Title: REASSESSMENT OF FISH HABITAT AVAILABILITY AND THE STATUS OF RIVER BLACKFISH POPULATIONS IN THE HODDLES CREEK CATCHMENT

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Cover photograph: Hoddles Creek near Yellow Gum Road

Summary

Following the establishment of the Hoddles Creek stream flow management plan (SFMP) working group in March 2000, it was recognised that an environmental flow of 6.9 Ml/d (as recommended by Zampatti and Raadik, 1997) would impact upon the existing security supply of diverters in the catchment. Furthermore, additional stream gauging data collected post 1997 indicated that discharge in Hoddles Creek naturally decreased below the low flow of 6.9 Ml/d observed by Zampatti and Raadik (1997). Consequently, the working group adopted an Interim Management Flow of 4 Ml/d in the 2000/2001 irrigation season.

As a component of the Hoddles Creek SFMP the Freshwater Ecology Section of the Department of Natural Resources and Environment were commissioned to review fish habitat availability and the status of river blackfish in Hoddles Creek. The objectives of the study were follows:

- Utilising the adapted instream flow incremental method (IFIM) at three sites, assess the ability of a 4 Ml/d flow to maintain suitable aquatic habitat for instream flora and fauna.

- Conduct fish surveys at all sites previously surveyed by Zampatti and Raadik (1997) and comment on river blackfish populations and recruitment in comparison to the findings of the 1997 survey.

- Comment on the biological significance of changes to the flow regime at an Interim Management Flow of 4 Ml/d.

Three of the habitat sites and eight of the fish survey sites surveyed by Zampatti and Raadik (1997) were resurveyed during February/March 2001 at a time when flows in Hoddles Creek were less than 6.9 Ml/d. The results of the 2001 habitat surveys indicate that potential river blackfish habitat decreases substantially as discharge decreases below approximately 7 Ml/d (as measured at site 1, the lowest site in the Hoddles Creek system). It appears from the available data and field observations that the interim flow of 4 Ml/d (as measured at gauging station 229224A) leads to a loss in the availability of potential river blackfish habitat, particularly to juvenile fish at site 1, 3 and 5 and adult fish at site 3.

In general, the results of the 2001 aquatic fauna survey were similar to those of the previous survey conducted during May 1997 (Zampatti and Raadik 1997). Mountain galaxias and river blackfish were the most abundant and widespread species. Two species recorded in the previous survey were not re-collected in the current survey; namely short-headed lamprey and the exotic roach. Both species were only collected in low numbers in 1997 and consequently may not have been detected in the current survey. Nevertheless, an additional native species, the migratory common galaxias, was recorded in the current survey.

Abundance of river blackfish varied between sites and was highest in the mid reaches of the catchment in both the 1997 and 2001 surveys. The higher relative abundance of river blackfish in the mid catchment may reflect the presence of more structurally diverse habitat and less shallow riffle areas compared to sites in the lower catchment. Abundances of river blackfish during the 2001 survey were equal at site 1, higher at site 2 and lower at sites 3, 4, and 5, in comparison to the 1997 survey. During the 2001 survey the area of riffle habitat at sites 3, 4, and 5 was greater compared to the 1997 survey. This increase in shallow exposed habitat areas may have contributed to the lower observed abundances at these sites in the current survey.

River blackfish size distribution data (1997 and 2001) indicates that recruitment may have been patchy in the lower reaches of Hoddles Creek in the past five years. In addition, the size distribution of river blackfish at sites 1 and 2 is skewed towards larger (older) fish. In the 2001 surveys, no recruitment from the 2000 spawning is apparent at sites 1-3. Conversely, sites 4 and 5 exhibit good recruitment in 2001 and a broad size range of river blackfish.

With regards to the biological impacts of low flows in Hoddles Creek, flows less than 7 Ml/d reduce the availability of important habitat attributes such as under-cut banks and accumulations of organic debris on the margins of pools and glides. Over the summer low-flow period a decrease in the availability of optimal habitat may occur naturally in Hoddles Creek. Nevertheless, it is possible that irrigation diversions in the Hoddles Creek catchment may increase the frequency and duration of low flow events thus subjecting fish to sub-optimal conditions for longer periods of time. Extended periods of sub-optimal conditions over the low-flow period of January to April may lead to poor recruitment of river blackfish in some years.

From the available data it appears that low flow events (less than 7 Ml/d) in Hoddles Creek substantially reduce the amount of habitat (with respect to water depth and velocity) that may be available to river blackfish. In addition, it is possible that low flows in the past four to five years may have affected river blackfish recruitment in the lower reaches of Hoddles Creek. Consequently, if a minimum environmental flow of 4 Ml/d is adopted by the Hoddles Creek SFMP working group, it would be preferable that the amount of habitat that is available at this discharge be compared with that which may be available under natural conditions (i.e. no diversions). It is also important that irrigation diversions do not artificially prolong or increase the frequency of low flow periods (with respect to those that may occur naturally). Therefore, spell duration analysis should be utilised to compare the frequency and duration of low flow events under natural and current conditions.

CONTENTS

1. INTRODUCTION

The State Environment Protection Policy (Waters of Victoria) Schedule F7 (Waters of the Yarra Catchment) specifies that Streamflow Management Plans (SFMP) be developed for waterways of the Yarra River catchment to ensure that there is sufficient allocation of water for environmental purposes. Melbourne Water commenced the Hoddles Creek SFMP in 1997, at which time an assessment of aquatic fauna values and environmental flows was conducted (Zampatti and Raadik, 1997). Despite the study being conducted during a drought period, discharges in the creek did not fall below 6.9 Ml/d, a flow that appeared to maintain fish habitat with respect to water depths and velocities. Consequently, due to a lack of further data, a minimum environmental flow of 6.9 Ml/d (at gauging station 22922A) was recommended for the summer/autumn low flow period (Zampatti and Raadik, 1997).

Following the establishment of the Hoddles Creek SFMP working group in March 2000, and the collection of further stream discharge data, it was recognised that flows in Hoddles Creek naturally decreased below 6.9 Ml/d. Furthermore, there was concern from the working group that an environmental flow of 6.9 Ml/d would impact upon the existing security supply of diverters in the catchment. Consequently, the working group adopted an Interim Management Flow of 4 Ml/d in the 2000/2001 irrigation season. This minimum flow was implemented pending further investigation of its potential effects on fish habitat availability and river blackfish (*Gadopsis marmoratus*) recruitment in the Hoddles Creek catchment.

As a component of the Hoddles Creek SFMP the Freshwater Ecology Section of the Department of Natural Resources and Environment has been commissioned to review fish habitat availability and the status of river blackfish in Hoddles Creek. The objectives of the study, as outlined in the Melbourne Water brief (December 2000), are as follows:

- Utilising the adapted instream flow incremental method (IFIM) at three sites, assess the ability of a 4 Ml/d flow to maintain suitable aquatic habitat for instream flora and fauna.

