

# Broken River Rehabilitation Project Summary Report 2009

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**The Murray-Darling Freshwater Research Centre  
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**A MDFRC Final for  
Goulburn-Broken  
Catchment  
Management Authority**



## Broken River Rehabilitation Project

A report prepared for Goulburn-Broken Catchment Management Authority by The Murray-Darling Freshwater Research Centre.

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## Introduction

The abundance of large woody debris (LWD) within lowland river channels is a major driver of both primary productivity and community structure of fish and invertebrates as well as other associated biota (Nicol et al 2002). In Australian lowland rivers the substratum generally consists of sand, silt or clay. In general these substrates are colonized by few invertebrates (Humphries et al. 1998). The principle substratum for biofilm development and macroinvertebrate colonization is large woody debris (Crook and Robertson 1999). Large woody debris supports a more diverse invertebrate community in comparison to other instream sediments (Humphries *et al.* 1998; Growns *et al.* 1999) and increases instream habitat complexity (Pusey and Arthington 2003).

The presence of LWD influences fish habitat at a number of scales. The number of fish in a river is often related to the quality and heterogeneity of instream habitat (Koehn and O'Connor 1990). The presence and complexity of LWD assists in the creation of scour pools and slackwaters promoting habitat diversity for fish and refuge from flow and predators. Fish communities in streams with a poor diversity of habitat are usually dominated by fish species that are tolerant of a wide variety of habitats. These generalists are most often introduced species (Koehn and O'Connor 1990), which compete with native fish species for food resources.

Between 1960 and 1975 "river improvement" works were carried out in the Broken River in an effort to decrease the frequency of flooding. Works undertaken included the construction of levees and removal of LWD. In 2006 work was commenced to re-snag the Broken River. This report builds on the fish data collected during 2006-2008 findings focuses on data from fish surveys as part of the re-snagging monitoring program undertaken between 2006-2008 following the introduction of the LWD.

## Objectives

The objective of this program is to re-snag the Broken River and to determine the impacts of re-snagging on the ecology of the Broken River by monitoring fish and macroinvertebrates. Macroinvertebrates were surveyed as part of this project during 2006-2008 but were not surveyed during the current survey periods October 2008- April 2009. Consequently this report builds on the information obtained from previous fish surveys undertaken between 2006-2008 and does not include any data from the macroinvertebrate sampling the result of which have been reported previously.

The specific aim of this report is to determine whether there are temporal changes in the abundance, species richness and composition, and age structure of fish as a result of re-snagging.

## Methods

### Site Selection

In December 2005 site assessments were undertaken along the Broken River to identify nine reaches approximately 500 m in length with either high (3 sites) or low (6 sites) existing wood densities. To be included, the study sites had to have a defined set of criteria (Table 1). Wood would then be added to 3 of the sites with low wood densities with the aim of eventually achieving a density of wood of 1m<sup>3</sup> per 10 m<sup>2</sup> of reach. The remaining reaches would act as reference reaches. Sites were selected based on

- Site visit
- Survey by Earthtech
- Data from previous MDFRC & CRCFE projects
- Site accessibility

The nine sites selected are located within 3 reaches of the Broken River; Benalla to Casey's weir (Reach 1); Casey's weir to Gowangardie weir (Reach 2); Gowangardie weir to Shepparton (Reach 3) (Table 2)..

**Table 1. Re-snagging treatments**

Treatment	Condition
Reference 1	These sites will have a reasonable density of LWD, in good condition, which will be used to determine the natural density of LWD. This will establish the density of snags to be added to the treatment sites. No snags will be added to these sites. They should also have an intact riparian zone
Reference 2	These sites will have a low density of snags, possibly in poor condition. No snags will be added to these sites. They may have a degraded or rehabilitated riparian zone.
Re-snagged.	These sites will have a low density of snags, possibly in poor condition. Preferably they will also be, or have been, targeted for riparian zone rehabilitation.

