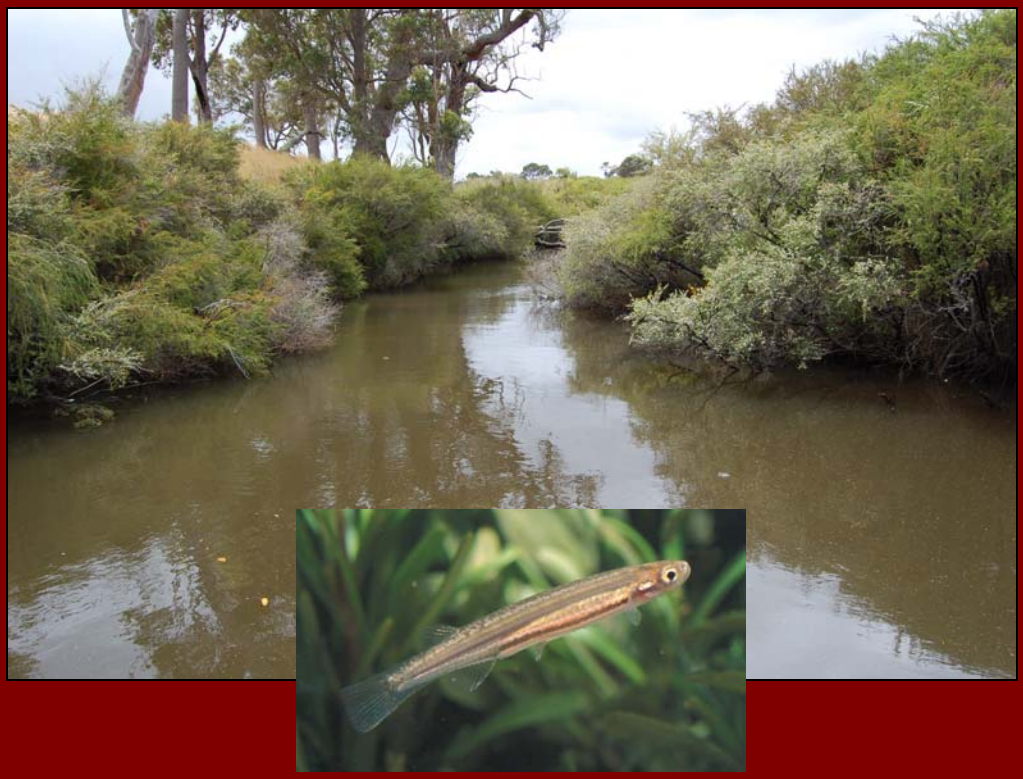
McLeod Creek (Blackwood River) fish survey: December 2007



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Prepared for

Lower Blackwood Landcare

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Background and scope of the study

The fish and crayfish fauna of south-western Australia is highly endemic (80% and 100% endemism of fishes and crayfishes, respectively). The fishes of the majority of the Blackwood River catchment have recently been well documented (Morgan *et al.* 1998, 2003, Morgan & Beatty, 2005; Beatty *et al.* 2007). The catchment is known to contain all of the eight endemic south-west fish species (with the Black-stripe Minnow and Salamanderfish being found in the wetland habitats on the Scott River). However, secondary salinisation of the catchment has resulted in many of the non-salt tolerant species now being restricted to tributaries within the lower, forested section of the catchment. This salinisation has also resulted in the upstream colonisation of the main channel by the estuarine species found in Hardy Inlet (Hodgkin 1978; Vallesini *et al.* 1997; Morgan *et al.* 2003; Morgan & Beatty, 2005; Beatty *et al.* 2006a).

However, the input of fresh groundwater from the Leederville and Yarragadee aquifers has recently been shown to continue to allow endemic freshwater species to utilise the large sections of the main channel during summer; when many tributaries contract or dry completely (Beatty *et al.* 2006a). The significant differences in fishes between the main channel and tributaries of the Blackwood River therefore result in halotolerant species such as the Freshwater Cobbler, Western Hardyhead, Swan River Goby and South-western Goby dominating main channel captures upstream of the tidal influence, while those less halotolerant species such as the Western Pygmy Perch, Nightfish, Mud Minnows and Balston's Pygmy Perch are mostly (exclusively for the Mud Minnow) captured in the tributaries (particular during elevated salinities found in winter).

The estuarine species within the tidal zone of the Blackwood River has previously been documented (Hodgkin 1978; Vallesini *et al.* 1997). It was found that considerable variations in the fish assemblages (grouped into estuarine species, marine-estuarine-opportunistic species and marine stragglers) of three estuarine habitats (i.e. the estuarine basin, estuarine channel and Deadwater Lagoon) occurred that was related to the seasonal patterns of freshwater discharge. For example during winter flows, marine stragglers exited the estuary, densities of marine estuarine-opportunistic reduced and the estuarine Western Hardyhead moved down from the Blackwood River increasing in density in the estuary (Vallesini *et al.* 1997). Furthermore, Deadwater Lagoon (present in 1997) had a limited tidal movement and high productivity that resulted in high densities of estuarine species and low densities of marine stragglers (Vallesini *et al.* 1997).

Previous research in the Blackwood River has therefore demonstrated the importance of freshwater tributaries for recruitment (i.e. spawning and nurseries) and therefore sustainability of freshwater fishes of the Blackwood River and the influence of seasonal discharge on the estuarine and marine invading fishes in the Hardy Estuary. Although fish distributions in many of the tributaries in the middle and upper reaches of the Blackwood River have been documented (Morgan *et al.* 2003; Morgan & Beatty, 2005; Beatty *et al.* 2007), the fish fauna of tributaries downstream of Great North Rd (including those within the zone of tidal influence) have not previously been well documented.

McLeod Creek is a relatively large tributary that discharges into the lower Blackwood River at approximately the upstream limit of the tidal influence. No information currently exists on the fishes or freshwater crayfishes of this tributary. The aim of the

study was to determine the fish and freshwater crayfish fauna in McLeod Creek and provide an assessment of its importance as a freshwater fish refuge.

