Freshwater fish and crayfish communities of the Carbunup and Buayanyup Rivers: conservation significance and management considerations

Prepared by

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Freshwater fish and crayfish communities of the Carbunup and Buayanyup Rivers: conservation significance and management considerations

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Project Summary

This study is the first to examine the fish and freshwater crayfish of the Carbunup and Buayanyup Rivers, south-western Australia. It aimed to determine the distribution of the fishes and freshwater crayfishes, their conservation significance and management implications to help ensure the ongoing viability of these communities.

- Ten sites each in the Carbunup and Buayanyup Rivers were sampled for fish and freshwater crayfish in November 2008.

Carbunup River

- Contained four of the eight endemic species of freshwater fishes of the south-west region, including the rare (Schedule 1 *Wildlife Protection Act 1950*) Mud Minnow.
- The Gilgie was the most widespread crayfish species and limited numbers of the Smooth Marron were also captured.
- All populations appeared viable based on abundances, distributions and population structures; however, the viability status of the Mud Minnow and Smooth Marron requires further investigation.
- The estuarine site at the mouth of the Carbunup River was found to house nine species of fish and two decapods; including Black Bream, Sea Mullet and Blue Swimmer Crabs.
- The estuarine habitat of the river probably provides nursery and/or spawning habitats for a number of estuarine and nearshore marine species.
- The introduced Eastern Gambusia was the only introduced species recorded in the Carbunup River (although historical reports of the Redfin Perch also exist for the system). The dry season abundance and distribution of Eastern Gambusia should be assessed to better understand its impact on native fishes in the system.

Buayanyup River

- Contained four endemic fishes; including the restricted Black-stripe Minnow. The identification of the species requires final confirmation by examination of a greater number of (larger) specimens or genetic analysis and, if confirmed, would represent a considerable range extension of the species.
- Three native freshwater crayfishes were recorded with the Gilgie again being widespread and abundant whereas the Smooth Marron and Koonac were recorded in low numbers and had more restricted distributions.
- Twelve fish and one shrimp species were recorded at the estuarine site in Buayanyup Brook; including Black Bream, Australian Salmon and Sea Mullet. As with the Carbunup

River, the tidal reach of Buayanyup probably provides nursery and/or spawning habitat for a number of estuarine and nearshore marine species.

- Both the introduced Yabbie and Eastern Gambusia were recorded in Buayanyup River with control programs of the species potentially able to reduce abundances and restrict their spread; but would be unlikely to completely eliminate them from the river.
- The widespread and abundant Western Pygmy Perch in Buayanyup River would be an ideal species for the proposed captive breeding program at the Naturaliste College. This species is a successful aquarium species and, if adequate habitat, food resources and water quality are provided, should be able to be successfully bred by the students.

Future actions

- Additional surveys should be undertaken to determine the distribution and viability of the Mud Minnow and Black-stripe Minnow (as well as its final identification) in the Carbunup and Buayanyup River, respectively.
- Additional, dry-season surveys of the distribution and abundances of Eastern Gambusia and Yabbie should be conducted with the aim of potentially developing control programs for these species.
- Greater understanding of the estuarine fish communities of both systems could be achieved by undertaking seasonal sampling in the lower reaches of these rivers.
- Protection and rehabilitation of riparian and instream vegetation via River Action Plan development for these systems would enhance the long-term viability of the prevailing native fish and freshwater crayfish communities via: helping to maintain and increase water quality, supplying shelter from predators, creating spawning habitat and supplying food resources.

Contents

Project Brief

Eight of the ten species of freshwater fishes found in south-western Australia are endemic to the region resulting in the South West Coast Drainage Division having the highest proportion of freshwater fish endemism of any drainage division in Australia (Morgan *et al.* 1998). All eleven species of native freshwater crayfishes are endemic to the region. These fauna are excellent bio-indicators of habitat change and water quality decline with the geographical ranges of many of species having been drastically reduced due to processes such as eutrophication, riparian degradation and salinisation. Therefore identifying and monitoring these communities aids greatly in the development and evaluation of effective catchment management plans and subsequent monitoring of overall river health.

The authors have an extensive database of freshwater fish distributions in this region (in excess of 1600 sampling sites); however, the fishes of the Carbunup River were only known from a single sample site (Morgan *et al.* 1998) and the Buayanyup River had not previously been surveyed. This therefore represented a considerable gap in our knowledge of fish and crayfish distribution of the south-west.

The aim of this study is to document the freshwater fish and crayfish distribution in the Carbunup and Buayanyup Rivers, assess their conservation significance and determine considerations for their management. This information will be able to be directly incorporated by GeoCatch in the development and implementation of River Action Plans for these systems.

Methods

Twenty sites were sampled during November 2008 for fish and freshwater crayfishes; ten each on Carbunup and Buayanyup Rivers distributed from the mouth of each system to their upper reaches including major tributaries (Figures 1-4).

On each system, two sites were chosen for the examination of upstream and downstream movements of fish and crayfish; including at the mouth of both rivers and one each in their freshwater sections. At the remaining nine sites on each system, a back-pack electrofisher (*Smith Root model 12-A*) was used to determine presence/absence of fish and crayfish and to estimate their densities.

All fish and freshwater crayfish were identified and a sub-sample of fish and freshwater crayfish were measured to the nearest 1 mm total length (TL) or orbital carapace length (OCL),

respectively. Length-frequency distributions of each species were plotted and analysed. These data were then used to provide an overall assessment of the fish communities in each system.

The study also involved landholder consultation and involvement through GeoCatch coordination. Furthermore, year eight students from the Naturaliste College joined the researchers for a field day on Buayanyup Brook to learn about freshwater fish in their region and as an introduction to the development of a captive breeding project at the school (Figure 2).

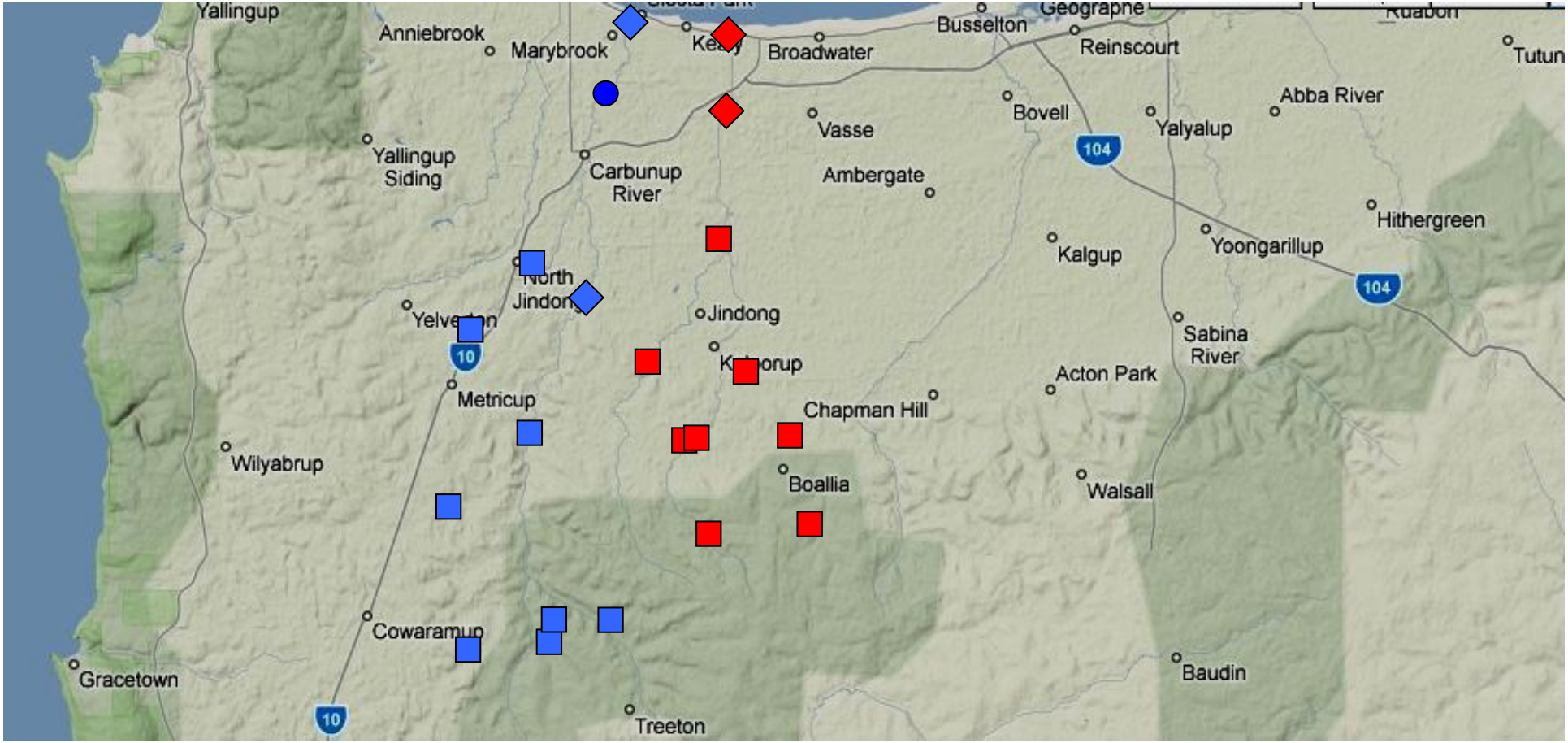
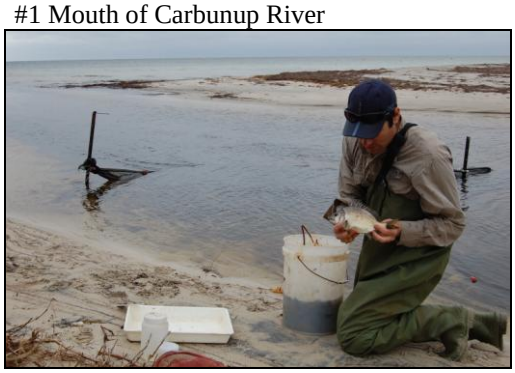


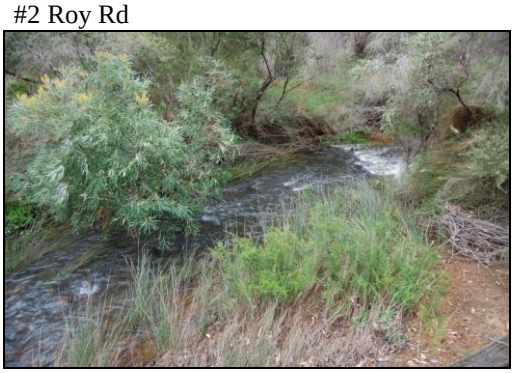
Figure 1: Satellite image of the sites sampled in Carbunup (blue symbols) and Buayanyup (red symbols) Rivers in November 2008. Source Google Maps (2008). N.B. diamonds indicate fyke net sites, squares density estimate sites, and the circle indicates the Morgan et al. (1998) site.

