Fish Assemblage Condition Monitoring for the Katarapko Anabranch System 2009

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Executive Summary

River regulation in the Murray-Darling Basin has altered the natural hydrological regime of the Murray River and led to decreases in abundance and distribution of native fish populations. The Katarapko Anabranch system provides hydraulic and habitat diversity (e.g. slow and fast flowing creeks and backwaters) in a region of the lower Murray River generally characterised by homogenous aquatic habitats. Investigations in the Chowilla Anabranch system suggest that these diverse offchannel habitats may provide an important ecological function for native fish.

The recent extended period of low flows (2001 - 2009) has exacerbated the effects of river regulation and impacted on the health of aquatic and floodplain ecosystems in the lower Murray River. In 2008, the *Katfish Reach Implementation Plan* was developed by the Katfish Reach Steering Group in an effort to improve the floodplain habitats of the Katarapko Anabranch system. This plan proposes a series of management interventions for the Katarapko system that aim to improve floodplain and aquatic ecosystem health.

Condition monitoring is a key component of the implementation plan and is essential for gaining an understanding of spatio-temporal variation in ecosystems. We developed a condition monitoring program in order to describe and assess the condition of the fish assemblage within the Katarapko Anabranch system. The data presented in this document is the first of the fish assemblage condition monitoring surveys to be undertaken.

A total of 3580 fish representing 11 native and four exotic species were captured within the Katarapko Anabranch system and adjacent Murray River during April 2009. Three native species of conservation significance were captured, namely freshwater catfish, silver perch and Murray cod. Most fish species were widespread through out the system, but species richness did vary between sites. Generally, species richness was greater in slow flowing (e.g. Katarapko Creek), fast flowing (e.g. Eckert Creek downstream Eckert Creek Weir) and main river channel (e.g. Murray River) mesohabitats than in backwater habitats.

Murray cod were captured only from sites in Katarapko Creek and the Murray River. These sites were characterised by abundant large woody debris and flowing water, both

important habitat attributes for Murray cod. Freshwater catfish were collected from sites in the Murray River and Eckert Creek where habitat diversity was greater than elsewhere.

The length-frequency distributions of medium and small-bodied native and exotic fish suggest some recent recruitment for most species. Detailed age frequency analysis for golden perch however, suggests episodic recruitment with no recruitment in the past 3 years.

Fish assemblages in the Katarapko Anabranch system and adjacent Murray River are likely to be structured by a number of complex ecological processes. Hence the diversity, distribution and recruitment of species in the system may vary over time. Data from this survey forms a robust baseline for further investigations of spatio-temporal variation in fish assemblages of the Katarapko Anabranch system.

Introduction

Flow regulation has altered the natural hydrodynamics of the lower Murray River, creating a series of lentic weir pool habitats in what was historically a highly variable lotic system (Walker, 2006). In turn this has led to a decrease in the abundance and distribution of native fish populations by restricting movement, reducing available habitat and altering the hydrology and hydraulics of water bodies (Cadwallader 1978; Gehrke *et al.* 1995; Barrett 2004).

The Katarapko Anabranch system is one of only three large anabranch systems providing hydraulically diverse offchannel habitats within the lower Murray River. All three anabranch systems (i.e. Lindsay-Mullaroo, Chowilla and Katarapko) bypass Lock and Weir structures along the main channel. The Katarapko Anabranch system bypasses Lock and Weir No. 4 and generates a head differential of ~ 3.5 m between the inlet of Eckert Creek and the confluence of Katarapko Creek with the Murray River. This creates higher velocity (> 1.5 ms^{-1}) environments than the main river channel, particularly in the upper reaches of the system (e.g. Eckert Creek). These fast flowing habitats are now uncommon in the lower Murray River (Zampatti *et al.* 2008).

Recent fish ecology investigations in the Chowilla Anabranch system, which bypasses Lock and Weir No. 6, suggest that hydraulically diverse offchannel habitats support a diverse native fish community and higher abundances of some fish species (e.g. Murray cod) in comparison to the main river channel (Zampatti *et al.* 2008). Like Chowilla, sections of the Katarapko Anabranch system (e.g. Katarapko Creek) have high densities of structural habitat such as woody debris, which has been shown to support increased abundances of Murray cod (Koehn and Nicol 1998; Crook and Robertson 1999; Zampatti *et al.* 2006; Jones and Stuart 2007) and golden perch (Zampatti *et al.* 2006). Furthermore, anabranch systems that bypass locks and weirs may facilitate fish passage around these major structures (Leigh and Zampatti 2005).

The recent extended period (2001 - 2009) of low flows in the lower Murray River has exacerbated the effects of river regulation. Floodplain habitats, in particular, have become increasingly degraded (MDBC 2003; Overton *et al.* 2006; Marsland *et al.* 2008). In an effort to improve the floodplain and aquatic habitats of the Katarapko Anabranch system a rehabilitation plan has been developed (Katfish Reach Steering Group, 2008).