Methodology

A total of six sites were sampled for fish and freshwater crayfish in McLeod Creek during December 2007 (see Figure 1 for descriptions and coordinates). Two fyke nets (each consisting of two wings that stretch across a large proportion of the stream channel and a central funnels that allows fish to enter but not exit the net) were set overnight at each site; one facing upstream (catching fish moving downstream) and one downstream (capturing fish moving upstream) (Figure 1). Depending on the instream habitat condition, either a back-pack electrofisher or a 10-m seine net was also deployed following the fyke-netting at each site. The back-pack electrofisher temporarily stuns the fish and crayfish allowing them to be collected with a scoop-net and the seine net actively captures the fishes by cordoning off an area allowing all fishes to be collected in the bunt of the net. A gill net (3 inch mesh, 50 m in length) was also set near the mouth of McLeod Creek (site 1, Figure 1).

Upon capture by the three methods, all fishes and crayfishes were identified to species and measured to the nearest 1-mm total length (TL) and orbital carapace length (OCL) for fishes and crayfishes, respectively. The area over which the electrofisher and seine netting occurred at each site was estimated and a density of each species determined. The percentage of the stream channel blocked by the fyke-netting was determined and the numbers capture overnight scaled to represent 100% blockage of the stream. The upstream and downstream movement of each species capture in the fykes was displayed graphically for each site.

The water temperature, dissolved oxygen, conductivity, turbidity and pH were recorded at three locations in each site and a mean (±1 SE) determined.

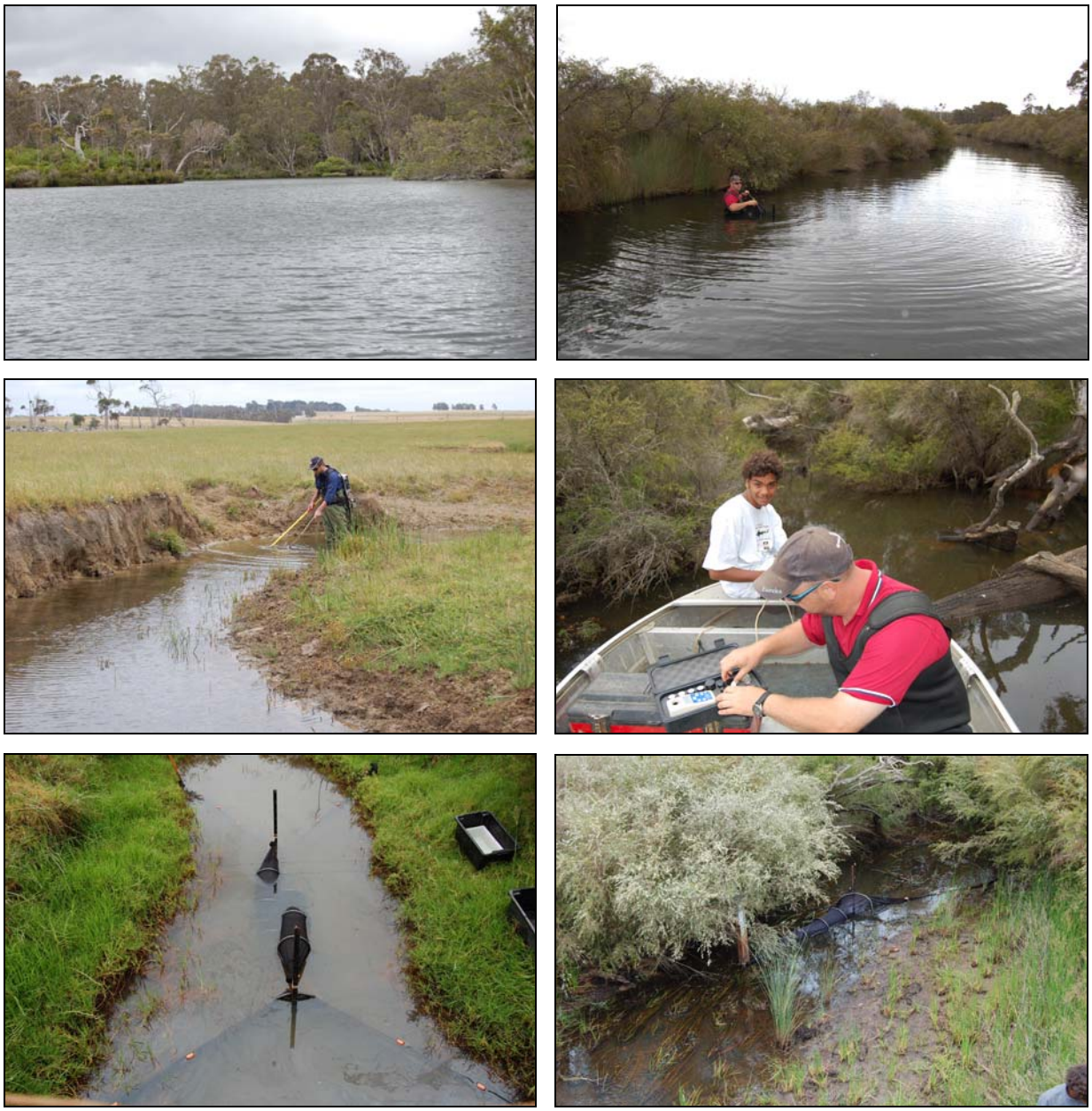

Figure 1 Clockwise (from top left): fyke nets in McLeod Creek site 1 (~200 m from the confluence with the Blackwood River, S34.15881, E115.18462), setting fyke nets at McLeod Creek site 2 (~900 m from the confluence, S34.15898, E115.17665), turbidity being taken in McLeod Creek site 3 (~1900 m from the confluence, S34.15792, E115.16567), fyke nets set at McLeod Creek site 4 (~4600m from the confluence, 34.16026, E115.12129), fyke nets set at Rushy Creek site 1 (~1800m from the confluence of McLeod Creek with the Blackwood River, S34.16278, E115.16636), electrofishing Rushy Creek site 2 (~3000 m from the confluence of McLeod Creek with the Blackwood River, S34.16301, E115.15324).