**Table 2. Selected sites within Broken River**

Site	Wood density	Reach
Morago	high	Benalla – Casey's weir
Scholes Rd	re-snag	(Reach 1)
Mokoan Park	low	
Quinn Rd	high	Casey's weir – Gowangardie weir
Burnells Rd	re-snag	(Reach 2)
Goomalibee Bridge	low	
Cosgrove Rd	high	Gowangardie weir – Shepparton
Pine Lodge Rd	re-snag	(Reach 3)
Keats Rd	low	

### **Quantity of LWD**

Over the period of 2006 – 07 approximately 1262 m<sup>3</sup> of wood was placed in the Broken River at Scholes road, 1067 m<sup>3</sup> at Burnells road and 735 m<sup>3</sup> at Pine lodge road.

### **Fish**

Fish were surveyed in November 2008, January 2009 and March 2009. Surveys were undertaken using a Smith-Root LR-24 backpack electrofisher employing the Sustainable River Audit sampling protocol (MDBC 2005). This meant that within each 500 meter reach of river, 8 shots of 150 seconds accumulated power-on time were undertaken, resulting in a total survey of 20

minutes active fishing. Fishing targeted the full range of habitats available at each site, increasing the chance of catching fish within each reach. Collected fish were identified, measured and returned to the river at or close to their point of capture. Declared noxious fish were euthanased and disposed of appropriately.

Electrofishing was complimented at each site with the deployment of 10 unbaited bait traps set along the length of the site. Bait traps were employed to catch small bodied fish that may not be targeted with the electrofisher. Collected fish from bait traps were processed in the same manner as outlined above.

For the purpose of this document we have selected comparable sample dates from previous years sampling to compare to the current samples. Multivariate analysis using PRIMER (V6) (Clarke & Warwick 2001) and PERMANOVA+ for PRIMER (Anderson et al. 2008) is used to determine if any differences in fish communities were occurring between years, reaches and treatments. PERMANOVA is a multivariate equivalent of analysis of variance. The experimental design is a randomised block design, with treatments randomly selected within reaches (blocks). A 3 factor model (time, reach and treatment) was analysed.

## Results and Discussion

Results from the PERMANOVA analysis indicated that there were significant differences ( $P < 0.050$ ) between years, reaches and for the interaction term reaches x treatments. There was not a significant effect for treatment (Table 4).

**Table 3. Survey dates used in the analysis**

Year A	Year B	Year C
13 October 2006	12 November 2007	17 <sup>th</sup> November 2008
18 <sup>th</sup> December 2006	21 January 2008	5 <sup>th</sup> January 2009
19 <sup>th</sup> February 2007	26 <sup>th</sup> March 2008	17 March 2009

**Table 4. PERMANOVA results**

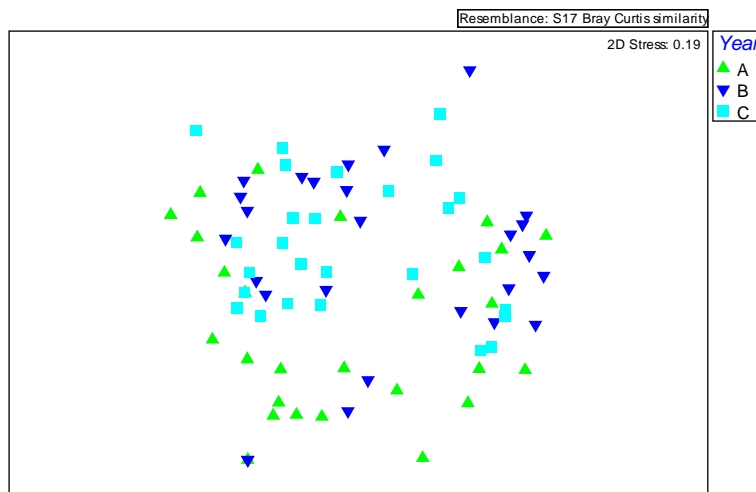
Source	df	SS	MS	Pseudo-F	P(perm)	perms
Year	2	11761	5880.5	2.8814	0.002	997
Reach	2	77047	38524	18.876	0.001	998
Treatment	2	5683.6	2841.8	1.3925	0.129	997
Year x Reach	4	11736	2934	1.4376	0.077	997
Year x Treatment	4	5919.8	1479.9	0.72515	0.856	997
Reach x Treatment	4	19793	4948.3	2.4246	0.001	997
Year x Reach x Treatment	8	14207	1775.8	0.87013	0.749	998
Res	54	1.10E+05	2040.9			
Total	80	2.56E+05				

