



**AN ASSESSMENT OF
ENVIRONMENTAL FLOW
REQUIREMENTS FOR
THE STRINGYBARK
CREEK CATCHMENT**

**for
Melbourne Water
Waterways and Drainage**



by

Wayne Koster and Paul Close



**Natural Resources
and Environment**

AGRICULTURE

RESOURCES

CONSERVATION

LAND MANAGEMENT

**Freshwater Ecology
Parks, Flora and Fauna**

JULY 2001

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CATCHMENT**

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Cover photographs (top to bottom):

- Log Creek (tributary of Stringybark Creek) at Medhurst Rd, Gruyere (photo by P. Close)
- Intensive horticulture in upper reaches of Stringybark Creek (photo by P. Close).
- Southern pygmy perch collected from Log Creek (photo by G. Aland).

Summary

Background

The State Environmental Protection Policy (Waters of Victoria) Schedule F7 (Waters of the Yarra Catchment) specifies that Streamflow Management Plans (SMP's) are to be developed for waterways in the Yarra Catchment (EPA 1999). SMP's are intended to create a balanced and sustainable sharing of available water between all stakeholders with the aim of providing a long-term management strategy for water use that includes provisions for the maintenance and/or restoration of environmental values within the system. In the Stringybark Creek catchment, stakeholders include the environment, licensed diverters, and non-consumptive water use (recreation and aesthetics).

As a component of the Stringybark Creek catchment SMP, **Freshwater Ecology (Department of Natural Resources and Environment)** has been commissioned to conduct an environmental flow study. The Stringybark Creek catchment is located about 35 kilometres east of Melbourne and drains a catchment area of approximately 76 km². The area covered by this SMP includes Stringybark Creek mainstem from the headwaters downstream to the confluence of Olinda Creek and two tributaries; Log Creek and Little Stringybark Creek.

This document represents the final component of a three-phase environmental flow study conducted as part of the Stringybark Creek Catchment SMP. This report details findings and outcomes for each of the three phases as described below.

- **Phase 1:** Understanding the system and recommending environmental management objectives
 - Identify significant environmental values
 - System management
 - Review/assess hydrology
 - Develop environmental management objectives

- **Phase 2:** Field assessment for environmental flow recommendations
 - Habitat availability assessments

- **Phase 3:** Environmental flow recommendations

Environmental Values

Environmental values in the Stringybark Creek catchment were identified and described in terms of flora and fauna with conservation significance. Nine species of fish (four native and five exotic), two species of decapod crustacean and, freshwater mussel and shrimp species have been recorded from the Stringybark Creek catchment (Close and Koster Appendix 1, DNRE 2001), although none of the native species are considered threatened in Victoria (DNRE 2000b). Macroinvertebrate populations are generally less diverse than expected and tend to be dominated by families tolerant to pollution (Bessell-Browne 2000). Approximately 16 species of reptile and eleven species of amphibian have been recorded in the Stringybark Creek catchment (DNRE 2000a). Two of these species are considered threatened in Victoria (DNRE 2000b); the warty bell frog (*Litoria raniformis*), classified as vulnerable, and the lace monitor (*Varanus varius*), classified as data deficient. Approximately 91 species of bird (82 native and nine exotic) and 16 species of mammal (12 native and four exotic) have been recorded (DNRE 2000a). Two of these species are considered threatened in Victoria (DNRE 2000b); the nankeen night heron (*Nycticorax caladonicus*), classified as vulnerable, and the powerful owl (*Ninox strenua*), classified as endangered and also listed on the Victorian *Flora and Fauna Guarantee Act* 1988. Approximately 80 species of instream and riparian flora (76 native and four exotic) have been recorded in the Stringybark Creek catchment (DNRE 2000c). One species, the swamp bush-pea (*Pultenaea weindorferi*) is considered rare in Victoria and Australia (Gullan *et al.* 1990).

Hydrology, System Management and Alterations to the Natural Flow Regime

Stringybark Creek is approximately 22 kilometres in length and drains a catchment of approximately 76 km². Mean annual rainfall in the Stringybark Creek catchment is approximately 1000 mm (Rowan 1982) and stream flows are seasonal with the low flows occurring in January through to May and high flows occurring in July through to October (Doeg 1999).

Both surfacewater and groundwater harvesting occurs in the Stringybark Creek catchment for commercial and domestic and stock use (Richards 1999). There are currently 55 licensed diversion permits in the catchment with a total licensed volume of 971 ML.yr⁻¹ (Melbourne Water unpublished data, Doeg 1999). The majority of licensed diversions are for irrigation and off-stream storages. The volume of water diverted from Stringybark Creek over the summer/autumn period ranges from 0.5-2.5 ML.d⁻¹. During the winter/spring months diversion volumes increase to between 2.5-5.2 ML.d⁻¹ as off-stream dam winter fill demand increases.

In Stringybark Creek over the low flow period, the magnitude of mean passing flows has decreased by approximately 0.9-7.7% from derived natural flows. A similar decrease has occurred during the high flow period (2.2-7.3%). In Log Creek over the low flow period, the magnitude of mean passing flows has decreased by approximately 0-9.4% from the derived natural flows. A similar decrease has occurred during the high flow period (2.8-8.4%).

Few water quality data are available for Stringybark Creek. In general, water temperature is highest over the summer period between November and March, and lowest over the cooler months between April and October. Dissolved oxygen concentrations are highest over the higher flow months between May and October. pH values fluctuate slightly about the neutral value and show no seasonal trend in variation. Electrical conductivity is high (600-850 $\mu\text{S}\cdot\text{cm}^{-1}$) throughout most of the year with peaks in February and June. Suspended solids are remain reasonably constant throughout the year whilst turbidity appears to be seasonal, with values tending to be higher between July and November.

Stream Condition

In general, the condition of instream and riparian areas within the Stringybark catchment is regarded as moderate to poor (Chesterfield and Sovitslis 1994). Riparian vegetation is highly disturbed throughout most of the catchment, particularly upstream of Wandin and downstream of Yering where exotic grasses and willows are widespread. Some native vegetation is present throughout the middle reaches of the catchment, although exotic grasses and blackberry are also common. In the upper reaches, instream habitat conditions are affected by bank instability, sedimentation, dam diversions and on-stream dams. Sedimentation and bank erosion is also evident in the mid reaches of the catchment. Instream habitat conditions are extremely poor in the lower reaches of the catchment with extensive stream channelisation and dense stands of cumbungi which impede stream flow and reduce habitat diversity. SIGNAL scores indicate macroinvertebrate populations tend to be dominated by families tolerant to pollution (SIGNAL score at Silvan - 5.21 and Coldstream - 5.35) (Bessell-Browne 2000).

Environmental Management Objectives

The following management objectives apply specifically to the management of stream flow in the Stringybark Creek catchment.

1. *Maintain appropriate minimum environmental flows over the low flow period.*
2. *Provide appropriate flushing flows and high flow regimes that provide suitable conditions for migration and spawning of native fish species and essential geophysical processes such as channel scouring and silt removal.*
3. *Maintain water quality in accordance with SEPP (Waters of Victoria) – Schedule F7 Waters of the Yarra Catchment (EPA 1999), including provision of summer flushing flows.*
4. *Ensure that winter-fill diversions are set at a level that does not impact on essential biological and geomorphological processes.*

In addition, several management objectives specifically apply to biodiversity conservation.

1. *Maintain and/or restore diversity and complexity of instream habitat (e.g. woody debris).*
2. *Maintain and/or enhance diversity of aquatic fauna species and encourage recolonization of Stringybark Creek by migratory species.*
3. *Provide unimpeded fish access throughout the Stringybark Creek system through removal of instream barriers.*

Habitat Availability and Environmental Flow Recommendations

Minimum environmental flows are recommended for the Stringybark Creek catchment based on an assessment of historical flow data (natural and current regimes), fish habitat availability and expert opinion. These recommendations aim to meet the environmental management objectives listed above. The precautionary principle (i.e. a suitable ecological safety margin) has been applied due to our limited knowledge of the relationship between flow regimes and the ecology of native freshwater fish in Stringybark Creek.

Minimum environmental flows are recommended for each site at which habitat surveys were undertaken.

Minimum environmental flow recommendations for sites on Stringybark Creek.	
Site location	Environmental Flow (ML.day⁻¹)
Stringybark Creek at Warburton Highway	1.5
Little Stringybark Creek at Rodger Road	1.0
Log Creek at Medhurst Road	1.5
Stringybark Creek at Melba Highway	4.5

Rules for winter-fill volumes and rates are currently being developed as a component of a sustainable diversion limits project being undertaken by the Department of Natural Resources and Environment. Recommendations that are developed through this project can be applied to the Stringybark Creek system when completed.

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1. INTRODUCTION

Alteration to the natural flow regimes of rivers and streams is considered a major threat to the health of waterways, aquatic flora and fauna communities and the maintenance of essential instream ecosystem processes (SAC 1992). For example, alterations to key components of the flow regime including flow magnitude, seasonality and variability are regarded as key factors responsible for the decline in distribution and abundance of many native freshwater fish species throughout Victoria (Koehn and O'Connor 1990). Altered flow regimes have been identified as a potentially threatening process under the Victorian *Flora and Fauna Guarantee Act 1988* (SAC 1992) and are nominated as a key threatening process under the *Environment Protection and Biodiversity Conservation Act 1999*.

Melbourne Water, being the authority responsible for waterway management in the Yarra catchment, is required to develop a Streamflow Management Plan (SMP) for the Stringybark Creek catchment as part of the State Environment Protection Policy (Waters of Victoria) Schedule F7 (Waters of the Yarra Catchment) (EPA 1999, Richards 1999). SMP's are intended to create a balanced and sustainable sharing of available water between all stakeholders which in the Stringybark Creek catchment include, the environment, licensed diverters, and non-consumptive water use (recreation and aesthetics). The aim of a SMP is to provide a long-term management strategy for water use that includes provisions for the maintenance and/or restoration of environmental values within the system. The development of a SMP for the Stringybark Creek catchment will enable Melbourne Water to:

- Clarify rights to water resources;
- Ensure the long term sustainability of the river system by reaching a balance between environmental requirements and consumptive uses of the water;
- Provide a framework of rules to operate the river system to meet agreed water management objectives and;
- Ensure that future development does not have a negative impact on existing water users and the environment.

As a component of the Stringybark Creek SMP, **Freshwater Ecology (Department of Natural Resources and Environment)** was commissioned to undertake an environmental flow study and determine appropriate minimum environmental flows for the Stringybark Creek catchment. The broad objectives of the study were to:

- Identify significant environmental values that need to be protected by adequate flows.
- Identify other significant impacts on environmental values.
- Recommend environmental management objectives.
- Comment on the biological significance of changes to the flow regime (natural versus regulated).
- Recommend environmental flows at a number of specified points within the system.

This document represents the final component of a three phase environmental flow study conducted as part of the Stringybark Creek catchment SMP. This report details findings and outcomes for each of the three phases as described below.