Results

Environmental variables

Top and surface water temperatures and conductivities were recorded at McLeod Creek site 2 and these measurements clearly showed that a tidal salt wedge existed as far up as this site; however this salt incursion was not present at McLeod Creek site 3 at the time of sampling (Figure 2). Temperature was greatest at McLeod Creek site 1 (near the mouth of the Blackwood River) then declining at McLeod Creek sites 2 (surface measurement), 3 and 4. The temperature at the two Rushy Creek sites was greater than those upstream in McLeod Creek (Figure 2). Conductivity measurements showed a sharp decrease upstream of the tidal influence at McLeod 1 and 2; being consistently fresh (<800 µm) at the upstream sites including the two sites in Rushy Creek (Figure 2). The trend in pH showed that both systems were approximately neutral at the time of sampling with a general increase moving upstream; ranging between ~7.3 to ~6.2. The system was relatively clear, however, a slight increase in turbidity was recorded moving upstream in McLeod Creek (Figure 2).

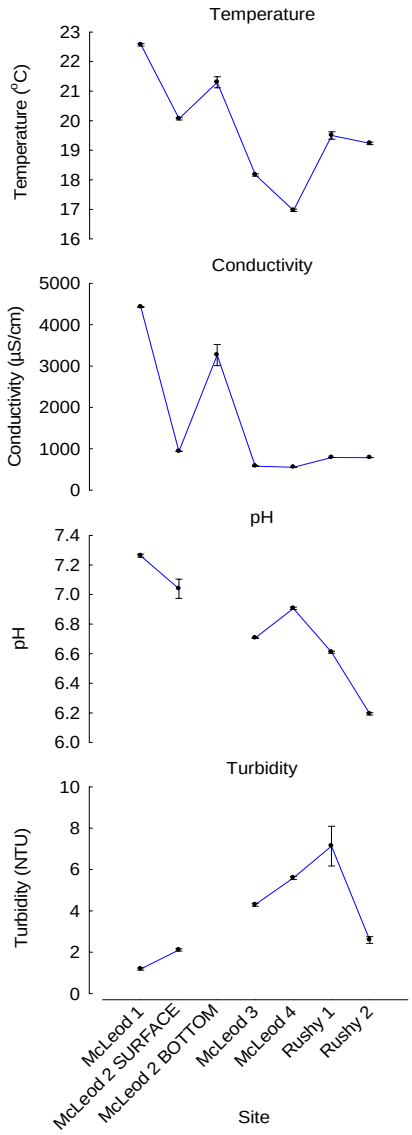

Figure 2 Mean water temperature, conductivity, pH and turbidity in the sites sampled in McLeod Creek and Rushy Creek during December 2007. N.B. the clear salt wedge that existed at McLeod 2 (~900 m from the mouth) as demonstrated by a sharp increase in the conductivity at the bottom of the water column compared to that on the surface.

Densities of fishes and decapods in McLeod Creek

A total of 2755 fish were captured using fyke nets, electrofisher, gill net, and seine nets during the McLeod Creek survey. Of these 66.1% were endemic freshwater fishes (Western Minnow, Western Pygmy Perch, Nightfish and Mud Minnow), 14.4% were estuarine species (Western Hardyhead, Swan River Goby, South-West Goby, Black Bream), and 19.5% of captures was the feral Eastern Gambusia.

Table 1 shows the density estimates of the species captured in the five sites where density sampling occurred using seine netting and electrofishing. The endemic freshwater fishes the Western Pygmy Perch and Western Minnow were recorded in relatively high densities in the McLeod Creek sites. The Western Minnow was also recorded at relatively high densities in the cleared farmland site in Rushy Creek (site 2, Figure 1); where the feral Eastern Gambusia was also recorded in relatively high densities (Table 1). Notably, the threatened Mud Minnow (listed as Schedule 1 CALM) was recorded at low density (0.13 ± 0.19 fish/m^2) at McLeod Creek site 4 (Figure 1, Table 1). McLeod Creek site 4 also housed the endemic Nightfish and high densities of the feral Eastern Mosquitofish (Table 1).

Three estuarine species commonly found in the main channel of the Blackwood River and Hardy Inlet were recorded in the density estimates at McLeod Creek 1 (near the mouth) although the Swan River Goby and Western Hardyhead were also recorded at sites further upstream in the fyke netting (see following fish movement section) (Table 1).

Three decapod species were recorded in the survey. The endemic freshwater crayfish the Gilgie and eastern Australian introduced species the Yabby were both recorded at the two most upstream sites in McLeod Creek (site 4) and Rushy Creek (site 2). Very high densities (69.7 ± 98.52 m^{-2}) of the endemic South-west Shrimp were recorded at McLeod Creek site 1 near the mouth (Table 1).

The threatened Mud Minnow

Table 1: Mean densities (±1 SE) of fish and decapods in McLeod Creek during sampling in December 2007. N.B. total numbers do not include fyke net captures, * Black Bream was recorded in the gill net at McLeod Creek 1.

Site	Native fishes				Estuarine fishes			Feral species		Native decapods	
	Western Minnow	Mud Minnow	Nightfish	Western Pygmy Perch	Black Bream	Swan River Goby	Western Hardyhead	Eastern Gambusia	Yabbie	Gilgie	Freshwater Shrimp
McLeod Creek 1	1.13 (1.23)	0	0	6.53 (9.24)	*	0.07 (0.09)	1.10 (1.56)	0.28 (0.02)	0.000	0.000	69. 67 (98.52)
McLeod Creek 4	1.41 (1.53)	0.13 (0.19)	0.25 (0.35)	5.10 (6.93)	0	0	0	6.00 (5.66)	0.03 (0.05)	0.08 (0.11)	0
Rushy Creek 1	0.06	0	0	3.140	0	0	0	1.04	0	0	0
Rushy Creek 2	5.14 (6.87)	0	0.04 (0.05)	0.43 (0.61)	0	0	0	2.43 (0.61)	0.57 (0.81)	0.40 (0.20)	0
TOTAL NUMBER	**432**	**4**	**15**	**567**	**0**	**2**	**33**	**506**	**81**	**23**	**2090**

Movements of fishes and decapods in McLeod Creek

The fyke netting in McLeod Creek revealed upstream and downstream movements of the various fish and decapod species. Figure 3 demonstrates that the Western Minnow were generally moving in an upstream direction in McLeod Creek. Movements of Western Pygmy Perch and Nightfish were recorded at all sites sampled; particularly downstream movement of Western Pygmy Perch and upstream movement of Nightfish at McLeod Creek site 1 (near the mouth of the system) (Figure 3). Very large downstream movement of the Eastern Mosquitofish was recorded at the uppermost farmland site in Rushy Creek (i.e. site 2) (Figure 3).

