

Barmah-Millewa Fish Condition Monitoring: 2009/2010 Annual Report

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Barmah-Millewa Fish Condition Monitoring: 2010 Annual Data Summary

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Front cover photo: Background: Gulf Creek (Photo: Scott Raymond).

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Summary

The Barmah-Millewa Forest (B-MF) is a complex wetland system on the mid-Murray River that provides important habitat for both terrestrial and aquatic fauna. The fish community supported by the forest is particularly important, and is the focus of a condition monitoring program, which has been underway since 2006/07. This program has been designed to monitor the health and status of the fish community across 21 fish sampling sites distributed across creeks, wetlands and rivers. A larval drift component was incorporated into the project to assess fish spawning from 2008/09. This component is a continuation of the sampling which has been underway for the past five years, thus continuing to build a long-term data set on fish spawning in the B-MF. This report gives a summary of the results of the fourth year of sampling.

2009/10 was characterised by low flow conditions (<11,000ML/day); this resulted in one creek and three wetland/lake sites being dry and therefore unable to be sampled this year. A total of 13,650 fish were collected this year (caught and observed combined), and was largely dominated by small-bodied native species, as well as the exotic gambusia. Bony bream have not previously been sampled by this study, but were collected for the first time this year in several Murray River sites. This species has never been caught in high numbers in the region, and tends to be in higher abundance further downstream.

All of the large-bodied species (Murray cod, trout cod, golden perch and silver perch) were again collected this year. Young-of-year (YOY) Murray cod (31 fish), trout cod (one fish) and golden perch (one) were also collected, but no YOY silver perch were sampled. Exotic species were also collected in high numbers, particularly carp. A high abundance of YOY carp was detected (307 fish), despite the absence of flooding, providing further evidence that the area is an important nursery site for this species.

Concerns for the persistence of southern pygmy perch in the B-MF were raised in previous reports given their absence from successive surveys coupled with the lack of appropriate conditions which favour successful recruitment (flooding). This species was not detected again this year, and has now not been sampled for three consecutive years. Consequently, it is likely that this species may be locally extinct in the B-MF given their short life-span and their apparent reliance on floods for recruitment. Dwarf flatheaded gudgeon were also not detected for the third consecutive year, although this species is extremely rare in this area.

Lower numbers of Murray crayfish were collected from the Murray River sites in 2009/10 compared with 2008/09 abundances and they were again absent from the Edward River sites. There were no mature female Murray crayfish recorded and only one of the female crayfish sampled was in excess of the legal recreational size (90mm).

Silver perch, flatheaded gudgeon, golden perch, Murray cod, Australian smelt and trout cod were all recorded spawning in the Murray River sites in spring/summer 2009 (as demonstrated by the presence of eggs and/or larvae). Spawning levels of golden perch and silver perch were similar to previous low flow years. Four larval trout cod were sampled from the Barmah Choke in 2009/10.

The fourth year of sampling has provided additional evidence of the importance of the B-MF to native fish species. This project has gathered data on the fish community during unprecedented low flow conditions, and is therefore well placed to measure the fish community response when, and if, high flows occur.

1 Introduction

Condition monitoring of fish, waterbirds and vegetation is necessary to provide ongoing information regarding the 'health' of The Living Murray icon sites (www.livingmurray.mdbc.gov.au). The working draft of the outcomes evaluation framework calls for the establishment of consistent monitoring framework across all icon sites that have agreed benchmarks. Murray-Darling riverine ecosystems are typified by highly variable hydrological conditions, which has probably resulted in temporal and spatial variability of its flora and fauna. Therefore, development of long-term monitoring programs are essential for reliable interpretation and management of the Basins ecosystems.

The Barmah-Millewa Forest (B-MF) is a 70,000 ha highly complex wetland system on the mid-Murray River near Echuca. The system contains a range of aquatic habitats including rivers, permanent and ephemeral creeks, wetlands, swamps and the floodplain proper which historically contained an abundant and diverse range of native fish (King 2005). Until around the 1930s, the area also supported the largest inland commercial fishery in Australia, although since the enhanced regulation of the Murray River by dams and weirs, native fish have been substantially reduced in both abundance and diversity, and exotic species are common (King 2005). Given the importance of the region for a range of flora and fauna, the B-MF is listed as an internationally important wetland under the RAMSAR convention and has subsequently received iconic status under the Murray-Darling Basin Commissions 'Living Murray Initiative'.

In 2007, a condition monitoring program commenced in the B-MF region in order to benchmark the status of fish communities at three major 'ecotypes' throughout the system; rivers, creeks and wetlands (Tonkin and Baumgartner 2007). The overall objectives of the monitoring program are:

- Monitor the health and status of the Barmah-Millewa fish community through annual sampling.
- Assess long term changes in fish communities and correlate any observed changes with factors such as flow, climate and thermal regimes.
- To provide information which can feedback into management plans and reporting on condition for the icon site.

The findings of the first three years of this condition monitoring project (2007-2009) were presented in a milestone report to the MDBA (Rourke and Tonkin 2009). The report found that despite the ongoing severe drought conditions experienced throughout the study, that the B-MF still supported a diverse native fish fauna. However, some species had not tolerated the drought so well, most notably the southern pygmy perch (*Nannoperca australis*), which was not recorded during the last two years of the study. This is probably due

to the combination of the species' short lifespan and a dependence on floodplain inundation for reproduction (Tonkin *et al.* 2008), which has not occurred since October 2005.

Another important finding of the study to date is the apparent skew in the ratio of females to male Murray crayfish (*Euasticus armatus*) above the recreational size limit, with 1.5 males collected for every female collected. Furthermore, no females were in breeding (berried) condition. These data suggest that female Murray crayfish may be affected by recreational fishing prior to coming into berry. Consequently, the breeding season of Murray crayfish may extend beyond that of the Murrumbidgee River, where nearly all females are in berry by late May (Gilligan *et al.* 2007). To fully understand the apparent reduced abundance of adult females, recreational fishery data should be collected to establish if recreational anglers do take legal sized females, not in berry, early in the season. These data could then be used to inform future management efforts to ensure that recreational fishing does not place undue pressure on this iconic species.

In 2008/09, a spawning component was introduced to the project in order to continue a monitoring regime that has been underway in the region since 2003 (King *et al.* 2009). These data will enable the detection of potential links between abundance of drifting eggs and larvae, and the subsequent abundance of adult fish. Specifically, the spawning component of the monitoring program aims to:

- Document the presence of spawning of riverine fish species which have drifting egg and/or larval stages [Murray cod (*Maccullochella peelii peelii*), trout cod (*Maccullochella macquariensis*), silver perch (*Bidyanus bidyanus*), golden perch (*Macquaria ambigua ambigua*), and carp (*Cyprinus carpio*)] in the Murray River within the B-MF.
- Continue the long term data set of sampling for riverine fish eggs and larvae in the region, which has been underway since 2003. This will enable greater confidence in explaining responses to environmental variables, such as environmental watering events.

The current report summarises the results of the fourth year of data collection for the condition monitoring program, which incorporates sampling for Murray crayfish and spawning success of four primarily riverine species.

2 Methods

To assess the current condition of fish communities, methods were developed to maintain compatibility with current SRA (Sustainable Rivers Audit) protocols. The program also maintained consistency by balancing the number of sites sampled in each forest (Barmah and Millewa).

2.1 Sampling

Previous sampling undertaken within the icon site has identified unique fish communities in four broad regions of the Murray River main channel (King *et al.* 2007). Subsequently, a balanced design was developed with two sites established in each of these four regions (Table 1; Figure 1). Sampling in the river sites (Murray and Edward Rivers) was conducted in May 2010, after water levels were reduced to winter base flows, and to ensure that water temperatures were low enough to successfully sample Murray crayfish. At each site, sampling involved 12 replicates of 90 second electrofishing (or equivalent total time) shots using boat mounted electrofishing units. All sites on the Murray River were sampled with a large electrofishing boat (7.5 KVA, Smithroot boat-mounted electrofishing unit), whilst both sites on the Edward River were sampled with a smaller electrofishing vessel (2.5 KVA, Smithroot boat-mounted electrofishing unit). In addition to electrofishing, 10 unbaited bait-traps (minimum two-hour soak) were set to capture any small fish not efficiently sampled during routine electrofishing. At the completion of each operation, all fish were identified, counted and measured for total length (maximum of 50 individuals per species per site).

Ten baited (liver) Munyana crab traps (75 cm diameter) were also set from the onset of electrofishing and retrieved after a minimum of 2 hours to collect Murray crayfish (*Euastacus armatus*) in the river sites (Figure 2). Very few Murray crayfish were captured in May, which was most likely due to higher than usual water temperature, and therefore, sampling was repeated in late June. All crayfish collected were measured for occipital carapace length (OCL) and their sex was determined where possible. Females were also assessed for maturation (setae surrounding the gonopores) and for the presence of eggs (berries) on the ventral side of the tail.