Figure 2: Sampling images from the survey in November 2008. N.B. the year eight science students from the Naturaliste College that were involved in the Buayanyup River survey with the view to undertaking a breeding program of their local freshwater fish. See the Buayanyup River section for the freshwater fish species present.

#1 Mouth of Carbunup River



#2 Roy Rd



#3 Island Brook – off Bussell Hwy Property

#4 Island Brook – Beckett Rd

#5 Tributary of Island Brook– Worgan Rd

#6 Carbunup River – Jindong-Treeton Rd

#7 Tributary of Carbunup River - Donaldson Rd

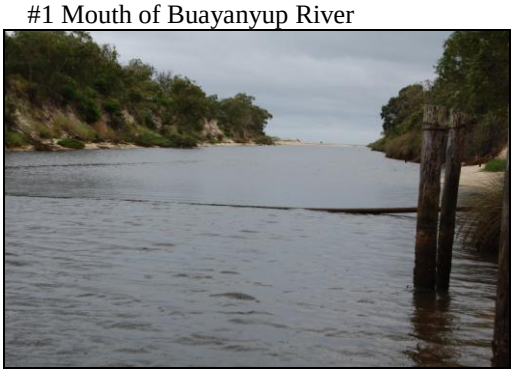
#8 Carbunup River - Gale Rd

#9 Tributary of Carbunup River – Ferguson Rd

#10 Tributary of Carbunup River – Ferguson Rd

Figure 3: Sites sampled on the Carbunup River during in November 2008.

#1 Mouth of Buayanyup River



#2 Buayanyup River – Florence Rd

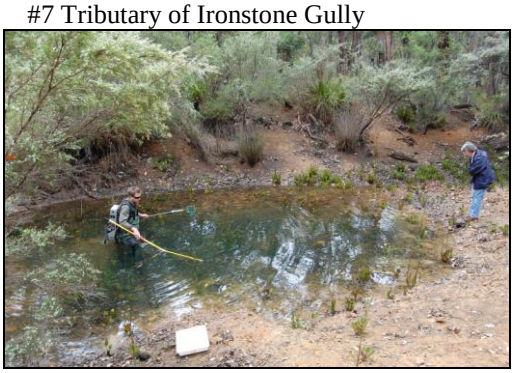
#3 Buayanyup River – Hairpin Rd Amelia Park

#4 Buayanyup River – Jindong Treeton Rd

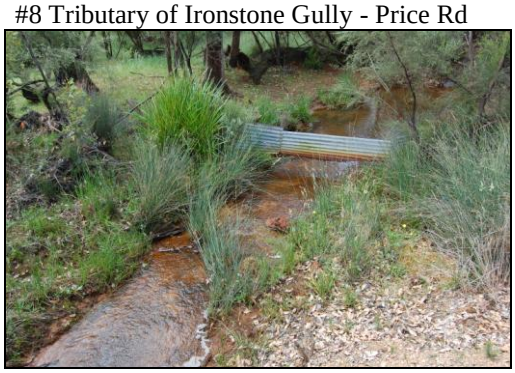
#5 Tributary of Buayanyup River – Adams Rd

#6 Tributary of Buayanyup River – Gale Rd

#7 Tributary of Ironstone Gully



#8 Tributary of Ironstone Gully - Price Rd



#9 Ironstone Gully – Kohlhagen Rd

#10 Ironstone Gully – Jacka Rd

Figure 4: Sites sampled on the Buayanyup River during in November 2008.

Results and Discussion

Carbunup River

Endemic freshwater fishes

There were 484 endemic freshwater fishes from four species captured in the Carbunup River during the study (Table 1). These species included the Western Minnow (*Galaxias occidentalis*), Western Pygmy Perch (*Edelia vittata*), Nightfish (*Bostockia porosa*) and the Mud Minnow (*Galaxiella munda*) (a rare species, listed as Schedule 1 *Wildlife Protection Act 1950*) (Table 1). The common south-west endemic Western Pygmy Perch was the most abundant (315 individuals or 65% of freshwater endemic fish captures) and widespread freshwater fish species being recorded at five of the nine freshwater sites (i.e. excluding the estuarine site #1 at the mouth of the river) up to a density of 3.36 fish m^{-2} (Table 1, Figure 1). The Western Minnow was also relatively abundant (149 individuals or 31% of freshwater endemic fish captures) and was recorded at four of the nine freshwater sites (Table 1). The Nightfish (18 individuals from a single site, 4% of freshwater endemic fish captured) and the Mud Minnow (two individuals, 0.4% of captures from two sites) were less abundant and more restricted in their distributions (Table 1).

Figure 5 shows the direction and strength (scaled for stream width) of movement of the three endemic fishes captured in the fyke nets at Roy Rd (site #2). Large upstream movements of Western Minnow (~91% of fyke net captures of this species) were recorded along with some upstream movement (~94% of captures) of Nightfish). Very minimal movements of the widespread and abundant Western Pygmy Perch were recorded at that site (Figure 5). It is likely that the movements were associated with feeding rather than upstream spawning migration as the all mature individuals of these species had spent gonads.

The length-frequency histograms of endemic fishes revealed the presence of multiple age classes of Western Minnow (including 0+ animals <~60 mm TL) probably recruited from spawning in winter 2008; the known breeding period of the species (see Pen & Potter 1991a). The Western Pygmy Perch also clearly consisted of at least two age cohorts, including a recently recruited 0+ cohort ~10-25 mm TL as a result of recent spring spawning; the known breeding period of this species (see Pen & Potter 1991b). The Nightfish probably consisted of three age classes including a single 0+ individual 36 mm TL from the spring spawning period (Pen & Potter 1991c) (Figure 6). The single Mud Minnow captured measured 45 mm TL and was probably 1+ years of age. The peak spawning period of this rare species is late winter/early spring (Pen *et al.* 1991) and it generally has a one year life-cycle making populations particularly vulnerable to disturbance. The recording of this species in Carbunup River represents a significant finding and a range extension of the species with nearby populations known from the upper Margaret River

(Morgan *et al.* 1998) and upper Vasse River (Morgan & Beatty 2004). It is generally only recorded in relatively undisturbed habitats and its presence at site #10 (Ferguson Rd in State Forest) was not unexpected; however, its presence at the private property on Donaldson Rd was somewhat unexpected but may be aided by the thick riparian vegetation present at that site that may offer hide and spawning habitat (Figure 3). This highlights the importance of protecting remnant riparian vegetation on private property to aid in the conservation of endemic fish populations.

The Carbunup River therefore houses viable populations of at least three endemic freshwater fishes with the viability status of the rare Mud Minnow unclear, but possibly vulnerable to extirpation from the system due to its highly restricted distribution and very low abundance. Protection and rehabilitation of riparian vegetation would benefit these populations and aid in their ongoing viability.

Table 1: Mean densities of fish and decapods at sites (excluding the estuarine site) sampled in Carbunup River in November 2008. N.B. * fyke netting record.

Site description/number	Lat	Long	Native fishes						Native decapods			Introduced species	
			Western Minnow	Mud Minnow	Nightfish	Western Pygmy Perch	Black-strip Minnow	Blue-spot Goby	Gilgie	Smooth Marron	South-west Shrimp	Yabbie	Eastern Mosquitofish
Carbunup River													
#2 Carbunup – Roy Rd	33.748	115.189	*		*	*			*	*	*		
#3 Island Brook 7151 Bussell Hwy Clive Smiths	33.737	115.168	**0.010**			**0.046**			**0.036**				**0.005**
#4 Island Bk Beckett Rd	33.760	115.142			**0.020**				**1.140**				
#5 Island Brook - small trib Worgan Rd	33.820	115.133							**2.400**				
#6 Carbunup - upper Jindong-Treeton Rd	33.858	115.200				**3.360**							
#7 Carbunup - 406 Donaldson Andrew Green	33.869	115.140	**0.323**	**0.020**		**1.720**			**0.403**				
#8 Carbunup - Gale Rd	33.796	115.166	**0.150**			**0.063**		**0.060**	**0.250**	**0.020**	**0.175**		
#9 Carbunup - small trib Ferguson Rd	33.860	115.176							**1.700**				
#10 Carbunup - small trib Ferguson Rd	33.866	115.175		**0.033**					**0.100**				
TOTAL NUMBER			**149**	**2**	**18**	**315**	**0**	**3**	**147**	**7**	**14**	**0**	**1**

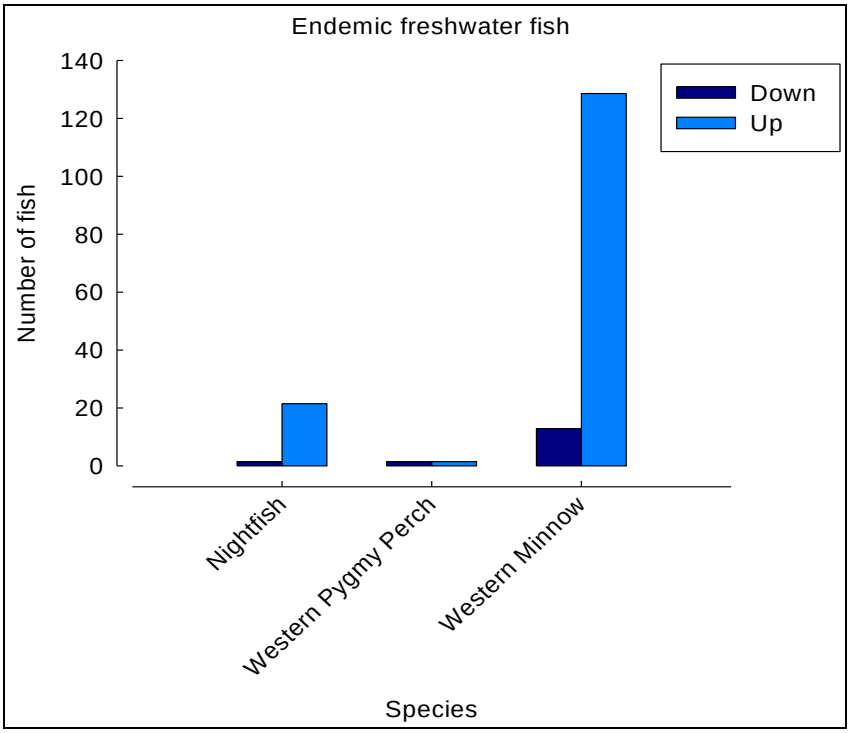


Figure 5: Scaled numbers and direction of movement of endemic fishes captured at Roy Rd in the Carbunup River.