- Conduct fish surveys at all sites previously surveyed by Zampatti and Raadik (1997) and comment on river blackfish populations and recruitment in comparison to the findings of the 1997 survey.

- Comment on the biological significance of changes to the flow regime at an Interim Management Flow of 4 Ml/d.

2. STUDY AREA

Hoddles Creek, a tributary of the upper Yarra River, is located on the north-western slopes of the Yarra Ranges. The creek rises on the southern side of Sale Hill then flows north-west past the townships of Hoddles Creek and Launching Place to its confluence with the Yarra River. Hoddles Creek falls steeply in its upper reaches, with a drop of 280 m between Hazeldene's Road and Yellow Gum Road. Downstream of Yellow gum Road the gradient of the creek decreases, falling only another 80 m to its junction with the Yarra River downstream of the Warburton Highway. Hoddles Creek has three main tributaries; Blackleather, Wombat and Wet Lead Creeks. The catchment drains an area of 34 km^2 and is comprised of remnant eucalypt forest, cleared grazing land and areas of intensive horticulture.

There are a total of 21 licensed diverters on Hoddles Creek and a further 10 on the major tributaries. Water is diverted for stock and domestic use, as well as market garden, vineyard and tree farm irrigation. A total volume of 528 Ml is allocated annually to diverters, however, data obtained from metered diversion points suggests that water use is lower, at an estimated 265 Ml/annum (Steve Hosking, Melbourne Water, pers. comm.). Accurate monthly diversion volumes for the Hoddles Creek system are unavailable, although estimates provided by Melbourne Water for the months of December to March range from 42.7 to 49.8 Ml/month.

At the time of the 1997 environmental flow study, long-term gauging data was unavailable for Hoddles Creek and data modelled from the nearby Little Yarra River catchment was found to be inaccurate (Zampatti and Raadik, 1997). Consequently, our knowledge of natural variability in stream flows in Hoddles Creek was limited. In the time since the original environmental flow study, discharge has been continuously monitored for a period of at least 3 years at gauging station 229224A. The lowest discharge recorded at this site was 2.1 Ml/d (diversion affected) in March 2001. Long-term hydrological data for the catchment has also been modelled (SKM, 2000). Based on modelled monthly data it is likely that average daily flows in lower Hoddles Creek may range from approximately 8 to 10 Ml/d during the low flow period (January to April)[1].

[1] Based on dividing average monthly flows by the number of days in each month

3. METHODS

3.1 HABITAT AVAILABILITY

Three of the habitat sites surveyed by Zampatti and Raadik (1997) were resurveyed during March 2001 (Table 3-1) at a time when flows in Hoddles Creek were less than 6.9 Ml/d. This subset of the original 1997 sites was chosen to provide information on discharge and habitat availability throughout the catchment. At each site, a measuring tape was extended across the stream at pre-existing transects (see Zampatti and Raadik 1997) and, depending on the width and uniformity of the stream, velocity (m/s), depth (m) and substrate type were measured at 0.1 to 0.5 m intervals. Depth was measured to the nearest 0.01 m using a 1 m steel ruler and velocity was measured using a Hydrological Services OSS PC-1 current meter with a CMC 20 digital counter.

3.2 MODELLING USING RHABSIM

The amount of habitat potentially available to juvenile and adult river blackfish was calculated using the RHABSIM hydraulic and habitat simulation system (Payne and Associates 1994). Criteria curves were constructed for adult and juvenile river blackfish to enable an assessment of habitat availability. The habitat preferences for this species were not weighted (Mathur *et al.* 1985). Instead, a binary approach was used and habitat was classified as being present or absent. When combined with the hydraulic characteristics of the stream section this approach predicts how much habitat (user defined) will be potentially available to a particular species[2].

3.3 AQUATIC FAUNA SURVEY

The eight sites surveyed by Zampatti and Raadik (1997) were resurveyed between the 27th February and 1st March 2001 (Table 3-1). Seven sites were located on Hoddles Creek and one on Wombat Creek. The survey technique used at each site was identical to that used by Zampatti and Raadik (1997), including the location and length of the survey reach. All available habitat types in a set reach of stream were sampled using a single-pass electrofishing technique (see Zampatti and Raadik, 1997). Instream substrate and habitat were also assessed and basic water quality parameters measured.

Table 3-1 Aquatic fauna and habitat survey sites in Hoddles Creek catchment.

Site No.	Description	Grid Reference	Altitude (m ASL)
1*	Hoddles Creek @ Warburton Hwy	8022 745177	105
2	Hoddles Creek @ Glenview Rd	8022 753155	130
3*	Hoddles Creek @ Bells property	8022 759141	150
4	Hoddles Creek @ at Blackleather Rd	8022 770126	170
5*	Hoddles Creek near Yellow Gum Rd	8022 776119	180
6a	Hoddles Creek @ Prices Rd (downstream)	8022 794083	360
6b	Hoddles Creek @ Prices Rd (upstream)	8022 794038	360
7	Hoddles Creek @ Hazeldene Rd	8022 802075	395
8	Wombat Creek @ unnamed track off Parkinson's Rd	8022 781123	190

* site also surveyed for habitat availability.

[2] See Zampatti and Raadik (1997) for a detailed description of habitat modelling

4. RESULTS

4.1 DAILY DISCHARGE

Immediately prior to the survey period, instantaneous discharges (measured immediately upstream of the Warburton Highway at station 229224A) were low, ranging from 2.6 to 4.1 Ml/d (Figure 4-1). Over the survey period (27/2 – 1/3/01) discharges were of the same magnitude (Figure 4-1).

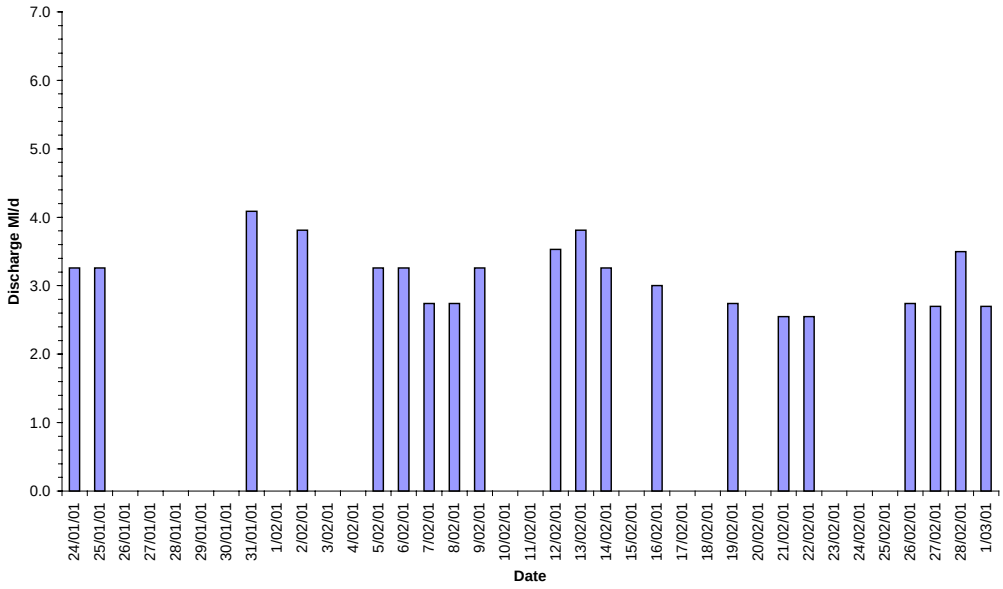

Figure 4-1 Instantaneous discharge measured at gauging station 229224A (Hoddles Creek upstream of Warburton Highway).