Table 1. Permanent river fish sampling sites in the Barmah-Millewa Forest indicating sites successfully sampled in each year of the study.

Site	2007	2008	2009	2010
Murray River				
Downstream Region				
Morning Glory	✓	✓	✓	✓
Barmah/Moria Lake area	✓	✓	✓	✓
Mid Forest Region				
Picnic Point	✓	✓	✓	✓
Woodcutters	✓	✓	✓	✓
Upstream region				
Ladgroves Beach	✓	✓	✓	✓
Gulf Creek area	✓	✓	✓*	✓
Edward River				
5km downstream offtake regulator	✓	✓	✓	✓
Downstream Gulpa creek confluence	✓	✓	✓	✓

✓ Site contained water and successfully sampled

*Site sampled on 14/08/09

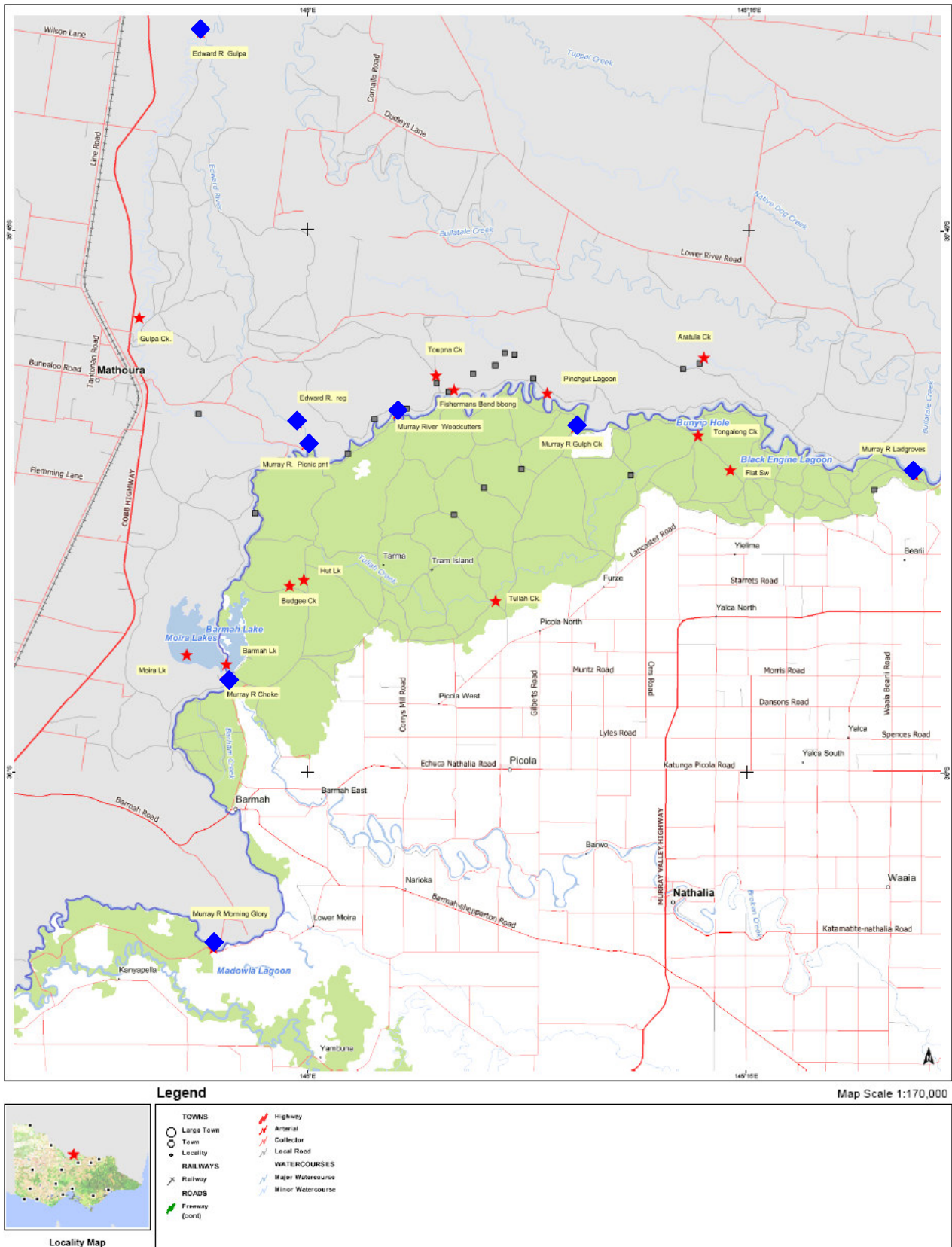


Figure 1. Barmah-Millewa forest (green shading) illustrating locations of river (blue diamonds) and creeks and wetland (red stars) fish monitoring sites. Additional refuge sites- grey squares.



Figure 2. Munyana crab trap used for Murray crayfish sampling in river sites.

The B-MF contains a complex matrix of creek systems and wetlands that contain a wide variety of fish species, some of which are known only to occur in these off-channel habitats (King *et al.* 2007). Twelve off-channel sites were selected for inclusion in annual sampling to represent the fish community of the B-MF (Figure 1). Sampling was fixed at six creek and six wetland sites within the B-MF. These sites were spatially stratified to include six within the Barmah Forest and six within the Millewa Forest (Table 2). An additional creek site on Gulf Creek was included in 2009 after additional surveys in 2008 revealed it to be an important refuge area for a large number of species (see Tonkin and Rourke 2008). Creek and wetland sampling took place during mid to late February 2010.

Sites within the forest experience a range of flow or water regimes over any given year which can greatly affect accessibility and the area available to be sampled. Therefore, sampling effort was slightly reduced from SRA standards, to ensure all sites could be completed in most years. Sampling involved 10 replicates of 90 second boat electrofishing shots at each site (with a 5 shot minimum during low water conditions). If the minimum of five boat shots could not be completed due to reduced wetland area or depth, 8 replicates of 150 seconds with a backpack electrofishing unit were undertaken at each site. In addition, 10 unbaited bait-traps were also set (minimum of two hours soak time) to capture fish not effectively caught using electrofishing techniques. As with river sites, all fish were identified, counted and measured (maximum of 50 individuals

per species per site) at the completion of each operation. Young-of-year (YOY) fish were classified based on their total length (carp <150mm, golden perch <100mm, Murray cod and trout cod <150mm; King *et al.* 2008).

To examine broad patterns in the fish community in 2009/10, data was standardised by abundance, and fourth root transformed using the software package PRIMER (Version 6.1.11) (Clarke and Gorley 2006). From these data, two dimensional multidimensional scaling (MDS) plots were constructed based on Bray-Curtis similarities of fish assemblages among river sites (Murray and Edward River), and among the creek and wetland and lake sites. Analysis of Similarity (ANOSIM) was then used to test if there were significant differences in fish assemblages between the two Edward River sites combined and the six Murray River sites combined, and between the creek and lake sites.

Table 2. Permanent creek and wetland fish sampling sites in the Barmah-Millewa Forest indicating sites successfully sampled in each year of the study.

Site	Forest	2007	2008	2009	2010
<i>Creek sites</i>					
Tongalong Creek	Barmah	✓	✓	✓	✓†
Budgee Creek	Barmah	✓	✓	✓	✓
Tullah Creek	Barmah	✓	✗	✗	✗
Toupna Creek	Millewa	✓	✓	✗	✓
Gulpa Creek	Millewa	✓	✓	✓	✓
Aratula Creek	Millewa	✓	✓	✓	✓
Gulf Creek @ 4 mile*	Barmah			✓	✓
<i>Wetland/Lake sites</i>					
Barmah Lake	Barmah	✓	✓	✓	✓
Hut Lake	Barmah	✗	✗	✗	✗
Flat Swamp	Barmah	✓	✗	✗	✗
Moirra Lake	Millewa	✓	✗	✗	✓
Pinchgut lagoon	Millewa	✓	✗	✓	✗
Fishermans Bend Billabong	Millewa	✓	✓	✓	✓

*commenced sampling in 2009

✓ Site contained water and successfully sampled

✗ Site dry and not sampled

† An additional search comprising of 1,500 electrofishing seconds was conducted in an attempt to locate southern pygmy perch. None were found.

2.2 Riverine larval drift sampling

Sampling for drifting eggs and larvae was targeted at four large bodied native species, Murray cod, trout cod, silver perch and golden perch as well as carp, which are known to demonstrate drifting behaviours during egg and/or larval life stages. Sampling was conducted fortnightly, from the 21st October until the 17th December. This period encompassed the known core drifting periods for these species (Humphries 2005; Koehn and Harrington 2006; King *et al.* 2007). Drifting fish eggs and larvae were collected from three sites on the Murray River at Morning Glory, Barmah Choke and Ladgroves Beach, which are located

downstream, mid and upstream of the Barmah-Millewa floodplain respectively (see Figure 1 for site locations). This sampling design was significantly reduced from previous surveys of King *et al.* (2008) but will allow some comparisons in data over the core breeding season for the large bodied riverine species listed.