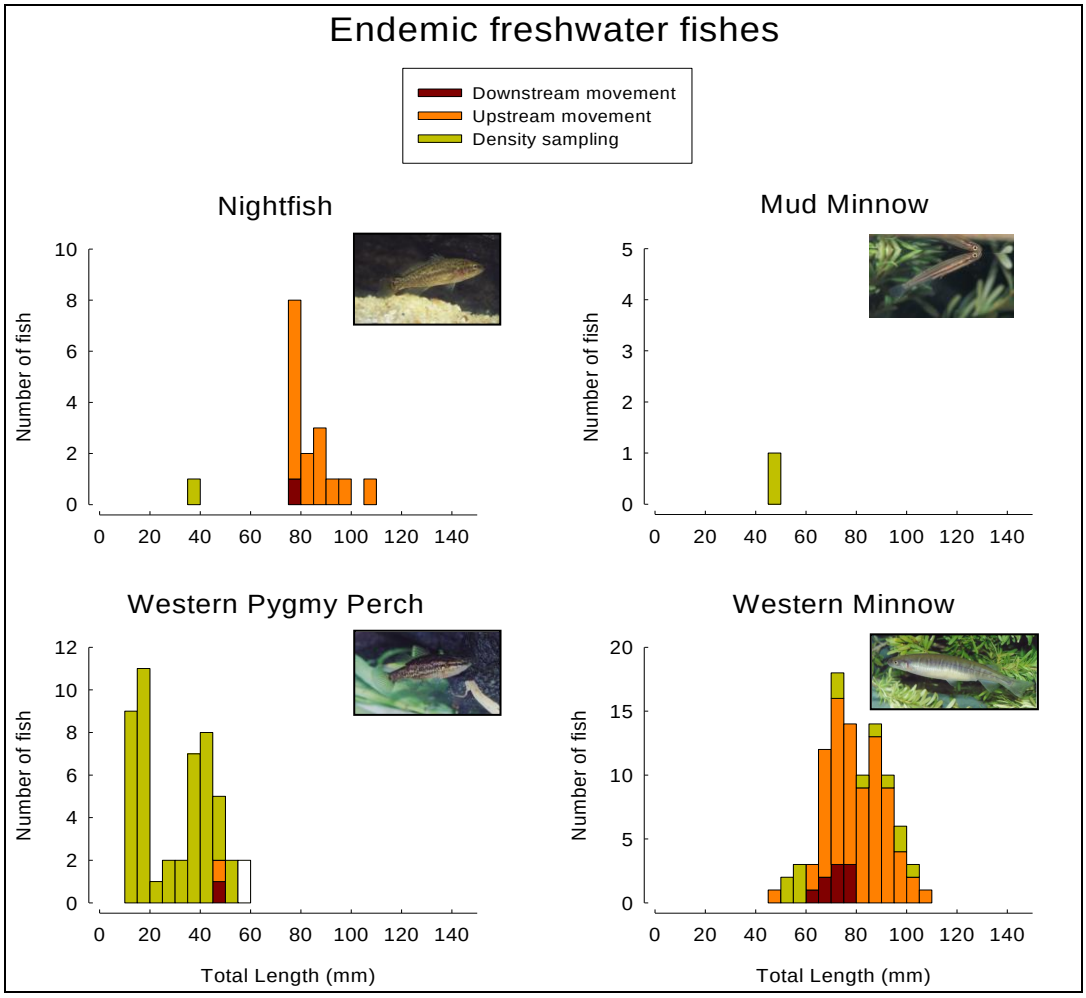


Figure 6: Length-frequency histograms of the freshwater endemic fishes captured in Carbunup River.

Endemic freshwater decapods

Native freshwater crayfishes captured in the freshwater sites were the Gilgie (*Cherax quinquecarinatus*) and Smooth Marron (*Cherax cainii*) with the native South-west Shrimp (*Palaemonetes australis*) also being recorded. The Gilgie was the most abundant (147 individuals or 88% of freshwater decapod captures) and widely distributed species captured in the Carbunup River being found in eight of the nine freshwater sites up to a density of 2.4 crayfish m^{-2} (Table 1). Seven Smooth Marron (4% of freshwater decapod captures) and 14 South-west Shrimp (8% of freshwater decapod captures) were captured from Gale Rd (site #8) and Roy Rd (in the fyke net sampling, see below, Table 1).

Movement of all three species (100% of Gilgies and South-west Shrimps, 67% of Smooth Marron) was predominantly in a downstream direction; and probably a result of nocturnal foraging (at least for the crayfishes) and not spawning as those crayfish captured were juveniles (see discussion below) (Figure 7).

Multiple age classes of both the Gilgie (total size range 9-25 mm OCL, see Figures 8 and 9) and Smooth Marron (size range 15-30 mm OCL) were evident in the Carbunup River; including 0+ (mode of 10-15 mm OCL for the Gilgie and 15-20 mm OCL for the Smooth Marron). The Gilgie has the ability to spawn multiple times from spring through summer (Beatty *et al.* 2005) whereas the Smooth Marron generally only breeds once during winter with juveniles generally released from the pleopods (under the abdomen) of females in November and December (Beatty *et al.* 2003). Therefore, the 0+ individuals of these species would probably have been released the previous spring/summer period.

The Gilgie is a relatively widespread endemic freshwater crayfish and has the ability to occupy both permanent and temporary freshwater habitats; including rivers, streams and wetlands. These adaptive traits would enable its wide distribution in the freshwater sites in the Carbunup River (and Buayanyup River, see next section). They also result in this species being relatively tolerant of habitat disturbance (apart from high levels of salinisation) and have been recorded in many altered drainage systems (for example see Morgan & Beatty 2008).

The Smooth Marron generally prefers larger aquatic habitats and its relatively low abundance in the Carbunup River may reflect the relatively small size of this river compared to other major rivers of the region. The species also requires permanent surface waters which would restrict its distribution to those areas of the Carbunup River that are perennial (e.g. areas with summer refuge pools). Its general non-burrowing nature also results in it relying on instream habitat for

shelter (such as large woody debris and rocks); particularly during breeding and moulting. Therefore, intact riparian vegetation is beneficial to the species by providing a natural source of shelter habitat.

The Carbunup River therefore supports two species of endemic freshwater crayfishes with the Gilgie being widespread and clearly viable whereas the Smooth Marron is more restricted and probably more vulnerable to disturbance due to its reliance on larger, permanent aquatic habitats and also exposure to recreational fishing pressure.

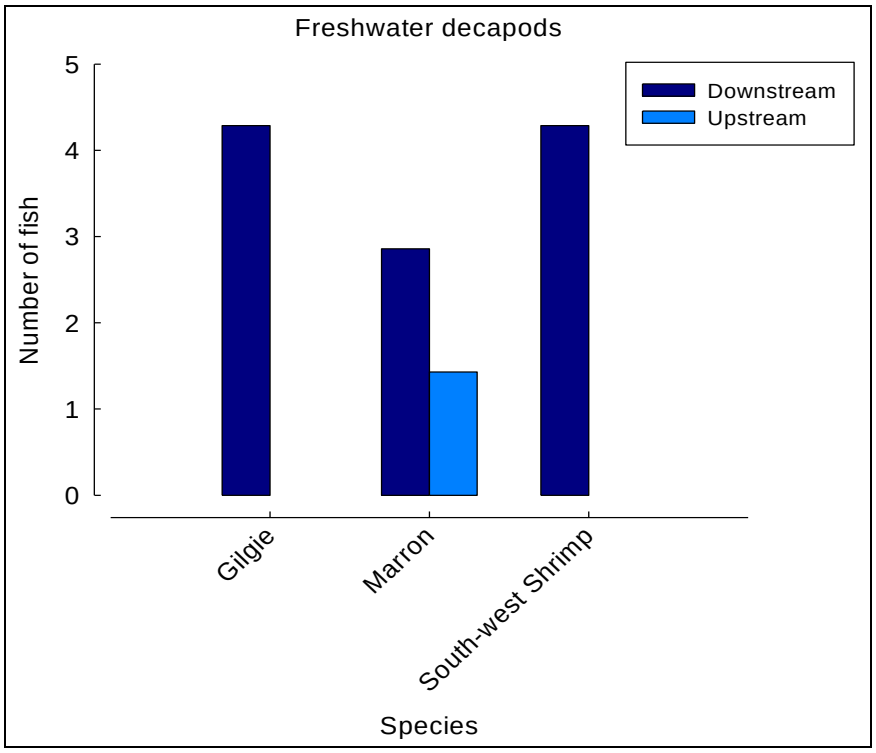


Figure 7: Scaled numbers and direction of movement of freshwater decapods captured at Roy Rd in the Carbunup River.

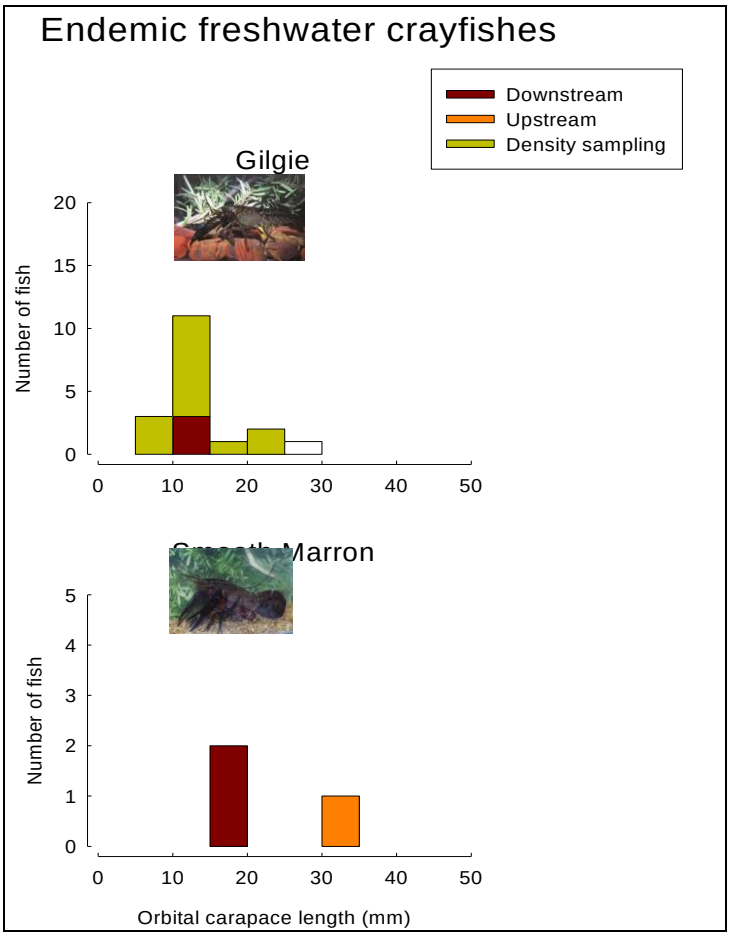


Figure 8: Length-frequency histograms of the freshwater endemic crayfishes captured in the Carbunup River.