4.2 WATER QUALITY

Water temperatures at the survey sites ranged from 13.6°C to 18.4°C (Table 4-1). Electrical conductivity was low (59 to 134 µS/cm) and generally increased with increasing distance downstream. Dissolved oxygen varied between 10.1 and 11.2 mg/l, and pH ranged from 6.3 to 7.5. Turbidity was low (7 to 17 NTU) and generally increased with increasing distance downstream.

Electrical conductivities (the only water quality parameter measured in 1997) were similar to those recorded in the 1997 survey, although electrical conductivity at the lower sites (1-5) were slightly higher in 2001 (Table 4-1). This is may be due to the occurrence of very low flows (2 – 4 Ml/d) at the time of the 2001 surveys.

Table 4-1. Basic water quality parameters measured at fish and habitat survey sites.

Site No.	Water temperature (°C)	Dissolved oxygen (mg/l)	Electrical conductivity (µS/cm) 1997 in brackets	Turbidity (NTU)	pH
1	16.9	10.1	134 (98)	17	6.5
2	17.3	10.5	118 (115)	14	7.5
3	18.4	10.0	130 (89)	14	7.4
4	16.5	10.5	88 (78)	7	6.3
5	16.6	10.6	87 (73)	7	6.7
6a	13.6	10.9	59 (67)	8	7.5
6b	13.6	10.9	59 (67)	8	7.5
7	15.8	10.8	60 (75)	7	6.9
8	17.0	11.2	82 (77)	14	6.9

4.3 HABITAT AVAILABILITY

Potential habitat availability for river blackfish was measured at discharges ranging from 1.4 to 1.8 Ml/d (discharges were measured at each site). At site 1, the habitat potentially available to juvenile and adult blackfish decreased by approximately 51% and 33% respectively when stream discharge decreased from 6.9 Ml/d to approximately 1.8 Ml/d (Figure 4-7). At site 3, the habitat potentially available to juvenile and adult blackfish decreased by approximately 32% and 52% respectively when stream discharge decreased from 6.0 Ml/d to approximately 1.4 Ml/d (Figure 4-8). The relationship between discharge and available habitat measured at site 5 is similar to site 1. A decrease in discharge from 3.5 Ml/d to 1.5 Ml/d decreases available habitat to juvenile and adult blackfish by 53% and 31% respectively (Figure 4-7).

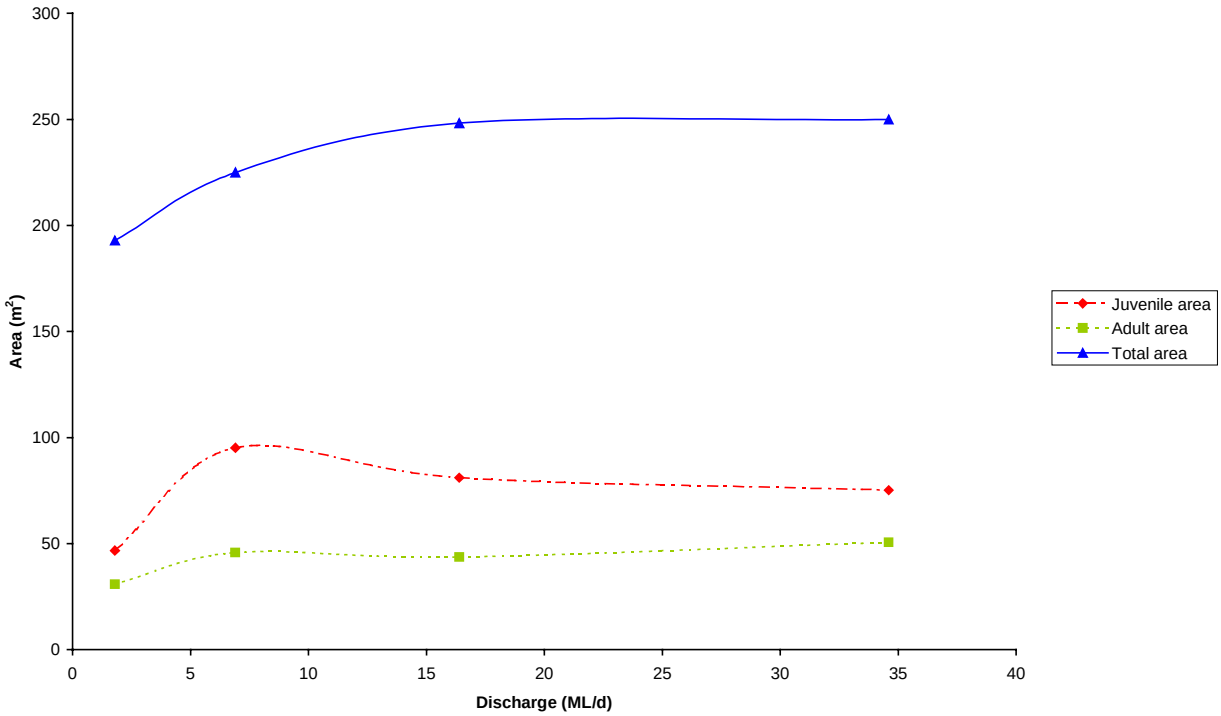

Figure 4-7. Habitat availability for river blackfish at a range of flows in Hoddles Creek - site 1.