This plan proposes a series of management interventions that aim to rehabilitate floodplain health. Condition monitoring is an important component of a rehabilitation plan (Boys *et al.* 2008). This type of monitoring is not specifically linked to a management intervention but is essential to gain an understanding of spatio-temporal variation in aquatic and terrestrial ecosystems.

The aim of the present study was to develop and undertake the initial survey for a fish condition monitoring program for the Katarapko Anabranch system and adjacent Murray River. A preliminary survey of the fish assemblages in the Katarapko Anabranch system was undertaken in March 2007 (Leigh *et al.* 2007). This survey provided the basis for the development of the survey design used in the current monitoring program. Here we report on the findings of the April 2009 condition monitoring surveys and describe the fish community in terms of the distribution of species, species richness (number of species) and recruitment (using length and, for golden perch, age frequency data). These data will provide a baseline for future interventions and monitoring.

Methods

Site selection

Fourteen sites were surveyed in the Katarapko Anabranch system and adjacent Murray River during April 2009 (Figure 1). Twelve of these sites (sites 1 - 12) were surveyed in 2007 (Leigh *et al.* 2007), and two additional sites were added (sites 13 and 14). Sampling locations were selected to represent the range of aquatic meso-habitats available in the Katarapko Anabranch system. These included fast and slow flowing habitats, backwater environments and the Murray River main channel (Table 1).

Table 1. Fish assemblage sampling sites in the Katarapko Anabranch system, April 2009.

Site number	Name	Aquatic mesohabitat type
1	Eckert creek d/s weir	Fast anabranch
2	Eckert creek Wide Water	Backwater
3	Eckert creek u/s log crossing	Slow anabranch
4	Eckert creek d/s log crossing	Fast anabranch
5	The Splash	Backwater
6	Katarapko d/s weir	Slow anabranch
7	Katarapko Island	Slow anabranch
8	Katarapko 500m u/s camp site 16	Slow anabranch
9	Katarapko lower	Slow anabranch
10	Murray 3-4km d/s Lock 4	Main river channel
11	Murray 10km d/s Lock 4	Main river channel
12	Murray d/s Katarapko junction	Main river channel
13	Eckert Creek below ford	Slow anabranch
14	Murray u/s Lock 4	Main river channel