### ***Fish communities between years***

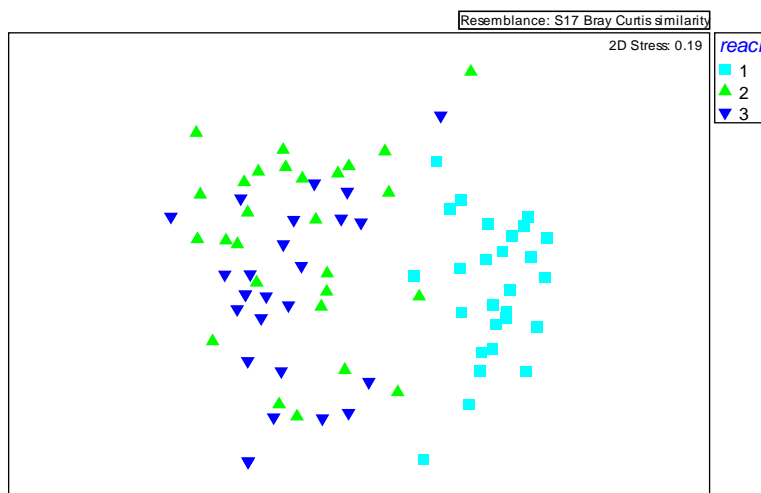
Not unexpectedly there are significant differences in fish communities between years across all sites, with the fish communities surveyed in the summer of 2006-07 significantly different from those in the following two summers ( $P < 0.05$ ) that were not significantly different from each other ( $P = 0.193$ ) (Figure 1). In the first sampling year rainbow fish, smelt and European carp were more abundant and in the following two years Murray cod have been more abundant.

### ***Fish communities between reaches***

There are significant differences in fish community structure among all reaches ( $P < 0.001$ ; Figure 2). Typically the reach above Casey's weir can be characterised as being dominated by small bodied fish. Reach 2 immediately downstream of Casey's weir is typified by a more diverse fish community consisting of primarily large bodied fish whereas the reach below Gowangardie weir is a less diverse community, also consisting of large bodied fish (Table 5).



**Figure 1. nMDS of fish communities across the three sampling periods (year A = summer 2006-07; year B = summer 2007-2008; year C = summer 2008-09)**



**Figure 2. nMDS of fish communities surveyed from each reach (reach 1 = Benalla to Casey's weir; reach 2 = Casey's weir to Gowangardie weir; reach 3 = Gowangardie weir to Shepparton)**



**Table 5. Species of fish that typify the fish community within each reach by occurring in consistent abundances in each survey.**

	Species	Average Abundance	Average Similarity	Similarity/STD	% contribution	Cumulative % contribution
Reach 1	<i>Hypseleotris</i> sp.	18.22	30.26	1.62	71.38	71.38
	<i>Melanotaenia fluviatilis</i>	8.22	5.87	0.67	13.86	85.23
	<i>Gambusia holbrooki</i>	4.48	2.57	0.48	6.06	91.29
Reach 2	<i>Maccullochella peelii peelii</i>	3.89	16.53	0.82	56.23	56.23
	<i>Melanotaenia fluviatilis</i>	2.00	4.75	0.62	16.17	72.4
	<i>Macquaria ambigua</i>	0.67	2.59	0.48	8.8	81.2
	<i>Cyprinus carpio</i>	0.81	2.24	0.36	7.62	88.82
	<i>Carassius auratus</i>	0.85	1.18	0.3	4.01	92.82
Reach 3	<i>Cyprinus carpio</i>	1.93	16.07	0.96	46.34	46.34
	<i>Maccullochella peelii peelii</i>	2.22	15.01	0.85	43.29	89.63
	<i>Melanotaenia fluviatilis</i>	2.22	1.52	0.25	4.38	94.02