Figure 9: Juvenile (0+) Gilgies captured from the upper Carbunup River (Ferguson Rd).

Estuarine fauna

There were nine species of fish and two species of decapods recorded from the (tidal) estuarine site at the mouth of the Carbunup River (Figure 10). Western Hardyhead (*Leptatherina wallacei*) and *Leptatherina presbyteroides* were captured in the greatest numbers; mostly moving in an upstream direction (Figure 10). Juvenile Sea Mullet (see length-frequencies below) were also recorded moving into the Carbunup River. All other species were captured moving in a downstream direction (Figure 10). Notable species included the Blue Swimmer Crab and Black Bream (Figure 10).

The length-frequency distributions of key fish species (in this case those of recreational fishing importance or where large numbers were captured) captured near the mouth are shown in Figure 11. The two hardyhead species (Western Hardyhead *Leptatherina wallacei* and *Leptatherina presbyteroides*) had similar length-frequency distributions. The Black Bream (see Figure 3) and two of the three Blue Swimmer Crabs were sub-legal size. Juvenile Sea Mullet were also recorded.

It appears that the tidal reaches of the Carbunup River are utilised by a number of estuarine or near-shore species as a nursery area or possibly for spawning. A more comprehensive study with at least seasonal sampling would be required to better understand the fish community dynamics of the estuarine reaches of the Carbunup River.

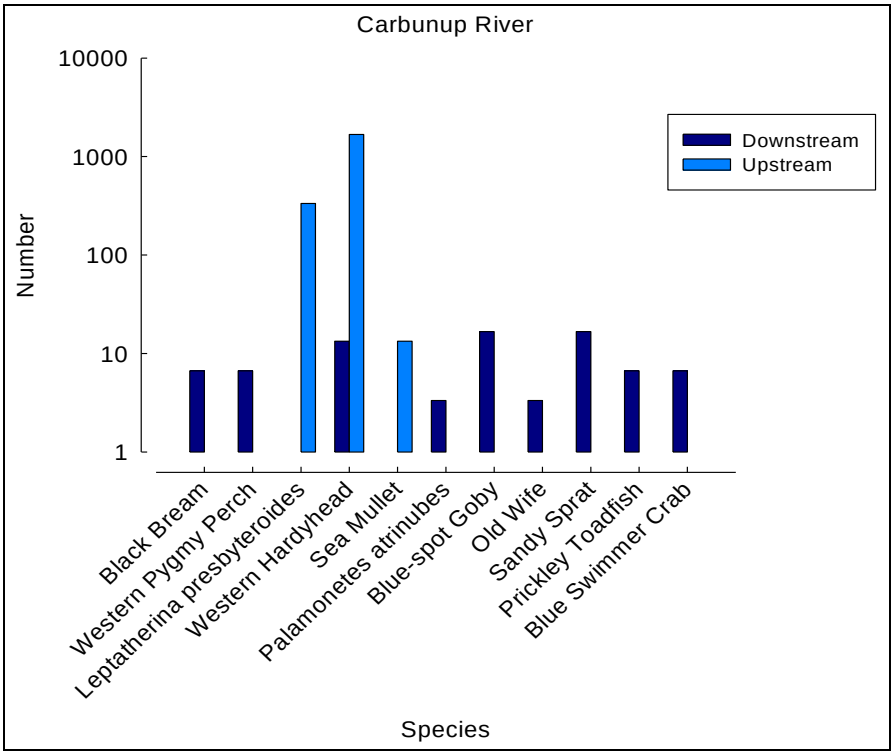


Figure 10: Scaled numbers (log scale) and direction of movement of fish and decapods captured at the mouth of the Carbunup River.

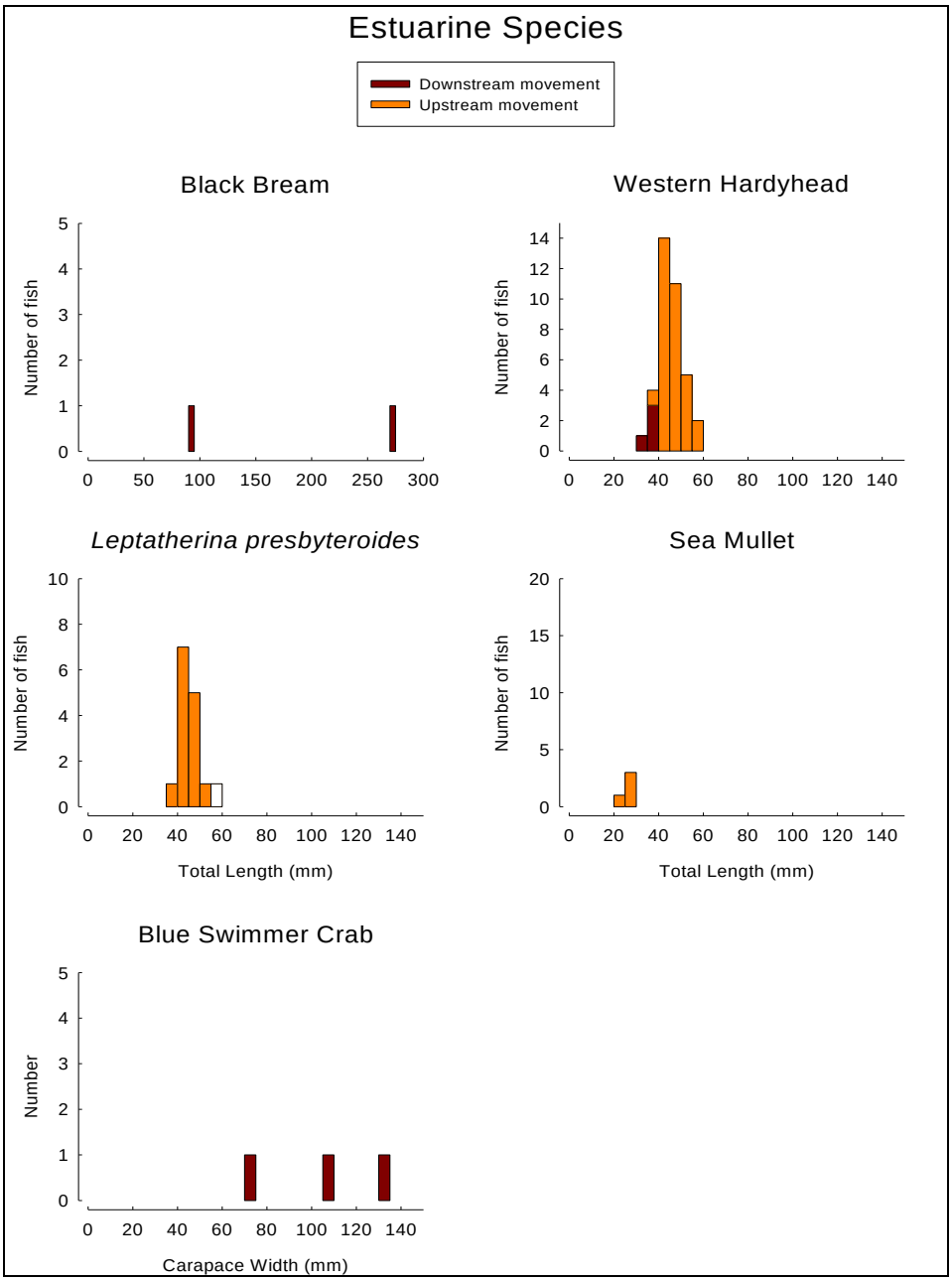


Figure 11: Length-frequency histograms of the fishes and decapods captured at the mouth of the Carbunup River.

Introduced species

Only one introduced species was recorded in the Carbunup River during the study; the Eastern Gambusia at a low density (0.005 fish m^{-2} Table 1) at the property on Bussell Hwy (site #3). However, it should be noted that although not captured during the current study, the Redfin Perch has previously been recorded at the single site previously sampled in the river. The Eastern Gambusia has the ability to rapidly proliferate (live-bearer, young age at maturity) and abundances of the species generally increase during the warmer breeding period; therefore greater numbers may exist in the Carbunup River during summer. It is a damaging species despite its small sized (<60 mm) as it is very aggressive and fin-nips native fishes; particularly Western Pygmy Perch and young (<1 year old) Nightfish (Pen & Potter 1991, Gill *et al.* 1999) (see Figure 12). Its fin-nipping behaviour results in loss of fin rays from the caudal fin reducing swimming ability further increasing susceptibility to attack. Loss of fins may ultimately result in death of individuals (Gill *et al.* 1999). The species generally thrives in slower flowing (or lentic systems), or degraded habitats such as irrigation drains that do not offer refuge (instream structure) for native fishes (Gill *et al.* 1999, Morgan unpublished data). Its low numbers in the current study may suggest that the system did not offer such ideal habitats; however, as mentioned, re-examination during summer could confirm this. Should this additional sampling confirm a restricted distribution and/or low abundance, then a control programme may be appropriate to attempt to eradicate this species from the system.

Figure 12: Fin-nipped Western Pygmy Perch from an Eastern Mosquitofish (insert – not to scale).

Buayanyup River

Endemic freshwater fishes

There were 510 endemic freshwater fishes from four species captured in the Buayanyup River during November 2008 (Table 2). Three of these species were the same as recorded in Carbunup River, i.e. the Western Minnow, Western Pygmy Perch and Nightfish. Based on the position of the origin of the dorsal fin relative to the position of the fifth anal fin ray (i.e. dorsal origin being vertically anterior to the fifth anal ray), the fourth species appeared to be the Black-stripe Minnow (*Galaxiella nigrostriata*) (recorded in Ironstone Gully on Kohlhagen Rd site #9, Figure 1, Table 1). However, additional specimens (of larger size) are still required to completely confirm this identification as the species is very similar in appearance to the Mud Minnow (the latter being recoded in the Carbunup River) (Table 2). This re-sampling is scheduled to occur in 2009 and genetic analysis may also be required.