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2. STUDY AREA

The Stringybark Creek catchment is located about 35 km east of Melbourne, is approximately 22 km in length and drains a catchment of approximately 76 km². Mean annual rainfall in the catchment is approximately 1000 mm (Rowan 1982). There are two major tributaries; Little Stringybark Creek which originates in the residential areas of Mount Evelyn, and Log Creek, which originates in the Warramate Hills near Gruyere (Figure 1). The headwaters of Stringybark Creek rise at an altitude of approximately 230 metres near Silvan. From its source, the creek flows for approximately four kilometres in a northerly direction through volcanic plains on quaternary volcanic rocks supporting areas of intensive horticulture, pasture lands and orchards before reaching the small rural subdivisions of Mt Evelyn and Wandin North (Rowan 1982, Melbourne Water 2000). The creek continues for approximately eight kilometres through undulating lands of palaeozoic sedimentary rocks supporting the pastures and orchards of Coldstream and Gruyere. The creek then flows in a north-westerly direction for approximately ten kilometres through quaternary alluvial plains supporting the pastures and viticulture areas around Yering prior to its confluence with Olinda Creek (Rowan 1982, Melbourne Water 2000). The lower sections of the Stringybark Creek have been extensively channelised. Native vegetation has been cleared from most of the catchment, except for a number of small bushland reserves and small areas of remnant bushland on private land and water frontage reserves. Private diversions of water from the Stringybark Creek catchment generally occur for high intensive horticulture cropping and nursery purposes in the Silvan/Wandin area, and for viticulture in the Coldstream/Gruyere area (Nicol 2000).

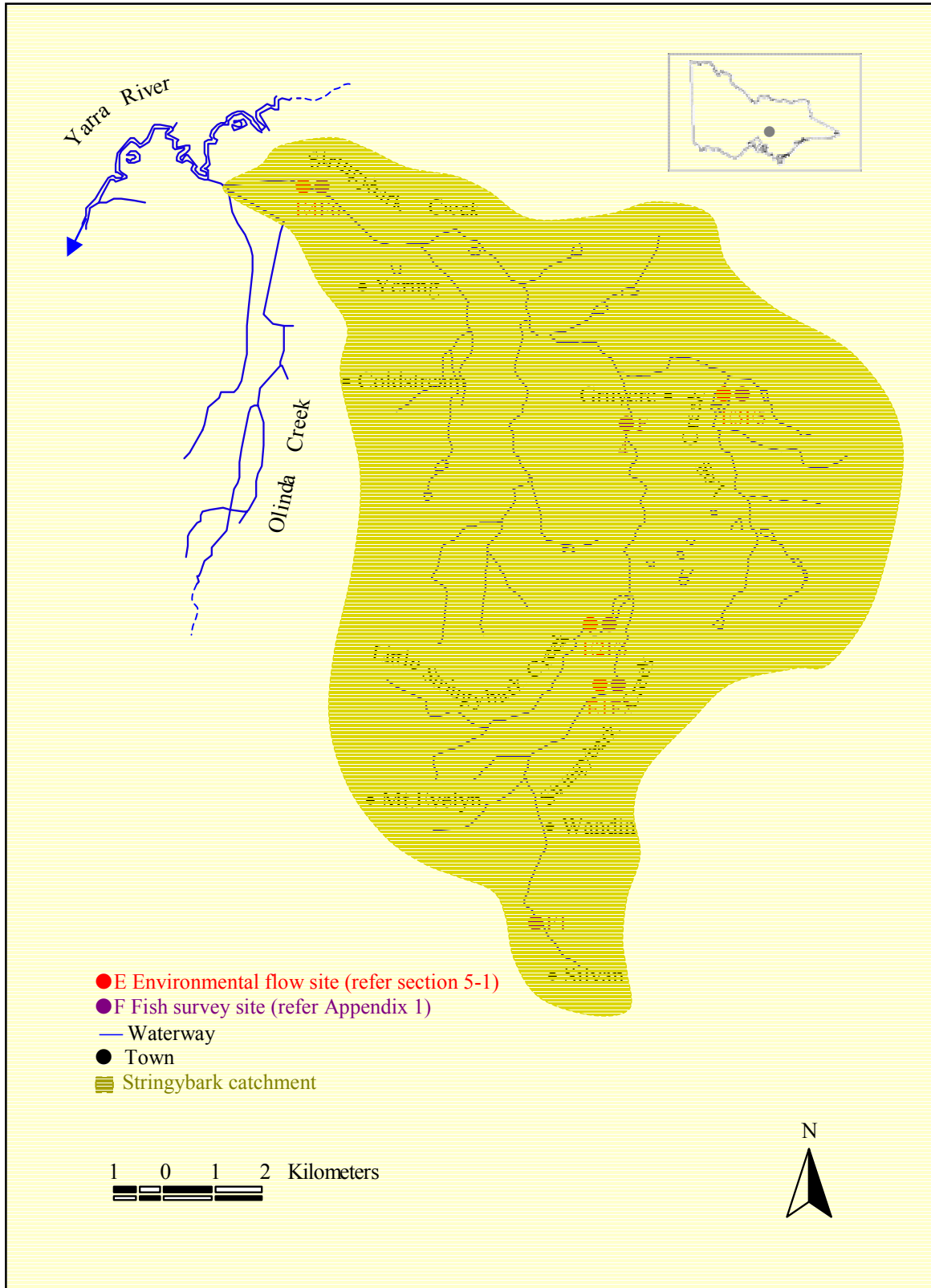


Figure 2-1. Location of environmental flow sites, gauging stations and other major reference points in the Stringybark Creek catchment.

3. ENVIRONMENTAL VALUES OF THE STRINGYBARK CREEK CATCHMENT

Environmental values in the Stringybark Creek catchment were identified and described in terms of flora and fauna with conservation significance. A review of literature, the Victorian Fish Database (DNRE 2001), the Atlas of Victorian Wildlife (DNRE 2000a) and the Victorian Flora Information System (DNRE 2000c) was undertaken to determine the distribution and diversity of significant biota that occur in the Stringybark Creek catchment.

3.1 Fish

Nine species of fish (four native and five exotic), two species of decapod crustacean and, freshwater mussel and shrimp species have been recorded from the Stringybark Creek catchment (Close and Koster Appendix 1, DNRE 2001). None of the native species are considered threatened in Victoria (DNRE 2000b).

Table 3-1 Fish and decapod crustacea recorded from the Stringybark Creek catchment*, including their conservation status.**

Scientific Name	Common Name	Conservation Status
Non migratory native fish		
<i>Galaxias olidus</i>	Mountain galaxias	C
<i>Nannoperca australis</i>	Southern pygmy perch	C
Migratory native fish		
<i>Anguilla australis</i>	Short-finned eel	C
<i>Galaxias maculatus</i>	Common galaxias	C
Exotic fish		
<i>Carassius auratus</i>	Goldfish	-
<i>Gambusia holbrooki</i>	Eastern gambusia	-
<i>Misgurnus anguillicaudatus</i>	Oriental weatherloach	-
<i>Perca fluviatilis</i>	Redfin	-
<i>Rutilus rutilus</i>	Roach	-
Decapod crustacea		
<i>Engaeus sp.</i>	Burowing cray	C
<i>Euastacus woiwuru</i>	Central highlands spiny cray	C
<i>Paratya australiensis</i>	Freshwater shrimp	C

*, after Close and Koster Appendix 1

** , from DCNR 1995, DNRE 2000b

C – Common.

Mountain galaxias (*Galaxias olidus*) have been recorded in the upper part of the catchment near Kalorama and Wandin North. This species typically inhabits small streams at higher elevations where water temperatures remain cool in summer (McDowall and Fulton 1996). Southern pygmy perch (*Nannoperca australis*) and common galaxias (*Galaxias maculatus*) have been recorded in the middle reaches of the catchment near Gruyere. These species generally prefer slow flowing open water abundant in submerged aquatic vegetation (Koehn and O'Connor 1990).

Short-finned eel (*Anguilla australis*) have been recorded throughout most of the catchment, from Wandin North in the headwaters to Yering in the lower reaches. Short-finned eel occupy a variety of habitats including rivers, creeks and wetlands (Beumer 1996).

In the past Dight's Falls represented a major barrier to the upstream movement of native migratory fish throughout the Yarra River catchment. It is likely that recolonisation of Stringybark Creek and its tributaries by common galaxias has been facilitated by the construction of a fishway at Dight's Falls in 1994. The occurrence of short-finned eel throughout the catchment is not unexpected because this species can bypass instream barriers by either climbing over or moving around them. An additional six species may recolonise Stringybark Creek catchment as a result of the Dight's Falls fishway being installed (Table 3-2). One of these species, the Australian grayling (*Prototroctes maraena*), is considered vulnerable in Victoria and is listed on the Victorian *Flora and Fauna Guarantee Act* 1988.

Table 3-2. Native fish species that have the potential to recolonise the Stringybark Creek catchment, including their Victorian conservation status*.

Scientific Name	Common Name	Conservation Status
<i>Galaxias truttaceus</i>	Spotted galaxias	C
<i>Galaxias brevipinnis</i>	Broad-finned galaxias	C
<i>Geotria australis</i>	Pouched lamprey	C
<i>Mordacia mordax</i>	Short-headed lamprey	C
<i>Prototroctes maraena</i>	Australian grayling	V, FFG
<i>Pseudaphritis urvilli</i>	Tupong	C

*, from DCNR 1995, DNRE 2000b

Abbreviations denote conservation status as; V – Vulnerable, C – Common, FFG indicates that the species is listed on the Victorian *Flora and Fauna Guarantee Act* 1988.

These species have been recorded in recent surveys of other Yarra River tributaries (Zampatti and Raadik 1997, Lieschke and Raadik 1999, Raadik *et al.* 1999, Koster and Raadik 2000). Their apparent absence from Stringybark Creek may be attributable to a number of factors including habitat conditions, unknown instream barriers and limited survey effort.

3.2 Aquatic Macroinvertebrates

A study by Hardwick and Waller (1999) on the macroinvertebrate assemblages of Stringybark Creek revealed low macroinvertebrate values according to the EPA (1999) ecological objectives criteria. Four of the six sites studied did not meet any ecological indicator objectives, and none of the sites studied exceeded all of their ecological indicator objectives. The most numerically dominant families in the catchment include taxa usually regarded as indicators of reduced water quality including Chironomidae (Diptera) and Hydrobiidae (Mollusca) (Hardwick and Waller

1999). AUSRIVAS¹ scores are 'below reference' at Silvan (0.64) and Coldstream (0.80) indicating that macroinvertebrate populations are generally less diverse than expected (Bessell-Browne 2000). SIGNAL² scores indicate macroinvertebrate populations tend to be dominated by families tolerant to pollution (SIGNAL score at Silvan - 5.21 and Coldstream - 5.35).