Collections at each site were made using 1.5 m long passive drift nets with a 0.5 m diameter mouth opening, constructed of 500 μm mesh, tapered to a removable collection jar (Figure 3). A General Oceanics Inc. (Florida, USA) flow meter was fixed in the mouth of each drift net to determine the volume of water filtered, thus enabling raw catch data to be standardised among all nets to the number of eggs and / or larvae 1000m^{-3} of water filtered. For each site, three nets were deployed just below the surface, across the river channel to account for spatial variability in drifting densities. All nets were set on dusk and retrieved as early as possible the following morning, generally before 10:00 hours. Samples were preserved in 95% ethanol in the field and returned to the laboratory for processing. Fish were removed from the samples using a dissecting microscope and identified by experienced staff using available keys (Serafini and Humphries 2004), and by collating a reference collection of successive larval stages.

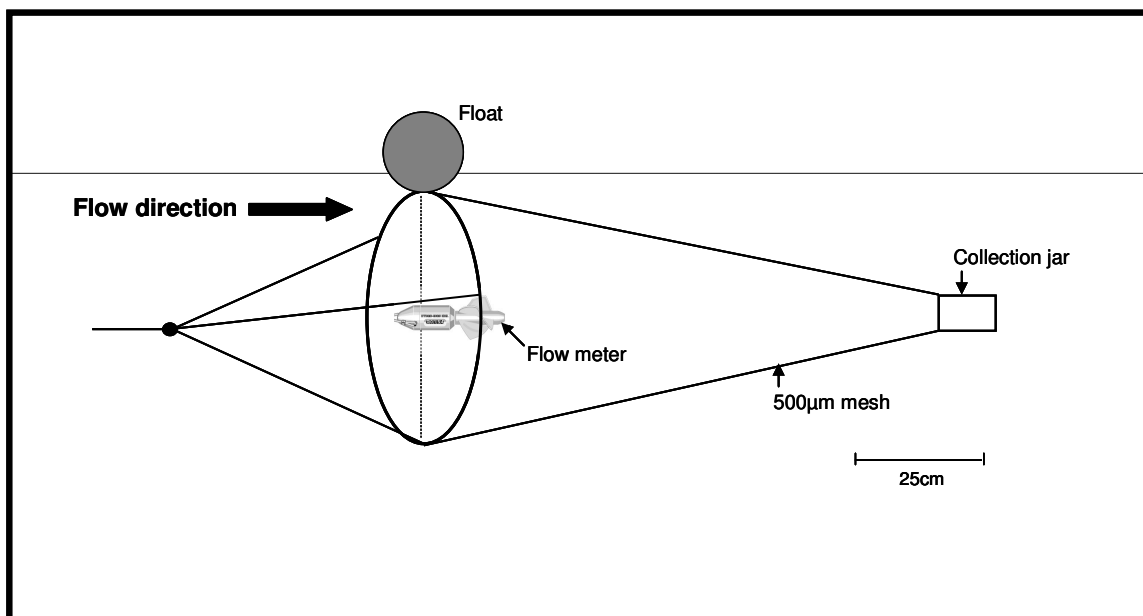


Figure 3. Side view illustration of the standard passive drift net used in the study.

3 Results

3.1 Hydrology

Dry conditions continued in the B-MF region throughout 2009/10 and water discharge was again insufficient to result in floodplain inundation (Figure 4). Average discharges throughout 2009/10 were however, slightly higher than the previous two years. The last time a flood was recorded in the B-MF was in October to December 2005 when an environmental flow was used to extend the spring flood event (King *et al.* 2007, King *et al.* 2010), but this inundated only approximately 50% of the forest. The lack of inundation subsequently reduced the number of wetland/lake sites that could be sampled this year, with one of the six creek sites and two of the six wetland/lake sites dry, while those that could be sampled had very low water levels and poor water quality parameters (Table 2).

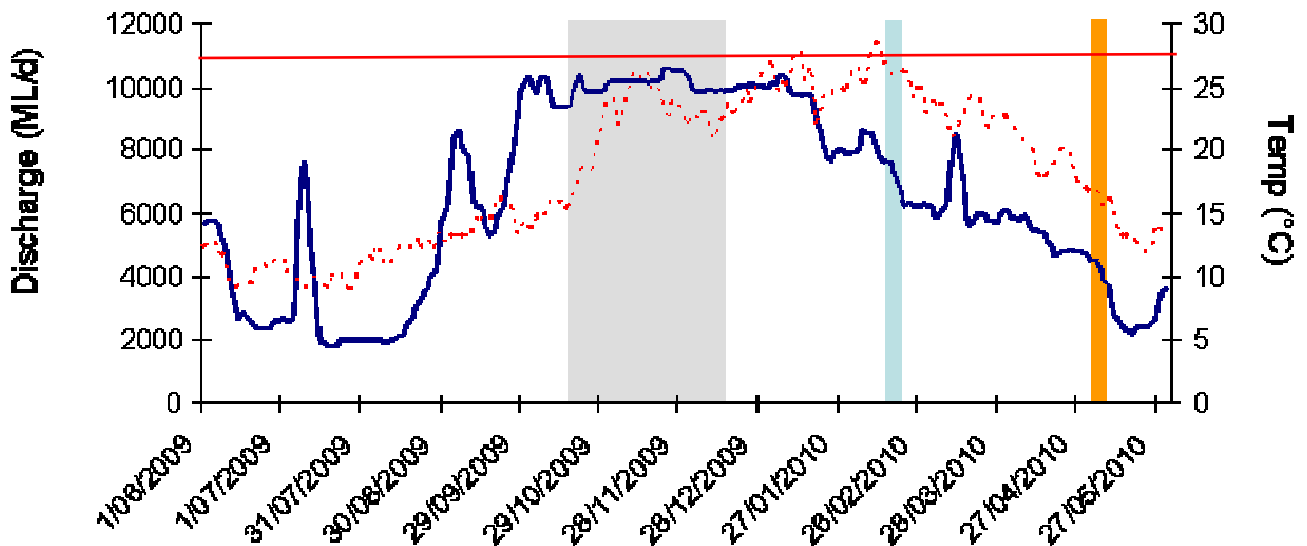


Figure 4. Mean daily discharge at the Murray River @ Tocumwal June 2009 to May 2010. The red line indicates the approximate floodplain inundation height throughout the Barmah-Millewa Forest and the dotted red line indicates water temperature. Grey bars represent the time of egg and larval sampling, light blue bars represent time of creek/wetland sampling and orange bar represent time of river sampling.

3.2 Total catch

This year was the most successful year of sampling in terms of raw numbers of fish recorded, with a total of 13,650 fish (caught and observed) from 16 species (11 native and five exotic) recorded (Table 3; Appendix 1). Sampling in riverine habitats contributed 9,200 (caught and observed) fish from 10 native and 4 exotic species, whilst 4,450 (caught and observed) individuals from eight native and four exotic species were collected from wetland and creek sites. Native fish accounted for 86% and 47% of the catch in the river and wetland/creek sites, respectively. A further 988 eggs and larvae from six native and two exotic fish species were collected in drift net sampling over the core spawning period. Of the five large-bodied fish species (four native and carp), Murray cod dominated the abundance of larval fish while silver perch dominated the abundance of fish eggs.

3.3 Rivers

In 2009/10, a total of 2,553 fish were collected in riverine sites (6647 observed) comprising 10 native and four exotic species (Table 3). The catch was dominated by three native species, Australian smelt (*Retropinna semoni*) (46%), unspotted hardyhead (*Craterocephalus stercusmuscarum fulvus*) (38%) and Murray River rainbowfish (*Melanotaenia fluviatilis*) (6%) while the most commonly caught exotic riverine fish species was carp (4%) and goldfish (*Carassius auratus*) (1%). All of the large-bodied native species (Murray cod, trout cod, golden perch and silver perch) previously recorded in the region were collected in 2009/10. Of the 80 Murray cod sampled, only three were over the legal recreational size limit (>600mm), continuing the pattern that has been evident over the course of this study.

