

Selected fish surveys in the Barwon and Moorabool River catchments following the prolonged low flow period of 2006-2007



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Summary

This report provides a summary of fish surveys conducted as a supplement to a drought assessment investigation in 2007. The main purpose of these surveys was to determine the status of important fish communities in the Barwon and Moorabool River catchments following an extended low flow period throughout 2006 and 2007. River systems selected in the Barwon River catchment included the upper Barwon River catchment (East and West Branches), Leigh River and Waurn Ponds Creek. Sites in the middle and upper reaches of the Moorabool River to access were also selected in the Moorabool River.

A total of 18 sites were surveyed with five on upper Barwon River, four on the Leigh River, five on Waurn Ponds Creek and four sites on the Moorabool River. With so few sites on each system, these brief fish surveys should not be considered as comprehensive fish investigations, but more appropriately as indicative assessments of drought impacts.

In the upper Barwon River, there was a distinct lack of migratory species such as common galaxias and spotted galaxias and a apparent decline in non-migratory species such as mountain galaxias and river blackfish. Platypus were in relatively high abundance, however the abundance of exotic fish species was relatively low. Other important fish species in the catchment that were reconfirmed include dwarf galaxias in Gosling Creek and Yarra pygmy perch in Pennyroyal Creek.

In the Leigh River, there was an overall low abundance and diversity of fish compared with other streams within the Barwon catchment. Short-finned eels, brown trout, tench and platypus were thriving within the system which was likely to be associated with the sustained flows provided by the Ballarat Goldfields and the Central Highlands Waste treatment plant. A lack of migratory fish species such as common galaxias and larger bodied non-migratory such as river blackfish are likely to be related to the distinct lack of instream habitat (such as woody debris and undercut banks), unconsolidated substrate and the dominance of predatory species (such as brown trout).

In Waurn Ponds Creek, Yarra and southern pygmy perch were abundant in the middle reaches and short-finned eels and common galaxias were abundant in the lower reaches. A lack of seasonal runoff from the upper catchment, lack of riparian vegetation, a number of low flow instream barriers and dominance of eastern gambusia in the upper reaches were thought to be responsible for the decline in distribution Yarra pygmy perch in the system.

In the Moorabool River, the abundance of river blackfish in the lower and middle reaches appears to have declines since 1998, however the population in the upper reaches of the West Branch appear to be self-sustaining. More intensive surveys are required in the lower and middle reaches to determine the recruitment success and status of the current population. None of five previously recorded small migratory fish species were captured, confirming that there has been a lack of attraction flow and migration opportunities into the system. The lack of exotic species was a positive result which is also likely to be related to the lack of fresh water inflows into the system.

Prolonged low flows in the upper Barwon and Moorabool River systems in 2006 and 2007 are likely to have led to a loss of connectivity between pools, restricted localised movement opportunities and reduced available instream habitat for native fish species. While most native species are likely to have experienced low flow conditions before, successive years of low flow is likely to have long lasting impacts on many species.

Small spring and summer freshes are critical for the native fish in these streams as they dilute and freshen the water quality, provide opportunity for localised movement and stimulate most non-migratory fish into spawning condition. Without refreshing inflows during this time and with limited available habitat, the success of the spawning events for these species is likely to

be compromised. The abundance and diversity of available habitat is greatly reduced and therefore if spawning had occurred the possibility of escaping predation (by species such as eastern gambusia) would be greatly reduced.

Deterioration of water quality is also a likely consequence during periods of low flow. Without adequate mixing of the water column, dissolved oxygen levels are likely to decrease and without adequate shading water temperatures are likely to increase. Without the dilution of inflowing freshwater, saline ground water influx may also lead to an increase in the salinity and electrical conductivity within the remnant pools.

With an estimated reduction in runoff in southwest Victoria, extended low to zero flow periods are likely to become more common and are likely to have a significant impact on native fish populations. Strategies such as maintaining habitat features of key refuge pools and the provision of additional water should be developed to help important fish communities through these periods of low flow.

Recommendations for river blackfish include more targeted and regular surveys in the upper Barwon and Moorabool Rivers, introduction of additional instream habitat such as large woody debris and allocation of large flows to flush sediment and spring freshes to stimulate spawning.

Recommendations for Yarra pygmy perch include more targeted and regular surveys in Pennyroyal and Waurn Ponds Creek, trials to establish the species maximum salinity and minimum dissolved oxygen tolerances, catchment management strategies such as stock exclusion and appropriate riparian revegetation, re-assessment of passing flow guidelines and water extraction volumes, an assessment of potential urban water quality issues in Waurn Ponds Creek and the development of site specific drought management strategies at key refuge sites.

Recommendations for dwarf galaxias include more targeted and regular surveys in Gosling Creek and the Barwon River floodplain upstream of Gerangamete, catchment management strategies such as stock exclusion and appropriate riparian revegetation, re-assessment of passing flow guidelines and water extraction volumes and the development of site specific drought management strategies at key refuge sites.

Australian Grayling have previously been recorded in the Barwon River near the confluence of the Moorabool River and in the lower Moorabool River. Recommendations for Australian grayling include additional opportunistic surveys in these locations immediately after high flow events in summer and autumn for migrating adults and spring and summer for juveniles.

Australian mudfish have previously been recorded in small drainage channels adjacent to the lower Barwon River at Belmont Common. Recommendations for Australian mudfish include more targeted and regular surveys in the lower Barwon River floodplain, catchment management strategies such as stock exclusion and appropriate riparian revegetation, investigation of captive breeding programs and site specific drought management strategies at key refuge sites.

Introduction

This report provides a summary of fish surveys conducted as a supplement to a drought assessment investigation commissioned by the Corangamite Catchment Management Authority (CCMA) in 2007 (Ryan and McGuckin 2007). The drought assessment study provided a snapshot of river conditions, key issues affecting aquatic health and categorises waters as severely stressed, moderately stressed or having minor stress due to the current drought.

The main purpose of these surveys was to determine the status of important fish communities in the Barwon and Moorabool River catchments following an extended low flow period throughout 2006 and 2007. River systems selected in the Barwon River catchment included the upper Barwon River catchment (East and West Branches), Leigh River and Waurn Ponds Creek.