The common south-west endemic Western Pygmy Perch was the most abundant (317 individuals or 62% of freshwater endemic fish captures, up to 1.413 fish m^{-2}) and, along with the Western Minnow (114 individuals or 22% of freshwater endemic fish captures) were recorded at four of the nine freshwater sites (i.e. excluding the estuarine site #1 at the mouth of the river) (Table 2). The Nightfish was the third most abundant and was the most widespread freshwater fish species being recorded at five of the nine freshwater sites up to a density of 0.24 fish m^{-2} (Table 2).

The direction and strength (scaled for stream width) of movement of the three endemic fishes captured in the fyke nets at Florence Rd bridge (site #2) demonstrated large downstream movements of Western Pygmy Perch (69% of individuals), Western Minnow (95% of individuals) and Nightfish (100% of individuals) (Figure 13).

Almost all gonads of mature female individuals appeared to be in a recovery state suggesting that they had already spawned (see the Carbunup River section for spawning period discussion). Therefore, downstream movements may have been a post-spawning response following a previous upstream movement during winter/early spring (additional seasonal sampling would be required to accurately determine spawning periods and associated migration patterns of these species).

As with the Carbunup River, the length-frequency histograms of endemic fishes revealed the presence of multiple age classes of Western Minnow (0+ animals <~55 mm TL) probably recruited from spawning in winter 2008 (Pen & Potter 1991a). Western Pygmy Perch also had at least two

age cohorts present with the recently recruited 0+ cohort having a size range of ~5-30 mm TL (Pen & Potter, 1991b). The Nightfish also had multiple age classes (total size range of 20-110 mm TL; probably up to four age classes) with the 0+ individuals ranging in size from ~20-50 mm TL) (Figure 14). The Black-stripe Minnows captured ranged from 20-30 mm TL (Figure 14). This species (listed as Lower Risk/Near Threatened IUCN) is known to generally have an annual life-cycle (as with the Mud Minnow) and is a multiple spawner between June and September (Pen *et al.* 1993). It is also able to aestivate thereby occupying seasonal wetlands (Pen *et al.* 1993). If its identification is confirmed, its discovery in the upper Buayanyup River (Ironstone Gully) will be a major range extension as its major geographical range (aside from isolated populations near Bunbury and Gingin) is on the south-coast; mostly in the acidic (pH 3.0-6.0) peat flat wetlands in the D'Estrecasteaux National Park (Morgan *et al.* 1998). Therefore, as with the discovery of the Mud Minnow in Carbunup River, this recording represents a considerable finding with conservation implications for the upper Buayanyup River. The habitat in which it was recorded in Ironstone Gully (see Figure 4) was adjacent to the pine plantation in shallow water; however it was recorded in a thick stand of native sedge that is a favoured habitat of the species. It is therefore extremely important to protect both remnant instream and riparian vegetation to aid in the conservation of this and other endemic fish populations. Furthermore, during the planned confirmation of identification of the species in Buayanyup River, the full extent of its range should be determined by a finer scale survey of the upper Ironstone Gully.

As with the Carbunup River survey, this study has revealed viable populations of the Western Pygmy Perch, Western Minnow and Nightfish and has probably discovered the restricted Black-stripe Minnow. The viability status of this latter species is currently unclear, but likely to be vulnerable in the system due to its apparent highly restricted distribution in upper Ironstone Gully and very low abundance. Similar to the Carbunup River, protection and rehabilitation of both instream and riparian vegetation would enhance the long-term viability of these endemic fish populations

The Western Pygmy Perch, the widespread and most abundant species recorded in Buayanyup River, would be an ideal species for the proposed captive breeding program at the Naturaliste College. This species is a successful aquarium species and, if adequate habitat, food resources and water quality are provided, should be able to be successfully bred by the students.

Table 2: Mean densities of fish and decapods at sites sampled (excluding the estuarine site) in Buayanyup River in November 2008. N.B. * fyke record.

Site description/number	Lat	Long	Native fishes					Native decapods				Introduced species	
			Western Minnow	Western Pygmy Perch	Nightfish	Mud Minnow	Black-strip Minnow	Koonac	Gilgie	Smooth Marron	South-west Shrimp	Yabbie	Eastern Mosquitofish
Buayanyup Brook													
#2 Buayanyup – Florence Rd	33.685	115.248	*	*	*			*		*	*	*	*
#3 Buayanyup - Hairpin Rd Amelia Park	33.729	115.245	**0.013**	**1.413**	**0.025**				**0.013**			**0.063**	
#4 Buayanyup - Jindong-Treeton Rd	33.772	115.215	**0.375**	**0.325**	**0.025**				**0.200**				
#5 Buayanyup - trib on Adams Rd	33.774	115.256											
#6 Ironstone - Gale Rd	33.796	115.235							**0.500**				
#7 Ironstone – trib Susan Seaman property	33.796	115.275			**0.240**				**0.240**				
#8 Ironstone - Price Rd	33.797	115.230	**0.500**	**0.380**					**0.120**				
#9 Ironstone - Kohlhagen Rd	33.830	115.241			**0.050**		**0.150**		**0.250**				
#10 Ironstone – trib Jacka Rd	33.826	115.282							**1.571**				
TOTAL NUMBER			**114**	**317**	**76**	**0**	**3**	**2**	**251**	**2**	**38**	**28**	**40**

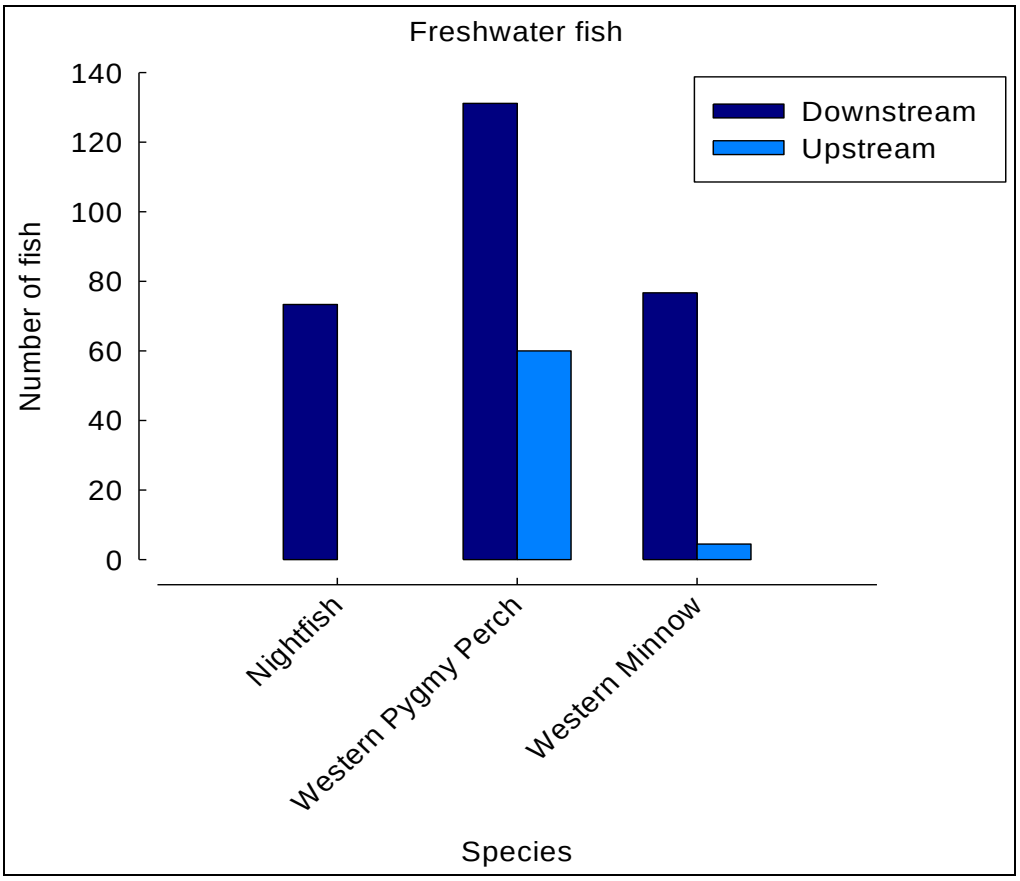


Figure 13: Scaled numbers (log scale) and direction of movement of fish and decapods captured at the Florence Rd site on the Buayanyup River.

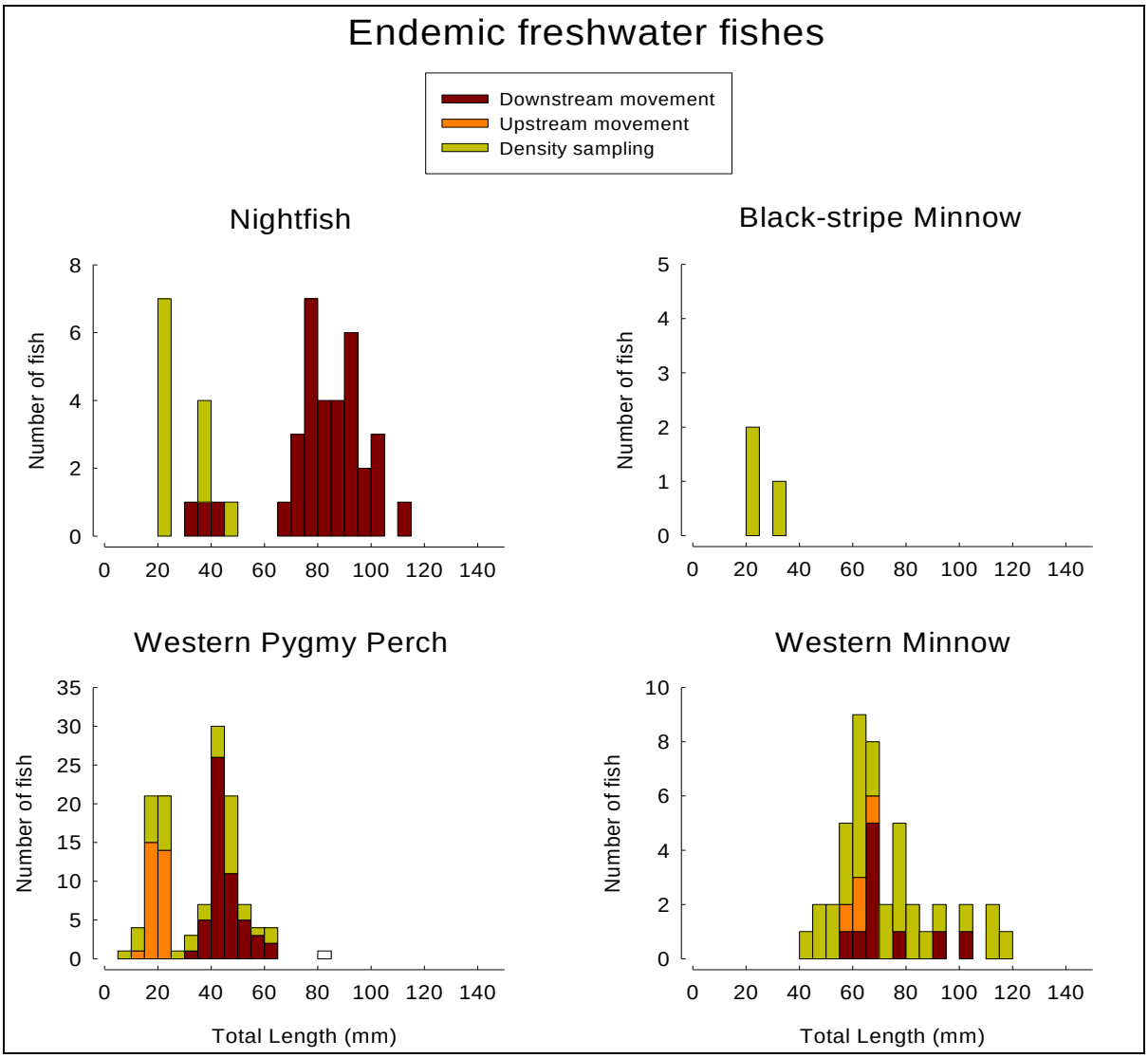


Figure 14: Length-frequency histograms of the freshwater endemic fishes captured in Buayanyup River.