3.3 Reptiles and Amphibians

Approximately 16 species of reptile and eleven species of amphibian have been recorded in the Stringybark Creek catchment (DNRE 2000a). Two of these species are considered threatened in Victoria (DNRE 2000b); the warty bell frog (*Litoria raniformis*), classified as vulnerable, and the lace monitor (*Varanus varius*), classified as data deficient. The warty bell frog inhabits vegetation within or at the edge of permanent water (Cogger 2000). The lace monitor does not directly depend on the riparian environment, although such areas often provide the only remaining habitat.

3.4 Other Vertebrates

Approximately 91 species of bird (82 native and nine exotic) and 16 species of mammal (12 native and four exotic) have been recorded in the Stringybark Creek catchment (DNRE 2000a). Two of these species are considered threatened in Victoria (DNRE 2000b); the nankeen night heron (*Nycticorax caladonicus*), classified as vulnerable, and the powerful owl (*Ninox strenua*), classified as endangered and also listed on the Victorian *Flora and Fauna Guarantee Act* 1988.

3.5 Instream and Riparian Flora

Approximately 80 species of instream and riparian flora (76 native and four exotic) have been recorded in the Stringybark Creek catchment. One species, the swamp bush-pea (*Pultenaea weindorferi*) is considered rare in Victoria and Australia (Gullan *et al.* 1990).

¹ AUSRIVAS (Australian Rivers Assessment System) is a predictive model used to assess river health. The model predicts families of macroinvertebrates which should occur at a particular sites and compares the probabilities of these predicted families with the number of families actually found.

² SIGNAL is a biotic index which uses sensitivity (tolerance or intolerance) of aquatic invertebrate families to pollutants

4. HYDROLOGY OF THE STRINGYBARK CREEK CATCHMENT

4.1 Flow Regime

Flow records are available from two gauging stations within the Stringybark Creek catchment (Table 4-1). Low flow months have been identified as January through to May and high flows occur from July through to October (Doeg 1999). At gauging station 229657 (Killara Road), median flow over the low flow period (January to May) ranges from 2.79-20.5 ML.d⁻¹. Over the high flow period (July to October) median flow is approximately 18.6-40.2 ML.d⁻¹.

Table 4-1. Location of gauging stations on Stringybark Creek and their period of record.

Gauge	Location	Period of Record
229657	Killara Road	Feb 1979 – July 1986
229401a	Clegg Road	Jan 1987 - Nov 2000

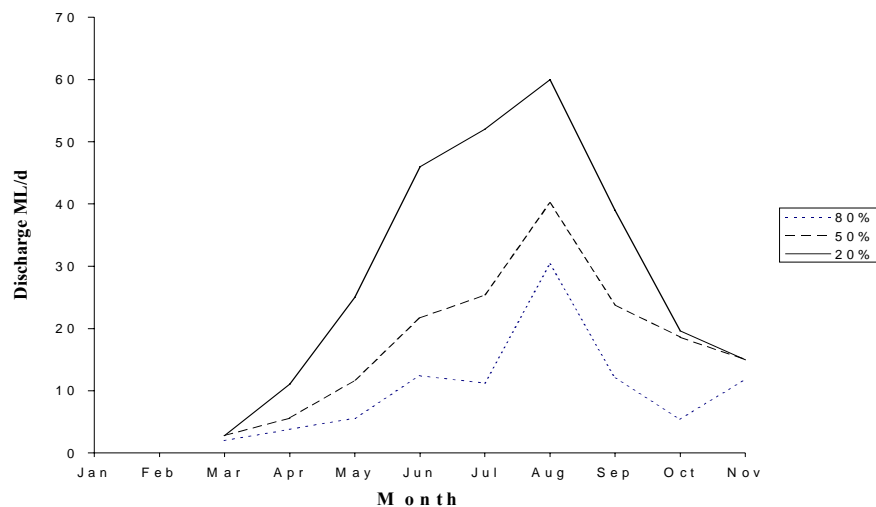


Figure 4-1. 80th, 50th and 20th percentile exceedence flows recorded at the Killara Road gauging station (229657). NB insufficient data for the period December to February inclusive.

Gauging station 229401 is located higher in the catchment immediately upstream from Clegg Road (Figure 2-1). The seasonal flow regime is similar to that described above for the Killara Road gauge. Median flow over the low flow period (January to May) ranges from 3.7-5.6 ML.d⁻¹. Over the high flow period (July to October) median flow is approximately 8.7-13.3 ML.d⁻¹.

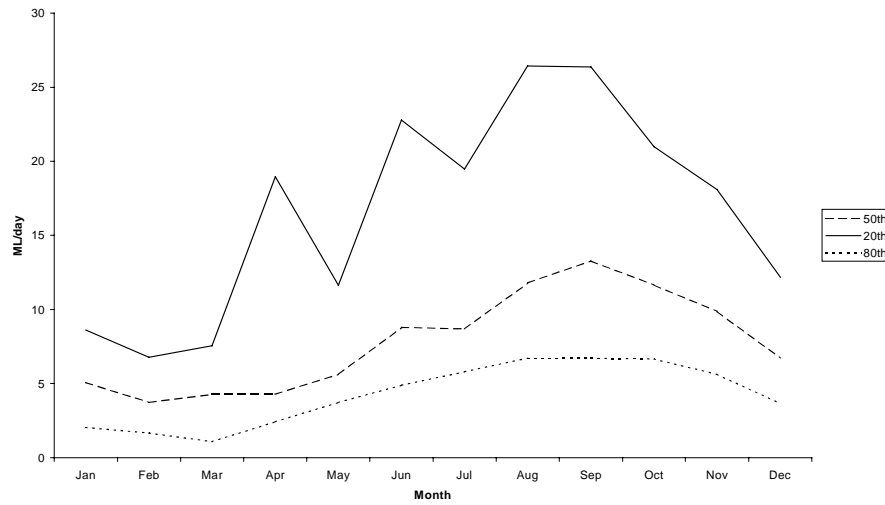


Figure 4-2. 80th, 50th and 20th percentile exceedence flows recorded at the Clegg Road gauging station (229401a).

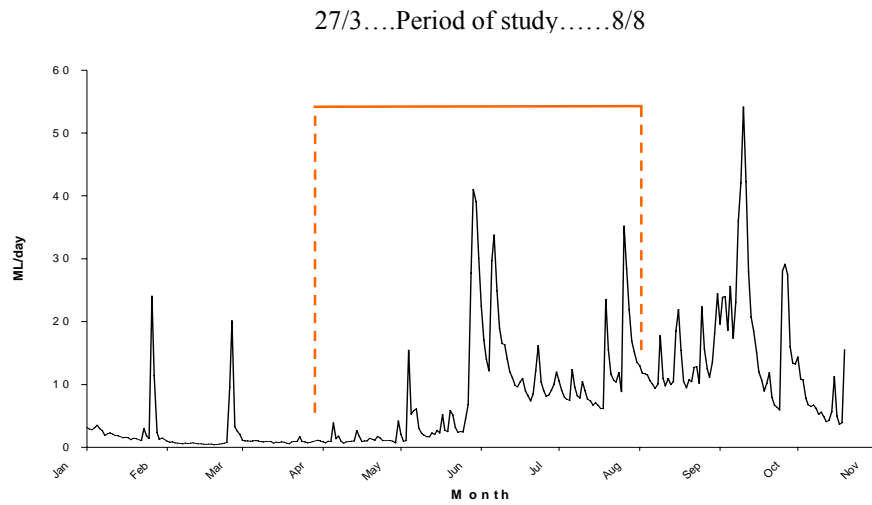


Figure 4-3. Mean daily discharge at the Clegg Road gauge (station number 229401a) between January and December 2000 including the period of study.

In the year 2000, the low flow season extended from January through to May, with the mean daily discharge generally less than 1-2 ML.d⁻¹. Flows of this magnitude represent very low flows in Stringybark Creek (>80th percentile exceedence flows, c.f. Fig. 4-2). Over the winter/spring months between June and October, flows in Stringybark Creek at Clegg Road were elevated and ranged between 6-15 ML.d⁻¹, with major flushes to 35 ML.d⁻¹ in June and 54 ML.d⁻¹ in September.

4.2 System Management

Both surfacewater and groundwater harvesting occurs in the Stringybark Creek catchment for commercial and domestic and stock use (Richards 1999) and Melbourne Water and Southern Rural Water manage these extractions respectively. There are currently 55 licensed diversion permits in the Stringybark Creek catchment which includes Little Stringybark Creek and Log Creek sub-catchments (Table 4-2). The total volume of water licensed for diversion within this area is 971 ML.yr⁻¹ (Melbourne Water unpublished data, Doeg 1999). The majority of licensed diversions are for irrigation and off-stream streams. Under the *Water Act 1989*, a person has a statutory right to take and use water from a waterway for that persons domestic and stock use (as defined in the Water Act) free of charge and without a licence if the waterway is on land the person occupies, or if the person occupies land immediately adjacent to the waterway ie. no crown land reserve between the persons land and the waterway.. There is no available information on how many landholders exercise this right or how much water is diverted (Haydon 1994). The volume of water diverted from Stringybark Creek over the summer/autumn period ranges from 0.5-2.5 ML.d⁻¹. During the winter/spring months diversion volumes increase to between 2.5-5.2 ML.d⁻¹ as off-stream dam winter fill demand increases. Similarly, diversion of water from Log Creek is greatest over the winter/spring months (0.6-1.3 ML.d⁻¹) and decreases during the summer/autumn period to between zero and 0.6 ML.d⁻¹. There is no available information for Little Stringybark Creek regarding the daily volumes of water diverted. During excessively dry spells when stream discharges drop to critical levels (as measured in the Yarra River at Warrandyte), Melbourne Water may implement a *Drought Response Plan* which places restrictions on water use.

Table 4-2. Entitlement details for licensed water diversion from Stringybark Creek and its tributaries* (from Theiss Environmental unpublished data).

License	Number (Volume ML.d ⁻¹)				Total No. of Licenses and (Volume) (ML.yr ⁻¹)
	Stringybark Crk	L. Stringybark Crk.	Log Crk.	Unnamed Tributary	
Irrigation	26 (197)	-	-	3 (22)	29 (219)
Stock and domestic	3 (6)	-	-	-	3 (6)
Stock, domestic Commercial	2 (8)	1 (4)	-	1 (4)	4 (16)
Off-stream dams	13(520)	2 (12)	3 (194)	-	18 (726)
On-stream dams	1 (4)	-	-	-	1 (4)
Totals	45 (735)	3 (16)	3 (194)	4 (26)	55 (971)

4.3 Alteration to the Natural Flow Regime

A comparison of derived natural flows, mean passing flows, minimum passing flows and diversion in Stringybark Creek is presented in Figure 4-3³. The magnitude of mean passing flows has decreased by approximately 0.9-7.7% over the low flow period and 2.2-7.3% during the high flow period from derived natural flows. Minimum passing flows during the low flow period range from approximately 1.3 to 14.1 ML.day⁻¹ and licensed water diversion during this period may range from 0.5 to 2.5 ML.day⁻¹. Minimum passing flows during the high flow period range from approximately 15.7 to 33.8 ML.day⁻¹ and licensed water diversion during this period may range from 3.6 to 5.2 ML.day⁻¹.