### **Differences between fish communities in treatments within reaches**

As already noted, there was no significant difference in fish community structure among the three treatments (high wood density, low wood density and re-snagged wood) when reach is ignored ( $P = 0.19$ ; Table 4). There are, however, some differences occurring between treatments within reaches (see Treatment x Reach interaction, Table 4). Pairwise comparisons of treatments within each reach indicates that there were no differences between treatments within reach 1 (Benalla to Casey's weir) but differences are occurring between treatments in the two reaches below Casey's weir (Table 6).

**Table 6. Pairwise comparisons of treatment pairs within each reach**

	Treatment pairs	t	P
Reach 1	Re-snagged – High density	0.99	0.46
	Re-snagged – Low density	0.49	0.95
	High density - Low density	0.79	0.675
Reach 2	Re-snagged – High density	2.59	0.001
	Re-snagged – Low density	1.67	0.038
	High density - Low density	1.41	0.084
Reach 3	Re-snagged – High density	1.60	0.025
	Re-snagged – Low density	1.28	0.164
	High density - Low density	1.20	0.219

In reach 2 - Casey's weir to Gowangardie weir – significant differences in fish communities were occurring between the re-snagged treatment and both the low and high density wood treatments (Table 6, Figure 3). Typically the high wood treatment can be characterised by having a higher diversity of fish compared to the low and re-snagged reaches. The re-snagged treatment has a lower diversity of fish but the greatest number of Murray cod (Table 7).

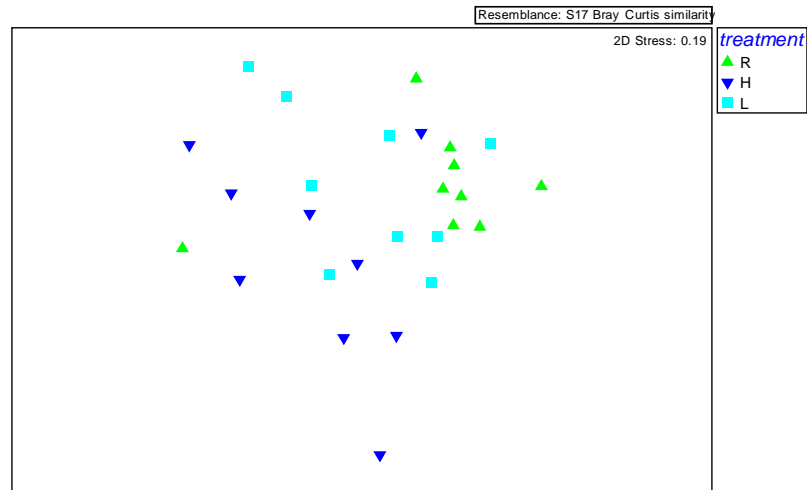


Figure 3. nMDS of fish communities in reach 2 – Casey’s weir to Gowangardie weir

Table 7. Species of fish that typify the fish community within each treatment in reach 2 (Casey’s weir to Gowangardie weir ) by occurring in consistent abundances in each survey

	Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
High density	<i>Melanotaenia fluviatilis</i>	2.89	4.79	0.74	18.02	18.02
	<i>Carassius auratus</i>	1.78	4.45	0.71	16.74	34.76
	<i>Macquaria ambigua</i>	0.89	4.36	0.74	16.4	51.16
	<i>Maccullochella peelii peelii</i>	1.11	3.76	0.52	14.13	65.29
	<i>Retropinna semoni</i>	1.44	3.62	0.4	13.6	78.89
	<i>Hypseleotris sp.</i>	0.89	2.01	0.35	7.55	86.44
	<i>Cyprinus carpio</i>	0.44	1.36	0.42	5.11	91.55
Low density	<i>Maccullochella peelii peelii</i>	3.11	17.31	1.12	51.7	51.7
	<i>Cyprinus carpio</i>	1.56	5.65	0.43	16.87	68.57
	<i>Melanotaenia fluviatilis</i>	2.11	4.75	0.51	14.18	82.75
	<i>Macquaria ambigua</i>	0.89	4.21	0.56	12.56	95.31
Re-snagged	<i>Maccullochella peelii peelii</i>	7.44	43.05	1.54	89.19	89.19
	<i>Melanotaenia fluviatilis</i>	1	3.78	0.56	7.82	97.01