The Murray River at Gulf Creek supported the highest abundance of fish with 2,871 individuals while the Edward River at Gulpa Creek supported the lowest abundance of fish with 85 individuals. Murray River sites at Picnic Point, Woodcutters and Ladgroves Beach supported intermediate (1,200 to 1,600) numbers of fish while the Murray River at Morning Glory and Barmah Choke/Lake and the Edward River (5km downstream of the regulator) supported lower (500 to 800) numbers of fish (Table 4). The species assemblage of Murray River sites varied slightly from 2008/09 to 2009/10, with flatheaded gudgeon (*Philypnodon grandiceps*) being absent while redfin were collected in this year's catch but not in 2008/09 (Table 4, Appendix 1). The multidimensional scaling plot (Figure 6) indicated a general separation of most sites this year, in particular a separation of the Edward River sites from the Murray River sites. However, this was not supported by ANOSIM (Global $R = -0.32$, $P = > 0.05$ with the Edward River sites and Murray River sites as factors).

Whilst abundance data has been compared in this report using raw numbers only, this also reflects a standardised comparison given an equivalent effort has been undertaken in each year (equivalent number of electrofishing seconds and shots for each site). A trend of fluctuating abundances of Murray cod, trout cod,

silver perch and carp was noted from the River sites from 2006/07 to 2009/10 (Table 4, Appendix 1). These four fish populations increased in total abundance from 2006/07 to 2007/08, decreased from 2007/08 to 2008/09 and increased from 2008/09 to 2009/10. Young-of-year (YOY) fish were collected for four large-bodied species this year; Murray cod (n=31) carp (n=307), trout cod (n=1) and golden perch (n=1). YOY Murray cod, carp and trout cod have been collected every year of the study, albeit in low abundances in some years, while this is the first time that a golden perch YOY has been sampled over the course of this study. Consistent with previous years, no YOY silver perch were recorded. Abundances of golden perch (all life stages) were consistent across years from 2007 to 2010 in the River sites (Table 4, Appendix 1), while bony bream (*Nematalosa erebi*) were sampled for the first time in this study with nine caught and 51 observed.

Numbers of Murray River rainbowfish also varied from 2006/07 to 2009/10; however, the changes in their raw abundances between years were opposite to those noted for the larger fish species with a decrease from 2006/07 to 2007/08, an increase from 2007/08 to 2008/09 and a decrease from 2008/09 to 2009/10. The Edward River D/S of the regulator was an important site for this species in previous years of this study, particularly in 2009 when 248 rainbowfish were caught. While numbers were down by more than half at this site this year (102 fish), four Murray River sites (Barmah/Moira Lake, Gulf Creek, Picnic Point and Ladgroves) contained relatively high numbers of this species (41, 240, 158 and 30 fish, respectively) compared with previous years when the highest number recorded from a Murray River site was 18 fish in 2008 from Gulf Creek (Appendix 2).

Murray crayfish sampling

Twenty-four Murray crayfish were sampled this year, bringing the total collected to 107 over the course of this monitoring program. As in previous years, none were collected from the two Edward River sites. Only nine of the 24 Murray crayfish captured in 2010 were female, none of which were sexually mature (or in berry; Figure 5). Only a single female exceeded the minimum legal size. More females than males were present in 2007/08 and 2008/09 while the reverse was observed in 2006/07 and 2009/10 (Table 5).

Table 3. Raw total abundances of species collected in forest creeks and wetlands and river sites using all methods in 2009/10. Numbers of fish observed but not collected are in parentheses.

Common name	Scientific name	2009/10, creeks, wetlands and lakes	2009/10, rivers	Total sample 2009/10
<i>Native</i>				
Australian smelt	<i>Retropinna semoni</i>	24 (20)	868 (3,385)	892 (3,405)
carp gudgeons	<i>Hypseleotris</i> spp.	1,509 (348)	96	1,605 (348)
flatheaded gudgeon	<i>Philypnodon grandiceps</i>	33 (3)		33 (3)
unspecked hardyhead	<i>Craterocephalus stercusmuscarum fulvus</i>	7	862 (2,633)	869 (2,633)
Murray cod	<i>Maccullochella peelii peelii</i>	2 (1)	78 (2)	80 (3)
trout cod	<i>Maccullochella macquariensis</i>		34	34
golden perch	<i>Macquaria ambigua ambigua</i>	1	14	15
silver perch	<i>Bidyanus bidyanus</i>	1	7 (2)	8 (2)
southern pygmy perch	<i>Nannoperca australis</i>			
Murray River rainbowfish	<i>Melanotaenia fluviatilis</i>	28 (3)	190 (387)	218 (390)
dwarf flatheaded gudgeon	<i>Philypnodon macrostomus</i>			
Murray crayfish	<i>Euasticus armatus</i>		24	24
Bony bream	<i>Nematalosa erebi</i>		9 (51)	9 (51)
<i>Exotic</i>				
Carp	<i>Cyprinus carpio</i>	186 (68)	267 (114)	453 (182)
Goldfish	<i>Carassius auratus</i>	189 (85)	72 (64)	261 (149)
redfin perch	<i>Perca fluviatilis</i>		2	2
Gambusia	<i>Gambusia holbrooki</i>	1,455 (463)	30 (5)	1,485 (468)
oriental weatherloach	<i>Misgurnus anguillicaudatus</i>	17 (7)		17 (7)
Sub-totals		3,452 (998)	2,553 (6647)	6,004 (7,645)
Total		4,450	9,200	13,650

Table 4. Total catch (caught + observed) and species richness for eight river sites sampled in 2009/10.

	Edward River 5km D/S regulator	Edward River D/S Gulpa Creek	Murray River @ Barmah choke	Murray River @ Gulf Creek	Murray River @ Ladgroves Beach	Murray River @ Morning Glory	Murray River @ Picnic Point	Murray River @ Woodcutters	Total	% of catch
Australian smelt	46	19	566	424	810	212	990	1,186	4,253	46.23
Bony bream				54		5	1		60	0.65
Carp	41	27	9	153	58	36	49	8	381	4.14
Gambusia	1	1	10		1		1	21	35	0.38
Golden perch	3	2		9		1	3		18	0.20
Goldfish	8	1	4	20	12	83	8		136	1.48
Murray cod	6	6	6	15	14	7	19	7	80	0.87
Murray River rainbowfish	102	5	41	240	30		158	1	577	6.27
Redfin perch	1					1			2	0.02
Silver perch			1	3	2	2		1	9	0.10
Trout cod	1	1	6	2	10	2	7	5	34	0.37
Unspecked hardyhead	511	8	31	1,942	471	163	337	32	3,495	37.99
Western carp gudgeon	17	15	1	7	14	26	9	7	96	1.04
Murray crayfish	0	0	1	3	5	5	8	2	24	0.26
Grand Total	737	85	676	2,871	1,427	543	1,590	1,270	9,200	
Species richness	11	10	11	12	11	12	12	10	13	

Table 5. Abundance, distribution, sex, mean length (+/- S.E) and size range of Murray crayfish captured from the six Murray River monitoring sites, 2009/10. Length measurements were taken using Occipital Carapace Length (OCL).

Monitoring site	Number of Murray crayfish	Sex	Mean length (mm) (+/- S.E.)	Range (mm)
Morning glory	5	M (2), F (3)	79 (5.0)	68-93
Barmah choke	1	M (1)	86 (0.0)	86
Picnic point	8	M (6), F (2)	85 (3.8)	62-98
Woodcutters	2	M (2)	110 (5)	105-115
Gulf track	3	M (2), F (3)	65 (8.4)	66-79
Ladgroves beach	5	M (2), F (3)	85 (6.6)	71-108
TOTAL	24			

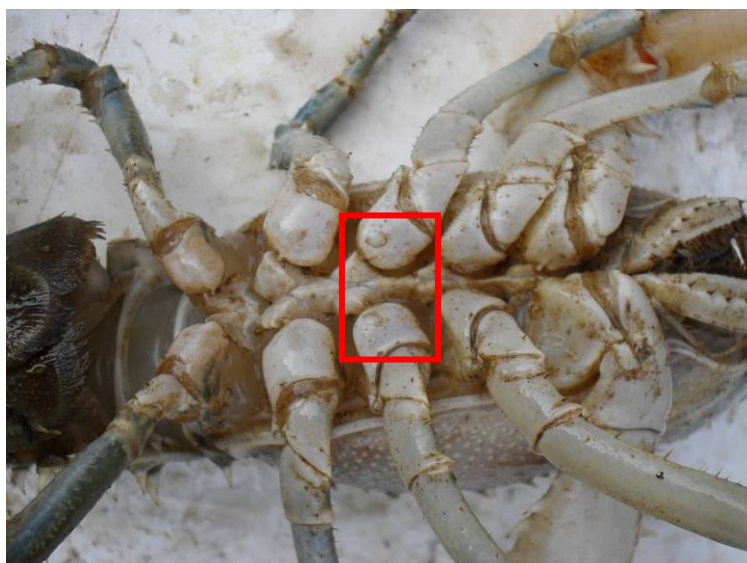


Figure 5. Immature female Murray crayfish as indicated by lack of setae surrounding gonopores.