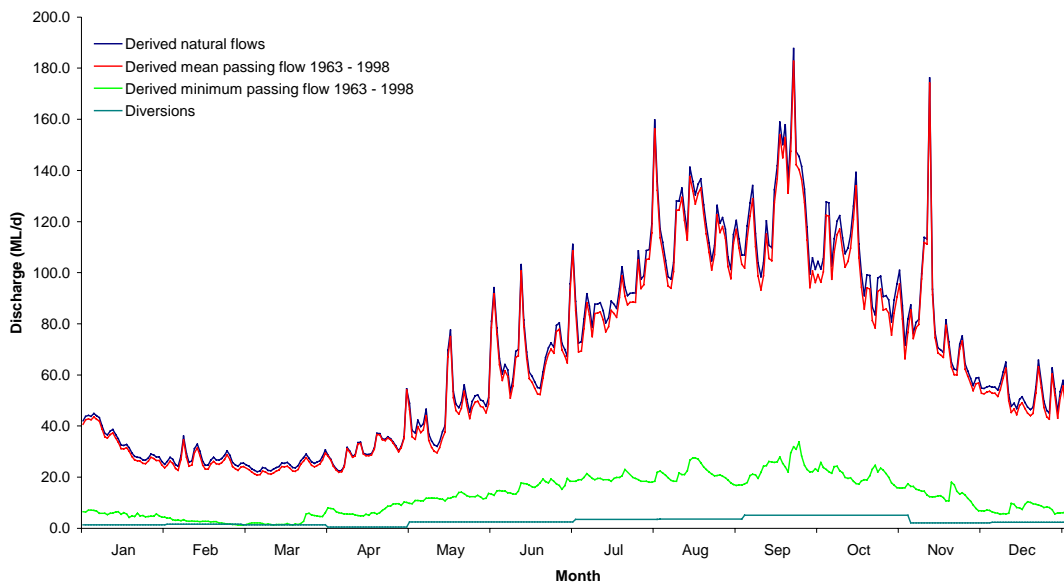


Figure 4-3. Gauged and modelled natural daily flows, and mean daily diversions for each month for Stringybark Creek.

A comparison of derived natural flows, mean passing flows, minimum passing flows and diversion at a monitoring site on Log Creek is presented in Figure 4-4. The magnitude of mean passing flows over the low flow period has decreased by approximately 0-9.4% over the low flow period and 2.8-8.4% during the high flow period from derived natural flows. Minimum passing flows during the low flow period range from approximately 0.3 to 2.9 ML.day⁻¹ and licensed water diversion during this period may range from 0 to 0.6 ML.day⁻¹. Minimum passing flows during the high flow range from approximately 3.3 to 6.9 ML.day⁻¹ and licensed water diversion during this period may range from 0.9 to 1.3 ML.day⁻¹.

³ Natural flows were derived by Theiss and represent gauged passing flows plus diversions plus a demand factor (Steven Nicol, Melbourne Water *pers. comm*)

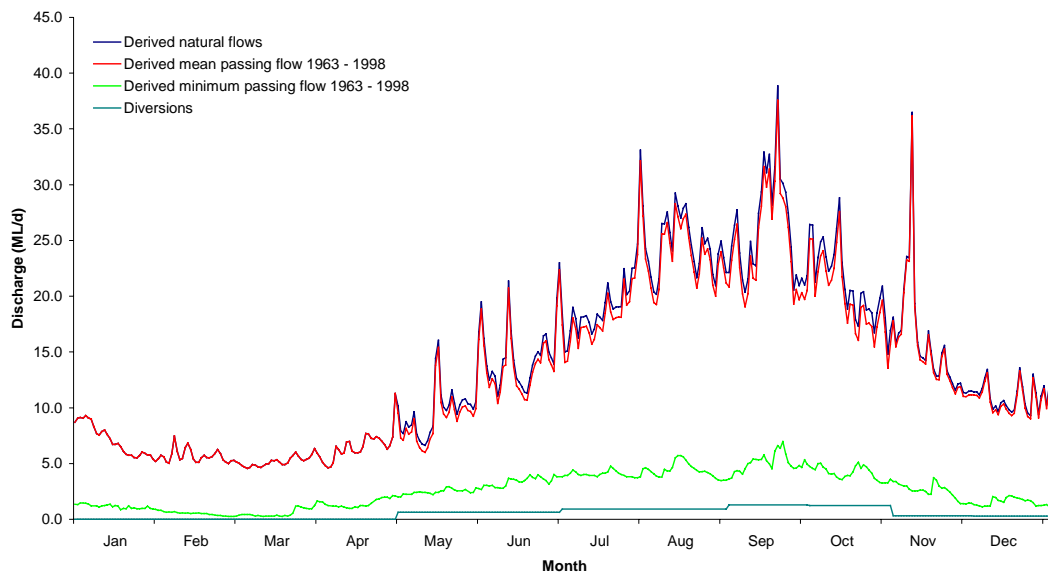


Figure 4-4. Gauged and modelled natural daily flows, and mean daily diversions for each month for Log Creek.

4.4 Water Quality

Few water quality data are available for the Stringybark Creek catchment. Water quality data for monthly spot measurements of Stringybark Creek at Melba Highway, Yering, between September 1995 and June 2000 was sourced from Melbourne Water (unpublished data Melbourne Water 2001). Data were pooled and median monthly values examined (Appendix 2). The number of observations for each month over the given period ranged from two to five. In general, water temperature is highest over the summer period between November and March, and lowest over the cooler months between April and October. Dissolved oxygen concentrations are highest over the higher flow months between May and October. pH values fluctuate slightly about the neutral value and show no seasonal trend in variation. Electrical conductivity is high ($600\text{-}850\ \mu\text{S}\cdot\text{cm}^{-1}$) throughout most of the year with peaks in February and June. Suspended solids remain reasonably constant throughout the year whilst turbidity appears to be seasonal, with values tending to be higher between July and November.

5. METHODOLOGY FOR ENVIRONMENTAL FLOW STUDIES

The technique employed in the present study was based on an adaptation of the instream flow incremental method (IFIM) (Bovee 1982) together with a multiple transect method, historical flows and expert knowledge to recommend environmental flows. These recommendations aim to protect the environmental values present in the Stringybark Creek catchment and also meet the objectives of the Stringybark Creek SMP through facilitating sustainable flows and management of water allocation throughout the year.

The IFIM technique relates changes in depth and velocity to the availability of fish habitat and has commonly been used in Victoria to aid in the determination of environmental flows (Tunbridge and Glenane 1988, Hall 1989). The application of this technique requires a sound knowledge of the flow and habitat requirements of the fish species of concern, particularly depth and velocity. In order to determine habitat availability for native fish species in Stringybark Creek, river blackfish were selected as key species. Although river blackfish were not recorded in the Stringybark Creek fish survey (Appendix 1), the species is present in the adjacent Olinda Creek catchment and is also widely distributed throughout other upper Yarra River tributaries (DNRE 2001). The species probably therefore also inhabits the Stringybark Creek system. River blackfish are the deepest bodied native fish species found in the Olinda/Stringybark Creek system and it is assumed that providing a suitable amount of potential habitat for river blackfish will also provide habitat for smaller native species, invertebrates and aquatic vegetation in the Stringybark Creek system.

The depth and velocity requirements of river blackfish have been derived from a study by Koehn *et al.* (1994) on the habitat preferences of this species in Armstrong Creek, a tributary of the upper Yarra River. The habitat requirements of river blackfish were divided into two life stages, juveniles (fish < 150 mm in length) and adults (fish > 150 mm in length) (Table 5-1).

Table 5-1. Depth and velocity requirements of river blackfish.

Species	Life Stage	Depth (m)	Velocity (m/s)
River blackfish	Juvenile	>0.1	<0.2
	Adult	>0.2	<0.2

Unlike previous Victorian studies (Tunbridge and Glenane 1988, Hall 1989), we have not divided habitat requirements into rearing, resting, passage and spawning requirements as the available data is not comprehensive enough to enable the modelling of habitat availability with regards to all requirements. The habitat requirements we have used encompass both rearing and resting activities. This habitat covers the largest component of stream area and is considered the most important habitat over the low flow period.

As a tool to aid in the determination of environmental flow regimes, fish habitat availability may be compared under natural and modified flow regimes and an arbitrary decision made on a specified level of fish habitat to maintain. However, the particular amount of habitat required is the subject of considerable conjecture (Pusey 1998). In order to refine our recommendations, a multiple transect analysis was used in addition to the IFIM method. This technique examines the relationship between wetted area and stream discharge to determine minimum environmental flows. We have used wetted useable area which is defined as that area that is greater than 0.02 m deep.

In the current study we have examined the relationship between stream discharge and, wetted useable area and blackfish habitat preferences in an attempt to maintain habitat availability similar to that which may occur naturally. These relationships have been examined in conjunction with an assessment of historical and derived natural flows (Melbourne Water unpublished data) for Stringybark Creek.

5.1 Field Measurements of Hydraulic Parameters and Habitat

Four sites were selected in the Stringybark Creek system to establish reaches where habitat availability could be measured at a range of flows (Figure 2-1, Table 5-2). Two sites were located on Stringybark Creek and one site on each of Little Stringybark and Log creeks, thus providing detailed information on discharge and habitat availability throughout the catchment.

At each flow site a series of transects was established in areas of habitat that were representative of that particular reach of river. The number of transects was determined by the number required to provide a representative sample of all habitat types and associated hydrological characteristics. Transects were placed perpendicular to the thalweg (from bank to bank), each end being identified by a permanent marker to facilitate future measurements at a range of flow conditions. A measuring tape was extended across the stream 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.

Table 5-2. Environmental flow study sites in Stringybark Creek catchment.

Site No.	Location	Grid Reference (map no., zone, coordinates)	Altitude (masl)
E1	Stringybark Creek, upstream of bridge on Warburton Hwy, Wandin North	7922 55 360600 5817700	205
E2	Little Stringybark Creek, upstream of bridge on Rodger Road, Wandin North	7922 55 360800 5819300	140
E3	Log Creek, upstream of bridge on Medhurst Road, Gruyere	7922 55 362800 5824100	100
E4	Stringybark Creek, downstream of bridge on Melba Hwy, Yering	7922 55 356700 5827500	50

*, masl denotes "metres above sea level"

5.2 Modelling Using RHABSIM

The amount of total wetted useable habitat (depths greater than 0.02 m) and habitat potentially available to juvenile and adult river blackfish, at a range of flows, was calculated using the RHABSIM hydraulic and habitat simulation system (Payne and Associates 1994). Criteria curves were constructed for adult and juvenile river blackfish. The habitat preferences for these 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. It is important to note that predictions made with RHABSIM do not suggest that system productivity will be altered through changes in habitat availability.