Movements of estuarine fishes are displayed in Figure 4. Small numbers of the South-west Goby were recorded moving at McLeod Creek sites 2 and 3 and the downstream site in Rushy Creek (Figure 4). Bidirectional movement of the Swan River Goby was recorded in McLeod Creek; particularly in a downstream direction at McLeod Creek site 1. The Western Hardyhead was recorded moving upstream in large numbers at McLeod Creek site 1 and this species was not found in either the density estimates or fyke netting upstream of McLeod Creek site 3 (Table 1, Figure 5).

Downstream movements of Gilgies and Yabbies were recorded at the uppermost site on Rushy Creek; the site where they recorded in relatively high densities (Figure 6, Table 1). South-west Shrimp was recorded moving upstream and downstream in large numbers at McLeod Creek 1; near the mouth of the system. However, this species was also recorded moving upstream at the other sites in the system (Figure 6).

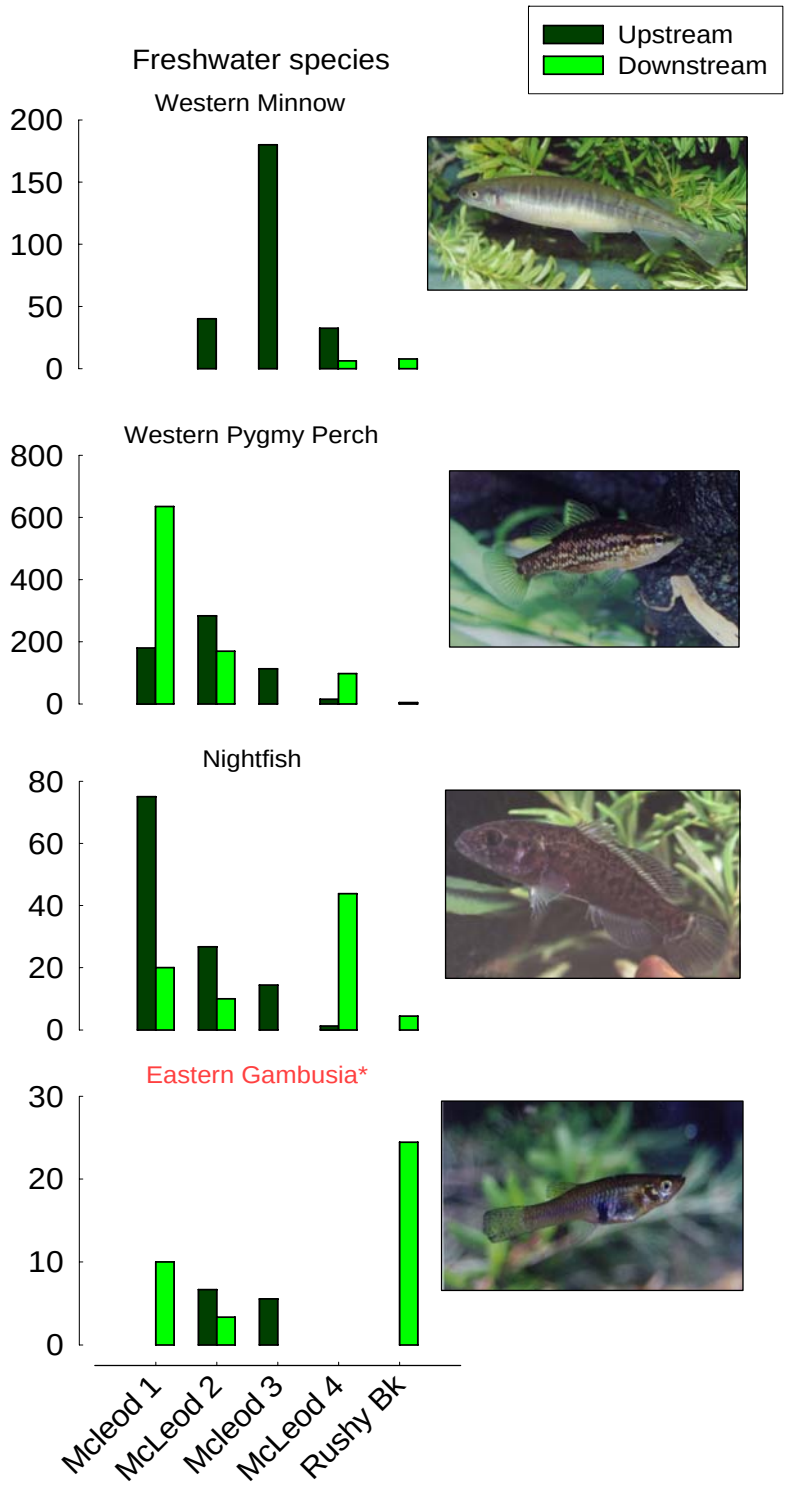

Figure 3 Upstream and downstream movements of freshwater fishes in McLeod Creek and Rushy Creek during sampling in December 2007. * denotes a feral species.