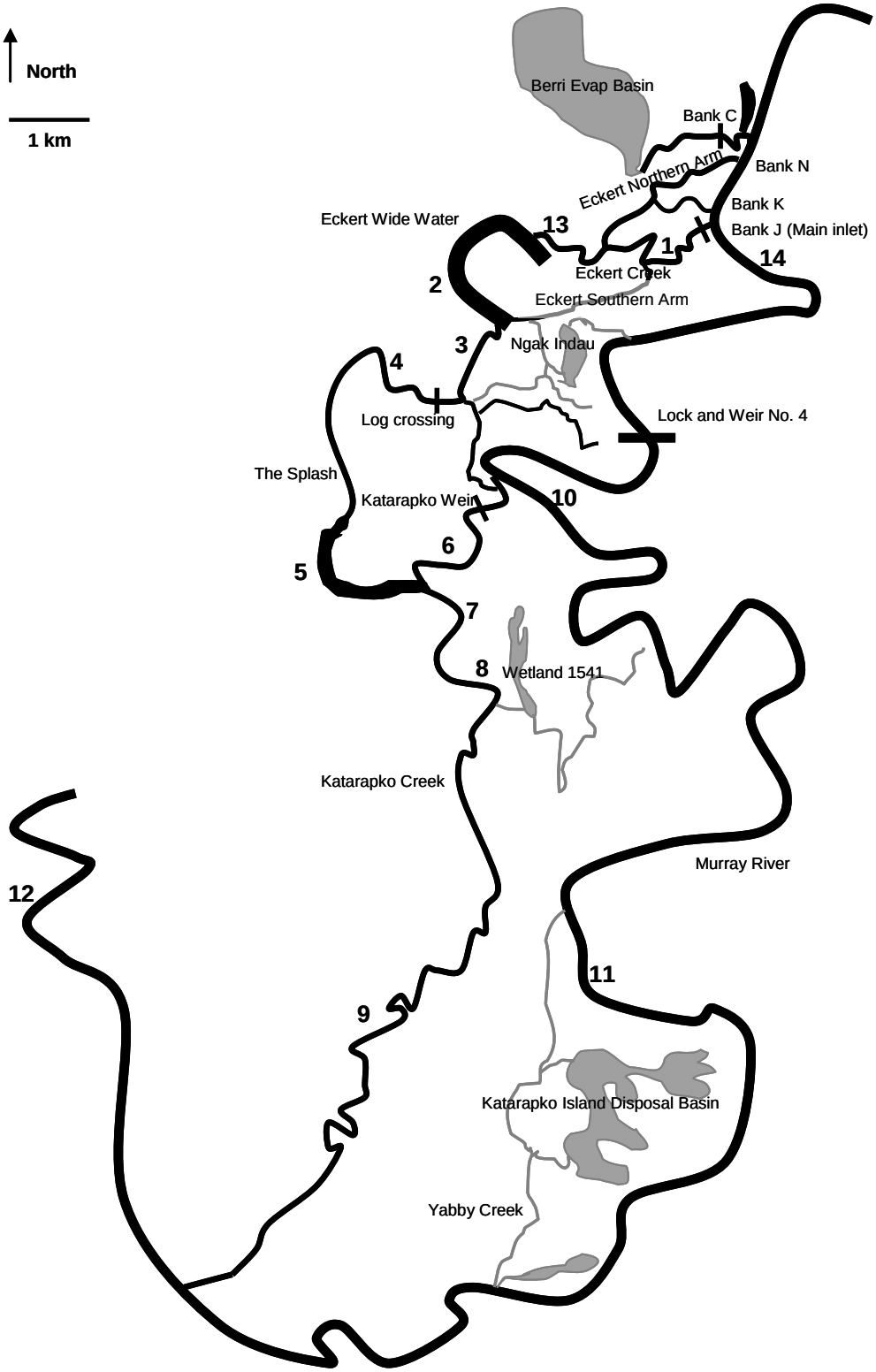

Figure 1. Map of the Katarapko Anabranch showing fish assemblage condition monitoring sites sampled during April 2009. Black indicates permanent water course, grey indicates ephemeral creeks and wetlands.

Sampling method

At each site fish were sampled using a boat mounted 5kW Smith Root Model GPP electrofishing system. Electrofishing incorporated 12 (6 on each bank) x 90 second (power on time) electrofishing shots during daylight hours. All fish were dip netted and placed in a re-circulating well. Fish from each shot were identified and a sub sample of 20 individuals was measured for length (caudal fork or total length, mm). Any positively identified fish unable to be dip netted were recorded as "observed".

Data analysis

Length frequency graphs were generated from length data for three small bodied and four large - medium bodied species. The species chosen are generally the most abundant species that occur in the region (Baumgartner *et al.* 2008; Davies *et al.* 2008; Zampatti *et al.* 2008) but are also representative of the wide range of life history strategies of freshwater fishes within the lower Murray River (Humphries *et al.* 1999). The relationship between length and age for golden perch (*Macquaria ambigua*) is highly variable (Anderson *et al.* 1992) therefore, a sub sample of 28 golden perch were euthanised, measured and their otoliths removed for a more accurate estimation of the population age structure.

Results

Total catch

A total of 3580 fish representing 15 species (11 native and four exotic species) were captured within the Katarapko anabranch system during April 2009 (Table 2). The most abundant species were bony herring (*Nematalosa erebi*) (*n*=1708), un-specked hardyhead (*Craterocephalus stercusmuscarum fulvus*) (*n*=876), goldfish (*Carassius auratus*) (*n*=319) and common carp (*Cyprinus carpio*) (*n*=193). Three species of conservation significance were captured, namely, freshwater catfish (*Tandanus tandanus*) and silver perch (*Bidyanus bidyanus*) (listed as protected species under the South Australia Fisheries Management Act 2007) and Murray cod (*Maccullochella peelii peelii*) (listed as threatened under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999). Nevertheless the abundances of these species were low (Murray cod *n*=7, silver perch *n*=5 and freshwater catfish *n*=2).

Species richness

Species richness ranged from seven species at sites 2 (Eckert Creek Wide Water) and 8 (Katarapko Creek 500m u/s camp site 16) to 12 species at sites 11 (Murray River 10km d/s Lock 4) and 14 (Murray River u/s Lock 4) (Table 2). Species richness was generally greater for slow, fast and main channel mesohabitats (sites 11, 12, 14, 7, and 1). Sites with the lowest species richness include slow and backwater mesohabitats (sites 2, 5, 8 and 13).

Table 2. Table showing species richness and total abundance of fish captured from Katarapko Anabranch system in April 2009.