Sites in the upper Barwon catchment were selected to assess the impact of reduced flows of resident populations in the system. The Leigh River was surveyed to determine if the supplementary water disposal (from the Ballarat Goldfields mine at Mount Clear and the Central Highlands Water waste water treatment site at Magpie) was able to provide key refuge habitat for fish species in the catchment. The survey of Waurn Ponds Creek was conducted primarily to determine the status of Yarra pygmy perch (*Nannoperca obscura*) previously found in the middle and upper reaches of that stream.

Sites in the middle and upper reaches were also selected in the Moorabool River to determine the potential impact of drought on fish populations in the system and in particular locally significant species such as river blackfish (*Gadopsis marmoratus*) and mountain galaxias (*Galaxias olidus*).

Methods

A total of 18 sites were surveyed, namely five on upper Barwon River, four on the Leigh River, five on Waurn Ponds Creek and four sites on the Moorabool River.

Electrofishing was conducted according to the Australian Code of Electrofishing Practice using a NIWA EFM300 backpack unit. A 100m reach at each site was measured, marked and fenced using fine mesh stop nets. Each site was to be sampled twice for 30 to 45 minutes (two consecutive electrofishing runs, 30 minutes apart). Where possible electrofishing was employed, however excessively low or deep water levels and elevated electrical conductivity necessitated the use of other techniques such as dip and fyke netting.

Fyke nets were set overnight at seven sites with appropriate approvals from DPI Fisheries and DSE (FFG Act 1988) and were labelled appropriately and firmly attached with the cod ends clearly above the water to allow for the survival of air breathing animals.

All fish were measured to the nearest millimetre using fork length for fish with forked caudal fins and total length for fish with rounded caudal fins. Where large numbers of individuals were caught, a subset of 20 individuals of each species were measured and weighed, with the remaining fish being counted and bulk weighed. Short-finned eels were counted and generally only the longest and shortest were estimated.

Fish identifications were confirmed with the use of McDowell and Frankenberg (1981) and McDowell (1996).

Fish capture results

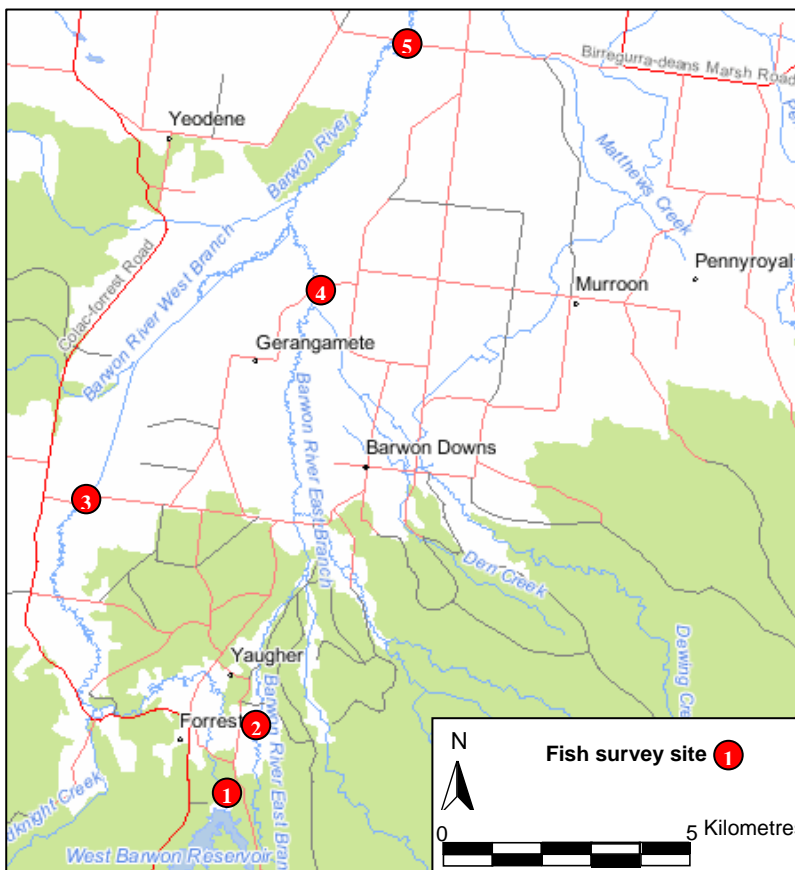
Upper Barwon River catchment

A lack of freshwater inflows and a high level of water extraction from the upper Barwon River catchment are likely to have impacted aquatic habitat conditions over the drought period. This survey was conducted in early August to determine the status of native fish populations in these upper reaches.

Five fish survey sites were selected on the upper Barwon River, namely two sites on the Barwon River East Branch, two sites on the Barwon River West Branch and one immediately downstream of the junction of these two anabranches on the Barwon River (Table 1, Figure 1).

Table 1: Fish survey locations in the upper Barwon River catchment

Site #	Waterway	Date of sampling	Location	GDA94 Latitude	GD94 Longitude	Vicroads Ref.
1	Barwon River West Branch	10/8/2007	Downstream of West Barwon Dam, Forrest	54 737275	5732309	101 D2
2	Barwon River East Branch	10-11/8/2007	Downstream of offtake weir , Forrest	54 738009	5732508	101D2
3	Barwon River West Branch	10-11/8/2007	Sevens Creek Bridge, Barwon Downs	54 734624	5738106	92 C9
4	Barwon River East Branch	10-11/8/2007	Dewings Bridge Road, Barwon Downs	54 739857	5742358	92 D8
5	Barwon River	10-11/8/2007	Deepdene Road, Yeodene	54 741771	5747339	92 E8



(Modified after Victorian Data Warehouse mapping tool) (DSE 2007a)

Figure 1: Map of fish survey locations in Upper Barwon River catchment

Five native fish species were captured in the upper Barwon River system, namely the short-finned eel (*Anguilla australis*), flat-headed gudgeon (*Philypnodon grandiceps*) and southern pygmy perch (*Nannoperca australis*), mountain galaxias (*Galaxias olidus*) and river blackfish (*Gadopsis marmoratus*). Short-finned eels represent the only migratory fish species. Three

exotic fish species were also captured, namely eastern gambusia (*Gambusia holbrooki*), tench (*Tinca tinca*) and redfin (*Perca fluviatilis*) (Table 2).