Endemic freshwater decapods

Four species of native freshwater decapods were recorded with the Gilgie being recorded throughout the Buayanyup River (251 individuals in seven of the nine freshwater sites up to a density of 1.57 crayfish m^{-2}). The other three species were only recorded in the fyke net sampling at Florence Rd (site #2) with the freshwater crayfishes the Smooth Marron (two individuals) and Koonac (two individuals) being captured along with the native South-west Shrimp (38 individuals) (Table 2).

Movement directions of decapods at the Florence Rd site was almost entirely in a downstream direction (Figure 15). The length-frequency distribution of the Gilgie in Buayanyup River was similar to that recorded in Carbunup River representing multiple age classes (Figure 16, see Beatty

et al. 2005). Although the biology and ecology of the Koonac has not been fully described, the species is probably similar to the Gilgie in terms of habitat utilisation (i.e. wide range of permanent and temporary aquatic systems) and probably life-cycle (see Beatty *et al.* 2005 for the life-cycle of the Gilgie). The two Koonacs captured were probably >0+ of age with no new recruits being recorded (Figure 16). The Smooth Marron captured (54 mm OCL) was just under legal size of capture. The South-West Shrimp is commonly encountered in a wide range of aquatic systems in south-west Australia; including in salinised and estuarine systems.

The Gilgie population in the Buayanyup River is obviously viable given its high abundance, and wide distribution and size range. Although low numbers of Koonacs were captured at a single site, this population may still be viable in Buayanyup River as it is known to be able to occupy a wide range of aquatic systems and probably has a flexible life-history strategy (similar to the Gilgie). It is unclear whether the Smooth Marron is viable in the Buayanyup River (see also discussion in the Carbunup River) due to its apparent low abundance, restricted distribution, reliance on larger, permanent aquatic habitats and possible recreational fishing pressure.

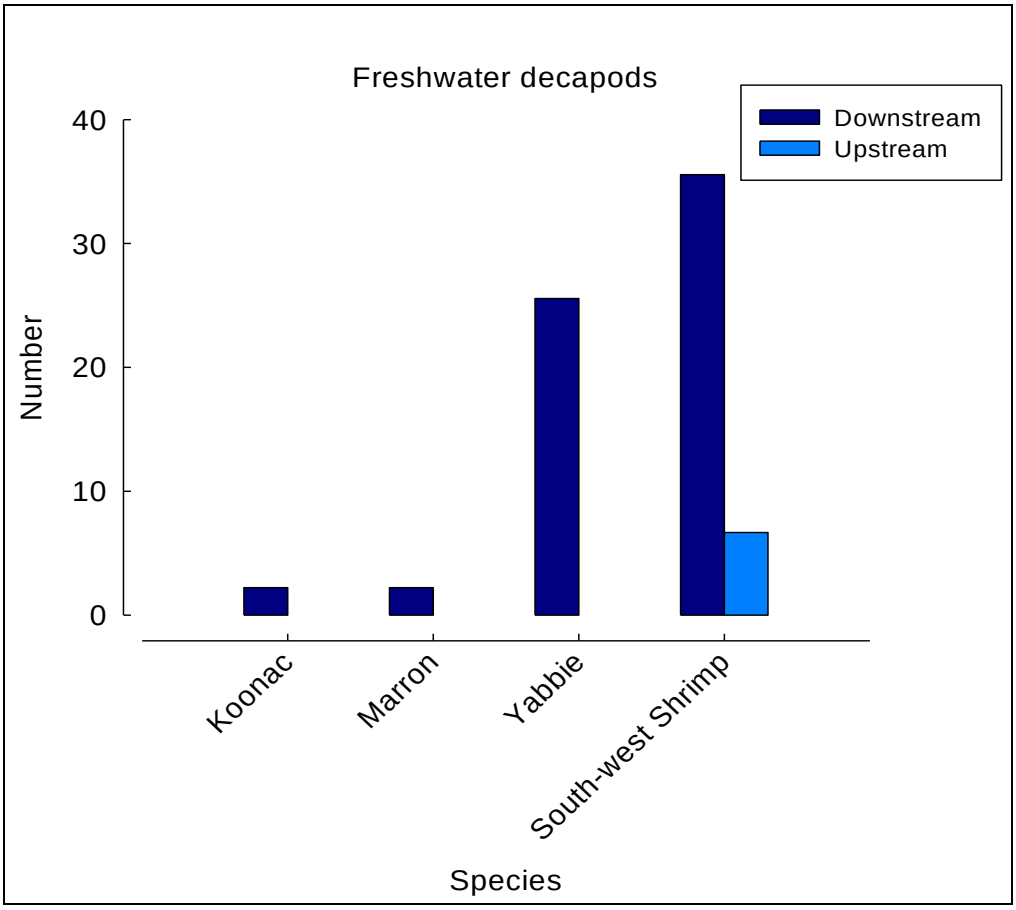


Figure 15: Scaled numbers (log scale) and direction of movement of decapods captured at Florence Rd in Buayanyup River River.

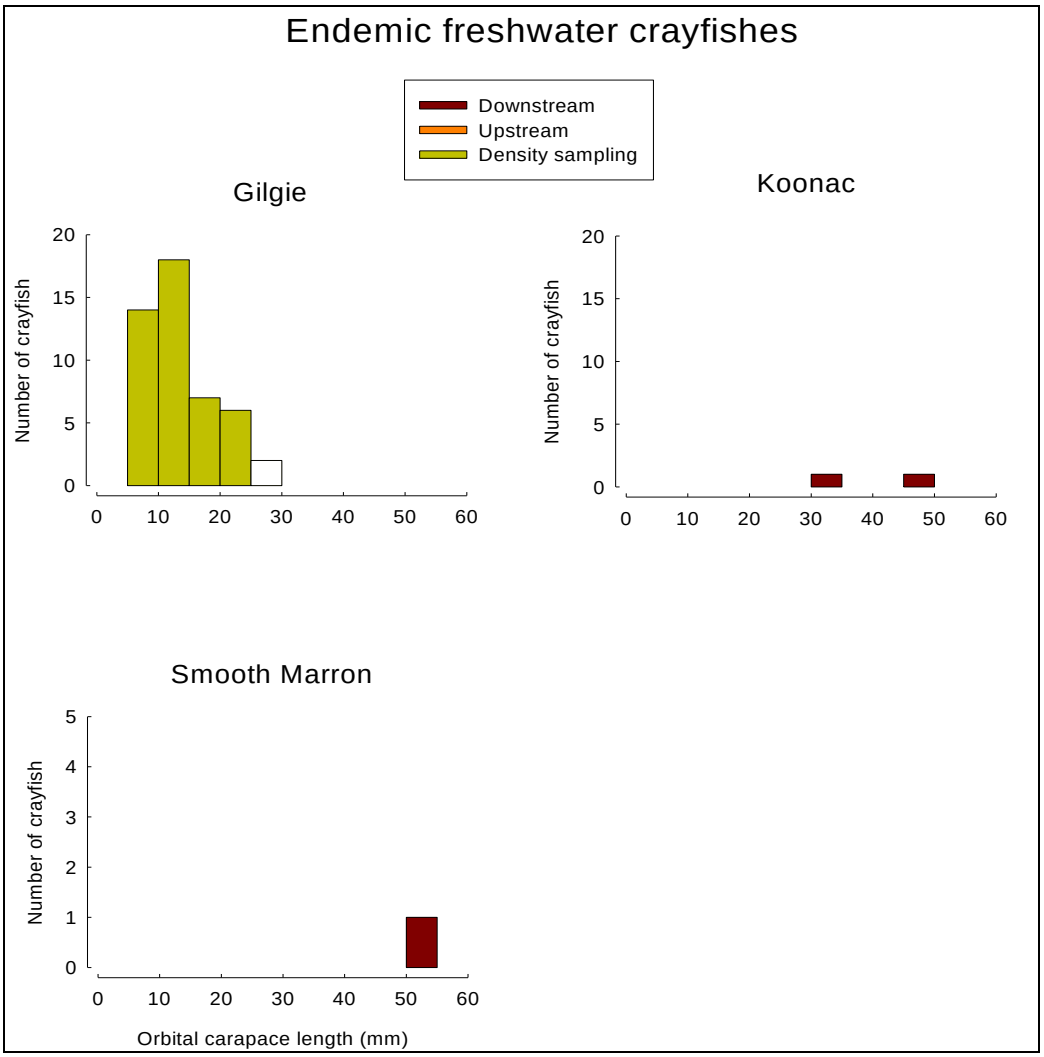


Figure 16: Length-frequency histograms of the freshwater endemic crayfishes captured in Buayanyup River.

Estuarine fauna

Twelve species of fish and one species of decapod were recorded estuarine site near the mouth of the Carbunup River (Figure 17). Similar to the Carbunup River, the Western Hardyhead and *Leptatherina presbyteroides* were captured in large numbers mostly moving upstream direction (Figure 17). Large numbers of Sandy Sprat (*Hyperlophus vittatus* otherwise known as Whitebait) were also recorded mostly moving in an upstream direction (Figure 17). The estuarine shrimp *Palaemonetes atrinubes* was found to be moving upstream and downstream at the site. Low numbers of Black Bream and juvenile Sea Mullet were recorded moving upstream at the site with a juvenile Australian Salmon also captured moving downstream (Figure 17).