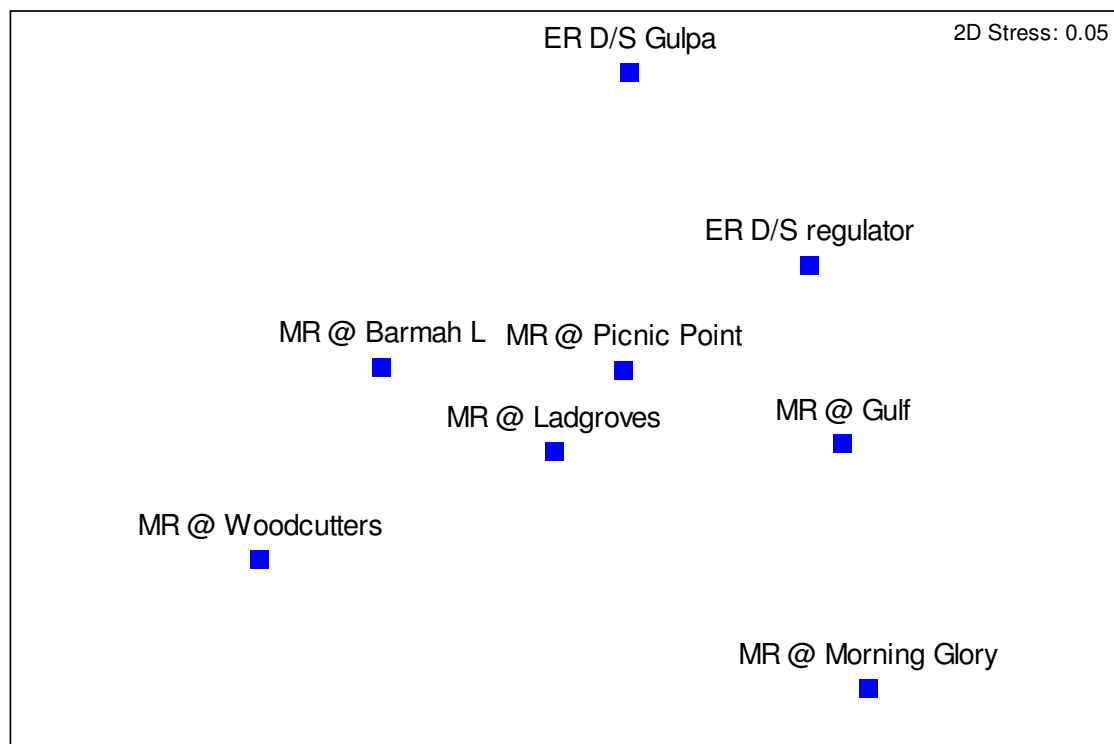


Figure 6. Two dimensional multidimensional scaling plot indicating the differences in the fish assemblages among the eight river sites sampled in 2009/10 (Murray crayfish excluded from analysis). Site codes: ER Edward River, MR Murray River.

3.4 Creeks and Wetlands

In 2009/10, nine of the 13 wetland/creek sites contained water and were successfully sampled with either boat electrofishing (four sites) or backpack electrofishing (five sites). Despite four sites being un-sampled (as they were dry), higher catches were collected this year than in previous years, with a total of 4,450 individuals collected or observed. The creek/wetland sites comprised eight native and four exotic species, and were dominated by the exotic gambusia (*Gambusia holbrooki*) (43%) and native carp gudgeons (*Hypseleotris* sp.) (42%), each of which was sampled in eight of the nine sites. The next most commonly sampled species was carp and goldfish (both 6%), followed by Australian smelt, flatheaded gudgeon, Murray River rainbowfish and Oriental weatherloach (*Misgurnus anguillicaudatus*) at approximately 1% of the sample each.

Of the large-bodied native species, only two Murray cod, and one golden perch and one silver perch were collected (in Gulpa Creek, Tongalong Creek and Budgee Creek respectively). Despite additional sampling effort at Tongalong Creek (1,500 electrofishing seconds), and the inclusion of Gulf Creek as a permanent site, no southern pygmy perch were located at any of the nine sites.

The multidimensional scaling plot (MDS) indicated a separation of most of the nine sites (Figure 7), though this was not supported by ANOSIM (Global $R = -0.63$, $P > 0.05$) (with creeks and lakes as factors). Note that Fishermans bend lagoon was omitted from this analysis given it was the only wetland site that was sampled this year.

Table 6. Total catch (caught + observed) and species richness for nine creek, wetland and lake sites sampled in 2009/10.

Species	Fishermans				Gulf	Gulpa Creek	Moir Lake	Tongalong Creek	Toupna Creek	Total catch	% of catch
	Aratula Creek	Barmah Lake	Budgee Creek	Bend Lagoon	Creek @ four mile						
Gambusia	489		2	867	389		17	2	152	1,918	43.10
Carp gudgeon	921	5	24	447	149		5	12	294	1,857	41.73
Carp	5	23	39		26	4	83	26	48	254	5.71
Goldfish	3	149	9		72	1	10	7	23	274	6.16
Australian smelt		3	26					15		44	0.99
Flatheaded gudgeon	17			19						36	0.81
Murray River rainbowfish	11							2	18	31	0.70
Oriental weatherloach	2				22					24	0.54
Unspecked hardyhead	2			2				3		7	0.16
Murray cod						3				3	0.07
Golden perch								1		1	0.02
Silver perch			1							1	0.02
Total catch	1,450	180	101	1,335	658	8	115	68	535	4,450	
Species richness	8	4	6	4	5	3	4	8	5	12	

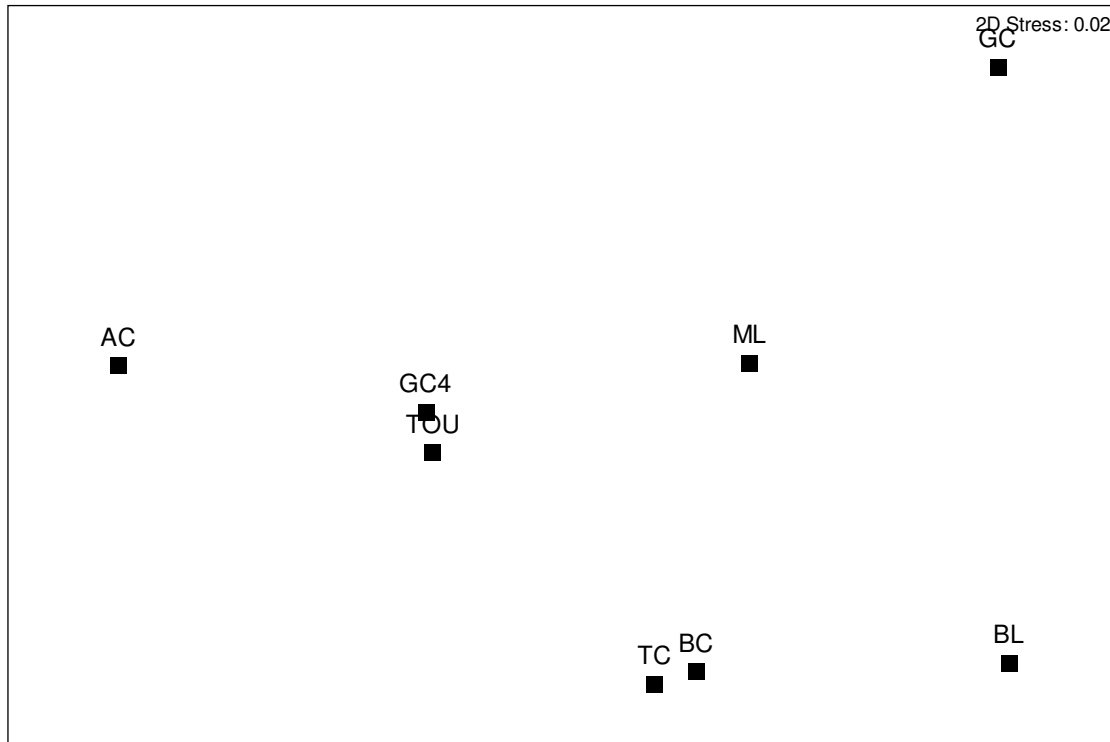


Figure 7. Two dimensional multidimensional scaling plot indicating the differences in the fish assemblages among the nine creek, wetland and lake sites sampled in 2009/10. Site codes: AC, Aratula creek; BC, Budgee Creek; BL, Barmah Lake; GC, Gulpa Creek; GC4, Gulf Creek @ 4 mile; ML, Moira Lake; TC, Tongalong Creek; TOU, Toupna Creek.

3.5 Riverine larval drift

The 2009/10 spring/summer spawning period had river levels well below average irrigation supply levels (Figure 4) which is similar with the hydrological conditions of the region throughout the last four years. A total of eight species were recorded spawning in the Murray river as indicated by the presence of 988 eggs and larvae captured in the drift sampling, of which 98% were native (Table 7).