	Sites														
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**Total**
Golden perch	1	-	6	1	-	2	9	15	8	8	10	6	-	3	**69**
Murray cod	-	-	-	-	-	-	2	-	-	-	4	-	-	1	**7**
Silver perch	-	-	-	-	-	1	1	1	-	-	1	1	-	-	**5**
Freshwater catfish	1	-	-	-	-	-	-	-	-	-	-	-	-	1	**2**
Bony herring	246	74	59	137	59	53	36	188	235	311	68	26	83	133	**1708**
Australian smelt	32	2	2	7	11	4	8	-	1	12	3	1	4	23	**110**
Murray rainbowfish	7	-	2	-	3	-	8	8	6	19	16	20	1	79	**169**
Flat-headed gudgeon	-	-	-	1	2	-	-	-	-	12	2	6	-	-	**23**
Dwarf flat-headed gudgeon	-	-	-	-	-	-	-	-	-	1	-	-	-	-	**1**
Un-specked hardyhead	96	10	17	151	13	39	52	10	11	158	118	66	22	113	**876**
Carp gudgeon	12	1	3	1	-	1	-	-	1	-	1	4	19	2	**45**
Common carp	5	15	5	11	25	9	2	16	-	24	14	34	17	16	**193**
Goldfish	7	85	42	38	48	2	1	6	5	3	6	25	50	1	**319**
Gambusia	8	1	1	13	5	3	1	-	1	10	2	1	4	2	**52**
Redfin perch	-	-	-	-	-	-	-	-	-	-	-	-	-	1	**1**
Total spp	**10**	**7**	**9**	**9**	**8**	**9**	**10**	**7**	**8**	**10**	**12**	**11**	**8**	**12**	
Total fish	**415**	**188**	**137**	**360**	**166**	**114**	**120**	**244**	**268**	**558**	**245**	**190**	**200**	**375**	**3580**

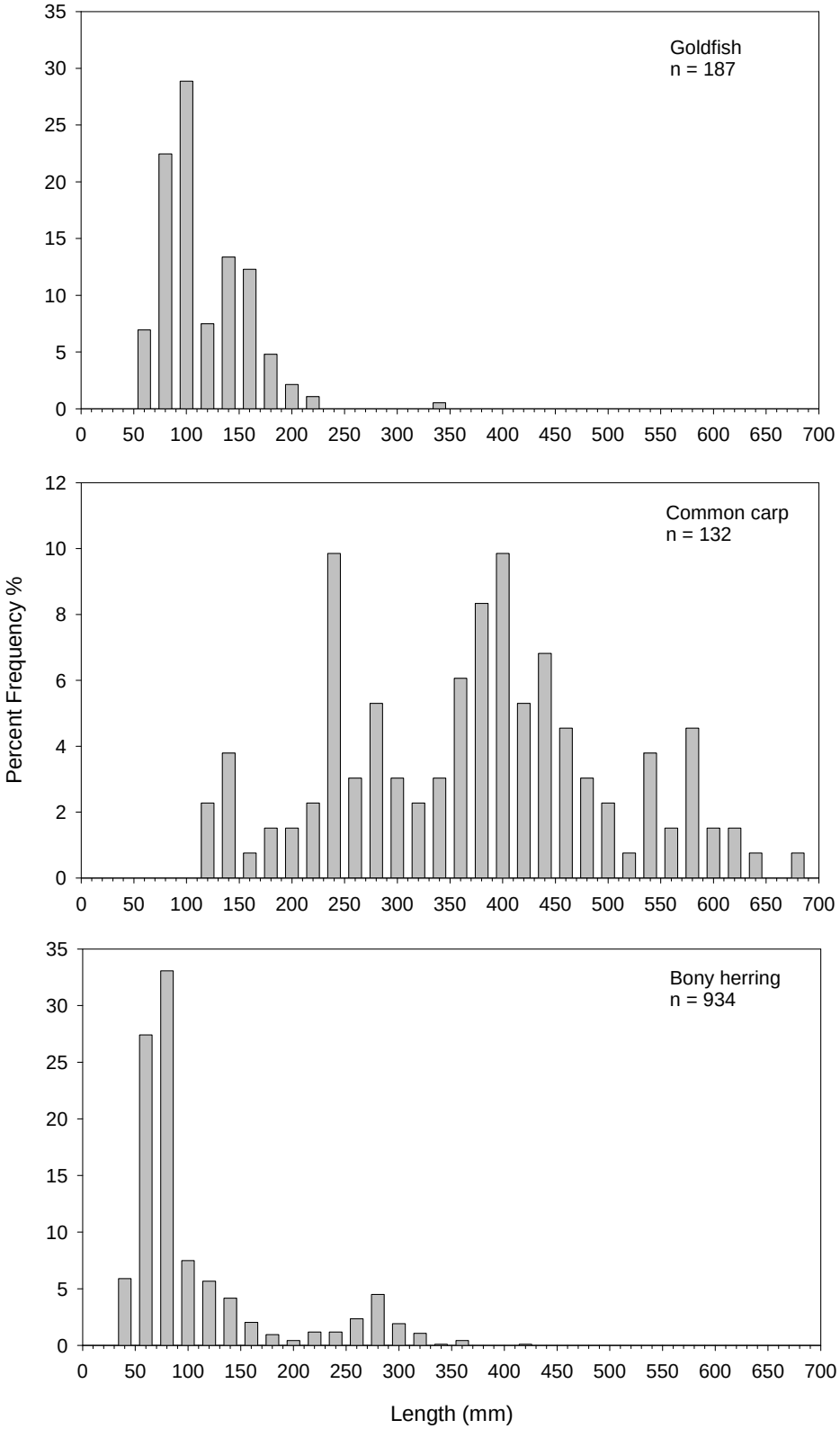

Figure 2. Length frequency graphs for large-medium bodied fish species captured from the Katarapko Anabranch system and the adjacent Murray River, April 2009. n, denotes the number of fish.

