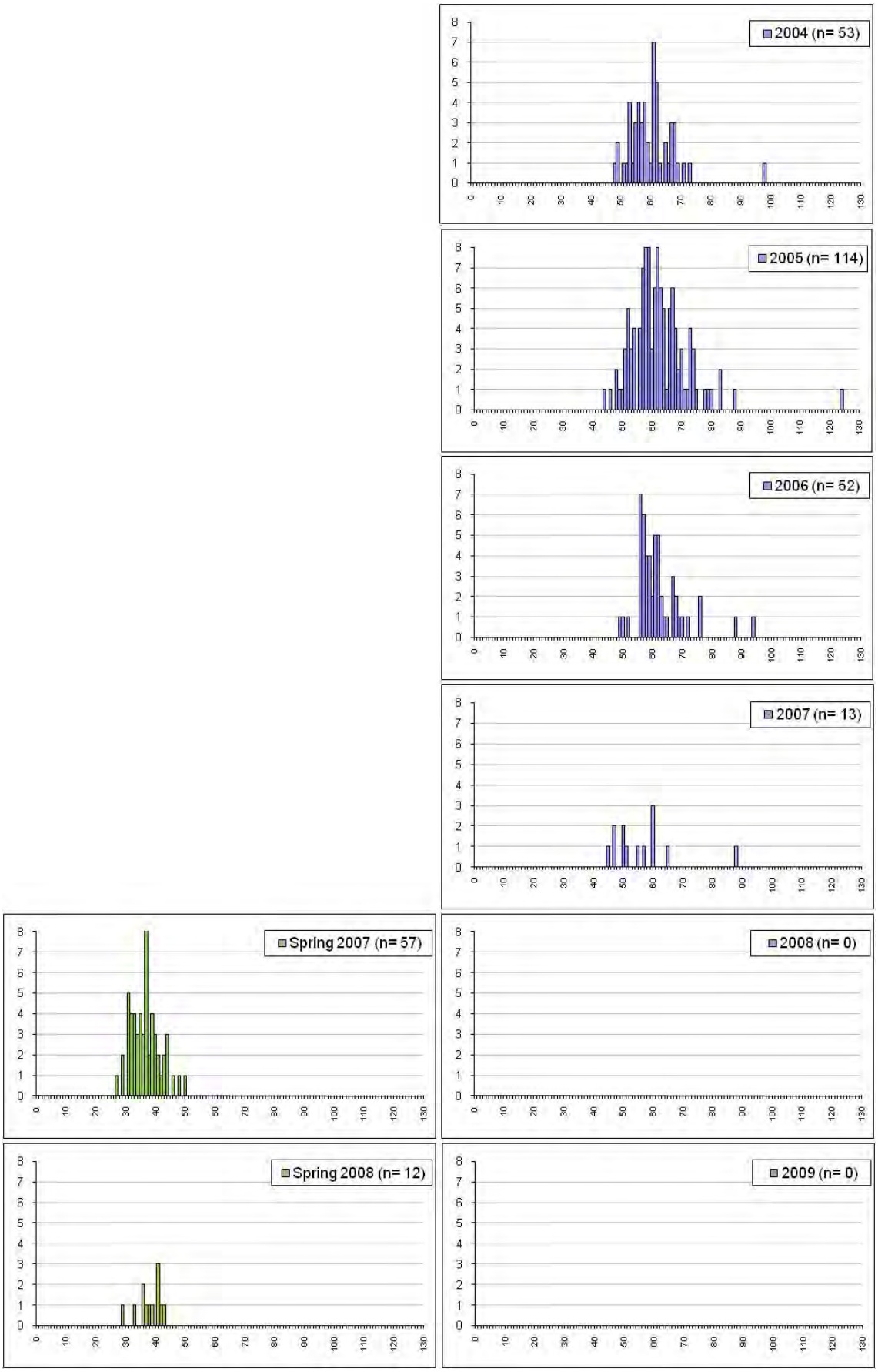


Figure 4.1.2b. Length frequency data for mountain galaxias at Jutland Road, Marne Catchment Lower Reach 2, over six years 2004-2009.

Reach 4 – North Rhine River

Recolonisation of adult mountain galaxias was recorded in this reach in autumn 2006 after extended seasonal flow conditions and/or a high flow event in November 2005. Monitoring on five occasions since 2006 (Appendix 2) has failed to re-record mountain galaxias, with a major decline in water availability (likely the worst since European settlement). In autumn 2009 only a small pool with depth 0.3m remained and had a salinity of >10,000µS/cm. Clearly conditions to form a sustaining population (spawning, recruitment or survivorship) after recolonisation have not been met, with the general persistence of this key refuge marginal.

Progressive and major water level decline at Pine Hutt Rd, North Rhine River:
Autumn 2007, 2008 & 2009 sequentially from top to bottom

Reach 5 – Marne Gorge

The Marne Gorge site represents a key measure of population resilience in the upstream catchment (relies on flows and fish from upstream). For example local extinction was noted in 2004, with subsequent recolonisation by juvenile (40-65 mm) and adult (>65mm) mountain galaxias detected the following autumn (Appendix 2, Figure 4.1.3). With respect to the current reporting period no fish were recorded in 2007, however this may be due to inefficient sampling (great water depth and extent) following the onset of seasonal flow conditions prior to sampling. In autumn 2008 a pulse of juvenile fish (0+) and potentially some 1+ adult fish were recorded, with a progression to a matching population the following spring (i.e. no major recruitment noted: Figure 4.1.3). By autumn 2009 local extinction was again evident and hence local conditions for survival were poor, including a concentrated and shallow refuge pool with very high salinity (>25,000µS: Appendix 2). Subsequent sampling will indicate the general condition and resilience of the upstream population.

Condition of Marne Gorge monitoring site in autumn 2009

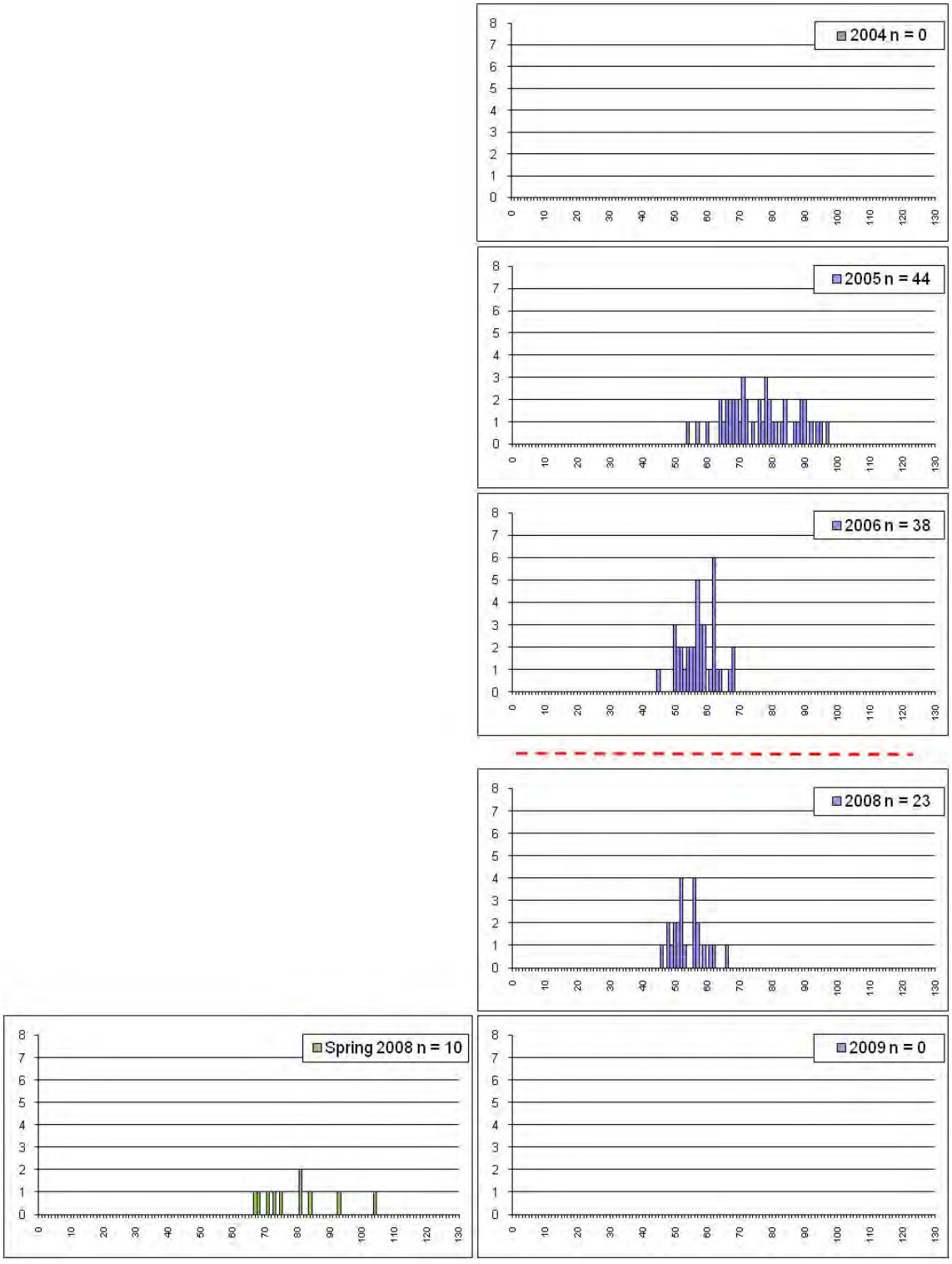


Figure 4.1.3. Length frequency data for mountain galaxias at the Marne Gorge 2004-2009. Note no fish were sampled in autumn 2007 but this may have been due to the onset of seasonal flows prior to sampling limiting catches, therefore data is not included.

Reach 8 – Black Hill Springs

Flow objectives for the Black Hill Springs reach relate primarily to the presence and viability of river blackfish, as well as the general condition of a diverse groundwater dependent fish community (i.e. the presence of other native fish and conversely the absence or low abundance of exotic fishes).

The localised population of river blackfish remains present, however there has been no indication of recruitment for at least five years. The general size of fish at the site has shown a gradual increase over 2002-2009, to now be all >200mm TL (Figure 4.1.4). Captures and *in situ* observations of fish have also been declining over the period (Appendix 2). A gravid female was recorded in Spring 2008 suggesting that some fish at least are displaying spawning activity, but that there is some ongoing failure of spawning or juvenile survival impacting recruitment. Observations on the general health condition of adult blackfish in autumn 2009 show signs of stress for several individuals, probably relating to deteriorating environmental conditions at the site.

Environmental conditions at the site remain relatively stable with respect to low permanent base flow, cool year round temperatures and moderate salinity (~5000µS/cm: Appendix 2). However, a change in the last two years involves the visible stratification of pools, and the development of a milky layer on the lower third to half of pools which on one occasion had low pH (~5.0) and always has a very low dissolved oxygen level (<1.0ppm). This eliminates a large area of habitat for fishes, including prime food forging areas for blackfish.

The ongoing presence of other native fish has been confirmed in the reporting period (main sampling in autumn 2008) including low numbers of Murray-Darling carp gudgeon, dwarf flathead gudgeon, and mountain galaxias. Only large adult mountain galaxias (>100mm) were observed in the last three years. No carp have been observed in recent years, and Gambusia numbers remain relatively low and stable (Appendix 2).

While precarious, water flow and fish remain present at the site, with the importance of spring flow further highlighted by the extended dry period being experienced. The ongoing lack of recruitment of river blackfish combined with recent habitat changes suggests that interim measures may need to be taken immediately to secure the population (e.g. wild egg harvest for rearing if this occurs, fish rescue and captive breeding). There is an urgent need to address the cause of the poor water quality in the lower half of pools.

Black Hills Spring site in 2007 including foraging adult river blackfish (top) and lower underwater view in 2009 of a dense white cloud in the lower 1/3 of the pool

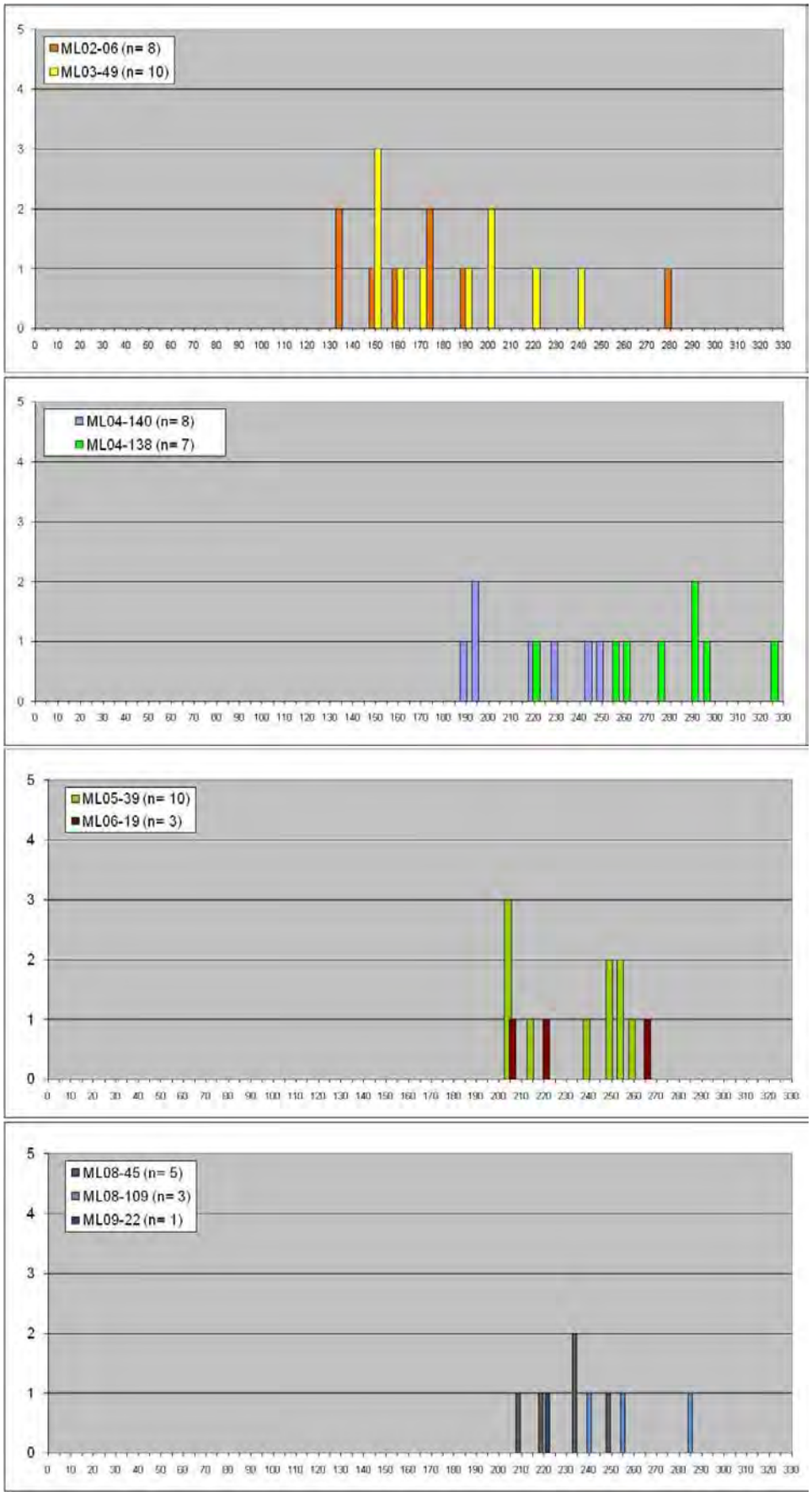


Figure 4.1.4. Length frequency data for river blackfish from Black Hill Springs during autumn 2002-2009. Only visual observations were made in autumn 2007.

Reach 9 – Marne under Murray influence (terminal wetland)

The Marne River terminates at its junction with the River Murray near Wongulla. The Marne Catchment environmental objectives for fish relate to the input of water to create a variable wetland capable of supporting a diverse fish community including diadromous and rare species. Flow from the Marne has not reached the terminal wetland for about a decade, and the wider poor condition of the Lower Murray resulted in the terminal wetland drying in 2007. Subsequent monitoring has observed the site in a dry state, being isolated from the river by a height of >1.0m (Appendix 2). Hence currently wetland species are excluded from the Marne catchment, and environmental objectives cannot be assessed until water again occurs.

Marne Mouth terminal wetland autumn 2008

Overall performance report

In 2006 there was an increasing trend of positive results for fish indicators relating to presence, population extent, recolonisation, recruitment or survivorship in stream reaches upstream of Black Hill Springs (Hammer 2007a). This trend has reversed considerably in the subsequent three years, for the catchment to overall be in poor to very poor condition. This is summarised in annual report cards (Tables 4.1.5-4.1.7).

Table 4.1.5. 2007 report card for Marne River Environmental Water Requirements – a summary of performance against fish indicators assessed with field data. Blank indicators were not assessed or not relevant in 2007. For exotic species ticks indicate the desirable result was observed (i.e. not detected, low abundance or invasion was not detected) and crosses indicate a negative result (i.e. present, abundance had not been suppressed or invasions occurred). *Recolonisation = invasion for exotic species. Yellow highlight show changes from the last assessment.

Asset	***Environmental Objective***	***Indicator***							
		Presence	Population extent	Recolonisation*	Recruitment	Survivorship	Spawning/larvae	Movement/habitat	Low exotic abundance
Reach 2 – Upper Marne pool/riffle channel									
Mountain galaxias (upper reach)	• Maintain or Restore a self-sustaining population.	✓	✓		✗	✓			
Mountain galaxias (lower reach)	• Maintain or Restore a self-sustaining population.	✓	✓		✓	✓			
Exotic species	• Discourage colonisation and establishment.	✓		✓					
Reach 4 – North Rhine main channel									
Mountain galaxias (longer term objective)	• Restore self-sustaining population.	✗	✗	✗	✗	✗			
Reach 5 – Marne Gorge									
Mountain galaxias	• Maintain or Restore a self-sustaining population.								
Exotic species	• Discourage colonisation and establishment.								
Reach 8 – Lower Marne under spring influence									
River Blackfish	• Maintain a self-sustaining population.	✓			✗	✓			
	• Restore a self-sustaining population (to springs in Reach that have dried).	✗		✗					
Lower Marne fish community	• Maintain diversity, demographics and composition of native fish community.	✓			✓	✓			
Exotic species	• Suppress exotics.	✗							✓
Reach 9 – Marne under Murray influence									
Lower Marne/Murray backwater fish community	• Maintain diversity and composition of fish community.								
	• Restore community of diadromous and rare species.								
Exotic species	• Discourage colonisation and establishment.								

Table 4.1.6. 2008 report card for Marne River Environmental Water Requirements – a summary of performance against fish indicators assessed with field data. Blank indicators were not assessed or not relevant in 2008. For exotic species ticks indicate the desirable result was observed (i.e. not detected, low abundance or invasion was not detected) and crosses indicate a negative result (i.e. present, abundance had not been suppressed or invasions occurred). *Recolonisation = invasion for exotic species. N = neutral performance. Yellow highlight show changes from the last assessment.

Asset	***Environmental Objective***	***Indicator***							
		Presence	Population extent	Recolonisation*	Recruitment	Survivorship	Spawning/larvae	Movement/habitat	Low exotic abundance
Reach 2 – Upper Marne pool/riffle channel									
Mountain galaxias (upper reach)	• Maintain or Restore a self-sustaining population.	✗	✗	✓	✗	✗	✓		
Mountain galaxias (lower reach)	• Maintain or Restore a self-sustaining population.	✗		✓	✗	✗	✓		
Exotic species	• Discourage colonisation and establishment.	✓		✓					
Reach 4 – North Rhine main channel									
Mountain galaxias (longer term objective)	• Restore self-sustaining population.	✗	✗	✗	✗	✗			
Reach 5 – Marne Gorge									
Mountain galaxias	• Maintain or Restore a self-sustaining population.	✓	✓		✓	✓			
Exotic species	• Discourage colonisation and establishment.	✓		✓					
Reach 8 – Lower Marne under spring influence									
River Blackfish	• Maintain a self-sustaining population.	✓			✗	✓			
	• Restore a self-sustaining population (to springs in Reach that have dried).	✗		✗					
Lower Marne fish community	• Maintain diversity, demographics and composition of native fish community.	✓			✗	✓			
Exotic species	• Suppress exotics.	✗							✓
Reach 9 – Marne under Murray influence									
Lower Marne/Murray backwater fish community	• Maintain diversity and composition of fish community.	✗		✗	✗	✗			✓
	• Restore community of diadromous and rare species.	✗		✗		✗			
Exotic species	• Discourage colonisation and establishment.	✓							

Table 4.1.7. 2009 report card for Marne River Environmental Water Requirements – a summary of performance against fish indicators assessed with field data. Blank indicators were not assessed or not relevant in 2009. For exotic species ticks indicate the desirable result was observed (i.e. not detected, low abundance or invasion was not detected) and crosses indicate a negative result (i.e. present, abundance had not been suppressed or invasions occurred). *Recolonisation = invasion for exotic species. N = neutral performance. Yellow highlight show changes from the last assessment.

Asset	***Environmental Objective***	***Indicator***							
		Presence	Population extent	Recolonisation*	Recruitment	Survivorship	Spawning/larvae	Movement/habitat	Low exotic abundance
Reach 2 – Upper Marne pool/riffle channel									
Mountain galaxias (upper reach)	• Maintain or Restore a self-sustaining population.	✗	✗	✗	✗	✗	✗		
Mountain galaxias (lower reach)	• Maintain or Restore a self-sustaining population.	✗	✓	✓	✗	✗	✓		
Exotic species	• Discourage colonisation and establishment.	✓		✓					
Reach 4 – North Rhine main channel									
Mountain galaxias (longer term objective)	• Restore self-sustaining population.	✗	✗	✗	✗	✗			
Reach 5 – Marne Gorge									
Mountain galaxias	• Maintain or Restore a self-sustaining population.	✗		✗	✗	✗			
Exotic species	• Discourage colonisation and establishment.	✓		✓					
Reach 8 – Lower Marne under spring influence									
River Blackfish	• Maintain a self-sustaining population.	✓			✗	✗			
	• Restore a self-sustaining population (to springs in Reach that have dried).	✗		✗					
Lower Marne fish community	• Maintain diversity, demographics and composition of native fish community.	✓			✗	✓			
Exotic species	• Suppress exotics.	✗							✓
Reach 9 – Marne under Murray influence									
Lower Marne/Murray backwater fish community	• Maintain diversity and composition of fish community.	✗		✗	✗	✗			✓
	• Restore community of diadromous and rare species.	✗		✗		✗			
Exotic species	• Discourage colonisation and establishment.	✓							

4.2 Saunders Creek Catchment

The Saunders Creek Catchment is of moderate size (222km^2), being a narrow, long area stretching from near Springton through to the River Murray north east of Mannum. Only a small section of the catchment extends into higher elevations and hence rainfall is low and irregular across most of the catchment (and even here there appears to be a significant rain shadow effect). Its headwaters comprise two small tributary streams that flow in a northerly direction, before both turn to the east. They join just before a steep rocky gorge. From below the gorge, the Saunders Creek is an ephemeral channel that meanders in a roughly south easterly direction until reaching a small section of spring fed, permanent pools lined with red gum and *Phragmites* in the region of Lenger Reserve (~5km upstream from the River Murray). Below here, the channel is once again ephemeral and shallow, with no real wetland area where the Creek joins the Murray. There is little permanent stream habitat in the catchment today, with only a few pools upstream of and in the Saunders Gorge, and the small string of pools near Lenger Reserve (Fig. 4.2.1). Stock access is common, however, significant sections of the Catchment where water occurs have been fenced or have no stock (e.g. Saunders Gorge Sanctuary and some areas upstream from here; Lenger Reserve and upstream pools). Instream habitat values are low, with generally ~20-30% submerged physical cover (rock, snags), no submerged aquatic vegetation (with the exception of *Chara* recorded from a small spring on Kinappa Creek, a small gully near Saunders Gorge) and only small amounts of submerged *Typha* or *Phragmites* at a few sites. Autumn water conductivity values are moderate to high (e.g. 5780-10,030µS in 2004).

Six provisional reaches are defined in the Saunders Catchment (Fig. 4.2.1).

Fish related ecological assets are identified in Hammer (2004), and shown in Table 4.2.1. Only a single native fish, Murray-Darling carp gudgeon, was recorded in the catchment, restricted to the small section of permanent pools at or above Lenger Reserve (Lowland Reach 5).

Environmental objectives, water requirements and monitoring recommendations are shown in Tables 4.2.1 & 4.2.2, and these match fish related ecological assets identified in the Saunders Creek Catchment to the relevant EWR tables of Section 2.3.

Monitoring of this catchment is periodical, occurring in 2009 at two sites in Reach 5 and as opportunistic checks for native species in the upper catchment (Appendix 3).

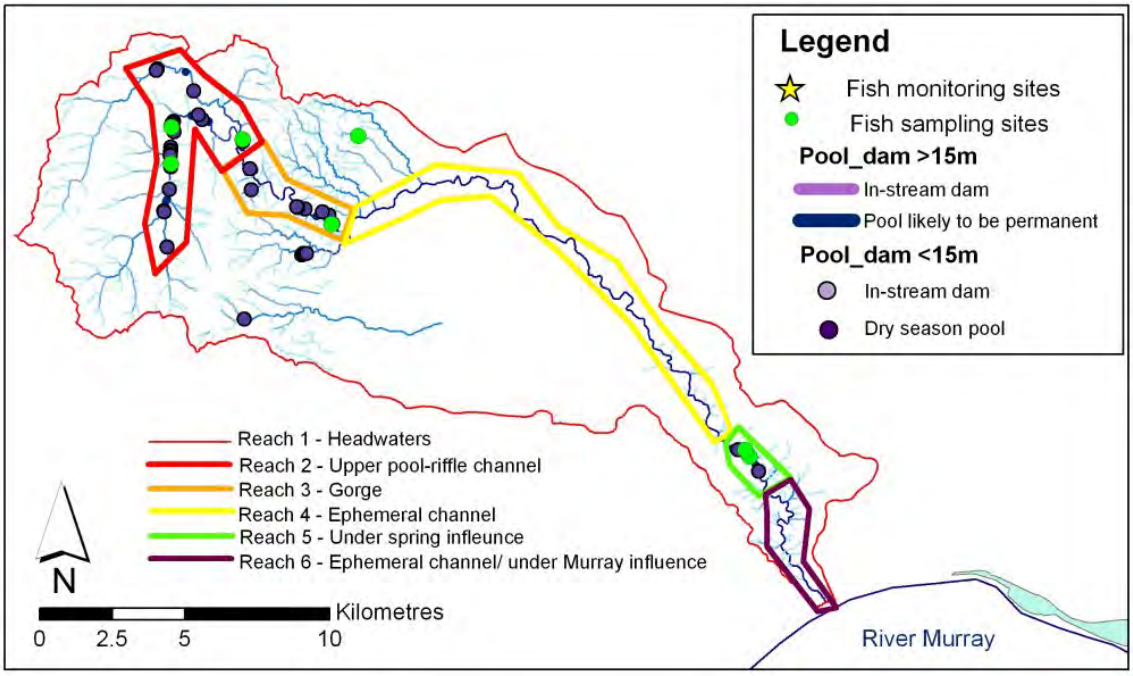


Figure 4.2.1. Map of the Saunders Creek Catchment showing provisional river reaches.

Table 4.2.1. Distribution patterns and significant environmental assets in the Saunders Creek Catchment relating to fish species and communities (plus opportunistic data for other biota).

Specific asset/pattern	**Location**	**EWR table**
1) Isolated population of carp gudgeon	• Reach 5	2.3.4 & 2.3.6
2) No permanent populations present due to lack of summer refuge, isolation and water quality (but mountain galaxias may have been present historically)	• Reach 2, 3	NA (potentially 2.3.1)
3) No permanent fish communities due to lack of permanent water	• Reaches 1 and 4, and possibly Reach 6	NA
4) Diverse terminal wetland fish community potentially present	• Reach 6	2.3.8
5) Freshwater shrimp (*Paratya*) 6) Charophytes	• Reaches 2, 3, 5 • Reach 2 (Kinappa Creek)	

Table 4.2.2. Summary of environmental objectives by reach for fish related ecological assets in the Saunders Creek Catchment.

Asset	***Environmental Objective***
Reach 1 Saunders Creek headwaters and minor tributaries	
NA	
Reach 2 – Upper Saunders pool/riffle channel (potentially EWR Table 2.3.1)	
NA	
Reach 3 – Saunders Gorge (potentially EWR Table 2.3.1)	
NA	
Reach 4 – Ephemeral channel	
NA	
Reach 5 – Lower Saunders under spring influence (EWR Tables 2.3.4 & 2.3.6)	
Isolated population of carp gudgeon	• Maintain a self-sustaining population
Reach 6 – Saunders under Murray influence (potentially EWR Table 2.3.8)	
Lower Saunders/Murray backwater fish community (if present)	• Restore diversity and composition of fish community

Reach 5 – Lower Saunders under spring influence

The condition of the carp gudgeon population seemed reasonable in 2004 with high abundances and juveniles detected, although salinity was high. An alien species (Gambusia) was in high abundance in 2004 (Appendix 3).

Sampling in autumn 2009 indicated a low abundance (n = 20) of carp gudgeon, with no sign of recent recruitment (all fish >40mm). Gambusia remained very common (observations of mixed sizes including juveniles) and a single adult carp (480mm TL) was recorded.

Environmental conditions point to salinity as a continuing threat to the gudgeon population, with a value of 11,580µS/cm in autumn 2009 around 50% higher than in 2001 and 2004 (Appendix 3). The site containing gudgeon was low and concentrated also in contrast to previous monitoring.

Overall the reach is in poor condition with obvious signs of stress from a dry climatic period (Table 4.2.3).

Table 4.2.3. 2009 report card for Saunders Creek Environmental Water Requirements – a summary of performance against fish indicators assessed with field data. Blank indicators were not assessed or not relevant in 2009. For exotic species ticks indicate the desirable result was observed (i.e. not detected, low abundance or invasion was not detected) and crosses indicate a negative result (i.e. present, abundance had not been suppressed or invasions occurred). *Recolonisation = invasion for exotic species.

Asset	***Environmental Objective***	***Indicator***							
		Presence	Population extent	Recolonisation*	Recruitment	Survivorship	Spawning/larvae	Movement/habitat	Low exotic abundance
Reach 5 – Lower Saunders under spring influence									
Carp gudgeon	• Maintain a self-sustaining population.	✓	✗		✗	✓			
Exotic species	• Discourage colonisation and establishment.	✗	✗		✗	✗			

4.3 Reedy Creek Catchment

The Reedy Creek catchment is a large, complex catchment (314km^2), reasonably elevated in its upper half which experiences moderate rainfall. Two main sub-catchments drain this upper section: Dairy/Baker Creek and Harrison Creek with an area stretching between Mount Torrens, Tungkillo and the Mt Pleasant-Sedan Road. These drainage networks transcend through very steep rocky sections (numerous natural rock barriers and waterfalls) as they converge towards a point above the Palmer to Mannum Road. Below the junction Reedy Creek is a lowland stream containing interspersed pools (the small Loxton/Gorge Creek sub catchment joins the main channel in this section), before reaching the Mannum waterfalls. Below the Murray Bridge to Mannum Road crossing, the channel enters an extensive shallow wetland with an opening to the River Murray near Caloote. Stream habitats are highly variable based on the distinct catchment sections. The section above Palmer has a general lack of large and deep permanent pools (long term refuges). There were some springs, but most pools have highly variable water levels, with significant contraction over summer. Spring feeding is apparent in a small section below Palmer. Stock access to watercourses is common in the catchment, with fenced areas highly contrasting to elsewhere (e.g. thick and diverse riparian vegetation on Bryce Creek).

Eight provisional reaches have been defined in the Reedy Creek Catchment (Fig. 4.3.1).

Fish related assets identified by Hammer (2004), and supplementary information by Smith (2006) for the lower catchment wetland, are shown in Tables 4.3.1 & 4.3.2. These include an isolated population of dwarf flathead gudgeon above the Mannum waterfalls (Reaches 5 & 6) and other native fish communities, including estuarine and diadromous in lower reaches (Reaches 7 & 8). Monitoring of the isolated population of dwarf flathead gudgeon in spring 2008 identified mountain galaxias in the catchment for the first time, an important new asset for consideration (additional targeted sampling identified them in Reach 4 & 5).

Environmental objectives, water requirements and monitoring recommendations are shown in Tables 4.3.1 & 4.3.2, and these match fish related ecological assets identified in the Reedy Creek Catchment to the relevant EWR tables of Section 2.3.

Autumn 2008, spring 2008 and autumn 2009 data was collected for all reaches of this catchment (Appendix 4).

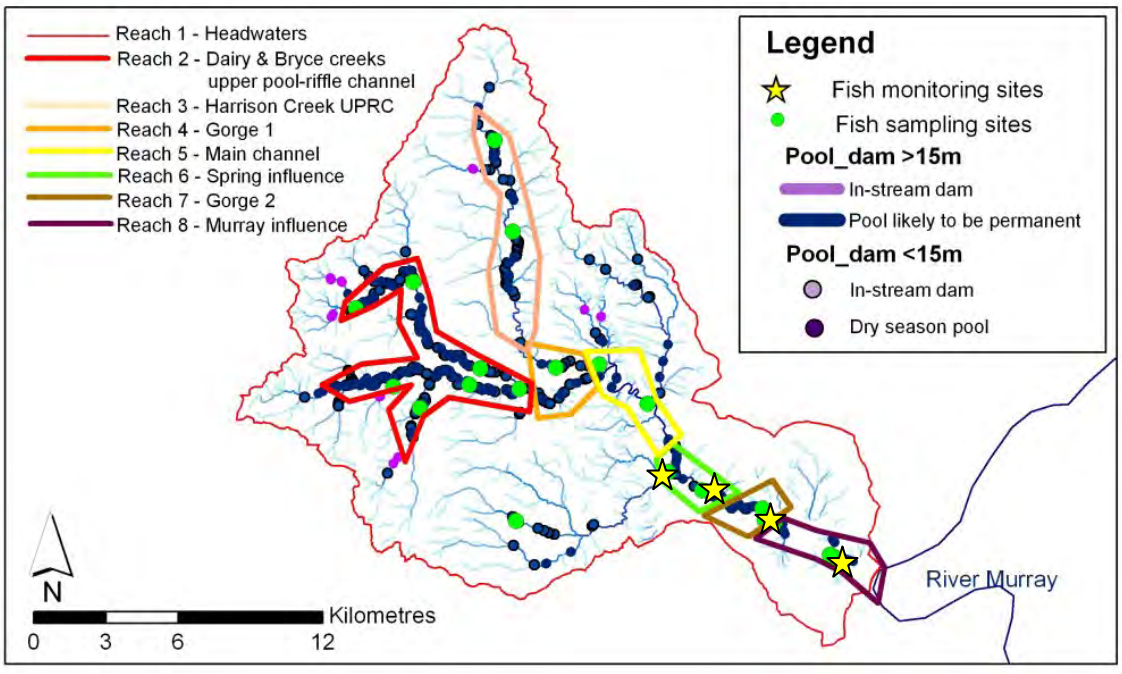


Figure 4.3.1. Map of the Reedy Creek Catchment showing provisional river reaches.

Table 4.3.1. Distribution patterns and significant environmental assets in the Reedy Creek Catchment relating to fish species and communities (plus opportunistic data for other biota).

Specific asset/pattern	Location	EWR Table
1) Isolated population of mountain galaxias	• Reaches 4 & 5	2.3.1
2) Isolated population of dwarf flathead gudgeon	• Reaches 5 & 6	2.3.4 & 2.3.6
3) Diadromous fish species	• Reaches 7 & 8	2.3.5, 2.3.7 & 2.3.8
4) No permanent populations present due to lack of summer refuge, natural isolation and water quality (but mountain galaxias may have occurred historically)	• Reaches 2, 3	Potentially 2.3.1
5) No permanent fish communities due to lack of permanent water	• Reach 1	NA
6) Lower Reedy diverse fish community	• Reaches 7 & 8	2.3.4, 2.3.7 & 2.3.8
7) Freshwater shrimp (*Paratya*) 8) River shrimp (*Macrobrachium*) 9) Charophytes	• Reaches 2, 3, 5 • Reaches 6, 7, 8 • Reach 6	

Table 4.3.2. Summary of environmental objectives by reach for fish related ecological assets in the Reedy Creek Catchment.

Asset	***Environmental Objective***
Reach 1 –headwaters	
NA	
Reach 2 & 3 – **Dairy, Bryce & Harrison creeks upper pool/riffle channel** (potentially EWR Table 2.3.1)	
NA	
Reach 4 – Gorge 1 (EWR Table 2.3.1)	
Core refuge of isolated population of Mountain galaxias	• Maintain self-sustaining population • Restore a self-sustaining population (to pools in Reach that have dried out
Isolated population of dwarf flathead gudgeon	• Maintain self-sustaining population • Restore a self-sustaining population (to pools in Reach that have dried out
Reach 5 – Reedy Creek mid channel (EWR Table 2.3.1, 2.3.4)	
Isolated population of dwarf flathead gudgeon	• Maintain self-sustaining population • Restore a self-sustaining population (to pools in Reach that have dried out
Isolated population of mountain galaxias	• Restore a self-sustaining population (improve from periodic presence)
Reach 6 – Mid channel under spring influence (EWR Tables 2.3.4 & 2.3.6)	
Isolated population of dwarf flathead gudgeon	• Maintain a self-sustaining population
Reach 7 – Gorge 2 & lowland channel (EWR Tables 2.3.4 & 2.3.7)	
Diverse fish community of gudgeon species (*Philypnodon* spp. and *Hypseleotris* spp.) and diadromous common galaxias	• Maintain diversity, demographics and composition of fish community
Reach 8 – Reedy Creek terminal wetland (EWR Tables 2.3.5 & 2.3.8)	
Lower Reedy/Murray backwater fish community including diadromous species (common galaxias) and isolated populations of estuarine species (smallmouthed hardyhead and western bluespot goby*)	• Maintain diversity and composition of fish community • Maintain community of diadromous/rare estuarine species.

* Estuarine species are rare outside the Lower Lakes being recorded only at a handful of sites along the lower River Murray

Reaches 2 and 3 – upland tributaries

No native fish were recorded in these upland tributaries in 2004, however mountain galaxias were likely present historically. Opportunistic checks for native species presence were made in spring 2008 (Dairy Creek and Talbot Creek), with no fish recorded (Appendix 3).

Reach 4 – Gorge 1

This reach was sampled in 2004, and although there were permanent pools, no fish were located. The discovery of juvenile mountain galaxias in the downstream reach in spring 2008 led to more detailed investigation in Reach 4, and subsequently (later in spring 2008) documented mountain galaxias from several pools in Reedy Creek proper and Baker Creek (southern branch) and dwarf flathead gudgeon from Baker Creek. Sampling in autumn 2009 saw a dramatic decline in surface water from strings of pools to singular pools on both arms of the reach. There was a matching contraction in range extent of both species to a single pool on Baker Creek (likely the key refuge for mountain galaxias in the catchment). As in 2004 large pools in Reedy Creek were apparently absent of fish. This highlights both the importance of the Baker Creek refuge habitat and the value of temporally replicated survey effort.

The first year of demographic data for this reach offers some insight into population processes. For mountain galaxias spring 08 data indicates strong spawning, however this translated to only low recruitment (40-65mm TL 0+ fish) in the autumn 2009 sample. Both spring and autumn data indicate reasonable survivorship of fish from larger size classes (>70mm or≥1+) (Fig. 4.3.2), and fish were in excellent condition in autumn (see images below). The life-history of dwarf flathead gudgeon is poorly known, and hence interpretation of a single annual snapshot is difficult. Nevertheless, they are likely to spawn in late spring to summer (low flow recruitment) and require interpretation of population processes in a different (seasonally opposite) pattern to mountain galaxias. The presence in spring 2008 of a basic bimodal peak at 40mm TL suggests strong recruitment and/or survivorship from previous breeding, and the presence of smaller fish <30mm in autumn 2009 suggest successful spawning and larger fish >45mm moderate survivorship (Figure 4.3.3). Salinity in this reach was moderate to high (i.e.≥8000µS) in spr ing and autumn (Appendix 4).

Given the importance of mountain galaxias as a flow indicator and key ecological asset in the catchment, a strong focus on temporal monitoring and further range mapping is recommended.

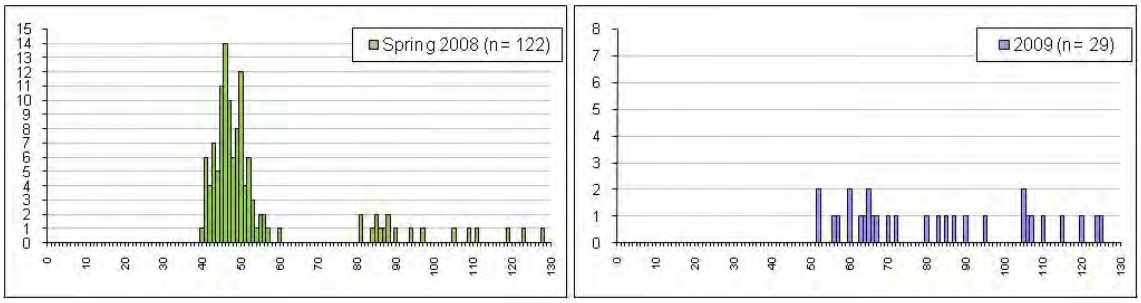


Figure 4.3.2. Length frequency data for mountain galaxias at Reedy Creek Gorge 1 2008-2009.

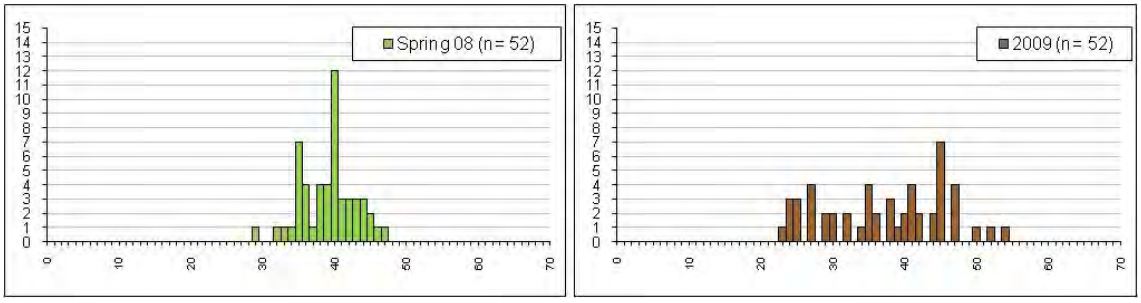


Figure 4.3.3. Length frequency data for dwarf flathead gudgeon at Reedy Creek Gorge 2008-2009.

Well conditioned mountain galaxias from Baker Creek refuge pool (autumn 2009)

Refuge pool on Baker Creek (autumn 2009)

Example of the dramatic contraction of surface water in Baker Creek between December 2008 and April 2009

Reach 5 – mid pool-riffle channel (no springs)

The mid-pool riffle stream between the two gorges on Reedy Creek contains a low gradient section with two reaches, differentiated by the presence or absence of spring discharge. Reach 5 has no spring input and so fluctuates widely in different seasons, representing an important area to test the resilience or survivorship of populations. Mountain galaxias juveniles were recorded in spring 2008 (Fig. 4.3.4) but not in autumn of 2008 or 2009 (nor 2004). It is likely the presence in the reach is currently based on immigrants from upstream spawning, which failed to recruit or survive in this reach under the conditions of the 2007 and 2008 flow seasons. Salinity was moderate in spring 2008 when mountain galaxias were recorded (9900µS) but consistently extremely high (>30,000µS) in autumn (Appendix 4). Again more information on life history is required to interpret demographic data for dwarf flathead gudgeon, but there were similar, if less obvious patterns as at this site that seen in Baker Creek –recruitment indicated by good representation of 25-40mm TL fish is spring, and moderate spawning indicated by a pulses of <25mm in autumn 2009. The additional insight of autumn 2008 supports this pattern, and suggest strong spawning in spring/summer 2007 (Fig. 4.3.5).

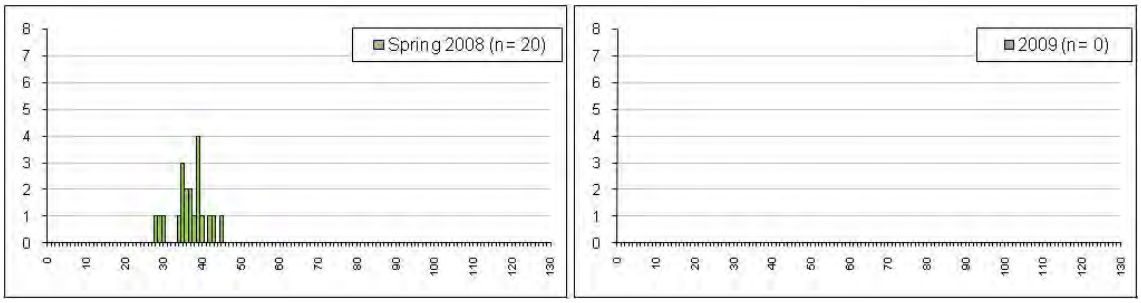


Figure 4.3.4. Length frequency data for mountain galaxias at Palmer Rd, Reedy mid pool-channel 2008-2009.

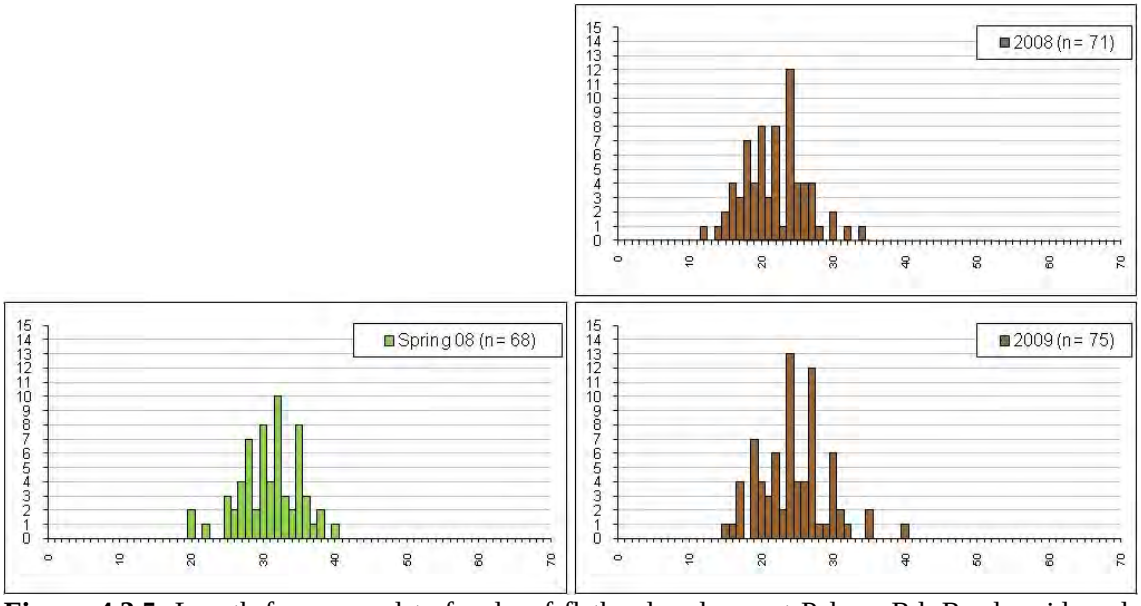


Figure 4.3.5. Length frequency data for dwarf flathead gudgeon at Palmer Rd, Reedy mid pool-channel 2008-2009.

Reach 6 – mid pool-riffle channel (springs)

Only basic monitoring occurred in this reach, with resources focused on upstream reaches. Data indicates the ongoing presence of dwarf flathead gudgeon (autumn 2009) and consistent moderate-high salinity (~15,000µS) and dense charophytes (Appendix 4).

Reach 7 – Gorge 2 and lowland channel

The second major gorge in the Reedy Creek catchment occurs near its junction with the Murray at the Mannum waterfalls. The gorge itself is steep and difficult to sample but is integrated with a small section of lowland stream before reaching the terminal wetland. The ecological assets of this reach are a diverse lowland fish community including gudgeons and the diadromous common galaxias. Sampling data for this reach covers the autumn of 2001, 2004, 2008 and 2009, plus an additional spring 2008 sample.

The diversity and abundance of native fish has steadily declined over the last eight years, cumulating in autumn 2009 when only 25 flathead gudgeon were recorded. Common galaxias have not utilised the area in the same abundance since 2001 (only four fish seen in 2008), smelt have not been recorded since 2001 and carp gudgeons have declined. Flathead gudgeon did remain in similar abundance until autumn 2009 (Appendix 4). The decline can be attributed to the general contraction of available habitat from poor stream flow, associated deterioration in water quality (i.e. steady increase in salinity by 300% since 2001 to >21,000µS in 2009), and much reduced connectivity with the River Murray through poor Reedy Creek flow and desiccation of the terminal wetland (Appendix 4).

Main monitoring pool at Waterfalls Reserve, highly concentrated in autumn 2009

Reach 8 – terminal wetland (under Murray influence)

Environmental objectives for the reach relate to the input of water to create a variable wetland capable of supporting a diverse fish community including diadromous, euryhaline and rare species. Flow from Reedy Creek has been episodic in recent years, and the wider low level of the Lower Murray resulted in the terminal wetland drying in 2007. Subsequent monitoring has observed the site to be mostly dry, being isolated from the river by a height of >1.0m (Appendix 4). Hence wetland species are currently excluded from the catchment, and environmental objectives cannot be assessed until water again occurs.

Overall performance report

A summary report for the Reedy Creek Catchment is detailed in Table 4.3.3. The mid-catchment is in moderate condition, but key indicator failures for mountain galaxias act as warning signs of potential decline. The lower catchment is in a poor state.

Table 4.3.3. 2009 report card for Reedy Creek Environmental Water Requirements – a summary of performance against fish indicators assessed with field data. Blank indicators were not assessed or not relevant in 2009. For exotic species ticks indicate the desirable result was observed (i.e. not detected, low abundance or invasion was not detected) and crosses indicate a negative result (i.e. present, abundance had not been suppressed or invasions occurred). *Recolonisation = invasion for exotic species.