In reach 3 - Casey’s weir to Gowangardie weir – there were differences in fish communities between the re-snagged treatment and the high density wood treatment (Table 6; Figure 4). Typically the re-snagged treatment had lower abundance of Murray Cod and higher abundances of European carp and mosquito fish (Table 8)

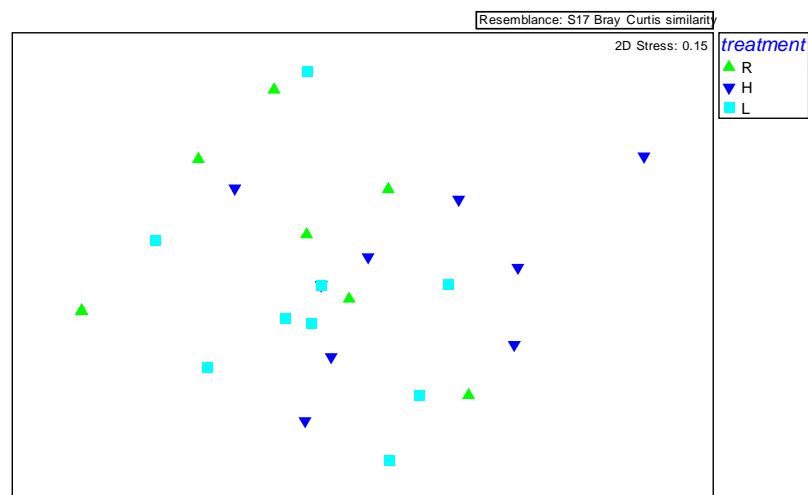


Figure 4. nMDS of fish communities in reach 3 –Gowangardie weir to Shepparton.

Table 8. Species of fish that typify the fish community within each treatment in reach 3 (Gowangardie weir to Shepparton ) by occurring in consistent abundances in each survey

	Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
High density	<i>Maccullochella peelii peelii</i>	2.78	20.49	1.5	53.92	53.92
	<i>Cyprinus carpio</i>	1.89	9.02	0.87	23.74	77.66
	<i>Melanotaenia fluviatilis</i>	6	7.41	0.53	19.5	97.16
Low density	<i>Maccullochella peelii peelii</i>	2.33	21.36	0.96	52.77	52.77
	<i>Cyprinus carpio</i>	1.67	17.21	0.98	42.51	95.28
Re-snagged	<i>Cyprinus carpio</i>	2.22	24.58	0.92	73.45	73.45
	<i>Maccullochella peelii peelii</i>	1.56	5.42	0.44	16.2	89.64
	<i>Gambusia holbrooki</i>	1.22	2.07	0.29	6.18	95.82

### Murray Cod

Size distributions and contingency tables for each reach below Casey’s weir were calculated using Murray cod size distributions at each sampling date (Table 9, Figure 5) and Pearson Chi-square was calculated to determine if the frequency of occurrence of Murray cod in each reach, in any size class at each sampling time occurs by chance. Of these six reaches only Burnells road had a significant Chi- square value (31.607, 6df, P<0.001). This indicates that Murray cod in the size class 100 to 250 mm are utilising this site more than can be explained by chance occurrence. Although a non significant result was obtained for Pine lodge there was an increase in small cod surveyed during the 2008-2009 sampling period (Table 9, Figure 5).