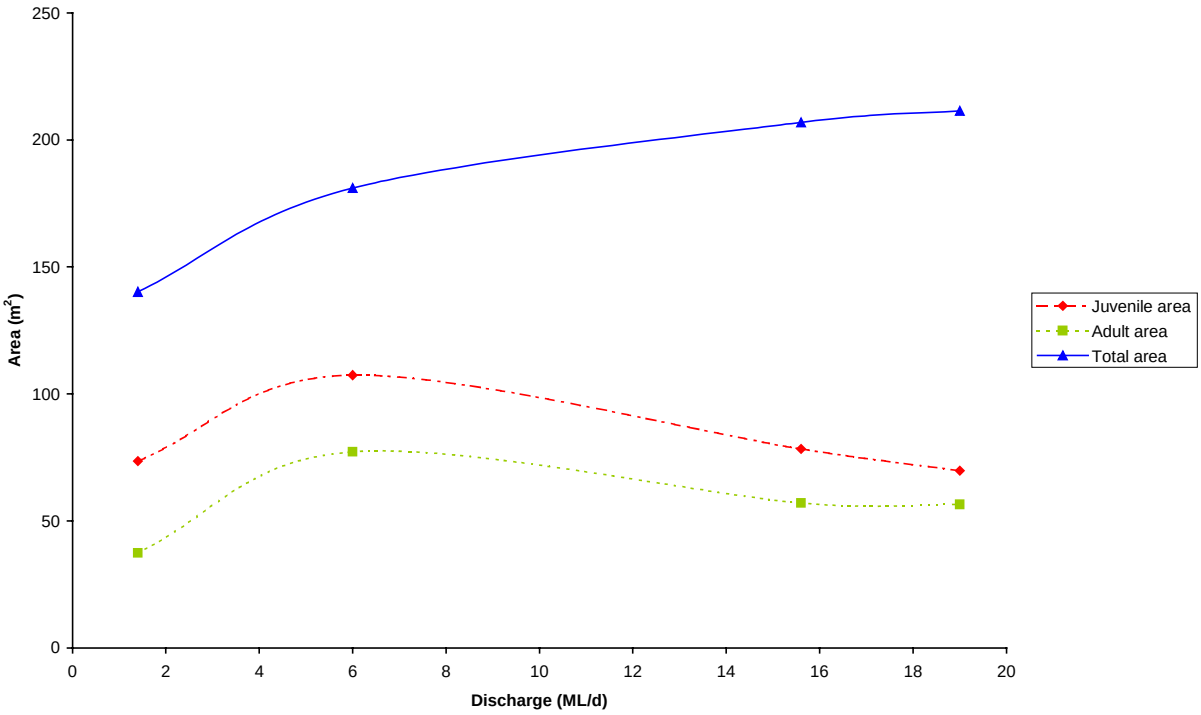

Figure 4-8. Habitat availability for river blackfish at a range of flows in Hoddles Creek - site 3.

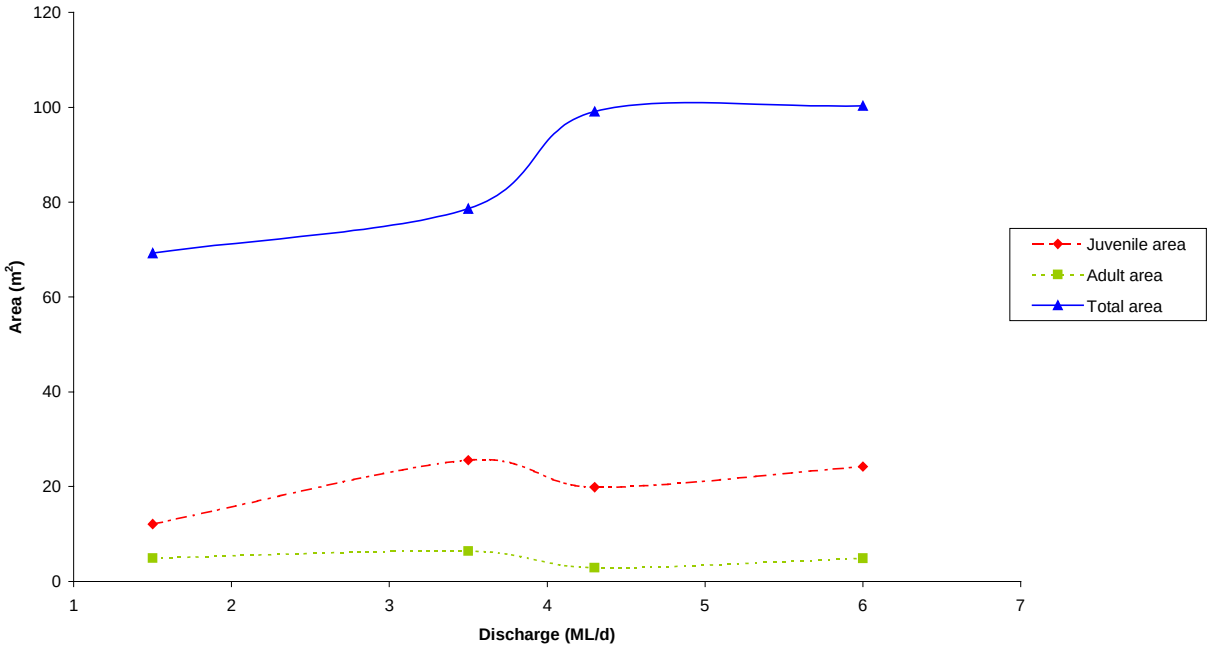

Figure 4-9. Habitat availability for river blackfish at a range of flows in Hoddles Creek - site 5.

4.4 FISH SURVEY RESULTS

4.4.1 Species diversity and abundance

A total of 230 individual fish representing four families and five species were recorded during the aquatic fauna surveys (Table 4-2, Appendix 1). Four of the fish species recorded were native, two of which migrate between freshwater and estuarine/marine habitats at some stage in their life cycle. Two species of decapod crustacean and one species of bivalve mollusc were also recorded. Native fish species contributed 87% of the total fish fauna, with non-migratory species numerically dominant (78% of the total catch). None of the native aquatic fauna species recorded are considered threatened in Victoria (DCNR 1995, DNRE 2000).

Mountain galaxias was the most widespread (collected at eight sites) and abundant (115 individuals) species. River blackfish was the second most abundant species (60 individuals) and was collected at five sites in the mid-lower catchment. Short-finned eel and exotic brown trout were both widespread (each recorded at five sites), and moderately abundant (19 and 29 individuals recorded respectively). A single common galaxias was recorded at the lowest site in the catchment (site 1). The size range of all fish species collected, excluding common galaxias, indicated that all life history stages were present in Hoddles Creek (see Appendix 1).

Table 4-2. Native and exotic freshwater fish and decapod crustacea recorded in this study, including their conservation status (DCNR 1995, DNRE 2000).

Scientific Name	Common Name	Conservation Status
Native Fish		
Anguilla australis[+]	Short-finned eel	C
Gadopsis marmoratus	River blackfish	C
Galaxias maculatus[+]	Common galaxias	C
Galaxias olidus	Mountain galaxias	C
Exotic Fish		
Salmo trutta	Brown trout	-
Decapod Crustacea		
Euastacus yarraensis	Yarra spiny cray	C
Euastacus woiwuru	Central Highlands spiny cray	C
Bivalve mollusc		
Alathyria jacksoni	River mussel	C

[+] native migratory species, C – Common and/or widespread

Yarra spiny cray were widespread (recorded at six sites), with a total of 29 individuals collected. Central Highlands spiny cray were more restricted in distribution and only recorded at two sites in the upper catchment. This species was less abundant (13 individuals collected).