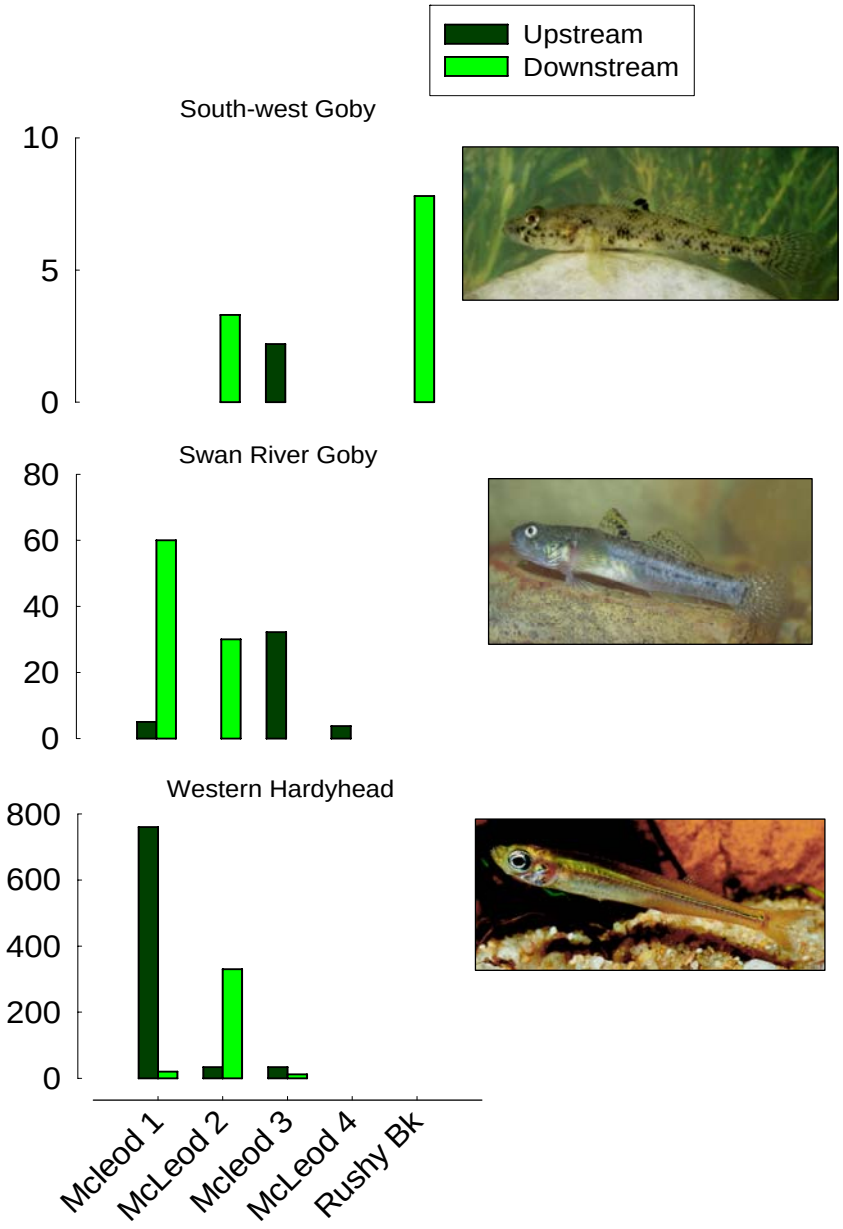

Figure 4 Upstream and downstream movements of estuarine fishes in McLeod Creek and Rushy Creek during sampling in December 2007.

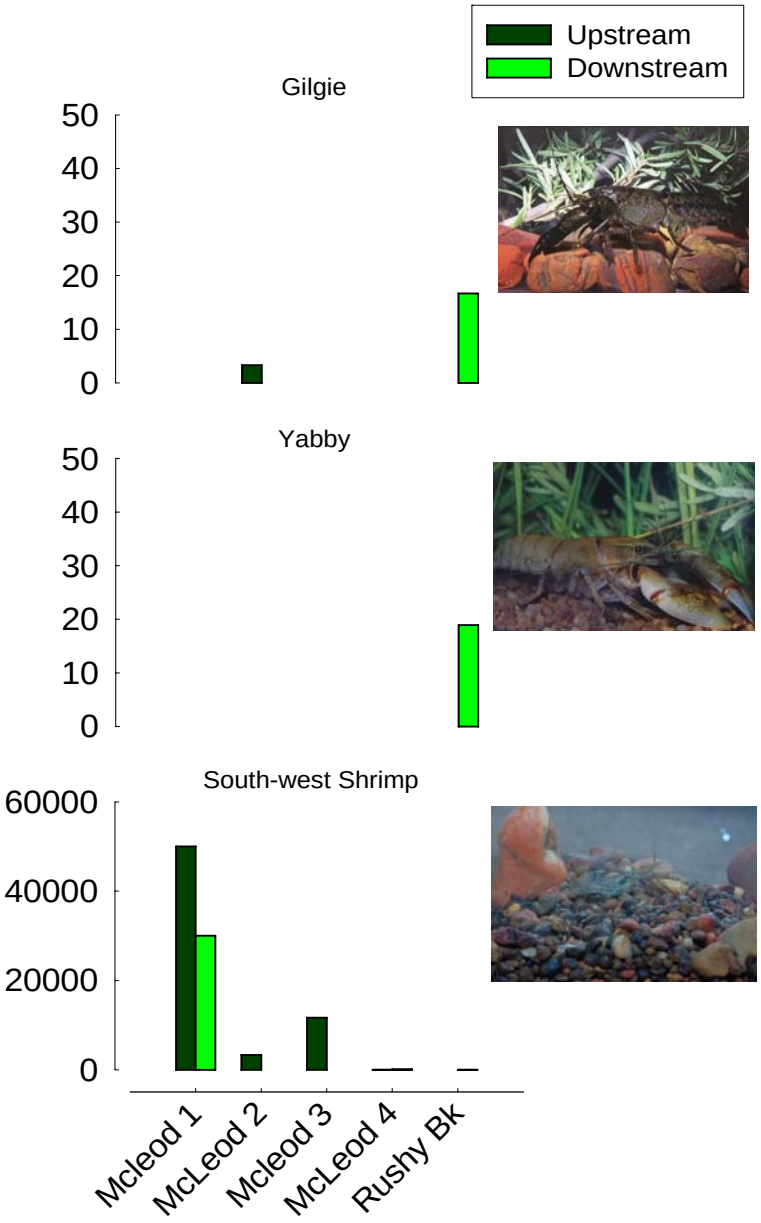

Figure 5 Upstream and downstream movements of decapod in McLeod Creek and Rushy Creek during sampling in December 2007.

Juvenile individuals of the three common endemic freshwater fishes dominated the captures of these species (Figure 6). For example, the mode of the length-frequency histogram for the Western Pygmy Perch was 20-25 mm TL, Western Minnow 55-60 mm TL and for Nightfish 25-30 mm TL. This dominance of juveniles in our captures confirms that considerable levels of spawning and recruitment of these species is occurring in McLeod Creek.