**Table 9 Contingency tables for Murray cod surveyed at each site**

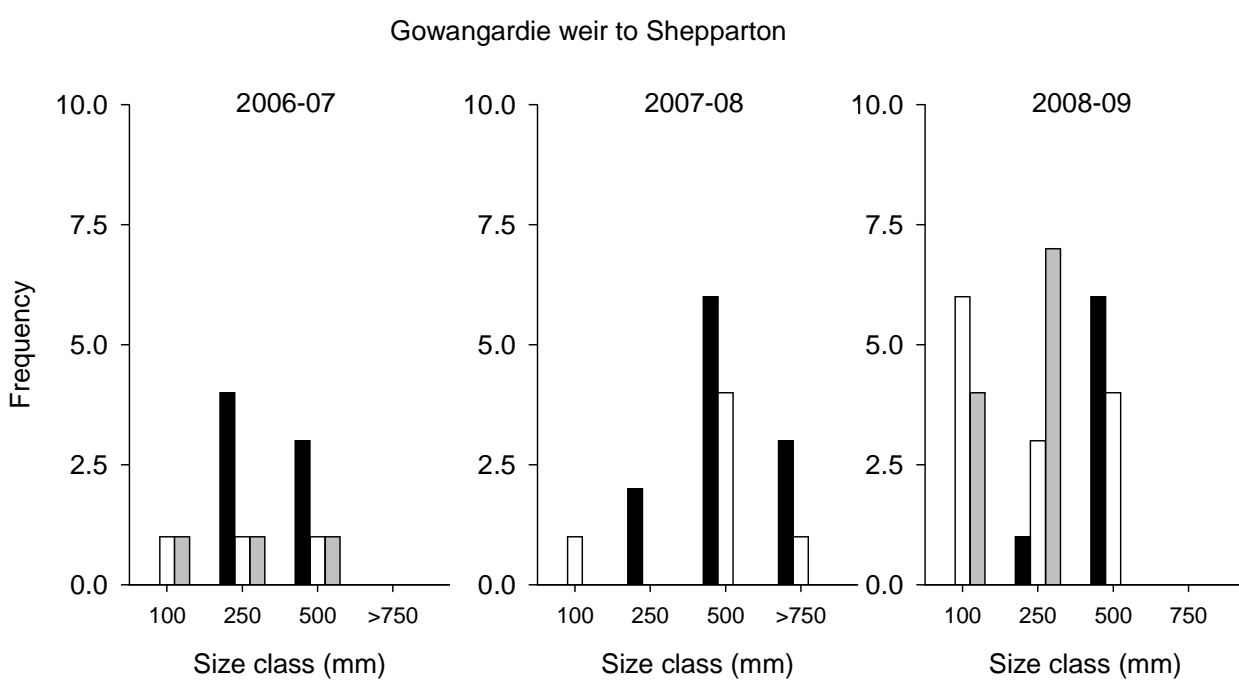
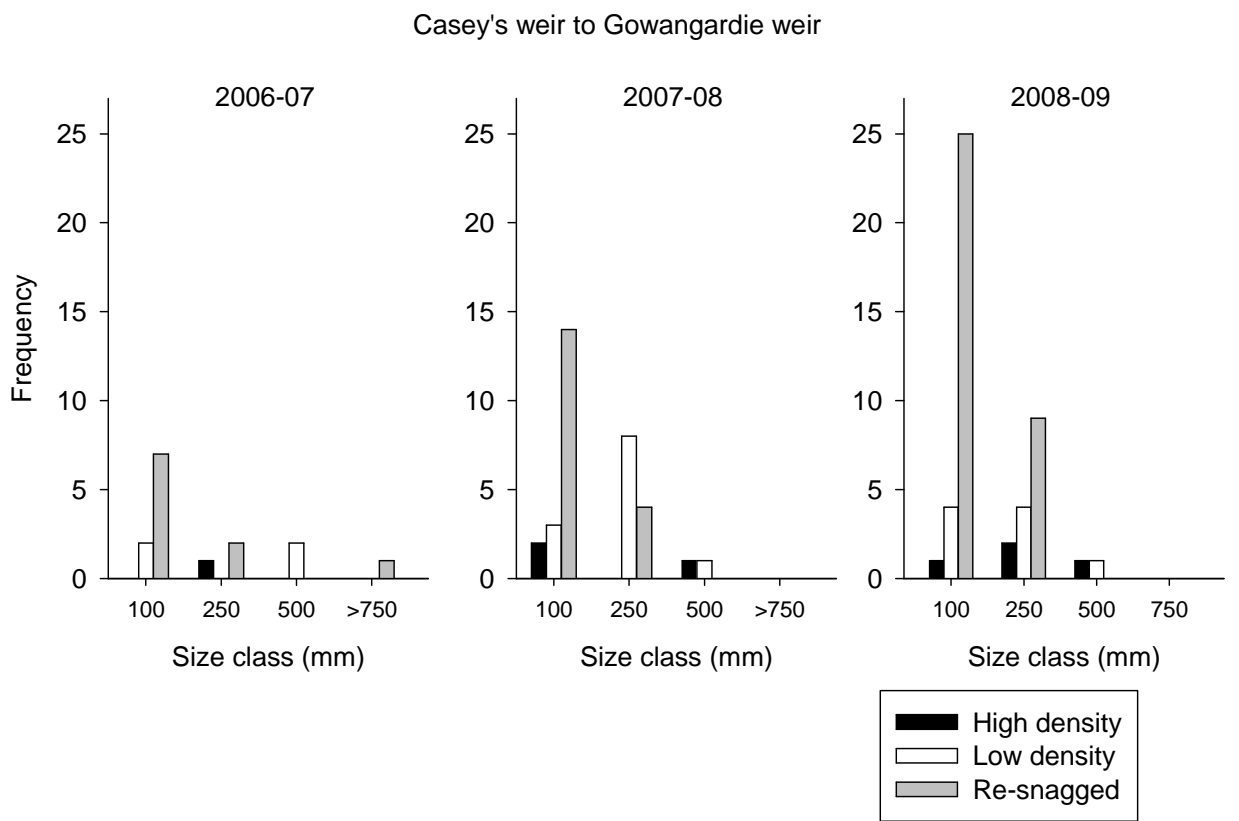
Reach	Date	Size class (mm)				Chi-square		
		<100	100-250	251-500	>500	Value	df	p
Burnells rd	2006-07	7	2	0	1	31.607	6	<0.001
	2007-08	1	14	4	0			
	2008-09	3	25	9	0			
Goomalibee	2006-07	2	0	2	0	8.080	6	0.232
	2007-08	0	3	8	1			
	2008-09	2	4	4	1			
Quinns rd	2006-07	0	1	0	0	4.767	6	0.574
	2007-08	2	2	0	1			
	2008-09	1	1	2	1			
Pine lodge	2006-07	1	1	1	0	3.183	6	0.786
	2007-08	0	0	0	0			
	2008-09	4	7	0	0			
Keats rd	2006-07	1	1	1	0	6.640	6	0.355
	2007-08	1	0	4	1			
	2008-09	6	3	4	0			
Cosgrove rd	2006-07	0	4	3	0	0.000	6	1.000
	2007-08	0	2	6	3			
	2008-09	0	1	6	0			

## Management Implications

- Many effects of the re-snagging are potentially being masked by the differences in fish communities within the 3 reaches of the river. There still remains no significant differences in fish communities between any of the treatments suggesting that re-snagging is not having an impact on fish communities within the Broken river, however there is some evidence that suggests Murray Cod may be beginning to utilize the re-snagged treatment at Burnells road.
- There is some evidence that juvenile Murray Cod are established in the re-snagged reaches below Casey's weir particularly at Burnells road. However the numbers are low and although analysis indicates that there is a positive increase in Murray cod care should be taken in the interpretation of this data at this point in time

## Other issues

- The aquatic introduced weed *Cabomba caroliniana* is now well established within the re-snagged section at Scholes Road. It is recommended that no further surveys be undertaken in this section in an effort to minimise its spread further downstream by fragmentation.



**Figure 5. Size class distributions of Murray cod collected from reaches below Casey's weir during the summers of 2006-07, 2007-08, 2008-09**

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