Table 2: Fish and bycatch capture summary for the Upper Barwon River catchment

Site No.	Technique	Fish captured (scientific name)	Fish captured (common name)	No. fish	Length (mm)	Weight (g)	Bycatch
1	Electrofishing (100m)	<i>Anguilla australis</i>	short-finned eel	7	250 - 870		40 FW shrimp Burrowing crayfish
		<i>Philypnodon grandiceps</i>	flat-headed gudgeon	1	103	11.3	
		<i>Nannoperca australis</i>	southern pygmy perch	5	48 - 70	1.9 - 4.5	
		<i>Perca fluviatilis</i>	redfin	4	75 - 104	4.9 - 12.7	
2	3 fyke nets	<i>Nannoperca australis</i>	southern pygmy perch	18	37 - 70	0.9 - 4.7	Platypus 20 FW shrimp
		<i>Galaxias olidus</i>	mountain galaxias	4	46 - 68	0.6 - 2.2	
3	4 fyke nets	<i>Nannoperca australis</i>	southern pygmy perch	14	44 - 72	1.4 - 4.4	Male platypus Burrowing crayfish
		<i>Galaxias olidus</i>	mountain galaxias	6	50 - 73	0.5 - 2.0	
		<i>Tinca tinca</i>	tench	3	95 - 148	48.5 - 148	
4	4 fyke nets	<i>Anguilla australis</i>	short-finned eel	3	250 - 900		90 FW shrimp Burrowing crayfish
		<i>Gadopsis marmoratus</i>	river blackfish	1	270	203	
		<i>Nannoperca australis</i>	southern pygmy perch	23	36 - 76	0.4 - 5.6	
		<i>Galaxias olidus</i>	mountain galaxias	8	54 - 68	1.1 - 3.0	
		<i>Gambusia holbrooki</i>	eastern gambusia	1	42	0.6	
5	3 fyke nets	<i>Anguilla australis</i>	short-finned eel	5	350 - 750		2 platypus 1 Male platypus Burrowing crayfish
		<i>Nannoperca australis</i>	southern pygmy perch	41	2.0 - 76	0.1 - 6.1	
		<i>Galaxias olidus</i>	mountain galaxias	3	58 - 62	0.9 - 1.0	

Southern pygmy perch were common at all sites and mountain galaxias were well represented at four of the five locations.

Mountain galaxias were common at four of the five sites Only one freshwater blackfish was captured in the Barwon River East Branch (site 4).

In comparison, lower numbers of exotic fish species were captured, including only four redfin, one tench and one eastern gambusia.

Platypus (*Ornithorhynchus anatinus*) were common with single captures at site 2 and site 3 and three captures at site 5.

Evidence of burrowing crayfish (*Engaeus* sp.) was evident at four of the five locations.

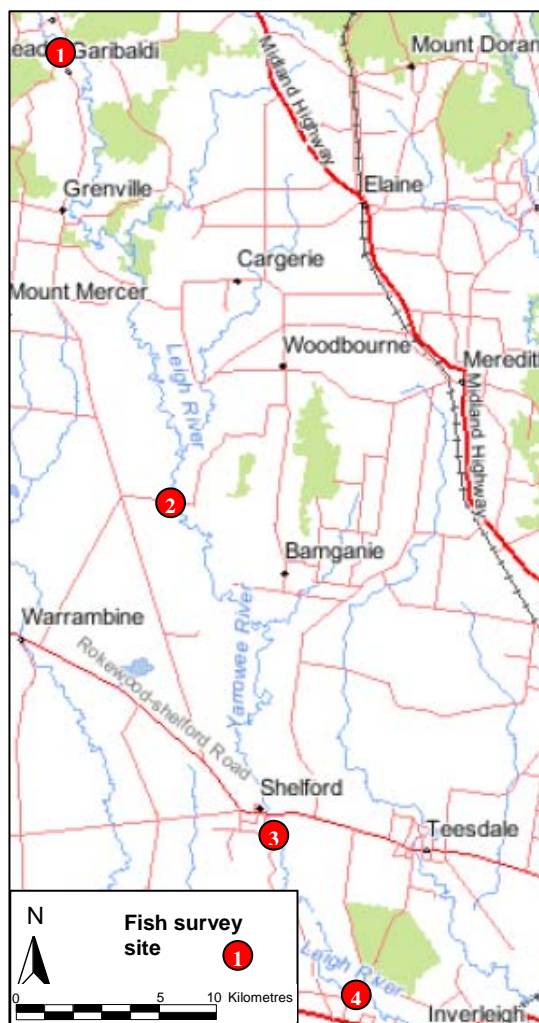
Leigh River

The Leigh River system was not thought to be impacted by the drought as much as other systems in the region due to supplementary water being discharged into the Yarrowee River (upper Leigh River) near Ballarat. As such the system was thought to provide a drought refuge for fish in the Barwon River system.

To determine this potential refuge ability, the survey locations were selected in the lower sections, while only one site was selected upstream of the Williamson Creek. Four sites were surveyed in the middle to lower Yarrowee and Leigh River from south of Buninyong to just north of Inverleigh (Table 3, Figure 2) and were based on previously surveyed locations from 2004 (DPI 2004).