Figure 7 shows the length-frequency histograms of the two most abundant estuarine species captured in McLeod Creek. The Swan River Goby captures were dominated by individuals that were probably born between spring 2006 and autumn 2007 with this species having previously been shown to have a biannual breeding period in the more northerly Swan River (Gill *et al.* 1996). Newly recruited Western Hardyheads were also recorded having a size range of 15-25 mm TL with larger individuals, probably born the previous summer dominating the captures (Figure 7).

The size range of the freshwater crayfish captured appeared to be dominated with individuals born the previous breeding period; likely to be between spring and summer 2006/2007 (Figure 8, see Beatty *et al.* 2005a, 2005b). It is interesting to note that the sizes of the Yabbies (22-44 mm OCL) were generally greater than those Gilgies captured (16-26 mm OCL) (Figure 8).

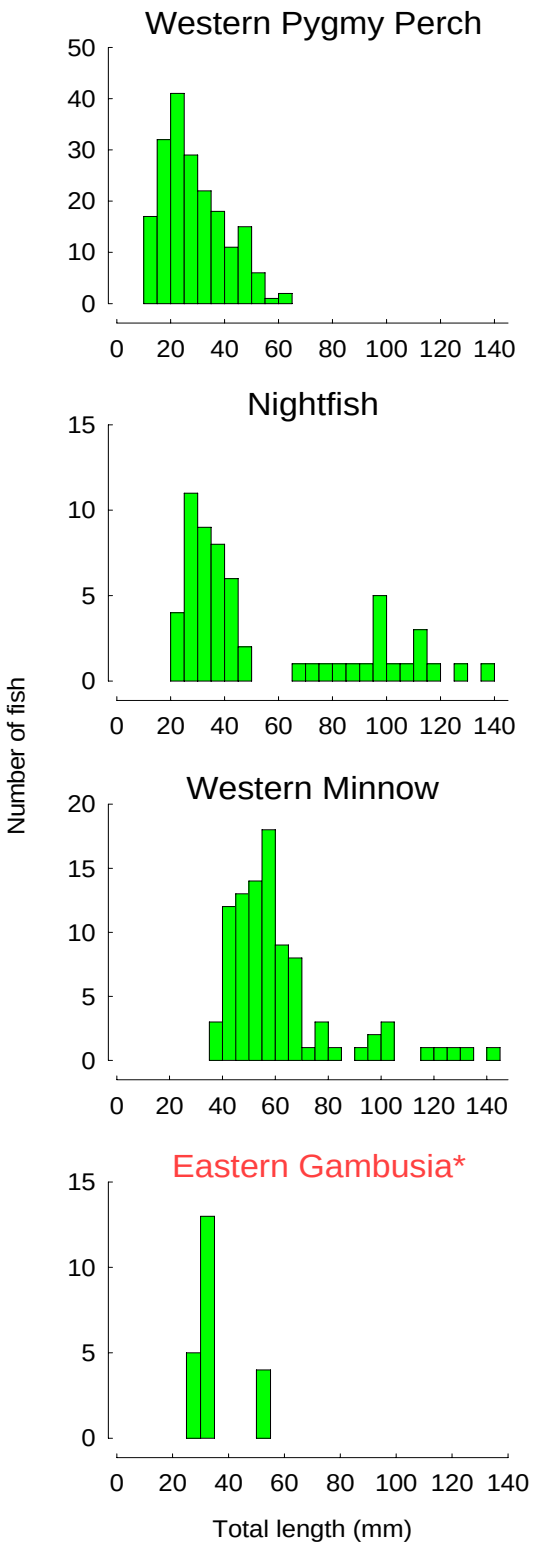

Figure 6 Length-frequency histograms of the freshwater fishes captured in McLeod Creek. N.B. the dominance of smaller individuals of the native species. * denotes a feral species.