Changes in habitat availability at a range of flows were measured in the field rather than by hydraulic simulation. Due to an absence of accurate stage/discharge data for most sites in the Stringybark Creek system, it was considered impractical to calibrate a hydraulic simulation model of the stream sections. In addition, the structural complexity (woody debris, aquatic vegetation etc.) of the stream reaches, may have resulted in inaccurate hydraulic calibration of a model (Gordon *et al.* 1992, Courot 1989).

5.3 Water Quality

Spot measurements of five basic water quality parameters, dissolved oxygen, electrical conductivity, temperature, turbidity and pH were recorded at each site at a range of flows. Water temperature (°C) and electrical conductivity ($\mu\text{S}\cdot\text{cm}^{-1}$ @ 25 °C) were measured with a WTW LF 320 meter, dissolved oxygen ($\text{mg}\cdot\text{L}^{-1}$) with a WTW OXI 320 meter and pH with a WTW pH 320 meter. All instruments were calibrated according to manufacture's specifications.

6. RESULTS AND OBSERVATIONS

6.1 Site Descriptions.

Site E1. Stringybark Creek upstream of bridge on Warburton Road.

Site E1 was located in the mid-upper reaches of the catchment near Wandin North. The creek is bordered by a public reserve on its western side and private property on its eastern side. Although the riparian zone was disturbed, the overstorey was dominated by eucalypts and wattles. Exotic grasses, ferns and sedges were predominant throughout the understorey. The stream channel was narrow with an average width of two metres and bank undercutting was evident. Flow type was predominantly glide (80%), with smaller sections of riffle (10%) and pool (10%). Substratum was predominantly clay (50%) and silt (40%). Instream cover comprised leaf litter (20%), woody debris (15%), bank overhang (10%), overhanging vegetation (5%) and aquatic vegetation (2%). Impacts on the environmental values of the site include clearing of vegetation, exotic plant species, residential housing and a walking track.



Figure 6-1. Stringybark Creek upstream of bridge on Warburton Highway.

Site E2. Little Stringybark Creek at Rodger Road, Wandin North.

Site E2 was located in the mid-upper reaches of the catchment near Wandin North. The creek is bordered by an orchard on its northern side and market gardens on its southern side. The riparian zone was highly disturbed, comprising a very narrow strip dominated by exotic species. The overstorey was sparse and consisted of eucalypts, wattles and tea trees whilst the understorey vegetation was dense and consisted of exotic grasses and blackberry. The average width of the stream was approximately two and a half metres and bank undercutting was evident. Flow type was predominantly glide (55%), with smaller sections of pool (20%), run (15%) and riffle (10%). Substratum type was predominantly silt (55%), with smaller areas of sand (20%) and clay (15%). Instream cover consisted of overhanging bank (15%), aquatic vegetation (15%) and woody debris (12%). Impacts on the environmental values of the site include extensive clearing of vegetation, exotic plant species and stock access.



Figure 6-2. Little Stringybark Creek at Rodger Road, Wandin North.

Site E3. Log Creek at Medhurst Road, Gruyere.

Site E3 was located in the mid-upper reaches of the catchment near Gruyere. The creek was bordered by orchards on both banks. The riparian zone was highly disturbed, comprising an extremely narrow strip of native and exotic species. The overstorey was sparse and consisted of tea trees and wattles. Understorey vegetation was sparse and consisted of exotic grasses and blackberry. The average width of the stream was two metres and bank erosion and sedimentation were evident. Flow type was predominantly glide (60%), with smaller sections of riffle (20%) and pool (20%). Substratum was predominantly silt (60%) and clay (40%). Instream cover comprised branches (20%), aquatic vegetation (10%) and leaf litter (5%). Impacts on the environmental values of the site include extensive clearing of vegetation and exotic plant species.



Figure 6-3. Log Creek at Medhurst Road, Gruyere.

Site E4. Stringybark Creek downstream of bridge on Melba Highway.

Site E4 was located in the lower reaches of the catchment near Yering. The creek was bordered by grazing land on both banks. The riparian zone was extremely disturbed, comprising only exotic grasses and sparse stands of willows. The average width of the stream was five metres and bank slumping and erosion were evident. Flow type was entirely glide (100% of wetted area) in high flow and predominantly pool with smaller sections of glide in low and medium flow. Substratum was predominantly clay (90%), with smaller areas of silt (10%). Impacts on the environmental values of the site include extensive clearing of vegetation, exotic plant species, stream channelisation, stock access and dense stands of cumbugi impeding stream flow.



Figure 6-4. Stringybark Creek downstream of bridge on Melba Highway.

6.2 Summary of Stream Condition and Flow Related Issues

In general, the condition of waterways (bed stability, bank stability, aquatic structure and shade) and riparian vegetation (bank vegetation, verge vegetation and pest/noxious plants) throughout the Olinda/Stringybark catchment is regarded as moderate to poor (Chesterfield and Sovitslis 1994). The riparian vegetation of Stringybark Creek upstream of Wandin is extremely disturbed, consisting almost entirely of exotic grasses. Instream habitat conditions are also relatively poor. A range of instream cover is present, including boulders, branch piles and aquatic vegetation, although the presence of some bank instability, sedimentation, dam diversions and on-stream dams detracts from these values.

In the region between Wandin and Gruyere, (including Little Stringybark Creek), riparian vegetation is highly disturbed. Some sections comprise a narrow strip of eucalypts, wattles and tea trees, although exotic grasses and blackberry are widespread and abundant. Although a range of instream cover is present, including logs, leaves, branch piles and overhanging vegetation, accumulation of silt within the creek smothers important benthic habitats (coarse substrates and organic debris) thereby reducing habitat diversity. Bank undercutting and erosion are also evident.

Between Gruyere and Yering, (including Log Creek), riparian vegetation is extremely disturbed and consists almost entirely of exotic grasses and sparse stands of tea trees and wattles. Instream habitat conditions are relatively poor. A range of instream cover is present, including aquatic vegetation, logs, leaves and overhanging vegetation, although sedimentation and bank erosion detract from these values.

Downstream of Yering to the Olinda Creek confluence, riparian vegetation is extremely degraded, consisting almost entirely of exotic grasses and willows. Instream habitat conditions are also very poor with instream cover largely restricted to dense stands of cumbungi which impede stream flow and reduce habitat diversity. Stream channelisation is extensive, and bank slumping, erosion and sedimentation are also evident.

6.3 Habitat Availability

Three parameters have been used to examine the relationship between available habitat and discharge over the summer low flow period namely, wetted useable area and, juvenile and adult blackfish habitat criteria. Reach length and number of transects varied between sites depending on the hydraulic and geomorphological complexity and habitat diversity (Table 6-1). The number of transects established at each site ranged from 10 to 14. Habitat availability was measured at each site during three flows of different magnitude (Table 6-2).

Table 6-1. Details of habitat survey reaches and multiple transects.

Site	Reach length* (m)	No. Transects	Average Distance between transects (m)
E1-Stringybark Crk.	59.1	13	4.5
E2-Little Stringybark Crk.	53.5	10	5.4
E3-Log Crk.	46.6	14	3.3
E4-Stringybark Crk.	66.7	10	6.7

*, thalweg length

Table 6-2. Habitat availability at four sites in Stringybark Creek at three discharges.

Site	Discharge (ML.d ⁻¹)		Habitat Availability**		
	Site	Clegg Rd*	Wetted useable area (≥0.02m)	Juvenile Blackfish	Adult Blackfish
E1	0.6	0.8	103.3	93.9	69.7
Stringybark	14.7	8.2	120.0	117.1	91.7
Wandin Nth	16.0	18.9	140.3	92.9	79.5
E2	0.2	0.8	114.6	107.0	83.8
Little Stringybark	1.6	8.2	113.0	107.9	87.4
Wandin Nth	8.8	18.9	125.4	115.9	108.0
E3	0.1	0.4	101.6	72.7	55.4
Log Crk	1.1	7.4	120.7	112.8	90.9
Gruyere	9.0	35.2	144.9	130.6	123.1
E4	0.0	0.9	352.2	328.0	285.7
Stringybark	14.0	7.4	398.9	390.5	356.0
Yering	30.0	11.2	538.5	519.8	489.6

*, telemetered reading at gauging station 229401a provided by Melbourne Water

**, for blackfish habitat criteria see section 5.

At site 1 (Stringybark Crk, Wandin North), wetted useable area (depths ≥ 0.02 m) decreased by approximately 26.0 % when stream discharge decreased from 16.0 to approximately 0.6 ML.day⁻¹. Similarly, the habitat potentially available adult blackfish decreased by approximately 12.0 %. In contrast, the area potentially available to juvenile blackfish was variable and showed no clear trend with discharge (Fig. 6-5).

At site 2 (Little Stringybark Crk, Wandin North) a decrease in discharge from 8.8 to 0.2 ML.day⁻¹ decreases wetted useable area by approximately 10.0 %. The area potentially available as habitat to juvenile blackfish showed a similar decrease of 7.7 %, whilst the area potentially available for adult blackfish decreased by 22.4 % (Fig. 6-6).

In contrast, wetted useable area and the area potentially available to juvenile and adult blackfish at site 3 (Log Crk Gruyere) decreased significantly with decreases in discharge. A decrease in discharge from 9.0 to 0.1 ML.day⁻¹ resulted in wetted useable area decreasing by approximately 29.9 %. Similarly, the area potentially available to juvenile and adult blackfish decreased by approximately 44.3 and 55.0 % respectively (Fig. 6-7). A significant loss in habitat occurred between 1 and 2 ML.day⁻¹. Below this discharge, habitat became fragmented and continuity was lost between pools.

At site 4 (Stringybark Crk, Yering), wetted useable area decreased by approximately 34.6 % when stream discharge decreased from 30.0 to approximately zero ML.day⁻¹. Similarly, the habitat potentially available juvenile and adult blackfish decreased by approximately 36.9 % and 41.6 % respectively (Fig. 6-5).

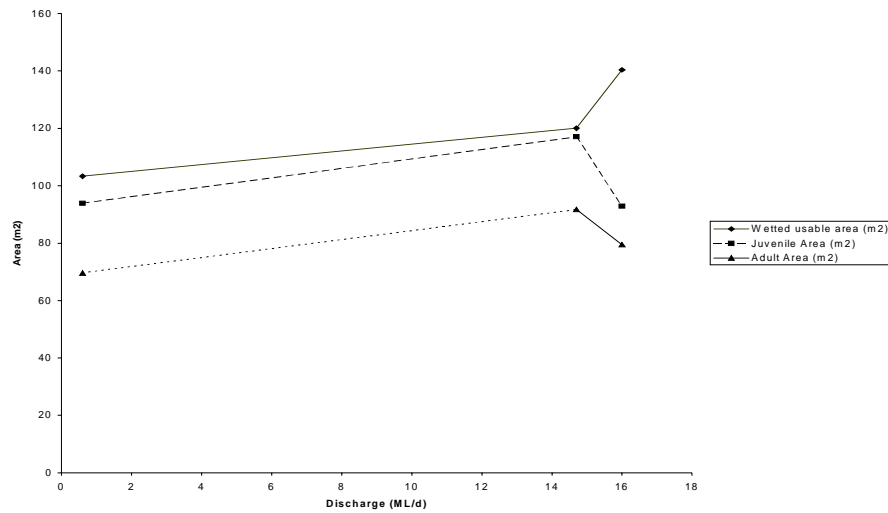


Figure 6-5. Habitat availability at a range of flows at site 1 (Stringybark Creek, Wandin North). Wetted useable are is that area with depths ≥ 0.02 m. Depth and velocity parameters for juvenile and adult blackfish are discussed in section 5.