Table 3: Fish survey locations in the Yarrowee / Leigh River

Site #	Waterway	Date of sampling	Location	GDA94 Latitude	GD94 Longitude	Vicroads Ref.
1	Yarrowee River	30-31/05/07	Buninyong - Mt. Mercer Road, Garibaldi	54 754064	5822054	76 F5
2	Leigh River	24/07/2007	Gundies Road, Bamganie	54 758226	5802276	76 G8
3	Leigh River	29-30/05/07	Downstream of Shelford	54 761589	5786118	93 A2
4	Leigh River	29-30/05/07	Teesdale Road, Inverleigh	55 238373	5780582	93 B3



(Modified after Victorian Data Warehouse mapping tool) (DSE 2007a)

Figure 2: Map of fish survey locations in the Yarrowee and Leigh River

Limited abundances of three native fish species were captured in the system, namely short-finned eel, flat-headed gudgeon and southern pygmy perch. Three exotic fish species were also captured including brown trout, tench and redfin. Short-finned eel were the most abundant species, with a total of 10 captures, followed by captures of five brown trout (Table 4).

Table 4: Fish and bycatch capture summary for the Leigh River

Site No.	Technique	Fish captured (scientific name)	Fish captured (common name)	No. fish	Length (mm)	Weight (g)	Bycatch
1	Elect – 100m	<i>Salmo trutta</i>	brown trout	1	424	888	
2	Electrofishing (100m)	<i>Anguilla australis</i>	short-finned eel	2	350, 750		300 FW shrimp
		<i>Philypnodon grandiceps</i>	flat-headed gudgeon	1	47	3	
		<i>Salmo trutta</i>	brown trout	2	124, 177	65, 115	
3	4 fyke nets	<i>Anguilla australis</i>	short-finned eel	4	450 - 680		Platypus
		<i>Nannoperca australis</i>	southern pygmy perch	1	63	7	
		<i>Tinca tinca</i>	tench	2	249, 344	226, 694	
		<i>Salmo trutta</i>	brown trout	1	483	1168	
		<i>Perca fluviatilis</i>	redfin	2	123, 126	23, 26	
4	4 fyke nets	<i>Anguilla australis</i>	short-finned eel	2	540 - 750		3 platypus 12 FW shrimp
		<i>Salmo trutta</i>	brown trout	1	185	65	

The capture of a southern pygmy perch represents a new species record for this system. The capture of four female (or possible juvenile) platypus, particularly the three upstream of Inverleigh (site 4) is also an encouraging result (Table 4).

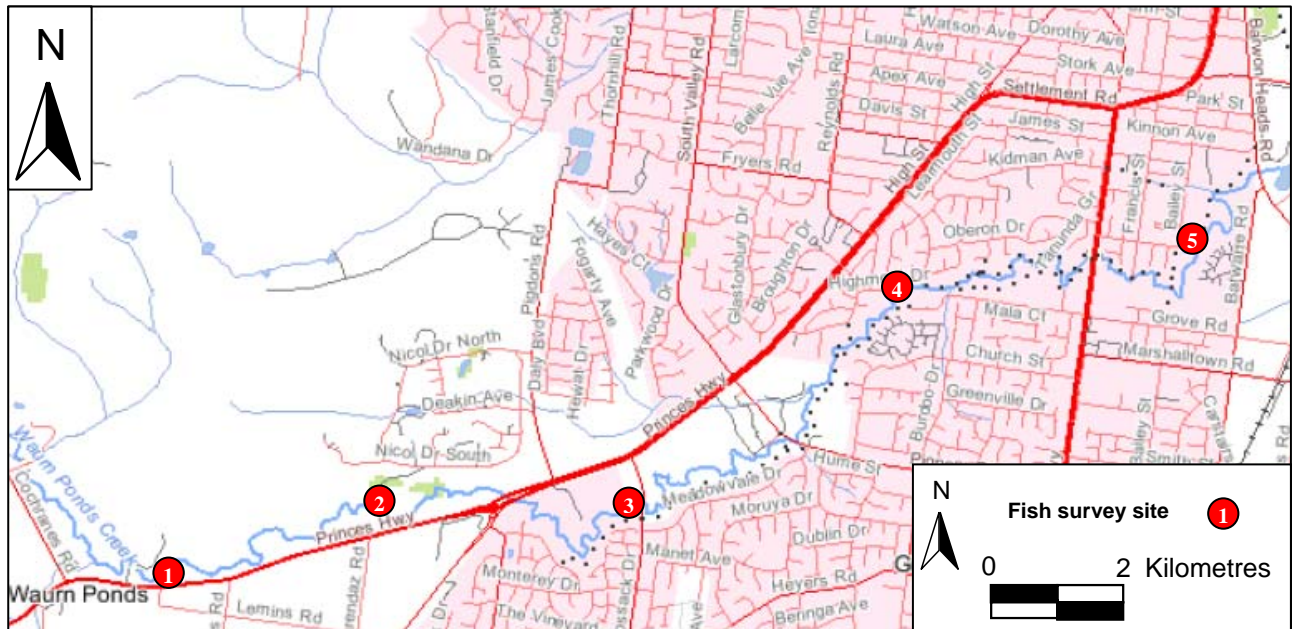
Waurm Ponds Creek

Stormwater inflows appeared to have sustained some sections of Waurm Ponds Creek over the drought period. However, this additional water and the infrastructure supporting it has come with a number of environmental hazards likely to adversely impact the system such as riparian vegetation removal, channel straightening and sediment and pollution runoff.

Five fish survey sites were selected between Cochranes Road and Barwon Heads Road to investigate the impact of drought and urban development on fish within the Waurm Ponds Creek, particularly the important and nationally protected Yarra Pygmy Perch (*Nannoperca obscura*) (Table 5, Figure 3). Locations were based on previously surveyed locations from 2002 (Close *et al.* 2002) and 2004 (DSE 2007b).

Table 5: Fish survey locations in the Waurm Ponds Creek

Site #	Waterway	Date of sampling	Location	GDA94 Latitude	GD94 Longitude	Vicroads Ref.
1	Waurm Ponds Creek	24/07/2007	Upstream of Waurm Ponds East tennis court	55 261751	5767665	93 F5
2	Waurm Ponds Creek	24/07/2007	Jarvis Oval Bridge, Waurm Ponds East	55 263171	5768067	93 F5
3	Waurm Ponds Creek	24-25/07/2007	Upstream of Rossack Road, Grovedale	55 264656	5768189	93 G5
4	Waurm Ponds Creek	24-25/07/2007	Hightmont Drive, Grovedale	55 266220	5769499	93 G5
5	Waurm Ponds Creek	24-25/07/2007	Bailey Street, Grovedale	55 267893	5769863	93 G5



(Modified after Victorian Data Warehouse mapping tool) (DSE 2007a)

Figure 3: Map of fish survey locations in Waurm Ponds Creek

Four native fish species were captured in the system, namely two migratory species (short-finned eel and common galaxias (*Galaxias maculatus*) and two non-migratory species (southern pygmy perch and Yarra pygmy perch). Two exotic fish species were also captured, namely eastern gambusia (*Gambusia holbrooki*) and goldfish (Table 6).