Asset	***Environmental Objective***	***Indicator***							
		Presence	Population extent	Recolonisation*	Recruitment	Survivorship	Spawning/larvae	Movement/habitat	Low exotic abundance
Reach 4 – Gorge 1									
Mountain galaxias	• Maintain or Restore a self-sustaining population.	✓	✗	✓	✗	✓	✓		
Dwarf flathead gudgeon	• Maintain or Restore a self-sustaining population.	✓	✗	✗	✓	✓	✓		
Exotic species	• Discourage colonisation and establishment.	✓							✓
Reach 5 – Reedy Creek mid channel (no springs)									
Mountain galaxias	• Maintain or Restore a self-sustaining population.	✗		✓	✗	✗	✗		
Dwarf flathead gudgeon	• Maintain or Restore a self-sustaining population.	✓	✓		✓	✓			
Exotic species	• Discourage colonisation and establishment.	✗							✓
Reach 6 – Reedy Creek mid channel (with springs)									
Dwarf flathead gudgeon	• Maintain or Restore a self-sustaining population.	✓							
Exotic species	• Discourage colonisation and establishment.	✗							✓
Reach 7 – Gorge 2 and lowland									
Lower Reedy fish community	• Maintain diversity, of native fish community.	✗	✗	✗	✗	✗			
Exotic species	• Suppress exotics.	✗							✓
Reach 9 – Reedy under Murray influence									
Lower Reedy Creek fish community	• Maintain diversity and composition of fish community.	✗		✗	✗	✗			
	• Maintain diversity of diadromous and rare species.	✗		✗	✗	✗			
Exotic species	• Discourage colonisation and establishment.	✓							✓

4.4 Salt, Preamimma and Rocky Gully creeks

The Salt Creek Catchment is a medium size catchment (199km2) at the extremities of the Mount Lofty Ranges (small spit of the Range on the eastern edge of the Bremer Valley). As a consequence it has low topography and low, highly variable rainfall. Much of the catchment comprises plains, with only a small defined section of elevation and hydrological organisation in the upper sections stretching from near Bondleigh to Tepko (i.e. Salt Creek and Long, Mitchell, Gum and Flag gullies). From below the Murray Bridge to Wellington Road the main ephemeral channel is shallow and poorly defined. Stream habitat is restricted to irregular pools along defined channels and given the dry, warm landscape, permanent pools are clearly maintained by vertical connectivity to groundwater sources. While there is not a great number of permanent pools (as of 2004), it is surprising to note some are quite large and up to 1.5m deep (e.g. Round Waterhole), serving as drought refuges. Several core refuges are fenced, otherwise stock access is common along watercourses in the catchment. Water conductivities are very high (as the creek name suggest) – 15,000-30,000µS. Rocky Gully and Preamimma creeks are almost devoid of pool habitat, with some minor spring soakage in mid-upper catchment areas, plus wetlands and some pools in the lower terminal ends of catchments under Murray influence.

Five provisional reaches have been defined for the grouped Salt, Preamimma and Rocky Gully creek catchments (Fig. 4.4.1).

A recent scarcity of water, high salinity and general isolation meant that few fish related ecological assets were identified by Hammer (2004), however Smith (2006) and Hammer (unpublished) identified important species and native fish communities in terminal wetland areas of the Rocky Gully and Salt/Preamimma stream channels. Assets include a diverse native fish community including isolated population of Murray hardyhead, freshwater catfish juveniles, isolated populations of estuarine species, and diadromous species (Tables 4.4.1 & 4.4.2).

Environmental objectives, water requirements and monitoring recommendations are shown in Tables 4.4.1 & 4.4.2, and these match fish related ecological assets identified to the relevant EWR tables of Section 2.3.

Recent sampling focused on Rocky Gully Creek wetland (Appendix 5).

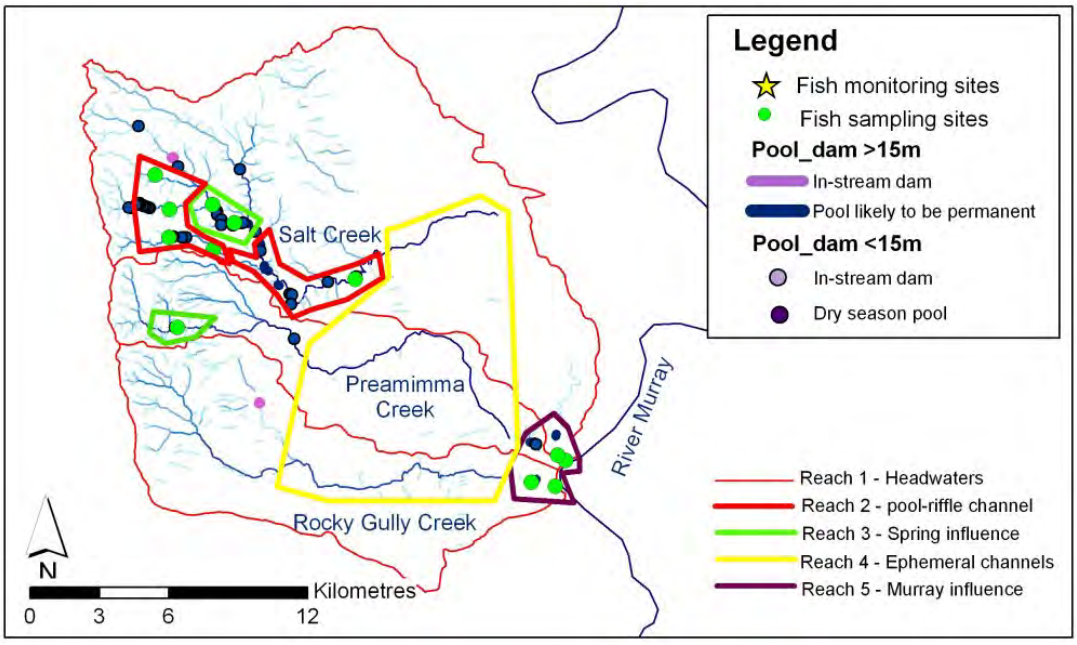


Figure 4.4.1. Map of the Salt, Preamimma and Rocky Gully creek catchments showing provisional river reaches.

Table 4.4.1. Distribution patterns and significant environmental assets in Salt, Preamimma and Rocky Gully creek catchments relating to fish species and communities (plus opportunistic data for other biota).

Specific asset/pattern	Location	EWR Table
1) Isolated population of Murray hardyhead (Rocky Gully Creek terminal wetland)	• Reach 5	2.3.8 (spatial variation in salinity compared to other Murray wetlands)
2) Lower Rocky Gully Creek diverse fish community including juveniles of threatened freshwater catfish and rare estuarine species	• Reach 5	2.3.8
3) Diadromous fish species in lower Rocky Gully Creek	• Reach 5	2.3.5 & 2.3.8
4) Native fish present (flathead gudgeon) in pools on lower Salt/Preamimma creeks	• Reach 5	2.3.4 & 2.3.8
5) No permanent populations present due to lack of summer refuge, natural isolation and/or water quality	• Reaches 2, 3 & 4	NA
6) No permanent fish communities due to lack of permanent water	• Reach 1	NA
7) Freshwater shrimp (*Paratya*) – Salt Creek 8) Charophytes – Salt Creek	• Reach 3 • Reaches 2 & 3	

Table 4.4.2. Summary of environmental objectives by reach for fish related ecological assets in the Salt, Preamimma and Rocky Gully creek catchments.

Asset	***Environmental Objective***
Reach 1 –headwaters	
NA	
Reach 2 – Salt Creek pool/riffle channel	
NA	
Reach 3 – Under spring influence - deeper spring fed pools on Salt Creek, small section of surface baseflow on Preamimma Creek	
NA	
Reach 4 – Ephemeral main channels	
NA	
Reach 5 – Terminal wetlands under Murray Influence (EWR Tables 2.3.4, 2.3.5 & 2.3.8)	
Rocky Gully Creek/Murray backwater diverse fish community including Murray hardyhead, juvenile freshwater catfish, diadromous species (common galaxias), and isolated populations rare estuarine species (lagoon goby, western bluespot goby and smallmouthed hardyhead*)	• Maintain diversity and composition of fish community • Maintain a self-sustaining population of Murray hardyhead and spawning habitat of freshwater catfish • Maintain community of diadromous/rare estuarine species.
Population of native fish (flathead gudgeon) present (Salt/Preamimma creeks)	• Maintain a self-sustaining population

* Estuarine species are rare outside the Lower Lakes being recorded only at a handful of sites along the lower River Murray

Reach 5

Environmental objectives for the reach relate to the input of water to create a variable wetland capable of supporting a diverse fish community including threatened species, diadromous and euryhaline species. Sampling focused on Rocky Gully where both Murray hardyhead and freshwater catfish have been previously reported (sustaining populations) in the wetland and channel. Moreover, Smith (2006) reported some 16 native species in baseline surveys including isolated upstream populations of several eurhayline species.

Sampling occurred in the autumn of 2007, 2008 and 2009. Note other sampling was conducted as part of SAMDBNRMB and DEH programs but is not presented, but it matches the presented trends. The wetland retained a diverse fish community up until dramatic water level lowering from 2007 in the Lower Murray which lead to drying of the channel below the control structure and disconnecting the remaining channel and wetland from the River Murray. After disconnection (i.e. autumn 2008 and 2009 data) species diversity declined dramatically, to the point that only Murray hardyhead and smallmouthed hardyhead were recorded in autumn 2009. Salinity in the wetland increased significantly (>50,000µS) and general water quality conditions (e.g. dissolved oxygen at depth) became critical (Appendix 5). The abundance of Murray hardyhead suffered a major reduction, and a sustaining population will be tested.

Overall the reach is in poor condition with obvious signs of stress from an altered River Murray environment and connection (Table 4.4.3). Environmental improvements are needed urgently (the first steps have been recently initiated).

Rocky Gully wetland (channel) in autumn 2009 – note the signs of poor water quality

Table 4.4.3. 2009 report card for Rocky Gully Creek Environmental Water Requirements – a summary of performance against fish indicators assessed with field data. Blank indicators were not assessed or not relevant in 2009. For exotic species ticks indicate the desirable result was observed (i.e. not detected, low abundance or invasion was not detected) and crosses indicate a negative result (i.e. present, abundance had not been suppressed or invasions occurred). *Recolonisation = invasion for exotic species.

Asset	***Environmental Objective***	***Indicator***							
		Presence	Population extent	Recolonisation*	Recruitment	Survivorship	Spawning/larvae	Movement/habitat	Low exotic abundance
Reach 9 – Rocky Gully Creek wetland under Murray influence									
Off-channel/Murray fish community	• Maintain diversity and composition of fish community.	✘	✘	✘	✘	✘			
	• Maintain a self-sustaining population of Murray hardyhead	✓	✘		✘	✘			
	• Maintain community of diadromous/rare species.	✘	✘	✘	✘	✘			
	• Maintain spawning habitat of freshwater catfish.	✘	✘	✘	✘	✘			
Exotic species	• Discourage colonisation and establishment.	✘							✓

4.5 Bremer River Catchment

The Bremer is a large catchment (589km^2) and also contributes flow intermittently to a lowland channel, Mosquito Creek (Ferriss-McDonald Catchment) that branches off near Langhorne Creek. The Bremer River runs roughly north to south parallel with the base of the MLR extending from small headwaters above Harrogate, through Callington then along a lowland plain via Langhorne Creek to its junction with Lake Alexandrina. The latter sections of the River from above Langhorne Creek are today ephemeral (but historically were large spring fed pools), with a small section of permanent river channel at the junction of the Lake. Two major tributaries drain from the flank of the range east toward the Bremer River: (a) the Mt Barker Creek sub catchment that includes Mt Barker, Western Flat, Nairne and Dawesley creeks, and (b) Rodwell Creek, joining the Bremer just below Woodchester. Hence sections of the catchment are contrasting in topography, geology, rainfall and vegetation, particularly between the Mt Barker Creek sub-catchment (high rainfall, elevation and gradient, considerable urban areas) and elsewhere (more agricultural, low rainfall and topography). Stream habitats vary accordingly in the two distinct regions of the catchment, with shallower creeks in headwater areas compared to a series of deep irregular pools along the Bremer main channel. Significant pollution has occurred as a result of mining activities along-side Dawesley Creek at Brukunga and stock access is commonplace in areas that are not urbanised.

Nine provisional reaches have been defined in the Bremer River Catchment (Fig. 4.5.1).

Fish related assets identified by Hammer (2004) are shown in Tables 4.5.1 & 4.5.2. The priority asset is a highly restricted and isolated remnant population of river blackfish in Rodwell Creek (Reach 2), plus mountain galaxias populations and other diverse native fish communities including diadromous and migratory species (Reaches 2, 3, 4, 6 & 8).

Environmental objectives, water requirements and monitoring recommendations are shown in Tables 4.5.1 & 4.5.2, and these match fish related ecological assets identified in the Bremer River Catchment to the relevant EWR tables of Section 2.3.

A range of data has been collected in this catchment opportunistically, but specific long-term monitoring sites occur at Mt Barker Creek and Rodwell Creek. Several sites have been initiated as long-term sites following the 2007 review, mainly the upper catchment at Harrogate, Mt Barker Creek, the Lowland channel (gauge station) and terminal wetland (Bremer Mouth) (Appendix 6).

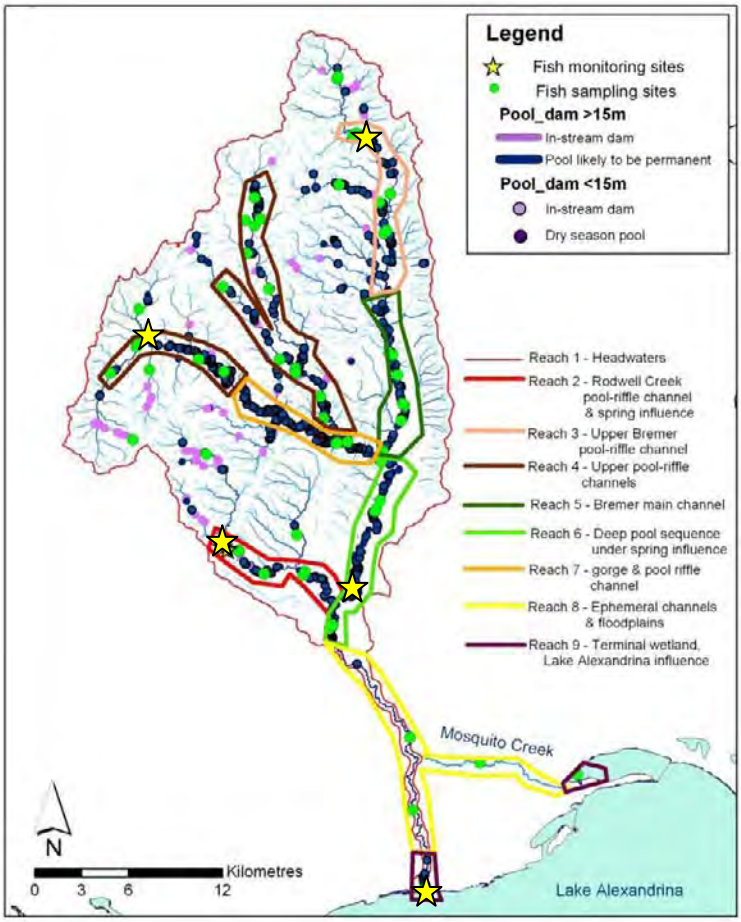


Figure 4.5.1. Map of the Bremer River Catchment showing provisional river reaches.

Table 4.5.1. Distribution patterns and significant environmental assets in the Bremer Catchment relating to fish species and communities (plus opportunistic data for other biota).

Specific asset/pattern	Location	EWR Table
1) River blackfish	• Reach 2 (local extinctions due to pools drying, historically also present throughout much of the catchment i.e. Reaches 3-8).	2.3.2 & 2.3.6
2) Mountain galaxias	• Reaches 2, 3, & 4	2.3.1
3) Carp gudgeons	• Reaches 2, 3, 5, 6 & 7	2.3.4
4) Lower Bremer diverse fish community	• Reach 6 (historically also Reach 8)	2.3.7
5) Bremer & Mosquito Creek terminal wetlands diverse fish community	• Reach 9	2.3.8
6) Presence of diadromous fish species in the Lower Bremer	• Reaches 6, 8 & 9	2.3.5
7) Presence of freshwater migratory fish species in the Lower Bremer	• Reaches 6, 8 & 9	2.3.5
8) No permanent fish communities due to lack of permanent water	• Reach 1	NA
9) Nardoo and *Ottelia*	• Reach 8	

Table 4.5.2. Summary of environmental objectives by reach for fish related ecological assets in the Bremer River Catchment.

Asset	***Environmental Objective***
Reach 1 – Bremer Catchment headwaters	
NA	
Reach 2 – Rodwell Creek pool/riffle channel under groundwater influence (EWR Tables 2.3.1, 2.3.2 , 2.3.4 & 2.3.6)	
River blackfish (upper section of reach)	• Maintain (2 existing pools) and Restore (extend range to improve security) a self-sustaining population
Mountain galaxias (upper section of reach)	• Maintain and Restore a self-sustaining population
Carp gudgeons (lower section of reach)	• Maintain a self-sustaining population
Reach 3 – Upper Bremer pool/riffle channel (EWR Tables 2.3.1 & 2.3.4)	
Mountain galaxias	• Restore a self-sustaining population (recent local extinctions with pool drying)
Carp gudgeons	• Maintain a self-sustaining population
Reach 4 – Upper pool/riffle channel - Western Flat/Mt Barker, Nairne and Dawesley creeks (EWR Table 2.3.1)	
Mountain galaxias	• Maintain or Restore a self-sustaining population (locally extinct in Dawesley Creek – mine pollution)
Reach 5 – Bremer main channel above Mt Barker Creek junction (EWR Table 2.3.4)	
Carp gudgeons	• Maintain a self-sustaining population
Reach 6 – Bremer deep pool sequence under groundwater influence below Mt Barker Creek junction (EWR Tables 2.3.5 & 2.3.7, potentially 2.3.2)	
Diverse native fish community including carp gudgeons, diadromous species (common galaxias, congolli recorded, historic records of shortfinned eel and pouched lamprey) and migratory species (Murray-Darling golden perch)	• Maintain diversity and composition of fish community • Maintain community of diadromous and migratory species
River blackfish and Murray cod (historic records and may be detected with additional sampling)	• Maintain or restore self-sustaining natural populations if located
Reach 7 – Mt Barker Creek Gorge and pool riffle channel (EWR Table 2.3.4, potentially 2.3.1, 2.3.2 & 2.3.5)	
Carp gudgeons, historically river blackfish, mountain galaxias and diadromous congolli	• Maintain a self-sustaining population • Restore community of rare and diadromous species
Reach 8 – Ephemeral channels and floodplains (EWR Table 2.3.5)	
Dispersal pathway of diadromous and migratory species (historically was permanent pool habitat)	• Maintain access for diadromous and migratory species; restore permanent populations
Reach 9 – Terminal wetlands under Lake Alexandrina influence (EWR Tables 2.3.5 & 2.3.8)	
Diverse native fish community including diadromous and migratory species	• Maintain diversity and composition of fish community
Murray hardyhead known from Boggy Lake at the terminus of Mosquito Creek and recently Bremer Mouth	• Maintain self-sustaining population

Reach 2 – Rodwell Creek (upper pool-riffle channel)

The key ecological asset in this reach is a remnant population of river blackfish, known to occur in only two pools in the reach and indeed the whole Bremer catchment (rediscovered in 2004 after ~50 years of no records). The sites are on the Highland Valley properties (a and b), and represent isolated spring fed pools during dry periods. Flow has become intermittent in the creek with a lack of any seasonal surface water flow in some years (2007 and 2008). The blackfish sites have been sampled annually (autumn) since 2004 (Appendix 6), with additional sampling at the upper-most site (a) in spring of 2007 and 2008. The most intensive sampling (fyke netting) was during inventory sampling in 2004, with subsequent less intensive checks performed (bait traps) due to the highly restricted nature of the population.

The localised population of river blackfish remains present, however there has been a deterioration of both sites since 2007. Water level became critical at site (a) in autumn 2008 (max depth 0.7m, general depth <0.5m) with a high risk of pool drying –subsequent emergency artificial watering has been implemented through the SA DEH Drought Action Plan to supplement water in the pool with bore water tanked to the site. Nine fish were also rescued from the pool into captivity as a backup in case of catastrophe. Site (b) has had consistently low dissolved oxygen levels at depths greater than 0.3m since autumn 2007 with no management intervention occurring, and fish were not recorded at the site in 2008 or 2009.

Overall, length frequency data supports the population model for the species (Section 2.5) with consistent diminishing peaks corresponding to 1+ (100-160mm fish), 2+ (150-200mm), and occasional older fish≥3+ (>200mm) (Figure 4.5.2a,b). Site (a) showed consistent signs of recruitment, albeit by annual appearance of the 2+ cohort into bait trap catches. Smaller fish were sampled with fykes nets in 2004 or periodically observed with night observations. This suggests they do not become consistently catchable with bait traps at this site until they reach 150mm. Survivorship after the 2+ size class however, appears to be relatively low with only occasional individuals trapped or observed >200mm (Figure 4.5.2a). At site (b) there was a similar pattern of regular recruitment witnessed by peaks of fish corresponding to 2+ fish in 2004-2007, with poor survivorship (i.e. few fish >250mm), prior to eventual population collapse after 2007. Other native fish remain rare in the monitoring pools (Appendix 6).

Environmental conditions at the sites have been variable reflecting reducing freshwater inflows (i.e. no stream flow in the 2007 and 2008 flow seasons, apparent reduction in groundwater input). Autumn salinity at site (a) rose over time from 4300µS in 2004 to 7200µS in 2008, with artificial watering reducing salinity and indeed improving depth and dissolved oxygen from autumn 2008 onwards (data not shown). Salinity at site (b) has risen from 6000µS to >10,000µS between 2004 and 2009 (Appendix 6).

In summary the ecological assets in this reach are under increasing threat and river blackfish would more than likely have been lost without artificial watering. Hence interpretation of catch and environmental data for EWR assessment needs to consider the required local management intervention, has been responsible for population persistence in a time of critical stress (i.e. giving more positive EWR indicators than that really exist, but retaining the future value of the species as an EWR indicator).

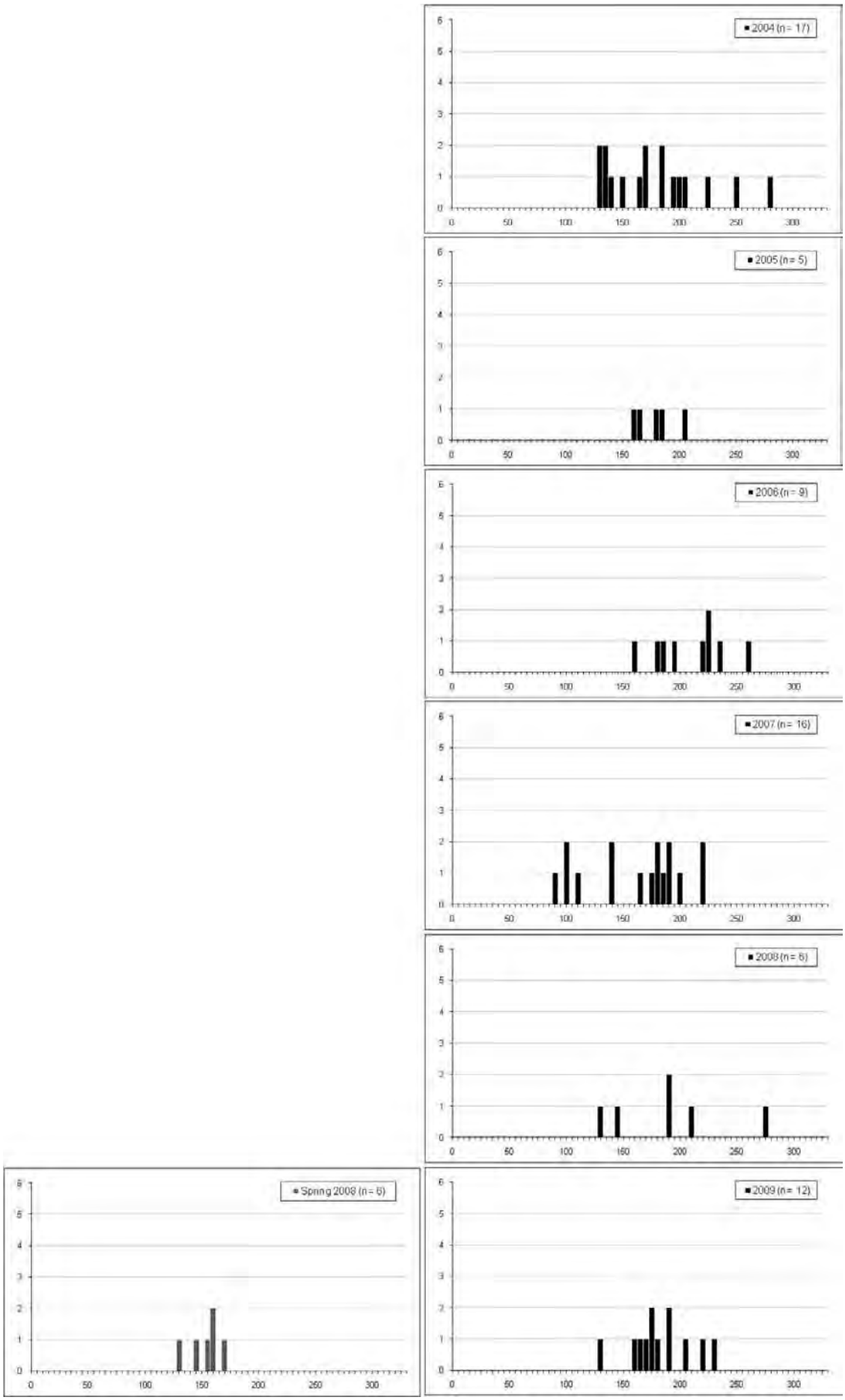


Figure 4.5.2a. Length frequency data for river blackfish at Rodwell Creek (a) 2004-2009.

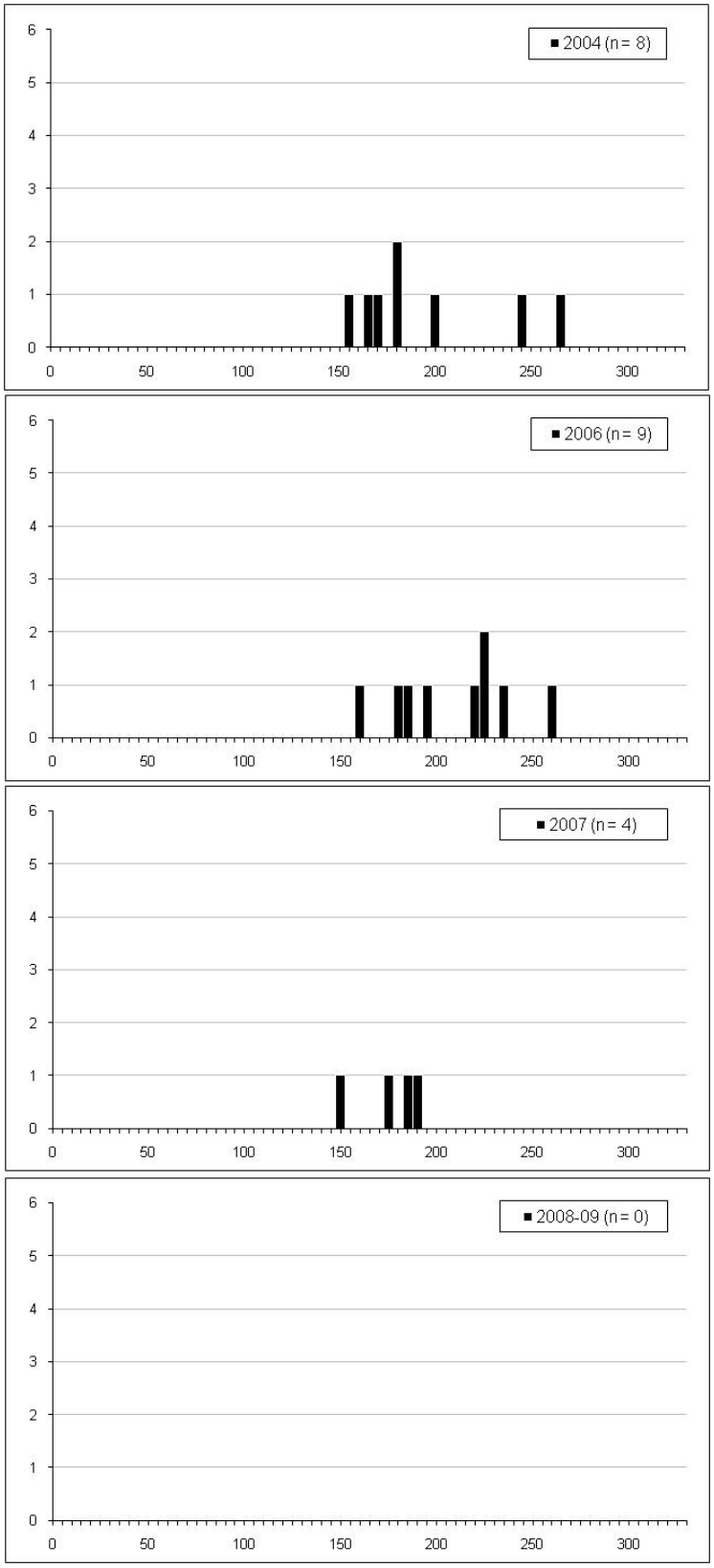


Figure 4.5.2a. Length frequency data for river blackfish at Rodwell Creek (b) 2004-2009.

Reach 3 – Upper Bremer

The Upper Bremer catchment has undergone a dramatic reduction in permanent pool habitat since 2001, impacting the presence and/or distribution of native fish species. Monitoring has been opportunistic, with more regular observations since autumn 2008 (Appendix 6).

Mountain galaxias and carp gudgeons have not been recorded at sites in Harrogate since 2002 and 2004 respectively as pools have become ephemeral (no native fish in 2008 and 2009). A large refuge pool for carp gudgeon at Military Road has also dried in the last two years.

Autumn salinities were greater than 10,000µS in this reach in the last two years (Appendix 6). Overall this reach is highly stressed.

Reach 4 - Tributaries

This reach contains wetter tributaries in the Mount Barker Creek sub-catchment including Dawesley, Nairne and Mount Barker creeks. The main ecological asset identified is mountain galaxias (river blackfish also occurred historically), with a monitoring site on Mt Barker Creek just below Adelaide Road. This site has baseline data from autumn 2002 and 2004 and has been a monitoring site since autumn 2007 (Appendix 6).

Mountain galaxias remain present at this site as a key refuge in the upper catchment. Abundances have been low with limited recruitment in recent autumns however, with diminishing water availability and quality at the site noted in autumn 2008 and 2009 (i.e. single pools compared to continuous reach; anoxic conditions: Appendix 6). No fish were caught in the main sampling reach in autumn 2009, with range mapping collecting fish upstream and used for length frequency analysis. Length data highlights some survivorship, particularly in spring 2008 where catchability was better due to clearer water and flow (Figure 4.5.3). Salinity over time has been variable but steady (range 1000-2000µS). Overall the resilience of the site is being tested.

Remaining small refuge pool at the Mount Barker Creek site autumn 2009

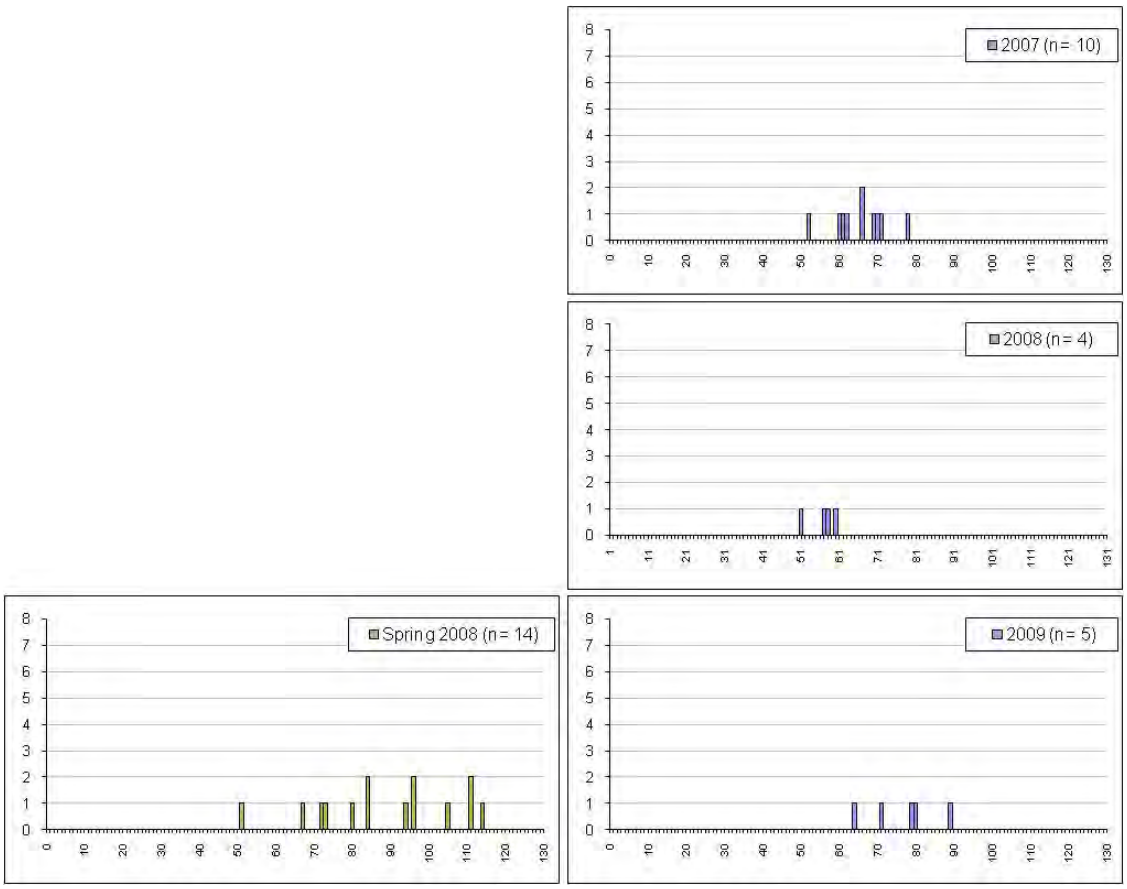


Figure 4.5.3. Length frequency data for mountain galaxias at Mount Barker Creek 2007-2009.

Reach 5- Bremer mid-channel

No recent sampling has occurred in this reach for assessment.

Reach 6 – Bremer Lowland Channel

Ecological assets identified in this reach include a diverse fish community including migratory species (both diadromous and potamodromous). Base line data is available for 2004, with annual monitoring being initiated in autumn 2008 at two sites, namely at the Hartley flow gauging station and just upstream of the Rodwell Creek junction (Appendix 6).

Diadromous species have in the last few years had only a minor presence in the reach. In spring 2007 fifty adult (size rage 90-130mm) common galaxias were electrofished congregated below the flow gauge, however only a few individuals were recorded after this time for either site (three fish in autumn 2008: Appendix 6). Only a single very large adult congolli was recorded (335mm TL). The combined effect of poor stream flow (i.e. affecting lowland channel access to upstream pools), poor pool condition (i.e. highly concentrated autumn levels) and broader impacts to the Lower Lakes (low level, long-term barrage closure) are all likely to have impacted the diadromous fish community in the reach. A large Murray-Darling golden perch was recorded at the Rodwell Creek site by a landholder in 2008 (angled: 425mm TL) indicating the presence of the potamodromous functional group in the reach (albeit with no smaller fish detected). The general diversity of the native fish community was also low, with flathead gudgeon the only other species recorded in any significant abundance. Conversely alien fishes were common in the reach, comprising juvenile and adult common carp at the flow gauge site and juvenile and adult redfin and gambusia at the Rodwell Creek junction (Appendix 6). Salinity was moderate (1200-6000µS) with a high reading at the concentrated flow gauge pool in autumn 2009 (18,500 µS). Overall the recent drying and lack of connectivity reflect the poor state of the fish community in the reach in 2009.

Bremer flow gauge pool autumn 2009 (a small refuge pool was present left of the picture)

Reach 7 – Mt Barker Creek Gorge

No sampling has occurred in this reach for assessment (knowledge gap on assets and EWR requirements).

Reach 8 – Lowland floodplain

A lack of permanent water limits fish sampling, with opportunistic sampling during periods of flow required to assess functional processes for fish (e.g. appropriate periods of connectivity for migration and spawning). However, the notes relating to a poor diadromous fish community in the upstream reach apply to the recent condition of this reach also.

Reach 9 – Terminal wetland

The terminal wetland of the Bremer comprises a narrow channel before entering Lake Alexandrina, and is an important off-channel habitat having a diverse community comprising generalists, diadromous, potamodromous and euryhaline species. Information for comparison was collated in 2004 Inventory sampling, with a monitoring site established in autumn 2007.

The Bremer Mouth habitat retained a diverse fish community up until it dried in summer/autumn 2009 due to regionally low Lake Alexandrina levels. In fact an additional threatened species, Murray hardyhead, appeared to colonise the site sometime around spring 2008 and good numbers of common galaxias occurred including large numbers of juveniles (n = 233) in spring 2008. Relatively low numbers of alien species were recorded prior to drying. Autumn salinity values increased from 1200-5800µS between 2004-2008 (Appendix 6).

As with the terminal wetlands of the River Murray (i.e. Marne, Reedy and Rocky Gully) and the Angas (see later) the broader impacts of critical water level lowering below Lock 1 has removed the terminal wetland habitat type, and the related ability for stream discharge to alter the performance of these habitats.

Murray hardyhead from the Bremer Mouth spring 2008

Bremer River Mouth spring 2008

Bremer River Mouth autumn 2009

Overall performance report

A summary report for the Bremer Catchment is detailed in Table 4.5.3. The catchment is poor condition, with indicators or actual failure of most ecological assets. Note Rodwell Creek has been artificially maintained, so the assessment does not reflect the true poor extent of this reach.

Table 4.5.3. 2009 report card for Bremer River Environmental Water Requirements – a summary of performance against fish indicators assessed with field data. Blank indicators were not assessed or not relevant in 2009. For exotic species ticks indicate the desirable result was observed (i.e. not detected, low abundance or invasion was not detected) and crosses indicate a negative result (i.e. present, abundance had not been suppressed or invasions occurred). *Recolonisation = invasion for exotic species.

Asset	***Environmental Objective***	***Indicator***							
		Presence	Population extent	Recolonisation*	Recruitment	Survivorship	Spawning/larvae	Movement/habitat	Low exotic abundance
Reach 2 – Rodwell Creek upper pool/riffle channel									
River blackfish (upper section of reach)	• Maintain and Restore a self-sustaining population	✓	✗	✗	✓	✓			
Mountain galaxias (upper section of reach)	• Maintain and Restore a self-sustaining population	✓	✗	✗	✗	✗			
Exotic species	• Discourage colonisation and establishment	✗	✓						✓
Reach 3 – Upper Bremer pool/riffle channel									
Mountain galaxias	• Restore a self-sustaining population	✗	✗	✗	✗	✗			
Carp gudgeons	• Maintain a self-sustaining population	✗	✗	✗	✗	✗			
Exotic species	• Discourage colonisation and establishment	✓							✓
Reach 4 – Upper pool/riffle channel - Mt Barker Creek									
Mountain galaxias	• Maintain or Restore a self-sustaining population	✓	✓	✗	✗	✗			
Exotic species	• Discourage colonisation and establishment	✗							✓
Reach 6 – Bremer lowland deep pool sequence									
Diverse fish community	• Maintain diversity and composition of fish community	✗	✗	✗	✗	✗			
	• Maintain diadromous and potamodromous species	✗	✗	✗		✗			
Exotic species	• Suppress exotics	✗							✗
Reach 9 – Bremer Mouth terminal wetland									
Bremer Mouth fish community	• Maintain diversity and composition of fish community	✗	✗	✗	✗	✗			
	• Maintain community of Murray hardyhead	✗		✗	✗	✗			
Exotic species	• Discourage colonisation and establishment	✓							✓

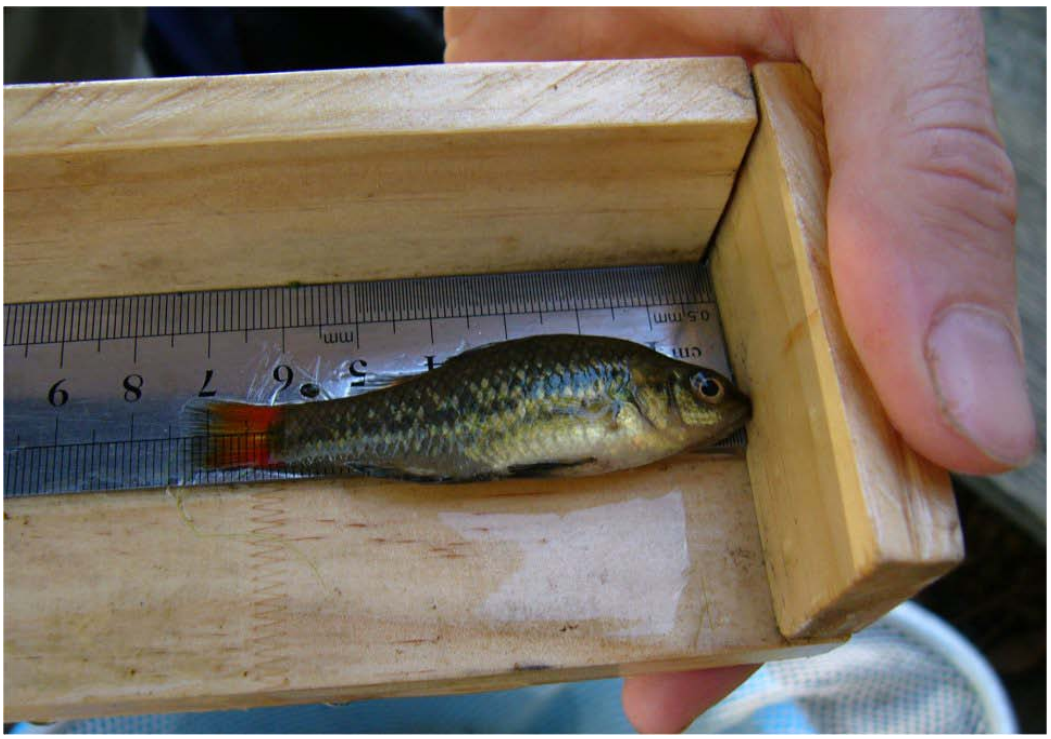
4.6 Angas River Catchment

The Angas River Catchment is moderate in size (199km^2) and has reasonable rainfall for most of its area. Much of the land has been cleared and dedicated to stock grazing, dairy or viticulture. It has a semi-circular arc of elevated land draining toward a main drainage channel, the Angas River, which extends from headwaters near Flaxley, through Strathalbyn, and to its confluence with Lake Alexandrina near Milang. A fan of tributaries including Middle/Paris, Dawson, Doctors and Burnside creeks join in or near Strathalbyn. Under current conditions, the latter two creeks are ephemeral (no permanent pools located), and the upper Angas River and Dawson and Middle creeks are episodic stream systems. There is a large degree of geomorphic variation within the catchment and considerable hydrological variability between stream sections. Much of the catchment consists of alluvial red gum lined tributaries, with spring fed upper reaches near Macclesfield. Below Strathalbyn, the character of the Angas differs considerably consisting of bedrock based, larger pools fringed with *Phragmites* and *Typha*. The stream gains permanent flow through much of this approximately 5km section via groundwater base flows. Further downstream, the stream becomes an ephemeral channel (significant natural barrier), meandering 13km across a lowland flat before reaching its terminus with Lake Alexandrina via a small section of river channel. Pools are generally smaller in upland areas, with a long series of deeper pools in the mid catchment.

Eight provisional reaches have been defined in the Angas River Catchment (Fig. 4.6.1).

Fish related assets identified by Hammer (2004) are shown in Tables 4.6.1 & 4.6.2. The priority assets are a highly restricted, genetically distinct population of southern pygmy perch (Reach 5, and a population of river blackfish (Reach 6). Reach 2 formerly had these two threatened species also. Other assets include mountain galaxias and other diverse native fish communities including diadromous species (reaches 2-8).

Environmental objectives, water requirements and monitoring recommendations are shown in Tables 4.6.1 & 4.6.2, and these match fish related ecological assets identified in the Angas River Catchment to the relevant EWR tables of Section 2.3. Long-term monitoring has occurred in reaches 2, 5, 6 and 8 (Appendix 7).



Angas River southern pygmy perch

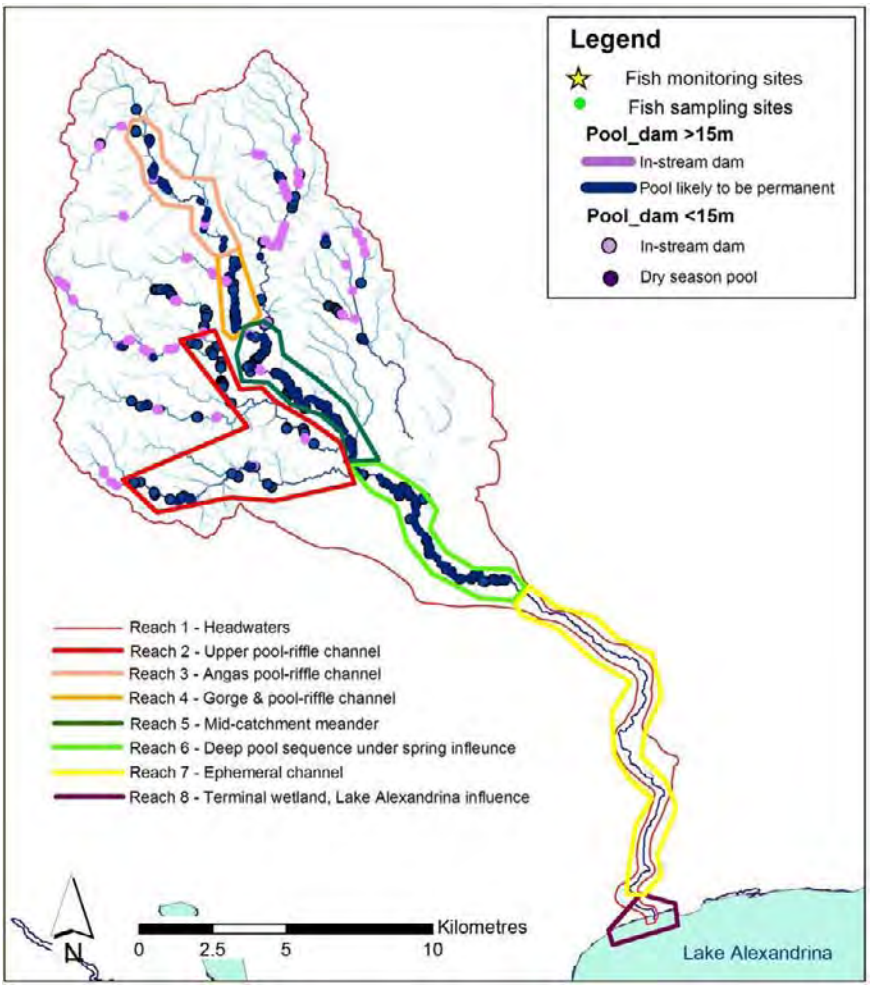


Figure 4.6.1. Map of the Angas River Catchment showing provisional river reaches.

Table 4.6.1. Distribution patterns and significant environmental assets in the Angas Catchment relating to fish species and communities (plus opportunistic data for other biota).

Specific asset/pattern	Location	EWR Table
1) Genetically distinct southern pygmy perch population (Evolutionary Significant Unit)	• Reaches 2 & 5 (recent local extinctions)	2.3.3
2) River blackfish	• Reach 6 (formerly also Reach 2)	2.3.2 & 2.3.6
3) Mountain galaxias	• Reaches 2, 3, 4, 5 & 6	2.3.1 & 2.3.6
4) Mid Angas diverse fish community	• Reaches 2, 5 & 6	2.3.6
5) Angas River terminal wetlands diverse fish community, including Lake Alexandrina genetic unit southern pygmy perch	• Reach 8	2.3.3, 2.3.5 & 2.3.8
6) Presence of diadromous fish species in the Lower Angas	• Reach 8 (formerly also 6)	2.3.5
7) No permanent fish communities due to lack of permanent water	• Reach 1	NA
8) Charophytes and *Potamogeton tricarinatus*	• Reach 5	
9) River shrimp (*Macrobrachium*)	• Reaches 3, 5 & 6	

Table 4.6.2. Summary of environmental objectives by reach for fish related ecological assets in the Angas River Catchment.

Asset	***Environmental Objective***
Reach 1 – Angas Catchment headwaters	
NA	
Reach 2 – Dawson Creek and Paris Creek pool/riffle channel (EWR Tables 2.3.1, 2.3.2 & 2.3.3)	
Mountain galaxias	• Maintain restricted self-sustaining populations
Southern pygmy perch and river blackfish	• Restore self-sustaining populations
River blackfish	• Restore self-sustaining populations
Reach 3 – Upper Angas pool/riffle channel (EWR Tables 2.3.1)	
Mountain galaxias	• Maintain restricted self-sustaining populations
Reach 4 – Angas gorge and pool-riffle channel (EWR Table 2.3.1)	
Mountain galaxias	• Maintain or Restore a self-sustaining population
Reach 5 – Mid pool-riffle (junction us Dawson Creek jn) (EWR Tables 2.3.1 & 2.3.3)	
Genetically distinct southern pygmy perch population (Angas)	• Maintain (core pool) a self-sustaining population
Mountain galaxias	• Maintain or Restore a self-sustaining population
Reach 6 – Lowland channel below Strathalbyn (EWR Tables 2.3.1, 2.3.2 & 2.3.6)	
Diverse native fish community including threatened river blackfish and mountain galaxias. Historically also included occasional diadromous species such as congolli, climbing galaxias and lampreys	• Maintain a self-sustaining populations of threatened species • Maintain diversity and composition of fish community • Restore community of diadromous species
Reach 7 – Ephemeral channel (EWR Table 2.3.5)	
Dispersal pathway of diadromous and migratory species (historically recorded)	• Restore access for community of diadromous species
Reach 8 – Terminal wetland/channel under Lake Alexandrina influence (EWR Tables 2.3.3, 2.3.5 & 2.3.8)	
Diverse native fish community including threatened and diadromous and migratory species	• Maintain diversity and composition of fish community
Southern pygmy perch (part of Lake Alexandrina genetic sub-population)	• Maintain a self-sustaining populations

Reach 2 – Dawson & Paris creeks

This reach has previously been considered as two upper pool riffle channel sections (i.e. Figure 4.6.1), however review of reach types suggest that lower reaches close to junctions with the Angas should also be included which slightly changes the information reported due to previous populations of southern pygmy perch and river blackfish. Hence the whole sub-catchments are considered in Reach 2, but the lower sections could easily be assessed in the mid-pool channel reach type (Reach 5).