Peak and average densities (expressed as the number of larvae/eggs sampled per 1000m³ of filtered water) of drifting Murray cod, trout cod, silver perch and carp larvae and/or eggs were similar to 2008 findings, a year which exhibited a very similar hydrological regime (See Rourke and Tonkin 2009 for comparisons).

The peak density of drifting Murray cod larvae recorded from the B-MF was approximately 65 larvae 1000m⁻³ with an average of 14 larvae 1000m⁻³ per sampling trip. The highest density of drifting Murray cod larvae was recorded during the first week of November 2009 with smaller numbers recorded two weeks later (Figure 8a). The densities of drifting Murray cod larvae were similar to that recorded in 2008/09 (Rourke and Tonkin 2009).

The peak density of drifting trout cod larvae recorded in 2009/10 was five larvae 1000m^{-3} (Figure 8b). Larvae of this species were only recorded during the second field trip (6th November), corresponding with the peak density of recorded drifting Murray cod larvae. This is the first occurrence of drifting trout cod larvae being recorded in the drift since 2007/08 (King *et al.* 2008), since the drift component was added to the B-MF fish condition program.

Peak densities of drifting silver perch eggs recorded in 2009/10 were around 600 eggs 1000m^{-3} . Silver perch eggs were collected throughout the sampling period (19th October – 17th December) with the greatest densities recorded at the beginning and end of sampling (Figure 8c). Densities of silver perch eggs were relatively similar to previous low flow years (both peaks and averages) and far lower than levels reported during the last high flow year (2005/06) (Tonkin and Rourke 2009; King *et al.* 2008, 2010).

Peak densities of drifting carp larvae recorded in 2009 were 50 larvae 1000m^{-3} compared with 800 larvae 1000m^{-3} in 2008. Similarly, the total average density of drifting carp larvae was lower in 2009 (17 larvae 1000m^{-3}) compared with 2008 (66 larvae 1000m^{-3}) (Rourke and Tonkin, 2009). Like previous years, the greatest density of drifting carp larvae was recorded in the first week of the sampling period (19-21 October) (Figure 8d).

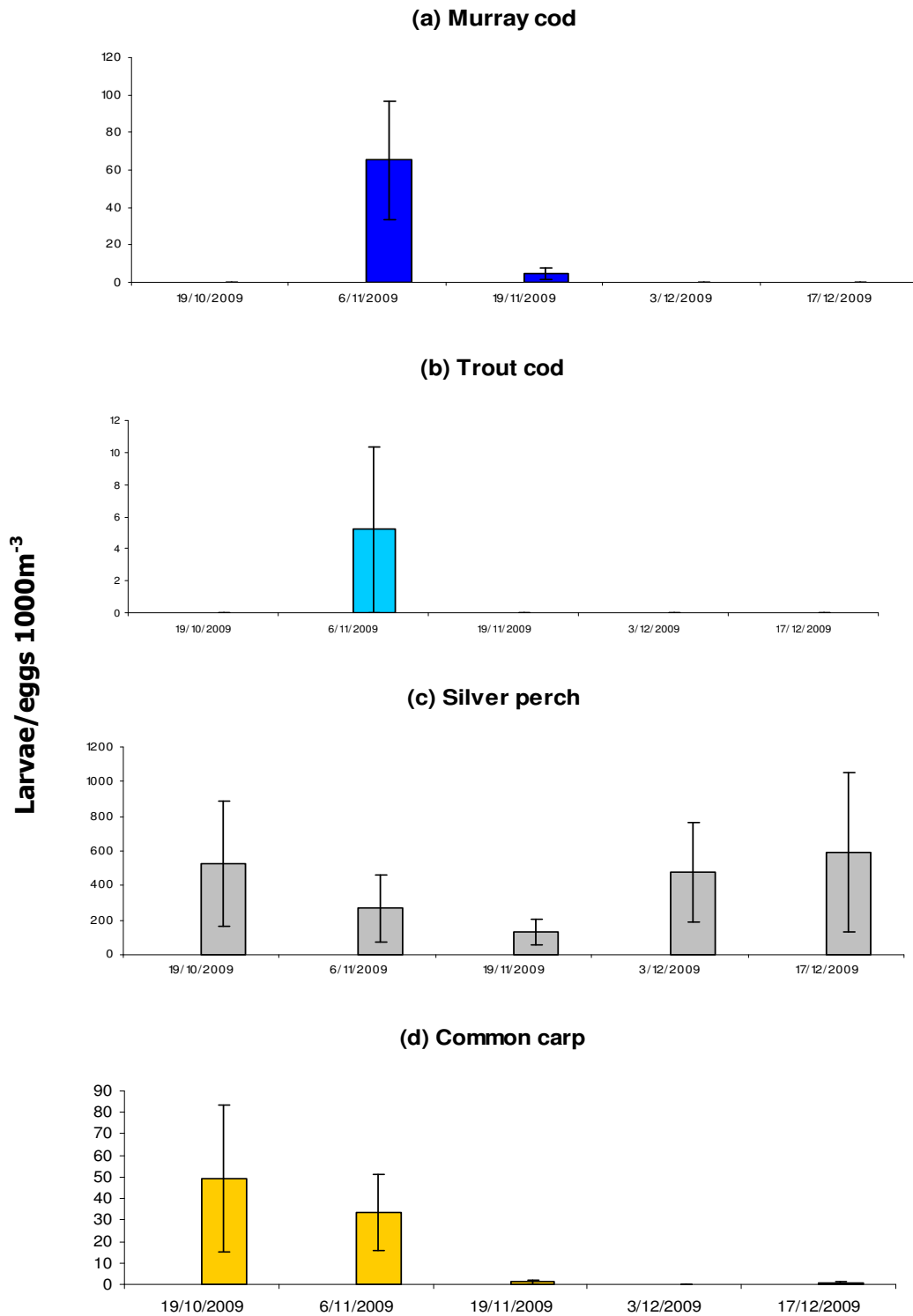


Figure 8. Mean +/- SE densities per 1000m⁻³ of drifting (a) Murray cod, (b) trout cod, (c) silver perch and (d) carp eggs and/or larvae collected from three Murray River sites within the B-MF.

Table 7. Raw numbers of eggs and larvae collected drifting from the three Murray River sites in 2009/10

Common name	Morning glory		Barmah choke		Ladgroves beach		TOTAL
	Eggs	Larvae	Eggs	Larvae	Eggs	Larvae	
Native							
Australian smelt	4	3	1	1	29	0	38
Flatheaded gudgeon	0	20	0	28	0	11	59
Golden perch	0	3	0	3	0	0	6
Murray cod	0	10	0	26	0	0	36
Silver perch	294	0	104	2	419	0	823
Trout cod	0	0	0	4	0	0	4
Exotic							
Carp	0	14	0	6	0	2	22
Redfin perch	0	0	0	0	0	1	1
Sub-totals							
Eggs	298		105		448		851
Larvae		50		70		14	134
TOTAL							988

4 Discussion

Despite the extended drought conditions limiting flows through the region for the past four years, the rivers habitats in the B-MF region continue to support a good range of native fish. Small-bodied native fish such as Australian smelt, unspocked hardyhead and rainbowfish dominated the native riverine fish catch and all were in higher numbers compared with previous surveys. Murray River rainbowfish were still found in high abundance at the Edward River 5km D/S, though in lower numbers to last year. However, unlike last year, they were more abundant in several of the Murray River sites, suggesting this species is coping well under the low-flows. Similarly, the low flow conditions do not seem to be having a negative impact on the riverine populations of Australian smelt and unspocked hardyhead.

As in 2007/08, there was a greater abundance of Murray cod and trout cod sampled this year compared with 2006/07 and 2008/09. The increase in Murray cod numbers compared to these years is primarily related to an increase in young-of-year (YOY), with numbers being similar to those reported in the higher recruitment year of 2007/08. Lyon *et al.* (2010) and Raymond *et al.* (2010) noted an increase in the abundance of YOY Murray cod in 2009/10 (compared with 2008/09 findings) in the Murray River from Lake Mulwala upstream to Cobram (upstream of Barmah-Millewa) and from the Ovens River Demonstration Reach (ORDR) (flows into Lake Mulwala), respectively. King *et al.* (2008) also reported a high abundance of YOY Murray cod and trout cod in the B-MF region in 2007/08 (a low flow year). The greater abundance of trout cod this year was not related to an increase in YOY fish, with only a single YOY fish detected. Immigration of trout cod from nearby populations may explain, in part, the increase in the trout cod population within the B-MF monitoring sites in 2009/10.