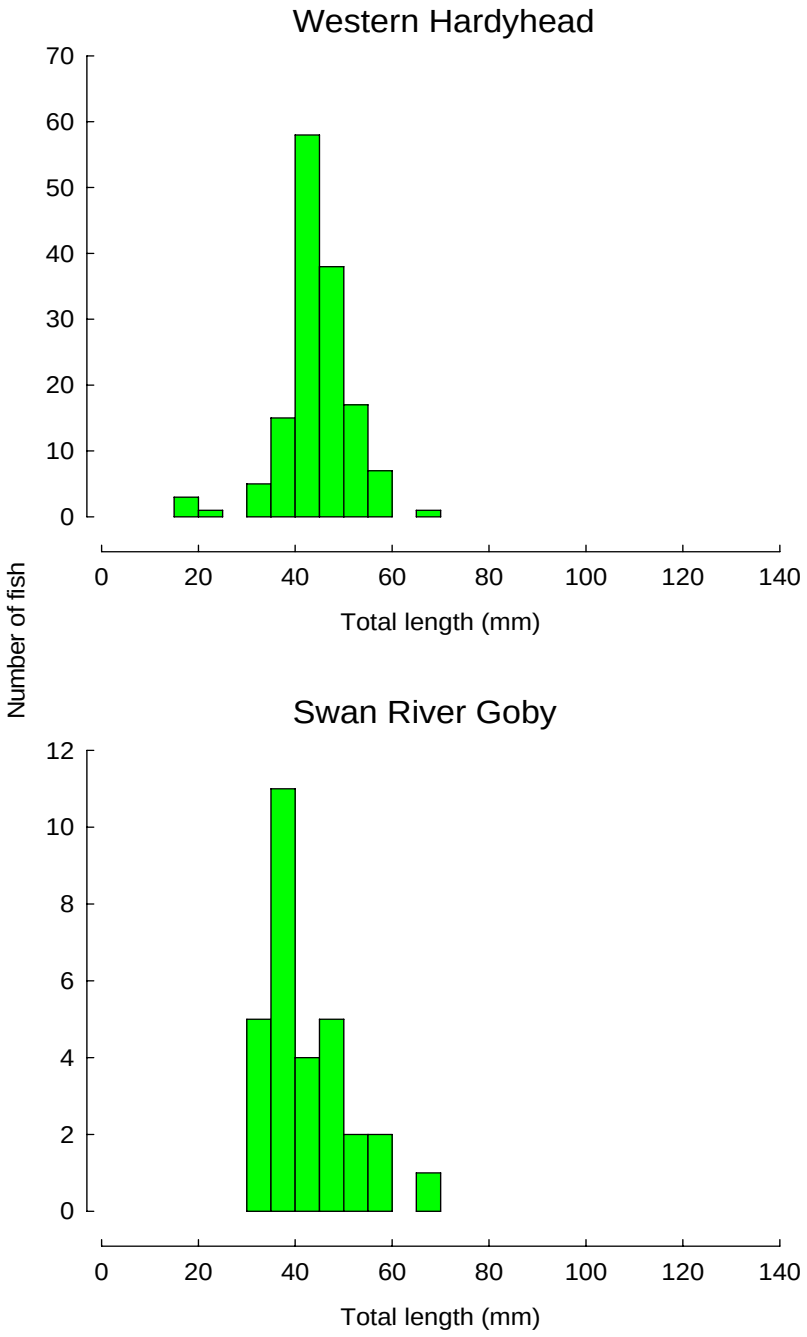

Figure 7 Length-frequency histograms of the estuarine fishes captured in McLeod Creek.

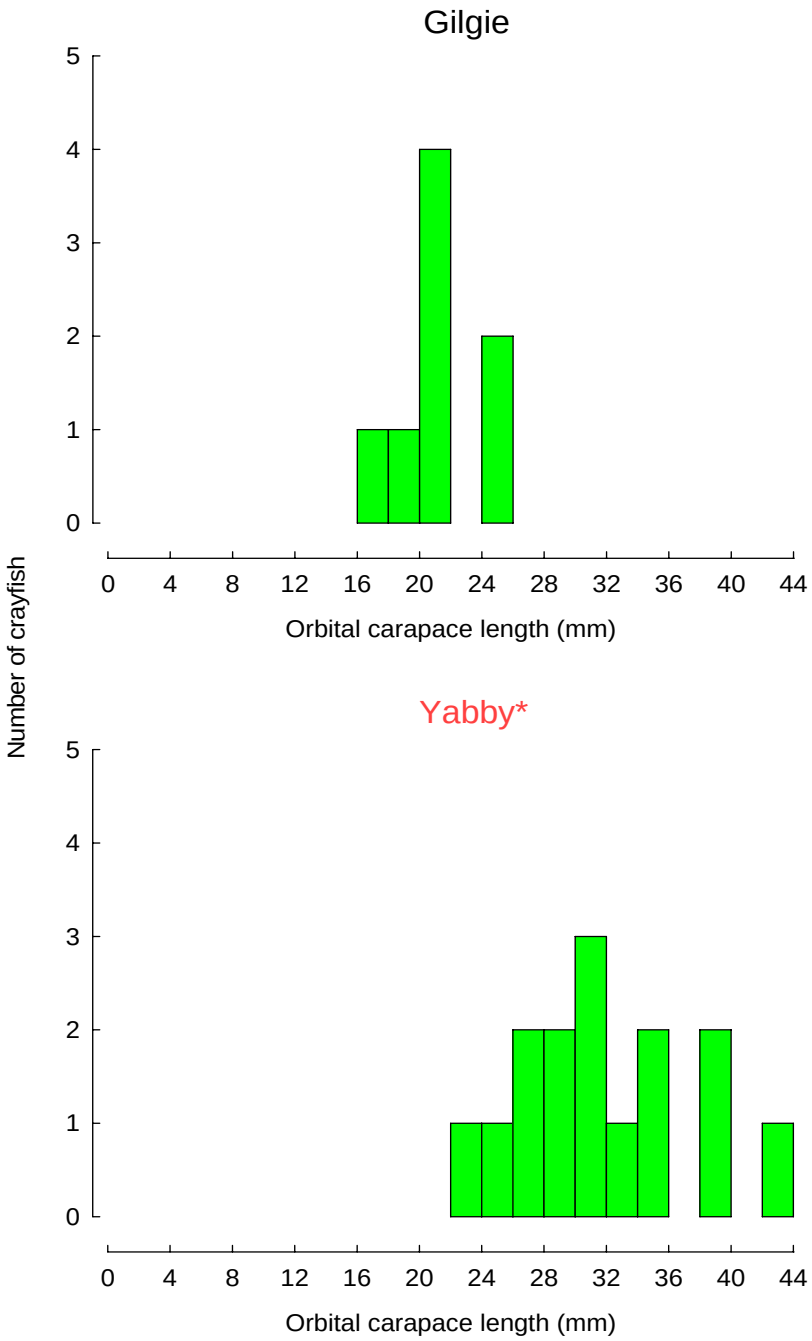

Figure 8 Length-frequency histograms of the crayfishes captured in McLeod Creek. N.B. * denotes the introduced yabby.

Discussion

Fishes of McLeod Creek

McLeod Creek houses self-sustaining populations of four endemic species (representing 50%) of the south-western Australian endemic fishes. This finding, and the recording of the threatened Mud Minnow, suggests that the system, as with other freshwater tributaries of the Blackwood River (Morgan *et al.* 2003, Beatty *et al.* 2006b), can be considered another important refuge for these species in the Blackwood River.

The density estimates, in conjunction with the fyke netting to record movements, demonstrated that at the time of sampling the range of Western Pygmy Perch, Western Minnow and Nightfish stretched between tidally influenced lower sites up to the uppermost site (i.e. from McLeod Creek 1 – 4). Very high numbers of Western Minnows and Western Pygmy Perch were recorded in McLeod Creek; as found to be the case in other fresh tributaries of the Blackwood River (Morgan *et al.* 2003; Beatty *et al.* 2006b).

A recent genetic study has found that a considerable genetic difference exist between tributary populations of Mud Minnows that suggested that the main channel has effectively completely isolated the populations. Genetic testing of the Mud Minnows of McLeod Creek could also confirm the genetic isolation of this population and, depending on the degree of uniqueness, this would further add to the conservation importance of McLeod Creek in terms of a refuge for endemic fishes (Phillips *et al.* 2007).