There is no monitoring data for upper tributary sections currently collected (mountain galaxias ecological objectives). Lower Dawson Creek had a population of river blackfish prior to the early 1990s, and more recent records of a sustaining population of southern pygmy perch. Annual drying of stream sections occurred in 2003 and then again from 2005-2009 and hence the asset is highly likely to have become locally extinct (Appendix 7). Similarly, large numbers of southern pygmy perch were recorded in lower Middle Creek in 2001, however major pool drying has occurred since, with records of a few individuals from a single pool lasting till 2004, with no water persisting in subsequent autumns (Appendix 7).

Hence based on local extinctions in lower stream sections, environmental water requirements for this stream reach have not been met for some time (however, mountain galaxias in upper sections remain to be assessed).

Reach 3 – Upper Angas River

Two sites have been monitored annually in this reach since 2004 and 2005 (Quarry Road and Searle Street), targeting mountain galaxias in small upper–pool channel habitat. Both populations have persisted over the five years of observation, including recent regional drought conditions. However at Quarry Road there has been a decline in relative abundance, with a near absence of surviving adults in catches for the last two autumns (Figure 4.6.2). A similar result for Searle Street (low abundance) in autumn 2009 requires confirmation with subsequent sampling. The latter site has variable water quality and often low dissolved oxygen in autumn (impact of willow leaf fall in periods when flow is low), and this has affected catches on some occasions, with subsequent high catches (e.g. 2007). In general this site shows strong recruitment with low survivorship (Figure 4.3.3).

Permanent flow is recorded at both sites in autumn of most years; autumn salinity has steadily increased at Quarry Road (doubled from ~2500-5000µS) and remained low/moderate at Searle Street (~2200µS). Emergent vegetation has encroached the Quarry Road site coinciding with lower winter scouring flow in recent years (Appendix 7, below image).

Quarry road autumn 2005 and 2009

Figure 4.6.2. Length frequency data for mountain galaxias at Quarry Rd 2005-2009.

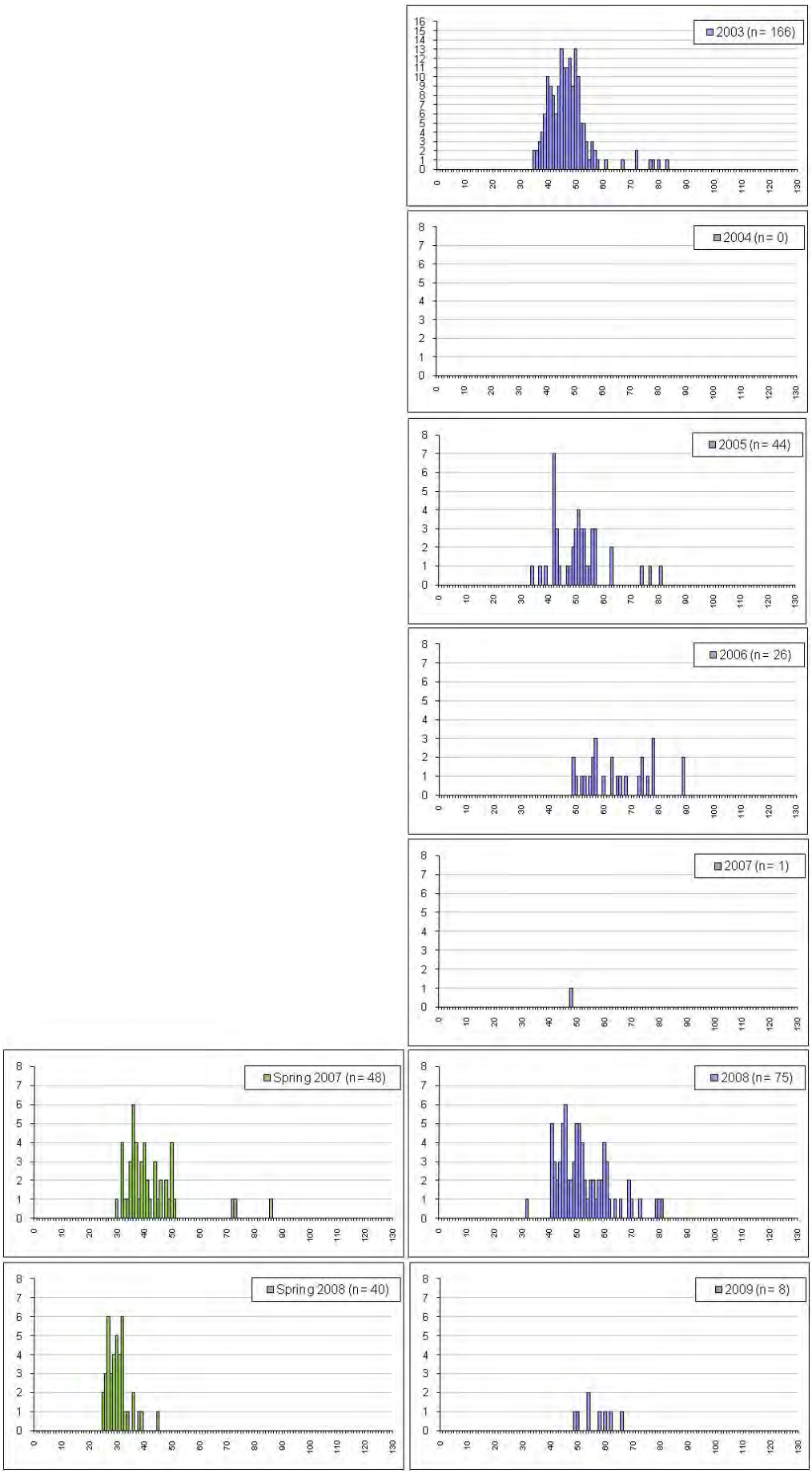


Figure 4.6.3. Length frequency data for mountain galaxias at Searle Street 2003-2009.

Reach 4 – Angas Gorge

No sampling occurred for mountain galaxias in this reach for assessment.

Reach 5 – Angas mid-pool riffle

Ecological objectives for this reach relate to maintaining southern pygmy perch, currently confined to a string of pools between the Middle Creek and Dawson Creek junctions. The species occurs in a core pool at the Middle Creek junction and periodically in other pools downstream, with indication of a localised recovery in downstream pools in the last few years.

The core pool has shown ongoing presence since 1999, with generally increasing abundance since 2005 (exception being 2007). Presumed recruits (0+) fish have shown a tendency to be smaller than predicted by the general population model (Fig. 2.5.3) i.e. 15-30mm compared to normally 30-45mm in autumn 2009. This may be due to late or additional spawning and/or stunting due to limited resources in a small, contracted pool. The most recent year saw reasonable survivorship of presumed 1+ fish as a clear shift in the previous autumn 0+ peak (but note these fish were again smaller than normally expected) (Fig. 4.6.4). At the downstream pools, larger fish only were recorded in 2007-2009 (Fig. 4.6.5). Autumn 2007 was dominated by a strong peak of 50-65mm fish (1+ and≥2+), but this size grouping was no longer apparent the following autumn. Instead a strong pulse of 40-50mm fish (likely 0+) was recorded, indicating successful spawning and recruitment during spring/summer 2007/08 (note although there are no juvenile fish in spring 07 sampling, many 10-25mm juveniles were captured opportunistically by dip netting emergent vegetation on 23/11/07 but were apparently cryptic and not entering fyke nets earlier). Autumn 2009 saw survival of the previous year's cohort (i.e. strong pulse of 45-60mm or 1+ fish) but limited recruitment (Fig. 4.6.5). Redfin have not been recorded in pygmy perch pools (i.e. upstream of the old swimming pool) in recent years.

The core pool has come under increasing environmental water related stress in recent years, with autumn water level just 0.5m in autumn 2009. Salinity at the site fluctuates between moderate and high (i.e. 2000-9000µS), but habitat (cover) remains reasonable, although encroachment of reeds may be an issue (Appendix 7). Downstream pools are quite variable in habitat conditions, with the main pool being upstream of the first small weir below North Parade – water level is relatively stable here, salinity also varies, and dense aquatic plant growth has developed over the last four years (*Potamogeton tricarinatus* and algae) (Appendix 7).

The assessment of fish related environmental requirements for this reach is mixed given the threat to the core pool, but currently stable lower pool, with continually fluctuating indicators of recruitment and survivorship at each area. Overall the key ecological asset is sustaining albeit under constant threat owing to its highly restricted occurrence (e.g. other range mapping occurs downstream but few catches are recorded: Appendix 7).

Core refuge pool at Middle Creek Junction, showing dense emergent and fringing vegetation (Left) and small area of remnant surface water (right)

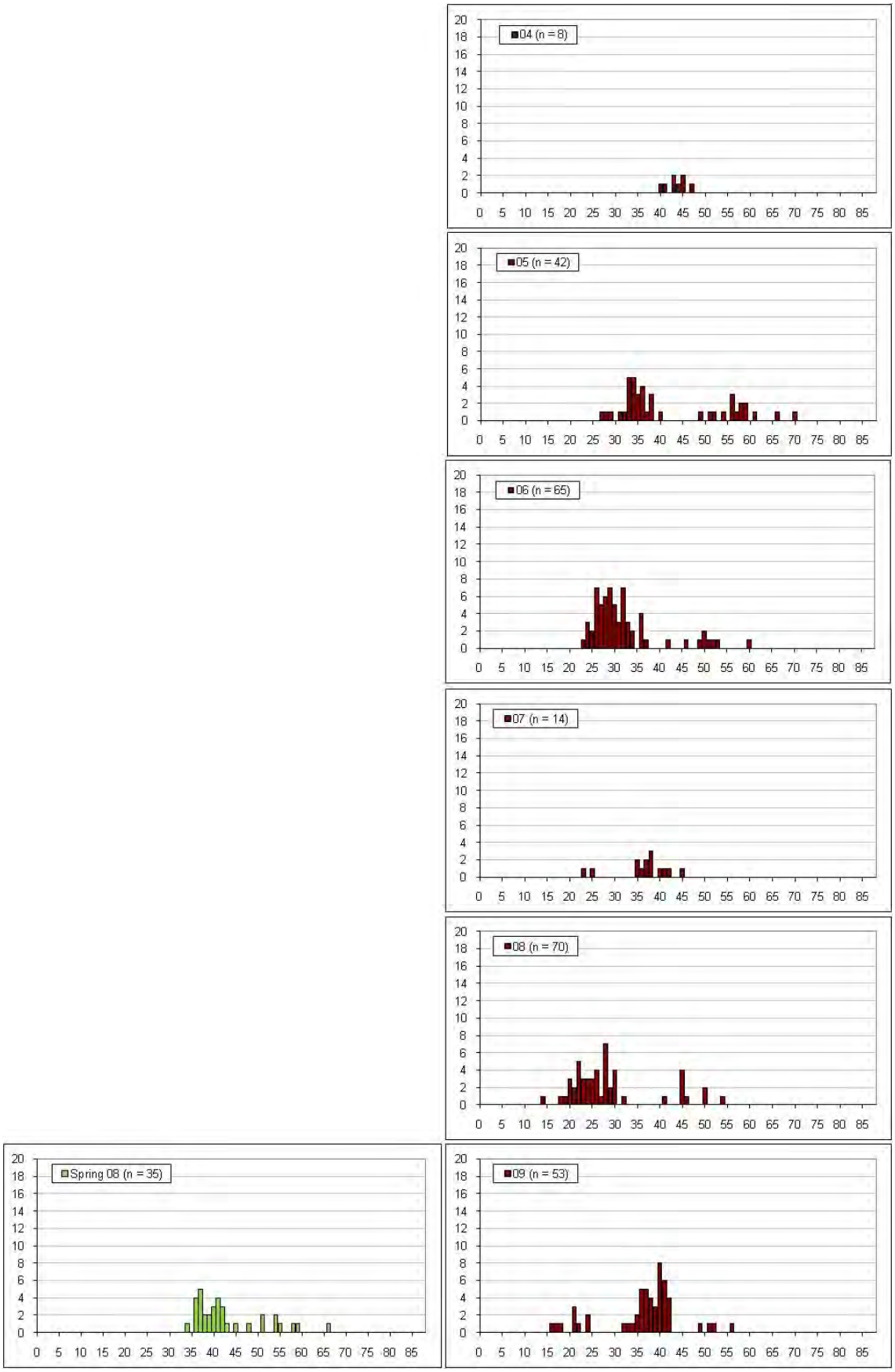


Figure 4.6.4. Length frequency data for southern pygmy perch at Middle Creek junction (core refuge pool) 2004-2009.

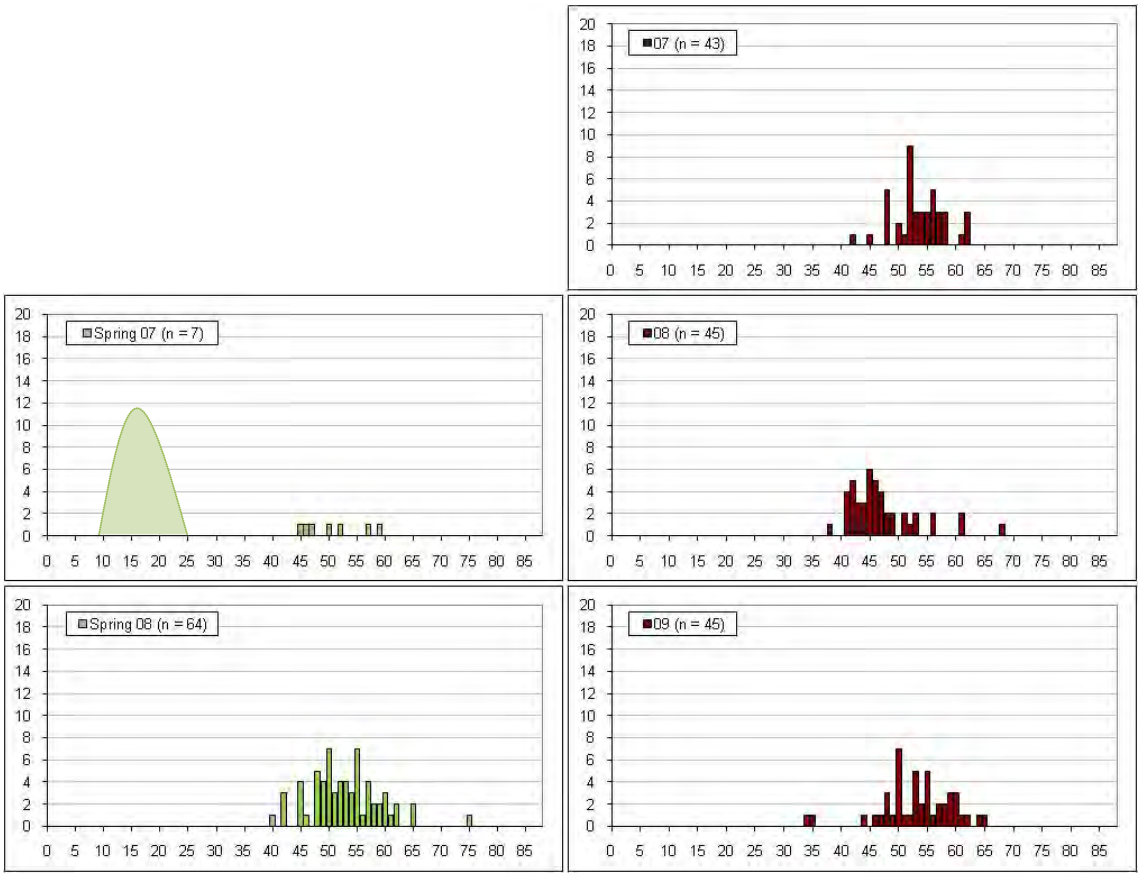


Figure 4.6.5. Length frequency data for southern pygmy perch at the first weir site, Angas River 2007-2009. NB 60+ 10-25mm juvenile fish were collected opportunistically two weeks after sampling in spring 2007 and are shown with green shading.

Angas River downstream of North Parade showing dense bed of Potamogeton tricarinatus.

Reach 6 – Angas lowland channel

Flow objectives for the lowland Angas River reach include maintaining a sustaining population of river blackfish and a diverse groundwater dependent fish community (i.e. the presence of other native fish and conversely the absence and low abundance of exotic fishes). Baseline survey was undertaken in 1999, with monitoring frequency at this site one in two years beginning in 2004, with additional fine scale monitoring after 2008 (i.e. spring 2008 and autumn 2009) (Appendix 7).

The population of river blackfish has remained relatively stable, although abundance was highest (nearly double) on the first monitoring in 2004. There is evidence of ongoing recruitment and reasonable survivorship, with fish between 100-150mm represented in autumn sampling each year, and a consistent spread of lager (older) fish between 150-300mm (Figure 4.6.6). The fish community remains relatively diverse, although mountain galaxias were not recorded in spring 2008 and autumn 2009. Conversely, flathead gudgeon has appeared in catches from autumn 2008 onwards. There has also been a dramatic decline in carp gudgeon abundance by an order of magnitude (100s recorded in 1999-2006, 10s from 2008 onwards) (Appendix 7). There appears to be a fish community shift as a possible signs of ecosystem change, which may impact upon river blackfish as a top-order predator. Most river blackfish were in good condition, however a fish in poor conditions was observed floating in autumn 2009: this may be early signs of the sub-lethal impacts of high salinity and fish condition and recruitment should be closely followed. No diadromous species were recorded in any of the six sampling events nor other opportunistic sites in the reach. Alien species including Gambusia and tench are present but in low abundance (Appendix 7).

Examination of environmental conditions indicates autumn salinity has shown increase since 2004 to be moderate to high (6000 to 8000µS), and flow decline and cessation has been a feature in recent summers/autumns (Appendix 7). Habitat availability remains steady, although there was a decline in the amount and condition of submerged aquatic vegetation (filamentous algae) in autumn 2009, which was smothered by black slime.

Overall fish related ecological assets in this reach are still present and in reasonable conditions, however there are early warning signs of stress and possible decline.

Flow gauge site on the Angas River autumn 2009
(flow is normally evident over rock bar between pools)

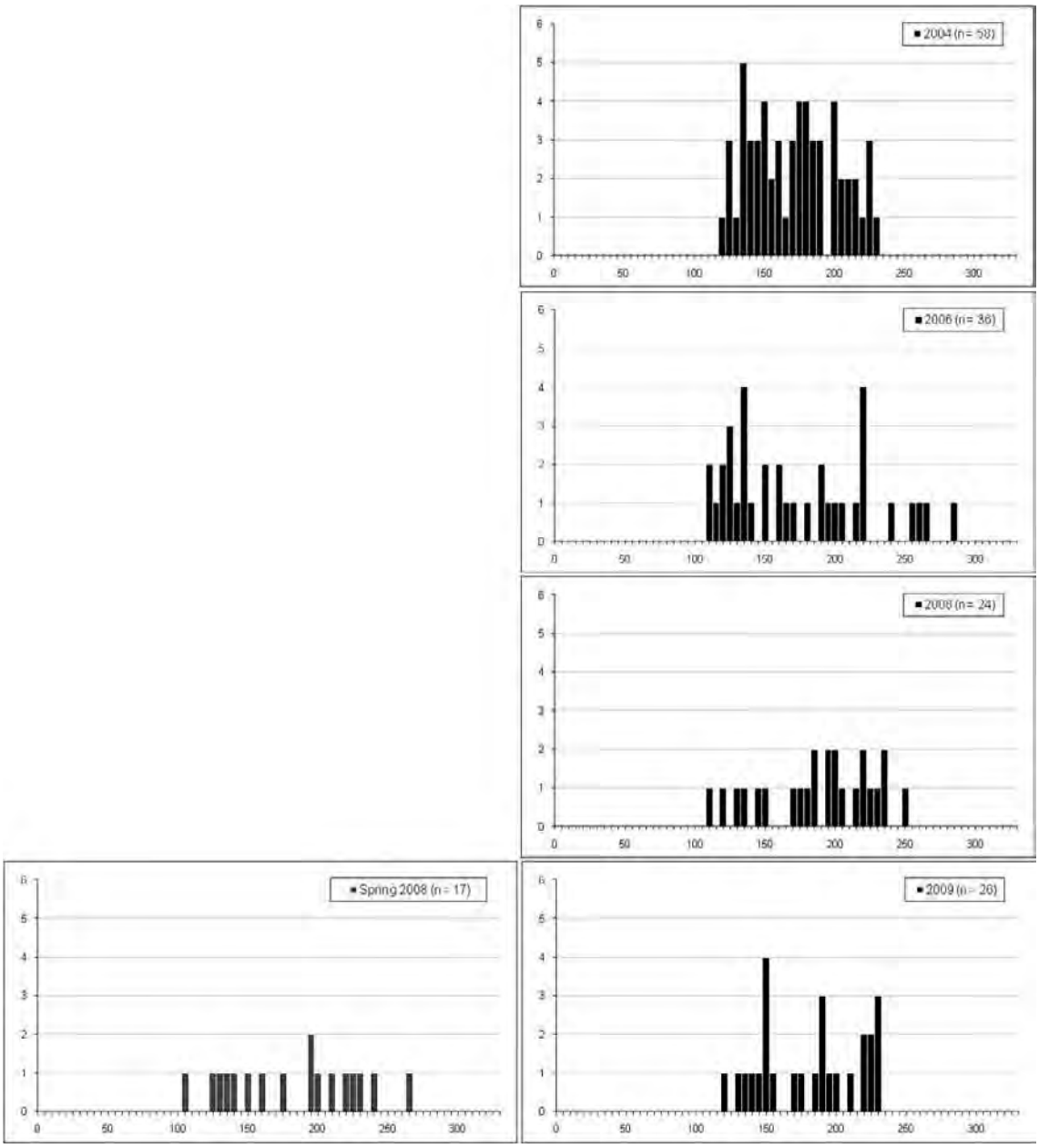


Figure 4.6.6. Length frequency data for River blackfish at the flow gauge site 2004-2009.

Stressed river blackfish, autumn 2009

Reach 7 – Angas ephemeral channel

Assessment of fish related EWR in this reach targets flow connection to asses migratory functional processes (e.g. appropriate periods of connectivity for migration). Primarily, linkage of the Angas with Lake Alexandrina may allow upstream passage of diadromous fish known to occur historically. Hence monitoring targeted pools within the reaches to asses colonisation of diadromous species in spring 2007 and 2008 following periods of stream flow (sites were visited in autumn also but where dry: Appendix 7).

Sampling indicated a lack of any diadromous, eurhyaline or terminal wetland species, and hence there is no suggestion of successful upstream migration. Low numbers of mountain galaxias were recorded, which appeared to all be young of year juveniles <65mm (Figure 4.6.7), and these likely colonised through downstream drift of larvae during flows.

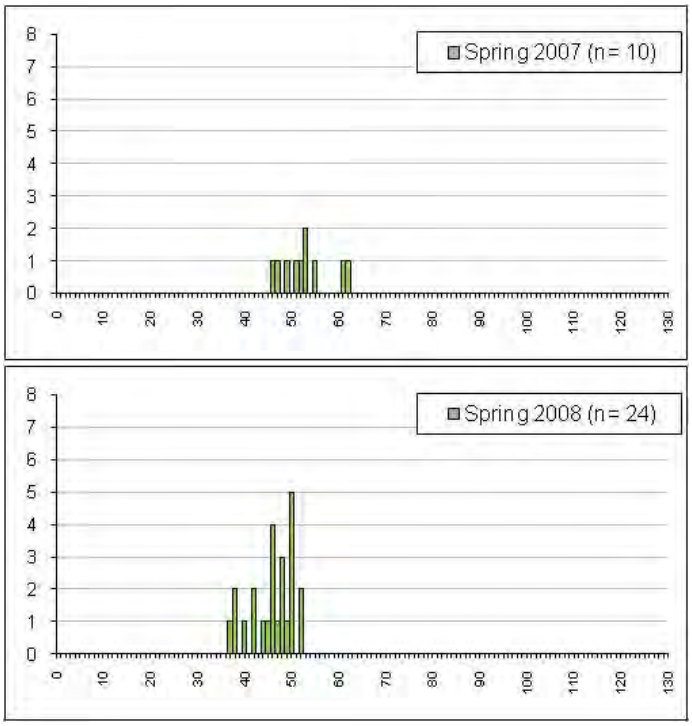


Figure 4.6.7. Length frequency data for mountain galaxias at Davidson/Watson Park roads spring 2008-2009.

Reach 8 – Terminal wetland

The terminal wetland of the Anags comprises a narrow channel before entering Lake Alexandrina, and is an important off-channel habitat having a diverse community comprising generalists, diadromous, potamodromous and euryhaline species (including the threatened southern pygmy perch). Monitoring occurred in 1999 and 2001, then all autumns from 2004 (Appendix 7).

The Angas terminal wetland retained a diverse fish community up until it dried in summer/autumn 2008 due to regionally low Lake Alexandrina levels. Sampling following Angas River stream flow which refilled wetland habitat (spring 2008) indicated strong recolonisation by euryhaline (smallmouthed hardyhead and lagoon goby), diadromous (common galaxias) and wetland generalist (flathead gudgeon and smelt) species. However the site was dry again by autumn 2009 (Appendix 7).

Prior to drying the site had dense submerged aquatic vegetation (*Ceratophyllum* and *Myriophyllum*) and low-moderate salinity <2500µS (Appendix 7).

Monitoring has also been undertaken at Turveys Drain in the general area of the Angas terminal wetland, and sometimes influenced by Angas flows (directly via flooding across a lowland swamp but also by general local water quality from discharge into the Lake). Overall it is likely to mostly reflect water requirements associated with Lake Alexandrina, however monitoring data is presented here for broader reference and as the nearest population for potential recolonisation of the Angas. Southern pygmy perch has been the main ecological asset at the site, with Murray hardyhead recorded only recently. Strong recruitment of southern pygmy perch was evident in autumn 2004, 2005 and 2006, but with general decline since (Figure 4.6.8). Salinity has increased tenfold since 2001 (476-7150µS) but cover has remained stable (the site has been artificially watered to counter lake level declines) (Appendix 7).

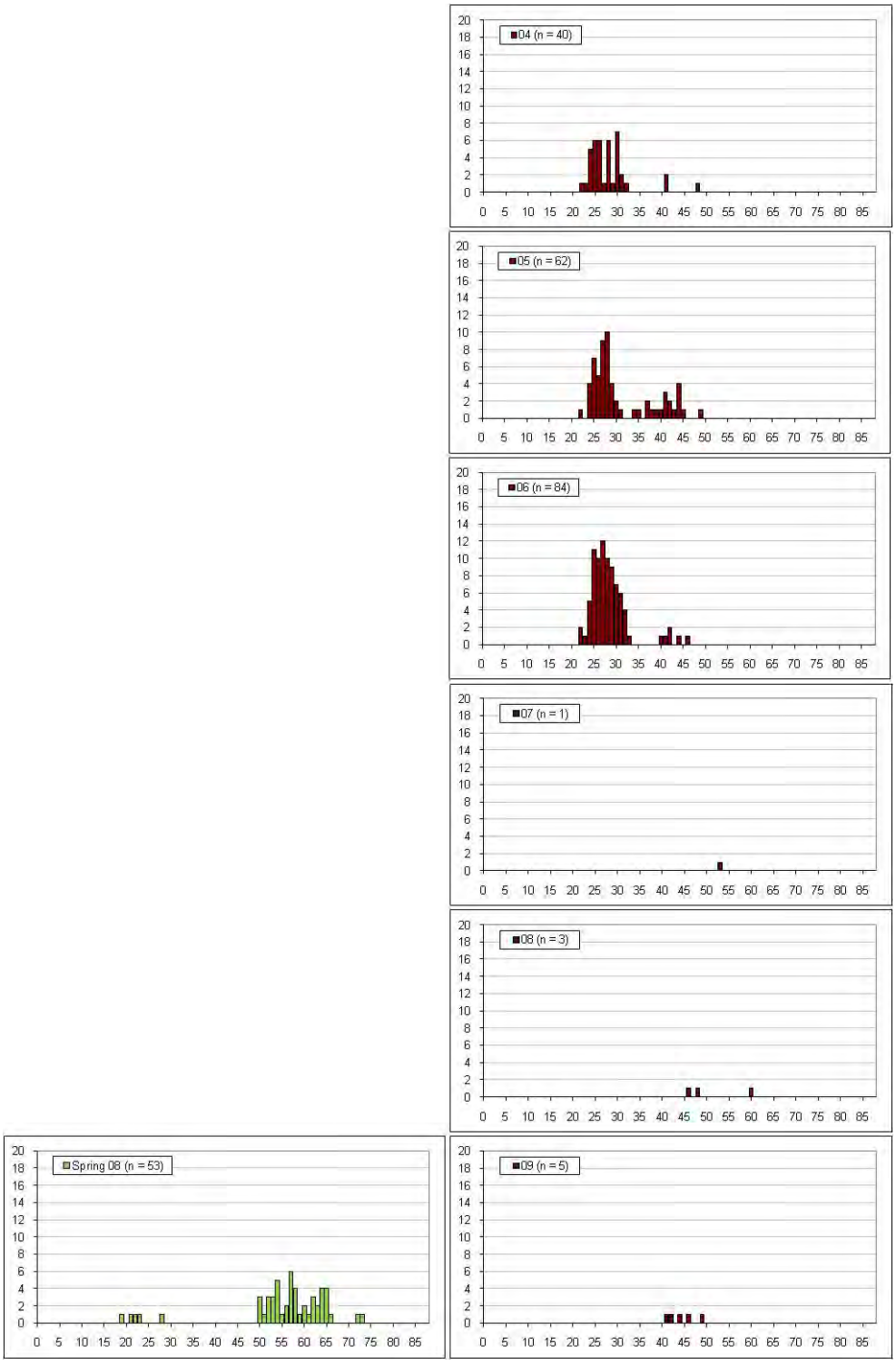


Figure 4.6.8. Length frequency data for southern pygmy perch at Turveys Drain 2004-2009.

Overall performance report

A summary report for the Angas Catchment is detailed in Table 4.6.3. Although declines and stress is noted, the catchment retains important ecological assets.

Table 4.6.3. 2009 report card for Angas River Environmental Water Requirements – a summary of performance against fish indicators assessed with field data. Blank indicators were not assessed or not relevant in 2009. For exotic species ticks indicate the desirable result was observed (i.e. not detected, low abundance or invasion was not detected) and crosses indicate a negative result (i.e. present, abundance had not been suppressed or invasions occurred). *Recolonisation = invasion for exotic species.

Asset	***Environmental Objective***	***Indicator***							
		Presence	Population extent	Recolonisation*	Recruitment	Survivorship	Spawning/larvae	Movement/habitat	Low exotic abundance
Reach 2 – Dawson & Paris creeks									
River blackfish and/or southern pygmy perch (lower reach)	• Restore self-sustaining populations	✘	✘	✘					
Mountain galaxias	• Maintain and Restore self-sustaining populations								
Exotic species	• Discourage colonisation and establishment	✓							✓
Reach 3 – Upper Angas pool/riffle channel									
Mountain galaxias	• Restore a self-sustaining population	✓	✓		✓	✘	✓		
Exotic species	• Discourage colonisation and establishment	✓							✓
Reach 5 – Angas mid-pool riffle									
Southern pygmy perch	• Maintain or Restore a self-sustaining population	✓	✓		✓	✓			
Exotic species	• Discourage colonisation and establishment (especially redfin)	✓							✓
Reach 6 – Angas lowland channel									
River blackfish	• Maintain self-sustaining populations	✓			✓	✓			
Diverse fish community	• Maintain diversity and composition of fish community	✓				✘			
Exotic species	• Suppress exotics	✓							✓
Reach 7 – Angas ephemeral channel									
Dispersal pathway	• Restore community of diadromous species	✘		✘					
Reach 9 – Angas Mouth terminal wetland									
Lower Angas fish community	• Maintain diversity and composition of fish community	✘		✓		✘			
Southern pygmy perch	• Maintain self-sustaining populations	✘		✘	✘	✘			
Exotic species	• Discourage colonisation and establishment	✓							✓

4.7 Finniss River Catchment

In contrast to other EMLR catchments the Finniss is relatively well vegetated, with significant patches of remnant vegetation in the mid section of the catchment. Nevertheless, agricultural pursuits are a common land use, with ever-increasing horticulture in lower sections. Much of this large catchment (372km^2) experiences medium to high rainfall and has steep topography through its middle section. The upper Finniss Catchment is a complex blend of tributaries, with the main arm an extension of the alluvial Meadows Creek which is then subsumed by the Finniss River and takes a sharp turn to the east through a constrained bedrock defined or loose rock dominated watercourse. A small swamp section originating from near Mt Compass (know today as Finniss Creek) also joins near Yundi. Major tributaries Bull Creek and Blackfellows Creek all join the main stem before Ashbourne. Downstream of Ashbourne is generally an intermittent reach through summer, except where a small region of base flow occurs just before a substantial waterfall. Below the waterfall, the stream is a lowland meander through to braided channel and into an extensive area of wetland that forms the upper section of an extended arm of Lake Alexandrina. Stream habitat in the Finniss Catchment is highly variable, with considerable heterogeneity at broad (i.e. geomorphic zones) and local scales with sites in close proximity often having contrasting habitat and hydrology and corresponding fish captures. Small to medium intermittent stream pools are the predominant habitat, with areas of peat swamp (e.g. Finniss Creek), rocky riffles (e.g. Finniss River above the waterfall) and long lowland pools and river channel (below the waterfall) also occurring. Occasional large and deep pools are located on the main stem of the Finniss River

Nine provisional reaches have been defined in the Finniss River Catchment (Fig. 4.7.1).

Fish related assets identified by Hammer (2004) are shown in Tables 4.7.1 & 4.7.2. These include a genetically distinct population of southern pygmy perch in small patches of different stream reaches, one of two populations of Yarra pygmy perch on the Murray-Darling Basin occurring in the Finniss terminal wetland (Reach 9), mountain galaxias populations which along with Tookayerta represent a different species to other EMLR catchments (SA Museum unpublished) and diverse native fish communities in the lower Finniss and wetland. The Finniss Catchment historically had even more ecological assets including river blackfish (several reaches) and southern purple-spotted gudgeon, Murray hardyhead and chanda perch (Reaches 8 & 9).

Environmental objectives, water requirements and monitoring recommendations are shown in Tables 4.7.1 & 4.7.2, and these match fish related ecological assets identified in the Finniss River Catchment to the relevant EWR tables of Section 2.3. Long-term monitoring (since 2001) has occurred in most reaches (Appendix 8).

Finniss River Yarra pygmy perch (left) and historic specimen of southern purple spotted gudgeon (right)

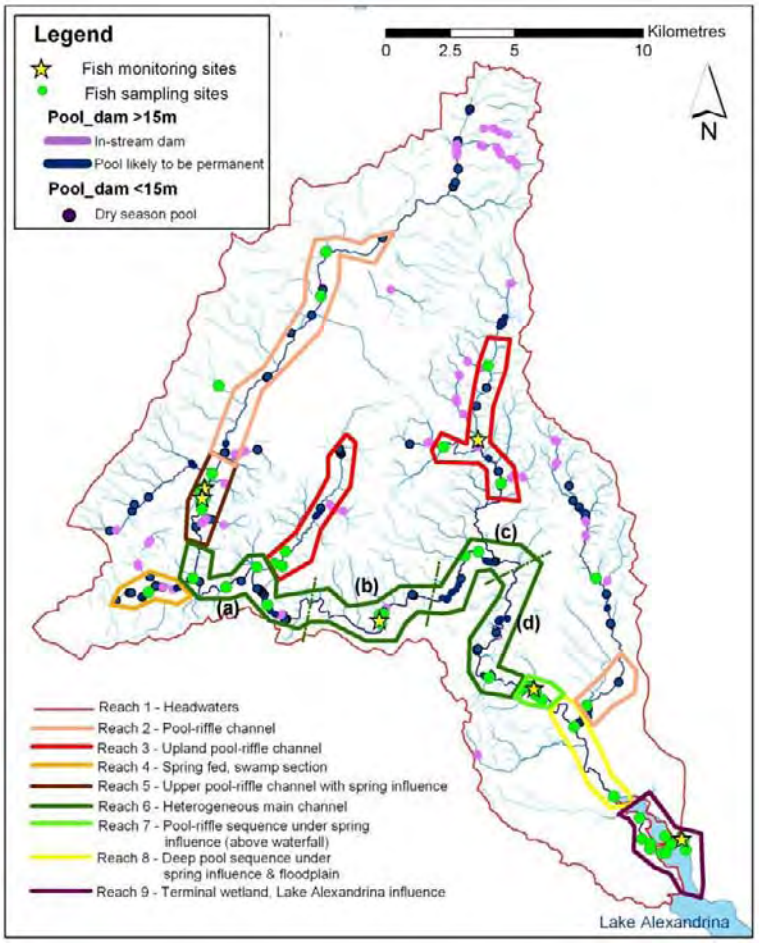


Figure 4.7.1. Map of the Finniss River Catchment showing provisional river reaches

Table 4.7.1. Distribution patterns and significant environmental assets in the Finniss Catchment relating to fish species and communities.

Specific asset/pattern	Location	EWR Table
1) Genetically distinct Finniss southern pygmy perch	• Reaches 4,5,6 and 7 (fragmented populations)	2.3.3, 2.3.6 & 2.3.9
2) Mountain galaxias (Finniss and Tookayerta catchments have different species from rest of EMLR)	• Reaches 2-8	2.3.1 & 2.3.6
3) Mid Finniss diverse fish community	• Reaches 6 & 7	2.3.6
4) Fleurieu Swamp fish community	• Reach 4	2.3.9
5) Finniss River lowland stream and floodplain diverse fish community	• Reach 8	2.3.5 & 2.3.7
6) Finniss River terminal wetland diverse fish community including Yarra pygmy perch	• Reach 9	2.3.8
7) Presence of diadromous fish species in the Lower Finniss	• Reaches 7, 8 & 9	2.3.5
8) River blackfish potentially present (historic records)	• Formerly Reaches 2, 3, 5, 6 & 8	Possibly 2.3.2
9) No permanent fish communities due to lack of permanent water	• Reach 1	NA

Table 4.7.2. Summary of environmental objectives by reach for fish related ecological assets in the Finniss River Catchment.

Asset	***Environmental Objective***
Reach 1 – Finniss Catchment headwaters	
NA (possibly mountain galaxias)	
Reach 2 – Meadows Creek upper pool/riffle channel (EWR Table 2.3.1)	
Mountain galaxias	• Maintain self-sustaining populations
Reach 3 – Blackfellows Creek and Bull Creek upper pool/riffle channel (EWR Table 2.3.2)	
Mountain galaxias	• Maintain self-sustaining populations (brown trout structuring populations)
Reach 4 – Finniss Creek spring fed swamp section (EWR Tables 2.3.1, 2.3.3 & 2.3.9)	
Genetically distinct Finniss southern pygmy perch population	• Maintain or Restore restricted self-sustaining population
Mountain galaxias	• Maintain a self-sustaining population
Reach 5 – Meadows Creek pool/riffle channel under spring influence (EWR Tables 2.3.1, 2.3.3 & 2.3.6)	
Genetically distinct Finniss southern pygmy perch population	• Maintain restricted self-sustaining population (population structured by trout and redfin)
Mountain galaxias	• Maintain or Restore a self-sustaining population
Reach 6 – Heterogeneous mid-channel (EWR Tables 2.3.1, 2.3.3, 2.3.4 & 2.3.6)	
Diverse native fish community including threatened southern pygmy perch and mountain galaxias, plus three gudgeon species. Historically also included river blackfish.	• Maintain a self-sustaining populations of threatened species • Maintain diversity and composition of fish community
Reach 7 – Finniss pool/riffle channel under spring influence above waterfall (EWR Tables 2.2.1, 2.3.3, 2.3.6 & 2.3.8)	
Genetically distinct Finniss southern pygmy perch population	• Maintain restricted self-sustaining population
Mountain galaxias	• Maintain a self-sustaining population
Diadromous species (common galaxias and potentially lampreys – natural waterfall acts to limit access)	• Maintain restricted access of diadromous species
Reach 8 – Lowland channel and floodplain (EWR Tables 2.3.1, 2.3.5 & 2.3.7, potentially 2.3.2 & 2.3.3)	
Diverse native fish community including mountain galaxias, diadromous species (common galaxias, congolli and lampreys) and migratory species (Murray-Darling golden perch. Formerly (and potentially with further investigation) also southern purple-spotted gudgeon, southern pygmy perch, Murray rainbowfish, river blackfish, silver perch, Murray cod and freshwater catfish)	• Maintain and restore diversity and composition of fish community • Maintain a self-sustaining population of mountain galaxias (populations structured by natural competitors)
Reach 9 – Terminal wetland under Lake Alexandrina influence (EWR Table 2.3.8)	
Diverse native fish community including threatened species (Yarra pygmy perch and southern pygmy perch) and diadromous and migratory species (as above). Historically community was richer including southern purples-spotted gudgeon, chanda perch, Murray hardyhead, freshwater catfish and Murray rainbowfish	• Maintain and restore diversity, demographics and composition of fish community • Maintain self-sustaining populations of threatened pygmy perches

Reaches 2 & 3 – upper-pool riffle channels

This is a broad grouping of upper pool-riffle channel sections of the catchment, including upper Meadows Creek, Giles, Blackfellows and Bull creeks. Baseline data identifies mountain galaxias as the main ecological asset in these areas (diadromous common galaxias also in Giles Creek), with monitoring occurring in Bull Creek since 2004 (Appendix 8). The Bull Creek site has shown high relative abundance and peaks matching to strong recruitment and survivorship throughout monitoring (except perhaps autumn 2007) (Figure 4.7.2), and represents a key perennial refuge though a dry climatic period (Appendix 8).

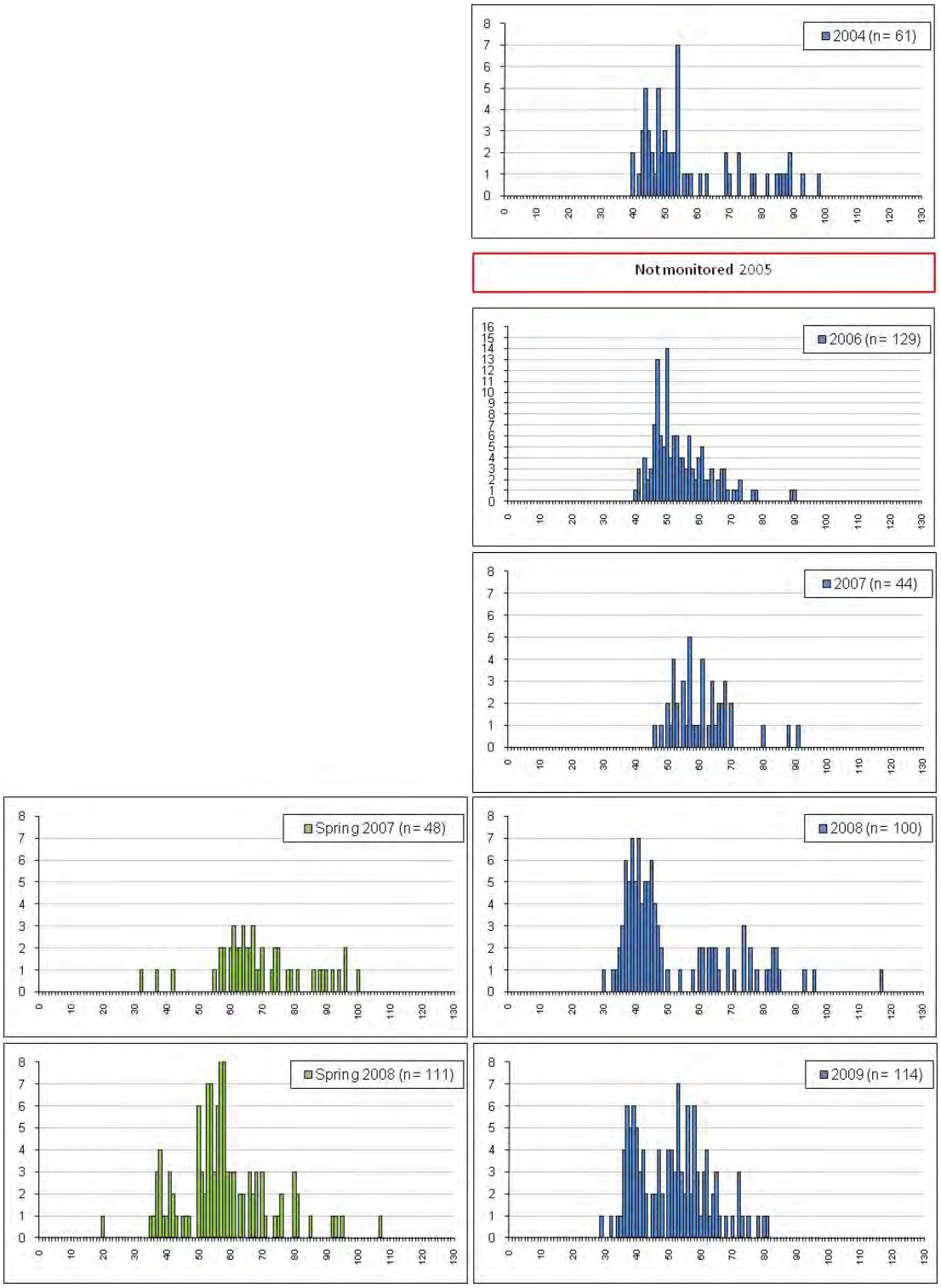


Figure 4.7.2. Length frequency data for mountain galaxias at Bull Creek 2004-2009.

Reach 4 – Finniss Creek swamps

A small population of southern pygmy perch was located in this swampy tributary to the Finniss in 2004 within an instream dam, no monitoring has occurred since.

Reach 5 – Meadows Creek

Lower Meadows Creek has a highly restricted population of threatened southern pygmy perch, under constant threat from large predatory introduced fishes (objectives relate to maintaining sustaining populations of natives and suppressing exotics). Mountain galaxias represent a second fish related ecological asset. The site has been monitored annually since 2001 (Appendix 8).

The relative abundance of southern pygmy perch has fluctuated, but was mostly low with occasional higher catches (i.e. autumn 2004 and 2009: Appendix 8). This translates to generally low recruitment with some better years, and ongoing low survivorship (Figure 4.7.3). Mountain galaxias have been collected only in low abundance up until spring 2007, with a large increase in relative abundance in this and subsequent monitoring events (Appendix 8). Demographic data indicates the resurgence relates to successive strong recruitment events (Figure 4.7.4). Adult introduced predatory brown trout and redfin have been sampled in low abundance from different pools since 2001 (normally one large predator in a pool), with removal of these non-native species undertaken to examine gut content and as a localised conservation measure for southern pygmy perch. No introduced predators were found in the ~500m sampling reach in spring 2008 and autumn 2009 (Appendix 8). The gut content of introduced predators during periods of low flow and static pools included low numbers of flathead gudgeon, as well as dragonfly larvae and yabbies. Sampling in autumn 2007 occurred after the break in season and the stomach content of a large brown trout (405mm TL) indicated active feeding on native fishes with onset of seasonal flow (16 fish: Table 4.7.3),

The extent of surface water availability decreased dramatically in autumn 2008 and 2009 with contraction to small pools. Autumn salinity was moderate with values ranging between 2000-4000µS between 2001-2007, with higher readings in the last two autumns (up to 6840µS) (Appendix 8).

The combined localised predator removal effort, low stream flow connectivity limiting colonisation, and poor conditions in concentrated pools appear to have limited the presence of large bodied predatory species, with a positive response in small native fishes previously suppressed as indicated by a long-term data set. While low flow is not ideal for native species owing to habitat loss and the risk of refuge drying, where introduced predators occur some level of flow related habitat disturbance (desiccation) seems to favour native species (cf. Closs and Lake 1996), and provides a window into their historic population processes (i.e. strong annual recruitment in the absence of introduced predators). Outside of low flow periods, strong heterogeneity viewed as a mosaic of small and large pools and different habitat types (e.g. shallows, amphibious and aquatic plants), links to flow related processes such as base flow and onset and cessation of flow, and likely allowed the persistence of native fishes at low population levels (i.e. resilience).

Fish indicators for EWR assessment suggests an overall good condition of the site to allow persistence of key ecological assets through time, especially in low flow periods and with the general presence of introduced predators.

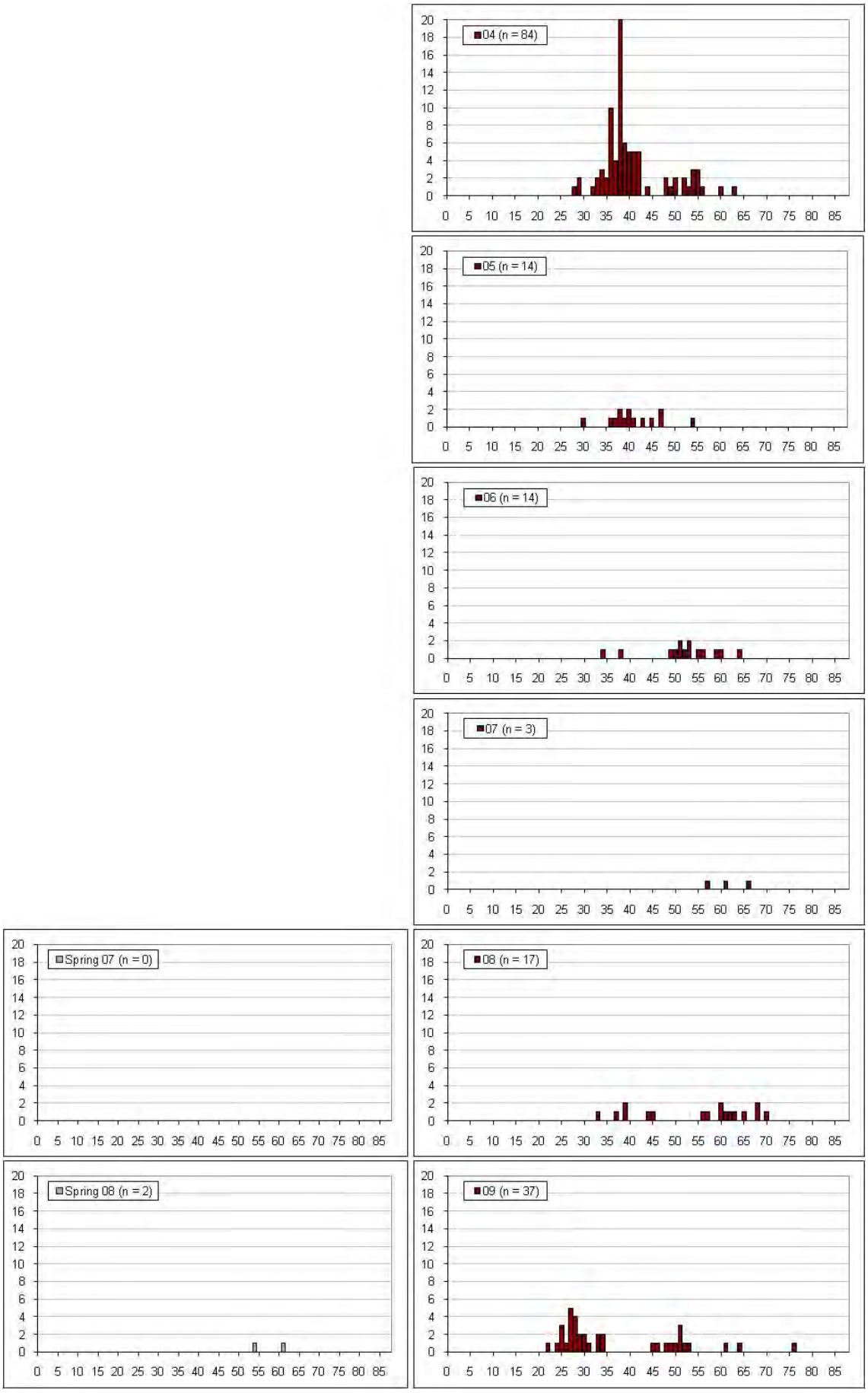


Figure 4.7.3. Length frequency data for southern pygmy perch at Meadows Creek 2004-2009.