Over the course of this study, no YOY silver perch, and only a single YOY golden perch (caught this year in a bait trap) have been collected, possibly due to electrofishing being an unsuitable method to sample this life stage of these species. Alternatively, this life stage may not have been present at the sampling sites, either because of poor recruitment, or recruitment may occur elsewhere and older individuals move into the region (although this does not match the spawning results). Other studies have also found it difficult to collect YOY golden and silver perch, even following a flood event in 2005/06 (Lyon *et al.* 2008; King *et al.* 2009), adding further support to the current opinion that electrofishing is not the ideal method to sample this life stage.

For the first time since the inception of the current study in 2007 bony bream were recorded from several Murray River sites. This species does not seem to be typically caught in large numbers in the B-MF area, preferring warmer water temperatures further downstream. For example, only a single individual was caught during one study in 2006 (King *et al.* 2007). Consequently, the capture of nine individuals this year, with a further 51 observed is an important finding. Water temperatures were still high during riverine sampling this season (16-18⁰C in the Murray River sites), and this may have influenced the species' presence.

The eight river sites sampled continued to support an abundance of exotic species, particularly carp and goldfish. In 2009/10, carp were caught in all six Murray River sites and both Edward River sites. The presence of carp larvae and YOY fish provides further evidence of that the B-MF continues to be an area heavily utilised as an important spawning and nursery area for this species. It is becoming clear that the practice of raising river heights slightly to provide additional water for irrigators also creates the suitable spawning and nursery grounds for carp by inundating vegetated benches. However, carp spawning and recruitment is expected to be far more prolific following floodplain inundation, which potentially may occur during the critical spawning period of 2010/11 given rainfall this winter has been greater than it has been for years, and may potentially continue to fall over spring. In addition, a good snow season this year may result in good inflows of melt water into the Murray River during early spring. The next round of sampling in February and May 2010/11 is well placed to detect a substantial increase in carp recruitment in the B-MF as a result of expected wetter conditions.

With four years of catch data of Murray crayfish, some interesting trends are emerging on the B-MF population. Murray crayfish are only present in the Murray River and either not present or in very low numbers in the Edward River, given they have not yet been detected at either sample site throughout the study. This year, the number of females and males less than the recreational size limit of 90 mm OCL was similar, but one female and eight males were captured above the recreational size limit. Furthermore, none of the females were mature (and therefore not in berry), whereas in previous years, at least a proportion of the females were mature and in berry. This suggests that there needs to be additional research conducted on this species in the Murray River into reproduction season, angler catch and potentially movement, given the inconsistent sex ratios and low number of mature fish detected among years. Such information is crucial to the effective management of the recreational fishery for this species.

The result of this study has demonstrated that the B-MF creek and wetland sites are important for native and exotic fish communities. There was an overall increase in raw numbers of fish collected in 2009/10, compared to 2008/09 possibly due to one extra site (Toupna Creek) being sampled this year. The increase in abundance of fish caught was primarily due to an increase in the abundance of three exotic species; gambusia, goldfish and carp. Fewer Oriental weatherloach abundance was lower than last year, though the species is clearly well established in the B-MF. Flatheaded gudgeons and Murray River rainbowfish were the only small-bodied native fish species to increase in raw abundance in the creek/wetland areas compared with 2008/09 findings. The pattern of increased abundance of exotic fish and corresponding reduction in native fish abundance is concerning as the exotic species may be out-competing small-bodied native fish (and juvenile large-bodied native fish) within these refuge sites, as well as providing source populations of exotic fish that may spread within the Murray River system following future flood conditions. For example,

of the 180 fish caught at Barmah Lake this year, just eight were natives (Australian smelt and carp gudgeon), while just five of 115 fish caught at Moira Lake were natives (carp gudgeons).

The continued absence of the southern pygmy perch this species reinforces concerns that the species may be locally extinct in the B-MF, particularly given the suggested conditions for successful recruitment of this short-lived species in the region have not occurred for more than five years (Tonkin *et al.* 2008). The expected wetter conditions this spring (from natural rainfall and a potential environmental flow) may potentially allow this species to recolonise from sites upstream of the B-MF. If this is the case, sampling next February in the creeks and wetlands may detect new recruits. Ideally, additional sites within the B-MF would be surveyed to increase the likelihood that small, isolated populations are detected. However, if the species fails to return following increased flows this year, a stocking program may be considered to return the species to suitable habitat within the B-MF. Ideally, this would be in an area that can be readily provided with environmental water over the spawning season (Tonkin *et al.* 2008) in the coming years to maximise the chance of successful spawning and recruitment.

The third year of egg/larval sampling has shown that despite continued low flows, the three Murray River sites are important spawning habitats for six species of native fish, including the four large-bodied native species. Silver perch eggs were recorded from all drift sites with particularly high numbers from Ladgroves Beach, consistent with last year's sampling. This indicates that either the B-MF region of the Murray River or a nearby upstream area is a likely consistent spawning ground for silver perch. In contrast, only six golden perch larvae were collected (and no eggs), suggesting limited spawning had occurred in the area. The mechanism that triggers spawning in this species is unclear (Mallen-Cooper and Stuart 2003; King *et al.* 2009; Tonkin *et al.* 2009).

Murray cod larval densities were highest in November 2009 and consistent with 2008/09 findings. The timing of the presence of Murray cod larvae is consistent with numerous other studies (e.g. Humphries 2005; Koehn and Harrington 2006; King *et al.* 2008, 2009). Average densities of drifting Murray cod larvae recorded in 2009/10 were around 14 larvae/eggs 1000m⁻³, compared to 8.9 in 2008/09. This supports the previous studies which indicates variable flow conditions have very little influence on the presence and densities of Murray cod larvae (e.g. Humphries 2005; Koehn and Harrington 2006; King *et al.* 2008). Only four trout cod larvae were also detected, the first since 2007/08 (King *et al.* 2009), though their presence is important given that the species is clearly spawning within, or in close proximity to the B-MF.

5 Summary and conclusions

- The B-MF contains a diverse fish fauna including iconic, threatened and endangered species, as well as those of recreational fishing importance.
- The region provides an important spawning and rearing habitat for a range of species including Murray cod, trout cod, Murray River rainbowfish and carp.
- Healthy populations of Murray River rainbowfish persist in the Edward River sites, and higher numbers have been recorded in the Murray River sites this year.
- Murray cod YOY were present in high numbers, comparable with the levels reported in 2007/08.
- A trend of fluctuating abundances of Murray cod, trout cod, silver perch and carp was noted from Murray River sites from 2006/07 to 2009/10.
- Murray crayfish are either not present or in very low numbers in both Edward River sites. None of the females collected this year were mature.
- The first capture of bony bream in this study, was recorded this year from a number of Murray River sites.
- The first collection of a larval trout cod in this study, was recorded this year in the larval drift component of the study.
- Southern pygmy perch have not been recorded in the B-MF for four years and are likely to be locally extinct.
- YOY carp were again sampled in abundance in the B-MF.
- Silver perch, flatheaded gudgeon, golden perch, Murray cod, Australian smelt and trout cod were all recorded spawning in the Murray River sites in spring/summer 2009.
- The average and peak densities of egg and/or larval Murray cod, trout cod, golden perch, silver perch and carp were similar to the previous three years of low flow.

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Appendix 1.

Raw total abundances of species collected in forest creeks and wetlands (including lakes) and river sites using all methods in 2007, 2008 and 2009). Numbers of fish observed but not collected are in parentheses.

Common name	Scientific name	Creeks and Wetlands			Rivers			Total (all years)
		2007	2008	2009	2007	2008	2009	
<i>Native</i>								
Australian smelt	<i>Retropinna semoni</i>	151 (222)	35 (175)	191 (144)	386 (212)	342 (990)	158 (339)	1281 (2051)
carp gudgeons	<i>Hypseleotris sp.</i>	1587 (632)	422 (15)	1735 (31)	28 (20)	50 (3)	361 (20)	4586 (678)
flatheaded gudgeon	<i>Philypnodon grandiceps</i>	49		7			1	68
unspecked hardyhead	<i>Craterocephalus stercusmuscarum fulvus</i>	32 (71)	1	62 (20)	220 (24)	633 (1316)	511 (804)	1326 (2162)
Murray cod	<i>Maccullochella peelii peelii</i>	1	3	4	25 (2)	77 (10)	24 (4)	133 (15)
trout cod	<i>Maccullochella macquariensis</i>				17	43 (1)	18	77 (2)
golden perch	<i>Macquaria ambigua ambigua</i>	2 (2)	2		18 (5)	17 (2)	14 (3)	54 (10)
silver perch	<i>Bidyanus bidyanus</i>	1		1	3	23 (2)	3 (1)	29 (5)
southern pygmy perch	<i>Nannoperca australis</i>	36 (2)						44 (2)
Murray River rainbowfish	<i>Melanotaenia fluviatilis</i>	4	1	10	89 (18)	41 (47)	281 (636)	399 (823)
dwarf flatheaded gudgeon	<i>Philypnodon macrostomus</i>	2						
Murray crayfish	<i>Euasticus armatus</i>				9	28	47	83
<i>Exotic</i>								
carp	<i>Cyprinus carpio</i>	95 (25)	110 (82)	118 (41)	152 (65)	254 (129)	109 (39)	765 (502)
goldfish	<i>Carassius auratus</i>	99 (45)	78 (53)	90 (7)	20	32 (15)	40 (8)	373 (130)
redfin perch	<i>Perca fluviatilis</i>	35 (16)			1			38 (16)
gambusia	<i>Gambusia holbrooki</i>	298 (124)	87 (107)	539 (58)		4	20	973 (299)
oriental weatherloach	<i>Misgurnus anguillicaudatus</i>	66 (166)	14 (7)	31 (25)		(1)		127 (175)
Total		2458 (1305)	753 (439)	2788 (326)	968 (446)	1544 (2516)	1587 (1854)	10,356 (6,870)

Appendix 2.