Table 6: Fish and bycatch capture summary for Wauron Ponds Creek

Site No.	Technique	Fish captured (scientific name)	Fish captured (common name)	No. fish	Length (mm)	Weight (g)	Bycatch
1	Dip net	NO FISH CAUGHT					
2	Dip net	<i>Gambusia holbrooki</i>	eastern gambusia +	45	13 - 37	<0.1 – 3.7	
3	Dip net	<i>Nannoperca obscura</i>	Yarra pygmy perch	10	17 - 60	<0.1 - 4	
		<i>Gambusia holbrooki</i>	eastern gambusia +	8	15 - 30	<0.1 – 3.0	
	2 fyke nets	<i>Nannoperca obscura</i>	Yarra pygmy perch	16	43 - 60	1.1 – 2.8	
		<i>Nannoperca australis</i>	southern pygmy perch	7	62 - 68	4.2 – 5.7	
		<i>Galaxias maculatus</i>	common galaxias	13	70 - 134	1.6 – 10.3	
4	3 fyke nets	<i>Nannoperca obscura</i>	Yarra pygmy perch	40	27 – 57	0.2 – 2.2	
		<i>Nannoperca australis</i>	southern pygmy perch	24	38 – 80	0.7 – 7.0	
		<i>Galaxias maculatus</i>	common galaxias	5	77 - 88	1.7 – 2.8	
		<i>Carassius auratus</i>	goldfish	2	87, 112	14.7, 27	
5	3 fyke nets	<i>Anguilla australis</i>	short-finned eel	1	650		1 FW shrimp
		<i>Nannoperca obscura</i>	Yarra pygmy perch	6	22 - 62	0.1 – 3.2	
		<i>Nannoperca australis</i>	southern pygmy perch	2	47 - 55	1.7 – 2.5	

Moorabool River

High domestic demand for water from the upper catchment has resulted in significantly reduced stream flows throughout the majority of the Moorabool River. In addition, a series of weirs between Batesford and Sheoaks (Raadik and Koster 2000) also represents a significant impediment to fish migration and potential recolonisation of native fish species.

Four fish survey sites were selected in the upper and middle reaches of the Moorabool River (Table 7, Figure 4). Sites were based on previously surveyed locations surveyed in the 1980's (DSE 2007b) and by Raadik and Koster (2000).

Table 7: Fish survey locations in the Moorabool River

Site #	Waterway	Date of sampling	Location	GDA94 Latitude	GD94 Longitude	Vicroads Ref.
1	Moorabool River West Branch	24-25/07/2007	Elaine - Egerton Road, Mt. Doran	55 243855	5822218	77 C5
2	Moorabool River	24-25/07/2007	Ballan - Meredith Road, Morrisons	55 244980	5813990	77 C6
3	Moorabool River	24-25/07/2007	Sheoaks - Steiglitz Road, She Oaks Bridge	55 247436	5801564	77 D8
4	Moorabool River	24-25/07/2007	Parker Road, Russells Bridge	55 252980	5788680	77 D10

Four native fish were captured at the four sites on the Middle and upper Moorabool River, including one migratory species (short-finned eel) at the lower site and three non-migratory species (river blackfish, flat-headed gudgeon, southern pygmy perch). River blackfish were found at all sites and were more abundant at the upstream site at Mount Doran. The upper Moorabool River sample had a range of fish lengths from 87 to 338 mm which represents at least four different length classes, indicating that the population is self sustaining and that recruitment was possible last year (87 mm fish) (Table 8).

Brown trout were also abundant in the upper Moorabool River with the sample of 20 captured fish at two sites exhibiting at least four different length classes, which is also indicative of a self sustaining population (Table 8).

A single platypus was also captured at Sheoaks and platypus burrows were evident at Morrisons and Russells Bridge.



(Modified after Victorian Data Warehouse mapping tool) (DSE 2007a)

Figure 4: Map of fish survey locations in the Moorabool River

Table 8: Fish and bycatch capture summary for the Moorabool River

Site No.	Technique	Fish captured (scientific name)	Fish captured (common name)	No. fish	Length (mm)	Weight (g)	Bycatch
1	Electrofishing (100 m)	<i>Gadopsis marmoratus</i>	river blackfish	15	87 -257	60 - 131	
		<i>Salmo trutta</i>	brown trout	10	125 - 295	23 - 241	
2	4 fyke nets	<i>Gadopsis marmoratus</i>	river blackfish	7	180 - 338	74 - 339	
		<i>Salmo trutta</i>	brown trout	10	280 - 348	241 - 398	
3	4 fyke nets	<i>Gadopsis marmoratus</i>	river blackfish	4	135 - 290	8 - 200	1 platypus
		<i>Philypnodon grandiceps</i>	flat-headed gudgeon	3	39	0.1	75 FW shrimp
4	dip net	<i>Gadopsis marmoratus</i>	river blackfish	1	309	229	1 FW shrimp
		<i>Anguilla australis</i>	short-finned eel	2	54, 56	1.3, 1.6	
		<i>Nannoperca australis</i>	southern pygmy perch	3	44 - 66	0.9 - 3.5	

Discussion

The brief fish surveys conducted as part of this study should not be considered as comprehensive fish investigations, but more appropriately as indicative surveys. More detailed investigations would be required in each system to obtain greater knowledge of the fish communities and potential influences on them. Never the less, these brief investigations provided the opportunity to assess the impact of drought on important native fish populations within these river systems.