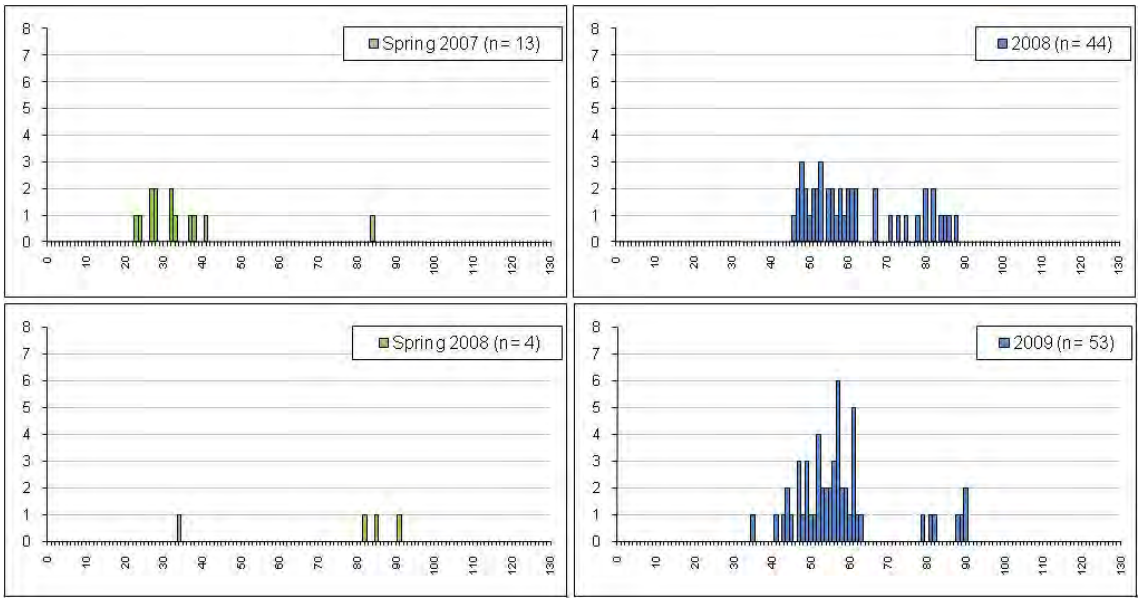


Figure 4.7.4. Length frequency data for mountain galaxias at Meadows Creek 2004-2009.

Comparison of available habitat at Meadows Creek in autumn 2007 and autumn 2009

Table 4.7.3. Stomach content of introduced predators at Meadows Creek 2005-2009 (FHG = flathead gudgeon, MG = mountain galaxias).

Species	Site code	Waterway	TL	Gut content
Brown trout	ML05-17	Meadows Creek	432	Gambusia x 1, boatman
Brown trout	ML05-17	Meadows Creek	301	Yabby
Brown trout	ML05-17	Meadows Creek	295	Surface insects
Brown trout	ML07-39	Meadows creek	405	FHG x 15 (34-90mm) and MG x1 (55mm)
Brown trout	ML07-69	Meadows Creek	445	Macroinvertebrates
Redfin	ML05-17	Meadows Creek	123	Dragon fly larva
Redfin	ML07-69	Meadows Creek	420	Yabby
Redfin	ML08-08	Meadows Creek	130	
Redfin	ML08-08	Meadows Creek	181	
Redfin	ML08-08	Meadows Creek	222	
Redfin	ML08-08	Meadows Creek	209	Dragonfly
Redfin	ML08-08	Meadows Creek	396	FHG x2
Redfin	ML08-08	Meadows Creek	401	
Redfin	ML08-08	Meadows Creek	198	FHG
Redfin	ML08-08	Meadows Creek	234	Gambusia

Stomach content of a brown trout from Meadows Creek - active feeding on native fishes was evident with the onset of seasonal flow (autumn 2007)

Reach 6 – Heterogeneous mid-pool channel

This reach is extensive and has strong site-based heterogeneity in the types of pools and geomorphology. There is widespread baseline sampling in the reach, with a site downstream of Coles Crossing having a restricted population of southern pygmy perch. The pygmy perch site has been the focus of monitoring since 2001.

The relative abundance and recruitment of southern pygmy perch was high between 2003-2005, but recruitment and survivorship has since been poor (especially 2007), cumulating with no fish recorded in autumn 2009 (Figure 4.7.5). Mountain galaxias are patchily distributed at the site (one core pool) but have shown reasonable recruitment and survivorship in recent years (Figure 4.7.6). Alien species occur in low abundance in smaller pools (larger pools are not efficiently sampled for predatory species with backpack electrofishing), however there was a notable successful spawning event of redfin in winter/spring 2008 as noted by a strong pulse of 50-100mm fish (Figure 4.7.6), a size previously un-recorded at the site.

Environmental data indicates salinity has been steady at 1500-2500µS for 2001-2009, with water availability much reduced in autumn 2008 and 2009 including the heavy concentration, then drying, of the core southern pygmy perch pool respectively (Appendix 8). Several small pools had black water and low dissolved oxygen.

The core southern pygmy perch pool represents a series of smaller pools representing a habitat type created and maintained by flow as a small refuge within larger pools that have introduced predatory fish (downstream is a large weir-pool created by an illegal in stream dam in 2003) (see Hammer 2005). Flow stress has reduced the resilience of the population by reducing heterogeneity in local habitat, causing the loss of key refuge habitat, and creating generally poor water quality in remaining pools. This represents stress beyond intermediate disturbance that has caused native species decline. Hence fish EWR indicators for this site indicate it to be in poor condition.

Core southern pygmy perch refuge pool at mid-Finniss – dry autumn 2009

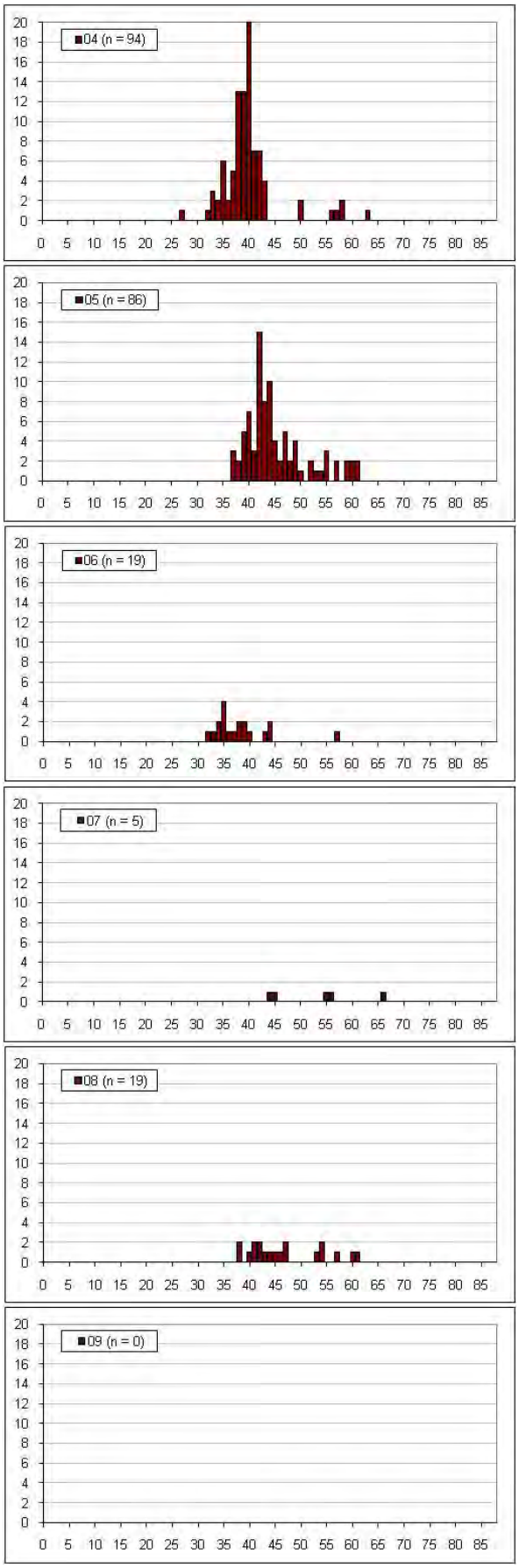


Figure 4.7.5. Length frequency data for southern pygmy perch at mid-Finniss 2004-2009.

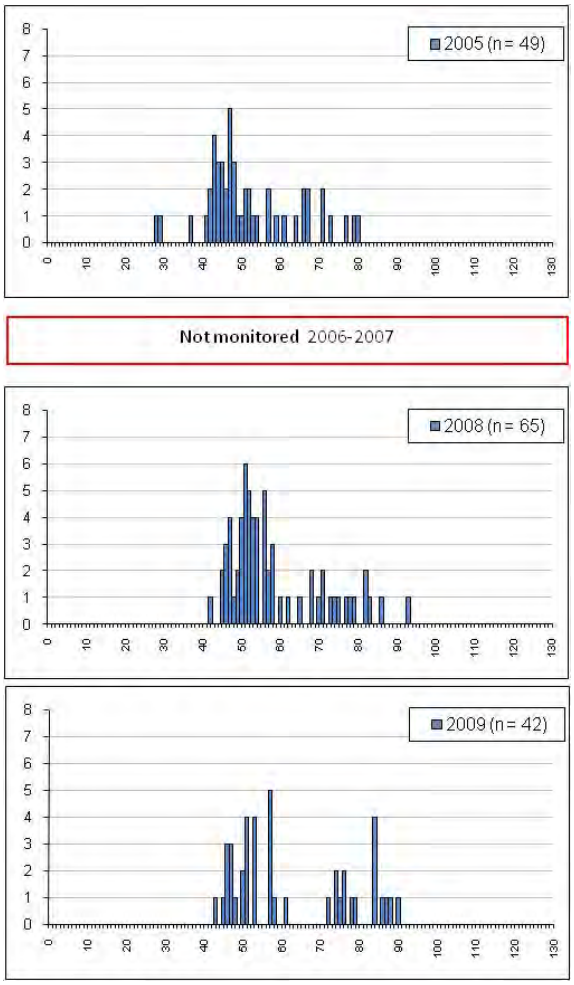


Figure 4.7.6. Length frequency data for mountain galaxias at mid-Finniss 2005-2009.

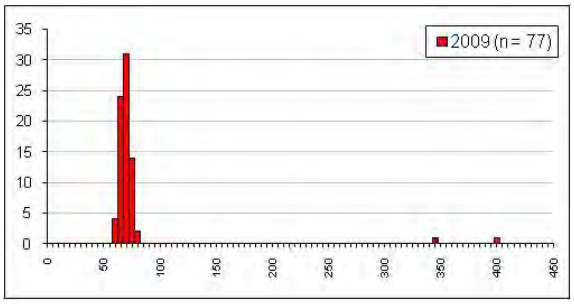


Figure 4.7.7. Length frequency data for redfin at mid-Finniss 2009.

Reach 7 – Mid-channel with springs

This stream reach represents a small section of the mid-channel under the influence of baseflow and above a waterfall. A localised diverse native fish community occurs in shallow rocky pools including southern pygmy perch, mountain galaxias and occasional common galaxias. The site has been monitored since 2001 (Appendix 8).

This reach has acted as a strong catchment refuge for a genetically distinct sub-population of southern pygmy perch, with high to very high relative abundance recorded from 2001-2007 (Appendix 8). Strong recruitment was always evident, with variable adult survival recorded, however in autumn 2008 less recruits (i.e. 25-45mm) were noted, and in autumn 2009 only a single fish was recorded with a population collapse evident (Figure 4.7.8). A diverse fish community was also maintained up until autumn 2009 (five other native species)

Perennial baseflow has traditionally been recorded at the site, this stopped briefly in January 2008, before an extended period of cease to flow in January and February 2009. During this time extensive habitat drying and desiccation occurred, and remaining pools had poor water quality (e.g. low dissolved oxygen: Appendix 8). Salinity has ranged between 1500-2500µS.

The loss of baseflow at this site has caused catastrophic decline in habitat condition with a matching crash in southern pygmy perch and native fish diversity. Thus one of the previously best performing sites in the EMLR has declined within a very short time, and any recovery will depend on return of baseflow conditions over summer 2009/10.

Finnnis waterfalls site in February 2009 –
pool drying occurred rapidly after the cessation of baseflow

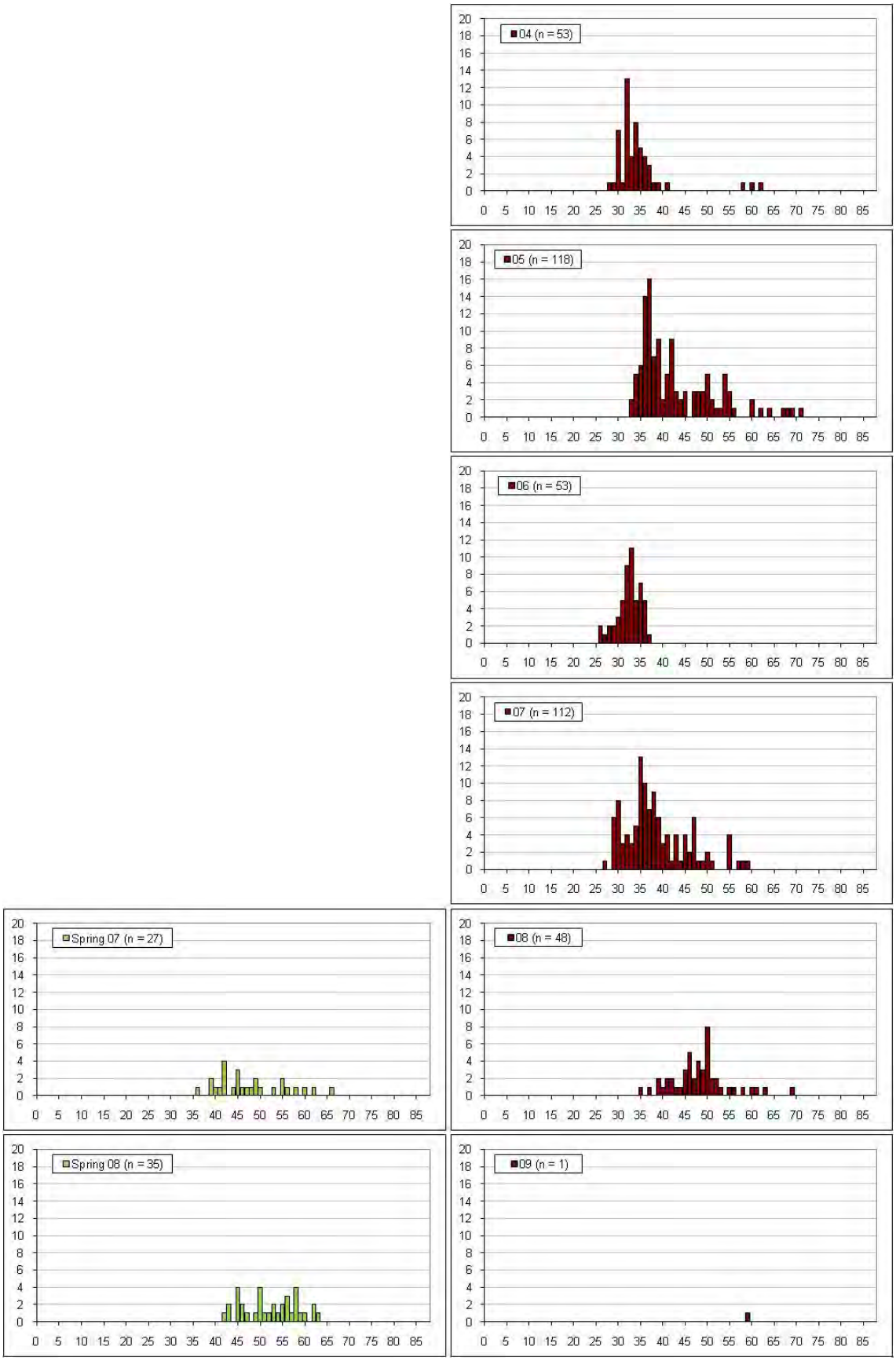


Figure 4.7.8. Length frequency data for southern pygmy perch at Finniss waterfalls 2004-2009.

Reach 8 – Lowland channel (with floodplain)

The section of lowland stream between the waterfalls and Winery Road is very heterogeneous, particularly the lower section which has floodplain and braided channel habitat. The reach supports a diverse native fish community including three diadromous species (Appendix 8). Historically many other species were also recorded including river blackfish, Murray cod, southern purple-spotted gudgeon, and Yarra pygmy perch. Baseline sampling has been undertaken at several sites, with temporal replication undertaken at the railway bridge in 2009 representing the extent of current monitoring in the reach (note ML04-44 is comparable with ML09-51 & 52). Additional information on habitat availability and species distribution was collated from sampling in the eastern arm of the Finniss downstream of the railway bridge site in autumn 2009 (i.e. ML09-60 & 61) as baseline for a potential reintroduction program (Appendix 8).

The diversity of native fish remained similar between 2004 and 2009 snapshots, however the 2009 total (*n*= 6) excluded the previously recorded mountain galaxias which was collected from riffles interconnecting pools in 2004 (two hybrid *Philypnodon* were recorded in 2009 only). Relative abundance of native fish was also similar, except for lower numbers by half for common galaxias in 2009. Length frequency data suggests that a lack of recruitment may be contributing to this decline, as all common galaxias captured were large adults >100mm (Figure 4.7.9). Likewise, no juvenile congolli were captured, with the few fish all being >170mm (Figure 4.7.10). The species and relative abundance of alien species was similar between 2004 and 2009 (Appendix 8).

Environmental conditions in the reach retain a high level of heterogeneity including a mosaic of small and large pools and interconnecting shallow riffles maintained in dry periods by local spring flows. Environmental descriptors were similar to 2004 with low-moderate salinity (i.e. 2000-3000µS) and moderate underwater cover, although edge vegetation had declined owing to heavy stock access (note fencing had been erected shortly before sampling) (Appendix 8). The diversity of aquatic plants is an important feature of the site (e.g. patches of *Vallisneria*, array of amphibious species), and more intensive sampling identified patches of *Ottelia, Myriophyllum and Ceratophyllum* all species which are rare or not seen elsewhere in EMLR streams and which have declined broadly from the region following desiccation of fringing habitats of the Lower Lakes.

Overall the performance to maintain the diversity of the fish community noted a slight decline (loss of flow sensitive mountain galaxias) and the vulnerability of diadromous species due to occurrence as only large adults. The potential to restore the community remains high. The lowland braided channel and heterogeneous small pool habitat downstream of the railway bridge represents an ideal restoration site as part of recovery efforts (reintroduction) for southern purple-spotted gudgeon and Yarra pygmy perch. Ongoing preservation of low flows and transition flows at the site will support and active habitat restoration measure such as fencing the stream corridor. Maintaining and restoring the area as a core tributary refuge upstream of the influence of Lake Alexandrina provides a key measure for persistence of aquatic fauna and flora for future recovery of the Lower Lakes with the return of suitable conditions.

Large refuge pool at the railway bridge

Small pool and riffle sequence between larger pools (contains Vallisneria*)*

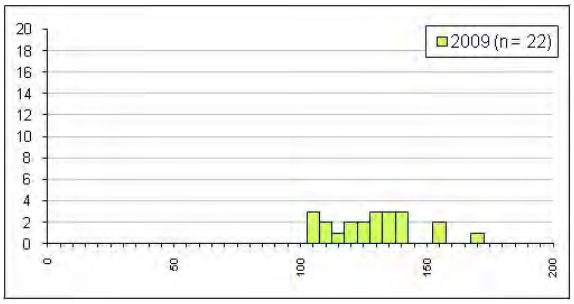


Figure 4.7.9. Length frequency data for common galaxias at railway bridge autumn 2009.

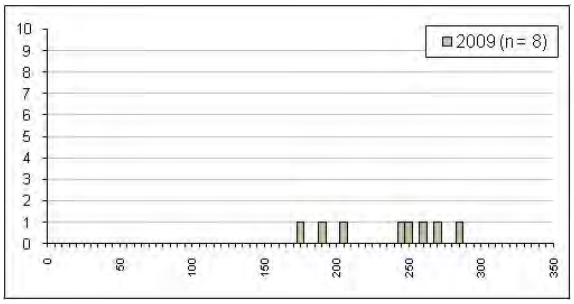


Figure 4.7.10. Length frequency data for congolli at Finniss railway bridge autumn 2009.

Large adult common galaxias from Finniss Lowland channel

Ottelia *in a small pool within the heterogeneous lowland Finniss channel*

Reach 9 – Terminal wetland

The Finniss terminal wetland contains key habitats including (1) pool transition between the Finniss and Lake just below Winery Road, (2) series of off channel wetlands including Blue Lagoon, (3) a deep river channel with dense fringing vegetation, and locations with dense submerged aquatic vegetation (mainly *Ceratophyllum*), and (4) junction point where the a deep channel opens out into Lake Alexandrina joining the Tookayerta (Black Swamp). These habitats collectively have recorded a high diversity of fishes including three threatened species in recent years (i.e. Yarra pygmy perch, southern pygmy perch and Murray hardyhead), and a range of other species historically. Data is mostly opportunistic for this reach as part baseline sampling prior to 2004 (Hammer 2001, 2004; Wedderburn and Hammer 2003), and as part of intensive efforts to locate Yarra pygmy perch as Lake Levels lowered after summer 2007 (Hammer 2007c). Monitoring sites have been initiated in the last two years for the section just downstream of Winery Road, and annual spring data was collected at Blue Lagoon as part of a Pembroke School education program since 2001 (Appendix 8). The Black Swamp area is covered under Tookayerta terminal wetland.

The diversity of fishes in the reach has declined with extensive drying and isolation of emergent vegetation due to low Lake Alexandrina levels. At Blue Lagoon, Yarra pygmy perch were initially recorded in dense *Ceratophyllum* and *Myriophyllum*, however the species declined with the gradual loss of this habitat, with no fish seen since spring 2004 and complete drying occurring by spring 2008. There is no baseline data prior to 2007 for immediately downstream of Winery Road, with the community relatively stable over 2008 and 2009 monitoring. The community is diverse with nine native species were recorded (including Murray hardyhead), however relative abundance have been consistently low for most species including diadromous species (Appendix 8). Previous habitat of Yarra pygmy perch and southern pygmy perch at and just downstream of Wallys Wharf have been dry or severely degraded due to low summer water levels, and both species have not been seen in recent years. Alien species are present in low to moderate relative abundance. A brief examination of fish movement during tributary flow in September 2008 (ML08-60) did not identify any significant upstream movement of diadromous or euryhaline species.

Environmental conditions have clearly declined in most of this reach due to broader lowering of Lake Alexandrina levels, however the pools below Winery Road have a small disconnection point that prevents complete exposure to regional water levels and instead is maintained mostly by Finniss flows. Salinity here is low-moderate (1500-3500µS) but with only moderate levels of underwater cover (does include some *Vallisneria*) (Appendix 8).

As for other EMLR terminal wetlands the condition of the relevant Finniss reach has been drastically altered by broader flow issues and has thus performed poorly in recent years.

Blue Lagoon spring 2007 – note isolation and desiccation of littoral (emergent) vegetation

Overall performance report

A summary report for the Finniss Catchment is detailed in Table 4.7.4. Some upper catchment areas performed well, but the mid and lower catchment are in declining condition.

Table 4.7.4. 2009 report card for Finniss River Environmental Water Requirements – a summary of performance against fish indicators assessed with field data. Blank indicators were not assessed or not relevant in 2009. For exotic species ticks indicate the desirable result was observed (i.e. not detected, low abundance or invasion was not detected) and crosses indicate a negative result (i.e. present, abundance had not been suppressed or invasions occurred). *Recolonisation = invasion for exotic species.

Asset	***Environmental Objective***	***Indicator***							
		Presence	Population extent	Recolonisation*	Recruitment	Survivorship	Spawning/larvae	Movement/habitat	Low_exotic abundance
Reach 3 – Bull Creek									
Mountain galaxias	• Maintain and Restore self-sustaining populations	✓			✓	✓	✓		
Exotic species	• Discourage colonisation and establishment	✓							✓
Reach 5 – lower Meadows Creek									
Southern pygmy perch	• Maintain a self-sustaining population	✓	✗		✓	✓			
Exotic species	• Discourage colonisation and establishment (especially redfin)	✓							✓
Reach 6 – mid pool channel									
Southern pygmy perch	• Maintain self-sustaining populations	✗	✗		✗	✗			
Mountain galaxias	• Maintain self-sustaining populations	✓	✗		✓	✓			
Exotic species	• Suppress exotics	✗							✗
Reach 7 – mid channel springs									
Southern pygmy perch	• Maintain self-sustaining populations	✓	✗		✗	✗			
Diverse fish community	• Maintain diversity and composition of fish community	✗	✗			✗			
Exotic species	• Suppress exotics	✓							✓
Reach 7 – Finniss lowland channel									
Diverse fish community	• Maintain diversity and composition of fish community	✗	✓			✗			
	• Maintain diadromous and potamodromous species	✓	✓		✗	✓			
Exotic species	• Suppress exotics	✗							✓
Reach 9 – Finniss terminal wetland									
Lower Finniss fish community	• Maintain diversity and composition of fish community	✓	✗		✗				
Threatened species	• Maintain or restore self-sustaining populations	✗	✗	✗	✗	✗			
Exotic species	• Suppress exotics	✗							✓

4.8 Tookayerta Creek Catchment

Characterised by glacial sands, peat, swamp heath vegetation and high rainfall, the Tookayerta Creek Catchment is highly contrasting to other catchments in the EMLR and indeed elsewhere in the state and Murray-Darling Basin. It is a small catchment (100km^2) perched in a low gradient basin with headwaters originating on either side of the Mount Compass Township. However, these are not headwaters in the traditional sense, rather a series of interconnected swamps (under natural conditions) along shallow depressions. The catchment is Y shaped and basically has three main arms: the Nangkita Creek and upper Tookayerta Creek (forming the branches of the Y) and a smaller tributary, Swampy Creek. These unite to form a continuous lower Tookayerta Creek section eventually connecting with the Finniss River arm of Lake Alexandrina. Stream habitats are generally heavily associated with swampy littoral areas or disappear into swamp vegetation (e.g. tea tree) or large beds of *Phragmites* along stream sections. The Swampy Creek area (and indeed much of the catchment) would have once been a continuous swamp, however, clearance (physical and by stock), excavation and drainage now means that fragments of swamps are interconnected by channels or dams. Creek lines are modified or artificial in many areas but there are still true lotic habitats, particularly in upper Tookayerta Creek. There is stock access in places of the catchment, but considerable areas are fenced or have alternate land use.

Eight provisional reaches have been defined in the Tookayerta Creek Catchment, these need some revision in line with broader geomorphologic review but does not affect current monitoring sites (Fig. 4.8.1).

Fish related assets identified by Hammer (2004) are shown in Tables 4.8.1 & 4.8.2. These include a patchy but secure population of river blackfish in unique swampy habitat, two genetically distinct populations of southern pygmy perch (a Tookayerta sub-population in the upper catchment and a Lake Alexandrina sub-population in the terminal wetland: Hammer 2001), mountain galaxias populations which along with the Finniss represent a different species to other EMLR catchments (SA Museum unpublished), one of two populations of Yarra pygmy perch on the Murray-Darling Basin occurring in the Tookayerta/Finniss terminal wetland (Reach 8), and diverse native fish communities in the terminal wetland.

Environmental objectives, water requirements and monitoring recommendations are shown in Tables 4.8.1 & 4.8.2, and these match fish related ecological assets identified in the Tookayerta Creek Catchment to the relevant EWR tables of Section 2.3. Long-term monitoring (since 2001) has occurred in several reaches (Appendix 9).

Tookayerta: distinct mountain galaxias form (left) and juvenile river blackfish

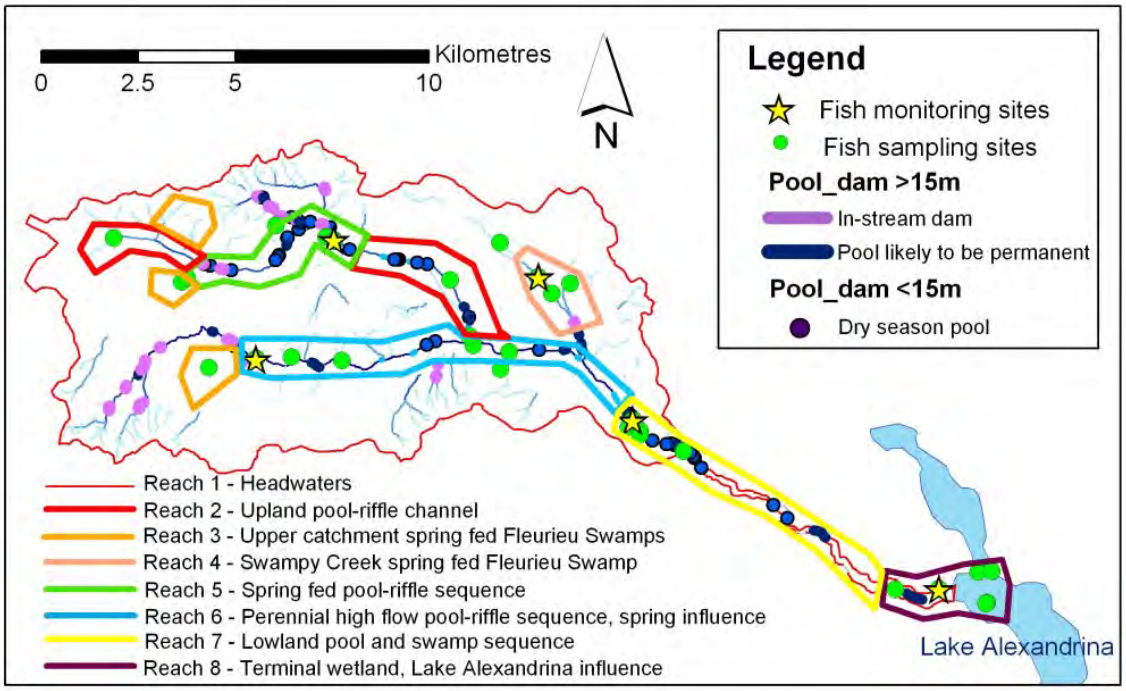


Figure 4.8.1. Map of the Tookayerta Creek Catchment showing provisional river reaches

Table 4.8.1. Distribution patterns and significant environmental assets in the Tookayerta Catchment relating to fish species and communities.

Specific asset/pattern	Location	EWR Table
1) Genetically distinct Tookayerta southern pygmy perch	• Reaches 2 (marginal population) 3, 4, 5, 6 & 7.	2.3.3, 2.3.6 & 2.3.9
2) River blackfish	• Reaches 4, 5, 6 & 7	2.3.2, 2.3.6 & 2.3.9
3) Mountain galaxias (Finniss and Tookayerta catchments different species from rest of EMLR)	• Reaches 2-6	2.3.1, 2.3.6 & 2.3.9
4) Lower Tookayerta/terminal wetland diverse fish community	• Reach 8	2.3.7 & 2.3.8
5) Yarra pygmy perch	• Reach 8	2.3.8
6) Presence of diadromous fish species in the Lower Tookayerta	• Reach 8	2.3.5
7) No permanent fish communities due to lack of permanent water	• Reach 1 (patchy populations may be present in perched swamps)	NA (possibly 2.3.1, 2.3.2 & 2.3.9)

Table 4.8.2. Summary of environmental objectives by reach for fish related ecological assets in the Tookayerta Creek Catchment.

Asset	***Environmental Objective***
Reach 1 – Tookayerta Catchment headwaters	
NA	
Reach 2 – Upland pool/riffle channel (EWR Tables 2.3.1, 2.3.2 & 2.3.3)	
Mountain galaxias	• Maintain self-sustaining populations
Southern pygmy perch and river blackfish	• Restore self-sustaining populations
Reach 3 – Upper catchment spring fed Fleurieu Swamps (EWR Table 2.3.9)	
Mountain galaxias	• Maintain self-sustaining populations
Genetically distinct Tookayerta southern pygmy perch	• Maintain (e.g. Square Waterhole) and Restore (School Swamp) self-sustaining populations
Reach 4 – Swampy Creek spring fed swamp section (EWR Tables 2.3.3 & 2.3.9)	
Genetically distinct Tookayerta southern pygmy perch	• Maintain or Restore restricted self-sustaining population
Mountain galaxias	• Maintain a self-sustaining population
Reach 5 – Spring fed pool/riffle sequence (EWR Tables 2.3.1, 2.3.2, 2.3.3 & 2.3.6)	
Genetically distinct Tookayerta southern pygmy perch	• Maintain restricted self-sustaining population
River blackfish	• Maintain restricted self-sustaining population
Mountain galaxias	• Maintain a self-sustaining population
Reach 6 – Perennial (spring influence) high flow pool-riffle sequence (EWR Tables 2.3.1, 2.3.2 & 2.3.6)	
River blackfish	• Maintain restricted self-sustaining population (population potentially structured by brown trout)
Mountain galaxias	• Maintain and restore a self-sustaining population (population structured by brown trout)
Reach 7 – Lowland pool and swamp sequence (potentially under spring influence) (EWR Tables 2.3.2, 2.3.3, 2.3.9)	
Genetically distinct Tookayerta southern pygmy perch population	• Maintain self-sustaining population
River blackfish	• Maintain self-sustaining population
Reach 8 – Black swamp and terminal wetland under Lake Alexandrina influence (EWR Tables 2.3.5, 2.3.7 & 2.3.8)	
Diverse native fish community including threatened southern pygmy perch (Lake Alexandrina sub-population – Black Swamp and terminal wetland), Yarra pygmy perch (terminal wetland only), gudgeons, and diadromous species (common galaxias and congolli). Formerly Murray hardyhead (terminal wetland)	• Maintain and restore diversity and composition of fish community • Maintain self-sustaining populations of pygmy perches

Reach 2 – Nangkita upper pool-riffle channel

Baseline sampling identified mountain galaxias and southern pygmy perch in this reach, but it is not currently monitored (but may reflect inter-connected spring fed reach Section 5).

Reaches 3 & 4 – Fleurieu swamps

The Tookayerta is unique among other EMLR catchments in containing areas of Fleurieu Swamp. Baseline sampling indicated this habitat type is occupied by several native species in different areas of the catchment with southern pygmy perch a key ecological asset. One swamp section, Swamp Creek, has had a long-term monitoring site at Brawley's Swamp (Appendix 9).

Southern pygmy perch relative abundance has remained low at the site (<25 fish), with length frequency data suggesting that low levels of recruitment occur with occasional better years such as that observed from autumn 2008 data (Figure 4.8.3). The extreme summer of 2009 lead to the cessation of base flow and drying of most surface water in the swamp, with a matching loss of fish detected in the subsequent autumn. Environmental conditions included consistently low salinity (<1000µS), generally low pH (5.2-6.7) with shallow and densely vegetated habitat (emergent swamp species) (Appendix 9).

Observations of sustaining population at low population level in all but the most extreme flow seasons (drought) suggest that swamps do provide a potential refuge for southern pygmy perch, and that the species can tolerate environmental extremes of these shallow and densely vegetated habitats. There are other sites nearby that have excavated pools or drainage channels that have more open water and have higher fish abundance (see Appendix 9), however the monitoring site was chosen to represent more natural swamp conditions. Future assessment will test connectivity within the system for recolonisation.

Shallow, densely vegetated Fleurieu Swamp habitat at Swamp Creek (autumn 2009)

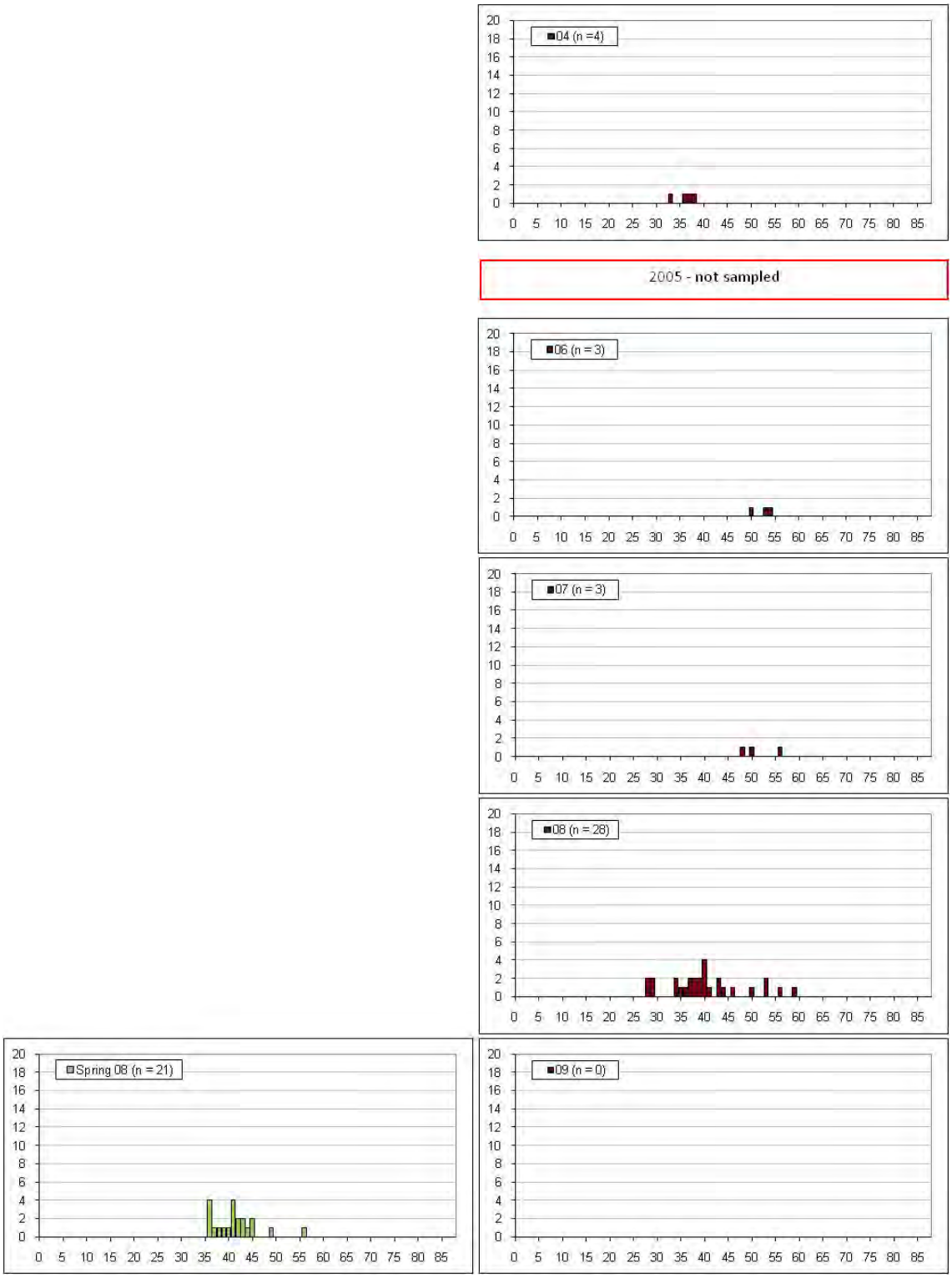


Figure 4.8.3. Length frequency data for southern pygmy perch at Brawley's Swamp 2004-2009.

Reach 5 – Nangkita spring fed upper pool-riffle channel

This perennial stream reach has high ecological value containing populations of three threatened freshwater specialists. The site has been monitored since 2001(Appendix 9).

Southern pygmy perch has persisted strongly at the site over the nine year monitoring period, including the last two years, with low-medium relative abundance and ongoing signs of recruitment and survivorship (Figure 4.8.4). The length frequency data show an unusual pattern at this site (similar also to Deep Creek Road, Reach 7) with a spread of fish across a wide range with only slight peaks, suggesting protracted or extended spawning and recruitment atypical to that seen in other populations. River blackfish are more difficult to monitor owing to dense cover and dark substrate, but even so ongoing recruitment and moderate survivorship has been noted (Figure 4.8.5). Data for mountain galaxias shows variable abundance, but with strong recruitment and survivorship in the last two years at least (Figure 4.8.6). Only occasional introduced species are recorded at the site (brown trout and Gambusia: Appendix 9), with a large brown trout (515mm) collected in autumn 2007 found to contain two adult mountain galaxias (79 & 83mm) and dragonfly larvae.

Environmental data at this site has been fairly consistent, with low salinity (<500µS), cool flowing water, and moderate levels of submerged physical and emergent cover. Submerged aquatic plants (*Potamogeton ochreatus*) have been recorded in some years, but not recently Appendix 9). This may be linked to increasing siltation since 2007 where the average depth of pools has been steadily decreasing in the absence of larger flushing flow periods.

The assessment of this site is positive as perennial base flow continues to support a key local and EMLR refuge for impotent ecological assets.

Willowburn Road site on Nangkita Creek autumn 2009

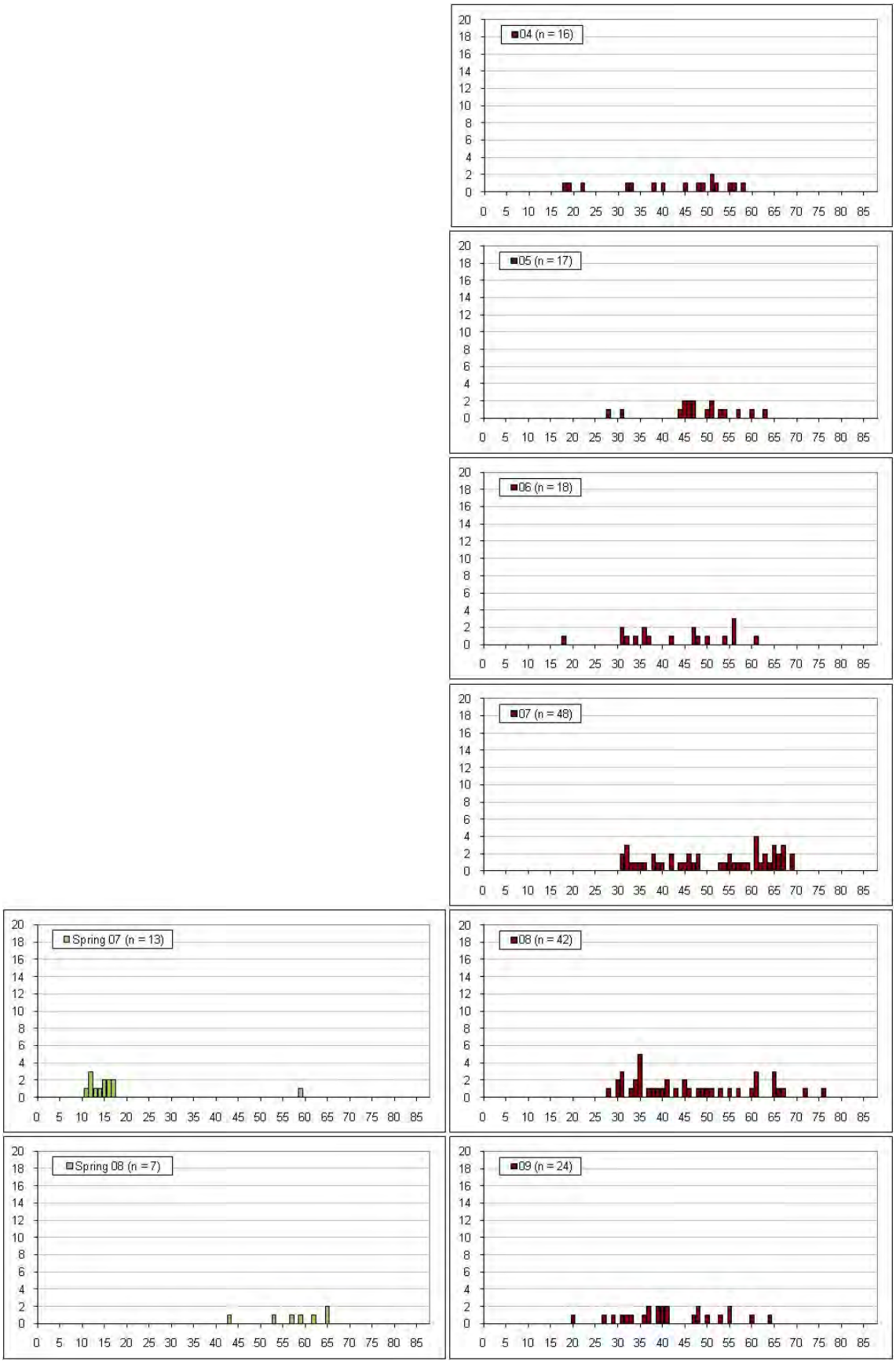


Figure 4.8.4. Length frequency data for southern pygmy perch at Willowburn Road 2004-2009.

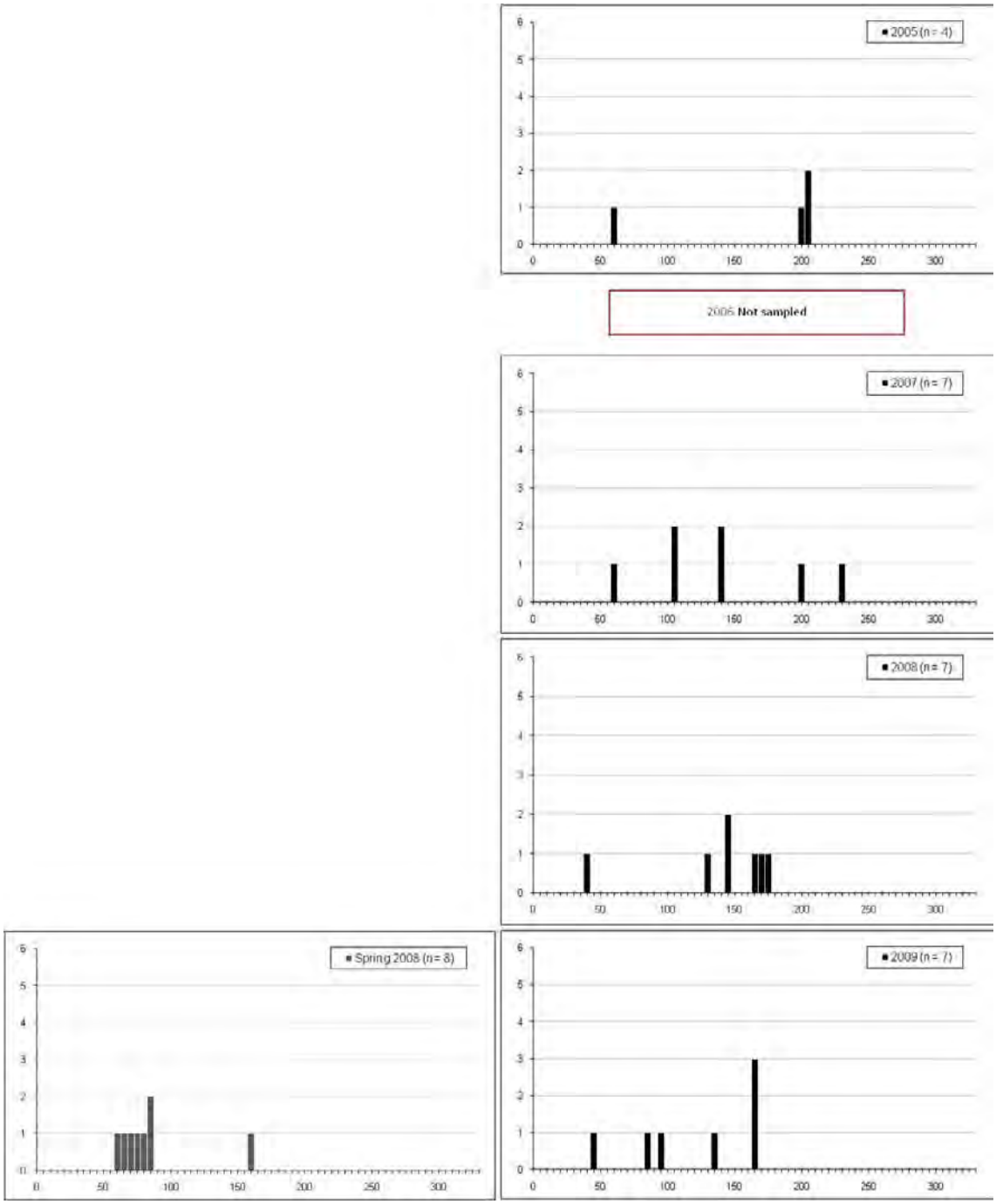


Figure 4.8.5. Length frequency data for river blackfish at Willowburn Road 2004-2009.