Raw catch data for individual sites from 2007 to 2009

	Species	2007	2008	2009	TOTAL
Aratula Creek	Australian smelt	13			13
	carp		6	2	8
	gambusia	86	5		91
	flatheaded gudgeon	7			7
	goldfish	1	3	4	8
	oriental weatherloach		11		11
	carp gudgeon spp	269	410	120	799
	TOTAL	377	437	129	
Barmah Lake	Australian smelt	11		51	62
	carp	6	18	21	45
	gambusia			2	2
	goldfish	17	12	22	51
	Murray River rainbowfish			2	2
	unspecked hardyhead			11	11
	TOTAL	34	30	109	173
Budgee Creek	Australian smelt	44	13	46	103
	carp	24	28	12	64
	gambusia	1	2	38	41
	golden perch	1			1
	goldfish		24	9	33
	Murray cod		1		1
	Murray River rainbowfish		1	2	3
	unspecked hardyhead			11	11
	carp gudgeon spp	5	6	59	70
	TOTAL	75	75	177	327
Edward River 5km d/s regulator	Australian smelt	18	9	7	34
	carp	8	14	22	44
	gambusia			15	15
	flatheaded gudgeon			1	1
	golden perch	1	3	1	5
	goldfish	9	3	7	19
	Murray cod	9		4	13
	Murray River rainbowfish	67	7	248	322
	trout cod	8			8
	unspecked hardyhead	82	219	366	667
	carp gudgeon spp	12	23	265	300
	TOTAL	214	278	936	1428
	Edward River d/s Gulpa Creek	Australian smelt	20	7	11
carp		8	14	16	38
gambusia				5	5
golden perch		4		5	9
goldfish		11	2	4	17
Murray cod		1	1	8	10
Murray River rainbowfish		1	2	28	31
silver perch			2		2
trout cod				3	3
unspecked hardyhead		13	7	4	24
carp gudgeon spp		1	2	26	29
TOTAL		59	37	112	208

	Species	2007	2008	2009	TOTAL
Fishermans Bend Lagoon	Australian smelt	26			26
	carp	13			13
	gambusia	30	14	40	84
	flatheaded gudgeon	19	9	7	35
	oriental weatherloach			1	1
	redfin perch	31			31
	southern pygmy perch	1			1
	unspecked hardyhead	21	1		22
	carp gudgeon spp	74	346	1284	1704
	TOTAL	215	370	1332	1917
Flat Swamp	Australian smelt	2	ns	ns	2
	carp	9			9
	dwarf flatheaded gudgeon	2			2
	gambusia	31			31
	goldfish	15			15
	oriental weatherloach	46			46
	redfin perch	5			5
	southern pygmy perch	4			4
	carp gudgeon spp	389			389
	TOTAL	503			503
Gulf Creek @ four mile	Australian smelt	ns	2	8	10
	carp		10	80	90
	gambusia		2	423	425
	goldfish		3	43	46
	oriental weatherloach		9	30	39
	redfin perch		1		1
	southern pygmy perch		7		7
	unspecked hardyhead			1	1
	carp gudgeon spp		40	259	299
	TOTAL		74	844	918
Gulpa Creek	Australian smelt	2	12	35	49
	carp	6	5	1	12
	golden perch		1		1
	goldfish	0	2	10	12
	Murray cod	1	1	1	3
	Murray River rainbowfish	1		4	5
	unspecked hardyhead	2			2
	carp gudgeon spp		1	11	12
	TOTAL	12	22	62	96
Moira Lake	Australian smelt	9	ns	ns	9
	carp	14			14
	goldfish	6			6
	silver perch	0			0
	carp gudgeon spp	25			25
	TOTAL	54			54

	Species	2007	2008	2009	TOTAL
Murray River @ Barmah/Moira Lake	Australian smelt	28	50	27	105
	carp	42	22	20	84
	gambusia		3		3
	golden perch	4		3	7
	Murray cod	1	4	1	6
	Murray Crayfish	1	4		5
	Murray River rainbowfish		3		3
	silver perch	0	4	1	5
	trout cod	4	6	5	15
	unspecked hardyhead	1	8		9
	carp gudgeon spp		17		17
	TOTAL	81	121	57	259
	Murray River @ Gulf Creek	Australian smelt	21	66	378
carp		23	52	40	75
golden perch		2	12	7	14
goldfish			9		9
Murray cod		7	14	10	21
Murray Crayfish		1	1	5	2
Murray River rainbowfish			18	5	18
silver perch			10	4	10
trout cod			4	6	4
unspecked hardyhead		78	55	46	133
carp gudgeon spp		2	1		3
oriental weatherloach				1	
TOTAL		134	242	502	878
Murray River @ Ladgroves Beach	Australian smelt	205	33	40	278
	carp	23	28	15	66
	golden perch	3		1	4
	goldfish		2		2
	Murray cod	6	24	4	34
	Murray Crayfish	1	4		5
	Murray River rainbowfish				
	silver perch		1		1
	trout cod	1	13	6	20
	unspecked hardyhead	33	114	97	244
	carp gudgeon spp	7			7
	TOTAL	279	219	163	661
	Murray River @ Morning Glory	Australian smelt	21	46	5
carp		21	20	9	50
gambusia			1		1
golden perch			3	3	6
goldfish			11	21	32
Murray cod		1	7	2	10
Murray Crayfish		3	10	39	52
Murray River rainbowfish			3		3
oriental weatherloach					
redfin perch		1			1
silver perch		1	2	2	5
trout cod			3	1	4
unspecked hardyhead			9	12	21
carp gudgeon spp	3	4		7	

	TOTAL	51	119	94	264
	Species	2007	2008	2009	TOTAL
Murray River @ Picnic Point	Australian smelt	38	57	60	155
	carp	14	15	18	47
	golden perch	2		1	3
	goldfish			7	7
	Murray cod		5	2	7
	Murray Crayfish	1		1	2
	Murray River rainbowfish		3	4	7
	silver perch		1		1
	trout cod	3	8	2	13
	unspecked hardyhead	4	45	6	55
	carp gudgeon spp	1	26	36	63
	TOTAL	63	161	137	361
Murray River @ Woodcutters	Australian smelt	36	84	8	128
	carp	10	25	9	44
	golden perch	2			2
	goldfish		5	1	6
	Murray cod		21	3	24
	Murray Crayfish	1	9	7	17
	Murray River rainbowfish		1	1	2
	silver perch	2	2		4
	trout cod		9	1	10
	unspecked hardyhead	11	83	26	120
	carp gudgeon spp	2		34	36
	TOTAL	64	239	90	393
Pinch Gut Lagoon	gambusia	76	ns		76
	southern pygmy perch	1			1
	carp gudgeon spp	241		2	243
	TOTAL	318		2	320
Tongalong Creek	Australian smelt	48	7	51	106
	carp	8	28	2	38
	gambusia		1	36	37
	golden perch	1	1		2
	goldfish	5	42	2	49
	Murray cod		1	3	4
	Murray River rainbowfish			2	2
	silver perch			1	1
	unspecked hardyhead	11	1	39	51
	carp gudgeon spp	2	1		3
	TOTAL	75	82	136	293

*Ns = not sampled

	Species	2007	2008	2009	TOTAL
Toupna Creek	carp	1		ns	1
	gambusia	34	79		113
	flatheaded gudgeon	20			20
	goldfish	6	1		7
	Murray River rainbowfish	1			1
	oriental weatherloach	7	3		10
	southern pygmy perch	31			31
	carp gudgeon spp	434	19		453
	TOTAL	534	102		636
Tullah Creek	Australian smelt	4	ns	ns	4
	carp	23			23
	gambusia	49			49
	flatheaded gudgeon	5			5
	goldfish	54			54
	oriental weatherloach	20			20
	carp gudgeon spp	127			127
	TOTAL	282			282

*Ns = not sampled