Upper Barwon River

A lack of migratory species such as common galaxias (*Galaxias maculatus*) and spotted galaxias (*Galaxias truttaceus*) was an obvious difference compared with previous surveys (Figure 5) and highlights the lack of migratory success over the drought period.

Mountain galaxias were common, but few river blackfish were found. River blackfish abundance was low in comparison with previous surveys (Raadik and Koster 2000). Low flow conditions during the drought period may have impacted this species, however, more targeted surveys would be required to other sites within the reach to confirm this. Surveys in many Melbourne Water catchments, such as Hoddles Creek and Woori Yallock Creek have indicated that the recent drought period has resulted in a decline in river blackfish populations and has also resulted in a decline of recruitment in at least the last two seasons (Ryan 2007a, Ryan 2007b). It is interesting to note that the species has not previously been recorded in the Barwon River West Branch, which may reflect a lack of riparian vegetation cover and instream woody debris. Further investigations are warranted to determine the sustainability and recruitment success of the river blackfish population.

Southern Victorian spiny crayfish (*Euastacus yarraensis*) have previously been recorded in this region (Figure 5), however, none were collected during this survey. Extended low flow may have also impacted the recruitment success of this crayfish species.

Five platypus captures from three of four sites is indicative of a relatively high population abundance. Conditions in the upper Barwon River appear to have remained suitable for platypus including suitable pool depth for habitat and aquatic invertebrates as a food source.

Exotic fish were in low abundance. Brown trout (*Salmo trutta*) were not collected, but have previously been recorded in all reaches surveyed. Redfin were previously recorded to be dominant in the Barwon River West Branch, but were not abundant in the two sites surveyed in this investigation. It is possible that low flows during the drought period have adversely impacted these exotic fish species.

	Native Freshwater Fish							Exotic Fish					Other Aquatic Fauna				
	Migratory			Non- migratory													
	Short finned eels	Common galaxias	Spotted galaxias	Mountain galaxias	River blackfish	Southern pygmy perch	Flat headed gudgeon	Australian smelt	Redfin	Brown trout	Tench	Goldfish	Eastern Gambusia	Southern Victorian spiny cray	Freshwater shrimp	Burrowing crayfish	Platypus
Barwon River East Branch	X			X	X	X						X		X	X	X	
Barwon River West Branch	X			X		X	X		X		X				X	X	X
Upper Barwon River	X			X		X											X

Grey squares indicate previous records, while ‘X’ indicates a capture of current survey.

Figure 5: Previously recorded and current fish capture in the Upper Barwon River catchment

Other important fish species in the region that deserve further consideration include dwarf galaxias (*Galaxiella pusilla*) and Yarra pygmy perch.

Dwarf galaxias were reconfirmed in Gosling Creek on May 18, 2007 upstream of Division Road (Ryan and McGuckin 2007). The survival of dwarf galaxias in the Barwon River floodplain upstream of Gerangamete (Raadik and Koster 2000) was not determined but should be assessed in the near future.

As the only self-sustaining population of this nationally threatened species in the region, it should receive priority management consideration. In accordance with the draft action statement for dwarf galaxias, important management action should include stock exclusion fencing, maintenance of aquatic macrophytes and water quality and prevention of low water levels (DSE 2007d). A drought management strategy for this population should be developed and include options to guarantee water level in this important habitat.

Similarly the important Yarra pygmy perch population, reconfirmed on May 30, 2007 in Pennyroyal Creek downstream from the Wurdee Boluc Reservoir offtake should also receive management priority.

A review of the passing environmental flows, first proposed by Raadik (2000) and a review of water extraction from these systems is considered a high priority.

Leigh River

The overall fish abundance appears to be low compared with other streams within the Barwon catchment. A distinct lack of instream habitat (such as woody debris and undercut banks) and the dominance of predatory species (such as brown trout) are likely to influence the overall abundance of fish.

Previous documented surveys include a single site on the Leigh River at Inverleigh in 1994 (DSE 2007b) and, eight sites in the Yarrowee and Leigh River in 2003 (DPI 2004). The overall fish diversity also appears to be relatively low, with the lack of two previously recorded native species, namely common galaxias and Australian smelt (*Retropinna semoni*) and goldfish (*Carassius auratus*) (Figure 6). The lack of common galaxias was particularly telling and may indicate a lack of migratory success from lower in the Barwon River system during the drought period.

	Native Freshwater Fish						Exotic Fish				Other Aquatic Fauna		
	Migratory			Non-migratory			Redfin	Brown trout	Tench	Goldfish	Freshwater shrimp	Platypus	Long neck tortoise
Short finned eels	Common galaxias	Galaxias sp.	Southern pygmy perch	Flat headed gudgeon	Australian smelt								
Middle Leigh River	X				X			X	X		X	X	X
Lower Leigh River	X			X			X	X	X		X	X	

middle/lower division = Shelford

Grey squares indicate previous records, while 'X' indicates a capture of current survey.

Figure 6: Previously recorded and current fish capture in the Leigh River

A fish survey conducted at five sites in the upper Leigh River (Yarrowee River) at Mount Clear in September 2007 confirmed the limited diversity in the system with the capture of numerous short-finned eels, brown trout and tench as well as two flat-headed gudgeon. The capture of a juvenile brown trout in the macroinvertebrate sweep net at site 5 indicates that this species is capable of breeding in the stream (Ryan *et al.* 2007).

Platypus appear to be thriving in this system as well as the Barwon, with four captures in this study and an additional capture at Mount Clear in September 2007 (Ryan *et al.* 2007). The sustained flows appear to have favoured the platypus as has then proliferation of macroinvertebrates that is likely to have resulted from the release of nutrient rich water from the Central Highlands waste treatment water.

The current results suggest that short-finned eels, brown trout, tench and platypus are thriving within the system. If these species are able to flourish, so should other native fish species. When migration from the lower Barwon River is possible migratory native fish such as common and spotted galaxias are likely to recolonise the system.