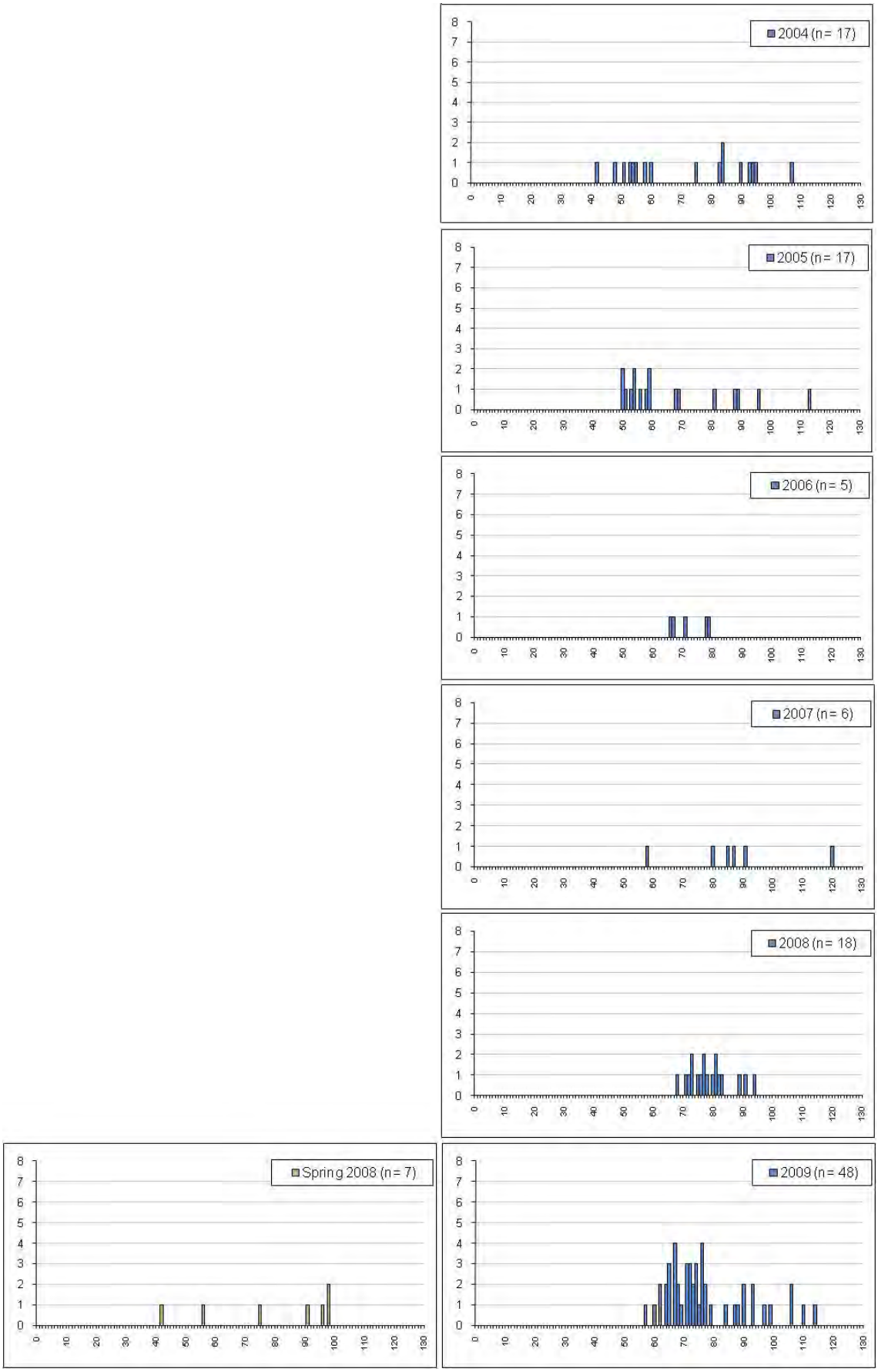


Figure 4.8.6. Length frequency data for mountain galaxias at Willowburn Road 2004-2009.

Reach 6 – Tookayerta spring fed upper pool-riffle channel

This reach has strong perennial flow with a core population of river blackfish and occasional other native species (mountain galaxias and southern pygmy perch). Brown trout are common in the area, with a trout free section monitored since 2004 (Appendix 9). Low numbers of blackfish have been consistently recorded within a small stretch of habitat, but importantly this included young of year (0+) fish in most years including the last two years (Figure 4.8.7). Increasing numbers of mountain galaxias and southern pygmy perch have been recorded in the last two years (Appendix 9). Environmental conditions have been stable with low salinity (<350µS), cool, flowing water and moderate levels of cover (Appendix 9). Hence this site remains in a good condition.

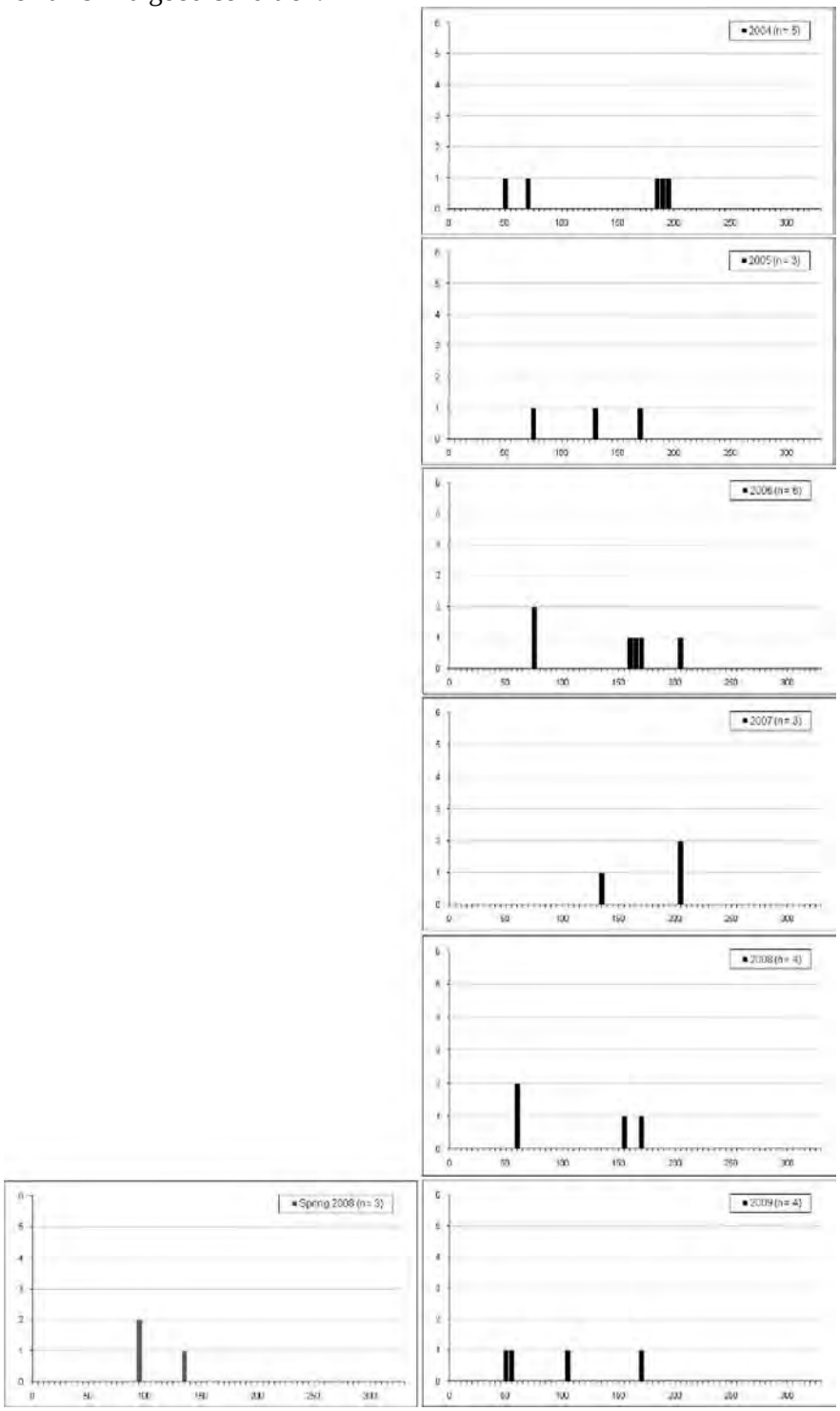


Figure 4.8.7. Length frequency data for river blackfish at Compass Cabins 2004-2009.

Reach 7 – Tookayerta lowland channel

The lowland reach of the Tookayerta contains larger pools interspersed with sections of swamp. This is core habitat for southern pygmy perch, with less abundant river blackfish and mountain galaxias, Gambusia also occur. Monitoring has occurred at Deep Creek Road since 2001 (Appendix 9).

Southern pygmy perch was recorded in moderate to high abundance up to 2008, with fewer fish recorded in autumn 2009. Ongoing recruitment and survivorship has been observed, with a wide spread of fish and few defined peaks in length frequency data (likely protracted spawning associated with cool base flow base as for Willowburn Road) (Figure 4.8.8). Electrofishing data for 2006 onwards recorded low numbers of river blackfish, however spikes correlating to young of year fish are noted in most years, especially 2006 (Figure 4.8.9). Gambusia has generally been recorded in low abundance particularly in recent years.

Environmental data at this site has been consistent, with low salinity (<900µS) and low to medium flow recorded in all autumns (note however that flow was observe to have ceased in at this site in summer 2008 and 2009). The levels of emergent cover have been steadily increasing since 2001, and conversely depth has been decreasing, mainly through the encroachment of *Phragmites* and concentration of silt, *Azolla* and *Callitriche* within its stems (Appendix 9). This has been particularly apparent in the low flow conditions of the last two years. Fish indicators for EWR assessment suggest an overall good condition of the site to allow persistence of key ecological assets through time, especially in the recent low flow period.

Deep Creek Road site in autumn 2005 (top) and 2009 (lower)

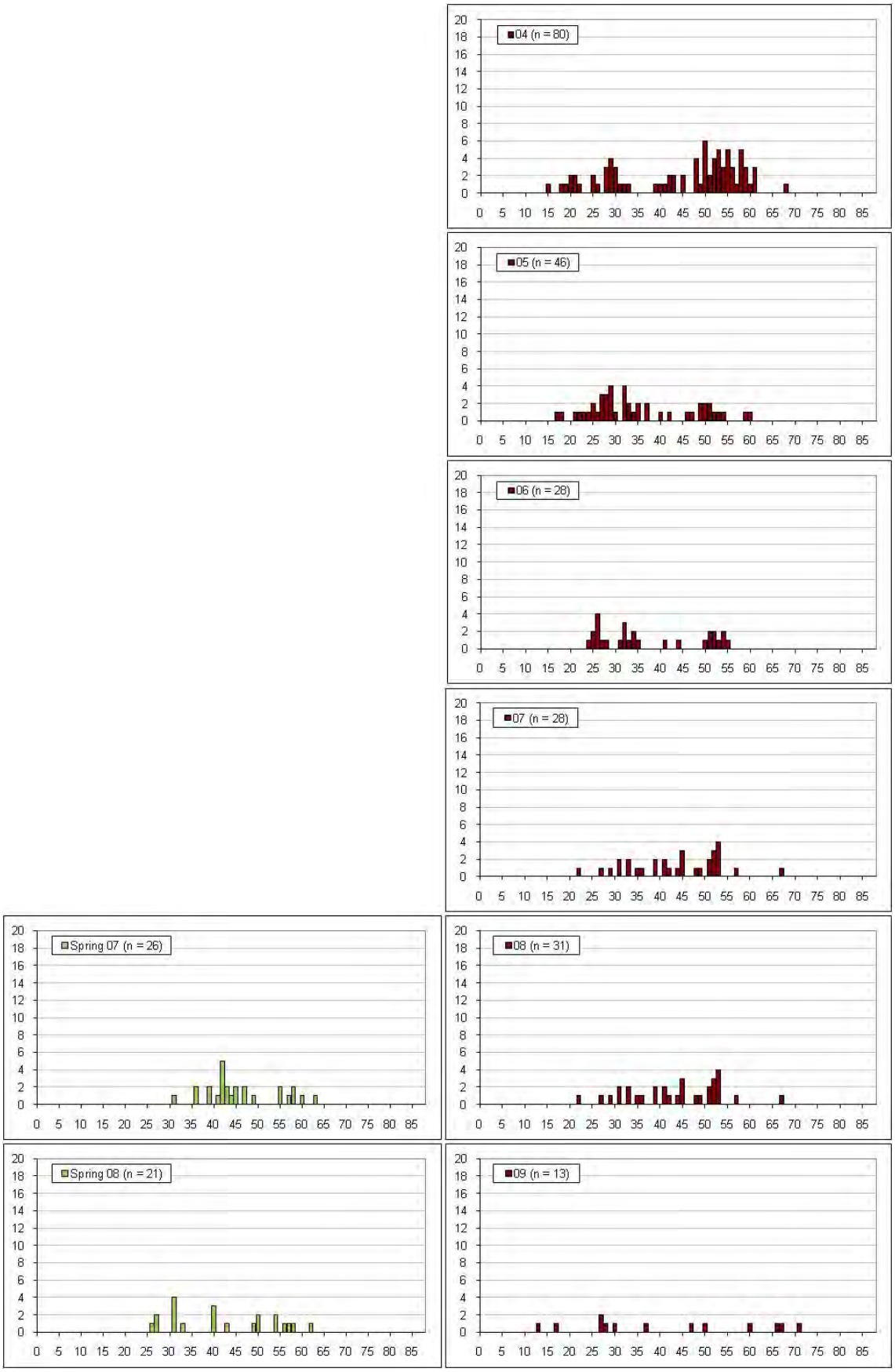


Figure 4.8.8. Length frequency data for southern pygmy perch at Deep Creek Road 2004-2009.

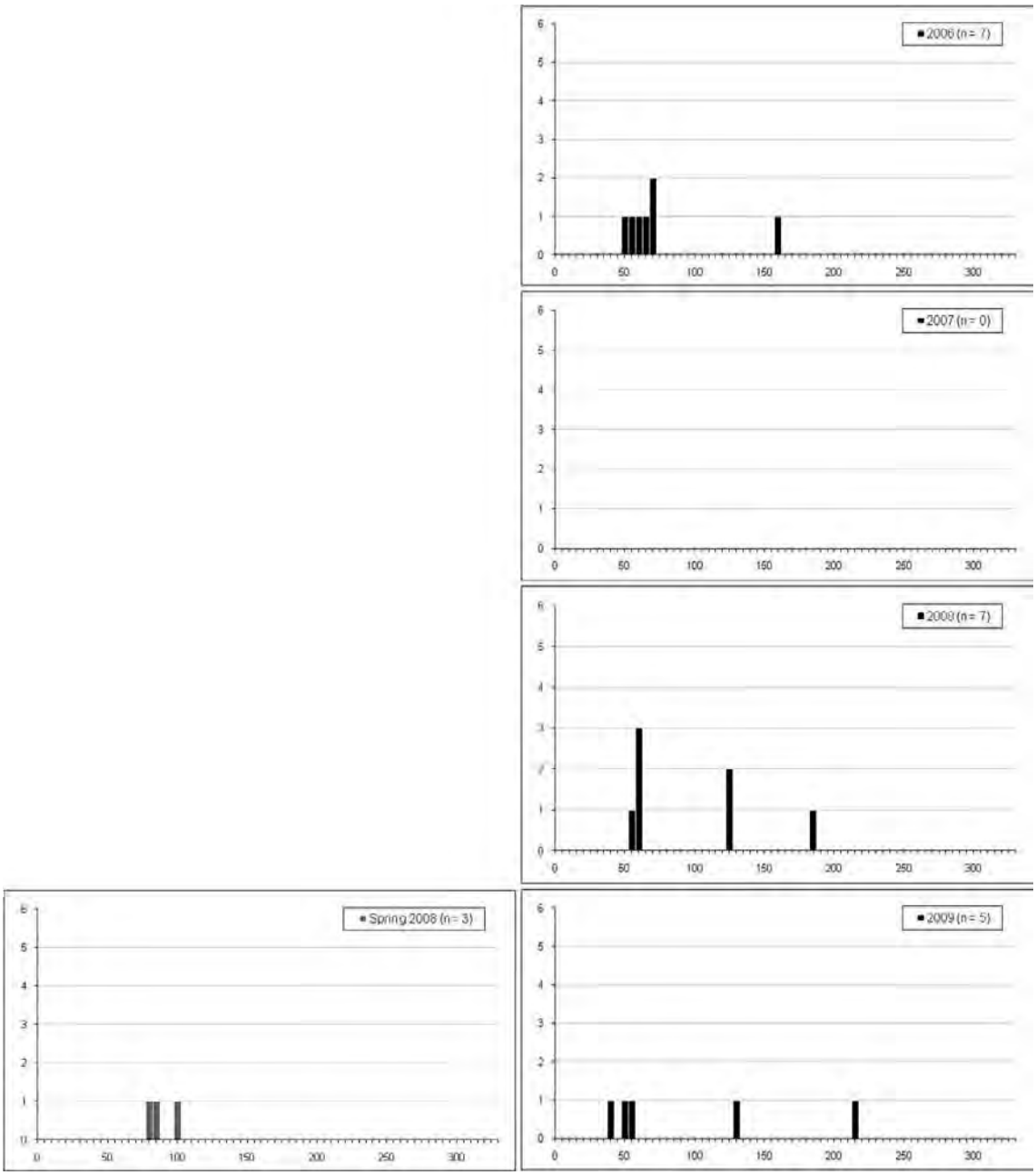


Figure 4.8.9. Length frequency data for river blackfish at Deep Creek Road 2004-2009.

Reach 8 – Terminal wetland (Black Swamp)

The terminal wetland of Tookayerta Creek is quite extensive including a large section of swamp downstream of Winery Road extending into a small open water wetland at the junction of the Finniss River in Lake Alexandrina. The swamp section contains southern pygmy perch, diadromous and some wetland generalists, while the wetland section additionally contains wetland specialists (Yarra pygmy perch). Access is general limited in this reach, however a site in the swamp has been monitored most years since 2001 (Protea farm) and the wetland section monitored opportunistically after baseline sampling in 2003 and 2004 (Appendix 9).

Low to moderate numbers of southern pygmy perch were recorded at the Protea farm up until 2007 whereby the site has been dry each autumn. A small drain off black swamp exiting into the Finniss River channel was found to contain southern pygmy perch in 2007 (Hammer 2007c), however none were recorded on a subsequent trip. In spring 2008 and autumn 2009 a site just upstream of Winery Road was sampled as the nearest section of permanent water to the monitoring site, recording southern pygmy perch and a single diadromous common galaxias (as well as blackfish and mountain galaxias), albeit with massive seasonal fluctuations in abundance (Figure 4.8.10; Appendix 9).

The wetland initially contained a diverse fish community but has been severely impacted by low Lake Alexandrina levels such that only one southern pygmy perch was recorded in 2007 (no Yarra pygmy perch) prior to complete drying (Appendix 9). The reach has clearly performed poorly in recent years.

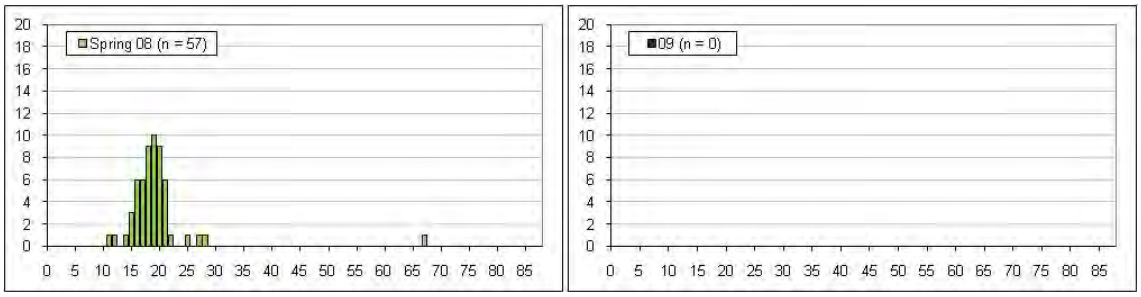


Figure 4.8.10. Length frequency data for southern pygmy perch at the Railway Bridge 2009.

Overall performance report

A summary report for the Tookayerta Catchment is detailed in Table 4.8.3. The majority of the catchment (three reaches assessed) performed very well through the recent dry period as a key regional refuge, with only a small Fleurieu Swamp and the lowest reach under Lake Alexandrina influence performing poorly.

Table 4.8.3. 2009 report card for Tookayerta Creek Environmental Water Requirements – a summary of performance against fish indicators assessed with field data. Blank indicators were not assessed or not relevant in 2009. For exotic species ticks indicate the desirable result was observed (i.e. not detected, low abundance or invasion was not detected) and crosses indicate a negative result (i.e. present, abundance had not been suppressed or invasions occurred). *Recolonisation = invasion for exotic species.

Asset	***Environmental Objective***	***Indicator***							
		Presence	Population extent	Recolonisation*	Recruitment	Survivorship	Spawning/larvae	Movement/habitat	Low exotic abundance
Reaches 4 – Swampy Creek (Fleurieu Swamp)									
Southern pygmy perch	• Maintain and Restore self-sustaining populations	✘			✘	✘			
Exotic species	• Discourage colonisation and establishment	✓							✓
Reach 5 – Nangkita Creek under spring influence									
Threatened species (southern pygmy perch, river blackfish, mountain galaxias)	• Maintain a self-sustaining populations	✓	✓		✓	✓			
Exotic species	• Discourage colonisation and establishment (especially redfin)	✓							✓
Reach 6 – Upper Tookayerta (spring fed)									
River blackfish	• Maintain self-sustaining populations	✓			✓	✓			
Exotic species	• Suppress exotics	✘							✓
Reach 7 – Tookayerta lowland channel									
Southern pygmy perch	• Maintain self-sustaining populations	✓	✓		✓	✓			
River blackfish	• Maintain self-sustaining populations	✓	✓		✓	✓			
Exotic species	• Suppress exotics	✓							✓
Reach 8 – Tookayerta terminal wetland									
Lower Tookayerta fish community	• Maintain diversity and composition of fish community	✘	✘	✘	✘	✘			
Threatened species (pygmy perches)	• Maintain or restore self-sustaining populations	✘	✘	✘	✘	✘			
Exotic species	• Suppress exotics	✓							✓

4.9 Deep Creek Catchment

A small catchment (68km^2) nested between the Currency Creek and Tookayerta Creek catchments. Two small tributaries extend from a steep hillside (small elevated section of the catchment with medium rainfall) and transcend into a highly incised lowland channel. Aquatic habitat consisted mainly of instream dams, and water was relatively fresh where present with spring fed sections in the upper reaches. A long dry stretch across the plain forms a considerable natural barrier.

Five provisional reaches have been defined in the Deep Creek Catchment (Fig. 4.9.1).

The restricted extent of habitat, high densities of exotic fishes (Gambusia) and natural isolation appears to have limited the presence of fish related ecological assets (Hammer 2004). Mountain galaxias may have occurred historically or exist as small undetected populations as habitat is suitable (Table 4.9.1 & 4.9.2).

No sampling occurred in this catchment.

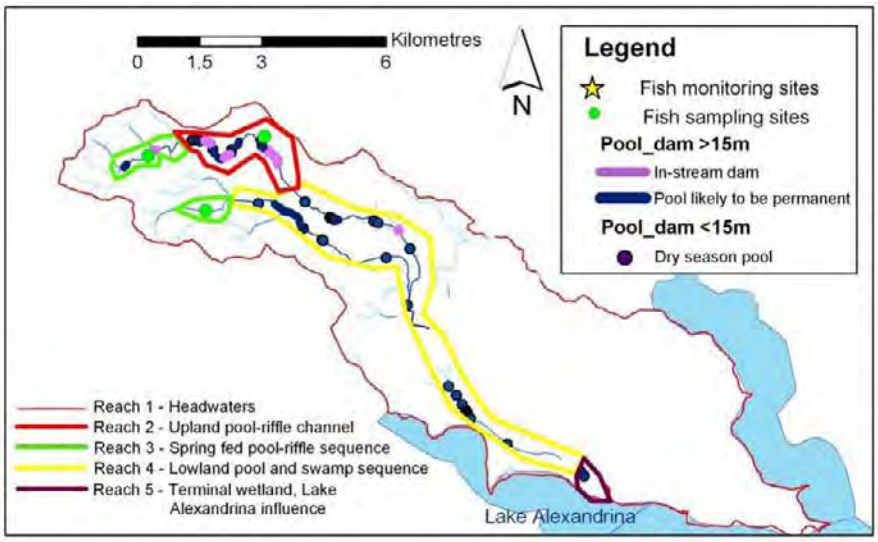


Figure 4.9.1. Map of the Deep Creek Catchment Showing provisional river reaches

Table 4.9.1. Distribution patterns in the Deep Creek Catchment (plus opportunistic biota data).

Specific asset/pattern	Location	EWR Table
1) Mountain galaxias potentially present historically	• Reaches 2 & 3	Potentially 2.3.1
2) No permanent populations present due to natural isolation and/or threatening processes	• Reaches 2 & 3	NA
3) No fish communities due to lack of permanent water	• Reach 1, 4, 5(?)	NA
4) Isolated population of freshwater shrimp (*Paratya*)	• Reach 3	
5) Diverse small amphibious plants	• Reach 3	

Table 4.9.2. Summary of environmental objectives in the Deep Creek Catchment.

Asset	***Environmental Objective***
Reach 1, 2 & 3 –headwaters, upland pool/riffle channel & ephemeral channel	
NA	
Reach 3 – Spring fed pool riffle sequence on north and south tributaries	
NA (potentially mountain galaxias)	
Reach 5 – Terminal wetlands under Murray Influence	
Unknown if habitat/fish present in this reach	

4.10 Currency Creek Catchment

The most southerly of the EMLR catchments, Currency Creek is a small (88km^2) and heavily branched system, experiencing moderate rainfall. It drains swampy upland areas through relatively steep alluvial and rocky creeks in an easterly direction. The main stream network comprises a north and south branch that join just before a steep gorge and then flow on a gradual slope past Stuart's Bridge (Mt Compass to Goolwa Road). There is a small waterfall just above the railway bridge near the Currency Creek Township and from here Currency Creek meanders toward an extended arm of Lake Alexandrina via a river channel. Remnant vegetation in the catchment is sparse, with often only a thin riparian strip of gums present. Flow is largely intermittent in most of the catchment (today) but localised springs occur at several sites. Pools are generally small and shallow, with heavy erosion and siltation obvious in the mid catchment. Larger and deeper pools do occur in the lower section of the catchment above and below the waterfall. Cover values are generally low comprising snags and some emergent vegetation (submerged aquatic plants were rare). Some stream sections are fenced, however much of the catchment has unrestricted stock access.

Seven provisional reaches have been defined in the Currency Creek Catchment (Fig. 4.10.1).

Fish related assets identified by Hammer (2004) are shown in Tables 4.10.1 & 4.10.2. These include patchy populations of mountain galaxias and diverse native fish communities in lowland and terminal wetland habitat (Reaches 6 & 7). Yarra pygmy perch have been recorded historically from Reach 7 and recently from Reach 8 (edge of Goolwa Channel) (Hammer 2007c) and river blackfish and southern pygmy perch may have once occurred above the waterfall.

Environmental objectives, water requirements and monitoring recommendations are shown in Tables 4.10.1 & 4.10.2, and these match fish related ecological assets identified in the Currency Creek Catchment to the relevant EWR tables of Section 2.3. Monitoring has been patchy in this catchment, with three sites across different reaches initiated after the 2007 review following on sites from 2004 baseline sampling (Appendix 10).

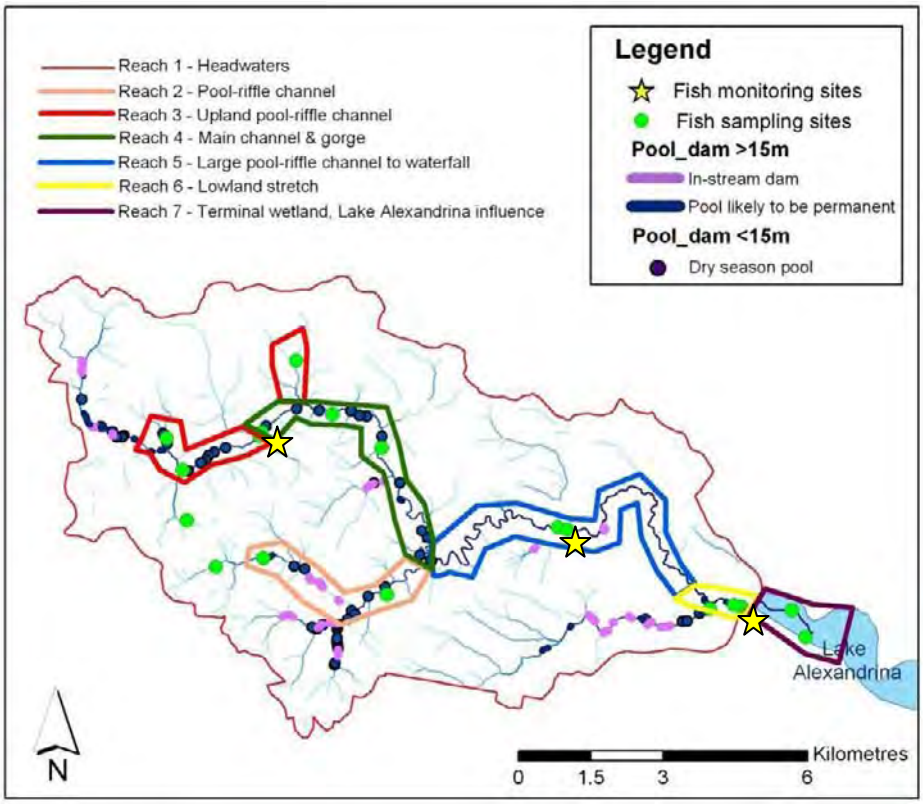


Figure 4.10.1. Map of the Currency Creek Catchment showing provisional river reaches

Table 4.10.1. Distribution patterns and significant environmental assets in the Currency Creek Catchment relating to fish species and communities.

Specific asset/pattern	Location	EWR Table
1) Mountain galaxias	• Reaches 2, 3, 4 (marginal), & 5	2.3.1
2) Flathead gudgeon	• Reaches 3-7	2.3.4 & 2.3.9
3) River blackfish potentially occurred historically	• Possibly reaches 4 & 5	2.3.2
4) Lower Currency/terminal wetland diverse fish community	• Reaches 6 & 7	2.3.7 & 2.3.8
5) Presence of diadromous fish species in the Lower Currency	• Reaches 6 & 7	2.3.5 & 2.3.8
6) No permanent fish communities due to lack of permanent water	• Reach 1	NA

Table 4.10.2. Summary of environmental objectives by reach for fish related ecological assets in the Currency Creek Catchment.

Asset	***Environmental Objective***
Reach 1 – Currency Creek Catchment headwaters	
NA	
Reach 2 – Pool/riffle channel (EWR Table 2.3.1)	
Mountain galaxias (restricted and declining populations)	• Maintain and restore self-sustaining populations
Reach 3 – Upland pool/riffle channel (EWR Table 2.3.1)	
Mountain galaxias	• Maintain self-sustaining populations
Reach 4 – Currency Creek main channel and gorge (EWR Tables 2.3.1 & 2.3.4)	
Mountain galaxias	• Restore self-sustaining population (population structured by trout species)
Flathead gudgeon	• Maintain a self-sustaining population
Reach 5 – Large pool/riffle channel above waterfall (EWR Tables 2.3.1 & 2.3.4, possibly 2.3.2)	
Mountain galaxias	• Maintain a self-sustaining population
Flathead gudgeon	• Maintain a self-sustaining population
River blackfish possibly occurs	• Maintain restricted self-sustaining population if located
Reach 6 – Lowland large pool-riffle sequence (EWR Tables 2.3.4 & 2.3.7)	
Diverse native fish community including gudgeons, diadromous species and River Murray species.	• Maintain and restore diversity and composition of fish community • Maintain a self-sustaining populations of gudgeons
Diadromous species (congolli, common galaxias and possibly lampreys)	• Maintain community of diadromous species
Reach 7 – Terminal wetland under Lake Alexandrina influence (EWR Tables 2.3.5 & 2.3.8)	
Diverse native fish community including diadromous species. Yarra pygmy perch at junction with Goolwa Channel.	• Maintain and restore diversity, demographics and composition of fish community

Reach 2 – South arm

Baseline sampling identified mountain galaxias at some sites in this arm of Currency Creek, no recent monitoring has occurred.

Reaches 3 & 4 – North arm

Two native species have been recorded from this reach, mountain galaxias (common but patchy) and flathead gudgeon (rare). Monitoring has occurred at a headwater site at 'Kilchoan' since 2004 (length data from 2005) (Appendix 10).

Mountain galaxias persist at this site as a key upland refuge, albeit in very low abundance since 2007 (Appendix 10). Data from spring 2008 indicates strong successful spawning, however this failed to translate to strong recruitment. A smaller pulse of 0+ juveniles did represent the only size range recorded in the corresponding autumn 2009. The opposite was true in 2007, with only surviving adults detected in refuge pools, and looking further back, recruitment and survivorship were both reasonable in 2004 (not shown) and 2005 (Figure 4.10.2). Gambusia remain common in remaining water at the site (Appendix 10).

Salinity has remained low ranging from 650-1050µS with consistent levels of moderate cover (Appendix 10). Available surface water has fluctuated greatly, especially with declines noted in recent years. In autumn 2007, 2008 and 2009 the section sampled was reduced to less than five small and shallow pools.

Hence fish indicators for the Reach indicate it to be highly stressed, with low flow periods testing local resilience of mountain galaxias.

Most pools in upper Currency Creek were dry in autumn 2007-2009

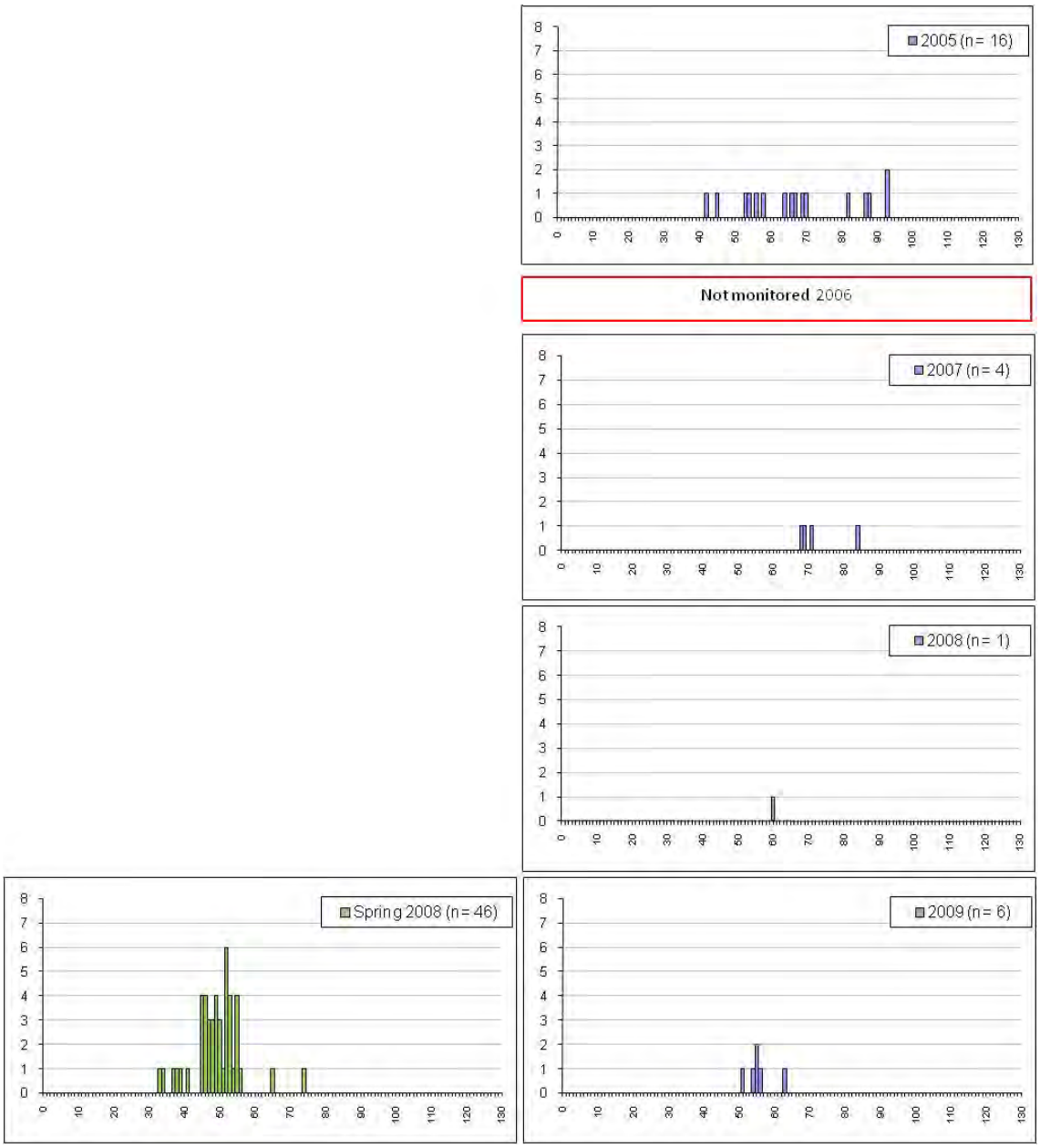


Figure 4.10.2. Length frequency data for mountain galaxias at Kilchoan 2005-2009.

Reach 5 – Mid pool riffle channel

Larger refuge pools occur in the mid-Currency catchment and are occupied by mountain galaxias and flathead gudgeon (plus alien species). A refuge site at Stuarts Bridge was examined in 2004 baseline sampling and opportunistically in 2005 (environmental data only), and has been initiated as a monitoring site since autumn 2007 (Appendix 10).

A generally large population of mountain galaxias occurs at Stuarts Bridge. Recruitment has been noted in each of the three autumns sampled, with moderate to strong survival of older fish (>70mm) (Figure 4.10.3). Strong spawning and recruitment was noted after the dry 2008 flow season (i.e. spring 2008 and autumn 2009 data). Low numbers of Gambusia represent the only alien fish recorded at the site (Appendix 10), despite brown trout recorded and heavily stocked upstream.

Environmental data indicates variable but moderate salinity at the site (2800-5080µS), with high levels of cover, dark low transparency water, and low autumn base flow (flow ceased in autumn 2009 however) (Appendix 10).

This site remains in good condition even through the recent dry conditions, acting as a key catchment refuge for mountain galaxias, and appears to have a level of natural disturbance that discourages alien species.

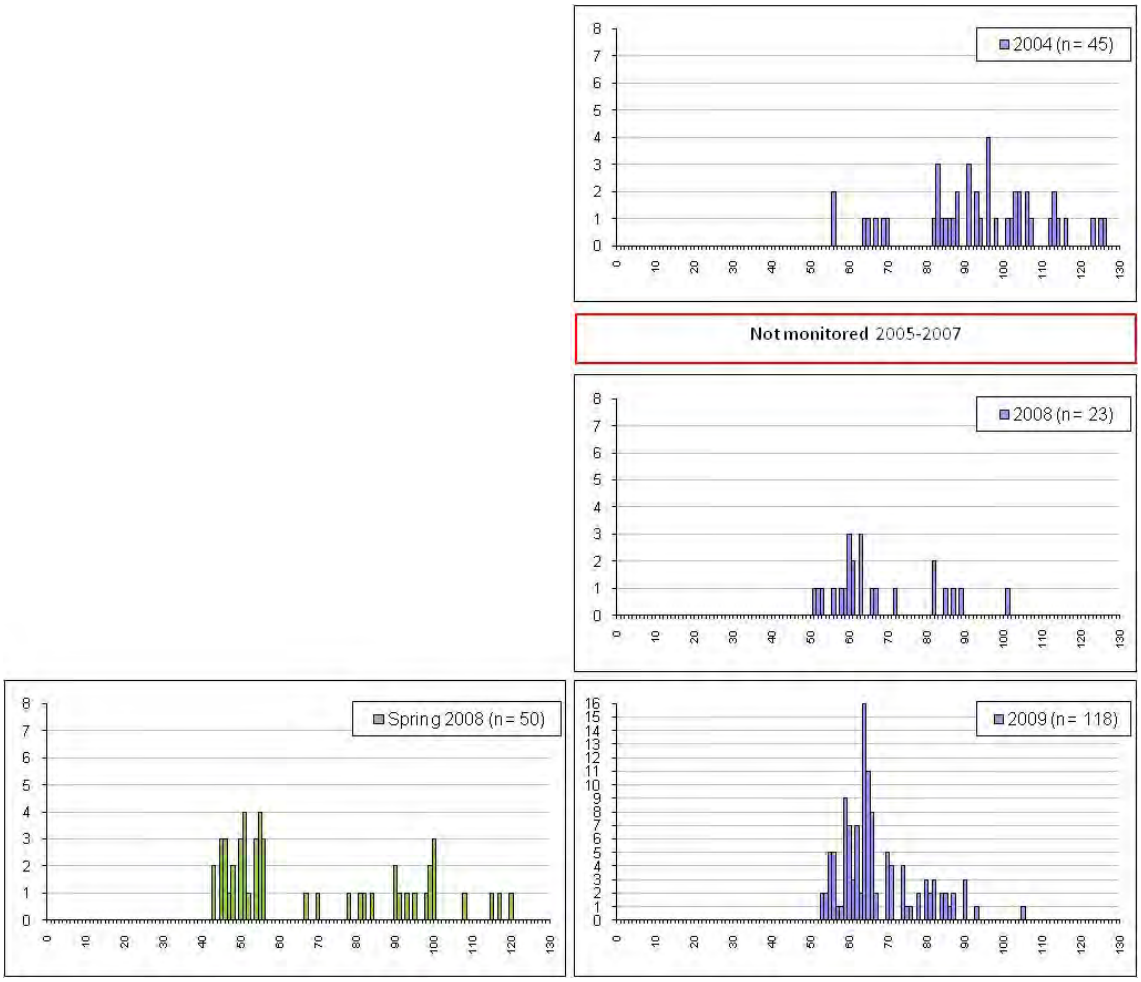


Figure 4.10.3. Length frequency data for mountain galaxias at Stuarts Bridge 2004-2009.

Reach 6 – Lowland channel

A small lowland channel occurs downstream of Currency Creek Waterfalls to just past Goolwa Road. Ecological assets include a diverse native fish community including diadromous species. Baseline data was collected in 2003 and 2004, with monitoring initiated in autumn 2008 (Appendix 10).

The fish community in the reach remains relatively diverse in 2008/09. Comparison to the species recorded in 2003/2004 indicates a slight shift in composition to exclude three wetland generalist (bony herring, smelt and unspecked hardyhead) and to include two euryhaline species (bluespot goby and Tamar goby) (Appendix 10). The diadromous common galaxias was in high abundance at the site in autumn 2008 and 2009, but in autumn 2009 only larger adult fish (≥100mm) were recorded (Figure 4.10.4; Appendix 10). Congolli occurred in low abundance with all fish in autumn 2009 >150mm (Figure 4.10.5). Directional fyke nets deployed during stream flow in early spring 2008 (ML08-61) did not record any upstream migrations of diadromous species. Relatively few alien species have been recorded at the site, but this has included juvenile and larger adult redfin particularly in autumn and spring 2008 (less in autumn 2009).

Environmental data indicates a steady increase in autumn salinity from 4000µS in 2003 to 8500µS in 2009 (Appendix 10). Habitat components are moderate to high, but have declined with low water levels experienced downstream of Goolwa Road since autumn 2008 (upstream of the bridge retains similar pool heights).

Disconnecting and the changing character of Lake Alexandrina is affecting the species composition at lower Currency Creek (i.e. loss of freshwater wetland elements and addition of estuarine species), and appears to have caused a shift in the demographic structure of diadromous species (no juveniles) as the early warning signs of loss for an additional functional group and species. Hence the site remains as an important lowland habitat and refuge but is clearly in decline due to broader Lake Alexandrina change.

Low water levels below the Goolwa Bridge (autumn 2009)

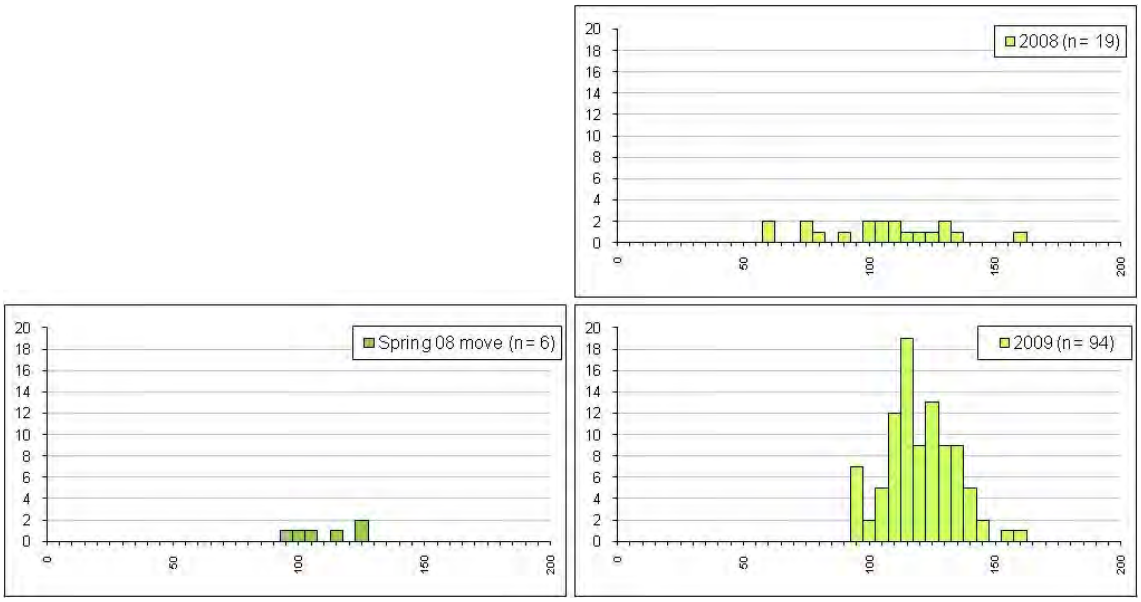


Figure 4.10.4. Length frequency data for common galaxias at Goolwa Road 2008-2009.

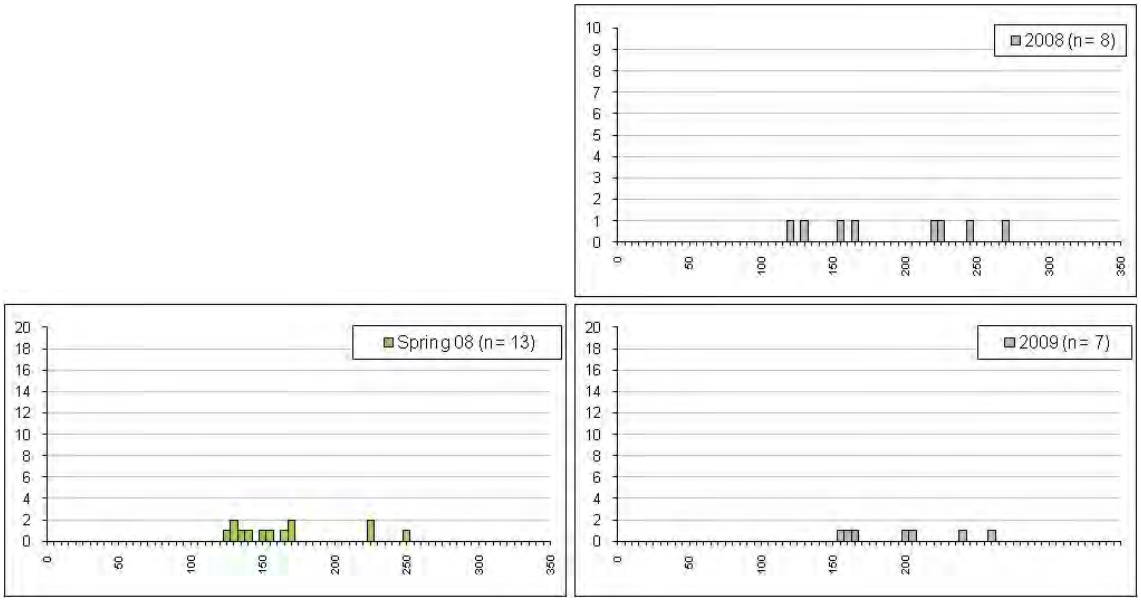


Figure 4.10.5. Length frequency data for congolli at Goolwa Road 2008-2009.

Adult and juvenile common galaxias in autumn 2008(juveniles were absent in 2009)

Reach 7 – Terminal wetland

The extended Currency Creek arm of Lake Alexandrina stretches from just downstream of Goolwa Road to the Goolwa Channel near Laffin point. Baseline sampling in 2003 identified a diverse fish community including diadromous species, with the threatened Yarra pygmy perch and Murray hardyhead recorded in 2007 and 2008 respectively (Appendix 10). Monitoring under Yarra pygmy perch and Drought Action Plan projects has been undertaken at Laffin Point since autumn 2007.

The reach has undergone extensive drying since summer 2007, with most surface water dry in autumn 2009. At Laffin point the fish community has changed markedly in recent years, shifting from a diverse freshwater community including threatened Yarra pygmy perch in 2003-2007, to a near estuarine community in autumn 2008, and to have no fish (dry) in autumn 2009 (Appendix 10). Hence the reach is in current poor condition.

Currency Creek terminal wetland at Laffin Point in autumn 2007 (top) and autumn 2009

Overall performance report

A summary report for the Currency Catchment is detailed in Table 4.10.3. There was a mix of conditions for different reaches, with one reach (mid-pool riffle) performing well and the others being in moderate to poor condition for fish EWR indicators.

Table 4.10.3. 2009 report card for Currency Creek Environmental Water Requirements – a summary of performance against fish indicators assessed with field data. Blank indicators were not assessed or not relevant in 2009. For exotic species ticks indicate the desirable result was observed (i.e. not detected, low abundance or invasion was not detected) and crosses indicate a negative result (i.e. present, abundance had not been suppressed or invasions occurred). *Recolonisation = invasion for exotic species.

Asset	***Environmental Objective***	***Indicator***							
		Presence	Population extent	Recolonisation*	Recruitment	Survivorship	Spawning/larvae	Movement/habitat	Low exotic abundance
Reaches 4 – Upper-pool riffle channel (north arm)									
Mountain galaxias	• Maintain and Restore self-sustaining populations	✓	✗		✓	✗	✓		
Exotic species	• Discourage colonisation and establishment	✗							✗
Reach 5 – Mid-channel									
Mountain galaxias	• Maintain a self-sustaining populations	✓	✓		✓	✓			
Exotic species	• Discourage colonisation and establishment (especially redfin)	✗							✓
Reach 6 – Currency lowland channel									
Diverse fish community	• Maintain diversity and composition of fish community	✓	✓			✗			
Diadromous species	• Maintain self-sustaining populations	✓	✓	✗	✗	✓			
Exotic species	• Suppress exotics	✗							✓
Reach 7 – Currency terminal wetland									
Diverse freshwater fish community	• Maintain diversity and composition of fish community	✗	✗	✗	✗	✗			
Yarra pygmy perch	• Maintain or restore self-sustaining populations	✗	✗	✗	✗	✗			
Exotic species	• Suppress exotics	✓							✓

4.11 Inman River Catchment

The Inman River Catchment is not within the defined EMLR study region occurring outside the geopolitical boundaries of the Murray-Darling Basin (i.e. in the SA Gulf Drainage Division and AMLR NRM region). However, as it has faunal similarities with the MDB (shared obligate freshwater fish species implying historic connectivity with the Murray: Hammer 2001) and has been included in recent monitoring of other EMLR species (southern pygmy perch: Hammer 2005) a brief review is included in this Section as data may assist interpretations in the EMLR and contribute to local EWR processes in the Inman Catchment.