The length-frequency distributions of the smaller species (the hardyheads and Sandy Sprat) probably represented multiple age classes (Figure 18). As with the Carbunup River, the Black Bream captured were of sub-legal size (range of 214-262 mm TL) as was the juvenile Australian Salmon (125 mm TL).

Similar to the Carbunup River, the estuarine habitats in the Buayanyup River provide nursery and probably spawning areas for a number of estuarine and nearshore fishes. To better understand the importance of the estuarine ecosystem to fish communities, seasonal sampling of the system would be required. This could provide detailed information on the life-cycles of the estuarine species and better assess the implications of upstream catchment management practices.

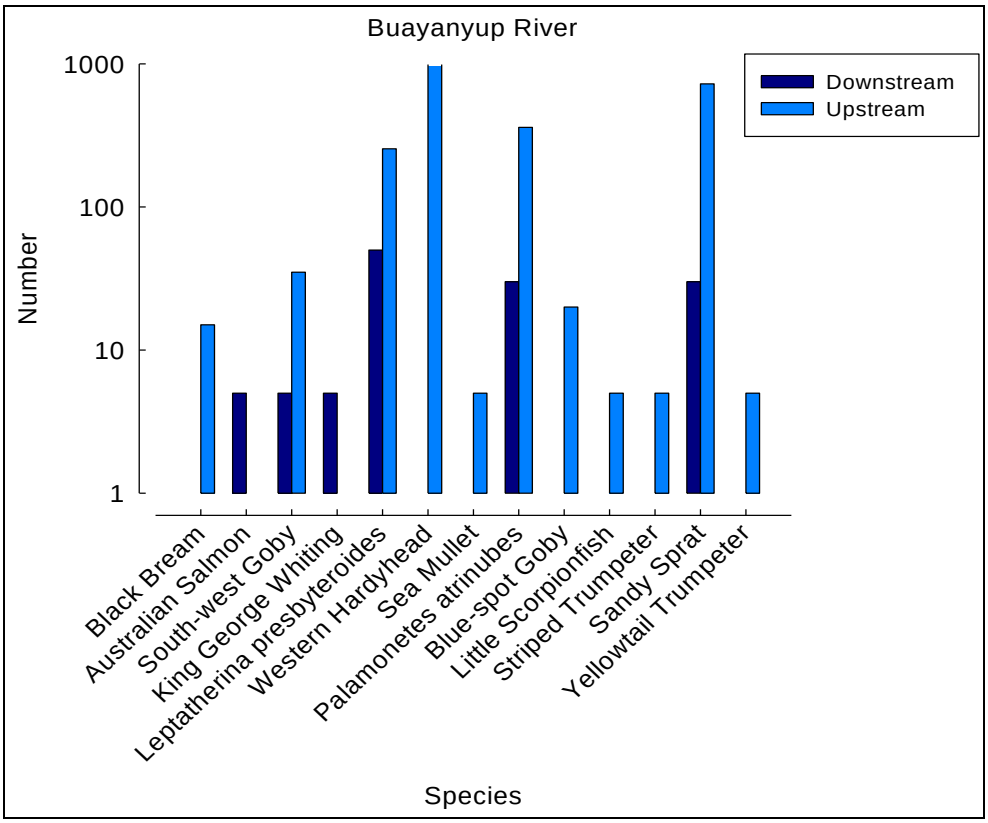


Figure 17: Scaled numbers (log scale) and direction of movement of fish and decapods captured near the mouth of the Buayanyup River.

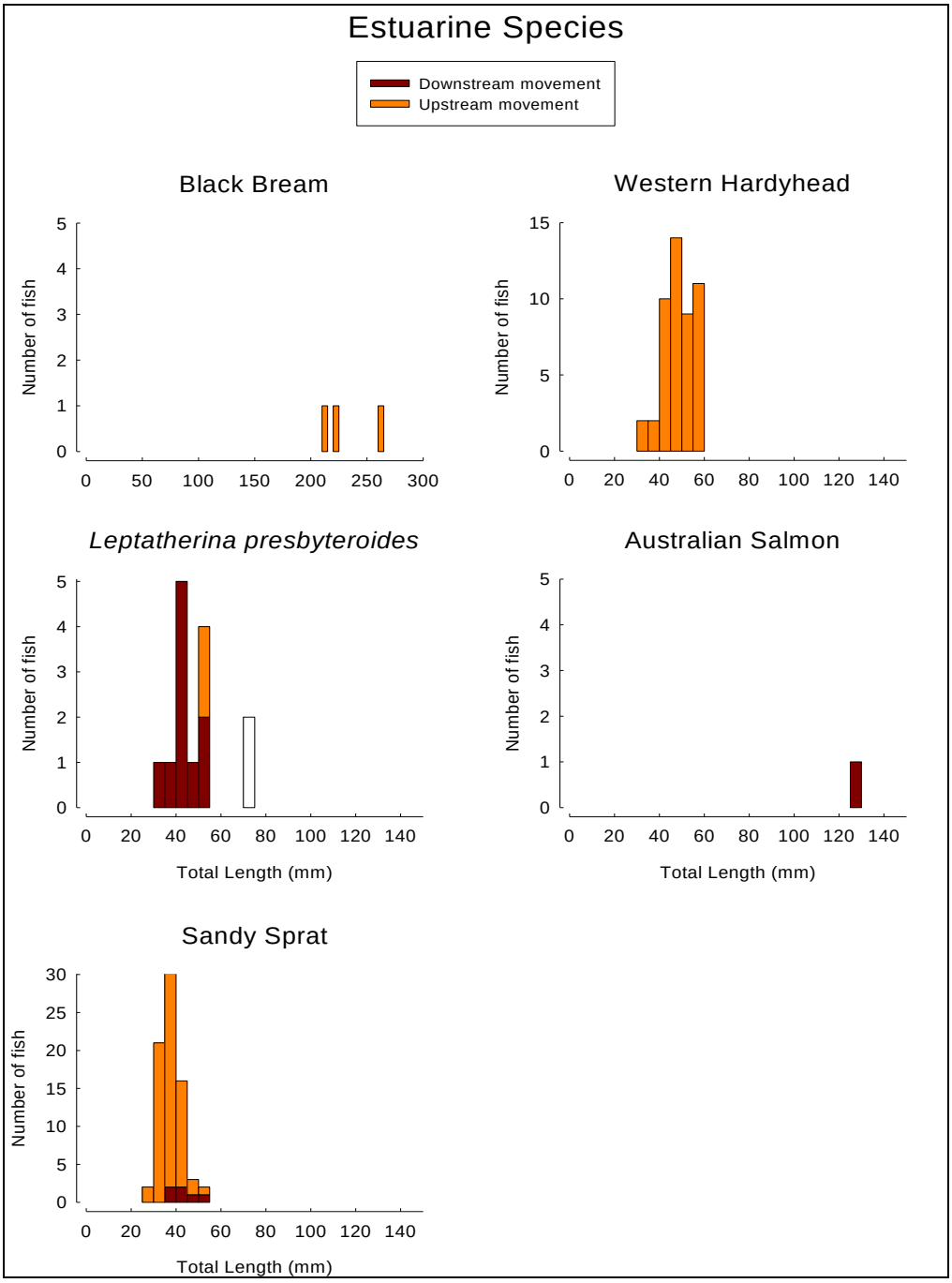


Figure 18: Length-frequency histograms of the fishes captured near the mouth of the Buayanyup River.

Introduced species

The Eastern Mosquitofish was recorded at the Florence Rd site (site # 2, Table 2, Figure 4, see Carbunup River section for the discussion of its impacts). The eastern Australian Yabbie was recorded from two sites in the more downstream freshwater sites in Buayanyup Brook (i.e. sites #2 and 3, Table 2). Figure 19 shows the length-frequency distribution of the species; the individuals were relatively large (~20-45mm OCL) and the population therefore appears to consist of multiple age classes and is presumably self-maintaining in the system.

A simple way to differentiate between the Yabbie and endemic freshwater crayfish of the south-west is presented in Figure 20. The Yabbie, introduced to the region in the 1930's, is an invasive species that is now found in numerous wild aquatic systems in south-western Australia (including the nearby Vasse River, Beatty et al. 2005a). It has a life-history strategy and habitat occupation similar to that of the smaller endemic freshwater crayfishes of the south-west (such as the Gilgie and Koonac). These traits include the ability breed multiple times at the end of its first year of life and able to occupy both permanent and seasonal aquatic habitats (Beatty et al. 2005a). It has been shown to also have a similar growth rate to the larger Smooth Marron it in its first year of life (Beatty et al. 2004, 2005a) and compete directly with it for food resources (Beatty 2006).

Therefore, the presence of a self-maintaining population of Yabbies in Buayanyup River is therefore of considerable concern. A control program could reduce numbers and, given its presence appears to be limited to downstream reaches, limit its upstream spread in the system. However, such a programme may not be able to eliminate it completely. Preventing introductions of aquatic species should be the focus of management attention (e.g. local education campaigns warning of the impacts of Yabbies and other introduced species) as their eradication once established is usually difficult or un-achievable.

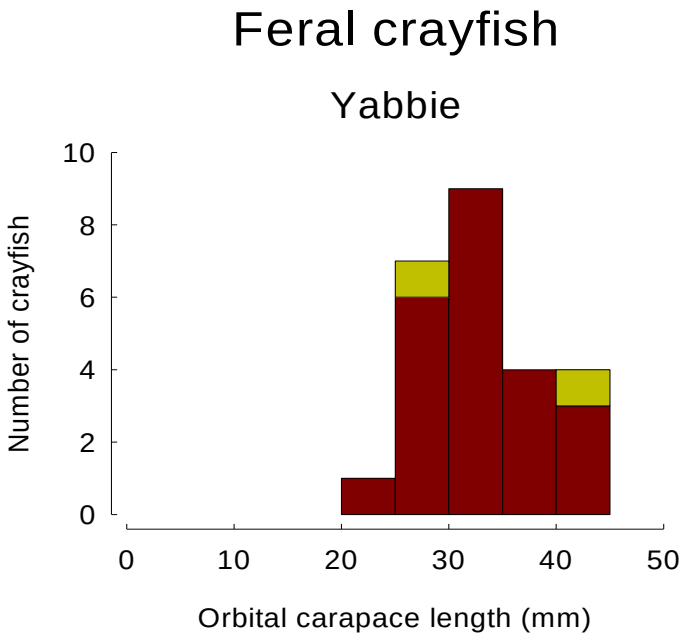


Figure 19: Length-frequency histograms of the Yabbie captured at Florence and Hairpin Rds on the Buayanyup River.