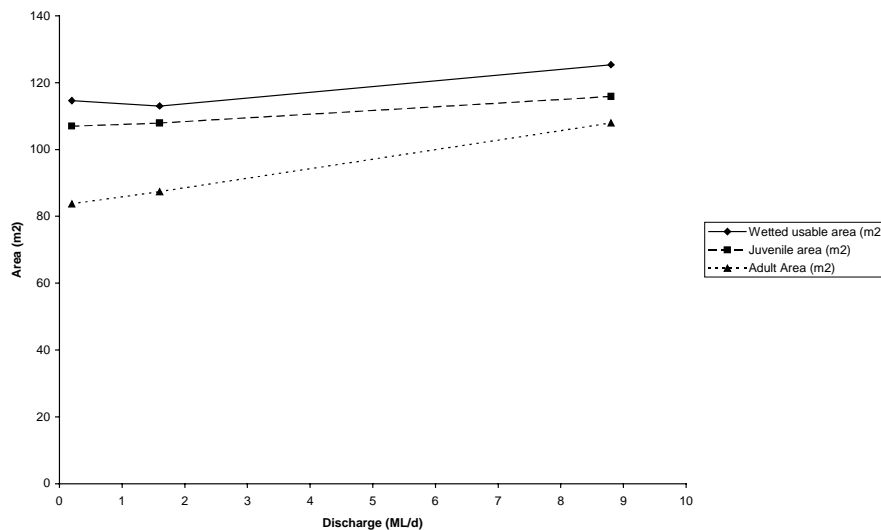


Figure 6-6. Habitat availability at a range of flows at site 3 (Little Stringybark Creek, Wandin North). Wetted useable are is that area with depths ≥ 0.02 m. Depth and velocity parameters for juvenile and adult blackfish are discussed in section 5

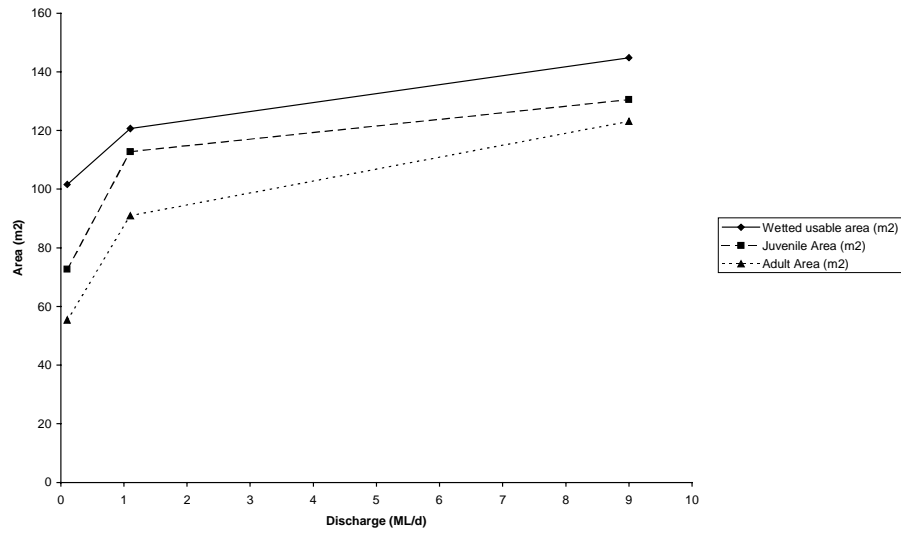


Figure 6-7. Habitat availability at a range of flows at site 4 (Log Creek, Gruyere). Wetted useable are is that area with depths ≥ 0.02 m. Depth and velocity parameters for juvenile and adult blackfish are discussed in section 5.

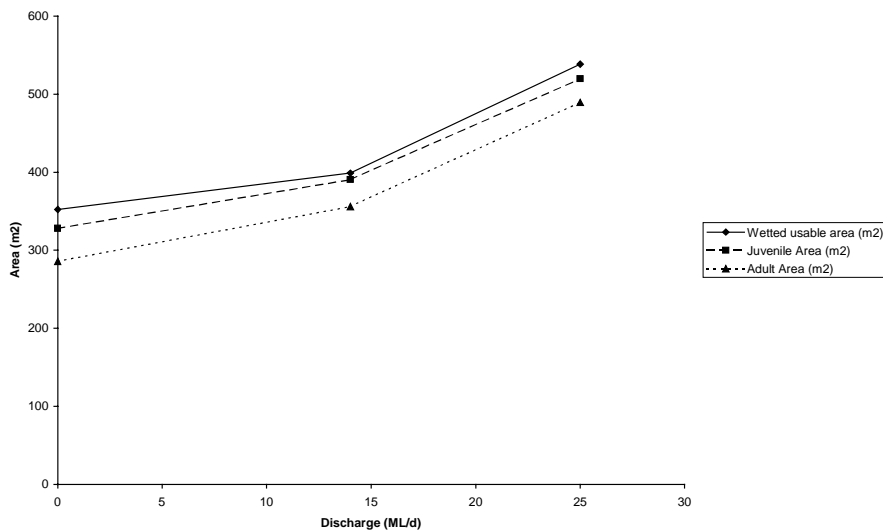


Figure 6-8. Habitat availability at a range of flows at site 2 (Stringybark Creek, Yering). Wetted useable are is that area with depths ≥ 0.02 m. Depth and velocity parameters for juvenile and adult blackfish are discussed in section 5.

6.4 Water Quality

Spot measurements of basic water quality parameters were recorded at each site on each occasion when habitat surveys were undertaken. The relationships between discharge and, water temperature, electrical conductivity, dissolved oxygen, turbidity and pH are shown in Table 6-3. Water temperature was highest during the summer low flow months at all sites and ranged from 9.0°C to 20.3°C. Dissolved oxygen increased with flow at site E3 and E4, but displayed no apparent trend to seasonal flows at site E1 and E2. pH remained stable at all sites for each flow event. Electrical conductivity was highest during the summer low flow months at all sites and ranged from 232 $\mu\text{S.cm}^{-1}$ to 2270 $\mu\text{S.cm}^{-1}$. Turbidity was highest during high flows at all sites.

Table 6-3. Measurements of water quality parameters at four sites in Stringybark Creek catchment at a range of discharges

Site	Site Discharge ML.day^{-1}	Date	Water Temp. (°C)	Electrical Conductivity ($\mu\text{S.cm}^{-1}$)	Dissolved Oxygen (mg.L^{-1})	Turbidity (NTU)	pH
E1	0.6	27/3/00	16.2	315	9.5	-	7.5
Wandin	14.7	19/6/00	9.1	231	11.7	26	7
Nth	16.0	8/6/00	10.8	236	9.4	68.3	7.1
E2	0.2	27/3/00	16.4	747	7.4	-	7.4
Wandin	1.6	19/6/00	9.0	646	-	19.3	7.5
Nth	8.8	8/6/00	10.7	393	9.1	70.1	7.6
E3	0.1	24/3/00	15.6	2270	2.4	-	6.6
Gruyere	1.1	20/6/00	9.1	1360	7.5	12.1	7.3
	9.0	26/7/00	9.1	909	9.6	53.8	7.6
E4	0.0	24/3/00	20.3	637	5.4	-	7.5
Yering	14.0	20/6/00	9.2	433	9.5	30.2	7.7
	30.0	8/8/00	12	558	10.8	31.1	7.6

7. ENVIRONMENTAL FLOW RECOMMENDATIONS

7.1 Environmental Flow Management Objectives

The following management objectives apply specifically to the management of stream flow in the Stringybark Creek catchment.

- 1. Maintain appropriate minimum environmental flows over the low flow period.*
- 2. Provide appropriate flushing flows and high flow regimes that provide suitable conditions for migration and spawning of native fish species and essential geophysical processes such as channel scouring and silt removal.*
- 3. Maintain water quality in accordance with SEPP (Waters of Victoria) – Schedule F7 Waters of the Yarra Catchment (EPA 1999), including provision of summer flushing flows.*
- 4. Ensure that winter-fill diversions are set at a level that does not impact on essential biological and geomorphological processes.*

In addition, several management objectives specifically apply to biodiversity conservation.

- 1. Maintain and/or restore diversity and complexity of instream habitat (e.g. woody debris).*
- 2. Maintain and/or enhance diversity of aquatic fauna species and encourage recolonization of Stringybark Creek by migratory species.*
- 3. Provide unimpeded fish access throughout the Stringybark Creek system through removal of instream barriers.*

7.2 Summer Low Flow Period

Minimum environmental flows are recommended for Stringybark Creek based on an assessment of historical flow data (natural and current regimes), fish habitat availability and expert opinion. These recommendations aim to meet the environmental management objectives listed above. The precautionary principle (ie. a suitable ecological safety margin) has been applied due to our limited knowledge of the relationship between flow regimes and the ecology of native freshwater fish in Stringybark Creek. Minimum environmental flows are recommended for each site at which habitat surveys were undertaken. During periods of very low flow, the minimum environmental flow recommendation or natural flow, whichever is least, should be applied.

Table 7-1. Minimum environmental flow recommendations for sites on Stringybark Creek.

Site location	Environmental Flow* (ML.day ⁻¹)
Stringybark Creek at Warburton Highway	1.5
Little Stringybark Creek at Rodger Road	1.0
Log Creek at Medhurst Road	1.5
Stringybark Creek at Melba Highway	4.5

In most instances, the recommended environmental flow is the same, or close to the lowest stream discharge measured during the fish habitat surveys. The relationship between habitat availability and stream discharge cannot be extrapolated beyond the lowest measured point on the habitat availability curves (see section 6).

Whilst natural flows have been derived for Log Creek at Gruyere, there is no derived natural flows for Little Stringybark Creek. Furthermore, the natural flows derived for Stringybark Creek (see section 4-3) are presumably for a location in the lower catchment and it is difficult to reference these flows to sites upstream for which hydrological data is available (e.g. Clegg Road and Killara Road gauges).

Consequently, the recommendation of a minimum environmental flow for Stringybark Creek and Little Stringybark Creek is difficult. As a result, the precautionary principle has been employed and flows substantially lower than the lowest discharge measured at each site have not been recommended. Nevertheless, the recommended flows are similar to the natural flows that may be expected during the lowest flow events if no diversion occurred. Summer flushing flows should also be maintained with the aim of alleviating potential water quality deterioration during the summer low flow months.