The Inman catchment is situated on the southern Fleurieu Peninsula discharging into the Southern Ocean at Victor Harbor. The catchment is complex having a combination of tributaries arising in and flowing through contrasting elevations and geological settings (and hence are hydrologically diverse also). For example the Back Valley Creek comprises extensive glacial sands and swampy creek sections, where as the Boundy Creek in the upper catchment is a perennial flowing stream originating from upland headwaters. Remnant vegetation is reasonable but patchy with extensive grazing and irrigation in the catchment.

Seven provisional reaches have been defined in the Inman River Catchment (Fig. 4.11.1).

Only broad baseline sampling has occurred in this catchment with detail on ecological assets still requiring further investigation (Hammer 2006a). Nevertheless fish related assets identified to date (Hammer 2001, 2006a) are shown in Tables 4.11.1 & 4.11.2. These include a genetically distinct sub-population of southern pygmy perch, Murray-Darling carp gudgeon and diadromous species (climbing galaxias and common galaxias). There are historical reports of mountain galaxias, and further sampling is required to assess the species status.

Environmental objectives, water requirements and monitoring recommendations are shown in Tables 4.11.1 & 4.11.2, and these match fish related ecological assets identified in the Inman River Catchment to the relevant EWR tables of Section 2.3. Long-term monitoring (since 2001) has occurred in Back Valley Creek (Appendix 11).

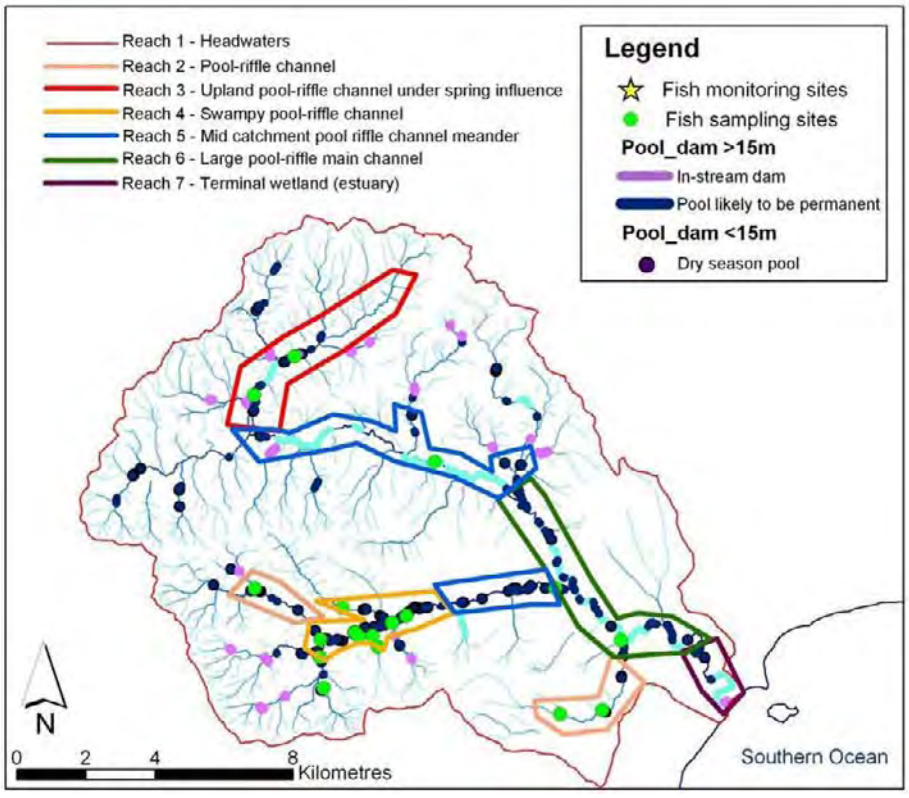


Figure 4.11.1. Map of the Inman River Catchment showing provisional river reaches

Table 4.11.1. Initial information on distribution patterns and significant environmental assets in the Inman River Catchment relating to fish species and communities.

Specific asset/pattern	Location	EWR Table
1) Southern pygmy perch	• Reaches 3 & 4	2.3.3, 2.3.6 & 2.3.9
2) Murray-Darling carp gudgeon	• Reaches 4, 5 & 6	2.3.4 & 2.3.7
3) Mountain galaxias and river blackfish potentially could occur	• Reaches 3, 5 & 6	Possibly 2.3.1 & 2.3.2
4) Lower Inman diverse fish community	• Reaches 6	2.3.7
5) Presence of diadromous fish species	• Reaches 2-7	2.3.5
6) No permanent fish communities due to lack of permanent water (populations may occur in perched Fleurieu swamps)	• Reach 1	NA (possibly 2.3.1, 2.3.3 & 2.3.9)

Table 4.11.2. Summary of environmental objectives by reach for fish related ecological assets in the Inman River Catchment.

Asset	***Environmental Objective***
Reach 1 – Inman Catchment headwaters	
NA	
Reach 2 – Upper Back Valley Creek and Hall Creek Pool/riffle channel (EWR Table 2.3.5, possibly 2.3.1)	
Freshwater and diadromous galaxias previously known	• Restore self-sustaining populations
Reach 3 – Upland pool/riffle channel under spring influence (EWR Table 2.3.3, 2.3.5 & 2.3.6)	
Inman genetic sub-population of southern pygmy perch	• Maintain a self-sustaining population
Climbing galaxias (diadromous)	• Maintain a self-sustaining population
Reach 4 – Back Valley Creek swampy pool channel (EWR Tables 2.3.3)	
Inman genetic sub-population of southern pygmy perch	• Maintain a self-sustaining population
Climbing galaxias	• Maintain a self-sustaining population
Mountain galaxias possibly occurs	• Maintain or restore a self-sustaining population
Reach 5 – Mid-catchment pool/riffle channel meander (EWR Tables 2.3.1 & 2.3.4, possibly 2.3.2)	
Murray-Darling carp gudgeon	• Maintain a self-sustaining population
Climbing galaxias and common galaxias (possibly lampreys)	• Maintain community of diadromous species
River blackfish may occur	• Maintain a self-sustaining population
Reach 6 – Large pool/riffle channel above estuary (EWR Tables 2.3.4, 2.3.5 & 2.3.7, possibly 2.3.2)	
Diverse fish community including Murray-Darling gudgeon, estuarine species (western bluespot goby) and diadromous species (common and climbing galaxias)	• Maintain and restore diversity, demographics and composition of fish community
River blackfish possibly occurs	• Maintain self-sustaining population
Reach 7 – Terminal wetland (estuary) (EWR Tables 2.3.5 & 2.3.7)	
Little known, highly polluted. At least a pathway for the access of diadromous species, but potentially habitat for estuarine species.	• Maintain and restore diversity and composition of fish community • Maintain access for diadromous species

Reach 4 – Back Valley Creek

The monitoring targets in Back Valley Creek are southern pygmy perch and diadromous species (climbing galaxias and common galaxias). Three sites are monitored, two in the upper sub-catchment (Kird Road and Kirk property since 2001) and one in the mid sub-catchment (Robertson property initiated in autumn 2008) (Appendix 11).

Southern pygmy perch have persisted in the upper sub-catchment over the nine year monitoring period. Kirk property has a string of shallower pools, so assessment here tests general resilience while Kirk Road is a deep pool and so the condition of a key refuge is monitored here. At Kirk property strong recruitment was noted in 2004, with subsequent declines to very low numbers in 2007 (few pools, no recruitment), but with some recovery in recruitment and distribution in 2008 and 2009 (Figure 4.11.2). A similar pattern of recent recovery is noted at Kirk Road with very strong recruitment noted in autumn 2009 (Figure 4.11.3). At Robertson property, the data is limited to 2008 and 2009 autumns. Similar patterns can still be detected, with low numbers of surviving fish suggesting poor recruitment/survivorship in 2007, then strong recruitment in autumn 2008, and strong recruitment and survivorship (population recovery) detected in autumn 2009 (Figure 4.11.4). Low numbers of common galaxias were recorded across all sites in recent years. No alien fishes were recorded at the three sites (Appendix 11).

Environmental data is variable across sites and years with a common factor being low transparency, humic-stained, water. At Kirk property autumn salinity has fluctuated between 1000-5000µS, and cover values have been low to moderate, especially with pool drying in recent years. Conditions at Kirk Road have been more consistent (2000-3500µS, moderate cover), but with low dissolved oxygen in recent assessments. Robertson property in the last two autumns has had high cover values, moderate salinity (~3000µS) and low dissolved oxygen.

The Inman sub-catchment retains important ecological assets which have shown recovery to good condition in the last two years, after declines noted in autumn 2007, despite regionally dry conditons. The absence of alien fishes in samples is very positive, and interesting considering historic reports of redfin in the stream including at Kird Road and presence of both redfin and Gambusia in connected sections of the Inman River (Appendix 11). Local environmental extremes or natural disturbance appear to be tolerated by native species but discourage establishment of aliens species (e.g. low transparency or associated particular water chemistry, low dissolved oxygen, cool winter temperatures and flushing flows).

Small refuge pool on Kirk property autumn 2009

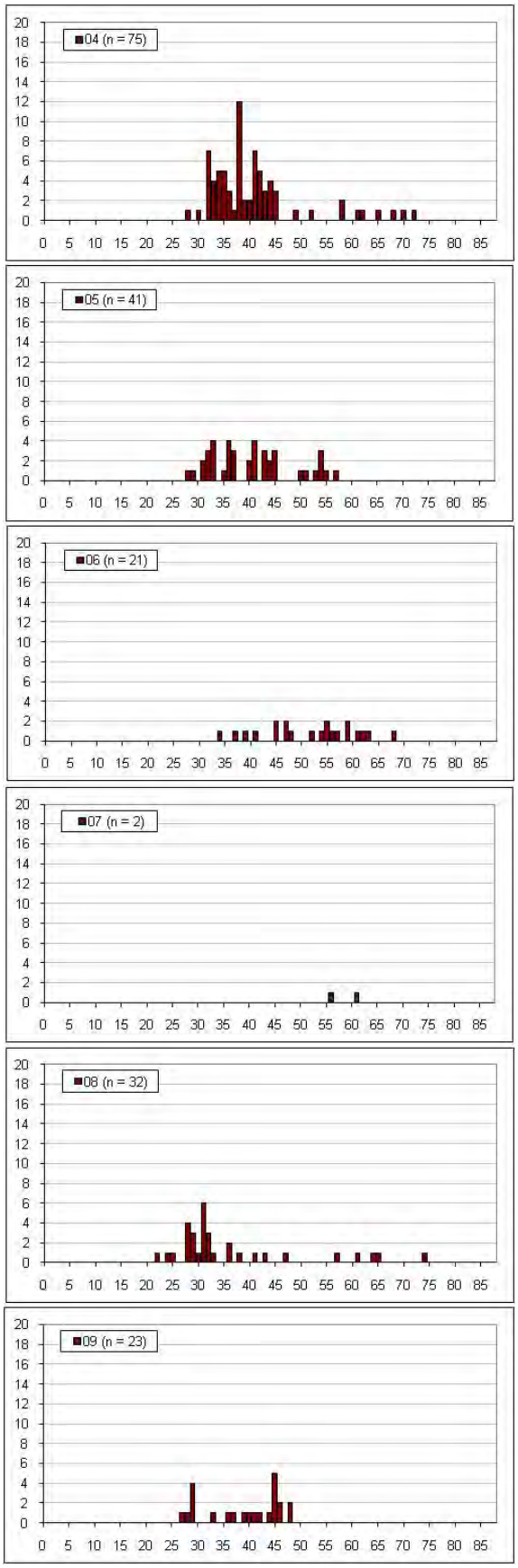


Figure 4.11.2. Length frequency data for southern pygmy perch at Kirk property 2004-2009.

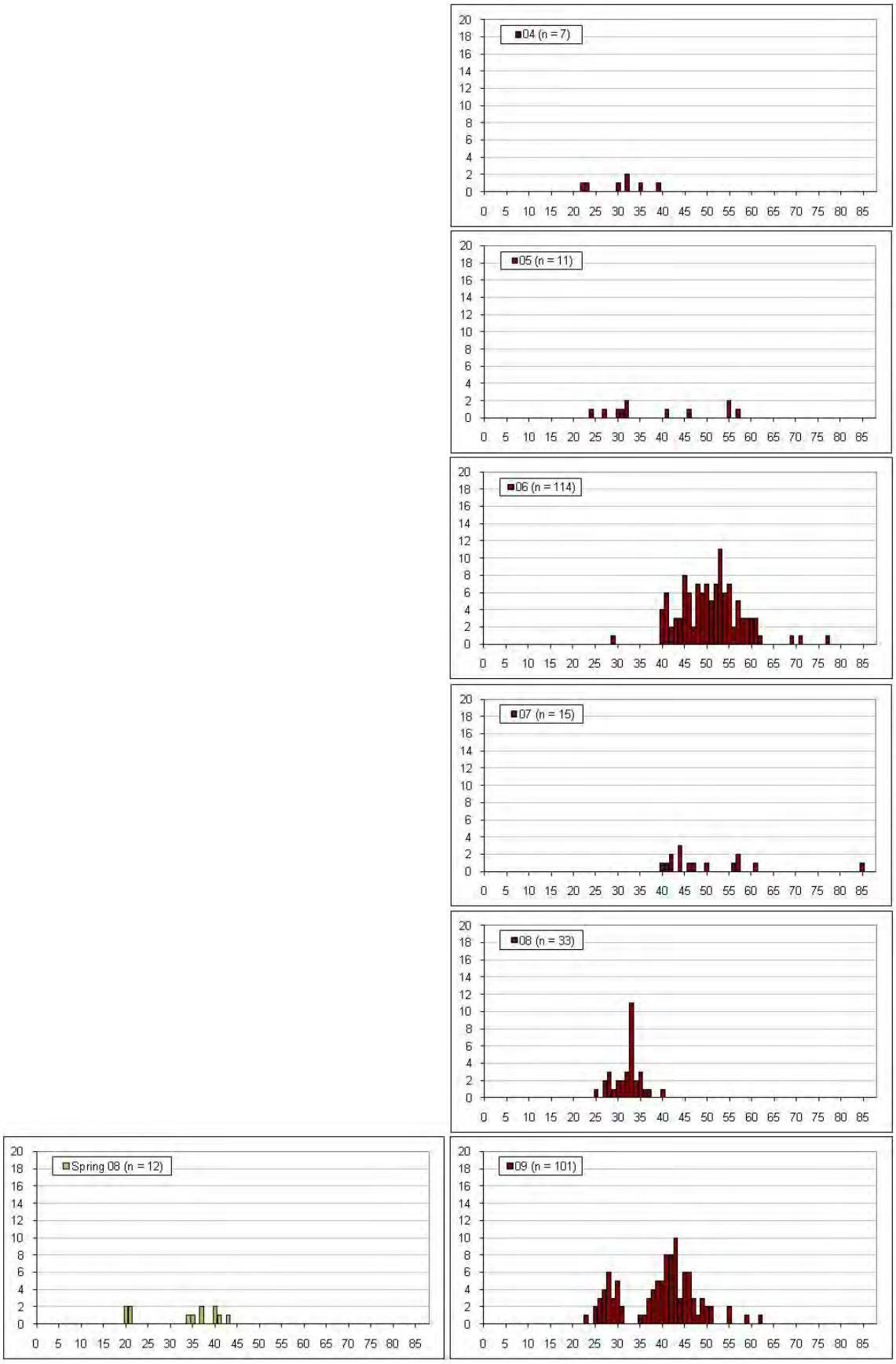


Figure 4.11.3. Length frequency data for southern pygmy perch at Kirk Road 2004-2009.

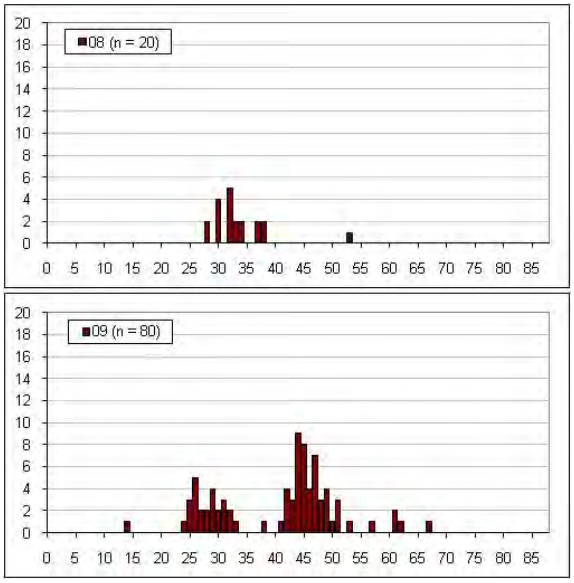


Figure 4.11.4. Length frequency data for southern pygmy perch at Robertson prop. 2008-2009.

Adult southern pygmy perch from Robertson property autumn 2009

Overall performance report

A summary report for the Inamn Catchment is detailed in Table 4.11.3 and pertains to Back Valley as the only Reach monitored currently – the sub-catchment is in moderate condition for fish indcators.

Table 4.11.3. 2009 report card for Inman River Environmental Water Requirements – a summary of performance against fish indicators assessed with field data. Blank indicators were not assessed or not relevant in 2009. For exotic species ticks indicate the desirable result was observed (i.e. not detected, low abundance or invasion was not detected) and crosses indicate a negative result (i.e. present, abundance had not been suppressed or invasions occurred). *Recolonisation = invasion for exotic species.

Asset	***Environmental Objective***	***Indicator***							
		Presence	Population extent	Recolonisation*	Recruitment	Survivorship	Spawning/larvae	Movement/habitat	Low exotic abundance
Reaches 4 – Back Valley Creek									
Southern pygmy perch	• Maintain and Restore self-sustaining populations	✓	✓	✓	✓	✓			
Diadromous species	• Maintain and restore self-sustaining populations	✓	✗	✗	✗	✓			
Exotic species	• Discourage colonisation and establishment	✓							✓

5.0 Discussion

The expansion of the EMLR fish EWR program after 2007 has generated useful region wide data to assess the condition and performance of different stream catchments and Reach types. Baseline data and long-term monitoring sites provide key context on the magnitude of recent changes. The interplay of drought conditions and significant water use across the EMLR and the broader MDB has had serious impacts to fish communities and ecological assets, with many failures in native fish indicators.

Terminal wetlands have suffered in particular due to the broader impacts of critical water level lowering below Lock 1. The terminal wetland Reach type has virtually been eliminated, and accordingly there is now limited ability for stream discharge to alter the performance of these habitats apart from offering ephemeral habitat or occasional dispersal routes. Freshwater species that had restricted populations to terminal wetlands may have been permanently lost (e.g. Yarra pygmy perch, southern pygmy perch).

Lowland reaches have been impacted by reduced species pools from impacts to terminal wetlands, as well as drying or low connectivity from low stream discharge (especially Bremer and Reedy). Nevertheless, lowland channels retain ecological assets including sensitive freshwater fishes such as river blackfish (Angas, Tookayerta and to a marginal extent Marne), and some of the last habitat for diadromous species in the MDB (Finniss and Currency). The persistence of diadromous species however, seems uncertain with a recent lack of recruitment noted. This may be indicative of the current segregation of the Lower Lakes from the sea, and hence loss of a required dispersal pathway since 2007 (Jennings *et al.* 2008).

The performance of mid-catchment reaches was mixed, with some retaining key refuges and populations for future recovery (e.g. Angas River, Currency Creek, Reedy Creek), but others observing critical declines in restricted populations (e.g. southern pygmy perch in the Finniss River).

Most upper catchment reaches suffered extensive drying in autumn 2008-2009, notable in the Marne (loss of fish from all relevant monitoring sites) and Rodwell Creek where artificial watering has been implemented to prevent complete desiccation of river blackfish habitat. Pockets that retained perennial flow have high importance to regional biodiversity conservation and catchment management, with two reaches in the Tookayerta Catchment standouts (strong populations of three freshwater specialists species), and other areas including Bull Creek and the Upper Angas.

Intermediate disturbance such as drying, low water transparency, moderate salinity, and low dissolved oxygen within tolerable limits appeared in some cases to assist with native fish persistence with respect to the impacts from alien species (mid-Currency Creek, mid Angas River, Meadows Creek and Back Valley Creek). However there appears a fine line before local extinction of native species may occur (e.g. mid-Finniss) (see also Closs and Lake 1996).

The dry period during this study clearly highlights that the primary flow components for targeting within stream reach EWR and flow provisions relates to the persistence of refuge pools and habitat heterogeneity over summer and autumn (i.e. base flow, onset of season flow and cessation of flow). Given the arguably exacerbated nature of habitat contraction due to altered flow regimes from anthropogenic change, close monitoring and targeted actions may be required to allow ecological assets to persist through critical periods, and once again act as indicator species with the onset of more favourable conditions (e.g. artificial watering, removal of aliens species, fencing and restoration of refuges, and captive maintenance). As some of the last freshwater refuge in the Lower Murray, EMLR streams deserve close attention within restoration programs that preserve regional fauna, with a prime example being the potential to rehabilitate a section of the Finniss River between Winery Road and the Railway Bridge.

To best detect change and performance of fish related EWR indicators under declining, stable or improving scenarios, long-term investigations are required and the continuation of the current spread of sites recommended (Hammer 2007d). Other reaches could be added into the program, perhaps on a priority basis where flow restoration initiatives are initiated. The focus on annual sampling seems appropriate, particularly in dry years as summer/autumn contraction ultimately determines critical population limits and environmental conditions. Spring data in the current program provided insight into recruitment and flow ecology under different (wetter) conditions. Importantly it indicated successful spawning of mountain galaxias in many areas with only low winter/spring flow, but that the extent of water availability over summer limited successful recruitment (i.e. the critical population process). In one case (Reedy Creek) this lead to a new discovery for the catchment, and subsequent identification of upstream refuges. Fine scale temporal monitoring is also crucial for ecological assets under threat (environmental data focus) to allow appropriate response to critical thresholds (this is being undertaken at several EMLR sites as part of the SA DEH Drought Action Plan). Finally, extensive drying has changed perceptions and knowledge of key stream refuges, and targeted sampling to expand and update 2004 baseline data would be useful to check for additional ecological assets and monitoring sites.

6.0 Acknowledgments

Thanks to Mardi van der Wielen (SAMDBNRM Board) for support and commitment to the fish monitoring program. Numerous persons assisted with field monitoring, and many landholders provided access to sites on their property and invaluable input to local conditions. Data presented includes data-sharing arrangements with SA DEH as part of the Drought Action Plan, and several previous projects funded by the SAMDBNRMB and DEH.

7.0 References

Bardsley, D. (2006). There's a change on the way — an initial integrated assessment of projected climate change impacts and adaptation options for Natural Resource Management in the Adelaide and Mt Lofty Ranges Region. Department of Water, Land and Biodiversity Conservation, Adelaide. p. 70.

Bunn, S. E., and Arthington, A. H. (2002). Basic principles and ecological consequences of altered flow regimes for aquatic biodiversity. *Environmental Management* **30**, 492-507.

Closs, G. P., and Lake, P. S. (1996). Drought, differential mortality and the coexistence of a native and an introduced fish species in a south east Australian intermittent stream. *Environmental Biology of Fishes* **47**, 17-26.

Conallin, A., and Hammer, M. (2003). Fish surveys of selected streams in the Eastern Mount Lofty Ranges, South Australia. MDFRC Report No. 7/2003. The Murray-Darling Freshwater Research Centre, Mildura. p. 59.

DEH (2003). 2003 review of the status of threatened species in South Australia. Proposed Schedules under the South Australian *National Parks and Wildlife Act 1972*: Discussion paper. National Parks and Wildlife Council in partnership with the Department for Environment and Heritage, Adelaide. p. 61.

DWLBC (2009). Surface water archive. http://e-nrims.dwlbc.sa.gov.au/swa, accessed June, 2009. Department of Water Land and Biodiversity Conservation, Adelaide.

Hammer, M. (2001) Molecular systematics and conservation biology of the southern pygmy perch *Nannoperca australis* (Günther, 1861) (Teleostei: Percichthyidae) in south-eastern Australia. B. Sc. (Honours) thesis, Adelaide University.

Hammer, M. (2002a). Recovery outline for the southern pygmy perch in the Mount Lofty Ranges, South Australia. Department of Environmental Biology, University of Adelaide and Native Fish Australia (SA) Inc., Adelaide. p. 32.

Hammer, M. (2002b). Environmental water requirements for freshwater fishes of the Marne River Catchment, South Australia. Report produced for the River Murray Catchment Water Management Board, Adelaide. p. 25.

Hammer, M. (2004). Eastern Mount Lofty Fish Inventory: distribution and conservation of freshwater fishes of tributaries to the Lower River Murray, South Australia. Native Fish Australia (SA) Inc & River Murray Catchment Water Management Board, Adelaide. p. 104.

Hammer, M. (2005). Recovery monitoring for the southern pygmy perch in the Mount Lofty Ranges South Australia, 2001-2005 review: confidential technical document. Native Fish Australia (SA) Inc., Adelaide. p. 53.

Hammer, M. (2006a). Report on stage one of the Southern Fleurieu fish inventory. Report to Department of Water Land and Biodiversity Conservation. Native Fish Australia Inc. and Aquasave, Adelaide. p. 44.

Hammer, M. (2006b). Review and 2005 performance of fish indicators for Environmental Water Requirements of the Marne River Catchment, South Australia. Report to SAMDB NRM Board. Aquasave Consultants, Adelaide. p. 30.

Hammer, M. (2006c). Review of monitoring data for river blackfish in the Eastern Mount Lofty Ranges, South Australia: 2002-2006. Report to the South Australian Murray-Darling Basin Natural Resources Management Board. Aquasave Consultants, Adelaide. p. 32.

Hammer, M. (2007a). Data summary and 2006 performance of fish indicators for Environmental Water Requirements of the Marne River Catchment, South Australia. Aquasave Consultants, Adelaide. p. 17.

Hammer, M. (2007b). A preliminary population model for Mountain Galaxias in the Eastern Mount Lofty Ranges, South Australia based on 2002-2006 monitoring data. Aquasave Consultants, Adelaide. p. 20.

Hammer, M. (2007c). Distribution, status and urgent conservation measures for Yarra Pygmy Perch in the Murray-Darling Basin. Report to Department for Environment and Heritage, South Australian Government. Aquasave Consultants, Adelaide. p. 29.

Hammer, M. (2007d). Freshwater fish monitoring for threatened species and environmental water requirements in the Eastern Mount Lofty Ranges. Report to the SA Murray-Darling Basin NRM Board. Aquasave Consultants, Adelaide. p. 62.

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

Jennings, P. R., Zampatti, B. P., and Bice, C. M. (2008). Fish movement and recruitment in the Coorong and Lower Lakes: 2008/08 progress report. SARDI publication number F2007/0005552. SARDI Aquatic Sciences, Adelaide. p. 41.

Marne River Environmental Flows Technical Panel (2003). Environmental Water Requirements of the Ephemeral Marne River System, South Australia. River Murray Catchment Water Management Board, Berri. p. 114.

McInnes, K. L., Suppiah, R., Whetton, P. H., Hennessy, K. J., and Jones, R. N. (2003). Climate change in South Australia. Report on: assessment of climate change, impacts and possible adaptation strategies relevant to South Australia. Undertaken for the South Australian Government by the Climate Impact Group, CSIRO Atmospheric Research, Aspendale, Victoria. p. 61.

McNeil, D. G., and Hammer, M. (2007). Biological review of the freshwater fishes of the Mount Lofty Ranges. SARDI publication number: F2006/000335. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. p. 104.

Mount Lofty Ranges Environmental Water Requirements Expert Panel (in preparation). Environmental water requirements of the Mount Lofty Ranges
report. SAMDBNRMB and DWLBC, Adelaide.

Savadamuthu, K. (2002). Impacts of farm dams on streamflow in the upper Marne Catchment. Department of Water, Land and Biodiversity Conservation, Adelaide. p. 34.

Savadamuthu, K. (2003). Surface Water Assessment of the Upper Finniss Catchment. Department of Water, Land and Biodiversity Conservation, Adelaide. p. 67.

SKM (2002). Determination of environmental water requirements of the Onkaparinga River Catchment, technical report V: fish survey. Sinclair Knight Merz PTY Limited, Armadale, Victoria. p. 17.

SKM, CRC for Freshwater Ecology, Freshwater Ecology (NRE), and Lloyd Environmental Consultants (2002). The FLOWS method: a method for determining environmental water requirements in Victoria. Department of Natural Resources and Environment, Melbourne. p. 90.

Smith, B. B. (2006). Final report on the 'fish' component of the 2005 River Murray Wetlands Baseline Survey. Primary Industries and Resources SA, SARDI Aquatic Sciences., Adelaide. p. 83.

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. p. 38.

8.0 Appendices

Appendix 1. Gear types and replicates for sites sampled in autumn 2009 (indicative values shown for dry sites).

Site Code	Date	River System	Location	Conductivity	7m seine	4m seine	Dip net	Large fyke	Small fyke	Double wing fyke	Bait trap	Efishing on time (seconds)	Volts	Hz	%	Night observations	Day observation
ML09-01	6/02/09	Finniss River	Waterfalls	2360			x				8						
ML09-02	11/02/09	Bremer River	'Stone End'	7760					4								
ML09-03	21/03/09	Finniss River	JVW Pty Ltd	420								1340	250	90	7		
ML09-04	23/03/09	Finniss River	Thorn Dairy	6840								1500	250	75	10		
ML09-05	24/03/09	Finniss River	us of waterfall	1958								1200	250	75	10		
ML09-06	29/03/09	Tookayerta Creek	Deep Creek Rd	845								600	250	75	10		
ML09-07	24/03/09	Angas River	Middle Creek junction	5140					1								
ML09-08	24/03/09	Angas River	Flow gauge site	8640				3									
ML09-09	25/03/09	Tookayerta Creek	us Willowburn Rd	325								945	300	75	10		
ML09-10	26/03/09	Lakes Alexandrina & Albert	Turveys Drain	7150				3									
ML09-11	30/03/09	River Murray	Channel at Road Bridge	56100	3			2	1	6							
ML09-12	1/04/09	Currency Creek	'Kilchoan'	870								415	250	75	10		
ML09-13	1/04/09	Tookayerta Creek	Compass Cabins	287								579	300	75	10		
ML09-14	1/04/09	Tookayerta Creek	Brawley Swamp	427								125	250	75	10		
ML09-15	1/04/09	Finniss River	McHarg Creek Road	2970								250	250	75	10		
ML09-16	2/04/09	Angas River	Quarry Road	5120							8						
ML09-17	2/04/09	Angas River	ds of Searle Street, Macclesfield	2019							10						
ML09-18	2/04/09	Angas River	New development, cliff pool	5920	1			1	2								
ML09-19	2/04/09	Angas River	Walkway at Colman Terrace	5400				1	2								
ML09-20	2/04/09	Angas River	First weir ds of Nth Parade	5080				2	2								
ML09-21	2/04/09	Angas River	'Belvidere' parking bay	4880		1											
ML09-22	26/03/09	Marne River	Black Hill Springs (b)	5640							6					x	
ML09-23	3/04/09	Angas River	War memorial park, Strathalbyn	5190				2	2								
ML09-24	3/04/09	Angas River	Davidson Rd ford	Dry		3											
ML09-25	3/04/09	Angas River	Watson Park Road	Dry		3											
ML09-26	3/04/09	Bremer River	Gauge station	18490	1												
ML09-27	3/04/09	Angas River	Old swimming pool, Strathalbyn	5510				2	1								
ML09-28	8/04/09	Currency Creek	Lions Park	8500				2	3								
ML09-29	8/04/09	Currency Creek	ds of Goolwa to Strathalbyn road	8131				3	1								
ML09-30	9/04/09	Finniss River	ds Winery Road, below barrier to Lake	3190		3											
ML09-31	9/04/09	Finniss River	500m ds of Winery Road	3080				2	4	1							
ML09-32	9/04/09	Finniss River	300m ds of Winery Road	3000				4	3								
ML09-33	14/04/09	Currency Creek	'Stuarts Bridge'	2820				4	4								
ML09-34	14/04/09	Marne River	Vigars Road	Dry	3												x
ML09-35	14/04/09	Marne River	off Jutland Rd	9100			x										
ML09-36	14/04/09	Marne River	Jutland Water Reserve	3300	2												
ML09-37	14/04/09	Marne River	Pine Hutt Rd	12000	1												
ML09-38	14/04/09	Marne River	Marne George	26300	1												
ML09-39	15/04/09	Tookayerta Creek	Tonkins Winery	976				2	3								
ML09-40	16/04/09	Bremer River	100m us of Rodwell Creek	6080				4	4								
ML09-41	16/04/09	Bremer River	Pump station	6080				2	2								
ML09-42	16/04/09	Bremer River	Military Road	6220			x										
ML09-43	16/04/09	Bremer River	Main Road, Harrogate	15000			x										
ML09-44	16/04/09	Finniss River	ds of Coles Crossing	2447								1500	250	75	10		
ML09-45	17/04/09	Bremer River	ds of foot bridge, Mt Barker	1976								250	250	75	10		
ML09-46	17/04/09	Bremer River	'Highland Valley' (b)	10870							7						
ML09-47	17/04/09	Bremer River	'Highland Valley' (a)	4280							10						
ML09-48	19/04/09	Inman River	Kirk Property	1150			x				6						
ML09-49	19/04/09	Inman River	Kirk Road	2780							10						
ML09-50	19/04/09	Inman River	Robertson Property	3210							8						
ML09-51	21/04/09	Finniss River	Railway Bridge 'Dunreath'	2715				3	4	2		1900	200	70	7		
ML09-52	21/04/09	Finniss River	ds of railway bridge, Vallis pool	2670				1	3								
ML09-53	23/04/09	Saunders Creek	ds of road junction (Lenger Reserve)	11580			x										
ML09-54	23/04/09	Saunders Creek	us of Springs Rd (circular pool)	10380	3												
ML09-55	23/04/09	Reedy Creek	Baker Creek Gorge	7950				2	3								
ML09-56	23/04/09	Reedy Creek	Reedy Creek Swamp	Dry	3			3	3								
ML09-57	24/04/09	Reedy Creek	300m us of fence line	8540				1	1								
ML09-58	24/04/09	Reedy Creek	ds of Mannum Waterfalls	22550			x										
ML09-59	24/04/09	Reedy Creek	Palmer Rd	31000	3												
ML09-60	7/05/09	Finniss River	us of ford on eastern arm	2780		3		5	3	1							
ML09-61	7/05/09	Finniss River	us of Winery Rd, east channel	2780		1	x	4	4	1							
ML09-62	5/05/09	Bremer River	'Stone End' dam	7210				2	2								
RM09-03	26/03/09	River Murray	Bridge on channel	57700				3									

Appendix 2. Marne Catchment fish sampling locations, water quality and catch summary 2002-2009 (* = Alien species, ++ plus wetland generalists).

Site Code	Date	Waterway	Location	Easting	Northing	Depth max (m)	Flow	Pool condition	Subsurface physical %	Subsurface biological %	Emergent %	Edge vegetation %	pH	Conductivity (µS/cm)	Temperature (°C)	DO - surface (ppm)	DO - depth (ppm)	Transparency (m)	Mountain galaxias	River blackfish	Carp gudgeons	Dwarf flathead gudgeon	Common carp*	Gambusia*	No fish
Reach 2																									
ML02-13	7/03/02	Marne River	Vigars Road	323155	6161928	1.0	None	Low level	40	0	0	20	-	4000	20.0			0.2	20						
ML04-134	4/05/04	Marne River	Vigars Road	323141	6161926	1.2	None	Low level	50	0	2	10	8.1	3920	13.0			0.4	19						
ML05-35	19/04/05	Marne River	Vigars Road	323144	6161942	1.2	None	Low level	40	2	1	5	-	3720	12.7			0.5	8						
ML06-21	6/04/06	Marne River	Vigars Road	323147	6161936	1.5	Low	Bank level	40	2	2	20	7.9	4070	13.1			0.4	95						
ML07-42	7/05/07	Marne River	Vigars Road	323178	6161956	1.2	Seep	Bank level	40	0	0	5	8.1	2960	16.4			0.3	11						
ML07-63	17/11/07	Marne River	Vigars Road	323123	6161940	1.2	Seep	Bank level	40	5	0	40	-	4240	17.1			0.5	154						
ML08-09	1/04/08	Marne River	Vigars Road	323148	6161933	0.1	None	Concentrated	30	1	0	20	7.8	10180	8.3	4.2	2.7	0.1							x
ML08-93	25/11/08	Marne River	Vigars Road	323145	6161939	1.0	None	Low level	50	0	0	40	7.7	5100	14.8	4.3		0.05							x
ML09-34	14/04/09	Marne River	Vigars Road	323148	6161933	0.0	None	Dry	0	0	0	10													x
ML02-158	16/05/02	Marne River	off Jutland Road	331500	6162200	1.0	None	Low level	20	0	30	40	7.5	3470	14.0			0.3	26						
ML04-133	4/05/04	Marne River	off Jutland Road	331644	6162341	1.0	None	Bank level	30	0	20	30	7.8	4970	13.0			0.4	53						
ML05-36	19/04/05	Marne River	off Jutland Road	331636	6162376		None	Low level	20	0	40	70	-	4620	11.3			0.3	114						
ML06-17	3/04/06	Marne River	off Jutland Road	331636	6162376	1.2	None	Bank level	40	-	20	70	-	4030	13.2			0.5	52						
ML07-45	7/05/07	Marne River	off Jutland Road	331683	6162373	1.0	None	Low level	30	0	10	60	7.5	6920	14.0			0.2	13						
ML07-64	17/11/07	Marne River	off Jutland Road	331693	6162396	1.2	None	Bank level	40	1	30	80	-	3260	18.4			0.4	157						
ML08-10	1/04/08	Marne River	off Jutland Road	331705	6162390	0.2	None	Concentrated	30	0	0	80	7.7	9800	12.6	4.2	1.6	0.2							x
ML08-94	25/11/08	Marne River	off Jutland Road	331690	6162394	1.0	None	Low level	30	0	30	80	7.5	6340	13.8	6.7		0.1	12						
ML09-35	14/04/09	Marne River	off Jutland Road	331690	6162395	0.2	None	Concentrated	30	0	1	60	7.5	9100	14.8	1.3		0.1							x
ML09-36	14/04/09	Marne River	Jutland Water Reserve	331747	6162054	0.8	None	Low level	30	0	10	60	7.2	3300	14.9	1.7		0.4	2						
Reach 4																									
ML02-22	8/03/02	North Rhine R.	Pine Hutt Road	332100	6168100	1.5	None	Low level	30	0	5	70	-	3900	-			0.4							x
ML06-22	6/04/06	North Rhine R.	Pine Hutt Road	332113	6168031	2.5	None	Bank level	30	0	10	60	7.4	5040	13.4			0.3	7						
ML07-44	7/05/07	North Rhine R.	Pine Hutt Road	332126	6168100	1.0	Seep	Bank level	50	0	10	70	8.2	2370	15.0			0.1							x
ML07-65	17/11/07	North Rhine R.	Pine Hutt Road	332127	6168106	1.0	None	Bank level	50	2	10	70	-	3490	21.9			0.6							x
ML08-11	1/04/08	North Rhine R.	Pine Hutt Road	332128	6168111	1.0	None	Low level	30	0	0	20	8.3	4120	12.8	8.8		0.2							x
ML08-95	25/11/08	North Rhine R.	Pine Hutt Road	332109	6168080	0.8	None	Low level	60	0	1	40	8.5	3880	15.4	8.0	7.4	0.3							x
ML09-37	14/04/09	North Rhine R.	Pine Hutt Road	332140	6168119	0.3	None	Concentrated	30	0	0	0	8.6	12000	18.3	13.5		0.1							x

Site Code	Date	Waterway	Location	Easting	Northing	Depth max (m)	Flow	Pool condition	Subsurface physical %	Subsurface biological %	Emergent %	Edge vegetation %	pH	Conductivity (µS/cm)	Temperature (°C)	DO - surface (ppm)	DO - depth (ppm)	Transparency (m)	Mountain galaxias	River blackfish	Carp gudgeons	Dwarf flathead gudgeon	Common carp*	Gambusia*	No fish
Reach 5																									
ML02-28	26/02/02	Marne River	Marne Gorge	338164	6161572	1.5	None	Low level	20	10	0	20	8.4	4600	22.0			0.2	25						
ML04-136	5/05/04	Marne River	Marne Gorge	338160	6161579	1.2	None	Low level	30	0	0	5	8.6	6990	13.9			0.3							x
ML05-37	19/04/05	Marne River	Marne Gorge	338149	6161588	1.2	None	Low level	30	0	5	20	-	6020	15.1			0.3	44						
ML06-18	3/04/06	Marne River	Marne Gorge	338161	6161611	1.2	None	Low level	30	2	0	5	9.0	4250	15.3			0.4	48						
ML07-46	7/05/07	Marne River	Marne Gorge	338167	6161576	1.4	Low	Bank level	10	0	10	50	10.9	5680	16.0			0.5							x
ML08-12	1/04/08	Marne River	Marne Gorge	338145	6161588	0.8	None	Low level	40	0	0	5	8.3	12410	15.5	9.3	5.8	0.3	23						
ML08-96	25/11/08	Marne River	Marne Gorge	338160	6161580	1.5	None	Low level	30	0	0	10	8.4	13510	19.5	8.5	4.6	0.7	10						
ML09-38	14/04/09	Marne River	Marne Gorge	338155	6161577	0.8	None	Concentrated	30	0	0	0	7.8	26300	19.3	9.0	6.5	0.3							x
Reach 8																									
ML02-06	25/02/02	Marne River	Black Hill Springs (b)	363088	6158313	1.3	Low	Bank level	10	2	60	90	-	5000	19.5			1.3+	9	21	6	10	3	2	
ML03-49	6/04/03	Marne River	Black Hill Springs (b)	363083	6158317	1.2	Medium	Bank level	10	0	30	90	8.3	5420	15.9			1.2+	1	10		4		1	
ML04-140	5/05/04	Marne River	Black Hill Springs (b)	363088	6158313	1.2	Low	Bank level	5	5	30	80	7.5	5150	11.8			1.0		10				5	
ML05-01	15/01/05	Marne River	Black Hill Springs (b)	363094	6158337	1.0	Medium	Bank level	20	0	30	80	-	4900	17.6			0.5		3	8	2		2	
ML05-39	19/04/05	Marne River	Black Hill Springs (b)	363083	6158317	1.1	Medium	Bank level	10	0	40	90	-	4820	14.2			1.0	25	10	1	8		10	
ML05-53	24/11/05	Marne River	Black Hill Springs (b)	363088	6158313	1.2	Medium	Bank level	10	2	30	80	7.5	4780	16.7			1.2	10	6	2			2	
ML06-19	3/04/06	Marne River	Black Hill Springs (b)	363088	6158313	2.0	Medium	Bank level	10	2	40	80	-	5170	14.6			2.0	5	9	5	2		4	
ML06-28	9/06/06	Marne River	Black Hill Springs (b)	363088	6158313	1.2	Medium	Bank level	10	0	40	80	7.9	5280	9.5			2.0	12	5			1		
ML07-03	28/02/07	Marne River	Black Hill Springs (b)	363092	6158307	1.0	Low	Bank level	30	0	30	80	-	4600	20.0			1.0	4	4	4			10	
ML07-59	25/08/07	Marne River	Black Hill Springs (b)	363092	6158309	1.2	Low	Bank level	10	0	30	80	-	5260	11.4			2.0	1	3					
ML07-66	17/11/07	Marne River	Black Hill Springs (b)	363092	6158309	1.2	Low	Bank level	10	1	30	80	-	5390	18.8			2.0	3	1					
ML08-45	27/04/08	Marne River	Black Hill Springs (b)	363033	6158325	1.5	Low	Bank level	10	30	20	80	7.4	5400	11.8	7.0	0.5	1.0	2	9	20	10		30	
ML08-109	10/11/08	Marne River	Black Hill Springs (b)	363033	6158325	1.1	Medium	Bank level	5	5	40	80	4.6	5600	18.2			1.2	4	6	3				
ML09-22	26/03/09	Marne River	Black Hill Springs (b)	363033	6158325	1.2	Low	Bank level	1	5	40	90	7.5	5640	17.1	4.8	0.7	1.2		5	1			1	
Reach 9																									
ML02-05	25/02/02	Marne/Murray	Marne Mouth	369657	6159363	1.0	None	Bank level	10	50	5	60	7.6	780	21.1			0.1			112	3	2	56	++
NA	27/04/08	Marne/Murray	Marne Mouth	369657	6159363	0.0	None	Dry	0	0	0	40													x
NA	26/03/09	Marne/Murray	Marne Mouth	369657	6159363	0.0	None	Dry	0	0	0	40													x

Appendix 3. Saunders Catchment fish sampling locations, water quality and catch summary 2001-2009 (* = Alien species).

Site Code	Date	Waterway	Location	Easting	Northing	Depth max (m)	Flow	Pool condition	Subsurface physical %	Subsurface biological %	Emergent %	Edge vegetation %	pH	Conductivity (µS/cm)	Temperature (°C)	DO - surface (ppm)	DO - depth (ppm)	Transparency (m)	Carp gudgeons	Carp*	Gambusia*	No fish
Upstream																						
ML04-129	3/05/04	Saunders Creek	Saunders Gorge Sanctuary	336231	6154156	1.5	None	Low level	20	0	0	20	8.3	8630	15.2			0.2				x
ML04-130	3/05/04	Saunders Creek	ds Strachans Road	330676	6156244	1.0	None	Low level	20	0	0	10	8.8	10030	12.4			0.2				x
ML04-131	4/05/04	Saunders Creek	'Myrtle Grove'	330697	6157512	1.5	Low	Low level	30	0	10	40	7.7	8860	13.4			0.3			200	
ML04-135	5/05/04	Kinappa Creek	Weir on spring	337148	6157203	0.6	Low	Bank level	20	30	10	30	7.6	2920	14.0			0.6+				x
ML04-132	4/05/04	Saunders Creek	ds Jutland Road	333153	6157094	1.2	None	Bank level	30	0	20	60	7.5	5780	12.2			0.3				x
ML07-43	7/05/07	Saunders Creek	ds Jutland Rd ford	333149	6157029	1.0	None	Low level	30	0	20	60	7.6	6300	14.5			0.2			100	
Reach 5																						
ML01-08	3/12/01	Saunders Creek	Lenger Reserve	350682	6146134	1.5+	None	Bank level	20	0	20	60	8.0	7800	-			0.3	15		40	
ML04-128	3/05/04	Saunders Creek	us Springs Road Junction	350531	6146364	1.1	None	Low level	30	0	5	80	10.7	8660	12.6			0.4	500		600	
ML09-54	23/04/09	Saunders Creek	us of Springs Rd (circular pool)	350522	6146356	0.45	None	Concentrated	2	0	4	90	7.7	10380	11.8	7.1	7.5	0.15	20	1	1000	
ML09-53	23/04/09	Saunders Creek	Lenger Reserve	350678	6146127	1.7	None	Low level	7	0	15	80	7.4	11580	12.3	12.5	9.8	0.3			80	

Appendix 4. Reedy Catchment fish sampling locations, water quality and catch summary 2001-2009 (* = Alien species).