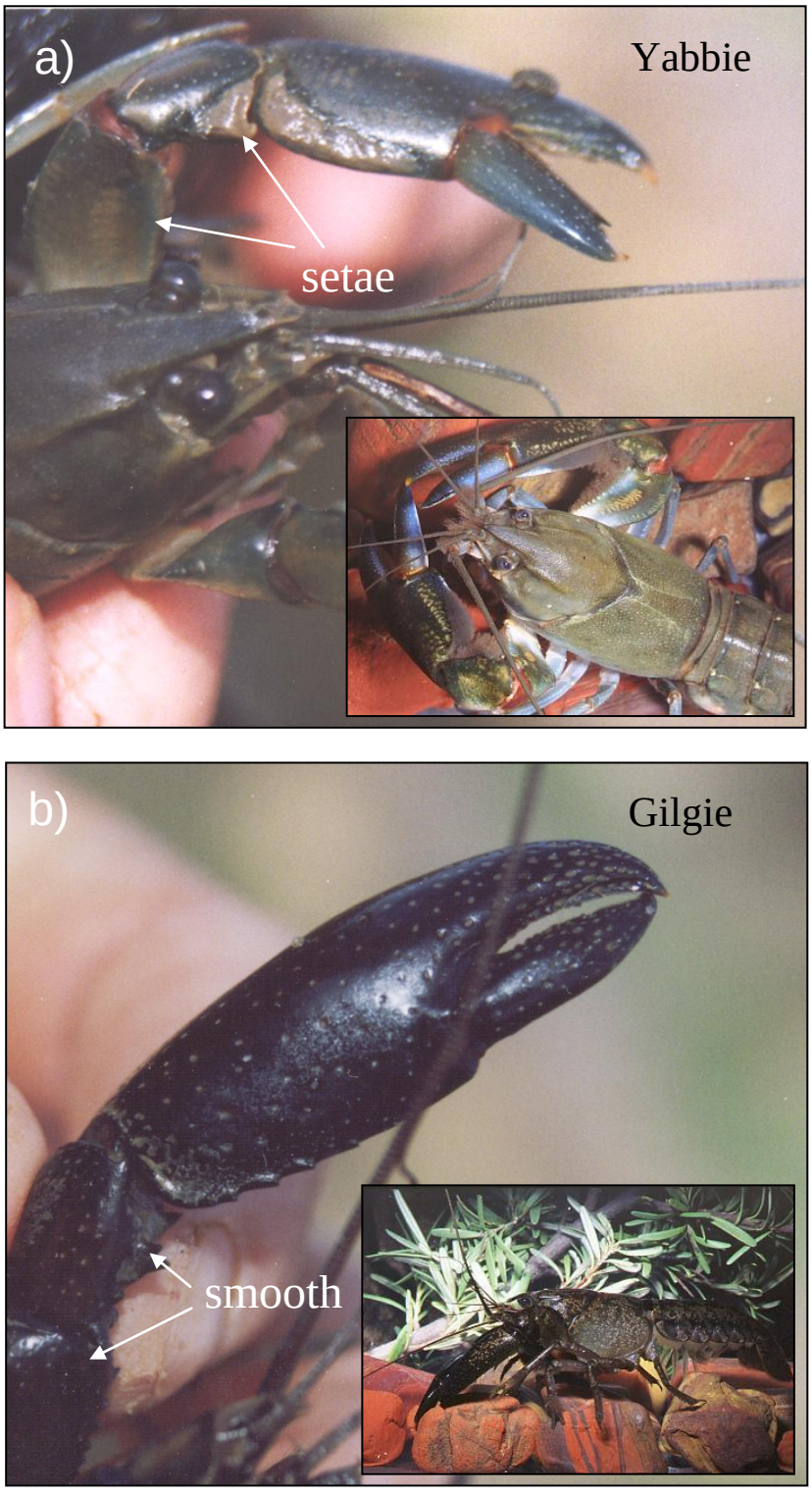


Figure 20: Differentiating between a native Gilgie and the introduced Yabbie. Note the setae on the carpus ('wrist') and merus ('arm') of the Yabbie, compared to the smooth condition of the Gilgie and all other native freshwater crayfish of Western Australia.

Summary and Recommendations

This study has addressed major knowledge gaps on the distribution of freshwater fishes in south-western Australia. It is the first to examine the fish and freshwater crayfish of the Carbunup and Buayanyup Rivers and has had some notable results that have conservation and management implications for these rivers.

Carbunup River

- Contains four of the eight endemic species of freshwater fishes of the south-west region, including the rare Mud Minnow. It was also found to house populations of the Gilgie (the most widespread species) and the Smooth Marron.
- The viability status of the Mud Minnow and Smooth Marron in the Carbunup River requires further investigation; however, as with other native species, these populations would benefit from preservation and rehabilitation of riparian vegetation.
- Nine fishes and two decapods were recorded at the mouth of the Carbunup River; including Black Bream, Sea Mullet and Blue Swimmer Crabs. It appears that the estuarine reaches of the river provide nursery and/or spawning habitats for a number of estuarine and nearshore marine species. Greater understanding of the estuarine fish community could be achieved by undertaking seasonal sampling in the lower reaches of the river.
- The introduced Eastern Gambusia was the only introduced species recorded in the Carbunup River (although historical reports of the Redfin Perch also exist for the system) and only a single individual was captured in Carbunup River (in the Island Brook tributary). Its dry season abundance and distribution should also be assessed to better understand its impact to native fishes in the system, and to develop possible control programs.

Buayanyup River

- Contains four endemic fishes; including the restricted Black-stripe Minnow. The identification of this latter species requires final confirmation by examination of a greater number of larger specimens; however would represent a considerable range extension of the species.
- Three native freshwater crayfishes were recorded with the Gilgie again been widespread and abundant when compared to the Smooth Marron and Koonac.
- Twelve fishes and one species of shrimp were recorded at the estuarine site in Buayanyup Brook; including Black Bream, Australian Salmon and Sea Mullet. As with the Carbunup

River, the tidal reach of Buayanyup probably provides nursery and/or spawning habitat for a number of estuarine and nearshore marine species.

- Both the introduced Yabbie and Eastern Gambusia were recorded in Buayanyup River with control programs of the species potentially able to reduce abundances and restrict their spread; but are unlikely to completely eliminate them from the river.
- The widespread and most abundant Western Pygmy Perch in Buayanyup River would be an ideal species for the proposed captive breeding program at the Naturaliste College. This species is a successful aquarium species and, provided adequate habitat, food resources and water quality are provided, should be able to be successfully bred by the students.

Future actions

- Additional surveys should be undertaken to determine the distribution and viability of the Mud Minnow and Black-stripe Minnow (as well as its final identification) in the Carbunup and Buayanyup River, respectively.
- Additional, dry-season surveys of the distribution and abundances of Eastern Gambusia and Yabbie should be conducted with the aim of potentially developing control programs for these species.
- Protection and rehabilitation of riparian and instream vegetation through development of River Action Plans for these systems would enhance the viability of the prevailing native fish and freshwater crayfish fauna via: helping to maintain and increase water quality, supplying shelter from predators, creating spawning habitat and supplying food resources.

REFERENCES

Beatty, S. J. (2006). The diet and trophic positions of translocated, sympatric populations of *Cherax destructor* and *Cherax cainii* in the Hutt River, Western Australia: evidence of resource overlap. *Marine & Freshwater Research* 57(8): 825-835.

Beatty, S.J., Morgan, D.L. & Gill, H.S. (2004). Biology of a translocated population of the large freshwater crayfish, *Cherax cainii* (Austin & Ryan, 2002) in a Western Australian river. *Crustaceana* 77(11): 1329-1351.

Beatty, S.J., Morgan, D.L. & Gill, H.S. (2005). Life history and reproductive biology of the gilgie *Cherax quinquecarinatus*, a freshwater crayfish endemic to south-western Australia *Journal of Crustacean Biology* 25(2): 251-262.

Beatty, S.J., Morgan, D.L. & Gill, H.S. (2005a). Role of life history strategy in the colonisation of Western Australian aquatic systems by the introduced crayfish *Cherax destructor* Clark, 1936. *Hydrobiologia* 549: 219-237.

Gill, H.S., Hambleton, S.J. & Morgan, D.L. (1999). Is *Gambusia holbrooki* a major threat to the native freshwater fishes of south-western Australia? In Seret, B. & Sire, J.-Y., (eds). *Proceedings 5th Indo-Pacific Fish Conference (Noumea, 3-8 November1997)*. Pp. 79-87. (Paris: Societe Francaise d'Ichtyologie & Institut de Recherche pour le Development).

Morgan, D. & Beatty, S. (2003). *Fish fauna of Margaret River Western Australia*. Centre for Fish & Fisheries Research, Murdoch University Report to the Margaret River Regional Environment Centre.

Morgan, D. & Beatty, S. (2004). *Fish fauna of the Vasse River and the colonisation by feral goldfish (Carassius auratus)*. Centre for Fish & Fisheries Research, Murdoch University Report to the Department of Environment, Government of Western Australia.

Morgan, D.L. & Beatty, S.J. (2008). *Check structures and fish and crayfish fauna in the Harvey Irrigation Area.* Centre for Fish & Fisheries Research, Murdoch University Report to Department of Water.

Morgan, D.L., Gill, H.S. & Potter, I.C. (1998). Distribution, identification and biology of freshwater fishes in south-western Australia. *Records of the Western Australian Museum Supplement No. 56*, 97 pp.

Pen, L.J., Gill, H.S.., Potter, I.C. & Humphries P. (1993) Growth, age composition, reproductive biology and diet of the black-stripe minnow *Galaxiella nigrostriata* (Shipway), including comparisons with the other two *Galaxiella* species. *Journal of Fish Biology* 43: 847-863.

Pen, L.J. & Potter, I.C. (1991a). Biology of the western minnow, *Galaxias occidentalis* Ogilby (Teleostei: Galaxiidae), in a south-western Australian river. 1. Reproductive biology. *Hydrobiologia* 211: 77-88.

Pen, L.J. & Potter, I.C. (1991b). The biology of the western pygmy perch, *Edelia vittata*, and comparisons with two other teleost species endemic to south-western Australia. *Environmental Biology of Fishes* 31: 365-380.

Pen, L.J. & Potter, I.C. (1991c). Biology of the nightfish, *Bostockia porosa* Castelnau, in south-western Australia. *Australian Journal of Marine and Freshwater Research* 41: 627-645.

Pen, L.J., Potter, I.C. & Hilliard, R.W. (1991). Biology of *Galaxiella munda* McDowall (Teleostei: Galaxiidae), including a comparison of the reproductive strategies of this and three other local species. *Journal of Fish Biology* 39: 717-731.