In general, the results of the February/March 2001 survey are similar to those of the previous survey conducted during May 1997 (Zampatti and Raadik 1997). Short-headed lamprey (*Mordacia mordax*) and the exotic roach (*Rutilus rutilus*), however, were both collected in the 1997 survey but not in the 2001 survey. The collection of common galaxias in the current survey, however, represents a new species record for Hoddles Creek.

4.4.2 River blackfish abundance

The abundance[3] of river blackfish during the 2001 survey varied between sites, and was highest in the middle reaches of the catchment (sites 3, 4 and 5) (Figure 4-1). In comparison to the 1997 surveys the abundance of river blackfish in Hoddles Creek was equal at site 1, higher at site 2 and lower at sites 3, 4, and 5 (Figure 4-2).

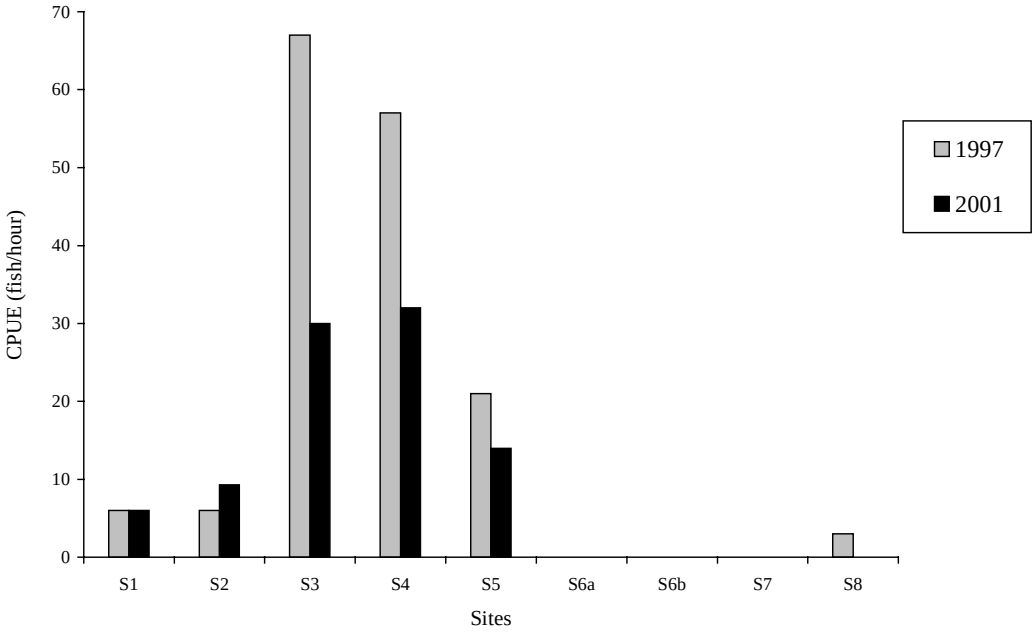

Figure 4-2 Abundance (CPUE – fish/hr) of river blackfish in Hoddles Creek catchment - 1997 and 2001.

4.4.3 River blackfish recruitment

Length frequency histograms indicate that the size distribution of river blackfish is limited at site 1 and 2, although fish numbers are generally low (Figure 4-3 and Figure 4-4). At site 1, younger age cohorts (i.e. 0+, 1+ and 2+) appear to be absent (Figure 4-3). Likewise at site 2, the 0+ cohort is absent and the frequency of 1+ fish is low (Figure 4-4). At site 3, the 0+ cohort is absent from the 2001 data, although 1+ fish (from the 1999 spawning) are present, as are a range of other cohorts (Figure 4-5). At sites 4 and 5 there are numerous age cohorts present in the data and evidence of successful recruitment in both 2000 (1999 spawning) and 2001 (2000 spawning) (Figure 4-6 and Figure 4-7).

Recruitment of 0+ fish (young of the year, 20–60 mm in length) appears to have occurred in summer 2001 at only two sites (sites 4 and 5), compared to three sites in 1996 (sites 3, 4 and 5) (Figures 4-3 to 4-7). In addition, it appears that recruitment may have been patchy in the lower reaches of Hoddles Creek (sites 1-3) over the past five years.

[3] Abundance is expressed as catch per unit effort (CPUE)

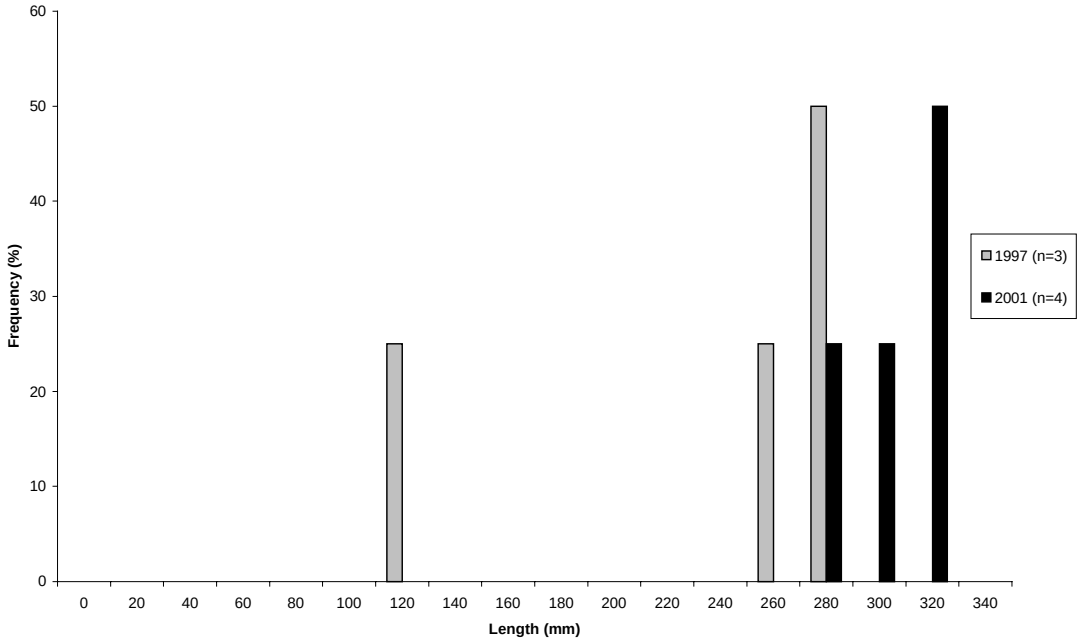

Figure 4-3 Length frequency histogram for river blackfish collected at site 1 – 1997 and 2001.