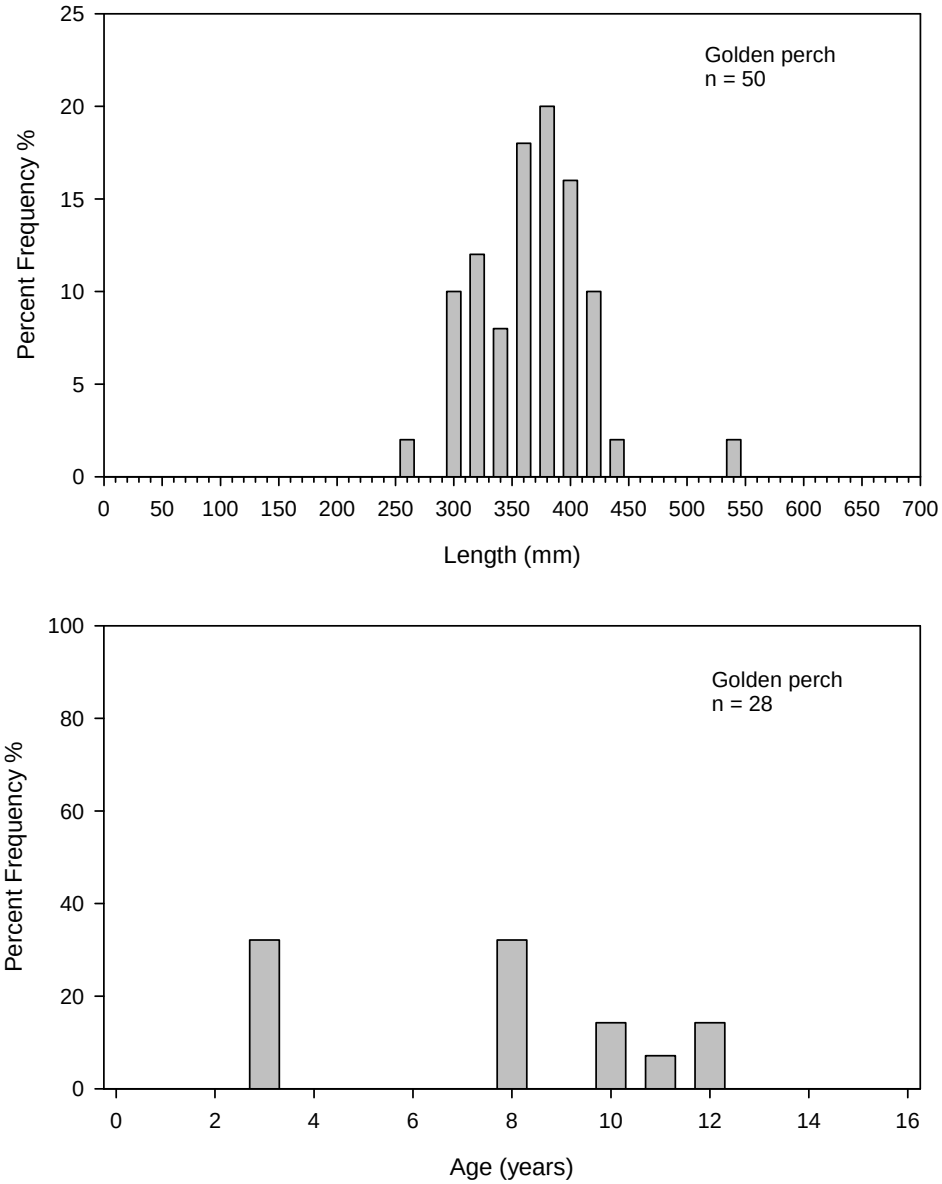

Figure 3. Length and age frequency graphs for golden perch captured from the Katarapko Anabranch system and the adjacent Murray River, April 2009. n, denotes the number of fish.