The biggest impediment to recolonisation of other native fish into this system is a lack of instream habitat diversity (woody debris and riparian cover) and a largely unconsolidated sand and gravel substrate. Alternative instream habitat enhancement methodologies may include the introduction of LUNKERS (Little Underwater Neighbourhood Keepers Encompassing Rheotaxic Salmonids) (FISRWG 2002). These are pre-cast concrete structures designed to mimic trout habitat which are placed in eroded catchments in northern America. Modifications may be required to ensure suitability for native fish and to suit the hydrodynamics and sediment transportation conditions in the Leigh River.

Wauru Ponds Creek

Yarra and southern pygmy perch were found to be abundant at three of the five locations, but were not found at the two upstream sites where they have been previously recorded. This represents a reduction in abundance and range of the pygmy perch population since 2002 (Close *et al.* 2002) and 2004 (DSE 2007b). A lack of water, instream barriers (such as underneath the Princes Highway) and dominance of eastern gambusia in the upper reaches of Wauru Ponds are all likely reasons for the decline of pygmy perch in the upper catchment.

As a highly aggressive fish, the high abundance of eastern gambusia in the upper reach (site 2) could have been a significant influence on the lack of other fish species at this location.

Relatively large short-finned eels and common galaxias captured at the lower two sites may indicate that migration occurred at least one year ago. Spotted galaxias and tupong (*Pseudaphritis urvillii*) were captured in 2002 but were not captured during this survey (Figure 7). Spotted galaxias captured in February 2007 as part of another study at Barwon Heads Road.

	Native Freshwater Fish							Exotic Fish	
	Migratory				Non-migratory			Goldfish	Eastern Gambusia
	Short finned eels	Common galaxias	Spotted galaxias	Tupong	Southern pygmy perch	Yarra pygmy perch	Flat headed gudgeon		
Upper Waurm Ponds Creek									X
Lower Waurm Ponds Creek		X			X	X		X	X

upper/lower division = Princes Highway

Grey squares indicate previous records, while 'X' indicates a capture of current survey.

Figure 7: Previously recorded and current fish capture in Waurm Ponds Creek

A decline in abundance and range of Yarra pygmy perch in the Waurm Ponds Creek has occurred since surveys in 2002. This decline is likely to be associated with low flows experienced during the drought period, but may have also been associated with the increase environmental stress due to an encroaching urban development in the catchment and the increased dominance of the eastern gambusia.

In accordance with the Action Statement for Yarra pygmy perch (Saddler 2003), protection of key refuge pools of Yarra pygmy perch in the system is strongly recommended and may include management requirements such as buffer zones and sediment retention for urban development, riparian plant revegetation and monitoring storm water discharges.

Moorabool River

Two non-migratory native fish previously recorded, were not captured during the current survey, namely mountain galaxias and Australian smelt (Figure 8). Mountain galaxias were not captured in the extensive fish survey of 11 sites in 1998 and therefore may not occur within the system. Australian smelt were recorded in high abundance in 1998 and their absence now could be considered a direct result of reduced flows and connectivity with the lower Barwon River system.

The abundance of freshwater blackfish appears to have declined in the middle reaches of the Moorabool River since the 1998 and 1999 surveys and may have been associated with reduced water flows and the drought conditions. More intensive surveys are required in this system to determine the survival and recruitment success of river blackfish in the Moorabool River. The river blackfish in the upper West Branch at Mount Doran had a range of length classes including a fish at 87 mm. It therefore appears that recruitment and this location is successful

in most years including last year. However, the recruitment success in the rest of the river would require more intensive fish surveys.

Five migratory species previously recorded in the middle reaches of the Moorabool River were not captured in the current survey, namely common galaxias, spotted galaxias, short-headed lamprey (*Mordacia mordax*), Australian grayling (*Prototroctes maraena*), and tupong (Figure 8). A combination of numerous instream barriers and lack of flow over the last two years (particularly peak flows during winter and spring) are likely to have limited migration opportunities for these species.

The lack of five previously recorded exotic fish species is potentially a positive aspect of the period of low flows. Previous surveys have recorded relatively low numbers of all exotic species with the exception of brown trout in the upper reaches. This pattern appears to have been maintained.

As was the case in the Barwon River catchment, southern Victorian spiny crayfish were not observed during this current survey.

	Native Freshwater Fish										Exotic Fish					Other Aquatic Fauna		
	Migratory					Non-migratory					Redfin	Brown trout	Tench	Roach	Goldfish	Eastern Gambusia	Southern Victorian spiny cray	Freshwater shrimp
Short finned eels	Common galaxias	Spotted galaxias	Short headed lamprey	Australian grayling	Tupong	Mountain galaxias	River blackfish	Southern pygmy perch	Flat headed gudgeon	Australian smelt								
Lower Moorabool River																		
Middle Moorabool River	X						X	X	X								X	X
Upper Moorabool River							X					X						

upper/middle division = morrison

Grey squares indicate previous records, while 'X' indicates a capture of current survey.

Figure 8: Previously recorded and current fish capture in the Moorabool River

Other threatened species not specifically targeted

Australian Grayling

Australian Grayling are considered ‘Vulnerable’ in Australia (EPBC Act 1999), ‘Vulnerable’ in Victoria (DSE 2007c) and is listed under the Victorian Flora and Fauna Guarantee Act 1988. They have previously been recorded in the Barwon River near the confluence of the Moorabool River and in the lower Moorabool River (DSE 2007b). It is likely the within 2006 and most of 2007 there were limited opportunities for Australian grayling to migrate into the Barwon River system.

It is recommended that opportunistic surveys be conducted targetting Australian grayling in the Barwon River and lower Moorabool River immediately after high flow events in summer and autumn for migrating adults and in spring and summer for juveniles.

Australian mudfish

Australian mudfish is considered ‘Critically Endangered’ in Victoria and is listed as a protected species under the *Flora and Fauna Guarantee Act 1988* (DSE 2007c). They have previously been recorded in small drainage channels adjacent to the lower Barwon River at Belmont Common.

In accordance with the Action Statement for the Australian mudfish (Skene et al. 2005), more intensive surveys are necessary to determine in more detail the effect of the environment on the life cycle of Australian Mudfish. Specifically, further survey work is required to determine more precisely the sequence and timing of environmental events relative to different life cycle stages and what adaptability the fish may have to environmental variations. Targeted surveys in the lower Barwon River catchment (in the vicinity of Belmont Common and other potential locations such as Reedy Lakes.