7.3 Winter Fill Diversions

Diversion of water during high flow periods (winter-fill) has the potential to alleviate environmental stress due to water abstraction during low flow periods. It is important to recognise however the importance of flushing flows and high flow regimes to maintaining essential biological and geomorphological processes.

Many native freshwater fish species require specific seasonal flow events, especially within the higher flow months of June to November, to stimulate or facilitate life history processes such as spawning and spawning migrations. Since the construction of Dight's Falls fishway it is likely that some species reliant on seasonal high flows will recolonise lower reaches of Stringybark Creek and its tributaries. Although the only native migratory species recorded in Stringybark Creek is common galaxias (*Galaxias maculatus*) (Appendix 1), other species such as Australian grayling and tupong also have the potential to recolonise. Furthermore, flushing flows and high flow regimes are essential for stream forming processes such as channel scouring and sediment removal. The magnitude and variability of flows to preserve processes such as these are difficult

to quantify and cannot be quantified using fish habitat availability. Nevertheless, a precautionary approach that preserves important components of the high flow regime may be used.

Rules for winter-fill volumes and rates are currently being developed as a component of a sustainable diversion limits project being undertaken by the Department of Natural Resources and Environment. Recommendations that are developed through this project can be applied to the Stringybark Creek system when completed.

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10. APPENDIX 1. FISH SURVEY

10.1 Background

In order to develop a streamflow management plan for the Stringybark Creek catchment, the environmental values of the system required identification. In particular, information on the type and abundance of fish assemblages present in the Stringybark Creek catchment was considered inadequate. Consequently, a fish survey was conducted at six sites throughout the system.

10.2 Methods

Survey Reach Selection

A total of six sites were surveyed in the Stringybark Creek catchment between the 28th February and 7th March 2000 (Figure 2-1). Four sites were located on Stringybark Creek and one on each of the tributaries Little Stringybark and Log Creeks. At each site, survey reaches were established to represent the available aquatic habitat attributes including flow types and cover elements. As a result the length of each reach fished varied from 70 m to 100 m in order to maximise the chance of collecting all aquatic fauna species of present. The location of each survey reach was defined by Australian Map Grid Reference (AMG) from topographic 1:100 000 scale maps (Table).

Table 10.-1. Location of fish survey sites in the Stringybark Creek catchment

Site Number	Description	Melway/ESMap Reference	AMG Reference (1:100 000)#
F1 Stringybark Crk.	Off Channel Rd, Kalorama	M120 K8	7922-55-360300-5813600
F2 Stringybark Crk.	Upstream of Warburton Hwy Bridge, Wandin North	M119 A10	7922-55-360600-5817700
F3 Little Stringybark Crk.	Rodger Rd., Wandin North	M119 A6	7922-55-360800-5819100
F4 Stringybark Crk.	Downstream of Killara Rd. Bridge, Gruyere.	M282 C7	7922-55-361300-5823600
F5 Log Crk	Upstream af Medhurst Rd., Gruyere	M282 F6	7922-55-362800-5824100
F6 Stringybark Crk.	Downstream of Melba Hwy., Yerring	M275 B11	7922-55-356700-5827500

AMG notation: map-zone-eastings-northings

Measurement of Site Attributes

For each survey reach the average width and average maximum depth (m) was calculated from at least five measurements of each dimension. Spot measurements of physico-chemical water quality parameters were recorded within each survey reach. Water temperature (°C) and electrical conductivity ($\mu\text{S}\cdot\text{cm}^{-1}$ @ 25 °C) were measured with a WTW LF 320 meter, dissolved oxygen ($\text{mg}\cdot\text{L}^{-1}$) with a WTW OXI 320 meter and pH with a WTW pH 320 meter. All instruments were calibrated according to manufacture's specifications at each survey reach.

A visual assessment of the relative abundance of hydrological flow types, habitat attributes and cover elements available to fish and decapod crustacea was made for each survey site. All relative abundance estimates were expressed as proportions (%) of wetted area. Hydrological flow components of each site were defined using the categories; cascade, rapid, riffle, glide, run, pool or backwater (after Anderson & Morrison, 1989; Anderson *et al.* 1989). The substrate for each site was described in terms of percentage composition of different substrate types defined by particle size as; boulder (particle size > 256 mm), cobble (64-255 mm particle size), pebble (16-63 mm particle size), gravel (2-15 mm particle size), sand (0.1-2 mm particle size) and silt/clay (particle size < 0.1 mm). An estimate of the relative abundance of dominant cover elements was also made. Physical cover elements were classified according to the criteria of Anderson *et al.* (1989) and included; substrate, woody debris (logs, branches), organic debris (leaves, bark), bank overhang, vegetation overhang and aquatic vegetation.

Fauna Sampling Method

A portable Smith-Root® model 12 backpack electrofishing unit was used at most sites or a Smith-Root® model 7.5 GPP generator powered electrofishing unit, at sites with high water electrical conductivities (Little Stringybark and Log Creeks). Each site was electro-fished once (single pass of the electro-fisher). The operator fished upstream from the downstream end of the section, fishing all types of habitat along the edges and the middle of the stream, stunning and retrieving fish and crustaceans. An assistant followed the operator collecting any missed individuals with a fine mesh dip net. At each site the time taken to electrofish was recorded. All electrofishing was conducted during daylight hours.

All fish and freshwater crayfish collected were identified and counted. A subsample of up to 20 individuals of each species at each site was measured for length. Where length measurements were taken, fish and freshwater crays were measured to the nearest 1 mm (length to caudal fork (LCF) or total length (TL) for fish, occipital carapace length (OCL) for crays). Only an estimate was made of total shrimp numbers, and weights and lengths were not taken. Searches were made for freshwater mussels during the fish sampling, and also during the measurement of site attributes.

Nomenclature for fish species follows Cadwallader and Backhouse (1983), Williams & Smith (1979) for freshwater shrimps, and Morgan (1986) for spiny crays.

10.3 Results

A total of 543 fish were recorded from the study area representing seven families and nine species (Tables 2-2 to 2-8). Four of the species recorded were native, two of which migrate between freshwater and estuarine/marine habitats at some stage in their life cycle (short-finned eel and common galaxias). Three species of decapod crustacea and the freshwater mussel and freshwater shrimp were also recorded. None of the native aquatic fauna species recorded are considered threatened in Victoria (DNRE 2000b).

Exotic species comprised 71% of total fish abundance. The exotic eastern gambusia was the most abundant fish species overall (331 individuals recorded). Eastern gambusia was found at two sites in Stringybark Creek in the middle (site f4 – Gruyere) and lower reaches (site f6 – Yering) of the catchment, and also in Log Creek (site f5 – Gruyere). Four other exotic species were recorded in lower numbers (11-18 individuals).

Mountain galaxias was the most abundant native species recorded (83 individuals). This species was found at two sites in Stringybark Creek in the upper reaches of the catchment (site f1 – Kalorama and site f2 - Wandin North). Southern pigmy perch was the second most abundant native species recorded, but were found at only one site in the middle reaches of the catchment (site f5 – Log Creek, Gruyere).

Migratory native species comprised 20% of total native fish abundance. Short-finned eel was the most widespread species recorded, being found at a total of four of the six survey sites (site f2 and f3 – Wandin North, site f4 – Gruyere and site f6 – Yering). Common galaxias was recorded in the middle reaches of the catchment in Stringybark Creek (site f4) and Little Stringybark Creek (site f5), near Gruyere.

Table 2-2. Aquatic fauna recorded in the Stringybark catchment, including their conservation status (DCNR 1995, DNRE 2000b).

Scientific Name	Common Name	Conservation status	Site number					
			f1	f2	f3	f4	f5	f6
Non migratory native fish								
<i>Galaxias olidus</i>	Mountain galaxias	C	✓	✓				
<i>Nannoperca australis</i>	Southern pigmy perch	C						✓
Migratory native fish								
<i>Anguilla australis</i>	Short-finned eel	C		✓	✓	✓		✓
<i>Galaxias maculatus</i>	Common galaxias	C				✓	✓	
Exotic fish species								
<i>Carassius auratus</i>	Goldfish	-		✓		✓		✓
<i>Gambusia holbrooki</i>	Eastern gambusia	-				✓	✓	✓
<i>Misgurnus anguillicaudatus</i>	Oriental weatherloach	-				✓	✓	
<i>Perca fluviatilis</i>	Redfin	-		✓		✓		
<i>Rutilus rutilus</i>	Roach	-			✓			✓
Decapod crustacea								
<i>Engaeus sp.</i>	Burowing cray	C			✓	✓	✓	
<i>Euastacus woiwuru</i>	Central highlands spiny cray	C	✓	✓				
<i>Paratya australiensis</i>	Freshwater shrimp	C		✓				
Bivalve molluscs								
<i>Velesunio ambiguus</i>	Freshwater mussel	C	✓					

C – Common and/or widespread, ✓ species present.

Table 2-3. Site details, water quality and collection data for Stringybark Creek at winery, off Channel Road, Kalorama.

SITE DETAILS				Site No.: f1	
Stream name:	Stringybark Creek				
Location:	at winery, off Channel Road, Kalorama				
AMG (map no., zone, coordinates):	7922 55 360300 5813600	Altitude:	205 masl		
Date sampled:	28/2/00	Time:	1325 hours		
SAMPLE DETAILS					
Sample length:	100 m	Average width:	0.75 m		
Gear type:	Electrofishing Backpack	Total time:	40 mins		
Average depth:	0.2 m	Maximum depth:	0.4 m		
PHYSICO-CHEMICAL DATA					
Conductivity:	207 (µS/cm)	pH:	7.2	Time:	1315 hours
Dissolved oxygen:	10.45 mg/L	Temperature:	18.1°C		
COLLECTION DATA					
Species	No.	Length (mm)		Weight (gms)	
		Mean	Range	Mean	Range
Mountain galaxias	46	56	43-93	1.4	0.8-6.0
Central highlands spiny cray	1	-	-	-	-
Freshwater mussel	1	-	-	-	-

Table 2-4. Site details, water quality and collection data for Stringybark Creek upstream of bridge on Warburton Hwy, Wandin North.

SITE DETAILS				Site No.: f2	
Stream name:	Stringybark Creek				
Location:	upstream of bridge on Warburton Hwy, Wandin North				
AMG (map no., zone, coordinates):	7922 55 360600 5817700		Altitude:	205 masl	
Date sampled:	28/2/00		Time:	1140 hours	
SAMPLE DETAILS					
Sample length:	100 m		Average width:	1.5 m	
Gear type:	Electrofishing Backpack		Total time:	40 mins	
Average depth:	0.4 m		Maximum depth:	0.6 m	
PHYSICO-CHEMICAL DATA					
Conductivity:	315 (µS/cm)		pH:	7.5	
Dissolved oxygen:	9.5 mg/L		Temperature:	16.5°C	
COLLECTION DATA					
Species	No.	Length (mm)		Weight (gms)	
		Mean	Range	Mean	Range
Short-finned eel	5	250	100-400	477	27-1226
Mountain galaxias	37	59	32-89	1.9	0.4-6.8
Goldfish*	11	187	117-214	111	78-150
Redfin*	2	80	72-87	7.0	5.2-8.9
Central highlands spiny cray	1	-	25	-	5.6
Freshwater shrimp	20	-	-	-	-

* Exotic species

Table 2-5. Site details, water quality and collection data for Little Stringybark Creek upstream of bridge on Rodger Road, Wandin North.