The dominance of juveniles of the three common endemic freshwater fishes in McLeod Creek suggests that considerable spawning and recruitment of these species occurs in McLeod Creek. Furthermore, compared with the equivalent sizes of juveniles of these species in other tributaries upstream in the Blackwood River (e.g. Rosa Creek and Milyeannup Creek) it appears that these juveniles are larger at the equivalent time of year (Beatty *et al.* 2006b). This suggests that either growth rate of these species is greater in McLeod Creek and/or spawning occurs earlier in this system compared to the upstream tributaries.

The estuarine species captured in McLeod Creek were generally more abundant moving downstream towards the confluence of the system with the Blackwood River. This is an expected result with all of these species were found by Vallesini *et al.* (1998) to commonly found downstream in the Hardy Estuary basin.

As discussed previously, the Blackwood River is a secondarily salinised system in its upper reaches and this has resulted in much of the main channel being unsuitable for many of the freshwater endemic species of fishes; at least outside of those zones of major Yarragadee and Leederville aquifer inputs (Beatty *et al.* 2006b). For example, three of the four endemic freshwater species recorded in the present study are generally not found in the main channel upstream of the major Yarragadee Aquifer discharge zone; whereas the more salt tolerant Western Minnow and the estuarine species (the latter species generally being recorded at the more downstream sites) in the McLeod Creek in the current study, are found to utilise both the main channel and tributaries (that are still important spawning sites) of the Blackwood right the way up the catchment in systems such as Hillman and Beaufort Rivers and Kojonup Creek (Morgan *et al.* 2003 and the authors unpublished data).

Therefore, it appears that the fresh McLeod Creek is acting as a refuge to these freshwater species from the (naturally) tidally influenced main channel just as Morgan *et al.* (2003) and Beatty *et al.* (2006a) demonstrated that those remaining forested

freshwater tributaries in further upstream in the catchment (i.e. between Great North Rd and Nannup) are acting as refuge sites from these species from the secondarily salinised main channel; particularly during the saline pulse that moves through the main channel during winter.

The presence of the Eastern Gambusia throughout McLeod and Rushy Creeks is of concern. This species is a native of North America and is now found throughout the south-west of Western Australia (Morgan *et al.* 2004). It has a life-history typically associated with a successful invasive aquatic species; such as reproducing in its first year of life, reproducing multiple times over an extended breeding period, bearing live young, and wide salinity tolerance. It is also an extremely aggressive species and fin-nips other native species, particularly the Western Pygmy Perch (Gill *et al.* 1999). Its eradication from McLeod Creek is currently unlikely and it is commonly found throughout the Blackwood River. It thrives in warmer, slow flowing water bodies such as those summer conditions found in the cleared irrigation drains on the Swan Coastal Plain; habitats that are similar to Rushy Creek site 2, see Figure 2. This contrasts with the more complex habitats generally favoured by native freshwater fishes; commonly associated with sites with relatively intact riparian vegetation such as that found in the sites sampled McLeod Creek.

The current study has documented the fish and crayfishes of McLeod Creek during early summer, when water levels had contracted considerably from peaks that would occur during spring. The study also occurred following the known breeding periods of the endemic freshwater species recorded in the system (that occur during winter and spring, depending on the species and system). These species are known to have distinctive upstream spawning migrations in tributaries in the Blackwood River. Although the current survey demonstrated that these species appeared to breed within McLeod Creek (based on the presence of small, juvenile individuals), those upstream areas that are likely to be important spawning sites were not documented due the timing of the sampling (n early summer) Therefore, in order to more fully describe the population dynamics, seasonal upstream ranges and spawning areas of these species, a follow-up survey targeting those upstream sites that were dry during the current survey is recommended. This information would be very useful in development of management plans in that it could allow identification of important areas for spawning; likely to be areas of relatively intact riparian and instream vegetation.

The discovery of the introduced Yabby in McLeod Creek and its tributary Rushy Creek represents a range extension of the species in Western Australia. The range of this invasive species in wild aquatic systems in Western Australia is believed to be increasing Beatty *et al.* (2005b). This species has a life cycle that allows it to rapidly colonise new systems being able to burrow to survive in temporary systems, being relatively fast growing, first reproducing following its first year of life and being able to reproduce multiple times during warmer periods (Beatty *et al.* 2005b).

The relative rapid growth of the Yabby compared to that of the Gilgie (see Beatty *et al*. 2005a) was highlighted by the greater minimum size of the Yabbies and larger maximum size compared with those of the Gilgie in McLeod Creek and Rushy Creek (Figure 8). The Yabby has also been shown to directly overlap in assimilated food sources with that of the larger endemic species the Marron (Beatty 2006b). Based on that latter study, it is believed that this species would be likely to directly compete with native freshwater

crayfishes, such as the slower growing Gilgie in McLeod Creek, for food and resources (Beatty *et al.* 2006b).

Conclusion

Sampling in December 2007 in McLeod Creek and its major tributary Rushy Creek demonstrated that the system housed four of the eight endemic freshwater fish species of the south-west; including the threatened Mud Minnow. It was also found to house four estuarine species that are commonly found in the Blackwood River, two species of freshwater crayfish (including the eastern Australian Yabby) and the feral Eastern Gambusia (native to North America). The populations of endemic fishes were found to be self-maintaining and it was found that at least three of the species appeared to have a relatively high level of spawning and recruitment in McLeod Creek. As found for other freshwater tributaries further inland in the catchment (where secondarily salinisation largely restricts inhabitation of the main channel of the Blackwood River) it appears that McLeod Creek represents an important refuge for endemic freshwater species in the lower Blackwood River catchment. The presence of the introduced Yabby and Eastern Gambusia that are known to thrive in altered aquatic habitats (such as those with degraded riparian zones) is of concern with the potential eradication of these species very unlikely.

Although this study has documented the aquatic species in McLeod Creek during relatively low water levels, additional sampling during winter/spring would allow determination of the maximum range of these fauna in McLeod Creek. This sampling could also determine where the upstream spawning habitats are for these species. This would then have implications for the development of a catchment management plan as areas of intact or complex instream and riparian habitats would likely be favoured by these endemic fish species.

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