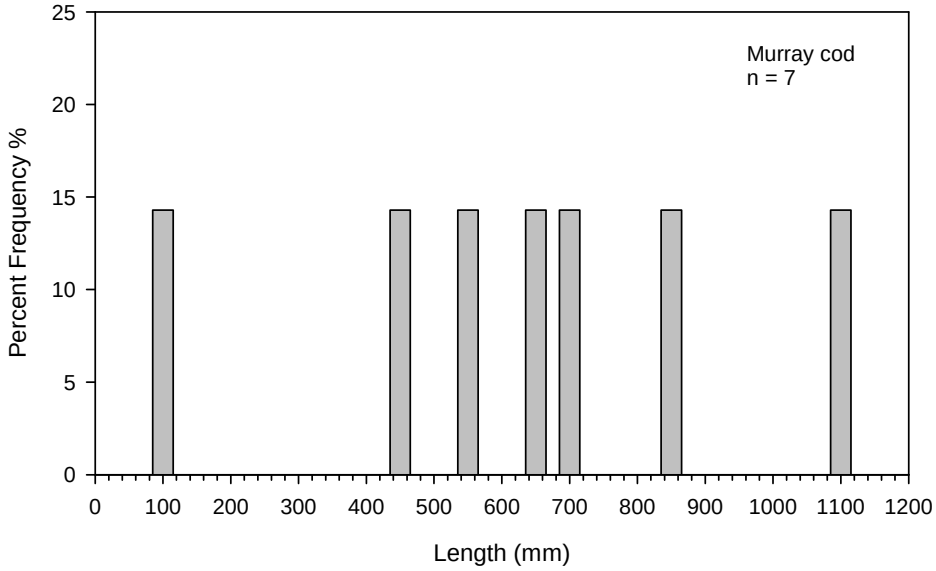

Figure 4. Length frequency graph for Murray cod captured from the Katarapko Anabranch system and the adjacent Murray River, April 2009. n, denotes the number of fish.

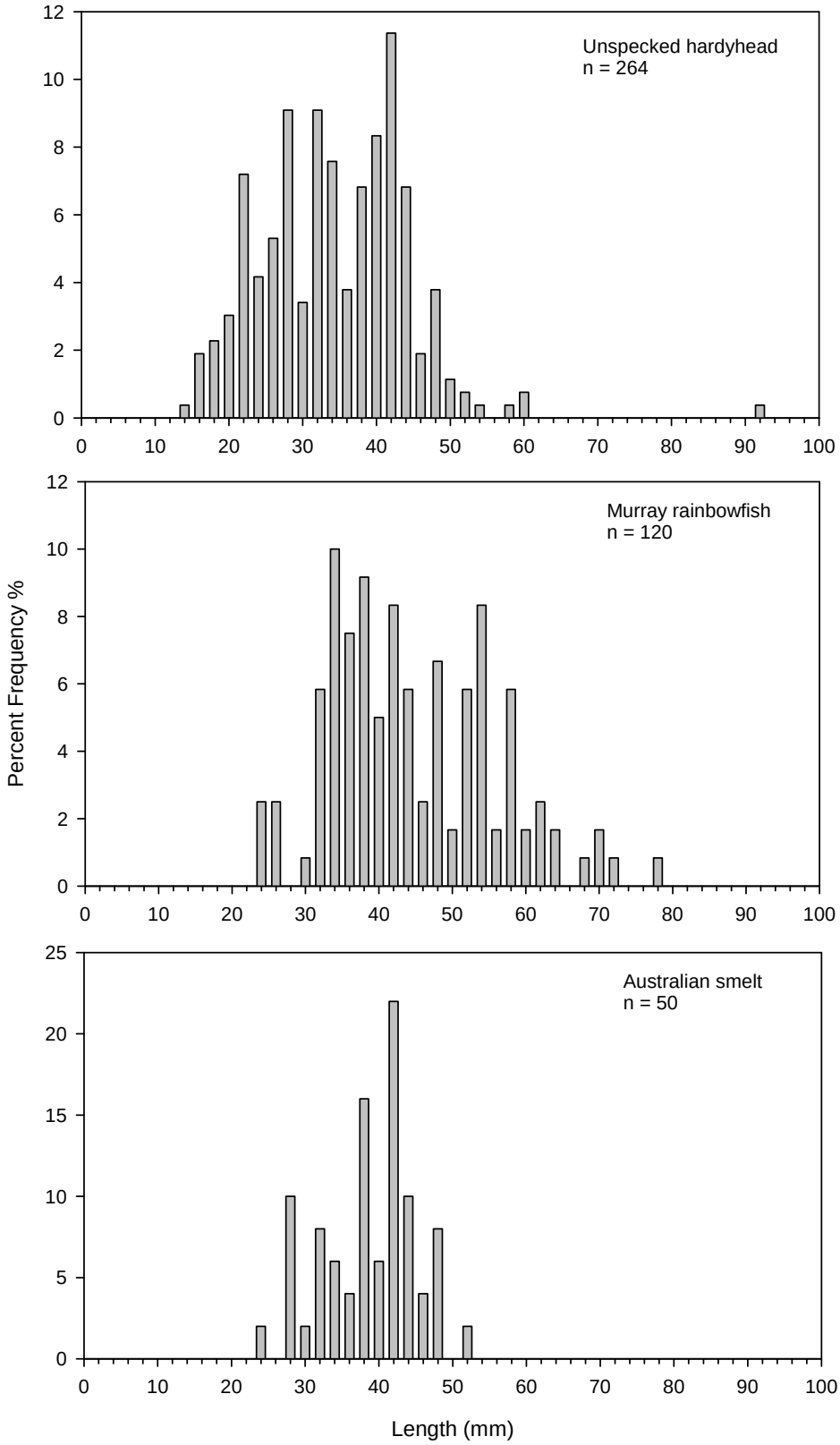

Figure 5. Length frequency graphs for small bodied species captured in the Katarapko Anabranch system and the adjacent Murray River, April 2009. n, denotes the number of fish.