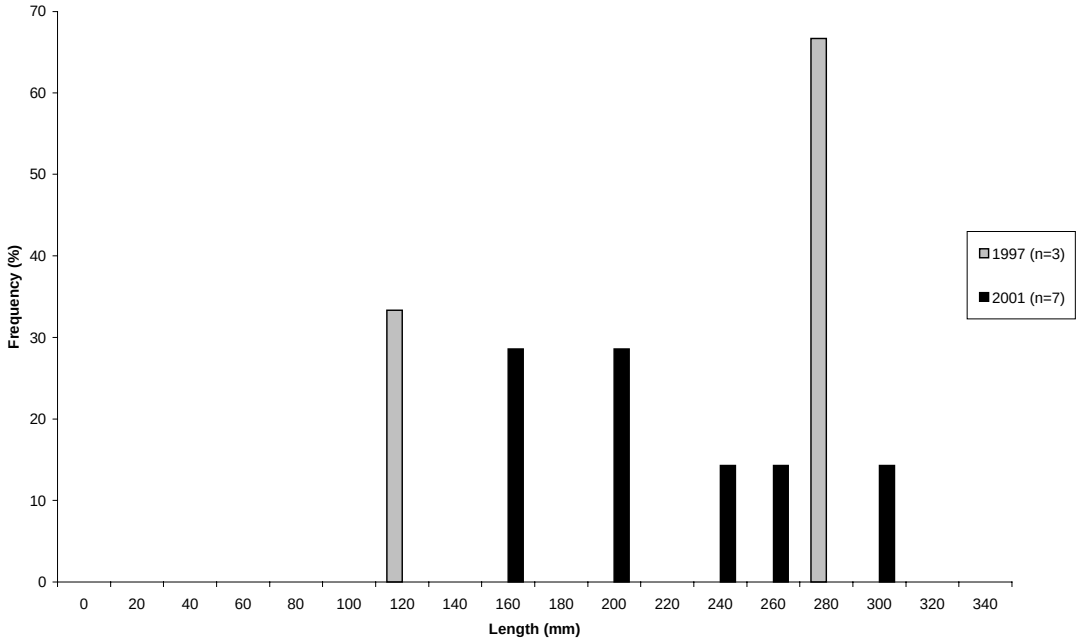

Figure 4-4 Length frequency histogram for river blackfish collected at site 2 - 1997 and 2001.

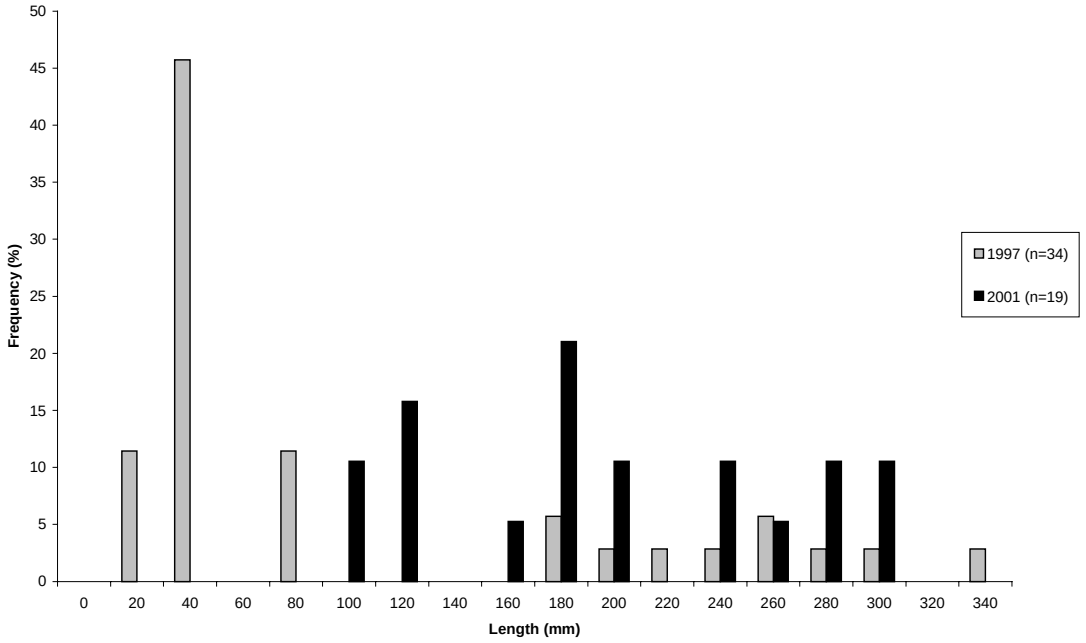

Figure 4-5 Length frequency histogram for river blackfish collected at site 3 - 1997 and 2001.

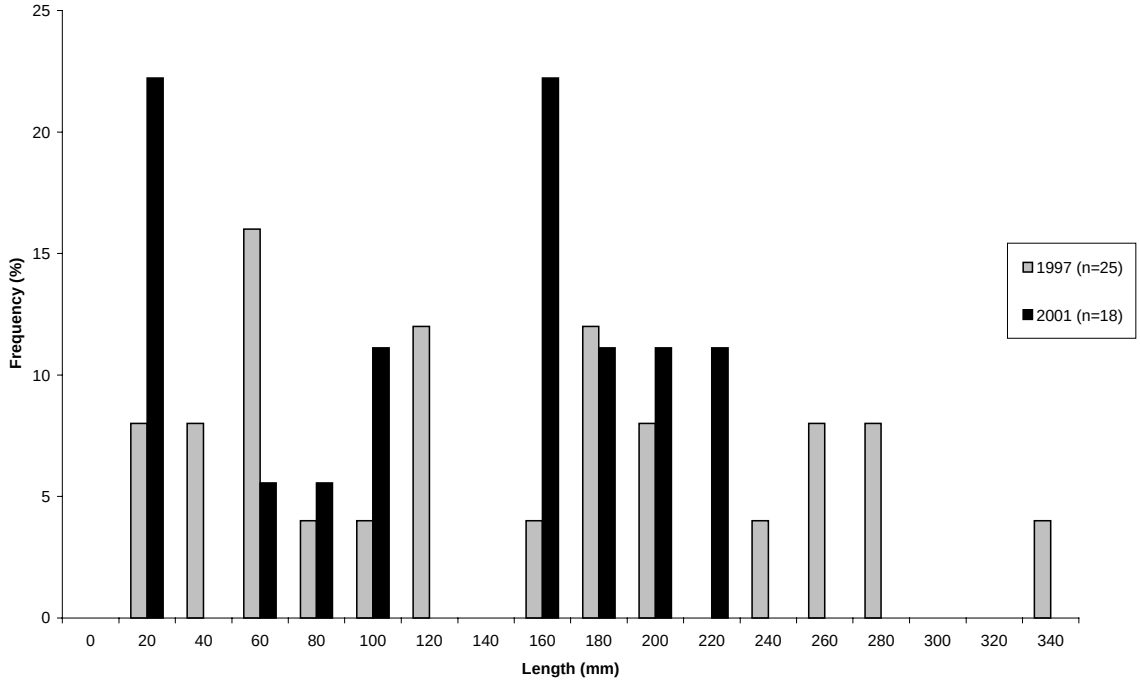

Figure 4-6 Length frequency histogram for river blackfish collected at site 4 - 1997 and 2001.