Site Code	Date	Waterway	Location	Easting	Northing	Depth max (m)	Flow	Pool condition	Subsurface physical %	Subsurface biological %	Emergent %	Edge vegetation %	pH	Conductivity (µS/cm)	Temperature (°C)	DO - surface (ppm)	DO - depth (ppm)	Transparency (m)	Carp gudgeons	Common galaxias	Dwarf flathead gudgeon	Flathead gudgeon	Mountain galaxias	Smelt	Common carp*	Gambusia*	Goldfish*	Redfin*	No fish
Reaches 2 & 3																													
ML04-103	21/04/04	Baker Creek	ds Henschke Road	325366	6139301	1.0	None	Low level	30	0	0	5	-	12340	18.4			0.5											x
ML04-106	22/04/04	Bryce Creek	East of power lines	320187	6141812	1.2	None	Bank level	40	0	20	20	7.8	10620	18.9			0.3								400			
ML04-107	22/04/04	Bryce Creek	us Hoads Woolshed Rd	322565	6142906	2.0	Low	Bank level	30	5	20	80	8.6	3660	15.2			0.8										2	
ML04-75	8/04/04	Dairy Creek	'Thorlindah'	324893	6138618	0.6	None	Concentrated	40	2	0	5	9.2	11290	19.1			0.2											x
ML04-100	19/04/04	Dairy Creek	'Dairy Springs'	321738	6138553	1.6	None	Bank level	10	2	10	60	8.0	6300	14.7			0.4											x
ML04-102	21/04/04	Dairy Creek	Jnc Dairy and Baker Ck	326983	6138459	1.5	None	Low level	40	2	2	15	9.1	8330	15.9			0.5											x
ML08-86	6/11/08	Dairy Creek	Collins Rd bridge	321754	6138907	1.8	None	Concentrated	5	0	30	20	7.5	7100	20.2	6.5	4.3	0.30											x
ML08-87	6/11/08	Dairy Creek	Hoad Rd	324356	6138654	0.6	None	Concentrated	15	0	0	30	7.9	7230	21.6	7.5	6.4	0.6											x
ML04-101	21/04/04	Dairy Creek trib.	Tea Tree Spring	322845	6137655	1.5	Low	Bank level	30	5	5	10	8.0	7330	16.3			0.3											x
ML04-77	8/04/04	Gorge Creek	Spring off Peachs Rd	333193	6135001	1.0	None	Bank level	0	70	10	60	8.4	10530	22.1			1.0								500			
ML04-104	22/04/04	Harrison Creek	Rosebank	325969	6148796	1.0	Low	Low level	20	2	5	10	7.9	3870	16.3			0.3											x
ML04-105	22/04/04	Harrison Creek	Tungkillo - Palmer Rd	326716	6144999	0.6	None	Low level	20	2	5	30	9.3	8130	18.0			0.3											x
ML04-122	29/04/04	Harrison Creek	ds Gorge	330312	6139467	1.2	None	Bank level	40	0	20	30	8.3	6740	11.6			0.3											x
ML04-121	29/04/04	Harrison Creek	Waterfall	328512	6139332	1.5	None	Bank level	30	0	10	30	8.9	7800	12.6			0.2											x
ML04-120	29/04/04	Loxton Creek	ds Kubens Rd	326855	6132968	0.5	Seep	Low level	15	0	5	20	8.2	5700	11.4			0.2											x
ML08-88	6/11/08	Talbot Creek	ds Hoads Fire Track	326814	6137150	0.7	None	Concentrated	5	30	0	100	8.3	24210	20.0	11.2	10.5	0.05											x
Reach 4																													
ML08-112	23/12/08	Baker Creek	us Reedy Ck junction	330629	6139270	0.5	None	Low level	30	2	1	30	8.1	10620	19.9	6.6	6.3	0.3			105		106						
ML09-55	23/04/09	Baker Creek	Baker Creek Gorge	330629	6139270	2.0	None	Low level	30	15	4	80	7.9	7950	14.1	8.4	8.2	1.8			305		29						
ML08-113	23/12/08	Reedy Creek	off Camel Hump Rd	330629	6139270	1.7	None	Low level	15	0	10	50	7.8	8810	16.8	2.5	1.6	0.3					16						
ML09-57	24/04/09	Reedy Creek	300m us of fence line	330493	6139497	1.1	None	Low level	25	0	15	60	7.5	8540	13.0	3.5	1.2	0.3											x

Site Code	Date	Waterway	Location	Easting	Northing	Depth max (m)	Flow	Pool condition	Subsurface physical %	Subsurface biological %	Emergent %	Edge vegetation %	pH	Conductivity (µS/cm)	Temperature (°C)	DO - surface (ppm)	DO - depth (ppm)	Transparency (m)	Carp gudgeons	Common galaxias	Dwarf flathead gudgeon	Flathead gudgeon	Mountain galaxias	Smelt	Common carp*	Gambusia*	Goldfish*	Redfin*	No fish
Reach 5																													
ML04-76	29/04/04	Reedy Creek	Palmer Road	332317	6137835	0.6	None	Concentrated	30	10	20	40	8.6	33000	16.6			0.4			31					200			
ML08-42	23/04/08	Reedy Creek	Palmer Road	332297	6137909	1.0	None	Low level	30	0	30	50	7.9	30900	13.4	4.6		1.0			71								
ML08-82	3/11/08	Reedy Creek	Palmer Road	332258	6137940	1.5	None	Low level	20	1	30	80	7.2	9940	16.5	8.0	5.4	0.30			126		21						
ML09-59	24/04/09	Reedy Creek	Palmer Road	332278	6137882	1.0	None	Low level	35	10	30	50	7.7	31000	14.8	7.0		0.6			100					200			
Reach6																													
ML04-125	2/05/04	Reedy Creek	'Abrahams'	334586	6134228	1.5	Low	Bank level	10	50	5	60	7.9	14080	14.0			1.0			143					200			
ML08-81	3/11/08	Reedy Creek	off Abrahams Rd	333657	6134665	1.5	None	Concentrated	5	15	60	20	7.0	16840	16.6	5.2	2.8	0.20								50			
ML08-41	23/04/08	Reedy Creek	'Abraham' property	334640	6134213	2.0	None	Low level	20	30	20	20	7.8	17070	16.5	9.7		2.0			4					150			
Reach 7																													
ML01-53	13/02/01	Reedy Creek	Waterfalls reserve	337598	6132931	0.7	None	Bank level	20	0	20	70	7.0	7250	25.0			0.5	200	100		300		10	20	500	20		
ML04-124	2/05/04	Reedy Creek	Waterfalls	337103	6133488	1.0	None	Low level	30	10	0	5	6.8	18270	13.4			0.5			2					100			
ML04-127	3/05/04	Reedy Creek	Waterfalls Reserve	337623	6132938	0.6	None	Concentrated	30	0	0	10	8.0	12300	14.0			0.3	17		5	304			6	50	19		
ML08-40	23/04/08	Reedy Creek	Below waterfall	337611	6132945	1.0	None	Concentrated	5	0	0	70	8.5	17000	16.8	12.0		0.05	15	4		449				2			
ML08-80	3/11/08	Reedy Creek	ds of waterfalls	337613	6132956	2.0	None	Low level	20	30	20	40	7.1	17610	19.7	5.0	5.7	0.15											x
ML09-58	24/04/09	Reedy Creek	ds of Waterfalls	337617	6132947	1.2	None	Low level	30	30	2	70	7.6	22550	16.5	6.4		0.3				25				4			
Reach 8																													
ML04-141	22/05/04	Reedy Creek	Reedy Creek Wetland	340129	6131436	0.8	Low	Concentrated	5	0	20	20	8.9	1140	17.8			0.1	1	1	1			1	x	50			
ML08-83	3/11/08	Reedy Creek	Reedy Creek Wetland	341535	6130330	0.4	None	Concentrated	0	0	0	50	8.1	636	20.4	6.8		0.05	18			3		20					
ML08-111	23/12/08	Reedy Creek	Track in swamp	340087	6132094	2.0	None	Low level	2	0	5	100	8.6	25000	28.0	14.2		0.2								15			
ML09-56	23/04/09	Reedy Creek	Reedy Creek Swamp	341429	6130386	0.0	None	Dry	0	0	0	80																	x

Appendix 5. Salt-Rocky Catchment fish sampling locations, water quality and catch summary 2004-2009 (* = Alien species, ++ plus wetland generalists).

Site Code	Date	Waterway	Location	Easting	Northing	Depth max (m)	Flow	Pool condition	Subsurface physical %	Subsurface biological %	Emergent %	Edge vegetation %	pH	Conductivity (µS/cm)	Temperature (°C)	DO - surface (ppm)	DO - depth (ppm)	Transparency (m)	Carp gudgeons	Common galaxias	Flathead gudgeon	Murray hardyhead	Smallmouthed hardyhead	Gambusia*	No fish
Salt Creek																									
ML04-117	29/04/04	Long Gully Creek	Off Annie Lane	327902	6123351	1.2	None	Low level	5	40	0	30	8.6	22600	11.0			0.5							x
ML04-74	8/04/04	Long Gully Creek	Critchley Road	325974	6123869	0.4	Seep	Concentrated	5	5	5	80	9.4	22850	19.5			0.1							x
ML04-118	29/04/04	Mitchell Gully Creek	Mitchell Gully Ruins	325982	6125082	0.6	None	Low level	20	10	5	80	8.4	25300	10.3			0.8							x
ML04-116	28/04/04	Salt Creek	Round Waterhole	327855	6125292	1.5	None	Low level	5	5	0	50	8.3	23040	13.7			0.7						50	
ML04-115	28/04/04	Salt Creek	us Rockleigh Rd xing	328800	6124500	1.0	Low	Bank level	10	30	10	40	8.3	30000	15.0			0.8						250	
ML04-114	28/04/04	Salt Creek	Pine Villa	334045	6122040	0.6	None	Low level	10	60	2	40	8.7	23970	14.8			0.6+						200	
ML04-119	29/04/04	Salt Creek Trib.	Gum Gully	325372	6126568	0.8	Seep	Bank level	20	20	2	30	8.6	17530	11.7			0.5							x
Preamimma and Milendella creeks																									
ML04-113	28/04/04	Preamimma Creek	Off Preamimma Rd	326332	6119966		None	Dry				20													x
ML04-126	2/05/04	Milendella Creek	off The Gap Road	331050	6147192	0.2	Low	Concentrated	2	5	60	60	8.2	2660	13.0			0.2+							x
Rocky Gully Creek																									
RM07-08	11/03/07	Rocky Gully Ck	ds control structure	342803	6114023	1.0	None	Low level	10	1	20	60	-	1500	21.8			0.4	20	2	100	1	1	200	++
RM08-06	17/03/08	Rocky Gully Ck	Bridge on channel	342112	6113172	1.0	None	Low level	10	20	2	70	8.1	46800	21.1			0.2			10	250	30	30	
ML09-11	30/03/09	Rocky Gully Ck	Bridge on channel	342112	6113172	1.0	None	Concentrated	5	0	1	50	8.5	56100	27.8			0.1				2	2	40	

Appendix 6. Bremer Catchment fish sampling locations, water quality and catch summary 2001-2009 (* = Alien species, ++ plus wetland generalists/euryhaline).

Site Code	Date	Waterway	Location	Easting	Northing	Depth max (m)	Flow	Pool condition	Subsurface physical %	Subsurface biological %	Emergent %	Edge vegetation %	pH	Conductivity (µS/cm)	Temperature (°C)	DO - surface (ppm)	DO - depth (ppm)	Transparency (m)	Carp gudgeons	Common galaxias	Congolli	Dwarf flathead gudgeon	Flathead gudgeon	Mountain galaxias	Murray hardyhead	Murray-Darling golden perch	River blackfish	Common carp*	Gambusia*	Goldfish*	Rainbow trout*	Redfin*	Tench*	No fish
Reach 2																																		
ML04-82	9/04/04	Rodwell Creek	'Highland Valley' (a)	310008	6104157	1.5	None	Low level	20	30	20	50	8.1	4300	15.9			0.3	35								17		15						
ML05-03	22/01/05	Rodwell Creek	'Highland Valley' (a)	309976	6104107	1.5	None	Low level	10	30	20	50	-	4650	17.7			0.5	100								5		105						
ML06-04	26/03/06	Rodwell Creek	'Highland Valley' (a)	310007	6104160	1.5	None	Low level	20	30	30	90	-	5740	17.7			0.3	40					2			7		40						
ML07-21	19/04/07	Rodwell Creek	'Highland Valley' (a)	310007	6104160	1.2	Seep	Low level	40	20	10	80	7.8	5650	15.5			1.0	20					4			16		22						
ML07-57	17/09/07	Rodwell Creek	'Highland Valley' (a)	310008	6104157	1.8	Low	Bank level	10	0	40	50	7.8	4550	10.3			0.15									1		50						
ML08-03	11/03/08	Rodwell Creek	'Highland Valley' (a)	310056	6104248	0.7	Seep	Concentrated	30	30	10	80	7.6	7260	21.4	4.3		0.3	30								8		200						
ML08-110	12/11/08	Rodwell Creek	'Highland Valley' (a)	310056	6104248	1.2	None	Low level	5	5	40	80	7.2	6500	17.2	7.0	4.1	0.7									6								
ML09-47	17/04/09	Rodwell Creek	'Highland Valley' (a)	310003	6104156	1.2	None	Low level	20	10	20	80	7.6	4280	14.8	6.6	5.4	0.7	2								14		3						
ML04-83a	9/04/04	Rodwell Creek	'Highland Valley' (b) cliff pool	310338	6103970	2.0	Seep	Bank level	20	0	30	40	7.9	6820	14.7			0.5	110					1			7		30						
ML06-05	26/03/06	Rodwell Creek	'Highland Valley' (b) cliff pool	310337	6103970	2.5	None	Bank level	20	0	40	60	-	6060	18.0			0.8	25								9		40						
ML07-22	19/04/07	Rodwell Creek	'Highland Valley' (b) cliff pool	310337	6103970	3.0	None	Bank level	10	0	50	50	8.0	7790	13.4			0.3	1								4		50						
ML08-04	11/03/08	Rodwell Creek	'Highland Valley' (b) cliff pool	310337	6103970	2.5	None	Bank level	10	0	30	20	7.6	8900	21.4	4.6	0.2	0.3	2					4					100						
ML09-46	17/04/09	Rodwell Creek	'Highland Valley' (b) cliff pool	310319	6103971	1.5	None	Bank level	10	0	30	20	7.5	10870	14.5	7.8	1.1	0.3											148						
ML01-50	4/01/01	Rodwell Creek	'Highland Valley' (b) corner	311100	6103850	2.0	None	Bank level	10	0	30	80	-	-	-			0.4	500					4					50						
ML04-83b	9/04/04	Rodwell Creek	'Highland Valley' (b) corner	311038	6103897		None	Dry				80																						x
ML04-110	27/04/04	Rodwell Creek	off Bunnetts Road	308972	6110076	0.6	None	Bank level	30	5	20	60	7.8	11620	11.3			0.2											20						
ML08-07	31/03/08	Rodwell Creek	'Stone End'	311192	6103405	3.0	None	Bank level	80	5	30	70	7.8	6850	14.9	7.1	6.1	0.4	1065					6					462						
ML09-02	11/02/09	Rodwell Creek	'Stone End'	311184	6103427	3.0	Low	Low level	20	0	20	70	8.0	7760	18.2	4.2	4.8	0.2	1380										630						
ML09-62	5/05/09	Rodwell Creek	Stone End'	311180	6103440	1.7	Low	Low level	30	0	50	95	7.9	7210	13.2	3.0		0.5	4600										2050						
ML04-84	9/04/04	Rodwell Creek	The Lagoon, Woodchester	315328	6102524	2.0+	Seep	Bank level	20	5	20	50	8.2	7400	19.3			0.4	63				94						30						
Reach 3																																		
ML04-90b	15/04/04	Bremer River	Instream dam, 'Taworri'	317446	6134368	1.5	None	Low level	10	0	0	2	7.9	2240	16.8			0.3					2				2				31			
ML04-90a	15/04/04	Bremer River	The Swimming Hole 'Taworri'	317394	6134216	1.0	None	Bank level	30	1	5	10	7.8	3260	15.5			0.4					5												
ML01-11	20/10/01	Bremer River	Harrogate, Tennis Courts	318400	6130600	1.2	Low	Bank level	20	0	10	30	-	-	-			1.0	13					6				6				1			
ML04-91b	15/04/04	Bremer River	Harrogate, Tennis Courts	318400	6130600		None	Dry				10																						x
ML01-10	20/10/01	Bremer River	Harrogate main bridge	318500	6130700	1.5	Low	Bank level	30	0	10	70	-	-	-			1.0	1				2	23			1				2			
ML02-159	16/05/02	Bremer River	Harrogate main bridge	318500	6130500	0.6	None	Concentrated	30	0	20	40	7.6	6880	15.1			0.3	30				50	23			1				1			
ML04-91a	15/04/04	Bremer River	Harrogate main bridge	318600	6130664	0.8	None	Concentrated	50	0	10	40	8.0	9990	16.5			0.4	1				9												
ML08-32	15/04/08	Bremer River	Harrogate main bridge	318591	6130675	0.6	None	Concentrated	40	0	10	50	8.0	13920	15.2			0.2																	x

Site Code	Date	Waterway	Location	Easting	Northing	Depth max (m)	Flow	Pool condition	Subsurface physical %	Subsurface biological %	Emergent %	Edge vegetation %	pH	Conductivity (µS/cm)	Temperature (°C)	DO - surface (ppm)	DO - depth (ppm)	Transparency (m)	Carp gudgeons	Common galaxias	Congolli	Dwarf flathead gudgeon	Flathead gudgeon	Mountain galaxias	Murray hardyhead	Murray-Darling golden perch	River blackfish	Common carp*	Gambusia*	Goldfish*	Rainbow trout*	Redfin*	Tench*	No fish
ML08-79	31/10/08	Bremer River	Harrogate main bridge	318590	6130632	1.5	Low	Low level	30	0	20	50	7.6	4910	12.0	7.0	3.6	0.05																x
ML09-43	16/04/09	Bremer River	Harrogate main bridge	313595	6130670	0.3	None	Concentrated	30	0	5	50	7.8	15000	12.0	1.8		0.15																x
ML04-92	15/04/04	Bremer River	Appleton Cottage, Harrogate	318662	6130751	1.0	None	Low level	40	0	20	60	8.3	9750	15.9			0.4					25											
ML04-93	15/04/04	Bremer River	Military Road	320569	6124470	1.2	None	Concentrated	30	0	0	5	8.4	10320	18.4			0.1	539															
ML08-31	15/04/08	Bremer River	Military Road	320516	6124458	0.1	None	Concentrated	30	0	0	20	8.0	12600	18.1			0.05	6															
ML08-73	31/10/08	Bremer River	Military Road	320529	6124489	1.7	None	Low level	40	0	5	30	7.9	3880	13.5	1.5	0.9	0.01																x
ML09-42	16/04/09	Bremer River	Military Road	320529	6124476	0.1	None	Concentrated	30	0	0	70	7.4	6220	13.5	3.1		0.1																x
ML04-99	19/04/04	Bryce Creek	us Harrogate Road	317504	6127405	0.8	Seep	Low level	30	0	5	30	8.1	10260	18.8			0.4																x
Reach 4																																		
ML04-85	14/04/04	Western Flat Ck	'Madabareenah'	304289	6111029	1.0	None	Low level	10	50	0	5	7.9	13140	16.9			0.5																x
ML04-108	27/04/04	Western Flat Ck	'Newenham', us bridge	302816	6115319	1.5	Low	Bank level	10	40	10	60	6.7	1750	9.6			0.4											50					
ML02-160	16/05/02	Mt Barker Ck	ds Adelaide Road	304500	6117000	1.2	Medium	Bank level	20	10	30	20	-	1370	13.5			0.5						40								7		
ML04-87	14/04/04	Mt Barker Ck	ds Adelaide Road	304600	6117200	1.5	None	Low level	20	10	20	50	-	2400	-			0.8											30					
ML07-51	12/05/07	Mt Barker Ck	ds Adelaide Road	304760	6117099	1.2	Low	Bank level	30	0	40	60	7.7	2110	11.4			0.4						12					30					
ML08-52	24/04/08	Mt Barker Ck	ds Adelaide Road	304750	6117101	1.5	None	Low level	30	0	10	20	7.5	2580	11.7	0.3		0.2						4					8					
ML08-89	12/11/08	Mt Barker Creek	ds Adelaide Road	304772	6117078	1.0	Low	Low level	30	20	5	50	7.8	2880	16.8	4.5		1.2						17					5			2		
ML09-45	17/04/09	Mt Barker Creek	ds Adelaide Road	304789	6117136	0.35	None	Concentrated	50	0	0	10	7.4	1976	14.5	2.5		0.1						5					11					
ML04-88	14/04/04	Mt Bark. Ck Trib.	Clegget Road	304678	6119416	0.6	Low	Bank level	20	20	20	20	7.5	2920	15.2			0.6+						1										
ML04-86	14/04/04	Mt Bark. Ck Trib.	Hurling Drive	305334	6115525	0.5	None	Concentrated	30	0	10	10	7.9	380	13.4			0.3+																x
ML04-89	14/04/04	Nairne Creek	Sydney Road	310052	6120862	0.6	None	Concentrated	30	20	10	60	7.5	1010	15.4			0.2						8										
ML08-57	13/07/08	Nairne Ck trib.	Beythorne Park dam, Nairne	308706	6121191	1.0	Low	Bank level	0	2	7	100	8.6	140	8.1	9.0		0.15											15			1		
ML07-20	9/04/07	Mt Barker Ck	Near sewage treatment	305903	6117079	1.2	None	Low level	15	0	2	35	7.4	1980	17.1			0.25						80					3					
ML04-109	27/04/04	Mt Barker Ck	Mt Barker Springs Gauge	310131	6115412	1.0	Medium	Bank level	30	2	15	60	6.8	1760	11.1			0.8											50					
ML04-96	18/04/04	Dawesley Ck	Princess Hwy	313000	6120700	1.0	Low	Bank level	30	0	10	50	5.3	3260	12.9			0.3																x
ML04-97	18/04/04	Dawesley Ck	us Peggy Buxton Road	312450	6125200	2.0	Low	Bank level	10	10	20	50	7.4	1730	12.3			0.3																x
Reach 5																																		
ML09-41	16/04/09	Bremer River	Pump station	317542	6100839	1.2	None	Low level	45	0	10	75	8.1	6080	14.8	12.5	9.7	0.2					1									7		
ML04-98	19/04/04	Bremer River	ds Crofton Park	320964	6116472	2.0+	None	Bank level	10	30	20	20	8.1	12810	18.5			0.6					20											
ML04-95	18/04/04	Bremer River	'Collray'	321280	6115200	1.2	None	Concentrated	20	30	10	20	9.0	10380	18.4			0.5	1				210					4	100					
ML04-73	18/04/04	Bremer River	Old Princess Hwy Bridge	321575	6113335	2.0	None	Bank level	30	5	20	70	7.7	12270	15.4			0.6	2				363						1104					
ML05-141	15/05/05	Bremer River	Old Princess Hwy Bridge	321699	6113212		None	Low level	30	2	20	70	-	10920	13.9			0.4					400					1	400					

Site Code	Date	Waterway	Location	Easting	Northing	Depth max (m)	Flow	Pool condition	Subsurface physical %	Subsurface biological %	Emergent %	Edge vegetation %	pH	Conductivity (µS/cm)	Temperature (°C)	DO - surface (ppm)	DO - depth (ppm)	Transparency (m)	Carp gudgeons	Common galaxias	Congolli	Dwarf flathead gudgeon	Flathead gudgeon	Mountain galaxias	Murray hardyhead	Murray-Darling golden perch	River blackfish	Common carp*	Gambusia*	Goldfish*	Rainbow trout*	Redfin*	Tench*	No fish
Reach 6																																		
ML04-111	27/04/04	Bremer River	us Jeansch Road	320138	6107095	3.0	None	Bank level	20	0	10	70	7.9	4190	14.3			0.5	1			4	32					1			1			
ML05-09	16/03/05	Bremer River	Jeansch Road ford	319918	6106568	1.5	None	Concentrated	20	0	5	90	-	4480	17.0			0.3	100	3		15	450					2	300					
ML08-44	24/04/08	Bremer River	South Bremer Road	318981	6104088	1.6	None	Low level	50	0	0	20	8.1	3570	11.1	3.2		0.2	27			26	34					7	73					
ML07-58	17/09/07	Bremer River	Hartley flow gauge station	318577	6101954	1.5	Medium	Bank level	30	5	20	50	7.8	2670	14.3			0.6		50			80					18	1	1				
ML08-30	15/04/08	Bremer River	Hartley flow gauge station	318529	6101976	0.6	None	Concentrated	40	0	0	30	8.1	1220	17.8	9.8		0.3					50					10	200			1		
ML08-71	30/10/08	Bremer River	Hartley flow gauge station	318504	6101989	1.3	None	Low level	20	5	20	20	8.0	3870	14.6	5.4	4.1	0.10	1			1	84					19						
ML09-26	3/04/09	Bremer River	Hartley flow gauge station	318544	6101993	0.4	None	Concentrated	40	0	0	40	7.9	18490	21.9	4.5		0.3					8					44	30					
ML08-56	1/06/08	Bremer River	us Rodwell Creek junction	317425	6100782	1.0	None	Low level	15	1	15	60	8.2	5180	11.7	8.5		0.15	2				2									1		
ML08-43	24/04/08	Bremer River	us Rodwell Creek junction	317436	6100800	1.0	None	Concentrated	20	0	5	20	8.6	5900	15.6	10.0		0.1	1	3	1		15			1		1	7			25		
ML08-72	30/10/08	Bremer River	us Rodwell Creek junction	317425	6100782	1.8	None	Bank level	5	0	10	80	7.9	2850	14.5	5.0	4.2	0.10					3									166		
ML09-40	16/04/09	Bremer River	us Rodwell Creek junction	317439	6100800	1.3	None	Low level	20	1	0	60	8.1	6080	14.8	12.5	9.7	0.2					8						3			29		
ML04-112	28/04/04	Bremer River	Wandstead Road	317096	6099102	1.0	None	Low level	30	2	10	40	7.9	8030	15.1			0.3		5	1	7	30			x		1	200			2		
Reach 8																																		
ML04-78	9/04/04	Bremer River	Floodplain: Hill Swamp	322815	6090124	1.5	None	Concentrated	20	20	10	40	7.0	4800	15.6			0.3										1		10		6		
ML04-80	9/04/04	Bremer River	Floodplain: 'Metella'	322248	6087192		None	Dry				60																					x
ML04-81	7/06/04	Bremer River	Frank Potts Reserve	322070	6091888		None	Dry				30																					x
ML04-79	9/04/04	Mosquito Ck	Gollan's Waterhole	326548	6090239	0.5	None	Concentrated	20	0	0	10	9.2	5050	19.2			0.3											5000					
Reach 9																																		
ML04-145	6/06/04	Bremer River	Bremer Mouth (channel)	323069	6082075	2.0	None	Bank level	10	20	20	30	8.5	1240	11.3			0.3		3	1	1	20			x			10					++
ML04-147	3/08/04	Bremer River	Bremer Mouth -Beach	323061	6081996	1.0	None	High level	15	0	5	20	-	1400	10.1			0.3				1	25											++
ML07-53	12/05/07	Bremer River	Us of bridge at mouth	323099	6082156	1.5	None	Low level	0	90	5	90	-	1460	14.6			0.5		20		1	50					2	300			1		++
ML08-24	9/04/08	Bremer River	Bremer Mouth (channel)	323062	6082060	0.5	None	Concentrated	5	20	5	20	9.0	3790	20.1	13.6		0.4		24			20		3				1			26		++
ML08-103	4/11/08	Bremer River	Bremer Mouth (channel)	323062	6082060	0.8	None	Low level	0	5	20	70	8.6	5810	22.9			0.3	1	238	1		61		9			1				4	2	++
NA	26/03/09	Bremer River	Bremer Mouth (channel)	323062	6082060	0.0	None	Dry				30																						x

Appendix 7. Angas Catchment fish sampling locations, water quality and catch summary 1999-2009 (*Alien species, ++ wetland generalists/euryhaline, # congolli, M = Murray hardyhead, R = rainbow trout*).

Site Code	Date	Waterway	Location	Easting	Northing	Depth max (m)	Flow	Pool condition	Subsurface physical %	Subsurface biological %	Emergent %	Edge vegetation %	pH	Conductivity (µS/cm)	Temperature (°C)	DO - surface (ppm)	DO - depth (ppm)	Transparency (m)	Carp gudgeons	Common galaxias	Dwarf flathead gudgeon	Flathead gudgeon	Mountain galaxias	River blackfish	Smallmouthed hardyhead	Southern pygmy perch	Common carp*	Gambusia*	Redfin*	Tench*	No fish
Reach 2																															
ML04-63	31/03/04	Dawson Creek	Ashbourne Road	307723	6096228	0.5	None	Low level	20	0	30	60	6.7	430	13.9			0.2													x
ML04-65	31/03/04	Dawson Creek	Dog Trap Road	302652	6095321	0.8	None	Low level	10	10	40	10	6.7	5040	12.8			0.5					5								
ML04-72a	6/04/04	Dawson Creek	Dorset Park'	300674	6095908	1.0	Low	Bank level	30	5	2	30	7.2	9660	16.2			0.5					30								
ML04-72b	6/04/04	Dawson Creek	Dorset Park' (fenced)	301334	6095587	0.6	Low	Bank level	30	20	10	80	7.4	8430	15.2			0.5+					100								
ML00-01	13/02/00	Dawson Creek	Large instream dam	306400	6095900	3.0	None	Low level	20	5	15	20	-	-	-			0.7	500				2							5	
ML99-01	3/04/99	Dawson Creek	below dam spillway	306500	6095950	1.5	None	Bank level	5	0	45	40	-	-	-			0.4	6												R
ML00-02	13/02/00	Dawson Creek	below dam spillway	306500	6095950	1.5	None	Bank level	5	0	40	40	-	-	-			0.5	250												
ML04-62b	31/03/04	Dawson Creek	below dam spillway	306400	6095950	1.2	None	Bank level	5	0	30	30	-	-	-			0.4	19				13			1					
ML01-58	3/03/01	Dawson Creek	Border pool	306539	6096019	1.0	None	Bank level	10	50	5	80	7.0	4230	20.0			0.7	20				1			7					
ML04-62a	31/03/04	Dawson Creek	Border pool	306639	6096087	0.5	None	Concentrated	30	2	20	60	6.9	3050	13.7			0.3					22			1					
ML05-21	13/04/05	Dawson Creek	Border pool	306639	6096087	0	None	Dry				30																			x
ML04-61	31/03/04	Dawson Creek	Fresian Drive	307071	6096181		None	Dry				50																			x
ML04-69	1/04/04	Paris Creek	Old Mine	299524	6101222	2.0	Low	Bank level	30	10	30	30	6.6	1740	14.8			1.0					80								
ML01-57	18/03/01	Paris Creek	us Middle Ck	303624	6099494	1.2	None	Concentrated	20	0	0	20	-	4870	23.0			0.5													x
ML04-60	31/03/04	Doctors Creek	Macclesfield Road	305095	6101800		None	Dry				5																			x
ML01-54	3/03/01	Middle Creek	Earthworks area	307734	6097179	0.3	None	Concentrated	5	0	10	90	-	4450	23.0			0.1	500							165	3				
ML04-66	1/04/04	Middle Creek	Earthworks area	307734	6097201		None	Dry				10																			x
ML01-55	18/03/01	Middle Creek	Whittwers property	307999	6096924	1.0	None	Concentrated	5	0	0	10	7.2	3190	19.0			0.35	1000				30			4					
ML03-47	6/04/03	Middle Creek	Whittwers property	307800	6097100	0.4	None	Concentrated	10	0	0	0	8.7	5810	21.0			0.15	300							2			2		
ML04-67	1/04/04	Middle Creek	Whittwers property	307831	6097149	1.1	None	Concentrated	20	0	0	10	6.5	3750	15.5			0.2	800							4					
ML05-20	13/04/05	Middle Creek	Whittwers property	307831	6097100	0	None	Dry				10																			x
Reach 3/4																															
ML99-02	10/03/99	Angas River	Quarry Road	301100	6107700	0.8	None	Low level	30	0	10	70	-	-	-			0.8					15								
ML05-18	13/04/05	Angas River	Quarry Road	301033	6107658	1.0	Low	Low level	10	5	20	80	-	2680	12.1			1.0+					38								

Site Code	Date	Waterway	Location	Easting	Northing	Depth max (m)	Flow	Pool condition	Subsurface physical %	Subsurface biological %	Emergent %	Edge vegetation %	pH	Conductivity (µS/cm)	Temperature (°C)	DO - surface (ppm)	DO - depth (ppm)	Transparency (m)	Carp gudgeons	Common galaxias	Dwarf flathead gudgeon	Flathead gudgeon	Mountain galaxias	River blackfish	Smallmouthed hardyhead	Southern pygmy perch	Common carp*	Gambusia*	Redfin*	Tench*	No fish
ML06-06	27/03/06	Angas River	Quarry Road	301024	6107782	0.8	Low	Low level	30	10	20	80	-	2920	14.3			0.4					75								
ML07-28	2/05/07	Angas River	Quarry Road	301022	6107801	0.6	Low	Low level	40	10	10	50	8.1	3430	12.8			0.6					28								
ML07-73	23/11/07	Angas River	Quarry Road	301024	6107798	0.6	Low	Bank level	10	0	20	50	-	3090	14.6			0.6					25								
ML08-20	8/04/08	Angas River	Quarry Road	301022	6107799	0.4	Low	Low level	30	2	40	60	6.2	4650	11.3	6.1		0.4					11								
ML08-68	29/10/08	Angas River	Quarry Road	301017	6107800	0.6	Low	Low level	10	20	20	80	8.0	2375	11.5	4.5	1.2	0.6					4								
ML09-16	2/04/09	Angas River	Quarry Road	301018	6107801	0.3	Low	Low level	15	0	65	70	7.3	5120	13.8	10.0		0.3					36								
ML02-171	17/5/02	Angas River	Searle Street	302851	6105691	1.2	Medium	Bank level	20	0	30	20	7.2	1485	13.6	2.5		1.2					75								
ML04-58	31/03/04	Angas River	Searle Street	302851	6105691	1.6	Low	Bank level	10	2	50	30	6.4	1800	11.1			1.0					40								
ML05-19	13/04/05	Angas River	Searle Street	302856	6105695	1.5	Low	Bank level	30	20	10	50	-	1810	12.7			1.0					44								
ML06-07	27/03/06	Angas River	Searle Street	302856	6105695	1.5	Low	Bank level	10	10	30	20	-	1740	14.5			0.4					26								
ML07-29	2/05/07	Angas River	Searle Street	302856	6105695	1.0	Seep	Bank level	20	20	10	30	7.7	2230	13.4			0.4					1								
ML07-71	23/11/07	Angas River	Searle Street	302861	6105683	1.0	Low	Bank level	5	2	30	60	-	1990	14.2			1.0					78								
ML08-21	8/04/08	Angas River	Searle Street	302862	6105693	1.5	None	Low level	30	20	25	30	7.0	1986	11.2	1.5		1.5					93								
ML08-69	29/10/08	Angas River	Searle Street	302363	6105687	1.0	Low	Low level	20	25	10	40	6.8	2010	10.6	2.6	0.6	1.0					40								
ML09-17	2/04/09	Angas River	Searle Street	302857	6105675	1.8	None	Bank level	10	10	20	50	6.9	2019	14.0	2.4	0.8	1.5					8								
ML08-51	24/04/08	Angas River	Macclesfield	303008	6105413	2.0	Low	Bank level	40	5	20	60	7.4	1730	15.5	3.4		1.2					24								
ML04-57	31/03/04	Angas River	Ds Crystal Lake	303063	6104706	1.0	Medium	Bank level	30	10	20	10	6.7	1700	13.6			1.0					30								R
ML04-59	31/03/04	Angas River	'Willowdene'	303674	6104282	1.5	Medium	Bank level	20	10	30	60	6.9	1890	11.5			0.8					60								
ML99-05	7/05/99	Angas River	Rankine property	307600	6097800	2.0	None	Bank level	30	0	10	30	-	-	14.0			0.6	89		17										
ML99-09	17/05/99	Angas River	'Riverview'	314500	6091500	1.0	None	Bank level	20	10	20	60	-	-	-			1.0	1									1			
ML99-04	17/05/99	Angas River	'Martindale'	305800	6099400	1.5	Low	Bank level	20	2	20	20	-	-	11.0			1.0													x
ML99-03	17/03/99	Angas River	'The Downs'	303900	6102800	1.5	Low	Bank level	30	0	40	70	-	-	16.0			1.0													x
Reach 5																															
ML04-71	6/04/04	Angas River	'The Lodge'	308055	6097135	2.0	None	Low level	30	5	20	20	7.5	4120	15.0			0.8	176				2			7			2		
ML06-01	15/03/06	Angas River	'The Lodge'	308001	6097389	1.5	None	Low level	20	0	20	60	7.9	3450	17.6			0.3	300		3	300	10				3				
ML05-22	13/04/05	Angas River	cliff pool	308085	6097127	1.2	None	Low level	10	0	30	10	-	-	-			0.5	100		1		4			27					
ML06-03	15/03/06	Angas River	cliff pool	308054	6097134	2.0	None	Bank level	20	0	40	70	7.5	3780	18.2			0.3	300			4	1			9	4		4		
ML07-30	7/05/07	Angas River	cliff pool	308059	6097134	3.0	Seep	Bank level	10	0	30	80	5.9	5230	13.0			0.2	29			47				3					
ML08-26	9/04/08	Angas River	cliff pool	308047	6097114	0.7	None	Low level	5	0	40	100	7.1	5650	13.0	3.4		0.1				3					1		19		

Site Code	Date	Waterway	Location	Easting	Northing	Depth max (m)	Flow	Pool condition	Subsurface physical %	Subsurface biological %	Emergent %	Edge vegetation %	pH	Conductivity (µS/cm)	Temperature (°C)	DO - surface (ppm)	DO - depth (ppm)	Transparency (m)	Carp gudgeons	Common galaxias	Dwarf flathead gudgeon	Flathead gudgeon	Mountain galaxias	River blackfish	Smallmouthed hardyhead	Southern pygmy perch	Common carp*	Gambusia*	Redfin*	Tench*	No fish
ML08-78	30/10/08	Angas River	cliff pool	308063	6097122	1.8	Low	Bank level	5	2	60	100	7.6	2860	14.8	4.3	3.3	0.4				1				2			1		
ML09-18	2/04/09	Angas River	cliff pool	308086	6097131	0.75	None	Low level	7	0	30	90	7.0	5920	15.1	3.1		0.1	2			26	9			5	0		5		
ML01-56	11/03/01	Angas River	Middle Ck junction	308149	6096924	1.0	None	Bank level	5	50	10	20	7.4	5640	22.5			0.6	100				1			3					
ML02-02	10/01/02	Angas River	Middle Ck Junction	308149	6096924	1.0	Low	Bank level	5	60	20	40	-	2500	-			0.3	100							10					
ML03-48	6/04/03	Angas River	Middle Ck junction	308134	6096949	1.2	None	Concentrated	0	70	20	80	8.3	5630	18.0			1.0	130							7					
ML04-68	1/04/04	Angas River	Middle Ck Junction	308154	6096930	1.5	None	Bank level	5	70	15	80	6.9	6810	15.1			0.7	33							8					
ML05-23	13/04/05	Angas River	Middle Ck Junction	308143	6096942	1.2	None	Low level	5	60	30	80	-	8490	14.2			0.6	60				19			42					
ML06-02	15/03/06	Angas River	Middle Ck Junction	308138	6096940	1.2	None	Bank level	5	40	40	90	7.6	6700	15.0			0.4	30				4			51					
ML07-31	2/05/07	Angas River	Middle Ck Junction	308147	6096937	1.0	None	Low level	2	5	40	80	7.9	6670	14.8			0.4	20				3			6					
ML08-106	5/11/08	Angas River	Middle Ck junction	308139	6096951	1.2	None	Low level	0	5	20	80	7.7	3150	19.9	6.6		1.2	21			4	4			35					
ML08-22a	8/04/08	Angas River	Middle Ck junction	308139	6096951	1.2	None	Low level	0	10	70	80	6.4	7740	11.5	1.2		0.2	100							86					
ML09-07	24/03/09	Angas River	Middle Ck junction	308139	6096951	0.5	None	Low level	0	30	50	90	7.7	5140	14.5	2.9		0.4	11				4			53					
ML05-10	16/03/05	Angas River	First weir	308036	6096548	1.5	Low	Low level	30	10	20	60	-	4910	17.1			0.4	2000		300	1	3			1					
ML07-32	2/05/07	Angas River	First weir	308046	6096575	1.5	Seep	Bank level	30	20	20	70	8.4	1340	15.3			0.6	238		5	73	6			25					
ML07-33	14/05/07	Angas River	First weir	308003	6096619	3.0	Seep	Bank level	15	30	20	70	7.8	3070	13.4			0.7	507		7	147	4			15					
ML07-62	1/11/07	Angas River	First weir	308043	6096583	1.5	Medium	Bank level	40	20	20	80	-	2670	15.3			1.0	40			10				7					
ML08-77	30/10/08	Angas River	First weir	308032	6096586	1.3	Low	Low level	20	30	40	50	7.6	2870	14.6	5.6	4.9	0.5	358		4	27				74					
ML08-22b	8/04/08	Angas River	First weir	308044	6096573	2.5	None	Low level	20	40	30	60	7.4	5920	13.5	4.4		0.6	149			39	1			12					
ML09-20	2/04/09	Angas River	First weir	308018	6096614	1.5	None	Low level	10	40	10	95	7.5	5080	16.8	9.1	6.9	0.4	221		8	175	6			40					
ML04-70	5/04/04	Angas River	North Parade	308128	6096850	2.0	None	Bank level	30	2	30	80	7.8	3660	15.2			0.6	800		1	2	2			1					
ML05-25	13/04/05	Angas River	Old swimming pool	308098	6096334	0.4	None	Concentrated	10	10	0	5	-	4600	20.0			0.15	20000		50	200	1				18		1		
ML06-20	5/04/06	Angas River	Old swimming pool	308093	6096316	1.5	Low	Low level	10	50	0	10	8.1	4160	16.2			0.5	7666		94	226	20			1					
ML07-14	13/03/07	Angas River	Old swimming pool	308093	6096316	0.9	None	Low level	2	10	0	0	-	6140	22.0			0.2	366			948							60	2	
ML07-34	13/05/07	Angas River	Old swimming pool	308209	6096457	1.5	Seep	Bank level	10	10	30	50	7.7	2560	15.5			1.0	447			186				3					
ML08-27	10/04/08	Angas River	Old swimming pool	308094	6096310	1.6	None	Low level	1	20	20	15	7.6	5790	16.2			0.2	54			104					5		7	1	
ML08-70	29/10/08	Angas River	Old swimming pool	308090	6096316	1.7	Low	Bank level	1	15	0	100	7.5	3070	14.5	4.7	3.7	0.15	73		1	168				1					
ML09-27	3/04/09	Angas River	Old swimming pool	308093	6096332	0.6	None	Low level	10	5	0	100	8.1	5510	17.4	6.6		0.3	68		2	356				2				1	
ML01-12	25/10/01	Angas River	Footbridge	308200	6096300	1.5	Low	Bank level	10	0	30	20	-	-	-			0.8	800		3						2			1	

Site Code	Date	Waterway	Location	Easting	Northing	Depth max (m)	Flow	Pool condition	Subsurface physical %	Subsurface biological %	Emergent %	Edge vegetation %	pH	Conductivity (µS/cm)	Temperature (°C)	DO - surface (ppm)	DO - depth (ppm)	Transparency (m)	Carp gudgeons	Common galaxias	Dwarf flathead gudgeon	Flathead gudgeon	Mountain galaxias	River blackfish	Smallmouthed hardyhead	Southern pygmy perch	Common carp*	Gambusia*	Redfin*	Tench*	No fish
ML08-23	8/04/08	Angas River	Footbridge	308170	6096496	2.0	None	Low level	70	0	60	100	7.8	5390	14.6	6.3		0.3	1042		7	152	2			33					
ML08-28	10/04/08	Angas River	Footbridge	308321	6096282	1.0	None	Low level	80	5	0	40	7.6	4140	16.2	3.1	1.7	0.3				6							19		
ML08-76	30/10/08	Angas River	Footbridge	308201	6096459	1.2	Low	Low level	20	15	20	70	7.5	2840	16.8	4.4	3.9	1.2	216		2	55	3			12					
ML09-19	2/04/09	Angas River	Footbridge	308113	6096525	1.5	None	Low level	30	0	15	95	7.7	5400	17.5	8.1	6.2	0.4	50		1	21				3					
Reach 6																															
ML01-03	27/09/01	Angas River	ds Strathalbyn	308045	6096604	1.2	Medium	Bank level	20	10	20	60	-	-	-			0.2	100												
ML01-51	11/02/01	Angas River	Strathalbyn	308300	6096300	1.5	None	Low level	30	0	30	30	-	-	-			0.4	14				7	4			2		4		
ML05-52a	1/12/05	Angas River	ds Sth Terrace	308987	6096113	1.0	Low	Bank level	10	10	70	90	-	2000	-			0.8	1				2	1					1		
ML05-52b	1/12/05	Angas River	ds South Terrace	308558	6096133	2.0	Low	Bank level	30	20	40	70	7.8	2006	19.8			0.5	11			1	18	3					8		
ML07-55	8/06/07	Angas River	above South Pde	308404	6096184	3.0	Medium	Bank level	40	10	30	50	7.4	2120	10.5			0.5				50	1	2					16		G
ML09-23	3/04/09	Angas River	Strathalbyn	308111	6096247	1.5	None	Low level	15	5	20	80	7.5	5190	17.4	9.1		0.3	6			104							6	3	
ML99-06	21/02/99	Angas River	us Humberg Road	310250	6095100	4.0	Low	Bank level	30	2	20	30	-	-	-			1.2	50					3				25	3		
ML99-07	21/04/99	Angas River	Flow gauge site	310615	6093918	3.0	Medium	Bank level	20	20	20	60	-	-	13.5			1.5	400		5		8	17				20			G
ML04-64	31/03/04	Angas River	Flow gauge site	310239	6094509	1.5	None	Bank level	20	20	30	30	6.9	6600	16.5			0.4	600		5		4	62				30		5	G
ML06-11	27/03/06	Angas River	Flow gauge site	310615	6093918	4.0	Medium	Bank level	30	20	20	60	-	7090	18.0			1.5	570		2		6	36			2	100		4	
ML08-105	5/11/08	Angas River	Flow gauge site	310628	6093962	2.0	Low	Bank level	20	20	20	70	7.8	5200	21.5	7.3	7.2	2.0	20		8	12	1	17						1	
ML08-29	10/04/08	Angas River	Flow gauge site	310628	6093962	2.5	Low	Bank level	20	30	20	80	7.4	8000	15.2	6.2	5.4	1.5	73		2	19		25				1		1	
ML09-08	24/03/09	Angas River	Flow gauge site	310628	6093962	1.5	Low	Bank level	20	5	10	50	8.0	8640	19.6			1.0	36		2	14		26						9	
ML04-143	6/06/04	Angas River	Belvidere	313228	6092606	2.0	Low	Bank level	20	0	30	70	8.1	6210	9.8			0.6	163		3		18				2		3		
ML99-08	17/05/99	Angas River	Belvidere	313200	6092600	2.0	Low	Bank level	20	0	30	50	-	-	-			0.6	2		1								8		
ML09-21	2/04/09	Angas River	Belvidere	313204	6092609	1.2	None	Low level	4	2	5	85	7.5	4880	17.2	6.8	6.0	1.0	36		2	41	47					199			
Reach 7																															
ML07-72	23/11/07	Angas River	Davidson Rd	317603	6087873	0.5	None	Low level	20	0	0	30	-	3750	18.0			0.3					9								
NA	8/4/08	Angas River	Davidson Rd	317603	6087873	0.0	None	Dry				30																			x
ML08-75	30/10/08	Angas River	Davidson Rd	317610	6087866	0.4	None	Concentrated	60	10	0	30	8.8	3450	16.2	6.1		0.10					2								
ML09-24	3/04/09	Angas River	Davidson Rd	317635	6087864	0.0	None	Dry	0	0	0	70																			x
ML07-70	23/11/07	Angas River	Watson Park Rd	317785	6086213	0.4	None	Low level	5	80	0	1	-	3970	20.4			0.4					2								
NA	8/4/08	Angas River	Watson Park Rd	317785	6086219	0.0	None	Dry				80																			x
ML08-74	30/10/08	Angas River	Watson Park Rd	317785	6086219	0.6	None	Concentrated	20	30	10	80	7.8	2830	21.6	5.8	7.4	0.6				1	22								

Site Code	Date	Waterway	Location	Easting	Northing	Depth max (m)	Flow	Pool condition	Subsurface physical %	Subsurface biological %	Emergent %	Edge vegetation %	pH	Conductivity (µS/cm)	Temperature (°C)	DO - surface (ppm)	DO - depth (ppm)	Transparency (m)	Carp gudgeons	Common galaxias	Dwarf flathead gudgeon	Flathead gudgeon	Mountain galaxias	River blackfish	Smallmouthed hardyhead	Southern pygmy perch	Common carp*	Gambusia*	Redfin*	Tench*	No fish
NA	3/4/09	Angas River	Watson Park Rd	317785	6086219	0.0	None	Dry				60																			x
Reach 8																															
ML99-10	25/03/99	Angas River	Bagley Bridge	318400	6081300	1.5	None	Bank level	5	65	15	40	-	-	18.0			1.0	2	14	1	4					4	28	3		++
ML01-52	11/03/01	Angas River	Bagley Bridge	318050	6081400	0.8	None	Low level	0	30	30	10	-	-	-			0.4		10		10					15	50			++
ML04-144	6/06/04	Angas River	Bagley Bridge	318373	6081222	1.5	None	Low level	2	80	10	60	8.0	2370	10.3			0.8		19	23	17					4	30	1		#G++
ML05-30	17/04/05	Angas River	Bagley Bridge	318388	6081224	1.5	None	Low level	10	70	10	80	-	1940	18.6			0.5		30	4	50				3	2		1		
ML06-08	27/03/06	Angas River	Bagley Bridge	318388	6081221	2.0	None	Bank level	20	70	5	80	-	1470	16.4			0.8		30	5	200						50	10		
ML07-52	12/05/07	Angas River	Bagley Bridge	318376	6081215	0.6	None	Low level	5	10	20	80	8.1	2390	16.3			0.05			12	15				14		10	2		
NA	9/4/08	Angas River	Bagley Bridge	318376	6081215	0.0	Dry					80																			
ML08-59	18/09/08	Angas River	Bagley Bridge	318400	6081120	0.7	Low	Low level	1	5	2	90	8.5	3180	11.4	10.3		0.3		202		6			1150						++
NA	26/3/09	Angas River	Bagley Bridge	318400	6081120	0.0	Dry					70																			
ML01-60	11/03/01	L. Alexandrina	Turveys Drain	319093	6081370	1.5	Low	Bank level	0	40	20	40	6.8	476	18.0			0.25				4				9	1	800			
ML04-09	2/03/04	L. Alexandrina	Turvey's Drain	319093	6081370	2.0	Low	Bank level	0	40	20	40	8.6	1180	23.3			0.3		10	2	10				116		1000			
ML05-32	17/04/05	L. Alexandrina	Turveys Drain	319088	6081368	1.2	Low	Low level	0	60	10	40	-	1420	15.9			0.8		24	1	5				162		200			++
ML06-09	27/03/06	L. Alexandrina	Turveys Drain	319093	6081369	2.0	None	Low level	0	50	20	50	-	1200	17.9			0.3				10				84		30			
ML07-54	12/05/07	L. Alexandrina	Turveys Drain	319091	6081365	0.5	Low	Low level	0	20	5	30	8.1	1790	16.2			0.2		13		12				1		35			++
ML08-104	4/11/08	L. Alexandrina	Turveys Drain	319101	6081362	1.2	Low	Bank level	0	60	20	30	9.1	5980	23.9			0.6		11	44	44			1	81		157			MG++
ML08-25	9/04/08	L. Alexandrina	Turveys Drain	319101	6081362	1.5	Low	Bank level	5	10	30	20	8.5	4430	19.2	7.7		0.3		7		22			28	3		2220			M++
ML09-10	26/03/09	L. Alexandrina	Turveys Drain	319101	6081362	1.0	None	Bank level	0	20	50	60	7.6	7150	19.6			0.3				8				5		390			M

Appendix 8. Finniss Catchment fish sampling locations, water quality and catch summary 2001-2009 (* = Alien species).