Stock exclusion fencing and maintenance of coastal tea tree vegetation and drainage lines is essential for the survival of this species. Suitable floodplain habitat is rapidly disappearing in coastal regions that are subject to encroachment by urban development.

Impact of prolonged low flows on fish

Prolonged low flows in the upper Barwon and Moorabool River systems in 2006 and 2007 are likely to have led to a loss of connectivity between pools, restricted localised movement opportunities and reduced available instream habitat for native fish species. While most native species are likely to have experienced low flow conditions before, successive years of low flow is likely to have long lasting impacts on many species.

Small spring and summer freshes are critical for the native fish in these streams as they dilute and freshen the water quality, provide opportunity for localised movement and stimulate most non-migratory fish into spawning condition. Non-migratory native fish (including River blackfish, Yarra pygmy perch, southern pygmy perch, Australian smelt and flat-headed gudgeon) spawn from late winter to summer. Without refreshing inflows during this time and with limited available habitat, the success of the spawning events for these species is likely to be compromised. The abundance and diversity of available habitat is greatly reduced and therefore if spawning had occurred the possibility of escaping predation (by species such as eastern gambusia) would be greatly reduced.

Deterioration of water quality is also a likely consequence during periods of low flow. Without adequate mixing of the water column, dissolved oxygen levels are likely to decrease and without adequate shading water temperatures are likely to increase. Without the dilution of inflowing freshwater, saline ground water influx may also lead to an increase in the salinity and electrical conductivity within the remnant pools.

With an estimated reduction in runoff in southwest Victoria between 5% and 20% by the year 2030 due to climate change (Jones and Durack 2005), extended low to zero flow periods are likely to become more common and are likely to have a significant impact on native fish populations. Strategies such as maintaining habitat features of key refuge pools and the provision of additional water should be developed to help important fish communities through these periods of low flow.

Conclusion

Flow regimes that regularly replenish the shallow freshwater habitats are essential for the survival of Yarra pygmy perch, dwarf galaxias and Australian mudfish. The connectivity of more permanent waterways with offstream waterbodies is vital to their long-term survival (particularly during extended dry conditions). Changes to natural flood and drying cycles, particularly in swamps and shallow creeks, through activities such as catchment clearing, establishing extensive plantations, construction of dams and direct extraction of water, pose threats to critical habitat. A review of the passing flows and water extraction guidelines for systems that support threatened species (and locally significant species) needs to be conducted in light of the likelihood of declining natural runoff.

With the projected decrease in overall runoff associated with climate change, the likelihood of extended low flow periods is likely to increase. In low flow conditions the connectivity between pools and offstream backwaters can be lost and available instream habitat can be greatly reduced. Most native non-migratory fish species appear to be relatively tolerant to the environmental conditions associated with drought including deteriorating water quality. However, if suitable spawning opportunities are not achieved for two consecutive seasons, it is likely that recruitment failure will result. Under such a scenario, the potential decline of Yarra pygmy perch and dwarf galaxias populations is highly likely.

Recommendations

River blackfish

- Allocate large flow events to upper Barwon River and Moorabool River to flush deposited sediment from deep pools and high flow freshes in spring to stimulate spawning of river blackfish;
- Introduce large woody debris as additional refuge for river blackfish and potential spawning habitat into deep pool locations of the upper Barwon River reaches and the middle and lower reaches of the Moorabool;
- Conduct regular surveys at least every 5 years of important river blackfish populations, to monitor recruitment success.

Yarra pygmy perch

- Conduct regular surveys of the Yarra pygmy perch population in the Pennyroyal Creek and Waurn Ponds Creek to assess abundance and recruitment (at least every three years, but more regularly during drought periods)
- Conduct salinity and dissolved oxygen tolerance trials to establish management target guidelines;
- Where possible stock exclusion fencing should maintain a 30 metre buffer and include as much creek frontage as possible including backwaters and anabranches;
- Manage the diversity and abundance of aquatic plants to maintain or enhance the available habitat for Yarra pygmy perch;
- A review of the passing environmental flows since first proposed by Raadik (2000) and water extraction for Pennyroyal Creek these system is considered a very high priority;
- Further investigate the water quality issues associated with stormwater runoff and other water disposal within Waurn Ponds Creek and develop emergency response strategies to safe guard against catastrophic population events;

- Develop a drought management strategy to incorporate important sites such as the pools in Pennyroyal Creek below the Wurdee Boluc Reservoir Offtake and the middle reaches of Wauron Ponds Creek.

Dwarf galaxias

- Conduct regular surveys of the dwarf galaxias population in Gosling Creek and the Barwon River floodplain upstream of Gerangemetete (at least every three years, but more regularly during drought periods)
- Where possible stock exclusion fencing should maintain a 30 metre buffer and include as much creek frontage as possible including backwaters and anabranches;
- A review of the passing environmental flow first proposed by Raadik (2000) and water extraction for these systems is considered a high priority;
- Develop a drought management strategy to incorporate important in Gosling Creek and the Barwon River floodplain upstream of Gerangemetete.

Other threatened species

Australian grayling

- It is recommended that opportunistic surveys be conducted to target Australian grayling in the Barwon River and lower Moorabool River immediately after high flow events in summer and autumn for migrating adults and spring and summer for juveniles.

Australian mudfish

- Conduct targeted surveys at regular intervals in the lower Barwon River catchment (in vicinity of Belmont Common and other potential locations such as Reedy Lakes.
- Conduct regular surveys of the Australian mudfish population to assess abundance and recruitment (at least every three years, but more regularly during extended drought periods)
- Stock exclusion fencing should maintain a 30 metre buffer wherever possible and include as much creek, swamp and backwater habitat as possible including backwaters and anabranches;
- Investigate captive breeding options in other isolated locations; and
- Develop a drought management strategy to incorporate important sites on the lower floodplains of the Aire, Calder, Wye and Barwon River systems.

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