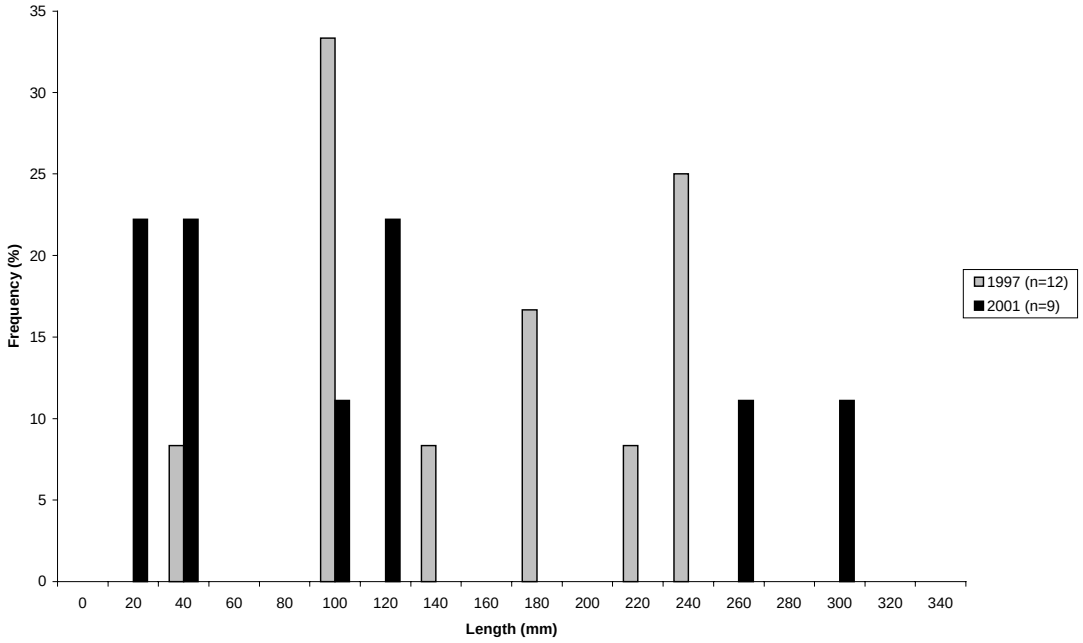

Figure 4-7 Length frequency histogram for river blackfish collected at site 5 - 1997 and 2001.

5. DISCUSSION

5.1 HABITAT AVAILABILITY

The results of the 2001 habitat surveys indicate that potential river blackfish habitat decreases substantially as discharge decreases below approximately 7 Ml/d (as measured at site 1, the lowest site in the Hoddles Creek system). At the three sites resurveyed in February 2001, it is apparent that potential juvenile river blackfish habitat decreases by up to 50% as flows decrease from 7 to approximately 2 Ml/d. The loss in habitat is primarily a result of a reduction in water depth at the edges of pools and in the glide/riffle sections that separate pools.

Shallow, low velocity habitats, particularly at the edge of pools, are often characterised by accumulations of leaf litter and other organic debris which inturn provide important refuge sites for juvenile river blackfish. Consequently, the loss of such habitats may force young-of-year river blackfish into sub-optimal habitats which may lessen their chance of survival (e.g through predation).

It appears from the available data and field observations that the interim flow of 4 Ml/d (as measured at gauging station 229224A) leads to a loss in the availability of potential river blackfish habitat, particularly to juvenile fish at site 1, 3 and 5 and adult fish at site 3. How this relates to habitat loss that may occur under natural conditions (i.e. no diversions) is unknown.

5.2 AQUATIC FAUNA DIVERSITY AND ABUNDANCE

In general, the results of the 2001 aquatic fauna survey are similar to those of the previous survey conducted during May 1997 (Zampatti and Raadik 1997). Two species recorded in the previous survey were not re-collected in the current survey; namely short-headed lamprey and the exotic roach. Both species were only collected in low numbers in 1997 and consequently may not have been detected in the current survey. Nevertheless, an additional native species, the migratory common galaxias, was recorded in the current survey. This is a new species recorded for Hoddles Creek and its occurrence is likely to have been facilitated by the construction of a fishway at Dight's Falls in the lower Yarra River in 1994. There are a number of other native migratory species that could also be expected to occur in Hoddles Creek e.g. spotted galaxias *Galaxias truttaceus*, broad-finned galaxias *Galaxias brevipinnis* and Australian grayling *Prototroctes maraena*. The apparent absence of these species may be attributable to a number of factors including habitat condition, time taken for recolonisation and limited survey effort.

The native non-migratory mountain galaxias dominated the fish community during both survey events (1997 and 2001) in terms of abundance and distribution. Mountain galaxias are most abundant in the upper parts of the catchment, which may reflect the absence of the exotic brown trout at the upper sites. Brown trout are known to adversely affect mountain galaxias through predation and competition (Raadik 1995, Raadik *et al*. 1996).

5.3 RIVER BLACKFISH ABUNDANCE AND RECRUITMENT

Abundance of river blackfish varied between sites and was highest in the mid reaches of the catchment in both the 1997 and 2001 surveys. The higher relative abundance of river blackfish in the mid catchment may reflect the presence of more structurally diverse habitat and less shallow riffle areas (subject to drying out) compared to sites in the lower catchment. In the upper reaches of the catchment stream gradient increases rapidly and habitat becomes less suitable for river blackfish.

Abundances of river blackfish during the 2001 survey were equal at site 1, higher at site 2 and lower at sites 3, 4, and 5, in comparison to the 1997 survey. During the 2001 survey the area of riffle habitat (% wetted area) at sites 3, 4, and 5 was greater compared to the 1997 survey. This increase in shallow exposed habitat areas may have contributed to the lower observed abundances at these sites in the current survey. The pool/riffle sequences may have altered in the 4 years intervening the surveys and led to a redistribution of suitable habitats in the survey reach. At sites 1 and 2 the area of riffle habitat (% wetted area) was similar to the 1997 survey, and there was only slight difference in abundance. There may also be natural variation in the abundance of river blackfish on a yearly basis; consequently it is difficult to attribute the lower abundance of river blackfish at sites 3 – 5 to any specific factor.