Size distribution

Large-medium bodied species

Common carp were captured over a wide range of lengths (105 - 667 mm) (Figure 2) however, only a small proportion of fish were < 230 mm (≤ 1+ individuals). Goldfish ranged from 44 - 339 mm in length and approximately 50% of fish were ≤ 100 mm (Figure 2). Bony herring ranged in length from approximately 20 - 420 mm and a large proportion (74 %) of the fish sampled were small fish (30 - 150 mm) (Figure 2).

The size distribution of golden perch in the Katarapko system ranged from 259 - 530 mm (Figure 3). Age estimates of a sub sample of golden perch show four distinct age groups of 3, 8, 10 and 12 year olds (Figure 3). Over 60 % of the population was represented by 3 and 8 year olds.

Seven Murray cod were captured ranging in length from 79 - 1100 mm (Figure 4). The smallest fish was 79 mm in total length and was captured from the Murray River upstream of Lock and Weir No. 4 (site 14). Four fish were captured from the Murray River 10 km downstream of Lock and Weir No. 4 (site 11) and ranged in size from 450 - 850 mm. Two fish were captured from Katarapko Creek at the Katarapko Island site (site 7) and were 540 and 1100 mm in length. One fish from site 11 had previously been captured at site 10 (3-4 km d/s Lock 4) in 2007, where it was originally tagged.

Small bodied species

Three small bodied native fish species, un-specked hardyhead, Australian smelt (*Retropinna semoni*) and Murray rainbowfish (*Melanotaenia fluviatilis*) all exhibited broad ranges in size distributions (Figure 5). Un-specked hardyhead lengths ranged from 14 - 92 mm with the majority of fish between 20 and 45 mm in length. Australian smelt ranged in length from 24 - 51 mm, and Murray rainbowfish from 23 - 78 mm.

Discussion

The fish community captured within the Katarapko system and adjacent Murray River is comparable to other studies within the main river channel (Baumgartner *et al.* 2008; Davies *et al.* 2008) and offchannel habitats (i.e. the Chowilla Anabranch system, Zampatti *et al.* 2008) of the lower Murray River. The most abundant species captured during this survey were bony herring, un-specked hardyhead, goldfish and common carp. These species are commonly abundant in the lower Murray River (Baumgartner *et al.* 2008; Davies *et al.* 2008; Zampatti *et al.* 2008).

Generally, most fish species were widespread throughout the Katarapko Anabranch system. Nevertheless, the distribution of freshwater catfish, silver perch, Murray cod, redfin perch (*Perca fluviatilis*), flat-headed gudgeon (*Philypnodon grandiceps*) and dwarf flat-headed gudgeon (*Philypnodon macrostomus*) was restricted to a small number (1 - 5) of sites. The abundances of these species were also generally low (freshwater catfish n=2, silver perch n=5, Murray cod n=7, redfin perch n=1, flat-headed gudgeon n=23 and dwarf flat-headed gudgeon n=1).

Murray cod were only captured from sites in the Murray River and Katarapko Creek. These sites were characterised by abundant large woody debris - an important habitat feature for Murray Cod (Koehn and Nicol 1998; Crook and Robertson 1999; Boys and Thoms 2006; Zampatti *et al.* 2006; Jones and Stuart 2007). Nevertheless, the number of Murray cod captured from Katarapko Creek in the 2007 and 2009 surveys is lower than expected considering the abundance of large woody debris present in this anabranch. Greater numbers of Murray cod were captured from Murray River sites (10km d/s Lock 4 in 2009 and 3-4km d/s Lock 4 in 2007). These sites had both abundant large woody debris and noticeable flow. The combination of both these attributes is a key component for Murray cod habitat (Koehn and Nicol 1998) and has been shown to have a significant positive effect on Murray cod abundances in the Chowilla Anabranch system (Zampatti *et al.* 2008).