SITE DETAILS				Site No.: f3	
Stream name:	Little Stringybark Creek				
Location:	upstream of bridge on Rodger Road, Wandin North				
AMG (map no., zone, coordinates):	7922 55 360800 5819300	Altitude:	140 masl		
Date sampled:	7/3/00	Time:	1250 hours		
SAMPLE DETAILS					
Sample length:	70 m	Average width:	1.9 m		
Gear type:	Electrofishing Bankmounted	Total time:	41 mins		
Average depth:	0.4 m	Maximum depth:	0.8 m		
PHYSICO-CHEMICAL DATA					
Conductivity:	747 (µS/cm)	pH:	7.4	Time:	1125 hours
Dissolved oxygen:	7.4 mg/L	Temperature:		16.4°C	
COLLECTION DATA					
Species	No.	Length (mm)		Weight (gms)	
		Mean	Range	Mean	Range
Short-finned eel	2	-	500	-	248
Roach*	10	116	49-172	28	1.4-84.6
Burrowing cray	1	-	20	-	2.0

* Exotic species

Table 2-6. Site details, water quality and collection data Little Stringybark Creek downstream of bridge on Killara Road, Gruyere.

SITE DETAILS				Site No.: f4	
Stream name:	Stringybark Creek				
Location:	downstream of bridge on Killara Road, Gruyere				
AMG (map no., zone, coordinates):	7922 55 361300 5823600	Altitude:	90 masl		
Date sampled:	28/2/00	Time:	1515 hours		
SAMPLE DETAILS					
Sample length:	100 m	Average width:	2.5 m		
Gear type:	Electrofishing Backpack	Total time:	40 mins		
Average depth:	0.6 m	Maximum depth:	1.0 m		
PHYSICO-CHEMICAL DATA					
Conductivity:	519 (µS/cm)	pH:	7.4	Time:	1450 hours
Dissolved oxygen:	7.8 mg/L	Temperature:	20.0°C		
COLLECTION DATA					
Species	No.	Length (mm)		Weight (gms)	
		Mean	Range	Mean	Range
Short-finned eel	10	436	130-600	318	3.0-650
Common galaxias	12	120	88-151	12	4.0-20
Goldfish*	2	175	112-237	118	23-213
Eastern gambusia*	8	32	24-41	0.4	0.2-1.0
Redfin*	9	154	134-235	69	40-231
Oriental weatherloach*	11	144	126-172	21	11.5-37
Burrowing cray	2	20	8-32	7.2	0.9-13.4

* Exotic species

Table 2-7. Site details, water quality and collection data for Log Creek upstream of bridge on Medhurst Road, Gruyere.

SITE DETAILS				Site No.: f5	
Stream name:	Log Creek				
Location:	upstream of bridge on Medhurst Road, Gruyere				
AMG (map no., zone, coordinates):	7922 55 362800 5824100	Altitude:	100 masl		
Date sampled:	7/3/00	Time:	1030 hours		
SAMPLE DETAILS					
Sample length:	70 m	Average width:	2.4 m		
Gear type:	Electrofishing Bankmounted	Total time:	45 mins		
Average depth:	0.6 m	Maximum depth:	0.9 m		
PHYSICO-CHEMICAL DATA					
Conductivity:	2270 (µS/cm)	pH:	6.6	Time:	1015 hours
Dissolved oxygen:	2.4 mg/L	Temperature:		15.6°C	
COLLECTION DATA					
Species	No.	Length (mm)		Weight (gms)	
		Mean	Range	Mean	Range
Common galaxias	1	-	149	-	20.6
Southern pigmy perch	43	49	46-60	1.9	1.5-3.5
Eastern gambusia*	235	32	19-45	0.7	0.1-1.3
Oriental weatherloach*	7	108	61-145	8.7	1.7-14.9
Burrowing cray	✓	-	-	-	-

* Exotic species, ✓ burrows present

Table 2-7. Site details, water quality and collection data for Stringybark Creek downstream of bridge on Melba Highway, Yering.

SITE DETAILS				Site No.: f6	
Stream name:	Stringybark Creek				
Location:	downstream of bridge on Melba Hwy, Yering				
AMG (map no., zone, coordinates):	7922 55 356700 5827500	Altitude:	50 masl		
Date sampled:	1/3/00	Time:	0850 hours		
SAMPLE DETAILS					
Sample length:	100 m	Average width:	5.4 m		
Gear type:	Electrofishing Backpack	Total time:	70 mins		
Average depth:	0.9 m	Maximum depth:	1.0 m		
PHYSICO-CHEMICAL DATA					
Conductivity:	637 (µS/cm)	pH:	7.5	Time:	1020 hours
Dissolved oxygen:	5.4 mg/L	Temperature:		20.4°C	
COLLECTION DATA					
Species	No.	Length (mm)		Weight (gms)	
		Mean	Range	Mean	Range
Short-finned eel	1	-	300	-	60.2
Eastern gambusia*	88	29	23-48	0.3	0.1-1.5
Goldfish*	2	30	23-37	0.7	0.2-1.1
Roach*	1	-	56	-	2.2

* Exotic species

10.4 Summary.

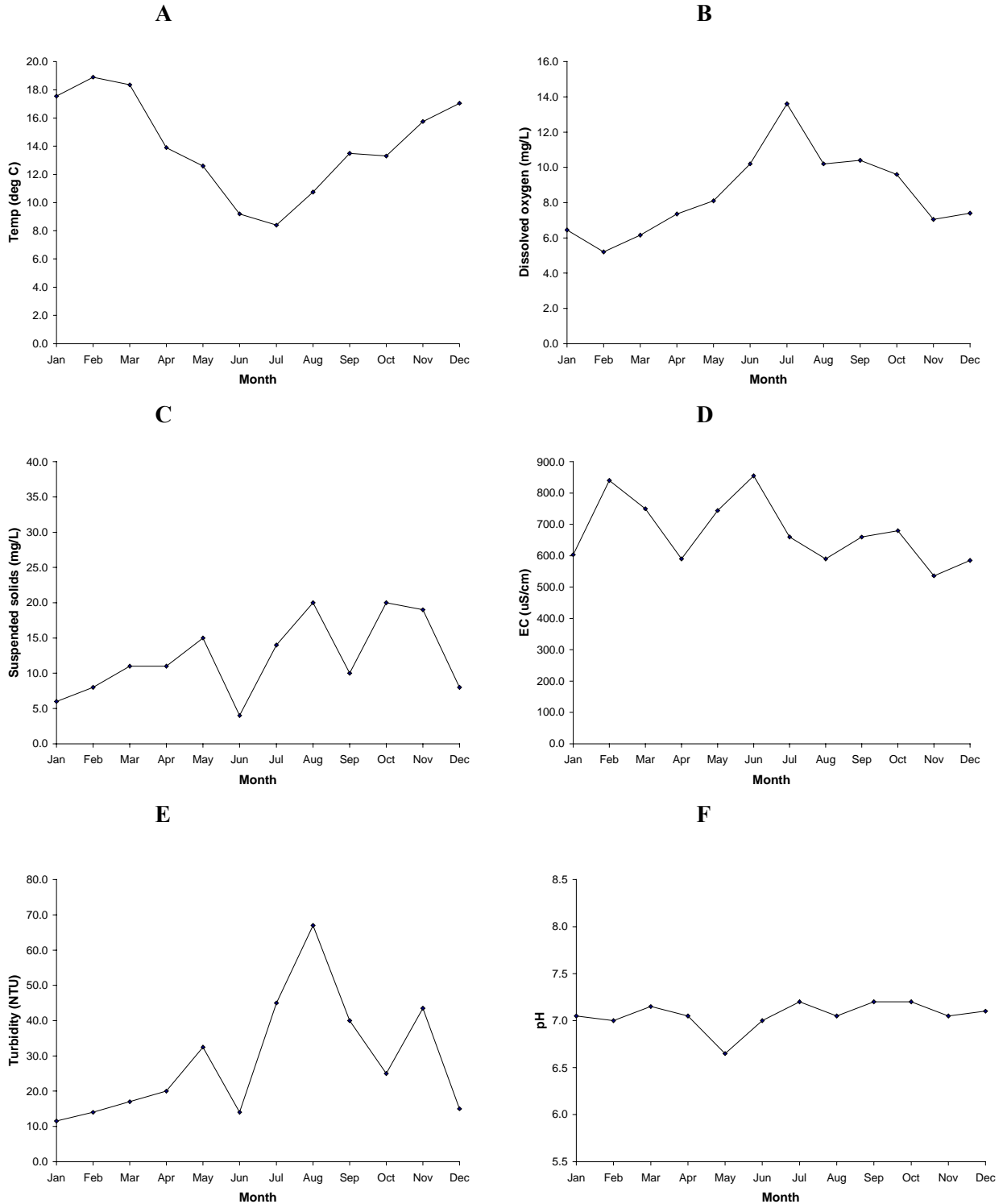
The aquatic fauna of Stringybark Creek is considered to be in moderately poor condition. Total abundance of exotic species was relatively high, and expected native species richness was low. There are a number of native migratory species present in other Yarra River tributaries that were not recorded in the Stringybark Creek catchment. The absence of these species may reflect the poor habitat conditions throughout the catchment and especially in the lower reaches around Yering. In particular, stream channelisation, lack of streamside vegetation, low instream habitat diversity and abundance and, bed and bank instability. The absence of these species may also be attributable to unknown instream barriers and limited survey effort.

The fish community of the Stringybark Creek catchment comprises approximately equal numbers of native and exotic species (four native and five exotic species), but is numerically dominated by exotic fish species (71% of total fish abundance). Currently the exotic eastern gambusia dominates the fish community in terms of abundance and distribution. The native short-finned eel and the exotic goldfish and roach are also widespread but less abundant. The native mountain galaxias and southern pigmy perch are relatively abundant, but are restricted in distribution. The other native species common galaxias and the exotic species redfin and oriental weatherloach are more restricted in both distribution and abundance.

10.5 References

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11. APPENDIX 2. WATER QUALITY



Median monthly spot measurements of basic water quality parameters at Stringybark Creek, Melba Highway (Yering) from September 1995-May 2000. A – temperature; B - dissolved oxygen; C – suspended solids; D - electrical conductivity; E – turbidity; and F – pH; over the period of study from July 1999 to June 2000. Data from Melbourne Water (2000)