From the size distribution data (1997 and 2001) it appears that recruitment may have been patchy in the lower reaches of Hoddles Creek in the past five years. In addition, the size distribution of river blackfish at sites 1 and 2 is skewed towards larger (older) fish. In the 2001 surveys, no recruitment from the 2000 spawning is apparent at sites 1-3. Conversely, sites 4 and 5 exhibit good recruitment in 2001 and a broad size range of river blackfish, suggesting that spawning, particularly at site 4, may have been successful on a number of occasions over the past five years. The greater length range and abundance of river blackfish at sites 3-5, suggests conditions for spawning and recruitment at these sites are likely to be more suitable compared to the downstream sites.

5.4 BIOLOGICAL IMPACTS OF REDUCED FLOWS

The potential biological impacts of reduced streamflows on fish may include a loss of physical habitat (leading to increased predation and loss of food resources), exposure to degraded or sub-optimal water quality, loss of spawning and migratory cues, and a reduction in overall habitat diversity.

With regards to river blackfish populations in Hoddles Creek, reduced streamflows during the summer/autumn low flow period primarily have an effect on physical habitat attributes such as cover elements (e.g. organic debris). Low flows (i.e. less than 7 Ml/d) in Hoddles Creek reduce the availability of important habitat attributes such as under-cut banks and accumulations of organic debris on the margins of pools and glides. Juvenile and adult blackfish have been found to have close associations with these habitat types (Davies, 1989; Koehn *et al.*, 1994)

Over the summer low-flow period a decrease in the availability of optimal habitat may occur naturally in Hoddles Creek. Nevertheless, it is possible that irrigation diversions in the Hoddles Creek catchment may increase the frequency and duration of low flow events thus subjecting fish to sub-optimal conditions for longer periods of time[4]. Extended periods of sub-optimal conditions over the low-flow period of January to April may lead to poor recruitment of river blackfish in some years. Furthermore, it is possible that low summer flows over the past four years have affected river blackfish recruitment in Hoddles Creek, particularly at the lower sites in the system.

[4]At present, data on the frequency and duration of low-flow events in Hoddles Creek are unavailable

5.5 RECOMMENDATIONS

From the available data it appears that low flow events (less than approximately 7 Ml/d) in Hoddles Creek substantially reduce the amount of habitat (with respect to water depth and velocity) that may be available to river blackfish. In addition, it is possible that low flows in the past four to five years may have affected river blackfish recruitment in the lower reaches of Hoddles Creek. Consequently, if a minimum environmental flow of 4 Ml/d is adopted by the Hoddles Creek SFMP working group, it would be preferable that the amount of habitat that is available at this discharge be compared with that which may be available under natural conditions (i.e. no diversions). It is also important that irrigation diversions do not artificially prolong or increase the frequency of low flow periods (with respect to those that may occur naturally). Therefore, spell duration analysis should be utilised to compare the frequency and duration of low flow events under natural and current conditions.

A long-term yearly monitoring program for river blackfish is also recommended inorder to determine that alterations to the flow regime in Hoddles Creek are not having a detrimental effect on river blackfish populations.

6. REFERENCES

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7. APPENDIX 1.

Table 7-1 Length, weight, numbers and abundances of native and exotic freshwater fish and decapod crustacea collected.

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6a	Site 6b	Site 7	Site 8
Short-finned eel[+]									
mean length (range) (mm)	517 (430-590)	316 (145-560)	290 (140-590)	435 (420-450)	-	-	-	610	-
mean weight (range) (g)	-	-	127 (3.8-374)	132 (114-150)	-	-	-	414	-
n	4	6	3	3	0	0	0	3	0
Abundance - fish/m^2	0.0210	0.0285	0.0125	0.0187	0	0	0	0.0294	0
River blackfish (2001)									
mean length (range) (mm)	313 (284-331)	223 (168-310)	204 (100-315)	134 (30-230)	121 (26-295)	-	-	-	-
mean weight (range) (g)	287 (219-335)	127 (50-301)	94 (8.6-230)	37 (0.2-111)	52 (0.3-222)	-	-	-	-
n	5	7	20	19	9	0	0	0	0
Abundance - fish/m^2	0.0263	0.0333	0.0833	0.1187	0.0631	0	0	0	0
River blackfish (1997) [5]									
mean length (range) (mm)	245 (135-291)	231 (126-288)	115 (34-358)	151 (34-340)	165 (45-257)	-	-	-	119
mean weight (range) (g)	170 (27-239)	146 (23-212)	52 (0.3-352)	72 9(0.5-311)	62 (1.3-154)	-	-	-	19
n	4	3	39	33	12	0	0	0	1
Abundance - fish/m^2	0.0009	0.0068	0.1238	0.1480	0.0627	0	0	0	0.0164
Common galaxias[+]									
mean length (range) (mm)	55	-	-	-	-	-	-	-	-
mean weight (range) (g)	0.9	-	-	-	-	-	-	-	-
n	1	0	0	0	0	0	0	0	0
Abundance - fish/m^2	0.0052	0	0	0	0	0	0	0	0

[5] from Zampatti and Raadik 1997.

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6a	Site 6b	Site 7	Site 8
Mountain galaxias									
mean length (range) (mm)	49 (42-72)	43 (30-63)	46 (27-62)	42 (33-59)	59 (44-68)	-	58 (33-95)	71 (35-87)	57 (40-75)
mean weight (range) (g)	0.8 (0.5-3.3)	0.5 (0.1-1.9)	0.7 (0.1-1.7)	0.5 (0.3-1.6)	1.7 (0.5-2.4)	-	2.6 (0.3-7.7)	3.8 (0.4-6.5)	1.7 (0.4-4.5)
n	16	21	12	8	3	0	21	17	17
Abundance - fish/m^2	0.0842	0.1	0.05	0.05	0.0210	0	0.12	0.1666	0.34
Salmo trutta*									
mean length (range) (mm)	137 (88-278)	154 (78-230)	245	230	-	198 (165-230)	-	-	-
mean weight (range) (g)	56 (7.8-271)	76 (5.8-147)	169	130	-	101 (65-140)	-	-	-
n	20	2	1	1	0	5	0	0	0
Abundance - fish/m^2	0.1052	0.0095	0.0041	0.0062	0	0.0714	0	0	0
Yarra spiny cray									
Mean length (range) (mm)	9.6 (8-10)	11	13 (4-34)	15 (8-28)	12 (8-15)	-	-	-	14
mean weight (range) (g)	0.5 (0.4-0.6)	0.1	17 (0.3-67)	19 (1.5-54)	2.8 (0.6-4.9)	-	-	-	2
n	6	2	5	4	2	0	0	0	2
Abundance - fish/m^2	0.0315	0.0095	0.0208	0.025	0.0140	0	0	0	0.04
Central Highlands spiny cray									
mean length (range) (mm)	-	-	-	-	-	18	-	12 (7-21)	-
mean weight (range) (g)	-	-	-	-	-	9	-	3.7 (1.5-8.1)	-
n	0	0	0	0	0	2	1	11	0
Abundance - fish/m^2	0	0	0	0	0	0.0285	0.0057	0.1078	0

+ native migratory species, * exotic species