Low numbers of freshwater catfish were captured from the Murray River (1 fish) and Eckert Creek downstream of the Eckert Creek Weir (1 fish). Freshwater catfish remain widespread in the lower Murray River however they are generally captured in low

numbers (Clunie and Koehn 2001; Lintermans 2007). Freshwater catfish occurs in a wide range of habitats and is considered to prefer a diverse range of structural habitats such as undercut banks, root masses and aquatic vegetation (Clunie and Koehn 2001; Lintermans 2007). This habitat association may explain why it was captured from Eckert Creek downstream of Eckert Creek weir (site 1). This site can be characterised by having a diverse and abundant instream habitats including woody debris and aquatic vegetation (Leigh *et al.* 2007). Freshwater catfish however, may also show a preference for slower flowing areas (Clunie and Koehn 2001) and this may explain their presence in the Murray River main channel.

Fish species richness has been shown to increase with habitat complexity (Gorman and Karr 1978; Merigoux *et al.* 1998). In the Katarapko Anabranch system species richness was greatest in slow (Katarapko Creek), fast (Eckert Creek downstream of the Eckert Creek Weir) and main river channel (Murray River) mesohabitats. These mesohabitats have diverse and abundant instream habitats including woody debris, aquatic vegetation and variable hydraulic environments (Leigh *et al.* 2007). Fish assemblages were similar between these mesohabitats. Conversely, backwater habitats were generally characterised by low species richness, low aquatic macrophyte diversity and low abundances of woody debris (Leigh *et al.* 2007). Common carp and goldfish contributed to a large proportion (53% and 43% respectively) of the total number of fish captured in backwater sites. This was also observed in the 2007 surveys and may be related to the habitat homogeneity within these sites (Leigh *et al.* 2007).

The size distributions of small bodied species (un-specked hardyhead, Australian smelt and Murray rainbowfish) were represented by a single mode. However these species are short lived (Lintermans 2007) and therefore this mode is likely to be comprised of both young-of-year (juveniles) and adult fish, suggesting annual recruitment has occurred. For example, length frequency distributions of Australian smelt show that by February/March young-of-year fish are no longer easily discernable from the adult size range (Leigh 2002).

Annual recruitment was particularly evident in the size distributions of bony herring (large - medium bodied, short lived species). A large proportion of small fish (45 - 120

mm TL) were sampled suggesting that these fish are ≤ 1 year old (Puckridge and Walker 1990).

Recruitment in populations of the exotic species (common carp and goldfish) varied. Only a small number of common carp < 230 mm (estimated to be ≤ 1 year old, Brown *et al.* 2005) were captured suggesting that only a low level of recent recruitment had occurred. Goldfish recruitment however, appears to be considerably greater. A large proportion (50%) of fish captured were ≤ 100 mm, the approximate size at maturity (Lintermans 2007) suggesting that these fish are recent recruits.

Although only a small number (*n*=7) of Murray cod were sampled there was some variation in the size distribution. Fish ranged in size from 79 - 1100 mm suggesting that a low level of recruitment has occurred within this region of the lower Murray River. Murray cod recruitment has been minimal in the main channel of the lower Murray River during the current low flow period (Ye and Zampatti 2007) suggesting that hydraulically diverse regions of the lower Murray River (e.g. anabranch and potentially some main channel tail-water habitats) may be important recruitment refugia for Murray cod.

The age structure of golden perch indicates episodic recruitment, with the youngest fish being three years old. The age structure observed in the Katarapko Anabranch system is consistent with other studies of golden perch in the lower Murray River, South Australia (Zampatti *et al.* 2006; Zampatti *et al.* 2008; Ye *et al.* 2008). The most recent cohort is likely to have been spawned in the spring/summer of 2005 during a period of a small increase in discharge (3,800 - 15,000 ML/d) in the lower Murray River. These observations suggest that the recruitment success of golden perch is linked to flow and provide further evidence that golden perch are a flow-cued spawner (Humphries *et al.* 1999; Mallen-Cooper and Stuart 2003).

Three major regulatory structures are likely to limit fish passage in the Katarapko Anabranch system. Low abundances of golden perch between the Eckert Creek Weir (Bank J) and Eckert Creek Log Crossing in both 2007 and 2009 suggest that movement of golden perch is limited through this section (Leigh *et al.* 2007). The Katarapko Stone Weir is also likely to be a significant barrier to fish movement between the anabranch and the Murray River main channel. Facilitating fish passage at these barriers would

increase connectivity of fish populations within the anabranch system and the Murray River main channel potentially increasing native fish abundance and/or species richness, particularly in Eckerts Creek. These barriers (Eckert Creek Weir, Eckert Creek Log Crossing and the Katarapko Stone Weir) are likely to have restricted water velocity in Eckert and Katarapko Creeks during the extended period of low flows in the lower Murray River (2001 - 2009). Low flow in Katarapko Creek in particular may have contributed to low abundances of native fish species such as Murray cod.

The ecological processes currently structuring fish assemblages in Katarapko anabranch system are likely to be complex and the diversity, distribution and recruitment of species in the system may vary over time. Condition monitoring will facilitate an understanding of the spatio-temporal variation in fish population dynamics and data from this survey provide a robust baseline for further investigations.

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