Site Code	Date	Waterway	Location	Easting	Northing	Depth max (m)	Flow	Pool condition	Subsurface physical %	Subsurface biological %	Emergent %	Edge vegetation %	pH	Conductivity (µS/cm)	Temperature (°C)	Dissolved oxygen surf. (ppm)	Dissolved oxygen depth (ppm)	Transparency (m)	Bony herring	Carp gudgeons	Common galaxias	Congolli	Dwarf flathead gudgeon	Flathead gudgeon	Lagoon goby	Mountain galaxias	Murray hardyhead	Murray-Darling golden perch	Philypnodon hybrid	Pouched lamprey	Smallmouthed hardyhead	Smelt	Southern pygmy perch	Tamar River goby	Unspecked hardyhead	Western bluespot goby	Yarra pygmy perch	Brown trout*	Common carp*	Gambusia*	Goldfish*	Murray rainbowfish*	Rainbow trout*	Redfin*	No fish
Reaches 2 & 3																																												
ML04-39	30/03/04	Blackfellows Ck	'Riverside'	287610	6090459	1.5	Medium	Bank level	30	10	10	50	6.0	560	13			0.3								15																		
ML03-44b	19/01/03	Blackfellows Ck	opp. Mt Magnificent CP	288712	6091079	1	None	Concentrated	30	10	10	30	-	-	-			0.4								4												60						
ML04-46	25/03/04	Blackfellows Ck	opp. Mt Magnificent CP	288602	6090503	1.5	Low	Bank level	30	2	20	80	7.2	760	13			0.3																										x
ML05-04	17/01/05	Blackfellows Ck	opp. Mt Magnificent CP	288294	6090590	2	Low	Low level	40	0	10	90	-	520	21			0.3								2												7						
ML08-50	12/04/08	Blackfellows Ck	opp. Mt Magnificent CP	288392	6090628	1.5	Seep	Low level	30	0	20	90	7.0	920	12	1.7		0.3								15												3						
ML09-03	21/03/09	Blackfellows Ck	opp. Mt Magnificent CP	288642	6090836	1	None	Concentrated	40	2	10	70	7.8	420	14	1.2		0.3								7												1	5					
ML04-29	18/03/04	Bull Creek	McHarg Creek Road	296194	6095462	2.0+	Low	Bank level	20	10	20	60	8.0	1680	15			1.2								216																		
ML06-27	21/04/06	Bull Creek	McHarg Creek Road	296209	6095451	2	Low	Bank level	30	10	20	40	7.8	1460	11			1.2								136																		
ML07-61	29/10/07	Bull Creek	McHarg Creek Road	296199	6095463	1	Medium	Bank level	30	40	10	80	-	1240	13			0.8								48																		
ML07-36	3/05/07	Bull Creek	McHarg Creek Road	296199	6095463	1.5	Low	Low level	20	0	30	70	7.9	2270	15			0.5								44																		
ML08-16	7/04/08	Bull Creek	McHarg Creek Road	296196	6095458	0.8	Low	Low level	30	10	10	80	7.6	1820	14	3.0		0.5								300																		
ML08-97	27/11/08	Bull Creek	McHarg Creek Road	296191	6095453	0.8	Medium	Bank level	30	20	5	80	8.2	1420	14	5.6		1								111																		
ML09-15	1/04/09	Bull Creek	McHarg Creek Road	296196	6095466	0.5	Seep	Low level	30	10	10	50	6.9	2970	15	3.5		0.5								214																		
ML04-40	22/03/04	Bull Creek	North of Ashbourne	297115	6093715	1	Low	Bank level	40	10	20	30	-	1990	14			0.5		116						244												2						
ML04-41	22/03/04	Bull Creek	us Bald Hills Road	296600	6098300	2	Low	Bank level	15	5	10	10	8.5	1160	14			1.5								300												15						
ML04-28	18/03/04	Mcharg Creek	Opposite Ti Tree Road	294874	6095120	1.5	Seep	Low level	10	10	30	10	8.4	1000	17			1								150																		
ML04-15	9/03/04	Giles Creek	Below Signal Flat Road	300431	6085062	1	Seep	Concentrated	20	10	10	20	7.8	9020	17			0.4			4					2														80				
ML04-17	10/03/04	Giles Creek	Haines Road	300798	6090023	1	None	Bank level	20	20	10	80	7.8	1310	15			0.5																										x
ML04-32	21/03/04	Meadows Creek	Heyson Trail Crossing	290288	6102727	1.2	Seep	Bank level	5	50	15	30	7.9	4860	14			0.5						40		150													500					
ML02-170	17/05/02	Meadows Creek	Wickhams Hill Road	290100	6101000	0.5	None	Concentrated	20	0	10	20	-	4110	12			0.1						60		60													15					
ML04-33	21/03/04	Meadows Ck trib.	Badgers Road	286126	6097518	0.5	None	Bank level	10	2	60	80	8.4	3760	13			0.5+																										x
Reach 4																																												
ML04-47	27/03/04	Finniss Creek	Burma Road	285117	6090025	0.8	Low	Bank level	20	0	10	40	6.8	370	13			0.3						2		13												3	60					
ML04-48	27/03/04	Finniss Creek	'Shoshanna'	283397	6089481	1.5	Low	Concentrated	2	0	5	10	6.4	850	15			0.1								410						380							1000					
Reach 5																																												
ML04-37	21/03/04	Meadows Creek	Water Reserve	285860	6094085	1.5	None	Low level	20	5	2	30	7.8	4060	13			0.9						2		1													10					
ML01-61	10/03/01	Meadows Creek	Thorn Dairy	285569	6093495	0.7	Low	Bank level	25	20	15	60	7.5	2700	19			1						3		5						22							60					
ML03-50	7/04/03	Meadows Creek	Thorn Dairy	285600	6093600	1.2	Low	Bank level	40	10	20	30	9.3	2500	14			1						3		2						9					2		30					
ML04-34	21/03/04	Meadows Creek	Thorn Dairy	285574	6093563	0.8	Low	Low level	40	30	10	80	8.1	2690	18			0.5						5		10						111							40					
ML04-35	21/03/04	Meadows Creek	Thorn Dairy	285432	6093018	1.2	None	Low level	20	20	15	80	7.9	4050	16			0.6						5								4					3	100			6		
ML05-16	11/04/05	Meadows Creek	Thorn Dairy	285559	6093577	1	Low	Low level	30	10	10	80	-	2410	15			0.6						1		1						14												
ML05-17	11/04/05	Meadows Creek	Thorn Dairy	285604	6093161	1.5	Low	Low level	30	10	10	80	-	2850	16			0.5						40		15						3					5	30			3		
ML06-12	29/03/06	Meadows Creek	Thorn Dairy	285574	6093563	1	Low	Bank level	40	5	10	80	-	2560	15			0.5						5		1						14						30					
ML06-13	29/03/06	Meadows Creek	Thorn Dairy	285489	6093183	1.8	Low	Bank level	40	10	10	80	-	2880	16			0.5						30		5						1					1			1				
ML07-39	6/05/07	Meadows creek	Thorn Dairy	285531	6093562	1	Low	Bank level	30	5	20	60	8.4	2260	15			0.3						35		2						3					2	12					
ML07-69	13/11/07	Meadows Creek	Thorn Dairy	285573	6093562	2	Low	Bank level	20	30	5	70	-	2900	17			1.5						5		100											2				1		
ML08-08	31/03/08	Meadows Creek	Thorn Dairy	285559	6093577	0.6	None	Concentrated	30	30	10	50	7.5	5100	17	8.5	8.4	0.5						108		104						22					1	150			8		
ML08-98	28/10/08	Meadows Creek	Thorn Dairy	285579	6093562	1.5	Low	Low level	20	10	20	70	7.0	2890	17			1								50						2												
ML09-04	23/03/09	Meadows Creek	Thorn Dairy	285579	6093562	0.5	None	Concentrated	20	5	20	30	7.8	6840	12			0.5						170		62						38							100					
ML05-41	17/05/05	Meadows Creek	ds Scout Camp	285474	6092706	2	Low	Low level	20	5	10	30	7.6	3870	11			1						15		10													1				17	

Site Code	Date	Waterway	Location	Easting	Northing	Depth max (m)	Flow	Pool condition	Subsurface physical %	Subsurface biological %	Emergent %	Edge vegetation %	pH	Conductivity (µS/cm)	Temperature (°C)	Dissolved oxygen surf. (ppm)	Dissolved oxygen depth (ppm)	Transparency (m)	Bony herring	Carp gudgeons	Common galaxias	Congolli	Dwarf flathead gudgeon	Flathead gudgeon	Lagoon goby	Mountain galaxias	Murray hardyhead	Murray-Darling golden perch	Philypnodon hybrid	Pouched lamprey	Smallmouthed hardyhead	Smelt	Southern pygmy perch	Tamar River goby	Unspecked hardyhead	Western bluespot goby	Yarra pygmy perch	Brown trout*	Common carp*	Gambusia*	Goldfish*	Murray rainbowfish*	Rainbow trout*	Redfin*	No fish
Reach 6																																												
ML04-36	21/03/04	Finniss River	East of Yundi (Chaplin)	286410	6089682	2.0+	Low	Bank level	30	20	5	50	7.5	620	14			0.6						7		6											2		50				7	
ML04-49	27/03/04	Finniss River	Enterprise Road	288008	6088987	2	Low	Bank level	30	0	20	50	6.3	1270	17			0.5						3															100				2	
ML08-49	22/04/08	Finniss River	us of Coles Crossing (CP)	291059	6088518	1.5	Low	Bank level	40	20	5	40	7.0	3130	14	3.1		0.6						9		50											3		6				1	
ML07-67	13/11/07	Finniss River	Cole Crossing	291685	6088085	1	Medium	Bank level	50	20	10	60	-	1780	20			0.8						10		35											1						4	
ML01-62	16/03/09	Finniss River	ds Cole's Crossing (cliff)	292379	6088395	0.5	None	Low level	55	10	0	20	7.5	1520	18			0.4						3		2							29						1					
ML03-51	7/04/03	Finniss River	ds Cole's Crossing (cliff)	292400	6088600	0.5	None	Concentrated	30	10	0	30	8.7	2330	17			0.2						15		20							117				1							
ML04-24	17/05/04	Finniss River	ds Cole's Crossing (cliff)	292374	6088407	0.8	None	Low level	15	15	0	60	8.2	1820	19			0.5								3							113											
ML05-15a	11/04/05	Finniss River	ds Cole's Crossing (cliff)	292366	6088393	0.7	None	Low level	30	5	10	30	-	1650	18			0.4						20									125											
ML06-14	29/03/06	Finniss River	ds Cole's Crossing (cliff)	292373	6088398	1.2	Low	Bank level	50	10	10	40		1830	17			0.8						15									19						50					
ML07-47	11/05/07	Finniss River	ds Cole's Crossing (cliff)	292388	6088363	1.5	Medium	Bank level	30	2	5	60	8.4	1300	13			0.4						90		3							8						9					
ML08-46	18/04/08	Finniss River	ds Cole's Crossing (cliff)	292399	6088310	2	None	Concentrated	40	20	0	20	8.1	2200	13			0.8						287		67							19					2	165			4	
ML09-44	16/04/09	Finniss River	ds Cole's Crossing (cliff)	292363	6088380	1.5	None	Low level	30	5	0	30	7.6	2447	14	5.8	4.6	0.6						155		44													15			77	
ML04-27	17/03/04	Finniss River	ds Coles Crossing (large)	292448	6088247	2.0+	None	Low level	30	10	10	60	7.7	1650	15			0.8						22		1							3										2	
ML04-25	17/03/04	Finniss River	ds Coles xing (causeway)	292530	6088631	2.0+	None	Bank level	10	0	0	10	8.1	1880	18			0.5						13															50				
ML05-42	18/05/05	Finniss River	ds Coles Crossing	292405	6088306	2.5	Low	Low level	30	20	2	40	6.9	2080	12			1.5						15		53							36					1				2	
ML03-52	7/04/03	Finniss River	ds Cole Xing - weir pool	292500	6088600	2.5	None	High level	20	0	-	30	8.9	2760	16			1						70									2						100				
ML05-15b	11/04/05	Finniss River	ds Coles xing, ds ford	292530	6088631	2	None	Bank level	20	5	0	20	-	1940	12			0.6						10															200				1	
ML04-38	22/03/04	Finniss River	Finniss Bridge	295700	6090900	1	None	Concentrated	20	0	0	5	-	2400	-			0.3		1				38																			27	
ML05-08	11/03/05	Finniss River	Orchard	296227	6091064	2	Low	Low level	30	0	20	60	-	2500	17			1					10	22		10																3	
ML05-46	20/05/05	Finniss River	~1.5km us Brayside Ford	296648	6086152	2	Low	Bank level	60	10	2	70	7.1	1063	10			1.0			7		1	4		298																3	
ML03-55	15/08/03	Finniss River	Braeside Ford	298100	6085800	2	High	In flood	10	0	30	50	-	-	-			0.3					1	11								6						1					
ML02-11	2/03/02	Finniss River	Braeside ford	298100	6085800	1.0+	Low	Low level	40	0	0	30	-	2600	19			0.3		1			5	40		40																	
ML04-16	9/03/04	Finniss River	Braeside ford	298040	6085831	2	None	Low level	40	0	2	20	7.9	2730	15			0.3					1	3															10				13	
ML04-149	3/08/04	Finniss River	Braeside ford	298043	6085778	2.0+	Very High	In flood	20	0	30	10	-	420	8.1			0.1								3																	
ML07-38	3/05/07	Finniss River	Braeside ford	298107	6085796	1	Medium	Bank level	60	0	5	80	8.1	1780	15			0.4			2					79																	
Reach 7																																												
ML01-63	11/03/01	Finniss River	us waterfalls	298354	6085750	1.2	Low	Bank level	15	10	5	70	7.5	1690	16			0.8		3	3		3	10		500							39											
ML03-54	7/04/03	Finniss River	us waterfalls	298440	6085670	0.8	Medium	Bank level	40	20	20	60	8.6	2000	16			0.8+			2					30							450											
ML03-53	7/04/03	Finniss River	us waterfalls	298300	6085800	1.5	Low	Bank level	30	10	20	40	8.6	2000	16			1.5			4			5		26							101											
ML04-30	19/03/04	Finniss River	us waterfalls	298353	6085776	1.2	Low	Bank level	30	20	10	60	7.6	1870	16			1								10							94											
ML04-31	19/03/04	Finniss River	us waterfalls	298446	6085658	0.6	Medium	Bank level	30	40	10	80	7.9	1860	17			0.6+								5							150											
ML05-34	17/04/05	Finniss River	us waterfalls	298353	6085781	1.2	Low	Bank level	20	30	10	30	-	1770	14			1								15							8											
ML05-47	20/05/05	Finniss River	us waterfalls	298460	6085470	1.2	Medium	Bank level	40	30	5	60	7.4	1838	15			1.2			1					51							339											
ML06-15	29/03/06	Finniss River	us waterfalls	298380	6085749	1	Low	Low level	40	5	2	60	-	1940	16			1.2								101							98											
ML07-37	3/05/07	Finniss River	us waterfalls	298257	6085764	1.2	Medium	Bank level	40	10	5	70	8.1	1860	15			0.2		1			1	1		4							112											
ML07-60	29/10/07	Finniss River	us waterfalls	298400	6085701	1.2	Medium	Bank level	30	40	30	70	-	1780	15			0.3					2			16							27											
ML08-53	31/03/08	Finniss River	us waterfalls	298460	6085470	1.2	Low	Low level	30	20	10	80	7.1	1900	15			1			5					220							73											
ML08-99	28/10/08	Finniss River	us waterfalls	298460	6085470	1.6	Low	Low level	20	30	5	70	7.1	1600	17	10.9		0.8		3				7		56							35											
ML09-01	6/02/09	Finniss River	us waterfalls	298460	6085470	0.3	None	Concentrated	50	10	0	20	7.6	2360	23	0.0	1.2	0.1		1	6		3	32		63							57											
ML09-05	24/03/09	Finniss River	us waterfalls	298460	6085470	0.8	Low	Bank level	20	1	10	50	7.6	1958	16	4.0	3.3	0.5								15							1											

Site Code	Date	Waterway	Location	Easting	Northing	Depth max (m)	Flow	Pool condition	Subsurface physical %	Subsurface biological %	Emergent %	Edge vegetation %	pH	Conductivity (µS/cm)	Temperature (°C)	Dissolved oxygen surf. (ppm)	Dissolved oxygen depth (ppm)	Transparency (m)	Bony herring	Carp gudgeons	Common galaxias	Congolli	Dwarf flathead gudgeon	Flathead gudgeon	Lagoon goby	Mountain galaxias	Murray hardyhead	Murray-Darling golden perch	Philypnodon hybrid	Pouched lamprey	Smallmouthed hardyhead	Smelt	Southern pygmy perch	Tamar River goby	Unspecked hardyhead	Western bluespot goby	Yarra pygmy perch	Brown trout*	Common carp*	Gambusia*	Goldfish*	Murray rainbowfish*	Rainbow trout*	Redfin*	No fish
Reach 8																																												
ML01-64	10/03/01	Finniss River	ds waterfalls	299059	6085185	1.5	Medium	Bank level	30	10	3	80	7.0	1850	19			1			20								1									20	100	10		1	4	
ML04-43	24/03/04	Finniss River	Wirra Wirra' (Giles Ck)	299945	6084246	1.5	Low	Bank level	30	2	10	60	6.3	1840	16			0.8			25	8	10			5											4					3	
ML04-44	24/03/04	Finniss River	Railway Bridge	301499	6081528	1.5	Low	Bank level	20	10	20	80	6.8	3000	16			0.6			40	2	70	10		5						20						4	20	5			1	
ML09-51	21/04/09	Finniss River	Railway Bridge	301470	6081544	1.7	Low	Low level	30	5	20	30	7.5	2715	14	7.4	4.5	0.6			8	2	36	6					1								1	7				2	
ML09-52	21/04/09	Finniss River	ds railway bridge (Vallis)	301566	6081428	1	Low	Low level	20	25	15	70	7.3	2670	14	5.3	4.1	0.5			9		5	8					1			7							21				
ML09-60	7/05/09	Finniss River	us of Winery Rd, east	302135	6081496	1.2	Low	Low level	10	5	25	20	7.3	2780	14	4.7		1.2					10									20					1						
ML09-61	7/05/09	Finniss River	us of Winery Rd, east	302679	6081227	0.4	Low	Low level	5	40	30	80	7.2	2780	15	7.8		0.4			6																	41	5				
ML04-148	3/08/04	Finniss River	Winery Road causway	302629	6080893	2.0+	Very High	In flood			30		-	780	9.9			0.4						3								20												
Reach 9																																												
ML07-02	20/02/07	Finniss River	ds Winery Road	302939	6080603	1.2	None	Low level	20	20	20	50	-	3210	23			0.6		5	20		12	150												4			300				1	
ML08-36	22/04/08	Finniss River	ds Winery Road	302953	6080603	3	None	Low level	30	5	30	60	7.7	2750	14			0.3		3	4		4	43																			
ML08-35	22/04/08	Finniss River	ds Winery Road	302305	6080638	3	None	Low level	20	0	40	80	7.4	3030	14			0.3		5		1	3	33														1				1	
ML08-37	22/04/08	Finniss River	ds Winery Road	302925	6080432	1.2	Low	Low level	0	25	30	50	7.8	3020	18			0.15			1		9	8											4			2	500				
ML08-60	18/09/08	Finniss River	ds Winery Road	302850	6080650	2	Medium	Bank level	15	30	35	20	8.1	1400	13	6.5	6.4	0.2		2	1		2	4								9			1				9			2	
ML08-65	24/10/08	Finniss River	ds Winery Road	302800	6080636	2.2	Low	Low level	10	10	30	60	7.5	1900	14	5.8	5.4	0.1		24			12	37							4	13			3						4	
ML08-66	25/10/08	Finniss River	ds Winery Road	302945	6080408	0.7	Low	Low level	0	2	30	40	7.9	1790	15	5.2		0.1					1	3							2	80						100			2	
ML08-67	25/10/08	Finniss River	ds Winery Road	302933	6080604	2	Low	Low level	20	2	30	60	7.5	1877	13	6.5	5.6	0.2			2	1	14	51							6	8						19			6	
ML09-30	9/04/09	Finniss River	ds Winery Road	302940	6080441	0.6	Low	Low level	1	5	25	40	7.8	3190	18	5.8		0.3					1	5			1				2	4			1			1	290	2			
ML09-31	9/04/09	Finniss River	ds Winery Road	302933	6080604	1.7	Low	Low level	20	1	30	80	7.4	3080	16	5.8	4.8	0.4		3	11	4	3	44							4	2									5	
ML09-32	9/04/09	Finniss River	ds Winery Road	302800	6080636	1.8	Low	Low level	10	0	40	80	7.4	3000	16	6.2		0.7		6			4	68								8			25							
ML03-19	5/02/03	Finniss River	us Wally's Warf	302926	6079707	0.5	Low	Bank level	0	90	2	80	8.8	4170	20			>0.9		9	49		25	94				2							2	1		2	14	1			5	
ML07-01	20/02/07	Finniss River	ds Wally's wharf at fence	303320	6079375	1.2	None	Low level	5	70	10	60	-	-	-			0.6	4	20			20	40								2	18		40	8		10	100	40			10	
ML01-65	27/01/01	Finniss River	Wallys Wharf	303130	6079485	2	None	Bank level	10	20	10	10	7.5	2050	23			0.25	30		1	1	15	35								5				2	1	4	40			2	
ML01-01	7/09/01	Finniss River	Blue Lagoon	304135	6079899	1.2	None	Bank level	2	80	10	60	-	-	-			0.2					70	200								20			30	10	24	1	10	1			
ML02-39	10/09/02	Finniss River	Blue Lagoon	304200	6079800	1	None	Bank level	0	30	10	50	7.0	2100	15			0.3				1	20	20								2			10	2	15		10				
ML03-46a	8/09/03	Finniss River	Blue Lagoon	304132	6079890	1.5	None	Bank full	5	30	20	20	8.4	930	18			0.3	1		2		50	100	5							30			5	50	21		5				
ML03-46b	8/09/03	Finniss River	Blue Lagoon	304300	6079450	2	None	Bank full	0	10	20	30	-	-	-			0.3		3	1	1	40	80							10	40			30	30	1		10			1	
ML04-150	6/09/04	Finniss River	Blue Lagoon	304132	6079890	1.5	None	Bank level	5	40	30	40	-	1320	13			0.4	6			2	154	287	1			1				165			17	7	2	4	10	4			
ML05-40	4/05/05	Finniss River	Blue Lagoon	304135	6079899	1.5	None	Low level	5	20	20	40	-	2130	15			0.3	30	2		1	10	80								50			40				5			15	
ML05-55	12/09/05	Finniss River	Blue Lagoon	304135	6079899	0.7	None	Bank level	0	5	20	30							8			1	1	7								57			3				1				
ML06-29	30/10/06	Finniss River	Blue Lagoon	304138	6079892	1.5	None	Bank level	5	20	10	60	8.4	7090	18			0.4		15	7	2	26	125	1							67						2	1	2		315	
ML07-74	29/10/07	Finniss River	Blue Lagoon	304153	6079896	0.4	None	Concentrated	5	5	1	40	-	4750	17			0.05																									x
ML04-45	25/03/04	Finniss River	'Reedlands'	303373	6079330	2.0+	None	Bank level	2	60	20	20	7.6	3010	21			0.3		40			50	100									3		10		2	2	200	30				
ML07-81	17/12/07	Finniss River	Wallys Wharf to Took.	304040	6079035	2	None	Low level	10	1	10	80	-	7790	20			0.2	10	20	20	1	5	40								50	5			1		5	10			40	
ML03-22	6/02/03	Finniss River	Finniss River channel	303525	6079335	1	None	Bank level	0	1	0	100	8.7	2910	21			0.2	2		5		1	9								33				2						1	
ML03-20	5/02/03	Finniss River	drain off channel	303715	6079669	0.5	None	Low level	0	30	1	80	8.2	4590	21			>0.5			33		33	127							3	1			15	5			78				

Appendix 9. Tookayerta Catchment fish sampling locations, water quality and catch summary 2001-2009 (* = Alien species).

Site Code	Date	Waterway	Location	Easting	Northing	Depth max (m)	Flow	Pool condition	Subsurface physical %	Subsurface biological %	Emergent %	Edge vegetation %	pH	Conductivity (µS/cm)	Temperature (°C)	Dissolved oxygen surf. (ppm)	Dissolved oxygen depth (ppm)	Transparency (m)	Bony herring	Carp gudgeons	Common galaxias	Dwarf flathead gudgeon	Flathead gudgeon	Lagoon goby	Mountain galaxias	River blackfish	Smelt	Southern pygmy perch	Tamar River goby	Unspecked hardyhead	Western bluespot goby	Yarra pygmy perch	Brown trout*	Common carp*	Gambusia*	Goldfish*	Rainbow trout*	Redfin*	No fish
Reach 2																																							
ML04-55b	30/03/04	Nangkita Ck Trib.	Mt Compass-Victor Road	283908	6085345	0.6	Low	Bank level	30	0	10	20	5.5	300	12			0.4							50														
ML02-37	30/05/02	Nangkita Creek	us Adelaide-Victor Road	282000	6086383	0.5	Low	Low level	5	0	70	10	7.0	240	9.6			0.2							1														
ML01-13	26/10/01	Nangkita Creek	off Waterfall Drive	290700	6085300	0.5	Low	Bank level	10	0	50	60	-	-	-			0.2							10									20					
ML05-43	18/05/05	Nangkita Creek	us Tookayerta Ck junction	291198	6083856	1.0	Medium	Bank level	5	5	20	80	7.2	348	12			0.3										1					1		10		3	4	
Reaches 3 & 4																																						
ML04-53	30/03/04	Swampy Creek	SA Forest dam	291990	6086259	0.6	None	Concentrated	10	10	0	20	5.8	500	17			0.2																					x
ML01-67	2/03/01	Swampy Creek	Brawleys Swamp	293079	6085290	0.3	Low	Bank level	0	0	90	100	6.2	475	15			0.2							5			20											
ML04-54	30/03/04	Swampy Creek	Brawleys Swamp	292976	6085382	0.2	Low	Bank level	5	0	90	100	5.2	590	11			0.2										4											
ML06-26	21/04/06	Swampy Creek	Brawleys Swamp	292964	6085371	0.3	Low	Low level	0	0	80	100	6.7	450	11			0.3										3											
ML07-41	6/05/07	Swampy Creek	Brawleys Swamp	292964	6085371	0.6	Seep	Bank level	10	0	60	100	7.9	630	14			0.4										3											
ML08-17	7/04/08	Swampy Creek	Brawleys Swamp	292976	6085383	0.5	Seep	Low level	10	1	30	80	6.7	860	11	4.3		0.5										28											
ML08-91	13/11/08	Swampy Creek	Brawleys Swamp	292974	6085308	0.4	None	Low level	10	0	40	80	6.5	492	24	2		0.3							2			21											
ML09-14	1/04/09	Swampy Creek	Brawleys Swamp	292975	6085381	0.3	None	Low level	5	0	50	80	5.5	427	18	2.1		0.3																					x
ML04-52	30/03/04	Swampy Creek	Scott property @ causway	293334	6084940	1.2	Low	Bank level	10	10	30	80	6.3	580	13			0.8							12	1		94											
ML04-55a	30/03/04	Nangkita Ck Trib.	Mt Compass Boardwalk	283763	6085240	0.3	Low	Low level	5	0	80	60	5.2	140	15			0.3							10														
ML04-56	30/03/04	Tookayerta Ck Trib.	'Square Waterhole'	284470	6083029	2.0	Low	Bank level	10	5	30	60	4.9	320	14			0.6							20			40											
Reach 5																																						
ML01-66	11/03/01	Nangkita Creek	us Willowburn Rd	287734	6086295	1.6	Medium	Bank level	20	0	40	30	6.2	293	16			0.5							3	4		8											
ML02-172	17/05/02	Nangkita Creek	us Willowburn Rd	287500	6086400	1.2	Medium	Bank full	30	10	30	10	7.3	270	14			0.5							30	20		35											
ML04-50	27/03/04	Nangkita Creek	us Willowburn Rd	287700	6086300	1.2	Medium	Bank level	10	10	20	10	6.1	350	12			0.4							17			16											
ML05-27	15/04/05	Nangkita Creek	us Willowburn Rd	287692	6086337	2.0	Medium	Bank level	30	5	30	20	-	310	11			0.5							47	7		67					2						
ML06-16	2/04/06	Nangkita Creek	us Willowburn Rd	287669	6088364	1.0	Medium	Bank level	30	2	30	30	-	280	14			0.4							5			18						1					
ML07-40	6/05/07	Nangkita Creek	us Willowburn Rd	287678	6086353	1.5	Medium	Bank level	50	0	10	50	8.4	570	15			0.2							6	7		67					1		16				
ML07-68	13/11/07	Nangkita Creek	us Willowburn Rd	287692	6086337	0.8	Low	High level	20	0	40	50	-	339	16			0.4										15											
ML08-15	4/04/08	Nangkita Creek	us Willowburn Rd	287656	6086382	1.0	Medium	Low level	30	0	20	40	7.8	300	13	8.5		0.8							24	9		52											
ML08-101	29/10/08	Nangkita Creek	us Willowburn Rd	287656	6086382	1.0	Medium	Low level	30	0	40	80	6.9	273	15			0.4							7	8		7											
ML09-09	25/03/09	Nangkita Creek	us Willowburn Rd	287656	6086382	0.8	Low	Low level	40	0	10	60	7.3	325	18	7.5	7.3	0.5							153	7		32											
Reach 6																																						
ML04-26a	17/03/04	Tookayerta Creek	Compass Cabins	285683	6083257	2.0	High	Bank level	10	50	20	80	9.0	330	12			0.8								5													
ML05-28	15/04/05	Tookayerta Creek	Compass Cabins	285671	6083257	1.2	Medium	Bank level	20	40	20	80	-	310	14			0.8								3												1	
ML06-24	21/04/06	Tookayerta Creek	Compass Cabins	285682	6083262	2.0	High	Bank level	30	10	20	70	7.9	320	12			1.0								7													
ML07-49	11/05/07	Tookayerta Creek	Compass Cabins	285687	6083259	1.4	High	Bank level	10	40	30	70	8.3	330	14			0.5							1	3													
ML08-18	7/04/08	Tookayerta Creek	Compass Cabins	285683	6083257	1.2	High	Bank level	10	30	30	70	7.4	250	17	6.8		1.0							13	4		6									x		
ML08-92	13/11/08	Tookayerta Creek	Compass Cabins	285682	6083259	1.0	Medium	Bank level	20	40	20	80	8.2	290	16	8.2		1.0							9	3		1											
ML09-13	1/04/09	Tookayerta Creek	Compass Cabins	285681	6083257	1.2	Medium	Bank level	5	30	40	50	6.5	287	13	6.2		1.2							18	6		7										1	
ML04-26b	17/03/04	Tookayerta Creek	Cleland Gully Road	286600	6083300	1.2	Medium	Bank level	10	10	30	30	-	-	-			1.0															4						
ML02-36	30/05/02	Tookayerta Creek	ds Ice Factory	287905	6083211	1.0	Medium	Bank level	20	30	30	30	6.8	310	11			1.0							1								5						

Site Code	Date	Waterway	Location	Easting	Northing	Depth max (m)	Flow	Pool condition	Subsurface physical %	Subsurface biological %	Emergent %	Edge vegetation %	pH	Conductivity (µS/cm)	Temperature (°C)	Dissolved oxygen surf. (ppm)	Dissolved oxygen depth (ppm)	Transparency (m)	Bony herring	Carp gudgeons	Common galaxias	Dwarf flathead gudgeon	Flathead gudgeon	Lagoon goby	Mountain galaxias	River blackfish	Smelt	Southern pygmy perch	Tamar River goby	Unspecked hardyhead	Western bluespot goby	Yarra pygmy perch	Brown trout*	Common carp*	Gambusia*	Goldfish*	Rainbow trout*	Redfin*	No fish
Reach 7																																							
ML01-68	11/03/01	Tookayerta Creek	Deep Creek Road	295410	6081695	1.5	Low	Bank level	15	0	20	100	6.8	730	20			0.5										31							100					
ML02-38	30/05/02	Tookayerta Creek	Deep Creek Road	295430	6081680	1.5	Medium	Bank level	20	0	10	50	7.0	490	9.4			0.4								5														
ML04-21	11/03/04	Tookayerta Creek	Deep Creek Road	295420	6081662	2.0	Medium	Bank level	5	5	30	90	7.7	590	17			0.5								1		80							30					
ML05-26	15/04/04	Tookayerta Creek	Deep Creek Road	295411	6081680	2.0	Medium	Bank level	10	0	40	90	-	530	12			0.3										46												
ML06-25	21/04/06	Tookayerta Creek	Deep Creek Road	295408	6081678	2.0	High	Bank level	10	5	40	80	7.2	580	12			0.5								7		30							14					
ML07-48	11/05/07	Tookayerta Creek	Deep Creek Road	295407	6081680	2.0	Medium	Bank level	5	5	70	90	8.0	690	13			0.4										29							2					
ML07-56	11/11/07	Tookayerta Creek	Deep Creek Road	295420	6081686	1.5	Medium	Bank level	5	0	60	80	-	520	14			0.3								1		26												
ML08-14	4/04/08	Tookayerta Creek	Deep Creek Road	295414	6081690	1.5	Medium	Bank level	10	0	70	90	8.0	570	13			0.8								7		36							2					
ML08-100	29/10/08	Tookayerta Creek	Deep Creek Road	295414	6081690	1.5	Low	Low level	5	5	70	80	6.9	510	16	7.2		0.8							1	3		21												
ML09-06	29/03/09	Tookayerta Creek	Deep Creek Road	295414	6081690	1.2	Low	Low level	0	10	70	100	7.2	845	16	8.3	7.8	0.6								6		16												
ML08-85	5/11/08	Tookayerta Creek	ds of railway bridge	299557	6078402	2.0	Low	Low level	5	10	70	70	8.2	830	14	6.6	4.7	0.2							184	1		306										1		
ML09-39	15/04/09	Tookayerta Creek	ds of railway bridge	299550	6078840	1.7	Low	Low level	30	0	65	80	7.1	976	12	11	7.7	1.5			1		7		2	1											2		
Reach 8																																						
ML01-69	4/03/01	Black Swamp	Protea farm	302540	6077295	2.0	None	Low level	5	0	5	80	7.0	1096	22			0.4		1000	20	100	10					3							800					
ML04-42	24/03/04	Black Swamp	Protea farm	303327	6077319	2.0	None	Low level	2	0	5	75	7.5	900	18			0.3		300	4	4	2					37							50					
ML05-29	15/04/05	Black Swamp	Protea farm	303327	6077318	2.0	None	Low level	20	0	5	50	-	940	17			0.3		32		14	3					9							45					
ML03-21	6/02/03	Finniss River	Tookayerta Ck mouth	304545	6076940	0.6	None	Low level	0	95	5	100	7.9	3040	18			0.3			5	4	74					11				19			86	12				
ML04-123	30/04/04	Black Swamp	Tookayerta Ck mouth	304579	6076969	1.5	None	Bank level	10	70	10	80	-	2540	15			0.3				1	14								1	12			6					
ML07-06	25/03/07	Finniss River	Tookayerta Ck mouth	304790	6076797	0.6	None	Low level	1	30	20	90	8.7	2950	13			0.3	129		101	19	139	3			21	1	20	30	2			10	195			61		
ML08-102	3/11/08	Black Swamp	Drain off Finniss channel	304235	6077725	1.0	None	Low level	5	5	25	100	6.1	1023	14			0.1		1	9																		
ML07-82	17/12/07	Finniss River	Drain off Finniss channel	304504	6077682	2.5	None	Low level	10	50	20	90	-	2000	19			0.4		2	10		5					120							40	20				

Appendix 10. Currency Catchment fish sampling locations, water quality and catch summary 2001-2009 (* = Alien species).

Site Code	Date	Waterway	Location	Easting	Northing	Depth max (m)	Flow	Pool condition	Subsurface physical %	Subsurface biological %	Emergent %	Edge vegetation %	pH	Conductivity (µS/cm)	Temperature (°C)	Dissolved oxygen surf. (ppm)	Dissolved oxygen depth (ppm)	Transparency (m)	Bony herring	Bridled goby	Common galaxias	Congolli	Dwarf flathead gudgeon	Flathead gudgeon	Lagoon goby	Mountain galaxias	Murray hardyhead	Smallmouthed hardyhead	Smelt	Tamar River goby	Unspecked hardyhead	Western bluespot goby	Yarra pygmy perch	Brown trout*	Common carp*	Gambusia*	Goldfish*	Redfin*	No fish
Reach 2																																							
ML04-05	1/03/04	Currency Creek Trib.	Mt Compass Road	285950	6075080	0.3	Low	Low level	30	0	40	80	6.5	640	14.3			0.3																					x
ML01-70	19/01/01	Currency Creek trib.	Burnt Oak'	289450	6074566	0.7	Seep	Bank level	20	30	0	30	7.0	7520	20.0			0.3																					x
ML04-06	1/03/04	Currency Creek (Sth)	Off Mosquito Hill Rd	286937	6075263	0.6	Seep	Low level	10	0	30	10	6.3	3480	15.2			0.5								6													
Reaches 3&4																																						
ML04-18	1/03/04	Currency Creek Trib.	Berrima' dams	285352	6076056	1.0	None	Bank level	10	0	40	80	7.7	510	15.0			0.3																		500				
ML04-04	1/03/04	Currency Creek Trib.	Leane Road	284938	6077779	0.4	None	Concentrated	10	0	10	80	6.4	580	16.1			0.2								12													
ML04-02	24/02/04	Currency Creek Trib.	Below Kidman Road	287620	6079400	0.5	Low	Low level	10	0	40	60	7.9	660	18.0			0.5								6													
ML04-03	24/02/04	Currency Creek (Nth)	Mt Compass Road	285259	6077117	1.6	None	Bank level	20	0	30	70	7.4	690	17.4			0.2								37													
ML04-19	11/03/04	Currency Creek	'Kilchoan'	286899	6077900	0.8	Low	Low level	20	0	10	50	7.9	1040	18.2			0.2								25										200			
ML05-45	19/05/05	Currency Creek	'Kilchoan'	286860	6077826	1.2	Low	Low level	15	2	10	50	7.5	678	11.9			0.4						1		16										273			
ML07-50	11/05/07	Currency Creek	'Kilchoan'	286832	6077742	0.8	Low	Low level	30	0	20	50	8.0	780	14.2			0.5								4										59			
ML08-19	7/04/08	Currency Creek	'Kilchoan'	286835	6077807	0.3	None	Concentrated	30	2	0	20	7.5	830	16.6	8.4		0.3								1										400			
ML08-90	13/11/08	Currency Creek	'Kilchoan'	286843	6077830	0.8	Low	Low level	50	5	5	50	7.9	800	21.6	7.5		0.6								56										46			
ML09-12	1/04/09	Currency Creek	'Kilchoan'	286835	6077807	0.5	None	Concentrated	30	1	0	30	6.9	870	13.1	1.1		0.3								6										116			
ML05-44	19/05/05	Currency Creek	'Kiloran'	288371	6078281	1.2	Low	Bank level	30	0	5	20	7.1	903	8.7			0.4						1		2								3		40			
ML08-48	16/04/08	Currency Creek	'Kiloran'	288371	6078279	0.6	Low	Low level	20	0	10	40	7.1	930	15.2	4.9		0.5																		2000			
ML04-20	11/03/04	Currency Creek	'Arundell'	289391	6077579	1.5	Low	Low level	20	10	20	30	7.5	2620	15.3			0.5						3												50			
Reach 5																																						
ML04-07	1/03/04	Currency Creek	'Stuarts bridge'	293241	6075865	2.0	Low	Bank level	40	10	5	40	7.4	5080	17.7			0.3						216		75													
ML05-11	16/03/05	Currency Creek	'Stuarts bridge'	293056	6075909	1.5	Low	Low level	40	20	10	50	-	3220	14.6			0.2						8															
ML08-47	16/04/08	Currency Creek	'Stuarts bridge'	293170	6075820	1.5	Seep	Low level	40	2	20	80	7.5	2800	15.4	0.4		0.4						3		23										1			
ML08-84	5/11/08	Currency Creek	'Stuarts Bridge'	293069	6075919	1.8	Low	Low level	10	2	20	90	7.7	3540	16.6	5.4	10.0	0.1						68		248										3			
ML09-33	14/04/09	Currency Creek	'Stuarts Bridge'	293083	6075882	1.5	None	Low level	50	0	30	90	7.3	2820	13.1	3.0	2.0	0.3						11		167										2			
Reach 6																																						
ML03-15	30/01/03	Currency Creek	ds of Goolwa Rd	296857	6074242	1.1	None	Bank level	5	0	5	85	8.0	3960	21.5			0.5	1		6			17					117						1	1		9		
ML04-01a	24/02/04	Currency Creek	Goolwa Road	297670	6074300	2.0	Low	Low level	40	5	5	30	7.6	5210	16.9			0.8	30		65	1	6	150				25	5		4			1	25		6		
ML08-38	17/04/08	Currency Creek	Goolwa Road	296549	6074360	2.0	Low	Low level	40	0	30	50	7.1	7630	12.4			0.4			10	1		7													20		
ML08-39	17/04/08	Currency Creek	Goolwa Road	296757	6074262	2.0	None	Low level	40	0	30	70	7.4	7460	12.9	3.0		0.4	3		137	8	1	252					3			21			5	155	6	11		
ML08-61	18/09/08	Currency Creek	Goolwa Road	296746	6074254	1.2	Medium	Low level	5	5	30	40	8.0	1890	14.1	7.6	6.6	0.2			6	1		2													2		
ML08-62	24/10/08	Currency Creek	Goolwa Road	296749	6074251	1.2	Low	Low level	20	2	30	60	8.2	3230	11.3	4.9	4.2	0.3			6	6		7													17		
ML08-63	24/10/08	Currency Creek	Goolwa Road	296803	6074207	1.8	Low	Low level	40	2	20	80	7.9	3600	13.7	4.0	2.3	0.2			10	6	2	251				261	21	4		5					1		
ML09-28	8/04/09	Currency Creek	Goolwa Road	296749	6074251	2.0	None	Low level	30	2	15	90	7.6	8500	16.0	3.8	2.8	1.0			94	5	4	41												12		3		
ML09-29	8/04/09	Currency Creek	Goolwa Road	296757	6074262	0.7	None	Low level	20	0	5	80	7.6	8131	16.2	7.8		0.5				2	1	114				2		1		4				20		1		
ML04-01b	1/03/04	Currency Creek Trib.	Peel Road	296200	6074200	0.0	None	Dry				40																										x

Site Code	Date	Waterway	Location	Easting	Northing	Depth max (m)	Flow	Pool condition	Subsurface physical %	Subsurface biological %	Emergent %	Edge vegetation %	pH	Conductivity (µS/cm)	Temperature (°C)	Dissolved oxygen surf. (ppm)	Dissolved oxygen depth (ppm)	Transparency (m)	Bony herring	Bridled goby	Common galaxias	Congolli	Dwarf flathead gudgeon	Flathead gudgeon	Lagoon goby	Mountain galaxias	Murray hardyhead	Smallmouthed hardyhead	Smelt	Tamar River goby	Unspecked hardyhead	Western bluespot goby	Yarra pygmy perch	Brown trout*	Common carp*	Gambusia*	Goldfish*	Redfin*	No fish
Reach 7																																							
ML03-16	30/01/03	Currency Creek	Level with old dairy	297907	6074177	1.0	None	Bank level	0	0	2	70	8.3	3140	21.4			0.26			2			15					5		3								
ML03-14	29/01/03	Currency Creek	West of Reed Island	303700	6071100	0.3	None	Low level	0	80	10	50	8.9	3170	25.9			>0.3						13				3			1	4			x	39		5	
ML03-17	30/01/03	Currency Creek	Skewes property	298189	6073606	0.2	None	Low level	0	0	2	100	8.7	3130	19.8			0.11			7			35				2	18		2	29						1	
ML03-18	31/01/03	Currency Creek	north Goolwa	301586	6071368	0.5	None	Low level	0	60	20	70	8.7	2500	20.1			0.28			17		3	64	1			6	3		130					54			
ML07-12	18/04/07	Goolwa Channel	Laffin Point	302542	6070058	0.4	None	Low level	5	60	20	50	8.3	6020	16.1			0.3			30			10	1			10	5		20		4			100		5	
ML08-02	6/02/08	Goolwa Channel	Laffin Point	302542	6070058	0.6	None	Concentrated	20	0	10	70	-	-	-			0.3			10			10				500	20			10				30			
ML08-64	24/10/08	Currency Creek	Laffin Point	298036	6074089	0.5	None	Low level	1	0	10	80	-	-	-			0.0					2	146				2				36				1			
ML08-107	5/11/08	Goolwa Channel	Laffin Point	302559	6070065	0.8	None	Concentrated	10	10	0	40	8.7	17850	22.7	8.95		0.4		22	2		3	76	16		11	5875	44	137		398				24		3	
NA	17/04/08	Currency Creek	Laffin Point	298036	6074089	0.0	None	Dry				20																											x

Appendix 11. Inman Catchment fish sampling locations, water quality and catch summary 2001-2009 (* = Alien species).

Site Code	Date	Waterway	Location	Easting	Northing	Depth max (m)	Flow	Pool condition	Subsurface physical %	Subsurface biological %	Emergent %	Edge vegetation %	pH	Conductivity (µS/cm)	Temperature (°C)	Dissolved oxygen surf. (ppm)	Dissolved oxygen depth (ppm	Transparency (m)	Carp gudgeons	Climbing galaxias	Common galaxias	Southern pygmy perch	Western bluespot goby	Brown trout*	Gambusia*	Rainbow trout*	Redfin*	No fish
Reach 2																												
SAG06-05	3/01/06	Hall creek	Roads property	280050	6061853	0.8	Low	Bank level	20	20	40	80	7.9	4390	17.1			0.4										0
SAG06-09	4/01/06	Hall Creek	Water Reserve/Heysen Trail	278837	6061741	1.2	Seep	Bank level	20	0	40	80	7.1	5080	16.4			0.2										0
SAG06-01	1/01/06	Back Valley Creek trib.	off Kirk Road	272534	6064827	1.5	Seep	Bank level	20	0	20	60	7.1	3930	16.7			0.3		11								
SAG06-03	3/01/06	Back Valley Creek trib.	'Rivington'	273573	6063683	1.0	None	Bank level	20	2	5	60	7.5	1740	18.6			0.2										0
ML01-19	19/12/01	Back Valley Creek trib.	Wilkins Crossing	271900	6063900	1.0	None	Bank level	2	20	60	30	-	-	-			0.3	3			15						
ML03-56	21/11/03	Nalinga Creek	West of Crompton Road	272000	6062500	0.5	Low	Bank level	10	10	60	80	-	1700	14.0			0.3	2	1								
Reach 3																												
ML04-14	4/03/04	Boundy River	'Illoura'	269981	6070987	1.5	Low	Low level	10	10	50	50	7.8	2360	20.8			0.4							50	2		
SAG06-04	3/01/06	Boundy River	Teague property	271154	6072122	1.5	Low	Bank level	40	20	30	80	7.9	770	16.4			0.3		8		9			10	9		
Reach 4																												
SAG06-08	4/01/06	Back Valley Creek	Warick property	270002	6065382	1.0	None	Low level	10	2	30	10	7.4	6530	20.1			0.5										0
ML01-71	16/03/01	Back Valley Creek	Kirk Property	272865	6064107	1.5	None	Low level	10	0	40	60	6.7	1233	17.0			0.1	45			9						
ML03-45a	6/04/03	Back Valley Creek	Kirk Property	272881	6064105	1.0	None	Concentrated	10	0	30	30	7.9	1960	13.2			0.3	20			12						
ML04-12	4/03/04	Back Valley Creek	Kirk Property	272898	6064111	1.0	None	Low level	10	10	20	30	7.8	2020	15.6			0.2	100			117						
ML05-12	10/04/05	Back Valley Creek	Kirk Property	272894	6064104	1.0	None	Low level	10	0	10	30	-	1250	15.4			0.3	200			41						
ML08-33	20/04/08	Back Valley Creek	Kirk Property	272895	6064097	1.0	None	Concentrated	10	0	20	60	-	5870	11.6			0.2	20			32						
ML09-48	19/04/09	Back Valley Creek	Kirk Property	272891	6064109	0.6	None	Low level	10	1	5	40	7.7	1150	13.4	4.5		0.2	100			23						
SAG06-33	31/03/06	Back Valley Creek	Kirk Property	272899	6064117	1.5	None	Low level	10	2	40	30	-	1050	15.2			0.4	30			21						
SAG07-04	31/03/07	Back Valley Creek	Kirk Property	272895	6064097	0.5	None	Concentrated	20	20	10	40	7.7	3200	13.5			0.3	51			3						
ML02-178	17/05/02	Back Valley Creek	Kirk Road	273400	6064000	2.0	None	Bank level	20	0	20	60	-	2180	11.9			0.4	20		1	3						
ML04-13	4/03/04	Back Valley Creek	Kirk Road	273971	6064387	2.0	None	Bank level	10	10	30	40	7.7	2400	18.5			0.5				8						
ML05-13	10/04/05	Back Valley Creek	Kirk Road	273965	6064393	2.0	None	Bank level	10	0	40	60	-	2380	16.0			0.5				11						
ML08-108	6/11/08	Back Valley Creek	Kirk Road	273955	6064387	1.0	None	Low level	1	0	40	60	6.9	3420	16.7	2	0.7	0.5	2			12						
ML08-34a	20/04/08	Back Valley Creek	Kirk Road	273955	6064387	1.2	None	Low level	10	0	30	60	-	2850	12.6			0.2	9			71						
ML09-49	19/04/09	Back Valley Creek	Kirk Road	273978	6064377	0.8	None	Low level	5	0	30	60	7.1	2780	13.9	1.9		0.2	8			101						
SAG06-07	4/01/06	Back Valley Creek	Kirk Road	273978	6064382	2.0	Seep	Bank level	20	2	30	80	7.2	3150	15.9			0.3	70		1	210						
SAG07-03	31/03/07	Back Valley Creek	Kirk Road	273955	6064387	1.5	None	Bank level	20	0	40	50	7.2	2690	14.7			0.2	5		2	14						
ML03-45b	6/04/03	Back Valley Creek	Kirk Road	276000	6065000	2.0	None	Bank level	20	0	30	80	7.6	2600	14.7			0.6	20	1		10						

Site Code	Date	Waterway	Location	Easting	Northing	Depth max (m)	Flow	Pool condition	Subsurface physical %	Subsurface biological %	Emergent %	Edge vegetation %	pH	Conductivity (µS/cm)	Temperature (°C)	Dissolved oxygen surf. (ppm)	Dissolved oxygen depth (ppm	Transparency (m)	Carp gudgeons	Climbing galaxias	Common galaxias	Southern pygmy perch	Western bluespot goby	Brown trout*	Gambusia*	Rainbow trout*	Redfin*	No fish
SAG06-02	1/01/06	Back Valley Creek	ds Kirk Rd	274389	6064586	1.2	None	Bank level	5	0	30	70	6.9	4810	16.7			0.3	30			17						
SAG08-10	1/03/08	Back Valley Creek	ds Kirk Rd	274173	6064479	2.0	None	Low level	10	0	30	20	7.3	4360	16.1			0.2	35			6						
ML08-34b	20/04/08	Back Valley Creek	Robertson Property	276855	6065227	1.0	None	Low level	40	0	30	80	-	3630	12.4			0.4	7		3	63						
ML09-50	19/04/09	Back Valley Creek	Robertson Property	277219	6065271	1.0	None	Low level	40	0	20	60	7.4	3210	14.6	1.4	0.8	0.3	3			121						
ML01-20	19/12/01	Back Valley Creek	Stock demonstration site	278700	6065400	2.0	Low	Bank level	10	0	30	60	-	-	-			0.3	150		2				35			
Reach 5																												
SAG08-09	1/03/08	Inman River	Glacier Rock (rd crossing)	274469	6069081	1.2	None	Concentrated	20	10	20	30	7.5	4390	14.0			0.7			1				93		11	
SAG06-31	19/01/06	Inman River	Stephens prop.	275205	6069052	1.5	Low	Bank level	30	2	10	30	7.7	2340	26.9			0.5			25			4	1	4	1	
Reach 6																												
SAG06-06	4/01/06	Inman River	Flow gauge station	280596	6063888	2.0	Low	Bank level	30	0	20	30	7.8	3320	19.3			0.4	8		30		25		12		14	